SOIL MAP UNIT DESCRIPTIONS

The following soil map unit descriptions are derived from the U.S. Department of Agriculture Soil Survey of Dade County Area, Florida, Printed 1996.

Biscayne Gravelly Marl, Drained

The drained Biscayne gravelly marl is a very shallow, nearly level, poorly drained soil located on broad, low flats, in sloughs, and in transverse glades. Individual areas are irregularly shaped or rectangular and have slopes that are smooth or concave and are less than 2 percent. Typically, the surface layer is about 7 inches of dark gray gravelly marl that has a silt loam texture. Limestone fragments are 15 to 25 percent, by volume, but can range to as much as 35 percent. The fragments typically range from 2 millimeters to 7.5 centimeters in diameter. Hard, porous limestone occurs at about 7 inches.

Permeability is moderate. The water table remains within 10 inches of the surface for 2 to 4 months during most years, receding to as deep as 36 inches during dry periods.

At some time in the past, all areas have been drained, rock-plowed or mechanically scarified, and cultivated. The natural vegetation no longer remains, and abandoned fields rapidly become overgrown. If a water-control system is installed and properly maintained, this soil is well suited to a variety of shallow-rooted cultivated crops. It is also suited for pasture.

This soil is poorly suited to the production of ornamental trees and shrubs because of the depth to bedrock. It is also poorly suited for the production of citrus and mangos because of the wetness. It is unsuited to the production of avocados. It is not used as forest land. Because of the wetness and the depth to bedrock, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development. Additional drainage measures and large amounts of fill are needed to overcome these circumstances.

Lauderhill Muck, Depressional

The Lauderhill muck depressional is a moderately deep, nearly level, and very poorly drained soil located on narrow drainageways and broad open areas in sawgrass marshes. Individual areas are long and narrow or broad and irregularly shaped, and slopes are smooth or concave and are less than 2 percent. Typically, the soil is muck to a depth of about 30 inches, the upper 7 inches is black, and the lower 23 inches is very dark brown. Hard, porous limestone bedrock is at a depth of about 30 inches.

Permeability is rapid. In most years, this soil type is ponded for 9 to 12 months. The water table is within 10 inches of the surface for the rest of the year.

Most areas support natural vegetation, which consists of cattail and sawgrass. Areas of this soil can provide cover for deer and excellent habitat for wading birds and other kinds of wetland wildlife.

This soil generally is not suited to cultivation under natural conditions. This soil is not suited to the production of citrus, avocados, or pine trees because of the wetness. Because of the ponding, excess humus, subsidence, low strength, and the depth to bedrock, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development.

Pennsuco Marl, Drained

The drained Pennsuco marl is a deep, nearly level, poorly drained soil located on broad, low coastal flats and in transverse glades. Individual areas are broad and irregularly shaped and range from 10 to 350 acres in size. Slopes are smooth or concave and are less than 1 percent. Typically, the surface layer is about 8 inches of dark grayish brown marl that has a texture of silt loam. The underlying material extends to a depth of about 44 inches. It is grayish brown in the upper 19 inches and dark gray in the lower 17 inches. Very pale brown, soft accumulations of calcium carbonate are between depths of 8 and 44 inches and very dark gray pockets and vertical streaks are below a depth of about 27 inches. Soft, porous limestone is at a depth of about 44 inches.

Permeability is moderately slow. The water table in the Pennsuco soil remains within a depth of 10 inches for 2 to 4 months during most of the year and is at a depth of 10 to 40 inches for the rest of the year.

At some time in the past, all areas have been drained and cultivated. The native vegetation no longer remains and abandoned fields quickly become overgrown. A water-control system has been installed in most areas. If the water-control system is properly maintained, this soil is well suited to a variety of cultivated vegetable and grain crops and ornamental trees or shrubs. This soil is also suited to pasture.

This soil is poorly suited to the production of citrus and mangos because of the wetness and is unsuited for the production of avocados. This soil is generally not used as forest land but is suited to pasture. Because of the wetness and the depth to bedrock, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development. Additional drainage and large amounts of fill generally are needed to overcome these limitations.

Pennsuco Marl

The Pennsuco marl is a deep, nearly level, very poorly drained soil located in broad, low coastal marshes and sloughs and in small depressional areas. Individual areas are broad and irregularly shaped. Slopes are smooth or concave and are generally less than 1 percent. Typically, the surface layer is about 4 inches of light brownish gray marl that has a texture of silt loam and has common black streaks in old root channels. From 4 to 46 inches, this soil is a light gray marl and has a few black streaks. Commonly, this soil has whole snail shells and shell fragments that are sand sized to 1 inch in diameter. Soft, porous limestone occurs at about 46 inches.

Permeability is moderately slow. The water table in the Pennsuco soil remains within a depth of 6 inches for 2 to 4 months during most of the year and is at a depth of 10 to 30 inches the rest of the year.

At some time in the past, all areas have been cleared, drained, and cultivated. The native vegetation no longer remains and abandoned fields quickly become overgrown. A water-control system has been installed in most areas. If the water-control system is properly maintained, this soil is well suited to a variety of cultivated vegetable and grain crops and ornamental trees and shrubs.

Generally this soil is not used as forest land or rangeland, and because of ponding, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development.

Perrine Marl, Drained

The drained Perrine marl is a moderately deep, nearly level, poorly drained soil located on broad, low coastal flats and in transverse glades. Individual areas are broad and irregularly shaped. Slopes are smooth or concave and are generally less than 1 percent. Typically, the surface layer is about 10 inches of grayish brown marl that has a texture of silt loam. From 11 to approximately 26 inches, this soil is a light brownish gray marl, of silt loam texture, with few to many light gray, soft accumulations of calcium carbonate and few grayish brown stains in pockets or around pores and root channels. Soft, porous limestone bedrock occurs at about 26 inches.

Permeability is moderately slow. During most years the water table remains within 10 inches of the surface for 2 to 4 months and is at a depth of 10 to 30 inches for the rest of the year.

At some time in the past, all areas have been cleared, drained, and cultivated. The native vegetation no longer remains, and abandoned fields quickly become overgrown. A water-control system has been installed in most areas. If the water-control system is properly maintained, this soil is well suited to a variety of cultivated vegetable and grain crops and ornamentals. This soil is also suited to pasture.

The soil is poorly suited to the production of citrus and mangos because of the wetness and is unsuited to the production of avocados. This soil generally is not used as forest land but is suited to pasture. Because of the wetness and the depth to bedrock, the soil is severely limited as a site for buildings, sanitary facilities, and recreational development.

Krome Very Gravelly Loam

Krome very gravelly loam is a very shallow, nearly level, moderately well drained soil located on broad, very low hills on the Miami Ridge. Individual areas are broad and irregularly shaped. Slopes are smooth and generally range from 0 to 2 percent. The soil is generally dark brown, about 7 inches thick. It is underlain by hard, porous limestone at about 7 inches.

Permeability is moderate. The water table is within the limestone bedrock. It is at a depth of 40 to 60 inches in most years.

At some time in the past, all areas have been rock-plowed or mechanically scarified and cultivated, and natural vegetation no longer remains. This soil is suitable for pasture, citrus, and a wide variety of fruit and vegetable crops with special management.

This soil generally is not used as forest land. Due to the depth to bedrock and small stones, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development. Local construction methods generally overcome these limitations, allowing this soil be to used for urban development.

Udorthents-Water Complex

The Udorthents-Water complex is a soil map unit that consists of Udorthents and open bodies of water. Udorthents' thickness range from very shallow to deep. They consist of unconsolidated or heterogeneous material removed during the excavation of ditches, canals, lakes, ponds, and quarries, with slopes from 15 to 60 percent. About 65 percent of this map unit is Udorthents, and about 20 percent is open water. Typically, the Udorthents consist of mixed light gray and white limestone gravel and loamy carbonate material, which can extend to depths of 80 inches or more.

Permeability is moderate. The water table in areas of the Udorthents is within the limestone bedrock.

Weeds and native grasses have become established in some areas, while other areas support little or no vegetation. This soil type is not used as cropland. In many areas it is used as a source of road-building material and as a source of fill for new homesites, golf courses, and other construction purposes.

Udorthents, Limestone Substratum-Urban Land Complex

Forty to 70 percent of this soil map unit consists of Udorthents in open areas. Twenty-five to 60 percent consists of Urban land, or areas covered by concrete and buildings. Slopes are generally 0 to 2 percent. The Udorthents typically consist of fill material that is light gray and white, extremely stony loam about 55 inches thick, underlain by limestone bedrock.

Udorthents are in areas of lawns, vacant lots, parks, and playgrounds. Urban land consists of streets, driveways, sidewalks, parking lots, buildings, and other structures in areas where the soil is covered and cannot be observed.

Permeability is moderate in the stony fill material. The water table in areas of the Udorthents is within the limestone bedrock.

The Udorthents areas are not used as cropland, but are used as fill material. The fill material improves the suitability of low areas for building site development or other urban uses. Lawns and ornamental plants established on the soils in this map unit, require a layer of good topsoil about 6 inches thick.

Udorthents, Marl Substratum-Urban Land Complex

Forty to 70 percent of this map unit consists of Udorthents in open areas. Twenty-five to 60 percent consists of Urban land, or areas covered by concrete and buildings. The Udorthents consist of heterogeneous material that has been excavated and spread. Slopes are generally 0 to 2 percent. Typically, the upper 12 inches of the Udorthents is a light gray, very gravelly loam. The next 29 inches is brown gravelly sandy loam. From 30 to more than 60 inches, this soil map unit is predominantly natural marl soil. Hard, porous limestone occurs at about 60 inches.

Udorthents are in areas of lawns, vacant lots, parks, and playgrounds. Urban land consists of streets, driveways, sidewalks, parking lots, buildings, and other structures in areas where the soil is covered and cannot be observed.

Permeability is moderate to moderately slow in the layers of marl. Depth to the water table in the Udorthents is frequently more than 40 inches, but varies, depending on the thickness of the fill.

The Udorthents are not used as cropland, but are used as fill material. The fill improves the suitability of low areas for building site development or other urban uses. Lawns and ornamental plants established on the soils in this map unit, require a layer of good topsoil about 6 inches thick.

Perrine Marl

Perrine marl is a moderately deep, nearly level, very poorly drained soil located in broad, low coastal marshes and sloughs and in small depressions. Individual areas are broad and irregularly shaped and slopes are smooth or concave and are generally less than 1 percent. Typically, the surface layer is about 4 inches of grayish brown marl with a silt loam texture, underlain to a depth of about 29 inches by a silt loam marl that is mottled in shades of light brownish gray and light gray, having very dark grayish brown pockets and streaks. Soft, porous limestone is at a depth of about 29 inches.

Permeability is moderately slow. The water table in the Perrine soil remains at or above the surface for 2 to 6 months in most years and is within a depth of 12 inches for the rest of the year. Areas of this soil provide excellent habitat for wading birds, aquatic reptiles, small crustaceans, and other wetland wildlife.

Because of ponding, high pH, and boron toxicity, this soil is poorly suited to cultivated crops and the production of nursery plants. This soil is generally not used as forest land. Because of the ponding and the depth to bedrock this soil is severely limited as a site for buildings, sanitary facilities, and recreational development.

Biscayne Marl

Biscayne marl is a very shallow or shallow, nearly level, very poorly drained soil located on broad, low coastal flats, in freshwater marshes and sloughs, and in small depressional areas. Individual areas are broad and irregularly shaped and slopes are smooth or slightly concave, generally less than 2 percent. Typically, the surface layer is about 5 inches of gray marl silt loam. From 6 to a depth of about 17 inches, the soil is a gray or grayish brown marl silt loam.

Permeability is moderate. The water table in the Biscayne marl soil remains at or above the surface for 2 to 4 months during most years and recedes down to 20 inches during dry periods. Areas of this soil provide habitat for wading birds, aquatic reptiles, small crustaceans, and other wetland wildlife.

Because of ponding and salinity in some areas, this soil is poorly suited to cultivated crops such as citrus, mangos, and avocados, the production of nursery plants, and pasture. This soil is generally not used as forest land. Because of the ponding and the depth to bedrock, this soil is severely limited as a site for buildings, sanitary facilities, and recreational development.

Urban Land

The Urban land soil map unit is in areas where more than 85 percent of the surface is covered by shopping centers, parking lots, streets, sidewalks, airports, large buildings, houses, and other structures. The natural soil cannot be observed. The soils in open areas, mostly lawns, vacant lots, playgrounds, and parks, are mainly Udorthents, having been altered by grading or fill.

Biscayne Marl, Drained

The drained Biscayne marl is a very shallow or shallow, nearly level, poorly drained soil located on broad, low coastal flats and in transverse glades. Individual areas are broad and irregularly shaped or are rectangular. Slopes are smooth or concave and are generally less than 2 percent. Typically, the surface layer is about 5 inches of gray marl silt loam. At depths to 15 inches, the soil is a gray and light gray marl with a silt loam texture. Hard, porous limestone bedrock occurs at about 15 inches.

Permeability is moderate. In the Biscayne marl soil, the water table remains within 10 inches of the surface for 4 to 6 months during most years and receding down to 20 inches during dry periods.

At some time in the past, all areas have been drained and cultivated. The native vegetation no longer remains and abandoned fields quickly become overgrown. A water-control system has been installed in most areas. If the water-control system is properly maintained, this soil is well suited to a variety of shallow-rooted cultivated crops. This soil is also suited to pasture.

Because of the wetness, the soil is poorly suited to the production of citrus and mangos, and is unsuited to the production of avocados. This soil is not used as rangeland or forest land.

This soil is severely limited as a site for buildings, sanitary facilities, and recreational development because of the wetness and the depth to bedrock.

Cardsound-Rock Outcrop Complex

This soil map unit consists of a Cardsound soil intermingled with areas of Rock outcrop. Individual areas are irregularly shaped or rectangular, and slopes are smooth and range from 0 to 2 percent. About 54 percent of this map unit is soils, and 38 percent is Rock outcrop. Typically, the surface layer of the Cardsound soil is a dark yellowish brown silty clay loam, generally about 4 inches thick underlain by hard, porous limestone.

Permeability is moderately slow. The water table in areas of the Cardsound soil is at a depth of 60 to 72 inches within the limestone bedrock.

This map unit is generally not used for fruit or vegetable crops.

Because of the depth to bedrock, this map unit is severely limited as a site for urban uses. However, with local construction methods, the limitations on use of this soil type for urban development can be overcome.

Opalocka-Rock Outcrop Complex

This soil map unit consists mainly of an Opalocka soil intermingled with areas of Rock outcrop. Individual areas are generally small in size, with smooth slopes that generally range from 0 to 2 percent. Typically, the surface layer of the Opalocka soil is brown sand, about 6 inches thick, with a hard, porous limestone bedrock underneath.

Permeability is very rapid in the soil. The water table in areas of the Opalocka soil is at a depth of 60 to 72 inches within the limestone bedrock.

Generally this map unit is not used for rangeland or fruit and vegetable crops. However, when cleared and rock-plowed, the map unit becomes Krome very gravelly loam, which commonly is used for crop production.

Because of the depth to bedrock, this map unit is severely limited for urban uses. However, with local construction methods, the limitations on the use of this soil type for urban development can be overcome.

Chekika Very Gravelly Loam

Chekika very gravelly loam is a very shallow, nearly level, somewhat poorly drained soil located in transitional areas between the Miami Ridge and the Everglades. Individual areas are broad and irregularly shaped. Slopes are smooth and generally range from 0 to 2 percent. Typically, the surface layer is dark grayish brown very gravelly loam, about 5 inches thick, with a hard, porous limestone bedrock underneath.

Permeability is moderate. In most years, the water table in areas of the Chekika soil is at a depth of 12 to 36 inches within the limestone bedrock.

At some time in the past, all areas have been rock-plowed and used for vegetable crops. This soil is suitable for pasture and fruit and vegetable crops, but special management is needed.

This soil is not used as forest land but is suited to pasture. Because of the depth to bedrock and the wetness, this soil is severely limited as a site for urban uses. Water-control measures and mounding may be needed on sites for septic tank absorption fields and buildings.

Matecumbe Muck

Matecumbe muck is a very shallow, moderately well drained soil located on small tropical hardwood hammocks on the Miami Ridge and in the Everglades. It is occasionally flooded. Slopes are smooth or slightly convex and are generally less than 2 percent. Typically, the surface layer is a thin bed of leaf litter, twigs, and branches in varying stages of decomposition. Soft limestone bedrock is at a depth of about 3 inches, with sinkholes of varying size.

Permeability is rapid. In most years, the water table in areas of the Matecumbe soil is at a depth of 18 to 36 inches within the limestone bedrock.

Generally this soil is not suited to pasture, vegetable crops, or the production of fruit or citrus because of the depth to bedrock. This soil is generally not used as rangeland. It is well suited to wildlife habitat. Because of the depth to bedrock, this soil is severely limited as a site for urban uses.

Biscayne-Rock Outcrop Complex

This soil map unit consists of Biscayne marl intermingled with areas of Rock outcrop. Individual areas are broad and irregularly shaped and slopes are smooth and generally less than 2 percent. Typically, the surface layer of the Biscayne soil is about 4 inches of grayish brown marl that has a texture of silt loam. It is underlain by a hard, porous limestone bedrock.

Permeability is moderate. The soil can be briefly ponded during extremely wet periods, but for the majority of most years, the water table is below the surface.

Most areas support natural vegetation, but this map unit is not used for fruit or vegetable crops, ornamental plants, forest land, or pasture.

Because of the wetness and the depth to bedrock, this map unit is severely limited as a site for urban uses and recreational development.

Perrine Marl, Tidal

The tidal Perrine marl is a moderately deep, nearly level, very poorly drained soil located in tidal mangrove swamps near the coast. Slopes are smooth or concave and are generally less than 1 percent. Typically, the surface layer is about 12 inches thick and consists of dark brown marl that has a texture of silt loam. From 12 to 26 inches, it is dark gray marl silt loam underlain by soft, porous limestone.

Permeability is moderately slow and, under natural conditions, this Perrine marl soil remains saturated as the water table fluctuates with the tides. Areas of this soil can provide excellent habitat for birds and small marine crustaceans.

This soil is not suited to cropland, groves, or improved pasture because of tidal flooding and salinity. Because of the tidal flooding, the depth to bedrock, and the wetness, this soil is severely limited as a site for all urban uses.

Pennsuco Marl, Tidal

The tidal Pennsuco marl is a deep, nearly level, very poorly drained soil in tidal mangrove swamps near the coast. Slopes are smooth or concave and generally less than 1 percent. Typically, the surface layer is about 51 inches of light gray marl with a silt loam texture that is underlain by soft, porous limestone bedrock.

Permeability is moderately slow and, under natural conditions, this Pennsuco marl soil remains saturated. The water table fluctuates with the tides. Areas of this soil can provide excellent habitat for birds and small marine crustaceans.

This soil is not suited to cropland, groves, or improved pasture because of tidal flooding and salinity. Because of tidal flooding and ponding, this soil is severely limited as a site for all urban uses.

Terra Ceia Muck, Tidal

The tidal Terra Ceia muck is a deep, level, very poorly drained soil located in saltwater swamps and marshes that are subject to tidal flooding. Individual areas are long and narrow, and slopes are generally less than 1 percent.

Typically, this soil is muck to a depth of 80 inches or more. The upper 8 inches is very dark brown, and the lower 72 inches or more is black.

Permeability is rapid, and, under natural conditions, the Terra Ceia soil remains saturated as fluctuating tides cover the surface twice daily.

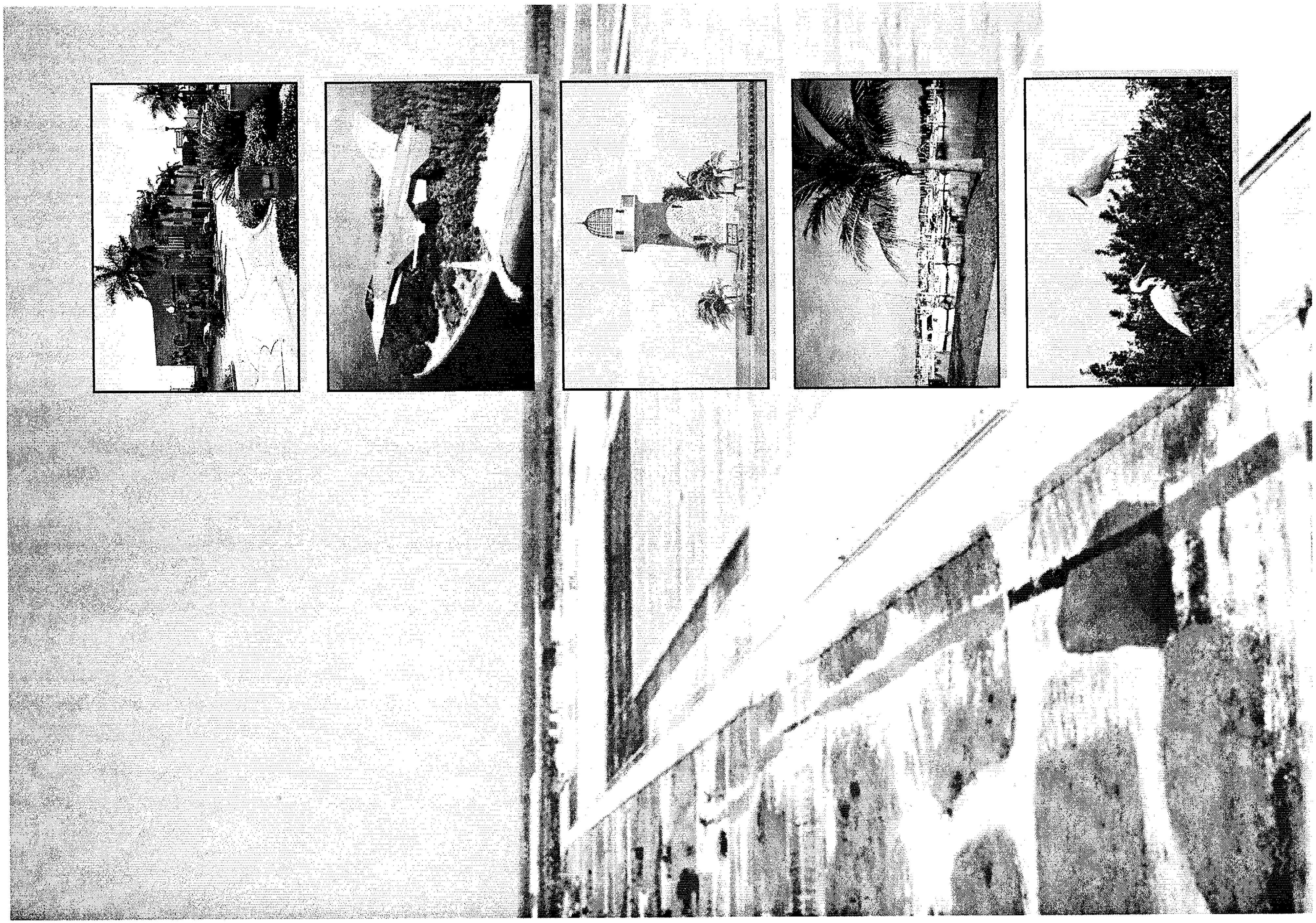
This soil is not suited to cropland, citrus, or improved pasture because of tidal flooding. Because of the tidal flooding and low strength, this soil is not suited to urban uses.

Udorthents, Limestone Substratum, 0 To 5 Percent Slopes

The limestone substratum, 0 to 5 percent slope, Udorthents are nearly level or gently sloping, moderately well drained or well drained soils, commonly 30 inches thick, consisting of thin or thick deposits of fill material that have been excavated from nearby areas and spread over the surface. Typically, the surface layer is a dark gray gravelly sand about 4 inches thick. Below this, to a depth of about 30 inches, are light gray, unconsolidated limestone fragments. Hard, porous limestone bedrock occurs underneath.

Permeability generally is rapid. Depending on the amount of fill material and the drainage measures in a given area, the depth to the water table varies. In most areas the water table is below a depth of 40 inches.

G BIOLOGICAL RESOURCES



BIOLOGICAL RESOURCES

This appendix discusses the methods and results of surveys conducted in 1998 for special-status species on and near former Homestead AFB (**Denton and Godley 1999**, **Mazzotti 1999b**). It provides a list of species with their scientific names that are mentioned in the biological sections of the SEIS (**Table G-1**). It also discusses the federal and state threatened and endangered species, as well as other rare species of concern (referred to as special-status species) occurring on and near former Homestead AFB and in other areas of south Florida, particularly Everglades and Biscayne NPs.

The analysis in this appendix depends heavily on the results of surveys for special-status species on former Homestead AFB, including a 1992–93 survey of flora and fauna (**Hilsenbeck 1993**), sensitive plant surveys (**Argonne National Laboratory 1997**, **PBS&J 1998b**), and other surveys (**Geraghty & Miller 1993**). Information regarding the flora and fauna along the western shoreline of Biscayne Bay and in other areas near former Homestead AFB is from Biscayne NP (**BNP 1998**, **Howitt 1996**), USEPA (**Metro-Dade County 1994b**), field surveys conducted for this assessment (**Denton and Godley 1999**, **Mazzotti 1999b**), and numerous other studies.

G.1 Survey Areas and Methods

Surveys for special-status species were conducted on former Homestead AFB and surrounding areas in the spring and summer of 1998. The species that were included in these surveys were determined during discussions with biologists from various federal and state agencies and from literature reviews.

G.1.1 Plants

A survey for special-status plant species was conducted on July 22, 1998 along the Military Canal and the reservoir at its western end (**Figure G-1**). The survey consisted of walking each canal bank and searching all potential habitat within 50 feet of the canal for species listed by the USFWS or the State of Florida under Section 581.185, Florida Statutes. All special-status species observed were plotted on field maps.

G.1.2 Reptiles

American Crocodile. Surveys for the American crocodile took place on former Homestead AFB (**Figure G-2**), in canals between the former base and Biscayne Bay, and along the western shoreline of Biscayne Bay in June and July 1998 (**Figure G-3**). Crocodile surveys on the former base were concentrated in the larger canals, lakes, and shallow wetlands. Surveys outside the former base took place along 44.1 miles of canals including the Florida City, North, Mowry, Military, C-102, Goulds, and L-31E canals, as well as 6.8 miles along the western shoreline of Biscayne Bay (**Table G-2**). Crocodile surveys began one-half hour after sunset and lasted for three to seven hours. The canals were spot lighted from a vehicle in areas where the canal was clearly visible from the road. A johnboat was used to survey segments of canals that were not visible from the road. The boat was also used to survey along the western shoreline of Biscayne Bay and the mouths of canals (**Mazzotti 1999b**).

Table G-1. Scientific Names of Biota

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
PLANT SPECIES				
Air potato vine	*Dioscorea bulbifera*			
Algae	*Chara* sp.	✓		
Anemia fern	*Anemia adiantifolia*			
Arrowhead	*Sagittaria lancifolia*	✓		
Australian pine	*Casuarina* sp.	✓		
Bahama brake	*Pteris bahamensis*	✓		
Bahama sachsia	*Sachsia polycephala*	✓		
Bald cypress	*Taxodium distichum*			
Beak-rush	*Rhynchospora* sp.	✓		
Bermuda grass	*Cynodon dactylon*	✓		
Bischofia	*Bischofia javanica*			
Black ironwood	*Krugiodendron ferreum*			
Black mangrove	*Avicennia germinans*			
Black needlerush	*Juncus roemerianus*			
Black olive	*Bucida bucera*			
Blackberry	*Rubus cuneifolius*			
Blazing star	*Liatris* sp.			
Blodgett's ironweed	*Vernonia blodgettii*	✓		
Blodgett's wild mercury	*Argythamnia blodgettii*			
Blueberry	*Vaccinium* spp.			
Brazilian pepper	*Schinus terebinthifolius*	✓		
Broomsedge	*Andropogon* spp.	✓		
Bulrush	*Scirpus* sp.			
Burma reed	*Neyraudia reynaudiana*			
Bushy beardgrass	*Andropogon glomeratus*	✓		
Bustic	*Dipholis salicifolia*			
Buttonwood	*Conocarpus erecta*			
Cabbage palm	*Sabal palmetto*			
Cactus	*Opuntia* sp.			
Carpet grass	*Axonopus* sp.			
Carter's small-flowered flax	*Linum carteri*	✓		
Castor bean	*Ricinus communis*	✓		
Cat's claw	*Pithecellobium unquis-cati*			
Cattail	*Typha* sp.	✓		
Christmas berry	*Crossopetalum ilicifolium*	✓		
Coastal plain willow	*Salix caroliniana*	✓		
Coffee colubrina	*Colubrina arborescens*			
Coontail	*Ceratophyllum demersum*	✓		
Deltoid spurge	*Chamaesyce deltoidea*			
Dog fennel	*Eupatorium capillifolium*			
Duck potato	*NI*			
Elderberry	*Sambucus canadensis*			
Fetterbush	*Lyonia lucida*			
Fire flag	*Thalia geniculata*			
Florida elm	*Ulmus americana* var. *floridana*			
Florida five-petaled leaf flower	*Phyllanthus pentaphyllus*	✓		
Florida lantana	*Lantana depressa*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Florida pinewood privet	*Foresteria segregata* var. *pinetorum*	✓		
Florida royal palm	*Roystonea elata*	✓		
Florida white-top sedge	*Dichromena floridensis*	✓		
Fox grape	*Vitis labrusca*			
Foxtail	*NI*	✓		
Gallberry	*Ilex glabra*			
Geiger tree	*Cordia sebestena*			
Giant reed	*Phragmites communis*	✓		
Giant wild pine	*Tillandsia utriculata*			
Glasswort	*Salicornia* sp.			
Goldenrod	*Solidago* sp.			
Greenbrier	*Smilax* spp.			
Guara	*Psidium guajava*			
Guiana-plum	*Drypetes lateriflora*			
Gumbo limbo	*Bursera simaruba*			
Indian grass	*Sorghastrum* sp.			
Inkwood	*Exothea paniculata*			
American hornbeam	*Carpinus caroliniana*			
Jamaica dogwood	*Piscidia piscipula*			
Krug's holly	*Ilex krugiana*	✓		
Lancewood	*Nectandra coriacea*			
Lantana	*Lantana camara*	✓		
Laurel oak	*Quercus hemisphaerica*			
Lignum vitae	*Guaiacum sanctum*			
Locustberry	*Byrsonima lucida*	✓		
Love grass	*Eragrostis* sp.			
Maiden cane	*Panicum hemitomon*	✓		
Manatee grass	*Syringodium filiforme*			
Manchineel	*Hippomane mancinella*			
Marlberry	*Ardisia escallonioides*			
Marsh elder	*Iva frutescens*			
Marsh pink	*Sabatia* sp.			
Mastic	*Mastichodendron foetidissimum*			
Melaleuca	*Melaleuca quinquenervia*			
Milkwort	*Polygala* sp.			
Mistflower	*Eupatorium coelestinum*			
Morning-glory	*Ipomoea indica*	✓		
Muhly grass	*Muhlenbergia fitipes*			
Musky mint	*Hyptis alata*			
Napier grass	*Pennisetum purpureum*	✓		
Oak	*Quercus* sp.			
One-nerved ernodea	*Ernodea cokeri*			
Papaya	*Carica papaya*			
Paradise tree	*Simarouba glauca*			
Parsely fern	*Odontosoria clavata*	✓		
Paw paw	*Asimina* sp.			
Pickerel weed	*Pontederia cordata*			
Pigeon plum	*Coccoloba diversifolia*			
Pine	*Pinus* spp.			
Pineland jacquemontia	*Jacquemontia curtissii*	✓		

Common Name	Scientific Name	See Note[(1)]	See Note[(2)]	See Note[(3)]
Pineland noseburn	*Tragia saxicola*	✓		
Pine pink orchid	*Bletin purpurea*			
Poisonwood	*Metopium toxiferum*			
Pond cypress	*Taxodium ascendens*			
Porter's spurge	*Chamaesyce porteriana*	✓		
Possum grape	*Cissus trifoliata*	✓		
Prickly ash	*Zanthoxylum clava-herculis*			
Rabbit tobacco	*Pterocaulon pycnostachyum*			
Red bay	*Persea borbonia*			
Red cedar	*Juniperus virginiana*			
Red mangrove	*Rhizopora mangle*			
Red maple	*Acer rubrum*			
Rockland painted-leaf	*Poinsettia pinetorum*	✓		
Royal palm	*Roystonea elata*			
Running oak	*Quercus pumila*			
Saltbush	*Baccharis* sp.			
Saltgrass	*Distichlis spicata*			
Saltwort	*Batis maritima*			
Sand flax	*Linum arenicola*			
Sand spur	*Cenchrus* sp.	✓		
Satin leaf	*Chrysophyllum oliviforme*			
Saw palmetto	*Serenoa repens*			
Sawgrass	*Cladium jamaicense*	✓		
Sea grape	*Coccoloba uvifera*			
Sea lavender	*Tournefortia gnaphalodes*			
Sea oxeye daisy	*Borrichia frutescens*			
Shoal grass	*Halodule wrightii*			
Shortleaf fig	*Ficus citrifolia*			
Silk tree	*Albizzia julibrissin*			
Silver palm	*Coccothrinax argentata*	✓		
Slash pine	*Pinus elliotii*	✓		
Small-leaved melanthera	*Melanthera parvifolia*	✓		
Small's milkpea	*Galactia smallii*			
Smartweed	*Polygonum* sp.	✓		
Smooth cordgrass	*Spartina alterniflora*			
Soapberry	*Sapindus* spp.			
Soldierwood	*Colubrina elliptica*			
Spanish moss	*Tillandsia usneoides*			
Spanish nettle	*Bidens pilosa*	✓		
Spikerush	*Eleocharis* sp.	✓		
St. Augustine grass	*Stenotaphrum secundatum*	✓		
Staggerbush	*Lyonia* sp.			
Star rush	*Dichromena latifolia*			
Strangler fig	*Ficus aurea*	✓		
Sweetgum	*Liquidambar styraciflua*			
Tallowwood	*Sapium sebiferum*			
Tar flower	*Befaria racemosa*			
Tetrezygia	*Tetrazygia bicolor*	✓		
Thatch palms	*NI*			
Three-hole grass	*Bothriochloa pertusa*	✓		

Common Name	Scientific Name	See Note[(1)]	See Note[(2)]	See Note[(3)]
Tickseed	*Coreopsis* sp.			
Torchwood	*Amyris elemifera*			
Torpedo grass	*Panicum repens*	✓		
Turtle grass	*Thalassia testudinum*			
Umbrella sedge	*Cyperus alternifolius*	✓		
Water lily	*Nymphaea lanceolata*			
Water oak	*Quercus nigra*			
Water pennywort	*Hydrocotyle* sp.	✓		
Water shield	*Brassenia schreberi*			
Wax myrtle	*Myrica cerifera*			
Wedgelet fern	*Sphenomeris clavata*	✓		
West Indian mahogany	*Swietenia mahogani*			
Weeping fig	*Ficus benjamina*			
White mangrove	*Laguncularia racemosa*			
White water lily	*Nymphaea odorata*			
Wild balsam apple	*Mormordica charantia*	✓		
Wild coffee	*Psychotria* spp.			
Wild lime	*Zanthoxylem fagara*			
Wild pine	*Tillandsia* spp.			
Wild potato morning-glory	*Ipomoea microdactyla*			
Wild tamarind	*Lysiloma bahamense*			
Willow	*Salix caroliniana*			
Wiregrass	*Aristida* sp.			
ANIMAL SPECIES				
Invertebrates				
Apple snail	*Pomacea paludosa*			
Blue crab	*Callinectes sapidus*			
Florida atala butterfly	*Eumaeus atala florida*			
Sheepswool sponge	*Hippiospongia lachne*			
Basket sponge	*Ircinia campana*			
Stone crab	*Menippe mercenaria*			
Fire coral	*Millepora alcicornis*			
Spiny lobster	*Panulirus argus*			
Schaus swallowtail	*Papilio aristodemus ponceanus*			
Penaeid shrimp	*Penaeus* sp.			
Finger coral	*Porites* sp.			
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*			
Starlet coral	*Siderastrea siderea, S. radians*			
Star coral	*Solenastrea* sp.			
Loggerhead sponge	*Spheciospongia vesparia*			
Yellow sponge	*Spongia barbara*			
Glove sponge	*Spongia cheiris*			
Grass sponge	*Spongia germinea*			
Fish				
Angelfish-rock beauty	*Holacanthus tricolor*			
Barracuda	*Sphyraena* sp.			
Black grouper	*Mycteroperca bonaci*			
Blacknose shark	*Carcharhinus acronotus*			
Bluegill	*Lepomis macrochirus*	✓		
Bonefish	*Albula vulpes*			

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Bonnethead shark	*Sphyrna tiburo*			
Common snook	*Centropomus undecimalis*			
Conchfish	*Astrapogon stellatus*			
Florida gar	*Lepisosteus plathrhincus*			
Foureye butterflyfish	*Chaetodon capistratus*			
Gizzard shad	*Dorosoma cepedianum*			
Goby	Gobiidae			
Hogfish	*Lachnolaimus maximus*			
Ladyfish	*Elops saurus*			
Largemouth bass	*Micropterus salmoides*	✓		
Lemon shark	*Negaprion brevirostrus*			
Midas cichlid	*Cichlasoma citrinellum*			
Mollie	*Poecilia latipinna*	✓		
Mosquito fish	*Gambusia affinis*			
Mullet	*Mugil cephalus*	✓		
Nassau grouper	*Epinephelus striatus*			
Oscar	*Astronotus ocellatus*			
Pearlfish	*Carapus bermudensis*			
Permit	*Trachinotus falcatus*			
Pompano	*Trachinotus* sp.			
Red drum	*Sciaenops ocellata*			
Red grouper	*Epinephelus morio*			
Sailfin catfish	*Pterygoplichthys multiradiatus*			
Sharpnose shark	*Rhizopriodon terraenovae*			
Silver perch	*Bairdiella batabana*			
Snapper	*NI*			
Spanish mackerel	*Scomberomorus maculatus*			
Spotted seatrout	*Cynoscion nebulosus*			
Spotted tilapia	*Tilapia mariae*			
Tarpon	*Megalops atlanticus*			
Toadfish	*Opsanus tau*			
Walking catfish	*Clarias batrachus*			
Warmouth	*Lepomis gulosus*			
Amphibians				
Bullfrog	*Rana catesbeiana*	✓		
Cuban treefrog	*Osteopilus septentrionalis*			✓
Florida chorus frog	*Pseudacris* sp.			
Giant Toad	*Bufo marinus*	✓		
Salamander	*NI*	✓		
Tree frog	*NI*	✓		
Reptiles				
American alligator	*Alligator mississippiensis*	✓	✓	✓
American crocodile	*Crocodylus acutus*	✓	✓	
Atlantic ridley sea turtle	*Lepidochelys kempi*			
Basilisk lizard	*Basiliscus vittatus*			✓
Brown anole	*Anolis sagrei*			✓
Corn snake	*Elaphe guttata guttata*	✓		
Diamondback terrapin	*Malaclemys terrapin*			
Dusky pygmy rattlesnake	*Sistrurus miliarius barbouri*			
Eastern indigo snake	*Drymarchon corais couperi*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Florida redbelly turtle	*Pseudemys nelsoni*			✓
Florida softshell turtle	*Apalone ferox*			
Gopher tortoise	*Gopherus polyphemus*		✓	
Green anole	*Anolis carolinensis*			✓
Green iguane	*Iguana iguana*			✓
Green sea turtle	*Chelonia mydas mydas*			
Hawksbill sea turtle	*Eretmochelys imbricata*			
Leatherback sea turtle	*Dermochelys coriacea*			
Loggerhead sea turtle	*Caretta caretta*			
Mangrove saltmarsh terrapin	*Malaclemys terrapin rhizophorarum*			
Mole skink	*Eumeces egregius*		✓	
Peninsula cooter	*Pseudemys nelsoni*			✓
Pine snake	*Pituophis melanoleucus*		✓	
Rat snake	*Elaphe obsoleta*	✓		
Rattlesnake	*NI*		✓	
Rim rock crowned snake	*Tantilla oolitica*		✓	
Ringneck snake	*Diadophis punctatus*			
Rough green snake	*Opheodrys aestivus*	✓		
Snapping turtle	*Chelydra serpentina*	✓		
Southeastern five-lined skink	*Eumeces inexpectatus*			
Spectacled caiman	*Caiman crocodilus*			
Birds				
Acadian flycatcher	*Empidonax virescens*			
American coot	*Fulica americana*	✓		✓
American crow	*Corvus brachyrhynchos*			✓
American goldfinch	*Cardeulis tristis*	✓		
American oystercatcher	*Haematopus palliatus*			
American redstart	*Setophaga ruticilla*	✓		
American robin	*Turdus migratorius*			✓
Anhinga	*Anhinga anhinga*	✓		✓
Antillean nighthawk	*Chordeiles gundlachii*		✓	
Artic peregrine falcon	*Falco peregrinus tundrius*		✓	
Audubon's shearwater	*Puffinus iherrminieri*			✓
Bald eagle	*Haliaeetus leucocephalus*	✓		
Bank swallow	*Riparia riparia*			✓
Barn swallow	*Hirundo rustica*			✓
Barred owl	*Strix varia*	✓		
Bell's vireo	*Vireo bellii*			✓
Belted kingfisher	*Ceryle alcyon*			✓
Black-and-white warbler	*Mniotila varia*			
Black-crowned night-heron	*Nycticorax nycticorax*	✓	✓	
Black-necked stilt	*Himantopus mexicanus*	✓		
Black rail	*Laterallus jamaicensis*		✓	
Black scoter	*Melanitta nigra*			✓
Black shouldered kite	*Elanus caeruleus*		✓	
Black skimmer	*Pynchops niger*			✓
Black-throated blue warbler	*Dendroica caerulescens*	✓		
Black-throated gray warbler	*Dendroica nigrescens*			✓
Black-throated green warbler	*Dendroica virens*			✓
Black vulture	*Coragyps atratus*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Black-whiskered vireo	*Vireo altiloquus*		✓	
Blackpoll warbler	*Dendroica striata*			✓
Blue grosbeak	*Guiraca caerulea*	✓		
Blue jay	*Cyanocitta cristata*	✓		
Blue-gray gnatcatcher	*Polioptila caerulea*	✓		
Blue-winged teal	*Anas discors*			✓
Boat-tailed grackle	*Quiscalus major*	✓		✓
Bobolink	*Dolichonyx oryzivorus*			✓
Bonaparte's gull	*Larus philadelphia*			✓
Broad-winged hawk	*Buteo platypterus*	✓		
Brown booby	*Sula leucogaster*			✓
Brown-headed cowbird	*Molothus ater*			✓
Brown pelican	*Pelecanus occidentalis*		✓	✓
Canada warbler	*Wilsonia canadensis*			✓
Canary-winged parakeet	*Brotogeris versicolurus*			✓
Cape May warbler	*Dendroica tigrina*			✓
Cape Sable Seaside sparrow	*Ammodramus maritimus mirabilis*			
Caspian tern	*Sterna caspia*			
Carolina wren	*Thryothorus ludovicianus*	✓		✓
Cattle egret	*Bubulcus ibis*	✓		✓
Cedar waxwing	*Bombycilla cedrorum*	✓		
Chimney swift	*Chaetura pelagica*			✓
Chipping sparrow	*Spizella passerina*			✓
Chuck-will's widow	*Caprimulgus carolinensis*			✓
Clapper rail	*Rallus longirostris*			
Common ground dove	*Columbina passerina*			✓
Common grackle	*Quiscalus quiscula*	✓		✓
Common gallinule	*Gallinula chloropus*	✓		✓
Common loon	*Gavia immer*			✓
Common nighthawk	*Chordeiles minor*	✓		
Common snipe	*Gallinago gallinago*			✓
Common tern	*Sterna hirundo*			✓
Common yellowthroat	*Geothlypis trichas*	✓		
Connecticut warbler	*Oporornis agilis*			✓
Cooper's hawk	*Accipiter cooperii*	✓		
Crested caracara	*Caracara plancus*			
Cuban yellow warbler	*Dendroica petechia gundlachi*			✓
Dickcissel	*Spiza americana*			✓
Double-crested cormorant	*Phalacrocorax auritus*	✓		
Downy woodpecker	*Picoides pubescens*			✓
Dunlin	*Calidris alpina*			✓
Eastern bluebird	*Sailia sialis*			
Eastern kingbird	*Tyrannus tyrannus*	✓		✓
Eastern meadowlark	*Sturnella magna*			✓
Eastern phoebe	*Sayornis phoebe*	✓		
Eastern screech-owl	*Otus asio*	✓		
Eastern towhee	*Pipilo erythrophthalmus*	✓		
Eastern wood pewee	*Contopus virens*			✓
Eurasian-collored dove	*Streptopelia dacaocto*			✓
European starling	*Sturnus vulgaris*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Fish crow	*Corvus ossifragus*	✓		
Florida burrowing owl	*Speotyto cunicularia*	✓		✓
Florida prairie warbler	*Dendroica discolor paludicola*			✓
Forster's tern	*Sterna forsteri*			✓
Franklin's gull	*Larus pipixcan*			✓
Fulvous whistling duck	*Dendrocygn bicolor*			✓
Glossy ibis	*Plegadis falcinellus*		✓	
Grasshopper sparrow	*Ammodramus savannarum*	✓		
Gray catbird	*Dumetella carolinensis*	✓		✓
Gray-cheeked thrush	*Catharus minimus*			
Gray kingbird	*Tyrannus dominicensis*	✓		
Gray plover	*Pluvialis squatarola*			✓
Great black-backed gull	*Larus marinus*			✓
Great blue heron	*Ardea herodias*	✓		✓
Great-crested flycatcher	*Myiarchus crinitus*			
Great egret	*Casmerodius albus*	✓	✓	✓
Great white heron	*Ardea herodia occidentalis*			
Greater yellowlegs	*Tringa melanoleuca*			✓
Green heron	*Butorides virescens*	✓		✓
Hairy woodpecker	*Picoides villosus*			✓
Herring gull	*Larus argentatus*			✓
Hill myna bird	*Gracula religiosa*			
Hooded warbler	*Wilsonia citrina*			✓
Horned grebe	*Podiceps auritus*			✓
House sparrow	*Passer domesticus*	✓		
House wren	*Troglodytes aedon*			✓
Indigo bunting	*Passerina cyanea*	✓		
Jager sp.				✓
Killdeer	*Charadrius vociferus*	✓		✓
Laughing gull	*Larus atricilla*			✓
Least bittern	*Lxobrychus exilis*	✓	✓	
Least flycatcher	*Empidonax minimus*			✓
Least sandpiper	*Calidris minutilla*			✓
Least tern	*Sterna antillarum*		✓	
Lesser black-backed gull	*Larus fuscus*			✓
Limpkin	*Aramus guarauna*		✓	
Little blue heron	*Egretta caerulea*	✓	✓	✓
Loggerhead shrike	*Lanius ludovicianus*	✓		
Louisiana waterthrush	*Seiurus motacilla*			✓
Magnificent frigatebird	*Fregata magnificens*		✓	
Magnolia warbler	*Dendroica magnolia*	✓		
Mangrove cuckoo	*Coccyzus minor*		✓	
Marsh wren	*Cistothorus palustris*			✓
Merlin	*Falco columbarius*			✓
Mississippi kite	*Ictinia mississippiensis*			✓
Monk parakeet	*Myiopsitta monachus*			✓
Mottled duck	*Anas fuligula*			✓
Mourning dove	*Zenaida macroura*	✓		✓
Muscoy duck	*Cairina moschata*			✓
Myrtle warbler	*Dendroica coronata*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Nashville warbler	*Vermivora ruficapilla*			✓
Northern bobwhite	*Colinus virginianus*			
Northern cardinal	*Cardinalis cardinalis*	✓		✓
Northern flicker	*Colaptes auratus*			✓
Northern gannet	*Morus bassanus*			✓
Northern harrier	*Circus cyaneus*			✓
Northern mockingbird	*Mimus polyglottos*	✓		✓
Northern oriole	*Icterus galbula*			✓
Northern parula	*Parula americana*	✓		
Northern pintail	*Anas acuta*			✓
Northern rough-winged swallow	*Stelgidopteryx serripennis*			✓
Northern waterthrush	*Seiurus noveboracensis*			✓
Orange-crowned warbler	*Vermivora celata*			✓
Osprey	*Pandion haliaetus*	✓	✓	✓
Ovenbird	*Seiurus aurocapillus*			✓
Painted bunting	*Passerina ciris*			✓
Palm warbler	*Dendroica palmarum*	✓		
Pied-billed grebe	*Podilymbus podiceps*			✓
Pileated woodpecker	*Dryocopus pileated*			
Pine warbler	*Dendroica pinus*			✓
Piping plover	*Charadrius melodus*			✓
Pomarine jaeger	*Stercorarius pomarinus*			✓
Prothonotary warbler	*Protonotaria citrea*			✓
Purple gallinule	*Porphyrula martinica*	✓		
Purple martin	*Progne subis*			✓
Purple sandpiper	*Calidris maritima*			✓
Red-bellied woodpecker	*Melanerpes carolinus*	✓		✓
Red-breasted merganser	*Mergus serrator*	✓		
Reddish egret	*Egretta rufescens*	✓		
Red-eyed vireo	*Vireo olivaceus*			✓
Red knot	*Calidris canutus*			✓
Red phalarope	*Phalaropus fulicaria*			✓
Red-shouldered hawk	*Buteo lineatus*			✓
Red-tailed hawk	*Buteo jamaicensis*	✓		✓
Red-winged blackbird	*Agelaius phoeniceus*	✓		✓
Ring-billed gull	*Larus delawarensis*			✓
Ringed turtle dove	*Streptopelia risoria*			✓
Rock dove	*Columba livia*	✓		✓
Roseate spoonbill	*Ajaia ajaja*	✓		
Roseate tern	*Sterna dougallii*			
Rose-breasted grosbeak	*Pheucticus ludovicianus*	✓		
Royal tern	*Sterna maxima*			
Ruby-crowned kinglet	*Regulus calendula*			✓
Ruby-throated hummingbird	*Archilochus colubris*			✓
Ruddy turnstone	*Arenaria interpres*			✓
Rufous hummingbird	*Selasphorus rufus*			✓
Sanderling	*Calidris alba*			✓
Sandhill crane	*Grus canadensis*			
Sandwich tern	*Sterna sandvicensis*			
Savannah sparrow	*Passerculus sandwichensis*	✓		

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Scarlet tanager	*Piranga olivacea*			✓
Scissor-tailed flycatcher	*Tyrannus forticata*			✓
Sedge wren	*Cistothorus platensis*			✓
Semipalmated plover	*Charadrius semipalmatus*			✓
Sharp-shinned hawk	*Accipiter striatus*	✓		
Sharp-tailed sparrow	*Ammodramus caudacutus*			
Short-billed dowitcher	*Limnodromus griseus*			✓
Short-eared owl	*Asio flammeus*	✓		
Short-tailed hawk	*Buteo brachyurus*		✓	✓
Snail kite	*Rostrhamus sociabilis plumbeus*	✓	✓	
Snowy egret	*Egretta thula*	✓	✓	
Solitary vireo	*Vireo solitarius*			✓
Sora rail	*Porzana carolina*			✓
Southeastern American kestrel	*Falco sparverius paulus*			
Spotted sandpiper	*Tringa macularia*			✓
Summer tanager	*Piranga rubra*			✓
Swainson's hawk	*Buteo swainsoni*		✓	
Swainson's thrush	*Catharus ustulatus*			✓
Swainson's warbler	*Limnothlypis swainsonii*			✓
Swallowtail kite	*Elanoides forficatus*			✓
Swamp sparrow	*Melospiza georgiana*	✓		
Tennessee warbler	*Vermivora peregrina*	✓		
Tree swallow	*Iridoprocne bicolor*			
Tricolored heron	*Egretta tricolor*	✓	✓	✓
Turkey vulture	*Cathartes aura*	✓		✓
Veery	*Catharus fuscescens*			✓
Western kingbird	*Tyrannus verticalis*	✓		
Western sandpiper	*Calidris mauri*			✓
Whimbrel	*Neumenius phaeopus*			✓
Whip-poor-will	*Caprimulgus vociferus*			✓
White-crowned pigeon	*Columba leucocephala*		✓	
White-eyed vireo	*Vireo griseus*	✓		
White ibis	*Eudocimus albus*	✓	✓	
White pelican	*Pelecans erythrorhynchos*			✓
White-winged dove	*Zenaida asiatica*	✓		
Wild turkey	*Meleagris gallopavo*		✓	
Willet	*Catoptropho semipalmatus*			✓
Wilson's plover	*Charadrius wilsonia*		✓	
Wood stork	*Mycteria americana*	✓		
Woodcock	*Scolopax minor*			
Worm-eating warbler	*Helmitheros vermivorus*			✓
Yellow-bellied sapsucker	*Sphyrapicus varius*			✓
Yellow-billed cuckoo	*Coccyzus americanus*			✓
Yellow-breasted chat	*Icteria virens*			✓
Yellow-crowned night-heron	*Nyctanassa violacea*	✓	✓	
Yellow-throated vireo	*Vireo flavifrons*	✓		
Yellow-throated warbler	*Dendroica dominica*	✓		
Mammals				
Black bear	*Ursus americanus*		✓	
Bobcat	*Lynx rufus*	✓	✓	

Common Name	Scientific Name	See Note(1)	See Note(2)	See Note(3)
Bottlenose dolphin	*Tursiops truncatus*			✓
Brazilian free-tailed bat	*Tadarida brasiliensis*		✓	
Cotton mouse	*Peromyscus gossypinus*			
Eastern yellow bat	*Lasiurus intermedius*			
Evening bat	*Nycticeius humeralis*			
Feral cat	*NI*			
Feral dog	*NI*			
Florida panther	*Felis concolor coryi*			
Gray fox	*Urocyon cinereoargenteus*	✓		
Gray squirrel	*Sciurus carolinensis*	✓		
Harvest mouse	*Reithrodontomys humulis*			
Hispid cotton rat	*Sigmondon hispidus*			
Key Largo cotton mouse	*Peromyscus gossypinus allapaticola*			
Key Largo woodrat	*Neotoma floridana smalli*			
Least shrew	*Cryptotis parva*			
Marsh rabbit	*Sylvilagus palustris*	✓		
Mastiff bat	*Eumops glaucinus*			
Mink	*Mustela vison*		✓	
Mole	*NI*			
Muskrat	*Ondatra zibethicus*		✓	
Opossum	*Didelphis virginiana*	✓		
Raccoon	*Procyon lotor*	✓		✓
Spotted skunk	*Spilogale putorius*			
Striped skunk	*Mephitis mephitis*	✓		
West Indian manatee	*Trichechus manatus latirostris*	✓		
White-tailed deer	*Odocoileus virginianus*			
Woodrat	*Neotoma floridana*			

Source: **SEA 1996, Florida Game and Fresh Water Fish Commission 1998a, Geraghty & Miller 1993, BNP 1998, Denton and Godley 1999, Mazzotti 1999b.**

Notes: [1] Species commonly found on and in the vicinity of Homestead ARS, Florida, as identified in Appendix D of the Final Integrated Natural Resources Management Plan (INRMP) (**SEA 1996**).

[2] Species recorded or with potential habitat in the vicinity of former Homestead AFB as identified in data provided by Florida Game and Fresh Water Fish Commission (**Florida Game and Fresh Water Fish Commission 1998a**).

[3] Observed during site-specific surveys on and in the area of the former Homestead AFB (**Geraghty & Miller 1993, Denton and Godley 1999, Mazzotti 1999b**) or at Biscayne National Park (**BNP 1998**).

NI species not identified

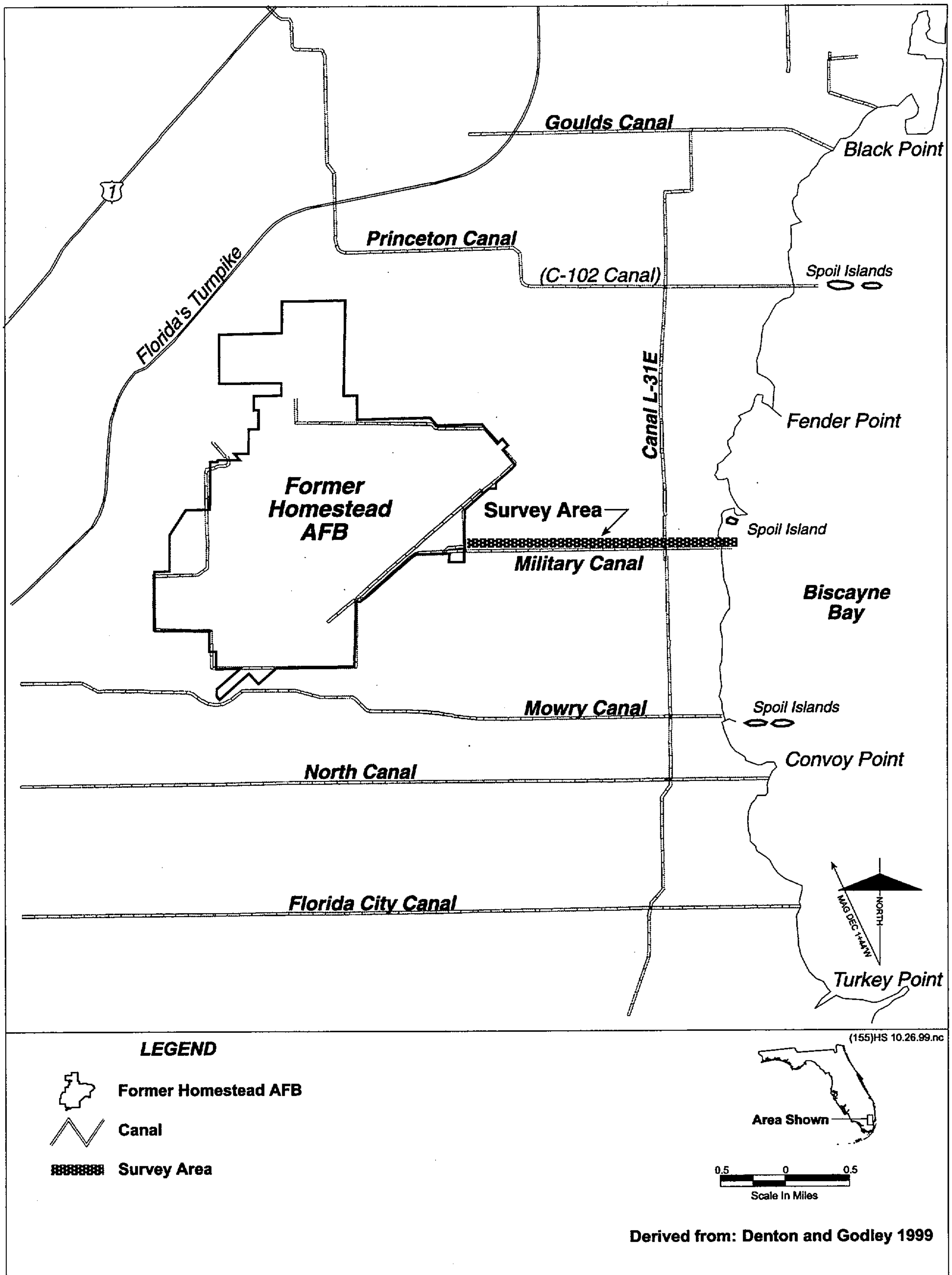
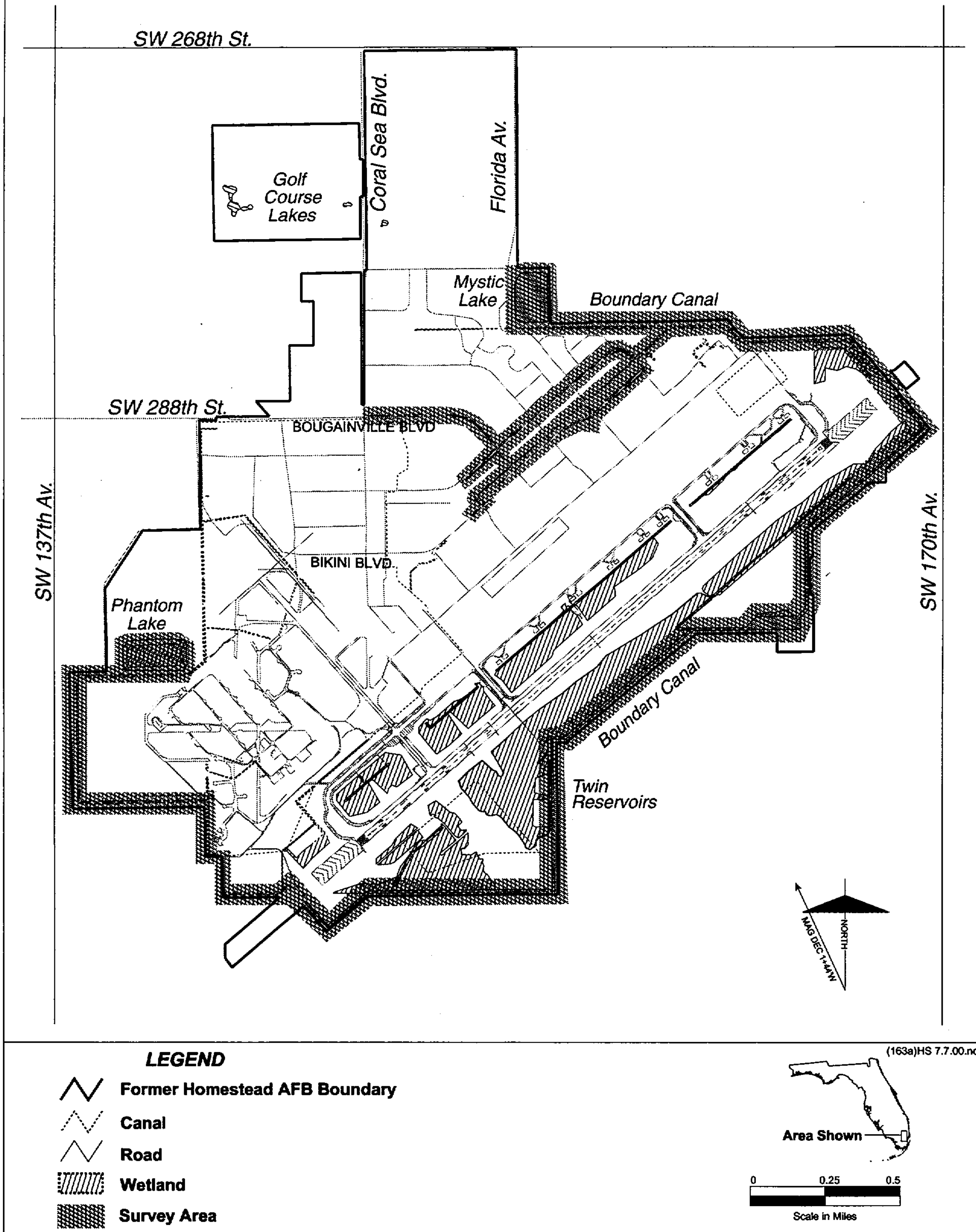


Figure G-1
Area Surveyed for Sensitive Plants Along Military Canal



Derived from: Mazzotti 1999b

Figure G-2
Areas Surveyed for the American Crocodile on Former Homestead AFB, June and July 1998

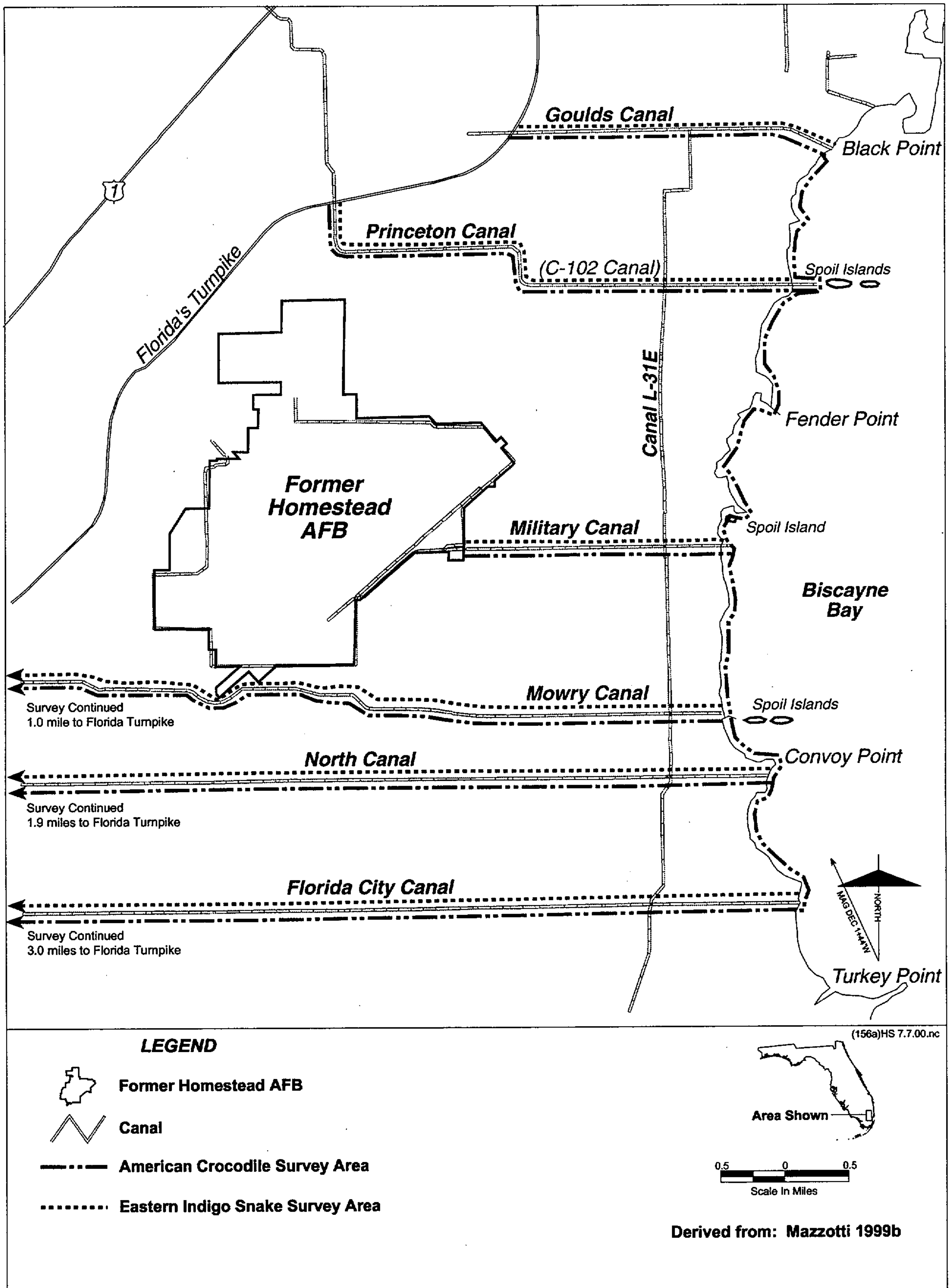


Figure G-3
Canals and the Western Shoreline of Biscayne Bay Surveyed for the American Crocodile and Eastern Indigo Snake, June and July 1998

Table G-2. Number of Miles of Canals and Western Shoreline of Biscayne Bay Surveyed for the American Crocodile and Eastern Indigo Snake in June and July 1998

Canal[1]	Species	
	American Crocodile	Eastern Indigo Snake
Florida City Canal	8.9	8.9
North Canal	7.6	7.6
Mowry Canal	6.4	6.4
Military Canal	2.0	2.0
Canal C-102	3.6	3.6
Goulds Canal	2.5	2.5
Canal L-31E	6.3	6.3
Biscayne Bay shoreline	6.8	0.0
Total Miles	44.1	37.3

Note: [1] See Figure G-3 for locations of survey routes.

Eastern Indigo Snake. Surveys for the eastern indigo snake took place on former Homestead AFB (**Figure G-4**), as well as along canals between the former base and Biscayne Bay (see Figure G-3). Surveys on the former base centered on the vacant land and roads in the Mystic Lake area and areas south of the runway. Approximately 37.3 miles of canals outside the former base, including Florida City, North, Mowry, Military, C-102, Goulds, and L-31E canals were surveyed (see Table G-2). Two observers surveyed the canal from a vehicle that drove slowly along the canal access roads. The surveys began at sunrise and ended within four hours; all wildlife observed were recorded. In addition, biologists conducting other wildlife surveys were instructed to look for the eastern indigo snake.

Rim Rock Crowned Snake. Surveys for the rim rock crowned snake were conducted in appropriate habitat on former Homestead AFB. This small fossorial snake is relatively cryptic in behavior and localized in distribution within a limited range. Specimens have been taken from sandy and rocky soils in slash pine flatwoods, tropical hardwood hammocks, and vacant lots and pastures with shrubby growth and scattered slash pines (**Moler 1992**).

Field surveys for the rim rock crowned snake were conducted consistent with the Florida Game and Fresh Water Fish Commission recommendations for fossorial herpetofauna although specific guidelines for rim rock crowned snake have not been established. A series of two meter long drift fences with small funnel traps were established in the two remaining patches of second growth, unmowed uplands on former Homestead AFB (see Figure G-4). A third upland site was investigated but consisted largely of concrete, so it was not possible to install drift fences in that area. The drift fences were installed in June 1998 and checked daily for four weeks in June and July 1998. Five drift fences were installed in a small remnant hardwood area along the southwestern portion of the runway, and 10 were installed in the larger hardwood area along the northeast portion of the runway. The drift fences were open for 336 nights. Searches for this snake were also conducted by overturning trash, logs, and other debris in the two study areas.

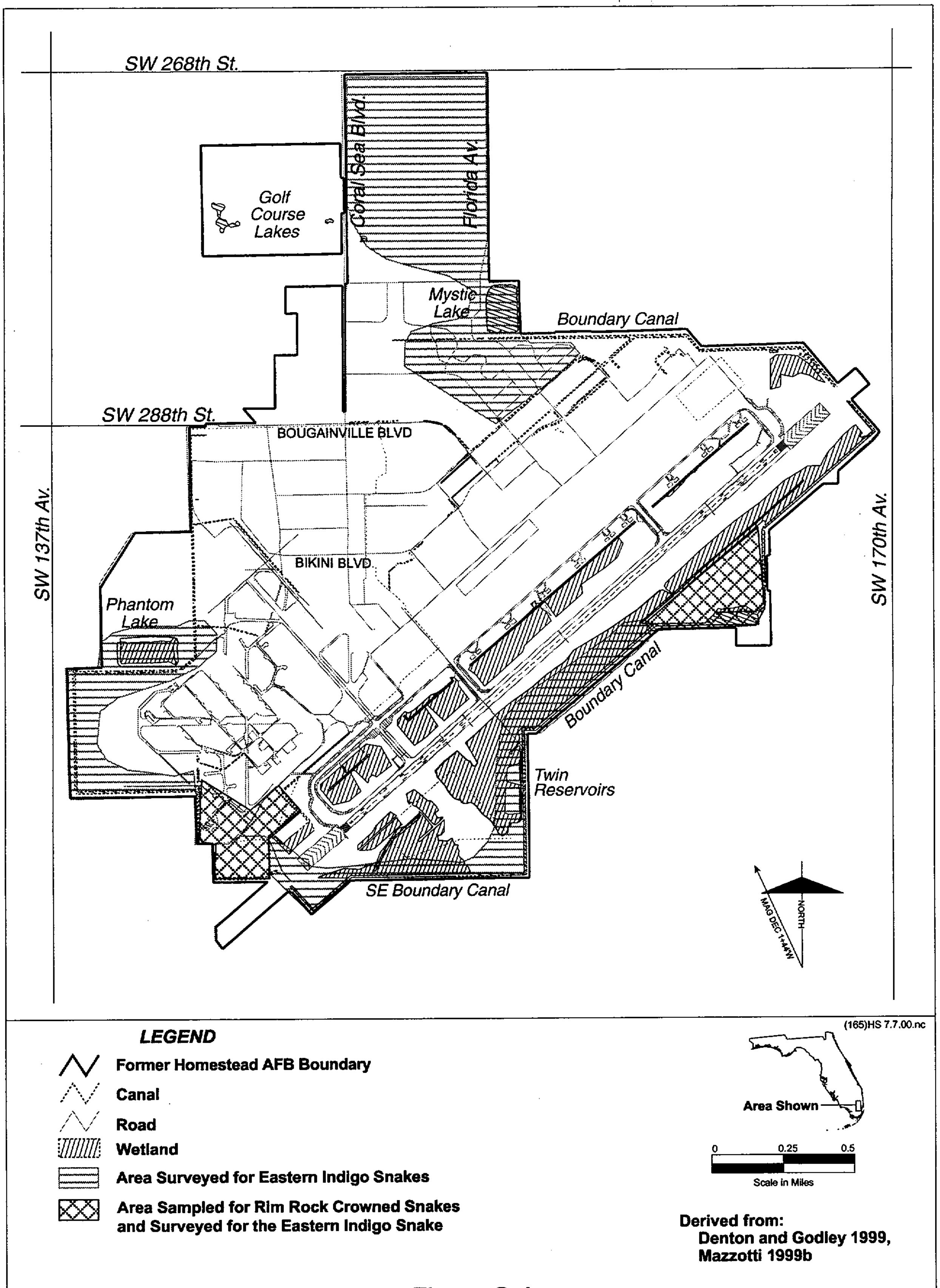


Figure G-4
Areas Surveyed for the Eastern Indigo Snake and Sampled for the Rim Rock Crowned Snake

G.1.3 Birds

Wood Stork and State-Listed Wading Birds. Helicopter surveys were conducted on June 2 and 26 and July 14, 1998 for the wood stork and state-listed wading birds on former Homestead AFB, and in an area between the former base and the Biscayne Bay coastline (**Figure G-5**). The species, number, and location of all listed wading birds were recorded along with any other special-status species that were observed. In addition, all wading birds observed were recorded during other biological surveys, which included ground surveys on former Homestead AFB and the canals and wetlands between the former base during the crocodile and indigo snake surveys, the neotropical migrant landbird surveys, and the burrowing owl and American kestrel surveys.

Southeastern American Kestrel. Surveys for the southeastern American kestrel were conducted in accordance with the *Wildlife Methodology Guidelines* recommended by the Florida Game and Fresh Water Fish Commission (**Denton and Godley 1999**). Ground surveys took place on former Homestead AFB in habitats that appeared to have the potential to support this species. Five surveys were conducted during the morning and afternoon in June and July 1998. The surveys were conducted from vehicles that moved slowly along roads in open habitat on the former base (**Figure G-6**). Researchers carefully scanned all features such as fence posts, trees, and telephone poles and lines. Biologists were instructed to look for this species while conducting other field surveys, and also during the aerial survey for wading birds. The agricultural lands near the former base were scanned for flying or perched kestrels.

Florida Burrowing Owl. Surveys for the Florida burrowing owl were conducted during the Southeastern American kestrel surveys (see Figure G-6). Areas that appeared suitable for burrow construction, and areas where owls had previously been reported were searched. All sightings of the burrowing owl were recorded and plotted on base maps.

Neotropical Migrant Landbirds. Surveys for mangrove cuckoo, black-whiskered vireo, Cuban yellow warbler, and Florida prairie warbler were conducted in overgrown areas on former Homestead AFB (see Figure G-6), in the coastal mangrove forests between Florida City Canal and Goulds Canal, and along the Military Canal and Canal L-31E (see Figure G-5). Based on the preliminary survey, it was apparent that all vegetated areas on former Homestead AFB had been cleared of native vegetation many years ago and are now dominated by exotic nuisance species such as Brazilian pepper, Australian pine, and papaya. On-site investigation revealed that the vegetated areas on the former base were too small to establish transects, so point surveys were conducted during June and July 1998. All species either heard or observed were recorded during a fixed time period at each sample point. During the initial three minutes, no methods of coaxing birds were used (i.e., no spishing or playback tapes). Thereafter, a continuous loop tape recording of breeding calls of the four target species was played for three minutes. All birds detected between stops were also recorded.

Parts of Military, L-31E, and Mowry canals were surveyed in accordance with the National Biological Services *Breeding Bird Survey* guidelines (see Figure G-5). Surveys along Military Canal consisted of slowly walking along the canal from Allapattah Road to Biscayne Bay, and stopping at approximate 300 foot intervals to record all birds detected. All species either heard or observed were recorded during a fixed time period at each sample point. During the initial three minutes, no methods of coaxing birds were used (i.e., no spishing or playback tapes). Thereafter, a continuous loop tape recording of breeding calls of the four target species was played for three minutes. All birds detected between stops were recorded. Surveys also were made along the edges of the reservoir at the head of the canal. Surveys along the L-31E Canal from the Florida City Canal to the C-102 Canal (4.9 miles) consisted of point counts every half mile using the same methods described above for Military Canal. All surveys started early in the morning, between 6:00 a.m. and 7:00 a.m.

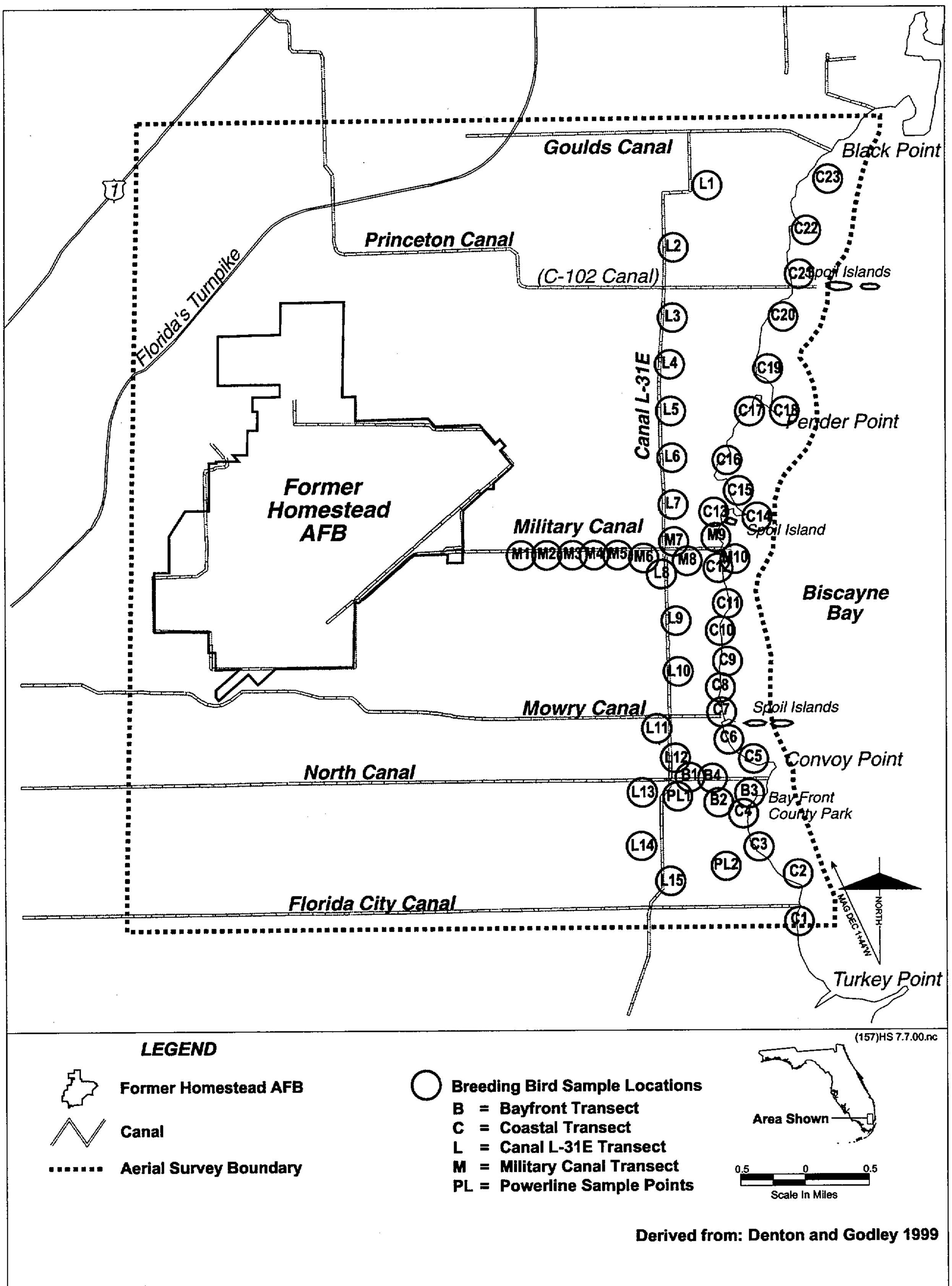


Figure G-5
Area Covered by Aerial Surveys and Breeding Bird Survey Routes Outside Former Homestead AFB

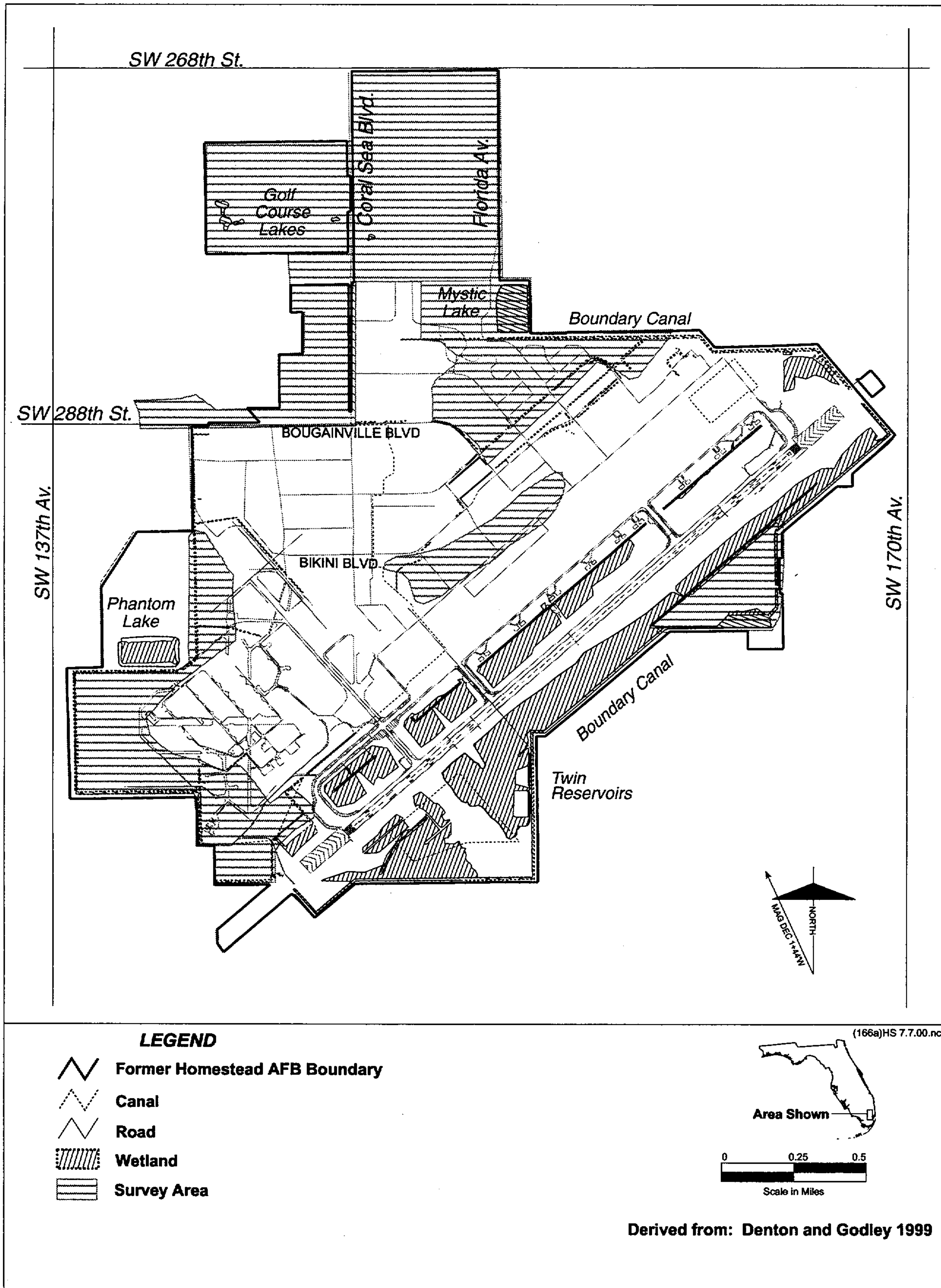


Figure G-6
Areas Surveyed for the Southeastern American Kestrel, Florida Burrowing Owl, and Neotropical Migrant Landbirds in June and July 1998

A helicopter survey was conducted to determine the most appropriate survey locations for neotropical migrant land birds along the west shore of Biscayne Bay. The tallest stands of red and black mangrove forests and any tropical hardwood hammocks were considered the most appropriate habitats because they are known to be preferred by mangrove cuckoo, black-whiskered vireo, Cuban yellow warbler, and Florida pine warbler. One hammock-like area was located near Bayfront County Park (see Figure G-5) and one transect with four stops approximately 300 feet apart was established. The helicopter flight revealed that the remainder of the shoreline along Biscayne Bay would be most appropriately surveyed by boat, as tall stands of mangroves were generally limited to within 150 to 225 feet of the shoreline. Numerous small tidal channels provide boat access to this shoreline zone. Boat surveys along the 6.8 miles of mangrove fringe from the Florida City Canal to Goulds Canal were conducted from a shallow draft motor boat at 0.5 mile intervals. Survey methods at each point were the same as used along the canals. During all nesting neotropical migrant bird surveys, all wildlife observations and signs were recorded, including wading birds and indigo snakes. Nesting neotropical migrant bird surveys were conducted in June and July 1998.

G.2 Special-Status Species

A total of 76 special-status species are known to occur on former Homestead AFB and/or the surrounding ROI (see Section 3.11 for definition of the ROI); 2 species have the potential to occur, and 2 species are unlikely to occur. These 80 species include 1 federally listed and 28 state listed plant species that have been observed on former Homestead AFB (27 species) or along Military Canal (2 species) and one federally listed species with the potential to occur on the former base. One species of butterfly occurs on the keys of Biscayne NP but not in the area of the former base. Six species of reptiles occur or have the potential to occur including three marine turtles, the American crocodile, and two species of snakes. Of the 39 special-status bird species, 36 are known to occur in the area, 1 has the potential to occur, and 2 are unlikely to occur in the area. The West Indian manatee and Florida panther are the only listed mammal species known to occur in the area. The Key Largo cotton mouse and woodrat occur farther away on Key Largo.

G.2.1 Plants

Surveys for plant species of concern were conducted on former Homestead AFB in 1992/93, 1996/97, and 1997, and along Military Canal in 1998. One federally and state endangered plant species and 28 state listed and sensitive plant species were observed (see Tables 3.11-3, 3.11-4, and 3.11-6). Twenty-three of the state species are endangered, two are threatened, and four are species of special concern. The federally listed deltoid spurge is included in this section although it has not been observed on the former base. This species occurs in pine rocklands elsewhere in Miami-Dade County.

The 1992/93 plant surveys covered all of former Homestead AFB (3,245 acres); the 1996/97 surveys covered only the Homestead ARS (937 acres); the 1997 survey covered the disposal portion of former Homestead AFB, and the 1998 survey covered all of Military Canal. The 1992/1993 surveys occurred between December 1992 and October 1993. The 1996/97 surveys occurred in November 1996 and January 1997, the 1997 surveys occurred in November 1997, and the survey along Military Canal took place in June 1998 (**Hilsenbeck 1993, Argonne National Laboratory 1997, PBS&J 1998b, Denton and Godley 1999**). A total of 26 locations were surveyed on former Homestead AFB (**Figure G-7**), and a brief description of those locations is provided in **Table G-3**. These plant surveys were conducted on Homestead AFB just after Hurricane Andrew, and again about five years after the hurricane.

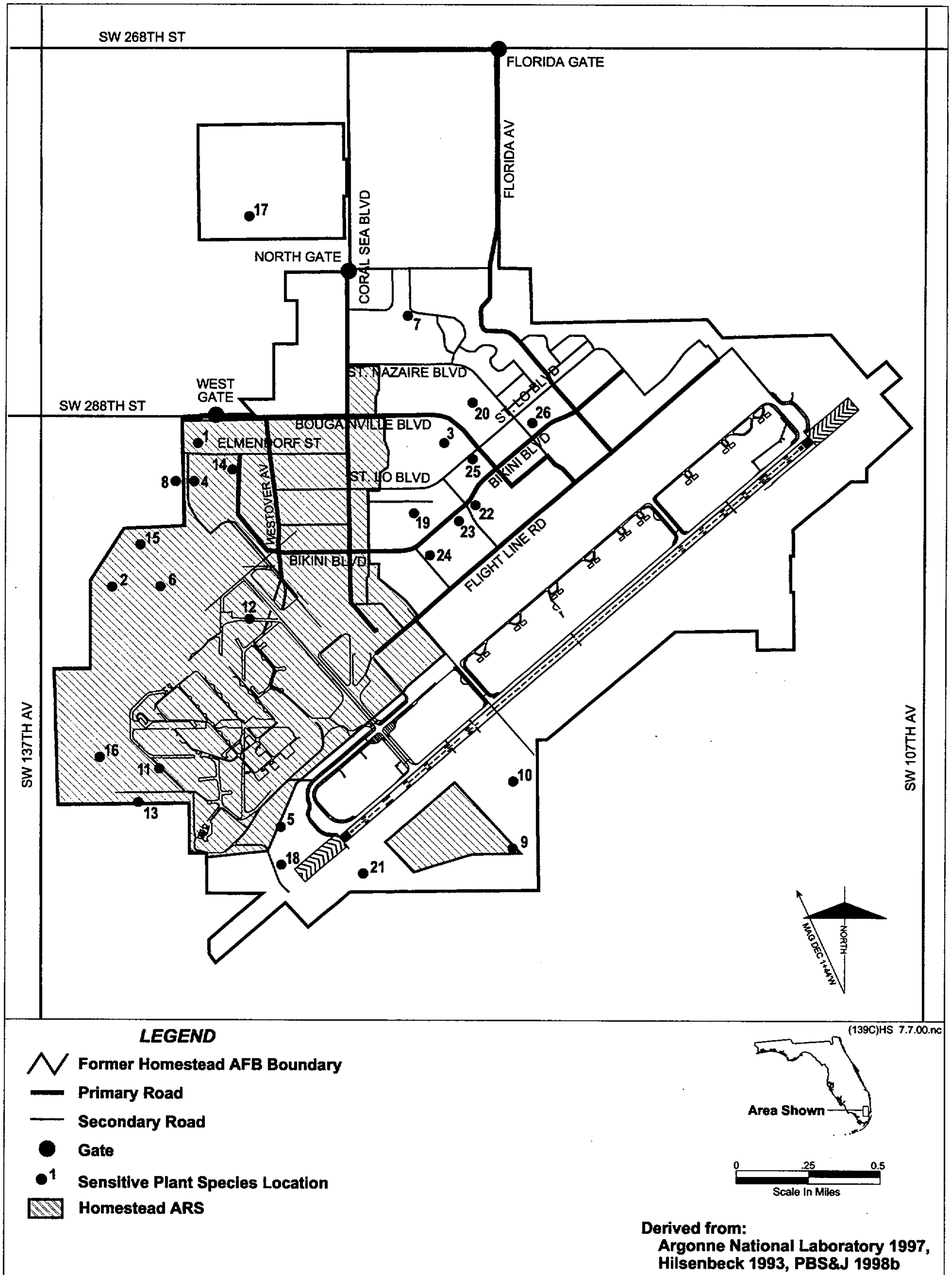


Figure G-7
Locations of Pine Rocklands and Sensitive Plant Species on the Surplus Lands

Table G-3. Locations Surveyed for Sensitive Plants on Former Homestead AFB

Number[1]	Name	Survey Dates		Description
		Disposal Land	Homestead ARS	
1	Pine rockland remnant		92/93, 96/97	Area (4.2 acres) had extensive hurricane damage. Plant community significantly degraded but contains some elements of the rare pine rockland type. Eight mature slash pine remain and some young pines were noted. Non-native species well established. Fourteen species of concern were observed during the 1992/93 survey and 13 species during the 1996/97 survey.
2	Southwest Easement		92/93, 96/97	Pine rockland and prairie types. There are many solution holes and a deep layer of litter. Diverse grass and forb species with a few Australian pine. Twelve species of concern were recorded during both the 1992/93 and 1996/97 surveys.
3	Bikini Boulevard	92/93		Site is frequently mowed with an almost continuous cover of exotic grass. There are some scattered limestone outcrops that support a rich pine rockland flora; 11 species of concern at this site.
4	West Boundary Canal		92/93, 96/97	4.2 acres were surveyed along this canal and patches of native and non-native trees and shrubs bordered canal. Much of the inside of the canal was obstructed deadfall Australian pine. Ten sensitive plant species were observed in and along this canal during the 1992/93 survey. Fourteen species were recorded during the 1996/97 survey.
5	South runway	92/93		A frequently mowed area with scattered limestone outcrops. Native flora along a canal and at limestone outcrops. There were 10 species of concern at this site
6	Southeast easement		92/93, 96/97	Former pine rockland that is dominated by Australian pine and Brazilian pepper. There are numerous limestone solution holes that support native pine rockland flora; nine species of concern were observed during both the 1992/93 and 1996/97 surveys.
7	VITA Course	92/93		This site is a frequently mowed treeless area rich in native flora along a canal that traverses the area; seven species of concern were observed during the 1992/93 survey.
8	West Boundary Canal Inner Wall		92/93, 96/97	Site consists of sheer inner walls of a deep canal constructed in the 1950s. Vegetation typical of unshaded sinkholes in south Florida; five species of concern observed during the 1992/93 survey. It was combined with location 4 during 1996/97 survey and 14 species were recorded.

Number[1]	Name	Survey Dates		Description
		Disposal Land	Homestead ARS	
9	Jet Test Site	92/93		Two acre site supports largely native flora dominated by grass. Soil shallow and limestone exposed. Five species of concern recorded during the 1992/93 survey.
10	East Borrow Area	92/93		Site consists of two deep borrow pits with steep sides filled with water. Limited native flora here and five species of concern were noted during the 1992/93 survey.
11	South of Magazine		92/93, 96/97	This a mesic prairie with numerous exposed limestone outcrops. Several areas of sawgrass in deeper depressions and many native species in the shallow depressions. Five species of concern recorded during the survey of 1992/93 and 11 during the 1996/97 survey.
12	Northeast of Magazine		92/93, 96/97	A frequently mowed site with an almost continuous cover of exotic grass. A very small remnant pine rockland forest. Four species of concern were observed during the 1992/93 survey and eight during the 1996/97 survey.
13	Southwest Boundary Canal		92/93, 96/97	This site is an inner wall of a narrow deep canal with vegetation typical of unshaded sinkholes in south Florida. There is limited native flora and only two species of concern were observed during the 1992/93 survey. Nine species were recorded during the 1996/97 survey.
14	North of Customs		96/97	Area covers 21.2 acres and supports mostly disturbed habitat. Site is bisected by a number of small canals bordered by native and nonnative trees and shrubs. Twelve species of concern occur in this area.
15	North Easement Tract		96/97	45.4 acre area has diverse mixture of mostly native hardwood shrubs and trees as well as open grasslands. Several slash pines and old stumps indicate that this area may support a pine rockland type. Ten species of concern were observed.
16	Grenade Range Prairie		96/97	30.8 acre open old field dominated by grass and forbs. The largest grassland community aside from area 15 on Homestead ARS. Site contains little soil and is underlain by limestone that is frequently exposed on the surface. Seven species of concern were recorded.
17	Golf Course/ Housing Area	97		125 acres at former golf course and housing area that is now covered with non-native vegetation. Four species of concern were observed.

Number[1]	Name	Survey Dates		Description
		Disposal Land	Homestead ARS	
18	Pine Rocklands SW of Runway	97		13.7 acre pine rockland remnant southwest of runway. Much of the area is mowed; unmowed areas overgrown with exotics. Mowed rocklands support 15 species of concern.
19	Pine Rocklands Next to Old Wing Head-quarters	97		12.8 acre remnant pine rockland that supports a few relic slash pine and has exposed rock in many areas which supports relatively diverse rockland flora. Sixteen species of concern were recorded from this site.
20	Pine Rocklands on Old Officers Club Road	97		2.6 acre remnant pine rockland that is somewhat open and was likely mowed routinely before Hurricane Andrew. Ten species of concern remain especially around old stumps.
21	Pine Rocklands South of Runway	97		0.4 acre remnant pine rockland south of runway that has considerable evidence of disturbance. Six species of concern were noted at this site.
22	Pine Rocklands South of Hangar	97		0.5 acre remnant pine rockland west of water tower has a relatively diverse rockland flora considering it is adjacent to aircraft pads and human activity. Eleven species of concern recorded from this site.
23	Pine Rocklands 100 Yards South of Water Tower	97		0.2 acre remnant pine rockland south of the water tower. Six species of concern were observed at this location.
24	Pine Rockland 200 Yards South of Water Tower	97		0.2 acre remnant pine rockland south of the water tower. It contains a relatively diverse rockland flora and 11 species of concern were recorded.
25	Pine Rockland North of Build-ing 624	97		0.1 acre pine rockland remnant that has been subject to considerable disturbance; five species of concern were recorded.
26	Pine Rockland West of Build-ing 757	97		0.3 acre remnant pine rockland site that has sustained considerable disturbance; five species of concern were recorded.

Source: **Argonne National Laboratory 1997, Hilsenbeck 1993, PBS&J 1998b.**
Note: [1] Refers to location numbers shown on Figure G-7.

Fifteen of the listed and sensitive plant species of concern were recorded on both disposal land and Homestead ARS, seven species were observed only on disposal land, and four species were observed only on Homestead ARS. Small's milkpea was only observed on the disposal land and was the only federally listed species recorded.

The following is a brief description of the plant species of concern recorded on former Homestead AFB. The locations referenced in these sections appear in Figure G-7 and are listed in **Table G-4**.

Table G-4. Locations of Special-Status Plant Species on the Disposal Property and Homestead ARS

Species	Surveys				Locations
	Disposal Land		Homestead ARS		
	92/93	97	92/93	96/97	
Pine pink orchid	—	✓	—	—	18
Locustberry	✓	✓	✓	✓	1,2,3,4,5,6,8,11,13,14,15,16,18, 19,20,22,24
Porter's spurge	✓	✓	✓	✓	1,2,3,4,5,6,7,8,9,10,11,12,18,19
Silver palm	✓	✓	✓	✓	3,4,8,14,18,19,20,23,24
Christmas berry	✓	✓	✓	✓	1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,18,19,20, 21,22,24,25,
One-nerved ernodea	—	✓	—	—	19,22,
Small's milkpea	—	✓	—	—	19,22,24
Krug's holly	—	—	✓	✓	2,4,6,8,11,15
Wild-potato morning-glory	✓	✓	—	—	3,18,19,20, 21,22,24,26
Pineland jacquemontia	✓	✓	✓	✓	1,2,3,4,5,6,7,8,9,11,13,14, 18,19,20,22,23,24,26
Florida lantana	—	✓	✓	✓	1,12,15,18, 19
Sand flax	—	✓	—	—	18,19,20,22,24,25
Carter's small flowered flax	✓	—	—	—	5,7
Small-leaved melanthera	✓	✓	✓	✓	1,2,3,4,5,8,9,10,11,12,13,14,15,16,18,19,20, 21,22,23,24,26
Rockland painted-leaf	—	✓	✓	✓	1,18
Bahama break	✓	✓	✓	✓	1,2,3,4,5,6,7,8,10,11,12,13,14,15,16,17,18, 19,21,22,23,24,25,26
Royal palm	—	✓	—	—	17
Bahama sachsia	✓	—	✓	—	1,2,3
Wedgelet fern	—	—	✓	✓	2,4,6,8,13,14
West Indian mahogany	—	✓	—	✓	1,11,14,17,19,20
Tetrazygia	—	✓	✓	✓	1,2,4,6,8,11,12,13,14,15,18,19
Giant wild pine	—	✓	—	—	17
Pineland noseburn	—	—	✓	—	1
Florida white-topped sedge	✓	✓	✓	✓	1,2,3,4,5,6,7,8,10,11,12,13,14,15,16,18,19, 20,21,22,23,24,25
Florida pinewood privet	—	—	✓	✓	1,2,4,8,14,15
Florida five-petaled leaf flower	✓	✓	✓	✓	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,18, 19,20,21,22,23,24,25,26
Blodgett's ironweed	✓	—	✓	✓	1,4,5,11,16

Source: **Hilsenbeck 1993, Argonne National Laboratory 1997, PBS&J 1998b.**

G.2.1.1 Federally Listed Species

Small's Milkpea. This is the only federally listed endangered species observed on former Homestead AFB. It is a small legume with purple flowers and a prostrate habit and is endemic to pine rocklands in Miami-Dade County. Small's milkpea was listed as endangered by the federal government in 1985, and the elimination of 98 to 99 percent of the pine rockland habitat in Miami-Dade County was the principal reason for its listing (**USFWS 1998a**). This species was recorded only on disposal land, and observed in three remnant pine rockland areas that ranged in size from 0.2 to 12.8 acres. Small's milkpea does not do well in areas being invaded by non-native species (**USFWS 1998a**).

Deltoid Spurge. The deltoid spurge is a federal and state endangered species. It is a prostrate plant that forms small mats. Its leaves are deltoid to oval in shape and are a few millimeters long. It is restricted to pine rocklands in Miami-Dade County and tends to grow in areas of open shrub canopy, often in sandy areas with sparse ground cover. This species was listed as endangered in 1985 as a result of the elimination of 98 to 99 percent of the pine rocklands in Miami-Dade County. The deltoid spurge is known from 31 locations, including small remnant pine rocklands. Fire suppression, with the resulting buildup of organic matter, and invasion of tropical hammock and exotic species are the major threats to this species' continued survival (**USFWS 1998a**). This species currently occurs in the Homestead area, but was not observed during sensitive plant species surveys on former Homestead AFB or along Military Canal.

G.2.1.2 State Listed Species on Former Homestead AFB

Locustberry. This is a medium-sized shrub typically found in areas with other native hardwood shrubs and occurs in pine rocklands and hardwood hammocks (**Florida Natural Areas Inventory 1997**). This species was observed in numerous locations on former Homestead AFB during all surveys. Twenty plants were recorded at locations 3 and 5 in 1992/93; the number of plants was not reported in 1997. Two hundred plants were observed on Homestead ARS in 1996/97, approximately the same number observed at the same location in 1992/93. There was a large decline in numbers, however, in the southwest easement area (location 2), possibly due to successional changes or invasion of non-native species such as Australian pine and Brazilian pepper.

Porter's Spurge. This state endangered species is a low-growing forb that colonizes areas of low vegetation density and exposed rock, particularly along road edges. It is found in pine rocklands, hardwood hammocks, and beach dunes on limestone soil (**Florida Natural Areas Inventory 1997**). This species was recorded from many areas on former Homestead AFB. Over 530 individuals were recorded on disposal land at locations 3, 5, 7, and 9 in 1992/93 on the disposal land. In 1997, this species was recorded at locations 18 and 19 on the disposal land, but the number of plants observed was not available. One hundred plants were observed in 1996/97 on Homestead ARS, fewer than the approximately 900 plants observed in 1992/93. This species was observed at five locations on Homestead ARS during the 1996/97 survey and was missing from two locations where it was recorded in 1992/93. These changes were probably due to natural succession.

Silver Palm. This state endangered species is found in pine rocklands and hardwood hammocks (**Florida Natural Areas Inventory 1997**). It was recorded from nine locations in small numbers during all surveys. One individual was observed at location 3 on disposal land in 1992/93, while it was found at five locations during the 1997 survey. This species has also apparently increased on Homestead ARS: one plant was observed in 1992/93, while in 1996/97 one plant with fruit was observed at location 4, and nine seedlings were noted at location 14. The seedlings were in a grassy field where they could be damaged or killed by mowing.

Christmas Berry. This state endangered species is found in pine rocklands, hardwood hammocks, and the edge of sinkholes (**Florida Natural Areas Inventory 1997**). It occurs in numerous locations on former Homestead AFB. This woody species forms low, dense mats and has conspicuous red berries. It was found in grassy areas with little shade. Over 100 plants were recorded in 1992/93 on disposal land; it was observed at seven sites in 1997. In 1996/97, it occurred in all areas on Homestead ARS except location 6. Approximately 300 plants were observed, an increase over the 60 plants found in 1992/93.

One-Nerved Ernodea. This state endangered species was recorded at locations 19 and 22 on disposal land in 1997. This species was not found in 1992/92 nor was it recorded on Homestead ARS during the 1996/97 survey.

Pine Pink Orchid. This plant was observed in only one location on disposal land in 1997. It was found growing on the limestone walls of small canals at location 18.

Krug's Holly. This state endangered species was observed at only six locations on Homestead ARS. It is a small tree that grows in scattered, almost pure stands, sometimes inter-mixed with other trees and shrubs in pine rocklands, hardwood hammocks, and disturbed ground (**Florida Natural Areas Inventory 1997**). In 1996/97, it was found on Homestead ARS in moderate to high densities at locations 2, 6, and 15 (about 500 plants observed). More plants were observed in 1996/97 on Homestead ARS than in 1992/93, and most plants recorded in 1996/97 were at location 15, which was not surveyed in 1992/93.

Wild Potato Morning-Glory. This is a state endangered species that occurs in pine rocklands but has also been observed in vacant lots (**Florida Natural Areas Inventory 1997**). It was observed only on disposal land in 1992/93 and 1997. This species was only observed at location 3 during 1992/93, while it was recorded at seven locations in 1997.

Pineland Jacquemontia. This state endangered species was found in many locations on both disposal lands and Homestead ARS. It is a small vine with conspicuous white flowers, found in association with tall grasses and forbs or at the edge of shrubby areas in pine rocklands. It also occurs on spoil banks and in vacant lots on limestone (**Florida Natural Areas Inventory 1997**). Over 100 plants were observed at four locations on disposal land during the 1992/93 survey. During the 1997 survey, it was observed at seven locations with approximately 150 plants, essentially the same number found in 1992/93. This species occurs in many unmowed grassy areas on Homestead ARS. It appears to be most vulnerable to natural succession, invasion by non-native plant species, and frequent mowing; however, occasional high mowing may provide some benefit by reducing shading.

Florida Lantana. This state endangered species was recorded at five locations on both disposal land and Homestead ARS. Lantana was generally found in open, unmowed grassy areas, near the border of shrubby thickets in pine rocklands, and beach dunes (**Florida Natural Areas Inventory 1997**). It was not observed on disposal land in 1992/93, but was seen at locations 18 and 19 on disposal land in 1997. Florida lantana was observed at locations 1 and 12 on Homestead ARS in 1992/93; approximately 45 plants were tallied. Lantana was also recorded on Homestead ARS during the 1996/97 survey, but none of the plants observed could be conclusively identified as Florida lantana. This species hybridizes with the closely related, non-native *Lantana camara*, and this hybridization is considered the most significant threat to the continued existence of the Florida lantana.

Sand Flax. This is a state endangered species endemic to pine rocklands in south Florida (**Florida Natural Areas Inventory 1997**). This species was not recorded in 1992/93 or on Homestead ARS in 1996/97. It was, however, recorded at six locations on disposal land in 1997.

Carter's Small-Flowered Flax. This is a state endangered species observed only on disposal land at locations 5 and 7 in 1992/93. It is endemic to pine rockland habitat in south Florida and can also be found on disturbed ground (**Florida Natural Areas Inventory 1997**). Approximately 55 individuals were observed at the two locations. The plants occurred along banks of small canals that traverse mowed remnant pine rockland habitat. Plants were observed in flower and fruit. This species was not observed on disposal land in 1997.

Small-Leaved Melanthera. This state endangered species was observed in numerous areas on both disposal lands and Homestead ARS. This fairly large, white-flowering forb is typically found in open, unmowed areas, in pine rocklands and on disturbed ground (**Florida Natural Areas Inventory 1997**). In 1992/93, over 380 plants were observed at locations 3, 5, 9, and 10. In 1997, this species was recorded on disposal land in eight areas. Small-leaved melanthera was observed at four locations in 1992/93 and in all areas except location 6 in 1996/97. Approximately 1,000 plants were observed on Homestead ARS in 1996/97, similar to the number observed on Homestead ARS in 1992/93. Threats to the continued existence of this species appear to be natural succession, invasion of non-native plants, and frequent mowing. However, occasional mowing may provide some benefit by reducing shading.

Rockland Painted-Leaf. This is a state endangered species that is endemic to pine rocklands in south Florida (**Florida Natural Areas Inventory 1997**). It occurs on one area of disposal land and one area of Homestead ARS. This small forb was not observed on disposal land in 1992/93, but was observed in 1997 at location 18, which is remnant pine rockland habitat that supports a fairly diverse flora. It was observed only at location 1 in an open area with sparse vegetation on Homestead ARS. Three individuals were observed in 1996/97, while five plants were reported in this same area in 1992/93. The plants observed in 1996/97 had seed capsules, but no young plants were observed. The immediate threat to this species appears to be invasion of non-native plant species such as silk reed and Australian pine, which grow in close proximity to these plants.

Bahama Brake. This state endangered species occurs in many locations on disposal land and Homestead ARS. This small fern was usually observed in open areas near exposed limestone and solution holes in pine rocklands and sinkholes (**Florida Natural Areas Inventory 1997**). During surveys on disposal land, approximately 475 individuals were recorded in 1992/93 at locations 3, 5, 7 and 10; and recorded at nine locations in 1997. Approximately 3,000 plants were observed in all locations surveyed on Homestead ARS in 1996/97 and all areas but locations 9 and 12 in 1992/93. Relatively high numbers were also observed during the 1992/93 survey. The plants observed on Homestead ARS in 1996/97 were in excellent condition.

Royal Palm. Only one of this state endangered species was observed on disposal land at location 17 in 1997. Location 17 includes the golf course and housing development of former Homestead AFB, which are now overgrown with non-native species and turf grass. It is not known if the one plant recorded is native or from nursery-grown stock. This species is typically found in hardwood hammocks (**Florida Natural Areas Inventory 1997**).

Bahama Sachisa. This state endangered species was observed at locations 1, 2, and 3 and only in 1992/93. This species is endemic to pine rocklands in south Florida (**Florida Natural Areas Inventory 1997**) and occurred in small pine-rockland remnants in areas on and near exposed limestone outcrops. A total of 10 plants were observed on disposal land at location 3, and 75 individuals were observed on Homestead ARS at locations 1 and 2. This species was not recorded during resurveys of these areas in 1996 or 1997.

Wedgelet Fern. This is a state endangered species that was observed in six areas on Homestead ARS; it was not recorded on disposal land. This small fern is endemic to pine rocklands in south Florida (**Florida Natural Areas Inventory 1997**) and forms dense clumps on the exposed limestone of shaded canal walls and, to a lesser extent, in limestone solution holes. In 1996/97, the largest populations were observed on Homestead ARS on the walls of canals at locations 4, 8, and 13, and in smaller canals at location 14. Over 2,000 plants were observed in 1996/97, substantially more than were recorded in 1992/93. The populations of this species appear to be increasing, but future threats include the colonization of canal walls by Australian pine and Brazilian pepper and the accumulation of litter and branches of these species in the canals.

West Indian Mahogany. This state endangered species was observed at locations 1, 11, and 14 on Homestead ARS in 1997, and at locations 17, 19, and 20 on disposal land in 1996/97. It was not observed in 1992/93. Five trees were found on Homestead ARS in 1996/97. This tree is typically found in hardwood hammocks and may be colonizing areas on base because of the long-term absence of fire. None showed signs of reproducing, and they may be too young to reproduce. Threats to their continued existence on Homestead ARS are invasion of non-native species, fire, and manual clearing.

Tetrazygia. This state threatened species was observed at 12 locations on disposal land and Homestead ARS. This species is a large shrub or small tree, typically a component of the hardwood shrub community, pine rocklands, and hardwood hammocks, as well as disturbed ground (**Florida Natural Areas Inventory 1997**). It was not observed on disposal land in 1992/93, but was recorded at locations 18 and 19 during the 1997 survey. It was observed in fairly large numbers at several locations on Homestead ARS in 1996/97, and was also seen in several locations in 1992/93. In addition many young individuals were observed, indicating this species is increasing on Homestead ARS. Many individuals observed at locations 2 and 15 during the 1996/97 survey had died back but were resprouting. The reason for the dieback is not known.

Giant Wild Pine. This state endangered species was only observed on disposal land in 1997 and only one individual was recorded at location 17, which is the site of the former golf course and housing area. The land is now overgrown with non-native plant species.

Pineland Noseburn. This is a state endangered species that occurs in pine rocklands and is confirmed only from Miami-Dade and Monroe counties (**Florida Natural Areas Inventory 1997**). It was only observed at location 1 on Homestead ARS in 1992/93, but not in 1996/97. Ten plants were observed at location 1, which is a pine rockland remnant. The plants were confined to several small limestone outcrops near the base of several large pines.

Florida White-Topped Sedge. This is a state sensitive species that was observed in numerous areas on disposal land and Homestead ARS. It is a small, grass-like sedge that occurs in open areas with little or no shade. This species was recorded at four locations on disposal land in 1992/93 and eight locations in 1997. Over 260 clumps or individual plants were observed during the 1992/93 survey on disposal land. Over 8,000 individuals of this species were observed in all areas surveyed on Homestead ARS in 1996/97; numbers of this species have increased substantially in all areas surveyed since the 1992/93 survey.

Florida Pinewood Privet. This state sensitive species was observed at six locations on Homestead ARS but not on disposal land. It is a small- to medium-sized shrub that grows with other shrubs and trees, and occurs in pine rocklands and on shallow mounds in mixed hardwoods (**Florida Natural Areas Inventory 1997**). The total number of plants observed during the 1996/97 survey on Homestead ARS was 135, with the largest populations at locations 2 and 15. Although the number observed on

Homestead ARS during the 1996/97 survey was higher than the 1992/93 survey, most of the additional plants were recorded in areas not surveyed in 1992/93. Colonization of non-native plants is a potential threat to this species.

Florida Five-Petaled Leaf Flower. This is a state sensitive species that was observed in numerous locations on disposal land and Homestead ARS. It is a small, low-growing forb and was most common in areas with little vegetation cover, especially along edges of exposed limestone in pine rocklands and on roadside edges (**Florida Natural Areas Inventory 1997**). This species was observed in five areas during the 1992/93 survey and nine areas during the 1997 surveys on disposal land. The estimated number of plants observed was over 1,500 during the 1992/93 survey. This species was observed at all locations surveyed on Homestead ARS in 1996/97, and over 2,000 individual plants were recorded, which is similar to the number observed in 1992/93. The invasion of non-native species may pose a threat to this species. It can tolerate and may even benefit from occasional mowing.

Blodgett's Ironweed. This state sensitive species is a small forb that occurs in a variety of habitats, including pine rocklands, flatwoods, dry prairie and marl prairie (**Florida Natural Areas Inventory 1997**). It was recorded at five locations on disposal land and Homestead ARS. This species occurs in small numbers, with 12 individuals recorded at location 5 on disposal land in 1992/93. Only 11 individuals were observed at locations 1, 4, 11, and 16 on Homestead ARS in 1996/97. The number of plants observed on Homestead ARS in 1992/93 was similar to 1996/97 numbers, but all plants recorded in the earlier survey were at location 1. Natural succession and the invasion of non-native plant species may pose threats to the continued existence of this species on former Homestead AFB.

G.2.1.3 State Listed Species Along Military Canal

Blodgett's Wild-Mercury. This state endangered species is endemic to pine rocklands and hardwood hammocks in Miami-Dade County and the Florida Keys. It is typically found in wet margins of hardwood hammocks (**Florida Natural Areas Inventory 1997**). One population of four plants was observed about halfway between the salinity control structure and the eastern tip of Military Canal.

Sea-Lavender. This state endangered species is a shoreline shrub that occurs from Florida Keys north to Brevard County. It commonly grows on coastal dunes or on the outer edge of salt flats. Two large plants of this species were observed at the eastern tip of Military Canal. One plant on the northern tip of the canal had partly died back due to competition with the exotic plant, *Scaevola sericea*, while the plant on the southern tip was healthy.

G.2.2 Invertebrates

Schaus Swallowtail Butterfly. Schaus swallowtail butterfly is a federally listed endangered species and is the only sensitive invertebrate known to occur in the area of former Homestead AFB. It is a large blackish-brown butterfly that occurs in undisturbed tropical hardwood hammocks mostly from Elliott Key in Biscayne NP south to northern Key Largo. Recently, its range was extended via reintroductions on Lower Matecumber Key in the Florida Keys and at the Charles Deering Estate County Park north of Biscayne NP. The Schaus swallowtail butterfly was listed as a threatened species in 1976 due to population declines associated with the destruction of tropical hardwood hammock habitat, spraying for mosquitoes, and over harvesting by collectors. It was listed as endangered in 1984 due to dramatic population declines after the initial listing. The largest population is centered on Elliott Key and the surrounding keys. From 1985 to 1990, the estimated population size ranged from 600 to 1,000 adults on Elliott Key, with 50 to 100 individuals on nearby keys. The population was reduced to an estimated 58 individuals after Hurricane Andrew, but increased to over 600 by 1994 and has remained stable since (**USFWS 1998a**).

Schaus swallowtail butterfly occurs in mature and well-drained tropical hardwood hammocks with some natural or man-made openings such as narrow trails. Adults live about two weeks and may be found near openings feeding on nectar of such plants as wild coffee and guava. Eggs are deposited on torchwood or wild lime, which provide food for emerging young (**USFWS 1998a**). This species has not been observed on former Homestead AFB and would not be expected to occur there due to lack of appropriate habitat. It would not be expected to occur in the freshwater and mangrove wetlands between the former base and Biscayne Bay.

G.2.3 Reptiles

Six species of special-status reptiles are known to occur in the Homestead area (see Tables 3.11-3 and 3.11-4). Three species are marine turtles that occur in Biscayne Bay. Information regarding these species was derived from data supplied by Biscayne NP and other sources. As indicated in Section G.1.2, surveys for the American crocodile, eastern indigo snake, and rim rock crowned snake were conducted for this SEIS.

G.2.3.1 Federally Listed Species

American Crocodile. The American crocodile was listed as a federally endangered species in 1975. Its critical habitat was designated in 1979 (**USFWS 1998a**) and is south of Turkey Point and Elliott Key in Biscayne Bay (see Figure 3.11-5). This species is found in coastal habitat in extreme southern Florida, as well as the Caribbean, Mexico, Central America, and northern South America. In south Florida, it once occurred as far north as Lake Worth in Palm Beach County and Tampa Bay, and as far south as Key West. The current distribution includes coastal areas of Dade, Monroe, Collier, and Lee counties (**USFWS 1998a**). Until very recently, the range of the crocodile in the Homestead area was in the mangrove habitat on North Key Largo and near Turkey Point (**Alleman 1995**). There is also a population about 20 miles south of the former base in Florida Bay. Except for scattered reports, this species had not been reported from the mangrove habitat along the west shoreline of Biscayne Bay north of Turkey Point. However, detailed surveys in 1997 and 1998 revealed that the crocodile has apparently expanded its range north of Turkey Point up to Chapman Field Park and apparently to Matheson Hammock County Park (**Denton and Godley 1999, Dalrymple 1998, Mazzotti 1999b, Mazzotti and Cherkiss 1998**).

The American crocodile is found primarily in mangrove swamps and along low-energy mangrove lined bays and creeks (**Kushlan and Mazzotti 1989**). At Turkey Point, adult crocodiles were found most frequently in the low saline and fresh water canals and ditches, subadults were in all areas, and juveniles in the most saline ditches. Other studies have also shown that adult crocodiles prefer less saline water (**Kushlan and Mazzotti 1989**) and exclude the juveniles from these preferred areas. Adult females at Turkey Point use higher saline water for nesting since the only good nesting habitat is adjacent to higher saline water (**Brandt et al. 1995**).

Male American crocodiles typically begin to establish breeding territories in late February. Territorial defense takes the form of vocalization, body posturing, and aggression. Following courtship and mating, females search for a nest site which, under natural conditions, includes sites with sandy shorelines or raised creek beds next to water (**USFWS 1998a**). Nesting at the north end of Key Largo and Turkey Point takes place on levees and spoil banks associated with canals (**Brandt et al. 1995, Moler 1991**), while nesting at Chapman Field Park takes place next to a borrow pit (**Dalrymple 1998**). There are no known crocodile nest sites in natural habitats in the Biscayne Bay-Key Largo area (**Mazzotti 1999a**). Nesting takes place from late April into early May. Incubation lasts about 86 days, during which time the female periodically visits the nest. In Florida, crocodiles are not known to regularly defend their nests against humans (**Kushlan and Mazzotti 1989**). The female must excavate the young from the nest after hatching because they cannot dig themselves out. Hatchlings stay in close proximity to the nest site for four to five weeks and then disperse. Most go only a short distance, but some may move 5 to 6 miles within three months of hatching (**Moler 1991**).

An estimated 1,000 to 2,000 crocodiles may have existed early in the 20th Century and by the mid-1970s, numbers of non-hatchling crocodiles were estimated at 100 to 400. The decline was due to habitat loss, collection, and hunting as well as human encroachment into estuarine habitats. The American crocodile population in south Florida has increased substantially over the last 20 years and this is best indicated by the increase in nesting crocodiles from 20 in the late 1970s to about 48 nests in 1995 (**USFWS 1998a**).

The closest nesting population of American crocodiles to the Homestead area is at Turkey Point. The cooling water canal system at Turkey Point was completed in 1974. Adult crocodiles were first observed at this site in 1976 and the first nest was discovered in 1978. The estimated non-hatchling population size was 17 to 19 from 1978 to 1981 (**Gaby et al. 1985**), and 24 to 30 from 1984 to 1993 (**Brandt et al. 1995**). The number of crocodiles at Turkey Point appears to be leveling off and the site may be reaching carrying capacity (**Brandt et al. 1995**).

Another American crocodile population occurs about 20 miles south of former Homestead AFB in Florida Bay in Everglades National Park. This population is centered in the crocodile sanctuary in northern Florida Bay in the area of Little Madeira and Joe Bays. The sanctuary was established in 1980 and covers 8,143 acres. Boat traffic and other recreation were originally prohibited throughout this area, but in 1992, some areas not frequented by crocodiles were reopened to boat traffic. Critical locations, such as areas used for nesting, are still off limits to all users (**Snow 1992**).

As indicated above, until recently, the American crocodile had not reoccupied its historic habitat along the western shoreline of Biscayne Bay north of Turkey Point (**Alleman 1995**). However, surveys in 1997 and 1998 revealed the presence of the American crocodile in that area (**Mazzotti and Cherkiss 1998**). Hatchlings were observed in September 1997 in a borrow pit at Chapman Field County Park about 14 miles north of Turkey Point and 11 miles north of Military Canal (**Dalrymple 1998, Mazzotti and Cherkiss 1998**). A total of 25 hatchlings were captured in the borrow pit, as well as several juvenile crocodiles up to 50 inches long (**Dalrymple 1998**).

Crocodile surveys were conducted in 1998 on former Homestead AFB, along 37 miles of canals near the former base, and along about 7 miles of the west shoreline of Biscayne Bay (see Table G-2, Figures G-2 and G-3). Each location was surveyed three times from June 7 through July 22, 1998. No crocodiles were observed at former Homestead AFB, but the spectacled caiman was common and a few American alligators were also observed (**Figure G-8**). The caiman was recorded 30 times, with the largest number observed during the second survey (**Table G-5**). It is assumed that at least 30 adult caiman reside on the former base based on the second survey, where 16 caiman and 14 unidentified crocodilians (assumed to be mostly caiman) were recorded. The crocodile was recorded twice in Florida Canal and twice in Goulds Canal (**Figure G-9**). The crocodiles were the same size and in the same location each time, so it is assumed that this represents two crocodiles. The alligator was common throughout the canal system and only one caiman was detected in the canals (**Figure G-10**). The maximum number of alligators detected was 19 during the second survey and, assuming the 11 unidentified crocodilians recorded during this survey were alligators, then at least 30 adult alligators resided in the 37 miles of canals surveyed or about one adult alligator per mile of canal (**Table G-6**). The crocodile was detected twice during wading bird surveys in June and July 1998: one at the mouth of Military Canal and the other in the Black Point area. These and other recent surveys have resulted in 11 crocodile observations from the Florida City Canal to Black Point in 1997 and 1998.

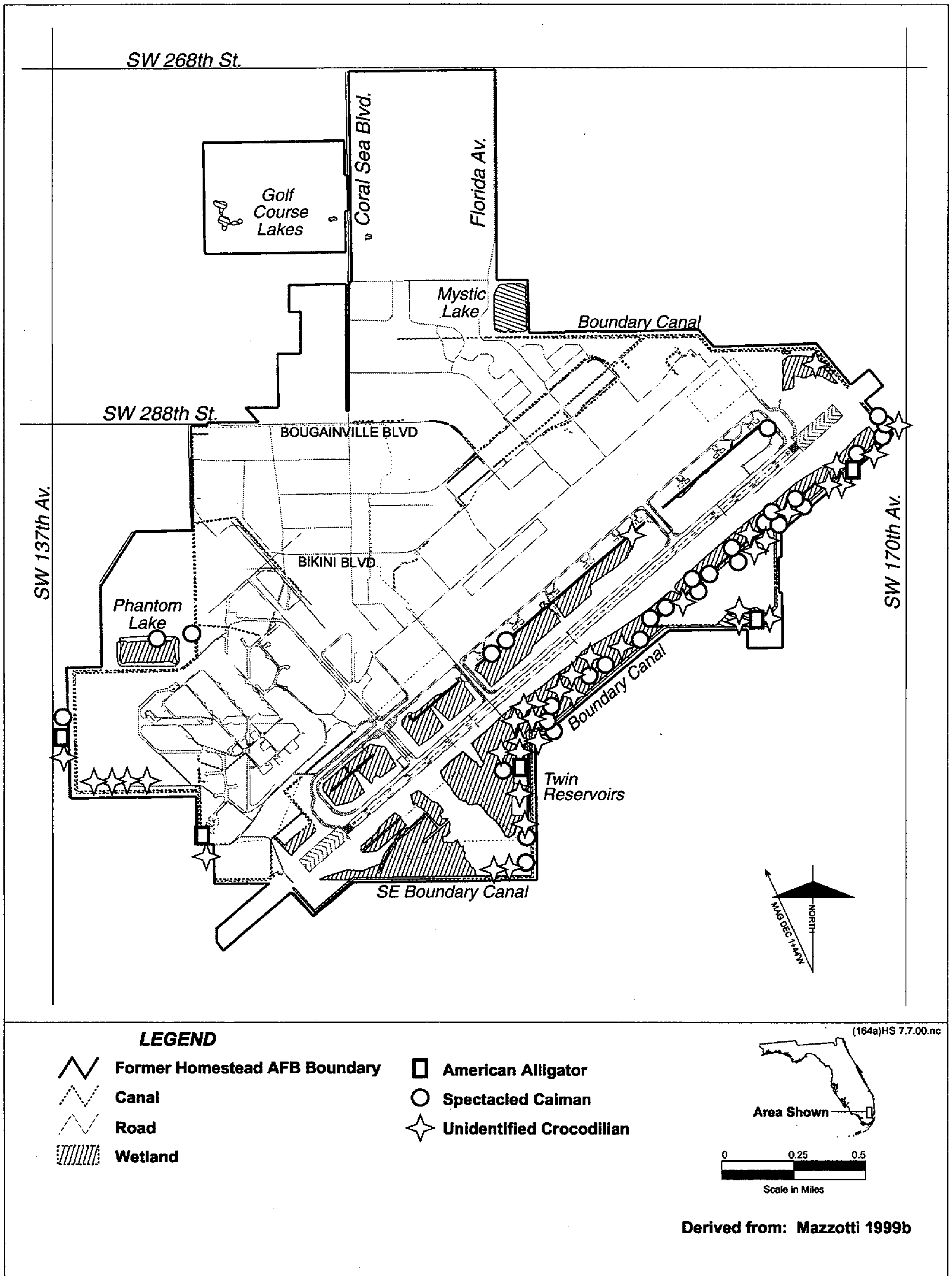


Figure G-8
Locations of Crocodilians
on Former Homestead AFB, June and July 1998

Table G-5. Alligator, Caiman, and Unidentified Crocodilian Observed on Former Homestead AFB, June and July

Species	Boundary Canal			Marsh	Reservoir	Twine Reservoirs	Canal North of Runway	Total
	South	West	East					
Alligator								
S1	2	0	0	0	1	0	0	3
S2	0	0	0	0	0	0	0	0
S3	0	2	0	0	0	0	0	2
Caiman								
S1	3	0	0	2	0	0	0	5
S2	1	1	2	12	0	0	0	16
S3	1	1	1	3	0	0	3	9
Crocodilian sp.								
S1	0	2	1	3	0	0	0	6
S2	1	0	0	12	0	1	0	14
S3	4	4	1	3	3	0	1	16
Total								
S1	5	2	1	5	1	0	0	14
S2	2	1	2	24	0	1	0	30
S3	5	7	2	6	3	0	4	27
Grand Total	**12**	**10**	**5**	**35**	**4**	**1**	**4**	**71**

Source: **Mazzotti 1999b.**
Note: S1 took place on June 7, 1998, S2 on June 28 and 29, 1998, and S3 on July 17 and 18, 1998.

Green Sea Turtle. In July 1978, the green sea turtle was listed as a federally endangered species in Florida and along the Pacific Coast of Mexico and is threatened in the remainder of its range. It can be found world wide, mostly in tropical and subtropical waters. It occurs around the U.S. Virgin Islands, Puerto Rico, and along the continental United States from Texas to Massachusetts. Areas known to be important feeding areas for the green sea turtle in Florida include Indian River Lagoon, Florida Keys, Florida Bay, and Cedar Key (**USFWS 1998a**).

In Florida, the green sea turtle nesting season is from June through September. Female green turtles emerge from the ocean at night to deposit their eggs, and from one to seven clutches can be deposited over the course of the nesting season; the average number of eggs per clutch is 136. Females typically do not breed every year; two to more than four years may pass before a female will produce eggs again. The age at sexual maturity for the green sea turtle ranges from 20 to 50 years (**USFWS 1998a**).

The number of nests in Florida ranged from 455 to 2,509 during 1988 to 1992. An increase in green turtle nests in Florida has been observed, but the reason for this increase is unknown. It could represent an actual increase in nesting or be the result of increased monitoring (**USFWS 1998a, Meylan et al. 1995**). In south Florida, the largest number of nests per year from 1985 through 1995 were observed in Palm Beach (301) and Martin counties (163); the average number of nests in Miami-Dade (4.5) and Monroe (6.5) counties was lower (**USFWS 1998a**).

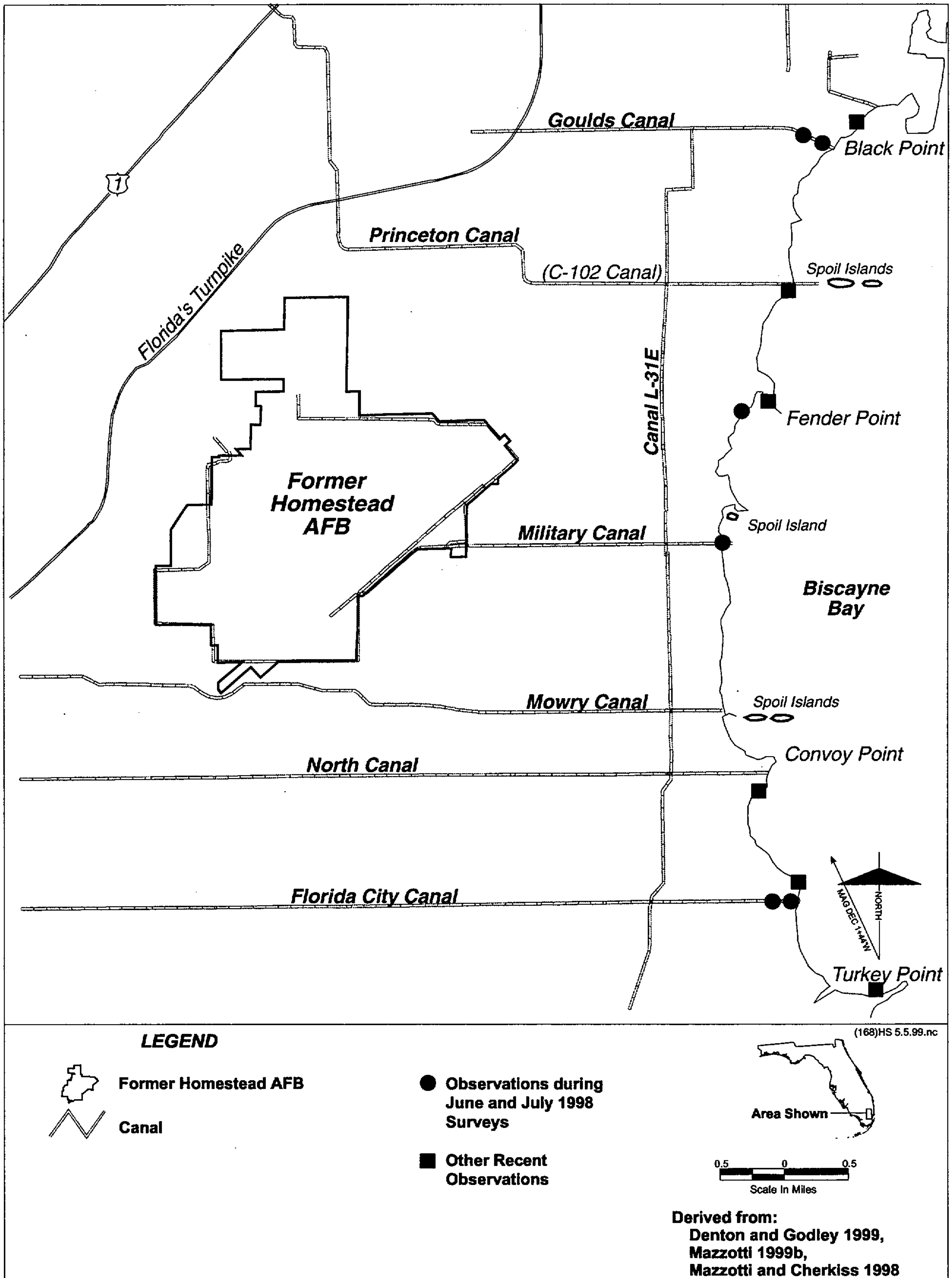


Figure G-9
Recent American Crocodile Observations Along the Western Shoreline of Biscayne Bay Between Turkey Point and Black Point

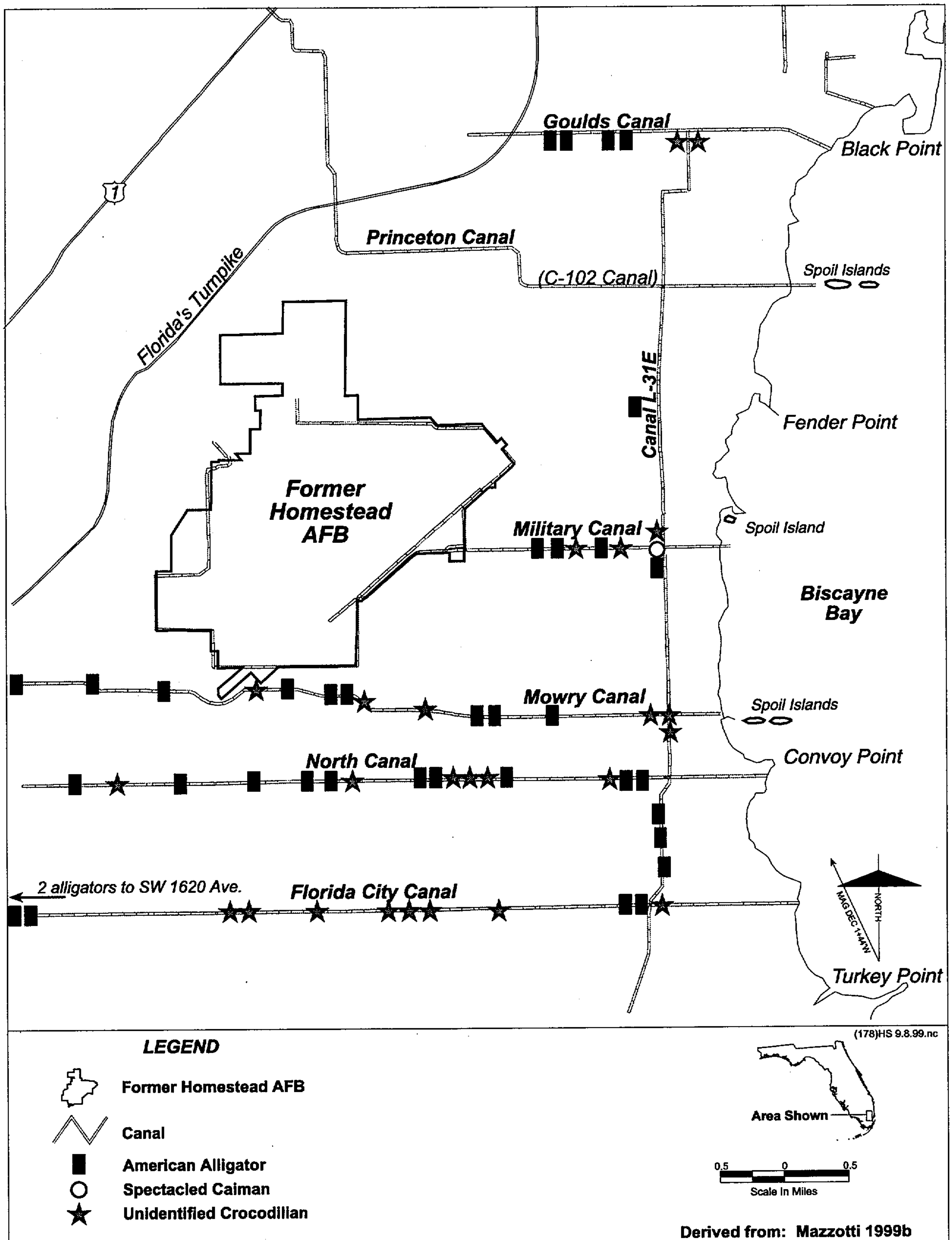


Figure G-10
Locations of Alligators, Spectacled Caiman, and Unidentified Crocodilians Observed During the Surveys in June and July 1998 Along Canals in the Area of Former Homestead AFB

Table G-6. Alligator, Caiman, Crocodile, and Unidentified Crocodilian Observed in the Canals in the Area of Former Homestead AFB, June and July 1998

Species	Canals							Total
	Goulds	Military	North	C-102	Fl. City	Mowry	L-31E	
Alligator								
S1	2	1	1	0	0	0	0	4
S2	1	3	6	1	3	4	1	19
S3	1	0	4	0	0	4	2	11
Caiman								
S1	0	1	0	0	0	0	0	1
S2	0	0	0	0	0	0	0	0
S3	0	0	0	0	0	0	0	0
Crocodile								
S1	1	0	0	0	0	0	0	1
S2	0	0	0	0	1	0	0	1
S3	1	0	0	0	1	0	0	2
Crocodilian sp.								
S1	0	1	4	0	0	0	0	5
S2	0	2	1	1	5	1	1	11
S3	1	0	1	0	3	3	3	11
Total								
S1	3	3	5	0	0	0	0	11
S2	1	5	7	2	9	5	2	31
S3	3	0	5	0	4	7	5	24
Grand Total	**7**	**8**	**17**	**2**	**13**	**12**	**7**	**66**

Source: **Mazzotti 1999b.**
Note: Refer to Figure G-3 for location of surveys. S1 took place on June 8 and 9, 1998, S2 on June 27 and 30, 1998, and S3 on July 20 and 23, 1998.

Except during migration, the green sea turtle is generally found in fairly shallow waters inside reefs, inlets, and bays. They are attracted to shallow water areas that have an abundance of marine plant life. The green sea turtle has not been recorded as a nesting species on the beaches of the keys in Biscayne NP. The closest known nesting sites are beaches in Miami-Dade County north of the park (**Mansfield 1996, USFWS 1998a**). This species has been frequently observed on the reef and in the sea grass beds in Biscayne Bay and uses the bay for foraging (**Alleman et al. 1995, Mansfield 1996**). The green sea turtle would be expected to forage along the western shoreline of Biscayne NP and in the salt water portion of Military Canal. Seventeen green sea turtle strandings were reported from Biscayne NP from 1995 through 1998; most of these turtles died or were dead (**BNP 1995, Mansfield 1996, Moulding and Lockwood 1997, Lockwood et al. 1999**).

Eastern Indigo Snake. This snake is a state and federally threatened species. It is the longest snake in North America, reaching lengths of over 8.5 feet. Historically, it occurred in the southern United States, including all of Florida and the coastal plains of Georgia, Alabama, and Mississippi. Georgia and Florida currently support the remaining populations of the eastern indigo snake, although it could still occur in Alabama. This species is thought to be widely distributed in Florida (**Moler 1985**). In south Florida, it occurs in pinelands, tropical hardwood hammocks, and mangrove forests. They seem to prefer hammocks and pine forests, since most observations occurred in these habitats (**Steiner et al. 1983**). The indigo snake also frequents canal banks in south Florida and may enter the water or crab holes along canal banks to escape (**Lawler 1977**). Eastern indigo snakes also make use of agricultural lands and various types of wetlands (**USFWS 1998a**).

Information regarding the reproductive cycle of the eastern indigo snake in south-central Florida indicates that breeding takes place from June to January, and egg laying from April to July, with hatching occurring from mid-summer to early fall. The indigo snake is an active, terrestrial predator. Their diet includes fish, amphibians, reptiles, birds, and mammals. These wide-ranging snakes utilize a large area of land; the average home range size for males in south-central Florida was 138 acres and females 47 acres. The male's maximum home range was almost 500 acres; the maximum female home range was 120 acres (**USFWS 1998a**).

The eastern indigo snake was listed as a threatened species because of a reduction in numbers due to habitat loss, collecting for the pet trade, and gassing gopher tortoise burrows for rattlesnakes. At the time of listing (1978), the main factor causing the decline of this snake was collecting for the pet trade. Pressures from pet collecting have been reduced due to effective law enforcement. Presently, the main cause for this species decline is habitat loss (**USFWS 1998a**). As noted above, this species has a large home range making it vulnerable to habitat loss, fragmentation, and degradation. Habitat is being destroyed by residential, commercial, and agricultural development, as well as by timber harvesting. Low-density housing is also a threat to this snake due to mortality caused by land owners and pets, as well as increased mortality along newly constructed roads. At present, there is no quantitative data to determine long-term trends of the indigo snake populations in south Florida. The indigo snake will probably persist where large sections of habitat (1,000 to 10,000 acres) remain. Preliminary estimates of the amount of land needed to protect the indigo snake are about 10,000 acres of unaltered habitat. However, population modeling will need to be completed to determine if a population of eastern indigo snakes could persist on this amount of land (**USFWS 1998a**).

Eight museum specimens collected between 1929 and 1967 from the Homestead and Florida City areas indicate this species inhabited this area historically. More recently, 13 observations of the eastern indigo snake were recorded from Biscayne NP; three at Convoy Point and the remainder on Sands, Elliott, and Old Rhodes Keys. Based on over 100 observations, freshwater marsh, mangrove forest, and abandoned farmland are considered marginal habitat for the eastern indigo snake. Only five sightings of this species occurred in mangrove swamps (6 percent of the total); of these, three were along canal berms and two were in wading bird colonies (**Steiner et al. 1983**).

Prior to Hurricane Andrew, Homestead AFB was in full operation and there would have been essentially no potential eastern indigo snake habitat on most of the base given the high degree of development and human activity. Some potential habitat likely existed south of the runway in wetlands and other undeveloped lands. Currently, much of former Homestead AFB outside of the Homestead ARS consists of abandoned land with much less human activity, and this area may now provide habitat for the eastern indigo snake. Biological surveys were conducted on the disposal lands in 1992, 1993, and 1997 and the indigo snake was not observed (**Hilsenbeck 1993, Geraghty & Miller 1993, PBS&J 1998b**). Surveys specifically for this species were conducted in much of the disposal property during the summer of 1998 (see Figure G-4 for survey area) and this species was not observed. In addition, the eastern indigo snake was not observed on the former base during other intensive wildlife surveys in 1998, including surveys for the American crocodile, rim rock crowned snake, neotropical migrant breeding birds, wading birds, Southeastern American kestrel, and burrowing owl. The eastern indigo snake was said to occur on the Homestead ARS (**SEA 1996**); however, this observation was not confirmed (**Mitchell 1999**). Homestead ARS is highly developed so it is doubtful the snake inhabits that area. It may occur occasionally along the canals and other water bodies near the base boundary that are adjacent to open land. It was also listed as a confirmed species on former Homestead AFB in a recent species account (**Hallam et al. 1998**). However, it was determined that the eastern indigo snake was not actually observed on the former base but was assumed to occur because of historical observations in the area and availability of potential habitat (**Moler 1999**).

There have been recent reports of the eastern indigo snake on lands between the former base and Biscayne Bay. An indigo snake was recently observed on disturbed land during a recent USEPA study (**Metro-Dade County 1994b**). The location of this observation was not provided. It and its shed skin have also been observed along Florida City Canal in recent years (**Moler 1999**). An adult indigo snake was observed along the berm of Military Canal on July 13, 1998. This indicates that the mangrove fringe forest, exotic dominated freshwater wetlands, canals, and abandoned lands east of former Homestead AFB are eastern indigo snake habitat. This would also include the agricultural land next to the above habitats and along the canals but not agricultural lands well away from the preferred habitat. The freshwater wetlands and mangrove forests, as well as agricultural lands near these habitats may represent marginal habitat for this species (**Steiner et al. 1983**).

Hawksbill Sea Turtle. The hawksbill sea turtle was listed as an endangered species by the federal government in 1970; it is also a State of Florida endangered species. Critical habitat for this species has been designated in Puerto Rico. This species occurs primarily in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. In U.S. jurisdictional waters, it is most common in Puerto Rico and the U.S. Virgin Islands. It also occurs along all the Gulf of Mexico states and along the Atlantic Ocean as far north as Massachusetts, but sightings north of Florida are rare (**USFWS 1998a**).

The hawksbill sea turtle is observed with some regularity in the waters off the Florida Keys and the reefs off Palm Beach County. Coral reefs are important foraging areas for this species because it feeds on sponges and other organisms that need a hard substrate to grow (**USFWS 1998a**). However, Hawksbills are also known to inhabit mangrove fringed bays and estuaries where coral reefs are absent (**Carr 1952**).

Nesting occurs July to October at low- to high-energy beaches, and the female typically emerges from the water at night and lays an average of 140 eggs. As with the green sea turtle, the female may lay eggs more than once during the nesting season, and then not reproduce again for a number of years. Within the continental United States, nesting occurs along the southeastern coast of Florida, including Miami-Dade and Monroe counties.

The hawksbill sea turtle has been recorded as nesting on one of the keys in Biscayne NP; two nests were observed in 1981 and two in 1990. The outcome of these nesting attempts is not known (**Moulding and Lockwood 1997**). Strandings of this species have also been reported from Biscayne NP, one each in 1995, 1996, and 1997 and zero in 1998 (**BNP 1995, Mansfield 1996, Moulding and Lockwood 1997, Lockwood et al. 1999**). The hawksbill sea turtle is less common in Biscayne Bay than the green and loggerhead sea turtles (**Alleman et al. 1995**), likely due to its preference for feeding on sponges that occur on coral reefs. This species may occur occasionally in waters near the mangrove fringe along the western shoreline of Biscayne NP and the salt water portion of Military Canal.

Loggerhead Sea Turtle. This turtle was designated as a federal threatened species in 1978 and is a State of Florida threatened species. It is distributed in temperate and tropical waters and inhabits the continental shelves and estuarine environments of the Atlantic, Pacific, and Indian oceans. The loggerhead sea turtle nests along the coast of the continental United States from Louisiana to Virginia. Major nesting areas are found on the coastal islands of North Carolina, South Carolina, and Georgia, as well as along the Atlantic and Gulf coast of Florida. This species nests in all coastal counties in south

Florida; the majority occur along the east coast in counties north of Miami-Dade County (**USFWS 1998a**).

Habitat used by the loggerhead sea turtle varies with age. Hatchlings apparently head to the open ocean after hatching and live in the pelagic drift lines for several years. Subadults then apparently move to the nearshore environment and live in estuarine waters near the coasts. Adults are also found in the nearshore environment. The primary food of subadult and adult loggerheads is invertebrates such as gastropods, mollusks, and crustaceans (**USFWS 1998a**).

In the southeastern United States, loggerheads begin nesting as early as mid-March and continue into September, with the peak months being June and July. Mean clutch size in the southeastern U. S varies from 100 to 126 and, as with other sea turtles, the female may nest multiple times during the nesting season. Incubation in Florida averages 53 to 55 days, and natural hatching success rates of 55.7 percent have been reported for Florida (**USFWS 1998a**).

The estimated number of loggerheads nesting in the southeastern United States in the 1980s was about 14,150 and, assuming 4.1 nests per female, these females accounted for about 58,000 nests. More recent data since 1990 indicates that the number of loggerhead nests in the southeastern United States is currently 60,000 to 70,000 (**Meylan et al. 1995**). These totals are believed to constitute 35 to 40 percent of the loggerhead turtles worldwide. From a global perspective, the southeastern United States nesting populations of the loggerhead sea turtle is second in size to the nesting aggregations of the islands in the Arabian Sea and is of paramount importance to the survival of the species (**USFWS 1998a**).

Data from 1989 to 1995 showed that the number of loggerhead nests in Florida ranged from about 39,200 to 59,400, with the largest number of nests in Brevard County. The average number of loggerhead nests in south Florida from 1985 to 1995 was about 29,400, and an average of 347 nests (1.2 percent of the total) were in Miami-Dade County (**USFWS 1998a**).

The loggerhead sea turtle nests on the keys in Biscayne NP, and detailed nesting studies have been conducted since 1995. Fifteen nests were discovered in 1995, and although the nesting species was not determined, they were all likely loggerhead nests. Eleven of the 15 nests were preyed on by raccoons (**BNP 1995**). In 1996, 19 nests were found and all were loggerhead nests. Twelve nests were preyed on by raccoons, including four that were totally destroyed, and eight that were partially destroyed. Reduced predation rates may have been due to the use of screens over the nest sites to protect them from raccoons. The 1996 average clutch size was 90.4; hatching success was 60.7 percent; and an estimated 779 hatchlings entered the ocean (**Mansfield 1996**). In 1997, six loggerhead nests were found and the predation rate was zero due to the use of screens. Hatching success was 62.8 percent, and an estimated 210 hatchlings entered the ocean (**Moulding and Lockwood 1997**). Thirty-eight loggerhead nests were found on Elliott, Boca Chita, and Soldier Keys in 1998. An estimated 910 hatchlings entered the ocean for a hatching success of 45.5 percent. Hatchling success was lower in 1998 than 1997 due to an increase in predation (**Lockwood et al. 1999**). Eighteen loggerhead sea turtle strandings were reported from Biscayne NP from 1995 through 1998 (**BNP 1995, Mansfield 1996, Moulding and Lockwood 1997, Lockwood et al. 1999**).

The loggerhead, along with the green sea turtle, are the species most frequently observed within Biscayne Bay (**Alleman et al. 1995**). This species would be expected to occur along the mangrove fringe of the western shoreline of the Bay and in the salt water portion of Military Canal.

G.2.3.2 State Listed Species

Rim Rock Crowned Snake. The rim rock crowned snake is a state threatened species and is found in eastern Miami-Dade and Monroe counties. Information from recent sightings indicates this species occurs in the area of former Homestead AFB (**Lynch 1998**). This species may be the rarest snake in Florida and is threatened due to the destruction of habitat throughout its range (**Moler 1992**).

The rim rock crowned snake has been observed in pine rocklands, tropical hammocks, and disturbed ground such as vacant lots (**Florida Natural Areas Inventory 1997**). It can be found beneath trash, rocks, and rotten logs. Limited potential habitat for this species occurs in the disposal land on former Homestead AFB, principally in the remnant pine rocklands and abandoned lands. This snake was not observed on former Homestead AFB during biological studies in 1992, 1993, and 1997 (**Hilsenbeck 1993, Geraghty & Miller 1993, PBS&J 1998b**), although these surveys were not specifically designed to look for this secretive species. A survey for this species was conducted in June and July 1998, by establishing funnel traps and searching appropriate areas (see Figure G-4). The rim rock crowned snake was not captured during 336 trap nights at 15 funnel traps nor was it detected during searches. In addition, it was not detected on or outside the former base during other biological surveys conducted in 1998. This indicates that the rim rock crowned snake is unlikely to occur on former Homestead AFB.

G.2.4 Birds

Six federally listed bird species occur or have the potential to occur in the Homestead area (see Table 3.11-3). These species are also listed as endangered or threatened by the state.

G.2.4.1 Federally Listed Species

Wood Stork. This bird is listed as an endangered species by both the federal and Florida state governments. The U.S. population of the wood stork was listed as endangered by the federal government in 1984 because it had declined by more than 75 percent since the 1930s. There is uncertainty regarding the size of the wood stork population in the 1930s; estimates have varied from 9,400 to 25,000 pairs and over 150,000 individuals (**USFWS 1998a, Kushlan and Frohring 1986**). By the 1970s, the estimated number of pairs was between about 5,110 and 7,600 (**USFWS 1998a**). Data from the mid-1980s indicated that the wood stork population stabilized at about 6,000 nesting pairs (**Ogden et al. 1987**) and, more recently (from 1991 through 1995), the number of nesting pairs ranged from 4,100 to 7,850 (**USFWS 1998a**). Prior to the mid-1970s, the U.S. population of the wood stork apparently did not breed outside of Florida; it now breeds in parts of Georgia and coastal South Carolina. An estimated 30 to 35 percent of the wood storks nested in south Florida in the early to mid-1990s, and the remainder nested further north in Florida, Georgia, and South Carolina (**USFWS 1998a**). From 1992 through 1998, the number of nesting pairs of wood storks in the Everglades ranged from 25 (1998) to 567 (1992) (**Frederick 1995; Gawlik 1997, 1998**). During the non-breeding season (July to October), wood storks are much less common in south Florida (**USFWS 1998a**).

The wood stork is primarily associated with fresh water marshes, which it uses for nesting, roosting, and foraging. They typically nest in tall trees in swamps or on islands that are surrounded by open water. Coastal nesting sites occur in red mangrove and, occasionally, Brazilian pepper, cactus, and Australian pine (**Rodgers et al. 1996**). During the non-breeding season or while foraging, storks can be found in a wide variety of wetland habitats, including freshwater marshes, stock ponds, narrow tidal creeks, and seasonally flooded roadside or agricultural ditches. The wood stork has a specialized feeding behavior that requires a fairly high density of fish to be successful. As a result, this species will forage in a wide variety of wetlands where fish have become concentrated. Although most wood storks no longer nest in the Everglades, the wetlands in this area are still important winter feeding areas. For example, during the winters of 1985 and 1989 (drought years), an estimated 29 and 40 percent of the U.S. wood stork population foraged in the wetlands in the water conservation areas north of Everglades NP. During the wet years of 1986 through 1988, an estimated 8 to 10 percent of the U.S. wintering population foraged in wetlands in south Florida (**Bancroft et al. 1992**).

Wood storks may nest in the same area as long as the site is undisturbed and foraging habitat exists in the surrounding area. As a result of drainage of wetlands, many wood storks have shifted their nest sites from natural to impounded wetlands. A shift in wood stork breeding colonies from south Florida to north and central Florida, as well as into Georgia and South Carolina has been observed. This shift may be due to a greater food availability in the northern breeding grounds than in south Florida (**Ogden et al. 1987**). Traditionally, wood storks in south Florida nested between November and January, but in response to deteriorating habitat, wood storks now start to nest in February or March of most years. Wood stork productivity varies greatly between years, with low production during years of limited food supplies and higher production when food supplies are greater (**USFWS 1998a**).

There are no known wood stork nest sites in the area of former Homestead AFB. The bird was not observed during the summer 1998 survey on the former base, or in the freshwater wetlands and mangrove forest along Biscayne Bay east of the former base. It was also not observed on the former base during prior summer studies (**Hilsenbeck 1993**). However, wood stork were recorded on the former base on February 11, 12, and 13, 1998; the largest number, 10, was seen on February 11 (**Table G-7**). It was also reported from disposal property (**PBS&J 1998b**), and single birds were observed foraging on disposal property twice in March 1997. The wood stork has been observed in freshwater wetlands and mangrove forests along the western shoreline of Biscayne Bay and points inland from Turkey Point north to Chapman Field Park. Observation along the western shoreline of Biscayne Bay north of Turkey Point indicates this species forages along the mangrove fringe, in freshwater wetlands, and along shallow roadside ditches (**Metro-Dade County 1994b, Dalrymple 1998, Lynch 1999, Lockwood 1998a**). Most of these observations were of single or small groups, although up to 13 were observed at Chapman Field Park (**Dalrymple 1998**), and 10 were recorded at Mangrove Point just south of Turkey Point in January 1982 (**BNP 1998**). Up to 15 wood storks were observed feeding in shallow roadside ditches over a two-month period during the winter of 1996. No birds were observed at this location during the winter of 1997, and one was observed during the winter of 1998. This location is about 1.1 miles north of the former base (**Peterla 1999b**). Most observations were during November through March, although two reports did not provide dates (**Metro-Dade County 1994b, Dalrymple 1998**). These studies confirm that the wood stork is uncommon in south Florida, including the Homestead area, during the summer. These studies also show that individuals or small groups of wood storks can be expected to occur in wetland habitat between former Homestead AFB and Biscayne Bay, particularly during the winter and early spring. Very few wood storks would be expected on the former base.

Snail Kite. The snail kite is considered endangered by the federal government and the State of Florida. It is a medium-sized raptor that occurs in Florida, Cuba, and Honduras. Critical habitat west of Homestead has been designated for this species (see Figure 3.11-5). The current distribution of the snail kite is limited to the central and southern portions of the state from the Kissimmee Chain of Lakes south to Lake Okeechobee and the Everglades (**USFWS 1998a**). This species also is known from the C-111 Basin west of U.S. Highway 1. In addition to the large freshwater systems described above, the snail kite uses many other smaller, widely dispersed wetlands within its range (**Bennetts and Kitchens 1997b**).

Table G-7. Number of Wading Birds Observed by Month on Former Homestead AFB in 1998

Month (n)[1]	Species						Total
	White Ibis	Cattle Egret	Great Egret	Great Blue Heron	Wood Stork	Other[2]	
January (18)	106	157	16	7	0	88	374
February (18)	98	22	39	38	16	126	339
March (16)	39	41	38	19	0	14	151
April (17)	18	295	18	4	0	0	335
May (18)	0	599	7	21	0	0	627
June (20)	3	587	4	22	0	0	616
July (20)	155	832	38	18	0	5	1048
August (12)	218	360	24	43	0	6	651
September (7)	750	110	0	59	0	0	919
October (16)	1062	290	22	56	0	0	1430
November (15)	641	425	16	11	0	50	1143
December (13)	81	15	1	54	0	0	151
Total (190)	3,171	3,733	223	352	16	289	7,784

Source: **Peterla 1999a.**
Notes: [1] Number of observations in parenthesis.
[2] Other comprises mostly little blue herons and snowy egrets with some tri-colored herons.

Snail kite habitat consists of freshwater wetlands and shallow vegetated edges of lakes were its primary food source, the apple snail, can be found. Freshwater marshes used by foraging snail kites have been characterized as palustrine emergent, long-hydroperiod wetlands (**Cowardin et al. 1979**). Typical foraging habitat is freshwater wetlands containing vegetation less than 10 feet high interspersed with open clear, calm water. Emergent vegetation in these wetlands includes spikerush and cattail, and common submerged species are water lily and arrowhead. Low trees and shrubs, such as willow and bald cypress, are often present and provide perches for foraging snail kites. Nesting is always over water, and nests are constructed in trees, shrubs, and wetland emergent vegetation. Roost sites are almost always over water, and more than 90 percent of the roost sites in Florida are in willow (**USFWS 1998a**).

During the non-breeding season, the snail kite roosts communally with anhingas, herons, and vultures. It nests in loose colonies and often forages in close proximity to other snail kites and, in some cases, with other birds such as herons (**Bennetts and Dreitz 1997**). The snail kite feeds almost exclusively on apple snails, although on rare occasions, it may feed on small turtles and fish (**Bennetts et al. 1994**). The snail kite is non-migratory, although they are highly nomadic within their range. Movements appear to be in response to changing water depths, hydroperiod, and food availability (**Bennetts et al. 1994, Bennetts and Kitchens 1997b**). Radio telemetry data indicate that the snail kites move throughout their range in Florida. They should be considered one population and managed on a regional basis (**Bennetts and Kitchens 1997a**).

The snail kite has been listed as endangered by the federal government since 1967 because of drastic population declines. In 1965, only 10 birds were found; 21 birds were found in 1967. Historically, the snail kite was considered common and was seen in groups of 100 birds. The numbers declined dramatically in the 1950s and 1960s. Annual midwinter surveys since 1969 have shown that the snail kite has increased in numbers. For example, from 1985 through 1994, an average of 562 snail kites were recorded, with almost 1,000 birds counted in 1994 (**USFWS 1998a**).

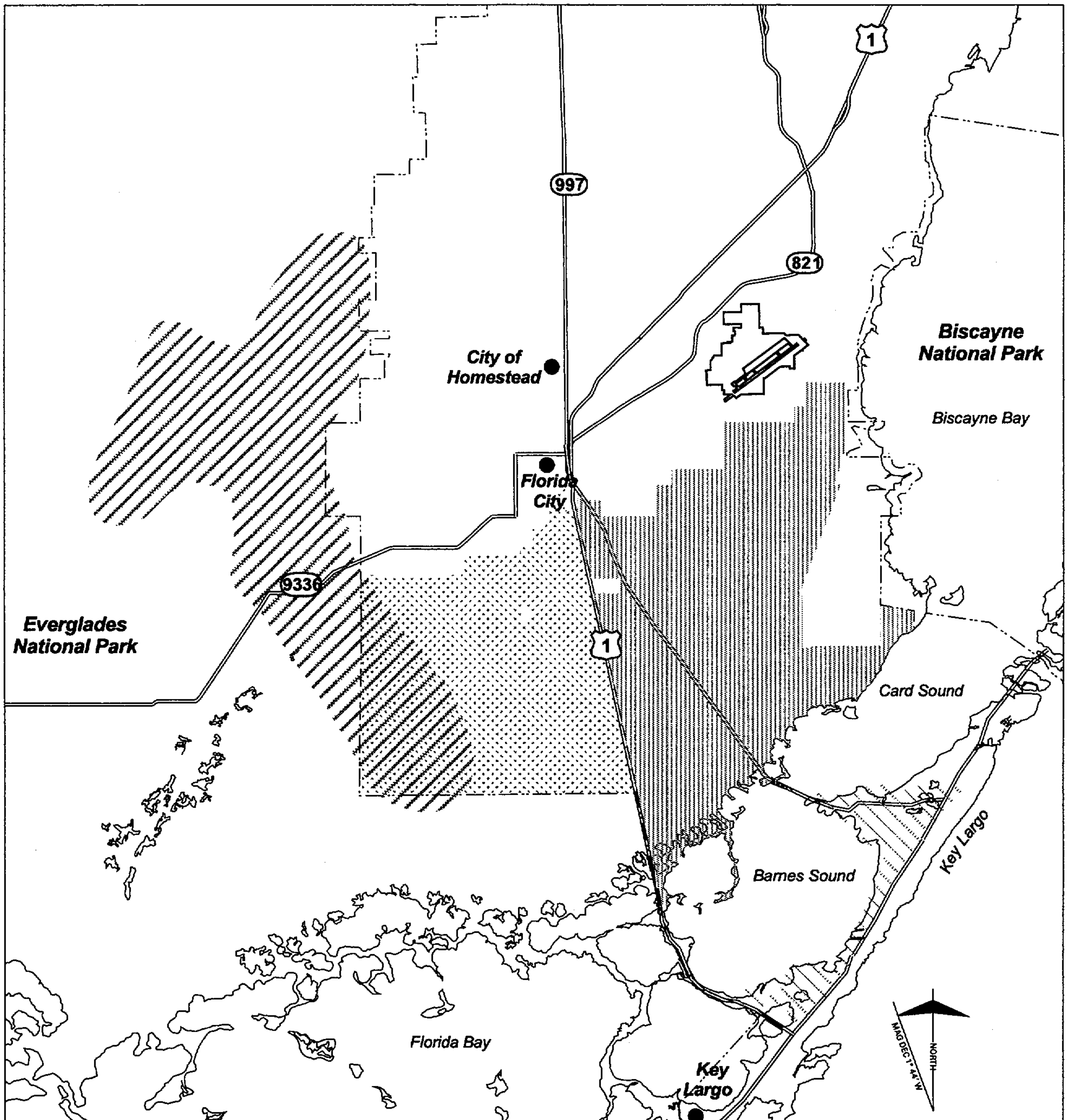
The snail kite has not been recorded during ecological surveys conducted on former Homestead AFB (**Hilsenbeck 1993, PBS&J 1998b, Geraghty & Miller 1993, Denton and Godley 1999, Mazzotti 1999b**), nor was it recorded during wildlife surveys in the area near former Homestead AFB (**Metro-Dade County 1994b, Denton and Godley 1999, Mazzotti 1999b**). In addition, it has not been recorded from Biscayne NP (**BNP 1998**). Given its highly nomadic nature, the snail kite has the potential to occur at former Homestead AFB and surrounding areas, but such an occurrence would likely be rare and of short duration.

Cape Sable Seaside Sparrow. The Cape Sable seaside sparrow is a federal and state endangered species; it has been federally listed since 1967. Critical habitat, which occurs west and south of the Homestead area in the Everglades, was designated in 1977 (see Figure 3.11-5). There are eight surviving subspecies of the seaside sparrow distributed along the east and gulf coasts of the United States. The Cape Sable seaside sparrow has the most restricted range of these eight subspecies, as well as having the most restricted range of any bird species in North America. It occurs only in the Everglades region of Miami-Dade and Monroe counties (**DOI 1997**).

In the 1930s, Cape Sable in Monroe County was the only known breeding range of the Cape Sable seaside sparrow. After the hurricane of 1935, the freshwater wetlands transitioned into areas dominated by salt-tolerant plants, and the Cape Sable seaside sparrow disappeared from Cape Sable. Currently, the center of abundance for the Cape Sable seaside sparrow is three populations in Shark River Slough in Everglades NP, Big Cypress National Preserve, and the Southern Glades Wildlife and Environmental Area. The western population is in the center of Everglades NP and southern Big Cypress National Preserve, the Ingram population is completely in Everglades NP, while the eastern population is in Everglades NP and the Southern Glades Wildlife and Environmental Area (**Figure G-11**). The eastern population is closest to the Homestead area. The most recent census data (1997) indicates that this species declined approximately 40 percent since 1981. The estimated population was 6,624 birds in 1981 and 3,920 birds in 1997 (**USFWS 1998a**). Since 1980, the western core population has declined 90 percent since 1980, the eastern population has declined 47 percent, and the Ingraham population has remained essentially stable. The decline in the western populations is attributed to high water levels, while the eastern population declined as a result of its habitat drying up and frequent fires. The root cause of these declines is changes in hydrology resulting from water management practices. It is predicted that the Cape Sable seaside sparrow will go extinct within 20 years if measures are not taken to facilitate the recovery of the western and eastern populations' habitat (**DOI 1997**).

Cape Sable seaside sparrows nest from late February through early August, with the majority of nesting in spring when the marl prairies are dry. The end of the breeding season usually begins when the rainy season starts (**Lockwood et al. 1997**). Nesting ceased in 1995 and 1996 when water depths reached 5.5 inches. The preferred nesting habitat is short hydroperiod prairie community dominated by muhly grass with open spaces. They avoid dense grassland, long hydroperiod wetlands, and shrubby areas.

Fire may be an important factor in the maintenance of Cape Sable seaside sparrow habitat by limiting the growth of woody vegetation and the density of ground cover (**USFWS 1998a**). However, fires may be detrimental if they occur too frequently. Presently, it is not known how long marl prairie will remain free of woody vegetation; therefore, the fire frequency necessary to maintain this habitat is not known (**DOI 1997**). The distribution of the Cape Sable seaside sparrow during the non-breeding season is not completely known (**Lockwood et al. 1997**), although it is non-migratory and tends to stay in its breeding territory after the end of the breeding season (**USFWS 1998a, DOI 1997**).



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LEGEND

- Former Homestead AFB
- Cape Sable seaside sparrow
- Model Lands Basin
- Southern Glades Wildlife and Environmental Area
- Crocodile Lake National Wildlife Refuge
- National Park Boundary
- Major Road
- U.S. Highway
- State Highway
- City

Area Shown

2 0 2 4

Scale in Miles

Source: DOI 1997

Figure G-11
Approximate Location of the Eastern Population of the Cape Sable Seaside Sparrow in Everglades National Park and the SFWMD Southern Glades Wildlife and Environmental Area

The Cape Sable seaside sparrow has not been recorded on former Homestead AFB or the surrounding area, including Biscayne NP (**Metro-Dade County 1994b, BNP 1998, Geraghty & Miller 1993, Hilsenbeck 1993, PBS&J 1998b, Denton and Godley 1999, Mazzotti 1999b, Bass and Ferro 1999**). The mangrove swamp forest and exotic plant dominated freshwater wetlands between former Homestead AFB and Biscayne Bay are not appropriate habitat for this species (**Bass and Ferro 1999**). The Cape Sable seaside sparrow would not occur in these areas in the future because of the lack of appropriate habitat and the restricted movement patterns of the populations in the Everglades.

Roseate Tern. The roseate tern was federally listed as endangered in the northeastern United States and threatened in Florida in 1987. The Caribbean population of the roseate tern breeds from Florida through the West Indies to islands off Central and South America. The roseate tern is strictly a coastal species that is usually observed forging along the nearshore surf. Open sandy beaches isolated from human activity provide the optimal nesting habitat for this species. In Florida, this species nests on isolated islands, rubble islets, dredge-spoil islands, and roof-tops between the Dry Tortugas and Marathon in the Florida Keys (**USFWS 1998a**).

The roseate tern, as well as other species of terns, experienced dramatic declines in the late 19th Century, but started to recovery after passage of the Migratory Bird Treaty Act. This species started to decline again in the 1950s, with the greatest declines beginning in the 1970s. Habitat destruction and alteration has had a major affect on this species in Florida. Currently, there are an estimated 300 pairs nesting from the Dry Tortugas to Marathon. Roseate terns are absent from their Florida nesting colonies after the breeding season and likely winter in South America (**USFWS 1998a**).

The nearest breeding roseate tern colonies are in the Florida Keys. Occasional transient terns from these colonies or migrants from the northeastern United States may occur at Biscayne Bay. Data from the bird occurrence information collected at Biscayne NP since the 1970s indicate that two juvenile roseate terns were observed in the reef tract in 1987 (**BNP 1998**). It is assumed that the roseate tern may occur very infrequently along the mangrove fringe of Biscayne Bay and even less infrequently as a transient in the area of former Homestead AFB.

Piping Plover. This is an endangered species in the Great Lakes region and threatened elsewhere in the United States (**USFWS 1988**). It is also considered a threatened species by Florida. The piping plover has experienced range-wide declines. The principal factors leading to the long-term declines are habitat deterioration (**Haig and Oring 1985**), human disturbance (**Flemming et al. 1988**), and predation (**Gaines and Ryan 1988**). The results of the 1996 international piping plover census indicate there are 5,837 breeding plovers in 20 states and 9 Canadian provinces; this represents a 7 percent increase over a 1991 census (**USGS 1996**). Studies on Assateague Island in Maryland and Virginia showed that predation accounted for 91 percent of the known nest losses and that recreational activities (off-road vehicle use and foot traffic) are likely not a factor in reduced productivity (**Patterson et al. 1991**). However, other studies indicate that human disturbances may be an important component in this species' decline throughout its range. Predation rates along beaches in southern Nova Scotia may have increased from 1975 to 1987 and, at the same time, the number of plovers nesting among the dune grass also increased (**Flemming et al. 1988**). Over 76 percent of the predation was from avian predators that patrol open beaches, but not grass nesting sites. In North Dakota, predation accounted for 93 percent of egg loss. In addition, nesting success was less in territories that showed evidence of human activity (e.g., all terrain vehicles) or cattle grazing (**Gaines and Ryan 1988**). In 1996, the increase in the number of piping plovers along the Atlantic seaboard was likely the result of intense efforts to reduce predation losses and human disturbance, while the declines in the great plains region is probably due to massive flooding of the Missouri River (**USGS 1996**).

The piping plover winters, but does not breed, in Florida. These birds are part of a wintering population that occurs along beaches from North Carolina to Jamaica and across the Gulf to Laguna Madre of Texas and Mexico (**USGS 1996**). This species can be found wintering at beaches, sandflats, dunes, barrier island beaches, and spoil islands along the Gulf of Mexico and the Atlantic Coast (**USFWS 1988**). In Florida, wintering piping plovers have been extirpated from entire counties. Museum records and Christmas bird counts indicate this species regularly wintered in Miami-Dade County; it is now rarely seen in the county during the winter (**USFWS 1998a**). This species was recorded only four times at Biscayne NP: once in 1978, once in 1996, and twice in 1997 (**BNP 1998**). This information plus the lack of suitable winter foraging habitat indicates that the piping plover would occur rarely along the western shoreline of Biscayne Bay. The occurrence of this species on former Homestead AFB would be even more infrequent.

Bald Eagle. The bald eagle is a federal and State of Florida threatened species. It is typically a water-dependant species occurring near estuaries, large lakes, reservoirs, major rivers, and along sea coasts. In Florida, this species usually nests within 1.5 miles of the open water it uses as foraging habitat. Nests are usually located in the tallest trees in an area. In Florida, nests are often in the ecotone between forest and water; in much of Florida bald eagles nest in pines (*Pinus* spp.) and bald cypress. In Florida Bay in the Everglades, most bald eagles nest in black and red mangroves, half of which are snags (**Curnutt and Robertson 1994**).

Bald eagles nest in south Florida in winter, generally beginning in September, with peak egg laying in December. Incubation takes about 35 days and fledging occurs within 10 to 12 weeks of hatching. Parental care may continue four to six weeks after fledging (**USFWS 1998a**). After the completion of the breeding season, many bald eagles migrate north for the summer. Based on banding returns, Broley (**1947**) determined that juvenile bald eagles fledged in Florida were also highly migratory, with some flying as far as the northern United States and southern Canada. Other researchers have documented the occurrence of adult, as well as juvenile non-breeding southern bald eagles in the northern United States and Canada in the summer (**Wright 1953, Stocek 1979, Spofford 1969**). Data from Hawk Mountain show a southward migration of adult and juvenile bald eagles during September, and it was assumed that these were southern birds migrating back to their breeding grounds (**Bildstein 1998**). Bald eagles with breeding grounds in southeast Florida, including the Everglades, apparently reside there year-round, while bald eagles from the west coast and central-Florida are more apt to migrate north for the summer (**Broley 1947, Robertson 1998, Millsap et al. 1999**).

A decline in nesting bald eagles in Florida was first noted in the late 1940s (**Broley 1947**). By the 1970s, the bald eagle population in most of Florida was less than 50 percent of historic levels and still decreasing. In contrast, data from the Everglades indicates that the number of nesting pairs has been stable from the 1960s to the present (**USFWS 1998a**). Since the bald eagle was listed as an endangered species, populations have recovered. The banning of DDT and other persistent organochlorines are major factors in this increase. The bald eagle was reclassified in 1995 as threatened because of substantial increases throughout its range. In 1963, there were an estimated 417 active nests producing 0.59 young per active nest and, by 1995, there were about 4,450 occupied territories producing 1.17 young per occupied territory. By 1998, there were an estimated 5,748 nesting pairs in the lower 48 states (**USFWS 1999a**). The increase in Florida has been equally dramatic, with the number of active breeding territories increasing from a low of 88 in 1973 to 980 in 1998 (**USFWS 1998a, 1999a**). In July 1999, the USFWS proposed to delist the bald eagle completely (**USFWS 1999a**).

The nearest breeding pair of bald eagles is about 7.5 miles south of former Homestead AFB at the south end of Biscayne NP. The next closest nest sites are in Florida Bay in Everglades NP where eagles have nested on 52 of the 235 keys (**Curnutt and Robertson 1994**). An estimated 35 to 40 bald eagle nests were observed in Florida Bay from October 1995 through March 1996 (**Gawlik 1998**). The nearest nest is about 17 miles south of the former base in Barnes Sound. Eagles have been nesting on the same mangrove island in Biscayne Bay since at least the 1950s. This nest site has been monitored sporadically over the years, and in 1995, a pair constructed a nest in a snag on this mangrove island. Breeding behavior was observed in November of 1995 and adults incubated up until at least February 10, 1996. One eaglet was sighted from a helicopter on March 11, 1996. One young fledged on May 7. The juvenile was last observed in the area on June 11, and the adults were last observed in the area on June 15. This was the first documented successfully fledged young from this nest site since 1984 (**Howitt 1996**). A pair of bald eagles was observed at this nest site in December 1998; and in February 1999, it appeared that the female was incubating, but subsequent observations indicated the bald eagles failed to produce any young in 1999 (**Lockwood 1999a**). Historic nest sites are located in the area of the Deering Estate, Key Biscayne, and Key Largo (**Lynch 1998**). Over the years, there have been numerous bald eagle sighting in the Black Point area, but nesting has never been confirmed (**Robertson 1998, Lockwood 1998b**). The most recent aerial survey for nesting bald eagles in this area occurred in 1998, and a bald eagle nest was not detected (**Lockwood 1998b**). Except for the current active nest site, the historic nest sites on Biscayne Bay were abandoned in the 1960s (**Robertson 1998**). The bald eagle has been reported from the former Homestead AFB on one occasion (**PBS&J 1996c**) and from Homestead ARS (**SEA 1997**). This information indicates that the bald eagle commonly forages along the western shoreline of Biscayne Bay north and south of Military Canal and occurs on rare occasions at former Homestead AFB.

G.2.4.2 State Sensitive Species

A total of 33 state-listed sensitive bird species occur or have the potential to occur in the Homestead area in addition to the 6 federal and state listed species considered in Section G.2.4.1 (see Tables 3.11-4 and 3.11-6). This includes 1 endangered, 3 threatened, 9 rare, 19 species of special concern, and 1 species whose status is undetermined (**Rodgers et al. 1996, Florida Game and Fresh Water Fish Commission 1997**).

Arctic Peregrine Falcon. This falcon is a Florida endangered species and the peregrine falcon (*Falco peregrinus anatum*) was a federally endangered species that was delisted in 1999 (**USFWS 1999b**). Historically, there were an estimated 7,000 to 10,000 nesting pairs of peregrine falcons in North America. Dramatic declines began in the 1940s at the same time organochlorine pesticides such as DDT were entering the environment. Declines continued into the 1970s, and this species was extirpated from east of the Mississippi River by 1965. At its lowest point, an estimated 324 pairs of peregrine falcons nested on the continent in 1975 (**Fyfe et al. 1976**). By 1980, the population level had stabilized. By 1985, the species had begun its recovery and by 1998, there were almost 1,600 breeding pairs in the United States and Canada (**USFWS 1998b**). The peregrine falcon recovery has been dramatic, and in 1995, the USFWS proposed to remove this species from the endangered species list. More recently, the ad hoc committee appointed by the Raptor Research Foundation reviewed the status of the peregrine falcon and recommended that the populations in Alaska, Pacific, Rocky Mountain Southwest, and Canada recovery regions be de-listed and the populations in the Eastern Recovery Region be down listed to threatened (**Millsap et al. 1998**). In August 1999, it was completely delisted.

The peregrine falcon does not nest in Florida, but either migrates through or winters in Florida, especially along the coastal and barrier island shorelines. Peregrine falcons typically arrive in Florida in September and October and begin their northward migration in March; most are gone by late May (**Rodgers et al. 1996**). The peregrine falcon has been recorded at Biscayne NP 42 times from 1980 to 1998 (**BNP 1998**). All these observations occurred when wintering birds would be expected in the area. In addition, one peregrine falcon was observed along the west shore of Biscayne NP in September 1998 (**Denton and**

Godley 1999). It is therefore assumed that migrating and wintering peregrine falcons occur along the west shoreline of Biscayne NP. This species may occur occasionally at former Homestead AFB, but its use of this area is expected to be infrequent. The peregrine falcon has not been observed on the former base during any biological surveys (**Geraghty & Miller 1993, Hilsenbeck 1993, PBS&J 1998b, Denton and Godley 1999, Mazzotti 1999b**).

Southeastern American Kestrel. The southeastern American kestrel is a state threatened species and a federal species of concern. The southeastern America kestrel and the northern American kestrel (*Falco sparverius*) are the only subspecies in the United States, although American kestrels in Cuba (*F. s. sparverioides*) may occur in the Florida Keys (**Robertson and Woolfenden 1992**). The southeastern and northern American kestrels are similar in appearance and are often confused during the winter when both can occur together in the southern United States (**Lane and Fischer 1997**).

The southeastern American kestrel pair bond is strong, and pairs often remain at or near the nesting territory year-round, using the same territory during successive years. Courtship and pair bonding begins in late January, and eggs are laid from mid-March to late May. Incubation lasts about 30 days, with fledging typically in another 30 days. The adults continue to bring food to the young for several weeks after fledging, and the family group will often hunt together until the young disperse (**Lane and Fischer 1997**).

The southeastern American kestrel is usually found in open pastures or woods that include snags. They can be found in agricultural lands, pine flatwoods, old-growth slash pine, grasslands, pastures, open sites in suburban areas such as golf courses and parks, edges of river bottoms, and in coastal areas. Their habitat must include an adequate amount of open areas, with perch sites for foraging, adequate prey base, and suitable nest sites. The availability of nest sites is considered a limiting factor in the distribution and abundance of the southeastern American kestrel (**Lane and Fischer 1997**).

The long-term decline of the southeastern American kestrel in Florida appears to be related to human-induced habitat modification. This species likely disappeared from Miami-Dade County between the mid-1930s and 1940s due to cutting of slash pine forests and fire suppression that resulted in increased growth of the understory. Furthermore, the reestablishment of the southeastern American kestrel in south Florida is not likely because foraging and nesting habitat have largely been eliminated (**Hoffman and Collopy 1988**). It is believed that the Southeastern American kestrel still does not occur in south Florida (**Lane and Fischer 1997, Rodgers et al. 1996**).

The American kestrel was a common species on former Homestead AFB from December 1992 through March 1993 and September and October 1993; it was not, however observed from April through August 1993 (**Hilsenbeck 1993**). This could indicate that the birds observed on the former base during that time were wintering migrant northern American kestrels, and not the southeastern subspecies. The southeastern American kestrel was reported on the former base, however, in March 1993 and November 1997 (**Geraghty & Miller 1993, PBS&J 1998b**). As indicated above, this is the time of year the northern American kestrel was previously observed on the former base, making identification between the two difficult. A series of five surveys for the southeastern American kestrel took place in appropriate habitat on former Homestead AFB during June and July 1998 (see Figure G-6 for the areas surveyed). The southeastern American kestrel was not observed during these surveys or during other biological surveys on the former base during the summer of 1998. The American kestrel was recorded 86 times from January to early April and October into December 1998. It was not recorded during the bulk of the breeding season from the second week in April through August even though 88 observations took place (**Peterla 1999a**). In addition, it was not recorded along canals in the area of the former base and the western shoreline of Biscayne NP during ground and aerial surveys for sensitive species of reptiles and birds during the summer of 1998. Other studies report the occurrence of the American kestrel in the area of former Homestead AFB, but do not provide subspecies information (**BNP 1998**, **Metro-Dade County 1994b**). Based on the 1992/1993 and 1998 surveys, and the fact that the southeastern American kestrel in not believed to occur in Miami-Dade County, it is concluded that the southeastern American kestrel does not presently reside on former Homestead AFB, and likely has not occurred in the area of the former base for many years. It is further concluded that the southeastern American kestrels previously reported on the former base (**Geraghty & Miller 1993**, **PBS&J 1998b**) probably were the northern American kestrel.

Least Tern. The least tern is a state threatened species because of habitat loss. It occurs along the coast of the United States, while the federally endangered interior least tern nests principally along the Missouri and Mississippi river systems (**Whitman 1988**). Historically, the least tern nested on open mainland and barrier island beaches with a coarse substrate of sand shells and small rocks. The development of beach front property and recreation has reduced suitable ground nesting locations for this species. With the disappearance of this habitat, this species now also nests on manmade areas such as dikes, dredged material islands, sand pit mines, construction fill sites, and on roofs of buildings (**Gore and Kinnison 1991**, **Whitman 1988**).

During a 1995 survey in southeastern Florida, 1,437 least terns in 29 active colonies were observed (**Zambrano et al. 1997**). Ninety-three percent of the colonies were on roof tops, and the remaining were on natural substrate such as beaches or rock coral. Four active colonies were observed in Miami-Dade County: two on the keys of Biscayne NP and two near the western shoreline of Biscayne Bay. One mainland site was in the Turkey Point area, and the other was near the northern boundary of Biscayne NP (**Zambrano et al. 1997**). In 1995, the least tern nested on a beach on Soldier Key in Biscayne NP and on a rooftop on Virginia Key. The beach nesting colony site on Soldier Key was not occupied in 1996 (**Howitt 1996**).

The least tern nests in the region around former Homestead AFB on Biscayne NP keys, and along the western shoreline of Biscayne Bay. It has been recorded 21 times at Biscayne NP, with most observations in the summer (**BNP 1998**). Twenty least terns were observed in June 1998 at nine locations along the western shoreline of Biscayne NP during breeding bird surveys (**Figure G-12**), and 20 more were observed during the aerial wading bird surveys (**Table G-8**). This species was observed twice on the former base in 1998 (**Table G-9**). The least tern will continue to occur at Biscayne NP, and occasional individuals will likely occur on former Homestead AFB.

White-Crowned Pigeon. The white-crowned pigeon is a state threatened species. This species is of recent West Indian origin and is generally confined to mangrove and tropical hardwood hammock forests on the mainland and Florida keys (**Odum et al. 1982**).

The white-crowned pigeon occurs at Biscayne NP, and observations indicate that it is likely a fairly common nesting species. During surveys on Biscayne NP keys, four adults were observed collecting nesting material on West Arsenicker Key on May 31, 1996, and 18 to 22 birds were observed roosting on this Key, also in May 1996 (**Howitt 1996**). Approximately 750 white-crowned pigeons were recorded at Biscayne NP during 74 observations between 1979 and 1997, and the range in number recorded per observation was 1 to 54 (**BNP 1998**). Most of the observations were on Biscayne NP keys. Potential habitat for this species occurs in the mangrove fringe along the western shoreline of Biscayne Bay. However, the white-crowned pigeon was not recorded during the June and July 1998 breeding bird surveys along the mangrove fringe and other habitats along the western shoreline of Biscayne NP. It also was not observed during breeding bird surveys on former Homestead AFB or during other wildlife surveys conducted in 1998 or at other times. This indicated that white-crowned pigeons would likely be rare along the western shoreline of Biscayne NP, and even more infrequent on the former base due to lack of appropriate habitat.

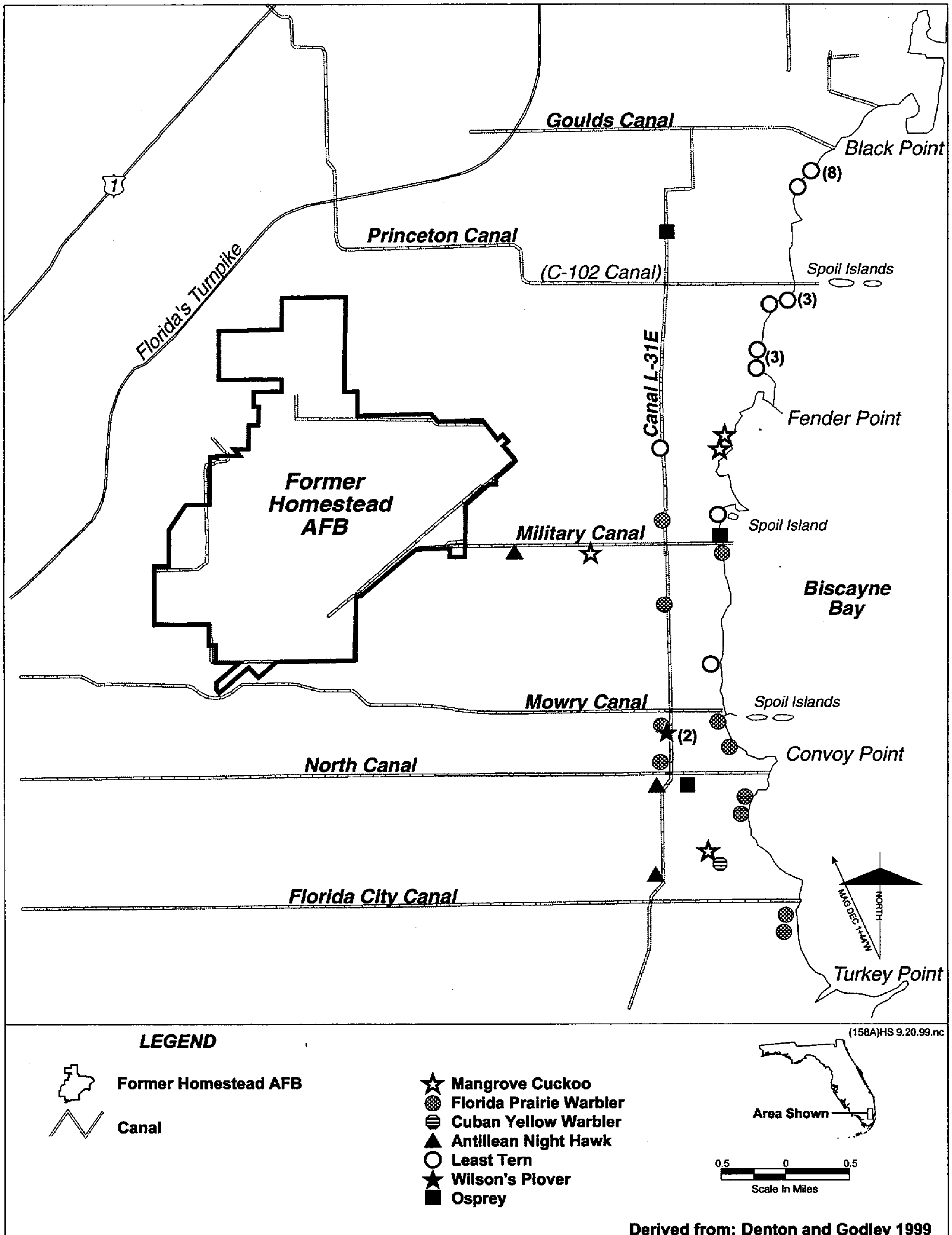


Figure G-12
Locations of Sensitive Bird Species Recorded During June and July 1998 Breeding Bird Surveys

Table G-8. Wading Birds and Other Aquatic Birds Observed During Aerial Surveys Along the Western Shoreline of Biscayne Bay, Freshwater Wetlands, and Other Habitats East of Former Homestead AFB

Species	Survey dates (1998)			Total
	June 2	June 26	July 14	
Cattle egret	7	213	5	225
White ibis[1]	7	81	113	201
Great egret[1]	3	7	31	41
Snowy egret[1]	1	5	35	41
Double-crested cormorant	0	8	13	21
Least tern[1]	0	8	12	20
Tricolor heron[1]	3	3	7	13
Little blue heron[1]	0	3	7	10
Great blue heron	0	1	7	8
Glossy ibis[1]	1	0	6	7
Brown pelican[1]	0	0	5	5
Great white heron[1]	3	2	0	5
Roseate spoonbill[1]	0	0	1	1
Muscovy duck	0	1	0	1
Osprey[1]	0	1	0	1
Common gallinule	0	0	1	1
Total State Sensitive Species	***18***	***110***	***217***	***345***
Grand Total	**25**	**333**	**243**	**601**

Source: **Denton and Godley 1999.**
Note: [1] State sensitive species.

Mangrove Cuckoo. The mangrove cuckoo is a state rare species found in most islands in the Caribbean Basin, as well as south Florida. It nests in mangroves and almost any other wooded habitat such as hardwood hammocks, provided they are not too fragmented. Its breeding range is generally restricted to coastal areas. This species is secretive, especially during the non-breeding season. However, evidence suggests that at least part of the population winters in south Florida (**Rodgers et al. 1996**).

From 1980 to 1997, the mangrove cuckoo was recorded 24 times from Biscayne NP (**BNP 1998**). One bird was observed in the winter and one in the summer, with the rest reported during the spring and fall. It was recorded in 1996 during breeding bird surveys of the outer keys and Biscayne NP, but was not considered a nesting species (**Howitt 1996**). The mangrove cuckoo was not detected during the 1993 wildlife surveys in the wetlands and mangrove forests along the western shoreline of Biscayne Bay (**Metro-Dade County 1994b**).

Table G-9. Number of Wading Birds and Other Aquatic Birds Observed on Former Homestead AFB During June and July 1998

Species	Dates (1998)							Total
	June					July		
	2	4	6	8	29	4	18	
Cattle egret	0	25	6	0	1	14	4	50
White ibis[1]	1	25	0	0	0	6	0	32
Snowy egret[1]	6	15	1	2	0	2	0	26
Great egret[1]	0	7	1	1	1	7	1	18
Laughing gull	7	0	0	0	0	9	0	16
Little blue heron[1]	4	0	1	4	1	3	0	13
Green-backed heron	0	0	3	0	0	2	8	13
Tricolor heron[1]	3	0	0	0	0	5	2	10
Great blue heron	1	1	0	0	0	2	1	5
Black-necked stilt	2	2	0	0	0	0	0	4
Common gallinule	0	0	0	0	0	0	3	3
Osprey[1]	1	0	0	0	1	0	0	2
Least tern[1]	0	1	0	0	1	0	0	2
Magnificent frigatebird	1	0	0	0	0	0	0	1
Total								
Sensitive species	15	48	3	7	4	23	3	103
Other species	11	28	9	0	1	27	16	92
Grand Total	**26**	**76**	**12**	**7**	**5**	**50**	**19**	**195**

Source: **Denton and Godley 1999, Mazzotti 1999b.**
Notes: [1] State sensitive species

Breeding bird surveys were conducted for the mangrove cuckoo and other species in June and July 1998. Twenty-two species that likely nest in the survey area were detected, and the common grackle was the most common species recorded (**Table G-10**). Other common species were the, northern cardinal, northern flicker, and red-bellied woodpecker. The mangrove cuckoo was detected at four locations including along Military Canal, a power line corridor south of Convoy Point, and twice at the same location along the Biscayne Bay shoreline between Military Canal and Fender Point (see Figure G-12). It was not recorded during 1998 breeding bird surveys or other wildlife surveys on former Homestead AFB, or during previous surveys on the former base. This information indicates that the mangrove cuckoo nests in small numbers in the wooded habitat along the west shore of Biscayne Bay. It likely does not nest on former Homestead AFB because extensive tracts of wooded nesting habitat required by this species are lacking.

Antillean nighthawk. This nighthawk is a state rare species. It was first recorded in Key West in 1941, and currently breeds throughout the Florida Keys including the outer keys of Biscayne NP. It nests mostly in man-made habitats such as at borrow pits, along unpaved roadsides, parking lots, airports, and on flat-roofed buildings (**Rodgers et al. 1996**). This species may have nested on the mainland in Miami-Dade County at Virginia Key in the 1950s and south of Florida City in the 1980s. An additional 30 records of this species (based on its calls) have been reported from the mainland in south Florida (**Robertson and Woolfenden 1992**).

Table G-10. Maximum Number of Birds Recorded During Breeding Bird Surveys Along Military and L-31E Canals, the Western Shoreline of Biscayne Bay, and a Tidal Creek[a]

Species[1]	Military Canal[2]	Canal L-31E	Biscayne Bay Shoreline	Tidal Creek	Total
Common grackle	20	98	8	6	132
Northern cardinal	24	38	21	6	89
Red-wing blackbird[3]	6	32	3	4	45
Northern flicker	3	10	6	0	19
Red-shouldered hawk	5	5	2	0	12
Red-bellied woodpecker	3	7	1	0	11
European starling	4	5	0	0	9
Mourning dove	3	5	1	0	9
Prairie warbler[3]	1	1	3	0	5
Purple martin[3]	0	2	2	0	4
Blue jay	2	1	0	0	3
Antillean nighthawk	1	2	0	0	3
Pileated woodpecker	0	2	1	0	3
White-eyed vireo[3]	1	1	0	0	2
Mangrove cuckoo[3,4]	1	0	1	0	2
Common ground dove	1	1	0	0	2
Gray kingbird[3]	0	0	0	2	2
Northern mockingbird	0	0	2	0	2
Chuck-will's-widow[3]	0	1	0	0	1
Clapper rail	0	1	0	0	1
Fish crow	1	0	0	0	1
Downy woodpecker	0	1	0	0	1
Cuban yellow warbler[3,5]	0	0	0	0	0
Total	**76**	**213**	**51**	**18**	**358**

Source: **Denton and Godley 1999.**

Notes:
1. Includes species that may breed along the transects and not wading birds and other species that only forage in the area.
2. 1998 Survey dates for Military Canal were June 3, 8, 22, 24 and July 13; for Canal L-31E were June 4 and 22 and July 13; for the coastline were June 9, 10, and 23 and July 14; and for the tidal stream were June 4 and 8.
3. Neotropical migrant (**BNP 1998**).
4. One additional mangrove cuckoo was detected along a power line corridor south of Convoy Point.
5. One Cuban yellow warbler singing along power line corridor south on Convoy Point.

The outer keys of Biscayne NP are included in the breeding range (**Rodgers et al. 1996**) of the Antillean nighthawk. It was recorded once near the Biscayne NP visitor center in 1986 (**BNP 1998**). Before 1998, this species was not recorded from former Homestead AFB or the surrounding area. One bird was recorded along Military Canal on June 3 and two birds along Canal L-31E on June 4 (see Table G-10). Seven were recorded from former Homestead AFB on June 2 and one on June 4, 1998. All records of this species were based on its call, which is distinct from the common nighthawk's call. It is not known if this species nests on or near the former base.

Black-whiskered vireo. The black-whiskered vireo is a state rare species that breeds throughout the Florida Keys and along the west and east shoreline up to central Florida. It winters in the Amazon Basin from central Brazil to Peru (**Rodgers et al. 1996**). This vireo is widespread in coastal mangrove forests and also in hardwood habitat that borders the mangroves (**Robertson and Woolfenden 1992**).

The black whiskered vireo was recorded 161 times on the outer keys of Biscayne NP during late March to late September of 1984 through 1997 (**BNP 1998**). Up to three individuals were recorded on Elliott Key during the 1996 breeding season, including two singing males, and it is assumed that this species breeds on the outer keys of Biscayne NP. The black-whiskered vireo was not detected during 1993 wildlife studies along the western shoreline of lower Biscayne Bay, although it is included in the Deering Estate bird list (**Metro-Dade County 1994b**). It was also not detected during breeding bird surveys along Military and L-31E canals and the western shoreline of Biscayne Bay in 1998. In addition, it was not detected during breeding bird surveys at former Homestead AFB in 1998 or during earlier surveys. Based on these studies, the black-whiskered vireo is likely not a nesting species on the former base although occasional individuals may occur during migration. It is probably a rare nesting species in the mangrove habitat along the west shoreline of Biscayne Bay.

Worm-Eating Warbler. This bird is a state rare species that breeds throughout much of the eastern United States, but only widely scattered breeding locations occur in extreme northern Florida. This species winters in Mexico, part of the Caribbean, and occasionally in south Florida. Its migration routes appear to be along the Florida Coast (**Rodgers et al. 1996**). Wooded areas with dense undergrowth are important migration and wintering habitat.

The worm-eating warbler has been recorded 38 times on Elliott and Sands Keys in Biscayne NP. Most of the observations have been during migration. Only four birds were observed from 1979 through 1997 during the Christmas Bird Counts (**BNP 1998**). This indicates that the worm-eating warbler is principally a migrant species at Biscayne NP. The worm-eating warbler has not been recorded on former Homestead AFB and is not expected to occur there given the open nature of the habitat.

Louisiana Waterthrush. The Louisiana waterthrush is a state rare species that breeds throughout much of the eastern United States, as well as in northern tier counties of Florida. It is rare throughout Florida during migration, although there are winter records from central Florida. Six Louisiana waterthrush were observed between 1986 and 1997 in Biscayne NP, but none during the Christmas Bird Counts (**BNP 1998**). It was not recorded during surveys on former Homestead AFB, and the potential for it to occur there is slight.

American Redstart. The American redstart is a state rare species. Its breeding range includes much of the eastern United States and Canada, as well as the extreme northwest portion of Florida. The redstart is a frequent winter resident in central and south Florida and is more common in south Florida along the coast. Typical winter habitat includes forest borders, second growth woodlands, and mangroves, although winter habitat requirements in Florida are not well known (**Rodgers et al. 1996**).

The American redstart was one of the most numerous birds recorded from Biscayne NP; it was detected 451 times from 1980 to 1998, mostly from the outer keys. Because only 15 of these observations were during the winter, it appears that the redstart uses Biscayne NP primarily during migration (**BNP 1998**). The redstart was not observed during wildlife surveys conducted along the mangrove fringe of Biscayne NP and associated freshwater wetlands, although it was listed in the Deering Estate bird list (**Metro-Dade County 1994b**). Small numbers of wintering redstarts were observed recently in disturbed and early successional habitat at Chapman Field Park and Matheson Hammock Park on Biscayne Bay (**Dalrymple and O'Hare 1998**, **Dalrymple 1998**). The redstart was uncommon on former

Homestead AFB in 1993 during the winter and during migration periods and was not observed during the summer (**Hilsenbeck 1993**, **Denton and Godley 1999**). This species will continue to occur in small numbers on former Homestead AFB during winter and during migration, as well as in wooded areas around the former base and along the western shoreline of Biscayne Bay.

Cuban Yellow Warbler. The Cuban yellow warbler is one of 37 subspecies of the wide-spread yellow warbler. This subspecies occurs in extreme southern Florida, Cuba, and the Bahamas. In the early 1940s, it was first recorded as a breeding species when it was detected in the Florida Keys. It has since spread north to Biscayne Bay. The Cuban yellow warbler inhabits red and black mangrove forests and is rarely found in other habitats (**Rodgers et al. 1996**). This species is thought to be non-migratory and winters in the area of its breeding grounds.

In much of its range, the Cuban yellow warbler nests in the same habitat as the Florida prairie warbler, with a nesting season from late April to early July (**Prather and Cruz 1995**). Densities in prime habitat in Florida Bay are an estimated one pair per hectare, with much lower densities in less favorable habitat (**Rodgers et al. 1996**). During breeding bird surveys of the outer keys at Biscayne NP, two singing males were heard, and nest material collection was observed on three different dates in May and June 1996, indicating this species likely nests on these keys. During breeding bird surveys in 1998, one singing Cuban yellow warbler was detected along a power line corridor just south of Convoy Point (Figure G-12). A total of 6.25 miles of mangrove fringe was surveyed three times during the 1998 breeding season, but this species was not recorded. This indicates the breeding population of Cuban Yellow warblers in the mangrove habitat along the west shoreline of Biscayne NP is low. This species was also not detected during other surveys of the mangrove forest along Biscayne Bay, nor was it detected during the 1998 breeding bird surveys and other wildlife surveys on former Homestead AFB. This species is absent from former Homestead AFB because of the lack of the preferred mangrove nesting habitat. This species would be expected to continue to nest in small numbers on the keys and, probably to a lesser degree, along the western shoreline of Biscayne NP.

Brown Pelican. The brown pelican is a Florida species of special concern, but is not a federally listed species in Florida. The brown pelican was listed in 1970 as an endangered species throughout its range, partially in response to the brown pelican's susceptibility to DDT, which was banned in the United States in 1972. Between 1968 and 1976, the average annual brown pelican population in Florida was over 6,300 pairs. After DDT and other pesticides such as endrin were banned, the brown pelican started its recovery, and the average number of pairs between 1977 and 1985 grew to over 8,000. That number increased to about 12,300 pairs in 1989, but then decreased to about 10,000 pairs in 1995. In 1985, this species was taken off the endangered species list in part of its range, including Florida. It remains federally endangered in other parts of its range (**Rodgers et al. 1996**).

As the brown pelican populations recovered in Florida, a change in breeding colony distribution was noted. A 40 percent decrease in nesting pairs was noted in south Florida, including Florida Bay and Florida Keys. It is believed that this decrease is due to decreased food supplies. At the same time, a 230 percent increase in nesting brown pelicans was observed along the Gulf of Mexico north of Tampa; nesting north of Vero Beach on the Atlantic coast increased by 255 percent (**Rodgers et al. 1996**).

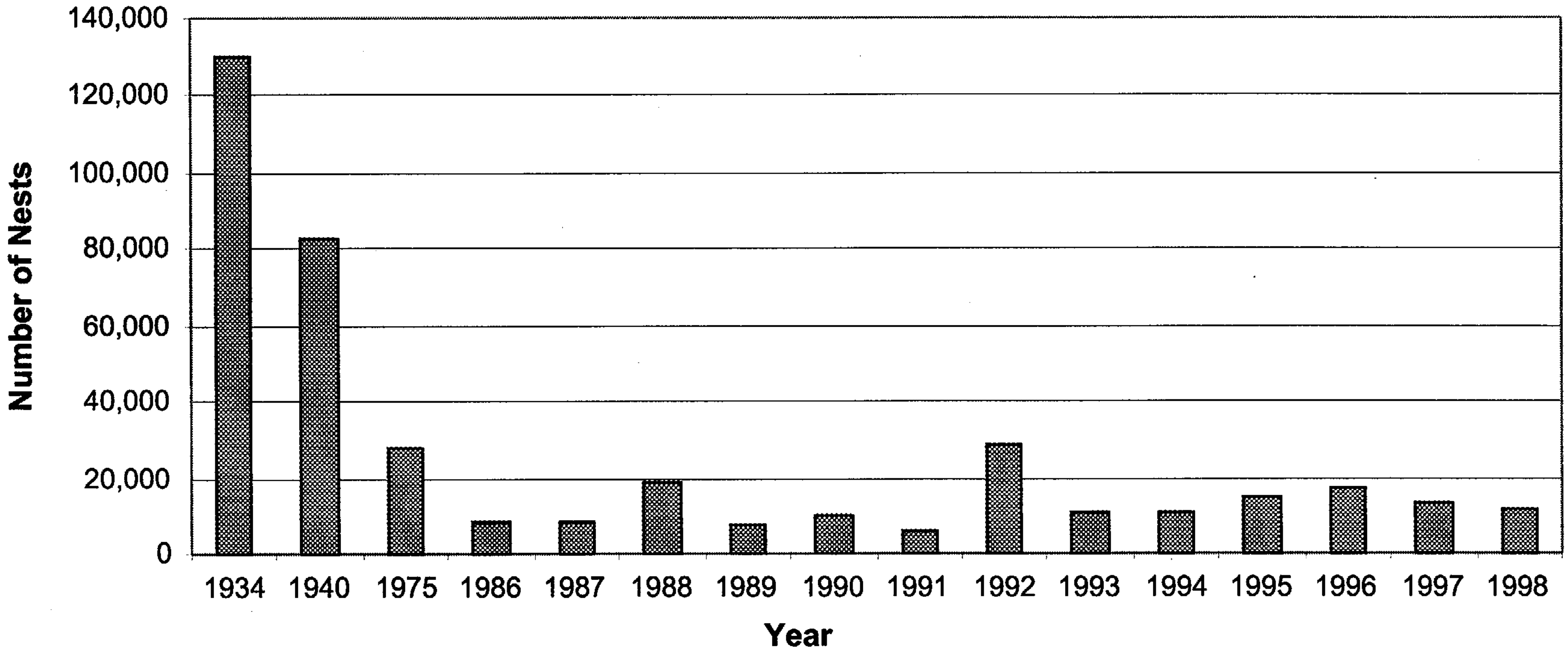
The brown pelican typically nests on small- to medium-sized islands, and most of the nest sites are or were at one time vegetated with mangroves. This species also requires loafing habitat, which can consist of beaches or mangroves. Mangrove islands used for loafing can also become nesting sites. Florida brown pelicans typically begin to lay eggs in December, with nesting continuing throughout the summer (**Rodgers et al. 1996**).

The brown pelican is not known to nest in Biscayne Bay or in Biscayne NP. However, Biscayne Bay is commonly used for foraging and loafing, and over 5,600 pelicans were recorded from 1979 to 1998. The majority were recorded in the winter, with some observed in the spring and fall, and very few in the summer (**BNP 1998**). This species was observed at the eastern end of Military Canal and also on former Homestead AFB in one study (**PBS&J 1998b**), but was not reported from the former base during other biological studies. The brown pelican will continue to be common at Biscayne NP, particularly during the winter, and it may occur periodically as an infrequent transient at the former base.

Wading Birds. The state endangered wood stork is addressed in Section G.2.4.1. The state species of special concern discussed in this section include the reddish egret, roseate spoonbill, great white heron, great egret, little blue heron, snowy egret, tricolored heron, black-crowned night heron, yellow-crowned night heron, glossy ibis, white ibis, and least bittern. This section provides an overview of the status of wading birds in south Florida, followed by brief species-specific discussions.

Historically, wading birds concentrated in the Everglades during the dry season because of the abundant aquatic life in pools as water levels decreased. These birds nested in large numbers along the southern edge of the Everglades in the mangrove forests that border Florida Bay and the Gulf of Mexico. Around the turn of the century, market hunters killed large numbers of these birds, but the populations recovered after market hunting was banned. By the 1930s, there were an estimated 125,000 to 150,000 wading birds nesting in the Everglades. This included 4,000 pairs of wood storks, 20,000 pairs of herons and egrets, with white ibis making up the remainder (**Bancroft 1989**). The largest colonies occurred along the mangrove fringe in Everglades NP. Wading bird survey data for the 1950s and 1960s were sporadic and incomplete. During that time period, wood storks and white ibis moved out of the Everglades in large numbers and began nesting in central and northern Florida, as well as South Carolina and Georgia (**Frederick 1995**). The movement out of the Everglades may have been in response to environmental degradation from agricultural development and surface water management practices that affected the aquatic prey populations and the ability of wading birds to capture prey items. This included decreased fresh water flow into the mangrove fringe estuary, which in turn resulted in a substantial decline in prey abundance in these areas (**Frederick 1995**, **Walters et al. 1992**). Studies have shown that wading bird nesting is directly linked to food supply and that nesting problems can be traced to inadequate or unavailable food supplies (**Frederick 1995**). As a result of these water management practices, the number of pairs of nesting wading birds in the Everglades has decreased substantially since the 1930s and 1940s and, except for 1992, have been around 10,000 to 15,000 pairs since 1986 (**Figure G-13**). Water management practices may also be why many wading birds now nest in the Water Conservation Areas rather than Everglades NP, and why many wading birds now delay their nesting season (**Frederick 1995**; **Bancroft 1989**; **Gawlik 1997, 1998**).

The estimated number of wading bird nests in the Everglades in 1997 (12,850) and 1998 (11,223) was similar. El Niño weather patterns in 1997 and 1998 resulted in delayed winter water drawdown and late nesting by wading birds. In addition, there was a decrease of 1,372 nests in the freshwater Everglades, and an increase of 1,244 nests in Florida Bay and the southwest coast, suggesting a shift in nest site locations. The estimated number of nests in the mainland colonies in Everglades NP was 756, which is the lowest number in the park's history. Only 4.6 percent of the 1998 nests along the south coast of the Everglades were in the mangrove fringe, whereas 75 to 95 percent of the nests in the 1930s and before were in this habitat type. One of the goals of the South Florida Ecosystem Restoration Task Force is for at least 26 percent of the nesting wading birds in the Everglades to use these mangrove areas. The percent of wading birds nesting in this habitat for the last three years has been much lower than this goal (2 to 11 percent) (**Gawlik 1997, 1998**).



Derived from: Gawlik 1998, Gawlik 1997, Frederick 1995

Figure G-13
Estimated Number of Nesting Pairs of Wading Birds in the Everglades Since 1934

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Great White Heron. This is the white phase of the great blue heron. Historic data for this species prior to human disturbance is lacking, but anecdotal information indicates there was a large population of great white herons in the Everglades. In the mid-1930s, the population was less than 50, but then it began to recover. By 1960, the population was 800 to 900 individuals, but a major hurricane in 1960 reduced the population by 30 to 40 percent. A search in a limited area detected 100 great white heron carcasses. Within two years, the population had recovered to within 90 percent of its pre-hurricane levels and by 1984, a little over 1,500 birds were counted (**Powell et al. 1989**). Current data indicate there were 171 to 257 great white heron nests in Florida Bay during the 1995–98 nesting seasons. An additional four nests were reported from mainland colonies in Everglades NP, and no nests were observed in the Water Conservation Areas or the Loxahatchee National Wildlife Refuge (**Gawlik 1997, 1998**). Telemetry studies and observations of marked birds have shown that many leave Florida Bay in the summer and move north to coastal and inland sites up to 300 kilometers north of Florida Bay. Many of these marked birds returned to Florida Bay for the winter nesting season (**Rodgers et al. 1996**).

The great white heron nests exclusively in coastal and estuarine areas, mostly on islands in Florida Bay. During the breeding season, this species forages mainly in shallow open water, mudflats, or shallow areas vegetated with sea grass. During the non-breeding season, they forage in marine and freshwater habitats.

The great white heron has been recorded numerous times at Biscayne NP throughout the year, but mostly in the winter (**BNP 1998**). It has been recorded as a nesting species on West Arsenicker and Arsenicker Keys in 1975, 1980, 1983-84, and 1996 (**Howitt 1996**). This species was recorded along the mangrove fringe of Biscayne NP during 1998 aerial surveys (**Denton and Godley 1999**), but not from former Homestead AFB (**Figure G-14**). The great white heron will continue to occur sporadically along the mangrove fringe of Biscayne NP, as well as in the wetlands inland from the fringe. Although it has not been observed on former Homestead AFB, it would be expected to occur occasionally on the former base.

Great Egret. This species was a prime target for plume hunters at the end of the 19th Century and, as a result, was almost driven to extinction; the passage of the Migratory Bird Treaty Act in 1918 probably saved this species. Under this protection, great egret populations recovered, and by the 1930s, there was an estimated 73,000 in Florida alone. The current breeding range of this species covers much of North America, including all of Florida (**Rodgers et al. 1996**). Surveys from 1992 through 1998 (1996 data not available) in the Everglades resulted in the observation of 3,300 to 4,500 great egret nests. This was the most common nesting species in the Everglades, except in 1992 when the White ibis was more numerous. In addition, 61 to 84 percent of these birds nested in Water Conservation Areas 2 and 3 during this time period (**Gawlik 1997, 1998**; **Frederick 1995**).

The great egret was recorded numerous times at Biscayne NP during all seasons, including during the Christmas Bird Counts (**BNP 1998**). This species has been observed nesting on Arsenicker and West Arsenicker Keys: 8 to 20 nests were observed in the 1970s, 100 nests in 1983-84, and three nests in 1996 (**Howitt 1996**). The great egret was observed at numerous locations on and in the area of former Homestead AFB (Figure G-14). This species typically occurred as single individuals, although small dispersed groups of two to four individuals were observed (**Tables G-11 and G-12**). In addition, it was one of the most common wading birds recorded during the 1998 summer wading bird aerial surveys (see Table G-8). The great egret was observed near the runway on former Homestead AFB every month of the year in 1992 and 1993 (**Hilsenbeck 1993**) and was also recorded from the former base during other studies (**PBS&J 1998b, Mazzotti 1999b, Peterla 1999a**). In 1998, 223 egrets were observed during 190 observations throughout the year on former Homestead AFB (**Peterla 1999a**). The great egret will continue to be a fairly common species at Biscayne NP and in the wetlands between the park and the former base. In addition, small numbers will continue to forage on the former base in the shallow wetlands and open fields.

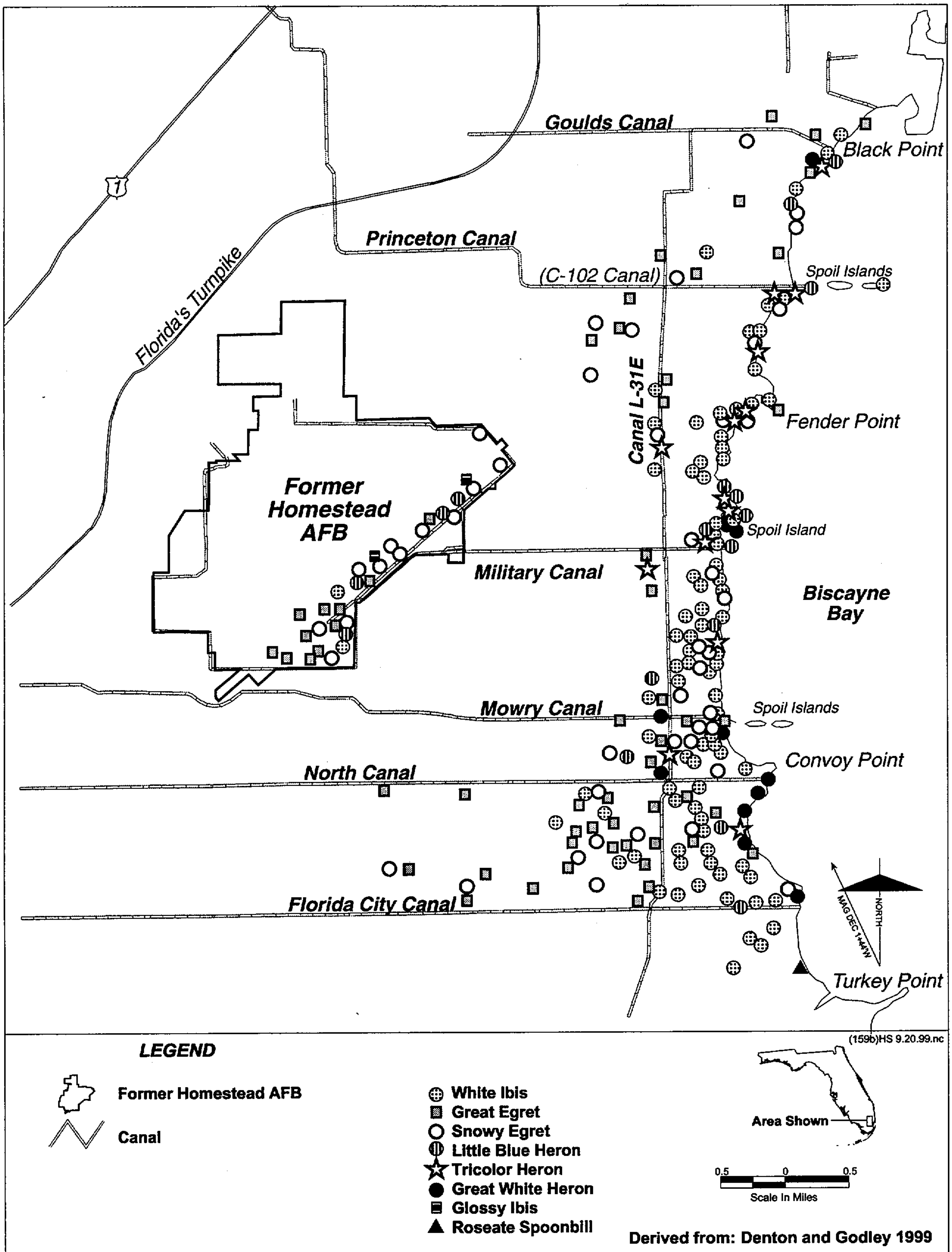


Figure G-14
Location of State Sensitive Wading Birds Observed During Aerial Surveys on June 2 and 26 and July 14, 1998, At and Near Former Homestead AFB

Table G-11. State Listed Wading Birds Observed Along Military Canal, Canal L-31E, and the Western Shoreline of Biscayne Bay, June and July 1998

Date/Sampling Point[1]	Species					Total
	Great Egret	Little Blue Heron	Snowy Egret	Tricolor Heron	White Ibis	
June 3, 1998						
M[2]	1	3	2	2	N[3]	8
June 4, 1998						
L10	1	1	0	0	1	3
L11	1	0	1	1	3	6
L12	0	0	0	1	0	1
L13	0	1	0	0	3	4
L14	0	0	0	0	14	14
L15	3	0	0	0	1	4
June 4, 1998						
B1	2	0	0	0	0	2
L3	0	0	0	1	0	1
L5	1	0	0	0	0	1
MO3	1	0	0	0	0	1
June 5, 1998						
L3	0	1	0	1	0	2
L5	1	0	0	0	0	1
L7	0	0	0	0	4	4
June 8, 1998						
B2	1	0	0	0	0	1
L10	0	0	0	0	3	3
L[2]	1	1	1	0	0	3
M3	0	1	0	0	2	3
June 9, 1998						
C8	0	0	0	1	0	1
C15	0	0	0	1	0	1
June 10, 1998						
C7	1	0	0	0	0	1
C13	0	1	0	0	0	1
C17	0	0	0	1	0	1
C[2]	0	1	1	1	0	3
June 22, 1998						
M6	0	1	0	0	0	1
L1	0	0	0	2	0	2
L7	0	0	0	0	4	4

Date/Sampling Point[1]	Species					Total
	Great Egret	Little Blue Heron	Snowy Egret	Tricolor Heron	White Ibis	
June 23, 1998						
C16	0	0	0	1	0	1
C17	0	0	2	0	0	2
C19	0	0	0	2	0	2
C20	1	0	0	2	0	3
C[2]	0	0	0	0	N	N
July 13, 1998						
L3	0	0	0	0	4	4
L5	0	0	0	0	31	31
L8	0	0	0	0	6	6
July 14, 1998						
C1	0	0	1	0	0	1
C4	0	0	0	1	0	1
C5	0	1	0	0	3	4
C7	2	1	0	4	0	7
C9	0	1	0	0	0	1
C12	0	0	0	2	11	13
C13	0	0	0	2	0	2
C16	0	0	0	0	8	8
C20	0	0	6	3	6	15
C23	4	0	8	4	20	36
July 15, 1998						
L9	0	2	0	0	4	6
L10	1	1	0	0	0	2
L12	1	1	0	0	0	2
Total						
B	3	0	0	0	0	3
C	8	5	18	25	48	104
L	10	8	2	6	78	104
M	1	5	2	2	2	12
MO	1	0	0	0	0	1
Grand Total	**23**	**18**	**22**	**33**	**128**	**224**
Average Number Per Detection	1.4	1.2	2.8	1.7	7.1	4.8

Source: **Denton and Godley 1999.**

Notes:
[1] B = tidal stream, C = Biscayne Bay coastline, L = Canal L-31E, M = Military Canal, MO = Mowry Canal. (See Figure G-5 for location of sampling points.)
[2] Sample points not provided.
[3] Numerous birds observed flying over site and not counted in total.

Table G-12. State Listed Wading Birds Observed Along Canals During the Eastern Indigo Snake Surveys in June and July 1998

Location/Date	Species						Total
	Great Egret	Little Blue Heron	White Ibis	Yellow Crowned Night Heron	Snowy Egret	Tricolor Heron	
Canal L31-E							
June 8	1	0	0	0	0	0	1
June 28	1	0	0	0	0	0	1
June 28	1	0	0	0	0	0	1
July 19	1	1	1	0	0	1	4
July 19	1	1	7	0	0	0	9
July 19	1	0	0	0	0	0	1
July 19	1	0	0	0	0	0	1
North Canal							
June 28	1	0	0	0	0	0	1
July 19	4	0	0	0	1	0	5
Military Canal							
June 8	0	1	1	0	0	0	2
June 9	1	0	0	0	0	0	1
July 19	4	0	0	0	0	0	4
Florida City Canal							
June 9	1	0	0	0	0	0	1
June 27	0	0	0	0	1	0	1
June 28	0	0	3	0	0	0	3
July 19	0	0	1	0	0	0	1
Canal C-102							
June 27	0	0	0	1	0	0	1
July 19	3	0	1	0	0	0	4
Mowry Canal							
June 8	1	0	0	0	0	0	1
June 27	3	0	0	0	0	0	3
June 28	0	0	1	0	1	0	2
July 17	0	0	2	0	0	1	3
Gould's Canal							
June 8	0	0	3	0	7	0	10
June 9	2	0	0	0	0	0	2
June 27	0	0	0	1	0	0	1

Location/Date	Species						Total
	Great Egret	Little Blue Heron	White Ibis	Yellow Crowned Night Heron	Snowy Egret	Tricolor Heron	
Total							
L31-E	7	2	8	0	0	1	18
North	5	0	0	0	1	0	6
Military	5	1	1	0	0	0	7
Florida City	1	0	4	0	1	0	6
C-102	3	0	1	1	0	0	5
Mowry	4	0	3	0	1	1	9
Gould's	2	0	3	1	7	0	13
Grand Total	**27**	**3**	**20**	**2**	**10**	**2**	**64**
Average Number Per Detection	1.7	1.0	2.2	1.0	2.5	1.0	2.6

Source: **Mazzotti 1999b.**

Little Blue Heron. The little blue heron is a widely distributed nesting species in Florida and elsewhere along the Atlantic coast and southeastern United States. It did not suffer from the plume trade in the late 19th and early 20th centuries, but has apparently declined as a result of degradation of wetlands and alteration of wetland hydroperiods. The little blue heron nests in a variety of woody vegetation at coastal and inland locations. It forages in diverse locations including man-made canals and roadside ditches. Migratory little blue herons move into and through Florida during the winter, resulting in an increase in numbers during that season (**Rodgers et al. 1996**). Recent data indicate that about 1,400 to 2,100 little blue herons nested in the Everglades from 1992 though 1995, with 47 to 70 percent nesting at Loxahatchee National Wildlife Refuge, and the reminder in Water Conservation Areas 2 and 3 (**Frederick 1995**).

The little blue heron is a common winter bird at Biscayne NP (**BNP 1998**). It also breeds at Biscayne NP, having been recorded at the rookeries on Arsenicker and West Arsenicker Keys in the 1970s and 1980s. Birds in breeding plumage were observed at these rookeries in 1996, but the number of nests was not determined (**Howitt 1996**). Scattered individuals were observed foraging along Military Canal, Canal L-31E, and the western shoreline of Biscayne Bay in June and July 1998 (see Figure G-14, Tables G-11 and G-12). The little blue heron roosted at small scattered sites along the western shoreline of Biscayne Bay during the winter of 1999. It was observed every month from December 1992 to October 1993 on former Homestead AFB, where four to six individuals consistently foraged in shallow wetlands (**Hilsenbeck 1993**). Zero to four individuals were detected in June and July 1998 (see Table G-9), comprising a large percentage of the "other" wading birds tallied on former Homestead AFB (see Table G-7). The little blue heron will continue to be a common species at Biscayne NP, especially during the winter, and small groups may establish roosts along the western shoreline of Biscayne Bay. Individuals and small groups will continue to forage along the canals in the area, as well as on former Homestead AFB.

Tricolor Heron. The tricolor heron nests along much of the Atlantic and Gulf Coasts of the United States, as well as over much of central and south Florida. This bird's dark color and habit of nesting in wooded areas makes accurate census counts difficult. The number of nesting birds in south Florida has decreased from an estimated 15,000 pairs in the 1930s to 3,500 pairs in the 1970s, to 1,100 to 1,400 pairs in 1986 and 1987 (**Rodgers et al. 1996**). More recently, the estimated number of pairs in the Everglades from 1992 through 1995 ranged from about 1,000 to 2,000 pairs (**Frederick 1995**).

The tricolor heron nests most often in mangrove islands along the coast, although it sometimes nests at inland locations. This species feeds in a wide variety of coastal and inland habitats such as marshes, mangrove swamps, roadside ditches, and around ponds and lakes.

The tricolor heron was recorded most frequently in Biscayne NP during summer and winter (**BNP 1998**). Summer observations were mostly of nesting herons on the Arsenicker keys, while winter observations occurred mostly during the Christmas Bird Counts. Nineteen to 100 tricolor heron nests were estimated to occur on the Arsenicker Keys in the 1970s and early 1980s, and it was assumed to nest on these keys in 1996, although this was not confirmed. This species nested from May to July on these keys (**Howitt 1996**). Widely scattered individuals and small groups were observed foraging along canals and the mangrove shoreline of Biscayne Bay in June and July 1998 (see Figure G-14, Tables G-11 and G-12). This species was more common along mangrove shoreline than canals, which is consistent with its preference for coastal areas. It was also observed every month from, December 1982 through October 1993, foraging in shallow wetlands on former Homestead AFB (**Hilsenbeck 1993**). Three to seven birds were also observed on the former base in June and July 1998 (Table G-9). This species will likely continue to nest at Biscayne NP and continue to forage along the mangrove fringe, wetlands, and canals inland from the fringe, and on the former base.

Reddish Egret. The reddish egret is a state rare species and historically may have nested as far north as Tampa Bay on the west coast and Cape Canaveral on the east coast of Florida. In the late 1800s, the reddish egret declined sharply in Florida and, by the early 1900s, had apparently disappeared from the state entirely. It reappeared in the 1930s, and by the mid-1970s there were an estimated 300 birds, mostly in Florida Bay (**Powell et al. 1989**). Very few reddish egret nests were observed in Florida Bay or elsewhere in the Everglades from 1995 through 1998 (**Gawlik 1998**). Reddish egrets nest exclusively on coastal natural or dredged material islands covered with mangrove, Brazilian pepper, or other woody vegetation. This species forages principally in coastal areas such as broad, barren sand or mudflats (**Rodgers et al. 1996**).

The reddish egret was recorded at Biscayne NP on eight occasions from 1979 through 1996, with three nesting pairs on West Arsenicker Key in 1980. Reddish egrets in breeding plumage were also observed on this key in 1996, but breeding was not confirmed (**BNP 1998**, **Howitt 1996**). This species was recorded during wildlife studies along the western coastline of Biscayne Bay in cattail and open water habitats (**Metro-Dade County 1994b**), but was not observed in this area during aerial and ground surveys conducted in 1998 (**Denton and Godley 1999**). In addition, the reddish egret was not recorded on Homestead AFB. The reddish egret may make occasional use of the mangrove fringe and other wetlands along the western shoreline of Biscayne Bay and may also nest in small numbers on West Arsenicker Key. It would occur very infrequently, if at all, on former Homestead AFB because it prefers to forage along the coastline.

Snowy Egret. The snowy egret, along with the great egret, was almost driven to extinction as a result of the plume trade in the late 19th and early 20th centuries. This species recovered after plume hunting ended and apparently reached peak numbers between the 1930s and early 1950s (**Rodgers et al. 1996**). As a result of water management practices, the number of snowy egrets began to decline. The average number of pairs in the Everglades from 1975 through 1978 was 3,400, and by the 1980s, this number had declined by 78 percent to an average of 946 pairs (**Bancroft 1989**). More recently, the number of pairs of snowy egrets in the Everglades was 2,295 in 1992, 1,494 in 1993, 461 in 1994, and 568 in 1995

(Frederick 1995). The estimated number of nests in the Everglades declined to about 450 in 1997 and 300 in 1998 (**Gawlik 1997, 1998**).

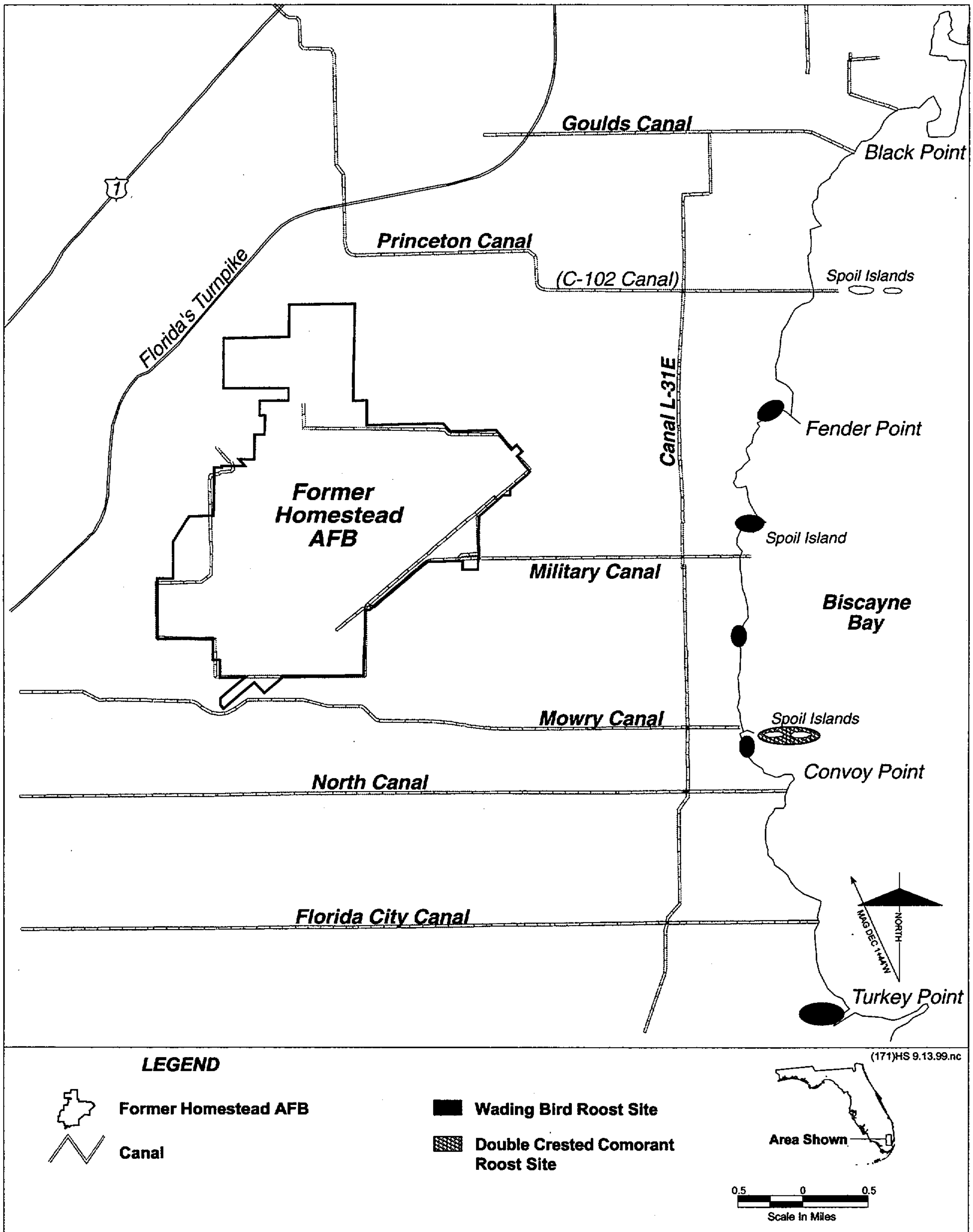
The snowy egret nests in a variety of woody plants both in coastal and inland wetlands. It is widely distributed in Florida and also nests along the Atlantic coast north of Florida and in the lower Mississippi Valley. This species is non-migratory in Florida, although snowy egrets from more northern breeding grounds move south for the winter (**Rodgers et al. 1996**).

The snowy egret is fairly common at Biscayne NP and was most often recorded during summer and winter (**BNP 1998**). Two nests of this species were found on the Arsenicker Keys in 1975, and 15 nests were observed on these keys in 1996 (**Howitt 1996**). Widely scattered individuals and small groups were observed along the western shoreline of Biscayne Bay and canals and wetlands inland from the bay in June and July of 1998 (see Figure G-14, Tables G-11 and G-12). This species also roosted in small numbers along the western shoreline of Biscayne Bay during the winter of 1998–99 (see **Figure G-15**). The snowy egret was recorded on former Homestead AFB every month from December 1992 through October 1993 (**Hilsenbeck 1993**), and up to 15 were observed during June and July of 1998 in the area of the runway (see Table G-9). In addition, this species comprised a large percentage of the "other" wading birds recorded during 190 observations from June 5 through December 12, 1998 (see Table G-7). The snowy egret will continue to occur at Biscayne NP and may continue to nest on the Arsenicker Keys. It is also expected to forage in small numbers on former Homestead AFB and in surrounding wetlands and canals.

Night Herons. The black-crowned and yellow-crowned night herons are both state species of special concern. The black-crowned night heron is widespread in North America and breeds throughout much of Florida. The Yellow-crowned night heron occurs in the eastern United States and nests in more widely scattered locations than the black-crowned night heron. Due to these species' dark plumage, tendency to nest below the canopy, and secretive habitats, there is little information regarding their population sizes. Both species nest in a variety of marine, estuarine, and inland wetland habitats (**Rodgers et al. 1996**).

The black-crowned night heron has been recorded more frequently at Biscayne NP than the yellow-crowned night heron, and most observations of both species were in the winter (**BNP 1998**). These species have not been recorded as nesting species at Biscayne NP (**Howitt 1996, BNP 1998**), but given their secretive nature, it is likely that one or both species nest in Biscayne NP. The yellow-crowned night heron was observed every month during an 11 month biological study on former Homestead AFB in 1992 and 1993 (**Hilsenbeck 1993**), but not during other biological surveys on the former base. The black-crowned night heron was not recorded on the former base during recent biological surveys, but is known from Homestead ARS (**SEA 1997**). Both species of night herons will continue to occur and likely nest in the mangrove fringe along Biscayne Bay and in the wetlands inland from the mangroves. Both will also continue to forage in the wetlands and along the canals around and on former Homestead AFB.

Glossy Ibis. The glossy ibis nests along the Atlantic seaboard and throughout much of Florida. This species was considered a rare breeding bird in Florida prior to the 1930s, but the number gradually increased during the next three decades to an estimated 3,500 birds in the 1970s. The population trend for this species since the 1970s is unknown. This species also spread up the Atlantic seaboard starting in the 1930s, with the northernmost colony established in Maine in 1972. The glossy ibis nests primarily in central Florida, with a small number of birds nesting in south Florida. It is essentially a freshwater species that forages in seasonally flooded grasslands, roadside ditches, shallow marshes, and along lake shores.



Derived from: Lockwood 1999a

Figure G-15
Lightly Used Wading Bird and Other Aquatic Bird Winter Roost Sites Along the Western Shorelines of Biscayne Bay, Winter of 1998-99

The glossy ibis was only recorded twice from Biscayne NP: once in 1975 and once in 1986 (**BNP 1998**). However, recent observations indicate this species is more common in the park than indicated by these data. During biological field surveys in June 1998, a flock of seven birds was observed in the early morning flying north up the western shoreline of Biscayne Bay, and a flock of seven was observed flying south along the shoreline in the late afternoon of the same day. Small numbers of glossy ibis were also observed during aerial wading bird surveys, also in June and July 1998 (see Table G-8). This species was not recorded from former Homestead AFB during earlier surveys, but was recorded during the 1998 surveys (see Figure G-14). The glossy ibis is expected to continue to occur at least as a transient along the mangrove shoreline of Biscayne NP and will likely forage in the mangrove fringe and other wetlands along this shoreline. It will likely continue to occur sporadically in the shallow wetlands on former Homestead AFB.

White Ibis. The white ibis nests along the Atlantic seaboard north to Virginia, along the Gulf coast, and in central and south Florida. This colonial nesting wading bird is nomadic, and nesting colonies are in different locations from year to year. There were an estimated 100,000 breeding white ibis in Florida during the first half of the 20th Century. This species began to decline in the 1950s, and statewide surveys in 1988 indicated there were 34,000 white ibis in Florida. Consistent with its nomadic nature, the number of white ibis nests counted recently in the Everglades have fluctuated dramatically from 16,500 nests in 1992 to 600 nests in 1993. Two to three thousand nests were reported from the Everglades in 1994 and 1995, while about 3,700 nests were reported in 1997 and 1560 nests in 1998 (**Gawlik 1997, 1998**; **Frederick 1995**). Overall, there has been a dramatic decrease (95 percent) in the number of nesting white ibis in Everglades NP. There has also been a shift out of Everglades NP to water Conservation Areas 2 and 3 and the Loxahatchee National Wildlife Refuge (**Frederick 1995**). The reduction in nesting white ibis in the Everglades reached an all time low in 1998 when no nests were reported (**Gawlik 1997**). Historically, this species nested in large numbers in the estuarine mangrove areas of the park, but they no longer use these areas because of a reduction in prey species over the last 30 years.

The white ibis nests in a variety of freshwater and marine habitats, although it appears that freshwater foraging habitat is required for adults who are feeding young. This species forages in shallow-water areas, although they have been observed feeding on lawns, pastures, and at landfills. The white ibis can travel up to 19 miles one way on foraging trips and still successfully raise its young.

The white ibis is commonly observed at Biscayne NP, with most observations occurring during the winter Christmas Bird Counts (**BNP 1998**). This species also nests on the Arsenicker Keys: 106 nests were counted in July 1975, 100+ nests in May 1976, 94 nests in June of 1980, and 11 nests in June of 1996 (**Howitt 1996**). Five flocks of 10 to 50 white ibis were observed flying north along the western shoreline of Biscayne Bay while conducting a breeding bird survey along Military Canal on June 3, 1998. One flight of 40 to 50 white ibis were then observed flying south along the western shoreline of Biscayne Bay past Military Canal in the late afternoon on June 2, 1998. This flight pattern indicates these birds were traveling to and from roost sites and/or rookeries to a foraging location(s). A potential foraging location is the Miami-Dade County landfill, about 3.4 miles north of Military Canal. The white ibis commonly forages at landfills even when feeding its young (**Rodgers et al. 1996**). Possible roost or rookery locations for these birds are the Arsenicker Keys or Florida Bay, where 200 nests were observed in June 1998 (**Gawlik 1998**). The one-way trip from the Arsenicker Keys to the landfill is 10 miles, and the same trip from the east end of Florida Bay is about 21 miles. The trip from Arsenicker Keys is within the foraging travel distances reported for this species (19 miles), while the trip from eastern Florida Bay exceeds this distance. Observation of the flight path of some of these groups indicated they were coming from the direction of Florida Bay and not the Arsenicker Keys.

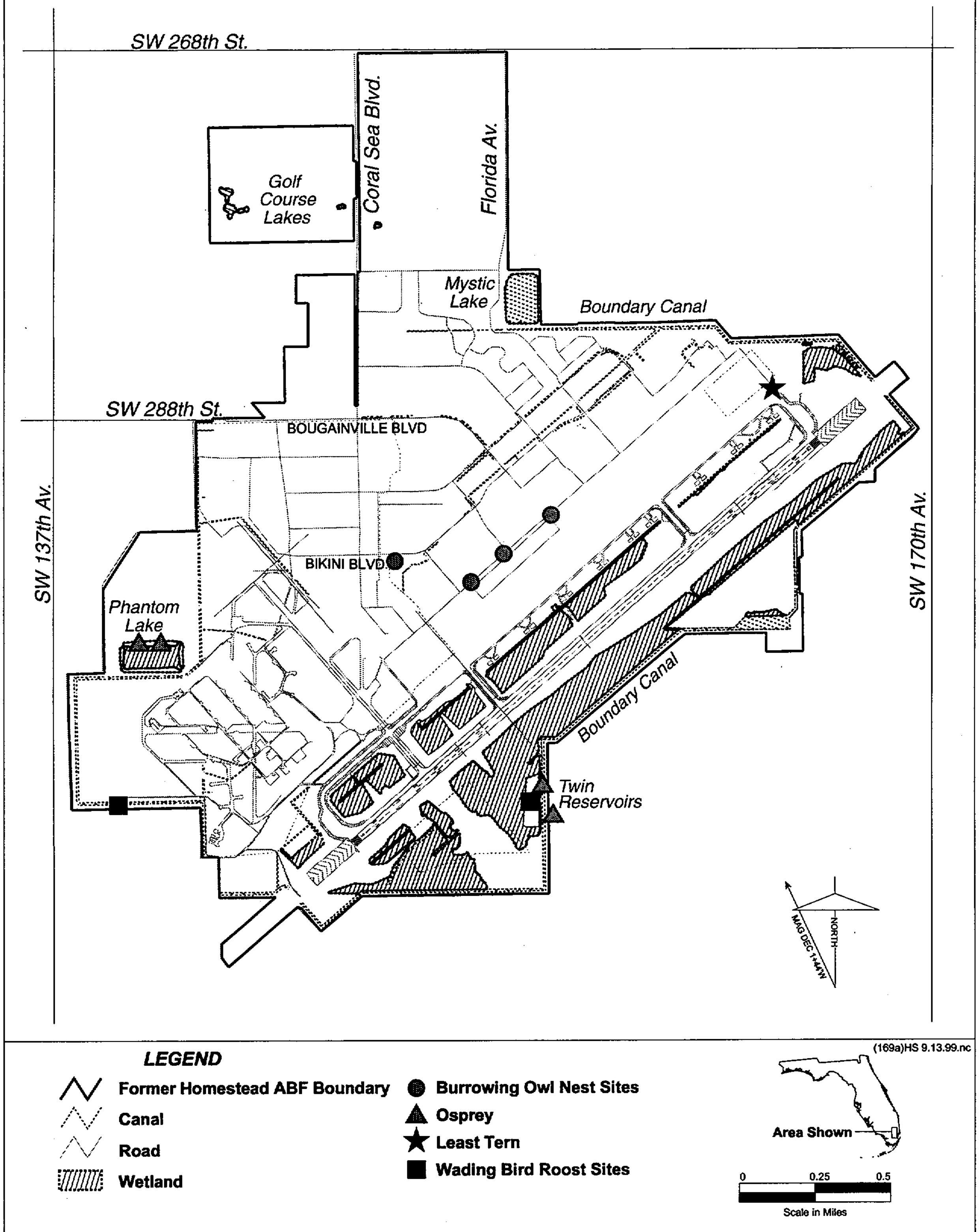
The white ibis was the second most common species of wading birds observed (cattle egrets were most numerous) during aerial surveys in June and July 1998, with 113 recorded on July 14, 1998 (see Table G-8) (**Denton and Godley 1999**). These birds were scattered throughout the mangrove and freshwater wetlands between former Homestead AFB and Biscayne Bay (see Figure G-14). White ibis were frequently observed foraging in small groups under the mangroves along the western shoreline of Biscayne Bay in February 1999. These birds may roost along the western shoreline of Biscayne Bay in the winter (see Figure G-15).

The white ibis was not observed during biological surveys of former Homestead AFB in 1992 and 1993 (**Hilsenbeck 1993**), but it was observed during surveys in June and July 1998 (see Table G-9). In addition, it was the second most common wading bird species (cattle egrets were more common) recorded during 190 observations in 1998. A total of 3,171 birds were recorded, with the largest number occurring from July through November. Very few were observed from March through June (see Table G-7). The largest number observed on the former base in 1998 was 600 on September 18. This species, along with cattle egrets and other unidentified species of herons and egrets, roost in Australian pine next to the twin reservoirs (see **Figure G-16**). The roost was active during the summer of 1998 (**BNP 1998**), as well as at other times during the last two years (**Peterla 1999b**). The white ibis will continue to use Biscayne NP, particularly during the winter and the summer nesting season. In addition, early morning and late afternoon flights along the western shoreline of Biscayne Bay may continue as long as roost and/or rookeries within flight distance of the preferred foraging location(s) are in use. This species is also expected to continue to forage along the mangrove fringe and other wetlands, canals, and roadside ditches in the area around and on former Homestead AFB.

Roseate Spoonbill. The roseate spoonbill is a state rare species and once bred in large numbers in south Florida prior to the 1880s. Plume hunters and later, meat hunters, reduced the roseate spoonbill to one colony of 15 pairs on Bottle Key in Florida Bay by 1941. Subsequently, the population began to recover, and by 1979 there were an estimated 1,254 breeding pairs. The population was reduced by 64 percent by 1984 and remained at this reduced level throughout the remainder of the 1980s (**Powell et al. 1989**). As the spoonbill recovered, it also reoccupied some of its former nesting range outside of Florida Bay. During the 1995–96 through 1997–98 nesting season, 45 to 50 spoonbill nests were observed in Florida Bay. However, this may be an underestimation because of the difficulty in observing this species during aerial surveys (**Gawlik 1998**).

The roseate spoonbill nests on coastal islands vegetated with mangroves and, in some cases, Brazilian pepper. They forage in shallow marine, brackish, and freshwater sites and the mangrove fringe; the freshwater Everglades are currently the main foraging areas for this species (**Rodgers et al. 1996**).

There are no records of the roseate spoonbill nesting at Biscayne NP, but it has been recorded from the park numerous times, mostly in the mid 1970s and mid- to late 1990s. In addition, most birds were observed in the winter (**BNP 1998**). This species was also observed in cattail marsh and open water during 1993 wildlife surveys of the western coastline of Biscayne NP (**Metro-Dade County 1994b**), and one bird was observed along the mangrove fringe during 1998 aerial wading bird surveys (see Table G-8 and Figure G-14). The spoonbill was not recorded on former Homestead AFB during recent wildlife surveys. This species will continue to occur sporadically along the mangrove fringe and associated freshwater wetlands, and although it has not been recorded on former Homestead AFB, it would be expected to occur on the former base from time to time.



Derived from: SEA 1997,
Denton and Godley 1999,
Mazzotti 1999b

Figure G-16
Locations of Sensitive Bird Species Recorded in June and July 1998 on Former Homestead AFB

Least Bittern. This bird occurs over much of the eastern United States, including all of Florida. It nests in fresh and brackish wetlands and is less common in mangroves. It inhabits a variety of wetland types, including lake shores, ditches, reservoirs and other impounded areas—even wetlands close to human habitation. Nests are typically built over water. The least bittern forages from perches (**Rodgers et al. 1996**).

There is no population estimate for the least bittern in Florida because it is a very secretive species. Available information indicates it is likely fairly common, and it may nest in the freshwater wetlands inland from the mangrove fringe along the western shoreline of Biscayne NP and in the cattail wetlands and around the lakes on former Homestead AFB. The reduction of wetlands in Florida has undoubtedly resulted in a reduction of this species, but it is one of the few wading birds that benefits from dense cattail stands in areas like the Everglades (**Rodgers et al. 1996**). This species has not been recorded in Biscayne NP, the mangrove fringe, or during most biological surveys on former Homestead AFB. This species was observed, however, on Homestead ARS (**SEA 1997**).

American Oystercatcher. The American oystercatcher's breeding and major non-breeding ranges are north of Miami. It needs extensive beaches, sandbars, or mudflats for feeding and roosting, and sparsely vegetated sand areas for nesting (**Rodgers et al. 1996**). Twelve American oystercatchers were observed on six dates at Biscayne NP from 1984 through 1997. This included one observation during the 1985 Christmas Bird Count (**BNP 1998**). This species would continue to occur very sporadically at Biscayne NP and would not be expected to occur at former Homestead AFB.

Wilson's Plover. Wilson's plover occurs along much of the Atlantic and Gulf coasts and nests and forages on sandy beaches and tidal flats along the coast in the Homestead area. Nesting populations occur north of Miami, Florida Bay, and the Florida Keys. This species also migrates through or winters in south Florida, with spring migration occurring from late February to mid-March, and fall migration in August and September (**Rodgers et al. 1996**).

A total of 53 Wilson's plovers were recorded on 25 days between 1979 and 1997 at Biscayne NP. Most of these observations took place in the summer and winter, and all but four have taken place in the 1990s (**BNP 1998**). This species successfully nested on Boca Chita Key in Biscayne NP in 1996 (**Howitt 1996**). Wilson's plover was not observed during wildlife surveys of the mangrove fringe and other wetlands along the western shoreline of Biscayne Bay, the Chapman Field or Matheson Hammock parks, or on former Homestead AFB. Two Wilson's plovers were observed along Canal L-31E on July 15, 1998 (see Figure G-12) and it may occur occasionally along the western shoreline of Biscayne Bay. This species will likely continue to use the beach habitat on the Biscayne NP keys for nesting and foraging. It would likely be very infrequent on former Homestead AFB.

Cooper's Hawk. The Cooper's hawk occurs as a breeding species over much of North America, including the northern two-thirds of Florida. It occurs in south Florida as a migrant and wintering species (**Rodgers et al. 1996**). Wintering and migrating Cooper's hawks can be found in woody habitat that supports their major food supply, which is small- to medium-sized birds. The Cooper's hawk has apparently recovered from population lows in the 1970s that were due to DDT and other persistent pesticides (**Bednarz et al. 1990**). It is questionable if it should continue to be a species of special concern in Florida (**Rodgers et al. 1996**).

Cooper's hawks were reported from Biscayne NP in the fall and winter on only five occasions (**BNP 1998**). They were observed on former Homestead AFB during the spring and fall migration of 1993, but was considered rare (**Hilsenbeck 1993**). This species was not observed on the former base during other biological surveys. Cooper's hawk would be expected to continue as a rare migrant and also, potentially, a winter resident on the former base. They could also occur as a rare migrant almost anywhere between the former base and Biscayne Bay.

Osprey. The osprey is a state species of special concern but is not listed by the federal government. It nests throughout Florida, and migrating osprey occur in Florida as they move back and forth from their northern breeding ground to their tropical wintering grounds. The osprey has recovered from serious declines in the 1950s and 1960s due to pesticide contamination, although the Florida populations were apparently not greatly affected (**Rodgers et al. 1996**).

The osprey nests in all regions of Florida, and they appear to be maintaining their historical distribution in the state. Nesting osprey are most common in bays and estuaries along the west coast of Florida between the mouth of the Apalachicola River and Florida Bay and along the Atlantic coast between St. Mary's River and Merritt Island. Osprey nest in cypress, mangrove, and pine trees. Nests in Florida Bay are usually in mangroves or shrubs, but can even occur on the ground (**Rodgers et al. 1996**). Osprey also require open, relatively clear water to capture fish.

Ospreys begin nesting in Florida Bay in late November and lay eggs before the end of December. Nesting is usually completed by April in south Florida and by July in north Florida. After nesting is complete, osprey in south Florida do not generally migrate out of the area, although some may travel into central Florida during the non-breeding season (**Rodgers et al. 1996**).

The osprey has been observed along the western shoreline of Biscayne Bay and along Military Canal. This species was recorded 100 times between 1974 and 1998 at Biscayne NP (**BNP 1998**). In 1998, there were three known active osprey nests in Biscayne NP: two on Elliott and one on Sands Keys (**Lockwood 1999a**). In addition, one osprey nest was reported from Chapman Field Park along the western shoreline of Biscayne Bay (**Dalrymple 1998**). Osprey nests were not recorded along the western shoreline of Biscayne Bay during aerial and ground surveys conducted in 1998 (**Denton and Godley 1999**), or during aerial surveys for bald eagle nests (**Lockwood 1998b**), so it likely does not nest along the coastline between Convoy Point and Black Point. The osprey was observed on former Homestead AFB near Phantom Lake (**SEA 1997**), and it was observed twice in June 1998, including at Phantom Lake and at the twin reservoirs (Figure G-16). The osprey will likely continue to nest in the keys of Biscayne Bay and forage along the western shoreline of the bay. In addition, it will likely continue to forage inland from the coast, but would use former Homestead AFB infrequently.

Florida Burrowing Owl. The Florida burrowing owl is a state species of special concern, but not a federally listed species. Historically, this species was reported in the central peninsula of Florida, the Florida Keys, and the Bahama Islands. The burrowing owl apparently underwent a range expansion in the 1940s, and it now occurs in south Florida including the Homestead area. Statewide surveys for this species have not been conducted, so the population size is unknown. Based on available information, the statewide population of the burrowing owl in 1987 was estimated to be between 3,000 and 10,000 pairs. Fairly dense populations occur in some Florida counties, including Miami-Dade County (**Rodgers et al. 1996**).

The Florida burrowing owl is usually found in open, well-drained areas with short herbaceous ground cover. Historically, these habitat requirements were met in the dry prairies of central Florida in the vicinity of burns. Clearing land for human development and draining wetlands greatly increased the amount of habitat available to the burrowing owl. This is thought to be the reason for its range expansion in Florida. This species now nests in developed areas such as golf courses, airports, canal banks, and in other partially developed areas. In developed areas, they tend to be found where 25 to 75 percent of the landscape is developed. It is believed that the Florida burrowing owl was nomadic in response to changing available habitat created by fire in its historic range. Today, this nomadic tendency is apparent as this species inhabits recently disturbed land, but then leaves when habitat conditions deteriorate **(Rodgers et al. 1996)**.

Most of the burrowing owl nesting activity occurs during the dry season from February through late May. Fledging activity peaked in late May in Cape Coral Florida. This species shows a high degree of site fidelity; 78 percent of the adults in the Cape Coral population remained on their territories from 1987 to 1989 **(Rodgers et al. 1996)**.

Two pairs of burrowing owls were observed on former Homestead AFB in 1992; these two pairs had disappeared in 1993 **(Geraghty & Miller 1993)**. This species was not recorded during the 1992/93 biological surveys of former Homestead AFB **(Hilsenbeck 1993)**. Biological surveys in 1998 revealed the existence of three active and one inactive burrowing owl nest sites in short-grass habitat near the runway (see Figure G-16). This species was not observed along Military Canal or any other areas surveyed for sensitive species outside the former base.

Terns. The royal, sandwich, and Caspian terns are state species of special concern. These species nest in a few locations along the central coasts of Florida, but can be found in south Florida during the winter. Wintering birds occur at aquatic habitats both along the coasts and at inland lakes, wetlands, and other water bodies **(Rodgers et al. 1996)**.

The Royal tern is the most common of the three species at Biscayne NP where it was recorded almost 100 times from 1979 through 1997, with all observations occurring between August and May. This species was one of the most common species in the Christmas Bird Counts at Biscayne NP, where 100 to almost 300 birds were recorded during each count. The Sandwich tern was recorded 37 times from 1979 through 1997 at Biscayne NP, and 34 of 37 birds were observed in fall and winter. The Caspian tern, the least common of the three, was recorded 20 times from 1979 through 1997. All these observation took place in late fall and early winter **(BNP 1998)**. In summer, the terns nest well away from Biscayne NP, as indicated above, which explains why they were not recorded there in summer. These species of terns were not recorded on former Homestead AFB, although an occasional individual may be expected to occur at one of the small lakes.

Florida Prairie Warbler. The Florida prairie warbler is a state sensitive species whose status is undetermined. There are two subspecies of the prairie warbler. The northern prairie warbler (*Dendroica discolor discolor*) breeds in the eastern United States and winters in the Caribbean. The Florida prairie warbler breeds in Florida and winters in Florida and the Caribbean. The Florida prairie warbler nests mostly in mangroves along the east and west coasts of central and south Florida, as well as in the Florida Keys. Recent surveys on Key Largo indicated that the density of this subspecies during the nesting season was 0.86 to 1.09 pairs per hectare. The breeding season in the Florida Keys was late April to early July. No evidence that cowbirds parasitized nests of the subspecies was noted in the keys **(Prather and Cruz 1995)**, although there is evidence that this does occur elsewhere **(Rodgers et al. 1996)**.

The prairie warbler is common at Biscayne NP, having been recorded 718 times from 1973 to 1998. Most of these observations occurred during the winter, including 330 observations during the Christmas Bird Counts from 1979 to 1997. There were also numerous observations during the spring and fall migrations **(BNP 1998)**. It is assumed that most of the wintering and migrant birds observed were the northern prairie warbler. The Florida prairie warbler was the most abundant warbler recorded during breeding bird surveys in Biscayne NP from April through June 1996; four to six territories were recorded on Sands, Elliott, Adams, and East Arsenicker keys **(Howitt 1996)**. Thirteen singing males were recorded during breeding bird surveys in 1998, and the locations of 11 were recorded (Figure G-12). One was heard along

Military and Mowry canals, four along Canal L-31E, and five along the mangrove fringe coastline (**Denton and Godley 1999**). The prairie warbler was not recorded on former Homestead AFB. Nesting Florida prairie warblers would not be expected to occur on the former base due to lack of appropriate nesting habitat, but migrating and, possibly, wintering prairie warblers are likely in the overgrown areas on the former base. In addition, this species will continue to nest along the mangrove fringe of the western shoreline of Biscayne Bay.

G.2.5 Mammals

Sensitive mammals that occur or have the potential to occur in the Homestead area are the West Indian manatee and Florida panther, both of which are listed by the federal and state governments. The Key Largo cotton mouse and Key Largo woodrat are included in this section, although these species do not occur in the Homestead area.

West Indian Manatee. The West Indian or Florida manatee was listed as a federally endangered species in 1967, and critical habitat was designated in 1976. It is also a State of Florida endangered species. The present distribution of the West Indian manatee includes the coasts and rivers of Florida and Georgia, the Greater Antilles, eastern Mexico, Central America, and northern South America. Two subspecies are recognized, the Florida manatee found in Florida and the Antillean manatee (*Trichechus manatus manatus)* found in the remaining range. Year-round populations of the Florida manatee occur in coastal and inland waterways in Georgia and Florida. During the summer months, Florida manatees may range as far north as Rhode Island, west to Texas, and east to the Bahamas. The abundance of the manatee in Florida tends to be greatest around areas such as the St. Johns River and Biscayne Bay. In the winter, they concentrate in areas of natural or man-made warm waters, including Biscayne Bay and its rivers and canals (**USFWS 1998a**).

Several factors contribute to the distribution of the manatee in Florida, including (1) areas of warm water to use in the winter, (2) availability of aquatic vegetation, (3) proximity of channels at least 6 feet deep, and (4) availability of fresh-water sources. Seventeen major manatee winter concentration sites have been identified, and manatee migrate to these areas when the water temperature drops below 68 degrees Fahrenheit. As the water warms up in the spring, some manatees will migrate out of the wintering areas to their summer habitats. In south Florida, manatees forage in submerged aquatic vegetation, with deeper channels often in close proximity to these foraging areas. They are frequently observed foraging in water three to 9 feet deep. In south Florida, the manatee feed most often on species such as turtle grass and manatee grass. In the winter, manatees will often spend most of the day in warm water and swim out to feeding sites in late afternoon to feed in the sometimes cooler water. Manatees often occur in quiet waters such as canals and rivers to feed, rest, obtain fresh drinking water, mate, and calve (**USFWS 1998a**).

Manatees emit sounds within the human auditory range and these vocalizations are probably used for communication. They hear fairly well, especially low-frequency sounds. Manatees can remain submerged for several minutes. The longest recorded time submerged was 24 minutes (**USFWS 1998a**).

Aerial surveys for the manatee have been conducted for the last 19 years, but given the limitations of this methodology, the actual population size cannot be determined. Therefore, the long-term population trends for the manatee in Florida are not known. Aerial surveys do provide a general index of manatee population status. For example, the aerial survey in 1996 resulted in an estimated 2,639 manatees in Florida, with 1,457 along the east coast and 1,182 along the west coast. These estimates represent a minimum number and may not be the total number of manatees in Florida (**USFWS 1998a**).

The distribution of the manatee in Biscayne Bay has been monitored by Miami-Dade County and Florida Department of Natural Resources since 1987. Biscayne Bay supports a year-round population of manatees, with the largest number observed in winter. During the winter months, the manatee concentrate in natural tributaries such as the Little River, Miami River, Coral Gables Waterway, and Black Creek. Manatees in north Biscayne Bay travel out to the sea grass beds in late afternoon, and radio tracking data indicate they feed in these areas at night. In the summer, it appears that most manatees travel north out of the bay; several radio tracked animals left Miami-Dade County and spent the summer in Brevard County. It appears that about 30 animals remain in Miami-Dade County in the summer. The majority of manatee sightings occur in northern Biscayne Bay and its tributaries. In the area around former Homestead AFB, there have been numerous manatee observations from 1989 through 1994 in and near Black Creek, about three miles north of Military Canal and Mowry Canal, and Convoy Point, about two miles south of Military Canal. Three manatee sighting were recorded in and near Military Canal from 1989 through 1994 (**Metro-Dade County 1995b**). More recent data indicate that two adult manatees were observed in Military Canal downstream of the salinity control structure on April 27, 1995; one adult manatee was observed feeding in Biscayne Bay at the mouth of Military Canal on April 21, 1996 (**Mayo 1998**); and two manatees were in the fresh water portion of Military Canal for an undetermined period of time in June 1999 (**Lockwood 1999b**). The manatee was not observed along the western shoreline of Biscayne Bay or the nearby canals during the extensive ground and aerial surveys in June and July 1998. This species was not recorded on former Homestead AFB and is not expected to occur in the canals on the former base in the future.

Florida Panther. The Florida panther is a federal and state endangered species. It is one of the most endangered mammals in the world, and a small population of 30 to 50 adults in south Florida represents the only known population of this subspecies in the wild. Historically, this species ranged to eastern Texas and the lower Mississippi Valley east through the southeastern states and all of Florida. The only known remaining population is centered around the Big Cypress Swamp and the Everglades region. Radio tracking data indicate the center of the population is in Collier and Hendry counties; tracking data has documented the occurrence of the Florida panther in eight other counties including Miami-Dade and Monroe counties (**USFWS 1998a**).

Florida panther preferred habitat consists of native upland forests, and understory thickets of very dense saw palmetto is important resting and denning habitat. Radio-telemetry studies have shown that hardwood hammocks and pine flatwoods are preferred over wetlands and disturbed habitat. Hardwood hammocks are the most productive habitats for white-tailed deer which may be why this habitat type is preferred by the panther (**USFWS 1998a**).

The Florida panther space themselves out over the available habitat, and the home range of several females may occur within one male's home range. The average home range size for males is from 20 to 457 square miles, averaging 200 square miles. Female home range size averages 75 square miles The average dispersal distance for subadult males was 23 miles and subadult females, 6 miles

The population size of the Florida panther at the turn of the century may have been about 500, but hunting, habitat loss through residential and agricultural development, loss of prey base, and other factors lead to its decline. In 1950, this species was listed as a game species in Florida and, by 1958, was listed as a Florida endangered species. The population was estimated to be 100 to 300 animals in 1966. The Florida panther continued to decline to its present population size and, based on existing demographic and genetic conditions, the Florida panther will likely be extinct in only a few decades. Factors that continue to affect the Florida panther are habitat loss and fragmentation; environmental contaminants; prey availability; human disturbances; and mortality, disease, and genetic erosion (**USFWS 1998a**).

The Florida panther has not been reported from Biscayne NP. Documented Florida panther habitat exists south of former Homestead AFB in the model lands and C-111 Basin (**Alleman et al. 1995**). Radio-tracking data from the late 1980s showed that a panther lived in the Model Lands and spent most of its time south of Palm Drive 3.5 or more miles from former Homestead AFB. It did, on occasion, travel closer to the base and approached to within less than one mile of the former base (**Ferro 1999a**). For example, on June 13, 1987, this cat was about one-half mile south of the base, and on March 30, 1988, it was about 0.75 mile south of the west end of the runway near North Canal (**Ferro 1999a**). More recently, there have been a few unconfirmed sightings of the Florida panther south of the former base in the Palm Drive area (**Wasilewski 1999a**). Based on this, the Florida panther would not be expected to occur on former Homestead AFB, would be unlikely to occur between the former base and Biscayne Bay, but may occur to the south of the former base.

Key Largo Cotton Mouse. The Key Largo cotton mouse is a federal and state endangered species. It is a subspecies of the cotton mouse, one of the most common small mammals in Florida and throughout the southeastern United States. This subspecies is distinct from other cotton mouse subspecies by its larger size, more reddish color, and restricted habitat. Historically, the Key Largo cotton mouse inhabited hardwood hammocks throughout Key Largo, but as a result of the elimination of this plant community type, it is found only in north Key Largo (north of the Intersection of U.S. Highway 1 and County Route 905). It uses a variety of tropical hardwood hammock plant community types, from recently burned early successional types to mature hammock forests. The Key Largo cotton mouse is a nocturnal species and feeds on a variety of plant and animal matter. It is often associated with the Key Largo woodrat and is found in woodrat holes, nests, and runways (**USFWS 1998a**).

The Key Largo cotton mouse was listed as an endangered species, and critical habitat was proposed in 1984. The critical habitat proposal was subsequently withdrawn in 1986. The principal factor leading to this listing was the elimination and fragmentation of habitat due to human commercial and residential development. Before European settlement, there were an estimated 12,000 acres of tropical hammock forest on Key Largo, which has been reduced to an estimated 2,100 acres in north Key Largo. Of this, 91 percent is protected, and the remainder is vulnerable to urbanization. It is believed that the remaining stands of tropical hardwood hammock in south Key Largo are too small and fragmented to support this species. An attempt was made to establish a population on Lignumvitae Key State Botanical Site in 1970, and although one cotton mouse was trapped in 1977, later trapping efforts indicate this species no longer occurs on this key (**USFWS 1998a**).

Key Largo Woodrat. The Key Largo woodrat is a federal and state endangered species. This subspecies is endemic to the tropical hardwood hammocks of Key Largo and is the southern most subspecies of the eastern woodrat that occurs over much of the eastern United States. The Key Largo woodrat once inhabited hardwood hammocks throughout Key Largo, but as a result of the elimination of this plant community type, it is found only in north Key Largo (north of the intersection of U.S. Highway 1 and County Route 905). The two most important habitat characteristics for this species are materials for building stick nests and cover. Nests are typically built at the base of a tree, boulder, or other object, and can be 4 feet high and 6.5 to 8 feet in diameter. The nests have several entrances and generally one central chamber. An individual may use more than one nest, and nests can be used by a number of generations. This species is an active climber and uses well-defined trails over the forest floor. They are nocturnal and feed on a wide variety of plant material (**USFWS 1998a**).

The Key Largo woodrat was listed as an endangered species in 1984. The decline of the woodrat and its extirpation from its historic range in south Key Largo is largely attributable to human commercial and residential development in its tropical hardwood hammock habitat. It is believed that the remaining stands of tropical hardwood hammock in south Key Largo are too small and fragmented to support this species. An attempt was made to establish a population on Lignumvitae Key State Botanical Site in 1970, and although an estimated 476 stick nests and 85 woodrats were present in 1979, the numbers began to decline in the 1980s, and no woodrats were taken during 400 trap nights in 1990. It is believed that this species occurs in very small numbers or may be extirpated from this key (**USFWS 1998a**).

H WYLE RESEARCH REPORT

WYLE RESEARCH REPORT
WR 99-17
THE SOUNDSCAPE IN SOUTH FLORIDA NATIONAL PARKS

This appendix presents a technical report completed by Wyle Laboratories for the National Park Service in June 2000 entitled, "The Soundscape in South Florida National Parks" (Wyle Report 99-17), to assist NPS in resolving methodological issues associated with defining the natural soundscape in the national parks. It includes a re-analysis of the ambient noise data collection and assessment programs conducted by FAA/John A. Volpe National Transportation Systems Center in 1998 and by NPS/Sanchez Industrial Design in 1997 and 1998 and used in the SEIS. The report also analyzes data from Wyle's south Florida noise monitoring conducted in June 1999.

The Wyle report expresses confidence in the FAA and NPS measurement data and indicates other areas of agreement, for example, that nighttime sound levels tend to be higher than daytime due to nocturnal activity by insects, amphibians, reptiles, and birds. The report, however, suggests that the data could be interpreted differently to characterize the natural ambient. The report also bases its analyses on L_n statistical metrics—L_{90}, L_{50}, and L_{10}—and suggests that the L_{90} could be used to calculate the natural ambient.

Wyle's suggested approaches are a departure from the observer-based ambient noise methodology that has been used in other federal studies, including in national parks, and was used for the SEIS. The FAA believes that observer-based measurements, as used in the SEIS, provide high quality and accurate data. The FAA also believes that observer-based measurements that distinguish the natural ambient from other sounds are preferable to using generalized statistical procedures in data analysis. The FAA's review of the Wyle report is included in this appendix in a January 19, 2000, letter to NPS and an October 24, 2000, addendum to the January comments. The FAA does not agree with Wyle's methodology. Accordingly, the Wyle report has been included in the SEIS but has not served as a basis for the noise analysis.

FAA Review of the Final Report
"The Soundscape in South Florida National Parks"
prepared by Wyle Laboratories
for the National Park Service

October 24, 2000

This is an Addendum to FAA's review of the draft Wyle report. FAA's review was performed prior to completion of the Draft SEIS and FAA's detailed comments were submitted to NPS by letter dated January 19, 2000.

This addendum was prepared in response to the final Wyle Research Report (WR-99-17) submitted by the National Park Service (NPS) to the Federal Aviation Administration (FAA) on July 31, 2000. NPS's transmittal of the final report to FAA included a summary of changes between the final version and the draft document of August 1999 (Draft SEIS Appendix H). Changes noted by the NPS were: clarification of statements about acoustical zoning, two new tables on variance analysis for acoustical zones; placement of L90 time-of-day variations in summaries; and corrected tabular data. Other than these few changes, the final report is similar to the draft report.

In reviewing the final report, there are some important contextual issues that need to be revisited briefly. Several of these issues were discussed previously in the FAA January 19 letter of response to the NPS on the draft report.

<u>Focus of the Wyle Report</u>

The Wyle report addresses a small aspect of the SEIS noise analysis—natural ambient data, which are considered as supplemental data. It must be emphasized that the focus of the SEIS ambient noise methodology is on the traditional ambient sound level (all sounds except aircraft). The values for traditional ambient were the only ambient values used in the SEIS to calculate noise impacts. The Wyle report does not examine or question the collection or accuracy of traditional ambient sound data used in the SEIS analysis. Rather, it looks at the measurement and interpretation of natural ambient sound levels, which are of interest to the NPS for park natural soundscape planning. Data collected by FAA on natural ambient levels is included in the SEIS on a supplemental basis so that the public can compare traditional and natural ambient levels at different parks and sites. From such comparisons, one can see where human and mechanical activity causes the traditional ambient sound levels to be higher than the natural ambient. It also shows how traditional and natural ambient levels may be similar or even the same at places where natural sounds dominate.

In addition to the focus on natural ambient data, the Wyle report precipitates other needs for clarification. For instance, it is incorrect to describe the Wyle report as a "reanalysis" because it is a *new* analysis for the most part. The report makes extensive use of new monitored data collected by Wyle subsequent to the SEIS noise analysis. Using these data, Wyle undertakes a series of comparisons with newly created statistical methods that have received no outside or scientific review. FAA concerns about the new Wyle methodology are discussed in more depth in our January 19 response to the draft report.

General Agreement of Data Despite Differences of Methodology

It should be noted that the NPS and Wyle received all of the FAA ambient measurement data, but analyzed only a partial set of the data. This is not explained adequately in the report and is omitted from the Executive Summary. Specifically, the Wyle report looks at 15 of the FAA's 29 measurement sites. The FAA sites not analyzed are the open water sites and four land-based sites that experience higher exposure to non-natural sound sources. The rationale for their omission is not clearly stated in the report. Moreover, for 3 of the 15 FAA sites used, the Wyle analyzed only part of the acoustic data, specifically 68 percent of the data for Chekika (Everglades National Park), 62 percent for Hidden Lake (Everglades National Park), and 32 percent for Boca Chita (Biscayne National Park).

The combination of new monitoring data, new statistical methodology, and partial analysis of FAA measurements creates a complicated and confusing result in the report. The analysis is hampered by its effort to evaluate disjointed data sets that are difficult to compare accurately. Amid the volume of tabular and statistical data analyzed, it lacks a clear and reasonable basis for some of its comparisons.

Despite these limitations, the overall conclusion drawn from the report is that the various data for natural ambient are consistent. For example, FAA/Volpe Center and NPS/Sanchez Industrial Design (SID) noise measurements, conducted with similar methods, were in close agreement at many common sites. The shared use of observer-based methodology insured the complete absence of aircraft in traditional ambient sound levels—the focus of the SEIS noise analysis. A full comparison of Volpe Center and SID measured data is contained in Section 6.8.1 of the Volpe technical report, "Ambient Sound Levels at Four Department of Interior Conservation Units," June 1999. There is no basis for the sweeping conclusion in the NPS cover letter to the final Wyle report that sound pressure data in the Volpe Center technical report are incorrect. NPS evaluations and prior statements have supported the accuracy and reliability of basic FAA/Volpe measurements. Areas of difference noted by Wyle focus on greater weightings for the use of natural ambient data. The FAA continues to have confidence in all of the ambient data collected by Volpe and believes that alternative techniques proposed in the NPS/Wyle report should undergo further development, testing, and scientific review.

In spite of differences in approach, the NPS/Wyle report shows a good fit between the Wyle analysis and Volpe Center measurements (see Table 3.1 of the Wyle report). The comparison indicates a small average difference of 1.4 dB for the 15 FAA measurement sites analyzed by Wyle. An average difference would need to approach 5 dB to raise a concern about inconsistency. Even the standard deviation of 4.1 dB reported by Wyle was surprisingly small and indicated constancy and uniformity of the Volpe Center data.

Wyle's noise monitoring data also reinforces confidence in the reliability and accuracy of Volpe Center measurements. Wyle's L90, L50, and L10 statistical comparison of Volpe Center measured data and Wyle monitored data showed average differences of 2.2 dB, 3.4 dB, and 4.0 dB, respectively (see Table 4.7 of the Wyle report). Another indicator of reliability is found in overall averages for natural ambient. Wyle states that the average 24-hour L50 (the median statistical level) for its sound level data was 42 dB. Volpe Center's average Leq for natural ambient data was 42.4 dB.

In summation, there are many ways to dissect and compare the data. However, despite Wyle's exclusive focus on natural ambient data, there is general agreement and consistency between data in the many ways analyzed. The biggest differences reported involve Wyle's use of the statistical L90 (quietest 10 percent of the data) in comparison with Leq values obtained by Volpe Center. Further comments about the L90 descriptor are included below.

Acoustic Zone Characterization for Variance Analysis

The subject of ambient mapping procedures represented the main area of revision between the draft and final Wyle report. Wyle questions the basis for the use of acoustic zones and the process of ambient mapping. The ambient mapping methodology used in the SEIS noise analysis is described in detail in the Volpe technical report (June 1999). The Volpe report notes that: "Similar studies in the national parks have established an extremely strong correlation between land cover, wind speed, and ambient sound level." The report states that in a low-level ambient sound environment, such as national parks, the vast majority of the natural sound contribution to the ambient level results from wind blowing through the vegetation or creating stronger wave action in the aquatic environment.

The basis for ambient mapping by land cover in national park environments is supported by several recent studies. The most recent study is the Final Supplemental Environmental Assessment for the Grand Canyon National Park (GCNP, February 2000). For the noise analysis in this study, the NPS provided the FAA with variable A-weighted ambient sound level data based on three vegetative categories: pinyon/juniper woodland, desert scrub, and sparse conifer forest. The NPS supported this work using its own analysis tool, the Noise Overflight Decision Support System (NODSS), which categorizes ambient sound levels for the Grand Canyon based solely on vegetative cover and wind speed.

Another study cited in the Volpe report is the FAA July 1998 study "Development of Noise Dose/Visitor Response Relationships for the National Parks Overflights Rule: Bryce Canyon National Park Study." The field measurements in this study showed an excellent correlation between increased wind speeds and increased ambient levels. Further supporting research is noted in the quotation from the Wyle report on the following page (i.e., references to the work of Fleming, Sneddon, and Reddingius).

The methodology used in the SEIS for ambient mapping began with the selection of noise measurement sites by representative land cover and geographic coverage. Regional mapping for the national parks was performed by referencing the measured data with eight representative categories of land-cover data obtained from the Florida Game and Fresh Water Fish Commission (FGFWFC), unit boundary data from the NPS, and site observations with photographs. Due to higher reflectivity of water surfaces, no cross-over assignments were made between open water and land-based measurements.

It is impossible to accurately assess the Wyle variance analysis (i.e., ANOVA) because of the extent to which Wyle reassigned SEIS FGFWFC land-cover data for the analysis. Although Wyle claims that its reclassification of Volpe and SID land cover data was similar (see below quote from Wyle report), there is little similarity between the FGFWFC acoustic zone classifications used in the SEIS and the reassigned categories by Wyle, as shown in Table 1.

> "Since natural sounds are related to the type of nearby vegetation (Fleming et al., 1998, Sneddon et al., 1994 and Reddingius, 1994), the population of animals that are drawn to the vegetation, and the interaction of the wind with vegetation, the reanalyzed data from Volpe 1998 and SID 1997 were classified into acoustical zones similar to the grouping used by Volpe in its analysis as shown in their Table 10 (Fleming et al., 1999)."

Table 1 lists the eleven FAA/NPS measurement sites in Everglades National Park (ENP) evaluated by Wyle and draws a comparison between the Volpe FGFWFC and Wyle land-cover categories for these sites. Land-cover was an important factor in developing the ENP ambient map, more so than Biscayne National Park (BNP) or Crocodile Lake National Wildlife Refuge (CLNWR), because of the fact that ENP is so large geographically and supports a wide variety of vegetation and land-based surfaces that influence sound attenuation. Of the eight FGFWFC land-cover categories used by Volpe Center, seven were applied in the ENP ambient mapping (see Table 10, Mapping of Land-Cover Categories for ENP in the Volpe technical report, June 1999). For the ANOVA variance analysis, Wyle uses its own system of seven categories, of which six are applied to ENP sites (see Wyle report Table 3.3).

There is no clear rationale for imposing a different classification scheme for the ANOVA analysis, especially because the FGFWFC was considered to be the best source of land-cover data available in the south Florida region. The lack of consistency in the land-cover reclassification by Wyle raises concerns about the findings of the Wyle variance analysis.

Although Wyle's use of ANOVA may be appropriate given the structure of the acoustic zone data sets and may be technically accurate for the data used by Wyle, it is possible that the Wyle ANOVA results would be quite different if Wyle kept the FGFWFC classes or made a more consistent reclassification.

Unmanned Monitoring Approach

In contrast to the SEIS use of observer-based measurements, the Wyle report relies primarily on unmanned noise monitoring, which requires software and statistics to replace the human ear in estimating the noise content of the sound level data.

Table 1: Wyle Reassignments of Volpe FGFWFC Land-Cover Categories used in the Wyle ANOVA analysis

ENP measurement site	Volpe (V) or SID (S) site	Acoustic Hard (H) or Soft (S)	Volpe FGFWFC Land Cover Category For SEIS	Wyle Land Cover Reassignment for ANOVA
Eastern Sparrow	V	H	Freshwater Marsh and Wet Prairie	Prairie, Slough
Hidden Lake	V	H	Freshwater Marsh and Wet Prairie	Open Forest
North Nest Key	V & S	H	Freshwater Marsh and Wet Prairie	Open Shoreline
Pa-hay-okee	S	H	Freshwater Marsh and Wet Prairie	Open Forest
Eco Pond	V& S	H	Mangrove Swamp	Dense Forest
Nine Mile Pond	S	H	Mangrove Swamp	Open Forest
Pavilion Key	V	H	Open Water	Dense Forest
Shark Valley	V	H	Scrub Swamp	Prairie, Slough
Chekika	V	S	Hardwood Hammocks & Forests	Prairie, Slough
Anhinga Trail	V & S	S	Grasslands	Intruded
Pinelands/Long Pine Key	V & S	S	Pineland	Open Forest

It is difficult to track the use of the unmanned monitored data in the Wyle document because there is no clear summary or description of the statistical procedures and assumptions used in the analysis. For example, it is unclear how transient aircraft events were treated in calculating the various average sound levels. In addition, the report suggests in the Executive Summary that there is a 20 dB difference between the L90 ambient value of 33 dB and the Volpe Center Leq value. This implies a Leq of 53 dB, and yet the Volpe Center measurements for Leq averaged about 42–43 dB.

While a monitoring approach may be appropriate for approximations and relative comparisons of data for internal park management of noise, it is not a good stand-alone tool for noise impact analysis. Unmanned monitoring produces less accurate data than observer-based measurements and does not identify the sources of sound.

<u>Noise Descriptors and Low-Level Impact Criteria</u>

TA versus Leq–The correlation of the time above (TA) metric with important human responses such as annoyance is poor, especially at the lower levels of aircraft noise affecting regions analyzed outside of airport noise contours. Leq and changes in Leq have the best predictive value for annoyance that is available at this time.

L90 versus Leq–The Wyle report does not present an effective argument for the use of an L90 descriptor, rather than Leq, to characterize typical natural ambient noise levels. The FAA believes that Leq offers a more reliable average of existing sound conditions for more of the time. It is a better predictor of what a person is likely to hear during a visit to the park. The fact that the acoustic-based Leq accounts for higher noise events is actually a strength in the metric because it is the higher sound level events that drive human annoyance. This is why Leq is also a better predictor of human response to aircraft noise than TA.

L90, Audibility, and Annoyance–The Wyle report contends that the statistical L90 noise descriptor provides an improved threshold for characterizing the natural soundscape and for assessing noise events. The report attempts to make a case for the establishment of new impact assessment methodology based on unmanned noise monitoring and the L90 (minimum) sound level average. This case is not persuasive either technically or procedurally. Also notable, there are no criteria suggested for the characterization of the *impact* of excursions above any of the experimental threshold levels (L90 plus 10, 20, 30, and 40 dB).

The application of Time Above (TA) L90 with noise monitored data to approximate the time of audibility of sound is inappropriate. The statistically derived L90 could be *below* hearing audibility for appreciable periods of time. It is unscientific and unrealistic to establish a threshold level for sound intrusions that is so low that sounds cannot be heard by attentive listeners at times. It separates noise from hearing detection and ignores masking effects of ambient sound. Furthermore, the audibility of sound does not equate to adverse effect. People and animals are physically capable of hearing sounds that are not loud enough to produce an adverse reaction (commonly referred to as "annoyance" on the part of people). The application of Wyle's methodology would classify various man-made sounds (including, but not limited to, aircraft noise) as an impact on the natural soundscape without relating those sounds to any negative consequences based on human or wildlife reactions to noise.

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JAN 19 2000

William B. Schmidt, Special Assistant
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Dear Bill:

Thank you for the opportunity to review and comment on the draft report prepared by Wyle Laboratories entitled "The Soundscape in South Florida National Parks". Our understanding is that the purpose of this report is to assist the National Park Service (NPS) in defining the "natural soundscape," which is further defined in your November 2 letter as "the conditions that do or would exist in national parks in the absence of human-caused noise". The report includes a review of data from earlier studies in south Florida parks and questions whether some of the methodology and assumptions in these earlier studies should be used to obtain the most accurate assessment of the natural soundscape.

The Federal Aviation Administration (FAA) has reviewed this draft report from two perspectives. One perspective is to offer our comments on the suggested new methodological approach to defining the natural soundscape in all national parks, which is a distinct departure from current NPS methodology. The second more immediate perspective has been to review Wyle's re-analysis of previous south Florida data and additional Wyle data based on monitoring in south Florida to consider the implications for all of the previous work done by FAA and NPS in that area, including the data used in the Homestead Draft Supplemental Environmental Impact Statement (Draft SEIS). The FAA has been assisted in our review of the Wyle report by the John A. Volpe National Transportation Systems Center (Volpe) that has done a great deal of work in the area of sound measurements in national parks, including the south Florida parks.

As you know, the Homestead SEIS uses traditional ambient noise measurements (i.e., all sounds except aircraft) together with computer-modeled aircraft noise to describe the existing noise environment in the south Florida national parks. Our purpose, under the National Environmental Policy Act (NEPA), is to describe a baseline affected environment—including all components that contribute to current noise levels—in order to evaluate how potential alternative reuses of Homestead would change noise within the affected environment. We continue to believe that the natural ambient alone does not fully describe the affected noise environment in the parks, particularly in Biscayne National Park which is influenced by boating noise, current aircraft noise from Homestead and Miami International Airports, and other visitor noises. We do not consider it reasonable at this point to base a NEPA analysis on a baseline natural ambient noise level under the assumption, put forward in your July 21 letter, that all non-natural noise sources—visitor noise, park operation noise, concessionaire noise, and aircraft noise—could be eliminated over time.

We recognize that the NPS has a quite different purpose in preparing national park soundscape plans, which leads you to focus on the natural ambient (i.e., the sounds of nature absent human and mechanical sounds) and has caused you to engage in a review of natural ambient data that was collected, along with traditional ambient data, in south Florida studies that contributed to the Homestead analysis. We were pleased to hear at the September interagency meeting on Homestead that the NPS has confidence in the accuracy of FAA measurement data used in the Homestead analysis, based on Wyle's work, and that NPS concerns essentially rest with the interpretation of the data for natural ambient.

Wyle's Reanalysis of South Florida Ambient Noise Measurement Data

To describe ambient noise conditions in south Florida, the FAA and NPS with the support of expert acoustic consultants undertook a major noise measurement program that encompassed 37 sites in four national parks and refuges. While the Homestead SEIS noise analysis is based on the traditional ambient measurements, it also presents three other categories of ambient measurements for comparison and information (SEIS Table 3.5-1). These categories are existing ambient (all sounds including aircraft), natural ambient (e.g., wind, waves, wildlife, insects), and natural plus visitor self-noise (e.g., voices and footsteps of visitors).

Ambient data was collected and analyzed using FAA guidelines for measuring and assessing low-level ambient noise. These guidelines set forth equipment specifications, data collection procedures, and analysis methods. The procedures outlined in the guidelines have undergone years of interagency and technical scrutiny. They evolved from NPS noise measurement programs at Grand Canyon and Hawaii National Parks in 1992, from Rocky Mountain National Park planning efforts in 1997, and from FAA dose-response studies at Bryce Canyon and Grand Canyon National Parks in 1997 and 1998. The guidelines insure improved quality and consistency of data sets collected by different organizations. Such consistency made it possible to combine FAA and NPS noise measurement data for use in the Homestead SEIS.

The Wyle report reanalyzes the ambient noise data that was collected by the Volpe National Transportation Systems Center in 1998 for FAA and by Sanchez Industrial Design (SID) in 1997 and 1998 for NPS. The original analysis of the data is presented in the technical report, *Ambient Sound Levels at Four Department of Interior Conservation Units: In Support of Homestead Air Base Reuse Supplemental Environmental Impact Statement* (June 1999).

The Wyle report adds confidence to the accuracy of FAA/Volpe and NPS/SID ambient measurement data, which Wyle tested independently. Wyle, however, suggests that the data could be interpreted differently to characterize the natural ambient. Wyle's draft report includes a statistical, computer-assisted method for increasing the amount of time and data classified as natural ambient. Using this method, acoustic data of less than 3 decibels over calculated average background levels are considered to be part of the natural ambient. The result is that the natural ambient is considered to occur for longer periods of time because man-made noises, including aircraft, continue to be counted as natural so long as they are less than 3 decibels over average background sound levels.

Wyle's natural ambient calculations contain aircraft noise and other man-made sounds. This appears to FAA to be inconsistent with the NPS definition of the natural soundscape, i.e., the natural condition that would exist in the absence of human caused noise. It is not the way that NPS work to date has distinguished aircraft sounds from natural sounds, and it is not clear to us that NPS would prefer such an approach. In addition to "contaminating" natural ambient data with man-made noises, it is somewhat arbitrary to take acoustic data of less than 3 decibels over computed average background levels and assign it to natural sound. In any case, Wyle's reanalysis of the Volpe south Florida measurement data using this approach shows an overall difference of only 1.4 decibels in ambient noise level for all of the measurement sites and sessions analyzed. This essentially shows close agreement between the results of both methods.

Noise Monitoring Versus Noise Measurement

In addition to the reanalysis, the Wyle report presents findings of its noise monitoring program conducted in south Florida in June 1999. While more data is always better, the report does not always distinguish clearly between the different data sets and how they contributed to the report's conclusions.

Wyle discusses the observer-based noise methodology that was used by both FAA/Volpe and NPS/SID for the south Florida noise measurement program. The observer-based techniques applied to this effort originated with NPS. For years, Federal agencies, including FAA, NPS, and the U.S. Air Force, have agreed that noise measurements with trained observers produce higher quality and more accurate data than unmanned noise monitoring. Trained acoustic observers can certify the presence of intruding sounds, the source of the sounds (such as aircraft), and how long the sounds last. The capacity of the human ear to identify and distinguish aircraft sounds, especially in low-level sound environments such as national parks, is better than unmanned noise monitors and statistical applications. This was reaffirmed in a recent noise validation field test at Grand Canyon National Park. An advisory committee of acoustic scientists and technicians enlisted by NPS and FAA at Grand Canyon recommended observer-based measurements rather than noise monitoring.

This is not to suggest that unmanned noise monitoring is inappropriate or not useful in certain circumstances if measurements cannot be done. Indeed, noise monitoring is less expensive than measurements and can be used for longer periods of time. However, the quality of data obtained from noise monitoring is less than that obtained from trained observer-based measurements and should not be regarded as a preferred, or even equivalent, substitute methodology.

In looking specifically at the category of natural ambient, the FAA's reasons for performing and preferring an observer-based methodology—where it is reasonable to do so—remains data quality.

This methodology guarantees that natural ambient data are uncontaminated and free of non-natural sounds. It also avoids distortions inherent in Wyle's suggested generalized statistical procedures for separating and defining noise events after-the-fact.

Metrics

With regard to metrics, Wyle provides analysis on L_n statistical metrics (L_{90}, L_{50}, and L_{10}) and uses the noise-monitored data to compare L_n levels with acoustic-based Leq levels. The Leq metric, which FAA used in the south Florida parks analysis, is the equivalent or average sound level incorporating all noise events, their duration, and the magnitude of sound. In a steady state sound environment, Leq and L_n levels tend to converge, particularly the Leq and L_{50}. Louder impulsive sounds, natural or otherwise, influence the acoustic-based Leq.

We believe that the Leq metric is an appropriate descriptor for several reasons. Research has shown that response to aircraft noise is related to loudness and frequency of noise events (Federal Interagency Committee on Aircraft Noise report, 1992). As stated, Leq is sensitive to loudness. In addition, the widely used Leq offers greater comparability with other studies. Conversely, analyzing noise monitored data with a simple statistical L_n metric is inadequate for quantifying specific components of the sound environment—an important element of noise analysis.

In situations where it is not practical to employ other than a simple statistical metric in conjunction with remote noise monitoring, L_{50} appears to be more appropriate than L_{90}. The L_{90} should not be used generally because it represents the quietest ten percent of the data and, as such, is a minimum level that does not reflect average natural sound levels in a park setting. L_{90} has not been used to evaluate ambient noise in the Grand Canyon for this reason. L_{50} provides a more representative statistical calculation of the natural ambient than L_{90}.

Wyle reports an average 24-hour natural sound level for south Florida national parks of 42 decibels, with a standard deviation of 4 decibels, based on an L_{50}. The average natural ambient levels reported in the SEIS, using the Leq metric, are similar. SEIS average natural ambient sound levels are approximately 43 decibels in Everglades National Park and 45 decibels in Biscayne National Park. These results show close broad agreement between Wyle and Volpe average natural ambient values, particularly when considering differences in methodology and in sites selected for data collection. It is only when Wyle applies the L_{90} to its monitored data—resulting in a minimum value, rather than median or average value—does it appear that the natural ambient would be lower than measured in previous studies. We do not believe that additional on-site measurements would verify that natural ambient levels in the south Florida parks are as low as statistically calculated using L_{90}.

Other Comments

Wyle indicates other specific areas of agreement with FAA/Volpe and NPS/SID data, for example, that nighttime sound levels in the south Florida national parks tend to be higher than daytime levels due to nocturnal activity by insects, amphibians, reptiles, and birds.

Attached are additional detailed comments on the draft Wyle report prepared with the assistance of acoustic experts at Volpe, plus further comments on the July 21, 1999 NPS letter. Among the comments is information on the consistency between the Volpe and SID measured data. The comments also note the agreements by our agencies on the benefits of observer-based data, the use of similar acoustic-state identification hierarchies (aircraft, non-aircraft, human, natural), and the selection of measurement sites. The selection of measurement sites in south Florida included many natural resource and wildlife locations recommended by the NPS. Site selection criteria also included representative land cover, geographic coverage, and access. For water sites, Volpe followed NPS advice for conducting boat-based measurements, with NPS supplying the boats and pilots. The comments confirm that the sound of wave action against boats was not classified as natural ambient.

Summary Conclusion

In summary, there was reasonable agreement in many major respects between Wyle's results and the previous studies. However, the FAA does not regard the methodology in the draft Wyle report as an approach that will result in a more accurate assessment of the natural soundscape than the approach that has been used to date.

We are cognizant that the NPS has a substantial task before it to characterize the natural soundscapes for many national parks, and that less expensive and resource-intensive tools may be needed to accomplish this entire task. Noise monitoring can be an appropriate alternative methodology, if used with representative measurements and adjusted for local conditions. If a L_n metric is used for statistical interpretation of monitored data, the L_{50} offers a more reasonable approximation of natural ambient sound levels than the L_{90}. There should be a level of confidence that statistical calculations of natural ambient can be verified by actual on-site measurements.

Various points in the Wyle report deserve further review and discussion among the agencies and members of the acoustic community engaged in national park noise. The NPS may find it useful to request a scientific peer review of the report. It is important to have a scientifically valid, consistent, and broadly-accepted methodology for assessing noise in national parks.

Sincerely,

Lynne Sparks Pickard

Lynne Sparks Pickard
Manager, Community and
Environmental Needs Division, APP-600

cc: Mr. Nat Wood, NPS
Mr. Doug Heady, USAF

Attachment

Additional Detailed Technical Comments

Acoustic State Logging

For measurements of the scope of those undertaken in southern Florida, the need for accurate, repeatable acoustic state identification is crucial. Section 2.0 of the Wyle Report makes reference to a "difference in collection schemes" between the FAA/Volpe and NPS/SID data sets. We cannot account for Wyle's view that the two data collection schemes were different. We believe they were, in fact, entirely consistent.

FAA/Volpe have emphasized the use of consistent measurement protocols in the development of the "Draft Guidelines for the Measurement and Assessment of Low-Level Ambient Noise" (Guidelines Document). Both the FAA/Volpe and NPS/SID measurement teams used the acoustic state hierarchy outlined in the Guidelines Document to consistently log the acoustic environment. In the "Purpose of Study" section of the NPS Technical Report, it is stated "the contractor followed the draft FAA/NPS protocol..." This is further supported by subsequent discussions between FAA/Volpe and NPS/SID. During the July 1998 scoping meetings with NPS that took place prior to the FAA/Volpe measurements, the measurement team emphasized the necessity for consistency. NPS subsequently reviewed the FAA/Volpe test plan and considered the plan reasonable, feasible and consistent with their previous work.

The FAA/Volpe team utilized an automated, macro-driven spreadsheet on a laptop computer to implement an acoustic-state hierarchy approach, while the NPS/SID team utilized the button-box assembly, which is a component of the LOWNOMS system. Section 3.3.1 of the Wyle Report purports to attribute differences in the two data sets to a time delay associated with the use of Volpe's spreadsheet. However, as with the LOWNOMS button-box system, only a single button is required to accurately establish the time of an acoustic state change, and as such, there is *no lag* in time associated with the FAA/Volpe hardware/software system. There may be a small and probably negligible time lag associated with a delay in *human response*, but this is inherent in both the FAA/Volpe and NPS/SID systems. Further, the FAA/Volpe spreadsheet version allows the user to view a brief history of the acoustic states in real-time and to correct any mistakes that may have been made while still fresh in the observer's mind. LOWNOMS does not offer this capability. Also, as is documented in the "Ambient Sound Levels at Four Department of Interior Conservation Units" report (Florida Ambient report), the differences between the FAA/Volpe and NPS/SID data sets are small and explainable. Section 6.8.1 of the Florida Ambient report highlights some of these reasons, including temporal and seasonal variations, and difference in sound level due to changes in insect activity.

A potential inconsistency between the FAA/Volpe and NPS/SID measurements is cited in Section 3.3 of Wyle's report. Here Wyle states that SID "judged [which acoustic state was] loudest at the time," rather than utilizing the audibility hierarchy outlined in the Guidelines Document. This conflicts with the LOWNOMS User's Manual, which instructs the user to "[listen] and [push] the appropriate intruding or background button when a sound is heard." Additionally, the NPS/SID Technical Report actually highlights an instance (propeller aircraft at EVER1 at 13:24) where the rise of the A-weighted sound level starts approximately 30 seconds after the acoustic state was identified by the trained acoustic observer as Propeller Aircraft. This indicates consistency with the FAA/Volpe hierarchy-based logging approach, and further is consistent with all similar NPS measurement studies over the last decade. Further discussions among FAA/Volpe, NPS/SID, and Wyle could help to clarify data collection practices.

Boat-Based Measurements

In section 4.5.5, Wyle makes reference to the inappropriateness of boat-based measurements for locations on the water. Boat-based data were collected during both the FAA/Volpe and NPS/SID measurement programs. By measuring from a boat, it is understood that the measurement team can introduce sounds into the environment (i.e., the sound of waves slapping against the hull of the boat). Generally it is advisable for the field-measurement team not to affect the acoustic environment, thus arguing against the use of a boat for water-based measurements. However, after expressing concern about this very issue to the NPS during the scoping meetings, including suggesting alternative approaches to performing water-based measurements, the NPS insisted, for the sake of consistency with previously collected NPS data, that all water-based measurements be conducted on boats. As such, the FAA/Volpe team reluctantly agreed.

The Wyle Report continues on to ascertain that "the natural sound levels were distorted because of wave slaps against the hull of the boat." Section 3.4 of the Florida Ambient document clearly outlines the fact that sounds generated by boats and the sound of waves against the hull of a boat were classified as "Non-Aircraft - Human", *not* "Natural", thus introducing no distortion into the FAA/Volpe natural data. In other words, the natural ambient sound levels reported in the Florida Ambient document do not include the sounds of waves slapping against the boat. They are truly representative of the sounds of nature.

Natural Ambient

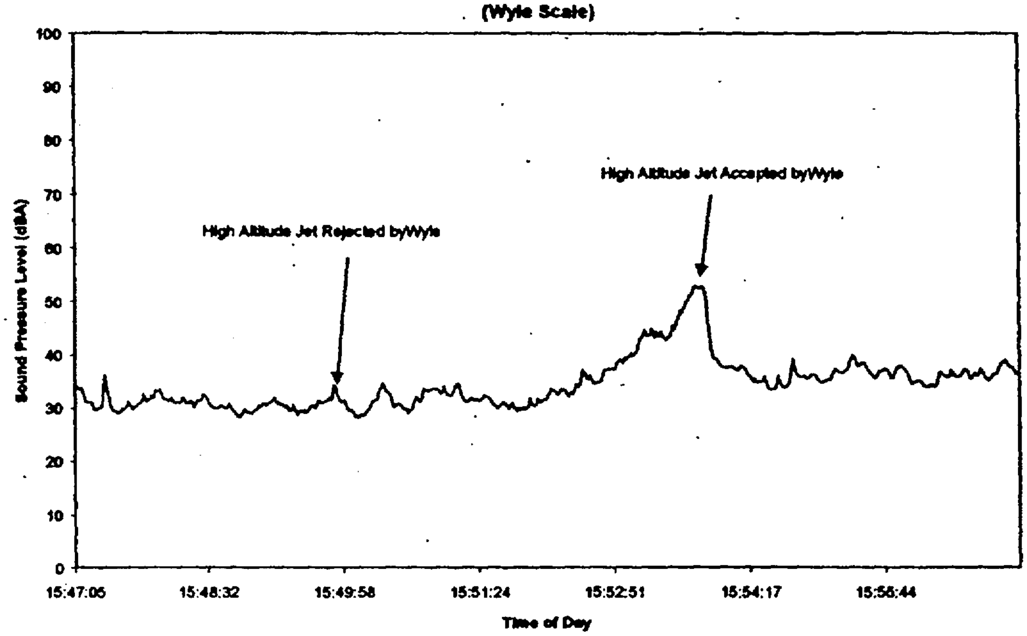
Section 3.1 of the Wyle Report documents what it terms a "misidentification" on the part of the FAA/Volpe data by stating "the lowest levels ascribed to non-natural sounds were often lower than the lowest levels ascribed to natural sounds. This cannot be the case..." As documented in the Florida Ambient report, we found the sounds of nature to be greater than man-made sounds at times at several sites. In particular, changes in the natural ambient sound levels by as much as several decibels due to changes in insect activity were not uncommon. This is further corroborated by the NPS/SID data for EVER1 (Broad River Campground- 10/3/97). These data illustrate that the natural ambient (insects and birds) can in fact be some 15 dBA greater than all intruding sound levels measured at that site, including low level noise from distant commercial jets and propeller aircraft. In effect, even though aircraft may be present, their noise can be acoustically "masked" by the sounds of nature.

Section 1.0 of the Wyle Report refers to "the bias [associated with] using the L_{eq} of the totality of sounds as a descriptor of the natural soundscape..." in the FAA/Volpe analysis. The Florida Ambient report rather utilizes the L_{Aeq} of only the sounds of nature, as observed in real-time by trained acousticians, to describe what the NPS refers to as the natural soundscape. Declaring that a "totality of sounds" was used illustrates a clear misunderstanding of that document and the four ambient definitions presented in Section 5.1 of the Guidelines Document.

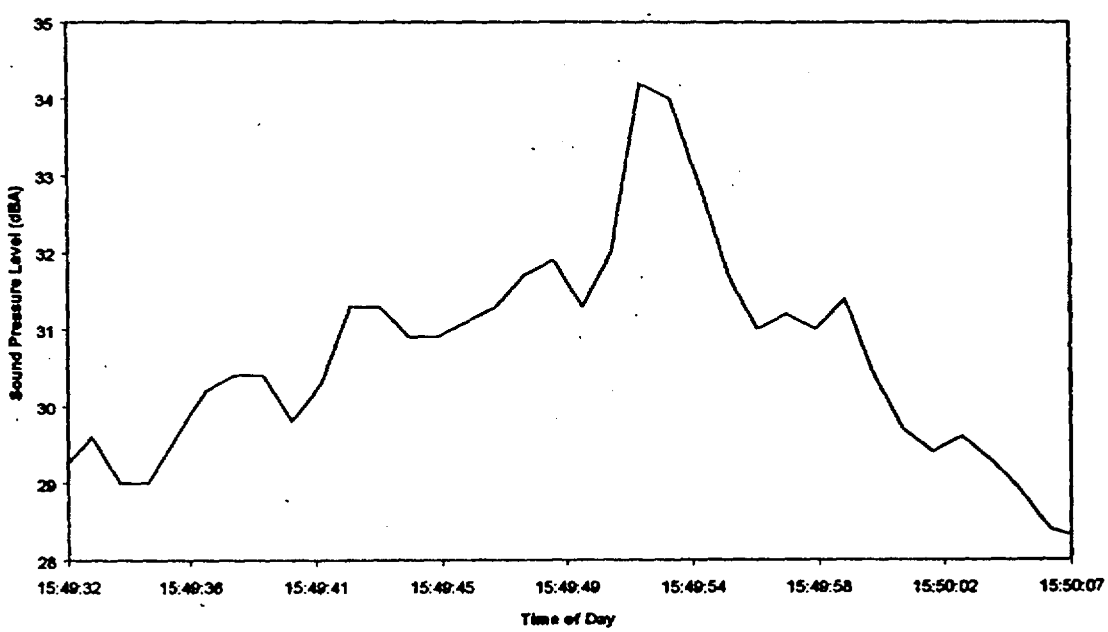
Wyle Re-Analysis Methodology

Wyle's re-analysis of Florida ambient data, outlined in section 3.2 of the Wyle Report, distorts the meticulously collected data sets. As illustrated in the figures below, the Wyle procedure uses an exaggerated y-axis scale that washes out detailed sound level information collected during the measurements. Using this exaggerated scale, Wyle incorrectly classified audible aircraft sounds (identified in the field by trained acoustic observers) as natural ambient. Effectively, this attributes sound energy *generated by aircraft* and other non-natural sources to natural ambient or natural quiet. The following figures illustrate our concerns with the Wyle re-analysis methodology.[1]

Anhinga Trail [81098B1] Time History
(Wyle Scale)



Anhinga Trail [81098B1] Time History
Close-up of High Altitude Jet Flyover Rejected by Wyle



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[1] The precise criteria for determining the surrounding ambient sound levels is not identified in the Wyle Report. As such, some assumptions were made in this discussion of their re-analysis.

The sound level time-history of the example jet reassigned as natural ambient in the Wyle re-analysis is considered to be typical of high altitude jets in an environment such as southern Florida. It is obvious from the close-up of the time-history that there is a substantial amount of aircraft sound energy associated with this event. Although in the purest sense it would not be a completely uncontaminated event, the aircraft energy rises above the surrounding natural ambient by some 5 to 6 dB. It is inappropriate to relegate this energy to data associated with the natural soundscape of the park.

The need for consistently measured and analyzed ambient sound level data throughout the national parks and other low-level sound environments cannot be stressed enough. Otherwise, the FAA and NPS will continue to collect disjointed data sets that are difficult to accurately compare and contrast.

Keeping in mind the need for the collection of consistent ambient data throughout the parks, it is interesting to note some issues with the Wyle re-analysis, as it relates to aircraft audibility. The NPS has promoted the use of audibility metrics for the analyses done for Grand Canyon National Park (GCNP). To further illustrate the potential gross anomalies which can result from an analysis of this type, a subset of ambient sound level data from the recently completed GCNP measurement study was re-analyzed. Specifically, data collected during the joint FAA/NPS Model Validation Project at the Grape Vine site (9/10/99) were subjected to our interpretation of the Wyle re-analysis criteria. The results are summarized in the following table:

Hour	Measured Time Audible (%)	*Re-Analysis* Time Audible (%)	*Difference*
0900	61	12	*49*
1000	44	2	*42*
1100	39	4	*35*

The data suggest that measured time audible of the range 39% to 61% would be reduced to between 2% and 12% for the three hours of data analyzed. Given the example data and the "error" associated with the Wyle re-analysis technique, GCNP would likely already have achieved the NPS goal of 50% of the park having natural quiet at least 75% of the time. As you know, there are considerable research funds from both FAA and NPS dedicated to achieving this goal.

<u>Measurement Site Selection</u>

As you are aware, every effort was made during the FAA/Volpe measurements to ensure that data collection and analysis methods would result in the most accurate and representative ambient sound levels being reported. As such, several measurement locations were chosen at the request of NPS, directly related to resource/wildlife protection. This is contradictory to the assertion in Wyle's "Reanalysis Results" section which states "...measurements were carried out primarily in areas where there was human activity..." Further evidence of the conservative nature of the results are the facts that measurements were made during the general time of year: (1) of least visitation to the area; and (2) of lowest winds. Both visitation and wind are likely to result in an increase in ambient sound levels during other times of the year.

Use of Statistical Noise Descriptors

The Wyle Report suggests the use of one or more of the L_n family of noise descriptors for describing the natural soundscape. It is important to recall the various issues related to use of L_n descriptors. First, the use of these descriptors generally means the use of unmanned acoustic monitors, which produces lower quality data than manned measurements. Second, when trying to quantify a specific component to the acoustic environment, e.g., the natural ambient, the use of statistical measures presents many limitations. For example, in a park environment where aircraft and other intruding sounds are often audible, use of statistical measures will result in the inclusion of aircraft sound in the statistical measures describing the natural ambient soundscape. Third, the use of the L90 descriptor, which represents the quietest 10 percent of data, is a minimum level that does not include the full range of natural sounds.

As part of the model validation effort at Grand Canyon National Park, a Technical Review Committee (TRC), hand-picked and agreed upon by the FAA and NPS for their expertise in transportation-related acoustics, was assembled. During an August 1999 pre-measurement meeting, the TRC intimated that an L_{eq} is preferable to a statistical measure in describing ambient sound levels. Further, it was the TRC's opinion that if an L_n were to be used, an L_{50} would be preferable to an L_{90} for approximating ambient sound levels. The use of the L_{90} descriptor is also not supported by the NPS' own acoustic consultant, whose stated reasoning is that L_{90}, by definition, only includes a small percentage of the original data set.

Other Observations

The Wyle Report suggests further noise monitoring is needed in order to best describe the southern Florida soundscape. The objectives highlighted would be to: (1) increase coverage area; (2) investigate seasonal variations; (3) investigate seasonal effects on diurnal patterns; (4) investigate seasonal effects on visitation; and (5) develop a transient event database. It is agreed that more data is always better in defining an ambient environment. The FAA/Volpe measurements did, however, cover the vast majority of areas of interest. Data is lacking on seasonal effects for both the natural ambient and visitation, but evidence points to the fact that the current data is conservative with respect to those effects (i.e., their effect would likely be to raise ambient sound levels). Further, the un-manned monitoring data collected for NPS suggests that although human-related activity (and associated sound levels) may typically decrease during nighttime hours, insect activity and other "natural" phenomena actually seem to at least partly compensate for this change.

As is illustrated by many of the issues raised herein, there exists a significant and pressing need for standardization of ambient sound level measurement and analysis. A significant step has already been taken by FAA/Volpe in the preparation of the draft Guidelines Document. Its methodologies and procedures have been tested several times by the FAA, NPS and the US Army. It is now hoped that the NPS and other federal (and international) agencies will collaborate in an effort to finalize a protocol for the collection and analysis of ambient sound level data that reflects the current technical knowledge base.

Integrated Noise Model

Another subject of the July 21, 1999 NPS letter was the Integrated Noise Model (INM). FAA modeling enhancements for the SEIS were based on INM Version 5.2. Virtually all of these enhancements, as with earlier INM enhancements for Grand Canyon analysis, were incorporated into public version INM 6.0. While INM noise calculations remain primarily A-weighted, INM noise computations will increasingly use the model's new aircraft spectral database. This database will support growing capabilities for advanced acoustic effects such as terrain shielding, meteorology, and new excess attenuation algorithms, currently under formal review by the Society of Automotive Engineers (SAE) Aviation Noise Committee.

With respect to INM validation, the INM has been the FAA's standard methodology for predicting and assessing noise impacts for over two decades. Over 700 government and private organizations throughout the United States and 40 foreign countries use INM. The FAA used the model for this analysis because of its: 1) widespread scientific acceptance; 2) conformance with industry and international standards; 3) measurement-derived noise and performance data; 4) large civil and military aircraft data base; and 5) adaptability and reliability for assessing a variety of situations, including southern Florida's high percentage of acoustically hard and mixed surfaces.

Formal INM validation involved three major airports and more than 50,000 aircraft flight events over a six-month period. It consisted of extensive field measurement programs correlated with actual aircraft position and performance data. For Homestead and surrounding park environments, we believe that INM provides very accurate estimates of noise impact. Reasonableness checks indicate that the modeled results for south Florida correlate well with the noise measurements taken by the FAA. More information will be available soon from two independent test efforts--the INM validation program with the NPS at Grand Canyon NP and an INM field measurement program with the National Aeronautics and Space Administration (NASA) at Boston Logan Airport.

Audibility

Finally, on the complex issue of audibility, the use of this concept for noise assessment has major limitations in both theory and practice. These limitations include historical roots not in psychoacoustics, but in physical detection of enemy assets. Audibility is an extreme measure of minimum change in the sound environment and assumes that the average person is actively listening for aircraft. As a frequency-based measure, audibility is extremely sensitive to weather and atmospherics, aircraft type, flight procedures, and terrain. It is costly and difficult to implement because it depends on proprietary aircraft manufacturer data, local measurements, and additional analysis. Understanding the audibility metric, d', is difficult by acousticians, let alone government representatives and the public. And most importantly perhaps, audibility has no established relationship with human response. In short, further research on audibility is needed.

United States Department of the Interior

NATIONAL PARK SERVICE
1849 C Street, N.W.
Washington, D.C. 20240

IN REPLY REFER TO:

July 12, 2000

Robin Brandin
SAIC
2109 Air Park Rd.,
Albuquerque, NM 87106

Dear Ms. Brandin,

I am writing to transmit the final version of the report by Wyle Laboratories entitled "The Soundscape in South Florida National Parks" for inclusion in the homestead Supplemental Environmental Impact Statement. Because this letter provides a link between the draft Wyle report that was part of the draft SEIS and because of the additional explanations provided below, we would like it included with the attached Wyle report in the final version of the SF15.

The more significant changes, i.e., other than typographical errors and rewording to clarify points in the draft, are as follows:

Acoustical Zoning: Statements about the independence of sound levels to acoustical zones have been modified. Instead of stating a certain independence exist, the report now states that no evidence of dependence between sound levels and acoustical zones was found in the data. The rewording appears in Sections 3.3,4. 4.5.4, and 5.1.

Additional Tables:
Two tables were added to Section 4 to demonstrate the ANOVA (analysis of variance) for time of day' and acoustical zones for unmanned measurements. Table 4.5. ANOVA for L90 versus time of day shows that the different periods are statistically different. Table 4.6 ANOVA for L90 versus Acoustical Zones shows that no dependence was observed.

Corrected Tables:
Table 4.2: Acoustical Zone Labels were corrected.
Table 4.4b: Average Leq numbers have been corrected. The numbers in the draft for this table were wrong.

Section 4.4.1: Sound level values for B3 (Hiking North of Elliott Key) and B4 (Hiking Trail South of Elliott Key) have been corrected.

Values for the time of day variations in L90 are included in the summaries.

In addition, some points were raised by reviewers that warrant comment but do not neatly fit within the framework of the report itself. We would like to deal with the more relevant of these here.

A basic question is why does the interpretation of the same data differ so much between the report "Ambient Sound Levels at Four Department of Interior Conservation Units" (Volpe report) funded by the FAA and this report by Wyle labs funded by The National Park Service. The answer is that the Volpe report inexplicably misinterprets the data by mixing audibility and sound pressure level information. It appears that the root of the problem is the rigid adherence by the Volpe observers to the hierarchy of sounds as described on page 47 of their report. As a consequence. the observers continued to record the presence of mechanical noise well below the ambient sound levels. Had the report merely presented the time a source, e.g., an aircraft, was audible, there would have been no problem. Unfortunately the authors went beyond that and assigned the sound pressure level for that entire time period to that event, even though an examination of their energy logs clearly shows that other sources were actually controlling the sound pressure level during a portion (or even all) of that period of time. As a consequence the NPS is confident that. all of the sound pressure data presented on pages 61 through 72 of the Volpe report are incorrect and, to the extent that those data are incorporated in the SEIS and related analyses. those elements are also incorrect.

Another question raised was why the NPS didn't use the audibility approach used for the ongoing studies of "restoration of natural quiet" at Grand Canyon National Park for the South Florida study. The answer lies in the definition of "restoration of natural quiet," a term specific to Grand Canyon. In that ease the issue of restoration specifically turns on the percentage of time that aircraft are audible. The issue for the NPS in South Florida is the restoration and preservation of the natural soundscape.

Another issue raised was why the NPS report asserted that the methodological differences between the data collected by Sanchez Industrial Design (SID) using the LOWNOMS system and that collected by Volpe using the VOLARE system accounted for the reanalysis difference between the two systems when both used the same "hierarchy of sounds" approach. The answer is that LOWNOMS and VOLARE do not use the same approach. As indicated above, the VOLARE approach required strict adherence to the aircraft/non-aircraft human/natural hierarchy regardless of the level of other competing sounds. The LOWNOMS approach requires the observer to log the <u>dominant</u> sound source.

The final question we would like to deal with is that of Leq versus an exceedance metric such as L_{90}. As commenters noted, the Leq corresponds very well with loudness and is frequently used in near-airport locations. The answer is that the NPS concern is with the protection of the natural soundscape — quietness rather than loudness.

Thank you.

cc: Lynne Pickard, FAA
Doug Heady. Air Force

Sincerely,

William B. Schmidt
Special Assistant to the Associate Director,
Natural Resource Stewardship and Science

WYLE RESEARCH REPORT

WR 99 – 17

The Soundscape In South Florida National Parks

Prepared For:

U. S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
1849 C STREET, NW
WASHINGTON, DC 20240

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June 2000

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Acknowledgments

The authors would like to acknowledge the staffs at Biscayne and Everglades National Parks for their assistance in the field measurements. We give special appreciation to Patrick Lynch, Janice Lynch, and Karyn Ferro for successfully coordinating the logistics of the field study. We also acknowledge input and advice of Gonzo Sanchez, Dr. William Bowlby, and Dr. Jim Foch. And, lastly, we appreciate the assistance and support of William Schmidt for his role as project manager for the National Park Service.

1 EXECUTIVE SUMMARY

The National Park Service (NPS) has been concerned about noise intruding on the natural soundscape within its parks for a long time. They have actively engaged in the measurement of intruding sounds and the natural ambient levels in the parks for more than 15 years. The NPS has developed policies related to soundscape management, preservation, and restoration, which require information about the natural ambient sound levels, referred to as soundscapes, in all of their properties throughout the country. Measurement of the south Florida parks have been undertaken to refine acoustical metrics that best describe the natural soundscape and to develop general procedures for measuring the natural soundscape. Coincidentally, the proposed conversion of Homestead Air Force Base to a civilian airport has brought the issue of preserving and restoring natural soundscape to the forefront.

In connection with the Supplemental Environmental Impact Statement (SEIS) for the proposed conversion action, several series of sound measurements have been made by NPS and Federal Aviation Administration (FAA) contractors: John A. Volpe National Transportation Systems Center Acoustics Facility (Volpe) and Sanchez Industrial Design, Inc. (SID). Two of these studies used manned observation stations to continuously measure the sound levels over limited periods (generally, one to three hours) and to identify the source of each sound. These measurement studies concentrated on the audibility of intrusive sounds on the natural soundscape.

This report investigates the natural soundscape using an acoustical energy basis[1] rather than audibility. As part of this change in approach, the sound level data from the previous studies are reanalyzed from an acoustical energy perspective. Also, additional unmanned measurements were conducted to provide a better understanding of the variations inherent in the natural soundscapes in the south Florida parks. From these additional measurements, the A-weighted sound levels due to natural sources are found to be reasonably consistent over the region for the time period monitored. The average 24-hour L_{90} for all of the Wyle monitored sites was 33 dBA, while the average 24-hour L_{50} was 42 dBA. Quantitatively, the protected shorelines were the quietest sites while the loudest sites were the dense forests, but no statistically significant dependence of any 24 hour sound level metric on acoustical zone (i.e. type of local ecosystem) was found. However, diurnal dependence was found with the daylight hours being the quietest period in general, and the nighttime hours being the loudest. The average

[1] The acoustical energy described in this report refers to the A-weighted acoustical energy

daytime L_{90} was 32 dBA, and the average nighttime L_{90} was 40 dBA with average sunrise and sunset L_{90}s falling in between at 36 and 35 dBA, respectively.

The unmanned measurements, along with the reanalyzed manned measurements, demonstrate that L_{90} provides a baseline for assessing the natural soundscape on an acoustical energy basis. L_{50}, on the other hand, represents the median levels occurring at a site and adds an indication of the range of sound levels. From the reanalysis of the SID and Volpe manned measurements, L_{90} of the subset of natural sounds was the same as that of the total data set, and it was not affected by human-caused noise. The reanalysis also demonstrated that the L_{50}, although a good representation of the total noise environment, generally overestimated the L_{50} of the natural sounds. Moreover, during periods of minimal intrusions, the difference between the hourly L_{50} and the hourly L_{90} was less than 5 dBA at most sites. Thus, characterizing the natural soundscape by L_{90}, rather than L_{50}, does not overly bias the characterization toward lower levels. Thus, for assessment purposes, the L_{90} of the totality of sounds provides an accurate baseline upon which to establish threshold levels for defining transient and/or intruding events. This finding differs from the reported results in the Volpe report (Flemming et al, 1999), which described the traditional ambient in terms of L_{eq} with variations based on vegetation.

The bias in using the L_{eq} of the traditional ambient as a descriptor of the natural soundscape is much more significant. Typically, hourly L_{eq} values were similar to the hourly L_{10} values. This relation means that the L_{eq} is biased toward the louder events. As an example, if the sound levels were 30 dBA for 95% of the time with some loud events of 60 dBA for 5% of the time, the corresponding L_{eq} for that time period would be 47.1 dBA. From the unmanned measurements, the difference between the average L_{90} and L_{10} was 20 dBA, which is significant in terms of acoustical energy. Use of L_{eq} or L_{10} as a baseline for natural sound levels is not appropriate since these values represent the loudest events occurring in the soundscape. Thus, use of these values to assess potential intrusions could prevent the NPS from achieving its goal of preserving and restoring the natural soundscape in its parks.

The unmanned sound level measurements demonstrated a diurnal pattern, with the highest levels occurring at night and the lowest during the day. This difference probably results from more active animal vocalization occurring during the night. Intruding transient sound events exhibited the opposite diurnal trend in that they increased during the day and decreased at night. This trend suggests that human-based activity generated most of the transient events.

This report provides details of a reanalysis of some of the acoustic data that has been acquired in south Florida with an eye toward defining the soundscapes in the measured properties. It also provides an analysis of additional acoustic data collected over a longer measurement period than in the earlier studies. Finally, based on the totality of acoustic data measured in the south Florida properties, it recommends general procedures for refining the definition of the soundscapes of these properties.

Park personnel can now start to establish criteria for assessing intrusions to the natural soundscape by using L_{90} as an objective basis for defining intruding event thresholds. The assessment of intruding sound events needs to include the maximum sound level of each event, the duration of each event, and the number of events occurring within a given time period. For our analysis, thresholds were set at 10 dBA, 20 dBA, 30 dBA, and 40 dBA above the hourly L_{90}. These thresholds act as filters and provide a good description of the intruding sound events that rise above the natural background level. Exact thresholds for assessment should be formulated so that the goals of soundscape preservation and restoration can be met. The exceedance metrics, e.g. L_{50} and L_{10}, should also be examined to ascertain the level at which the intruding events have an impact on the natural soundscape.

For assessing aircraft noise impacts, noise models such as INM and NoiseMap may be used to calculate aircraft noise intrusiveness based on the established guidelines. For INM, the Time Above calculation can be used to determine potential intrusiveness. For NoiseMap the top contributor calculation can be used to determine intrusiveness although some work would be required to translate the calculated data into individual transient events. Also, for a complete assessment, additional information is required on the hourly operational rates that are not included in the data bases of either of these aircraft noise models.

Chapter 2 provides background information relating to the previous acoustic measurement programs. Chapter 3 describes the reanalysis that was carried out on these measurements, and discusses general conclusions that can be made from this reanalysis. Chapter 4 summarizes the results of the unmanned field measurements that were conducted in south Florida. Chapter 5 provides recommendations for acoustic metrics, and the related acquisition procedures, to be used in refining the definition of the soundscapes in the NPS south Florida properties.

2 BACKGROUND

The NPS is developing noise and soundscape management plans for its parks in south Florida – Everglades National Park, Biscayne National Park, and Big Cypress National Preserve. An essential tenet is the definition of the natural ambient soundscape as a resource to be managed per the NPS Organic Act of 1916 and other relevant mandates. The key to this concept is the development of a credible and defensible description of that resource.

There have been at least three significant sound monitoring efforts in one or more of the parks that have collected data on the nature of the sound environment. The first was by Sanchez Industrial Design, Inc. (SID) in September-October of 1997 (Sanchez, 1997), the second was by the John A. Volpe National Transportation Research Center (Volpe) in August of 1998 (Flemming et al, 1999), and the third was by SID in November of 1998 (Sanchez, 1998).

The first two of these studies employed trained observers to acquire acoustic data at 1-second intervals for short periods of time (1 to 3 hours) along with meteorological information (temperature, humidity, and wind speed and direction) and to identify the sound source that was heard at each instant of time. For the Volpe study, emphasis was on separating periods of time in which no human or mechanical sounds were heard from periods of time in which intruding sounds from non-natural sources, such as aircraft, boats, and human activity were audible. Thus, natural sounds were identified when no other human or mechanical sound could be heard. In addition, the intruding sounds were identified based on a hierarchy of sounds that placed greatest emphasis on aircraft noise followed by "human noise," and lastly on natural sounds.

For the SID 1997 data, the separation of the sound levels into two groups, natural and intrusive, was based on the dominant sound source as determined by the listener at the time of data collection (Sanchez, 1999). For the Volpe data, the data were grouped according to a hierarchy of sounds heard without regard of the dominant sound source. Therefore, a difference exists between the two data sets because of difference in collection schemes. It is also important to note that with audibility based measurements, the observer notes "natural" sounds when he is really noting the absence of intruding human-caused noise. Thus, "natural" should be the quietest period of the record. There are exceptions, such as thunder and birdcalls, but they generally do not cause the overall natural sound levels to be louder than the intruding levels.

For the third study, SID 1998, unmanned monitors were used to collect 24 hours of sound level data at a limited number of sites along with some one-hour duration manned measurements. The unmanned approach was used to obtain an understanding of how the sound levels varied throughout the day, which was lacking in the previous studies. It demonstrated that unmanned monitoring provided a good picture of the hourly variations and diurnal dependence of the sound levels.

The acoustic metric used to quantify the intensity of the measured sound in these studies was the A-weighted sound level. This measure approximates the frequency response of the human ear, which is most sensitive at frequencies between 1,000 and 6,000 Hz and less sensitive at other frequencies. The A-weighted sound level is the most common measure used to quantify environmental sounds - both natural and man-made. The ranges of sound levels ascribed to natural and non-natural sound sources was described in terms of various statistical acoustic metrics, such as L_{eq}, the energy-average sound level and L_x, the sound level exceeded x-percent of the time.

3 REANALYSIS OF PREVIOUS MEASUREMENTS

3.1 Criteria for Natural vs. Intrusive Sound Events

One's ability to detect a given noise source does not depend on the magnitude of its A-weighted sound level alone. The human mind can discriminate between two sounds of different frequencies even though one may be at a much lower A-weighted sound level than the other. Consequently, a human can detect a given sound source even though that source may not be the dominant source which controls the measured A-weighted sound level. Because of this fact, the procedure used to identify sources of sound in the south Florida studies often resulted in A-weighted sound levels from natural sources being identified as being from non-natural sources since some of the intruding sound energy was below the natural background sound energy. This distinction is important when considering audibility versus acoustical energy based measurements.

For example, suppose an observer hears something and reports the identity of the source in a time-based log, and at the same time independently records the A-weighted sound levels. A difference can appear when the observer log is compared to the recorded sound levels, since the observer may have heard a certain sound source that did not dominate the sound level at that particular time. At this instance, the natural sound is intruded upon based on audibility, but on an acoustical energy basis, the natural soundscape levels are not affected. The error occurs when this affected sound level is associated with an intrusive source although that source does not significantly contribute to the overall sound level. This difference between audibility-based and acoustical energy-based approaches is the reason for the reanalysis since in the original analysis a sound level is identified as intrusive just because the listener could hear an intrusion.

This misidentification of acoustical energy had two consequences. First, the amount of acoustic data ascribed to natural sounds was much less than actually occurred, resulting in less statistical confidence in the range of natural sound levels occurring at a site. Second, the lowest levels ascribed to non-natural sounds during a given measurement period were often lower than the lowest levels ascribed to natural sounds during that period. This cannot be the case since natural sounds are what remain when non-natural sounds are no longer present. Thus, this misidentification can erroneously skew the non-natural population of sound levels toward lower levels, and it can erroneously skew the natural population of sound levels toward higher levels. In fact, in Table 4 of Volpe's report (Flemming et al, 1999), there are several measurement points where the traditional ambient (everything but aircraft) is less than the natural ambient. This would mean that the addition of some man-made sounds would reduce the average sound levels. This finding does not appear to accurately assess the natural soundscape.

In order to correct this potential identification error, the acoustic data acquired in the south Florida parks by SID, Inc. in 1997 and by the Volpe National Transportation Research Center in 1998 were reanalyzed using an energy-based definition of an intruding event. The ambient level was determined based on the observer's identification of the periods of natural sounds to anchor the acoustic data and place them in a more accurate context. This new definition identifies a sound intrusion when the intruding source is seen to increase the overall A-weighted sound level from what it was just before and just after the identified event. An event is not identified as intruding if an increase in sound level is not apparent in the acoustic time history.

This energy-based identification procedure only identifies an intruding event if the total sound level (intruding plus background) is equal to or greater than 3 dBA above the background level. This 3 dBA increase occurs when the intruding and natural sound energies are equal (i.e. if both the intruding and background levels are 40 dBA, then the overall sound level is 43 dBA). This discrimination ensures that the acoustic energy of the intruding event is equal to or greater than that of the background. Thus, for example, even though a passing aircraft may be audible at levels, which are well below the A-weighted sound levels of the background, it is not identified as an intruding source until its A-weighted sound level is equal to or greater than that of the background.

3.2 Reanalysis Procedures

The reanalysis was accomplished by inspection of the one-second L_{eq} time histories, the observer notes, and the temperature and wind speed records. Using the criterion described above, each one second L_{eq} was identified as being either natural or intrusive.

To reanalyze the manned data of Volpe and SID 1997 in accordance with these criteria, computer software was developed to simultaneously display on a computer monitor the one-second L_{eq}, information from the source observation logs, the temperature, and the wind speed. Elevated wind speed would could indicate the presence of the natural sounds of wind rustling leaves or grass. Temperature could potentially be related to animal activity and vocalizations. Simultaneous observation of each of these pieces of information allowed the analyst to identify when an intruding event caused the total A-weighted sound level to rise above the background A-weighted sound level just before and just after the sound event.

Figure 3.1 is an example of the output display of this computer software. The A-weighted sound level during a 10-minute time period from 15:47:07 to 15:57:07 is displayed in the figure, as is the temperature (at top) and wind speed (at bottom). The scales for sound level and temperature are on the left vertical axis; that for the wind speed is on the right. The horizontal axis shows the local time during the observation. Vertical lines (with identifying letters near the bottom of the line) delineate the noise source identified by the observer.

The figure starts at 15:47:07 with an aircraft (A-A) being identified as present, followed by a very short period of time in which the source is identified as natural (N-N). Next, a short period of time in which the source is identified as aircraft is again followed by a very short period of time in which the source is identified as natural. Throughout each of these periods, the sound level varies between 30 and 35 dBA. There is no apparent difference in the range of sounds levels between those segments identified as aircraft and those segments identified as natural. During this time, an aircraft was audible but it does not appear to have effected the overall levels occurring at this site during this time period.

Next is a large period of time in which the source is identified as aircraft, followed by a short period of time, beginning about halfway from 15:52:07 to 15:57:02, in which the source is identified as natural and a similar period of time in which the source is identified as human activity (H-H). During the remainder of the time to 15:57:07 natural, human, and aircraft sounds are identified. Note that, during this time period, the A-weighted sound level varies from about 35 dBA to about 40 dBA with no apparent change as different sources are identified.

The only event in the figure that can be clearly identified as intruding is an aircraft, which caused the gradual rise from around 35 dBA to about 53 dBA and return to 35 dBA that occurs just before 15:54:07. This is the only portion of the 10-minute A-weighted sound level time record that one might conclude is not natural. Thus, the reassignment identified all other portions of this time period as natural.

This reassignment is done interactively within the computer program. While scrolling through the observation data, the user can set cursors at two times and reclassify the contained time period as natural or intrusion. In the figure, the horizontal line just below 70 dBA represents the reclassification. The solid portion of the line denotes natural sources and the dashed portion of the line denotes intrusions. This method is not totally objective but requires the analyst to use judgement in re-identifying the sound levels.

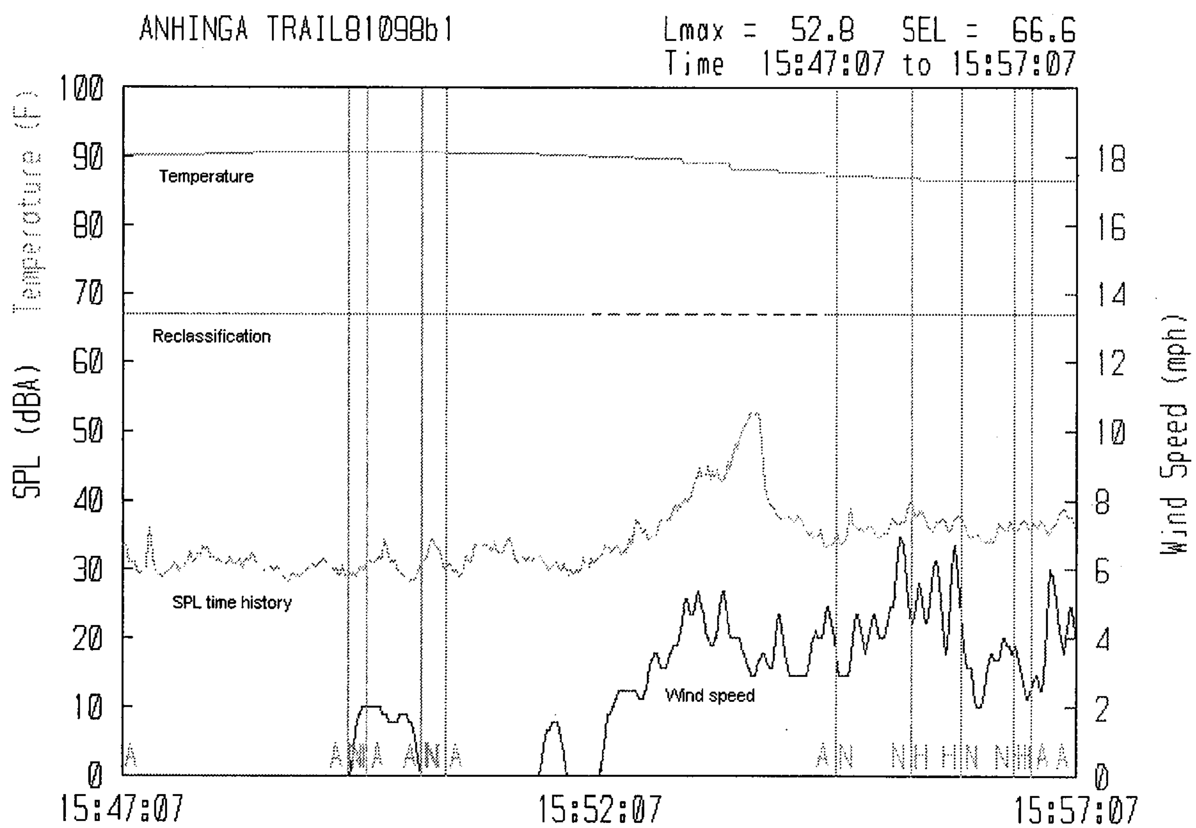


Figure 3.1. Example of the Reanalysis Procedure

Several examples were performed independently by three people in order to test the reproducibility of this approach. This comparison showed that the general results were stable with some variations in the exact identifications. These variations did not effect the overall statistical results.

3.3 Reanalysis Results

The SID 1997 and Volpe 1998 studies focused on the audibility of aircraft noise intrusion, although their discrimination schemes were slightly different, with Volpe focusing on their hierarchy of noise sources rather than the dominant sound. At some sites, measurements were made during weekdays and weekends to quantify the effects of increased visitor activity on the sound levels.

The measurements were performed while observers were present so that sound sources could be identified. For the Volpe measurements, a hierarchy of identification was used which went from aircraft to mechanical to human to natural. Thus, whenever an airplane was heard, the resulting sound levels were identified as aircraft noise even though (a) other noise sources, such as boats, humans, or birds, could also be heard or (b) the aircraft noise did not change the measured overall A-weighted one-second L_{eq} from what it had been prior to the onset of the aircraft noise.

For the SID 1997 measurements, the observer identified as the sound source that source which was judged the loudest at the time. Again, no effort was made to determine whether or not a new noise source changed the A-weighted one-second L_{eq} from what it was for the previous noise source.

The SID 1997 and Volpe 1998 measurements were generally carried out between 08:00 and 16:00, thus precluding any identification of diurnal variation in the natural soundscape. Several of the SID 1998 measurements were made over periods of at least 24 hours. The associated diurnal variation will be discussed below.

During the SID 1997 and Volpe 1998 studies, measurements on open water were carried out in a boat. The sound level data appeared to be influenced by noise from the wave action on the boat hull. Recordings of these measurements were not made available so that times where the sound levels were not distorted by the wave slap on the hull were not determined. Accordingly, sites in which measurements were conducted from a boat were not reanalyzed. However, a comparison of data obtained from these sites with Wyle's unmanned measurements is provided in Chapter 4.

3.3.1 Comparison of Volpe and SID Analysis with Wyle Reanalysis

Table 3.1 compares the natural ambient L_{eq} from Volpe's analysis of 23 of its non-boat measurements with the natural ambient L_{eq} from Wyle's reanalysis of those data. The average difference in L_{eq} between Volpe and Wyle is 1.4 dBA, with a standard deviation of 4.1 dBA. The largest positive difference (Volpe L_{eq} > Wyle L_{eq}) is 11.5 dBA at Elliot Key on August 15, 1998; the largest negative difference (Volpe L_{eq} < Wyle L_{eq}) is -3.2 dBA at Mangrove Inlet on August 18, 1998. This results shows that the L_{eq} is insensitive to changes in the quieter noise levels in an overall distribution of levels since the L_{eq} is controlled by the louder events. Thus, this small difference in L_{eq} from the reanalysis is expected since the reanalysis recovers the lower sound levels.

Of more interest, in terms of defining the natural ambient, is the time recovered by the Wyle reanalysis. This figure represents the time that was attributed to non-natural sources by Volpe's identification system, but for which the A-weighted sound level did not change from the range it occupied during nearby time periods in which the source was identified as natural. For all of the reanalyzed data, an average of 5484 seconds were recovered, representing 49 percent of the total observed measurement time. This demonstrates the misidentification error of using audibility based observations and applying them to energy based levels.

For the most extreme case, the Soldier Key measurement on August 16, 1998, Volpe identified only 228 seconds of the 10,894 second measurement period as being due to natural sources, whereas Wyle's reanalysis identified 9734 seconds as being due to natural sources. This raised the percentage of time for which natural conditions dominated at this site from 2% to 89%. This represents a reassignment of 87 percent of the measurement period from intrusion to natural.

The least extreme cases were the August 18, 1998 measurements at Eastern Sparrow and North Nest Key, both of which were remote sites that would be expected to be dominated by natural sounds. Even then, in each case, 29 percent of the measurement period was reassigned from intrusion to natural. For Eastern Sparrow, the percentage of time of natural levels was corrected from 46% to 74%, and for North Nest Key, the percentage was corrected from 57% to 86%.

These differences mean that the Volpe identification skewed the intrusive levels inappropriately toward low values by including large amounts of natural sound levels into the intrusive grouping. Moreover, this recovered time demonstrates that natural ambient

Table 3.1. Comparison of Natural Ambient L_{eq} - Volpe Measurements vs. Wyle Reanalysis

							Natural - Volpe Measurement			Natural - Wyle Reanalysis			Volpe-Wyle	Time	Total	
Data File	Site ID	Site Name	Acoustical Zone	Date	Start Time	Stop Time	Leq (dBA)	Duration (seconds)	% of time	Leq (dBA)	Duration (seconds)	% of time	Difference (dBA)	Recovered (seconds)	Duration (seconds)	% Time Recovered
81098C1	C	Boca Chita	6	08/10/1998	12:13:13	14:59:46	42.0	1677	17	42.6	5668	57	-0.6	3991	9993	40
81298I1	I	Elliot Key	7	08/12/1998	9:34:59	12:37:02	49.2	1397	13	42.2	7616	70	7.0	6219	10923	57
81598I1	I	Elliot Key		08/15/1998	14:13:28	17:09:25	58.0	228	2	47.3	6061	57	10.7	5833	10557	55
81798I1	I	Elliot Key		08/17/1998	13:26:53	16:27:06	56.4	706	7	44.9	8026	74	11.5	7320	10813	68
81198F1	F	Fender Point	7	08/11/1998	7:18:48	10:20:16	42.2	3905	36	40.9	7682	71	1.3	3777	10888	35
81498F2	F	Fender Point		08/14/1998	11:12:14	14:12:31	33.1	564	5	34.1	5228	48	-1.0	4664	10817	43
81398L1	L	Soldier Key	6	08/13/1998	10:49:46	13:34:19	54.4	510	5	57.4	8466	86	-3.0	7956	9873	81
81698L1	L	Soldier Key		08/16/1998	9:41:48	12:43:22	58.1	228	2	59.8	9734	89	-1.7	9506	10894	87
81098B1	B	Anhinga Trail	1	08/10/1998	15:21:52	18:22:02	40.7	3913	36	39.3	7530	70	1.4	3617	10810	33
81298B1	B	Anhinga Trail		08/12/1998	7:57:08	10:32:59	65.6	620	7	58.6	5381	58	7.0	4761	9351	51
81598B1	B	Anhinga Trail		08/15/1998	7:32:55	10:08:03	56.2	1513	16	51.3	7536	81	4.9	6023	9308	65
81098O1	O	Chekika	4	08/10/1998	8:52:42	13:01:56	40.6	5034	34	39.9	9996	67	0.7	4962	14954	33
81898V1	V	Eastern Sparrow	4	08/18/1998	9:41:18	14:55:34	31.2	8603	46	31.6	14004	74	-0.4	5401	18856	29
81498Q1	Q	Eco Pond	3	08/14/1998	8:44:40	14:39:32	48.1	5372	25	48.6	18407	86	-0.5	13035	21292	61
81598R1	R	Hidden Lake	2	08/15/1998	11:55:29	14:55:24	35.1	2808	26	35.6	8822	82	-0.5	6014	10795	56
81898X1	X	North Nest Key	6	08/18/1998	14:34:24	17:30:03	40.1	6020	57	40.3	9026	86	-0.2	3006	10539	29
82098AA1	AA	Pavilion Key	3	08/20/1998	8:07:21	11:06:16	45.5	5267	49	45.5	10075	94	0.0	4808	10735	45
81398N1	N	Shark Valley	4	08/13/1998	9:26:15	12:31:10	43.2	1824	16	41.4	6805	61	1.8	4981	11095	45
81698N1	N	Shark Valley		08/16/1998	8:05:23	11:04:49	46.3	4783	44	47.3	9622	89	-1.0	4839	10766	45
81898AC2	AC	Mangrove Inlet	3	08/18/1998	14:39:41	16:09:43	33.4	198	4	36.6	2238	41	-3.2	2040	5402	38
81698S1	S	Golightly Campground	1	08/16/1998	12:52:40	15:40:48	36.0	2044	20	38.4	5234	52	-2.4	3190	10088	32
81798S1	S	Golightly Campground		08/17/1998	7:59:03	10:58:55	42.7	6659	62	42.9	9991	93	-0.2	3332	10792	31
82098AE1	AE	National Scenic Trail	1	08/20/1998	8:43:50	11:21:27	44.6	541	6	42.9	7394	78	1.7	6853	9457	72
												Average	1.4	5484	11261	49
												St. Dev.	4.1	2383	3197	17
												Count	23	23	23	23

Acoustical Zone Key
1 = Intruded
2 = Open Forest
3 = Dense Forest
4 = Prairie, Slough
5 = Open Water
6 = Open Shoreline
7 = Protected Shorline

levels are present within the park for most of the time and are more likely to be impacted by additional noise intrusions.

Table 3.2 shows similar information for the SID 1997 data. Differences between the SID analysis and the Wyle reanalysis of that data were not as extreme as for the Volpe data. The average L_{eq} difference for 11 non-boat measurements was 0.0 dBA with a standard deviation of 0.4 dBA. The largest positive difference (SID L_{eq} > Wyle L_{eq}) was 0.8 dBA at North Nest Key on October 5, 1997; the largest negative difference (SID L_{eq} < Wyle L_{eq}) was -0.7 dBA at Elliott Key on September 20, 1997.

The remarkable difference in how each of the two analysis with Wyle's reanalysis may be due to the different assignment hierarchies used in the two studies. Volpe identified the measurements as being due to an airplane whenever an airplane could be heard; SID identified the measurements as being due to whatever noise source was judged the loudest at each second of time.

Additionally, differences in technique may have affected the identifications. SID used a button box to log the identification of the dominant noise source and , as a result, was able to keep track of short periods of time in which that source changed by pressing a single button. Volpe entered source identification data into a spreadsheet in a laptop computer. Because of the time required to type in source identification comments, short periods of time in which aircraft (or other sources in the hierarchy) could no longer be heard may have been omitted. The omission would result in more time associated with an intruding sound instead of natural sound.

3.3.2 Comparison of Exceedance Plots for All and Natural Only Sounds

Figures 3.2 and 3.3 are examples of sound level exceedance plots, which show the percentage of the measurement time during which a given A-weighted sound level is exceeded. The abscissa of the plots is a linear scale showing the A-weighted sound level; the ordinate is a normal probability scale showing the percentage of time (or probability) that each sound level is exceeded. A normally distributed set of data would appear as a straight line on such a plot, with the median value of the data being at the 50 percent level. Thus, the straightness of the distributions curve (or lack thereof) demonstrates how normal the distributions are.

Figure 3.2 shows data taken by SID, Inc. at the Anhinga Trail in Everglades National Park from 15:22:31 to 16:33:11 on October 5, 1997. The dashed line represents all of the acquired data; the solid line represents the subset of data that was identified in the reanalysis as being due to natural sounds. Note that, at low sound levels, corresponding

Table 3.2. Comparison of Natural Ambient L_{eq} - SID Measurements vs. Wyle Reanalysis

Data File	Site ID	Site Name	Acoustical Zone	Date	Start Time	Stop Time	Natural - SID Measurement Leq (dBA)	Natural - SID Measurement Duration (seconds)	Natural - SID Measurement % of time	Natural - Wyle Reanalysis Leq (dBA)	Natural - Wyle Reanalysis Duration (seconds)	Natural - Wyle Reanalysis % of time	SID-Wyle Difference (dBA)	Time Recovered (seconds)	Total Duration (seconds)	% Time Recovered
Bis-1	B1	Visitor Center BISC	1	9/18/97	13:50:34	14:47:47	48	2216	65	47.8	2827	82	0.2	611	3433	18
Bis-8	B8	Elliott Key	7	9/20/97	11:25:33	12:38:18	44	1260	29	44.7	1939	44	-0.7	679	4365	16
Bis-8(2)	B8			9/22/97	12:49:04	13:54:21	36	2651	68	35.6	2853	73	0.4	202	3917	5
Ever-2(2)	E2	Anhinga Trail	1	10/5/97	15:22:31	16:33:11	40	2691	63	40.2	3049	72	-0.2	358	4240	8
Ever-3(2)	E3	Long Pine Key	2	10/1/97	12:20:52	13:23:11	34	3155	84	34.5	3261	87	-0.5	106	3739	3
Ever-4	E4	Pa-hay-okee O'look	2	10/1/97	10:05:22	11:07:04	38	3177	86	38.3	3382	91	-0.3	205	3702	6
Ever-4(2)	E4			10/4/97	17:45:27	18:49:54	41	2826	73	41	3076	80	0	250	3867	6
Ever-5	E5	Nine Mile Pond	2	10/1/97	17:53:57	18:58:25	34	1878	49	33.9	1831	47	0.1	-47	3868	-1
Ever-6	E6	Eco Pond	3	10/1/97	7:39:52	8:42:08	35	2774	74	35.3	2961	79	-0.3	187	3736	5
Ever-6(2)	E6			10/3/97	17:27:58	18:35:32	42	2512	62	41.7	3262	80	0.3	750	4054	19
Ever-8	E8	North Nest Key	6	10/5/97	10:05:20	11:15:18	39	3191	76	38.2	3322	79	0.8	131	4198	3
												Average	0.0	312	3920	8
												St. Dev.	0.4	258	274	7
												Count	11	11	11	11

Acoustical Zone Key
1 = Intruded
2 = Open Forest
3 = Dense Forest
4 = Prairie, Slough
5 = Open Water
6 = Open Shoreline
7 = Protected Shorline

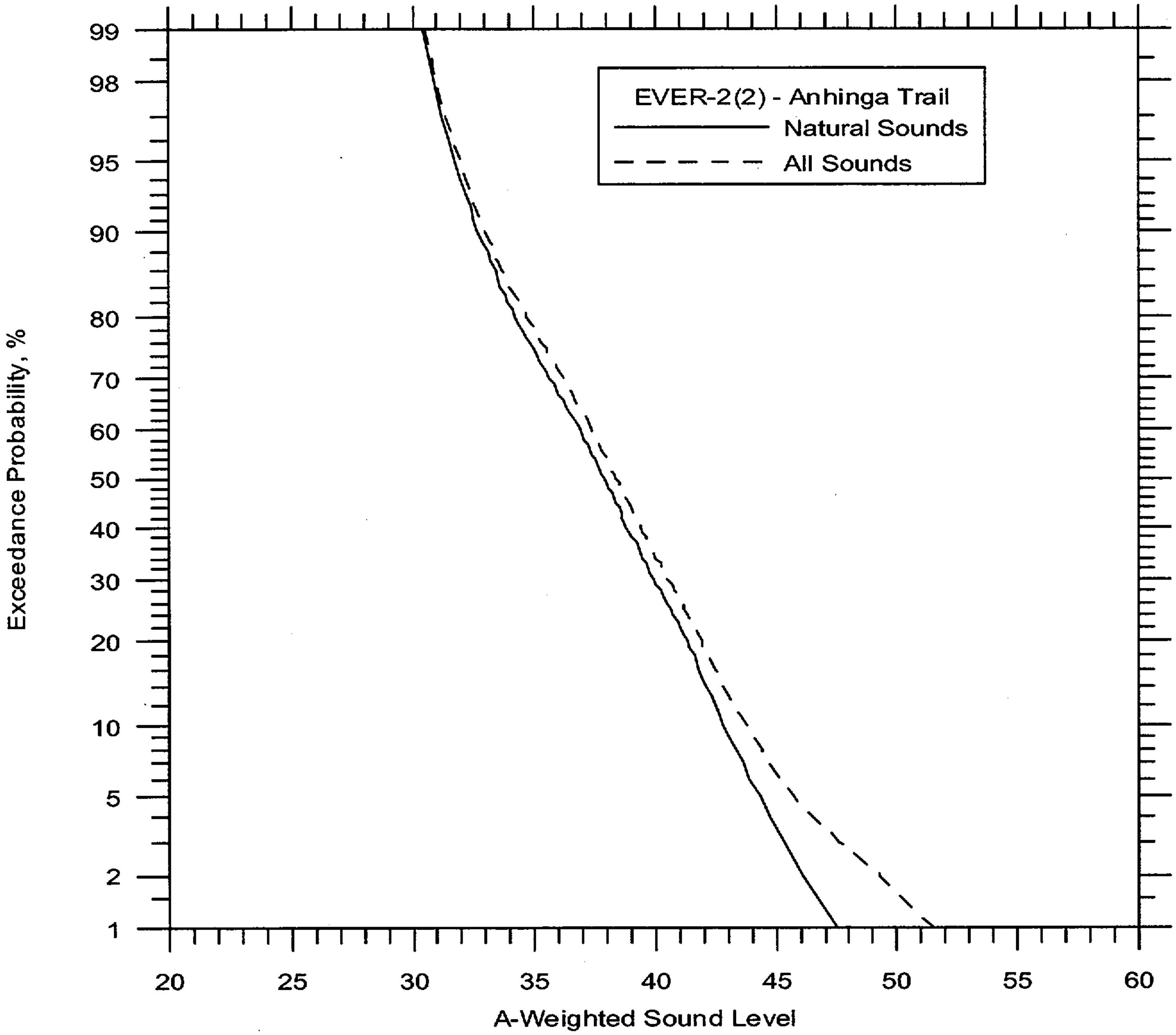


Figure 3.2. Exceedance Plot for SID Data at Anhinga Trail

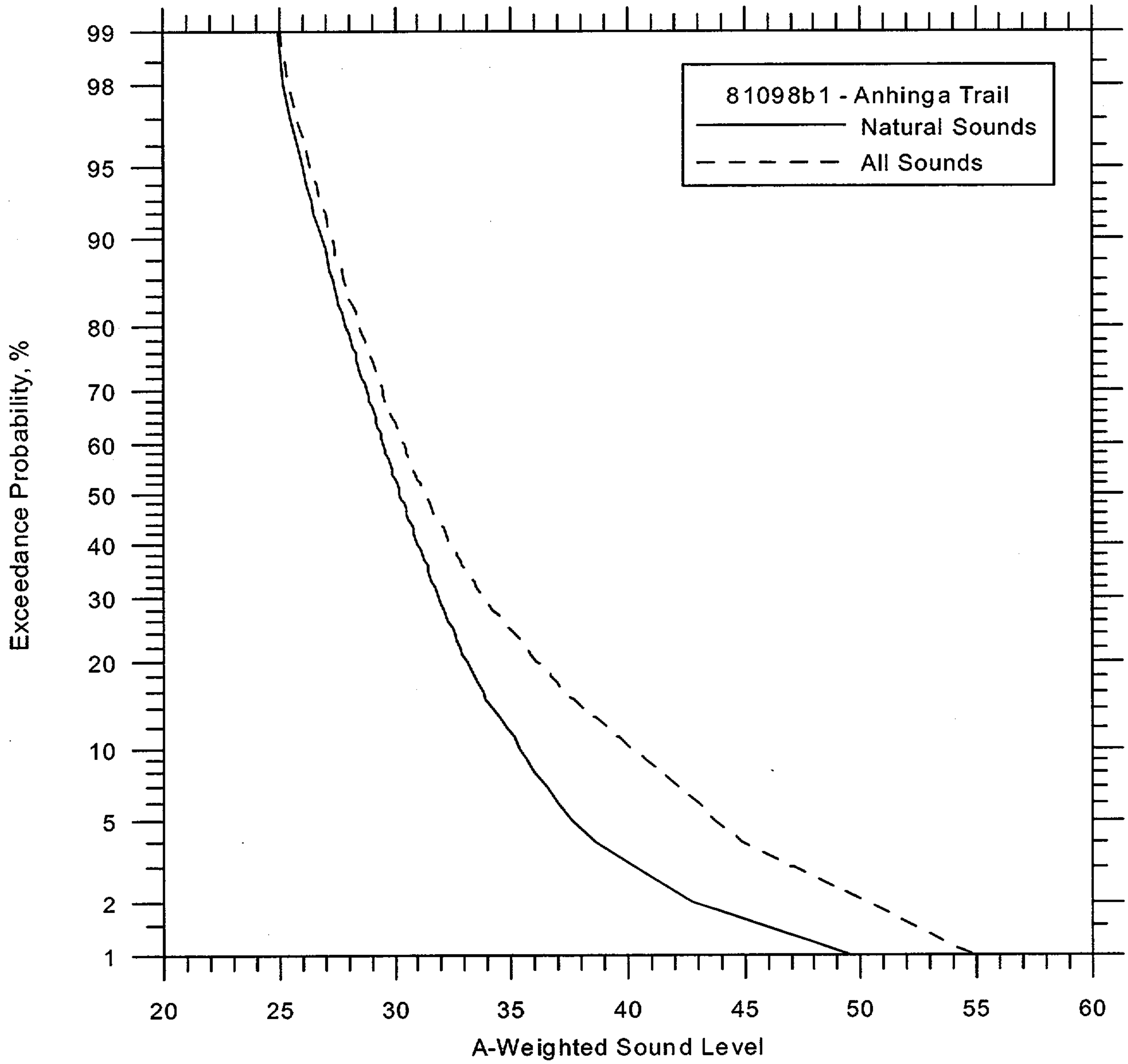


Figure 3.3. Exceedance Plot for Volpe Data at Anhinga Trail

to exceedance levels L_{99}, L_{95}, and L_{90}, which metrics are typically used to characterize ambient or background sounds levels, there is little difference between the two sets of data. It is only at higher sound levels, corresponding to exceedance levels L_1, L_5, and L_{10} (metrics typically used to characterize intrusions), that appreciable differences occurred because of intruding sounds.

Exceedance plots for each of the non-boat measurements acquired by SID in 1997 are contained in Appendix A.

Figure 3.3 shows similar data taken by Volpe at the Anhinga Trial form 15:21:52 to 18:21:52 on August 10, 1998. Although the behavior to the two curves is similar to that of the SID data in the previous year, the range of sound levels differs. For the SID data, the A-weighted sound levels ranged from 30.5 dBA to 51.5 dBA; for the Volpe data, these levels ranged from 25 dBA to 55 dBA. Thus, the range of daytime sound levels is on the order of 20 to 20 dBA.

Exceedance plots for each of the non-boat measurements acquired by Volpe in 1998 are contained in Appendix B.

Exceedance curves for the exclusive subset of natural sounds can only be obtained with manned measurements. Observations are required to identify sources of the sound so that the levels may be divided into two distinct subsets (natural and intrusive) from the totality of sound levels. It is much less labor-intensive (and more cost effective) to use automatic data recording instruments site. In order to determine how accurately various exceedance levels for the total set of sounds approximate the corresponding exceedance levels for the subset of natural sounds, the average differences between L_x of the total data set and L_x of the natural sounds were computed for both the SID 1997 and the Volpe 1998 data.

Figures 3.4 and 3.5 show the average differences as a function of exceedance percentile for the SID data and the Volpe data, respectively. At each exceedance percentile in these figures, a solid circle indicates the average value of the difference: $(L_x)_{total} - (L_x)_{natural}$. The vertical bars represent ± one standard error of the mean about the average value.

From these figures, it can be seen that the value of L_{90} for the natural sounds differs from that of the totality of sounds by less than one-half dBA. The value of L_{50} for the natural sounds differs from that of the totality of sounds less than 2 dBA.

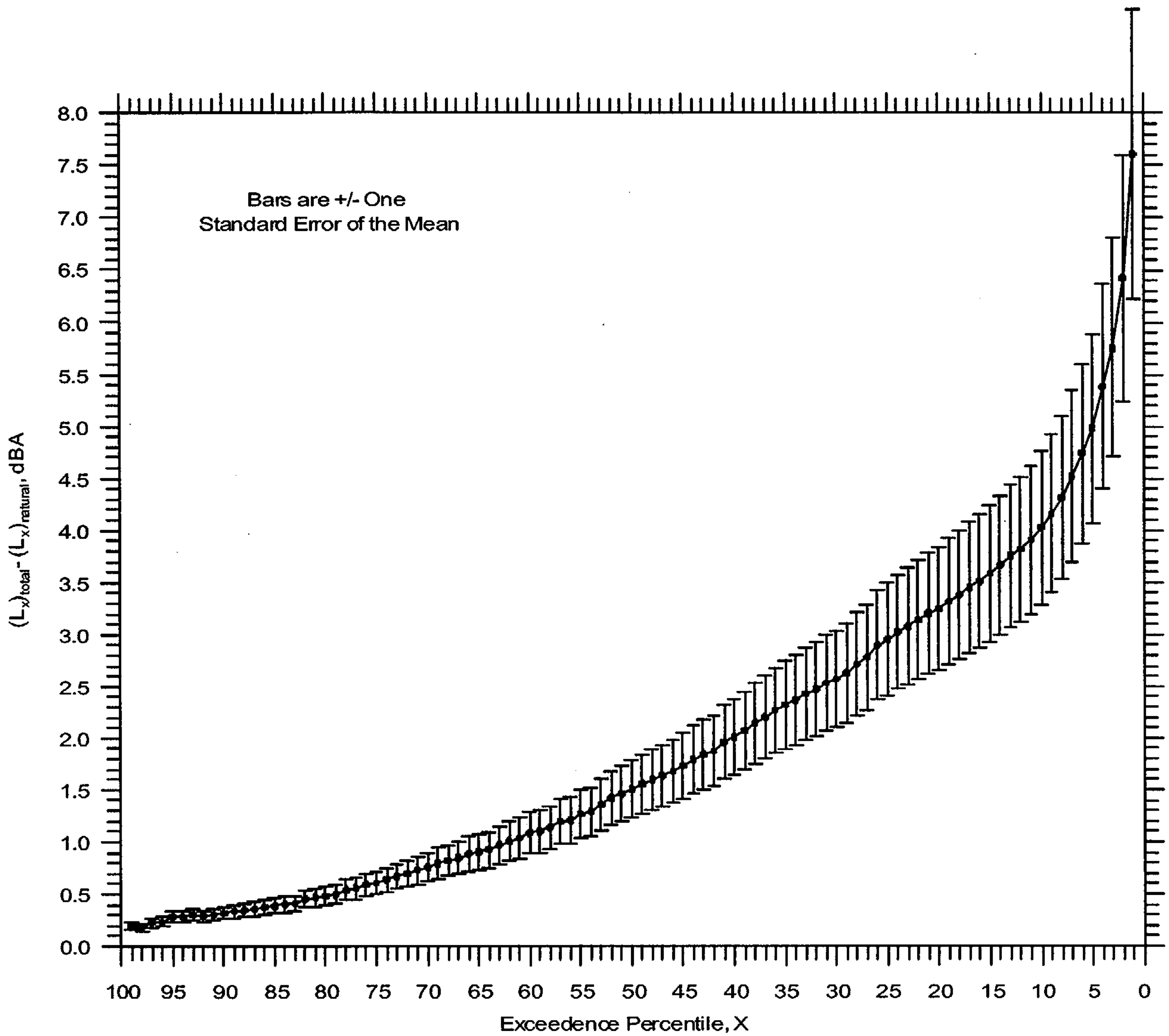


Figure 3.4. Average Differences Between Total and Natural Exceedance Levels for SID Data

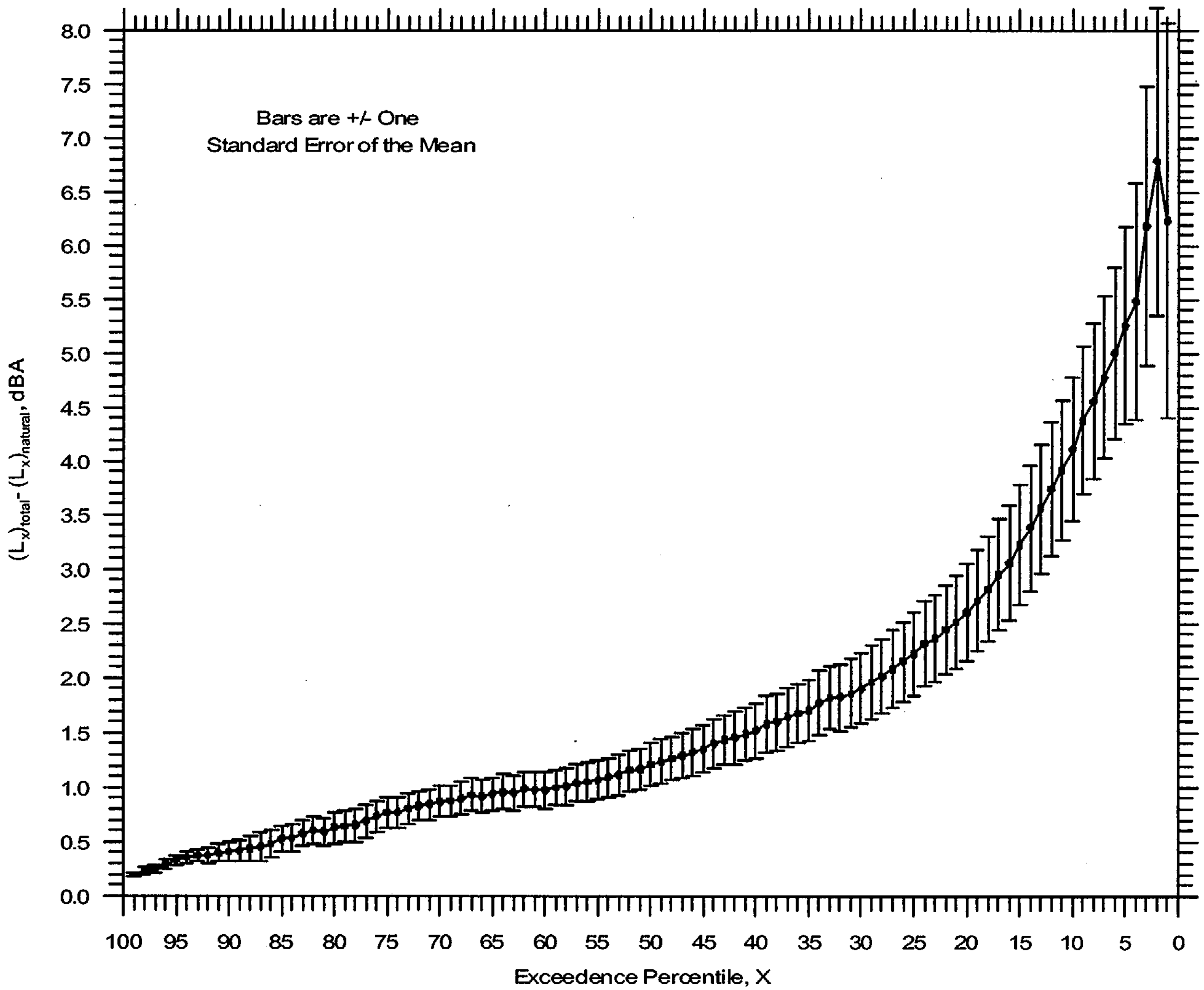


Figure 3.5. Average Differences Between Total and Natural Exceedance Levels for Volpe Data

These accuracy estimates can probably be considered upper bounds, since the data were taken during daylight hours during which intruding, non-natural sounds were relatively common. Figure 3.6 show the hourly L_{50}, L_{90} and Leq values made at the Anhinga Trail by SID in November 1998. Note that, during nighttime hours when there were relatively few intruding noise sources, the hourly L_{50} and L_{90} values are nearly identical. This fact indicates a near constancy of sound level which, absent nearby constant non-natural noise sources (such as HVAC equipment), implies that L_{50} and L_{90} of the total data set are equal to the L_{50} and L_{90} of the subset of natural sounds.

Appendix C contains plots of hourly L_{50}, L_{90}, and L_{eq} values for each of the seven measurement sites in the SID 1998 study.

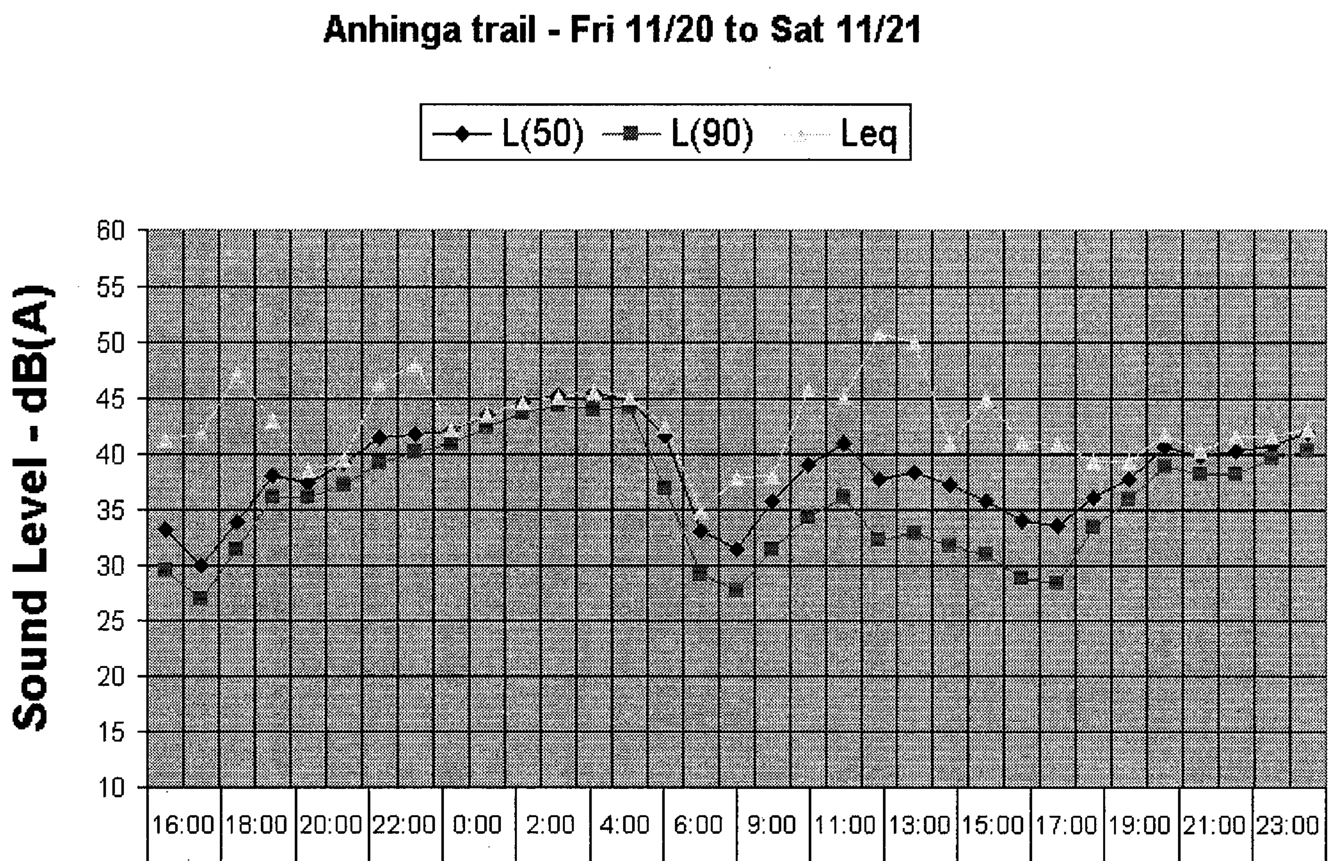
3.3.3 Exceedance Plots for 24-Hour Measurements

The SID 1998 study measured 1-second Leq values at seven sites for periods in excess of 24 hours. From these data, 24-hour exceedance plots have been developed. Figure 3.7 shows an example of such a plot from the data taken at the Anhinga trial on 16-17 Nov 1998. The solid curve shows the exceedance plot for the entire 24-hour period, with levels ranging from 27 dBA to 54 dBA. Exceedance plots for two subsets of the data are also shown in this figure - hours corresponding to darkness (dashed line) and hours corresponding to day light (dot-dashed line). Note that, except for levels above L_{10}, the darkness hours are louder than the daylight hours. Thus , the natural soundscape is louder at night at this location than in the daytime, and the total sound levels, as defined by the L_{10} are louder during daylight hours. This difference probably results form insects being more active at night and human caused intrusions occurring during the daytime.

Appendix D contains exceedance plots for each of the sites in the SID 1998 study.

3.3.4 Dependence of Acoustic Metrics on Acoustical Zone

Since natural sounds are related to the type of nearby vegetation (Flemming et al, 1998, Sneddon et al, 1994 and Reddingius, 1994), the population of animals that are drawn to the vegetation, and the interaction of the wind with vegetation, the reanalyzed data from Volpe 1998 and SID 1997 were classified into acoustical zones similar to the grouping used by Volpe in its analysis as shown in their Table 10 (Flemming et al, 1999). These classifications allow the data to be tested for any dependence of the overall natural sound levels on the local area conditions.



	16:00	18:00	20:00	22:00	0:00	2:00	4:00	6:00	9:00	11:00	13:00	15:00	17:00	19:00	21:00	23:00
L(50)	33.3	33.9	37.4	41.4	42.1	44.6	45.5	41.6	35.8	40.9	38.4	35.8	33.6	37.8	39.9	40.8
L(90)	29.5	31.5	36.1	39.2	41	43.7	44.1	36.9	31.4	36.2	32.9	31	28.4	35.9	38.2	39.7
Leq	41.3	47.1	38.6	46.3	42.2	44.7	45.6	42.6	38.1	45.1	50	45	40.9	39.4	40.3	41.6

Hour

Figure 3.6. SID 1997 Anhinga Trail 24-hour Measurements

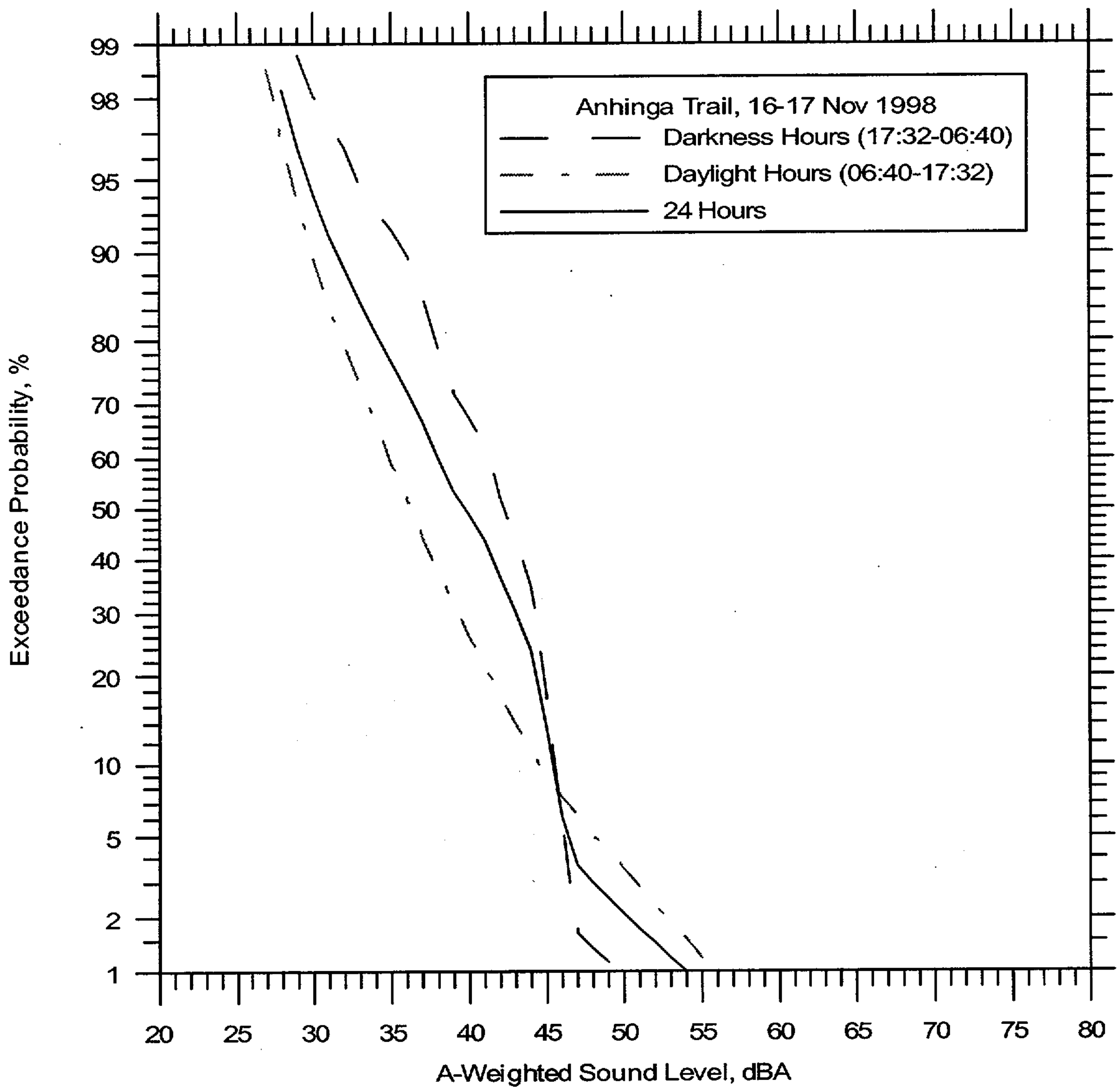


Figure 3.7. 24-Hour Exceedance Plot at the Anhinga Trail

These acoustical zone classifications are a relatively simple set that represents the types of vegetation occurring in the south Florida National Parks. This grouping looks at potential differences between natural sound sources might include leaves fluttering in the wind, insects, frogs, rainfall on the leaves, and birds.

For the reanalysis, the following acoustical zones descriptions were used to group the data: intruded , open and dense forests, prairie, open water, and open and protected shoreline. Simple statistical analyses of variances (ANOVA) were carried out to investigate whether or not the values of these metrics differ between acoustical zones. Table 3.3 shows the L_{eq}, L_{90}, and L_{50} that resulted form the reanalysis of the SID 1997 and Volpe 1998 data as a function acoustical zone.

Table 3.4 shows the results of a single-factor analyses of variance of L_{eq} as a function of acoustical zone classification at the 95 percent level of confidence, no dependence of the L_{eq} on acoustical zones is demonstrated. Tables 3.5 and 3.6 show similar results for L_{90} and L_{50}.

Although on-site experience has shown that the timbre of the natural sounds in many of these acoustical zones are different, the A-weighted sound level is apparently not a sufficiently precise measure to reflect those differences. This is not surprising, given that all spectral information, which defines the quality of the sound, is removed once the A-weighting filter has been applied to the sounds.

On the other hand, this lack of dependence of acoustic metric on acoustical zone may simply result from seasonal variations in the vocalizations of the animal populations. It must be recalled that the SID 1997 and Volpe 1998 data were gathered over short periods - usually from one to three hours during daylight hours when natural sounds were lower and more intrusions occurred. Differences between acoustical zones that might be evident for longer times, such as 24 hours, might be obscured by the short samples collected in these studies. In addition, the data may not be statistically robust enough to demonstrate a dependence. This point is examined in more detail in Section 4.0 which describes the unmanned 24-hour measurements that were carried out by Wyle Laboratories in 1999.

Table 3.3. Reanalyzed SID/Volpe Metrics as a Function of Acoustical Zone

Site Name	Acoustical Zone	Date	Leq (dBA)	L90 (dBA)	L50 (dBA)
Boca Chita	6	08/10/1998	42.6	30.7	36.3
Elliot Key	7	08/12/1998	42.2	28.3	31.9
		08/15/1998	47.3	33.8	37.3
		08/17/1998	44.9	29.8	32.5
Fender Point	7	08/11/1998	40.9	28.6	34.3
		08/14/1998	34.1	28.0	32.2
Soldier Key	6	08/13/1998	57.4	38.2	52.5
		08/16/1998	59.8	53.5	57.3
Anhinga Trail	1	08/10/1998	39.3	26.9	30.2
		08/12/1998	58.6	28.3	31.3
		08/15/1998	51.3	35.9	38.2
Chekika	4	08/10/1998	39.9	32.1	35.3
Eastern Sparrow	4	08/18/1998	31.6	22.9	28.2
Eco Pond	3	08/14/1998	48.6	41.2	47.3
Hidden Lake	2	08/15/1998	35.6	29.3	32.0
North Nest Key	6	08/18/1998	40.3	24.1	30.7
Pavilion Key	3	08/20/1998	45.5	34.0	43.0
Shark Valley	4	08/13/1998	41.4	36.1	38.5
		08/16/1998	47.3	43.1	45.3
Mangrove Inlet	3	08/18/1998	36.6	29.2	34.6
Golightly Campground	1	08/16/1998	38.4	29.2	32.9
		08/17/1998	42.9	33.0	37.2
National Scenic Trail	1	08/20/1998	42.9	35.2	40.1

Site Name	Acoustical Zone	Date	Leq (dBA)	L90 (dBA)	L50 (dBA)
Visitor Center BISC	1	09/18/1997	47.8	44.8	46.9
Elliott Key	7	09/20/1997	44.7	38.9	41.7
		09/22/1997	35.6	27.2	30.6
Anhinga Trail	1	10/05/1997	40.2	32.7	37.9
Long Pine Key	2	10/01/1997	34.5	22.9	31.7
Pa-hay-okee O'look	2	10/01/1997	38.3	31.0	35.8
		10/04/1997	41.0	34.9	38.6
Nine Mile Pond	2	10/01/1997	33.9	23.0	27.3
Eco Pond	3	10/01/1997	35.3	31.5	33.7
		10/03/1997	41.7	38.3	39.9
North Nest Key	6	10/05/1997	38.2	36.1	37.3

Acoustical Zone Key
1 = Intruded
2 = Open Forest
3 = Dense Forest
4 = Prairie, Slough
5 = Open Water
6 = Open Shoreline
7 = Protected Shoreline

Table 3.4. ANOVA of L_{eq} vs. Acoustical Zone

SUMMARY				
Acoustical Zone	Count	Sum	Average	Variance
1	8	361.4	45.2	48.6
2	5	183.3	36.7	8.7
3	5	207.7	41.5	32.2
4	4	160.2	40.1	41.9
6	5	238.3	47.7	102.9
7	7	289.7	41.4	24.3

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	397.6	5	79.5	1.9	0.1	2.6
Within Groups	1187.1	28	42.4			
Total	1584.7	33				

$F < F_{crit}$ means that we must acept the hypothesis that the means of each population are equal at the 95 percen level of confidence.

Table 3.5. ANOVA of L_{90} vs. Acoustical Zone

SUMMARY				
Acoustical Zone	Count	Sum	Average	Variance
1	8	266.0	33.3	32.3
2	5	141.1	28.2	27.3
3	5	174.2	34.8	24.0
4	4	134.2	33.6	71.1
6	5	182.6	36.5	119.9
7	7	214.6	30.7	17.9

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	230.7	5	46.1	1.0	0.4	2.6
Within Groups	1231.0	28	44.0			
Total	1461.7	33				

$F < F_{crit}$ means that we must acept the hypothesis that the means of each population are equal at the 95 percen level of confidence.

Table 3.6. ANOVA of L_{50} vs. Acoustical Zone

SUMMARY				
Acoustical Zone	**Count**	**Sum**	**Average**	**Variance**
1	8	294.7	36.8	29.3
2	5	165.4	33.1	18.6
3	5	198.5	39.7	32.7
4	4	147.3	36.8	50.4
6	5	214.1	42.8	130.8
7	7	240.5	34.4	15.1

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	331.7	5	66.3	1.6	0.2	2.6
Within Groups	1175.7	28	42.0			
Total	1507.4	33				

$F < F_{crit}$ means that we must acept the hypothesis that the means of each population are equal at the 95 percen level of confidence.

4 UNMANNED FIELD MEASUREMENTS

4.1 Objectives

In order to describe the energetics of the natural soundscape in the south Florida National Parks, unmanned monitors were employed to collect the sound level data to characterize the natural soundscape. The few 24-hour measurements conducted by SID in 1998 demonstrated that the unmanned measurements provided a clear picture of the variations in the sound levels at a site. Recent studies have demonstrated the robustness of employing unmanned monitoring to describe and define the natural soundscape. (Foch, 1998 sand Gdula Gudorf, 1998). Observer based measurements were not used as the primary data collection method because of their limitations in describing the variation of the natural sounds.

One major limitation of observer based data collection is the short time periods of data collection. From these small data samples, it is difficult to determine the range of the naturally occurring sound levels. In addition, the previous observer-based data were limited to daylight periods that preclude any comprehension of the diurnal variations of the sound levels. Another pitfall of observer-based measurement is confusing audibility based metrics with energy based metrics as demonstrated by results from the reanalysis in Chapter 3.

Acoustical data collected with unmanned monitors deployed over longer periods provide a clear picture of the variations within the natural soundscape. This acoustical data helps to estimate sound levels associated with park maintenance, visitors, and intruding sounds, such as aircraft. Data from these unmanned measurements can demonstrate the diurnal variations in the sound levels, can highlight transient events occurring throughout the day, and can examine the dependence of sound levels on acoustical zones.

Unmanned monitoring of the sound levels can be used to address the following questions about the natural soundscape:

- What is the level of dependence of the natural soundscape acoustical energy levels of on the local ecosystem of acoustical zone (i.e. grassy prairie vs. forest)?
- What is the diurnal dependence of the soundscape?
- How do day-to-day variations in the soundscape compare to diurnal variations?

Since other studies (Fleming, et al, 1998, Sneddon et al, 1994, and Reddingius, 1994) have hypothesized a dependence of sound levels on acoustical zones, the first item addressed with the unmanned measurements was testing the statistical independence of acoustical zones that was not found in the reanalysis. (Strictly speaking, the results derived from this data set are limited to the summer season in south Florida and should not be extrapolated to other seasons at this time until seasonal variations are evaluated. Continued monitoring should be a part of the NPS soundscape management activity that will help to perform this seasonal variation evaluation.)

4.2.1 Measurement Methods and Equipment

Sound levels were measured at selected sites within Biscayne National Park and Everglades National Park, each representing an acoustical zone. In order to address the first question, two spatially independent sites were selected for each acoustical zone. At each site, the microphones were placed above the ground and secured so that no branches or leaves would interfere with the microphone. A four-inch diameter spherical foam windscreen was placed over the microphone to reduce wind noise. This windscreen provided shielding from artificial wind induced noise. This type of windscreen is effective for wind speeds up to 10 knots. For faster wind speeds, artificial wind noise will increase the recorded sound levels.

Two-second L_{eq} time histories were recorded using a Larson-Davis 820 Sound Level Monitor (Larson Davis, 1991). The two-second time interval was selected to increase monitoring periods to four days before the units memory would be filled and would need to be downloaded. The units were time synched to the local time to facilitate comparisons between sites and with supporting data. The sound level data were stored in the monitor and were downloaded to a laptop computer for detailed analysis. The two-second time histories were used to calculate the different acoustic metrics used to assess the natural soundscape.

Supporting weather data was obtained from Homestead Air Force Base, Homestead General Airport, several weather reporting station in the Everglades National Park, and a USGS monitoring site in Taylor Slough near the Ernst Coe Campsite. These supporting weather data ranged in detail from daily values to 15 minute averaged values for temperature, wind speed, relative humidity, and precipitation.

At some of the sites, manned observations were made for short periods to identify the local sounds sources. During some of these observations, a DAT recorded was used to document the sounds heard at the site and to verify the recorded levels of the sound level meters.

4.3 Selected Sites

Sites were selected based on representative acoustical zones, access to site, and park limitations on human intrusions. The areas covered did not include all areas of the park but did include all of the major acoustical zones environments found at the parks. Table 4.1 provides a listing of the sites with the site identification, location, acoustical zone, and dates of monitoring. The locations are highlighted in Figure 4.1 along with the sites from the previous studies.

4.3.1 Biscayne NP

At Biscayne National Park, the following acoustical zones were monitored: open water, forest on key, key shoreline, and shoreline of mangrove key. Appendix E contains pictures of the sites, which shows the placement of the sound level monitor within each acoustical zone.

The site at Convoy Visitor Center, B1, represents an intruded acoustical zone since humans, office buildings, cars, and boats are present. Three sites were located on Elliot Key. One site, B2, was in the picnic area away from the docs and close to the hiking trails.

This site was in an open forest acoustical zone, an area with an open canopy and ample light. Air conditioners and generators were audible in this area and the exact monitor location was chosen to minimize acoustic energy received from the units. The other two sites, B3 and B4, were placed along the hiking trail approximately ½ mile from the Elliot Key Visitor Center. Both sites were in dense forest acoustical zones since the tree canopy shielded most of the sunlight.

The next sites were located along the shoreline of mangrove keys. One monitor, B5, was on Long Arsenicker Key. The microphone was placed on the top of a mangrove and was approximately ten feet from the edge of the key. The key is near open water. However, the shoreline was considered protected since shallow water surrounded the key for most of the time. The other site, B6, was located on Old Rhodes Key along a narrow channel. The microphone was place atop an old mangrove branch at the edge of the key. This site was also considered protected since it was only accessible during high tide.

Table 4.1 Site Identification and Measurement Dates

Sites		Acoustical Zone	Jun 7	8 T	9 W	10 T	11 F	12 S	13 S	14 M	15 T	16 W	17 T	18 F	19 S
B1	Visitor Center	1	SU	Bad	Bad/SU	Bad/TD				SU	+	TD			
B2	Elliot Key	2	SU	+	V	V	V	+	+	TD					
B3	Hiking Trail North of B2	3	SU	V	V	+	TD								
B4	Hiking Trail South of B2	3	SU	V	TD										
B5	Long Arsenicker Key	7	SU	V	+	TD									
B6	Rhodes Keys	7	SU	V	+	V	V	+	+	TD					
B7	Adam's Key	6	SU	V	+	V	V	+	+	TD					
B8	Shoal Marker Open water	5	SU	V	V	V	V	+	+	TD					
B9	Shoal Marker Pelican Bank	5			SU	+	TD								
E1	Open water key	6											SU	TD	
E2	Coastal Prairie	4									SU	+	+	TD	
E3	South Joe River Chickee	7								SU	+	+	TD		
E4	N. Harney River/ mangrove	7								SU	+	+	TD		
E5	In mangrove	3								SU	+	+	TD		
E6	Mahogany Hammock (outside)	2			SU	+	TD								
E7	Mahogany Hammock (inside)	3			SU	+	TD								
E8	Prairie near Ernest Coe	4					SU	+	+	TD					
E9	Hidden Lake Education center	2					SU	+	TD						
E10 A&B	Pineland fire road	4 & 2									SU*	+*	+*	+*	TD
E11	Long Pine Key campground	2									SU	+	V	TD	
E12	Anhinga Trail	1					SU	+	TD						
E14	L67 canal in Shark Valley	4										SU	+	+	TD
E15	Chekika	1										SU	+	+	TD

(SU = setup site, V = visit, + = continue measurement, TD = tear down site.)

Acoustical Zones

1 = intruded

2 = open forest

3 = dense forest

4 = prairie

5 = open water

6 = open shoreline

7 = protected shoreline

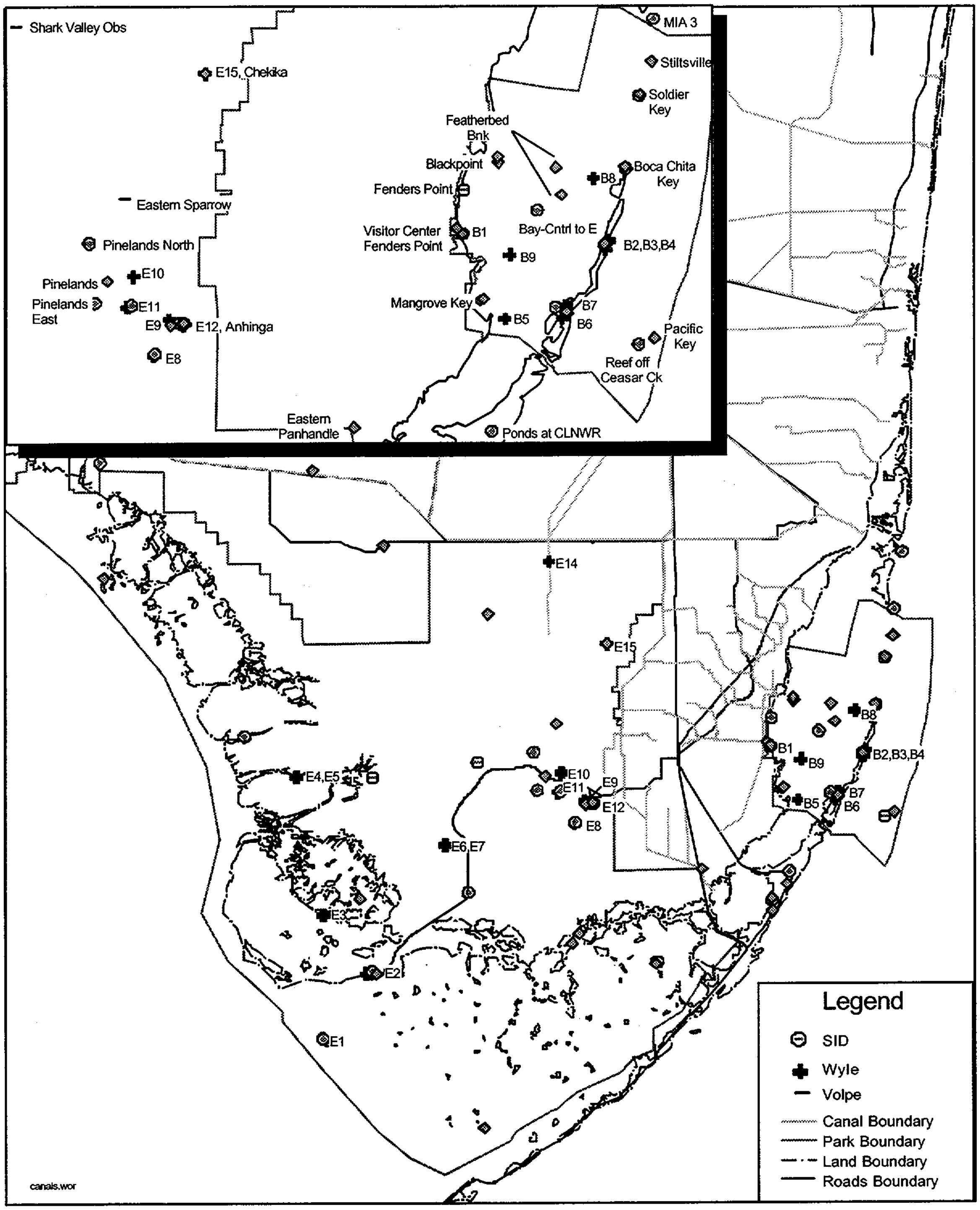


Figure 4.1 Location of Monitored Sites in South Florida Parks

The site at Adam's Key, B7, was considered open shoreline since it was close to a major channel for boat traffic to and from the open ocean waters. The microphone was placed approximately 20 feed from the shoreline and sway from the docks. The soundscape was influenced by an operating generator that provides power for the residences on the key and for a picnic area.

Two sites, B8 and B9 were located in the open water. Monitors were placed on shoal warning markers near the Feather Bank shoal. And the Pelican Bank shoal. The microphones were secured to each post about eight feet above the water and about ten inches from the post.

4.3.2 Everglades NP

At Everglades National Park, the following acoustical zones were monitored: pineland forest, mangrove forest, prairies, slough, hardwood hammock, and protected and open shoreline. Appendix E contains pictures of the sites which shows the placement of the sound level monitors within each acoustical zone.

The first group of sites was located in the southwestern portion of the park near Flamingo. Site E1 was located on Carl Ross Key, which is a key in the open waters of the Florida Bay. The microphone was placed five feet above the ground and was 20 feet away from the open shoreline on two sides. Site E2 was located near the Coastal Prairie Trail in the open prairie. The microphone was placed five feet above the ground and away from small groups of brushes. Site E3 was placed on the South Joe River Chickee, which is a campsite (an elevated wooden platform with a roof constructed over open water) located about 30 feet from the shoreline. This site is considered a protected shoreline since it is in a cove well away from any major boat traffic channel. Sites E4 and E5 were placed close to an environmental monitoring station on the North Harney River. Site E4 was placed at the shoreline about six feet above the water surface. Site E5 was placed about 300 feet into the dense mangrove forest.

Two monitors were located at the Mahogany Hammock. Site E6 was placed at the border of the forest and the slough. Site E7 was placed inside the dense hammock along the boardwalk trail.

The next group of sites was located in the eastern section of the park. Site E8 was sited in the open prairie near Taylor Slough and about two miles northeast of Ernest Coe campsite. Site E9 was in the Hidden Lake Education Center. This site can be characterized as either open forest or intruded acoustical zone depending on the use of facilities at the time. During the monitoring period, there were no environmental education activities, and therefore the site is categorized as open forest. The site is surrounded by trees and has open stage areas for the educational activities. Two sites, E10 A&B, were placed at the transition zone between the Long Pine Key and the open marl prairie. The two monitors were separated by approximately 1000 feet. Site E10A was placed in the open prairie whereas site E10B was placed within a dense stand of trees. These two monitor sites were selected to help assess any spatial variation in the soundscape. Site E11 was in the open forest areas of the campgrounds in Long Pine Key. This site was not influenced by visitor intrusions during the monitor period since the campground was closed.

Two intruded sites were monitored in the Everglades. One, E12, was along Anhinga Trail and the other, E15, was near the Chekika parking lot. Anhinga Trail is a boardwalk that allows visitors to observe some of the wildlife and plants found in the Everglades. For the most part visitors tend to be quiet as they walk along the boardwalk. At Chekika, the site was placed at the edge of the parking lot and about 5 feet into the sawgrass. The sound levels at this site could be affected by cars as visitors entered and left the recreational area.

The last site at Everglades was in the Shark River Slough, E14. The actual location was 2 miles south of Highway 41 along the L-67 extension canal, which cuts through the center of Shark River Slough. This site is characterized as open prairie.

4.4 Acoustic Data

The acoustic data were analyzed and hourly, daily, and total L_{90}, L_{50}, L_{10} and L_{eq} metrics were calculated and transient sound events above a threshold were determined. The hourly metric analysis provides a good way to observe the diurnal variations occurring in the soundscape. Appendix F contains all of the monitored time histories.

Figure 4.2 shows a representative plot of these temporal variations. These data are from site B5 on Long Arsenicker Key. In this plot it can be seen that all of the metrics are within 5 dBA of each other during the evening hours and diverge during the daylight hours.

To assess diurnal variations the 24-hour day was separated into four periods:

- nighttime (2200 to 0459)
- sunrise (0500 to 0759)

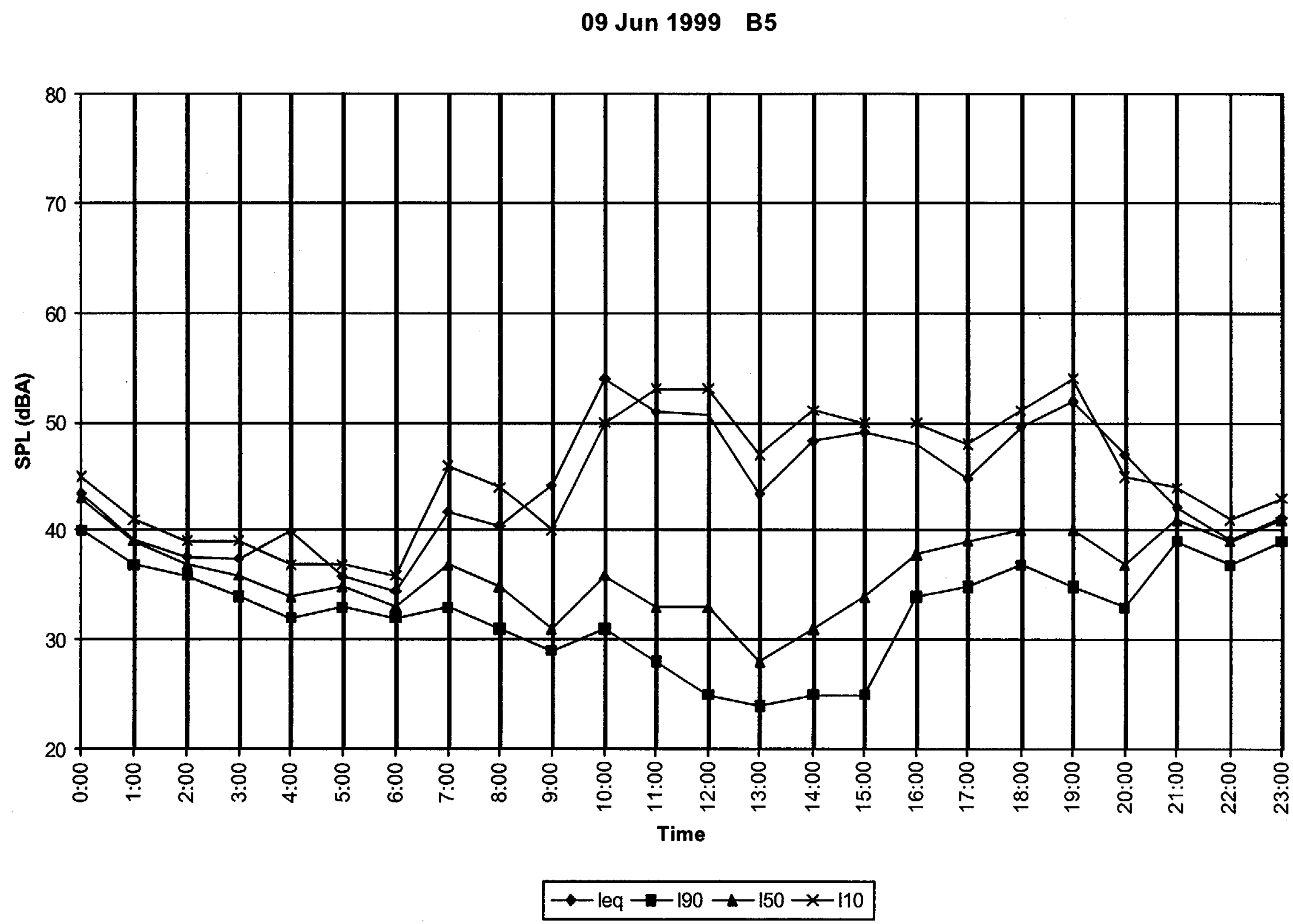


Figure 4.2. Example of Hourly Variation in Acoustic Metrics – Long Arsenicker Key

- daytime (0800 to 1859)
- sunset (1900 to 2159).

Table 4.2 provides the period breakdown along with the total values for all of the sites.

The total L_{90}, L_{50} and L_{10} metrics were determined from the entirety of the measured data at that site. These metrics are used to assess variations occurring among sites. L_{90} shows the variations occurring in the background sound levels, or the levels, occurring at a site. L_{50} demonstrates how the median sound levels vary. And, L_{10} and L_{eq} illustrate the variations occurring in the higher levels. When these three metrics are within 5 dBA, the total soundscape is fairly consistent over the recorded period. When they diverge, transient events are occurring that rise well above the background sound levels.

In the final data analysis, individual sound events that exceeded thresholds above the hourly, L_{90} at a site were identified. The hourly L_{90} was selected as the threshold basis since the reanalysis in Chapter 3 showed the L_{90} form the total populations of sound levels was essentially equal to the L_{90} of the subset of natural sound levels. Thus, the L_{90} determined from the unmanned data is a very good measure of the L_{90} of the natural soundscape.

This individual exceedance analysis shows when the natural background sound levels are concealed by louder transient sound events. Transient events are those events whose sound energy rises out of the background towards a maximum then diminish into the background over some short period. Examples of transient events are aircraft overflights, car drive bys, and thunder. This process does not judge the source of the transient event, but it does provide an assessment of the number and nature of transient occurring at a site.

Exceedance thresholds for transient identification were set at 10 dBA, 20 dBA, 30 dBA, and 40 dBA above the hourly L_{90}. These thresholds present exclusive groupings so that the first group would be for transient events that had an L_{Amax} between 10 and 20 dBA above the hourly L_{90}. The first 10 dBA step was chosen to identify transient events that would be perceived as twice as loud as the natural ambient background. The increasing thresholds represent events that are perceived to be approximately twice as loud as the preceding threshold.

To be identified as an intrusion, an event had to have a duration between 10 seconds to 15 minutes. For each such transient event, the actual duration was determined along

Table 4.2 Total and Period L_{90}, L_{50}, and L10 for Unmanned Measurements

Site	Acoustical Zone	L_{90}					L_{50}					L_{10}				
		Total	Night	Sunrise	Day	Sunset	Total	Night	Sunrise	Day	Sunset	Total	Night	Sunrsie	Day	Sunset
B 1	1	36	36	35	38	36	39	38	38	43	38	51	44	52	55	44
B 2	2	39	44	39	38	39	44	47	42	43	44	51	52	48	51	49
B 3	3	30	42	29	29	33	40	46	37	35	41	47	48	47	46	45
B 4	3	34	40	34	32	34	41	43	40	39	40	46	46	50	46	44
B 5	7	32	34	32	30	37	40	39	34	41	43	49	44	40	52	49
B 6	7	29	32	32	28	28	38	40	40	35	37	45	44	45	46	46
B 7	6	33	33	32	34	33	36	34	35	39	36	49	41	51	52	48
B 8	5	34	31	29	35	41	48	46	46	49	49	55	54	56	56	56
B 9	5	33	34	28	34	41	44	47	36	44	47	54	54	41	55	53
E 1	6	34	36	41	31	32	41	38	44	46	36	52	43	47	53	45
E 2	4	30	39	42	28	31	41	45	46	35	40	47	48	49	44	46
E 3	7	25	28	26	24	24	32	32	29	35	30	46	40	34	49	48
E 4	7	33	44	37	31	37	43	49	43	38	45	51	51	45	45	49
E 5	3	39	55	48	36	44	51	63	51	46	58	69	76	62	52	64
E 6	2	28	42	29	26	32	40	46	36	32	47	54	61	41	44	69
E 7	3	28	53	35	26	33	44	55	42	32	54	60	61	58	45	65
E 8	4	28	38	31	26	30	38	41	38	34	39	47	48	44	44	47
E 9	2	33	50	39	31	33	45	51	42	38	49	52	52	49	46	54
E 10A	4	39	44	45	37	40	46	48	48	44	46	56	55	52	58	64
E 10B	2	36	47	40	34	40	47	53	42	41	53	61	69	49	56	63
E 11	2	35	42	43	32	36	43	45	45	39	45	47	47	48	46	48
E 12	1	35	38	39	34	33	41	41	41	40	42	48	43	45	53	48
E 14	4	35	38	38	33	39	42	43	41	39	56	57	56	45	50	63
E 15	1	39	45	43	37	37	47	49	48	44	44	54	54	53	52	59
average		33.2	40.2	36.1	31.8	35.1	42.1	45.0	41.0	39.6	44.1	52.0	51.3	48.0	49.8	52.8
st dev		3.9	6.9	6.0	4.1	4.7	4.2	6.8	5.1	4.6	6.8	5.7	8.8	6.1	4.5	8.0

with the maximum A-weighted level and the L_{eq} for the event. Figure 4.3 provides an example of the transient event identification. This example shows 20 minutes of the sound level time history obtained at Anghinga Trail on 12 June 1999. During this hour the L_{90} was 41 dBA: thus the threshold levels are set at 51 (L_{90} + 10 dBA), 61 (L_{90} + 20 dBA), 71 (L_{90} + 30 dBA), and 81 (L_{90} + 40 dBA). One transient event which starts at 8:10:00 is identified in Figure 4.3. This event rises above the first threshold level for 46 seconds (8:10:12 to 8:10:58) which is greater than the 10 second duration threshold. For this transient event, the maximum level was 56 dBA, and its sound exposure level was 71 dBA. It is also important to note the very short event that occurs at 8:09:26. Even though the maximum level of this event is 52 dBA, it is not classified as a transient event because its duration is less than one second.

The one-hour averaged values of the transient events are provided in Section 4.5.2. The number of individual exceedances occurring are grouped by hour to show temporal variation of these transient sound events. the number of events was averaged for each hour based on the number of times that hour was monitored. Appendix H contains the plots of number of occurrences for each hour for each site.

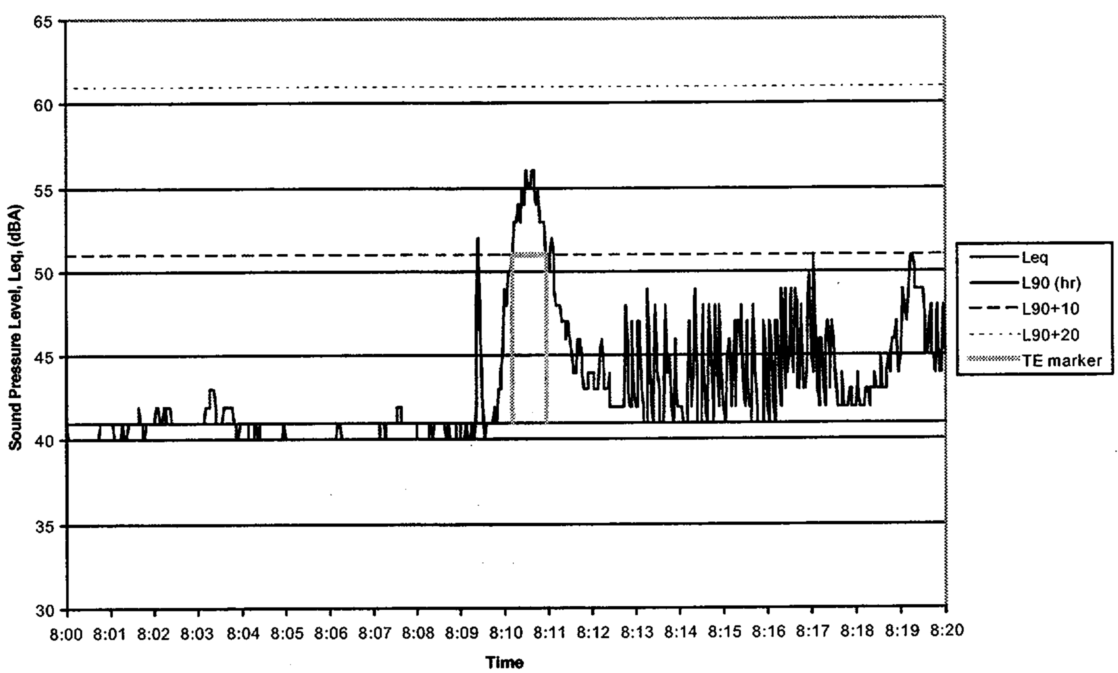


Figure 4.3. Transient event identification example: Anhinga trail on 12 June 1999

4.4.1 Biscayne NP

<u>B1 Convoy Point:</u> This site was monitored for 49 hours between 14 and 16 June 1999. During this period, the L_{90} of 38 dBA with a daytime L_{90} of 38 dBA being the loudest and with a nighttime, sunrise and sunset L_{90} of 36 dBA, 35 dBA, and 36 dBA, respectively. The L_{50} was 39 dBA with the high of 43 dBA also occurring during the daytime. The L_{10} was 51 dBA with a maximum of 55 dBA occurring during the daytime period. For a threshold of 10 dBA above the L_{90} the average hourly number of transient events was 3.9 with an average duration of 49 seconds. Transient events were greatest during the daytime with an average of 8 events per hour. For this exceedance threshold, the maximum number of occurrences per hour was 10. For the hourly variation, L_{90}, L_{50}, L_{10}, and Leq were within 5 dBA during the night and separated during the daytime. The separation started around 0600 and ended around 1900, which agree with the variation in the number of exceedances. These findings agree with expectations that visitors impact the natural soundscape during the daytime at this site.

<u>B2 Elliot Key:</u> This site monitored for 162 hours between 7 and 14 June 1999. During this period the L_{90} was 39 dBA with a nighttime L_{90} of 44 dBA being the loudest and with a sunrise, daytime, and sunset L_{90} of 39 dBA, 38 dBA, and 39 dBA, respectively. The L_{50} was 44 dBA with the high of 47 dBA also occurring during the nighttime. The L_{10} was 51 dBA with a maximum of 52 dBA occurring during the nighttime period. for a threshold of 10 dBA above the L_{90} , the average hourly number of transient events was 5.3 with a duration 32 seconds. These low threshold events occurred throughout the day; the events with a threshold of 20 dBA above the L_{90} were also greatest during the daytime. The greatest number of events was 13 per hour for the exceedance threshold of 10 dBA above the L_{90} and 5 per hour for a threshold of 20 dBA above L_{90}. for the hourly variation, L_{90}, L_{50}, L_{10}, and L_{eq} were within 5 dBA during most of the monitoring period except for a few times during the daytime. These finds demonstrate that the sound levels are fairly constant over the day with most intrusion occurring during the daylight hours. Also, it is important to note that the air conditioners and generators at the nearby building probably increased the sound levels at this site. This increase can be seen by comparing the L_{90} measured at this site to the L_{90} measured at sites B3 and B4 described later.

<u>B3 Hiking Trail North of Elliot Key:</u> This site was monitored for 94 hours between 7 and 11 June 1999. During this period the L_{90} was 30 dBA with a nighttime L_{90} of 42 dBA being the loudest and with a sunrise, daytime, and sunset L_{90} of 29 dBA, 29 dBA, and 33 dBA, respectively. The L_{60} was 40 dBA with the high of 46 dBA occurring during the nighttime. The L_{10} was 47 dBA with a maximum 48 dBA occurring during the nighttime

period. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 4.9 with a duration of 22 seconds. The number of events was greatest during the daytime with a peak occurring around noon. For this threshold, the maximum number of occurrences was 37 during 1200 to 1300. For the hourly variation, L_{90}, L_{50}, L_{10} and L_{eq} were within 3 dBA during the nighttime hours with the L_{90}, and L_{50} decreasing during the daylight hours. The sound levels at this site showed a definite diurnal pattern with the quietest background noise occurring during the daytime.

<u>B4 Hiking Trail South of Elliot Key:</u> This site was monitored for 45 hours between 7 and 9 June 1999. During this period the L_{90} was 34 dBA with a nighttime L_{90} of 40 dBA being loudest and with a sunrise, daytime, and sunset L_{90} of 34 dBA, 32 dBA, and 34 dBA, respectively. The L_{50} was 41 dBA with the high of 43 dBA occurring during the nighttime. The L_{10} was 46 dBA with a maximum of 50 dBA occurring during the sunrise period. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 4.6 with a duration of 33 seconds. The events were greatest during the daytime with peaks occurring around sunrise, and from 1300 to 1400. For the hourly variation , L_{90}, L_{50}, L_{10}, and L_{eq} were within 3 dBA during the nighttime hours with the L_{90} and L_{50} decreasing during the daylight hours. The sound levels monitored at site B4 are greater than the corresponding levels at site B3. These increased levels may have resulted from a generator that was just audible at the site during set up and tear down. The sound levels at this site showed a diurnal pattern with the quietest background noise occurring during the daytime.

<u>B5 Long Arsenicker Key:</u> This site was monitored for 69 hours between 7 and 10 June 1999. During this period, the L_{90} was 32 dBA with the highest L_{90} of 37 dBA occurring at sunset and with a nighttime, sunrise, and daytime L_{90} of 34 dBA, 32 dBA, and 30 dBA, respectively. The L_{50} was 40 dBA with the high of 43 dBA occurring during sunset. The L_{10} was 49 dBA with a maximum of 52 dBA occurring during the daytime. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 5.0 with a duration of 52 seconds. The events were greatest during midday. For this threshold, the maximum number of occurrences was 22 during 1500. For the hourly values, L_{90}, L_{50}, L_{10}, and L_{eq} were within 5 dBA during the nighttime hours with the L_{90} and L_{50} decreasing and the L_{10} and L_{eq} increasing during the daylight hours. The sound levels at this site showed a diurnal pattern with the quietest background noise occurring during the day time. Also, this site had significant increase of transient events during the daytime as can be seen in the 20 dBA separation between the L_{90} and L_{10} values.

<u>B6 Old Rhodes Key:</u> This site was monitored for 163 hours between 7 and 14 June 1999. During this period the L_{90} was 29 dBA with the highest L_{90} of 32 dBA occurring at

nighttime and sunrise and with a daytime and sunrise L_{90} of 28 dBA. The L_{50} was 38 dBA with the high of 40 dBA occurring during nighttime and sunrise. The L_{10} was fairly constant at 45 dBA throughout the day. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 8.1 with a duration of 60 seconds. The number of events was greatest during the daylight hours and was fairly constant during these hours with some events occurring during nighttime. For the hourly variation, L_{90}, L_{50}, L_{10}, and L_{eq} did not show a strong diurnal pattern. The levels were close for some nights although this did not occur all of the time. There appears to be a general increase in the sound levels form 0300 to 0600.

B7 Adam's Key: This site was monitored for 166 hours between 7 and 14 June 1999. During this period the L_{90} was 33 dBA with the highest L_{90} of 34 dBA occurring at daytime and with a nighttime, sunrise, and sunset L_{90} of 33 dBA, 32 dBA, 33 dBA, respectively. The L_{50} was 36 dBA with the high of 39 dBA occurring during daytime. The L_{10} was 49 dBA with a maximum of 52 dBA occurring during the daytime. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient event was 5.0 with a duration of 47 seconds. The events were level during the daylight hours with some minor peaks at 1100 and 1400 hours. For this threshold, the maximum number of occurrences was 20 during 1100. for the hourly variation, L_{90}, L_{50}, L_{10}, and L_{eq} were within 5 dBA during the nighttime hours with the L_{10} and Leq increasing during the daylight hours. For most of the monitoring period the L_{90} and L_{50} were within 3 dBA of each other except during the weekend daylight hours when they were separated by 5 to 10 dBA. The sound levels at this site showed a diurnal pattern in L_{10} and Leq with the quietest background noise defined by L_{90} remaining constant over the entire monitoring period. It should be noted that this site was influenced by the power generator utilized on the key. In addition, this site had significant increase of transient events during the daytime as can be seen in the 15 dBA separation between the L_{90} and L_{10} values.

B8 Shoal Warning Post at Feathered Bank: This site was monitored for 166 hours between 7 and 14 June 1999. During this period, The L_{90} was 34 dBA with the highest L_{90} of 41 dBA occurring at sunset and with a nighttime, sunrise, and daytime L_{90} of 31 dBA, 29 dBA, and 35 dBA, respectively. The L_{50} was 48 dBA with the high of 49 dBA occurring during daytime and at sunset. The L_{10} was 55 dBA with a maximum of 56 dBA occurring during the daylight hours. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 5.3 with a duration of 38 seconds. For this threshold, the events were common throughout the day with an increase in the early daylight hours. for the higher thresholds, the events were prevalent during the daylight hours and were minimal at night. For the exceedance threshold of 10 dBA above the L_{90}, the maximum number of occurrences was 14 during 0700. There was a large day to day variation observed in the hourly L_{90}, L_{50}, L_{10}, and L_{eq} values. Most of the time they were within 10 dBA of each other but with no real dependence found with time of day. The wide variations observed suggest that the monitored levels were possibly controlled by the wind. The type of windscreen utilized would lose it effectiveness for wind speed above 10 mph.

B9 Shoal Warning Post at Pelican Bank: This site was monitored for 166 hours between 7 and 14 June 1999. During this period, the L_{90} was 33 dBA with the highest L_{90} of 44 occurring at sunset and with a nighttime, sunrise and daytime L_{90} of 34 dBA, 28 dBA, and 34 dBA, respectively. The L_{50} was 44 dBA with the high of 47 dBA occurring at sunset and during nighttime. The L_{10} was 54 dBA with a maximum of 56 occurring during the daylight hours. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 7.7 with a duration of 51 seconds. Events occurred throughout the day for the low threshold and during the daylight hours for the higher thresholds similar to the observations at site B8. For the exceedance threshold of 10 dBA above the L_{90}, the maximum number of occurrences was 31 during 1400 to 1500. There was a large day to day variation observed in the hourly L_{90}, L_{50}, L_{10}, and L_{eq} similar to that seen at site B8. Most of the time they were within 10 dBA of each other but with no real dependence found with time of day. Comparison with site B8 shows similar results in the levels. Thus, the monitor levels were consistent across the open water.

4.4.2 Everglades NP

E1 Carl Ross Key: This site was monitored for 24 hours between 17 and 18 June 1999. During this period, the L_{90} was 34 dBA with a L_{90} of 41 dBA at sunrise being the loudest and with a nighttime, daytime, and sunset L_{90} of 36 dBA, 31 dBA, and 32 dBA respectively. The L_{50} was 41 dBA with the high of 46 dBA occurring during the daytime. The L_{10} was 52 dBA with a maximum of 53 dBA occurring during the daytime period. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 7.7 with a duration of 38 seconds. Events were greatest during the midday with other peaks occurring around sunrise and sunset. For this threshold, the maximum number of occurrences was 32 during 1200. For the hourly variation, L_{90}, L_{50}, L_{10} and L_{eq} were within 8 dBA during the nighttime hours. The limited monitoring period precludes any strong statement about time of day variations.

E2 Coastal Prairie Trail: This site was monitored for 71 hours between 15 and 18 June 1999. During this period, the L_{90} was 30 dBA with the highest L_{90} of 42 dBA occurring at sunrise and with a nighttime, daytime, and sunset L_{90} of 39 dBA, and 31 dBA, respectively. The L_{50} was 41 dBA with the high of 46 dBA occurring at sunset. The L_{10}

was 47 dBA with a maximum of 49 dBA occurring at sunrise. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 8.4 with a duration of 45 seconds. Events ere greatest during the daylight hours for all threshold levels. For this threshold, the maximum number of occurrences was 25 during 1100. For the hourly values, L_{10} and L_{eq} were somewhat constant during the monitored period, and the L_{90} and L_{50} exhibited a diurnal pattern with decreases during the daylight hours. During the nighttime, all of the levels were within 5 dBA of each other . Thus, the daylight hours had the quietest background levels as defined by the L_{90} and L_{50}.

E3 South Joe River Chickee: This site was monitored for 71 hours between 14 and 17 June 1999. During this period, the L_{90} was 25 dBA with the highest L_{90} of 28 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 26 dBA, 24 dBA, and 24 dBA, respectively. The L_{50} was 32 dBA with the high of 35 dBA occurring during daytime. The L_{10} was 46 dBA with a maximum of 49 dBA also occurring daytime. For threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 9.6 with a duration of 27 seconds. Events were greatest during the late afternoon (1500-1800). For this threshold, the maximum number occurrences was 36 during 1600. For the hourly values, L_{90}, and L_{50} are within 5 dBA except for the period where there are many exceedances. As for L_{10} and L_{eq}, there is a large scatter in the data. The pattern suggests loud transient events are occurring during the morning to late afternoon periods at this site. L_{90} and L_{50} showed diurnal pattern with decreases during the daylight hours. During the early morning hours, the exceedance levels were within 5 dBA of each other. The quietest hours were between midnight and noon. This site had the lowest observed L_{90} values of the study.

E4 North Harney River Shoreline: This site was monitored for 70 hours between 14 and 17 June 1999. During this period, the L_{90} was 33 dBA with the highest L_{90} of 44 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 37 dBA, 31 dBA, and 37d BA, respectively. The L_{50} was 43 dBA occurring during nighttime. The L_{10} was 51 dBA with a maximum of 51 dBA also occurring during nighttime. Transient events occurred between 1300 and 1900. At all other hours the number of transient events was negligible. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 2.4 with a duration of 37 seconds. For this threshold, the maximum number of occurrences was 18 during 1400 and 1500. For the hourly values, L_{90}, L_{50}, L_{10}, and Leq ere within 5 dBA except for the periods where there were transient events. The values were loudest during the nighttime and quietest during the daytime. Thus, a diurnal pattern exist at this site. Also, during observations at this site several commercial aircraft overflights were seen and heard. During the hour of observation, aircraft noise was above the natural background for 16 minutes.

E5 Mangrove Forest along North Harney River: This site was monitored for 70 hours between 14 and 17 June 1999. During this period, the L_{90} was 39 dBA with the highest L_{90} of 55 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 48 dBA, 36 dBA and 44 dBA, respectively. The L_{50} was 51 dBA with the high of 63 dBA occurring during nighttime. The L_{10} dBA 69 dBA with a maximum of 76 dBA also occurring during nighttime. For a threshold set 10 dBA above L_{90}, the average hourly number of transient events was 3.1 with a duration of 43 seconds. Transient events occurred between 1300 and 2000 with minor events during 0400 and 0500. At all other hours the number of transient events was negligible. For this threshold, the maximum number of occurrences was 21 during 1800. For the hourly value, L_{90}, L_{50}, and L_{10} were within 8 dBA except for the periods where there were transient events. However, it should be noted that during the nighttime the levels were unexpectedly high. For two of the three nights, the L_{90} was above 70 dBA whereas it was 57 for the other night. Weather records indicate that there were local rain showers during the quietest night, which probably limited animal sounds. Since no direct observation were made during this period, the exact source of the high sound levels can not be identified. No obvious equipment problems were found, so the sound levels at this site need to be directly observed to verify or to correct the monitored levels. Otherwise, it can be stated that a diurnal pattern exists with the levels loudest during the nighttime and quietest during the daytime.

E6 Outside Mahogany Hammock: This site was monitored for 44 hours between 9 and 11 June 1999. During this period, the L_{90} was 28 dBA with the highest L_{90} of 42 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 29 dBA, and 32 dBA, d respectively. The L_{50} was 40 dBA with the high of 47 dBA occurring at sunset. The L_{10} was 54 dBA with a maximum of 69 dBA also occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 10.0 with a duration of 26 seconds. Large numbers of transient events occurred during the daylight hours at this site. During the night, the number of transient events was negligible. For this threshold, the maximum number of occurrences was 40 during 1000 to 1100. For the hourly values, L_{90}, L_{50}, L_{10} and L_{eq} were within 3 dBA during most of the nighttime hours. Large differences in the values were present during the day light hours as a result of the large number of transients events. L_{90} and L_{50} show a diurnal dependence as the levels were lowest during the day and increased at night.

E7 Inside Mahogany Hammock: This site was monitored for 44 hours between 9 and 11 June 1999. During this period, the L_{90} was 28 dBA with the highest L_{90} of 53 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 25 dBA, 26 dBA, and 33 dBA, respectively. The L_{50} was 44 dBA with the high of 55 dBA occurring during nighttime. The L_{10} was 60 dBA with a maximum of 65 dBA occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 6.8 with a duration of 25 seconds. Similar to site E6, large numbers of transient events occurred during the daylight hours at this site. During the night, the number of transient events was negligible. For this threshold, the maximum number of occurrences was 30 during 0900. For the hourly values, L_{90} and L_{50} are within 3 dBA for most of the time and they show a strong diurnal dependence between night and day. The daytime values are about 25 dBA lower than the nighttime values. During the night, all of the metrics are within 5 dBA. Large differences in the values were present during the daylight hours as a result of the large number of transient events. L_{90} and L_{50} show a diurnal dependence as the levels were lowest during the day and increased at night. Compared to site E5, this site also had loud sound levels during the night as seen with L_{90} values greater than 50 dBA.

E8 Prairie in Taylor Slough near Ernest Coe Campsite: This site was monitored for 74 hours between 11 and 14 June 1999. During this period, the L_{90} was 28 dBA with the highest L_{90} of 38 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 31 dBA, 26 dBA, and 30dBA, respectively. The L_{50} was 38 dBA with the high of 41 dBA occurring during nighttime. The L_{10} was 47 dBA with a maximum of 48 dBA also occurring at nighttime. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 10.4 with a duration of 29 seconds. Many transient events occurred between 0700 and 2000 with strong peaks at 0700 and 1400 at this site. During the night, the number of transient events was negligible except for some peaks at 0100 and 2300 hours. For this threshold, the maximum number of occurrences was 44 during 1500 to 1600. For the hourly values, L_{90} and L_{50} are separated by 5 dBA for most of the daytime and are within 3 dBA during the nighttime. A strong diurnal dependence between night and day was present with the daytime values being 10 to 15 dBA lower than the nighttime values. During the night, all of the exceedance metrics are within 5 dBA. Large differences in the values were present during the daylight hours as a result of the large number of transient events. L_{10} and L_{eq} show a weak diurnal dependence as the levels were below 40 dBA through the day and higher than 40 dBA at night. The USGS monitoring station was near this site and provided weather data for comparison to the sound levels. No strong relationship was found for any weather parameter, even wind speed. Wind speeds varied from 0 to 10 knots, and recorded sound levels were independent of the wind speed.

E9 Hidden Lake Education Center: This site was monitored for 43 hours between 11 and 13 June 1999. During this period, the L_{90} was 33 dBA with the highest L_{90} of 50 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 39 dBA, and 33 dBA, respectively. The L_{50} was 45 dBA with the high of 51 dBA occurring during nighttime. The L_{10} was 52 dBA with a maximum of 54 dBA occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 4.5 with a duration of 39 seconds. Many transient events occurred between 0600 and 1900 at this site. During the night, no exceedances were monitored. For this threshold, the maximum number of occurrences was 31 during 1100 to 1200. For the hourly values, L_{90}, L_{50}, L_{10}, and L_{eq}. All of the metrics showed a diurnal pattern with the daytime being the quietest time and the dependence was strong for L_{90} and L_{50}. During the night, the levels were loud with an L_{50} of 50 dBA..

E10A Transition Zone between Marl Prairie and Pinelands: This site was in the open prairie part of the transition zone. This site was monitored for 90 hours between 15 and 19 June 1999. During this period, the L_{90} was 39 dBA with the highest L_{90} of 45 dBA occurring at sunrise and with a nighttime, daytime and sunset L_{90} of 44 dBA, and 40 dBA, respectively. The L_{50} was 46 dBA with the high of 48 dBA occurring during nighttime and sunrise. The L_{10} was 56 dBA with a maximum of 64 dBA occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 3.8 with a duration of 38 seconds. Most transient events occurred between 0800 and 1100 at this site. For this threshold, the maximum number of occurrences was 17 during 0800. For the hourly values, L_{90}, L_{50}, L_{10}, and L_{eq} were within 2 dBA during the entire monitoring period. L_{90} and L_{50} are separated by 3 dBA for most of the time. Variations are seen but no string diurnal effect was observed. One day the levels are constant throughout the entire day while for another day they are elevated during the evening hours.

E10B Transition Zone between Marl Prairie and Pinelands: This site was in a stand of pine and other trees in the transition zone. This site was monitored for 90 hours between 15 and 19 June 1999. During this period, the L_{90} was 36 dBA with the highest L_{90} of 47 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 40 dBA, 34 dBA, and 40 dBA, respectively. The L_{50} was 47 dBA with the high of 53 dBA occurring during nighttime and at sunset. The L_{10} was 61 dBA with a maximum of 69 dBA occurring during nighttime. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 6.6 with a duration of 40 seconds. Most transient events occurred between 0200 and 1700 at this site. For this threshold, the maximum number of occurrences was 18 at 1200. During the night, L_{90}, L_{50}, L_{10} and L_{eq} were within 5 dBA and the levels were high especially around midnight where the levels were around 70 dBA. During the day, the spread in the values was about 10 dBA although there were some time when the values were within 2 dBA of one other. The levels were consistently high during the night and low during the day. The daily variations were not the same for the four-day monitoring period, which means other factors beside diurnal effect were influencing the sound levels at this site.

E11 Long Pine Key Campground: This site was monitored for 69 hours between 15 and 18 June 1999. During this period, the L_{90} was 35 dBA with the highest L_{90} of 43 dBA occurring at sunrise and with a nighttime, daytime, and sunset L_{90} of 42 dBA, and 36 dBA, respectively. The L_{50} was 43 dBA with the high of 45 dBA occurring during nighttime, sunrise and sunset. The total L_{10} was 47 dBA with a maximum of 48 dBA occurring at sunrise and sunset. For a threshold of dBA above the L_{90}, the average hourly number of transient events was 4.5 with a duration of 41 seconds. Most transient events occurred between 0800 and 2000 at this site. For this threshold, the maximum number of occurrences was 15 that occurred at 1000 to 1100. During the night, L_{90}, L_{50}, L_{10} and L_{eq} were within 4 dBA. During the day, L_{90} and L_{50} decreased about 10 dBA on average and they were separated by 3 dBA.

E12 Anhinga Trail: This site was monitored for 69 hours between 11 and 13 June 1999 which was the weekend when the site is expected to have the most visitation and therefore significant amount of noise intrusions should have occurred. During this period, the L_{90} was 35 dBA with the highest L_{90} of 39 dBA occurring at sunrise and with a nighttime, daytime, and sunset L_{90} of 38 dBA, 34 dBA, and 33 dBA, respectively. The L_{50} was 41 dBA with the high of 42 dBA occurring at sunset. The L_{10} was 48 dBA with a maximum of 53 dBA occurring during the day. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 6.4 with a duration of 27 seconds. Most transient events occurred between 1000 and 2000 as expected. During the nighttime, minimal events were observed. For this threshold, the maximum number of occurrences was 35 that occurred at 1500 to 1600. During the night, L_{90}, L_{50}, L_{10} and L_{eq} were within 4 dBA. During the daylight hours, L_{90} and L_{50} decreased slightly, and L_{10} and L_{eq} increased slightly as a result of visitors. The quietest period as defined by L_{90} occurred during late afternoon.

E14 Prairie in Shark Valley: This site was monitored for 73 hours between 16 and 19 June 1999. During this period, the L_{90} was 35 dBA with the highest L_{90} of 39 dBA occurring at sunset and with a nighttime, sunrise, and daytime L_{90} of 38 dBA, 38 dBA, and 33 dBA, respectively. The L_{50} was 42 dBA with the high of 56 dBA occurring at sunset. The L_{10} was 57 dBA with a maximum of 63 dBA also occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 9.0 with a duration of 32 seconds. Transient events occurred throughout the day except for the hours of 2100 and 2200. For this threshold, peaks of 26 events occurred at 1100 to 1200. For the hourly values, L_{90} was about 10 dBA lower than L_{10} and 2 to 5 dBA lower than L_{50}. L_{90} was highest during sunset and lowest during daytime. The increased levels observed at sunset were repeatable. Field observation at this site noted low rumbles of airboats and aircraft. This site was close to several air tour boat operators who are along Highway 41 directly north of the park.

E15 Chekika: This site was monitored for 74 hours between 16 and 19 June 1999. During this period, the L_{90} was 39 dBA with the highest L_{90} of 45 dBA occurring during nighttime and with a sunrise, daytime, and sunset L_{90} of 43 dBA, 37 dBA, and 37 dBA, respectively. The L_{50} was 47 dBA with the high of 49 dBA occurring during nighttime. The L_{10} was 54 dBA with a maximum of 59 dBA occurring at sunset. For a threshold of 10 dBA above the L_{90}, the average hourly number of transient events was 6.2 with a duration of 33 seconds. Transient events occurred between 1000 and 2000. For this threshold, about 14 events per hour occurred during this period. For the hourly values, L_{90} was 2 to 5 dBA lower than L_{50} L_{90} and L_{50} were highest during sunset and lowest during the afternoon. The increased levels observed at sunset were repeatable.

4.5 Observations

4.5.1 Overall

The collected sound level data describes the sound energy that currently exists at Biscayne and Everglades National Parks. Sound energy data demonstrate the range of levels occurring within the parks and provides a basis for defining potential intrusive sound events. It is important to understand that these data are based on sound energy and not on audibility. The sound levels were collected with an A-weighting filter and nothing can be inferred about the frequency content of the monitored sound spectra. Therefore, these data should not be used to define the audibility of a particular sound source such as a boat or an airplane. Figures 4.4, 4.5, and 4.6 show the L_{90}, L_{50}, and L_{10}, respectively, of the monitored sound level data.

Table 4.2 in Section 4.4 provided the average of the total L_{90}, L_{50} and L_{10} measurements at each site. The average L_{90} was 33 dBA with a standard deviation of 4 dBA. Thus, the overall L_{90} occurring within the parks has minimal variation. The L_{90} had an absolute measured range from a low of 25 dBA at E3 (South Joe River Chickee) in the Everglades to a high of 39 dBA at B2 (Elliot Key picnic area), at E10A (transition zone between the Marl Prairie and the Pinelands), and at E15 (Chekika).

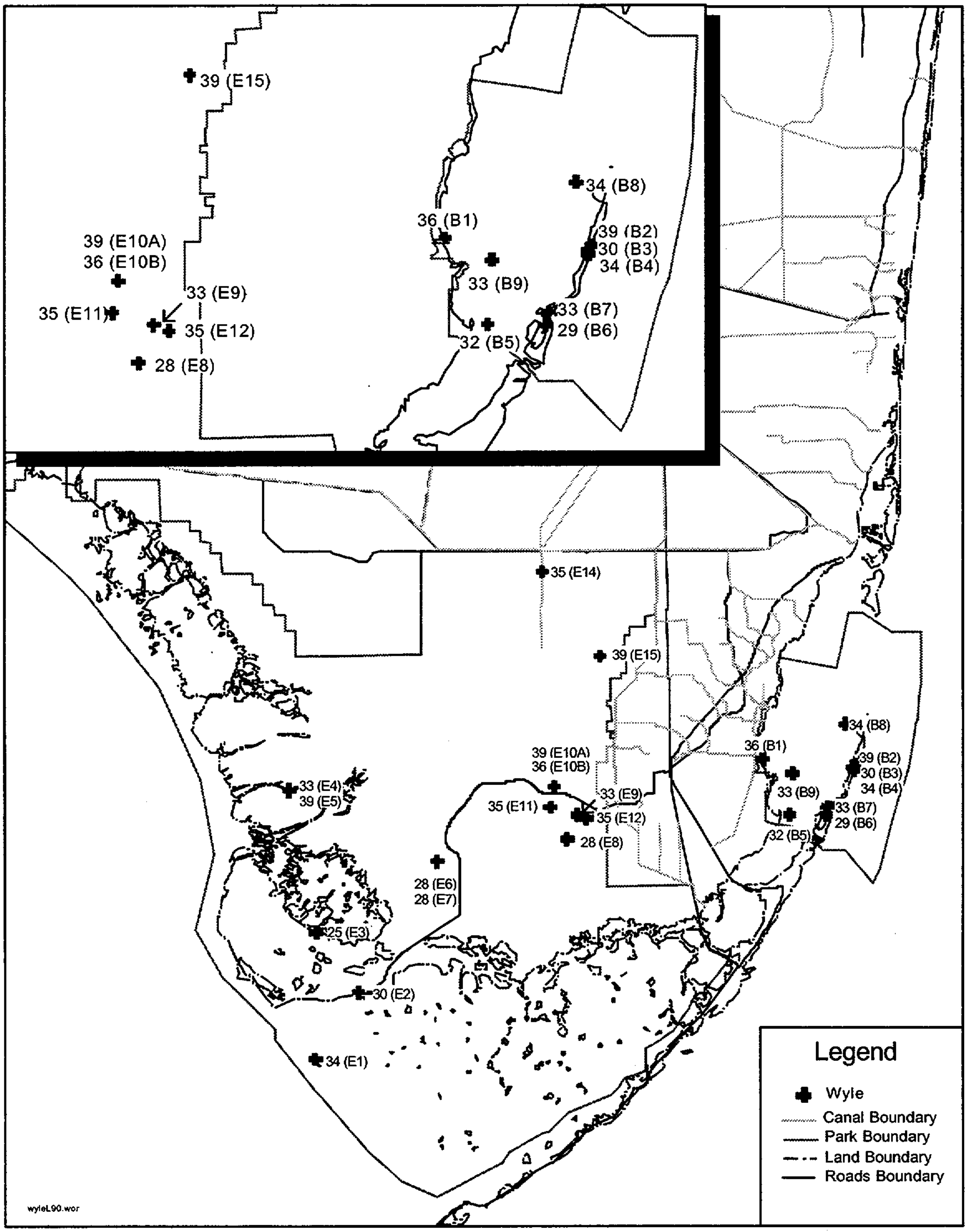


Figure 4.4. Map of L_{90} Based on Unmanned Measurements

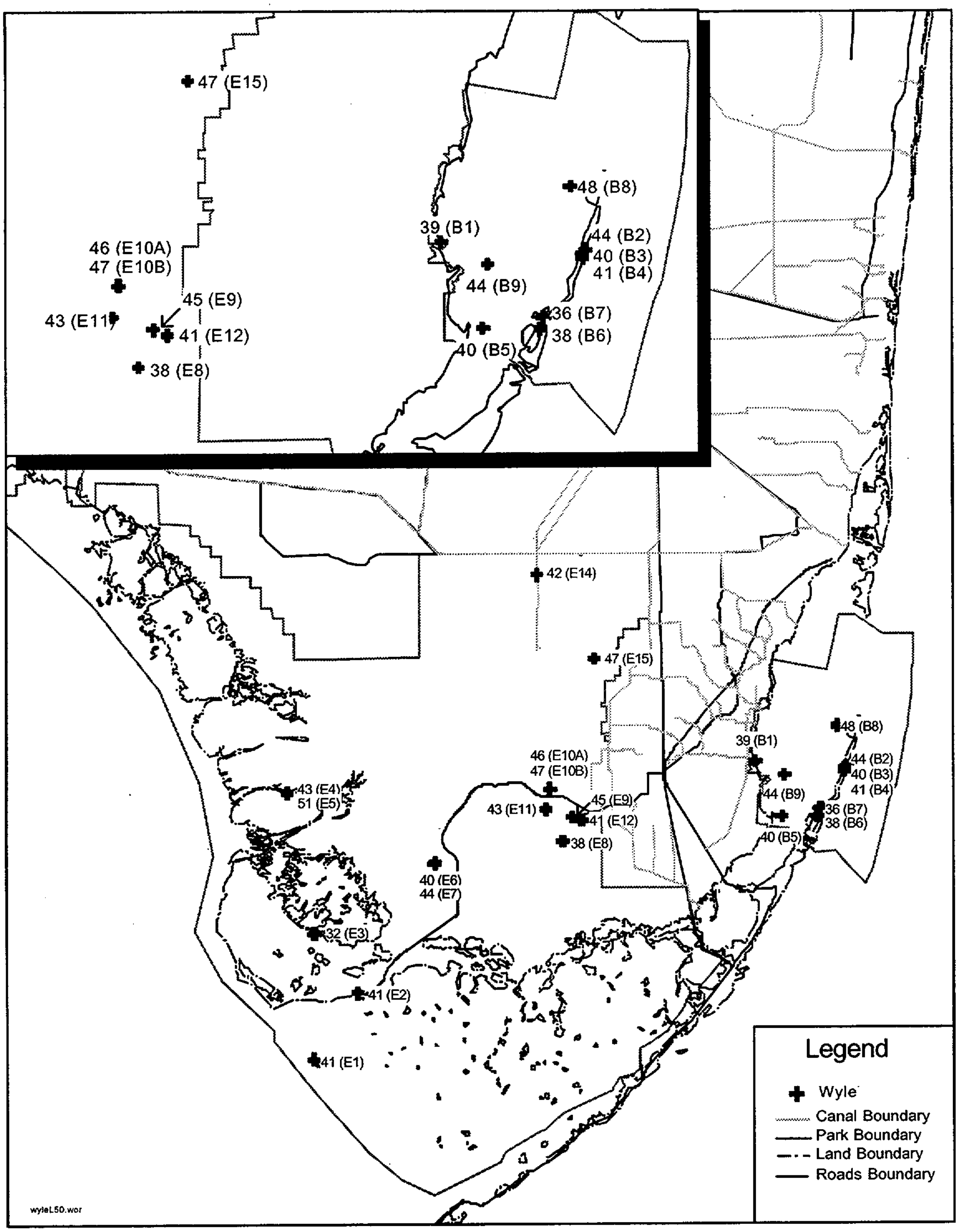


Figure 4.5. Map of L_{50} based on Unmanned Measurements

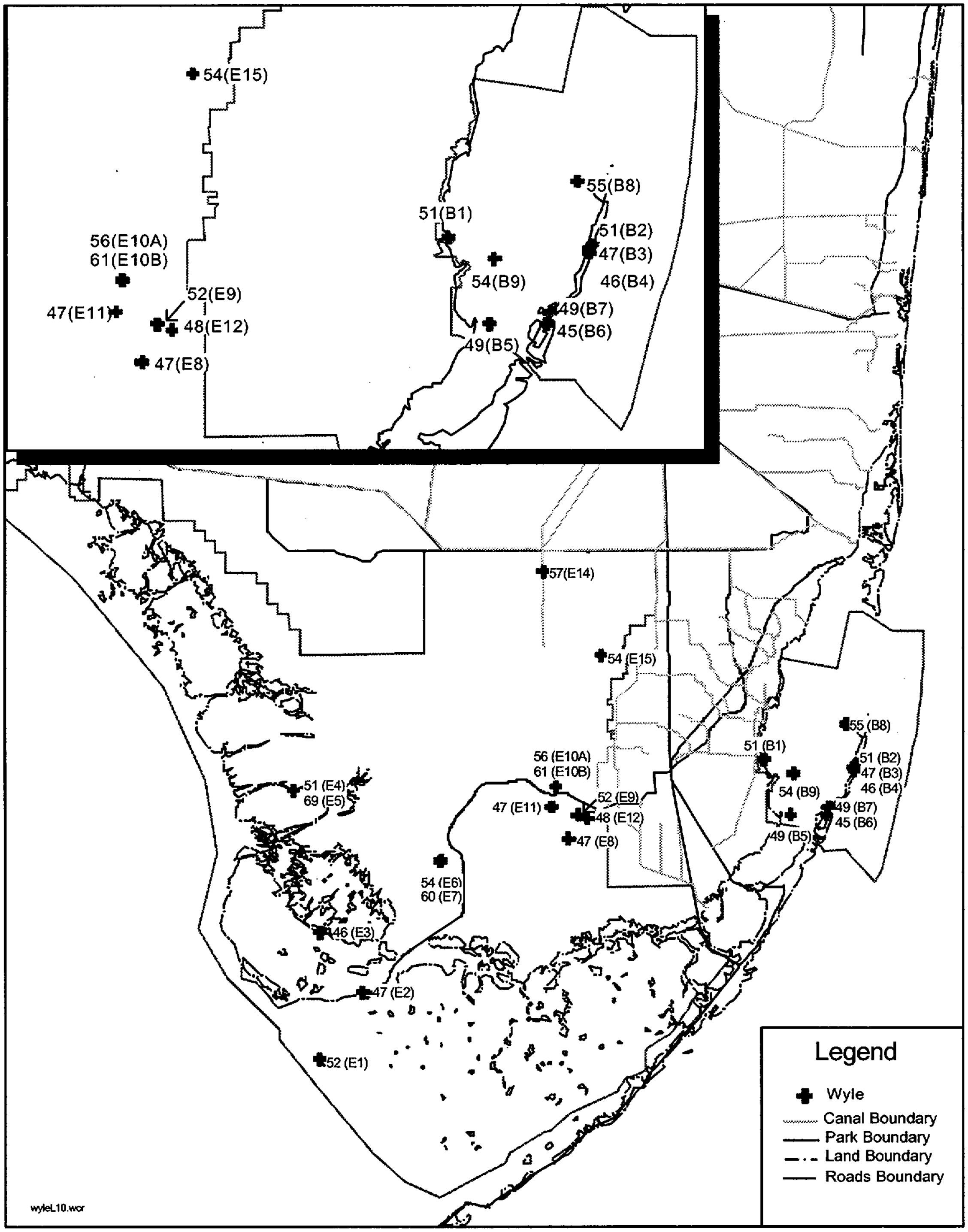


Figure 4.6. Map of L_{10} based on Unmanned Measurements

The average L_{50} was 42 dBA with a standard deviation of 4 dBA, again showing that the median sound levels varied little throughout the area. The measured range of the L_{50} was a low of 32 dBA also at E3 (South Joe River Chickee) and a high of 51 dBA at E5 (Mangrove Forest along North Harney River). The average L_{10} was 52 dBA with a standard deviation of 6 dBA. The measured range of L_{10} was from 45 dBA at B6 (Old Rhodes Key) to 69 dBA at E5 (Mangrove Forest along North Harney River). Thus, the L_{10} was more variable than the L_{90} and L_{50}, most likely because it was influenced by different sets of intrusive events at each site.

An important finding to note is the similarity between L_{10} and L_{eq}. For the hourly values, these two metrics were similar in magnitude. This equivalent relationship means that using L_{eq} to represent the average acoustical energy for a given period as the basis for defining the background sound levels inappropriately skews the definition of natural ambient toward higher levels. For this data set, using L_{eq} to define the baseline for natural ambient sound levels would set the baseline sound levels about 20 dBA higher compared to using L_{90}. This difference is significant in terms of acoustical energy.

The L_{90} hourly levels were close to the L_{50} and L_{10} levels when the sound level was constant. This occurred mostly at night and indicates the absence of intruding non-natural sources. The diurnal variation observed in L_{10} correlates with the number of hourly transient events. This result is as expected since transient events will cause a separation between L_{90}, L_{50}, and L_{10} by creating a greater distribution of observed sound levels.

From the reanalysis in Chapter 3, it was noted that the L_{90} of the totality of sounds is an accurate measure of the L_{90} of the natural sounds. The total L_{50} was shown to be above the natural L_{50} due to intrusive events. Thus, in using L_{50} as a basis one must adjust the unmanned measurements of L_{50} to account for the effect of intrusive events, whereas the unmanned measured L_{90} needs no adjustment. Therefore, the L_{90} obtained by unmanned monitoring provides the natural background sound levels and furnishes a solid basis for determining intrusive event threshold levels.

The soundscape at Site B2 appears to be effected by the air conditioners and generators at the visitor area. The L_{90} level recorded here was 5 to 9 dBA higher than levels recorded ½ mile north and south of this location (sites B3 and B4). Also comparing with similar acoustical zones (open forest), this site had the highest L_{90} of the group but its L_{50} and L_{10} values were lower within the group. This finding suggests that air conditioners and generators are effecting the background levels, thereby making it impossible to determine the natural soundscape at this location.

Another observation about potential impact is for Anhinga Trail. Visitors do not appear to greatly increase the sound levels as expected. The L_{90}, L_{50}, and L_{10} values are similar to those in the open forest acoustical zones (except B2 as noted above). Transient events are noted to occur primarily during the daylight hours when visitor are present but their disruptions do not greatly impact the natural soundscape. Thus, it can be inferred that most visitors are quiet and respectful as they observe the environment at this location.

4.5.2 Transient Events

The measured number of transient events provides an assessment of the level of intruding sound events occur3ring during a given period. Transient events were defined by thresholds with offsets of 10, 20, 30, and 40 dBA above the hourly L_{90}. These events were also defined by their durations. The minimum duration was set at 10 seconds with a maximum of 15 minutes. The minimum limit filters out short events such as birdcall, and the maximum limit filters out sound level shifts that result from shifts in the background from daytime to nighttime levels. These long duration events were natural transitions between daytime lower levels to higher levels at nighttime. This identification of transient events does not attempt to identify the sources of the transient events. A series of detailed observations are required to develop a source identification methodology before statistical judgements can be made about the source of the transient sound events.

For the analysis, the following thresholds were set: L_{90}(hr)+10dBA, L_{90}+20dBA, L_{90}(hr)+30dBA, and L_{90}(hr)+40dBA. This range of thresholds provides a good description of the magnitude of the transient events occurring within the parks. Table 4.3 provides a summary of the overall average of events per hour and their duration for each park.

Table 4.3. Transient Event Overall Summary

	Everglades		Biscayne	
Threshold	#/hr	Duration	#/hr	Duration
L_{90}+10 dBA:	6.6	35 s	5.5	43 s
L_{90}+20 dBA:	1.9	65 s	1.7	105 s
L_{90}+30 dBA:	0.4	102 s	0.5	163 s
L_{90}+40 dBA:	0.1	95 s	0.1	217 s

The overall average shows that few very loud events (i.e., 20 dBA or greater above L_{90}) currently occur within the parks on an hourly basis. Also, these numbers show that the average durations are different between the two parks. Everglades NPA has shorter duration events compared to Biscayne, yet the number of events per hour are very similar. This difference in duration may result from the boat traffic occurring near most of the Biscayne sites. The explanation of this difference can be confirmed with a few observations at some of the different sites.

Table 4.4a and 4.4b provide the averages for the transient events at each site. The average values include the number of events per hour, duration, and event L_{eq}.

At most of the sites, an increase during the daylight hours was observed as expected since human intrusions occur mostly during the daylight hours as well as birds and wind generated sounds. Transient events were also reduced during the night because of the increase in the background levels. In general, the analysis of transient events provides a credible basis on which to base acceptable levels, numbers, and duration of intrusive events, since any proposed intrusive event can be evaluated in terms of its additional disruption to the natural soundscape.

4.5.3 Temporal Variations

The data were separated into four time periods since the sound levels at most sites demonstrated a diurnal pattern. The periods were defined as the following: Nighttime (2200 to 0459), Sunrise (0500 to 0759), Daytime (0800 to 1859) and Sunset (1900 to 2159). This grouping separates out Sunrise and Sunset periods since animals tend to be very active during these transitional times. Table 4.5 shows the results of a single-factor analysis of variance of L_{90} as a function of time of day at the 95% confidence levels. This analysis if the time-based group showed that a significant difference exists between the four periods for L_{90}. Nighttime had the highest levels at most sites. The average L_{90} for the nighttime period was 40 dBA with a standard deviation of 7 dBA. These levels were primarily natural since they were constant during most of the observed nights. A few sites, however, were impacted by continuously operating air conditioners or electrical generators. Insect, amphibians, reptiles and, possibly, birds are probably the main contributors for the natural nighttime levels.

The natural ambient was quietest during the daytime at most sites. The average daytime L_{90} was 32 dBA with a standard deviation of 6 dBA. The average daytime L_{50} was 40 dBA with a standard deviation of 5 dBA. L_{90} generally decreased during the day at most sites, which suggests that the natural levels decreased during the daylight hours.

Table 4.4a. Transient Event Summary for Biscayne National Park

Hourly Average Number of Intrusions						total hours
Site	Aco. Zone	L90+10	+20	+30	+40	observed
B1	1	3.9	1.3	0.5	0.1	49
B2	2	5.3	1.9	0.3	0.0	162
B3	3	4.9	1.8	0.5	0.1	94
B4	3	4.6	1.2	0.2	0.1	45
B5	7	5.0	1.5	0.7	0.1	69
B6	7	8.1	2.3	0.7	0.1	163
B7	6	5.0	3.0	0.5	0.1	166
B8	5	5.3	1.0	0.3	0.1	166
B9	5	7.7	1.5	0.5	0.1	47
average/hr		5.5	1.7	0.5	0.1	

1=intruded
2=open forest
3=dense forest
4=prairie
5= open water
6= open shoreline
7= protected shoreline

Average Durations (seconds)					
Site	Aco. Zone	L90+10	+20	+30	+40
B1	1	49.4	97.5	278.3	266.4
B2	2	31.5	46.8	44.5	98.0
B3	3	22.4	78.9	198.6	360.8
B4	3	33.0	133.8	67.8	86.7
B5	7	51.6	104.1	144.6	307.1
B6	7	60.3	94.4	163.4	225.0
B7	6	46.7	122.8	202.1	221.1
B8	5	37.7	116.7	186.7	171.1
B9	5	51.2	152.6	180.5	217.3
average		42.7	105.3	162.9	217.1

Average L_{eq} of Events					
Site	Aco. Zone	L90+10	+20	+30	+40
B1	1	49.0	55.7	64.0	65.6
B2	2	52.6	59.8	67.2	68.4
B3	3	41.6	47.3	55.3	65.7
B4	3	45.8	53.2	62.7	65.5
B5	7	45.3	51.0	55.3	62.5
B6	7	41.0	47.1	54.1	57.7
B7	6	46.4	52.3	58.3	67.0
B8	5	47.0	52.8	56.9	62.9
B9	5	46.1	53.6	57.1	67.2

Table 4.4b: Transient Event Summary for Everglades National Park

		Hourly average of intrusions				total hours
Site	Aco. Zone	L90+10	+20	+30	+40	observed
E1	6	7.7	2.0	0.5	0.0	23
E2	4	8.4	1.5	0.3	0.0	71
E3	7	9.6	2.9	0.2	0.1	71
E4	7	2.4	0.7	0.3	0.1	70
E5	3	3.1	0.8	0.3	0.1	70
E6	2	10.0	4.3	0.9	0.2	44
E7	3	6.8	3.3	1.0	0.2	44
E8	4	10.4	2.0	0.6	0.1	74
E9	2	4.5	1.9	0.1	0.1	43
E10A	4	3.8	0.5	0.1	0.0	90
E10B	2	6.6	0.8	0.0	0.0	90
E11	2	4.5	0.7	0.1	0.0	69
E12	1	6.4	2.2	0.4	0.1	49
E14	4	9.0	4.1	0.8	0.1	73
E15	1	6.2	1.3	0.2	0.0	74
average/hr		6.6	1.9	0.4	0.1	

1=intruded
2=open forest
3=dense forest
4=prairie
5= open water
6= open shoreline
7= protected shoreline

		Average Duration			
Site	Aco. Zone	L90+10	+20	+30	+40
E1	6	38.4	39.9	52.2	22.0
E2	4	44.5	80.3	104.3	120.0
E3	5	26.8	89.3	183.9	100.0
E4	5	36.5	57.1	39.7	45.8
E5	3	43.4	34.2	39.2	37.2
E6	2	25.5	57.0	106.4	42.3
E7	3	25.2	49.7	58.1	62.6
E8	2	29.2	77.4	120.2	44.4
E9	4	39.4	58.3	41.5	420.7
E10A	4	37.7	75.8	83.1	0.0
E10B	2	40.1	73.8	309.0	119.3
E11	2	40.5	89.0	126.3	268.0
E12	1	27.0	49.4	68.2	114.4
E14	4	32.4	65.4	100.3	29.7
E15	1	32.9	83.2	103.4	0.0
average		34.6	65.3	102.4	95.1

		Average Leq			
Site	Aco. Zone	L90+10	+20	+30	+40
E1	6	45.1	57.0	106.4	42.3
E2	4	41.7	49.7	58.1	62.6
E3	5	42.8	77.4	120.2	44.4
E4	5	43.0	58.3	41.5	420.7
E5	3	55.0	75.8	83.1	0.0
E6	2	39.5	73.8	309.0	119.3
E7	3	39.3	89.0	126.3	268.0
E8	2	41.2	49.4	68.2	114.4
E9	4	45.7	65.4	100.3	29.7
E10A	4	50.7	83.2	103.4	0.0
E10B	2	50.5	0.0	0.0	0.0
E11	2	46.1	0.0	0.0	0.0
E12	1	46.7	0.0	0.0	0.0
E14	4	47.5	0.0	0.0	0.0
E15	1	49.9	0.0	0.0	0.0

This result may arise because most animals tend to be less active during the daylight hours for this time of year. In addition, it should be noted that transient events increased during the daylight hours, which corresponds to human activity. Thus, transient events are most apparent during the daylight hours.

Sound levels occurring during sunrise and sunset were distinct from nighttime and daytime levels and usually as a transition between the two. The average sunrise L_{90} was 36 dBA with a standard deviation of 6 dBA, and the average sunset L_{90} was 35 dBA with a standard deviation of 5 dBA.

Table 4.5. ANOVA of L_{90} vs. time of day for unmanned measurements

SUMMARY				
Time of day	*Count*	*Sum*	*Average*	*Variance*
Nighttime	30	1270.0	42.3	49.2
Sunrise	30	1128.0	37.6	26.9
Daytime	30	1062.5	35.4	26.7
Sunset	30	1170.3	39.0	33.2

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	757.0	3	252.3	7.4	0.0	2.7
Within Groups	3942.8	116	34.0			
Total	4699.8	119				

4.5.4 Acoustical Zones

The measurement sites were selected to test the reanalysis finding that no dependence of the natural sound levels on acoustical zones were found. Table 4.6 shows the results of a single-factor analysis of variance of L_{90} as a function of acoustical zone at the 95% confidence level. For the unmanned monitored data, the variation within the data did not demonstrate a significant difference between the acoustical zones. Therefore, no dependence on acoustical zones was found in the data. Qualitatively, the protected shoreline data had the lowest average L_{90} of 3 dBA and the intruded sites had the highest L_{90} of 37 dBA.

This finding agrees with the lack of dependence on acoustical zone determined from the reanalysis of the Volpe and SID data. Thus, for the summer season single A-weighted metrics may be used to set general levels throughout large areas of a park since they are independent of acoustical zones. From this finding one can not say that the different acoustical zones have the same sound quality. A-weighted levels only define the acoustical energy occurring at a site and do not say anything about the timbre of the sounds occurring at a site.

This finding needs to be tested for other periods of the year to verify this apparent independence of acoustical zones. More detail statistical methods may be required to determine if an acoustical dependence exists for Everglades and Biscayne National Parks.

Table 4.6. ANOVA of L_{90} vs. acoustical zones for unmanned measurements

SUMMARY				
Acoustical Zones	*Count*	*Sum*	*Average*	*Variance*
Intruded	3	118.3	39.4	8.3
open forest	6	241.2	40.2	11.6
dense forest	5	196.6	39.3	35.3
prairie	4	151.4	37.9	21.6
open water	4	163.6	40.9	7.5
open shoreline	3	106.6	35.5	5.5
protected shoreline	5	167.1	33.4	17.9

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	199.8	6	33.3	2.0	0.1	2.5
Within Groups	386.0	23	16.8			
Total	585.8113	29				

4.5.5 Comparison with Volpe and SID data

To link these new findings to the previous measurements, Table 4.7 provides a comparison between existing sound levels for all of the data sets. This comparison uses the daytime period from the Wyle measurements and land-based measurement sites from the previous SID and Volpe measurements. The comparison points were further restricted to locations that were near each other.

This comparison shows that the average differences in L_{90}, L_{50}, and L_{10} were 2 dBA, 3dBA, and 4dBA, respectively, with standard deviations between 5 dBA and 6 dBA. These differences show good overall agreement, and no general discrepancies exist between the three data sets. The size of the variation in the differences, as represented by the standard deviations, is what can be typically expected in outdoor environmental noise measurements. Sources of the variation were from differences in sample size and potentially from rainfall and seasonal changes.

It should be noted that the Wyle measurements included periods of rain, which were excluded from the SID 1997 and Volpe 1998 measurements.

Several SID and Volpe sites included boat-based measurements. At these sites, the natural sound levels were distorted because of wave slaps against the hull of the boat. Sites B8, B9, B6, and E3 from the Wyle measurements are compared to Volpe and SID measurements to assess the potential effect of the wave slaps. It should be noted that no recordings were available to directly assess the effect of the wave slaps. Table 4.8 provides a comparison of measured daytime values of L_{90}, L_{50}, and L_{10}.

It was noted (Sanchez, 1999) that there was no wave slap for the measurements of Bis-7(2) because the water surface was still. The levels recorded at this site are similar to the monitored levels at site B6, Old Rhodes Key. These sites had very similar surroundings and were within ½ mile of each other.

For the other measurements made at Rubicon Key when the water surface was not still, the L_{90} and L_{50} levels are greater but the L_{10} is similar to the L_{10} at site B6. This trend suggests that the wave slap increased the background sound levels by adding acoustical Energy to the measurements. Moreover, the comparison between the measurements in Whitewater Bay also shows this same trend. The L_{10} levels are similar, but the L_{90} values are on the order of 10 dBA higher for the boat-based measurements. This trend was also observed at the open water site at B8. During observations, a sound level meter was used on the boat that was 1000' from the shoal marker. The sound meter recorded levels of 43 dBA whereas at site B8 the recorded level was 35 dBA.

However, the overall comparison between the open water sites, does not show as strong a difference in the data as expected. For both of the boat-based and shoal marker measurements, the sound levels are similar in magnitude. For the shoal marker based monitors, the effect of surface winds may explain this result via a natural or artificial manner. First, surface wind generated waves on the open water may have created levels comparable to the wave slap noise. Second, the surface winds that are higher on the open water may have distorted the readings by generating interference noise on the microphone.

Table 4.7: Comparison between Wyle Unmanned Sound Levels and Volpe and SID Data (Daytime period from Wyle data used)

Acoustical Zone	Volpe/SID Site	L_{90}	L_{50}	L_{10}	Wyle Site	L_{90}	L_{50}	L_{10}	Differences Between Sites ΔL_{90}	ΔL_{50}	ΔL_{10}
1	**Bis-1**	45	48	52	**B1**	38	43	55	-7	-5	3
1	**Bis-1(2)**	40	46	63					-2	-3	-8
1	**Bis-8**	40	47	58	**B2**	38	43	51	-2	-4	-7
1	**Bis-8(2)**	27	32	40					11	11	11
1	**81298I**	29	34	46					9	9	5
1	**81598I**	34	39	52					4	4	-1
1	**81798I**	30	34	49					8	9	2
4	**81898V**	23	29	38	**E8**	26	34	44	3	5	6
2	**81598R**	30	33	40	**E9**	31	38	46	1	5	6
2	**Ever-3**	23	32	39	**E11**	32	39	46	9	7	7
1	**Ever-2**	33	38	44	**E12**	34	40	51	1	2	7
1	**81098B**	27	31	40					7	9	11
1	**81298B**	29	33	45					5	7	6
1	**81598B**	36	39	45					-2	1	6
4	**81398N**	36	39	45	**E14**	33	39	50	-3	0	5
4	**81698N**	43	46	50					-10	-7	0
1	**81098O**	32	37	43	**E15**	37	44	52	5	7	9
								Average	2.2	3.4	4.0
								St.dev	5.9	5.5	5.4

Table 4.8. Assessment of Wave Slap on Background Sound Levels

Location	Previous	L_{90}	L_{50}	L_{10}	Wyle	L_{90}	L_{50}	L_{10}
Feathered Bank	81298P1	42	48	53	B8	35	49	56
	81498P1	25	36	46	B9	34	44	55
	81598P1	31	40	50				
	Bis-5	50	53	57				
Old Rhodes Key					B6	28	35	46
Rubicon Key	Bis-7(2)*	29	35	45				
	Bis-7	36	42	47				
	81198D1	36	43	52				
	81498D1	40	50	55				
Whitewater Bay	81798T1	38	41	45	E3	24	35	49

* denotes still water surface measurement conditions

For boat-based measurements near open and protected shoreline areas, the effect of the wave slap appears to have increased the background levels on the order of 10 dBA in terms of A-weighted sound energy. For the open water measurements, no effect was observed, but it is possible that measurement error obscured the effect. To ascertain the exact distortion of wave slaps on the background sound levels measured in the open water, further measurements will be required to determine the undistorted wind influenced sound levels occurring in the open waters.

5 CONCLUSIONS AND RECOMMENDATIONS FOR REDEFINING SOUTH FLORIDA NATIONAL PARKS SOUNDSCAPES

5.1 Conclusion about South Florida Ambient Data

In the south Florida National Parks, the A-weighted sound levels due to natural sources are reasonably constant over the region. The average 24-hour L_{90} for all of the monitored sites was 33 dBA with a standard deviation of 4 dBA, while the average 24-hour L_{50} was 42 dBA with a standard deviation of 4 dBA. Quantitatively, the protected shorelines were the quietest sites and the loudest sites were the dense forests, but no statistically significant dependence of sound level on acoustical zone (i.e., type of local ecosystem) was determined. This finding suggests that single A-weighted L_{90} exceedance value can appropriately describe the natural background acoustical energy occurring in large areas of the park. The unmanned measurements, along with the reanalyzed manned measurements, demonstrate that L_{90} provides a baseline for assessing the natural soundscape on an acoustical energy basis.

L_{50}, on the other hand, represents the median levels occurring a t a site and provides an understanding of the range of sound levels at a site. From the reanalysis, L_{90} for all of the monitored sites was 33 dBA with a standard deviation of 4 dBA, while the average 24-hour L_{50} was 42 dBA with a standard deviation of 4 dBA. Quantitatively, the protected shorelines were the quietest sites and the loudest sites were the dense forests, but no statistically significant dependence of sound level on acoustical zone (i.e., type of local ecosystem) was determined. This finding suggests that single A-weighted L_{90} exceedance value can appropriately describe the natural background acoustical energy occurring in large areas of the park. The unmanned measurements, along with the reanalyzed manned measurements, demonstrate that L_{90} provides a baseline for assessing the natural soundscape on an acoustical energy basis.

L_{50}, on the other hand, represents the median levels occurring at a site and provides an understanding of the range of sound levels at a site. From the reanalysis, $L_{90}$of the subset of natural sounds was the same as that of the total data set, and it was not affected by human-caused noise. The reanalysis of the manned measurements also demonstrated that the L_{50}, although a good representative of the total noise environment, often overestimated the L_{50} of the natural sounds.

Moreover, during periods of minimal intrusion, the difference between the hourly L_{50} and the hourly L_{90} was less than 5 dBA. Thus, characterizing the natural soundscape by L_{90}, rather than L_{50},does not unreasonably bias the characterization toward lower levels.

Thus, for assessment threshold levels for defining transient and/or intruding events. This finding differs from the reported results in the Volpe report, which described the traditional ambient in terms of L_{eq} with variations based on terrain.

The monitored sound levels demonstrated a diurnal pattern with the highest natural sound levels occurring mostly at night and the lowest during the day. The average daytime L_{90} was 32 dBA, and the average nighttime L_{90} was 40 dBA with the average sunrise and sunset L_{90}s falling in between at 36 and 35 dBA, respectively. This difference probably results from more active animal sounds occurring during the night. Intruding transient sound events exhibited the opposite diurnal trend in that they increased during the day and decreased at night. This trend suggests that human-based activity generated most of the transient events.

The Wyle measurements also did not find any statistical dependence of the soundscape, as defined by the acoustical energy, on acoustical zones. This finding asserts that natural sound energy levels are fairly constant over the park areas and that levels do not appear to vary according to specific regions. This finding does not allude to any details about the sound quality throughout the park. The observed sound quality varied among the acoustical zones.

The bias in using the L_{eq} of the totality of sounds as a descriptor of the natural soundscape, as was done in the Volpe study, is significant. Typically, hourly L_{eq} values were similar to hourly L_{10} values, which biases the sound level toward that of intruding, transient events. The difference between the average L_{90} and L_{10} as a baseline for natural sound levels is not appropriate since these values represent the loudest levels occurring in the soundscape. Use of these values to assess potential intrusions could prevent the NPS from achieving its goal of preserving and restoring the natural soundscape in its parks.

5.2 Recommendations about South Florida Nature Ambient Soundscape

Park personnel can now start to establish criteria for assessing intrusions to the natural soundscape by using L_{90} as an objective basis for defining intruding event thresholds. The assessment of intruding sound events needs to include the maximum sound level of each event, the duration of each event, and the number of events occurring within a given time period.

For our analysis, thresholds were set at 10 dBA, 20 dBA, 30 dBA, and 40 dBA above the hourly L_{90}. These thresholds act as filters and provide a good description of the intruding sound events that rise above the natural background level. Exact thresholds for assessment should be formulated so that the goals of soundscape preservation and restoration can be met. Along the identification and assessment of intruding events, the exceedance metrics, e.g. L_{50} and L_{10}, should be examined to ascertain the level at which the intruding events have an impact on the natural soundscape.

Continued unmanned monitoring of the natural soundscape is recommended to build on these findings. Additional sites should include coverage of the entire parks as well as assessment of seasonal variations to test the statistical independence of A-weighted sound levels on acoustical zones at other seasons of the year than were considered here. It is recommended that at least 7 complete days of measurements be conducted at these additional sites so that the diurnal pattern can be established with more confidence.

These on-going measurements can be accomplished with a few sound level monitors that are rotated to different sites on a week by week basis. This approach will quickly build a database of sound levels that can be used to describe the character of the soundscapes in the parks. The unmanned monitor data will also highlight areas where direct observations should be undertaken.

Additional unmanned monitor data will bring the natural soundscape into focus and make direct observations efficient by assessing the need before they are conducted. Observation periods can concentrate on assessing the sound environment and the characteristics of the transient events occurring at the site. These observations will build a database of both natural and intrusive transient events for statistical discrimination of the events at other times and locations. This database will help in assessing the impact on the natural soundscape from both current and proposed noise events.

The recommended on-going monitoring should have the following objectives in order to describe the soundscape:

- Additional measurement to cover the entire park areas
- Seasonal variations in natural soundscape
- Seasonal influences on the diurnal pattern
- Seasonal variations in visitor impacts
- Observations to build a database of characteristic transient events

The observational data collected by both Volpe and SID can be used as a starting point for the development of a transient event database. The observational data along with the associated acoustic record can be analyzed to determine the characteristics of noise from intrusive sources such as aircraft and boats. With these basic characteristics defined, the transient events identified in the unmanned data can be described as natural or intrusive.

Once these objectives are met, an assessment monitoring plan can be established to evaluate the effectiveness of guidelines in preserving and restoring the natural soundscape in the parks.

5.3 Intrusive Assessment Approaches

For the south Florida National Parks, the thresholds based on the hourly L_{90} used in this analysis are recommended. The acceptable number and level of transient events will have to be determined by park personnel so that the goal of preservation and restoration of the natural soundscape can be pursued.

Several intrusive sources were identified in the course of the unmanned measurements. The generators and air conditioners at Elliot Key visitor area obscured the natural soundscape. The noise from these units was the dominant noise source in the area. The generator at Adam's key was also noticeable during our observations although boat noise was also present. At Convoy Visitor Center, the concessionaire tour boats were noisy as well as the air conditioners. Since this site serves as a focal point for visitors to Biscayne NP and as the office complex for park personnel, the natural soundscape may not be realistically restored, but the noise levels could be minimized.

At the Everglades NP, airboats could be heard in the northern Shark Valley region. Few land based noise sources were observed at the Everglades NP because the number of visitors was very low during the monitoring period. Another general noise source was aircraft which include military, commercial and regional airliners, general aviation and helicopters. Aircraft were heard in all areas of the park during the monitoring.

For assessing aircraft noise impacts, noise models such as INM and NoiseMap may be used to calculate aircraft noise intrusiveness based on the established guidelines. For INM, the Time Above calculation can be used to determine intrusiveness although some work would be required to translate the calculated data into individual transient events. Also, for a complete assessment, additional information is required on the hourly operational rates that are not included in the data bases of these aircraft models.

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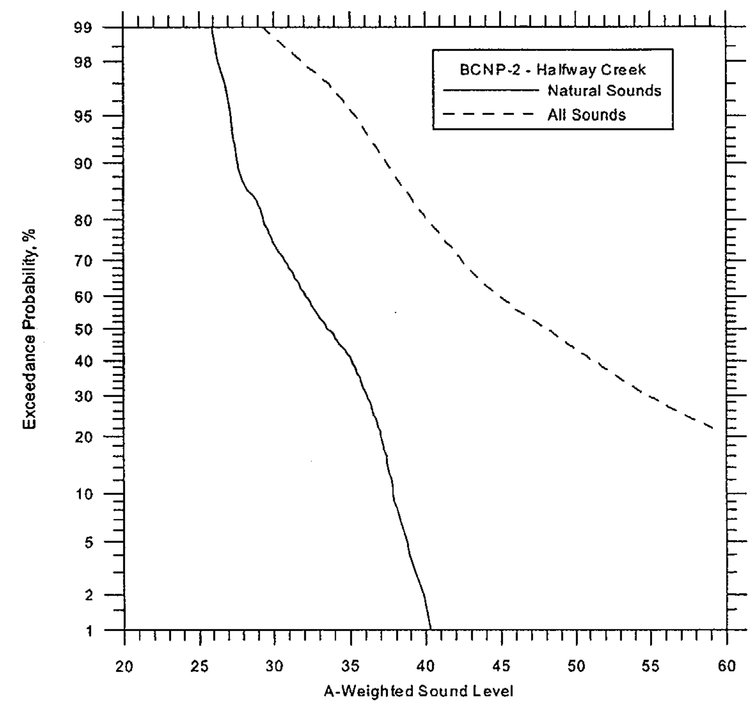
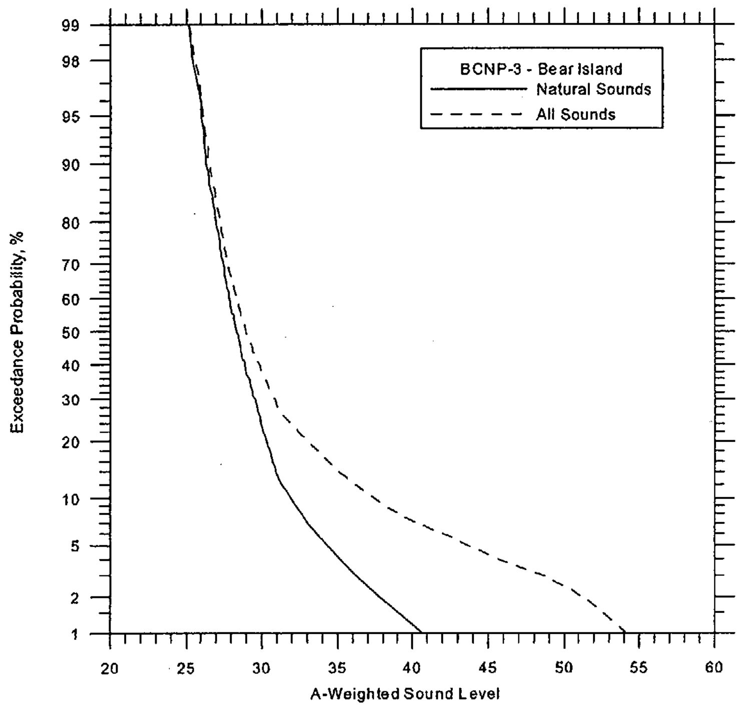
_______, Model 820 Precision Sound Level Meter: Owner's Manual, First Edition, Provo, UT, Larson•Davis, December 1991.

Appendix A
Exceedance Plots for Sanchez Industrial Design 1997 Measurements




BCNP-3 - Bear Island
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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10
5
2
1
20
25
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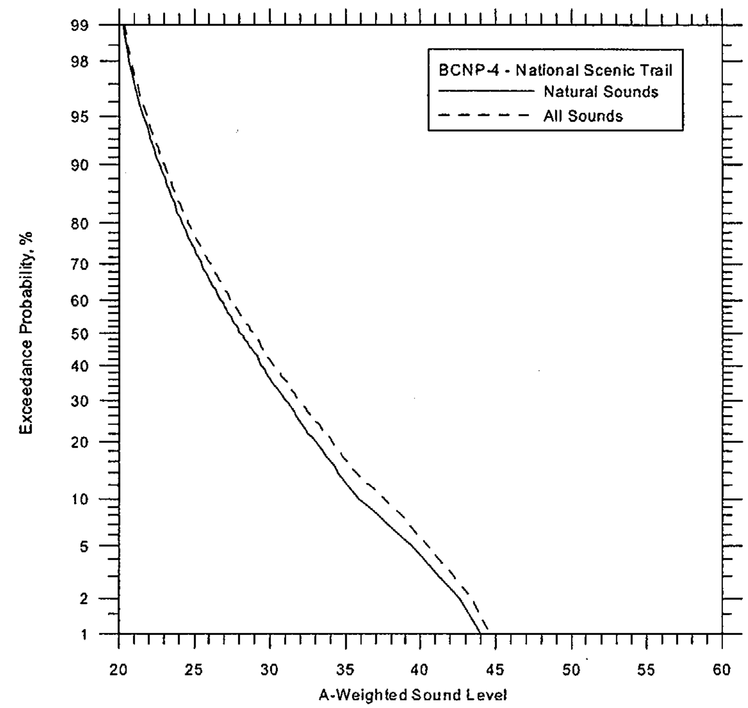
35
40
45
50
55
60
A-Weighted Sound Level


BCNP-4 - National Scenic Trail
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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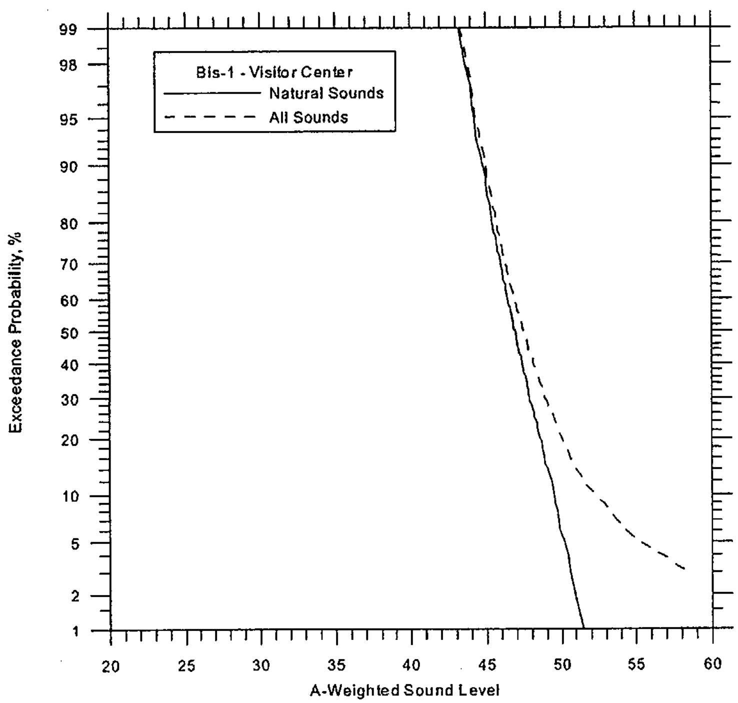
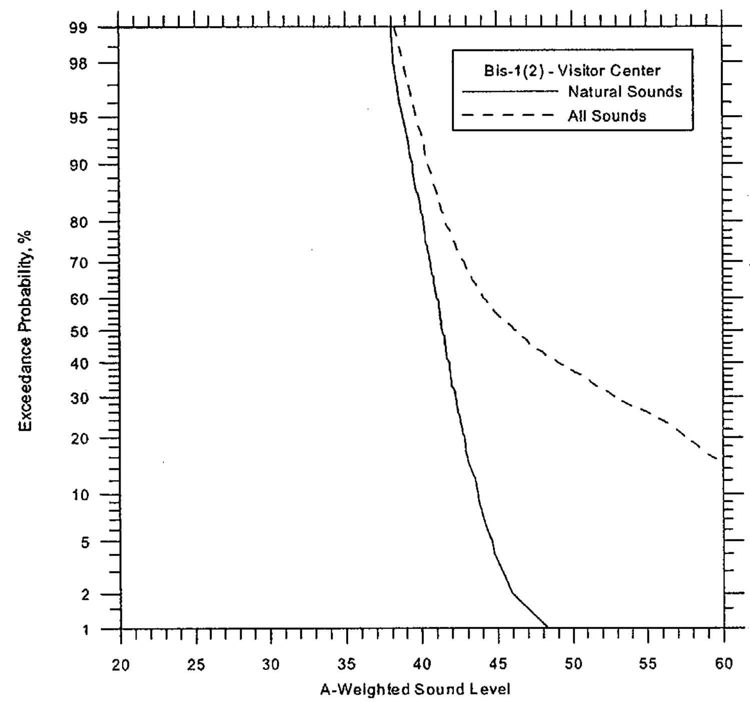
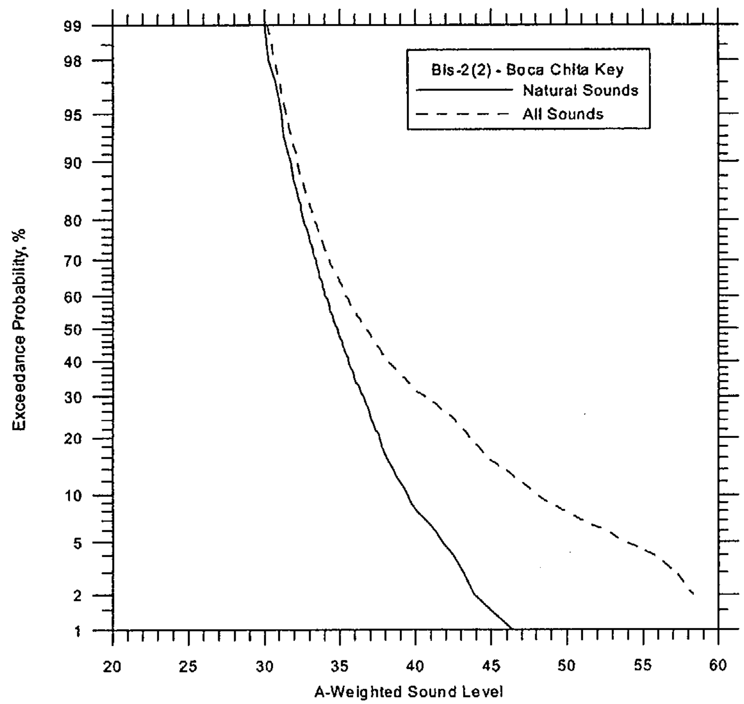
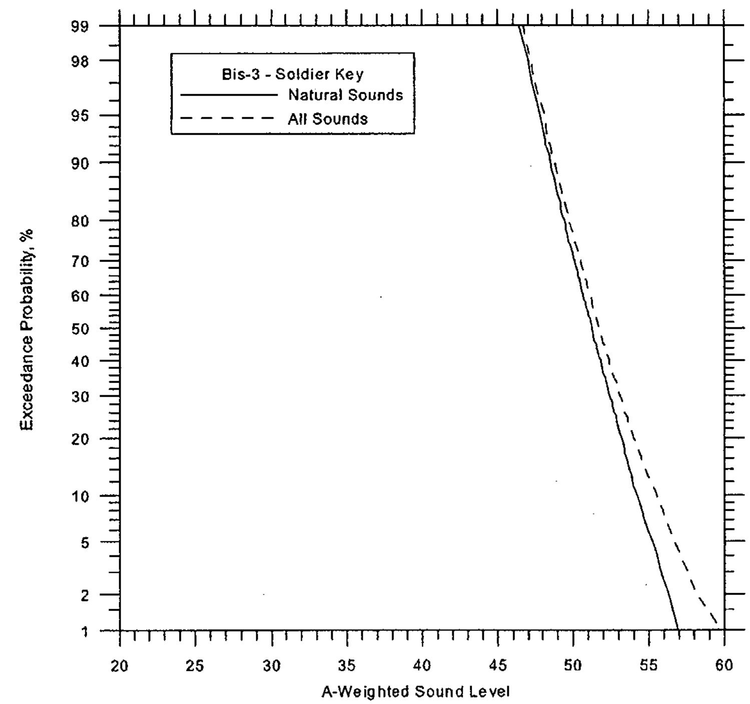
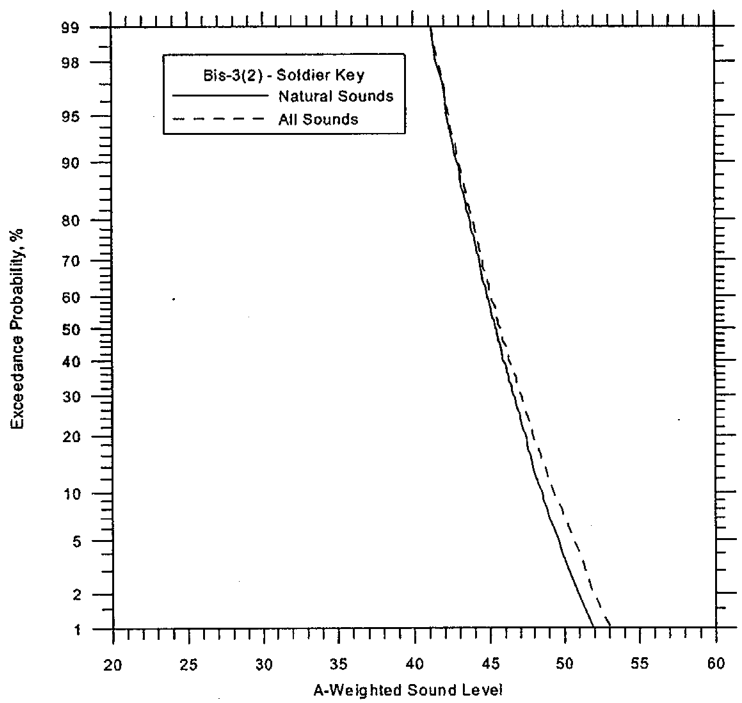
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level

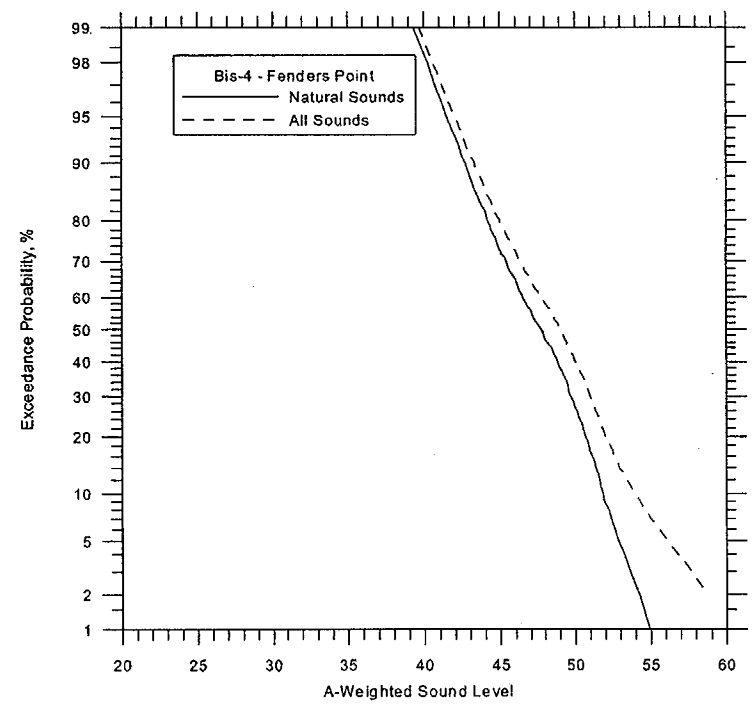

Bis-1 - Visitor Center
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level

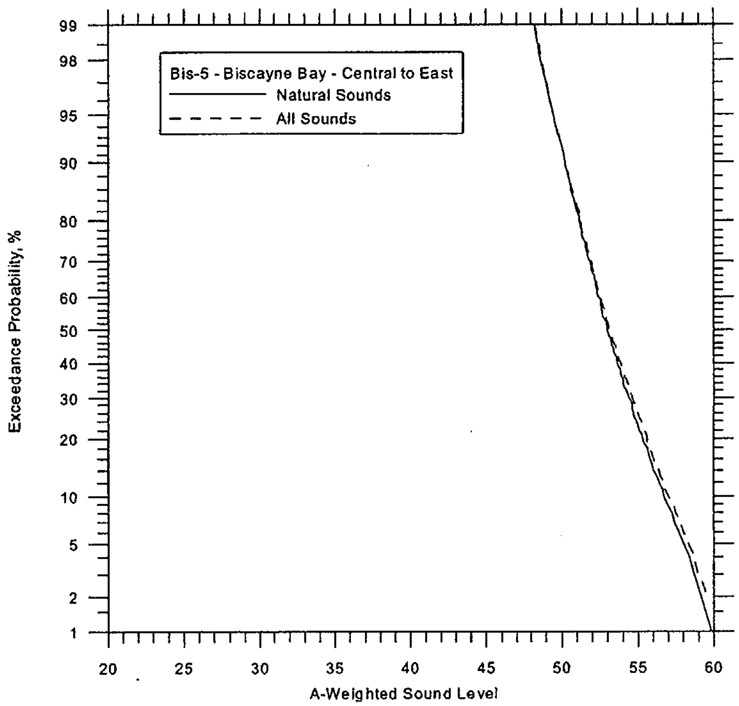

Bis-1(2) - Visitor Center
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level

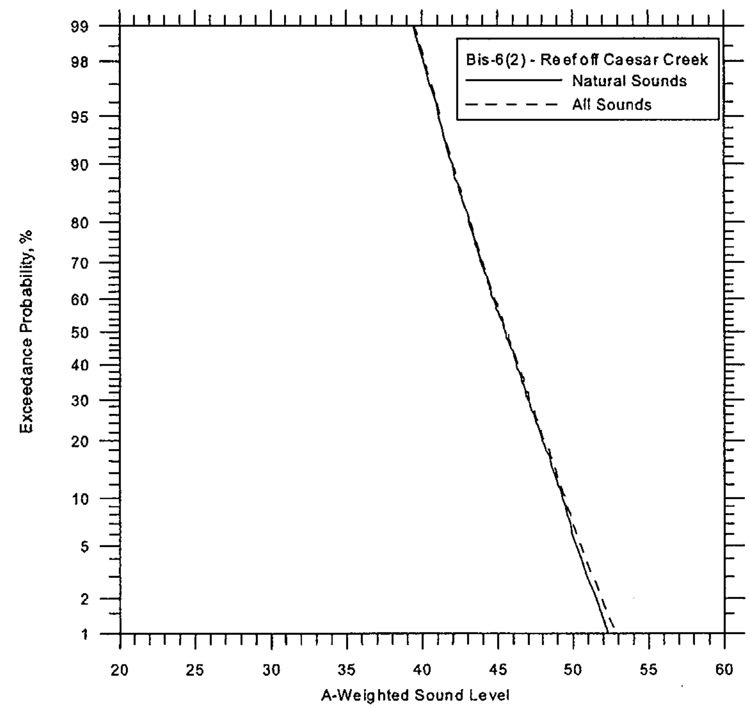

Bis-2(2) - Boca Chita Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level

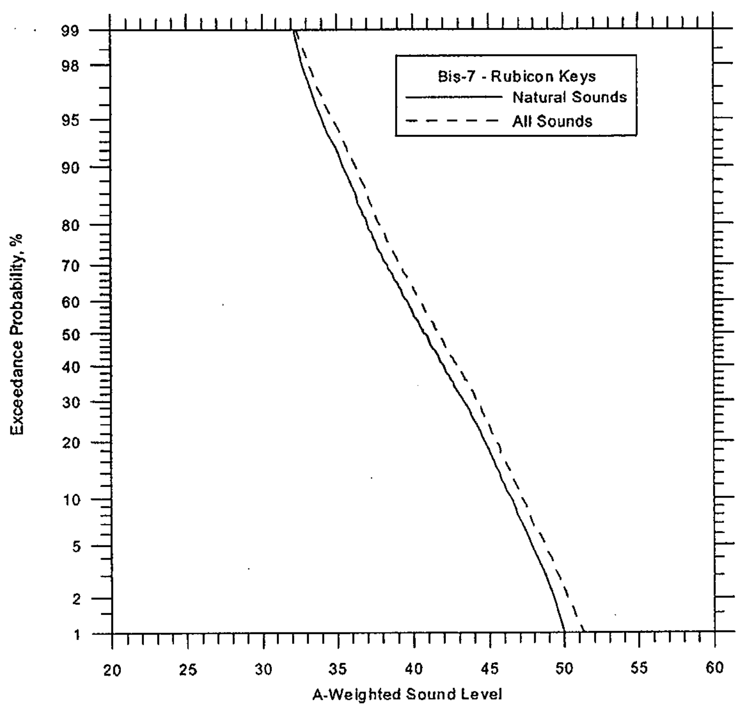

Bis-3 - Soldier Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level

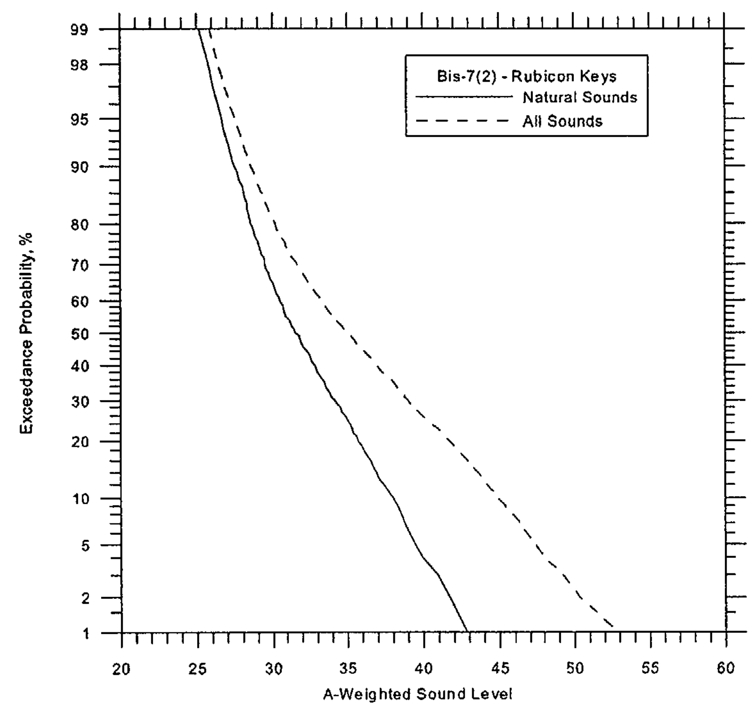

Bis-3(2) - Soldier Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level

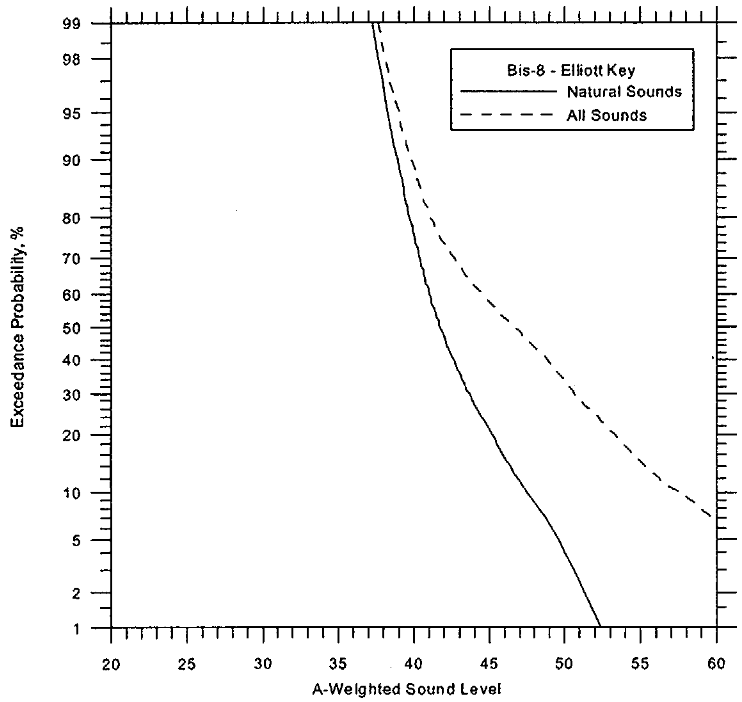

Bis-4 - Fenders Point
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level

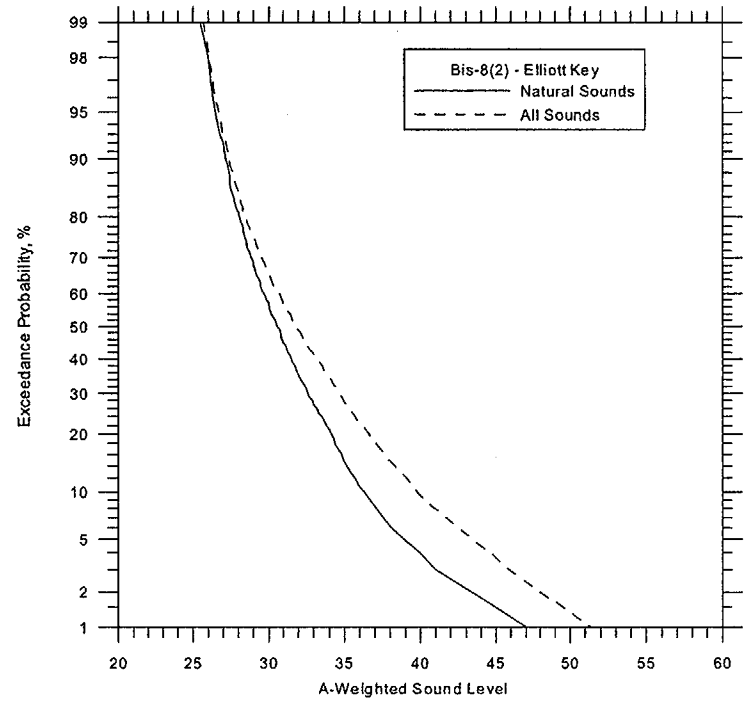

Bis-5 - Biscayne Bay - Central to East
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


Bis-6(2) - Reef off Caesar Creek
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


Bis-7 - Rubicon Keys
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


Bis-7(2) - Rubicon Keys
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


Bis-8 - Elliott Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


Bis-8(2) - Elliott Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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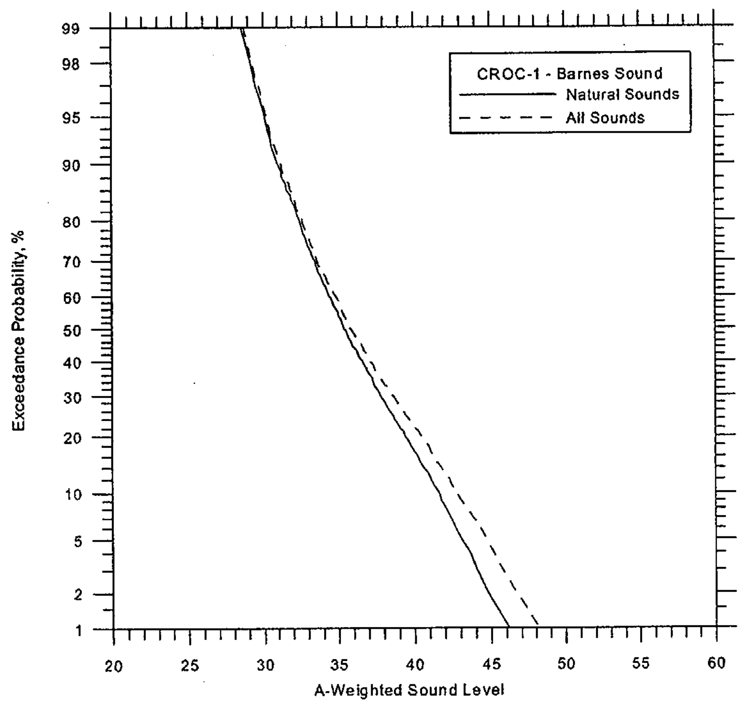
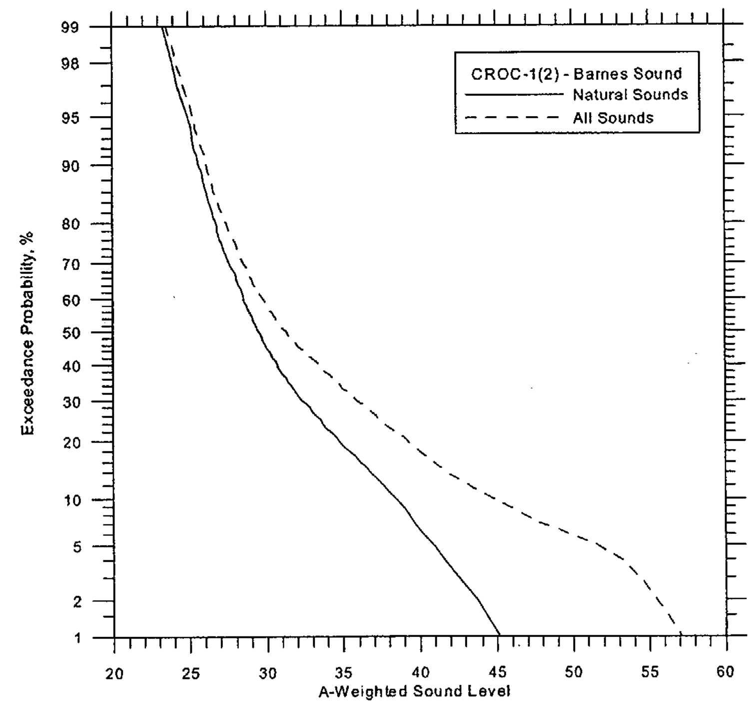
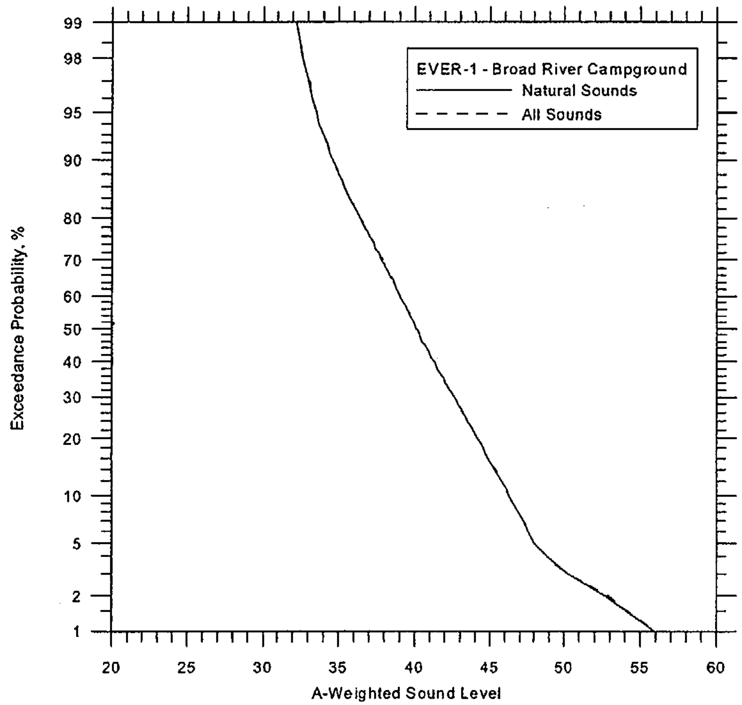
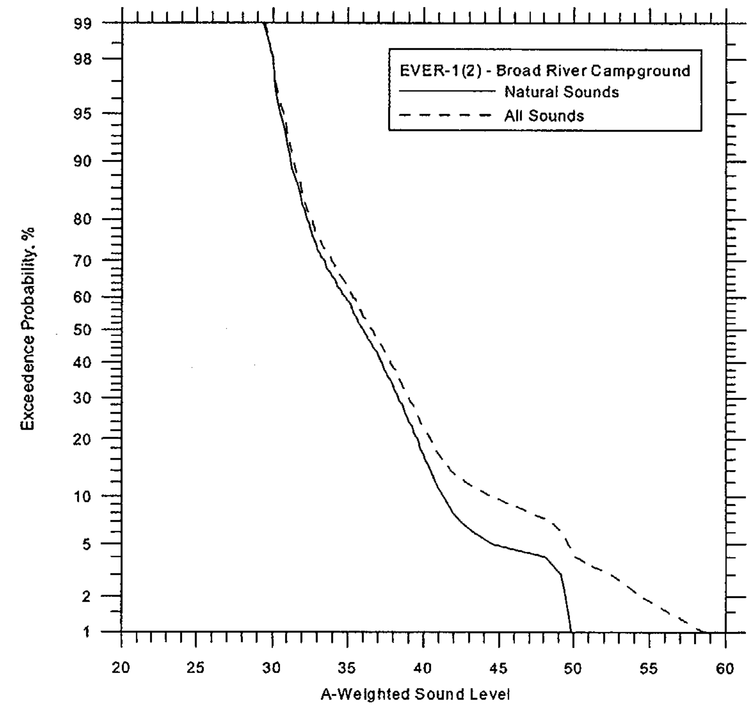
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


CROC-1 - Barnes Sound
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


CROC-1(2) - Barnes Sound
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


EVER-1 - Broad River Campground
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


EVER-1(2) - Broad River Campground
Natural Sounds
All Sounds
Exceedence Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
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50
40
30
20
10
5
2
1
20
25
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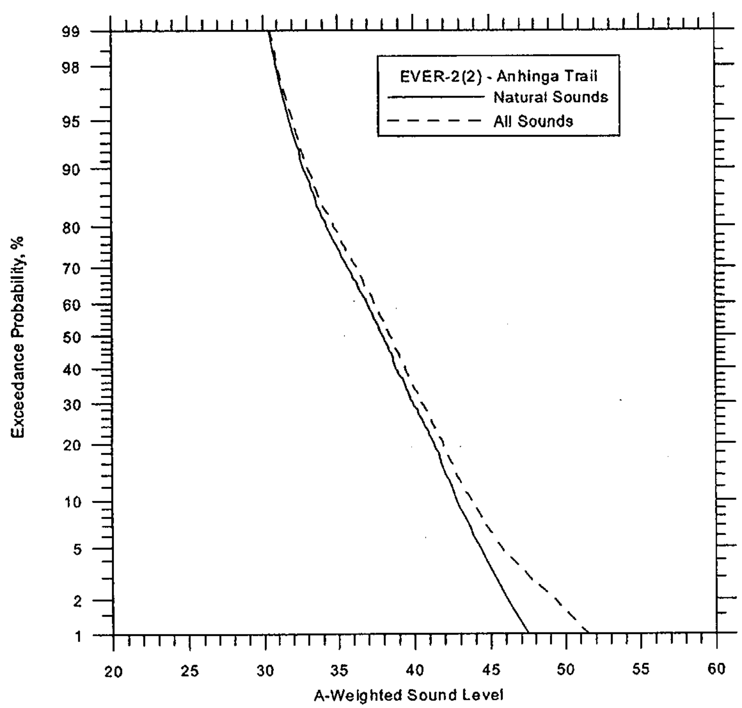
35
40
45
50
55
60


EVER-2(2) - Anhinga Trail
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
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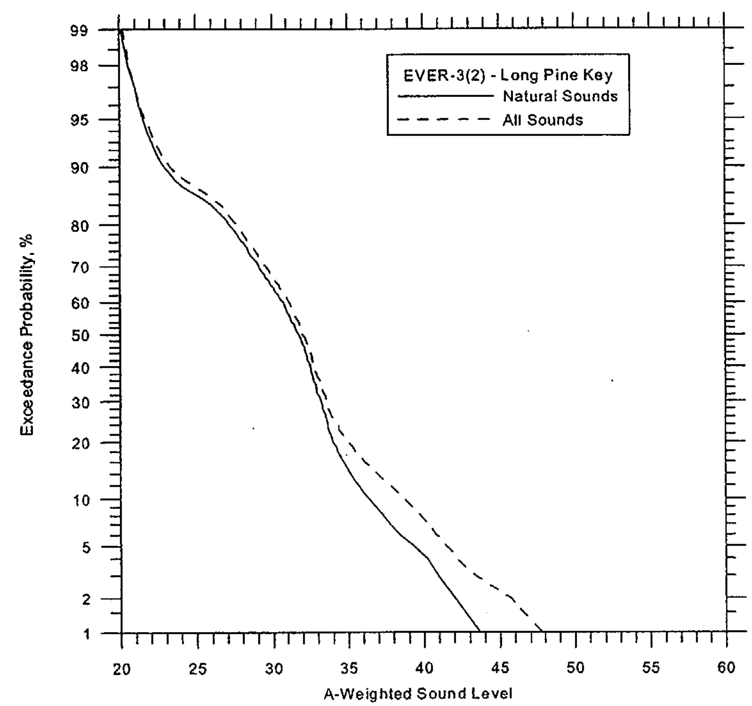
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


EVER-3(2) - Long Pine Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
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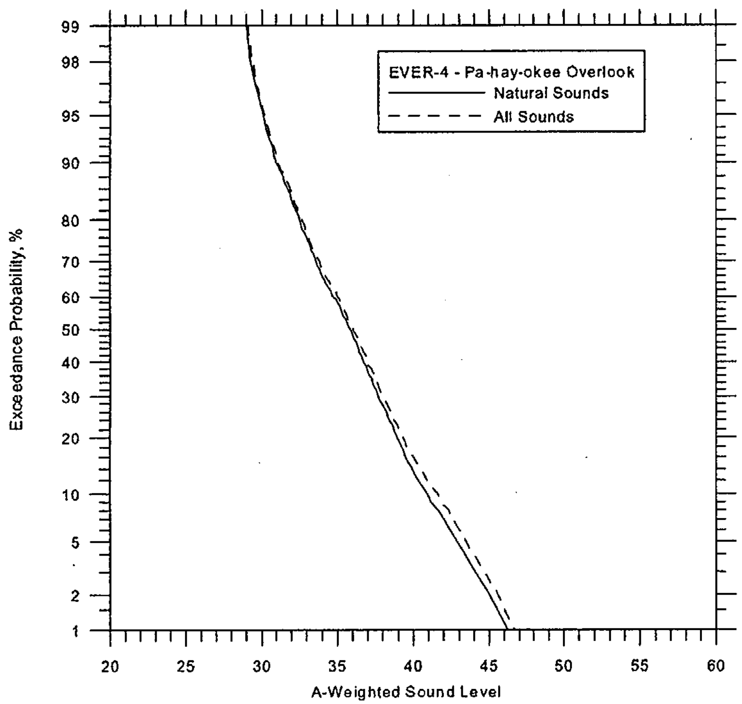
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


EVER-4 - Pa-hay-okee Overlook
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
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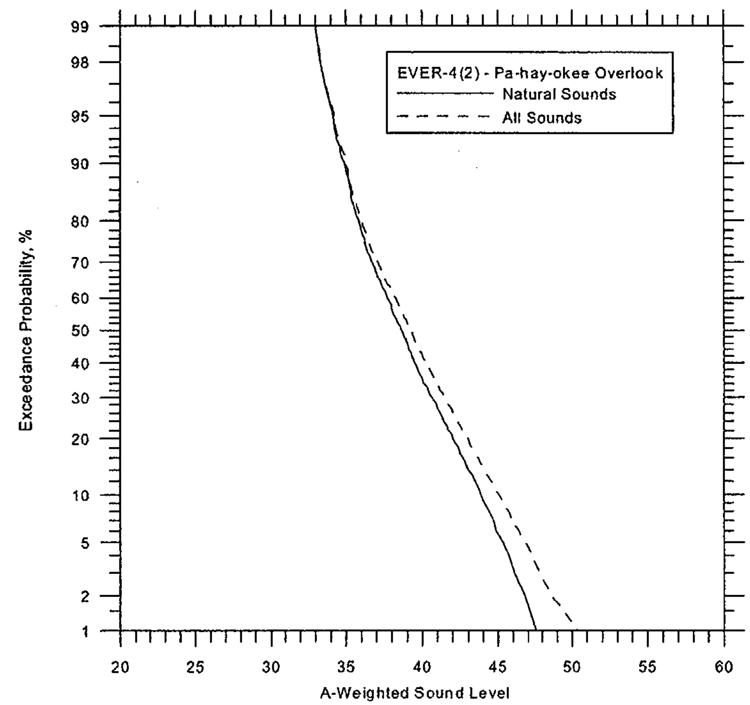
EVER-4(2) - Pa-hay-okee Overlook
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
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40
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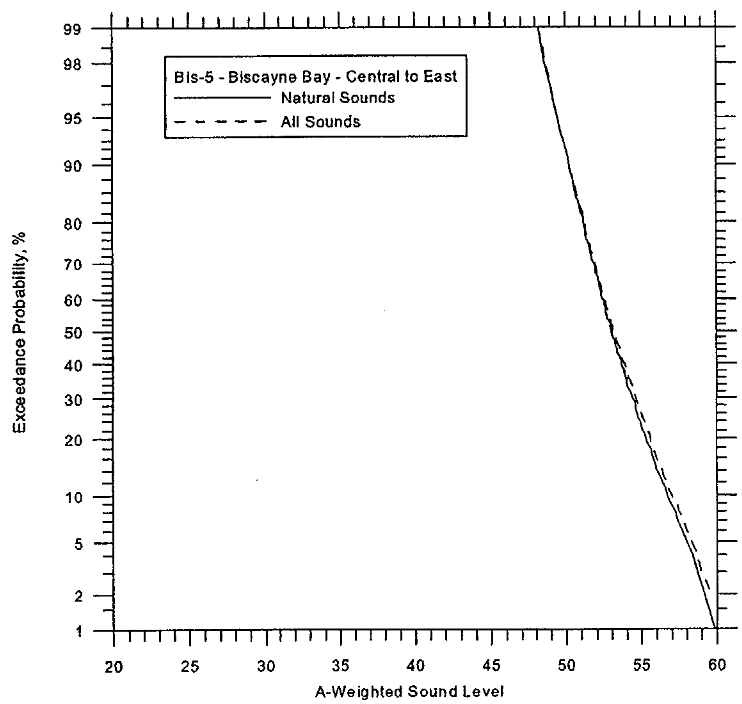
Bis-5 - Biscayne Bay - Central to East
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
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2
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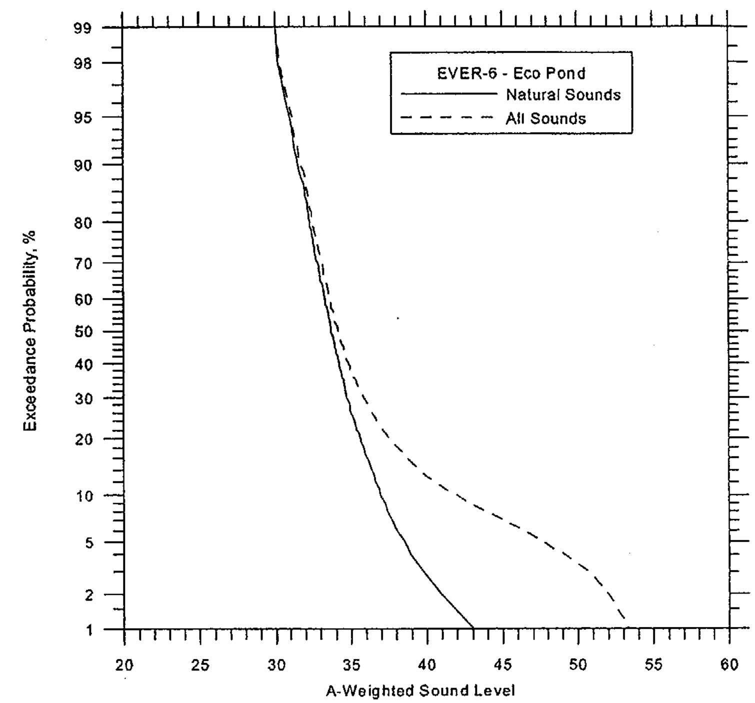
EVER-6 - Eco Pond
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
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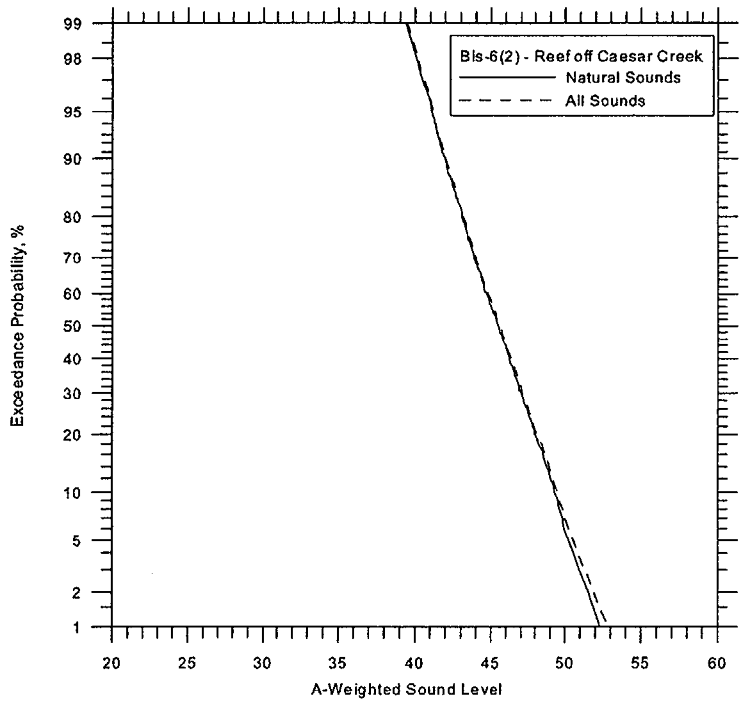
Bis-6(2) - Reef off Caesar Creek
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
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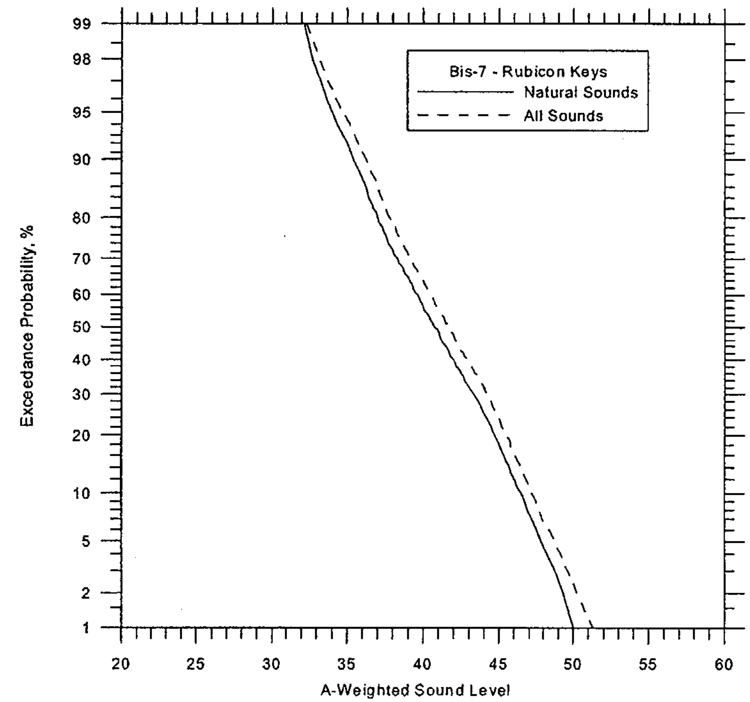
Bis-7 - Rubicon Keys
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
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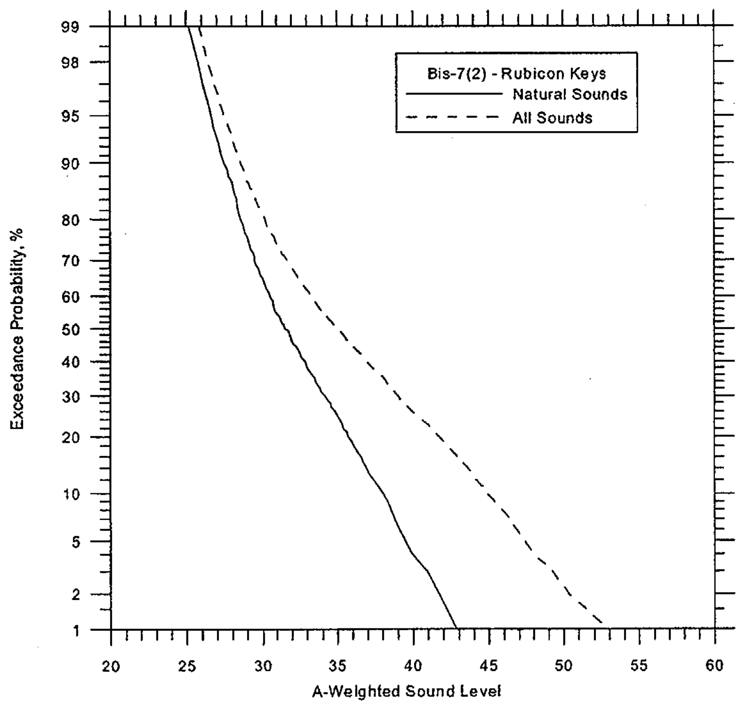
Bis-7(2) - Rubicon Keys
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
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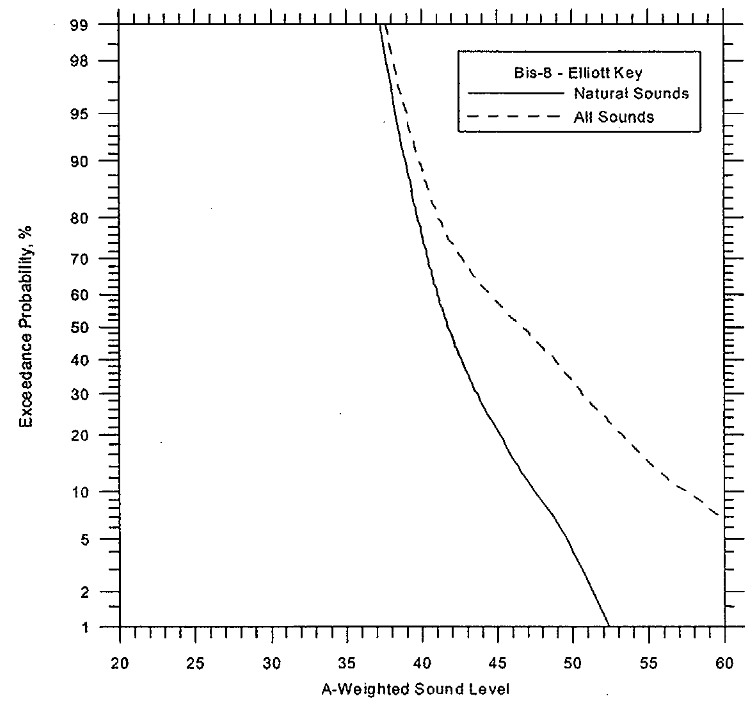
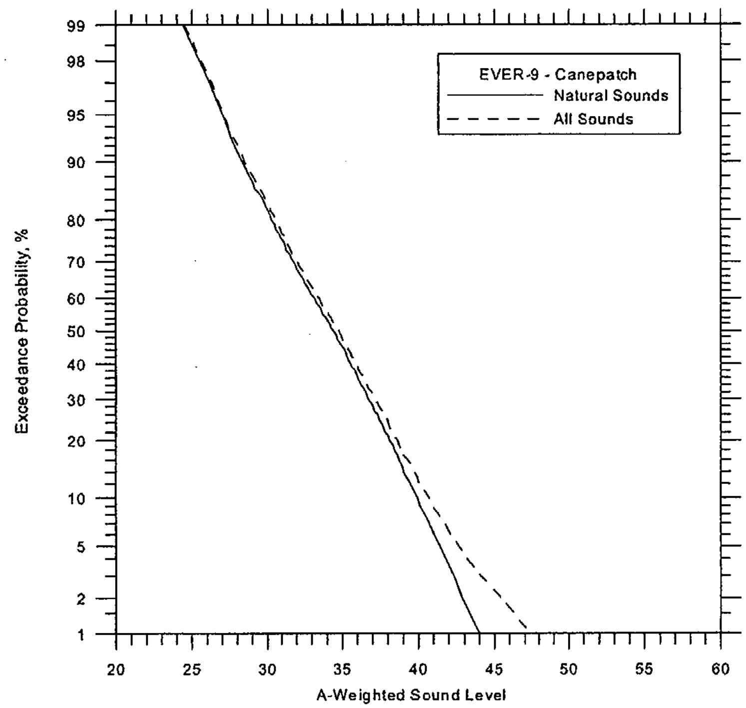
50
55
60
A-Weighted Sound Level


Bis-8 - Elliott Key
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level



EVER-9 - Canepatch
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
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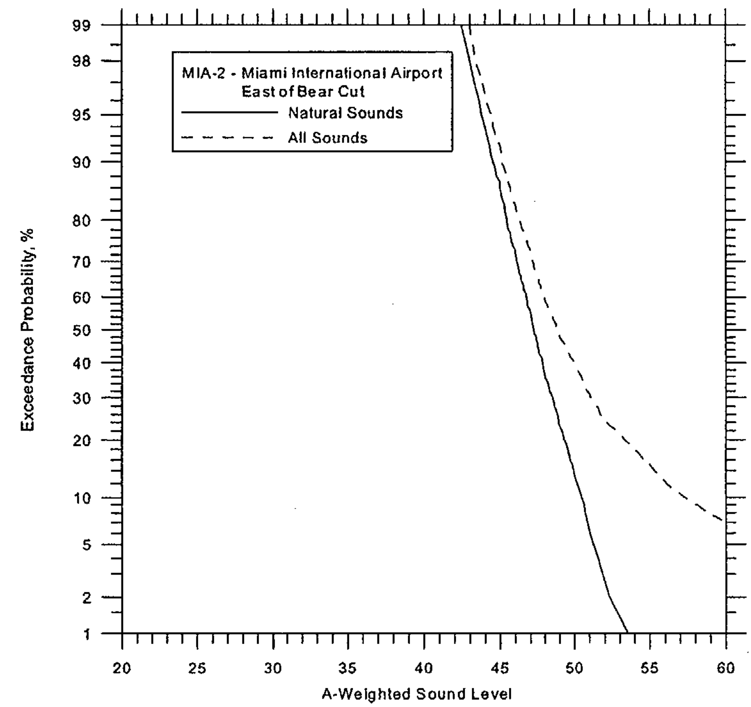
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level



MIA-2 - Miami International Airport
East of Bear Cut
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
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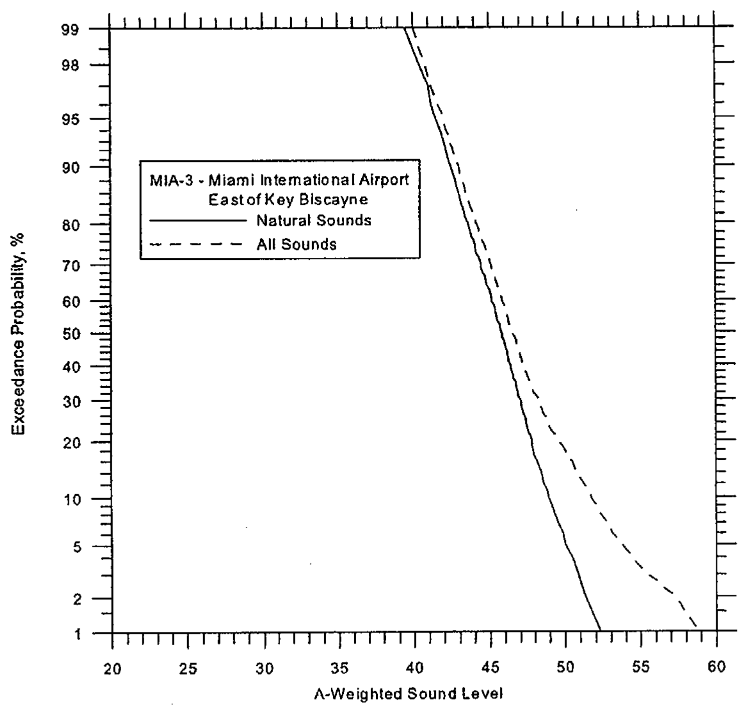
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


MIA-3 - Miami International Airport
East of Key Biscayne
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
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70
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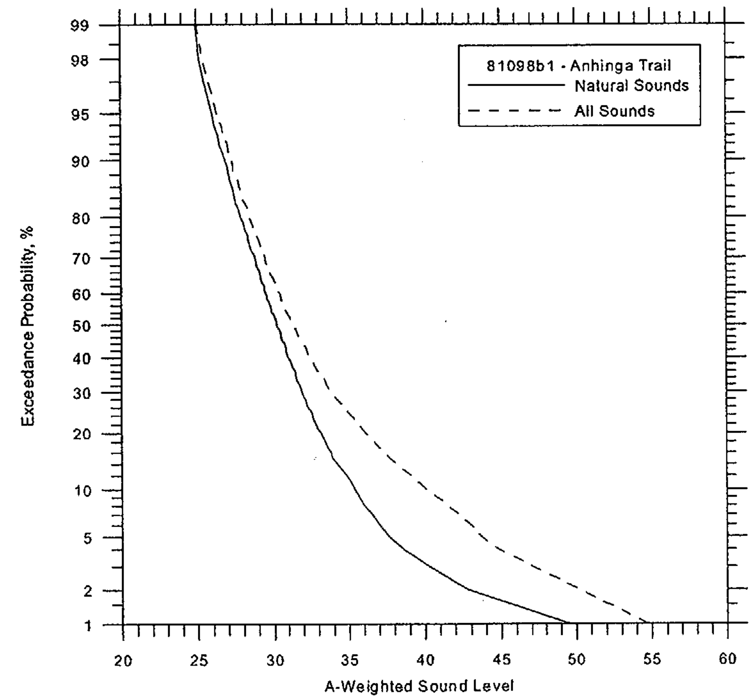
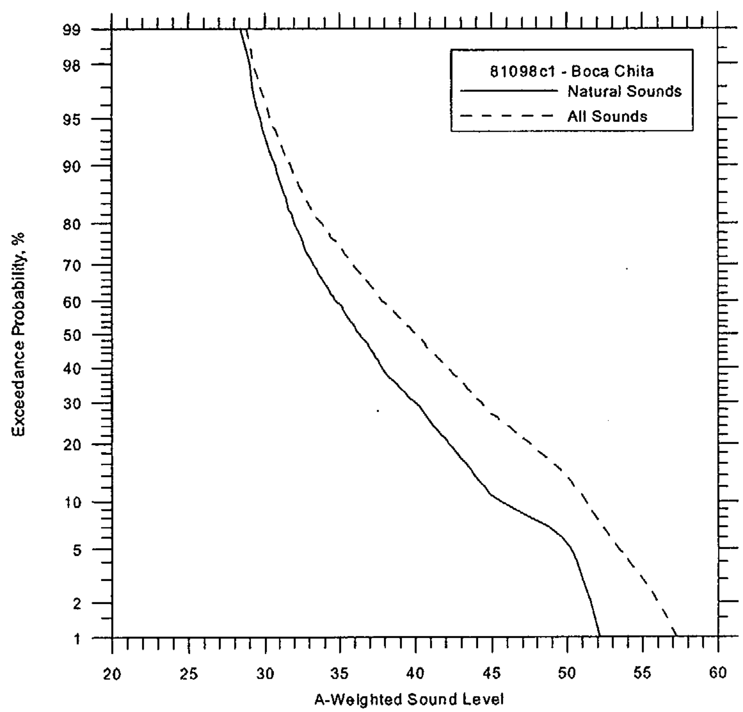
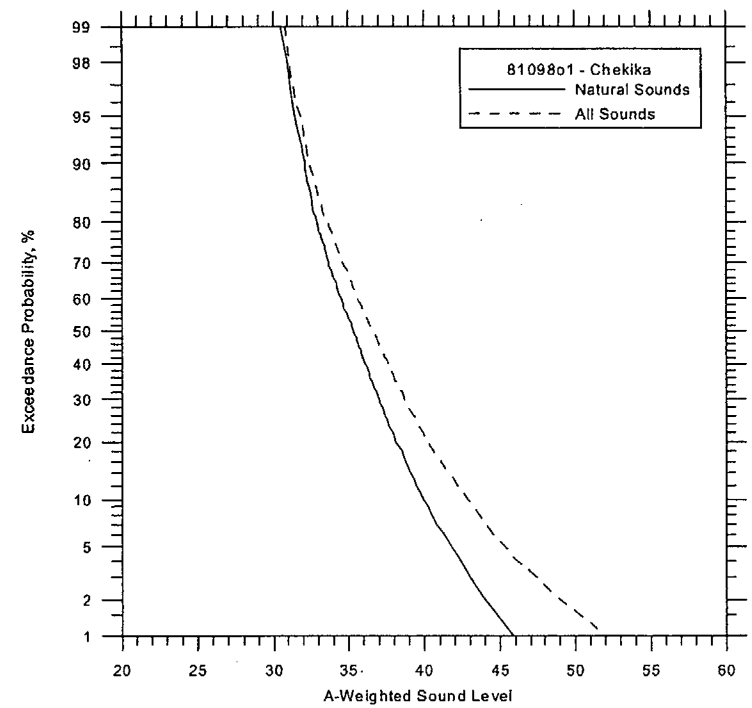
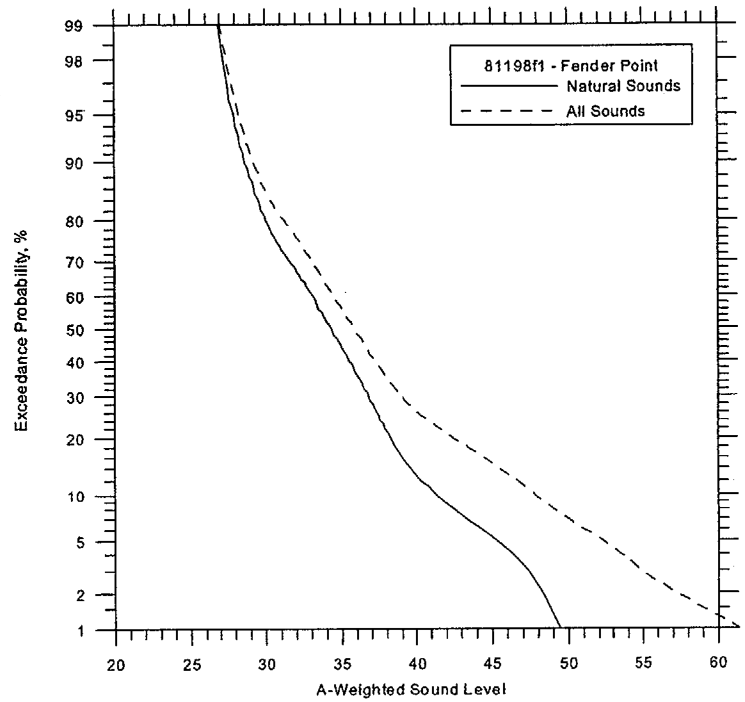
Appendix B

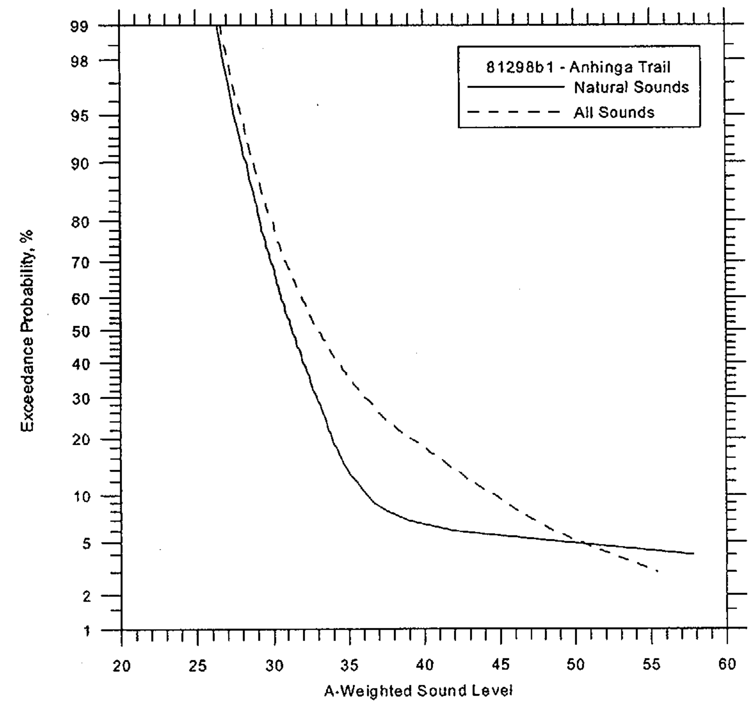
Exceedance Plots for John A. Volpe National Transportation Research Center 1998 Measurements

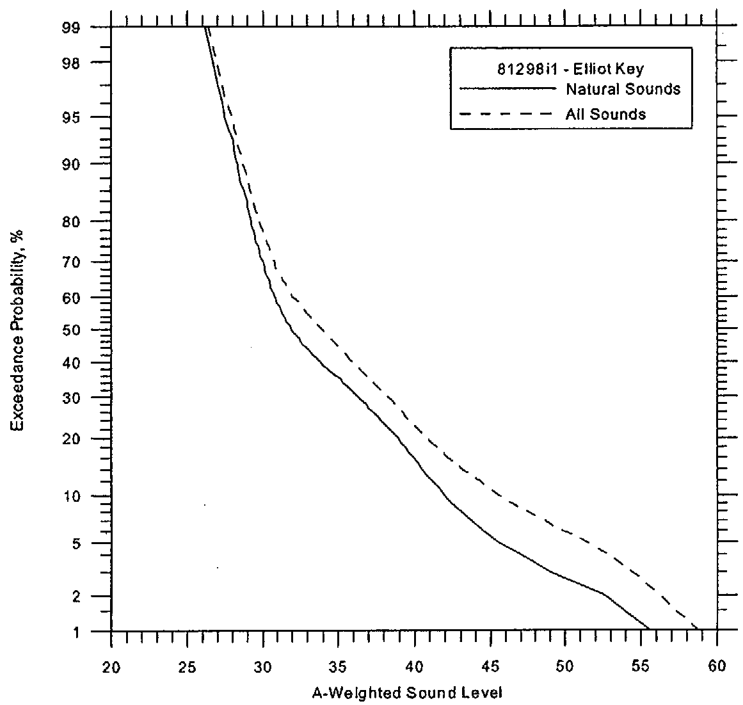



81098c1 - Boca Chita
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81098o1 - Chekika
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81198f1 - Fender Point
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81298b1 - Anhinga Trail
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81298i1 - Elliot Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
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2
1
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45
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55
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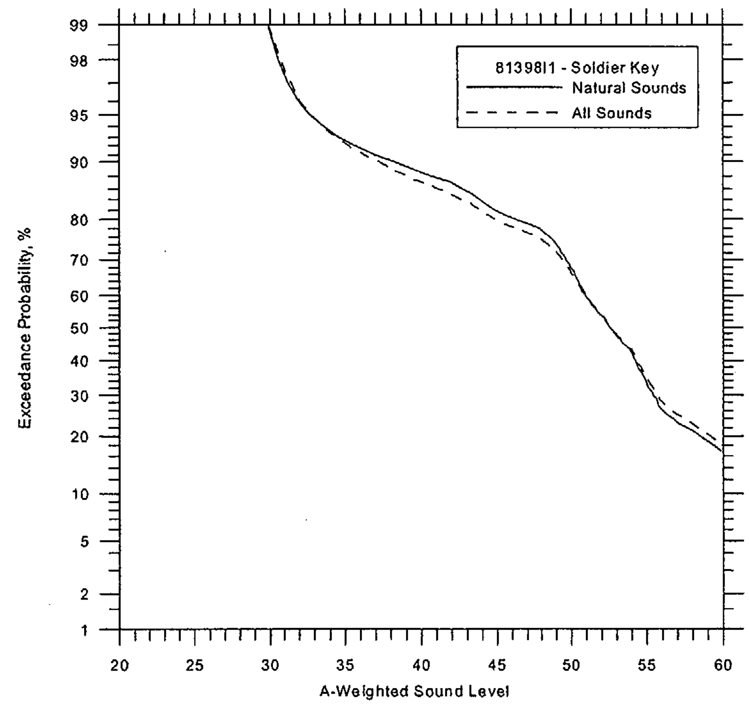
81398l1 - Soldier Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
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25
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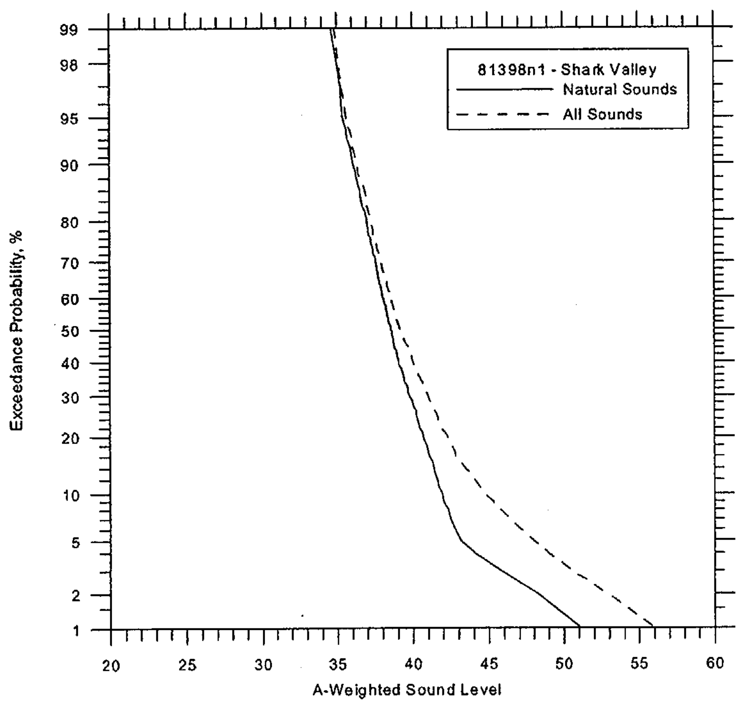
81398n1 - Shark Valley
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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10
5
2
1
20
25
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35
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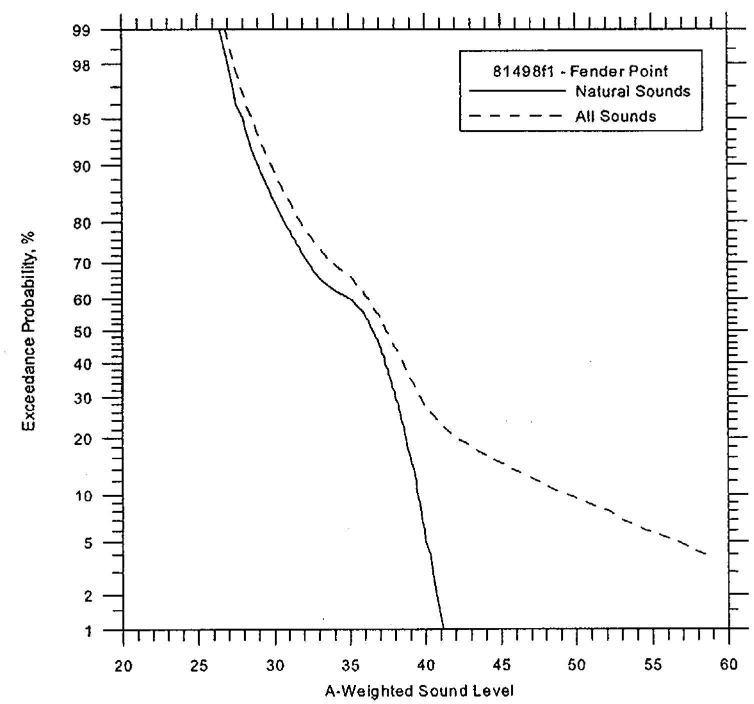
45
50
55
60
A-Weighted Sound Level


81498f1 - Fender Point
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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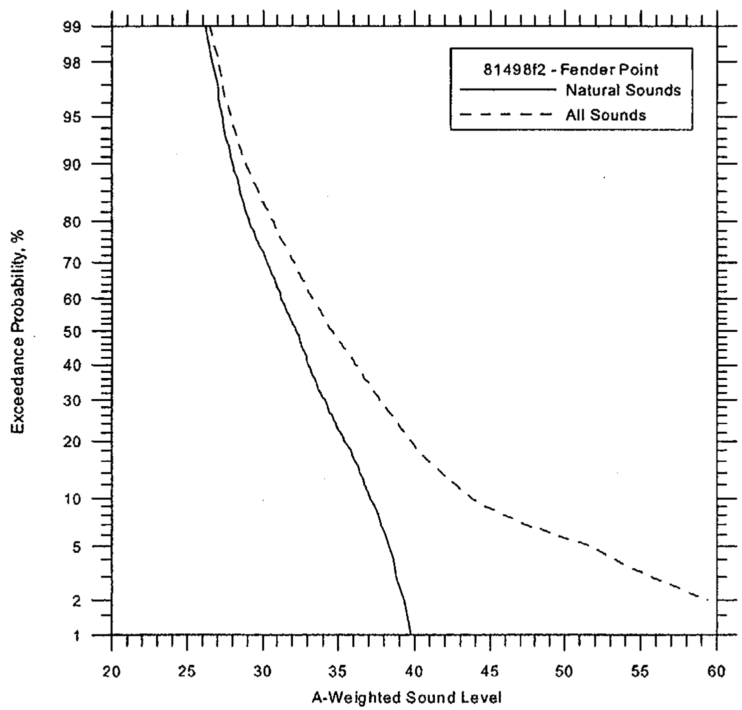
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81498f2 - Fender Point
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
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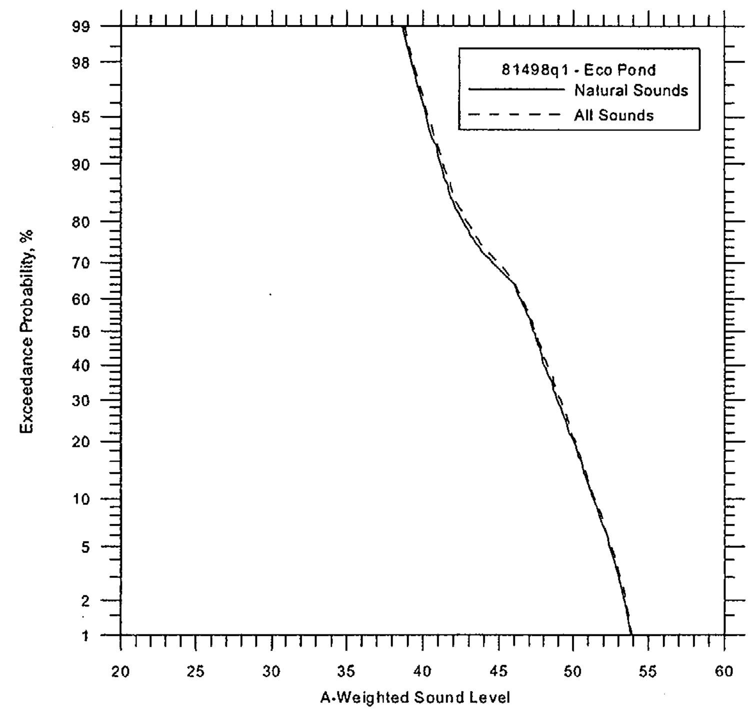
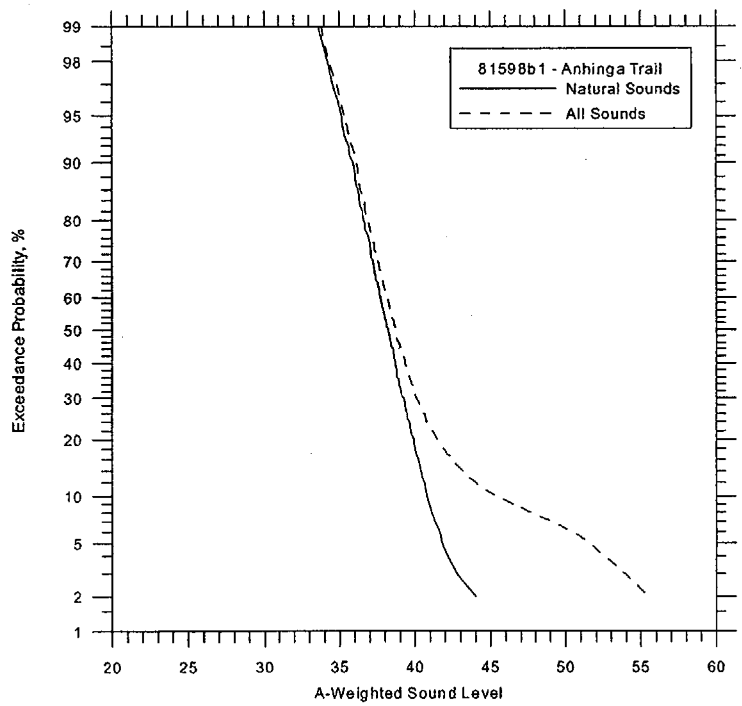
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81498q1 - Eco Pond
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81598b1 - Anhinga Trail
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
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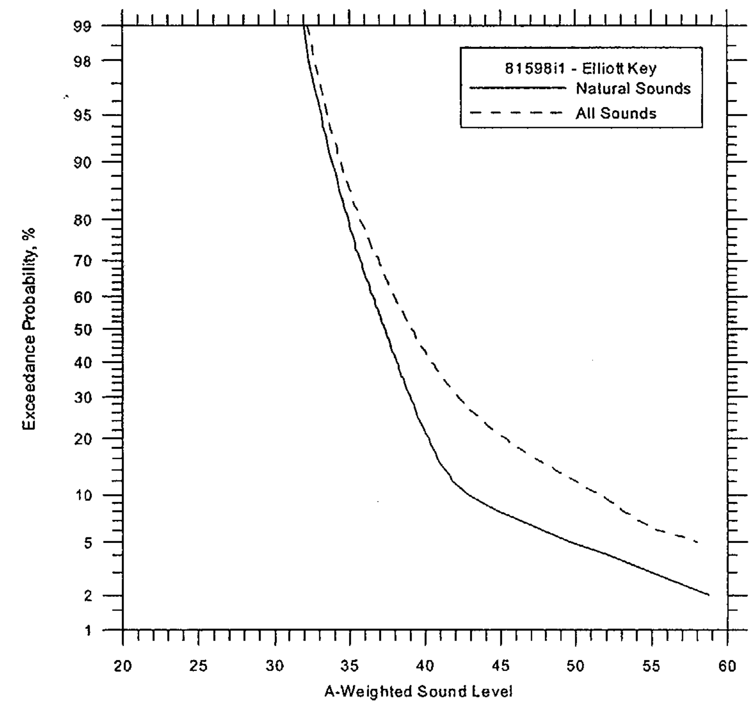
81598i1 - Elliott Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
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2
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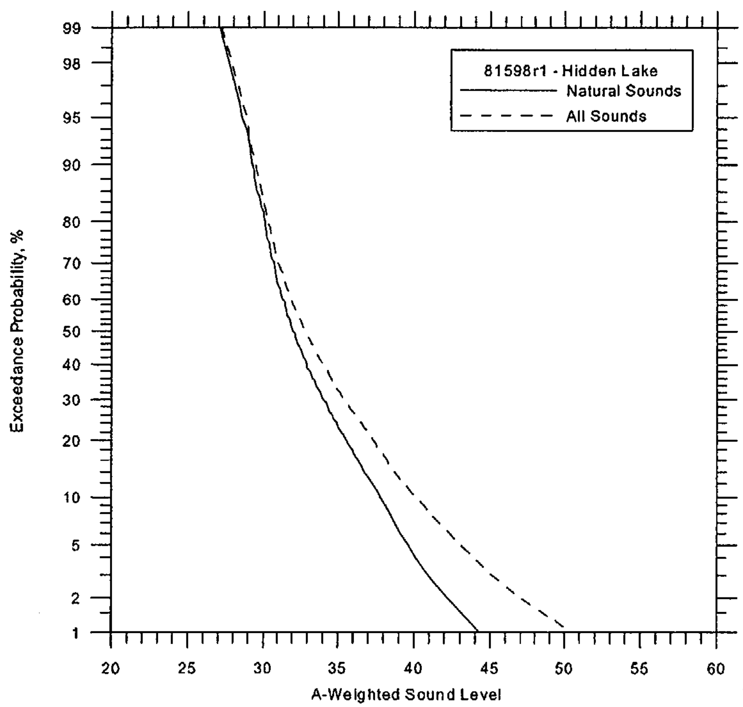
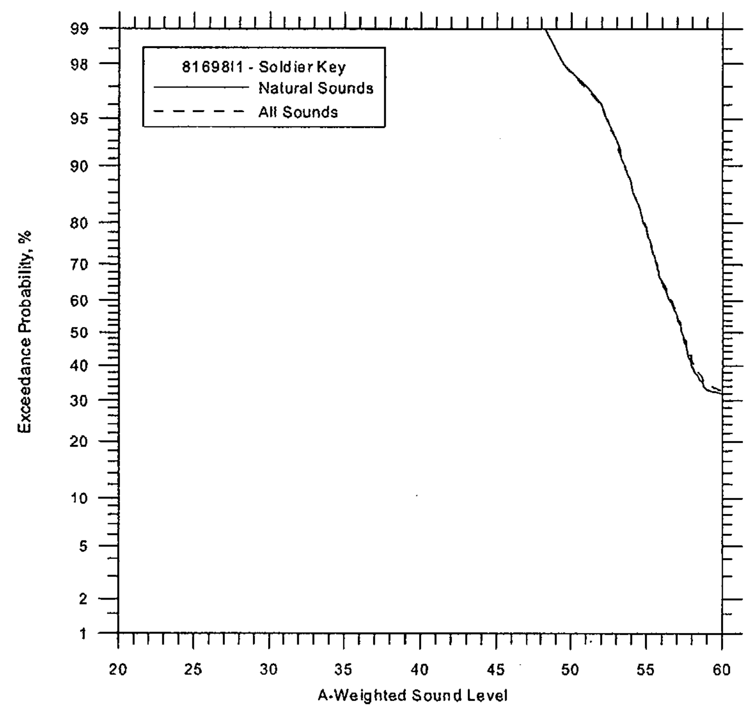
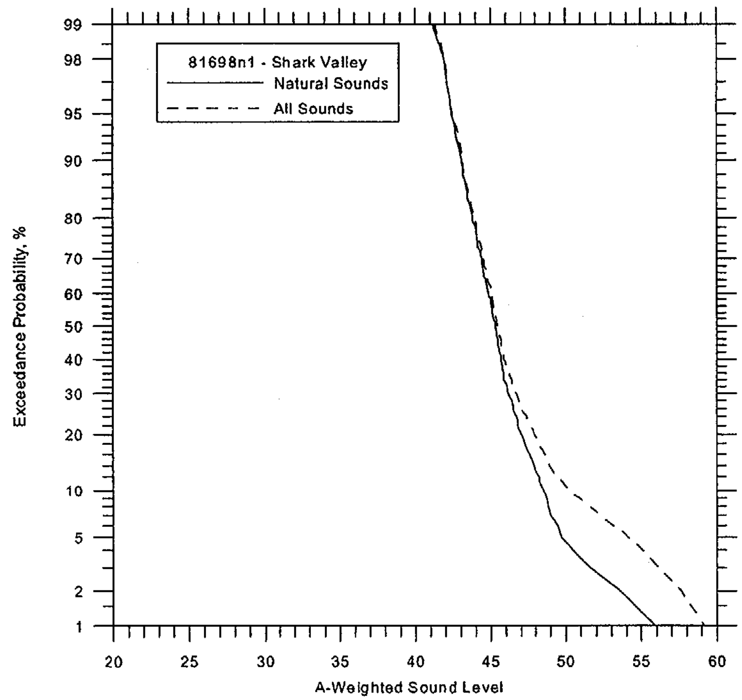
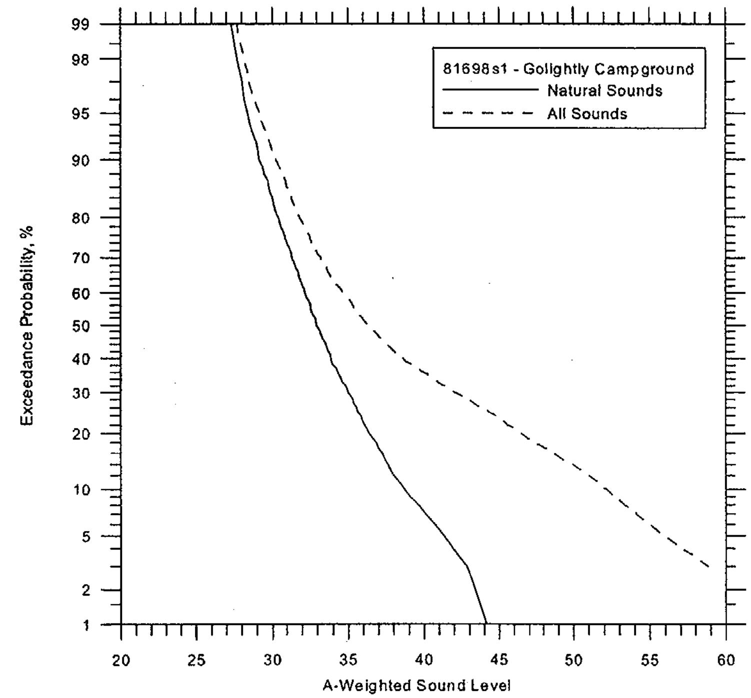
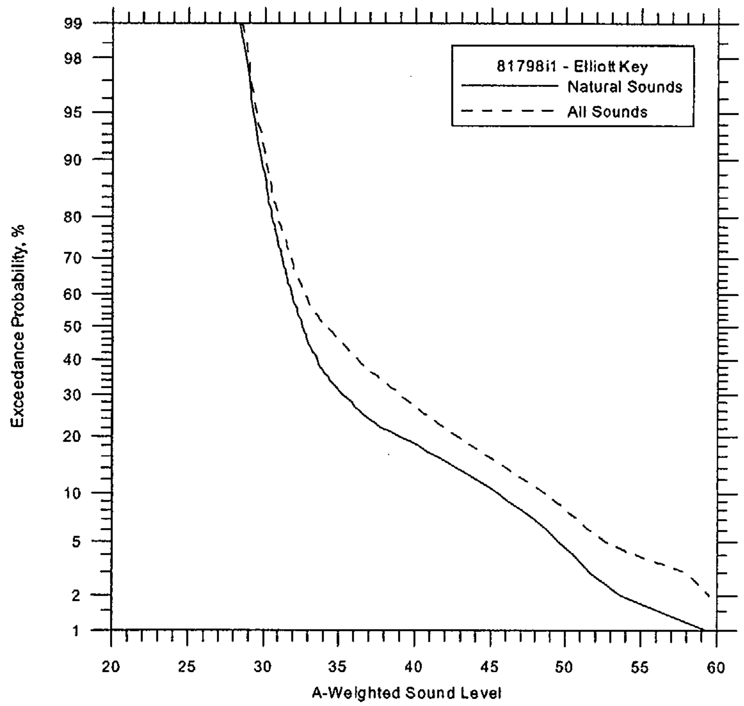
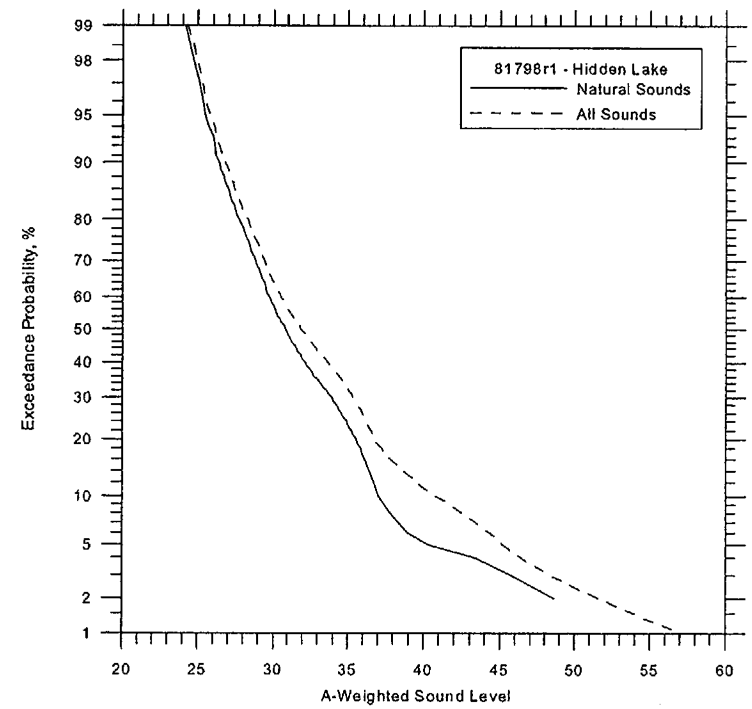

81598r1 - Hidden Lake
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level

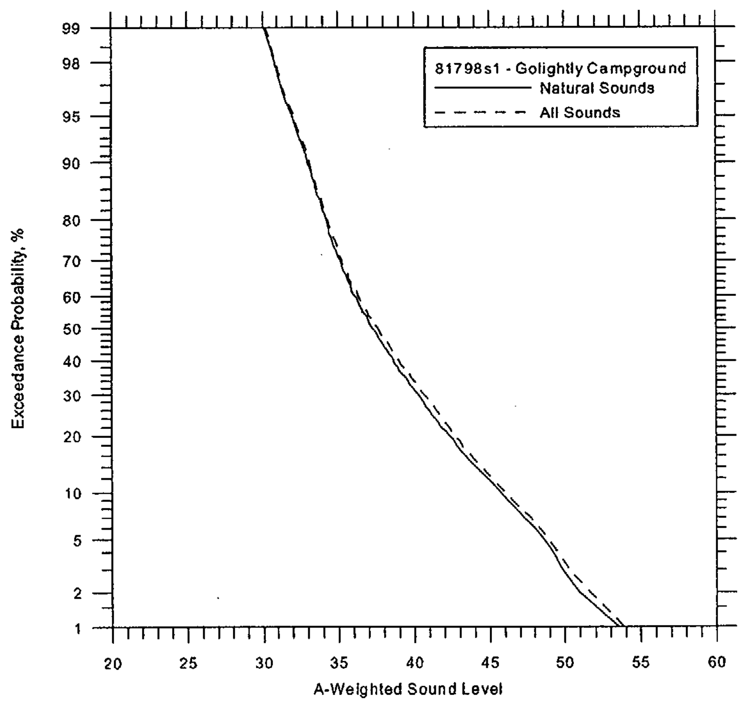

81698l1 - Soldier Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level

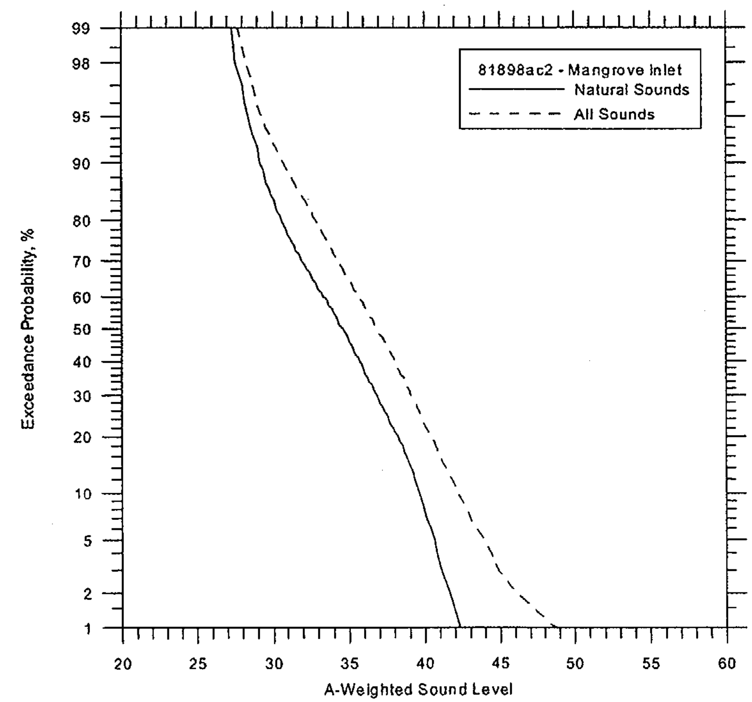

81698n1 - Shark Valley
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60

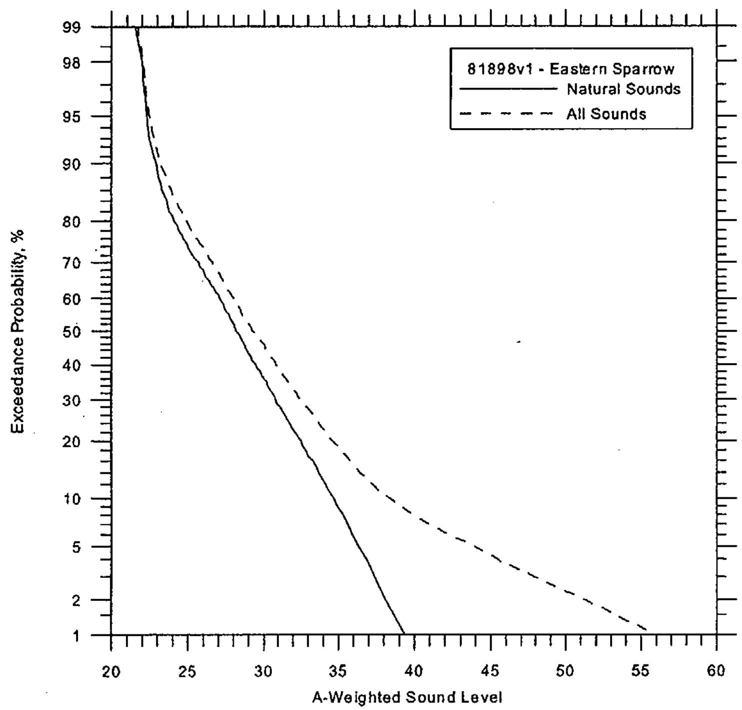

81698s1 - Golightly Campground
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60

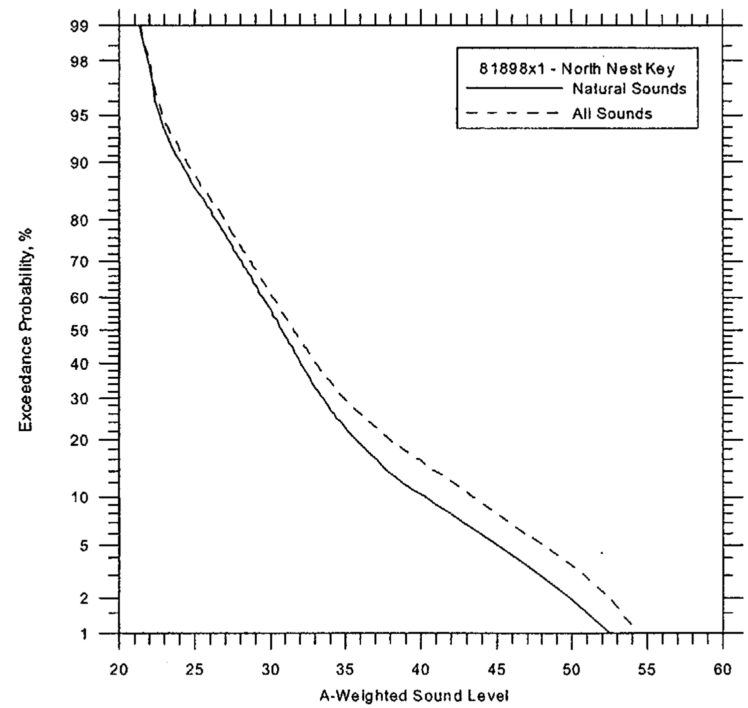

81798i1 - Elliott Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


81798r1 - Hidden Lake
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


81798s1 - Golightly Campground
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81898ac2 - Mangrove Inlet
Natural Sounds
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
A-Weighted Sound Level


81898v1 - Eastern Sparrow
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


81898x1 - North Nest Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
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30
20
10
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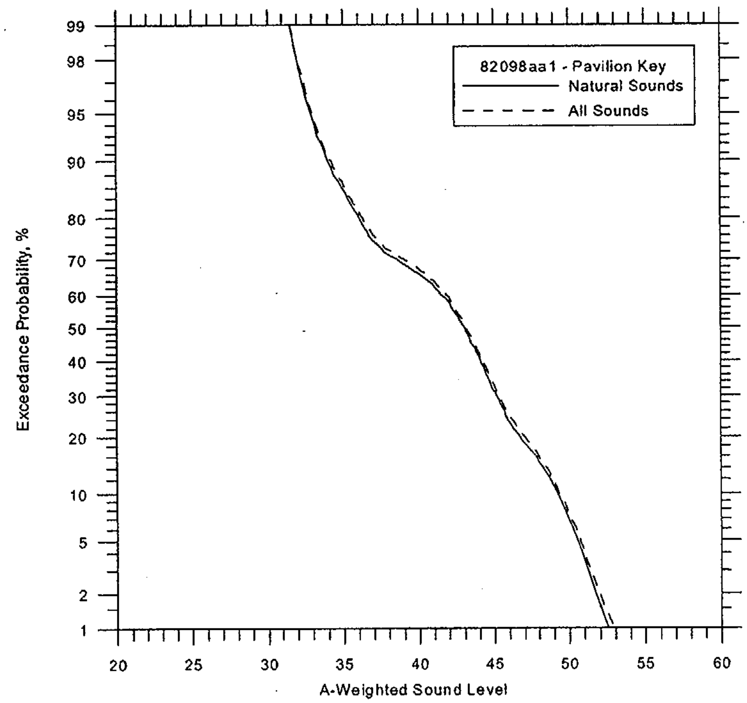
2
1
20
25
30
35
40
45
50
55
60


82098aa1 - Pavilion Key
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
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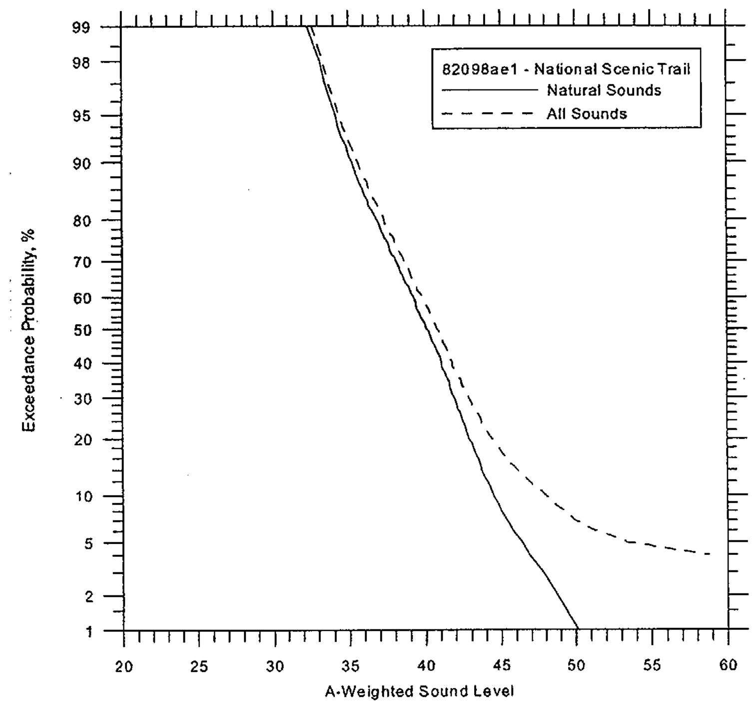
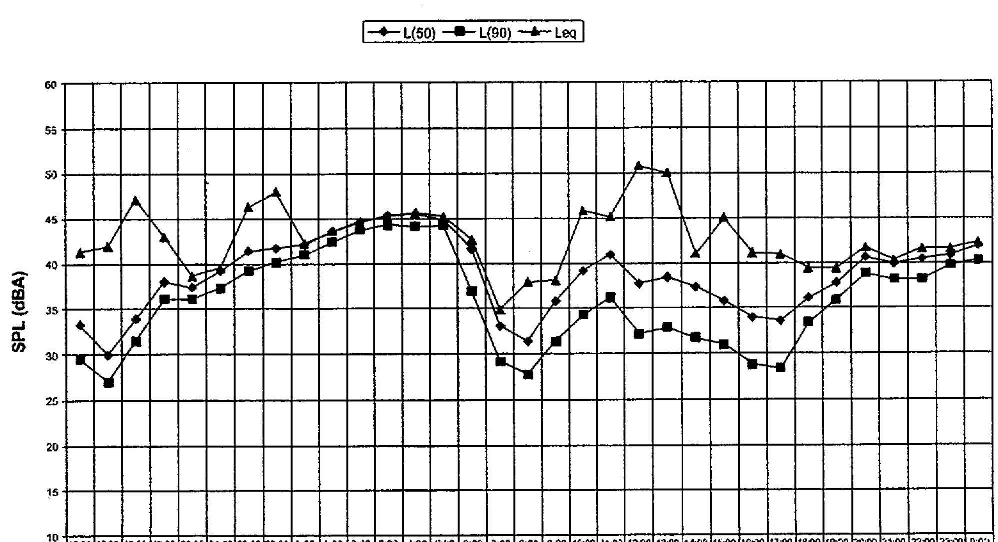
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60


82098ae1 - National Scenic Trail
Natural Sounds
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60

Appendix C

Hourly L50, L90, and Leq for Sanchez Industrial Design 1998 Measurements

Anhinga trail - Fri 11/20 to Sat 11/21

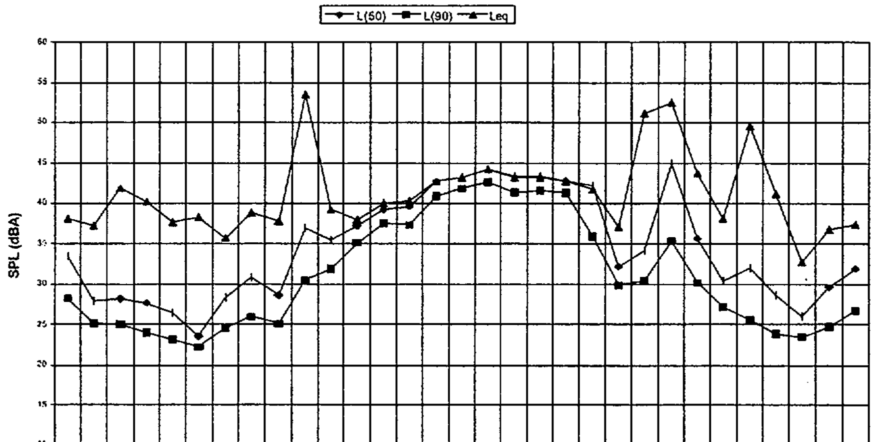


	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00
L(50)	33.3	30	33.9	38	37.4	39.2	41.4	41.7	42.1	43.6	44.6	45.3	45.5	44.9	41.9	33.1
L(90)	29.5	27	31.5	36.1	36.1	37.3	39.2	40.2	41	42.4	43.7	44.3	44.1	44.2	36.9	29.2
Leq	41.3	41.9	47.1	43	38.6	39.5	46.3	48	42.2	43.3	44.7	45.2	45.6	45.2	42.8	34.9

	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00
L(50)	31.4	35.8	39.1	40.9	37.7	38.4	37.3	35.8	34	33.6	36.1	37.8	40.6	39.9	40.4	40.8	41.9
L(90)	27.8	31.4	34.3	36.2	32.2	32.9	31.7	31	28.8	28.4	33.4	35.9	38.8	38.2	38.2	39.7	40.3
Leq	37.9	38.1	45.8	45.1	50.8	50	41	45	41.1	40.9	39.4	39.4	41.7	40.3	41.5	41.8	42.2

Hour

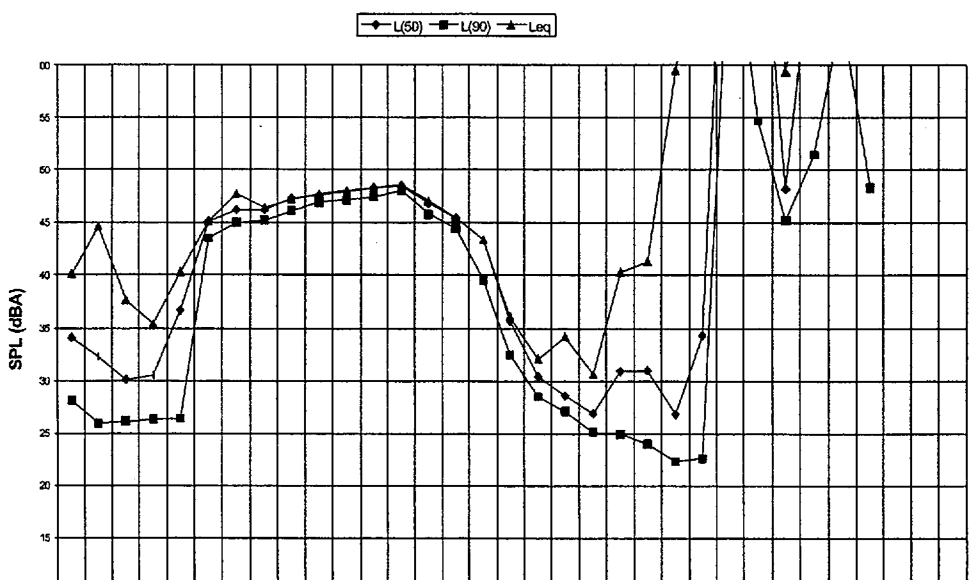
Big Cypress - 11 mile road - Tue 11/17 to Wed 11/18



	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
L(50)	33.6	27.9	28.2	27.7	26.6	23.6	28.4	30.8	28.7	36.9	35.6	37.2	39.2	39.6	42.7	43.2	44.2	43.3	43.3	42.8	42.2	32.2	34.2	44.9	35.7	30.4	32	28.7	26.1	29.6	31.9
L(90)	28.3	25.2	25	24	23.1	22.2	24.8	26	25.1	30.5	31.8	35.1	37.6	37.3	40.9	41.5	42.6	41.3	41.5	41.3	35.9	29.9	30.4	35.4	30.2	27.2	25.6	23.9	23.5	24.7	26.6
Leq	38.1	37.2	41.8	40.2	37.7	38.3	35.7	38.8	37.8	53.5	39.2	38	40	40.3	42.7	43.2	44.2	43.2	43.2	42.7	41.7	37.1	51.2	52.5	43.7	38.1	40.6	41.2	32.7	36.6	37.4

Hour

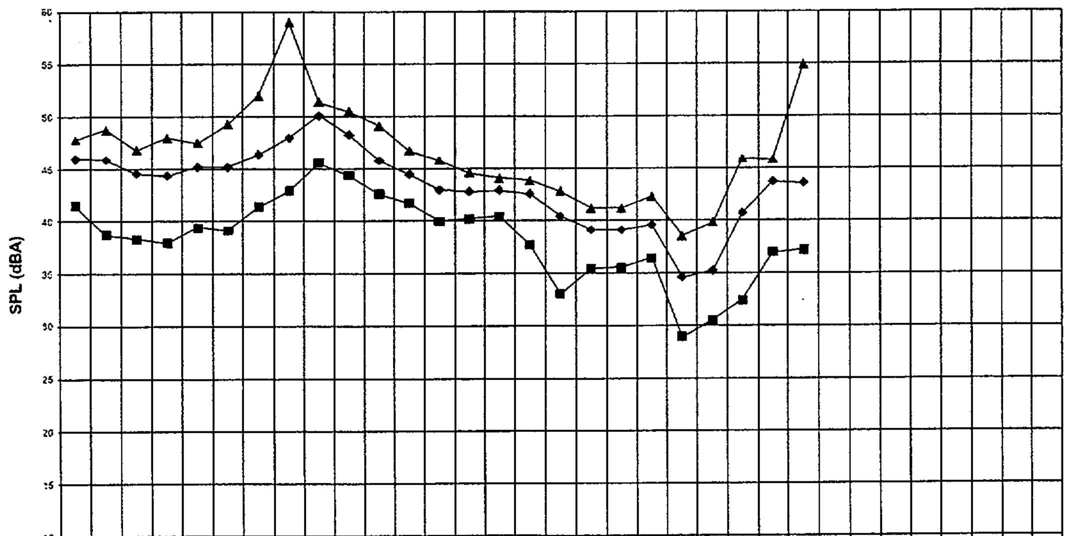
Canepatch - Thur 11/19 to Fri 11/20



	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00			
L(50)	34.1	32.3	30.1	30.5	36.7	45.1	46.2	48.2	47.3	47.6	47.9	48.3	48.5	46.8	45.4	43.4	35.7	30.4	28.6	26.9	30.9	31	26.8	34.3	92	79.7	48.2	72.9	72.5	66.6			
L(90)	28.1	25.9	26.1	26.3	26.4	43.5	45	45.2	46.1	46.9	47.1	47.4	48	45.6	44.4	39.6	32.5	28.5	27.1	25.1	24.9	24	22.3	22.6	75	54.7	45.2	51.5	64.8	48.3			
Leq	40.1	44.0	37.6	35.4	40.3	45.1	47.7	46.4	47.2	47.7	48	48.3	48.6	47	45.4	43.4	30.1	32.1	34.2	30.6	40.3	41.3	59.5	72.2	91.8	92.5	59.4	74.2	72.8	76.2			

Hour

Crocodile Lakes (Barnes Sound) - Fri 11/20 to Sat 11/21

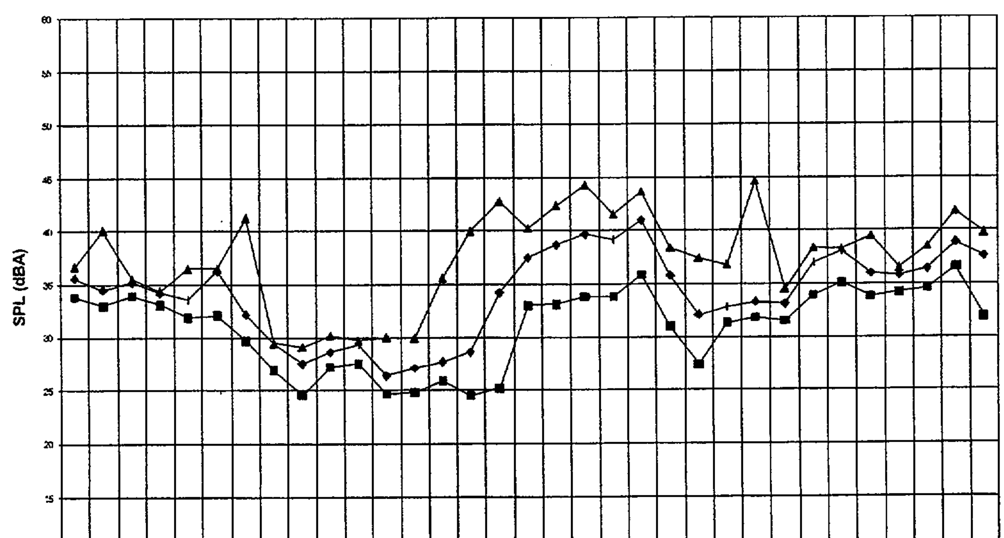


	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00
L(50)	46	45.9	44.6	44.4	45.2	45.2	46.4	48	50.1	48.3	45.8	44.5	43
L(90)	41.5	38.7	38.3	37.9	39.4	39.1	41.4	42.9	45.6	44.4	42.6	41.7	40
Leq	47.6	48.8	46.8	48	47.5	49.3	52	59	51.4	50.5	49.1	46.7	45.8

	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00
L(50)	42.8	42.9	42.6	40.4	39.1	39.1	39.8	34.6	35.2	40.7	43.7	43.6
L(90)	40.2	40.4	37.7	33	35.4	35.5	36.4	28.9	30.5	32.4	36.9	37.2
Leq	44.8	44.1	43.9	42.8	41.2	41.2	42.3	38.5	39.8	45.9	45.8	54.9

Hour

Ernest Coe - Tue 11/17 to Thur 11/19

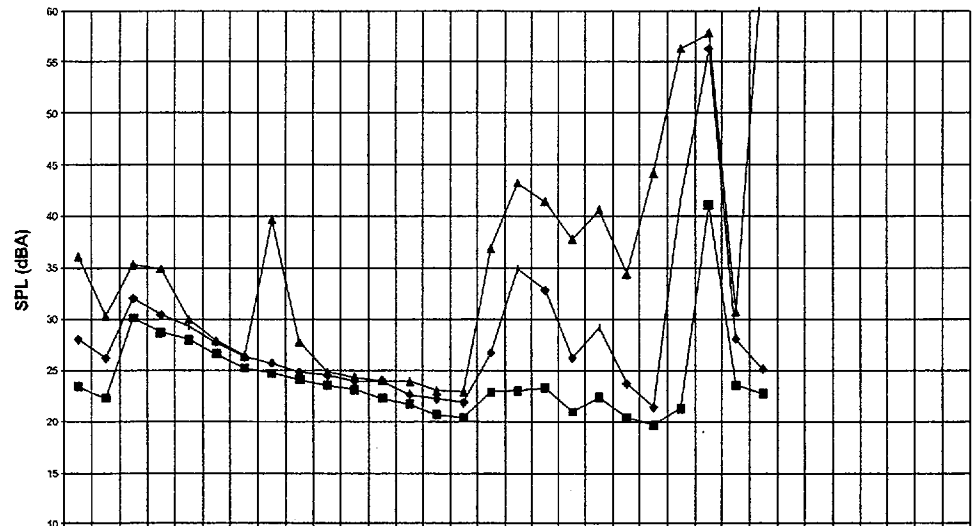


	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00
L(50)	35.6	34.5	35.2	34.2	33.6	36.3	32.2	29.4	27.5	28.0	29.3	26.4	27.1	27.7	28.6	34.2
L(90)	33.8	33	33.9	33.1	31.9	32.1	29.7	26.8	24.6	27.2	27.5	24.7	24.8	25.9	24.5	25.2
Leq	36.7	40.1	35.5	34.4	36.5	36.5	41.3	29.5	29.1	30.2	29.7	30	29.9	35.6	40	42.6

	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00
L(50)	37.5	38.7	39.7	39.2	41	35.8	32.1	32.8	33.3	33.3	37	38.1	36	35.8	36.4	38.9	37.6
L(90)	33	33.1	33.8	33.8	35.5	31	27.4	31.3	31.8	31.5	33.9	35.1	33.8	34.2	34.6	36.6	31.9
Leq	40.3	42.4	44.3	41.6	43.7	38.4	37.4	36.8	44.7	34.5	38.4	38.3	39.5	36.5	38.5	41.8	39.8

Hour

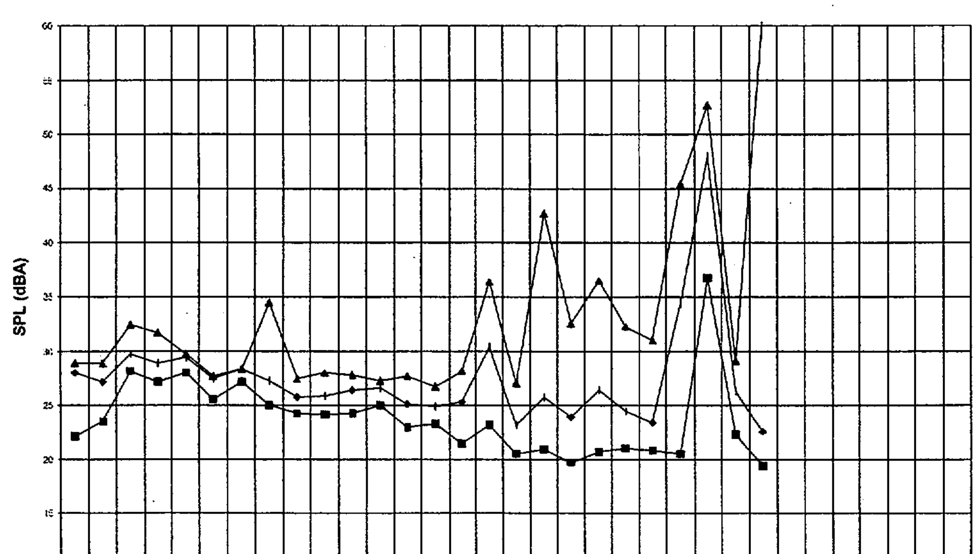
Pinelands East - Mon 11/16 to Tue 11/17



	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
L(50)	28	26.2	32	30.4	29.3	27.7	26.3	25.7	24.8	24.5	23.9	24	22.6	22.2	21.9	26.7	34.9	32.8	26.2	29.2	23.7	21.4	41.6	56.3	28.1	25.1
L(90)	23.4	22.3	30.1	28.7	28	26.6	25.2	24.7	24.1	23.5	23.1	22.3	21.7	20.7	20.4	22.9	23	23.3	21	22.4	20.4	19.7	21.3	41.1	23.8	22.7
Leq	36.1	30.3	35.3	34.9	30	27.9	26.4	39.7	27.8	24.8	24.3	24	23.9	23	22.9	36.9	43.2	41.4	37.8	40.6	34.4	44.2	58.3	57.8	30.7	65.5

Hour

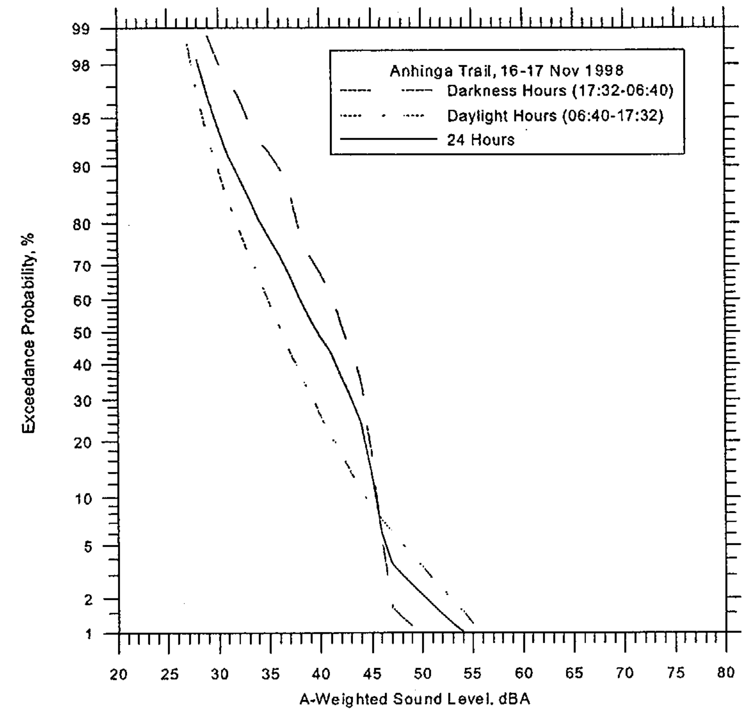
Pinelands North - Mon 11/16 to Tue 11/17

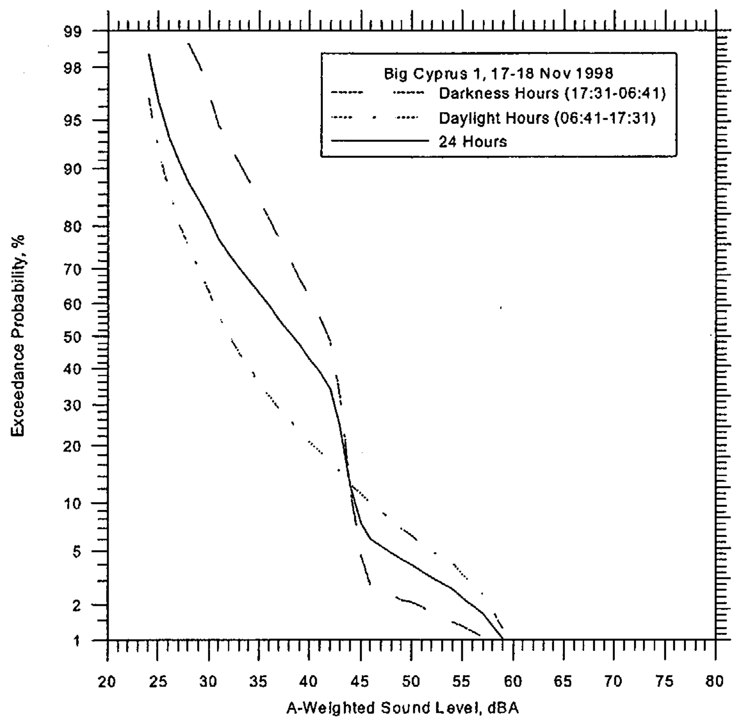


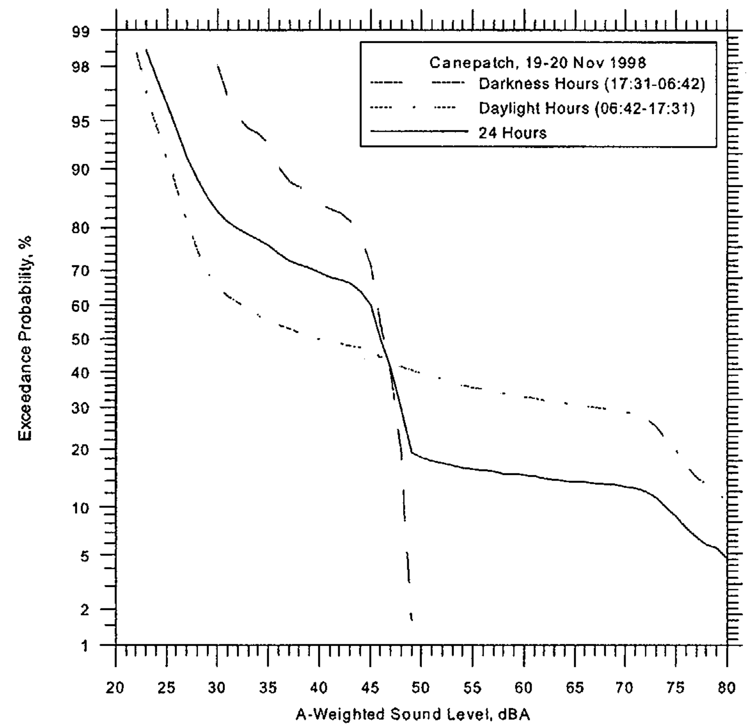
	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
L(50)	28	27.2	29.8	28.9	29.4	27.5	28.4	27.3	25.8	25.9	26.4	26.6	[illegible]	24.9	25.3	30.4	23.2	25.8	23.9	26.4	24.5	23.4	34.4	48	26.3	22.6
L(90)	[illegible]	23.5	28.2	27.2	28	25.6	27.2	25	24.3	24.2	24.3	25	23	23.3	21.5	23.2	20.5	20.9	19.7	20.7	21	20.8	20.5	36.8	22.3	19.4
Leq	28.9	28.9	32.5	31.7	29.8	27.7	28.4	34.5	27.5	28	27.8	27.3	27.7	26.8	28.2	36.4	27.1	42.7	32.6	36.5	32.3	[illegible]	45.4	52.7	[illegible]	60.7

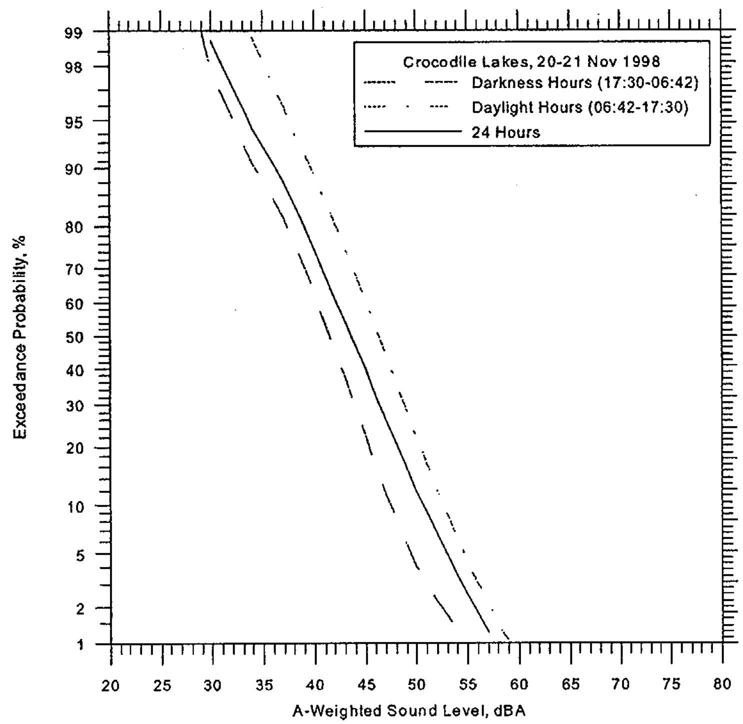
Hour

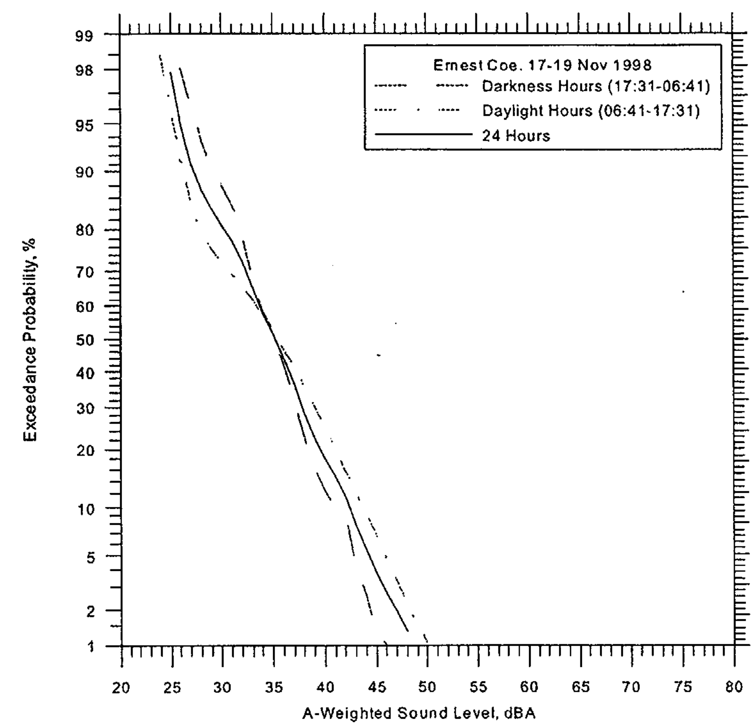
Appendix D
Exceedance Plots for Sanchez Industrial Design 1998 Measurements

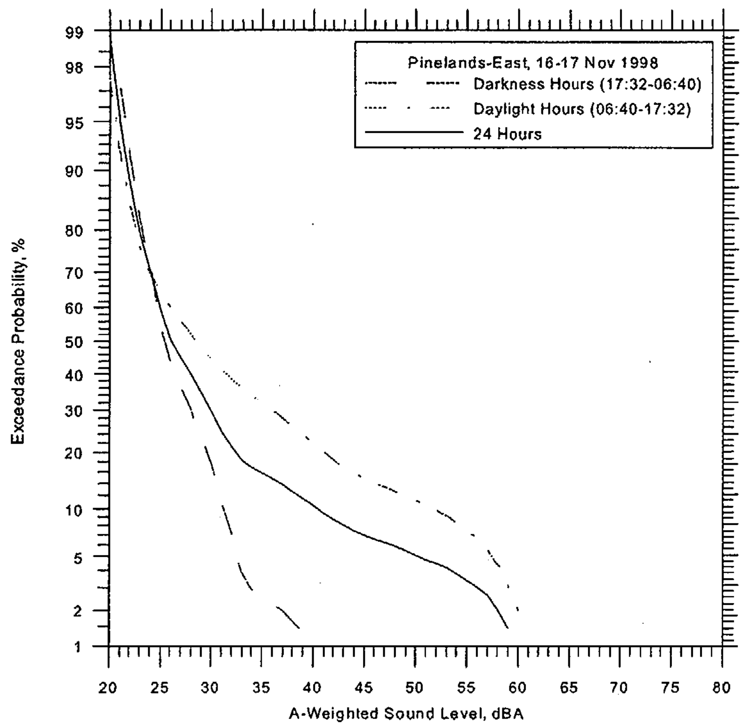



Big Cyprus 1, 17-18 Nov 1998
Darkness Hours (17:31-06:41)
Daylight Hours (06:41-17:31)
24 Hours
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level, dBA

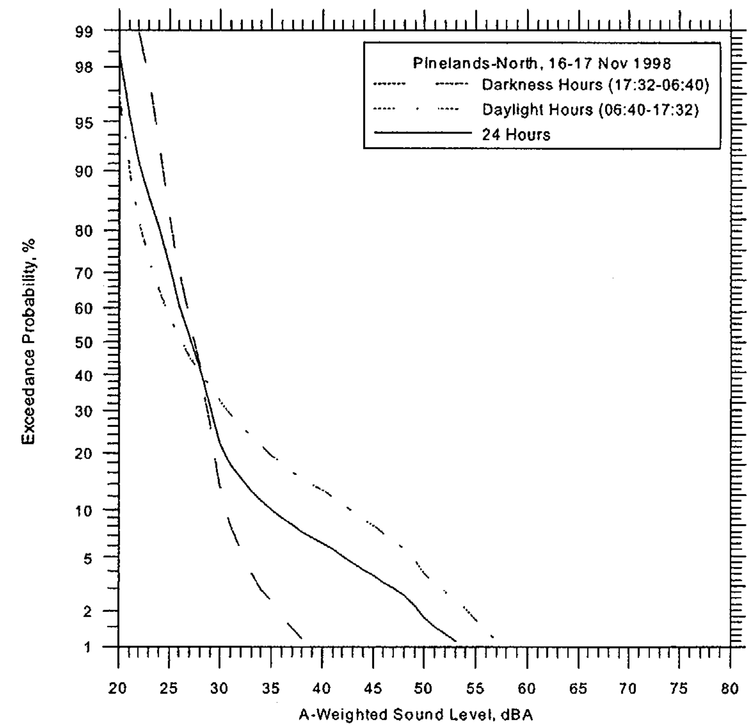

Canepatch, 19-20 Nov 1998
Darkness Hours (17:31-06:42)
Daylight Hours (06:42-17:31)
24 Hours
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level, dBA


Crocodile Lakes, 20-21 Nov 1998
Darkness Hours (17:30-06:42)
Daylight Hours (06:42-17:30)
24 Hours
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level, dBA

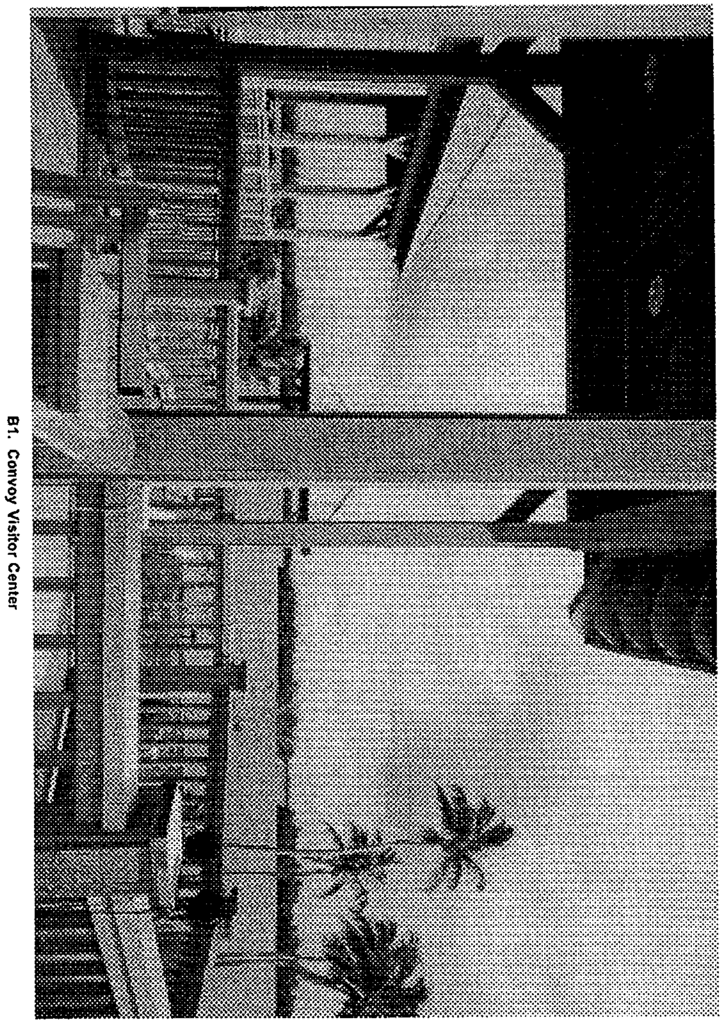

Ernest Coe. 17-19 Nov 1998
Darkness Hours (17:31-06:41)
Daylight Hours (06:41-17:31)
24 Hours
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level, dBA



Appendix D Exceedance Plots for SID 1998 Measurements The Soundscape in South Florida NP

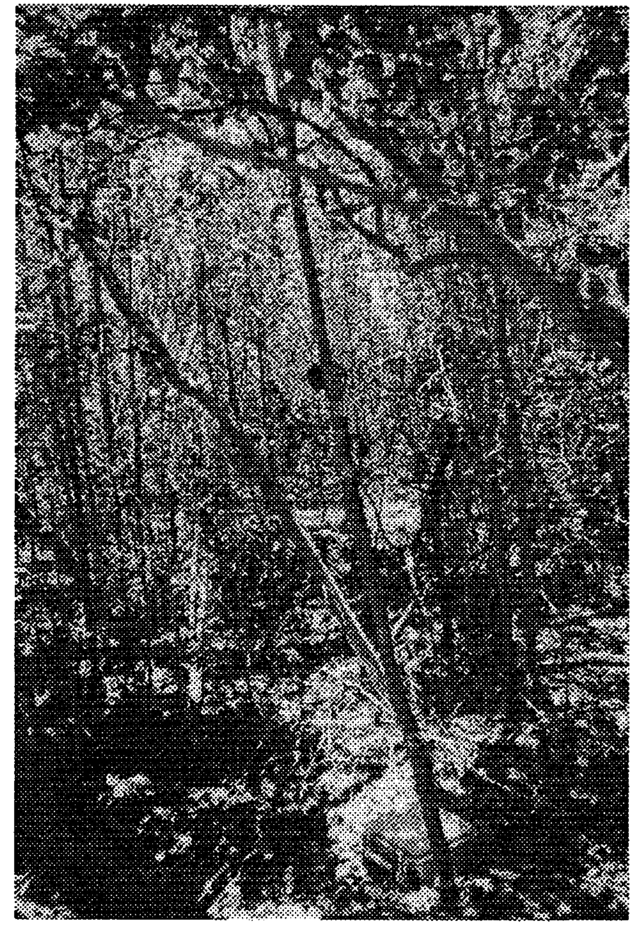


Appendix E
Pictures of Wyle 1999 Monitoring Sites



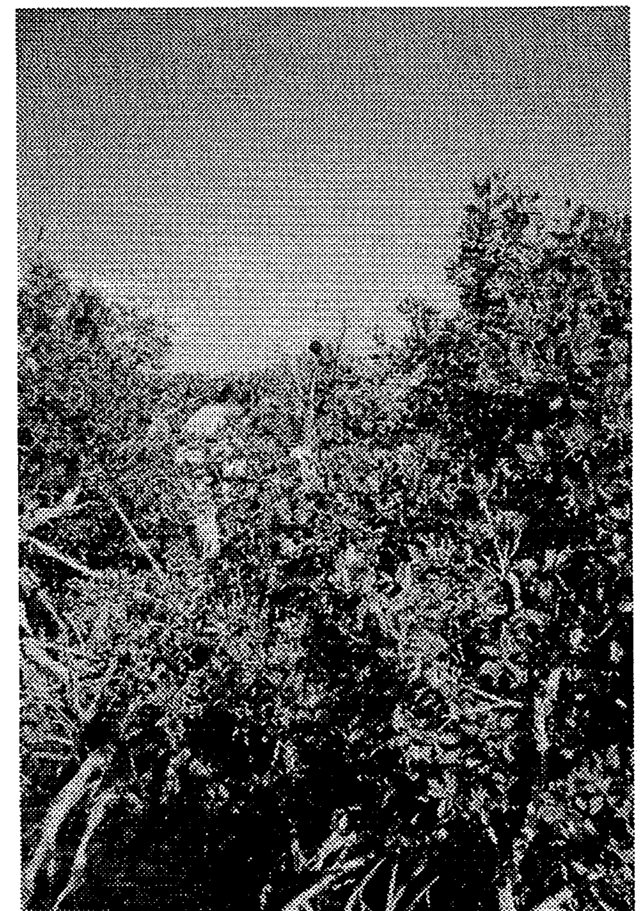
B1. Convoy Visitor Center

B2. Elliot Key Picnic Grounds

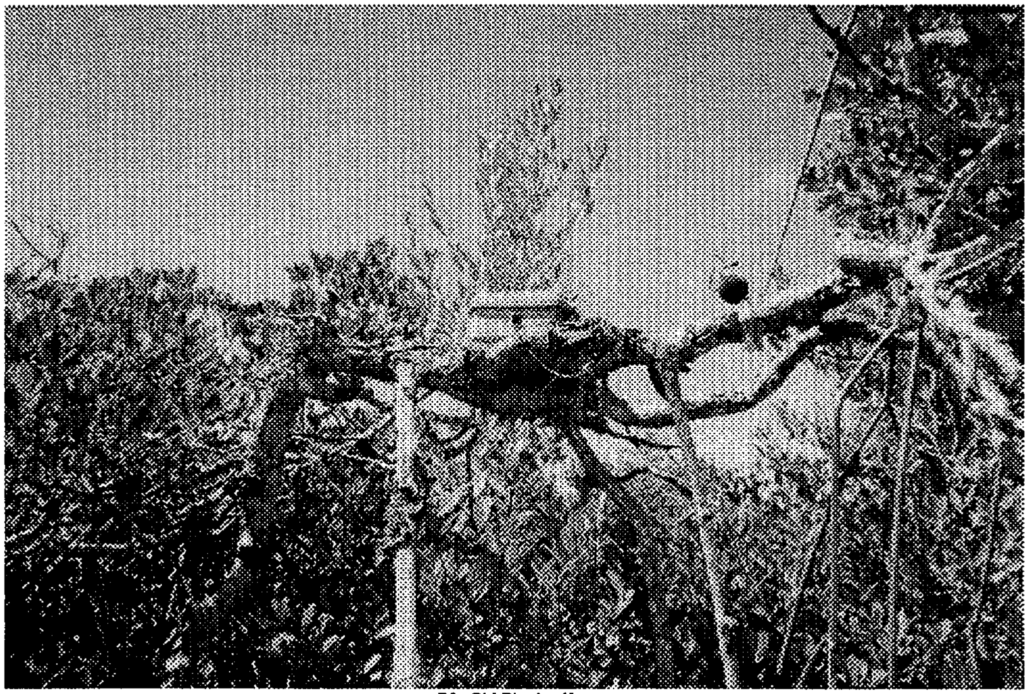


B3 Hiking Trail North of Elliot Key

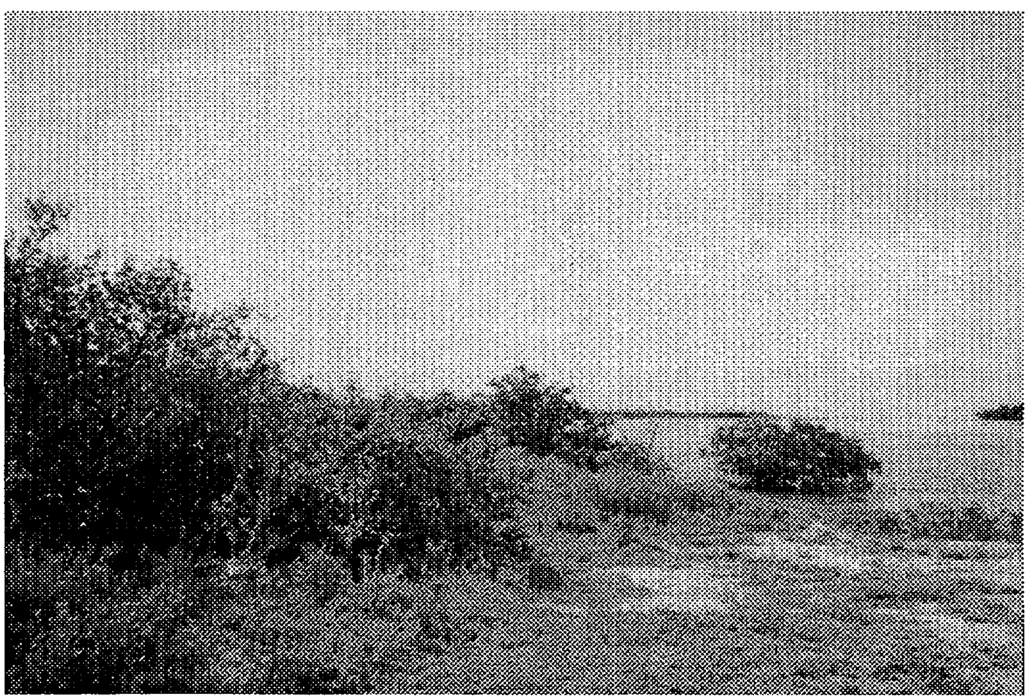
B4. Hiking Trail South of Elliot Key
Missing Photo



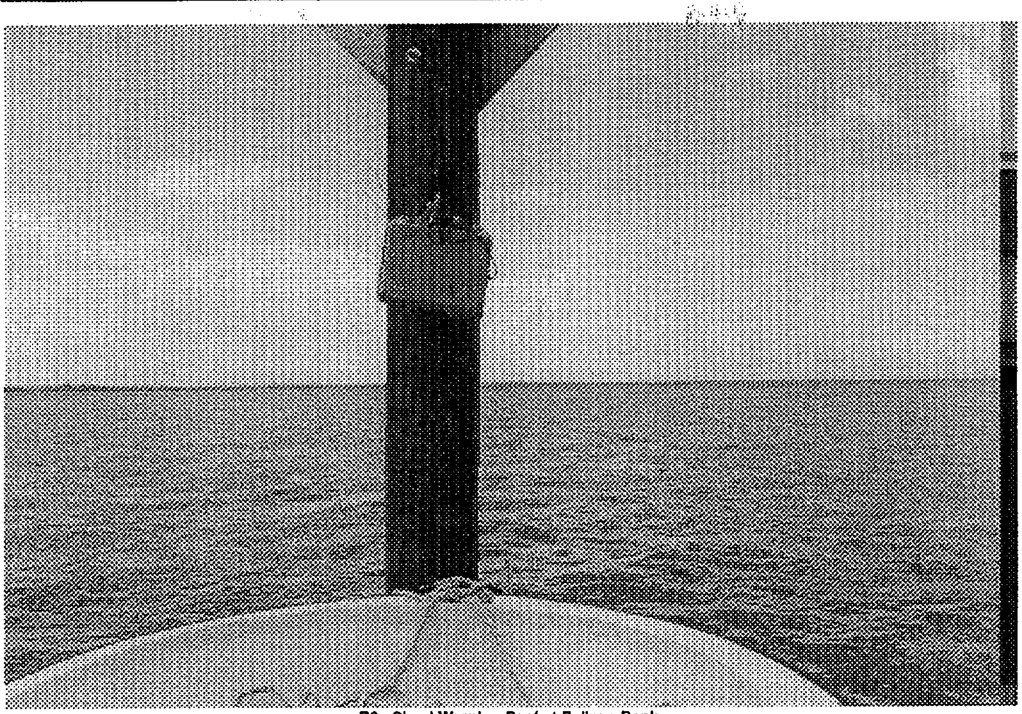
B5. Long Arsenicker Key



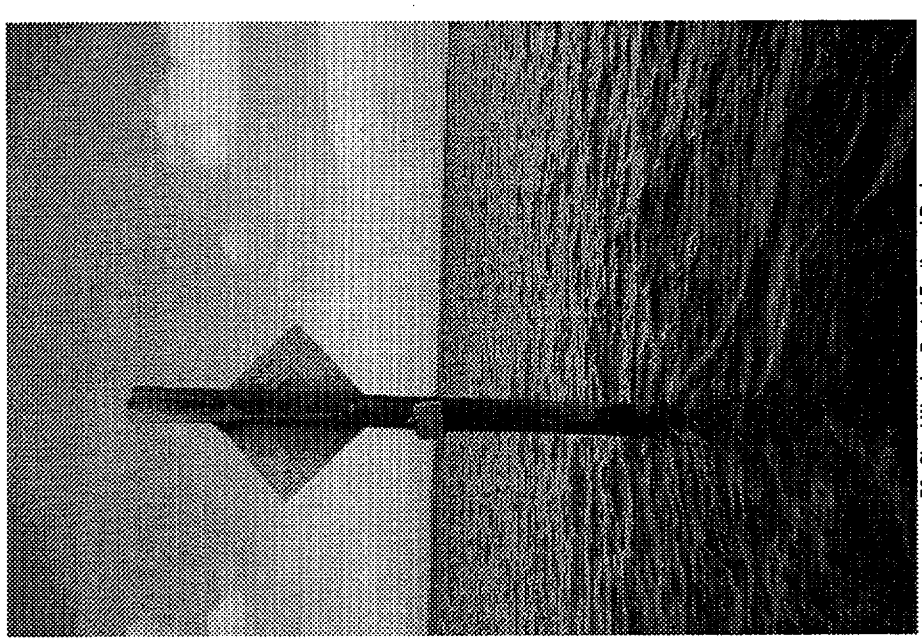
B6. Old Rhodes Key



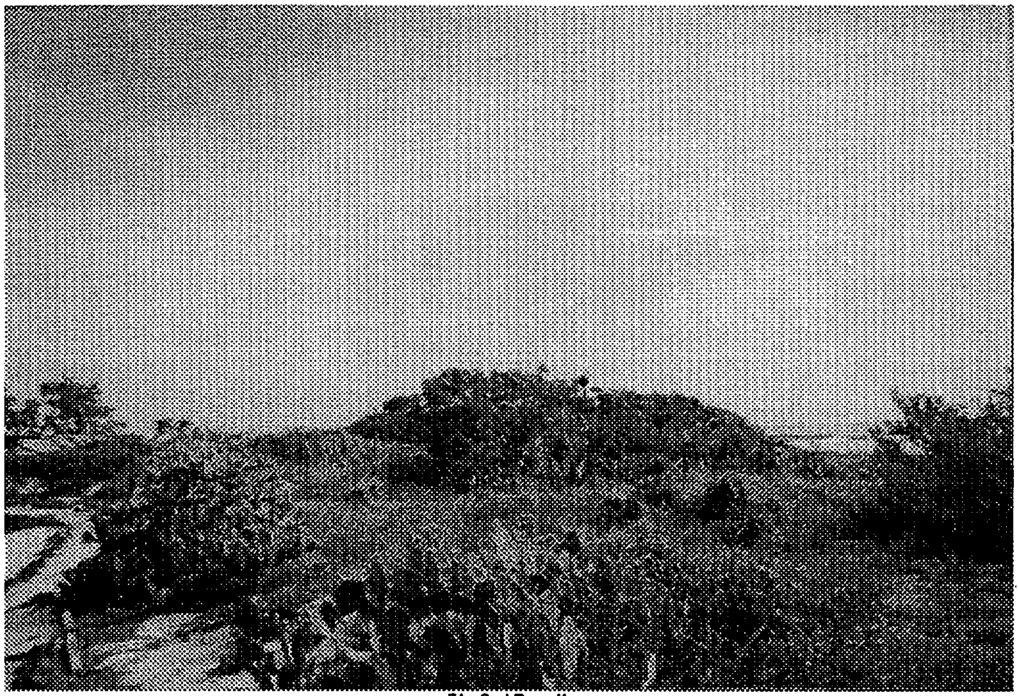
B7. Adam's Key



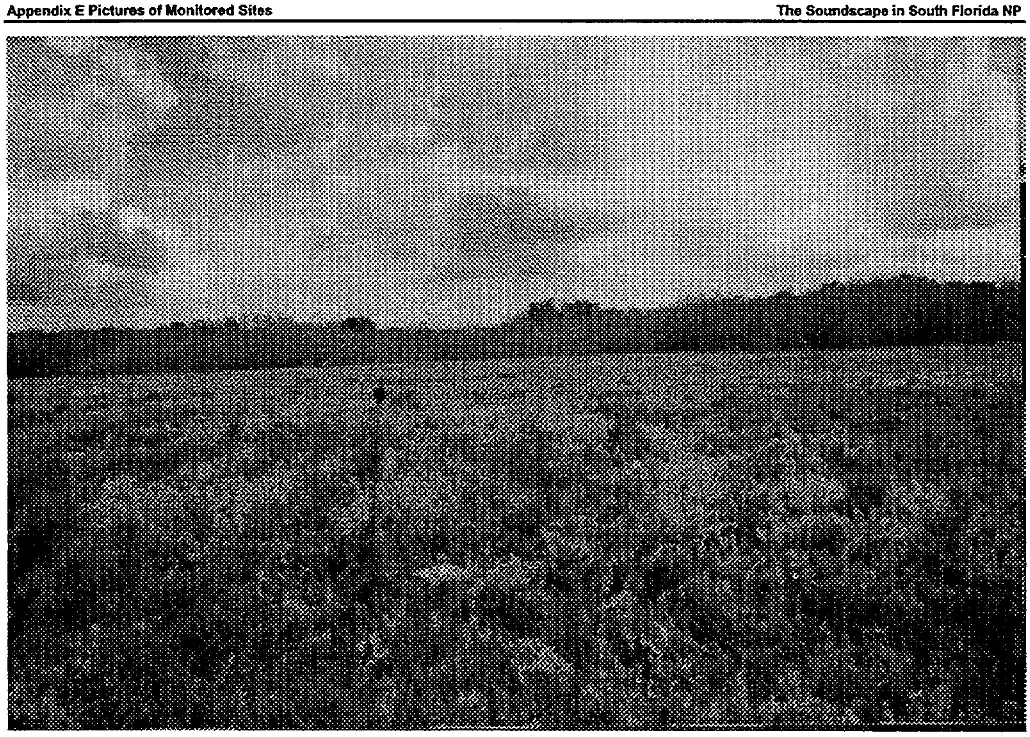
B9. Shoal Warning Post at Pelican Bank



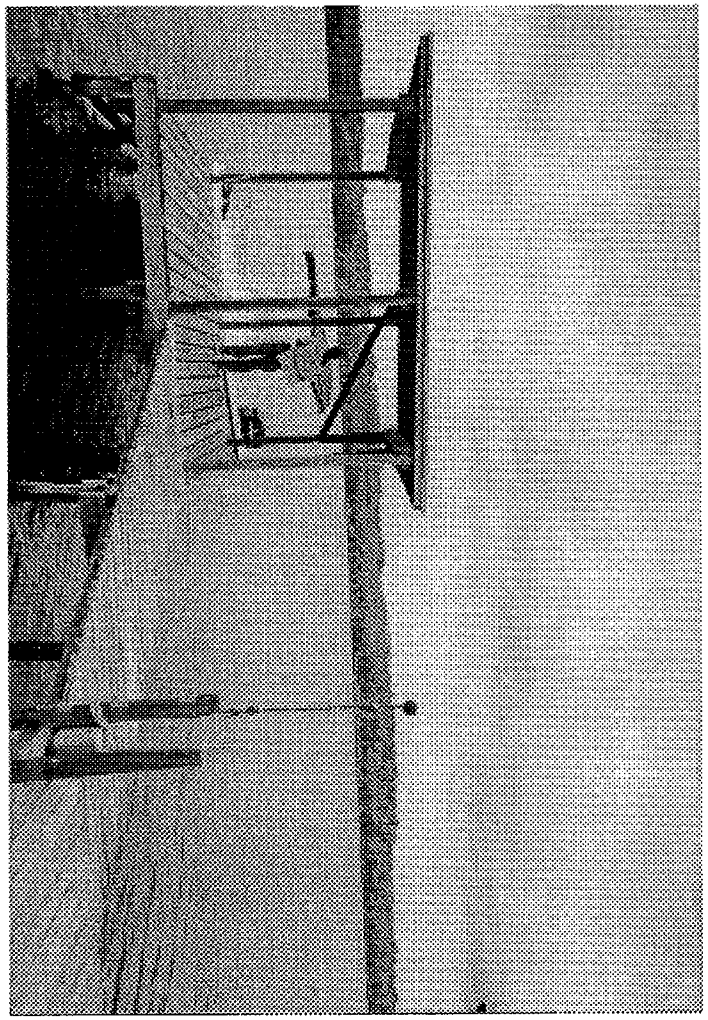
B8. Shoal Warning Post at Feathered Bank



E1. Carl Ross Key

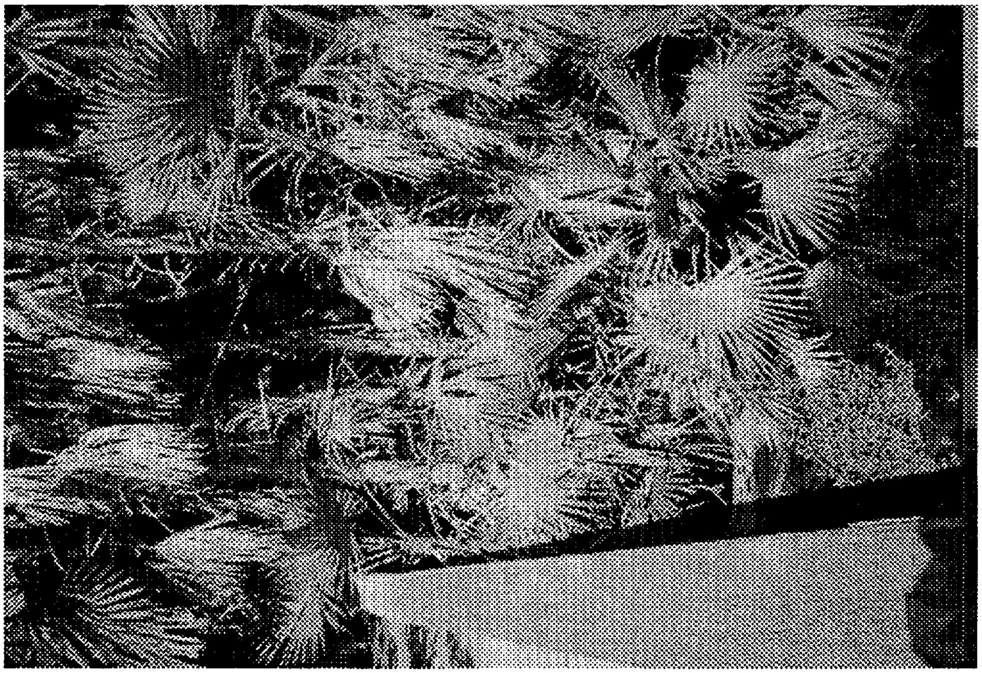


E2. Coastal Prairie Trail



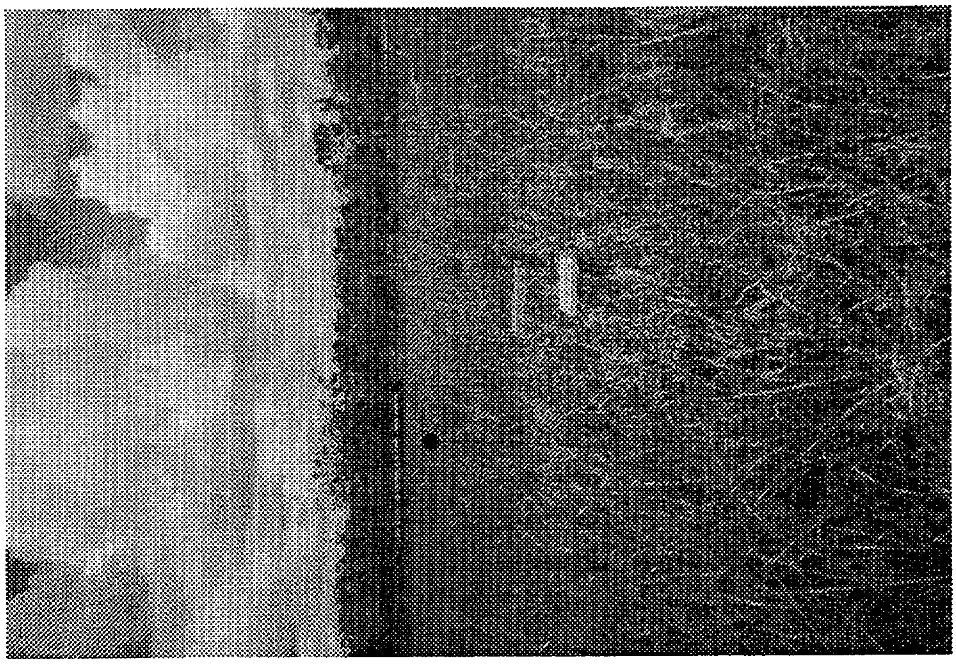
E3. South Joe River Chickee

E-4. North Harney River Shoreline
Photo Missing



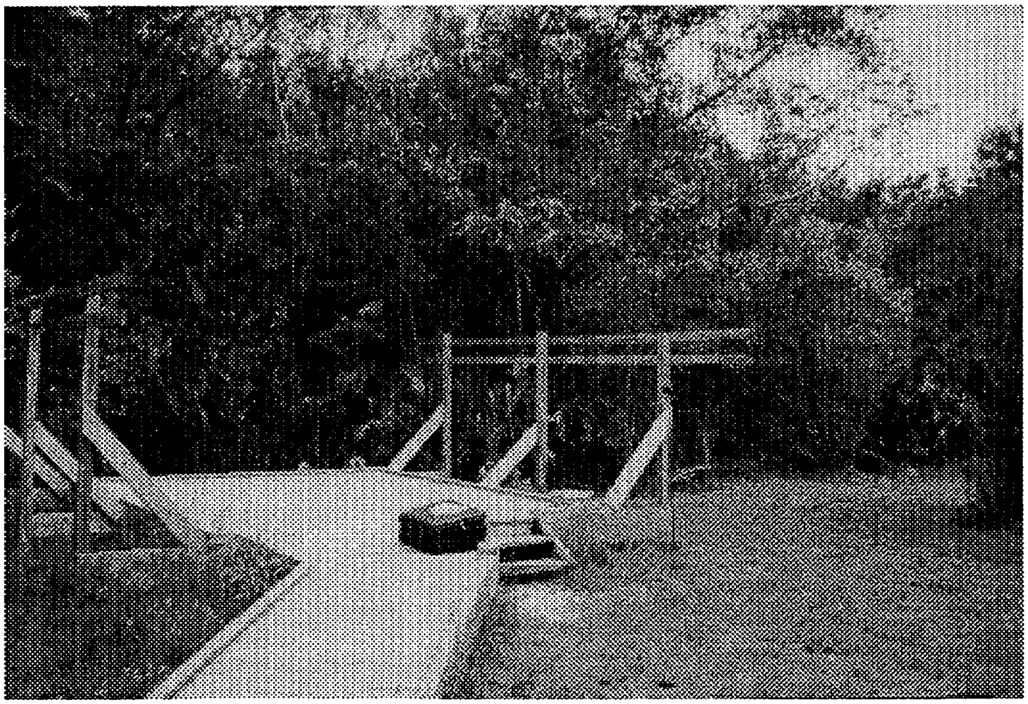
E6. Outside Mahogany Hammock

E5. Mangrove Forest along North Harney River

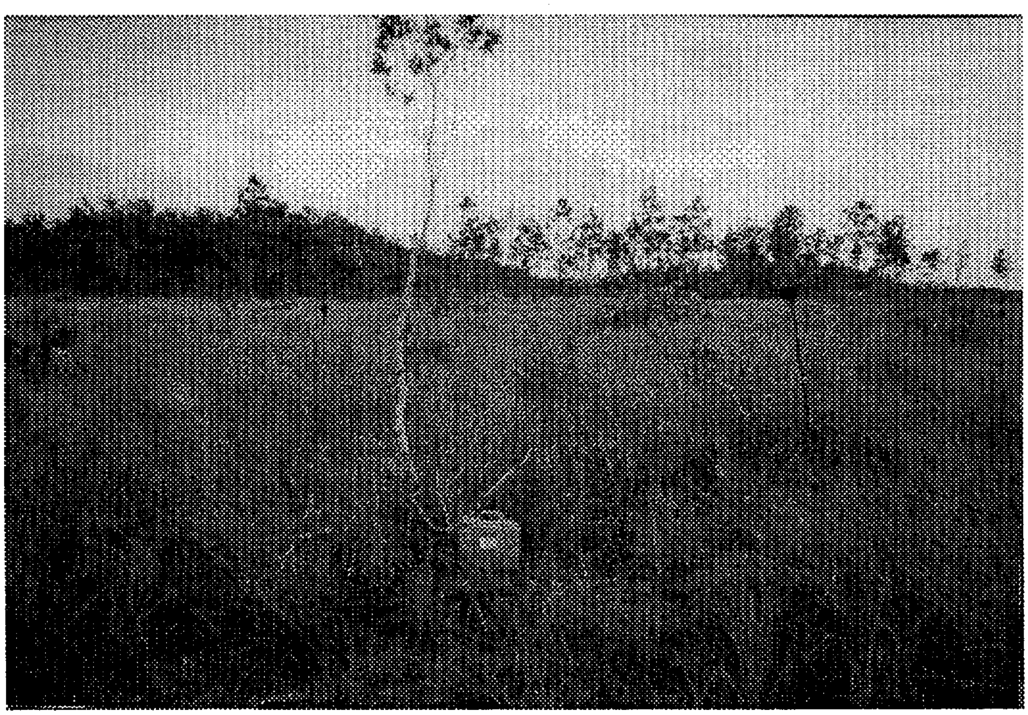


E8. Prairie in Taylor Slough Near Ernest Coe Campsite

E7. Inside Mahogany Hammock



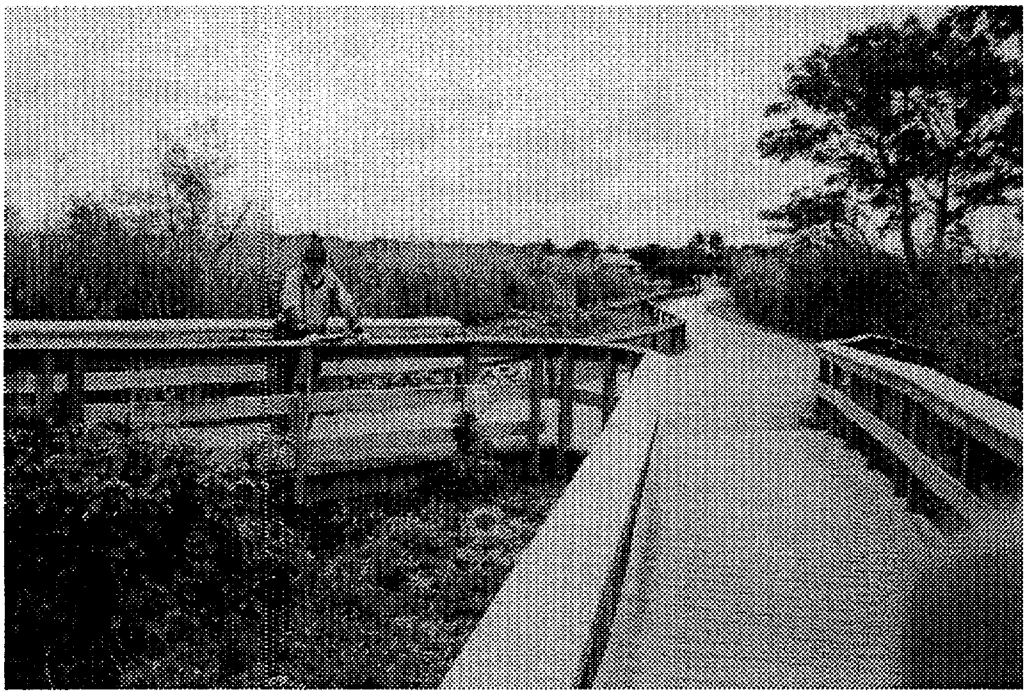
E9. Hidden Lake Education Center



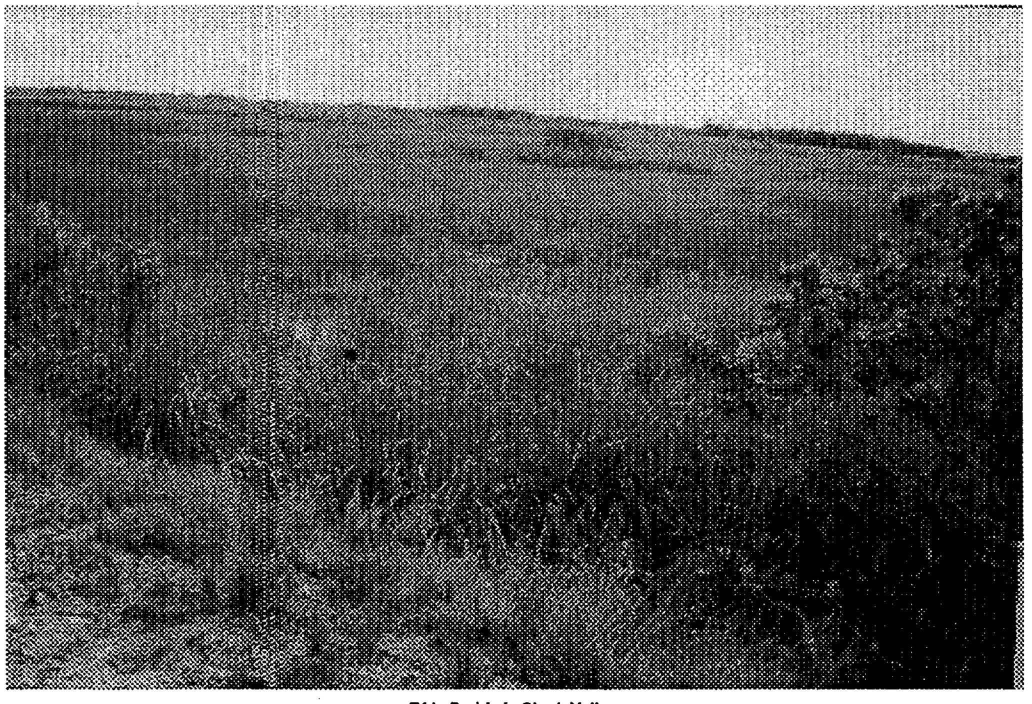
E10a. Transition Zone Between Marl Prairie and Pinelands

E10b. Transition Zone Between Marl Prairie and Pinelands

E11. Long Pine Key Campground



E12. Anhinga Trail



E14. Prairie in Shark Valley

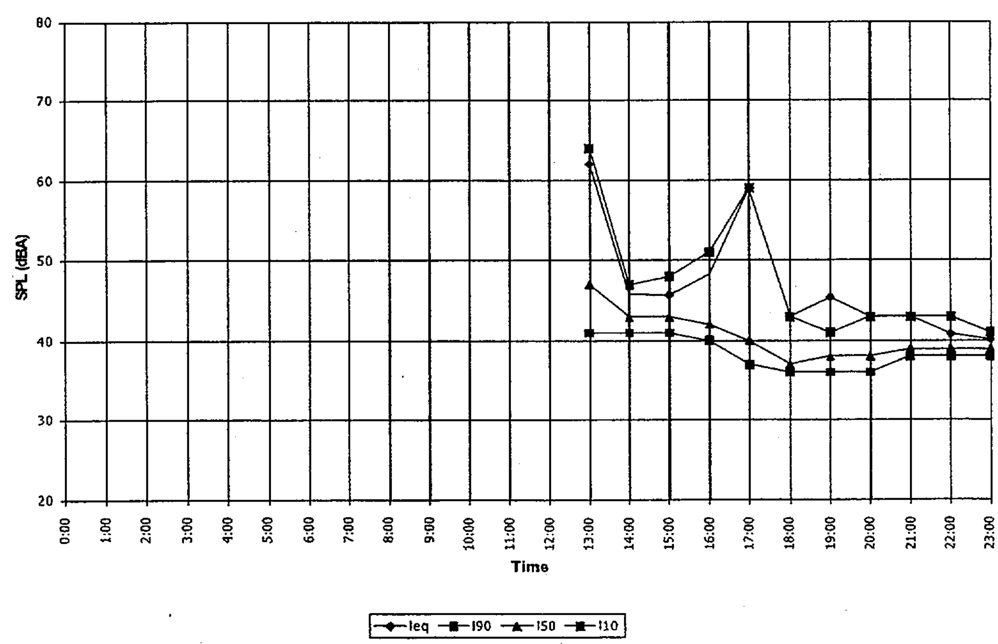
E15. Chekika

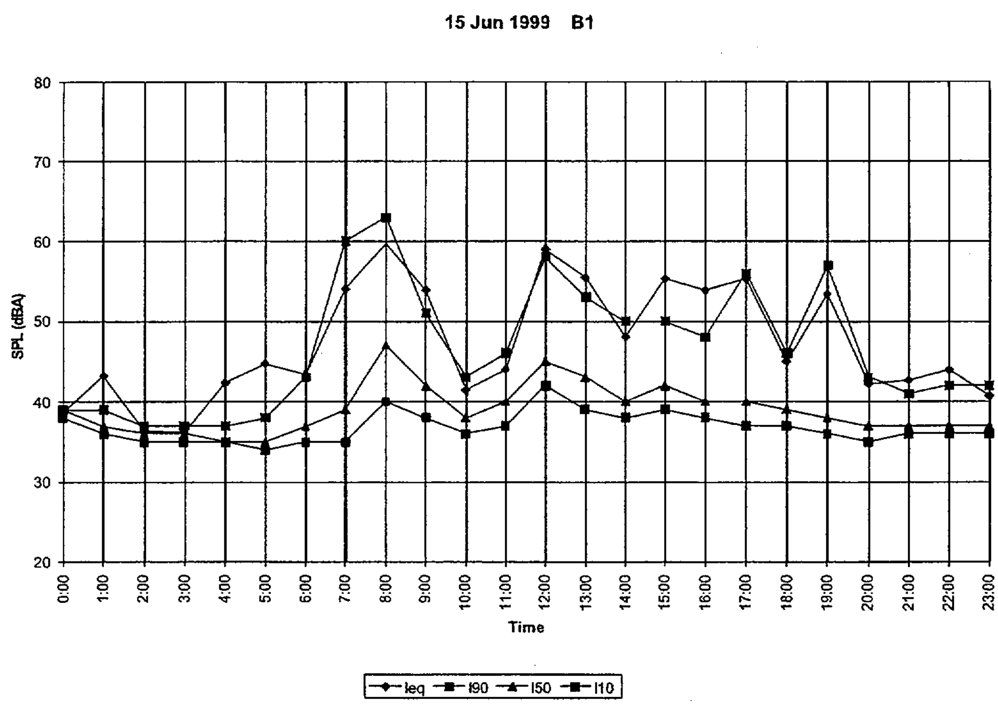
Appendix F
Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements

WR 99-17

wyle

14 Jun 1999 B1




15 Jun 1999 B1
SPL (dBA)
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18:00
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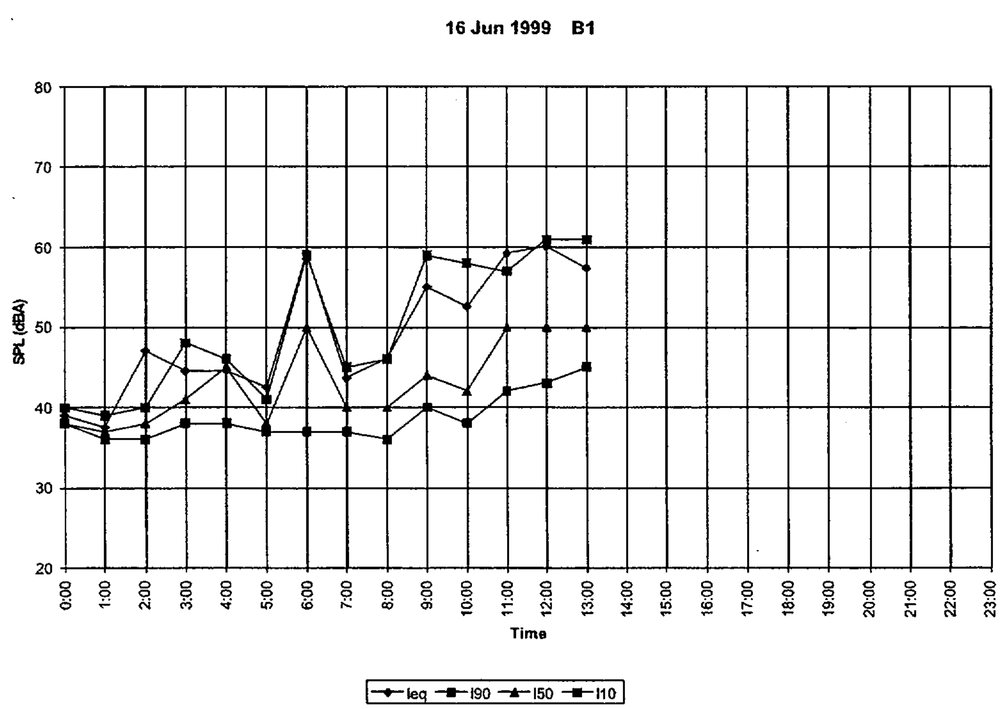
21:00
22:00
23:00
Time
leq
l90
l50
l10


16 Jun 1999 B1
SPL (dBA)
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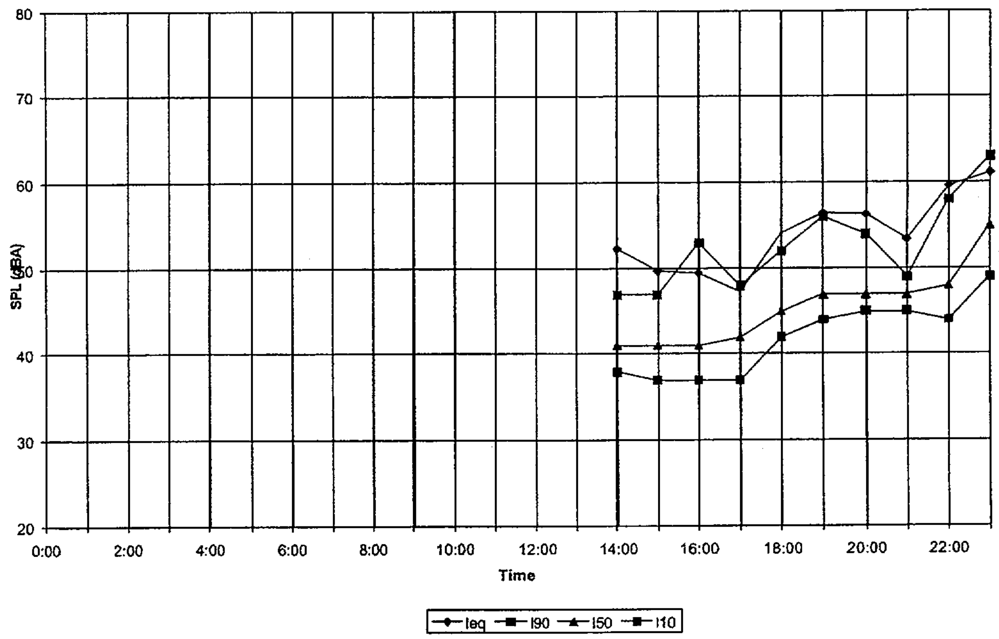
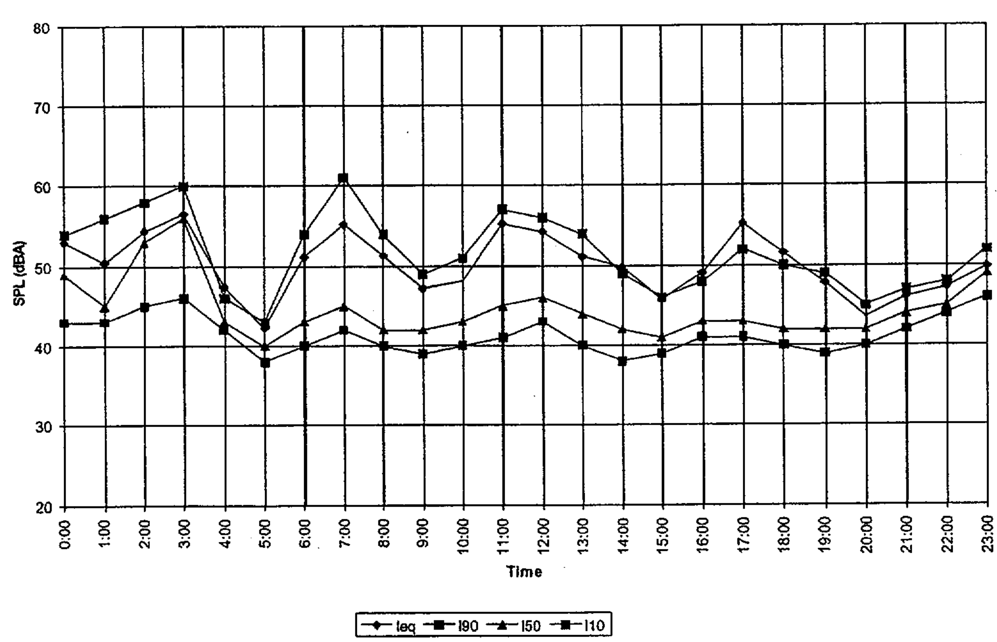
23:00
Time
leq
l90
l50
l10

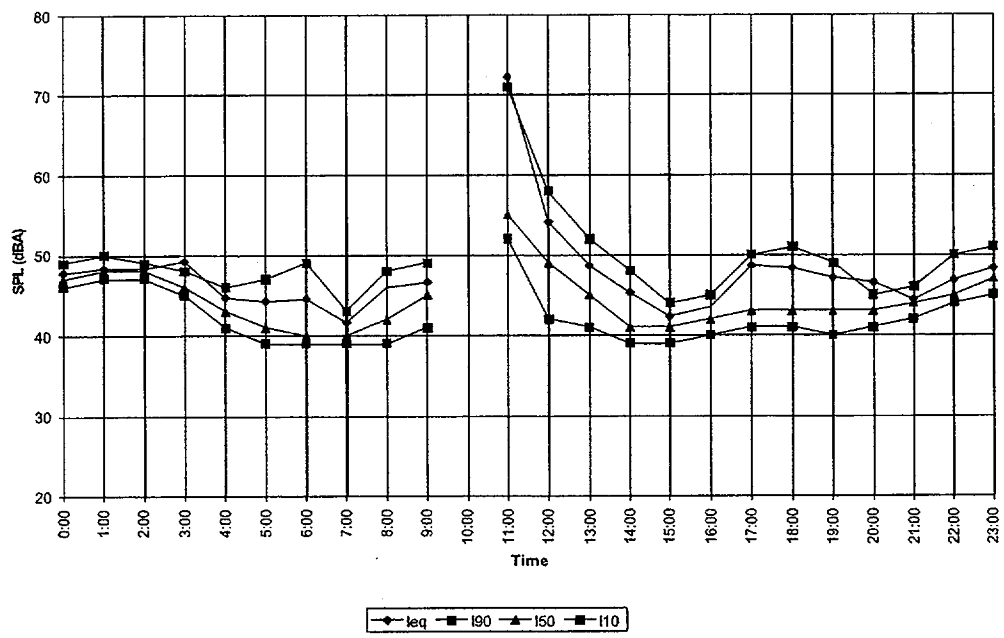
7 Jun 1999 B2



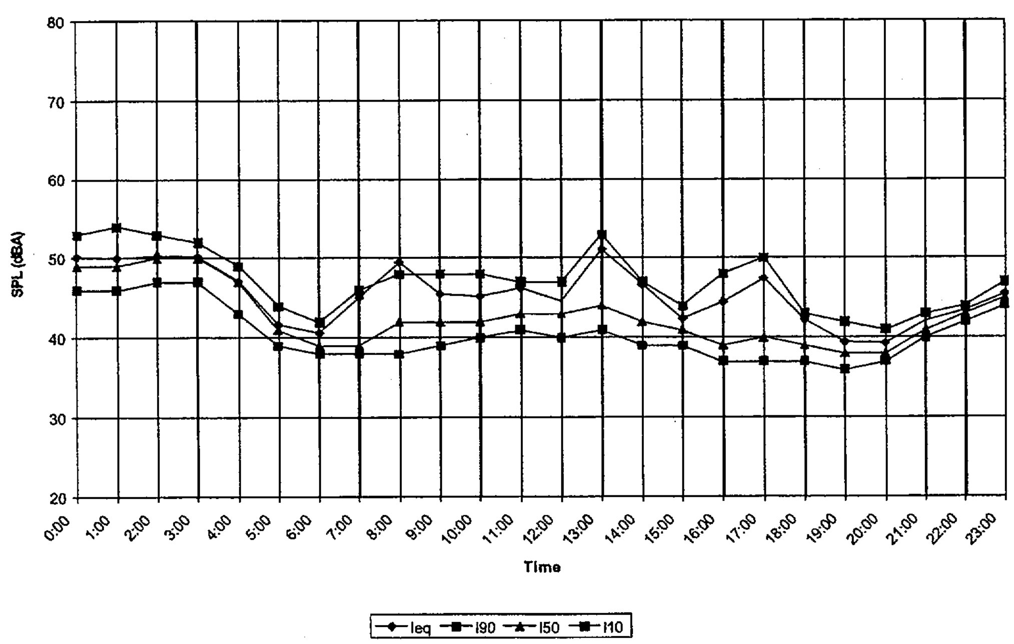
8 Jun 1999 B2

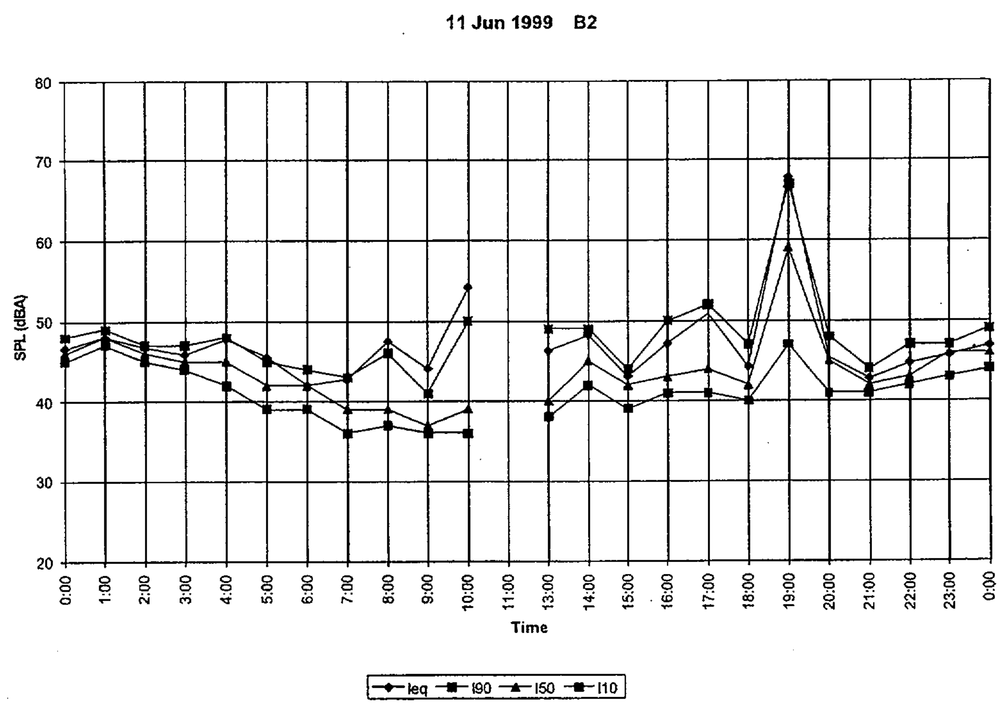


9 Jun 1999 B2



10 Jun 1999 B2




11 Jun 1999 B2
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SPL (dBA)
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Time
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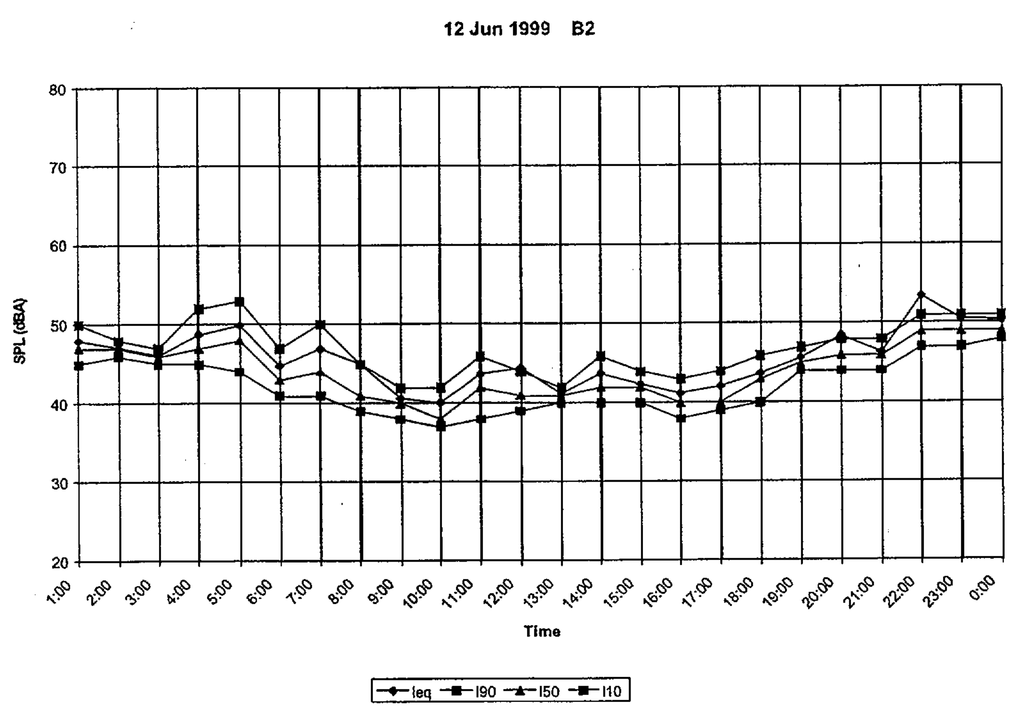
l90
l50
l10


12 Jun 1999 B2
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SPL (dBA)
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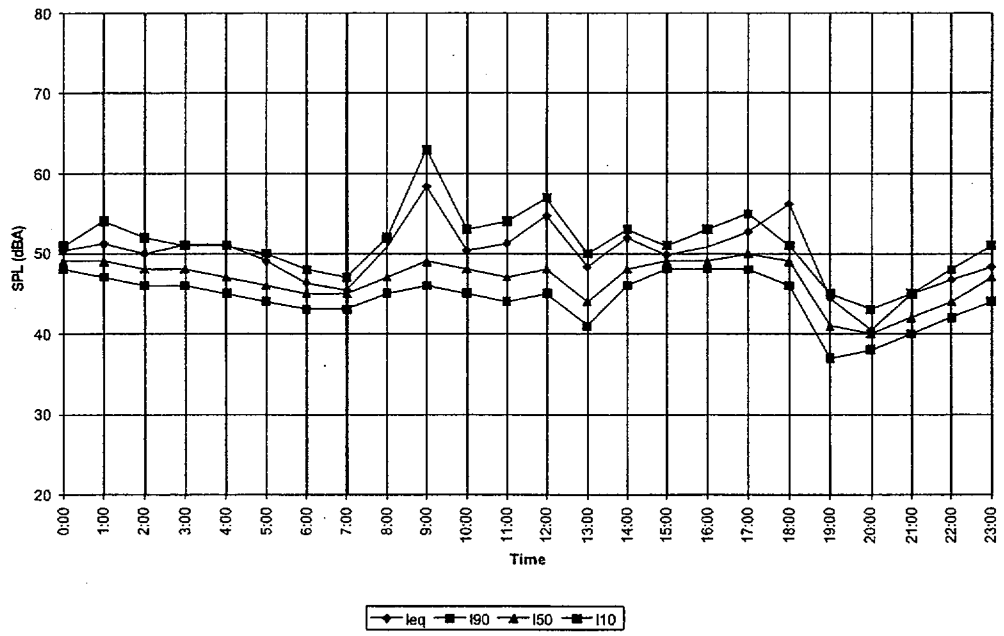
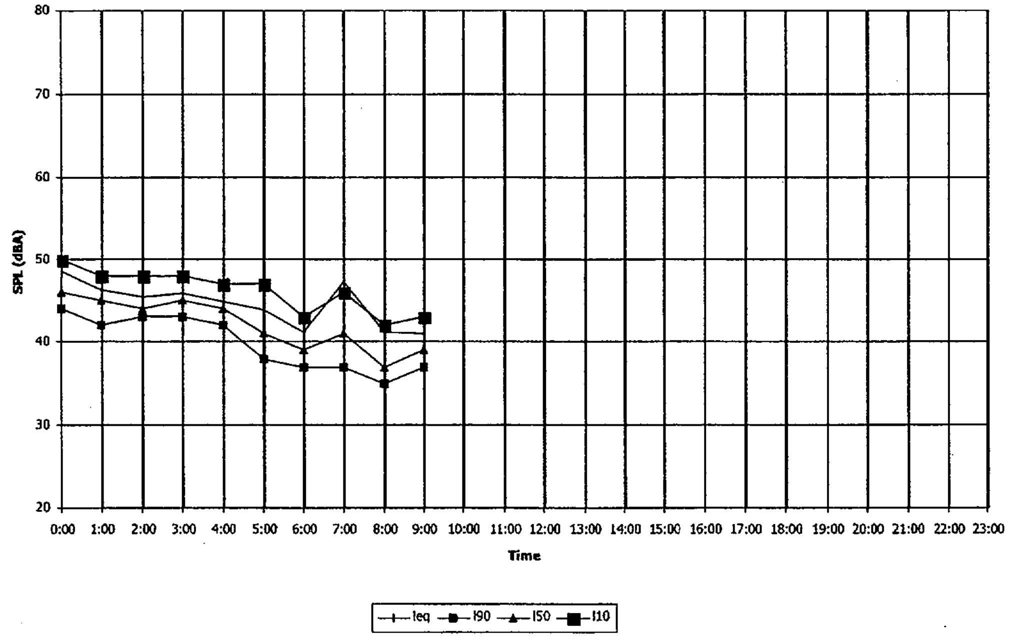
Time
leq
l90
l50
l10

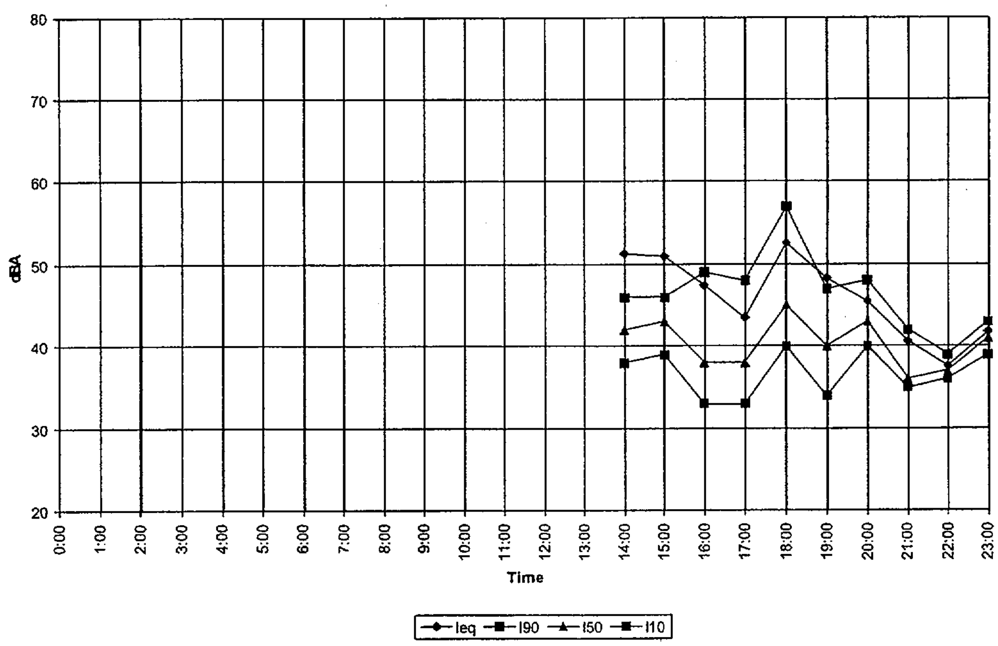
13 Jun 1999 B2



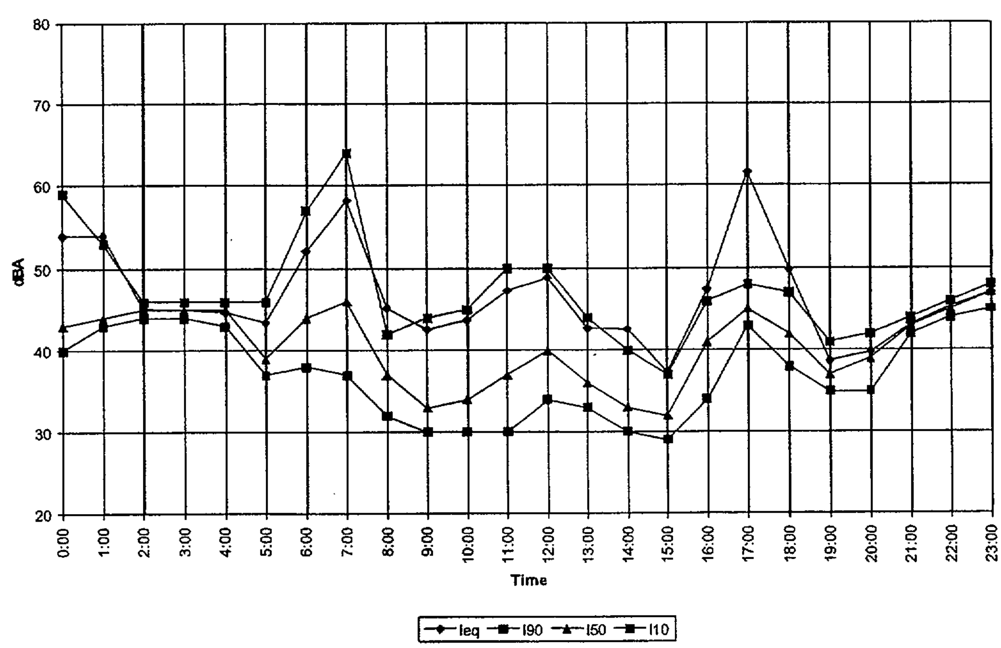
14 Jun 1999 B2

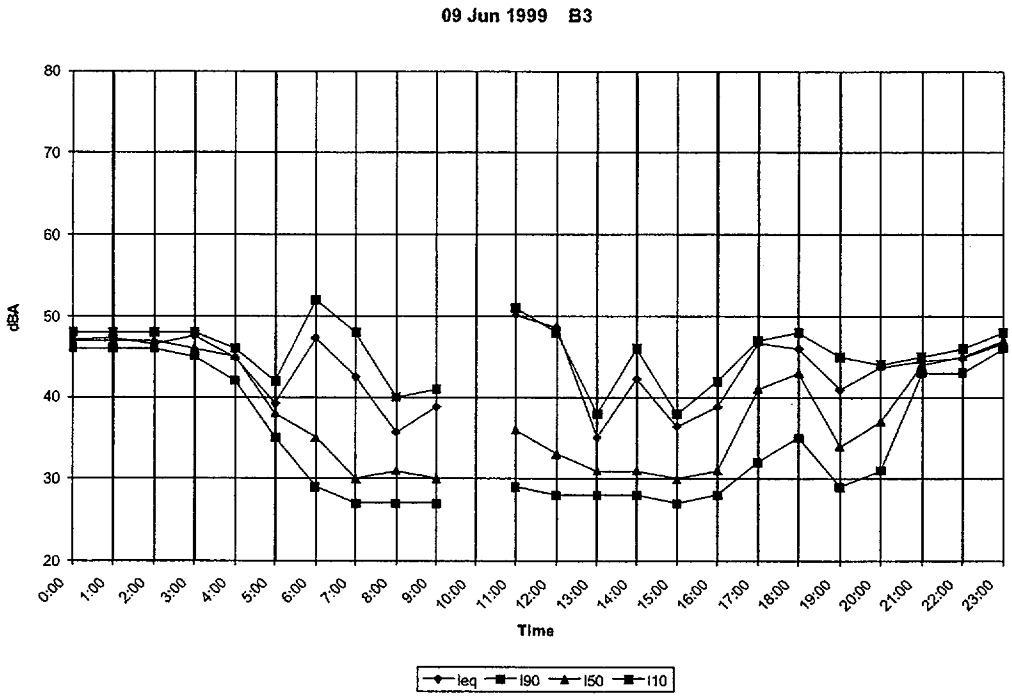


07 Jun 1999 B3



08 Jun 1999 B3




09 Jun 1999 B3
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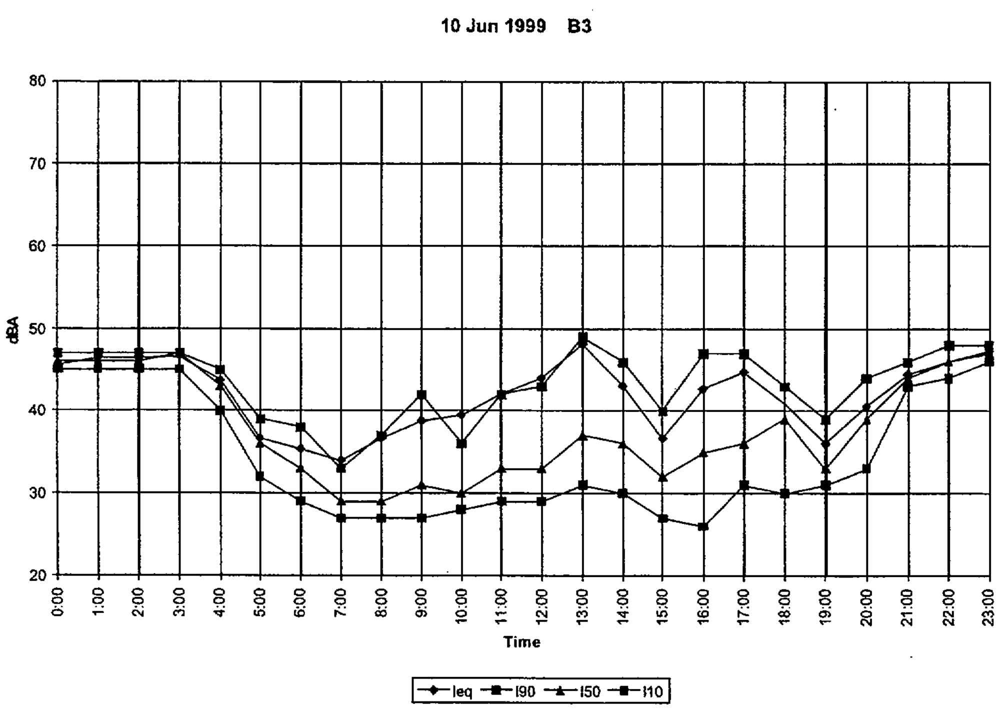
23:00
Time
leq
l90
l50
l10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23:00
Time
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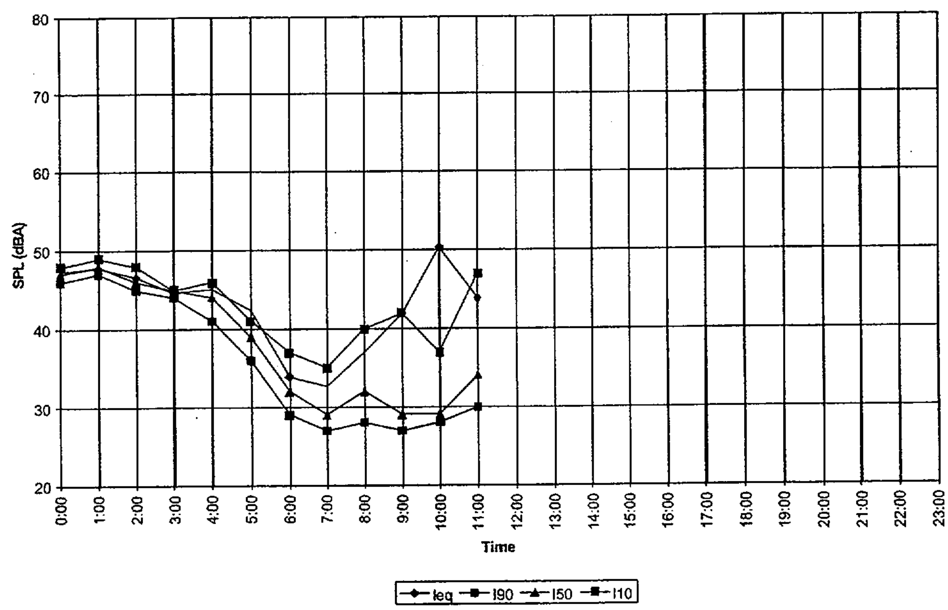
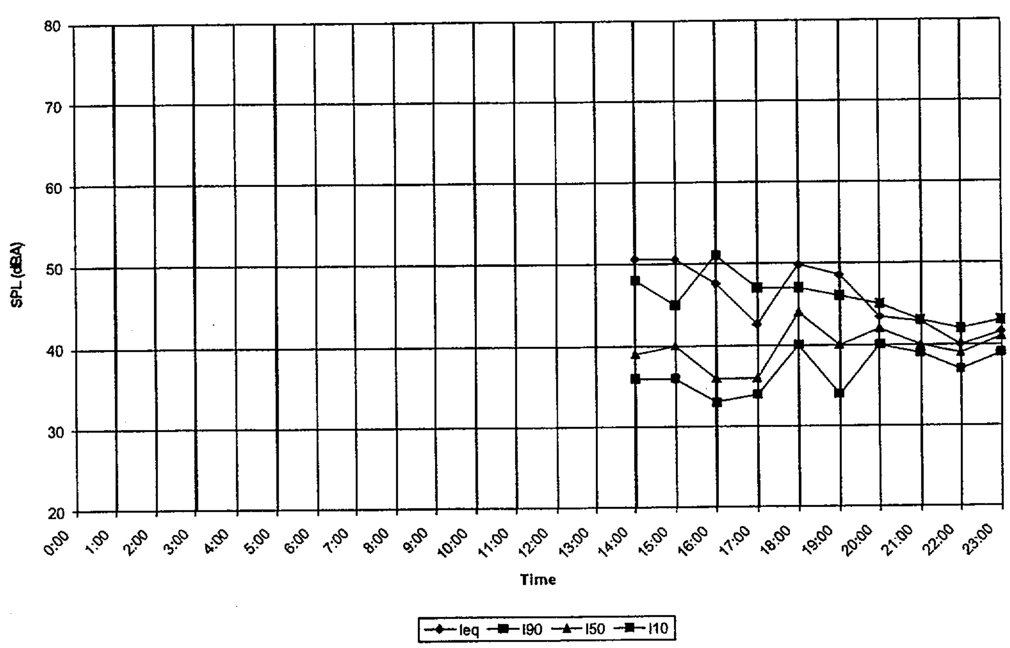
l90
l50
l10

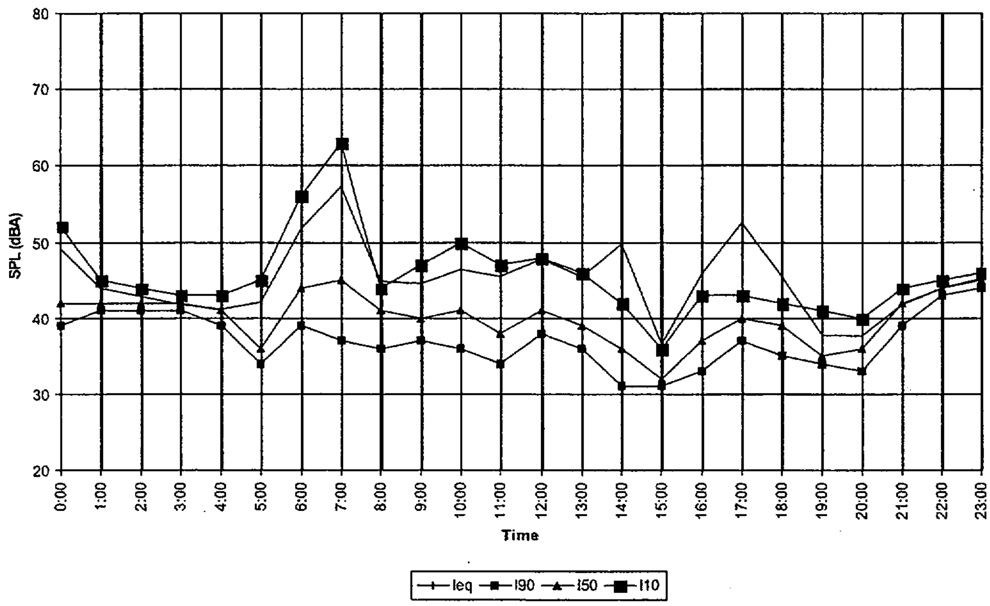
11 Jun 1999 B3



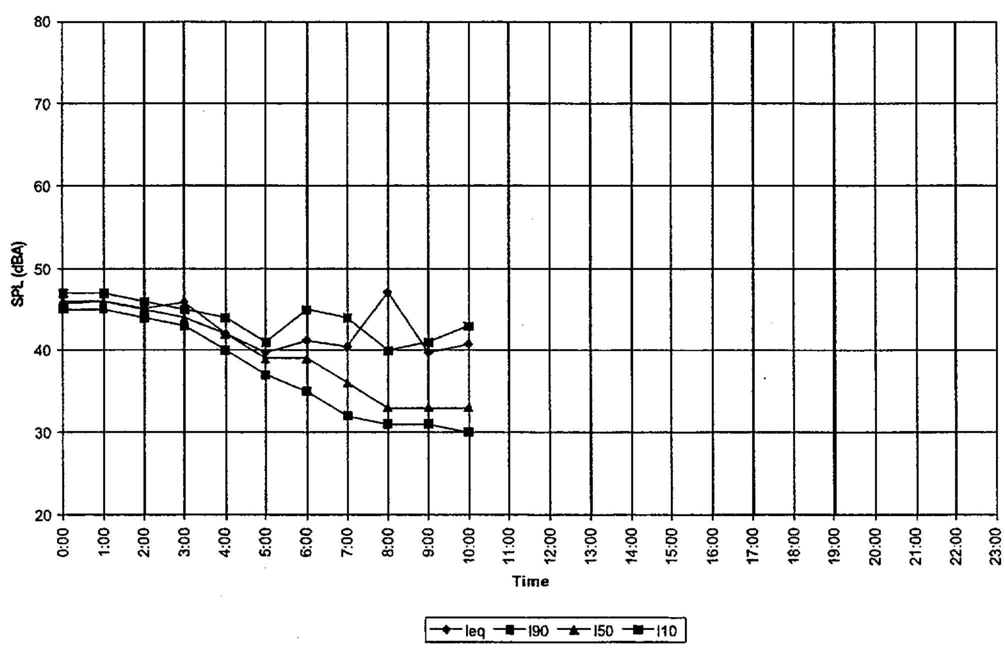
07 Jun 1999 B4

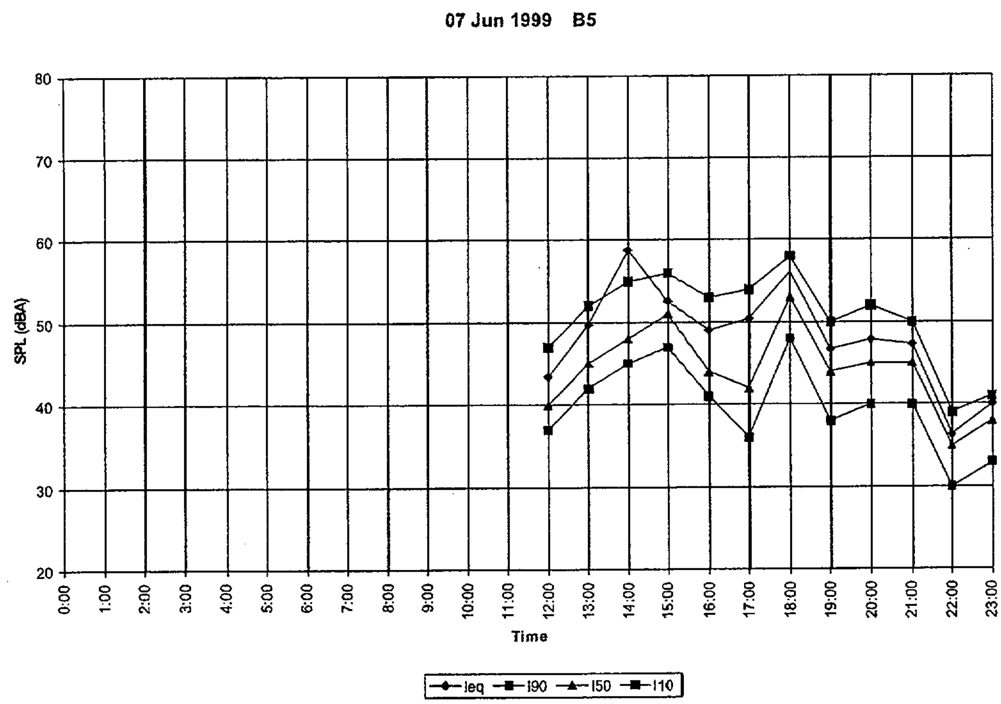


08 Jun 1999 B4



09 Jun 1999 B4

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SPL (dBA)
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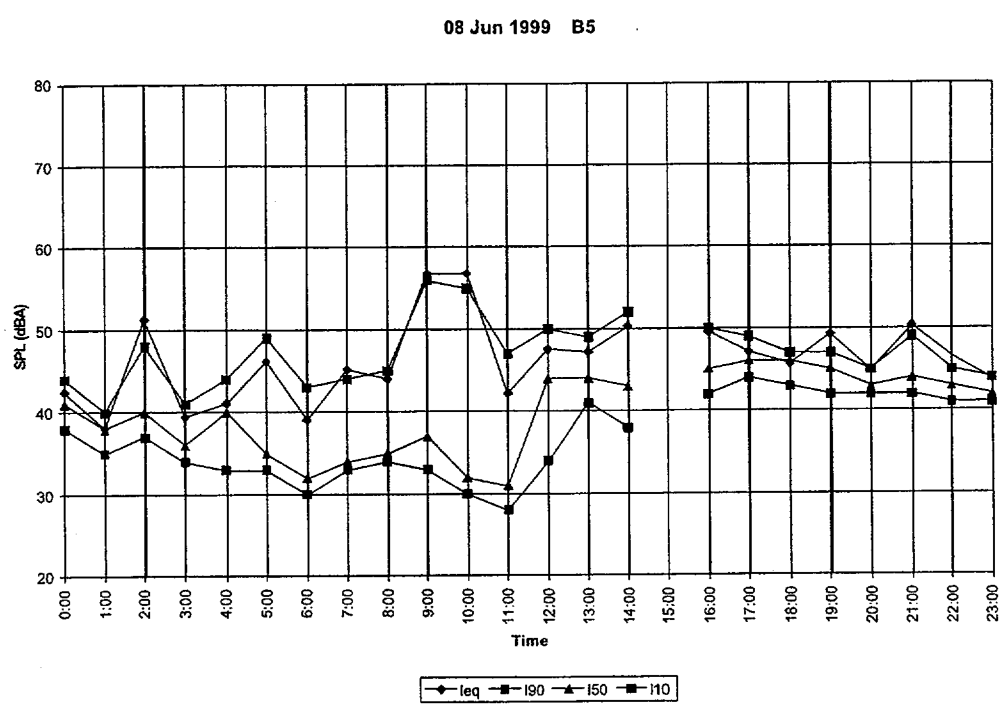
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10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SPL (dBA)
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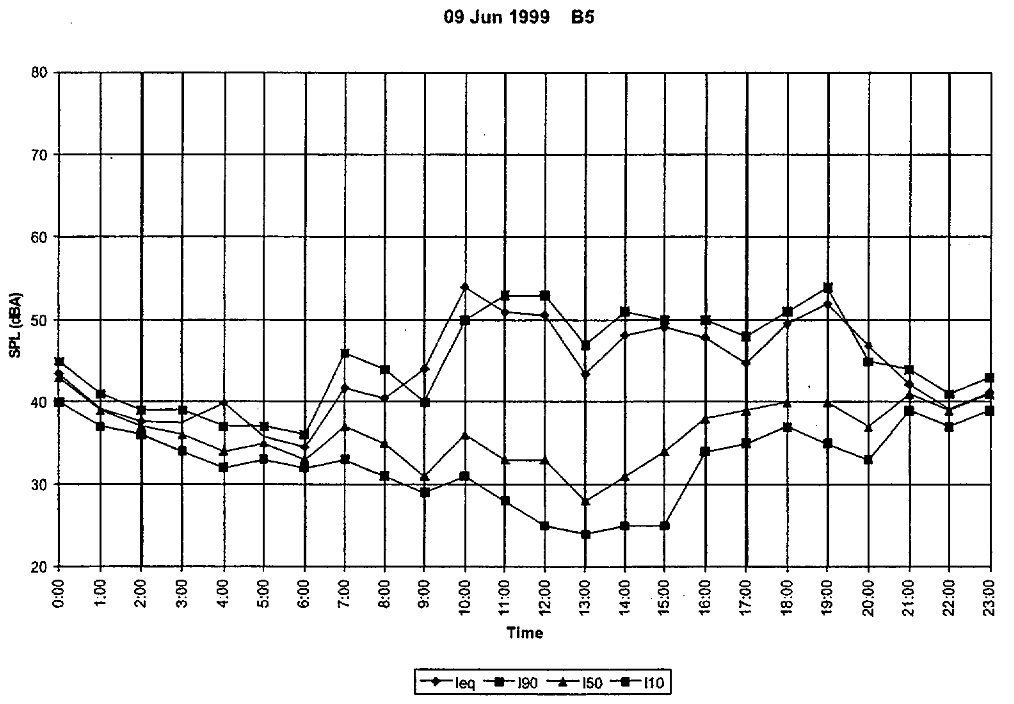
Time
leq l90 l50 l10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SPL (dBA)
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23:00
Time
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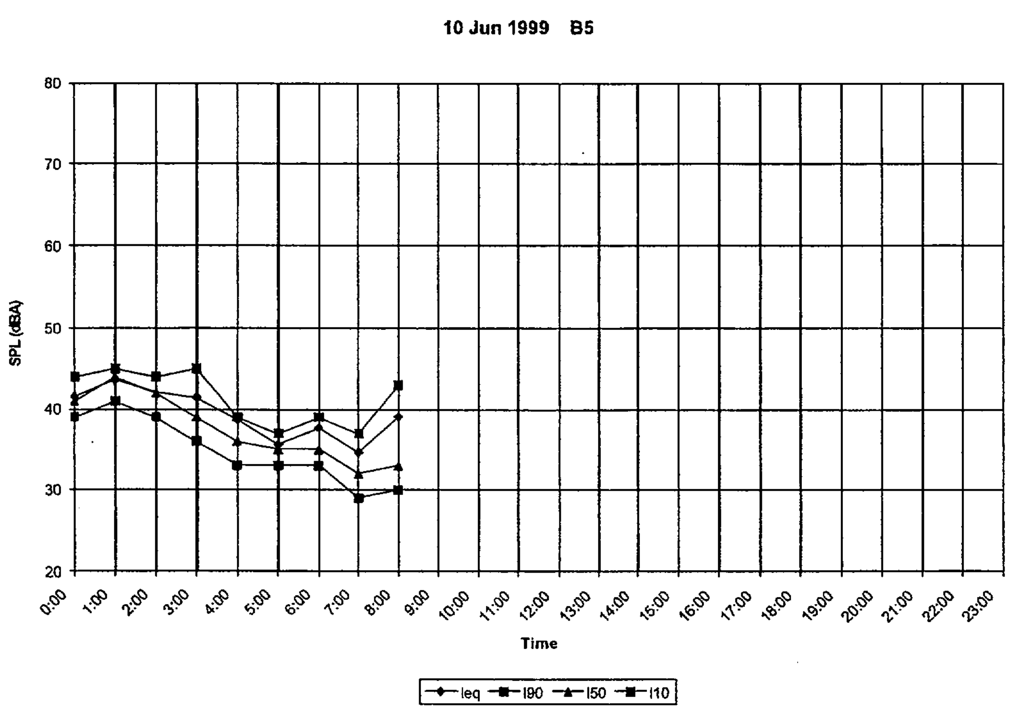
l90
l50
l10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SPL (dBA)
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Time
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l90
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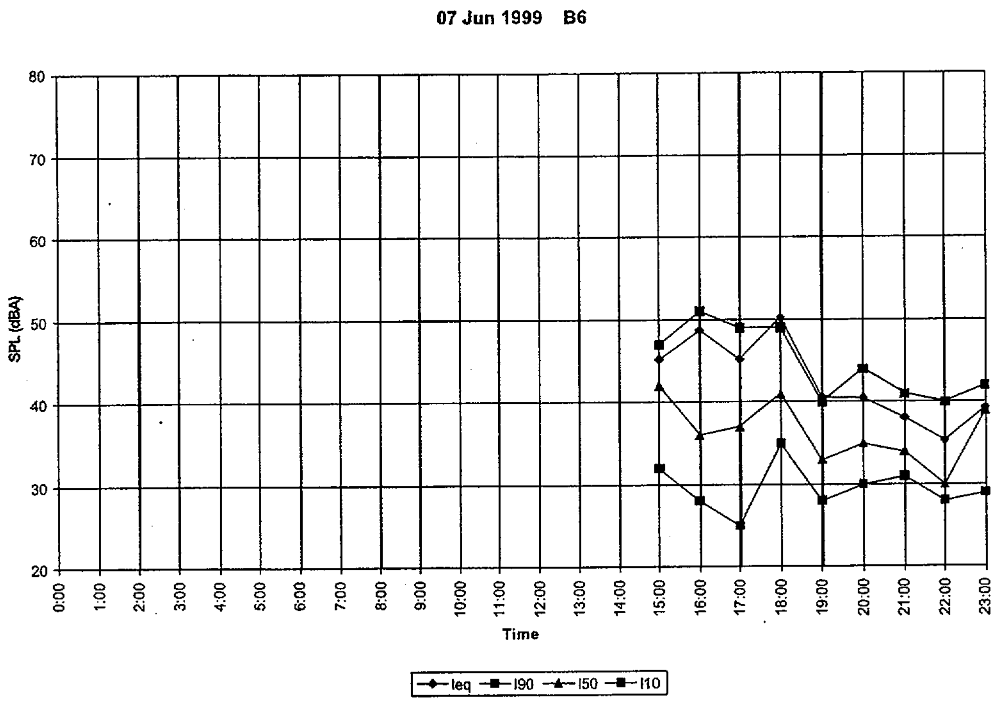
l10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SPL (dBA)
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Time
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l90
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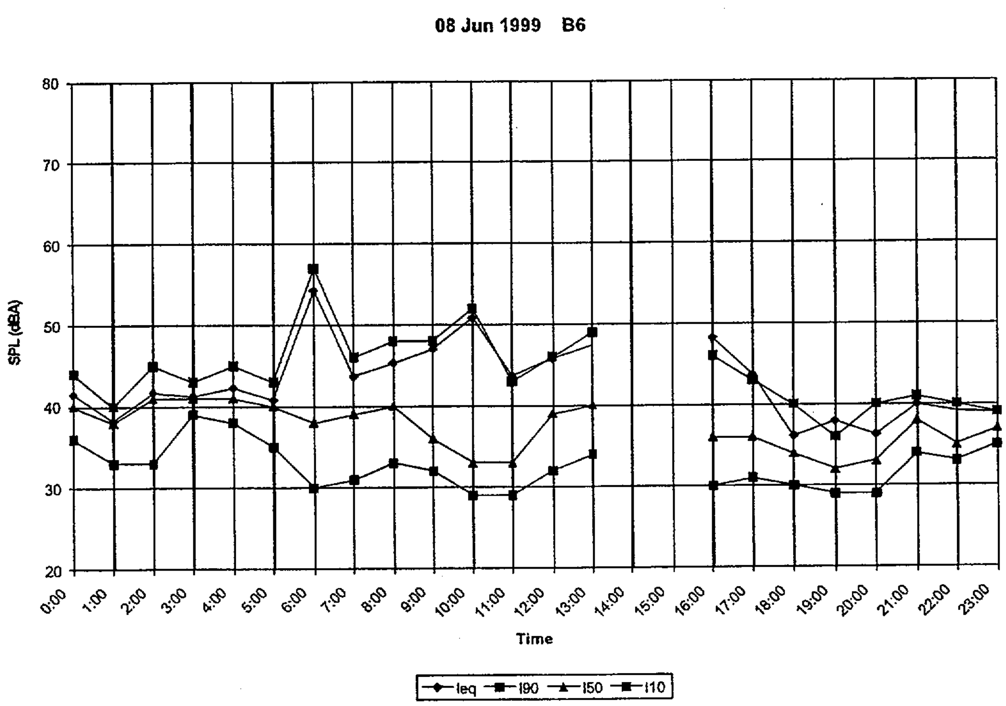
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SPL (dBA)
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Time
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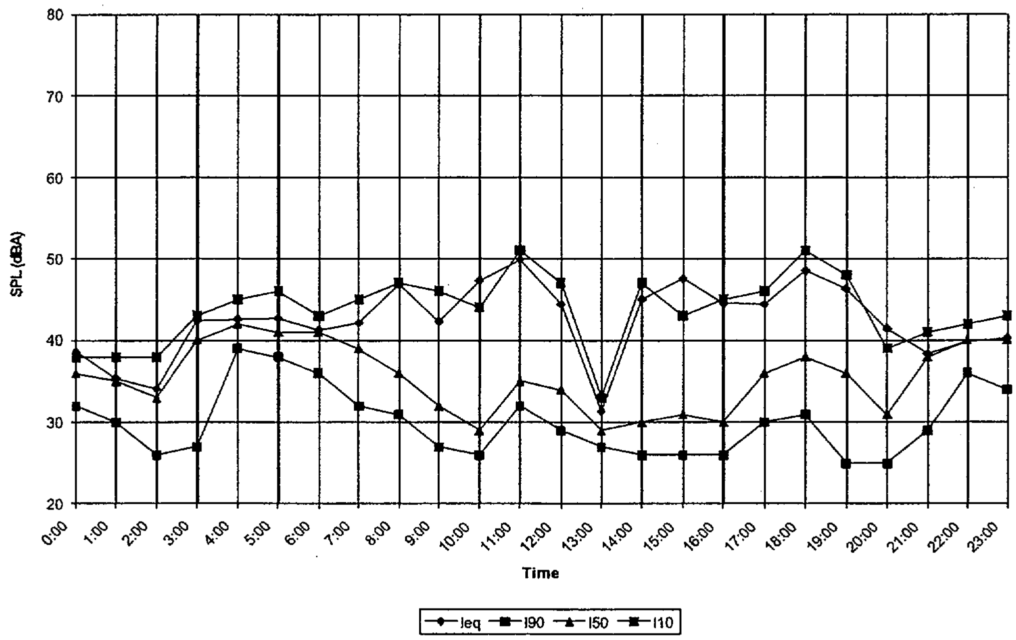
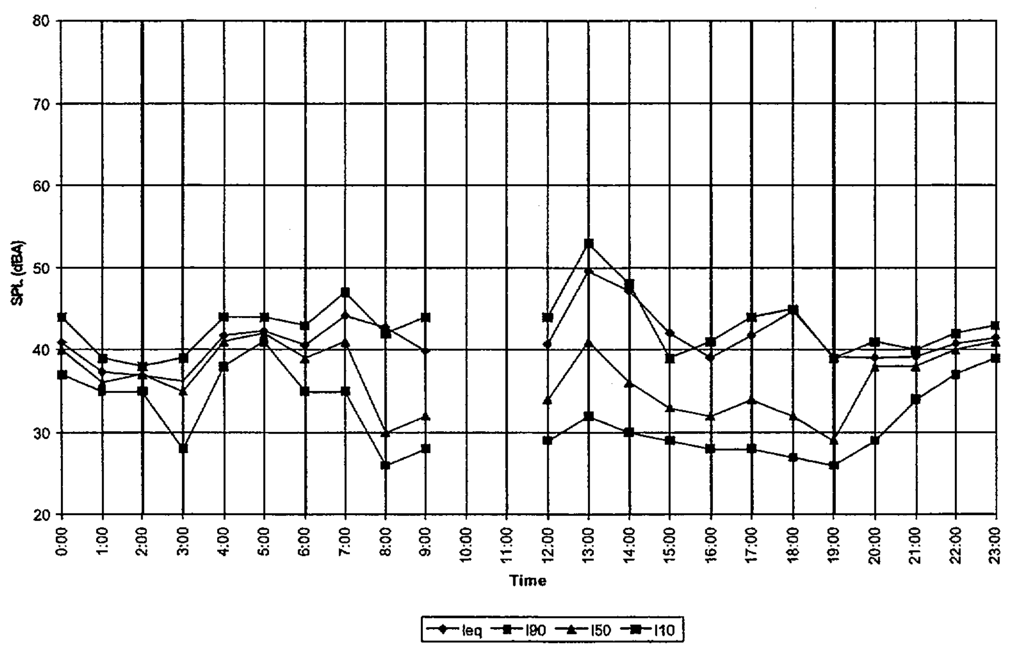
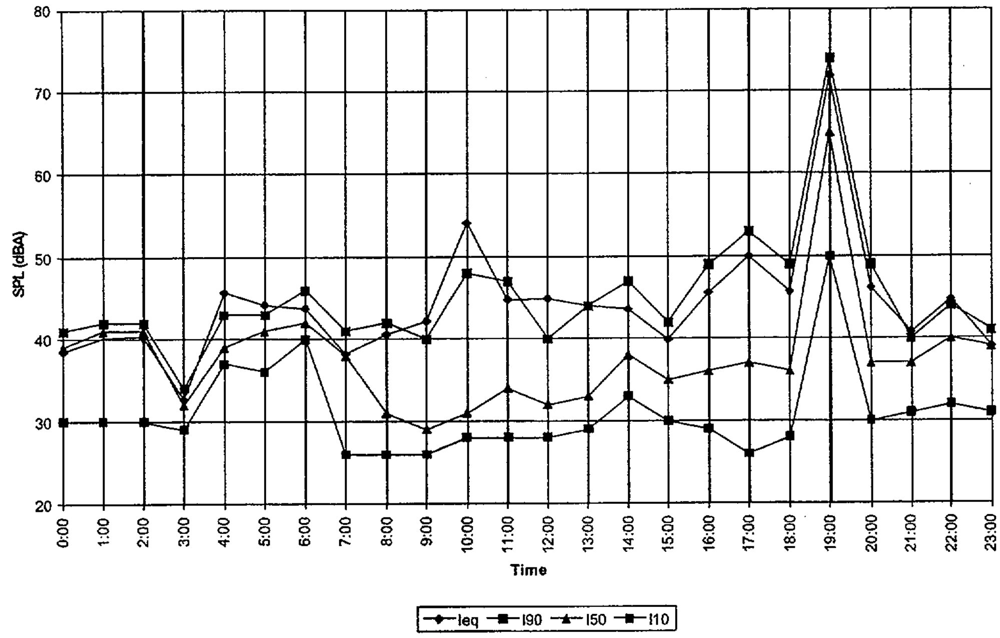
09 Jun 1999 B6



10 Jun 1999 B6

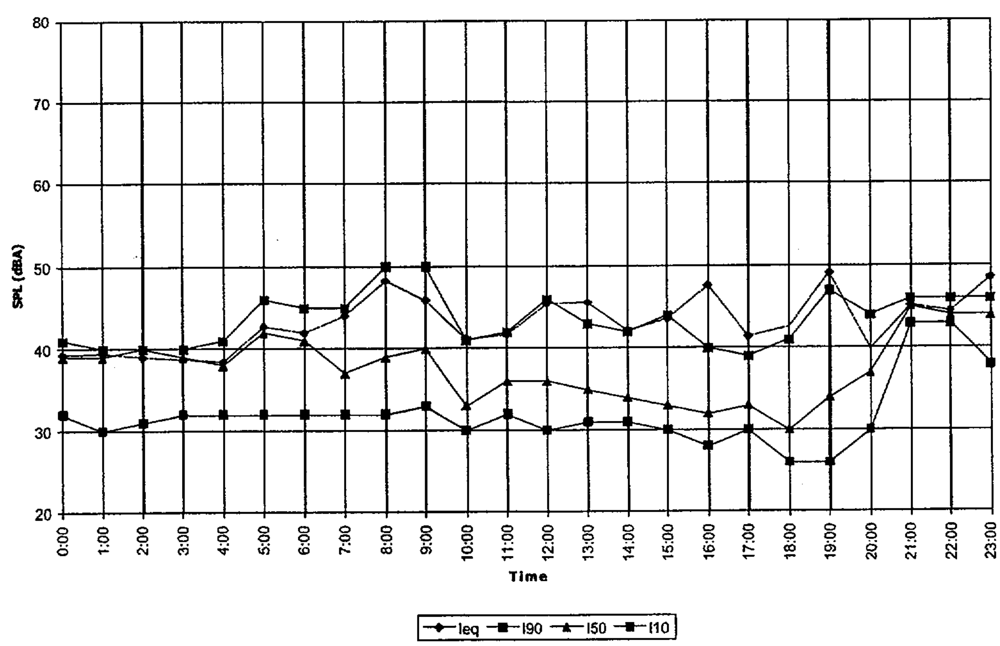


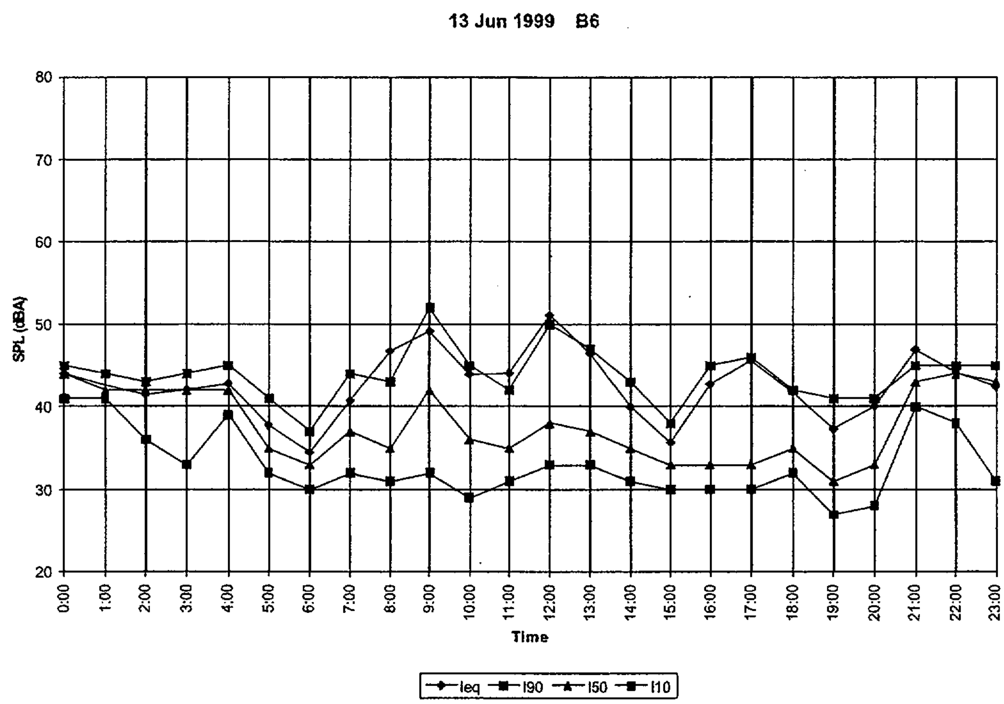
11 Jun 1999 B6



Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements The Soundscape in South Florida NP

12 Jun 1999 B6




13 Jun 1999 B6
SPL (dBA)
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23:00
Time
leq
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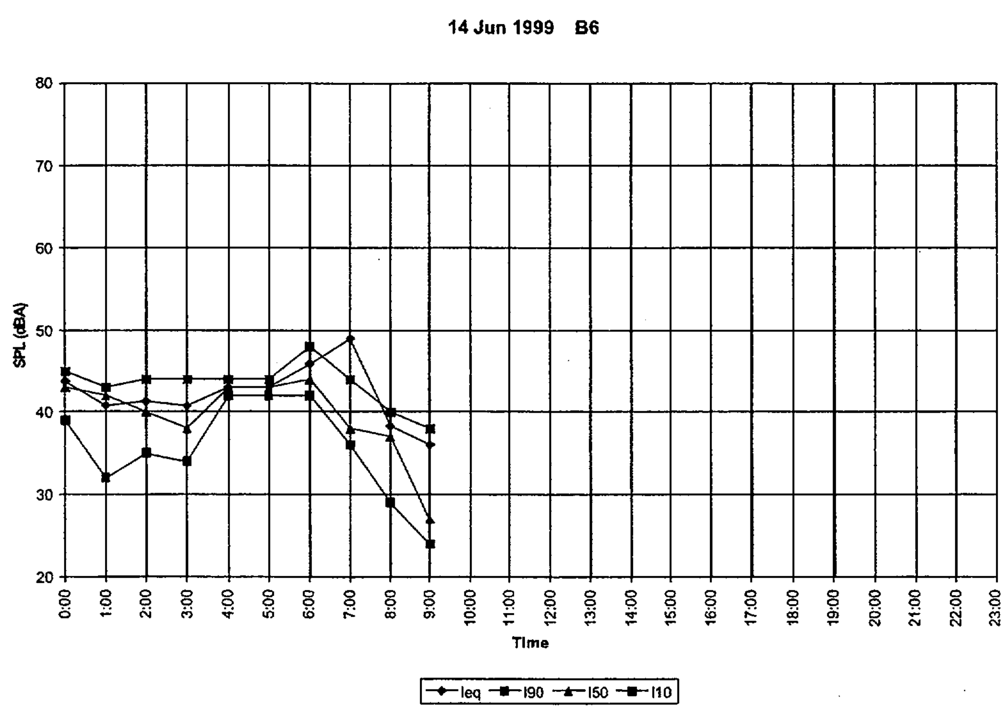
l50
l10


14 Jun 1999 B6
SPL (dBA)
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Time
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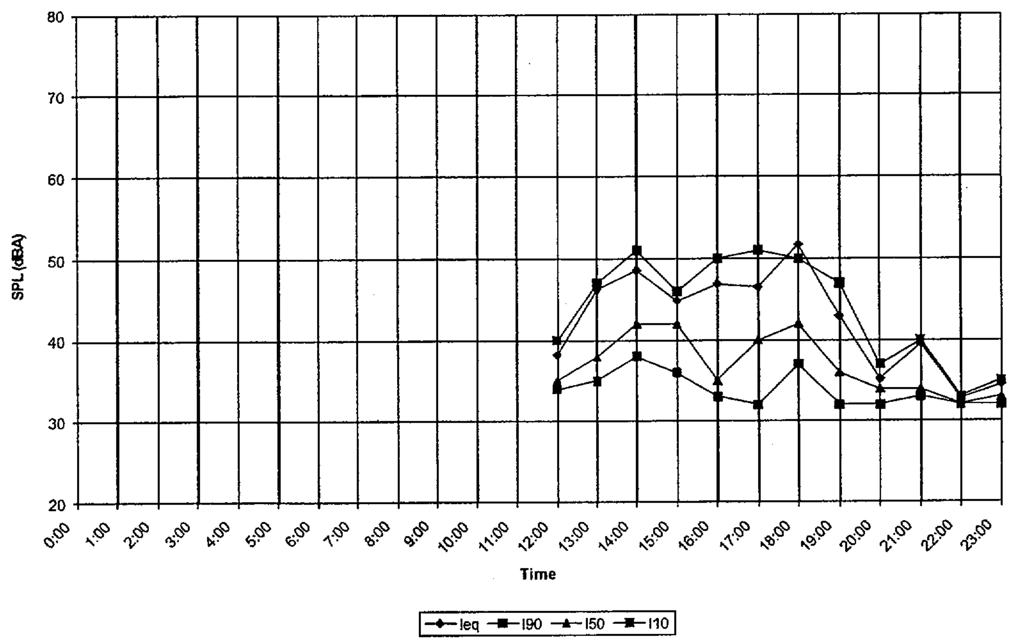
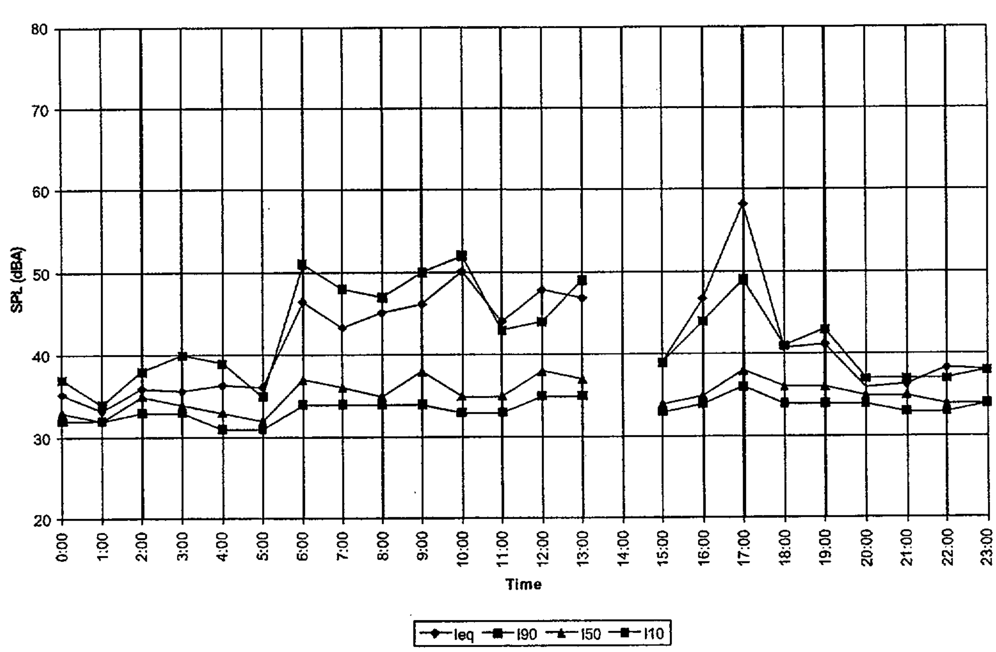
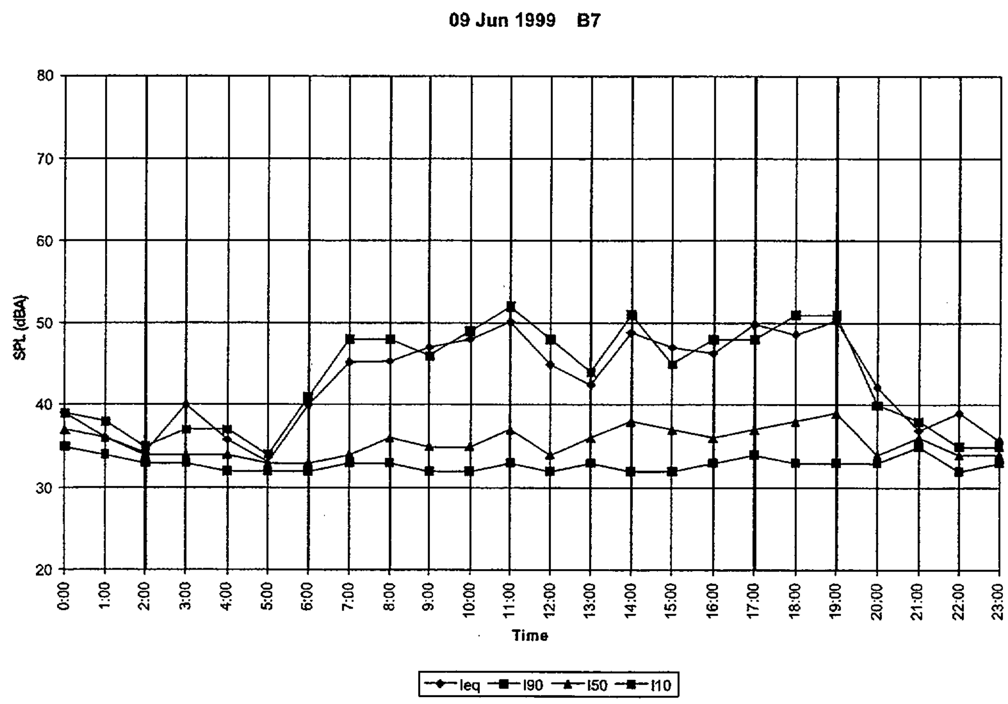
07 Jun 1999 B7



08 Jun 1999 B7




09 Jun 1999 B7
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19:00
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21:00
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23:00
Time
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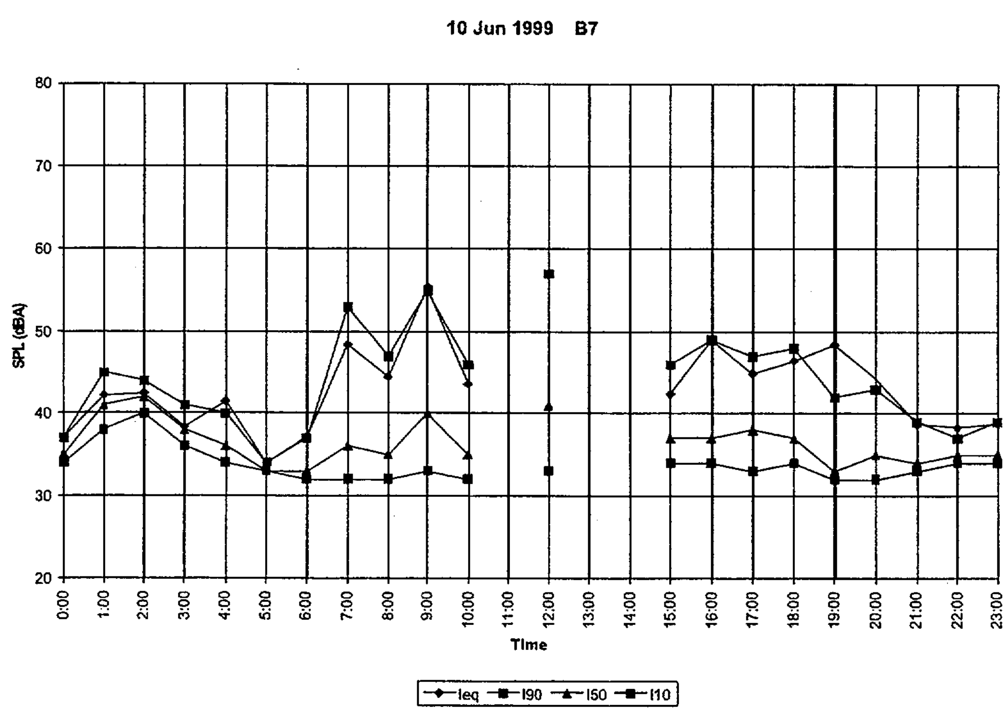
10 Jun 1999 B7
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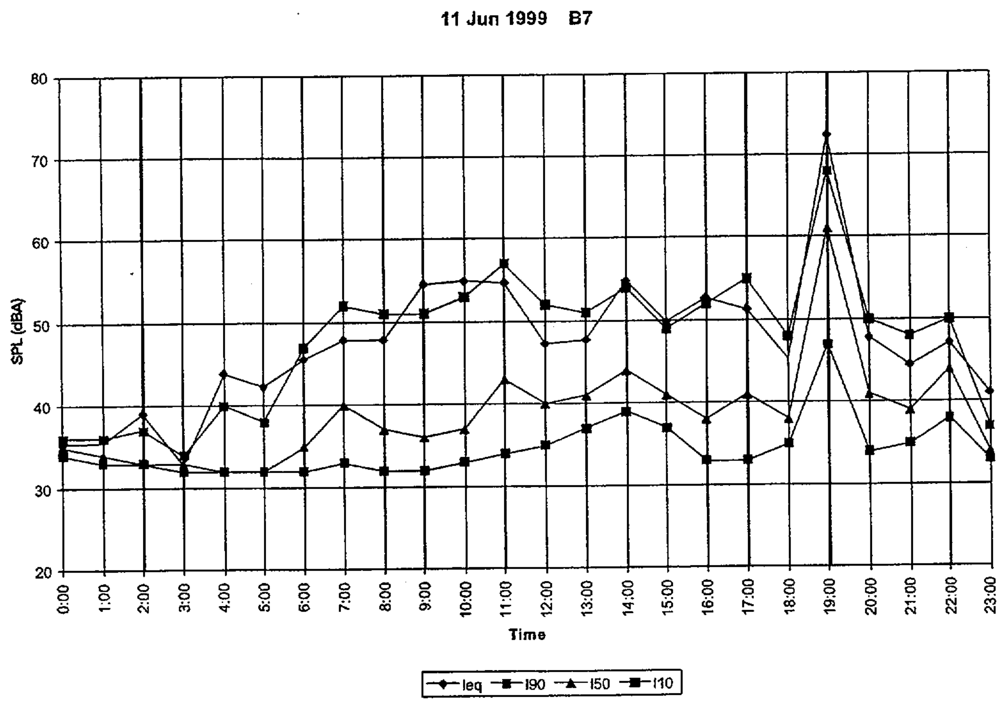
22:00
23:00
Time
leq
l90
l50
l10


11 Jun 1999 B7
SPL (dBA)
80
70
60
50
40
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0:00
1:00
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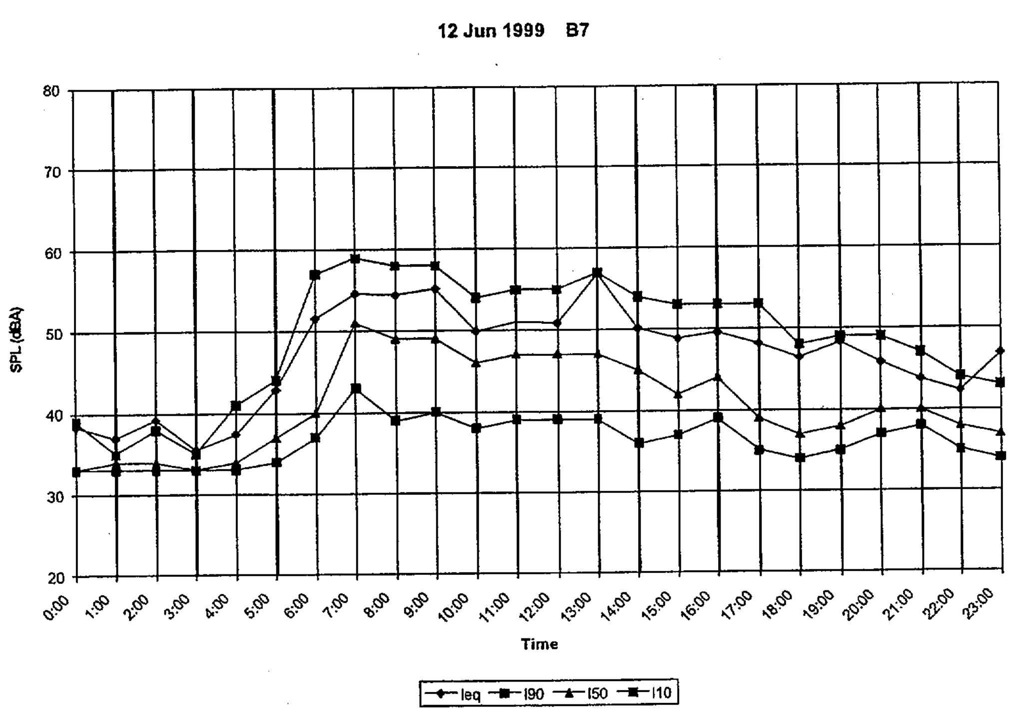
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


12 Jun 1999 B7
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
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5:00
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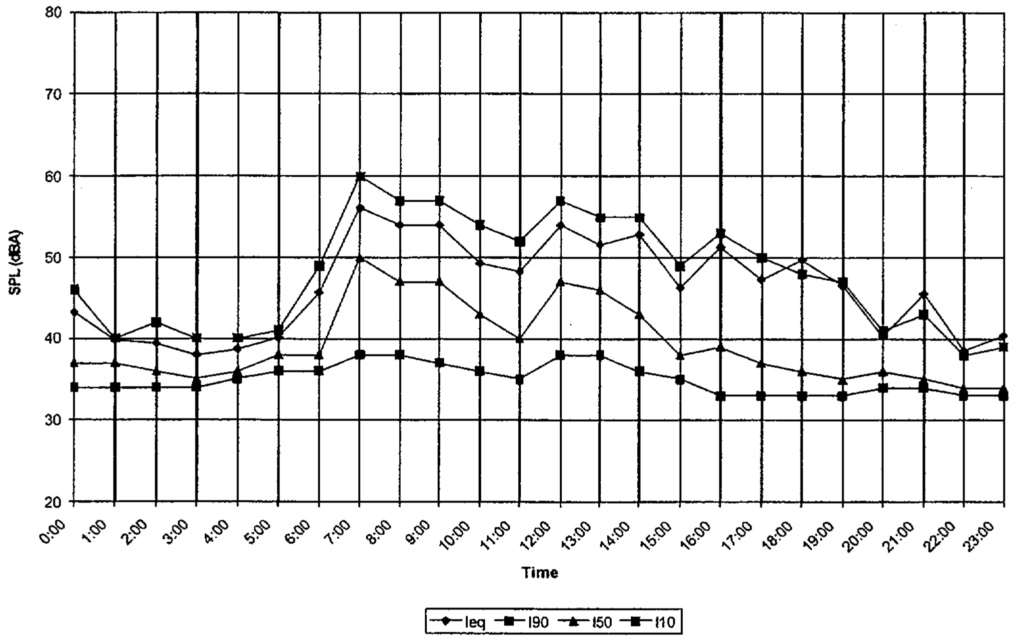
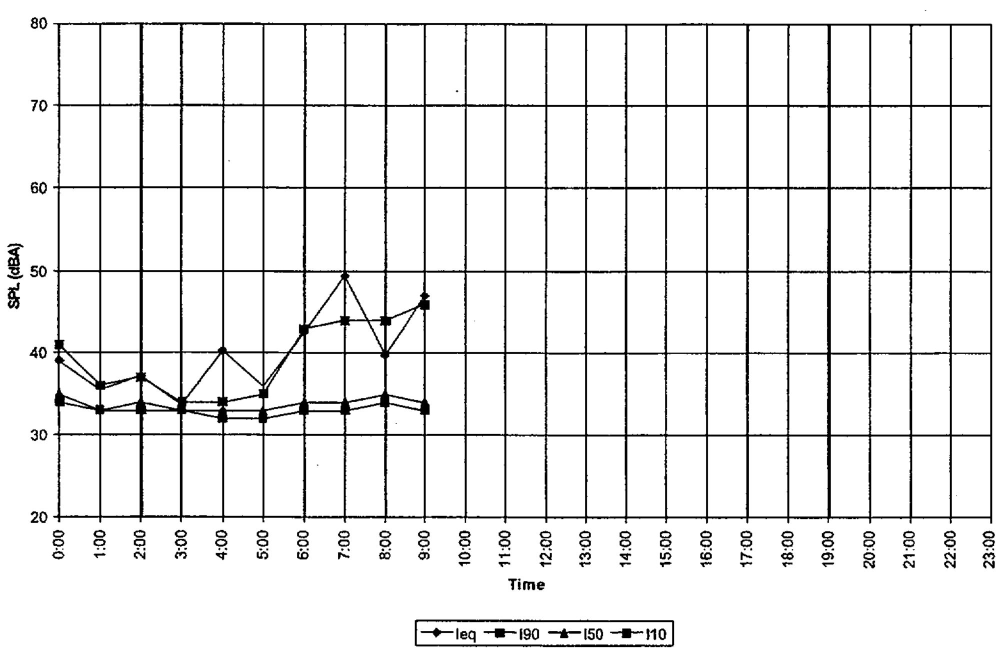
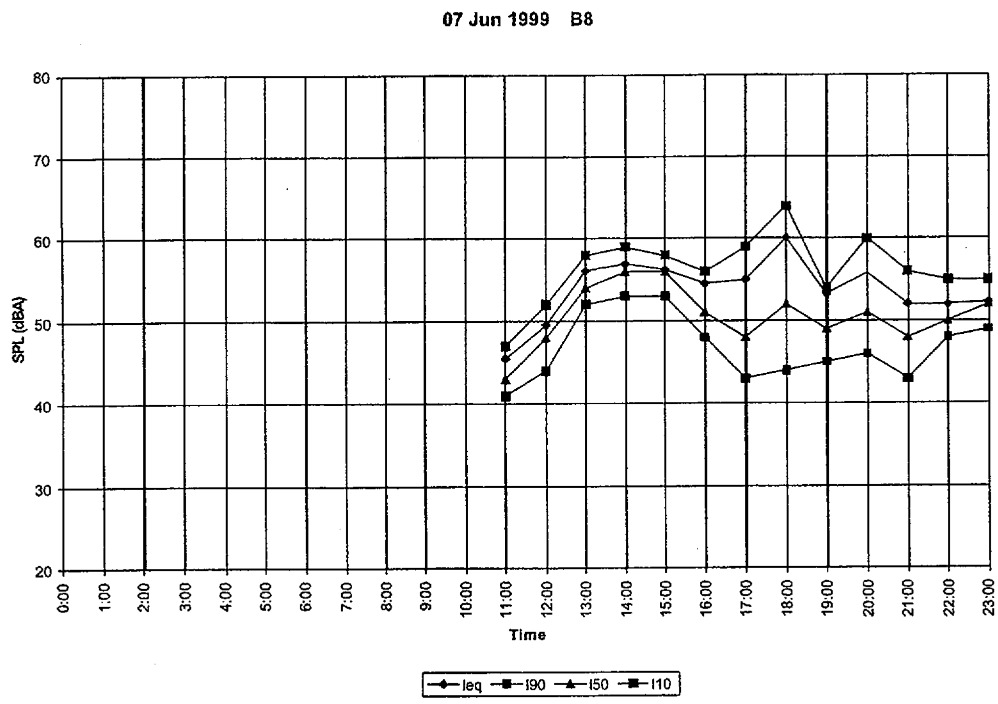
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

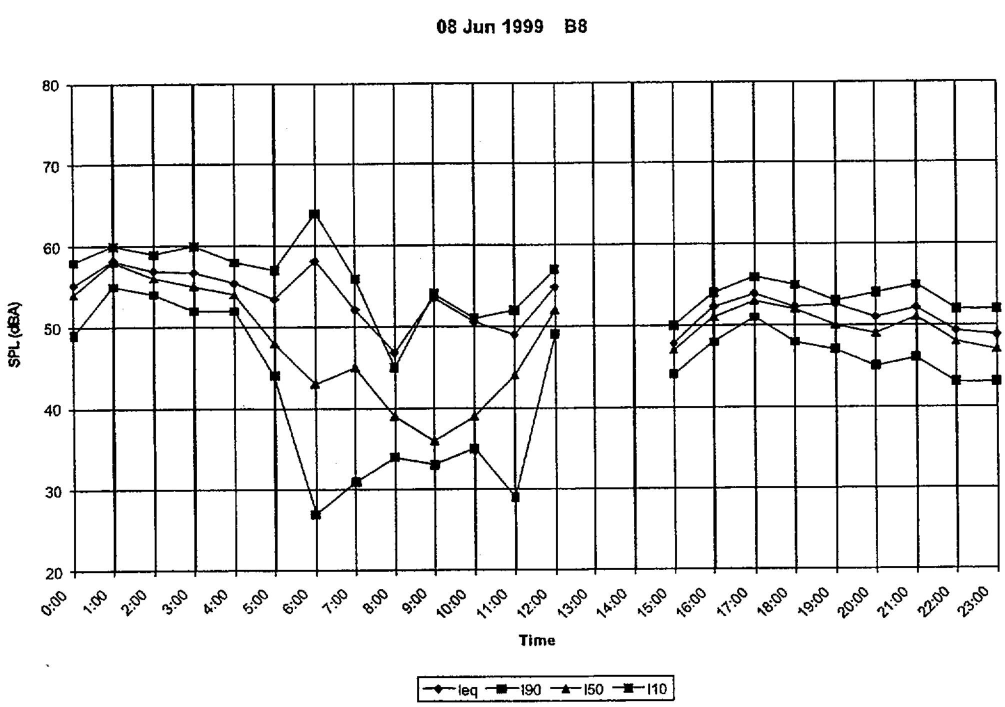
13 Jun 1999 B7



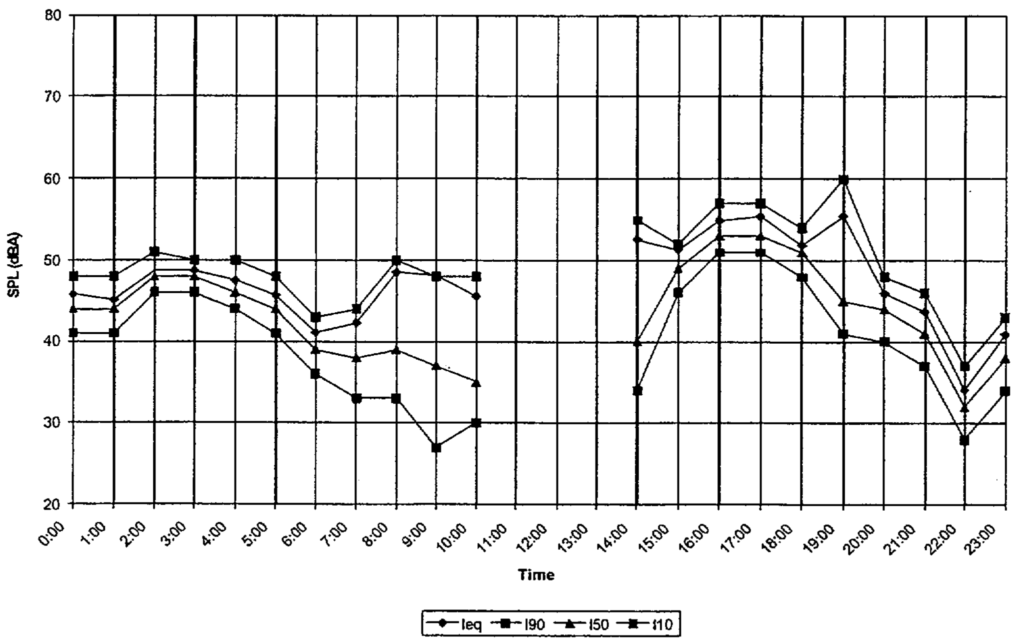
14 Jun 1999 B7




07 Jun 1999 B8
SPL (dBA)
Time
leq
l90
l50
l10

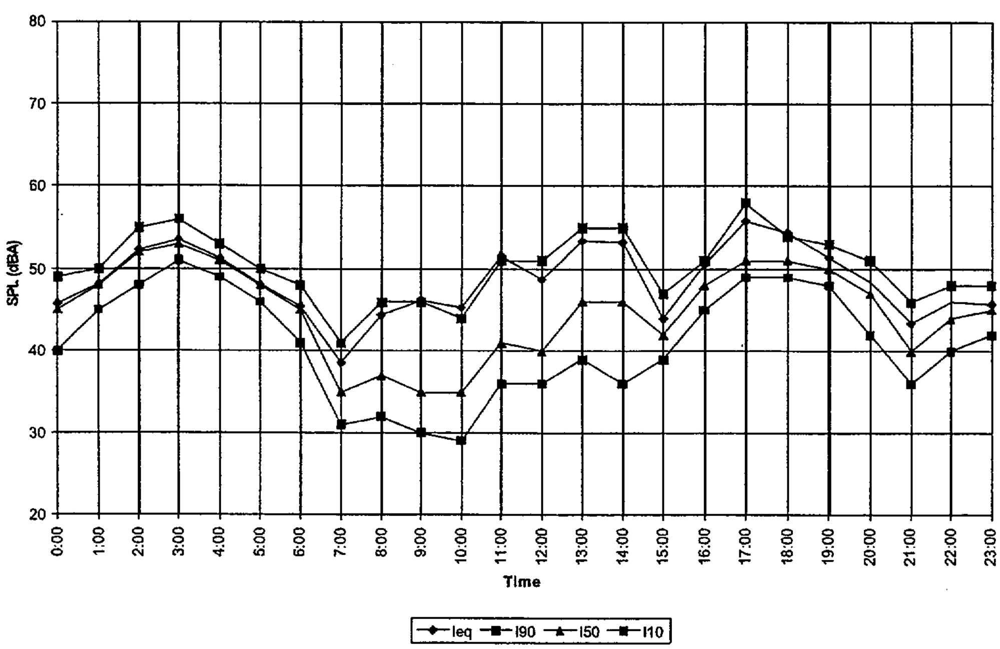

08 Jun 1999 B8
SPL (dBA)
Time
leq
l90
l50
l10

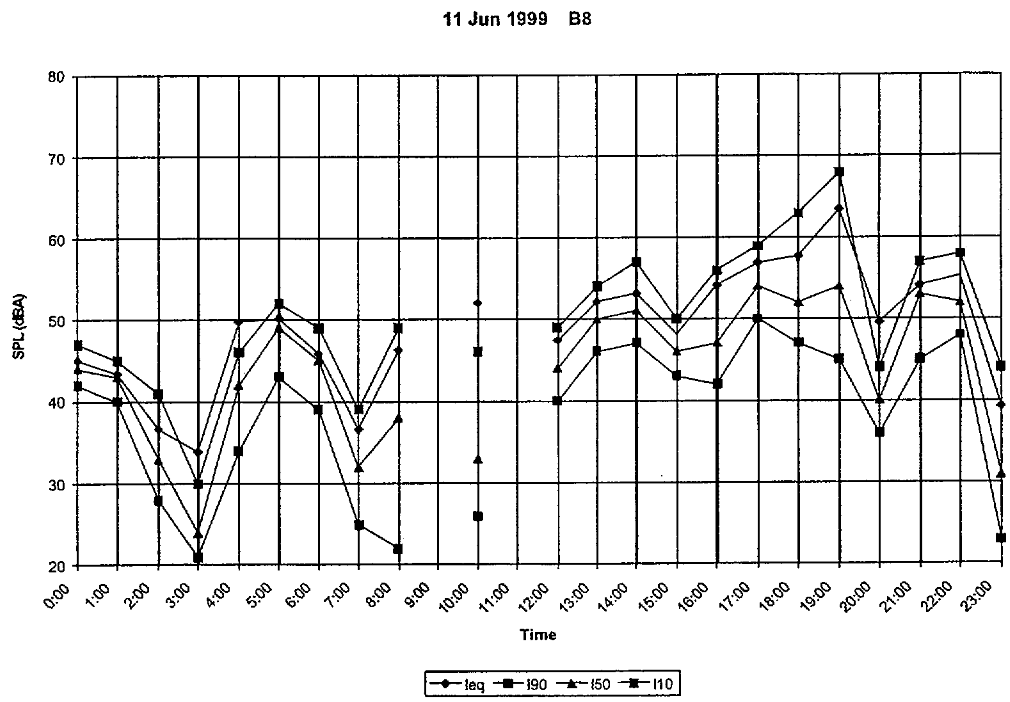
09 Jun 1999 B8



Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements The Soundscape in South Florida NP

10 Jun 1999 B8




11 Jun 1999 B8
SPL (dBA)
80
70
60
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20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
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13:00
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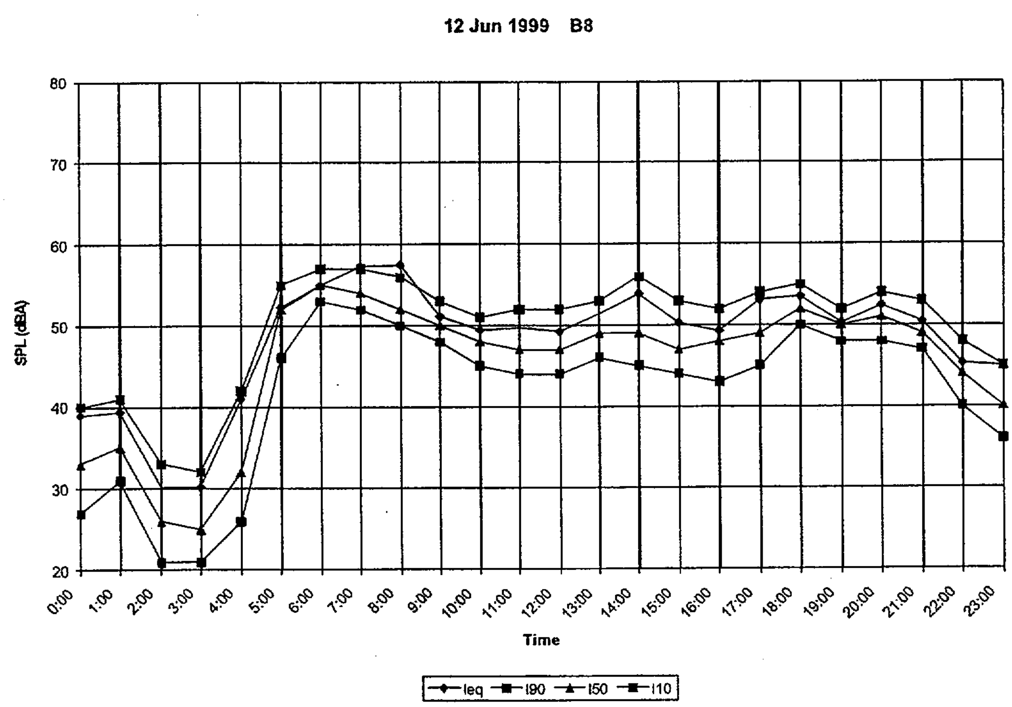
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


12 Jun 1999 B8
SPL (dBA)
80
70
60
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40
30
20
0:00
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2:00
3:00
4:00
5:00
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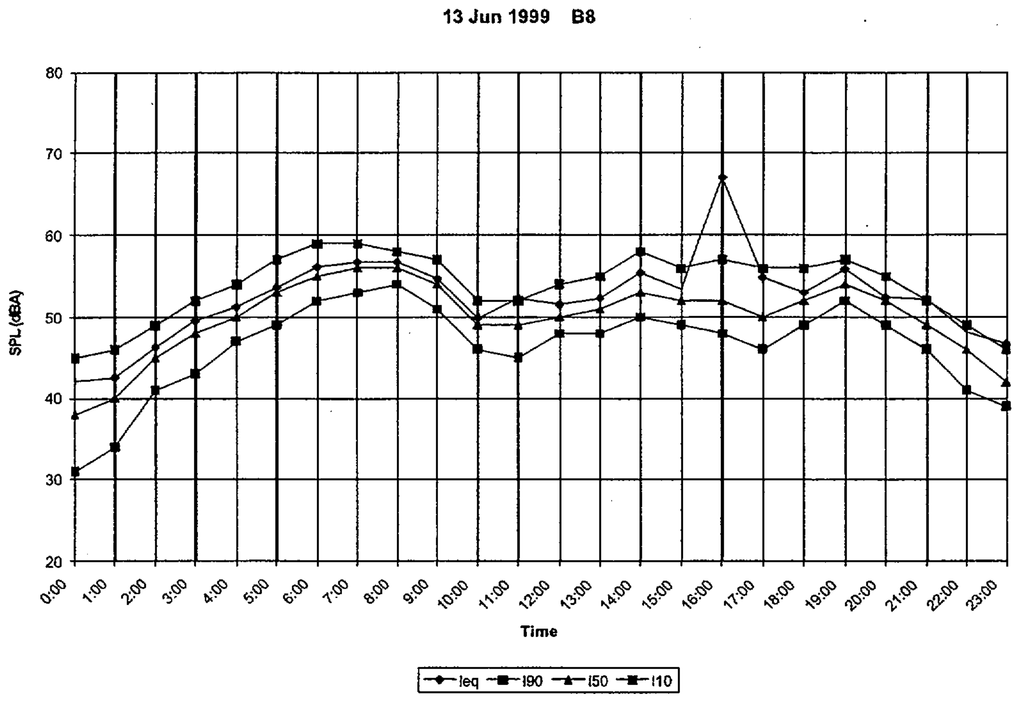
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


13 Jun 1999 B8
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
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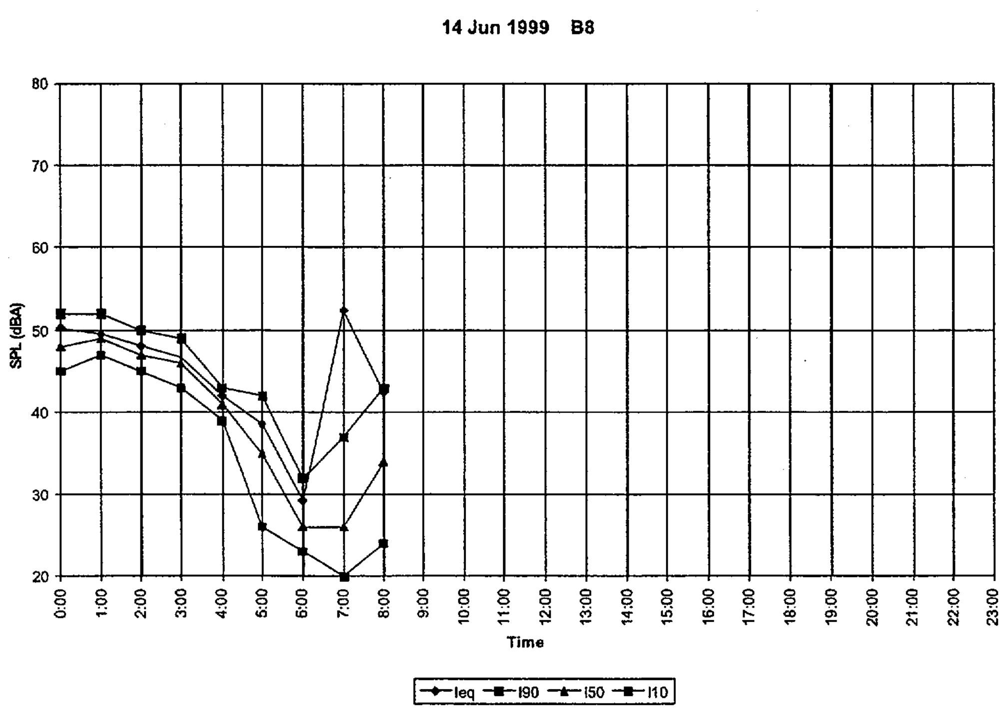
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


14 Jun 1999 B8
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
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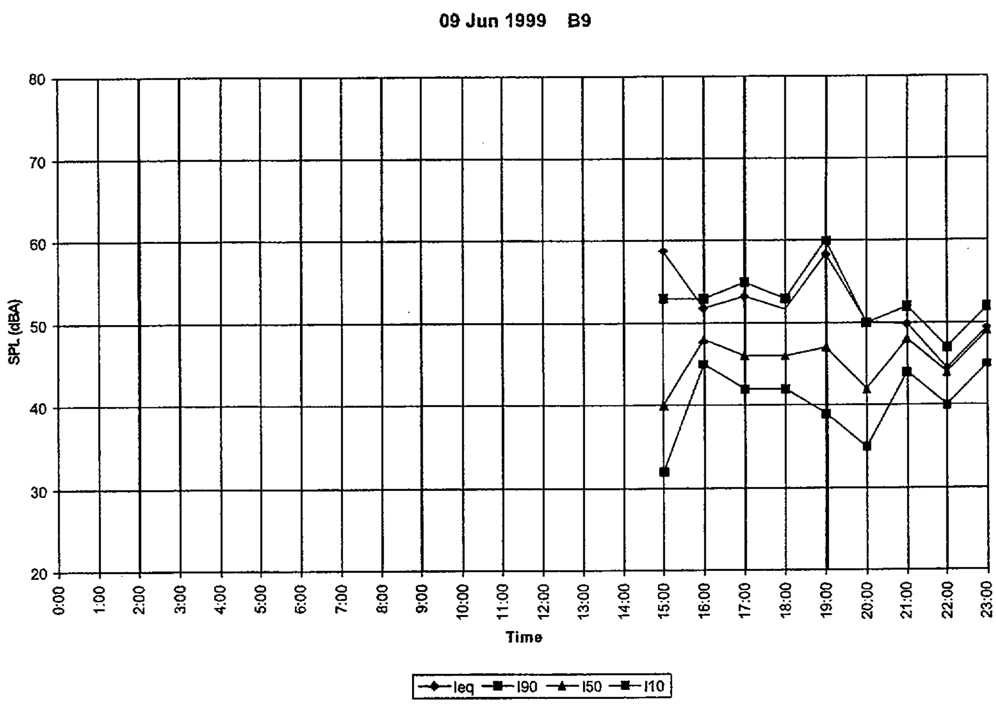
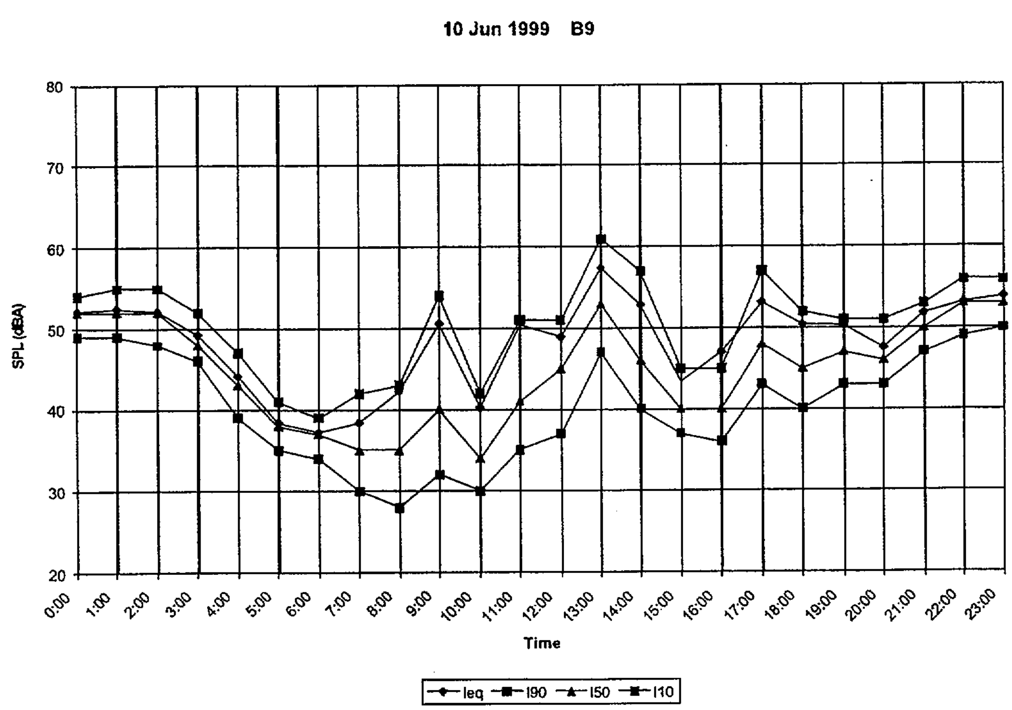
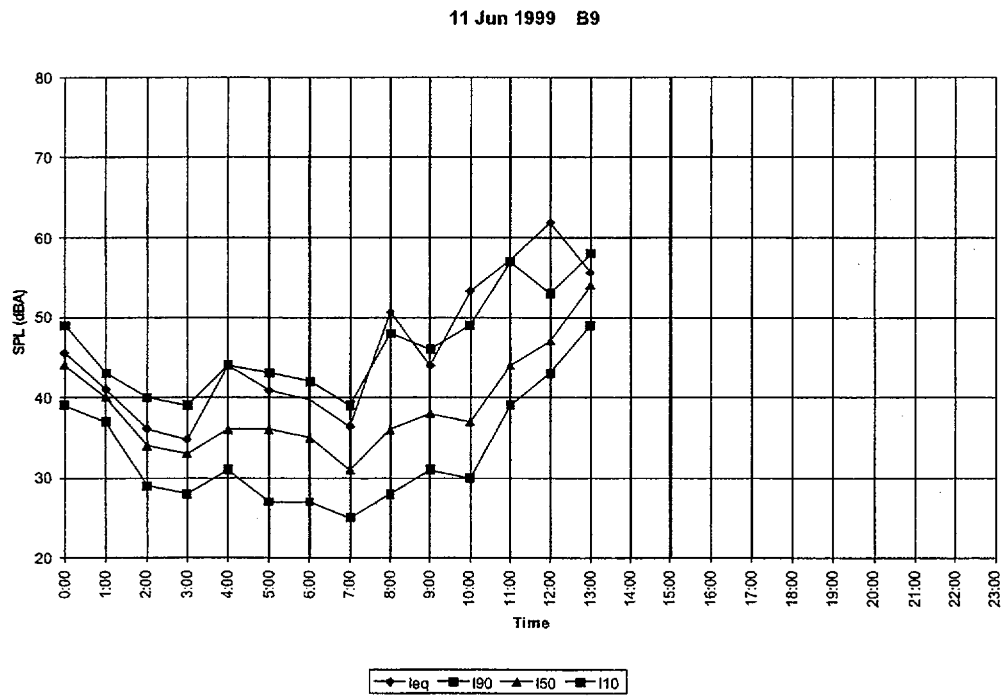
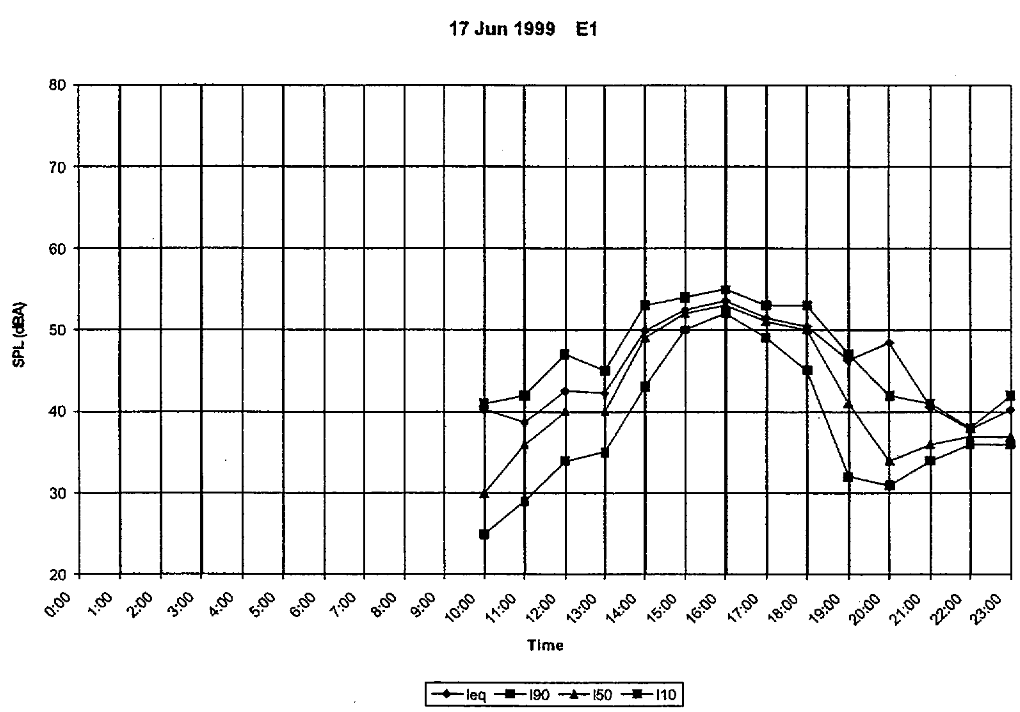
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

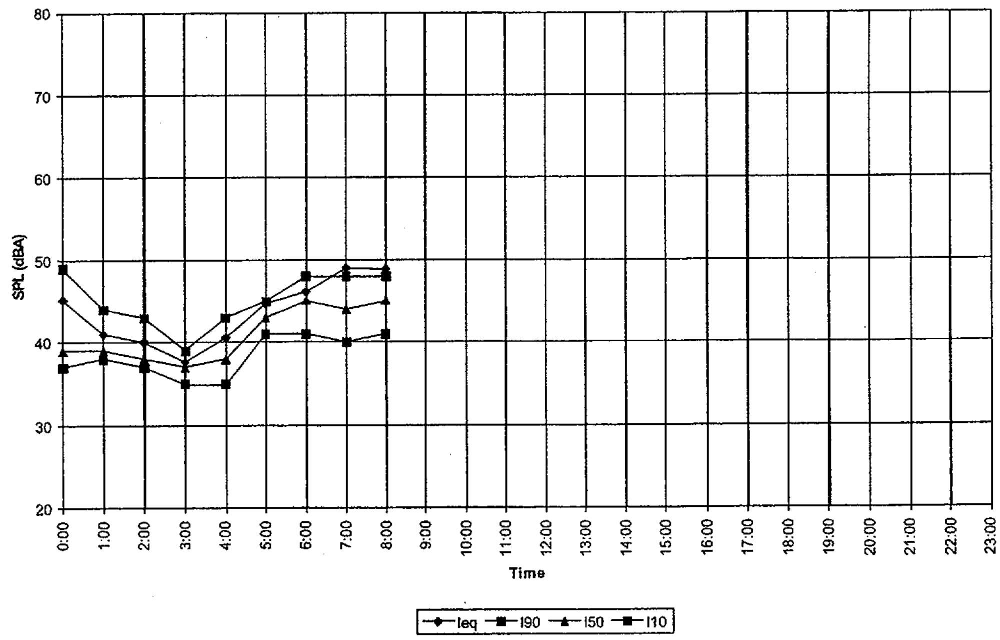

09 Jun 1999 B9
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10


10 Jun 1999 B9
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10


11 Jun 1999 B9
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

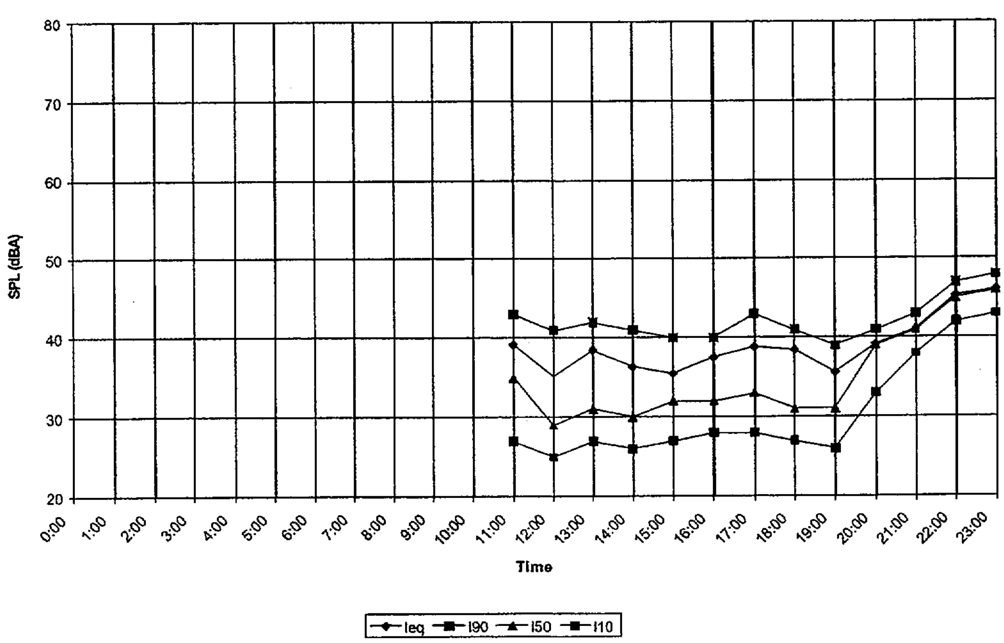

17 Jun 1999 E1
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

18 Jun 1999 E1

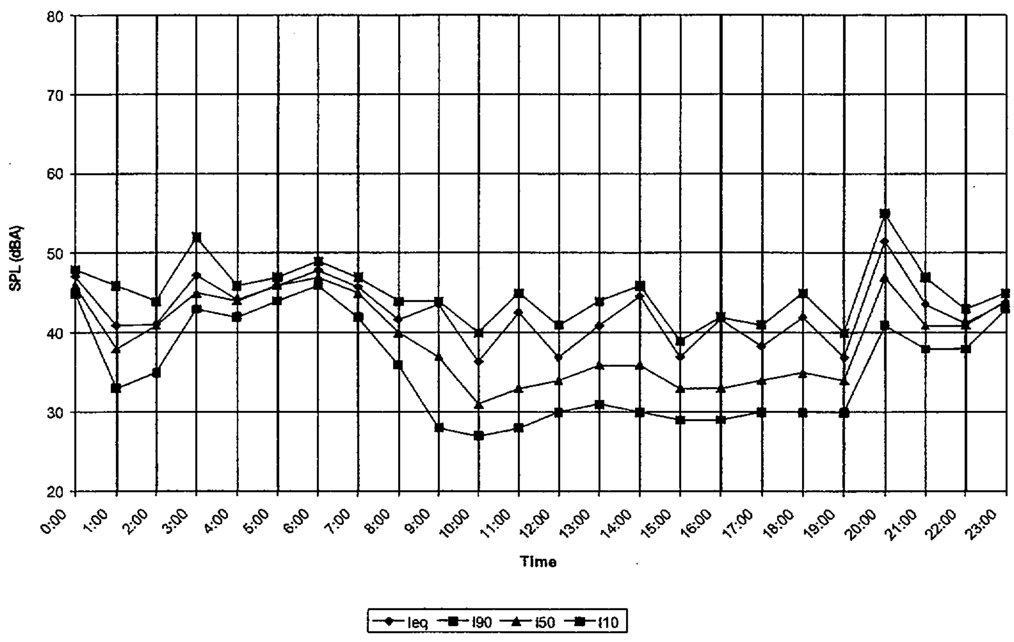


Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements
The Soundscape in South Florida NP

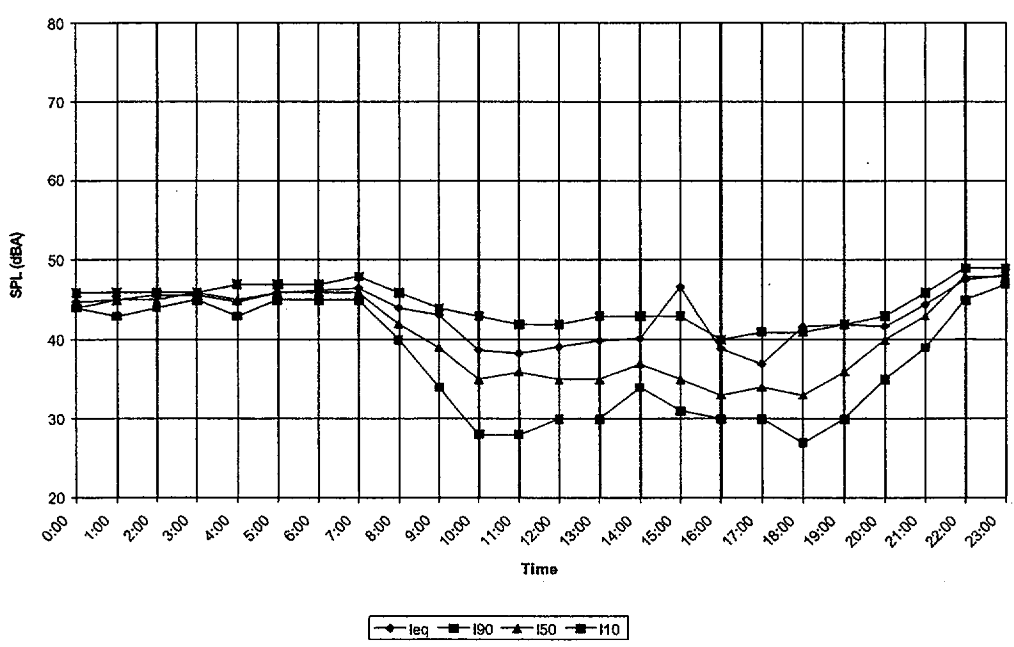
15 Jun 1999 E2

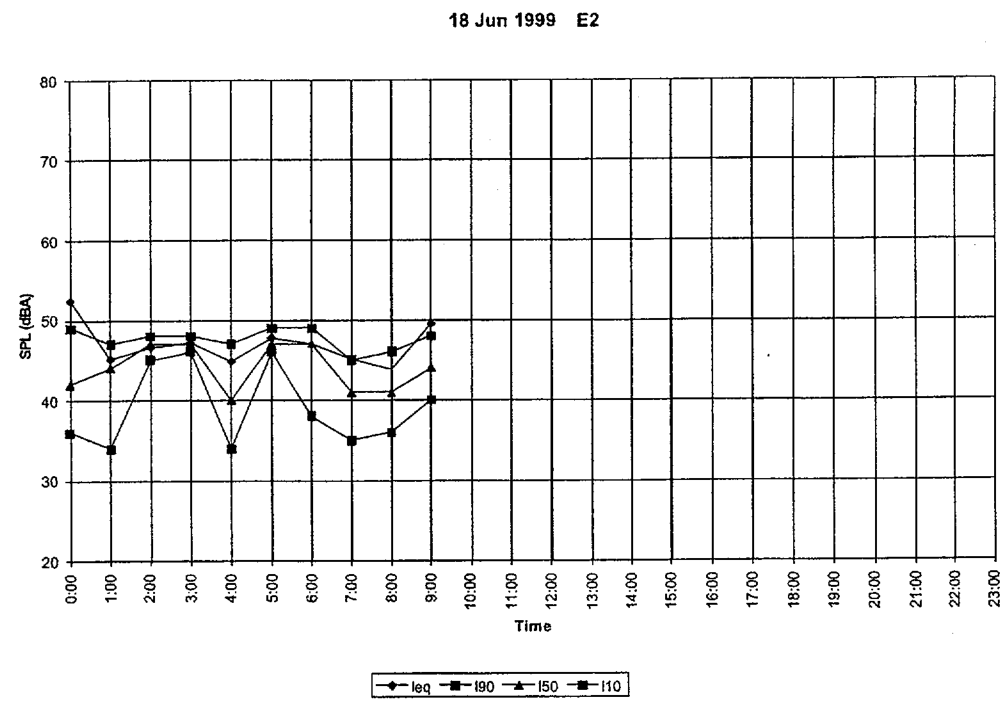


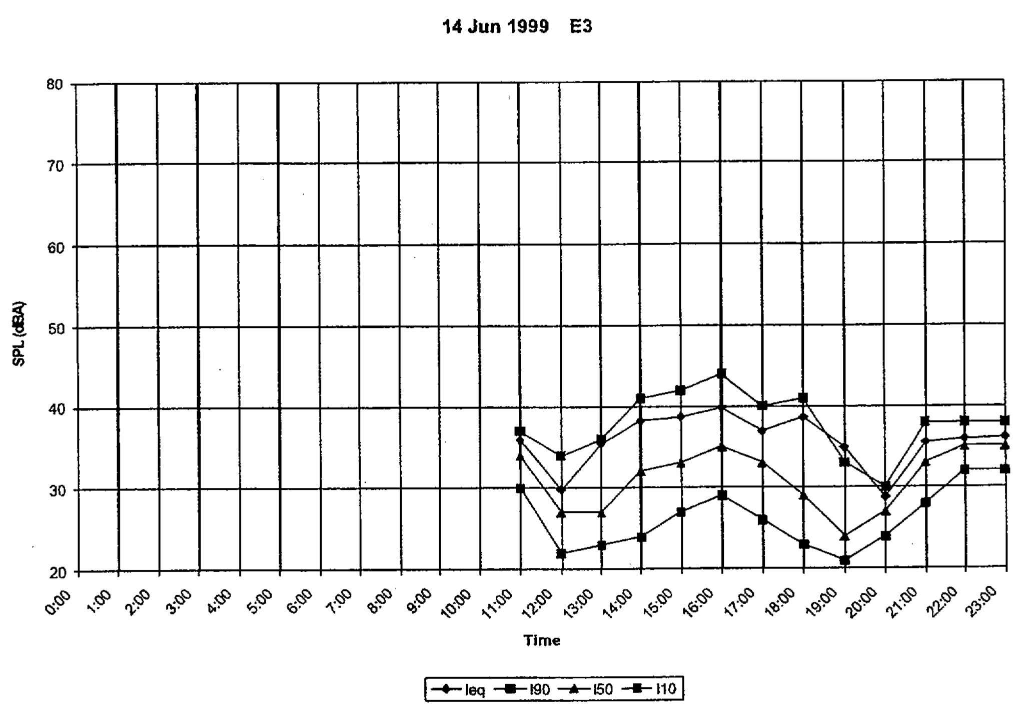
16 Jun 1999 E2



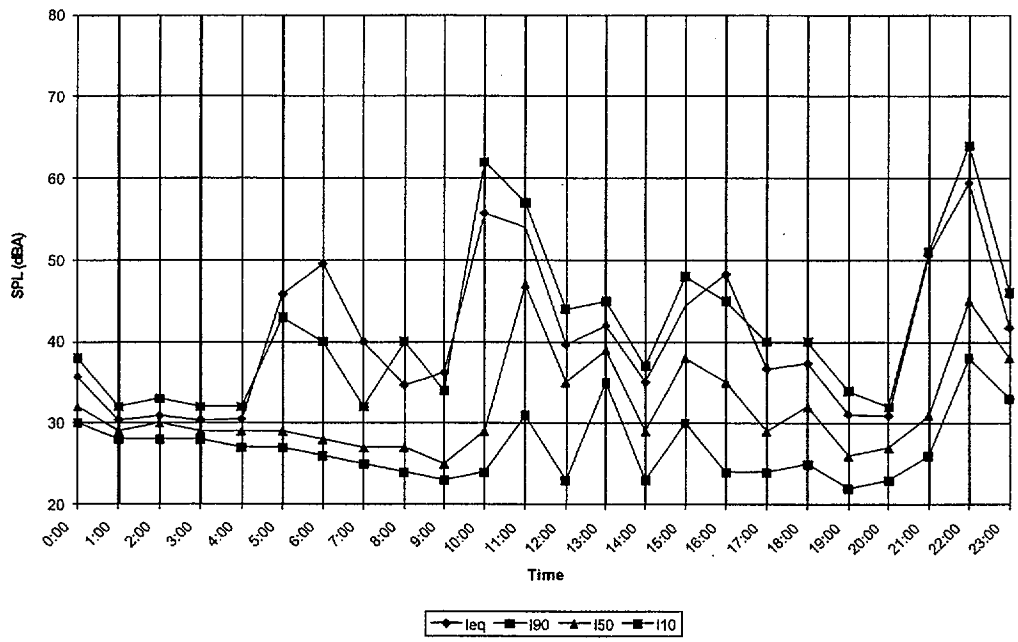
17 Jun 1999 E2




18 Jun 1999 E2
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

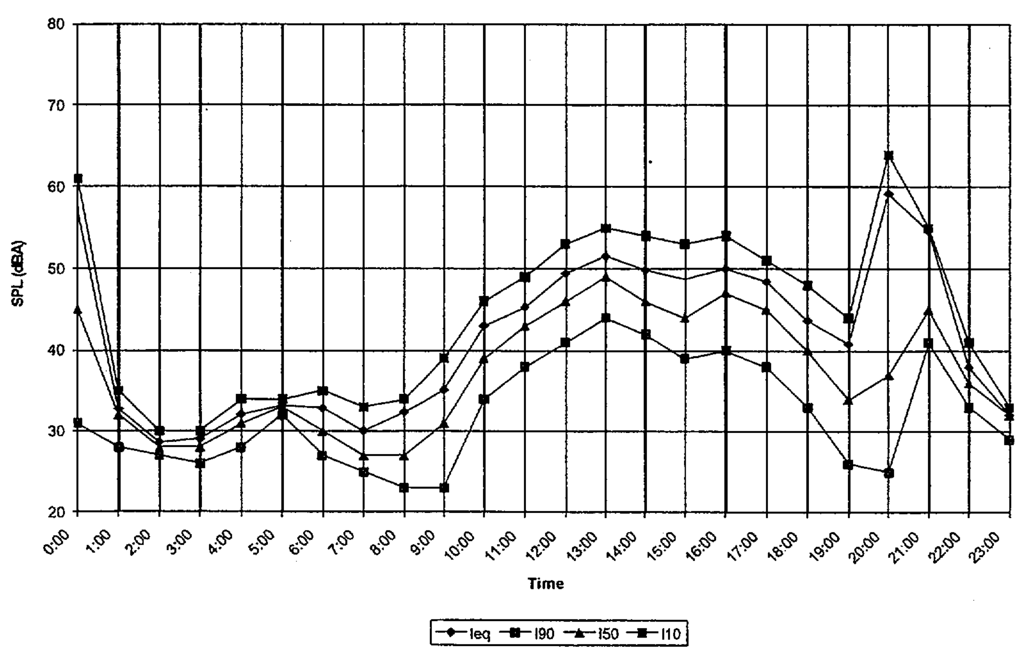

14 Jun 1999 E3
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

15 Jun 1999 E3

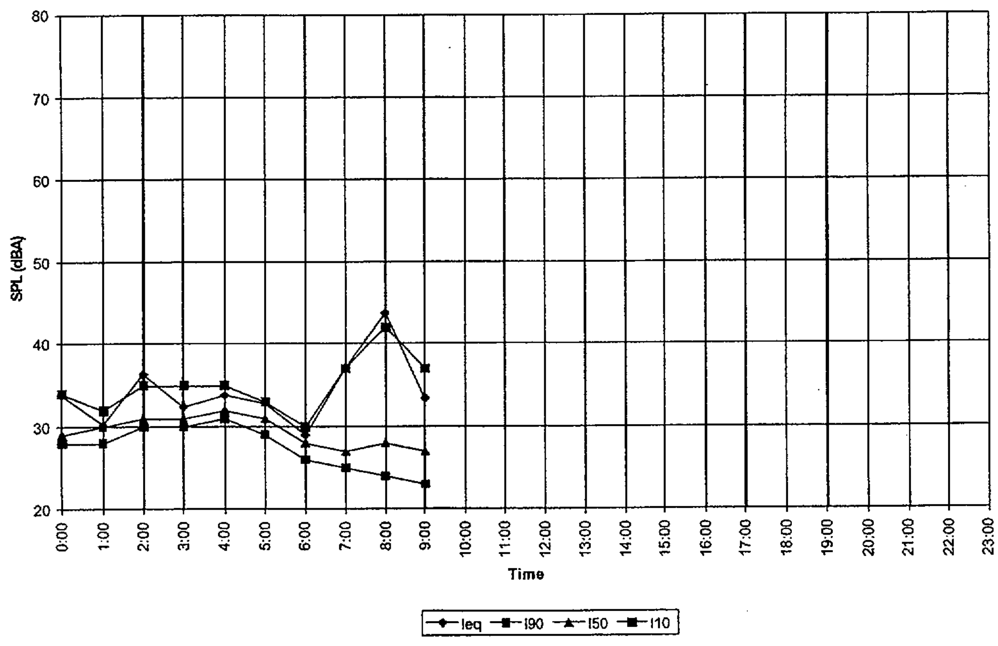


Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements The Soundscape in South Florida NP

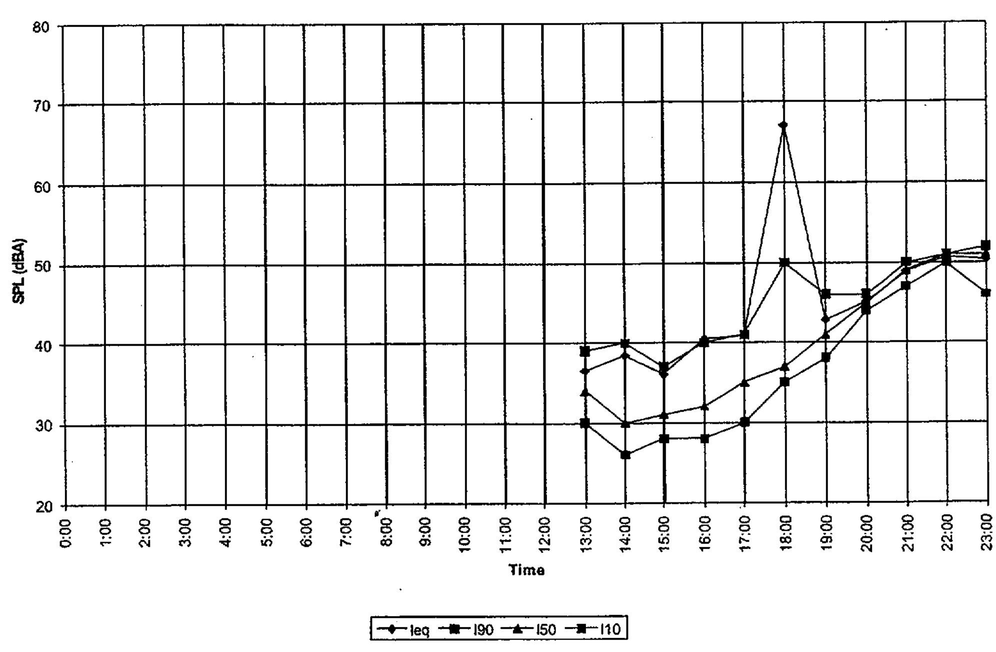
16 Jun 1999 E3



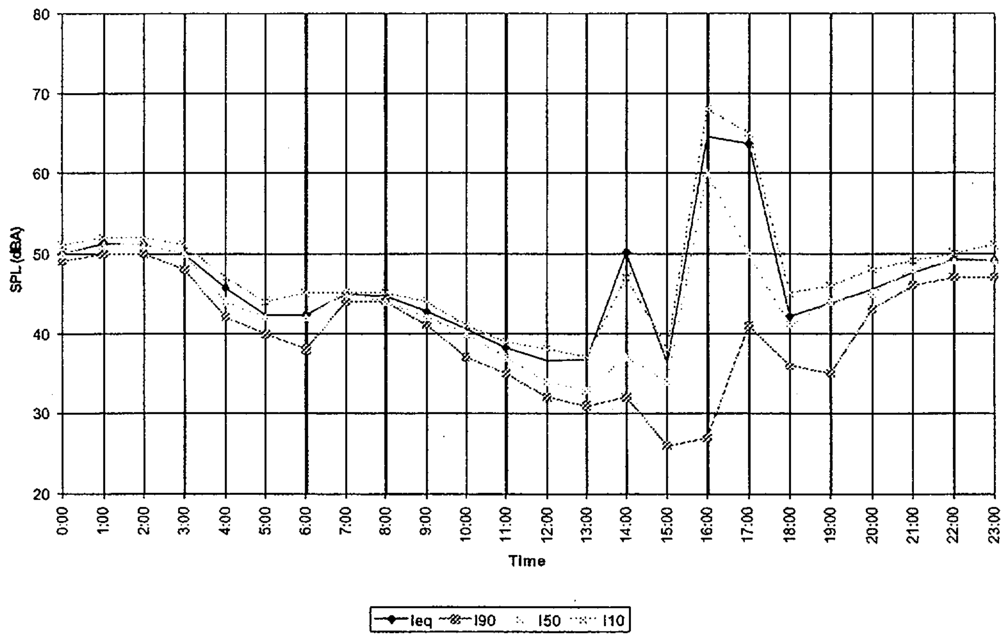
17 Jun 1999 E3



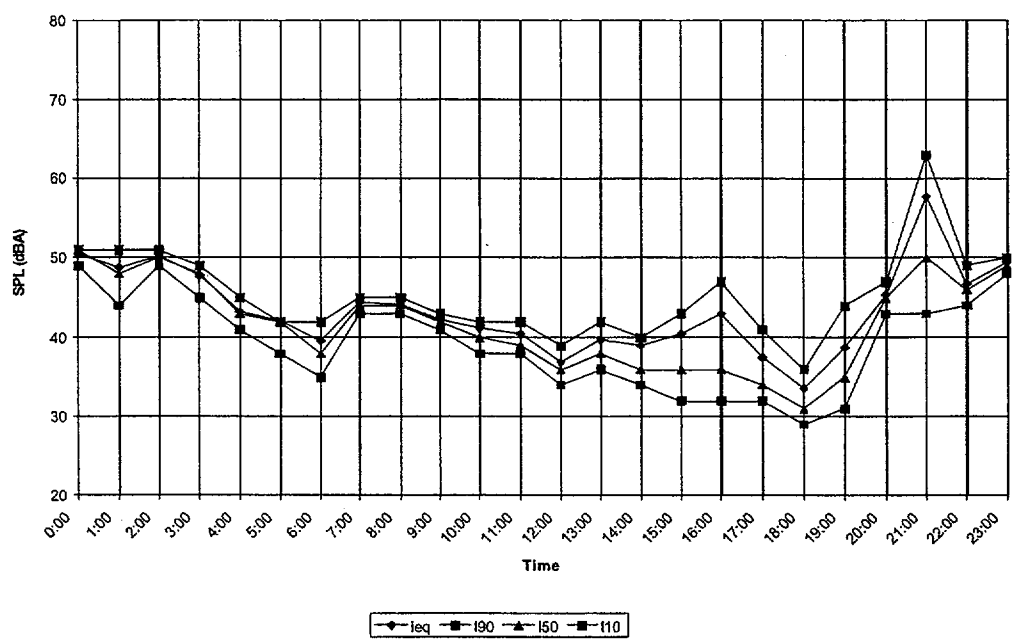
14 Jun 1999 E4

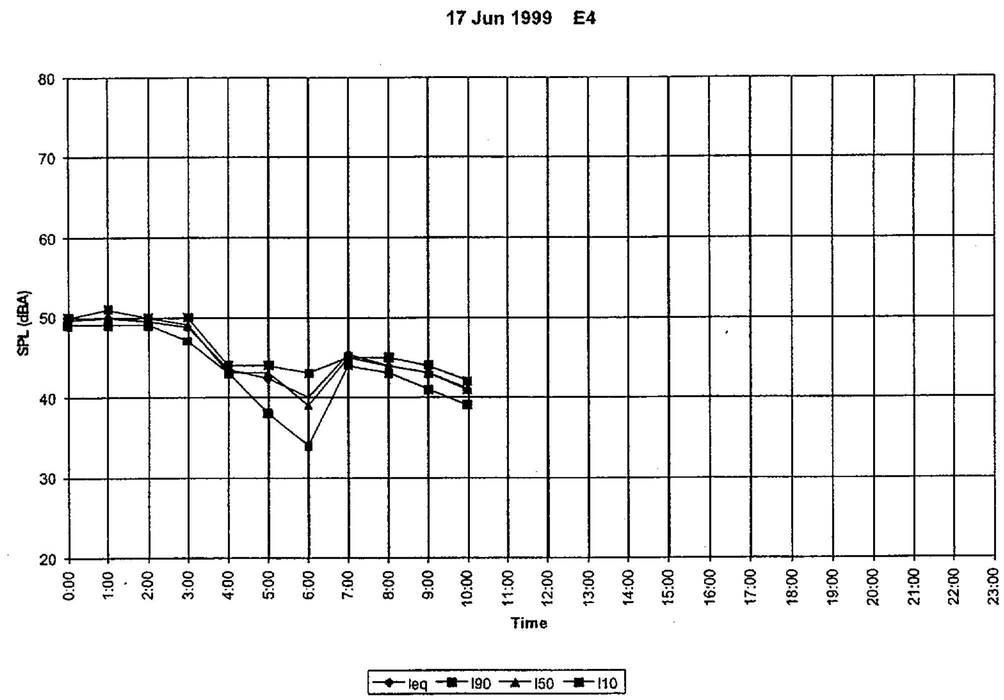


15 Jun 1999 E4



16 Jun 1999 E4

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SPL (dBA)
80
70
60
50
40
30
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0:00
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2:00
3:00
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5:00
6:00
7:00
8:00
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10:00
11:00
12:00
13:00
14:00
15:00
16:00
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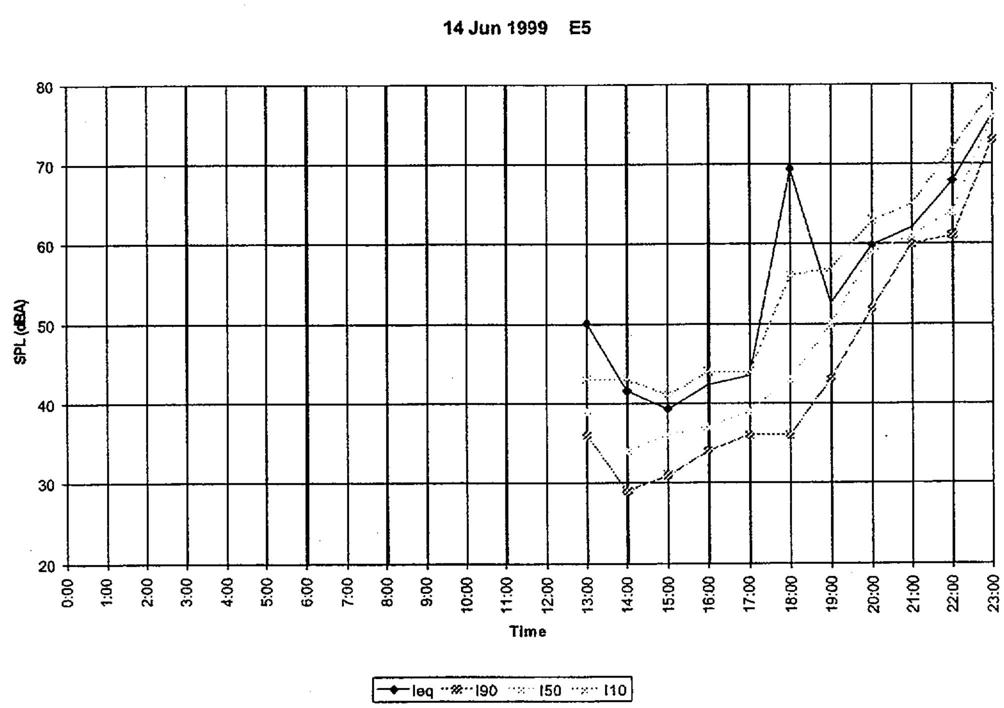
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


14 Jun 1999 E5
SPL (dBA)
80
70
60
50
40
30
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0:00
1:00
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3:00
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5:00
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8:00
9:00
10:00
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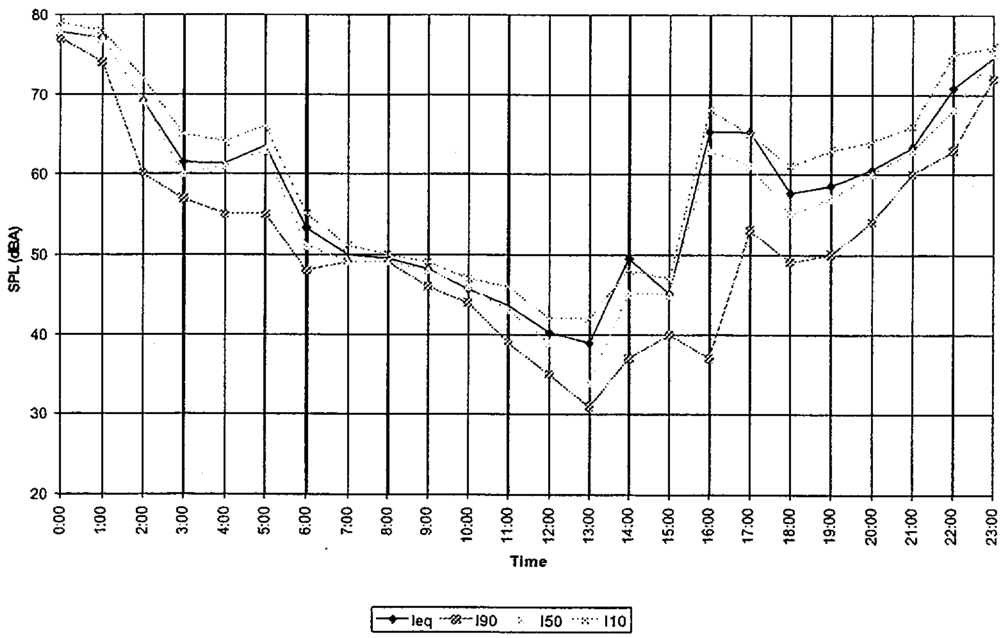
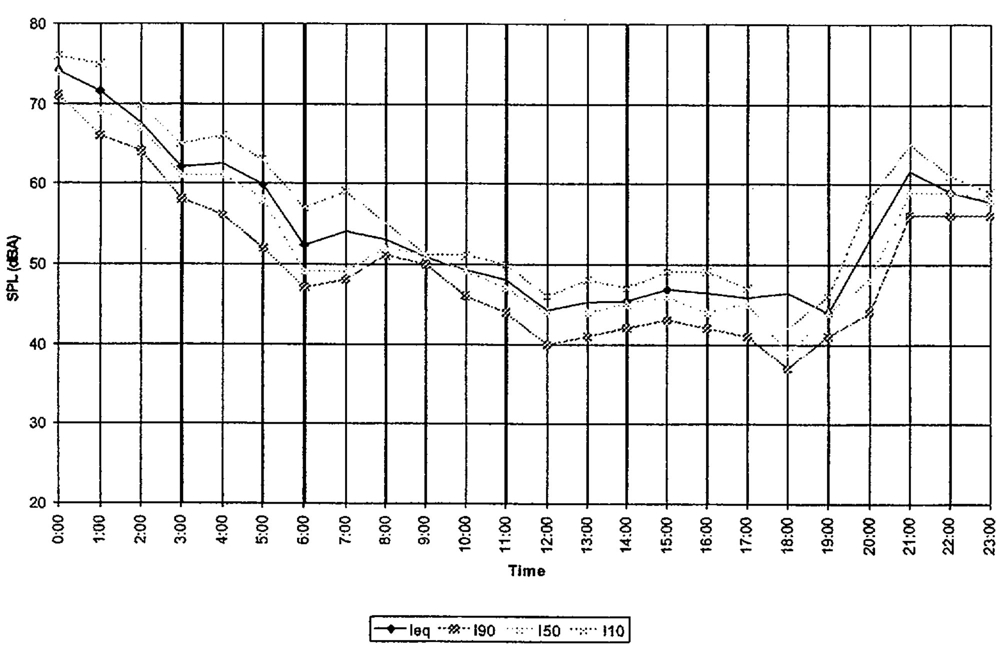
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

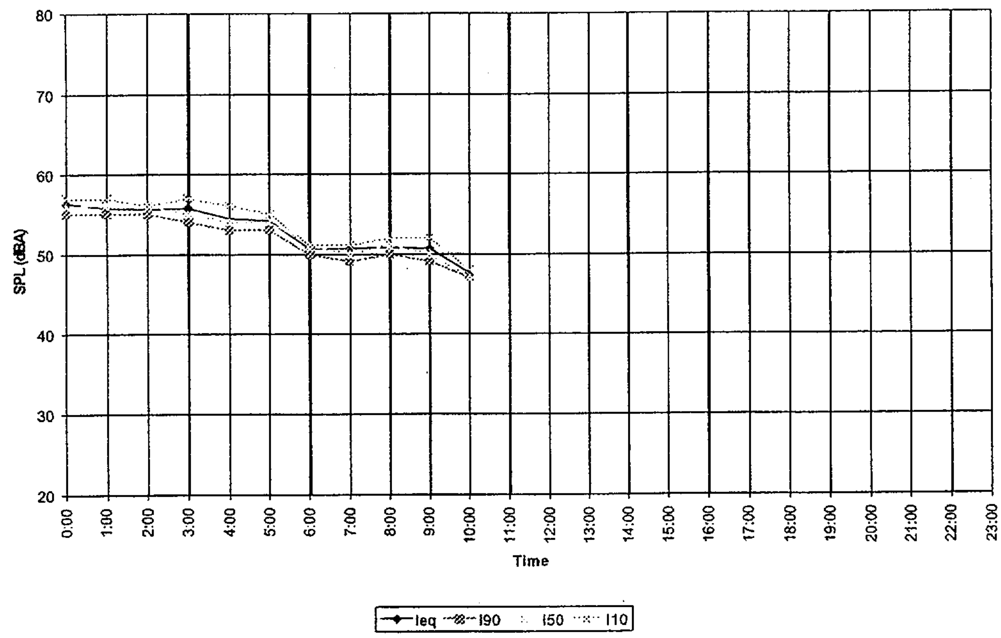
15 Jun 1999 E5



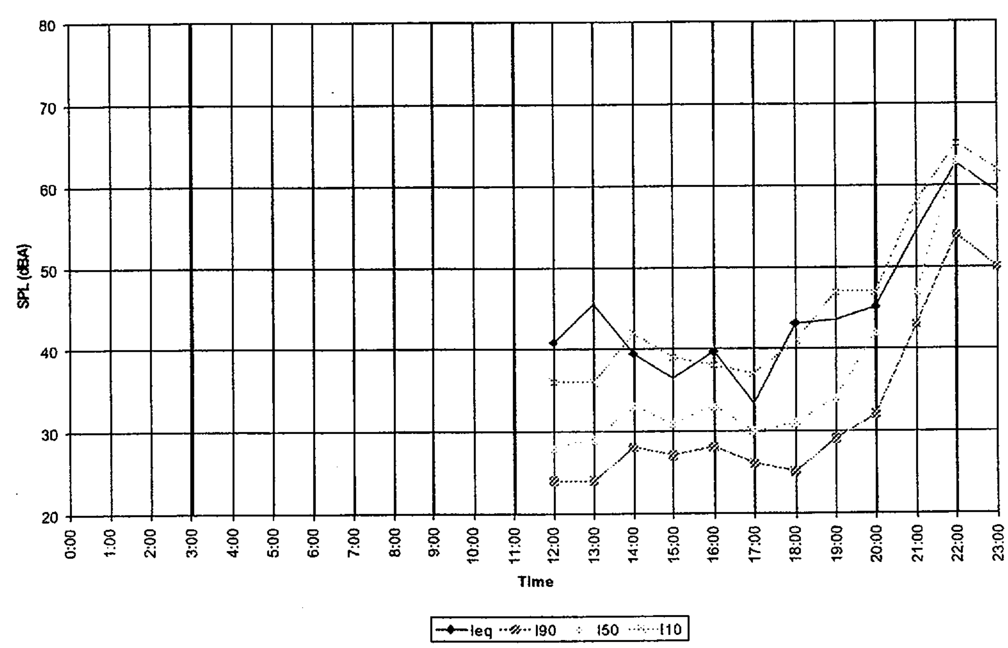
16 Jun 1999 E5

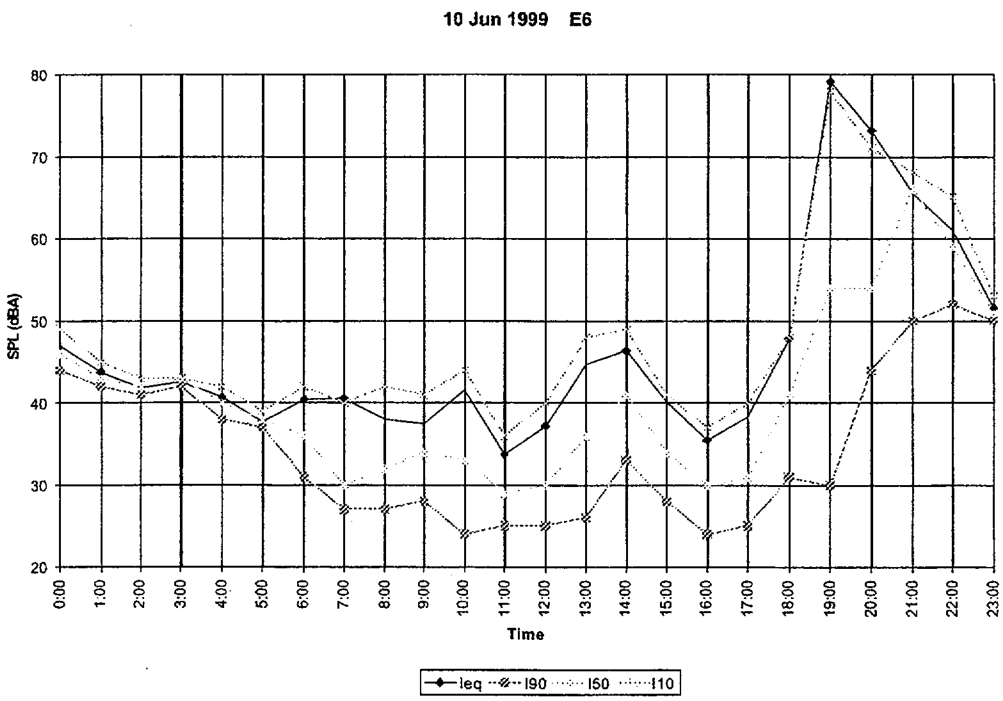


17 Jun 1999 E5



09 Jun 1999 E6




10 Jun 1999 E6
SPL (dBA)
80
70
60
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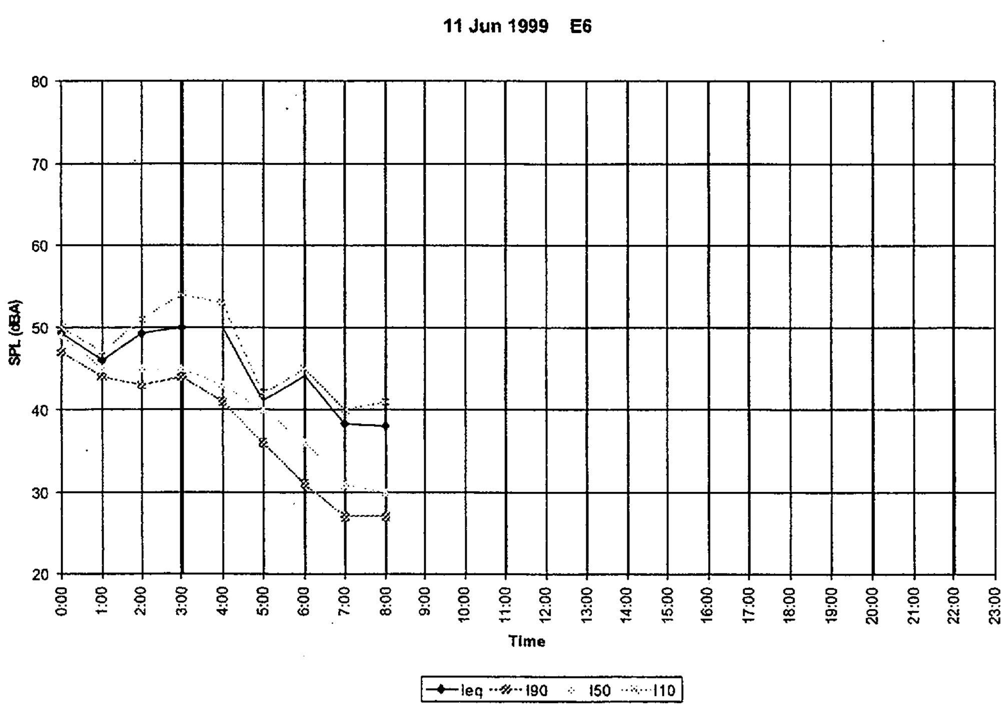
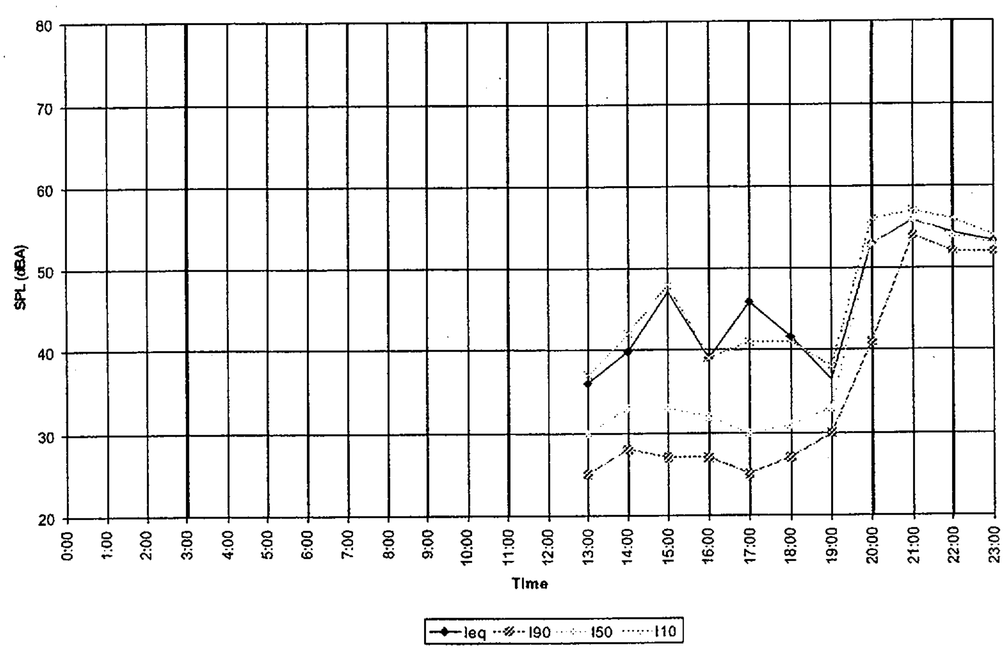
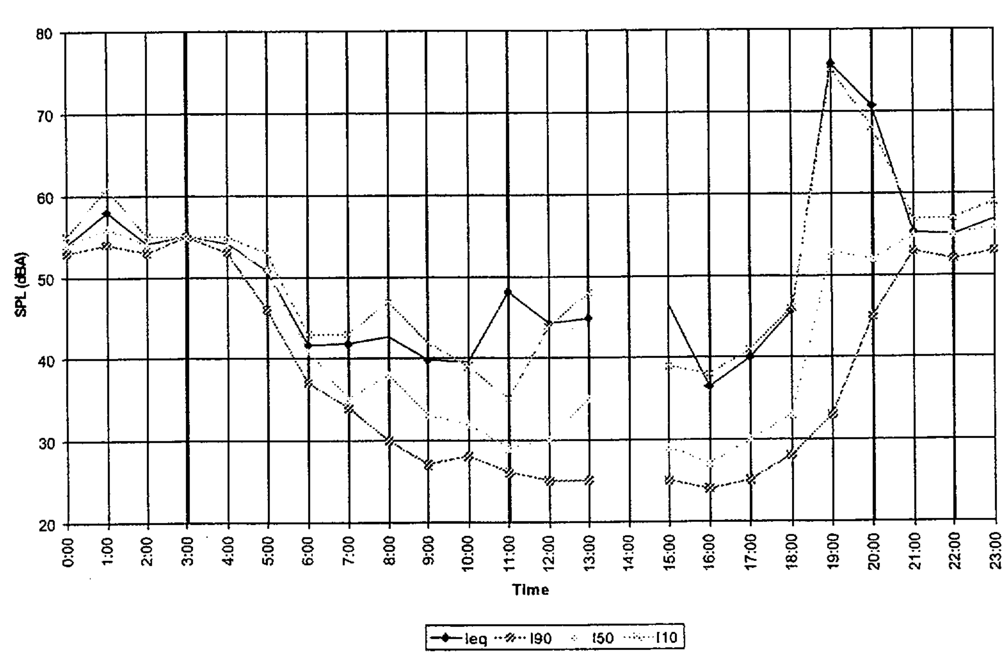
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10


11 Jun 1999 E6
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10

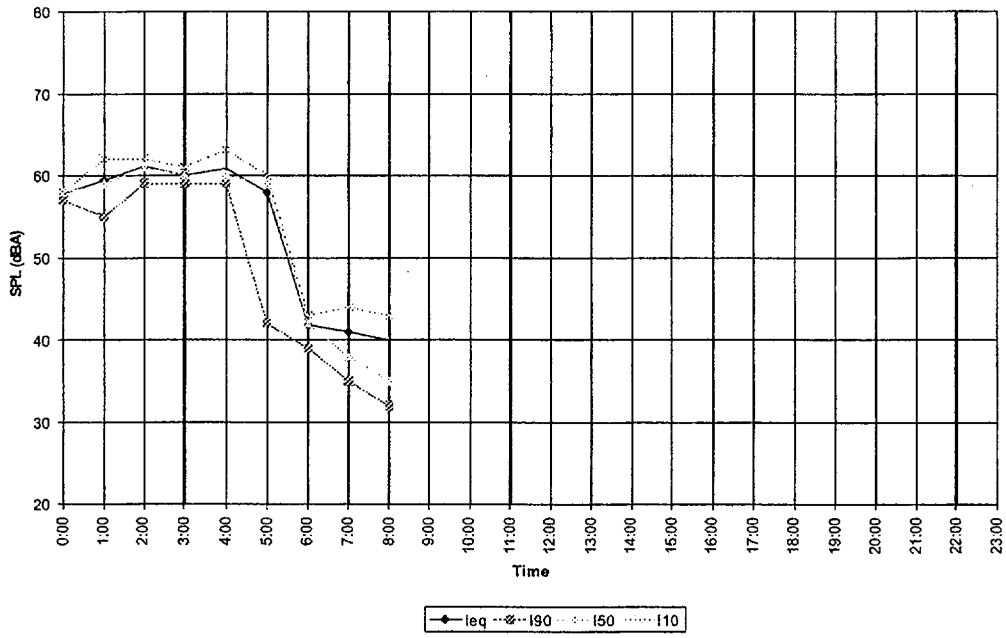
09 Jun 1999 E7



10 Jun 1999 E7

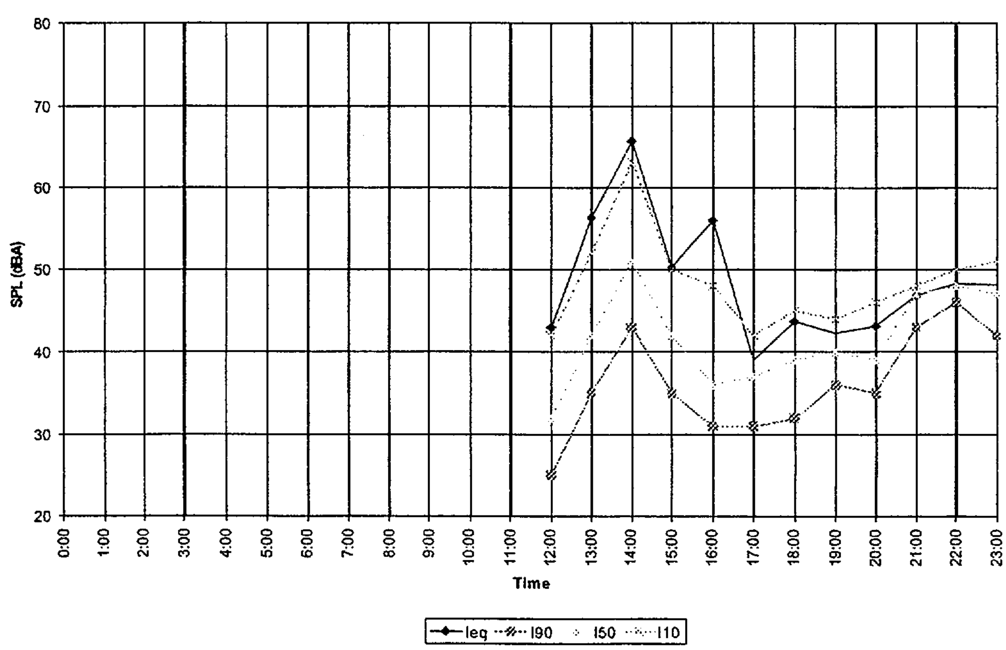


11 Jun 1999 E7

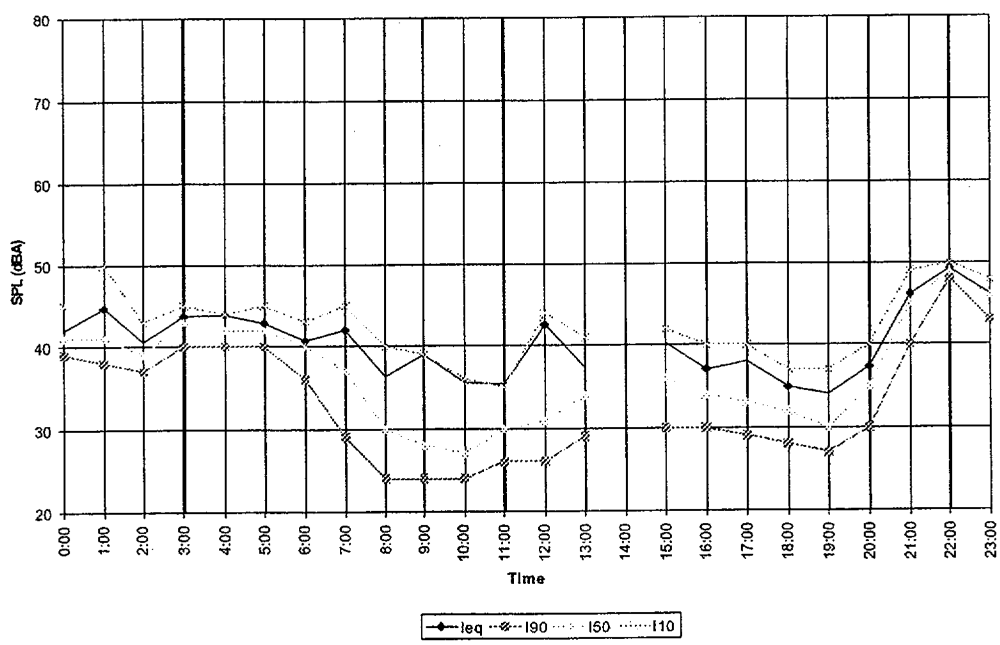


Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements The Soundscape in South Florida NP

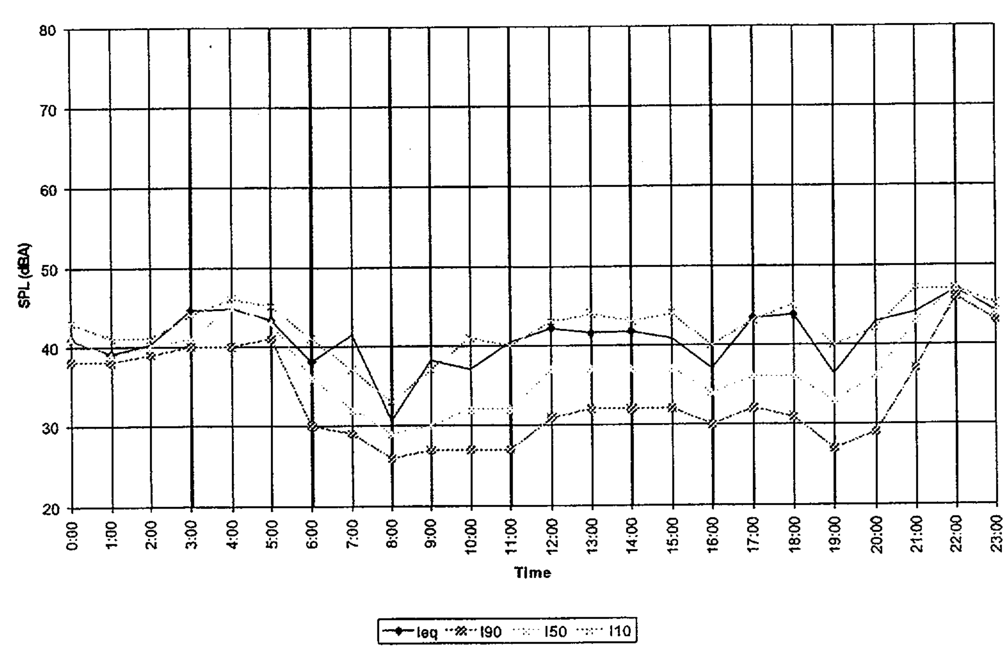
11 Jun 1999 E8



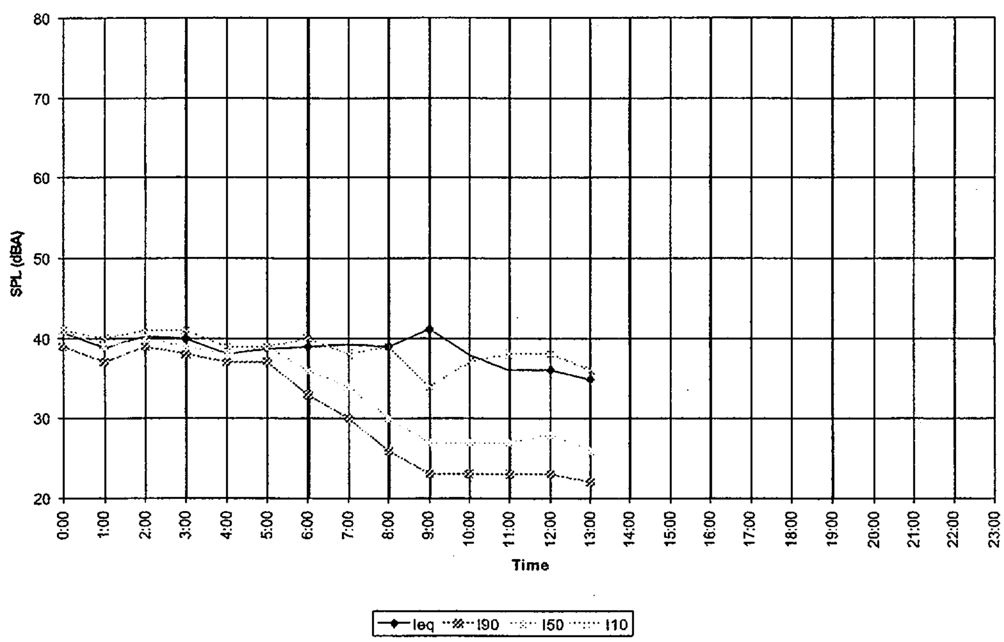
12 Jun 1999 E8



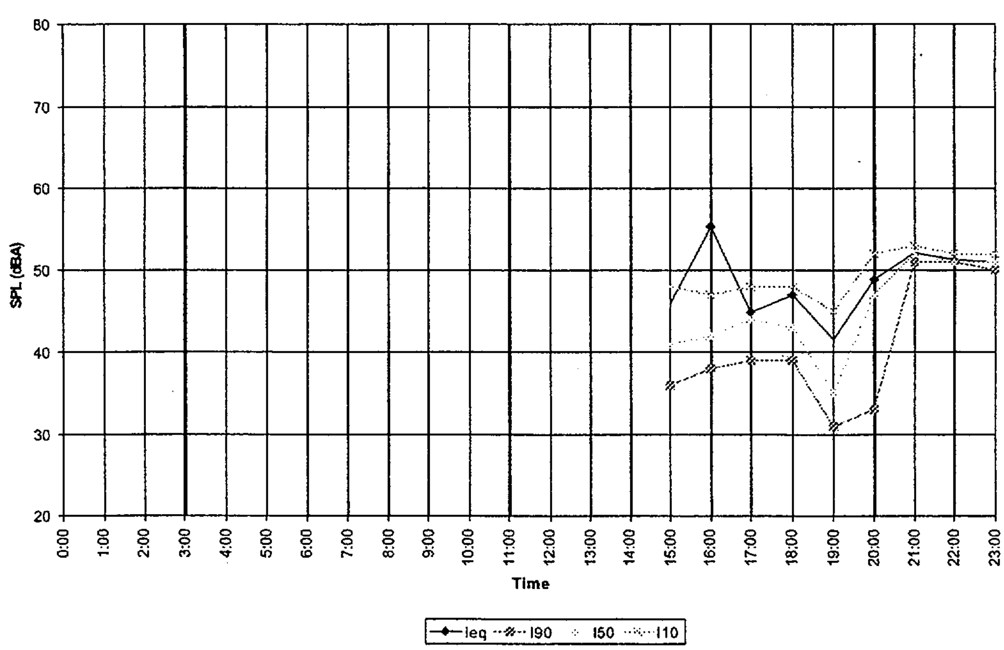
13 Jun 1999 E8

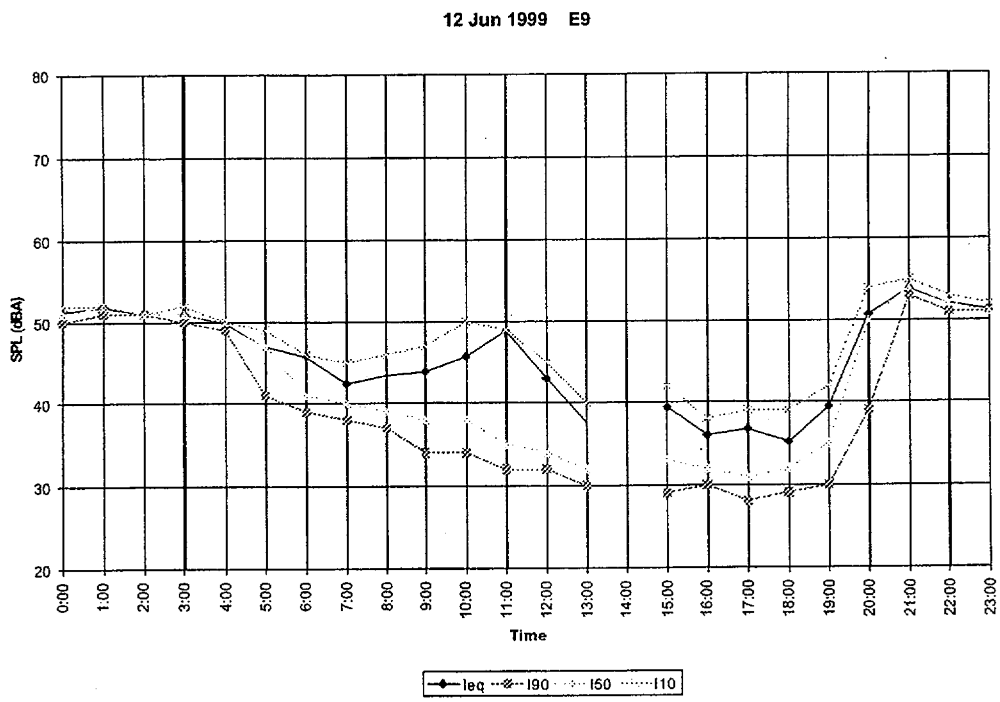


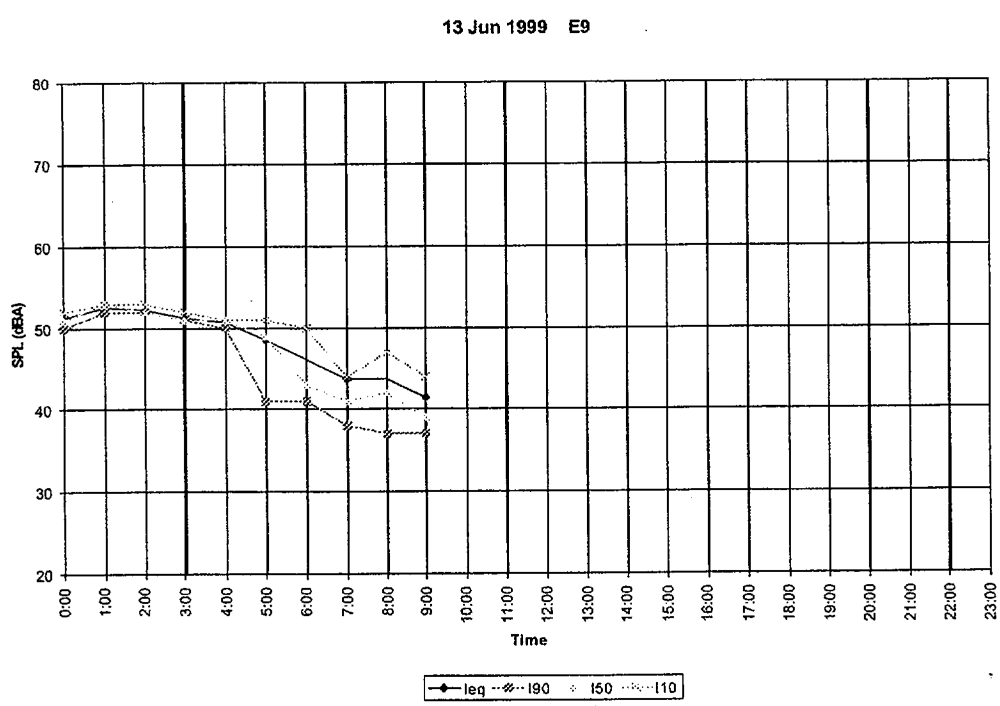
14 Jun 1999 E8



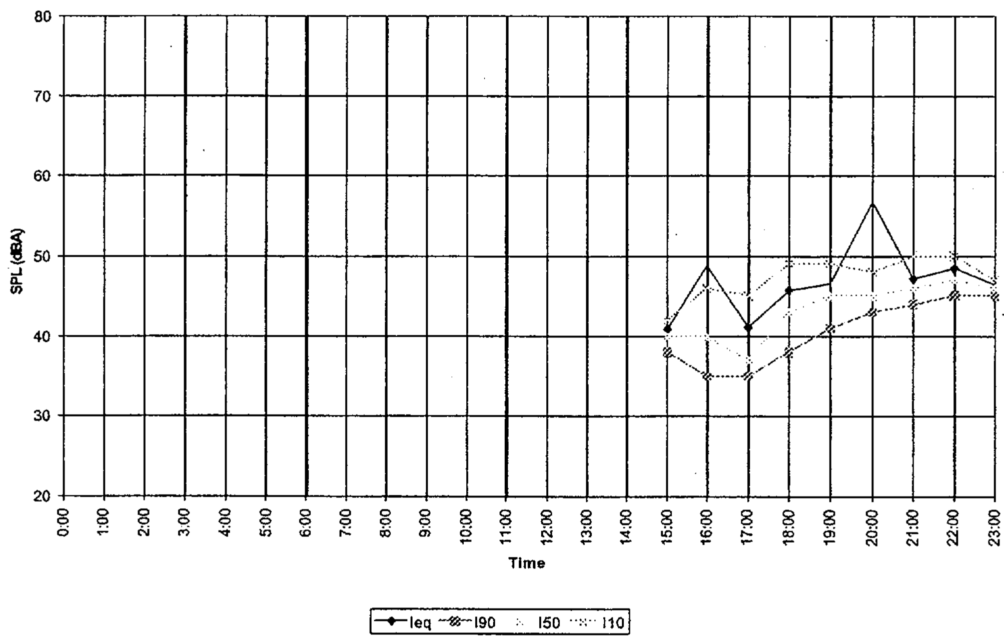
11 Jun 1999 E9




12 Jun 1999 E9
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

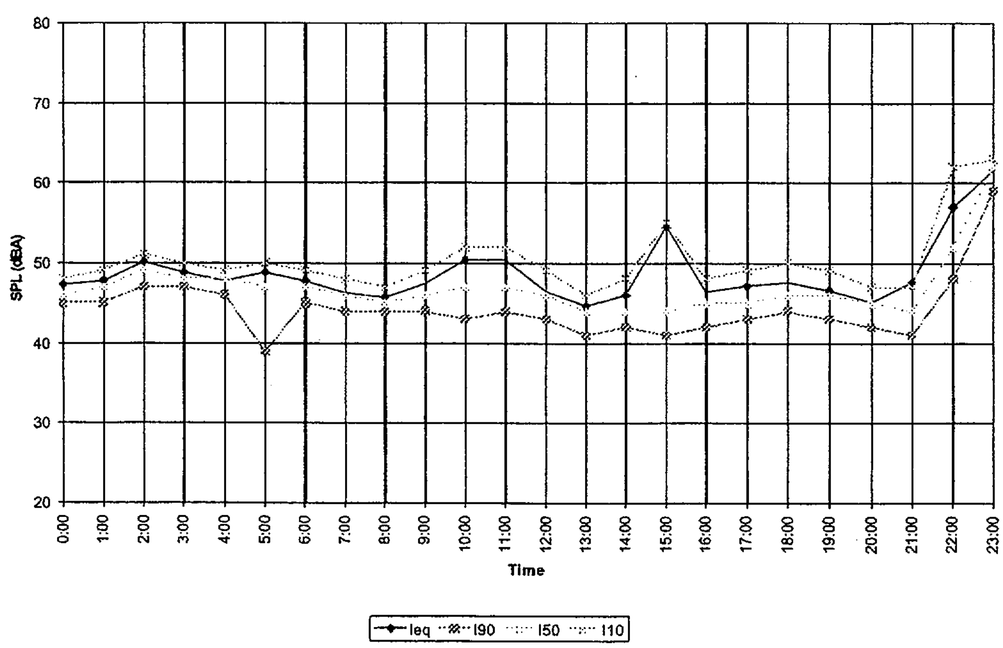

13 Jun 1999 E9
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

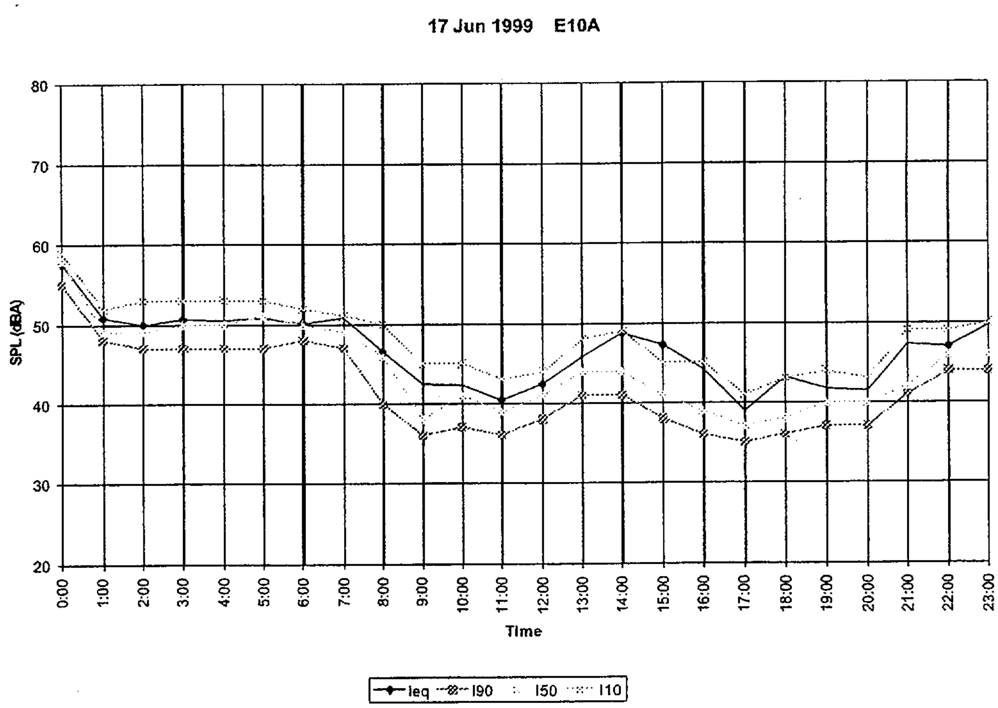
15 Jun 1999 E10A

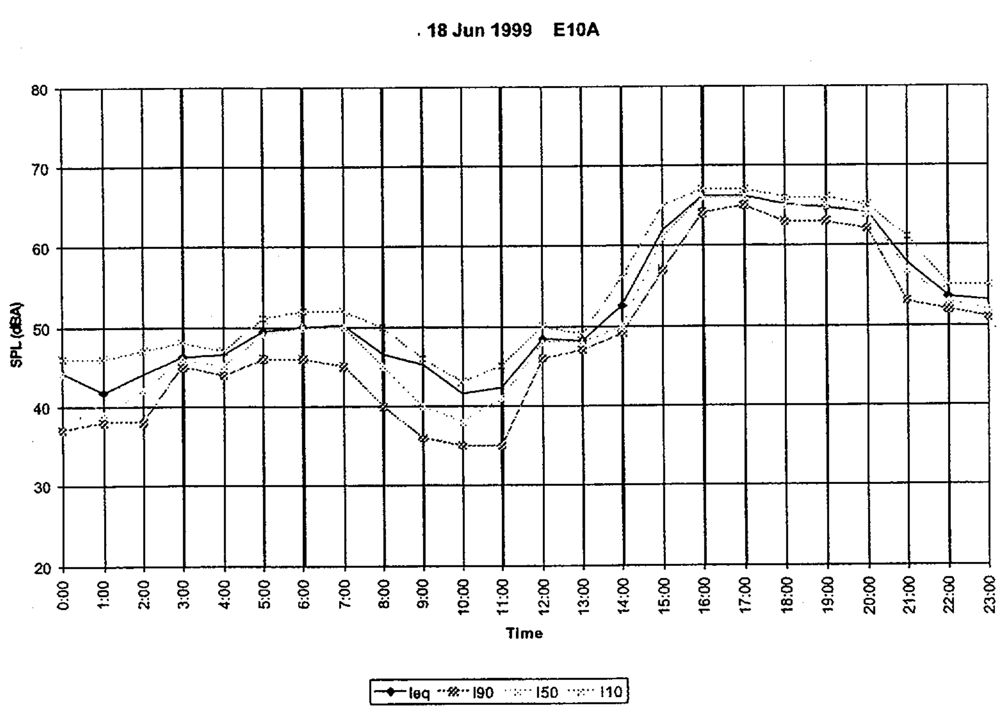


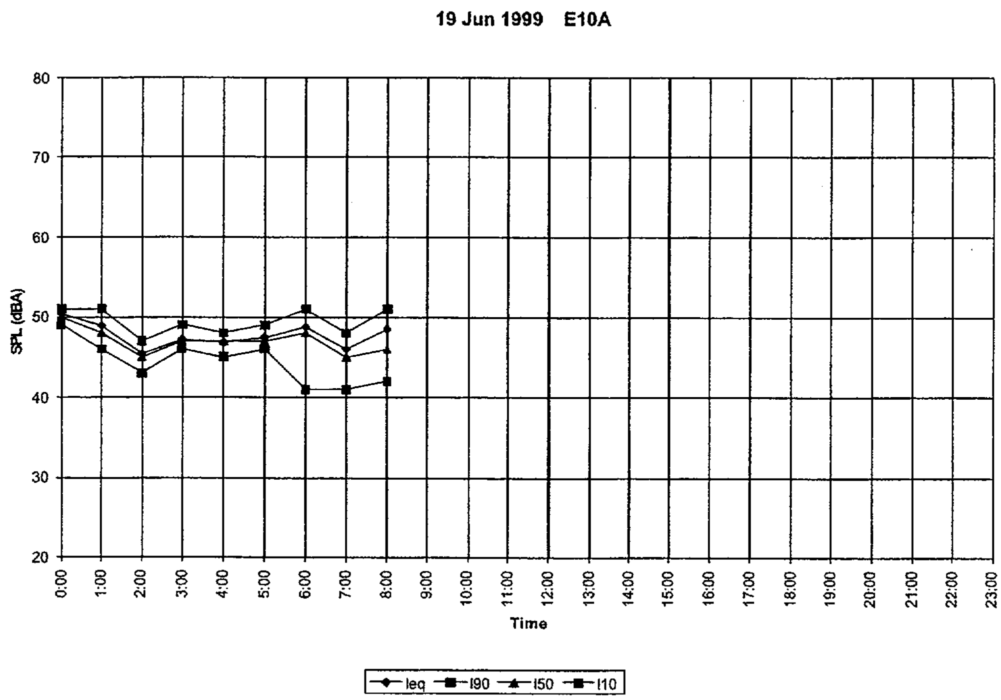
Appendix F Hourly L90, L50, L10 and Leq Time Histories for Unmanned Measurements The Soundscape in South Florida NP

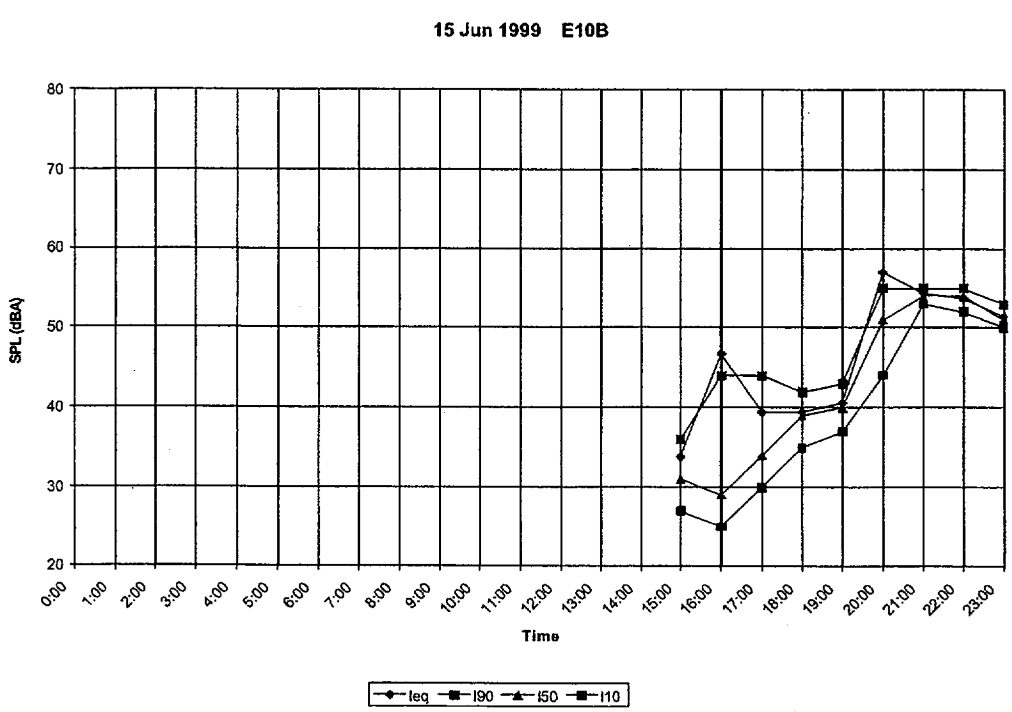
16 Jun 1999 E10A



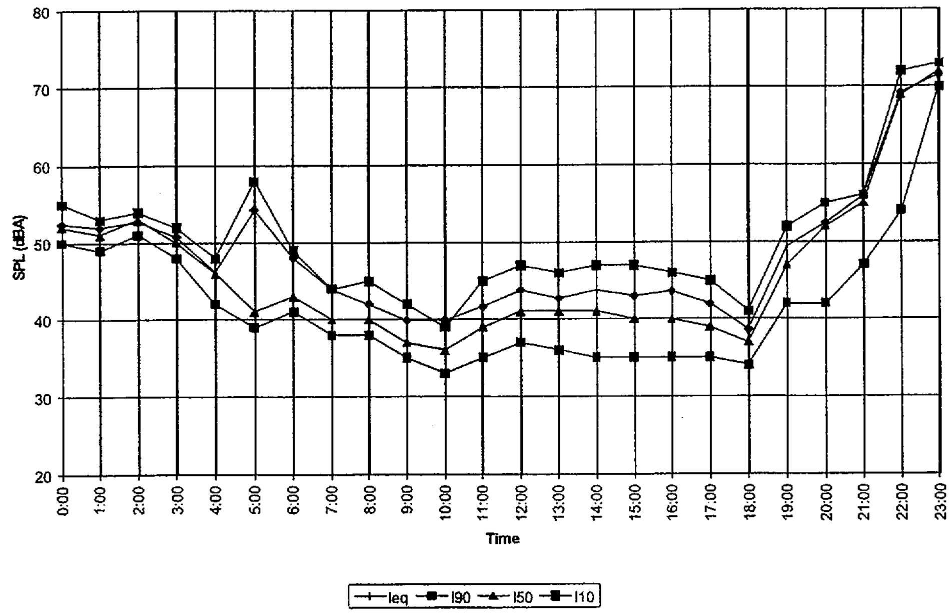

17 Jun 1999 E10A
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


18 Jun 1999 E10A
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

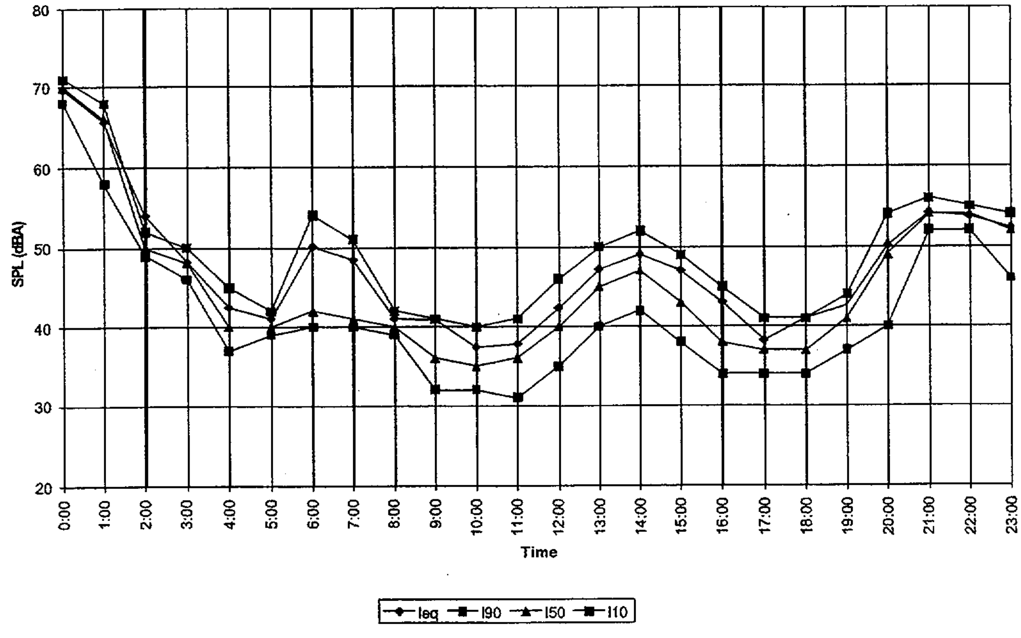

19 Jun 1999 E10A
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

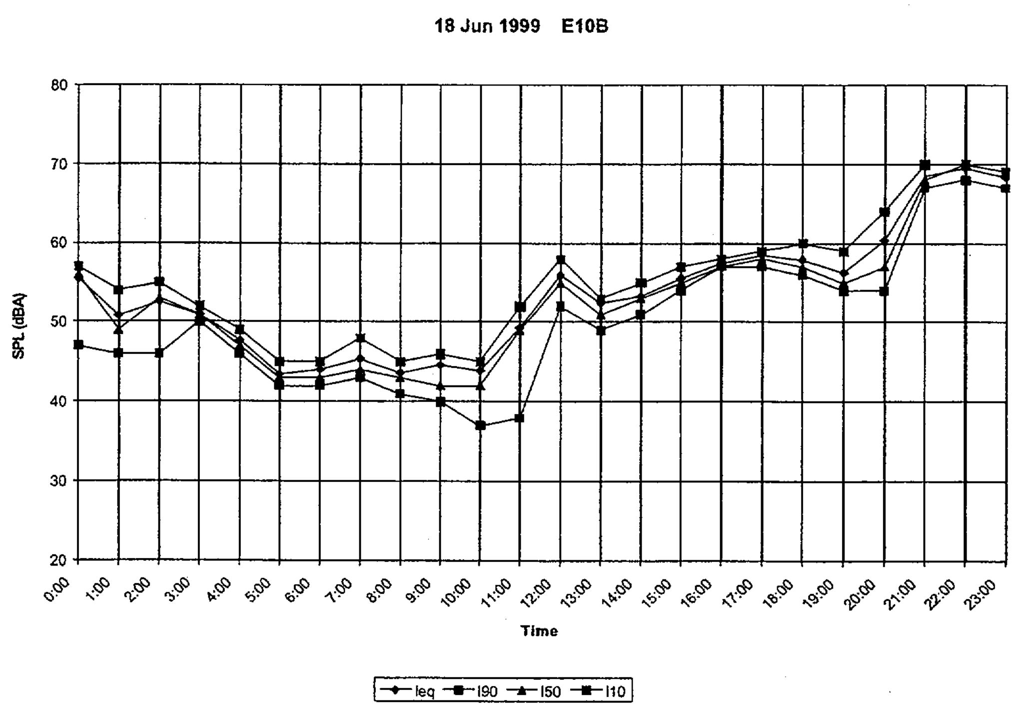

15 Jun 1999 E10B
80
70
60
50
40
30
20
SPL (dBA)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

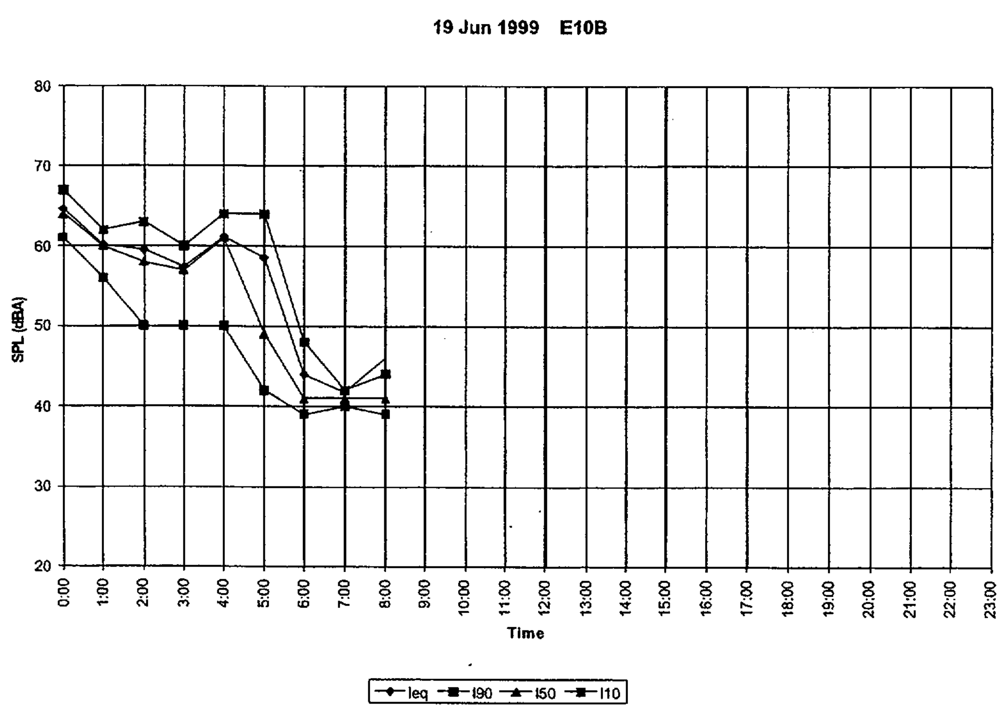
16 Jun 1999 E10B



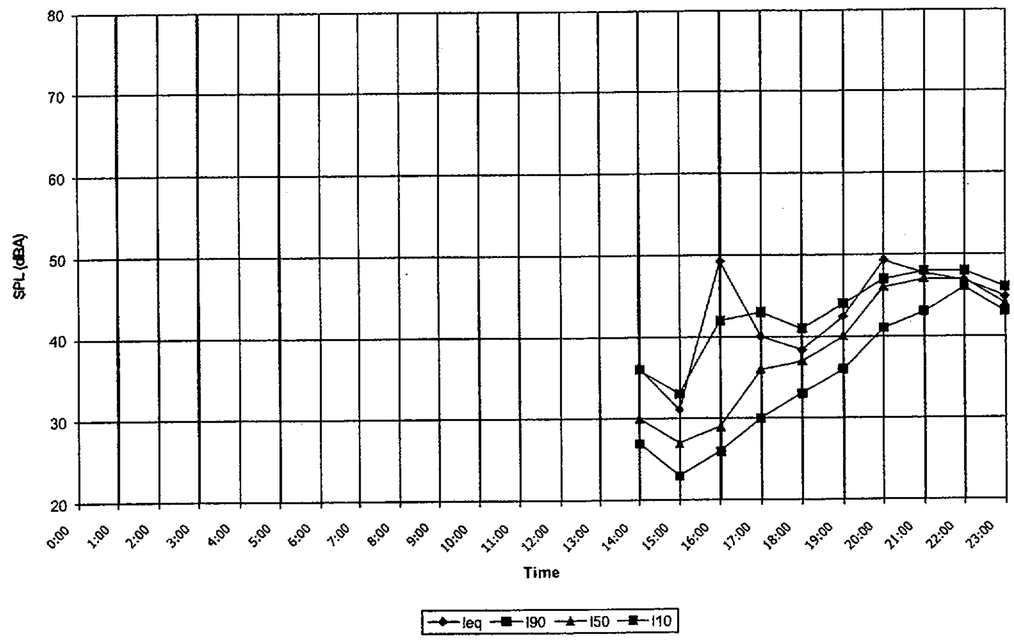
17 Jun 1999 E10B



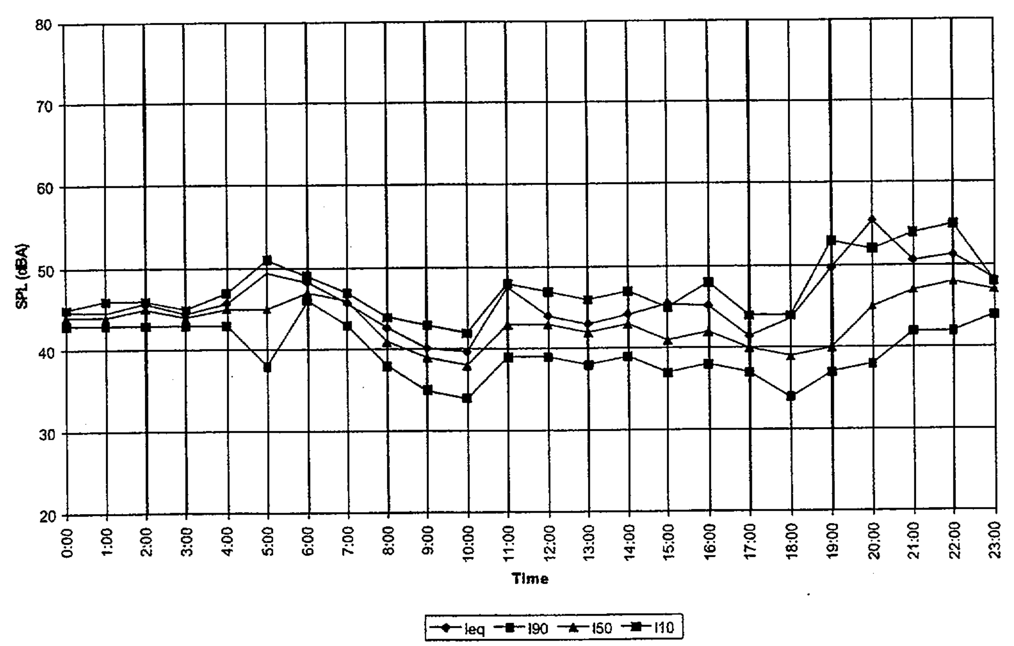

18 Jun 1999 E10B
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10

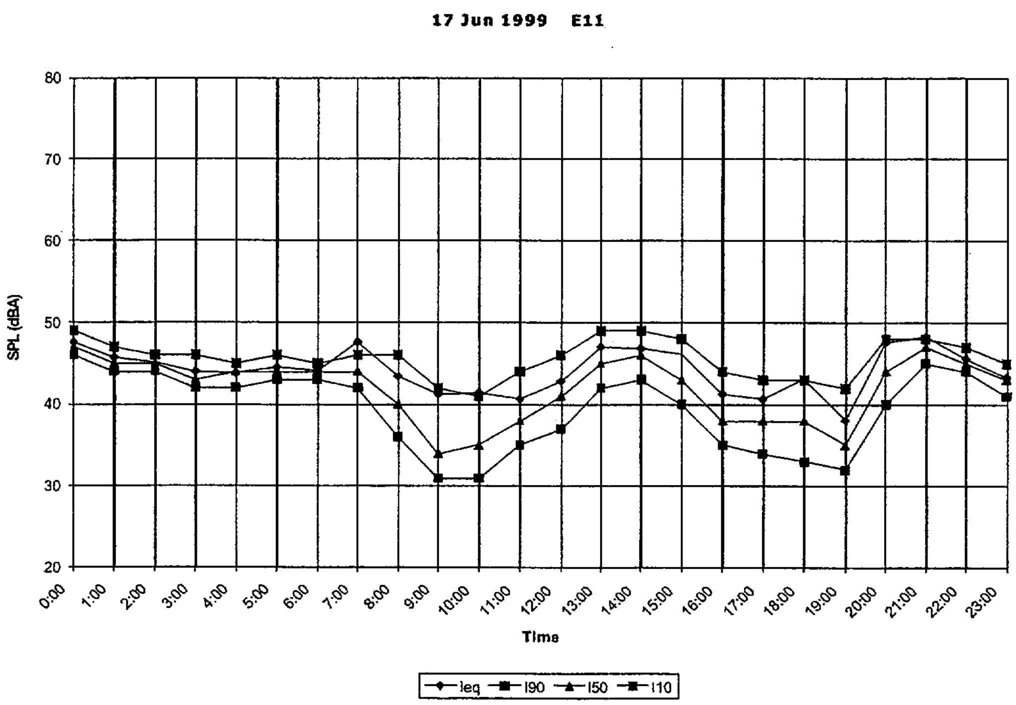

19 Jun 1999 E10B
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10

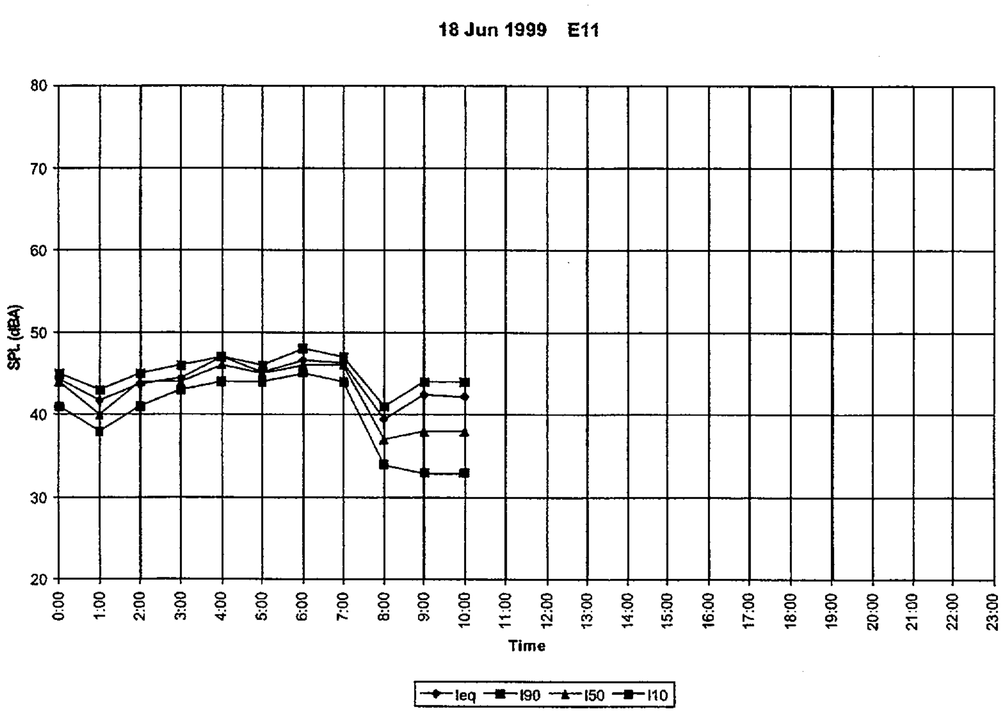
15 Jun 1999 E11

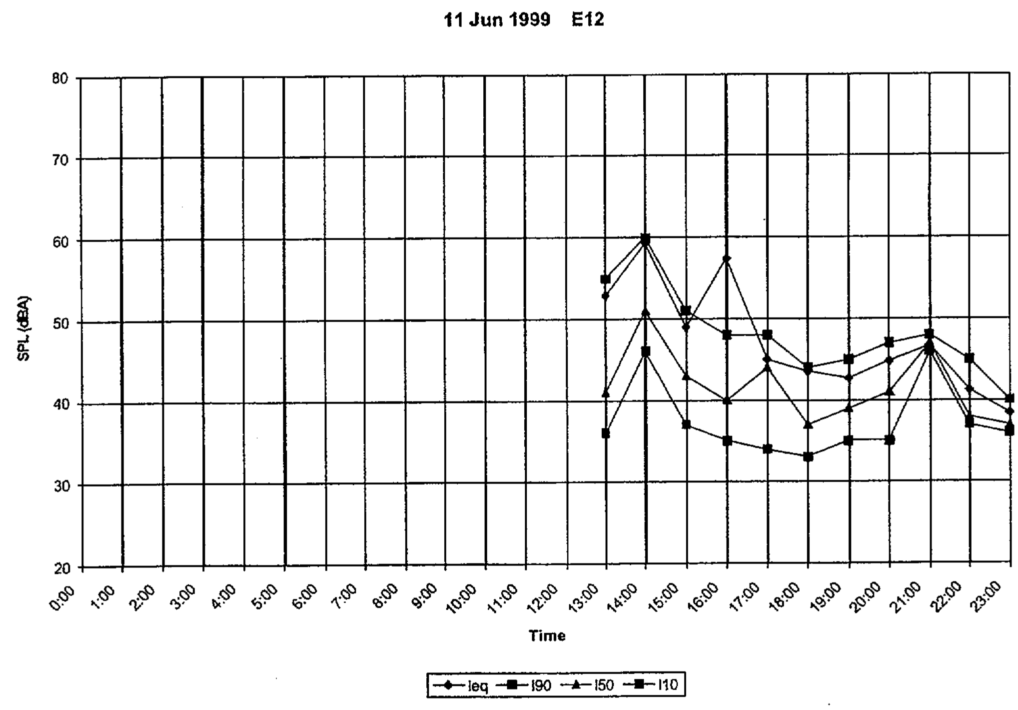


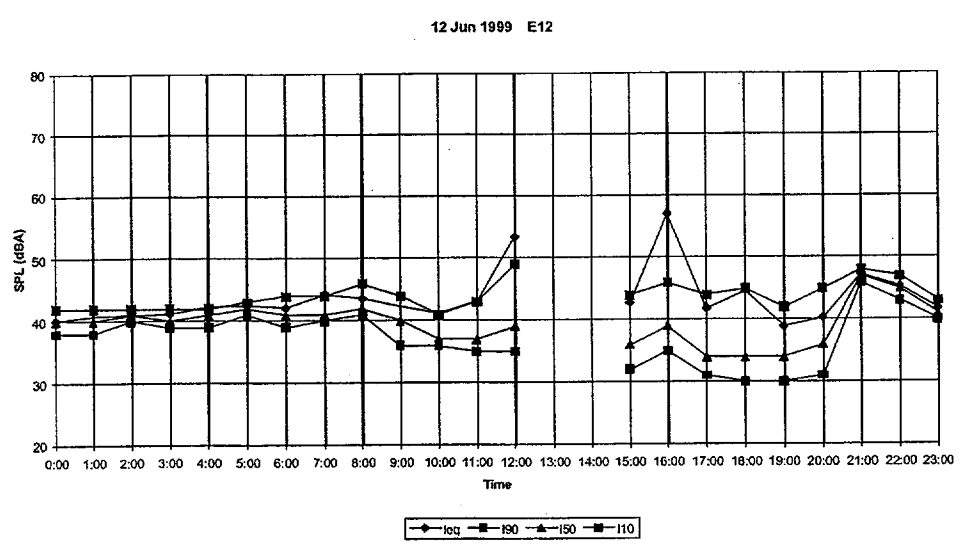
16 Jun 1999 E11



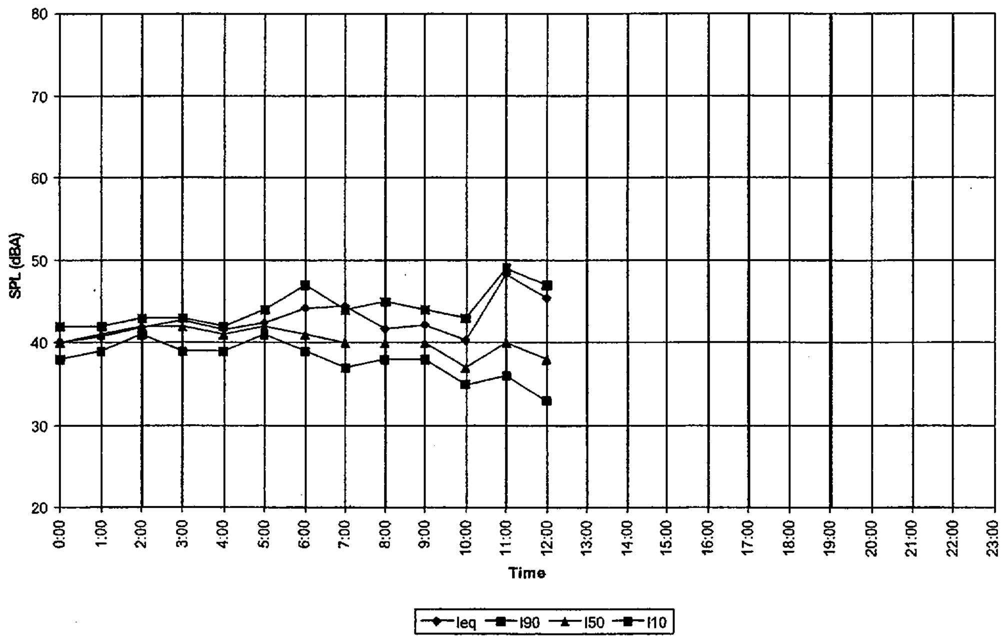

17 Jun 1999 E11
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10


18 Jun 1999 E11
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

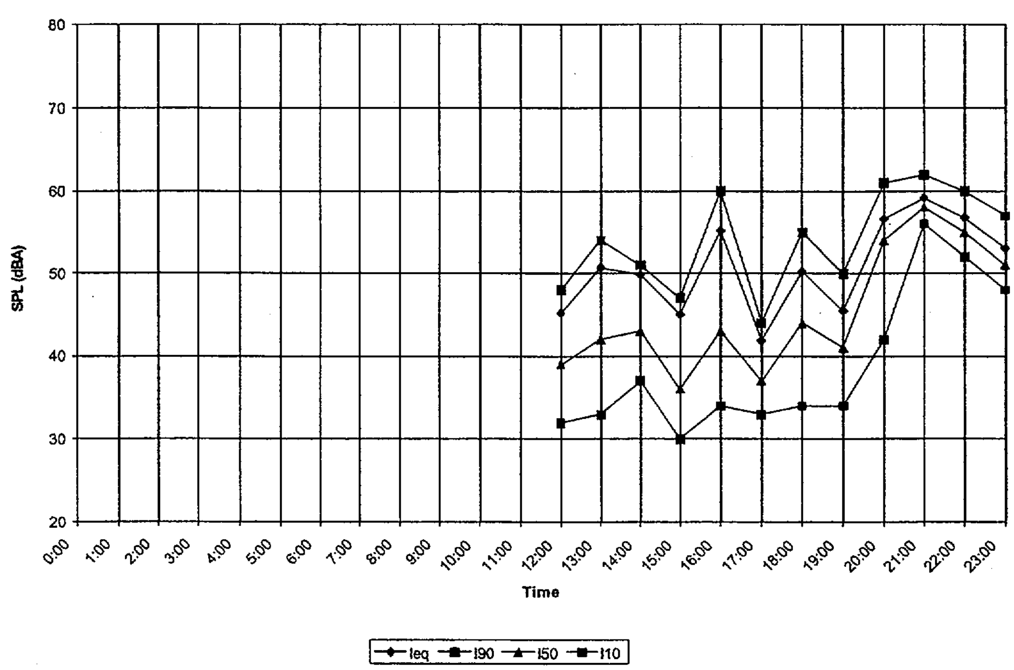

11 Jun 1999 E12
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10


12 Jun 1999 E12
SPL (dBA)
80
70
60
50
40
30
20
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time
leq l90 l50 l10

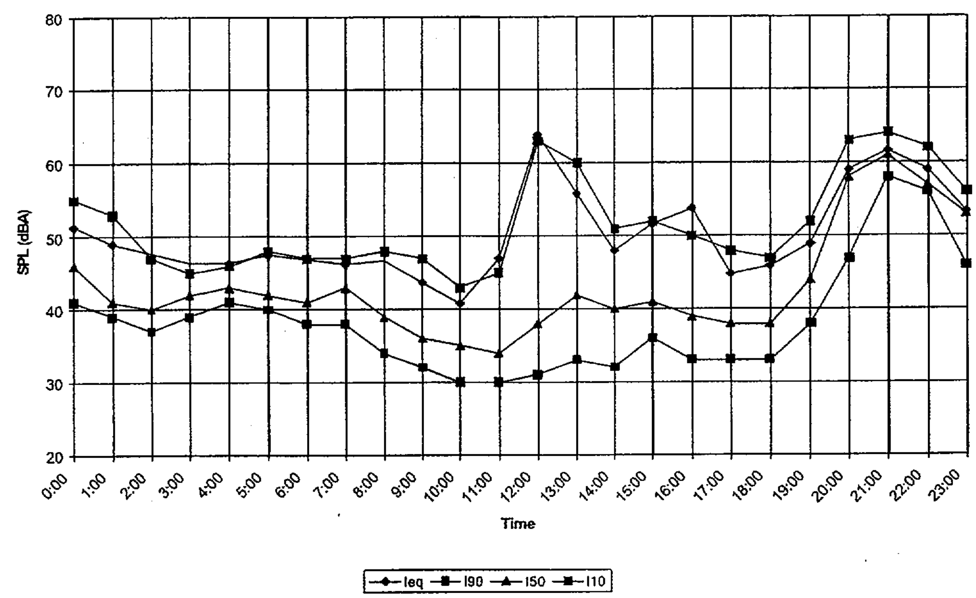
13 Jun 1999 E12



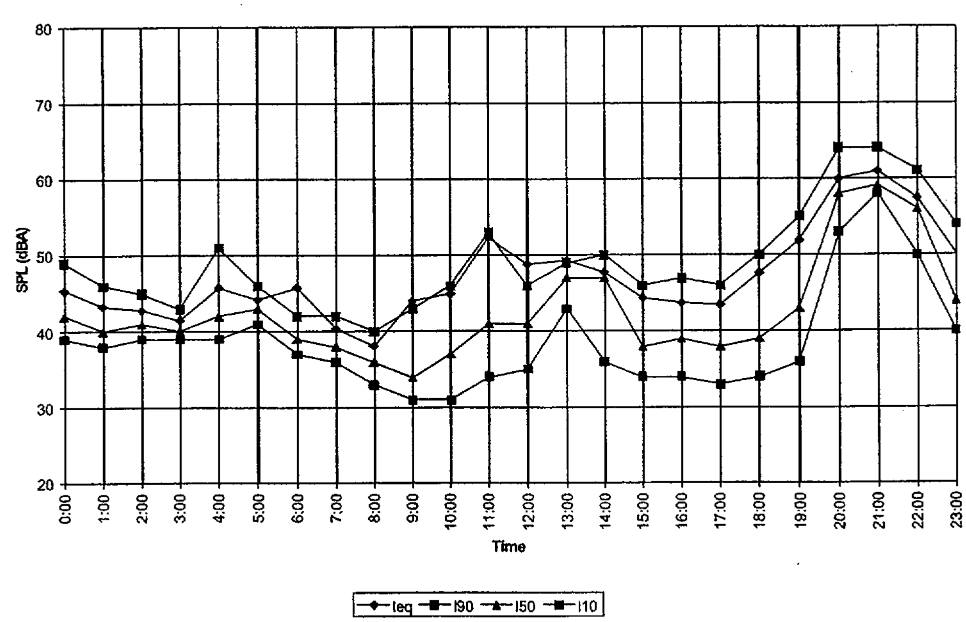
16 Jun 1999 E14



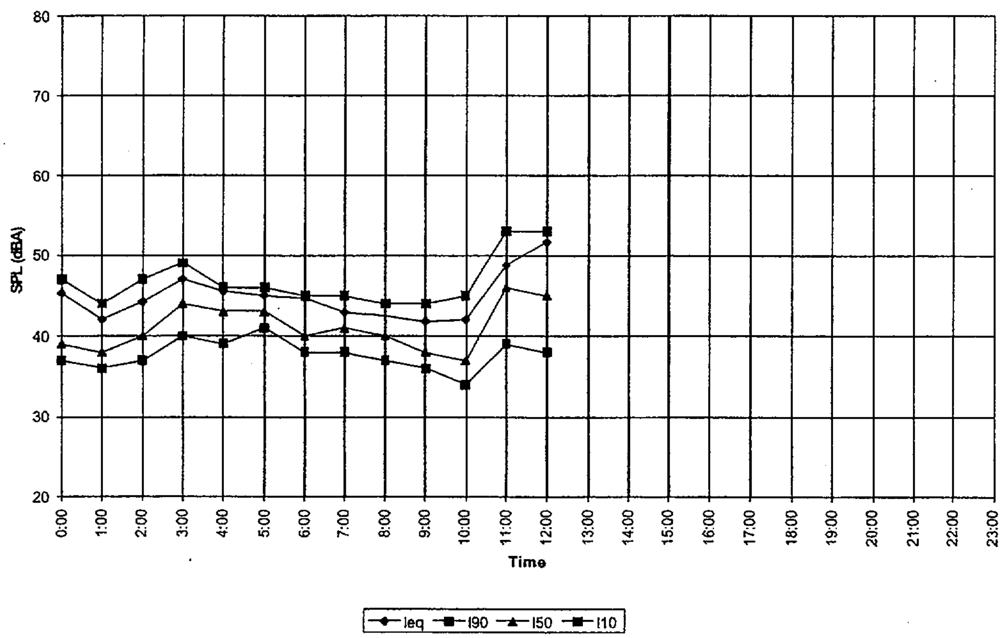
17 Jun 1999 E14



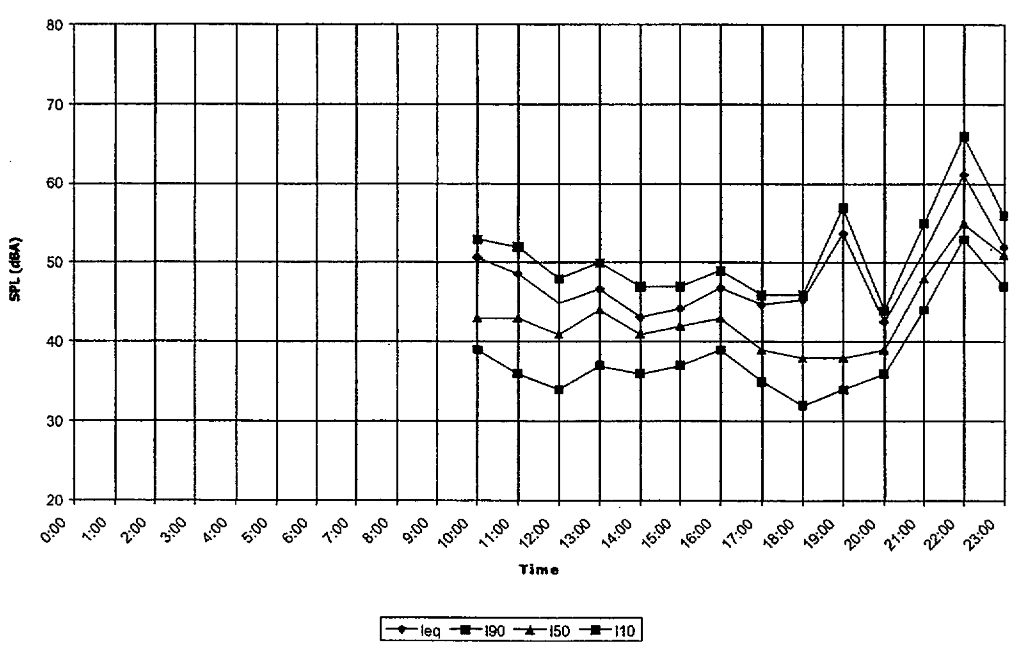
18 Jun 1999 E14

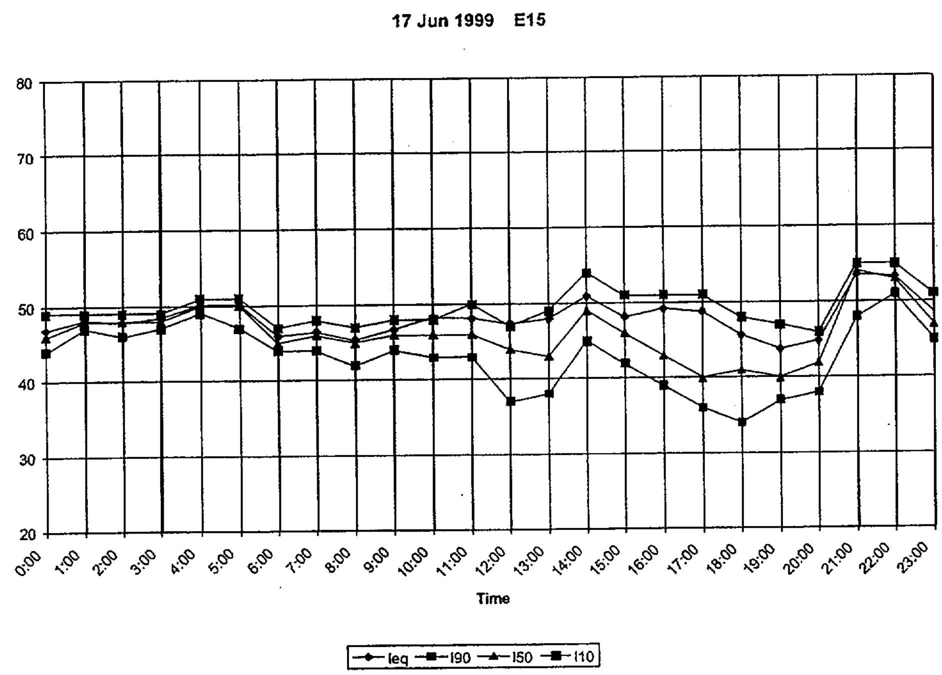


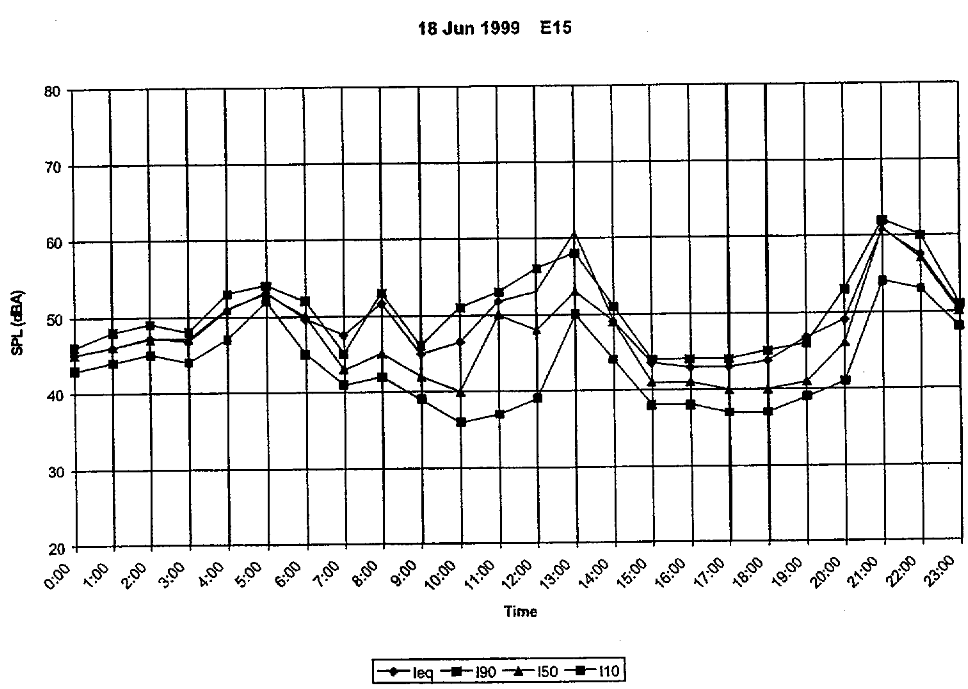
19 Jun 1999 E14

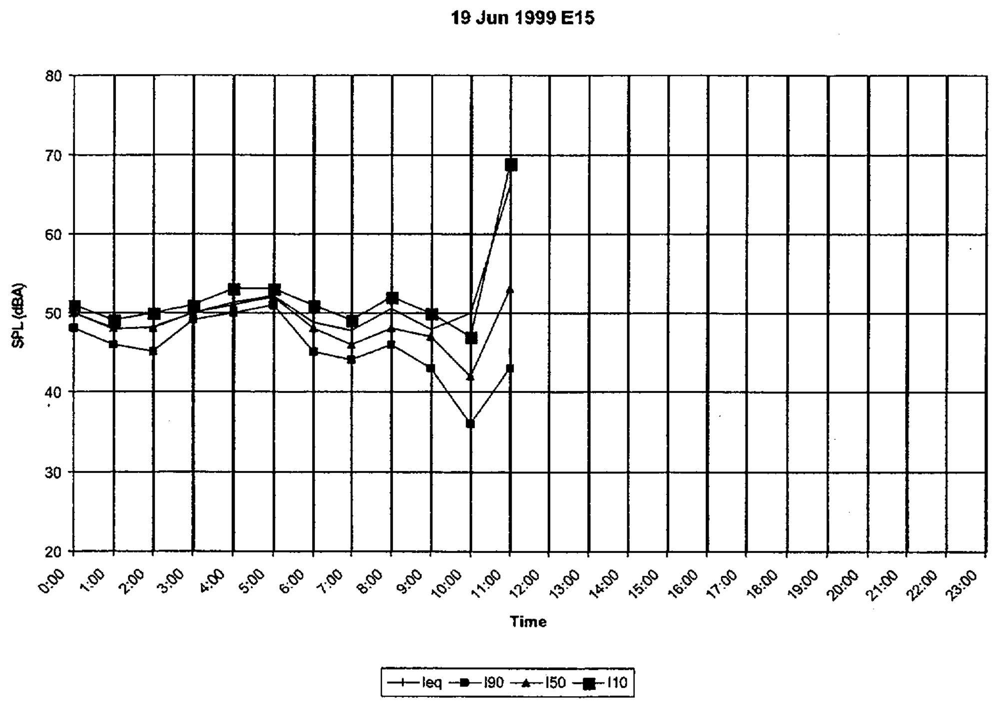


16 Jun 1999 E15

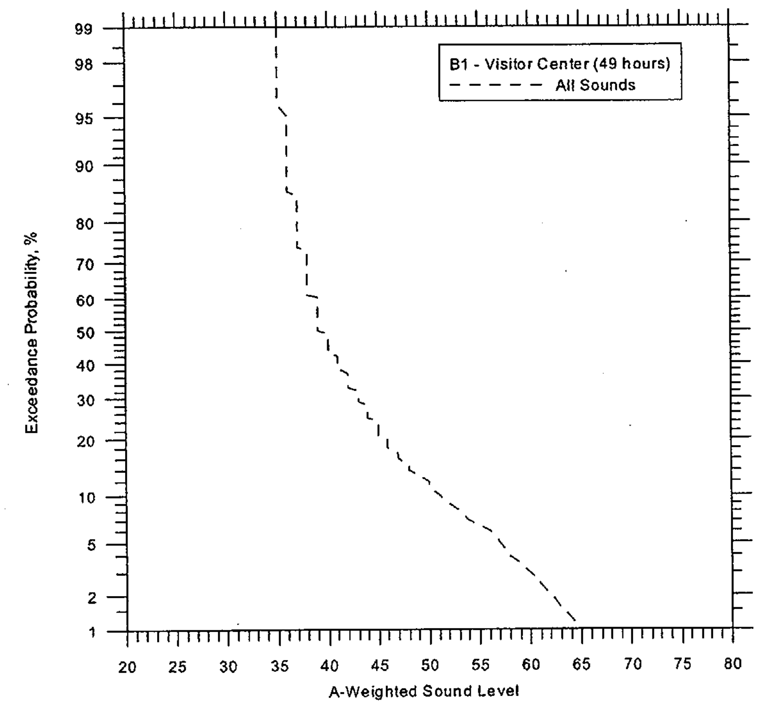


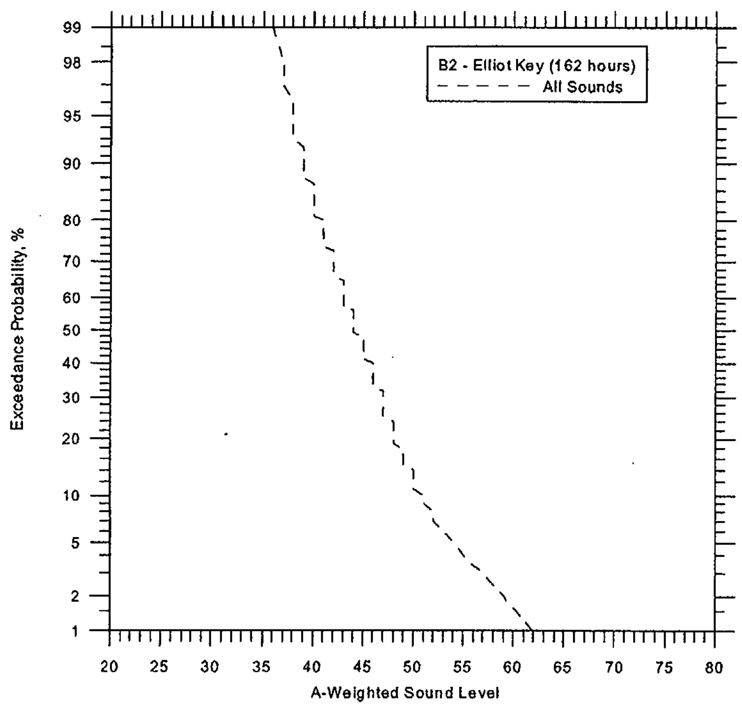

17 Jun 1999 E15
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

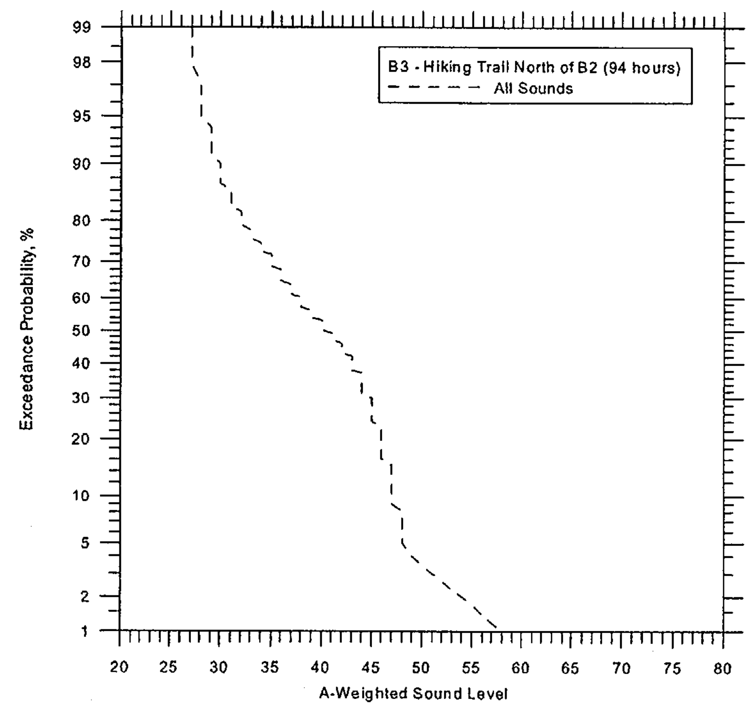

18 Jun 1999 E15
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

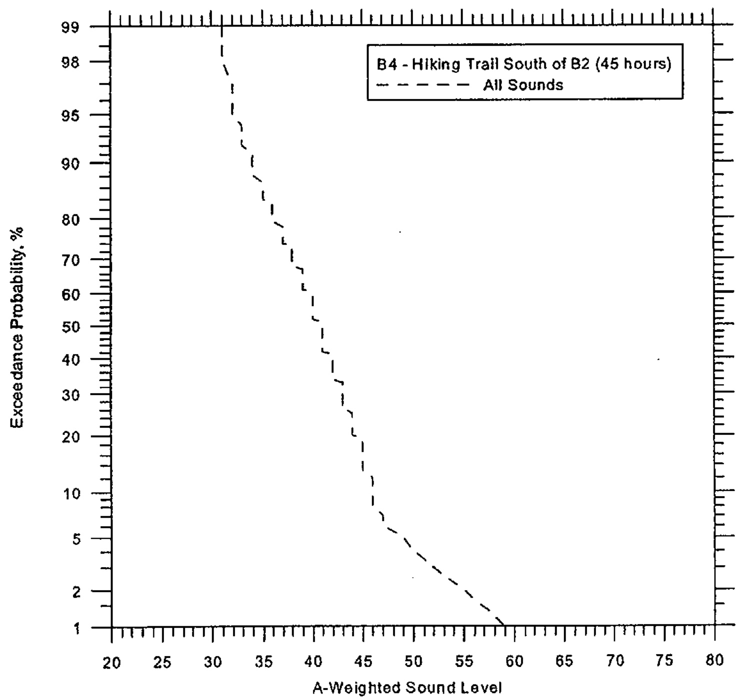

19 Jun 1999 E15
SPL (dBA)
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
leq
l90
l50
l10

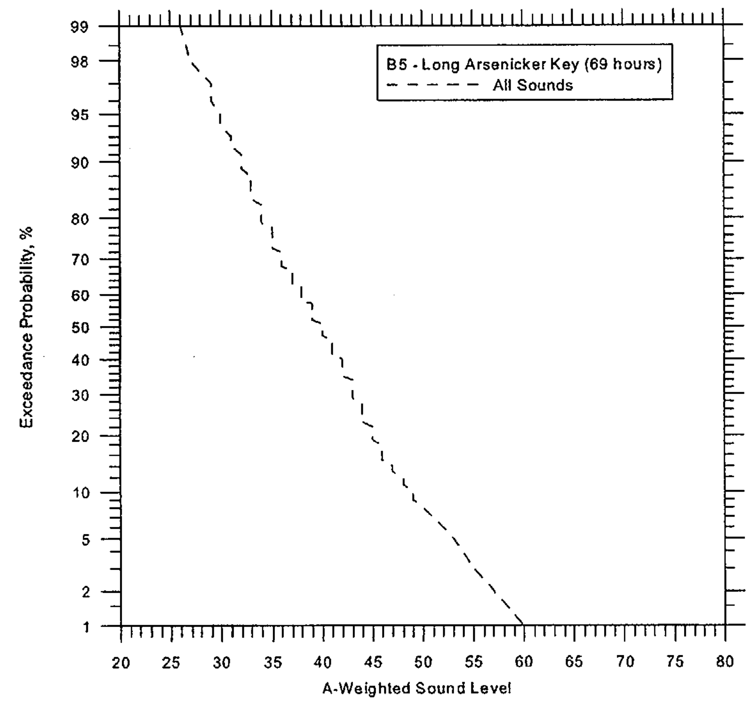
Appendix G
Exceedance Plots for Unmanned Measurements

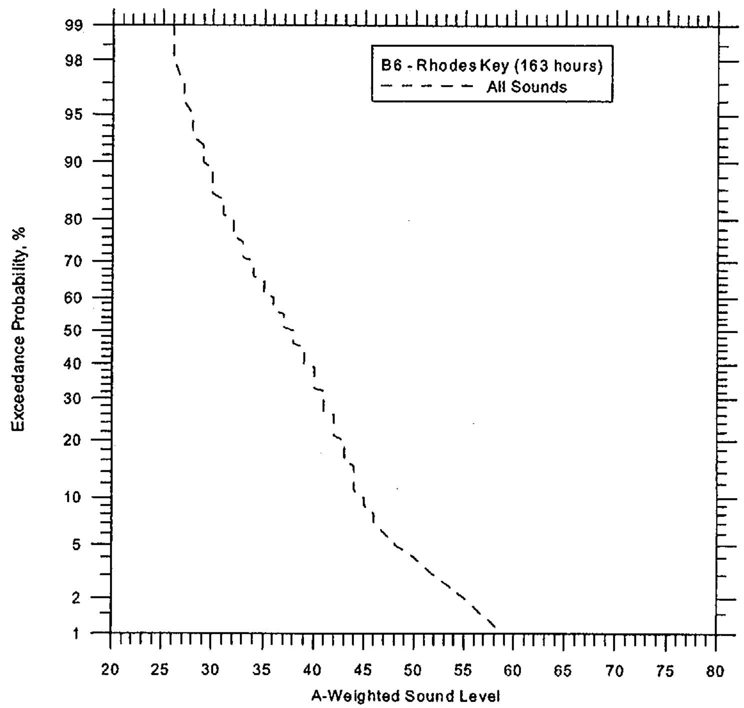


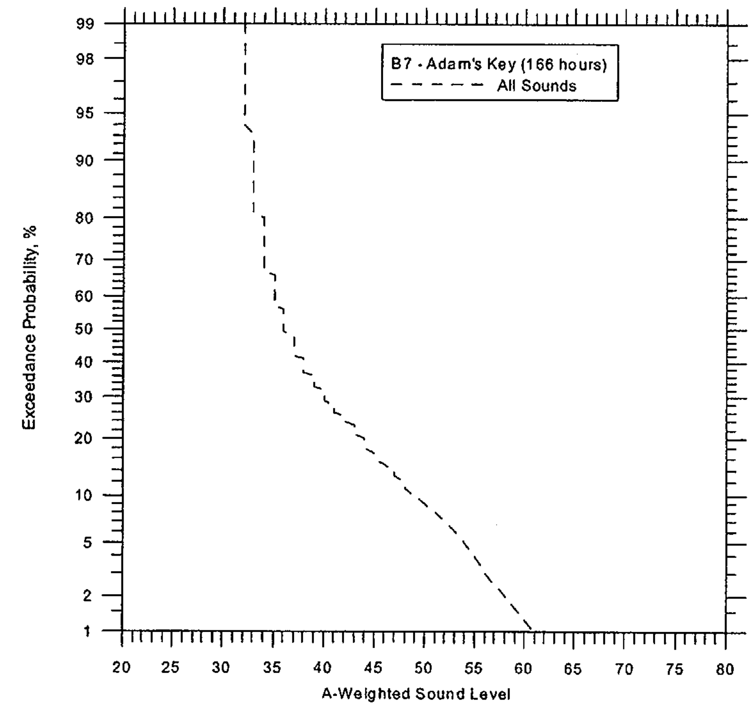

B2 - Elliot Key (162 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

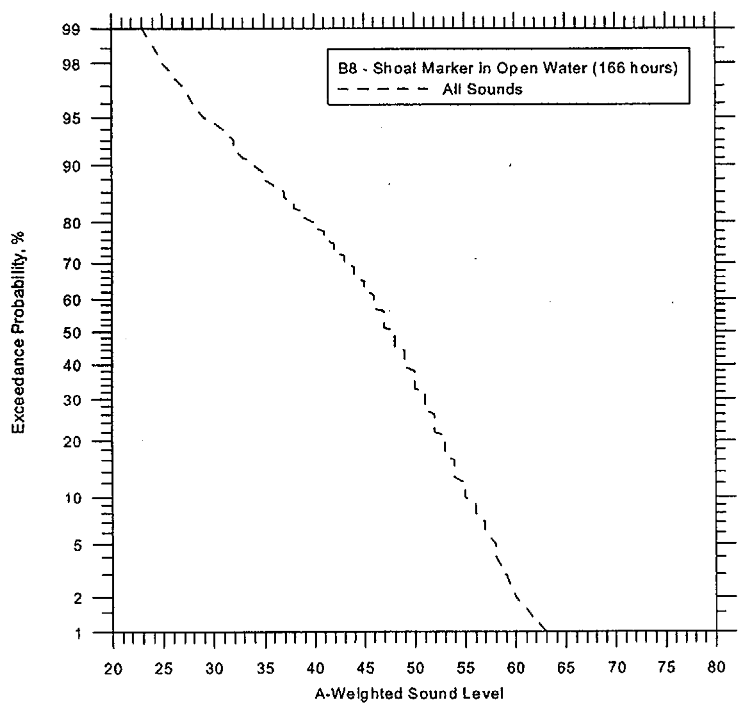

B3 - Hiking Trail North of B2 (94 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

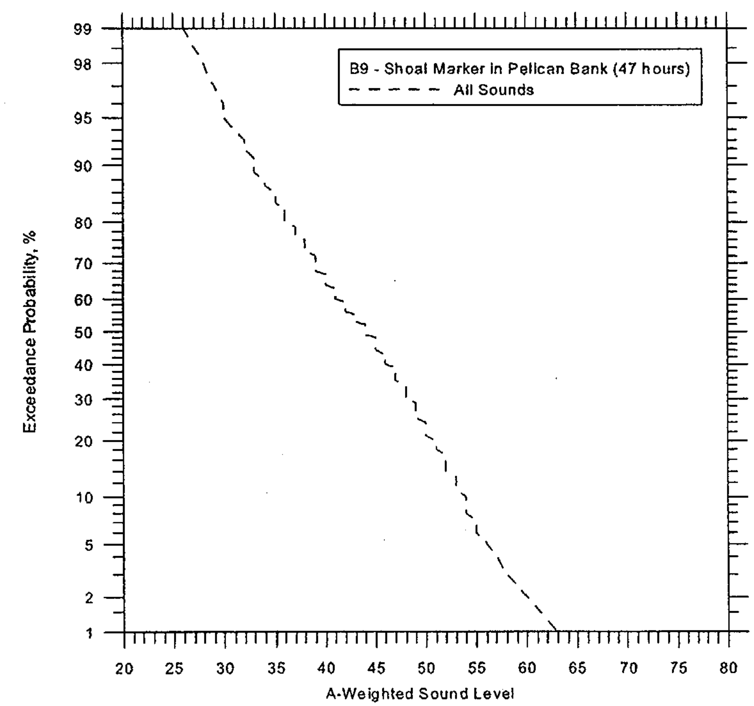

B4 - Hiking Trail South of B2 (45 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

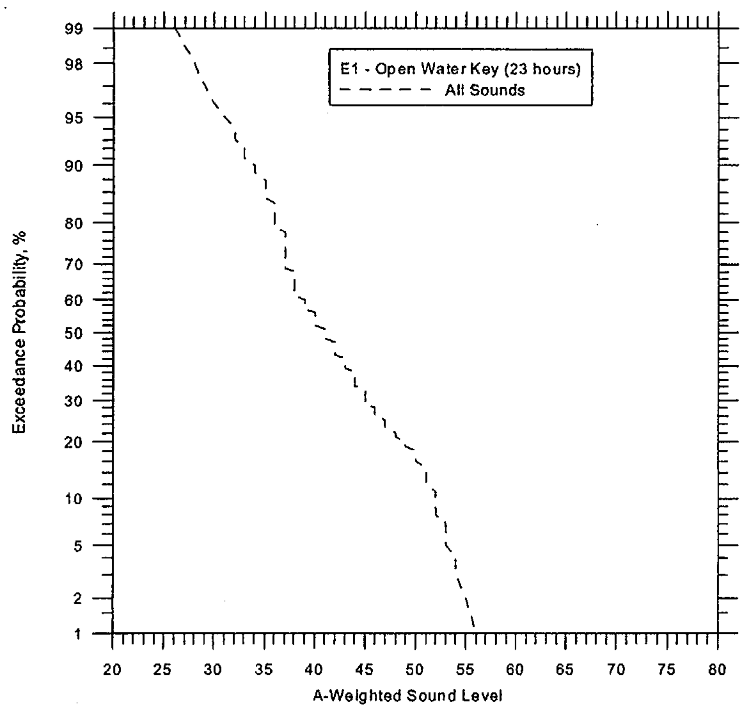

B5 - Long Arsenicker Key (69 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

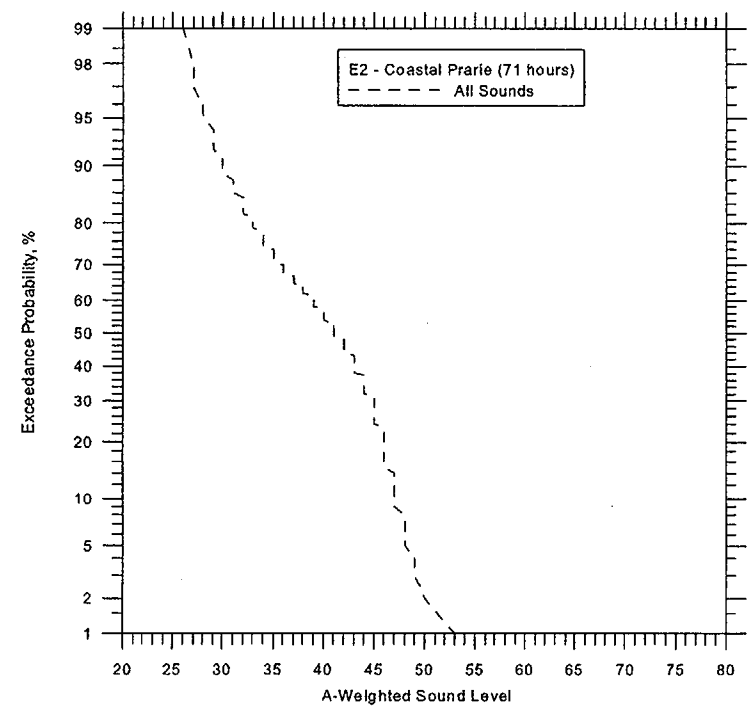

B6 - Rhodes Key (163 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

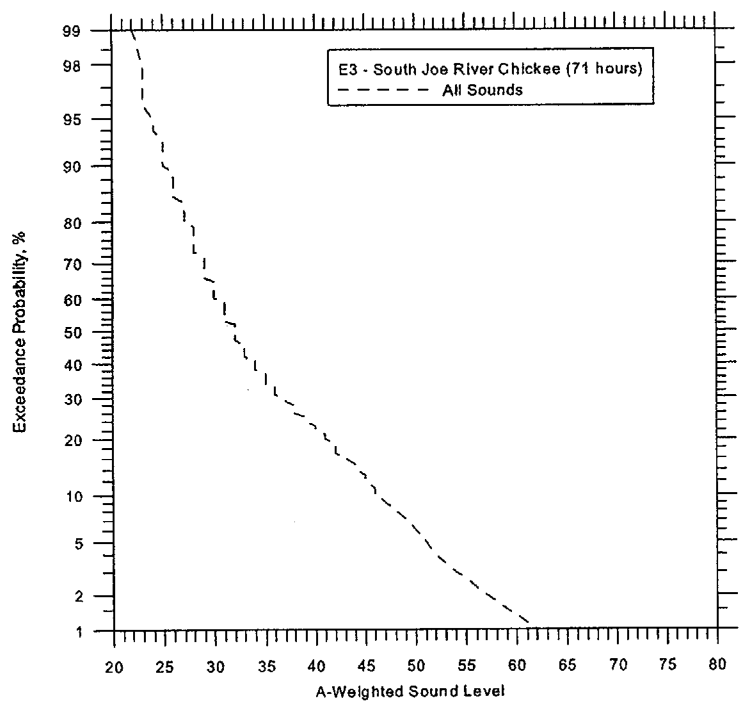

B7 - Adam's Key (166 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

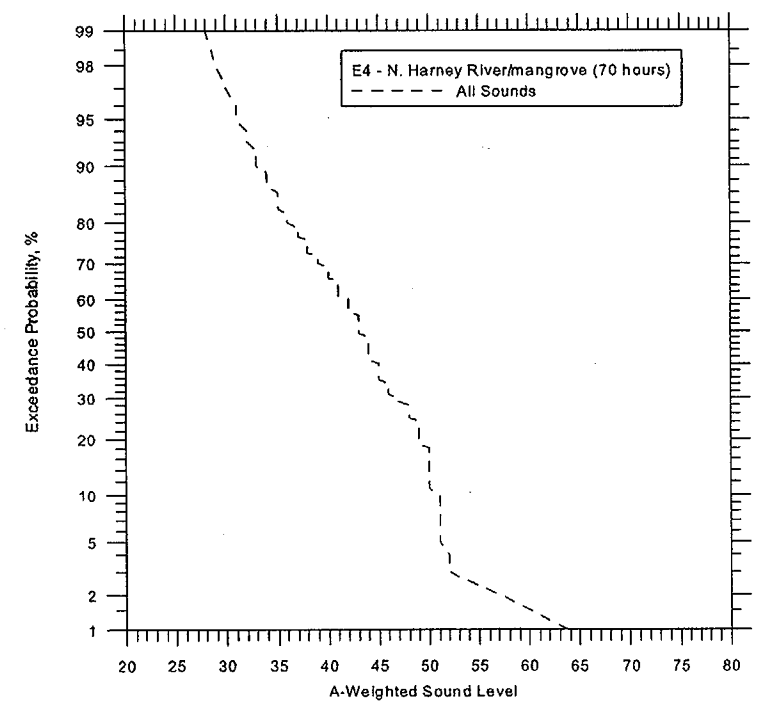

B8 - Shoal Marker in Open Water (166 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

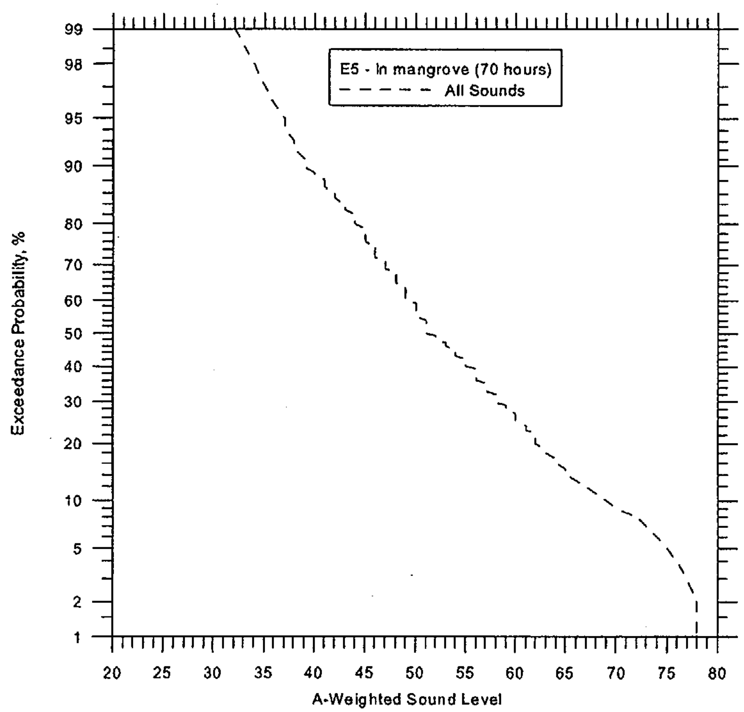

B9 - Shoal Marker in Pelican Bank (47 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

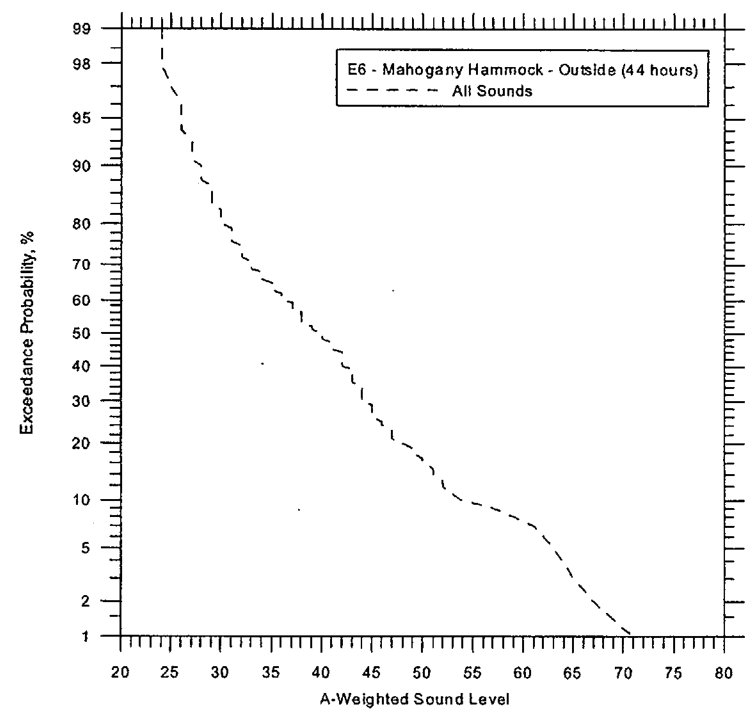

E1 - Open Water Key (23 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

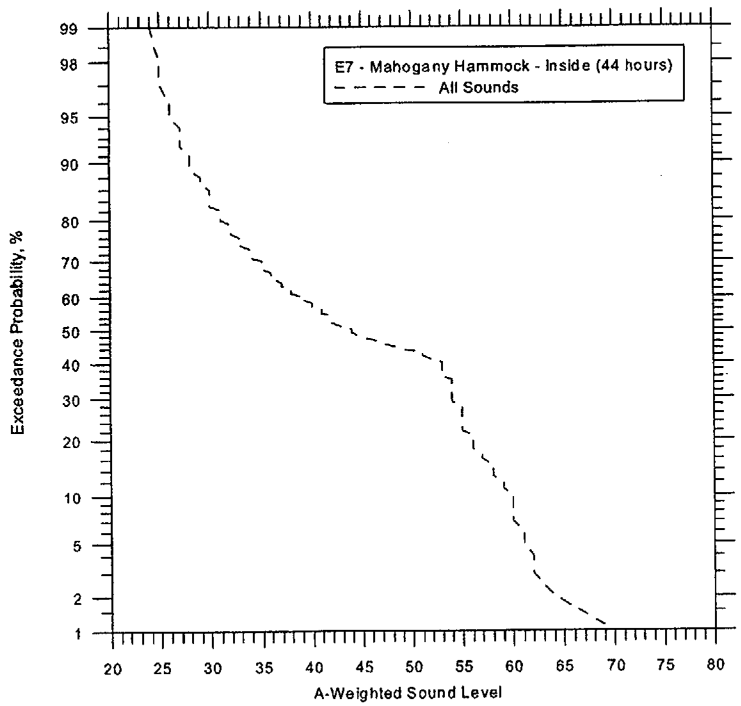

E2 - Coastal Prarie (71 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

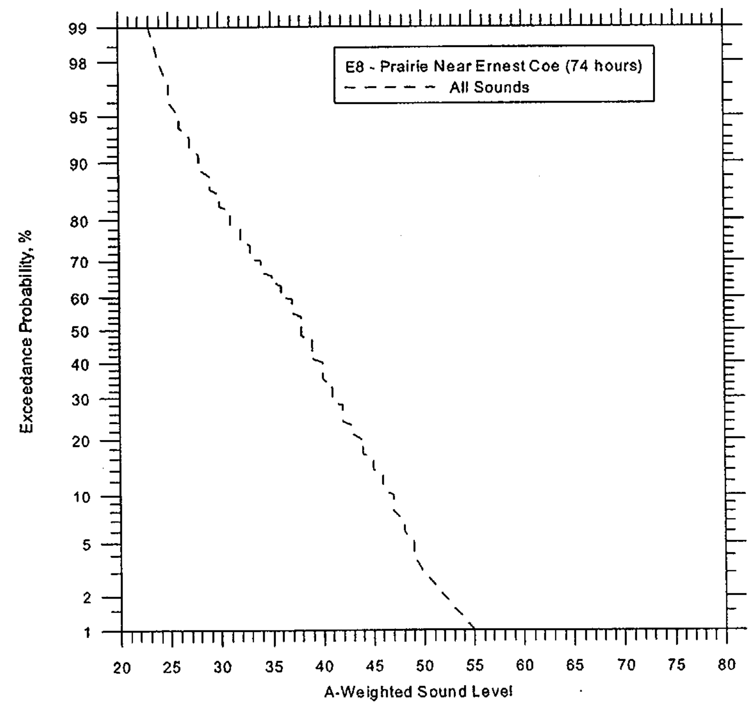

E3 - South Joe River Chickee (71 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

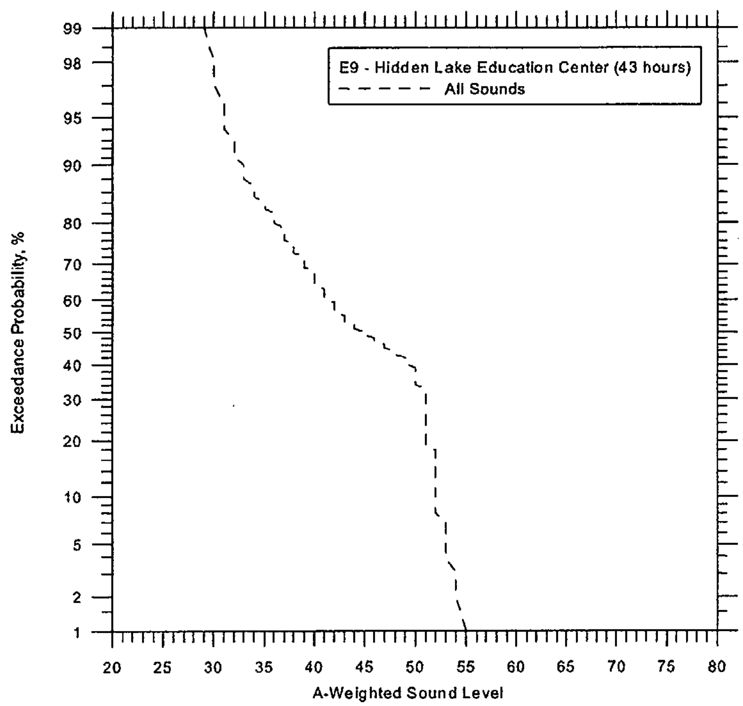

E4 - N. Harney River/mangrove (70 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80
A-Weighted Sound Level

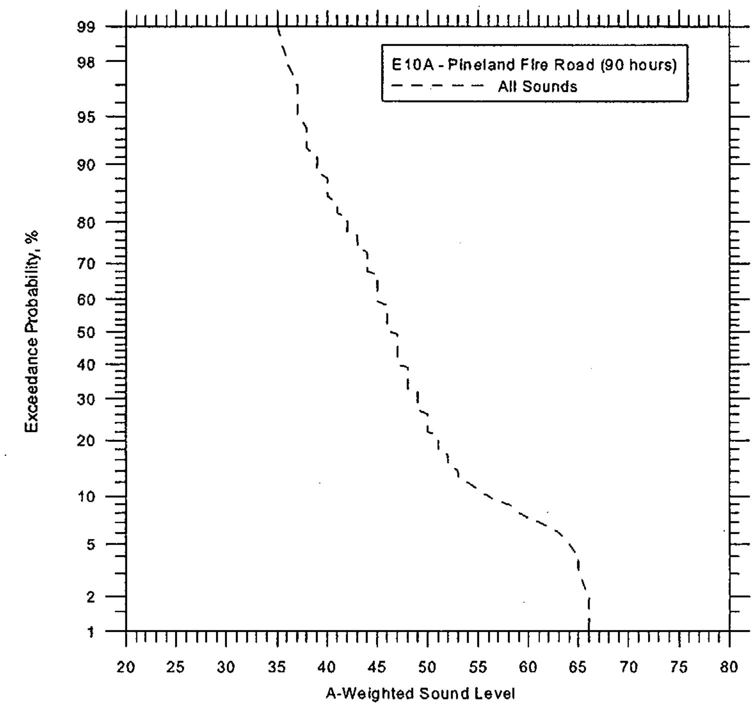

E5 - In mangrove (70 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level

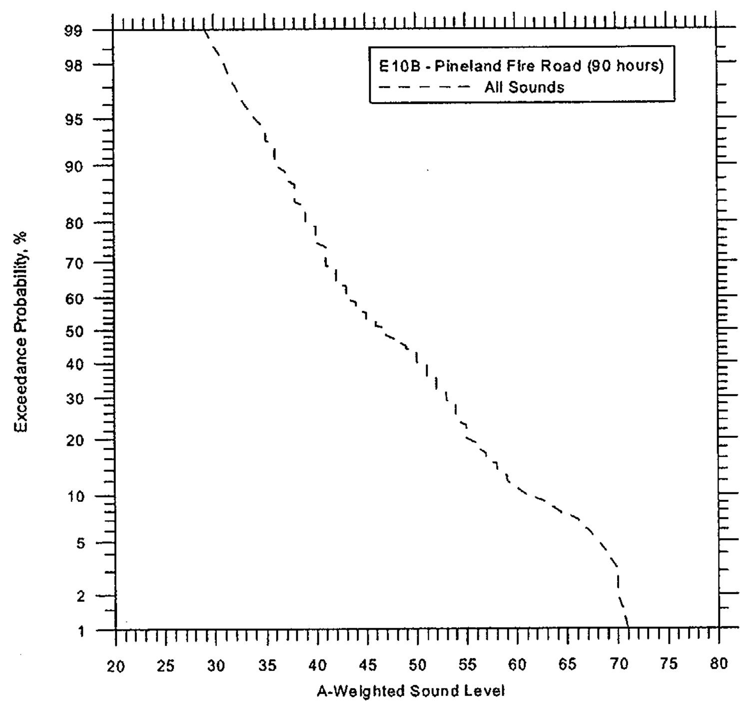

E6 - Mahogany Hammock - Outside (44 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level

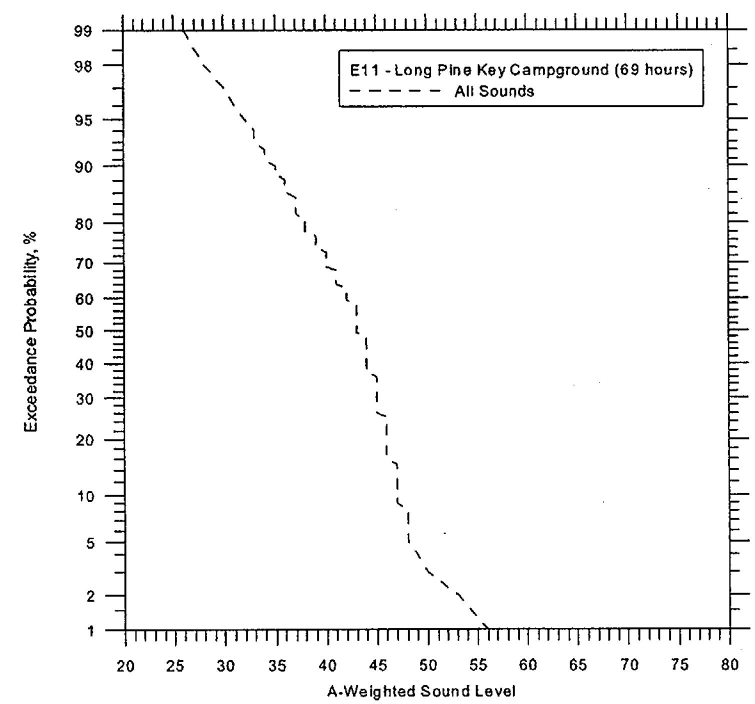

E7 - Mahogany Hammock - Inside (44 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80

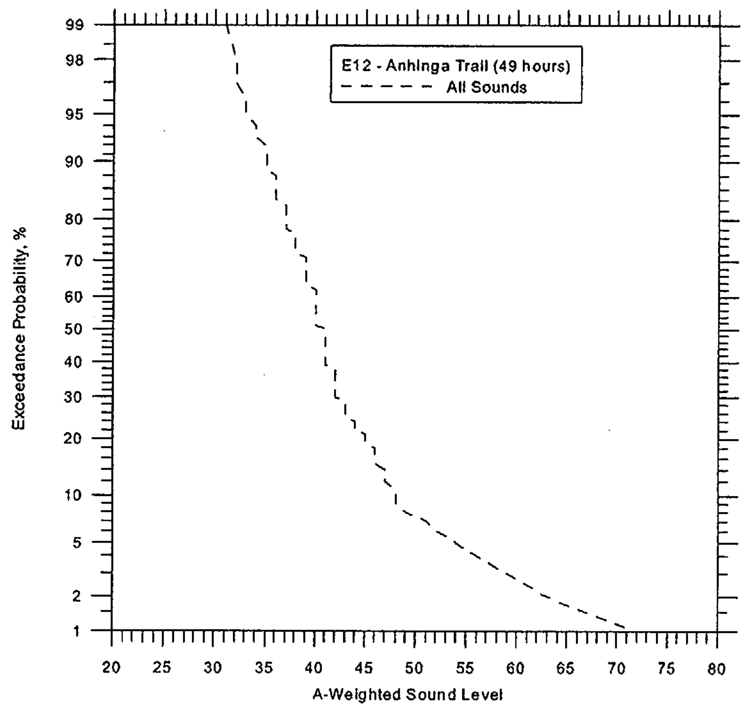

E8 - Prairie Near Ernest Coe (74 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80

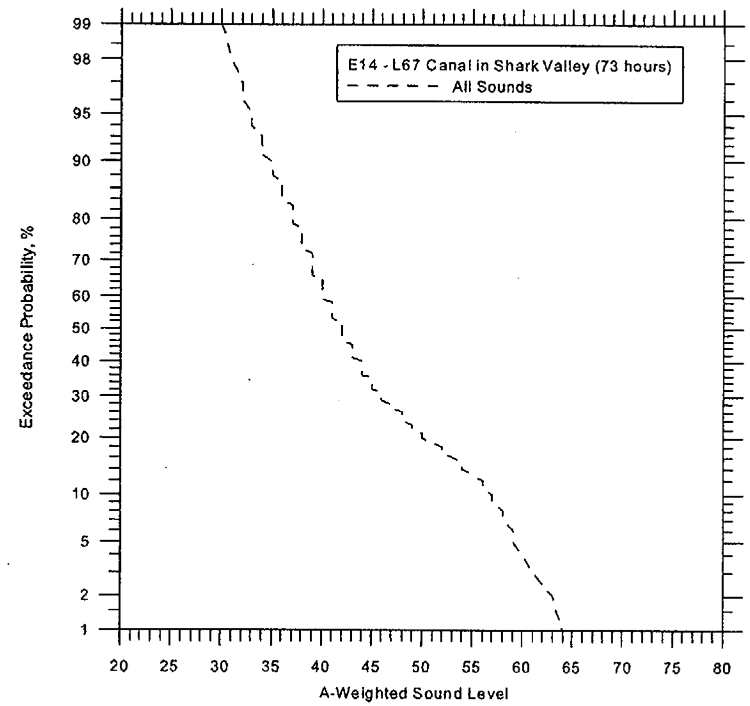

E9 - Hidden Lake Education Center (43 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

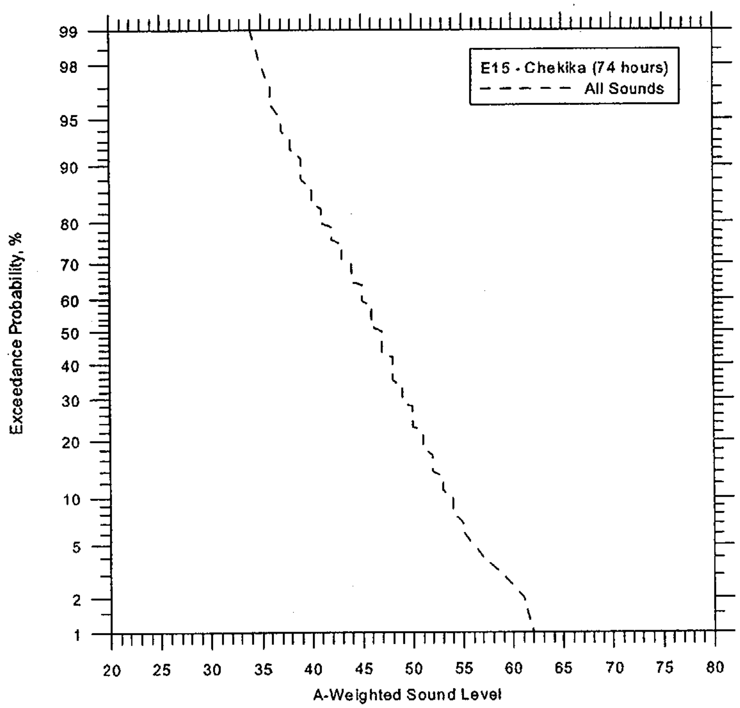

E10A - Pineland Fire Road (90 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80


E10B - Pineland Fire Road (90 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level


E11 - Long Pine Key Campground (69 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level


E12 - Anhinga Trail (49 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level


E14 - L67 Canal in Shark Valley (73 hours)
All Sounds
Exceedance Probability, %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20 25 30 35 40 45 50 55 60 65 70 75 80
A-Weighted Sound Level


E15 - Chekika (74 hours)
All Sounds
Exceedance Probability, %
A-Weighted Sound Level
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
20
25
30
35
40
45
50
55
60
65
70
75
80

Appendix H
Transient Events Plots for Unmanned Measurements

WR 99-17

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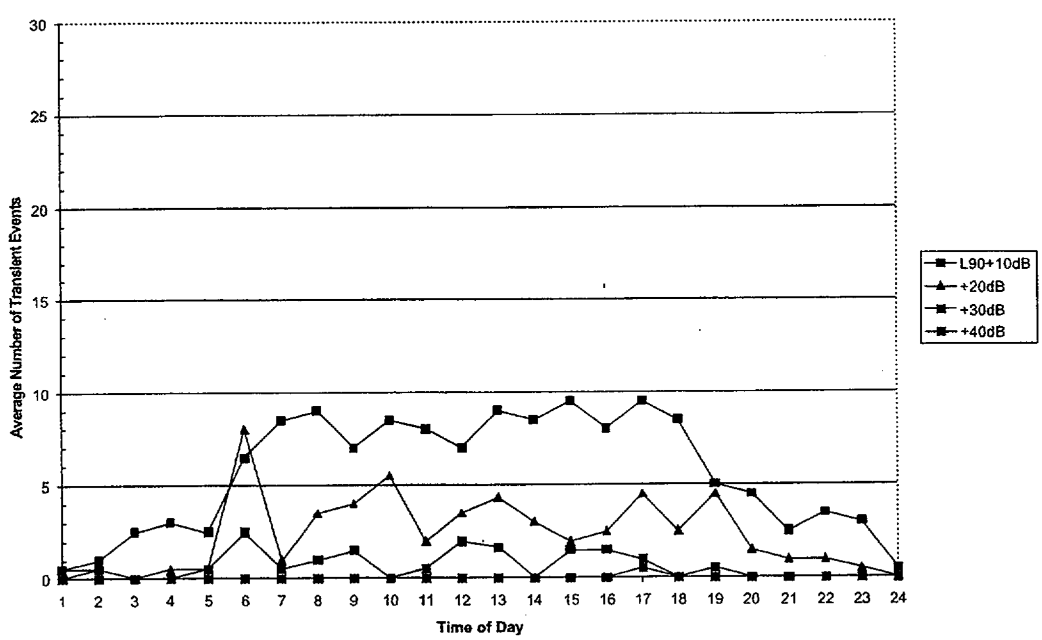
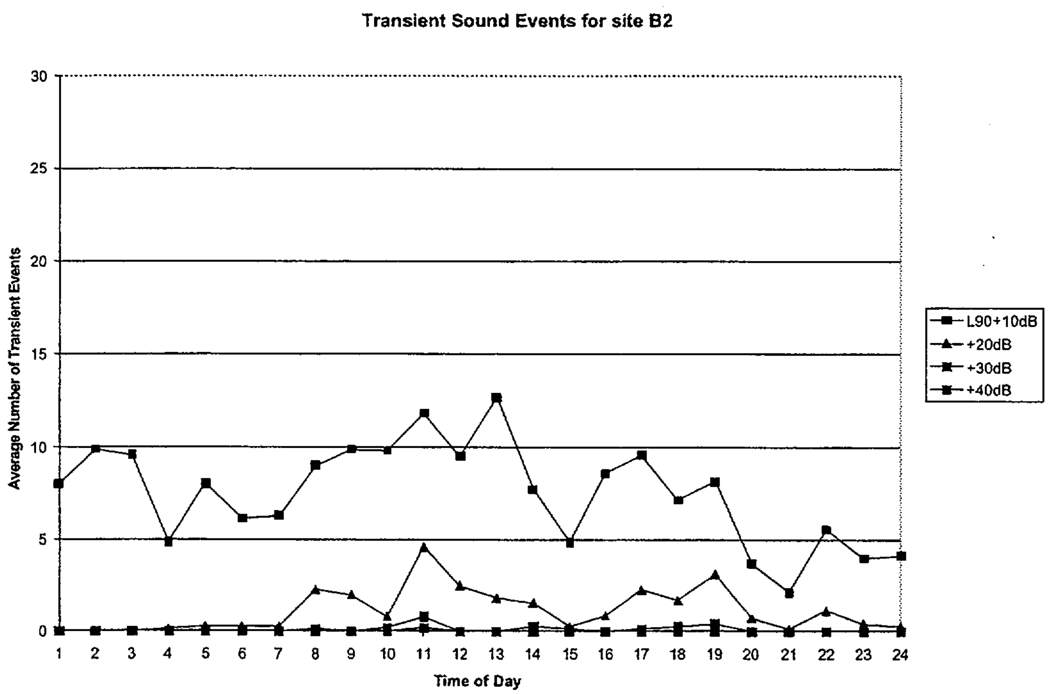
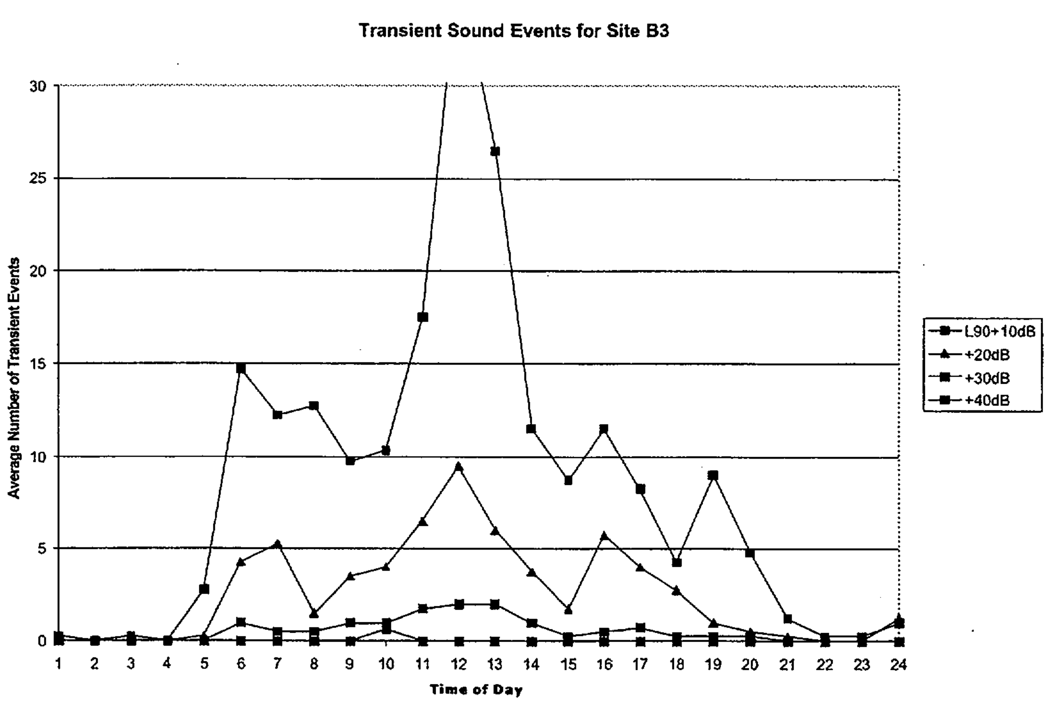
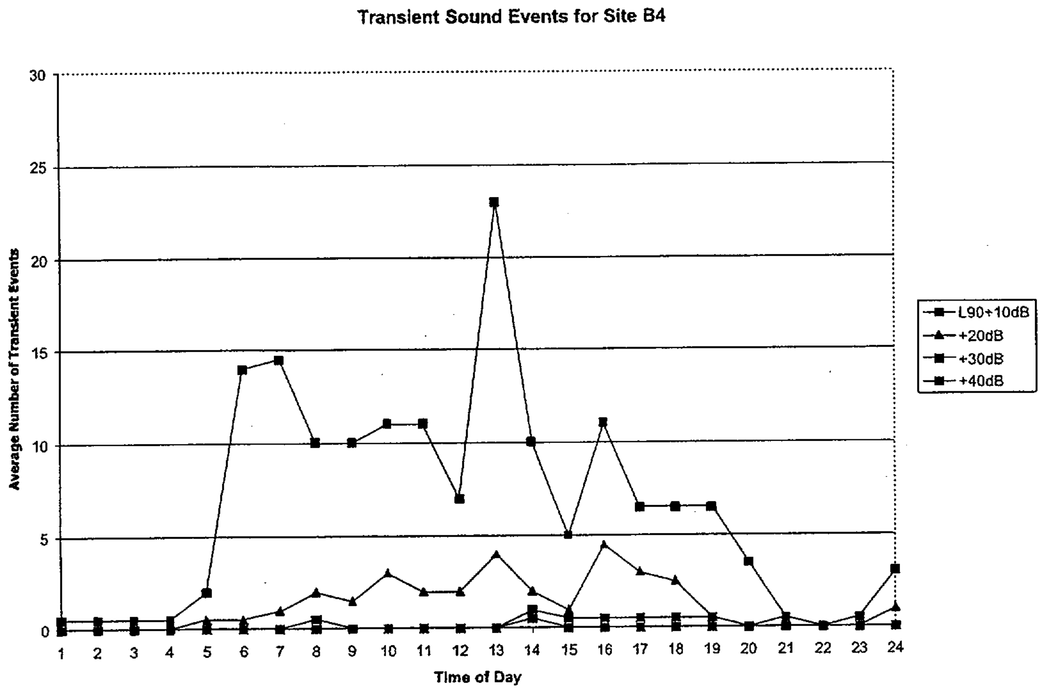
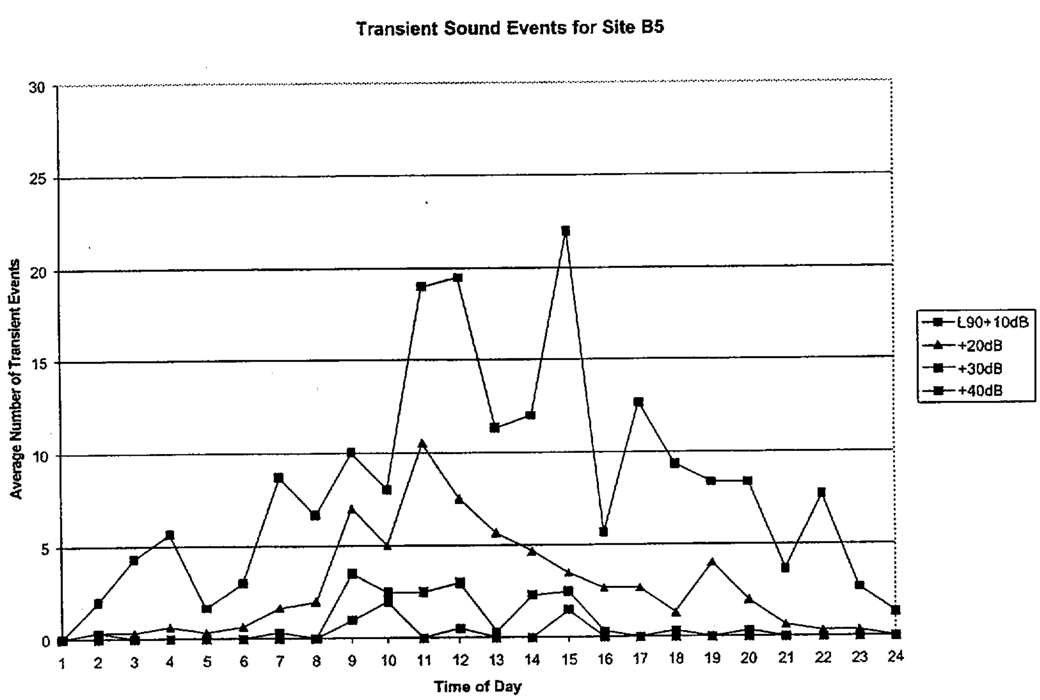
Transient Sound Events for site B1



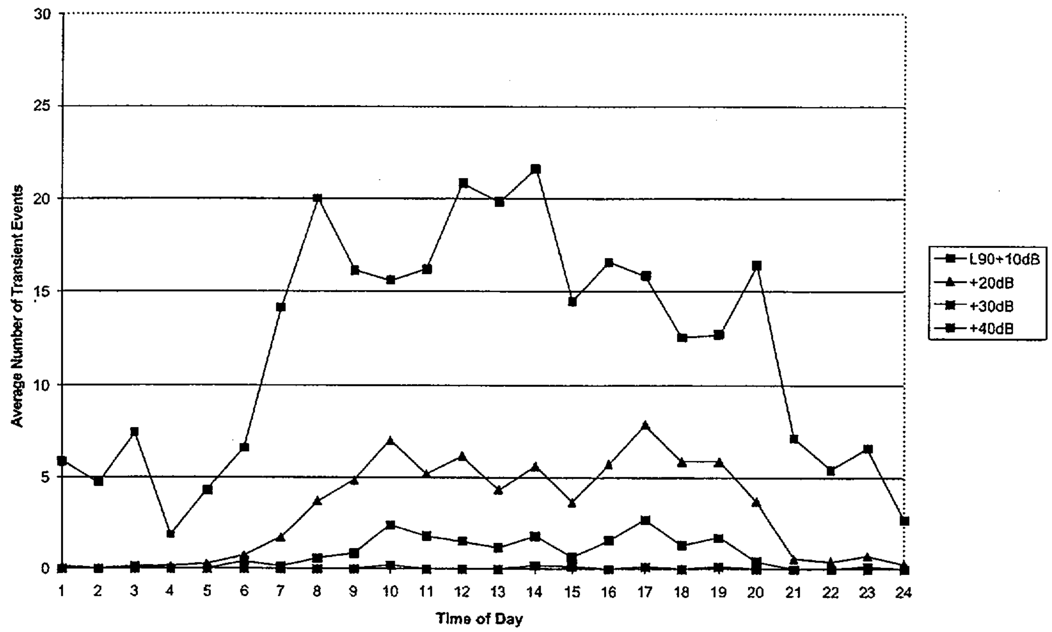

Transient Sound Events for site B2
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB
0
5
10
15
20
25
30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


Transient Sound Events for Site B3
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB
0
5
10
15
20
25
30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

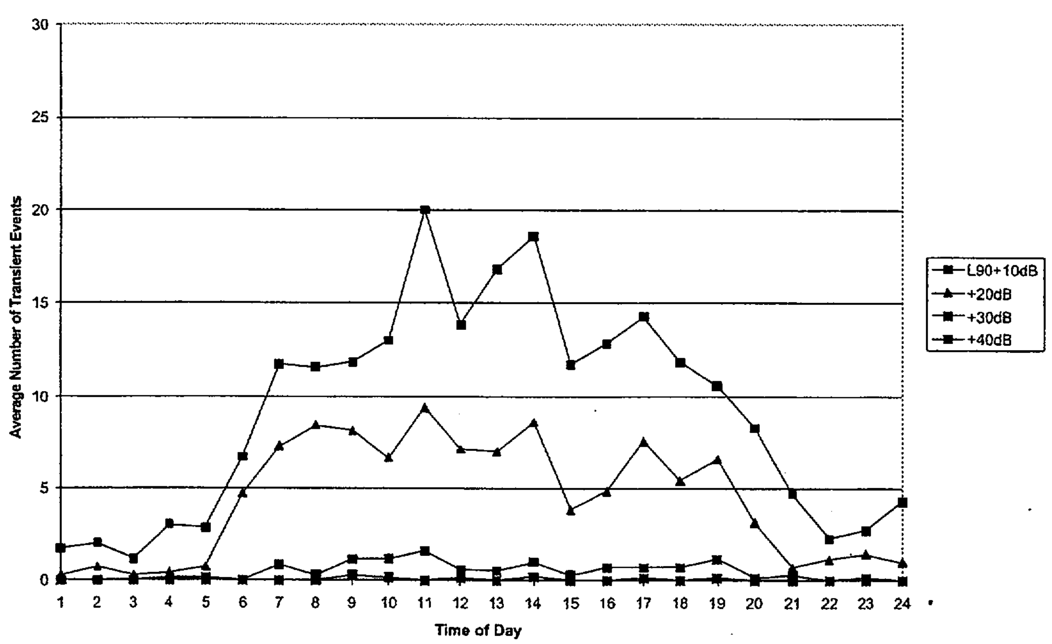

Transient Sound Events for Site B4
Average Number of Transient Events
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day
L90+10dB
+20dB
+30dB
+40dB


Transient Sound Events for Site B5
Average Number of Transient Events
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day
L90+10dB
+20dB
+30dB
+40dB

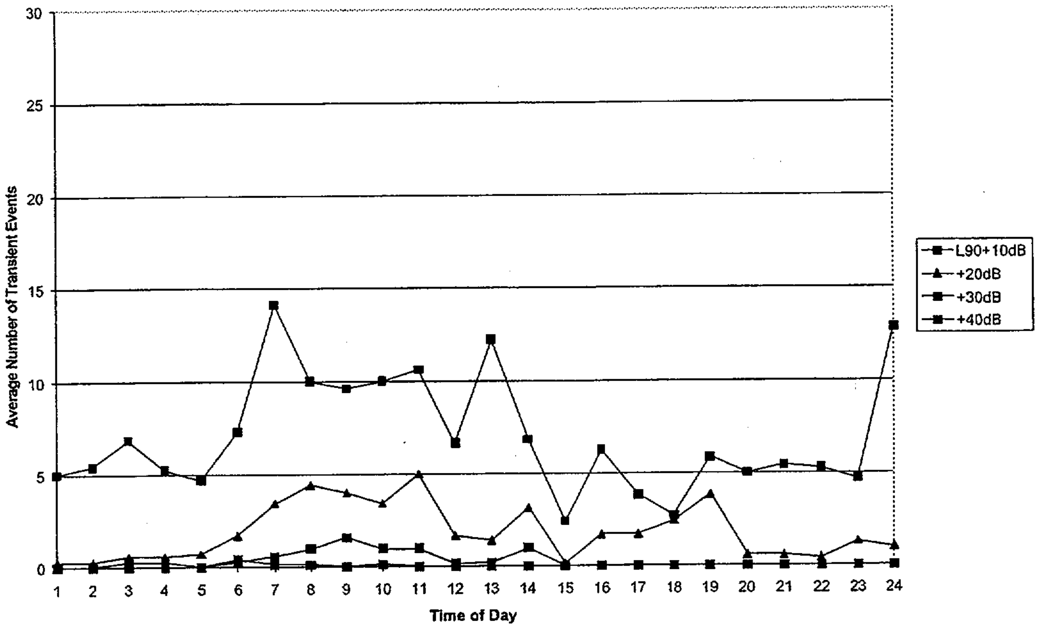
Transient Sound Events for Site B6



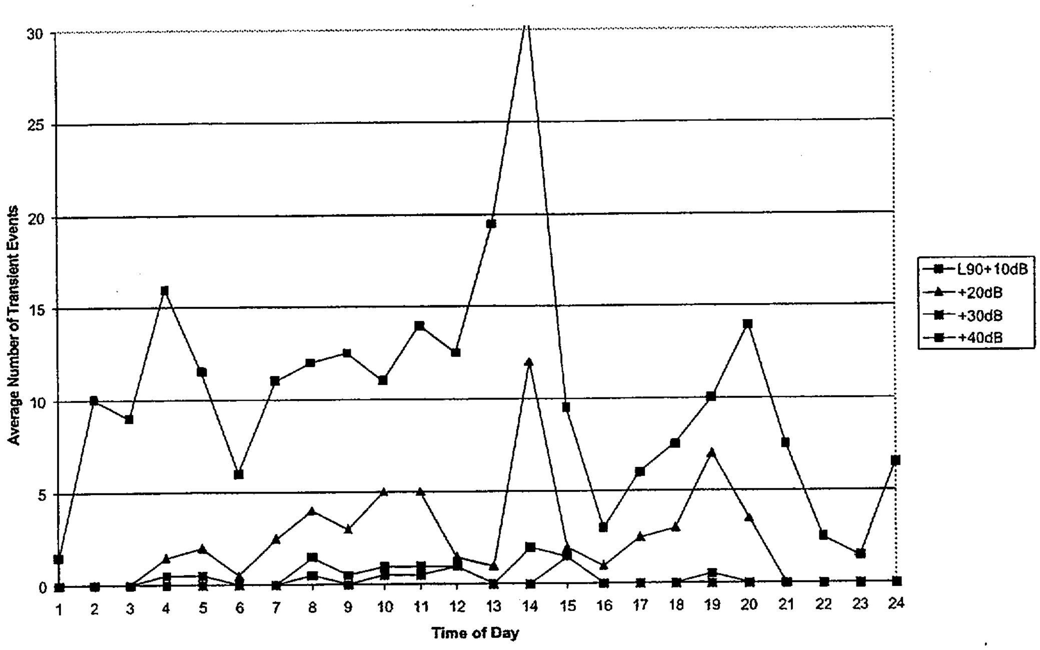
Transient Sound Events for Site B7

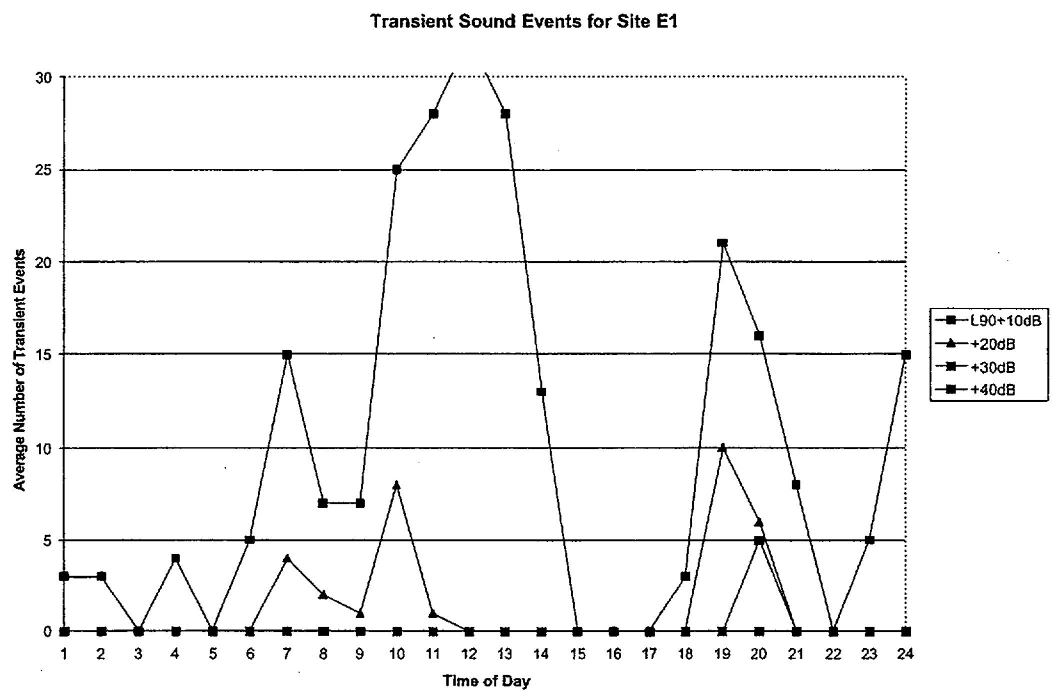


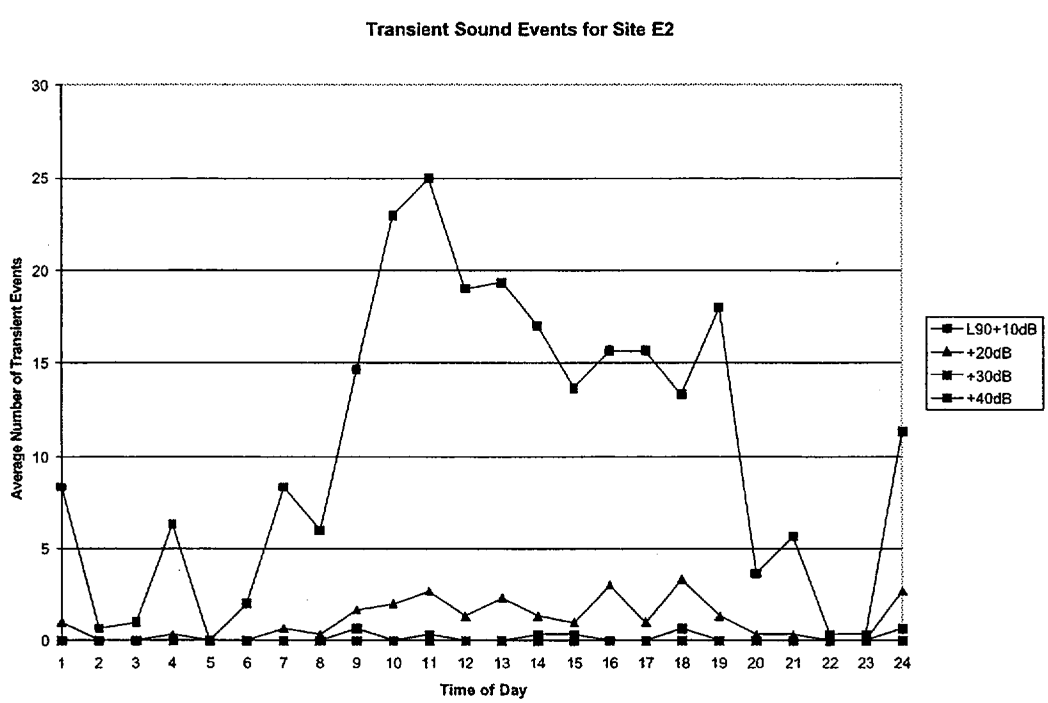
Transient Sound Events for Site B8



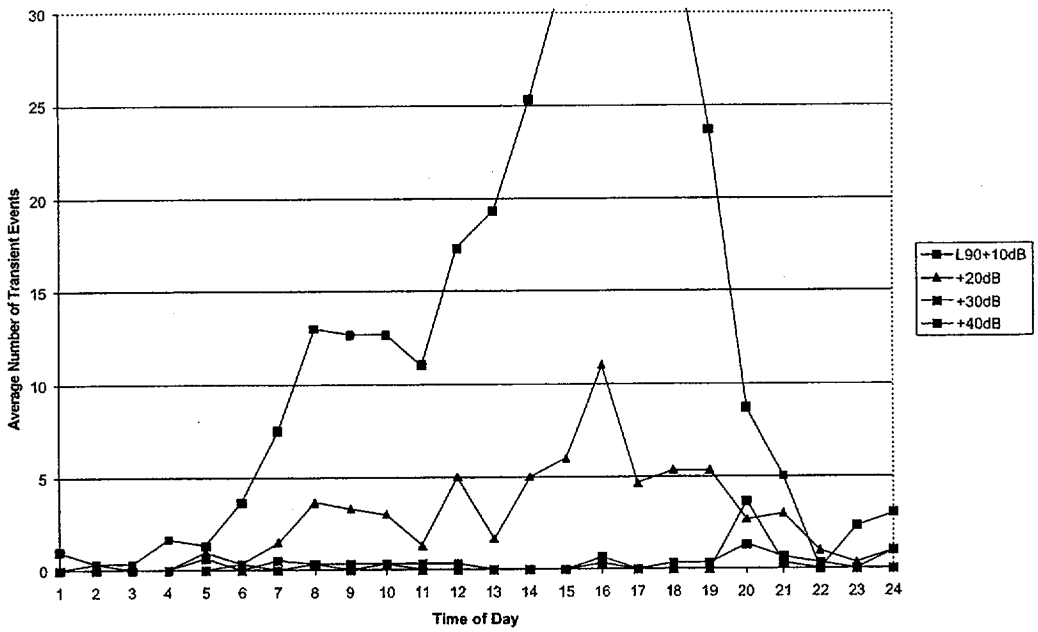
Transient Sound Events for Site B9



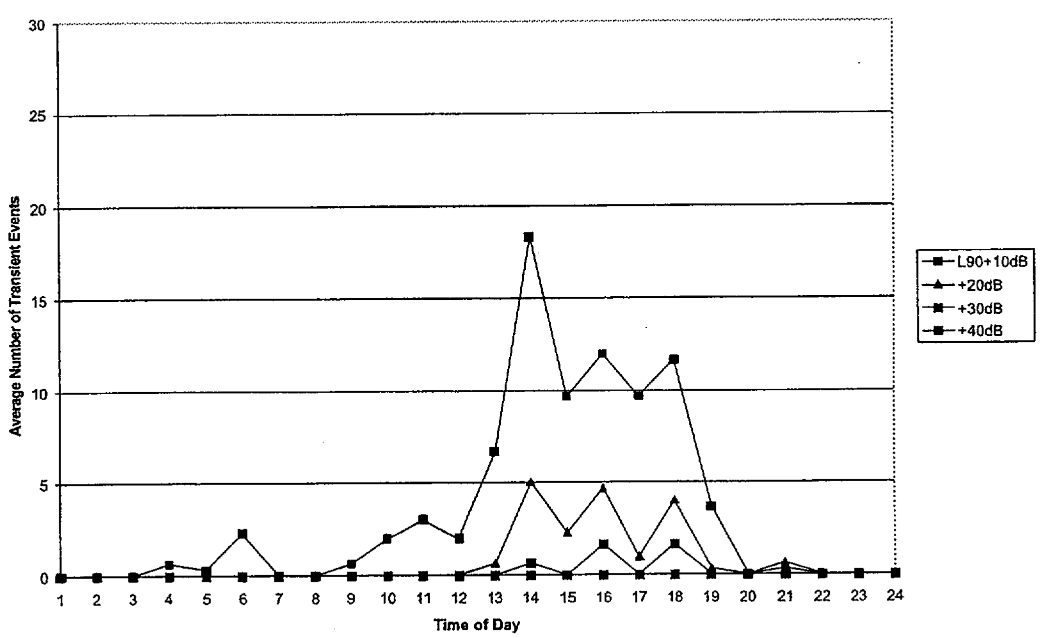

Transient Sound Events for Site E1
Average Number of Transient Events
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day
L90+10dB
+20dB
+30dB
+40dB

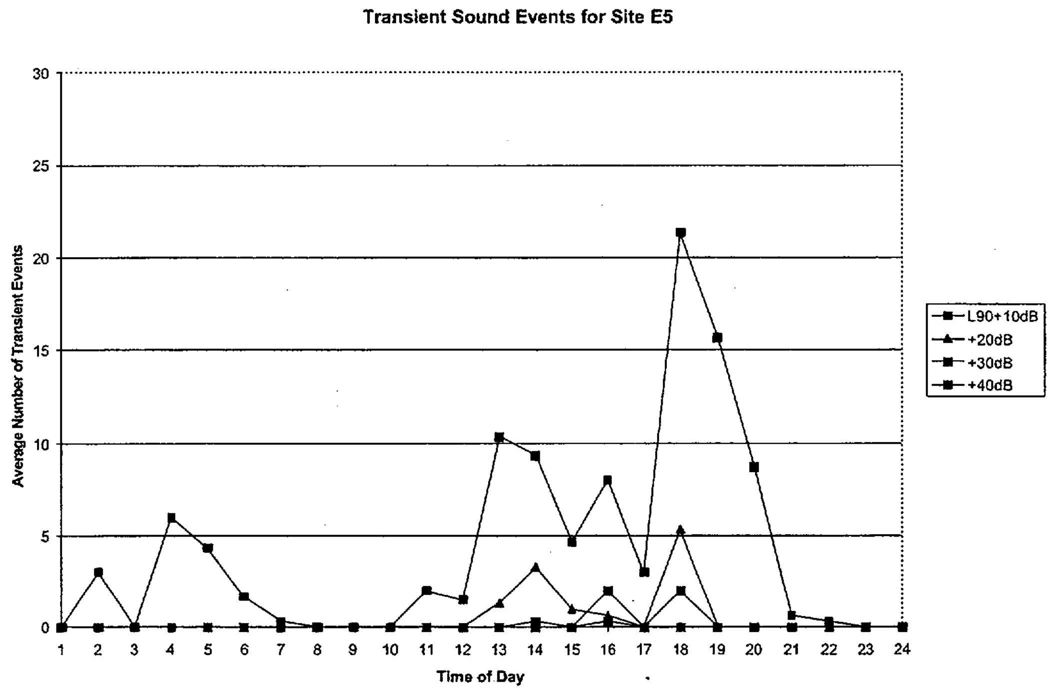

Transient Sound Events for Site E2
Average Number of Transient Events
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day
L90+10dB
+20dB
+30dB
+40dB

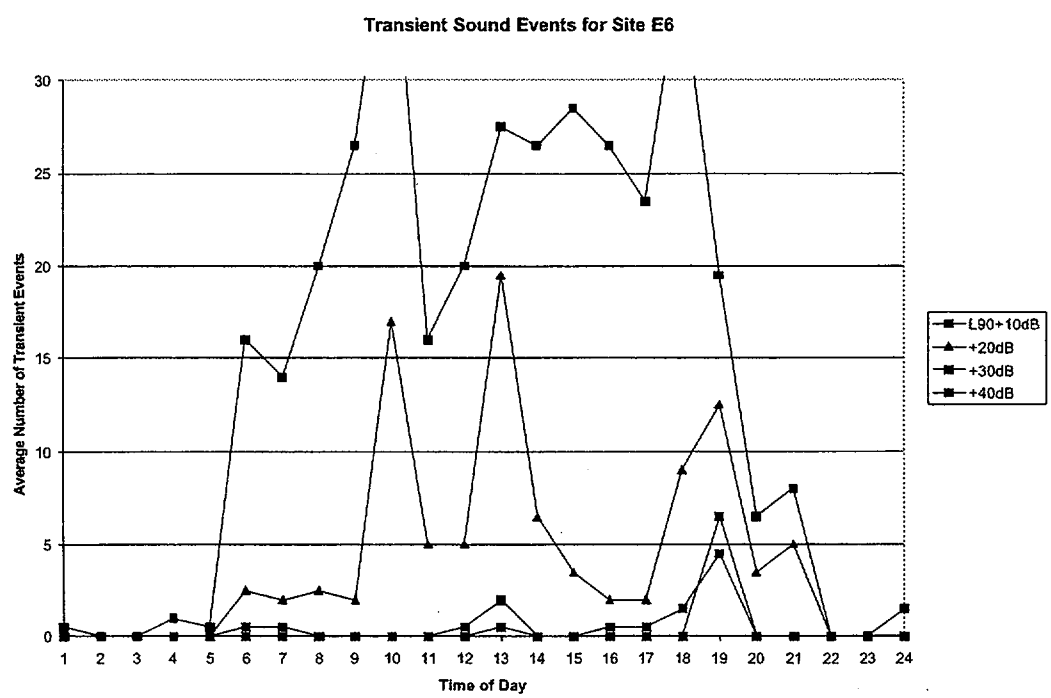
Transient Sound Events for Site E3

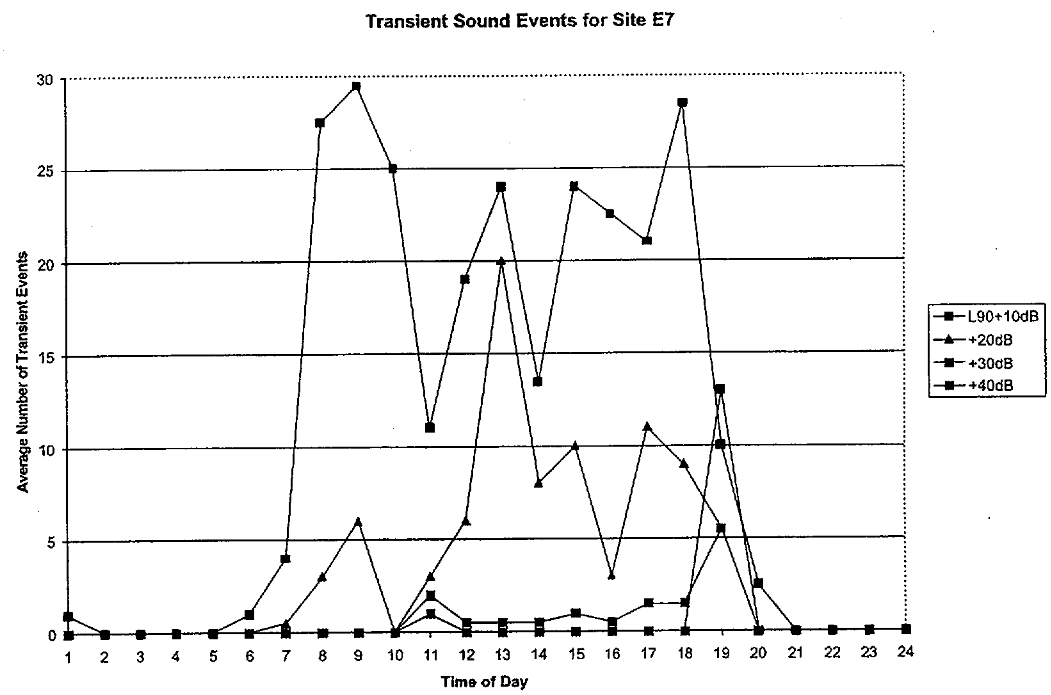


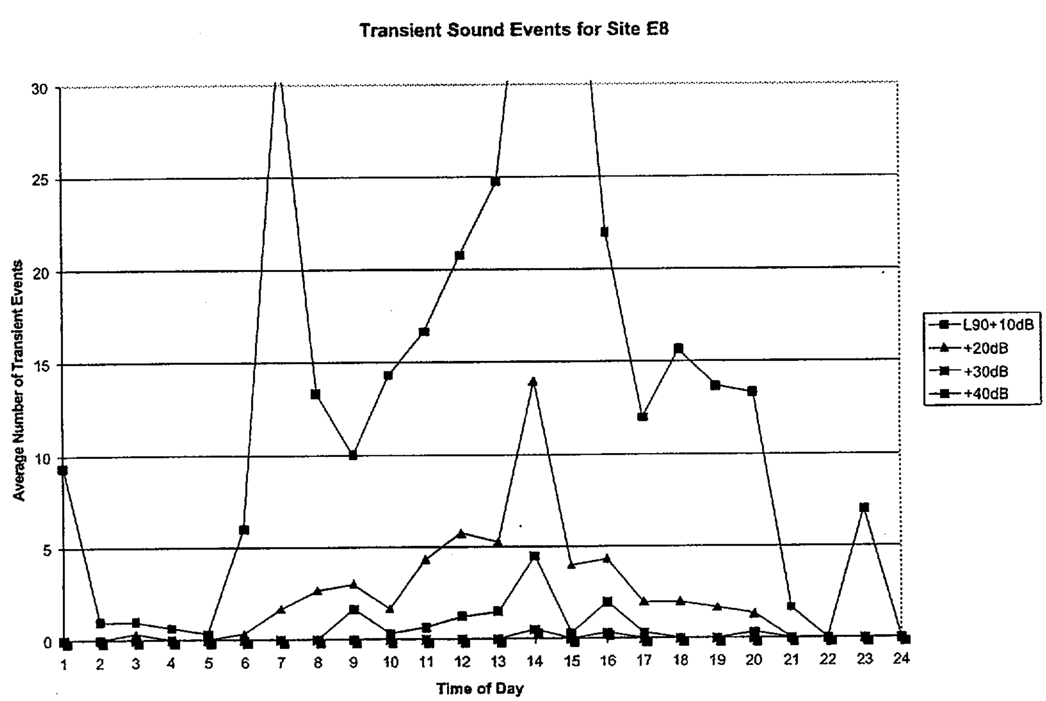
Transient Sound Events for Site E4



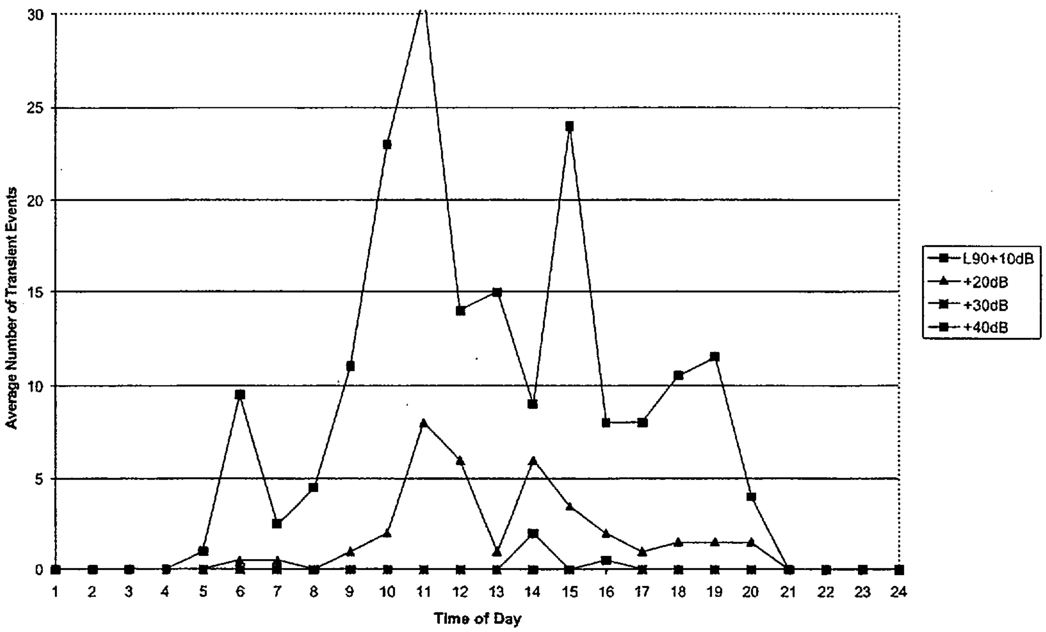

Transient Sound Events for Site E5
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB


Transient Sound Events for Site E6
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB

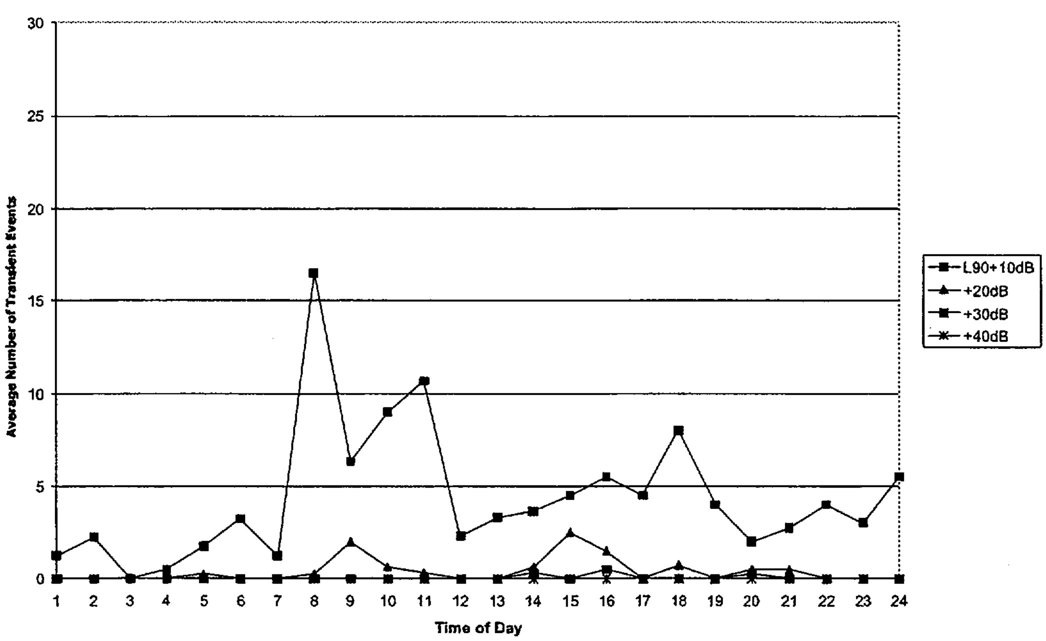

Transient Sound Events for Site E7
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB

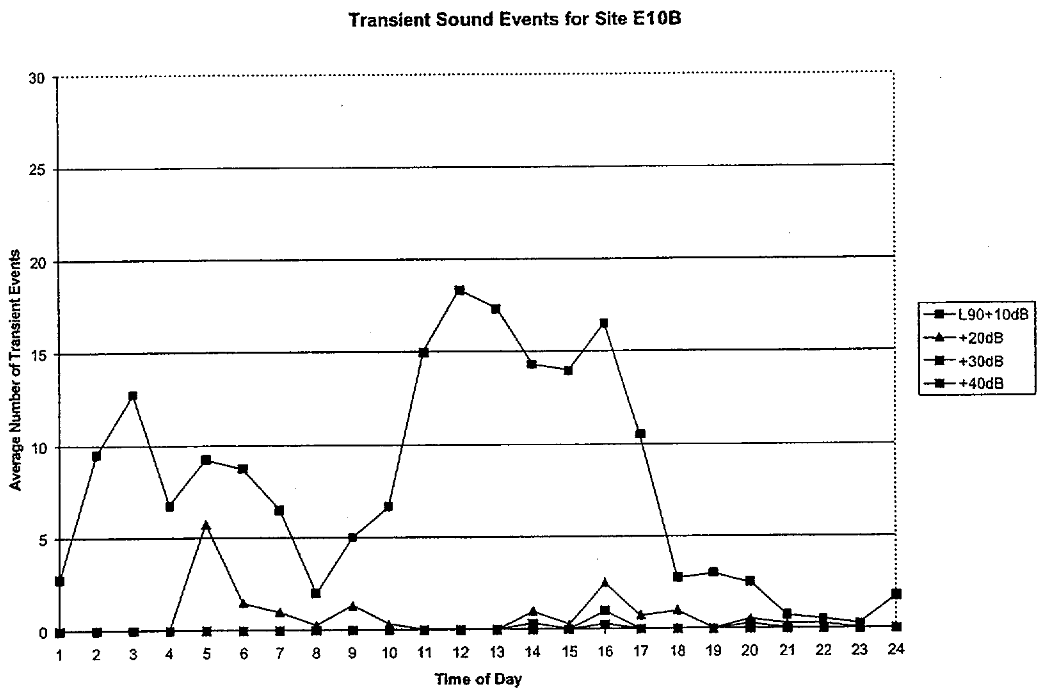

Transient Sound Events for Site E8
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB

Transient Sound Events for Site E9

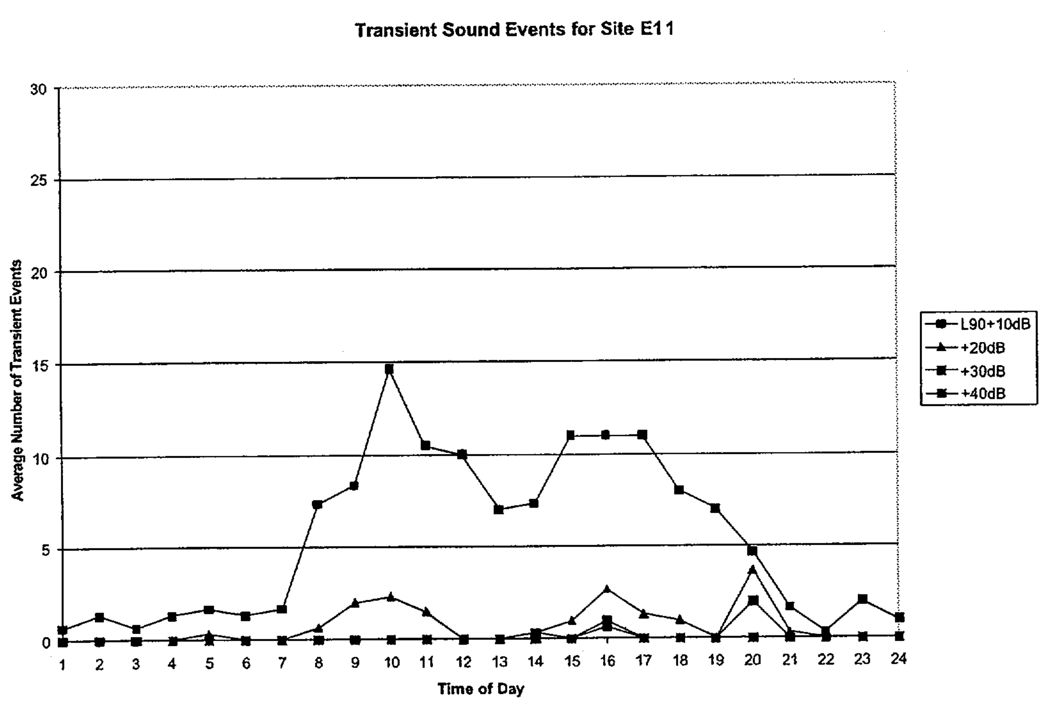


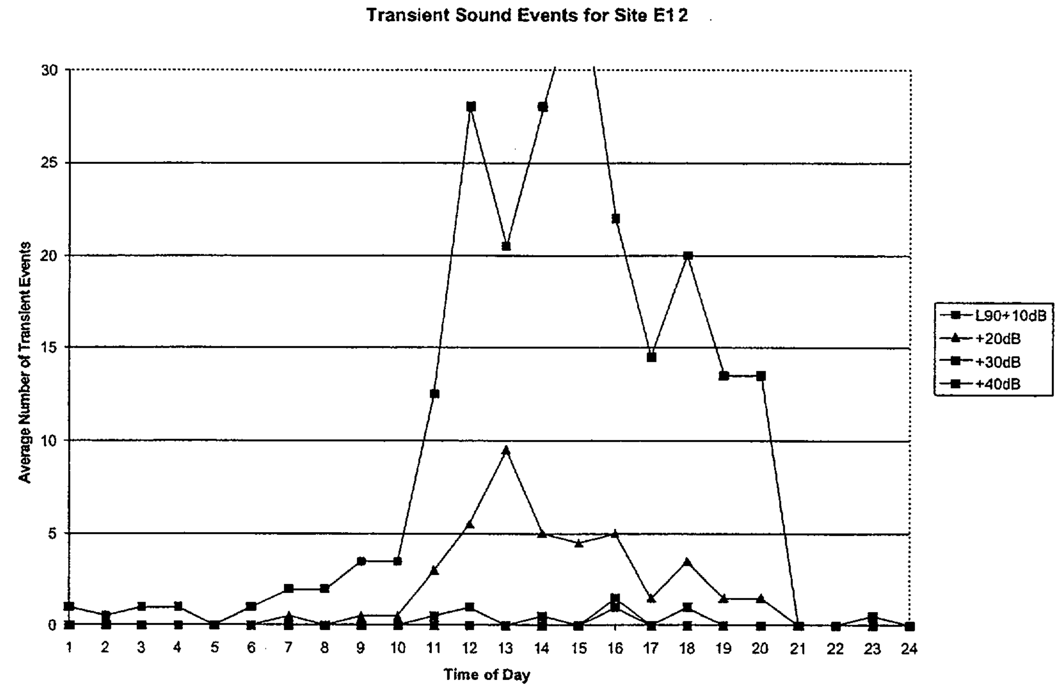
Transient Sound Events for Site E10A

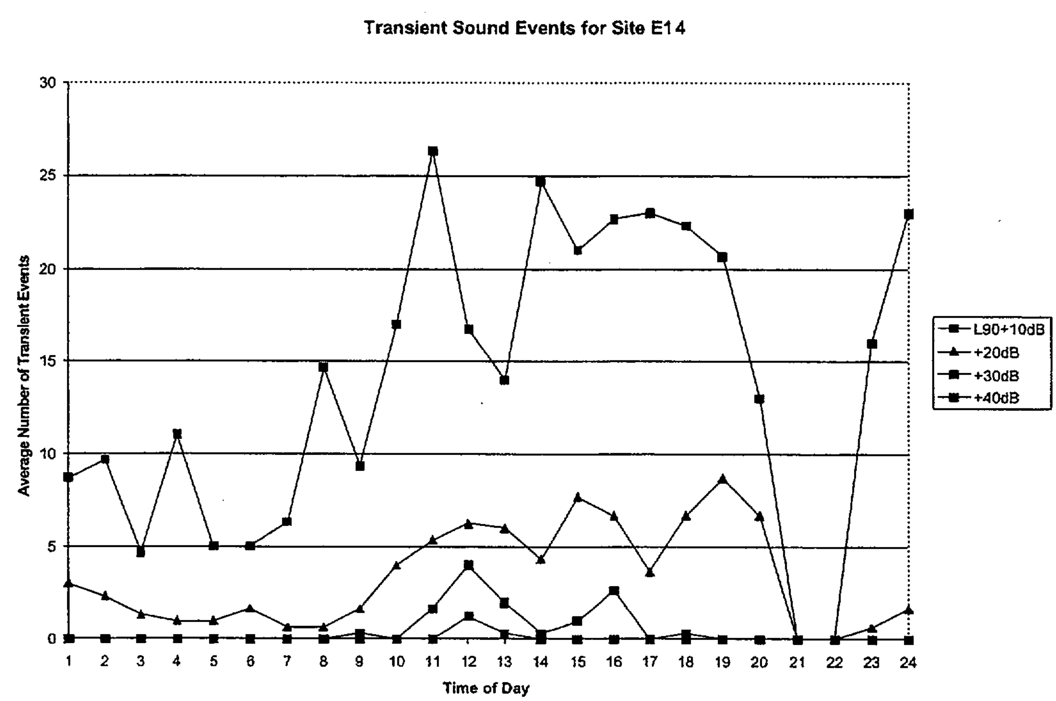




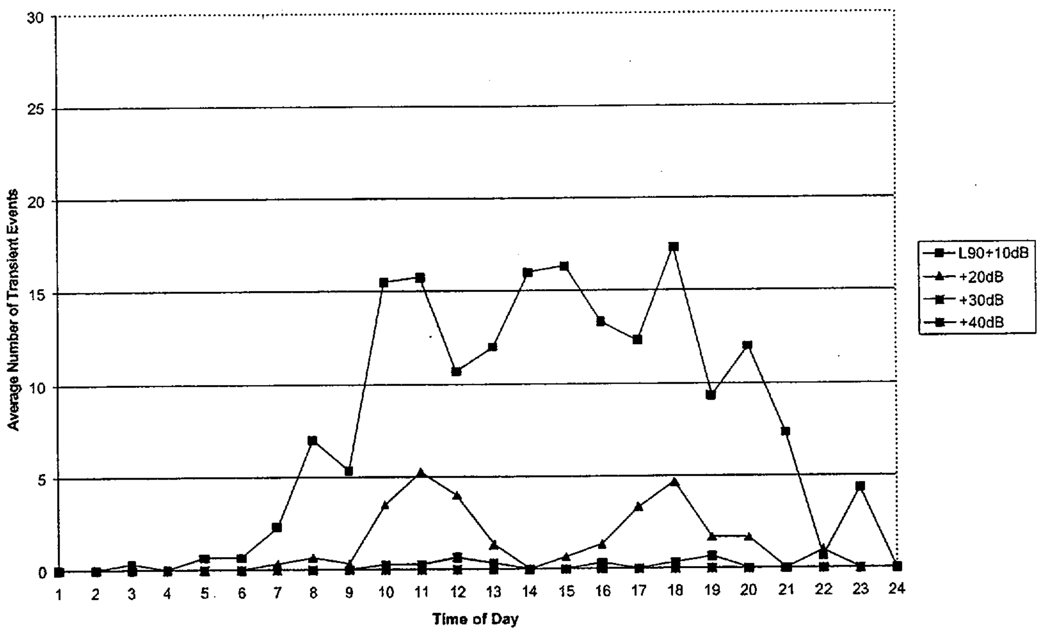
Appendix H Transient Events Plots for Unmanned Measurements
The Soundscape in South Florida NP




Transient Sound Events for Site E12
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB


Transient Sound Events for Site E14
Average Number of Transient Events
Time of Day
L90+10dB
+20dB
+30dB
+40dB

Transient Sound Events for Site E15



I CORRESPONDENCE ON TURKEY POINT PLANT

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 26, 2000

Mr. Douglas J. Heady
SAF/GCN
1740 Air Force Pentagon
Washington D.C. 20330-1740

SUBJECT: POTENTIAL RISK ON TURKEY POINT PLANT OF THE PROPOSED CIVIL AND GOVERNMENT AIRCRAFT OPERATIONS AT HOMESTEAD AIR FORCE BASE (TAC NOS. MA8912 AND MA8913)

Dear Mr. Heady:

This acknowledges receipt of your letter dated May 2, 2000, addressed to the U.S. Nuclear Regulatory Commission (NRC) Document Control Desk. Your letter forwarded Mr. Oncavage's comments on the Draft Supplemental Environmental Impact Statement (SEIS), Disposal of Portions of the Former Homestead Air Force Base (HAFB), Florida. Mr. Oncavage believes that some of his comments should be addressed by the NRC because they relate to the above subject. The NRC staff activities regarding the above subject are summarized below.

The NRC staff is currently performing a review of Florida Power and Light Company's (FPL's) submittal, dated November 17, 1999, regarding the impact of a commercial airport at HAFB on the safe operation of Turkey Point. FPL based its analysis on the flight projections provided by the Air Force letter of August 23, 1999, (Heady to NRC Document Control Desk). Our review focuses on the probability of aircraft crashes damaging the safety-related facilities at the Turkey Point Nuclear Plant, Units 3 and 4. For this review, the staff utilizes the guidance provided in the enclosed NRC Standard Review Plan (SRP), Sections 2.2.3 "Evaluation of Potential Accidents," and 3.5.1.6 "Aircraft Hazards." The acceptance criterion stated in SRP Section 2.2.3 is that the probability of initiating events resulting in radiological consequences greater than Title 10, Code of Federal Regulations (10 CFR) Part 100 exposure guidelines is acceptable if it is about 10^{-6}/year and reasonable qualitative arguments can be made to show that the realistic probability estimate is lower (i.e., in the range of about 10^{-7}/year). The acceptance criterion stated in SRP Section 3.5.1.6 is that the probability of aircraft accidents resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines be less than about 10^{-7}/year.

The NRC staff will document its review of the potential risk to the Turkey Point Plant of the proposed civil and government operations at HAFB in a safety assessment. The staff is targeting the issuance of its assessment by early June.

In addition, your letter of August 23, 1999, stated that, "The SEIS is also examining an alternative to the proposed regional airport which would involve developing a commercial spaceport at former Homestead AFB. Very little is currently known about how spacecraft would operate from the spaceport. . . ." FPL's November 17, 1999, submittal stated that the potential impact of a spaceport at the base would be bounded by the impact associated with a commercial airport. In the absence of specific data and an analysis of potential spacecraft mishaps, the staff can not determine the acceptability of FPL's conclusion. Hence, should the base be used as a commercial spaceport in addition to the military and government operations, the potential impact must be quantified in order to determine the risk for the safe operation of Turkey Point Units 3 and 4. Therefore, the NRC staff is not in a position, at this time, to assess the potential risk of the proposed spaceport to the Turkey Point Plant. Also, for the same reason, the staff is not in a position to address Mr. Oncavage's comments related to the proposed spaceport.

The NRC staff will address Mr. Oncavage's other comments, as well as the Sierra Club's comments transmitted by a letter dated February 24, 2000, in its forthcoming safety assessment or by separate correspondence.

Emergency preparedness issues, including the evacuation of potentially increasing populations in the Emergency Planning Zone, are being addressed by FPL and the State of Florida in conjunction with Dade County. FPL stated, in its letter of June 15, 1998, that they continue to discuss this matter with local and state authorities in order to ensure that any issues emerging from the commercialization of the base are identified, that the offsite emergency preparedness program to address these issues is adequately evaluated, and that the Federal Emergency Management Agency (FEMA) concur with any changes to the offsite emergency preparedness plan. FEMA is the lead Federal Agency for assessing emergency preparedness around nuclear power plants, and provides its findings to the NRC for the NRC's use in making regulatory decisions concerning plant operation.

Based on the currently available information, the NRC staff believes that the spectrum of potential projects resulting from the disposal of the former HAFB is still under examination and development. As the potential projects become more defined, the NRC staff will continue to assess any aspects related to the safe operation of the Turkey Point Nuclear Plant.

If you have any comments related to this matter, please contact the NRC Project Manager for Turkey Point, Kahtan Jabbour, at (301) 415-1496.

Sincerely,

Richard P. Correia

Richard P. Correia, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosures: As stated

cc w/enclosures: See next page

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U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

REVIEW RESPONSIBILITIES

Primary - Siting Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

The applicant's identification of potential accident situations in the vicinity of the plant is reviewed to determine the completeness of and the bases upon which these potential accidents were or were not accommodated in the design. (See Standard Review Plan Sections 2.2.1 and 2.2.2.)

With respect to potential offsite accidents which could affect control room habitability (e.g., toxic gases, asphyxiants), those accidents which are to be accommodated on a design basis, as determined within SRP Section 2.2.3 review, will be addressed by the Accident Evaluation Branch (AEB) within SRP Section 6.4 review, in accordance with TMI-Related Requirement III.D.3.4 of NUREG-0694.

The applicant's probability analyses of potential accidents involving hazardous materials or activities in the vicinity of the plant, if such analyses have been performed, are also reviewed by the Applied Statistics Branch (ASB/MPA) on request by SAB to determine that appropriate data and analytical models have been utilized.

The analyses of the consequences of accidents involving nearby industrial, military, and transportation facilities which have been identified as design basis events are reviewed.

II. ACCEPTANCE CRITERIA

SAB acceptance criteria are based on meeting the relevant requirements of 10 CFR Part 100, §100.10 (Ref. 1) as it relates to the factors to be considered in the evaluation of sites, which indicates that reactors should reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products. In addition, 10 CFR Part 100, §100.10 indicates that the site location, in conjunction with other considerations, should insure a low risk of public exposure.

Specific criteria necessary to meet the relevant requirements of 10 CFR Part 100, §100.10 are described in the following paragraphs.

Offsite hazards which have the potential for causing onsite accidents leading to the release of significant quantities of radioactive fission products, and thus pose an undue risk of public exposure, should have a sufficiently low probability of occurrence and be within the scope of the low probability of occurrence criterion of 10 CFR Part 100, §100.10. Specific guidance with respect to offsite hazards is provided in Chapter 2, Section 2.2.3 of Regulatory Guide (RG) 1.70 (Ref. 2). As indicated therein, the identification of design basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant is acceptable if the design basis events include each postulated type of accident for which the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines is estimated to exceed the NRC staff objective of approximately 10^{-7} per year. Because of the difficulty of assigning accurate numerical values to the expected rate of unprecedented potential hazards generally considered in this SRP section, judgment must be used as to the acceptability of the overall risk presented.

The probability of occurrence of the initiating events leading to potential consequences in excess of 10 CFR Part 100 exposure guidelines should be estimated using assumptions that are as representative of the specific site as is practicable. In addition, because of the low probabilities of the events under consideration, data are often not available to permit accurate calculation of probabilities. Accordingly, the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The effects of design basis events have been adequately considered if analyses of the effects of those accidents on the safety-related features of the plant have been performed and measures have been taken (e.g., hardening, fire protection) to mitigate the consequences of such events.

III. REVIEW PROCEDURES

In some cases it may be necessary to consult with or obtain specific data from other branches, such as the Structural Engineering Branch (SEB) or Auxiliary Systems Branch (ASB), regarding possible effects of external events on plant structures or components.

The applicant's probability calculations are reviewed, and an independent probability analysis is performed by the staff if the potential hazard is considered significant enough to affect the licensability of the site or is important to the identification of design basis events.

All stochastic variables that affect the occurrence or severity of the postulated event are identified, and judged to be either independent or conditioned by other variables.

Probabilistic models should be tested, where possible, against all available information. If the model or any portion of it, by simple extension, can be used to predict an observable accident rate, this test should be performed.

The design parameters (e.g., overpressure) and physical phenomena (e.g., gas concentration) selected by the applicant for each design basis event are reviewed to ascertain that the values are comparable to the values used in previous analyses and found to be acceptable by the staff.

Each design basis event is reviewed to determine that the effects of the event on the safety features of the plant have been adequately accommodated in the design.

If accidents involving release of smoke, flammable or nonflammable gases, or toxic chemical bearing clouds are considered to be design basis events, an evaluation of the effects of these accidents on control room habitability should be made in SAR Section 6.4 and on the operation of diesels and other safety-related equipment in SAR Chapter 9.

Special attention should be given to the review of standardized designs which propose criteria involving individual numerical probability criteria for individual classes of external man-made hazards. In such instances the reviewer should establish that the envelope also includes an overall criterion that limits the aggregate probability of exceeding design criteria associated with all of the identified external man-made hazards. Similarly, special attention should be given to the review of a site where several man-made hazards are identified, but none of which, individually, has a probability exceeding the acceptance criteria stated herein. The objective of this special review should be to assure that the aggregate probability of an outcome that may lead to unacceptable plant damage meets the acceptance criteria of subsection II of this SRP section. (A hypothetical example is a situation where the probability of shock wave overpressure greater than design overpressure is about 10^{-7} per reactor year from accidents at a nearby industrial facility, and approximately equal probabilities of exceeding design pressure from railway accidents, highway accidents and from shipping accidents. Individually each may be judged acceptably low; the aggregate probability may be judged sufficiently great that additional design features are warranted.)

IV. EVALUATION FINDINGS

If the reviewer, after a review of the offsite hazards identified in SRP Section 2.2.1-2.2.2 and evaluated in the above SRP section, concludes that the probability of exceeding the 10 CFR Part 100 dose guidelines due to offsite hazards is within the acceptance criteria given in subsection II of this SRP section, then the staff concludes that the site location insures a low risk of exposure, in compliance with 10 CFR Part 100, §100.10. A conclusion of the following type may be prepared for the Staff's Safety Evaluation Report.

> The staff concludes that the site location is acceptable and meets the relevant requirements of 10 CFR Part 100. This conclusion is based on the following. The applicant has identified potential accidents related to the presence of hazardous materials or activities in the site vicinity which could affect the plant, and from these the applicant has selected those which should be considered as design basis events and has provided analyses of the effects of

these accidents on the safety-related features of the plant. From the analyses, the applicant has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to potential accidents which may occur as the result of the presence of hazardous materials or activities at nearby industrial, military, and transportation facilities.

V. IMPLEMENTATION

The following provides guidance to applicants and licensees regarding the NRC staff's plan for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternate method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

V. REFERENCES

1. 10 CFR Part 100, "Reactor Site Criteria," Section 100.10.

2. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

3. Affidavit of Jacques B. J. Read before the Atomic Safety and Licensing Board in the matter of Skagit Nuclear Power Project, Units 1 and 2, July 15, 1976. Docket Nos. STN 50-522, 523.

4. Atomic Safety and Licensing Board, Supplemental Initial Decision in the Matter of Hope Creek Generating Station, Units 1 and 2, March 28, 1977. Docket Nos. 50-354, 355.

5. Section 2, Supplement 2 to the Floating Nuclear Plant Safety Evaluation Report, Docket No. STN 50-437, September 1976.

NUREG-0800
(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.5.1.6 AIRCRAFT HAZARDS

REVIEW RESPONSIBILITIES

Primary - Siting Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

The staff reviews the applicant's assessment of aircraft hazards. The purpose of the review is to assure that the risks due to aircraft hazards are sufficiently low. Probabilistic considerations may be used to demonstrate that aircraft hazards need not be a design basis concern. Otherwise, design basis aircraft identification is made and the applicant's plant design is evaluated to assure that it is protected against the potential effects of aircraft impacts and fires.

The SAB reviews the applicant's assessment of aircraft hazards to the plant and determines whether or not they should be incorporated into the plant design basis. If the aircraft hazards are incorporated into the plant design basis, the SAB identifies and describes the design basis aircraft in terms of aircraft weight, speed, and other appropriate characteristics.

On request by SAB, the following branches with primary review responsibility will review specific aspects of aircraft hazards:

1. The Structural Engineering Branch (SEB), in the area of missile effects (SRP Section 3.5.3), with respect to aircraft impacts,
2. The Chemical Engineering Branch (CMEB), in the area of fire protection (SRP Section 9.5.1), with respect to aircraft fires, and
3. The Auxiliary Systems Branch (ASB), in the area of structures, systems, and components (SSC) important to safety (SRP Section 3.5.2), with respect to protection requirements against aircraft crashes.

4. For those areas of review identified above as being part of the primary responsibility of other branches, the acceptance criteria necessary for the review and the methods of their application are contained in the referenced SRP sections of the corresponding primary branches.

5. The Applied Statistics Branch (ASB/MPA) will provide technical review support with respect to aircraft accident statisics.

II. ACCEPTANCE CRITERIA

SAB acceptance criteria are based on meeting the relevant requirements of one of the following sets of regulations:

1. 10 CFR Part 100, §100.10 as it relates to indicating that the site location, in conjunction with other considerations (such as plant design, construction, and operation), should insure a low risk of public exposure. This requirement is met if the probability of aircraft accidents resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines is less than about 10^{-7} per year (see SRP Section 2.2.3). The probability is considered to be less than about 10^{-7} per year by inspection if the distances from the plant meet all the requirements listed below:

   (a) The plant-to-airport distance D is between 5 and 10 statute miles, and the projected annual number of operations is less than 500 D^2, or the plant-to-airport distance D is greater than 10 statute miles, and the projected annual number of operations is less than 1000 D^2,

   (b) The plant is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation,

   (c) The plant is at least 2 statute miles beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

If the above proximity criteria are not met, or if sufficiently hazardous military activities are identified (see item b above), a detailed review of aircraft hazards must be performed. Aircraft accidents which could lead to radiological consequences in excess of the exposure guidelines of 10 CFR Part 100 with a probability of occurrence greater than about 10^{-7} per year should be considered in the design of the plant. If the results of the review do not support a finding that the risk due to aircraft activities is acceptably low, then the design basis acceptance criteria outlined in Item II.2 below applies.

2. General Design Criterion (GDC) 4 of 10 CFR Part 50 (Ref. 13), Appendix A, requires that structures, systems, and components (SSC) important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit. GDC 3 of 10 CFR Part 50, Appendix A, requires that SSC important to safety be appropriately protected against the effects of fires. The plant meets the relevant requirements of GDC 3 and GDC 4, and is considered appropriately protected against design basis aircraft impacts (Ref. 6) and fires (Ref. 3) if the SSC important to safety are capable of withstanding the effects of the

postulated aircraft impacts and fires without loss of safe shutdown capability, and without causing a release of radioactivity which would exceed 10 CFR Part 100 dose guidelines.

The safety-related SSC to be considered with respect to the above acceptance criteria include those described in the Appendix to Regulatory Guide 1.117, "Structures, Systems, and Components of Light-Water-Cooled Reactors to be Protected Against Tornadoes." Other safety-related SSC, which may not be included in Regulatory Guide 1.117, will be considered on a case-by-case basis in accordance with the acceptance criteria of the appropriate branches having primary responsibility for their protection.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this SRP section as may be appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is based on a inspection of the material presented to see whether it is similar to that recently reviewed on other plants and whether items of special safety significant are involved.

The staff's review of the aircraft hazard assessment consists of the following steps:

1. Aviation Uses. Data desribing aviation uses in the airspace near the proposed site, including airports and and their approach paths, federal airways, Federal Aviation Administration (FAA) restricted areas, and military uses is obtained from Section 2.2.1-2.2.2 of the SAR. For many cases, no detailed analysis need be made as the probability can be judged adequately low based on a comparison with analyses previously performed (Refs. 5, 7, 8, 9 and 10). In general, civilian and military maps should be examined to verify that all aviation facilities of interest have been considered. In the process, the reviewer should develop an independent assessment of the aircraft hazards. Communications with agencies responsible for aircraft operations and the evaluation of aircraft operational data may be utilized.

2. Airways. For situations where federal airways or aviation corridors pass through the vicinity of the site, the probability per year of an aircraft crashing into the plant (P_{FA}) should be estimated. This probability will depend on a number of factors such as the altitude and frequency of the flights, the width of the corridor, and the corresponding distribution of past accidents.

   One way of calculating P_{FA} is by using the following expression:

   $$P_{FA} = C \times N \times A/w$$

   where:

   C = inflight crash rate per mile for aircraft using airway,

   w = width of airway (plus twice the distance from the airway edge to the site when the site is outside the airway) in miles,

N = number of flights per year along the airway, and

A = effective area of plant in square miles.

This gives a conservative upper bound on aircraft impact probability if care is taken in using values for the individual factors that are meaningful and conservative. For commercial aircraft a value of $C = 4 \times 10^{-10}$ (Ref. 11) per aircraft mile has been used. For heavily traveled corridors (greater than 100 flights per day), a more detailed analysis may be required to obtain a proper value for this factor.

3. Civilian and Military Airports and Heli-Ports (Refs. 2, 4, and 14). The probability of an aircraft crashing into the site should be estimated for cases where one or more of the conditions in Item II.1 of the Acceptance Criteria are not met.

The probability per year of an aircraft crashing into the site for these cases (P_A) may be calculated by using the following expression:

$$P_A = \sum_{i=1}^{L} \sum_{j=1}^{M} C_j N_{ij} A_j$$

where:

- M = number of different types of aircraft using the airport,
- L = number of flight trajectories affecting the site,
- C_j = probability per square mile of a crash per aircraft movement, for the jth aircraft,
- N_{ij} = number (per year) of movements by the jth aircraft along the ith flight path, and
- A_j = effective plant area (in square miles) for the jth aircraft.

The manner of interpreting the individual factors in the above equation may vary on a case-by-case basis because of the specific conditions of each case or because of changes in aircraft accident statistics.

Values for C_j currently being used are taken from the data summarized in the following table:

Distance From End of Runway (miles)	Probability ($\times 10^8$) of a Fatal Crash per Square Mile per Aircraft Movement			
	U.S. Air Carrier[1]	General Aviation[2]	USN/USMC[1]	USAF[1]
0-1	16.7	84	8.3	5.7
1-2	4.0	15	1.1	2.3
2-3	0.96	6.2	0.33	1.1
3-4	0.68	3.8	0.31	0.42
4-5	0.27	1.2	0.20	0.40
5-6	0	NA[3]	NA	NA
6-7	0	NA	NA	NA
7-8	0	NA	NA	NA
8-9	0.14	NA	NA	NA
9-10	0.12	NA	NA	NA

[1]Reference 2.
[2]Reference 4.
[3]NA indicates that data was not available for this distance.

4. Designated Airspaces. For designated airspaces involving military or civilian usage, a detailed quantitative modeling of all operations should be verified. The results of the model should be the total probability (C) of an aircraft crash per unit area and time in the vicinity of the proposed site.

The probability per year of a potentially damaging crash at the site due to operations at the facility under consideration (P_M) is then given for this case by the following expression:

$$P_M = C \times A$$

where:

C = total probability of an aircraft crash per square mile per year in the vicinity of the site due to the airports being considered, and

A = effective area of one unit of the plant in square miles.

Where estimated risks due to military aircraft activity are found to be unacceptably high, suitable airspace or airway relocation should be implemented. Past experience has been that military authorities have been responsive to modification of military operations and relocation of training routes in close proximity to nuclear power plant sites. (Ref. 12)

5. Holding Patterns. Holding patterns are race track shaped courses at specified altitudes, associated with one or more radio-navigational facilities, where aircraft can "circle" while awaiting clearance to execute an approach to a landing at an airport or to continue along an airway. Holding patterns which are sufficiently distant from the plant need not be considered (See subsection II above). Otherwise, traffic in the holding pattern should be converted into equivalent aircraft passages taking into account the characteristics, including orientation with respect to the plant, of the holding pattern. The information in Item III.2 above should be used in this evaluation.

6. The total aircraft hazard probability at the site equals the sum of the individual probabilities obtained in the preceding steps.

7. The effective plant areas used in the calculations should include the following:

   a. A shadow area of the plant elevation upon the horizontal plane based on the assumed crash angle for the different kinds of aircraft and failure modes.

   b. A skid area around the plant as determined by the characteristics of the aircraft under consideration. Artificial berms or any other man-made and natural barriers should be taken into account in calculating this area.

   c. The areas of those safety-related SSC which are susceptible to impact or fire damage as a result of aircraft crashes.

IV. EVALUATION FINDINGS

The reviewer drafts an introductory paragraph for the evaluation findings describing the procedure used in evaluating the aircraft hazards with respect to the safety-related SSC. The reviewer verifies that the site location is acceptable and meets the requirements of 10 CFR Part 100, §100.10.

The basis for the above findings may be strictly in terms of the probabilities associated with potential aircraft crashes onsite. If the aircraft crash statistics applicable to the onsite facilities are such that SRP Section 2.2.3 criteria are met without explicit consideration of plant design features, then conclusions of the following type should be included in the staff's safety evaluation report:

> The staff concludes that the operation of the _______ plant in the vicinity of _________ does not present an undue risk to the health and safety of the public and meets the relevant requirements of 10 CFR Part 100, §100.10. This conclusion is based on the staff's independent verification of the applicant's assessment of aircraft hazards at the site that resulted in a probability less than about 10^{-7} per year for an accident having radiological consequences worse than the exposure guidelines of 10 CFR Part 100.
>
> In addition, plant sites reviewed in the past which had equivalent aircraft traffic in equal or closer proximity were, after careful examination, found to present no undue risk to the safe operation of those plants. Based upon this experience, in the staff's judgment, no undue risk is present from aircraft hazard at the plant site now under consideration.

In the event that the staff evaluation of the aircraft hazards does not support the above basis, i.e., if SRP Section 2.2.3 criteria are not met, then the basis for acceptance is derived from applying GDC 3 and GDC 4 criteria. If the protection against aircraft impacts and fires is such that the plant safety-related SSC meet GDC 3 and GDC 4 criteria, then 10 CFR Part 100 requirements are considered to be met and conclusion of the following type may be included in the staff's safety evaluation report:

> The staff concludes that the operation of the _______ plant in the vicinity of ________ does not present an undue risk to the health and safety of the public due to aircraft hazards and meets the relevant requirements of General Design Criteria 3 and 4. This conclusion is based on the staff having independently verified the applicant's assessment of aircraft hazards, including aircraft fires and impacts, at the site and that if the appropriate safety-related structures, systems, and components are designed to withstand the aircraft selected as the design basis aircraft, the probability of an aircraft strike causing radiological consequences in excess of the exposure guidelines of 10 CFR Part 100 is less than about 10^{-7} per year.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, and method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREG.

VI. REFERENCES

1. 10 CFR Part 100, "Reactor Site Criteria."

2. D. G. Eisenhut, "Reactor Siting in the Vicinity of Airfields." Paper presented at the American Nuclear Society Annual Meeting, June 1973.

3. I. I. Pinkel, "Appraisal of Fire Effects from Aircraft Crash at Zion Power Reactor Facility," July 17, 1972 (Docket No. 50-295).

4. D. G. Eisenhut, "Testimony on Zion/Waukegan Airport Interaction" (Docket No. 50-295).

5. USAEC Regulatory Staff, "Safety Evaluation Report," Appendix A, "Probability of an Aircraft Crash at the Shoreham Site" (Docket No. 50-322).

6. "Addendum to the Safety Evaluation by the Division of Reactor Licensing, USAEC, in the Matter of Metropolitan Edison Company (Three Mile Island Nuclear Station Unit 1, Dauphin County, Pennsylvania)," April 26, 1968 (Docket No. 50-289).

7. Letter to Honorable J. R. Schlesinger from S. H. Bush, Chairman, Advisory Committe on Reactor Safeguards, "Report on Rome Point Nuclear Generating Station," November 18, 1971 (Project No. 455).

8. Letter to Mr. Joseph L. Williams, Portland General Electric Company, from R. C DeYoung (in reference to Mr. Williams' letter of May 7, 1973), November 23, 1973 (Project No. 485).

9. "Aircraft Considerations-Preapplication Site Review by the Directorate of Liensing, USAEC, in the Matter of Portland General Electric Company, Boardman Nuclear Plant, Boardman, Oregon," October 12, 1973 (Project No. 485).

10. Letter to Mr. J. H. Campbell, Consumers Power Company, from Col. James M. Campbell, Dep. Chief, Strategic Division, Directorate of Operations, U.S. Air Force, May 19, 1971 (Docket No. 50-155).

11. H. E. P. Krug, "Testimony on Aircraft Operations in Response to a Question from the Board" (Docket Nos. 50-275 and 50-323).

12. Letter to Mr. J. H. Campbell, Consumers Power Company, from Col. James M. Campbell, Dep. Chief, Strategic Division, Directorate of Operations, U.S. Air Force, May 19, 1971 (Docket No. 50-155).

13. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

14. NUREG-0533, "Aircraft Impact Risk Assessment Data Base for Assessment of Fixed Wing Air Carrier Impact Risk in the Vicinity of Airports."

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 19, 2000

Mr. Thomas F. Plunkett
President - Nuclear Division
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: SAFETY ASSESSMENT OF POTENTIAL RISK TO TURKEY POINT PLANT OF THE PROPOSED CIVIL AND GOVERNMENT AIRCRAFT OPERATIONS AT HOMESTEAD AIR FORCE BASE (TAC NOS. MA6249 AND MA6250)

Dear Mr. Plunkett:

By letters dated June 15, 1998, November 17, 1999, and May 1, 2000, Florida Power and Light Company (FPL or the licensee) provided information in response to the U.S. Nuclear Regulatory Commission (NRC) staff letters of April 14, 1998, September 16, 1999, and March 8, 2000, respectively. The information provided was related to the conversion of the Homestead Air Force Base (HAFB) site to a regional commercial airport, in addition to its support of military and government operations.

FPL performed a risk assessment which focused on the probability of aircraft crashes damaging the safety-related facilities at the Turkey Point site. FPL concluded that the results indicate that the risk to the safe operation of Turkey Point Units 3 and 4 associated with the proposed commercial operation, in addition to its use for military and government operations, is within the guidelines of NRC Standard Review Plan (SRP), Sections 2.2.3, "Evaluation of Potential Accidents," and 3.5.1.6, "Aircraft Hazards."

The NRC staff has reviewed the licensee's assessment methods and finds that they are acceptable and that the estimated risk associated with potential on-site aircraft crashes is within the acceptance criteria of SRP Sections 2.2.3 and 3.5.1.6. However, the staff notes that the margin between the estimated aircraft crash frequency and the acceptance guidelines of SRP 3.5.1.6 is relatively small. Hence, the staff believes that FPL would need to monitor the aircraft operations (i.e., air traffic and flight track information) at the airport on a regular basis. Should the actual aircraft operations exceed those projected for the year 2014, a reassessment of the aircraft risk would need to be made. Please inform us of your plans to monitor air traffic and flight tracks at the HAFB site on a periodic basis after it becomes operational as a commercial airport, and to reassess the risk as stated above.

With respect to the alternate option of the HAFB site being developed into a commercial spaceport, the licensee did not quantify the risks. However, the licensee indicated that the potential impact of a spaceport at the site would be bounded by the impact associated with a commercial airport. In the absence of specific data and an analysis of potential spacecraft mishaps, the staff cannot, at this time, determine the acceptability of this conclusion. Hence, should the site be used as a commercial spaceport, the potential impact would have to be quantified in order to determine the risk to the safe operation of Turkey Point Units 3 and 4.

Emergency preparedness issues, including the evacuation of potentially increasing populations in the Emergency Planning Zone, are being addressed by FPL and the State of Florida in conjunction with Dade County. FPL stated, in its letter of June 15, 1998, that they will continue to discuss this matter with local and state authorities in order to ensure that any issues emerging from the commercialization of the base are identified, that the offsite emergency preparedness program to address these issues is adequately evaluated, and that the Federal Emergency Management Agency (FEMA) concurs with any changes to the offsite emergency preparedness plan. FEMA is the lead Federal Agency for assessing emergency preparedness around nuclear power plants, and provides its findings to the NRC for the NRC's use in making regulatory decisions concerning plant operation.

Based on the currently available information, the NRC staff notes that the spectrum of potential projects resulting from the disposal of the former HAFB site is still under examination and development. As the potential projects become more defined, the NRC staff will continue to assess any aspects related to the safe operation of Turkey Point Nuclear Plant.

If you have any comments related to this matter, please contact me at (301) 415-1496.

Sincerely,

Kahtan N. Jabbour

Kahtan N. Jabbour, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure: NRR Safety Assessment

cc w/enclosures: See next page

Mr. T. F. Plunkett
President - Nuclear Division

TURKEY POINT PLANT

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FLORIDA LIGHT AND POWER COMPANY

TURKEY POINT UNITS 3 & 4

DOCKET NOS. 50-250 and 50-251

1. INTRODUCTION

The former Homestead Air Force Base (HAFB) site, situated about 5 miles from the Turkey Point Plant, Units 3 and 4, was determined to be surplus property by the U.S. Air Force (USAF). The USAF is seeking to dispose of the property in accordance with the requirements of the Defense Base Closure and Realignment Act. Miami-Dade County has been designated as the Local Reuse Authority responsible for a reuse plan of the former base property. Currently the plan involves the proposed conversion of the surplus property into a commercial airport in addition to its use for military and government operations. The above actions will lead to a new flight pattern and aircraft mix being serviced by the combined facility.

In response to a December 9, 1997, letter from the Friends of the Everglades, the U.S. Nuclear Regulatory Commission (NRC) staff requested, by letter dated April 14, 1998, Florida Power and Light Company (FPL or the licensee) to provide information regarding the proposed HAFB site conversion to a commercial airport. In a June 15, 1998, letter to the NRC, FPL provided the requested information which focused on the probability of aircraft crashes damaging the safety-related facilities at Turkey Point Units 3 and 4. The risk estimate provided by FPL was based on the available flight data at that time.

Subsequently, On August 23, 1999, the USAF notified the NRC staff that a Supplemental Environmental Impact Statement was being prepared for the HAFB site conversion project to reflect updated air traffic information associated with the proposed civil aircraft operations at the HAFB in addition to its continuing support of military and government operations. The USAF letter provided information to support the assessment of the potential risk to the Turkey Point units. By letter dated September 16, 1999, the NRC staff forwarded the above information to FPL and requested that FPL assess the impact of the proposed changes and update the Turkey Point Final Safety Analysis Report and other related documents when the proposal becomes more defined. By letter dated November 17, 1999, FPL submitted its response to the NRC staff request. Also, by letter dated May 1, 2000, FPL responded to the staff request for additional information dated March 8, 2000.

2. ASSESSMENT

The NRC staff review of the subject aircraft activities and the associated risk to Turkey Point is based on the acceptance criteria and review procedures in Sections 2.2.3, "Evaluation of Potential Accidents," and 3.5.1.6, "Aircraft Hazards," of the NRC Standard Review Plan (SRP), NUREG-0800, Revision 2, July 1981. The acceptance criterion stated in SRP Section 2.2.3 is that the probability of initiating events resulting in radiological consequences greater than

Title 10, *Code of Federal Regulations* (10 CFR), Part 100 exposure guidelines is acceptable if it is about 10^{-6}/year provided that reasonable qualitative arguments can be made to show that the realistic probability estimate is lower (i.e., in the range of about 10^{-7}/year). The acceptance criterion in SRP Section 3.5.1.6 is that the probability of aircraft accidents resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines be less than about 10^{-7} per year. The staff review has led to the assessment below.

As indicated above, the staff had requested FPL to provide information regarding the proposed conversion of the HAFB site. FPL's responses, dated June 15, 1998 and November 17, 1999, as well as the response to the staff request for additional information, dated May 1, 2000, were reviewed by the staff and the findings are described below.

FPL used DOE methodology in its estimate of the risk. This methodology is similar to that described in SRP 3.5.1.6, "Aircraft Hazards." The results of the analysis documented by letter dated June 15, 1998, indicate that the probability of exceeding 10 CFR Part 100 guidelines associated with the proposed aircraft operations did not meet the SRP 3.5.1.6 criterion. The on-site aircraft crash frequency was based on projected aircraft operations (commercial and military) for the year 2014, and was conservatively estimated to be about 8.11×10^{-7}/year. The corresponding on-site aircraft crash frequency based on the 1994 military operations was conservatively estimated to be about 4.91×10^{-7}/year. Hence, the new estimate represented an increase of a factor of about 1.6 over what had been projected previously.

Since the estimated crash frequency exceeds SRP 3.5.1.6 acceptance criteria, further analysis normally would be appropriate in order to address some of the conservatism inherent in the estimated frequency. For example, the estimate is based on the simplifying assumption that each and every on-site aircraft crash leads to a release in excess of 10 CFR Part 100 dose guidelines. This is conservative, since taking into account the presence of minimum structural strength requirements associated with safety-related structures would tend to reduce the chances of a release in excess of 10 CFR Part 100.

Subsequently, on August 23, 1999, the USAF notified the NRC staff that a Supplemental Environmental Impact Statement was being prepared for the proposed HAFB site conversion to reflect updated air traffic information, alternate flight track configurations, and to evaluate environmental impacts associated with the optional use of the base as a commercial spaceport. As a result, by letter dated September 16, 1999, the NRC staff requested FPL to assess the impact of the new information on the previous risk estimate.

In a November 17, 1999, letter to the NRC, FPL provided a reassessment of the proposed air traffic changes. The principal changes in the projected operations consist of two opposing trends. Specifically, the military traffic is projected to decrease sevenfold for large aircraft and about 28% for small aircraft, the opposing trend is the projected increase in commercial jumbo jet operations by a factor of three. The net effect is a 55% reduction in the frequency of aircraft crashes that would lead to exposures exceeding 10 CFR Part 100 guidelines. On the basis of the revised air traffic projections, FPL's results indicate a decrease in the estimated risk. Specifically, the previously estimated value of 8.11×10^{-7}/year was revised to 3.63×10^{-7}/year.

In the course of the staff's review of the licensee's analyses, the licensee was requested to provide additional information regarding some site-specific aspects with respect to the projected aircraft activities at the Homestead Air Force Base. In particular, the licensee was asked to estimate the potential for bird strikes causing aircraft mishaps in the vicinity of the airport. The licensee has indicated that, on the basis of data in the U.S. Department of Transportation Federal Aviation Administration report "Wildlife Strikes to Civil Aircraft in the United States," the fraction of civil aircraft accidents caused by bird strikes is about 0.175%. With respect to military aircraft, the licensee estimates (on the basis of USAF aircraft mishaps due to bird strikes reported for the period 1/85 through 2/98) that the fraction of military aircraft mishaps caused by bird strikes is about 4.1%. These estimates were based on nationally averaged data. The licensee adjusted the fractions to reflect the bird strike frequency characteristic of Florida. The adjusted fractions are 0.875% for civil aviation and 20.5% for military aircraft. Hence, 20.5% represents an upper bound on the increase in the aircraft crash rate at Turkey Point.

The licensee also was asked to address the effect of the projected high fraction (more than 80%) of the civil air traffic flights being from Latin America, the Caribbean, or other international locations. The intent was to determine the effect of using U.S. civil aviation crash rates for an aircraft mix that has a high fraction of foreign aircraft. Some reports indicate the possibility of substantially higher air mishap rates for aircraft of foreign origin. For example, the Commercial Aviation Safety Strategy Team has issued a report wherein the aircraft mishap rate for Latin America is estimated to be about 5.7 major accidents per million departures, compared to 0.5 for the U.S. The licensee performed a sensitivity analysis by increasing the crash frequency for commercial air carriers by a factor of 10 to approximate the effect of a high fraction of the aircraft being from Latin America, the Caribbean, or other foreign locations. The result of the above increase was estimated to raise the overall aircraft crash rate only by about 5%, since the projected total air traffic is dominated by military aircraft.

Taking into account the above effects of potential bird strikes and the adjustment for foreign carriers from Latin America, the estimated aircraft crash frequency is increased by a factor of 1.22, changing the 3.63×10^{-7}/year to 4.43×10^{-7}/year which meets the SRP 3.5.1.6 acceptance criterion of about 10^{-7}/year. In addition, FPL's estimate is within the guidelines of SRP 2.2.3, wherein the acceptance criterion of 10^{-6}/year is applicable if reasonable qualitative arguments can be made to show that the realistic probability estimate is lower. Actual configurations or situations at the plant for which qualitative arguments can be made regarding the fact that they may decrease the risk estimate, do not readily lend themselves to modeling and analysis due to the complex nature of the configurations or situations. Therefore, sound engineering judgment is utilized in determining the acceptance criteria for the probability estimate. Specifically, FPL has qualitatively identified some conservatism inherent in its analysis which indicates that the actual risk from on-site aircraft crashes is lower than the estimate of 3.63×10^{-7}/year. For example, FPL notes that shielding by adjacent structures or heavy machinery, as well as the canal and the adjacent fossil units are not fully credited. Moreover, the structural capability of safety-related structures (e.g., containment building) against missile impacts has not been taken into account when considering conditional core damage probability and conditional containment failure probability. Based on its review , the staff concludes that the risks associated with on-site aircraft crashes for Turkey Point are acceptable.

It should be noted, however, that the margin between the estimated aircraft crash frequency and the acceptance guidelines of SRP 3.5.1.6 is relatively small. Hence, the staff believes that FPL would need to monitor the aircraft operations at the proposed airport on a periodic basis.

Should the actual aircraft operations exceed those projected for the year 2014, a reassessment of the aircraft risk would need to be made. It is necessary for the licensee to inform the staff of their plans to monitor the air traffic and flight tracks at the HAFB site on a periodic basis after it becomes operational as a commercial airport, and to reassess the risk as stated above.

Regarding the potential for the base to be used as a spaceport for handling vehicle launches and landings, the licensee has not performed an analysis of the associated risks. FPL indicates that the potential impact is bounded by the impacts associated with a commercial airport. However, with no supporting data or analysis, the staff cannot, at this time, make a finding of acceptability regarding potential spaceport operations. Hence, if the base conversion leads to the implementation of spaceport operations, FPL would need to address the associated risk by providing a risk assessment for staff review and evaluation.

3. CONCLUSION

Based on its review, the staff finds the risk analysis submitted by FPL meets the acceptance criteria of SRP Sections 2.2.3 and 3.5.1.6, and, therefore, is acceptable. The staff cannot, at this time, make any conclusion with respect to the spaceport. Emergency preparedness issues will be addressed after the potential project becomes more defined.

Principal contributor: Kazimieras Campe, NRR

Date: June 19, 2000

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 18, 2000

Mr. Douglas J. Heady
SAF/GCN
1740 Air Force Pentagon
Washington D.C. 20330-1740

SUBJECT: TURKEY POINT UNITS 3 AND 4 - HOMESTEAD AIR FORCE BASE PROPERTY DISPOSAL

Dear Mr. Heady:

Enclosed is a copy of Mr. Oncavage's letter dated June 9, 2000, related to the May 26, 2000, letter from Richard P. Correia, U.S. Nuclear Regulatory Commission (NRC), to you regarding the above subject. In Mr. Oncavage's June 9, 2000, letter, he stated with regard to the assessment of the potential risk to Turkey Point of the proposed spaceport, that the "Sierra Club - Miami Group realizes very little is currently known about the proposed spaceport operations." However, he requested that a detailed statement by the "responsible official" be made of any adverse environmental effects which cannot be avoided should the proposal be implemented. Mr. Oncavage stated that this request is in accordance with the National Environmental Policy Act of 1969 (NEPA). Mr. Oncavage believes that this requirement has not been met by NRC.

We are in the process of responding to Mr. Oncavage's other comments. However, his comment regarding the "detailed statement by the responsible official" should be addressed by you, as we note that the U.S. Air Force and the Federal Aviation Administration are the Federal agencies preparing the Supplemental Environmental Impact Statement. We will inform Mr. Oncavage that you will be dealing with this issue as appropriate.

If you have any comments regarding this matter, please contact me at (301) 415-1496.

Sincerely,

Kahtan N. Jabbour

Kahtan N. Jabbour, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure: Mr. Oncavage's letter of June 9, 2000

cc w/enclosure: See next page

cc:
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SIERRA CLUB Miami Group

Post Office Box 43-0741 • South Miami, Florida 33243-0741

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

June 9, 2000

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
Homestead AFB Property Disposal

Sierra Club, Miami Group would appreciate the opportunity to comment on the Nuclear Regulatory Commission ("NRC") letter by Richard P. Correia, Chief, Section 2, dated May 26, 2000 to Mr. Douglas Heady, SAF/GCN, United States Air Force ("USAF").

Mr. Correia states: "Therefore, the NRC staff is not in a position, at this time, to assess the potential risk of the proposed spaceport to the Turkey Point Plant." Sierra Club, Miami Group realizes very little is currently known about the proposed spaceport operations. However, the National Environmental Policy Act of 1969 ("NEPA") requires a detailed statement by the responsible official of any adverse environmental effects which cannot be avoided should the proposal be implemented. We believe this requirement has not been met. We feel the NRC cannot suspend its obligation to provide a safety assessment of Turkey Point operations in close proximity to spaceport operations. If the information provided by the USAF on spaceport operations cannot be used to demonstrate safe operation of Turkey Point, then the assessment must be decisively negative.

The Mission Statement of the NRC (see attachment) reads in part "...to ensure adequate protection of the public health and safety..." If the NRC cannot demonstrate adequate public health and safety concerning Turkey Point operations in relation to the spaceport operations, then again, the assessment must be decisively negative. This assessment will most likely be included in the Final Supplemental Environmental Impact Statement ("FSEIS") which will most likely be used by the decision makers to convey or not convey portions of the former Homestead Air Force Base to the spaceport developers. We expect the decision on conveyance to be made shortly after the publication of the FSEIS. The Mission Statement does not provide for a suspension of the NRC's obligations to the health and safety of the public.

The Sierra Club, Miami Group would also appreciate the opportunity to comment on the "Response to Request for Additional Information" by R.J. Hovey, Vice President, Turkey Point Plant, dated May 1, 2000.

Response 2

The twin 400' chimneys (413' above mean sea level) need to be factored into the calculation of the effective area since their presence may cause a crash of a wayward low flying aircraft that otherwise might have cleared all the other plant structures. The height of the twin chimneys (232' taller than the containment buildings) likely increases not decreases the probability of air crashes. The effective area needs to be recalculated.

As to the notion that the chimneys offer a form of protection for the nuclear site, it is not likely that a B-767 weighing 450,000 lbs. or a MD-11 weighing 633,000 lbs. (see attachment) would be stopped by a chimney. It is far more realistic that such a collision would create missiles in the form of chimney pieces that could impact the nuclear site in addition to the crashing aircraft. There is also a remote possibility that an aircraft could strike both chimneys bringing them both down. The mass and velocity of chimney pieces as missiles needs to be factored into the calculations.

Response 3

Omitted from the target building data table were Unit 1 smokestack, fire fighting equipment, all fuel tanks (including the tanks associated with fossil units 1 & 2), and the switchyard. The on-site crash frequency needs to be recalculated encompassing all the safety related structures.

Response 4

Attached is a copy of a letter from Bernice U. Constantin, U.S. Dept. of Agriculture to Lt. Col. Dunaway, dated March 4, 1996. The letter describes the seriousness of bird hazards, site specific to Homestead Air Force Base. A quantitative multiplier needs to be incorporated into the air crash probability calculations.

Response 5

Increasing the crash frequency of commercial carriers by a factor of 10 to account for 80 % of operations connected with Latin America, the Caribbean, or other international locations disregards the 56,771 operations of general aviation. According to NUREG-0800, general aviation has a crash frequency 4.44 higher than commercial aviation. An assumption can be made that 80 % of the general aviation operations will have an international connection.

Question 5 quotes a crash frequency of 0.5 major accidents per million departures for U.S. commercial carriers and 5.7 for Latin American carriers. Using a factor of 10 appears to significantly underestimate the risk of a major air crash for Latin American carriers.

Omitted from the hit frequency table were unit 1 smokestack, unit 2 smokestack, fire fighting equipment, all fuel tanks (including the tanks associated with fossil units 1 & 2), and the switchyard.

The hit frequency table data for CCDP and CCFP for spent fuel building units 3 and 4 appear to imply a catastrophic radiological accident independent of the nuclear steam supply system, yet still able to cause core damage and containment failure. The radiological consequences of an aircraft impacting the spent fuel buildings needs to be addressed along with core damage and containment failure. We are extremely concerned about a catastrophic failure of the spent fuel pools in relation to air crashes. We estimate that Turkey Point houses in excess of 300,000 spent fuel rods.

In conclusion, we hope this letter will help clarify our positions for the

NRC staff. We apologize for its lateness. We urge the NRC to revisit the letter of Februáry 24, 2000 from the Sierra Club, Miami Group and request that the information is incorporated into the Safety Evaluation Report.

Sincerely,

Mark Oncavage
Energy Chair

Mission and Organization

Contents

Mission

THE mission of the U.S. Nuclear Regulatory Commission (NRC) is to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the use of nuclear materials in the United States. The NRC's scope of responsibility includes regulation of commercial nuclear power reactors; nonpower research, test, and training reactors; fuel cycle facilities; medical, academic, and industrial uses of nuclear materials, and the transport, storage, and disposal of nuclear materials and waste.

Statutory Authority

The NRC was created as an independent agency by the *Energy Reorganization Act of 1974*, which abolished the Atomic Energy Commission (AEC) and moved the AEC's regulatory function to NRC. This act, along with the Atomic Energy Act of 1954, as amended, provides the foundation for regulation of the nation's commercial nuclear power industry.

NRC regulations are issued under the *United States Code of Federal Regulations* (CFR) Title 10, Chapter 1. Principal statutory authorities that govern NRC's work are--

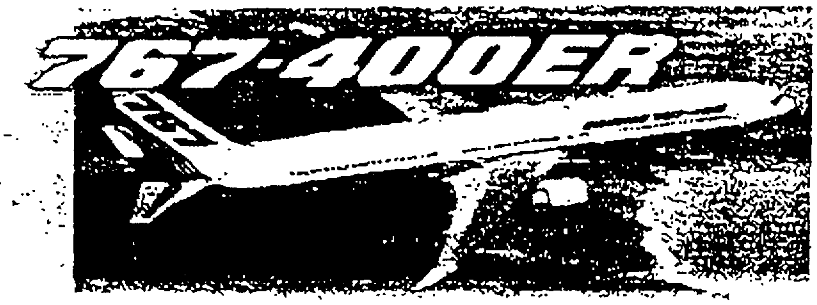
- Atomic Energy Act of 1954, as amended
- Energy Reorganization Act of 1974, as amended
- Uranium Mill Tailings Radiation Control Act of 1978, as amended
- Nuclear Non-Proliferation Act of 1978
- Low-Level Radioactive Waste Policy Act of 1980
- West Valley Demonstration Project Act of 1980
- Nuclear Waste Policy Act of 1982
- Low-Level Radioactive Waste Policy Amendments Act of 1985
- Diplomatic Security and Anti-Terrorism Act of 1986
- Nuclear Waste Policy Amendments Act of 1987
- Solar, Wind, Waste and Geothermal Power Production Incentives Act of 1990
- Energy Policy Act of 1992

The NRC and its licensees share a common responsibility to protect the public health and safety. Federal regulations and the NRC regulatory program are important elements in the protection of the public. NRC licensees, however, have the primary responsibility for the safe use of nuclear materials.

Licensing and Regulatory Responsibilities

The NRC fulfills its responsibilities through a system of licensing and regulatory activities that include--

- Licensing the construction and operation of nuclear reactors and other nuclear facilities, such as nuclear fuel cycle facilities and test and research reactors, and overseeing their decommissioning
- Licensing the possession, use, processing, handling, and export of nuclear material
- Licensing the siting, design, construction, operation, and closure of low-level radioactive waste disposal sites under NRC jurisdiction and the construction, operation, and closure of the geologic repository for high-level radioactive waste



BOEING

commercial

Background Info

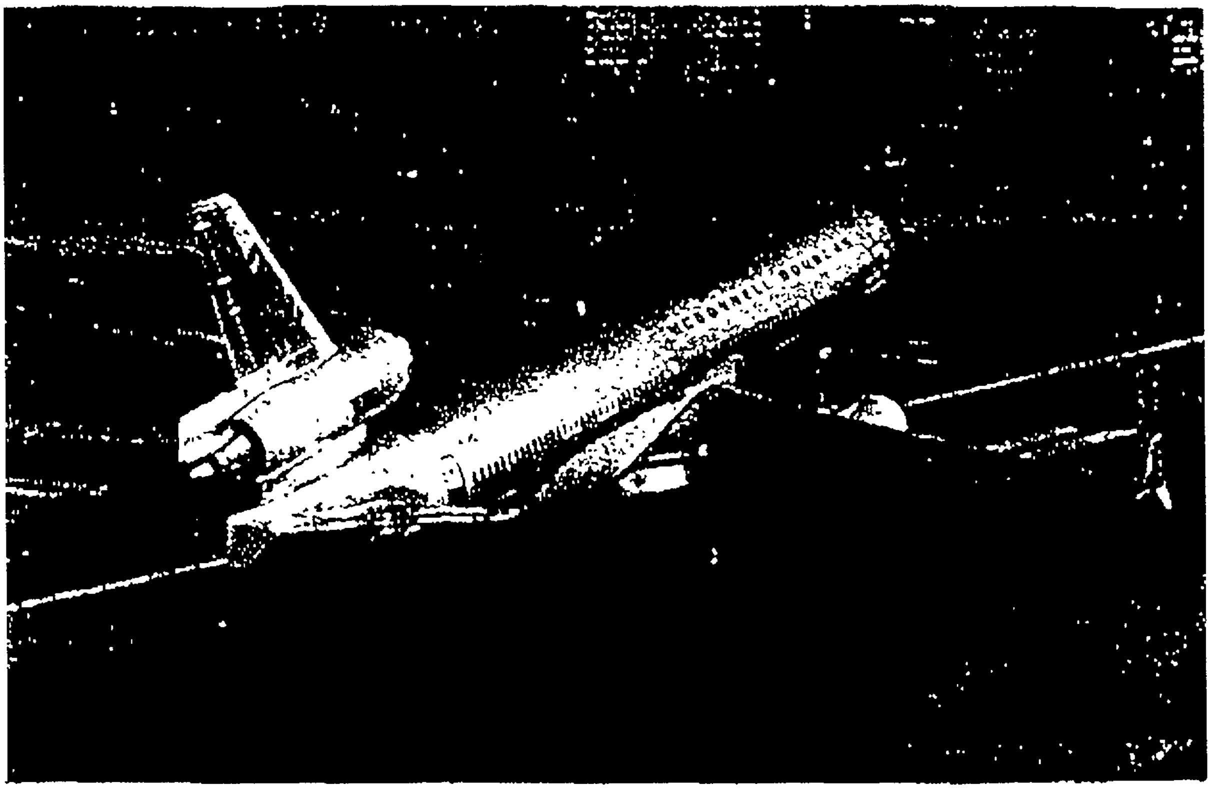
Technical Specs

SPECS EXTERIOR

Passengers	
Typical 3-class configuration	245
Typical 2-class configuration	304
Typical 1-class configuration	up to 375
Cargo	4,580 cu ft (129.6 cu m)
Engines maximum thrust	Pratt & Whitney PW4000 63,300 lb (28,713 kg)
	General Electric CF6-80C2 62,100 lb (28,169 kg)
Maximum Fuel Capacity	24,140 U.S. gal (91,380 l)
Maximum Takeoff Weight	450,000 lb (204,120 kg)
Maximum Range	6,480 statute miles (10,426 km) Typical city pairs: London-Tokyo
Typical Cruise Speed at 35,000 feet	0.80 Mach 530 mph (854 km/h)
Basic Dimensions	
Wing Span	170 ft 4in (51.9 m)
Overall Length	201 ft 4in (61.4 m)
Tail Height	55 ft 4in (16.8 m)
Interior Cabin Width	15 ft 5 in (4.7 m)

Search

The McDonnell Douglas MD-11



Some Quick Stats

Passenger Capacity: 295-410

Length: 61.6m

Wingspan: 51.7m

Engines: P&W 4000's, GE CF6-80C2D

Maximum Take-off Weight: 602-633,000lbs.

Fuel Capacity: 148,000 litres

Max. Range: 13,240km

Cruise Speed: 882km/h

Cargo Capacity: Passenger: 6,850 cubic ft. Freighter: 22,000 cubic ft.

Jun-09-00 01:53A

Attch 1

United States Department of Agriculture

Animal and Plant Health Inspection Service

Animal Damage Control

2820 East University
Gainesville, FL
904/377-[illegible]

March 4, 199[illegible]

Lt. Col. Joe Dunaway
482nd SE
Homestead ARS, FL 33039-1299

Dear Col. Dunaway,

It was a pleasure getting together with you, Flight Chief John Mitchell and Environmental Specialist Andy Bobick to review the bird situation at Homestead ARS as it relates to air traffic safety. I appreciate the opportunity to comment on the need for bird control at the base.

The cursory inspection tour of the airbase and part of the surrounding area gave me an indication of the magnitude and cause of the bird problems you are experiencing. Though I did not see large numbers of birds on the airbase, I noted several reasons for the reported excessive bird activity there. The main reason is that a county operated landfill located three miles north-northeast of the end of the runway is attracting large numbers of birds. Landfills are artificial attractants to birds because of the constant supply of available food and the large expanse of open land for loafing. As you are aware, we observed hundreds of vultures and gulls on the face of and soaring above the landfill. These two groups of birds are especially hazardous to aircraft because of their size and soaring habits. Vultures weigh from 4 to 5 pounds and will soar at great heights for several hours at a time. Gulls weigh 1 to 1.5 pounds and also soar for long periods of time. This situation is exacerbated by the fact that gulls using the landfill roost in an area just south or southeast of the airbase. According to base OPS personnel, hundreds of gulls fly through the runway area each morning and evening going to and from the landfill and roosting area. This will be hard to prevent unless gulls are deterred from using the landfill.

Ring-billed gulls were observed using a water puddle on the base. Gulls habitually use standing water on runways, parking lots and other concrete surfaces after a rain. Serious problems occur when this happens on or near runways. Gulls and wading birds will also frequent puddles in grassy areas in search of frogs, worms, insects and other small animals.

Other birds of concern at the airbase are wading birds, (e.g. egrets, herons, etc) and diving birds (e.g. cormorants, anhingas, etc.). Some of these were observed using the drainage ditch and marshy area that parallels the runway. The standing water and marshy grasses in this area should be eliminated and measures taken to keep drainage ditches open to facilitate water flow and keep water from ponding.

Another concern is the reported congregating of cattle egrets and gulls around the tractor-mowers during grass cutting. This commonly happens as birds are attracted to the large number of insects, frogs and other small prey that become available when grass is cut.

As previously stated, the county landfill located north-northeast of Homestead ARB presents a major problem for air traffic using the base. The course of the runway directs air traffic almost directly over the landfill where bird activity is very heavy. Also, bird numbers in the area will always be artificially high because of the birds attracted to the landfill. The soaring habits of most of these birds inadvertently brings them over the airbase and into air traffic lanes. Controlling bird activity at the airbase will be difficult unless bird management is also implemented at the landfill.

Because of the complexities of bird usage at Homestead ARB, and the urgent need to reduce bird activity in the aerodrome, I recommend that a biological assessment and hazard action analysis be conducted concurrently with an operational hazard control program. This program would determine pertinent facts relative to bird use at Homestead ARB such as species composition, bird numbers, daily and seasonal activity and habitat factors that attract wildlife. It would also implement new control strategies based on observations and evaluate the effectiveness of the current bird control program. An assessment/operational program would allow us to develop long-range bird management plans for Homestead ARB. This assessment/operational program would be in compliance with the BASH Reduction plan for Homestead ARB.

Another benefit that can be realized from a bird control program at Homestead ARB is controlling birds in hangers and other open buildings. Birds using hangers for roosting and nesting can cause problems when their manure and nesting debris gets into engine parts or on airplane surfaces. Bird manure, because of the high acidic content, tends to corrode the body and canopy of airplanes, and manure and debris can contaminate sensitive mechanical and electrical equipment. In fact, it was stated during our meeting when discussing this problem that repainting areas where bird manure has corroded the paint can be quite a lengthy and expensive process.

I want to make you aware that I met with the Environmental Engineer for the Florida Air National Guard, Major David Youmans, and informed him of the situation at Homestead ARB. Major Youmans said that he would recommend that the Air National Guard support any bird hazard management operations at Homestead.

As mentioned at our meeting, the USDA, ADC, Wildlife Services has Wildlife Biologists who are trained at assessing wildlife damage problems and implementing operational programs at airports and military air installations. I would be happy to provide assistance to your agency for implementing a bird hazard assessment/operational program.

I have enclosed the "Wildlife Hazard Prevention and Control" section of the ADC Airport Safety Manual. This section expounds on the principles and guidelines set forth in the BASH Reduction Plan for Homestead ARB. I have also submitted a draft Work Plan and budget for the USDA, Wildlife Services to conduct an assessment/operational program for Homestead ARB for your consideration.

Contact me should you have any questions or want to discuss the subject of this letter. I look forward to hearing from you soon. This office remains ready to serve you should you need our assistance.

Regards,

Bernice U. Constantin
State Director

Enclosure:

cc: John B. Mitchell, Flight Chief, Homestead ARB
Andrew L. Schick, Environmental Specialist, Homestead ARB
Bart Vernace, District Office FAA, Airports

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 25, 2000

Ms. Barbara Lange
Messrs. Mark Oncavage and Alan Farago
Sierra Club - Miami Group
Post Office Box 43-0741
South Miami, Florida 33243-0741

SUBJECT: TURKEY POINT UNITS 3 AND 4 - HOMESTEAD AIR FORCE BASE PROPERTY DISPOSAL

Dear Sierra Club Representatives:

This is in response to your letter of February 24, 2000, as supplemented by letters dated March 3 and 27, and June 9, 2000, from Mark Oncavage. The above letters contained comments regarding the proposed commercial operations at the Homestead Air Force Base (HAFB) site, and the potential risk to Turkey Point Units 3 and 4 from these oerations. You requested that the U.S. Nuclear Regulatory Commission (NRC) staff address these comments in its safety assessment (SA) of the above subject. By letter dated April 26, 2000, the staff informed you that these comments will be addressed in the staff's SA or in separate correspondence. Additionally, as stated in our letter to you dated April 4, 2000, we have added your individual names to our distribution for the documents related to this subject sent by the NRC to FPL and the U.S. Air Force (USAF).

The staff issued its SA on this subject by letter dated June 19, 2000, to Thomas F. Plunkett, President of the Nuclear Division, Florida Power and Light Company (FPL). Sierra Club's (SC's) comments stated in the February 24, 2000, letter regarding the crash risk from bird strikes and the foreign aircraft operations were addressed in the SA. Also, the SA, as well as our May 26, 2000, letter to Douglas J. Heady, USAF, provided the reason (i.e., the lack of information, at this time, on how spacecrafts would operate from the spaceport) for not addressing Mr. Oncavage's comments as stated in his letter dated March 3, 2000, related to the proposed spaceport (i.e., Comments #4, 5, 6, 7, 8, 13, 14, 15, and 18). Mr. Oncavage's Comments #25, 28, 29 30, and 34 are addressed herein. It should be noted that Mr. Oncavage's April 17, 2000, letter requested the USAF and the Federal Aviation Administration (FAA) to address the remaining comments (i.e., Comments #1, 2, 3, 9, 10, 11, 12, 16, 19, 20, 21, 22, 23, 26, and 32 to be addressed by the USAF, and Comments #17, 24, 27, 31, and 33 to be addressed by FAA).

In the June 9, 2000, letter, Mr. Oncavage stated with regard to the assessment of the potential risk to Turkey Point of the proposed spaceport that the "Sierra Club, Miami Group realizes very little is currently known about the proposed spaceport operations." However, he requested that a detailed statement by the "responsible official" be made of any adverse environmental effects which cannot be avoided should the proposal be implemented. Mr. Oncavage stated that this request is in accordance with the National Environmental Policy Act of 1969 (NEPA). Mr. Oncavage believes that this requirement has not been met.

The USAF and the FAA are the Federal agencies preparing the Supplemental Environmental Impact Statement. This comment should be addressed by them. In this regard, by our letter of July 18, 2000, to Mr. Heady, we forwarded this comment to the USAF. Also, in the June 9, 2000, letter, Mr. Oncavage discussed the Mission Statement of the NRC which reads in part

". . . to ensure adequate protection of the public health and safety. . . ." He added that "If the NRC cannot demonstrate adequate public health and safety concerning Turkey Point operations in relation to the spaceport operations, then again the assessment must be decisively negative." The staff understands that for a spaceport there is a need for a separate Environmental Impact Statement which focuses on this issue. Therefore, the staff is not able to make a safety finding on the adequacy of the spaceport operations until sufficient information is available. At that time, the staff will ensure that its finding meets the Commission regulations and that there is reasonable assurance that the activities can be conducted without endangering the health and safety of the public. The staff is of the opinion that it is fulfilling its Mission Statement by not making a finding at this time.

The excerpt below taken from the June 19, 2000, SA, and the subsequent paragraphs discuss each of the remaining comments.

<u>Excerpt from the staff's SA of June 19, 2000</u>

> Taking into account the above effects of potential bird strikes and the adjustment for foreign carriers from Latin America, the estimated aircraft crash frequency is increased by a factor of 1.22, changing the 3.63×10^{-7}/year to 4.43×10^{-7}/year which meets the SRP [Standard Review Plan] 3.5.1.6 acceptance criterion of about 10^{-7}/year. In addition, FPL's estimate is within the guidelines of SRP 2.2.3, wherein the acceptance criterion of 10^{-6}/year is applicable if reasonable qualitative arguments can be made to show that the realistic probability estimate is lower. Actual configurations or situations at the plant for which qualitative arguments can be made regarding the fact that they may decrease the risk estimate, do not readily lend themselves to modeling and analysis due to the complex nature of the configurations or situations. Therefore, sound engineering judgment is utilized in determining the acceptance criteria for the probability estimate. Specifically, FPL has qualitatively identified some conservatism inherent in its analysis which indicates that the actual risk from on-site aircraft crashes is lower than the estimate of 3.63×10^{-7}/year. For example, FPL notes that shielding by adjacent structures or heavy machinery, as well as the canal and the adjacent fossil units are not fully credited. Moreover, the structural capability of safety-related structures (e.g., containment building) against missile impacts has not been taken into account when considering conditional core damage probability and conditional containment failure probability. Based on its review, the staff concludes that the risks associated with on-site aircraft crashes for Turkey Point are acceptable.
>
> It should be noted, however, that the margin between the estimated aircraft crash frequency and the acceptance guidelines of SRP 3.5.1.6 is relatively small. Hence, the staff believes that FPL would need to monitor the aircraft operations at the proposed airport on a periodic basis. Should the actual aircraft operations exceed those projected for the year 2014, a reassessment of the aircraft risk would need to be made. It is necessary for the licensee to inform the staff of its plans to monitor the air traffic and flight tracks at the HAFB site on a periodic basis after it becomes operational as a commercial airport, and to reassess the risk as stated above.
>
> Regarding the potential for the base to be used as a spaceport for handling vehicle launches and landings, the licensee has not performed an analysis of the associated risks. FPL indicates that the potential impact is bounded by the impacts associated with a commercial airport. However, with no supporting data or analysis, the staff cannot, at this time, make a finding of acceptability regarding potential spaceport operations. Hence, if the base conversion leads to the implementation of spaceport operations, FPL would need to address the associated risk by providing a risk assessment for staff review and evaluation.

SC's comment on public record (February 24, 2000, letter)

> . . . . a significant amount of information seems to be missing from the public record including the Draft Supplemental Environmental Impact Statement [DSEIS].

Response

In accordance with 10 CFR 2.790 of the NRC's "Rules and Practice," a copy of this letter is available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of the NRC's document system (the Agencywide Documents Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room). Our understanding from Mr. Heady is that the DSEIS was widely distributed in December 1999, and at the public hearings that the USAF and FAA held in February 2000 in the vicinity of the HAFB site. Also, by letter dated June 8, 2000, Mr. Heady sent a copy of the DSEIS to the NRC Document Control Desk and, therefore, it is now available in ADAMS with an accession number ML003723827.

SC's comment on the equations used to estimate the aircraft crash probability (Comment #1 of February 24, 2000, letter)

> FP&L's [sic] response (ref. 4 and ref. 7) utilizes formulae that appear to be inconsistent with NUREG-0800 [SRP 3.5.1.6].

Response

The NRC staff's SA stated that FPL used the Department of Energy (DOE) methodology which is equivalent to the SRP methodology. The SRP does not require the use of the formulae stated in Section 3.5.1.6. The staff accepts equivalent methodologies in the review of documents submitted by its licensees.

SC's comment on calculations (Comment #2 of February 24, 2000, letter)

> We request that a line-by-line, calculation-by calculation probability analysis . . . be included in the SER, as specified by NUREG-0800.

Response

The SRP does not specify that a line-by-line, calculation-by-calculation be included in the staff's SA. The staff's SA dated June19, 2000, conformed to the SRP recommendation for addressing safety issues and is in congruence with the standards that have normally been followed by the staff for SAs and evaluations.

SC's comment on flights to all the countries of the Caribbean, Central America, and South America (Comment #3 of February 24, 2000, letter)

> . . . by 2015, of these 51,220 operations, more than 80% are estimated to be Latin American . . . .

Response

The staff's SA dated June 19, 2000, addressed this concern on page 3. This results in an increase of the risk probability by about 5%.

SC's Comment on the distance between HAFB and Turkey Point (Comment #4 of February 24, 2000, letter)

> . . . maps and diagrams appear to show that portions of Homestead Air Force Base lie within a 5-mile radius of the plant . . . .

Response

The distance criterion is based on the proximity of an airport runway rather than the property boundary. In any case, the distance between the Turkey Point facility and the runway is a factor that is accounted for when using the DOE or the SRP methodology. In addition, in response to an NRC comment, FPL stated in its letter of May 1, 2000, that the estimated distance from the Turkey Point site (Units 1, 2, 3 and 4) to the HAFB runway is 4.9 miles with an estimated uncertainty of ±0.2 miles.

SC's comment on the flight path over Turkey Point (Comment #5 of February 24, 2000, letter)

> In an addendum to the DSEIS, on the flight path chart named "HST EAST FLOW," it appears that the following flight paths over Turkey Point . . . . How do these over flights meet acceptance criteria, II.1.c of NUREG-0800?

Response

The listed flights are part of the total air activity in the vicinity of the Turkey Point site that is addressed in assessing aircraft risk for the site. The first step is the application of the proximity/operations screening criteria of SRP 3.5.1.6, Part II. If these are met, the risk is considered to be within the acceptance criteria. If not, appropriate air crash estimates are made to estimate the risk. Specific equations are used to estimate aircraft operations in connection with an airport, as well as aircraft activities associated with commercial and military air routes.

SC's comment on the critical structure for risk assessment (Comment #6 of February 24, 2000, letter)

> FP&L [sic] lists the critical structures for risk assessment . . .

Response

As shown in the staff's SA (please refer to the SA excerpt stated above), the aircraft crash risk is acceptably low. SRP Section 3.5.1.6 states that the safety-related structures, systems, and components (SSC) to be considered with respect to the screening criteria include those described in the Appendix to Regulatory Guide (RG) 1.117, "Structures, Systems, and Components of Light-Water-Cooled Reactors to be protected Against Tornadoes." Other safety-related SSC, which may not be included in RG 1.117, will be considered on a case-by-case basis. Some of the items listed in this comment such as all firefighting equipment, the fuel tanks for Turkey Point Units 1 and 2, and the switchyard, are not classified as safety-related equipment. The fuel tanks for the Turkey Point Unit 4 diesel generators (DGs) are housed inside the Unit 4 DG building. The day tanks for the Unit 3 DGs are housed inside the Unit 3 DG building. The 7-day tank for Unit 3 DGs is located outside the DG buildings and is classified as safety-related. However, the area of the tank is very small in relation to the total area that was considered. Hence, its inclusion in the estimated total target area would not change the total area significantly.

SC's comment on the Brookhaven National Laboratory (Comment #7 of February 24, 2000, letter)

> In a study by Brookhaven National Laboratory (ref. 8, p. 4-2) the worst-case scenario of an accident at a spent fuel pool . . . .

Response

As shown in the staff's SA (please refer to the SA excerpt stated above), the aircraft crash risk is acceptably low. The SRP does not require addressing this structure if the risk is acceptable.

SC's Comment on bird strike hazards (Comment #8 of February 24, 2000, letter) and Mr. Oncavage's comment on bird strikes (Comment #25 of March 3, 2000, letter), also Response 4 from Mr. Oncavage's letter dated June 9, 2000

> Attached is a copy of a letter from Bernice U. Constantin . . . .

Response

As shown in the SA excerpt above, the bird strike effect was considered and led to an increase of the crash risk. The combined effect of potential bird strikes and the adjustment for foreign carriers from Latin America led to an increase of 22% of the crash risk.

Mr. Oncavage's comment on air crash probability (Comment #28 of March 3, 2000, letter), also Response 5 from Mr. Oncavage's letter dated June 9, 2000

> How does the NRC quantify the air crash probabilities for Turkey Point for air carriers from the Caribbean, Central American, and South American Countries?
>
> Increasing the crash frequency by a factor of 10 to account for 80% of operations . . . .

Response

To address the effect of South American flights, the crash frequencies for commercial aviation presented in SRP 3.5.1.6 were increased by a factor of 10 for all commercial aviation using the Homestead airport. On this basis, the factor of 10 is more than sufficient to account for South American flights which are projected to be 80% of the total.

Mr. Oncavage's comment on the consequences of a worst-case accident (Comments #29 and #30 of March 3, 2000, letter), also Responses 2 and 3 from Mr. Oncavage's letter dated June 9, 2000

> What would be the consequences of a worst-case accident crashing into the Turkey Point control building?
>
> What would be the consequences of a worst-case accident crashing into the Turkey Point spent fuel pool buildings?
>
> The twin 400' chimneys need to be factored . . . .
>
> Omitted from the target data . . . .

Response

As shown in the staff's SA (please refer to the excerpt stated previously), the aircraft crash risk is acceptably low. Actual configurations or situations at the plant for which qualitative arguments can be made regarding the fact that they may decrease the risk estimate, do not readily lend themselves to modeling and analysis due to the complex nature of the configurations or situations. Therefore, sound engineering judgment is utilized in determining the acceptance criteria for the probability estimate. Specifically, FPL has qualitatively identified some conservatism inherent in its analysis, which indicates that the actual risk from on-site aircraft crashes is lower than the estimate of 3.63×10^{-7}/year. For example, FPL notes that shielding by adjacent structures or heavy machinery, as well as the canal and the adjacent fossil units, are not fully credited. Moreover, the structural capability of safety-related structures (e.g., containment building) against missile impacts has not been taken into account when considering conditional core damage probability and conditional containment failure probability. Based on its review, the staff concludes that the risks associated with on-site aircraft crashes for Turkey Point are acceptable. The low crash risk probability provides reasonable assurance that no release exceeding 10 CFR Part 100 will occur.

Mr. Oncavage's comment on statistical probability (Comment #34 of March 3, 2000, letter)

> What is the NRC's statistical probability of an airplane crash at Turkey Point from the Homestead Airport?

Response

The FPL's statistical probability is as stated in the staff's SA, which is 4.43×10^{-7}/year. The staff finds that the methodology used to generate this probability is acceptable.

If you have any comments regarding this matter, please contact Kahtan Jabbour, Project Manager for the Turkey Point Plant. Mr. Jabbour may be contacted at 301-415-1496.

Sincerely,

Richard P. Correia

Richard P. Correia, Chief, Section 2
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Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

cc: See next page

Ref: Homestead AFB

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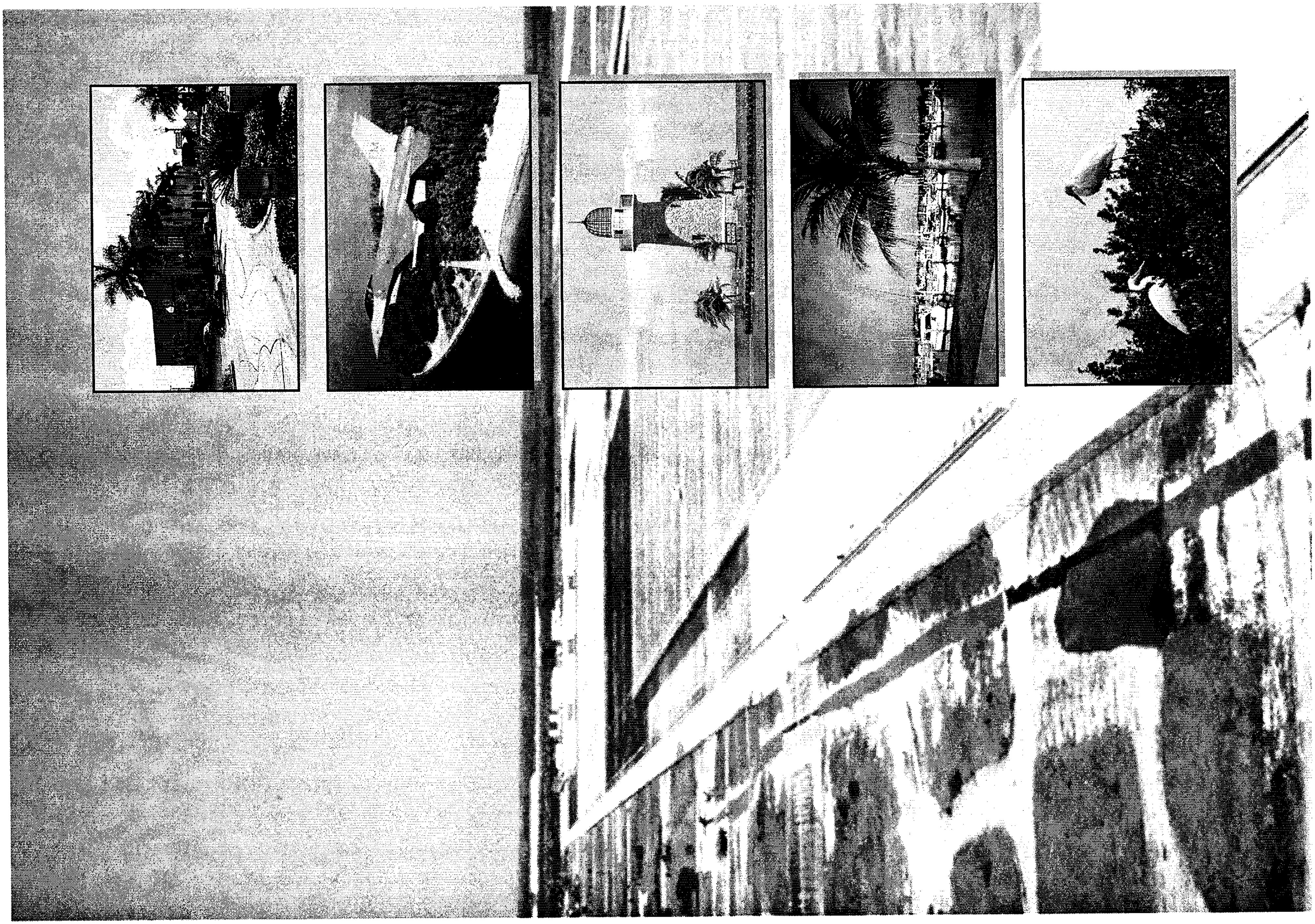
J ESSENTIAL FISH HABITAT ASSESSMENT



ESSENTIAL FISH HABITAT ASSESSMENT FOR THE DISPOSAL OF PORTIONS OF FORMER HOMESTEAD AIR FORCE BASE, FLORIDA

Submitted to:

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Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Submitted by:

Air Force Base Conversation Agency
United States Air Force

August 2000

ESSENTIAL FISH HABITAT ASSESSMENT FOR THE DISPOSAL OF PORTIONS OF FORMER HOMESTEAD AIR FORCE BASE, FLORIDA

1. PROJECT DESCRIPTION

The project is the disposal of portions of former Homestead Air Force Base (AFB) in southern Florida. Homestead AFB was identified for realignment by the Defense Base Realignment and Closure Commission in 1993. The underlying purpose of the Proposed Action and other alternatives is to fulfill the requirement of disposing of property determined to be excess to military needs. The Air Force has determined that 1,631.8 acres at former Homestead AFB are excess to its needs and surplus to the needs of the federal government. The Air Force seeks to dispose of this surplus property in a manner that supports local community plans for economic revitalization of South Florida and protects Biscayne Bay and the nearby national parks (**USAF/FAA 1999**).

The Proposed Action is to transfer 1,631.8 acres of surplus property at former Homestead AFB to Miami-Dade County for use as a commercial airport. In accordance with the Defense Base Closure and Realignment Act (DBCRA), Miami-Dade County has served as the Local Redevelopment Authority (LRA) responsible for formulating a reuse plan for the former base property. The disposal and reuse alternatives under consideration are described in a Draft Supplemental Environmental Impact Statement (SEIS) prepared by the U.S. Air Force and Federal Aviation Administration (**USAF/FAA 1999**).

Other reasonable alternatives are also being considered. They include a Commercial Spaceport alternative and a Mixed Use alternative.

During scoping for this action, the Air Force received two proposals from prospective commercial space launch vehicle operators to use former Homestead AFB as a location for launching missions. This alternative reflects those proposals in a plan to develop a Commercial Spaceport for Reusable Launch Vehicles. The new launch vehicles described in these proposals are currently under development and are being designed to take off and land horizontally like airplanes. It is anticipated that these vehicles would be able to use the existing runway at the former base (**USAF/FAA 1999**).

The Mixed Use alternative reflects the type of reuse that might be expected on surplus property if it were not converted to an airport or spaceport. In that event, the Air Force would retain the 915 acres comprising the airfield for continued military and other government use. This would leave approximately 717 acres of surplus land available for disposal and reuse. A market study was conducted to identify the non-aviation development potential of this property, referred to as the Market-Driven Mixed Use alternative. In addition, two proposals were received by the Air Force from the Collier Resources Company and the Hoover Environmental Group and included in the Draft SEIS. Those proposals were recently combined into a single plan for non-aviation-related redevelopment of the disposal property, referred to as the Collier-Hoover proposal. This proposal is a comprehensive development plan with a mixture of commercial, recreational, and commercial/industrial uses.

For all alternatives, including the Proposed Action, the action being taken by the Air Force is transfer of title to surplus federal property. Actual future development and use the property will be undertaken by the property recipient.

2. EFFECTS ON ESSENTIAL FISH HABITAT

The potential environmental impacts of the Proposed Action and other alternatives have been analyzed and reported in the Draft SEIS. The analysis found that the potential for the project to affect essential fish habitat (EFH) is related to changes in water inputs to Biscayne Bay and in nutrients and toxic chemicals. These changes would be caused by development on site at the former base (and resulting increase in impervious surface and stormwater runoff) and by aircraft operation associated with the Proposed Action. In addition, the on-site development can be expected to stimulate a certain amount of secondary growth and development off site.

Estimated changes in water inputs would be primarily related to stormwater management practices on and off the former base. With the exception of the Market-Driven Mixed Use alternative, all the alternatives are expected to involve a comprehensive stormwater management system for on-site development that would reduce surface water discharges from the site into Biscayne Bay. No comparable system has been identified for the secondary development off site, which is expected to occur incrementally in scattered locations around the region.

Estimated changes in loadings of nutrients and toxic chemicals due to the Proposed Action and other alternatives would also be related to the extent of on-site and off-site development, to stormwater management practices, and to the kinds of activities that would occur on the former base. There would be no waste discharge or physical alteration of Biscayne Bay associated with the Proposed Action or other alternatives.

Stormwater discharges from the former base and the surrounding area to Biscayne Bay are currently through canals. On-site stormwater is discharged through Military Canal, and stormwater from areas immediately surrounding the former base discharge through Princeton and Mowry Canals. Canal discharge to the bay is controlled by structures that open when canal water levels exceed bay water levels by given amounts and close when canal water levels are more nearly equal to those of the bay. This results in pulses of fresh water that are generally nutrient rich and contain some toxic chemicals at levels that generally comply with Florida State Water Quality Criteria.

Unrelated to redevelopment of the surplus property at former Homestead AFB, studies have been ongoing to characterize contaminated sediments in Military Canal. There is a potential for those sediments to become resuspended, perhaps during severe storm events, and subsequently be discharged to Biscayne Bay.

3. EFH IN BISCAYNE BAY

EFH in Biscayne Bay comprises seagrasses, estuarine mangroves, intertidal flats, estuarine water column, live/hard bottoms, and coral reefs. Seagrasses occur in a broad band near the western and eastern (Key) shores of Biscayne Bay and surround a relatively large area of live/hard bottom. Seagrass areas have been designated as an EFH Area of Particular Concern for postlarval and juvenile shrimp and red drum and juvenile gray snapper. Intertidal flats occur in a narrow band shoreward of the seagrasses, and estuarine mangroves occur as a shoreline fringe, particularly along the western edge of the bay. Once estuarine, Biscayne Bay is now largely marine in character, although reduced salinities occur following major storms or extended periods of rainfall. Isolated coral patches occur on the hard bottom areas of the bay, but coral reefs occur only seaward of the fringing keys on the eastern boundary of the bay.

4. MANAGED SPECIES IN BISCAYNE BAY

Fisheries management plans have been developed for the following species or species groups that occur in Biscayne Bay: shrimp, red drum (*Sciaenops ocellatus*), snapper/grouper, Spanish mackerel (*Scomberomorus maculatus*), spiny lobster (*Panulirus argus*), and sharks. The most common penaeid shrimp in the bay is the pink shrimp (*Penaeus duorarum*), but the brown shrimp (*Penaeus astecus*) also occurs there (**South Atlantic Fishery Management Council 1998**). Of the snapper/grouper group, the species that occurs most frequently is the gray snapper (*Lutjanus griseus*). Most of the other species in this group frequent deeper water around coral reefs throughout the majority of their life cycle. Sharks known to occur in Biscayne Bay include the nurse (*Ginglymostoma cirratum*), bonnethead (*Sphyrna tiburo*), lemon (*Negaprion brevirostris*), bull (*Carcharhinus obscurus*), and black tip (*C. limbatus*).

Shrimp

The following information is taken primarily from South Atlantic Fishery Management Council (**1998**). Pink shrimp are found most commonly on hard sand and calcareous shell bottom. Pink shrimp apparently spawn at depths between 3.7 and 15.8 m. Off eastern Florida, peak spawning activity seems to occur during summer. Pink shrimp move into estuaries during late spring and early summer, beginning in April and early May. If they behave similar to white shrimp, they move out of estuaries to deeper waters from August to December. Smaller pink shrimp may remain in estuaries during winter.

Pink shrimp occur from southern Chesapeake Bay to the Florida Keys. Along the Atlantic Coast of the U.S., the pink shrimp occurs in sufficient abundance to be of major commercial significance only in North Carolina. Pink shrimp are most abundant in waters of 11–37 m and are common in the estuaries and shallow marine waters surrounding southern Florida. Spawning apparently occurs in water greater than 10 m off the Dry Tortugas. Larvae are swept southwesterly into the Florida Current by way of the Loop Current, and are carried northeasterly along the outer edge of the Florida Reef Tract.

Brown shrimp appear to prefer muddy or peaty bottoms rich in organic matter and decaying vegetation in inshore waters and, as adults, may also be found in areas where the bottom consists of mud, sand, and shell. Brown shrimp appear to spawn in water greater than 13.7 m, with the greatest percentage of ripe females at 45.7 m. Spawning season for brown shrimp is uncertain, although there is an influx of postlarvae into estuaries during February and March. Brown shrimp postlarvae appear to overwinter in offshore bottom sediments.

On the Atlantic Coast, brown shrimp occur from Martha's Vineyard to the Florida Keys, with highest densities off the coast of the Carolinas, Georgia, and northern and central Florida. Breeding populations apparently do not occur north of North Carolina.

Essential fish habitat for both species includes inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all interconnecting water bodies. Inshore nursery areas include tidal freshwater, estuarine, and marine emergent wetlands (e.g., intertidal marshes); tidal palustrine forested areas; mangroves; tidal freshwater, estuarine, and marine submerged aquatic vegetation (e.g., seagrass); and subtidal and intertidal non-vegetated flats.

Appropriate habitat for both species in Biscayne Bay include the mangrove fringe, seagrass beds, and subtidal non-vegetated flats. The redevelopment of former Homestead AFB could result in increased nutrient inputs from off-site secondary development near the former base and increased nitrogen deposition from aircraft emissions. Increased nutrients would probably not affect the coastal mangroves or the non-vegetated bottom habitats of the bay, but could contribute to epiphytic growth on nearshore seagrasses, reducing their productivity and possibly reducing their viability. The relatively small increase in nutrient inputs—estimated at less than 2 percent of current surface water nutrient inputs to southern Biscayne Bay, an amount well within the expected annual variation of inputs—suggests that overall impact on the seagrass beds is not likely to be discernible and shrimp populations would probably not be appreciably affected. The largest increase in nutrient inputs would occur with the Proposed Action, with other alternatives contributing less. With anticipated population growth in the area unrelated to redevelopment of the former base, however, nutrient inputs could increase by almost double those associated with the Proposed Action.

Similarly, while stormwater discharges of toxic chemicals from the former base are projected to decrease under all alternatives except the Market-Driven Mixed Use alternative, secondary development would lead to increased toxic chemical inputs from stormwater runoff. Because most of the toxic chemicals would attach to sediments and be deposited relatively near canal mouths, the nearshore mangrove fringe and seagrasses could become less desirable as shrimp habitat. Offshore effects are likely to be small. As with nutrients, changes in inputs of toxic chemicals would be primarily related to increases in water flows, which would be less than 1 percent of current canal inputs to southern Biscayne Bay.

Mitigation of potential impacts from increased nutrient and toxic chemical inputs have already been incorporated into on-site stormwater management plans for the Proposed Action and all alternatives except the Market-Drive Mixed Use alternative. The Air Force is presently conducting a Feasibility Study to determine remediation actions for Military Canal, which could eliminate the potential for resuspended contaminants from being discharged to Biscayne Bay.

Potential mitigation measures for reducing stormwater discharges generated by off-site secondary development could include aggressive stormwater management (retention and possible treatment) on all developed lands in southern Miami-Dade County. These types of controls would have to be implemented by the South Florida Water Management District and Miami-Dade County's Department of Environmental Resources Management, and could not be implemented by the Air Force or FAA.

Red Drum

Red drum spawn in the ocean along beaches and in the vicinity of inlets and passes and possibly in high salinity estuaries. Eggs and larvae are carried through tidal and current movement into estuarine systems. Juveniles remain in the estuarine system through perhaps the first two years, and then move to more offshore areas. In North Carolina, juveniles are found in abundance in seagrass flats inside barrier islands.

Red drum juveniles are abundant in the Indian River Inlet and the St. Johns River in Florida, but are rare in Biscayne Bay. This is presumably because of the larval preference for lower salinity waters, which are only present intermittently in the bay, and the tendency for juveniles to stay in one area for up to two years. In general, juveniles move to higher salinity waters as they mature, but it is not clear how this general trend would be evidenced in the relatively high salinity of Biscayne Bay. They may then move to deeper waters outside of the bay.

Red drum essential fish habitat includes the following habitats to a depth of 50 meters offshore: tidal freshwater; estuarine emergent vegetated wetlands (flooded salt marshes, brackish marsh, and tidal creeks); estuarine scrub/shrub (mangrove fringe); submerged rooted vascular plants (sea grasses); oyster reefs and shell banks; unconsolidated bottom (soft sediments); ocean high salinity surf zones; and artificial reefs. The area covered includes Virginia through the Florida Keys. In Biscayne Bay, the areas most likely to be inhabited by red drum include the mangrove fringe and seagrasses.

With its current high salinity regime, Biscayne Bay is apparently only marginal habitat for juvenile red drum, with the smallest fish probably using the nearshore mangroves and seagrasses and larger fish moving to the deeper seagrass beds inside and outside of the keys that form the eastern boundary of the bay. If this is the case, then red drum recruitment could be limited by lowered nearshore seagrass productivity caused by increased nutrient inputs associated with the Proposed Action and other alternatives. The limitation is not likely to be measurable, because discernible changes in seagrasses are not expected with the magnitude of estimated changes in nutrient inputs to the southern bay (about 2 percent of current inputs). Toxic chemical inputs could potentially reduce the abundance of prey species such as copepods, mysids, and fish that form the dominant prey of smaller juveniles. Again, the magnitude of estimated changes is small, on the order of 1 percent of current inputs to the southern bay. Mitigation of these impacts would be the same as those described above for shrimp.

Snapper/Grouper

The gray snapper occurs in marine and estuarine waters from North Carolina and Bermuda through Brazil. Spawning activity occurs offshore and peaks during the summer and early fall. Eggs and larvae are planktonic and occur offshore.

Juvenile gray snapper are euryhaline and occur at salinities from 0-37 ppt. Gray snapper are carnivorous at all life stages. Juveniles primarily prey on crustaceans, but can also consume fish, mollusks and polychaetes. Adults are typically nocturnal predators, consuming mostly fish, but also taking shrimp and crabs. Adults may show seasonal spawning migrations.

In the Biscayne Bay area, newly settled stages commonly occur in grassbeds, are consistently absent from mangrove and hard bottom habitats, and are uncommon or rare from all habitats exceeding 5 m in depth. Early juvenile stages (2.5–7 cm) were more widely distributed, particularly on the habitat scale, occurring among a variety of hard structures as well as mangroves and grass beds.

Early stages occur in estuaries and shallow marine areas. Bottom types of high value include seagrass flats; soft marl bottoms, fine marl mud with shell and rock outcrops; mangrove roots; hard bottom structures; and shallow basins with seagrasses adjacent to mud banks. Adults are primarily marine and occur in deeper waters than juveniles, but can occur in estuaries and rivers. Adults are euryhaline, ranging from 0-47 ppt waters. Bottom types of high value for adults are diverse and include coral reefs and hard bottom offshore, ledges of channels, artificial structures, mangroves and grass beds, alcyonarians, and sponges.

Essential fish habitat for the gray snapper that occur in Biscayne Bay include nearshore hard bottom areas, mangrove habitat, and seagrass habitat. The effects of the Proposed Action and alternatives on these habitats and potential mitigation measures would be the same as described above for shrimp.

Spanish Mackerel

Spanish mackerel are fast swimming fish that inhabit the coastal ocean waters of the eastern U.S. and the Gulf of Mexico. They live from five to eight years, and females spawn by age two. Older fish may attain a weight of several pounds. Along the east coast, Spanish mackerel range from the Florida Keys to New York and occasionally to New England. These fish winter off Florida and move northward to North Carolina in early April and to New York in June. Later in the year, as waters cool, there is a reverse southern migration and return to Florida waters.

Juvenile Spanish mackerel are depicted as common in Biscayne Bay from May through July. Essential fish habitat for Spanish mackerel includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf stream shoreward, including Sargassum. Essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights. In addition, it includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagics (for example, in North Carolina this would include all Primary Nursery Areas and all Secondary Nursery Areas). Biscayne Bay contains essential fish habitat because of the density of prey species that are taken by juveniles.

The impacts of the Proposed Action and other alternatives on Spanish mackerel essential fish habitat and potential mitigation measures would be the same as described above for shrimp.

Spiney Lobster

Spiny lobster begin their existence in the Keys as larvae that arrive on oceanic currents. As planktonic larvae, they pass through 11 life stages in more than six months. They then metamorphose into a transitional swimming stage (puerulus) that is found along Florida's southeast coast all year long.

Pueruli travel through channels between the Keys and enter nursery areas in Florida Bay and the Gulf, where they preferentially settle into clumps of the red alga *Laurencia*. In seven to nine days, they metamorphose into juveniles and take a solitary residence in the algal clumps for two to three months.

When juvenile spiny lobster reach a carapace length of 15 to 16 mm, they leave the algal clumps and reside individually within rocky holes, crevices, coral, and sponges. They remain solitary until carapace length reaches approximately 25 to 35 mm, when they begin congregating in rocky dens. They remain in these nurseries for 15 months to two years.

Adult lobsters move to deeper waters in the coral reef environment and move to the offshore reef to spawn.

Essential fish habitat for spiny lobster includes nearshore shelf/oceanic waters; shallow subtidal bottom; seagrass habitat; unconsolidated bottom (soft sediments); coral and live/hard bottom habitat; sponges; algal communities (*Laurencia*); and mangrove habitat (prop roots). In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse spiny lobster larvae.

Areas that meet the criteria for essential fish habitat-habitat areas of particular concern for spiny lobster include Florida Bay, Biscayne Bay, Card Sound, and coral/hard bottom habitat from Jupiter Inlet through the Dry Tortugas.

Because of its reliance on seagrass, the impacts of the Proposed Action and other alternatives on essential fish habitat for the spiney lobster would be the same as described for shrimp. Hard bottom habitats, because of their distance from nutrient and toxic chemical inputs, are unlikely to be affected by changes in discharge associated with the Proposed Action and other alternatives. Potential mitigations for spiney lobster essential fish habitat would be the same as described for shrimp.

Sharks

The managed sharks that occur in Biscayne Bay are classified by National Marine Fisheries Service (NMFS) as Coastal Sharks, and all but the bonnethead are classified as large coastal sharks. The following information is taken from National Marine Fisheries Service (1999).

Adult sharks usually congregate in specific areas to mate, and females travel to specific nursery areas to pup. Nurseries are discrete geographic areas, usually in waters shallower than those inhabited by adults. Frequently, nursery areas are in highly productive coastal or estuarine waters where abundant small fishes and crustaceans provide food for the growing pups. These areas also may have few large predators, thus enhancing the chances of survival of young sharks. In temperate zones, the young leave the nursery with the onset of winter; in tropical areas, young sharks may stay in the nursery area for a few years.

Coastal species inhabit estuaries, the nearshore and waters of the continental shelves, and possibly wetland tidal creeks.

Blacktip Sharks. The blacktip shark is a fast moving shark that is often seen at the surface, frequently leaping and spinning out of the water. It often forms large schools that migrate seasonally north-south along the coast. Neonate blacktip sharks are found in very shallow waters, juvenile blacktip sharks inhabit a variety of coastal habitats, and adults are found in both coastal and oceanic waters.

Blacktip sharks have been captured in salinities ranging from 15.8 to 37.0 ppt. Other factors must contribute significantly to the distribution of sharks, and some likely parameters include light levels, pressure, substrate, dissolved oxygen, and probably others.

Blacktip sharks have been reported in Bulls Bay, South Carolina and in Charlotte Harbor, Florida, by Hueter. In South Carolina, the sharks are found over shallow muddy bottoms, while in Florida, blacktip sharks are found over shallow, clear seagrass beds.

As temperatures warm in the spring or summer, blacktip sharks move north along the coast. Pups (neonates) are born in specific areas (e.g., estuaries or coastal habitats), and they typically remain in the same general area until the arrival of cooler temperatures in the late fall or early winter. At that time, they typically move offshore and/or southward, although the extent of these movements is not well defined. The following year, their seasonal movements change, more closely mimicking the migrations of the adults, until they join the adult migrations in subsequent years.

No essential fish habitat for the blacktip shark has been designated in Biscayne Bay, but essential fish habitat is included in Florida Bay and west of the Florida Keys.

Bull Sharks. The bull shark is a large, shallow water shark that is cosmopolitan in warm seas and estuaries. It often enters fresh water and may penetrate hundreds of kilometers upstream.

Nursery areas are in low-salinity estuaries of the Gulf Coast and the coastal lagoons of the east coast of Florida. Off the Florida West Coast, neonates were found in Yankeetown, Tampa Bay, and Charlotte Harbor from May to August. The neonates were found in temperatures of 28.2–32.2°C, salinities of 18.5–28.5 ppt. Juveniles have been found off the Florida West Coast in temperatures of 21.0–34.0° C, salinities of 3.0 to 28.3 ppt, and dissolved oxygen (DO) of 3.7–8.4 ml/l. Generally, bull sharks, while present in Biscayne Bay, would not use this area as a primary nursery ground.

Biscayne Bay is included in essential fish habitat for late juvenile/subadult bull sharks: shallow coastal waters, inlets and estuaries in waters less than 25 m deep, from Savannah Beach, Georgia at 32°N southward to the Dry Tortugas, Florida. Presumably, the habitat preference for the bull shark is the seagrass areas of the bay, and impacts on this habitat are described above for shrimp.

Lemon Sharks. The lemon shark is common in the American tropics, inhabiting shallow coastal areas, especially around coral reefs. It is reported to use coastal mangroves as some of its nursery habitats, although this is not well documented in the literature. The primary population in continental U.S. waters is found off south Florida, although adults stray north to the Carolinas and Virginia in the summer. Its nurseries are in shallow waters around mangrove islands off tropical Florida and the Bahamas. Lemon shark neonates have been found in Tampa Bay, Florida during May, at temperatures of 22.0° to 25.4° C, salinities of 26.8 to 32.6 ppt, and DO of 5.9 to 9.6 ml/l. Juveniles have also been found over a wider area off western Florida and in a wider range of temperatures and salinities.

Biscayne Bay has been designated essential fish habitat for all life stages of the lemon shark (neonates/early juveniles, late juveniles/subadults, and adults). Minimal impacts are expected from the Proposed Action and other alternatives on mangroves and coral reefs, but small, probably indiscernible impacts on seagrasses could occur through nutrient discharge. Available information, however, indicates that seagrass might not be an important habitat for this species.

Nurse Sharks. The nurse shark inhabits littoral waters in both sides of the tropical and subtropical Atlantic, ranging from tropical West Africa and the Cape Verde Islands in the east, and from Cape Hatteras, North Carolina to Brazil in the west. It is also found in the east Pacific, ranging from the Gulf of California to Panama and Ecuador. It is a shallow water species, often found lying motionless on the bottom under coral reefs or rocks. It often congregates in large numbers in shallow water.

Its nurseries are in shallow turtle grass (Thalassia) beds and shallow coral reefs. However, juveniles are also found around mangrove islands in south Florida. Numerous juveniles were found along the west coast of Florida, in temperatures of 17.5° to 32.1° C, salinities of 28.5 to 35.1 ppt, and DO of 4.7 to 97 ml/l. Large numbers of nurse sharks often congregate in shallow waters of the Florida Keys and the Bahamas at mating time in June and July. A small area has been set up for protection of mating sharks at Fort Jefferson in the Dry Tortugas. It is not certain, however, whether this area is a primary mating ground or a refuge for mated females.

Biscayne Bay is included in essential fish habitat all life stages (neonates/early juveniles, late juveniles/subadults, adults) for the nurse shark. Minimal impacts are expected from the Proposed Action and other alternatives on mangroves and coral reefs, but small, probably indiscernible impacts on seagrasses could occur through nutrient discharge.

Bonnethead Shark. The bonnethead is a small hammerhead that inhabits shallow coastal waters where it frequents sandy or muddy bottoms. It is confined to the warm waters of the western hemisphere. "Young of the year" and juveniles were found in the west coast of Florida, at temperatures of 16.1° to 31.5° C , salinities of 16.5 to 36.1 ppt, and DO of 2.9 to 9.4 ml/l.

Biscayne Bay is included in essential fish habitat for late juveniles/subadults of the bonnethead shark, but there is very limited sandy or muddy bottoms in this area, and impacts to these habitats from the Proposed Action and other alternatives are expected to be minimal.

5. SUMMARY

Biscayne Bay contains essential fish habitat that could be affected, but is unlikely to be appreciably affected by changes in nutrient and toxic chemical discharges associated with the Proposed Action and other alternatives. The greatest of the impacts would be associated with off-site secondary development induced by activities on the former base. The impacts of on-site development would be minimized through the implementation of a stormwater management system. Mitigating the impacts of the induced off-site development would require retaining and possibly treating the stormwater that would be generated by newly developed areas. This could only be accomplished through imposition of increased controls by the South Florida Water Management District and Miami-Dade County's Department of Environmental Management. The Air Force and FAA do not have the means to implement mitigations outside the former base property.

Independent of the disposal and redevelopment of surplus property at former Homestead AFB, the Air Force is conducting a Feasibility Study to identify remediation measures for contaminated sediments in Military Canal.

6. REFERENCES

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