LNP
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Supplemental 316(b) Information on Potential Impacts to Aquatic Biota at LNP

ATTACHMENT A

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Supplemental 316(b) Information on Potential Impacts to Aquatic Biota at LNP

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1.0 Introduction

Progress Energy Florida, Inc. (PEF), is proposing to build and operate two nuclear energy generating units. The proposed Levy Nuclear Plant Units 1 and 2 (LNP) will be located in Levy County, Florida, east of State Road 19 and approximately 6.4 kilometers (km) (4 miles [mi.]) north of the Levy County and Citrus County border. The LNP will withdraw cooling water from the Cross Florida Barge Canal (CFBC), which extends west about 11.9 km (7.4 mi.) from the Inglis Lock at Lake Rousseau to the Gulf of Mexico.

On December 18, 2001, the U.S. Environmental Protection Agency (USEPA) promulgated the National Pollutant Discharge Elimination System (NPDES) Final Regulations Addressing Cooling Water Intake Structures (CWIS) for New Facilities (Final Rule, Title 40, Code of Federal Regulation [40 CFR] Parts 9, 122, 125; USEPA, 2001) under Section 316(b) of the Clean Water Act (CWA), hereafter called the Final Rule. The Final Rule establishes national technology-based performance requirements applicable to the location, design, construction, and capacity of CWIS. The Final Rule establishes the best technology available (BTA) for minimizing adverse environmental impact associated with the use of CWIS on aquatic organisms. This Final Rule requires that new electric power-generating facilities meet uniform requirements based on cooling water intake capacity.

The LNP meets all five criteria for being considered a new facility under the Final Rule because:

- It is a greenfield or stand-alone facility.
- It uses a newly constructed CWIS.
- It uses at least 25 percent of the water withdrawn from the CFBC exclusively for cooling purposes.
- It has a design intake flow of approximately 122 million gallons per day (mgd) (that is, greater than the 2 mgd threshold).
- It is required to obtain an NPDES permit.

The Final Rule establishes a two-track approach for regulating CWIS at new facilities. Track I establishes uniform requirements based on facility cooling water intake capacity. New facilities under Track I with a design intake flow greater than 10 mgd are required to have cooling water intake flow at a level commensurate with that achievable with a closed-cycle, recirculating cooling system and to design the CWIS to achieve less than 0.5 foot per second (fps) through-screen velocities at the traveling screens. Track II provides the opportunity to establish that alternative requirements will achieve comparable performance to the Track I design requirements.

The mechanism for documenting compliance with the Final Rule is the submittal of a 316(b) Demonstration and the subsequent incorporation of Section 316(b) requirements into an NPDES permit. A 316(b) Demonstration study detailing the proposed approach for achieving compliance with the Final Rule requirements for the LNP was submitted as part of the Site Certification Application (SCA) to the Florida Department of Environmental Protection (FDEP) Siting Coordination Office on June 2, 2008. PEF intends to comply with the Final Rule at the LNP under Track I. The LNP will use 3/8-inch (in.) dual-flow traveling water screens with a through-screen velocity less than 0.5 fps and mechanical draft cooling towers to minimize impingement and entrainment of aquatic organisms.

The previously submitted LNP 316(b) Demonstration indicated that supplemental information discussing potential impacts to aquatic biota would be provided following completion of ongoing 2007/2008 biological studies in the CFBC and adjacent waters. This Technical Memorandum (TM) provides an analysis of potential impacts to the aquatic biota of the CFBC from the operation of the proposed LNP CWIS based on the completed biological studies. Impacts on the aquatic biota from the operation of the proposed LNP CWIS are focused on the impingement and entrainment losses of fish and shellfish.

2.0 Methodology

The section provides a brief summary of the data collection methods performed in the field and calculation methods used in the data reduction and interpretation. Data collection was performed using the methods and collection equipment described in the Combined License Application (COLA) Aquatic Sampling Work Plan (CH2M HILL, 2007). Sampling stations are presented on Figure 2-1. Sampling dates are shown in Table 2-1.

2.1 Data Collection

Motile macroinvertebrates were collected using crab traps and trawls at Stations 1 through 4. A total of five baited crab traps were deployed across the 1-mi. segment for each station. A 6-foot otter trawl was pulled along the bottom at multiple locations within the 1-mi. segment for each station (Stations 1 through 4). Trawls were taken for 5 minutes at a speed of typically 2 miles per hour (mph) or less.

The fish community was sampled at Stations 1 through 4. Collection techniques included beach seining, gill netting, trawling, cast netting, and minnow traps. Fish were identified to species, measured and enumerated in the field, and released. Voucher specimens of small or difficult to identify species were retained by preserving with alcohol, while larger or readily identifiable species were documented with photographs. Dr. George Burgess of the University of Florida (Gainesville) Ichthyology Department provided quality control review of the fish species identification.

- Shoreline fish species were sampled using a ¼- in. mesh, 50-foot seine with a 6- by 6- by 6-foot bag. Duplicate samples were collected at Stations 1, 2, and 3. Samples were collected by anchoring one end of the seine to the shoreline, while the opposite end was drawn by boat back to the shoreline. Beach seine samples were not collected at Station 4, at which point the CFBC channel connects to the Gulf of Mexico. At Station 4, the linear shoreline of the canal gives way to salt marsh and oyster reef, making the use of a beach seine as a viable sampling gear problematic.
- Trawling was conducted to assess demersal fish species near the mid-depth and bottom of the water column. A 16-foot perimeter by 25-foot length otter trawl with 1.5-in. mesh was pulled along the bottom at multiple locations within the 1-mi. segment for each station (Stations 1 through 4). Trawls were taken for 5 minutes at a speed of typically 2 mph or less.
- Gill nets 75 feet long and 6 feet deep with varying mesh size (1- to 6-in.) were deployed within the 1-mi. segment for each station (Stations 1 through 4). The smallest mesh end of each gill net was secured at or near the shoreline in shallower water with a cinder block and stretched perpendicular to the shoreline into deeper water and anchored with a cinder block. Net soak times were limited by terms of the approved State collector's permits and concerns for netting manatees and did not exceed 2 hours between being

pulled completely out of the water and fish removed. The nets were tended and observed during the deployment period.

- Cast netting was conducted at various locations across the 1-mi. segment for each station (Stations 1 through 4). Cast nets (6-foot and 7-foot radius) with 5/8 in. and 1 in. mesh sizes were thrown a minimum of 40 times and a maximum of 50 times from a boat.
- Ten minnow traps (16- by 9-in.) were baited and deployed across the 1-mi. segment for each station (Stations 1 through 4). Traps were retrieved up to 24 hours after deployment.

The ichthyoplankton and meroplankton community was sampled at Stations 1 through 4 using conical nets (0.5-meter [m] diameter) with standard flow meters. A 330-microgram (µ) net was used in replication to quantify ichthyo-, mero-, and holoplankton at each station. Duplicate 330-µ oblique plankton tows were taken during the day and night for a total of four plankton samples per station, resulting in 16 total samples per event. A tow time of 100 seconds was selected to achieve the desired volume of water sampled. Samples were preserved in formalin and submitted to taxonomic specialists at Ecological Associates in Jenson Beach, Florida, for plankton enumeration and identification.

2.2 Calculations

Calculations used in the data reduction and interpretation are as follows:

Arithmetic Mean (Average):

$$= \frac{1}{n}\left(x_1 + \ldots + x_n\right)$$

Flow Meter Calculations

Distance:

$$= \frac{(End\,Value - Start\,Value) \times 26{,}873}{999{,}999}$$

Volume:

$$= \frac{(Distance \times Diameter\ of\ net\ (0.5\,m)^2 \times 3.14)}{4}$$

Density:

$$= \left(\frac{Number\ of\ Individuals}{Volume\ (100\,m^3)}\right)$$

Percent Composition:

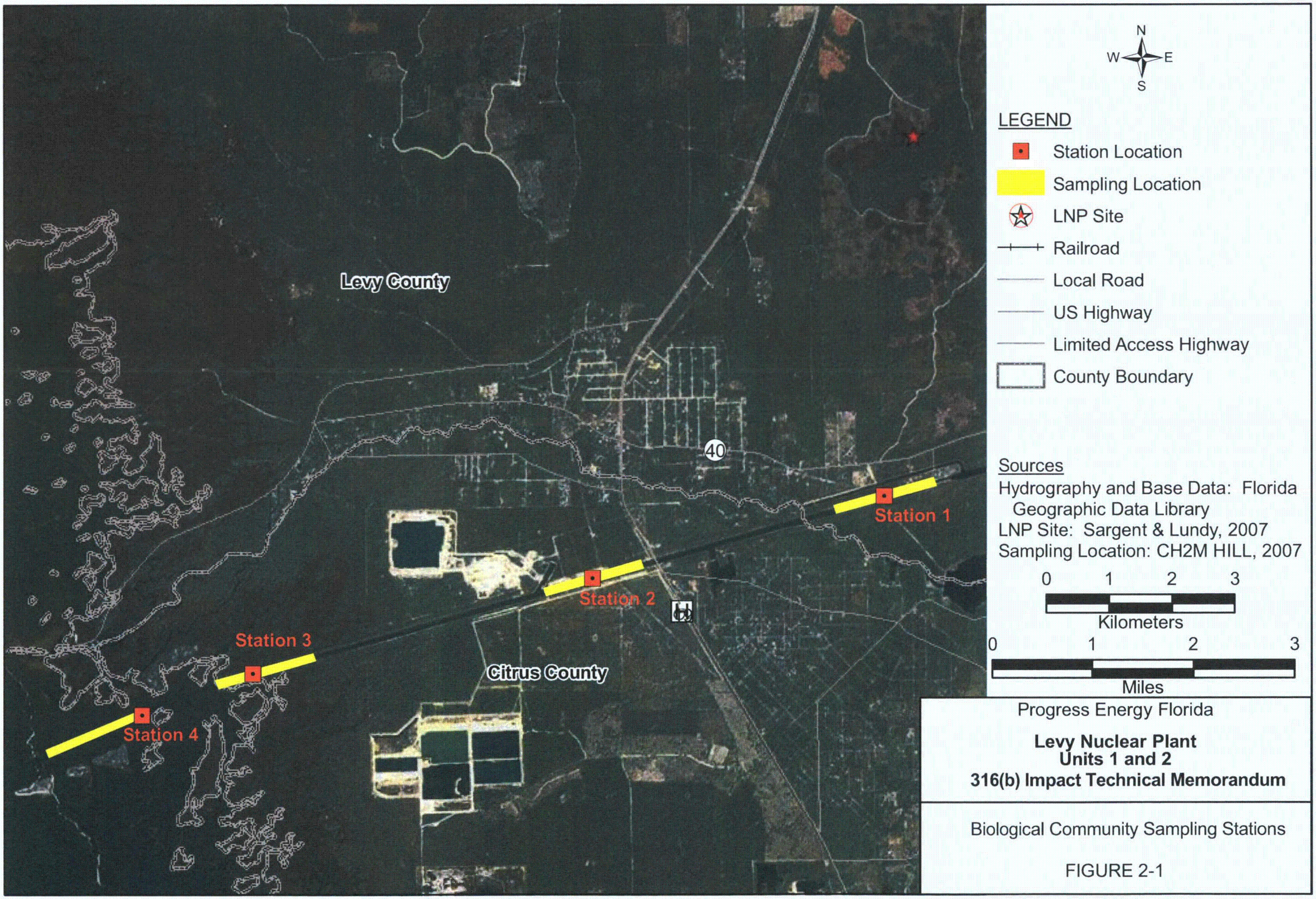
$$= \left(\frac{Number\ of\ Individuals\ per\ Species}{Total\ Number\ of\ Collected\ Individuals}\right) \times 100$$

Catch per Unit Effort (CPUE)

$$=\left(\frac{Total\ Catch\ (Number\ of\ Individuals)}{Total\ Effort\ Spent\ (time\ or\ number\ of\ efforts)}\right)$$

TABLE 2-1
Sampling Dates per Parameter in the Cross Florida Barge Canal

		Station			
Parameter	**Event**	**1**	**2**	**3**	**4**
Motile Invertebrates Beach Seine Otter Trawl Gill Net Cast Net Minnow Trap	1	10/29 – 11/7/07	10/29 – 11/7/07	10/29 – 11/7/07	10/29 – 11/7/07
	2	12/3 – 12/12/07	12/3 – 12/12/07	12/3 – 12/12/07	12/3 – 12/12/07
	3	5/12 – 6/19/08	8/25 – 9/5/08	8/25 – 9/5/08	8/25 – 9/5/08
	4	8/25 – 9/5/08	8/25 – 9/5/08	8/25 – 9/5/08	8/25 – 9/5/08
Zooplankton	1	10/18/07	10/18/07	10/18/07	10/18/07
	2	12/7/07	12/7/07	12/7/07	12/7/07
	3	4/11/08	4/11/08	4/11/08	4/11/08
	4	4/21/08	4/21/08	4/21/08	4/21/08
	5	5/7/08	5/7/08	5/7/08	5/7/08
	6	5/22/08	5/22/08	5/22/08	5/22/08
	7	6/4/08	6/4/08	6/4/08	6/4/08
	8	6/20/08	6/20/08	6/20/08	6/20/08
	9	7/21/08	7/21/08	7/21/08	7/21/08
	10	8/6/08	8/6/08	8/6/08	8/6/08
	11	9/3/08	9/3/08	9/3/08	9/3/08
	12	9/15/08	9/15/08	9/15/08	9/15/08
	13	10/28/08	10/28/08	10/28/08	10/28/08
	14	11/13/08	11/13/08	11/13/08	11/13/08



Biological Community Sampling Stations

FIGURE 2-1

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3.0 Data Used to Estimate Impingement and Entrainment

This section provides data on species collected in the CFBC in the vicinity of the proposed LNP CWIS that may potentially be impinged or entrained when the CWIS is operating. Because the CWIS-induced flows may change the salinity characteristics of the CFBC at the proposed LNP CWIS location, data from Station 4 located in near-shore Gulf waters adjacent to the terminus of the CFBC were considered most conservative of future biological conditions and used to assess impacts to the species that may potentially be impinged or entrained and to provide insight into the rates at which they may be impinged and entrained.

3.1 Impingement Data

The potential of motile macroinvertebrates, juvenile and adult fish, and threatened and endangered species to be impinged at the LNP was evaluated using the motile macroinvertebrate and finfish data and threatened and endangered species observations at Station 4. Because beach seining was not conducted at Station 4 due to the lack of shoreline, beach seine data at Station 3 were used in the evaluation.

3.1.1 Motile Macroinvertebrates

Motile macroinvertebrates were collected using crab traps and trawls at Station 4 during four events (Table 2-1 and Figure 2-1). Both techniques collected low abundances of macroinvertebrates across the four sampling events.

A total of five baited crab traps were deployed across the 1.6-km (1-mi.) segment at Station 4 during four events for a total of 20 trap days. Blue crab (*Callinectes sapidus*) was the only invertebrate species collected in the crab traps. The 20 crab traps deployed collected a total of 19 blue crabs at Station 4. Of the blue crabs collected, 68 percent were females and 32 percent were males. Blue crab carapace length ranged from 76 to 169 millimeters (mm) (approximately 3 to 6.5 in.).

Seventeen individuals, representing eight invertebrate species were collected in the 16 trawls taken at Station 4 over the four sampling events. Mud crab (*Panopeidae sp.*) was the most abundant macroinvertebrate, with seven individuals, accounting for 41.2 percent of the total catch. Three species of hermit crabs (*Pagurus longicarpus, Pagurus pollicaris, and Pagurus annulipes*) represented 35.3 percent of the total catch. Other species in which only one or two individuals were collected included decorator crab (*Stenocionops furcata*), pink shrimp (*Farfantepenaeus duorarum*), and ragged seahare (*Bursatella leachii*). Motile macroinvertebrates were collected in the highest abundance during Event 4 due to the collection of seven mud crabs and one pink shrimp. Event 2 collected seven total individuals with six of the seven being hermit crabs. Events 1 and 3 only collected one individual.

3.1.2 Fish

Adult and juvenile fish were collected using five different gear types at Station 4 during four events (Table 2-1 and Figure 2-1). Fisheries data were collected using otter trawls, gill nets, cast nets, and minnow traps. As mentioned above, beach seining data from Station 3 near the mouth of the CFBC was used in the impact analysis, since beach seining was not conducted at Station 4.

A total of 929 fish representing 45 taxa was collected at Station 4 over four events using the five gear types. Because the collection success of the different gear types can vary, fisheries data are presented by gear type on a CPUE basis. Macroinvertebrates, discussed in Subsection 3.1.1, were excluded from the following analysis.

3.1.2.1 Beach Seine

Shoreline fish species were sampled using a 15.2 m (50-foot) beach seine with a bag at Station 3 over four events. A total of 68 individuals, representing 15 fish species, were collected using beach seines.

Spotfin mojarra (*Eucinostomus argenteus*) was the most abundant species collected, with 35 individuals accounting for 51.5 percent of the total catch (Figure 3-1). Six individuals each of the Atlantic needlefish (*Strongylura marina*) and bay anchovy (*Anchoa mitchilli*) represented 8.8 percent each of the total catch. Other predominant species (in order of decreasing abundance) were redfin needlefish (*Strongylura notata*), Pinfish (*Lagodon rhomboids*), Atlantic threadfin (*Polydactylus octonemus*), Goby sp., ladyfish (*Elops saurus*), and silver perch (*Bairdiella chrysoura*).

CPUE was calculated by the number of individuals per beach seine haul for comparison of abundance between sampling events at Station 3 (Table 3-1). Event 2 had the highest CPUE of 20.5, primarily due to the collection of 30 spotfin mojarra and a species CPUE of 15.0. Event 1 had the second highest CPUE of 9.0, followed by Event 4 (2.5) and Event 3 (2.0).

3.1.2.2 Trawl

Trawling was conducted to assess demersal fish species near the mid-depth and bottom of the water column at Station 4 over four events. A total of 484 individuals, representing 20 fish species, were collected using trawls.

Two schooling species were collected in high abundances during one event and collectively accounted for 75.2 percent of the total catch: silver perch (*Bairdiella chrysoura*) and bay anchovy (*Anchoa mitchilli*). Silver perch was collected across all events and was the most abundant species with 240 individuals accounting for 49.6 percent of the total catch (Figure 3-2). A total of 204 silver perch was collected in one trawl during Event 1. Bay anchovy was the second most abundant species with 124 individuals representing 25.6 percent of the total catch. A total of 117 bay anchovy was collected in one trawl during Event 4. Other predominant species (in order of decreasing abundance) were Hardhead catfish (*Ariopsis felis*), Atlantic bumper (*Chloroscombrus chrysurus*), Spot (*Leiostomus xanthurus*), and Sand seatrout (*Cynoscion arenarius*).

Because the number of trawls per station varied, CPUE was calculated by number of individuals per trawl for comparison of abundance between sampling events at Station 4

(Table 3-2). Event 1 had the highest CPUE of 231.0, primarily due to the collection 204 silver perch. Event 4 had the second highest CPUE of 73.5 due to the high bay anchovy catch, followed by Event 2 (48.5) and Event 3 (3.0).

3.1.2.3 Gill Net

Gill nets 22.9 m (75 feet) long and 1.8 m (6 feet) deep with varying mesh sizes were deployed within the 1.6-km (1-mi.) segment at Station 4 over four events. A total of 17 individuals, representing nine fish species, were collected using gill nets.

Four species collectively accounted for 70.6 percent of the total catch: Spanish mackerel (*Scomberomorus maculates*), Ladyfish (*Elops saurus*), Longnose gar (*Lepisosteus osseus*), and Bonnethead shark (*Sphyrna tiburo*). Spanish mackerel was the most abundant with four individuals accounting for 23.5 percent of the total catch (Figure 3-3). Three individuals each of Ladyfish and Longnose gar represented 17.6 percent each of the total catch. Two bonnethead sharks were collected, representing 11.8 percent of the total catch. All other species had only one individual collected.

Because the net soak times varied, CPUE was calculated by number of individuals per day for comparison of abundance between sampling events at Station 4 (Table 3-3). Event 2 had the highest CPUE of 30.0, primarily due to the collection of Longnose gar. Event 4 had the second highest CPUE of 28.0, followed by Event 1 (25.5) and Event 3 (11.9).

3.1.2.4 Cast Net

Cast netting was conducted at various locations across the 1.6-km (1-mi.) segment at Station 4 over four events. Cast nets with up to a 2.1-m (7-foot) radius were used, and nets were tossed multiple times from a boat. A total of 401 individuals, representing 19 fish species, were collected using cast nets.

Gulf menhaden was the most abundant species collected with a total of 225 collected during one event, representing 56.1 percent of the total catch (Figure 3-4). White and striped mullets (*Mugil curema* and *Mugil cephalus*) were relatively abundant and collectively accounted for 21.4 percent of the total catch. Spotfin mojarra (*Eucinostomus argenteus*), pinfish (*Lagodon rhomboids*), and scaled sardine (*Harengula jaguana*) were also abundant, each representing greater than 5 percent of the total catch.

Because the number of casts per station varied, CPUE was calculated by number of individuals per 25 casts for comparison of abundance between sampling events at Station 4 (Table 3-4). Event 4 had the highest CPUE (157.9), primarily due to the high abundance of Gulf menhaden, and species richness (10 species). Event 2 had the second highest CPUE of 56.9 and was dominated by mullets and spotfin mojarra. Events 1 and 3 had similar CPUEs of 16.2 and 16.3, respectively.

3.1.2.5 Minnow Trap

Ten minnow traps (approximately 41 by 23 centimeters (cm) [16 by 9 in.]) were baited and deployed across the 1.6-km (1-mi.) segment at Station 4 over four events. A total of 23 individuals, representing seven fish taxa, were collected using minnow traps.

Three taxa collectively accounted for 73.9 percent of the total catch: Goby sp., silver perch (*Bairdiella chrysoura*), and pigfish (*Orthopristis chrysoptera*). Six individuals each of Goby sp. and silver perch represented 26.1 percent each of the total catch (Figure 3-5). Pigfish represented 21.7 percent of the total catch. All other species had less than two individuals collected.

Because the trap soak time varied, CPUE per event was calculated by number of individuals per day for comparison of abundance between sampling events at Station 4 (Table 3-5). Three of the four events had a total CPUE of less than one fish per day. Event 3 had a CPUE of 1.3 due to the collection of five Goby sp. and five pigfish. Events 1 and 4 had CPUEs less than one fish (0.8 and 0.6, respectively). Event 2 had a CPUE of less than 0.1 because only one fish, Gulf toadfish (*Opsanus beta*), was collected out of the 10 minnow traps deployed.

3.1.3 Threatened and Endangered Species

The potential for federally and state-listed species to occur in the CFBC in the proposed LNP CWIS location was evaluated using published species lists, online database searches, and field observations.

Eight federally listed threatened or endangered aquatic species were either directly observed or identified from the published listings as having the potential to occur in the vicinity of the LNP site (Table 3-6). Nine State of Florida-listed endangered, threatened, or species of special concern were either observed or identified as having the potential to occur in the vicinity of the LNP site (Table 3-6). No federally or state-listed species that are currently *proposed* for listing were found to have the potential to occur within the project vicinity.

Of the federal and state endangered, threatened, or species of concern, West Indian manatee (*Trichechus manatus*), American alligator (*Alligator mississippiensis*), and sea turtles were observed in the CFBC (Table 3-7). No Gulf sturgeon (*Acipenser oxyrinchus desotoi*) or smalltooth sawfish (*Pristis pectinata*) were collected or observed during the sampling period. Manatees were observed almost year-round, along the entire length of the CFBC. Alligator observations were limited to one occasion at night. Sea turtle observations were brief, with only a head visible above the water surface, so species could not be identified. These brief encounters occurred approximately 7 mi. from the CFBC mouth in the Gulf of Mexico in September, October, and December 2007.

3.2 Entrainment Data

Zooplankton in the CFBC was collected at Stations 1 through 4 during 14 sampling events (Table 2-1 and Figure 2-1). Zooplankton are the heterotrophic component of the plankton community. Meroplankton refers to developmental stages (generally eggs and larvae) of organisms which are not planktonic as adults. Ichthyoplankton refers to fish eggs and larvae. Juvenile and adult fish collected in the plankton samples were excluded from the calculations.

Commercially or recreationally important meroplankton larvae that may be entrained at the LNP were evaluated using the plankton data collected at Station 4. Commercially important pink shrimp (*Farfantepenaeus duorarum*) were not collected at Station 4, but were collected in low abundance at night at Station 3 during Event 2 (12/7/2007) and Event 9 (7/21/2008). Since pink shrimp were collected at Station 3, and to provide data for the impact analysis, pink shrimp data at Station 3 were evaluated. Brown shrimp (*Farfantepenaeus aztecus*) were collected during the day and night, mostly at night, from June to September. Shrimp not identified to species that could potentially be commercially important were collected during the day and night, and most abundant from April to May (Events 3 through 5). Blue crab larvae (megalopae) were collected at Station 4 and were evaluated. Blue crab larvae were collected in low abundances during Event 1 (10/18/2007) and Event 11 (9/3/2008) during the day and Event 2 and Event 1 (9/3/2008) and Event 11 (9/3/2008) during the night.

Fish eggs and larvae that may be entrained at the LNP were evaluated using the plankton data collected at Station 4. Total ichthyoplankton ranged from 0.8 individuals/100 cubic meters (m^3) during Event 14 (day) to 8,916 individuals/100 m^3 during Event 4 (day). The mean abundance of fish eggs at Station 4 during the day varied from 0 individuals/100 m^3 during Events 1, 2, 5, 12, 13, and 14 to 6,817 individuals/100 m^3 during Event 4 (Figure 3-6). The daytime mean abundance across all events was 652 individuals/100 m^3. Mean abundance of fish eggs during the night ranged from 0 individuals/100 m^3 during Events 1, 5, 6, 7, 12, 13, and 14 to 4,113 individuals/100 m^3 during Event 3 (Figure 3-7). The nighttime mean abundance across all events was 333 individuals/100 m^3. Engraulidae (anchovy) eggs were the most numerically dominant of the eggs collected during the day and night sampling, accounting for 98 percent of the daytime mean across events and 87 percent of the nighttime mean across events. Egg complexes representing the families of Achiridae, Merlucciidae, Paralichthyidae, Sciaenidae, and Serranidae were collected in low abundances during the day, and an egg complex of Paralichthyidae and Sparidae was collected at night.

Fish larvae were more abundant than fish eggs. The daytime mean abundance of fish larvae ranged from 0.8 during Event 14 to 2,714 individuals/100 m^3 during Event 3 (Figure 3-8). Nighttime mean abundance of fish larvae ranged from 10 individuals/100 m^3 during Event 14 to 2,207 individuals/100 m^3 during Event 5 (Figure 3-9). Two families collectively accounted for 90 percent of the total larvae (daytime and nighttime means across all events): Gobiidae and Engraulidae. Gobiidae larvae represented 81 and 56 percent of the daytime and nighttime larvae means, respectively. Engraulidae larvae was the second most abundant during both the day and night sampling, accounting for 12 and 30 percent of the daytime and nighttime larvae means, respectively. Larvae of Gobiidae and Engraulidae were collected during all of the sampling events, indicating that these are year-round resident populations with extended reproduction periods in the CFBC and near-shore Gulf of Mexico. Larvae of pelagic fishes, including that of Sciaenidae (croakers and drums), Clupeidae (menhadens), Atherinoformes (silversides) and Gerreidae (mojarras) were also among the most abundant fish larvae from Station 4. Larvae of small demersal fishes, including representatives of Blenniidae and Achiridae, were also common.

Fish larvae were mostly collected as post yolk-sac larval stages. Post yolk-sac larvae represented 96 and 98 percent of the total fish larvae collected during the day and night, respectively. Gobies were the most dominant post yolk-sac larvae during the day and night (Figures 3-10 and 3-11). Gobies accounted for greater than 85 percent of the daytime mean and 57 percent of the nighttime mean. Naked goby (*Gobiosoma bosc*) was the most abundant goby collected during the day and night sampling. Anchovies (Engraulidae and bay anchovy) represented 30 percent of the nighttime mean (Figure 3-11). Yolk-sac larvae represented 4 percent of the total fish larvae collected during the day and only 2 percent at night. Engraulidae (anchovy) were the most dominant identifiable yolk-sac larvae during the day and night at all stations. Other yolk-sac larvae taxa collected included Atherinoformes (silversides), Blennidae (blennies), and Clupeidae (sardines and menhadens).

Larvae of commercially or recreationally important fishes including silver perch (*Bairdiella chrysora*), spotted seatrout (*Cynoscion nebulosus*), sand weakfish (*Cynoscion aerenarius*), southern kingfish (*Menticirrhus americanus*), red drum (*Sciaenops ocellatus*), and leatherjacket (*Oligoplites saurus*) were collected in low abundances as post yolk-sac larvae. Post yolk-sac larvae collected in low abundances identified to family with commercial or recreational importance were Carangidae (jacks and pompanos), Haemulidae (grunts), and Sparidae (breams and porgies).

No eggs or larvae of the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) were collected during the sampling period.

TABLE 3-1
Beach Seine CPUE per Event at Station 3

Common Name	Species	Event 1	Event 2	Event 3	Event 4
Atlantic needlefish	*Strongylura marina*	2.0	0.5	0.0	0.5
Atlantic threadfin	*Polydactylus octonemus*	0.0	1.0	0.0	0.0
Bay anchovy	*Anchoa mitchilli*	3.0	0.0	0.0	0.0
Florida blenny	*Chasmodes saburrae*	0.0	0.5	0.0	0.0
Goby	*Gobiidae*	0.0	1.0	0.0	0.0
Gulf flounder	*Paralichthys albigutta*	0.0	0.0	0.0	0.5
Ladyfish	*Elops saurus*	1.0	0.0	0.0	0.0
Leatherjacket	*Oligoplites saurus*	0.0	0.0	0.0	0.5
Pigfish	*Orthopristis chrysoptera*	0.0	0.0	0.0	0.5
Pinfish	*Lagodon rhomboides*	1.0	0.5	0.0	0.0
Redfin needlefish	*Strongylura notata*	0.0	0.0	2.0	0.0
Scaled Sardine	*Harengula jaguana*	0.0	0.5	0.0	0.0
Silver Perch	*Bairdiella chrysoura*	0.0	1.0	0.0	0.0
Skilletfish	*Gobiesox strumosus*	0.0	0.5	0.0	0.0
Spotfin Mojarra	*Eucinostomus argenteus*	2.0	15.0	0.0	0.5
Total		**9.0**	**20.5**	**2.0**	**2.5**

TABLE 3-2
Trawl CPUE per Event at Station 4

Common Name	Species	Event 1	Event 2	Event 3	Event 4
Atlantic bumper	*Chloroscombrus chrysurus*	0.0	0.0	0.0	10.0
Atlantic croaker	*Micropogonias undulatus*	0.0	0.5	0.0	0.0
Atlantic spadefish	*Chaetodipterus faber*	0.0	0.0	0.0	1.0
Barred searobin	*Prionotus martis*	0.0	0.5	0.0	0.0
Bay anchovy	*Anchoa mitchilli*	1.0	0.0	2.0	58.5
Bighead searobin	*Prionotus tribulus*	0.0	0.0	0.3	0.0
Fringed flounder	*Etropus crossotus*	1.0	1.0	0.0	0.0
Grunt	*Haemulidae*	0.0	0.5	0.0	0.0
Hardhead catfish	*Ariopsis felis*	1.0	15.5	0.0	0.0
Ladyfish	*Elops saurus*	2.0	0.0	0.0	0.0
Ocellated flounder	*Ancylopsetta quadrocellata*	0.0	0.0	0.3	0.0
Pigfish	*Orthopristis chrysoptera*	1.0	1.5	0.0	0.0
Pinfish	*Lagodon rhomboides*	0.0	1.5	0.0	0.0
Polka-dot batfish	*Ocgocephalus cubifrons*	0.0	2.0	0.0	0.0
Sand seatrout	*Cynoscion arenarius*	6.0	2.0	0.0	1.0
Silver perch	*Bairdiella chrysoura*	204.0	14.5	0.3	3.0
Southern flounder	*Paralichthys lethostigma*	0.0	1.0	0.0	0.0
Southern kingfish	*Menticirrhus americanus*	2.0	2.0	0.0	0.0
Spot	*Leiostomus xanthurus*	13.0	1.5	0.0	0.0
Spotfin mojarra	*Eucinostomus argenteus*	0.0	4.5	0.0	0.0
Total		**231.0**	**48.5**	**3.0**	**73.5**

TABLE 3-3
Gill Net CPUE per Event at Station 4

Common Name	Species	Event 1	Event 2	Event 3	Event 4
Atlantic stingray	*Dasyatis sabina*	0.0	0.0	4.0	0.0
Bonnethead shark	*Sphyrna tiburo*	0.0	0.0	0.0	8.0
Gulf menhaden	*Brevoortia patronus*	0.0	0.0	0.0	4.0
Hardhead catfish	*Ariopsis felis*	0.0	0.0	0.0	4.0
Ladyfish	*Elops saurus*	5.1	0.0	4.0	4.0
Longnose gar	*Lepisosteus osseus*	0.0	30.0	0.0	4.0
Southern stingray	*Dasyatis americana*	5.1	0.0	0.0	0.0
Spanish mackerel	*Scomberomorus maculatus*	15.3	0.0	0.0	4.0
Spot	*Leiostomus xanthurus*	0.0	0.0	4.0	0.0
Total		**25.5**	**30.0**	**11.9**	**28.0**

TABLE 3-4
Cast Net CPUE per Event at Station 4

Common Name	Species	Event 1	Event 2	Event 3	Event 4
Atlantic bumper	*Chloroscombrus chrysurus*	0.0	0.0	0.0	2.5
Atlantic needlefish	*Strongylura marina*	0.0	0.0	1.5	0.0
Atlantic Thread Herring	*Opisthonema oglinum*	1.3	0.0	0.0	0.0
Bay Anchovy	*Anchoa mitchilli*	0.6	0.0	0.0	0.0
Black Drum	*Pogonias cromis*	0.6	0.0	0.0	0.0
Crested blenny	*Hypleurochilus geminatus*	0.0	0.0	0.0	0.6
Gulf Menhaden	*Brevoortia patronus*	0.0	0.0	0.0	141.0
Inshore Lizardfish	*Synodus foetens*	0.6	0.0	0.0	0.0
Ladyfish	*Elops saurus*	0.0	0.0	0.0	0.6
Leatherjacket	*Oligoplites saurus*	0.0	0.0	0.0	0.6
Pigfish	*Orthopristis chrysoptera*	0.0	0.0	0.5	0.6
Pinfish	*Lagodon rhomboides*	0.0	5.0	6.1	0.6
Puffer	*Sphoeroides sp.*	0.6	0.0	0.0	0.0
Scaled Sardine	*Harengula jaguana*	10.6	2.5	0.0	0.0
Southern Stingray	*Dasyatis americana*	0.6	0.0	0.0	0.0
Spotfin Mojarra	*Eucinostomus argenteus*	0.6	14.4	0.5	1.9
Striped Mullet	*Mugil cephalus*	0.0	15.0	3.6	2.5
White Mullet	*Mugil curema*	0.0	20.0	4.1	6.9
Whitefin Sharksucker	*Echeneis neucratoides*	0.6	0.0	0.0	0.0
Total		**16.2**	**56.9**	**16.3**	**157.9**

TABLE 3-5
Minnow Trap CPUE per Event at Station 4

Common Name	Species	Event 1	Event 2	Event 3	Event 4
Bluegill	*Lepomis macrochirus*	0.0	0.0	0.0	0.1
Code goby	*Gobiosoma robustum*	0.0	0.0	0.1	0.0
Goby	Gobiidae	0.4	0.0	0.5	0.0
Gulf Toadfish	*Opsanus beta*	0.0	<0.1	0.1	0.0
Pigfish	*Orthopristis chrysoptera*	0.0	0.0	0.5	0.0
Pinfish	*Lagodon rhomboides*	0.4	0.0	0.0	0.1
Silver Perch	*Bairdiella chrysoura*	0.0	0.0	0.1	0.5
Total		**0.8**	**<0.1**	**1.3**	**0.6**

TABLE 3-6
Federally and State-Listed Threatened and Endangered Aquatic Species with the Potential to Occur in the Vicinity of the LNP Site

Common Name	Scientific Name	Federal Status	State Status
Mammals			
West Indian manatee	*Trichechus manatus*	LE	LE
Reptiles			
American alligator[a]	*Alligator mississippiensis*	Treated as Threatened[a]	LS
Loggerhead sea turtle	*Caretta caretta*	LT	LT
Green sea turtle	*Chelonia mydas*	LE	LE
Leatherback sea turtle	*Dermochelys coriacea*	LE	LE
Hawksbill sea turtle	*Eretmochelys imbricata*	LE	LE
Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	LE
Suwannee Cooter	*Pseudemys concinna suwanniensis*	N	LS
Fish			
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	LT	LS
Smalltooth sawfish	*Pristis pectinata*	LE	N

Notes:

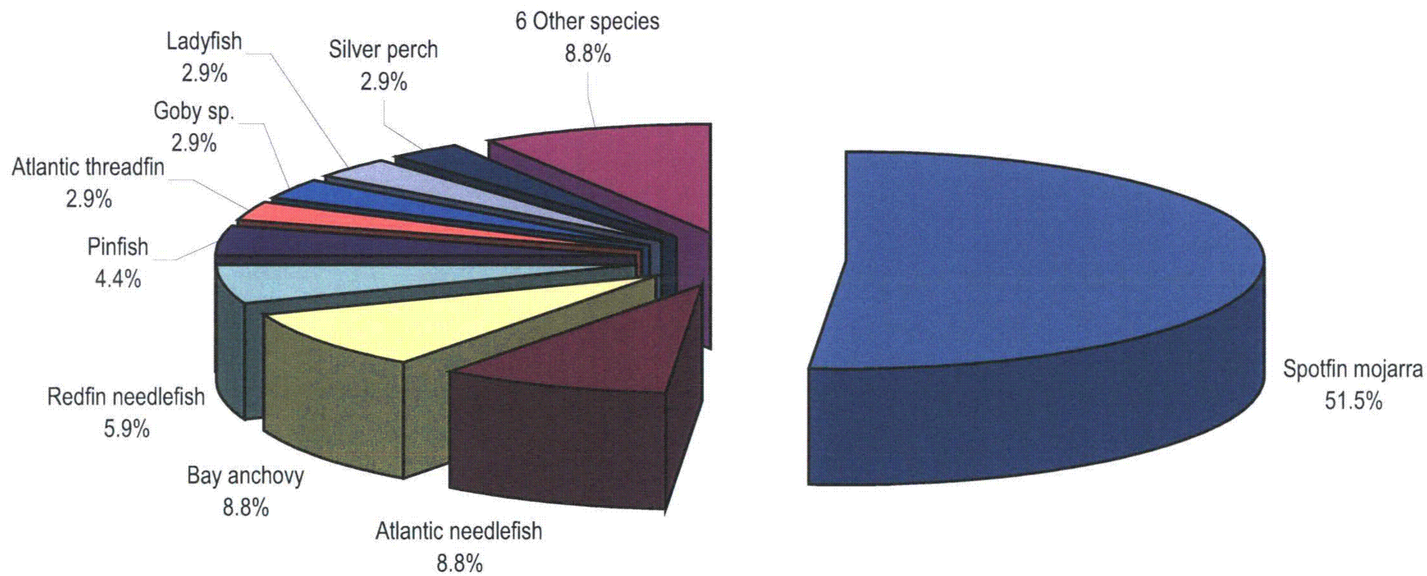
a) The American alligator's federal status is "Treated as Threatened" by the USFWS due to the close resemblance to the American crocodile.

N = Not Listed
LE = Listed Endangered
LS = Listed State Species of Special Concern
LT = Listed Threatened
USFWS = U.S. Fish and Wildlife Service

Source: Florida Fish and Wildlife Conservation Commission (FFWCC), 2007

TABLE 3-7
Federally and State-Listed Threatened and Endangered Aquatic Species Observations in the Cross Florida Barge Canal

Common Name	Scientific Name	Date	Location	Notes
West Indian manatee	*Trichechus manatus*	5/8/2007	Immediately downstream of the Inglis Lock	3 manatees (age indeterminate)
		10/16/2007	Near Station 3	One manatee (age indeterminate)
		11/13/2007	Near Station 4	1 adult manatee during an aerial survey
		12/4/2007	Southwest of Station 4 in the shallows	1 manatee (age indeterminate)
		5/1/2008	Near Station 2	1 adult manatee
		5/7/2008	Near Station 4	2 manatee, 1 adult and 1 juveniles
		5/27/2008	Near Station 1	6 manatee, 2 adults 4 juveniles
		6/18/2008	Near Station 4	2 juveniles swimming along shoreline
		7/21/2008	Near Station 2	1 adult manatee
		10/28/2008	Near Station 4	1 manatee (age indeterminate) swimming upstream with floating marker attached
American alligator	*Alligator mississippiensis*	10/16/2007	Near Station 2	1 adult alligator on the CFBC bank
		10/16/2007	Near Station 1	1 alligator (age indeterminate)
		10/16/2007	Near Station 3	1 alligator (age indeterminate)
Sea turtles	Not Identified to species	September, October and December 2007	Near Station 7	Five (5) brief encounters between October and December 2007. Age and species indeterminate



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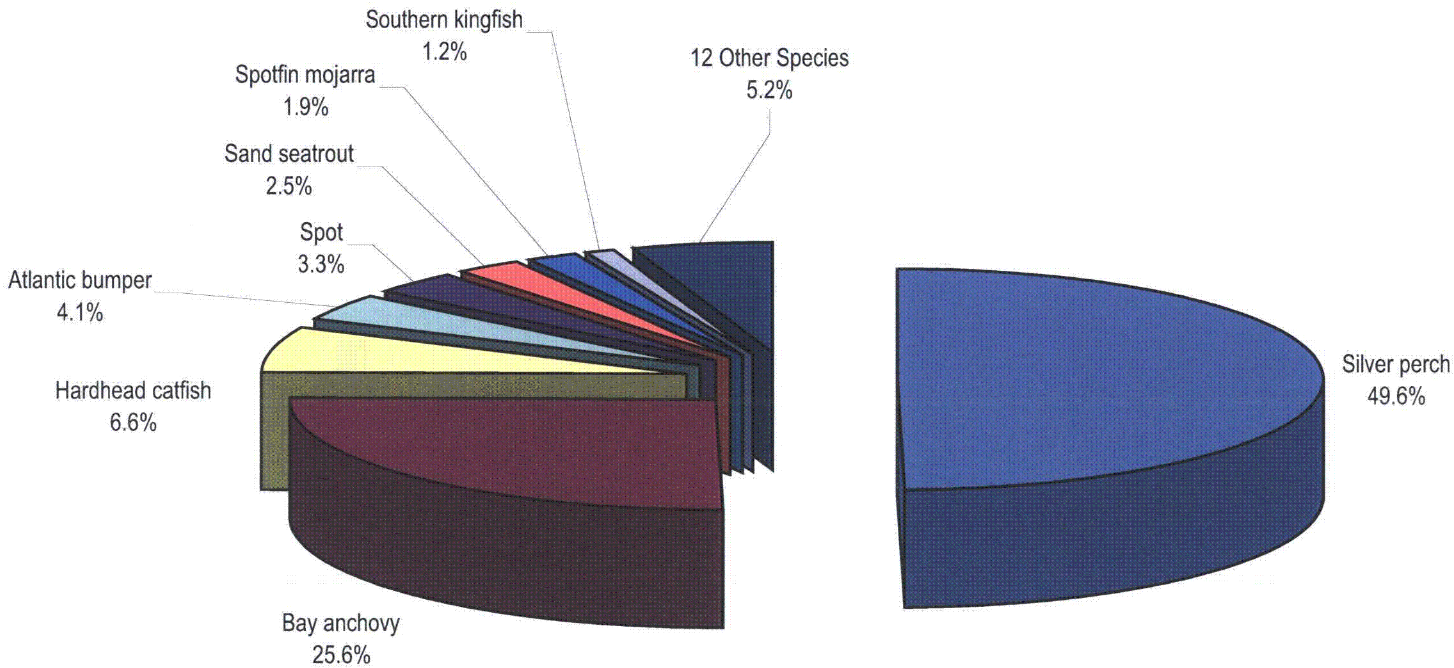
Beach Seine Species Composition at Station 3

FIGURE 3-1



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Trawl Species Composition at Station 4

FIGURE 3-2

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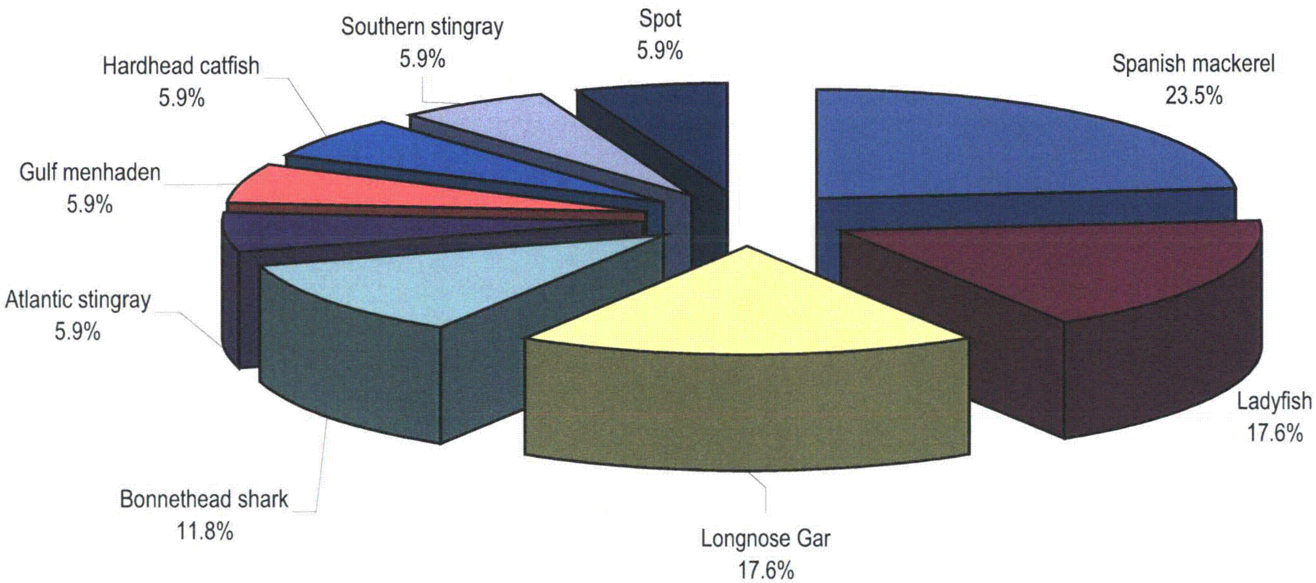

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Gill Net Species Composition at Station 4

FIGURE 3-3

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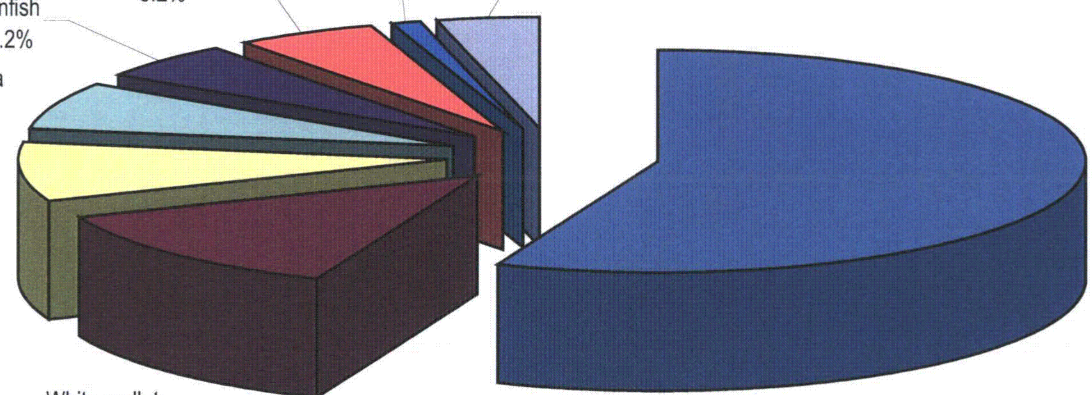

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Cast Net Species Composition at Station 4

FIGURE 3-4

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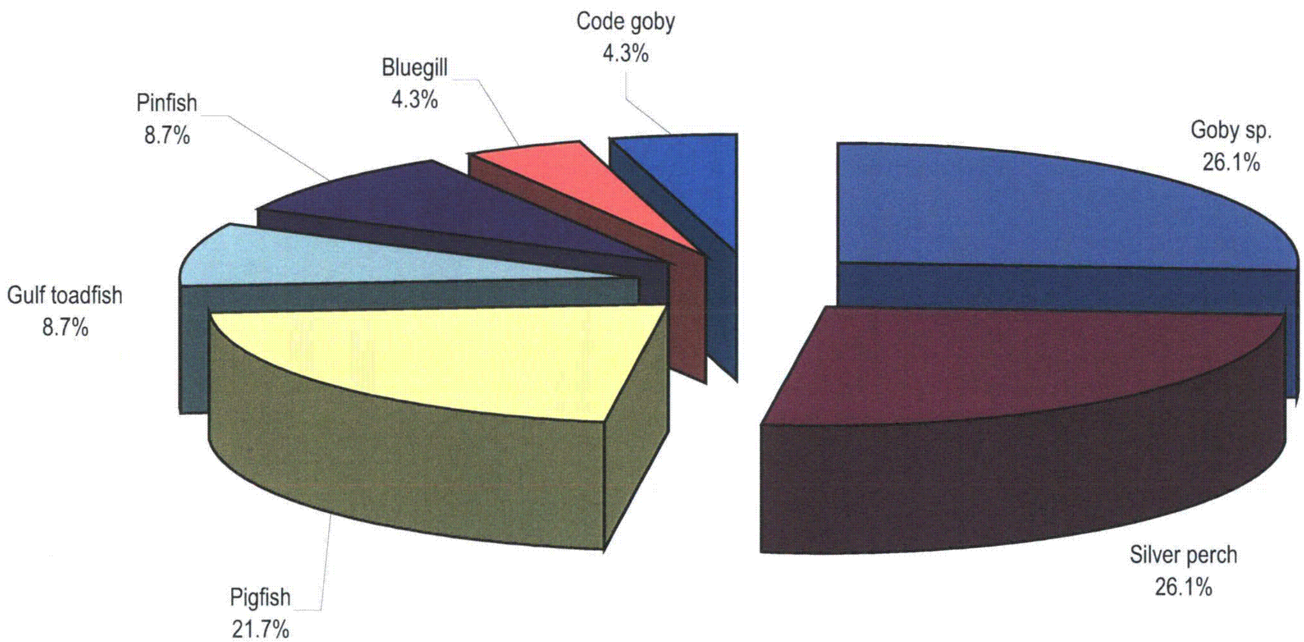

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Minnow Trap Species Composition at Station 4

FIGURE 3-5

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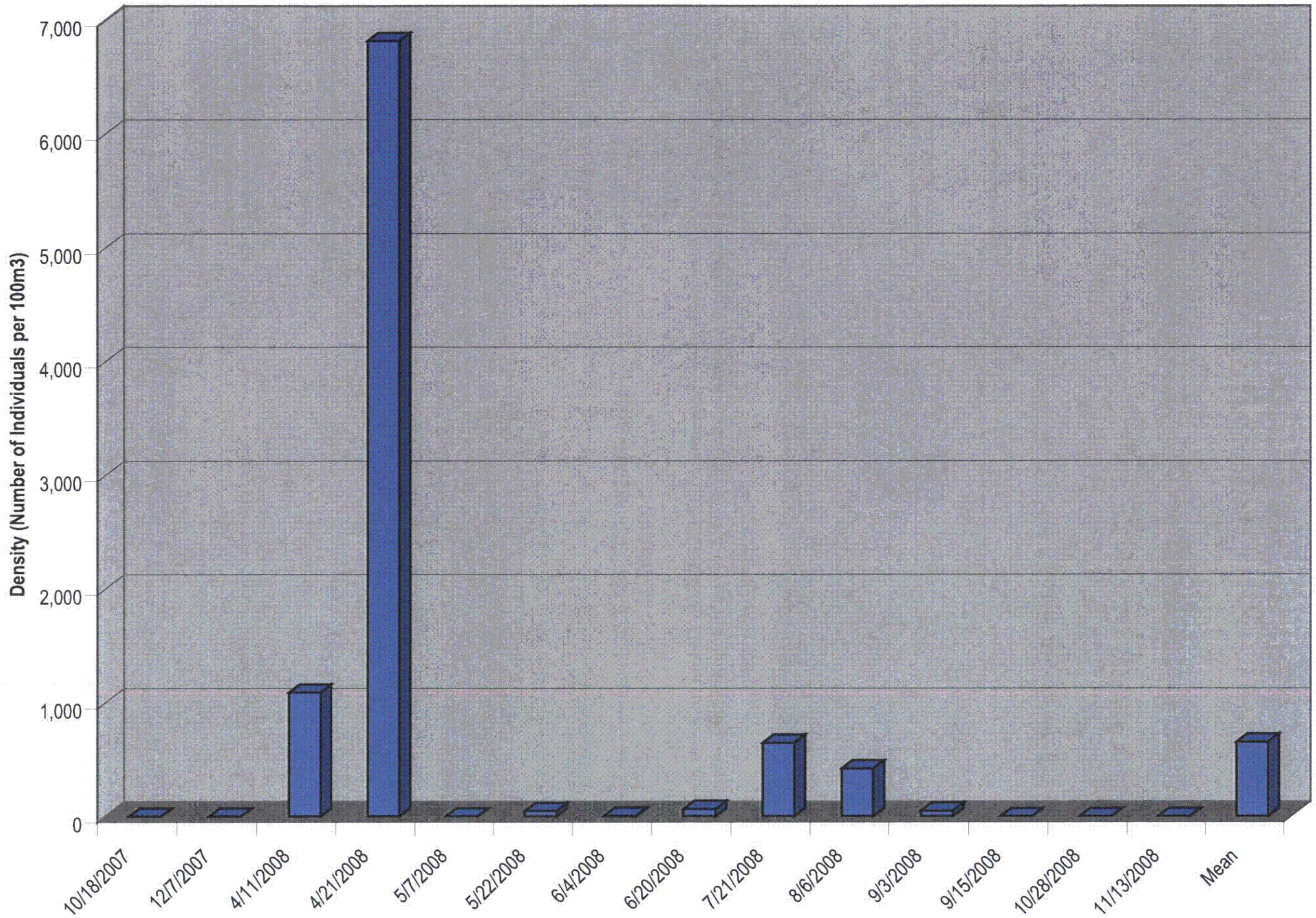

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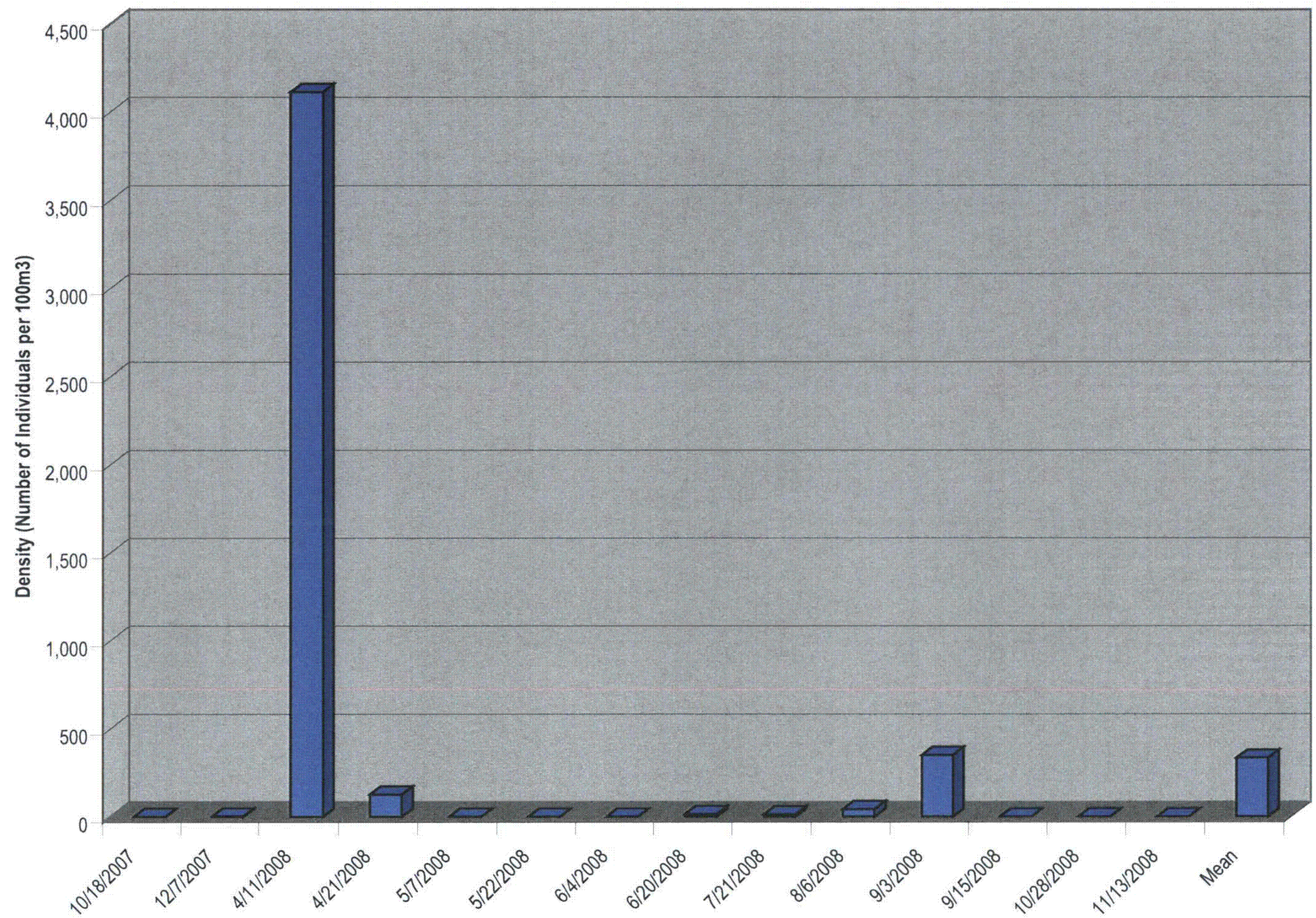
Daytime Egg Densities at Station 4 per Event

FIGURE 3-6

\\Odin\Groups\Publications\~JMS-2008\Progress_Energy\Wiggins\figure_3-6.pdf Date: 1/29/2009; Tech: HRobertson



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Nighttime Egg Densities at Station 4 per Event

FIGURE 3-7

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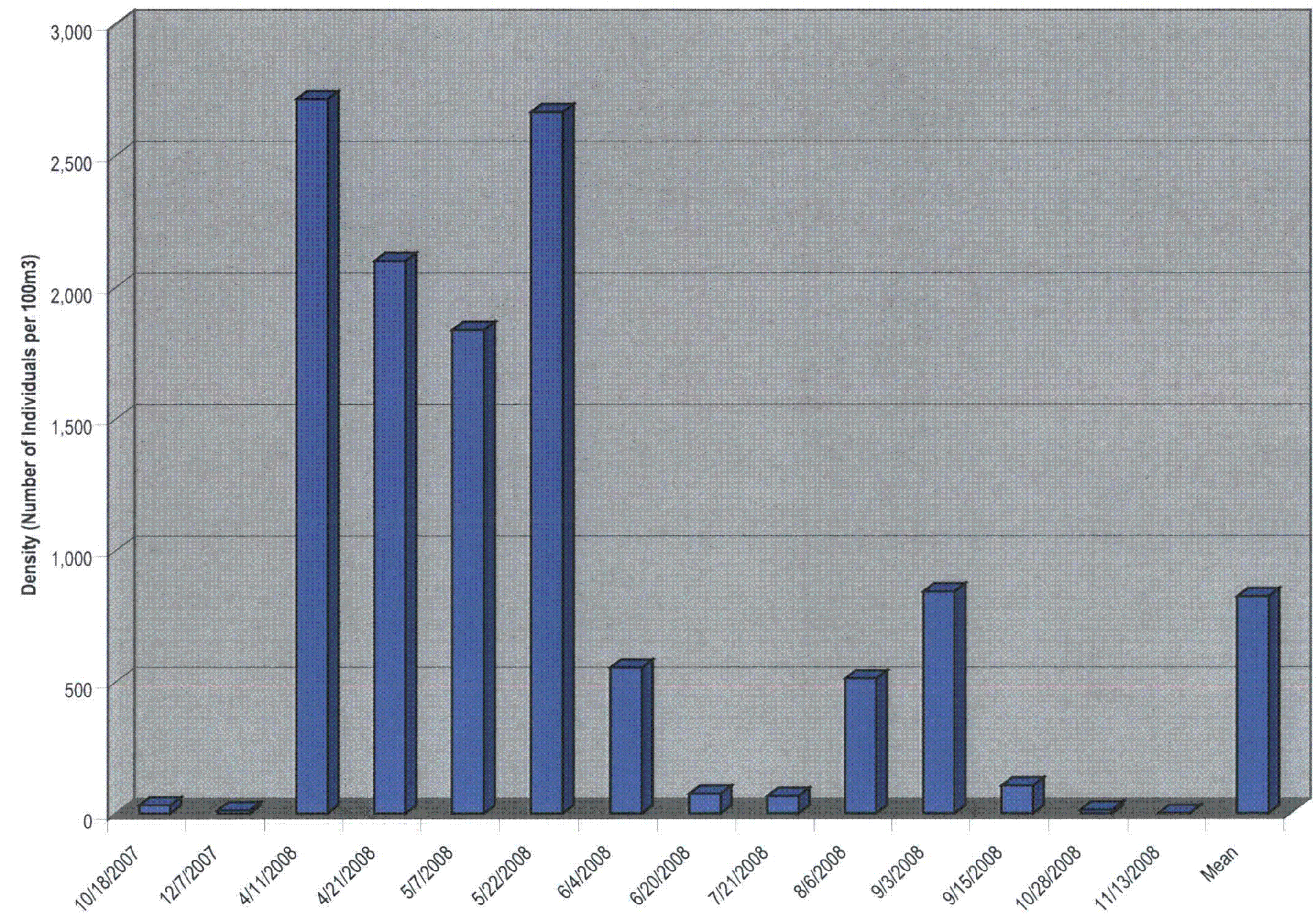

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Daytime Larvae Densities at Station 4 per Event

FIGURE 3-8

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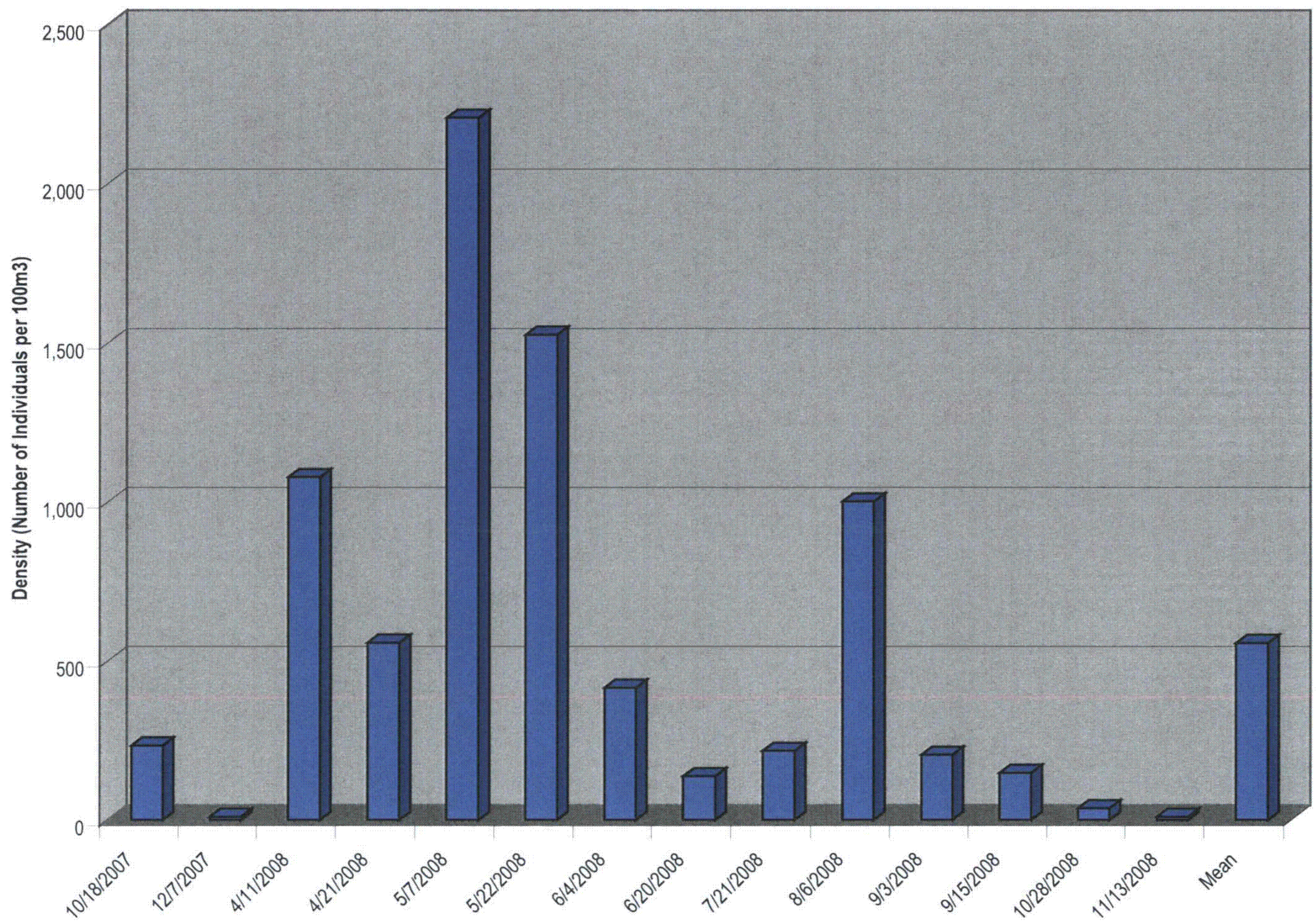

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Nighttime Larvae Densities at Station 4 per Event

FIGURE 3-9

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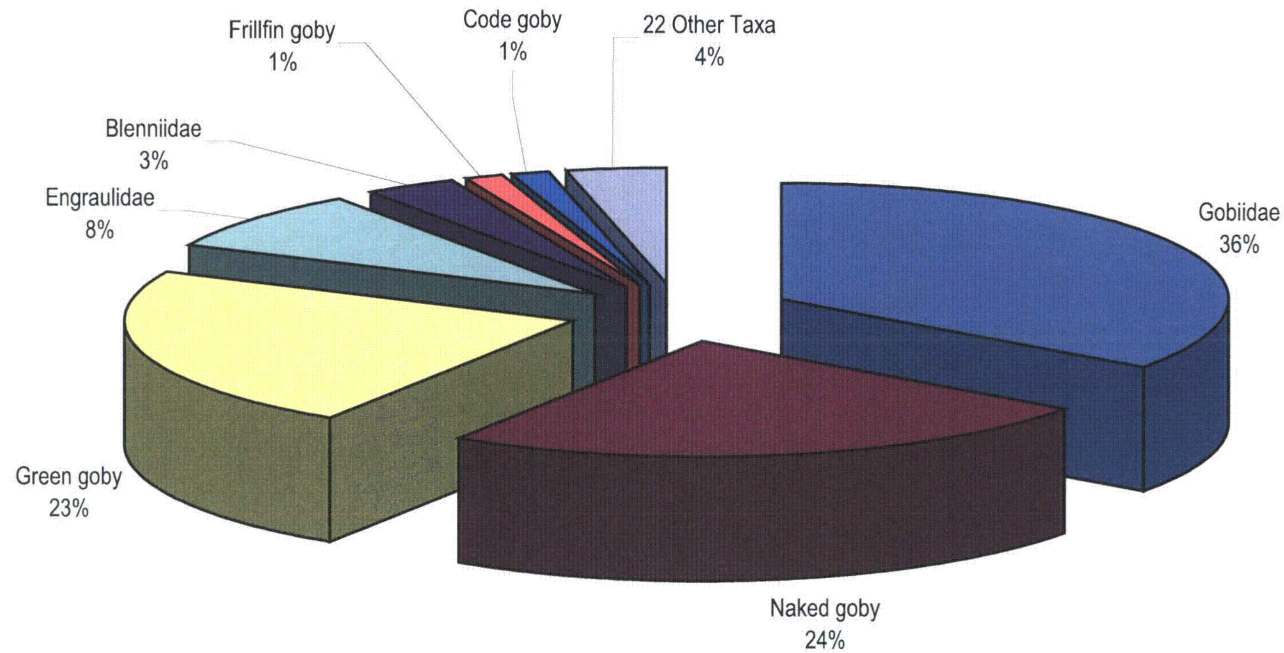

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Daytime Post Yolk-sac Larvae Species Composition at Station 4

FIGURE 3-10

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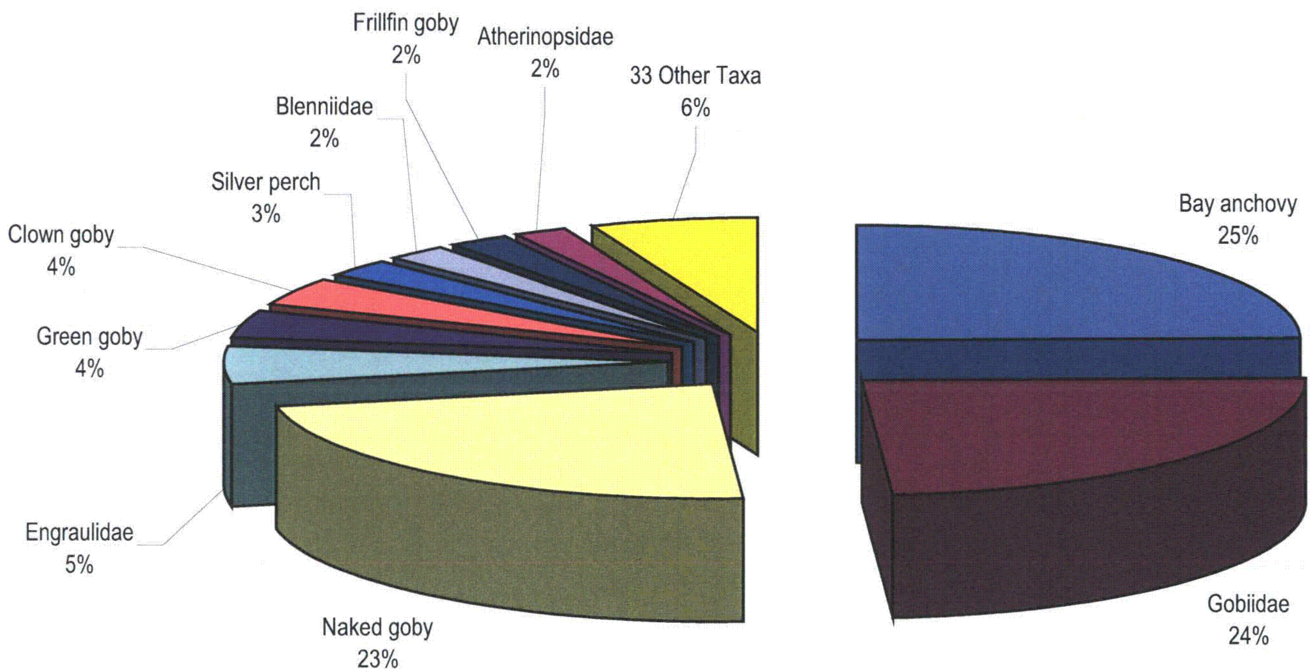

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Nighttime Post Yolk-sac Larvae Species Composition at Station 4

FIGURE 3-11

\\Odin\Groups\Publications\~JMS-2008\Progress_Energy\Wiggins\figure_3-11.pdf Date: 1/29/2009; Tech: HRobertson

4.0 Cooling Water Intake Structure Impacts

The section provides an assessment of estimated impingement and entrainment losses and projected potential impacts on the fish and shellfish populations in the CFBC from the operation of the proposed LNP CWIS.

4.1 Impingement Impacts

Projected impingement losses were qualitatively evaluated since the proposed LNP CWIS will use closed-cycle cooling (BTA) and is designed to meet the 316(b) Phase I through-screen velocity requirement of less than 0.5 fps (USEPA, 2001). The potential of motile macroinvertebrates, juvenile and adult fish, and threatened and endangered species to be impinged at LNP was evaluated using the finfish and motile macroinvertebrate data collected at Stations 3 or 4 (Section 3), life history data, and data from power plants with similar CWIS designs.

Representative species to be evaluated are those that are projected to be commonly impinged, are ecologically or economically important, or are protected species of special interest. The dominant motile macroinvertebrates were blue crabs and mud crabs. The dominant fish were bay anchovy, spotfin mojarra, gulf menhaden, and silver perch. Based on the motile macroinvertebrate and fish data, the species most likely to be impinged are blue crabs, mud crabs, bay anchovy, spotfin mojarra, gulf menhaden, and silver perch. Threatened and endangered species observed in the CFBC and nearshore Gulf of Mexico were manatees. Although sea turtles were observed approximately 7 mi. from the CFBC mouth in the Gulf of Mexico, they may enter the CFBC and are included as a representative species.

The proposed LNP CWIS is designed to have very low velocities in the immediate area of the intake to minimize impingement. Intake velocity is one of the key factors that can affect the impingement of fish and other aquatic biota, because in the immediate area of the intake, it exerts a direct physical force against which fish and other organisms must act to avoid impingement and entrainment (USEPA, 2004a). The proposed intake bay size was designed to achieve a 0.25 fps approach velocity at the bar screens at the entrance to the intake forebay and a through-screen velocity of less than 0.5 fps at the face of the traveling screens. Data from swim speed studies indicated that a 0.5 fps through-screen velocity is protective of at least 96 percent of the tested fish (USEPA, 2004a). Therefore, it can be concluded that the largest majority of healthy individuals of the macroinvertebrates and fish species collected in the CFBC have the swimming capability to swim against the 0.25 fps approach velocity and a through-screen velocity of less than 0.5 fps and will use this swimming speed capability to avoid impingement on the proposed LNP CWIS traveling screens.

Some benthic organisms, particularly blue and mud crabs, may attach to the trash racks and traveling screens to feed on the sessile organism community (barnacles, sponges, and similar marine organisms) that will quickly develop on the CWIS structures. Some of these attached crabs will be flushed from the screens during periodic screen wash events, deposited into a debris collection bin, and ultimately lost to the system. The number of crabs potentially impinged will not be known until the CWIS is operational and the post-operational phase of the planned monitoring studies are completed. It is also likely that periodic wind driven populations of low mobility organisms, such as jellyfish, will enter the CFBC and be impinged on the traveling screens. The frequency of such events and the numbers of wind driven low mobility organisms will be known only with a developed CWIS operational history.

The proposed LNP CWIS also is equipped with trash racks spaced approximately 4 in. apart (center to center), physically excluding manatee and most sea turtles from entering the intake bay and traveling screens. Therefore it can be concluded that the potential for threatened and endangered species to become impinged at the proposed LNP CWIS is very low. If smaller individuals of any endangered species do pass through the 4-in. bar screens and are trapped in the LNP CWIS forebay, PEF will inform the appropriate agencies by first contacting the USFWS and will take the appropriate actions to safely remove the animals unharmed. It should be noted that the automated trash rack cleaning system is also being designed to minimize potential impacts to manatee and that a manatee protection plan will address cleaning protocols to provide the maximum protection practical for manatees.

The conclusion from the evaluation of the CWIS design, fish, motile crustaceans, and threatened and endangered species collected or observed, literature reviews for protected species, and fish swimming speed data is that the impingement impacts from the proposed LNP CWIS are anticipated to be very low and primarily restricted to localized populations of crabs and periodic wind driven populations of low mobility organisms, such as jellyfish. Pre- and post-operational monitoring programs conducted at the proposed LNP CWIS will determine the actual level of impingement.

4.2 Entrainment Impacts

PEF intends to comply with the Final Rule at the LNP under Track I by using closed-cycle mechanical draft cooling towers to minimize entrainment of aquatic organisms. Closed-cycle cooling systems in salt water reduce the required amount of water intake by approximately 70 to 96 percent as compared to once-through cooling systems, thereby yielding equivalent reductions in entrainment of aquatic organisms (USEPA, 2001).

Life stages of marine organisms that are free-floating or have limited swimming ability and are small enough to pass through the proposed LNP CWIS traveling screen slot openings (3/8 in.) could potentially be entrained and exposed to in-plant processes, resulting in mortality. Projected entrainment losses of susceptible representative species were quantitatively estimated using the meroplankton and ichthyoplankton densities at Station 4 and the power plant flow rate. The projected impact of entrainment losses was evaluated using an equivalent adult analysis using the Goodyear/Horst model (Goodyear, 1978; Horst, 1975). A comparison of the estimated adult equivalents lost to some reference value, such as commercial harvest or estimates of the population in the area, was performed when data were available to determine the magnitude of the impact.

4.2.1 Representative Species

Representative species to be evaluated are those that are projected to be commonly entrained, ecologically or economically important, or protected species of special interest. To determine impacts of the CWIS on the species (or taxa) collected in the vicinity of the CWIS, reproductive strategies were analyzed to determine whether these species would likely be susceptible to entrainment at the proposed LNP CWIS.

Meroplankton species collected at Stations 3 and 4 that are considered recreationally or commercially important and have planktonic larvae are Pink shrimp (*Penaeus duorarum*) and Blue crab (*Callinectes sapidus*). The larvae of these two macroinvertebrate species will **likely be susceptible** to entrainment at the proposed LNP CWIS.

Overall fish reproductive strategies fall naturally into the following broad classes (Thresher, 1984):

- Demersal spawners, which produce demersal eggs and either deposit them in preselected and prepared nests or orally brood them
- Pelagic spawners, which produce pelagic eggs and generally release them at the peak of an ascent off the bottom
- Egg-scatterers, which spawn in a manner similar to the pelagic spawners, but which produce demersal eggs that settle back to the bottom in a haphazard fashion
- Benthic broadcasters, which shed planktonic eggs while remaining on the bottom
- Livebearers, which retain fertile eggs in utero until after hatching and which subsequently release live free-swimming young

The first four reproductive strategies are combinations of two variable characteristics: egg type (pelagic versus demersal) and spawning location (off the substratum versus on it). Pelagic spawners lay large numbers of small buoyant eggs, which generally have short incubation periods and produce eggs and larvae that are particularly vulnerable to predation. Demersal spawners may be divided into two general groups. The first group broadcasts large numbers of non-buoyant and possibly adhesive eggs, which have short incubation, as is the case with pelagic eggs and larvae, and are highly vulnerable to predation. The second group lays a small number of adhesive eggs in a "nest," and one or both parents guard the eggs throughout the incubation period, which may last several days, and protect eggs and newly hatched larvae from predation.

Pelagic eggs and larvae that were commonly found at Station 4 would be susceptible to entrainment at the proposed LNP CWIS. Species that exhibit dermersal spawning strategies were not considered to be susceptible to entrainment at the proposed LNP CWIS because eggs of demersal spawners that were found in the ichthyoplankton collections are considered ecologically dead (even if viable) because they are subject to abnormal predation pressure and are displaced from their normal habitat. The latter is particularly true of the second type of demersal spawner, as the adults of some species have been observed to remove abnormal eggs from the developing egg mass and eject them from the nest (Thresher, 1984).

Based on the vulnerability characteristics of the various reproductive strategies, the following families and species collected at Station 4 have pelagic eggs and/or larvae that are **likely to be susceptible** to entrainment at the proposed LNP CWIS:

- Atheriniformes, Atherinopsidae (Silversides; *Menidia sp.*)
- Carangidae (Leatherjacket; *Oligoplites saurus*)
- Engraulidae (Bay anchovy; *Anchoa mitchilli*)
- Ephippidae (Atlantic spadefish; *Chaetodipterus faber*)
- Gerreidae (Mojarras; *Eucinostomus* sp.)
- Sciaenidae (Silver perch, Spotted seatrout, Southern kingfish, Red drum)
- Synodontidae (Inshore lizardfish; *Synodus foetens*)

The following families and species collected at Station 4 are demersal spawners, and their larvae settle quickly to the bottom. As mentioned above, eggs of these families and species collected in the water column as plankton are considered ecologically dead because they are subject to abnormal predation pressure and are displaced from their normal habitat. The following families and species are **not likely to be susceptible** to entrainment at the proposed LNP CWIS:

- Achiridae (Lined sole, *Achirus lineatus*)
- Blenniidae (Blennies; *Chasmodes saburrae, Hypsoblennius sp., Lupinoblennius nicholsi*)
- Cynoglossidae (Blackcheek tonguefish; *Symphurus plagiusa*)
- Gobiesocidae (Skilletfish, *Gobiesox strumosus*)
- Gobiidae (Frillfin goby, Darter goby, Naked goby, Code goby, Clown goby, Green goby)
- Microdesmidae (Wormfishes)
- Paralichthyidae (Large-tooth flounders)
- Triglidae (Searobins)

Syngnathidae (Gulf pipefish; *Syngnathus scovelli*) collected at Station 4 brood eggs in a ventral marsupium (mouth brooders) and are **not likely to be susceptible** to entrainment at the proposed LNP CWIS.

To conclude the evaluation of the potential for entrainment at the proposed LNP CWIS based on reproductive strategies, entrainment losses of the following representative species were calculated because they are projected to be commonly entrained based on their abundance at Station 4, have pelagic eggs and larvae, and are ecologically or economically important:

- Blue crab
- Pink shrimp
- Atheriniformes, Atherinopsidae (Silversides)
- Engraulidae (Bay anchovy)

- Gerreidae (Mojarras)
- Silver perch (*Bairdiella chrysoura*)
- Spotted seatrout (*Cynoscion nebulosus*)
- Red drum (*Sciaenops ocellatus*)

4.2.2 Projected Entrainment Losses

Projected entrainment losses for each representative species was determined by calculating the projected entrained (E_T) population at the proposed LNP CWIS as follows:

$$E_T = C_P \times Q_P \times t \times m$$

where:

Cp = population densities per 100 m^3

Qp = plant design flow in 100 m^3 per day

t = time period in days (365 days)

m = estimated mortality of entrained species

Projected annual entrainment losses were calculated using densities per 100 m^3 at Stations 3 or 4. The meroplankton and ichthyoplankton data used to project annual entrainment losses was from October 18, 2007 (Event 1), to September 15, 2008 (Event 12). Events 13 and 14 were not used in the calculation because they overlapped a 1-year cycle. For example, Events 1 and 13 were taken during the same months but different years. To be conservative, Event 1 was used to project entrainment losses in October because meroplankton and ichthyoplankton densities were higher in October 2007 than in October 2008.

Entrainment during periods between sampling events was estimated by interpolation. Entrainment losses over a time were calculated by using the trapezoid rule to estimate the area (T) under the plot of population densities entrained and killed ($Cp \times t \times m$). T has the unit, No.-days/100 m^3 and substituted into equation above, which becomes:

$$E_T = T \times Q_P$$

where:

E_T = total number of organisms lost to entrainment per unit time

The projected entrainment of eggs and larvae of representative species are presented in Table 4-1. For these estimates, 100 percent mortality is assumed for any organism entrained through the power plant. Entrainment estimates are based on the average plant flow of 122 million gallons per day or 4,618 100 m^3 per day.

4.2.3 Adult Equivalent Analysis

The equivalent adult model (Goodyear, 1978; Horst, 1975) was used to estimate the equivalent number of adults lost as a result of entrainment. In computing equivalent adult loss, the number of eggs spawned is multiplied by successive survival rates through hatching, yolk-sac larvae, post yolk-sac larvae, young-of-the-year, and so on until reproductive age is reached. The resultant number is equivalent to the number of adults the eggs would have produced. Numbers of equivalent adults that would have survived from larvae are calculated similarly.

The model developed is based on Horst (1975 and 1978) and Goodyear (1978) and derived from the following equation:

$$N_{t+1} = R \; x \; N_t$$

where:

N_{t+1} = number of fish in the population at time t+1

N_t = number of fish in the population at time t

R = rate of population growth

t = time in years or generations

In a population that is in equilibrium, each breeding pair produces one replacement breeding pair:

$$2 = S_E \; x \; F,$$

or

$$S_E = \frac{2}{F}$$

where:

S_E = survival from egg to adult

F = fecundity of the female for her lifetime

Survival from egg to adult is the product of survival from egg to larva (S_{E-L}) and survival from larva to adult (S_L):

$$S_E = S_{E-L} \; x \; S_L$$

Survival from larva to adult is two divided by the product of survival from egg to larva and fecundity:

$$S_L = \frac{2}{S_{E-L} \; x \; F}$$

To estimate the equivalent number of adults (N_A) lost as a result of entrainment, the number of eggs entrained (N_E) is multiplied by survival from egg to adult (S_E) and added to the product of the number of larva entrained (N_L) and survival from larva to adult (S_L). Projected entrainment estimates for yolk-sac and post yolk-sac larvae were summed and used as the estimate for total larval entrainment in the model:

$$N_A = N_E \; x \; S_E + N_L \; x \; S_L$$

Because the specific survival rates for all life stages of all species in the study are not known, certain assumptions about the life history of species were made and theoretical survival rates were applied to entrainment estimates to calculate equivalent adults. Certain assumptions regarding the numbers of eggs and larvae, as well as survivorship and fecundity, were necessary to model equivalent adult loss of the representative species. Assumptions used to calculate the equivalent number of adults lost per representative species are presented in the following impact discussions (Subsection 4.2.4).

Table 4-2 presents the adult equivalent model results for each representative species.

4.2.4 Impacts to Representative Species

4.2.4.1 Pink Shrimp (*Penaeus duorarum*)

Pink shrimp are the most abundant shrimp in Florida, with a range extending from the lower Chesapeake Bay to south Florida (including Bermuda) in the Atlantic Ocean and into the Gulf of Mexico, terminating south of Cabo Catoche at Isla Mujeres, Mexico (Bielsa et al., 1983). They are found in the greatest abundance along the Gulf coast and are common in shallow bays, estuaries, and shallower offshore waters. The pink shrimp commercial fishery is one of the largest in Florida, and shrimping areas include the Big Bend Grounds, which extends from Pasco County along the central-west coast to Franklin County. There does not appear to be a commercial fishery for pink shrimp in Levy and Citrus counties. No commercial landings were recorded in Levy County, and only 1,631 pounds (lbs) were recorded in Citrus County (FFWCC 2008).

Spawning takes place throughout the year, but peaks when bottom water temperatures reach their maximum. Adults migrate from shallow coastal waters to deeper offshore waters to spawn (Bielsa et al., 1983). Eggs are pelagic and drift for about a half hour until becoming demersal, approximately 14 to 16 hours prior to hatching (Tabb et al., 1972). Peak spawning offshore of the Tampa Bay area occurred from April through September, with limited spawning in February and December (Eldred et al., 1961). Batch fecundity estimates have been reported to be from 66,000 to 460,000 (Martosubroto, 1974) to 860,000 (Bielsa et al., 1983). Females have been reported to spawn more than once during their lifetime (Cummings, 1961; Perez-Farfante, 1969). A small female that spawns in the spring may spawn again in the fall (Eldred et al., 1961).

Pink shrimp go through five naupliar stages, three protozoeal stages, and two to five mysis stages (Bielsa et al., 1983). Post-larvae enter estuarine and coastal bay nurseries via currents and tides with peaks of abundance in spring and late fall (Bielsa et al., 1983). Juveniles inhabit coastal bays and estuaries, and as they grow, they gradually move into deeper water (Costello and Allen, 1966). Juveniles and adults utilize soft substrates and vegetation in estuaries for habitat (Bielsa et al., 1983)

Pink shrimp post-larvae were not collected at Station 4, but were collected in relatively low abundances at Station 3 in the CFBC in July. Penaeidae and unidentified pro- and post-larval shrimp were collected at Station 3. To be conservative, Penaeidae sp. and unidentified shrimp were subdivided into pink and brown shrimp by multiplying the ratio of the density of identified pink and brown post-larvae to the unidentified shrimp, which equates to the estimated percentage of unidentified shrimp that are pink and brown shrimp. This number was then added to the known densities for pink shrimp to obtain an adjusted larval density. Based on the adjusted pink shrimp larval densities at Station 3, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 8,701,193 larvae (Table 4-1). Adult equivalents were estimated assuming an average fecundity value of 462,000 (average of 66,000, 460,000 and 860,000 x 1 spawn) and 10 percent survival from pro- to post-larvae. Based on these assumptions, an estimated annual total of 377 adult pink shrimp would be lost as a result of entrainment (Table 4-2). Assuming a total length of 100 mm and using the total length to weight conversions for female pink shrimp (Bielsa et al., 1983), 337 shrimp weigh approximately 18 lbs. This is less than 2 percent of the landings in Citrus County. Considering the size of the offshore spawning areas and regional population and landings not considered in the above calculation, there should be minimal to no impact on the pink shrimp population due to the operation of the proposed LNP CWIS.

4.2.4.2 Blue Crab (*Callinectes sapidus*)

Blue crabs are an abundant, commercially important invertebrate found from Nova Scotia to northern Argentina (Williams, 1974). Blue crabs inhabit bays and estuaries with muddy bottoms. Males are abundant in upper estuarine habitats near the mouths of rivers, while females migrate between the estuary and offshore waters to spawn. Blue crabs are a valuable food resource in the United States. The commercial blue crab landing (hard and soft) in 2007 in Citrus and Levy counties was 1,158,998 lbs (FFWCC, 2008).

Spawning takes place throughout the spring, summer, and fall (Williams, 1965; Pearson, 1948). Gravid females move offshore to spawn, carrying the egg mass on their underside, beneath their aprons, and open to the water to expose an orange, round, sponge-like mass. Depending on crab size, the "sponge" may contain from 750,000 to 8,000,000 eggs (Prager et al., 1990). Florida female crabs have been reported to produce about two million eggs per sponge (Futch, 1965). Blue crabs are serial spawners and can spawn up to three times in a season (McConaugha et al., 1983; Jones et al., 1990). Eggs hatch in 12 to 17 days, depending on water temperature, typically in high-salinity waters ranging from 23 to 30 parts per thousand (ppt) (Churchill, 1921). Crab larvae are hatched and released from the egg mass to enter a planktonic existence where they are subject to a host of environmental pressures, such as wind-driven circulation patterns, tidal currents, temperature, salinity, and extensive predation (Maryland Department of Natural Resources [MDNR], 2001). Larvae develop offshore and in the lower estuary where higher salinities are more favorable, becoming benthic as they mature and enter the estuary (FFWCC, 2005a). Blue crabs go through eight stages of development, seven zoeal stages, and one megalopae stage (Costlow and Bookhout, 1959). Early zoeal stages are located in surface waters of high salinity, 20 ppt or more (Tagatz, 1968a; Dudley and Judy, 1971; Sandifer, 1973; Dittel and Epifanio, 1982; Perry, 1975; Hill, 1989). Larval development progresses normally when salinity is between 20.1 and 31.1 ppt and temperature is approximately 77 degrees Fahrenheit (°F) (Williams, 1965). Megalopae are common in surface samples at night (Williams, 1971; Smyth, 1980).

Once in the estuarine habitat, juvenile and adult blue crabs tolerate a wide range of salinities (FFWCC, 2005a). Juveniles migrate to shallow waters of lower salinity (2 to 21 ppt) during the summer and move to deeper channels or hibernate during the winter (Van Engel, 1958; Cronin 1954). Juveniles prefer shallow salt marsh habitats with soft detritus or mud-shell and seagrass beds (Hill, 1989; Wilson et al., 1990). Blue crabs average 10 to 12 molts during the molting season, which is from mid-April to October (Millikin and Williams, 1984). Crabs are mature after 18 to 20 post-larval molts (Van Engel, 1958). Time to maturity from hatching depends on the growing season length and can range from 10 to 20 months (Perry, 1975; Van Engel, 1958). Adult blue crabs can be found from low tide to 120 feet deep in muddy bottoms covered with eel grass and salinity measurements less than 34 ppt. Adult males grow to between 117- and 181-mm carapace width, while mature females reach between 128- and 182-mm carapace width (Tagatz, 1968b).

Blue crab larvae (megalopae) were collected in relatively low abundances at Station 4 in the CFBC in May, September, October, and December. Unidentified *Callinectes* sp. were assumed to be blue crab for projected annual entrainment and equivalent adult calculations. Based on the blue crab larval densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 3,684,705 (Table 4-1). Adult equivalents were estimated assuming a fecundity value of 4,000,000 (2,000,000 x 2 sponges) and 10 percent survival from zoae to megalops larvae. Based on this evaluation, a total of 18 adult blue crabs would be lost annually as a result of entrainment (Table 4-2). Adult blue crabs weigh from 1 to 2 lbs. Assuming an adult crab weighs 1.5 lbs, 18 blue crab adults account for less than 0.002 percent of the commercial landings in Citrus and Levy counties. Considering the size of the offshore spawning areas and regional population and landings not considered in the above calculation, there should be minimal to no impact on the blue crab population due to the operation of the proposed LNP CWIS.

4.2.4.3 Bay Anchovy (*Anchoa mitchilli*)

The bay anchovy is an inshore schooling species that can be found along the Atlantic coast of the United States in estuaries and brackish water bays from Maine to Texas, with the highest abundance west and south of Cape Cod (McEachran and Fechhelm, 1998; Bigelow and Schroeder, 1953). Bay anchovy is one of the most abundant estuarine fish in the northern Gulf of Mexico and is an important forage fish species for aquatic organisms because of their small size and large numbers (Robinette, 1983). Bay anchovies have been collected in water temperatures ranging from 36 to 80.8°F and from water salinities ranging from 0 to 80 ppt (Morton, 1989).

Bay anchovies mature at 30 to 60 mm in length and probably spawn at 1 year of age (Stevenson, 1958; Hildebrand and Cable 1930). Spawning has been reported to be protracted year-round in warmer waters (Hoese and Moore, 1977), typically less than 20 m (65.6 feet) deep (Robinette, 1983). Bay anchovy females have been reported to spawn every 1.3 to 4 days, with up to 54 total spawnings (Luo and Musick, 1991). In Tampa Bay, Florida, spawning began after water temperatures reached 68°F, with spawning occurring from early spring through early summer and egg densities peaking from April through July (Robinette, 1983). Lifetime fecundity has been estimated to be 45,110 eggs per female (Luo and Musick, 1991). Eggs are pelagic and buoyant and hatch after about 24 hours at temperatures of 80.9 to 82.1°F (Kuntz, 1914) and salinities greater than 31 ppt (Scotton et al., 1973). Larvae are 1.8 to 2.7 mm at hatching (Scotton et al., 1973). At about 60 mm in length, the bay anchovy will have acquired adult characteristics (Hildebrand and Schroeder, 1928). Mortality during embryonic and larval development is high, with average seasonal egg mortality rates up to 98.2 percent (Castro and Cowen, 1991).

Engraulid eggs and larvae (including those identified as bay anchovy) were collected at Station 4 in the CFBC throughout the sampling period and collectively were the most abundant pelagic ichthyoplankton. Eggs and larvae identified as Engraulidae and Anchoa sp. were considered to be bay anchovy for projected annual entrainment and equivalent adult calculations. Based on the bay anchovy densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 1,051,989,265 eggs and 141,068,417 larvae (Table 4-1). Adult equivalents were estimated assuming a lifetime fecundity value of 45,110 and 10 percent survival from egg to larvae. An estimated total of 109,184 adult bay anchovy would be lost annually as a result of entrainment (Table 4-2).

In order to determine the relative impact from the loss of 109,184 adult anchovy, an estimate of the resident breeding population was calculated based on the number of eggs sampled in plankton tows at Station 4. The estimated number of Engraulid eggs at Station 4 per year was calculated to be 1,051,989,265 eggs/100 m^3. The breeding population of bay anchovy was estimated to be contained within the volume of water in the CFBC (359,982 100 m3). This volume was then multiplied by the estimated number of Engraulid eggs per year at Station 4 to yield 3.79×10^{14} Engraulid eggs in the CFBC per year. The resultant value was divided by an estimate of the egg incubation period for bay anchovy, which has been reported to be about 1 day (24 hours) at temperatures of 80.9 to 82.1°F (Kuntz, 1914). The production estimate calculated from this procedure was 3.79×10^{14} eggs. This estimate was then divided by the estimated fecundity of 45,110 eggs per female and multiplied by 2 to account for males. The estimated number of breeding anchovies based on the above calculations is 16,789,965,426 fish. A ratio of the number of equivalent adults calculated by the adult equivalent model (109,184 fish) and the estimate of breeding adults (16,789,965,426) represents an annual mortality of less than 0.0007 percent. Based on these calculations, the entrainment impact of the proposed LNP CWIS on the anchovy population is minimal to none.

The bay anchovy is the prime example of an opportunistic strategist, as it is a principle food source for a variety of predators, yet it is generally one of the most abundant fishes in its range. To compensate for the large amount of predation, the bay anchovy maintains a high intrinsic rate of growth by utilizing early maturation, an extended spawning season, and rapid population turnover rates (Cowen, 2002). Considering the life history of bay anchovy, along with the size of the spawning area and regional population not considered in the above calculation, there should be minimal to no impact on the bay anchovy population due to the operation of the proposed LNP CWIS.

4.2.4.4 Silversides (Antherinopsidae)

Atheriniformes and Atherinopsidae (*Menidia sp.*) yolk-sac and post yolk-sac larvae were collected in the plankton samples in low abundances at Station 4 from April to June. No silverside species were collected in the CFBC fisheries sampling. The only identified silverside species collected in the nearshore Gulf of Mexico fisheries sampling near the Crystal River Energy Complex was Tidewater silverside (*Menidia peninsulae*). This species inhabits coastal bays and estuaries with intermediate to high salinities. It has a disjunct distribution extending from Daytona Beach, Florida, to Horn Island, Mississippi, and Galveston Bay, Texas, to Timiahua, northern Veracruz, Mexico (Johnson, 1975; Chernoff et al., 1981). The reproductive ecology of the tidewater silverside was studied during February

1982 through February 1983 along the shoreline of Santa Rosa Island, Florida (Middaugh and Hemmer, 1987). The annual reproductive cycle extended from February through July or August with the highest spawning activity during March through June at water temperatures of 16.7 to 30.8°C. Spawning in response to tidal and lighting schedules in the laboratory indicated that the Tidewater silverside is predominantly a nocturnal spawner and that spawning coincides with interruptions in current velocities (Middaugh and Hemmer, 1984). Adults were observed at low tide spawning on a red alga (*Ceramium byssoideum*), which was growing in the cracks and crevices of a rocky substrate just below the low tide line (Middaugh and Hemmer, 1987).

Limited life history information is available on this species. Therefore, closely related silverside species' (Atlantic silverside and Inland silverside) life history information was used to estimate entrainment impacts. Fecundity of Atlantic silversides has ranged from 4,725 to 13,525 total eggs, with the average number of eggs actually spawned in a season of 4,500 to 5,000 per female (Fay et al., 1983). Fecundity for Inland silverside has been reported to range from 20,000 to 170,000 eggs (Weinstein, 1986).

Based on the silverside densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 11,684,123 larvae (Table 4-1). Adult equivalents were estimated assuming a lifetime fecundity value of 65,000 (average of 5,000, 20,000, and 170,000) and 10 percent survival from egg to larvae. An estimated total of 3,595 adult silversides annually would be lost as a result of entrainment (Table 4-2). Given the loss of only 3,595 adult silversides and the fact that silversides are abundant in the Gulf of Mexico, and have a short life span, high spawning frequency, and high relative fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

4.2.4.5 Menhaden (*Brevootia* sp.)

Clupeidae and *Brevoortia* sp. yolk-sac and post yolk-sac larvae were collected in low abundances in the plankton samples at Station 4 in December and from April to September. The only menhaden species collected in the fisheries collections was Gulf menhaden (*Brevoortia patronus*). Gulf menhaden were collected in relatively high abundance using cast nets in the CFBC.

Gulf menhaden are found in near shore marine and estuarine waters from Cape Sable, Florida, to Veracruz, Mexico, with centers of abundance off Louisiana and Mississippi (Lassuy, 1983a). Gulf menhaden form large surface schools, appearing in nearshore Gulf waters from about April to November (FFWCC, 2006).

Spawning is reported to occur in open Gulf of Mexico waters from 2 to 128 m (6 to 420 feet) deep (Roithmayr and Waller, 1963; Etzold and Christmas, 1979) up to 96 km (60 mi.) from shore, but is concentrated in waters of less than 18 m or 60 feet (Christmas and Waller, 1975). Gulf menhaden may spawn up to four or five times during a single spawning season, each time releasing only that fraction of the developing ova which has matured (Combs, 1969). Spawning occurs for the first time at Age 1 (FFWCC, 2006). Batch fecundity of Gulf menhaden has been reported to range from 21,860 to 151,000 for fish ages 1 to age 5 (Lassuy, 1983a). Atlantic menhaden (*Brevoortia tyrannus*) annual egg production ranges from approximately 100,000 to 600,000 eggs for fish age 1 to age 5 (USEPA, 2004b). Eggs are spherical and float near the surface (Lassuy, 1983a). Eggs hatch at sea and larvae are carried by currents into estuaries (FFWCC, 2006). Larvae may spend 3 to 5 weeks in offshore waters before moving into estuaries at 9 to 25 mm standard length (SL) (Reintjes, 1970; Etzold and Christmas, 1979), where they develop into juveniles and spend the early part of their lives (FFWCC, 2006).

Based on menhaden densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 2,005,909 larvae (Table 4-1). Adult equivalents were estimated assuming an annual fecundity value of 350,000 (mean of 100,000 and 600,000 eggs) and 10 percent survival from egg to larvae (Table 4-2). An estimated annual total of 115 adult menhaden would be lost as a result of entrainment. Given the loss of only 115 adult menhaden and the fact that they are abundant in the CFBC and in the Gulf of Mexico, and have a short life span, high spawning frequency, and high relative fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

4.2.4.6 Mojarras (*Gerreidae*)

Gerreidae and Eucinostomus spp. post yolk-sac larvae were collected in low abundances in the plankton samples at Station 4 in December and June. Three mojarra species were collected in the fisheries collections: Spotfin mojarra (*Eucinostomus argenteus*), Common mojarra (*Eucinostomus gula*), and Tidewater mojarra (*Eucinostomus harengulus*). Spotfin mojarras were the most abundant species collected using beach seines in the CFBC.

Limited life history information is available on this species or other mojarras. Spotfin mojarra occur seasonally in Chesapeake Bay and other estuaries south to Florida (Kerschner et al., 1985), to Brazil (Godefroid et al., 2001), the Bahamas, West Indies, and the Gulf of Mexico. Spotfin mojarra is an abundant, schooling fish that inhabits shallow (less than 12 m [39.3 feet] deep) areas near shore, with soft bottom areas of bays and salinities ranging from fresh to marine (Stoner, 1986; Fishbase, 2009). Mojarras are benthic feeders that use their highly protrusible mouths to forage for infaunal invertebrates, feeding primarily on bivalves, polychaetes, and crustaceans (Kerschner et al., 1985; Bronco et al., 1997). The spawning season of spotfin mojarra occurs during the warmer months of December to June in Brazilian waters (Godefroid et al., 2001). Common mojarra spawn year-round; however, the peak season is in the warmer summer months in Brazilian waters (Godefroid et al., 2001). Fecundity data for spotfin, common and tidewater mojarra were not available; however, batch fecundities of striped mojarra (*Eugerres plumieri*) have been reported to range from 85,345 to 953,870 eggs (Rubio, 1975; Arango and Rodas, 1978). Eggs are pelagic. Larval forms and juveniles of the spotfin and common mojarra are found from December to June in water temperatures of 16 to 29°C and salinities ranging from 19 to 34 ppt (Godefroid et al., 2001). Schools of juveniles are encountered more frequently in seagrass beds.

Based on mojarra densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 366,850 larvae (Table 4-1). Adult equivalents were estimated assuming an annual fecundity value of 519,608 (mean of 85,345 and 953,870 eggs) and 10 percent survival from egg to larvae. A total of 14 adult mojarra would be lost as a result of entrainment (Table 4-2). Given the loss of only 14 adult mojarra and the fact that they are abundant in the CFBC and Gulf of Mexico, and have a short life span, high spawning frequency, and high relative fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

4.2.4.7 Silver Perch (*Bairdiella chrysoura*)

Silver perch are one of the top five most abundant sciaenids in the Gulf of Mexico and the Atlantic coast (Chao and Musick, 1977; Rooker et al., 1998; Gelwick et al., 2001). Silver perch were the most abundant species collected in the CFBC using trawls.

Silver perch are found in deeper waters offshore in winter and move inshore to bays and coastal lagoons in spring to spawn between May and September (FFWCC, 2001; Gunter, 1945; Springer and Woodburn, 1960). Spawning is believed to occur in April and early May in the Tampa Bay area (Springer and Woodburn, 1960), and spawning was reported to be in the spring in the Crystal River area (Grimes and Mountain, 1971). Eggs are pelagic (Welsh and Breder, 1923). Hatching time is temperature-dependent, ranging from 40 to 50 hours at 18 to 21°C (Welsh and Breder, 1923) to 18 hours at higher temperatures (Kuntz, 1914).

Sexual maturity is reached around the first year at a length of 110 to 120 mm SL (Waggy et al., 2006). Fecundity of a mature female was estimated to be 52,800 eggs (Hildebrand and Schroeder, 1928). Eleven females collected at Crystal River had 17,920 to 147,050 eggs per female, averaging 48,140 eggs per female (Stone and Webster Engineering Corporation, 1985). Batch fecundity per ova has been reported to be up to 50,565 (Waggy et al., 2006).

The only life stage of silver perch identified during sampling was post yolk-sac larvae. Silver perch post yolk-sac larvae were collected at Station 4 from April through August. Larvae identified as Sciaenidae were subdivided into silver perch, sand weakfish, spotted seatrout, southern kingfish, and red drum by multiplying the ratio of the post yolk-sac density of these species to the Sciaenidae density, which equates to the estimated percentage of Sciaenidae that are silver perch, sand weakfish, spotted seatrout, southern kingfish, and red drum. This number was then added to the known densities for silver perch to obtain an adjusted larval density. Based on the adjusted silver perch densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 8,186,149 larvae (Table 4-1). Adult equivalents were estimated assuming a lifetime fecundity value of 144,420 (48,140 at Crystal River x 3 spawns) and 10 percent survival from egg to larvae. An estimated annual total of 1,134 adult silver perch would be lost as a result of entrainment (Table 4-2). Given the loss of only 1,134 adult silver perch and the fact that silver perch are abundant in the CFBC and Gulf of Mexico, and have a short life span, high spawning frequency, and high relative fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

4.2.4.8 Spotted Seatrout (*Cynoscion nebulosus*)

Spotted seatrout are found in coastal waters from Cape Cod, Massachusetts, to the Bay of Campeche, Mexico. Spotted sea trout are common along the entire Gulf of Mexico coast, but most abundant off eastern Louisiana, south Texas, Mississippi, and Alabama (Lassuy, 1983b). Spotted seatrout is an opportunistic carnivore that inhabits seagrass beds in shallow nearshore and estuarine waters in salinities ranging between 0 and 37 ppt (Johnson and Seaman, 1986; Lassuy, 1983b).

Spotted seatrout have a protracted spawning season and has been reported to occur in all months with a first peak in May and a lesser peak in fall in Florida and April to July in the Gulf of Mexico (Janke, 1971; Tabb, 1966). Spotted seatrout spawn in Tampa Bay from early April through October, with two major seasonal peaks in the spring and summer. Minor monthly peaks associated with the full moon also occur (USEPA, 2004b). Both sexes have been reported to mature and spawn as early as the end of their first year of life (Brown-Peterson, 2003; Sundararaj and Suttkis, 1962). Batch fecundity estimates of 1.1 million eggs were reported for spotted seatrout of 433 to 625 mm SL (Pearson, 1929; Tabb, 1961; Sundararaj and Suttkus, 1962). Females have been reported to lay up to 10 million eggs annually (USEPA 2004b). Eggs are spherical and pelagic or demersal depending upon salinity. Eggs are buoyant at a salinity of 30 ppt, but sink at 25 ppt. (Perret et al., 1980). Eggs hatch in 40 hours at 25°C (77°F) (Pearson, 1929).

The only life stage of spotted seatrout identified in the samples was post yolk-sac larvae. Spotted seatrout post yolk-sac larvae were collected in relatively low abundance at Station 4 from April through September. Larvae identified as Sciaenidae were subdivided into silver perch, sand weakfish, spotted seatrout, southern kingfish, and red drum by multiplying the ratio of the post yolk-sac density of these species to the Sciaenidae density, which equates to the estimated percentage of Sciaenidae that are silver perch, sand weakfish, spotted seatrout, southern kingfish, and red drum. This number was then added to the known densities for spotted seatrout to obtain an adjusted larval density. Post yolk-sac larvae identified as Cynoscion sp. were also assumed to be spotted seatrout and added to the adjusted larval density. Based on the adjusted silver perch densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 1,689,591 larvae (Table 4-1). Adult equivalents were estimated assuming a lifetime fecundity value of 10 million and 10 percent survival from egg to larvae. An estimated annual total of three adult spotted seatrout would be lost as a result of entrainment (Table 4-2). Given the loss of only three adult spotted seatrout and the fact that they are abundant in the Gulf of Mexico and have a high fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

4.2.4.9 Red Drum (*Sciaenops ocellata*)

Red drum are distributed from the Gulf of Maine to Tuxpan, Mexico, are rare north of New Jersey, and are most abundant in the coastal waters of eastern Florida and the Gulf states. Greatest concentrations are in Louisiana and Texas (Reagan, 1985). They inhabit coastal waters and most estuary systems in Florida. Red drum can tolerate a wide range of salinities and temperatures and can be found offshore and in freshwater riverine systems. Juveniles inhabit seagrass beds for refugia and food sources and spread further out into estuaries as they mature. Food sources include copepods, crabs, mollusks, and ray-finned fishes (FFWCC, 2005b; McEachran and Fechhelm, 2005). Adults can be found most often in groups offshore with other sexual mature red drum (FFWCC, 2005b). The red drum is one of the most important sport and commercial coastal species in the Gulf of Mexico (Reagan, 1985). Commercial landings were not reported for red drum in Citrus and Levy counties in 2007 (FFWCC 2008).

Spawning takes place at the mouth of estuaries and passes from August through mid November (Reagan, 1985). Red drum have very high fecundity, producing millions of eggs during a spawning season. Analysis of 51 specimens yielded batch fecundity estimates ranging from 0.16 million to 3.27 million oocytes (immature ovum), with a mean batch fecundity of 1.54 million ova (Wilson and Nieland, 1994). Fecundity estimates for 77 female red drum sampled offshore west-central Florida in 1996 to 1998 ranged from 114,934 to 2,318,315 oocytes (Murphy and Crabtree, 1999). Estimates of red drum fecundity in the wild range from 0.5 to 15.8 million oocytes per season (Pearson, 1929; Miles, 1950; Holt et al., 1983a).

Red drum eggs are spherical and float at salinities of 25 ppt and higher, but sink when salinities drop below 20 ppt (Holt et a1., 1981). Newly hatched red drum spend about 20 days in the water column before becoming demersal (FFWCC, 2007). Post-larvae live among seagrasses, particularly along the edges of shoal grass in Florida (Holt et al., 1983b). Post-larvae may live in open waters only during low tide and move back into cordgrass marsh at high tide. Juvenile red drum (15 to 300 mm long) tend to migrate from primary bays, which open to the sea, into secondary bays which open into primary bays (Reagan, 1985).

The only life stage of red drum identified in the plankton samples was post yolk-sac larvae. Red drum post yolk-sac larvae were collected in relatively low abundance at Station 4 in September. Larvae identified as Sciaenidae were subdivided into silver perch, sand weakfish, spotted seatrout, southern kingfish and red drum by multiplying the ratio of the post yolk-sac density of these species to the Sciaenidae density, which equates to the estimated percentage of Sciaenidae that are silver perch, sand weakfish, spotted seatrout, southern kingfish, and red drum. This number was then added to the known densities for red drum to obtain an adjusted larval density. Based on the adjusted red drum densities at Station 4, LNP volume of 122 mgd, and 100 percent mortality from the LNP cooling water system, annual entrainment was projected to be 390,585 larvae (Table 4-1). Adult equivalents were estimated assuming a lifetime fecundity value of 2 million eggs and 10 percent survival from egg to larvae. An estimated annual total of four adult red drum would be lost as a result of entrainment (Table 4-2). Given the loss of only four adult red drum and the fact that they are abundant in the Gulf of Mexico and have a high fecundity, the impact on the entire population in the CFBC and Gulf of Mexico due to the operation of the proposed LNP CWIS would likely be minimal to none.

TABLE 4-1
Projected Entrainment of Eggs and Larvae of Representative Species

Taxa	Species	Common Name	Annual Eggs Entrained	Annual Larvae Entrained
Penaeidae	*Farfantepenaeus duorarum*	Pink shrimp	0	8,701,193
Portunidae	*Callinectes sapidus*	Blue crab	0	823,752
Portunidae	Callinectes sp.	Blue crab	0	2,860,953
Atheriniformes		Silverside	0	4,861,721
Atherinopsidae		Silverside	0	6,072,127
Atherinopsidae	Menidia sp.	Silverside	0	750,275
Clupeidae		Herrings, sardines, and menhaden	0	1,295,878
Clupeidae	Brevoortia sp.	Menhaden	0	710,031
Engraulidae		Anchovy	1,051,989,265	88,594,554
Engraulidae	*Anchoa mitchilli*	Bay anchovy	0	50,801,550
Engraulidae	Anchoa sp.	Anchovy	0	1,672,313
Gerreidae		Mojarra	0	204,575
Gerreidae	Eucinostomus sp.	Mojarra	0	162,275
Sciaenidae	*Bairdiella chrysoura*	Silver perch	0	8,186,149
Sciaenidae	*Cynoscion nebulosus*	Spotted seatrout	0	1,689,591
Sciaenidae	*Sciaenops ocellatus*	Red drum	0	390,585

TABLE 4-2
Adult Equivalent Model Results

Taxa	Species	Common Name	Annual Adult Equivents from Eggs	Annual Adult Equivents from Larvae	Total Annual Adult Equivalents
Penaeidae	Farfantepenaeus duorarum	Pink shrimp	0	337	337
Portunidae	Callinectes sapidus	Blue crab	0	4	4
Portunidae	Callinectes spp.	Blue crab	0	14	14
Atheriniformes		Silverside	0	1,496	1,496
Atherinopsidae		Silverside	0	1,868	1,868
Atherinopsidae	*Menidia sp.*	Silverside	0	231	231
Clupeidae		Herrings, sardines, and menhaden	0	74	74
Clupeidae	*Brevoortia sp.*	Menhaden	0	41	41
Engraulidae		Anchovy	46,641	39,279	85,920
Engraulidae	*Anchoa mitchilli*	Bay anchovy	0	22,523	22,523
Engraulidae	*Anchoa sp.*	Anchovy	0	741	741
Gerreidae		Mojarra	0	8	8
Gerreidae	*Eucinostomus sp.*	Mojarra	0	6	6
Sciaenidae	*Bairdiella chrysoura*	Silver perch	0	1,134	1,134
Sciaenidae	*Cynoscion nebulosus*	Spotted seatrout	0	3	3
Sciaenidae	*Sciaenops ocellatus*	Red drum	0	4	4

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