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AN ECOLOGICAL STUDY OF THE SUSQUEHANNA RIVER NEAR THE THREE MILE ISLAND NUCLEAR STATION

Annual Report for 1982

by

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For

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1.0 INTRODUCTION AND SUMMARY

Ichthyological Associates, Inc. (IA) studied the aquatic ecology of the Susquehanna River near the Three Mile Island Nuclear Station (TMINS) for GPU Nuclear Corporation during 1982. The broad objectives are to obtain a comprehensive data base necessary to establish the natural fluctuations and baseline conditions of various parameters within the ecosystem and on site, and thereby identify any significant biological alterations resulting from the TMINS. Data from studies prior to 1982 have been presented in annual reports (1974 through 1981). The present report is a summary of the aquatic studies of the ecology of York Haven Pond, a mainstream impoundment on the lower Susquehanna River in southeastern Pennsylvania, conducted during 1982. Various physicochemical characteristics of the river were measured, and macroinvertebrate and fish populations were monitored. Descriptions of sampling procedures, detailed data tabulations, and interpretation of the results are presented in this report.

The Susquehanna River has a total drainage area of about 71 X 10^3 km^2 (27,400 square miles) and extends about 715 km (444 miles) in length. The TMINS is located on Three Mile Island (TMI) about 275 m from the east bank of the Susquehanna River in Londonderry Township, Dauphin County, Pennsylvania at river kilometer 90 (river mile 56). The nearest metropolitan area is Harrisburg, Pennsylvania located about 16 km (10 miles) northwest of the Station.

The TMINS consists of two pressurized water reactors, with a total electrical generating capacity of 1,830 megawatts (871 mega-

watts for Unit 1 and 959 for Unit 2). Commercial operation of Unit 1 began in 1974 and Unit 2 in 1978. The TMINS is jointly owned by Metropolitan Edison Company (50%), Jersey Central Power and Light (25%), and Pennsylvania Electric Company (25%). All are wholly owned subsidiaries of General Public Utilities Corporation (GPU). During 1982, both Unit 1 and 2 remained shutdown pending regulatory response to uncertainties arising from the March 1979 accident at Unit 2.

The Station is surrounded, except along its southern border, by a small reservoir formed by York Haven and Red Hill dams. The (York Haven) pond created by the dams extends about 6 km (3.5 miles) upstream and forms the area for the aquatic studies. Normal pond elevation is 84 m (277 feet) above mean sea level and mean depth is about 3 m (9 feet). At the site, the Susquehanna River is about 2,135 m (7,000 feet) wide and divided by islands into three channels (west, center, and east). The Intake and Discharge structures for TMINS are located along the west shore of TMI and utilize water from the center channel.

1.1 Macroinvertebrates

Macroinvertebrates were collected once in January and semi-monthly March through December 1982. A total of 66,048 specimens representing 165 taxa was collected.

Total number of taxa was the highest since 1974. Total number of organisms, density, and biomass were the lowest to date; low number of organisms was a continuation of trends noted since the 1980 drought.

Dominant taxa were Limnodrilus hoffmeisteri, Chironomus decorus group sp., and Pisidium spp. Elimia virginica, C. decorus group sp., and L. hoffmeisteri had the greatest biomass.

Fifteen species were collected for the first time in macroinvertebrate samples during 1982.

Spring breeding and population growth of Limnodrilus hoffmeisteri were found to be localized. Spring breeding and growth of the emergent insect, Chironomus decorus group sp., were synchronized at the stations.

Number of taxa collected in March at Station 1A2 was the highest to date. Monthly diversity ranged from 0.95 to 3.63. Similar to 1981, the annual diversity at each station in 1982 was highest at 1A1 and lowest at 9B1; diversity at 11A1 was the second highest. Greatest similarity (PSc) was between Stations 11A1 and 9B1 (91%). As in previous years Station 1A1 was least similar (PSc) to all other stations. The 1982 results were similar to 1981; low density of Limnodrilus hoffmeisteri, high density of Chironomus decorus group sp., and high diversity values at all stations relative to other years.

Analysis of covariance showed a significant change in the slopes of Limnodrilus hoffmeisteri densities, using control Station 1A2 as the independent variate and indicator Station 11A1 as the dependent variate, between years of plant operation (1975 through 1978) and those of plant shutdown (1979 through 1982). Differences in slopes may be related to slight changes in the

(11.1%). The four most frequently impinged fishes at Unit 2 were the tessellated darter (21.7%), channel catfish (11.3%), redbreast sunfish (10.0%), and pumpkinseed (9.5%).

Statistical analyses showed no significant differences in numbers of fish impinged during the three 8-hour time intervals, but did reveal a difference between years. Numbers of fish impinged were significantly greater in 1977 than all other years. Significantly more fish were dead than alive at both Intakes. Relationships between species composition of impingement surveys and seine and electrofishing samples taken near the Intakes were weak. The impact of impingement upon Susquehanna River fish populations near TMINS was negligible in 1982.

1.5 Fish

1.5.1 Trapnet

Trapnet collections were taken at four stations once in March and semimonthly April through December 1982. A total of 152 collections (38 collections at each station) yielded 2,531 fish of 27 species and one hybrid. Most fish (1,032) and most species (22) occurred at Station 9B2. The mean number of fish per collection ranged from 11.84 at Station 11A3 to 27.16 at Station 9B2. The largest monthly catch occurred in May (504 fish) and coincided with the peak pumpkinseed catch (330).

Common fishes included the pumpkinseed (41.2% of the catch), black crappie (14.8%), white crappie (14.0%), rock bass (7.6%), and bluegill (6.7%). The common carp accounted for the greatest biomass for a single species (73.08 kg). Juvenile and adult pump-

kinseed condition factors in 1982 were higher than their corresponding 1981 values. Most pumpkinseed, white crappie, and black crappie collected were adults. Pumpkinseed abundance and spawning appeared to vary with water temperature fluctuations in May and June.

Parasite occurrence was minimal throughout the year and exceeded 10 occurrences per month only in May and November. No pattern of parasite infection, fish anomalies, or fishkills was observed with respect to the location of TMINS.

Although the 1982 total catch, number of specimens per collection, biomass, and diversity index were lower than their 1981 counterparts, values were well within the ranges established in previous years. Catch reductions were likely caused by natural fluctuations in water temperature, river flow, and fish populations and were not related to TMINS.

1.5.2 Seine

Seine collections were taken at 10 stations once in January and semimonthly March through December 1982. A total of 871 hauls yielded 102,892 fish of 40 species. Most fish (33,130) and greatest biomass (5.82 kg) occurred at Station 13B5 while most species (28) were taken at both 10B5 and 1A2. The mean number of specimens per haul ranged from 22.60 at Station 9A1 to 552.17 at Station 13B5. Most fish (19,417) were captured in September. Peak biomass (3.66 kg) occurred in June.

The spotfin shiner comprised 80.8% of the catch and was the most abundant species at all stations. Other common species were

the mimic shiner (5.0%), spottail shiner (3.8%), pumpkinseed/bluegill (1.9%), pumpkinseed (1.6%), bluegill (1.3%), bluntnose minnow (1.2%), white sucker (1.1%), and tessellated darter (1.0%). New maximum values for minnow and sunfish composition were set at four and two stations, respectively. Spotfin shiner dominance led to low diversity indices, but high percent similarities.

Differences in spotfin shiner mean weights and condition factors were negligible among stations with large comparable catches. Growth of the 1981 spotfin shiner year class did not appear to resume until June 1982.

Parasite occurrence was moderate to heavy throughout the year. Patterns of parasite infection and fish abnormalities were similar to those reported in previous years and seemed most affected by natural trends in parasite life cycles, water temperature, and fish size rather than by TMINS.

Results indicated that although large differences in annual seine catches have occurred, the magnitudes of changes and species rankings at stations have remained similar. Seasonal Susquehanna River flow patterns favor the intermittent spawning of spotfin shiner. Discrepancies with key factors for impact assessment were attributed to the effects of naturally occurring environmental variables on the year class strengths of common resident fishes.

1.5.3 Electrofishing

A boat-mounted AC electrofisher was used to sample 12 nearshore zones in York Haven Pond March through December 1982. A total of 6,341 fish of 27 species and one hybrid was captured. The pumpkinseed was the most abundant species. Five centrarchids, the rock bass,

redbreast sunfish, pumpkinseed, bluegill, and smallmouth bass accounted for 68.8% of the total catch.

Condition factor (K) was computed for all rock bass, redbreast sunfish, pumpkinseed, smallmouth bass, and walleye captured during April through November, 1976 through 1982. Statistical analyses indicated monthly and yearly differences among mean K factors for all five fishes. Rock bass, redbreast sunfish, and pumpkinseed mean K's were largest in June, probably reflecting gonadal maturation of these fishes. Smallmouth bass and walleye mean K's were high during June through September, probably indicating that summer is the maximum growth season of these fishes in York Haven Pond. Yearly differences in mean K factors probably reflect differences in monthly abundance.

Species diversity indices (H') computed for the total catch at each zone ranged from 2.67 (Zone 10B1) to 3.19 (15B2). The smallest monthly H' (all zones combined) occurred in June (2.96) and the largest (3.27) in October.

Percent similarity and Kendall's τ, both measures of species importance in the catch, showed similar groupings of zones.

The mean numbers of fish per minute captured during 15 sampling periods (April through the first November sample date) over six years (1977 through 1982) were compared with a three factor analysis of variance. Years, sampling periods, and zones all showed significant differences ($P \leq 0.05$). The years 1977, 1978, 1979, and 1981 were similar; all were significantly larger than 1982. All years were significantly larger than 1980. Among sampling

periods, spring (second April and first May sample dates) and fall (both October sample dates) had the largest means, while summer means (June through first August sample date) were smallest. Zones 10A3 and 16A2 were similar and significantly larger than most other zones; 15A2 and 10B1 were similar and significantly smaller than all other zones.

A stepwise multiple linear regression that utilized selected physicochemical parameters measured with each collection accounted for only 17.7% of the variability in numbers of fish per minute data.

Differences in species composition and abundance among zones, sampling periods, and years were probably due to habitat differences, changes in river flow and water temperature, and natural fluctuations inherent in fish populations.

1.6 Movements of Fishes

A total of 1,165 fish was tagged in 1982: 16 brown bullhead, 158 channel catfish, 476 rock bass, 426 smallmouth bass, 54 largemouth bass, and 35 walleye.

The total number of recaptures in 1982 was 116: 5 brown bullhead, 9 channel catfish, 60 rock bass, 37 smallmouth bass, 3 largemouth bass, and 2 walleye. Most 1982 recaptures (3 brown bullhead, 7 channel catfish, 48 rock bass, 28 smallmouth bass, 3 largemouth bass, and 1 walleye) were taken within York Haven Pond.

Numbers of mobile (18) and sedentary (14) brown bullhead recaptured since 1974 were similar. The majority of mobile brown bullhead (66.7%) made complex movements.

The number of mobile (34) channel catfish recaptured since 1974 was significantly larger than the number of sedentary (8) individuals.

Numbers of mobile (209) and sedentary (246) rock bass recaptured since 1974 were similar. Analysis indicated that type of movement was independent of season; distance moved was not. More than 59% of the mobile rock bass were recaptured within 2.0 km of the tagging site.

Numbers of mobile (131) and sedentary (164) smallmouth bass were similar. Analysis indicated that type of movement was independent of season; distance moved was not. More than 57% of the mobile smallmouth bass were recaptured within 2.0 km of the tagging site.

Numbers of mobile (15) and sedentary (13) largemouth bass recaptured since 1976 were similar.

Numbers of mobile (40) walleye recaptured since 1975 were significantly larger than sedentary (3) individuals. Most (83.7%) walleye moved upstream.

The proportions of mobile brown bullhead that made upstream and complex movements; rock bass that moved downstream; and walleye that made all these types of movements were significantly different from 1/3 ($P \leq 0.05$). For all species combined, the number of fish that moved upstream was significantly greater than 1/3, while the number moving downstream was significantly less than 1/3. Apparently, fish tagged in York Haven Pond have a tendency to move upstream.

Analysis of movements made by rock bass and smallmouth bass tagged in areas upstream and downstream of the TMINS Discharge indicated no differences in type of movements or distances moved by fish tagged in these areas. TMINS probably had no effect on the movements of fishes tagged nearby.

1.7 Population Estimates of Fishes

Population estimates of rock bass, redbreast sunfish, pumpkinseed, bluegill, smallmouth bass, and walleye were made at four zones near TMINS in summer (23 June through 28 July) and/or fall (27 September through 1 November) 1982. Comparison of estimates among zones during each sampling period and among sampling periods at each zone (fall 1974, summer and fall 1975, summer 1976, summer and fall 1977, summer and fall 1978, summer and fall 1980, summer and fall 1981, and summer and fall 1982) were made by inspection of the 95% confidence limits.

The mean numbers of fish per minute captured at each zone during 13 sampling periods were compared with a two factor analysis of variance. Sampling periods showed the largest difference followed by zones and their interactions. Differences among zones probably reflected habitat differences. Differences among sampling periods probably reflected fish response to variations in environmental parameters such as river flow and water temperature.

1.8 Creel Surveys

Roving creel surveys were conducted on the Susquehanna River near TMINS from January through December 1982. An estimated 19,914 anglers caught 45,603 fish, kept 12,546 fish, and fished for 34,053 hours;

resulting in an estimated annual catch/effort (c/e) of 1.34 and havest/effort (h/e) of 0.37. The number of anglers, fish kept, and hours fished were the highest since the inception of the program in 1974. The largest number of anglers, fish caught, fish kept, and hours fished in all areas combined were reported in May; however, the largest c/e and h/e were recorded in April and November, respectively. The York Haven Generating Station and General Reservoir areas combined, accounted for most anglers, fish caught, fish kept, and hours fished. The West Dam area had the highest c/e and the East Dam the highest h/e.

The channel catfish, rock bass, smallmouth bass, and walleye comprised 82.8% of the total catch and 68.6% of all fish kept. The smallmouth bass was the most abundant species caught and kept by anglers ranking first in the catch, April through November.

Over 70% of the anglers interviewed were residents of York or Dauphin counties. Most anglers indicated that they ate at least some of their catch. One hundred thirteen (4.4%) anglers still reported a change in use of catch due to the 1979 TMINS accident, with change being independent of residence and age group.

1.9 Water Quality

Surface water samples were collected once in January and semi-monthly March through December 1982.

Most data collected were within ranges that have been established since 1978. However, new maximum values were recorded for turbidity and total copper.

emergent insect, C. decorus group sp. Large numbers of C. decorus group sp. fourth instar larvae were present at each station on the same sample date. Spring breeding of L. hoffmeisteri did not occur on the same date at all stations. The more spatially isolated L. hoffmeisteri tend towards localized breeding cycles.

2.2.2.4 STATISTICAL ANALYSIS

Results of the three factor ANOVA for Limnodrilus hoffmeisteri residual density were significant for sample date, station, replicate, and the date-station interaction (Table 2.2-59). Although the date effect was significant it was low relative to station effect. Results of the SNK test on replicates showed replicates A and D were not significantly different; replicates A, B, and C were not significantly different from each other. The SNK test performed on station residual mean densities is presented in Table 2.2-60, along with the actual mean densities. Stations 11A1 and 11A2 were not significantly different.

2.2.3 COMMUNITY ANALYSIS

2.2.3.1 TAXA

Seasonal distribution of the number of taxa at the stations was lowest in April and June (18 taxa) at 11A2 and 9B1, respectively, and highest in March at 1A2 (66 taxa) (Figure 2.2-7). The 66 taxa were the highest monthly total ever collected (Nardacci and Associates 1977, 1978, 1979, 1980, 1981, 1982; Potter and Associates 1975, 1976). The high number may be attributed in part to drift from high spring flows (Hynes 1970). Number of taxa were evenly distributed among stations; no station contained continually higher numbers of taxa than the others.

2.2.3.2 DIVERSITY

Monthly diversity (H') values ranged from 0.95 in March at Station 9B1, when Limnodrilus hoffmeisteri comprised 87% of the organisms (23 taxa), to 3.63 in March at 1A2, when L. hoffmeisteri comprised 41% of the organisms (66 taxa) (Table 2.2-61). Peak monthly diversity at each station occurred in August at 1A1, March at 1A2, April at 11A1, January at 11A2, and November at 9B1.

Monthly station comparison of H' values in 1982 showed peak diversity occurred at Station 1A1 during 6 of the 11 months sampled. Numbers of taxa at Station 1A1 were not higher than the other stations, but diversity values were higher. The higher H' values were attributed to relatively low densities of all species present throughout the year.

Annual H' values based on all data collected at each station are presented in Table 2.2-61. Diversity was highest (2.93) at Station 1A1, and lowest (2.13) at 9B1; diversity at the TMINS Discharge (11A1) was second highest (2.67).

2.2.3.3 PERCENT SIMILARITY

Range of percent similarity values (PSc) between stations is presented in Table 2.2-62. The greatest similarity was between Stations 11A1 and 11A2 (91%). As in other years Station 1A1 was least similar to all other stations. Lowest similarity was between 1A1 and 9B1 (51%). The reason for low PSc values between 1A1 and the other stations was attributed to habitat differences.

Station 11A1 and another station. Station diversities in 1982 were more similar than any other year. The narrow range between station diversity in 1982 was attributed to a more even distribution of Limnodrilus hoffmeisteri and Chironomus decorus group sp. populations among the stations relative to other years.

2.4 SUMMARY

In 1982, the lowest number of organisms were collected since 1974; annual diversity was highest and similar to the 1981 diversity. In general, 1982 results were much like those of 1981; relatively low density of Limnodrilus hoffmesiteri, relatively high density of Chironomus decorus group sp., and high diversity values at all stations combined relative to other years. These results were attributed to the 1980 drought.

Analysis of covariance performed on Limnodrilus hoffmeisteri densities showed a linear relationship between control Station 1A2 and each indicator station. ANCOVA showed a significant change in slopes, using control Station 1A2 as the independent variate and indicator Station 11A1 as the dependent variate, between years of plant operation (1975 through 1978) and those of plant shutdown (1979 through 1982). Differences in slopes may be related to slight changes in the thermal and/or chemical make-up of the TMINS Discharge.

was as follows: common carp (6), quillback (2), white sucker (1), northern hog sucker (1), shorthead redhorse (6), unidentifiable sucker (2), unidentifiable bullhead (1), channel catfish (14), rock bass (1), redbreast sunfish (1), smallmouth bass (25), and walleye (1). Dead fish were most numerous in May (20 specimens), June (11), and July (18) and may have originated upstream outside the study area. The 1982 dead fish total (61) was similar to that reported in 1981 (64) and much less than 1980 (136) or 1979 (107) (Nardacci and Associates 1982).

No pattern of parasite infection, anomalies, or fishkills was observed with respect to the location of TMINS.

6.1.3 DISCUSSION

The 1982 trapnet catch (2,531 fish) represented a decrease of over 1,000 fish from the peak catch (3,580) established in 1981. Other 1982 totals of number of specimens per collection (16.65) and biomass (371.70 kg) also represented decreases from their 1981 counterparts (23.55 and 402.55 kg, respectively). However, the 1982 diversity index (2.83) was similar to the 1981 value (2.85).

Annual catches of channel catfish, rock bass, pumpkinseed, white crappie, and black crappie are illustrated in Figure 6.1-2. The channel catfish catch was less than half the 1981 value and represented the second lowest annual catch. Except for 1974 and 1975 channel catfish catches which were dominated by juveniles, most specimens captured have been adults. The rock bass catch declined from the

Table 6.1-2

List of scientific and common names of fishes collected by Ichthyological Associates, Inc. from the Susquehanna River near TMINS since 1974.

Scientific Name	Common Name
Amiidae	Bowfins
Amia calva Linnaeus	Bowfin
Anguillidae	Freshwater eels
Anguilla rostrata (Lesueur)	American eel
Clupeidae	Herrings
Alosa aestivalis (Mitchill)	Blueback herring
Alosa pseudoharengus (Wilson)	Alewife
Alosa sapidissima (Wilson)	American shad
Dorosoma cepedianum (Lesueur)	Gizzard shad
Salmonidae	Trouts
Salmo gairdneri Richardson	Rainbow trout
Salmo trutta Linnaeus	Brown trout
Salvelinus fontinalis (Mitchill)	Brook trout
Esocidae	Pikes
Esox lucius Linnaeus	Northern pike
Esox masquinongy Mitchill	Muskellunge
Esox niger Lesueur	Chain pickerel
Cyprinidae	Carps and Minnows
Campostoma anomalum (Rafinesque)	Central stoneroller
Carassius auratus (Linnaeus)	Goldfish
Cyprinus carpio Linnaeus	Common carp
Exoglossum maxillingua (Lesueur)	Cutlips minnow
Nocomis micropogon (Cope)	River chub
Notemigonus crysoleucas (Mitchill)	Golden shiner
Notropis amoenus (Abbott)	Comely shiner
Notropis cornutus (Mitchill)	Common shiner
Notropis hudsonius (Clinton)	Spottail shiner
Notropis procne (Cope)	Swallowtail shiner
Notropis rubellus (Agassiz)	Rosyface shiner
Notropis spilopterus (Cope)	Spotfin shiner
Notropis volucellus (Cope)	Mimic shiner
Pimephales notatus (Rafinesque)	Bluntnose minnow
Pimephales promelas Rafinesque	Fathead minnow
Rhinichthys atratulus (Hermann)	Blacknose dace
Rhinichthys cataractae (Valenciennes)	Longnose dace
Semotilus atromaculatus (Mitchill)	Creek chub
Semotilus corporalis (Mitchill)	Fallfish
Catostomidae	Suckers
Carpiodes cyprinus (Lesueur)	Quillback
Catostomus commersoni (Lacepède)	White sucker
Hypentelium nigricans (Lesueur)	Northern hog sucker
Moxostoma macrolepidotum (Lesueur)	Shorthead redhorse
Ictaluridae	Bullhead catfishes
Ictalurus catus (Linnaeus)	White catfish
Ictalurus natalis (Lesueur)	Yellow bullhead
Ictalurus nebulosus (Lesueur)	Brown bullhead
Ictalurus punctatus (Rafinesque)	Channel catfish
Noturus insignis (Richardson)	Margined madtom
Cyprinodontidae	Killifishes
Fundulus diaphanus (Lesueur)	Banded killifish
Gasterosteidae	Sticklebacks
Culaea inconstans (Kirtland)	Brook stickleback
Percichthyidae	Temperate basses
Morone americana (Gmelin)	White perch
Morone saxatilis (Walbaum)	Striped bass
Centrarchidae	Sunfishes
Ambloplites rupestris (Rafinesque)	Rock bass
Lepomis auritus (Linnaeus)	Redbreast sunfish
Lepomis cyanellus Rafinesque	Green sunfish
Lepomis gibbosus (Linnaeus)	Pumpkinseed
Lepomis macrochirus Rafinesque	Bluegill
Micropterus dolomieui Lacepède	Smallmouth bass
Micropterus salmoides (Lacepède)	Largemouth bass
Pomoxis annularis Rafinesque	White crappie
Pomoxis nigromaculatus (Lesueur)	Black crappie
Percidae	Perches
Etheostoma olmstedi Storer	Tessellated darter
Etheostoma zonale (Cope)	Banded darter
Perca flavescens (Mitchill)	Yellow perch
Percina peltata (Stauffer)	Shield darter
Stizostedion vitreum vitreum (Mitchill)	Walleye

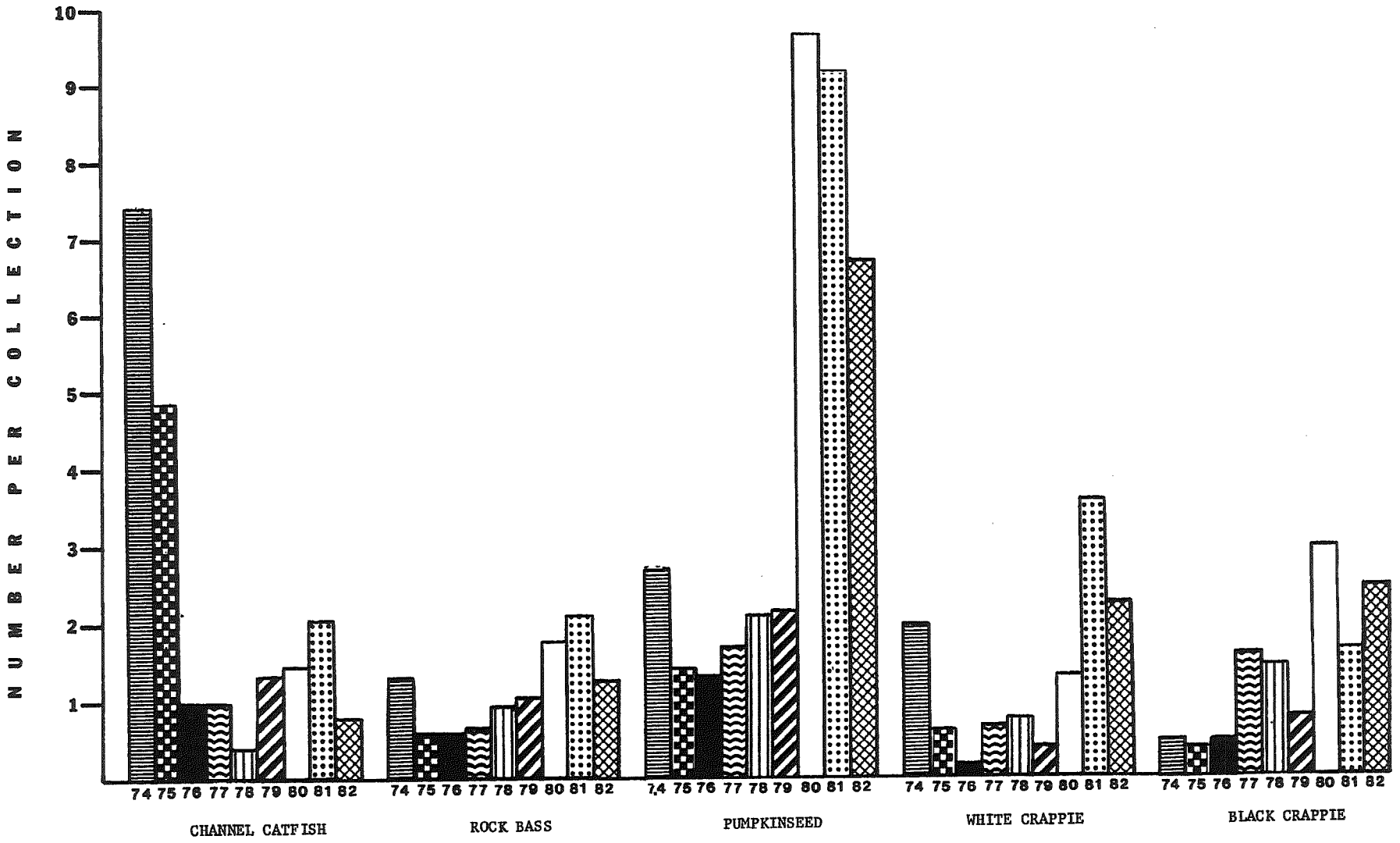

Figure 6.1-2. Yearly catches (number per collection) of channel catfish, rock bass, pumpkinseed, white crappie, and black crappie taken by trapnet near TMINS, 1974 through 1982.

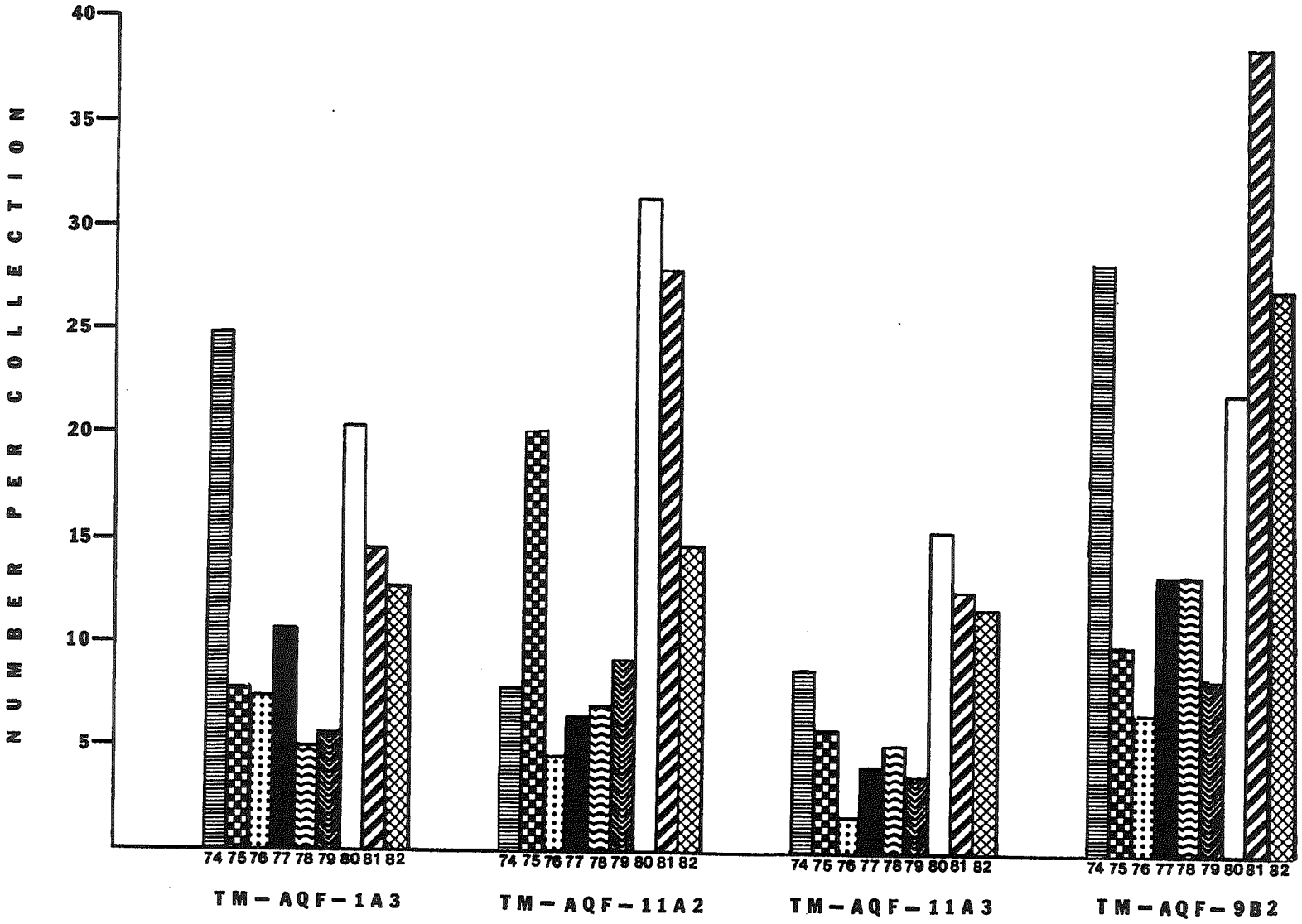

Figure 6.1-3. Yearly total catch (number per collection) at trapnet stations near TMINS, 1974 through 1982.

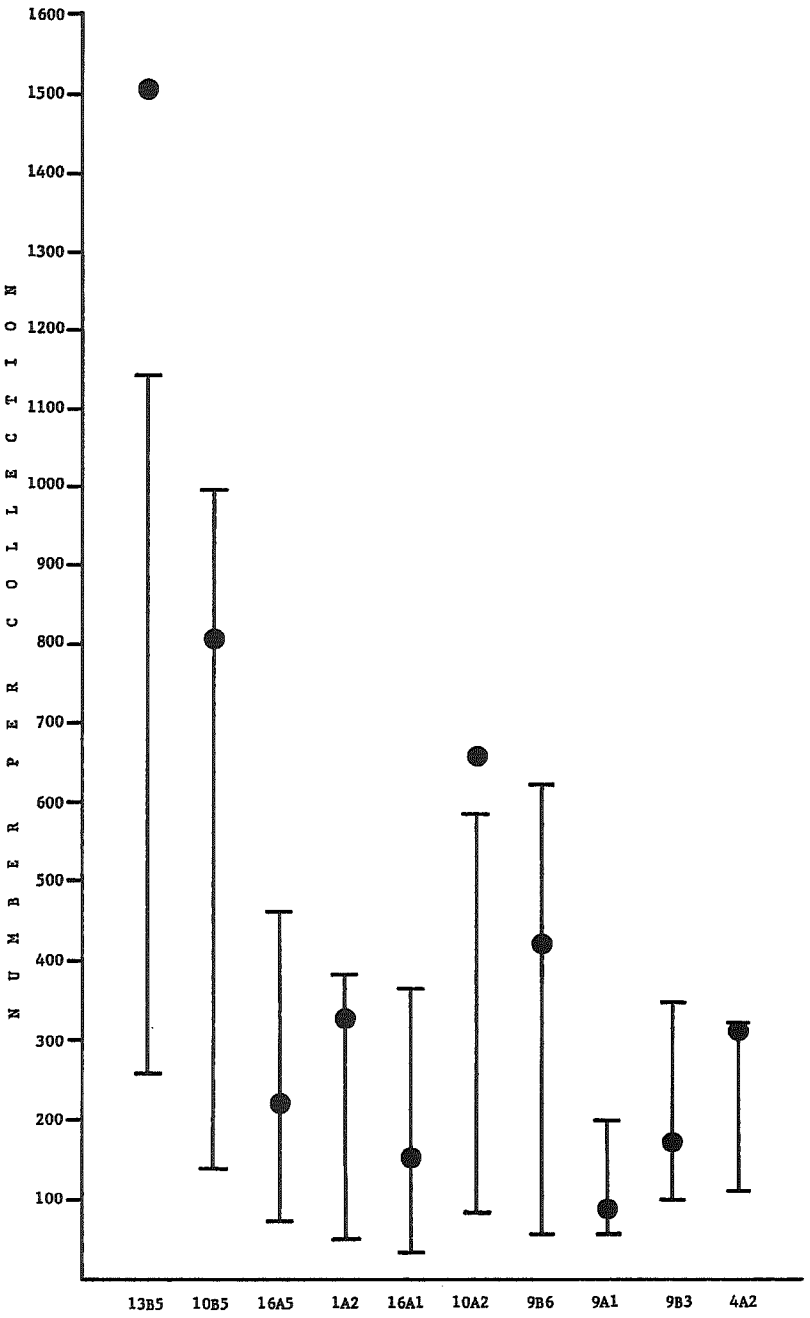

Figure 6.2-4. Range of yearly catches (number per collection) at seine stations 1974 through 1981 compared to 1982 catches (●). Sampling at 13B5, 10B5, 16A5, 9B6, and 4A2 began in 1976.

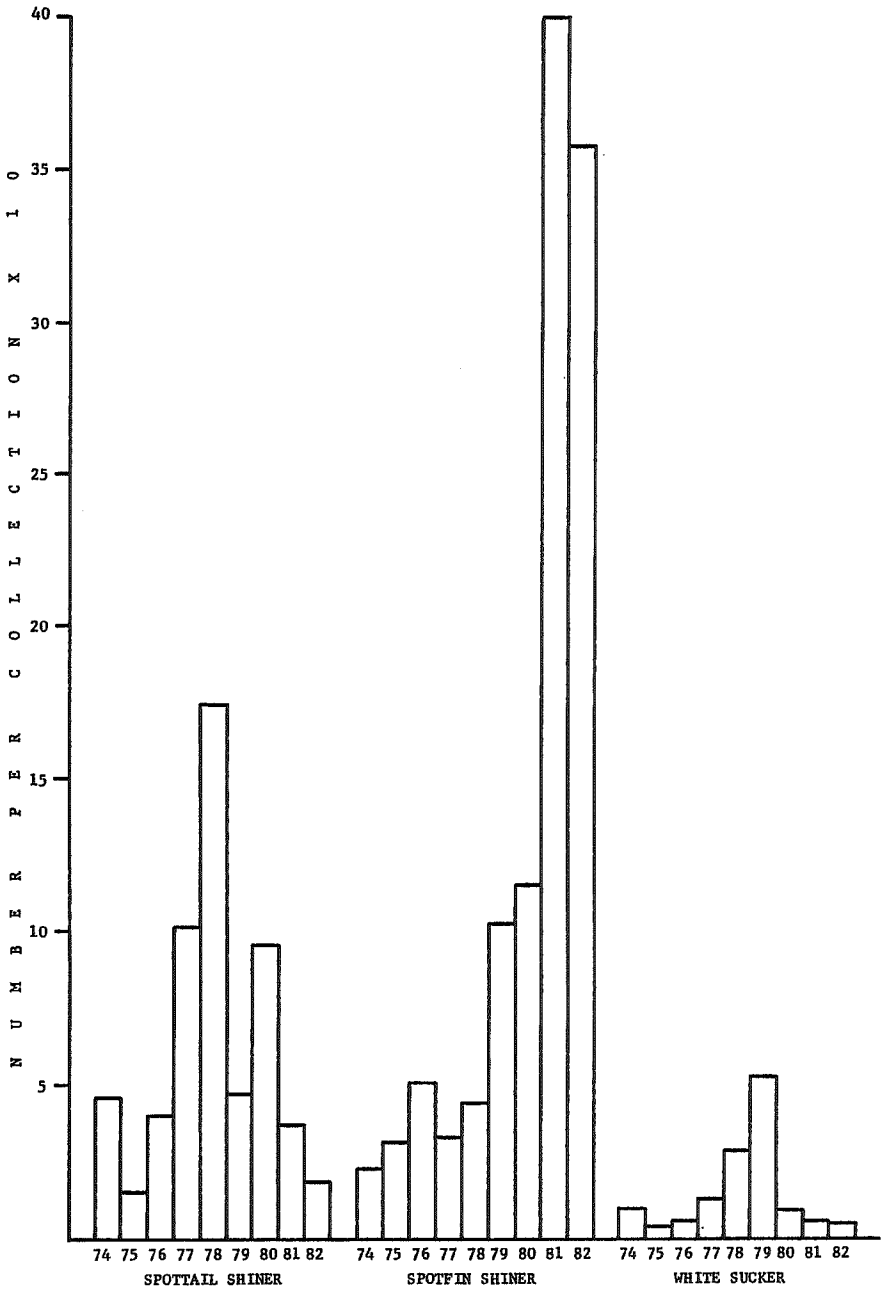

Figure 6.2-5. Yearly seine catches (number per collection) of spottail shiner, spotfin shiner, and white sucker, 1974 through 1982.

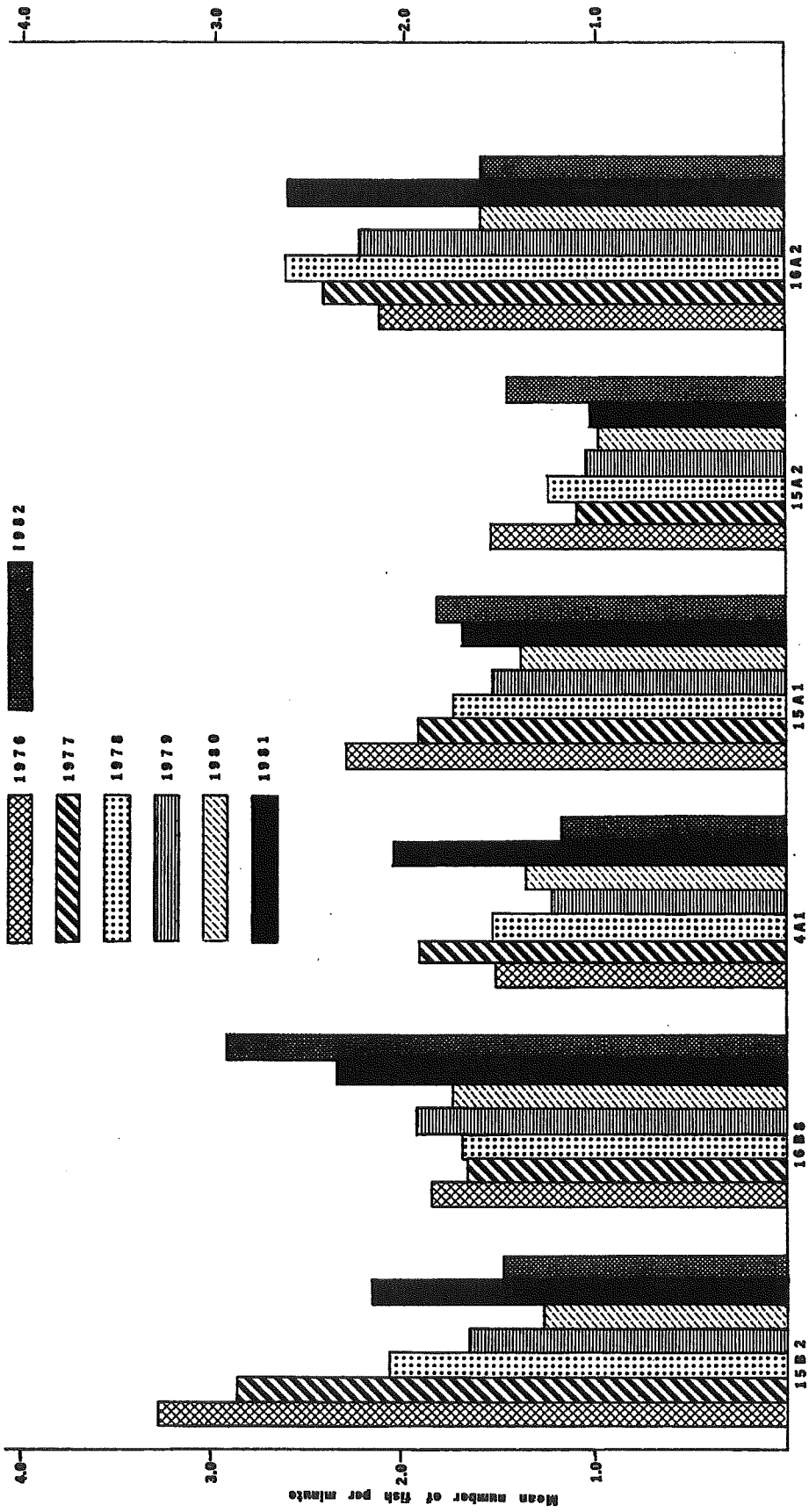

Figure 6.3-4. Mean number of fish per minute at the 12 electrofishing zones near TMINS, 1976 through 1982.

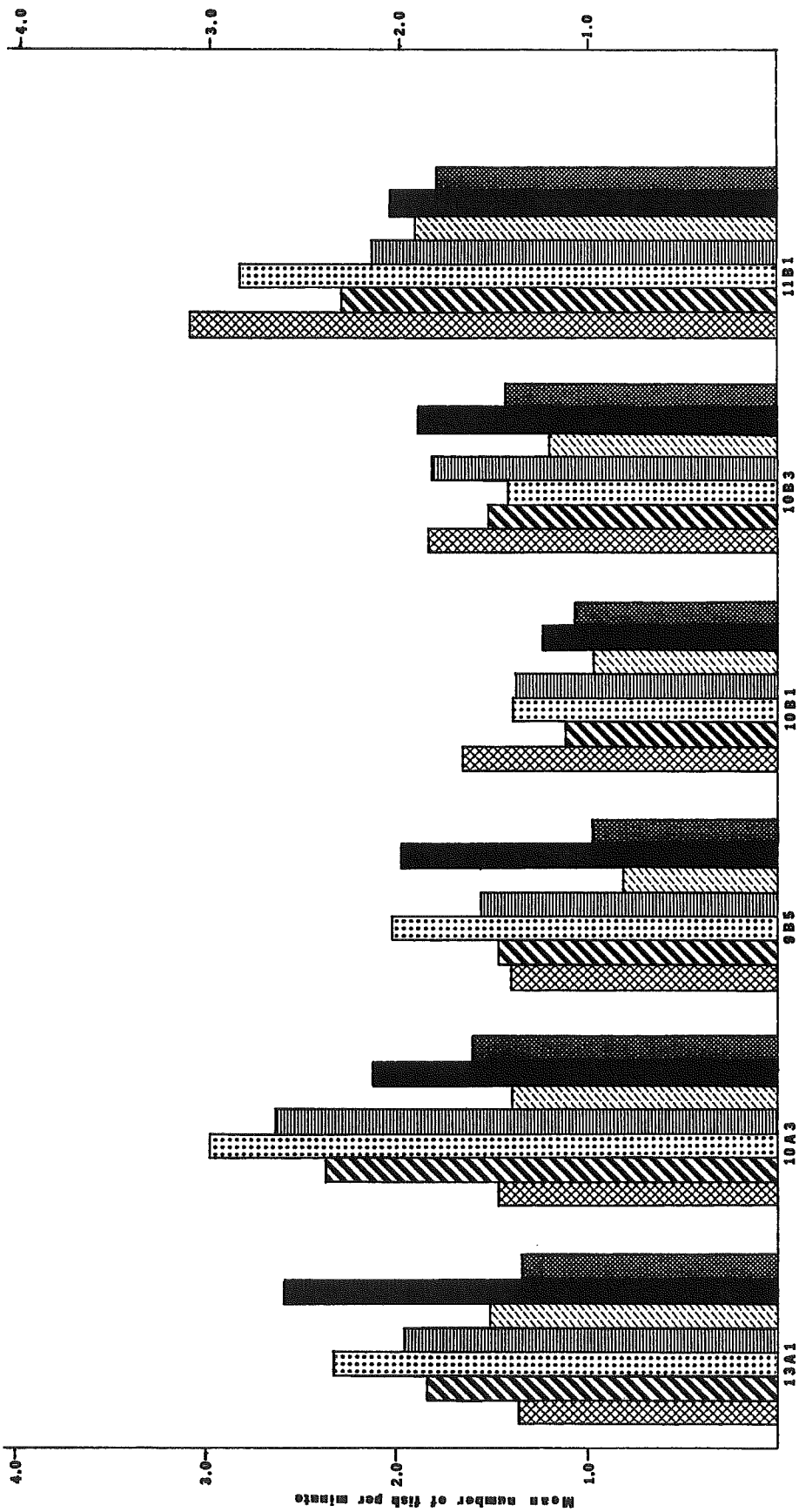

Figure 6.3-4. continued.