Tampa Bay National Estuary Program
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DISTRIBUTION OF SELECTED FISH SPECIES IN TAMPA BAY

FINAL REPORT

MAY 1992

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DISTRIBUTION OF SELECTED FISH SPECIES IN TAMPA BAY

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FOREWORD

This report dated May 1992 and titled "Distribution of Selected Fish Species in Tampa Bay" was prepared by Coastal Environmental Services, Inc. for the Tampa Bay National Estuary Program. All work was prepared under a contract entered into on 16 September 1991 by and between Tampa Bay Regional Planning Council on behalf of Tampa Bay National Estuary Program and Coastal Environmental Services, Inc. The final products of the project reflect adjustments to the original scope of work that were required by the availability of data and time and effort considerations. These adjustments have been made in consultation with the Tampa Bay National Estuary Program, and are described in a detailed work plan submitted on 21 September 1991, and in a revision to the work plan submitted on 17 January 1992.

This is Technical Publication #05-92 of the Tampa Bay National Estuary Program.

ACKNOWLEDGEMENTS

This project has benefitted from the work of many people, and particularly from the willingness of researchers and data managers in the Tampa Bay area to share information on their studies. In particular: Dick Eckenrod and Holly Greening of the Tampa Bay National Estuary Program provided excellent advice, guidance, and assistance throughout the project. Bob McMichael and Tim MacDonald of the Marine Research Institute provided data and extensive background information for the Fisheries-Independent Monitoring Program, while Ken Haddad provided advice and referrals. Thomas Lo of SWFWMD provided the GIS shoreline and hydrographic data we used in generating GIS maps.

This report was written by Sara Cairns of Coastal, based on work performed by the author and Bob Berardo, Peggy Derrick, Doug Heimbuch, Tony Janicki, Susan Janicki, John Seibel, and Dave Wade. Special thanks to those whose contributions went above and beyond the call of duty.

ABSTRACT

Three reports have been generated as products of the Synthesis of Historical Biological Data project of the Tampa Bay National Estuary Program (TBNEP): "Oligohaline Areas in Tampa Bay Tributaries: Spatial Extent and Species Lists", "Database of Benthic Sampling Locations in Tampa Bay", and the current report, "Distribution of Selected Fish Species in Tampa Bay". The ten fish species chosen for distribution analysis (bay anchovy, silver perch, snook, spotted seatrout, spot, tarpon, striped mullet, red drum, hogchoker, and clown goby) were those identified by TBNEP as potential living resource targets. The analyses were based on extensive spring and fall sampling conducted for the Florida Department of Natural Resources' Fisheries-Independent Monitoring Program. An index of relative abundance was developed that classified one-minute (latitude by longitude) grids within the Bay as having zero catch-per-unit-effort (CPUE), low-to-medium CPUE, or high CPUE. Maps based on these analyses were prepared for each combination of species, length class, gear, and season for which adequate data were available. Several species were shown to concentrate primarily in tributaries during one or more seasons, especially small snook and red drum, and hogchokers of all lengths. Species with a wide-spread distribution in the Bay with little evidence of seasonal change in distribution include bay anchovy and silver perch.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

Page

LIST OF FIGURES (continued)

INTRODUCTION

The Tampa Bay National Estuary Program (TBNEP) conducted two Framework for Characterization workshops in June and July of 1991. One of the conclusions of the workshops was that the distribution and historical trends in abundance of fish species in Tampa Bay should be priority topics for further investigation. Coastal Environmental Services, Inc. focused on these topics as one component of the TBNEP's Synthesis of Historical Biological Data project. The other two components of the project were the location of oligohaline areas in Tampa Bay tributaries (Coastal 1992a) and benthic communities in the Bay (Coastal 1992b).

In order to analyze trends in fish abundance, it is necessary to have access to data that provide reasonable estimates of absolute abundance of a population at different points in time. The most extensive data available on Tampa Bay fish populations comes from commercial landings statistics collected by the National Marine Fisheries Service (NMFS). A recent report (Haddad 1985) used these data to analyze trends in two fish populations, but the author noted that commercial landings data have major limitations as a source of abundance estimates. The specific location where the fish were caught (e.g., within the Bay or offshore) is not known, and there is no reliable estimate of the amount of fishing effort. A rise or decline in total landings can easily reflect changes in the number of fishermen targeting that species, rather than the abundance of the population.

The NMFS data analyzed by Haddad (1985) indicate that bait shrimp *(Penaeus duorarum)* and spotted seatrout *(Cynoscion nebulosus)* have declined markedly over the period from 1951-1955 to 1981. When trends in landings data are large and consistent over time, there is good reason to conclude that populations are declining. Unfortunately, non-catastrophic changes in abundance are difficult to detect with landings data, being likely to be obscured by changes in fishing effort.

Historical data on fish populations other than the NMFS commercial landings data are also limited in their ability to provide abundance estimates for use in trends analysis. Extensive sampling is required to estimate abundance while taking into account such factors as shifts in distribution within an area, migration into and out of the area, and (especially for juvenile populations) mortality. In addition, variations in gear efficiency make it difficult or impossible to combine data from different studies. TBNEP decided soon after the start of the Synthesis of Historical Biological Data that the available data were not adequate to support analyses of long-term trends in fish populations. The focus of the project therefore shifted to analyzing current distribution patterns within the Bay.

An extensive sampling program recently begun by the Florida Department of Natural Resources (FDNR), the Fisheries-Independent Monitoring Program, provides a source of data on fish distributions that is free of the problems associated with commercial landings data. The program is specifically intended to collect data that will provide baseline trends and assessments of fish stocks. It targets juvenile fishes and uses carefully designed sampling methods and techniques. Although not designed specifically for measuring the distribution of fish within the Bay, it provides the best available data for this purpose and was selected as the source of data for the distribution analyses.

The ten species of fish identified as potential living resource targets by TBNEP were chosen as the subjects for distribution analyses. These are bay anchovy, silver perch, snook, spotted seatrout, spot, tarpon, striped mullet, red drum, hogchoker, and clown goby (see Table 1 for scientific names).

METHODS

Three full years of data were available from the Fisheries-Independent Monitoring Program (FIMP), for 1989 to 1991. The FIMP collects data from two types of sampling stations: fixed stations and those selected by stratified random sampling (FMRI 1990). Fixed stations are sampled monthly, and two types of gear have been used consistently across all years: trawls and seines. Random samples are collected during two seasons: spring (March-June) and fall (September-December). For the random samples, four types of gear have been used consistently across all years: trawls, seines, gill nets and drop nets. Each gear type is used only in areas appropriate for that gear, as defined by water depth and habitat type (Table 2). Within each season, one bay-wide set of samples is collected for each gear during the dawn/day time period and one set is collected during the dusk/night period. Figure 1 displays the sites actually sampled by each gear type for one year (1991). Details on sampling methods are described in the 1989 Annual Report (FMRI 1990).

The sampling area covered by the FIMP is divided into six zones that include Boca Ciega Bay, lower Tampa Bay, Old Tampa Bay, Hillsborough Bay, and the lower reaches of the Alafia, Little Manatee, and Manatee Rivers. Random sampling occurs throughout these zones, while at least two of the 22 fixed stations are within each zone (Figure 2).

The choice of what spatial unit to use in describing fish distributions was an important decision in the analyses. The FIMP uses a latitude/longitude grid drawn at one-minute intervals to define grid cells used in selecting the randomly stratified sampling locations (Figure 3). We decided to use these grid cells as the basic spatial unit for distribution analyses. Technically, due to the random sample design used in the FIMP, data from individual sampling sites could be used to draw inferences regarding abundance for all grid cells suitable for that gear within the zone in which the site was located. In practice, we decided (in consultation with

Dr. Robert McMichael of DNR) that analyses based on zones would result in misleading apparent differences between zones. Since zones were defined for logistical reasons and not based on habitat differences that would affect fish distributions, we decided not to conduct analyses at the level of zones. Analyzing the data at the level of grid cells rather than zones had the added advantage of allowing us to combine data from the fixed and random sampling programs.

Since juvenile and adult fish of the same species often have different distributions, it was desirable to perform separate analyses for these two age classes. Due to natural variations in rates of growth within populations, otolith analysis of individual fish is the only reliable method of aging most fish. The FIMP recorded lengths for up to 20 fish per sample, but did not age individual fish. We therefore used length to infer age.

For four of the species (snook, spotted seatrout, striped mullet, and red drum) we were able to find length limits to use in classifying individual fish as being less than or greater than one year of age (Table 3). Within-year variability in growth rates for some species (e.g. snook) meant that a more accurate division of different ages could be made using different length limits for the fall and spring sampling seasons, For six species we did not have length-at-age data based on Gulf of Mexico populations, and we combined all catches (regardless of length) to assess distribution patterns.

We restricted analyses to those gears that were deployed in all three years of the study (excluding experimental gear types). For each species and age class, we also excluded any gear that never caught at least 10 fish in any one year. Samples that collected no fish (zero catches) can be used to infer that few or no fish were present only if that gear is known to be effective in capturing that size and type of fish. By requiring some evidence that a gear type could be effective in collecting a given species and age class we increased the probability that observed values of zero catch-per-unit-effort (CPUE) reflected low fish abundance rather than poor gear efficiency.

Several different methods (parallel beach set, boat set, and offshore circle set) were used to deploy seines in different habitats. Since measures of sampling effort (area swept) were available for each, we estimated CPUE separately for each deployment method and then treated all seine samples as one gear.

For each species, age class, gear, year, and season (spring or fall) we calculated the average CPUE for each grid cell. Data from the fixed and random sampling programs were combined prior to calculating the average CPUE. We used these average values (including zeros) to determine the frequency distribution of CPUE across all grid cells sampled. We used the 75th percentile of this distribution as a cutoff value in classifying individual grid cells as having a 'medium to low' CPUE or 'high' CPUE. For example, if the average CPUE values ranged from 0 to 15.2, with 75% of all grid cells having a CPUE value less than 12.8, then only those grid cells with an average value greater than 12.8 were classified as 'high'. Grids with zero CPUE (no fish ever collected) were assigned an index value of 0, grids with low to medium relative CPUE (less than the 75th percentile cutoff) were assigned an index value of 1, and grids with high relative CPUE were assigned an index value of 2.

Relative abundance index values were calculated for each grid cell sampled in each of the three years. If a grid cell was sampled in more than one year, index values were averaged across years. Any average index greater than 0 but less than 1.5 was given an overall value of 1 (low to medium relative CPUE). (Values less than 0.5 were not rounded down, so that index values of 0 reflect an absence of catches in all years.) Average values between 1.5 and 2 were given an overall value of 2 (high relative CPUE).

It is important to note that these index values reflect relative, rather than absolute abundance. In any given season, the total population of a given species and age class in the Bay may be either low or high. In either case, these analyses will identify those areas (grid cells) with the highest CPUE relative to all grid cells sampled that season. In an extreme case, if only 1 fish was collected in one season, the grid cell in which it was caught would be classified as having a high relative CPUE. Combining data across a three-year period decreases the chance that a single sample will determine a grid cell's rank, but due to the random sampling design many grid cells were only sampled in one or two of the three years.

RESULTS

The minute-by-minute (latitude and longitude) grid cells defined by the FIMP were the units of analysis for relative abundance, and are also the units used in presenting the results. A table of grid cells provides a map of the Bay (see Figure 3), slightly distorted if the ratio of height to width of a table cell is not the same as the ratio of a minute of longitude to a minute of latitude.

The results of the relative abundance analyses are presented as tables of grid cells in Figures 4-34. Each figure presents two maps of Tampa Bay. A separate map is shown for each combination of species, length class, gear, and season (with spring and fall presented side-by-side on the same page). Unsampled grid cells are left blank, cells with zero catches are lightly stippled, and increasing relative abundance is indicated by darker shading.

In addition to grid cell tables for all species, we generated GIS maps of relative abundance for two species: red drum *(Sciaenops ocellatus)* less than 303 mm in length in the spring, and snook *(Centropomus undecimalis)* larger than 150 rnm in the fall. These maps have been submitted to TBNEP as one of the final products for this project.

In interpreting the results, greater weight can be attached to maps that are based on relatively large numbers of fish captured. Table 4 presents the total number of fish caught for each combination of species, length class, gear, and season. These numbers do not reflect absolute abundance since sampling effort varied with gear, year, and season. They do indicate, for example, that the distribution maps for bay anchovy seine and trawl collections are based on large numbers of fish. On the other hand, the spring map for bay anchovies collected by drop nets simply reflects an apparent absence of bay anchovies in the habitats sampled by dropnets rather than a strong concentration of the population in Old Tampa Bay.

DISCUSSION

Tarpon *(Megalops atlanticus).* Tarpon inhabit estuaries and shallow coastal waters, spawning offshore but with inshore development of larvae and juveniles (Boschung et al. 1983). Their life history within Tampa Bay is not well known, and only three tarpon were caught by the FIMP for all gears combined between 1989 and 1991. Tarpon was the only one of the ten target species for which we could not analyze relative abundance.

Bay anchovy *(Anchoa mitchilli).* Bay anchovies inhabit shallow bays and estuaries (Robins and Ray 1986). This species appears to spawn twice, and sometimes three times, a year in the Tampa Bay area (Springer and Woodburn 1960). The highest abundance of bay anchovies encountered by Springer and Woodburn (1960) was in the late summer and fall. The distribution of this species does not appear to be salinity dependent, with specimens collected over a wide range of salinities (Springer and Woodburn 1960).

The wide salinity tolerance of bay anchovies was confirmed by our analyses of relative abundance. Bay anchovy were distributed widely throughout the bay in both seasons of the year, both in the deep water sampled by trawls (Figure 4) and the shallow habitats sampled by seines (Figure 5). The only exception was a possible low relative abundance in deep waters near the mouth of the bay during spring (Figure 4). Drop nets in seagrass beds (Figure 6) collected few total bay anchovies, and those only in Old Tampa Bay.

Striped mullet *(Mugi/ cephalus).* Striped mullet spawn from October through May on Florida's west coast (Collins 1985). Juveniles frequent coastal waters, salt marshes, and estuaries, during both spring and fall, although some juveniles may move offshore in the fall when adults migrate to deeper water to spawn.

Small striped mullet were collected by the FIMP in large numbers only by seines (shallow waters). They were distributed throughout the margins of the bay, particularly in the eastern tributaries and Boca Ciega Bay in spring (Figure 7). A few larger striped mullet were collected by seines (Figure 8), but gill nets (Figure 9) were more effective. They were distributed throughout the bay in the spring, but none were collected south of Cockroach Bay during the fall season. These results are consistent with those of Springer and Woodburn (1960) who reported that striped mullet in the Tampa Bay area occur in all habitats throughout the year, but who also reported anecdotal evidence of spawning migrations of larger fish along the north shore in the fall.

Silver perch *(Bairdiella chrysoura).* The spawning activity of silver perch in Tampa Bay begins in June and continues through August. Springer and Woodburn (1960) reported that young silver perch appeared in Tampa Bay during the month of June, and that the silver perch population in the Bay increased markedly during July, then declined until by November very few individuals were being caught.

The FIMP collected large numbers of silver perch using both trawls and seines. As with bay anchovies, there were no apparent concentrations of silver perch in particular areas of the Bay (Figures 10 and 11). Drop nets deployed in vegetated areas collected very few silver perch during the spring, compared to reasonable numbers, distributed throughout the bay, in the fall (Figure 12).

Spot *(Leiostomus xanthurus).* Spot spawn from late December through March in the Tampa Bay area (Springer and Woodburn 1960). Spawning usually occurs offshore either close to bay entrances (Pearson 1929, cited by Springer & Woodburn 1960) or in deeper offshore waters (Dawson 1958, cited by Springer & Woodburn 1960). Trawl and seine data from previous studies indicate a widely distributed population in the spring months (Springer & Woodburn 1960). Stomach contents indicate that large spot are bottom feeders (Springer and Woodburn 1960).

Spot were collected in large numbers by trawls and seines, and in moderate numbers by gill nets. The deep-water trawl data suggest a possible southern and eastern concentration of spot in the fall (Figure 13). Fall seine samples also suggest a concentration in the tributaries and the south of the Bay (Figure 14), but very few total numbers were captured by seines. Both trawl and seine data indicate a widely distributed population in the spring, agreeing with data reported in Springer and Woodburn (1960). Gill nets, however, (which probably tend to capture larger, older fish than either of the other gears) suggest a concentration of fish near the mouth of the Bay in spring (Figure 15).

Hogchoker *(Trinectes maculatus).* Hogchokers are a bottom-dwelling species commonly inhabiting shallow estuarine areas. In freshwater, they often travel hundreds of miles upstream (Robins and Ray 1986). The sizes of the few specimens collected by Springer and Woodburn (1960) suggested that larger individuals may be found in more saline waters.

Hogchokers appeared in large numbers in both trawl and seine collections of the FIMP. Both gears indicate that these fish are concentrated in the eastern tributaries during the fall (Figures 16 and 17). For the shallow-water habitats sampled by seines the eastern tributaries also had high relative abundances in the spring (Figure 17), while the deep-water trawls show grid cells with high relative abundance throughout the bay in both seasons.

Clown goby *(Microgobius gulosus).* Clown gobies inhabit protected, vegetated areas with muddy bottoms (Robins and Ray 1986). Springer and Woodburn (1960) documented spawning activity in July and November.

During the FIMP clown gobies were collected in large numbers by seines, in moderate numbers by trawls, and in low numbers by drop nets. Trawls generally found low relative abundance in the central part of the bay (Figure 18), while seines found patches of high relative abundance throughout the shoreline (Figure 19). Drop nets also indicated high relative numbers bay-wide (Figure 20). None of the three gears suggested any seasonal changes in distribution.

Red drum *(Sciaenops ocellatus).* The peak spawning season for red drum in Tampa Bay normally occurs from September through October, but has been known to occur as early as mid-August (Murphy and Taylor 1990). Pearson (1929, cited by Murphy and Taylor 1990) concluded that spawning typically occurred in nearshore waters close to channels and passageways; McMichael and Peters (1987) recorded nearshore spawning as well as spawning in areas at the mouth of Tampa Bay. The same authors reported that the majority of red drum larvae exist in the lower Bay areas, and that juveniles migrate toward low salinity backwater areas (tributaries) of the Bay in the spring months. During sampling from September 1981 through November 1983, McMichael and Peters (1987) reported that 98 percent of all juveniles caught were collected in tributary areas, with 85 percent coming from the Alafia River.

During the FIMP small red drum were captured in highest numbers by seines, though trawls were apparently effective in capturing the smaller fish that occur in the fall. Seines recorded areas of high relative abundance in the tributaries in both seasons, with scattered high-abundance areas occurring throughout the rest of the shoreline (Figure 21). In both seasons, the only areas of high relative abundance for the deep-water trawl samples occurred in or near the mouths of the major tributaries (Figure 22). Drop nets (fished in vegetated areas) caught no small red drum in vegetated areas in the spring, and only a few in the east of the Bay during the fall (Figure 23). These results agree with those of McMichael and Peters (1987) regarding the concentration of juvenile red drum in tributaries to the Bay.

Larger red drum were only occasionally captured during the FIMP, by seines and gill nets. The fall seine data hint at a concentration in the tributaries (Figure 24), but gill net collections in the same season found high relative abundance grid cells along the western shore (Figure 25). Gill nets data indicated that larger red drum were widely distributed throughout the nearshore areas of the Bay in the spring.

Spotted seatrout *(Cynoscion nebulosus).* Spotted seatrout appear to have a spawning season that extends from March and April through September and October (Mercer 1984, cited by McMichael & Peters 1989). McMichael and Peters (1989) concluded that spotted seatrout spawn in middle and lower Tampa Bay, with specific spawning areas changing from year to year (depending upon salinity and temperature). Juvenile spotted seatrout were commonly found in both vegetated seagrass habitats and backwater areas, and appear to be very adaptable to different habitat types. McMichael and Peters (1989) suggested that seagrass is the primary habitat for juveniles, with 78% of all captured juveniles having been collected over seagrass areas. A major long-term decline in commercial catches of spotted seatrout may be due in part to loss of seagrass habitat within the Bay (Haddad 1985).

During the FIMP, small spotted seatrout were caught in large numbers by seines, moderate numbers by trawls, and low numbers by drop nets. Data from trawls showed a scattered distribution in the fall, with low relative abundance in the main stem of the Bay in spring (Figure 26). The more abundant seine catches indicated possible concentrations near the mouths (saline portions) of tributaries in the fall (Figure 27). Distribution in the spring appeared similar to that in the fall, except for lower concentrations in the mouth of the Bay and the Manatee River. In general these results are consistent with the conclusions of McMichael and Peters (1989). If young spotted seatrout are concentrated in seagrass areas, however, the drop nets used by FIMP were not very effective at capturing them (Figure 28).

Larger spotted seatrout were captured during the FIMP in moderate numbers by gill nets, and occasionally by trawls. Total captures were too few to put·much emphasis on the trawl data (Figure 29). The gear that captured the most fish, gill nets, indicates a possible concentration in the lower portion of the main stem of the Bay in the fall, with a more scattered distribution in the spring (Figure 30). Unlike many of the other species, no high relative abundance of spotted seatrout was found inside the tributaries to the Bay.

Snook *(Centropomus undecimalis).* Snook spawn between April and December. Juvenile snook prefer shallow, protected bodies of water with a small surface area (Springer and Woodburn 1960). According to Gilmore et al. (1983, cited in McMichael et al. 1989), juvenile snook move from shallow, riverine areas to deeper waters of the Bay as they grow. Movements of snook between habitats has also been attributed to temperature change (Springer and Woodburn 1960).

During the FIMP small snook were effectively captured only by seines. These data show the best evidence for a very localized distribution among any of the species. Relatively large numbers were caught, but almost exclusively within just two of the tributaries (the Alafia and Little Manatee Rivers), in both spring and fall (Figure 31). These results are consistent with Springer and Woodburn's (1960) description of juvenile habitats.

Larger snook were captured during the FIMP in low to moderate numbers by each of three gears (trawls, seines, and gill nets). The data are relatively scant but tend to show a distribution similar to the juveniles, concentrated in the tributaries (Figures 32 and 33). The exception is gill net captures in the spring (only 22 fish total), which were scattered throughout the nearshore areas of the Bay (Figure 34).

SUMMARY

Coastal prepared maps of distribution within Tampa Bay for nine of the 10 species idenfified as potential TBNEP living resource targets. The results were typically consistent with reported distribution patterns for those species described in the literature, while providing an overview for all nine species based on consistent sampling methods and effort. A strong pattern of concentration in tributaries was found for small snook, indicating the probable importance of habitats within fresh-water tributaries as nursery areas for juvenile snook. The highest observed relative abundance of small red drum also tended to occur within tributaries, as did that for hogchokers of all lengths. In contrast, some species had high relative abundances scattered throughout the Bay in both the fall and spring seasons. This was particularly true of bay anchovy and silver perch, with the analyses indicating no strong habitat preferences or seasonal movements.

Table 1. Fish species selected for distribution analyses.

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Bairdiella chrysoura	Silver perch
Centropomus undecimalis	Snook
Cynoscion nebulosus	Spotted seatrout
Leiostomus xanthurus	spot
Megalops atlanticus	Tarpon
Mugil cephalus	Striped mullet
Sciaenops ocellatus	Red drum
Trinectes maculatus	Hogchoker
Microgobius gulosus	Clown goby

Table 2. Gear types used in the Fisheries-Independent Monitoring Program, and the water depth and bottom type suitable for each gear (FMRI 1990).

Gear Type	Water Depth	Bottom Type
Seines	< 1.5 m	Most
Trawls	> 1.5 m	Non-vegetated
Drop nets	< 1.0 m	Seagrass and algae
Gill nets	< 2.0 m	Most

Table 3. Length limits used to classify four species of fish as juveniles (less than one year of age).

Species	Upper Length Limit for Juveniles	
	Fall (September-December)	Spring (March-June)
Snook[1]	≤ 150 mm	≤ 300 mm
Spotted seatrout	≤ 170 mm[2a]	≤ 230 mm[2b]
Red drum[3]	≤ 77 mm	≤ 303 mm
Striped mullet[4]	≤ 178 mm	≤ 178 mm

[1]McMichael et al. 1989. Based on Figure 2 (p. 117)

[2a]McMichael and Peters. 1989. Page 99.

[2b]Michael Murphy, FDNR (pers. comm.) - based on range given of 200-250 mm.

[3]Peters and McMichael. 1987. Based on size-at-age equation (p. 98) for 4-month-old fish in the fall (August-December) and 12-month-old fish in the spring.

[4]Collins, M.R. 1985. Table 1 (p. 4).

Table 4. Total number of fish caught by gear and season, all years (1989 - 1991).

Species	Lengths	Gear	Total Catch	
			Fall	Spring
Bay Anchovy	All	Trawl	38,990	55,161
"	"	Seine	641,849	777,742
"	"	Drop net	130	2
Striped Mullet	≤ 178 mm	Seine	256	15,578
"	> 178 mm	Seine	28	11
"		Gill net	134	83
Silver Perch	All	Trawl	1,653	5,717
"	"	Seine	3,040	21,998
"	"	Drop net	9	356
Spot	All	Trawl	874	1,908
"	"	Seine	86	12,414
"	"	Gill net	125	169
Hogchoker	All	Trawl	538	1,399
"	"	Seine	6,610	1,628
Clown goby	All	Trawl	216	213
"	"	Seine	2,842	4,212
"	"	Drop net	554	187

Table 4 (continued). Total number of fish caught by gear and season, all years (1989 - 1991).

Species	Lengths	Gear	Total Catch Fall	Total Catch Spring
Red drum	≤ 77 (F) ≤ 303 (S)	Trawl	305	8
"	"	Seine	2,016	483
"	"	Drop net	24	0
"	> 77 (F) > 303 (S)	Seine	23	1
"	"	Gill net	19	28
Spotted seatrout	≤ 170 (F) ≤ 230 (S)	Trawl	127	290
"	"	Seine	1,186	1,673
"	"	Drop net	13	19
"	> 170 (F) > 230 (S)	Trawl	17	2
"	"	Seine	6	0
"	"	Gill net	33	73
Snook	≤ 150 (F) ≤ 300 (S)	Seine	919	167
"	> 150 (F) > 300 (S)	Trawl	30	4
"	"	Seine	72	12
"	"	Gill net	25	22

DNR FIMP
Sampling Sites

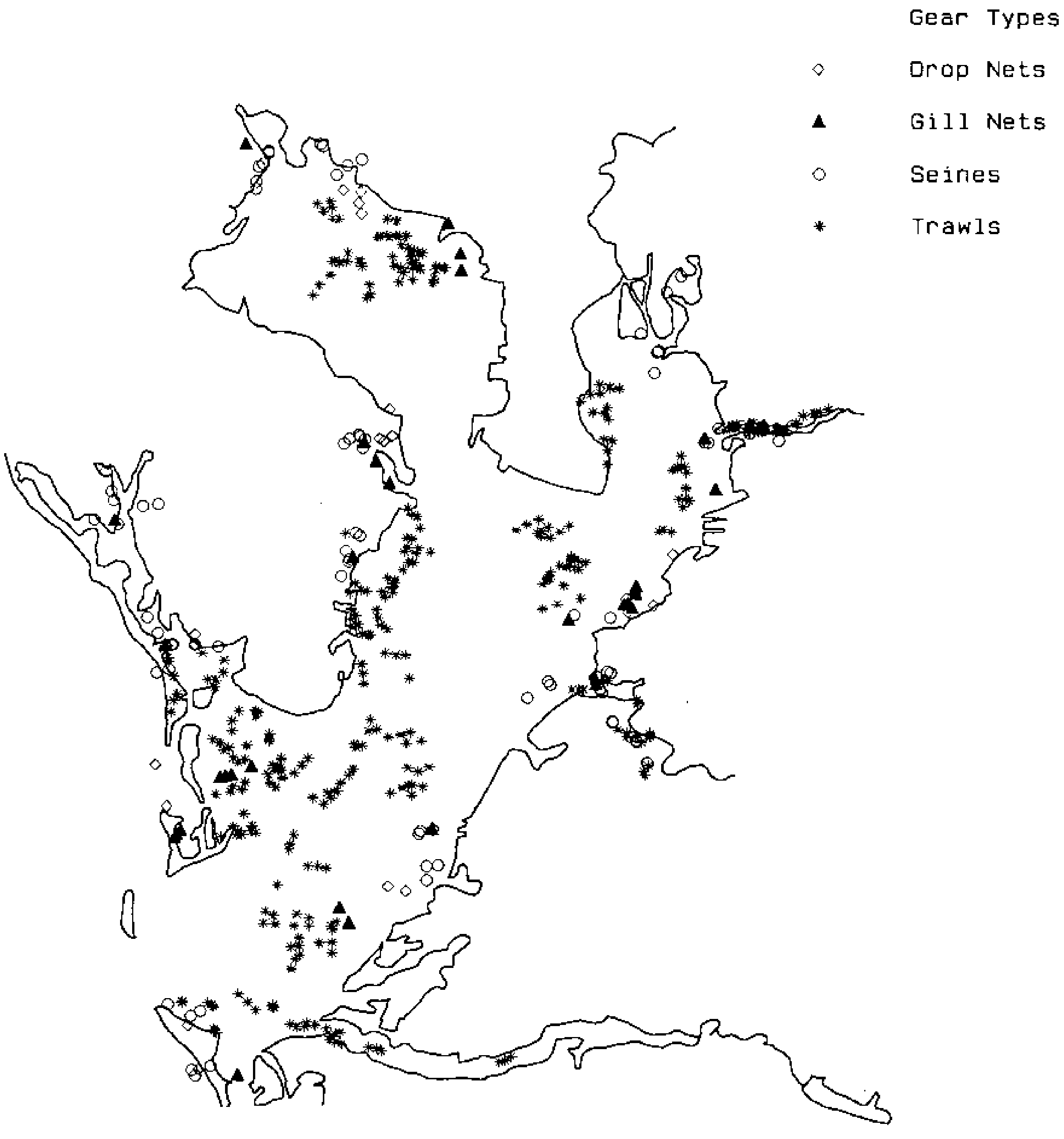


Figure 1. Sites sampled by the Fisheries-Independent Monitoring Program in 1991, not including fixed stations.

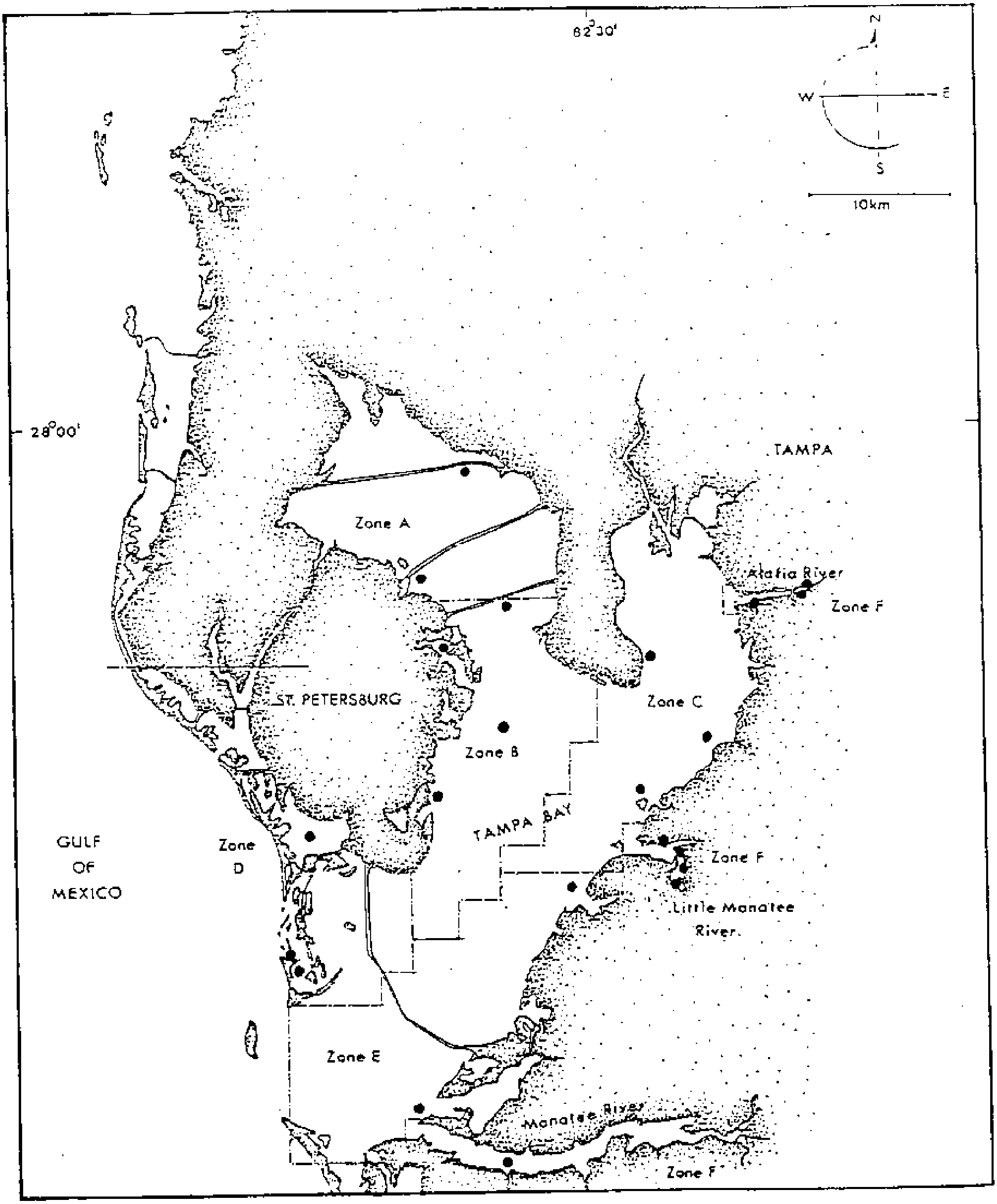


Figure 2. Sampling zones (A-F) and fixed stations (●) used in the Fisheries-Independent Monitoring Program.

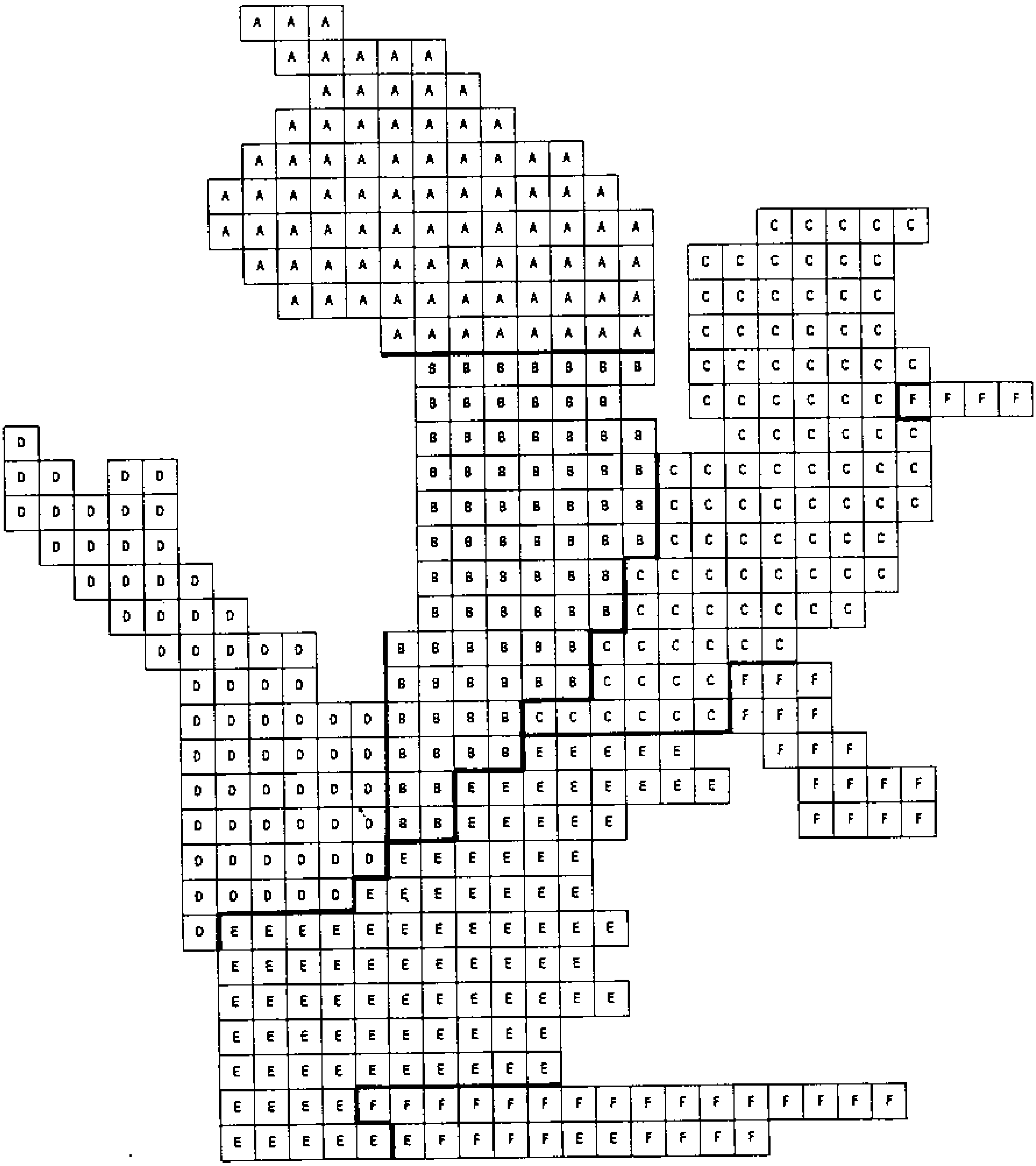


Figure 3. One-minute grids used by the Fisheries-Independent Monitoring Program, labelled by zone (A-F).

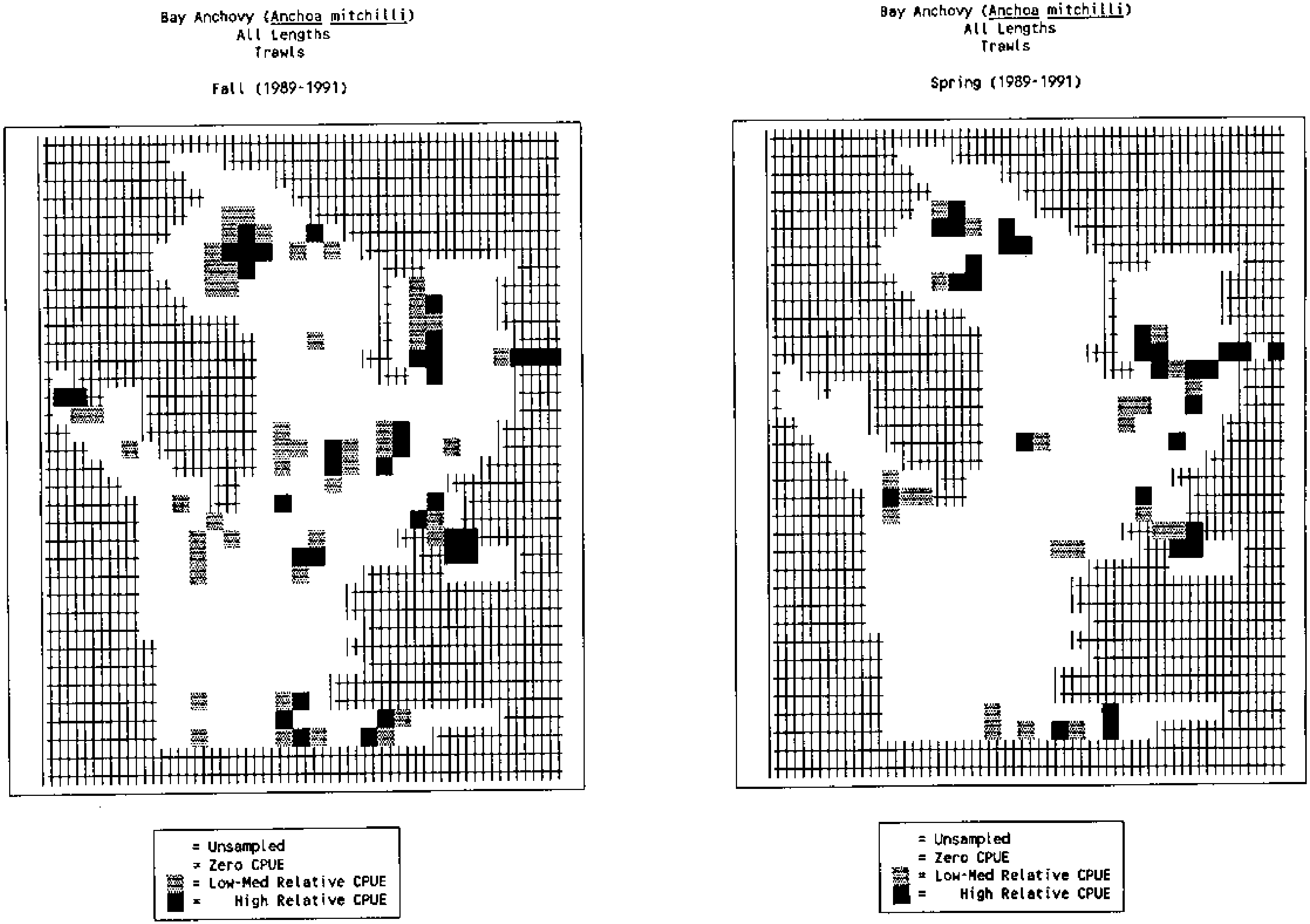


Figure 4. Bay anchovy relative abundance maps: fish of all lengths collected by trawls in the fall and spring seasons.

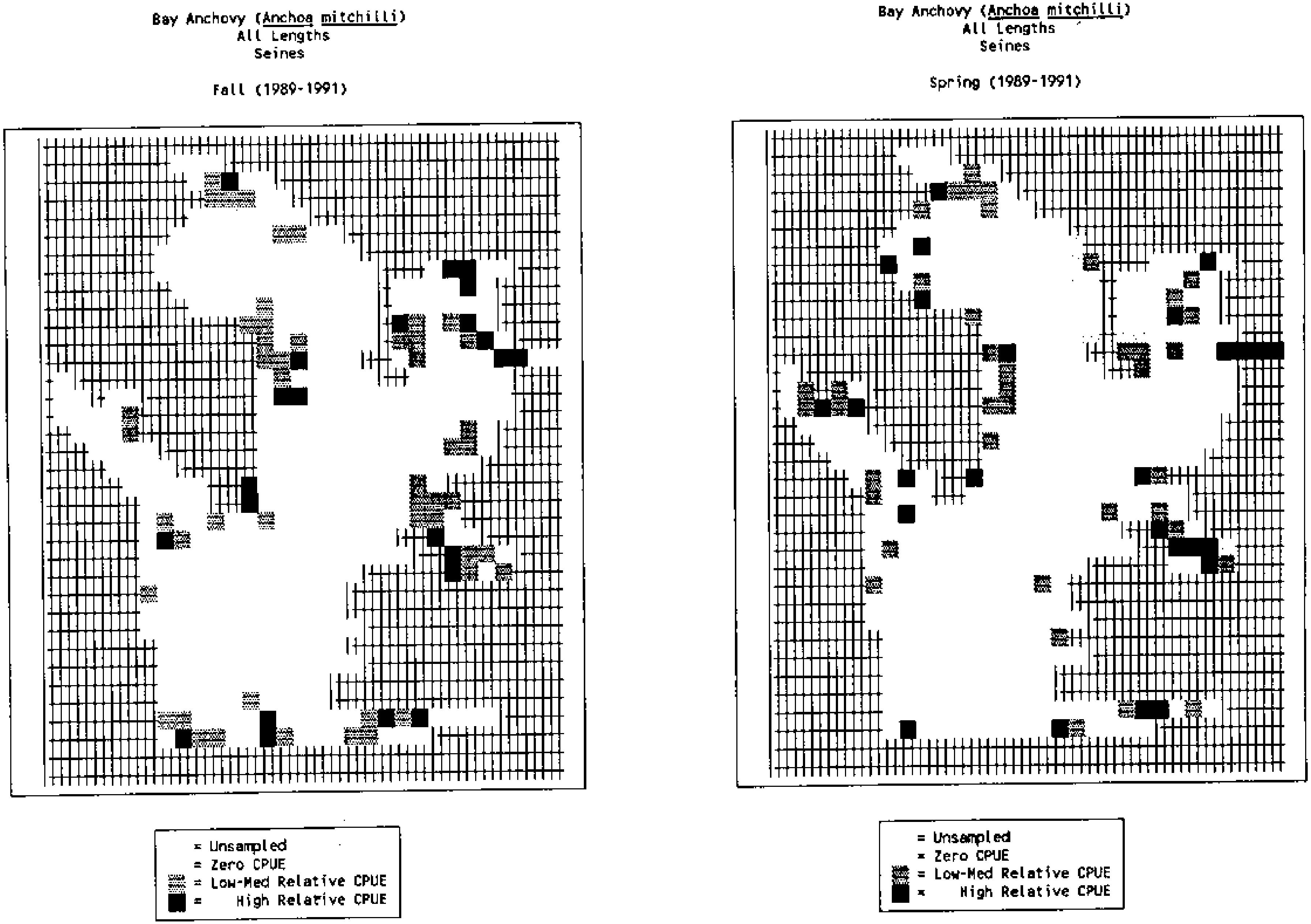
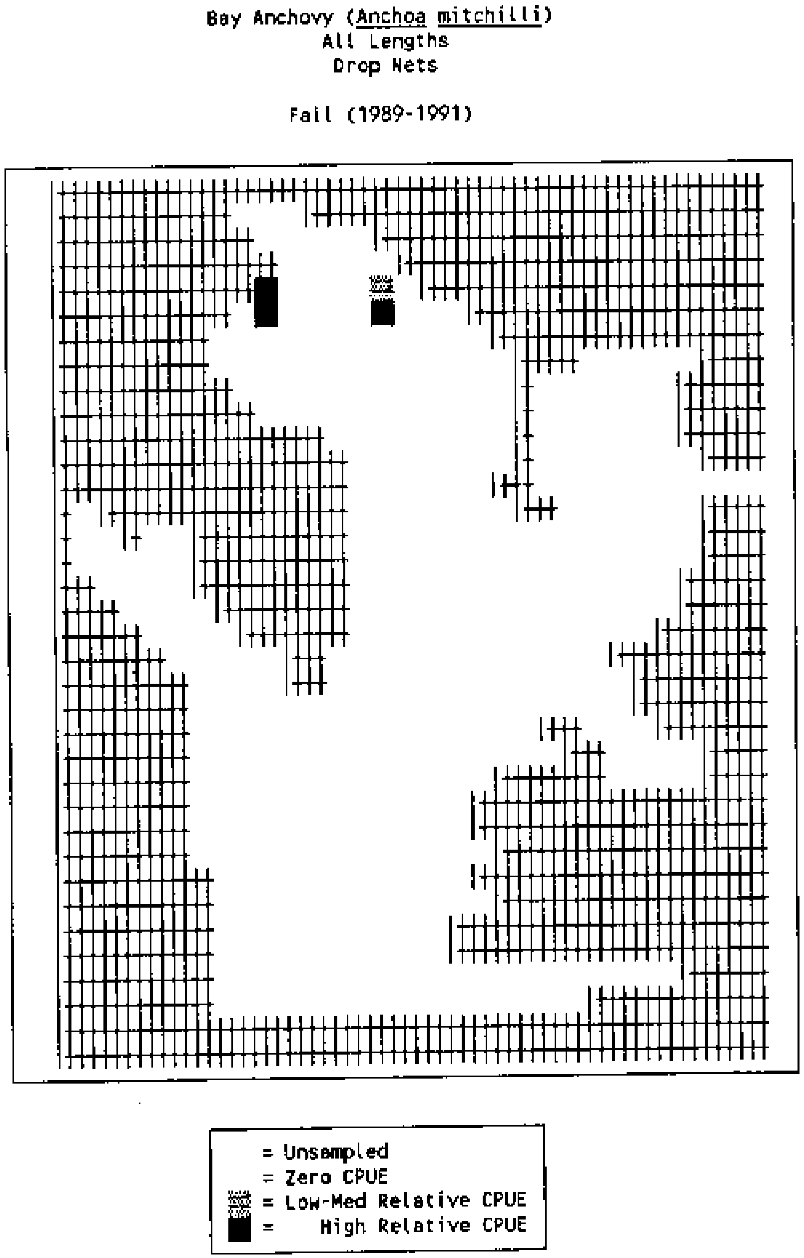


Figure 5. Bay anchovy relative abundance maps: fish of all lengths collected by seines in the fall and spring seasons.



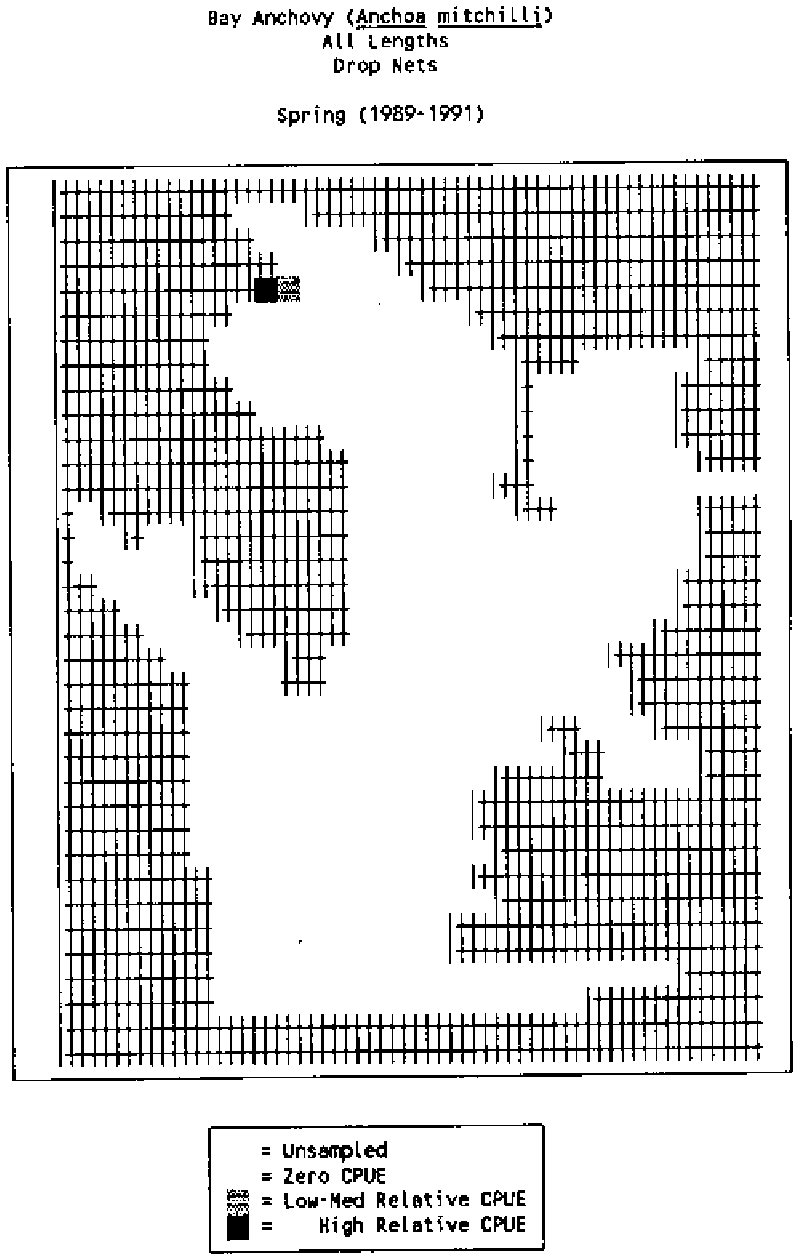


Figure 6. Bay anchovy relative abundance maps: fish of all lengths collected by drop nets in the fall and spring seasons.

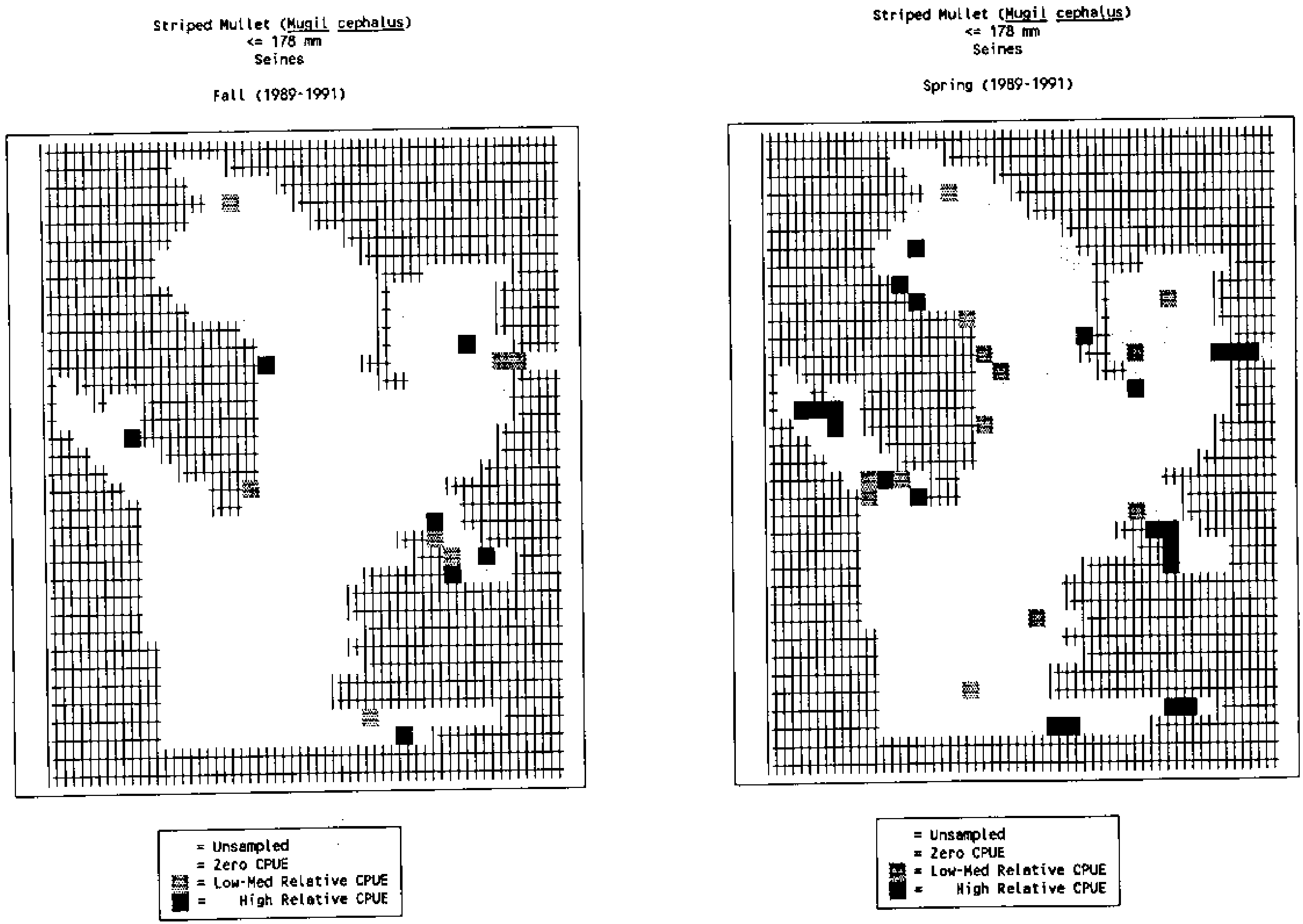


Figure 7. Striped mullet relative abundance maps: fish < = 178 mm in length collected by seines in the fall and spring seasons.

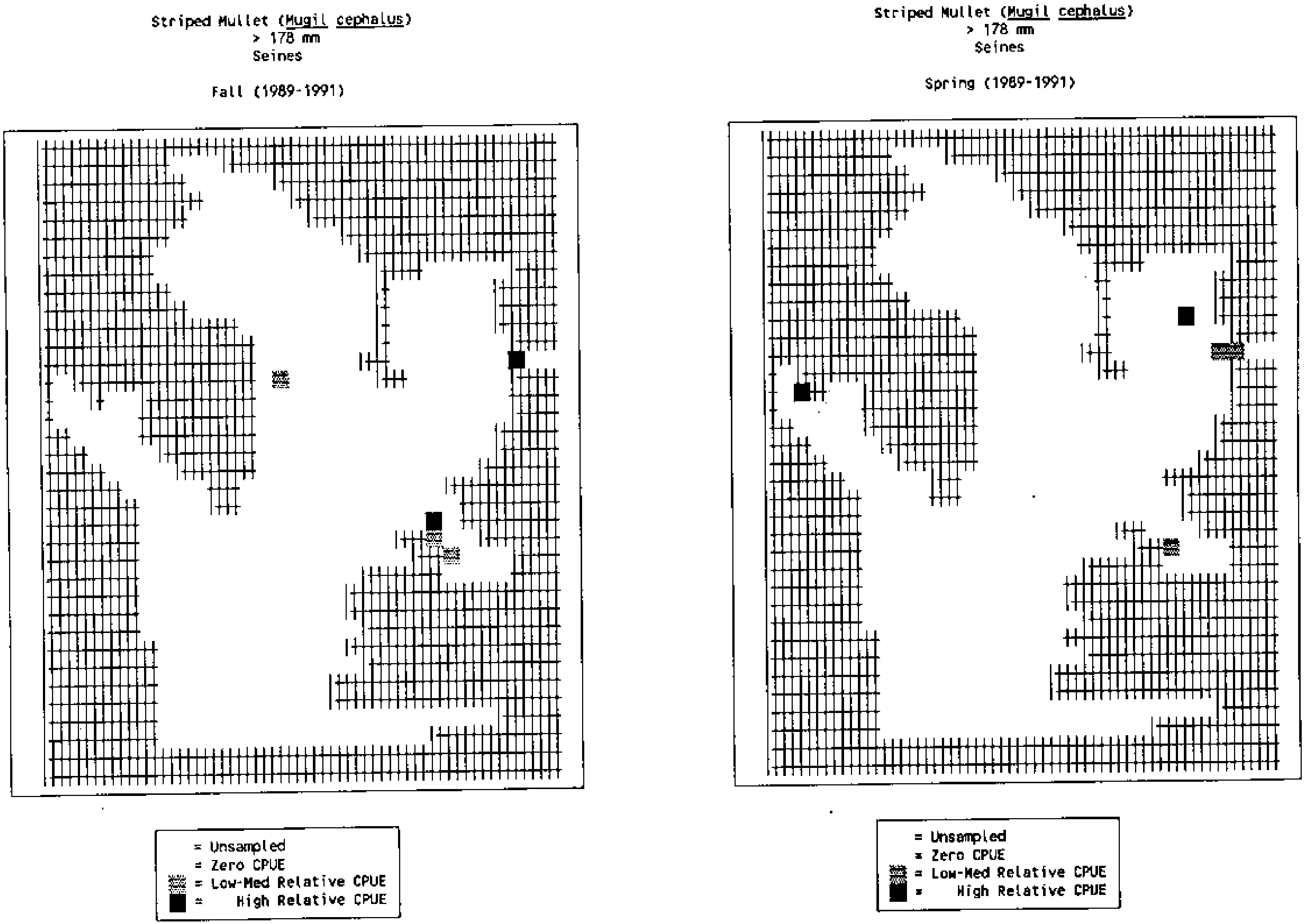


Figure 8. Striped mullet relative abundance maps: fish > 178 mm in length collected by seines in the fall and spring seasons.

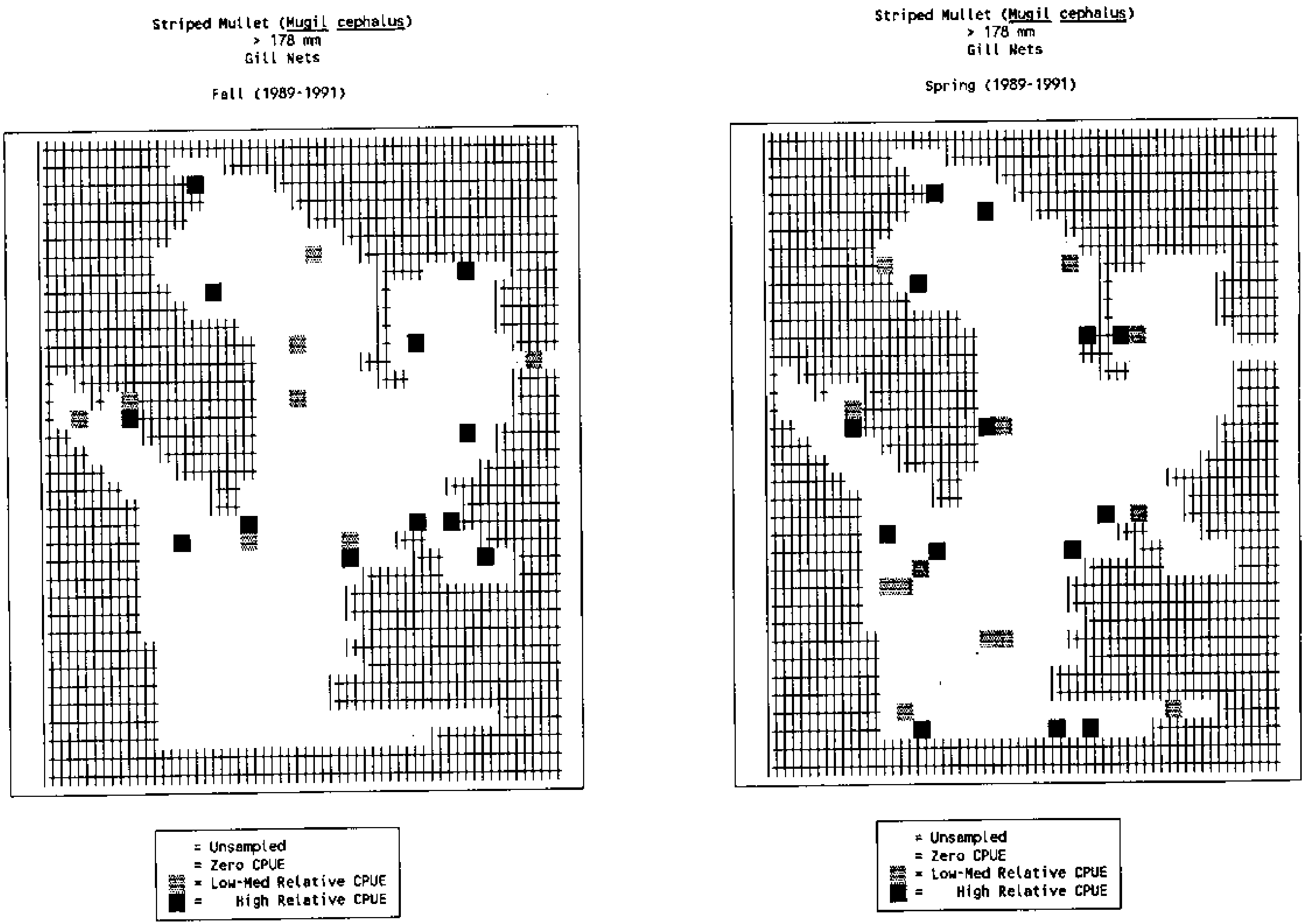


Figure 9. Striped mullet relative abundance maps: fish > 178 mm in length collected by gill nets in the fall and spring seasons.

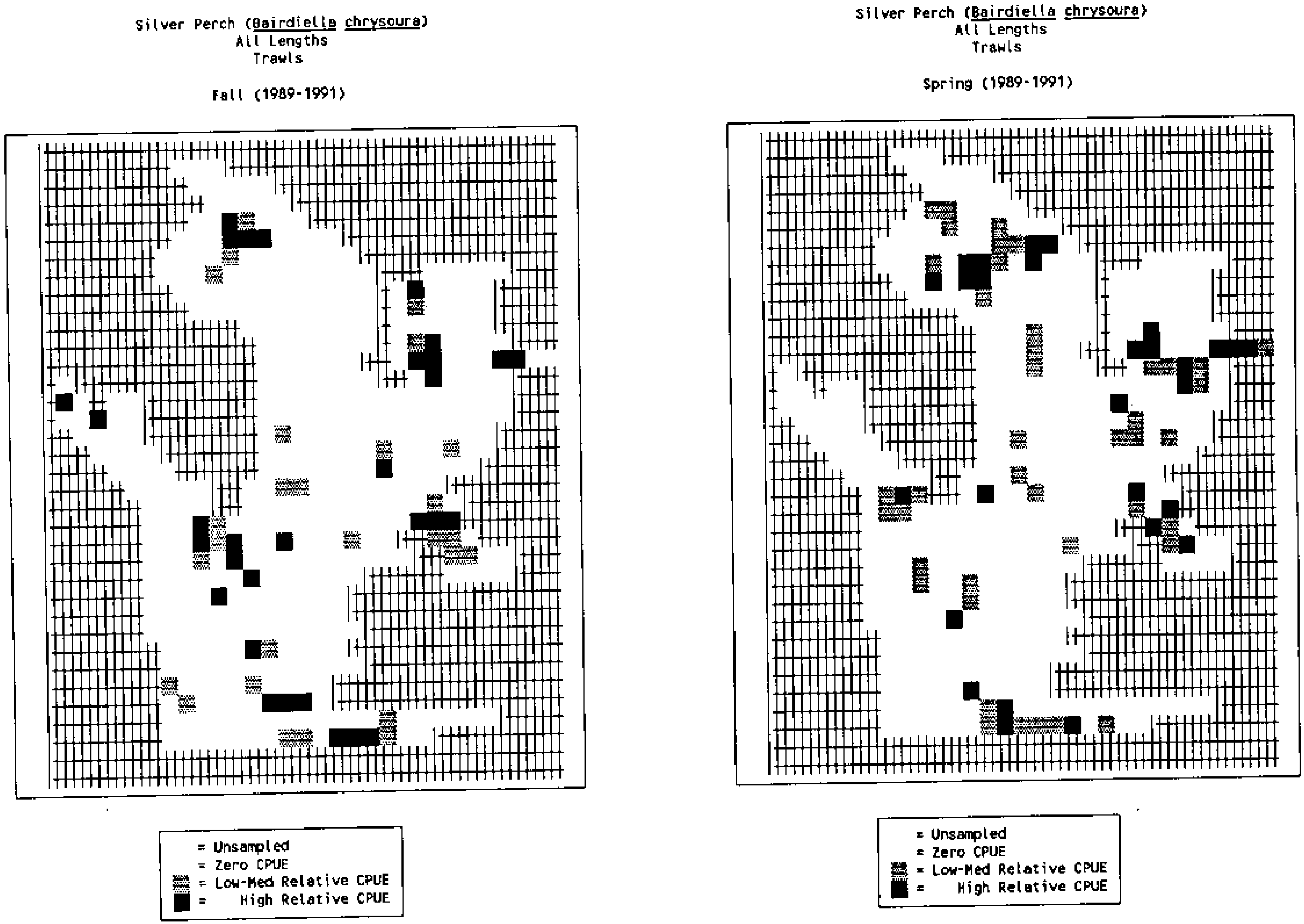
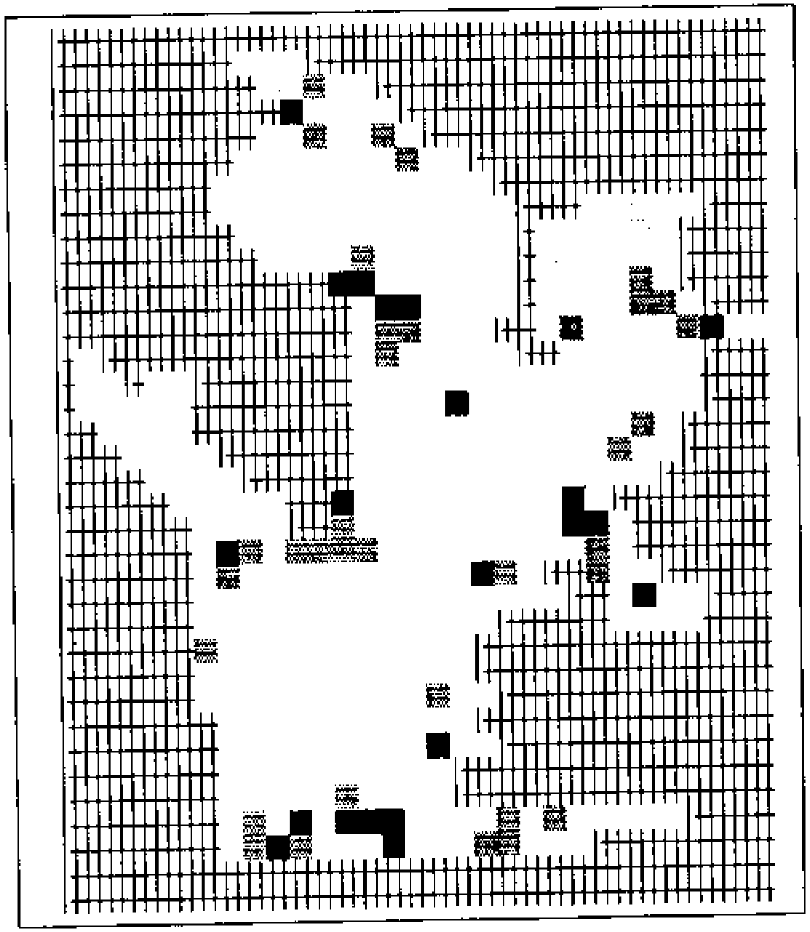


Figure 10. Silver perch relative abundance maps: fish of all lengths collected by trawls in the fall and spring seasons.

Silver Perch (Bairdiella chrysoura)
All Lengths
Seines

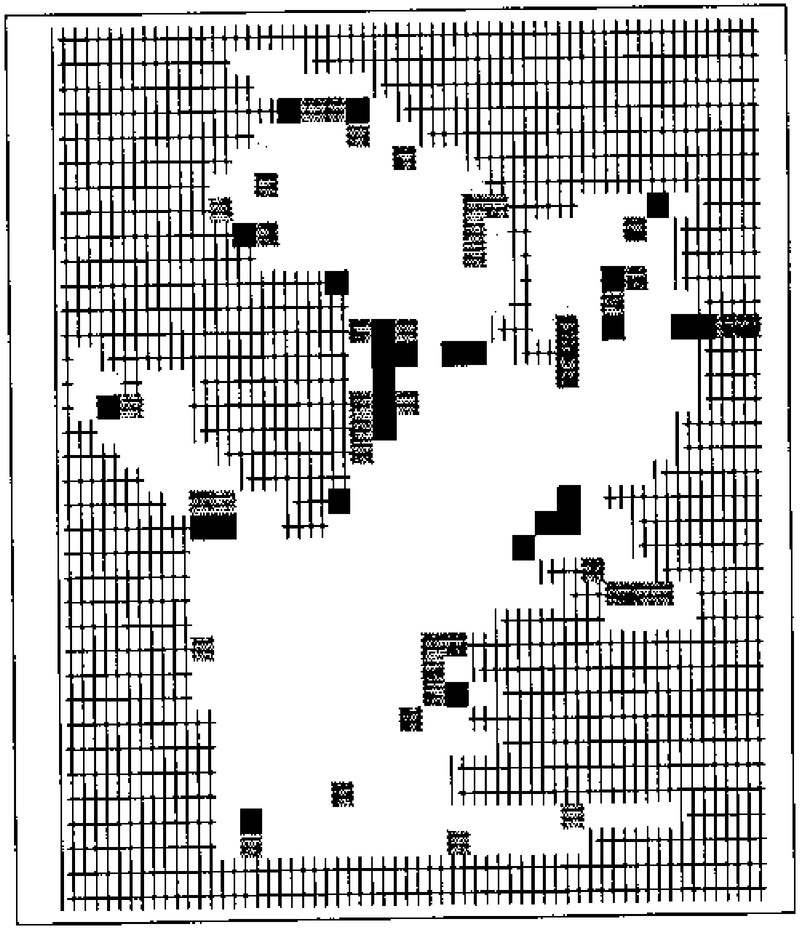
Fall (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Silver Perch (Bairdiella chrysoura)
All Lengths
Seines

Spring (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Figure 11. Silver perch relative abundance maps: fish of all lengths collected by seines in the fall and spring seasons.

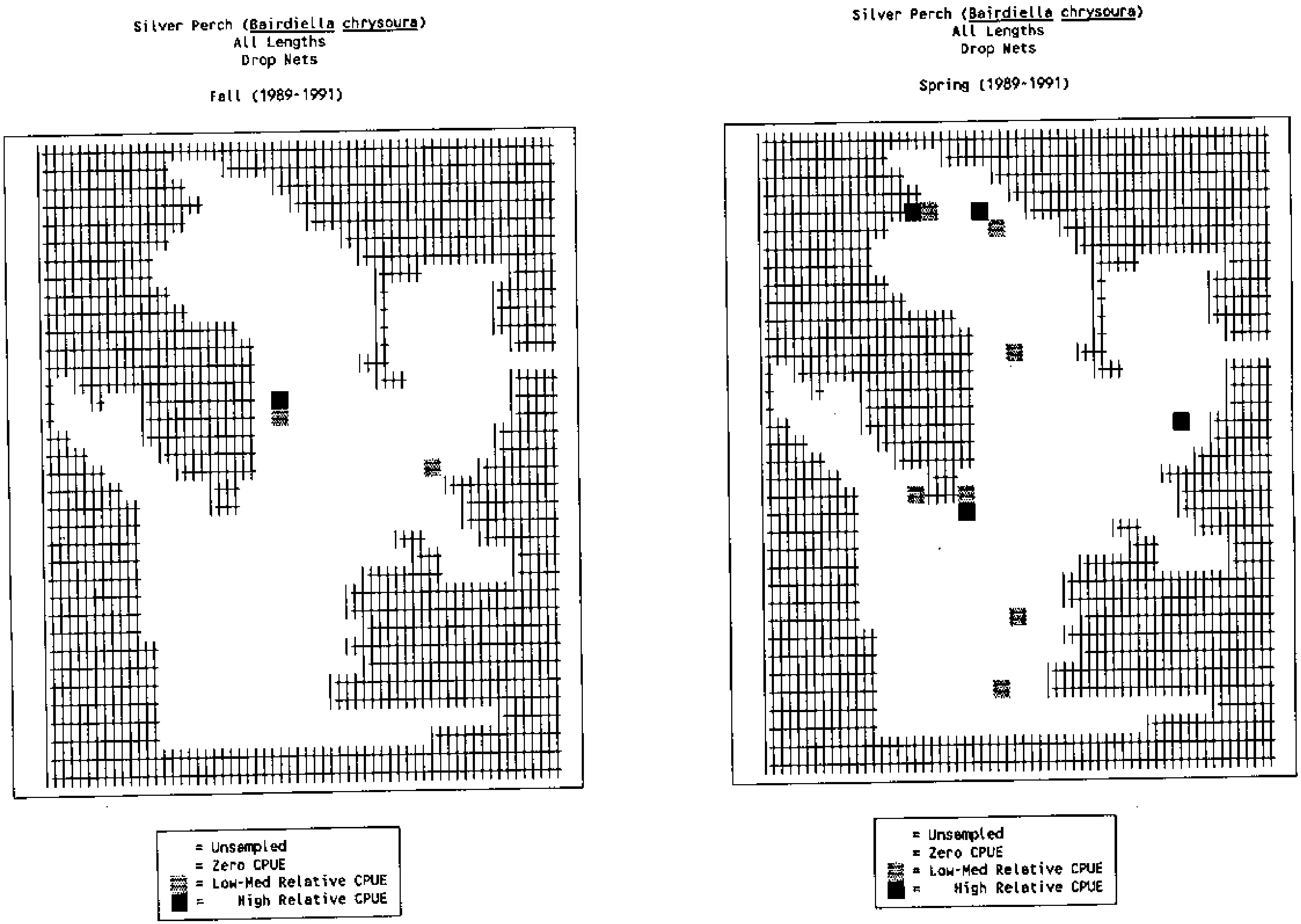
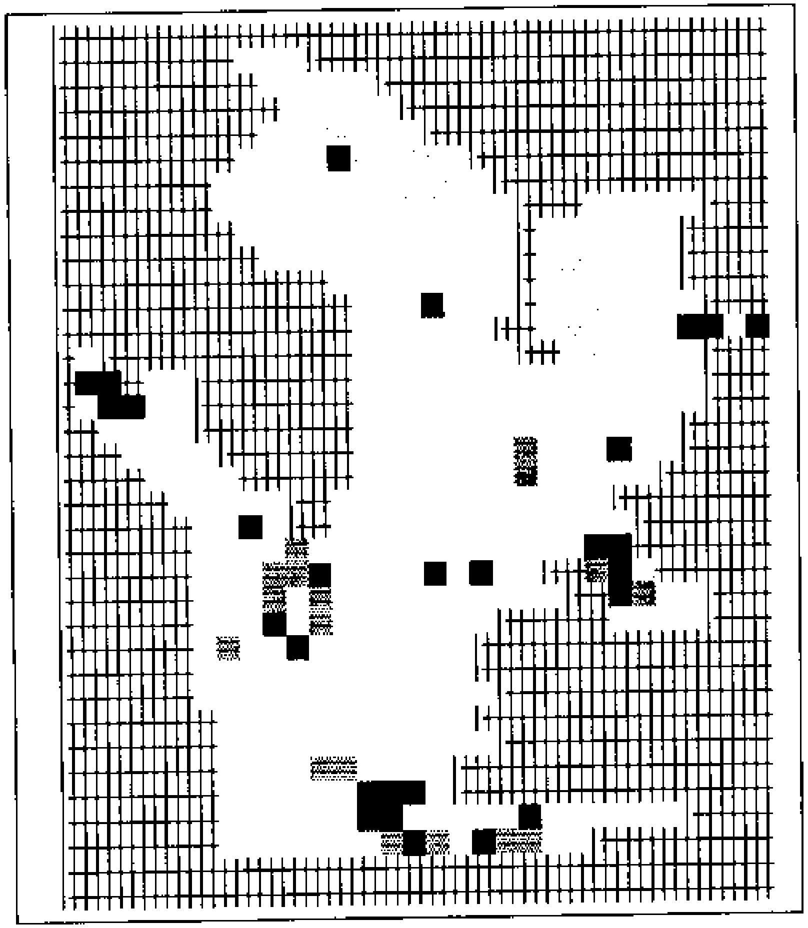


Figure 12. Silver perch relative abundance maps: fish of all lengths collected by drop nets in the fall and spring seasons.

Spot (Leiostomus xanthurus)
All Lengths
Trawls

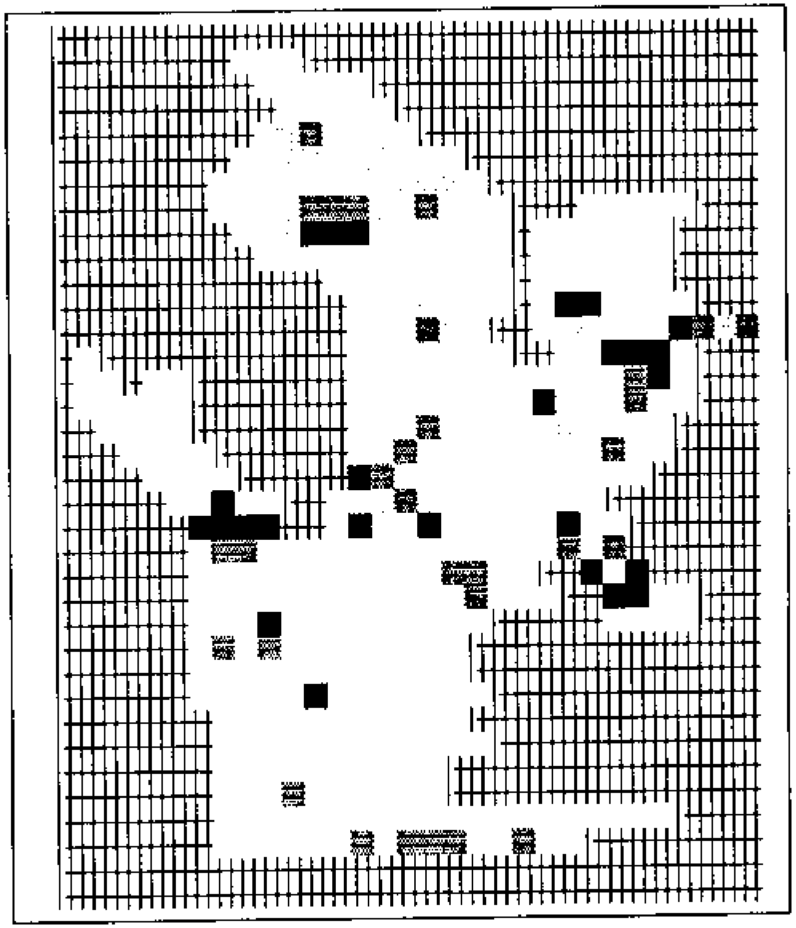
Fall (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Spot (Leiostomus xanthurus)
All Lengths
Trawls

Spring (1989-1991)

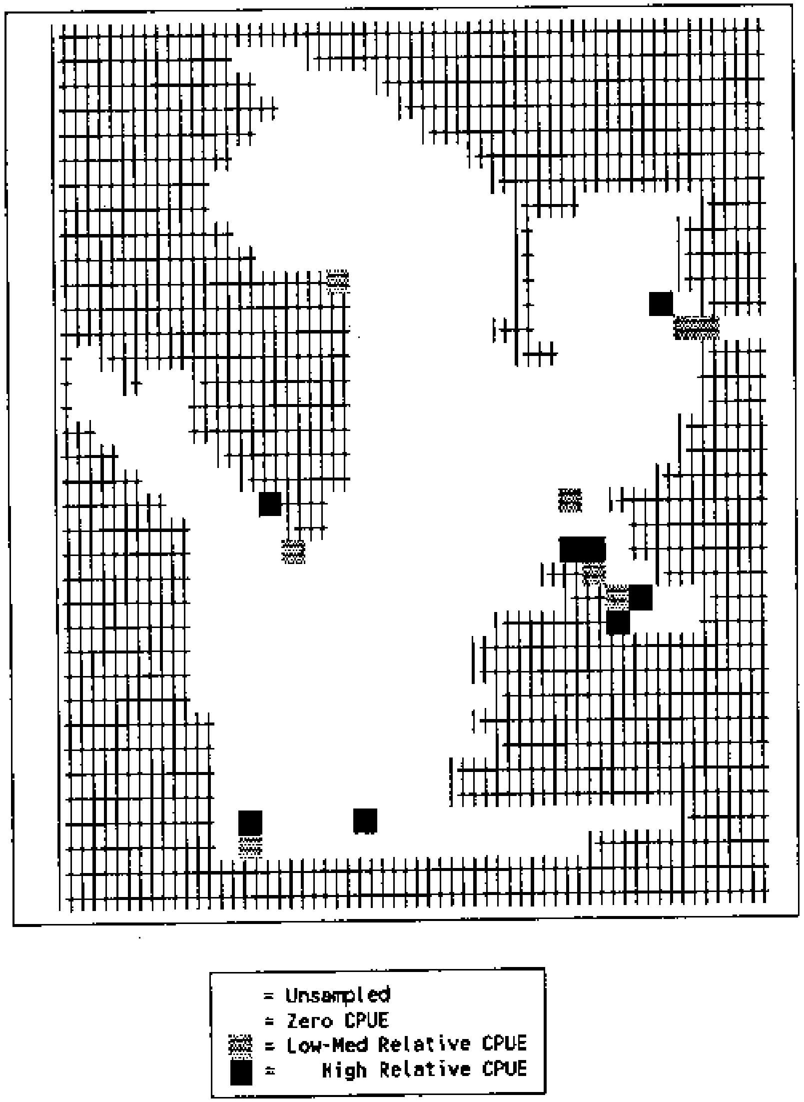


= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Figure 13. Spot relative abundance maps: fish of all lengths collected by trawls in the fall and spring seasons.

Spot (Leiostomus xanthurus)
All Lengths
Seines

Fall (1989-1991)



Spot (Leiostomus xanthurus)
All Lengths
Seines

Spring (1989-1991)

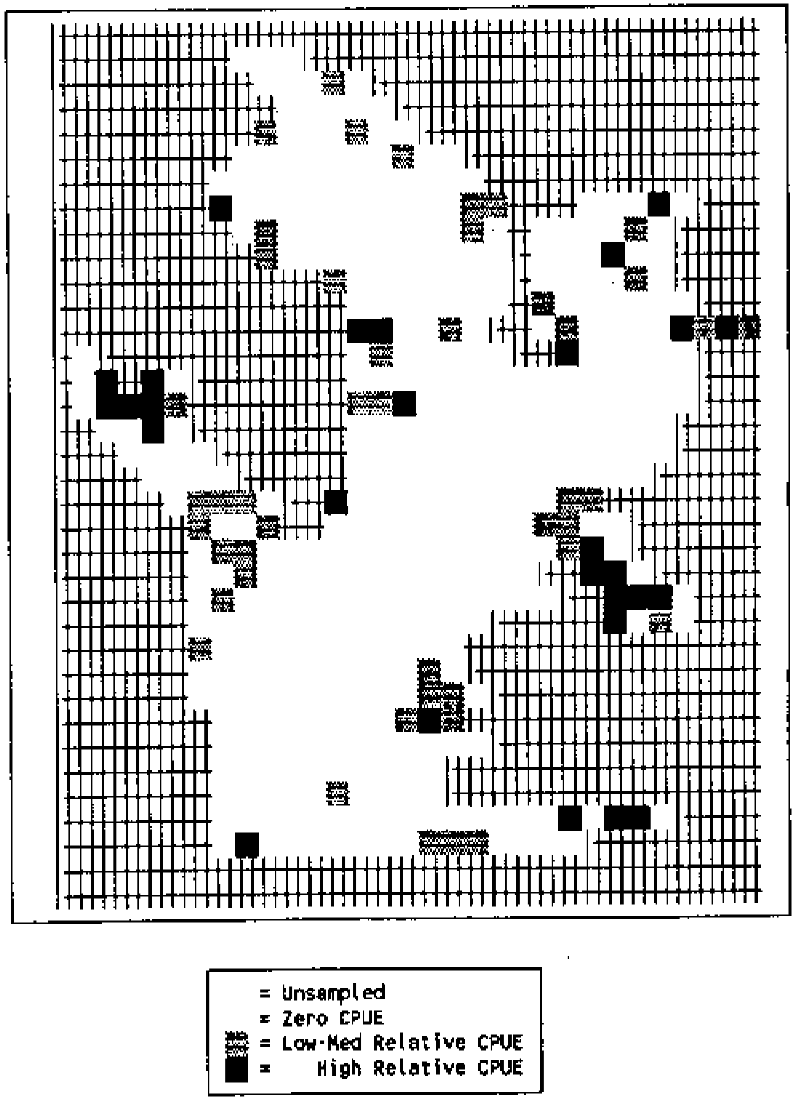


Figure 14. Spot relative abundance maps: fish of all lengths collected by seines in the fall and spring seasons.

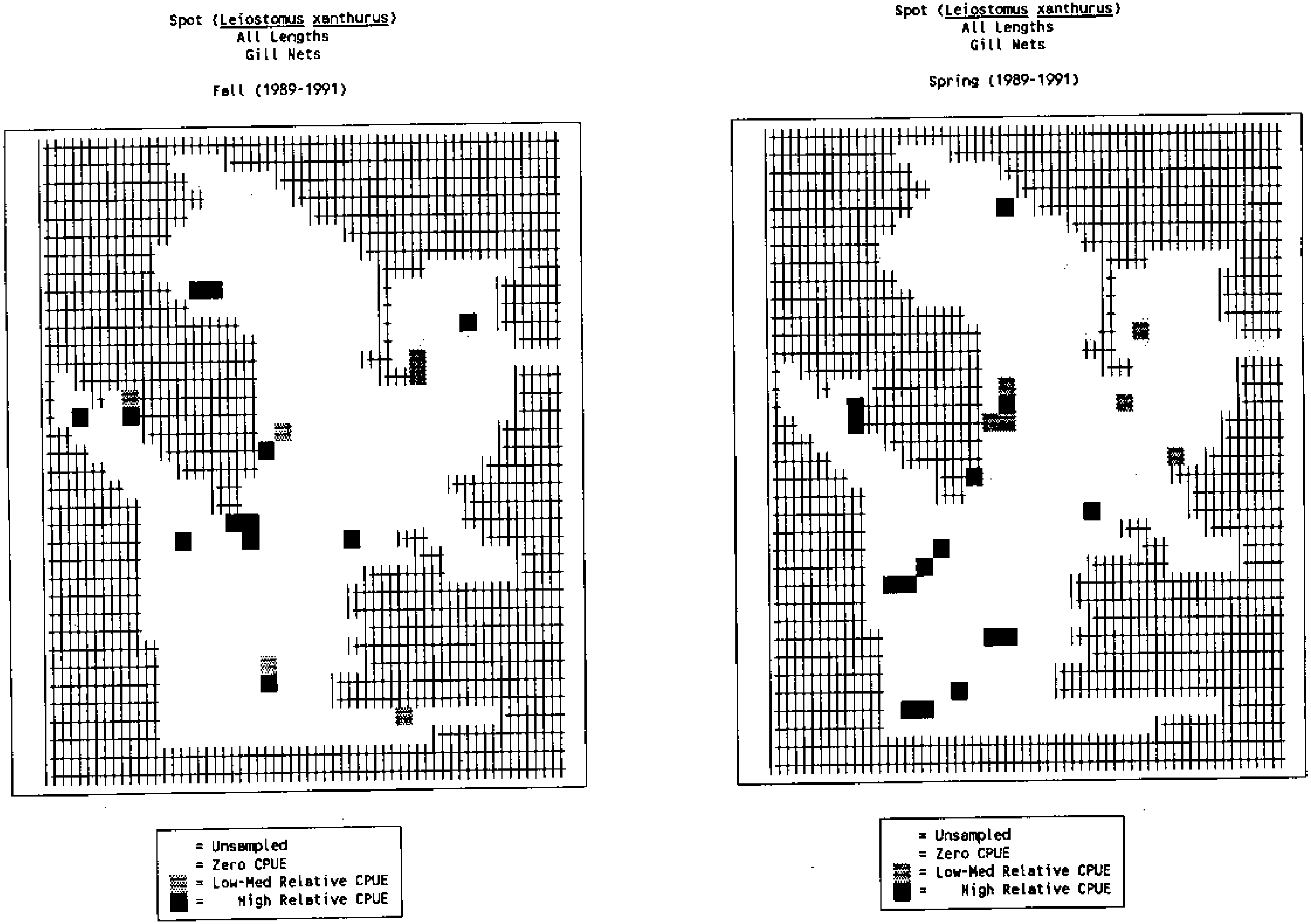


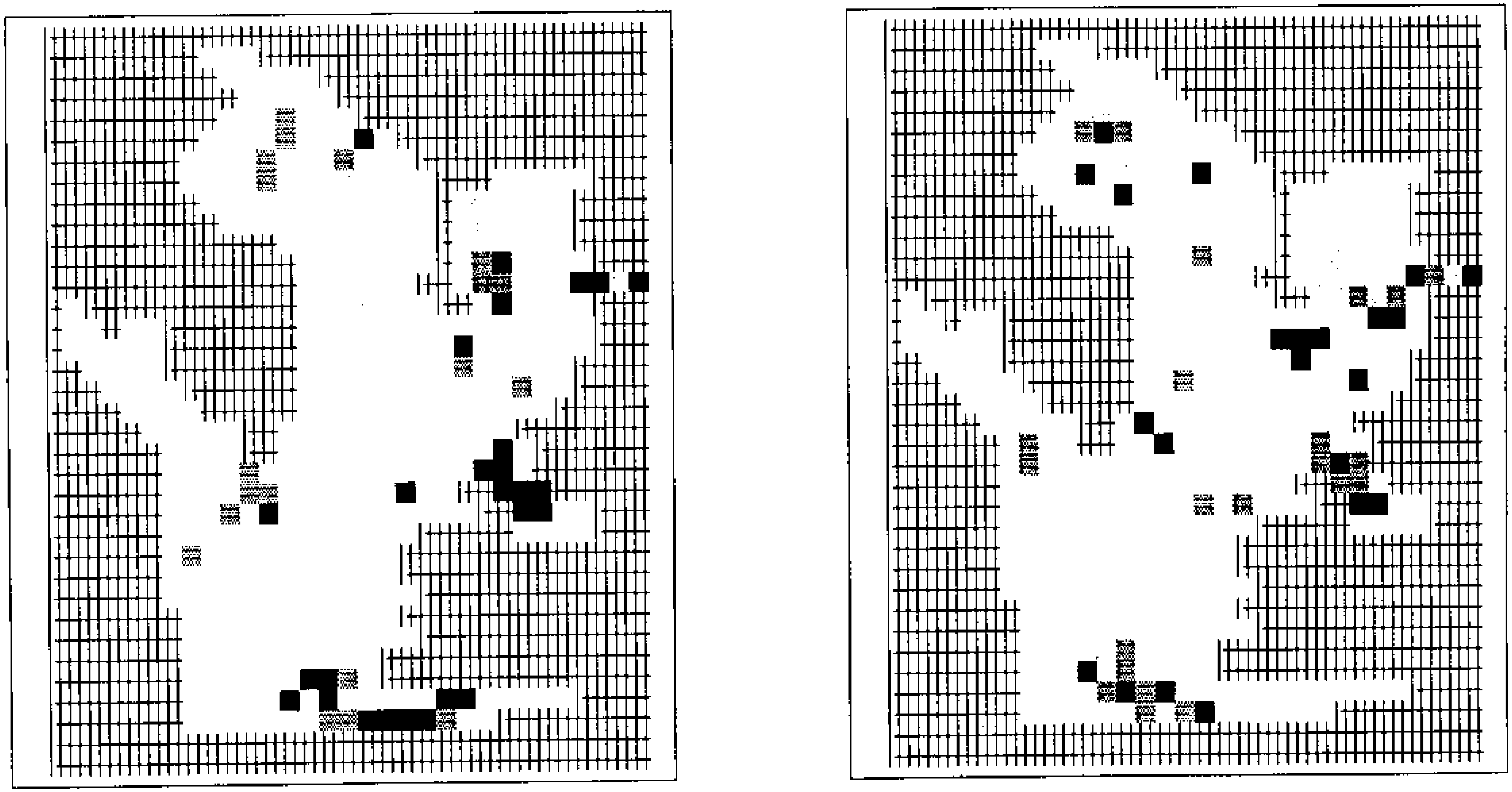
Figure 15. Spot relative abundance maps: fish of all lengths collected by gill nets in the fall and spring seasons.

Hogchoker (Trinectes maculatus)
All Lengths
Trawls

Fall (1989-1991)

Hogchoker (Trinectes maculatus)
All Lengths
Trawls

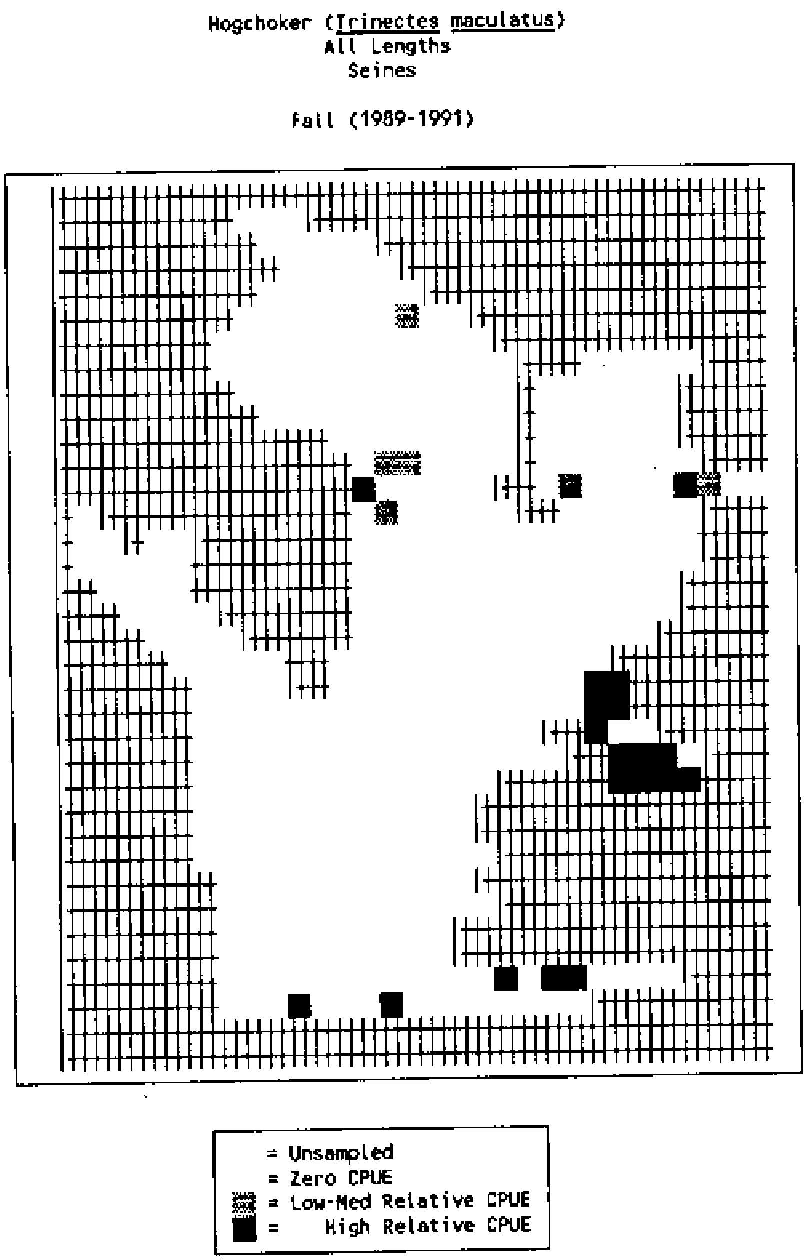
Spring (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Figure 16. Hogchoker relative abundance maps: fish of all lengths collected by trawls in the fall and spring seasons.



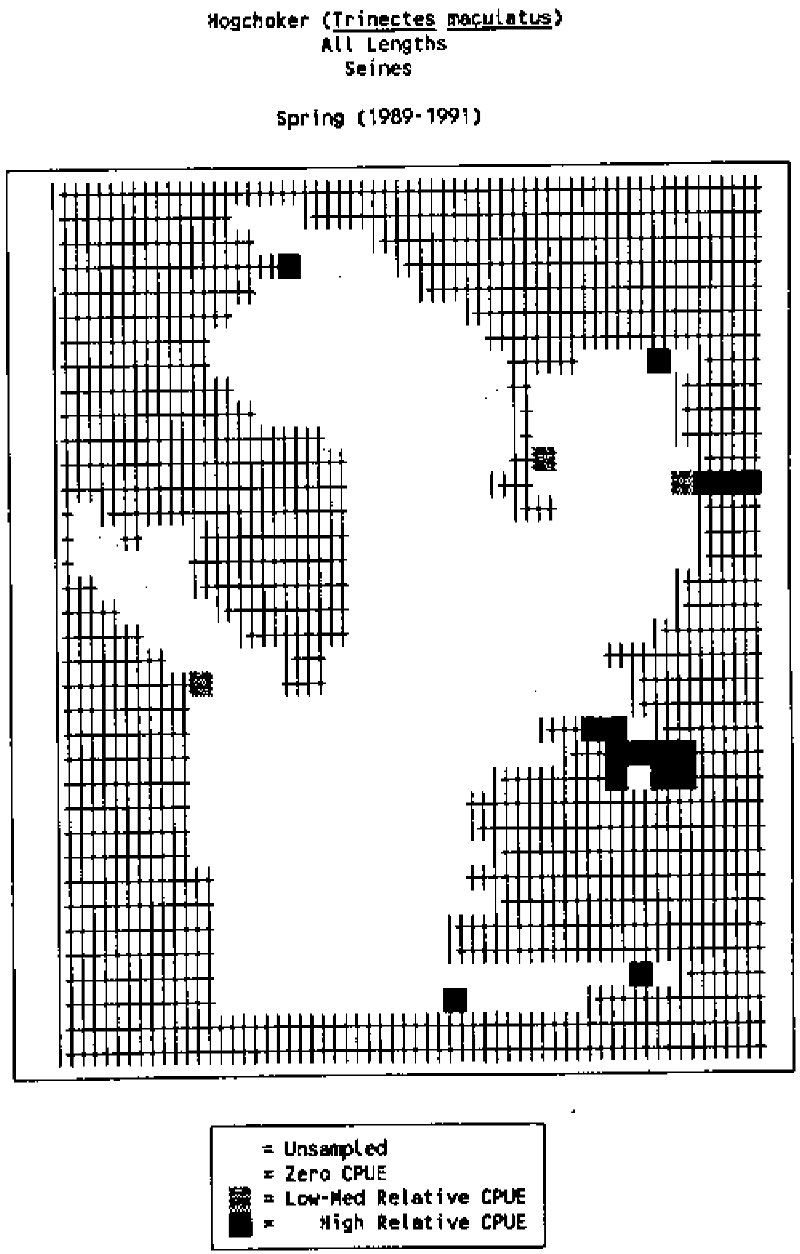
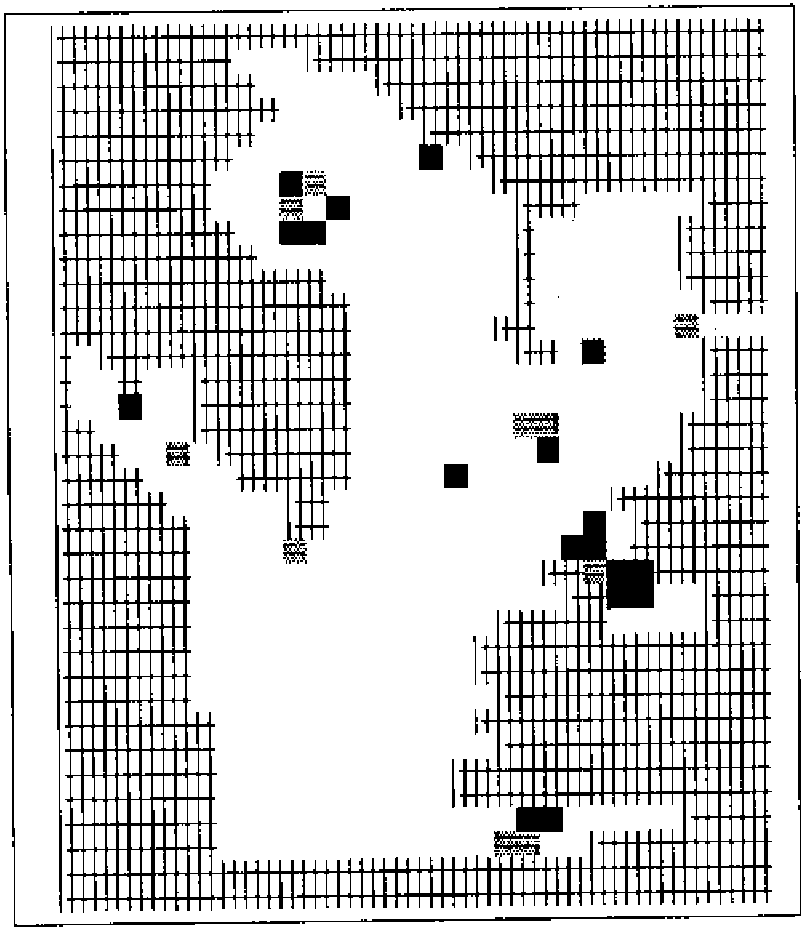


Figure 17. Hogchoker relative abundance maps: fish of all lengths collected by seines in the fall and spring seasons.

Clown Goby (<u>Microgobius</u> <u>gulosus</u>)
All Lengths
Trawls

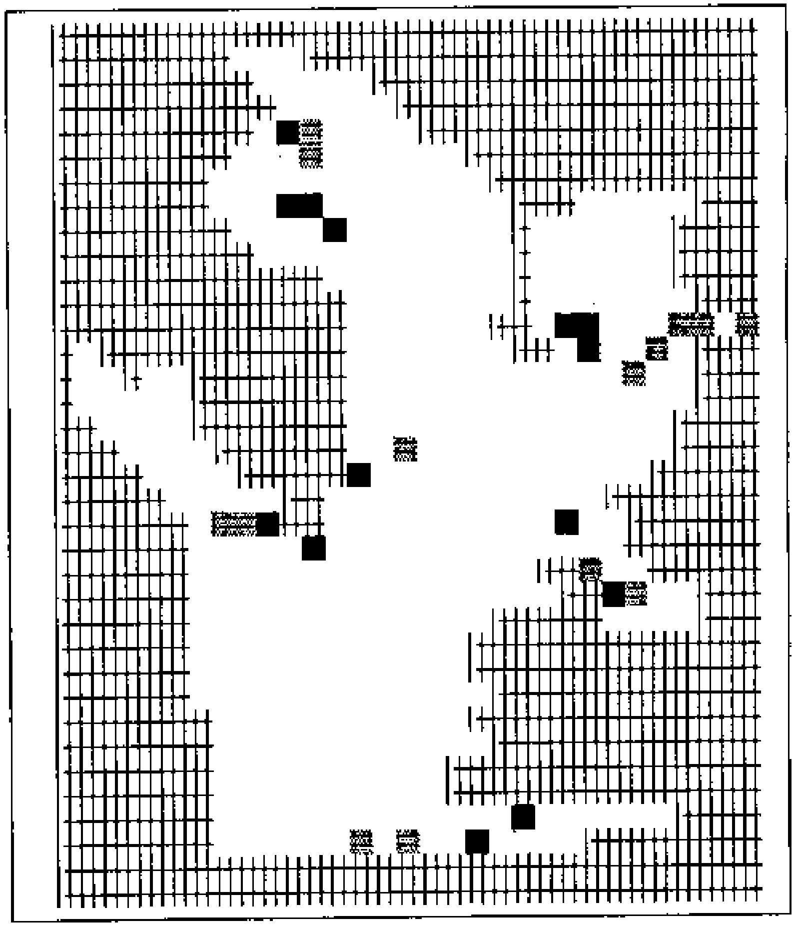
Fall (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Clown Goby (<u>Microgobius</u> <u>gulosus</u>)
All Lengths
Trawls

Spring (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Figure 18. Clown goby relative abundance maps: fish of all lengths collected by trawls in the fall and spring seasons.

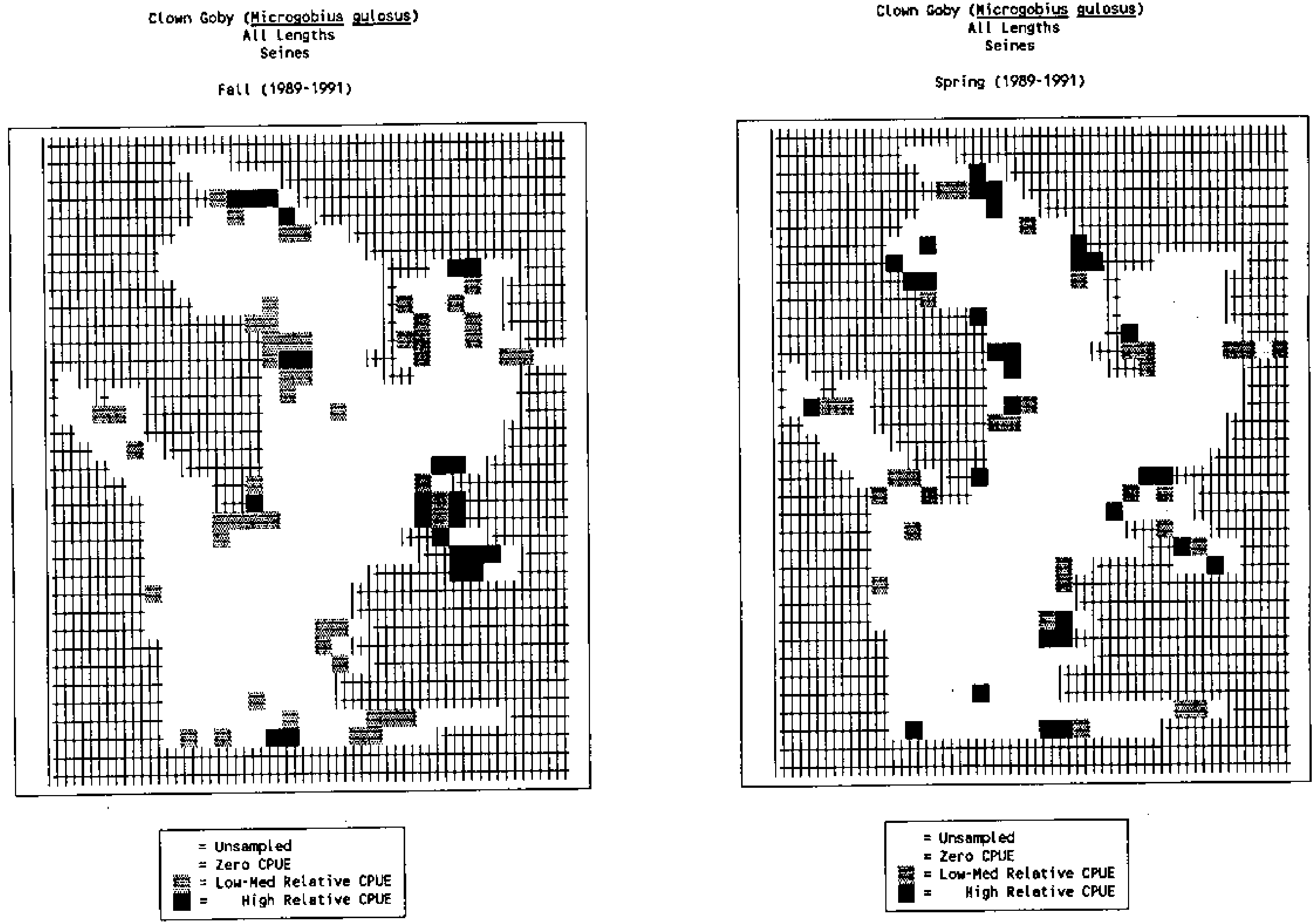
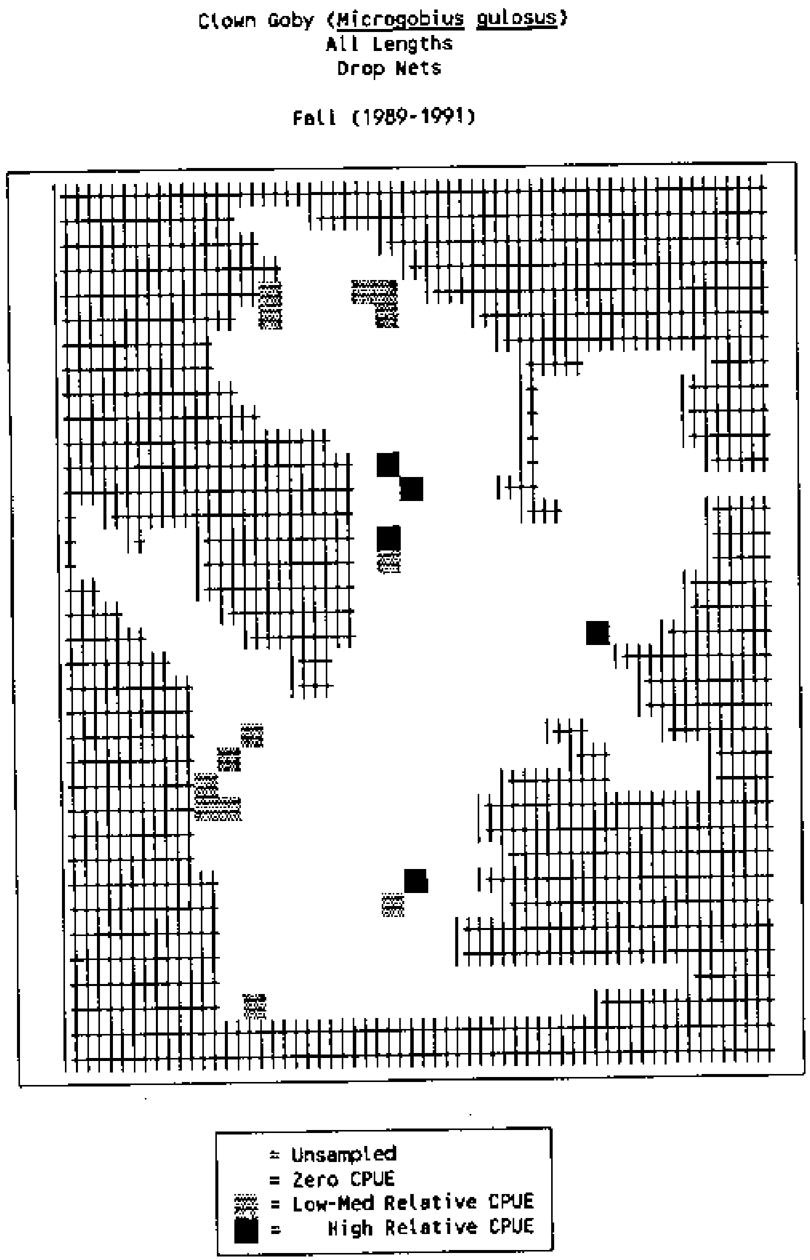


Figure 19. Clown goby relative abundance maps: fish of all lengths collected by seines in the fall and spring seasons.



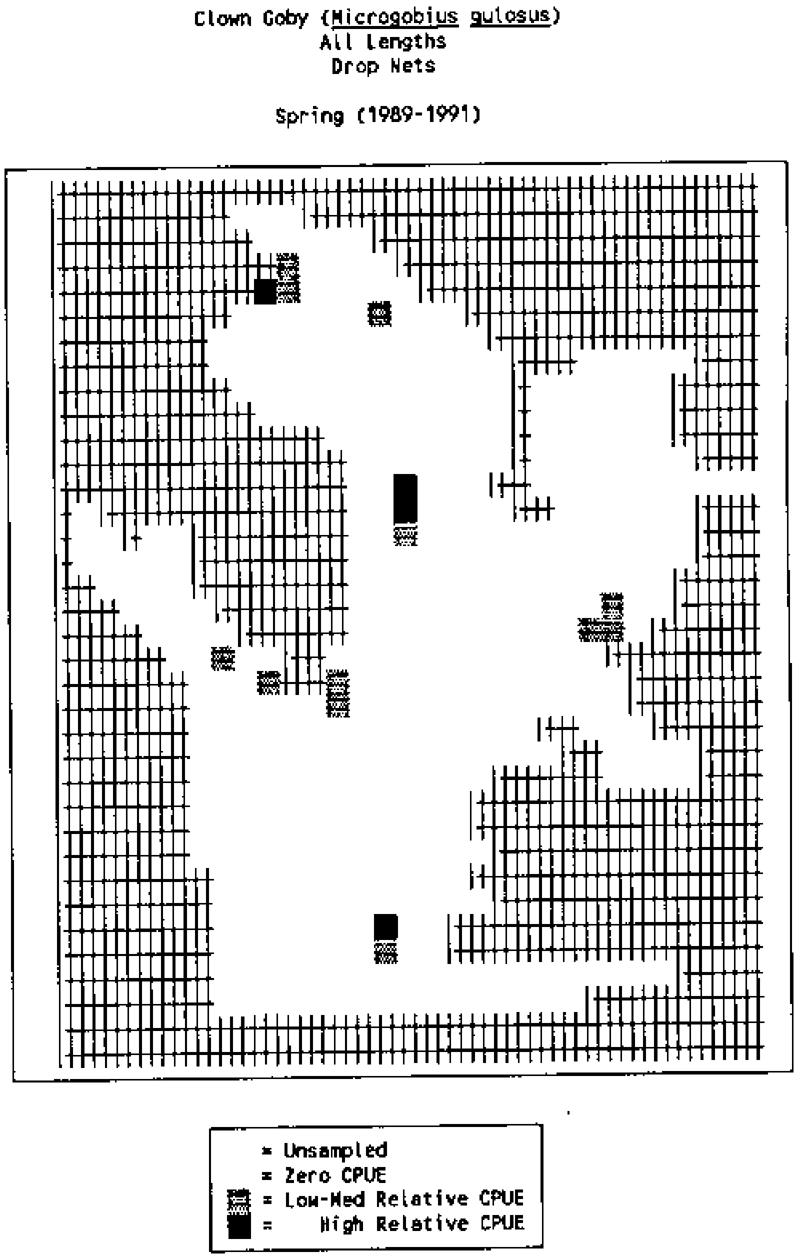


Figure 20. Clown goby relative abundance maps: fish of all lengths collected by drop nets in the fall and spring seasons.

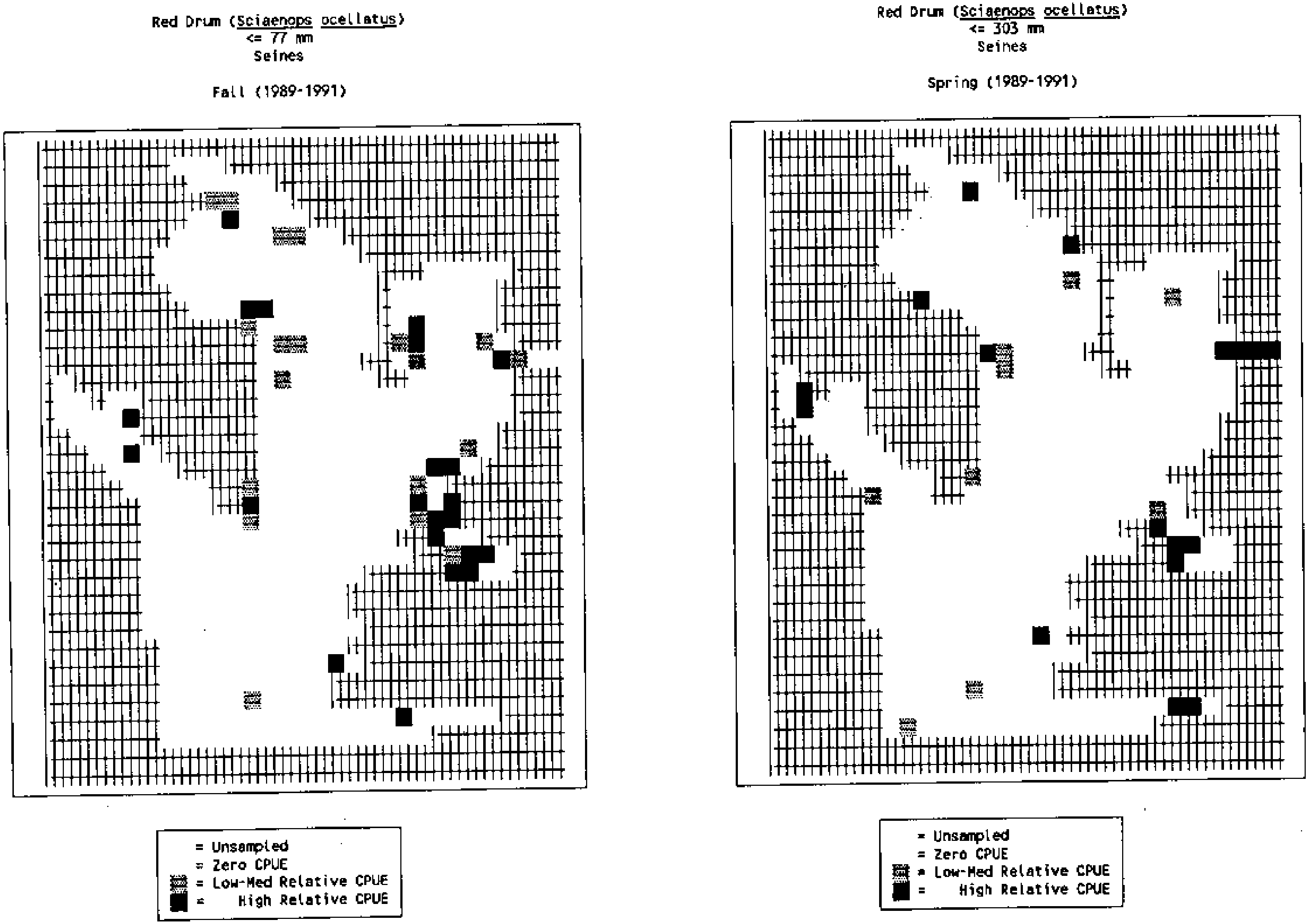


Figure 21. Red drum relative abundance maps: fish < = 77 mm in length collected by seines in the fall and spring seasons.

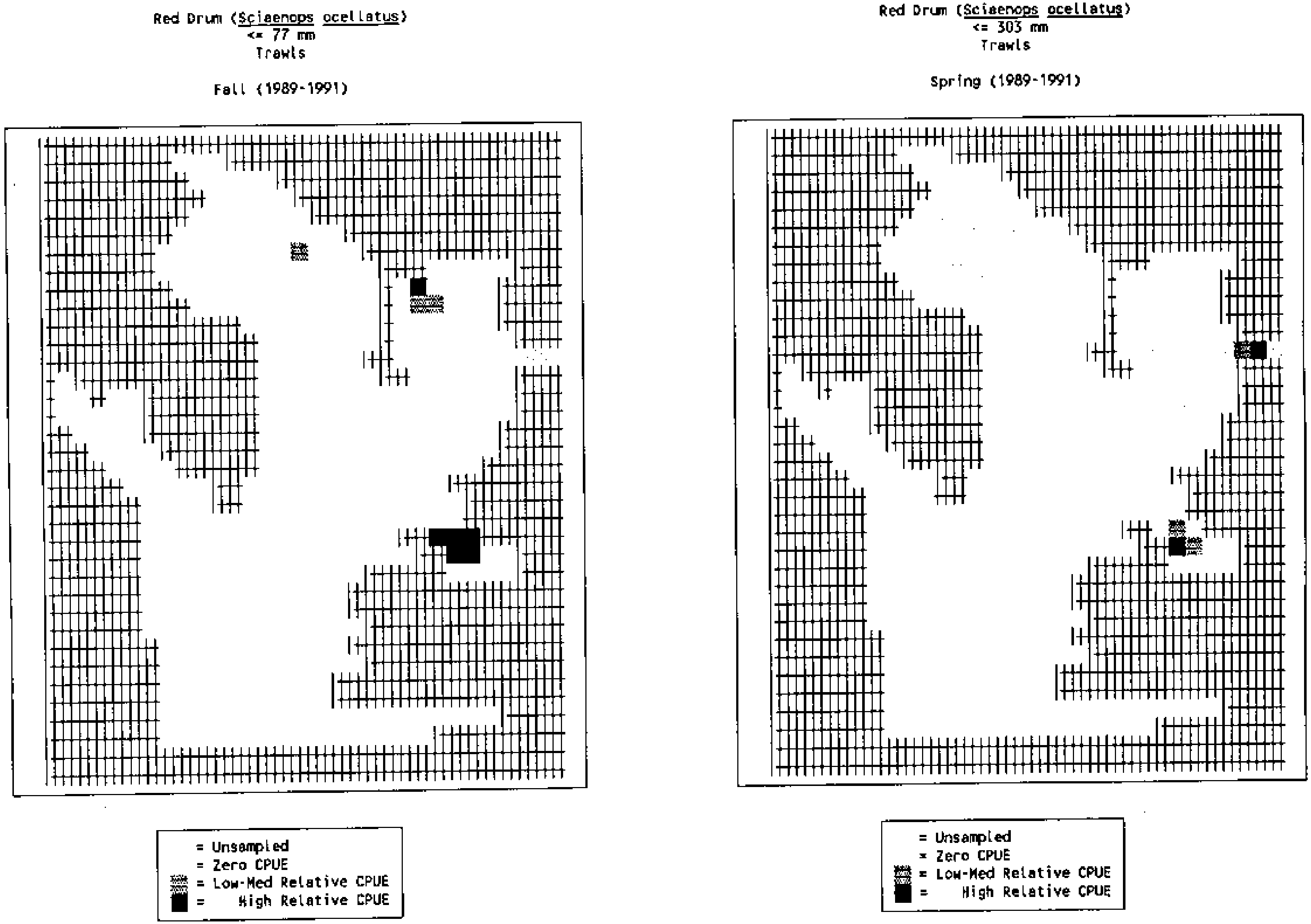


Figure 22. Red drum relative abundance maps: fish < = 77 mm in length collected by trawls in the fall and spring seasons.

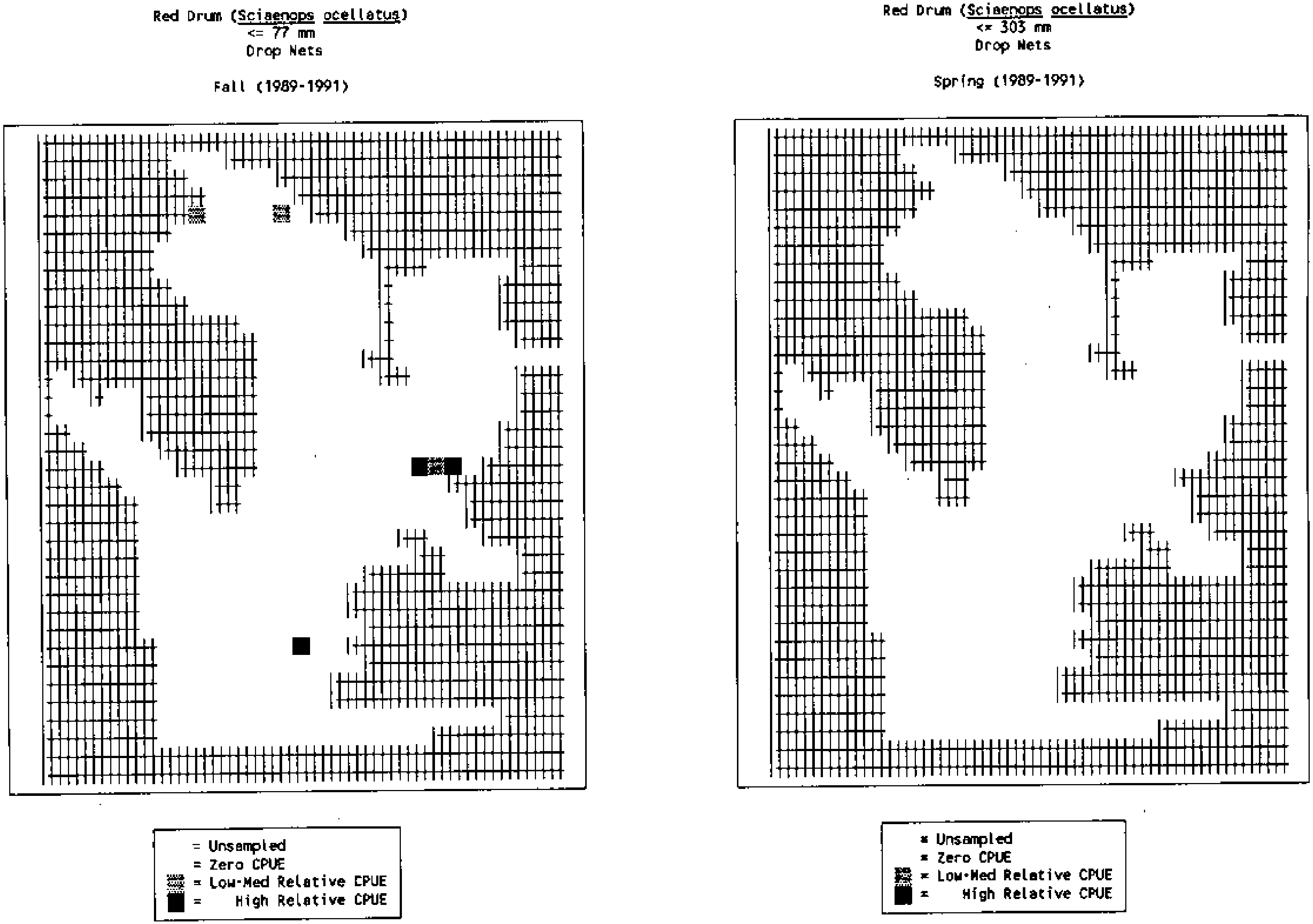
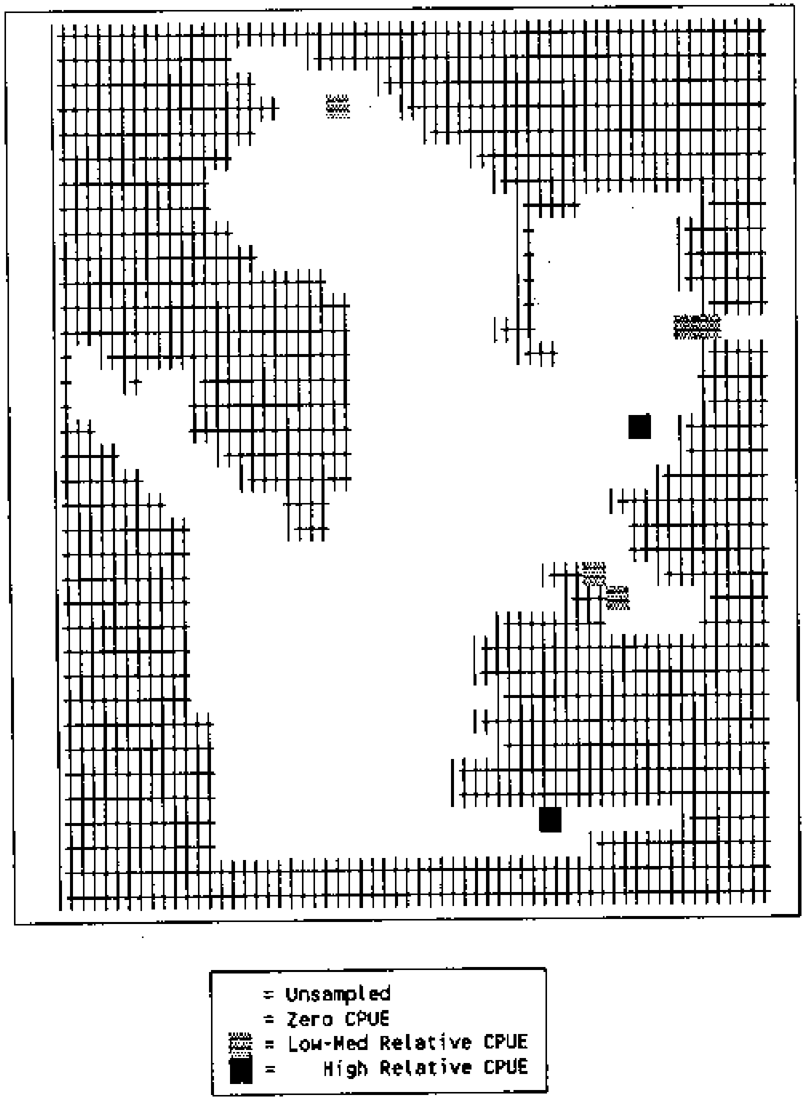


Figure 23. Red drum relative abundance maps: fish < = 77 mm in length collected by drop nets in the fall and spring seasons.

Red Drum (Sciaenops ocellatus)
> 77 mm
Seines

Fall (1989-1991)



Red Drum (Sciaenops ocellatus)
> 303 mm
Seines

Spring (1989-1991)

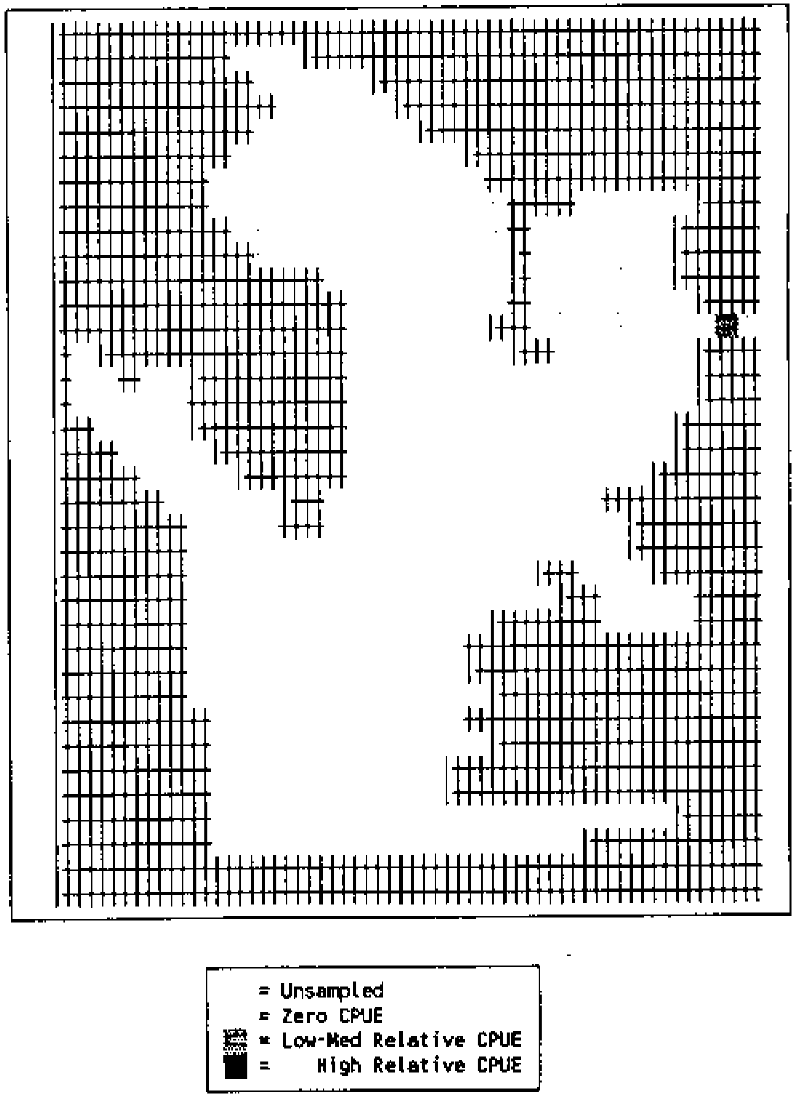


Figure 24. Red drum relative abundance maps: fish > 77 mm in length collected by seines in the fall and spring seasons.

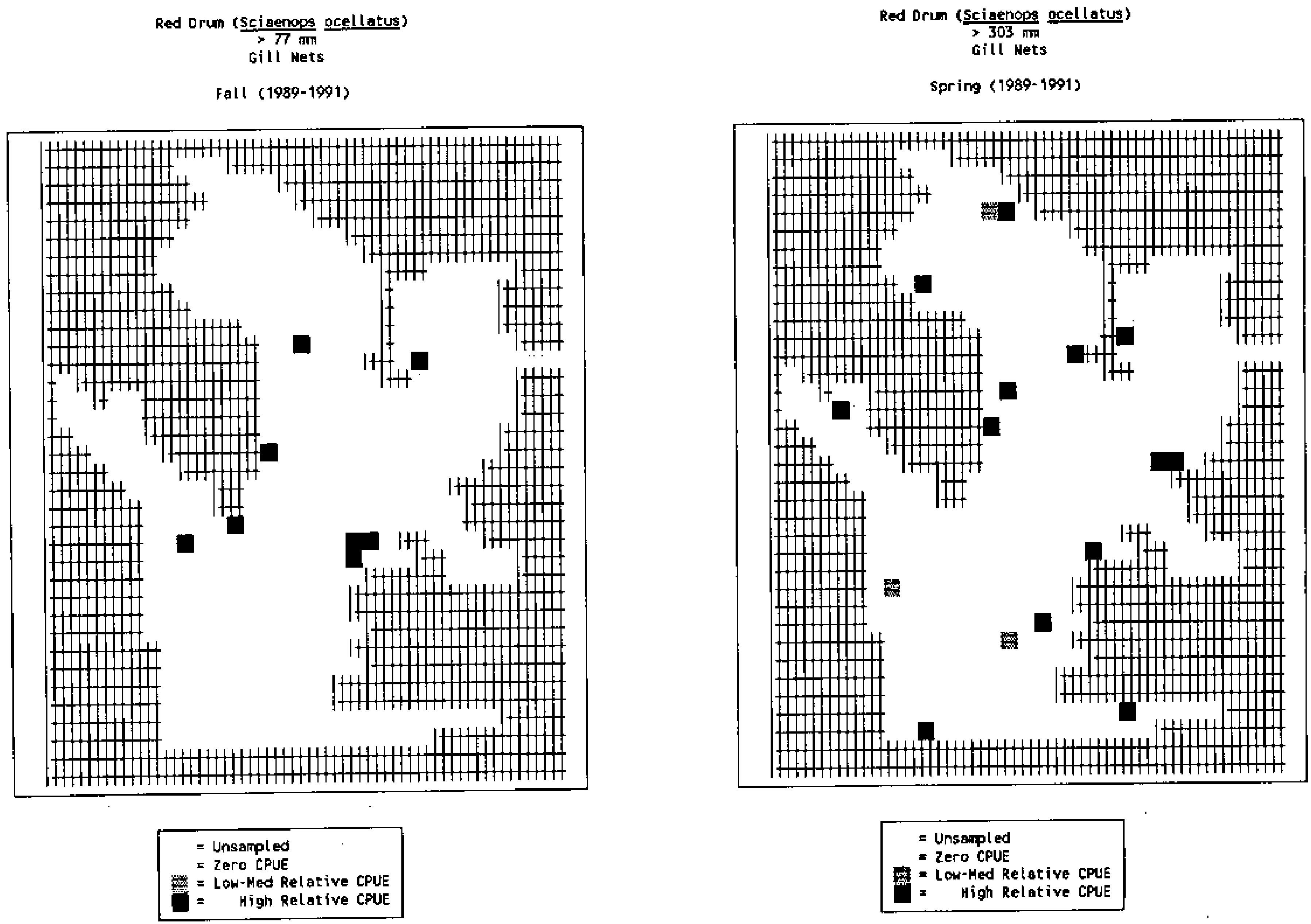


Figure 25. Red drum relative abundance maps: fish > 77 mm in length collected by gill nets in the fall and spring seasons.

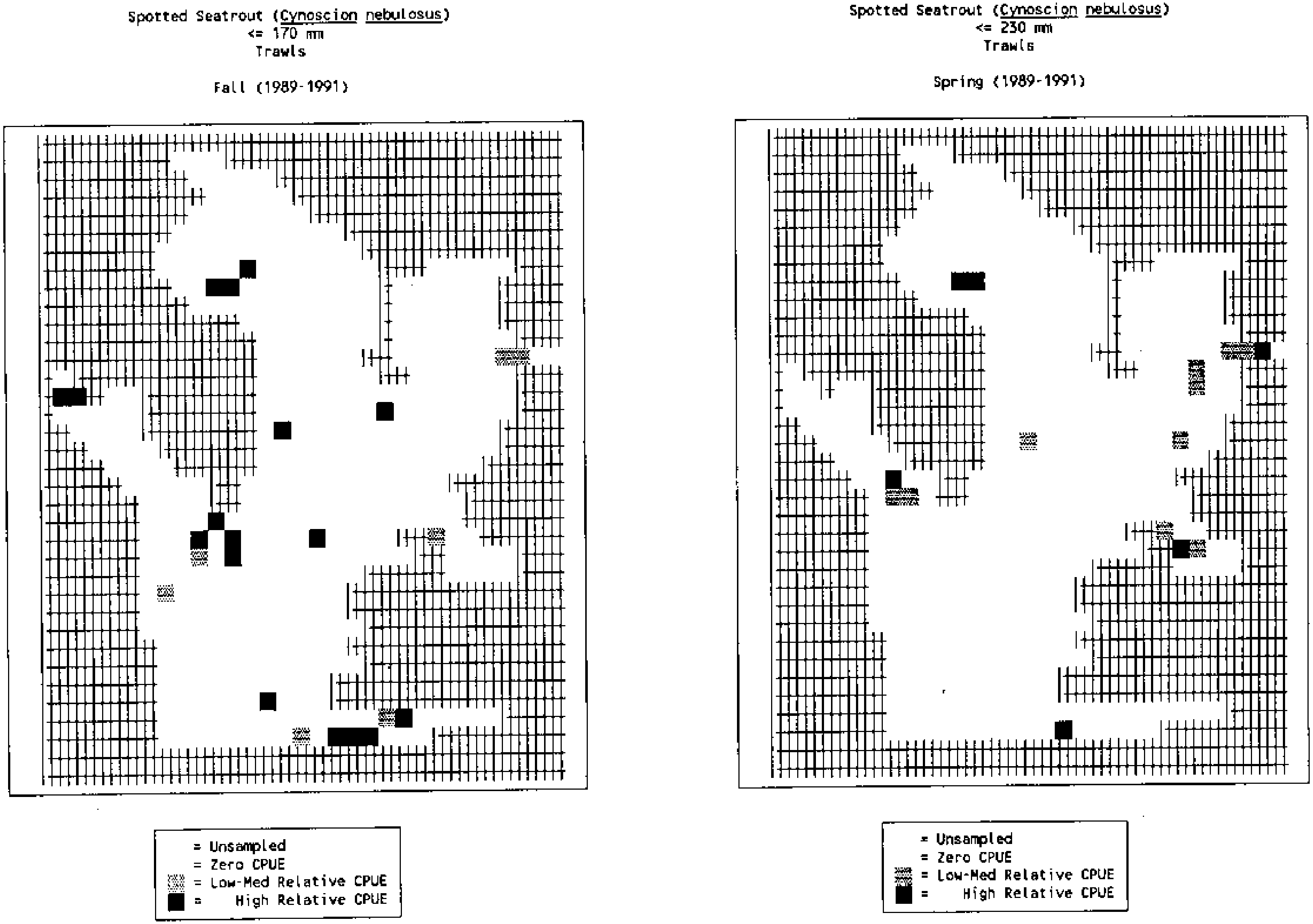


Figure 26. Spotted seatrout relative abundance maps: fish < = 170 mm (fall) or 230 mm (spring) in length collected by trawls in the fall and spring seasons.

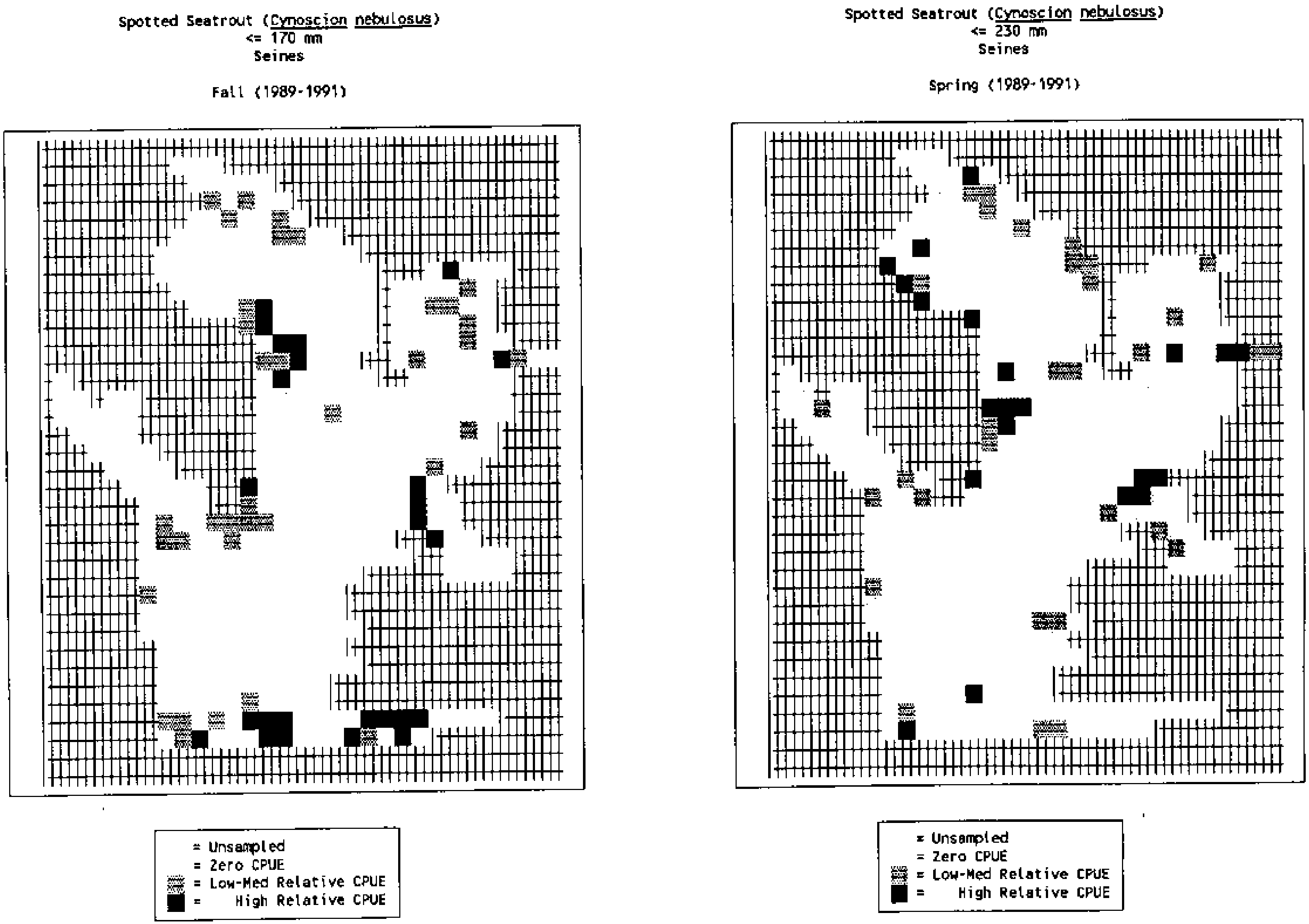
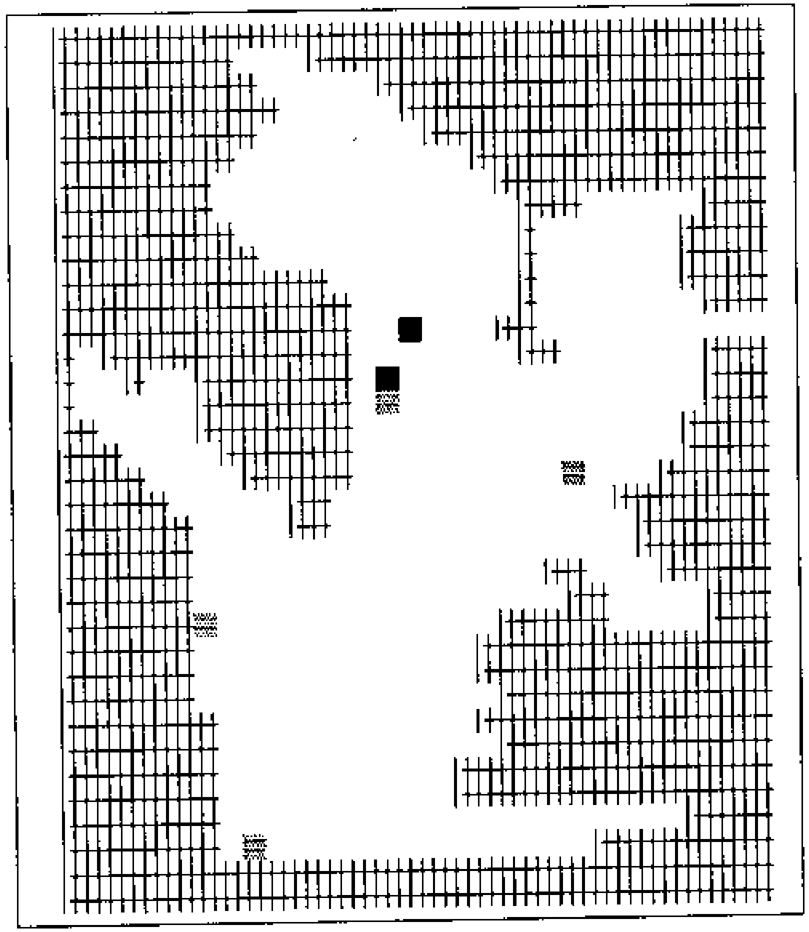


Figure 27. Spotted seatrout relative abundance maps: fish < = 170 mm (fall) or 230 mm (spring) in length collected by seines in the fall and spring seasons.

Spotted Seatrout (Cynoscion nebulosus)
<= 170 mm
Drop Nets

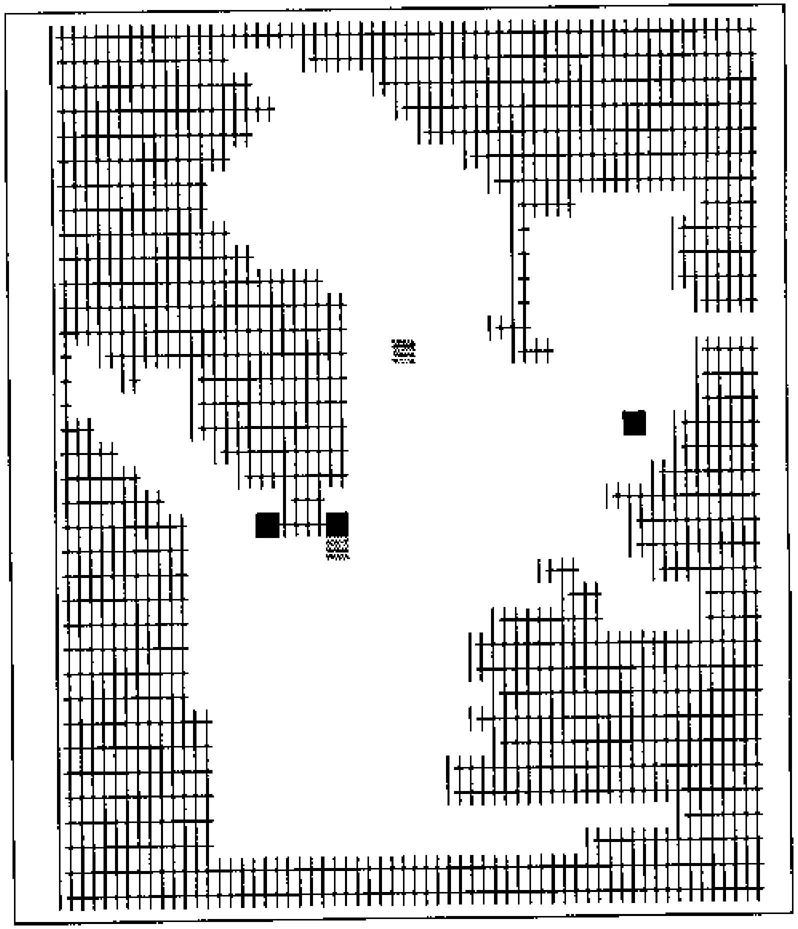
Fall (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Spotted Seatrout (Cynoscion nebulosus)
<= 230 mm
Drop Nets

Spring (1989-1991)



= Unsampled
= Zero CPUE
= Low-Med Relative CPUE
= High Relative CPUE

Figure 28. Spotted seatrout relative abundance maps: fish < = 170 mm (fall) or 230 mm (spring) in length collected by drop nets in the fall and spring seasons.

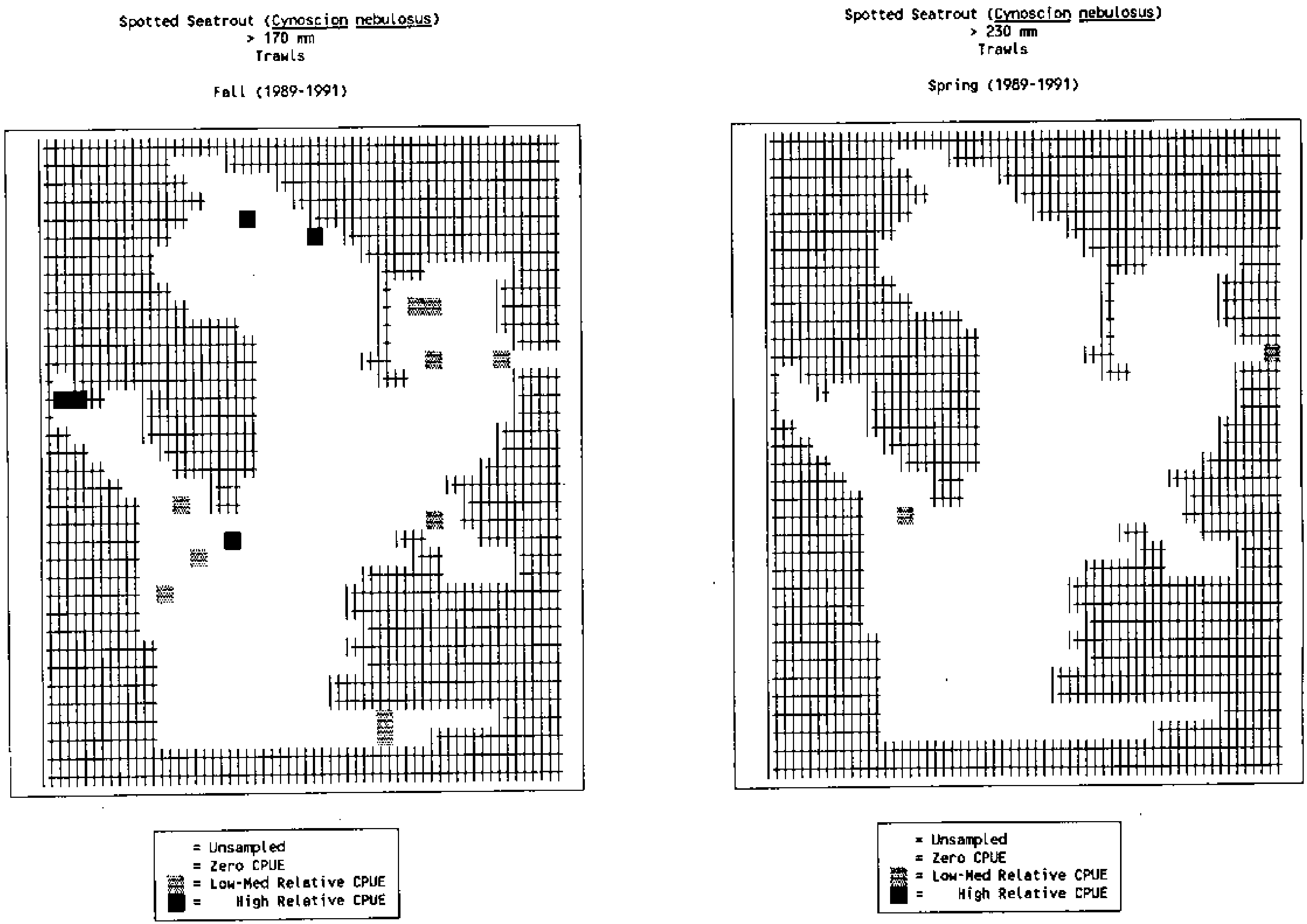
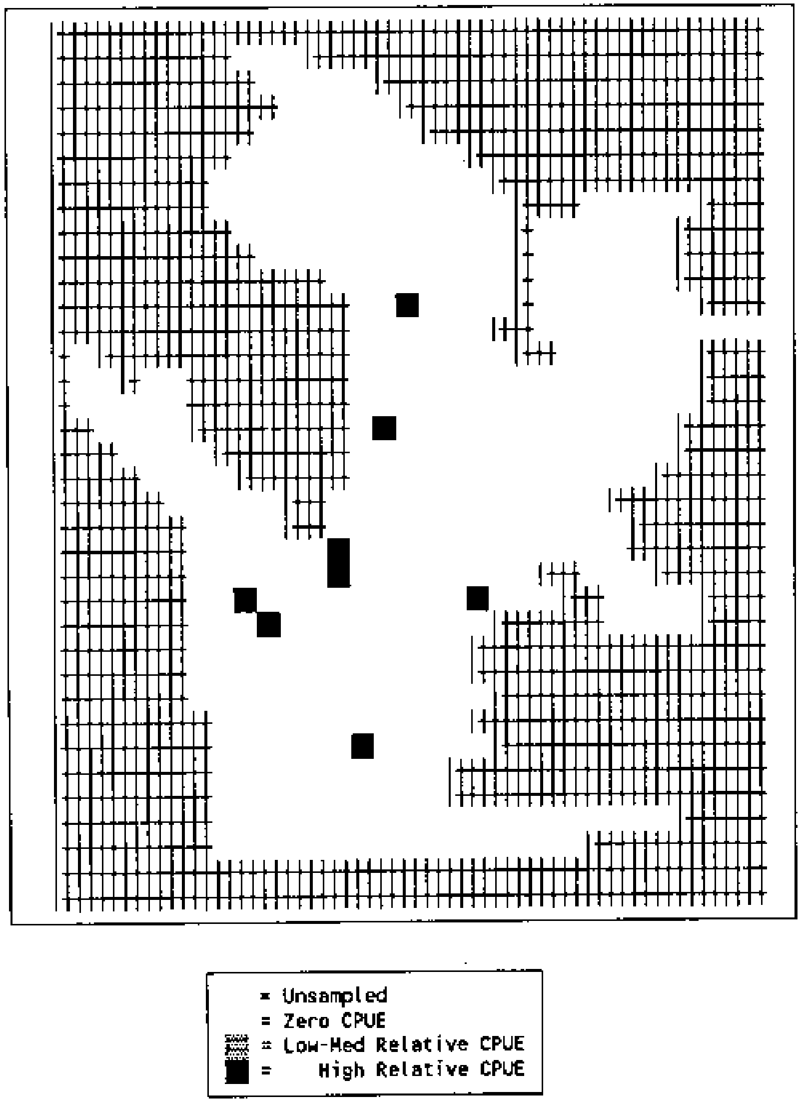


Figure 29. Spotted seatrout relative abundance maps: fish > 170 mm (fall) or 230 mm (spring) in length collected by trawls in the fall and spring seasons.

Spotted Seatrout (Cynoscion nebulosus)
> 170 mm
Gill Nets

Fall (1989-1991)



Spotted Seatrout (Cynoscion nebulosus)
> 230 mm
Gill Nets

Spring (1989-1991)

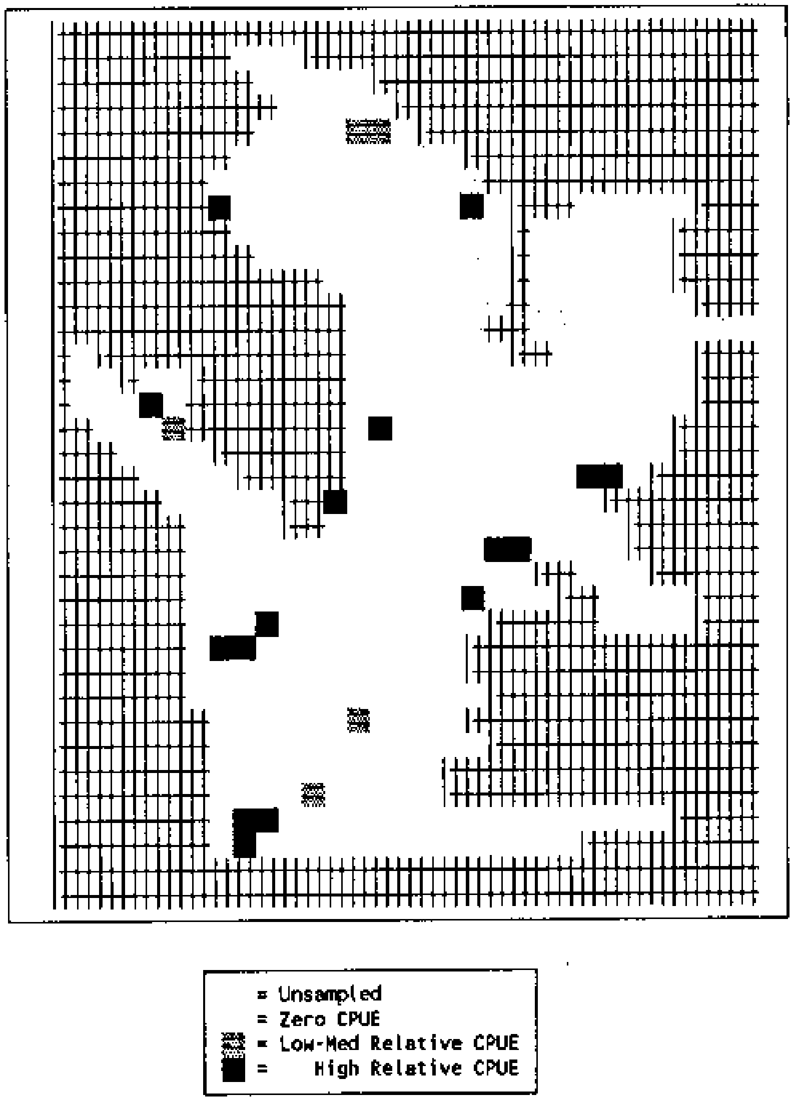


Figure 30. Spotted seatrout relative abundance maps: fish > 170 mm (fall) or 230 mm (spring) in length collected by gill nets in the fall and spring seasons.

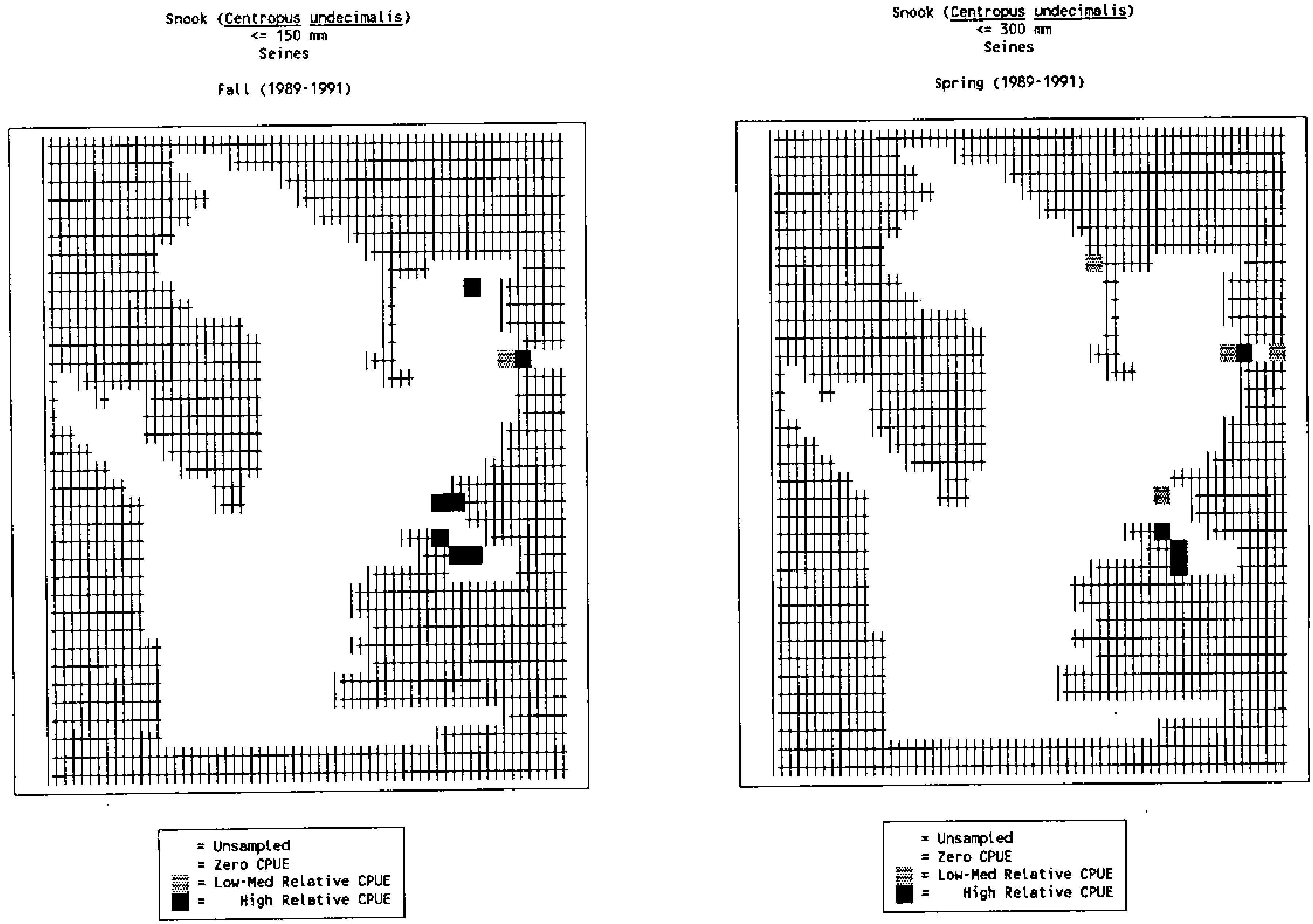
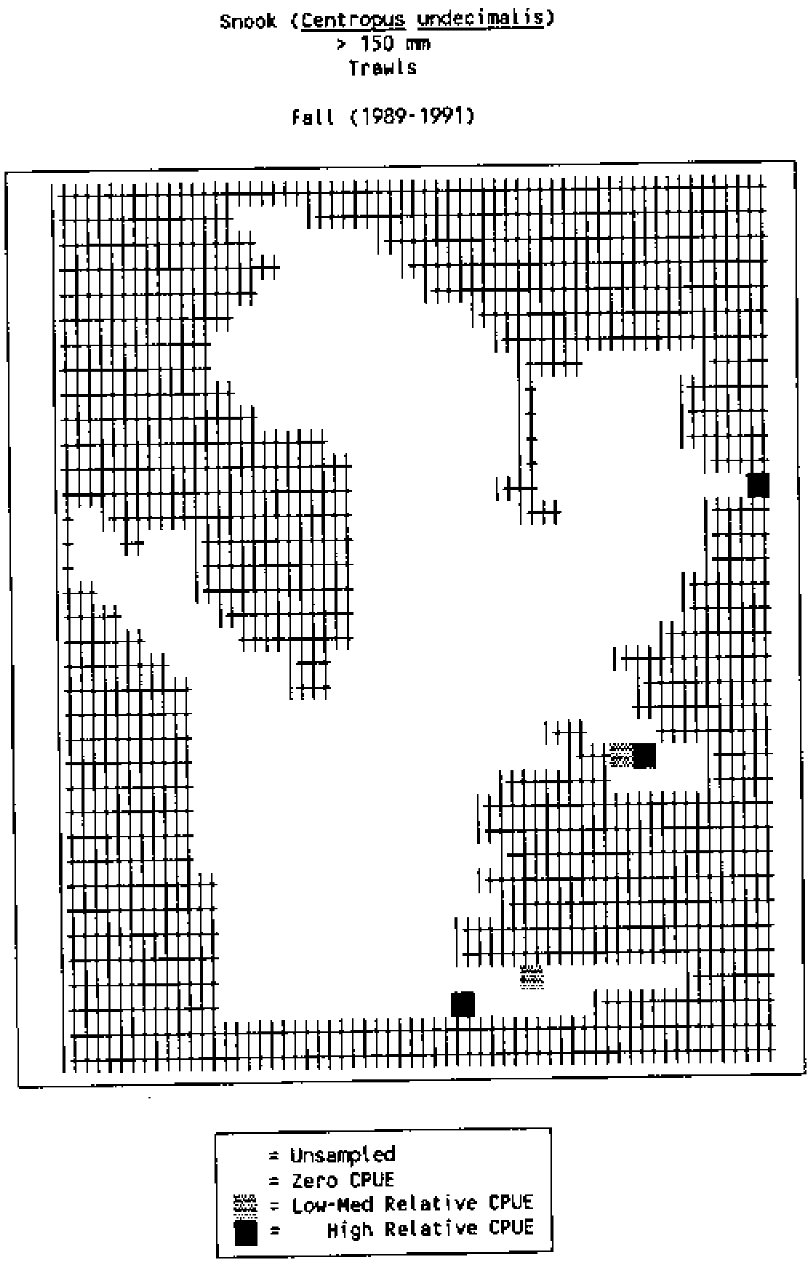


Figure 31. Snook relative abundance maps: fish < = 150 mm (fall) or 300 mm (spring) in length collected by seines in the fall and spring seasons.



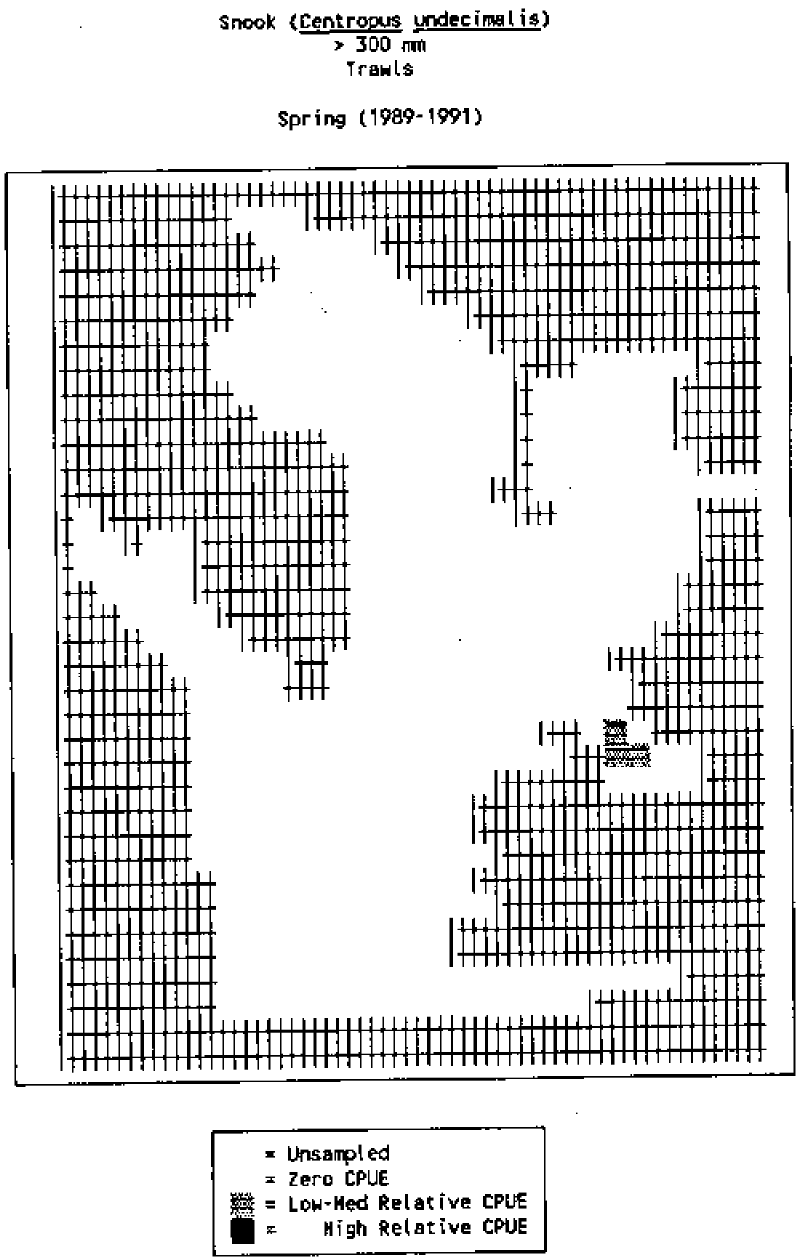
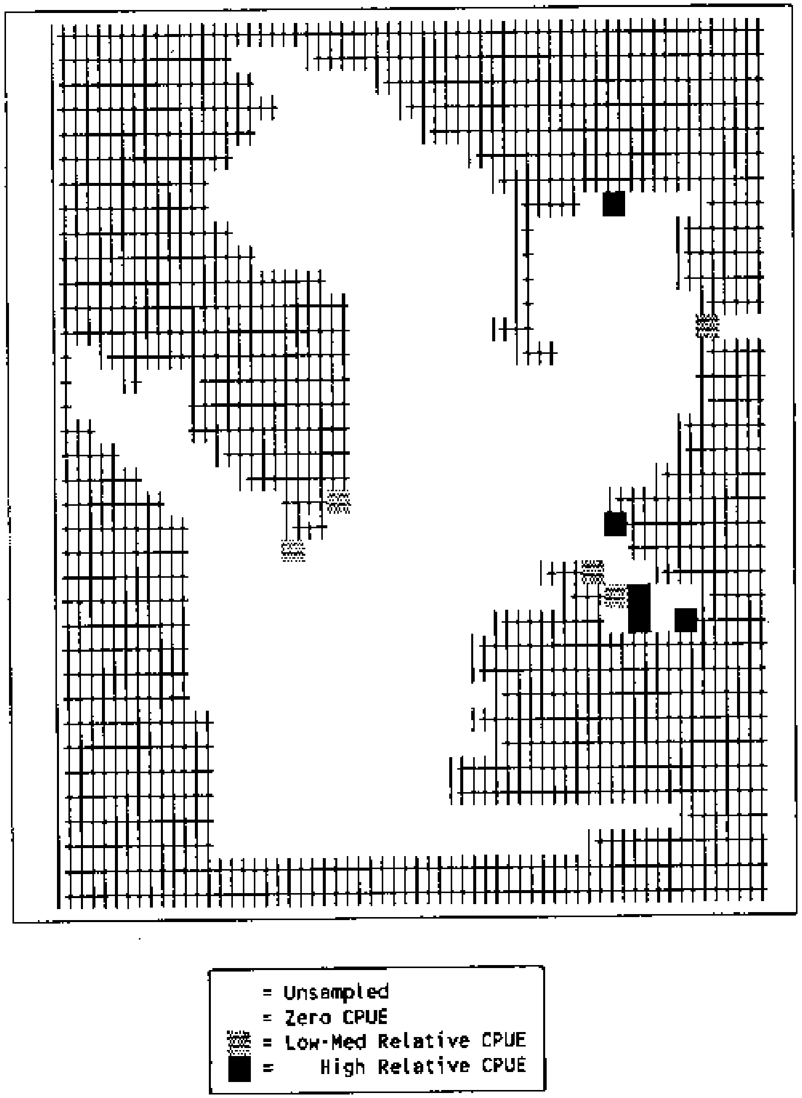


Figure 32. Snook relative abundance maps: fish > 150 mm (fall) or 300 mm (spring) in length collected by trawls in the fall and spring seasons.

Snook (Centropus undecimalis)
> 150 mm
Seines

Fall (1989-1991)



Snook (Centropus undecimalis)
> 300 mm
Seines

Spring (1989-1991)

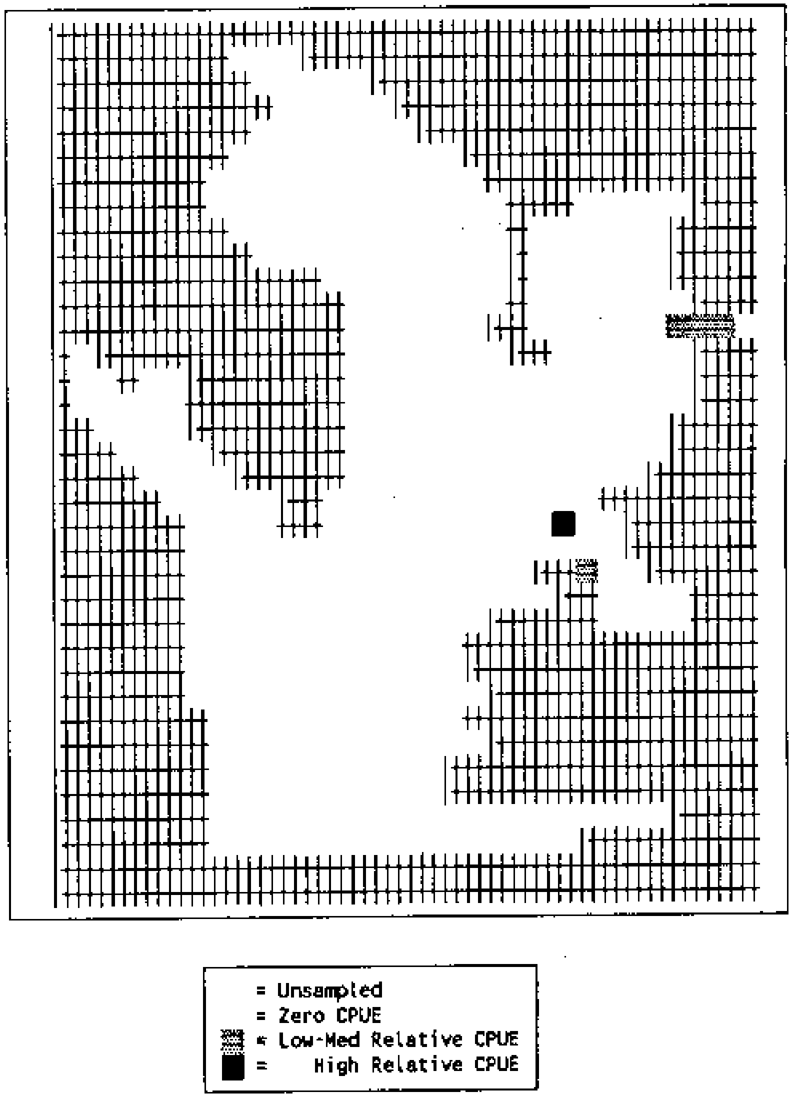


Figure 33. Snook relative abundance maps: fish > 150 mm (fall) or 300 mm (spring) in length collected by seines in the fall and spring seasons.

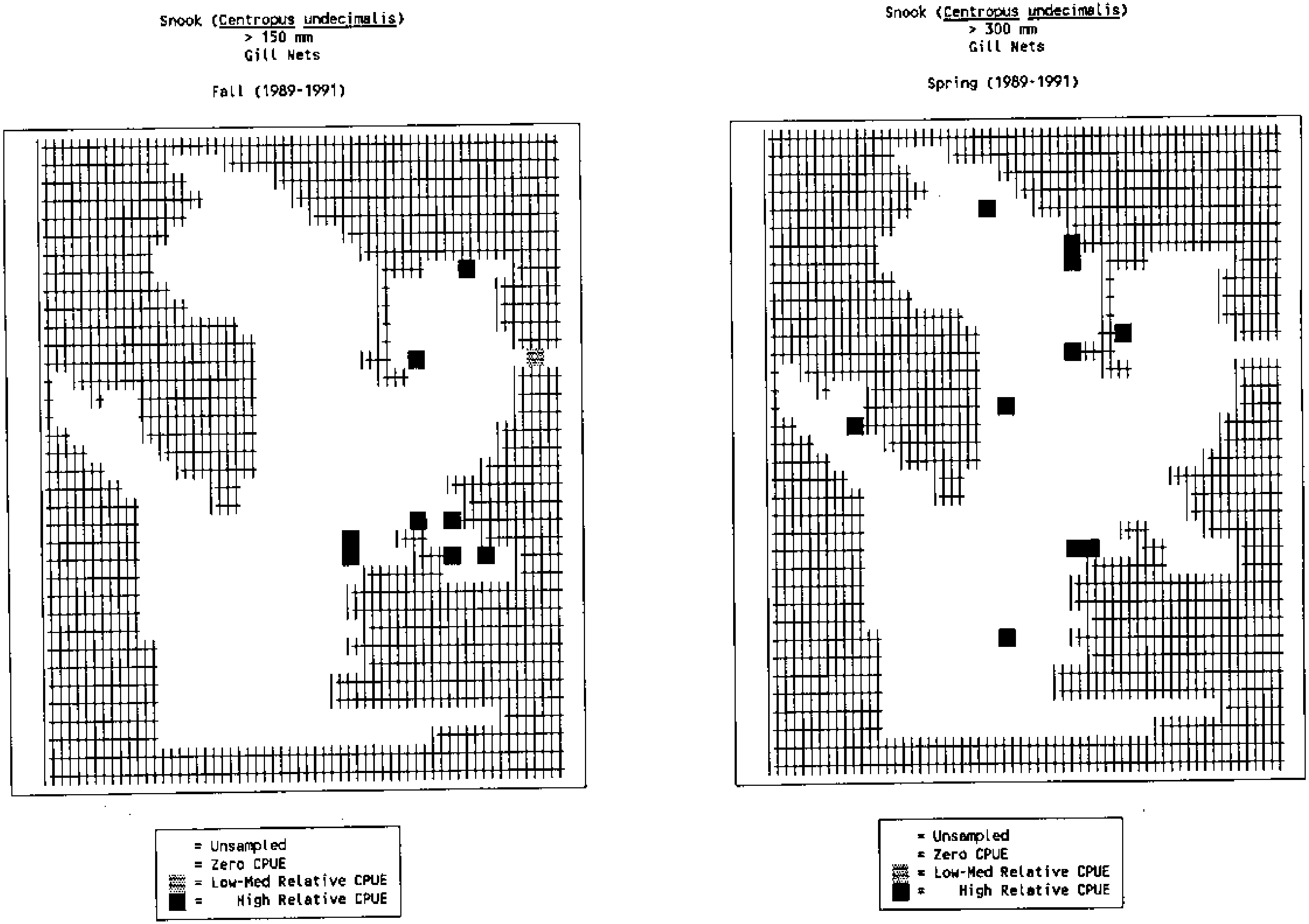


Figure 34. Snook relative abundance maps: fish > 150 mm (fall) or 300 mm (spring) in length collected by gill nets in the fall and spring seasons.

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