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USING A MODIFIED PURSE SEINE TO COLLECT AND MONITOR ESTUARINE FISHES

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Abstract We developed a modified purse seine to sample shallow water estuarine habitats and evaluated the efficacy of using this gear as a tool for monitoring estuarine fish populations in Tampa Bay, Florida. The purse seine (183-m long, 5.2 m deep and 50-mm stretch mesh nylon throughout) was easily deployed and retrieved by a 7 m flat-bottomed, bow-driven boat with a hydraulic wench and aluminum pursing davit. Retention rates of pinfish (*Lagodon rhomboides*) marked and released into 35 net sets averaged 49% (range 9–100%). Retention rates were not significantly influenced by sets over vegetated and unvegetated bottom types, various water depths from 1–3.3m and sets with and without bycatch. We then used the modified purse seine to sample fishes at 550 randomly selected sites in Tampa Bay from January 1997 to December 1998. Sampled habitats ranged from 1.0 to 3.3 m deep and included seagrass beds and non-vegetated sand or mud bottoms. Benthic, demersal, and pelagic fishes were captured, indicating the purse seine effectively sampled the entire water column. A wide size range of fishes was collected including pre-recruitment sizes of several economically important species. The ability of purse seines to fish independent of adjacent shorelines allowed us to sample nearshore waters that included large expanses of seagrass meadow.

Introduction

Purse seines have been used for centuries to capture pelagic fishes in subsistence fisheries throughout the world (Ben-Yami 1994). During the 20th century, purse seines revolutionized several important commercial fisheries in the United States, including Pacific tuna and Atlantic menhaden fisheries (McNeely 1961, June 1972, Schaaf and Huntsman 1972). In the Gulf of Mexico, purse seines are used in the Gulf menhaden fishery, which reports an average of 560,500 metric tons landed per year (Smith et al. 2002), and the Florida baitfish fishery, which supports a multimillion dollar industry in Florida (Pierce and Mahmoudi 2001).

Though widely used in commercial fisheries, purse seines have been used by scientists conducting fisheries-independent studies only when traditional sampling gears were inadequate for the researchers' needs. Hunter et al. (1966) used a 'miniature' purse seine to collect juvenile pelagic fishes that congregated beneath floating material at sea. Levi (1981) developed a two-boat purse seine to collect menhaden for mark and recapture experiments. Both authors found the purse seine to be suitable as a collection gear and commented on its potential in fisheries science. Despite these uses and Kjelson and Colby's (1977) specific suggestion that purse seines be developed for monitoring estuarine fish populations, our study in Tampa Bay, Florida, documents the first known use of a purse seine in a multi-species fisheries-independent study with a random-sampling design.

Florida's Fisheries-Independent Monitoring (FIM) program monitors the relative abundance of fish stocks in seven estuaries around the state including Tampa Bay. Gear used by the FIM program includes small-mesh seines to sample juvenile fishes recruiting to shallow waters and trawls designed to capture these juveniles in the deeper parts of the estuary (Nelson 1998). Large haul seines are used to collect large-juvenile and adult fishes and have proven to be effective for this purpose (Kupschus and Tremain 2001); however, this gear is restricted to use along shoreline habitats. Our interest was to expand our sampling of large fishes (> 75 mm) to include areas away from the shoreline in Tampa Bay. The ability of purse seines to sample the entire water column, and to fish areas away from the shoreline, made it a promising gear for this purpose.

Tampa Bay is a shallow estuary with a modal depth of 3 m and a shallow shelf along the periphery that varies in width from 500 m to 1,200 m (Lewis and Estevez 1988). Much of this nearshore estuarine environment includes expansive seagrass meadows. Seagrasses are known to influence the abundance and diversity of ichthyofauna in Florida estuaries and are well documented as critical habitat for many fish species (Stoner 1983, Comp and Seaman 1985, Sogard et al. 1989), but historically have been under-sampled by our program. The purpose of this study was to: 1) design a purse seine and vessel suitable for fishing estuarine waters to 3.3 m deep; and 2) evaluate the efficacy of using this gear through gear retention experiments and random sampling as part of the FIM program's objectives to monitor large-juvenile and adult fish populations in Tampa Bay, Florida.

MATERIALS AND METHODS

Gear description

The 183 m purse seine used in this study was a scaled-down version of commercial purse seines used in Florida's baitfish industry. The body (wing) of the net was constructed of 50 mm stretch mesh knotless #242 nylon twine and was 5.2 m deep. Football floats (0s2) were spaced every 61 cm and pipe leads were spaced every 30 cm along the body of the net. The bunt end (bag) was 16 m long x 7 m deep and constructed of 50 mm knotted #15 nylon. Floats were positioned more tightly together along the bag of the net to minimize escapement during net retrieval. Stainless steel alpine clips (10 cm long) were used for purse rings and were attached to the lead line of the net with lengths (45–63.5 cm) of 10 mm polypropylene line. Purse rings were spaced 3.1 m apart on the wing and 1.5 m apart on the bag. The purse line was a single length (250 m) of 10 mm low-stretch nylon yacht braid.

Vessel Description

The vessel used in this study was a 7 m mullet skiff; a flat-bottomed, bow-driven boat capable of running in shallow water (< 1 m). The skiff had a large, open net-well that allowed the purse seine to be deployed quickly from the stern. We modified the mullet skiff by installing a hydraulic system and an aluminum pursing-davit (Figure 1). A 40-L hydraulic system was driven by an 8-hp engine coupled to a gear pump that created 72.5 KPa (500 psi) at 2,500 revolutions per minute. Attached to the pursing-davit were a capstan and net roller used to retrieve the net. A dual-circuit hydraulic valve was used to control the capstan and the net roller independently. The capstan was 15 cm in diameter, turned at 75 revolutions per minute and retrieved the purse line at a rate of approximately 11 m per minute. A 14 mm stainless steel rod (ring bar) held the purse rings in position, and a 45 kg tom weight kept the purse line on the bottom while the net was being pursed. The cost of net construction, purse rings, tom weight and purse line was about US$12,000 and vessel modifications including aluminum davit and hydraulic components cost an additional US$2,500.

Deployment of the purse seine was similar to that described by Ben-Yami (1994). In estuarine conditions where tidal currents affected the set, we standardized the shape of the set to an oval pattern to minimize the amount of net set across the current (Figure 2). An average set sampled ca. 2,210 m^2 and required 25 minutes to deploy and retrieve the gear.

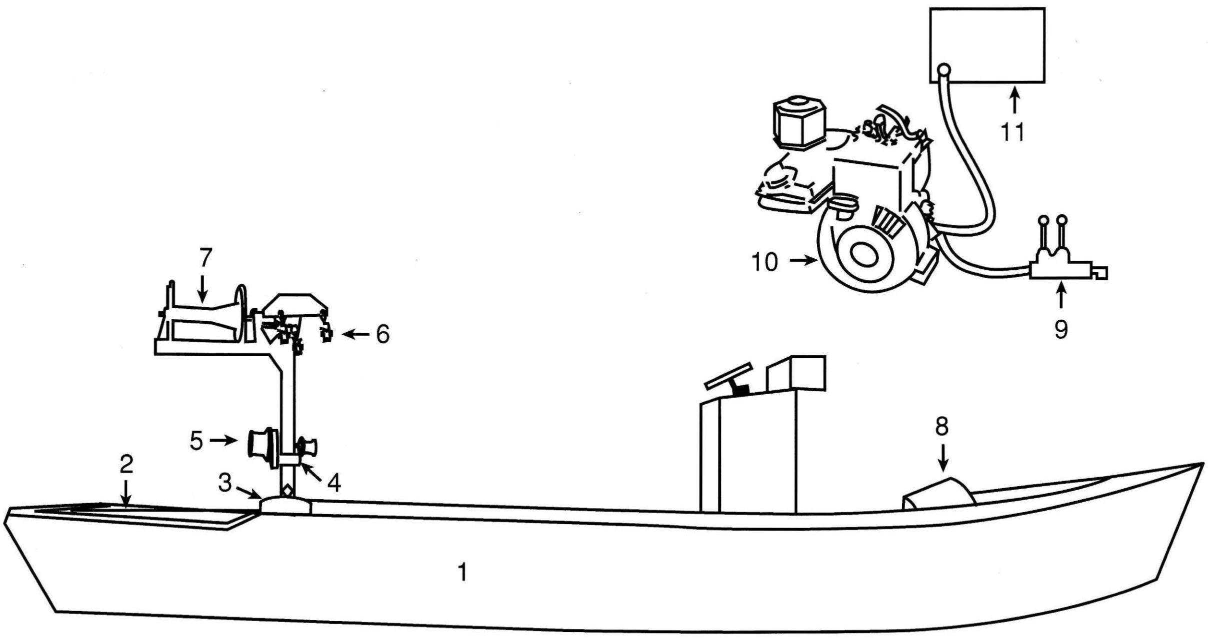

Figure 1. Mullet skiff and equipment used to convert the skiff to a purse seiner. 1 = mullet skiff, 2 = ring bar, 3 = tom weight, 4 = hydraulic motor, 5 = capstan, 6 = blocks, 7 = net roller, 8 = outboard engine, 9 = dual-circuit hydraulic valve, 10 = 8 hp gas engine w/coupled hydraulic gear pump, 11 = 40-L hydraulic tank.

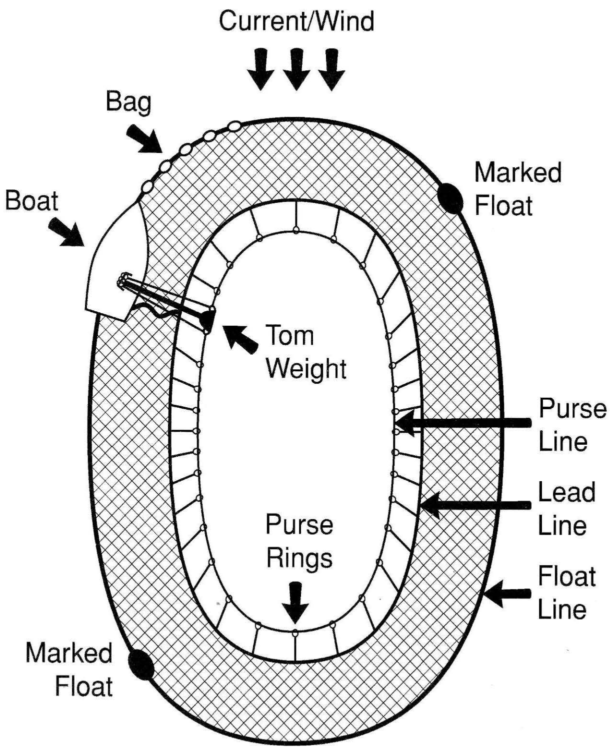

Figure 2. Diagram of a typical 183-m purse seine set in estuarine conditions. Set is made in an oval shape and started into the current.

Gear Retention

We designed an experiment to estimate purse seine gear retention using mark and recapture techniques. We conducted the experiment in lower Tampa Bay in an area with expansive seagrass meadows and unvegetated sand/silt bottom. Sets were stratified by water depth (i.e., < 1.6 m or 1.6–3.3 m). Pinfish (*Lagodon rhomboides*), the most abundant species available during gear testing trials, were used for the experiment. Experimental animals were collected, measured (SL, mm), marked by clipping a portion of the anal fin, and held in the net well of a second (release) boat until approximately 60 fish were collected for an experimental set. Only pinfish in good condition and ≥ 105 mm SL and 45 mm body depth (42 mm was the inside dimension of the 50 mm stretch-mesh knotless nylon twine, as measured on a wet net using digital calipers) were used in the experiment to avoid effects of mesh selectivity on retention estimates.

Marked fish were released throughout the area encircled by the net once the wing and bag end were together and the tom weight was on the bottom. The net was then pursed and all fish collected. Captured fish were measured and checked for fin clips (marks). The number of recaptured fish was recorded for use in retention estimates.

Mean retention rate and associated variance was calculated using the ratio estimator described by Charles-Dominique (1989). We assumed that marked and unmarked fish were equally capable of escaping during the retrieval process. Retention rate estimates were subjected to normality tests (Shapiro-Wilks test: Zar 1996) which indicated a normal distribution. The Student's two-sample t-test was then used to test retention rate differences between vegetated and unvegetated bottom types, presence or absence of bycatch, quantity of bycatch (0–38 L vs > 38 L), and water depth (< 1.6 m vs. 1.6–3.3 m).

Random Sampling

After thoroughly field testing the modified purse seine, we incorporated it into the FIM program's Tampa Bay random-sampling design beginning in January 1997. Sampling locations were randomly selected each month from all possible sites in Tampa Bay < 3.3 m in water depth. Sampling effort was distributed evenly throughout the available sampling area in Tampa Bay. At each sample location, we recorded environmental variables such as water depth, bottom type, by-catch type and quantity, and abiotic variables (i.e., temperature (°C), salinity (‰), dissolved oxygen (mg/ml), and pH).

Captured fishes were identified in the field to the lowest practical taxon and enumerated. At least 20 randomly selected individuals of each species collected in each sample were measured to the nearest millimeter standard length (SL). Length statistics were generated for all species and density estimates calculated for species where more than 100 individuals were collected. Length-frequency histograms were plotted for four commonly collected species of economic importance. Density estimates (Number of fish/1000 m^2) and Shannon-Wiener diversity (H') estimates were calculated for each set and their distributions tested for normality. Due to significant departures from normality, the Wilcoxon rank-sum test was used to compare density and diversity estimates between sets over vegetated and unvegetated bottom types.

RESULTS

Gear Retention

A total of 2,015 pinfish were marked and used in thirty-five replicate gear-retention trials. The trial's mean retention rate was 49% and ranged from 9% to 100%, with a coefficient of variation (CV) of 45%. Retention rates were not significantly different between sets over vegetated and unvegetated bottom types or

TABLE 1

Mean retention rates and results of Student's two-sample t-test for variables recorded in association with experimental purse seine mark and recapture sets.

Variable	Level	Number of sets	Mean % Retention	Std. Dev. (diff.)	t-value (*P*-value)
Bottom vegetation	Seagrass	22	52.7		1.89
	No seagrass	13	37.9	22.33	(0.067)
Water depth	Shallow (< 1.6 m)	18	50.9		0.98
	Deep (1.6–3.3 m)	17	43.2	23.2	(0.334)
Bycatch	Presence	19	45.4		0.48
	Absence	16	49.3	23.4	(0.63)
Bycatch quantity	Low (< 38 L)	24	43.3		1.50
	High (> 38 L)	11	55.7	22.8	(0.143)

sets in shallow (< 1.6 m) and deep water (1.6–3.3 m). Retention rates were also not affected by presence or quantity of bycatch (Table 1).

Random Sampling

The purse seine was deployed in shallow-water (< 3.3 m) habitat types, including seagrass flats and sand and mud bottoms, throughout Tampa Bay, Florida. Most sets took place more than 100 m from an adjacent shoreline, and less than 20% of the sets occurred over seagrass (vegetated: $n = 93$, unvegetated: $n = 457$). Typically, five net sets were completed in a sampling day. Mean set time, including sample processing, was 45 minutes and varied with size of the catch.

In 550 purse seine sets, 54,082 individuals representing 84 fish species were collected, ranging in size from 25 mm to more than 1,000 mm SL (Table 2, Figure 3). The purse seine catch included both juvenile and adult fishes. Demersal ($n = 34$), pelagic ($n = 34$), and benthic species ($n = 16$) comprised 52%, 45%, and 3% of the total catch, respectively. Density and diversity estimates were significantly higher (density $P < 0.001$; diversity $P = 0.048$) in sets over vegetated bottom types (Figure 4).

The purse seine catch was dominated by pinfish, which were collected in 48% of the hauls and made up 25% of the total catch. Clupeids, including *Opisthonema oglinum* (threadfin herring), *Brevoortia* spp. (menhaden), and *Harengula jaguana* (scaled sardine), composed 25% of the total catch. Sciaenids, including *Bairdiella chrysoura* (silver perch), *Leiostomus xanthurus* (spot), *Menticirrhus americanus* (southern kingfish), *Cynoscion arenarius* (silver seatrout), and *Cynoscion nebulosus* (spotted seatrout), composed an additional 13% of the total catch.

Many of the species ($n = 27$) collected were of economic importance, composing about 20% of the total catch (Table 2). The most abundant economically important species in the catch were *Elops saurus* (ladyfish), spot, silver seatrout, spotted seatrout, *Paralichthys albigutta* (southern flounder), and southern kingfish. Length-frequency distributions for several economically important fish species included modal sizes reflecting cohorts of pre-fishery recruits (Figure 5).

DISCUSSION

We developed, tested, and implemented a modified purse seine for sampling estuarine fish populations in Tampa Bay, Florida. We found that the purse seine could be consistently set in a variety of estuarine habitat types and that the sample area was easily standardized and quantified. The purse seine is an active gear, and the dimensions and design of the net characterize how and where it may be fished. Our net was designed to sample the entire water column in depths of 1–3.3 m. The maximum depth fished by this type of purse seine is simply limited by the depth of the webbing used. The maximum depth for our net was selected based upon the topography of Tampa Bay (modal depth = ~ 3 m) and our desire to sample deep seagrass beds, previously under-sampled with other gear types used by our program. Seagrass beds are critical habitat for many fish species (Comp and Seaman 1985, Sogard et al. 1989, Rozas and Odum 1988).

TABLE 2

Species collected with a 183-m purse seine in Tampa Bay from January 1997 through December 1998 (550 sets). Species are listed by decreasing order of number of individuals collected and density estimates and frequency of occurrence (%) are provided where greater than 100 individuals were collected. Species of economic importance are indicated by '$'.

	Species	Individuals Collected	Density Fish/1000m^2 (% Occurrence)	Standard length (mm) Mean	Range
	Lagodon rhomboides	13,769	11.33 (48.7)	110	31–203
	Opisthonema oglinum	7,337	6.04 (23.6)	144	74–196
$	*Elops saurus*	5,215	4.29 (27.8)	311	143–490
	Harengula jaguana	4,160	3.42 (27.6)	119	61–209
$	*Leiostomus xanthurus*	3,185	2.62 (16.5)	137	93–210
	Arius felis	3,181	2.62 (48.9)	270	95–506
	Bairdiella chrysoura	2,394	1.97 (16.4)	137	114–185
	Brevoortia spp.	1,943	1.60 (11.5)	198	104–280
	Orthopristis chrysoptera	1,300	1.07 (21.5)	129	48–215
	Chaetodipterus faber	1,236	1.02 (13.6)	112	45–275
	Eucinostomus gula	1,138	0.94 (22.0)	95	55–135
	Rhinoptera bonasus	1,038	0.85 (29.3)	590	249–970
	Dasyatis sabina	902	0.74 (43.1)	246	65–590
	Chilomycterus schoepfi	849	0.70 (43.1)	133	25–282
	Lactophrys quadricornis	829	0.68 (40.2)	142	35–288
	Chloroscombrus chrysurus	795	0.65 (16.2)	132	66–198
$	*Cynoscion arenarius*	674	0.55 (11.1)	203	101–324
$	*Cynoscion nebulosus*	551	0.45 (23.6)	249	125–545
	Bagre marinus	477	0.39 (19.3)	315	119–520
	Prionotus scitulus	477	0.39 (35.5)	139	53–200
	Caranx hippos	232	0.19 (7.1)	191	118–354
$	*Paralichthys albigutta*	213	0.17 (20.7)	178	90–371
$	*Menticirrhus americanus*	206	0.17 (11.5)	205	143–315
	Aluterus schoepfi	141	0.12 (8.2)	252	92–347
	Eucinostomus harengulus	135	0.11 (4.9)	94	43–194
	Dasyatis say	123	0.10 (12.2)	415	130–623
$	*Scomberomorus maculatus*	115	0.10 (10.4)	296	140–494
	Monacanthus hispidus	95	.	79	48–165
	Synodus foetens	88	.	194	102–270
$	*Pomatomus saltatrix*	83	.	298	136–450
	Oligoplites saurus	81	.	167	62–261
	Sphoeroides nephelus	80	.	140	97–225
	Caranx crysos	71	.	154	110–218
	Trinectes maculatus	71	.	82	60–116
	Achirus lineatus	67	.	72	52–100
$	*Archosargus probatocephalus*	56	.	172	73–430
$	*Menticirrhus saxatilis*	56	.	212	137–290
	Rhinobatos lentiginosus	53	.	416	258–660
	Peprilus alepidotus	47	.	135	44–180
$	*Mugil gyrans*	45	.	153	117–230
	Selene vomer	45	.	131	38–178

Table 2 (Continued)

	Species	Individuals Collected	Density Fish/1000m² (% Occurrence)	Standard length (mm) Mean	Range
	Prionotus tribulus	36	.	119	54–186
	Opsanus beta	36	.	128	53–227
$	*Trachinotus falcatus*	32	.	237	130–350
	Diplodus holbrooki	31	.	92	76–122
$	*Mugil cephalus*	29	.	245	149–400
$	*Lutjanus griseus*	26	.	170	114–213
$	*Haemulon plumieri*	25	.	112	83–168
	Hippocampus erectus	21	.	126	82–155
	Nicholsina usta	21	.	144	120–176
	Symphurus plagiusa	21	.	130	35–160
$	*Sphyrna tiburo*	20	.	503	294–692
$	*Trachinotus carolinus*	20	.	261	181–398
	Ancylopsetta quadrocellata	17	.	166	74–225
	Gymnura micrura	17	.	343	202–538
	Dorosoma petenense	14	.	123	100–140
	Echeneis naucrates	14	.	373	286–520
	Lactophrys trigonus	14	.	91	36–126
$	*Mycteroperca microlepis*	12	.	234	169–330
$	*Rachycentron canadum*	12	.	529	231–820
	Dasyatis americana	11	.	560	310–790
	Decapterus punctatus	9	.	179	172–190
	Calamus arctifrons	9	.	136	90–207
	Diapterus plumieri	8	.	74	65–88
$	*Centropristis striata*	8	.	109	75–137
	Hemicaranx amblyrhynchus	8	.	126	77–160
	Lutjanus synagris	8	.	118	109–136
	Aluterus scriptus	6	.	118	100–143
$	*Centropomus undecimalis*	5	.	532	248–740
	Scorpeana brasiliensis	5	.	110	68–132
$	*Menticirrhus littoralis*	5	.	239	185–370
	Ogcocephalus radiatus	5	.	154	86–243
	Lepisosteus osseus	4	.	828	650–1,050
$	*Sciaenops ocellatus*	4	.	452	378–538
$	*Mugil curema*	3	.	177	148–233
	Caranx ruber	2	.	157	147–166
	Diplectrum formosum	2	.	153	–
	Etropus crossotus	2	.	101	100–102
$	*Micropogonias undulatus*	2	.	129	123–134
	Astroscopus y-graecum	1	.	101	–
	Aetobatus narinari	1	.	525	–
	Hippocampus zosterae	1	.	121	–
	Hyporhamphus unifaciatus	1	.	159	–
	Lepisosteus platyrhincus	1	.	1,005	–

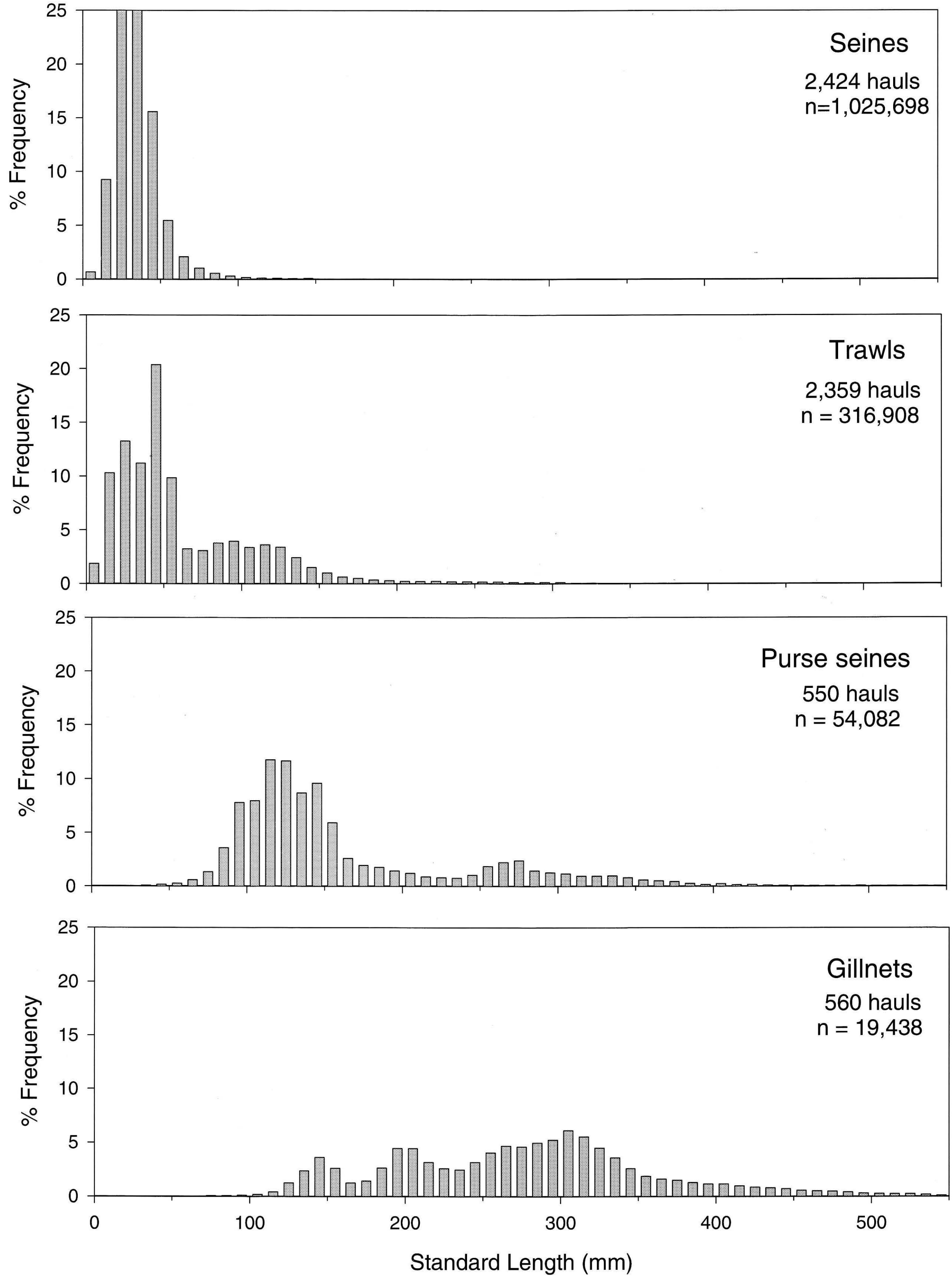

Figure 3. Overall length-frequency distributions (SL mm, all species combined) of fish captured in small seines (1989–1997 seasonal), trawls (1989–1997 seasonal), purse seines (1997–1998, current study), and gillnets (1989–1995 seasonal, night-time) collections conducted by the FIM program in Tampa Bay, Florida.

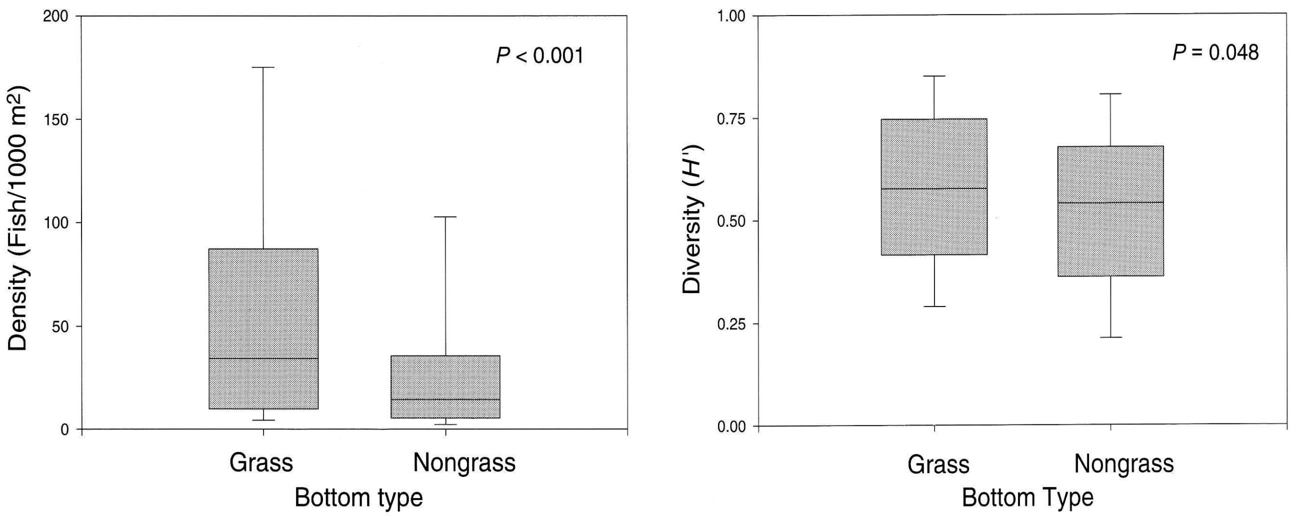

Figure 4. Box and whisker plots of Density (Fish/1000m^2) and Shannon-Wiener diversity estimates (H') in Tampa Bay purse seine sets over vegetated (n = 93) and unvegetated (n = 457) bottom types in Tampa Bay 1997–1998. Median estimates (horizontal line) and 25th and 75th quartiles (box) are shown with 5th and 95th percentiles as the whiskers.

The purse seine provided valuable data on the diverse fish communities inhabiting nearshore environments of Tampa Bay. We collected a variety of fish species and a wide size range using the purse seine. The design of the gear allowed us to collect benthic (e.g., southern flounder, *Dasyatis sabina* [atlantic stingray]), demersal (e.g., pinfish, silver perch), and pelagic (e.g., menhaden, scaled sardine) fish species. Pre-recruitment size classes for several species of recreational or commercial importance were represented. Collections of economically important species (e.g., ladyfish, spot, spotted seatrout, silver seatrout), provided us with life-history data later used to develop age-length keys for ongoing fisheries management purposes (Table 2).

The FIM program's previous attempts to characterize large-juvenile and adult fish populations associated with Tampa Bay's nearshore estuarine environments included the use of 6.1 m otter trawls and multi-panel gillnets (2" to 6" stretched mesh). These types of gear were decidedly unproductive for this purpose (McMichael 1995). Trawls sampled only near the bottom and rarely captured fishes greater than 75 mm in SL (Figures 3 and 5), while gillnet effectiveness relied on nighttime sampling and extended soak-times (ca. 1.5 hours not including time for retrieval and sample work up) that reduced the number of samples that could be collected in a given sampling trip. Further, gillnet selectivity and their use as a passive gear, limits their effectiveness for multi-species surveys (Rozas and Minello 1997).

Our aim in developing the purse seine was to complement the catch of seines and trawls by collecting fish greater than 75 mm SL. Length frequency distributions showed that purse seine samples contained the highest proportion of fishes between 100 mm and 200 mm SL (Figure 3). This size class of fishes was dominated by pinfish, small coastal pelagics (e.g., scaled sardine, threadfin herring), and other species that are important trophic links between primary producers and a variety of piscivorous fish species (Seaman and Collins 1983, Sogard et al. 1989, Pierce and Mahmoudi 2001).

Raw catch data can be inaccurate without estimates of gear efficiency (Kjelson and Colby 1977). Since either escapement or avoidance can affect efficiency of a gear, retention estimates are an important part of understanding the overall effectiveness of a fishing gear. Avoidance estimates were beyond the scope of our study; however, estimating the rate at which a gear type retains fish can be used as an upper estimate of the efficiency of a gear (Charles-Dominique 1989). Variability in retention rates in our study was consistent across several comparison groups (bottom type, water depth, and bycatch) suggesting purse seine efficiency was stable over a variety of estuarine conditions.

Purse seine retention rates and variability in our study were similar to many other types of gear that are routinely used in fisheries science. Kjelson and Johnson (1974) reported retention rates ranging from 10% to 60% for a large offshore pull-through seine, and Charles-Dominique (1989) estimated retention rates for their purse seine at between 10% and 79% using techniques similar to those employed in our study. Kjelson and Colby (1977) reported gear-efficiency estimates (which

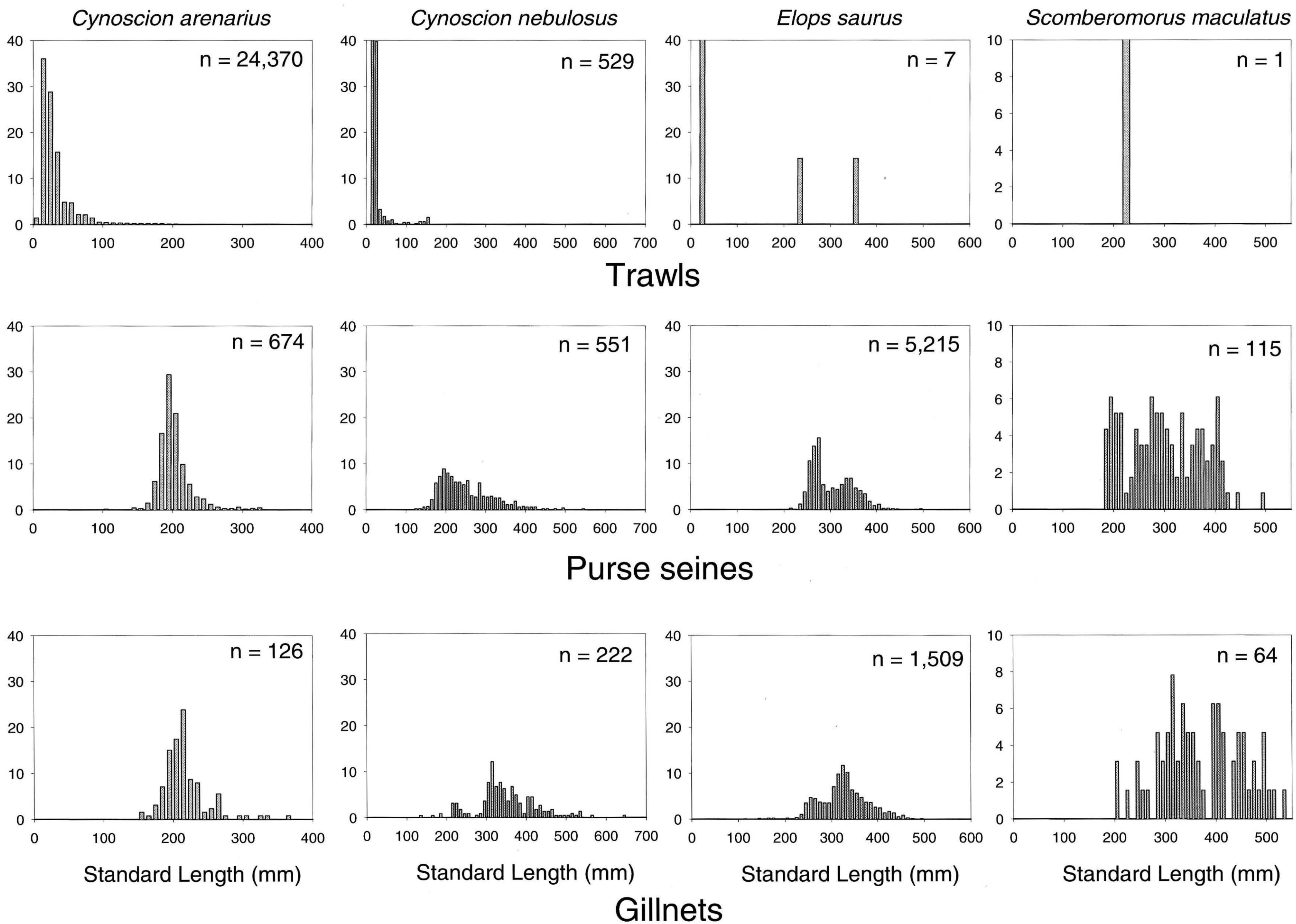

Figure 5. Length-frequency distributions (SL mm) of four species of economic importance collected using trawls (1989–1997 seasonal), purse seines (1997–1998, current study), and gillnets (1989–1995 seasonal, nighttime) by the FIM program in Tampa Bay, Florida.

included avoidance estimates) for a variety of sampling gears (i.e., plankton net, beam trawl, portable drop net, haul seines, and otter trawls) that ranged from 5% to 80%, and similar variability in gear-efficiency estimates have been reported by other authors as well (Weinstein and Davis 1980, Parsley et al. 1989). Rozas and Minello (1997) recommended enclosure gears, including purse seines, for sampling shallow estuarine waters due to their generally higher catch efficiency and ease in quantification of the sample area; however, purse seines were not recommended for use over seagrass. In contrast, our purse seine performed reliably well over vegetated bottom types and provided important information on fish species utilizing these critical habitats.

In conclusion, the use of a purse seine has enabled our program to obtain quantitative information on large juveniles and adults of benthic, demersal, and pelagic fishes inhabiting estuarine waters of Tampa Bay, Florida. This gear allowed our program to adequately sample a variety of estuarine habitats in which previous attempts using trawls and gillnets had been less successful. Gear-efficiency estimates for our purse seine based on retention-rate experiments were comparable with those of other types of sampling gear typically used in fisheries science, and the purse seine was durable enough for standard field use. The purse seine had limitations, as do other gear types. It was susceptible to strong tidal currents and winds, which caused the lead line to roll, twisting the purse line and rings into the webbing. Further, the gear could not be fished properly in areas with obstructions or hard bottom, that snagged the net or purse line. Finally, the initial costs associated with building a purse seine, and the vessel to work the gear, were considerable (about US$15,000).

Future studies will concentrate on the versatility of the purse seine as a sampling tool in other Florida estuaries and comparisons with the catch of large haul seines used along shoreline habitats, providing more information on the benefit of this gear type as an ecological fish-monitoring tool.

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LITERATURE CITED

Ben-Yami, M. 1994. Some principles concerning the design of purse seines. Infofish International, May, 1994:61–67.

Charles-Dominique, E. 1989. Catch efficiencies of purse and beach seines in Ivory Coast lagoons. Fishery Bulletin, US 87:911–921.

Comp, G.S. and W. Seaman, Jr. 1985. Estuarine habitat and fisheries resources of Florida. In: William Seaman Jr., eds. Florida aquatic habitat and fisheries resources. Florida Chapter of the American Fisheries Society, Eustis, FL, USA, p. 337–436.

Hunter, J.R., D.C. Aasted, and C.T. Mitchell. 1966. Design and use of a miniature purse seine. Progressive Fish-Culturist 28:175–179.

June, F.C. 1972. Variations in size and length composition of Atlantic menhaden groupings. Fishery Bulletin, US 70(3):699–713.

Kjelson, M.A. and D.R. Colby. 1977. The evaluation and use of gear efficiencies in the estimation of estuarine fish abundance. In: M.L. Wiley, ed. Estuarine processes. Acedemic Press, New York, NY, USA, p. 416–424.

Kjelson, M.A. and G.N. Johnson. 1974. Description and evaluation of a long-haul seine for sampling fish populations in offshore estuarine habitats. Proceedings, 28th Annual Conference of Southeastern Association of Game and Fish Commissioners, Frankfort, Ky, USA, Date, p. 171–179.

Kupschus, S. and D. Tremain. 2001. Associations between fish assemblages and environmental factors in nearshore habitats of a subtropical estuary. Journal of Fish Biology 58:1383–1403.

Lewis, R.R. and E. Estevez. 1988. The ecology of Tampa Bay, Florida: An estuarine profile. US fish and Wildlife Service Biological Report. 85(7.18), p. 132.

Levi, E.J. 1981. Design and operation of a small two-boat purse seine. Estuaries 4(4):385–387.

McMichael, R.H. 1995. Fisheries-Independent Monitoring Program: Annual Report. IHR1995-001. Florida Marine Research Institute, St. Petersburg, FL, USA.

McNeely, R.L. 1961. The purse seine revolution in tuna fishing. Pacific Fisherman. June, 1961.

Nelson, G.A. 1998. Abundance, growth and mortality of young-of-the-year pinfish, *Lagodon rhomboides,* in three estuaries along the gulf coast of Florida. Fishery Bulletin, US 96:315–328.

Parsley, M.J., D.E. Palmer, and R.W. Burkhardt. 1989. Variation in capture efficiency of a beach seine for small fishes. North American Journal of Fisheries Management 9:239–244.

Pierce, D.J. and B. Mahmoudi. 2001. Nearshore fish assemblages along the central west coast of Florida. Bulletin of Marine Science 68(2):243–270.

Rozas, L.P. and T.J. Minello. 1997. Estimating densities of small fishes and Decapod crustaceans in shallow estuarine habitats: A review of sampling design with focus on gear selection. Estuaries 22(1):199–213.

Rozas, L.P. and W.E. Odum. 1998. Occupation of submerged aquatic vegetation by fishes: Testing the role of food and refuge. Oecologia 77:101–106.

SAS Institute Inc. 1989. SAS/STAT User's guide, 5th edition SAS Institute Inc. Cary, NC, USA.

Schaaf, W.E. and G.R. Huntsman. 1972. Effects of fishing on the Atlantic menhaden stock. Transactions of the American Fisheries Society 101(2):290–297.

Seaman W., Jr. and M. Collins. 1983. Species profiles: Life histories and environmental requirements of coastal fishes and invertabrates. US Fish and Wildlife Service FWS/OBS-82/11.16.

Smith, J.W., E.A. Hall, N.A. McNeil, and W.B. O'Brier. 2002. The distribution of purse seine sets and catches in the Gulf Menhaden fishery in the Northern Gulf of Mexico. Gulf of Mexico Science 20(1):12–24.

Sogard, S.M., G. Powell, and J. Holmquist. 1989. Utilization by fishes of shallow-water seagrass banks in Florida Bay: 2 diel and tidal patterns. Environmental Biology of Fishes 24(2):81–92.

Stoner, A.W. 1983. Distribution of fishes in seasgrass meadows: role of macrophyte biomass and species composition. Fishery Bulletin, US 81(4):837–846.

Weinstein, M.P. and R.W. Davis. 1980. Collection efficiency of seine and rotenone samples from tidal creeks, Cape Fear River, NC. Estuaries 3(2):98–105.

Zar, J.H. 1996. Biostatistical Analysis. 3rd Edition. Prentice-Hall, Upper Saddle River, NJ, USA, p. 662.