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Fisheries Research 89 (2008) 222–229
FISHERIES RESEARCH
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Comparison of the Sameoto, Manta, and MARMAP neustonic ichthyoplankton samplers in the Gulf of Alaska

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Received 3 May 2007; received in revised form 7 August 2007; accepted 24 August 2007

Abstract

A comparison of three types of neuston-sampling gear, the Sameoto, the Manta, and the Marine Resources Monitoring, Assessment, and Prediction Program (MARMAP) array was conducted to examine and understand the effectiveness of each sampler in collecting larval fishes in the Gulf of Alaska. Comparison criteria included: number of individuals collected, assemblage diversity, and lengths of larvae. The MARMAP array had lower overall abundance compared to the Sameoto and Manta arrays. Species diversity was comparable among the gears, though the MARMAP array had a slightly higher and more evenly distributed range of taxa compared to the Sameoto and Manta arrays. Larval lengths were statistically comparable among gears, though the MARMAP array had relatively fewer large larvae compared to the Sameoto and Manta arrays. Based on these results, choice of gears should be considered depending on whether the primary objective is to obtain estimates of abundance or estimates of diversity.
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Keywords: Neuston; Sampling gear; Ichthyoplankton; Sameoto; Manta; MARMAP; Gulf of Alaska

1. Introduction

The neuston layer (0–20 cm depth) is an ecologically significant habitat for unique groups of fish larvae in a variety of locations. The selection of gear for reliable sampling of surface-occurring larval fishes is important for estimating their population dynamics (abundance, size, and distribution) and for understanding year-class success. Quantitative sampling of neustonic eggs and fish larvae is necessary but difficult. Traditional oblique sampling approaches do not effectively collect neustonic eggs and larvae (Doyle, 1992; Matarese et al., 2003), and sampling gear specifically designed to sample the neuston is highly selective (Ahlstrom and Stevens, 1976).

Modern improvements have created a variety of sampling gears based on the biology and behavior of the items collected. Several of these designs are actively used in a variety of locations; however, it is difficult to evaluate and compare results among investigations due to the lack of direct comparisons of the catch efficiencies of the gears. Furthermore, few studies directly compare the sampling efficiencies of various commonly used neuston and ichthyoplankton sampling gears.

Neuston-sampling gear must be specifically designed to effectively collect the unique population of ichthyoplankton occurring in the surface water. It should always ride at the surface and the mouth opening of the net should remain in the water for the duration of the tow. The net also should not be towed through any turbulent water created by the vessel. There are few types of sampling gears specifically designed for sampling the neuston layer. In some cases, oblique sampling gears, such as the multiple opening/closing net environmental sensing system (MOCNESS) (Wiebe et al., 1976) Methot trawl (Methot, 1986), and Tucker trawl (Tucker, 1951) have been modified to sample the neuston layer. These systems have the disadvantage of not being designed specifically for the purpose of neuston-sampling and may miss fish species or stages present in the surface layer. Neutral buoyancy of neuston nets provides the added reliability of effectively sampling the neuston layer over the modified nets.

The Sameoto neuston array (Sameoto and Jaroszynski, 1969) (hereafter referred to as the Sameoto) was specifically designed to sample the oceanic surface layer. The Sameoto has been used by the NOAA Ecosystems and Fisheries-Oceanography Coordinated Investigations (Eco-FOCI) program to collect surface ichthyoplankton in the North Pacific since 1977. This gear was

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0165-7836/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.fishres.2007.08.019

chosen for its compact size, durability and ease of deployment and retrieval in Alaska waters. By comparison, other neuston-sampling methodologies and gear types are employed at NMFS science centers in the United States: NOAA's Southeast Fisheries Science Center (SEFSC) in Pascagoula, MS, uses a standard Marine Resources Monitoring, Assessment, and Prediction Program neuston array (hereafter referred to as the MARMAP) for sampling the surface layer in the Gulf of Mexico (Jossi and Marak, 1983), and NOAA's Southwest Fisheries Science Center (SWFSC) uses the Manta sampling array (hereafter referred to as the Manta) (Brown and Cheng, 1981) in the California Coastal Current ecosystem (Moser et al., 2002). Though each has been employed in different regions, the relative catch efficiencies of these neuston samplers have never been evaluated among one another. The purpose of this study was to directly compare commonly used neuston-sampling gears (Sameoto, MARMAP, Manta) in terms of numbers, taxa and sizes of fish larvae collected.

2. Materials and methods

2.1. Field sampling

Sampling was conducted in the Gulf of Alaska southwest of Kodiak Island during September 2002 as part of an ongoing ichthyoplankton study (Fig. 1). Three types of neuston arrays were used for sampling surface ichthyoplankton. First, the Sameoto array is made up of a stainless steel, metal rectangular frame with angled wings attached to the side (Sameoto and Jaroszynski, 1969; Brown et al., 1999). The mouth opening is 30 cm high × 50 cm wide (1500 cm^2) and the frame is designed to fish half in and half out of the surface water. The collection net is 1.5 m long. Second, the Manta neuston array is a rectangular frame sampler supported by two square lateral projections covered with plywood and urethane foam (Moser et al., 2002). These projections stabilize the net at the surface when it is towed through the water. The mouth opening is 15.5 cm high × 86 cm wide (1333 cm^2). The collection net is 2.85 m. Third, a standard MARMAP neuston sampler array has a rectangular mouth constructed of 3.2 cm aluminum pipe with opening dimensions of 50 cm high × 100 cm wide (5000 m^2). A 2.3 kg weight was added to the frame to have the sampler towed half in and half out of the water. The net is conical and 4.9 m long. More information on the MARMAP and Manta arrays can be found at: http://www.st.nmfs.noaa.gov/st4/protocol/Ichthyoplankton%20protocols.pdf.

All the samplers were equipped with 505 μm mesh nets and calibrated flowmeters positioned in the mouth of each net. Samplers were towed consecutively (Sameoto, Manta, MARMAP) from the 63 m NOAA ship *Miller Freeman* at 17 randomly selected stations throughout an established area, which was part of a larger research study (Fig. 1). Towing of each subsequent net was over a new area of water surface, but all within a 0.5 nm radius of one another. Due to logistical constraints the Sameoto and the Manta were deployed off the starboard side of the ship and the MARMAP was deployed off the port side. The samplers were all towed at a ship's speed of 2–4 knots for 10 min. Tows were conducted during nighttime hours to maximize potential catch and to minimize net avoidance as compared with daytime sampling, since many larvae migrate vertically into the neuston layer at night (Doyle et al., 1995). Organisms collected were immediately preserved in 1.8% buffered formaldehyde for later quantitative analyses.

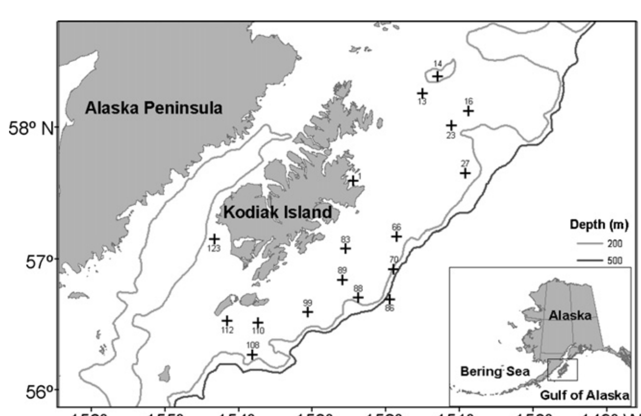

Fig. 1. Sampling locations (+) in the western Gulf of Alaska during September 2002 that were used for comparison of neuston-sampling gears. Each location is assigned a station number.

2.2. Laboratory analyses

Ichthyoplankton samples were sorted, identified to the lowest possible taxon, measured to standard length (SL mm), and enumerated at the Plankton Sorting and Identification Center in Sczcecin, Poland. Individual larvae were removed, transferred to 70% ethanol and sent back to the Alaska Fisheries Science Center for verification of species identification. The sample collection data (e.g., geographic coordinates, date/time, gear, tow time, number of larvae) were archived in ICHBASE, an ichthyoplankton relational database maintained by the Alaska Fisheries Science Center.

2.3. Abundance analyses

Descriptive statistics, such as frequency of occurrence, total abundance, mean abundance and standard deviations, were calculated for each tow. Larval fish relative abundance by taxon was standardized to catch per 1000 m^3 and used to compare the neuston samplers. Since we were primarily interested in how abundance of all species varied across gears, we used absolute rather than relative (percent composition) abundance. A 4th root transformation was applied to the data for all subsequent analyses in order to downweight the very abundant species and allow the rare species to have some contribution (Clarke and Warwick, 2001).

Several multivariate procedures were used to determine if and how the abundance of all species, collectively, varied across gears. First, a two-way crossed with no replication Analysis of Similarity (ANOSIM, Clarke, 1993) was applied. This ANOSIM is a multivariate permutation test analogous to a blocked ANOVA in that it tests the null hypothesis that there are no treatment (gear) differences, while allowing for blocked (station) effects. The test uses a Spearman correlation coefficient computed on the matched rank similarity matrices for every pair of stations and then averaged across all possible pairs (Clarke and Warwick, 2001). The inputs for this analysis were Bray–Curtis dissimilarity measures, or the percent differences between each pair of station across all species (Clarke and Warwick, 2001).

The ANOSIM was followed by nonmetric multidimensional scaling (MDS; Clarke, 1993), an ordination method which yields a plot of the relative distances between gear collections at stations in terms of the Bray–Curtis dissimilarity of their species composition. These plots were used to compare how strongly data from different gears were separated. The Mantel test using the RELATE procedure in PRIMER software was also applied to determine if the absolute abundance between any two gear was significantly correlated (Clarke and Gorley, 2001).

Univariate tests used included a randomized block Analysis of Variance (ANOVA) preformed on the abundance of the most common taxa (*Bathymaster* spp., *Hexagramma octogrammus*, *Mallotus villosus*, *Hexagrammos lagocephalus*). The dependent variable was 4th root transformed CPUE of each tow where gear was the treatment and station was a block. Whenever a significant difference among gears was found in the ANOVA, a Fishers least squared difference (LSD) multiple comparison test followed to see which two gears were significantly different (Milliken and Johnson, 1996).

2.4. Diversity analyses

Species diversity is a measure of both species richness and evenness. Margalef's Index (Legendre and Legendre, 1998), which is a measure of how many species are observed, adjusted for sample sizes, and was chosen to measure species richness. Pielou's Index (Legendre and Legendre, 1998), which measures how evenly the individuals are distributed among the species, was used as a measure of species evenness. A randomized block ANOVA using the same design as for CPUE was performed to determine if species evenness and richness differed between gears. In addition, the percent frequency of occurrence was used to compare performance of each of the neuston samplers.

2.5. Length analyses

The mean standard lengths (±S.D.) of larvae collected for each gear at each station were calculated. The same multivariate analyses that were used on the abundance data described above (i.e., ANOSIM, Mantel tests, MDS, univariate ANOVA) were also applied to the length data of all species, collectively. Univariate ANOVA analyses were only performed on the top four most abundant taxa (*Bathymaster* spp., *M. villosus*, *H. octogrammus*, *H. lagocephalus*). Histograms of the length frequency distributions for each of these taxa, pooled among stations, were also examined.

Table 1
List of taxa present (X) or absent (blank) by family and species in the Sameoto, Manta and MARMAP neuston-sampling gears collected in Gulf of Alaska during September 2002

Family	Taxon	Sampling gear		
		Sameoto	Manta	MARMAP
Bathymasteridae	*Bathymaster* spp.	X	X	X
	R. jordani	X	X	X
	G. aculeatus	X	X	X
Cyclopterdae Cottidae	*A. ventricosus*	X	X	X
	A. harringtoni	X		
	S. marmoratus	X	X	
	Icelus spp.			X
	L. armatus	X		
Hexagrammidae	*H. lagocephalus*	X	X	X
	H. octogrammus	X	X	X
	Hexagrammos spp.	X	X	
	H. stelleri	X	X	X
Pleuronectidae	*H. elassodon*			X
Liparidae	*L. fucensis*			X
	Liparis spp.	X		
Osmeridae	*M. villosus*	X	X	X
Scorpaenidae	*Sebastes* spp.	X	X	X
Total: 17				
Percent of total		82	65	71

3. Results

Collectively, larvae of 17 taxa (12 species, 5 genera) representing 8 families were identified from the samples (Table 1). The Manta collected 12 taxa and the MARMAP collected 11 taxa, while the Sameoto collected 13 taxa. Of the 17 taxa collected, 8 are considered obligate members of the neuston (Doyle et al., 1995), including hexagrammids and some cottids. *Bathymaster* spp., *Hippoglossoides elassodon* (flathead sole), *Ronquilus jordani* (northern ronquil), *Scorpaenichthys marmoratus* (cabezon) (>35 mm SL), and *Sebastes* spp. (>15 mm SL) are known as facultative members of the neuston. *Bathymaster* spp., *Ronquilus jordani* and *Sebastes* spp. were numerically important at several stations appearing in all the gear types. In both MARMAP and the Sameoto samples, larvae were collected which have not been previously described as associated with the neuston, notably *Artedius harringtoni* (scalyhead sculpin), *Liparis fucensis* (slipskin snailfish), *Liparis* spp., *Aptocyclus ventricosus* (smooth lumpsucker), and *Leptocottus armatus* (Pacific staghorn sculpin). These larvae were rare with a percent occurrence of less than 1%.

3.1. Abundance

Rock greenling (*H. lagocephalus*) was the most abundant neustonic species caught by all the gears (Table 2). Rock greenling represented more than 50% of the catch in the Manta and the Sameoto, as compared to 40% of the catch in the MARMAP (Fig. 2). The second most abundant species was masked greenling (*H. octogrammus*), representing 20% of the MARMAP and

Table 2
Abundance (#/1000 m^3) of the larvae collected in each neuston sampler at 17 locations in the Gulf of Alaska during September 2002

Family	Species	Station no.																
		1	13	14	16	23	27	66	70	83	86	88	89	99	108	110	112	123
Sameoto																		
Bathymasteridae	*Bathymaster* spp.			56.20		54.58		29.09	91.73	23.22	536.36	87.12	835.35					36.42
	G. aculeatus				50.03													
	R. jordani			56.20	50.03		81.66				134.09		147.42		119.68			36.42
Cottidae	*A. harringtoni*																28.44	
	L. armatus					27.29												
	S. marmoratus			28.10		27.29			22.93									
Cyclopteirdae	*A. veniricosus*										33.52							
Hexagrammidae	*H. lagocephalus*	211.98	380.09	56.20	600.39	81.87	40.83	523.69	344.00	3413.21	402.27	696.98	1375.87	51.63	279.24	12536.12	796.44	254.97
	H. octogrammus	2296.45	221.72	196.68	150.10	327.48		58.19		371.51	134.09		147.42	180.70	299.19	2525.94		364.24
	H. stelleri	741.93													19.95	795.20		36.42
	Hexagrammos spp.											43.56						
Liparidae	*Liparis* spp.						40.83											
Osmeridae	*M. villosus*		633.49	84.29	450.29		81.66	116.38					49.14	17.21	1156.86		341.33	
Scorpaenidae	*Sebastes* spp.		63.35	28.10							67.05				19.95		28.44	
Manta																		
Bathymasteridae	*Bathymaster* spp.		9.56	18.49		9.51	41.49	11.11	420.03	39.58	450.49	16.19	3552.73					358.34
	G. aculeatus		9.56		12.98	28.53	41.49						12.42					44.79
	R. jordani		47.80		19.47	28.53					56.31	48.58	571.42		114.29	24.92	10.33	119.45
Cottidae	*S. marmoratus*					9.51			10.00									
Cyclopteirdae	*A. ventricosus*																	14.93
Hexagrammidae	*H. lagocephalus*	316.02	172.06	73.94	227.18	218.75	13.83	1589.30	1540.12	395.79	323.79	2137.67	3366.40	79.59	546.06	14730.34	216.96	477.79
	H. octogrammus	790.04	191.18	147.89	77.89	456.53		22.23	110.01	79.16	126.70	97.17	869.55	318.37	165.09	5009.81	10.33	761.48
	H. stelleri									13.19			12.42	22.74		1171.45		283.69
	Hexagrammos spp.										14.08				25.40			
Osmeridae	*M. villosus*	158.01	28.68		214.20	9.51		100.03						79.59			754.18	
Scorpaenidae	*Sebastes* spp.				45.44		41.49	33.34			14.08			11.37	12.70	24.92		94.73
MARMAP																		
Bathymasteridae	*Baihymasier* spp.						9.10	5.15	4.13	5.30	47.57	10.42	189.95	8.36	7.14			15.43
	G. aculeatus											5.21						5.14
	R. jordani							10.30			14.27		44.17		60.65		15.71	25.72
Cottidae	*Icelus* spp.																5.24	
Cyclopteirdae	*A. ventricosus*			4.74														
Hexagrammidae	*H. lagocephalus*	8.66	7.44		4.82		9.10	370.94	8.25	5.30	14.27	72.92	53.01	8.36	82.06	351.94	235.60	149.17
	H. octogrammus	82.23	23.02	4.74				51.52	4.13	5.30	4.76	46.88	13.25	41.78	71.36	262.89		221.18
	H. stelleri														7.14	29.68		
Liparidae	*L. fucensis*													4.18				
Osmeridae	*M. villosus*	8.66		18.94	4.82	4.40	4.55	36.06				5.21	13.25	83.56	7.14	29.68	361.26	15.43
Pleuronectidae	*H. elassodon*		7.44															
Scorpaenidae	*Sebastes* spp.		53.87	9.47		4.40						5.21				4.24		94.73

Taxa are organized by family and species. Station numbers correspond to locations in Fig. 1.

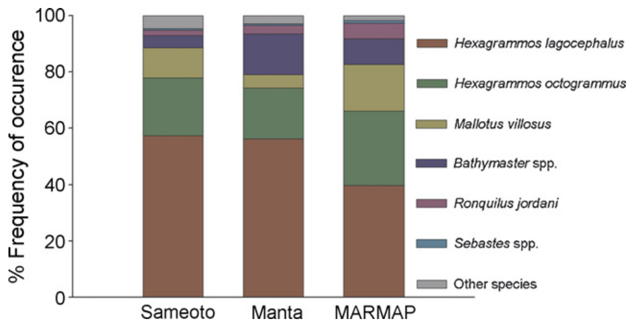

Fig. 2. Percent frequency of occurrence for the most abundant taxa caught in the Sameoto, Manta, and MARMAP neuston-sampling gears.

Sameoto catch and 18% of the Manta's catch. Capelin (*M. villosus*) was the third most abundant species caught in the Sameoto and the MARMAP, while the Manta's third most abundant taxon was *Bathymaster* spp.

Geographically, rock or masked greenling was the most abundant species at 6 of the 17 stations in all the gear types and were present in more than 50% of the catch. At four other stations the larval abundance was dominated either by capelin or *Bathymaster* spp. Capelin comprised 50% or more of the catch in the MARMAP at five stations and 60% of the catch in the Sameoto at one station. *Bathymaster* spp. was the most abundant taxon in all three gears at one station located over the continental slope and was the most abundant taxon in the MARMAP and Manta at two shelf stations.

There were significant differences in the overall catch (number of individuals) among gears (ANOSIM, $p = 0.03$). MDS analysis (Fig. 3) revealed that the distribution from the MARMAP was spatially separated from both the Sameoto and the Manta, suggesting that catch in the MARMAP was different compared to the other two gear types. The plot also showed that the catch distributions in the Sameoto and the Manta overlap, indicating no differences in abundance. The results of the Mantel tests further supported this difference, by showing no relationship between the MARMAP and the Manta, or between the MARMAP and the Sameoto. However, the test showed that abundances collected in the Manta and Sameoto were similar ($p = 0.001$).

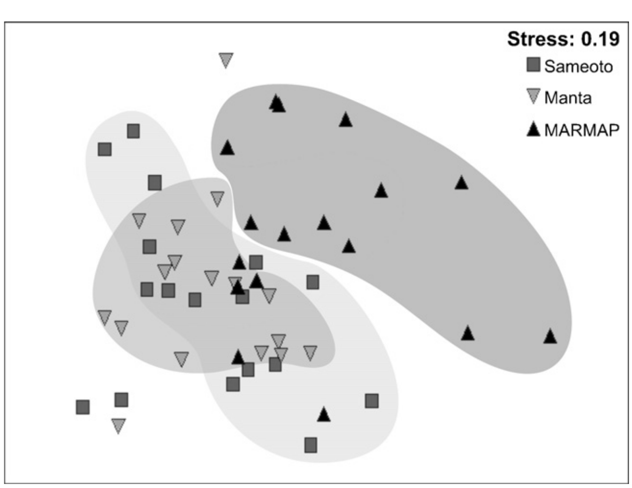

Fig. 3. Multidimensional scaling analysis plot for the abundance of larvae collected in the different neuston-sampling gears. The contour shows the relative concentration of data points.

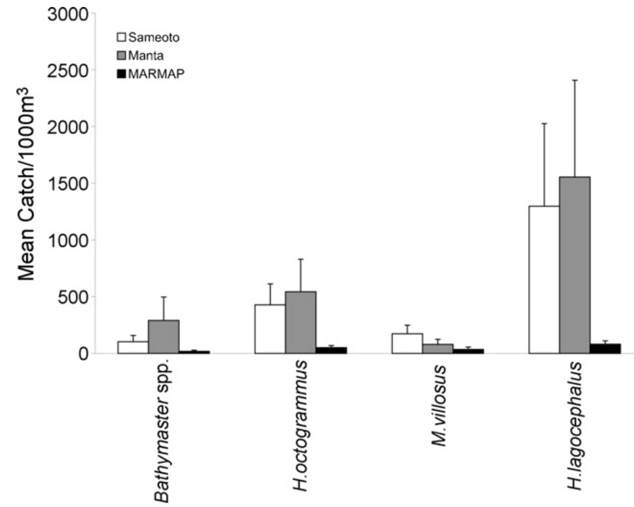

Fig. 4. Mean catch of the four most abundant taxa collected in Sameoto, Manta and MARMAP sampling gears with standard error bars.

ANOVA results showed that the mean abundance of Bathymaster spp. was significantly higher in the Manta when compared to the MARMAP ($p = 0.008$). Abundance of rock and masked greenlings in the MARMAP was significantly lower in both the Manta and the Sameoto ($p \leq 0.001$). The mean abundance of capelin was not significantly different among any of the gears ($p = 0.42$). Taken together, results indicate that the catch rates were lower in the MARMAP relative to the other two gears (Fig. 4).

3.2. Diversity

The ANOVA showed no significant difference at 5% in the total number of species, a measure of species richness, collected among the gears ($p = 0.08$). However, the analysis of variance for Margalef's index of richness, and Pielou's index of evenness showed significant differences. Species richness (adjusted for sample size) was significantly different between the MARMAP and the Sameoto ($p = 0.003$); species evenness was significantly different between the MARMAP and the Manta ($p = 0.016$). The MARMAP appeared to catch more taxa for a given number of individuals than the Sameoto and caught a more even distribution of taxa than the Manta.

3.3. Length

The larvae collected in all gear types were of similar length ranges. The analysis of similarities indicated no significant differences in the larval lengths among the gears, and the MDS plot supported this conclusion (Fig. 5). The Mantel tests showed that the length data of larvae collected in the Sameoto were correlated with that from the Manta and MARMAP (rejecting the null hypothesis of no relationship at 5% with $p = 0.009$ and $p = 0.003$, respectively). However, there was not enough evidence to show

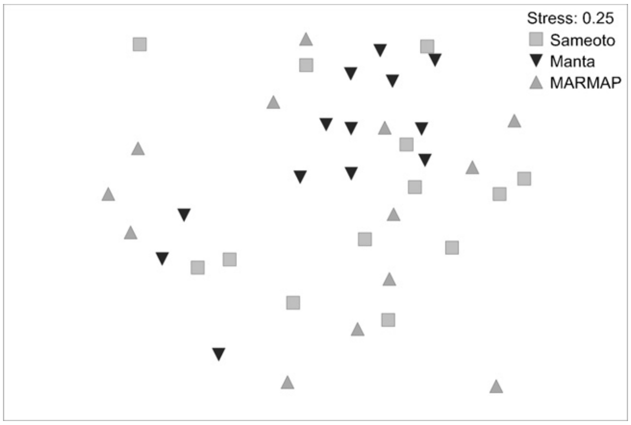

Fig. 5. Multidimensional scaling analysis plot of the length of larvae collected in Sameoto, Manta and MARMAP sampling gears.

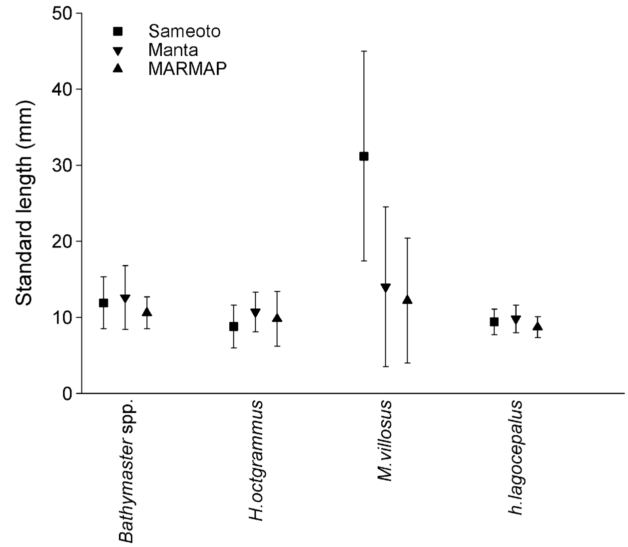

Fig. 6. Mean standard length (±S.D.) for the four most abundant taxa collected in Sameoto, Manta and MARMAP sampling gears.

correlation between the Manta and the MARMAP (failed to reject with $p = 0.18$). The ANOVA results of mean larvae lengths of the four most abundant taxa were, in general, in agreement with the multivariate test results in that there were no significant differences among the gear. Mean larval lengths with standard deviation bars overlapping between each gear and each taxon indicated little difference in lengths collected between the gears (Fig. 6). However, the length frequency distributions displayed in Fig. 7 shows some interesting trends. It appeared that the MARMAP collected more small-sized *Bathymaster* spp. larvae and fewer large-sized larvae than the other two gears (Fig. 7).

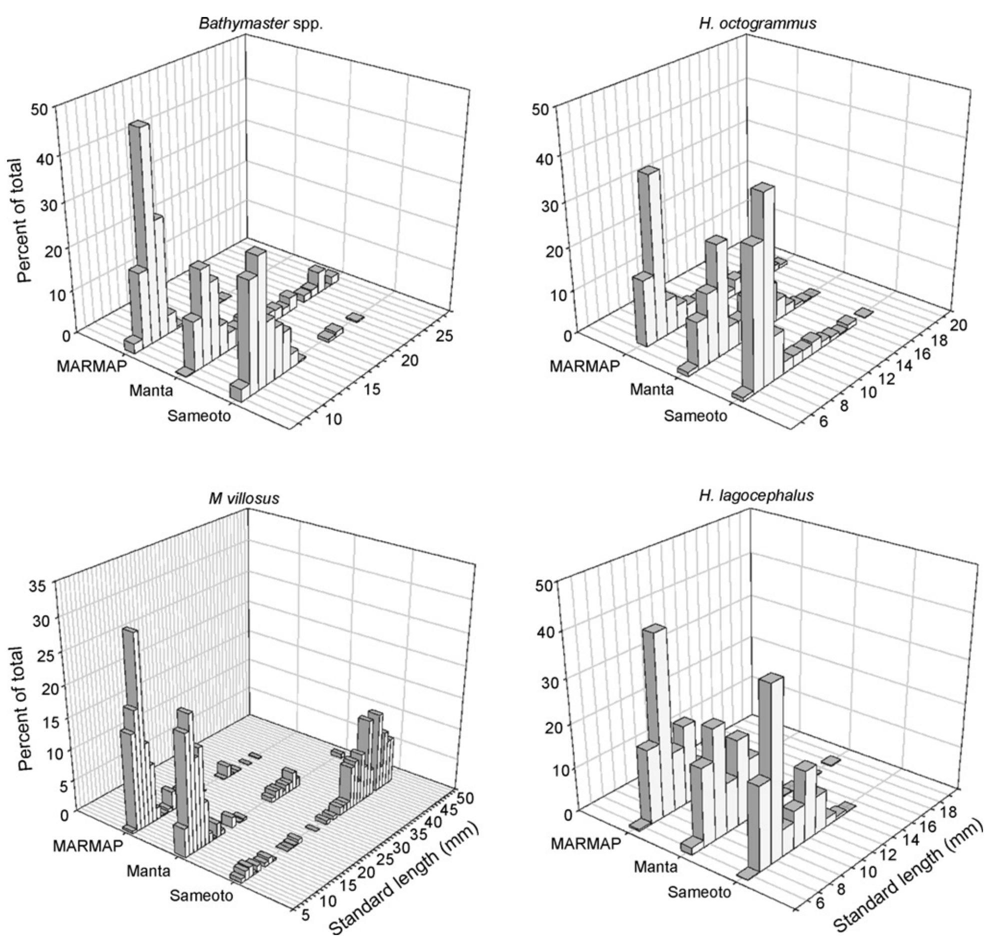

Fig. 7. Length distribution by percent of total of *Bathymaster* spp., *Hexagramma octogrammus*, *Mallotus villosus*, and *Hexagrammas lagocephalus* captured by the Sameoto, Manta and MARMAP sampling gears. *Note*: smaller scale for percent of total on *M. villosus*).

In addition, the length distributions of masked greenlings show that the Manta collected a greater number of midsize and fewer smaller larvae than the other two gears (Fig. 7). Capelin larvae length distributions indicated that the Sameoto collected greater numbers of large capelin larvae (Fig. 7), a result that was corroborated by analysis of the mean lengths (Fig. 6).

4. Discussion

Our study evaluated relative performance of three commonly used neuston-sampling gears. We found that the catch spectra (abundance, size, diversity) of the three neuston-sampling gears were different from one another when used in the Gulf of Alaska. The MARMAP neuston array's overall catch was significantly lower when compared to the Sameoto or the Manta. The Manta and Sameoto showed similar patterns in collections of the neustonic layer, with few differences in overall abundances or length statistics between the two. The lower catch estimates in the MARMAP could be a consequence of the non-randomized towing of the sampling gears, though that hypothesis seems unlikely since the water surface towed by each gear was distinct and undisturbed by previous towing efforts. Still, a randomized gear sampling order could decrease any bias and would be an improvement upon this study.

It is also unlikely that mouth diameter is a cause for the lower catch estimates in the MARMAP. The mouth opening of the MARMAP is substantially larger than the other two gears and previous work has shown that there is reduced net avoidance in larger opening nets. Fleminger and Clutter (1965) found that marine copepods and mysids in laboratory experiments more effectively avoided smaller nets, and Clutter and Anraku (1968) concluded that avoidance would be minimized with larger, faster and more transparent nets. Other studies have also suggested that larger nets capture larger and more fishes due to less net avoidance (Methot, 1986). However, in our study, it appeared that the MARMAP array also did not catch as many large-sized larvae as the Sameoto or Manta arrays, despite the larger size mouth opening of the MARMAP.

While we did not specifically examine the mechanics of collection of these three gears, we can speculate on the sources of the observed differences. The frame of the MARMAP used in this study was a 3.2-cm diameter aluminum pipe frame, which may have contributed to catch differences. The lightweight aluminum frame appeared to make it difficult for the MARMAP to stay partially submerged in the water in all sea states. Even with an added 2.3 kg weight, the MARMAP would briefly emerge from the water, thereby not sampling the neuston consistently. In addition, the large diameter of the frame relative to the smaller-width Sameoto (0.32 cm) and Manta frames (1.0 cm) may have created a sufficient bow (pressure) wave in front of the gear, which could deflect larvae away from the net's mouth opening. Clogging of the net mesh can also contribute to bow pressure waves, though differential clogging seems an unlikely explanation given that all gear types were deployed with the same mesh size. Differences in net length may have been a factor, since the net for the MARMAP was so much longer than the other two gears. Differences in bridle or towing configurations may have also contributed, though it appeared that bridles were mostly out of the water during fishing, and that net distance from the ship did not differ among the three gear types (3–5 m).

Regardless of the factor or factors responsible for differences in catch, larger-sized larvae were not as effectively sampled by the MARMAP. It is likely that increases in visual acuity and development of the lateral line system in larger, more mature larvae permitted detection of that gear from a greater distance, allowing some larvae to evade capture. Net avoidance has been suggested as the most common reason for underestimates of larval fish populations (Urho, 1997). Visual avoidance increases as larvae develop (Brander et al., 1987). When comparing towed net and pump collections, Cada and Loar (1982) suggested that clupeid larvae avoidance was visual rather than tactile due to the observation that there were no differences during night sampling (densities of both sampling methods were lower at night). Watanabe and Kawaguchi (1999) showed that larvae that migrate vertically to the neuston might be able to avoid a Maruchi neuston net due to the towing bridles creating water disturbance.

Anecdotically, the Manta appeared to have a smoother-sampling path, remaining on the surface, following the movements of the sea, compared to the Sameoto; however, we found no significant difference in the catch. Observed pitching or oscillating of the Sameoto did not seem to have an effect on the abundance, diversity or length of the catch. Modifications to the Sameoto may be helpful for more consistent sampling. The Manta performed well in rough seas, and we believe this is due to the aquaplane floats on its wings. These enabled the sampler to consistently fish half in and half out of the water. Adding floatation to the wings of the Sameoto could make the sampler stable at the surface of the water column.

Future work could evaluate the performance of the Sameoto as compared to other sampling gears that are modified to sample the neuston. Gears such as the MOCNESS, Methot (Methot, 1986) and Tucker (Tucker, 1951) nets can be modified to collect neuston samples for comparison. However, gears not specifically designed for collecting neuston have several drawbacks. Even though a larger mouth size has been shown to be advantageous, modified gear(s) are larger and may need faster towing speeds, intensifying the disturbance in the water and increasing larval avoidance (Smith and Richardson, 1977). Additionally, the larger gears collect larger samples that increase the complexity of sorting and identification, whereas the smaller more selective neuston samplers would be more readily processed. Also, sea conditions could have a greater negative effect on the modified gears because of their size. These gears do not have the ease of deployment as gears designed for the neuston. Choat et al. (1993) found no added advantages to using a Tucker trawl when sampling larvae and pelagic juveniles, and they found the smaller bongo net sampler easier to deploy and retrieve.

Repeating this study with added daytime sampling in the spring when there is the highest abundance and diversity in the neuston in the GOA (Doyle et al., 1995) may offer additional insights into the sampling efficiencies of the sampling gears. For the moment, researchers should be aware of these differences between these gears when evaluating and comparing results among neuston ichthyoplankton investigations. Furthermore, our study demonstrates that gear choice is an important consideration depending on whether the objective is to obtain estimates of abundance, size, or diversity of larval fishes in the neuston layer.

Acknowledgements

We would like to thank the SWFSC for loaning us the Manta sampler used in this study. Also, we would like to express our appreciation to the NOAA ship *Miller Freeman*'s officers and crew. Thanks to M. Doyle, S. Picquelle, J. Napp, and A. Matarese for comments on an earlier version of this manuscript. This research is contribution EcoFOCI-0626 to NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations.

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