

Population estimates and habitat types of bottom fish assessed by a remotely operated vehicle (ROV) around the San Juan Islands, Washington

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Abstract:

A remotely operated vehicle was used to assess fish populations around the San Juan Islands in two different habitat types: primarily sand and primarily rock. A comparison was conducted between the population assemblage observed by the ROV and that observed from a trawl and also a comparison was done between the number of *Sebastes emphaeus* observed at Pt. George by a dive survey and by an ROV survey. The fish populations were greatest in the rocky reef type habitats, especially those with greater complexity. There was a difference in the fish assemblages observed in the trawl and those observed with the ROV, mainly faster, pelagic fish seen with the ROV and more cryptic fish caught in the trawl. The ROV has great potential as a tool for studying habitat types and fish interactions with them, however it is important to bear in mind that it too has biases and limitations that must be taken into account as well.

Introduction:

Estimates of fish population size are essential in understanding how communities change over time and how anthropogenic factors affect these communities. Having an accurate population estimate of a commercially important fish allows fisheries managers to gauge the amount of harvesting that can occur without hurting the stock. Similarly, population estimates for non-commercial fish are important for determining dwindling populations of recreationally important fish or simply in order to assess the diversity of a fish assemblage. Often the tools and methods used to make the population estimate can make a difference in terms of what species are observed and in what numbers.

Currently, different methods exist for estimating fish populations, each with their own inherent biases and limitations. For this report I have assessed fish populations in four areas around the San Juan Islands, Washington with a remotely operated vehicle (ROV). The ROV is practical for population assessment at depths typically greater than 40 meters, depths previously unreachable by SCUBA diving techniques (e.g. Moulton, 1977). Unlike trawling techniques the ROV is able to sample in soft bottom areas that may contain rocks, as well as areas that are rocky reef habitats (Adams et al., 1995; Krieger, 1993). I will compare the fish assemblage observed from trawls with that observed from ROV transects within the same habitat area, as well as compare the fish density of *Sebastes emphaeus* determined from ROV transects to the estimate determined from a diver survey in the same area.

Within the San Juan Islands, marine protected areas (MPAs) have been established with the aim of rebuilding stocks of fish species that have shown decreasing population sizes. The majority of the fish that are protected within these MPAs are rockfish (*Sebastes*) species and other similar rocky reef inhabiting species. In order to gauge the effectiveness of these MPAs

around the islands it is necessary to know, accurately, the size of the population of fish. This has been accomplished so far only with SCUBA diving techniques, and as such the ROV could become a useful tool in assessing deeper water fish populations in these rocky habitats around the islands.

In addition, the ROV is useful for observing fish behavior in situ, especially interactions with habitat (Norcross and Mueter, 1999). Understanding fish-habitat associations is ecologically important in terms of designing marine reserves that encompass the habitat types associated with the desired fish species. In this study I have looked at the habitat associations of the observed fish species in two areas with a primarily sandy bottom: NW of Point Caution on San Juan Island and outside of Indian Cove on Shaw Island (named “Point Slaughter” for this study). The other two areas observed, the mouth of Parks Bay and SE of Point George, are mainly rocky areas with some high complexity rocky reef areas, especially SE of Point George. In 1990 the University of Washington established a MPA encompassing Parks Bay and Point George in order to, ideally, boost depleted stocks of ground fish (Murray and Ferguson, 1998).

Materials:

Data was collected using a Deep Ocean Engineering Inc. (San Leandro, CA.) Phantom HD 157 remotely operated vehicle (ROV) to identify fish and habitat types along each transect. The ROV (Fig. 1) has an industrial CCD color camera fitted with a 4.8 mm auto-iris lens housed within the hull capable of tilting 90° from directly horizontal to directly vertical. During preliminary experiments with a calibrating grid, it was determined that when the camera is .5 m off the bottom (our typical operating depth) and angled 40° below the horizontal, the transect width was .75 m (Wakefield and Genin, 1987). Two tungsten-halogen

lights at 250 watts (240 V) were mounted on either side of the camera and supplied illumination when necessary, which was the majority of the time in this study. Five high efficiency ducted propellers provided propulsion: 2 in the rear of the ROV for horizontal movement, 1 through the middle of the hull for vertical movement and 1 on each side for lateral movement. The ROV is connected to the surface boat with a 154 meter long, sea water buoyant, umbilical cable that is 18 mm in diameter with 30 conductor wires inside.

The ROV was deployed from a 22-foot boat, the R1, which was outfitted with all the necessary elements, including a generator, to run the ROV autonomously on the water. HyPack Max (Coastal Oceanographics, Inc.) software was installed on a laptop computer, and synthesized all the information coming from the hardware (Fig. 2). A Garmin global positioning system (GPS) provided the latitude and longitude coordinates for the boat while a KVH electrical compass determined the magnetic heading of the boat. The ROV was tracked using a Trackpoint II system (Ore International Inc.), which consists of a hydrophone mounted on the boat communicating with a transponder (pinger) attached to the ROV. The latitude and longitude of the ROV were determined in relation to the boat by HyPack Max and these coordinates were displayed on the ROVs video display. A Sony digital video recorder recorded each transect onto a digital video tape while a Horita Co. GPT-50 GPS video titler displayed the time, date, latitude and longitude onto the video. The depth was recorded onto the digital videotape via audio.

Methods:

Transect sites were determined by personal communication with Jake Gregg, Don Gunderson and Bruce Miller in order to find areas relatively close to the labs which contained a variety of different habitat types. The 4 transect sites observed were northwest of Point

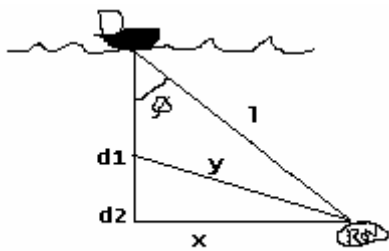
Caution (Fig. 3), the mouth of Parks Bay (Fig 4), SE of Point George (Fig 4), and a point outside of Indian Cove (referred to as “Point Slaughter” for this report) (Fig 5). Northwest of Pt. Caution the bottom is primarily sandy with some shell hash, and some rocky habitat near the shore. The mouth of Parks Bay and SE of Pt. George are both primarily large rocky reefs, while Indian Cove is a gradually sloping soft bottom habitat.

The R1 was deployed to each of the four transect sites on calm days, for the most part during relatively slack tides (Table 1). Once at a site the specific position of the boat was determined using HyPack software. After moving the boat to an ideal depth for starting a transect the anchor was dropped and set. The ROV was set, carefully, into the water and descended to the bottom where a compass heading was found that headed into deeper water and the tape began recording. At the beginning of each transect, an observer on the boat watching a screen of the current ROV view recorded the transect number as well as current depth of the ROV which was determined from the Trackpoint II. The ROV driver allowed the latitude and longitude to settle down before driving along the transect, while two people on the deck of the boat payed out the tether connected to the ROV.

The observer would describe the habitat type at the beginning of the transect as well as when the habitat changed significantly. Every time a fish was seen the observer would note depth and identify it if possible otherwise it would be noted for further identification by analysis of the tape later on. When the tether reached the end (at 154 m) the transect end point was recorded by the observer along with depth and habitat type. The ROV was then driven back to the boat and retrieved.

Viewing of the tapes was done at a later point to identify species and characterize habitat type (Table 2) at points of fish observations. Latitude and longitude were recorded

from the tape at the start and end points and at 1 minute intervals in between along each transect. These coordinates were entered into a geographic information system (GIS) (ArcView 3.2; ESRI Corp.) which contained shoreline data for the San Juan Islands and displayed approximate transect lines at each site (Figures 3-5). From this GIS data a rough length was calculated for each transect line, which was verified against a trigonometric calculation of maximum possible transect length:



l = length of tether (154 m), $d1$ = transect start depth, $d2$ = transect end depth, y = maximum transect length

$$\cos\theta = d1/l \quad x = d2(\tan\theta)$$

$$y = \sqrt{((d2 - d1)^2 + x^2)}$$

Dividing number of fish observed by the area (transect length multiplied by transect width) gave a population estimate of the number of fish in the given area of the transect.

Two trawls were completed on board the R/V Nugget in Indian Cove on November 22, 2002 using a 7.6 m Otter trawl, which has an operating mouth width of 3.8 m, a vertical opening of 1 m, a body mesh size of 38 mm and a cod-end mesh size of 6mm (Miller et al., 1990). Both trawls started at 38 m and ended at 48 m with the length of the first trawl at 400 m and the second one at 406 m. For a complete description of the deployment methodology consult Miller et al., 1990. On November 23 2002 the ROV was deployed twice in the same area, covering 205 m total length of the same habitat type as the trawls. The densities and species composition of fish caught in the trawl were then compared with those observed along the ROV transects. The population estimate of Puget Sound rockfish (*Sebastes emphaeus*) determined by a dive survey at Point George this fall was compared to the ROV population estimate.

Results:

Fish Populations and Habitat Types:

After observation of tapes the number of fish was tallied for each transect and then for each area sampled (Table 3). The number of Puget Sound Rockfish (*Sebastes emphaeus*) encountered was five times greater than for shiner surfperch (*Cymatogaster aggregata*), the next most abundant species. The mean number of fish per 100 m² was calculated to be 6.9 NW of Point Caution, 7.1 in the mouth of Parks Bay, 37.1 SE of Point George, and 4.5 at “Point Slaughter” (Figure 6).

When *S. emphaeus* are removed from the SE of Point George tally, the mean number of fish per 100 m² decreases to 8.6 (Figure 7). With *S. emphaeus* removed from the other sites the numbers are: 6.3 NW of Point Caution, 5.3 in the mouth of Parks Bay and 3.9 at “Point Slaughter” (Figure 7). The average number of *S. emphaeus* per 100 m² for each transect can be seen in Figure 8. The average number of *S. emphaeus* per 100 m² was calculated from a dive survey to be 8.7 (Sausman, 2002) and compared to the amount calculated from the ROV survey, which is 28.5 (Figure 9).

At each point that a fish was observed on the tape the type of habitat surrounding that fish was assessed using a distinct key (Table 2). The three main substrate types were: Mud, Sand, Bedrock and Rocky Reef (Bedrock is not complex while Rocky Reef contains complexity); and the modifier substrate types were: shells, vegetation, small cobble, medium rocks, large boulders and coral encrustations. Main substrate type is considered to be the bottom type of habitat, while the modifier habitat type is basically whatever is on top of that main bottom type. There can be 100% of certain different modifier types because the modifiers can compound upon each other.

SE of Point George and the mouth of Parks Bay were the sites with the most varied habitat types. Rocky Reef bottom was the main type SE of Point George and Bedrock was the primary bottom type at the mouth of Parks Bay (Figure 10). The area NW of Point Caution had 100% Sand substrate at all fish observations and also 100% shell coverage (Figure 11). “Point Slaughter” was 90% Sand substrate with 80% shell coverage.

ROV Observations Vs. Trawl Observations:

The catch from the two trawls done in Indian Cove comprised a total of 7 fish representing 4 fish species (Figure 12). The fish observed during nearby ROV transects totaled 30 with 20 of those fish being shiner surfperch (*Cymatogaster aggregata*) none of which were found in either of the trawls. Six species were observed from the ROV including one great sculpin (*Myoxocephalus Polycanthocephalus*), which was also caught in one trawl. Four Northern Spearnose Poachers (*Agonopsis vulsa*) were caught in the trawls while none were observed along either ROV transect.

Discussion:

The fish populations estimated from this study were fairly typical of those described in similar habitat areas. For the most part the fish observed have habitat ranges that extend much deeper than our study area (Eschmeyer et al. 1983), so no real depth gradient would be observed. In terms of actual number of fish estimated at each transect site the fact that a greater number were found SE of Point George (Fig. 6) most likely relates to its habitat type, which is primarily rocky reef (Fig. 10). SE of Point George was one of the sites with the highest number of different types of substrate, which also probably accounted for its higher fish population. The mouth of Parks Bay has a similarly rocky habitat however it is not as complex as Point George, yet both areas are protected within the MPA which leads me to

believe that the difference in fish populations results from the difference in complexity of the rocky substrate.

The large amount of *S. emphaeus* observed at Point George was the main reason that the fish population estimate was much higher than at the other sites, however with this species removed Point George still had the highest mean number of fish (Fig. 7). A dive survey occurring concurrently at Pt. George, albeit a bit farther north of the ROV transects (Fig 4), estimated the population of *S. emphaeus* to be 20 fish less than the ROV survey (Fig 9). I don't believe this difference arose because of sample size due to the fact that my sample set was 4 transects and the diver survey had 6 surveys, however along the same transect (Sausman 2002). The maximum depth reached by the dive survey was 20 m, which was 20 m shallower than the beginning depth of any ROV transects at Pt. George (Table 1) and I think this could have been a factor in population estimates, although depth range of *S. emphaeus* encompasses all these depths. Habitat complexity could be different between the two areas sampled and this could account for the difference, to determine this a more in depth survey of habitat at the two areas would need to be done. Another possible reason of this difference could have been because of biases associated with the different survey methods, however I would hypothesize that the ROV, because of the greater noise and the bright lights would have been the method which saw the fewer amount of fish and not the less intrusive diver method. The fish could also have been moving about in one large school and considering that my transects were all done in one day I could have gotten the majority of fish at that point.

In terms of habitat types at each transect site, more in depth analysis of the tapes would be necessary in order to classify the total habitat composition of each transect. However, as it is, the habitat types presented here are at points when fish were observed in order to assess

fish-habitat associations. The overall habitat was not looked at but with more time it would be ideal to classify the habitat type at each one of these transects in terms of presence or absence of fish. The habitat types where fish were observed were typical for these species, with rockfish inhabiting the rocky reef areas (Pacunski and Palsson, 1999) and smaller forage fish found among the sandy bottom type areas. Flatfish (*Pleuronectidae* sp.) species were observed in primarily sandy bottoms yet a few were found in Point George transects, however these were in sandy areas within the rocks. The cryptic nature of the flatfish and their behavior may also account for their relatively low numbers observed in the sandy areas.

Crypsis of certain species is most likely the reason that some types of fish were not observed by the ROV along the transects, namely young of the year (YOY) Lingcod (*Ophiodon elongatus*) and *A. vulsa*. The fact that out of two trawls, 4 *A. vulsa* were caught and not a single one was seen in any of the ROV transects could be evidence that the ROV is not capable of seeing certain cryptic fish which would otherwise be caught in a trawl. However it is interesting to note that a school of 20 *C. aggregata* were observed on the ROV transect while none were caught in trawls in the same area (Fig 10). This is most likely due to the nature of *C. aggregata* which is a fast moving pelagic fish that could conceivably move out of the way of the trawl, or possibly wasn't even in the trawl area because of movement in and out of the area. This is a major benefit of population estimation from the ROV, because it is able to see species that would otherwise escape capture from nets. Yet population estimates from the ROV are biased due to the avoidance fish would exhibit because of either the light or the noise of the ROV, or simply even because of its size. When watching the tapes the fish almost always swam away from the ROV as we approached them which suggests that they are avoiding it and probably some sooner than we could view on the screen.

Issues arose with the tracking of the ROV through the water, mainly that the latitude and longitude coordinates determined hydroacoustically through the Trackpoint II system were often wrong. The coordinates recorded at one minute intervals from watching the video may well have been completely off the actual transect line and when entered into the GIS they would skew the true transect line. The ideal way to record the coordinates from the video would have been every time the Trackpoint system determined a new coordinate which would have been every 2 seconds, but this was not feasible in the time frame for this project. This would yield a much more accurate transect line, since it would be easier to remove outlying points that obviously are not on the transect. As it is, the lines presented here (Figures 3,4,5) are approximations but they do represent, in general, where the ROV went. Typically though, the start and end points are accurate because the ROV stopped and the tracking system allowed to stabilize. The depth, which was determine from the Trackpoint system, could also have been wrong but for the most part while on the boat depths that were obviously wrong were not recorded but some still could be not completely accurate.

I see a huge potential for further research with the use of the ROV mainly with habitat typing and fish-habitat interactions and possibly even invertebrate population analysis. Population estimation is also a very useful product of the ROV work, although it too has its own biases and limitations which must be taken into account. The lights and the noise it makes from the propellers probably scare away a number of fish before they even enter the viewing field, and quick moving fish could get out of the way as well. The tether attaching the ROV to the boat is of limited length, in our case 154 m, and this is a limiting factor because you can only go as far as your tether allows. Nevertheless the ROV is invaluable for habitat typing and

fish behavior/interactions because it allows a first hand look at what is going on in these deeper water fish communities.

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First off I thank the Washington Research Foundation, the Mary Gates Endowment, the UW's Tools for Transformation Program and the David and Lucile Packard Foundation for providing this wonderful opportunity for me. I thank my professors Don Gunderson and Bruce Miller for their incredible amounts of help and guidance along my project. My TAs Dan Cooper, Nick Lowry, Kathryn Sobocinski and Lucie Weis for all their help with my project and insight into the life of a grad student (which looks pretty cool). I also thank Jake Gregg for all his time and hard work he spent helping me with the ROV and all the data collection, I'm glad we actually got this thing working. I thank all the FHL staff for the support and all the resources. Lastly I thank my classmates for helping out on the R1 and for providing such a rich and fun research environment, and a special shout out to the computer lab family, Kirsten Rodgers, Emily Thompson and Jake Sausman for keeping those late nights a bit more entertaining than they would have been alone.

Literature Cited:

- Adams, P.B., Butler, J.L., Baxter, C.H., Laidig, T.E., Dahlin, K.A., Wakefield, W.W., 1995. Population estimates of Pacific coast groundfish from video transects and swept-area trawls. *Fishery Bulletin, U.S.* 93: 446-455.
- Eschmeyer, William N. and Earl S. Herald, 1983. *Pacific Coast Fishes*. Houghton Mifflin Company, New York.
- Krieger, Kenneth J., 1993. Distribution and Abundance of rockfish determined from a submersible and by bottom trawling. *Fishery Bulletin, U.S.* 91: 87-96.
- Miller, B., Gunderson, D., Dinnel, P., Donnelly, B., Armstrong, D., 1990. Recommended Guidelines for Sampling Soft-Bottom Demersal Fishes by Beach Seine and Trawl in Puget Sound. 40 pp.

- Moulton, L., 1991. An ecological analysis of fishes inhabiting the rocky nearshore regions of northern Puget Sound, Washington. Ph.D diss., Univ. Washington, Seattle, WA, 181 p.
- Murray, M.R. and L. Ferguson, 1998. The status of marine protected areas in Puget Sound. Volume II: MPA sites and profiles. Puget Sound/Georgia basin environmental report series, number 8. 397 pp.
- Norcross, B.L. & Mueter, F.J., 1999. The use of an ROV in the study of juvenile flatfish. Fisheries Research 39: 241-251.
- Pacunski, R.E. & Palsson, W.A., 1999. Macro-and Micro-habitat Relationships of Adult and Sub-Adult Rockfish, Lingcod, and Kelp Greenling in Puget Sound. Report to WDFW. 11 p.
- Sausman, J., 2002. Comparison and Analysis of the nearshore rocky reef fish densities at Point George, Shaw Island, Washington. Unpublished class project, FISH492, University of Washington, Friday Harbor Laboratories, WA. 12 pp.
- Wakefield, W.W. & Genin, A. 1987. The use of a Canadian (perspective grid) in deep-sea photography. Deep-Sea Research, 34: 469-478.

Table 1: Transect sites and pertinent information about each transect.

Site	Start		Date	Time	
	Latitude	Longitude		Start	End
NW of Point Caution					
Transect 1	4834.715	12303.3501	11/19/2002	1000	1015
Transect 2	4834.6969	12303.3149	11/19/2002	1030	1045
Transect 3	4834.6489	12303.2774	11/19/2002	1100	1115
Mouth of Parks Bay					
Transect 4	4833.9291	12259.2879	11/19/2002	1200	1215
Transect 5	4833.8656	12259.1972	11/19/2002	1230	1245
Transect 6	4833.9678	12259.3104	11/19/2002	1300	1315
SE of Point George					
Transect 7	4833.2414	12258.8939	11/21/2002	900	915
Transect 8	4833.2445	12258.9144	11/23/2002	1230	1245
Transect 9	4833.2551	12258.9425	11/23/2002	1300	1315
Transect 10	4833.2675	12259.0075	11/23/2002	1330	1345
Indian Cove (Point Slaughter)					
Transect 11	4832.9002	12256.5616	11/14/2002	1030	1045
Transect 12	4832.6537	12256.7431	11/14/2002	1100	1115
Transect 13	4832.7795	12256.6235	11/14/2002	1130	1145
Indian Cove (Trawl comparison)					
Transect 1	4832.92	12256.3156	11/23/2002	1030	1045
Transect 2	4832.9249	12256.1669	11/23/2002	1100	1115

Site	Current (kt=knot)	Length (m)	Depth (m)	
			Start	End
NW of Point Caution				
Transect 1	flood -0.55 kt	145	27	51
Transect 2	flood -0.38 kt	133.5	32	46
Transect 3	flood -0.21 kt	143	34	43
Mouth of Parks Bay				
Transect 4	flood 0.05 kt	101	N/A	N/A
Transect 5	flood 0.24 kt	145	37	49
Transect 6	flood 0.46 kt	155	39	53
SE of Point George				
Transect 7	flood -0.97 kt	127	42	70
Transect 8	flood -0.56 kt	128	44	57
Transect 9	flood -0.48 kt	129	41	55
Transect 10	flood -0.42 kt	140	50	62
Indian Cove (Point Slaughter)				
Transect 11	flood 0.96 kt	149	20	40
Transect 12	flood 1.02 kt	147	25	46
Transect 13	flood 1.02 kt	146	35	48
Indian Cove (Trawl comparison)				
Transect 1	flood -0.89 kt	74	38	38
Transect 2	flood -0.84 kt	131	41	39

Table 2: Habitat classifications used in this study

MAIN SUBSTRATE		MODIFIERS	
Code	Substrate Type	Code	Type
1	Sand/Mud	s	shells
2	Bedrock (flat)	v	vegetation
3	Rocky reef (complex)	c	small cobble
		r	med rocks
		b	large boulders
		l	coral encrusted

Table 3: Fish counts for each of the thirteen transects.

NW Pt. Caution	Transect 1	Transect 2	Transect 3	Transect 4	Total
<i>Cymatogaster aggregata</i>			10	n/a	10
<i>Gadidae sp.</i>		3	2	n/a	5
<i>H. stelleri</i>		1		n/a	1
<i>Lumpenus sagitta</i>			1	n/a	1
<i>Pleuronectidae sp.</i>			1	n/a	1
<i>S. emphaeus</i>	2		2	n/a	4
Mouth of Parks Bay					
<i>Gadidae Sp.</i>		5	1	n/a	6
<i>H. decagrammus</i>	1	2		n/a	3
<i>H. stelleri</i>	1			n/a	1
<i>Pholididae Sp.</i>	1		1	n/a	2
<i>Pleuronectidae sp.</i>			2	n/a	2
<i>S. emphaeus</i>	4	1		n/a	5
<i>S. maliger</i>	1			n/a	1
SE Pt. George					
<i>Cottidae sp.</i>		1			1
<i>Gadidae sp.</i>	6	1		5	12
<i>H. decagrammus</i>	2	1	9	5	17
<i>Pholididae sp.</i>			1		1
<i>Pleuronectidae sp.</i>			2		2
<i>S. emphaeus</i>	10		55	49	114
<i>S. nigrocinctus</i>			1		1
Indian Cove					
<i>Cottidae sp.</i>	1		1	n/a	2
<i>H. decagrammus</i>		2	1	n/a	2
<i>H. stelleri</i>				n/a	1
<i>Lumpenus sagitta</i>	1		2	n/a	3
<i>Pholididae Sp.</i>		1		n/a	1
<i>Pleuronectidae sp.</i>	1	1		n/a	2
<i>S. emphaeus</i>	2			n/a	2
Unidentified sp.		2		n/a	2

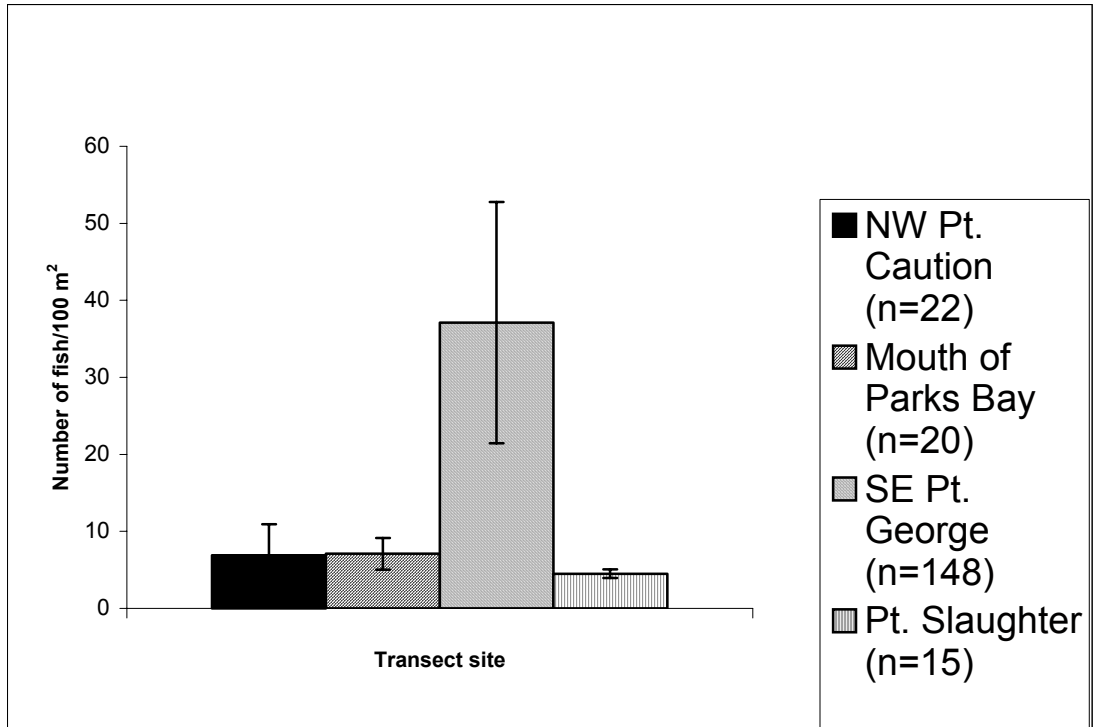


Figure 6: The average number of fish observed per 100 m² calculated for each site, with one standard error included. The “n” refers to total number of fish seen at each site.

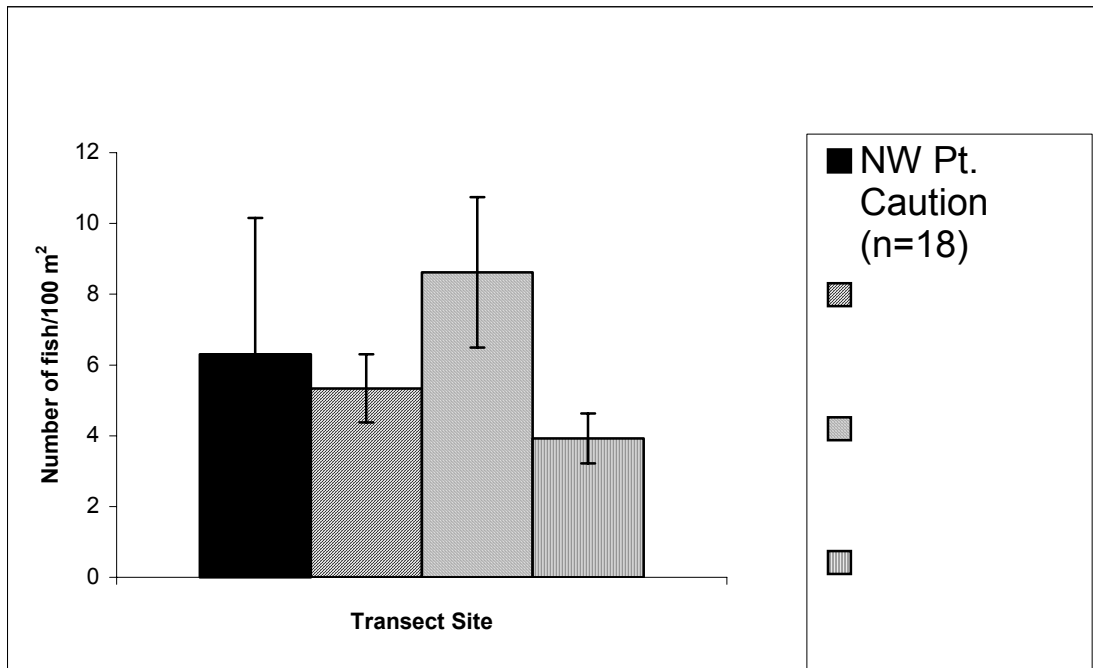


Figure 7: The average number of fish, not including *Sebaste emphaeus*, observed per 100 m² calculated for each site, with one standard error included. The “n” refers to total number of fish seen at each site.

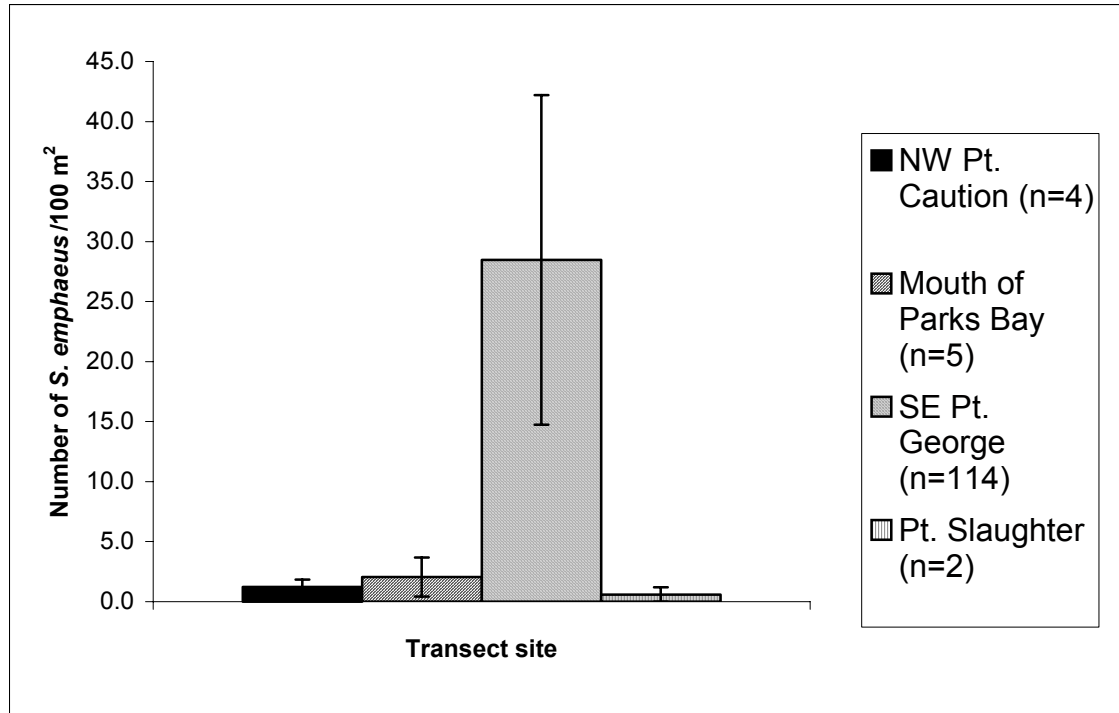


Figure 8: The average number of observed *Sebastes emphaeus* per 100 m² at each transect site, with one standard error included. The “n” refers to total number of fish seen at each site

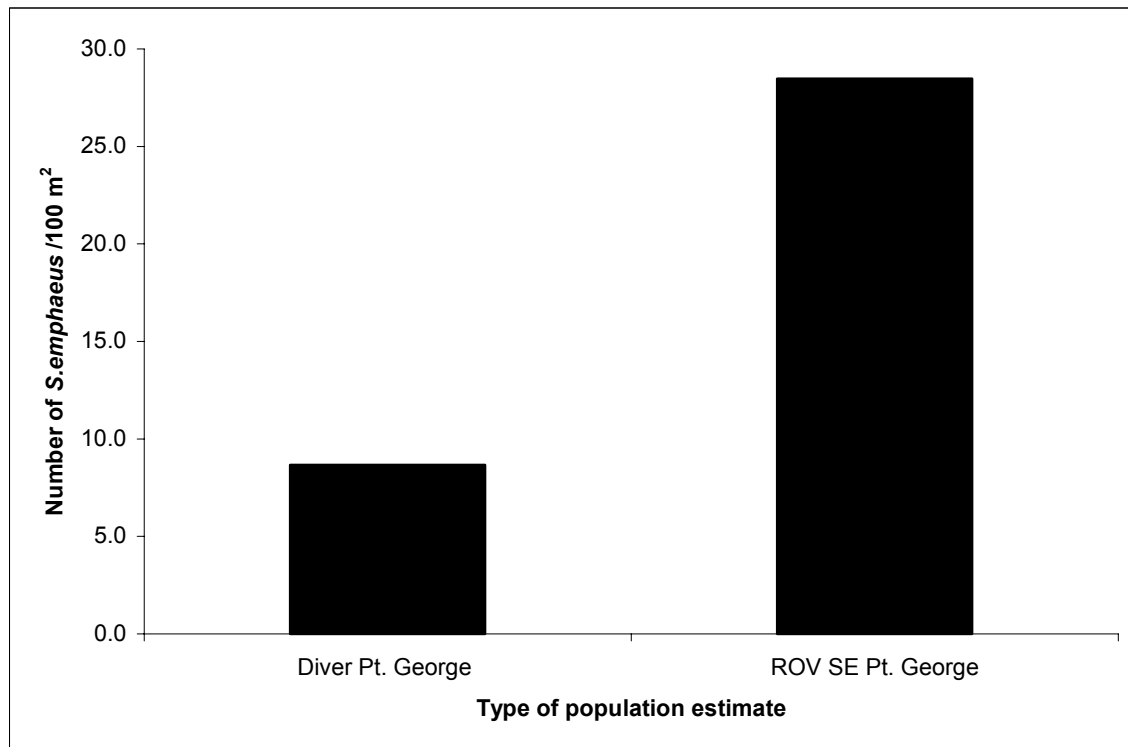


Figure 9: Average number of *Sebastes emphaeus* observed by a diver survey method and by the ROV method per 100 m² around Point George.

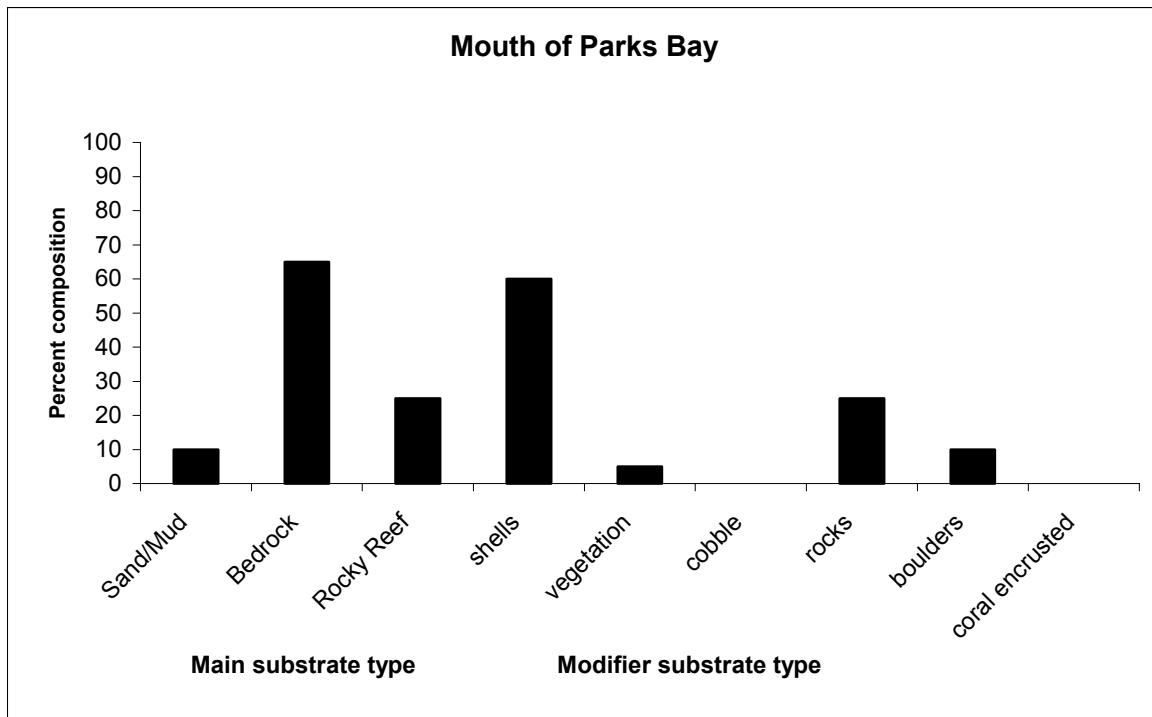
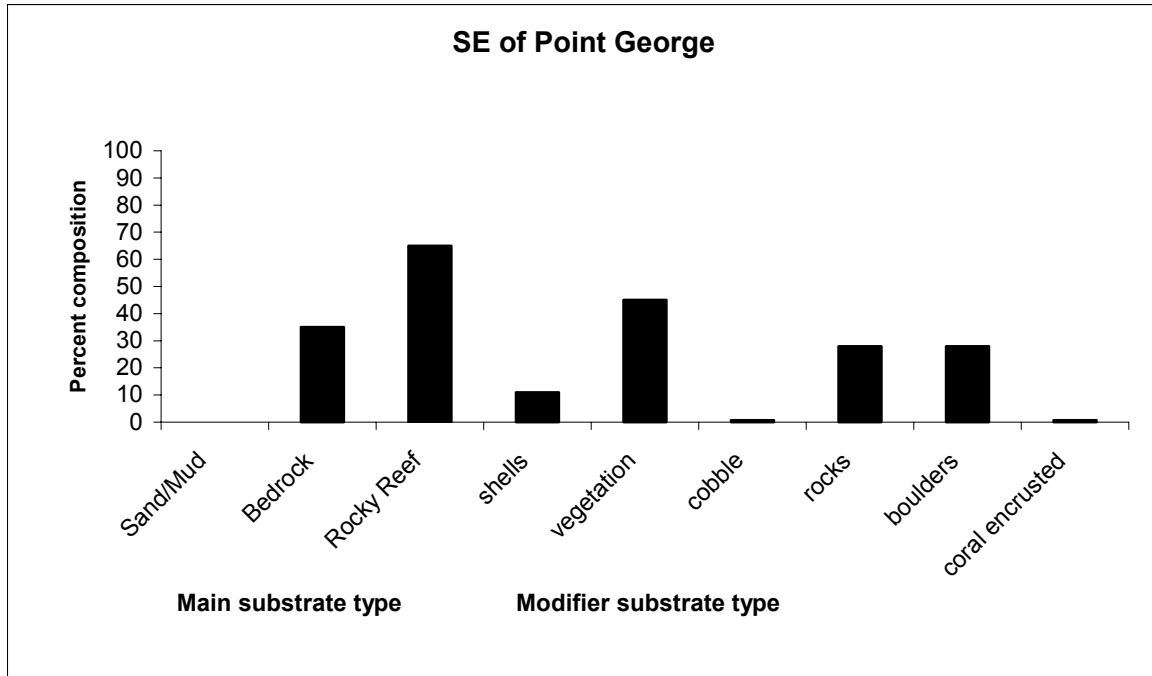


Figure 10: Habitat composition for two primarily rocky habitat type transect sites. Numbers don't add to 100% because main substrate type and modifier substrate type are different categories, and modifier substrate type could also be 100% in certain categories at once.

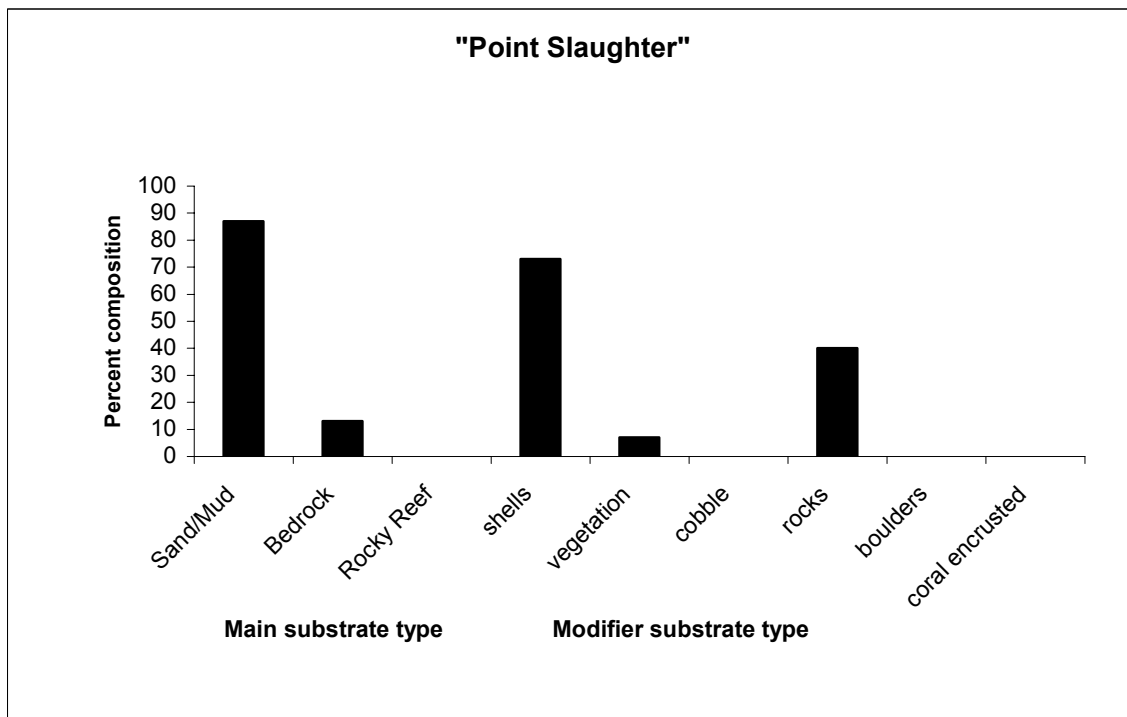
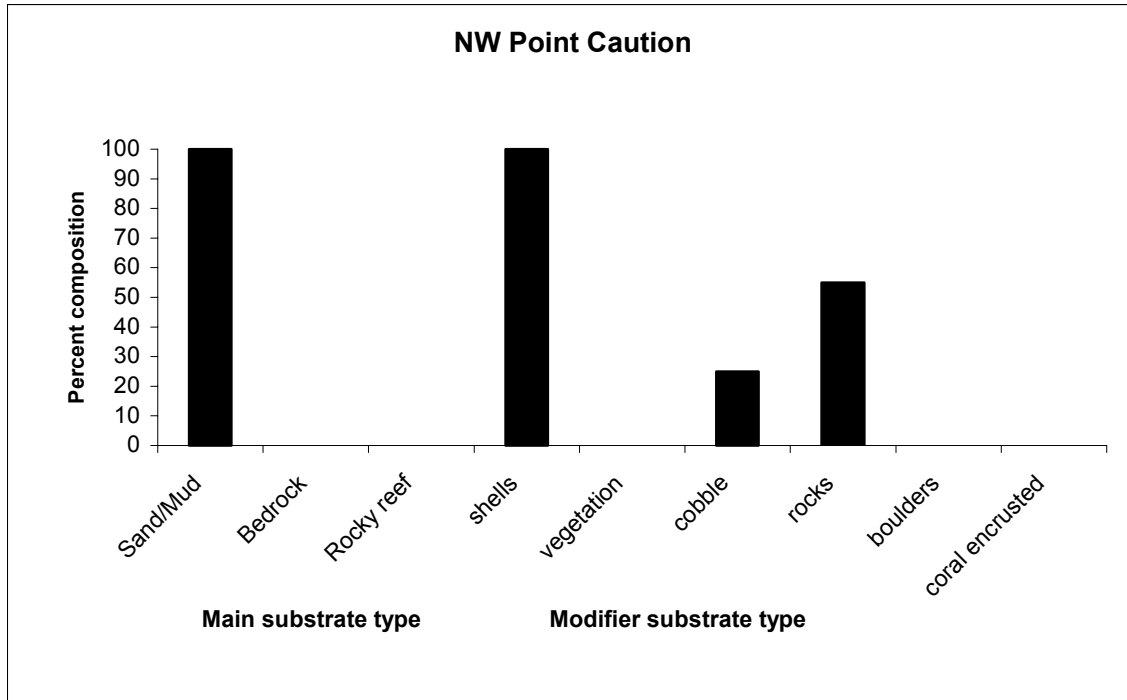


Figure 11: Habitat composition for two primarily sandy bottom habitat transect sites. Numbers don't add to 100% because main substrate type and modifier substrate type are different categories, and modifier substrate type could also be 100% in certain categories at once.

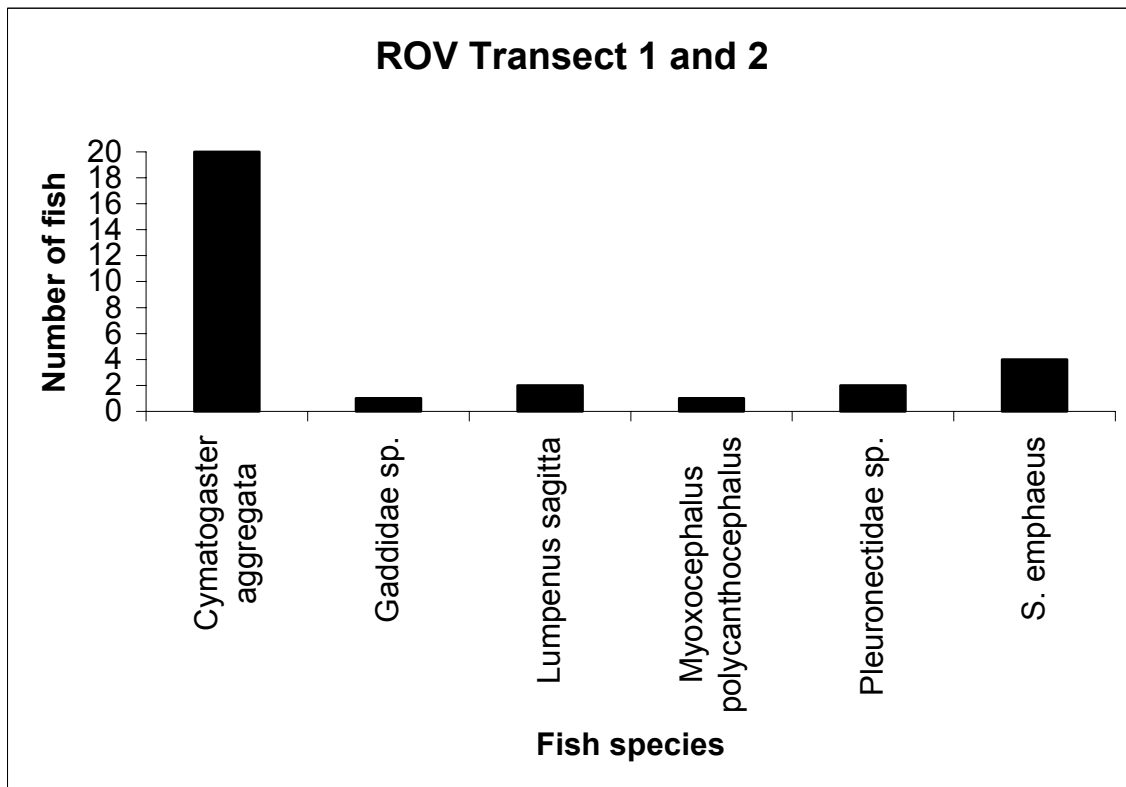
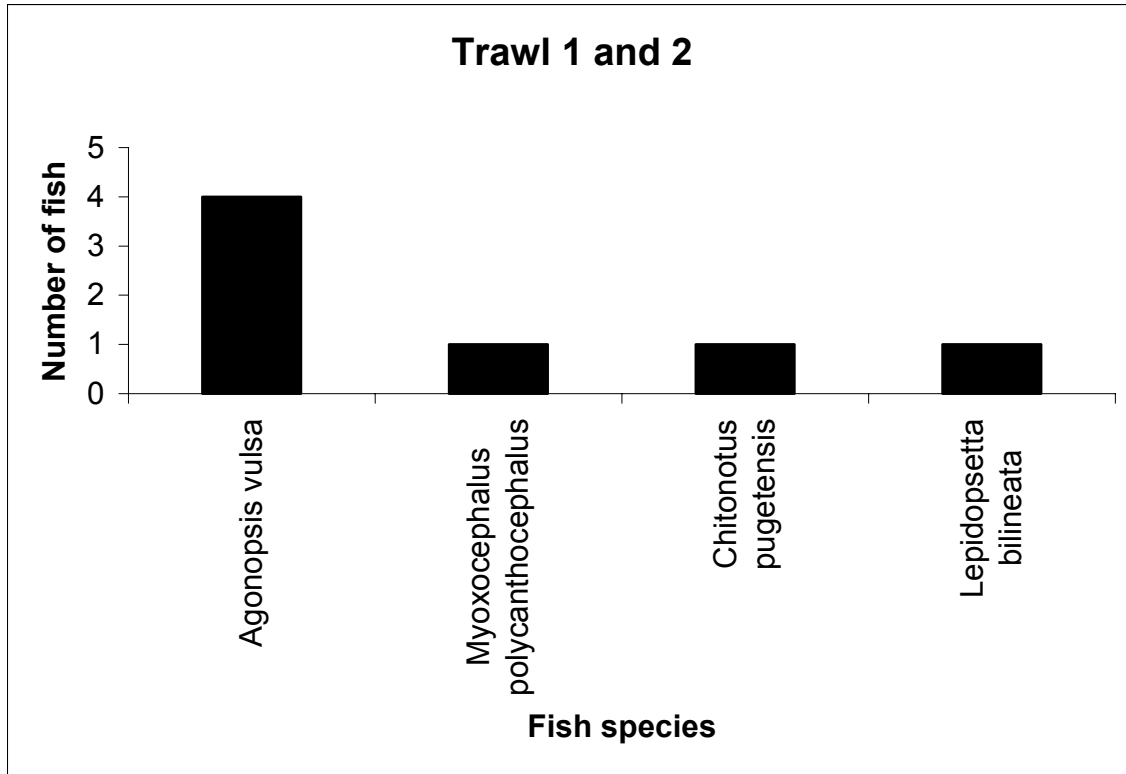


Figure 12: The fish species observed during two trawls and two ROV transects from Indian Cove.

