Fish Foraging on an Artificial Reef in Puget Sound, Washington

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ABSTRACT— This study was designed to determine the degree of foraging by striped seaperch, Embiotoca lateralis; *pile perch* Rhacochilus vacca; *and quillback rockfish,* Sebastes maliger, *on organisms associated with an artificial reef in Puget Sound, Wash. Stomachs of these fish species, dissected from 609 fish speared on, around, and near the artificial reef between August 1977 and December 1978, were examined and the contents were compared with organisms present in the immediate area.*

Medium and large fish (over 121 mm for all three species) foraged more on organisms associated with the artificial reef than did small fish of the same species. Abundance of preferred food items of medium and large striped seaperch and quillback rockfish associated with the artificial reef was an important factor in attracting large numbers of these species. Conversely, medium and large pile perch were largely absent from the artificial reef due to a lack of preferred food items.

Introduction

Fishermen and scientists have known for centuries that fish are attracted to solid objects. This knowledge has been used to increase harvests by creating artificial reefs on sand bottoms, thereby increasing the numbers of economically important fishes in the area.

Many factors are important to the success of an artificial reef in attracting fish, including the presence of food items (Breder and Nigrelli, 1938). Fager (1972) observed that organisms growing on experimental 1 m cubes off La Jolla, Calif., influenced the types of predators attracted to the cubes. Walton (1979) determined that new tire reefs in Puget Sound, Wash., attracted a higher percentage of surfperch (Embiotocidae) and rockfish (Scorpaenidae) than adjacent tire reefs 1 year older. He speculated that changes in the fish community are correlated with successional development of organisms growing on the artificial reefs.

This study was designed to determine the degree of foraging by two embiotocids (*Embiotoca lateralis* and *Rhacochilus vacca*) and one scorpaenid (*Sebastes maliger*) on organisms associated with an artificial reef in Puget Sound to increase our knowledge of the changes in the structure of the fish community during the reef's early stages of successional development.

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Materials and Methods

The Study Area

The artificial reef is located off the west shoreline of Edmonds, Wash., 24 km north of Seattle (Fig. 1). It was built during the summer of 1976, and is composed of 88 tire modules constructed from 10,000 discarded tires (Walton, 1979). Five different configurations were spaced in groups on a flat sand bottom, occupying a total surface area of 1,450 m^2 in an 11-hectare area between 10 and 15 m below mean lower low water. The artificial reef lies 60 m offshore from a riprap breakwater and 200 m south of a ferry pier. Algal and invertebrate growth on the artificial reef began during the spring of 1977 (Hueckel, 1980). The surface of the tires forming the artificial reef was covered by a lush growth of algae in which a dense population of crabs, shrimp, amphipods, and harpacticoid copepods took refuge.

Table 1.—Length classes of fish collected from the study area off Edmonds, Wash., between August 1977 and December 1978.

Species	Length group (mm)		
	Small	Medium	Large
Striped seaperch	≤120	121-250	≥251
Pile perch	≤120	121-250	≥251
Quillback rockfish	≤120	121-200	≥201

Field and Laboratory

All fish were collected for this study by spearfishing between August 1977 and December 1978. Collected fish were divided into three length classes (Table 1). Large numbers[1] of striped seaperch and quillback rockfish were observed in the study area and were speared exclusively from the artificial reef. Small pile perch also occurred around the artificial reef in large numbers, while medium and large pile perch were scarce[2]. Schools (footnote 1) of medium and large pile perch were subsequently observed near the riprap and ferry pier pilings. Pile perch from all length classes were speared from the artificial reef, riprap, and ferry pier pilings. All fish were

[1]Greater than 100 fish, either schooling or solitary, observed per dive.
[2]Less than 10 fish observed per dive.

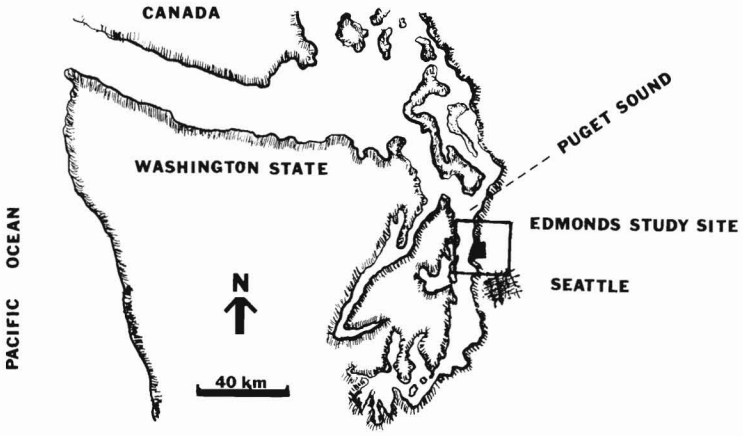
speared during the mid-morning hours except in winter months. Striped seaperch and quillback rockfish were taken at night during winter since their abundance was highest during this time. No pile perch were collected during winter due to their absence from the study area.

In the laboratory collected fish were weighed, measured, and labeled. Stomachs were removed and preserved with 10 percent buffered Formalin[3]. Due to their extremely small size, we defined striped seaperch and pile perch "stomachs" as the anterior one-quarter of their digestive tract. Stomach contents were emptied into Petri dishes and examined under a dissecting microscope (10-30×). Individual prey items were identified, blotted dry, weighed to the nearest 0.001 g, and enumerated.

Prey items were ranked by the Index of Relative Importance (IRI) developed by Pinkas et al. (1971). This index was calculated as IRI = $FO(N+W)$, where FO is the percentage frequency of occurrence of each prey item, N is the numerical percentage of each prey item contributing to the total diet, and W is its percentage of weight. IRI values for prey items in fish from each length class were totaled, and were expressed as a percentage of the total IRI.

The substrate from which the fish were feeding was determined by matching prey items in the fish stomachs to their respective habitats. Habitats of prey were determined from benthic cores, plankton net tows through the algae covering the tire surfaces, and visual observations. Prey items were assigned to one of six different categories: 1) Artificial reef, 2) riprap and ferry pier pilings, 3) infauna (on and in sand), 4) epifauna (free moving, in reef algae and sand), 5) planktonic, and 6) unknown. Category 2 applies to only those prey items from pile perch speared around the riprap and ferry pier pilings.

To correlate feeding habits with prey habitat we assumed fish did not migrate from outside of the immediate area of capture during feeding. This assumption seems justified since 1) striped seaperch and pile perch were observed feeding in the same area over extended periods of time; 2) prey found in the anterior gut suggest recent ingestion; and 3) a lack of extensive migratory movements by quillback rockfish was shown by Walton (1979). However, a few stomachs from medium and large striped seaperch and pile perch from the artificial reef con-



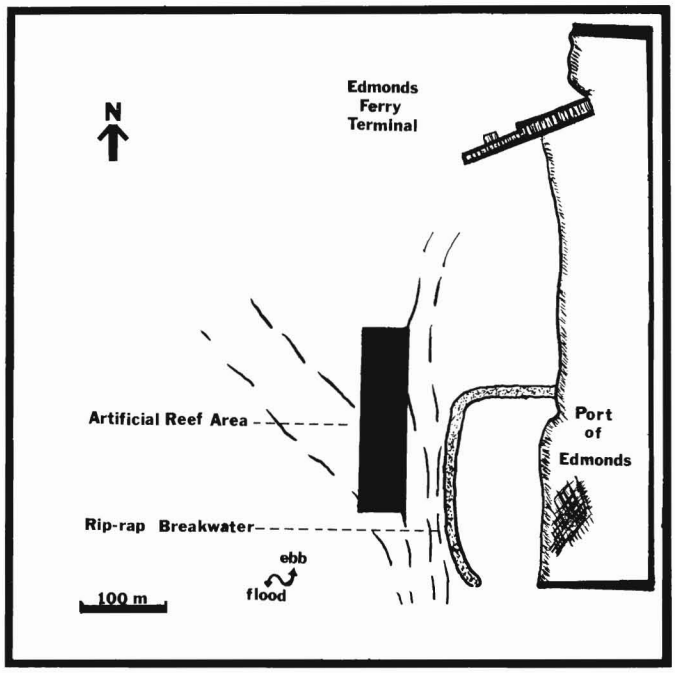


Figure 1.—Study area and location in Puget Sound.

[3]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

tained trace amounts (<0.1 percent IRI) of contents foreign to the reef indicating they migrated from other areas after feeding. Infrequent occurrence of these foreign contents suggests migrations are uncommon.

Feeding Observations

Observations of striped seaperch, pile perch, and quillback rockfish feeding around selected tire modules of the artificial reef were conducted during 84 5-minute periods. Twenty stations were established, each station encompassing one side of a tire module (7.6 m^2), and the sand area (15.0 m^2) immediately in front of it. During each 5-minute observation period, one of the authors sat approximately 3.3 m away from the tire module and observed fish feeding from the area. Each time an individual fish took a "bite" from the substrate, the species and length class of the fish, and the type of substrate were recorded. Care was taken not to count the same fish feeding more than once during the period. Striped seaperch and pile perch generally foraged in small aggregations (< 10 fish) so that individuals could be identified. Once an aggregation left the station, it usually did not return within the observation period. Occasionally larger aggregations (> 10 fish) foraged from the stations, in which case there may have been some repetitive counts. However, this happened so infrequently that if there was any repetition, we feel it did not have any significant affect on the results of these observations. Quillback rockfish individuals were easily identified as they always remained sedentary in concentrations of not more than 10 fish per station.

Results

We identified prey organisms from 161 striped seaperch, 190 pile perch, and 194 quillback rockfish from seven different phyla (Table 2).

Striped Seaperch

We examined 27 small, 104 medium, and 49 large striped seaperch stomachs. Stomachs from 12 medium and from 7 large specimens were empty (Table 3).

Harpacticoid copepods and gammarid and caprellid amphipods dominated the diet (98.5 percent IRI) of small striped seaperch (Table 3). We classified these prey organisms as epifauna since they were present in algae on the artificial reef, and in sand. Small striped seaperch stomachs contained small amounts (1.0 percent IRI) of organisms which had been observed only on the artificial reef, primarily barnacles, *Balanus glandula.*

Medium striped seaperch foraged on epifauna (43.6 percent IRI), consisting primarily of gammarid amphipods and harpacticoid copepods; planktonic crustaceans (42.8 percent IRI), consisting entirely of brachyuran crab zoea obtained during the spring months; and brachyuran crabs (10.6 percent IRI) and *B. glandula* (1.3 percent IRI), from the artificial reef (Table 3).

Large striped seaperch fed from many habitats. Planktonic crustaceans (brachyuran crab zoea) comprised 38.0 percent IRI; epifauna (primarily gammarid and caprellid amphipods) accounted for 34.8 percent IRI. Organisms associated with the artificial reef structures (primarily caridean shrimp and brachyuran crabs) made up 13.8 percent IRI, while infauna (primarily polychaete annelids) accounted for 12.1 percent IRI (Table 3).

Pile Perch

We collected 71 small, 77 medium, and 52 large pile perch; 19 small, 42 medium, and 39 large pile perch were speared from the riprap and ferry pier pilings; and 52 small, 35 medium, and 13 large specimens were speared from

Table 2.—Habitats of organisms identified from stomachs of striped seaperch, pile perch, and quillback rockfish speared from the study area off Edmonds, Wash., from August 1977 through December 1978.

Artificial reef	Infauna	Epifauna	Planktonic	Riprap/ ferry pier pilings	Unknown
Arthropoda	Annelida	Arthropoda	Arthropoda	Annelida	Arthropoda
Balanus glandula	Polychaeta sp.	Harpacticoida	Calanoida sp.	Serpulidae	Crustacea sp.
Caridea sp.		*Acanthomysis* sp.	Euphausiacea		Mysidacea
Hippolytidae	Arthropoda	Gammaridea	Brachyura (zoea)	Arthropoda	
Eualus spp.	Ostracoda (Cypridinidae)	Caprellidea		*Balanus glandula*	Mollusca
Heptacarpus brevirostris	Cumacea	Paguridea	Vertebrata	Brachyrhyncha sp.	Gastropoda sp.
Pandalus danae	Tanaidacea		*Ammodytes hexapterus*	Oxyrhyncha sp.	
		Vertebrata	*Clupea harangus pallasii*	*Pugettia gracilis*	Vertebrata
Brachyura sp.	Mollusca	Cottidae			Teleostei sp.
Brachyrhyncha sp.	*Clinocardium nuttallii*			Mollusca	
Cancer oregonensis	*Pandora filosa*			*Mytilus edulis*	
Lophopanopeus bellus	*Transenella tantilla*			*Collisella pelta*	
Oxyrhyncha sp.	*Polinices lewisii*				
Pugettia gracilis					
Ectoprocta					
Membranipora sp.					
Mollusca					
Odostoma sp.					
Chlorophyta					
Ulva spp.					
Phaeophyta					
Laminaria saccharina					

the artificial reef. Empty stomachs occurred in one small, four medium, and five large pile perch (Table 4).

Small pile perch collected from the riprap, ferry pier pilings, and the artificial reef used the sand habitat for their primary source of food. Benthic crustaceans (ostracods and the clam *Transenella tantilla*) made up 93.3 percent IRI of the diet of small pile perch collected from the riprap and ferry pier piling habitats, and 87.3 percent IRI of the diet from small pile perch collected from the artificial reef (Table 4). Only 7.9 percent IRI of the diet of small pile perch collected from the artificial reef was obtained from the reef, and that consisted of the gastropod *Odostoma* sp.

Medium pile perch speared from the riprap and ferry pier pilings consumed clams, *T. tantilla,* and ostracods from the sand (68.1 percent IRI), and barnacles, *B. glandula;* mussels, *Mytilus edulis;* and limpets, *Collisella pelta,* from the rocks and pilings (31.1 percent IRI) (Table 4). Medium pile perch captured from the artificial reef foraged basically on clams, *T. tantilla,* and ostracods from the sand (92.7 percent IRI) with only trace amounts (1.4 percent IRI) of their diet originating from the artificial reef (Table 4).

The diet of large pile perch speared from the riprap and ferry pier pilings habitats consisted primarily of barnacles, *B. glandula,* and mussels, *M. edulis* (95.0 percent IRI) (Table 4). Around the artificial reef, large pile perch fed less on encrusting organisms (60.4 percent IRI) and more on sand-oriented organisms (34.4 percent IRI) than they did around the riprap and ferry pier pilings.

Table 3.—Stomach contents identified from striped seaperch speared from the artificial reef off Edmonds, Wash., from August 1977 through December 1978.

	Percent Index of Relative Importance (IRI)[1]		
	Small	Medium	Large
	(*n* 27; 0 empty)	(*n* 104; 12 empty)	(*n* = 49; 7 empty)
Taxonomic Classification			
Annelida			
Polychaeta sp		0 9	11 6
Serpulidae		0 8	0.4
Arthropoda			
Crustacea sp.			0 7
Harpacticoida	58.5	4.4	
Balanus glandula	0.8	1 3	0.4
Acanthomysis sp.			0 3
Tanaidacea	0.3		0 5
Gammaridea	35.3	39.0	28.1
Caprellidea	4.7	0 2	6.4
Hippolytidae			2 4
Eualus spp.			2 1
Heptacarpus brevirostris			0.4
Pandalus danae			1.4
Brachyura sp.		10.4	4.6
Brachyura (zoea)		42.8	38.0
Brachyrhyncha sp		0.2	
Cancer oregonensis			0.7
Pugettia gracilis			1 3
Ectoprocta			
Membranipora sp	0.2		
Chlorophyta			
Ulva spp.			0.5
Total	99.8	100.0	99.8
Habitat classification			
Artificial reef	1.0	11.9	13.8
Infauna	0.3	0.9	12.1
Epifauna	98.5	43.6	34.8
Planktonic		42.8	38.0
Unknown		0.8	1.1
Total	99.8	100.0	99.8

[1]Greater than 0.1 percent IRI.

Quillback Rockfish

We collected 229 quillback rockfish from the artificial reef between August 1977 and December 1978. Thirty were small, 99 were medium, and 100 were large. Empty stomachs were found in 2 small, 19 medium, and 14 large specimens (Table 5).

Small quillback rockfish foraged primarily on caridean shrimp, *Pandalus danae,* and brachyuran crabs from the artificial reef (51.8 percent IRI), as well as planktonic euphausids and calanoid copepods (34.1 percent IRI), and epibenthic gammarid amphipods (12.4 percent IRI) (Table 5).

Medium and large quillback rockfish obtained 95.0 percent IRI and 92.5 percent IRI of their respective diets from the artificial reef, foraging primarily on the caridean shrimp, *P. danae,* and crabs (Table 5). Planktonic brachyuran crab zoea contributed small amounts to medium and large quillback rockfish diets (4.6 percent and 4.7 percent, respectively), obtained exclusively during the spring months.

Feeding Observations

Feeding observations took place on four different days in September, October, and November of 1978. During 7 hours of observations, 353 striped seaperch, 197 pile perch, and 4 quillback rockfish were observed feeding (Table 6).

Striped seaperch and pile perch were observed to forage in a grazing manner characteristic of many embiotocids (Turner et al., 1969; Bray and Ebeling, 1975). Search for prey items was conducted with the head directed toward the substrate. Rapid pectoral fin movements stabilized the fish and feeding bites from the substrate were quick and distinct. At times fish were observed to feed interchangeably from tires and nearby sand. Feeding from the artificial reef was primarily from the algae covering the tire surfaces. Through examination of their stomach contents, fish were shown to be picking small invertebrates from algae shelters. On numerous occasions, striped seaperch were seen picking large pieces of algae from the substrate, followed by rapid mouth and opercular

movements resulting in ejection of the algae into the open water. This process was repeated several times by the same fish with the same piece of algae; this was probably a method of obtaining small invertebrates from the algae. It was not uncommon to find incidental pieces of algae in stomach samples of perch.

Medium and large striped seaperch fed more from the artificial reef than did small striped seaperch (Table 6). The majority of pile perch from all length groups were observed feeding from the sand (Table 6). Overall, the numbers of striped seaperch and pile perch observed feeding during the observational periods decreased with increasing size of the fish.

The small number of quillback rockfish observed feeding may be attributable to their preference for relatively large prey items. Feeding by quillback rockfish is probably confined to short intervals during the course of a day or night. One quillback rockfish was seen consuming a shiner perch, *Cymatogaster aggregata*, immediately above the artificial reef, while the remainder were seen eating the caridean shrimp, *P. danae*, on the artificial reef.

Discussion

Striped seaperch from all length groups foraged primarily on small, noncalcareous epibenthic crustaceans. Most prey items were present on the artificial reef and sand, making it impossible to determine the specific habitat from which these fish were feeding. Observations of striped seaperch revealed that medium and large fish fed predominately from the artificial reef, and that small striped seaperch fed equally from both habitats.

The optimal foraging theory states "... an optimal consumer should be willing to expend more energy [or time] to find and capture food items that return the most energy per unit of expenditure upon them" (Pianka, 1974). Assuming striped seaperch feed optimally, the net energy gained per unit of feeding time expended by medium and large striped seaperch is greater by feeding over the reef than by feeding over sand. This may be due, in part, to the larger size, or density, of

Table 4.—Stomach contents identified from pile perch speared from the artificial reef, riprap, and ferry pier pilings off Edmonds, Wash., from August 1977 through December 1978.

	Percent Index of Relative Importance (IRI)					
	Small		Medium		Large	
	Riprap/ ferry pier pilings (n = 19; 0 empty)	Artificial reef (n 52; 1 empty)	Riprap/ ferry pier pilings (n 42; 2 empty)	Artificial reef (n 35; 2 empty)	Riprap/ ferry pier pilings (n 39; 2 empty)	Artificial reef (n 13; 3 empty)
Arthropoda						
Ostracoda (Cypridinidae)	65.1	32.4	26 9	22 1	0.2	3.4
Balanus glandula			11 7	0.2	75 3	56.4
Mysidacea						
Acanthomysis sp.						2.0
Cumacea					0.9	
Gammaridea	4.3	4 6		0.2		0.2
Hippolytidae				0.6		
Pandalus danae						2.8
Paguridae			0 3	5 1		3 0
Brachyura			1 0			
Brachyura (zoea)						
Brachyrhyncha			0.3			
Cancer oregonensis						
Oxyrhyncha			0 4			
Pugettia gracilis					0 4	1.2
Mollusca						
Gastropoda			0.4	0.3		
Collisella pelta	2 3		8.3		0.2	
Lirularia lirulatus				0.3		
Odostoma sp.		7.9		0.3		
Polinices lewisii						0.5
Clinocardium nuttalli				0.3		0.2
Mytilus edulis			9 4		19.7	
Pandora filosa						0.2
Pectinidae						0.7
Transenella tantilla	28.2	54.9	41 2	70 3	3.2	29.4
Total	99.9	99 8	99.9	99.7	99.9	100 0
Habitat classification						
Artificial reef	N/A	7.9	N/A	1.4	N/A	60.4
Riprap/ferry pier pilings	2.3	N/A	31 1	N/A	95.6	N/A
Infauna	93.3	87.3	68.1	92.7	4.3	34.4
Epifauna	4.3	4.6	0.3	5.3	—	5.2
Planktonic	—	—	—	—	—	—
Unknown	—	—	0 4	0.3	—	—
Total	99.9	99.8	99.9	99.7	99.9	100.0

[1]Greater than 0.1 percent IRI.

invertebrates that take refuge in the algae growing on the artificial reef in comparison with those found on open sand. Assuming small striped seaperch also feed in an optimal manner, there was no difference in the energy gained from the artificial reef or from the sand.

Throughout this study, striped seaperch were present in large numbers around the artificial reef. Walton (1979) observed that striped seaperch were absent from the study area prior to the placement of the artificial reef, even though Hueckel (1980) discovered that potential prey items were abundant on and in the sand. Walton (1979) also noted embiotocids were the first group of fish to colonize the artificial reef, even before algae and invertebrates started growing on the tire surfaces, and that the average size of early colonizing striped seaperch was smaller than striped seaperch on the older riprap and nearby sunken boat hulls, both of which were covered with invertebrates and algae. Observations made by the author on a bare, newly constructed concrete reef in Puget Sound show an overwhelming majority of 8,200 small to only 76 medium and large striped seaperch. Small striped seaperch appear to be attracted to artificial reefs for shelter or orientation; larger perch are subsequently attracted by the presence of organisms growing on the surface of the reefs.

Stomach contents from small pile perch captured from all habitats, as well as the in situ feeding observations, indicated a diet composed primarily of organisms living in or on sand. The artificial reef, riprap, and ferry pier pilings provided very small amounts of prey organisms for small pile perch, yet they were observed near all these structures in large numbers. Like small striped seaperch, small pile perch also colonized the artificial reef prior to the development of organisms on the surface of the tires (Walton, 1979), and were apparently attracted by the cover (or orientation points) offered by the artificial reef.

Few medium and large pile perch were observed around the artificial reef in contrast to many seen around the riprap and ferry pier pilings. Medium and large pile perch fed primarily on barnacles and mussels around the riprap and ferry pier

Table 5.—Stomach contents identified from quillback rockfish speared from the artificial reef off Edmonds, Wash., from August 1977 through December 1978.

	Percent Index of Relative Importance (IRI)[1]		
	Small (n = 30; 2 empty)	Medium (n = 99; 19 empty)	Large (n = 100; 14 empty)
Taxonomic Classification			
Annelida			
Polychaeta sp.			
Arthropoda			
Crustacea sp.	0.3		
Calanoida	23.8		
Gammaridea	12.4	0.3	0.7
Euphausiacea	10.3		
Caridea sp.	8.5	4.0	1.4
Eualus spp		2.6	
Pandalus danae	30.0	71.5	42.0
Brachyura sp.	12.2	15.3	46.7
Brachyura (zoea)		4.4	3.3
Brachyrhyncha sp.	0.5	1.0	0.3
Cancer oregonensis		0.6	1.7
Lophopanopeus bellus			0.2
Pugettia gracilis			0.2
Vertebrata			
Teleostei sp.	0.5		1.4
Ammodytes hexapterus		0.2	
Clupea harengus pallasi			1.4
Cottidae sp.			0.4
Phaeophyta			
Laminaria saccharina	0.6		
Total	99.3	99.9	99.7
Habitat classification			
Artificial reef	51.8	95.0	92.5
Infauna	0.2	—	—
Epifauna	12.4	0.3	1.1
Planktonic	34.1	4.6	4.7
Unknown	0.8	—	1.4
Total	99.3	99.9	99.7

[1]Greater than 0.1 percent IRI.

Table 6.—Numbers of striped seaperch, pile perch, and quillback rockfish feeding on the sand and artificial reef off Edmonds, Wash., during 7 h of observations.

	Striped seaperch						Pile perch						Quillback rockfish	
	Small		Medium		Large		Small		Medium		Large		Large	
Station	AR[1]	S[2]	AR	S	AR	S	AR	S	AR	S	AR	S	AR	S
1	10	8	5	4	3	3	3	3	1	0	0	0	0	0
2	6	7	1	0	1	0	1	2	0	0	0	0	0	0
3	12	43	2	0	2	0	1	17	0	0	0	0	0	0
4	14	7	7	6	2	1	5	0	4	5	2	2	0	0
5	6	5	3	0	3	0	0	0	1	4	0	0	0	0
6	2	3	2	0	3	0	1	3	0	0	0	0	0	0
7	7	4	3	0	3	2	3	4	3	0	0	0	0	0
8	4	0	4	5	0	0	3	4	0	3	0	3	0	0
9	6	0	3	0	2	0	1	1	0	1	0	0	2	0
10	2	0	8	0	0	0	1	9	0	0	0	0	0	0
11	3	11	0	0	1	2	2	4	0	0	0	0	0	0
12	12	8	5	3	1	0	3	13	2	3	0	0	0	0
13	6	1	1	0	2	0	1	1	0	0	0	0	0	0
14	1	1	4	0	0	0	0	9	0	0	0	0	0	0
15	0	5	3	2	0	1	1	13	1	0	0	0	0	0
16	3	5	1	3	0	2	1	7	0	2	1	0	1	0
17	9	2	0	0	0	0	1	1	1	0	1	0	1	0
18	2	3	2	0	2	0	0	3	0	5	0	0	0	0
19	2	2	1	1	3	0	1	2	0	7	0	0	0	0
20	3	8	1	0	0	1	4	13	0	1	0	2	0	0
Total	110	123	56	24	28	12	33	109	13	31	4	7	4	0
Percent	47.2	52.8	70.0	30.0	70.0	30.0	23.2	76.8	29.5	70.5	36.4	63.6	100.0	0.0

[1]Artificial Reef.
[2]Sand.

pilings; around the artificial reef feeding was proportionally more from sand. Barnacles and mussels heavily encrusted both riprap and ferry pier pilings. Initial barnacle population on the artificial reef was rapidly depleted to low numbers by starfish predation and mussels never colonized the tire surfaces. Subsequent algal growth on the tires inhibited barnacle repopulation. The small population of barnacles and failure of mussels to attach to the tire surfaces appear to have created a food shortage for medium and large pile perch on the artificial reef, suggesting these food organisms are an important attractant for these fish.

Quillback rockfish foraged more on artificial reef associated food organisms as their size increased. Medium and large quillback rockfish obtained nearly 100 percent (IRI) of their diet directly from the artificial reef. Walton (1979) observed that the average size of quillback rockfish increased over time on the artificial reef. Small quillback rockfish inhabited the artificial reef prior to algae and invertebrate colonization, indicating smaller quillback rockfish were initially attracted to the artificial reef for reasons other than food. The proximity of small quillback rockfish to small crevices in the artificial reef and their quickness to dart into these crevices when approached suggest they are benefiting from protection offered by the artificial reef. Subsequently, larger quillback rockfish were attracted to the artificial reef following the colonization by shrimp (Hueckel, 1980).

Summary

It was shown in this study the importance of organisms growing on an artificial reef to the diets of three Puget Sound fish species. Medium and large striped seaperch, pile perch, and quillback rockfish were attracted to the artificial reef more by the presence of food items than were the small fish of the same species. The small striped seaperch, pile perch, and quillback rockfish used the adjacent sand areas and plankton to forage for much of their diet, which emphasizes the importance of those habitats to these small fish. The numerous hiding spaces in the artificial reef were often used by the small striped seaperch, pile perch, and quillback rockfish as a refuge and must aid in protection from predation. The abundance of preferred food items on the artificial reef for medium and large striped seaperch and quillback rockfish was an important factor in attracting large numbers of these fish species. Conversely, medium and large pile perch were largely absent from the artificial reef due to a lack of preferred food items.

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