ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/240765610

Recent and Historical Spatial Distributions of Juvenile Rockfish Species in Rocky Intertidal Tide Pools, with Emphasis on Black Rockfish

Article *in* Transactions of the American Fisheries Society · May 2009

DOI: 10.1577/T08-080.1

CITATION
1

READS
20

3 authors, including:

Rebecca Garwood
California Department of Fish and Wildlife
13 PUBLICATIONS **49** CITATIONS

SEE PROFILE

All content following this page was uploaded by Rebecca Garwood on 22 December 2015.

The user has requested enhancement of the downloaded file.

AR018021

Transactions of the American Fisheries Society 138:645–651, 2009
© Copyright by the American Fisheries Society 2009
DOI: 10.1577/T08-080.1

[Note]

Recent and Historical Spatial Distributions of Juvenile Rockfish Species in Rocky Intertidal Tide Pools, with Emphasis on Black Rockfish

REBECCA S. STUDEBAKER,*[1] KARAH N. COX,[2] AND TIMOTHY J. MULLIGAN

Telonicher Marine Laboratory, Department of Fisheries Biology, Humboldt State University, 570 Ewing Street, Trinidad, California 95570, USA

Abstract.—Understanding the full complement of habitats used by juvenile fish is essential for species management and the protection of habitat. This study evaluated the distribution of juvenile rockfish *Sebastes* spp. in northern Pacific rocky intertidal habitats. Observations were made along the northern California and Oregon coasts in an attempt to better define the geographical extent of intertidal habitat use. Juvenile rockfish were observed in rocky intertidal habitats ranging from MacKerricher State Park, California, to Ecola State Park, Oregon. Museum collections were also searched to examine the historical ranges of rocky intertidal use by juvenile rockfish. A total of 12 species of juvenile rockfish were identified in rocky intertidal habitats, black rockfish *S. melanops* being the dominant species identified. Our observations, along with museum records, showed that juvenile rockfish, especially black rockfish, use rocky intertidal habitats over a large geographic range.

Many temperate marine fishes use a variety of habitats during their life history. Several demersal species, such as rockfishes *Sebastes* spp., produce pelagic young that disperse and recruit to nursery or transitional habitats (Love et al. 1991). These pelagic juveniles often recruit to habitats shallower than conspecific adults, with different species occupying a range of habitat and depth niches (Hallacher and Roberts 1985; Love et al. 1991, 2002). Rockfishes recruit to a variety of structurally complex habitats, including kelp forests, rocky areas, floating kelp mats, sea grasses, and rocky intertidal tide pools (Singer 1985; Moring 1986; Matthews 1990; Carr 1991; Shaffer et al. 1995). Knowing how different life stages of rockfishes use various habitats is critical to understanding the structure and ecological interactions of marine communities, and is essential for species management and habitat protection.

* Corresponding author: rstudebaker@dgf.ca.gov
[1] Present address: California Department of Fish and Game, 619 Second Street, Eureka, California 95501, USA.
[2] Present address: Long Marine Laboratory, Department of Ecology and Evolutionary Biology, University of California at Santa Cruz, 100 Shaffer Road, Santa Cruz, California 95060, USA.

Received April 30, 2008; accepted December 22, 2008
Published online May 7, 2009

The rocky intertidal is a unique and demanding habitat that can serve as a recruitment area for some age-0 rockfish. The first published account of juvenile *Sebastes* spp. in tide pools occurred in a paper by Hubbs and Schultz (1933), who described the black rockfish *S. melanops* as having "young developing in the tide-pools." Love et al. (2002) noted five species of *Sebastes*—black rockfish, blue rockfish *S. mystinus*, canary rockfish *S. pinniger*, grass rockfish *S. rastrelliger*, and yellowtail rockfish *S. flavidus*—that are typically thought to use intertidal areas as age-0 fish. Studies by Moring (1986) and Studebaker and Mulligan (2008) noted large numbers of age-0 black rockfish in rocky intertidal habitats of northern California from May though August. However, these studies provide limited detail regarding geographic coverage. Additional notations of rockfishes using the rocky intertidal habitat in other geographic regions of the Pacific Northwest coast are widely scattered in the literature and museum records. In this paper, we review the published literature and museum records and report on current field collections, to determine the number of species and geographical extent of tide pool habitat use by juvenile rockfish.

Methods

Historical records.—Published literature, as well as available museum collections throughout the United States, were reviewed for references to the use of intertidal areas by juvenile rockfish. Only museum collections with locality descriptions specifying that samples were taken from "tide pools" were reported. Museums with juvenile rockfish collected from tide pools were the Academy of Natural Sciences, Philadelphia (ANSP), the California Academy of Sciences (CAS), Scripps Institution of Oceanography (SIO), Stanford University (SU, located at CAS), the University of British Columbia (UBC), and the University of Michigan Museum of Zoology (UMMZ). An extensive search of additional museum collections was conducted, but no other collections of juvenile rockfish from tide pools were found.

Current surveys.—Eighteen rocky intertidal sites were surveyed from Ecola State Park, Oregon, to Point

AR018022

FIGURE 1.—Locations surveyed for juvenile rockfish in northern California and Oregon, 2005. Closed circles represent locations at which black rockfish were detected, open circles locations at which no black rockfish were detected.

Reyes, California, for juvenile rockfish (Figure 1). Approximately equal numbers of rocky bench and boulder habitats were studied (Table 1). Surveys took place from 22 to 29 May and from 20 to 26 June, 2005, during minus tides. All sites were surveyed by two researchers, each using two 127-mm × 101-mm hand-held aquarium nets. Timed searches were conducted during daylight hours in tide pools with well-defined borders that were clearly separated from subtidal waters at the time of sampling. Searches were conducted in 20-min periods of time with the goal of five 20-min searches per sample event. Limited habitat availability at a site or tide constraints, or both, restricted search times at some locations. Fish were identified, enumerated, and released. Up to 50 rockfish for each date and site were measured to the nearest millimeter (fork length [FL]).

Results

Historical Accounts

A review of the published literature shows that juveniles of eight species have been found in rocky intertidal habitats ranging from San Diego, California, to Cape Arago, Oregon (Table 2). Of the total number reported, approximately 88% were identified as black rockfish, the majority of collections occurring in areas north of San Francisco Bay, California.

An extensive search of museum collections provided additional accounts of rockfish occurring in rocky intertidal areas. Museum collections included the juveniles of five species (Table 3) not reported in the published literature, the collections ranging from Baja California, Mexico (SIO 75-675), to Forrester Island, Alaska (UBC 65-0584), to Sagami, Japan (UMMZ 19202, 19207), the majority in central and northern California (Figure 2). Black rockfish were noted in tide pools from Forrester Island, Alaska, to Piedras Blancas Point, California (SU 48891) and represented 12% of the total number reported. Unidentified rockfishes accounted for 85% of all the individuals noted (Table 3). Out of the 61 individual museum collections reviewed, 11 contained only a single individual, 38 contained less than 10 individuals, while 11 contained more than 100 individual juveniles.

Current Field Study

A total of 3,695 black rockfish and 15 blue rockfish individuals were collected in the 2005 field surveys. These were the only species collected in the timed searches, although other rockfish species were observed in several of the surveyed areas (Studebaker and Mulligan 2008). The majority of the black rockfish (74%) and blue rockfish (86%) were collected in Oregon. The sampling effort in northern California was doubled compared with the effort in Oregon, in both the number of surveyed sites and total search times (Table 1).

An average of 30 juvenile black rockfish were collected per 20-min search at locations where fish were detected. The largest number collected during a single 20-min search occurred at Marine Park, Oregon,

AR018023

TABLE 1.—Habitat type and catch per minute of juvenile black rockfish at 18 rocky intertidal locations in California and Oregon. Samples were collected on 22–29 May and 20–26 June 2005.

		May			June		
Site	Habitat	Minutes surveyed	Number collected/minute	Total collected	Minutes surveyed	Number collected/minute	Total collected
Oregon							
Ecola State Park	Boulder				100	1.62	162
Boiler Bay	Bench	100	1.38	138	100	1.17	117
Marine Park	Bench	100	0.90	90	100	6.13	613
Cape Arago	Mixed	100	6.00	600	100	1.17	117
Cape Blanco	Mixed	100	6.92	692	100	2.09	209
California							
Point St. George	Boulder	100	1.55	155	100	1.09	109
False Klamath Cove	Boulder	100	0.45	45	100	1.11	111
Palmer's Point	Boulder	100	0.46	46	100	0.47	47
Cape Mendocino	Boulder	100	0.97	97	100	0.35	35
Point Delgada	Bench	100	1.49	149	100	0.18	18
Bear Harbor	Bench	100	0.23	23			
Kibesillah Hill	Boulder	40	0	0			
MacKerricher State Park	Mixed	100	0.52	52	100	0.7	70
Mendocino Headlands	Bench	80	0	0	100	0	0
Stornetta Ranch	Bench	100	0	0			
Shell Beach	Boulder	100	0	0			
Bodega Marine Lab	Bench	80	0	0			
Point Reyes	Bench	80	0	0			
All sites				2,087			1,608

where 335 were collected on 22 June 2005. Juvenile black rockfish were noted in rocky intertidal areas from Ecola State Park to MacKerricher State Park (Figure 1) with most occurring north of Point Delgada (Table 1). Juveniles ranged in size from 37 to 78 mm FL (mean = 52 mm). Blue rockfish were detected at only three rocky intertidal locations: Cape Arago, Oregon, and Patrick's Point and Point Delgada, California. A total of 15 juvenile blue rockfish were collected, the majority (13) being taken at Cape Arago. Blue rockfish were collected on 24 May and 23 June and ranged from 46 to 63 mm FL (mean = 57 mm).

Discussion

Black rockfish appeared to be the dominant rockfish species using rocky intertidal habitats in the Pacific Northwest, especially in northern California and Oregon. Age-0 black rockfish are known to use nearshore habitats (Love et al. 2002). Their use of rocky intertidal areas is not unexpected, although few empirical data have been collected in this habitat. More intensive and focused searches are needed to determine the full extent of rocky intertidal usage by juvenile black rockfish.

The range of black rockfish extends from the Aleutian Islands, Alaska, to northern Baja California, Mexico (Miller and Lea 1972). The lack of juvenile black rockfish in rocky intertidal sites south of MacKerricher State Park during the 2005 field study was in contrast to both published literature and museum collections that noted large intertidal collections (150+ individuals) of black rockfish as far south as Dillon Beach, California (Grossman 1982), and *Sebastes* spp. as far south as Duxbury Point, California (CAS 27394). The distribution of juvenile black rockfish in rocky intertidal areas observed in the 2005 field study may be explained by a reported "total failure in reproductive success" for rockfishes in the areas between Point Conception and Cape Mendocino for 2005 (Sakuma et al. 2006). This suggests that the distribution of rocky intertidal usage by rockfishes varies on an annual basis, possibly being affected by such factors as oceanic conditions and reproductive success.

The northern extent of black rockfish in rocky intertidal areas was not determined in the 2005 study. Museum collections indicate the northern boundary of rocky intertidal usage may extend to Forrester Island, Alaska. However, age-0 black rockfish may use rocky intertidal habitats throughout their range.

Large variations in species abundances over relatively small spatial scales have been shown for many marine species (Caffey 1985; Gaines et al. 1985; Menconi et al. 1999; Underwood and Chapman 2000; Griffiths 2003). Abundances of age-0 rockfish are also often highly variable over time and space (Moser and Boehlert 1991; Sakuma et al. 2006; Laidig et al. 2007). Similarly, the 2005 field study showed large variations in abundance over a relatively small spatial scale. For

AR018024

TABLE 2.—Rockfish species for which juveniles were collected in rocky intertidal areas, according to published literature and reports (NR = not reported).

Location	Latitude	Species found	Number reported	Year(s) collected	Source
Cape Arago	43°20′01″N	*Sebastes* spp.	"Large numbers"	1957	Jopson (1958)
Point St. George	41°44′49″N	Black rockfish	NR	1969	Moring (1972)
		Blue rockfish	NR	1969	Moring (1972)
		Bocaccio *S. paucispinis*	1	1969	Moring (1972)
		Black rockfish	1,045	2003–2005	Studebaker and Mulligan (2008)
		Grass rockfish	1	2004	Studebaker and Mulligan (2008)
		Widow rockfish *S. entomelas*	1	2004	Studebaker and Mulligan (2008)
Damnation	41°41′47″N	Black rockfish	6	2004–2005	Cox (2007)
Endert's Beach	41°39′09″N	Black rockfish	2	2004–2005	Cox (2007)
False Klamath Cove	41°35′37″N	Black rockfish	91	2004–2005	Cox (2007)
Palmer's Point	41°07′53″N	Black rockfish	1,705	2003–2005	Studebaker and Mulligan (2008)
Trinidad Bay	41°03′21″N	Black rockfish	77	1968–1970	Moring (1986)
		Blue rockfish	4	1968–1970	Moring (1986)
Point Delgada	40°01′22″N	Black rockfish	470	2003–2005	Studebaker and Mulligan (2008)
		Blue rockfish	25	2003–2004	Studebaker and Mulligan (2008)
		Canary rockfish	1	2004	Studebaker and Mulligan (2008)
		Copper rockfish *S. caurinus*	1	2004	Studebaker and Mulligan (2008)
Bruhel Point	39°36′26″N	Canary rockfish	20	1973	Chadwick (1976)
Point Arena	38°56′16″N	Black rockfish	76	1971–1973	Yoshiyama et al. (1986)
		Blue rockfish	30	1971–1973	Yoshiyama et al. (1986)
		Yellowtail rockfish	1	1971–1973	Yoshiyama et al. (1986)
		Grass rockfish	<10	1971–1973	Yoshiyama et al. (1986)
Point Arena area	38°57′16″N–38°54′56″N	Black rockfish	53	1971–1972	Gotshall et al. (1973)
		Blue rockfish	30	1971–1972	Gotshall et al. (1973)
		Sebastes spp.	2	1971–1972	Gotshall et al. (1973)
Dillon Beach	38°15′14″N	Black rockfish	247	1979	Grossman (1982)
		Grass rockfish	118	1979	Grossman (1982)
		Black rockfish	74	1980	Grossman (1982)
		Grass rockfish	63	1980	Grossman (1982)
		Grass rockfish	17	1981	Grossman (1982)
		Black rockfish	5	1984	Yoshiyama et al. (1986)
		Grass rockfish	23	1984	Yoshiyama et al. (1986)
Pescadero Point	37°14′34″N	*Sebastes* spp.	33	1975–1976	Yoshiyama et al. (1986)
		Sebastes spp.	27	1977	Yoshiyama et al. (1986)
		Sebastes spp.	5	1982	Yoshiyama et al. (1986)
		Sebastes spp.	16	1984	Yoshiyama et al. (1986)
Monterey	36°37′17″N[a]	Blue rockfish	NR	1931	Wales (1952)
Soberanes Point	36°27′03″N	*Sebastes* spp.	11	1973–1974	Yoshiyama et al. (1986)
Diablo Cove	35°12′44″N	Black rockfish	1	1975	Gotshall et al. (1984)
False Point or Ocean Beach	32°45′38″N or 32°41′35″N	Grass rockfish	<25	1996–2000	Davis (2000)

[a] Estimated from description.

example, two locations (Boiler Bay and Marine Park, Oregon) that are located approximately nine coastal kilometers apart had highly differing abundances of juvenile rockfish during a sampling event on 22 June, approximately 1 fish/min (117 fish/100 min) being collected at Boiler Bay and 6 fish/min (613 fish/100 min) at Marine Park (Table 1).

The use of rocky intertidal habitats may provide benefits including increased water temperatures and concentrated food resources during low tide events (Metaxas and Scheibling 1994), which may increase the growth rates of the individuals occupying the area. Intertidal areas may also provide shelter from subtidal predators (Whoriskey 1983; Kneib 1987). Trade-offs may occur with increased stress levels due to wide fluctuations in temperature and salinity over a short period of time (Metaxas and Scheibling 1993; Johnson 2001). In 2004, rockfish were observed in tide pools with salinities as low as 28.9‰ (due to freshwater intrusion) and temperatures as high as 17.1°C (R. S. Studebaker, unpublished data). Further studies are needed that directly compare intertidal and subtidal recruitment of juvenile rockfish, especially black rockfish. Methods such as diving surveys, otolith analysis, and fish tagging could be used to compare characteristics such as abundance, growth rates, and

AR018025

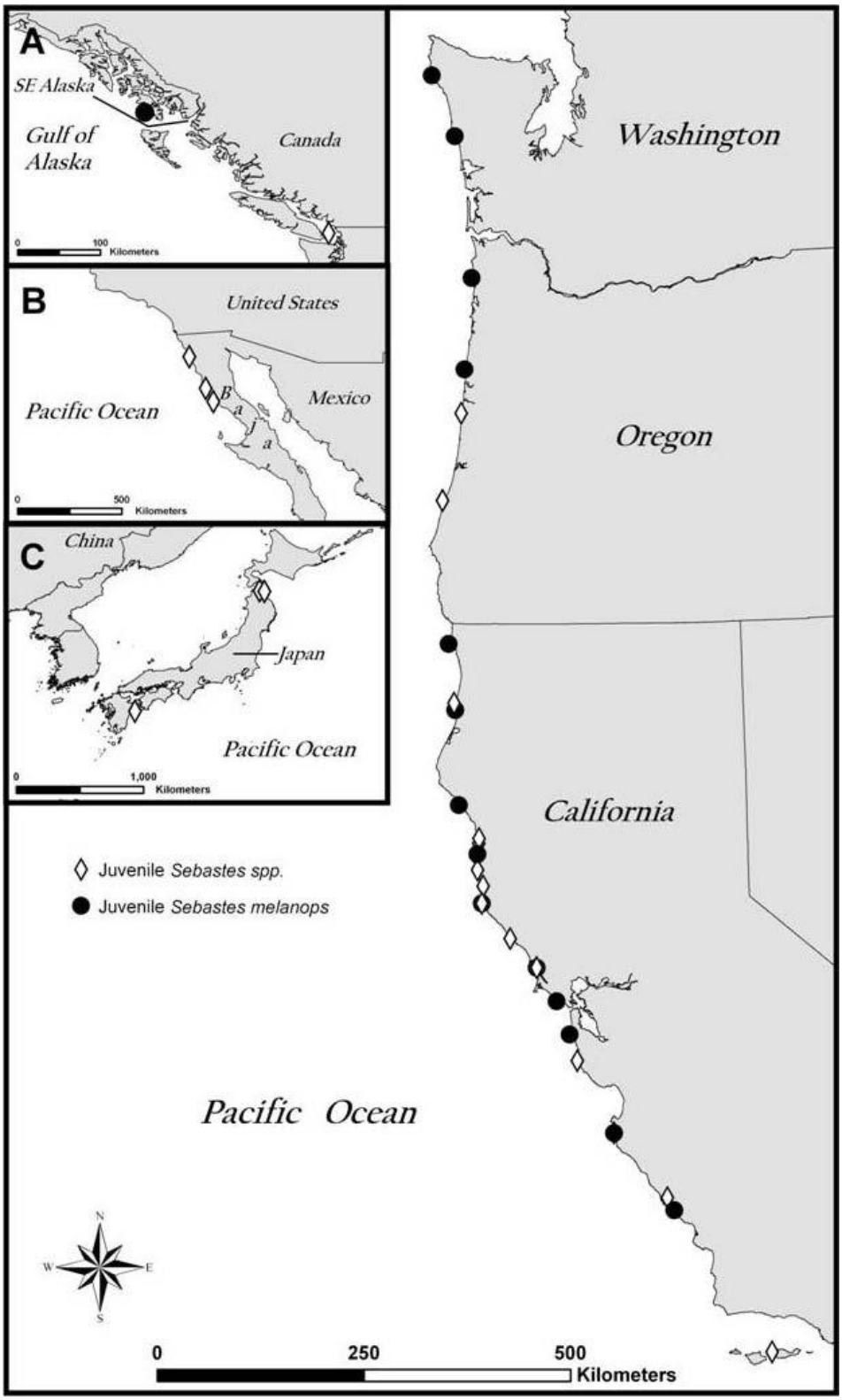

FIGURE 2.—Locations of juvenile rockfish from museum collections (see Table 2 for sources). Circles represent locations at which black rockfish were collected, diamonds locations at which all other rockfish species were collected. The insets show collection locations in **(A)** Alaska, **(B)** Mexico, and **(C)** Japan.

AR018026

TABLE 3.—Rockfish species and number of juveniles collected in tide pools as determined from museum accounts. Collections were made from 1926 to 1975. Museums were as follows: the Academy of Natural Sciences, Philadelphia (ANSP), the California Academy of Sciences (CAS), Scripps Institution of Oceanography (SIO), Stanford University (SU, located at CAS), the University of British Columbia (UBC), and the University of Michigan Museum of Zoology (UMMZ).

Species	Number collected	Catalog numbers
Sebastes spp.	2,614	CAS 27378, CAS 27394, CAS 27581, CAS 27853, CAS 28132, CAS 28148, CAS 28230, CAS 28307, CAS 28631, CAS 28650, CAS 29098, CAS 29266, CAS 29787, CAS 29807, SU 47744, SU 47750, SU 68893, UMMZ 192027
Brown rockfish *S. auriculatus*	2	SIO 63-1054, SIO 75-675
Copper rockfish	1	UBC 59-0109
Black-and-yellow rockfish *S. chrysomelas*	2	CAS 80631, SIO 47-204
Black rockfish	421	ANSP 97344, CAS 20055, CAS 20067, CAS 25115, CAS 25130, CAS 25159, CAS 27322, CAS 27393, CAS 40356, CAS 40625, CAS 40633, CAS 42368, CAS 52361, SIO 73-219, SU 34463, SU 35421, SU 48891, UBC 65-0584, UMMZ 186558, UMMZ 94257, UMMZ 94267, UMMZ 94272, UMMZ 94273, UMMZ 94285
Blue rockfish	36	CAS 29708, CAS 40658, CAS 48101
Bocaccio	31	CAS 80284
Canary rockfish	1	UMMZ 94248
Grass rockfish	17	SIO 47-77, CAS 23593, CAS 27321, SU 17975, SU 48923, SU 67268, SU 67269, SU 68896
Korean rockfish *S. schlegeli*	8	UMMZ 191935, UMMZ 191938
Olive rockfish *S. serranoides*	1	SIO 47-77

survival to determine the importance of rocky intertidal areas for adult rockfish populations.

Understanding the full complement of habitats used by this commercially and recreationally important group of fish is essential for effective resource management. Many temperate rocky intertidal habitats are vulnerable to deterioration from a variety of processes including increased public use, pollution, and urbanization. Conservation of these habitats may be an important step in maintaining adequate levels of recruitment for species such as black rockfish. To more fully determine the importance of rocky intertidal habitats to rockfish species, the contribution of rocky intertidal areas to harvestable populations must be determined over the largest spatial and temporal scales possible.

Acknowledgments

We thank the Marin Rod and Gun Club and the Fly Fishers Club of Orange County for funding this research. Special acknowledgment is also given to the many people who donated numerous hours in the field, especially R. Wadsworth, J. Gough, and W. Gilkerson, and J. Garwood for both field and GIS assistance. We thank the Bodega Marine Laboratory; California Department of Parks and Recreation, North Coast Redwoods and Mendocino districts; Redwood National and State parks; and others for granting access to intertidal sites and permitting this sampling to occur.

References

Caffey, H. 1985. Spatial and temporal variation in settlement and recruitment of intertidal barnacles. Ecological Monographs 55(3):313–332.

Carr, M. 1991. Habitat selection and recruitment of an assemblage of temperate reef zone fishes. Journal of Experimental Marine Biology and Ecology 146:113–137.

Chadwick, M. E. 1976. A comparison of growth and abundance for tidal pool fishes in California and British Columbia. Journal of Fish Biology 8(1):27–34.

Cox, K. 2007. Abundance and distribution patterns of intertidal fishes at three sites within Redwood National and State parks, 2004–05. Master's thesis. Humboldt State University, Arcata, California.

Davis, J. 2000. Changes in a tidepool fish assemblage on two scales of environmental variation: seasonal and El Nino Southern Oscillation. Limnology and Oceanography 45(6):1368–1379.

Gaines, S., S. Brown, and J. Roughgarden. 1985. Spatial variation in larval concentrations as a cause of spatial variation in settlement for the barnacle, *Balanus glandula*. Oecologica 67:267–272.

Gotshall, D., R. Lea, L. L. Laurent, and T. Hoban. 1973. Mendocino power plant site ecological study annual report, July 1, 1971, to December 31, 1972. California Department of Fish and Game, Marine Resources Administrative Report 73-4, Monterey.

Gotshall, D. W., L. L. Laurent, S. L. Owens, J. Grant, and P. Law. 1984. A quantitative ecological study of selected nearshore marine plants and animals at the Diablo Canyon power plant site: a preoperational baseline, 1973–1978. California Department of Fish and Game, Marine Resources Technical Report 48, Long Beach.

AR018027

Griffiths, S. 2003. Spatial and temporal dynamics of temperate Australian rockpool ichthyofaunas. Marine and Freshwater Research 54:163–176.

Grossman, G. 1982. Dynamics and organization of a rocky intertidal fish assemblage: the persistence and resilience of taxocene structure. American Naturalist 119:611–637.

Hallacher, L., and D. Roberts. 1985. Differential utilization of space and food by the inshore rockfishes (Scorpaenidae: *Sebastes*) of Carmel Bay, California. Environmental Biology of Fishes 12(2):91–110.

Hubbs, C., and L. Schultz. 1933. Descriptions of two new American species referable to the rockfish genus *Sebastodes*, with notes on related species. University of Washington Publications in Biology 2(2):15–44.

Johnson, M. 2001. Metapopulation dynamics of *Tigriopus brevicornis* (Harpacticoida) in intertidal rock pools. Marine Ecology Progress Series 211:215–224.

Jopson, H. 1958. A concentration of the ratfish, *Hydrolagus colliei*, Cape Arago, Oregon. Copeia 1958:232.

Kneib, R. T. 1987. Predation risk and use of intertidal habitats by young fishes and shrimp. Ecology 68:379–386.

Laidig, T., J. Chess, and D. Howard. 2007. Relationship between abundance of juvenile rockfishes (*Sebastes* spp.) and environmental variables documented off northern California and potential mechanisms for the covariation. U.S. National Marine Fisheries Service Fishery Bulletin 105:39–48.

Love, M., M. Carr, and L. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. Environmental Biology of Fishes 30:225–243.

Love, M., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley.

Matthews, K. 1990. A comparative study of habitat use by young-of-the-year, subadult, and adult rockfishes on four habitat types in central Puget Sound. U.S. National Marine Fisheries Service Fishery Bulletin 88:223–239.

Menconi, M., F. Benedetti-Cecchi, and F. Cinelli. 1999. Spatial and temporal variability in the distribution of algae and invertebrates on rocky shores in the northwest Mediterranean. Journal of Experimental Marine Biology and Ecology 233:1–23.

Metaxas, A., and R. E. Scheibling. 1993. Community structure and organization of tidepools. Marine Ecology Progress Series 98:187–198.

Metaxas, A., and R. E. Scheibling. 1994. Spatial and temporal variability of tidepool hyperbenthos on a rocky shore in Nova Scotia, Canada. Marine Ecology Progress Series 108:175–184.

Miller, D., and R. Lea. 1972. Guide to the coastal marine fishes of California. Fish Bulletin 157:1–249.

Moring, J. 1972. Check list of intertidal fishes of Trinidad Bay, California, and adjacent areas. California Fish and Game 58:315–320.

Moring, J. 1986. Seasonal presence of tidepool fish species in a rocky intertidal zone of northern California. Hydrobiologia 134:21–27.

Moser, G., and G. Boehlert. 1991. Ecology of pelagic larvae and juveniles of the genus *Sebastes*. Environmental Biology of Fishes 30:203–224.

Sakuma, K., S. Ralston, and V. Wespestad. 2006. Interannual and spatial variation in the distribution of young-of-the-year rockfish (*Sebastes* spp.): expanding and coordinating a survey sampling frame. CalCOFI Report 47:127–139.

Shaffer, J., D. Doty, R. Buckley, and J. West. 1995. Crustacean community composition and trophic use of the drift vegetation habitat by juvenile splitnose rockfish *Sebastes diploproa*. Marine Ecology Progress Series 123:13–21.

Singer, M. 1985. Food habits of juvenile rockfishes (*Sebastes*) in a central California kelp forest. U.S. National Marine Fisheries Service Fishery Bulletin 83:531–541.

Studebaker, R. S., and T. J. Mulligan. 2008. Temporal variation and feeding ecology of juvenile *Sebastes* in rocky intertidal tidepools of northern California, with emphasis on *Sebastes melanops* Girard. Journal of Fish Biology 72:1393–1405.

Underwood, A., and M. Chapman. 2000. Variation in abundances of intertidal populations: consequences of extremities of environment. Hydrobiologia 426:25–36.

Wales, J. H. 1952. Life history of the blue rockfish *Sebastodes mystinus*. California Fish and Game 38(4):485–498.

Whoriskey, F. G. 1983. Intertidal feeding and refuging by cunners, *Tautogolabrus adspersus* (Labridae). U.S. National Marine Fisheries Service Fishery Bulletin 81:426–428.

Yoshiyama, R., C. Sassaman, and R. Lea. 1986. Rocky intertidal fish communities of California: temporal and spatial variation. Environmental Biology of Fishes 17:23–40.

View publication stats

AR018028