Larval Rockfish in Puget Sound surface waters

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Background

In 2011, the National Marine Fisheries Service (NMFS) listed Puget Sound Distinct Population Segments (DPS's) of three rockfish species – bocaccio (*Sebastes paucispinis*), yellow-eye (*S. ruberrimus*), and canary rockfish (*S. pinniger*) – as threatened or endangered under the Endangered Species Act (ESA). These listings have resulted in consultations under section 7(a)(2) of the ESA between NMFS and the US Army Corps of Engineers (ACOE) to evaluate potential impacts of dredge sediment disposal into pelagic waters. Larval rockfish are known to occur in surface and subsurface waters after hatching from eggs, so it is possible that sediment disposal could negatively affect rockfish at larval stages. However, little knowledge of larval rockfish densities across Puget Sound over time exists by which NMFS could infer impacts to stocks or ACOE could mitigate for sediment disposal by changing the timing or placement of disposal.

Most of the research that has been done on rockfish larval distributions in Puget Sound has been limited across either time or space. Chamberlin et al (2004) and Weis (2004) used several methods to capture larval rockfish in nearshore waters of the San Juan Islands between April and July in one or two field seasons, thereby determining presence of a variety of larval rockfish within a relatively small geographic area over a short period of time. Miller et al. (1977) collected larval rockfish using several techniques across the San Juan archipelago over an entire year. Busby et al. (2000) dip-netted larval fish at NOAA's Manchester Pier during day and night periods for 8 months over 10 years, providing a detailed temporal description of rockfish larval presence in the region, but at just one site in Puget Sound. Expanding in the spatial dimension, Waldron (1972) collected larval fish from 13 sites scattered across all major basins of Puget Sound, but had a limited temporal sampling scheme (April, 1967). Hence, it is difficult to apply these previous studies to a sediment management program for which both spatial variation and seasonal changes are relevant.

In an effort to incorporate broad temporal and seasonal components into our understanding of larval rockfish distributions, the Northwest Fisheries Science Center sampled juvenile fish and larval fish at 79 sites across Puget Sound over seven months (April-October 2011). The 79 sites were across the major biogeographic basins in the Puget Sound. These five interconnected basins include: 1) Admiralty Inlet, 2) Main Basin, 3) Whidbey Basin, 4) South Puget Sound, 5) Hood Canal, and 6) The San Juan/Strait of Juan de Fuca Basin (also called "Rosario Basin"). These basins encompass contiguous, ecologically unique, and spatially isolated freshwater, estuarine, and marine habitats (Downing 1983; Burns 1985). The basins are delineated by relatively shallow sills that regulate water exchange and define different biogeographic regions (except where the Whidbey Basin meets the Main Basin). Additional sampling for larval fish was conducted at six sediment disposal sites in Puget Sound from April 2011 through February 2012. This sampling was part of a larger project funded by the EPA to understand the ecological health of the Puget Sound nearshore pelagic foodweb. In this summary report, we focus on several sets of samples collected during this field effort:

1) Collections at the six sediment disposal sites across 11 months
2) Collections at 16 of the 79 sites across Puget Sound across seven months
3) Collections at all sites in the month of August.

Methods

Sites. We sampled larval fish at two sets of sites: six Puget Sound Dredged Material Management Program (DMMP) disposal sites, and 79 index sites (Fig. 1). The six disposal sites were located in deep water (range 29-172 m, Table 1) and at least 1 km from any shoreline, while index sites were located in subtidal areas along shorelines at 5-40 m depth.

Table 1. Site characteristics of DMMP sediment disposal sites.

Site	Basin	Latitude North	Longitude West	Area (m^2)	Depth (m)	Distance to Shore (m)
Anderson Island	South Sound	47.15700	122.65783	1,286,900	135	1,270
Commencement Bay	Central	47.30242	122.46358	1,254,525	168	1,430
Elliot Bay	Central	47.59850	122.35750	1,679,445	101	1,290
Port Gardner	Whidbey	47.98083	122.27900	1,286,900	128	2,020
Rosario Strait	Rosario	48.51450	122.72600	2,630,457	36	2,300
Bellingham Bay	Rosario	48.71367	122.55183	1,052,183	29	2,950

Index sites were chosen based on a number of criteria, including oceanographic basin, proximity to shorelines, depth, geomorphic type (tidal delta front, small embayment (≤ 2500 m shoreline), large embayment (> 2500 m), and exposed shoreline), and degree of anthropogenic disturbance along shorelines. The entire design was produced to maximize spatial coverage of Puget Sound, although this plan reduced the potential for replication at each site (at the habitat unit spatial scale for tidal deltas only, and not at the site level). For analysis of larval fish, we delineated a subset of 16 sites that replicated the overall sampling design across basins, geomorphic types, and levels anthropogenic disturbance (Fig. 1).

Larval fish sampling. Larval fish were collected using a 500 µ mesh net (1 m diameter x 3 m long) attached by line to a winch. A General Oceanics Inc. current meter was attached so it hung in the middle of the net opening to record the volume of water that was sampled and a 40 pound weight was attached at the bottom of the net opening. The net was let out to 24.3 m and towed at 2-3 m depth for 3 minutes at idle speed (1-1.5 kts). Once the net was pulled back into the boat, it was sprayed down with water through the outside of the net so all the contents collected in the cod end. The contents were then poured into a 500 µ mesh sieve using water filtered through a 250 µ mesh sieve and large debris was sprayed off and removed. If a large volume of jellyfish was collected, each jellyfish was sprayed off and jellyfish of the same species were weighed and returned to the sea. Then the sample was transferred into a sample bottle. The sample was fixed with 5% neutral buffered formalin, as formalin is better than ethanol at retaining pigmentation features important for visual identification. However, after mid-October, samples were fixed in 70% ethanol at the request of DMMP managers for potential future genetic analysis. From April through October, nets were deployed off large (> 15 m) research vessels with hydraulic winches, but thereafter were deployed off a 7 m vessel with a crab-pot hauler and davit. For a small number of visits (1 visit in the ACOE dataset, 8 visits in the 16-index site dataset, and 4 visits in the August dataset), samples were not collected due to adverse conditions or equipment failure.

Identification. Larval fish samples were processed in the lab using a dissecting microscope. All larval fish were removed from the rest of the sample material, counted, and identified to species if possible via comprehensive North Pacific larval fish references (Matarese et al. 1989, Matarese et al. 2011, Matarese et al. 2012). Individual specimens were identified to the most detailed taxonomic level possible, and the developmental stage of each specimen was noted as well as the standard length (±0.1 mm) of one specimen at each developmental stage.

Analysis. We chose several subsets of the samples to analyze for larval fish. The first dataset was the entire set of samples collected at the disposal sites (6 sites x 11 months = 66 samples). The second dataset was a subset of 16 index sites across all basins and seven months (16 sites x 7 months = 112 samples). The third dataset comprised all index sites in the month of August (79 samples), the month when Puget

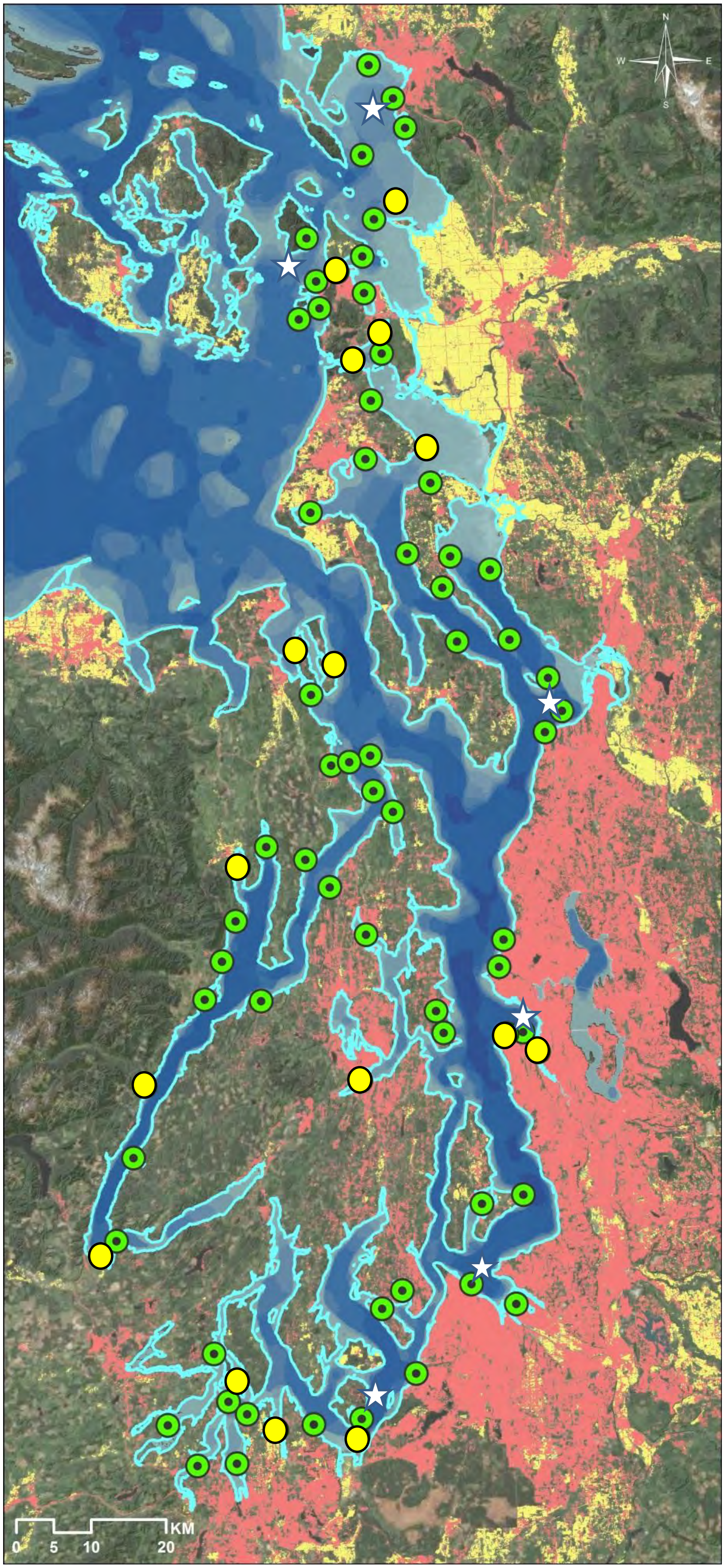

Figure 1. Locations of sediment disposal sites (white stars) and index sites (circles) in Puget Sound. Index sites analyzed for the 16-site subset are shown in yellow.

Sound exhibited a seasonal peak in productivity. While we were unable to analyze all plankton samples we collected (79 samples x 7 months x 2 net types for index sites and all samples from disposal sites), we identified all rockfish larvae from the three sample sets. These samples provide a broad sampling of both temporal and spatial patterns, and were sufficient to provide sound conclusions on overall patterns of abundance. For all three sets of samples, we examined both absolute density of rockfish (fish/1000 m^3), and relative abundance (%). Absolute density of rockfish was estimated for each sample based on the volume of water sampled during a tow:

density = 1000 * # larval rockfish / ($\pi r^2 d$)

where r is the radius of the net (0.5 m), and d is the water swept by the tow as estimated by the current meter. The actual density (fish/m^3) is multiplied by 1000 to scale density estimates to other estimates that have been made for larval rockfish (e.g., Waldron 1967). Relative abundance was simply the proportion of all fish larvae counted in a sample that were rockfish:

Relative abundance = 100 * # rockfish larvae / # of fish larvae.

Results

Disposal sites. Rockfish ichthyoplankton were a common constituent of surface waters of Puget Sound's sediment disposal sites. Their relative abundance (% of total catch composed of rockfish) tended to increase over the sampling period, peaking in August or September 2011 (Fig. 2). However, when the data were examined using actual densities, larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound. Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November (Fig. 2, Appendix 1). Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to Central and South Sound, and rockfish larvae were practically nonexistent at the Bellingham Bay site.

Index sites. To examine whether the pelagic waters above disposal sites accurately reflect regional patterns in density, we also examined rockfish ichythoplankton at the 79 index sites. Our first comparison was a subset of 16 sites that retained the overall sampling design (comparisons possible across months, oceanographic basins, geomorphic types, and land use). For the purposes of this report, we focused on variation across basins and months. Our second dataset focused on all sites during the month of August, when relative abundance of rockfish generally peaked.

Our subset of 16 index sites corroborated the strong temporal and spatial differences suggested at the disposal sites, albeit at much lower average abundance levels. Relative abundance of rockfish ichthyoplankton peaked in either April or May, or in August or September (Fig. 3, Appendix 2), and this difference appeared to be related to connectivity of the basin to oceanographic processes or areas of high spawner abundance. Less connected basins like South Sound, Hood Canal, and Whidbey Basin exhibited high relative abundance of larval rockfish early in the year, while the more connected systems like Admiralty Inlet, Central Basin, and Rosario Basin exhibited the largest peaks later in the year. This same pattern was observed in the density data in Admiralty and Rosario basins but not in Central Basin, which peaked during the same time as South Sound. Regardless of timing, the highest peaks were still observed in the more connected oceanographic basins in the late summer.

Abundance patterns in August at all index sites mirrored the results of sixteen index site subset Fig. 4). Again, the three oceanographic basins that were most connected (Admiralty Inlet, Central Basin, and Rosario Basin) had the highest relative and absolute abundances in August, although both relative and absolute values were lower in the complete dataset compared to the subset. This was likely a reflection of a greater range of habitat types represented by the entire set of index sites. The difference in habitat types in the two datasets may also explain why Whidbey Basins exhibited higher abundance levels across all sites compared to the smaller subset.

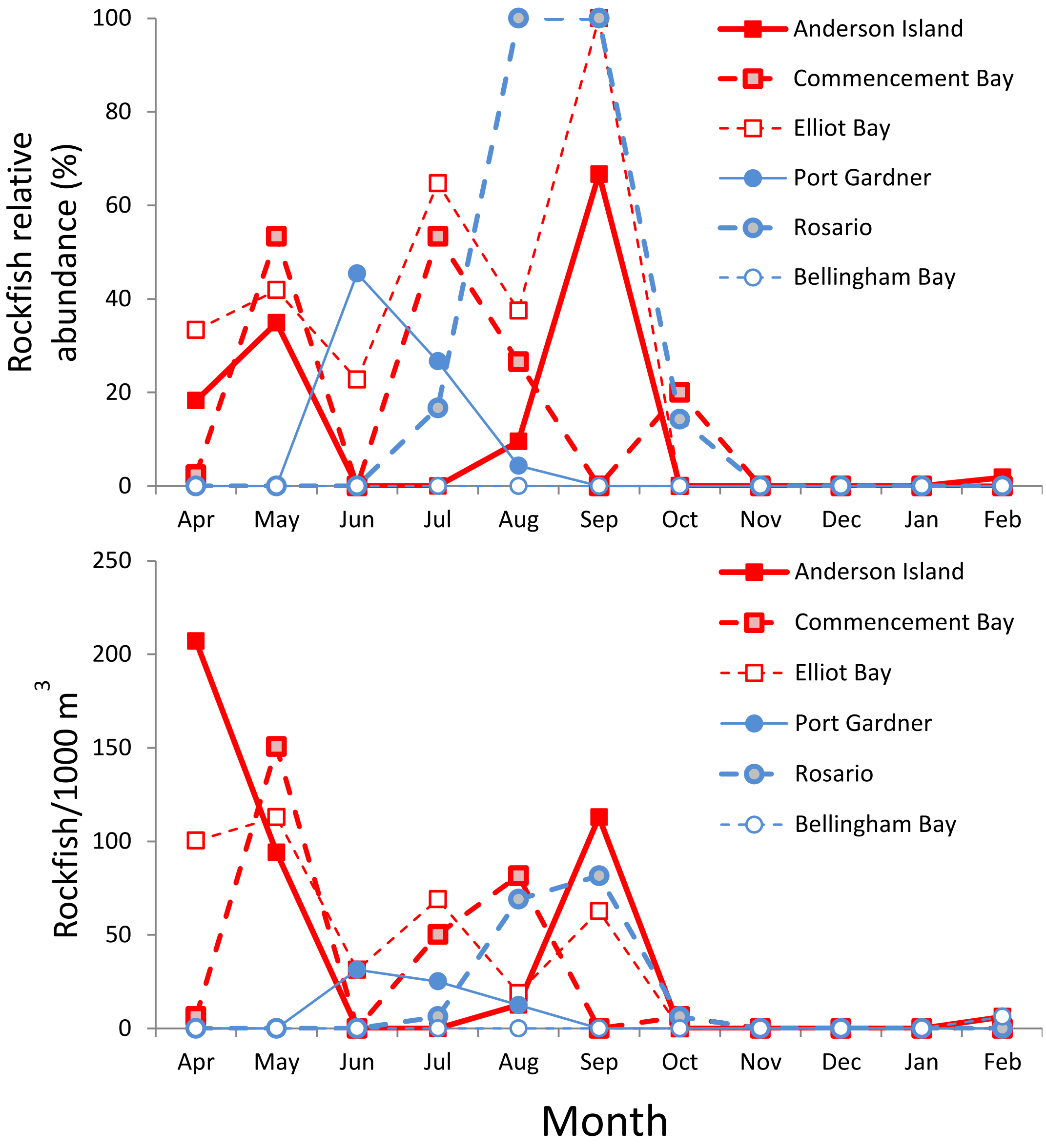

Figure 2. Relative abundance (% of all specimens identified as rockfish) and density (rockfish larvae/1000 m^3) at the six sediment disposal sites from April 2011 through February 2012.

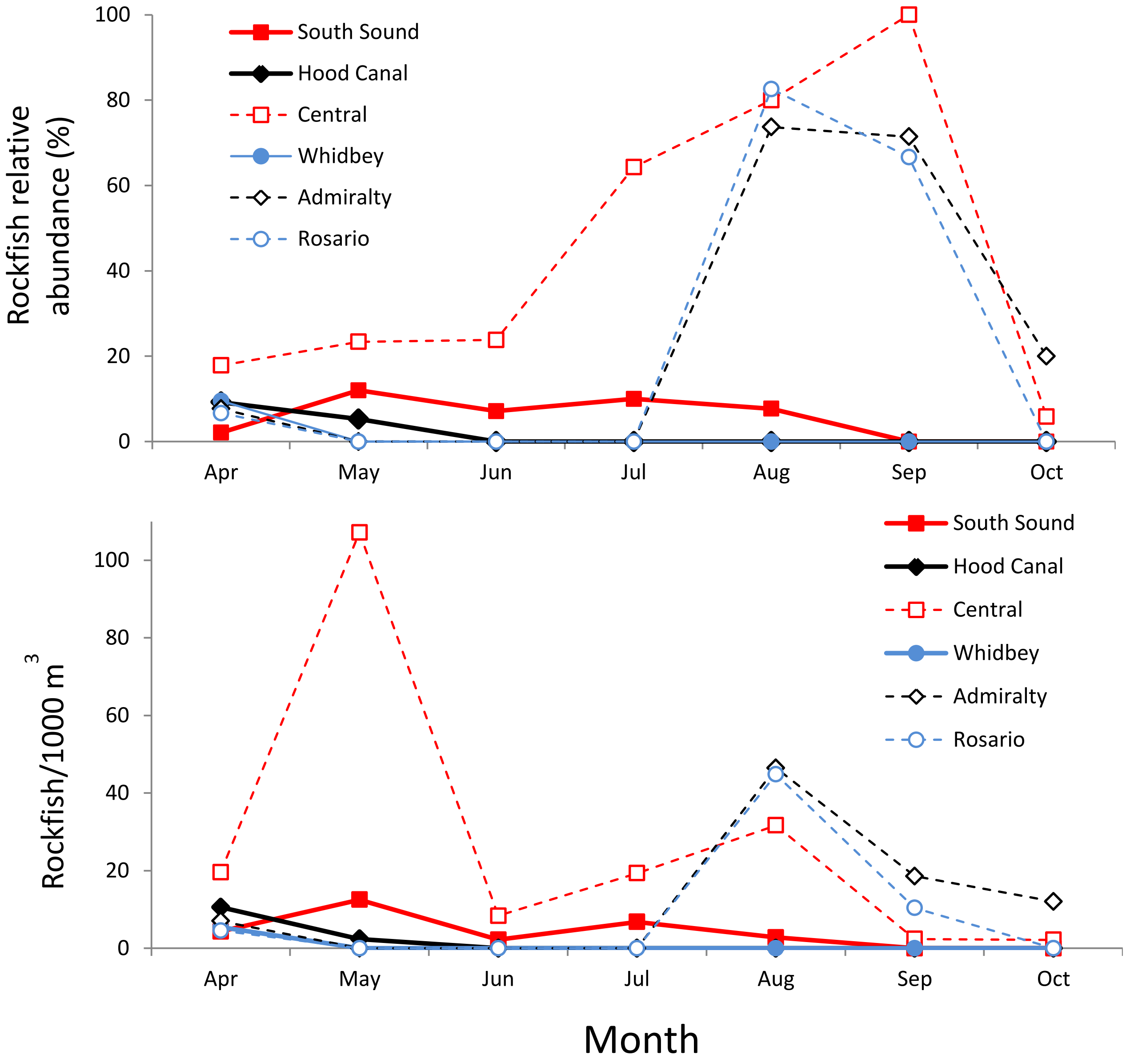

Figure 3. Relative abundance and density at a subset of 16 index sites in six oceanographic basins from April through October.

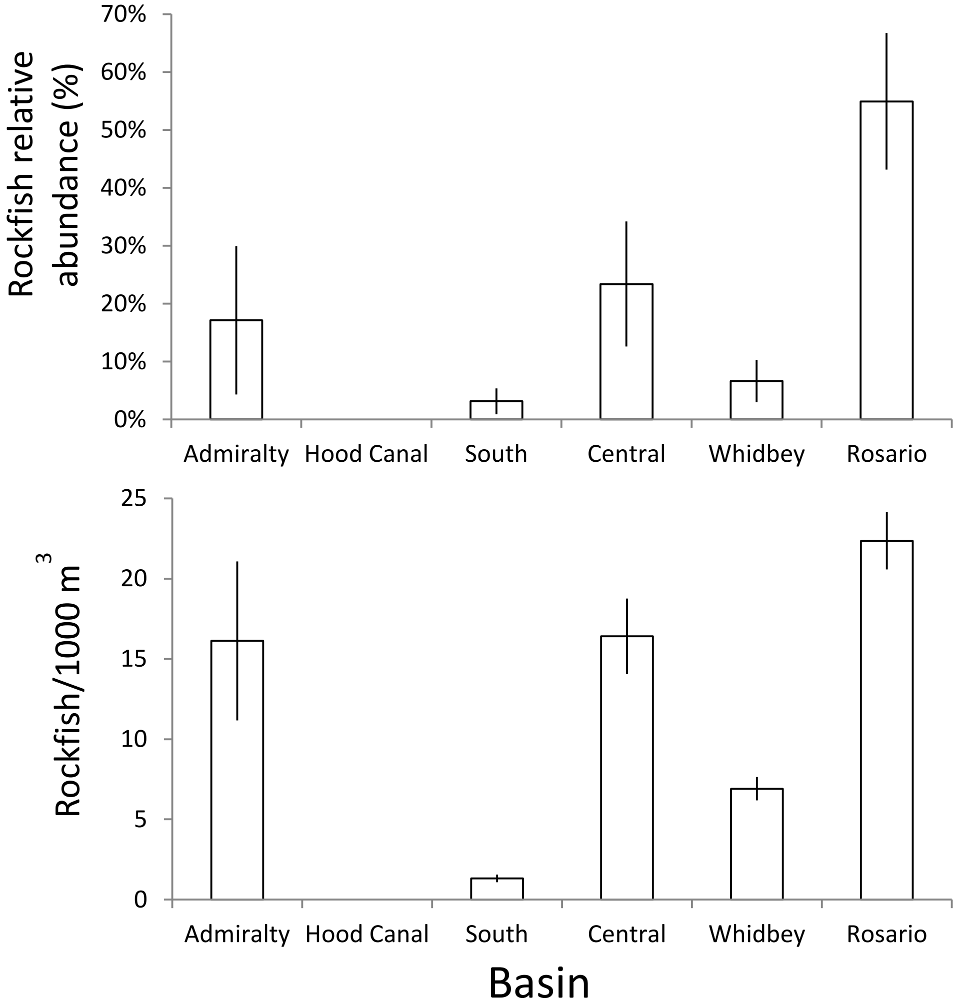

Figure 4. Relative abundance and average density (± standard error) of rockfish larvae at all index sites in August.

Conclusions

Based on patterns at both sediment disposal sites and index sites, larval rockfish densities correspond well with temporal patterns in productivity, peaking in early spring, exhibiting a second peak in the summer, and then declining sharply in the fall. However, this pattern exhibits some variability across oceanographic basins, possibly related to connectivity with adult spawning areas. There was also substantial variation among datasets, with densities at disposal sites being two to ten times greater than those at index sites. This pattern is likely a result of biological and physical differences between deepwater disposal sites and nearshore index sites. As these estimates are based on a single year of data, they should be considered as an initial determination. Many other measured indicators indicated that 2011 was a relatively cool year for which peak productivity was substantially delayed. If so, the temporal pattern we observed might be expected to shift earlier in average or warmer years. Within a given year, larval rockfish abundance patterns likely reflect a combination of water circulation and residence time, larval movements into nearshore habitats (Paulsson et al. 2009), and spatiotemporal variation in spawning among multiple species. Our future work will address how these characteristics affect larval distributions.

One aspect we can readily examine is the influence of spawn timing and spatial pattern of adult rockfish. Adults are likely the primary determinant of the places and times larval fish are abundant Paulsson et al. (2009). We collected information from previous literature on surveys of adult rockfish across Puget Sound, as well as the timing of reproduction (gravid females or observations of spawning behavior) for all observed species. These are summarized in Appendix 4 and 5.

We found evidence that larval abundance patterns were influenced by adult abundance. Adult abundances were ranked as common, uncommon, or rare primarily based on catch records from Miller and Borton (1980) with updates from Paulsson et al. (2009), and these rankings were then averaged to rank abundance among basins. The ranking of adult catch frequency across oceanographic basins from highest catch to lowest was Central Basin, Admiralty Inlet, Hood Canal, Whidbey Basin, South Sound, and Rosario Basin. The ranking of rockfish larval density (based on data from the 16 index sites) was Central Basin, Admiralty Inlet, Rosario Basin, South Sound, Hood Canal, and Whidbey Basin. Therefore, adult and larval fish datasets were similar in terms of the two highest ranked basins. Adult surveys in the San Juan Islands top all other basins, so it is possible that the relatively high ranking of Rosario Basin in the larval fish dataset partly reflects advection of larval fish from the San Juan Islands.

We also examined patterns of larval timing expected from spawn timings of various rockfish species. We collected information from three references (Paulsson et al. 2009, Hart 1973, Matarese et al. 2011), as well as personal communication with Marc Tagal (Northwest Fisheries Science Center), who has worked closely with captive-bred rockfish at the Seattle Aquarium. To estimate a rough index of spawn timing based on these references, we constructed ranges of spawning for all species based on these references, then calculated the citation rate for which rockfish spawning was reported for each month (# of reports of spawning rockfish/total reports possible). The results are shown in Figure 5, along with the consensus reports for the three listed rockfish species. The citation rate for all species captured the general spring peak observed in some of our data, but not the drop-off in late spring or the second peak in summer. A handful of rockfish species are reported to spawn in the summer, including both the listed yelloweye rockfish and the more common Puget Sound rockfish (Appendix 5). If spawn timing is the primary determinant of the temporal pattern of larval abundance, the summer abundance peak must be driven by differential abundance of adult rockfish species.

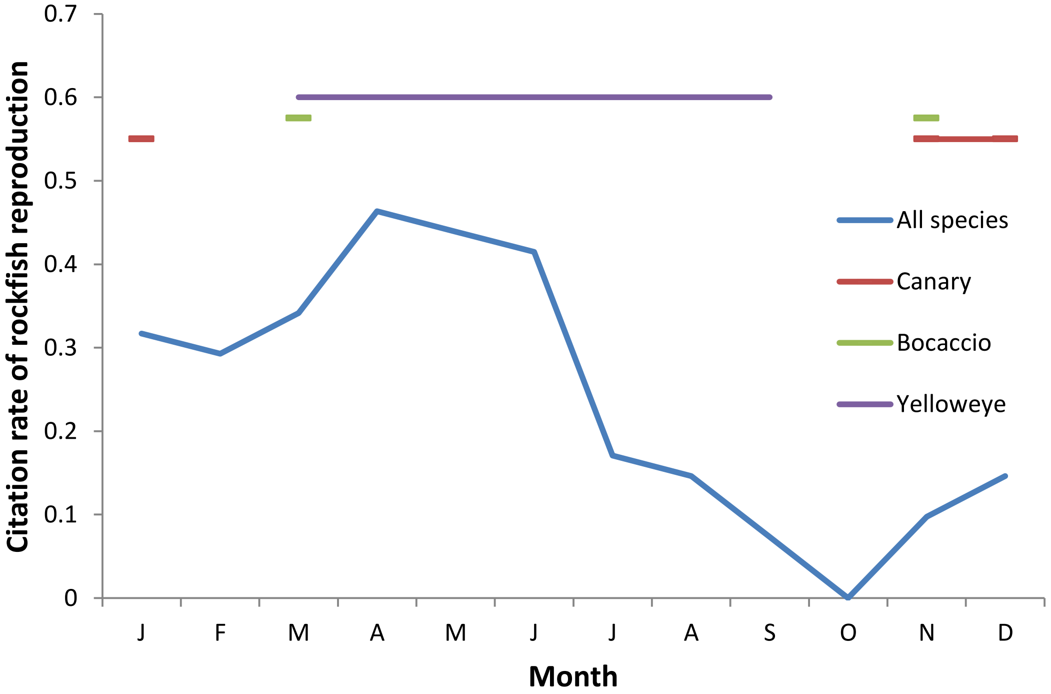

Figure 5. Citation rates of rockfish spawning in different months. The pattern across all species is shown in blue, while spawn timing by ESA listed species is shown for comparison.

Identifying risks to listed rockfish species is complicated at the larval stage because different species are notably difficult to distinguish during the larval phase. One listed species that can be readily identified visually at early larval stages are boccacio, due to the pronounced size and distinct pigmentation of larval pectoral fins (Matarese et al. 2011). Among the 495 rockfish identified in our samples, not even one of these was identified as boccacio, testifying to their rarity in Puget Sound waters. If bocaccio numbers accurately reflect abundance of yelloweye rockfish and canary rockfish due to their shared rarity, estimating anthropogenic impacts to larval life stages of these species will be difficult, particularly because natural mortality is expected to be quite high during early life stages (Beckman et al. 1998). It is possible to identify rockfish larvae using genetic techniques (Rocha-Olivares 1998, Wimberger et al. 1999, Gray et al. 2006) on samples that were originally stored in formalin; these can be used for genetic identification with relatively high success when stored in ethanol for a sufficient time that ethanol replaces the formalin in tissues (Perez et al. 2005), although multiple primers may need to be used to overcome species diversity of rockfish and any DNA degradation caused by formalin. Ongoing ROV surveys for adults performed by the Washington Department of Fish and Wildlife are likely to provide an additional good indicator of whether particular areas will likely produce listed fish larvae.

It would also be advisable to compare the density estimates in this report with other estimates of larval rockfish densities in Puget Sound. The only other study to our knowledge that examined sites across Puget Sound was Waldron (1972), in which sampling occurred in all oceanographic basins in April 1967. The range in density found at that time was 155, 113, 45, and 231 larvae/1000 m^3 in South Sound, Central Basin, Whidbey Basin, and Rosario Basin, respectively. The differences in these values compared to our lower estimates are likely a combination of temporal variation (interannual variation in larval production), differences in methodology (vertical vs. horizontal tows), habitat differences, and possibly directional changes in abundance of adult rockfish over time.

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Appendix 1. Raw densities (fish/1000 m^3) and counts of rockfish larvae caught at six DMMP disposal sites from April 2011 to February 2012. Dashes denote missing values.

Month:	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
						Densities					
Anderson Island	235.1	136.8	0	0	12.6	135.9	0	0	0	0	7.2
Bellingham Bay	0	0	0	0	0	0	0	0	0	0	7.2
Commencemnent Bay	6.2	150.6	0	50.2	81.6	0	6.3	0	0	0	0
Elliot Bay	101.0	126.8	31.4	69.0	26.8	88.5	0	0	0	0	0
Port Gardner	--	--	31.4	25.1	12.6	0	0	0	0	0	0
Rosario Strait	0	0	0	6.3	69.0	81.6	6.3	0	0	0	0
						Counts					
Anderson Island	33	15	0	0	2	18	0	0	0	0	1
Bellingham Bay	0	0	0	0	0	0	0	0	0	0	1
Commencemnent Bay	1	24	0	8	13	0	1	0	0	0	0
Elliot Bay	16	18	5	11	3	10	0	0	0	0	0
Port Gardner	--	--	5	4	2	0	0	0	0	0	0
Rosario Strait	0	0	0	1	11	13	1	0	0	0	0

Appendix 2. Rockfish densities and counts by month for the 16-index site subset. Boldface numbers indicate basin averages. Dashes represent missing values.

	Density							**Counts**						
Month:	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Admiralty	**7.0**	**0**	**0**	**0**	**46.5**	**18.6**	**12.0**	**1.0**	**0**	**0**	**0**	**7.0**	**2.5**	**1.0**
Nodule Point	0	0	0	0	0	37.2	--	0	0	0	0	0	5.0	--
Port Townsend	14.0	0	0	0	92.9	0	12.0	2.0	0	0	0	14.0	0	1.0
Hood Canal	**10.6**	**2.4**	**0**	**0**	**0**	**0**	**0**	**2.0**	**0.3**	**0**	**0**	**0**	**0**	**0**
Skokomish	26.5	0	0	--	0	0	0	5.0	0	0	--	0	0	0
Vinland	5.3	7.2	0	0	0	0	0	1.0	1.0	0	0	0	0	0
Dabob Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Sound	**4.3**	**12.5**	**2.2**	**6.8**	**2.8**	**0**	**0**	**0.7**	**1.5**	**0.3**	**1.0**	**0.3**	**0**	**0**
Nisqually	13.0	25.0	6.6	13.6	8.3	0	0	2.0	3.0	1.0	2.0	1.0	0	0
Henderson Inlet	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Squaxin Island	0	--	0	--	0	0	0	0	--	0	--	0	0	0
Central Basin	**19.6**	**107.1**	**8.4**	**19.3**	**31.7**	**2.4**	**2.2**	**3.3**	**9.7**	**1.7**	**3.0**	**4.0**	**0.3**	**0.3**
Duwamish	52.7	261.6	6.3	20.2	31.7	7.1	6.5	9.0	22.0	2.0	3.0	4.0	1.0	1.0
Alki	6.0	59.9	18.8	6.7	--	0	0	1.0	7.0	3.0	1.0	--	0	0
Sinclair Inlet	0	0	0	31.0	--	0	0	0	0	0	5.0	--	0	0
Whidbey Basin	**5.4**	**0**	**0**	**0**	**0**	**0**	**0**	**1.3**	**0**	**0**	**0**	**0**	**0**	**0**
Skagit delta	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoypus Pt	16.3	0	0	0	0	0	--	4.0	0	0	0	0	0	--
Similk Bay	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosario Basin	**4.6**	**0**	**0**	**0**	**44.8**	**10.4**	**0**	**1.0**	**0**	**0**	**0**	**9.5**	**2.0**	**0**
Samish Bay	0	0	0	0	52.1	6.1	0	0	0	0	0	11.0	1.0	0
Guemes Channel	9.1	--	0	0	37.5	14.7	0	2.0	--	0	0	8.0	3.0	0

Appendix 3. Average and standard error of density and counts of larval rockfish across all index sites in each oceanographic basin in August.

	Basin					
	Admiralty	**Hood Canal**	**South**	**Central**	**Whidbey**	**Rosario**
Average of Density	16.1	0.0	1.3	16.4	6.9	22.3
Std Error of Density	5.0	0.0	0.2	2.3	0.7	1.8
Average count	2.3	0.0	0.1	2.0	0.9	4.7
Std Error of count	2.0	0.0	0.1	0.9	0.4	1.4
Number of sites	7	12	14	11	17	14

Appendix 4. Spatial distributions of adult rockfish based on surveys reported in Paulsson et al. (2009). Depth preferences are shallow (< 40 m) and deep (50-500 m), and occurrence is categorized as rare (R), uncommon (U), and common (C), or very rare or absent (blank). Rankings were primarily based on frequencies of catch by Miller and Borton (1980) (rare: frequency ≤ 10, uncommon: 60 ≥ frequency ≥ 11, common: frequency > 60), modified by more recent survey techniques described by Paulsson et al. (2009). The overall ranking (6 = higher frequency) of adult spatial distribution across basins is provided at the bottom.

			Occurrence						
Name	**Scientific name**	**Depth preference**	**Admiralty**	**Hood Canal**	**South**	**Central**	**Whidbey**	**Rosario**	**SJ**
Black rockfish	*Sebastes melanops*	Shallow	U	U		C	U	U	C
Blue rockfish	*S. mystinus*	Shallow							
Brown rockfish	*S. auriculatus*	Shallow		R	U	C			
China rockfish	*S. nebulosus*	Shallow	R						R
Copper rockfish	*S. caurinus*	Shallow	U	C	C	C	C	U	C
Puget Sound Rockfish	*S. emphaeus*	Shallow	C			R	R	U	U
Quillback rockfish	*S. maliger*	Shallow	U	U	U	C	C	U	C
Rosy rockfish	*S. rosaceus*	Shallow				R			
Rougheye rockfish	*S. aleutianus*	Shallow					R		R
Tiger rockfish	*S. nigrocinctus*	Shallow				R			U
Bocaccio	*S. paucispinis*	Deep	R	R		C	R	R	
Canary rockfish	*S. pinniger*	Deep	U	U	R	U	R	R	U
Darkblotched rockfish	*S. crameri*	Deep	R				R		
Greenstriped rockfish	*S. elongatus*	Deep	R	U	R	U	R		R
Halfbanded rockfish	*S. semicinctus*	Deep	R						
Pacific ocean perch	*S. alutus*	Deep	R						R
Redbanded rockfish	*S. babcocki*	Deep		R					R
Redstripe rockfish	*S. proriger*	Deep	R	U	R	R	R	R	R
Rosethorn rockfish	*S. helvomaculatus*	Deep							R
Sharpchin rockfish	*S. zacentrus*	Deep			R	R	R		R
Shortspine thornyhead	*Sebastolobus alascanus*	Deep	R	R	R	R	R	R	R
Silvergray rockfish	*S. brevispinis*	Deep			R				R
Splitnose rockfish	*S. diploproa*	Deep		R		R			R
Stripetail rockfish	*S. saxicola*	Deep		R	R	R	R		
Vermilion rockfish	*S. miniatus*	Deep	R						R
Widow rockfish	*S. entomelas*	Deep							U
Yelloweye rockfish	*S. ruberrimus*	Deep	R	U	R	R	R	U	C
Yellowtail rockfish	*S. flavidus*	Deep	U	R	R	C	U		U
Overall Rank			**5**	**4**	**2**	**6**	**3**	**1**	**7**

Appendix 5. Spawn timing of rockfish species occurring in Puget Sound, based on observations of gravid females and spawning of fish in captivity.

Name	Depth preference	Spawn timing	Reference
Black rockfish	Shallow	Jan-Apr	Paulsson et al. 2009
Blue rockfish	Shallow	Nov-Mar	Hart 1973
Brown rockfish	Shallow	Mar-Jun	Paulsson et al. 2009
China rockfish	Shallow	Jan-Jun	M. Tagal, pers. comm.
Copper rockfish	Shallow	Mar-Jun	Paulsson et al. 2009
Puget Sound Rockfish	Shallow	Aug-Sep	Paulsson et al. 2009
Quillback rockfish	Shallow	Mar-Jun	Paulsson et al. 2009
Rosy rockfish	Shallow		
Rougheye rockfish	Shallow		
Tiger rockfish	Shallow	Apr-Jul	M. Tagal, pers. comm.
Bocaccio	Deep	Nov, Mar	Hart 1973
Canary rockfish	Deep	Nov-Jan	M. Tagal, pers. comm.
Darkblotched rockfish	Deep	Feb	Hart 1973
Greenstriped rockfish	Deep	May-Jul	Hart 1973
Halfbanded rockfish	Deep		
Pacific ocean perch	Deep		
Redbanded rockfish	Deep	Apr-May	Hart 1973
Redstripe rockfish	Deep		
Rosethorn rockfish	Deep		
Sharpchin rockfish	Deep		
Shortspine thornyhead	Deep		
Silvergray rockfish	Deep	May-Aug	Hart 1973
Splitnose rockfish	Deep	Apr-Aug	Paulsson et al. 2009
Stripetail rockfish	Deep	Jan-Feb	Hart 1973
Vermilion rockfish	Deep	Dec-Feb	M. Tagal, pers. comm.
Widow rockfish	Deep	Jan-Feb	Hart 1973
Yelloweye rockfish	Deep	May-Aug	M. Tagal, pers. comm.
Yellowtail rockfish	Deep	Nov-Mar	Paulsson et al. 2009