

Chapter 8. Nearshore Assessment: Overstory kelp bed snorkeling survey of the central Strait of Juan de Fuca, including the Elwha nearshore, 2007

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Abstract

Kelp bed function in the Elwha drift cell is little understood but an important component to the upcoming nearshore restoration associated with the Elwha dam removals. This study provides information on fish use of overstory kelp beds in Elwha and comparative drift cells. A total of 14 snorkeling surveys were conducted in the kelp beds within Elwha and comparative drift cells during the summer of 2007. Surf smelt, herring, and sand lance were the dominant species. Very few salmon were observed relative to snorkeling surveys conducted during June-August 2001. Fish density was significantly higher in kelp beds than in non-kelp habitat and significantly higher in kelp beds within the comparative drift cells than in the Elwha drift cell. Geomorphic habitat type was also a significant variable in fish use of overstory kelp beds: kelp beds at embayed sites had higher fish density than spits and bluff sites. Kelp density and water depth are theorized to contribute to the observed difference in function. The drop in densities of some species from 2001 sampling may be due to stock declines, or interannual variation. Additional work defining the structure and functional processes of kelp beds, as well as long term variability in fish use, is recommended.

Introduction

Kelp beds are a dominant nearshore habitat of the Strait of Juan de Fuca (Shaffer et al 2008). In general, kelp habitats composition and form here are highly temporally and geographically variable (Thom and Hallum, 1990; Shaffer 2000). Previous study assessing of fish use of overstory kelp beds indicates that overstory kelp bed function in the central Strait is complex and species dependant (Shaffer 2004). Understory kelp beds have also been documented to be heavily used by forage fish (Norris et al 2007)

Substrate type is a determining factor for kelp distribution within the nearshore Strait of Juan de Fuca, including the Elwha nearshore (Warrick et al 2008). Sediment processes in the central Strait, including the Elwha nearshore, have been severely disrupted by extensive shoreline armoring and in river dams. The resulting sediment starvation has resulted in expanded kelp bed distribution.

The restoration response associated with upcoming dam removals on the Elwha River has not been defined for kelp beds in the Elwha drift cell (Warrick et al 2008). In particular, little is known about the current and predicted fish use of the Elwha nearshore, including overstory kelp beds (Shaffer et al 2008). Surveys of understory kelp beds in the Elwha nearshore indicate that fish use of kelp habitats is high (Norris et al 2007). Understanding overstory kelp bed function for fish use is therefore a key component to defining the role and priority of kelp beds for future restoration action. The purpose of this study then is to define salmon and forage fish use of overstory kelp beds along key areas of the central Strait, and provide at least an initial assessment of fish use of overstory kelp beds of the Elwha nearshore. This information will provide managers and researchers a baseline for developing additional restoration priorities to optimized the upcoming nearshore restoration event associated with the dam removals and additional assessment needs.

Methods and Materials

Six sites located along geomorphic habitat types of embayed shorelines, feeder bluffs, and spits within Elwha and comparative drift cells along the Strait of Juan de Fuca were selected for monthly sampling from June through August 2007 (Figure 1; Table 1; Shaffer et al 2008). Each site consisted of a paired kelp and no-kelp area. Methods were the same as those used in Shaffer 2004. Specifically, three permanent snorkeling transects were established in each kelp bed to assess inner, middle, and outer areas of each kelp bed. One permanent no-kelp transect was also established at each site. No-kelp transects were in immediate proximity to kelp beds, and shared the same orientation, depth, and distance from shore. Transect locations were defined by

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selecting prominent features along the shoreline that were visible from each of the transects and also distinguishable on aerial photos and USGS 7.5 minute quadrangle maps. GPS coordinates were noted for the beginning and end of transects. Lengths of each transect were calculated from coordinates. Water depth along each kelp and no kelp area was determined using boat based SONAR and converted to MLLW.

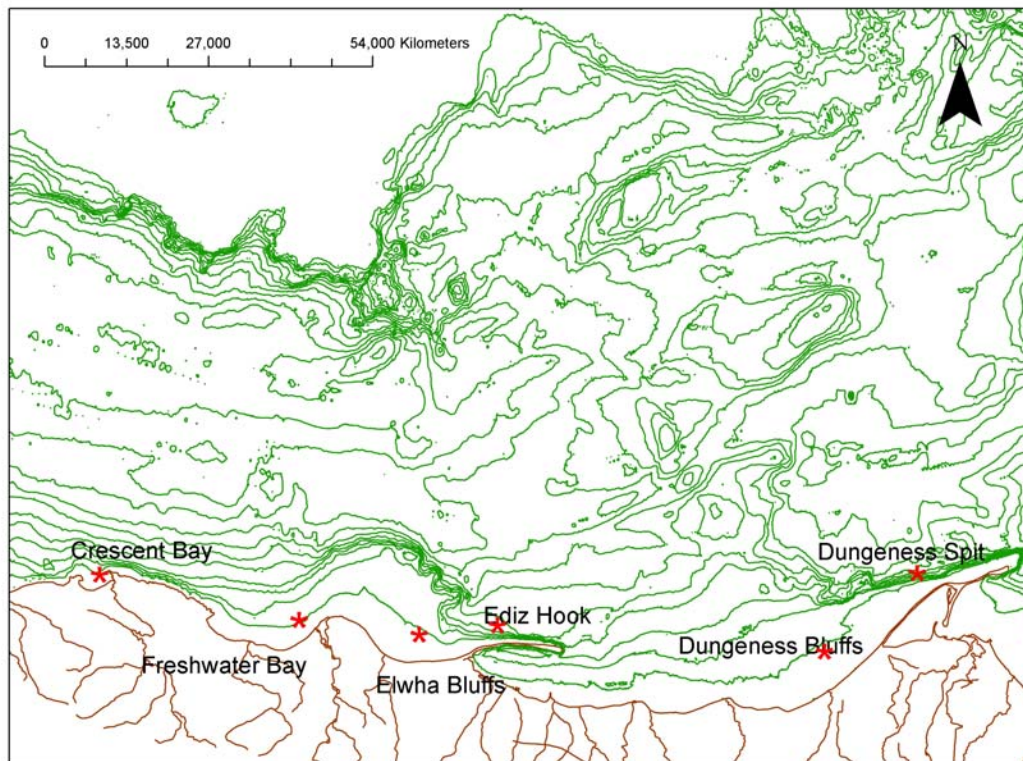


Figure 1. Kelp bed snorkeling sample sites.

Table 1. Snorkeling survey sample sites by geomorphic habitat site, 2007. Red font indicates Elwha nearshore, blue font indicates comparative habitats.

<u>Site</u>	<u>Embayment</u>	<u>Spit</u>	<u>Bluff</u>
Crescent Bay	X		
Freshwater Bay	X		
Elwha Bluffs			X
Dungeness Bluffs			X
Ediz Hook		X	
Dungeness Spit		X	

For each site, the inner kelp transect was located on the shallow edge, and parallel to, the shoreward edge of the kelp bed. The middle kelp bed transect extended in a straight line across the kelp bed from its inner to outer edge. The outer kelp bed transect covered the outer, deeper, edge of the kelp bed that bordered the main basin of the Strait. No-kelp transects were established along the same depth contour and immediately adjacent to the paired kelp bed, and parallel to the shoreline.

Kelp beds and no-kelp areas were sampled by snorkeling permanent transects. Visibility was a minimum of 15 feet (4.6 m) for sampling. Swimmers snorkeled each established transect and noted all juvenile and adult salmon and forage fish observed within three meters of the transect. Fish were identified to major grouping (salmon/ sand lance/ smelt/herring), and estimated fish depth, and water depth were recorded for each fish observation. At least two observations on kelp type and water depth were recorded for each transect, regardless of fish presence. All four transects within a site were sampled within two hours. Kelp and no-kelp beds were attempted to be sampled at least twice a month from June thru August 2007. Elwha and respective comparative sites were sampled within a two-day time period. Data were log transformed and subjected to a Kruskal-Wallis test to define significant differences in fish density between kelp and no kelp habitats, geomorphic habitat type (GMHT) and the Elwha and comparative drift cells.

Results

Sampling conditions. (in particular high turbidity) limited surveys to July and August. Areas successfully sampled for each site are provided in Table 2. A total of 14 surveys were conducted from July to September. All overstory kelp beds were comprised of bull kelp, *Nereocystis luetkeana*. Kelp depths ranged from approximately 1 meter on the inner kelp bed transect to 10 meters along the outer kelp transect. The no-kelp transects were in average of 5-9 meters of water (Table 2).

Surf smelt and herring had the highest observations. Sand lance and salmon were observed in far lower numbers (Figure 4). Kelp, geomorphic habitat type, and drift cell all played a significant role in fish density. The kelp habitats, and embayed sites outside the Elwha drift cell, were observed to have higher total fish numbers than non-kelp habitats. By species, only surf smelt had significantly higher densities in kelp than non-kelp habitats. All other species densities were non-significant (Table 3). Combined fish density, and surf smelt density was significantly different between geomorphic habitat type.

Overall the majority of fish were observed in the kelp beds within embayments. Fewer fish were observed at the spit and bluff sites. Within the embayed sites, the comparative site (Crescent Bay) had consistently higher number of fish than the site within the Elwha drift cell (Freshwater Bay) site. For the spits and bluff kelp beds, there did not appear to be a strong difference in fish numbers between the kelp and non-kelp habitat types. Location however was important: Dungeness Spit and Bluffs (comparative sites) had consistently higher numbers of fish than Elwha Bluffs and Ediz Hook located within the Elwha drift cell.

Table 2. Average kelp snorkeling survey areas (square meters), and depths (meters)

Site	<u>Lat/Long</u>	Area, square meters			Depth, meters		
		<u>Kelp</u>	<u>No Kelp</u>	<u>Combined</u>	<u>Kelp</u>	<u>No-Kelp</u>	<u>Combined</u>
Crescent Bay	48.16533/ 123.70624	5,418	1,806	7,224	3.6	4.8	4
Freshwater Bay	48.14293/ 123.57124	3,587	1,196	4,782	4	6.9	5
Ediz Hook	48.14013/ 123.46133	2,960	987	3,946	8.1	8.5	8.2
Dungeness Spit	48.15039/ 123.17545	4264	1421	5685	4.4	7.6	5.5
Elwha Bluffs	48.13606/ .50366	3986	1329	5314	8	9	8.3
Dungeness Bluffs	48.13932/ 123.23183	3752	1251	5003	4.7	7.3	5.5

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Figure 3. Total fish observed in 2007 kelp snorkeling surveys central Strait of Juan de Fuca.

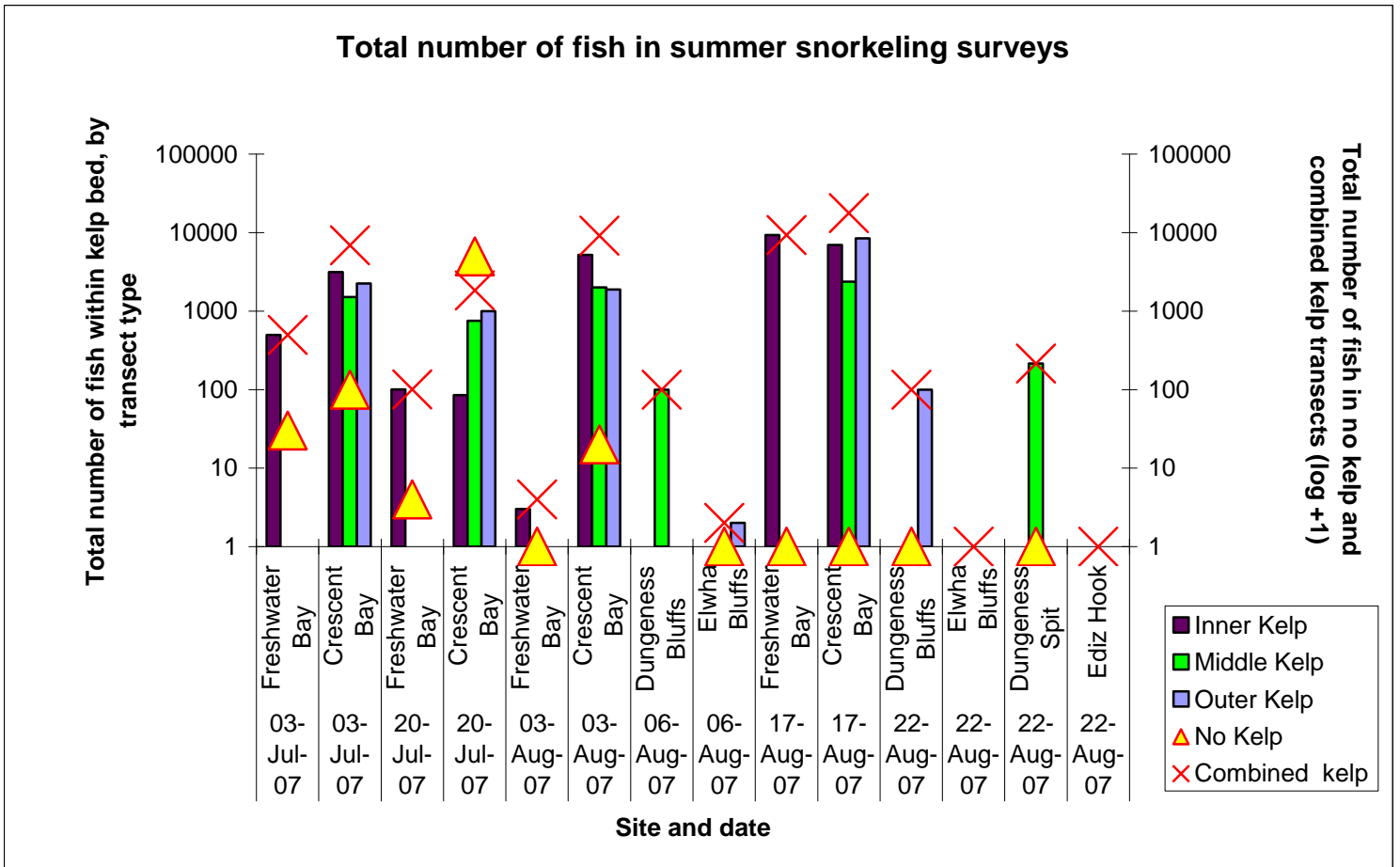


Table 3. Kruskal Wallis results of fish density, fish/sqm.

Row Labels	Chi-squared	df	p-value
Drift cell			
herring	1.3018	1	0.2539
salmon	1.6925	1	0.1933
sand lance	0.0814	1	0.7755
smelt	12.345	1	0.0004422
total fish	5.5531	1	0.01845
GMHT			
herring	4.626	2	0.09896
salmon	1.2608	2	0.5324
sand lance	9.7244	2	0.007733
smelt	0.6347	2	0.7281
total fish	8.7421	2	0.01264
Kelp presence			
herring	7.0939	2	0.02881
salmon	0.9188	2	0.6317
sand lance	1.4241	2	0.4906
smelt	7.0462	2	0.02951
total fish	12.7996	2	0.001662

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2007 Nearshore central Strait of Juan de Fuca kelp snorkeling survey

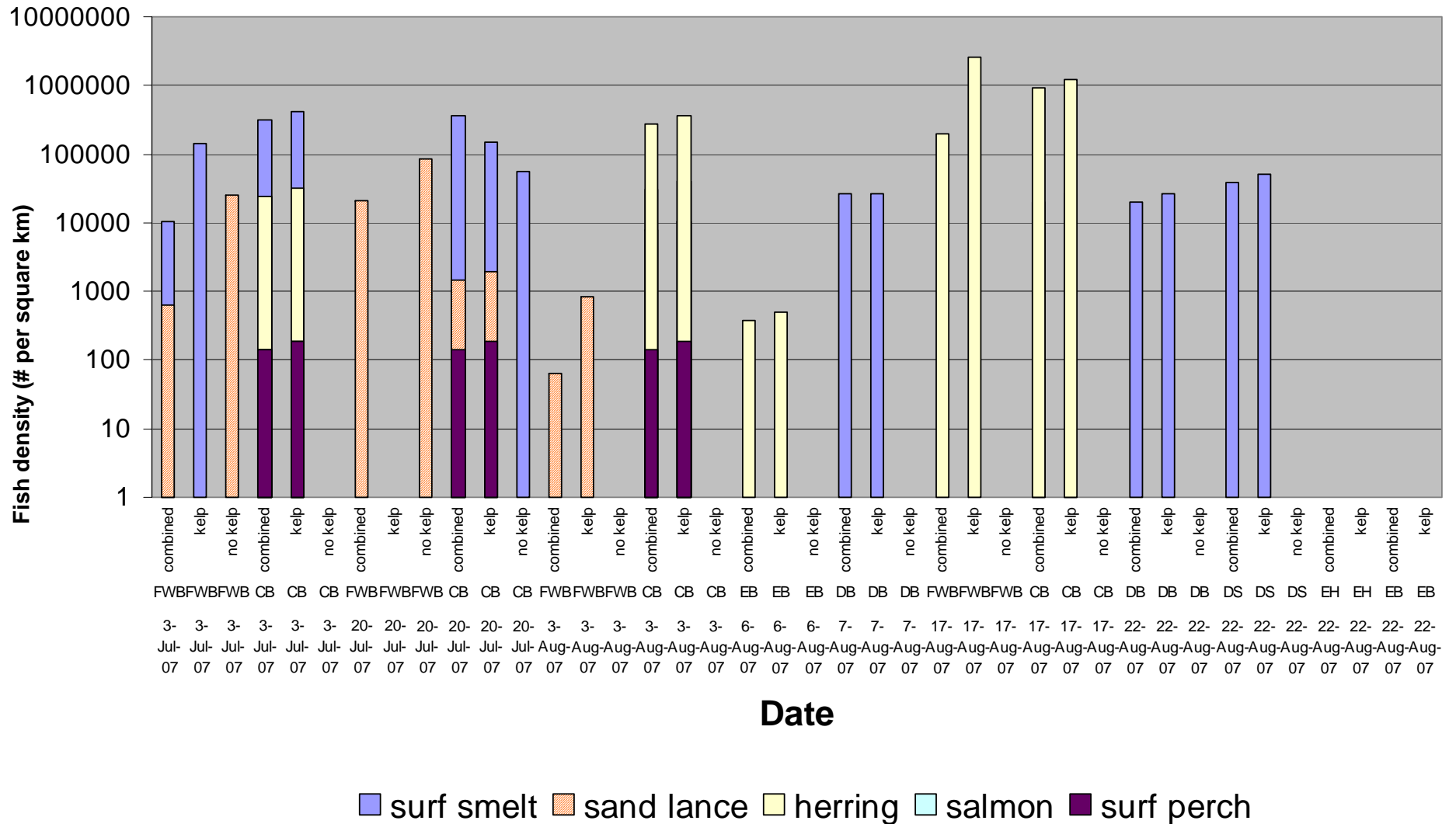


Figure 4. Fish density, number per square kilometer, by group. Central Strait of Juan de Fuca kelp beds, July and August 2007. CB=Crescent Bay, FWB=Freshwater Bay; DB=Dungeness Bluffs; EB=Elwha Bluffs; DS=Dungeness Spit; EH=Ediz Hook

Discussion

Kelp bed habitats of the central Strait of Juan de Fuca proved difficult to study this field season. Remote sites and unfavorable sea conditions combined with chronic low visibility at the spit and bluff sites often made snorkeling surveys impossible. None the less the surveys we were able to achieve provide intriguing insight into how kelp bed habitats of the central Strait function for fish, as well as how the Elwha nearshore may be functioning relative to comparative, intact kelp beds. On a broad scale, trends in observed fish use indicate that geomorphic habitat type and kelp beds both play a role in nearshore fish use, both for total fish, and by certain fish species. Embayed kelp beds are used differently than kelp beds along spits and bluffs. Also, kelp beds tend to have more fish than adjacent non-kelp areas, both in total number of fish, and fish density. Higher fish density in kelp beds relative to non-kelp beds is consistent with previous work assessing fish use of kelp beds (Shaffer 2004).

Trends in fish numbers indicate that the Elwha drift cell may be functioning differently, and in particular providing habitat for fewer fish, than comparative habitats outside of the Elwha drift cell. In all but one sample date at all habitat types the Elwha drift cell kelp habitat were observed to have fewer fish than the kelp habitat in comparative areas. Reasons for this observed trend may include different habitat composition between the kelp beds. Visually, kelp beds in the Elwha drift cell appeared less dense than kelp beds in the comparative areas. Also, average depth of the kelp beds in the Elwha drift cell was deeper than other sites (Table 2). Physical elements such as depth, sediment substrate size, and relative turbidity levels, may also be playing a role in kelp bed structure and subsequently, function. Additional scrutiny of the kelp habitat structure within the Elwha systems and comparative areas would help tease this out, and is recommended.

Another interesting trend is the change in species composition from that observed in surveys conducted seven years ago. While overall fish numbers reached about the same density, sand lance were observed in log scale fewer numbers in this study compared to kelp beds surveyed five years ago (Table 2). Similarly, salmon were observed in only one kelp bed survey of this

study. The decrease in observations of these two fish groups may be due to the difference in location of kelp beds of this study: only two of the six sites sampled in this study were adjacent to river/stream mouths, while all of the study sites in 2004 were in proximity to a stream/river mouth. While not a driving factor, proximity to creek mouth may play a role in this years observation. It may also indicate temporal variation in fish species abundance. Sand lance have not been studied in detail, but observations of sand lance have been on the decline in recent years (Wildermuth, pers comm.). Salmon species are also on the decline, and the focus of extensive restoration efforts in the central Olympic Peninsula (see Ward et al 2008 for a discussion). Further surveys should be conducted in successive years to define if trends are real, or simply due to interannual variation.

Table 4 . Fish densities (f/skm) and ln density observed in 2001 and 2007 kelp bed surveys.
*(2001 data are reprinted from Shaffer, 2004).

<u>Date</u>	<u>Site</u>		<u>Salmon</u> <u>Lnden</u> <u>Average</u>	<u>Salmon</u> <u>density</u> <u>(f/skm)</u> <u>Average</u>	<u>Surf</u> <u>smelt</u> <u>Lnden</u> <u>Average</u>	<u>Surf smelt</u> <u>density (f/skm)</u> <u>Average</u>	<u>Sand</u> <u>lance</u> <u>Lnden</u> <u>Average</u>	<u>Sand lance</u> <u>density (f/skm)</u> <u>Average</u>
2001*	Central and western Strait	Average	6.0	678.5	7.3	44,605.4	7.5	36,794.1
		sd	1.2	3374.8	2.5	194165.8	2.6	86557.5
2007	Central Strait	Average	0.3	7.7	4.4	41,558.4	2.4	4,870.2
		sd	1.1	35.2	5.5	96400.8	4.0	14485.1

In summary, this work supports existing literature documenting higher fish densities in overstory kelp habitats relative to unvegetated areas, and also suggests that kelp beds along the Strait appear to function differently, and in particular that Elwha nearshore kelp beds appear to be functioning at a lower level for fish use than kelp beds in comparative habitats outside the Elwha drift cell. Sediment starvation, a dominant limiting factor in the Elwha nearshore that is due to extensive shoreline armoring and in river dams, has resulted in an increase in overstory kelp coverage in the last 100 years (Barry 2005; Norris et al 2007; Shaffer et al 2008). Dam removals will partially restore nearshore sediment processes, and may well affect the kelp habitat

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associated with the Elwha nearshore (Warrick et al 2008). Our observations indicate that this change may not be a significant change for fish use of overstory kelp beds. Norris et al 2007 documented large schools of juvenile and adult forage fish utilizing understory kelp beds within the Elwha nearshore. Further detailed assessment is therefore recommended to quantify fish use of understory kelp beds and the restoration opportunities associated with shallow subtidal vegetated habitats.

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