Environ Biol Fish (2011) 90:61–70
DOI 10.1007/s10641-010-9718-6

Diel differences in fish assemblages in nearshore eelgrass and kelp habitats in Prince William Sound, Alaska

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Received: 27 November 2009 / Accepted: 24 August 2010 / Published online: 4 September 2010

Abstract The importance of a particular habitat to nearshore fishes can be best assessed by both diurnal and nocturnal sampling. To determine diel differences in fish assemblages in nearshore eelgrass and understory kelp habitats, fishes were sampled diurnally and nocturnally at six locations in western Prince William Sound, Alaska, in summer 2007. Abundance of fish between day and night were similar, but species composition and mean size of some fish changed. Species richness and species diversity were similar in eelgrass during the day and night, whereas in kelp, species richness and species diversity were greater at night than during the day. In eelgrass, saffron cod (*Eleginus gracilis*) was the most abundant species during the day and night. In kelp, the most abundant species were Pacific herring (*Clupea pallasii*) during the day and saffron cod at night. Diel differences in fish size varied by species and habitat. Mean length of saffron cod was similar between day and night in eelgrass but was greatest during the day in kelp. Pacific herring were larger at night than during the day in kelp. Diel sampling is important to identity nearshore habitats essential to fish and help manage fish stocks at risk.

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Keywords Nearshore fishes · Diel catches · Alaska · Beach seine · Eelgrass · Kelp

Introduction

Nearshore vegetated habitats in Alaska support diverse and abundant fish assemblages, and are particularly important for juveniles including several commercially important species such as chum salmon (*Oncorhynchus keta*), Pacific cod (*Gadus macrocephalus*), pink salmon (*O. gorbuscha*), and walleye pollock (*Theragra chalcogramma*) (Laur and Haldorson 1996; Dean et al. 2000; Murphy et al. 2000; Johnson et al. 2003; Johnson and Thedinga 2005; Thedinga et al. 2006; Konar and Hamilton 2007; Laurel et al. 2007; Thedinga et al. 2008). In addition to rearing habitat, nearshore areas also provide important spawning habitat for forage species such as Pacific herring (*Clupea pallasii*) in vegetated habitats and capelin (*Mallotus villosus*) and Pacific sand lance (*Ammodytes hexapterus*) in non-vegetated habitats (Blankenbeckler and Larson 1982; Arimitsu et al. 2008). Although it is well established that many fish species use the nearshore environment, often in large numbers, what is unknown is their dependence on specific habitats, and how that changes between day and night. Thus, information is needed on diel fish use of nearshore habitats to adequately identify and protect habitats essential to early life history stages of many managed species. Most studies of nearshore fish assemblages, particularly in Alaska, however, have been limited to sampling during the day, and thus, use of eelgrass (*Zostera marina*) and kelp habitats at night (Laminariales) is poorly understood.

Diel changes in habitat use by nearshore fishes have been documented in nearshore areas in other areas of the world (Bayer 1981; Keats 1990; Grant and Brown 1998; Gray et al. 1998; Cote et al. 2001; Griffiths 2001; Pessanha et al. 2003; Unsworth et al. 2007). In Alaska, these types of studies have been primarily related to vertical migrations of walleye pollock (*Theragra chalcogramma*) in offshore areas (Brodeur and Wilson 1996; Sogard and Olla 1996).

Knowledge of the diel behavior of fishes is necessary to identify overall use and importance of nearshore habitats. Fish may be present or vulnerable to sampling gear in certain habitats only during the day or at night if there is a diel cycle of movement. For example, juvenile Atlantic cod (*Gadus morhua*) move from offshore to shallow nearshore habitats at night (Keats 1990; Grant and Brown 1998). In addition, use of a habitat may not be realized if fish abundance is underestimated because of diel movement into or away from an area. Therefore, without diel sampling, the importance of some nearshore habitats may be underestimated; this could have implications for managing nearshore habitats, allowing uninformed management decisions. In high-latitudes, seasonal extremes in day length limit diel sampling opportunities; only a few weeks in a year have sufficient minus tides in the day and night to allow sampling the same nearshore habitats during a single minus tide series. To our knowledge, this study was the first to examine diel differences in fish use of nearshore habitats in Alaska. Our objective in this study was to examine diel differences in fish abundance, species composition and fish size in two vegetated habitats in western Prince William Sound (PWS), Alaska.

Methods

Study site

Prince William Sound is a prominent embayment in the Gulf of Alaska comprising about 5,400 km^2 (Weingartner 2007). Numerous islands within the sound create a mosaic of habitat types including sheltered and rocky shores, fiords, tidewater glaciers, sand and gravel beaches, eelgrass meadows, exposed bedrock outcrops, and cobble beaches with understory kelp. Our study area extended from Ewan Bay to Flemming Island in western PWS (Fig. 1). In each of six locations within our study area, we sampled one eelgrass and one kelp habitat for a total of six eelgrass and six kelp sites.

Eelgrass sites were located inside sheltered coves or bays, whereas kelp sites occupied more exposed areas. Eelgrass sites had flat to moderate gradient (5–10%), and substrates consisted mostly of fine-grained sediments. In western PWS, eelgrass is minimally exposed to air even at the lowest tides (−0.26 m to −0.77 m below mean lower low water, MLLW). Kelp sites had a moderate gradient (10–20%), and substrates were predominantly large cobble, small cobble, and gravel. For kelp sites, the understory kelp (*Saccharina latissima*) (formerly *Laminaria saccharina*) was the most common kelp species; (*Agarum clathratum*) and (*Desmarestia aculeata*) were often secondary species. Nearshore areas adjacent to our eelgrass sites were predominately eelgrass with small amounts of kelp, and areas adjacent to our kelp sites generally had sparse kelp or were non-vegetated with gravel or cobble substrate. Water temperature and salinity (practical salinity unit; PSU) were measured at a depth of approximately 20 cm with a thermometer and a hand-held refractometer. Among eelgrass sites, mean temperature was 12°C (range, 10°C to 14°C) and mean salinity was 18 PSU (range, 16 to 22 PSU). Among kelp sites, mean temperature was 13°C (range, 11°C to 14°C) and mean salinity was 20 PSU (range, 10 to 23 PSU).

Fish capture

We captured fish with a 37-m long variable-mesh beach seine that tapered from 5 m deep at the center to 1 m deep at the wing ends. The outer panels were 10 m long and consisted of 32-mm stretch mesh; the intermediate panels were 4 m long and consisted of 6-mm square mesh; and the bunt was 9 m long and consisted of 3.2-mm square mesh. Each end of the seine had an approximate 5 m length of line attached. We set the seine as a round haul by holding the end of one line on the beach, backing around in a skiff with the other line in an arc back to the beach about 18 m from the starting point, and pulling the seine onto

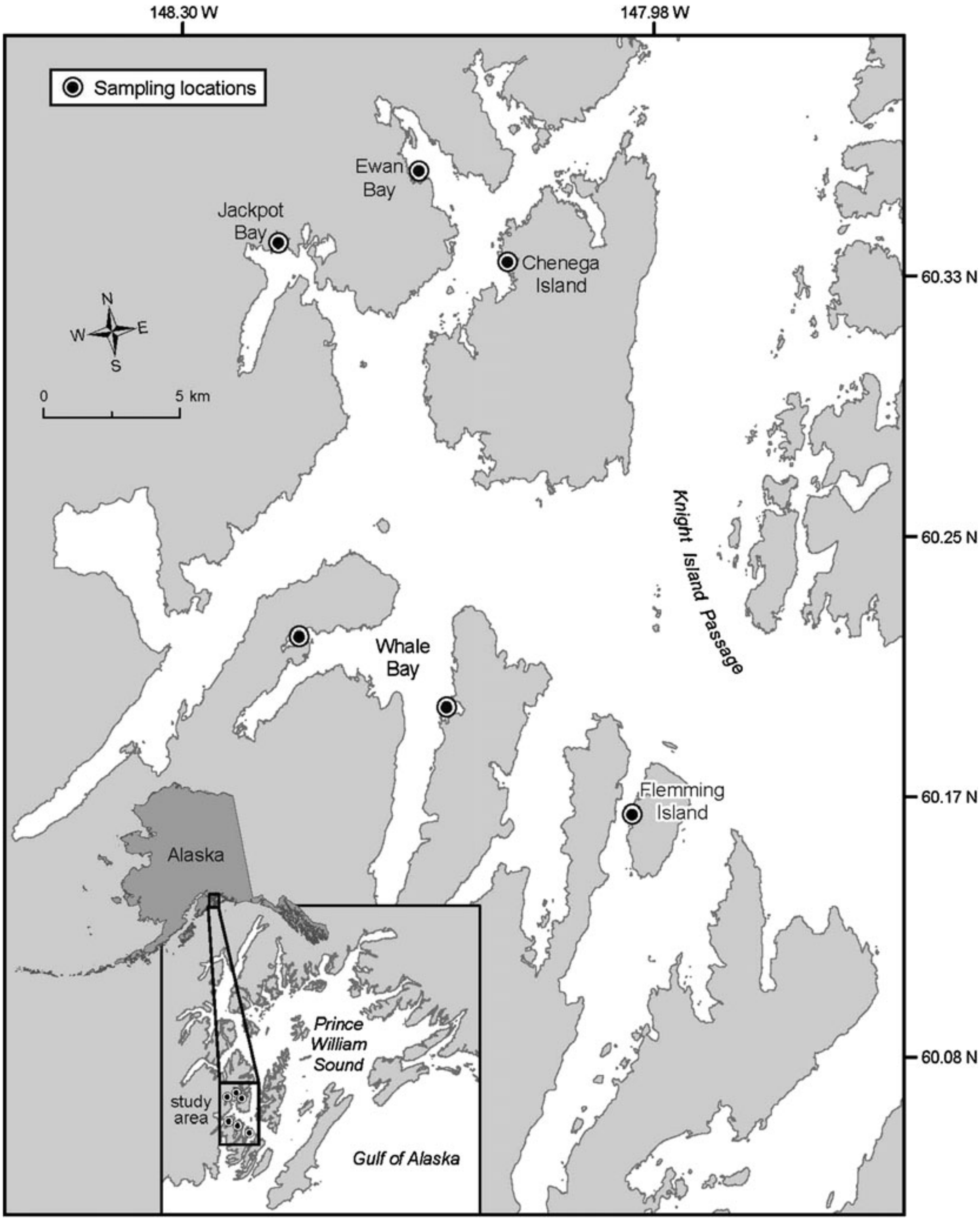

Fig. 1 Six locations in western Prince William Sound, Alaska, sampled with a beach seine during the day and night for nearshore fish assemblages. At each location, eelgrass and kelp habitats were sampled from August 29–September 4, 2007

shore. The maximum distance of the seine from the beach was about 14 m and the area seined was approximately 250 m^2. The seine had a lead line and a float line so that the bottom contacted the substratum and the top floated on the surface. All seine sites were sampled within 2 h of low tide (range, +1.0 m to −1.5 m below MLLW).

Fish were sampled during both the day and night at each location from August 29 to September 4, 2007. These dates were chosen because this was the only time in summer or fall that there were minus tides within a single tide series that occurred during both the day and night. Seining was during minus tides so that the eelgrass and kelp habitats could be most effectively sampled. At each location, one seine set was made in both an eelgrass and an understory kelp site for a grand total of 12 seine hauls; each site was first sampled during the day followed by sampling at night approximately 62 h later. To standardize seine areas, boundaries of each site were marked on the beach with fluorescent pipes during the day so that the boundaries could be located at night and the areas resampled. Only flashlights were used to locate sites at night in order to minimize attracting fish. At night, after each seine haul was secured onshore, battery-powered lights were illuminated onshore, and high-powered halogen lights from an offshore support vessel were turned on to provide illumination needed to process fish catches.

Fish captured were identified to species and enumerated; smaller individuals (<40 mm length) from the families Cottidae, Scorpaenidae, and Liparidae could not be easily identified in the field to species so they were only identified to family. Fork length or total length (depending on species) was measured to the nearest millimeter for a random subsample of most fish species. Selection and number of fish to measure was based on the amount of sampling time available and the type of fish captured (e.g., forage fish and commercially valuable species were given highest priority). Fish were anesthetized in a mixture of one part carbonated water to two parts seawater for identification and measurement.

Data analysis

Differences in total catch per site were tested with two-way analysis of variance (ANOVA). A log transformation of catch data was necessary to stabilize variance and normalize data. Differences in species richness (number of species) and species diversity (Menhinick's index) were calculated for each site. Menhinick's index was calculated by:

$$D = \frac{s}{\sqrt{N}},$$

where s equals the number of different species in a sample, and N equals the total number of fish in a sample. Differences in species richness and diversity between day and night and between habitats were tested with one-way ANOVA. The level of significance for all tests was $\alpha=0.05$. Juvenile sculpins and juvenile rockfish were counted in the total catch, but were not considered a separate species for species richness and diversity calculations because at least one identifiable species of sculpin was captured in all seine hauls; juvenile snailfish were considered a separate species because no identifiable species from the family Liparidae was captured. To test for differences in species composition between habitats and between day and night, we conducted an analysis of similarity (ANOSIM), using a Bray-Curtis similarity matrix of samples (Clarke and Green 1988). To determine which species contributed most to the similarity and dissimilarity between habitats and between day and night, a similarity percentages analysis (SIMPER) was used (Clarke 1993). Frequency of occurrence (FO) was determined for all species; FO represents the number of seine hauls in which a species was captured divided by the total number of seine hauls multiplied by 100.

Results

Catch

Total catch was dominated by saffron cod (*Eleginus gracilis*) in eelgrass and by saffron cod and Pacific herring in kelp. Overall, total catch (day and night combined) was significantly greater ($P<0.01$) in eelgrass (947 fish) than in kelp (234 fish); within each habitat, however, catches were similar ($P>0.05$) between day and night (Fig. 2). A total of 1,181 fish representing 32 species were captured during both day and night; 629 fish representing 20 species during the day and 552 fish representing 30 species at night. Overall, saffron cod was numerically the dominant species comprising 45% of the total catch in eelgrass and kelp. Saffron cod comprised 57% of the catch during the day and 40% at night in eelgrass, and 6% of the catch during the day and 46% at night in kelp. Pacific herring was the most abundant species in kelp during the day comprising 38% of the catch. Some species were exclusively caught in only one habitat or only during the day or night. Nine species were unique to eelgrass and ten species were unique to kelp (Table 1). Of the 32 total species captured in both

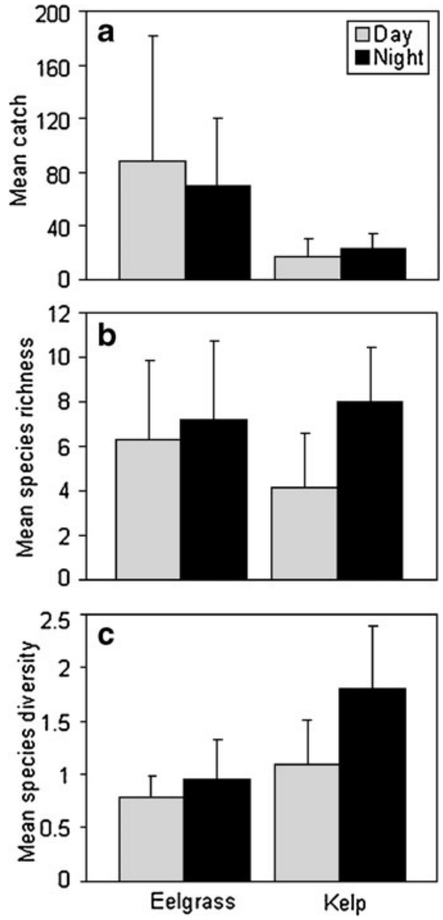

Fig. 2 **a** Mean catch (+ SD) of fish, **b** mean species richness (mean number of species) (+ SD), and **c** mean species diversity (Menhinick's index) (+ SD) by habitat sampling time at six locations in western Prince William Sound, Alaska, August 29–September 4, 2007. At each location, both habitats were sampled once during the day and night; n=6 for each habitat

habitats, 12 were caught exclusively at night, albeit in low numbers: 6 were unique to kelp, 3 were unique to eelgrass, and 3 were captured in both habitats.

Frequency of occurrence was similar between day and night in eelgrass but differed in kelp (Table 1). For example, FO of saffron cod was 100% in eelgrass in both the day and night, and at least 67% in the day or night for crescent gunnel (*Pholis laeta*), tubesnout (*Aulorhynchus flavidus*), bay pipefish (*Syngnathus leptorhynchus*), and manacled sculpin (*Synchirus gilli*). In kelp, FO was higher at night than during the day for saffron cod (100% vs. 17%), crescent gunnel (100% vs. 67%), and whitespotted greenling (*Hexagrammos stelleri*) (50% vs. 17%). For Pacific herring, including both day and night sampling, FO was higher in kelp (50%) than in eelgrass (17%).

Species composition

Species composition varied by habitat and between the day and night. Pairwise tests showed significant differences in species composition between eelgrass and kelp in the day (ANOSIM: r=0.478, P<0.01) and at night (ANOSIM: r=0.334, P<0.05) (Fig. 3). The species contributing most to differences during the day (80%) were saffron cod, tubesnout, manacled sculpin, Pacific herring, and crescent gunnel and to differences at night (78%) were saffron cod, bay pipefish, crescent gunnel, tubesnout, and manacled sculpin. Species composition was significantly different in kelp between day and night (ANOSIM: r=0.307, P<0.05) but was similar for eelgrass (ANOSIM: r=−0.104, P=0.83). The species contributing most to the diel differences in kelp (71%) were saffron cod, Pacific herring, crescent gunnel, padded sculpin (*Artedius fenestralis*), and bay pipefish.

Saffron cod contributed the most to species similarity among sampling sites. During the day and night at eelgrass sites and during the night at kelp sites, saffron cod accounted for about 60% of similarity among sampling sites. In eelgrass, saffron cod, tubesnout, crescent gunnel, and bay pipefish accounted for 92% of similarity for catches during the day; saffron cod, crescent gunnel, and tubesnout accounted for 93% of similarity for catches at night. In kelp, crescent gunnel, padded sculpin, Pacific herring, and juvenile sculpins (Cottidae) accounted for 98% of similarity for catches during the day; saffron cod, crescent gunnel, juvenile sculpins, pink salmon, Pacific herring, and whitespotted greenling accounted for 91% of similarity for catches at night.

Species richness and diversity varied between habitats and between day and night. In eelgrass, mean species richness was similar (P=0.75) in the day (6) and night (7), whereas in kelp, mean species richness was significantly greater (P<0.05) at night (8) than during the day (4) (Fig. 2). The total number of species captured during the day was 14 in eelgrass and 13 in kelp, and at night was 19 in eelgrass and 22 in kelp (Table 1). Species diversity was significantly (P<0.01) greater in kelp (D=1.44) than in eelgrass (D=0.87) sites (Fig. 2). In kelp, species diversity was

Table 1 Mean catch per haul, standard deviation (SD), and frequency of occurrence (FO, %) of fish captured with a beach seine during the day and night in eelgrass and kelp habitats in western Prince William Sound, Alaska, August 29–September 4, 2007

Taxon		Day						Night					
		Eelgrass			Kelp			Eelgrass			Kelp		
		Catch/haul	SD	FO	Catch/haul	SD	FO	Catch/haul	SD	FO	Catch/haul	SD	FO
Saffron cod	*Eleginus gracilis*	50.7	77.1	100	1.0	2.4	17	27.5	18.7	100	9.5	7.3	100
Bay pipefish	*Syngnathus leptorhynchus*	7.5	12.7	67	0.3	0.8	17	15.8	1.4	67	2.0	3.1	17
Crescent gunnel	*Pholis laeta*	4.3	3.7	67	4.2	4.6	67	11.8	29.6	100	1.8	1.3	100
Tubesnout	*Aulorhynchus flavidus*	12.5	16.5	67				8.0	10.2	83			
Manacled sculpin	*Synchirus gilli*	9.2	19.2	33				1.3	2.8	33			
Pacific herring	*Clupea pallasii*	0.3	0.8	17	6.3	9.3	50				1.2	1.9	50
Padded sculpin	*Artedius fenestralis*	0.2	0.4	17	2.0	2.4	67	0.7	0.8	50	1.0	1.9	33
Threespine stickleback	*Gasterosteus aculeatus*	1.2	1.2	67	0.3	0.8	17	0.7	0.8	50	0.3	0.5	17
Juvenile sculpin	Cottidae	0.2	0.4	17	0.8	1.0	50	0.2	0.4	17	0.7	0.5	17
Snake prickleback	*Lumpenus sagitta*	0.3	0.5	33				0.8	2.0	17			
Coho salmon	*Oncorhynchus kisutch*										1.0	2.0	33
Crested sculpin	*Blepsias bilobus*	0.7	1.6	17				0.3	0.8	17			
Whitespotted greenling	*Hexagrammos stelleri*				0.2	0.4	17	0.2	0.4	17	0.7	2.0	50
Tidepool sculpin	*Oligocottus maculosus*	0.5	0.5	50				0.3	0.5	33			
Brown Irish lord	*Hemilepidotus spinosus*				0.3	0.5	33				0.3	2.8	17
Copper rockfish	*Sebastes caurinus*	0.2	0.4	17							0.5	0.5	50
Frog sculpin	*Myoxocephalus stelleri*							0.5	0.8	33	0.2	0.4	17
Masked greenling	*Hexagrammos octogrammus*	0.2	0.4	17	0.2	0.4	17	0.2	0.4	17	0.2	0.4	17
Scalyhead sculpin	*Artedius harringtoni*				0.2	0.4	17	0.2	0.4	17	0.3	0.4	33
Arctic shanny	*Stichaeus punctatus*				0.3	0.5	33				0.2	0.4	17
Lingcod	*Ophiodon elongatus*							0.3	0.8	17	0.2	0.4	17
Northern sculpin	*Icelinus borealis*							0.2	0.4	17	0.3	0.5	33
Pink salmon	*Oncorhynchus gorbuscha*										0.5	0.5	50
Sailfin sculpin	*Platichthys stellatus*										0.5	0.4	33
Searcher	*Bathymaster signatus*				0.2	0.4	17				0.3	0.5	33
Juvenile rockfish	Scorpaenidae	0.3	0.5	33									
Pacific cod	*Gadus macrocephalus*										0.3	0.5	33
Walleye pollock	*Theragra chalcogramma*										0.3	1.9	33
Capelin	*Mallotus villosus*							0.2	0.4	17			
Juvenile snailfish	Liparidae										0.2	0.4	17
Pacific sand lance	*Ammodytes hexapterus*							0.2	0.4	17			
Quillback rockfish	*Sebastes maliger*							0.2	0.4	17			
Painted greenling	*Oxylebius pictus*				0.2	0.4	17						
Sockeye salmon	*Oncorhynchus nerka*	0.2	0.4	17									

Blank spaces represent the absence of a taxon

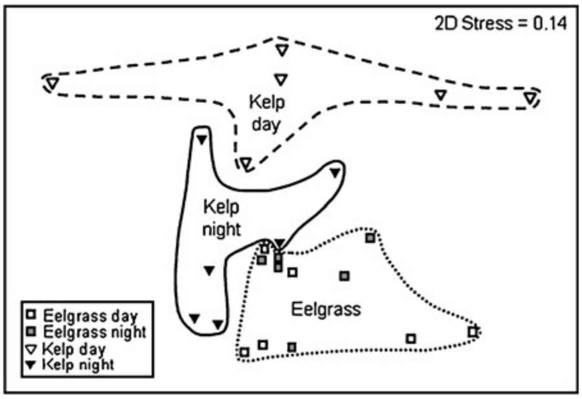

Fig. 3 Non-metric multidimensional scaling ordination of fish assemblages based on fish abundance for fish captured with a beach seine in eelgrass and kelp habitats at six locations in western Prince William Sound, Alaska, August 29–September 4, 2007. At each location, both habitats were sampled once during the day and night; n=6 for each habitat

significantly different (P<0.05) between day (D=1.35) and night (D=1.57) but was similar (P>0.05) in eelgrass (day, D=0.78; night, D=0.94).

Fish length and life stage

Fish size varied between day and night for the numerically dominant species in each habitat, saffron cod and Pacific herring (Table 2). In eelgrass, mean length of saffron cod was similar (P=0.56) during the day and night, but in kelp was significantly (P<0.05) larger during the day (152 mm) than at night (120 mm). Pacific herring, however, was significantly (P<0.001) greater at night (41 mm) than during the day (81 mm) in kelp. Captured fish were predominately juveniles, although adults of some species such as frog sculpin (*Myoxocephalus stelleri*), bay pipefish, crescent gunnel, and snake prickleback (*Lumpenus sagitta*) were captured diurnally and nocturnally.

Discussion

The importance of a particular habitat to nearshore fishes can be best assessed by both diurnal and nocturnal sampling. Different fish species may utilize a particular habitat more at night and in greater numbers than during the day, but in Alaska, most sampling of nearshore habitats has been limited to daytime hours (Dean et al. 2000; Johnson et al. 2003; Johnson and Thedinga 2005). In terms of absolute numbers, our catches were similar between the day and night in eelgrass and kelp. Other studies have shown, however, increased numbers of fish in shallow nearshore waters at night compared to day (Horn 1980; Bayer 1981; Keats 1990; Gibson et al. 1996; Grant and Brown 1998; Unsworth et al. 2007). Some species such as Atlantic cod move into shallow nearshore waters to feed at night (Keats 1990; Cote et al. 2001), while others may seek nearshore vegetated habitats for nighttime refuge (Unsworth et al. 2007). In addition, the abundance of some species may change between day and night depending on season (Horn 1980; Bayer 1981; Pessanha et al. 2003). The abundance of some species changed between day and night in our study, but we sampled only during a 1-week period in late August; sampling at other times of the year may yield different results.

Fish assemblage structure is another measure of how nearshore habitats may be utilized differently between day and night. In the present study, species richness and species diversity increased at night compared to the day in kelp but were the same in eelgrass. Species composition also varied between eelgrass and kelp in the day and night and in kelp between day and night. Eelgrass may offer better cover than kelp, therefore nighttime darkness may be more important to fish as an aid for refuge in kelp habitat. The increase of fish species at night in nearshore vegetated and non-vegetated habitats has also been noted by others (Horn 1980; Layman 2000; Griffiths 2001; Unsworth et al. 2007). A similar species richness between day and night in vegetated nearshore habitats, however, was reported by Bayer (1981) and Jackson et al. (2002). Kopp et al. (2007) suggests that the type of adjacent habitat can affect the diel change in fish assemblage in seagrass fish communities; when coral reefs were adjacent to seagrass beds, species richness increased at night in seagrass beds, whereas if mangroves were nearby, fish assemblages were similar in seagrass beds between day and night. Nearshore areas adjacent to our eelgrass sites were predominately eelgrass with small amounts of kelp, and areas adjacent to our kelp sites generally had sparse kelp or were non-vegetated with gravel or cobble substrate and no offshore reefs. In our study, although there were ten species caught in low numbers exclusively at night in kelp, changes in species composition between day and night was primarily because of the change in abundance of the

Table 2 Total catch, number measured (n), mean fork or total length (mm), and length range of fish captured with a beach seine during the day and night in eelgrass and kelp habitats in western Prince William sound, Alaska, August 29–September 4, 2007

Taxon	Eelgrass—Day				Eelgrass—Night				Kelp—Day				Kelp—Night			
	Catch	Length			Catch	Length			Catch	Length			Catch	Length		
		n	Mean	Range		n	Mean	Range		n	Mean	Range		n	Mean	Range
Saffron cod	304	146	107	79–247	165	160	112	81–265	6	6	152	103–256	57	57	120	80–240
Bay pipefish	45	1	240		95	0			2	0			12	0		
Crescent gunnel	26	0			71	0			25	0			11	0		
Tubesnout	75	12	127	56–162	48	10	140	74–172								
Manacled sculpin	55	5	17	15–18	8	3	30	20–42								
Pacific herring	2	2	67	57–76					38	24	50	27–90	7	7	83	41–130
Padded sculpin	1	0			4	4	91	70–104	12	12	49	18–91	6	1	90	
Threespine stickleback	7	5	28	23–32	4	2	25	25–25	2	2	40	39–40	2	0		
Juvenile sculpin	1	1	20		1	0			5	0			4	0		
Snake prickleback	2	1	234		5	1	270									
Coho salmon													6	6	140	120–162
Crested sculpin	4	4	135	127–140	2	2	152	150–154								
Whitespotted greenling					1	1	250		1	1	141		4	4	176	138–238
Tidepool sculpin	3	1	39		2	2	54	52–56								
Brown Irish lord									2	2	80	75–85	2	2	127	113–140
Copper rockfish	1	1	83										3	3	90	80–100
Frog sculpin					3	3	252	102–365					1	0		
Masked greenling	1	1	190		1	1	80		1	1	103		1	1	238	
Scalyhead sculpin					1	1	77		1	1	50		2	2	53	38–67
Arctic shanny									2	1	102		1	1	88	
Lingcod					2	2	323	320–325					1	1	121	
Northern sculpin					1	1	55						2	1	65	
Pink salmon													3	3	132	120–142
Sailfin sculpin													3	3	107	93–120
Searcher									1	1	93		2	0		
Juvenile rockfish	2	2	18	16–19												
Pacific cod													2	2	147	99–195
Walleye pollock													2	2	82	72–92
Capelin					1	1	105									
Juvenile snailfish													1	1	30	
Pacific sand lance					1	1	89									
Quillback rockfish					1	1	92									
Painted greenling									1	1	27					
Sockeye salmon	1	1	29													

Blank spaces represent the absence of a taxon

two dominant species, saffron cod and Pacific herring. Changes in species composition between habitats was primarily because of the presence or absence of the six most dominant species, of which three were only captured in eelgrass. Pessanha et al. (2003) also found that changes in fish assemblages were mainly due to changes in the occurrence of several of the dominant species.

Size of fish in nearshore habitats can vary between diurnal and nocturnal sampling. Size of two of the dominant species in this study showed differing trends between habitats. In eelgrass, mean length of saffron cod was similar between day and night, whereas in kelp, saffron cod were larger during the day than at night. Mean length of Pacific herring was greater at night than during the day in kelp. In Newfoundland, more and larger Atlantic cod were captured with a beach seine at night than during the day (Methven and Bajdik 1994). Mean fish size was greater in deep channels adjacent to seagrass beds at night compared to during the day (Griffiths 2001), but Horn (1980) caught similar size fish during day and night sampling in eelgrass. Larger Atlantic cod move from vegetated habitats in the day to more open sand-gravel nearshore areas at night (Keats 1990; Cote et al. 2001). Larger fish in Alaskan waters may move into nearshore habitats with less cover at night, where prey may be easier to capture than in habitats with more cover such as eelgrass.

Diel sampling is difficult in nearshore areas of Alaska and other high-latitude areas because seasonal extremes in day length limit diel sampling opportunities. Diurnal and nocturnal minus tides rarely occur in the same tide series, and only two tidal windows were suitable for our diel study, spring and late summer. Without diel sampling, however, the importance of some habitats may be underestimated, allowing uninformed management decisions to be made. We found that fish assemblages and size of fish can differ between day and night, particularly in kelp habitats in summer. Diel sampling throughout the world, including other areas of Alaska and during different times of the year would further identify nearshore habitats essential to fish and help manage fish stocks at risk.

Acknowledgements We thank Fletcher Sewall and Ashwin Sreenivasan for help with field work, the crew of the R/V *Solstice* for vessel support, and Adam Moles and Jacek Maselko for reviewing this manuscript. Funding for this research was provided by the North Pacific Research Board (Project 642, Publication #261) and the NOAA Fisheries Essential Fish Habitat Program.

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