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PARASITES OF FORAGE FISHES IN THE VICINITY OF STELLER SEA LION (*EUMETOPIAS JUBATUS*) HABITAT IN ALASKA

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ABSTRACT: Fish serve as intermediate hosts for a number of larval parasites that have the potential of maturing in marine mammals such as Steller sea lions (*Eumetopias jubatus*). We examined the prevalence of parasites from 229 fish collected between March and July 2002 near two islands used by Steller sea lions in Southeast Alaska and island habitats in the Aleutian Islands. Sea lion populations have remained steady in Southeast Alaska but have been declining over the last 30 yr in the Aleutian Islands. Even though the fish samples near the Southeast Alaska haul-outs were composed of numerous small species of fish and the Aleutian Islands catch was dominated by juveniles of commercially harvested species, the parasite fauna was similar at all locations. Eleven of the 20 parasite taxa identified were in their larval stage in the fish hosts, several of which have been described from mammalian final hosts. Four species of parasite were more prevalent in Southeast Alaska fish samples, and seven parasite species, including several larval forms capable of infecting marine mammals, were more prevalent in fish from the Aleutian Islands. Nevertheless, parasites available to Steller sea lions from common fish prey are not likely to be a major factor in the decline of this marine mammal species.

Key words: Alaska, Aleutian Islands, *Corynosoma* sp., forage fish, parasites, Steller sea lions.

INTRODUCTION

Parasites can act to regulate aquatic populations. There is increasing evidence that parasites may in fact be as important as competition and predation in structuring animal communities (Minchella and Scott, 1991). Present throughout the food web, parasites are a major component of the ecosystem and can exert influence on their hosts in a variety of ways, ranging from mortality to behavioral changes. Larval helminths may, once transmitted from their fish intermediate hosts, grow considerably as they mature in their final mammalian or avian hosts. They can also, in concert with factors such as predation, food limitation, or climate change, act as a compensatory or additive stress on their final hosts (Azar et al., 2001).

Marine mammals that feed on fish are the final hosts for a wide variety of parasitic helminths. Larval worms encyst in the viscera and muscles in fish, and the life cycle is complete when the helminth is consumed by the mammal. One of the predators of fish in the northeastern Pacific Ocean is the Steller sea lion (*Eumetopias jubatus*), a marine mammal whose abundance in the last decade has been declining at a rate of 5% per year in the western regions of the Gulf of Alaska. This follows an 80% drop in abundance since the late 1970s (Loughlin and York, 2000). In contrast, Steller sea lions in Southeast Alaska have increased by 1–2% per year during the same period (Calkins et al., 1999). Results of mitochondrial DNA studies suggest that these are two distinct stocks (Bickham et al., 1996).

Hypotheses advanced to account for the recent declines in the western stock of Steller sea lions include poor recruitment, nutritional stress, predation, and disease (National Research Council, 2003). The western stock feeds largely on walleye Pollock, *Theragra chalcogramma* (Pallas, 1814), and Atka mackerel, *Pleurogrammus monopterygius* (Pallas, 1810), whereas sea lions in the eastern stock feed on a diverse diet of forage fishes in addition to walleye pollock (Merrick et al., 1997). This difference in diet suggests that the sea lions could be acquiring a different suite of

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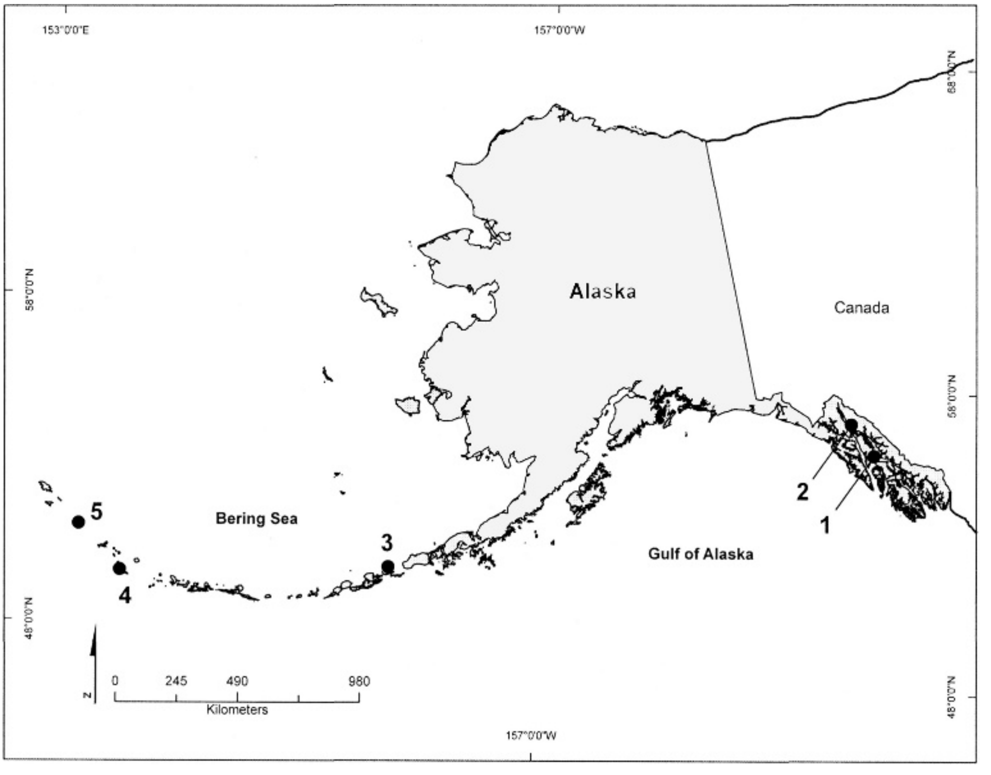

FIGURE 1. Map of the study area in the northeastern Pacific Ocean. Sample locations are numbered. 1. Brothers Island. 2. Benjamin Island. 3. Akun Island. 4. Amchitka Island. 5. Buldir Island.

parasites, some of which could have the potential to be detrimental. Parasitic infections are, along with drowning in nets, gunshot wounds, and predation, a source of adult mortality in Steller sea lions (Loughlin et al., 1987). Large numbers of gastrointestinal helminths have been previously noted in a number of pinnipeds that have died (Ridgway et al., 1975) and some species of nematodes and acanthocephalans are capable of causing ulcerations of the gastric mucosa in Steller sea lions (Liu and Edwards, 1971; Shults, 1986; Haebler and Moeller, 1993). For a population such as the Aleutian Steller sea lion that has poor recruitment, any disruption of gastric functions might limit recovery.

The objective of the present study was to compare the parasite fauna of fish around the thriving Southeast Alaska haul-outs and the declining rookeries in the Aleutian Islands to document the parasites present in the fishes near these habitats. Specifically we compared the prevalence of various fish parasites that occur among the common prey species available to the sea lions. Differences in the availability of parasites between the two regions may provide some insight about the probability of these parasites playing a role in the health of sea lion populations.

MATERIALS AND METHODS

Twenty species of fish were collected between 27 March 2002 and 25 July 2002 near five Steller sea lion haul-outs in the Gulf of Alaska (Fig. 1). Haul-outs are those sites where sea lions rest on land but no pups are born. Two of the haul-outs, Benjamin Island and the Brothers Islands, are only 118 km apart in the inside waters of Southeast Alaska with an estimated population of 286 and 74 sea lion residents, respectively. Because of their

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proximity, these sites were treated as a single sampling area. Fish at these sites were captured by midwater trawl, beach seine, and jigging with depth of captures ranging from 5 m to 105 m (Table 1). All fish were frozen for later examination. The three rookeries in the Aleutian Islands, Akun, Amchitka, and Buldir islands, are widely dispersed, with the farthest away of the islands separated by over 1,000 km. Rookeries are sites where mating and birth take place, so only sexually mature individuals and pups are usually present. Fish at these sites were collected with a bottom trawl at depths ranging from 74 m to 160 m as part of a major survey of commercial fish distributions and abundance (Table 1). Sea lions typically forage within 16 km of these habitats (Fadely et al., 2005) and as deep as 288 m, although average diving depths are 26 m for pups and 63 m for yearlings (Loughlin et al., 2003.).

In the laboratory, fish were examined for external parasites and then partially thawed to remove the kidneys, liver, stomach, intestine, gills, and mesenteries. The body cavity was rinsed and examined visually for any parasites. The removed tissues were examined stereomicroscopically and then digested in a 0.7% acidic pepsin solution. The resultant slurry was sieved and examined for parasites. The filleted muscle tissue was diced into 2-g pieces and also digested. In the case of the Aleutian Islands fish, only 200 g of the diced muscle was digested. Total necropsies, which included eyes, brain, urinary and gall bladders, gonads, spleen, heart, and the entire musculature were only performed on five specimens of each species of fish to confirm that these were not common sites of infection for larval parasites. Fish that were not subject to total necropsy were then returned to the freezer for their original intended use, proximate analysis. Voucher specimens were deposited in the National Marine Fisheries Service Auke Bay Laboratory Museum (accession number AB06-333). Because the partial necropsies only give a sample of the types of parasites encountered rather than a total count, we report only parasite prevalence (percentage of fish infected with a given parasite). Prevalence data has the advantage of being potentially stable over time for some host–parasite combinations (Azar et al., 2001). Some fresh fish were examined to obtain parasite specimens for taxonomic purposes. Parasite prevalence values for fish from a given region were pooled and chi-square and Fisher's exact tests were used to test for significance.

RESULTS

Twenty-two species of parasites were found in the fish from the four locations: two protozoa, one monogenetic trematode, seven digenetic trematodes, four each of cestodes and nematodes, and two each of acanthocephalans and copepods (Tables 2 and 3). Fixed specimens of the larval acanthocephalan were all identified as *Corynosoma strumosum,* but it proved impractical to identify the remainder of the larval parasites below the generic level. A few specimens of the 22 species were found on other organs during the complete necropsies, but no additional taxa were present. All of the parasites found have been previously reported from Canadian (McDonald and Margolis, 1995) waters, but this is the first time most of these host–parasite associations have been reported in Alaskan waters. The most frequently encountered parasites were the larval nematodes. *Anisakis* sp. larvae were associated with the intestines, mesenteries, and, sometimes, musculature digests. Low intensities of larval *Pseudoterranova* sp. were common in the muscle tissue, and the adult nematode *Hysterothylacium aduncum* was found in many of the examined intestines. The copepods and monogenetic trematodes were encountered on the gills, the microsporidian *Pleistophora* sp. were encysted in muscle, the myxosporean *Zschokkella* sp.was located in kidney smears, and all other parasites were found in samples from the digestive tract.

Four species were statistically more prevalent ($P<0.05$) in the Southeast Alaska samples: *Pleistophora* sp., *Lecithaster gibbosus*, *Tubulovesicula lindbergi*, and *Phyllobothrium* sp. In contrast, seven species were statistically more prevalent in the Aleutian Island samples: *Steganoderma formosum*, *Abothrium gadi*, *Anisakis* sp., *Hysterothylacium aduncum*, *Pseudoterranova* sp., *Corynosoma* sp., and *Echinorhynchus gadi*. The larval nematodes *Anisakis* sp. and *Pseudoterranova*

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TABLE 1. Location, depth, capture data, and mean size (±standard deviation) of fishes captured near Steller sea lion haul-outs in the Gulf of Alaska. MWT = midwater trawl, BT = bottom trawl.

Species	Location (island)	Coordinates	Capture method	Modal depth (m)	Capture date	*n*	Mean length (cm)
Ammodytes hexapterus	Brothers	57°18′N, 133°50′W	Seine	5	12 July 2002	10	13±0.8
Clupea pallasii	Brothers	57°18′N, 133°22′W	MWT	5	3 June 2002	4	18±1.3
Gadus macrocephalus	Brothers	57°18′N, 133°48′W	Jig	10	15 July 2002	13	26±3.4
Sebastes ciliatus	Brothers	57°18′N, 133°52′W	Jig	52	11 July 2002	11	26±1.7
Thaleichthys pacificus	Brothers	57°12′N, 133°33′W	MWT	78	29 May 2002	10	18±1.3
Theragra chalcogramma	Brothers	57°18′N, 133°53′W	MWT	90	27 May 2002	18	30±5.3
Ammodytes hexapterus	Benjamin	58°34′N, 134°55′W	Seine	5	24 July 2002	10	7±0.3
Clupea pallasii	Benjamin	58°27′N, 134°37′W	MWT	40	23 May 2002	7	22±1.8
Lepidopsetta bilineata	Benjamin	58°31′N, 134°50′W	Seine	5	25 July 2002	20	30±4.6
Mallotus villosus	Benjamin	58°34′N, 134°53′W	MWT	105	27 March 2002	10	12±0.8
Theragra chalcogramma	Benjamin	58°27′N, 133°47′W	MWT	68	23 May 2002	11	37±4.5
Atherestes stomias	Akun	54°25′N, 165°31′W	BT	83	19 May 2002	9	51±13.3
Gadus macrocephalus	Akun	54°25′N, 165°31′W	BT	83	19 May 2002	6	61±9.2
Pleurogrammus monopterygius	Akun	54°25′N, 165°31′W	BT	83	19 May 2002	21	39±2.3
Theragra chalcogramma	Akun	54°25′N, 165°31′W	BT	83	19 May 2002	22	47±2.7
Gadus macrocephalus	Amchitka	51°30′N, 178°40′W	BT	160	25 June 2002	11	45±9.6
Pleurogrammus monopterygius	Amchitka	51°30′N, 178°40′W	BT	160	25 June 2002	15	38±2.3
Theragra chalcogramma	Amchitka	51°30′N, 178°40′W	BT	160	25 June 2002	13	20±6.5
Gadus macrocephalus	Buldir	52°15′N, 176°01′W	BT	137	10 July 2002	3	78±5.5
Pleurogrammus monopterygius	Buldir	52°20′N, 175°52′W	BT	74	9 July 2002	15	34±4.6

sp. were found in 95% and 54%, respectively, of the Aleutian Islands samples. Of the 22 species, the trematode *S. formosum* was absent from Southeast Alaska samples whereas the trematode *T. lindbergi* and protozoan *Zschokkella* sp. were absent from Aleutian Islands samples. For walleye pollock, the one species common to both collections, only *Pleistphora* sp. and *Phyllobothrium* sp. were present in significantly greater proportions among Southeast Alaska fishes. Prevalences of the other parasites in pollock did not differ between regions.

DISCUSSION

There is every indication from scat analysis done by previous investigators that the fish species examined in this

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TABLE 2. Prevalence of parasites, expressed as number of fish infected/number of fish examined and as percent (%) infected, recovered from forage fish in the vicinity of Steller sea lion haul-outs in Southeast Alaska.

	Fish species							
	Ammodytes hexapterus	*Clupea pallasi*	*Gadus macrocephalus*	*Lepidopsetta bilineata*	*Mallotus villosus*	*Sebastes ciliatus*	*Thaleichthys pacificus*	*Therargra chalcogramma*
Protozoa								
Pleistophora sp.	0/20 (0%)	0/11 (0%)	3/13 (23%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	6/29 (21%)
Zschokkella sp.	0/20 (0%)	0/11 (0%)	0/13 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	3/29 (10%)
Monogenea								
Entobdella hippoglossi	0/20 (0%)	0/11 (0%)	0/13 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Digenea								
Brachyphallus crenatus	0/20 (0%)	4/11 (36%)	0/13 (0%)	4/20 (20%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Bucephalid metacercariae	0/20 (0%)	3/11 (27%)	0/13 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Derogenes varicus	0/20 (0%)	0/11 (0%)	0/13 (0%)	4/20 (20%)	0/10 (0%)	1/11 (9%)	0/10 (0%)	0/29 (0%)
Lecithaster gibbosus	12/20 (60%)	0/11 (0%)	12/13 (92%)	1/20 (5%)	1/10 (10%)	0/11 (0%)	1/10 (10%)	0/29 (0%)
Podocotyle sp.	0/20 (0%)	0/11 (0%)	0/13 (0%)	2/20 (10%)	0/10 (0%)	2/11 (18%)	0/10 (0%)	8/29 (28%)
Steganoderma formosum	0/20 (0%)	0/11 (0%)	0/13 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Tubulovesicula lindbergi	0/20 (0%)	0/11 (0%)	1/13 (8%)	20/20 (100%)	0/10 (0%)	8/11 (73%)	0/10 (0%)	0/29 (0%)
Cestoda								
Abothrium gadi	0/20 (0%)	0/11 (0%)	3/13 (23%)	0/20 (0%)	0/10 (0%)	0/11 (0/11)	0/10 (0%)	1/29 (3%)
Nybelinia surmenicola	0/20 (0%)	0/11 (0%)	5/13 (38%)	2/20 (10%)	0/10 (0%)	6/11 (55%)	0/10 (0%)	15/29 (52%)
Phyllobothrium sp.	2/20 (10%)	2/11 (18%)	0/13 (0%)	0/20 (0%)	1/10 (10%)	0/11 (0%)	2/10 (20%)	4/29 (14%)
Scolex sp.	0/20 (0%)	1/11 (9%)	0/13 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Nematoda								
Anisakis sp.	4/20 (20%)	6/11 (55%)	13/13 (100%)	13/20 (65%)	6/10 (60%)	3/11 (27%)	2/10 (20%)	28/29 (97%)
Contracaecum sp.	0/20 (0%)	2/11 (18%)	2/13 (15%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	2/10 (20%)	6/29 (21%)
Hysterothylacium aduncum	0/20 (0%)	3/11 (27%)	5/13 (38%)	6/20 (30%)	1/10 (10%)	1/11 (9%)	0/10 (0%)	18/29 (62%)
Pseudoterranova sp.	0/20 (0%)	0/11 (0%)	11/13 (85%)	0/20 (0%)	0/10 (0%)	3/11 (27%)	0/10 (0%)	5/29 (17%)
Acanthocephala								
Corynosoma sp.	0/20 (0%)	0/11 (0%)	1/13 (8%)	2/20 (10%)	0/10 (0%)	1/11 (9%)	0/10 (0%)	0/29 (0%)
Echinorhynchus gadi	0/20 (0%)	0/11 (0%)	6/13 (46%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	13/29 (45%)
Crustacea								
Clavella sp.	0/20 (0%)	0/11 (0%)	0/23 (0%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)
Lepeophtheirus parviventris	0/20 (0%)	0/11 (0%)	1/13 (8%)	0/20 (0%)	0/10 (0%)	0/11 (0%)	0/10 (0%)	0/29 (0%)

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study are the primary prey of Steller sea lions at those sites. Steller sea lions around Benjamin and the Brothers islands feed on seasonally available forage fish >17 cm in length, with the species caught in our survey the primary diet items among the 60+ fish species recorded from Steller sea lion scat at those sites (Womble and Sigler, 2007; Trites et al., in press). In the Aleutian Islands, summer diets are dominated by the four species of fish in our sample, especially Atka mackerel (Sinclair and Zeppelin, 2002). The Steller sea lion is an opportunistic carnivore, selecting its prey by availability (Spaulding, 1964). Most of the fish in our samples from both regions were within the 8–64-cm length estimated to be the size range of walleye pollock eaten by sea lions (Frost and Lowry, 1986). Nearly all the fish captured were late-stage juveniles with the exception of the adult arrowtooth flounder (*Atherestes stomias*).

The greater prevalence of larval nematodes and acanthocephalans, the only species in our study that are directly transmitted from fish to marine mammals, in the Aleutian samples is probably related to the different species of fish host from which they were harvested and the availability of infected intermediate and final hosts. The four species of fish sampled from the Aleutian Islands are demersal fishes with periods of benthic feeding. In contrast, the fishes available to sea lions at the Southeast Alaska sites were either feeding pelagically or on the bottom at depths of less than 60 m. The intermediate hosts for these larval parasites may not be part of the routine diet of the Southeast Alaska fishes. Fish caught near the ocean floor, such as the Aleutian Islands fish, are more likely to be benthic feeders, and both acanthocephalans (Margoliese 1995) and some species of Anisakinae (Anderson, 2000) are often associated with the benthic intermediate hosts such as amphipods during at least some of their life cycle. There are also more potential final hosts in the Aleutian Islands, where populations of Steller sea lions, although declining, numbered over 42,000 in 2004 (Fritz and Stinchcomb, 2005). In contrast, the total counts of Steller sea lions in Southeast Alaska remain under 5,000 (Womble et al., 2005). Levels of *Pseudoterranova* sp. and *Corynosoma* sp. infection in Scotian Shelf groundfish are directly related to the densities of grey seal populations (Marcogliese and McClelland, 1992).

Anisakis sp., *Contracaecum* sp., *Pseudoterranova* sp. (as *Phocanema decipiens*), and *Corynosoma* sp. are known to mature in the stomach and intestines of Steller sea lions (Shults, 1986).The nematodes, when occurring in large numbers, have been associated with stomach lesions in some species of marine mammals. The heads of immature *Contracaecum* spp. penetrated the mucosa and submucosa of a Steller sea lion stomach, resulting in an ulcerative lesion (Liu and Edwards, 1971). Gastric lesions, destruction of the overlying mucosa, and inflammation have also been reported for large clusters of immature *Contracaecum* sp. and *Anisakis* sp. in grey seals (*Halichoerus grypus*; Young and Lowe, 1969). *Pseudoterranov*a sp., although associated with ulcerous gastric lesions in harbor seals (*Phoca vitulina*), appears to be nonpathogenic in most of its definitive mammal hosts (McClelland, 1980).

Corynosoma spp. are also less common among Southeast Alaskan fishes—even those with active demersal feeding habits. Species such as *Gadus macrocephalus*, *Lepidopsetta bilineatus*, and *Sebastes ciliatus* are all benthic feeders, but the prevalence of *Corynosoma* sp. in those Southeast Alaska fish samples was ≤10%. The rockfish *Sebastes aleutianus* and *Sebastes borealis* from Southeast Alaska also have a significantly lower prevalence of *Corynosoma* sp. than do specimens collected from outer coast areas of the Gulf of Alaska (Moles et al., 1998). This latitudinal increase in prevalence of *Corynsoma* sp. may be the result of differ-

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TABLE 3. Prevalence of parasites, expressed as number of fish infected/number of fish examined and as percent (%) infected, recovered from forage fishes in the vicinity of Steller sea lion rookeries in the Aleutian Islands.

	Pleurogrammus monopterygius			*Gadus macrocephalus*			*Theragra chalcogramma*		*Atherestes stomias*
	Akun Island	Amchitka Island	Buldir Island	Akun Island	Amchitka Island	Buldir Island	Akun Island	Amchitka Island	Amchitka Island
Protozoa									
Pleistophora sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	1/21 (5%)	0/13 (90%)	0/9 (0%)
Zschokkella sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Monogenea									
Entobdella hippoglossi	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	1/9 (11%)
Digenea									
Brachyphallus crenatus	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	1/11 (9%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Bucephalid metacercariae	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Derogenes varicus	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	2/11 (18%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	2/9 (22%)
Lecithaster gibbosus	0/22 (0%)	2/15 (13%)	0/15 (0%)	0/6 (0%)	3/11 (27%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Podocotyle sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	12/21 (57%)	4/13 (31%)	0/9 (0%)
Steganoderma formosum	0/22 (0%)	0/15 (0%)	1/15 (7%)	0/6 (0%)	2/11 (18%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	3/9 (33%)
Tubulovesicula lindbergi	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Cestoda									
Abothrium gadi	0/22 (0%)	0/15 (0%)	0/15 (0%)	4/6 (67%)	5/11 (45%)	0/3 (0%)	5/21 (24%)	0/13 (0%)	0/9 (0%)
Nybelinia surmenicola	2/22 (9%)	1/15 (7%)	1/15 (7)	5/6 (83%)	8/11 (73%)	1/3 (33%)	10/21 (48%)	0/13 (0%)	3/9 (33%)
Phyllobothrium sp.	1/22 (5%)	0/15 (0%)	0/15 (0%)	1/6 (17%)	0/11 (0%)	0/3 (0%)	0/21 (0%)	0/13 (0%)	0/9 (0%)
Scolex sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	1/11 (9%)	0/3 (0%)	1/21 (5%)	0/13 (0%)	0/9 (0%)
Nematoda									
Anisakis sp.	22/22 (100%)	15/15 (100%)	15/15 (100%)	6/6 (100%)	11/11 (100%)	3/3 (100%)	15/21 (71%)	13/13 (100%)	9/9 (100%)
Contracaecum sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	2/11 (18%)	0/3 (0%)	1/21 (5%)	0/13 (0%)	0/9 (0%)
Hysterothylacium aduncum	0/22 (0%)	0/15 (0%)	0/15 (0%)	6/6 (100%)	10/11 (91%)	3/3 (100%)	14/21 (67%)	12/13 (92%)	3/9 (33%)
Pseudoterranova sp.	16/22 (73%)	10/15 (67%)	11/15 (73%)	5/6 (83%)	9/11 (82%)	3/3 (100%)	2/21 (10%)	2/13 (15%)	4/9 (44%)
Acanthocephala									
Corynosoma sp.	4/22 (18%)	2/15 (13%)	1/15 (7%)	1/6 (17%)	5/11 (45%)	1/3 (33%)	1/21 (5)	1/13 (8%)	6/9 (67%)

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TABLE 3. Continued.

	Pleurogrammus monopterygius			*Gadus macrocephalus*			*Theragra chalcogramma*		*Atheresthes stomias*
	Akun Island	Amchitka Island	Buldir Island	Akun Island	Amchitka Island	Buldir Island	Akun Island	Amchitka Island	Amchitka Island
Echinorhynchus gadi	1/22 (5%)	0/15 (0%)	0/15 (0%)	6/6 (100%)	10/11 (91%)	0/3 (0%)	9/21 (43%)	6/13 (46%)	0/9 (0%)
Crustacea									
Clavella sp.	0/22 (0%)	0/15 (0%)	0/15 (0%)	0/6 (0%)	0/11 (0%)	0/3 (0%)	1/21 (5%)	0/13 (0%)	0/9 (0%)
Lepeophtheirus parviventris	2/22	1/15	0/15	0/6 (0%)	0/11 (0%)	0/3 (0%)	0/21 (0%)	0/13 (0/13)	0/9 (0%)

ences in diet, unfavorable conditions for transmission, or the parasite may be more common in offshore samples than in the inside protected waters of Southeast Alaska. Spatial variations in infection rates for various parasites have been reported for a number of parasite taxa (Marcogliese, 2002), often related to the distribution of the intermediate host.

Acanthocephalans are also capable of causing damage to marine mammals. Adult acanthocephalans of the species *Profilicollis* sp. attach to the mucosa of the small intestine using recurved hooks along the proboscis and have been associated with intestinal perforation and peritonitis in southern sea otters (*Enhydra lutris nereis*; Mayer et al., 2003). It is unlikely that juvenile *Corynosoma* sp. would cause similar damage in Steller sea lions. *Corynosoma* spp. is usually restricted to the intestinal villi and is not associated with any inflammatory host response in southern sea otters. *Corynosoma* sp., even when present in large numbers in the intestines of sea otters, did not cause significant damage (Mayer et al., 2003). When acanthocephalans are removed from sea lion stomachs, a small unperforated ulcer remains (Howard et al., 1983).

Several of the more abundant forage fishes in the Aleutian Islands harbor a greater proportion of nematode and acanthocephalan parasites, some of which are potentially pathogenic and capable of infecting sea lions. Only by knowing how the intensity of infection (total number of worms ingested) differs between sites and how the sea lion hosts might react to infection can we determine if these parasites are constraining recovery. Some parasites known to cause serious health problems in pinnipeds, such as the lungworm *Parafilaroides* or the hookworm *Uncinaria*, would not have been detected by the methods in this study. The data presented should be useful for future work, as variations in the prevalence of fish parasites can provide useful

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information about the trophic role of their host.

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LITERATURE CITED

ANDERSON, R. C. 2000. Nematode parasites of vertebrates: Their development and transmission. CABI Publishing, Wallingford, UK, 672 pp.

AZAR, J., J. A. BALBUENA, M. FERNANDEZ, AND J. A. RAGA. 2001. Living together: The parasites of marine mammals. *In* Marine mammals: biology and conservation, P. G. H. Evans and J. A. Raga (eds.). J. A. Plenum Publishers, New York, New York, pp. 385–423.

BICKHAM, J. W., J. C. PATTON, AND T. R. LOUGHLIN. 1996. High variability for control-region sequences in a marine mammal: Implications for conservation and biogeography of Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy 77: 95–108.

CALKINS, D. G., D. C. MCALLISTER, K. W. PITCHER, AND G. W. PENDELTON. 1999. Steller sea lion status and trend in Southeast Alaska: 1979–1997. Marine Mammal Science 15: 462–477.

FADELY, B. S., B. W. ROBSON, J. T. STERLING, A. GREIG, AND K. A. CALL. 2005. Immature Steller sea lion (*Eumetopias jubatus*) dive activity in relation to habitat features of the eastern Aleutian Islands. Fisheries Oceanography 14: 243–258.

FRITZ, L. W., AND C. STINCHCOMB. 2005. Aerial, ship, and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in the western stock in Alaska, June and July 2003 and 2004. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-AFSC-153. Alaska Fisheries Science Center, Seattle, Washington, 57 pp.

FROST, K. J., AND L. F. LOWRY. 1986. Sizes of walleye pollock (*Theragra chalcogramma*) consumed by marine mammals in the Bering Sea. Fishery Bulletin 84: 192–197.

HAEBLER, R., AND R. B. MOELLER, JR. 1993. Pathobiology of selected marine mammal diseases. *In* Pathobiology of marine and estuarine organisms, advances in fisheries science, J. A. Couch and J. W. Fournie (eds.). CRC Press, Boca Raton, Florida, pp. 217–244.

HOWARD, E. B., J. O. BRITT, AND G. K. MATSUMOTO. 1983. Parasitic diseases. *In* Pathobiology of marine mammal diseases, Vol. I, E. B. Howard (ed.). CRC Press, Boca Raton, Florida, pp. 96–162.

LIU, S.-K., AND A. G. EDWARDS. 1971. Gastric ulcers associated with *Contracaecum* spp. (Nematoda: Ascaroidea) in a Steller sea lion and a white pelican. Journal of Wildlife Diseases 7: 266–271.

LOUGHLIN, T. R., AND A. E. YORK. 2000. An accounting of the sources of Steller sea lion, *Eumetopias jubatus*, mortality. Marine Fisheries Review 62 (4): 40–45.

———, M. A. PEREZ, AND R. L. MERRICK. 1987. *Eumetopias jubatus*. Mammalian species, No. 283. The American Society of Mammalogists, Provo, Utah, 7 pp.

———, J. T. STERLING, ———, J. L. SEASE, AND A. E. YORK. 2003. Diving behavior of immature Steller sea lions (*Eumetopias jubatus*). Fishery Bulletin 101: 566–582.

MARCOGLIESE, D. 2002. Food webs and the transmission of parasites to marine fish. Parasitology 124: S83–S99.

———, AND G. MCCLELLAND. 1992. *Corynosoma wegeneri* (Acanthocephala: Polymorphida) and *Pseudoterranova decipiens* (Nematoda: Ascaridoidea) larvae in Scotian Shelf groundfish, Canadian Journal of Fisheries and Aquatic Sciences 49: 2062–2069.

MAYER, K. A., M. D. DAILEY, AND M. A. MILLER. 2003. Helminth parasites of the southern sea otter *Enhydra lutris nereis* in central California: Abundance, distribution, and pathology. Diseases of Aquatic Organisms 53: 77–88.

MCCLELLAND, G. 1980. *Phocanema decipiens*: Pathology in seals. Experimental Parasitology 49: 405–419.

MCDONALD, T. E., AND L. MARGOLIS. 1995. Synopsis of the parasites of fishes of Canada: Supplement (1978–1993). Canadian Special Publications of Fisheries and Aquatic Sciences, No. 122. National Research Council of Canada, Ottawa, Ontario, Canada, 265 pp.

MERRICK, R. L., M. K. CHUMBLEY, AND G. V. BYRD. 1997. Diet diversity of Steller sea lions (*Eumetopias jubatus*) and their population decline in Alaska: A potential relationship. Canadian Journal of Fisheries and Aquatic Sciences 54: 1342–1348.

MINCHELLA, D. J., AND M. E. SCOTT. 1991. Parasitism: A cryptic determinant of animal population structure. Trends in Ecology and Evolution 6: 250–254.

MOLES, A., J. HEIFETZ, AND D. C. LOVE. 1998. Metazoan parasites as potential markers for selected Gulf of Alaska rockfishes. Fishery Bulletin 96: 912–916.

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NATIONAL RESEARCH COUNCIL. 2003. Decline of the Steller sea lion in Alaskan waters: Untangling food webs and fishing nets. The National Academies Press, Washington, D.C., 216 pp.

RIDGWAY, S. H., J. R. GERACI, AND W. MEDWAY. 1975. Diseases of pinnipeds. Rapports et process-verbaux des Réunions Conseil International pour l'Exploration de la Mer 169: 327–337.

SHULTS, L. M. 1986. Helminth parasites of the Steller sea lion, *Eumetopias jubatus*, in Alaska. Proceedings of the Helminthological Society of Washington 53: 194–197.

SINCLAIR, E. H., AND T. K. ZEPPELIN. 2002. Seasonal and spatial differences in diet of the western stock of Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy 83: 973–990.

SPAULDING, D. 1964. Comparative feeding habits of the fur seal, sea lion, and harbor seal on the British Columbia coast. Fisheries Research Board of Canada Bulletin 146: 1–52.

TRITES, A. W., D. G. CALKINS, AND A. W. WINSLIP. In press. Diets of Steller sea lions (Eumetopias jubatus) in Southeast Alaska from 1993–1999. Fishery Bulletin 105 (2).

WOMBLE, J. N., AND M. F. SIGLER. 2007. The influence of seasonally abundant, density aggregated prey on the diet and abundance of an aquatic carnivore, the Steller sea lion. Marine Ecology Progress Series 325: 281–283.

———, M. F. WILSON, M. F. SIGLER, B. P. KELLY, AND G. R. VANBLARICOM. 2005. Distribution of Steller sea lions *Eumetopias jubatus* in relation to spring-spawning fish in SE Alaska. Marine Ecology Progress Series 294: 271–282.

YOUNG, P. C., AND D. LOWE. 1969. Larval nematodes from fish of the subfamily Anisakinae and gastrointestinal lesions in mammals. Journal of Comparative Pathology 79: 301–313.

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