Chapter 7: Socioeconomic considerations

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Introduction

Sea otters have a wide array of strong direct and indirect effects on coastal ecosystems of the North Pacific Ocean and southern Bering Sea (see Chapter 5 for an overview). Accordingly, the nearshore coastal ecosystems within this region that now lack sea otters are qualitatively different from what they would have looked like prior to the extirpation of otters during the fur trade. And, by the same token, the repatriation of sea otters into such areas will cause these ecosystems to change again from what they now are. In this chapter we discuss some of the likely social and economic implications of these ecological changes for people.

The Pacific maritime fur trade drove once-abundant sea otter populations across the Pacific rim to the brink of extinction by the late 19th century (Kenyon 1969). Modern human societies in the Pacific northwest therefore developed for the most part in an environment without otters. People often perceive these otter-free systems as the "pristine" or "natural" state because that is the world they grew up in and became familiar with. Human perceptions and values have developed accordingly (Pauly 2019). Understanding and measuring these values is central to this socioeconomic analysis.

The value of anything can defined in terms of its "*desirability*, often in respect of some property such as usefulness or exchangeability, worth, merit, or importance" [1]. Value comes in an array of forms (or currencies). The most universally recognized and widely used of these currencies is money. Money is the foundation of modern capitalism[2] and capitalism is the socioeconomic structure in which most of today's globalized social/political system operates. However, humans also use other currencies (e.g., existence, emotional, cultural) to assign or experience value. While it is important to include these various currencies in any socioeconomic analysis of the potential effects of repatriating sea otters to Oregon, doing so involves a number of daunting challenges. One such challenge is the assembly of a fair and reasonably thorough array of relevant currencies. Another challenge lies with the comparative weighting of these different currencies. Economists sometimes attempt to do this through a process of 'value equivalency' (e.g., establishing a person's willingness to pay [in monetary terms] for something of non-monetary value [e.g., the opportunity to see a sea otter in nature or to partake in recreational shellfisheries]). Moreover, the available options may not be determinable solely in terms of economics, but also as constrained by law.

Regardless of currency, human existence in a world with or without sea otters has various costs and benefits. Until recently, these socioeconomic effects were seen largely as costs associated

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[1] From the online free dictionary.

[2] an economic system characterized by private or corporate ownership of capital goods, by investments that are determined by private decision, and by prices, production, and the distribution of goods that are determined mainly by competition in a free market (Merriam-Webster).

with the negative effects of sea otters on shellfisheries. This perspective surfaced in the mid-1960s with concern over the long-term viability of California's commercial abalone fishery (Lowry and Pearse 1973, Wendell 1994). Like many of the sea otter's macroinvertebrate prey, North Pacific abalones probably increased greatly in size and abundance following the post-fur trade ecological extinction of sea otters (Watson 2000, Estes et al. 2005). The hyper-abundant abalones subsequently became the foundation for various commercial and subsistence fisheries. Many of these fisheries may not have been sustainable, even in the absence of sea otters (Tegner 2000). Regardless, the end came quickly as predation by the growing sea otter population in central California reduced remaining abalone stocks, thus leading to a conflict between commercial/recreational abalone fishers and sea otters (Wendell 1994). The currencies of this conflict were money (e.g., reduced ex-vessel landing values to the fishers and various associated businesses) and lifestyle (e.g., the ability to make a living and to enjoy doing so in accordance with family traditions and values). As sea otter populations continued to recover from the fur trade in the eastern North Pacific Ocean, similar conflicts have developed for other shellfish species in other areas (Pitcher 1989, Larson et al. 2013, Carswell et al. 2015).

The early socioeconomic perception of sea otters was largely negative, owing to lost revenues and lifestyles associated with the *direct effects* of sea otter predation on shellfisheries (Estes and VanBlaricom 1985). This perception broadened as the *indirect effects* of sea otters became better known and people began to realize that some of these indirect effects could have associated economic costs and benefits (Estes et al. 2004). Most recently, a comprehensive analysis of economic costs and benefits, including both direct and indirect effects, was completed for British Columbia (Gregr et al. 2020). Another review of some of the potential direct and indirect effects of sea otter recovery was also completed for the Oregon coast (Kone et al. 2021). Here, we draw upon these previously published analyses and other sources to explore the direct and indirect effects of sea otters that are important to consider prior to the species' reestablishment in Oregon. This includes a synopsis of some of the specific commercial activities in Oregon that may be affected. We also note that a more comprehensive Economic Impacts Assessment of potential return of sea otters to Oregon is currently underway and will be available as a companion piece to this Feasibility Study report.

Direct Effects

Sea otters are predators and as such their main direct effect is via prey limitation. In such cases wherein the sea otter's macroinvertebrate prey are consumed and valued by humans, one cost of living with sea otters is the reduction or elimination of shellfisheries. Although such direct negative impacts of sea otter predation have influenced various mollusk, crustacean, and echinoderm fisheries from Alaska to California, the magnitude of these impacts varies considerably among species and locations. The strong negative effects of sea otters on urchin dive fisheries have been quite consistent (Johnson 1982, Carswell et al. 2015), and in Oregon there is a high potential for recovering sea otters to impact urchin fisheries, as most of the same areas where sea otters are likely to recover (see Chapter 3) are also areas where urchin fishing activity is highest (Kone et al. 2021). Negative impacts on existing commercial clam fisheries are another common feature of sea otter recovery, including pismo clams in California (Kvitek and Oliver 1988) and geoduck clams in SE Alaska (Kvitek et al. 1993, Hoyt 2015). The magnitude and timing of this negative effect will depend on the pattern and rate of sea otter recovery and the relative availability of alternative (non-commercial) prey species (Hoyt 2015). Another related direct effect involves not just fisheries, but the conservation status of affected shellfish species. The best-known example is that of abalone, which for some species are themselves listed under the ESA as threatened or endangered. The imperiled status of these species and stocks could be exacerbated by further losses to sea otter predation. It is possible, however, that these species and stocks might be enhanced via the otter-urchin-kelp trophic cascade (see Chapter 5, and below).

For other shellfisheries, the nature and magnitude of direct effects by sea otters has been less consistent. Sea otters have had a strong negative effect on commercially valuable sea cucumbers in SE Alaska (Larson et al. 2013) , but this effect has not been described elsewhere. Similarly, the expanding sea otter population in eastern Prince William Sound clearly reduced Dungeness crab populations, causing local crab fisheries to collapse (Garshelis et al. 1986), and similar declines were observed in SE Alaska (Hoyt 2015). In contrast, crab fisheries in California appear to have been largely unaffected by recovering sea otters (Grimes et al. 2020, Boustany et al. 2021), probably owing to nuanced features of the behavior and natural history of otters and crabs combined with differences in coastal bathymetry. Regional differences in the impact of sea otters on Dungeness crab fisheries seems to be related to an interaction between bathymetry (water depth) and size selectivity by foraging sea otters.

Sea otters are size-selective predators and avoid the consumption of smaller bodied prey almost entirely. For example, although sea otters in the Aleutian Islands prey on (and strongly limit) sea urchins, they seldom consume urchins less than about 2cm in test diameter (Estes and Duggins 1995), thereby potentially increasing the production of this segment of the urchin population by reducing intraspecific competition between the smaller recruits and larger adults. Size selectivity patterns have also been reported for sea otters foraging on urchins in BC (Burt et al. 2018) and California (Smith et al. 2021) and on *Cancrid* crabs in California (Grimes et al. 2020). It is possible that this size selectivity, combined with intraspecific competition among size classes, may modulate the impact of sea otter predation on Dungeness crab populations in central California. Like many marine invertebrates, Dungeness crabs have dispersive early life stages (larvae) that develop and grow at sea. These larvae return to coastal zones via transport by internal waves, where they settle and are recruited into adult populations but are also limited by intraspecific competition with larger adults. The addition of otters to estuaries reduces the abundance of adult crabs (Hughes et al. 2013) but not these smaller recruits, thereby potentially enhancing juvenile crab population productivity (Grimes et al. 2020). Moreover, adult crabs, because of their mobility, spend much of their lives in deeper water, near or even beyond the break of the continental shelf, where they realize a depth refuge from predation by sea otters. Sea otter predation therefore exerts little cost on, and may even confer a benefit to, Dungeness crab fisheries in some areas (Grimes et al. 2020, Boustany et al. 2021). The relative costs and benefits of sea otter predation on Dungeness crabs depend largely on water depth and the frequency and intensity of larval recruitment. In Oregon, the coastal areas where most commercial crab fishing occurs do not overlap with areas that are likely to support higher densities of sea otters (Kone et al. 2021), and like California these areas have bathymetric profiles that should confer depth refuges for adult Dungeness crab: thus, it is reasonable to conclude that effects of sea otter recovery on commercial Dungeness crab fisheries in Oregon will more closely resemble the California example (little to no significant effects) than the Alaskan examples (moderate to substantial effects). However, given the economic and social importance of this industry, more research on this subject is clearly warranted.

Positive effects of sea otters have also been noted for black abalone in central California (Raimondi et al. 2015). The mechanisms underlying this pattern are not entirely clear, although they may relate to complex responses by abalones to sea otter predation that result from nutritional benefits (i.e., increased production and food because of the otter-urchin-kelp trophic cascade—see Chapter 5) and reduced vulnerability to human exploitation because abalones seek refuge from foraging otters in cryptic habitats (Lowry and Pearse 1973). Similarly, in British Columbia, there was an overall decrease in abundance of northern abalone in response to the return of sea otters; however, abalone in cryptic habitats actually increased in abundance after the recovery of sea otters (Lee et al. 2016). Because cryptic abalone are not readily available to human harvesters, the net effect of sea otters on abalone fisheries is likely to be negative in most cases, however the impacts of sea otters on abalone population health and viability is not necessarily negative and may even be positive in some cases (Raimondi et al. 2015).

Indirect Effects

While the direct effects of otters on shellfisheries are largely negative (i.e., depressing), the indirect effects of otters on other coastal resources are often positive (i.e., enhancing). Positive effects occur primarily through the enhancing effects of otters on primary producers, especially kelp (i.e., the otter-urchin-kelp trophic cascade), and the knock-on effects of kelp via increased production and habitat provisioning (see Chapter 5). Significant increases in the abundance of several commercially or recreationally valuable finfish species (e.g., rockfishes, greenlings and ling cod) have been shown to occur following sea otter recovery, with these increases explained by the increased productivity and habitat structure associated with the kelp forests that flourished after sea otter recovery (Reisewitz et al. 2006, Markel and Shurin 2015). The effects of sea otter recovery on other finfish and their associated fisheries, while likely significant, remain poorly documented. For example, kelp can have a positive impact on Pacific herring populations because herring spawn on kelp, and the positive effect of sea otters on kelp increases the production of the coastal water column ecosystem in which herring live and feed.

A similar indirect effect of otters may occur within estuaries. In Oregon estuaries such as Coos and Yaquina Bay, herring spawn on eelgrass. Currently, eelgrass abundance in estuaries is in decline in Oregon (see Chapter 6), but a case study from a California estuary where sea otters have recovered (Elkhorn Slough) shows that the return of sea otters to estuaries can have a positive indirect effect on the extent and stability of the eelgrass community (Hughes et al. 2013), via complex trophic interactions. In contrast, in British Columbia where sea otters foraged in eelgrass habitats but also had ready access to kelp beds, their impact on eelgrass habitat was not as evident (Hessing-Lewis et al. 2018). These examples suggest that, while the outcome is not certain, there is the potential for positive indirect effects of sea otters on eelgrass and thereby on the various invertebrate and fish species (including herring) that use eelgrass as nursery habitat. Herring in turn are of value to people as the direct target of fisheries, and indirectly as forage fish that support numerous other species (e.g., salmon and whales) that people also value.

Kelp and eelgrass can influence human welfare via other ecosystem pathways: for example, by sequestering atmospheric carbon dioxide ($C0_2$) (Wilmers et al. 2012) or reducing wave energy and thus stabilizing and protecting shorelines (Pinsky et al. 2013, Nicholson et al. 2018). Sea otters can also impact human welfare through wildlife viewing opportunities and the benefits that imparts on the ecotourism industry (Gregr et al. 2020, Martone et al. 2020).

Although the negative and positive socioeconomic influences of sea otters through their direct and indirect effects on other species and ecological processes have long been recognized, the first comprehensive effort to measure these effects in monetary terms was done by Gregr et al. (2020), who considered the following four ecosystem services—shellfisheries, finfisheries, carbon sequestration, and ecotourism. Gregr et al.'s (2020) findings, which were specific to Vancouver Island in British Columbia, indicated that the repatriation of sea otters to this particular area resulted in 37% more annual ecosystem biomass; increases of 9.4 million, 2.2 million, and 42.0 million CA$ from fin fisheries, carbon sequestration, and ecotourism, respectively; and a -7.3 million CA$ loss from shellfisheries.

Non-monetary Effects

Although Gregr et al.'s (2020) analysis of sea otter economic impacts in British Columbia was both unprecedented and transformative, it also involves an extraordinarily complex issue that was beset by at least two limitations. One of these limitations is the incomplete breadth of indirect effects that were used in the ecological and cost assessments. The impacts of sea otters in coastal ecosystems extend to numerous species via diverse pathways, most of which either remain unrecognized, or simply are not yet well enough understood to be included in such an analysis (the aforementioned possible effects on herring, salmon and whales is a case in point). The other limitation to Gregr et al. (2020) is the singular currency (i.e., monetary value) used in the analysis. This is not a weakness, as monetary value is tangible, measurable, and broadly important to most people. However, money is not the only commodity that matters to people, especially when people are considered as individuals or special interest groups. Burt et al. (2020) made this point for British Columbia's First Nations peoples, who value shellfisheries for both cultural reasons and food security. Indeed, there is growing evidence that aboriginal maritime peoples in the Northeast Pacific Ocean limited sea otters in some areas (Simenstad et al. 1978, Groesbeck et al. 2014, Salomon et al. 2015, Slade et al. in press) thereby enhancing shellfish availability, although the extent to which these prehistoric effects were the purposeful consequence of shellfisheries management, or fortuitous epiphenomena of sea otter population reductions from overhunting, remains uncertain. In any case, any assessment of socioeconomic impacts of sea otter recovery must provide a comprehensive accounting of the social values of the relevant communities, including both monetary and non-monetary variables.

Synopsis of Direct and Indirect Effects

The socioeconomic consequences of repatriating sea otters to Oregon, while germane and important, are difficult to assess, in part because of uncertainties over details of the ecological effects of sea otters, in part because of the differing currencies by which people value the resulting natural resources, and in part because of differences in the way different people embrace these differing values. While the use of a monetary value system is the single most common way of conducting such a socioeconomic analysis, it is important to keep in mind the non-monetary values and recognize there may be no obvious way forward that all or even most parties will find completely fair and reasonable. We acknowledge that these complex issues are largely outside the realm of expertise of the authors of this report. Some of the differing views and values of various stakeholders are discussed in Chapter 11. However, these issues will be taken up separately by more qualified experts in the areas of resource economics and the social sciences.

Potentially Affected Oregon Fisheries

Although Oregon's coastal fisheries are identifiable, a detailed assessment of the impacts of sea otters on these fisheries is beyond the scope of this chapter (although we note that a full economic impacts assessment is underway). Both direct and indirect effects are likely to occur. Direct effects are via predation, and the majority of these influences on prey populations will be negative, although there are exceptions (see above) and the magnitude of impact varies strongly among species and habitats (see above). Most of the indirect effects will probably be positive, although here too one should recognize the likely variation among species, ecosystem types, and specific areas. In Oregon, the invertebrate species which are fished commercially and taken by recreational harvesters, and which potentially would be affected by sea otter recovery, include: Dungeness crab, red rock crab, razor clams, butter clams, Gaper clams, littleneck clams, cockles, mussels, ghost shrimp, and red and purple sea urchins. We do not further consider finfisheries and the potential indirect effects of sea otters on these fisheries in this document, though we emphasize that such effects are likely to occur and, in most cases, will be positive (Reisewitz et al. 2006, Markel and Shurin 2015, Gregr et al. 2020).

Commercial Invertebrate Coastal Fisheries

Oregon has consistently been one of the largest producers of Dungeness crab on the U.S. west coast, harvesting a long-term average (20 years) of 17.3 million pounds of crab per season (Figure 7.1). Most of the catch is from the open ocean, and landings are made at all Oregon ports. Red sea urchins were first harvested commercially in Oregon in Port Orford in 1986, and landings quickly escalated and peaked at 9.3 million pounds in 1990. Virgin stocks were quickly reduced, and by 1996 the urchin fishery boom was over: from 1996 to 2015 the urchin fishery landings stabilized at a much lower level (Figure 7.2.). Red sea urchins are harvested exclusively from kelp beds, and most of Oregon's kelp beds occur south of Charleston, where about 90% of the harvest occurs. The most important harvest areas are Orford reef, just northwest of Port Orford (~50% of harvest) and Rogue reef, just northwest of Gold Beach (~25% of harvest). It is notable that both these areas have been identified as potential habitat for sea otter recovery (Chapters 3 and 6 of this report, and Kone et al. 2021). Nearshore areas of Brookings, Cape Arago, and reefs off of Depoe Bay account for the remaining 25% of harvest. Purple sea urchins account for less than 1% of the 43 million pounds of sea urchins which have been harvested from Oregon since 1986. California sea cucumbers are also covered by an urchin permit, though harvest of this species has been minimal. Data from ODFW landing statistics for invertebrates, not including oysters, at the eight major ports in Oregon provide insights into the current extent of commercial activity. These data are summarized below (Tables 7.1 – 7.8) based on data from: [https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/index.asp.](https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/index.asp) Although shrimp (*Pandalus jordani)* is included in these tables, the fishery for this species occurs at depths of 40 to 125 fathoms (240 to 750 feet) in areas of mud or sand, and the species is only rarely consumed by sea otters. In recent years a market squid (*Doryteuthis opalescens*) fishery has developed in Oregon coastal waters. All other species in the Tables 7.1 – 7.8 are harvested in estuaries.

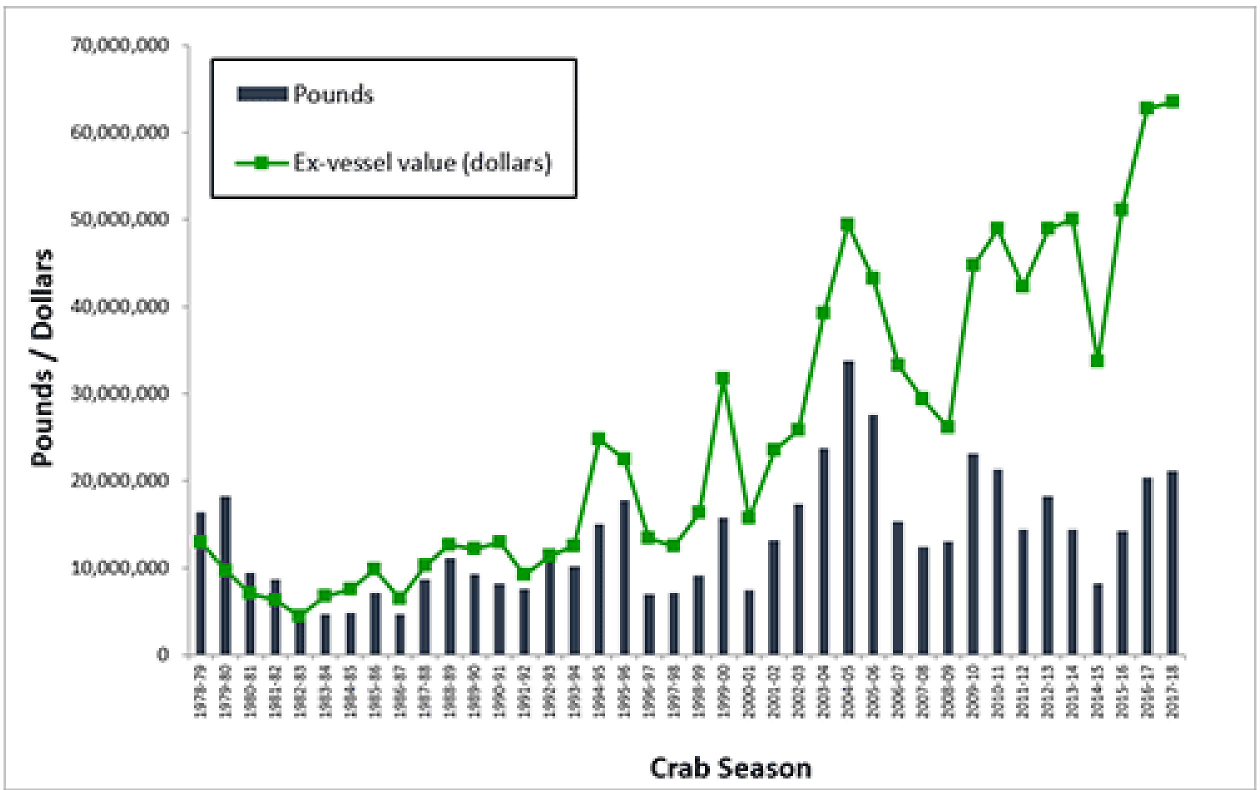

Figure 7.1. Annual Dungeness crab landings in Oregon over time. Data from: https://www.dfw.state.or.us/MRP/shellfish/commercial/crab/landings.asp

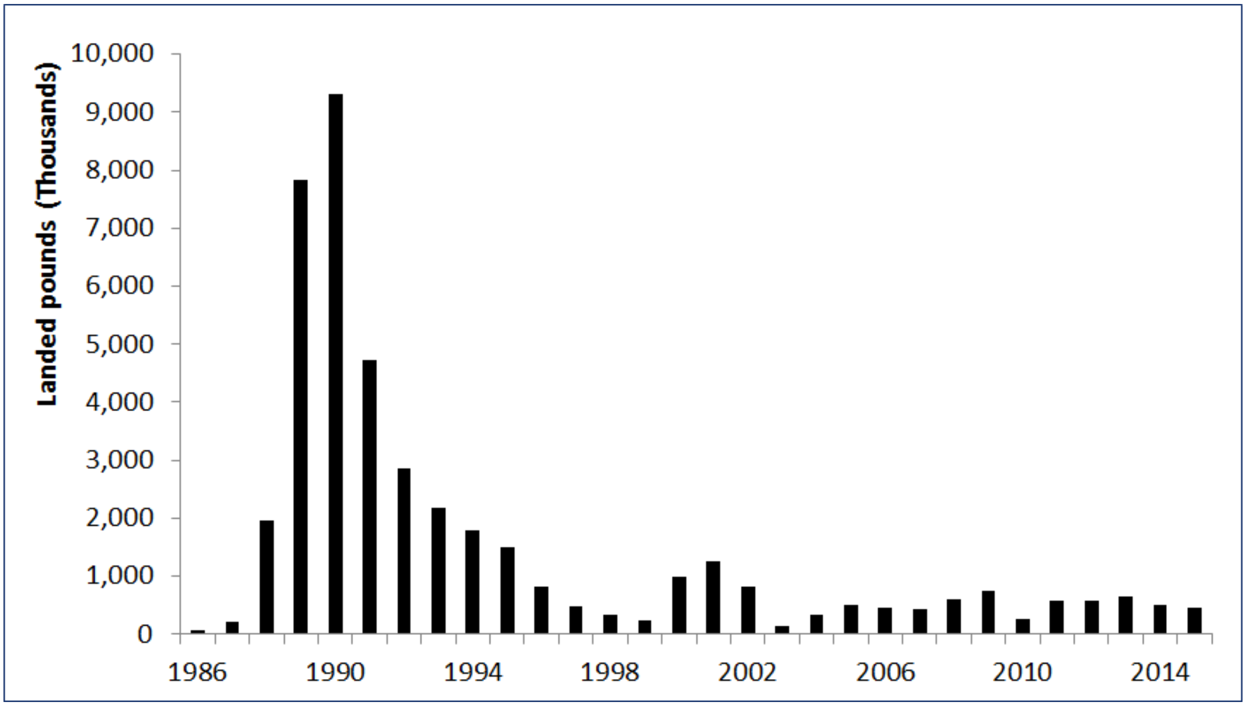

Figure 7.2. Annual urchin landings in Oregon over time. Data from:
https://www.dfw.state.or.us/mrp/shellfish/commercial/urchin/index.asp

Table 7.1 Commercial Catch statistics for ASTORIA (Columbia River Mouth)

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - ASTORIA

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crustaceans	#	2,750,269	429,965	148,577	1,131,990	2,073,900	1,589,975	2,163,850	877,896	260,337	182,069	1,018	22,953	11,632,799
	$	8,353,683	1,757,282	656,774	1,029,353	1,756,119	1,236,897	1,510,418	657,987	213,775	137,086	1,000	68,501	17,378,875
Crab, box	#						1							1
	$						0							0
Crab, Dungeness, bay	#										206	200		406
	$										1,330	1,000		2,330
Crab, Dungeness, ocean	#	2,750,269	429,965	148,577	35,752	20,050	6,889	3,108	253	2	1	818	22,953	3,418,637
	$	8,353,683	1,757,282	656,774	179,121	126,638	32,931	14,383	980	0	0	0	68,501	11,190,293
Shrimp, pink	#				1,096,238	2,053,850	1,583,085	2,160,742	877,643	260,335	181,862			8,213,755
	$				850,232	1,629,481	1,203,966	1,496,035	657,007	213,775	135,756			6,186,252

Table 7.2 Commercial Catch statistics for SEASIDE to NEHALEM BAY. Note that razor clams are harvested commercially from the intertidal of Clatsop beaches and account for an estimated 15% of the total razor clam harvest, the remaining harvest is recreational and is not represented in these landing statistics. The bay clams come mostly from Tillamook and Netarts Bays.

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - GEARHART-SEASIDE-CANON BEACH-GARIBALDI-NEHALEM BAY

		January	February	March	April	May	June	July	August	September	October	November	December	Total
	$	1,723,509	454,268	281,928	161,195	142,885	68,136	52,394	18,439	3,980	3,183	5,408	907	2,916,232
Barnacle, gooseneck	#						33	47	60	43	41	20	15	259
	$						330	430	510	391	335	158	105	2,259
Crab, Dungeness, bay	#									554	476	866		1,896
	$									3,244	2,644	4,814		10,702
Crab, Dungeness, ocean	#	533,515	106,735	60,438	23,705	19,395	11,931	10,861	3,786			403	797	771,566
	$	1,723,504	454,265	281,900	161,185	142,834	67,762	51,937	17,888			403	797	2,902,475
Crab, rock	#									107	49	14		170
	$									321	147	28		496
Shrimp, ghost	#	3	2	17	6	34	28	18	27	16	38	3	3	195
	$	5	3	28	10	51	44	27	41	24	57	5	5	300
lolluscs	#	89,902	66,388	90,433	28,236	33,533	33,065	342,698	29,074	12,515	18,364	21,120	20,186	785,514
	$	116,729	82,048	118,895	45,192	67,298	60,086	313,659	23,270	7,868	17,985	17,271	14,079	884,380
Clams, butter	#	8,023	13,537	11,288	3,770	1,671	2,146	6,490	4,187	7,712	13,519	19,392	19,712	111,447
	$	6,590	10,083	8,300	3,016	1,374	1,717	5,185	2,987	5,171	8,265	12,392	12,619	77,699
Clams, cockle	#	81,681	52,345	78,142	18,928	16,123	18,841	26,704	16,528	1,707	41			311,040
	$	110,000	71,541	108,491	25,261	18,346	22,832	23,425	15,870	935	78			396,779
Clams, gaper	#	198	506	413	158	374	46	302,372	8,323	3,063	2,204	131		317,788
	$	139	424	344	126	507	37	264,600	4,377	1,729	1,873	105		274,261
Clams, razor	#			590	5,380	15,365	12,032	7,078			2,571	1,594	474	45,084
	$			1,760	16,789	47,071	35,500	20,368			7,740	4,771	1,460	135,459
Mussels, bay	#							54	36	33	18	3		144
	$							81	36	33	18	3		171
Octopus	#										11			11
	$										11			11
Total	#	624,038	174,832	157,873	56,172	66,517	55,112	383,320	290,157	62,446	99,435	27,161	22,730	2,019,793
	$	1,841,641	540,041	417,646	217,393	254,044	167,598	477,548	508,813	103,732	167,266	34,006	19,340	4,749,068

Table 7.3 Commercial Catch statistics for PACIFIC CITY to DEPOE BAY. Note that the urchins would have been harvested close to Depoe Bay

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - NETARTS - PACIFIC CITY - SILETZ - SALMON RIVER - DEPOE BAY

		January	February	March	April	May	June	July	August	September	October	November	December	Total
	$			1,802										1,802
Sea urchin, purple	#			1,500										1,500
	$			1,500										1,500
Sea urchin, red	#			302										302
	$			302										302
Total	#	13,321	2,543	9,494	12,783	16,335	14,436	16,895	9,329	6,832	11,670	10,494	2,416	126,548
	$	41,464	6,741	26,581	35,278	36,104	24,646	57,394	24,064	12,550	35,400	30,815	7,148	338,185
Crustaceans	#	11,787	1,434	3,551	1,083	2,594	1,510	2,102	1,690	608	2,636	2,499	229	31,723
	$	37,930	4,398	15,481	4,510	13,092	6,474	10,970	8,512	1,023	12,389	10,687	351	125,817
Crab, Dungeness, bay	#									18	1,781	1,980		3,779
	$									108	11,051	9,879		21,038
Crab, Dungeness, ocean	#	11,393	1,024	3,038	700	1,633	938	1,653	1,264					21,643
	$	37,327	3,773	14,700	3,929	11,640	5,600	10,277	7,850					95,096
Crab, rock	#										18	5		23
	$										54	15		69
Shrimp, ghost	#	394	410	513	383	961	572	449	422	590	837	514	229	6,274
	$	603	625	781	581	1,452	874	693	654	915	1,284	793	351	9,606
Shrimp, mud	#								4					4
	$								8					8
Molluscs	#				2,888	6,093	7,677					871		17,529
	$				1,444	3,453	4,929					697		10,523
Clams, butter	#											871		871
	$											697		697
Clams, cockle	#				2,888	6,093	7,677							16,658
	$				1,444	3,453	4,929							9,826
Other Invertebrates	#			1,802										1,802

Table 7.4 Commercial Catch statistics for NEWPORT

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - NEWPORT

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crustaceans	#	5,212,577	1,090,296	365,302	115,574	1,503,130	3,144,434	1,786,150	1,324,137	895,387	349,073	17,106	61,121	15,864,287
	$	16,684,187	4,815,565	1,725,540	795,031	1,426,082	2,400,229	1,457,341	1,092,437	847,344	306,853	16,420	183,423	31,750,452
Barnacle, gooseneck	#									15	57			72
	$									60	228			288
Crab, box	#		8											8
	$		8											8
Crab, Dungeness, bay	#									4	101	1,138		1,243
	$									16	808	5,218		6,042
Crab, Dungeness, ocean	#	5,212,577	1,090,288	365,302	115,570	47,102	19,271	11,154	3,404	19		2,852	61,121	6,928,660
	$	16,684,187	4,815,557	1,725,540	795,027	369,676	122,864	72,481	24,235	0		0	183,423	24,792,990
Crab, rock	#				4							82		86
	$				4							123		127

Table 7.5 Commercial Catch statistics for YACHATS to WINCHESTER BAY. Note: Ghost shrimp are harvested for bait in the intertidal of bays.

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - WALDPORT - YACHATS - FLORENCE - WINCHESTER BAY

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crustaceans	#	500,790	172,008	72,370	28,923	19,796	9,832	5,262	2,987	3,067	10,897	18,162	2,035	846,129
	$	1,758,512	752,955	337,684	185,711	139,926	50,022	23,571	13,121	8,320	43,378	83,542	3,817	3,400,559
Crab, box	#				257									257
	$				900									900
Crab, Dungeness, bay	#										7,659	17,091		24,750
	$										34,845	80,418		115,263
Crab, Dungeness, ocean	#	499,276	170,487	69,810	26,286	16,349	7,585	3,372	1,609				969	795,743
	$	1,754,393	748,777	330,492	177,589	130,661	44,218	18,290	9,163				555	3,214,138
Shrimp, ghost	#	1,514	1,521	2,560	2,380	3,447	2,247	1,890	1,378	3,067	3,238	1,071	1,066	25,379
	$	4,119	4,178	7,192	7,222	9,265	5,804	5,281	3,958	8,320	8,533	3,124	3,262	70,258

Table 7.6. Commercial Catch statistics for CHARLESTON (Coos Bay)

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - CHARLESTON

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crab, box	#					6								6
	$					12								12
Crab, Dungeness, bay	#										926	1,801		2,727
	$										4,017	7,638		11,655
Crab, Dungeness, ocean	#	2,282,972	1,565,359	287,609	121,259	55,257	19,059	10,735	2,210	19		1,840	63,405	4,409,724
	$	7,109,328	6,056,058	1,197,934	809,955	432,775	107,911	52,583	12,924	0		0	186,584	15,966,052
Crab, mole	#					3								3
	$					3								3
Shrimp, ghost	#		42	110	66	283	434	192	90	111	157	144	113	1,742
	$		84	220	132	566	868	384	180	209	312	285	226	3,466
Shrimp, pink	#					1,061,690	1,952,869	1,137,086	1,128,881	387,417	78,612	625		5,747,180
	$					754,268	1,368,010	759,637	835,997	302,611	71,276	531		4,092,330
Molluscs	#		903	2,433	2,289	125,984	186,873	96,218	1,212,196	497,151	44	203	706	2,125,000
	$		1,180	3,317	3,312	68,751	94,780	49,709	706,057	297,884	55	278	929	1,226,252
Clams, butter	#		255	703		91	199	59						1,307
	$		290	778		91	239	59						1,457
Clams, cockle	#		648	1,730	2,246	63	77	1,569				95	134	6,562
	$		890	2,539	3,247	95	116	2,354				143	201	9,585
Clams, gaper	#										44	108	520	672
	$										55	135	650	840
Octopus	#				43			25					52	120
	$				65			13					78	156
Squid, Market	#					125,830	186,597	94,565	1,212,196	497,151				2,116,339
	$					68,565	94,425	47,283	706,057	297,884				1,214,214
Other Invertebrates	#					13	2,014	9,277						11,304
	$					0	3,497	13,545						17,042
Jellyfish	#					2	15							17
	$					0	0							0
Sand dollars	#					11	1							12
	$					0	0							0
Sea urchin, red	#						1,998	9,277						11,275
	$						3,497	13,545						17,042

Table 7.7 Commercial Catch statistics for BANDON/PORT ORFORD. Note: the majority of these landings would have been from Port Orford

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - BANDON - PORT ORFORD

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crustaceans	#	1,206	555,476	83,219	30,063	30,418	17,602	15,520	7,364		67	268	66,121	807,324
	$	0	1,851,104	334,093	150,928	167,306	96,295	63,906	30,793		335	0	196,554	2,891,314
Crab, Dungeness, bay	#										67			67
	$										335			335
Crab, Dungeness, ocean	#	1,206	555,476	83,219	30,063	30,418	17,602	15,520	7,364			268	66,121	807,257
	$	0	1,851,104	334,093	150,928	167,306	96,295	63,906	30,793			0	196,554	2,890,979
Molluscs	#		689	1,103	154	117	95		24				31	2,213
	$		456	671	99	69	98		12				16	1,421
Octopus	#		689	1,103	154	117	95		24				31	2,213
	$		456	671	99	69	98		12				16	1,421
Other Invertebrates	#	18,213			4,073	1,184							14,052	37,522
	$	64,122			8,545	4,736							59,310	136,713
Sea cucumber, California	#				566	1,184								1,750
	$				2,264	4,736								7,000
Sea urchin, purple	#				66									66
	$				66									66
Sea urchin, red	#	18,213			3,441								14,052	35,706
	$	64,122			6,215								59,310	129,647

Table 7.8. Commercial Catch statistics for GOLD BEACH/BROOKINGS. Note: the majority of these landings would have been in Brookings

2019 FINAL

POUNDS AND VALUES OF COMMERCIALLY CAUGHT FISH AND SHELLFISH LANDED IN OREGON - GOLD BEACH - BROOKINGS

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Crab, Dungeness, ocean	#		1,508,179	166,088	36,501	18,150	6,940	3,014	1,123			253	106,955	1,847,203
	$		5,251,980	665,809	213,825	106,731	37,938	15,599	6,286			0	321,780	6,619,948
Sea urchin, red	#	15,498	11,943	21,099		23,755	22,708				16,455	21,965		133,423
	$	55,193	43,651	69,966		60,897	58,161				55,778	79,696		423,342

The commercial landings summarized in Tables 7.1-7.8 are somewhat reflective of where the catch occurs, although this is not always certain. For example, depending on weather and where they have put their pots, bigger boats from Charleston might sell crab in Newport. Commercial in-bay crabbing for Dungeness crab is permitted from Labor Day through December 31, while ocean crabbing season is December 1 – August 14.

Commercial Harvests in Estuaries

The landings data presented above (Tables 7.1-7.8) show that there is a small commercial take of Dungeness crab from estuaries landed in most ports, and it accounts for less than 5% of total crab landings. Ghost shrimp (*Neotrypaea californiensis)* are harvested from estuaries for bait. There is a commercial bay clam harvest in four of Oregon's estuaries (Figure 7.3). Bay clam species commonly harvested include Gaper (*Tresus capax*), butter (*Saxidomus giganteus*), cockle (*Clinocardium nuttallii*), littleneck (*Leukoma staminea*), softshell (*Mya arenaria*) and purple varnish clams (*Nuttallia obscurata*), all of which have been documented as prey items for sea otters (Estes and Bodkin 2002, Tinker et al. 2012).

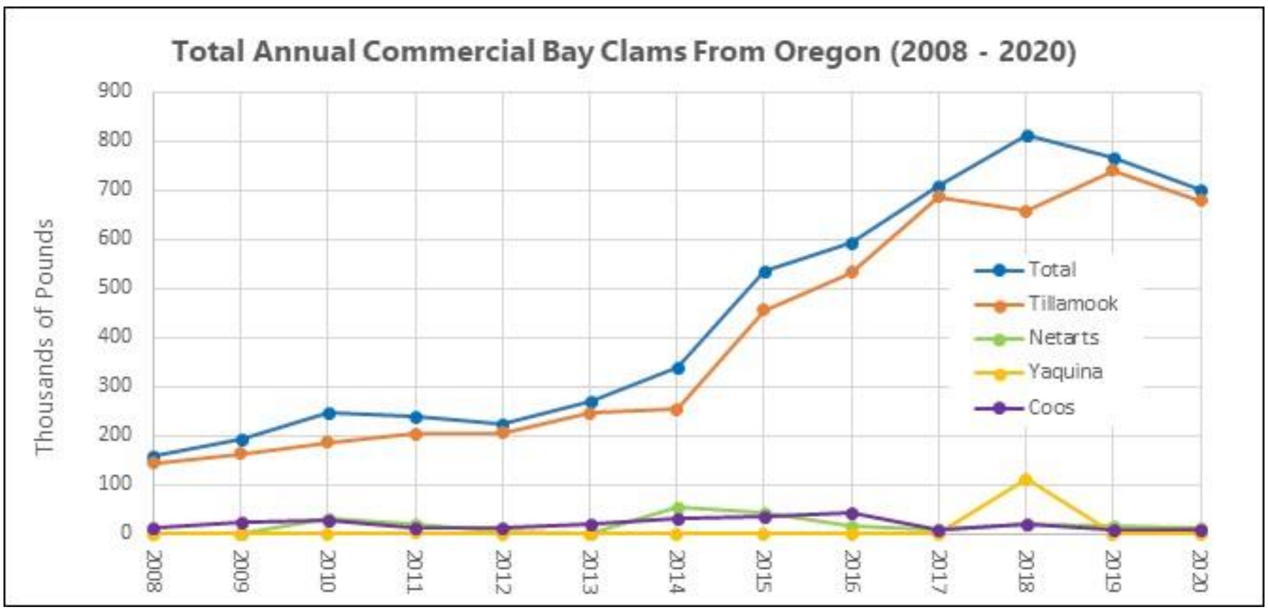

Figure 7.3. Summary of fisheries landings for commercially harvested bay clams in Oregon estuaries

The subtidal clam dive fishery is limited entry (15 permits statewide). The intertidal clam fishery is an open access fishery with generally between 30 to 60 permits sold each year. Of those, only about 20-30 license holders make significant landings in a given year. The intertidal harvesters focus primarily on cockles and most of this fishery happens in Tillamook Bay. The 2020 landings at Gearhart / Seaside / Cannon Beach / Garibaldi / Nehalem Bay, which represents the Tillamook harvest, are shown in Table 7.9. Cockles are the only species shown in landings reported from Netarts / Pacific City / Siletz Bay / Salmon River / Depoe Bay and from Charleston (Table 7.10). Oysters are harvested commercially in five of Oregon's estuaries (Table 7.11). Oyster harvest is regulated by the Oregon Department of Agriculture on estuarine bottom lands leased from the state, or in the case of some regions in Coos Bay, owned by the Port or Coos County.

Table 7.9. Summary of 2020 landings of clams from Tillamook bay estuary and nearby areas. Data from: https://www.dfw.state.or.us/fish/commercial/statistics.asp

Clam species	No. of lbs.	Value ($)
Butter clam	189,217	130,577
Cockle	329,113	406,823
Gaper clam	237,073	174,041

Table 7.10 Summary of 2020 landings of clams from Netarts / Pacific City / Siletz Bay / Salmon River / Depoe Bay and from Charleston. Data from: https://www.dfw.state.or.us/fish/commercial/statistics.asp

Port	No of lbs.	Value($)
Netarts etc.	14,519	8,277
Charleston	11,462	10,554

Table 7.11. 2020 Commercial oyster production on Oregon state leased lands in five estuaries.

ESTUARY	ACRES LEASED*	GALLONS SHUCKED	BUSHELS RAW**	TOTAL PRODUCTION***	PRODUCTION VALUE****	LEASE/FEES COLLECTED
South Slough	240.13	245.00	8,218.17	8,463.17	$507,790.00	$4,093.83
Netarts Bay	425.22	38.00	5,514.17	5,552.17	$333,130.00	$6,605.53
Tillamook Bay	2,605.14	2,833.75	27,943.00	30,826.75	$1,849,605.00	$36,961.92
Umpqua River	60.00	0.00	28.83	28.83	$1,730.00	$843.46
Yaquina Bay	517.00	5,805.00	3053.55	8,858.55	$531,513.00	$7,164.71
Totals	**3,847.49**	**8,971.75**	**44,757.72**	**53,729.47**	**$3,223,768.00**	**$55,669.45**

Source: Oregon Department of Agriculture, Food Safety Program

N.B. South Slough is the State leased land in Coos Bay. Additional oyster production occurs on Port and County lands in upper Coos Bay that is not accounted for in these data.

Recreational Harvest in Estuaries

Recreational crabbing for Dungeness crab occurs in all estuaries or bays where this species is present. Annually, recreational harvest in estuaries is about 5% the size of the commercial harvest. A much smaller number of red rock crabs (*Cancer productus)* are harvested. Ainsworth et al. (2012) provides the most comprehensive information on recreational crabbing in Oregon estuaries. From 2007 through 2011 ODFW collected data on boat-based crabbing effort and catch in Oregon in the bays and open ocean. For the purpose of this report, we have included the estimates of number of recreational crabbing trips and the estimates of number of crabs harvested in five estuaries: Tillamook, Netarts, Yaquina, Alsea and Coos (Figures 7.4 – 7.8).

Recreational crabbing in the open ocean is increasingly popular as people purchase larger boats with more reliable engines. There is limited data on this activity, but a report by Ainsworth et al. (2012) shows the number of trips taken from Oregon ports to the open ocean in 2007 – 2011 (Figure 7.9).

Estimated monthly recreational crabbing trips in Tillamook Bay (NS = not sampled).

	2008	2009	2010	2011
April	89	663	451	320
May	229	1,108	814	641
June	378	479	630	203
July	575	1,958	788	631
August	1,373	1,721	1,589	1,330
September	1,426	1,536	1,531	2,512
October	2,370	NS	1,276	NS
Total (95% conf. interval)	6,440 (4,635-8,245)	7,465 (5,829-9,102)	7,080 (5,503-8,657)	5,637 (4,355-6,919)

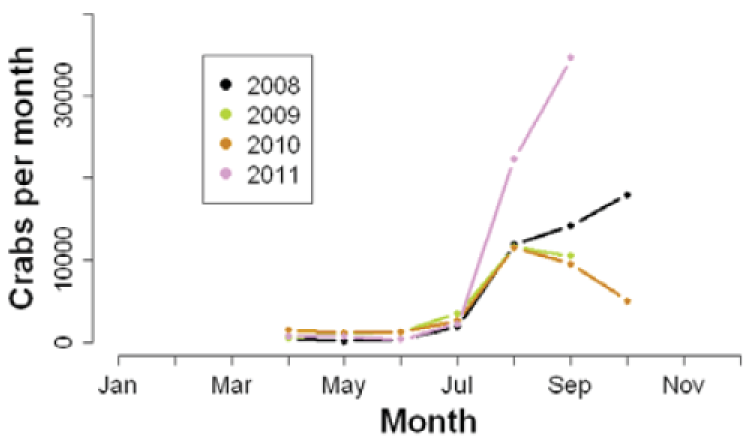

Figure 7.4. Estimated number of crabs harvested recreationally, by month and year from 2008-11, for TILLAMOOK BAY. Adapted from (Ainsworth et al. 2012)

Estimated monthly recreational crabbing trips in Netarts Bay (NS = not sampled).

	2008	2009	2010	2011
April	299	333	434	553
May	406	559	467	694
June	285	267	455	510
July	360	1,928	1,240	1,042
August	801	1,612	2,745	1,297
September	930	1,664	2,767	1,924
October	1,871	NS	2,140	NS
Total (95% con. interval)	4,951 (3,485-6,418)	6,363 (5,001-7,724)	10,248 (8,131-12,364)	6,020 (4,666-7,375)

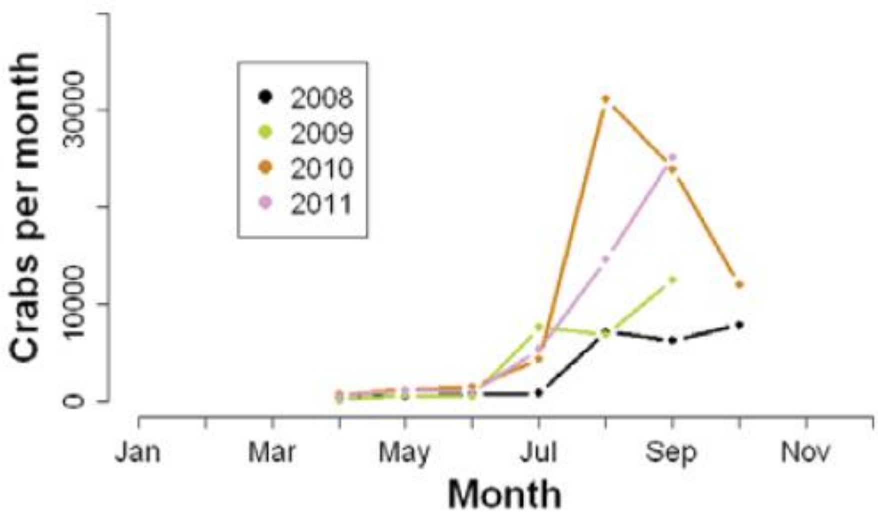

Figure 7.5 Estimated number of crabs harvested recreationally, by month and year from 2008-11, for NETARTS BAY. Adapted from (Ainsworth et al. 2012)

Estimated monthly recreational crabbing trips in Yaquina Bay.

	2007	2008	2009	2010	2011
Jan.	927	251	1,435	656	684
Feb.	923	644	1,127	1,397	645
Mar.	1,264	658	1,031	1,054	578
April	738	601	1,061	1,154	423
May	1,181	1,040	869	497	853
June	1,301	976	1,084	1,311	716
July	4,210	2,599	1,817	2,307	2,169
Aug.	2,617	2,285	1,966	2,240	1,927
Sept.	1,356	3,658	2,572	2,144	2,065
Oct.	4,038	3,506	2,161	3,730	2,125
Nov.	972	3,390	1,335	695	596
Dec.	406	474	1,126	566	936
Total (95% conf. inter-val.)	19,934 (13,879 - 25,988)	20,081 (15,628 - 24,535)	17,586 (13,851 - 21,321)	17,752 (13,927 - 21,577)	13,716 (10,648 - 16,748)

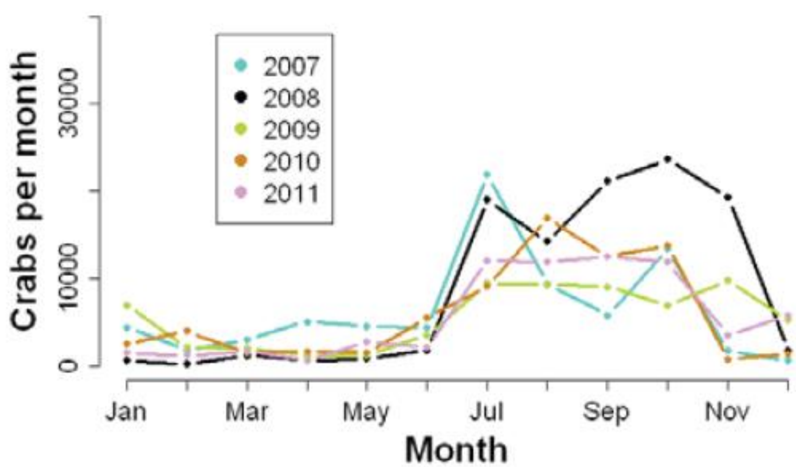

Figure 7.6. Estimated number of crabs harvested recreationally, by month and year from 2008-11, for YAQUINA BAY. Adapted from (Ainsworth et al. 2012)

Estimated monthly recreational crabbing trips in Alsea Bay.

	2007	2008	2009	2010	2011
Jan.	300	169	553	54	252
Feb.	400	163	275	295	90
Mar.	286	276	209	48	80
April	180	133	168	99	64
May	292	145	500	191	497
June	460	437	380	161	299
July	2,519	1,455	1,462	1,077	1,312
Aug.	2,613	3,724	2,109	2,721	2,055
Sept.	3,296	3,715	3,363	2,913	2,136
Oct.	3,077	3,306	2,821	1,719	2,503
Nov.	901	2,418	1,314	896	1,048
Dec.	486	675	773	577	1,221
Total (95% conf. inter-val.)	14,810 (9,698 - 19,923)	16,615 (13,059 - 20,171)	13,929 (10,775 - 17,082)	10,752 (8,318 - 13,186)	11,558 (8,951 - 14,269

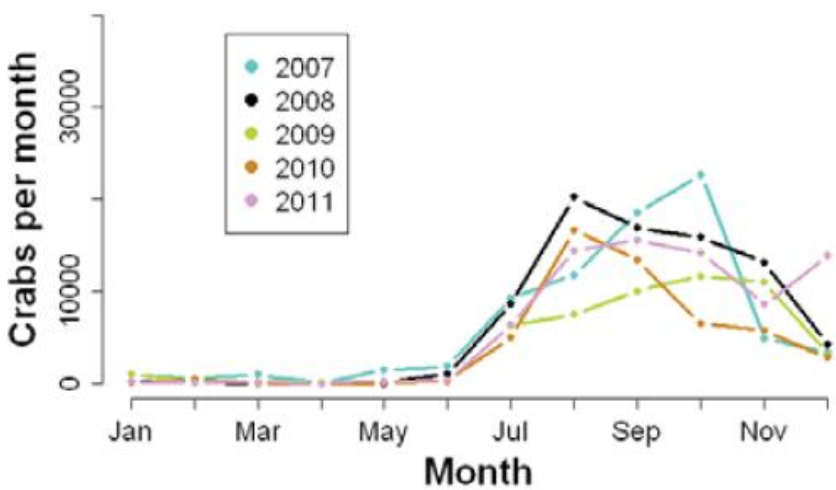

Figure 7.7. Estimated number of crabs harvested recreationally, by month and year from 2008-11, for ALSEA BAY. Adapted from (Ainsworth et al. 2012)

Estimated monthly recreational crabbing trips in Coos Bay (NS = not sampled).

	2008	2009	2010	2011
Jan.	NS	1,845	NS	1,530
Feb.	NS	NS	NS	NS
Mar.	351	1,329	319	928
April	683	1,143	359	375
May	877	864	1,000	920
June	638	663	1,153	874
July	1,834	2,033	2,021	2,000
Aug.	6,155	2,136	3,085	2,481
Sept.	3,468	2,572	2,476	2,671
Oct.	3,616	NS	2,126	2,431
Nov.	1,886	NS	NS	NS
Dec.	NS	NS	NS	NS
Total (95% conf. inter-val.)	19,507 (14,076 - 24,939)	12,584 (8,264 - 17,106)	12,540 (8,657 - 16,422)	14,209 (10,337 - 18,081)

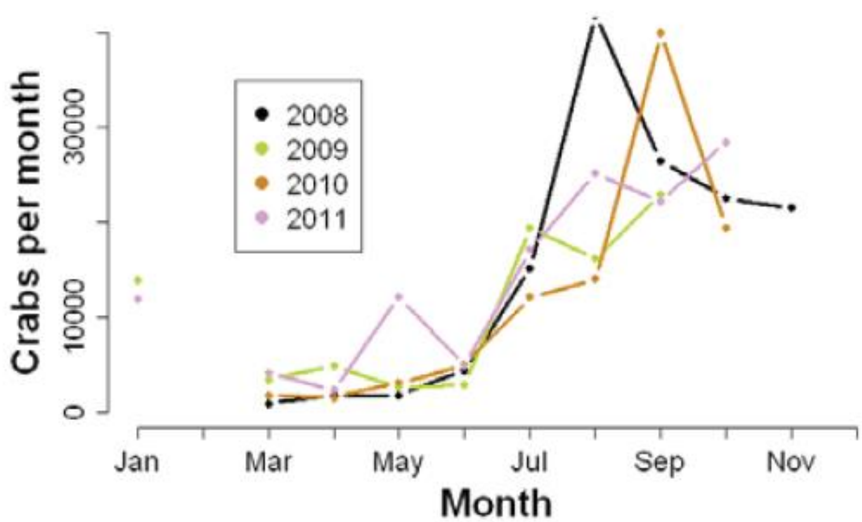

Figure 7.8. Estimated number of crabs harvested recreationally, by month and year from 2008-11, for COOS BAY. Adapted from (Ainsworth et al. 2012)

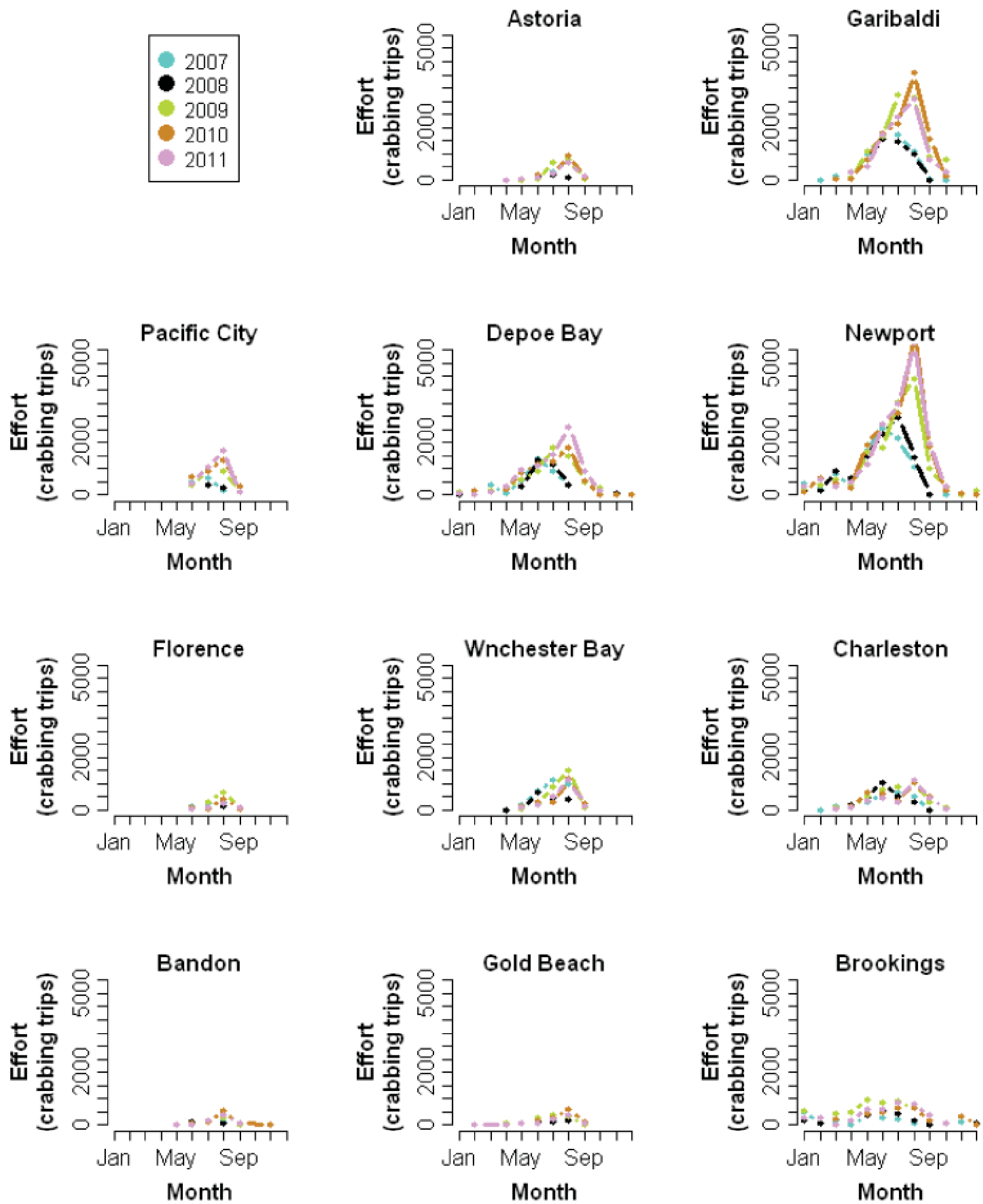

Figure 7.9. Estimated monthly recreational ocean crabbing trips, including charter and private boats (Ainsworth et al. 2012).

Recreational clamming is also a popular activity in Oregon estuaries. ODFW's SEACOR surveys (https://www.dfw.state.or.us/mrp/shellfish/seacor/maps_publications.asp) provide data on clam species presence and abundance for six estuaries (Tillamook, Netarts, Siletz, Yaquina, Alsea, and Coos) where significant recreational clamming occurs. From 2008 – 2012, ODFW conducted surveys of the number of recreational clam-digging trips to these bays with the exception of Alsea Bay (Table 7.11). The time periods covered for each bay differs. Surveys in Tillamook took place from April to August. Those in Netarts averaged a mean of 32% days annually. Yaquina Bay surveys started as early as January or February in some years and lasted through August. Coos Bay clammers were surveyed during the spring and summer, with an average of 33% of the potential survey days sampled.

Table 7.11. Number of recreational clam-digging trips for each of 4 estuaries in Oregon, 2008-2012. Data from ODFW's SEACOR program.

BAY	2008	2009	2010	2011	2012
Tillamook	9,832	9,818	6,207	6,134	11,018
Netarts	12,081	23,262	11,177	9,786	13,653
Yaquina	6,114	13,002	11,961	7,363	7,052
Coos Bay	13,598	15,428	13,030	11,113	9,729

The 2019 – 2023 Oregon Outdoor Recreation Plan ("Outdoor Recreation in Oregon: Responding to Demographic and Societal Change", https://www.oregon.gov/oprd/PRP/Documents/SCORP-2019-2023-Final.pdf) contains the results of a survey of 3,069 randomly selected Oregonians to assess their participation in outdoor recreation activities. Crabbing and clamming are included as a recreational activity, and an estimate of their economic value is included in Table 7.12.

Table 7.12. Estimate of the economic value of recreational crabbing and clamming activity in Oregon. Note: User occasions are the number of times individuals participated in outdoor recreation activities in 2017. An activity day is defined as one person recreating for some portion of a day. RUVD is the Recreation Use Values Database which is based on an extensive review of recreation economic value studies spanning 1958 to 2015 conducted in the United States and Canada

SCORP Activity	RUVD Activity	2017 SCORP User Occasions (million)	Activity Days per User Occasion	2017 Activity Days (million)	MRA RUVD Value/Person /Activity Day ($; 2018 USD)	Total Net Economic Value ($million; 2018 USD)
Crabbing	Shellfishing	1.858	2.496	4.638	$49.88	$231.324
Shellfishing / clamming	Shellfishing	1.012	2.496	2.527	$49.88	$126.057

Summary

As a keystone species, sea otters have inordinately large effects on marine ecosystems, which means that the socioeconomic impacts of sea otter recovery are correspondingly large. These effects are often disruptive to existing social and economic activities, although previous examples of sea otter recovery include both positive and negative impacts. The full range of effects are diverse; however, they can generally be classified into direct effects of sea otter predation (which are generally negative from a human perspective insomuch as they involve shellfish species that are harvested commercially, recreationally or as part of subsistence fisheries) and indirect effects that result from food web interaction pathways. Direct effects of sea otter predation are relatively easy to quantify and are often the first to be documented, in part because sea otter diets have the highest proportion of commercially valuable species during initial stages of recovery. In Oregon, invertebrate species which are fished commercially or recreationally, and which potentially would be affected by sea otter recovery, include: Dungeness crab, red rock crab, razor clams, butter clams, Gaper clams, littleneck clams, cockles, mussels, ghost shrimp, and red and purple sea urchins. Some of these fisheries represent hundreds of thousands of dollars annually, or even (in the case of Dungeness crab) tens of millions of dollars, thus the potential economic impacts of even a small reduction due to sea otter recovery are consequential. However, while for some of fisheries (e.g., urchin dive fisheries) there is good reason to project a substantial negative impact of sea otter recovery, in the case of others (e.g. crab, shrimp) it is far from clear whether there would be a negative impact, or how substantial such an effect would be. In the case of Dungeness crab, negative impacts were found to be associated with sea otter recovery in Alaska, while in California there were no measurable impacts associated with sea otter recovery, and in fact there was a positive correlation between sea otter recovery and crab landings.

Indirect effects are often more difficult to measure than direct effects as they involve complex suites of interactions with other species. In cases where indirect effects have been measured, they are often associated with reductions in herbivores and corresponding increases in primary producers (plants), which in coastal marine ecosystems include kelp and sea grass. Because kelp forests and eelgrass beds support many other species (including commercially valuable finfish species) and provide a variety of ecosystem services for people, these indirect effects of sea otter recovery are generally considered positive from a human perspective. In addition to supporting a variety of other fauna, kelp and eelgrass can influence human welfare by sequestering atmospheric carbon dioxide or reducing wave energy and thus stabilizing and protecting shorelines. Sea otters can also impact human welfare through wildlife viewing opportunities and the benefits that imparts on the ecotourism industry. Finally, it is important to recognize that monetary considerations are not the only way of measuring human values. Communities based around fishing activity provide many important non-monetary values to people. In the case of First Nations peoples, subsistence shellfisheries often provide cultural as well as economic value, while the return of sea otters to the ecosystem may also have cultural importance. Any assessment of socioeconomic impacts of sea otter recovery should therefore provide a comprehensive accounting of the social values of the relevant communities, including both monetary and non-monetary variables.

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