Photo by Patrick Webster.

Chapter 7

SOCIOECONOMIC CONSIDERATIONS

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Sea otters (*Enhydra lutris*) 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 of these effects). Accordingly, the nearshore coastal ecosystems within this region that now lack sea otters are qualitatively different than what they would have been before 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). Therefore, modern human societies in the Pacific Northwest developed, for the most part, in an environment without otters. People often perceive these otter-free systems as the "pristine" or "natural" state because it 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 are central to this socioeconomic analysis.

The value of anything can be defined in terms of its "relative worth, utility, 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 sociopolitical system operates. However, humans also use other currencies (e.g., existential, 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 assembling 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 nonmonetary 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 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 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

1 The definition of "value" is from the *Merriam-Webster.com Dictionary:* https://www.merriam-webster.com/dictionary/value.

2 The definition of "capitalism" from the *Merriam-Webster.com Dictionary* is "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." See https://www.merriam-webster.com/dictionary/capitalism.

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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 have 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 completed for the Oregon coast (Curran et al. 2019, 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 before the species' reestablishment in Oregon. This chapter includes a synopsis of some of the specific commercial activities in Oregon that may be affected. We also note that a more comprehensive economic impact assessment of the potential return of sea otters to Oregon has been completed (Elakha Alliance 2022) and is available as a companion piece to this feasibility study.

DIRECT EFFECTS

Sea otters are predators, and as such, their main direct effect is via prey limitation. In such cases where 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 Southeast (SE) Alaska (Kvitek et al. 1993, Hoyt 2015). The magnitude and timing of these negative effects will depend on the pattern and rate of sea otter recovery and the relative availability of alternative (noncommercial) 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 Endangered Species Act 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 have 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 seem 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 2 cm 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 British Columbia (Burt et al. 2018) and California (Smith et al. 2021) and on cancroid 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. Adding 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, because of their mobility, adult crabs 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 (Shanks and Roegner 2007). 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 this industry's economic and social importance, 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 the 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; however, the impacts of sea otters on abalone population health and viability are 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 (due to 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 lingcod) 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 positively impact 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 Bays, herring spawn on eelgrass. Currently, eelgrass abundance in Oregon's estuaries is in decline (see Chapter 6), but a case study from a California estuary where sea otters have recovered (Elkhorn Slough) showed that the return of sea otters to estuaries could 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 a nursery habitat. In turn, people value herring directly as the target of fisheries and indirectly as forage fish supporting 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 (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 they impart 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, Gregr et al. (2020) conducted the first comprehensive effort to measure these effects in monetary terms. The researchers 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 CAN 9.4 million, CAN 2.2 million, and CAN 42.0 million from finfisheries, carbon sequestration, and ecotourism, respectively; and a loss of CAN 7.3 million from shellfisheries.

NONMONETARY EFFECTS

Although Gregr et al.'s (2020) analysis of sea otter economic impacts in British Columbia was both unprecedented and transformative, it also involved an extraordinarily complex issue beset by at least two limitations. One of these limitations was the incomplete breadth of indirect effects 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 understood well enough to be included in such an analysis (the aforementioned possible effects on herring, salmon, and whales are cases in point).

The other limitation of the Gregr et al. study (2020) was the singular currency (i.e., monetary value) used in the analysis. It 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. 2022), thereby enhancing shellfish availability. 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 the socioeconomic impacts of sea otter recovery must provide a comprehensive accounting of the social values of the relevant communities, including both monetary and nonmonetary 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 using a monetary value system is the single most common way of conducting such a socioeconomic analysis, it is important to keep in mind the nonmonetary 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 our expertise. Some of the differing views and values of various stakeholders are discussed in Chapter 11. The full suite of socioeconomic consequences has been taken up separately by more qualified experts in the areas of resource economics and the social sciences and presented in a companion economic impact assessment undertaken by the Elakha Alliance (2022).

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, as previously mentioned, a full economic impact assessment is available as a companion to this study). 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 the impact varies greatly among species and habitats (see above). Most of the indirect effects will probably be positive, although here, one should also recognize the likely variation among species, ecosystem types, and specific areas. In Oregon, the invertebrate species fished commercially and taken by recreational harvesters that could potentially be affected by sea otter recovery include Dungeness crabs (*Metacarcinus magister*), red rock crabs (*Cancer productus*), Pacific razor clams (*Siliqua patula*), butter clams (*Saxidomus gigantea*), gaper clams (*Tresus capax*), littleneck clams (*Leukoma staminea*), cockles (*Clinocardium nuttallii*), mussels, ghost shrimp (*Neotrypaea californiensis*), and red and purple sea urchins (*Mesocentrotus franciscanus* and *Strongylocentrotus purpuratus*, respectively). 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).

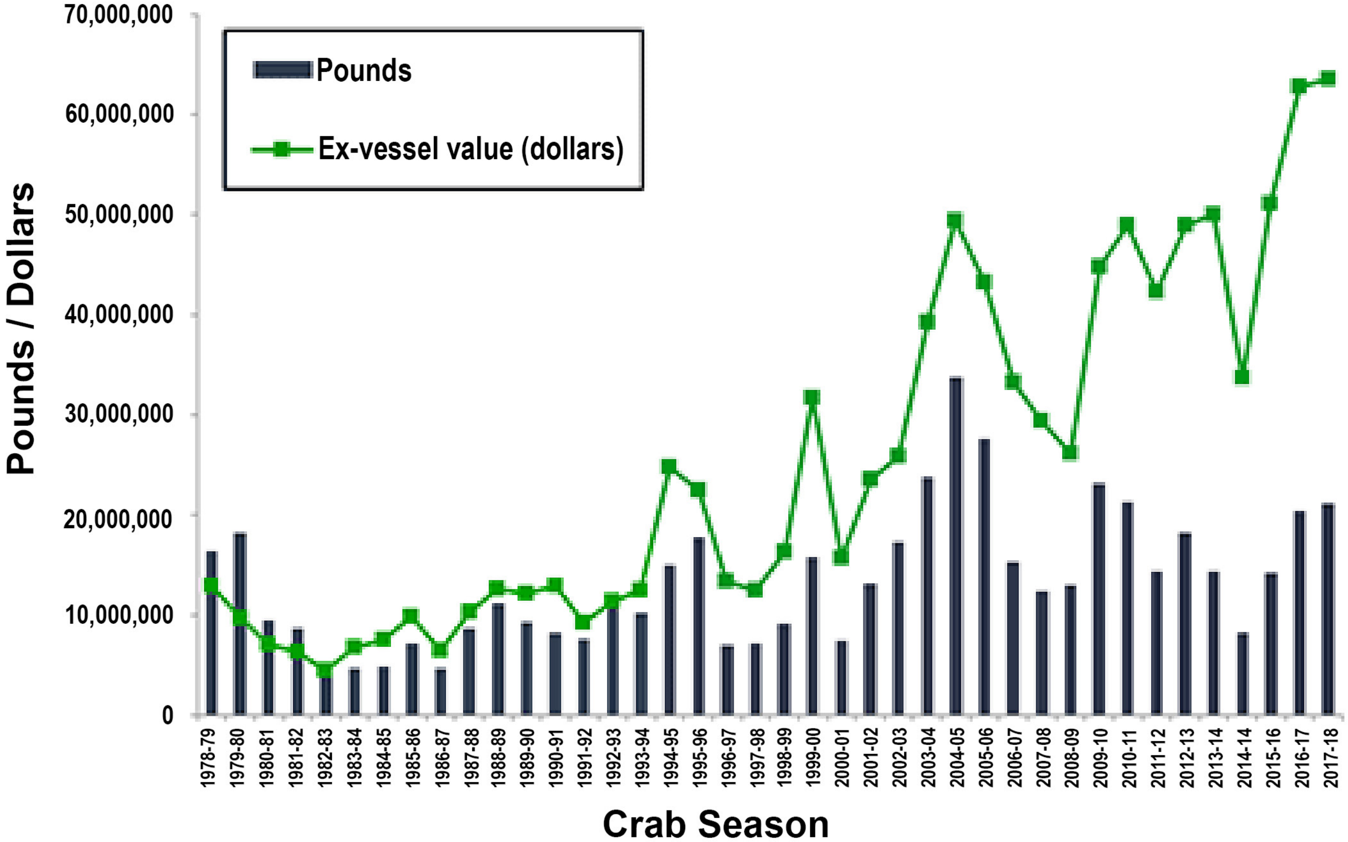
Commercial Invertebrate Coastal Fisheries

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 (7,847,148.00 kg) 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 (4,218,409.04 kg) 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 (Chapter 3 and Chapter 6 of this study; Kone et al. 2021). Nearshore areas of Brookings, Cape Arago, and reefs off of Depoe Bay account for the remaining 25% of the harvest. Purple sea urchins account for less than 1% of the 43 million pounds (19,504,471.91 kg) of sea urchins harvested from Oregon since 1986. California sea cucumbers (*Apostichopus californicus*) are also covered by an urchin permit, though harvest of this species has been minimal.

Data from the Oregon Department of Fish and Wildlife (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

Figure 7.1. Annual Dungeness crab landings in Oregon over time.



Note. 1 lb = 0.454 kg. Data from ODFW commercial crab landings: https://www.dfw.state.or.us/MRP/shellfish/commercial/crab/landings.asp.

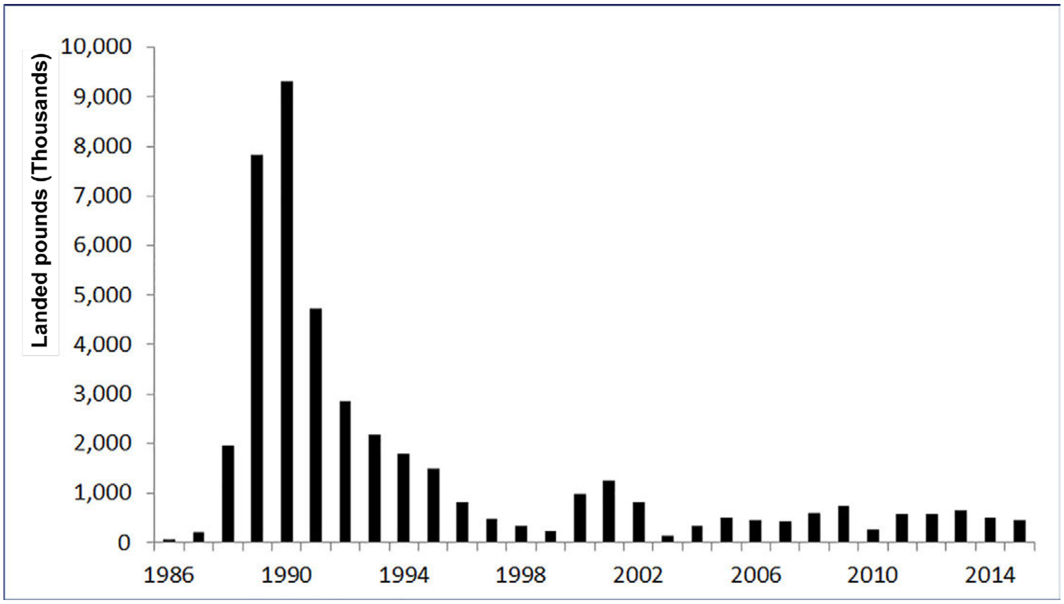
Table 7.1. Commercial catch statistics for ASTORIA (Columbia River mouth).

Species		January	February	March	April	May
Crab, box	lb $					
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	2,750,269 8,353,683	429,965 1,757,282	148,577 656,774	35,752 179,121	20,050 126,638

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Astoria" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 11:01:59 a.m.).

are summarized below (Tables 7.1–7.8).[3] 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 ft; 73.15 to 228.60 m) 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 Tables 7.1–7.8 are harvested in estuaries.

Figure 7.2. Annual red sea urchin landings in Oregon over time.



Note. 1 lb = 0.454 kg. Data from ODFW commercial red sea urchin landings: https://www.dfw.state.or.us/mrp/shellfish/commercial/urchin/landings.asp.

The commercial landings summarized in Tables 7.1–7.8 are somewhat reflective of where the catch occurs, although the location is not always certain. For example, depending on the 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.

3 See https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/index.asp for the ODFW landing statistics used for Tables 7.1–7.8.

June	July	August	September	October	November	December	Total
1 0							1 0
				206 1330	200 1000		406 2330
6889 32,931	3108 14,383	253 980	2 0	1 0	818 0	22,953 68,501	3,418,637 11,190,293

Table 7.2. Commercial catch statistics for GEARHART to NEHALEM BAY.

Species		January	February	March	April	May
Barnacle, gooseneck	lb $					
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	533,515 1,723,504	106,735 454,265	60,438 281,900	23,705 161,185	19,395 142,834
Crab, rock	lb $					
Shrimp, ghost	lb $	3 5	2 3	17 28	6 10	34 51
Clams, butter	lb $	8023 6590	13,537 10,083	11,288 8300	3770 3016	1671 1374
Clams, cockle	lb $	81,681 110,000	52,345 71,541	78,142 108,491	18,928 25,261	16,123 18,346
Clams, gaper	lb $	198 139	506 424	413 344	158 126	374 507
Clams, razor	lb $			590 1760	5380 16,789	15,365 47,071
Mussel, bay	lb $					
Octopus	lb $					

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Note that razor clams are harvested commercially from the intertidal area of Clatsop County 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. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Gearhart – Seaside – Cannon Beach – Garibaldi – Nehalem Bay" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:17:37 PM).

June	July	August	September	October	November	December	Total
33 330	47 430	60 510	43 391	41 335	20 158	15 105	259 2259
			554 3244	476 2644	866 4814		1896 10,702
11,931 67,762	10,861 51,937	3786 17,888			403 403	797 797	771,566 2,902,475
			107 321	49 147	14 28		170 496
28 44	18 27	27 41	16 24	38 57	3 5	3 5	195 300
2146 1717	6490 5185	4187 2987	7712 5171	13,519 8265	19,392 12,392	19,712 12,619	111,447 77,699
18,841 22,832	26,704 23,425	16,528 15,870	1707 935	41 78			311,040 396,779
46 37	302,372 264,600	8323 4377	3063 1729	2204 1873	131 105		317,788 274,261
12,032 35,500	7078 20,368			2571 7740	1594 4771	474 1460	45,084 135,459
	54 81	36 36	33 33	18 18	3 3		144 171
				11 11			11 11

Table 7.3. Commercial catch statistics for NETARTS to DEPOE BAY.

Species		January	February	March	April	May
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	11,393 37,327	1024 3773	3038 14,700	700 3929	1633 11,640
Crab, rock	lb $					
Shrimp, ghost	lb $	394 603	410 625	513 781	383 581	961 1452
Shrimp, mud	lb $					
Clams, butter	lb $					
Clams, cockle	lb $				2888 1444	6093 3453
Sea urchin, purple	lb $			1500 1500		
Sea urchin, red	lb $			302 302		

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Note that the urchins would have been harvested close to Depoe Bay. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Netarts – Pacific City – Siletz – Salmon River – Depoe Bay" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:21:11 p.m.).

Table 7.4. Commercial catch statistics for NEWPORT.

Species		January	February	March	April	May
Barnacle, gooseneck	lb $					
Crab, box	lb $		8 8			
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	5,212,577 16,684,187	1,090,288 4,815,557	365,302 1,725,540	115,570 795,027	47,102 369,676
Crab, rock	lb $				4 4	
Shrimp, ghost	lb $					

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Newport" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:22:43 p.m.).

June	July	August	September	October	November	December	Total
			18 108	1781 11,051	1980 9879		3779 21,038
938 5600	1653 10,277	1264 7850					21,643 95,096
				18 54	5 15		23 69
572 874	449 693	422 654	590 915	837 1284	514 793	229 351	6274 9606
		4 8					4 8
					871 697		871 697
7677 4929							16,658 9826
							1500 1500
							302 302

June	July	August	September	October	November	December	Total
			15 60	57 228			72 288
							8 8
			4 16	101 808	1138 5218		1243 6042
19,271 122,864	11,154 72,481	3404 24,235	19 0		2852 0	61,121 183,423	6,928,660 24,792,990
					82 123		86 127
	19 38						19 38

Table 7.5. Commercial catch statistics for WALDPORT to WINCHESTER BAY.

Species		January	February	March	April	May
Crab, box	lb $				257 900	
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	499,276 1,754,393	170,487 748,777	69,810 330,492	26,286 177,589	16,349 130,661
Shrimp, ghost	lb $	1514 4119	1521 4178	2560 7192	2380 7222	3447 9265

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Note that ghost shrimp are harvested for bait in the intertidal area of bays. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Waldport – Yachats – Florence – Winchester Bay" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:24:23 p.m.).

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

Species		January	February	March	April	May
Crab, box	lb $					6 12
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	2,282,972 7,109,328	1,565,359 6,056,058	287,609 1,197,934	121,259 809,955	55,257 432,775
Crab, mole	lb $					3 3
Shrimp, ghost	lb $		42 84	110 220	66 132	283 566
Clams, butter	lb $		255 290	703 778		91 91
Clams, cockle	lb $		648 890	1730 2539	2246 3247	63 95
Clams, gaper	lb $					
Octopus	lb $				43 65	
Sea urchin, red	lb $					

Note. This table spans the two facing pages. 1 lb = 0.454 kg. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Charleston" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:27:56 p.m.).

June	July	August	September	October	November	December	Total
							257 900
				7659 34,845	17,091 80,418		24,750 115,263
7585 44,218	3372 18,290	1609 9163				969 555	795,743 3,214,138
2247 5804	1890 5281	1378 3958	3067 8320	3238 8533	1071 3124	1066 3262	25,379 70,258

June	July	August	September	October	November	December	Total
							6 12
				926 4017	1801 7638		2727 11,655
19,059 107,911	10,735 52,583	2210 12,924	19 0		1840 0	63,405 186,584	4,409,724 15,966,052
							3 3
434 868	192 384	90 180	111 209	157 312	144 285	113 226	1742 3466
199 239	59 59						1307 1457
77 116	1569 2354				95 143	134 201	6562 9585
				44 55	108 135	520 650	672 840
	25 13					52 78	120 156
1998 3497	9277 13,545						11,275 17,042

Table 7.7. Commercial catch statistics for BANDON/PORT ORFORD.

Species		January	February	March	April	May
Crab, Dungeness, bay	lb $					
Crab, Dungeness, ocean	lb $	1206 0	555,476 1,851,104	83,219 334,093	30,063 150,928	30,418 167,306
Octopus	lb $		689 456	1103 671	154 99	117 69
Sea cucumber, California	lb $				566 2264	1184 4736
Sea urchin, purple	lb $				66 66	
Sea urchin, red	lb $	18,213 64,122			3441 6215	

Note. This table spans the two facing pages. 1 lb = 0.454 kg. The majority of these landings would have been from Port Orford. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Bandon – Port Orford" at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:29:15 p.m.).

Table 7.8. Commercial catch statistics for GOLD BEACH/BROOKINGS.

Species		January	February	March	April	May
Crab, Dungeness, ocean	lb $		1,508,179 5,251,980	166,088 665,809	36,501 213,825	18,150 106,731
Sea urchin, red	lb $	15,498 55,193	11,943 43,651	21,099 69,966		23,755 60,897

Note. This table spans the two facing pages. 1 lb = 0.454 kg. The majority of these landings would have been in Brookings. Adapted from ODFW 2019 landing data in "2019 Final: Pounds and Values of Commercially Caught Fish and Shellfish Landed in Oregon – Gold Beach – Brookings," available at https://www.dfw.state.or.us/fish/commercial/landing_stats/2019/ (data as of 4/14/2020 3:32:09 PM).

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 (*N. 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 (*T. capax*), butter (*S. gigantea*), cockle (*C. nuttallii*), littleneck (*L. 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).

The subtidal clam dive fishery is a limited-entry fishery (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, and Nehalem Bay represent the Tillamook harvest; these landings are shown in Table 7.9. Cockles are the only species shown in landings reported from Netarts, Pacific City, Siletz Bay, Salmon River, and Depoe Bay, as well as 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 bottomlands leased from the state or, in the case of some regions in Coos Bay, owned by the port or Coos County.

June	July	August	September	October	November	December	Total
				67 335			67 335
17,602 96,295	15,520 63,906	7364 30,793			268 0	66,121 196,554	807,257 2,890,979
95 98		24 12				31 16	2213 1421
							1750 7000
							66 66
						14,052 59,310	35,706 129,647

June	July	August	September	October	November	December	Total
6940 37,938	3014 15,599	1123 6286			253 0	106,955 321,780	1,847,203 6,619,948
22,708 58,161				16,455 55,778	21,965 79,696		133,423 423,342

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

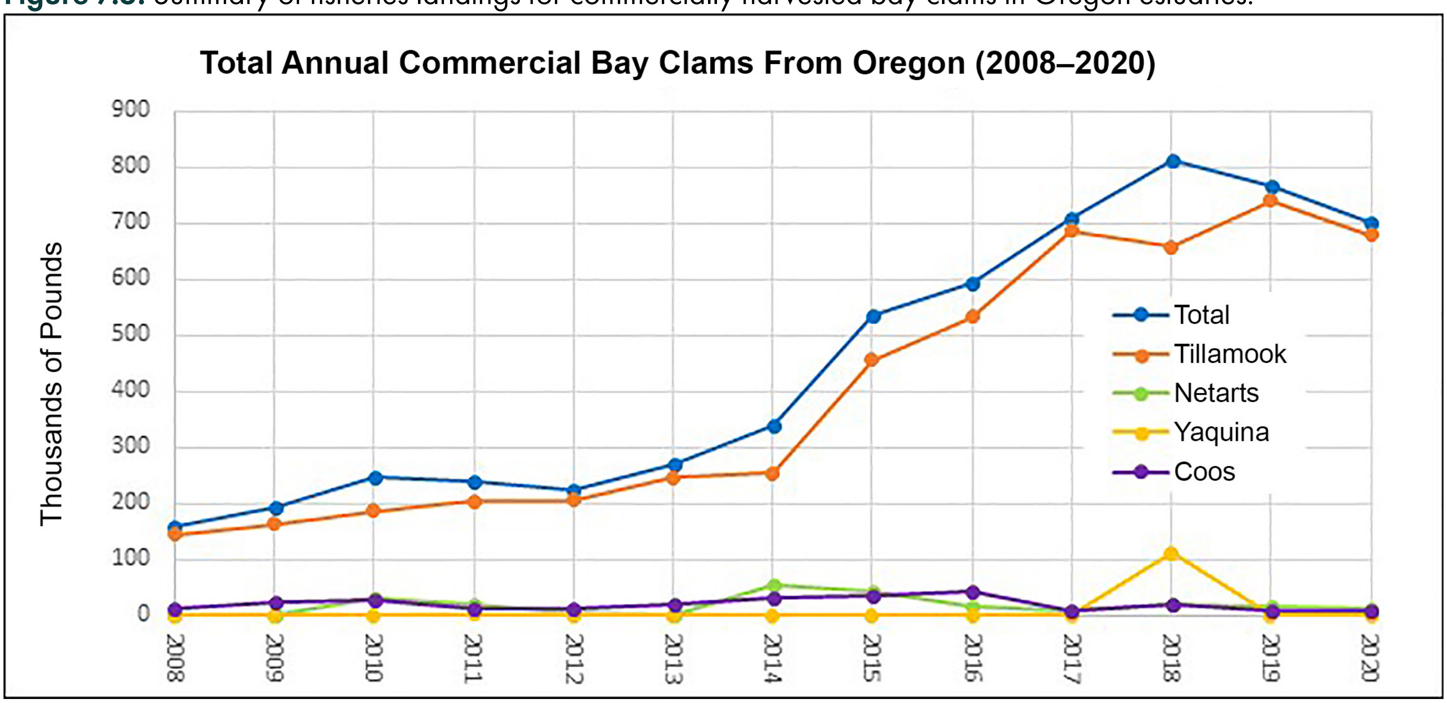


Table 7.9. Summary of 2020 landings of clams from the Tillamook Bay estuary and nearby areas.

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

Note. 1 lb = 0.454 kg. Data from https://www.dfw.state.or.us/fish/commercial/statistics.asp.

Table 7.10. Summary of 2020 landings of clams from Netarts, Pacific City, Siletz Bay, Salmon River, and Depoe Bay, as well as from Charleston.

Port	No. of lb.	Value ($)
Netarts, etc.	14,519	8277
Charleston	11,462	10,554

Note. 1 lb = 0.454 kg. Data from https://www.dfw.state.or.us/fish/commercial/statistics.asp.

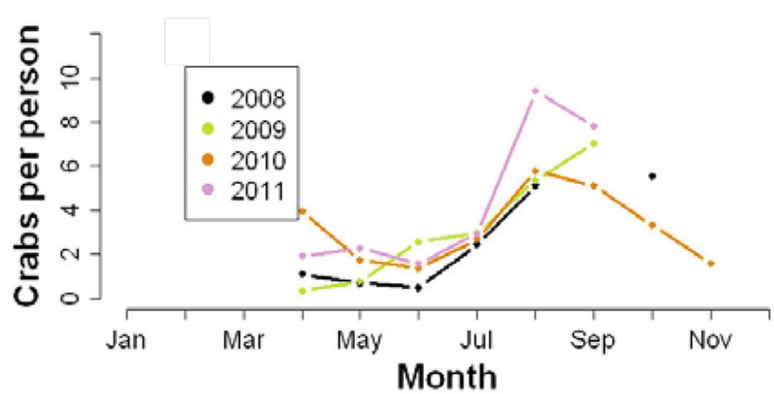
Table 7.11. 2020 commercial oyster production on Oregon state-leased lands in five estuaries.

Estuary	Acres leased	Gallons shucked	Bushels raw	Total production	Production value	Lease/fees collected
South Slough	240.13	245.00	8218.17	8463.17	$507,790.00	$4093.83
Netarts Bay	425.22	38.00	5514.17	5552.17	$333,130.00	$6605.53
Tillamook Bay	2605.14	2833.75	27,943.00	30,826.75	$1,849,605.00	$36,961.92
Umpqua River	60.00	0.00	28.83	28.83	$1730.00	$843.46
Yaquina Bay	517.00	5805.00	3053.55	8858.55	$531,513.00	$7164.71
Totals	3847.49	8971.75	44,757.72	53,729.47	$3,223,768.00	$55,669.45

Note. 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. Data from the Oregon Department of Agriculture, Food Safety Program, https://www.oregon.gov/oda/programs/FoodSafety/Shellfish/Pages/ShellfishPlat.aspx — on this web page, see "Shellfish plat production annual report (2020)," accessed in December 2021.

Figure 7.4. Estimated number of crabs harvested recreationally, by month and year from 2008–2011, for TILLAMOOK BAY.

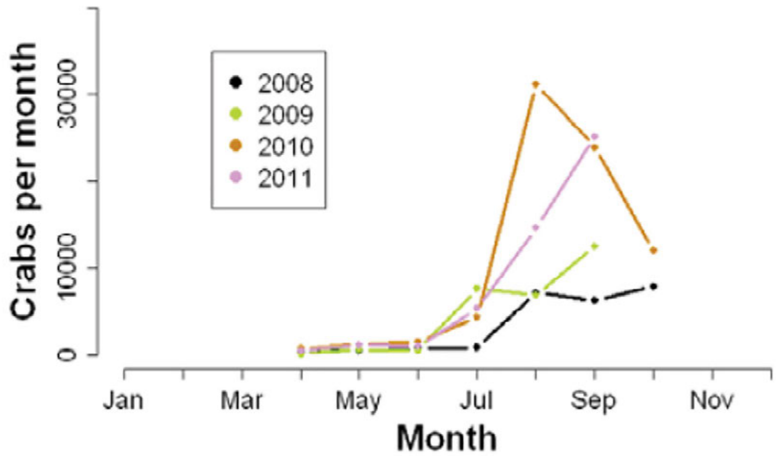
	2008	2009	2010	2011
April	89	663	451	320
May	229	1108	814	641
June	378	479	630	203
July	575	1958	788	631
August	1373	1721	1589	1330
September	1426	1536	1531	2512
October	2370	NS	1276	NS
Total (95% CI)	**6440** (4635-8245)	**7465** (5829-9102)	**7080** (5503-8657)	**5637** (4355-6919)



Note. NS = not sampled. Adapted from Ainsworth et al. (2012).

Figure 7.5. Estimated number of crabs harvested recreationally, by month and year from 2008–2011, for NETARTS BAY.

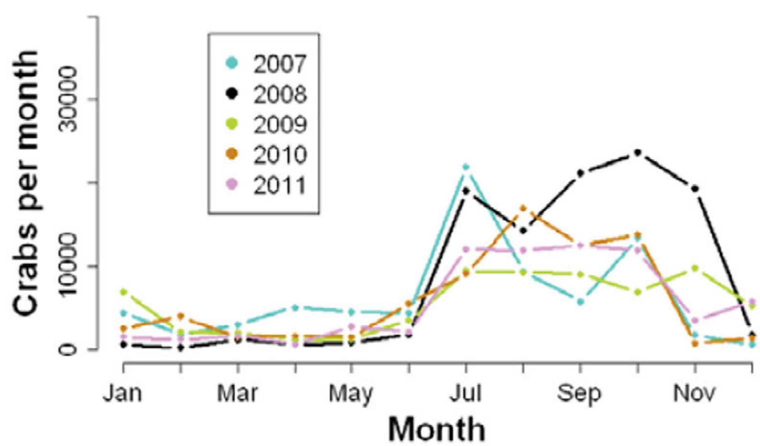
	2008	2009	2010	2011
April	299	333	434	553
May	406	559	467	694
June	285	267	455	510
July	360	1928	1240	1042
August	801	1612	2745	1297
September	930	1664	2767	1924
October	1871	NS	2140	NS
Total (95% CI)	**4951** (3485-6418)	**6363** (5001-7724)	**10,248** (8131-12,364)	**6020** (4666-7375)



Note. NS = not sampled. Adapted from Ainsworth et al. (2012).

Figure 7.6. Estimated number of crabs harvested recreationally, by month and year from 2007–2011, for YAQUINA BAY

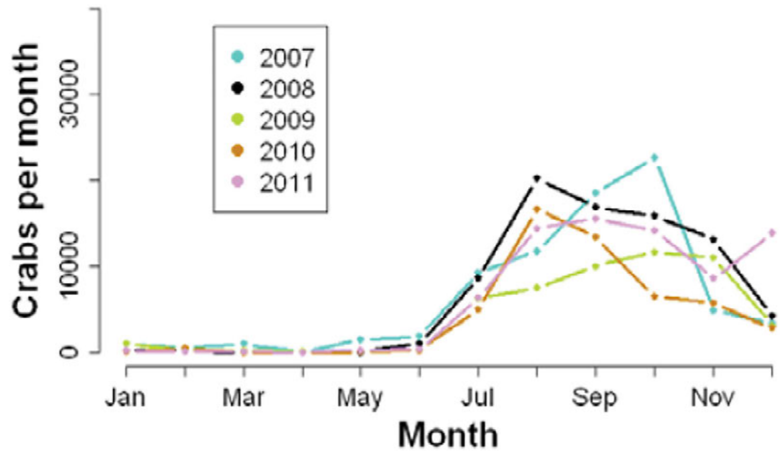
	2007	2008	2009	2010	2011
Jan.	927	251	1435	656	684
Feb.	923	644	1127	1397	645
Mar.	1264	658	1031	1054	578
Apr.	738	601	1061	1154	423
May	1181	1040	869	497	853
June	1301	976	1084	1311	716
July	4210	2599	1817	2307	2169
Aug.	2617	2285	1966	2240	1927
Sept.	1356	3658	2572	2144	2065
Oct.	4038	3506	2161	3730	2125
Nov.	972	3390	1335	695	596
Dec.	406	474	1126	566	936
Total (95% CI)	**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)



Note. Adapted from Ainsworth et al. (2012).

Figure 7.7. Estimated number of crabs harvested recreationally, by month and year from 2007–2011, for ALSEA BAY.

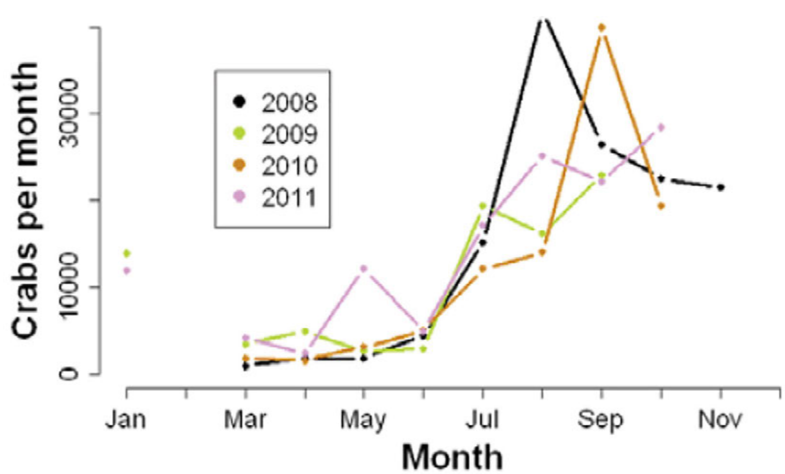
	2007	2008	2009	2010	2011
Jan.	300	169	553	54	252
Feb.	400	163	275	295	90
Mar.	286	276	209	48	80
Apr.	180	133	168	99	64
May	292	145	500	191	497
June	460	437	380	161	299
July	2519	1455	1462	1077	1312
Aug.	2613	3724	2109	2721	2055
Sept.	3296	3715	3363	2913	2136
Oct.	3077	3306	2821	1719	2503
Nov.	901	2418	1314	896	1048
Dec.	486	675	773	577	1221
Total (95% CI)	**14,810** (9698-19,923)	**16,615** (13,059-20,171)	**13,929** (10,775-17,082)	**10,752** (8318-13,186)	**11,558** (8951-14,269)



Note. Adapted from Ainsworth et al. (2012).

Figure 7.8. Estimated number of crabs harvested recreationally, by month and year from 2008–2011, for COOS BAY.

	2008	2009	2010	2011
Jan.	NS	1845	NS	1530
Feb.	NS	NS	NS	NS
Mar.	351	1329	319	928
Apr.	683	1143	359	375
May	877	864	1000	920
June	638	663	1153	874
July	1834	2033	2021	2000
Aug.	6155	2136	3085	2481
Sept.	3468	2572	2476	2671
Oct.	3616	NS	2126	2431
Nov.	1886	NS	NS	NS
Dec.	NS	NS	NS	NS
Total (95% CI)	**19,507** (14,076-24,939)	**12,584** (8264-17,106)	**12,540** (8657-16,422)	**14,209** (10,337-18,081)



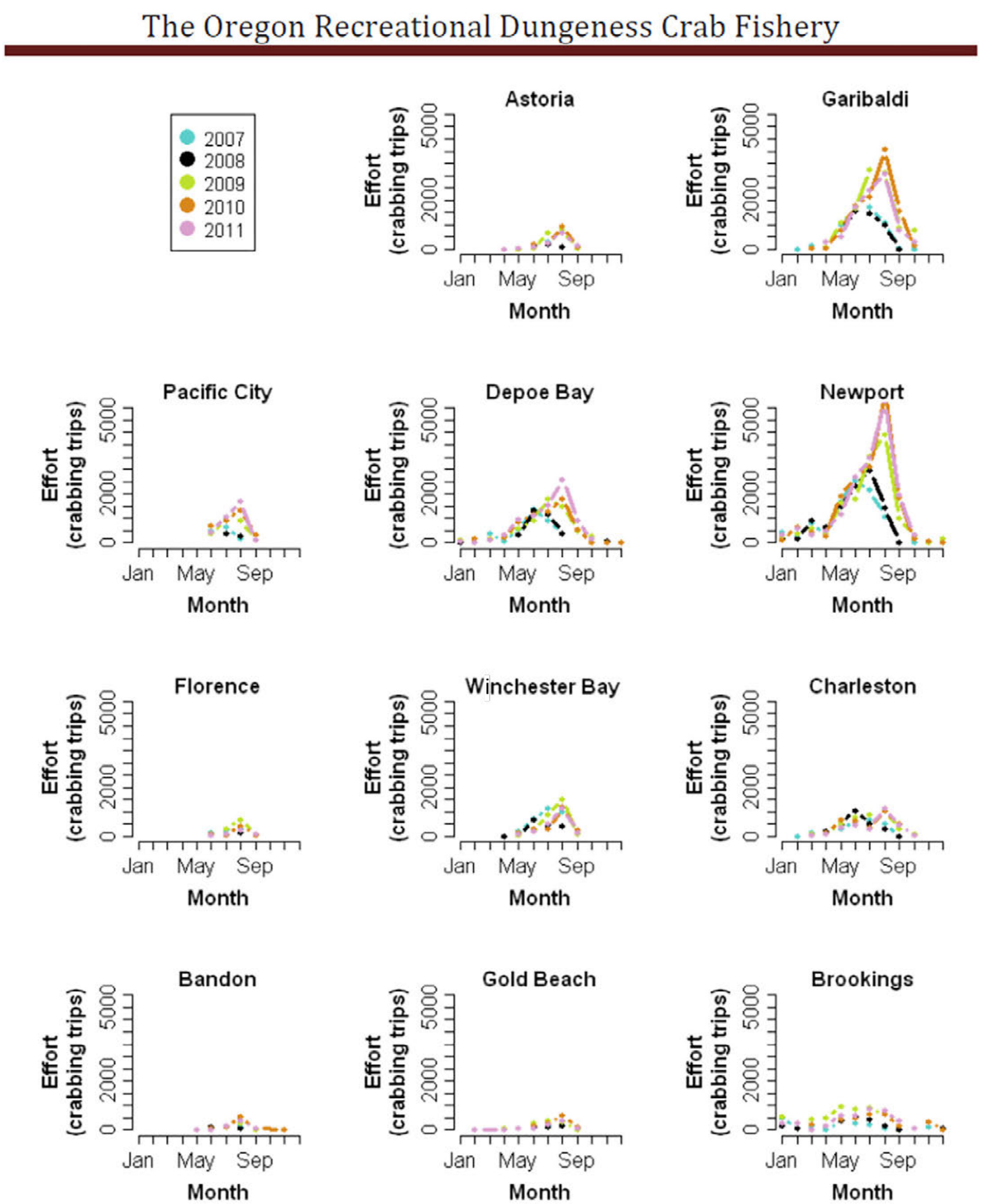
Note. NS = not sampled. Adapted from Ainsworth et al. (2012).

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 (*C. productus*) are harvested. Ainsworth et al. (2012) provided 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 study, we have included the estimates of the number of recreational crabbing trips and the estimates of the 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) showed the number of trips taken from Oregon ports to the open ocean in 2007–2011 (Figure 7.9).

Figure 7.9. Estimated monthly recreational ocean crabbing trips, including charter and private boats.



Note. From Ainsworth et al. (2012).

Recreational clamming is also a popular activity in Oregon estuaries. Surveys from ODFW's Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR[4]) 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 to 2012, ODFW conducted surveys of the number of recreational clam-digging trips to these bays, with the exception of Alsea Bay (Table 7.12). The time periods covered for each bay differ. 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.

The 2019–2023 Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP; officially titled *Outdoor Recreation in Oregon: Responding to Demographic and Societal Change*; Oregon Parks and Recreation Department 2019) contains the results of a survey of 3069 randomly selected Oregonians. It assessed their participation in outdoor recreation activities. Crabbing and clamming were included as recreational activities, and an estimate of their economic value is reported in Table 7.13.

4 See https://www.dfw.state.or.us/mrp/shellfish/seacor/maps_publications.asp.

Table 7.12. Number of recreational clam-digging trips for each of four estuaries in Oregon, 2008–2012.

Bay	2008	2009	2010	2011	2012
Tillamook	9832	9818	6207	6134	11,018
Netarts	12,081	23,262	11,177	9786	13,653
Yaquina	6114	13,002	11,961	7363	7052
Coos Bay	13,598	15,428	13,030	11,113	9729

Note. Data from ODFW's SEACOR program: https://www.dfw.state.or.us/mrp/shellfish/seacor/maps_publications.asp.

Table 7.13. Estimate of the economic value of recreational crabbing and clamming activity in Oregon.

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

Note. SCORP = Statewide Comprehensive Outdoor Recreation Plan. 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. User occasions are the number of times individuals participated in outdoor recreational activities in 2017. An activity day is defined as one person recreating for some portion of a day.

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 is diverse; however, they can generally be divided into two categories: (1) direct effects of sea otter predation, which are generally negative from a human perspective insomuch as they involve shellfish species harvested commercially, recreationally, or as part of subsistence fisheries, and (2) 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 fished commercially or recreationally that could 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 tens of millions of dollars in the case of Dungeness crab. Thus, the potential economic impacts of even a small reduction due to sea otter recovery are consequential. However, the impacts are not always clear. For some fisheries (e.g., urchin dive fisheries), there is good reason to project a substantial negative impact from sea otter recovery. But for 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 negative impacts associated with sea otter recovery—in fact, there was actually a positive correlation (though likely not a causal relationship) between sea otter abundance 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 have often been associated with reductions in herbivores and corresponding increases in primary producers (plants), which in coastal marine ecosystems include kelp and seagrass. 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, thus stabilizing and protecting shorelines. Sea otters can also impact human welfare through wildlife viewing opportunities and the benefits imparted to 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 nonmonetary values to people. In the case of Indigenous 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 the socioeconomic impacts of sea otter recovery should therefore provide a comprehensive accounting of the social values of the relevant communities, including both monetary and nonmonetary variables.

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