# Pacific Coast Fisheries Diversification Framework

# I. INTRODUCTION

This goal of this project is to provide resources for fishermen and coastal communities to make informed decisions as they face changing conditions and economic uncertainty due to climate change. Our hope is that this document can be a vital resource for communities making determinations about what kinds of fisheries activities to engage in, what kind of fisheries permit and quota assets to invest in, what kind of infrastructure investments to make, and what kind of market activities to engage in. We understand that every community is different, and have their own unique needs advantages, and cultural considerations that need to be balanced when making both individual and community decisions. Therefore, we have tried to create a tool that can serve as a guide for communities and individual fishermen to help them collect, synthesize, and understand fisheries data; organize and build consensus for community action;, and determine what interventions are appropriate and scalable for their communities. As such, we hope that the data and suggestions that we put forward here are used as a jumping off point for each community, rather than as hard truth for what the best options are.

We have also included several fisheries profiles, which include overviews of key elements of the fisheries, including history, season, fleet size, and historical volume and value trends. These fisheries were selected for a variety of reasons, including their economic importance, cultural significance, accessibility to new entrants and smaller fishermen, and likelihood to experience population shifts due to climate chance. This information is intended to provide basic information and a framework for considering other fisheries and future decision making for fishermen and ports.

# II. PROBLEM STATEMENT

The fisheries industry has a very deep history in the US. Throughout the centuries it has supported indigenous people, provided an economic powerhouse across several regions, and nourished countless generations. However, the industry as it sits today is facing several challenges that threaten to dramatically alter the economic, biologic, and cultural bedrock of this way of life.

On the biological side, many keystone species have experienced dramatic shifts in abundance over the past decades throughout the world. Atlantic Cod was once the driver of New England's fledging economy and was immortalized by the "sacred cod' hanging in the

Massachusetts state house, has suffered a collapse and has been very slow to recover. Salmon that were once described as being thick enough to walk across rivers on their backs have experienced a precipitous decline, being almost entirely extirpated on the East Coast and are heavily depleted on the West Coast, though strong runs still exist in more northerly regions like Alaska. While the reason for these declines are not always agreed upon and include aspects like overfishing, habitat destruction, and climate change, it is impossible to dispute the declining catch numbers. As climate change continues to accelerate, it is increasingly likely that species abundance will change as well. Cold water species will continue to move poleward and face challenges to their resilience as both habitat and traditional forage sources change. At the same time, it is possible that warmer water species will move into the ecological niches previously occupied by other species, with increasing prevalence of squid on the West Coast and skyrocketing numbers of Black Seabass off New England providing two examples of species thriving in new territories.

Biological shifts also will impact the viability of fishing activities in other ways. As the climate changes, marine species like whales are changing their behavior, showing up in places at times that they never used to. This has led to an increase of whale entanglements in fixed gear like crab pots, and at times has shut down the Dungeness fisheries on the West Coast and threatens to do the same to the East Coast lobster fishery. Climate change also has the potential to impact lifecycles throughout the food web in multiple ways. Increasing acidity of the ocean due to the absorption of $CO_2$ and subsequent creation of Carbonic Acid has the potential to severly disrupt organisms that use calcium and other materials to create shells, such as shellfish and crustaceans. Changing temperatures also impact the prevalence of microorganisms, resulting in increased levels of algae that can cause toxic blooms, eutrophication, fisheries closures, and die offs. Additionally, changing the strength and duration of season events such as the spring upwelling transition in the California Current has the potential to disrupt the recruitment success of multiple species, including Dungeness crab. Fishermen will need to assess what species are accessible to them, what fisheries may look like in the future, and how they might adapt to create a robust fishing business that can survive changing times.

Coastal communities have also been experiencing profound changes to their culture and economies as fisheries abundance has shifted. Many smaller ports are currently facing infrastructure challenges, including dilapidated docks, limited access to cold storage and ice, and competition for waterfront property with real estate developers who can make more money by turning working waterfronts into condos than by reinvesting in vessel offload and repair facilities. This has been one factor that has driven consolidation in the industry towards large, vertically integrated companies in a handful of ports that have the critical mass in their fleet size to support infrastructure reinvestment. This has often left small-holder owner-operator fishermen with fewer options for offloads, less bargaining power when setting price, and longer runs to deliver products. While there has been a subsequent rise in service economy industries like tourism, those jobs do not pay as well as jobs in extractive industries like fishing, and often an active fishing port serves as a driver for tourism, meaning the successful transition to a service economy still benefits greatly from working waterfronts.

Finally, the regulatory structure of fisheries assets itself is creating challenges for smaller fishermen and, alongside the infrastructure situation mentioned above, is driving the consolidation of fisheries assets towards larger ports, larger fishing businesses, and vertically integrated organizations. The Magnuson-Stevens act, first passed in 1976, has been the driving regulatory force behind fisheries management in the United States. One management tool has been the rationalization of fisheries, implementing limited access permits and fisheries quotas as a way of controlling fishing effort and biomass exploitation across many species. However, the creation of asset classes like permits and quotas has also had unintended impacts on fishermen's ability to access the resource. These assets are highly valuable, often trading at multiples of several times the landing values of a given stock. This has created a situation where younger fishermen who are looking to become captains and run their own fishing business are often unable to afford the up-front costs of buying permits and/or quotas. The byzantine regulations often mean that it is difficult for third parties like quota banks or community organizations to buy and lease assets, as some assets are unable to be leased, or only very specific types of assets within a fishery can be leased, leading to high prices for assets like Alaskan Sablefish A-Shares, which can be leased, vs standard quota shares. Finally, many financial instituions are hesitant to lend to young fishermen to help them get into the business, as fishing has a huge amount of volatility. If they are going to provide capital, they often require insurance, proof of income, and other costs on the fishermen that they are not used to bearing and in many instances have not priced into their operations in the past. Layered on top of this is the fact that across the country many fishermen are approaching retirement age ("the graying of the fleet") and are looking to divest their assets to fund their retirement.

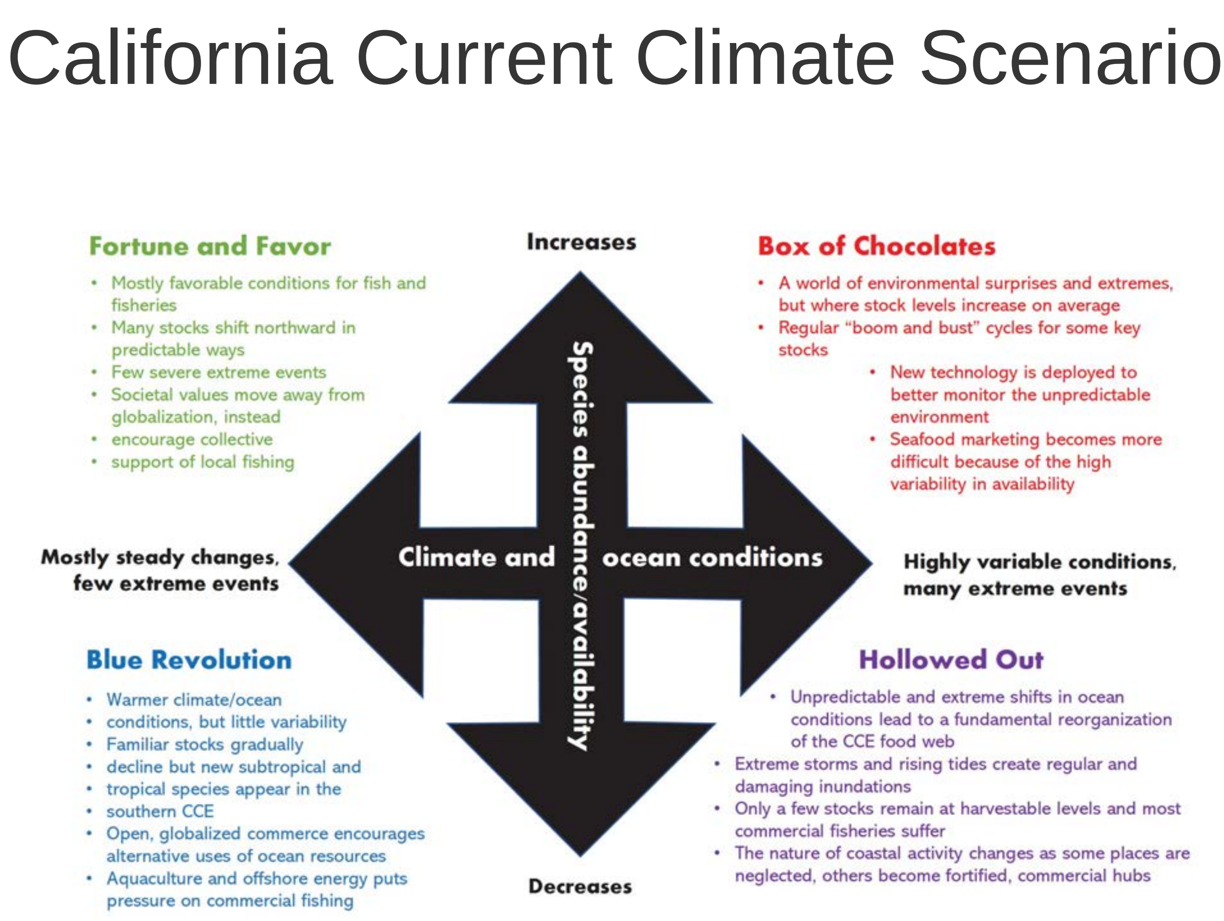
The end result of these regulatory and financial dynamics is that fishermen who are looking to divest their assets in smaller communities are finding it difficult to keeping those assets within their communities. Younger fishermen lack the capital to buy them outright, and often find it very difficult to secure outside financing. The retiring fishermen are then forced to either work out a special deal with a younger entrant for them to assume control those assets, which carries with it additional risk and complication, or sell to a buyer who has the cash on hand. This results in the consolidation of assets in ports with larger, established fishing businesses, leaving a smaller and smaller asset base to support fleets in smaller communities.

To summarize, there are several facets that make up the problem statement that fishermen are facing today: Overfishing, habitat degradation, and climate change have caused declines in key fisheries, and may continue to drive declines into the future. Additionally, changing environmental conditions are resulting in new and different species behavior in the oceans, which is altering the makeup of available species and causing negative interactions with some species and fishing activities. A lack of reinvestment in working waterfronts has hobbled some ports' ability to remain competitive, and is exacerbating trends towards consolidation of assets in a few major ports. Barriers to accessing capital is further driving the consolidation of assets. On this backdrop, fishermen must make decisions on how to plan for an uncertain future, making decisions that will enable them to maintain access to key fisheries, branch out into new fisheries, and maximize the value of existing activities so that they can have a diverse enough income stream to weather future disruptions and sea changes.

# III. CLIMATE SCENARIOS

The world is warming, and the oceans are one of its primary heat and carbon sinks. In addition to warming temperatures, increased Greenhouse Gas (GHG) levels have multiple follow-on impacts on the ocean, including increased acidity due to CO2 absorption creating carbonic acid, changing current and upwelling patterns, increased algal blooms, shifting weather patterns, declining Dissolved Oxygen, and increased human interactions such as pollution, energy use, and extractive industries. In summer 2020, the Pacific Fishery Management Council's Climate and Communities Core Team issued a report outlining four broad scenarios for how the California Current Ecosystem (CCE) could change in the future along two axes. The scenarios examined possible futures based on two different drivers: physical conditions and biological productivity (see figure 01). The left side of the matrix indicate scenarios where there is low variability in physical drivers, but rather steady changes over time towards a new equilibrium, while the right side of the matrix are scenarios assuming high variability in the physical climate conditions. Likewise, the top of the matrix consists of scenarios where the respective physical drivers align with increased biological productivity, while the bottom of the matrix are scenarios where physical drivers coincide with lower biological productivity. We have excerpted a section of the climate scenario report "2040: Scenarios for West Coast Fisheries" written by the Pacific Fisheries Management Council (PFMC). Summaries of the four different scenarios as created by the Pacific Fisheries Management Council (PFMC) are repeated below to provide some additional background.

**Figure 1: Climate Scenario Matrix from the PFMC.**




Excerpt from *2040: Scenarios for West Coast Fisheries* italicized below.

## *Fortune and Favor*

### *Low climate/ocean variability, stock availability increases*

*The natural environment in this scenario is not radically different from today. By 2040, conditions seem pretty favorable for fish and fisheries. The frequency of extreme events (such as marine heatwaves) is little changed from the 20 year-period up to 2020, although high-end temperatures depart from a higher long-term average. Many economically important stocks are about as abundant as they were in 2020 and in some cases they have increased. Although the*

*effects of climate change have been gradual and relatively benign, ocean conditions—and fish stocks—have been far from static. Societal values have turned decisively to favor reducing green-*

*house gas emissions, and there is broad support for new collective action through a variety of policies and government interventions.*

*In Fortune and Favor, warming has been gradual and at the low end of current global warming projections. Inter-annual variability in ocean temperature is relatively low compared to the Hollowed Out and Box of Chocolates scenarios. Likewise, marine heatwaves and swings between El Niño and La Niña conditions are also less intense and frequent, compared to the Hollowed Out and Box of Chocolates scenarios. However, ocean temperature variations diverge from a higher mean than today.*

*Compared to 2020, already modest upwelling in the southern CCE further relaxes while strengthening in northern CCE, resulting in persistent seasonal hypoxic (low oxygen) conditions in nearshore benthic areas in the northern CCE. Changes in upwelling strength are mostly noticeable from decade to decade, but less obvious from year to year.*

*Terrestrial climate impacts have not been as dire as predicted back in 2020. While West Coast droughts have occurred, their severity and duration has been limited. On average, precipitation levels in the Sierras have remained consistent over time, although a greater percent of that precipitation is falling as rain. Annual snow accumulation levels are not significantly lower in 2040 than they were in 2020. Occasional cooler and wetter years (La Niña years) improve river low and conditions for salmon.*

*Extreme winter storms, and rough weather generally, are much less frequent as winds weaken overall.*

***Policy, market, and technological conditions***

*While the effects of climate change have been relatively mild, the U.S. economy experienced major shocks during the 2020s. The impact of the Covid-19 pandemic was followed by worldwide cyber conflicts that further disrupted finance and supply chains. International relationships became more fractured, resulting in hostility, mistrust, and further declines in economic confidence. To dig out of such a difficult situation, all industries needed to challenge their conventions. By the mid 2030s, the fishing industry became less international and came to rely more on on demand from U.S. consumers. This is aided by broad-scale efforts to promote domestically produced seafood, driven by entrepreneurs, communities, and governments. By 2040, there is a renewed emphasis on buying local, supporting American seafood, and exploring alternative, community-based approaches to fishery management.*

*American culture in the 2040s shifts to emphasize nature-based solutions to address long-term climate and pollution concerns. Despite the shocks that set back the economy and fishing industry in the 2020s, there is a growing realization that the 2020-2040 period granted the* *fishing industry a "temporary reprieve" from the long-term effects of ocean warming and acidification. A younger generation is now taking a longer-term, more ecosystem-based perspective to ensure long-term sustainability of the industry and the environment. This includes removing dams in some areas, restoring natural wetlands, and renewed efforts to recover depleted and endangered species. National and global policy commitments to ramp up greenhouse reduction efforts began in the early 2030s. By the 2040s, the U.S. economy is firmly on the road to decarbonization.*

*By 2040, especially on the West Coast, fish is seen as a healthy, sustainable, local source of protein. As the fishing industry resurged in the 2030s, national policy promoted communal and cooperative approaches. This encouraged the growth of community-focused fishing, processing, and marketing, informed by investments in new monitoring technologies. A new generation is inspired to participate in fisheries. After "losing their way" in the 2020s, coastal communities re-embrace fishing as central to their identity and adopt new social arrangements (e.g., regional co-management). The economic shocks of the 2020s also accelerated a decline in recreational fisheries. But changing attitudes and new technologies (e.g., carbon neutral vessel propulsion) led to growing participation in the 2030s.*

*The gradually warming ocean has created an interesting balance of challenges and opportunities for fishermen and fisheries management. There is a greater diversity of fish species available in the CCE, but evidence suggests that, on average, fish are smaller-bodied than 20 years ago. Greater abundance and diversity have led to increased catch of weak stocks in fisheries using less selective gear. Fishermen are frustrated by resulting limits on the catch of target species. But while an ecosystem-based perspective in fisheries management constrains catch in individual fisheries, catches across all fisheries increase. There is growing pressure for technological innovations and institutional changes to address these issues and seek solutions.*

### ***Ecosystem response***

*Continued ocean acidification has not led to threshold effects that reorganize trophic structure. Populations of most shell-forming plankton at the base of the food chain have adapted to lower pH (more acid) conditions, although shellfish aquaculture operations continue to struggle. Harmful algal blooms occur but are not as extensive or damaging as in the other scenarios. Over- all, conditions have stayed within the physiological tolerance range for most species, while ocean warming over these two decades produces more forage.*

*With some exceptions, most marine mammal populations are near or at what scientists estimate are pre-exploitation levels. The loggerhead sea turtle population in the West Coast EEZ has recovered and is de-listed under the Endangered Species Act; the leatherback sea turtle population, while not extinct, remains severely depleted, due to impacts far outside the CCE at nesting beaches.*

*For many important target species, 2020 to 2040 was a time of range expansion and/or range shifts. Important species are often available for longer, creating opportunities for discussions about extending fishing seasons. These changes seldom take fishermen and fisheries managers by surprise—fish movements are broadly predictable using enhanced data and modeling, and fleets have been able to reach the changing locations of stocks. Large purse seine vessels targeting CPS have been able to move with the stocks, and port infrastructure has been able to develop in northern areas to continue to support the industry. Place-based tribal fisheries see winners and losers.*

The table below presents the quantitative Fortune and Favor assumptions that we have set forth in the Diversification Model to illustrate potential impacts on the local fishery and community.

***Figure 2: Fortune and Favor Scenario Assumptions***

| Fishery | Projected Changes |
|---|---|
| Dungeness crab | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Halibut | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Lingcod | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Rockfish, Nearshore | • No change to current average abundance or landings (modest potential increase driven by higher primary productivity is offset by decline in abundance driven by reduction of variability and its impact on reproductivity dynamics.)<br>• Flattening of variability relative to current dynamics, reducing variability in baseline landings by half.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Sablefish | • No change to current average abundance or landings.<br>• No change to variability.<br>• Modest decline in ex-vessel prices, dropping [1% per year over for ten years, or 10% in total.] |
| Salmon, Chinook | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Market Squid | • No change to current average abundance or landings.<br>• No change to variability. |

| | |
|---|---|
| | • Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Albacore Tuna | • Modest increases to abundance and landings, rising .05% per year for 10 years, or 5.0% in total.<br>• No change to variability.<br>• No change to average ex-vessel prices. |
| Shrimp | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |

Excerpt from *2040: Scenarios for West Coast Fisheries* italicized below.

# *Blue Revolution*

## *Low climate/ocean variability, stock availability decreases*

*Similar to the Fortune and Favor scenario, in Blue Revolution the climate warms but is less variable year to year. Many familiar stocks decline but new subtropical and tropical species appear in the southern CCE. Although new fishing opportunities arise, the*

*growth in alternative ocean uses puts pressure on many commercial fisheries. An open and globalized economy is looking for inexpensive ways to supply protein, and wild-caught fish struggle to meet those needs. Industry players don't suddenly go bankrupt, but interest in commercial fisheries gradually falls away as stocks decline and ocean use competition intensifies. Fish are still valued in this scenario, but in different ways.*

## *Physical drivers*

*In Blue Revolution the same set of physical drivers are affecting the CCE as those described above for Fortune and Favor, although the way in which the ecosystem has responded is different.*

*Warming has been gradual and at the low end of current global warming projections. Inter-annual variability in ocean temperature is relatively low compared to the Hollowed Out and Box of Chocolates scenarios. Likewise, marine heatwaves and swings between El Niño and La Niña conditions are also less intense and frequent, compared to the Hollowed Out and Box of Chocolates scenarios. But ocean temperature variations diverge from a higher mean than today.*

*Compared to 2020, already modest upwelling in the southern CCE further relaxes while strengthening in the northern CCE, resulting in persistent seasonal hypoxic (low oxygen) conditions in nearshore benthic areas in the northern CCE but are less widespread in the southern CCE. Changes in upwelling strength are mostly noticeable from decade to decade, but less obvious from year to year.*

*Terrestrial climate impacts have not been as dire as predicted back in 2020. While West Coast droughts have occurred, their severity and duration has been limited. On average, precipitation levels in the Sierras have remained consistent over time, although a greater percent of that precipitation is falling as rain. Annual snow accumulation levels are not significantly lower in 2040 than they were in 2020. Occasional cooler and wetter years (La Niña years) improve river low and conditions for salmon.*

*Extreme winter storms, and rough weather generally, are much less frequent as winds weaken*

## ***Policy, market, and technological conditions***

*The deep economic difficulties of the early 2020s prompted a coordinated response from the G-20—the governments of the world's largest economies. The challenge was to revive prosperity while also dealing with growing climate concerns and the threat of international hostilities. The result was a significant investment in various technologies (e.g. biotech, alternative energy, data science) and commitment to a more open, market-based global trading regime. There is support for multilateral institutions (including bilateral and regional fishery management arrangements) to solve global environmental problems.*

*Throughout the 2030s, public sentiment (and public policy) became focused on reducing carbon emissions as climate crises became more apparent around the world. This led to a number of developments with direct and indirect consequences for the fishing industry.*

*First, national and regional policies provided incentives for the extensive deployment of offshore energy platforms using wind, currents, and the thermal properties of ocean waters. Large installations were built as far as 20 miles offshore, capitalizing on new technologies and less stormy conditions. Second, technological and regulatory innovations encouraged the rapid development of inshore and offshore aquaculture. Driven by environmental concerns, public tastes and values have moved away*

*from the consumption of animal-based protein. By 2040, seafood and plant-based proteins are the main beneficiaries of this shift in demand.*

*While aquaculture has put more competitive pressure on large scale commercial fisheries, in 2040 small, boutique operations are still appealing in an "ocean to market" setting. Fishing communities retain some of their character, helped by investments in and maintenance of coastal infrastructure, sup- ported by Federal spending and the needs of new ocean industries. Experience in the 2020s conclusively demonstrates that knowledge work is no longer tethered to the office, so many well-compensated workers move out of urban areas, including to rural coastal communities. This is facilitated by large public and private investments in rural broadband access. While lifestyles in coastal communities don't collapse, commercial fisheries have shifted fundamentally towards a more symbolic role (such as offering demonstration tours).*

*The few remaining large-scale fisheries have shifted to offshore processing and/or consolidated inland operations, because of competition for shorefront property.*

*After declining throughout the 2020s, fishing as a form of recreation regained popularity, contributing to growth coastwide. While actual recreational catch is much lower in 2040, the experience is highly valued. Recreational fishermen also see more benefit when fish congregate around new energy installations.*

*The growing influence of aquaculture led to efforts to amend the Magnuson-Stevens Act to make fishery management councils responsible for regulating aquaculture activities in Federal waters. Additionally, relations between new ocean users and remaining commercial fishermen became fraught because of conflicts over space. The increasing competition for ocean space creates increasing administrative burden for the Council as it is drawn into regional ocean management projects and processes.*

## *Ecosystem response*

*In the Blue Revolution scenario, by 2040 harmful algal blooms are more frequent compared to the early 2020s. Although the evidence is not definitive, many believe that harmful algal blooms have gotten worse due to waste generated by intensive inshore aquaculture operations combined with warmer ocean temperatures. In this scenario the ecosystem has become less productive over time, which may be a result of the effects of more acidic ocean water affecting lower trophic levels (plank- ton, forage) in the CCE food web.*

*Marine mammal populations mostly decline. Due to successful international efforts (nesting beach protections, fishery bycatch mitigation), sea turtle populations stabilize and sea turtles are frequently seen in the central CCE.*

*Commercially important species like sablefish become much less abundant; others like hake and sardine establish very different, more north- ward distributions, making them less available in the West Coast EEZ. Formerly infrequently-seen species, like skipjack tuna, regularly occur as far north as San Francisco, but not in quantities that can support large-scale commercial fisheries. Fishery managers are forced to address increased range compression of some targeted species and co-occurring protected species, especially around offshore facilities*

The table below presents the quantitative Blue Revolution assumptions that we have set forth in the Diversification Model to illustrate potential impacts on the local fishery and

***Figure 1: Blue Revolution Scenario Assumptions***

| **Projected Changes** |
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|---|
| • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• No change to ex vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• No change to ex vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• Flattening of variability relative to current dynamics, reducing variability in baseline landings by half.<br>• Modest decrease to average ex-vessel prices, falling .05% per year for 10 years, or 5.0% in total. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• Modest decline in ex-vessel prices, dropping 1% per year over for ten years, or 10% in total, driven by increased competition from aquaculture. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• No change to ex vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• Some stabilization to variability.<br>• No change to ex vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• No change to average ex-vessel prices. |
| • Modest decrease to abundance and landings, falling 1% per year for 10 years, or 10.0% in total.<br>• No change to variability.<br>• No change to ex vessel prices. |

Excerpt from *2040: Scenarios for West Coast Fisheries* italicized below.

## *Hollowed Out*

## *High climate/ocean variability, stock availability decreases*

*This scenario creates extreme and sometimes insurmountable challenges for the fishing industry. Ocean acidification, deoxygenation, and shifts in decadal oceanographic processes lead to a fundamental reorganization of the CCE food web. Only a few stocks remain at* *harvestable levels and commercial fisheries suffer—a few firms opportunistically engage in commodity fisheries while small, part-time operations deliver local, boutique products. Extreme storms and rising tides create regular and damaging inundations. Interest in recreational fishing continues on a long-term decline.*

## *Physical drivers*

*Warming is at the high end of current global warming projections. Ocean temperature records are set across the entire CCE and nearshore waters are particularly affected. There is lots of variability from year to year, driven by the intensification of periodic and cyclical climate phenomena. Marine heatwaves, sometimes coinciding with large magnitude El Niño events, are persistent. The magnitude and frequency of swings between El Niño and La Niña conditions are much greater than at present. The North Pacific Gyre current system shifts northward. The Pacific Decadal Oscillation signal is weaker, with very few cool periods and deviations from higher mean temperatures compared to present.*

*Upwelling strength and regional hypoxia events vary substantially year to year in both frequency and magnitude. Upwelling is weaker and less seasonally persistent throughout the CCE compared to current average conditions. Nutrient availability is often limited, due to strong stratification from increasing temperatures, reducing the development of productive habitat. In many years, strong offshore winds disperse nutrient-rich water, reducing the development of productive habitat. Furthermore, during marine heatwaves upwelling habitat is compressed into the nearshore area. Harmful algal blooms in coastal waters are chronic in Northern California and Southern Oregon, driving periodic fishery closures. Coastwide harmful algal blooms occur in some years.*

*More precipitation falls as rain except at very high elevations. In a few years, maximum snowpack depth comes within 90% of the present day historical average, but melts off more rapidly in most years and rarely lasts beyond midsummer. In the 2030s, California enters a period of prolonged drought with low to no snowpack. Coastwide, the intermittent relatively cooler and wetter years become ever more important to snow- pack buildup and river low volumes.*

*In some years strong winds and heavy seas are a constant in the winter and large storms regularly roll through. Freak weather events such as intense summer wind/rain squalls occur in the Southern CCE. Seasonal wind direction is less predictable.*

## *Policy, market, and technological conditions*

*By 2040, the effects of economic downturns, climate change and marine pollution have become more and more apparent across the world. In many ways, the market for fishery products never really recovered from the economic shocks of the early 2020s. More generally, people worry about species extinction and basic ecosystem services, and they put more emphasis on* *protected species and alternative protein sources like algae, hemp, and laboratory-grown "meat." Commercial fishing is seen as an unsustainable way of obtaining protein. As fisheries decline, a smaller portion of government budgets is devoted to science and management.*

*With supply lacking, wild caught fish has become a high-priced delicacy that only a few rich people can take advantage of. In a world of polluted oceans, wild caught fish need rigorous quality control, or catches from pristine, less-polluted locations.*

*A large segment of the population now opposes killing animals for food, and public awareness campaigns periodically dampen broad demand for seafood in the U.S. while related trade barriers choke off exports. In 2040, there is strong public support for broad protections of ocean space in reaction to visible degradation of the terrestrial environment.*

*Most commercial fishermen could not see the benefits of staying in the game given public attitudes, bad fishing conditions, and limited opportunity to catch financially viable amounts of fish. Few are willing to replace those retiring from fisheries. In response, public support of long-term subsidy programs to sustain fisheries and fishing communities grows. With international trade restricted, domestic food security is an under- lying rationale voiced by proponents. Only those with the deepest pockets and the deepest convictions survived. By 2040, a few large firms involved in commodity production remain, along with artisanal operations supplying local markets. But these small, fragmented artisanal operations are ill-equipped to influence the policy debate about public support. Recreational fishing still exists, although participation continues its long-term, declining trend.*

*Coastal infrastructure suffered, thanks to sea level rise, coastal inundation, and storms, further limiting public exposure and access to seafood and the ocean. Funding for public infrastructure maintenance and adaptation has been limited and directed to essential facilities and urban areas. Rural fishing and coastal areas were not considered national priorities and declined economically and socially in its and starts. Some rural fishing communities were thus abandoned; others adapted and refocused to cater to a public that now sees the coast and ocean as a last wild space for nature appreciation. Remaining fishing firms consolidated and located in a few ports that were maintained primarily for other purposes such as shipping, tourism, or urban waterfront. These locations invest heavily in fortifications against damaging storms.*

*Even aquaculture has suffered in such difficult conditions. Coastal areas that might have hosted fish farming were seen as too polluted to support the production of healthy foods. Existing facilities were further hurt by storms. Policies generally discourage or block the development of marine aquaculture. Some land-based, closed-cycle aquaculture of marine species survives to supply the remaining high-end seafood market.*

## ***Ecosystem response***

*The CCE has been rocked by a series of "ecological surprises" including the unexpected effects of ocean acidification on primary productivity. Other surprises resulted from unexpected shifts in the occurrence and availability of previously unexploited species like short belly rockish, pyrosomes, and pelagic red crabs, sometimes resulting in large bycatch events. A very warm ocean marked by extreme swings in physical drivers results in an overall decline in productivity. Productive areas become extremely compressed and spawning habitat is lost. Traditional fishing grounds move, some are lost, and patchiness grows.*

*Harmful algal blooms in coastal waters are chronic in Northern California and Southern Oregon, driving periodic fishery closures. Coastwide harmful algal blooms occur in some years.*

*Marine mammal populations decline, with some species disappearing from the CCE entirely. The population of leatherback sea turtles foraging in the CCE has gone extinct while the rebound in the loggerhead sea turtle population has been checked.*

*For the majority of managed stocks, recruitment and productivity is low compared to current averages, with only occasional spikes. Overall, all or most key stocks become less abundant; some remain intractably depleted while others seem to disappear for a time and then reappear for a year or two in harvestable quantities, but overall there is less to catch in the water. Some species suffer population changes such as smaller maximum body size, making them less profitable to catch.*

*Streams and rivers dry up or are subject to such high fluctuation that salmon runs are permanently lost, especially in California and Oregon, and 2020s ESA-listed species are now extinct.*

*Some of the few newly-seen species outcompete previously valued target species. The food web becomes more top down, with a few dominant predators. Some of these new species provide windows of opportunity as markets and consumer attitudes change; for example, at the other end of the food chain, harvesting periodic jellyfish blooms becomes modestly profitable, and environmentally-conscious consumers choose to eat "low on the food chain," paradoxically increasing demand for lower trophic level species at the same time that predation pressures have increased.*

The table below presents the quantitative Hollowed Out assumptions that we have set forth in the Diversification Model to illustrate potential impacts on the local fishery and community.

***Figure 2: Hollowed Out Scenario Assumptions***

| Fishery | Projected Changes |
|---|---|

| | |
|---|---|
| Dungeness crab | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Halibut | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 20% up and 20% down every other year.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Lingcod | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 20% up and 20% down every other year.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Rockfish, Nearshore | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 20% up and 20% down every other year.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Sablefish | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 10% up and 10% down every other year.<br>• Modest decline in ex-vessel prices, dropping [1% per year over for ten years, or 10% in total.] |
| Salmon, Chinook | • Decreases to abundance and landings, falling 6.0% per year for 10 years, or 60.0% in total.<br>• No change to variability.<br>• Increasing prices, rising by 5% per year, or 50% in total. |
| Market Squid | • Modest increase to current average abundance and landings, rising by 1.0% per year or 10.0% in total.<br>• Increases to variability, ranging between 10% up and 10% down every other year.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Albacore Tuna | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 10% up and 10% down every other year.<br>• No change to average ex-vessel prices. |
| Shrimp | • Decreases to abundance and landings, falling 2.0% per year for 10 years, or 20.0% in total.<br>• Increases to variability, ranging between 10% up and 10% down every other year.<br>• No change to average ex-vessel prices. |

Excerpt from *2040: Scenarios for West Coast Fisheries* italicized below.

## *Box of Chocolates*

### *High climate / ocean variability, stock availability increases*

*This is a scenario of environmental surprises and extremes—but where, on average year to year, the abundance and availability of exploited species is at or near historical levels. Fishermen see* *"boom and bust" cycles for some key stocks. Species infrequently seen before on fishing grounds periodically appear in catchable amounts, while other species dwindle. New technology is deployed to better monitor the environment, predict environmental conditions, and exploit resources. Seafood marketing becomes more difficult because of the high variability in availability.*

## *Physical drivers*

*In Box of Chocolates the same set of physical drivers are affecting the CCE as those described above for Hollowed Out, although the way in which the ecosystem has responded is different.*

*Warming is at the high end of current global warming projections. Ocean temperature records are set across the entire CCE and nearshore waters are particularly affected. There is lots of variability from year to year driven by the intensification of periodic and cyclical climate phenomena. Marine heatwaves, sometimes coinciding with large magnitude El Niño events, are persistent. The magnitude (and frequency) of swings between El Niño and La Niña conditions are much greater than at present. The North Pacific Gyre current system shifts northward. The Pacific Decadal Oscillation signal is weaker with very few cool periods and deviations from higher mean temperatures compared to present.*

*Upwelling strength and regional hypoxia events vary substantially year to year in both frequency and magnitude. Upwelling is weaker and less seasonally persistent throughout the CCE compared to current average conditions. Nutrient availability is often limited, due to strong stratiication from increasing temperatures, reducing the development of productive habitat. In many years, strong offshore winds disperse nutrient-rich water, reducing the development of productive habitat. Furthermore, during marine heatwaves upwelling habitat is compressed into the near- shore area.*

*Harmful algal blooms in coastal waters are chronic in Northern California and Southern Oregon, driving periodic fishery closures. Coastwide harmful algal blooms occur in some years.*

*More precipitation falls as rain except at very high elevations. In a few years, maximum snowpack depth comes within 90% of the present day historical average but melts off more rapidly in most years and rarely lasts beyond midsummer. In the 2030s California enters a period of prolonged drought with low to no snowpack. Coastwide, the intermittent relatively cooler and wetter years become ever more important to snowpack buildup and river low volumes.*

*In some years strong winds and heavy seas are a constant in the winter, and large storms regularly roll through. Freak weather events such as intense summer wind/rain squalls occur in the Southern CCE. Seasonal wind direction is less predictable.*

## *Policy, market, and technological conditions*

*This is a highly turbulent, unpredictable world that tests ishing opera- tors and managers to their limits. Technology offers valuable assistance. Precise monitoring of environmental conditions and human activities has allowed improved prediction of environmental conditions, although accurately predicting stock abundance remains challenging for short- er-lived species. For example, technologies like the mechanized reading of otoliths (ear bones in ish used to determine their age) allows more frequent and accurate stock assessments for a wider range of species. A revolution in ishing technology has occurred, with new remote sensing platforms and gear innovation allowing ishermen to better capitalize on the shifting availability of stocks.*

*However, in 2040 fishing operations are more capital-intensive, and new kinds of technological expertise, both in the fishing and processing realms, is required to compete. The latter has given an advantage to younger fishermen who are, on average, more adept and willing to use new technology. But they had to raise the capital to buy out existing rights holders and invest in technology. This intensified long-term trends in consolidation and vertical integration in many places.*

*The functional extinction of many wild salmon stocks in California, combined with the evolution of techniques that improve hatchery production and ocean survival (including the use of wide scale genetic modification), drove policy changes in both the ESA and Magnuson-Stevens Act. Dams were breached on the Klamath and Snake Rivers, improving prospects for some wild stocks. Wide- scale deployment of other alternative energy sources continued to drive debate about dam removal on the main stem of the Columbia River, counteracted by the need for water storage in the face of increasing drought frequency.*

*While the 2020s is a period of great power competition that roils inter- national trade, by the mid 2030s the U.S. has recommitted to multilateralism and global trade. However, the U.S. negotiates trade agreements designed to mitigate the environmental and employment effects of a more open economy.*

*Consumers have become much more receptive to wild-caught fish for health and emotional reasons. However, processing and marketing the variability in the mix of species landed from year to year became a difficult task. Consumers (and hence buyers) want a degree of predictability, and yet this is a world where nothing stays the same for long, stressing markets. This regulatory environment and mix of incentives allows the expansion of marine aquaculture, but not on the scale seen in Blue Revolution, because ocean conditions make wide scale deployment challenging.*

*Some fisheries (albacore, swordfish, sablefish, salmon) focused on moving up the value chain through boutique fresh products and connections between harvesters and consumers. Commodity fisheries (hake, Pacific sardine, market squid) developed more sophisticated prepared products to increase margins. Innovation and consumer appreciation for wild caught fish has allowed for more successful exposure of new and underexploited species. The* *opportunity to catch species not previously encountered off the West Coast, especially in the Southern California Bight, proves a boon to recreational fisheries.*

*Coastal infrastructure is more often damaged in winter storms, especially on Northern California and Oregon coasts. Some smaller ports effectively cease to function except where new ways of landing and processing seafood are pioneered. Small vessel artisanal fisheries survive, but larger vessels concentrate in a few ports. It remains unclear whether the infrastructure will be able to catch up to highly unpredictable conditions.*

## ***Ecosystem response***

*In the Box of Chocolates scenario, primary production (of plankton and forage species) is comparable to Fortune and Favor conditions in some years, but much more variable from year to year. Due to harmful algal blooms, fishermen that depended on the Dungeness crab fishery for much of their income shift their efforts into other state and Council-man- aged fisheries.*

*Many marine mammal stocks have recovered to pre-exploitation levels, but their occurrence on fishing grounds tends to be variable. The leatherback sea turtle population migrating into the CCE from the Western Pacific has stabilized and forages extensively in the Columbia River plume.*

*The ranges of many stocks shift northward and deeper, affecting their availability to West Coast fisheries. This is compounded by big changes in local abundance from year to year, especially for short-lived species. These big swings in abundance increase pressure for fishermen to move fluidly between fisheries, especially those that rely on similar gear types. Range shifts result in previously absent subtropical and tropical species being periodically abundant (or taking up residence) in Southern California.*

The table below presents the quantitative Box of Chocolates assumptions that we have set forth in the Diversification Model to illustrate potential impacts on the local fishery and community.

***Figure 3: Box of Chocolates Scenario Assumptions***

| Fishery | Projected Changes |
|---|---|
| Dungeness crab | • No change to current average abundance or landings.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Halibut | • Modest increase to abundance and landings rising by 1% per year, or 10.0% in total.<br>• Modest increase to variability, up by 20% and down by 20% every few years.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Lingcod | • Modest increase to abundance and landings rising by 1% per year, or 10.0% in total.<br>• Modest increase to variability, up by 20% and down by 20% every few years. |

| | |
|---|---|
| | • Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Rockfish, Nearshore | • Modest increase to abundance and landings rising by 1% per year, or 10.0% in total.<br>• Modest increase to variability, up by 20% and down by 20% every few years.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Sablefish | • Increases to abundance and landings, rising 2 % per year for 10 years, or 20.0% in total.<br>• No change to variability.<br>• No change to ex vessel prices. |
| Salmon, Chinook | • No change to current average abundance or landings.<br>• Modest increase to variability, up by 20% and down by 20% every few years.<br>• No change to ex vessel prices. |
| Market Squid | • Modest increases to abundance and landings, rising 2% per year for 10 years, or 20.0% in total.<br>• Increases to variability, up 20% and down 20% every few years.<br>• Modest increase to average ex-vessel prices, rising .05% per year for 10 years, or 5.0% in total. |
| Albacore Tuna | • Increases to abundance and landings, rising 2 % per year for 10 years, or 20.0% in total.<br>• Increases to variability, up 20% and down 20% every few years.<br>• No change to average ex-vessel prices. |
| Shrimp | • Modest increases to abundance and landings, rising 1% per year for 10 years, or 10.0% in total.<br>• Increases to variability up 10% and down 10% every few years.<br>• No change to ex vessel prices. |

In summary, the table below provides a side-by-side comparison of the assumptions varied by scenario for each of the key drivers in our model, including abundance and landings, variability in abundance and landings, and ex vessel prices.

No Change

Modest Positive Change

Significant Positive Change

Modest Negative Change

Significant Negative Change

| Fishery | Fortune and Favor | | | Blue Revolution | | | Box of Chocolates | | | Hollowed Out | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume | Variability | Price | Volume | Variability | Price | Volume | Variability | Price | Volume | Variability | Price |
| Dungeness Crab | | | | | | | | | | NC | NC | NC |
| Halibut | NC | NC | NC | -10% | NC | NC | +10% | +/-20% | +5% | -20% | +/-20% | +5% |
| Lingcod | NC | NC | NC | -10% | NC | NC | +10% | +/-20% | +5% | -20% | +/-20% | +5% |
| Rockfish, Nearshore | NC | -/+10% | +5% | -10% | -/+10% | -5% | +10% | +/-20% | +5% | -20% | +/-20% | +5% |
| Sablefish | NC | NC | -10% | -10% | NC | -10% | +20% | NC | NC | -20% | +/-10% | -10% |
| Salmon, Chinook | NC | NC | NC | -10% | NC | NC | NC | +/-20% | NC | -60% | NC | 50% |
| Market Squid | NC | NC | +5% | -10% | -/+10% | NC | +20% | +/-20% | +5% | +10% | +/-10% | +5% |
| Albacore Tuna | +5% | NC | NC | -10% | NC | NC | +20% | +/-20% | NC | -20% | +/-10% | NC |
| Shrimp | NC | NC | NC | -10% | NC | NC | +10% | +/-10% | NC | -20% | +/-10% | NC |

# IV. FISHERIES OUTLOOK

The fisheries profiles below provide brief overviews of key fisheries on the West Coast. This is not an exhaustive overview, but a deeper showcase of several key fisheries that form the basis of economic activity in many fishing ports on the West Coast.

## A. Dungeness Crab Fishery Profile




### *Overview*

Dungeness crab is the most economically important species in the Pacific Northwest. Landings in WA and OR annually have averaged over $120MM and comprise roughly 1/3 of the value of the all wild-capture fisheries in these states. This fishery has contributed well over $300MM to the GDP of these states on average over the past decade, and is a key cultural and economic lynchpin to many communities up and down the coast.

Landing volumes can fluctuate widely from year to year, but on average have gradually increased over time. A historical high of over 85MM lbs was landed in 2013, and an analysis of the historical data shows an average in recent years of around 60mm pounds. The fishery is active in California, Oregon, and Washington, with Washington often having a plurality of the volume and value. Price per pound adjusted to 2019 dollars has gradually risen from around $2/lb in 1970 to over $4/lb in 2017. When supply is low (such as in 2015 when OR and CA fisheries were significantly impacted by domoic acid levels) prices spike in response, indicating high demand regardless of price. Key challenges in the fishery include a) climate change impacts on reproduction, b) climate change impacts on domoic acid and resultant fishing access, and c) rising whale entanglements.

### *Fishery Status and Priority Issues*

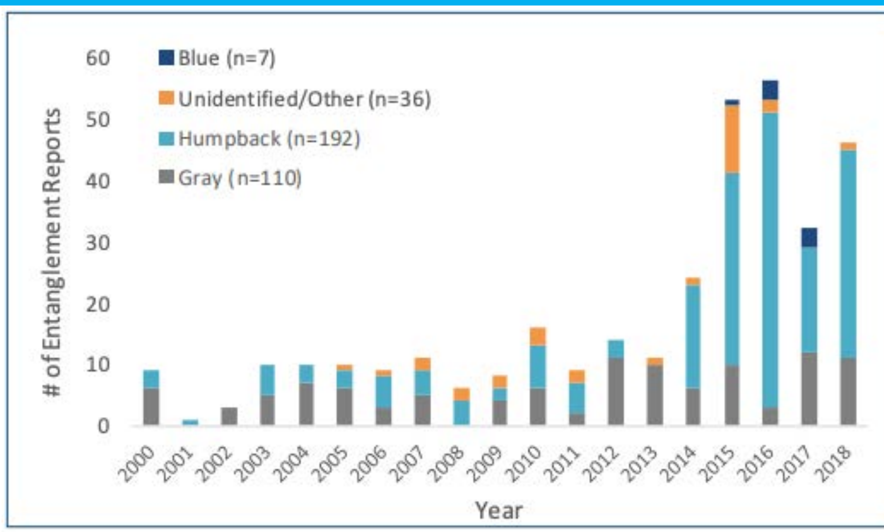
The Dungeness crab fishery is considered to be healthy and abundance is thought to have increased over the last two decades in spite of heavy fishing, rising to an estimated five times abundance levels from 1970-2020[1]. Dungeness crab is an effort-regulated fishery, which means that there are limitations on the season, gear type, gear amount, size, and sex. Each management area has different regulations on gear, but typically commercial fishermen use set gear traps attached to buoys. Permits are issued with varying pot allocations (i.e. 50, 200, 300, etc), and vessels may have permits to fish in multiple states (i.e. an OR based vessel has a 200 pot permit for WA and a 300 pot permit for CA). Landed crabs must be male with a minimum of 6.25" across their back, leaving less mature crabs to reproduce for two years before capture. Stock assessments are not conducted for Dungeness crab, leaving some uncertainty around stock status. Seafloor impacts are of low concern. The Washington, Oregon, and California Dungeness crab fisheries are rated 'Good Alternative' by Monterey Bay Aquarium's Seafood Watch, which highlights whale entanglements as a growing concern. Climate change impacts are of growing concern.

<table>
<tr><th colspan="2">Figure 4: Dungeness Crab - Priority Challenges</th></tr>
<tr><td>Key Fishery Challenge 1: Climate Change and the Spring Transition</td><td>Climate change may be pushing the "Spring Transition" to occur later in the fishing season, with fishery models projecting a <u>resultant reduction</u> in crab recruitment levels, population numbers, and ultimately catch levels over time.</td></tr>
<tr><td colspan="2">The health of Dungeness crab stocks is directly tied to the ecology of the California Current. Crab catches are generally tied to the strength of the so-called 'Spring Transition' four years prior to the fishing season. The 'Spring Transition' is a weather pattern change that occurs in the spring as prevailing winds shift from their winter pattern, which is not conducive to upwelling, to their summer pattern, which promotes upwelling. Upwelling is key to ecosystem productivity, as nutrient rich deep water reaches the surface and fuels biological productivity. The transition can occur suddenly and sharply or over time, making the exact date of the transition hard to nail down. Some climate models predict that as sea temperatures rise and atmospheric carbon increases the average date of the spring transition will be pushed back later. A delayed transition has been correlated to lower crab recruitment levels. If changes to the spring transition result in lower recruitment, then catches will likewise follow suit due to lower overall population numbers.</td></tr>
<tr><td>Key Fishery Challenge 2: Climate Change and Algal Blooms</td><td>As waters warm and algal blooms become more common, there will likely be increased incidence of domoic acid and increased probabilities of closures during the crab season.</td></tr>
</table>

[1] Northwest Fisheries Science Center, May 7, 2020.

<table>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Algal blooms are a source of domoic acid in shellfish, which is fatal to humans if consumed in high enough quantities. The presence of domoic acid led to the closure of the Dungeness crab fishery in 2015 and overall caused $100M in losses to the West Coast Fishery. Rising ocean temperatures are linked to frequency and intensity of algal blooms, and cause increasing volatility in crab landings in the future.</td></tr>
<tr><td>Key Fishery Challenge 3: Whale Entanglements</td><td>Increasing regulatory action to reduce whale entanglements may have a negative impact on Dungeness crab fishermen and fishing businesses.</td></tr>
<tr><td colspan="2">Population sizes of cetacean species including gray, humpback, and blue whales, have increased, and climate change may have altered their migration patterns. This has caused them to come into conflict with set gear for Dungeness and other fisheries (Figure 6). Growing public concern over whale entanglements threatens to force additional fishing closures in areas of high whale activity. Entanglements have been above historical norms since 2014, with very high levels of entanglements from 2015-2018. If this trend continues, entanglement response will be a major regulatory question for future years.</td></tr>
</table>

***Figure 5: West coast whale entanglements by species and year***




Source: Oregon Sea Grant

*Historical Fishing Activity*

**Season:** The Washington Puget sound season generally begins in October and ends in April, while the Coastal season begins in December and typically runs to the middle of September. In Oregon, the commercial season typically begins December 1 and runs through August 15. However, season opening may be delayed for reasons such as high domoic acid content in crabs, or low meat fill (crabs must be at least 25% meat by weight). Furthermore, issues such as whale entanglements have resulted in seasonal closures in California and could threaten potential closures in the future in OR and WA. Seasonal closures also occur while crabs are molting.

**Size of the Fleets:**

- Washington has two separate Dungeness fisheries, coastal with 228 licenses and Puget Sound with 248. Additionally, there are two permit tiers in Washington, with a maximum of 300 or 500 pots. There are also specific local limits, such as a 200 pot limit for treaty and non-treaty fishers operating out of Grays Harbor. The state of Washington also has treaty obligations to share the fishery with the Quinault, Quileute, and Makah Tribes (the Hoh tribe also has access rights but as of 2007 was not exercising them). As of 2007 the fishery was still dominated by non-treaty fishermen, however the state has expressed an interest in achieving a 50-50 split between treaty and non-treaty fishermen in the future. Washington has examined the possibility of a buyback to further reduce the number of permits to achieve this goal as well as to spread the harvest of crabs out over a longer period of time, achieving 50% capture by March instead of January, as has been typical .

- Oregon issues around 430 licenses to commercial crab fishers, however during any given season only 300-330 of those licenses are actively fishing. There are three tiers of permits in OR, with 96 permits allowing 200 pots, 177 permits allowing 300 pots, and 156 permits allowing 500 pots.
- California has a total of around 570 permits in multiple tiers ranging from 500 pots to 175 pots. Vessels may have multiple permits and fish in multiple states.

**Landings:** It is estimated that as much as 95% of allowable crab is caught each season, with up to 80% of that often coming in the month of December alone. It is believed that crab landings track the overall population size very closely. In years of higher abundance, more crabs are caught, while in years of lower abundance, fewer are caught. Therefore, changes in allowable gear or size of fleet (with the exception of size limit changes or allowing the taking of female crabs) are unlikely to drastically change the landings of species (i.e. allowing 50% more or fewer traps is unlikely to increase or decrease crab landings by 50%, the actual change will be much more muted and closer to historical averages). Therefore, we believe that this stock is being fully exploited and will continue to be fully exploited for the foreseeable future regardless of changes to the number of permits or pots allowed.

***Figure 6: Landings Volume 1970 – 2017 in pounds with polynomial line of best fit***

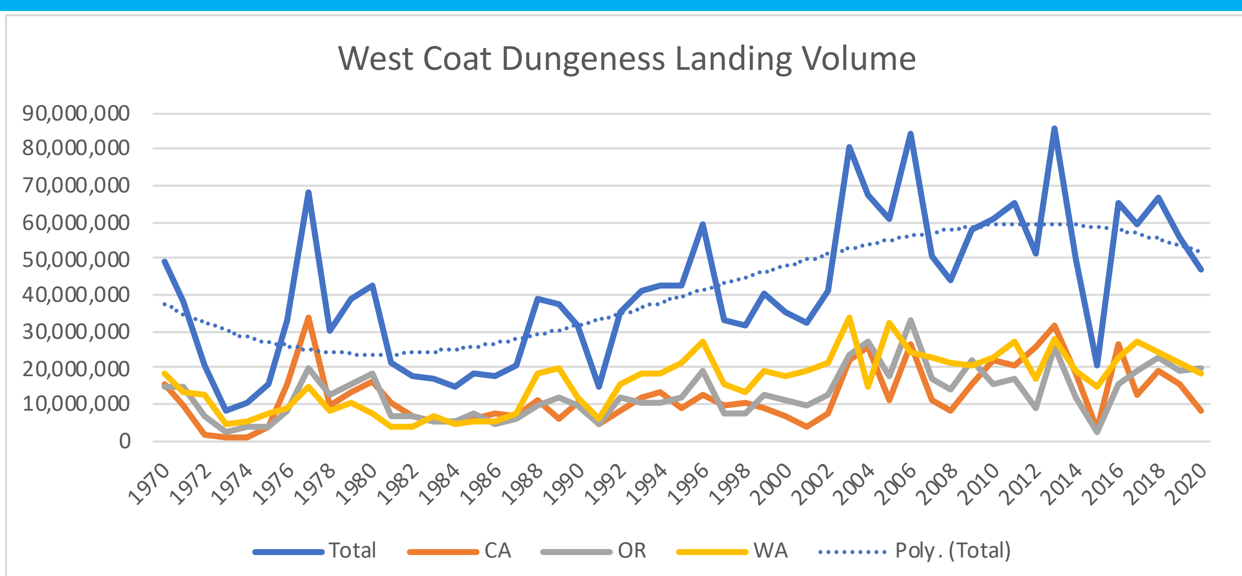


***Figure 7: Average price per pound for each state 1970 – 2017 (2019 dollars) with polynomial line of best fit***

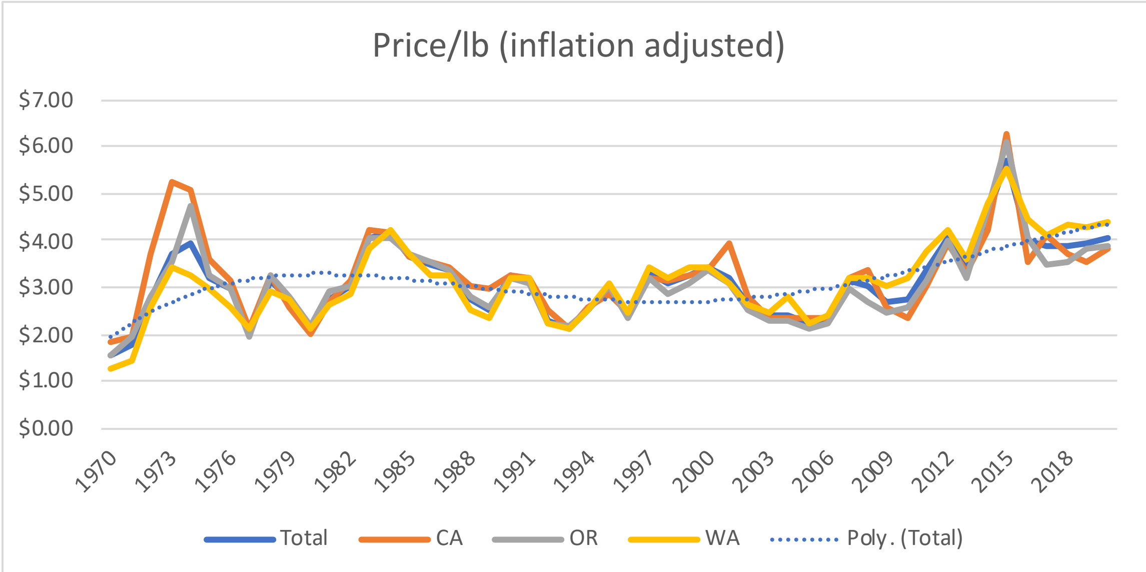



***Figure 8: Nominal dollar value of fishery 1970 - 2017***

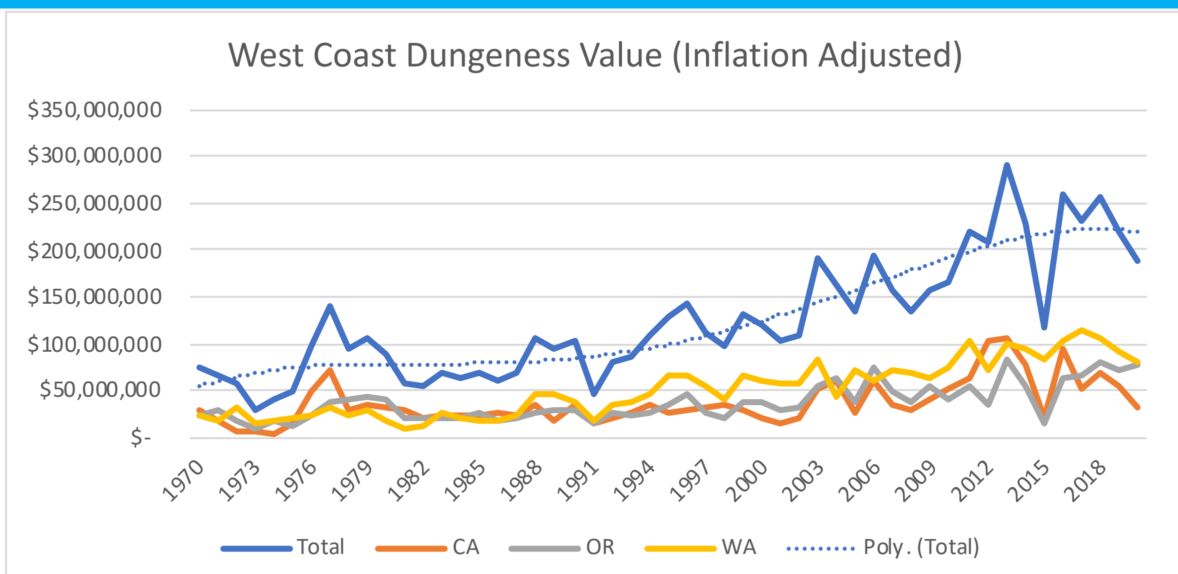
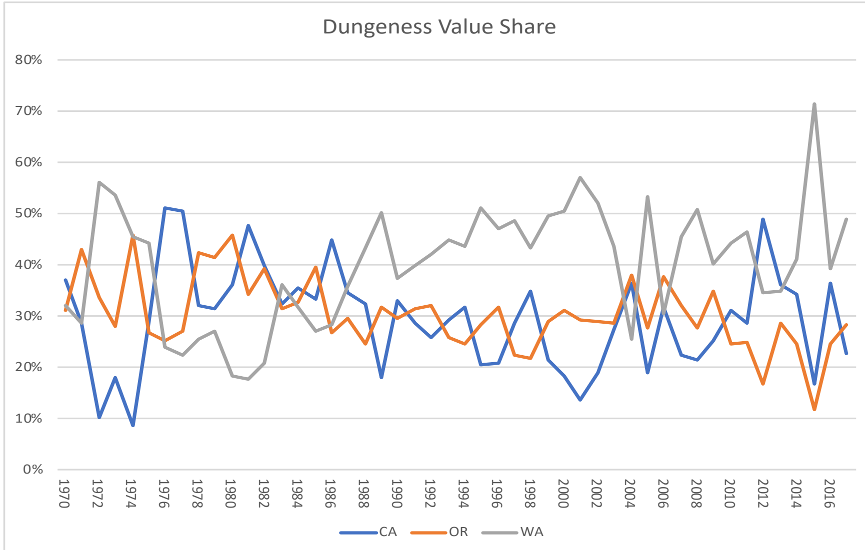


***Figure 9: Relative share of Dungeness crab fishery landing value by state***




## B. Groundfish Fishery Profile

*Fishermen aboard Miss Sue, of Newport, Oregon, haul in their catch of rockfish off the West Coast. Credit: John Rae.*

### *Overview*

Groundfish is a very diverse fishery sector in the Pacific Northwest, encompassing many species. For the purposes of this analysis, we are considering the "groundfish" category to primarily consist of various species of rockfish, cod, ling cod, sole, sharks, skates, and other species. While there is often overlap with the Pacific whiting fleet, whiting is not included in our analysis of groundfish fisheries in the Pacific Northwest.

Groundfish landings are not currently a significant driver to the coastal economy, accounting for 2% of statewide landings values in Washington and 10% of all statewide landing values in Oregon. However, they can play an outsized role in smaller ports and for fishermen who are able to access live fish markets. Groundfish species are also caught by vessels participating in other fisheries such as Pacific whiting and sablefish, though those vessels are not specifically targeting other groundfish species. it is of great importance to specific coastal communities including Astoria, Newport, and Port Orford, which specializes in sales of live rockfish. Landings in WA and OR annually have averaged over $16.7MM.

Landing volumes in the groundfish industry peaked in the late 1970s and early 1980s, with nearly 190,000,000 pounds of groundfish landed in 1982 between both Oregon and Washington. Volumes declined quickly after that, averaging at or below 40,000 pounds of groundfish combined between both Oregon and Washington. While Washington landed the majority of the groundfish harvest until the late 1980's, since then Oregon has taken the lead in groundfish landings. Groundfish is also proportionally a larger piece of fisheries activity in Oregon than Washington. Despite wide fluctuations in volume, the inflation adjusted price per pound for groundfish species has remained consistent, fluctuating around the $0.60 per pound point since the 1970s.

### *Fishery Status and Priority Issues*

The West Coast groundfish fishery is a high volume, low value fishery complex. It experienced huge landings volumes and overfishing in the 1970s and 1980s, which led to a collapse in the 1980s and 1990s. This collapse was particularly concerning for rockfish species, which are very long-lived and slow to reproduce. In response, conservation activities including acquisition of permits by TNC were able to effectively rebuild the stock. As a result, the West Coast groundfish complex is currently MSC certified. Additionally, the stock assessment conducted by the PFMC found that only two species in the West Coast groundfish complex were considered overfished, however there may be regional sub populations of other species which are currently unsustainably utilized. Effective management in the future will be necessary to avoid overharvesting of vulnerable species like rockfish, as well as minimize the environmental impact of the groundfish fleet through habitat damage and bycatch-associated mortality of non-target species.

| ***Figure 10: Groundfish - Priority Challenges*** | |
|---|---|
| Key Fishery Challenge 1: Monitoring | **Engage in more effective monitoring scheme** |
| The requirement to have an observer onboard is expensive and can be particularly cumbersome in the age of COVID. Implementing electronic monitoring is a good way to enhance the quality and quantity of data being generated at sea to better monitor the environmental impacts of the fishery. | |
| Key Fishery Challenge 2: Bycatch | **Bycatch Reduction** |
| Similar to the above, an effective bycatch monitoring scheme is vital to ensure that unintended species are not captured at rates which would impact the health of their stocks. | |
| Key Fishery Challenge 3: Economic Value | **Enhance the value of groundfish products** |
| There is an opportunity in certain ports to enhance the overall value of the species being landed and provide an advantage to smaller vessels operating in nearshore locations. For example, Port Orford is experimenting with live holding facilities to sell a higher value live fish product. | |

## *Historical Fishing Activity*

**Season:**

The season for groundfish varies based on fishery type (limited entry, open access, nearshore), gear type, and species targeted. For the nearshore rockfish permit in Oregon, the season is open so long as there is uncaught quota. There are several closed areas on the coast which are protected as being critical habitat

**Size of the Fleets:**

There are several different fisheries which are focused on the West Coast groundfish complex, namely the limited entry groundfish trawl, the open access groundfish fishery, and the nearshore groundfish fishery in Oregon. The LE groundfish trawl fleets encompass around 60 vessels in Oregon, and 80 vessels in Washington, and while open access numbers are difficult to find, over 200 vessels took part in the Oregon Open Access fishery in recent years. There are also up to 130 permits available for the nearshore rockfish fishery in Oregon. Therefore, it is reasonable to assume that around 500 vessels take part in the groundfish fishery in Washington and Oregon.

**Landings:**

***Figure 11: Landings Volume 1970 – 2017 in pounds with polynomial line of best fit***

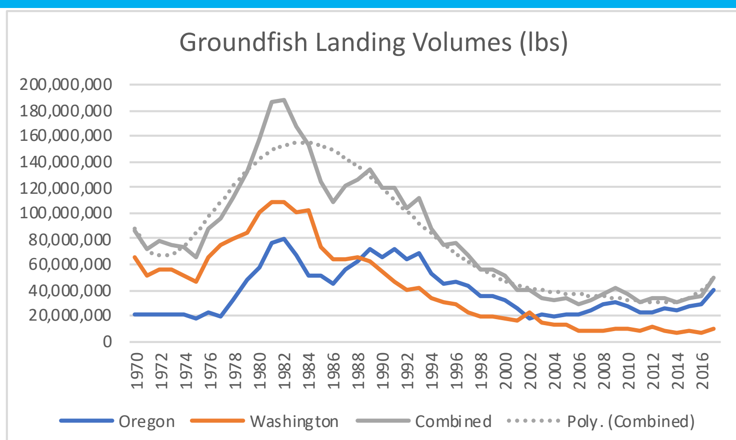



***Figure 12: Average price per pound for each state 1970 - 2017 (2019 dollars) with polynomial line of best fit***

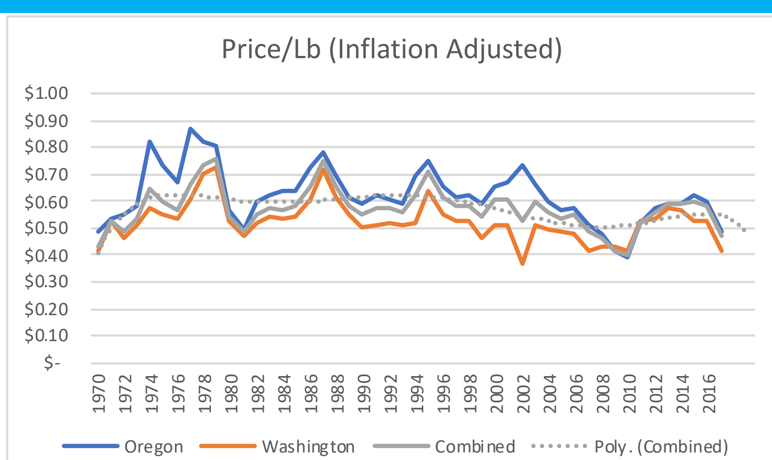
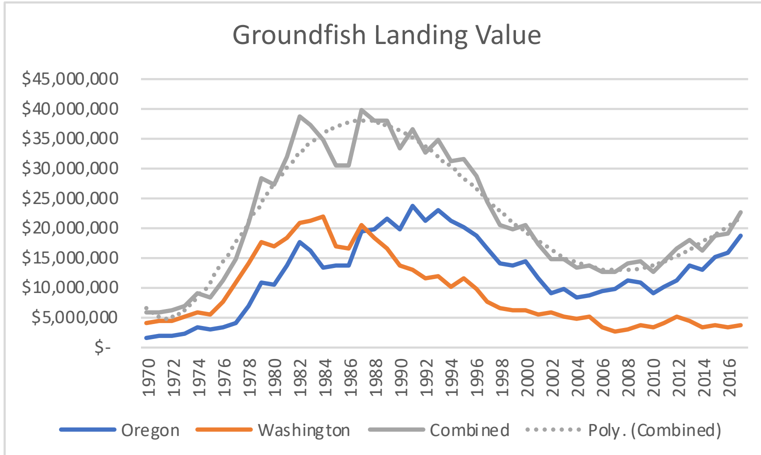


*Figure 13: Nominal dollar value of fishery 1970 - 2019*




## C. Salmon Fishery Profile

### *Overview*

After a century of being a significant driver of the Pacific Northwest fishing economy, salmon have declined to being one the least economically valuable species, with the total ex-vessel value of the annual catch well under $10,000,000 per year. Catch data from recent years represent a 90%+ decline in vessels and lbs from the 1980's, and a 99% decline from peak harvest year in the 1900's. This decline is due to a number of factors, including environmentally insensitive methods of harvest, the damming of most major Northwest salmon rivers, and poor protection/maintenance of salmon habitat. (Declining ocean conditions are also often cited as a factor, but this remains under investigation as due to strong salmon populations in Alaska and Russia which share ocean conditions with Pacific Northwest salmon.)

The highly regulated Pacific Northwest salmon industry has two primary harvest methods: a) Commercial Ocean Troll; and b) River Gillnet. Both methods, along with allocation of salmon available to be harvested, are managed by the PFMC. The PFMC is made up of 14 voting and 5 non-voting members (appointed by Governors), and oversees regulations for 119 species of fish harvested in the 317,690 acre economic zone off of Washington, Oregon, and California. PFMC sets the quota's for total catch for each geographic area and type of gear. Then, each state with a

Pacific salmon fishery manages its salmon fleet by use of a permit system. Obtaining a permit allows a commercial fisherman to pursue salmon in a specific geographic area using a specific type of gear.

### *Fishery Status and Priority Issues*

Pacific salmon are unique in that they are anadromous, meaning they migrate between freshwater and saltwater. Their lifecycle starts as eggs in a small freshwater stream, usually in a pebbly stretch of river known as a Redd. After roughly 3 months, the eggs hatch and become alevin, which live off of their yolk sac in their natal river. Within 10 weeks, the alevin become fry, or juvenile salmon. These juvenile salmon stay in their natal river for up to a year, transitioning through a parr stage (when they get their markings) and a smolt stage (where they become large enough to survive in the ocean.) Soon after becoming Smolts, and usually triggered by high water conditions, smolts migrate to the ocean where they mature into adults. After spending 2-4 years in the ocean, the salmon return to spawn in their natal stream, and the cycle repeats.

Given the nature of their lifecycle, the health of salmon is directly tied to conditions at each stage. In the Redd, Alevin, Fry, Parr and Smolt stage, estuary or river conditions, low or warm water, scouring flooding, dams (still water in particular), pollution and predation all have a large negative effect. Dams are particularly impactful, because the still water created behind dams drains the energy of smolts (they have to swim through still water) and makes them more vulnerable to predation (they cannot hide in the faster water.) During their Open Ocean phase, poor ocean conditions, a population/food imbalance and overharvesting all contribute to a declining % of salmon returning to their natal rivers to spawn each year. During the Spawning phase, dams again are particularly impactful due to lack of fish passage and stacking up salmon making them more vulnerable to predation. Low or warm water flows (which reduce the oxygen available) can also be especially harmful to returning salmon, with the last 10-20 years seeing massive in stream die offs throughout their range.

Various conservation strategies have been implemented over the past century to mitigate the ongoing decline of salmon runs. Chief among these are hatchery habitat programs. Each year, nearly $140,000,000 is spent by OR ($61m) and WA ($78m) on their hatchery programs. In addition to the hatchery programs, a wide variety of habitat restoration, fish transportation and dam mitigation efforts are undertaken each year. All told, it is estimated that over $1bn a year is spent on salmon restoration in the Northwest. Despite these efforts, the number of Pacific salmon returning to spawn in WA and OR has dropped by 99% since 1900, and 95% since 1950, with commensurate drops in commercial harvest levels.

There is very little commercial salmon fishing done off of the coast of WA and OR. What commercial fishing that is done is almost entirely in Ocean Troll fishery, which uses lures or baited hooks towed behind a vessel to catch salmon as they migrate towards their spawning grounds. Inland, River Gillnet fishing is allowed on the Columbia River, the largest river in the Northwest which is a shared border of WA and OR. River Gillnet fishing involves stretching a mesh net across the river, with the mesh net sized to capture salmon as they swim into the net.

Both methods have drawbacks to the long term sustainability of salmon. Ocean Troll fisheries are indiscriminate in that they harvest mixed stocks of salmon i.e. salmon bound for different watersheds. This is consistent with the long time policy of the PFMC that "a salmon is from where it is caught" not the natal river to which it is returning. River Gillnet's only catch salmon bound for their natal river, but they cannot identify hatchery vs. wild fish. They are also extremely efficient, and if not carefully regulated can quickly wipe out a run of salmon before escapement limits can be put into effect.

| *Figure 14: Pacific Salmon - Priority Challenges* | |
|---|---|
| Key Fishery Challenge 1: Open Ocean Mortality | The vast majority of Lower 48 salmon mortality is believed to occur while salmon are in the ocean. The primary contributing factors are believed to be ocean conditions (low water quality and reduced food quantity) and open ocean predation (primary through intercept fisheries, but also through increased predation by ocean mammals.) A secondary factor often cited is habitat, however the small number of returning hatchery fish despite large number of hatchery fish suggests the more impactful issues occur in the ocean. |
| | |
| Key Fishery Challenge 2: Habitat Degradation | Salmon need access cold, clean water to thrive and reproduce. The combination of overlogging, development, restructuring of waterways, and river blocking dams have dramatically reduced this access, with a corresponding decline in Lower 48 salmon populations. A multi-decade effort is required to restore as much habitat as possible to the proper condition. |
| | |
| Key Fishery Challenge 3: Industry Inertia/Indiscriminate Harvest Methods | Methods of salmon harvest have not changed for 100 years. The image of the "lone ranger" salmon fisherman using seines and gillnets to harvest salmon is a highly prized cultural legacy of the Lower 48. In reality, current methods of salmon harvest are outdated and damaging to the fishery. Fish destined for Lower 48 rivers are being caught in BC and Alaska. Fish that make it to Lower 48 rivers are being killed by indiscriminate methods of harvest (ex. gillnetting.) High mortality rates at sea remain a key barrier to stock recovery. |

## *Historical Fishing Activity*

**Season:**
Pacific Salmon have a wide variety of lifecycles, meaning difference genetic strains and species of Salmon migrate in and out of rivers at different times (Spring, Summer, Winter, Fall) and to different places (Rivers, Lakes, Streams, Estuaries). So taken as a whole, the Pacific Salmon industry has the potential to be a year round operation, with salmon being harvested in every month of the year (albeit in different locations.) The commercial Pacific salmon season is set annually, with catch limits set by species and geography. For the past 50 years, the philosophies underlying catch limits have been "Escapement". Escapement is the number of fish that need to reach the spawning grounds in order to reproduce enough fish to sustain future runs. Prior to each season, the PFMC sets Escapement goals by species and geography based on the expected run return. During the season, the PFMC estimates the actual return, and adjusts catch limits accordingly in season (i.e. if the return is lower than that used to project the escapement goal, catch limits are reduced or the season is canceled.)

**Size of the Fleets:**
The Pacific Northwest Salmon Commercial harvest is a highly regulated industry. Catch quotas are set annually at the beginning of the season by the PFMC, and often adjusted during the season. This has created uncertainty around the available catch, which has greatly reduced the number of boats and permits fishing for salmon. Those changes are reflected in the numbers below:

**<u>WA (1980/2019)</u>**
Permits: 2797/155 (94% decline)
Active Vessels: 2626/88 (97% decline)

**OR (1980/2019)**
Permits: 4314/923 (79% decline)
Active Vessels: 3875/220 (94% decline)

The 2019 PFMC Review of Ocean Salmon Fisheries report documents the 2016-2019 averages for non-Indian/Indian commercial Ocean Troll salmon fisheries in Washington and Oregon as follows:

- Vessel Participating: 308
- # of fish: 80,000
- Lbs: 630,000
- Ex-vessel value: $4,933,000
- Ex vessel value per boat: $14,618

The Columbia River Gillnet fishery is primarily an Indian fishery, and the PFMC reports the 2016-2019 average annual ex-vessel value of $1,500,000. Non-Indian River Gillnet ex-vessel value during the same time period is in the low hundreds of thousands.

It is anticipated that this decline will continue due to a combination of the aging of the fleet, increased uncertainty due to changing regulations around the harvest of salmon, and the uneconomic nature of harvesting the available catch using open ocean methods.

**Landings:**

***Figure 15: Landings Volume 1976 – 2019 in thousands of pounds***

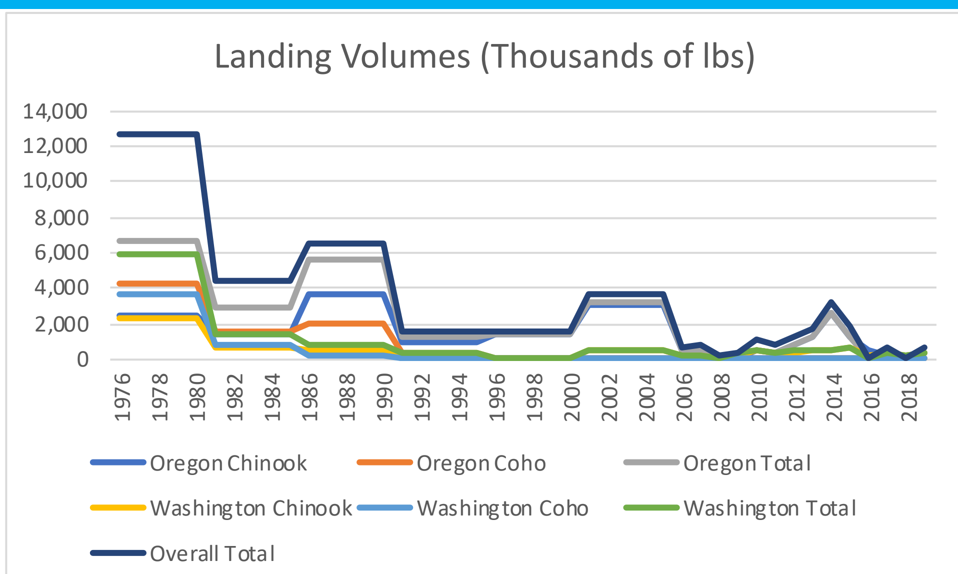


***Figure 16: Average price per pound for Chinook and Coho Salmon 1971 – 2019 (2019 dollars)***

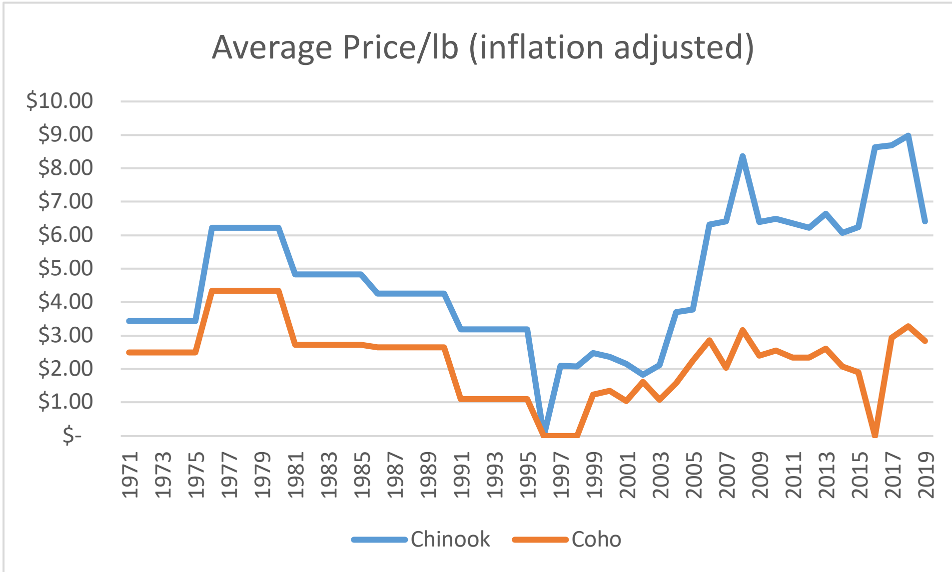
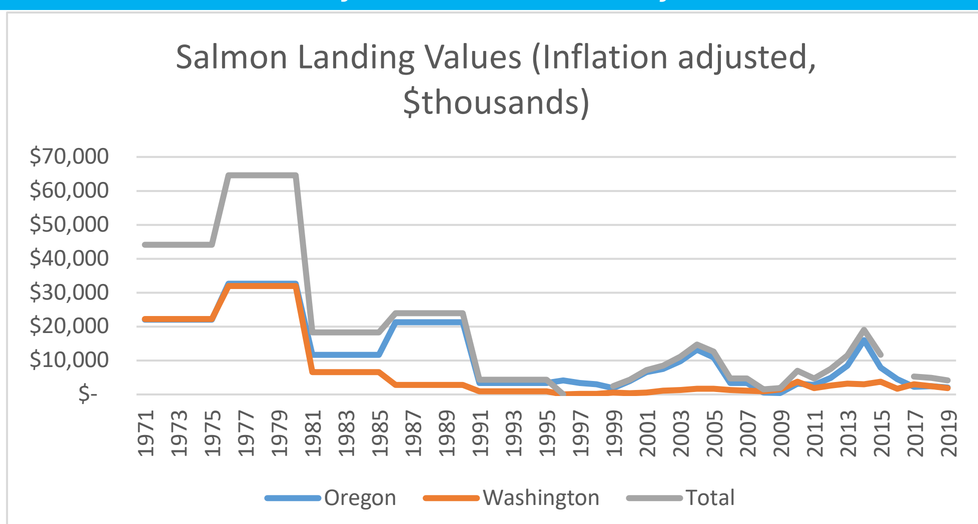



***Figure 17: Nominal dollar value of fishery 1971-2019 inflation adjusted in thousands of dollars***




## D. Albacore Tuna Fishery Profile

## *Overview*

Pacific Albacore is a white-fleshed tuna that can be found off the West Coast. It has a variety of applications, including canned, pouched, fresh, frozen, and raw products, and is an important part of commercial fisheries activity on the Pacific coast. While California has historically had a significant albacore fishery, catch from their waters has fallen off in recent decades, with the catch from Washington and Oregon waters far outpacing California in the past 20 years. The fishery is dominated by hook and line fishers using either bait or troll gear, which has a minimal impact on the environment and other species. The fishery is relatively easy to access as well, with the only permit required being a Federally-issued HMS permit. This has led some communities to view Albacore as a gateway fishery for aspiring captains.

The stock assessment points to a relatively healthy stock with biomass estimates at levels comfortably above overfished levels, however some future projections show an increasing risk of overfishing if current levels of fishing continue into the next decade (30% risk with the most extreme assumptions by 2025). Catch levels coastwide peaked in the early 1970s at just over 60,000,000 lbs coastwide and bottomed out in the early 1990s at over 3,000,000lbs. Catch Levels fluctuated between 20,000,000 and 30,000,000 lbs from the mid 1990s until the mid 2010s, but have steadily fallen in recent years. Coastwide catch value peaked in 2012 at over $45,000,000 but has fallen steadily since then, averaging $32,000,000 in the past 5 years.

## *Fishery Status*

The Albacore fishery has been a small, though significant part of West Coast fisheries in recent years. Over the past 10 years it has accounted for close to 10% of total fishery value in both Oregon and Washington. Fishing activity occurs up and down the coast with offloads at many ports, but volume is centralized, with the ports of Newport, Charleston, and Astoria in Oregon accounting for around 90% of landing volumes in the state. In Washington, Ilwaco and Westport land the majority of Albacore in the state as well, though activity occurs elsewhere. Many vessels that participate in the Albacore fishery also participate in other fisheries as well such as salmon or crab.

The fishery was MSC certified from 2010-2015 but that certification has lapsed, though it has a “Good Alternative” rating from the Monterrey Bay Seafood Watch program. Despite a healthy stock assessment conducted in 2015 (revised in 2017), landings have been on a downward trend in the past several years, though it was reversed somewhat in 2019.

In conversations with fishermen in Ilwaco, access to facilities like cold storage and ice was identified as being a major barrier for small, independent fishermen, with larger buyers using their infrastructure to control the fleet (i.e. if you don’t sell to us we won’t provide ice/bait/storage).

| Figure 18: Albacore - Priority Challenges | |
|---|---|
| Key Fishery Challenge 1: Infrastructure | **Equitable access to infrastructure** |
| Cold storage, icemaking, and other infrastructure is often controlled by buyers, which provides them with significant leverage over fishermen. Providing infrastructure to fishermen independent of buyers would help rebalance power dynamics between fishermen and fish buyers while enabling DTC sales channels. | |
| Key Fishery Challenge 2: Declining Catches | **Declining Catches** |
| While stock assessments are generally healthy for Albacore, the downward trend in catches in recent years is concerning. This could be due to changing environmental conditions, and could presage a new pelagic species mix. A formal data collection and monitoring program may be able to both aid fishermen in targeting Albacore while also quantifying the increasing incidence of warmwater species like yellowfin tuna and market squid, opening new markets for fishermen. | |
| Key Fishery Challenge 3: | **Avoid Overfishing** |
| As catch levels decline, there can be an incentive to increase effort to compensate. If this occurs, the stock assessment predicts that the biomass will fall below the target threshold. Therefore, robust monitoring and best fishing practices will be a key component to ensuring that stocks remain healthy. | |

## *Historical Fishing Activity*

**Season:**

Albacore has primarily a summer season, with the bulk of landings occurring between July and September, with smaller volumes reported in June and October.

**Size of the Fleets:**

Participating Vessels

California
2019: 106
10 Year average: 95

Oregon
2019: 329
10 Year average: 373

Washington
2019: 202
10 Year average: 256

Canadian vessels also participate in the fishery and can make limited landings in US ports per treaty agreements. However, the number of Canadian vessels participating is small (5 vessels in Oregon in 2019) as are landing volumes (225,000lbs in Oregon in 2019).

**Landings:**

*Figure 19: Landings Volume 1970 – 2018 in pounds with polynomial line of best fit*

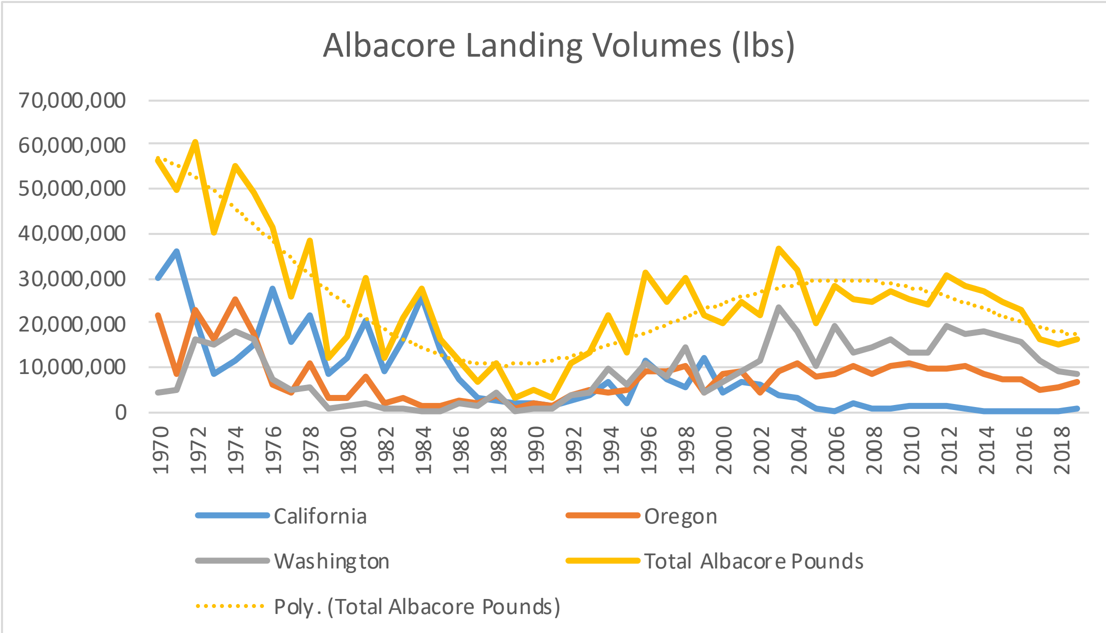



*Figure 20: Average price per pound for each state 1970 - 2018 (2019 dollars) with polynomial line of best fit*

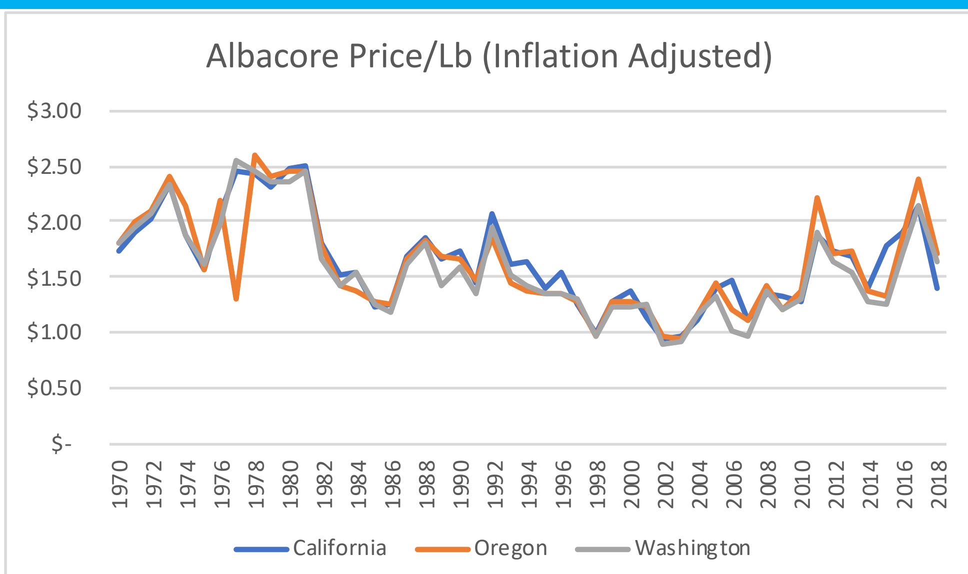



*Figure 21: Nominal dollar value of fishery 1970 - 2018*

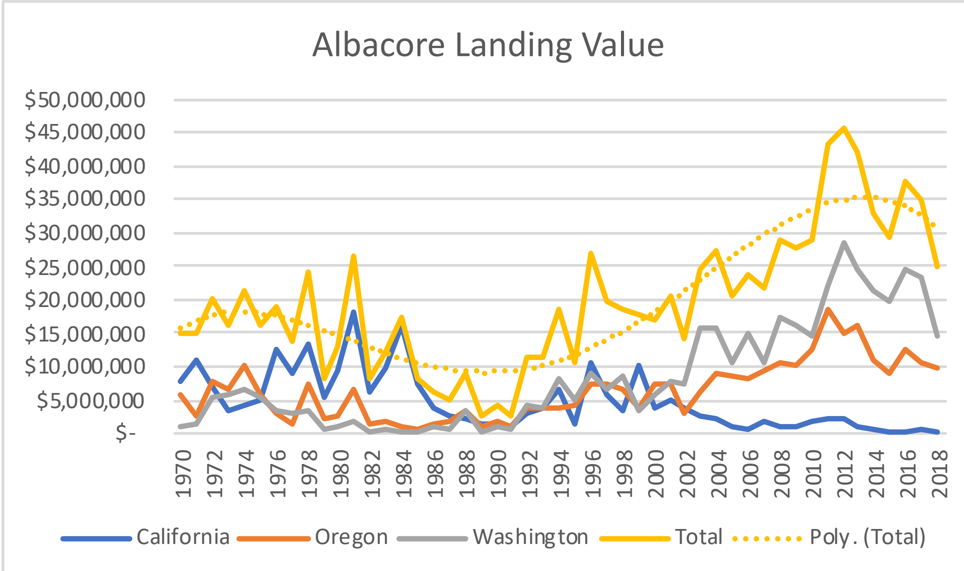
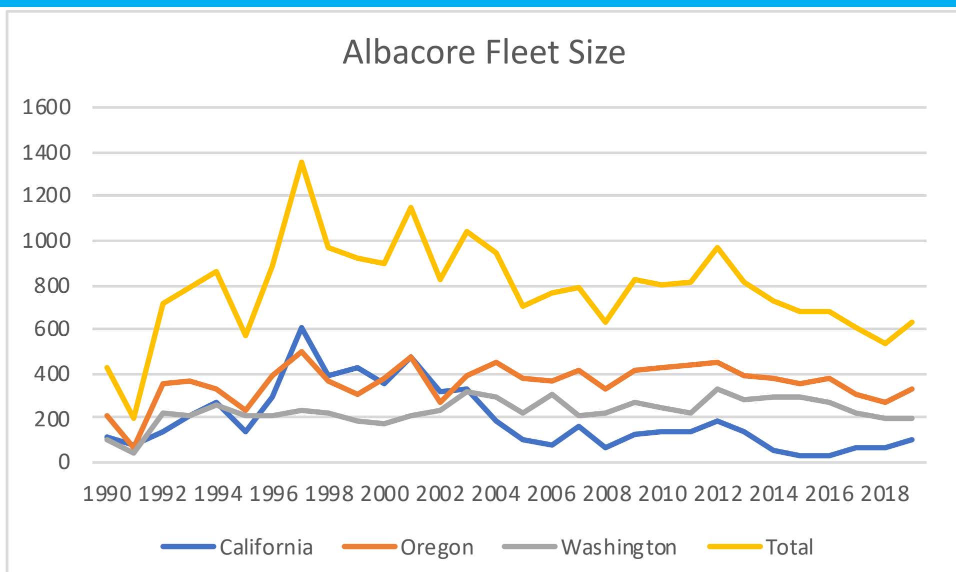



***Figure 22: Albacore fleet size over time***




## E. Pink Shrimp Fishery Profile

**Overview:**

Pink shrimp (*pandalus jordani*), also called cold water shrimp, salad shrimp or pacific ocean shrimp, are a commercially important species on the West Coast of the United States. The fishery is a high-volume, low-value fishery when compared to other species such as crab, and has fluctuated widely in the past 50 years. The fishery is currently considered sustainable and is MSC certified, however shrimp are short-lived and particularly susceptible to environmental factors that may influence sustainability in the future. This is a high volume, low value fishery, with real price per lb dropping drastically over time by as much as 50%.

The health of the pink shrimp fishery is directly tied to the population size, and catch numbers are an accurate proxy for population metrics. However, given the short life span of shrimp there is no long term stock assessment and the fishery is susceptible to short term fluctuations in conditions. One driver of catch volume is the recruitment success of shrimp in a given year, as the majority of shrimp captured are 1 year old, with smaller numbers of 2 and 3 year old shrimp rounding out the rest of the harvest. Pink shrimp are not known to live longer than 3 years. Therefore, the pink shrimp stock, while healthy in the short term, may be negatively impacted by environmental factors that limit recruitment in future years such as warming waters and delayed spring transition events in the California Current ecosystem.

### *Fishery Status*

Pink Shrimp in Washington and Oregon are managed with limits on the open season and a maximum count per lb of 160. This means that the shrimp must be large enough that one pound of shrimp cannot contain more than 160 individual animals (smaller animal size= higher count per lb). Additionally, measures are in place for emergency shut downs or other changes to the open season if average catch per trip falls below a certain threshold. In Oregon, If the June average catch per trip is less than 12,500 lbs then the season will close 15 days early and open 15 days later the following year. If the average catch per trip in June is below 10,000lbs, then the fishery will close immediately and open 15 days later the following year.

Bycatch had been an issue previously, and there are measures in place to limit the amount of groundfish caught per trip and per day. Eulachon (also called hooligan, oolichan, or Columbia river smelt) have historically been captured in shrimp trawls and are endangered in their southern range, which coincides with the pink shrimp grounds. However, new advancement in excluder devices, including LED lights and Bycatch Reduction Devices (BRD's, also called "shrimp gates"), have been successful in reducing bycatch of groundfish and eulachon to acceptable levels. The fishery has been proactive in adopting measures to reduce bycatch, with the OR and WA fleets achieving 100% use of LED lights to limit eulachon bycatch the fishery voluntarily prior to the introduction of regulations requiring their use. The fishery is MSC certified in both WA and OR.

While shrimp landing volumes have fluctuated over time, the trend is towards generally increasing catch volume over time (see Figure X). The vast majority of these landings have been in the state of Oregon, with Washington representing the second highest landings since the year 2000 and California in a distant third in the same time frame (see Figure 5). However, at the same time the real value of price per lb has fallen over time (see Figure 4) and now hovers at a little over $0.50/lb. Similarly, the number of active vessels fishing for shrimp in both Washington and Oregon has clearly declined in the past 30 years (Figures 10-11), indicating that a drop in real price has caused a resultant consolidation in the industry. Additionally, when speaking with processors in Brookings, OR, we learned that there has been a consolidation in buyer power as well, with large incumbents like Pacific Seafood holding large shares of offloading and processing facilities.

| ***Figure 25: Shrimp - Priority Challenges*** | |
|---|---|
| Key Fishery Challenge 1: | **Changes in seasonal timing may drive down recruitment** |
| Climate change may push the "Spring Transition" to occur later in the fishing season, with fishery models projecting a resultant reduction in shrimp recruitment success and therefore harvest amounts. The 'Spring Transition' is an weather pattern change that occurs in the spring as prevailing winds shift from their winter pattern, which is not conducive to upwelling, to their summer pattern, which promotes upwelling. Upwelling is key to ecosystem productivity, as nutrient rich deep water reaches the surface and fuels biological productivity. The transition can occur suddenly and sharply or over time, making the exact date of the transition hard to nail down. However, some climate models predict that as sea temperatures rise and atmospheric carbon increases the average date of the spring transition will be pushed back later. A delayed transition has been correlated to lower shrimp recruitment levels (see Figure 9). If changes to the spring transition result in lower recruitment, then catches will likewise follow suit due to lower overall population numbers. | |
| Key Fishery Challenge 2: | **Migrating Range** |
| Latitudinal migration of species as a result of climate change has been observed in other species, notably the related *pandalus borealis*, which is a related shrimp species in the Atlantic. Similar migration patterns may be observed in shrimp fisheries on the west coast, though conclusive evidence of such has not yet been noted. | |
| Key Fishery Challenge 3: | **Future Stock status Opaque** |
| Shrimp live relatively short lives, and they are susceptible to the environmental conditions over a very narrow window. Future stock health is predicated on the health of the year classes before it, and since there are at most only three or four year classes in existence at a time, projections beyond 2-3 years are difficult to make with any degree of accuracy. | |

Figure 26: Correlation between recruitment of pink shrimp and Sea Level Height in Crescent City California, a proxy for warm vs cold water anomalies (from OR 2019 Pink Shrimp review )

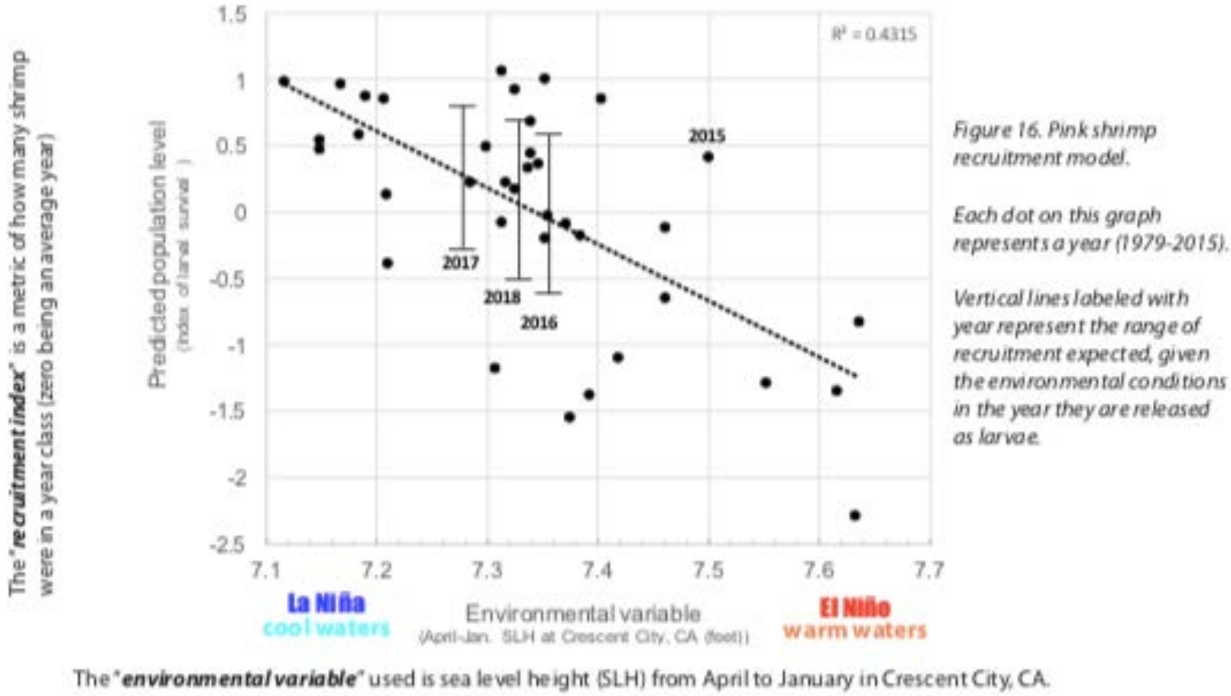
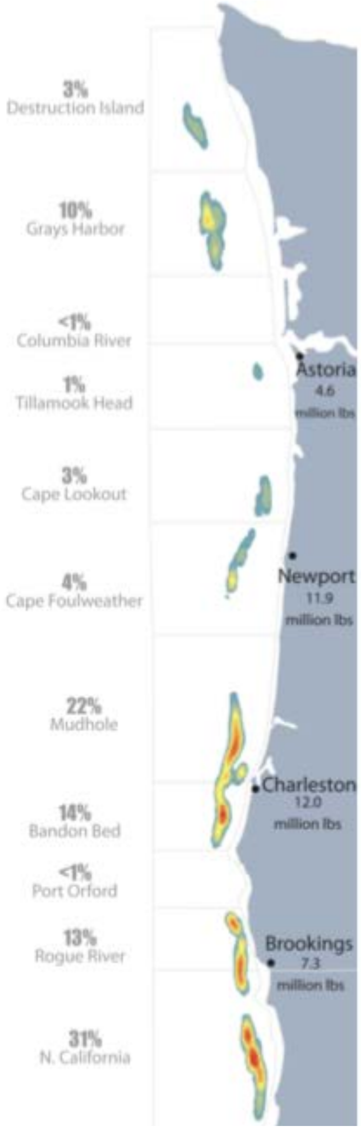
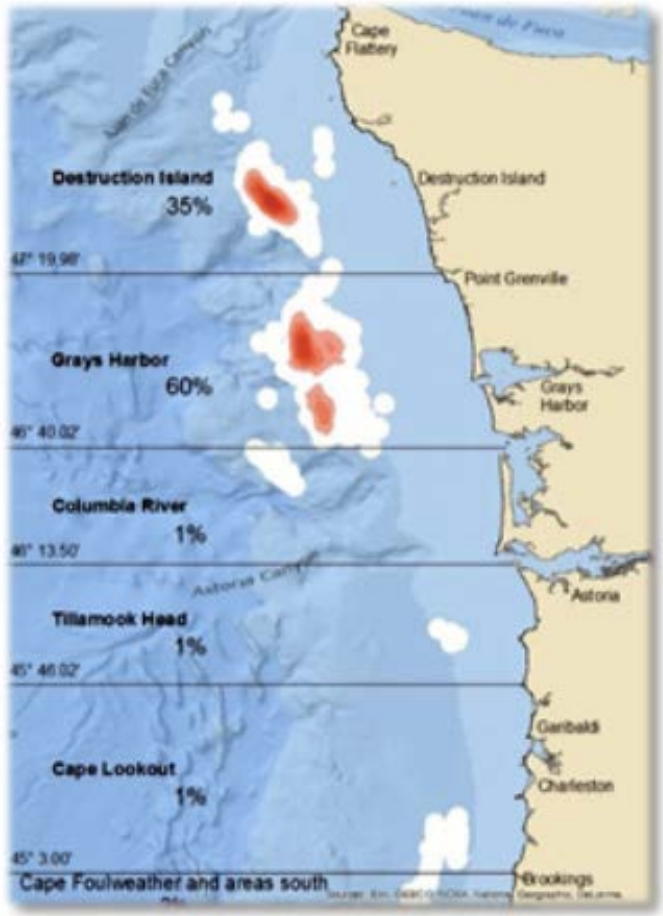



Figure 27: Heat map of capture areas of shrimp landed in Oregonand Washington,2018 (from OR 2019 Pink Shrimp review and WA 2019 Pink Shrimp newsletter)




**Season:**

In CA, OR, and WA the season lasts from 4/1 to 10/31. However, changes to the open season may be made if catch reports fall below certain thresholds.

**Size of the fleet:**

Currently there are 138 total permits in OR, but only 64 active permits on average from 2000-2017. In WA, there are 21 vessels active in the 2019 season, and while it appears that 80 limited entry permits were granted in 2019 it is unclear how many of them actively fished. CA has a two management areas for pink shrimp, northern and southern, with an average of 33 permits in the northern area and 18 permits in the southern area in recent years (2012).

Figure 28: Volume of shrimp landings over time in pounds

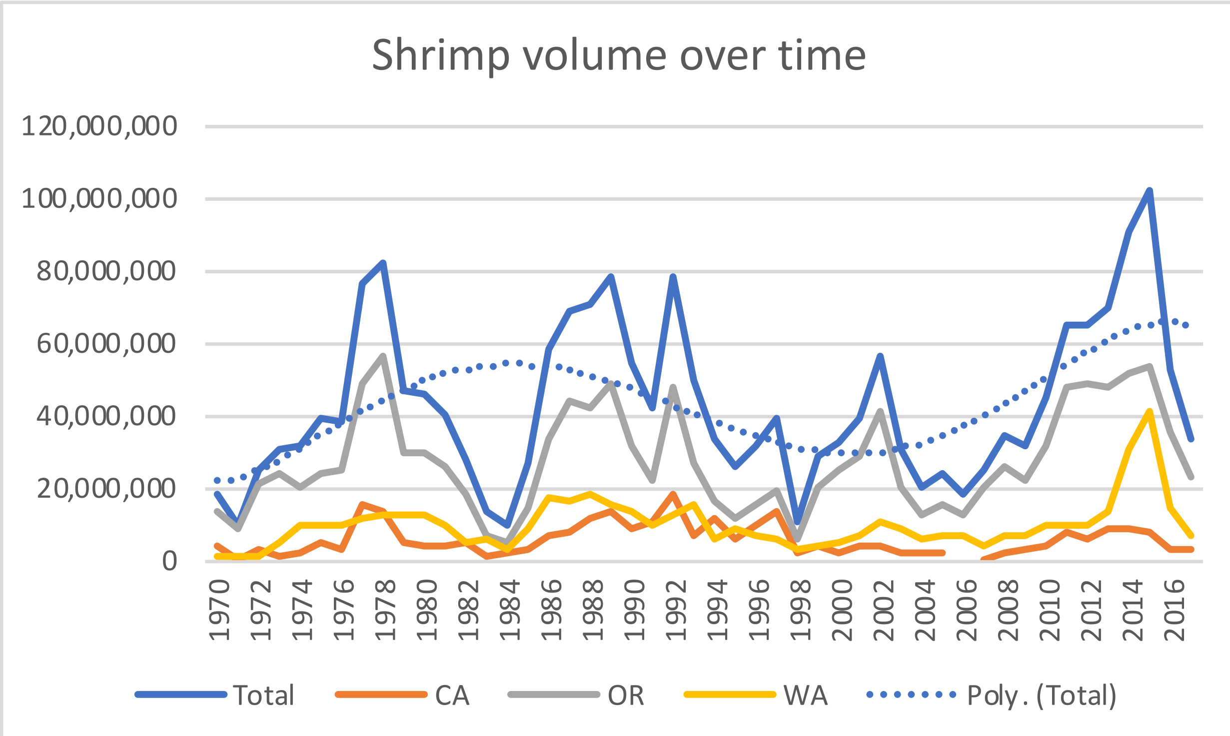



Figure 29: Nominal value of shrimp landings over time (USD)

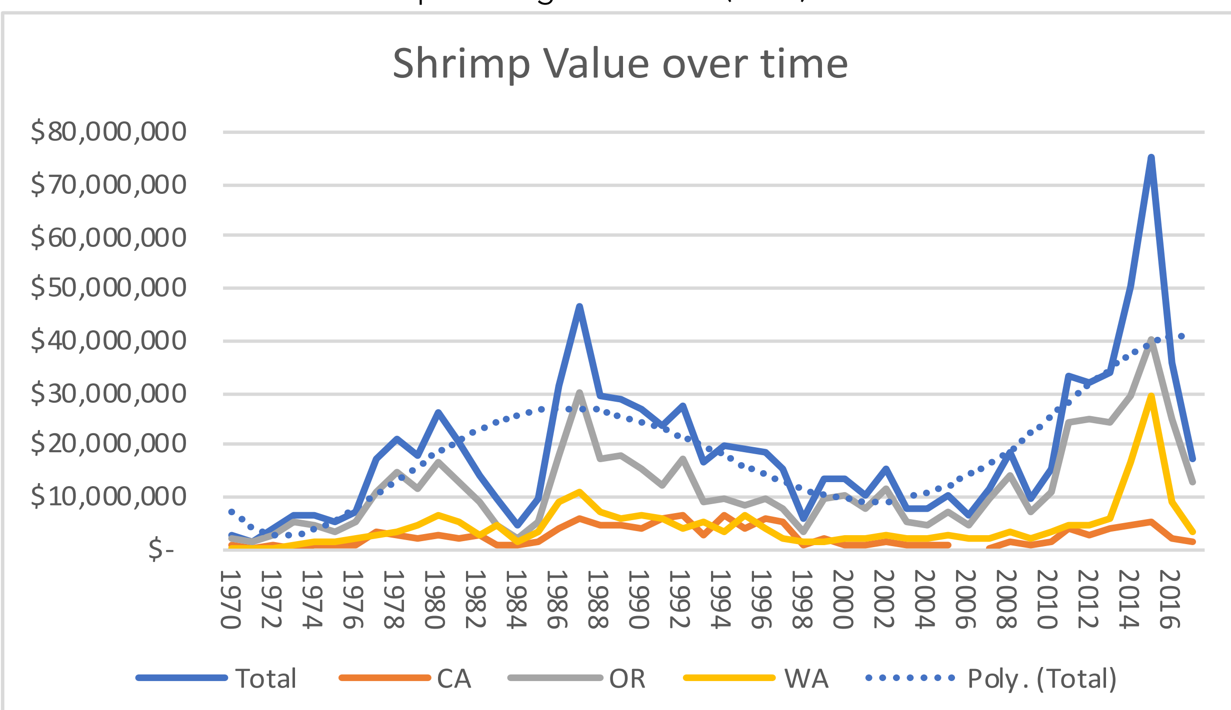



Figure 30: Shrimp price per lb (nominal value)

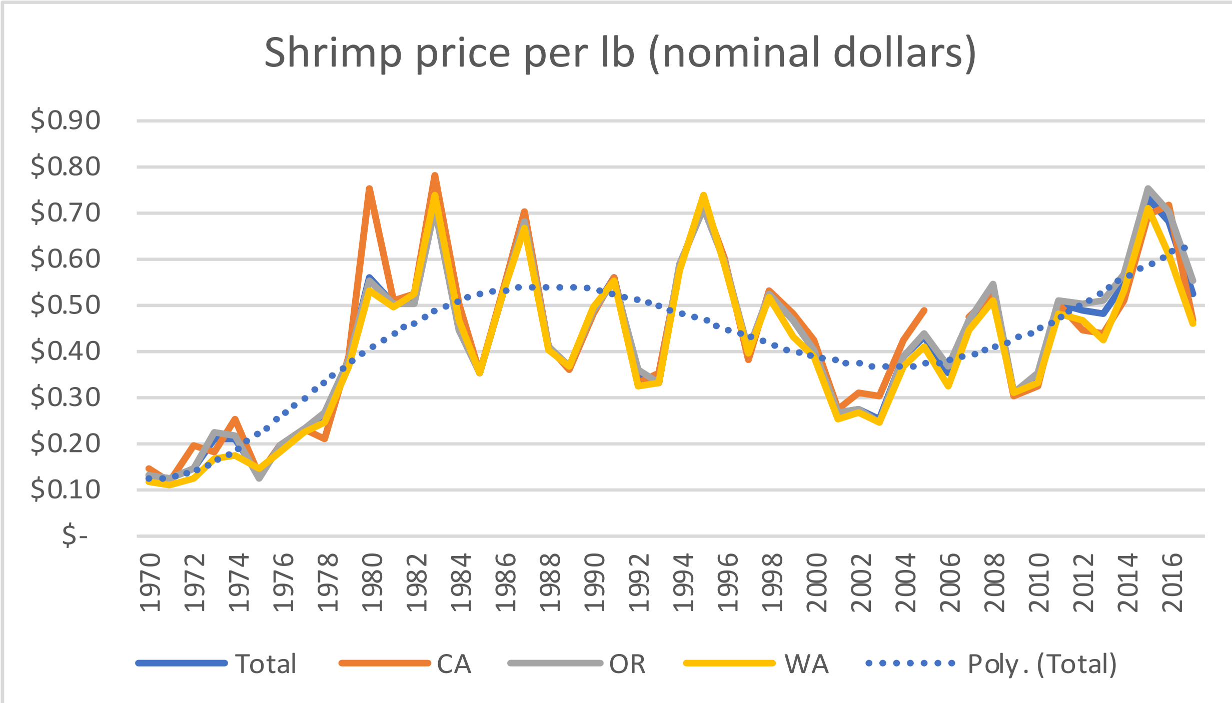
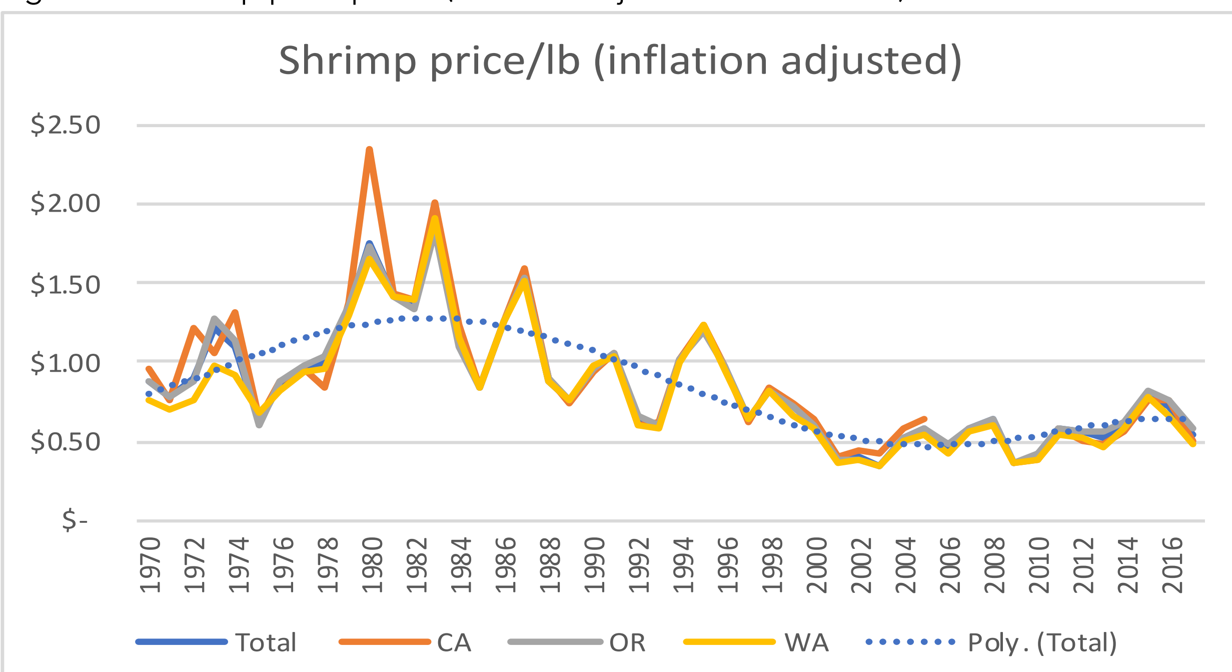



Figure 31: Shrimp price per lb (inflation adjusted 2019 dollars)



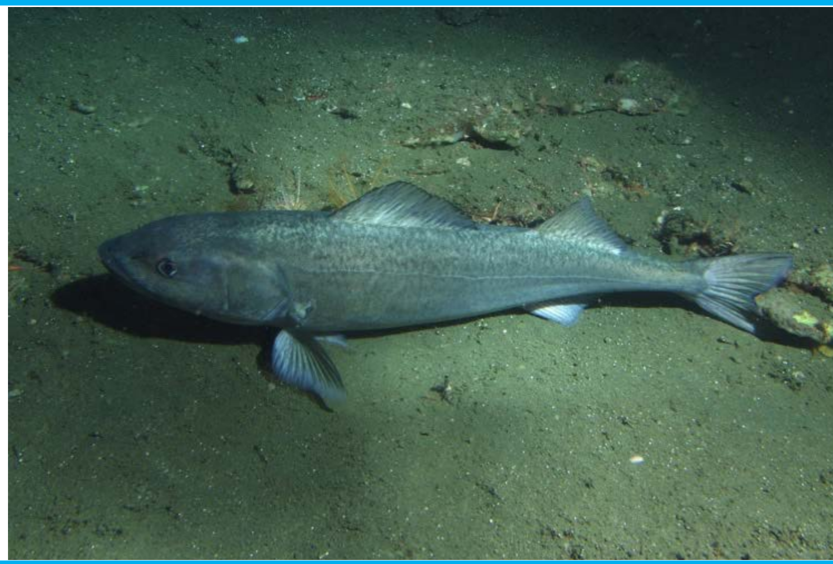

## F. Sablefish Fishery Profile

A fisherman unloads Sablefish, or black cod, in Port Orford.
Source: The Ford Family Foundation

## Overview

Sablefish (*Anoplopoma fimbria*), also known as black cod, are a groundfish species found along the eastern north Pacific coast from Baja, Mexico to Alaska, with the highest abundance centered in the Gulf of Alaska. Sablefish are a long-lived species with individuals up to forty years old commonly caught in the commercial fishery. Sablefish reach reproductive maturity at five to seven years old and spawn annually thereafter. Spawning occurs in deep water in late fall through the winter in Pacific waters, with eggs developing at depth and larvae drifting in surface waters. Pelagic juveniles drift inshore and remain there until around age two, when they begin to move into deeper water. Sablefish settle into their adult habitat at four to five years of age and inhabit deep water ranging from 600′ to 4,800′ along the continental slope, in shelf gullies, or in fjords. Sablefish prey on copepods while in the larval stage, small fishes, copepods and cephalopods (mostly squids) as juveniles, and finally to include rockfishes and octopus as adults. Bottom trawling, traps, and longlines have been the primary methods of capture.

*Figure 23: Sablefish.*



Sablefish have been a historically important fishery on the West Coast, and while it has declined in volume in recent years, it remains vital to many fishing communities. Over the past 20 years, landings averaged around $25 million coastwide. (adjusted to 2021 dollars) While that number has declined somewhat in recent years, some fishermen see increasing access and effort in sablefish fisheries as a potentially important diversification strategy, given the projected future health of the biomass, and the high value of sablefish products in the market under certain conditions.

Landing volumes in the sablefish industry peaked in the late 1970s and early 1980s, with over 24k metric tons (54 mil lbs) of sablefish landed in 1976 across Oregon, Washington, and California[2]. Sablefish are predominantly landed in Oregon, which has accounted for just under 50% of landings over the last 20 years, while California and Washington split the remainder relatively evenly. Despite some fluctuations in volume, the inflation adjusted price per pound for sablefish has strengthened over time as the product has met with higher consumer demand, including from Asia where appxoimately 80% of landings are exported, rising from less than $.50 per pound in the 1970s to between $2.50 - $3.50 per pound in recent years. However, a recently sharp decline in prices has occurred, with driving causes being smaller landed size and COVID-related export market disruptions.

## Fishery Status and Priority Issues

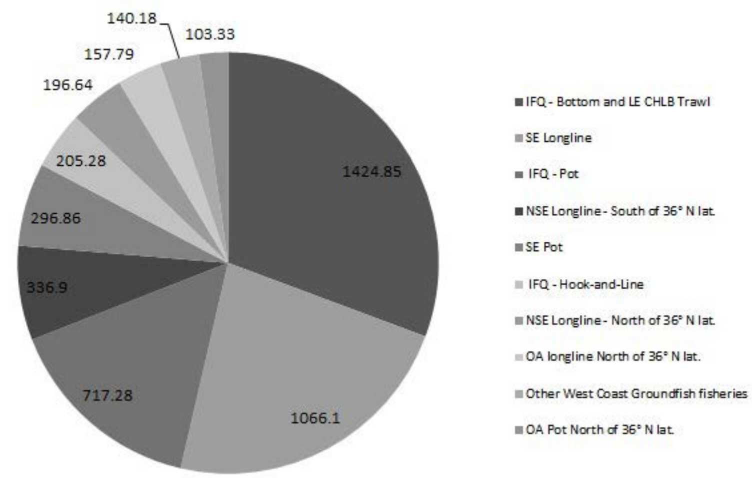
Sablefish is managed under the West Coast Groundfish Fishery Management Plan (FMP). The Pacific Northwest sablefish fishery is currently considered to have strong management controls, with frequent, high quality stock assessments, management measures such as biomass reference points, harvest control rules, and incorporation of uncertainty when determining catch limits. A catch share program was implemented in 2011 for the groundfish trawl[3] fishery, including for sablefish, issuing limited entry

[2] Haltuch, M.A., Johnson, K.F., Tolimieri, N., Kapur, M.S., and Castillo-Jordán, C.A. 2019. Status of the sablefish stock in U.S. waters in 2019. Pacific Fisheries Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR. 398 p.

[3] IFQ permits issued for trawl fishermen may be used for fixed gear (longline and pot) as well.

permits, and requiring 100% observer coverage. Approximately 30% of sablefish landings are caught by IFQ longline and open access longline gears, while the trawl fishery (approximately nearly 1,500 tons of sablefish landings) is certified as sustainable by the Marine Stewardship Council. The remainder of landings are caught using pot traps, which are considered to have minimal negative environmental impacts.

**Sablefish Landings by Fishery, 2012 (Landings, tons)**




Sablefish spawning stock biomass has been in steady decline since the early 1980s and is considered to be below the targeted reference point, but has recently shown some signs of beginning to increase, driven by above-average cohorts with large recruitments in the 2008, 2010, 2013 cohorts, and the 2016 cohort, considered to be the largest since the 1970s. Most indicators suggest poor recruitment in 2017 and 2018 with warmer oceanic conditions and decreased availability of northern zooplankton in 2019, likely driving recruitment further down in 2019. Fishery managers do not believe, however, that overfishing is occurring.

| ***Figure 24: Sablefish - Priority Challenges*** | |
|---|---|
| Key Fishery Challenge 1: Climate | **Stock ranges are shifting in response to climate impacts.** |
| Sablefish ranked very high in their likelihood of experiencing distributional shifts due to climate effects. That is, high adult mobility, high dispersal of early life stages, and lack of habitat specificity suggest that sablefish may respond to climate variability by shifting distribution, which may affect the fishery's access to the stock. However, southern stocks are more likely to be impacted than northern fisheries in Oregon and Washington. | |
| Key Fishery Challenge 2: Whales | **Whale entanglement with pot gear has the potential to limit effort in pot-gear sectors.** |

| | |
|---|---|
| Fleet-wide estimated entanglements were consistently above the 5-year running average threshold during 2002-2017. Growing advocacy for whale safety has caused new limits to be placed on the California Dungeness crab fishery, with possible implications for the Oregan and Washington crab and sablefish pot fisheries. | |
| Key Fishery Challenge 3: Economic Value | **Stock biomass vulnerability may be inhibiting sablefish and adjacent fishery value.** |
| Sablefish catch limits may in turn limit catch of hake, Dover sole, and thornyfish resulting in lost economic opportunity. Reduced prey levels may inhibit sablefish size at the time of catch, resulting in lower prices per pound, even while recruitment levels and landings may be increasing. | |

## Historical Fishing Activity

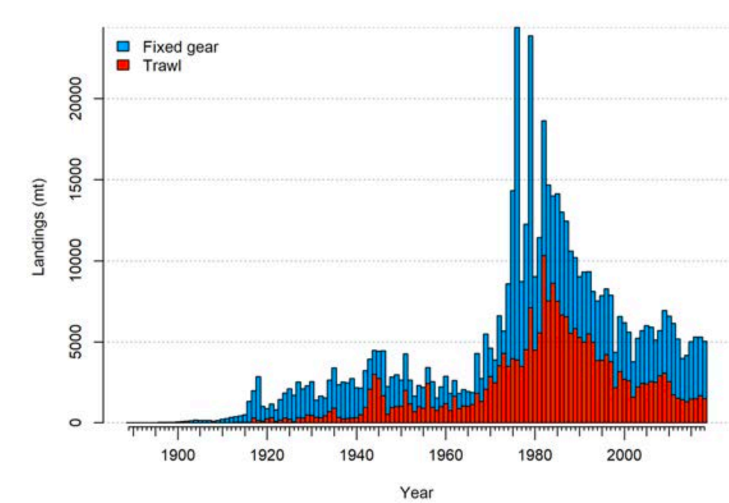
**Season:**

The sablefish season in the waters off the US West Coast typically starts in early April and runs through the end of October.

**Landings:**

Landings for sablefish peaked in the late 1970's and early 1980's and have been in decline in the decades since. Only recently has there been some expectation of increased landings as sablefish recruitment has improved in the last decade. Fisheries landed 5.2 million metric tons of sablefish with an ex-vessel value of $24.7 mil in 2018 making sablefish one of the most valuable stocks in the region. Fishery value has fluctuated but remains strong, ranging between $25 mil - $35 mil over the past five years.

***Figure 25: Landings Volume 1890 – 2018 in metric tons, by gear type.[4]***




4 Haltuch, M.A., Johnson, K.F., Tolimieri, N., Kapur, M.S., and Castillo-Jordán, C.A. 2019. Status of the sablefish stock in U.S. waters in 2019. Pacific Fisheries Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR. 398 p. Note that peak landings in 1976 and 1979 were largely driven by landing from foreign fleets.

**Figure XX: Landings Volume 1970 – 2020 in pounds with polynomial line of best fit**

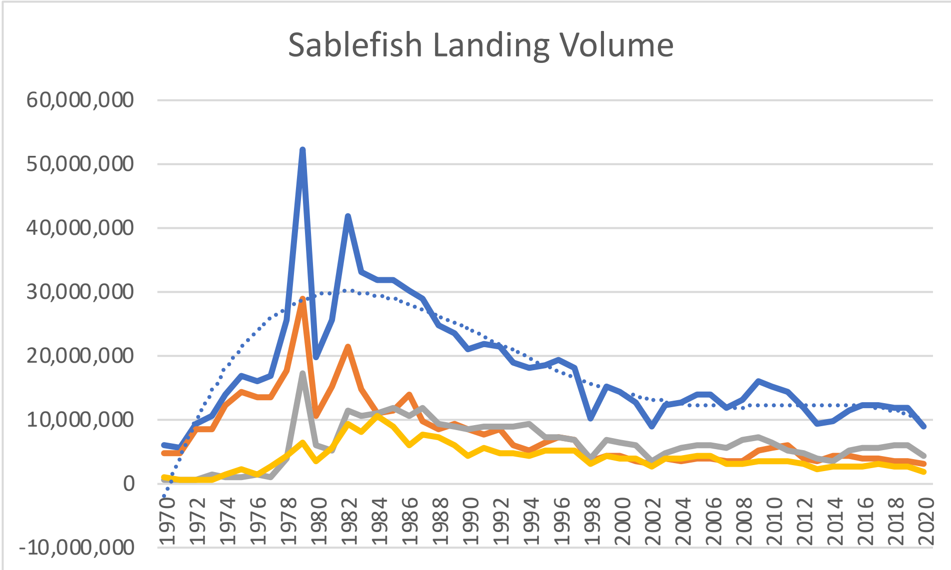



**Figure XY: Average price per pound for each state 1970 – 2020 (2021 dollars) with polynomial line of best fit**

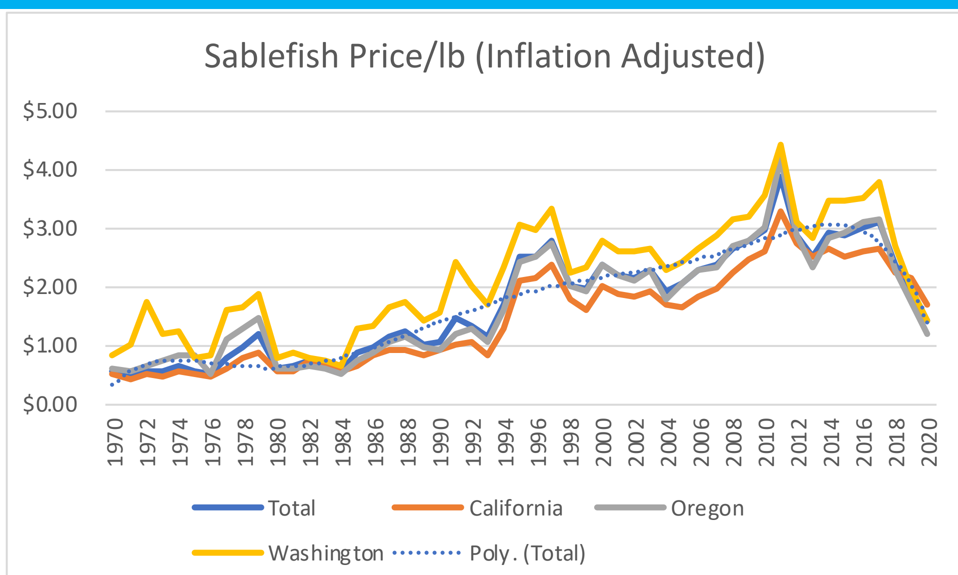



**Figure 26: Adjusted dollar value of fishery 1970 - 2020**

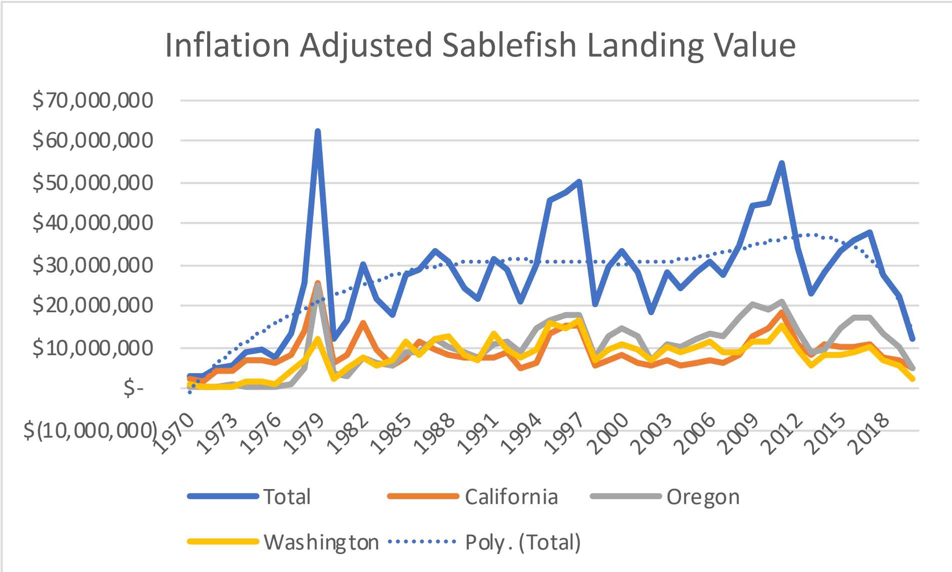
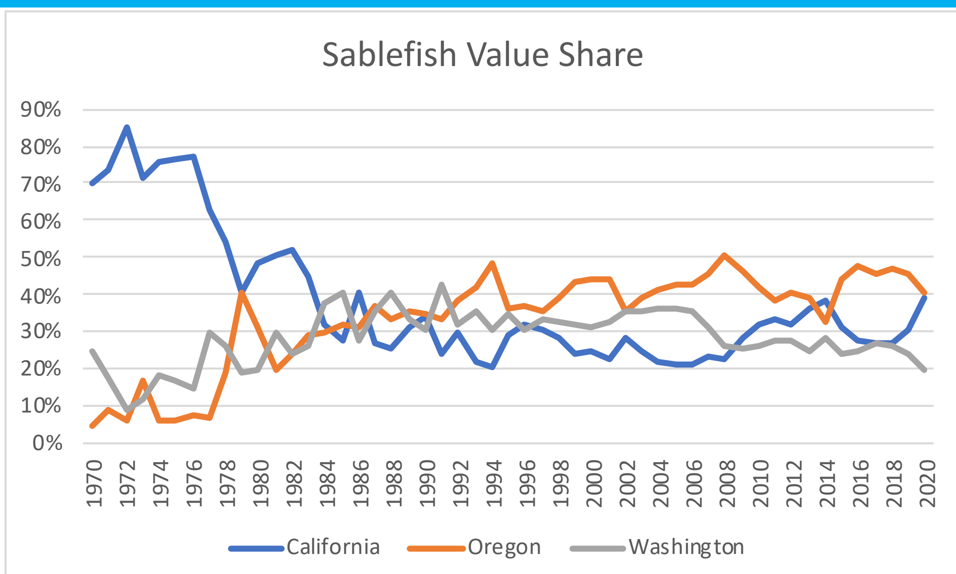



**_Figure 27: Relative share of Sablefish crab fishery landing value by state_**



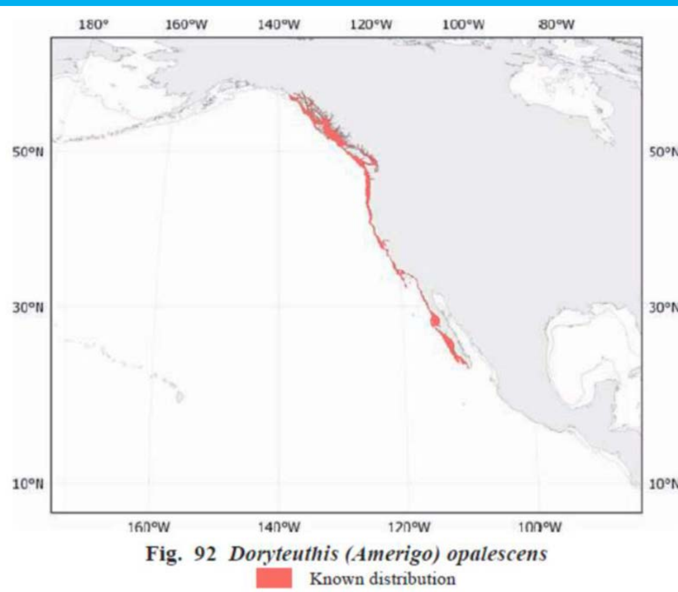

## G. Market Squid Fishery Profile

*Photos of the market squid offloading process.*

## *Overview*

California market squid (*Doryteuthis opalescens*, formerly *Loligo opalescens*) (Hereafter referred to as "market squid") are small pelagic mollusks that range along the eastern north Pacific coast from Baja California Sur, Mexico to southeastern Alaska, with the highest abundance historically found along the southern and central coasts of California.

*Figure 28: Known range for market squid.*




Market squid are a short-lived species with life spans ranging from six to ten months. Individuals reach up to one foot in length including their arms. Reproduction occurs just before death, and spawning occurs year-round, including April – October in Central California and October through the end of April or May in Southern California. Spawning squid congregate in large schools near spawning grounds, usually over sandy habitats. Females produce about 20 egg cases, each with 200 eggs, and eggs hatch within 2 to 5 weeks depending on temperature conditions. Newly hatched eggs are called paralarvae and resemble miniature adults. Juvenile squid feed first on small crustaceans, then krill, small fish, and other squid as they grow. In turn they are a critical food source for a variety of fish (salmon, lingcod, rockfish), seabirds, and marine mammals. Adult squid can be found in open waters above the continental shelf from the surface to depths of 2300 feet.

*Figure 29: Market squid.*

The commercial fishery has been important to Californian fishermen since the 1860's when Chinese immigrants began to harvest small quantities from Monterey Bay. In 1993, after the introduction of purse seine gears, the market squid fishery became the largest California commercial fishery by volume, and by 1996 was the most valuable fishery in the state. Regulations were introduced in 1998 to limit participation and landings as well as the use of lights to attract squid for harvesting.

Market squid has not been a productive commercial fishery in Oregon and Washington throughout its known life history. However, likely pushed by climate driven changes to ocean conditions, the market squid fishery boomed in 2018, and saw record numbers in 2020 in Oregon, drawing an estimated 29 vessels into the fishery and landing more than 7 million tons. The nearly $6 million value of the catch doubled the value of Oregon's Pacific salmon catch. In the spring of 2021, Oregon Department of Fish and Wildlife began to consider new regulations to preserve squid populations into the future.

### *Fishery Status and Priority Issues*

Market squid are managed by the Pacific Fishery Management Council, which delegated authority to manage the fishery to the California Fish and Game Commission, and the California Department of Fish and Wildlife ("CDFW"). CDFW adopted a Fishery Management Plan in 2005 consistent with federal fishery management guidelines, including seasonal catch limits currently set at 118,000 tons annual landings, monitoring programs, time and seasonal closures (including weekend closures), limitations to use of lights to attract squid in certain areas, and permit systems to limit access to the fishery. Short-term and long-term changes to population are poorly understood so there are no reliable estimates of population health.

In 2019, commercial landings of market squid totaled more than 32 million pounds and were valued at approximately $16.4 million according to the NOAA Fisheries commercial landings database. Purse seines and scoop nets are the primary gears used to catch market squid, and habitat and bycatch impacts are minimal because the gears are used at the surface around dense schools of fish, which usually contain only one species. As adult market squid die within weeks after spawning, even without fishing the entire population replaces itself annually. As a result, market squid populations can handle significant fishing pressure, so long as fishermen capture squid after spawning has occurred. The market squid fishery is not thought to be under threat from overfishing given its aggregation and spawning dynamics and the current management regime for the fishery. Nonetheless, there are some areas for management improvement as follow:

<table>
<tr><th colspan="2">Figure 30: Market Squid - Priority Challenges</th></tr>
<tr><td>Key Fishery Challenge 1: Stock Assessments</td><td>Stock assessments have limited visibility into the health of the biomass.</td></tr>
<tr><td colspan="2">The primary challenge facing the fishery is in making sure enough squid have spawned and laid eggs before capture. Stock assessments are unable to determine MSY, and use instead an egg escapement measure to determine stock health. Some scientists believe that market squid may be the most prolific and abundant marketable species in Pacific coastal waters. However squid have been observed to achieve declining lengths over the recent decades, likely reducing fecundity as egg production is thought to be linked to female squid length, and the reproductive output of the population may be affected. Population health may be negatively impacted by warming waters which may inhibit fecundity.</td></tr>
<tr><td>Key Fishery Challenge 2: Shifting Range</td><td>Market squid may be moving north driven by climate change impacts.</td></tr>
<tr><td colspan="2">Little information is available on the extent and distribution of spawning grounds throughout the range of market squid on the Pacific coast, including intra-state dispersals at varying depths as well as across geographic ranges. Additional research needs to be conducted to understand such distributions, especially in deeper water and areas north of Central California not traditionally targeted by fishing vessels.</td></tr>
</table>

## *Historical Fishing Activity*

**Season:**

The fishery is open year-round in California but closes on weekends from Friday at noon through Sunday at noon, with restrictions on the use of attraction lighting. In response to the emergent presence of market squid off of the coast of Oregon, fishery managers there have also determine to allow year-round fishing and has implemented a weekend closure.

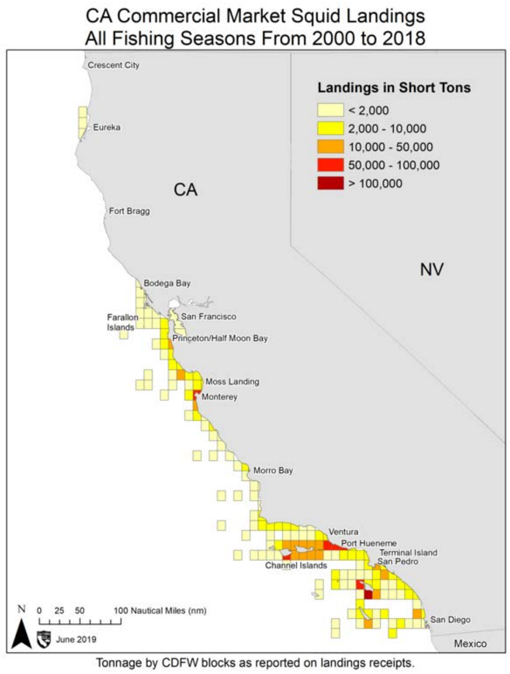
**Size of the Fleets:**

The commercial market squid fishery operates under a Restricted Access program. At the start of the 2018-2019 fishing season, there were 74 vessel, 33 light boat, and 45 brail permits. Up to 33 vessels made up 75% of the catch during the 2013-2017 fishing seasons. 96% of market squid are harvested with purse seine vessels.

**Landings:**

Landing volumes in the market squid fishery peaked in the late 1990s and early 2000s, with nearly 120k metric tons (240 mil lbs) of squid landed. Nearly 100% of landings have historically occurred in California, although spawning aggregations are occasionally found as far north as British Columbia, and in the early 1980's, a short-term fishery developed along the coast of Oregon. The commercial fishery for market squid in California is one of the largest in terms of volume and value. From 1997 – 2017, market squid represented the largest single species fishery by volume in the state for all but four years and was the largest ex-vessel value for over half of those years.

**Market Squid Landings 2000 - 2018**

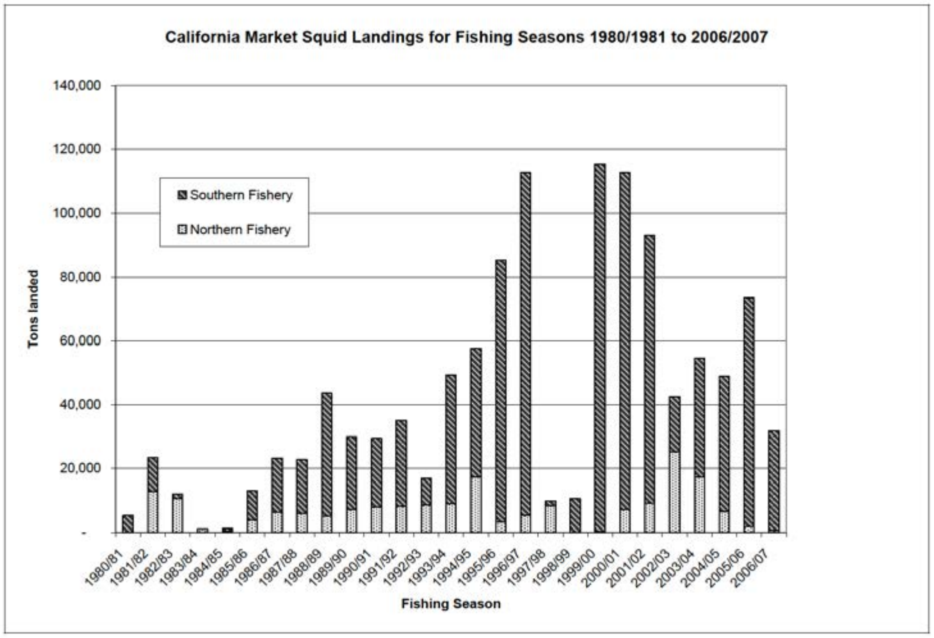



Over time, market squid abundance is considered highly variable in response to environmental conditions including El Nino/La Nina cycles, longer term Pacific Decadal Oscillations, and more recently climate change impacts. Climate change is thought to be altering the physical and chemical properties of ocean water off the Pacific coast. Ocean warming, changes to the pH of ocean water via ocean acidification, and changes in the oxygen content of ocean water may alter or compress the availability of suitable habitat for Market Squid spawning. It is hypothesized that this could lead to increasingly localized and dense spawning, resulting in potentially important changes for both the fishery and market squid ecology generally. Naturally occurring hypoxic OMZs off the coast of California have been getting shallower and could compress the depth range for adult market squid.

The recent presence of market squid in sufficient quantities to interest commercial fishermen in Oregon is an anomaly with uncertainty around future catch levels. Lower catch levels in California beginning in 2015 at 40k tons annually and dropping to as low as 15k tons in 2020 may reflect some movement of the spawning stocks further north in response to warming waters, or may reflect other unknown population movements, as spawning aggregations can occur at depths that are not accessible to commercial fishermen. In addition, landings levels at times reflect supply fluctuations from other sources of squid globally, and demand fluctuations responding to times of harvesting abundance worldwide.

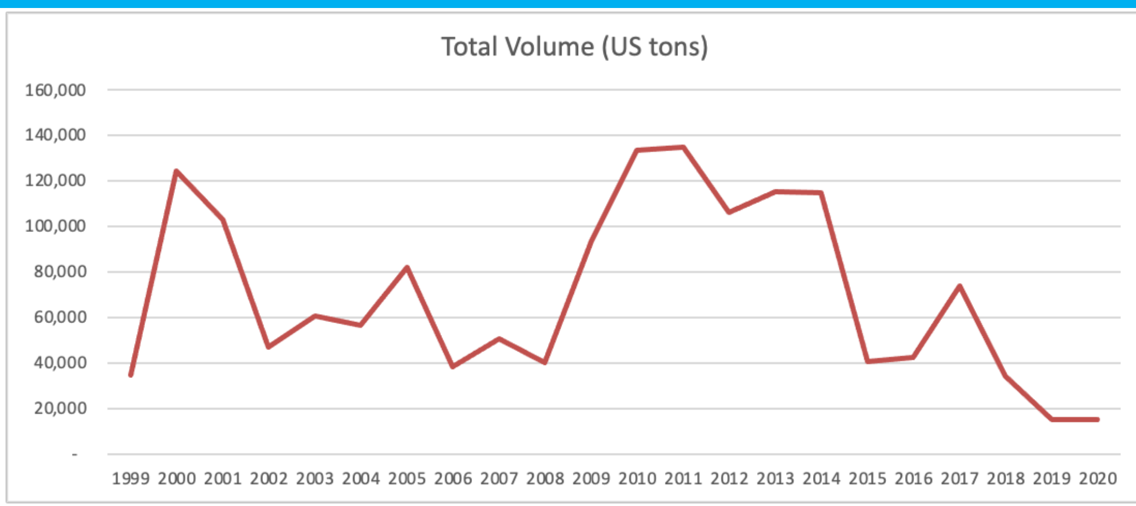
Most market squid are exported in frozen blocks to China, Japan, and Europe for human consumption, while a certain amount are sold in California as bait. Prices for market squid have steadily risen from $0.10 / lb ($194/ton) in 2000 to a recent high of $0.61/lb ($1,215 per ton). Alltogether, total landings values have fluctuated as a function of volume and price between $6 mil in 1999 to $73 mil in 2017, and dropping to approximately $20 million in 2020.

***Figure 31: Landings Volume 1980 - 2006 in metric tons***



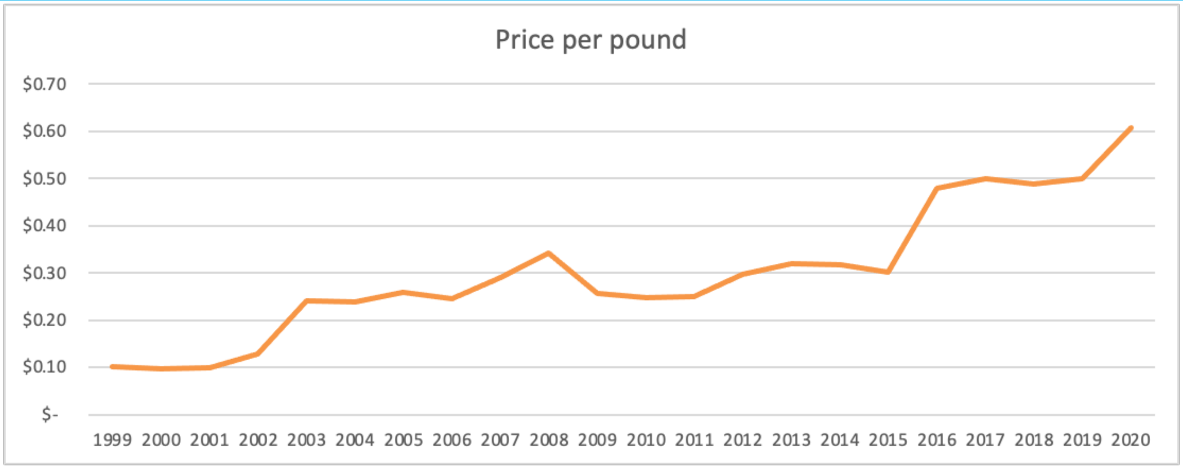

*Fishery performance for market squid sourced from California Market Squid Status Report 2006 located at https://californiawetfish.org/pdf/status2006squid.pdf*

***Figure 32: Landings Volume 1999 - 2020 in metric tons***



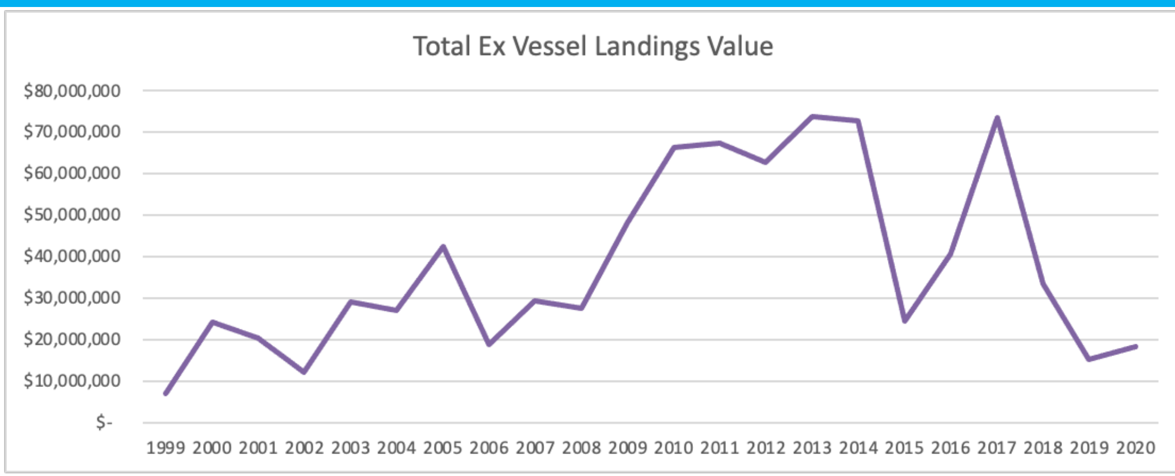

*Fishery performance for market squid sourced from https://wildlife.ca.gov/Conservation/Marine/Pelagic/Market-Squid-Landing*

**Figure 33: Average price per pound 1999 - 2020**




*Fishery performance for market squid sourced from https://wildlife.ca.gov/Conservation/Marine/Pelagic/Market-Squid-Landing*

**Figure 34: Total ex vessel revenue 1999 - 2020**




*Fishery performance for market squid sourced from https://wildlife.ca.gov/Conservation/Marine/Pelagic/Market-Squid-Landing*

# V. FISHERIES ACCESS OVERVIEW

**Below is an outline of the major fisheries in the Pacific Northwest and the primary management scheme that they are under. This is not an exhaustive list, and there may be more specific and localized permitting requirements and other considerations.**

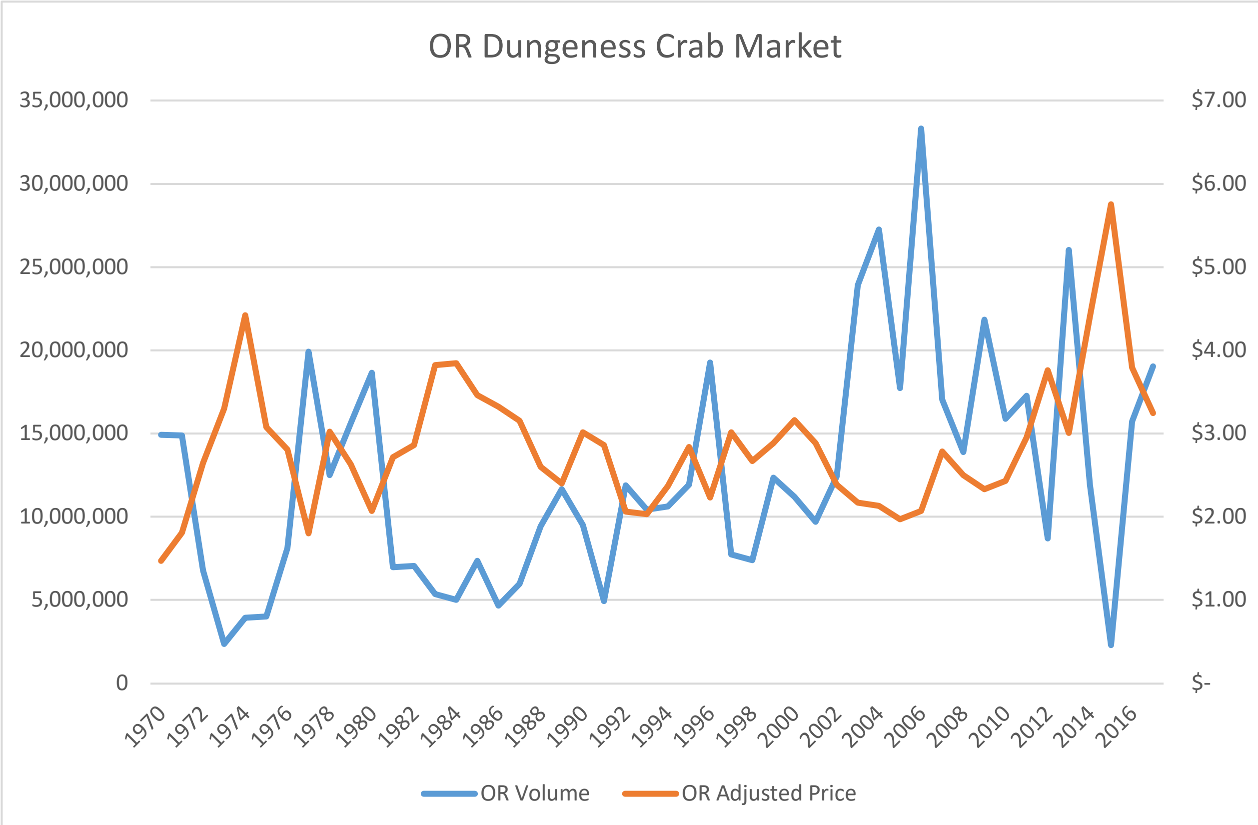
| Fishery | Species | Permit/License Requirements |
|---|---|---|

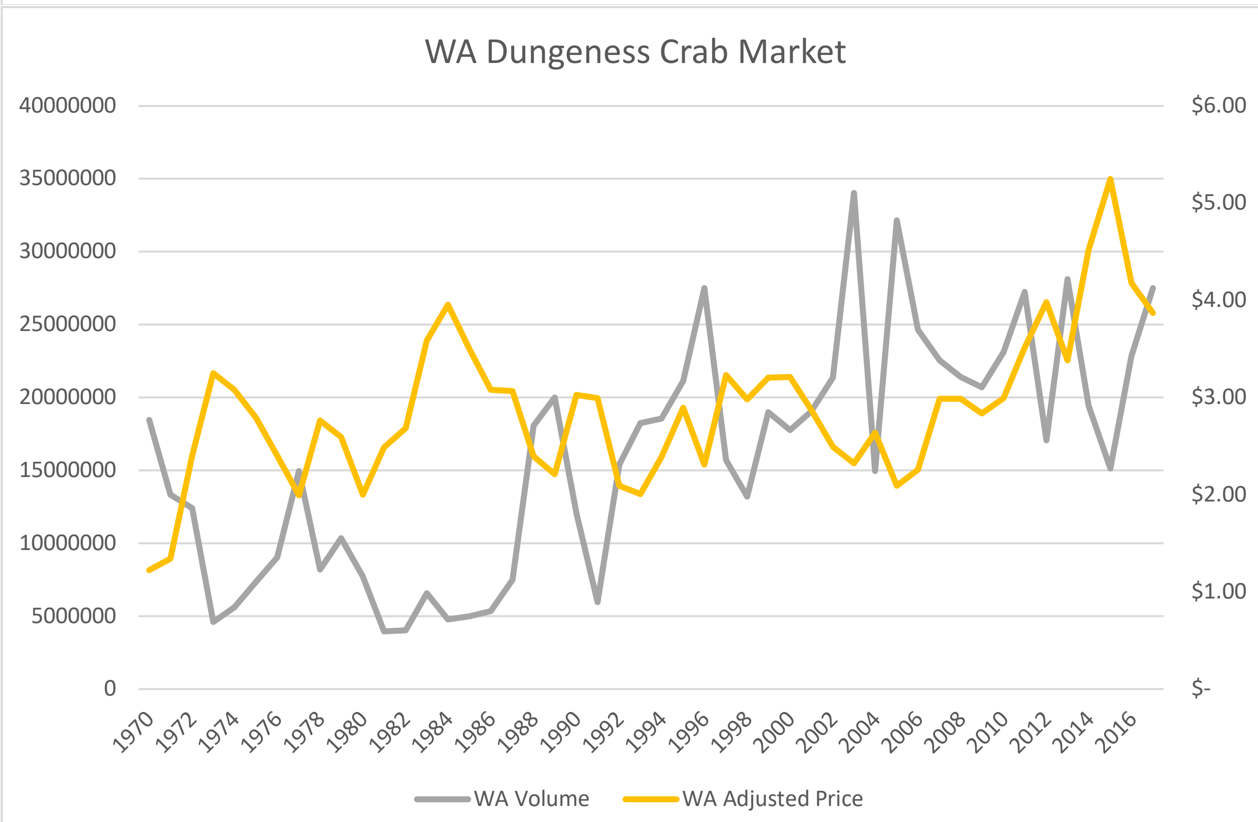
| | | |
|---|---|---|
| Salmon | Troll Salmon (OR) | Permit required, currently there is no cap permits as there has been in previous ye but with no way to reissue their number slowly declining. Estimated that 40-60% permits active on any given year. |
| | Columbia River Salmon (OR) | Treaty rights, or commercial permit requ for commercial fishing |
| | Troll Salmon (WA) | Commercial limited entry permit require |
| | Columbia River Salmon (WA) | Commercial limited entry permit require |
| | | |
| Groundfish | 65 rockfish, 12 flatfish, 6 roundfish, 6 sharks and skates, and other | |
| | Rockfish (OR 2017) | Limited entry trawl and limited entry f gear require Pacific Coast Groundfish Li Entry permit. Black and Blue Rockfish p with or without nearshore endorseme required to target Black and Blue rockfis nearshore complex species in OR. |
| | Rockfish (WA 2017) | |
| | Lingcod (OR 2017) | |
| | Lingcod (WA 2017) | |
| | All Sole (OR) | |
| | Dover Sole (OR) | |
| | English Sole (OR) | |
| | Petrale Sole (OR) | |
| | Rex Sole (OR) | |
| | All Sole (WA) | |
| | Dover Sole (WA) | |
| | English Sole (WA) | |
| | Petrale Sole (WA) | |
| | Rex Sole (WA) | |
| | Arrowtooth flounder (OR) | |
| | Pacific Sanddab (OR) | |
| | Kelp Greenling (OR) | |
| | Pacific Cod (OR) | |
| | Pacific Cod (WA) | |
| | | |
| Pacific Halibut | Halibut (OR) | IPHC License required |
| | Halibut (WA) | IPHC License required |
| | | |
| Highly Migratory | Albacore Tuna (OR) | Federal HMS Permit required. |
| | Albacore Tuna (WA) | |
| | Spiny dogfish (OR) | |
| | Spiny dogfish (WA) | |

| | | |
|---|---|---|
| Coastal Pelagic | Squid (OR) | |
| | Squid (WA) | |
| | Northern Anchovy (OR) | |
| | Northern Anchovy (WA) | |
| | Pacific Sardine (OR) | |
| | Pacific Sardine (WA) | |
| | Jack Mackerel (OR) | |
| | Jack Mackerel (WA) | |
| | | |
| Dungeness Crab | Oregon Commercial (2017-2018) | Tiered State Limited Entry License |
| | Washington total commercial 2017 | Tiered State Limited Entry License |
| | | |
| Pacific Whiting | Whiting (OR) | Limited Entry Permit |
| | Whiting (WA) | Limited Entry Permit |
| | | |
| Sablefish/Black Cod | Sablefish (OR) | |
| | Sablefish (WA) | |
| | | |
| Shrimp | Ocean Shrimp (OR) | State Limited Entry Permit |
| | Ocean Shrimp (WA) | State Limited Entry Permit |

# VI. MARKET OUTLOOK

Crab Market:

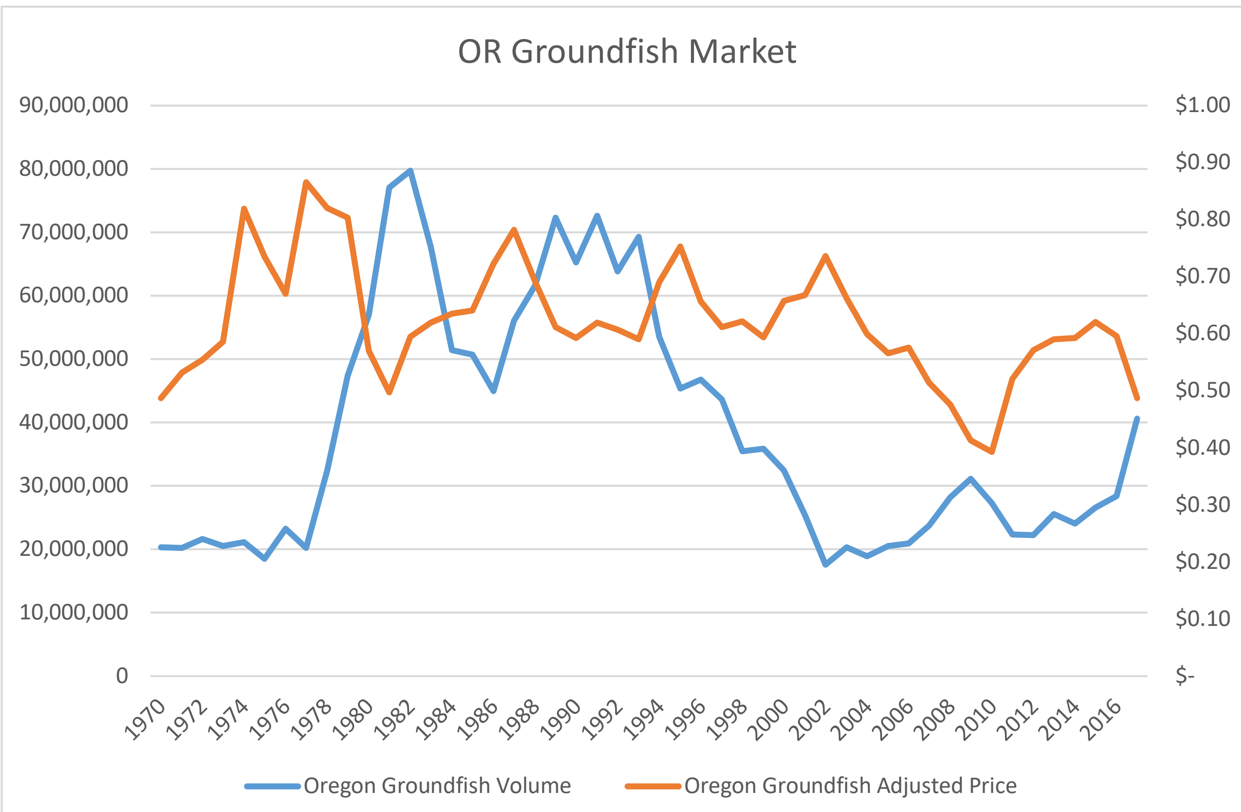


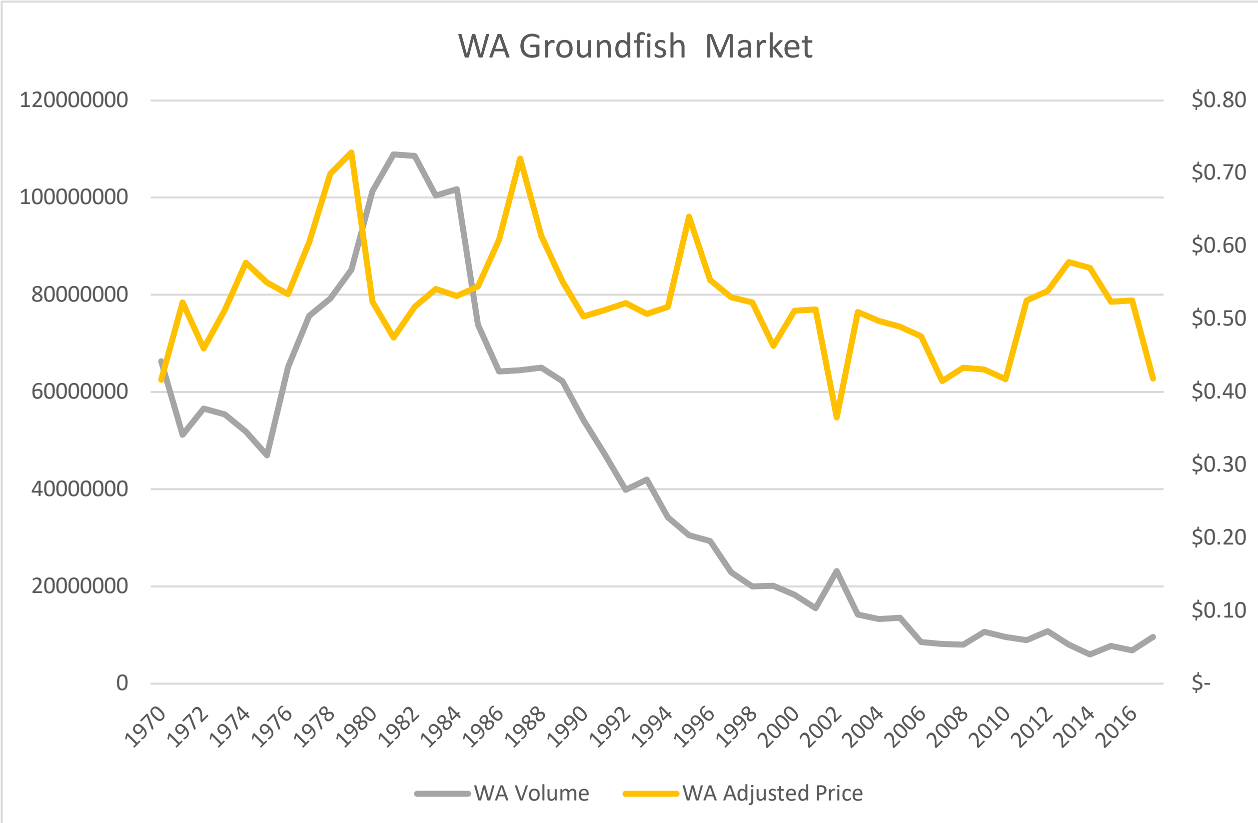




Trends:
Dungeness crab is the highest value fishery on the West Coast, providing a uniquely sweet crab meat that is sold as a live product, whole cooked crab, or cooked and shelled. It is a staple of

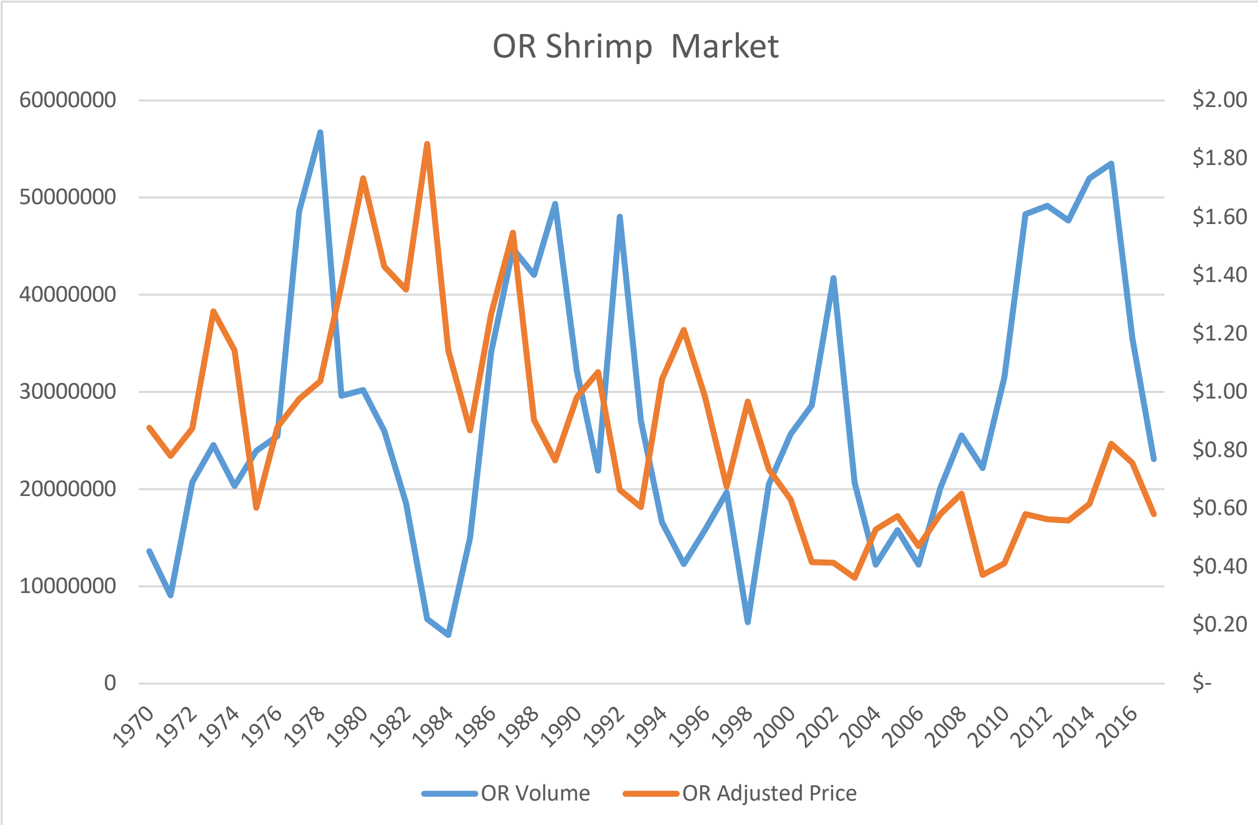
shoreside crab shacks, fine dining establishments, and export markets. There is considerable price variability in crab prices over the course of the season, with the majority of crab being caught in the first two months of the season in the winter, prices rise over the course of the summer until the fishery is closed at the end of summer. Much of the early crab is sent to export markets, primarily in China. The uniqueness of the product and high demand both domestically and abroad give Dungeness very stable pricing, with an inflation adjusted floor of around $2/lb regardless of the volumes landed. However, when supply becomes constrained prices often spike to over $5/lb , showcasing the high demand and high willingness to pay that consumers hold for Dungeness. This is a product with high demand and few substitutes, with strong market opportunities.

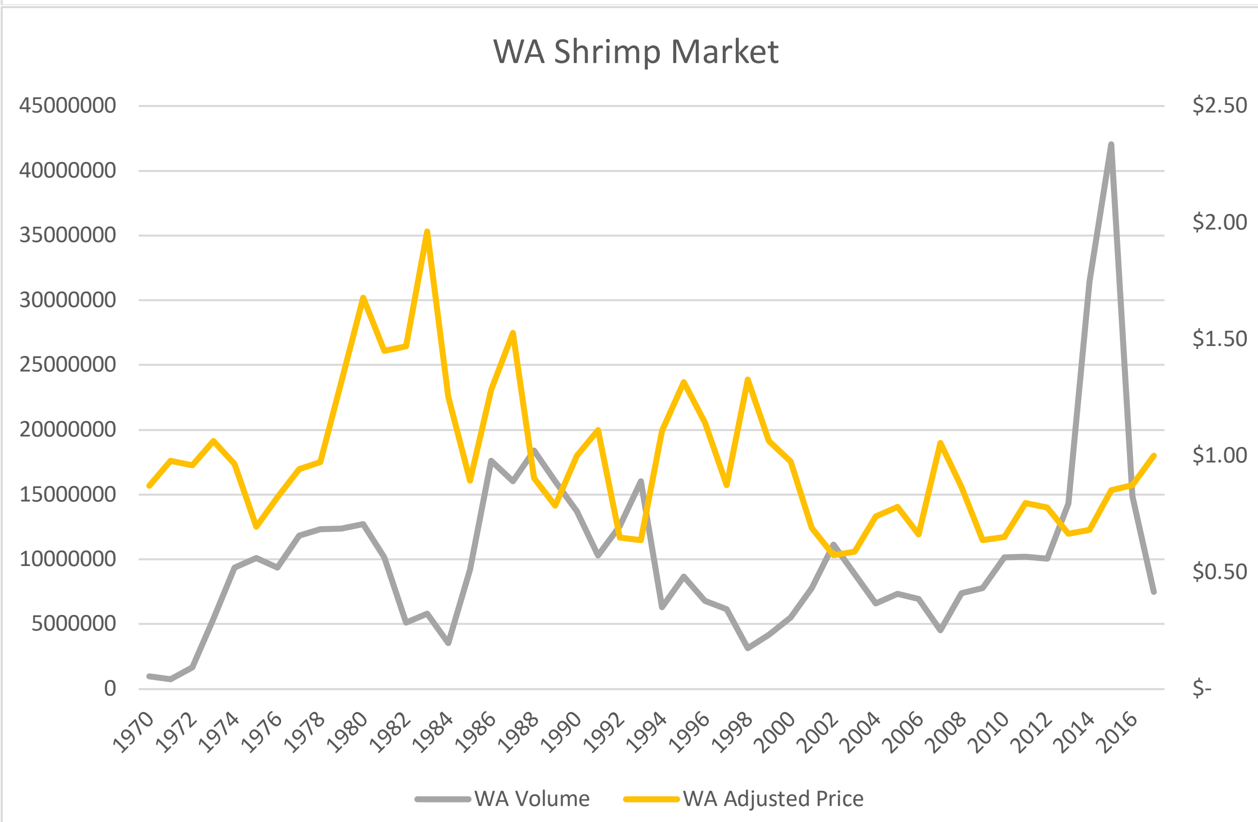
Groundfish market:





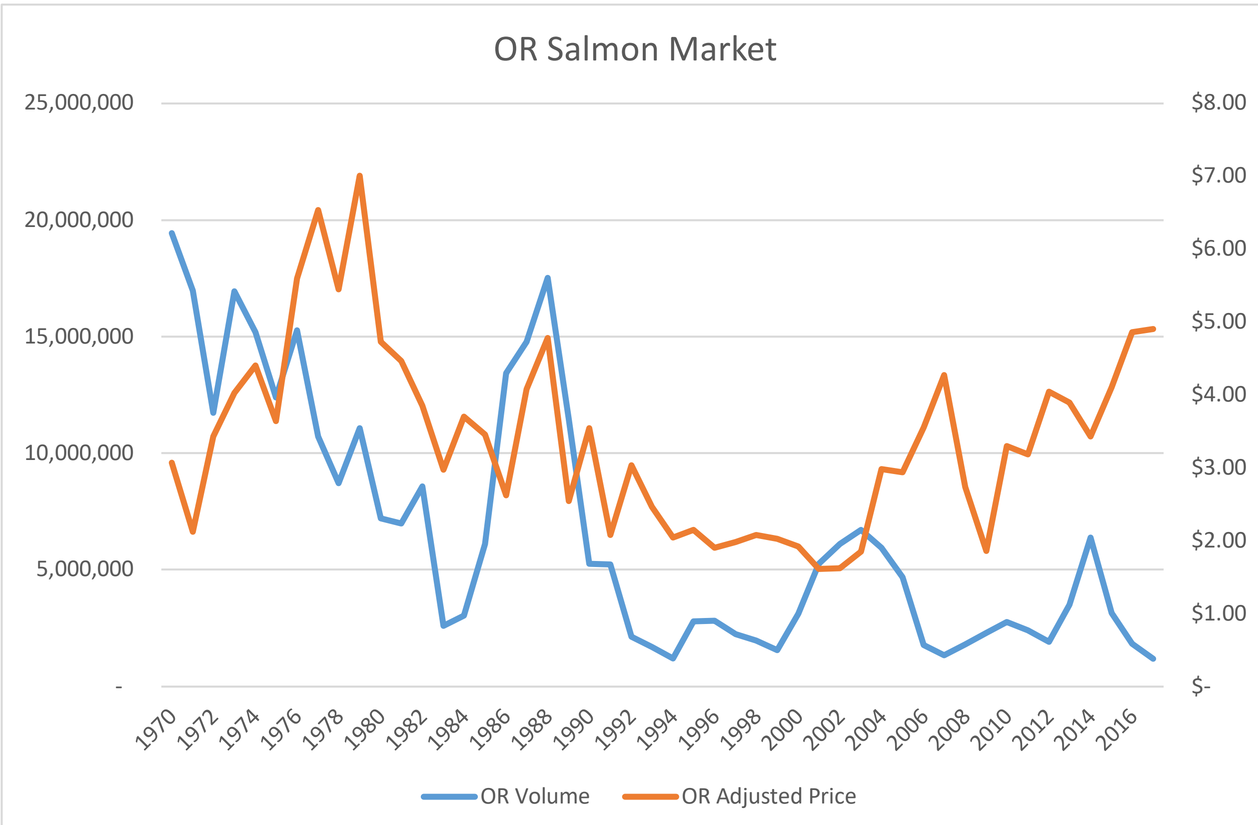

For our analysis, groundfish includes rockfish, cod, ling cod, sole, sharks, skates, and other species but does not include sablefish (Black Cod), whiting, or halibut, which are managed separately and offer different products on the market. Groundfish fisheries in Oregon and Washington experienced a precipitous decline in the late 80s and into the 90s, though restoration efforts have effectively restored many stocks to healthy status. Groundfish typically have white, flaky, mild tasting flesh, and are a staple of seafood recipes around the world. They are also a category with multiple options for substitutions, as species like cod, haddock, lingcod, hake and others have similar tastes and textures. As a result, pricing has been relatively stable, generally holding at around $0.40-$0.60/lb (inflation adjusted) over the past 50 years, though Oregon fishermen have been able to command slightly higher prices than Washington, on average. This implies that the product is relatively commoditized, though in recent years the Oregon market has shown more sensitivity to volume in how ex-vessel prices are set. Additionally, niche fisheries like live rockfish and lingcod may behave differently from commoditized groundfish markets, as they are much more location specific and offer a unique product form that non-local domestic and foreign groundfish fleets cannot compete with.

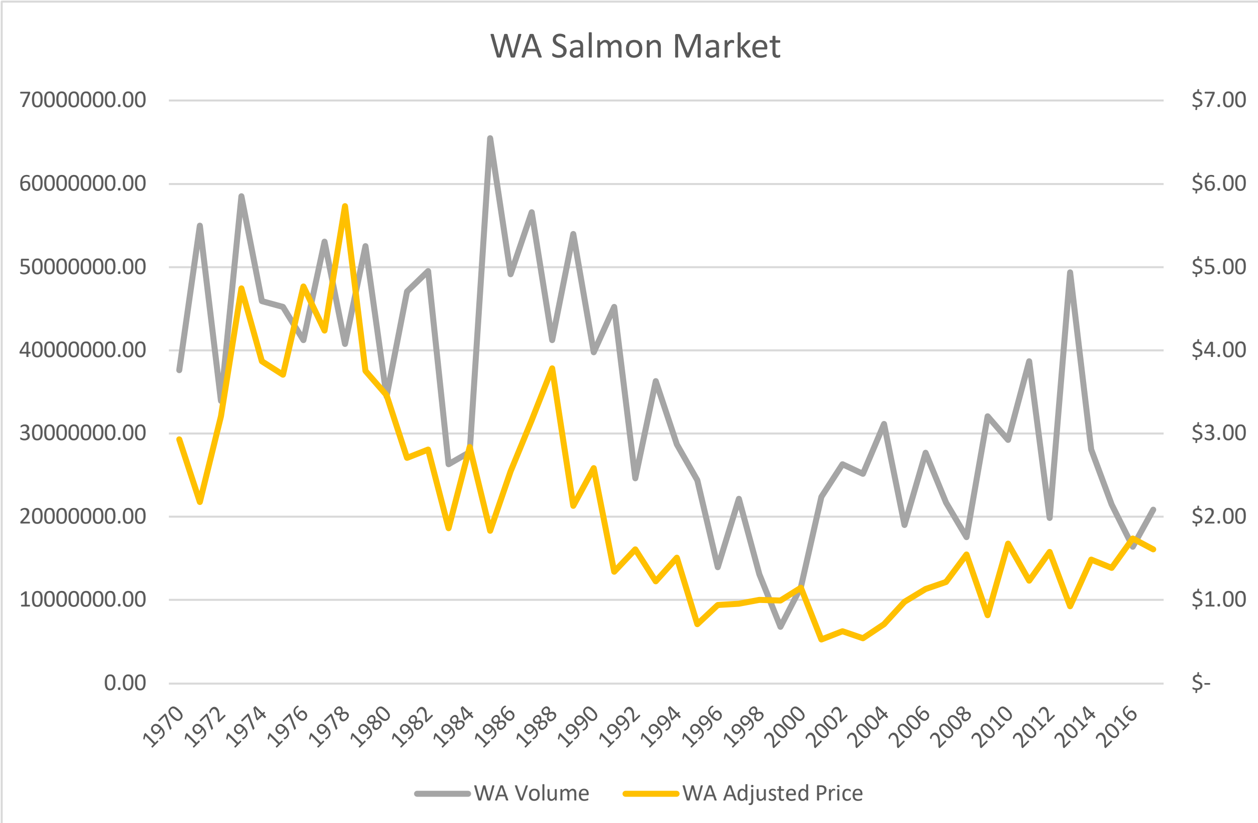



Pacific Pink Shrimp (*pandalus jordani*), also sometimes called cold-water shrimp or salad shrimp, are a small, sweet shrimp used in a variety of applications. They are smaller than Gulf shrimp or imported tiger prawns, but they are very similar to Northern Shrimp (*pandalus borealisi)* and are often sold cooked, peeled, and deveined. The shrimp market is a global market and has become commoditized. While Washington fishermen have been able to command higher prices than Oregon fishers in recent years, both market prices appear to be only loosely linked to the volume of landings, which implies that they are both part of a larger market which includes substitute products from other regions of the world.

Salmon Market:





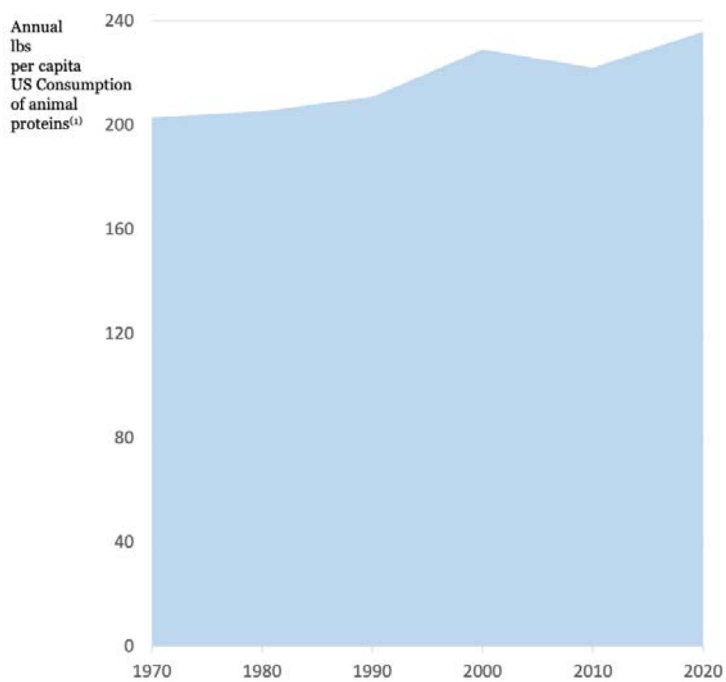

Pacific Salmon is an iconic group of species that is a cultural and culinary touchstone for the Pacific Northwest. While numbers have been declining over the past several decades, value remains high, especially for the highest value fish, King (Chinook) salmon. For the graphs above, aggregate values for all species are shown, though the predominant local fisheries in Washington, Oregon, and California are King (Chinook) and Coho salmon Washington data is somewhat skewed in this case, as many vessels that fish in Alaskan waters land their catch in Washington, introducing different salmon species (Keta, Pink), and different product forms that can drop aggregate price. However deep cultural heritage, combined with and strong local, national, and global demand means that wild Pacific Salmon has very little substitution risk other than from other species of wild Pacific Salmon, though lower value species like Keta and Pink salmon may find themselves in more direct competition with farmed Atlantic salmon. The key risk for the salmon market is finding enough product, and ensuring the health of the stock for future harvests. This may also create conditions where prices rise as stock health declines, as limitations on supply cause price spikes for local, wild Salmon.

Future Outlook:

All around the nation, seafood markets are changing. The most obvious influence in recent months has been the COVID-19 pandemic, which had significant impacts on West Coast fishermen as Dungeness crab trade to China was suspended, along with live fish and sea urchin markets. Particularly in the Pacific Northwest, where the seafood market is dominated by a few major actors, it became difficult for local consumers to purchase seafood as food supply chains shut down. These intense pressures prompted the port to build an open a dockside seafood market and online marketplace to allow fishermen to market their own catch directly to local consumers.

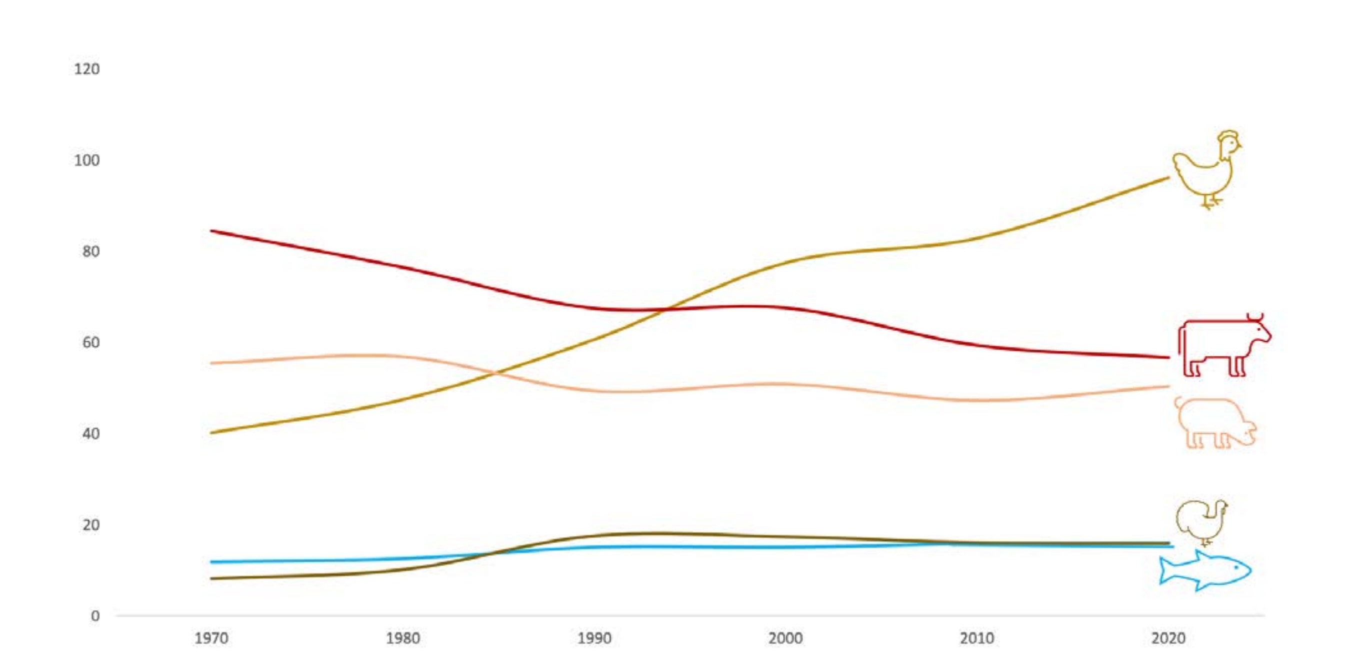
Even prior to the pandemic, however, there had been a marked sea change in the overall demand for seafood, as well as in what those seafood consumers care about and are willing to pay for. Although protein consumption and purchasing has increased steadily over the past several decades, the market share of seafood has remained relatively flat—possibly due to the fact that most fish was consumed at "away-from-home" settings, including takeout, delivery, and restaurant dining-in.

*Figure 1: US per capita consumption of animal proteins over time*[5]



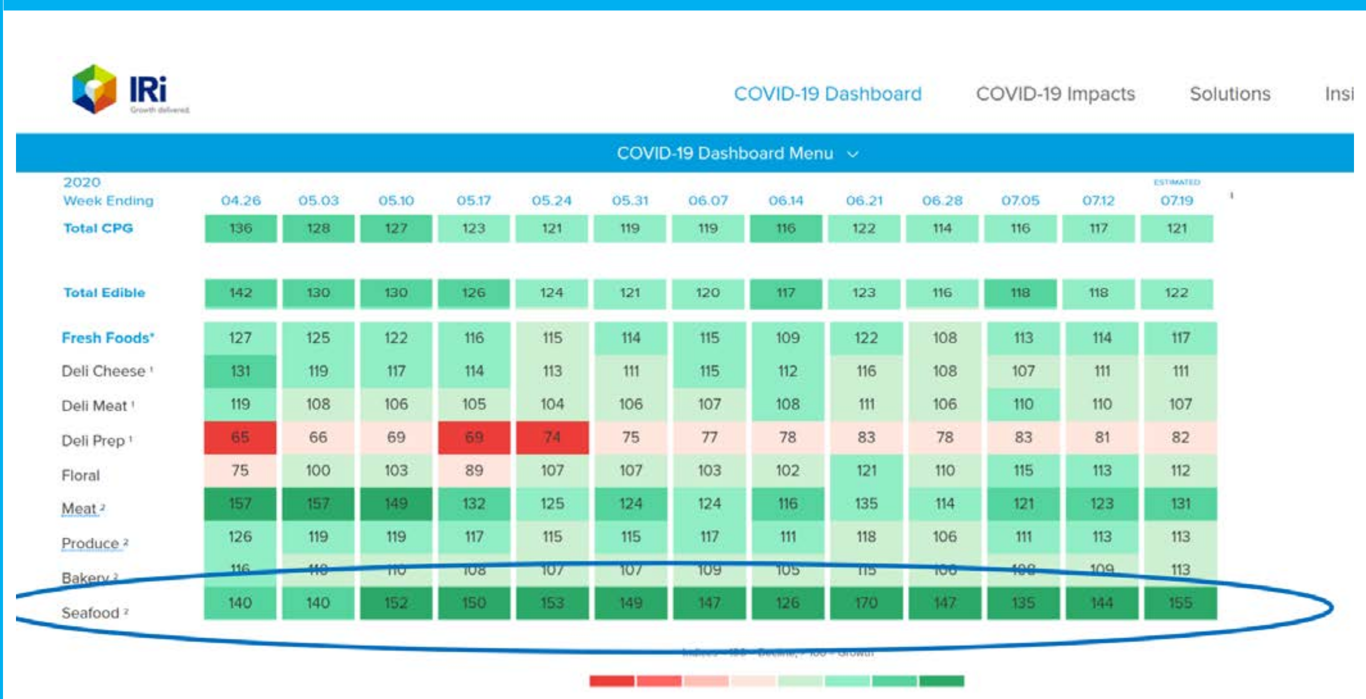

[5] Egan, Mary. *Sustainably caught U.S. seafood: Branding for American consumers opportunity assessment*. Prepared for Catch Together. Sept 2020.

Figure 2: Protein consumption by species over time[1]




Nevertheless–and surprisingly–seafood has grown more than any other fresh food category in grocery sales during the pandemic. This presents a real opportunity for the seafood industry to improve their sales to at-home US users, rather than focusing on restaurants and international markets.

Figure 4: Grocery sales during April-July 2020[1]

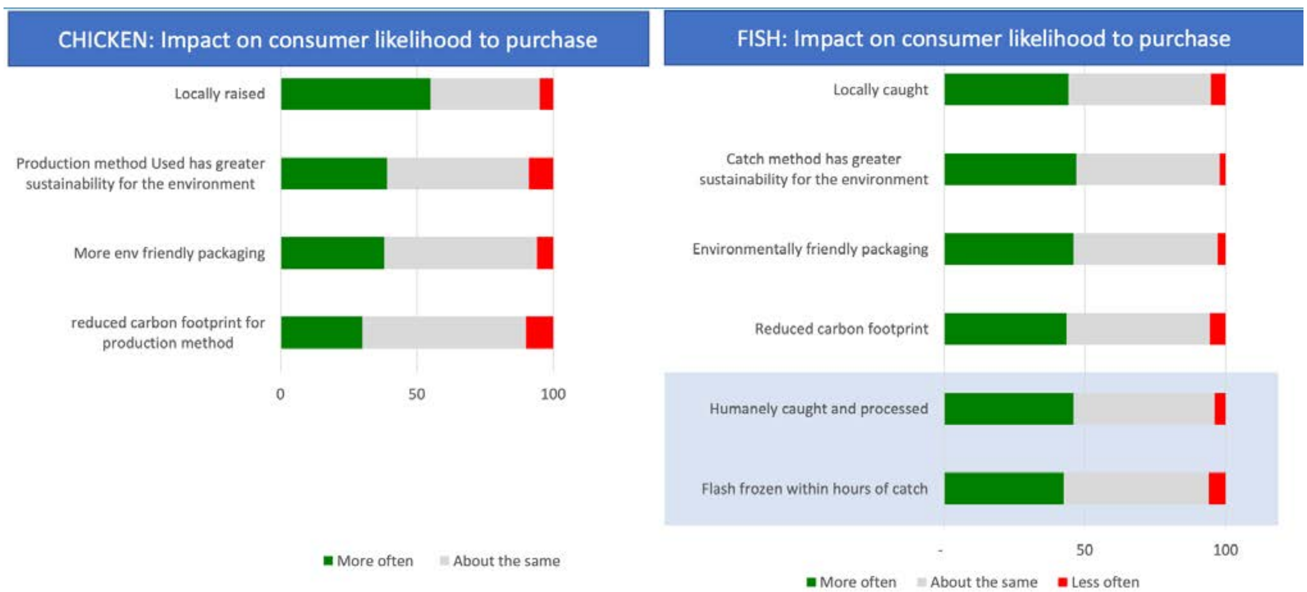



| 2020 Week Ending | 04.26 | 05.03 | 05.10 | 05.17 | 05.24 | 05.31 | 06.07 | 06.14 | 06.21 | 06.28 | 07.05 | 07.12 | ESTIMATED 07.19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total CPG** | 136 | 128 | 127 | 123 | 121 | 119 | 119 | 116 | 122 | 114 | 116 | 117 | 121 |
| **Total Edible** | 142 | 130 | 130 | 126 | 124 | 121 | 120 | 117 | 123 | 116 | 118 | 118 | 122 |
| **Fresh Foods*** | 127 | 125 | 122 | 116 | 115 | 114 | 115 | 109 | 122 | 108 | 113 | 114 | 117 |
| Deli Cheese [1] | 131 | 119 | 117 | 114 | 113 | 111 | 115 | 112 | 116 | 108 | 107 | 111 | 111 |
| Deli Meat [1] | 119 | 108 | 106 | 105 | 104 | 106 | 107 | 108 | 111 | 106 | 110 | 110 | 107 |
| Deli Prep [1] | 65 | 66 | 69 | 69 | 74 | 75 | 77 | 78 | 83 | 78 | 83 | 81 | 82 |
| Floral | 75 | 100 | 103 | 89 | 107 | 107 | 103 | 102 | 121 | 110 | 115 | 113 | 112 |
| Meat [2] | 157 | 157 | 149 | 132 | 125 | 124 | 124 | 116 | 135 | 114 | 121 | 123 | 131 |
| Produce [2] | 126 | 119 | 119 | 117 | 115 | 115 | 117 | 111 | 118 | 106 | 111 | 113 | 113 |
| Bakery [2] | 116 | 110 | 110 | 108 | 107 | 107 | 109 | 105 | 115 | 106 | 108 | 109 | 113 |
| Seafood [2] | 140 | 140 | 152 | 150 | 153 | 149 | 147 | 126 | 170 | 147 | 135 | 144 | 155 |

A.

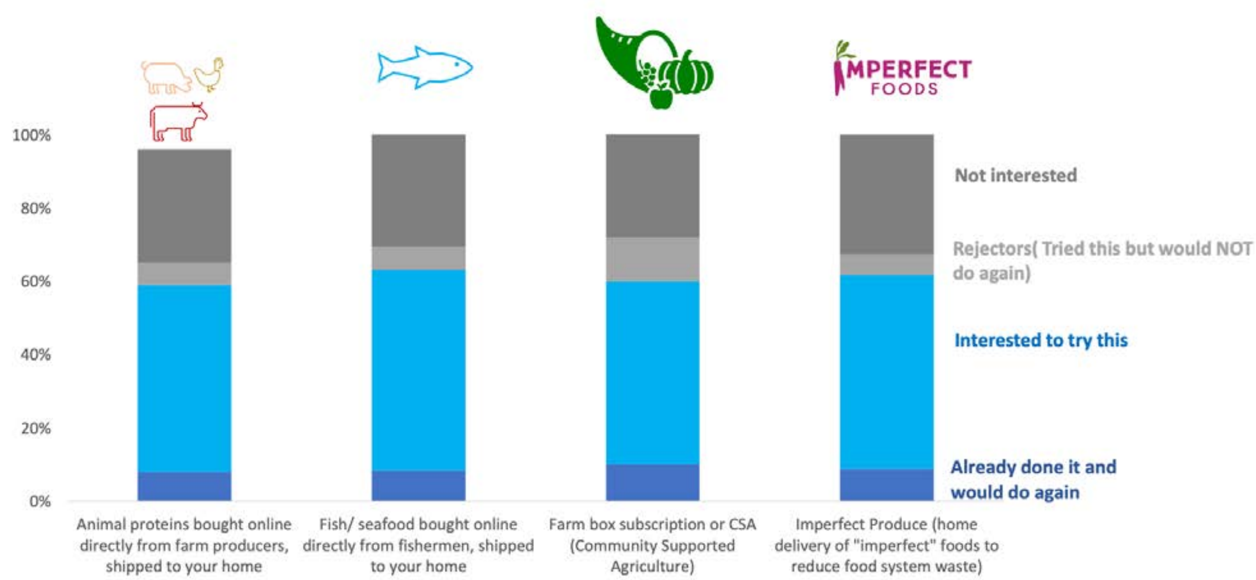
Luckily for smaller ports such as Port Orford, Ilwaco, Garibaldi, and others, which are often remote communities that are unlikely to compete with major processors at the national scale–consumers have also started to shift their buying preferences within seafood just as they have in other sectors. Many people across the country are no longer looking to purchase only the cheapest seafood available to them. Rather, they have begun to demonstrate willingness to pay extra for local, fresh seafood that aligns with their beliefs and priorities.

*Figure 5: Consumer values in chicken and fish purchases*[1]




B.

*Figure 6: Consumer attitudes toward direct-to-consumer models*[1]



What this suggests specifically for the fishermen and fish workers of coastal communities is that there's a real opportunity to target sales directly to local consumers and build a campaign around a local "brand" of fresh-caught, sustainable seafood.

# VII. DIVERSIFICATION GUIDE AND MODEL

### C. <u>Introduction to the Guide</u>

Although some of the situations in the Pacific Northwest are unique to the region, the uncertain future the industry faces in light of climate change is not. Across the world, shifts in stock abundance are already being seen as a result of changing ocean temperatures and sea level rise. Each fishing community in the US faces its own unique challenges and must first assess the mix of species they rely on to determine if changes should be made. But in many cases, increasing the number of fisheries as well as the unit value and profitability of fisheries that the individual businesses and the local fishing fleet as a whole are invested in is crucial to ensuring fishermen can adapt their fishing activities to match the biological and market opportunities available to them.

This diversification guide is intended to create a roadmap for fishing communities to plan for their future and preserve a coastal fishing economy that benefits fishing families and community stakeholders in the face of growing climate, market, and management challenges. It is organized as a step-by-step guide, with phases (defining the challenge and opportunity, developing a strategy, establishing key partnerships, setting up an organization, raising capital for the strategy, and building community) encompassing chronological steps that are further broken down into goals and specific outcomes for communities to focus on. By the time a community has walked through each of the phases outlined in this guide, they will have a robust plan for fisheries diversification and a strong idea of how to carry that plan out.

The full Diversification Guide is available at Appendix XX.

### D. <u>Introduction to the Model</u>

The diversification model is intended to be used as an illustrative tool for fishermen, port commissions, and other interested parties to assess how their existing portfolio and a hypothetical portfolio will behave in each of the four scenarios outlined above as well as a custom scenario of their own design. It is intended to show general trends in fisheries and provide a tool for users to think about their best pathway to creating resilient fishing businesses that are well-positioned to weather future climate change events. It relies on historical inputs including landing volumes, prices, margins, and other information which can be provided at the port/organizational level or at the individual fishing business level. The communityoriented approach outlined in the Diversification Guide also provides a good framework for communities to fill out the model with an eye to their specific circumstances. The model has instructions included, and we have provided a sample case model for Port Orford as a guide for what a completed model could look like.

The model is available in Appendix XX, and a completed case model for Port Orford is available in Appendix YY.

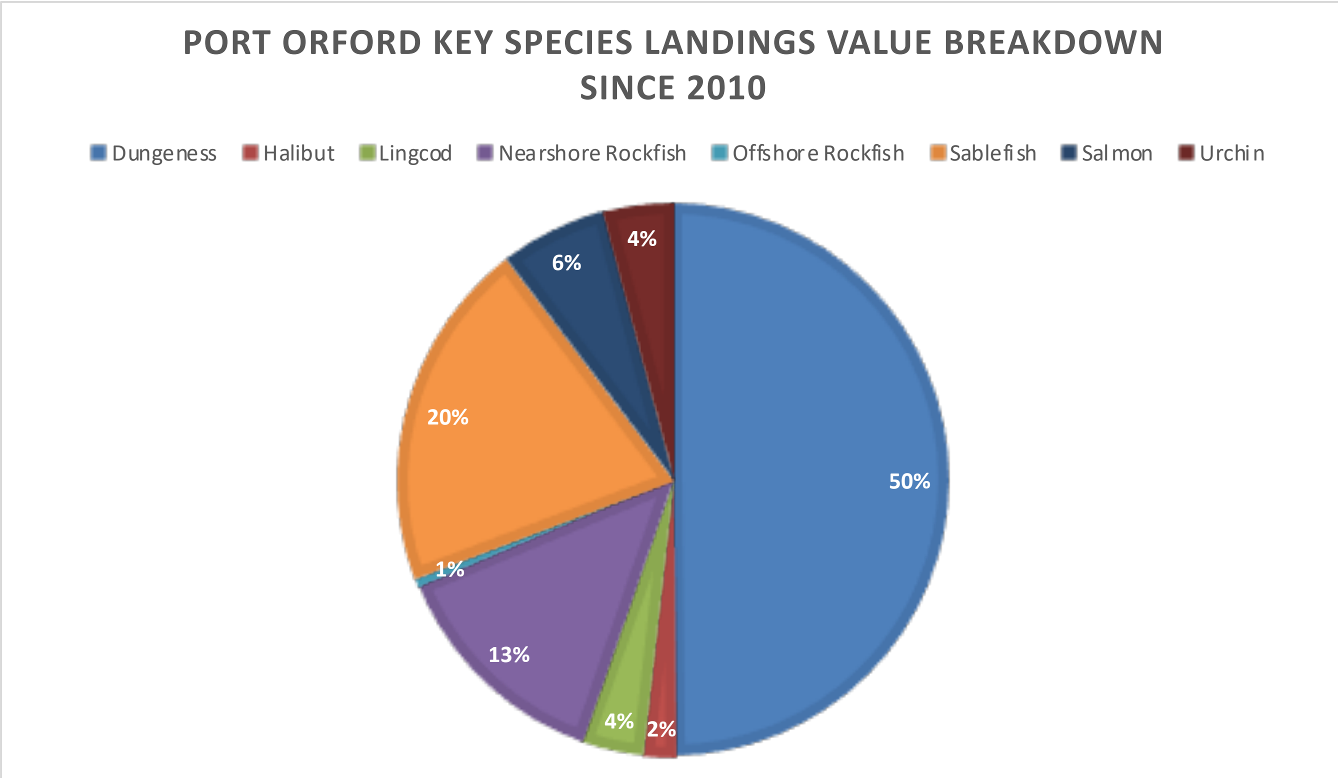
# VIII. PORT ORFORD: CASE STUDY

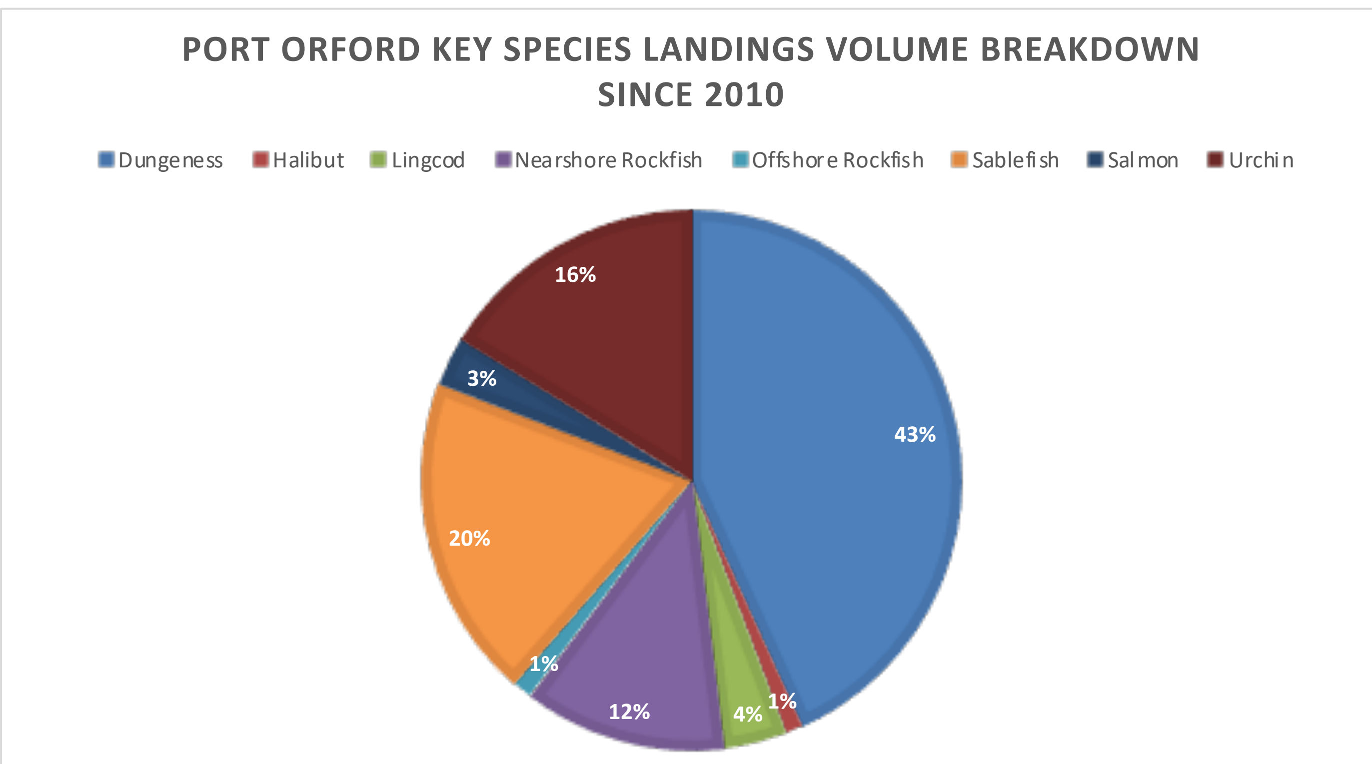
## INTRODUCTION TO PORT ORFORD

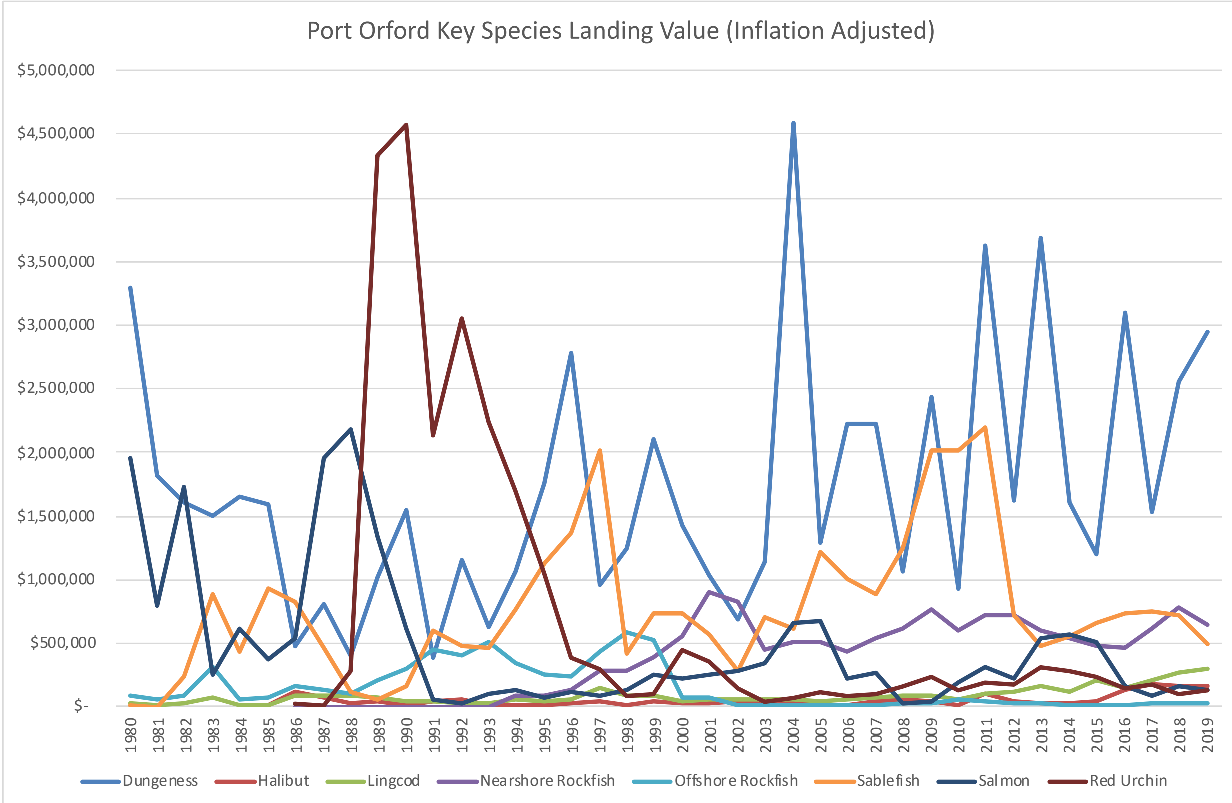
Port Orford is a unique fishing port located on the southern Oregon coast. Situated immediately adjacent to a marine sanctuary and a highly productive upwelling area on the continental shelf, fishermen from Port Orford are able to utilize marine resources in ways specific to their location, including live holding tanks dockside that also support algae and urchin mariculture. The port also faces a unique set of challenges as one of only two "dolly docks" on the West Coast, where all vessels are hoisted out of the water after every fishing trip. This has led to the development of a fleet of small vessels uniquely adapted to operate out of Port Orford that holds over 35% of the nearshore groundfish permits in the state. In order to demonstrate the applicability of the above diversification guide and model, we have worked closely with the community of Port Orford to apply them in real life. While small, the community has some significant players including the Oregon State University research station located onsite. Additionally, Port Orford is attempting to revitalize their port, with significant infrastructure investments from players including the Army Corps of Engineers and the DOT.

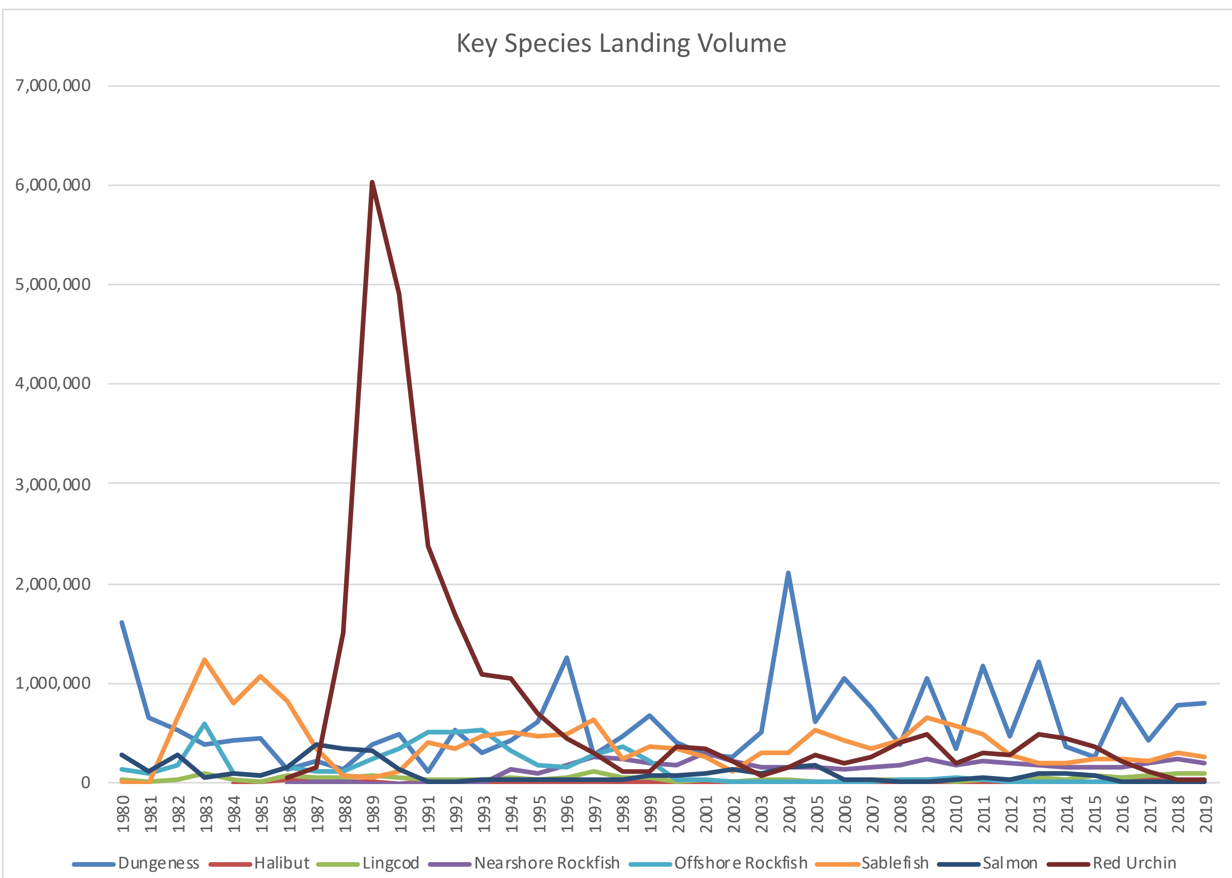
**Key Fisheries**

Traditionally, Port Orford has relied on 4-5 key fisheries to support their fleet. Today, the leading fisheries are Dungeness crab, Sablefish (black cod), groundfish species (including nearshore and offshore rockfish, lingcod, and halibut), salmon, and urchin. Historically, salmon and urchin have played a much larger role in the Port Orford economy than they do now, however in the early 90s, both species experienced a precipitous decline in value which neither has recovered from. Additionally, several species have been seeing an increase in landing volumes and value, or are the focus of interest as potential targets for fisheries diversification, including market squid and albacore tuna.

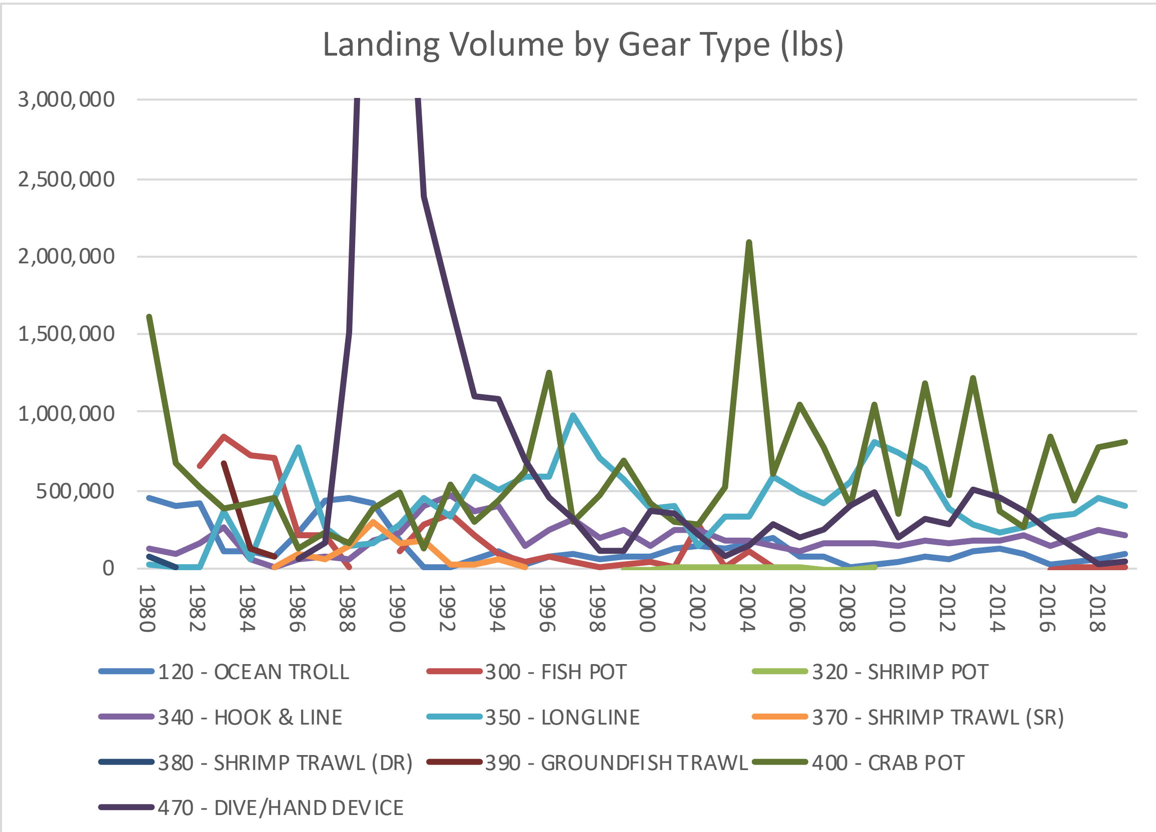

PORT ORFORD KEY SPECIES LANDINGS VALUE BREAKDOWN SINCE 2010
Dungeness
Halibut
Lingcod
Nearshore Rockfish
Offshore Rockfish
Sablefish
Salmon
Urchin
50%
2%
4%
13%
1%
20%
6%
4%

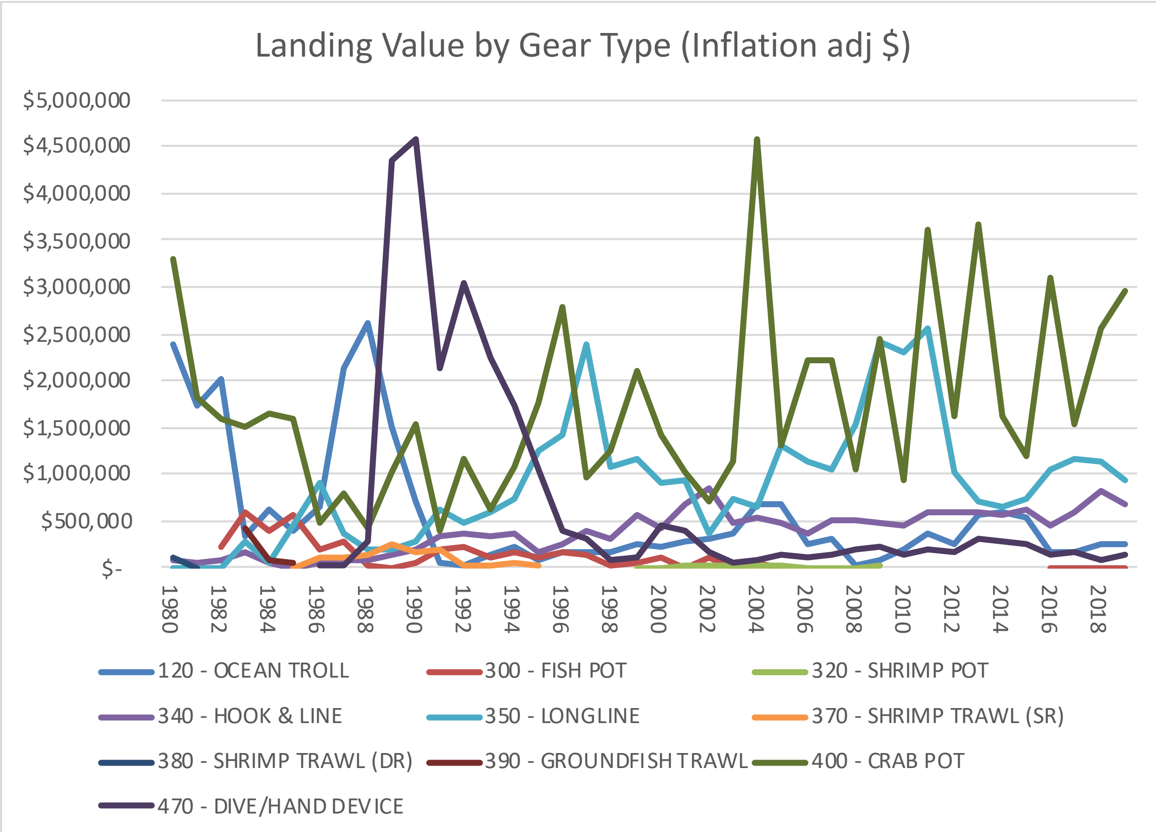

PORT ORFORD KEY SPECIES LANDINGS VOLUME BREAKDOWN SINCE 2010
Dungeness
Halibut
Lingcod
Nearshore Rockfish
Offshore Rockfish
Sablefish
Salmon
Urchin
43%
1%
4%
12%
1%
20%
3%
16%

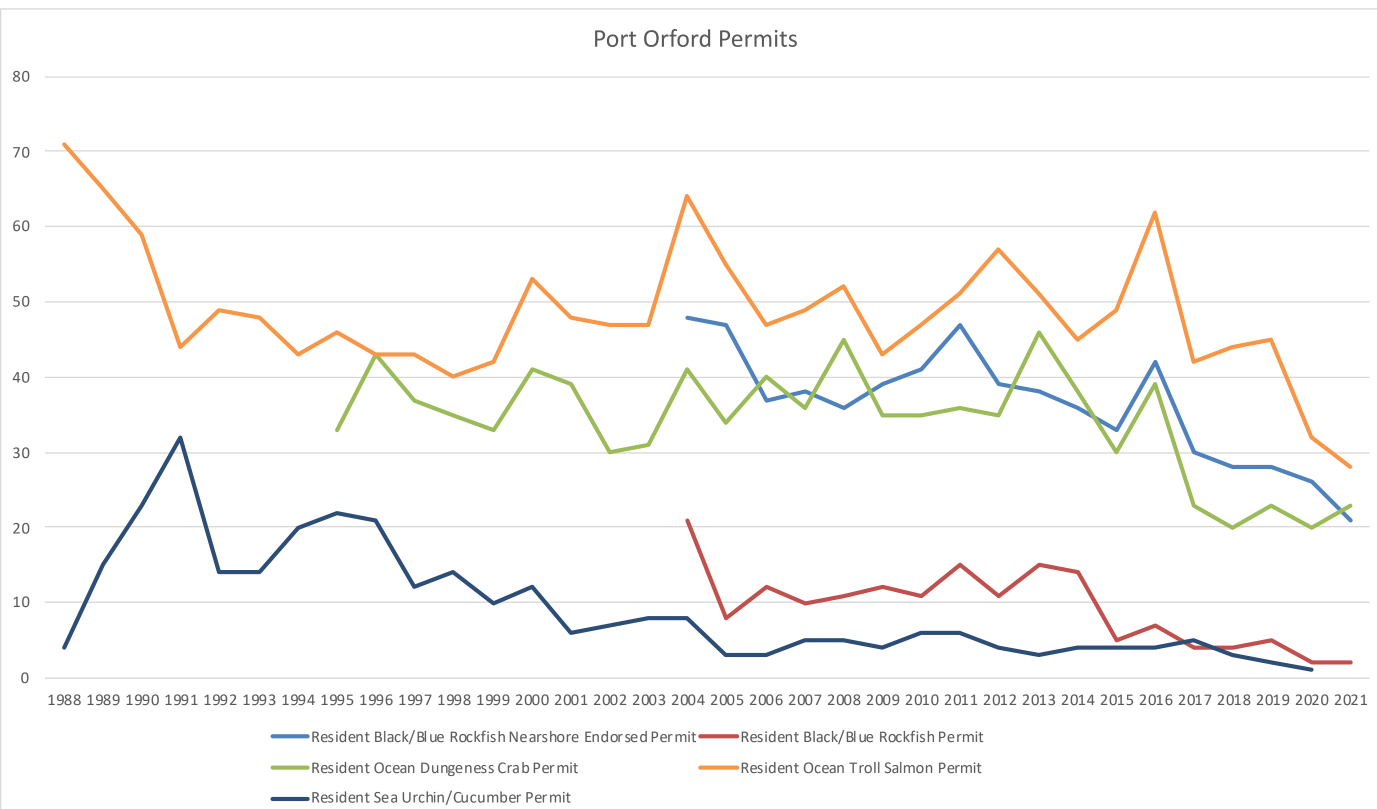

Port Orford Key Species Landing Value (Inflation Adjusted)
$5,000,000
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Dungeness
Halibut
Lingcod
Nearshore Rockfish
Offshore Rockfish
Sablefish
Salmon
Red Urchin


Key Species Landing Volume
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Dungeness
Halibut
Lingcod
Nearshore Rockfish
Offshore Rockfish
Sablefish
Salmon
Red Urchin

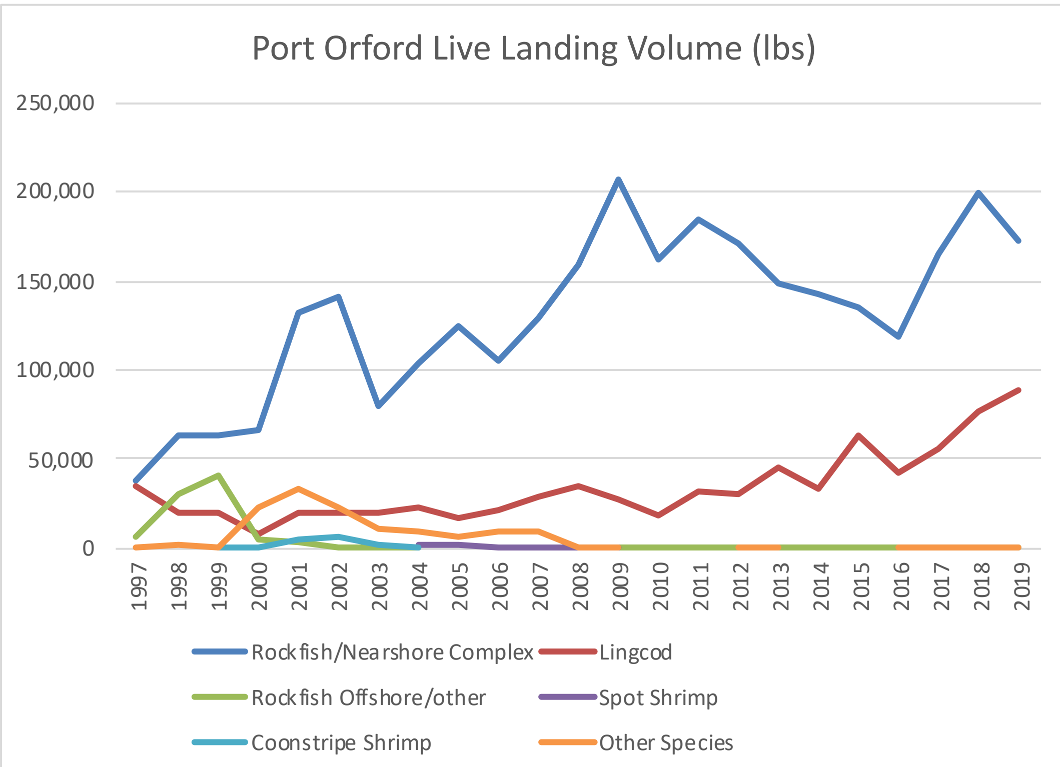
The fleet in Port Orford primarily revolves around fixed gear such as crab pots, longline vessels, and hook and line fishers, including trollers. As seen in figures X and Y, these gear types account for the vast majority of landings in the port. Over time, the number of permits registered in Port Orford has largely been on a declining trend, however the data in figure Z is meant to be illustrative of a trend, not display actual number of permits in the port, as ODFW data only collects the address where the permit is registered, and therefore is missing several permits which are registered to addresses outside Port Orford.

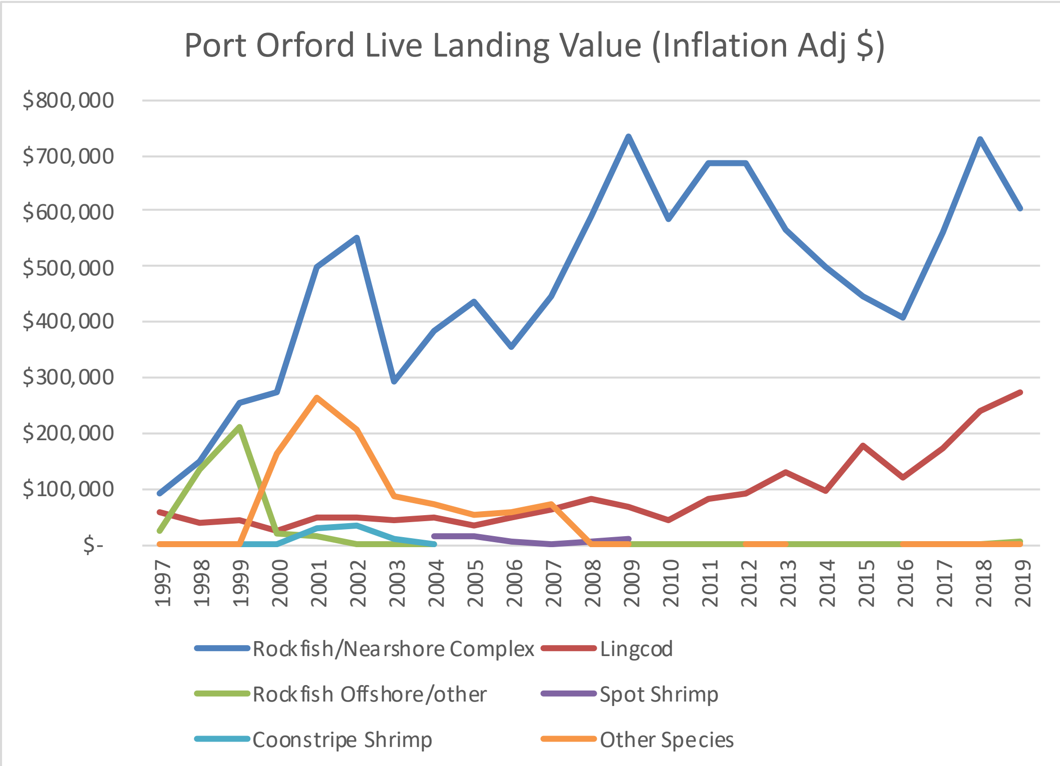



Landing Value by Gear Type (Inflation adj $)
$5,000,000
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
120 - OCEAN TROLL
300 - FISH POT
320 - SHRIMP POT
340 - HOOK & LINE
350 - LONGLINE
370 - SHRIMP TRAWL (SR)
380 - SHRIMP TRAWL (DR)
390 - GROUNDFISH TRAWL
400 - CRAB POT
470 - DIVE/HAND DEVICE


Port Orford Permits
80
70
60
50
40
30
20
10
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Resident Black/Blue Rockfish Nearshore Endorsed Permit
Resident Black/Blue Rockfish Permit
Resident Ocean Dungeness Crab Permit
Resident Ocean Troll Salmon Permit
Resident Sea Urchin/Cucumber Permit

One unique aspect of Port Orford is the prominence of live fish landings, especially for rockfish and lingcod. Since ODFW started tracking live landings numbers in 1997, live rockfish and lingcod landings have gone from a fractional share of their respective fisheries landing volume and value to dominating both fisheries. Since 2010, live rockfish has accounted for over 80% of landing volume and over 90% of landing values, with lingcod averaging above 80% for both metrics as well. This shows evidence of fishermen maximizing the value of their unique assets, however it also indicates that future action to further increase landed value per lb may yield diminishing returns.






**Fleet Size**

Port Orford is the homeport for approximately 50 vessels.

**Buyers**

In Port Orford, across the Oregon coast, and indeed all around the nation, seafood markets are changing. The most obvious influence in recent months has been the COVID-19 pandemic, which had significant impacts on Port Orford fishermen as Dungeness crab trade to China was suspended, along with live fish and sea urchin markets. Particularly in the Pacific Northwest, where the seafood market is dominated by a few major actors, it became difficult for local consumers to purchase seafood as food supply chains shut down. These intense pressures prompted the port to build an open a dockside seafood market and online marketplace to allow Port Orford fishermen to market their own catch directly to local consumers.

Port Orford has three primary buyers: Hallmark Fisheries, NorCal Fisheries, and Port Orford Sustainable Seafood (POSS). Hallmark is a small-medium sized buyer active in several Oregon ports and based out of Charleston. They focus on West Coast staples such as salmon, Dungeness, sablefish, and other groundfish, and deal primarily in the fresh and frozen market.

NorCal is a specialized live-fish buyer which constitutes the core of the live market in Port Orford, focusing on transporting live rockfish and lingcod to ethnic markets in the Bay Area. POSS is focused on a CSF model serving local consumers, however they are also exploring with more direct sales.

**Port Orford Problem Statement:**

The Port of Port Orford is at a crucial nexus point in their history, on the cusp of reinvesting in their port infrastructure at a time when there are many questions about the future of fisheries. The Port is facing a decline in traditional fisheries such as salmon, while the future of other key fisheries like crab and rockfish are unclear. At the same time, infrastructure and capital limitations have been driving key access rights out of the community. As the Port considers its future direction, there are several key challenges and problems that it must consider regarding economic diversification, infrastructure, fisheries regulations, changing demographics and climate, and how social norms and capital providers intersect in fisheries:

**Port Infrastructure**

First, the port infrastructure revolves around a unique dolly dock system, which limits vessels to no more than 42' and 22.5 Tons, or 45,000 lbs. This creates a key bottleneck in vessel size that must be considered when evaluating diversification options and creates an incentive for successful fishermen to leave the port if their business needs to increase vessel size to one too big for the dock to handle. The port is planning investments to address this by reconfiguration of dock infrastructure, but this will take time.

**Fisheries Regulations**

The bulk of existing fisheries value in Port Orford is focused on 3 primary fisheries: Dungeness crab, nearshore rockfish, and sablefish comprising around 90% of fisheries value over the past 20 years, with past powerhouses like salmon and urchin at fractional levels of their former activity. This creates another challenge, as there are limited numbers of all three permit types and the regulatory landscape is complex. For example, sablefish permits are federally managed and have multiple different access categories and permit tiers; nearshore rockfish are a relatively limited permit class, and Port Orford fishermen already hold more than 40% of the nearshore permits; Dungeness crab permits are expensive, tiered by number of pots allowed, and are unable to be held by a third party in Oregon. These regulatory structures limit the flexibility of permit and quota-based diversification strategies.

**Access to Capital**

Finally, because there are few to no local sources of capital, fishermen often find themselves in a compounding cycle that results in a large portion of the fleet being un-banked. This in turn results in assets leaving the community and difficulty for local fishermen to diversify their holdings. Fishermen often view vessel insurance and strict adherence to tax law as expensive costs without a clear benefit to them. As a result, even if there were to be a local capital provider, fishermen would need to change their operating procedures to qualify for lending programs. Therefore, when fisheries assets in Port Orford come up for sale, often times highliners or vertically integrated organizations in major ports like

Newport are able to offer cash up front, while fishermen in Port Orford often have to work out a gentlemen's agreement with the seller to pay them back over time for the assets in order to keep them local. This often incentivizes retiring fishermen to sell assets outside of the community for financial stability considerations. Additionally, fisheries assets are not always valued rationally and may be overpriced. As a result, the yields that they produce may not support debt service obligations even if fishermen are able to secure a loan. This results in fisheries assets like permits, quota, and vessels gradually migrating away from the port.

**Port Orford Diversification Goals:**

After compiling and analyzing historical landings data and having a series of discussions with Port Orford fishermen, we have created a case study diversification model and several interventions for fishermen. Overall, the overarching goals for any fisheries diversification efforts should include targeted activities that ameliorate the challenges or inherent weaknesses identified above in the problem statement. For Port Orford, this means providing the necessary environment for successful fishermen to scale up their operations locally, increasing the sales channels available to fishermen, anchoring value-added activities in the community, increasing access to capital and/or fisheries access rights for local fishermen, and fostering new revenue streams for fishermen both in new fisheries like squid and new activities like data collection, For a full overview of five model fisheries interventions in Port Orford, See Appendix XXX. The case study Port Orford intervention is available in Appendix XXY.

# IX. APPENDICES