Oregon
Kate Brown, Governor

Department of Fish and Wildlife
Charleston Field Office
63538 Boat Basin Dr.
P.O. Box 5003
Charleston, OR 97420
(541) 888-5515
FAX (541) 888-6860

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To: Chris Kern ODFW Salem, Caren Braby, Dave Fox and Steve Rumrill MRP Newport

From: Scott Groth, MRP Charleston

Subject: Memo regarding shrimp season opening date issues.

Executive Summary

Dynamics of Oregon's pink shrimp, *Pandalus jordani,* fishery have changed over time and season start date should be considered accordingly to meet modern social, biological and economic conditions. Fishing season begins April 1 and closes October 31 annually (unchanged since 1972). Historically, the season has been characterized by the majority of vessels starting fishing synchronously, although not often starting at the April 1 regulatory start date. In recent years, the season has been characterized by decreasingly synchronous starts (i.e. some vessels fishing while others are waiting for as long as two months) based on industries' varied interpretation on the best time to begin fishing. Biologically, early season catch may have negative effects (e.g. catch of gravid shrimp) and increases catch of small shrimp which can result in rules violations and wastage. A 2004 study showed that a later season start date increases the value of the fishery in most scenarios dependent on monthly growth, natural and fishing mortality rates (Gallagher, Hannah and Sylvia 2004). Based on research, fleet interactions and literature review, modifying the season start date is likely to have positive effects on social, biological and economic aspects of Oregon's pink shrimp fishery.

In recent years, several members of Oregon's pink shrimp industry have requested consideration of start date modification, due to trends in fishery dynamics. In response, two surveys were administered to Oregon pink shrimp permit holders. A 2019 Oregon Trawl Commission (OTC) and a 2020 ODFW survey showed similar results. In both, a majority of Oregon permit holders (65 and 58%, respectively) preferred a later start date with strong support from south and central coast ports, whereas north coast permit holders preferred status quo (Groth et al. 2021). Accordingly, California shrimpers are generally in favor of a season start date change and Washington shrimpers are generally for status quo.

While support for a season change outweighs status quo, there is strong minority opposition and legal hurdles to negotiate. Many shrimpers have voiced opposition citing the loss of precious fishing time to the extent that they have traveled to distant OTC meetings to be heard. The current season dates in Washington and California would also have to be considered and their interest in such a change appears variable.

Staff Recommendation

ODFW staff recommend the annual start date of Oregon's pink shrimp fishery to change from April 1 to May 1 for social, biological and economic reasons.

Background

Pink shrimp, *Pandalus jordani*, is a small shrimp endemic to the Northeast Pacific Ocean. Pink shrimp live short lives (up to 4 years) and are found on sand and mud bottoms along the continental shelf at depths of 110-183 meters (Dahlstrom 1970). Recruitment is environmentally forced, where oceanographic conditions determine recruitment levels primarily, while spawner abundance, predator abundance and anomalous climate conditions are also factors (Hannah 1993, Groth and Hannah 2018, Hannah 1995, Hannah 2011). Pink shrimp are protandrous, sequential hermaphrodites, maturing first as males then transition to female depending on demographic conditions (Charnov and Groth 2019).

Pink shrimp are an important fishery target; they are Oregon's second most valuable commercial fishery, valued at approximately 25 million dollars per year (ex-vessel, 2011-2020) and is managed as a sustainable fishery (MSC 2021). Oregon is central to the West Coast Pink Shrimp Fishery; however, Washington and Northern California are important fishing areas and ports. An average of 69 large vessels (50-80') participate in Oregon's fishery each year, landing an annual average of 39.7 million pounds into Oregon (2011-2020). Fishing is performed exclusively by semi-pelagic trawl. Pink shrimp are sold on international and domestic markets as "cold water shrimp" and compete with an Atlantic species (*Pandalus borealis*) which is typically 75-85% of the total market share of this group.

Management regulations for pink shrimp aim for maximum value and sustainable yield, providing a stable regulatory environment, and preventing overfishing while minimizing bycatch. Fishing season dates (April 1 to October 31) minimize catch of gravid (egg bearing) shrimp while size regulations (160 shrimp per pound in aggregate) minimize catch of age one shrimp in the first months of the season when they are especially small and less valuable. Recognizing environmentally forced recruitment, combined with effects of low spawner abundances, targets and limits used in management depend on ocean conditions and employ seasonal delays to conserve spawners during specific situations, typically encountered in El Nino conditions (Hannah, Jones and Groth 2018). Bycatch is minimal (2-5%; (Groth et al. 2020)) given the use of two types of bycatch reduction devices: Rigid grates (aka BRDs, shrimp grates, excluders, etc.) provide physical exclusion of larger animals (Hannah and Jones 2007) and LED fishing lights prevent net entrainment of many fish species (Hannah, Lomeli and Jones 2015, Lomeli et al. 2018, Lomeli et al. 2019). A Fishery Management Plan (FMP) sets targets and limits to assure sustainability of catch; however, does not heavily consider economics of catch (Hannah et al. 2018). Regarding management authority, Oregon's Fishery Conservation Zone (FCZ) (ORS 506.755) assumes Oregon's management of marine fisheries resources 50 miles seaward from shore. Pink shrimp is a state managed fishery, which occurs primarily outside of state waters (3 miles from shore), and FCZ rules (50 miles from shore) would give Oregon authority to manage areas seaward of Oregon independent of other states.

Results and Discussion:

Here, I'll describe each of these three factors and provide quantitative analysis of each issue.

Social:

Social issues are key to orderly fishery management. In Oregon's pink shrimp fishery, synchronicity of the start of fishing has caused division among industry members. A later start date will contribute to a more synchronous start to fishing, relieving some social tension. A season start date change in Oregon will add complexity to the regional management of pink shrimp where California and Washington would decide separately on the tenability of status quo.

Synchronous Start

Changes in both the efficiency of the fleet and pricing structure have affected the tenability of an April 1 start date. Historically, the fleet gets off to a slow start, with full effort not occurring until the season has been open for a month or more (Figure 1). In recent years this effect has been exacerbated and most vessels have tended to wait until May or June to begin fishing (Figure 2). This recent delay appears to be driven by market conditions such as split pricing (market demand for larger shrimp) and competition with international markets.

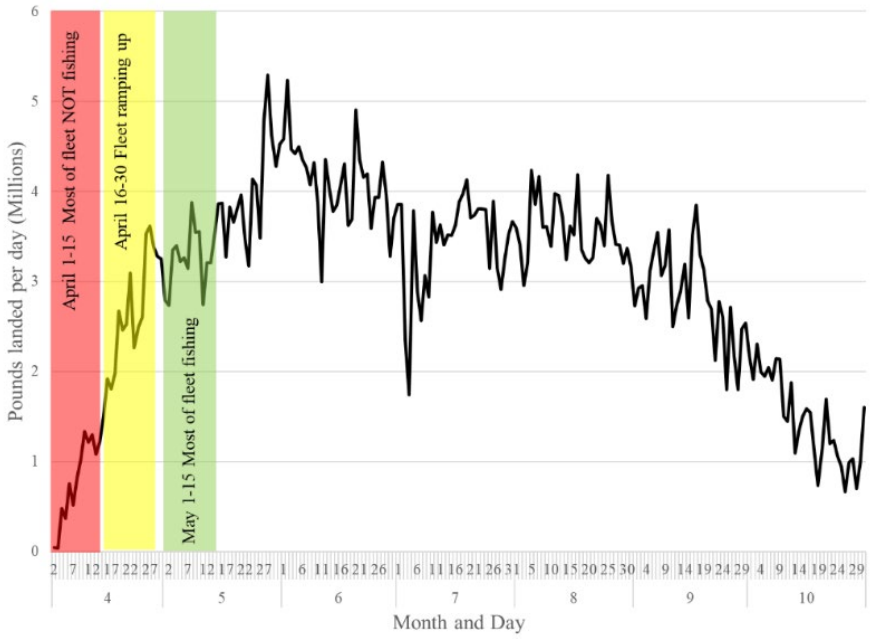

Figure 1. Catch of pink shrimp (Pandalus jordani), delivered to Oregon ports, by month and day (2000-2019). Note that the fishery tends to start slowly, often awaiting egg release and price negotiations.

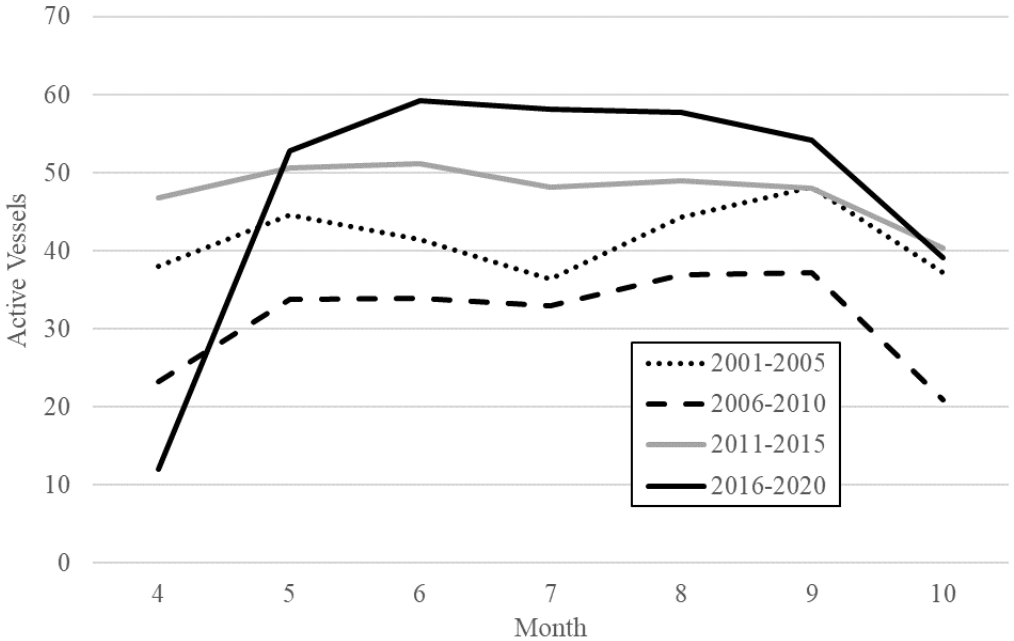

Figure 2. Active vessels fishing for pink shrimp (Pandalus jordani) per month by 5 year period (2001-2021), in Oregon. Note: low amount of vessels active in April in recent years.

Interstate issues

If Oregon were to modify the season start date, this would occur independently of California and Washington whose current season start date is April 1. California Department of Fish and Wildlife (CDFW) has conducted a series of meeting with shrimpers regarding rules modification at which shrimpers have expressed wide support for a later season start date. Washington Department of Fish and Wildlife (WDFW) are in the process of developing a survey aimed at understanding the opinions of Washington shrimpers in 2021; however, many have expressed their desire for status quo.

Overall, the issue of season start date has an interesting geographic split, where the general tendency is for northern shrimpers to prefer status quo, but for central and southern shrimpers to prefer a change. The difference of opinion by geography appears weighted by the fishing permit portfolios of northern versus southern shrimpers, where the former has a narrower portfolio (e.g. many with only a shrimp permit) and the latter has a wider portfolio (e.g. many with groundfish trawl, crab, etc). This juxtaposes the fact that shrimp grow slower as latitude increases, making northern shrimp tend to grow slower, resulting in catch of smaller shrimp. Last, gravid shrimp are rarely found in northern areas in April, however northern shrimp become gravid earlier in the fall.

Biological

Biological issues involve sustainability (e.g. spawner escapement) of catch, but are also tied to economic and social issues (e.g. wastage and discard). Catch of gravid shrimp, waste of shrimp via direct discard and sorting, bycatch and climactic change issues are discussed.

Gravid Shrimp

The current season start date (April 1) was set in 1972 to protect gravid (egg-bearing) female shrimp, limiting the effect fishing may have on reproductive potential. One to three percent of April catch is comprised of gravid shrimp and is skewed to southern areas. Eggs are released rapidly and are nearly all extruded by May (Figure 3). Catch of these gravid females has biological consequences, particularly in years of low spawner abundances (Hannah 1999). Spawner abundance affects recruitment in southern areas is greater than in northern areas (Groth et al. 2021).

Protection of gravid shrimp in April is a key component of Oregon's Pink Shrimp Fishery Management Plan, which employs a season delay in low abundance years (Hannah et al. 2018). A later season date would afford increased protection to these gravid shrimp.

An additional consideration is the number of gravid shrimp caught at the end of the season (September and October). At that time, a high percentage of gravid shrimp are caught; however, have less value to the spawning stock than April gravid shrimp (less mature eggs, which have not survived winter).

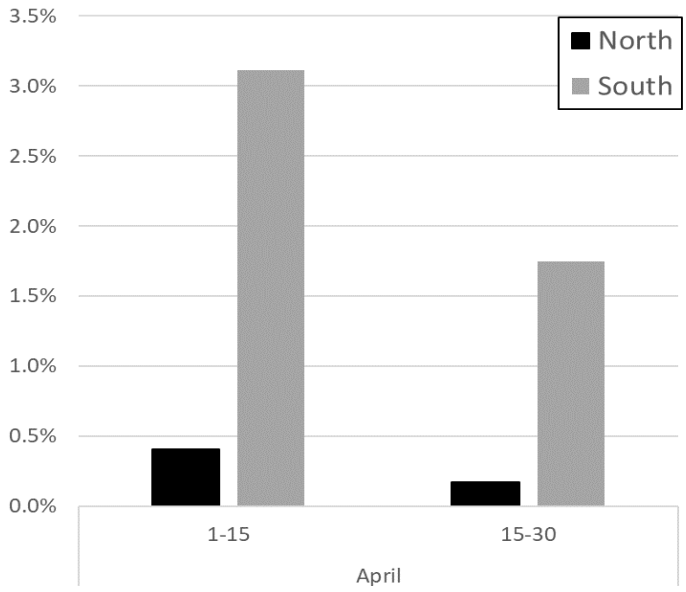

Figure 3: Percentage of egg-bearing shrimp in April from Oregon samples, separated by North and South using Heceta Head, OR, 2003-2020.

Count-per-pound Problems

Conventionally, shrimp size is described as the number of individual animals per pound, count-per-pound (CPP), where the higher the count, the smaller the shrimp. Legal catch must be lower than 160 shrimp per pound across the landings catch. Early season catch often does not meet legal count-per-pound (CPP) requirements given the difficulty of finding age two and three shrimp combined with the small size of age one shrimp at that time. While on average the fleet is below the 160 CPP threshold, the percentage of biological samples that are greater than 160 CPP is greatest in April and May (Figure 4). Moving the season start date to May 1 would reduce the amount of small shrimp caught in the early months of the fishery. This would allow the small age one shrimp to grow to a size where they will be more valuable and there should be less landings that do not meet legal CPP requirements.

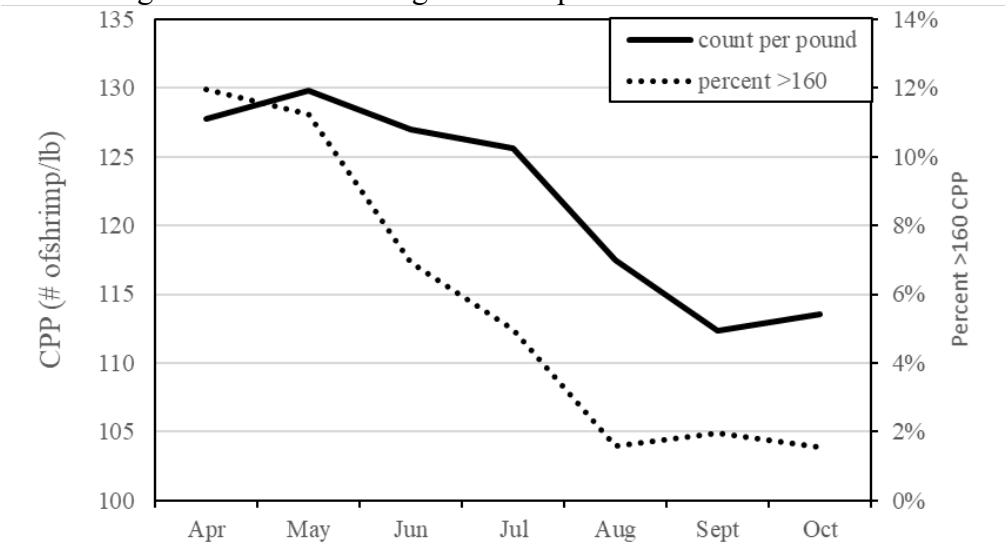

Figure 1. Mean count-per-pound (CPP) and percentage of samples greater than 160 CPP from biological samples of pink shrimp (Pandalus jordani) in Oregon 2000-2020.

Shrimp Discard

Discarding shrimp (aka "Dumping") at-sea occurs when catch of high CPP shrimp is expected to affect the legality of the total catch of the trip. Shrimp discard is expected to result in high mortality (i.e. wastage). Discard of shrimp is legal; however, industry and management alike consider this a wasteful practice to mitigate count-per-pound issues. Shrimp discard occurs mainly in the first months of the season, when the fleet switches from older shrimp to age one shrimp (May and June). Discard rates are low in April, since age two and three shrimp are easier to find, then again in July-October, since age one shrimp are legal size in their own right (Figure 5). A later season start date would in turn delay this transition of size/age catch targets, likely reducing discard via the availability of larger shrimp allowed to avoid fishery mortality an additional month.

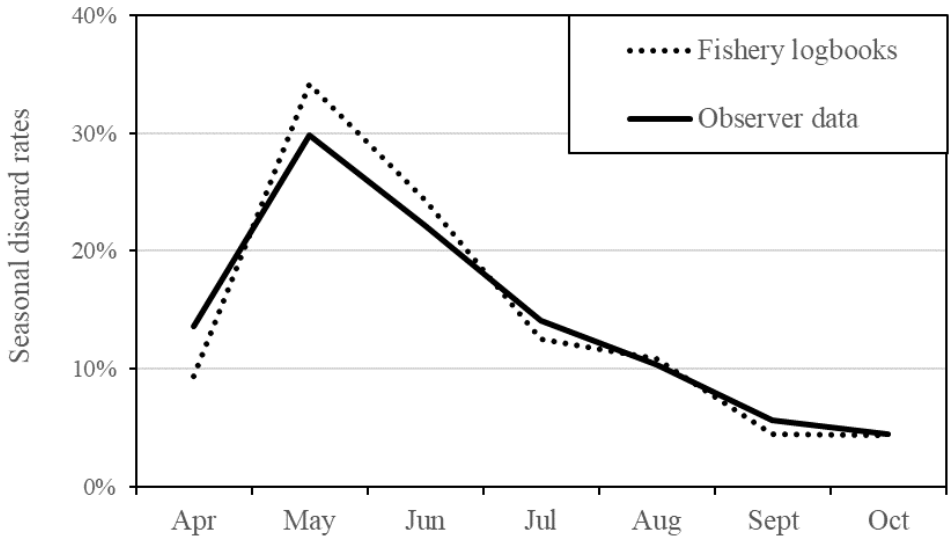

Figure 5. Percentage rates of seasonal discard of pink shrimp (Pandalus jordani) by month using fishery logbook data (2008-2020) and observer data (2004-2018). Note that total shrimp discard in a year is estimated to be 2% of season catch (from observer data).

Targeting and Sorting

To reduce the catch of small shrimp, two methods are employed: 1) avoidance of areas of small shrimp and 2) physical at-sea sorting of shrimp. The first method (area avoidance) causes no wasteful mortality of shrimp; however, is less likely to be employed when only small shrimp are available. Often, large volumes of small shrimp are available while areas with larger shrimp are less efficient (i.e. lower CPUE). The second methods (physical at-sea sorting) is employed by on-deck sorting (e.g. sorting machines or hopper modification) or use of larger net mesh sizes (allowing escapement of smaller shrimp that are more likely to slip through mesh). Both methods of at-sea sorting are legal; however, cause wastage of shrimp since the mortality of those methods is likely to be high. Using targeting and sorting are effective methods to improve CPP of catch but are not optimal for business practices or waste caused by fishing smaller sized shrimp.

Eulachon

Eulachon, *Thaleichthys pacificus*, are an anadromous smelt which are common bycatch to US west coast pink shrimp trawling and are listed as "threatened" under the Endangered Species Act (ESA). Reduction of bycatch of Eulachon has been an important goal of recent research and regulation change (Hannah et al. 2015, Lomeli et al. 2018, Lomeli et al. 2019, Groth 2018). While these efforts have been highly successful, consistent efforts to reduce fishery impacts to Eulachon populations is an ongoing.

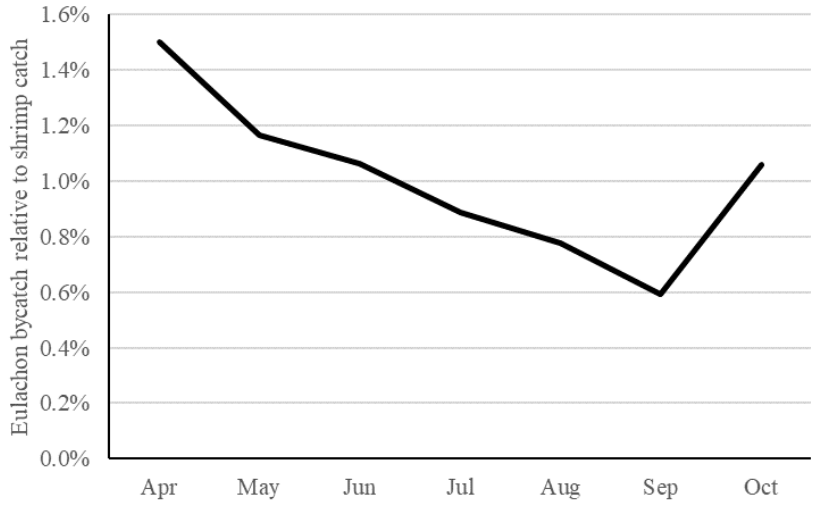

Figure 6. Eulachon bycatch relative to shrimp catch in Oregon's pink shrimp fishery 2004-2018, from NMFS observer data.

Eulachon bycatch is expected to fluctuate with 1) annual abundances of Eulachon, 2) shrimping effort rates, and 3) gear modifications.

ODFW has implemented the use of bycatch reduction devices (i.e. "Eulachon optimized" rigid grates and LED fishing lights); however catch of shrimp and bycatch of Eulachon is also influenced by fishing line height (Hannah et al. 2011) which is not specified in regulation.

Analysis of NMFS observer datasets show seasonal fluctuation of Eulachon bycatch rates. Bycatch rates of Eulachon show highest catch rates in April (Figure 6); however, it is unknown if this is a result of "fishing down", fleet behavior, or Eulachon migration.

Climate change

Ongoing ocean condition changes (e.g. acidification, increasing temperature, etc.) are affecting the biology of many fished species. Climate change has had noticeable impacts on a similar shrimp, *Pandalus borealis*; their hatch timing and duration have modified in response to changing temperatures (Richards 2012, Koeller 2009). Pink shrimp biology is also affected by factors of ongoing climate change. Ocean acidification has negative effects to the development of invertebrates that have calcareous structures (Arnberg et al. 2013, Kroeker et al. 2013), including pink shrimp (Waldbusser pers comm). Studies evaluating effects of climate change on the reproduction and development of *P. borealis* found that fluctuating temperatures have a stronger negative effect than decreased pH (i.e. ocean acidification), but that local adaptation as a response to thermal variation is common (Ouellet 2017). Sea water temperature changes can affect metabolic rates, growth, food availability, and hatch timing/duration, in turn affecting catch abundance and composition. A later season start date may insulate pink shrimp from these potential changes by allowing for broader hatch timing, which appears a likely effect of ongoing climate change to shrimp.

Economic

The economic value of the shrimp fishery depends on two components: price per pound and total volume of catch. Allowing shrimp to grow to a larger size increases their price-per-pound; however, natural mortality affects total volume.

A later start date would improve the value of the fishery. In a 2004 publication, a later start date was shown to improve the economic value of the fishery in most scenarios. Since that time, key inputs used in that modeling (fleet efficiency and pricing structure) have changed in a way that would lend further to the economic gains of a later start date.

Bioeconomic Modeling:

A 2004 paper reviewed the differences in yield and fishery value using several scenarios in season volume and natural mortality. The model considered shrimp growth and pricing structure. Briefly, the results showed that an early season start was optimal for total volume; however, later season starts were more economically valuable and required less effort (Gallagher et al. 2004).

A revision of this model is underway; however, not immediately available. It would be expected that an updated model would lend further support to a later season start date. Increased disparity of split pricing (where larger shrimp have become more valuable relative to smaller shrimp) combined with the increased fleet efficiency since 2004 would add to the economic gains predicted by that analysis.

<u>Age and Growth:</u>

In their first year, pink shrimp are small, but grow quickly. Typically, age one shrimp are high CPP in spring months, but of legal size by summer (Figure 7).

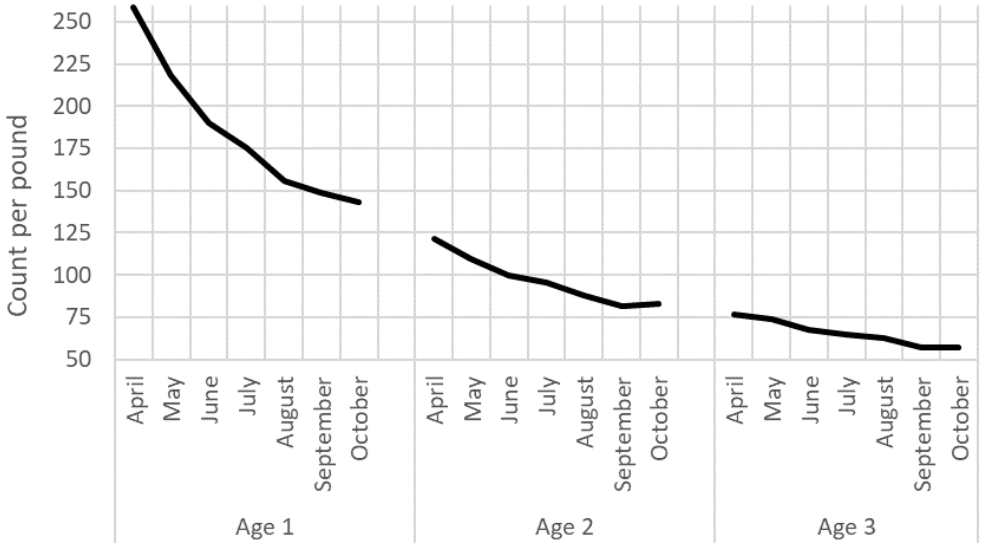

Figure 7. Predicted size (expressed in CPP) of pink shrimp (Pandalus jordani) by age from biological samples, 2008-2019, in Oregon.

The typical scenario for the fishery season is age two and three shrimp are fished down, then catch of age one shrimp become primary (Figure 8). The timing of this switch in targeted catch determines the level of CPP problems which can result in citations and/or dumping of large catches of small shrimp.

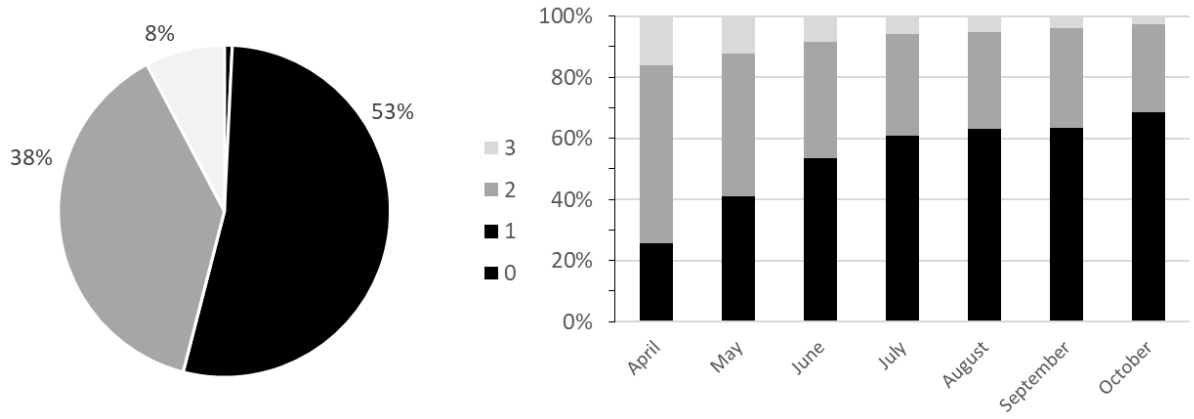

Figure 8. Number of pink shrimp (Pandalus jordani), by age in catch composition from biological samples 2008-2019, in Oregon. Note that age-one shrimp, by count (number of shrimp) are a smaller component of the fishery, early in the season, as the fleet works to avoid catching high percentages of smaller shrimp.

Conclusion

It's important to note that the main issues which industry is immediately concerned with are economic. Economic concern are driven by CPP issues, where the lower the CPP, the higher the price and lower the discard/wastage. CPP is driven by the timing of the switchover in fishing larger (age two and three shrimp) to targeting age one shrimp. A later season start date will delay this switchover, allowing rapidly growing, age one shrimp to become larger at the time of catch. The expected result of a season delay then would be lower count shrimp which would require less discard/wastage, producing higher prices and higher volume of large shrimp.

A season delay would affect shrimpers with a narrow fishing portfolio (i.e. only a shrimp permit) by reducing their time to fish. The current fishing power of the fleet is high and would be able to catch the

shrimp available within a season even with a reduced duration. This will likely cause a shift to a more valuable fishery overall, although it will favor more efficient vessels with wider fishing portfolios. There could also be potential coordination issues if Washington and California do not choose to delay their seasons.

A season delay would improve the sustainability of the fishery by reducing fishery impacts upon spawning stock, improving economic value, lowering discard, lowering effort, and allowing the Oregon fleet to have a more synchronous and orderly start.

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