30th Annual (diamond edition)

Oregon Department of Fish and Wildlife · Marine Resources Program

Pink Shrimp Review

2019

What's Inside

Have Questions?

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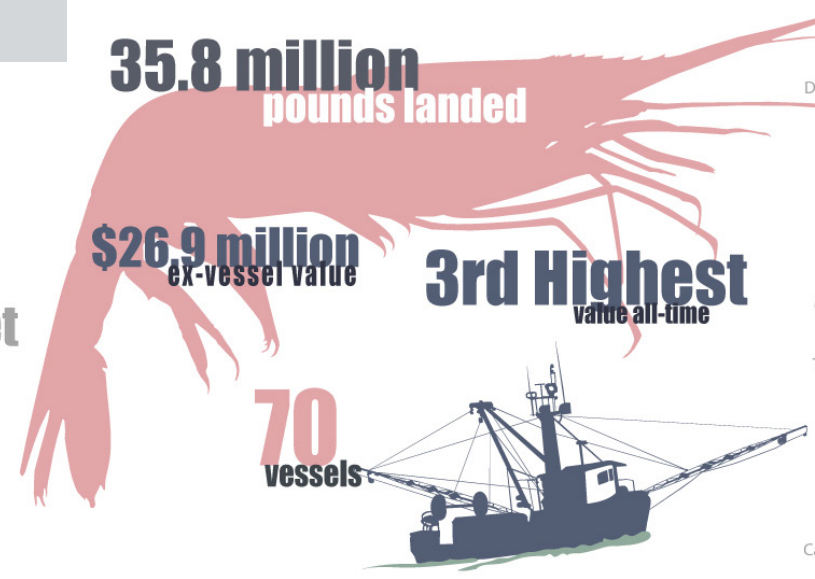
www.dfw.state.or.us/MRP/shellfish/commercial/shrimp

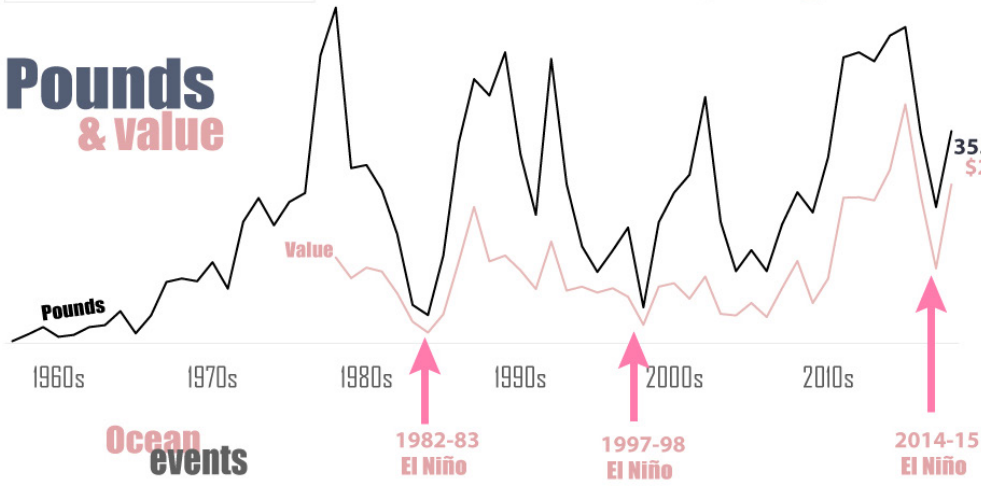
This newsletter provides a summary of Oregon's 2018 pink shrimp *Pandalus jordani*, season including trends in the fishery, its stock and information relevant to stakeholders. Oregon's pink shrimp fishery is managed sustainably via cooperation between fishermen, processors, scientists and managers.

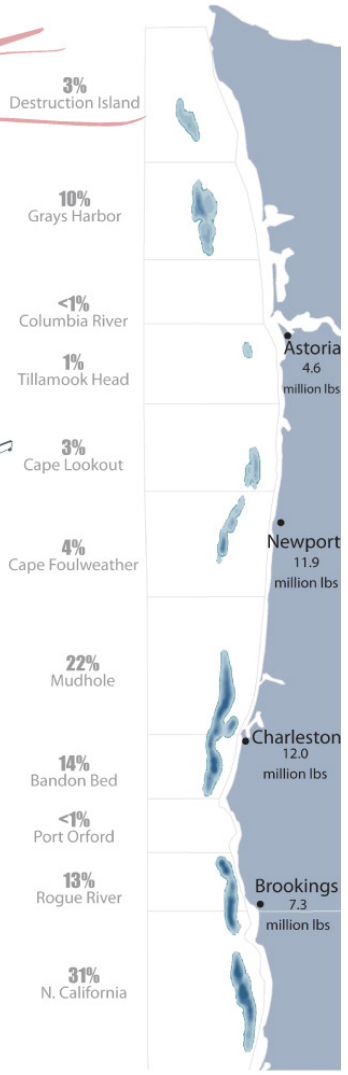
The 2018 pink shrimp season was a great success. Based on low catch rates during the end of the 2017 season, the fleet was expecting a slow year in 2018. Instead, when boats went out in spring of 2018, large quantities of small shrimp were found. Considering their size and growth rates, fishermen and processors worked together to carefully decide when to begin harvesting shrimp. In the end, it was the third most valuable season of all time (26.9 million dollars)!

The 2019 pink shrimp season will open April 1 and extend through October 31.

2018 Season







New for 2019: Section 6 Grant

In a cooperative project, Oregon (ODFW), Washington (WDFW) and California (CDFW) state fish and wildlife agencies applied for and received a Section 6 Grant. These grants support states in management, research, monitoring, and/or outreach activities that have direct conservation benefits for species listed under the Endangered Species Act (ESA). In this grant, we will assist the west coast shrimp trawl fleet in the conservation of eulachon *Thaleichthys pacificus*, an anadromous smelt listed in the ESA as "Threatened".

Eulachon smelt

What's the problem?

The southern distinct population segment (Northern California to British Columbia) of eulachon has been identified as threatened under the ESA and conservation needs are elevated. Although eulachon are anadromous (return to rivers and streams to spawn), they spend most their lives in offshore marine habitats, overlapping with pink shrimp populations, to some extent. As a result, eulachon have been a common bycatch of the shrimp fishery throughout its history.

Eulachon populations have declined over time. A number of threats (e.g. climate change, freshwater habitat degradation, dams, etc.) have been identified as threats or limiting factors; amongst these are bycatch in fisheries, principally the trawl fishery for pink shrimp (National Marine Fisheries Service 2017).

How the shrimp industry has helped

Over the years, Oregon's shrimp industry has shown leadership in clean fishing by implementing technologies which minimize bycatch. Bycatch Reduction Devices (BRDs or "shrimp grates") first addressed bycatch of larger fishes (2003), then were optimized for eulachon bycatch reduction (2012). In 2014, ODFW led research discovered the value of footrope lighting (i.e. LED fishing lights); immediately afterwards, industry adopted LED use voluntarily.

Although the modern shrimp trawl fishery uses efficient bycatch reduction methods which are unlikely to affect eulachon at a population level (Hannah 2016), the conservation of this ESA listed stock remains a high priority among the industry and fishery managers.

Corey Rock (F/V Kylie Lynn) and Bob Hannah (ODFW ret.) researching bycatch reduction

In the spirit of sustainability, managers in Oregon and Washington worked with industry to implement required light usage on the footropes, technology that is known to be strongly effective in the reduction of eulachon bycatch.

How LEDs help

Used properly, LEDs are VERY effective for reducing the bycatch of eulachon in shrimp nets. In three separate studies LEDs were found to dramatically reduce (i.e. ~80-90%) bycatch of eulachon (Hannah, et al. 2015, Lomeli et al. 2018, Lomeli et al 2019, in press). Bycatch of many other key species (e.g. rockfishes) was also reduced.

What we're doing

Using funding from the NOAA Section 6 Grant, the three US west coast state agencies (ODFW, WDFW, and CDFW) that manage pink shrimp will work together to distribute LEDs and information on bycatch and LED use to the shrimp fleet. Specifically, we will:

1. Provide a year supply of LEDs to each active shrimp vessel on the US west coast

A one year supply of LED fishing lights

2. Develop and distribute information regarding bycatch (i.e. brochures, bycatch identification information, etc.)

How can you learn more?

The project team for the grant includes pink shrimp staff from each of the three states. We're just getting this project underway as we are printing this newsletter, so expect to hear more about it when we get further along. This spring, we'll be figuring out how to best distribute the LEDs and develop the informational materials.

We welcome Morgan "Mo" Bancroft who will be stationed in the Charleston, OR office from January to July of 2019. Mo will coordinate much of this project; check in with him if you have any questions (541) 252-2554.

Mo Bancroft, Shrimp Bycatch Specialist

2018 Season Summary

In 2018, catch was greater (35.8 million pounds) and more valuable (26.9 million dollars) than many were expecting. expected. The value was the third highest on record (not adjusted for inflation).

Catch rates were very low in the final months of the 2017 shrimp season, causing low expectations for the 2018 season. The environmental model, however showed a likelihood for a strong age one year class. Indeed, 2018 was characterized by a high catch of age one shrimp. Careful actions by the shrimp industry assured that catch was legally sized, key to the valuable 2018 season.

Landings data

Oregon pink shrimp landings for 2018 were 12 million pounds higher than those from 2017 (Figure 1). Seventy vessels participated in 2018, a little more than recent years (Figure 2).

Shrimpers made 992 individual trips last year (Figure 3). The average landing was increased in 2018 (36,164 pounds/trip), one of the higher rates we've seen over the years (Figure 4).

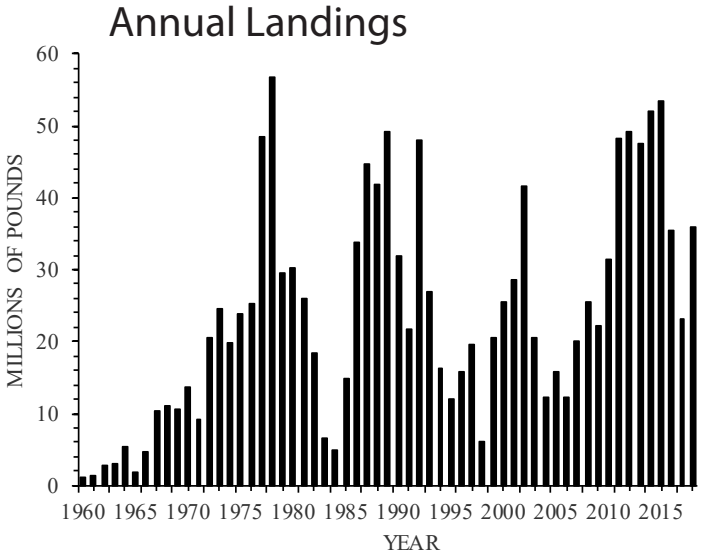


Figure 1. Annual landings (millions of pounds) of pink shrimp into Oregon: 1957-2018.

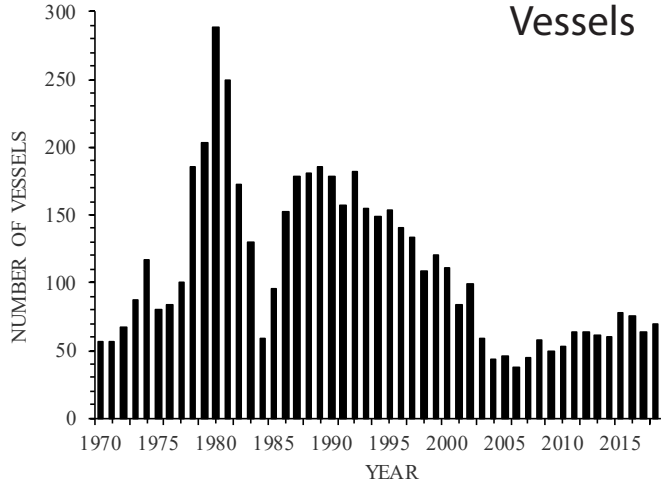


Figure 2. Annual number of vessels landing pink shrimp into Oregon: 1970-2018.

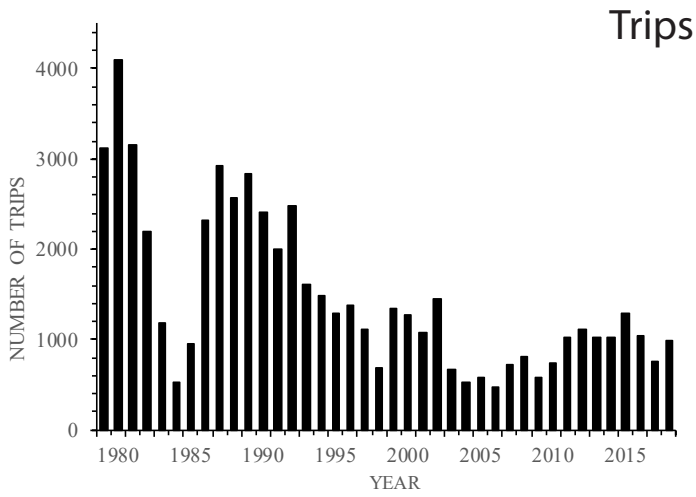


Figure 3. Annual number of trips landing pink shrimp into Oregon: 1979-2018.

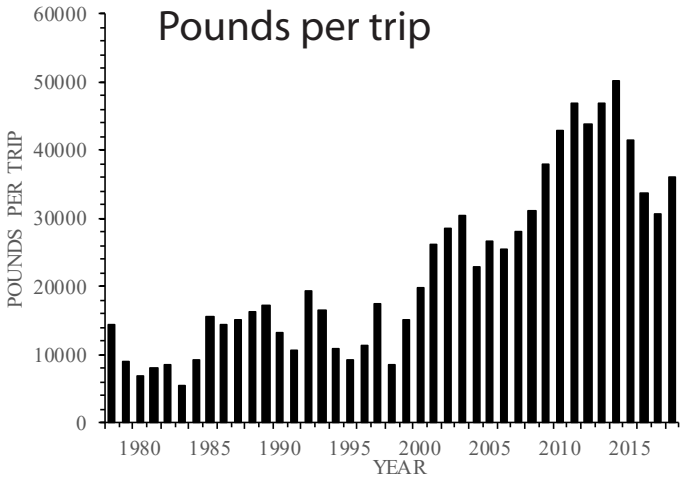


Figure 4. Annual average catch-per-trip (pounds) for pink shrimp vessels landing into Oregon: 1978-2018.

2018 Catch Area

Catch in 2018 focused in southern areas, about 80% was harvested south of Cape Perpetua (Figure 5 and 7). The abundance of southern shrimp combined with a new processing plant in Brookings drove their landings to their second highest ever (landings were 8.3 million back in 1992). Catch in northern areas was slow, only 7 of the 35.8 million pounds landed into Oregon in 2018 came from northern areas (Figure 6).

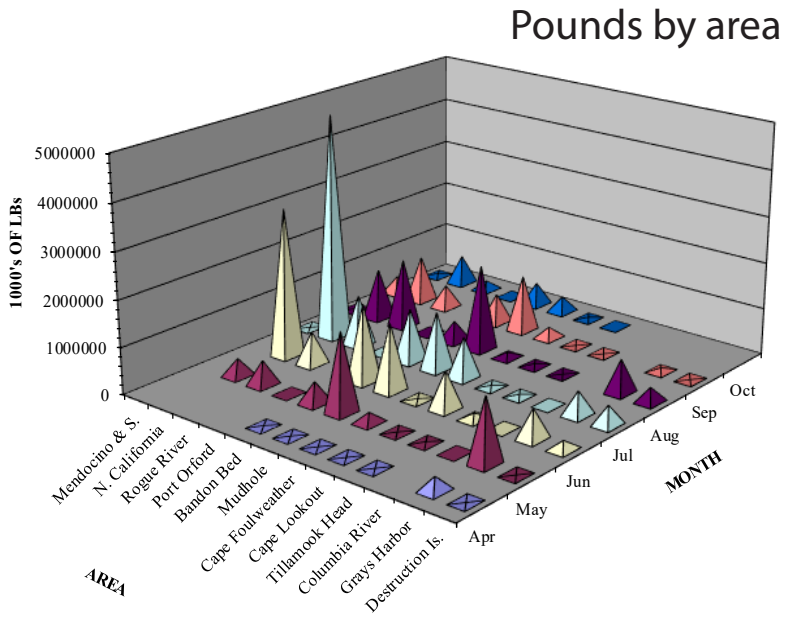


Figure 5. Estimated weight of pink shrimp caught in each area by month that were landed in Oregon during 2018.

Why has it been so good down South?

Although catch in recent years has been much stronger in southern areas than northern areas, this hasn't always been the case. Throughout the early 2000s stocks in the north were robust, while southern stocks were comparably low. The cause of lower southern stocks was linked to strong upwelling that likely caused excessive larval transport (Hannah 2011). In recent years southern stocks have certainly made a comeback (Figure 6)!

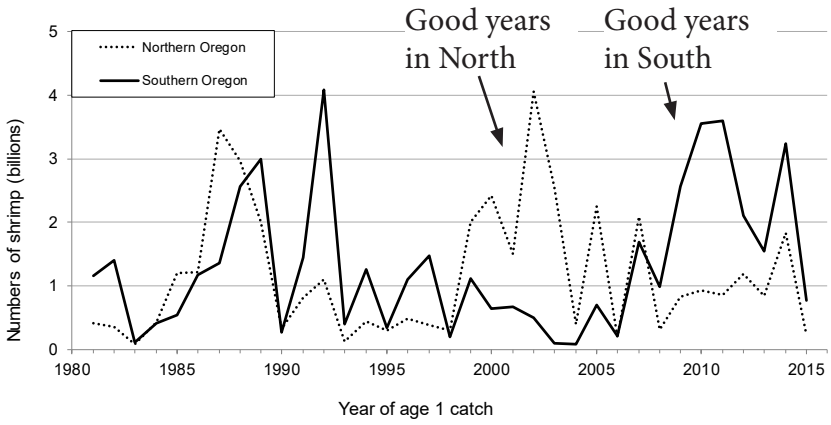


Figure 6. Age one pink shrimp catch by region (within Oregon only).

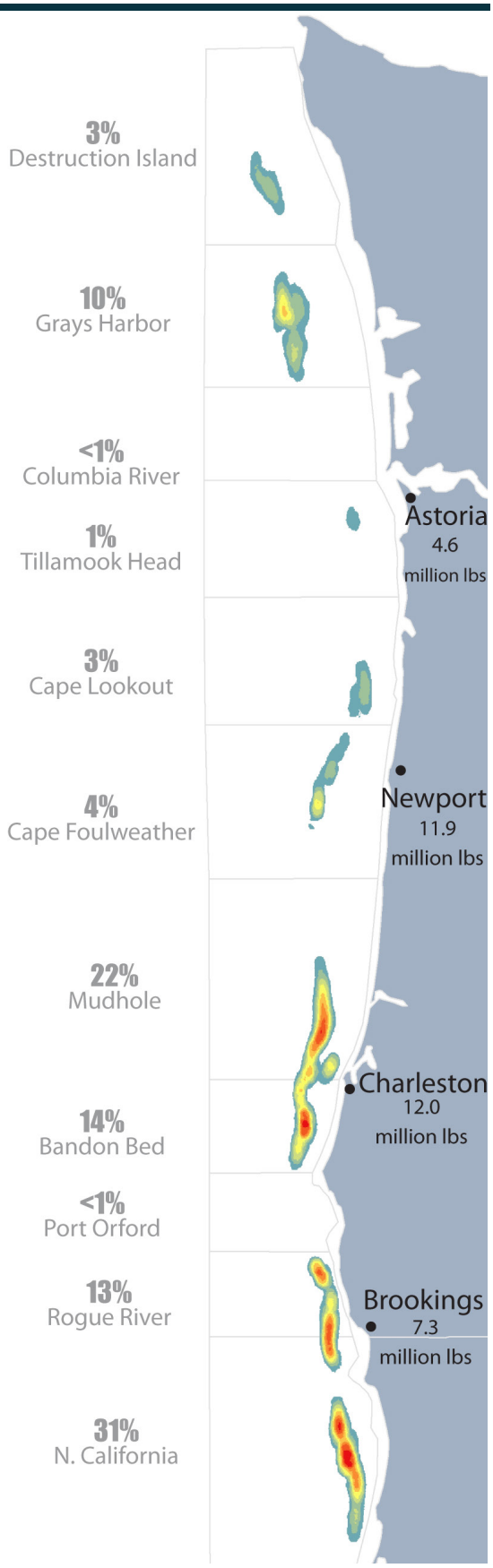


Figure 7. Heat map of pink shrimp catch by state statistical areas for 2018 Oregon landings, and amount of pounds delivered to each port.

Effort (hours fished)

Effort was similar to recent years, but lower than historic numbers (Figure 8). Hours of effort are displayed in units of Single Rig Equivalent (SRE) hours, meaning that single rig hours are counted 'as is' and double rig hours are multiplied by 1.6. Patterns of effort were similar to catch, with most concentrated near Coos Bay and around Brookings/Northern California (Figure 9).

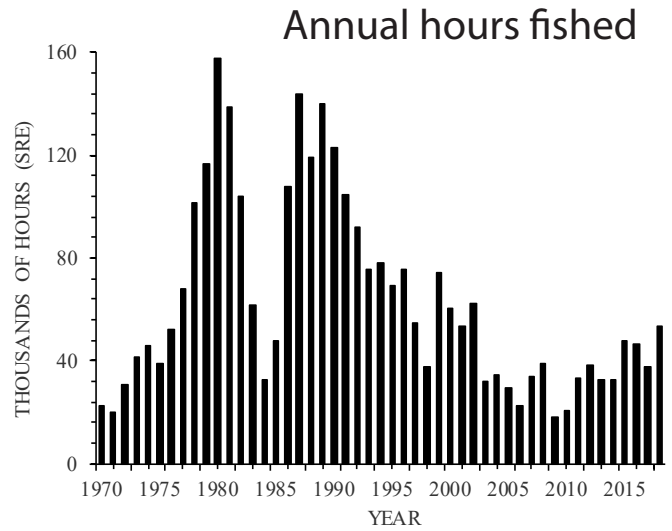


Figure 8. Annual hours (SRE) spent trawling for pink shrimp that were landed in Oregon: 1968-2018.

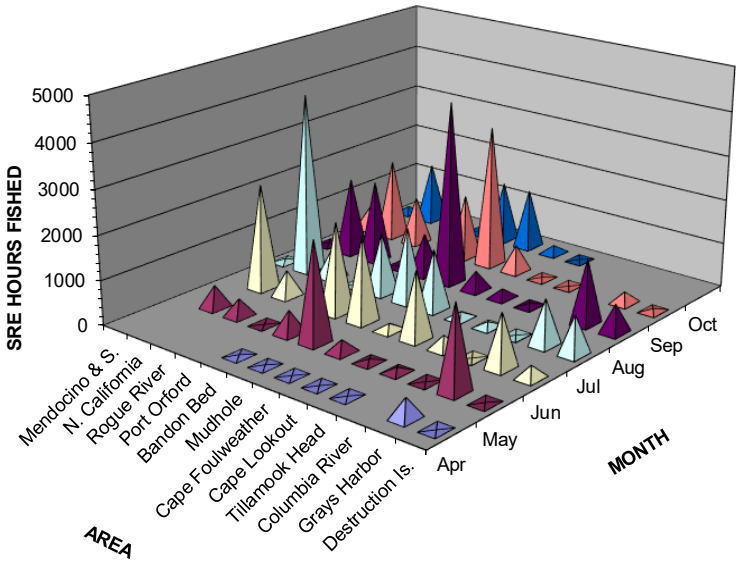


Figure 9. Estimated total hours (SRE) spent trawling for pink shrimp in each area by month during 2018.

Efficiency (CPUE)

Annual efficiency, expressed in Catch Per Unit of Effort (CPUE) reduced to numbers similar to those in the early 2000's (Figure 10). CPUE is calculated by taking the amount of catch and dividing by hours (adjusted to a single rig equivalent). 2018 CPUE was slightly higher than 2017's and fairly high among the entire history of the fishery. Catch was consistently best in the south and sustained throughout much of the season (Figure 11).

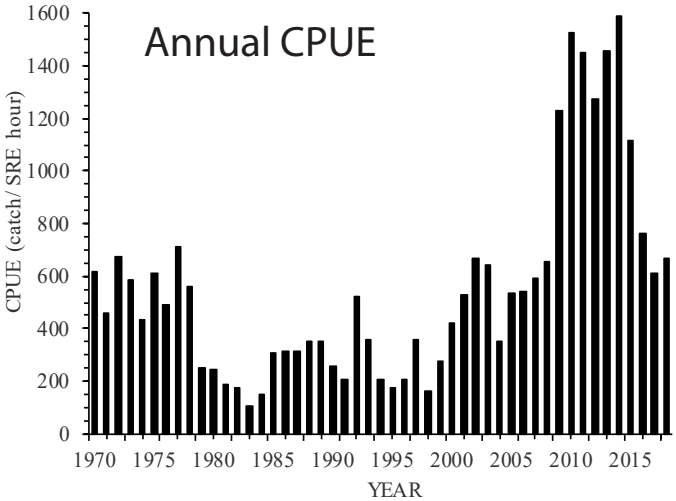


Figure 10. Annual average pounds of pink shrimp caught per hour (SRE) for vessels landing pink shrimp in Oregon: 1968-2018.

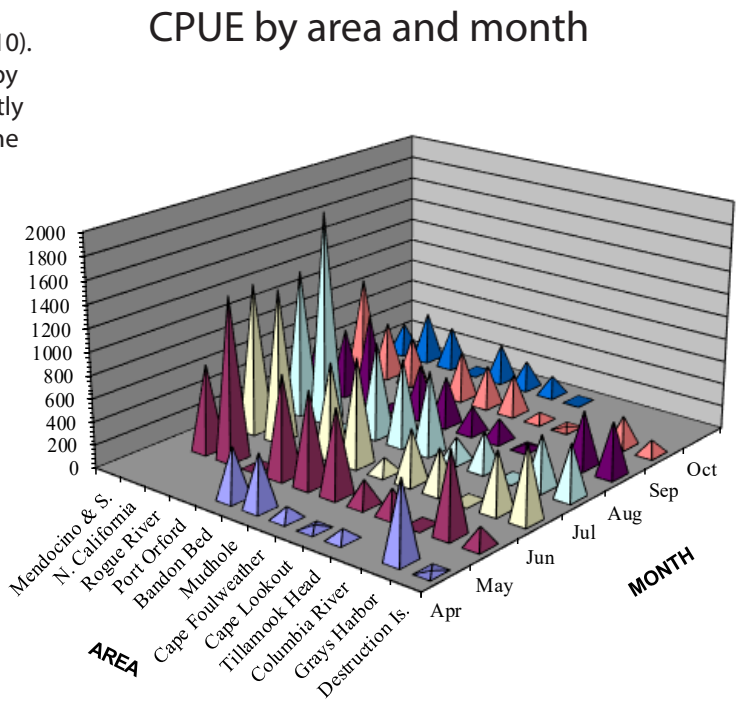


Figure 11. Estimated average pounds of pink shrimp caught per hour (SRE) by area and month for vessels landing pink shrimp in Oregon during 2018.

Value

The real story in 2018 was value, much higher than many of the recent ~50 million pound seasons and third highest of all time (not adjusted for inflation) at 26.9 million dollars (Figure 12).

At $0.75 per pound, the average price per pound was the second highest of all time (Figure 13).

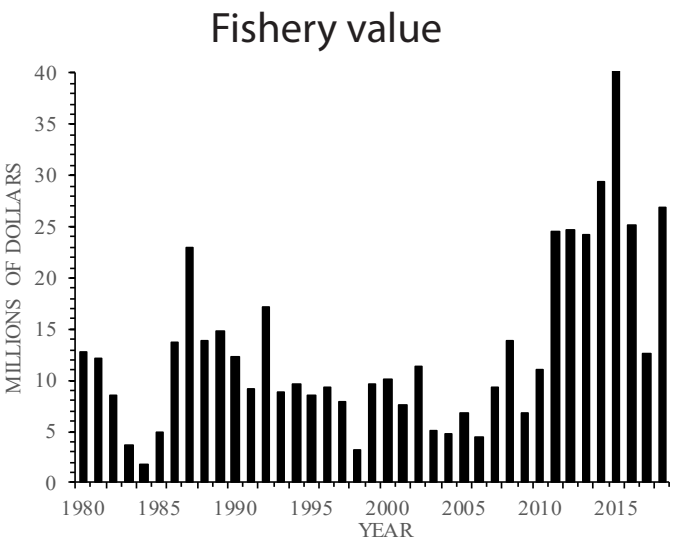


Figure 12. Annual ex-vessel value (in USD) of pink shrimp landed into Oregon: 1978-2018.

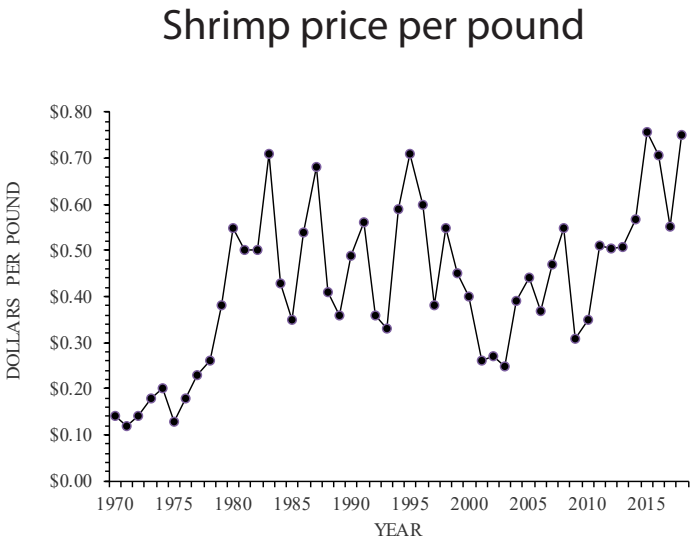


Figure 13. Annual average ex-vessel price-per-pound of pink shrimp into Oregon: 1968-2018.

Age and Size

Pink shrimp live short lives and grow quickly; catch is typically composed of 3 year classes (age 1, 2 and 3). In most years, catch focuses heavily on age one shrimp, which are released from their mother's belly in spring, then are a key component of the fishery only a year and a few months later.

In 2018, age one shrimp (89% of catch) were dominant, many age two shrimp (9%) were caught, and very few age three shrimp (2%) were found (Figure 14). Because of optimal environmental conditions in 2017, pink shrimp recruitment was outstanding. 2018 catch was heavily dependent on the age one year class that were larvae during 2017.

As the 2018 season progressed, count per pound changed quickly. While early season catches were high count, catch from the middle to the end of the season were much lower.

The average count per pound in 2018 was 133 shrimp/lb (Figure 15).

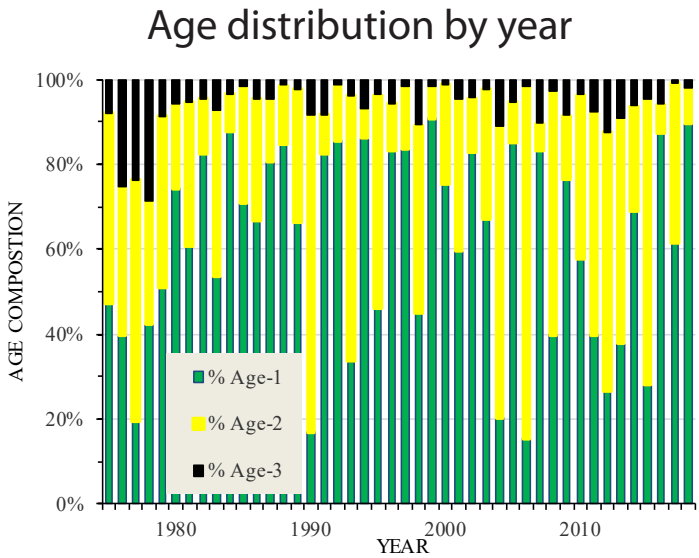


Figure 14. Annual percent age composition of pink shrimp landed into Oregon: 1975-2018.

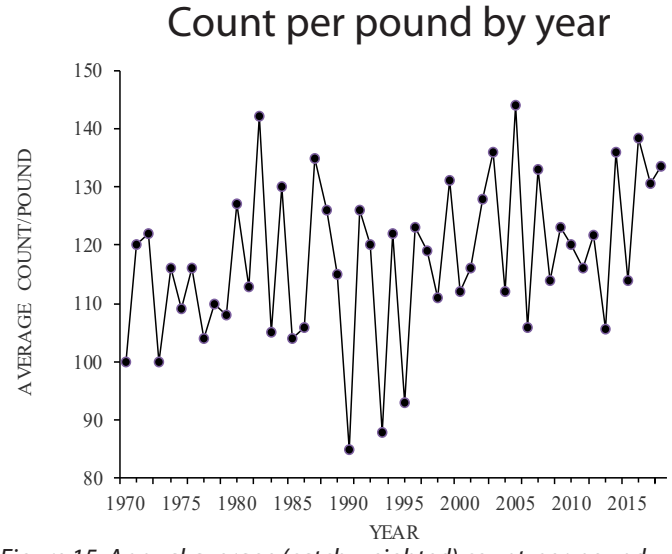


Figure 15. Annual average (catch weighted) count-per-pound (count) of pink shrimp landed into Oregon: 1966-2018.

"The best qualification of a prophet is to have a good memory."
--Marquis of Halifax

In this case, the *good memory* is the robust and continuous data series developed and maintained carefully over years; the *prophet* is simply the mathematical model developed using these data. Careful comparisons of Oregon's pink shrimp population data series against key environmental data show relationships that allow some ability to predict coming seasons.

To understand what the pink shrimp stock may look like in the next year, two elements must be considered:

1) Abundance (how many shrimp) and,

2) Age/size distribution (percentage of each year class)

Abundance

By comparing long-term shrimp population data to environmental data, we can forecast shrimp abundance in the next year. The number of shrimp which recruit to the fishery have a strong relationship to oceanographic conditions during their larval period (Figure 16). Specifically, sea level height at Crescent City, CA during the pink shrimp's larval period has shown a strong link to recruitment in Oregon, the lower the sea level, the greater the shrimp recruitment.

Why sea level? While it may not matter to a pink shrimp if there's a few extra inches of water above their head or not, the average height of the sea where it meets land does indicate environmental conditions which are known to affect shrimp larvae (larval transport, food supply from upwelling, etc).

In 2019, shrimp catch will be composed of three year classes (those born in 2016, 2017, and 2018).

2018 year class: Age one recruitment is typically the largest component of the fishery. According to the model, the conditions which larval pink shrimp experienced in 2018 was decent, when compared among the past 30 years, it was in the 55th percentile (i.e. a little bit better than average).

2017 year class: Age two shrimp are often a lesser component of catch given their longer exposure to natural and fishery mortalities (which occur at a high rate given their short lives). In 2019, we expect a substantial portion of the catch are these shrimp (born in 2017) as larval conditions were in the 78th percentile (excellent!) and were 89% of last year's catch.

2016 year class: Age three shrimp are often the least component of catch as they are approaching the end of their lives. In 2019, we are expecting few age three shrimp. Catch of age two shrimp last year was fair and larval conditions in 2016 were in the 45th percentile (a little lower than average).

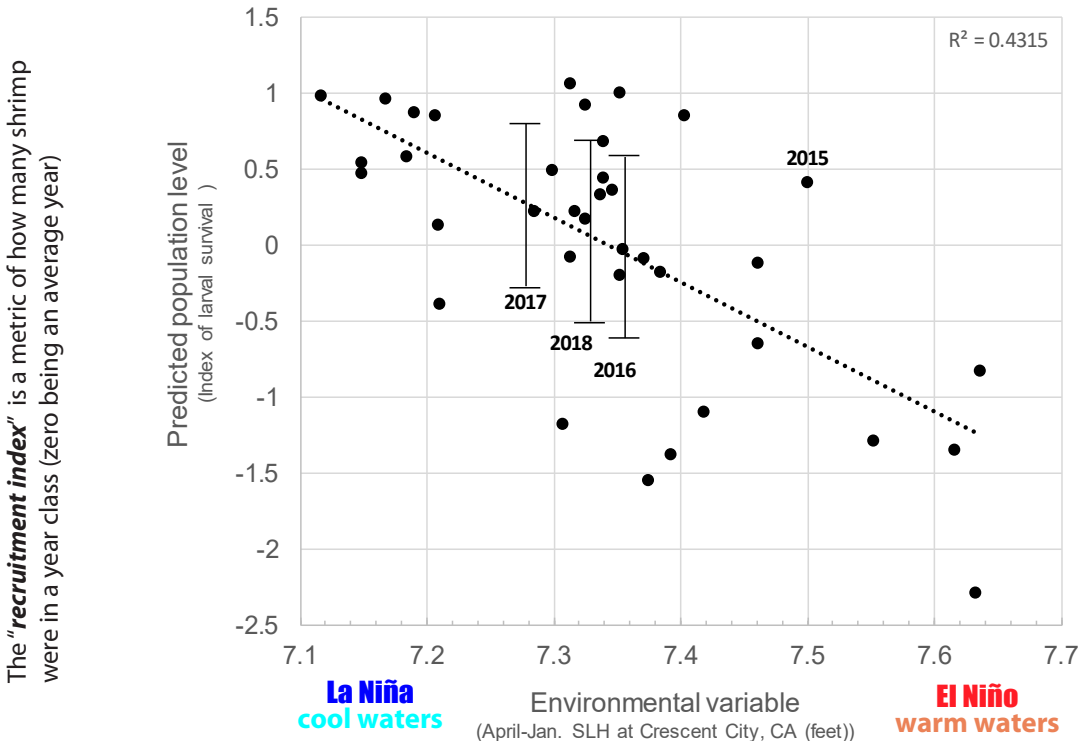


Figure 16. Pink shrimp recruitment model.

Each dot on this graph represents a year (1979-2015).

Vertical lines labeled with year represent the range of recruitment expected, given the environmental conditions in the year they are released as larvae.

The "***environmental variable***" used is sea level height (SLH) from April to January in Crescent City, CA.

Age/Size Distribution

Crustaceans lack hard structures for aging, such as ear bones (otoliths) used in fish aging; thus other means must be used. Pink shrimp simultaneously release eggs, grow quickly, and live short lives. These three attributes allow for age assignment using statistical (multimodal distribution) analysis. In this way, ages of shrimp are determined by bulk measurement of their size over time. Size measurements (carapace lengths (CL)) are aggregated then compared to other time periods to determine age and growth.

Each graph tells a story; in the example to the right (Figure 17), there are many age one shrimp, then a few age two and three. While a single graph is like a snapshot, comparing changes in these graphs over time tells a story. The horizontal (X) axis of these graphs indicates the size of the shrimp (larger as you move to the right); the vertical (Y) axis shows the relative amount of each size group (not total abundance). The "lumps" of these graphs are caused by the central tendency of each age group; thus changes to relative amounts of age classes can be tracked along multiple graphs. Arrows track year classes and indicate rate of growth as time goes on. These graphs look a little complex at first, but once understood, it becomes easy to visualize (Figure 18 and 19).

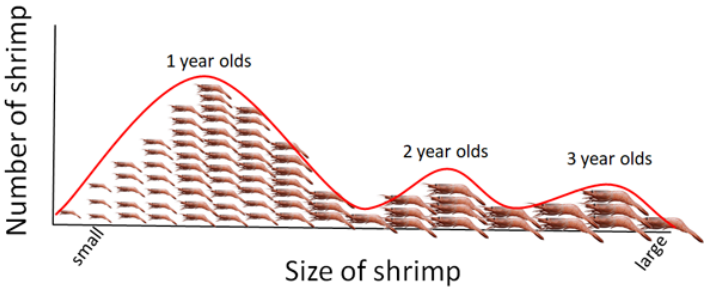


Figure 17. Hypothetical multimodal size distribution of shrimp

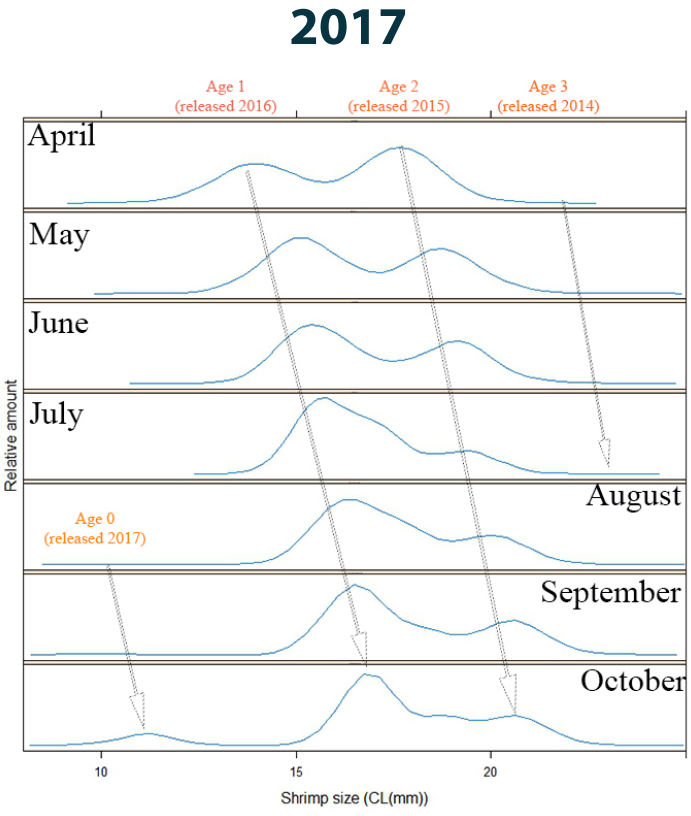


Figure 18. 2017 Oregon pink shrimp size distributions by month. Notes: Age 0 shrimp (released as eggs only a few months prior) were detected first in samples in August, age 1 shrimp began as the minority of the catch but became the primary catch by fall. Age 2 shrimp catch started strong as expected, but tapered off quickly. Few age 3 shrimp were caught.

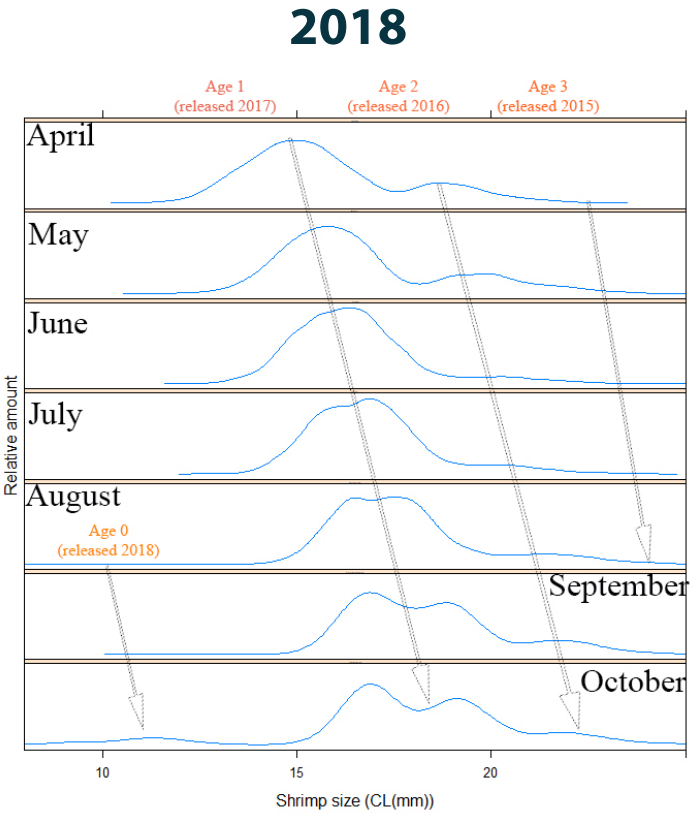


Figure 19. 2018 Oregon pink shrimp size distributions by month. Notes: Age 0 shrimp (released as eggs only a few months prior) were detected first in samples in August, age 1 shrimp were the majority of catch throughout 2018, growing very quickly compared to other years. Many age 1 shrimp transitioned directly to females causing a bifurcation in the size distribution of age 1 shrimp toward the end of the season, when eligible shrimp change sexes. A good amount of age 2 shrimp were caught, few age 3 shrimp were caught.

2019 Forecast

In 2019, pink shrimp stocks will be comprised of three year classes; these were released as larvae from 2016 to 2018. We expect moderate catches (in the context of the whole history of the fishery) for the 2019 season. The 2018 season ended with scratchy fishing, but zeros were found in many places. It will be interesting to see how those two conditions relate to 1) holdover of age two shrimp and 2) the footprint of recruitment of age one shrimp.

While thinking of this prediction it is critical to consider that age one shrimp are typically the principal component of catch.

Table 1. Review of current pink shrimp year classes, based on prediction and observation.

Larval release year	Age in 2019	Prediction (recruitment model [percentile])	Observation (age/size distribution)
2016	3	Moderate [45th]	Moderate
2017	2	Strong* [78th]	Strong
2018	1	Moderate [55th]	Moderate

*we predicted a moderate 2017 year class last year, but in hindsight was inaccurately conservative

Regulation Info

VMS and declarations required:
The National Marine Fisheries Service (NMFS) permanently requires shrimp vessels to have an approved and operating Vessel Monitoring System (VMS) on-board. For VMS-related information, please consult the NMFS "Compliance Guide for the Pacific Coast Groundfish Fishery Vessel Monitoring Program" at the following website: www.westcoast.fisheries.noaa.gov/fisheries/management/vms.html or call NMFS OLE at 206-526-6133.

Additionally, NMFS requires shrimpers to file a declaration report before the vessel is used to fish in any Rockfish Conservation Area (RCA). Shrimpers need to declare before leaving for their first shrimp trip of the season. Only one declaration is required for the season, providing that the vessel doesn't engage in another fishery during the season. For details about declaration procedures, please visit the NOAA Fisheries Office for Law Enforcement website: www.nmfs.noaa.gov/ole/index.html. Declarations may be made via phone by calling 1-888-585-5518.

Key regulations that apply to **Oregon** pink shrimp deliveries

		Fishing off CA*	Fishing off OR**	Fishing off WA***
Areas	0-3 miles	No fishing	OR permit needed	No fishing
	3-200 miles Key closed areas	Delgada Canyon, Tolo Bank, other closed areas (see CA regs)	Nehalem Bank, Daisy Bank, Stonewall Bank, Heceta Bank, Coquille Bank	Grays Canyon (see WA regs)
Mesh size		Minimum 1-3/8"	No minimum	
BRD		≤ ¾" spaced rigid grate		
LEDs		5 LEDs in central 16 feet of each net, spaced 4 feet apart (More LEDs may be used)		
Count per pound		≤160 shrimp/ pound		
VMS/ RCA declaration		Required		
Season		April 1- October 31		
Groundfish by-catch****		Groundfish: 500 lb/day, multiplied by the number of days of the trip, not to exceed 1,500 lb/trip. The following sublimits also apply and are counted toward the overall 500 lb/day and 1,500 lb/trip groundfish limits: lingcod 300 lb/month (minimum 24" size limit); sablefish 2,000 lb/month; canary, thornyheads, and yelloweye rockfish are PROHIBITED. All other groundfish species taken are managed under the overall 500 lb/day and 1,500 lb/trip groundfish limits and do not have species specific limits. The amount of groundfish landed may not exceed the amount of pink shrimp landed.		

*CA Regulation details: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=154314&inline, pages 103-107.
**OR Regulation details: http://www.dfw.state.or.us/OARs/05.pdf, pages 30-34.
***WA Regulation details: http://wdfw.wa.gov/fishing/commercial/shrimp/license_permit_requirements.html
**** NMFS groundfish limits

Research Priorities

Here, we address three research areas, in priority order: 1) shrimp population dynamics, 2) non-target catch and 3) ecosystem effects. Although we address each priority every year, we don't necessarily have planned activities for all three every year. In interpreting the 2019 plan, it should be noted that regardless of what priority is assigned to a component, the completion of work in any given year will always depend on availability of staff and funding resources.

Priority 1: Shrimp Population Dynamics

Our documentation and analysis of pink shrimp population dynamics is the highest priority goal of our program. Understanding changes in the shrimp population and comparing it to past populations, environmental data and other factors is critical to our ability to detect and address overfishing. ODFW's pink shrimp program has a thorough, long term dataset of shrimp populations, which is central to our ability to assure it is fished sustainably.

Accomplished in 2018:
We calculated annual indices on the number of shrimp using fish ticket, logbook and biological sample data. ODFW biologists entered data for **11,207** shrimp tows and measured **26,408** shrimp. We use these data to understand the effects of fishing and the environment on shrimp stocks.

We digitized 2016-2018 shrimp biological raw sample data, then uploaded this to ODFW's data clearinghouse.

We completed an update of the report series evaluating fishery and environmental effects on the population structure and recruitment levels of ocean shrimp (Groth and Hannah, 2018).

Planned for 2019:
Our first priority is to work with industry to obtain, enter/measure and analyze fishery logbooks and biological samples.

Lastly, as time allows, we will continue to assemble past biological sample data in raw formats and make the information available on ODFW's data clearinghouse: https://nrimp.dfw.state.or.us/DataClearinghouse

Priority 2: Bycatch Reduction

Accomplished in 2018:
Published cooperative work led by Pacific States Marine Fisheries Commission (PSMFC) researcher Mark Lomeli regarding bycatch reduction efficiency using differing amounts of LED fishing lights on shrimp footropes. In ICES Journal of Marine Science, December 2018 (more on page 11).

ODFW partnered for another PSMFC led Bycatch Reduction Engineering Program (BREP) grant which aimed to determine the efficiency of LED fishing lights for bycatch reduction, on their own, without the use of a Bycatch Reduction Device (BRD).

We spent 8 days at sea testing LED efficiency with Mark Lomeli (PSMFC) and the capable crew of the F/V Ms Julie. This work is currently being considered for publication.

Crew of F/V Ms Julie with PSMFC and ODFW researchers

ODFW, in cooperation with WDFW and CDFW was awarded a Section 6 Grant from National Oceanographic and Atmospheric Administration (NOAA) to provide LEDs and develop education materials regarding the effective use of LEDs and distribute bycatch identification information. More on page 2 of this document.

Planned for 2019:
Our main focus in regards to non-target catch is to implement the Section 6 Grant (more on page 2).

Priority 3: Ecosystem Effects

Research on ecosystem effects is our lowest research priority, simply because our research program is small, and the issue of ecosystem effects of west coast fisheries is large and complex (large spatial scales, effects from multiple fisheries, a generally poor understanding of many species that are not the focus of major fisheries, etc.).

Accomplished in 2018:
We investigated funding the Nehalem Bank habitat research, including a pre-proposal for a Saltonstall-Kennedy grant.

We worked with OSU researchers George Waldbusser and Jessamyn Johnson, aboard the F/V Eddie and Rod, to collect gravid shrimp on a Oregon Sea Grant project. The larvae from those shrimp were maintained under different pH conditions, and preliminary analyses found the shrimp in lower pH grew significantly slower than the larval shrimp in the elevated pH.

Planned for 2019:
We will continue to look for grant money for the Nehalem Bank habitat project.

Despite valiant efforts, gravid shrimp caught did not persist, however, important knowledge was gained that strongly improves the chance for success in 2019, with significant redesign of the experimental seawater system. We plan to again assist OSU researchers in collection of gravid shrimp for another round of temperature and pH effects on growth and development of the larvae (more on page 13).

Bycatch Reduction Research

ODFW staff was involved in a cooperative project led by Mark Lomeli from Pacific States Marine Fisheries Commission (PSMFC). We evaluated how changing the number of LEDs on the footrope affected bycatch rates. A key goal of this project was to determine how much light would be most efficient for the shrimp trawl fleet to use.

In the summer of 2017, we chartered the shrimp vessel F/V Miss Yvonne for sea trials. Owner/Captain Jeff Boardman set up his two trawls identically, then we added varying numbers (5, 10 or 20) LEDs on one side while leaving the second side dark. Catch from each side of each tow was measured and weighed separately to determine the differences in catch. We completed 83 tows during 15 days mostly just north of Coos Bay, OR.

Jeff and Chad with the F/V Miss Yvonne in Charleston, OR

2017 was a very low bycatch year, making appropriate study areas (we need to have bycatch to find out how to reduce it) hard to find. We are grateful for help from the shrimp fleet and scientists at NOAA for finding a good site. Unlike past years, little difference could be detected by glancing in the hopper as catch was VERY clean.

Bycatch rates in 2017 were extremely low. Because it was so clean, differences in bycatch rates were not as apparent as some years from a mere glance.

After sorting through shrimp and small amount of bycatch separately, the difference from the lighted side and "dark" side becomes apparent.

Key points from this publication include:

- The presence of LEDs significantly reduced bycatch (especially of eulachon) when compared to the other (unlighted) side.
- Higher numbers of LEDs (we used 5, 10 and 20) did not make a significant reduction to bycatch
- Catch of shrimp was unaffected by use of LEDs

The results of this work guided rules regarding footrope lighting that were adopted by Oregon and Washington. For a copy of this manuscript or for questions about results, check in with Mark Lomeli (MLomeli@psmfc.org) or ODFW.

Effects of Environment and Fishing

Understanding the effect of fishing and the environment upon a stock is critical to sustainable fisheries management. Using data about the shrimp stock from your logbooks combined with biological samples, we've compared stock metrics to environmental and fishery metrics to assure that our management practices are appropriate.

Since things change (environment, fishing efficiency, etc.), we review these analysis often, most recently in a 2018 publication found **here**.

Key points from this publication include:

- Shrimp grow faster as shrimp densities decrease.
- Shrimp grow faster as sea surface temperatures increase.
- Shrimp recruitment is strongly dependent on environmental conditions during their first year of life and less dependent on the size of spawning stock (Figure 20).

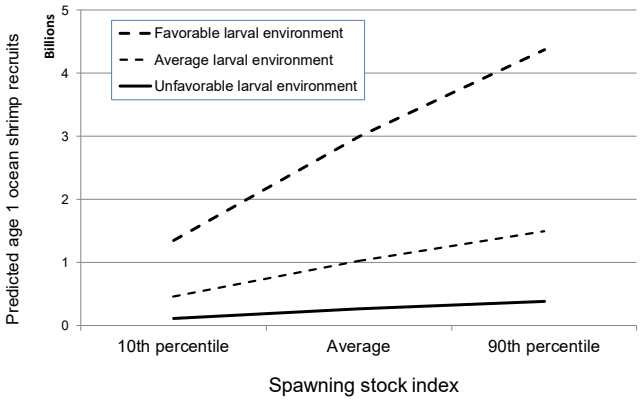


Figure 20. Recruitment related to the number of spawners in three different environmental conditions. Note: changes in spawning stock does not have near the effect as changes in environmental conditions.

While the results tell an important story, it is also a complex analysis and may be best absorbed in a short presentation; ODFW aims deliver such a presentation to Oregon Trawl Commission in 2019. Check in with us for details.

MSC News

On February 13, 2018, MRAG Americas assessment team recommended that Oregon's pink shrimp fishery meets the requirements for a well-managed and sustainable fishery. This means Oregon's pink shrimp fishery is Marine Stewardship Council (MSC) certified "sustainable" for the next five years. Annual audits track the fishery each year, but the recertification process occurs at five year increments. This is the fisheries 2nd recertification; it was first certified in 2007.

See more on Oregon's pink shrimp MSC status here.

International Guests

Cooperation between fishermen, processors, scientists and managers in Oregon's pink shrimp fisheries has been crucial to sustaining valuable pink shrimp harvests. Fostering this cooperation has allowed development of highly effective bycatch methods. The world has noticed Oregon's leadership and as a result we've had a number of folks interested to see how this fishery has achieved success.

On August 28-29, 2018 we hosted a visiting engineer from England, Dan Watson from SafetyNet technologies. Dan gave a presentation at the August OTC meeting regarding innovations in LED technology, then toured and got to see some real life applications of this technology in Charleston. Dan works with a company who is developing LEDs specifically for fishery applications. Many thanks to OTC for making time and also to Shane Chambers (F/V Cape Sebastian) and Jim Burns (F/V Galway Bay) for showing off their vessels and discussing their use of LEDs for bycatch reduction.

On September 25-27, 2018 a delegation from the Association of Captains Owners of Gaspésie Inc. (ACPG) from Gaspe, Quebec, Canada came to Newport and Charleston to visit with fishermen, net makers, processors and scientists in the interest of improving the practices of their fishery for the northern shrimp, *Pandalus borealis*.

ACPG group met with net makers and researchers in Newport, OR

The group spent one day in Newport getting a tour of net technology from Sara Skamser (Foulweather Trawl), discussion of bycatch exclusion with Mark Lomeli (PSMFC research) and ODFW staff, then shrimping talk with Lee Web (F/V Ms Law).

Next, in Charleston, Nick Edwards (F/V Carter Jon) and ODFW staff took the group to tour the commercial docks, visiting with fishermen Jon Silva (F/V Jeanette Marie), Bryan Fletcher (F/V Texas Lady), and Ben Downs (F/V Pacific Dove). Pacific Seafoods in Charleston provided a shrimp processing tour. Last, ODFW reviewed the scientific background of the sustainability of Oregon's pink shrimp fishery.

Ben Downs describes bycatch reduction, Photo Nick Edwards

Overall, these visits were a great chance for fishermen, scientists, processors and other key industry members to get together and chat with people facing issues from another area, speaking different languages, sharing experiences of these similar fisheries.

Permit Review Board

The shrimp/scallop permit review board is made up of five members (three permit holders and two at-large members). Currently, one permit holder position is open. Terms are two years and may be renewed once. All hearings are via phone. Contact Linda Lytle, ODFW License Services Manager, for details at (503) 947-6112.

Enforcement News

On March 5, 2018 ODFW staff met with Oregon State Police (OSP) Marine Team in Gearhart, OR regarding regulation issues. In particular, we discussed methodology of measuring legal shrimp loads and the new footrope lighting rules. In addition, we worked with WDFW describing our methodology in the development of a Virtual Population Estimate (VPE), key to understanding the shrimp stock.

Count per pound issues:
Despite a number of checks by OSP, no cases were necessary to be made in 2018. As discussed previously, the industry did a great job avoiding a potential problem of small shrimp. 99% of the 221 samples ODFW measured last year counted out below the 160 count per pound maximum, nice work!

Shrimp Growth

In April 2018, after large volumes of small shrimp were found, we fielded a number of questions regarding shrimp growth. Below we present a couple of graphs from biological sample data which may help interpret shrimp growth.

Individual shrimp growth:

Shrimp live short lives, typically not beyond 3 years. As in many animals, growth is faster at younger ages. In Figure 21, we show the growth of an average shrimp throughout its life. Roughly, pink shrimp are 233 count per pound (ct/lb) in April of their first year, when they are first caught in the greatest numbers. They grow very quickly in their first year, getting to 133 ct/lb by October. In their second year they grow more slowly, 122 ct/lb in April then 82 ct/lb in October, as they focus more energy into reproduction, then even more slowly in their third year, 78 ct/lb in April, 57 ct/lb in October.

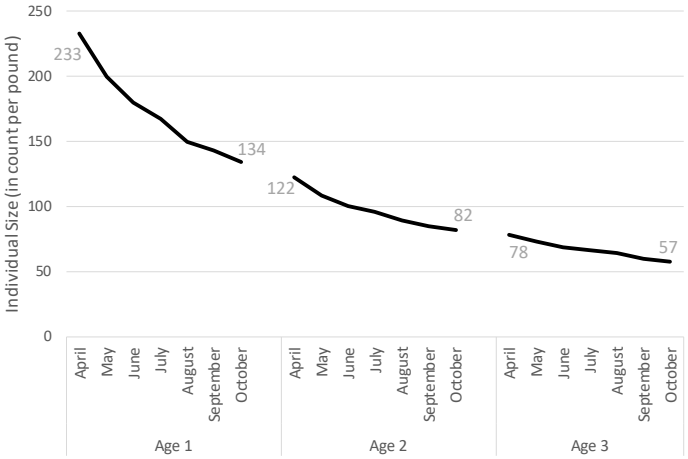


Figure 21. Average growth of an individual pink shrimp (based on regional 2012-2018 data) expressed in count per pound (converted from individual weight).

So where are all the 50-100 ct/lb shrimp that everyone loves? Natural and fishing mortality are very high in pink shrimp, causing few older shrimp to be available at those ages.

Count per pound changes within the season

Catch in the pink shrimp fishery is a mix of three age classes (age one, two and three). In each year a new age class of age one shrimp enters the fishery and mixes with the previous two. For this reason, the resulting average count per pound tends to be high in the beginning part of the year, then reducing as the season progresses. In the past three seasons shrimp catch began at around 150 ct/lb and ended the season around 115 ct/lb, (Figure 22).

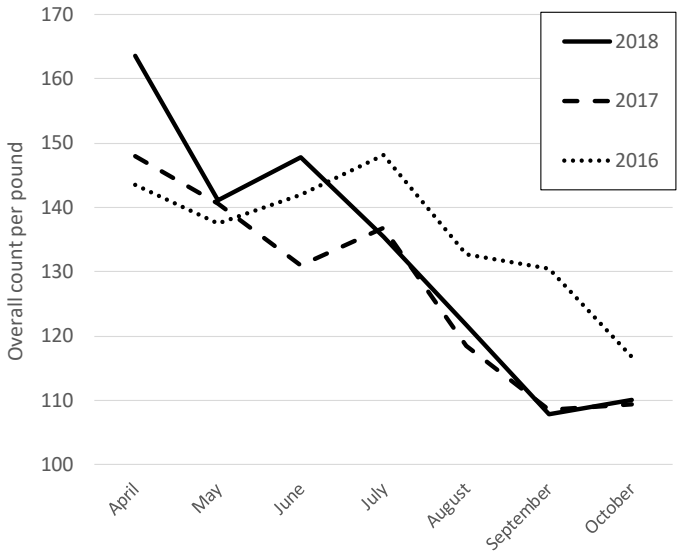


Figure 22. Average count per pound by month for Oregon landings: 2016-2018.

In coming years, we hope to work towards providing improved understanding of shrimp growth. Central to this goal is improving raw data availability and building on the shoulders of the impressive science that precedes us.

Egged Shrimp Collection

Ocean acidification and climate change may affect future pink shrimp stocks by impacting shrimp larvae. Researchers at Oregon State University (OSU) are leading an Oregon Sea Grant funded project which aims to evaluate the effects of different levels of acidification and temperature on larval pink shrimp growth and development. To accomplish this project, larval pink shrimp are needed.

In 2018, ODFW worked with OSU to obtain egged (or gravid) shrimp by connecting with shrimpers. The way the 2018 season opened up was abnormal, causing this to be very difficult. The crew of the F/V Kaya C was able to obtain several live egged shrimp which was helpful for pilot work. A directed effort was made in late April by the F/V Eddie & Rod. The team was able to learn a lot about collecting and caring for egged shrimp! We really appreciate these two boats stepping up to help.

We'll be trying to collect again prior or during the 2019 season. Please check in with us if you're interested in helping.

OSU researchers aboard F/V Eddie and Rod

3/4" grates

In recent years, shrimpers have inquired about increasing the flexibility of grate size (e.g. allowing the use of up to 1"). Shrimpers have identified two concerns with ¾" spaced grates 1) clogging, 2) loss of large shrimp (e.g. spot prawns). Here we want to provide some background of the ¾" BRD spacing and propose ways to evaluate its appropriateness in the future.

Background:

The implementation of bycatch reduction devices (BRDs) in the shrimp fishery has been very successful for both shrimpers and conservation. Due to conservation needs of rockfish and lingcod, BRDs were first required in Oregon's shrimp fishery in 2003. This not only resulted in an estimated 66-88% reduction in fish bycatch, but also increased efficiency by allowing fishing in new locations. Implementing BRDs then, resulted in the avoidance of bycatch limitation to the shrimp fishery while assisting other sectors, and taking a big step forward in clean and efficient fishing. After the 2010 ESA listing of eulachon, staff investigated sizing BRDs to optimize for eulachon reduction. Research found that using ¾" grates versus 1" grates reduced bycatch of eulachon significantly while not affecting shrimp catch (Hannah et al. 2011). Progress with BRDs has been well received by shrimpers and conservationists alike, in addition BRDs have increased the fleet's efficiency.

Current problem:

Recently, warm waters have ruled the Pacific and the result has been a boom of jellies and pyrosomes, gelatinous and numerous, these species have troubled shrimpers day-to-day operation. Shrimpers have suggested that increasing grate spacing could minimize clogging, reducing the amount of time they are needlessly towing.

Possible solutions:

Eulachon bycatch is an issue that's been taken very seriously by shrimpers, and even among those who have inquired about grate size flexibility, low impacts remain the highest priority. There are a few solutions to the grate clogging issue:

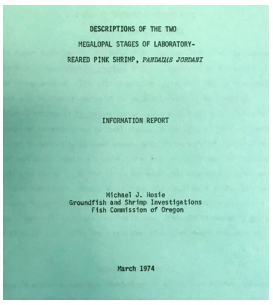
We suggest that a collaborative method may best investigate this question. What might work is ODFW staff working on shrimp boats for short trips where catch and eulachon bycatch can be measured while paired trawls are equipped identically, aside from differing grate sizes. Three things would essentially be needed 1) identical trawls, 2) split hoppers, and 3) two different sized grates (e.g. ¾ and 1"). We don't really know how practical this would be for vessels, but we're interested in helping you investigate this. Let's talk and see what's possible.

New OTC Director

After a effective tenure as Oregon Trawl Commission Director, Brad Pettinger retired (from that position) in 2018. Brad was a tremendous help to the ODFW over the years and in recent years his wisdom was very helpful in our own recent staff transitions. Yelena Nowak is the new director, we look forward to working with her!

Michael Hosie

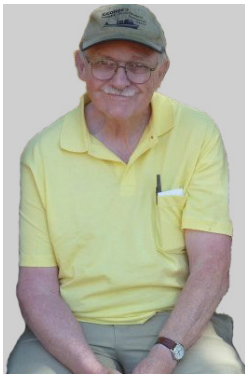
Michael Hosie, former ODFW biologist and key contributor to the science that described the larval behavior of pink shrimp passed away in 2018. Michael was a lifelong learner and often checked in with these authors on their progress. He provided a helpful historical perspective on agency in-workings and the development of the scientific understanding we've come to. Michael was an advocate for fishermen, coastal economies, and a Rotarian, where he worked to provide food to children in third world countries. His contributions to science will live on, while Michael's personality will be missed.


DESCRIPTIONS OF THE TWO
MEGALOPAL STAGES OF LABORATORY-
REARED PINK SHRIMP, *PANDALUS JORDANI*

INFORMATION REPORT

Michael J. Hosie
Groundfish and Shrimp Investigations
Fish Commission of Oregon

March 1974



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Hannah, R. W., M. J. M. Lomeli & S. A. Jones (2015) Tests of artificial light for bycatch reduction in an ocean shrimp trawl: Strong but opposite effects at the footrope and near the bycatch reduction device. Fisheries Research, 170, 60-67.

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Lomeli, M. J. M., S. D. Groth, M. T. O. Blume, B. Herrmann & W. W. Wakefield (2018) Effects on the bycatch of eulachon and juvenile groundfish by altering the level of artificial illumination along an ocean shrimp trawl fishing line. ICES Journal of Marine Science, 76, 6, 2224-2234.

Who we are

ODFW's mission is to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations.

The pink shrimp fishery project is managed with the following long term objectives:

1. Maximize biomass yield from the ocean shrimp fishery, consistent with detecting and addressing any significant growth or recruitment overfishing that develops.

2. Operate the fishery, to the extent possible, under a stable regulatory environment that allows vessel operators maximum flexibility in deciding where, when and how to fish for ocean shrimp.

3. Through collaborative research with vessel operators and the sharing of research findings, develop and implement measures to minimize direct bycatch mortality, the unseen mortality of animals that escape capture and any adverse effects on seafloor habitat from the operation of the fishery.

Oregon's pink shrimp project is spread out among the major ports of Oregon to:
1. Collect fishery dependent data (biological samples and logbooks)
2. Assist and communicate with shrimpers.

Questions?

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Jill Smith, assistant project leader		(503) 325-2462
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OREGON Fish & Wildlife

Marine Resources Program

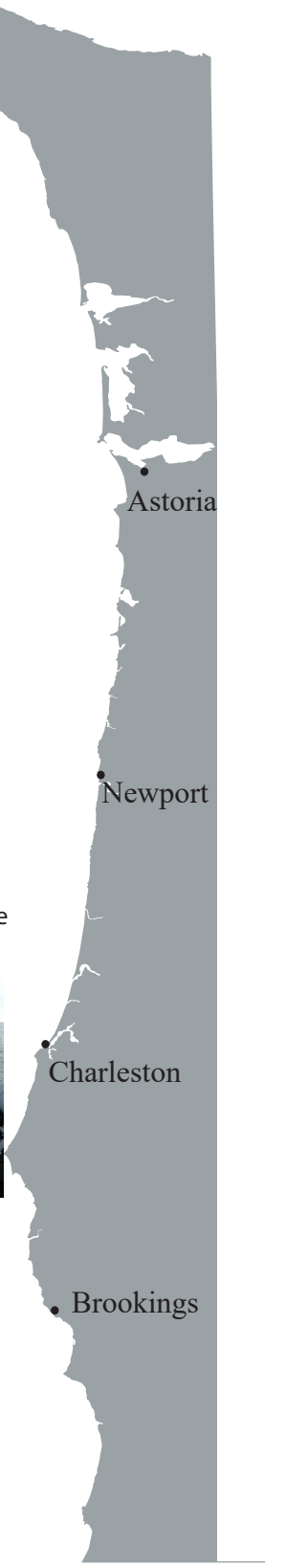
Pink shrimp Team

Astoria: Jill Smith

Newport: Matt Blume and Kelly Lawrence

Charleston: Scott Groth, Kendall Smith and Dean Headlee

Brookings: Craig Good



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This annual newsletter is created primarily for Oregon's pink shrimp industry. We wish to thank the hard-working fishermen, plant staff, vessel owners and other industry members for their continued cooperation and assistance.

Last, we thank Bob Hannah for skilled mentorship in pink shrimp fishery research and management.

Good Luck Shrimping in 2019!

Oregon Dept of Fish and Wildlife:
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Charleston, OR 97420