28th Annual

Oregon Department of Fish and Wildlife · Marine Resources Program

# Pink Shrimp Review

2017

## What's Inside


2016 Summary..... 3
2017 Indicators..... 7
Research Priorities ..... 9
Regulation Info..... 10
Commission Issues..... 11
Other Topics ..... 13


## Have Questions?


**Contact:**
Scott Groth: Scott.D.Groth@state.or.us
Matthew Blume: Matthew.Blume@state.or.us
Jill Smith: Jill.M.Smith@state.or.us


**Visit Our Website:**
www.dfw.state.or.us/MRP/shellfish/commercial/shrimp

Oregon pink shrimp landings in 2016 were impressive, particularly when considering recent ocean conditions. More than 35 million pounds of pink shrimp were landed in Oregon, despite the expectation for a very low landing year typically following warm water "El Niño" events. Much of 2016 catch (87%) was of one year old shrimp from the surprisingly strong 2015 year class was first detected June 2015. Given their small size and large volume, they had to be actively avoided or mixed with older/larger shrimp until they became legal size in their own right by late 2016. These shrimp grew quickly, resulting in unexpectedly good catches toward the end of the 2016 season. We expect the first part of 2017 catch will be heavily influenced by this year class which will be age 2, and even larger come spring; abundance may be moderate.

## 2016 Season

**75** vessels

**lower** CPUE

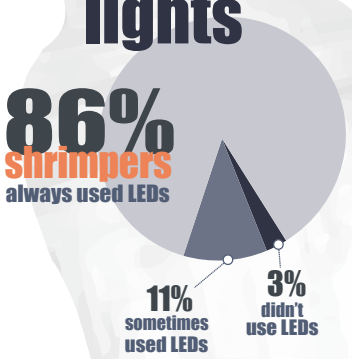
**35 million** pounds landed

**3rd highest** value of all time

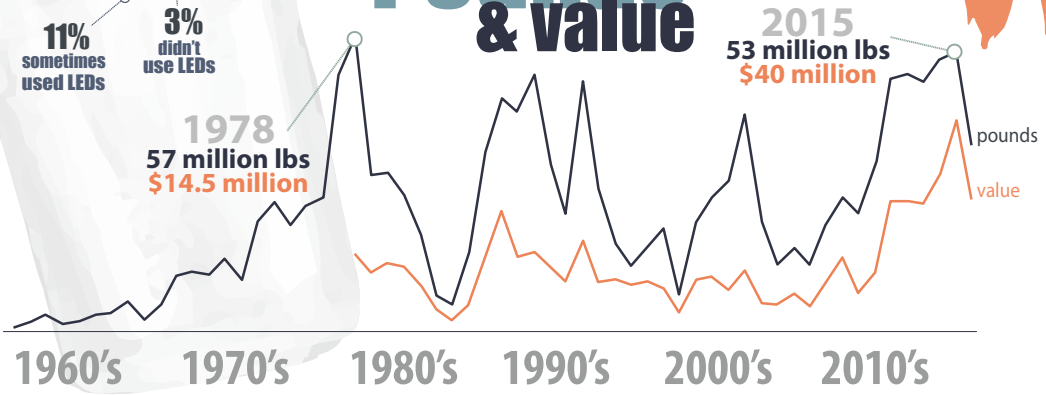
**$25 million** ex-vessel value

**Fewer** pounds than the past 5 years

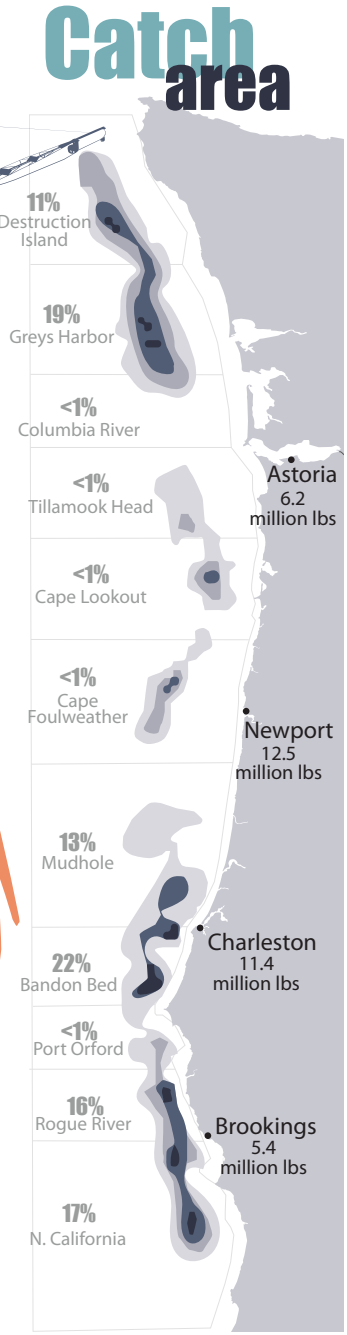
## LED lights



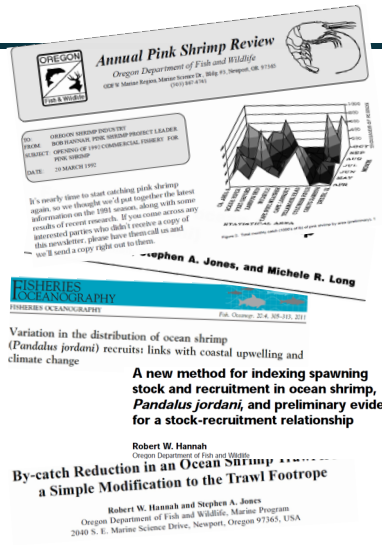

## Pounds & value




## Catch area

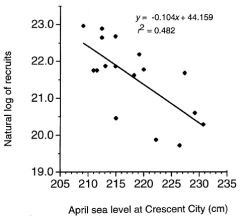


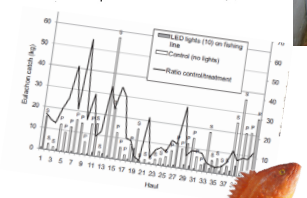
# Shrimp project staff changes

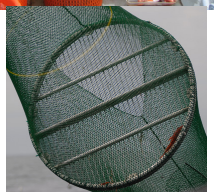




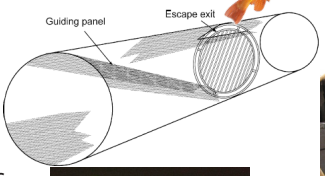
The 2016 pink shrimp season was a season of transition for not only shrimp stocks, but also shrimp staff. Three longtime staff members moved on to their retirements while job duties shifted and new employees were brought in.



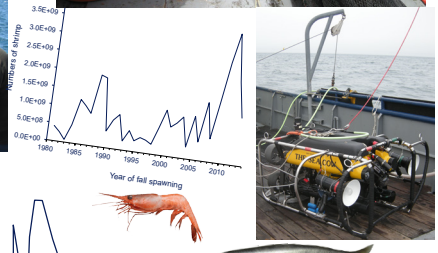



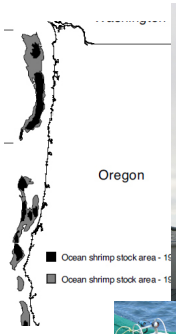
Bob Hannah and Steve Jones, together the principal managers of Oregon's pink shrimp fishery for the last 30 years moved on to their well-deserved retirements. In this role, they were the authors of this "Annual pink shrimp review" for the prior 27 editions! They leave a legacy of quality data, analysis, innovation, and continuous cooperation with an educated, professional industry that lead to many advancements in Oregon's pink shrimp fishery. Their work lead to the accurate understanding of the environmental drivers of the stock and effective bycatch reduction, which ultimately lends to the profitable, sustainable fishery. Future shrimp staff will benefit from their hard work and strive to meet their level of skill.

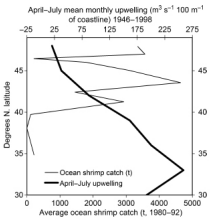


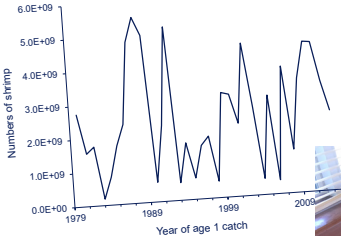

The retirement of the shrimp project leader and assistant project leader necessitated their replacement. Scott Groth, who has worked closely with Bob and Steve on the pink shrimp project will absorb Bob Hannah's duties as pink shrimp project leader, and do so from Charleston. Matt Blume, will assume much of Steve Jones's role in Newport. Though Matt is new to the pink shrimp project, he's worked at ODFW for many years performing at-sea research.


Jim Heinrich, shellfish sampler in Charleston, moved on to his second retirement after 8 years of excellent service to shellfish stocks and users. Jim did much of the groundwork on shrimp in Charleston in recent years, entering logbook data accounting for more than 124 million pounds of shrimp and measuring more than 1600 meters worth of shrimp carapace lengths!




# 2016 Season Summary

While it fell short of recent measures, 2016 was an excellent season relative to the long-term history of the fishery. Landings exceeded long term averages, effort was similar to recent years, efficiency (catch per unit effort (CPUE)) lowered, and value was high (3rd most all-time). Overall, quite a success! Here, we summarize landings, effort, efficiency, value, and stock dynamics of pink shrimp from Oregon landings.

## Landings Data

To understand fluctuations in fisheries over time, data from landings are useful metrics. For Oregon landings of pink shrimp, we examine the number of pounds harvested, the number of vessels participating, the number of directed trips performed and the average landed weight of each year's trips.

35.5 million pounds of pink shrimp were landed into Oregon in 2016, the streak of five consecutive ~50 million pound seasons came to a predictable end (Figure 1). While the number of vessels (Figure 2) and trips (Figure 3) remained similar to recent years, pounds per trip reduced (Figure 4). 2016 landings are decreased from recent history, but beat the 20 year average (29.4 million pounds from 1996-2015).

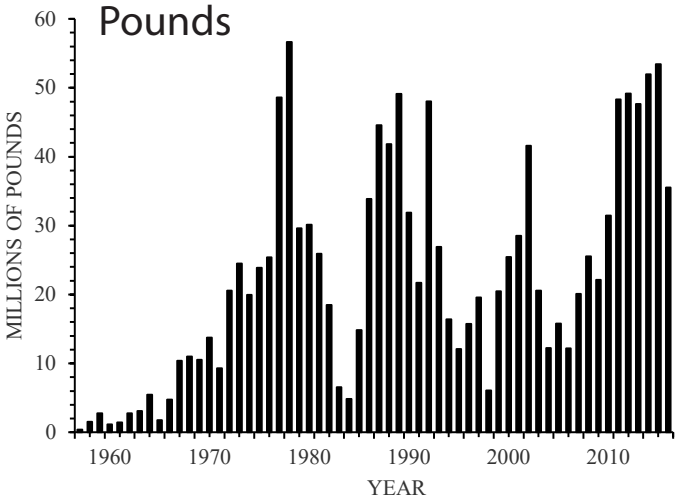



Figure 1. Annual Oregon pink shrimp landings by year (millions of pounds): 1957-2016

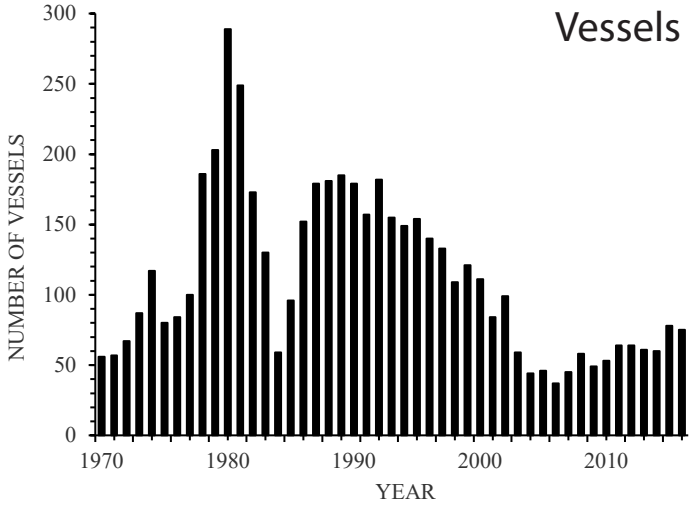



Figure 2. Annual number of vessels landing pink shrimp into Oregon: 1970-2016

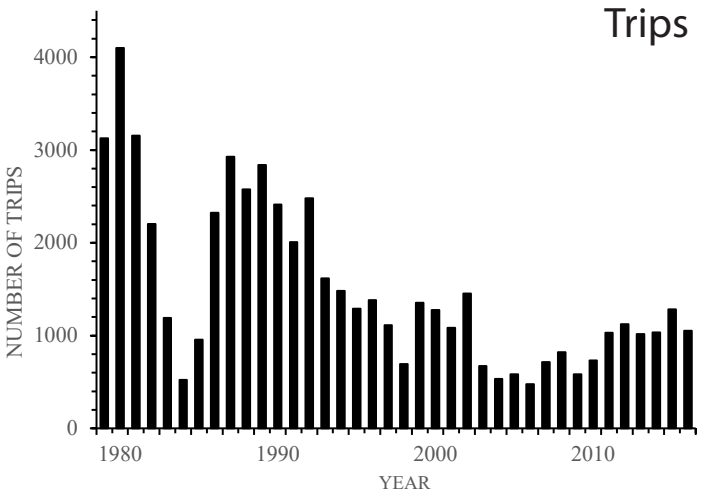



Figure 3. Annual number of trips landing pink shrimp into Oregon: 1979-2016

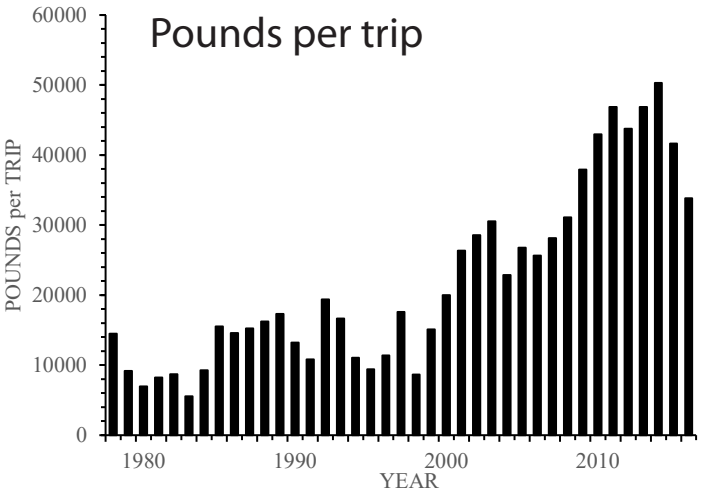



Figure 4. Annual average catch-per-trip (pounds) for shrimp vessels landing into Oregon: 1978-2016

# 2016 Catch Area

A popular section of each years pink shrimp review has been catch area; describing how much shrimp was caught in each state area each month. We've typically used 3 dimensional graphs as below (Figure 5) to illustrate this, but as you might have noticed from the front page, we're adding something new. The "heat map" to the right (Figure 6) is the result of analysis of catch over area from throughout the season. The darker the area, the greater the amount of shrimp caught in each area. Something similar would be popular graphics used in baseball that show where a pitcher throws relative to a strike zone. This new heat map can aid in understanding of 1) the size of the shrimping area (known to vary based on population) and 2) the hot spots from the previous year.

In 2016, the fleet was compressed to different areas, depending on seasonal stock conditions. As the year began, southern areas were the only place to fish; mid coast abundances were low and northern area shrimp were simply too small. By mid-summer, northern area shrimp had grown to legal size and were fished intensely. By the end of the year, catch was surprisingly excellent near Coos Bay (Figure 5).

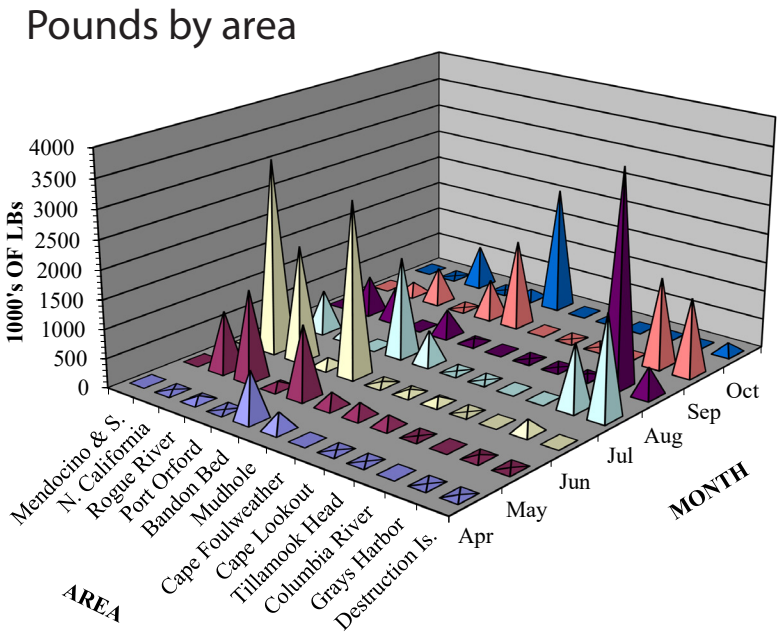



Figure 5. Estimated weight (thousands of pounds) of pink shrimp caught in each area by month that were landed into Oregon during 2016.

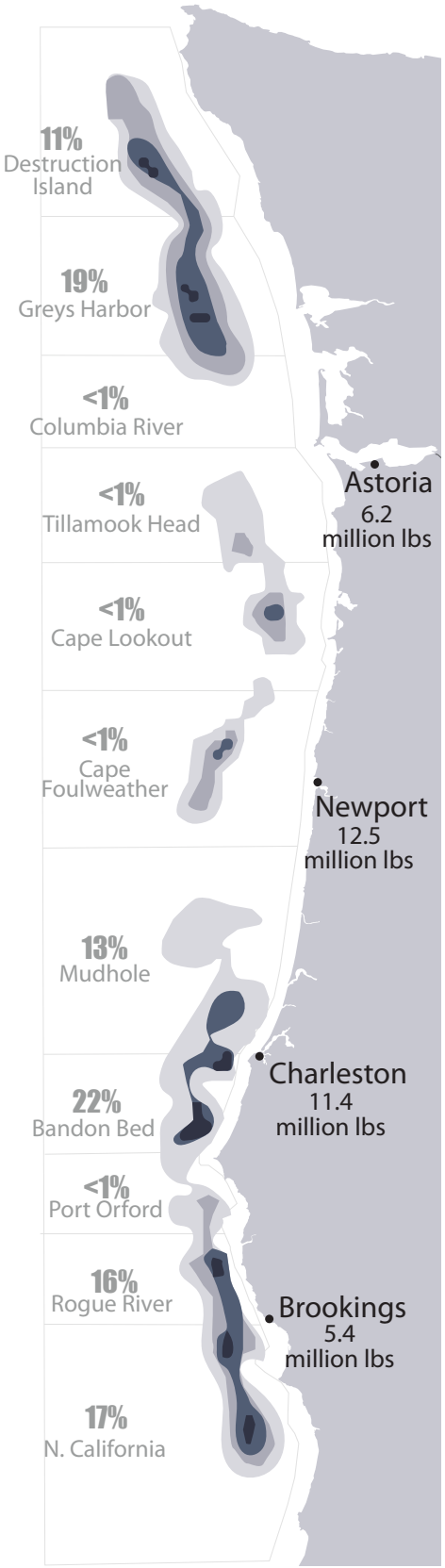



Figure 6. Heat map of pink shrimp catch by state statistical areas for 2016 Oregon deliveries and amount of pounds delivered to each port. Note: darker areas indicate increased catch levels.

# Effort (hours fished)

Effort was similar to recent years, but lower than historic numbers (Figure 7). Hours of effort are displayed in units of Single Rig Equivalent Hours (SREH), meaning that single rig hours are counted as is and double rig hours are multiplied by 1.6 (as double rig is known to be approximately that much more efficient). Effort by area and month mirrored trend to catch, lots of effort in the south early, then north, then again in the south in the fall (Figure 8).

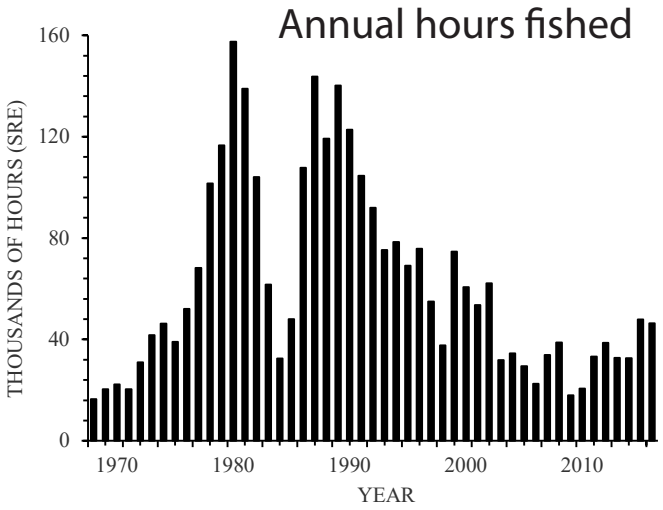



Figure 7. Annual hours (1000's of SRE) spent trawling for pink shrimp that were landed in Oregon, 1968-2016.

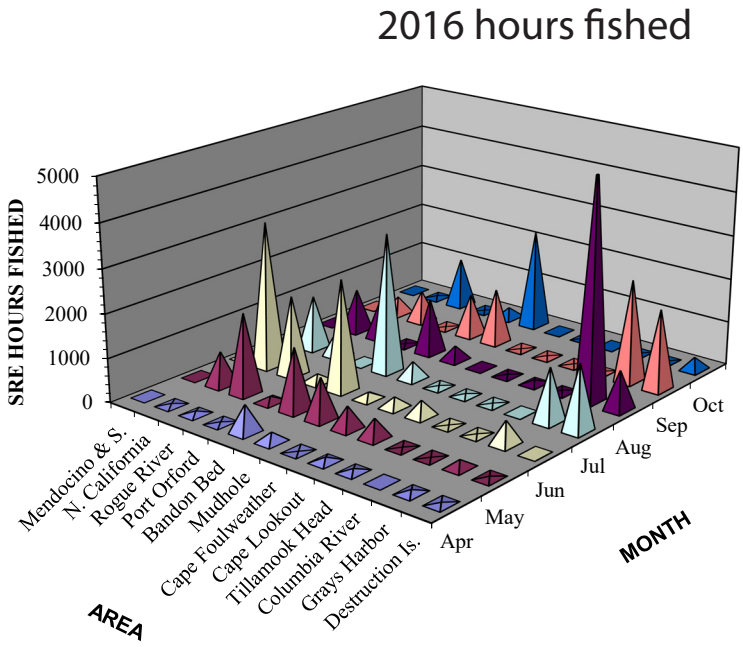



Figure 8. Estimated total hours (SRE) spent trawling for pink shrimp in each area by month during 2016.

# Efficiency (CPUE)

Annual efficiency, measured in catch per unit effort (CPUE) reduced to numbers similar to those in the mid 2000s (Figure 9). CPUE is calculated by taking the amount of catch and dividing by hours (using SREH). Lowered CPUE in 2016 alludes to lower abundances, likely due to the weak 2014 year class of shrimp (the 2 year olds in 2016).

Over the course of 2016, CPUE was steady in the south, while consistently improving in northern areas, as the dominant 1 year old year class grew to legal size (Figure 10).

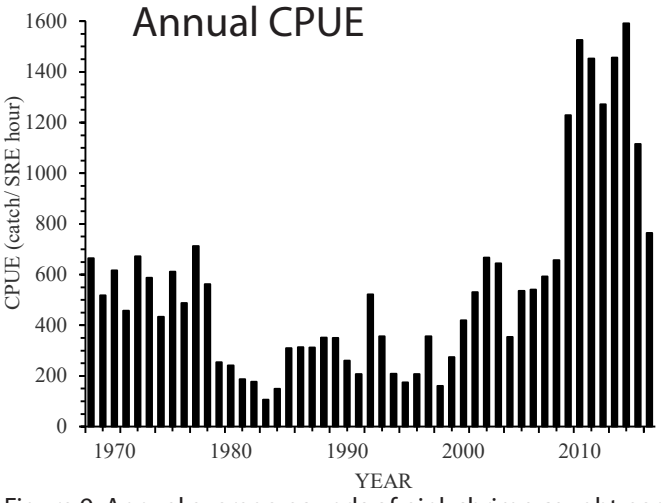



Figure 9. Annual average pounds of pink shrimp caught per hour (SRE) for vessels landing pink shrimp into Oregon; 1968-2016.

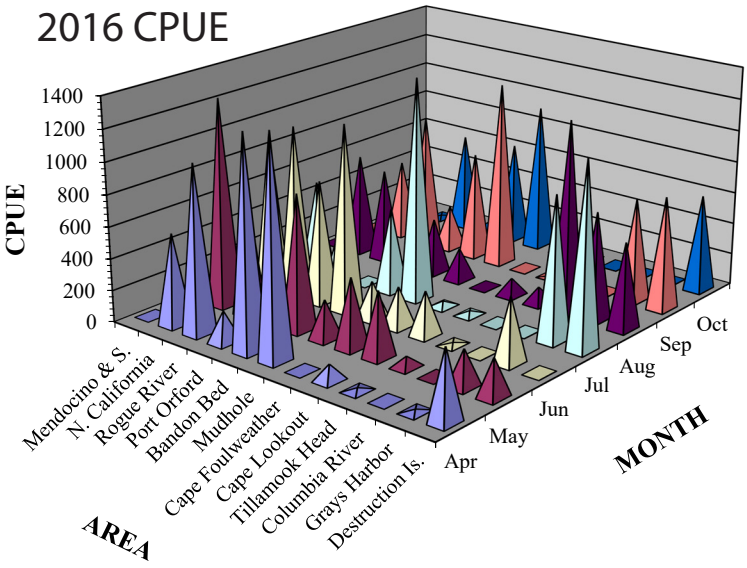



Figure 10. Estimated average pounds of pink shrimp caught per hour (SRE) by area and month for vessels landing pink shrimp into Oregon during 2016.

# Value

Although 2016 didn't yield as much volume as recent years, the total value was third most all time. Ex-vessel value in 2016 was 25.1 million dollars, down from last year's record setting season (Figure 11). A continued emphasis on quality product delivered to markets that demand sustainable fishery products aided the continued high price per pound of Oregon pink shrimp. Average price in 2016 was 71 cents per pound (Figure 12).

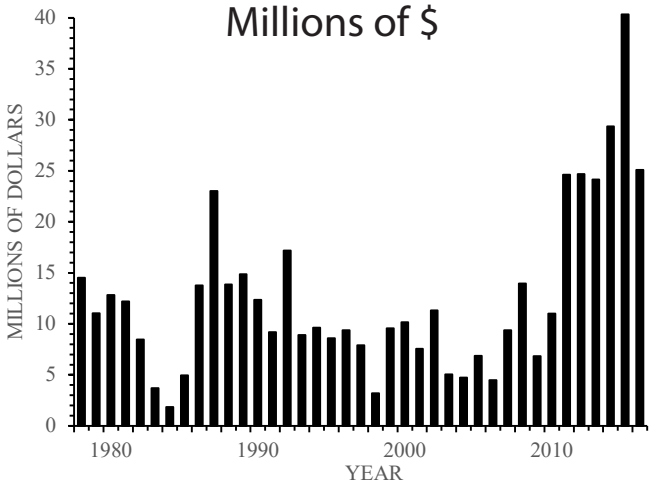



Figure 11. Annual ex-vessel (millions of dollars) of pink shrimp landed into Oregon from 1978 through 2016.

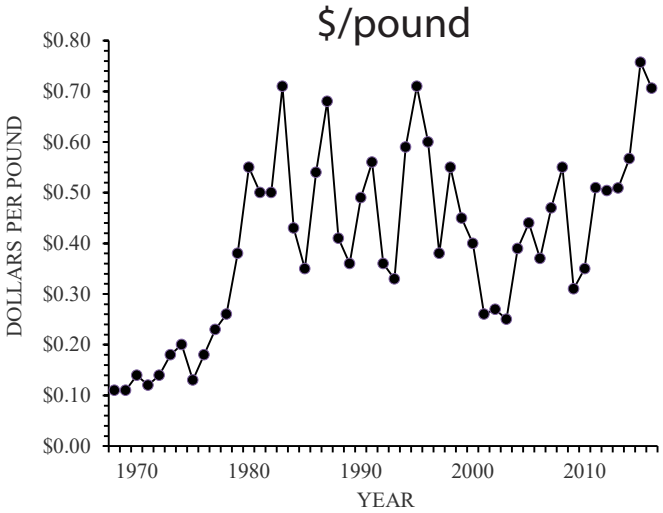



Figure 12. Annual average ex-vessel price-per-pound paid for pink shrimp in Oregon; 1968-2016

# Age and Size

Using data from biological samples, we assess the age composition of shrimp delivered to Oregon by month and area. Pink shrimp live short lives and grow quickly; stocks are typically composed of 3 year classes. Typically, age 1, 2, and 3 are found in the first half of the season, then age 0,1,2 in the second half. In 2016, stocks were comprised of shrimp released as eggs during the springs of 2013, 2014, and 2015; by September of 2016, age 0 shrimp (the shrimp released as eggs in April 2016) were first detected. 87% of 2016 catch was of age 1 shrimp, the 3rd highest percentage of age 1 shrimp we've seen (Figure 13). These shrimp were from the same year class caught in great quantities during the fall of 2015 as age 0. Age 2 shrimp are normally a major component of the catch, however were only weakly present in 2016. The dominance of age 1 shrimp in 2016 catch caused average count per pound to be higher than past years (Figure 14).

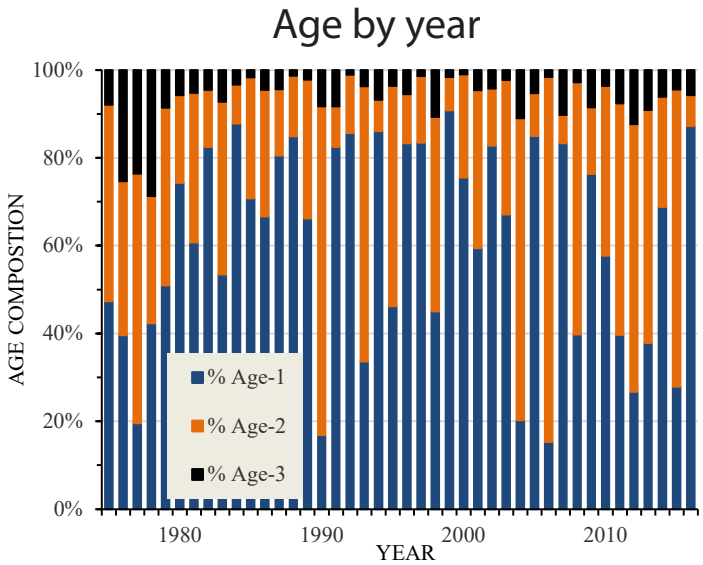



Figure 13. Annual percent age composition of pink shrimp landed in Oregon; 1975-2016

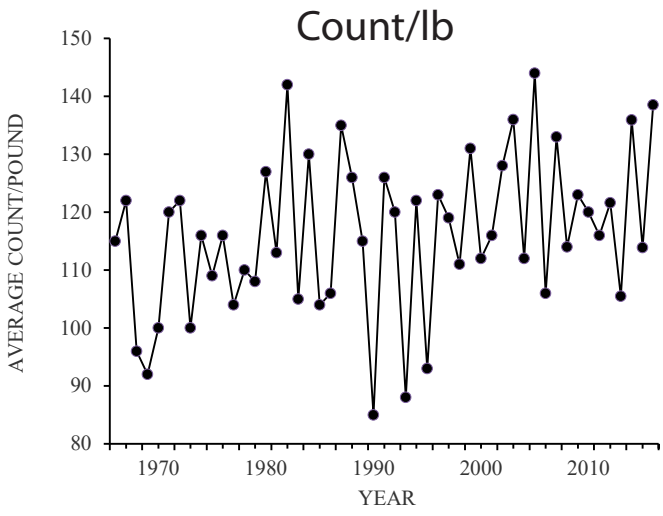



Figure 14. Annual average (catch weighted) count-per-pound (count) of pink shrimp landed into Oregon; 1966-2016

# 2017 Indicators

Given the fishery statistics from 2016, we expect the 2017 season to be of moderate volume (in the context of historic average) with no initial count per pound issues. Depending on how well the age 2 shrimp hold up, count per pound issues could arise by summer.

To predict what the pink shrimp stock may look like in the upcoming year, two elements must be considered from the past year:

1) **Abundance** (how many shrimp) and,

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

First, a quote for reminder:

*"Prediction is very difficult, especially about the future."*
-Niels Bohr

## Abundance

Pink shrimp abundance is very difficult to predict, however, by using long-term data from the fishery and weather stations we can estimate future returns. Generally, the number of shrimp larvae which survive and recruit to the fishery are a result of the oceanographic conditions in the year they are born. If, when larvae are released in the spring, conditions are favorable (early spring transition and strong southward currents), the year class tends to be more robust.

The below recruitment model compares the number of shrimp caught from a given year class (e.g. "2013" shrimp were caught in 2013 at age 0, 2014 at age 1 and 2015 at age 2, and 2016 at age 3) to the sea level height in Crescent City.

Given the oceanographic conditions, recruitment in 2014 and 2015 was expected to be very low, but 2016 is expected to be higher (Figure 15). Worth noting on this graph was the tremendous larval survival of the 2013 year class (in italics); this comprised much of the 2014 and 2015 catch (totaling over 5 trillion shrimp caught from this year class). Unfortunately, the 2013 year class has reached their life span (~3).

The "***recruitment index***" is a measure of how many shrimp from any particular year class were in the catch. Each year class are tracked for 4 years, added together then matched to the corresponding "environmental variable" from the year of larval release.

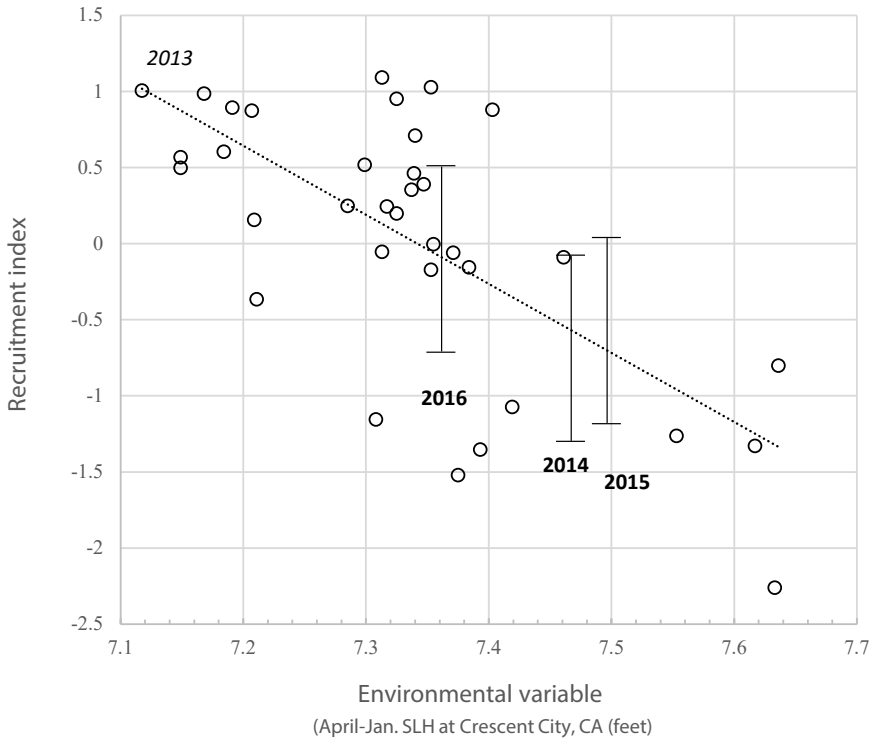



Figure 15. Pink shrimp recruitment model. A key environmental variable (mean April-January sea level height in Crescent City, CA) works as predictive measure for total pink shrimp recruitment in each year.

Each dot on this graph represents a year, dating back to 1979.

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

The "***environmental variable***" used in this model is sea level height (SLH) from April to January in Crescent City, CA. Why sea level height? Sea level height varies by year and by month based on wind direction and intensity; these factors are known to affect the larval survival of newly hatched shrimp.

# Age/size distribution

Crustaceans lack hard structures for ageing such as ear bones (otoliths) used in fish ageing, thus other means must be used to determine their age. 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 taken, aggregated, then compared to other time periods to determine age and growth. As pink shrimp stocks are of mixed ages, they must be separated using statistical analysis and a biological understanding. A primary method of tracking fishery stocks is the evaluation of these size distributions to determine the relative proportion of each year class.

Measurements of shrimp size are aggregated by time and area then analyzed to understand population trends. Each graph tells a story; in the example to the right (Figure 16), there are many age 1 shrimp, then a few age 2 and 3. While a single graph is like a picture, comparing changes in these graphs over time gives a bit of a moving picture. 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 amount of ages can be tracked along multiple graphs. Arrows track year classes and indicate rate of growth as they move to the right. These graphs look a little complex at first, but once understood, visualization of changes to populations are eased (Figure 17 and 18).

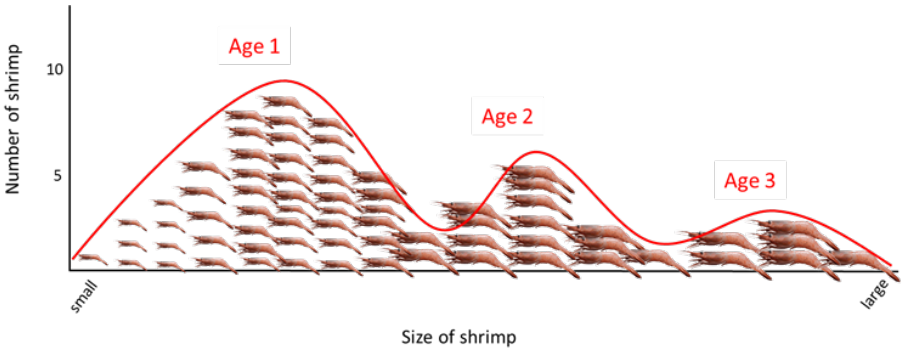



Figure 16. Hypothetical multimodal size distribution of shrimp

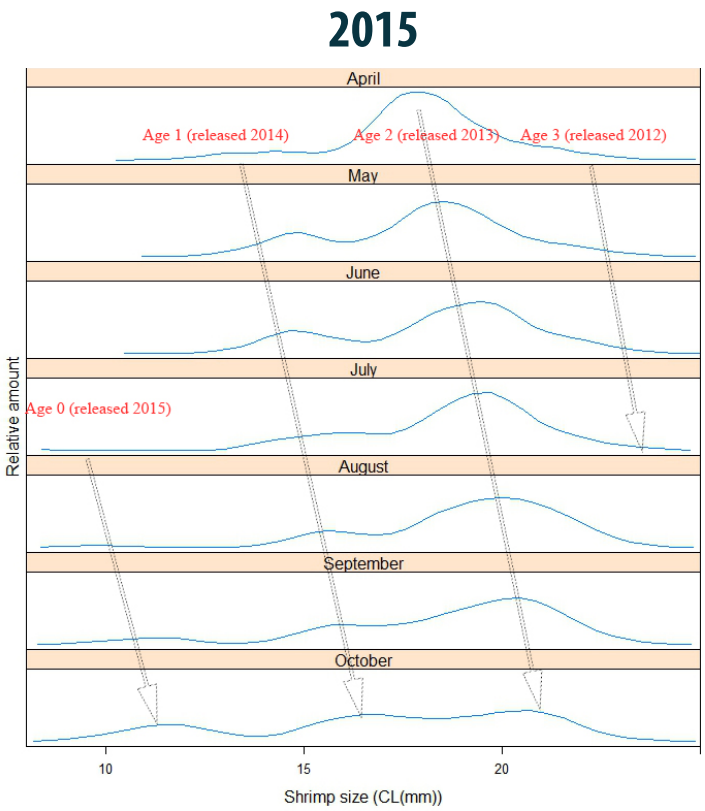



Figure 17. 2015 Oregon pink shrimp size distributions by month. Notes: Age 0 shrimp (released as eggs only a few months prior) are detected first in samples in July, then become a large part of samples by the end of 2015: age 1 shrimp were less prevalent than typical, age 2 shrimp were a major part of catch (this year class was one of the most abundant on record), age 3 shrimp were a small part of catch.

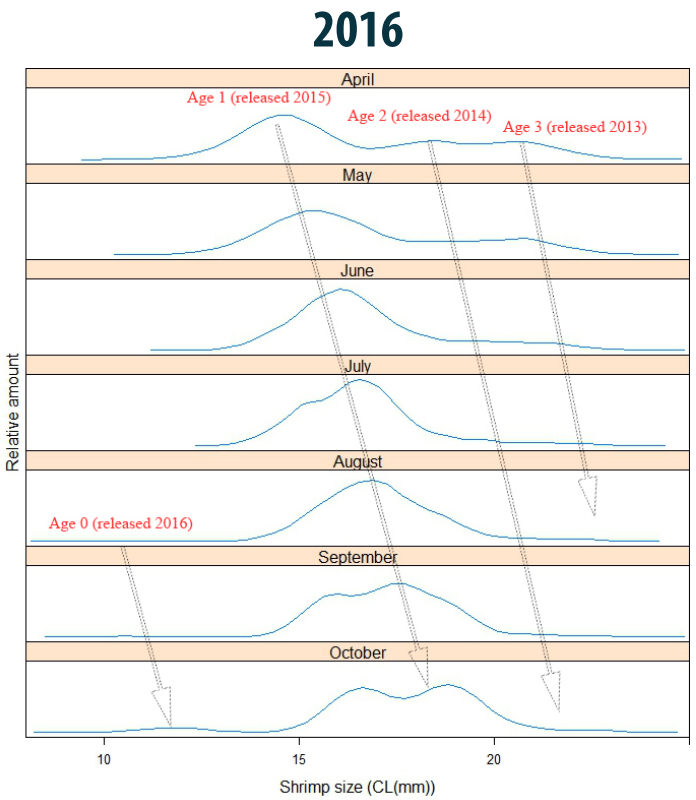



Figure 18. 2016 Oregon pink shrimp size distributions by month. Notes: Age 0 shrimp are first detected in samples in August (given their small size, any detection of age 0 shrimp is a good sign); age 1 shrimp were a huge part of 2016 catch, not surprising given the high proportion of age 0 in October 2015, age 2 shrimp were a small part, given the weak recruitment of 2014; typically, few shrimp live until age 3: given the big recruitment of 2013, there were still a fair amount in the first months of the 2016 season, easing count per pound issues.

# 2017 Forecast

In 2017, pink shrimp stocks will be comprised of 3 year classes; these were released as larvae from 2014 to 2016. Prediction from the recruitment model (Figure 15) showed that conditions for larval survival in 2014 and 2015 year classes should be weak, while 2016 is moderate.

So far, the recruitment model seems to have held true for the 2014 year class, but 2015 year class (age 0 in 2015 (Figure 17), age 1 shrimp (Figure 18)) were present in better than expected numbers. Detection of a few age 0 shrimp at the end of 2016 bodes well for the models prediction of that year class (Table 1).

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

| Larval release year | Age in 2017 | Prediction (recruitment model) | Observation (age/size distribution) |
|---|---|---|---|
| 2014 | 3 | Weak | Weak |
| 2015 | 2 | Weak | Moderate-strong |
| 2016 | 1 | Moderate | Moderate |

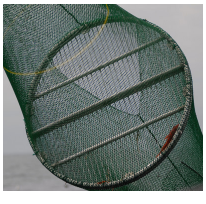
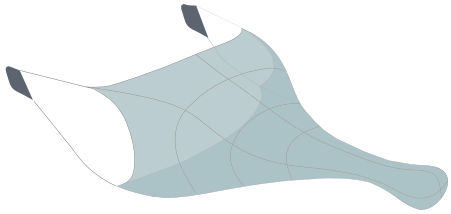
# Research Priorities

Starting in 2013, we changed the format of this section presenting our research plans for the upcoming year. The change addresses an MSC requirement that the shrimp project formalize its approach to planning for the fishery-related research that we do. In our new format, we address three research areas briefly every year: shrimp population dynamics, non-target catch and ecosystem effects. Note that although we address each priority every year, we don't necessarily have planned activities for all three every year. In interpreting the 2017 plan presented below, it should be noted that regardless of what priority is assigned to any particular research plan component, the completion of work in any given year will always depend on staff and equipment availability and the amount and type of funding available. The availability of research funding can be highly variable from year to year.

***Shrimp population dynamics (Priority 1);***
Our ongoing efforts to sample the fishery, analyze sample and logbook data and periodically evaluate our environmental models, trends in the fishery and any new evidence relating to fishery-driven stock declines is our top priority. This work is our top priority because it is the basis for managing the fishery the way we do, using primarily just a 7-month season, limited entry system and a maximum count-per-pound regulation. In 2017, this component of our research plan will consist of three primary activities. First, we will continue with our basic monitoring program consisting of fishery sampling and collecting and analyzing logbook data to estimate total catch-at-age and effort by area. Second, we will update our shrimp population models and re-evaluate how environmental effects continue to influence shrimp recruitment. Lastly, we will fully convert to electronic caliper measurements for shrimp and store data in a new format that allows shrimp samples to be evaluated individually, increasing our ability to understand shrimp populations.

***Non-target catch (Priority 2);***
During 2017, we will further examine use of LEDs in bycatch reduction. In collaboration with the Pacific States Marine Fisheries Commission (PSMFC), we plan to spend as much as 16 days at sea testing effects of different LED configurations along the fishing line of pink shrimp trawls. The LED configurations used during the 2014 research were green Lindgren Pittman Electralume® LED fishing lights, spaced approximately 4' apart along the center third of a trawl fishing line. The 2017 experiments will further test the use of LEDs and determine how catches of eulachon, darkblotched rockfish, other fishes, and ocean shrimp are affected by 1) altering the number of lights attached along the central portion of the trawl fishing line, and 2) attaching lights along the fishing line of the trawl wings as opposed to the central portion. The goal of this work is to understand the most efficient way to use LEDs for reducing bycatch.

***Ecosystem effects (Priority 3)***
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.).

# 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.

***New sorting requirements for landings:***

In May of 2016, the Pacific Fisheries Management Council and the National Marine Fisheries Service adopted regulations for federal waters (outside 3 miles) to protect forage fish by prohibiting new directed fishing on a suite of species, including some that are caught as bycatch in the shrimp fishery. In September of 2016, the Oregon Fish and Wildlife Commission (OFWC) adopted complementary regulations for state waters (0-3 miles offshore), and the description of intent in the form of the Oregon Forage Fish Management Plan (OR-FFMP). The OR-FFMP includes the same suite of species that are in the federal plan, such as smelts, anchovies, squids, and others.

*How does this affect shrimp fishing?*

The regulations (both Federal and State) allow discard at sea of the relevant species; State regulations now require new sorting categories and process for all fishery landings that include relevant species. Per standing rules, landed species which have a market category (e.g. hake, eulachon smelt, rockfish, etc.) must be weighed and included within the landing fish ticket. Beginning this year (as of January 1, 2017 for all fisheries), there is a new market category to separate out Humboldt squid and a new category for a "miscellaneous tote" which must be weighed and included as well. With these two new categories, we will be able to track 100% of the weight of landings, and we will improve our understanding of the species (catch and bycatch) that hit the docks. Over time, we will be able to detect major changes in bycatch. For more details, please see the plan here: http://www.dfw.state.or.us/mrp/ffmp.asp. For questions regarding fish tickets and reporting, please contact Nadine Hurtado, Commercial Fisheries Information Program Leader (503) 947-6247.

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 Banks, Daisy Bank, Stonewall Bank, Heceta Bank, Coquille Banks | Grays Canyon (see WA regs) |
| Mesh size | | Minimum 1-3/8" | No minimum | |
| BRD | | ≤ ¾" spaced rigid grate | | |
| 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 Regulations details: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=123803&inline, pages 81-84.
**OR Regulations details: http://www.dfw.state.or.us/OARs/05.pdf, pages 28-32.
***WA Regulation details: http://wdfw.wa.gov/fishing/commercial/shrimp/license_permit_requirements.html
**** NMFS published groundfish limits: http://www.westcoast.fisheries.noaa.gov

# Commission Issues

At the end of the 2017 pink shrimp season, ODFW intends to propose two issues regarding the pink shrimp fishery to Oregon Fish and Wildlife Commission (OFWC):

1) We will propose adoption of the Fishery Management Plan (FMP) for Oregon's pink shrimp drafted last year.

2) We will propose a regulation, practical for shrimpers, requiring the use of LEDs.

Please review the following information and provide comments on these two issues prior to August 1, 2017.
The best way is via email to : Scott.D.Groth@state.or.us, though we always like to talk with you in person.

## Pink Shrimp Fishery Management Plan

The Oregon shrimp fishery was recertified for five years in 2013. One of the conditions of recertification was the development and adoption of a formal pink shrimp Fishery Management Plan (FMP). To meet this requirement, we have developed a draft FMP and seek industry input. We encourage industry members to read the plan and to comment to us (Scott Groth or Matt Blume) by the end of the 2017 shrimp season. The draft document's short introduction provides a good overview of what it covers, so we'll quote it here:

"The Oregon trawl fishery for ocean shrimp (Pandalus jordani) is managed by the Oregon Department of Fish and Wildlife (ODFW) as a sustainable fishery, however, historically it has been managed without a written state fishery management plan. The purpose of this initial fishery management plan is to document ODFW's management objectives, regulations, fishery controls and fishery monitoring activities that are designed to maintain the long-term sustainability of the fishery. It is anticipated that this management plan will be updated whenever there are significant changes in the fishery or the regulatory environment or at least every 10 years. The structure of this draft management plan follows, to the extent practicable, the draft framework for Oregon Fishery Management Plans.".

The draft document is available on the ODFW web site at: http://www.dfw.state.or.us/MRP/publications/#Shrimp

## LEDs

By dramatically reducing bycatch in a simple and inexpensive way, LED lights have changed the game in the pink shrimp fishery. In 2014, LED fishing lights placed on the "fishing line" of the footrope of pink shrimp trawls were discovered to have dramatic reduction in bycatch (Figure 19). In experiments conducted by ODFW and PSFMC, then published in the peer reviewed journal "Fisheries Research" (May 2015), LEDs showed a 91% reduction in eulachon smelt bycatch. While minimizing bycatch is an overall goal for Oregon's fisheries, eulachon is listed as "threatened" under the Endangered Species Act (ESA), so there is a particularly strong need to minimize bycatch of this species.

LED fishing lights illuminate the shrimp net, allowing fish to see a way to avoid the net completely (Figure 21). The addition of light to the deep, dark environments of shrimp grounds appear to have the most benefit to strong swimming fish. Bycatch of stronger swimming fish (e.g. smelts, rockfish, and flatfish) are markedly reduced while other species, such as hake (and thankfully shrimp!) appear unaffected.

*Use by shrimp fleet:*
Use of LEDs has been high among the Oregon pink shrimp fleet. In 2016, we talked to 66 vessels landing shrimp into Oregon; of these, 57 vessels reported using LEDs 100% of the time, 7 reported using them sometimes (depending on bycatch rates, deferred maintenance cost, etc.), and 2 reported not using them at all. NMFS observer data from 2015 showed that of the 2,137 hauls observed: 1,466 used LEDs, 66 did not use LEDs, and on the 605 remaining hauls, this data was not reported.

Figure 19. a divided shrimp hopper where no LEDs were used on the left side and LEDs were used on the right side, notice the marked difference in eulachon smelt (the silver fish).

# LEDs (continued)

*How to install LEDs*

Research found that proper installation of LEDs is key to bycatch reduction. Installation should occur at the fishing line, shining down on the escape area (Figure 20). Conversely, when experiments put LEDs on the shrimp grate, it doubled the take of key bycatch. These results highlight the importance of proper installation at the fishing line with a good clearance below (drops) for fish to escape.

2014 experiments used Lindgren- Pittman (LP) Electralume® lights; these have been found to be inexpensive and durable. ODFW surveys from 2016 showed that 97% of the fleet using LEDs, primarily used this model. From feedback in the fleet we estimate that each well cared for LP LED (retails for $39.95 each) may last an entire season. These lights are designed to be powered by lithium AA batteries, which are more expensive, but last longer and shine brighter than alkaline batteries. While cost is additional to fishing operation, skippers using them attested that the decreased cost of sorting the cleaner catch more than recovers these costs. Based on 2014 experiments, we recommend that LEDs are used at 4' increments (minimum) in the center third of the net. In a double rig set up of 90' net this would require 18 lights (9 per side). Many boats that have chosen to use brighter configurations and have observed further decrease in bycatch with brighter lights.

*LEDs in regulation:*

As outlined in the 2016 pink shrimp newsletter, ODFW plans to propose regulations requiring LED use, to assure their continued use. LEDs dramatically reduce the bycatch of ESA listed eulachon smelt, are practical to use and inexpensive. Nearly every skipper we've talked to who use them, do this to increase the efficiency of their operation via bycatch reduction. Fleet wide use of LEDs will be necessary to assure good standing as a sustainable fishery and prevent more restrictive actions (e.g. bycatch quotas) in the future. In their "Eulachon Draft Recovery Plan" National Marine Fisheries Service (NMFS) identified work with agencies and industry to implement LED rules as a top priority.

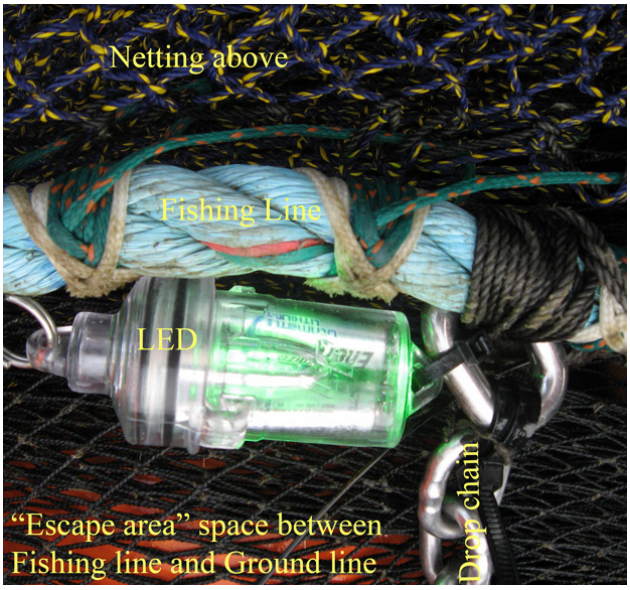



Figure 20. Proper LED placement on the fishing line, the upper line of a shrimp trawl. Fish swim out between the fishing line and the groundline, un-entrained by trawl.

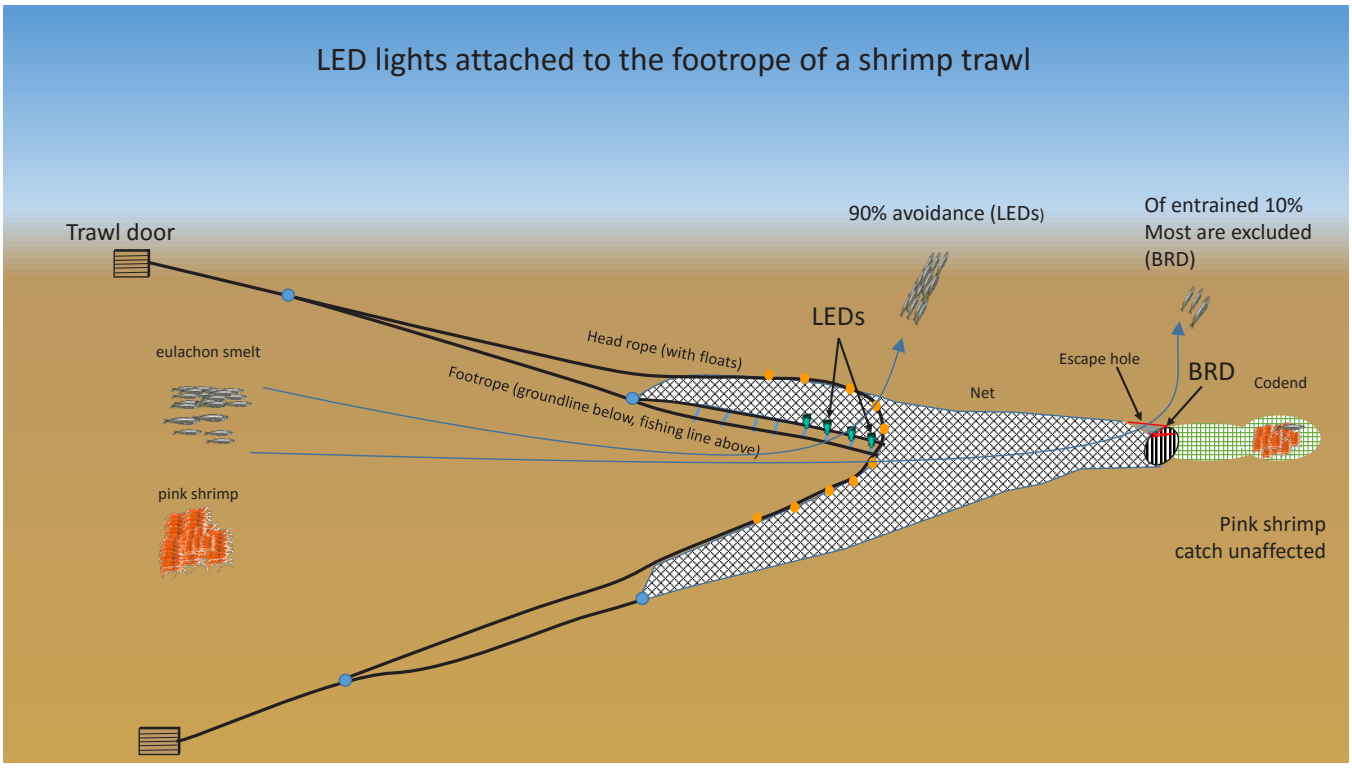



Figure 19. schematic of modern pink shrimp trawl net, illustrating the exclusion of eulachon smelt by LEDs and BRD

# Other topics

## Enforcement news

**OSP "Marine Team" training:**
Given the high percentage of age 0 shrimp in samples at the end of 2015, count per pound enforcement was expected to be an issue in 2016. Prior to the 2016 season, ODFW staff worked with the newly formed OSP "Marine team" for training on the methods for determining legality of loads.

***Count per pound issues:***
Despite an overwhelming number of age 1 shrimp, count per pound issues were mostly avoided. Only one count per pound issue came up, from a shrimper working in Washington early in the season. The fleet did an excellent job avoiding small shrimp in 2016. A brief "stand down" in early May occurred when the fleet reacted to this high volume of small, age 1 shrimp. While the actual timing when age 1 shrimp are legal without some mix of older/larger shrimp is typically fall, this stand down was a good showing of awareness by the fleet. As pink shrimp populations are highly dynamic, each year brings a new set of circumstances and adaptation/ communication among the fleet is of extreme value. Overall, it is very impressive that no major count per pound issues arose given 2016 pink shrimp population dynamics.

## Slime eel gear

Over the years, we've heard increasing concern for hang-ups from derelict or poorly marked slime eel gear (Figure 20A). As a way to understand the breadth this problem, we ask that you add a "note" on that column in your ODFW shrimp logbook, on tows where slime eel gear is encountered.

Figure 20.
A) slime eel pot caught in shrimp trawl lines

B) Pacific hagfish aka slime eel, a face only a mother could love

## Jellyfish

With extreme changes to oceanographic conditions, there are winners and losers. Warm water conditions like those caused by El Niño conditions of 2015-2016 saw big upticks of many species which thrive in warm water, fouling shrimp nets (Figure 21). Jellies became so abundant in the summer of 2016 that shrimpers used innovative methods to reduce clogging of nets and BRD's. Oversize rectangular BRD grates were used to optimize water flow through nets, some reported more success than others using these.

Figure 21. Jellyfish fouling a shrimp net (photo courtesy of Matt Hakki, F/V Big Wave)

National geographic ran an informative article on the 2015-16 El Nino and the Pacific "blob" of warm water:

http://www.nationalgeographic.com/magazine/2016/09/warm-water-pacific-coast-algae-nino/

## MSC news

Oregon's pink shrimp fishery was the first shrimp fishery in the world to be certified "well managed and sustainable" by the Marine Stewardship Council (MSC). This certification recognizes the hard work of Oregon's pink shrimp industry, Oregon Trawl Commission (OTC), and ODFW. The certification is something for all Oregonians to be proud of and is an invaluable tool for promoting Oregon pink shrimp, especially to those markets that demand only sustainable seafood products.

As part of the certification, annual surveillance audits are conducted, assuring that the fishery continues to be sustainable into the future fishing and minimize impacts. Oregon pink shrimp's certification expires in February of 2018, which means that the fishery will, once again, be up for re-certification. In the coming year, members of the pink shrimp industry, OTC, and ODFW will be working hard to assure we continue to meet this prestigious certification standard.

## Egg bearing "zero"

In April of 2016 we found the smallest females ever recorded to be egg bearing. These shrimp, likely released as eggs only 12 months prior (April 2015) grew quickly to its size (13.6 and 14.4 mm carapace length) then matured as a female (Figure 22), about half the size when they typically make the change. Normally, during the first year of a pink shrimp's life, they are immature, but this shrimp beat the odds. Spring 2016 shrimp populations were dominated by males, surely a good time to make a switch if you can!


Figure 22. An age 0, ovigerous pink shrimp

## Primary females

With such short lives and highly variable recruitment, pink shrimp have adapted to change sex throughout their lives to balance male/female ratios of the population. Pink shrimp are protandrous sequential hermaphrodites; while this description is a mouthful, it simply means that pink shrimp typically mature first as males, then change sex to female. The timing of this sex change is fascinating, and has been found to be a social response. Imagine if your goal was reproduction and you could change sex to give yourself the best chance to do so. In this way, when a population is dominated by females, males will delay their sex change. Conversely, when few large, female shrimp are around, small, immature pink shrimp will often mature directly to female. These are known as "primary females" meaning, they were never male and functioned as females in their first year.

Toward the end of 2016, as a social response to a low number of 2 and 3 year old shrimp, our samples showed a high number of "primary females". This early change to females was a result of the population condition: a very weak year class (those released as larvae in 2014) is followed by a robust year class (those released as larvae in 2015). 2016 showed a high primary female rate by the end of 2016 (55% of one year old shrimp developed directly to female by October), these shrimp were fast growing and likely contributed to the quick improvement of count per pound within the year.

## Vessel lost

In 2016 we lost the F/V Patty AJ. The Patty AJ was an example of excellence in the fleet. In 2011, with her skilled captain (Ron Silva) and crew, she saved the lives of two fishermen when another vessel sunk prior to crab season. On March 23, 2016, the Patty AJ itself sunk just inside the jetties of Coos Bay, OR. Three crew members were rescued unharmed, very sadly however, the captain, Jerry Barkley was lost with the ship.

This author (Scott Groth) worked with Jerry Barkley for many years in Charleston, OR. Jerry always had a smile and a joke when we met on the docks. He was an example of positivity, undeterred from the condition of his hips he ran boats using two canes, never missing a beat. Soon after hip replacement he was spry again and equally upbeat. His handwriting was among the best in the fleet, I frequently kidded with him about how much that meant to me (as the one entering the logs). We often joked and shared funny stories about high school typing class. Jerry's boat was always neatly kept and crew satisfied.

We'll miss you Tex.

## 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, and,

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, and,

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.

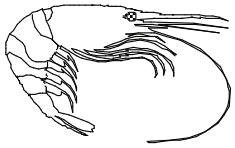
The pink shrimp project is spread out among the major ports of Oregon to:
1. Collect fishery dependent data (market samples and logbooks)
2. Assist and communicate with shrimpers.

## Acknowledgements

This project was funded in part by a grant/ cooperative agreement from the National Oceanic and Atmospheric Administration (NOAA). The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies. This project was financed in part with Federal Interjurisdictional Fisheries Act funds (75% federal, 25% state of Oregon funds) through the U.S. National Marine Fisheries Service (grant # NA15NMF4070412).

We wish to thank the Oregon pink shrimp industry for their contiued cooperation and assistance last year.

**Good Luck Shrimping in 2017!**



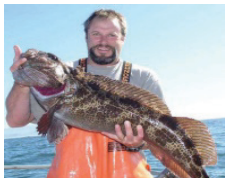
## Questions?

| | | |
|---|---|---|
| Scott Groth, project leader | | (541) 888-5515 |
| Matt Blume, assistant project leader | | (541) 867-4741 |
| Jill Smith, assistant project leader | | (503) 325-2462 |
| Licensing: | Julie Shryock | (503) 947-6142 |
| Fish Tickets: | Nadine Hurtado | (503) 947-6247 |

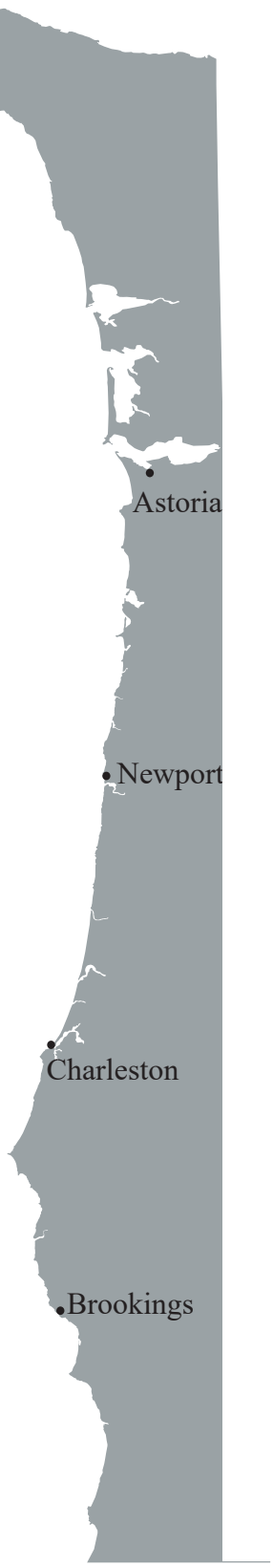
Astoria: Jill Smith
North Coast Shellfish Biologist
Phone: (503) 325-2462 x226
email: Jill.M.Smith@state.or.us

Newport: Matt Blume
Central Coast Pink Shrimp/
Groundfish Research Biologist
Phone: (541) 867-4741 x239
email: Matthew.Blume@state.or.us

Charleston: Scott Groth
Pink Shrimp Fishery Project Leader
Phone: (541) 888-5515 x233
email: Scott.D.Groth@state.or.us



Brookings: Craig Good
South Coast Port/Research Biologist
Phone: (541) 412-7364
email: Craig.D.Good@state.or.us



Oregon Dept of Fish and Wildlife:
2040 S.E. Marine Science Drive
Newport, OR 97365