Economic Impacts from Oregon Department of Fish and Wildlife Proposed Regulations for Whale Entanglement Avoidance

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SUMMARY

The Oregon Department of Fish and Wildlife (ODFW) proposed regulations in the Spring 2020 to lower risk of whale entanglements from interactions with vertical gear used in the Dungeness crab fishery. The regulations are intermediary until a final suite of measures are approved in an Endangered Species Act Section 10 incidental take permit (ITP) by the National Marine Fisheries Service. A humpback whale distinct population segment that transits the Oregon Coast is an ESA listed species. The Oregon Coastal Crab Association (an industry group) requested the Oregon Dungeness Crab Commission sponsor a study to determine economic impacts from the proposed regulations. We provide impact result information using an already developed interactive bio-economic model for the fishery. We offer discussions about the veracity of the prescriptive regulations given limited information about fleet capacity utilization. Finally, there is discussion about the procedural approach for gaining approval for an ITP. We advise that the approach will benefit from having a decision support tool in-place during ITP preparation and negotiations. As of the date for this study summary writing, the proposed regulations have not yet been brought before the Oregon Fish and Wildlife Commission for their consideration.

It was necessary to determine the validity for assessing current trend economic impacts given the bio-economic model's base period was seven seasons 2007-08 through 2013-14.[1] It was found the existing model calibration would not have been much different seasonally if it were based on a more recent period (four seasons 2014-2015 through 2017-2018). Several indicators were used including pot soak days. This indicator would be of interest to the concern for whale entanglement as it is a measure of gear line exposure to whale presence. The correlation coefficient for soak days trend was highly positive (r=.9395). Based on the indicator comparisons between the two periods, there is argumentation and statistical confidence in continuing to use the model without re-calibration. There is a difference in average season revenue between the two periods. The model's price input variable was changed to reflect current period data for model output calculations relating to economic impact metrics.

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[1] Davis, S., Sylvia, G., Yochum, N., and Cusack, C.. Oregon Dungeness Crab Fishery Bioeconomic Model: A Fishery Interactive Simulator Learning Tool. Prepared for the Oregon Dungeness Crab Commission. 2017. Available at: http://oregondungeness.org/wp-content/uploads/2017/06/ODCC-crab-model-report-ver.-5.7.pdf

The assessment provided a more encompassing bracket around the proposed regulations by looking at two management alternatives:

Assessed Management Alternatives
1. Season closure starting the first day of April, May, and June.
2. Decreased effort by 10 percent, 20 percent, and 30 percent starting April, May, and June.

There is significant fishery fleet heterogeneity based on indicators for pot tiers, vessel length, Dungeness crab fishery tenure, exit/entry dates, and delivery numbers. Five vessel classes were statistically chosen to represent the diversity based on the key characteristics. "Early-exiters" leave the fishery by week 10, and "summers" remain in the fishery until almost the end of the season. The vessel class "miscellanies" have the highest per vessel revenue from the Dungeness crab fishery and the highest total per vessel revenue. This vessel class is highly diversified across fisheries as are the "early-exiters." "Summers" and "partakers" have the lowest total per vessel revenue and a large majority of their revenue is derived from the Dungeness crab fishery.

Economic impact metrics included changed community income. We only describe changed harvest value in this study summary. For example, the early season closure alternative on April 1 will result in a negative $2.5 million or 6.0 percent of the average base period harvest value. A June 1 closure would be 1.0 percent of the average base period harvest value. The 20 percent reduction on May 1 in allowed pots will result in a negative $157 thousand or .38 percent of the average base period harvest value. A 20 percent June 1 reduction is a negative $13 thousand or .031 percent of the average base period harvest value.

The bio-economic model is sensitive to abundance gains in future seasons due to deferred harvest mortality in present seasons. In regard to vessel class detail, an April 1 closure would mean the summers vessel class would lose an average $21,231 per vessel which is 16.4 percent of their fishery revenue. However, the early-exiters vessel class would gain an average $2,030 per vessel which is 1.8 percent of their fishery revenue. All vessel classes except summers have a very small gain in harvest value for the June 1 closure.

A 20 percent reduced effort on April 1 would mean the summers vessel class would lose an average of $3,446 in harvest value per vessel which is 2.7 percent of their fishery revenue. The early-exiters vessel class would gain $502 which is .45 percent of their fishery revenue. Again, all vessel classes except summers have minute gains in harvest value if the 20 percent reduction was in place starting June 1.

There were caveats for the economic impact assessment.

1) The ODFW proposed regulation for effort reduction included a 30-fathom depth restriction area closure. The model does not yet have a spatial structure to test management measures having zonal dimensions. The assessment assumed that participation would not be affected. However, it could be there will be decreased catch per unit effort (CPUE) due to increased fishing intensity and finding new grounds to avoid congestion will increase fishing costs.

2) A shift to other fisheries caused by a Dungeness crab fishery closure and reduced allowed gear was not included in the assessment. For both assessed management alternatives, there may be increased compensating revenue from other fisheries, but also the shift may dilute average vessel catch to others in those fisheries. If a Dungeness crab fishery permit owner does not have the other fisheries shift opportunity, there may be owner consideration for possible abandonment from Oregon fisheries due to solvency because of loss of Dungeness crab fishery revenue.

3) The assessed economic impacts are from harvester and processor effects and do not address effects on retail operations for the whole cooked fresh product market during the Oregon Coast summer visitor season. An improved assessment would look at the social and economic profiles of fishery participants to determine interrupted season impacts on harvester operations, processor market channels, and other effects such as displacement to other fisheries. A subset of the investigation would include participants who are vertically integrated in order to determine whether economic effects include regional retail sector operations.

4) The assessment is not itemized by ports. There is unequal vessel class distribution along the coast and negative impacts will be disproportional at ports with higher percentage of summer vessel types.

5) This study's assessment assumed a pot limit reduction was synonymous with effort reduction. However, there could be fleet behavior response that would not accomplish reducing actual on-ground gear deployment.2 There is significant dormant fishing power in the Dungeness crab fishery spring and summer season. Vessels that do not usually fish in that period could elect to participate. Permits not being fished may elect to participate. Another consequence is the current spring/summer participants could increase their participation in earlier months leading to congestion and lower CPUE.

6) An unknown for the assessment is whether the fleet is using the maximum tier pot counts during the spring/summer period. A fishing capacity utilization analysis has not been undertaken nor proposed. The proposed reduced allowed gear measure may need further effectiveness review through post implementation monitoring. If fished pot counts are less than 20 percent, then the reduced gear restriction regulation would be management invariant. Logbook information does not provide information about pots deployed. It only requires reporting of pot pulls and pot soak time per trip.

In summary, the proposed management measures have minor overall economic impact even with liberal assumptions about fleet response to gear and depth restrictions. However, there will be

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2 There is a 1,200 pound weekly catch quota after the second Monday in June and summer summed harvests cannot exceed 10 percent of season harvests in winter and spring (December through May). Fishery participants may elect only to pull deployed pot strings until the weekly quota is reached. Another regulation is gear must not be deployed more than 14 days without making a landing of Dungeness crab. This regulation is to counteract the effects from situations heard about during the Fall 2019 Industry Meetings that harvesters will simply leave pots in the ocean for storage until undertaking removal sweeping operations.

adverse impacts felt by those participants that do depend on the spring/summer weekly net revenues for business vitality. There also may be impacts to the local retail market offerings for fresh locally caught crab if reduced catch or changed delivery timing is a consequence.

A risk assessment is for the number of confirmed entanglements by Oregon Dungeness crab fishery. Over the period from 2003 through 2019 (i.e. 17 years), gear entanglements were 6 on gray whales and 6 on humpbacks. Average season soak days during the model base period were 180 thousand so soak days during 17 years are approximately 3.1 million. The probability for entanglement across the period is occurrence divided by events and when expressed as chance there will be 1 incidence per 255 thousand soak days. Another probability calculation could be done for the whale migration April to August period. In either case, the statistical risk is miniscule.

Another perspective for risk is whether a confirmed entanglement exceeds a lawsuit settled standard or NMFS adopted ITP standard.[3,4] An authorized ITP permit will generally include adaptive management provisions whereby reduced or curtailed gear exposure is triggered. A trigger for adaptive management based on current guidance for implementing the Marine Mammal Protection Act is a mortality standard for 1.6 whales computed using an entanglement mortality factor of .7. An entanglement risk impact would include public perception fallout leading to adverse effects on consumer markets. [5]

NMFS and ODFW/OSU are underway on studies to identify and model co-occurrence of gear and whale presence to estimate entanglement risk.[6] The U.S. East Coast is facing a similar

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[3] The lawsuit settlement in California called for an industry/agency/environmental representative working group to bi-weekly assess data against pre-determined criteria per fishery district, such as confirmed entanglement criteria with Dungeness crab fishery gear for one+ ESA listed species or unknown origin gear for two+ ESA-listed species, whale presence criteria for 20 surveyed or 5+ ESA-listed whales over a one-week period, and other criteria. The season closes seasonally starting April 1 in southern districts unless the CDFW Director decides the closure or other management changes (such as using ropeless fishing gear) are unnecessary. The settlement has many other provisions for ITP application submittal, gear retrieval/marking/development, sea turtle evaluation (NMFS EcoCast model adaptation and monitoring), humpback and blue whale distribution model development, etc. The agreement will be usurped by the ITP application process.

[4] NMFS standards will be derived based on requirements in the Marine Mammal and Protection Act and the Endangered Species Act. Because certain humpback whale distinct population segments are listed, all entanglements are prohibited without ITP authorization.

[5] A harvester financial risk impact definition would be the entanglement probability times loss where loss would include decreased revenue from management changes affecting catch (i.e. shortened and modified seasons) as well as consumer purchasing resistance resulting in lowered prices. There would be other harvester risk exposure factors such as safety due to increased need to service a lesser number of pots.

[6] NOAA Fisheries Marine Mammal Protection. Assessing Potential Entanglement Risk for Large Whales on the West Coast. Access: https://www.fisheries.noaa.gov/west-coast/marine-mammal-protection/assessing-potential-entanglement-risk-large-whales-west-coast. February 2020. Leigh Torres. Working toward identifying co-occurrence between whales and fishing effort in Oregon to reduce entanglement risk. OSU Marine Mammal Institute Geospatial Ecology of Marine Megafauna Laboratory. Access: https://mmi.oregonstate.edu/gemm-lab/where-are-whales-oregon-waters . February 2020. Other academic studies include Macks, S. Assessment of Entanglement Risk: A Vertical Line Co-occurrence Model of Large Whales and the Commercial Fixed Gear Dungeness Crab (Cancer magister) Fishery Off the U.S. West Coast. University of Washington School of Marine and Environmental Affairs. 2018; and, Saez, L. et. al. Co-occurrence of Large Whales and Fixed Commercial Fishing

situation to reduce lobster fisheries gear entanglements of the North Atlantic Right Whale (NARW). Developing protection plans and securing approvals are further along than on the West Coast. [7]

The West Coast will benefit from a decision support tool as states move forward on their habitat conservation plans and ITP applications. The key is to get the state and federal agencies to work with the fishing industry on a two-track process for developing rational entanglement standards and a best approach to meet the standard. The Oregon bio-economic model could be used within a larger decision support process to best meet (i.e. lowest costs) government entanglement standards. Developing a transparent well-designed decision support tool will be just as important as determining smart and "fair" standards. As witnessed in the East Coast NARW process, there can be concern that standards and decision support get intertwined in policy destructive ways.[8]

Gear: California, Oregon, and Washington, National Marine Fisheries Service, Southwest Region, Protected Resources Division, Long Beach, CA 2010.

[7] The statement is an author presumption given the two coasts different regulatory and legal situations for whale protection. The Center for Biological Diversity (CBD) has filed lawsuits against fishery management agencies on both coasts stipulating there is inadequate whale protection. An interim settlement for the California lawsuit requires, among other processes, that the CDFW obtain an ITP for the Dungeness crab fishery. The ODFW and WDFW are viewing the California requirement as a portent and are also working towards obtaining ITP's. The judge for the East Coast lawsuit declared there is not ESA compliance through issuance of a NMFS biological opinion that addresses incidental take standards. There are different protection paths being taken between the two coasts, but in the end, they will undoubtably have legally required similarities. The authors view the East Coast situation as a bit more mature in gaining protection measure approvals.

[8] Rappaport, Stephen. "Scientists weigh in on whale risk tool" in The Ellsworth American. February 26, 2020.

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MEMORANDUM

To: Oregon Dungeness Crab Commission
From: Shannon Davis, The Research Group, LLC (TRG) and Gil Sylvia, retired Executive
    Director, Coastal Oregon Marine Experiment Station
Date: Wednesday, March 11, 2022
Subject: Economic Impacts Proposed Regulations for Whale Entanglement Avoidance
Attachments: Study Results Presentation

This memorandum is to briefly describe results from using the Oregon Dungeness crab bio-economic model to assess economic impacts from proposed measures to reduce risk of fisheries gear whale entanglements. [1] It is a transmittal for presentation displays prepared for a March 18, 2020 Oregon Dungeness Crab Commission (ODCC) meeting agenda item. This research was authorized by the ODCC in an agreement dated December 2, 2019 with TRG (Contract No. PSK#'19-'20/03 ODCC-TRG/Davis). A summary list of tasks from the agreement is:

> Task 1: Describe Dungeness crab fishery participation to determine bio-economic model
>   validity for assessing current trend economic impacts.
> Task 2: Use existing bio-economic model to assess two management alternatives
> Task 3: Discuss management alternatives impacts.
> Task 4: Provide risk assessment discussion.

The ODCC agreement stipulates study results are confidential until approval for release. As such the attached presentation has not yet been distributed to interested parties.

The authors acknowledge the close assistance provided by Oregon Department of Fish and Wildlife (ODFW) managers and staff Caren Braby, Kelly Corbett, and Troy Buell. We held three meetings called with short notice with the ODFW staff. The study was initiated by the new organization Oregon Coast Crab Association (OCCA). Ed Backus served as consulting staff; and, Clint Funderburg and Joe Conchelos were the organization's industry representatives. Other input was provided through personal interviews with Dungeness crab fishery participants or through attendance at the ODFW Fall 2019 Dungeness crab industry meetings. Hugh Link, Executive Director ODCC provided guidance in framing and contextualizing how results will be

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[1] The model report contains a glossary for terms used in this memorandum. It also has method descriptions for procedures used to derive the results presented in this memorandum. The model report can be accessed at:
https://oregondungeness.org/wp-content/uploads/2017/06/ODCC-crab-model-report-ver.-5.7.pdf

useful to the industry. Even with this outside attention, the authors are solely responsible for study results.[2]

Task 1 purpose is to review current fishery trends (four seasons 2014-2015 through 2017-2018) to determine if the existing model's base period (seven seasons 2007-08 through 2013-14) is similar. If the current trend's structure is much different, then model utility would be suspect. The remedy would be to recalibrate the model for a new base period using the more current data.

The data used for the review is from logbook information and fish ticket information. When logbook information needs to be summed to represent a season total (e.g. monthly pot soak days), then it is adjusted for sample size expansion and compliance rates. Logbook content includes hailed catch as well as a record added by ODFW for delivered catch using fish ticket information.

The attached slides 1 and 2 show indicators for the seasons included in the base period and current trend period. The indicators from fish ticket information was available for complete season 2018-2019 and indicators relying on logbook information was available for seasons through 2017-2018. The indicators are delivered catch (excluding harvests for research and discards), price (adjusted to be in real 2019 dollars), pot-pulls, CPUE (catch is pounds and effort is pot-pull), and soak days (days between pot set and retrieve). Slide 3 shows the indicators for monthly average soak time per pot fished and monthly average pounds delivered per month for the base and current periods. Slide 4 shows the differences between the periods by month for the two indicators.

The indicators used on these graphics were selected to be tell-tale of the fishery status. Also, the indicator for pot soak days would be of interest to the concern for whale entanglement as it is a measure of gear line exposure to whale presence.

Slides 5 through 8 show the percent difference for the graphically displayed indicators plus others itemized for port groups and season months. The other indicators in these tables are unique vessel participation counts, harvest revenue (adjusted to be in real 2019 dollars), and the share of the Dungeness crab fishery revenue to a vessel's total revenue. The additional indicators were to make sure the explanatory variables used in the model's effort predictor equations were being reviewed.

The review showed there was sometimes significant differences between the two periods for monthly itemizations. This is because season start dates have been delayed to different dates during both the current period and base period. Despite the incongruities, most of the indicators used in the model predictor equation had small percent differences on a <u>seasonal basis</u> (e.g. vessel participation differed by -2 percent and soak days differed by -1 percent). The correlation coefficients for soak days trend (r=.9395) and catch trend (r=.4722) are positive. Based on the indicator comparisons between the two periods, there is argumentation and statistical confidence

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[2] The authors do not make any warranties with respect to the project including fitness for any particular purpose. In no event shall the authors assume any liability for use of the program or derived information and shall not be responsible for any direct, indirect, or consequential damages that might arise from application.

in continuing to use the model without re-calibration.[3] Even if there are significant differences, the cause may be environmental or regulation rather than influences on fishery participant behavior.

There is a difference in average season revenue between the two periods. A small increase in catch (9 percent) and a large increase in real price (27 percent) caused fishery revenue to increase by 39 percent. The model's price input variable was changed to reflect current period data for model output calculations relating to economic impact metrics.

Task 2 purpose is to use the bio-economic model to assess two management alternatives. The model was developed to be interactive. A user can modify assumptions and investigate management actions relative to a status quo to reveal impacts. Impact metrics include catch (harvest pounds), ex-vessel revenue (harvest value), harvester profitability (ex-vessel revenue minus trip variable costs), wholesale value, processor value added, community economic impacts (income and jobs), and changes to handling mortality numbers. The assessment for this study selected catch, ex-vessel revenue, profitability, and community income as measures to show impacts.

The model impact calculations rely on a fishery production function. Production was defined to be effort. Slide 9 shows the model effort equation form. [4] Assessing management alternatives means adjusting the equations explanatory variables numbers. The variables were specifically chosen to show changes singularly or a mix of management measures for delayed opening, reduced effort, and early season closure.[5]

The ODFW has been working with industry participants and interested parties during the course of this study to find meaningful whale entanglement mitigation measures that will reduce risk and minimize economic hardships. The intent is to bring proposed measures before the Oregon Fish and Wildlife Commission (OFWC) at their April 2020 meeting.[6]

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[3] An argumentation justification would be looking at shape and means for the two periods. A statistical justification example is looking at the correlation coefficient for the two periods. A correlation coefficient "r" which ranges from -1 to 1 (1 indicates a strong positive relationship, -1 indicates a strong negative relationship, and zero indicates no relationship).

[4] The model's weekly effort predictor equation's explanatory variables are fishing power (vessel counts); fishing success knowledge (revenue per pot pull lagged by one week); opportunity cost, i.e. attractiveness for other fisheries (ratio of D. crab fishery to a vessels total revenue); riskiness measure (variance of pot pulls); and, explanatory uncertainness (continuous time absorption variable).

[5] The model framework is to calculate the difference between a one-season simulated status quo alternative and a two-season management action alternative. The action alternative is for a current season and one following season. The following season is for the fishery utilizing the conserved biomass (if any) from the current season. The carryover biomass is any saved prerecruit and legal size crab less its natural mortality plus an individual's growth during the current season. Effects from additional years' carryover biomass is minimal due to high natural mortality (adult instantaneous rate 1.25 per year) and high fishing mortality (51 to 92 percent exploitation rate legal size crab).

[6] ODFW Industry Notice dated February 20, 2020.

This study provides a more encompassing bracket around the proposed measures by assessing two management alternatives:

> Assessed Management Alternatives
> 1. Season closure starting the first day of April, May, and June.
> 2. Decreased effort by 10 percent, 20 percent, and 30 percent starting April, May, and June.

The assessed management alternatives will provide additional economic impact information to industry and the OFWC in the event it is decided the proposed measures should be modified for the existing season or strengthened in future seasons. The discussion in the Task 3 narrative below relates the assessed management alternatives to the ODFW proposed measures.

There were an average 321 vessels out of a permitted 424 vessels that participated in the fishery during the model base period. A slightly higher number have been participating in more recent years. Slides 10 through 12 display the fleet's significant heterogeneity. The key characteristics include pot tiers, vessel length, Dungeness crab fishery tenure, exit/entry dates, and delivery numbers. Five vessel classes were statistically chosen to represent the diversity based on the key characteristics. Slide 10 shows the base period's average number of participating vessels by class and by week.[7] The graph illustrates that "early-exiters" leave the fishery by week 10, and "summers" remain in the fishery until almost the end of the season. The vessel class "miscellanies" have the highest per vessel revenue from the Dungeness crab fishery and the highest total per vessel revenue. This vessel class is highly diversified across fisheries as are the "early-exiters." "Summers" and "partakers" have the lowest total per vessel revenue and a large majority of their revenue is derived from the Dungeness crab fishery.

The model does not yet have a spatial structure to test management measures having zonal dimensions. The proposed model spatial structure enhancement is to relate an areal choice for fishing grounds to: economic behavior (such as seeking greater efficiency), safety, competition (such as pots deployed per sandy and unconsolidated bottom areas), knowledge based cooperation, avoid bycatch (soft crab, marine mammals, birds, etc.), and keep away from conservation reserves. Slide 13 shows in a typical season there is significant changes in fishing ground depth during the course of a season. Fishing will occur in greater depths at season start and most fishing is less than 40 fathoms after March.

Slide 15 is a table and Slide 18 is a graphic showing summary economic impacts for the two management alternatives. For example, the early season closure alternative on April 1 will result in a negative $2,484,187 or 6.0 percent of the average base period harvest value. A June 1 closure would be 1.0 percent of the average base period harvest value. The 20 percent reduction on May 1 in allowed pots will result in a negative $156,779 or .38 percent of the average base period harvest value. A 20 percent June 1 reduction is a negative $13,008 or .031 percent of the average base period harvest value.

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[7] The base period average unique vessel participation fleetwide for selected portions of the season: April 1 to end of season 204, May 1 to end of season 155, June 1 to end of season 109, July 1 to end of season 70, and August 1 to end of season 46.

Slide 16 itemizes the early season closure alternative by vessel class per vessel. For example, an April 1 closure would mean the summers vessel class would lose an average $21,231 per vessel which is 16.4 percent of their fishery revenue. The early-exiters vessel class would gain an average $2,030 per vessel which is 1.8 percent of their fishery revenue. All vessel classes except summers have a very small gain in harvest value for the June 1 closure.

Slide 17 itemizes the reduced effort alternative by vessel class. For example, a 20 percent reduced effort on April 1 would mean the summers vessel class would lose an average of $3,446 in harvest value per vessel which is 2.7 percent of their fishery revenue. The early-exiters vessel class would gain $502 which is .45 percent of their fishery revenue. Again, all vessel classes except summers have minute gains in harvest value if the 20 percent reduction was in place starting June 1.

Task 3 purpose is to provide discussion for the two study assessed management alternatives (i.e. early closure and effort reduction).

1) A shift to other fisheries caused by a Dungeness crab fishery closure and reduced allowed gear was not included in the assessment. For both assessed management alternatives, there may be increased compensating revenue from other fisheries, but also the shift may dilute average vessel catch to others in those fisheries. If a Dungeness crab fishery permit owner does not have the other fisheries shift opportunity, there may be owner consideration for possible abandonment from Oregon fisheries due to solvency because of loss of Dungeness crab fishery revenue.

2) The assessed economic impacts are from harvester and processor effects and do not address effects on retail operations for the whole cooked fresh product market during the Oregon Coast summer visitor season. An improved assessment would look at the social and economic profiles of fishery participants to determine interrupted season impacts on harvester operations, processor market channels, and other effects such as displacement to other fisheries. A subset of the investigation would include participants who are vertically integrated in order to determine whether economic effects include regional retail sector operations.

3) The assessment is not itemized by ports. There is unequal vessel class distribution along the coast and negative impacts will be disproportional at ports with higher percentage of summers.

4) Management alternative 2 for effort reduction was to evaluate the proposed management measure for a late season reduction of pot limits by 20 percent June 1 for the existing season and May 1 for the next two seasons. There would also be a depth restriction for 30 fathoms in order to especially avoid the ESA listed humpback whale distinct population segments.[8] Additional specification addressing enforcement is not included in the proposal.

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[8] The NMFS has circulated a proposed rule (comment period ended January 2020) to designate critical habitat for the distinct population segments (DPS) that transit adjacent to the Oregon Coast. The DPS's are the Central America (endangered listed) and the Mexico (threatened listing). The nearshore boundary adjacent to the Oregon

a) This study's assessment assumed a pot limit reduction was synonymous with effort reduction. However, there could be fleet behavior response that would not accomplish reducing actual on-ground gear deployment.[9] There is significant dormant fishing power in the Dungeness crab fishery spring and summer season. Vessels that do not usually fish in that period could elect to participate. Permits not being fished may elect to participate. Another consequence is the current spring/summer participants could increase their participation in earlier months leading to congestion and lower CPUE.

    i) An unknown for the assessment is whether the fleet is using the maximum tier pot counts during the spring/summer period. A fishing capacity utilization analysis has not been undertaken nor proposed.[10] The proposed reduced allowed gear measure may need further effectiveness review through post implementation monitoring. If fished pot counts are less than 20 percent, then the reduced gear restriction regulation would be management invariant.[11] Logbook information does not provide information about pots deployed. It only requires reporting of pot pulls and pot soak time per trip.

Coast for the critical habitat area is the 50 meter isobath (~27 fathoms). Access: https://www.federalregister.gov/documents/2019/10/09/2019-21186/endangered-and-threatened-wildlife-and-plants-proposed-rule-to-designate-critical-habitat-for-the Access February 2020.

[9] There is a 1,200 pound weekly catch quota after the second Monday in June and summer summed harvests cannot exceed 10 percent of season harvests in winter and spring (December through May). Fishery participants may elect only to pull deployed pot strings until the weekly quota is reached. Another regulation is gear must not be deployed more than 14 days without making a landing of Dungeness crab. This regulation is to counteract the effects from situations heard about during the Fall 2019 Industry Meetings that harvesters will simply leave pots in the ocean for storage until undertaking removal sweeping operations.

[10] A fishing capacity utilization analysis would identify optimal levels of fleet and gear composition associated with a sustainable fishery target. Generally, the target is a numerical catch amount developed using stock assessments, however stock assessments are not completed for the management of the Dungeness crab resource. Methods for determining capacity utilization levels under vessel constraints (ie using fishing days, gear configurations) have progressed since formation of the NMFS Excess Capacity Task Force in 1999. Economist notions are to use least cost to find fleet compositions, but in this case, there would be a dual goal for also finding least gear amounts. Once fishing capacity numbers are determined, the management levers to attain reductions will be difficult. Property rights approaches based on assigned individual catches (output controls) accompanied with vessel buyouts are being used in other fisheries (e.g. the West Coast groundfish trawl program). A property rights approach may still be viable for the Dungeness crab fishery using maximum gear levels (input controls) and has been adopted in other fisheries (e.g. Florida spiny lobster). Property rights programs are controversial, not the least contentious issue being initial allocation of rights. There are administration and monitoring cost disadvantages to such programs and there is concern about consolidation adversely affecting communities, but there are also meaningful rewards for fleet viability, meeting market quality demands, improved resource stewardship, and avoiding bycatch (e.g. whales). Other management approaches related to reduced gear exposure are area/time closures, hotspot closures, pot limitations, permit stacking, long-lining (2 pots per buoy for example), buy-backs, permit stacking, territorial user rights and cooperative allocations.

[11] While 20 percent restriction on allowed pots may be an impressionable level, a capacity utilization analysis would help determine the threshold upon which the management specification is not superfluous. For example, how little gear is necessary for permittees to catch weekly cumulative trip limits after the second Monday in June? And whether there are unintended incentives to draw other permittees into the fisheries (such as less congestion and higher CPUE) prior to June in which case additional limited entry controls may also be needed in order to successfully reduce deployed pots.

ii) An analysis was attempted to show whether all pots allowed were being pulled each trip. Slide 19 shows the potential pot pulls and soak time by vessel tier capacity for the 2013-2014 season. The potential is the amount that would have resulted from a vessel pulling the number of pots in their tier in every trip, less the actual amount. The spring/summer analysis includes trips that took place in April to August. The annual analysis includes all trips in all months of the season. It appears that only 30 percent of allowed pots are pulled during the spring/summer months. Slide 20 shows base period average pot pull totals and per vessel by tiers over the season. Weekly pot pulls for the late spring and summer are about two-thirds of the maximum for the 300 and 500-tier vessels and half of the maximum for the 200-tier vessel. The analysis is only a suggestion that reduced gear allowance will not correspond similarly to reduced gear deployment. Added logbook information or an industry survey to find actual gear deployment over the season is needed to relate gear allowance to gear deployment.

b) The effort reduction alternative assessment also assumed that participation would not be affected by a 30-fathom depth restriction. Slide 13 showed there was about 15 percent catch deeper than 30-fathoms after April 1 for the 2012-13 season. More recent years logbook information shows more effort occurring beyond 30 fathoms. The assessment assumes no additive effort change to the gear reduction requirement due to the area closure. It could be there will be decreased CPUE due to increased fishing intensity and finding new grounds to avoid congestion will increase fishing costs.

In summary, the proposed management measure has minor overall economic impact even with liberal assumptions about fleet response to gear and depth restrictions. However, there will be adverse impacts felt by those participants that do depend on the spring/summer weekly net revenues for business vitality. There also may be impacts to the local retail market offerings for fresh locally caught crab if reduced catch or changed delivery timing is a consequence.

Task 4 purpose is to provide a risk assessment discussion. The number of confirmed entanglements by Oregon Dungeness crab fishery gear is tiny. Over the period from 2003 through 2019 (i.e. 17 years), gear entanglements were 6 on gray whales and 6 on humpbacks. Entanglements by months were 3 in April, 4 in May, 0 in June, 1 in July, 2 in August, and 2 in other months (NMFS).[12] West Coast whale entanglements have been increasing since 2014. Industry/citizen awareness and an increased whale presence may be factors for the increase. Santora et. al. postulates that observed habitat compression from coastal upwelling, changes in availability of forage species (krill and anchovy), and shoreward distribution shift of foraging

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[12] NOAA Fisheries West Coast Large Whale Entanglement Response Program. 2018 West Coast Whale Entanglement Summary. Access https://seagrant.oregonstate.edu/sites/seagrant.oregonstate.edu/files/wcr_2018_entanglement_report_508.pdf . February 2020. A formal assessment for waters adjacent to Washington, Oregon, and California is described in Saez, L., D. Lawson, and M. DeAngelis. Large whale entanglements off the U.S. West Coast, from 1982-2017. NOAA Tech. Memo. NMFS-OPR-63. February 2020.

whales combined with recovering whale populations contributed to the exacerbation of entanglements.[13]

Average season soak days during the model base period were 180 thousand so soak days during 17 years are approximately 3.1 million. The probability for entanglement across the period is occurrence divided by events and when expressed as chance there will be 1 incidence per 255 thousand soak days. Another probability calculation could be done for the whale migration April to August period.

Another perspective for risk is whether a confirmed entanglement exceeds a lawsuit settled standard or NMFS adopted incidental take permit (ITP) standard.[14,15] An authorized ITP permit will generally include adaptive management provisions whereby reduced or curtailed gear exposure is triggered. A trigger for adaptive management based on current guidance for implementing the Marine Mammal Protection Act is a mortality standard for 1.6 whales computed using an entanglement mortality factor of .7. An entanglement risk impact would include public perception fallout leading to adverse effects on consumer markets. [16]

NMFS and ODFW/OSU are underway on studies to identify and model co-occurrence of gear and whale presence to estimate entanglement risk.[17] The U.S. Northeast is facing a similar

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[13] Santora, Jarrod A. and eleven other authors. "Habitat compression and ecosystem shifts as potential links between marine heatwave and record whale entanglements" in Nature Communications **11**, Article number: 536. January 2020.

[14] The lawsuit settlement in California called for an industry/agency/environmental representative working group to bi-weekly assess data against pre-determined criteria per fishery district such as confirmed entanglement criteria with Dungeness crab fishery gear for one+ ESA listed species or unknown origin gear for two+ ESA-listed species, whale presence criteria for 20 surveyed or 5+ ESA-listed whales over a one-week period, and other criteria. The season closes seasonally starting April 1 in southern districts unless the CDFW Director decides the closure or other management changes (such as using ropeless fishing gear) are unnecessary. The settlement has many other provisions for ITP application submittal, gear retrieval/marking/development, sea turtle evaluation (NMFS EcoCast model adaptation and monitoring), humpback and blue whale distribution model development, etc. The agreement will be usurped by the ITP application process.

[15] NMFS standards will be derived based on requirements in the Marine Mammal and Protection Act and the Endangered Species Act. Because certain humpback whale distinct population segments are listed, all entanglements are prohibited without ITP authorization.

[16] A harvester financial risk impact definition would be the entanglement probability times loss where loss would include decreased revenue from management changes affecting catch (i.e. shortened and modified seasons) as well as consumer purchasing resistance resulting in lowered prices. There would be other harvester risk exposure factors such as safety due to increased need to service a lesser number of pots.

[17] NOAA Fisheries Marine Mammal Protection. Assessing Potential Entanglement Risk for Large Whales on the West Coast. Access: https://www.fisheries.noaa.gov/west-coast/marine-mammal-protection/assessing-potential-entanglement-risk-large-whales-west-coast. February 2020. Leigh Torres. Working toward identifying co-occurrence between whales and fishing effort in Oregon to reduce entanglement risk. OSU Marine Mammal Institute Geospatial Ecology of Marine Megafauna Laboratory. Access: https://mmi.oregonstate.edu/gemm-lab/where-are-whales-oregon-waters . February 2020. Other academic studies include Macks, S. Assessment of Entanglement Risk: A Vertical Line Co-occurrence Model of Large Whales and the Commercial Fixed Gear Dungeness Crab (Cancer magister) Fishery Off the U.S. West Coast. University of Washington School of Marine and Environmental Affairs. 2018; and, Saez, L. et. al. Co-occurrence of Large Whales and Fixed Commercial Fishing Gear: California, Oregon, and Washington, National Marine Fisheries Service, Southwest Region, Protected Resources Division, Long Beach, CA 2010.

situation to reduce lobster fisheries gear entanglements of the North Atlantic Right Whale (NARW). Developing protection plans and securing approvals are further along than on the West Coast.[18]

NMFS on the West Coast has not yet issued entanglement incident mortality standards. NMFS does have target risk standards for the NARW. NMFS developed a decision support tool (DST) to test different management scenarios and get feedback on how a management scenario changes the spatial distribution and gear configurations of the lobster fishery.[19] Within the model, risk posed to the NARW population is calculated as the product of: (1) the density of vertical lines associated with lobster traps at a given location, (2) the threat vertical lines pose to NARW given the configuration of the lobster gear, relative to alternative gear configurations, and (3) the density of NARW expected the given location. The DST quantifies risk as the geographic overlap of vertical lines and whale density, with an added allowance for varying levels of threat associated with different gear configurations. The DST does not attempt to incorporate more complex location- or situation-specific variables that may lead to severe entanglements including whale behavior (transiting vs feeding), adjacent gear density, or how environmental conditions affect the characteristics of vertical lines in the water, including line tension and orientation. While there is reason to believe that these factors are important, empirical data on these factors are generally insufficient to include in modeling. The DST does not currently quantify groundlines attributed to lobster traps and associated threat to whales, though this may be incorporated in the future.

The West Coast will benefit from a similar predictive tool as states move forward on their habitat conservation plans and ITP applications. The key is to get the state and federal agencies to work with the fishing industry on a two-track process for developing rational entanglement standards and a best approach to meet the rational standard. The Oregon bio-economic model could be used within a larger decision support process to best meet (i.e. lowest costs) government entanglement standards. Developing a transparent well-designed decision support tool will be just as important as determining smart and "fair" standards. As witnessed in the Northeast process, there can be concern that standards and decision support get intertwined in policy destructive ways.[20]

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[18] The statement is an author presumption given the two coasts different regulatory and legal situations for whale protection. The Center for Biological Diversity (CBD) has filed lawsuits against fishery management agencies on both coasts stipulating there is inadequate whale protection. An interim settlement for the California lawsuit requires, among other processes, that the CDFW obtain an ITP for the Dungeness crab fishery. The ODFW and WDFW are viewing the California requirement as a portent and are also working towards obtaining ITP's. The judge for the East Coast lawsuit declared there is not ESA compliance through issuance of a NMFS biological opinion that addresses "incidental take" standards. There are different protection paths being taken between the two coasts, but in the end, they will undoubtably have legally required similarities. The authors view the East Coast situation as a bit more mature in gaining protection measure approvals.

[19] This paragraph paraphrases DST documentation provided by Sean Hayes (Chief of the Protected Species Branch, Northeast Fisheries Science Center), personal communication, February 2020.

[20] Rappaport, Stephen. "Scientists weigh in on whale risk tool" in The Ellsworth American. February 26, 2020.

Study Results Presentation
Economic Impacts Proposed Regulations for Whale Entanglement Avoidance

Authors: Shannon Davis, The Research Group, LLC
Gil Sylvia, retired Executive Director, Coastal Oregon Marine Experiment Station

Tasks: 1. Describe Dungeness crab fishery participation to determine bio-ec model validity to assess current trend economic impacts.

2. Use existing bio-economic model to assess management alternatives:

a. Early season closure.

b. Decreased effort (less allowed pots).

3. Discuss management alternatives impacts.

4. Provide risk assessment discussion.

Oregon Ocean Dungeness Crab Fishery Harvest Volume and Price by Week for Seasons in 2007-08 Through 2018-19
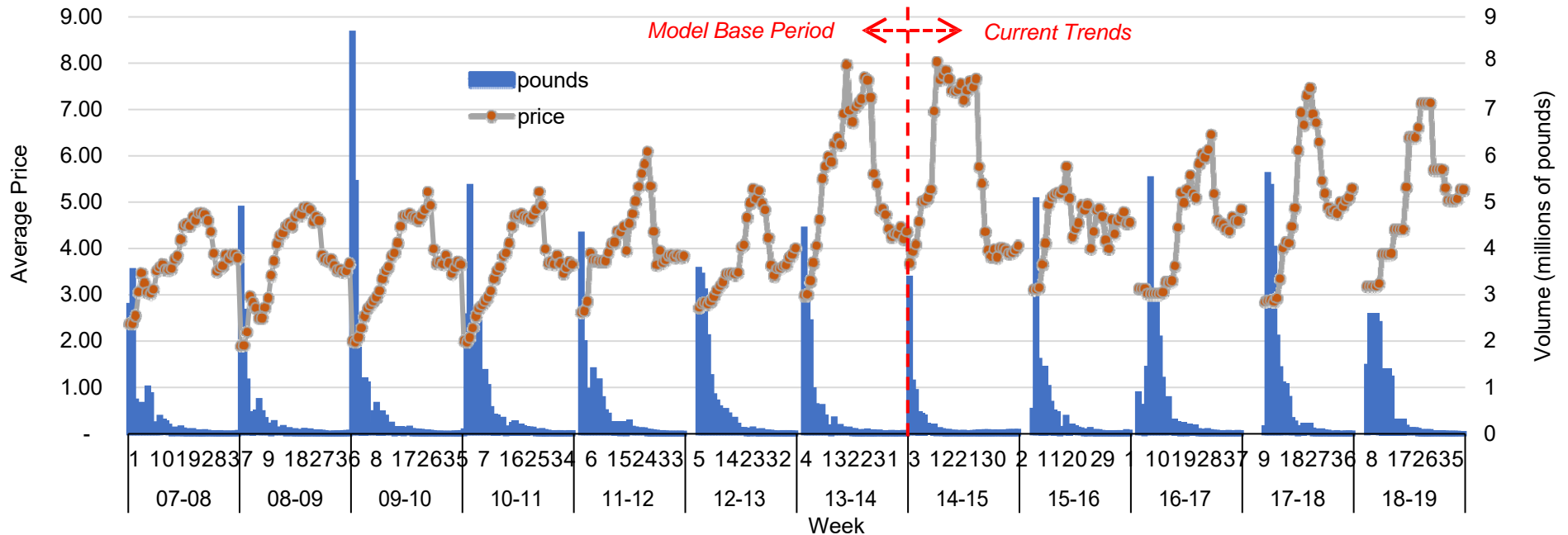
Notes: 1. Model base period averages are for seven seasons, 2007-08 through 2013-14. The comparison current trends averages are for five seasons, 2014-15 through 2018-19.

2. Price is in 2019 dollars adjusted using the GDP implicit price deflator developed by U.S. Bureau of Economic Analysis.

3. Seasons are shown from December 1 whether or not there was a season delayed opening. Any landings after week 37 (which would be after season ending date August 14) are not shown.

4. Fish tickets include Oregon onshore landings from ocean catch areas. They exclude research and discard disposition.

5. Year 2019 estimates used monthly landings available from PacFIN APEX reports. Weekly compilations used an average monthly landings per day. Landings may include some bay Dungeness crab fishery harvests.

Sources: PacFIN fish ticket data, April 2009, March 2010, July 2011, April 2013, March 2014, April 2015, November 2016, March 2017, June 2018, and July 2019 extractions; and PacFIN APEX report CRAB001 downloaded October 15, 2019.

Annual Effort and Harvest for 2007-08 to 2017-18
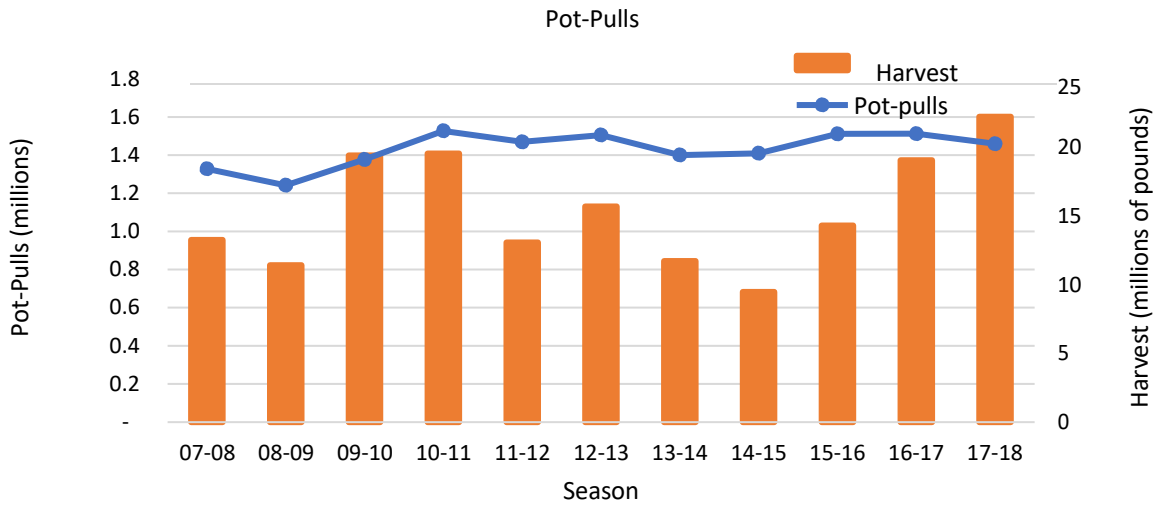
Pot-Pulls

Note: Logbook data expanded to represent 100% fleet.
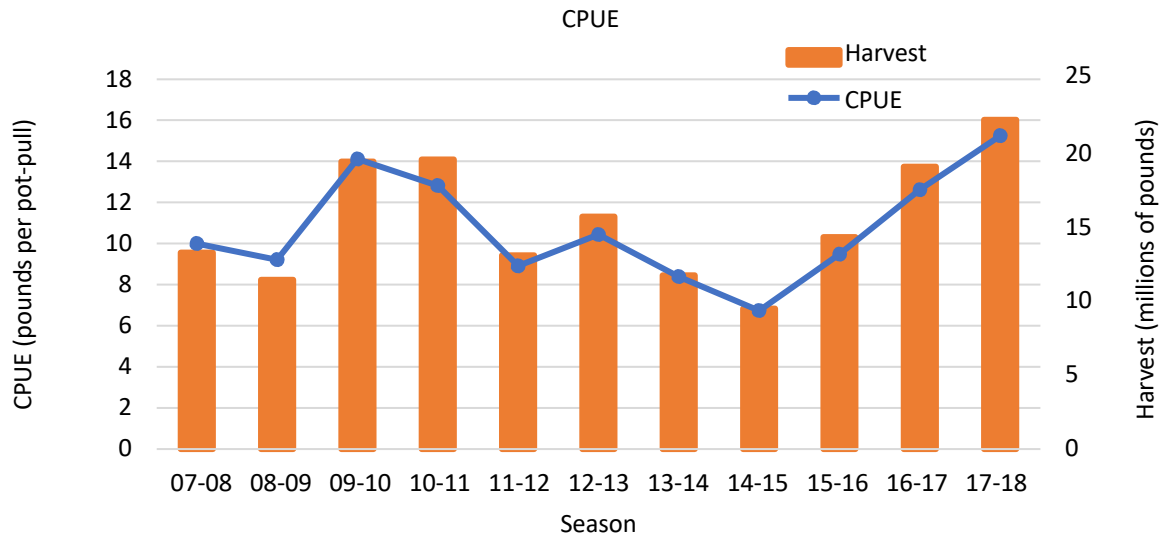
CPUE

Note: Catch per unit effort (CPUE) is catch (pounds) divided by pot-pulls.
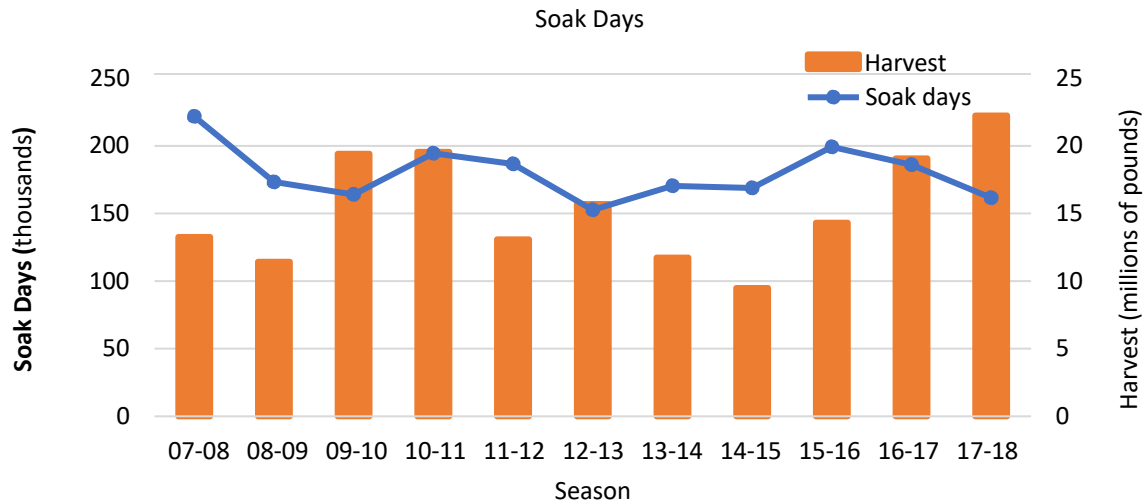
Soak Days

Note: Soak days are days between set and retrieve.
Source: ODFW crab logbook data.

Average Soak Time Per Pot Fished for 2014-15 to 2017-18 and Base Period Average

Days

— Current trend
— Base period

Calendar Month
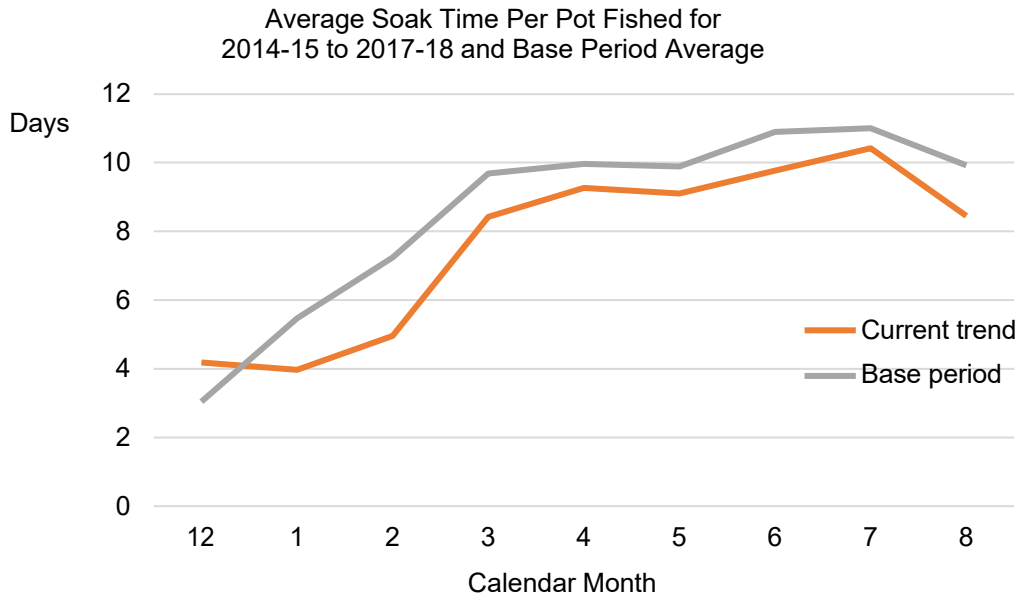
Notes: 1. Soak days are days between set and retrieve.
2. Adjusted for sample size and compliance by season.
Source: ODFW crab logbook data.

Average Pounds Per Month for 2014-15 to 2017-18 and Base Period Average

lbs   Millions

— Current trend
— Base period

Calendar Month
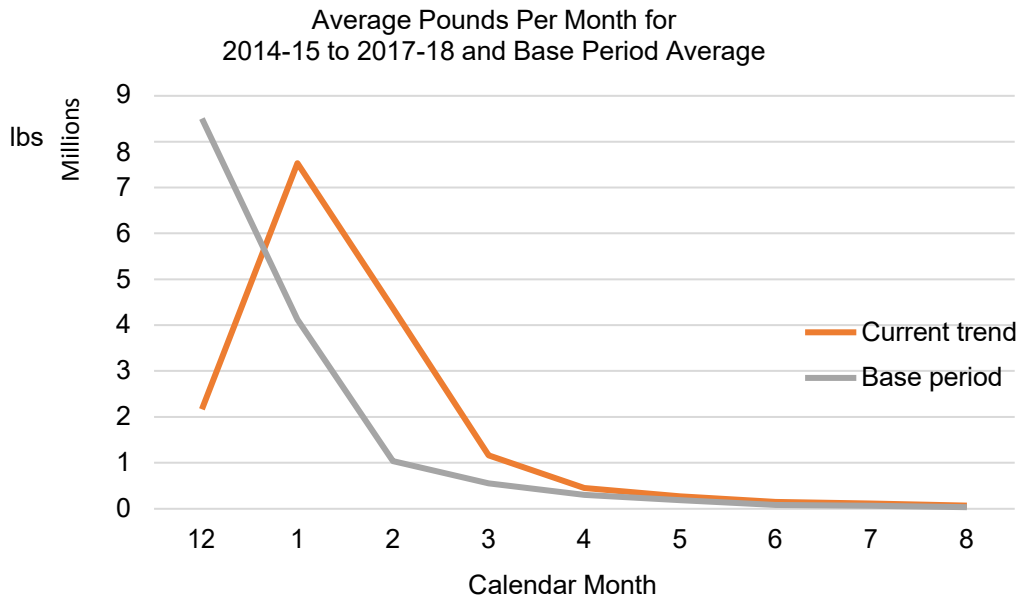
Note: Adjusted for sample size and compliance by season.
Source: ODFW crab logbook data.

Model Base Period and Current Trend Comparisons

Monthly Fishery Characteristics

| Characteristic | Average of Seasons | | Percent |
	Base Period	Current Trend	Difference
Vessel participation	320.6	313.0	-2%
December	257.0	88.0	-66%
January	286.7	257.0	-10%
February	260.7	267.5	3%
March	223.9	240.3	7%
April	187.3	185.0	-1%
May	141.9	142.3	0%
June	98.7	100.3	2%
July	62.7	71.8	14%
August	46.4	57.0	23%
Catch (pounds millions)	14.89	16.28	9%
December	8.51	2.16	-75%
January	4.12	7.53	83%
February	1.04	4.37	321%
March	0.55	1.16	110%
April	0.30	0.45	52%
May	0.19	0.27	46%
June	0.08	0.14	75%
July	0.06	0.11	70%
August	0.04	0.07	100%
Harvest revenue ($ millions)	41.5	57.6	39%
December	19.9	8.2	-59%
January	12.4	23.8	93%
February	3.8	14.7	290%
March	2.3	5.2	122%
April	1.4	2.7	87%
May	1.0	1.6	65%
June	0.3	0.7	94%
July	0.2	0.5	90%
August	0.1	0.3	124%
Ex-vessel price	2.79	3.54	27%
December	2.34	3.79	62%
January	3.00	3.16	5%
February	3.63	3.37	-7%
March	4.21	4.45	6%
April	4.80	5.90	23%
May	5.17	5.85	13%
June	4.13	4.59	11%
July	3.85	4.32	12%
August	3.98	4.45	12%

Model Base Period and Current Trend Comparisons (cont.)

Monthly Fishery Characteristics (cont.)

| Characteristic | Average of Seasons | | Percent |
	Base Period	Current Trend	Difference
Pot-pulls (millions)	1.41	1.47	5%
December	0.42	0.17	-60%
January	0.41	0.43	6%
February	0.21	0.38	78%
March	0.14	0.20	42%
April	0.10	0.13	24%
May	0.07	0.08	25%
June	0.03	0.04	41%
July	0.02	0.03	43%
August	0.01	0.01	73%
Soaking days (thousands)	180.5	178.9	-1%
December	23.4	12.4	-47%
January	44.7	31.6	-29%
February	32.1	37.6	17%
March	29.2	36.2	24%
April	22.1	25.3	15%
May	13.7	16.3	19%
June	7.2	10.2	43%
July	4.4	6.4	45%
August	1.8	2.9	64%
CPUE (pounds per pot-pull)	10.5	11.0	4%
December	20.3	12.9	-37%
January	10.1	17.4	72%
February	4.8	11.5	137%
March	3.9	5.8	48%
April	2.9	3.6	23%
May	2.8	3.2	17%
June	2.7	3.4	24%
July	3.6	4.2	18%
August	4.6	5.4	16%
Soak time per pot (days)	6.2	5.9	-4%
December	3.0	4.2	37%
January	5.5	4.0	-27%
February	7.2	5.0	-32%
March	9.7	8.4	-13%
April	10.0	9.3	-7%
May	9.9	9.1	-8%
June	10.9	9.8	-10%
July	11.0	10.4	-5%
August	9.9	8.5	-15%

Slide 7

Model Base Period and Current Trend Comparisons (cont.)

Geographical Fishery Characteristics

Characteristic	Average of Seasons Base Period	Current Trend	Percent Difference
Vessel participation	320.6	313.0	-2%
Astoria	74.9	75.8	1%
Tillamook	24.9	29.5	19%
Newport	104.1	97.5	-6%
Coos Bay	83.6	83.3	0%
Port Orford	27.0	22.3	-18%
Brookings	43.4	49.0	13%
Catch (pounds millions)	14.9	16.3	9%
Astoria	3.1	3.7	16%
Tillamook	0.9	0.7	-23%
Newport	4.9	6.0	22%
Coos Bay	3.5	3.8	8%
Port Orford	0.7	0.6	-14%
Brookings	1.7	1.5	-9%
Harvest revenue ($ millions)	41.5	57.6	39%
Astoria	8.5	12.5	48%
Tillamook	2.7	2.7	0%
Newport	13.7	21.2	54%
Coos Bay	9.8	13.8	41%
Port Orford	2.1	2.2	6%
Brookings	4.8	5.2	8%
Ex-vessel price	2.79	3.54	27%
Astoria	2.69	3.43	27%
Tillamook	2.89	3.78	31%
Newport	2.79	3.53	27%
Coos Bay	2.81	3.68	31%
Port Orford	2.88	3.54	23%
Brookings	2.83	3.37	19%

Model Base Period and Current Trend Comparisons (cont.)

Other Fishery Characteristics

Characteristic	Average of Seasons		Percent
	Base Period	Current Trend	Difference
Harvest revenue ($ millions)			
D. crab fishery	47.1	57.3	22%
All Oregon fisheries	87.6	100.6	15%
Ratio	53.7%	56.9%	6%

Notes:
1. The base period is 2007-08 through 2013-14 seasons. The current trend is 2014-15 through 2017-18 seasons. Both is 2007-08 through 2017-18.
2. The dollar year for both base period and current trend has been adjusted to 2019 using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
3. For monthly and geographical fishery characteristics, vessel participation excludes disposition for research or discards, and gear codes other than pot.
4. For monthly and geographical fishery characteristics, crab logbook data is adjusted for sample size and compliance by season.
5. For other fishery characteristics, D. crab fishery excludes disposition for research or discards, and gear codes other than pot. Also excludes landings from vessels with id of "NONE" or starting with "ZZ".
6. For other fishery characteristics, all Oregon fisheries are for the vessels with D. crab fishery landings, and ratio is the D. crab fishery revenue divided by their Oregon fishery revenue. All Oregon fisheries revenue is for calendar year of D. crab fishery season end, for all fisheries other than D. crab, and includes season revenue for D. crab.

Sources: PacFIN fish ticket data April 2009, March 2010, July 2011, April 2013, March 2014, April 2015, November 2016, March 2017, June 2018, and July 2019 extractions for monthly and geographical fishery characteristics vessel participation, and for all of other fishery characteristics; ODFW crab logbook data for monthly and geographical fishery characteristics other than vessel participation.

Model's Effort Prediction Equation

The model's weekly effort predictor equation explanatory variables are:

1) Fishing power (vessel counts),
2) Knowledge about success (revenue per pot pull lagged by one week),
3) Opportunity cost, i.e. attractiveness for other fisheries (ratio of D. crab fishery to a vessels total revenue) ,
4) Riskiness measure (variance of landings), and
5) Explanatory uncertainness (continuous time absorption variable)

Then catch is a function of <u>catchability</u> times <u>effort</u> times <u>biomass</u>.

Note: Effort is measured by pot-pulls.

Vessel Participation by Vessel Classifications for Base Period
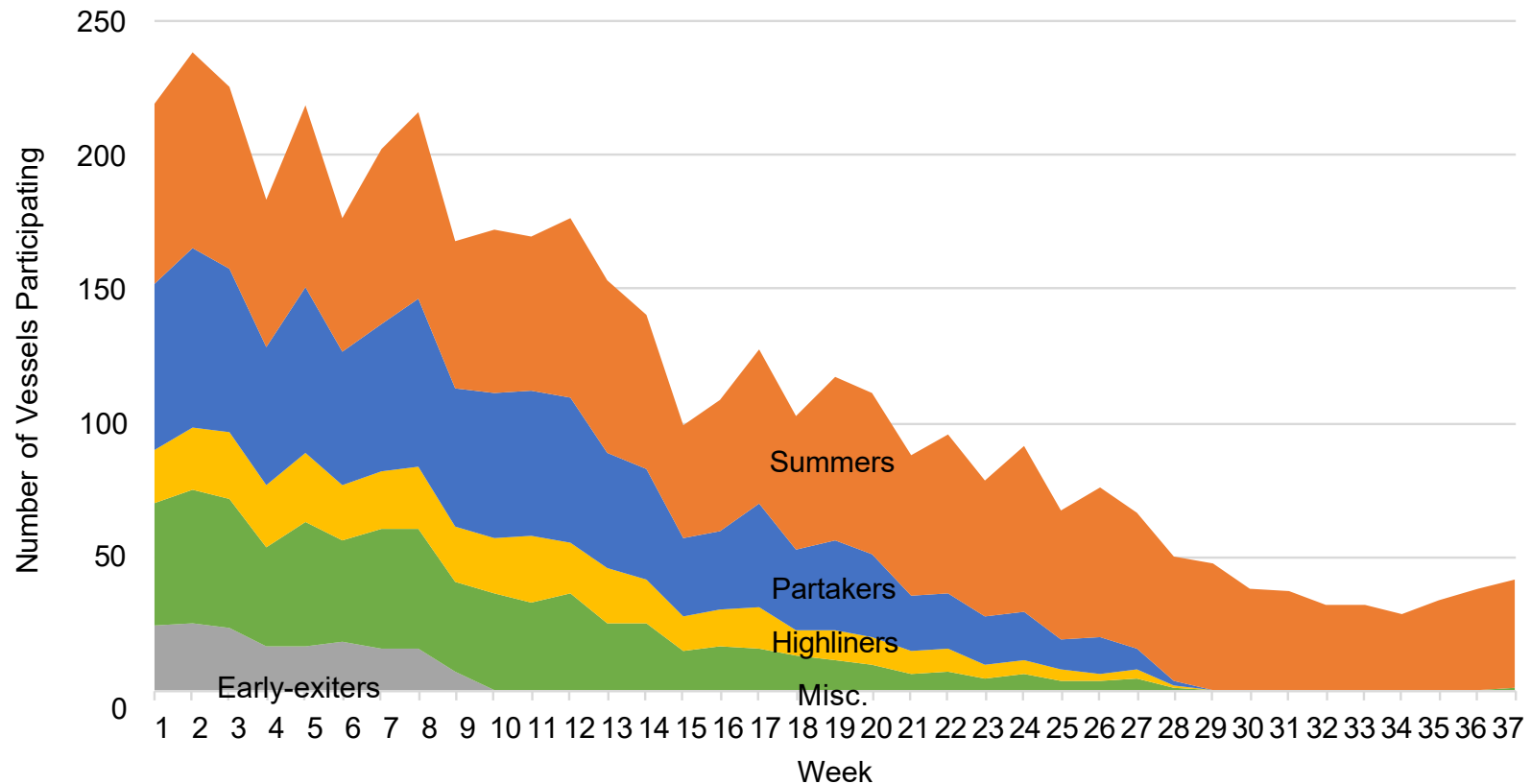
Notes: Classification descriptions by hierarchy order are:
 1) Summers: Vessels harvest Oregon ocean D. crab on or after June 10 and on or before August 14.
 2) Early-exiters: leave fishery on or before January 31.
 3) Highliners: D. crab is majority of revenue and total revenue greater than $250,000.
 4) Partakers: D. crab is majority of revenue and total revenue less than or equal $250,000.
 5) Miscellanies: D. crab less than a majority of revenue.

Effort, Revenues, and Profitability by Vessel Classifications for Base Period

	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
Vessels	96	38	36	84	67	321
Effort	469,208	92,270	215,561	324,450	305,665	1,407,155
Dec-Feb	263,740	92,270	164,773	255,265	265,248	1,041,296
Mar-Aug	205,468	0	50,788	69,185	40,418	365,859
Trips	3,086	403	865	1,891	1,489	7,735
200 tier	669	34	16	353	97	1,169
300 tier	1,384	130	187	1,024	546	3,271
500 tier	1,033	239	662	514	847	3,294
Fishery ($000's)						
Revenue	12,434	4,233	6,845	10,055	10,338	43,905
Profitability	7,440	1,844	2,819	5,998	4,152	22,251
Per effort						
Revenue	26.5	45.9	31.8	31.0	33.8	31.2
Profitability	15.9	20.0	13.1	18.5	13.6	15.8
Per vessel						
Revenue	129,526	111,407	192,424	120,311	153,313	136,958
Profitability	77,497	48,521	79,237	71,768	61,570	69,412

Frequency Distribution of D. Crab Revenue for Vessel Average of Base Period Seasons

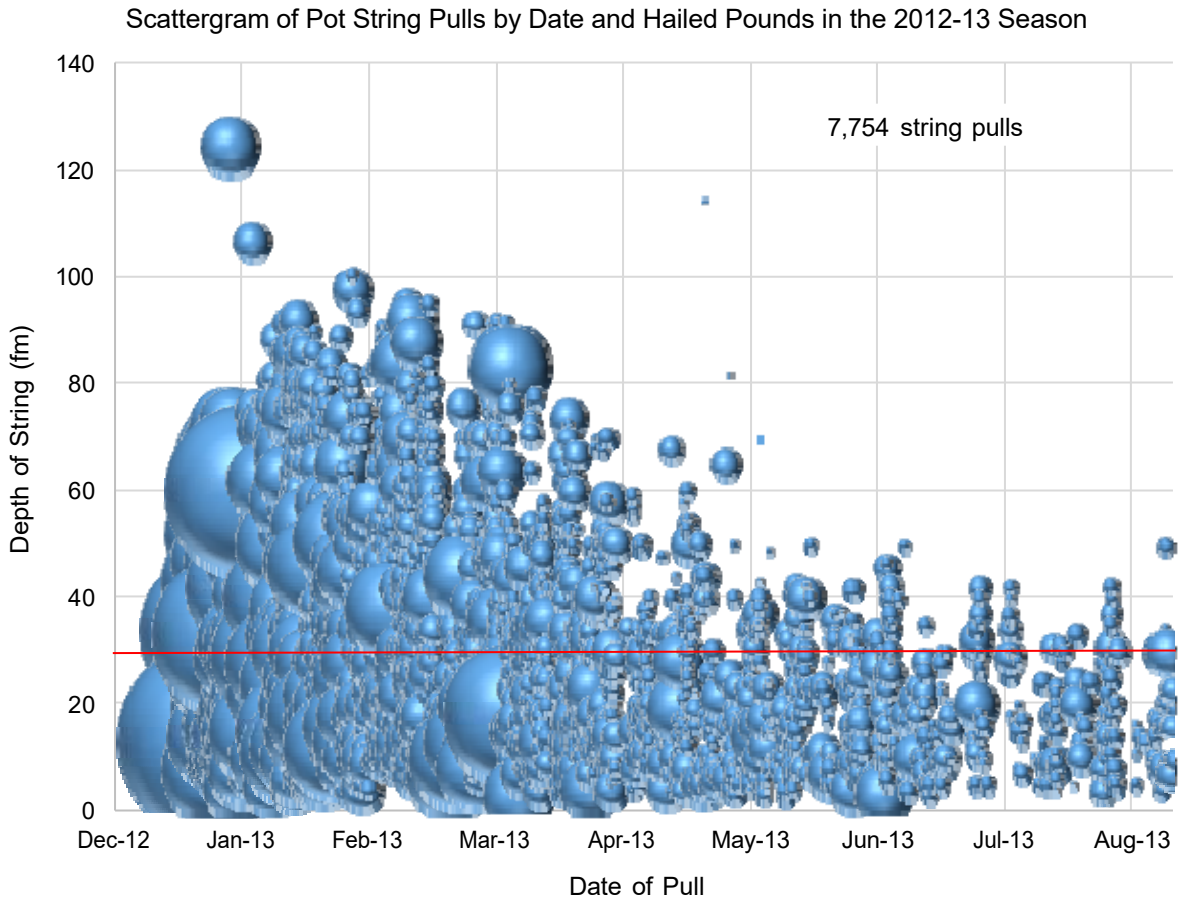| Revenue Bin	Shares of Vessel Counts by Vessel Classification					
	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
<1,000	7.2%	22.7%	6.3%	9.9%	9.5%	10.7%
>=1,000 and <10,000	17.0%	31.2%	7.9%	16.9%	23.7%	19.4%
>=10,000 and <100,000	61.7%	40.3%	64.6%	69.1%	51.7%	58.7%
>=100,000 and <200,000	10.6%	4.5%	11.0%	4.0%	10.0%	7.8%
>=200,000	3.4%	1.3%	10.2%	0.0%	5.2%	3.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Notes: 1. Average revenue by vessel is in 2015 dollars for counting bin assignment, which is the base period dollar year for revenue shown as average revenue by vessel.
2. A vessel may be assigned a different classification in different seasons.
3. Revenue is D. crab ex-vessel value, excluding disposition for research or discards, and gear codes other than pot, and landings from vessels with id of "NONE" or starting with "ZZ", using PacFIN data.

Monthly 7-Year Average Base Period by Vessel Classifications

Month	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
			Revenue			
Dec	5,268,175	3,418,896	3,608,448	5,444,955	6,332,621	24,073,095
Jan	2,360,038	771,788	1,558,888	2,257,622	2,457,059	9,405,396
Feb	1,297,075	42,770	869,283	1,083,909	916,358	4,209,395
Mar	1,077,084	0	538,938	646,802	408,011	2,670,835
Apr	1,042,124	0	204,444	485,843	179,772	1,912,184
May	562,049	0	63,157	122,679	39,608	787,493
Jun	413,354	0	1,621	12,748	4,218	431,941
Jul	249,757	0	0	0	0	249,757
Aug	164,798	0	0	0	0	164,798
Total	12,434,454	4,233,455	6,844,780	10,054,558	10,337,647	43,904,894

Note: Months are approximated by groups of weeks. December is Weeks 1 to 4, January is Weeks 5 to 8, February is Weeks 9 to 12, March is Weeks 13 to 17, April is Weeks 18 to 22, May is Weeks 23 to 26, June is Weeks 27 to 31, July is Weeks 32 to 35, and August is Weeks 36 to 37.

Scattergram of Pot String Pulls by Date and Hailed Pounds in the 2012-13 Season

7,754 string pulls

Notes: 1. Each bubble represents a crab pot string pull. Bubble radius is hailed pounds.
Source: ODFW crab logbook data, Feb. 26, 2016.

Management Alternative Summary Total Harvester Impacts, With Model Price Increased to Current Trend

Week	Early Closure	Effort Reduction Starting at Indicated Week		
		10%	20%	30%
Catch (pounds)				
Week 26	-64,682	1,830	7,401	18,392
Week 22	-217,788	-10,853	-15,982	-12,720
Week 18	-444,482	-31,922	-56,279	-69,353
Revenue (dollars)				
Week 26	-392,663	-16,943	-13,008	21,036
Week 22	-1,232,595	-94,298	-156,779	-172,931
Week 18	-2,484,187	-219,945	-397,521	-512,521
Profitability (dollars)				
Week 26	-152,729	2,804	14,646	39,607
Week 22	-508,791	-28,317	-42,797	-36,967
Week 18	-1,041,270	-79,584	-140,886	-174,881
Income (dollars)				
Week 26	-573,233	-21,507	-12,323	41,137
Week 22	-1,809,720	-134,393	-222,000	-241,443
Week 18	-3,651,208	-318,080	-573,897	-737,682

Notes: 1. Weeks indicate when closure or effort reduction starts. Week 18 is about April 1; Week 22 is about May 1; and Week 26 is about June 1.
2. Results are with model dashboard price (Menu Item 3.b.ii. Harvest economic terms - Season pattern) current and following sliders set to 33% to get $3.50 season price, which is the average of current trend seasons 2014-15 to 2017-18 in 2019 dollars, excluding disposition for research or discards, and gear codes other than pot, and landings from vessels with id of "NONE" or starting with "ZZ", using PacFIN data.

Slide 15

Harvester Impact Per Vessel and Per Vessel Season Shares by Vessel Classifications for Early Season Closure, With Model Price Increased to Current Trend

	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
Week 26 Early Closure Impacts						
Revenue						
Season per vessel	-7,010	1,063	1,651	882	1,337	-1,225
Season share	-5.41%	+0.95%	+0.86%	+0.73%	+0.87%	-0.89%
Profitability						
Season per vessel	-3,164	463	739	590	589	-476
Season share	-4.08%	+0.95%	+0.93%	+0.82%	+0.96%	-0.69%
Week 22 Early Closure Impacts						
Revenue						
Season per vessel	-13,616	1,478	24	-975	991	-3,845
Season share	-10.51%	+1.33%	+0.01%	-0.81%	+0.65%	-2.81%
Profitability						
Season per vessel	-6,486	643	608	-192	714	-1,587
Season share	-8.37%	+1.33%	+0.77%	-0.27%	+1.16%	-2.29%
Week 18 Early Closure Impacts						
Revenue						
Season per vessel	-21,231	2,030	-3,802	-4,929	-377	-7,749
Season share	-16.39%	+1.82%	-1.98%	-4.10%	-0.25%	-5.66%
Profitability						
Season per vessel	-10,486	884	-97	-2,005	672	-3,248
Season share	-13.53%	+1.82%	-0.12%	-2.79%	+1.09%	-4.68%

Note: Twelve-week early closure is at Week 26 (about June 1); sixteen-week early closure is at Week 22 (about May 1); and twenty-week early closure is at Week 18 (about April 1).

Harvester Impact Per Vessel and Per Vessel Season Shares by Vessel Classifications for Effort Reduction, With Model Price Increased to Current Trend

	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
-10% Effort, starting at Week 26						
Revenue						
Season per vessel	-548	142	216	109	176	-53
Season share	-0.42%	+0.13%	+0.11%	+0.09%	+0.11%	-0.04%
Profitability						
Season per vessel	-173	64	103	77	82	9
Season share	-0.22%	+0.13%	+0.13%	+0.11%	+0.13%	+0.01%
-10% Effort, starting at Week 22						
Revenue						
Season per vessel	-1,197	204	88	-55	167	-294
Season share	-0.92%	+0.18%	+0.05%	-0.05%	+0.11%	-0.21%
Profitability						
Season per vessel	-492	92	109	14	108	-88
Season share	-0.63%	+0.19%	+0.14%	+0.02%	+0.18%	-0.13%
-10% Effort, starting at Week 18						
Revenue						
Season per vessel	-1,988	284	-286	-455	52	-686
Season share	-1.54%	+0.25%	-0.15%	-0.38%	+0.03%	-0.50%
Profitability						
Season per vessel	-900	128	55	-162	121	-248
Season share	-1.16%	+0.26%	+0.07%	-0.23%	+0.20%	-0.36%
-20% Effort, starting at Week 26						
Revenue						
Season per vessel	-717	230	343	166	280	-41
Season share	-0.55%	+0.21%	+0.18%	+0.14%	+0.18%	-0.03%
Profitability						
Season per vessel	-165	103	165	121	133	46
Season share	-0.21%	+0.21%	+0.21%	+0.17%	+0.22%	+0.07%
-20% Effort, starting at Week 22						
Revenue						
Season per vessel	-1,927	349	106	-139	265	-489
Season share	-1.49%	+0.31%	+0.06%	-0.12%	+0.17%	-0.36%
Profitability						
Season per vessel	-758	157	179	5	184	-134
Season share	-0.98%	+0.32%	+0.23%	+0.01%	+0.30%	-0.19%
-20% Effort, starting at Week 18						
Revenue						
Season per vessel	-3,446	502	-609	-906	47	-1,240
Season share	-2.66%	+0.45%	-0.32%	-0.75%	+0.03%	-0.91%
Profitability						
Season per vessel	-1,540	226	78	-332	208	-439
Season share	-1.99%	+0.47%	+0.10%	-0.46%	+0.34%	-0.63%

	Summers	Early-exiters	Highliners	Partakers	Misc.	Total
-30% Effort, starting at Week 26						
Revenue						
Season per vessel	-342	239	340	149	281	66
Season share	-0.26%	+0.21%	+0.18%	+0.12%	+0.18%	+0.05%
Profitability						
Season per vessel	102	107	171	117	140	124
Season share	+0.13%	+0.22%	+0.22%	+0.16%	+0.23%	+0.18%
-30% Effort, starting at Week 22						
Revenue						
Season per vessel	-1,984	407	27	-263	266	-539
Season share	-1.53%	+0.37%	+0.01%	-0.22%	+0.17%	-0.39%
Profitability						
Season per vessel	-698	183	196	-37	212	-115
Season share	-0.90%	+0.38%	+0.25%	-0.05%	+0.34%	-0.17%
-30% Effort, starting at Week 18						
Revenue						
Season per vessel	-4,130	627	-981	-1,346	-39	-1,599
Season share	-3.19%	+0.56%	-0.51%	-1.12%	-0.03%	-1.17%
Profitability						
Season per vessel	-1,800	282	56	-511	248	-546
Season share	-2.32%	+0.58%	+0.07%	-0.71%	+0.40%	-0.79%

Note: Week 18 is about April 1; Week 22 is about May 1; and Week 26 is about June 1.

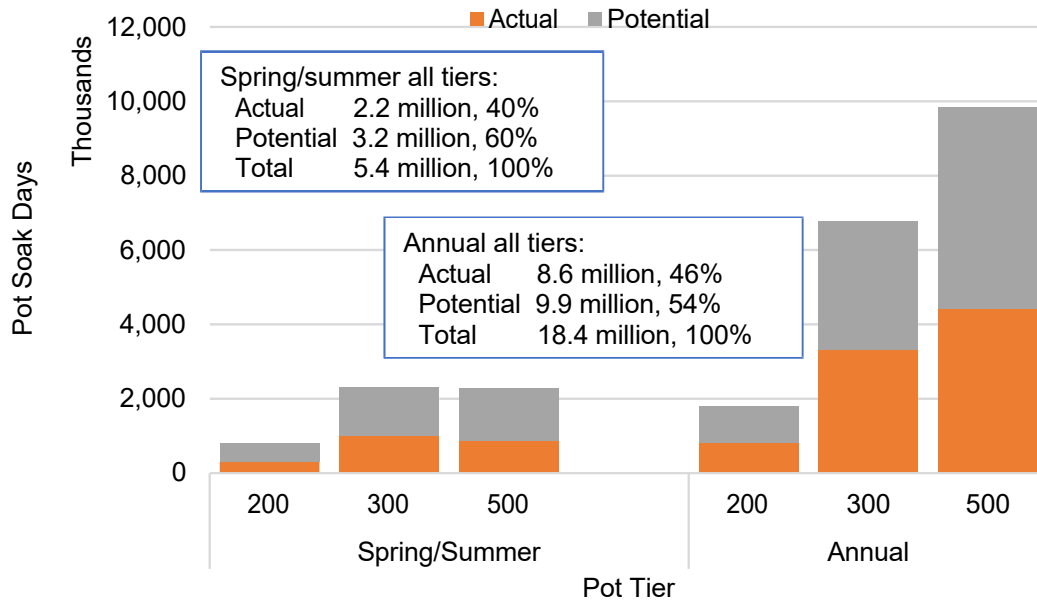Total Harvester Impacts for Management Alternatives Starting at Selected Weeks
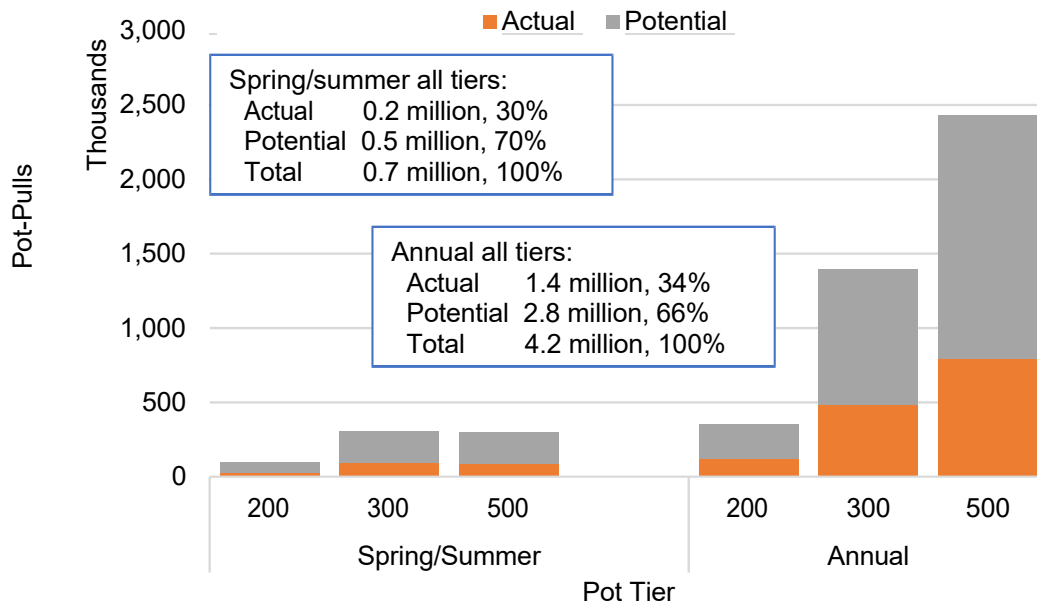With Model Price Increased to Current Trend

Revenue

■ Week 26   ■ Week 22   ■ Week 18

	Closure	Effort Reduction Starting at Indicated Week		
	Early	10%	20%	30%

Dollars (y-axis: 500,000 to -3,000,000)
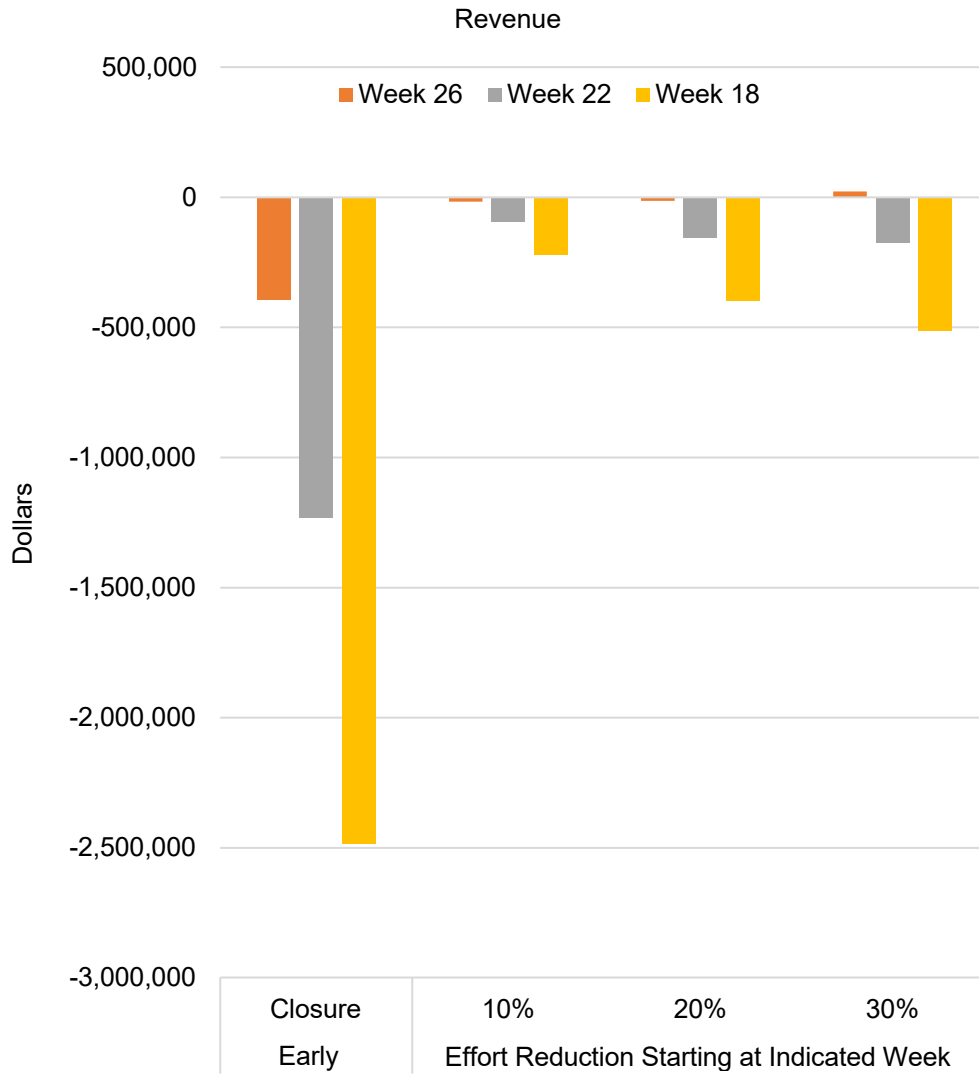
Notes: 1. See notes for management alternative table.

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Potential Crab Pot Soak Time by Vessel Pot Tier Capacity for 2013-2014 Season

Spring/summer all tiers:
  Actual   2.2 million, 40%
  Potential 3.2 million, 60%
  Total   5.4 million, 100%

Annual all tiers:
  Actual   8.6 million, 46%
  Potential 9.9 million, 54%
  Total   18.4 million, 100%

Potential Crab Pot-Pulls by Vessel Pot Tier Capacity for 2013-2014 Season

Spring/summer all tiers:
  Actual   0.2 million, 30%
  Potential 0.5 million, 70%
  Total   0.7 million, 100%

Annual all tiers:
  Actual   1.4 million, 34%
  Potential 2.8 million, 66%
  Total   4.2 million, 100%

Notes: 1. Method uses logbook data that is adjusted using sampling and compliance ratios.
2. Pot soak days are pots pulled in a string times the number of days a string was left soaking.
3. A trip is a day on which a vessel pulled pots.
4. Potential is the amount that would have resulted from a vessel pulling the number of pots in their tier in every trip, less the actual amount.
5. Spring/summer includes trips that took place in April to August. Annual includes all trips in all months of the season.
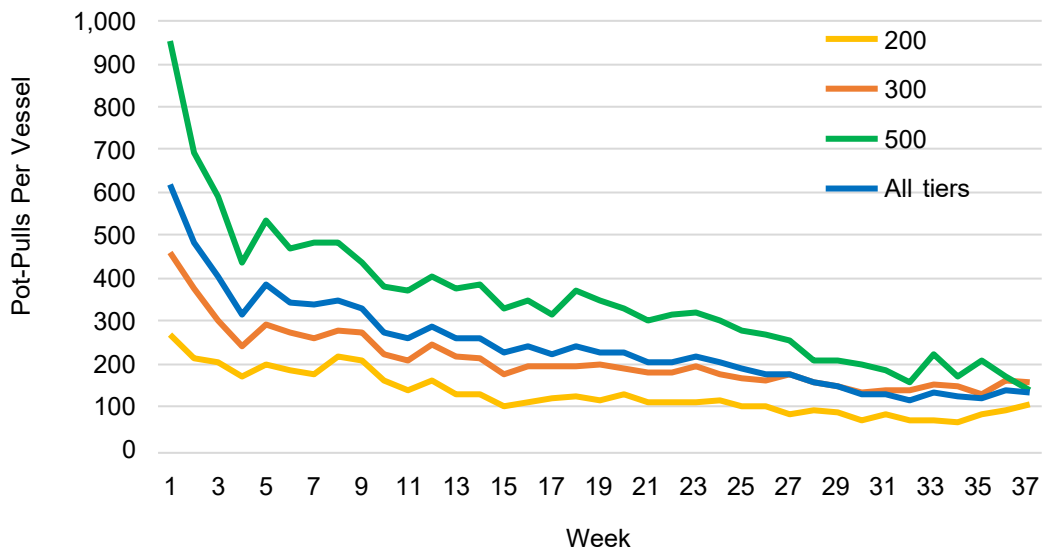
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Pot-Pulls and CPUE by Month for Ocean Dungeness Crab Vessels in Base Period
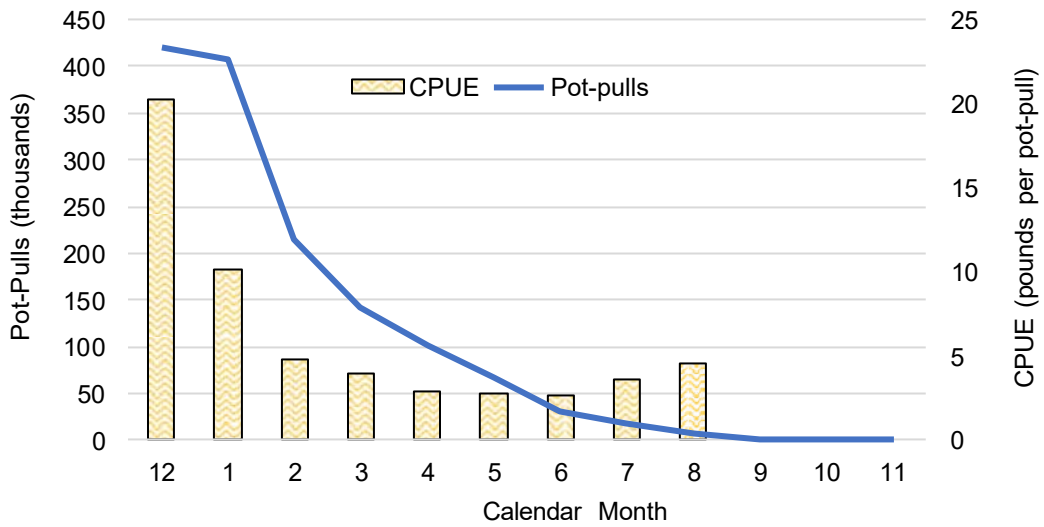
Note: Catch per unit effort (CPUE) is catch (pounds) divided by pot-pulls.
Source: ODFW crab logbook data, February 26, 2016 version.

Pot-Pulls Per Vessel by Week by Pot Tier for Base Period

Notes: 1. Week adjusted each year for season start.
2. Pots pulled per trip are defined to be all pots pulled on one day for one vessel.

Risk Assessment Discussion

- Confirmed entanglements by Oregon Dungeness crab fishery gear is tiny: 17 years ending in 2019: 6 on gray whales and 6 on humpbacks; 3- April, 4-May, 0-June, 1-July, 2-August, 2-other months (NMFS). Pot soak days during that period are about 3.1 million.

- NMFS and an ODFW/OSU are working on risk assessment modeling.

- U.S. Northeast facing a similar situation to reduce lobster fisheries gear entanglements of the North Atlantic Right Whale (NARW). Developing habitat conservation plans and securing incidental taking permits are further along than on the West Coast. NMFS has issued risk standards and a decision support tool has been developed.

- There can be concern that standards and decision support get intertwined in policy destructive ways without transparency and collaboration in development.

Study Takeaways

1.The study used an existing bio-ec model to show economic impacts (measured by fishery revenue and community effects) from proposed management alternatives having to do with gear constraints. The input value for fishing power in the effort prediction equations gets adjusted for the restrictions being suggested. However, there is an issue for assuming each vessel fishing in a particular week is using all of their allowed pots. Does 20% less allowed pots for each tier equate to 20% less effort measured by soak days? (One soak day is the exposure to whales from one line in the water for one day.) Other consequences from constraining pots, such as from vessel behavior to desist fishing or shift to other fisheries, would need additional model input adjustments.

2.From using logbook data, we found that not all allowed pots were being pulled per weekly trips. This implies whale exposure to lines in the water may not be entirely related to management levers for tier pot allowance. More comprehensive research will be required for capacity utilization in order to show how gear constraints affect actual spatial and temporal vessel-effort behavior. Logbook data for pot count deployment would assist the research otherwise a fleet survey will be necessary. The research will need to consider increased effort from latent demand or participation reduction in response to gear restrictions. This would inform management decisions for additional limited entry controls.

3.Prior to undertaking the HCP/ITP scoping process for identifying reasonable alternatives and potential impacts, a decision support tool should first be developed in collaboration between industry, NGO, ODFW, and NMFS. The decision support tool would determine entanglement/mortality standards and impact calculation methods to test potential management alternatives. The ongoing saga for the Northeast lobster fishery management and impacts to the listed right whale is an example of management procedural dysfunction.

4.When developing the decision support tool, there will be an issue with trying to use very large numbers (such as soak days) to determine small numbers (whale entanglements). Expert opinion will be necessary to deal with the uncertainty envelopes hence the necessity for the collaborative decision making. Higher level support tool methods would be aided with the availability of whale migration density and distribution models. There has been some success using habitat-based models for West Coast humpback whale concentrations and locations.