



## **Summary of Science Workshop Pinniped Predation on Salmonids Committee**

Prepared for the Washington Department of Fish and Wildlife

May 2022

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Seattle, WA

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This activity was supported by Agreement No. 21-18006 with the Washington Department of Fish and Wildlife. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of the organization or agency that provided support for the project. **This product reflects the proceedings of a workshop and not the opinions of the Academy committee.**

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Suggested citation: Washington State Academy of Sciences. (2022). Summary of Science Workshop: Pinniped Predation on Salmonids Committee. Seattle, WA: WSAS, 1-12.

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## **WORKSHOP OVERVIEW**

In response to a request from the Washington Department of Fish and Wildlife (WDFW), the Washington State Academy of Sciences (WSAS) convened a committee charged with reviewing the science regarding pinniped predation on salmonids in Washington's waters and coastal areas. Deliverables from the committee to WDFW will include a bibliography of pinniped predation research and a report that includes 1) what is known about pinniped predation of salmonids, and with what level of certainty, 2) where the knowledge gaps are, 3) where additional research is needed, 4) how the science may inform policymakers, and 5) an assessment of the scientific and technical aspects of policies and potential management actions within Washington. Notably, the committee's report to WDFW will not recommend specific management actions, but rather will summarize the science and current research on this issue. Early in this process, the committee conducted two workshops to engage members of the scientific community and stakeholders with expertise in pinniped predation to gather information on published and unpublished research and data to integrate into the bibliography and final report.

The first workshop was conducted on February 9, 2022 and included scientists and researchers who have expertise on pinniped predation. This workshop served as a forum for experts to present relevant research and for the committee and invited experts to discuss this data. Information shared during the workshop will inform the committee's bibliography and report to the state summarizing the current science around pinniped predation on salmonids, which will be delivered later this year.

The workshop drew 59 attendees in total, including 13 invited presenters, 9 committee members, 5 WSAS staff members, and 32 other participants. This document summarizes key points of the workshop presentations and subsequent discussions; the workshop agenda and a full list of participants are included as appendices.

## **PRESENTATIONS AND DISCUSSION**

During the workshop, speakers delivered 13 presentations pertaining to five broad topics:

- Pinniped and salmonid populations
- Quantification of pinniped predation on salmonids
- Factors affecting pinniped predation on salmonids
- Ecological interactions affecting pinniped predation on salmonids
- Potential management actions

After the conclusion of all presentations under each topic, the committee facilitated a discussion session on that issue. Structured according to these broad topics, the sections below review the key takeaways from the presentations and discussions.

### **Current and historical pinniped and salmonid populations**

Presenters shared that pinniped populations in Washington primarily comprise three species: harbor seals, California sea lions, and Steller sea lions. Harbor seals and Steller sea lions are year-round

residents of Washington waters, while California sea lions are typically present between September and May. Speakers shared data showing that (a) the California sea lion population in Washington rose dramatically from the 1970s to 2010 and stabilized thereafter (b) Steller sea lion abundance increased steadily from the 1980s to 2012 and has remained stable since then, and (c) the harbor seal population also experienced an increase beginning in the 1970s but stabilized in the early 2000s. One coastal seal harbor stock and three inland marine water stocks reside in Washington.

Presenters described that that pinniped diet is assessed through hard parts and genetic analyses of scat samples. They shared that data from these analyses point to a preference among harbor seals to prey upon clupeids (marine forage fish including herring), though their diet is diverse and varies temporally and by location. Speakers noted that more research is needed to understand the diets of the sea lions that reside in Washington waters. Speakers also noted gaps in the data on pinniped diet in this geographic area including individual specialization among pinnipeds, impacts of predation to salmon runs, and the indirect effects of predation on salmonids.

Speakers also described how currently, three evolutionarily significant units (ESUs) of salmon in the Puget Sound are listed as threatened: Puget Sound Chinook, Puget Sound steelhead, and Hood Canal summer chum. Lake Ozette sockeye are the only coastal ESU categorized as threatened. Presenters showed that Hood Canal summer chum have almost reached the recovery goal, while the other three threatened ESUs have achieved minimal progress of less than 10% of their respective recovery goals. Presenters also showed that trends in the return of adult salmon to the Puget Sound show a decline in returns among coho, sockeye, and natural-origin Chinook and an increase in returning chum salmon, pink salmon, and hatchery Chinook.

Committee member and invited expert discussion points regarding pinniped and salmonid populations included the following:

- The relationship between current and historic pinniped populations, including archaeological data on precontact species abundance and distribution
- Data limitations regarding historical salmonid consumption by pinnipeds
- Current efforts to compile data on documented historical culling and subsistence hunting and related impacts on pinniped and salmonid populations

### **Quantification of overall pinniped predation on salmonids**

Speakers shared various studies illustrating that fish size is one of the most significant parameters influencing the population-level impacts of salmonid consumption by pinnipeds. DNA metabarcoding has recently provided a more precise diet analysis by enabling species-level data regarding the fish consumed by harbor seals in the Salish Sea. Presenters shared resulting estimates suggesting that harbor seals primarily feed on hake and herring, with salmon comprising approximately 16% of their diet. They indicated that, of the salmon consumed by harbor seals, chum is the predominantly consumed species, followed by Chinook. Among Steller sea lions, researchers estimate that salmon account for 8.9% of the animals' diet.

Presenters shared data suggesting that the impacts of marine mammals on salmonid populations exceed the impacts created by fisheries. The Steller sea lion population has now exceeded pre-cull levels and continues to grow, with pup production increasing sixfold in recent years. Speakers indicated that, due to this population growth, depensatory mortality is a growing concern for small pelagic fish, including herring and sockeye salmon. They outlined policy options in response to this data, including continuing with current precautionary harvest policies, regulating marine mammal abundance, and restoring the traditional First Nations marine mammal harvesting system.

Committee member and invited expert discussion points regarding the quantification of pinniped predation included the following:

- Modeling for the impacts of predation and other variables on both additive and compensatory mortality
- Impacts on other fish populations, such as herring and groundfish
- The feasibility of reinstating traditional harvests by Indigenous peoples

### **Factors affecting pinniped predation on salmonids**

Speakers shared that, in addition to consumption of prey, the presence of predators impacts prey populations by influencing the behavior of migratory prey. To survive predation, prey animals often modify their migration patterns. Presentations indicated that, among salmonids, antipredator behavior includes nocturnal migration and increased speed of migration. This behavior likely alters predator-prey interactions between pinnipeds and salmonids. Speakers suggested that more research is needed to understand how antipredator behavior may affect populations and behavior patterns among salmonids specifically.

Speakers indicated that pinniped response to seasonal prey aggregations may vary temporally and spatially depending on life history. The life cycles of both predator and prey are key considerations in understanding pinniped responses to seasonal prey distribution. Presenters described how pinniped life history can influence foraging and diving behavior, diet, seasonal attendance patterns, distribution, and abundance. For example, the energetic demands of pupping and breeding season may alter foraging behavior.

Presenters described how, in addition to the influences of life history, social factors may also affect pinniped behavior. Research has highlighted evidence of social transmission among sea lions regarding knowledge of foraging opportunities. Speakers indicated that sea lions have demonstrated an ability to learn from one another's successful foraging habits; however, early intervention helps disrupt this process.

Committee member and invited expert discussion points regarding influences on pinniped predation include the following:

- The possibility of other pinnipeds assuming the roles of nuisance pinnipeds that are culled

- The effects of human-caused alterations to habitat on migratory prey behavior
- Possible variations in antipredator behavior between wild fish and hatchery fish
- Non-lethal deterrents for problematic foraging behavior
- The feasibility of encouraging desired antipredator behaviors among salmonids and desired foraging behaviors among pinnipeds
- Seasonal memory among pinnipeds regarding where and how to forage

### **Ecological interactions affecting pinniped predation on salmonids**

The presenter described how the Puget Sound Atlantis Ecosystem Model, which simulates relationships between all species in the food web and within the context the ecosystem's biological processes, has identified a strong trophic linkage between herring population dynamics and salmon abundance. This predicted ecological interaction primarily affects Chinook and impacts coho and chum to a lesser degree. The speaker indicated that, because of the linkages between pinnipeds and these fish species, this relationship has implications for seals and sea lions as well. They indicated that the model predicts greater impacts to California sea lions compared to Steller sea lions.

Committee member and invited expert discussion points regarding ecological interactions included the following:

- The role of fish size in the predicting ecological interactions
- Modeling of seasonal targeting in pinniped response to prey and the related impacts
- The prey buffering hypothesis and opportunistic feeding patterns among pinnipeds based on prey availability
- Variability in prey migration due to other factors, such as water levels
- Recent study findings that indicate a lack of correlation between killer whale demography and Chinook abundance

### **Potential management actions**

Speakers described how the Marine Mammal Protection Act (MMPA) governs the management of marine mammals. They indicated that this legislation established a moratorium on culling marine mammals but offers several exceptions. Namely, states can apply to cull individual pinnipeds identified as causing negative effects to the recovery of salmon populations listed (or being considered for listing) under the Endangered Species Act. Presenters stated that states and other jurisdictions would benefit from the flexibility to tailor marine mammal management approaches to their unique situations and to implement site-specific strategies.

Committee member and invited expert discussion points regarding the management of marine mammals included the following:

- Challenges to implementing appropriate management strategies, including the extensive data collection required to justify lethal culling and the need for agreement on an approach when multiple jurisdictions are involved
- Variability in the benefits of certain management actions across locations and circumstances
- Whether culling problematic individual pinnipeds is an effective management approach (there was disagreement among committee members and invited experts on this issue)

## **NEXT STEPS**

The committee will hold a second workshop designed to engage with stakeholders and will also share a summary of that workshop. Over the next several months, the committee will draft a report and bibliography on the science of pinniped predation on salmonids.

## APPENDIX A: PARTICIPANT LIST

Role	First Name	Last Name	Affiliation
Committee	Alejandro	Acevedo-Gutierrez	Western Washington University
Committee	Mike	Etnier	Western Washington University
Committee	Tessa	Francis	University of Washington
Committee	Ray	Hilborn	University of Washington
Committee	Megan	Moore	NOAA Fisheries
Committee	Daniel	Schindler	University of Washington
Committee	Jonathan	Scordino	Makah Fisheries Management, Makah Tribe
Committee	Kathryn	Sobocinski	Western Washington University
Committee	Andrew	Trites	University of British Columbia
Observer	Mickey	Agha	Washington Department of Fish and Wildlife
Observer	Mark	Baltzell	Washington Department of Fish and Wildlife
Observer	Sarah	Colosimo	Washington Department of Fish and Wildlife
Observer	Derek	Dapp	Washington Department of Fish and Wildlife
Observer	Joe	Ebersole	Environmental Protection Agency
Observer	Tara	Galuska	Governor's Office
Observer	Lucas	Hall	Long Live the Kings
Observer	Robert	Harris	St. Andrews University, Scotland
Observer	Dennis	Heinemann	Marine Mammal Commission
Observer	Kirt	Hughes	Washington Department of Fish and Wildlife
Observer	Iris	Kemp	King County
Observer	John	Kocik	NOAA NEFSC
Observer	Robert	Kopperl	Willamette CRA
Observer	Kessina	Lee	Washington Department of Fish and Wildlife
Observer	Ryan	Lothrop	Washington Department of Fish and Wildlife
Observer	Charles	Morrill	Washington Department of Fish and Wildlife
Observer	Nate	Pamplin	Washington Department of Fish and Wildlife
Observer	Coral	Pasi	Washington Department of Fish and Wildlife
Observer	Jeremiah	Shrovnal	Washington Department of Fish and Wildlife
Observer	Tim	Sippel	Washington Department of Fish and Wildlife
Observer	Jessica	Stocking	Washington Department of Fish and Wildlife
Observer	Eric	Winther	Washington Department of Fish and Wildlife
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Participant	Liz	Allyn	Makah Tribe
Participant	Robert	Anderson	NOAA/NMFS
Participant	Barry	Berejikian	NOAA/NMFS/NWFSC/efs
Participant	Michael	Brown	Oregon Department of Fish and Wildlife
Participant	Virginia	Butler	Portland State University
Participant	Robert	DeLong	NMFS, AFSC, MML (Retired)
Participant	John	Edwards	Washington Department of Fish and Wildlife
Participant	Joseph	Gaydos	SeaDoc Society, UC Davis Wildlife Health Center



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<b>Participant</b>	Frances	Gulland	Marine Mammal Commission
<b>Participant</b>	Lee	Harber	Fisheries and Oceans Canada
<b>Participant</b>	Doug	Hatch	Columbia River Inter-Tribal Fish Commission
<b>Participant</b>	Mark	Henderson	US Geological Survey
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<b>Participant</b>	Sharon	Melin	National Oceanic and Atmospheric Administration
<b>Participant</b>	Eric	Palkovacs	UC Santa Cruz
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<b>Participant</b>	Joseph	Taylor	Simon Fraser University
<b>Participant</b>	Amy	Trainer	Swinomish Indian Tribal Community
<b>Participant</b>	Eric	Ward	National Oceanic and Atmospheric Administration
<b>Participant</b>	Julie	Watson	Washington Department of Fish and Wildlife
<b>Participant</b>	David	Welch	Kintama Research Services Ltd
<b>Participant</b>	Rob	Williams	Oceans Initiative
<b>Participant</b>	Bryan	Wright	Oregon Department of Fish and Wildlife
<b>Speaker</b>	Joe	Anderson	Washington Department of Fish and Wildlife
<b>Speaker</b>	Casey	Clark	Washington Department of Fish and Wildlife
<b>Speaker</b>	Scott	Pearson	Washington Department of Fish and Wildlife
<b>Speaker</b>	Brandon	Chasco	National Marine Fisheries Service
<b>Speaker</b>	Peter	Olesiuk	Pacific Eco-Tech Environmental Research
<b>Speaker</b>	Austen	Thomas	Smith-Root
<b>Speaker</b>	Carl	Walters	University of British Columbia
<b>Speaker</b>	Megan	Sabal	Oregon State University
<b>Speaker</b>	Zac	Schakner	NOAA Fisheries
<b>Speaker</b>	Jamie	Womble	National Park Service
<b>Speaker</b>	Hem Nalini	Morzaria-Luna	Long Live the Kings
<b>Speaker</b>	Steven	Jeffries	Cascadia Research
<b>Speaker</b>	Joe	Scordino	Retired NOAA Fisheries
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## APPENDIX B: WORKSHOP AGENDA

### Agenda – Workshop for Scientists and Co-Managers

#### Pinniped Predation on Salmonids Study

February 9, 2022 | 9:00 am – 1:00 pm PT

The Washington State Academy of Sciences (WSAS) Pinniped Predation on Salmonids committee is hosting a virtual workshop to engage members of the scientific community with expertise relating to pinniped predation on salmonids.

The aim is for invited scientists and researchers, whether academic, tribal, federal, nonprofit, or industry, to share their understanding of the relevant published and unpublished research, data, and context for existing and current studies. The information gathered at the workshop and in the request for written input will inform the study committee's summary of the science of pinniped predation on salmonids, with an emphasis on Washington's portion of the Salish Sea and Washington's outer coast.

Please submit files, literature, data, resources, or comments through this link:

[https://wsu.co1.qualtrics.com/jfe/form/SV\\_71e5LDbdwXknCwm](https://wsu.co1.qualtrics.com/jfe/form/SV_71e5LDbdwXknCwm)

There will be a separate workshop in March 2022 to hear from stakeholders. More information about the committee is at: <https://washacad.org/portfolio-items/pinniped-predation/>. All workshop participants are expected to follow WSAS's Code of Conduct: <https://washacad.org/code-of-conduct/>.

9:00 am     **Opening and introduction to the project and workshop objectives; Workshop logistics**  
*Daniel Schindler (Committee Chair), Jessica Stocking (WDFW), Yasmeen Hussain (WSAS)*

9:05 am     **Session 1: Current and historical pinniped and salmonid populations in Washington's Salish Sea and Outer Coast;** *Daniel Schindler, Mike Etnier*

Presentations:

- Scott Pearson – Pinniped population and stock assessment
- Casey Clark – Pinniped diet data
- Joe Anderson – Salmon status, trends, and data collection

Open discussion. Points of particular interest:

- Current and historical pinniped population levels in Washington's Salish Sea or outer coast
  - Pinniped migration patterns
  - Factors limiting pinniped population size

- Traditional ecological knowledge about pinniped abundance and distribution
- Historic hunting of pinnipeds
- Current and historical salmonid population levels in Washington’s Salish Sea or outer coast
  - Regional, species-specific, and life stage-specific information
- On which key studies should the committee primarily base its understanding of how pinniped and salmonid populations have changed over time in this area?

9:25 am    **Session 2: Quantifying overall pinniped predation on salmonids;** *Kathryn Sobocinski, Jonathan Scordino*

Presentations:

- Carl Walters – Pinniped and salmon relationships in the Salish Sea
- Austen Thomas – Harbor seal diet data; Consumption in the context of salmon population
- Peter Olesiuk – Steller sea lion consumption of salmon
- Brandon Chasco – Population-level impacts of pinniped predation on salmonids

Open discussion. Points of particular interest:

- Consumption of salmonids by pinnipeds in Puget Sound and Washington’s outer coast
  - Specific to each geographic area
  - By phase of salmon life history
  - Extrapolation of diet data for seals/sea lions to other populations, regions, etc.
- How predation levels have changed over time
  - Relative to pinniped population changes
  - Relative to other predation or impacts on salmonids
  - Relative to salmonid abundances
- Magnitude of predation impacts relative to other sources of mortality; what affects salmon mortality and how pinniped predation factors in
- If pinniped predation contributes to salmon population declines or marine survival rates
- On which key studies should the committee primarily base its understanding of overall pinniped predation on salmonids? What additional research is needed?

10:15 am    *Break*

10:25 am **Session 3: Factors affecting pinniped predation on salmonids;** *Andrew Trites, Alejandro Acevedo-Gutiérrez*

Presentations:

- Megan Sabal – Predator effects on migratory animals: incorporating prey behavior into conservation
- Jamie Womble – Steller sea lion response to seasonal distribution of prey in southeastern Alaska, and relevance to WA waters
- Zac Schakner – Modeling of sea lions sharing knowledge of foraging opportunities in Columbia River, and relevance to Puget Sound

Open discussion. Points of particular interest:

- Factors that may regulate pinniped predation on salmonids (e.g. pinniped number, pinniped age and sex, location (Salish Sea, outer coast, rivers, Puget Sound, Strait of Juan de Fuca), salmonid populations, the natural environment, artificial structures, anthropogenic activities, number/size of haul-outs)
- Density dependence of pinniped predation on salmonids
- Relative pinniped predation impacts on hatchery-origin salmon versus wild-origin salmon
- Empirical evidence for predation ‘hot spots’, pinniped learned behavior, individual ‘specialist’ pinnipeds, foraging within/between stock boundaries
- On which key studies should the committee primarily base its understanding of factors affecting pinniped predation on salmonids? What additional research is needed?

11:10 am **Session 4: Ecological interactions affecting pinniped predation on salmonids in the Salish Sea and Washington’s outer coast;** *Tessa Francis, Megan Moore*

Presentations

- Hem Morzaria Luna – Salmon population sensitivity to changes in herring population

Open discussion. Points of particular interest:

- Trophic relationships (direct and indirect) between pinnipeds and other predators of salmonids in the Salish Sea and Washington’s outer coast (e.g., pinniped consumption of other predators of salmonids)
- Consumption of salmonids relative to other prey species consumed by pinnipeds
- Impacts of hatchery production on the consumption of wild salmonids by pinnipeds

- Empirical/model evidence for “predator release” hypothesis (reduction in pinnipeds → increase in other salmon predators → increased predation of those predators on salmonids)
- Empirical/model evidence for “prey buffering” hypothesis (greater abundance of other pinniped prey species → reduced pinniped consumption of salmonids)
- Management challenges of generalist predators
- Empirical/model evidence for effects on reducing pinniped abundance in the Salish Sea on prey for transient killer whales, SRKW, or NRKW
- On which key studies should the committee primarily base its understanding of ecological interactions affecting pinniped predation on salmonids? What additional research is needed?

11:55 am *Break*

12:05 pm **Session 5: Potential management actions** *Ray Hilborn, Daniel Schindler*

Presentations

- Steve Jeffries – Mitigating Pinniped Predation on ESA-Listed Chinook in the Columbia River under MMPA Section 120
- Joe Scordino – Pinniped management and the MMPA

Open discussion. Points of particular interest:

- For potential management actions (including long and short term, non-lethal and lethal), empirical information or model analyses regarding potential benefits, magnitude of impacts, ecological risks, uncertainty, and/or interactions with other management actions
- Evidence for whether pinniped culls have been effective in reducing salmon predation rates
- Evidence for pinniped behavioral avoidance of areas where lethal removals occur
- Constraints of the MMPA PBR limit on pinniped removal
- Potential for changes in salmon abundance as a result of pinniped removal
- Evidence on interrupting socially-transmitted pinniped predation behaviors
- Management challenges and opportunities with variation among individual predators (e.g. individual ‘specialist’ pinniped)
- On which key studies should the committee primarily base its understanding of potential management actions? What additional research is needed?

12:50 pm **Summary and Wrap-Up;** *Daniel Schindler, Yasmeen Hussain*

1:00 pm **Adjourn**