Dr. Curry James Cunningham
Curriculum Vitae

Assistant Professor of Fisheries
University of Alaska Fairbanks
College of Fisheries and Ocean Sciences
17101 Point Lena Loop Road
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Experience

- Groundfish stock assessment author and management strategy evaluation coordinator for the NOAA Alaska Fisheries Science Center.
- Developing management strategy evaluations (MSEs) and paired simulation-estimation analyses to investigate Bristol Bay Alaska commercial sockeye salmon fisheries, Alaskan sablefish apportionment, and Pacific halibut prohibited species catch limits.
- Operation of the University of Washington, Alaska Salmon Program field research camp at Lake Iliamna (2012 – 2016, 2019-present). Duties include logistics, boat and generator maintenance, and oversight of data collection for various long-term and temporary ecosystem monitoring and assessment projects related to salmon and climate change.
- Many years of employment as a commercial fisherman in Bristol Bay, Alaska.

Employment

2017-2019   Research Fisheries Biologist, National Oceanic and Atmospheric Administration, Alaska Fisheries Science Center, Auke Bay Laboratories. Focus on groundfish stock assessment and Management Strategy Evaluation.

Academic Positions

2019-present Assistant Professor, University of Alaska Fairbanks – College of Fisheries and Ocean Sciences.
2019-2020   Research Assistant Professor, Alaska Pacific University – Fisheries, Aquatic Science, & Technology Laboratory.
2015-2017   Postdoctoral researcher, University of Alaska Fairbanks, College of Fisheries and Ocean Sciences. *Pollock Conservation Cooperative Research Center*: *Using a stage structured population dynamics model to determine key environmental and fishery-related drivers of AYK Chinook salmon survival*. Supervisors: Drs. Peter Westley and Milo Adkison.
2016-2019   Affiliate faculty, Alaska Pacific University, Fisheries, Aquatic Science, & Technology Laboratory.

Education

2010-2015   PhD, University of Washington, School of Aquatic and Fishery Sciences. Advisors: Drs. Ray Hilborn and Thomas Quinn.
2005-2010   BSc in Animal Biology, University of British Columbia, Vancouver.

Peer-reviewed Publications (*Featured on journal cover, ‡Faculty 1000 recommended)
Google Scholar: https://scholar.google.com/citations?user=49EsNzMAAAAJ&hl=en

1. Deane, C. E., L. G. Carlson, **C. J. Cunningham**, P. Doak, K. Kielland, and G. A. Breed. 2023. Prior choice and data requirements of Bayesian multivariate hierarchical models fit to tag-recovery data: The need for power analyses. **Ecology Evolution** 13.
2. Cheng, M. L. H., C. J. Rodgveller, J. A. Langan, **C. J. Cunningham**, and S. Zhou. 2023. Standardizing fishery-dependent catch-rate information across gears and data collection programs for Alaska sablefish (Anoplopoma fimbria). **ICES Journal of Marine Science**.
3. Feddern, M. L., E. R. Schoen, R. Shaftel, **C. J. Cunningham**, C. Chythlook, B. M. Connors, A. D. Murdoch, V. R. von Biela, and B. Woods. 2023. Kings of the North: Bridging Disciplines to Understand the Effects of Changing Climate on Chinook Salmon in the Arctic-Yukon-Kuskokwim Region. **Fisheries**.
4. Brandhuber, M., S. Atkinson, **C. Cunningham**, T. Roth, and E. Curry. 2023. Assessing Dehydroepiandrosterone Sulfate (DHEAS) as a novel biomarker for monitoring estrus and successful reproduction in polar bears. **General and Comparative Endocrinology** 338:114276.
5. Hyun, S.-Y., and **C. J. Cunningham**. 2022. A new in-season forecast density of anadromous fish return abundance. **Fisheries Research** 256.
6. Sethi, S. A., M. P. Carey, J. Gerken, B. P. Harris, N. Wolf, **C. Cunningham**, F. Restrepo, and J. Ashline. 2022. Juvenile salmon habitat use drives variation in growth and highlights vulnerability to river fragmentation. **Ecosphere** 13.
7. Dittman, A. H., **C. J. Cunningham**, and T. P. Quinn. 2022. Can unique amino acid profiles guide adult salmon to natal streams? A comparison of streams sampled prior to and after the arrival of adult Pacific salmon. **Hydrobiologia**.

8. Ovando, D., **C. J. Cunningham**, P. Kuriyama, C. Boatright, and R. Hilborn. 2022. Improving forecasts for Sockeye Salmon (Oncorhynchus nerka) with parametric and non-parametric models. **Canadian Journal of Fisheries and Aquatic Sciences.**

9. Manishin, K. A., **C. J. Cunningham**, P. A. H. Westley, and A. C. Seitz. 2021. Can late stage marine mortality explain observed shifts in age structure of Chinook salmon? **PLoS:** ONE 16.

10. Rhodes-Reese, M., D. Clay, **C. Cunningham**, J. Moriles-Miller, C. Reese, J. Roman, J. D. Warren, and H. C. Pearson. 2021. Examining the Role of Marine Mammals and Seabirds in Southeast Alaska's Marine Ecosystem Dynamics. **Frontiers in Marine Science** 8.

11. Thorson, J. T., **C. J. Cunningham**, E. Jorgensen, A. Havron, P.-J. F. Hulson, C. C. Monnahan, and P. von Szalay. 2021. The surprising sensitivity of index scale to delta-model assumptions: Recommendations for model-based index standardization. **Fisheries Research** 233.

12. Rosellon-Druker, J., M. Szymkowiak, K. Y. Aydin, **C. J. Cunningham**, E. A. Fergusson, S. Kasperski, G. H. Kruse, J. H. Moss, M. Rhodes-Reese, K. S. Shotwell, E. Spooner, and E. M. Yasumiishi. 2021. Participatory place-based integrated ecosystem assessment in Sitka, Alaska: Constructing and operationalizing a socio-ecological conceptual model for sablefish (Anoplopoma fimbria). **Deep Sea Research Part II: Topical Studies in Oceanography**.

13. Murphy, R., **C. Cunningham**, B. P. Harris, and C. Brown. 2021. Qualitative and Quantitative Fisher Perceptions to Complement Natural Science Data for Managing Fisheries. **Fisheries** 46:209-219.

14. Oke, K.B., **C. J.Cunningham**, P. A. H. Westley, M. L. Baskett, S. M. Carlson, J. Clark, A. P. Hendry, V. A. Karatayev, N. W. Kendall, J. Kibele, H. K. Kindsvater, K. M. Kobayashi, B. Lewis, S. Munch, J. D. Reynolds, G. K. Vick, and E.P. Palkovacs. 2020. Accelerating declines in salmon body size impact ecosystems and people. **Nature Communications**.

15. Litzow, M. A., M. J. Malick, N. A. Bond, **C. J. Cunningham**, J. L. Gosselin, and E. J. Ward. 2020. Quantifying a Novel Climate Through Changes in PDO-Climate and PDO-Salmon Relationships. **Geophysical Research Letters.**

16. Jones, L., E. Schoen, R. Shaftel, **C. J. Cunningham**, S. Mauger, D. Rinella, and A. St. Savior. 2020. Regional and watershed-scale climate drivers influence Chinook salmon productivity in southcentral Alaska. **Global Change Biology**.

17. Litzow, M. A., M. E. Hunsicker, N. A. Bond, B. J. Burke, **C. J. Cunningham**, J. L. Gosselin, E. L. Norton, E. J. Ward, and S. G. Zador. 2020. The changing physical and ecological meanings of North Pacific Ocean climate indices. **Proceedings of the National Academy of Sciences**: 201921266.

18. Armstrong, J. B., D. E. Schindler, **C. J. Cunningham**, W. Deacy, and P. Walsh. 2019. Watershed complexity increases the capacity of salmon-wildlife interactions in coastal ecosystems. **Conservation Letters**.

19. Litzow, M. A., L. Cianelli, **C. Cunningham**, B. Johnson, and P. Puerta. 2019. Nonstationary effects of ocean temperature on Pacific salmon productivity. **Canadian Journal of Fisheries and Aquatic Sciences** 76(11): 1923-1928.

20. Rosellon-Druker, J., M. Szymkowiak, **C. J. Cunningham**, S. Kasperski, G. H. Kruse, J. H. Moss, and E. M. Yasumiishi. 2019. Development of social-ecological conceptual models as the basis for an integrated ecosystem assessment framework in Southeast Alaska. **Ecology and Society** 24(3).

21. Oke, K. B., **C. J. Cunningham**, T. P. Quinn, and A. P. Hendry. 2019. Independent lineages in a common environment: the roles of determinism and contingency in shaping the migration timing of even- versus odd-year pink salmon over broad spatial and temporal scales. **Ecology Letters** 22(10): 1547-1556.

22. Manishin, K. A., K. J. Goldman, M. Short, **C. J. Cunningham**, P. A. H. Westley, and A. C. Seitz. 2019. Prey consumption estimates for salmon sharks. **Marine & Freshwater Research**. https://doi.org/10.1071/MF18345.

23. **Cunningham, C. J.**, C. Anderson, J. Y. Wang, M. Link, and R. Hilborn. 2019. A management strategy evaluation of the commercial sockeye salmon fishery in Bristol Bay, Alaska. **Canadian Journal of fisheries and Aquatic Sciences** 76(9): 1669–1683. – *Special Issue: Management Strategy Evaluation – 147th AFS*.

24. Wirsing, A. J., T. P. Quinn, **C. J. Cunningham**, J. R. Adams, A. D. Craig, and L. P. Waits. 2018. Alaskan brown bears (*Ursus arctos*) aggregate and display fidelity to foraging neighborhoods while preying on Pacific salmon along small streams. **Ecology and Evolution:** 8:9048-9061.

25. **Cunningham, C. J.**, P. A. H. Westley, and M. D. Adkison. 2018. Signals of large scale climate drivers, hatchery enhancement, and marine factors in Yukon River Chinook salmon survival revealed with a novel Bayesian life history model. **Global Change Biology**: 29 (9) 4399-4416.

26. Wang, J. Y., C. M. Anderson, **C. J. Cunningham**, and R. Hilborn. 2018. Does more fish mean more money? Evaluating alternative escapement goals in the Bristol Bay salmon fishery. **Canadian Journal of Fisheries and Aquatic Sciences**: 76(1): 153-167.

27. **Cunningham, C. J.** T. A. Branch, T. H. Dann, M. Smith, J. E. Seeb, L. W. Seeb, and R. Hilborn. 2018. A general model for salmon run reconstruction that accounts for interception and differences in availability to harvest. **Canadian Journal of Fisheries and Aquatic Sciences** 75(3): 439-451.

28. Quinn, T. P., **C. J. Cunningham**, and A. J. Wirsing. 2017. Diverse foraging opportunities drive the functional response of local and landscape-scale bear predation on Pacific salmon. **Oecologia** 183(2): 415-429.

29. Adkison, M. D., and **C. J. Cunningham**. 2015. The effects of salmon abundance and run timing on the performance of management by emergency order. **Canadian Journal of Fisheries and Aquatic Sciences** 72(10): 1518-1526.

30. Hurtado-Ferro, F., C. S. Szuwalski, J. L. Valero, S. C. Anderson, **C. J. Cunningham**, K. F. Johnson, R. Licandeo, C. R. McGilliard, C. C. Monnahan, M. L. Muradian, K. Ono, K. A. Vert-Pre, A. R. Whitten, and A. E. Punt. 2015. Looking in the rear-view mirror: bias and retrospective patterns in integrated, age-structured stock assessment models. **ICES Journal of Marine Science** 72:99-110.
31. Quinn, T. P., A. Wirsing, B. Smith, **C. J. Cunningham**, and J. Ching. 2014. Complementary use of motion-activated cameras and unbaited wire snares for DNA sampling reveals diel and seasonal activity patterns of brown bears foraging on adult sockeye salmon. **Canadian Journal of Zoology**.
32. Carlson, S. M., **C. J. Cunningham**, and P. A. H. Westley. 2014. Evolutionary rescue in a changing world. **Trends in Ecology and Evolution** 29:521-530[*‡]. ***Note: All authors contributed equally.***
33. Quinn, T. P., **C. J. Cunningham**, J. Randall, and R. Hilborn. 2014. Can intense predation by bears exert a depensatory effect on recruitment in a Pacific salmon population? **Oecologia**:1-12.
34. Johnson, K. F., C. C. Monnahan, C. R. McGilliard, K. A. Vert-pre, S. C. Anderson, **C. J. Cunningham**, F. Hurtado-Ferro, R. R. Licandeo, M. L. Muradian, K. Ono, C. S. Szuwalski, J. L. Valero, A. R. Whitten, and A. E. Punt. 2014. Time-varying natural mortality in fisheries stock assessment models: identifying a default approach. **ICES Journal of Marine Science**.
35. Ono, K., R. Licandeo, M. L. Muradian, **C. J. Cunningham**, S. C. Anderson, F. Hurtado-Ferro, K. F. Johnson, C. R. McGilliard, C. C. Monnahan, C. S. Szuwalski, J. L. Valero, K. A. Vert-Pre, A. R. Whitten, and A. E. Punt. 2014. The importance of length and age composition data in statistical age-structured models for marine species. **ICES Journal of Marine Science**.
36. **Cunningham, C. J.**, G. T. Ruggerone, and T. P. Quinn. 2013. Size selectivity of predation by brown bears depends on the density of their sockeye salmon prey. **American Naturalist** 181:663-673.
37. **Cunningham, C. J.**, M. G. Courage, and T. P. Quinn. 2013. Selecting for the phenotypic optimum: size-related trade-offs between mortality risk and reproductive output in female sockeye salmon. **Functional Ecology** 27:1233-1243.
38. Quinn, T. P., A. H. Dittman, H. Barrett, **C. Cunningham**, and M. H. Bond. 2012. Chemosensory responses of juvenile coho salmon, Oncorhynchus kisutch, Dolly Varden, Salvelinus malma, and sculpins (Cottus spp.) to eggs and other tissues from adult Pacific salmon. **Environmental Biology of Fishes** 95:301-307.

Reports and Technical Memos
1. **Cunningham, C. J.**, P. F. Hulson, C. R. Lunsford, and D. H. Hanselman. 2018. Assessment of the Northern Rockfish stock in the Gulf of Alaska. https://www.fisheries.noaa.gov/resource/data/2018-assessment-northern-rockfish-stock-gulf-alaska
2. Dorn, M. W., **C. J. Cunningham**, M. T. Dalton, B. S. Fadely, B. L. Gerke, A. B. Hollowed, K. K. Holsman, J. H. Moss, O. A. Ormseth, W. A. Palsson, P. A. Ressler, L. A. Rogers, M. A. Sigler, P. J. Stabeno, and M. Szymkowiak. 2018. A climate science regional action plan for the Gulf of Alaska. U.S. Dep. Commer. https://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-376.pdf
3. **Cunningham, C. J.**, A. N. Hendrix, E. Dusek-Jennings, R. Lessard, and R. Hilborn 2015. A multi-stock population dynamics framework for the recovery of Sacramento River Chinook salmon. Delta Science Program, Delta Stewardship Council. http://deltacouncil.ca.gov/sites/default/files/2039%20Final%20Report.pdf
4. **Cunningham, C. J.**, J. Wang, R. Hilborn, C. Anderson, and M. R. Link. 2015. Analysis of escapement goals for Bristol Bay sockeye salmon taking into account biological and economic factors. University of Washington, School of Aquatic and Fisheries Sciences and LGL Alaska Research Associates, Inc. http://www.bbedc.com/wp-content/uploads/2015/03/Evaluation-of-Alternative-Escapement-Goals-in-Bristol-Bay-10-March-2015.pdf
5. **Cunningham, C. J.**, D. E. Schindler, and R. Hilborn. 2015. An evaluation of biological escapement goals for sockeye salmon of Bristol Bay, Alaska. University of Washington. http://www.bbedc.com/wp-content/uploads/2015/03/BB-BEG-Evaluation-V12_Feb-25_2015.pdf
6. **Cunningham, C. J.**, R. Hilborn, J. Seeb, M. Smith, and T. A. Branch. 2012. Reconstruction of Bristol Bay sockeye salmon returns using age and genetic composition of catch. SAFS-UW-1202. https://digital.lib.washington.edu/researchworks/handle/1773/20963

Editorials
1. Schindler, D. and **C. J. Cunningham**. 2020. What if there's no salmon fishery? How covid-19 could affect salmon populations. **National Fisherman**. https://www.nationalfisherman.com/viewpoints/alaska/what-if-theres-no-salmon-fishery-how-covid-19-could-affect-escapement/
2. Westley, P. A. H. and **C. J. Cunningham**. 2020. Specter of overescapement shouldn't influence fisheries decisions on COVID-19. **Anchorage Daily News** Opinion. https://www.adn.com/opinions/2020/04/14/specter-of-overescapement-shouldnt-influence-fisheries-decisions-on-covid-19/

Dissertation
Cunningham, C. J. (2015). *Salmonid selection, evolution, and historical abundance patterns.* (PhD), University of Washington, Seattle.

This dissertation focused on: 1) evaluating whether selective predation by brown bears (*Ursus arctos*) depends upon the density of their sockeye salmon (*Oncorhynchus nerka*) prey, 2) quantifying strength and direction of natural and anthropogenic selection forces and life history tradeoffs that shaping optimal phenotypic distributions for populations of sockeye in Bristol Bay, Alaska, 3) development of methods for reconstructing salmon run size by partitioning mixed-stock catches while accounting for differences in availability to harvest within common fishing areas and interception in spatially proximate terminal fishing districts using both age and genetic composition of catch data, 4) simulation testing of a stage-structured statistical life cycle model for evaluating the natural and anthropogenic drivers of Chinook salmon (*O. tshawytscha*), and 5) an application for the statistical life cycle model to seven populations of fall and spring-run Chinook in the Sacramento River watershed of California.

Teaching Experience

2023   **Instructor:** FISH 622: Quantitative Fish Population Dynamics. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2023   **Workshop Instructor: Introduction to Git and GitHub.** Alaska Chapter, American Fisheries Society, student subunit.

2022   **Instructor:** FISH/MSL 627: Statistical Computing with R. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2022   **Instructor:** FISH 692: Application of Machine Learning Methods in Fisheries and Aquatic Science. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2022   **Instructor:** FISH 621: Estimation of Fish Abundance. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2021   **Co-instructor:** MAR 32000 Perspectives and Practice in Fish Biology. Alaska Pacific University, field course at Iliamna Lake research station.

2021   **Instructor**: FISH/MSL 627: Statistical Computing with R. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2021   **Instructor**: FISH 622: Quantitative Fish Population Dynamics. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2020   **Instructor**: FISH/MSL 627: Statistical Computing with R. University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.

2019   **Instructor**: 3-day workshop for the Alaska Native Tribal Health Consortium: *Introduction to Data Analysis and Statistical Inference in R.*

2018   **Co-instructor** with Dr. Jim Thorson for a short course on spatio-temporal models for survey index standardization at the NOAA Alaska Fisheries Science Center.

2017   ***Substitute* lecturer and lab instructor** for Dr. Franz Mueter. *Modern Applied Statistics in Fisheries* (FISH 604), UAF College of Fisheries and Ocean Sciences.

2017   ***Substitute* lecturer and lab instructor** for Dr. Milo Adkison. *Fisheries Population Dynamics* (FISH 421), UAF College of Fisheries and Ocean Sciences.

2017   **Instructor**: Workshop on the use of Git/Github for version control and collaborative project design for the American Fisheries Society, University of Alaska Fairbanks student subunit.

2017   **Instructor**: Workshop on the use of Git/Github for version control and collaborative project design for the NOAA Auke Bay Laboratories.

2011   **Lab instructor and teaching assistant:** Modeling and Estimation in Conservation and Resource Management (FISH 458), University of Washington. Duties as instructor for computer labs included lessons in excel and R focusing on: maximum likelihood approaches for fitting models to data, predatory-prey dynamics, evaluation of alternative management policies, information-theoretic approaches to model selection, population viability analysis, and parameter estimation using size and age-structured population dynamics models.

2010   **Teaching assistant**: Aquatic Ecological Research in Alaska (FISH 491), University of Washington. AERA is a 6-week undergraduate field course held at the U of W research camps in Alaska, focusing on limnology, geomorphology, and the population dynamics and evolutionary ecology of salmon. Duties included preparation of field experiments and sampling equipment, as well as aiding students in development and implementation of individualized research projects.

Graduate Students

Tristan Sebens	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Kevin Siwicke	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences, co-advised by Dr. Andy Seitz (UAF, CFOS)
Lilian Hart	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Matt (Lok) Cheng	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Genoa Sullaway	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Lindsay Turner	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Aaron Lambert	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Rachel Ertz	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.

Kari Fenske	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended September, 2022.

Postdoctoral Fellows

Dr. Kimberly Fitzpatrick	Postdoc at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences; research focused on understanding how uncertainty in bottom trawl survey abundance estimates resulting from spatial variation and sample design influence age-structured stock assessment estimates. April 2023 – present.
Dr. Megan Feddern	Postdoc at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences; research focused on estimating climate impacts on Arctic-Yukon-Kuskokwim region Chinook salmon. Jan. 2022 – present.
Dr. Joseph Langan	Postdoc at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences; research focused on modelling the distribution of salmon on the high seas using contemporary and historical data. Sept. 2021 – present.
Dr. Szymon Surma	Postdoc at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences; research focused on trophic modelling for the Eastern Gulf of Alaska. Dec. 2021 – May 2022.

Graduate Committees

Jasmine Nyce	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Daniel Smith	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Sabrina Garcia	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Janessa Esquible	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Sam Rosenbaum	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Rebecca Shaftel	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Austin Flanigan	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Garrett Dunne	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Chris Guo	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Lia Domke	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Cody Deane	Doctoral student at University of Alaska Fairbanks: Biology Department.
Monica Brandhuber	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Sonia Kumar	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences.
Cara Hasselbach	Masters student at Alaska Pacific University: Fisheries, Aquatic Science & Technology Laboratory.
Mary Spanos	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended June, 2022.
Molly Payne	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended May, 2022.
Becca Cates	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended December, 2021.
Erika King	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended December, 2021.
Kelly Cates	Doctoral student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended May, 2021.
Duncan Green	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended July 2020.
Kaitlyn Manishin	Masters student at University of Alaska Fairbanks: College of Fisheries and Ocean Sciences. Successfully defended September, 2018.

Funding

2022   Cunningham, C. J. *Bristol Bay Regional Seafood Development Association.* **Extension of Machine Learning Methods to Bristol Bay Run Timing Forecasts.** Award amount: $32,000.

2022   Cunningham, C. J. *Yukon River Panel Restoration & Enhancement Fund.* **An Integrated Run Abundance Projection Model for Canadian-origin Yukon River Chinook Salmon.** Award amount: $71,794.

2021   Cunningham, C. J. *Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES).* **Spatio-temporal synthesis of regional ocean model predictions and field collections for zooplankton**. Award amount: $157,824.

2021   Cunningham, C. J. *Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES).* **Developing a generic MSE framework for North Pacific groundfish.** Award amount: $89,191.

2021   Cunningham, C. J. *Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES).* **Development of standardized Catch Per Unit Effort (CPUE) indices for Pacific cod.** Award amount: $89,191.

2021   Schoen, E., Cunningham, C. J., and R. Shaftel. *Alaska Sustainable Salmon Fund.* **Drivers and Diversity of Chinook Salmon Populations in the AYK Region**. Award amount: $127,132.

2021	Cunningham, C. J., and D. E. Schindler. *NOAA Saltonstall-Kennedy Grant Program*. **Development of A Management Strategy Evaluation Framework for Subsistence Salmon Fisheries of the Kuskokwim River Watershed.** Award amount: $266,186.
2021	Burt, W. and C. J. Cunningham. *NASA*. **Enhancing ocean color remote sensing tools to better constrain fisheries forecasting models in a critical subarctic system.** Award amount: $207,694.
2021	Cunningham, C. J., and D. E. Schindler. *Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative.* **MSE for Salmon Fisheries in the Kuskokwim River.** Award amount: $252,422.
2020	Cunningham, C. J. *University of Washington, School of Aquatic and Fishery Sciences*. **Development and deployment of statistical salmon forecast tools for the Bristol Bay commercial fishery.** Award amount: $14,877.
2020	Cunningham, C. J. *USGS Cooperative Agreement*. **Alaska Forage Fish Data Compilation and Modeling for Risk Assessment and Resource Management in Oil and Gas Development Regions.** Award amount: $133,479
2020	Cunningham, C. J. *Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES)*. **Development of Fishery-dependent Abundance Indices for Alaska Sablefish (Anoplopoma fimbria).** Award amount: $74,974.
2020	Cunningham, C. J. *Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES)*. **Understanding Movement Patterns of Juvenile and Adult Sablefish in Alaska.** Award amount: $10,888.
2020	Yasumiishi, E., and C. J. Cunningham. *NOAA Essential Fish Habitat*: **Spatio-temporal environmental covariates refine salmon EFH within the Bering and Chukchi seas of the U.S. Exclusive Economic Zone off Alaska.** Award amount: $83,556.
2020	Cunningham, C. J, J. Thorson, M. Bryan, and C. Tribuzio. *Pollock Conservation Cooperative Research Center (PCCRC)*: **Evaluation of spatio-temporal methods for standardization of data from multiple fishery-independent surveys in the Gulf of Alaska, Bering Sea and Aleutian Islands.** Award amount: $212,419.
2019	Cunningham, C. J. *Bering Sea Fishermen's Association.* **Technical review of Yukon River Canadian-origin Chinook salmon Interim Management Escapement Goal.** Award amount: $75,972.
2018	Shelton, O., J. Watson, C. Cunningham, E. Ward, A. Gray, M. Ford, and K. Sommers. *NOAA/NMFS National Protected Species toolbox (NPST) Initiative*: **Integrating Chinook catches from directed fisheries and trawl bycatch to improve distribution information for bycatch avoidance and impacts on predators in a changing environment.** Award amount: $158,000.
2017	Litzow, M., E. Ward, B. Burke, C. Harvey, S. Zador, C. J. Cunningham, N. Bond. *NOAA Fisheries and the Environment (FATE) Program:* **Measuring the strength of ocean-atmosphere coupling to predict climate forcing of northeast Pacific ecosystems.** Award amount: $200,000
2017	Rooper, C., R. Wilborn, S. Lowe, P. Spencer, D. Hanselman, C. Cunningham. *NOAA Habitat Assessment Improvement Plan (HAIP)*: **Accounting for habitat variables to improve abundance indices in Alaska trawl surveys with an emphasis on results from averaging multiple modeling methodologies**. Award amount: $130,161
2015	Westley, P, M. D. Adkison, and C. J. Cunningham. *Pollock Conservation Cooperative Research Center* funding award for postdoctoral research at the University of Alaska Fairbanks, College of Fisheries and Ocean Sciences. $207,171. *Ghost wrote* proposal in collaboration with Drs. Westley and Adkison (UAF, CFOS).

Honors and Awards

2022	Dean's Recognition Award: Outstanding Instructor, University of Alaska Fairbanks, College of Fisheries and Ocean Sciences.
2014	*University of Washington, Graduate School Fund for Excellence and Innovation (GSFEI)* international travel award to present at Canadian Society of Ecology and Evolution conference in Montreal, Quebec.
2012-2013	Faculty Merit Award, University of Washington, School of Aquatic and Fishery Sciences.
2012	National Science Foundation, Graduate Research Fellowship Program, honorable mention in the field of evolutionary biology.
2011	National Science Foundation, Graduate Research Fellowship Program, honorable mention in the field of population and community ecology.

Working Group Membership

2021-present	National Marine Fisheries Service, Fisheries Integrated Modeling System (FIMS) Council. Focus on providing guidance and feedback as NOAA-NMFS develop the next-generation framework for fisheries stock assessment.
2018-2020	NOAA Fisheries and the Environment (FATE) program working group: *Measuring the strength of ocean-atmosphere coupling to predict climate forcing of northeast Pacific ecosystems*.
2017-2020	National Center for Ecological Synthesis and Analysis (NCEAS), State of Alaska Salmon and People (SASAP) project: *Consistency, Causes, and Consequences of Declining Size and Age of Alaskan Salmon.*

Presentations and Guest Lectures

May 2023	NOAA Spring Preview of Ecosystem and Economic Conditions (PEEC): ***Bristol Bay Salmon Forecast***.

May 2023	Invited public presentation for the Bristol Bay Regional Seafood Development Association (BBRSDA), 2023 Bristol Bay Fleet Meeting: ***Application of Machine Learning Methods for Predicting Bristol Bay Run Timing.***
Jan. 2023	Bristol Bay Seafood Processor Meeting: ***Juvenile High Seas Salmon Surveys as a Forecasting Tool.***
Dec. 2022	University of Washington, Alaska Salmon Program, Annual Research Symposium: ***Summer 2022 Acoustic Surveys of Iliamna Lake***.
June 2022	Invited public symposium for the Pacific Salmon Commission: ***Considering Environmental Variation and Implementation Uncertainty with Management Strategy Evaluations for Salmon.***
May 2022	Invited public presentation for the Bristol Bay Regional Seafood Development Association (BBRSDA), 2022 Bristol Bay Fleet Meeting: ***Application of Machine Learning Methods for Predicting Bristol Bay Run Timing.***
May 2022	Invited public presentation for Freezer Longline Coalition (FLC) Annual Symposium: ***Pacific Cod CPUE Index.***
May 2022	NOAA Spring Preview of Ecosystem and Economic Conditions (PEEC): ***Bristol Bay Salmon Forecast and Trends in Age Composition and Population Productivity***.
Mar. 2022	American Fisheries Society, Alaska Chapter Meeting: ***Synthesizing realized salmon escapements from AK to CA: How close are we to yield-based targets?***
Feb. 2022	Bristol Bay Seafood Processor Meeting: ***What do high seas survey data tell us about Bristol Bay salmon?***
Dec. 2021	Invited public presentation for Young Fishermen's Summit, Alaska Sea Grant Marine Advisory Program (Kodiak, AK; remote): ***Climate and fisheries in Alaska***.
Nov. 2021	Presentation at National American Fisheries Society Meeting (Baltimore, MD; remote): ***Evolution and advancements in forecast methodology for Alaskan salmon fisheries***. Invited speaker for symposium on ecological forecasting. Co-authors: Ovando, D. (UW) Murphy, J (NOAA-AFSC).
Aug. 2021	Public presentation to the Pedro Bay, Alaska Village Council: ***FRI/ASP Presentation 2021***
July 2021	Public presentation at Wood River, Bristol Bay, Alaska: ***Salmon science at the UW/FRI field stations.***
May 2021	Presentation at the NOAA Preview of Ecosystem and Socioeconomic Conditions (PEEC) workshop: ***Bristol Bay salmon forecast.***
April 2020	Guest lecture for Dr. Megan McPhee's UAF-CFOS course *Data Visualization in Fisheries* (F493/693): ***Interactive R graphics.***
April 2020	Guest lecture for Dr. Anne Beaudreau's UAF-CFOS course *Management of Renewable Marine Resources* (F640): ***Salmon fishery management in Alaska.***
Mar. 2020	NOAA AFSC Ecosystem and Socioeconomic Profiles (ESPs) workshop: ***Methods for estimating indicator importance.***
Feb. 2020	UAF College of Fisheries and Ocean Sciences departmental seminar: ***What can we learn from coast-wide analyses of salmon population dynamics?***
Jan. 2020	Kuskokwim River interagency science meeting (Anchorage, AK): ***1. Approaches to defining risk: A perspective from the NPFMC process, 2. Overview of precautionary approaches to fisheries management.***
Jan. 2020	UW Alaska Salmon Program Industry Meeting (Seattle, WA): ***Design and development of a new inseason forecast model.***
Jan. 2020	ICES Workshop on Unavoidable Survey Effort Reduction (Seattle, WA): ***Implications of changes in bottom trawl survey effort on the quality of stock assessment results.***
Oct. 2019	Alaska Native Tribal Health Consortium, Research Methods Brownbag Seminar: ***Ecology in the era of Big Data: Bayesian hierarchical models for exploring demographic processes at coast-wide scales.***
Oct. 2019	Invited speaker for *The Science of Pacific Salmon Conservation: Foundations, Myths, and Emerging Insights* symposium the national American Fisheries Society Meeting (Reno, NV): ***Origins and evidence of overcompensation in salmon***.
June 2019	Community presentation in Dillingham, AK: ***Salmon science at the UW/FRI field stations***.
May 2019	UAF College of Fisheries and Ocean Sciences departmental seminar (Juneau, AK): ***Fishery management and assessment in the context of ecological change***.
April 2019	Presentation to the NPFMC Scientific and Statistical Committee (Anchorage, AK): ***Exploration of overcompensation and the spawning abundance producing maximum sustainable yield for Upper Cook Inlet sockeye salmon stocks***.
May 2018	Presentation at Western Division American Fisheries Society Meeting (Anchorage, AK): ***Life cycle modeling of Yukon River Chinook salmon reveals signals of large scale climate drivers, hatchery enhancement, and density-dependent juvenile survival***.
May 2018	Presentation at Western Division American Fisheries Society Meeting (Anchorage, AK): ***Use of Port Moller test fishery CPUE and genetic composition of catch data to improve in-season Bristol Bay run size forecasts***.
May 2018	Presentation at Western Division American Fisheries Society Meeting (Anchorage, AK): ***What is causing changes in the size of Alaskan salmon?***
April 2018	Guest Lecture for Dr. Megan McPhee at UAF, CFOS: ***Salmon fishery management in Alaska.***
April 2018	Presentation to NOAA-AFSC Alaska Integrated Ecosystem Assessment Meeting: ***Management strategy evaluation in the context of IEA***.

Nov. 2017	Guest Lecture for Dr. Peter Westley at UAF, CFOS: ***Conflict, compromise, and Chinook: Balancing multiple ecosystem objectives in California's Central Valley***.
Sep. 2017	Presentation to North Pacific Fishery Management Council, BSAI and GOA Groundfish Plan Teams: ***Evaluation of VAST spatial Delta-GLMM for GOA and AI bottom trawl survey data***.
Aug. 2017	Presentation at the national American Fisheries Society meeting (Tampa, FL): ***Bristol Bay, Alaska commercial salmon fishery MSE: Accounting for variable production regimes and the importance of industry and harvester participation***.
May 2017	NOAA/NMFS Quantitative Ecology and Socioeconomics Training (QUEST) webinar: ***Management Strategy Evaluation: Ideas and Application***.
Jan. 2017	Presentation to Pollock Conservation Cooperative Research Center board: ***Using stage structured population dynamics to determine drivers of AYK Chinook salmon survival***.
Oct. 2016	UAF, College of Fisheries and Ocean Sciences guest lecture (Fairbanks, AK): ***Bristol Bay salmon fishery: History, abundance, and forecasting methods.***
Feb. 2016	UAF, College of Fisheries and Ocean Sciences departmental seminar (Fairbanks, AK): ***Salmonid selection, evolution, and historical abundance patterns***.
Jan. 2016	Presentation at the Alaska Marine Science Symposium (Anchorage, AK): ***Evaluating the freshwater and marine drivers of Yukon River Chinook salmon survival with stage-structured life cycle model"***.
Nov. 2015	Presentation at the American Fisheries Society, Alaska Chapter Meeting (Homer, AK): ***New methods in estimating stock-recruitment relationships for anadromous species***.
Nov. 2015	Invited speaker for UAF, Juneau Fisheries Seminar (Juneau, AK): ***A management strategy evaluation for Bristol Bay sockeye salmon***.
March 2015	Invited speaker at the 2015 California Interagency Ecological Program meeting (Folsom, CA): ***Sacramento River Chinook: A statistical model for evaluating the influence of environmental variability and competition on survival***.
Feb. 2015	Presentation at the SAFS, UW Quantitative Seminar: ***A management strategy evaluation framework for Bristol Bay sockeye salmon***.
Dec. 2014	Presentation at the UW-NOAA Fisheries Think Tank: ***Methods for forecasting Bristol Bay, Alaska sockeye salmon abundance***.
Dec. 2013	Presentation at the SAFS, UW Quantitative Seminar: ***Sacramento River Chinook: A statistical model for evaluating the environmental drivers of survival and competition among populations***.
Jan. 2013	Guest lecture for University of Washington, Wildlife Science Seminar (ESRM 455 & SEFS 554): ***Boats, bears, and bravery: Interactions between natural and anthropogenic selection on sockeye salmon***.
Nov. 2012	Presentation to the Wild Salmon Center (Portland, OR), ***Sacramento River Chinook: Modeling the influence of environmental variability on survival***. This presentation to a group of scientists and policy experts described simulation testing of a Fall-run Sacramento River Chinook model and results from a Winter-run Chinook model.
Oct. 2012	Presentation at the 7th Biennial Bay-Delta Science Conference (Sacramento, CA): ***Sacramento River Chinook: Modeling the influence of environmental variability***, and summarized simulation testing of a Fall-run Chinook population dynamics model with generated data, and panel member for discussion of population dynamics modeling efforts in the Sacramento and San Joaquin watersheds.
May 2012	Presentation at the SAFS, UW Quantitative Seminar: ***Sacramento River winter-run Chinook: Evaluating the environmental drivers of survival***.
Sep. 2011	Presentation at the national American Fisheries Society meeting (Seattle, WA): ***Evaluating the interaction between natural and anthropogenic selection with predictive individual-based modeling***.

Posters

Jan. 2015	Poster at the Alaska Marine Science Symposium (Anchorage, AK): ***Evaluating the impact of bycatch, changing demography, and environmental factors on Yukon River Chinook salmon production***.
Oct. 2014	Poster at the Biennial Bay-Delta Science Conference (Sacramento, CA): ***Sacramento River Chinook: Modeling the influence of environmental variability***.
April 2012	Poster at the Interagency Ecological Program 2012 Annual Workshop (Folsom, CA): ***Sacramento River Chinook: Evaluating the natural and anthropogenic drivers of survival***.

Skills

- Programming in R, AD Model Builder (ADMB) and Template Mode Builder (TMB) software platforms.
- State-space population dynamics modeling with JAGS and Stan.
- Git/Github.
- Expertise in frequentist statistical theory, as well as maximum likelihood and Bayesian estimation methods.
- Stock Synthesis 3, integrated stock assessment software.
- Programming Bayesian models using JAGS, Stan, and the LaplacesDemon package in R.
- Visualization of multivariate data and model outputs using R (base and ggplot graphics).
- Creation of multivariate autoregressive state-space models, including dynamic linear models.

- Advanced mathematics including but not limited to: single and multiple variable integral and differential calculus.
- Applied mathematics and probability theory.
- Decision analysis and management strategy evaluation procedures.
- Analyzing spatially explicit NOAA sea surface temperature and oceanographic data products.

Service

- *Ad hoc* proposal reviewer for the *North Pacific Research Board* competitive research grant program.
- *Ad hoc* proposal reviewer for the *NOAA Saltonstall-Kennedy* grant program.
- *Ad hoc* manuscript reviewer for: *Nature Climate Change, Fisheries Research, PeerJ, Natural Resource Modeling, PLoS One, Canadian Journal of Fisheries and Aquatic Sciences, Journal of Wildlife Management, Ecology.*
- *Academic reviewer* for Alaska Department of Fish and Game Reports, both Sport and Commercial Fisheries Divisions.

Recent Research

Spatial Ecology of Juvenile and Adult Salmon in the North Pacific

The marine portion of the Pacific salmon lifecycle has long been highlighted as a key knowledge gap, given the high cost of high seas sampling relative to freshwater habitats, despite its clear importance for lifetime growth and survival. To better understand the spatial distribution of juvenile and adult salmon in the marine environment and the ecosystem processes driving variation in distribution across time, my lab is leading research to apply a range of species distribution models to available high seas salmon data. These data include juvenile salmon abundances in the eastern and northern Bering Sea from NOAA surface trawl surveys, and high seas gillnet and longline survey data from historical sampling starting in the 1950's by North Pacific Anadromous Fish Commission (NPAFC) member nations (US, Canada, Russia, Japan). This research leverages spatiotemporal models (VAST, GAMs) and machine learning methods (boosted regression trees) to quantify variation in distribution and occupancy, juvenile salmon Essential Fish Habitat, and species-specific thermal niche within the marine environment. **Collaborators:** Dr. Joe Lanagan (UAF-CFOS), Lilian Hart (UAF-CFOS), Skip McKinnel (DFO Canada, retired), and Dr. Ed Farley (NOAA-AFSC).

Management Strategy Evaluation of Harvest Apportionment Alternatives for the Sablefish Stock in the North Pacific

The acceptable biological catch (ABC) for sablefish (*Anoplopoma fimbria*) in Alaskan waters is apportioned among NMFS management areas in each year. Traditionally, ABC was apportioned based on the distribution of sablefish observed in fishery-independent surveys following an exponentially-weighted moving average. However, since 2014 apportionment has been fixed at the 2013 proportions due to concerns regarding the variability in the traditional approach. To address concerns from both stake holders and recommendations from the NPFMC SSC we have initiated a MSE to evaluate the potential outcome of a range of apportionment alternatives developed in collaboration with the stakeholder community. A spatially-explicit operating model (OM) is being developed based on demographic parameters from the 2017 sablefish stock assessment and movement rates informed by the NOAA-NMFS Sablefish Tagging Program. The OM will be paired with the existing sablefish stock assessment model, with representative observation and implementation uncertainty, and used to evaluate the biological and harvest outcomes for the range of proposed apportionment alternatives. **Collaborators:** Dr. Dana Hanselman and Ms. Kari Fenske (AFSC).

Management Strategy Evaluation of the Bristol Bay Commercial Fishery

Management of the Bristol Bay commercial sockeye salmon fishery has traditionally operated under a fixed escapement policy, with active in-season regulation of fishing effort to achieve these targets. However, previous escapement goal analyses did not account for: 1) biological uncertainty in future production regimes, 2) implementation uncertainty in the management process, and 3) the economic costs of high catch variability to the processing and harvesting sectors. To address these concerns and assess management alternatives, we conducted a MSE for this fishery in collaboration with stakeholder representatives from the harvesting and processing sectors, fisheries economists, and the Alaska Department of Fish and Game. As part of this MSE, I developed a simulation framework that uses time-varying stock-recruitment relationships to simulate variation in future production dynamics, and approximates the in-season behavior of fishery managers to account for the imprecision associated with mixed-stock management and delays in information. This MSE process was successful in developing consensus among stakeholders and resulted in changes to the management targets for Bristol Bay beginning in 2015. **Collaborators**: Drs. Ray Hilborn and Chris Anderson (SAFS, UW), Michael Link (Bristol Bay Science and Research Institute).

Evaluation of Prohibited Species Catch Limit Alternatives for Pacific Halibut

To limit bycatch of Pacific halibut in Alaskan groundfish fisheries, the North Pacific Fisheries Management Council (NPFMC) sets Prohibited Species Catch (PSC) limits for Pacific halibut in Alaskan waters. However, these limits are fixed for long periods of time and therefore functionally independent of halibut abundance. In contrast, directed commercial halibut fishery catch limits are set by the International Pacific Halibut Commission (IPHC) on an annual basis as informed by stock assessment. This current management structure has resulted in concern that as halibut abundance declines the PSC impact rate on the halibut stock functionally increases; placing the burden of halibut conservation on directed fishery participants. To evaluate alternative methods for setting halibut PSC limits that are responsive to changes in halibut stock

status, I have the privilege of collaborating on two projects that are concurrently developing MSE frameworks intended to quantify the ecological and economic impacts of PSC limit alternatives on directed and non-directed (PSC) fisheries. **Collaborators:** *Saltonstall-Kennedy funded effort:* Dr. Courtney Carothers (CFOS, UAF) and Dr. Matt Reimer (ISER). *NMFS-IPHC collaboration:* Drs. Carey McGilliard, Jim Ianelli, and Dana Hanselman (AFSC), and Dr. Allan Hicks (IPHC).

AYK Chinook: Bayesian Lifecycle Models for Evaluating Marine and Freshwater Drivers of Survival
In the Arctic-Yukon-Kuskokwim region, concern regarding the sustainability of Chinook salmon stocks has fostered increased interest in understanding the abiotic and biotic factors influencing survival in both marine and freshwater environments, including quantifying the age-specific impacts of bycatch in Bering Sea trawl fisheries. As part of my postdoctoral research at CFOS funded by the *Pollock Conservation Cooperative Research Center (PCCRC)*, I developed a stage-structured Bayesian population dynamics model to estimate how Chinook salmon survival responds to a range of candidate environmental and ecosystem factors. I implemented Bayesian variable selection methods to account for model structural uncertainty by estimating the inclusion probability for each predictor variable. When applied to the Chena and Salcha Chinook salmon populations of the Yukon River, the date of freshwater ice-out, wintertime marine temperatures, and competition with foreign hatchery-reared salmonids were identified as key predictors of survival. In addition, evidence for density-dependent capacity limitation in freshwater habitats was found. **Collaborators**: Drs. Milo Adkison and Peter Westley (CFOS, UAF).

NCEAS working group: Consistency, Causes, and Consequences of Declining Size and Age of Alaskan Salmon
Scientists, commercial fishers, and subsistence users alike have long noted declines in the size and age of Alaskan salmon, which could result from fisheries-induced evolution, climate change, inter or intra-specific competition at sea, or increased marine predation, among other hypotheses. As part of a working group funded by the *State of Alaska Salmon and People (SASAP)* initiative at the *National Center for Ecological Synthesis and Analysis (NCEAS)*, I am collaborating with researchers from academic institutions, state and federal agencies, and tribal organizations in Alaska, California, New York, and Canada, to analyze patterns in the magnitude and consistency of changes in size and age of salmon and test alternative hypotheses about the processes driving these observed changes. Ultimately, our goal is to quantify the impact of these changes on commercial fisheries value, subsistence opportunity, and ecosystem productivity and stability. My role in this working group has been to collaborate in leading statistical analyses of trends in, and drivers of, changes in salmon size and age at return. **Funding**: *The Moore Foundation, through NCEAS*. **Lead collaborators**: Dr. Eric Palkovacs (University of California Santa Cruz), Dr. Peter Westley (UAF, CFOS), Dr. Bert Lewis (ADFG).

Alternative Methods to Define Biological Escapement Goals for Bristol Bay, Alaska: Paleolimnological Priors and Shifting Production Regimes
Traditional methods for defining MSY-based escapement goals for Bristol Bay sockeye salmon have suffered from an inability to accurately estimate density-dependent parameters given the relatively small range of spawning abundances observed historically, and the assumption of time-invariant production dynamics. To address the problem of true system capacity and allow for non-stationary production, I collaborated with Dr. Daniel Schindler (SAFS, UW) to incorporate paleolimological reconstructions of historical salmon abundance from marine-derived nitrogen concentrations in lake sediment cores into a hidden Markov version of the traditional Ricker model. Using this novel approach, we were able to provide important baseline data, estimate differences in potential yield and optimal biological escapement goals across production regimes, quantify the probability of occupying those regimes in the future, and develop management recommendations that are more robust to future environmental variation. **Funded by**: Bristol Bay Economic Development Corporation. **Collaborators**: Drs. Daniel Schindler and Ray Hilborn (SAFS, UW).

Evaluation of Geostatistical Delta-GLMMs for NOAA Bottom Trawl Survey Index Standardization
A large component of my recent research has focused on evaluating the use of spatio-temporal methods for standardizing survey data for commercially important marine species harvested in the Alaska region. NOAA-NMFS Alaska bottom trawl surveys provide valuable fishery-independent biomass indices for stock assessment. While a simple design-based estimator has been used in the past to generate indices from these survey data, several advances in methodology have fostered interest in exploring alternative model-based methods for index standardization. These advances include delta-models that separately quantify the encounter probability and catch rate for a species, and geostatistical methods that account for the spatial and spatio-temporal correlation in observed species presence and biomass. I am collaborating with a working group focused on evaluating the use of these spatio-temporal delta generalized linear mixed models (delta-GLMMs) for generating model-based indices from Gulf of Alaska and Aleutian Island bottom trawl survey data. The purpose is to identify whether geostatistical methods provide greater precision and whether uncertainty in these indices is more robust to possible future reductions in survey effort. **Collaborators**: Dr. Jim Thorson (NOAA, NWFSC), Dr. Jim Ianelli (NOAA, AFSC), Dr. Dana Hanselman (NOAA, AFSC).

Sacramento River Chinook: A Statistical Lifecycle Model for Evaluating the Environmental Drivers of Survival
Chinook salmon in the Central Valley of California are subject to a broad suite of anthropogenic stressors stemming primarily from extensive habitat alteration and water management, including water exports from the Sacramento-San

Joaquin Delta for agricultural and urban use. To investigate the influence of anthropogenic and natural processes on the survival of threatened and endangered Chinook salmon stocks in the Sacramento River watershed, I developed a stage-structured population dynamics model that estimated the impact of the environmental factors hypothesized to affect maximum survival and habitat capacity, across freshwater and marine life stages. Results indicated nearshore marine upwelling and oceanographic conditions, water exports, and juvenile rearing temperature to be major drivers of Chinook survival variation. These estimates were then used to predict population viability and abundance trends under a range of future climate and water management scenarios for the Central Valley. **Funded by:** *Delta Science Program, Delta Stewardship Council*. **Collaborators:** Dr. Ray Hilborn (SAFS, UW), Dr. Noble Hendrix (QEDA Consulting), Dr. Robert Lessard (Columbia River Intertribal Fish Commission).