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Education

University of Washington, Ph.D. Aquatic and Fishery Sciences 2003-2006
- Committee: Ray Hilborn (advisor), Andre Punt, Tim Essington

Montana State University, MSc Biology 2000-2003
- Advisor: Dan Goodman

University of California San Diego, BSc Ecology and Evolution 1995-1999

Employment

Statistician Northwest Fisheries Science Center, NMFS (NOAA) 2009 - present

Affiliate Associate Professor University of Washington (SAFS) 2013 - present

Post-doctoral researcher National Research Council 2007 - 2008

Stock assessment scientist Wellington, New Zealand Spring 2005

Graduate research assistant University of Washington 2003 - 2006

Journal Articles (peer - reviewed)

93. Warlick, A.J., G.M. Ylitalo, S.M. O'Neill, M.B. Hanson, C. Emmons, and **E.J. Ward**. 2020. Using bayesian stable isotope mixing models and generalized additive models to resolve diet changes for fish eating killer whales (orcinus orca). *Marine Ecology Progress Series*, :.
92. 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*, :. [link](#)
91. Barnett, L., **E.J. Ward**, J.E. Jannot, and A.O. Shelton. 2019. Dynamic spatial heterogeneity reveals interdependence of marine faunal density and fishery removals. *Ecological Indicators*, 107:. [link](#)
90. Chasco, B., J.T. Thorson, S. Heppell, L. Avens, J. Braun-McNeill, A.B. Bolten, K.A. Bjorndal, and **E.J. Ward**. 2019. Estimating growth and ages for species with incomplete ageing histories: a case study for loggerhead sea turtle (Caretta caretta) using an integrated mixed-effect model. *Marine Ecology Progress Series*, :.
89. Ohlberger, J., D.E. Schindler, **E.J. Ward**, T.E. Walsworth, and T.E. Essington. 2019. Resurgence of an apex marine predator and the decline in prey body size. *Proceedings of the National Academy of Sciences*, 116:26682–26689. [link](#)

88. Tennessen, J.B., M.M. Holt, **E.J. Ward**, M.B. Hanson, C.K. Emmons, D.A. Giles, and J.T. Hogan. 2019. Hidden Markov models reveal temporal patterns and sex differences in killer whale behavior. *Scientific Reports*, 9:14951. [link](#)
87. **Ward, E.J.**, S.C. Anderson, L.A. Damiano, M.E. Hunsicker, and M.A. Litzow. 2019. Modeling regimes with extremes: the bayesdfa package for identifying and forecasting common trends and anomalies in multivariate time-series data. *The R Journal*, :.
86. Deacy, W.W., W.B. Leacock, **E.J. Ward**, and J.B. Armstrong. 2019. Aerial surveys cause large but ephemeral decreases in bear presence at salmon streams in Kodiak, Alaska. *PLOS ONE*, 14:1-17. [link](#)
85. Nelson, B.W., A.O. Shelton, J.H. Anderson, M.J. Ford, and **E.J. Ward**. 2019. Ecological implications of changing hatchery practices for Chinook salmon in the Salish Sea. *Ecosphere*, 10:e02922. [link](#)
84. Gonzalez, S., J.K. Horne, and **E.J. Ward**. 2019. Temporal variability in pelagic biomass distributions at wave and tidal sites and implications for standardization of biological monitoring. *International Marine Energy Journal*, 2:15-28. [link](#)
83. Beaudreau, A.H., **E.J. Ward**, R.E. Brenner, A.O. Shelton, J.T. Watson, J.C. Womack, S.C. Anderson, A.C. Haynie, K.N. Marshall, and B.C. Williams. 2019. Thirty years of change and the future of Alaskan fisheries: Shifts in fishing participation and diversification in response to environmental, regulatory, and economic pressures. *Fish and Fisheries*, 20:601-619. [link](#)
82. Anderson, S.C., and **E.J. Ward**. 2019. Black swans in space: modelling spatiotemporal processes with extremes. *Ecology*, 100:1-9. [link](#)
81. Marshall, K.N., J.T. Duffy-Anderson, **E.J. Ward**, S.C. Anderson, M.E. Hunsicker, and B.C. Williams. 2019. Long-term trends in ichthyoplankton assemblage structure, biodiversity, and synchrony in the Gulf of Alaska and their relationships to climate. *Progress in Oceanography*, 170:134 - 145. [link](#)
80. Shelton, A.O., W.H. Satterthwaite, **E.J. Ward**, B.E. Feist, and B.J. Burke. 2019. Using hierarchical models to estimate stock-specific and seasonal variation in ocean distribution, survivorship, and aggregate abundance of fall run Chinook salmon.. *Canadian Journal of Fisheries and Aquatic Sciences*, 76:95-108. [link](#)
79. Stock, B.C., **E.J. Ward**, J.T. Thorson, J.E. Jannot, and B.X. Semmens. 2019. The utility of spatial model-based estimators of unobserved bycatch. *ICES Journal of Marine Science*, 76:255-267. [link](#)
78. **Ward, E.J.**, H. Delgado-Nordmann, R.E. Brenner, A.H. Beaudreau, S.D. Moffitt, and A.O. Shelton. 2019. Assessing long-term changes in sex ratios of Pacific herring in Prince William Sound, Alaska. *Fisheries Research*, 211:300 - 308. [link](#)
77. Stock, B.C., **E.J. Ward**, T. Eguchi, J.E. Jannot, J.T. Thorson, B.E. Feist, and B.X. Semmens. 2018. Comparing predictions of fisheries bycatch using multiple spatiotemporal species distribution model frameworks. *Canadian Journal of Fisheries and Aquatic Sciences*, :. [link](#)

76. **Ward, E.J.**, S.C. Anderson, A.O. Shelton, R.E. Brenner, M.D. Adkison, A.H. Beaudreau, J.T. Watson, J.C. Shriver, A.C. Haynie, and B.C. Williams. 2018. Effects of increased specialization on revenue of Alaskan salmon fishers over four decades. *Journal of Applied Ecology*, 55:1082–1091. [link](#)
75. Ford, M.J., K.M. Parsons, **E.J. Ward**, J.A. Hempelmann, C.K. Emmons, M.B. Hanson, K.C. Balcomb, and L.K. Park. 2018. Inbreeding in an endangered killer whale population. *Animal Conservation*, 21:423–432. [link](#)
74. **Ward, E.J.**, K.L. Oken, K.A. Rose, S. Sable, K. Watkins, E.E. Holmes, and M.D. Scheuerell. 2018. Applying spatiotemporal models to monitoring data to quantify fish population responses to the Deepwater Horizon oil spill in the Gulf of Mexico. *Environmental Monitoring and Assessment*, 190:530. [link](#)
73. Stock, B.C., A.L. Jackson, **E.J. Ward**, A.C. Parnell, D.L. Phillips, and B.X. Semmens. 2018. Analyzing mixing systems using a new generation of Bayesian tracer mixing models. *PeerJ*, 6:e5096. [link](#)
72. Bal, G., M.D. Scheuerell, and **E.J. Ward**. 2018. Characterizing the strength of density dependence in at-risk species through Bayesian model averaging. *Ecological Modelling*, 381:1–9. [link](#)
71. Ohlberger, J., **E.J. Ward**, D.E. Schindler, and B. Lewis. 2018. Demographic changes in Chinook salmon across the Northeast Pacific Ocean. *Fish and Fisheries*, 19:533–546. [link](#)
70. Shelton, A.O., M.E. Hunsicker, **E.J. Ward**, B.E. Feist, R. Blake, C.L. Ward, B.C. Williams, J.T. Duffy-Anderson, A.B. Hollowed, and A.C. Haynie. 2018. Spatio-temporal models reveal subtle changes to demersal communities following the Exxon Valdez oil spill. *ICES Journal of Marine Science*, 75:287–297. [link](#)
69. Linder, H.L., J.K. Horne, and **E.J. Ward**. 2017. Modeling baseline conditions of ecological indicators: marine renewable energy environmental monitoring. *Ecological Indicators*, 83:178–191. [link](#)
68. Chasco, B.E., I.C. Kaplan, A.C. Thomas, A. Acevedo-Gutiérrez, D.P. Noren, M.J. Ford, M.B. Hanson, J.J. Scordino, S.J. Jeffries, K.N. Marshall, A.O. Shelton, C. Matkin, B.J. Burke, and **E.J. Ward**. 2017. Competing tradeoffs between increasing marine mammal predation and fisheries harvest of Chinook salmon. *Scientific Reports*, 7:15439. [link](#)
67. Anderson, S.C., **E.J. Ward**, A.O. Shelton, M.D. Adkison, A.H. Beaudreau, R.E. Brenner, A.C. Haynie, J.C. Shriver, J.T. Watson, and B.C. Williams. 2017. Benefits and risks of diversification for individual fishers. *Proceedings of the National Academy of Sciences*, 114:10797–10802. [link](#)
66. Deacy, W.W., J.B. Armstrong, W.B. Leacock, C.T. Robbins, D.D. Gustine, **E.J. Ward**, J.A. Erlenbach, and J.A. Stanford. 2017. Phenological synchronization disrupts trophic interactions between Kodiak brown bears and salmon. *Proceedings of the National Academy of Sciences*, 114:10432–10437. [link](#)
65. Boyd, C., D.P. DeMaster, R.S. Waples, **E.J. Ward**, and B.L. Taylor. 2017. Consistent extinction risk assessment under the U.S. Endangered Species Act. *Conservation*

Letters, 10:328–336. [link](#)

64. Hussey, N.E., J.D. DiBattista, J.W. Moore, **E.J. Ward**, A.T. Fisk, S. Kessel, T.L. Guttridge, K.A. Feldheim, B.R. Franks, S.H. Gruber, O.C. Weideli, and D.D. Chapman. 2017. Risky business for a juvenile marine predator? Testing the influence of foraging strategies on size and growth rate under natural conditions. *Proceedings. Biological Sciences*, 284:. [link](#)
63. **Ward, E.J.**, M. Adkison, J. Couture, S.C. Dressel, M.A. Litzow, S. Moffitt, T.H. Neher, J. Trochta, and R. Brenner. 2017. Evaluating signals of oil spill impacts, climate, and species interactions in Pacific herring and Pacific salmon populations in Prince William Sound and Copper River, Alaska. *PLOS ONE*, 12:e0172898. [link](#)
62. Chasco, B., I.C. Kaplan, A. Thomas, A. Acevedo-Gutiérrez, D. Noren, M.J. Ford, M.B. Hanson, J. Scordino, S. Jeffries, S. Pearson, K.N. Marshall, and **E.J. Ward**. 2017. Estimates of Chinook salmon consumption in Washington State inland waters by four marine mammal predators from 1970 to 2015. *Canadian Journal of Fisheries and Aquatic Sciences*, 74:1173–1194. [link](#)
61. Moriarty, P.E., T.E. Essington, and **E.J. Ward**. 2016. A novel method to estimate prey contributions to predator diets. *Canadian Journal of Fisheries and Aquatic Sciences*, 74:168–177. [link](#)
60. Thorson, J.T., M.L. Pinsky, and **E.J. Ward**. 2016. Model-based inference for estimating shifts in species distribution, area occupied and centre of gravity. *Methods in Ecology and Evolution*, 7:990–1002. [link](#)
59. Adams, J., I.C. Kaplan, B. Chasco, K.N. Marshall, A. Acevedo-Gutiérrez, and **E.J. Ward**. 2016. A century of Chinook salmon consumption by marine mammal predators in the Northeast Pacific Ocean. *Ecological Informatics*, 34:44–51. [link](#)
58. Stier, A.C., J.F. Samhouri, M. Novak, K.N. Marshall, **E.J. Ward**, R.D. Holt, and P.S. Levin. 2016. Ecosystem context and historical contingency in apex predator recoveries. *Science Advances*, 2:e1501769. [link](#)
57. Jorgensen, J.C., **E.J. Ward**, M.D. Scheuerell, and R.W. Zabel. 2016. Assessing spatial covariance among time series of abundance. *Ecology and Evolution*, 6:2472–2485. [link](#)
56. Ono, K., A.O. Shelton, **E.J. Ward**, J.T. Thorson, B.E. Feist, and R. Hilborn. 2016. Space-time investigation of the effects of fishing on fish populations. *Ecological Applications*, 26:392–406. [link](#)
55. **Ward, E.J.**, M.E. Dahlheim, J.M. Waite, C.K. Emmons, K.N. Marshall, B.E. Chasco, and K.C. Balcomb. 2016. Long-distance migration of prey synchronizes demographic rates of top predators across broad spatial scales. *Ecosphere*, 7:n/a–n/a. [link](#)
54. Armstrong, J.B., **E.J. Ward**, D.E. Schindler, and P.J. Lisi. 2016. Adaptive capacity at the northern front: sockeye salmon behaviourally thermoregulate during novel exposure to warm temperatures. *Conservation Physiology*, 4:. [link](#)
53. Marshall, K.N., A.C. Stier, J.F. Samhouri, R.P. Kelly, and **E.J. Ward**. 2016. Conservation challenges of predator recovery. *Conservation Letters*, 9:70–78. [link](#)

52. **Ward, E.J.**, J.E. Jannot, Y. Lee, K. Ono, A.O. Shelton, and J.T. Thorson. 2015. Using spatiotemporal species distribution models to identify temporally evolving hotspots of species co-occurrence. *Ecological Applications*, 25:2198–2209. [link](#)
51. Westley, P.A.H., A.H. Dittman, **E.J. Ward**, and T.P. Quinn. 2015. Signals of climate, conspecific density, and watershed features in patterns of homing and dispersal by Pacific salmon. *Ecology*, 96:2823–2833. [link](#)
50. **Ward, E.J.**, J.H. Anderson, T.J. Beechie, G.R. Pess, and M.J. Ford. 2015. Increasing hydrologic variability threatens depleted anadromous fish populations. *Global Change Biology*, 21:2500–2509. [link](#)
49. Galloway, A.W.E., M.T. Brett, G.W. Holtgrieve, **E.J. Ward**, A.P. Ballantyne, C.W. Burns, M.J. Kainz, D.C. Müller-Navarra, J. Persson, J.L. Ravet, U. Strandberg, S.J. Taipale, and G. Alhgren. 2015. A fatty acid based Bayesian approach for inferring diet in aquatic consumers. *PLOS ONE*, 10:e0129723. [link](#)
48. Thorson, J.T., J.M. Cope, K.M. Kleisner, J.F. Samhoury, A.O. Shelton, and **E.J. Ward**. 2015. Giants' shoulders 15 years later: lessons, challenges and guidelines in fisheries meta-analysis. *Fish and Fisheries*, 16:342–361. [link](#)
47. Thorson, J.T., A.O. Shelton, **E.J. Ward**, and H.J. Skaug. 2015. Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast groundfishes. *ICES Journal of Marine Science*, 72:1297–1310. [link](#)
46. Thorson, J.T., H.J. Skaug, K. Kristensen, A.O. Shelton, **E.J. Ward**, J.H. Harms, and J.A. Benante. 2015. The importance of spatial models for estimating the strength of density dependence. *Ecology*, 96:1202–1212. [link](#)
45. Bjorkland, R.H., S.F. Pearson, S.J. Jeffries, M.M. Lance, A. Acevedo-Gutiérrez, and **E.J. Ward**. 2015. Stable isotope mixing models elucidate sex and size effects on the diet of a generalist marine predator. *Marine Ecology Progress Series*, 526:213–225. [link](#)
44. Sergeant, C.J., J.B. Armstrong, and **E.J. Ward**. 2015. Predator-prey migration phenologies remain synchronised in a warming catchment. *Freshwater Biology*, 60:724–732. [link](#)
43. **Ward, E.J.**, K.N. Marshall, T. Ross, A. Sedgley, T. Hass, S.F. Pearson, G. Joyce, N.J. Hamel, P.J. Hodum, and R. Faucett. 2015. Using citizen-science data to identify local hotspots of seabird occurrence. *PeerJ*, 3:e704. [link](#)
42. Chasco, B.E., **E.J. Ward**, J.A. Hesse, C. Rabe, R. Kinzer, J.L. Vogel, and R. Orme. 2014. Evaluating the accuracy and precision of multiple abundance estimators using state-space models: a case study for a threatened population of Chinook salmon in Johnson Creek, Idaho. *North American Journal of Fisheries Management*, 34:945–954. [link](#)
41. Anlauf-Dunn, K.J., **E.J. Ward**, M. Strickland, and K. Jones. 2014. Habitat connectivity, complexity, and quality: predicting adult coho salmon occupancy and abundance. *Canadian Journal of Fisheries and Aquatic Sciences*, 71:1864–1876. [link](#)

40. Phillips, D.L., R. Inger, S. Bearhop, A.L. Jackson, J.W. Moore, A.C. Parnell, B.X. Semmens, and **E.J. Ward**. 2014. Best practices for use of stable isotope mixing models in food-web studies. *Canadian Journal of Zoology*, 92:823–835. [link](#)
39. Shelton, A.O., J.T. Thorson, **E.J. Ward**, and B.E. Feist. 2014. Spatial semiparametric models improve estimates of species abundance and distribution. *Canadian Journal of Fisheries and Aquatic Sciences*, 71:1655–1666. [link](#)
38. Thorson, J.T., and **E.J. Ward**. 2014. Accounting for vessel effects when standardizing catch rates from cooperative surveys. *Fisheries Research*, 155:168–176. [link](#)
37. **Ward, E.J.**, E.E. Holmes, J.T. Thorson, and B. Collen. 2014. Complexity is costly: a meta-analysis of parametric and non-parametric methods for short-term population forecasting. *Oikos*, 123:652–661. [link](#)
36. Nosrati, K., G. Govers, B.X. Semmens, and **E.J. Ward**. 2014. A mixing model to incorporate uncertainty in sediment fingerprinting. *Geoderma*, 217–218:173–180. [link](#)
35. Bodey, T.W., **E.J. Ward**, R.A. Phillips, R.A.R. McGill, and S. Bearhop. 2014. Species versus guild level differentiation revealed across the annual cycle by isotopic niche examination. *Journal of Animal Ecology*, 83:470–478. [link](#)
34. Hampton, S.E., E.E. Holmes, L.P. Scheef, M.D. Scheuerell, S.L. Katz, D.E. Pendleton, and **E.J. Ward**. 2013. Quantifying effects of abiotic and biotic drivers on community dynamics with multivariate autoregressive (MAR) models. *Ecology*, 94:2663–2669. [link](#)
33. Hanson, M.B., C.K. Emmons, **E.J. Ward**, J.A. Nystuen, and M.O. Lammers. 2013. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders. *The Journal of the Acoustical Society of America*, 134:3486–3495. [link](#)
32. Thorson, J.T., and **E.J. Ward**. 2013. Accounting for space–time interactions in index standardization models. *Fisheries Research*, 147:426–433. [link](#)
31. Parnell, A.C., D.L. Phillips, S. Bearhop, B.X. Semmens, **E.J. Ward**, J.W. Moore, A.L. Jackson, J. Grey, D.J. Kelly, and R. Inger. 2013. Bayesian stable isotope mixing models. *Environmetrics*, 24:387–399. [link](#)
30. Semmens, B.X., **E.J. Ward**, A.C. Parnell, D.L. Phillips, S. Bearhop, R. Inger, A. Jackson, and J.W. Moore. 2013. Statistical basis and outputs of stable isotope mixing models: comment on Fry (2013). *Marine Ecology Progress Series*, 490:285–289. [link](#)
29. Holtgrieve, G.W., M.E. Arias, K.N. Irvine, D. Lamberts, **E.J. Ward**, M. Kummu, J. Koponen, J. Sarakkula, and J.E. Richey. 2013. Patterns of ecosystem metabolism in the Tonle Sap Lake, Cambodia with links to capture fisheries. *PLOS ONE*, 8:e71395. [link](#)
28. Daele, M.V., C. Robbins, B. Semmens, **E. Ward**, L.V. Daele, and W. Leacock. 2013. Salmon consumption by Kodiak brown bears (*Ursus arctos middendorffi*) with ecosystem management implications. *Canadian Journal of Zoology*, 91:164–174. [link](#)

27. Westley, P.A.H., **E.J. Ward**, and I.A. Fleming. 2013. Fine-scale local adaptation in an invasive freshwater fish has evolved in contemporary time. *Proceedings of the Royal Society of London B: Biological Sciences*, 280:20122327. [link](#)
26. **Ward, E.J.**, G.R. Pess, K. Anlauf-Dunn, and C.E. Jordan. 2012. Applying time series models with spatial correlation to identify the scale of variation in habitat metrics related to threatened coho salmon (*Oncorhynchus kisutch*) in the Pacific Northwest. *Canadian Journal of Fisheries and Aquatic Sciences*, 69:1773–1782. [link](#)
25. Holmes, E., **E.J. Ward**, and K. Wills. 2012. MARSS: multivariate autoregressive state-space models for analyzing time-series data. *R Journal*, 4:11–19.
24. **Ward, E.J.**, P.S. Levin, M.M. Lance, S.J. Jeffries, and A. Acevedo-Gutiérrez. 2012. Integrating diet and movement data to identify hot spots of predation risk and areas of conservation concern for endangered species. *Conservation Letters*, 5:37–47. [link](#)
23. Holtgrieve, G.W., D.E. Schindler, W.O. Hobbs, P.R. Leavitt, **E.J. Ward**, L. Bunting, G. Chen, B.P. Finney, I. Gregory-Eaves, S. Holmgren, M.J. Lisac, P.J. Lisi, K. Nydick, L.A. Rogers, J.E. Saros, D.T. Selbie, M.D. Shapley, P.B. Walsh, and A.P. Wolfe. 2011. A coherent signature of anthropogenic nitrogen deposition to remote watersheds of the northern hemisphere. *Science*, 334:1545–1548. [link](#)
22. **Ward, E.**, A. Zerbini, P. Kinas, M. H.Engel, and A. Andriolo. 2011. Estimates of population growth rates of humpback whales (*Megaptera novaeangliae*) in the wintering grounds off the coast of Brazil (Breeding Stock A). *Journal of Cetacean Research and Management*, Special Issue:145–149.
21. Zerbini, A., **E.J. Ward**, P. Kinas, M. H.Engel, and A. Andriolo. 2011. A Bayesian assessment of the conservation status of humpback whales (*Megaptera novaeangliae*) in the western Atlantic Ocean (Breeding Stock A). *Journal of Cetacean Research and Management*, Special Issue:131–144.
20. Pattengill-Semmens, C., B. Semmens, E. Holmes, **E.J. Ward**, and B. Ruttenberg. 2011. Integrating time-series of community monitoring data. *Proceedings of the 63rd Gulf and Caribbean Fisheries Institute*, 63:214–216.
19. Anderson, J.H., **E.J. Ward**, and S.M. Carlson. 2011. A model for estimating the minimum number of offspring to sample in studies of reproductive success. *Journal of Heredity*, 102:567–576. [link](#)
18. Yeakel, J.D., M. Novak, P.R.G. Jr, N.J. Dominy, P.L. Koch, **E.J. Ward**, J.W. Moore, and B.X. Semmens. 2011. Merging resource availability with isotope mixing models: the role of neutral interaction assumptions. *PLOS ONE*, 6:e22015. [link](#)
17. Berntson, E.A., R.W. Carmichael, M.W. Flesher, **E.J. Ward**, and P. Moran. 2011. Diminished reproductive success of steelhead from a hatchery supplementation program (Little Sheep Creek, Imnaha Basin, Oregon). *Transactions of the American Fisheries Society*, 140:685–698. [link](#)
16. Francis, T.B., D.E. Schindler, G.W. Holtgrieve, E.R. Larson, M.D. Scheuerell, B.X. Semmens, and **E.J. Ward**. 2011. Habitat structure determines resource use by zooplankton in temperate lakes. *Ecology Letters*, 14:364–372. [link](#)

15. **Ward, E.J.**, B.X. Semmens, E.E. Holmes, and K.C.B. Iii. 2011. Effects of multiple levels of social organization on survival and abundance. *Conservation Biology*, 25:350–355. [link](#)
14. **Ward, E.J.**, B.X. Semmens, D.L. Phillips, J.W. Moore, and N. Bouwes. 2011. A quantitative approach to combine sources in stable isotope mixing models. *Ecosphere*, 2:1–11. [link](#)
13. Williamson, K.S., A.R. Murdoch, T.N. Pearsons, **E.J. Ward**, and M.J. Ford. 2010. Factors influencing the relative fitness of hatchery and wild spring Chinook salmon (*Oncorhynchus tshawytscha*) in the Wenatchee River, Washington, USA. *Canadian Journal of Fisheries and Aquatic Sciences*, 67:1840–1851. [link](#)
12. **Ward, E.J.**, B.X. Semmens, and D.E. Schindler. 2010. Including source uncertainty and prior information in the analysis of stable isotope mixing models. *Environmental Science & Technology*, 44:4645–4650. [link](#)
11. Warren, D.R., M.M. Mineau, **E.J. Ward**, and C.E. Kraft. 2010. Relating fish biomass to habitat and chemistry in headwater streams of the northeastern United States. *Environmental Biology of Fishes*, 88:51–62. [link](#)
10. **Ward, E.J.**, H. Chirakkal, M. González-Suárez, D. Auriol-Gamboa, E.E. Holmes, and L. Gerber. 2010. Inferring spatial structure from time-series data: using multivariate state-space models to detect metapopulation structure of California sea lions in the Gulf of California, Mexico. *Journal of Applied Ecology*, 47:47–56. [link](#)
9. Semmens, B.X., **E.J. Ward**, J.W. Moore, and C.T. Darimont. 2009. Quantifying inter- and intra-population niche variability using hierarchical Bayesian stable isotope mixing models. *PLOS ONE*, 4:e6187. [link](#)
8. **Ward, E.J.**, E.E. Holmes, and K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. *Journal of Applied Ecology*, 46:632–640. [link](#)
7. Semmens, B.X., J.W. Moore, and **E.J. Ward**. 2009. Improving Bayesian isotope mixing models: a response to Jackson et al. (2009). *Ecology Letters*, 12:E6–E8. [link](#)
6. **Ward, E.J.**, K. Parsons, E.E. Holmes, K.C. Balcomb, and J.K. Ford. 2009. The role of menopause and reproductive senescence in a long-lived social mammal. *Frontiers in Zoology*, 6:4. [link](#)
5. **Ward, E.J.** 2008. A review and comparison of four commonly used Bayesian and maximum likelihood model selection tools. *Ecological Modelling*, 211:1–10. [link](#)
4. **Ward, E.J.**, R. Hilborn, R.G. Towell, and L. Gerber. 2007. A state-space mixture approach for estimating catastrophic events in time series data. *Canadian Journal of Fisheries and Aquatic Sciences*, 64:899–910. [link](#)
3. **Ward, E.J.** 2006. A new BEAST: Bayesian software tools for ecological trend analysis. *Wildlife Society Bulletin*, 34:1420–1424. [link](#)
2. Branch, T.A., R. Hilborn, A.C. Haynie, G. Fay, L. Flynn, J. Griffiths, K.N. Marshall, J.K. Randall, J.M. Scheuerell, **E.J. Ward**, and M. Young. 2006. Fleet dynamics and

fishermen behavior: lessons for fisheries managers. *Canadian Journal of Fisheries and Aquatic Sciences*, 63:1647–1668. [link](#)

1. **Ward, E.J.** 2005. Differences between fishery-dependent and fishery-independent estimates of single-and mixed-species dolphin schools: implications for single-species stock assessments. *Marine Mammal Science*, 21:189–203. [link](#)

Technical Reports

23. Srinivasan, M., S.K. Brown, E. Markowitz, M. Soldevilla, E. Patterson, K. Forney, K. Murray, E. Ward, J.M. Ver Hoef, J. Redfern, and T. Eguchi. 2019. Proceedings of the 2nd National Protected Species Assessment Workshop. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-F/SPO-198, 52 p. [link](#)
22. Eguchi, T., C. Fahy, J. Jannot, K. Somers, and **E. Ward**. 2019. 2018 Leatherback sea turtle estimated bycatch reporting requirements as set out in the NMFS Biological Opinion for the continuing authorization of the Pacific Coast groundfish fisheries. National Marine Fisheries Service, SWFSC, La Jolla, CA 92039. [link](#)
21. Good, T. P., **E. Ward**, J. Jannot, R. Shama, and J. McVeigh. 2019. Observed and Estimated Bycatch of Short-tailed Albatross in U.S. West Coast Groundfish Fisheries 2002-2017. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. [link](#)
20. Harvey, C.J., N. Garfield, G.D. Williams, N. Tolimieri, E.L. Hazen, I.D. Schroeder, K.S. Andrews, C. Barceló, K. Barnas, S.J. Bograd, R.D. Brodeur, B.J. Burke, J.M. Cope, L. deWitt, J.C. Field, J.L. Fisher, T.P. Good, C.M. Greene, D.S. Holland, M.E. Hunsicker, M. Jacox, S. Kasperski, S.J. Kim, A. Leising, S.R. Melin, C.A. Morgan, B. Muhling, S.H. Munsch, K. Norman, W.T. Peterson, M.R. Poe, J.F. Samhour, W.J. Sydeman, J. Thayer, A.R. Thompson, A. Varney, B.K. Wells, T.H. Williams, J.E. Zamon, D. Lawson, S.C. Anderson, J. Gao, M.A. Litzow, S. McClatchie, **E.J. Ward**, S. Zador. Ecosystem status report of the California Current for 2018: a summary of ecosystem indicators compiled by the California Current Integrated Ecosystem Assessment team (CCIEA). U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-NWFSC-145. [link](#)
19. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2017 Elwha River Steelhead Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
18. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2017 Elwha River Chinook Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
17. Ferguson, L., M. Srinivasan, E. Oleson, S. Hayes, S.K. Brown, R. Angliss, J. Carretta, E. Holmes, **E.J. Ward**, J. Kocik, K. Mullin, R. Dean, and J. Davis (eds.). 2017. Proceedings of the First National Protected Species Assessment Workshop. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-F/SPO-172, 92 p. [link](#)

16. Hanson, M.B., **E.J. Ward**, C.K. Emmons, M.M. Holt, and D.M. Holzer. 2017. Assessing the movements and occurrence of Southern Resident Killer Whales relative to the U.S. Navy's Northwest Training Range Complex in the Pacific Northwest. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-15-MP-4C363.[link](#)
15. Eguchi, T., C. Fahy, J. Jannot, K. Somers, and **E. Ward**. 2017. 2016 Leatherback sea turtle estimated bycatch reporting requirements as set out in the NMFS Biological Opinion for the continuing authorization of the Pacific Coast groundfish fisheries. National Marine Fisheries Service, SWFSC, La Jolla, CA 92039. [link](#)
14. Good, T. P., **E. Ward**, J. Jannot, R. Shama, N. Riley, and J. McVeigh. 2017. Observed and Estimated Bycatch of Short-tailed Albatross in U.S. West Coast Groundfish Fisheries 2014-2015. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. (link)[https://www.pcouncil.org/wp-content/uploads/2017/03/F5a_NMFS_Rpt6_ElectricOnly_STAL_bycatch_report_2017_Apr2017BB.pdf]
13. Gustafson, R., Y.-W. Lee, **E. Ward**, K. Somers, V. Tuttle, J. Jannot, and J. McVeigh. 2017. Observed and Estimated Bycatch of Eulachon in 2002–2015 US West Coast Groundfish Fisheries. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. [link](#)
12. Lee, Y.-W., R. Gustafson, J. Jannot, J. McVeigh, N. Riley, K. Somers, V. Tuttle, S. Wang, and **E. Ward**. 2017. Observed and Estimated Bycatch of Green Sturgeon in 2002–2015 US West Coast Groundfish Fisheries. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. [link](#)
11. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2016 Elwha River Steelhead Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
10. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2016 Elwha River Chinook Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
9. Gustafson, R.G., L. Weitkamp, Y.W. Lee, **E.J. Ward**, K. Somers, V. Tuttle, and J. Jannot. 2016. Status Review Update of Eulachon (*Thaleichthys pacificus*) Listed under the Endangered Species Act: Southern Distinct Population Segment. [link](#)
8. Gerrodette, T., **E.J. Ward**, R.L. Taylor, L.K. Schwarz, T. Eguchi, P.R. Wade, and G.K. Himes-Boor. 2016. Daniel Goodman's empirical approach to Bayesian statistics. Pre-print at PeerJ [link](#)
7. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2015 Elwha River Steelhead Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.

6. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2015 Elwha River Chinook Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
8. Eguchi, T., R. Bjorkland, C. Fahy, J. Jannot, T. Mitchell, K. Somers, **E. Ward**, B. Whiteside. 2015. Reporting requirements as set out in the NMFS Biological Opinion Leatherback sea turtles for the continuing authorization of the Pacific Coast groundfish fisheries. National Marine Fisheries Service, SWFSC, La Jolla, CA 92039. [link](#)
7. Gustafson, R., Y.-W. Lee, **E. Ward**, K. Somers, V. Tuttle, J. Jannot. 2015. Observed and Estimated Bycatch of Eulachon in 2002–2013 US West Coast Groundfish Fisheries. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. [link](#)
6. Lee, Y.-W., R. Gustafson, J. Jannot, J. McVeigh, N. Riley, K. Somers, V. Tuttle, S. Wang, **E. Ward**. 2015. The next link/button will exit from NWFSC web site Observed and Estimated Bycatch of Green Sturgeon in 2002–2013 US West Coast Groundfish Fisheries. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112. [link](#)
5. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2014 Elwha River Steelhead Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
4. Denton, K., M. McHenry, R. Moses, **E.J. Ward**, M. Liermann, O. Stefankiv, W. Wells and G. Pess. 2014 Elwha River Chinook Escapement Estimate Based on DIDSON/ARIS Multi-Beam SONAR Data. Lower Elwha Tribe, Port Angeles, Washington.
3. **E.J. Ward**, M.J. Ford, R.G. Kope, J.K.B. Ford, A. Velez-Espino, C.K. Parken, L. LaVoy, M.B. Hanson, K.C. Balcomb. Estimating the impacts of Chinook salmon abundance and prey removal by ocean fishing on Southern Resident killer whale population dynamics. 2013. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-123, 71 p. [link](#)
2. Stout, H.A., P.W. Lawson, D.L. Bottom, T.D. Cooney, M.J. Ford, C.E. Jordan, R.G. Kope, L.M. Kruzic, G.R. Pess, G.H. Reeves, M.D. Scheuerell, T.C. Wainwright, R.S. Waples, **E.J. Ward**, L.A. Weitkamp, J.G. Williams, and T.H. Williams. 2012. Scientific conclusions of the status review for Oregon coast coho salmon (*Oncorhynchus kisutch*). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-118, 242 p. [link](#)
1. Northwest Fisheries Science Center. 2011. Risk assessment of U.S. West Coast groundfish fisheries to threatened and endangered marine species. NWFSC, NMFS. 2725 Montlake Blvd E, Seattle, WA. [link](#)

Book Chapters

E.J. Ward 2012. Population Dynamics. In *Grzimek's Animal Life Encyclopedia*. pp. 195- 208.

Teaching Experience

FISH 507: Applied Time Series Analysis, University of Washington 2012 - present
Co-taught course with Eli Holmes and Mark Scheuerell [webpage](#)

Ecological Society of America (ESA) 2008 - 2011
Co-taught Analysis of Multivariate Time-Series Data Using State-Space Models, and Introduction to MARSS

NWFSC R workshop (organized & taught) 2010 - 2011

Visiting lecturer University of Washington 2007 - 2009
Taught FSH 497 Introductory modeling and programming course

External Funding

2019-2021 D. Finnoff, E.J. Ward, T. Miller, T. Schwoerer, M. Horning, D. Dugan. *Thresholds in a changing ocean environment: bioeconomic implications to inform adaptation decisions for Alaska's salmon fisheries*. NOAA Ocean Acidification Program, \$1,050,000.

2018-2020 A.O. Shelton, J. Watson, C. Cunningham, E.J. Ward, A. Grey, M.J. Ford, K. Sommers. *Integrating Chinook Catches from Directed Fisheries and Trawl Bycatch to Improve Distribution Information for Bycatch Avoidance and Impacts On Predators in a Changing Environment*. NOAA Protected Species, \$200K.

2018-2020 E.J. Ward, C. Harvey, J. Samhour, etc. *Spatial ecosystem state and pressure indicators and scale-dependence of temporal indicator performance*. FATE (Fisheries And The Environment), \$192K.

2018-2020 M. Hunsicker, M. Litzow, E.J. Ward, B. Burke, S. Zador, C. Cunningham, and N. Bond. *Measuring the strength of ocean-atmosphere coupling to predict climate forcing of northeast Pacific ecosystems*. FATE (Fisheries And The Environment), \$198K.

2018-2020 G. Holtgrieve, C. Harvey, and E.J. Ward. *Reconstructing a Century of Coastal Productivity and Predator Trophic Dynamics using Compound-specific Stable Isotopes from Archival Bone Specimens*. Washington Sea Grant, \$192K.

2018-2020 L. Hauser, B. Vadopalas, R. Childer, B. Hudson, B. Eudeline, and E.J. Ward. *Development of genetic risk assessment tools and Management Strategy Evaluation for Aquaculture of Native Shellfish*. Saltonstall-Kennedy Grant, \$299K.

2017-2018 E.J. Ward, G. Holtgrieve, C. Harvey. *Reconstructing a ecosystem productivity and marine mammal trophic dynamics using compound-specific stable isotopes from bone specimens*. NWFSC Internal Grants Program

2016-2018 T.E. Essington, T.B. Francis, C. Greene, L. Kuehne, D. Lowry, E.J. Ward. *Recovering historical baselines in Puget Sound*. Washington Sea Grant, \$243K.

2016 E.J. Ward *Improving bycatch estimation through spatial statistics* \$100K.

2015 E.J. Ward, A.O. Shelton and M.J. Ford. *Portfolio Effects in Historic Chinook Hatchery Practices on Prey Availability for Southern Resident Killer Whales* National Fish and Wildlife Foundation, \$110K.

2014-2015 I. Kaplan, E.J. Ward, et al. *A spatially explicit ecosystem model for quantifying marine mammal impacts on Chinook salmon* Pacific Salmon Commission Southern Fund, \$206K.

2013-2014 T. Eguchi, E.J. Ward, and E.E. Holmes. *Developing risk assessment tools for marine sea turtles* \$100K.

2013-2014 Holmes, E.E. and E.J. Ward. *Developing web based computing tools for protected species.* \$200K.

2013 M.B. Hanson, E.J. Ward. et al. *Modeling the distribution of endangered killer whales in Pacific Northwest Navy ranges using acoustic recorder detections and satellite tagged whales*, US Navy.

2013 Shelton, A.O., E.J. Ward, J.T. Thorson, M. Bellman, B. Feist. *Integrating spatial habitat and fisheries effort data to improve abundance estimates of west coast groundfish.* \$56K.

2011 E.J. Ward et al., *Incorporating multiple data sources into a unified framework to improve estimates of adult salmon returns and population productivity.* \$33K.

2009 NSF Comparative Analysis of Marine Ecosystem Organization: New statistical tools for analyzing community dynamics with applications to marine zooplankton, \$347K (141K from NCEAS). Associate Investigator (Principal Investigator - E.E. Holmes)

Fellowships and Awards

2006 *Cumulative Risk Assessment for Endangered Species* 2 year NRC post-doc awarded \$92K.

2003 *National Marine Fisheries Service / Washington Sea Grant Fellowship in Population Dynamics: Incorporating model selection and decision analysis into population dynamics modeling.* Grant awarded for \$120K.

Post-docs

2012 Jim Thorson (NRC Research Post-doc). With Michelle McClure, Eli Holmes, and Mark Scheuerell

2012-2013 Guillaume Bal (NRC Research Post-doc). Co-supervised with Eli Holmes and Mark Scheuerell

2015-2017 Sean Anderson (Smith Fellow). Co-supervised with Trevor Branch

2017-2019 Lewis Barnett (NWFSC)

2017- Ben Nelson (NWFSC). Co-supervised with Ole Shelton

2019- Christian Commander (NWFSC) Co-supervised with Lewis Barnett

Supervised Graduate Students or Committees

2017- Natalie Lowell (L. Hauser), SAFS, University of Washington (NMFS Population Dynamics Fellowship)

2017- Megan Feddern (G. Holtgrieve), SAFS, University of Washington

2017-2020 Elizabeth Ng (T. Essington), SAFS, University of Washington (NMFS Population Dynamics Fellowship)

2012-2018 Pam Moriarty (T. Essington), SAFS, University of Washington

2013-2016 Brandon Chasco (S. Heppell) Oregon State University (NMFS Population Dynamics Fellowship)

2014-2015 Brian Stock (B. Semmens) SIO, with Tomo Eguchi

2015-2016 Hannah Linder (J. Horne) UW

Service and Outreach

Subject Editor, Ecological Applications 2013 - present

Puget Sound Seabird Survey 2005-present

Developed survey methodology for Puget Sound's first land-based citizen science seabird survey and oversaw data analysis

Orca Bowl Washington State Sea Grant / University of Washington

Secretary & Treasurer, Statistical Ecology Section, Ecological Society of America 2010-2012