

# Sarah Gaichas

RESEARCH FISHERY BIOLOGIST ZP-IV

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## Educational History

### University of Washington

PHD Seattle, WA

2000 - 2006

### College of William and Mary, School of Marine Science

M.S. Gloucester Point, VA

1994 - 1997

### Swarthmore College

B.A. Swarthmore, PA

1986 - 1991

## Professional History

### Research Fishery Biologist NOAA/NMFS Northeast Fisheries Sci. Center, Woods Hole, MA

Ecosystem Assessment, MSE September 2011 - present

Contribute to integrated ecosystem assessments and management strategy evaluations (MSEs) for the Northeast U.S. continental shelf by analyzing research survey, fishery, oceanographic, and economic data, and by developing and testing multispecies assessment models and ecosystem indicators. Conduct research on ecosystem based management reference points balancing multiple objectives. Chair National and Northeast MSE working groups to build capacity and coordinate work plans. Lead editor, State of the Ecosystem reports. Provide results in peer-reviewed literature and to the New England and Mid-Atlantic Fishery Management Councils.

Acting Branch Chief January-April 2017

Managed Ecosystem Dynamics and Assessment Branch (EDAB) administrative duties during temporary rotation (simultaneous with regular duties). Led program meetings, responded to leadership requests, conducted employee mid-term reviews, coordinated with other Branch Chiefs within the Division, temporarily acted as Division Chief. Completed 2021 Labor planning for EDAB (developed plans with branch, participant in cross-center working group) and developed budget (SPERS) plans for EDAB.

### Research Fishery Biologist NOAA/NMFS Alaska Fisheries Science Center, Seattle, WA

Ecosystem Modeling June 2006 - September 2011

Established an ecosystem context for fishery management through analysis of food web, fishery, and research survey data combined with ecosystem modeling. Evaluated the cumulative effects of fishing, climate change, and other factors on the marine ecosystem and species within it. Conducted independent research on ecosystem level indicators and thresholds and provided results in peer-reviewed literature and to the North Pacific Fishery Management Council. Participated in research surveys at sea.

Stock Assessment November 1998 - June 2006

Assessed the condition of commercially exploited fish stocks through analysis of fishery and research survey data combined with population dynamics modeling. Evaluated the effects of fishing on non-target species and the marine ecosystem. Conducted Ph.D. research. Attended 2001 Complex Systems Summer School, Santa Fe Institute, Santa Fe NM. Participated in research surveys at sea.

Stock assessments: 1999 Gulf of Alaska (GOA) and 2000 - 2004 Bering Sea Aleutian Islands (BSAI) "Other species" (all species of skates, sharks, sculpins, octopi, and squids), 2000-2005 BSAI squids, 2005 BSAI skates, 2003-2005 GOA skates, 2000-2005 GOA Thornyheads, and 2006 GOA squids.

Observer Program March 1997 - October 1999

Conducted statistical analyses of fishery observer data, evaluated present and proposed data collection methods through directed research, and examined uses of observer data in multiple applications.

## Awards

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- End-year performance bonuses each year, 2006-2020.
- Individual cash award for State of the Ecosystem reporting, August 2020.
- Individual cash award for Acting Branch Chief performance, July 2017.
- ICES/MYFISH symposium Targets and Limits for Long Term Fisheries Management Most Inspiring Paper award, October 2015.
- Department of Commerce “Cash-In-A-Flash” award, December 2011.
- Department of Commerce Special Act Award: Alaska Fisheries Science Center Employee of the Year, 2010.
- Department of Commerce Special Act Award for service on North Pacific Council Gulf of Alaska Plan Team and for ecosystem research contributions, July 2005.
- Department of Commerce Special Act Award for innovations in nontarget species management and ecosystem modeling, 2004.
- National Association of Environmental Professionals Award for Environmental Excellence in NEPA for assistance with the Steller Seal Lion Protection Measures SEIS, June 2003.
- Mote International Symposium on Confronting Trade-offs in the Ecosystem Approach to Fisheries Management Young Investigator Award, November 2002.
- Department of Commerce Special Act Award for service as the Nontarget and Prohibited Species Team Leader in the development of the Draft Programmatic SEIS for groundfish fisheries in Alaska, September 2000.
- Department of Commerce “Cash-In-A-Flash” awards, March and June 1998.
- College of William and Mary William J. Hargis Jr. Fellowship Award and Dean’s Fellowship. April, 1995.

## Publications

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### PAPERS PUBLISHED IN PEER-REVIEWED JOURNALS

Bastille, K., S. Hardison, L. deWitt, J. Brown, J. Samhoury, S. Gaichas, S. Lucey, K. Kearney, B. Best, S. Cross, S. Large, and E. Spooner (2021). “Improving the IEA Approach Using Principles of Open Data Science.” In: *Coastal Management* 49.1, pp. 72-89. DOI: 10.1080/08920753.2021.1846155.

DePiper, G., S. Gaichas, B. Muffley, G. Ardini, J. Brust, J. Coakley, K. Dancy, G. W. Elliott, D. C. Leaning, D. Lipton, J. McNamee, C. Perretti, K. Rootes-Murdy, and M. J. Wilberg (2021). “Learning by doing: collaborative conceptual modelling as a path forward in ecosystem-based management.” In: *ICES Journal of Marine Science*. DOI: 10.1093/icesjms/fsab054.

Friedland, K. D., E. T. Methratta, A. B. Gill, S. K. Gaichas, T. H. Curtis, E. M. Adams, J. L. Morano, D. P. Crear, M. C. McManus, and D. C. Brady (2021). “Resource Occurrence and Productivity in Existing and Proposed Wind Energy Lease Areas on the Northeast US Shelf.” In: *Frontiers in Marine Science* 8. DOI: 10.3389/fmars.2021.629230.

Lucey, S. M., K. Y. Aydin, S. K. Gaichas, S. X. Cadrin, G. Fay, M. J. Fogarty, and A. Punt (2021). “Evaluating fishery management strategies using an ecosystem model as an operating model.” In: *Fisheries Research* 234, p. 105780. DOI: 10.1016/j.fishres.2020.105780.

Muffley, B., S. Gaichas, G. DePiper, R. Seagraves, and S. Lucey (2021). “There Is no I in EAFM Adapting Integrated Ecosystem Assessment for Mid-Atlantic Fisheries Management.” In: *Coastal Management* 49.1, pp. 90-106. DOI: 10.1080/08920753.2021.1846156.

Reum, J. C. P., H. Townsend, S. Gaichas, S. Sagarese, I. C. Kaplan, and A. Grüss (2021). “It’s Not the Destination, It’s the Journey: Multispecies Model Ensembles for Ecosystem Approaches to Fisheries Management.” In: *Frontiers in Marine Science* 8. DOI: 10.3389/fmars.2021.631839.

Link, J. S., G. Huse, S. Gaichas, and A. R. Marshak (2020). “Changing how we approach fisheries: A first attempt at an operational framework for ecosystem approaches to fisheries management.” In: *Fish and Fisheries* 21.2, pp. 393-434. DOI: 10.1111/faf.12438.

Lucey, S. M., S. K. Gaichas, and K. Y. Aydin (2020). “Conducting reproducible ecosystem modeling using the open source mass balance model Rpath.” In: *Ecological Modelling* 427, p. 109057. DOI: 10.1016/j.ecolmodel.2020.109057.

Weiskopf, S. R., M. A. Rubenstein, L. G. Crozier, S. Gaichas, R. Griffis, J. E. Halofsky, K. J. W. Hyde, T. L. Morelli, J. T. Morissette, R. C. Muñoz, A. J. Pershing, D. L. Peterson, R. Poudel, M. D. Staudinger, A. E. Sutton-Grier, L. Thompson, J. Vose, J. F. Weltzin, and K. P. Whyte (2020). “Climate change effects on biodiversity, ecosystems, ecosystem ser-

vices, and natural resource management in the United States.” In: *Science of The Total Environment*, p. 137782. DOI: 10.1016/j.scitotenv.2020.137782.

Goethel, D. R., S. M. Lucey, A. M. Berger, S. K. Gaichas, M. A. Karp, P. D. Lynch, and J. F. Walter (2019). “Recent advances in management strategy evaluation: introduction to the special issue “Under pressure: addressing fisheries challenges with Management Strategy Evaluation””. In: *Canadian Journal of Fisheries and Aquatic Sciences* 76.10, pp. 1689-1696. DOI: 10.1139/cjfas-2019-0084.

Karp, M. A., J. O. Peterson, P. D. Lynch, R. B. Griffis, C. F. Adams, W. S. Arnold, L. A. K. Barnett, Y. deReynier, J. DiCosimo, K. H. Fenske, S. K. Gaichas, A. Hollowed, K. Holsman, M. Karnauskas, D. Kobayashi, A. Leising, J. P. Manderson, M. McClure, W. E. Morrison, E. Schnettler, A. Thompson, J. T. Thorson, J. F. Walter, A. J. Yau, R. D. Methot, and J. S. Link (2019). “Accounting for shifting distributions and changing productivity in the development of scientific advice for fishery management.” In: *ICES Journal of Marine Science* 76.5, pp. 1305-1315. DOI: 10.1093/icesjms/fsz048.

Townsend, H., C. J. Harvey, Y. deReynier, D. Davis, S. G. Zador, S. Gaichas, M. Weijerman, E. L. Hazen, and I. C. Kaplan (2019). “Progress on Implementing Ecosystem-Based Fisheries Management in the United States Through the Use of Ecosystem Models and Analysis.” In: *Frontiers in Marine Science* 6. DOI: 10.3389/fmars.2019.00641.

Deroba, J. J., S. K. Gaichas, M. Lee, R. G. Feeney, D. V. Boelke, and B. J. Irwin (2018). “The dream and the reality: meeting decision-making time frames while incorporating ecosystem and economic models into management strategy evaluation.” In: *Canadian Journal of Fisheries and Aquatic Sciences*. DOI: 10.1139/cjfas-2018-0128.

Feeney, R. G., D. V. Boelke, J. J. Deroba, S. K. Gaichas, B. J. Irwin, and M. Lee (2018). “Integrating Management Strategy Evaluation into fisheries management: advancing best practices for stakeholder inclusion based on an MSE for Northeast U.S. Atlantic herring.” In: *Canadian Journal of Fisheries and Aquatic Sciences*. DOI: 10.1139/cjfas-2018-0125.

Gaichas, S. K., G. S. DePiper, R. J. Seagraves, B. W. Muffley, M. Sabo, L. L. Colburn, and A. L. Loftus (2018). “Implementing Ecosystem Approaches to Fishery Management: Risk Assessment in the US Mid-Atlantic.” In: *Frontiers in Marine Science* 5. DOI: 10.3389/fmars.2018.00442.

Goethel, D. R., S. M. Lucey, A. M. Berger, S. K. Gaichas, M. A. Karp, P. D. Lynch, J. F. Walter III, J. J. Deroba, S. K. Miller, and M. J. Wilberg (2018). “Closing the Feedback Loop: On Stakeholder Participation in Management Strategy Evaluation.” In: *Canadian Journal of Fisheries and Aquatic Sciences*. DOI: 10.1139/cjfas-2018-0162.

Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. L. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morissette, H. Moustahfid, R. Munoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. S. Waples, and J. F. Weltzin (2018). *Ecosystems, Ecosystem Services, and Biodiversity*. Other Government Series. U.S. Global Change Research Program, p. 268321. DOI: 10.7930/NCA4.2018.CH7.

Olsen, E., I. C. Kaplan, C. Ainsworth, G. Fay, S. Gaichas, R. Gamble, R. Girardin, C. H. Eide, T. F. Ihde, H. N. Morzaria-Luna, K. F. Johnson, M. Savina-Rolland, H. Townsend, M. Weijerman, E. A. Fulton, and J. S. Link (2018). “Ocean Futures Under Ocean Acidification, Marine Protection, and Changing Fishing Pressures Explored Using a Worldwide Suite of Ecosystem Models.” In: *Frontiers in Marine Science* 5. DOI: 10.3389/fmars.2018.00064.

DePiper, G. S., S. K. Gaichas, S. M. Lucey, P. Pinto da Silva, M. R. Anderson, H. Breeze, A. Bundy, P. M. Clay, G. Fay, R. J. Gamble, R. S. Gregory, P. S. Fratantoni, C. L. Johnson, M. Koen-Alonso, K. M. Kleisner, J. Olson, C. T. Perretti, P. Pepin, F. Phelan, V. S. Saba, L. A. Smith, J. C. Tam, N. D. Templeman, and R. P. Wildermuth (2017). “Operationalizing integrated ecosystem assessments within a multidisciplinary team: lessons learned from a worked example.” In: *ICES Journal of Marine Science* 74.8, pp. 2076-2086. DOI: 10.1093/icesjms/fsx038.

Gaichas, S. K., M. Fogarty, G. Fay, R. Gamble, S. Lucey, and L. Smith (2017). “Combining stock, multispecies, and ecosystem level fishery objectives within an operational management procedure: simulations to start the conversation.” In: *ICES Journal of Marine Science* 74.2, pp. 552-565. DOI: 10.1093/icesjms/fsw119.

Holsman, K., J. Samhuri, G. Cook, E. Hazen, E. Olsen, M. Dillard, S. Kasperski, S. Gaichas, C. R. Kelble, M. Fogarty, and K. Andrews (2017). “An ecosystem-based approach to marine risk assessment.” In: *Ecosystem Health and Sustainability* 3.1, p. e01256. DOI: 10.1002/ehs2.1256.

Tommasi, D., C. A. Stock, A. J. Hobday, R. Methot, I. C. Kaplan, J. P. Eveson, K. Holsman, T. J. Miller, S. Gaichas, M. Gehlen, A. Pershing, G. A. Vecchi, R. Msadek, T. Delworth, C. M. Eakin, M. A. Haltuch, R. Séférian, C. M. Spillman, J. R. Hartog, S. Siedlecki, J. F. Samhuri, B. Muhling, R. G. Asch, M. L. Pinsky, V. S. Saba, S. B. Kapnick, C. F. Gaitan, R. R. Rykaczewski, M. A. Alexander, Y. Xue, K. V. Pegion, P. Lynch, M. R. Payne, T. Kristiansen, P. Lehodey, and F.

E. Werner (2017). "Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts." In: *Progress in Oceanography* 152, pp. 15-49. DOI: 10.1016/j.pocean.2016.12.011.

Wildermuth, R. P., G. Fay, and S. Gaichas (2017). "Structural uncertainty in qualitative models for ecosystem-based management of Georges Bank." In: *Canadian Journal of Fisheries and Aquatic Sciences* 75.10, pp. 1635-1643. DOI: 10.1139/cjfas-2017-0149.

Zador, S. G., S. K. Gaichas, S. Kasperski, C. L. Ward, R. E. Blake, N. C. Ban, A. Himes-Cornell, and J. Z. Koehn (2017). "Linking ecosystem processes to communities of practice through commercially fished species in the Gulf of Alaska." In: *ICES Journal of Marine Science* 74.7, pp. 2024-2033. DOI: 10.1093/icesjms/fsx054.

Gaichas, S. K., R. J. Seagraves, J. M. Coakley, G. S. DePiper, V. G. Guida, J. A. Hare, P. J. Rago, and M. J. Wilberg (2016). "A Framework for Incorporating Species, Fleet, Habitat, and Climate Interactions into Fishery Management." In: *Frontiers in Marine Science* 3. DOI: 10.3389/fmars.2016.00105.

Olsen, E., G. Fay, S. Gaichas, R. Gamble, S. Lucey, and J. S. Link (2016). "Ecosystem Model Skill Assessment. Yes We Can!" In: *PLOS ONE* 11.1. Ed. by C. N. Bianchi, p. e0146467. DOI: 10.1371/journal.pone.0146467.

Weijerman, M., J. Link, E. Fulton, E. Olsen, H. Townsend, S. Gaichas, C. Hansen, M. Skern-Mauritzen, I. Kaplan, R. Gamble, G. Fay, M. Savina, C. Ainsworth, I. van Putten, R. Gorton, R. Brainard, K. Larsen, and T. Hutton (2016). "Atlantis Ecosystem Model Summit: Report from a workshop." In: *Ecological Modelling* 335, pp. 35-38. DOI: 10.1016/j.ecolmodel.2016.07.009.

Zador, S. G., K. K. Holsman, K. Y. Aydin, and S. K. Gaichas (2016). "Ecosystem considerations in Alaska: the value of qualitative assessments." In: *ICES Journal of Marine Science: Journal du Conseil*, p. fsw144. DOI: 10.1093/icesjms/fsw144.

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Gaichas, S. K., G. Odell, K. Y. Aydin, and R. C. Francis (2012). "Beyond the defaults: functional response parameter space and ecosystem-level fishing thresholds in dynamic food web model simulations." In: *Canadian Journal of Fisheries and Aquatic Sciences* 69, pp. 2077-2094. DOI: 10.1139/F2012-099.

Gaichas, S., A. Bundy, T. Miller, E. Moksness, and K. Stergiou (2012). "What drives marine fisheries production?" In: *Marine Ecology Progress Series* 459, pp. 159-163. DOI: 10.3354/meps09841.

Gaichas, S., R. Gamble, M. J. Fogarty, H. Benoit, T. Essington, C. Fu, M. Koen-Alonso, and J. Link (2012). "Assembly Rules for Aggregate-Species Production Models: Simulations in Support of Management Strategy Evaluation." In: *Marine Ecology Progress Series* 459, pp. 275-292.

Link, J., S. Gaichas, T. Miller, T. Essington, A. Bundy, J. Boldt, K. Drinkwater, and E. Moksness (2012). "Synthesizing Lessons Learned from Comparing Fisheries Production in 13 Northern Hemisphere Ecosystems: Emergent Fundamental Features." In: *Marine Ecology Progress Series* 459, pp. 293-302.

Link, J., T. Ihde, C. Harvey, S. Gaichas, J. Field, J. Brodziak, H. Townsend, and R. Peterman (2012). "Dealing with uncertainty in ecosystem models: The paradox of use for living marine resource management." In: *Progress in Oceanography* 102, pp. 102-114. DOI: 10.1016/j.pocean.2012.03.008.

Moksness, E., J. Link, K. Drinkwater, and S. Gaichas (2012). “Bernard Megrey: pioneer of Comparative Marine Ecosystem analyses.” In: *Marine Ecology Progress Series* 459, pp. 165-167. DOI: 10.3354/meps09582.

Pranovi, F., J. Link, C. Fu, A. Cook, H. Liu, S. Gaichas, K. Friedland, K. Rong Utne, and H. Benoît (2012). “Trophic-level determinants of biomass accumulation in marine ecosystems.” In: *Marine Ecology Progress Series* 459, pp. 185-201. DOI: 10.3354/meps09738.

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Salomon, A. K., S. K. Gaichas, N. T. Shears, J. E. Smith, E. M. P. Madin, and S. D. Gaines (2010). “Key Features and Context-Dependence of Fishery-Induced Trophic Cascades.” In: *Conservation Biology* 24.2, pp. 382-394. DOI: 10.1111/j.1523-1739.2009.01436.x.

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#### PAPERS SUBMITTED TO PEER-REVIEWED JOURNALS

Staudinger, M., Lynch, A., Gaichas, S., Fox, M., Gibson-Reinemer, D., Langan, J., Teffer, A., Thackeray, S., and Winfield, I. Accepted April 2021. How does climate change affect emergent properties of aquatic ecosystems? *Fisheries*.

Kaplan, I.C., S.K. Gaichas, C.C. Stawitz, P.D. Lynch, K.N. Marshall, J.J. Deroba, M. Masi, J.K.T. Brodziak, K.Y. Aydin, K. Holsman, H. Townsend, D. Tommasi, J.A. Smith, S. Koenigstein, M. Weijerman and J. Link. Accepted May 2021. Management Strategy Evaluation: Allowing the Light on the Hill to Illuminate More than One Species. Original Research, *Front. Mar. Sci. - Marine Fisheries, Aquaculture and Living Resources*.

#### OTHER PAPERS (BOOK CHAPTERS)

Gaichas, S.K., C. Reiss, and M. Koen-Alonso. 2014. Ecosystem Based Management in high latitude ecosystems. Chapter 10, p. 277-324 in *The Sea, Volume 16: Marine Ecosystem Based Management*. Harvard U. Press.

#### REPORTS

*Northeast Fisheries Science Center State of the Ecosystem Reports; lead editor for Mid-Atlantic 2017-2021, lead editor for New England 2017-2020, supporting editor for New England 2021*

##### 2021 State of the Ecosystem:

- Mid-Atlantic <https://apps-nefsc.fisheries.noaa.gov/rcb/publications/SOE-MAFMC-2021-508-Final.pdf>
- New England <https://apps-nefsc.fisheries.noaa.gov/rcb/publications/SOE-MAFMC-2021-508-Final.pdf>

##### 2020 State of the Ecosystem:

- Mid-Atlantic <https://doi.org/10.25923/1f8j-d564>
- New England <https://doi.org/10.25923/4tdk-eg57>

##### 2019 State of the Ecosystem:

- Mid-Atlantic [https://www.mafmc.org/s/Tab09\\_State-of-the-Ecosystem-Report\\_2019-04.pdf](https://www.mafmc.org/s/Tab09_State-of-the-Ecosystem-Report_2019-04.pdf)
- New England [https://s3.amazonaws.com/nefmc.org/11\\_SOE-NEFMC-2019.pdf](https://s3.amazonaws.com/nefmc.org/11_SOE-NEFMC-2019.pdf)

##### 2018 State of the Ecosystem:

- Mid-Atlantic [https://www.mafmc.org/s/Tab04\\_State-of-the-Ecosystem-Apr2018.pdf](https://www.mafmc.org/s/Tab04_State-of-the-Ecosystem-Apr2018.pdf)
- New England [https://s3.amazonaws.com/nefmc.org/2\\_Ecosystem-Status-Report.pdf](https://s3.amazonaws.com/nefmc.org/2_Ecosystem-Status-Report.pdf)

##### 2017 State of the Ecosystem:

- Mid-Atlantic [https://www.mafmc.org/s/Tab02\\_2017-04\\_State-of-the-Ecosystem-and-EAFM.pdf](https://www.mafmc.org/s/Tab02_2017-04_State-of-the-Ecosystem-and-EAFM.pdf)
- New England: [https://s3.amazonaws.com/nefmc.org/2\\_2016-State-of-the-Ecosystem-Report.pdf](https://s3.amazonaws.com/nefmc.org/2_2016-State-of-the-Ecosystem-Report.pdf)

ICES. 2021. Working Group on Multispecies Assessment Methods (WGSAM; outputs from 2020 meeting). ICES Scientific Reports. 3:10. 231 pp. <https://doi.org/10.17895/ices.pub.7695>

ICES. 2021. Workshop of Fisheries Management Reference Points in a Changing Environment (WKRChange, outputs from 2020 meeting). ICES Scientific Reports. 3:6. 39 pp. <https://doi.org/10.17895/ices.pub.7660>

ICES. 2019. Working Group on Multispecies Assessment Methods (WGSAM). ICES Scientific Reports. 1:91. 320 pp. <http://doi.org/10.17895/ices.pub.5758>

ICES. 2018. Report of the Working Group on Multispecies Assessment Methods (WGSAM), 15–19 October 2018, Paris, France. ICES CM 2018/HAPISG:20. 89 pp.

#### *Selectied NOAA Technical Memoranda*

Townsend, H., K. Aydin, K. Holsman, C. Harvey, I. Kaplan, E. Hazen, P. Woodworth-Jefcoats, M. Weijerman, T. Kellison, S. Gaichas, K. Osgood, J. Link (editors). 2017. Report of the 4th National Ecosystem Modeling Workshop (NEMoW 4): Using Ecosystem Models to Evaluate Inevitable Trade-offs. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-173, 77 p.

Link, J.S., D. Mason, T. Lederhouse, S. Gaichas, T. Hartley, J. Ianelli, R. Methot, C. Stock, C. Stow, and H. Townsend. 2015. Report from the Joint OAR-NMFS Modeling Uncertainty Workshop. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-F/SPO-153, 31 p.

Link, J. S., T.F. Ihde, H. Townsend, K. Osgood, M. Schirripa, D. Kobayashi, S. Gaichas, J. Field, P. Levin, K. Aydin, G. Watters, and C. Harvey (editors). 2010. Report of the 2nd National Ecosystem Modeling Workshop (NEMoW II): Bridging The Credibility Gap – Dealing With Uncertainty In Ecosystem Models. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-102, 72 p.

Connors, M.E., J. Cahalan, S. Gaichas, W.A. Karp, T. Loomis, and J. Watson. 2009. Sampling for estimation of catch composition in Bering Sea trawl fisheries. NOAA Tech. Memo. NMFS-AFSC-199, 42 p.

Aydin, K., S. Gaichas, I. Ortiz, D. Kinzey, and N. Friday. 2007. A comparison of the Bering Sea, Gulf of Alaska, and Aleutian Islands large marine ecosystems through food web modeling. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-178, 298 p.

Gaichas, S.K., and J.C. Field, 2003. Comparative modeling approaches for exploited marine ecosystems in the North Pacific: what are these models good for? In Mace, P.M. (ed.), Proceedings of the seventh NMFS National Stock Assessment Workshop, (Re)building Sustainable Fisheries and Marine Ecosystems. NOAA Tech. Memo NMFS-F/SPO-62.

#### **OTHERS (FISHERY MANAGEMENT COUNCIL DOCUMENTS)**

April 2020-2021: Lead author, State of the Ecosystem Request tracking memo for the Mid-Atlantic and New England Fishery Management Councils. [https://www.mafmc.org/s/Tab01\\_2020-SOE-Report\\_2020-04.pdf](https://www.mafmc.org/s/Tab01_2020-SOE-Report_2020-04.pdf) (2020; pp 33-49 of combined pdf), [https://www.mafmc.org/s/Tab06\\_SOE-Mid-Atlantic-Risk-Assessment\\_\\_2021-04.pdf](https://www.mafmc.org/s/Tab06_SOE-Mid-Atlantic-Risk-Assessment__2021-04.pdf) (2021; pp 44-60 of combined pdf)

October 2017-2021: Lead author, Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management Risk Assessments. [https://www.mafmc.org/s/Tab08\\_EAFM-Risk-Assessment.pdf](https://www.mafmc.org/s/Tab08_EAFM-Risk-Assessment.pdf) (2017), [https://www.mafmc.org/s/MAB\\_RiskAssess\\_08\\_18.pdf](https://www.mafmc.org/s/MAB_RiskAssess_08_18.pdf) (2018), [https://www.mafmc.org/s/Tab10\\_EAFM\\_Updates\\_2019-04.pdf](https://www.mafmc.org/s/Tab10_EAFM_Updates_2019-04.pdf) (2019), [https://www.mafmc.org/s/Tab01\\_2020-SOE-Report\\_2020-04.pdf](https://www.mafmc.org/s/Tab01_2020-SOE-Report_2020-04.pdf) (2020; pp 50-62 of combined pdf), [https://www.mafmc.org/s/Tab06\\_SOE-Mid-Atlantic-Risk-Assessment\\_\\_2021-04.pdf](https://www.mafmc.org/s/Tab06_SOE-Mid-Atlantic-Risk-Assessment__2021-04.pdf) (2021; pp 61-81 of combined pdf)

December 2019: Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management Conceptual models and visualizations. [https://nefsc.github.io/READ-SSB-DePiper\\_Summer\\_Flounder\\_Conceptual\\_Models/sfconsmod\\_riskfactors\\_subplots.html](https://nefsc.github.io/READ-SSB-DePiper_Summer_Flounder_Conceptual_Models/sfconsmod_riskfactors_subplots.html) [https://nefsc.github.io/READ-SSB-DePiper\\_Summer\\_Flounder\\_Conceptual\\_Models/sfconsmod\\_final\\_2col.html](https://nefsc.github.io/READ-SSB-DePiper_Summer_Flounder_Conceptual_Models/sfconsmod_final_2col.html)

April 2016: Contributor to Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management Guidance Document (1st Draft). [http://www.mafmc.org/s/Tab05\\_EAFM.pdf](http://www.mafmc.org/s/Tab05_EAFM.pdf)

February 2016: Lead author for A Framework for Incorporating Species, Fleet, Habitat, and Climate Interactions into Fishery Management: A DRAFT White Paper to Inform the Mid-Atlantic Fishery Management Council. [http://www.mafmc.org/s/02\\_DRAFTInteractionsWhitePaper\\_bbdraft.pdf](http://www.mafmc.org/s/02_DRAFTInteractionsWhitePaper_bbdraft.pdf)

April 2015: Contributor/Editor for Climate Change and Variability: A White Paper to Inform the Mid-Atlantic Fishery Management Council on the Impact of Climate Change on Fishery Science and Management. [http://www.mafmc.org/s/Climate-Change-and-VariabilityWhite-Paper\\_BBook\\_second\\_draft\\_final.pdf](http://www.mafmc.org/s/Climate-Change-and-VariabilityWhite-Paper_BBook_second_draft_final.pdf)

December 2014: Contributor to Managing Forage Fishes in the Mid-Atlantic Region: A White Paper to Inform the Mid-Atlantic Fishery Management Council. [http://www.mafmc.org/s/3\\_ForageWhitePaper\\_Nov2014\\_draft3-2.pdf](http://www.mafmc.org/s/3_ForageWhitePaper_Nov2014_draft3-2.pdf)

November 2010: Lead author, Bering Sea Ecosystem Assessment, and Ecosystem Considerations SAFE co-editor: <http://access.afsc.noaa.gov/reem/ecoweb/Eco2010.pdf>

October 2010: GOA Crab Protection Closures Environmental Assessment, contributed ecosystem effects analysis in section 4: [http://www.fakr.noaa.gov/npfmc/current\\_issues/bycatch/G0Acrab.pdf](http://www.fakr.noaa.gov/npfmc/current_issues/bycatch/G0Acrab.pdf)

September 2010: Ecosystem Considerations SAFE editor (while S. Zador was on leave): [ftp://ftp.afsc.noaa.gov/afsc/public/Plan\\_Team/ecosystem.pdf](ftp://ftp.afsc.noaa.gov/afsc/public/Plan_Team/ecosystem.pdf)

November 2009: Ecosystem Assessment coauthor: <http://www.afsc.noaa.gov/refm/docs/2009/ecosystem.pdf>

September 2008: Arctic Fishery Management Plan Environmental Analysis; contributed Arctic Ecosystem Description, Chapter 8, Section 1: [http://www.fakr.noaa.gov/analyses/arctic/ArcticFMP\\_EA1108.pdf](http://www.fakr.noaa.gov/analyses/arctic/ArcticFMP_EA1108.pdf)

December 2007: Aleutian Islands Fishery Ecosystem Plan; Ecosystem Plan Team member, contributed food web analyses: [http://www.fakr.noaa.gov/npfmc/current\\_issues/ecosystem/AIFEPbrochure1207.pdf](http://www.fakr.noaa.gov/npfmc/current_issues/ecosystem/AIFEPbrochure1207.pdf)

1999-2006: Stock assessment reports (see above under Professional History) contributed to North Pacific Fishery Management Council Stock Assessment and Fishery Evaluation Reports: [https://archive.fisheries.noaa.gov/afsc/REFM/stocks/Historic\\_Assess.htm](https://archive.fisheries.noaa.gov/afsc/REFM/stocks/Historic_Assess.htm)

## **Presentations**

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Summary: Speaker, moderator, and symposium organizer at regional to international professional meetings (American Fisheries Society, ASLO, Conservation Biology, Ecological Society of America, GLOBEC, IMCC, World Fisheries Congress, ICES Annual Science Conference) 1995-present.

### **TALKS PRESENTED AT PROFESSIONAL MEETINGS**

#### *Upcoming invited presentations*

Invited keynote speaker on best practices in multispecies modeling, Multispecies modeling applications workshop (online), June 2021.

Invited keynote speaker on ecosystem indicators contextualizing stock assessments, U.S. Fishery Management Council 7th Scientific Coordination Subcommittee (formerly National SSC), August 2020 (meeting postponed to 2022)

Invited speaker for two American Fisheries Society (AFS) Annual meeting symposia, November 2021. Submitted abstracts:

- Gaichas, S., B. Muffley, G. DePiper. Climate news you can use: risk assessment and ecosystem reporting in the US Mid-Atlantic. (Connecting the dots, management approaches for climate-ready fisheries symposium)
- Gaichas, S., V. Saba, S. Lucey. Integrated Ecosystem Assessment and Ecological Forecasting: Let's Do This. (Ecological Forecasting: Bridging fish, ecosystems, weather, water, climate and communities symposium)

#### *Selected presentations (post PhD)*

Gaichas, S.K., G. DePiper, R. Seagraves, B. Muffley, S. Lucey. There is no I in EAFM: adapting Integrated Ecosystem Assessment for Mid-Atlantic Fisheries Management. 2019 Coastal and Estuarine Research Foundation Biennial Conference, Mobile AL. (Presented by Sean Lucey due to conflict with review panel)



- Gaichas, S.K., J. Deroba, M-Y. Lee. Are any herring harvest control rules good for both fisheries and predators? 2018 ICES Annual Science Conference, Hamburg, Germany.
- Deroba J.J., S.K. Gaichas (speaker), M-Y. Lee, R.G. Feeney, D. Boelke, B. Irwin. Getting on the same page, or at least in the same library: lessons in communication from a stakeholder-driven MSE for Northeast US Atlantic herring. 2017 IMBER IMBIZO, Woods Hole MA.
- Gaichas, S.K., R. Seagraves, J. Coakley, G. DePiper, V.G. Guida, J. Hare, P. Rago and M. Wilberg. The Mid-Atlantic Fishery Management Council's Framework for Incorporating Species, Fleet, Habitat, and Climate Interactions into Fishery Management: Initial Risk Assessment. 2017 AFS Annual Meeting, Tampa FL.
- (Invited) Gaichas, S., M. Fogarty, G. DePiper, G. Fay, R. Gamble, S. Lucey, and L. Smith. Combining stock, multi-species, and ecosystem level status determination criteria: what tradeoffs can we expect? 2015 ICES symposium "Targets and limits for long term fisheries management," Athens, Greece.
- Gaichas, S.K., M. Fogarty, R.J. Gamble, S.M. Lucey, L. Smith, C. Perretti, G. Fay. Multispecies stock assessment for Georges Bank: model development, performance testing, and multimodel inference. 2015 AFS Annual Meeting, Portland, OR.
- (Invited) Gaichas, S., J. Link. Incorporating Climate into Ecosystem Based Fisheries Management. 2015 NOAA GFDL Application of Seasonal to Decadal Climate Predictions for Marine Resource Management Workshop, Princeton, NJ.
- Gaichas, S., J. Link, J. Hare, M. Fogarty, P. Pinto da Silva, G. DePiper, J. Cournane, J. Manderson, S. Lucey, M. Lowe, S. Large, and G. Fay. Towards operational assessments: selection, vetting, and standardized analysis of ecosystem indicators for the Northeast US Large Marine Ecosystem. 2014 ICES Annual Science Conference, A Coruña, Spain.
- Gaichas, S., J. Link, T. Miller, T. Essington, A. Bundy, J. Boldt, K. Drinkwater, and E. Moksness. What drives marine fisheries production? Emergent features from comparisons across 13 northern hemisphere ecosystems. 2012 World Fisheries Congress, Edinburgh, Scotland.
- Gaichas, S., K. Aydin, S. Zador, and I. Ortiz. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. 2012 AIFRB Symposium, New Bedford, MA.
- Gaichas, SK, MJ Fogarty, L Col, G Fay, R Gamble, S Large, JS Link, S Lucey and TJ Miller. Developing a multispecies model for ecosystem based management on the Northeast U.S. continental shelf. 2012 Ecological Society of America Annual meeting, Portland OR.
- (Invited) Gaichas, S. Uncertainty in ecosystem indicators: known knowns, known unknowns, and unknown unknowns. 2011 PICES FUTURE workshop on Ecosystem Indicators, Honolulu HI.
- Fogarty, M., S. Gaichas (presenter), H. Benoit, T. Essington, C. Fu, R. Gambale, M. Koen-Alonso, J. Link. Assembly Rules for Aggregate-Species Production Models: Simulations in Support of Management Strategy Evaluation. 2011 AFS Annual Meeting, Seattle, WA.
- Gaichas, S., K. Aydin, and R. Francis. What Drives Dynamics in the Gulf of Alaska? Integrating Hypotheses of Species, Fishing, and Climate Relationships Using Ecosystem Modeling. 2010 Lowell Wakefield Ecosystems Symposium, Anchorage AK.
- Gaichas, S. From the Aleutians to the Arctic: integrating ecosystem approaches within the Alaska fishery management process. 2010 AFS Annual Meeting, Pittsburgh, PA.
- Gaichas, S., K. Aydin, G. Odell, and R. Francis. Complex systems models of trophic and fishing interactions with implications for research and management. 2009 GLOBEC Open Science Meeting, Victoria BC.
- Gaichas, S. K. Aydin, G. Odell, and R. Francis. Identifying critical interactions and thresholds in eastern north Pacific ecosystems through model simulations. 2008 Advances in Marine Ecosystem Modelling Research (AMEMR) symposium, Plymouth, UK.
- Gaichas, S., G. Odell, R. Francis, and K. Aydin. Fishing the Gulf of Alaska marine food web: do predator prey interactions imply ecosystem thresholds? 2007 PICES Annual meeting, Victoria, B.C. Also presented at 2007 AFS Annual Meeting, San Francisco CA.
- (Invited) Gaichas, S., G. Odell, R. Francis, K. Aydin. Fishing the Gulf of Alaska marine food web: are there thresholds related to functional response? 2007 Society for Conservation Biology, Port Elizabeth, South Africa.

Gaichas, S. K. Aydin, and V. Agostini, Quantitative methods for comparative ecosystem analysis: relationships and thresholds in the Gulf of Alaska and the California Current. 2006 PICES Annual meeting, Yokohama ,Japan.

#### **POSTERS PRESENTED AT PROFESSIONAL MEETINGS (RECENT)**

Gaichas, S., G. DePiper, R. Seagraves, L. Colburn, A. Loftus, M. Sabo, B. Muffley. Which MSE should you do first? Prioritizing MSE investments using risk assessment under an Ecosystem Approach to Fishery Management. National SSC meeting in San Diego, January 2018

Deroba, J., S. Gaichas, Lee M-Y., Feeney R.G., Boelke D., Irwin B.“Getting on the same page, or at least in the same library: lessons in communication from a stakeholder-driven management strategy evaluation for northeast US Atlantic herring. National SSC meeting in San Diego, January 2018

#### **OTHER SEMINARS/PRESENTATIONS**

Summary: Regular presentations to managers and stakeholders at Fishery Management Council meetings and management strategy evaluation stakeholder workshops. Presenter for the Marine Resource Education Program and at the Maine Fishermen’s Forum. Presenter in multiple agency and academic seminar series including OneNOAA, Alaska and Northeast Fishery Science Centers, University of Washington, University of Massachusetts, Rutgers University, and others. Invited speaker for public lecture series, teacher workshops, outreach events, and university courses. Links to representative presentations within the past 3 years are listed, as well as titles of selected older presentations.

#### **2021**

May: (Invited) “Integrated Ecosystem Assessment (IEA) and State of the Ecosystem Reporting,” for the Mid-Atlantic Council on the Ocean Ocean Forum; [https://noaa-edab.github.io/presentations/20210506\\_MACO\\_IEASOE\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210506_MACO_IEASOE_Gaichas.html)

April: “State of the Ecosystem and EAFM Risk Assessment: Mid-Atlantic,” for the MAFMC; [https://noaa-edab.github.io/presentations/20210407\\_MAFMC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210407_MAFMC_Gaichas.html)

March-April: “Mid-Atlantic Ecosystem Approach,” for Mid-Atlantic Fishery Management Council Summer Flounder MSE stakeholder workshops (3); [https://noaa-edab.github.io/presentations/20210329\\_MAFMC\\_MSEwkshp\\_EAFM\\_Intro\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210329_MAFMC_MSEwkshp_EAFM_Intro_Gaichas.html)

March: (Invited) “How is our ocean doing? Data, statistics, and modeling for management advice,” guest lecture for Stockton University Survey of Marine Life course; [https://noaa-edab.github.io/presentations/20210329\\_Stockton\\_ecotalk\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210329_Stockton_ecotalk_Gaichas.html)

March: “State of the Ecosystem: Mid-Atlantic,” for the MAFMC SSC; [https://noaa-edab.github.io/presentations/20210407\\_MAFMC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210407_MAFMC_Gaichas.html)

February: (Invited) “Developing and using ecosystem information in fishery management: Examples from the Northeast US,” for the Department of Fisheries and Oceans Canada ecosystems working group; [https://noaa-edab.github.io/presentations/20210209\\_DFO\\_EBFM\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210209_DFO_EBFM_Gaichas.html)

January: (Invited) “Mid-Atlantic State of the Ecosystem Report,” for Chesapeake Bay Program Goal Implementation Team Meeting; [https://noaa-edab.github.io/presentations/20210114\\_ChesapeakeFishGIT\\_Gaichas.html](https://noaa-edab.github.io/presentations/20210114_ChesapeakeFishGIT_Gaichas.html)

#### **2020**

November: “Integrating Climate into SOE and Model Skill Assessment,” for Northeast Fisheries-Climate PI workshop; <https://docs.google.com/presentation/d/184Af-afIIv-aGSRT6-Ed9SRmqf5n8Y00/edit#slide=id.p1>

October: “Multispecies models: US update,” for ICES Working Group on Multispecies Assessments; [https://noaa-edab.github.io/presentations/20201012\\_WGSAM\\_USupdate\\_Gaichas.html](https://noaa-edab.github.io/presentations/20201012_WGSAM_USupdate_Gaichas.html)

October: (Invited) “Species Interactions in Multispecies models,” for NOAA Fisheries Integrated Toolbox Technical meeting; [https://noaa-edab.github.io/presentations/20201008\\_FIT\\_MSmods\\_Gaichas.html](https://noaa-edab.github.io/presentations/20201008_FIT_MSmods_Gaichas.html)

September: (Invited) “Herring HCR accounting for its role as forage,” for ICES Workshop on Reference Point Changes; [https://noaa-edab.github.io/presentations/20200923\\_herringWKRChange\\_Gaichas.html#1](https://noaa-edab.github.io/presentations/20200923_herringWKRChange_Gaichas.html#1)

September: “Mid-Atlantic Ecosystem Approach, Overview and Progress,” for MAFMC MSE introductory workshop; [https://noaa-edab.github.io/presentations/20200504\\_MAFMC\\_EAFM\\_Intro\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200504_MAFMC_EAFM_Intro_Gaichas.html)

September: (Invited) “US Reference Points Introduction,” for ICES Workshop on Reference Point Changes; [https://noaa-edab.github.io/presentations/20200921\\_USrefpts\\_WKRPchange\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200921_USrefpts_WKRPchange_Gaichas.html)

September: “State of the Ecosystem: Improving Synthesis and Management Applications” and “wind energy discussion,” for MAFMC SSC; [https://noaa-edab.github.io/presentations/20200909\\_MAFMC\\_SSC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200909_MAFMC_SSC_Gaichas.html) and [https://noaa-edab.github.io/presentations/20200909\\_MAFMC\\_SSC\\_WindSOE\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200909_MAFMC_SSC_WindSOE_Gaichas.html)

August: “FAIR data: resources and details! Avoiding data problems, best practices for metadata and controlled vocabularies,” for EDAB seaside chat series; [https://noaa-edab.github.io/presentations/20200803\\_seasideFAIRdata\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200803_seasideFAIRdata_Gaichas.html)

July: (Invited) Deep Uncertainty and MSE, for NOAA Science Advisory Board’s Ecosystem Sciences and Management Working Group; [https://noaa-edab.github.io/presentations/20200716\\_MSEUncertainty\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200716_MSEUncertainty_Gaichas.html)

June: “Open Science, FAIR data, and the Fish Condition project,” for EDAB seaside chat series; [https://noaa-edab.github.io/presentations/20200601\\_seasideFAIRdata\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200601_seasideFAIRdata_Gaichas.html)

May: Climate and Fisheries, for National Academy of Sciences Ocean Studies Board panel; [https://noaa-edab.github.io/presentations/20200508\\_US\\_SOEUUpdate\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200508_US_SOEUUpdate_Gaichas.html)

May: “State of the Ecosystem 2020,” for ICES Working Group on the Northwest Atlantic Regional Sea, (pre-recorded in April); [https://noaa-edab.github.io/presentations/20200508\\_US\\_SOEUUpdate\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200508_US_SOEUUpdate_Gaichas.html)

May: “US Council update (EAFM/EBFM),” for ICES Working Group on the Northwest Atlantic Regional Sea, (pre-recorded in April); [https://noaa-edab.github.io/presentations/20200508\\_USCouncilUpdate\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200508_USCouncilUpdate_Gaichas.html)

April: (Invited) “What does math have to do with fish? Data, statistics, and modeling for management advice,” Worcester Polytechnic Institute SIAM seminar; [https://noaa-edab.github.io/presentations/20200428\\_WPI\\_SIAMtalk\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200428_WPI_SIAMtalk_Gaichas.html)

April: “State of the Ecosystem: Mid-Atlantic 2020 with updates to EAFM Risk Assessment” for MAFMC; [https://noaa-edab.github.io/presentations/20200407\\_MAFMC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200407_MAFMC_Gaichas.html)

March: State of the Ecosystem: New England” for the NEFMC SSC; [https://noaa-edab.github.io/presentations/20200331\\_NEFMC\\_SSC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200331_NEFMC_SSC_Gaichas.html)

March: “State of the Ecosystem: Mid-Atlantic 2020 with updates to EAFM Risk Assessment” for the MAFMC SSC in Baltimore MD; [https://noaa-edab.github.io/presentations/20200310\\_MAFMC\\_SSC\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200310_MAFMC_SSC_Gaichas.html)

February: “What is Ecosystem Based Fishery Management?” for Marine Resource Education Program Science Workshop in Falmouth MA; [https://noaa-edab.github.io/presentations/20200226\\_EBFM\\_MREP\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200226_EBFM_MREP_Gaichas.html)

January: (Invited) “There is no I in EAFM: Adapting Integrated Ecosystem Assessment for Mid-Atlantic Fisheries Management,” for NOAA EBM/EBFM webinar series (online); [https://noaa-edab.github.io/presentations/20200108\\_EBFM\\_Gaichas.html](https://noaa-edab.github.io/presentations/20200108_EBFM_Gaichas.html) recording: <https://youtu.be/VnI3XMRw3FI>

## 2019

December: “summer Flounder Conceptual Model and Questions,” interactive webpage presentations for MAFMC, Annapolis MD; [https://nefsc.github.io/READ-SSB-DePiper\\_Summer\\_Flounder\\_Conceptual\\_Models/sfconsmod\\_final\\_2col.html](https://nefsc.github.io/READ-SSB-DePiper_Summer_Flounder_Conceptual_Models/sfconsmod_final_2col.html)

November: (Invited) “Progress on Implementing Ecosystem-Based Fisheries Management in the United States Through the Use of Ecosystem Models and Analysis,” for CAUSES workshop, Woods Hole MA; [https://noaa-edab.github.io/presentations/20191120\\_CAUSES\\_Gaichas.html](https://noaa-edab.github.io/presentations/20191120_CAUSES_Gaichas.html)

November: (Invited) “Fragile ecosystems, robust assessments? (What I did with my summer vacation),” OneNOAA AFSC seminar (online). Also given as UMass School of Marine Science and Technology in New Bedford MA, and NEFSC seminar in Woods Hole MA in October; [https://noaa-edab.github.io/presentations/20191009\\_SMAST\\_Gaichas.html](https://noaa-edab.github.io/presentations/20191009_SMAST_Gaichas.html)

September: “Conceptual models: What are they? How can we use them?” for MAFMC Ecosystem and Ocean Planning Committee (EOP), Baltimore MD; [https://noaa-edab.github.io/presentations/20190918\\_MAFMC\\_EOP\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190918_MAFMC_EOP_Gaichas.html)

August: “Management Strategy Evaluation, National Progress and Needs,” briefing for NOAA leadership (online)

July: (Invited) “Ecosystem modelling approaches: What questions can we address?” Shoals Marine Lab Integrated Ecosystem Assessment course guest lecture and lab, Appledore Island ME; [https://noaa-edab.github.io/presentations/20190723\\_SMLlab\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190723_SMLlab_Gaichas.html)

July: (Invited) “Fishing within food webs: Modeling for management advice,” Shoals Marine Lab Rock Talk evening seminar series, Appledore Island ME; [https://noaa-edab.github.io/presentations/20190723\\_SMLrocktalk\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190723_SMLrocktalk_Gaichas.html)

May: (Invited) “Generating datasets for model performance testing: How challenging can it be?” Institute for Marine Research (IMR) Departmental seminar, Bergen, Norway; [https://noaa-edab.github.io/presentations/20190528\\_deptIMR\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190528_deptIMR_Gaichas.html)

May: (Invited) “Implementing an Ecosystem Approach to Fishery Management: A Risk Assessment Example,” IMR Institute seminar series, Bergen, Norway

May: “Integrated Ecosystem Assessment: Mid-Atlantic Fishery Management’s Success Story” for NOAA-IMR bilateral meeting, Bergen, Norway; [https://noaa-edab.github.io/presentations/20190506\\_IEA\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190506_IEA_Gaichas.html)

May: “Scientist Exchange (2019): A collaborative U.S.- IMR research project” for NOAA-IMR bilateral meeting, Bergen, Norway; [https://noaa-edab.github.io/presentations/20190507\\_REDUS\\_Gaichas.html](https://noaa-edab.github.io/presentations/20190507_REDUS_Gaichas.html)

April: SOE for the MAFMC

April: EAFM Risk Assessment: Mid-Atlantic 2019 Update, for the MAFMC

March: SOE for the MAFMC SSC

## **2018**

October: “The Dream and the Reality: challenges with modeling marine mammals for the New England Fishery Management Council’s herring MSE,” for Workshop on MSE applied to Marine Mammal Conservation and Management, Providence, RI

October: WGSAM

September: (Invited) Climate-models NE workshop

September: MAFMC EOP

July: WPI REU

May: (Invited) presenter, “Implications of Ecosystem Approaches to Fisheries Management (EAFM) for Pelagic Fisheries,” for workshop co-organized by European pelagics fishing industry and MAFMC, Gloucester, MA.

April: (Invited) “Can we integrate ecosystem and multispecies interactions into TACs and other fishery management?” for International TAC workshop in Xiamen China

April: SOE for the MAFMC

March: “US Risk Assessment and Ecosystem Reporting Update” for ICES WGNARS

March: SOE for the MAFMC SSC

February: (Invited) “Analytical approaches for Ecosystem Based Fishery Management: Models and Indicators,” for Marine Resources Education Program (MREP) 200 course on EBFM; also organizing committee member. (Invited to parallel West Coast MREP but unable to attend)

## **2017**

December: “The Dream and the Reality: Meeting decision-making times frames while incorporating ecosystem and economic models into management strategy evaluation,” QUEST webinar

November: NSF Wind Energy Workshop in New Bedford, MA, November 2017 (“IEAs”)

October: “Update on US modeling activities,” “Indicator based risk assessment,” “Herring MSE update” and 6 presentations for other US scientists at ICES WGSAM in San Sebastian, Spain

October: “Mid-Atlantic Fishery Management Council EAFM Based Risk Assessment,” for MAFMC in Riverhead, NY

September: “Mid-Atlantic EAFM Risk Assessment: Review context, prior work, Expand to new elements,” for MAFMC Ecosystem and Ocean Planning Committee (EOP)

June: MAFMC EOP in Baltimore, MD

May: “State of the Ecosystem Report: Northeast US Shelf” and “Northeast Climate Vulnerability Assessment and Regional Action Plan,” for US-Norway bilateral in Woods Hole, MA

April: (Invited) “State of the Ecosystem Report: Mid-Atlantic,” for Fisheries Leadership and Sustainability Forum in Monterey, CA

April: “State of the Ecosystem Report: Mid-Atlantic,” for the MAFMC in Avalon, NJ

March: MAFMC Habitat meeting in Sandy Hook, NJ

March: “State of the Ecosystem Report: Mid-Atlantic” for the MAFMC SSC (online)

March: “Predator models” for NEFMC Herring MSE peer review in Boston, MA

March: “US IEA Update” for ICES WGNARS in Halifax, NS

February: “Northeast Fisheries Science Center Ecosystem Modeling: Applications Investigating Tradeoffs” and “Management Strategy Evaluation (MSE)” for National Ecosystem Modeling Workshop in St Petersburg, FL.

## **2016**

December: “Predator models” and “Predator metrics and results” for Herring MSE stakeholder workshop in Portsmouth, NH

October: “Update on US MSE activities and Atlantis Poseidon Adventure project,” Mid-Atlantic Ecosystem Approach to Fisheries Management”, and two presentations for other US scientists. ICES WGSAM in Reykjavik, Iceland

June: (Invited) “Management Strategy Evaluation in the US,” kickoff meeting for the Norwegian Research Council project Reducing Uncertainty in Stock Assessment (REDUS), Bergen, Norway

June: “Management Strategy Evaluation (MSE)” for NEFSC Ecosystem and Climate Science Program Review, Woods Hole, MA

May: “What do we know about Atlantic herring’s role as forage?” for NEFMC herring MSE stakeholder workshop in Portland, ME

## **Selected presentations, 2015-2007**

September 2015: (Invited) “Seasonal forecasting and ecosystem based fishery management.” for American Meteorological Society Capitol Hill Policy Briefing on Applications of Seasonal Forecasting, Washington, DC

April 2015: (Invited) “Uncertainty in Ecosystem Models: Taxonomy and Treatment,” NMFS-OAR Uncertainty Workshop,

November 2014: “WGNARS: IEA progress, opportunities, and challenges” ICES WKRISCO in Copenhagen, Denmark

November 2014: “Ecosystem metrics for fisheries management: examples and suggestions,” for Chesapeake Bay Forage Workshop in Solomons, MD

October 2014: “Mixed fisheries in multispecies and ecosystem models” for ICES WGSAM (presented remotely)

February 2013: (Invited) “Visualizing complexity” Data Visualization Workshop, Portland ME

April 2011: “Diet data products for stock assessment” for the Stock-specific ecosystem indicators workshop hosted by Alaska Fisheries Science Center, Seattle, WA

March 2011: “Central GOA dynamic model simulations of whale restoration, jellyfish fluctuations, and no fishing” for GLOBEC Pan-Regional Synthesis PI meeting, Seattle, WA

December 2010: “Marine ecosystems science and management from Alaska to Puget Sound” with Chris Harvey (NWFSC) at the Science Cafe, an informal public lecture series in Seattle, WA sponsored by Pacific Science Center

September 2010: “Ecosystem Considerations SAFE” to the joint Groundfish Plan Teams, Seattle, WA

May 2010: “Arctic ecosystem knowledge, where do we stand and where do we go from here?” in the AFSC seminar series, Seattle, WA

May 2010: “GOA ecosystem overview and data summary,” and examples of fitting our models to time series data at CAMEO stock production modeling workshop, Woods Hole MA, May 10-14

April 2010: “Fishing policy simulations in end-to-end models” at CAMEO end to end modeling workshop, Woods Hole MA

March 2010: “GOA food web modeling and management applications” for CAMEO Predator-Prey Interactions workshop in Corvallis, OR

March 2010: “Ecosystem Considerations in the North Pacific: Groundfish SAFE & Aleutian Islands FEP” for the Ecosystem Science and Management workshop in Silver Spring, MD

December 2009: “Combining single species and ecosystem modeling results in ecosystem assessments” for UW-NMFS Fisheries Think Tank on Dec 8, 2009

December 2009: (Invited) “Where does ecosystem modeling fit into fisheries management? Examples from the North Pacific” for UW SAFS “Young Investigator” departmental seminar, Seattle, WA.

August 2009: “Gulf of Alaska food web modeling and predation mortality estimates: information for single-species M” at the national workshop on Natural Mortality, Seattle, WA.

August 2009: “Analysis of comparisons of single species and ecosystem model results across NMFS Science Centers” at NEMoW II meeting in Annapolis, MD.

January 2008: University of Washington Career Week panelist for marine science careers, Seattle, WA

May 2008: “Science on Tap” informal evening outreach presentation on ecosystem modeling and fishery management, sponsored by Pacific Science Center, Seattle, WA

May 2008: Food-web ecology demonstration, Marine Science Weekend at Pacific Science Center, Seattle WA

May 2008: “Food web modeling and results,” Guest lecture for Ray Hilborn’s University of Washington course, Seattle, WA

October 2007: (Invited) “Alaskan fisheries and deep-sea resources” for Asia-Pacific Economic Cooperation (APEC) workshop on developing a network on deep sea resources and fisheries, in Lima, Peru

October 2007: “Ecosystem threshold modeling” at UW mini-workshop, Seattle WA

October 2007: “Ecosystem modeling” for Pacific Science Center Teacher workshop, Seattle WA

August 2007: “Ecosim model” for National Ecosystem Modeling workshop, Santa Cruz CA

August 2007: “Computation involved in ecosystem modeling” for visiting junior college teachers from Fresno City College and other schools touring the NOAA facility, Seattle, WA

March 2007: “GOA ecosystem description and comparison methods used in Alaska” for Marine Ecosystems of Norway and the US (MENU) workshop, Bergen Norway

February 2007: Co-leader of UW Mini-workshop on fitting ecosystem models to data, Seattle, WA

## Funded research

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PI and Co-PI on multiple Northeast Fisheries Science Center internal R&D proposals:

\* Evaluating environmental indicators of energy density of forage species in the Northeast U.S. (2020, 2021) \* Building operational multispecies assessments: comparing performance of length- and age-based multi-species modeling approaches (2020) \* Development of oceanographic indicators for Northern shortfin squid (2020) \* Climate-driven Atlantis ecosystem model hindcasts and projections for the U.S. Northeast Shelf: Implications of future management strategies under climate change (2019)

Co-PI on multiple Northeast Fisheries Science Center internal Groundfish/Climate proposals: \* Evaluating annual variation and environmental regulation of fecundity in winter and yellowtail flounder with implications for stock reference points (2021) \* Incorporating multivariate physical and biological data as covariates in state-space age-structured stock assessments (2020)

PI and Co-PI on NMFS SF MSA proposals \* MAFMC MSE support (2020, 2021)

- Co-PI on NMFS SF International fellowship (2019):
- Co-PI on COCA proposal with GMRI/SMASST on MSE for groundfish under climate change (2017-present), developing MSE framework and testing a range of standard and climate-informed harvest control rules for multiple groundfish species. Postdoc hiring committee member: reviewed resumes, participated in interviews, selected candidates. Facilitated collaboration between COCA postdocs and NEFSC scientists, adding economists.
- Co-PI on NMFS Stock Assessment Methods R&D proposal: A comparison of length- and age-based multi- and single-species modeling approaches (2016)
- Co-PI on modeling portion of the North Pacific Research Board's GOA Integrated Ecosystem Research Plan (2010-2011).
- Investigator with 22 others on the interdisciplinary "Collaborative Research: GLOBEC Pan-Regional Synthesis: End-to-end Energy Budgets in US-GLOBEC Regions" project comparing four marine ecosystems in the Southern Ocean, in the Pacific off Alaska and the U.S. West Coast, and in the Atlantic off the U.S. East Coast (2008-2011).

## Professional Affiliations/Activities/Service

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### PROFESSIONAL SOCIETIES

Current member: American Fisheries Society (AFS), American Institute of Fishery Research Biologists (AIFRB)

Past member: Ecological Society of America, The Society for Conservation Biology, American Society of Ichthyologists and Herpetologists

### EDITORIAL POSITIONS

Guest editor, 2018-2019. Canadian Journal of Fisheries and Aquatic Sciences virtual special issue "Under pressure: addressing fisheries challenges with management strategy evaluation."

Guest editor, 2011-2012. Marine Ecology Progress Series Theme Section "Comparative analysis of marine fisheries production."

### MEMBERSHIP ON PANELS

Chaired multispecies model key run reviews for ICES WGSAM, October 2020 (North Sea), October 2019 (Baltic Sea). Participant in WGSAM model key run reviews 2015-2018.

Invited review panelist:

- Atlantic States Marine Fisheries Commission Atlantic Menhaden stock assessment and ecological reference points, November 2019.
- South African Assessment review, November 2018. MSE-based management procedures for 4 species were reviewed over the course of a week by an international panel. (Also invited for 2019 panel, but declined due to conflicts).
- International Whaling Commission, JARPN II February 2016 (Tokyo, Japan), NEWREP-NP February 2017 (by correspondence)
- NOAA NMFS Ecosystem Science Program reviews:
  - Alaska Program (Juneau, May 2016)
  - Northwest Program (Seattle, July 2016)
- Woods Hole Oceanographic Institution CINAR Fellows review panel, December 2012
- External reviewer for the Canada Maritimes Region Ecosystem Research Initiative, March 2012

## ADVISORY SERVICES

### Active

- Mid-Atlantic Fishery Management Council Scientific and Statistical Committee (SSC), (2014-present): determining Allowable Biological Catch (ABC) advice for fishery management and other scientific support. Lead for bluefin tilefish and ecosystems. Member of OFL-CV working group (2017-2019), economics working group (2020-2021), and newly-formed ecosystem working group (2021-).
- Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management (EAFM) work group (2013-present): scientific support for ongoing EAFM efforts. Presented in Council EAFM development workshops (2013-2015), supported development of EAFM policy guidance (2016), EAFM risk assessment (2017-2018), EAFM conceptual model (2019), and ongoing EAFM Management Strategy Evaluation (MSE; 2020-).
- ICES Working Group on North Atlantic Regional Seas (WGNARS), (2012-present, co-chair 2013-2016): developing ecosystem indicators and integrated ecosystem assessments for Canadian and U.S. waters. Co-chaired working group meetings in January 2013, February 2014 (also local host), and February 2015:
  - Developed agendas, 3 year Terms of Reference for 2014-2016, co-authored and submitted reports
  - Organized working sessions - 2013: ecosystem indicator thresholds/performance testing and ecological risk assessment, led section on risk assessment - 2014: reviewing, selecting and operationalizing management objectives and large scale ecosystem drivers - 2015: conceptual model development for Gulf of Maine/Georges Bank connecting large scale ecosystem and social drivers, focal ecosystem components, human activities, and human social system components as well as selected management objectives drawn from US law and published work
- ICES Working Group on Multispecies Assessment Methods (WGSAM), (2013-present, co-chair 2017-present): reviewing and contributing to multispecies and ecosystem modeling progress across ICES regions. Co-chaired working group meetings in October 2017, October 2018, October 2019, October 2020:
  - Developed agendas, 3 year Terms of Reference for 2019-2021, co-authored and submitted reports
  - Developed review criteria and organized working sessions on multispecies model key-run reviews
  - Currently leading intersessional work on multispecies model skill assessment
- Advisory partner in the European Commission's PANDORA project (2018-2022), which is designing toolsets for new dynamic ocean resource assessments and exploitation.

### Completed

- ICES Workshop on Reference Point Change (WKRChange; 2020)
- Atlantic herring benchmark stock assessment working group (2018)
- Herring MSE steering committee member, New England Fishery Management Council (2016).
- Ecosystem Based Fishery Management Plan Development Team member, New England Fishery Management Council (2012-2016)
- Invited speaker/participant, Multispecies Fisheries Management Workshop, Fujian, China 2018
- National Climate Assessment (NCA4; 2016-2018) Ecosystem Chapter author contributing to climate effects on trophic interactions and emergent properties
- National Integrating Climate Effects into Fisheries Management (ICE-FM) working group member ICES WKS WKRChange 2020

facilitated a Stellwagen Bank NMS conceptual modeling workshop (March 2017) WKRISCO 2014

- Advisory partner in the European Commission's MYFISH project (2012-2015), which defined alternative approaches to Maximum Sustainable Yield including ecological, social, and economic dimensions.
- NEFSC Stock Assessment Program Review steering committee member (2013-2014). Participated in planning meetings (including Directorate briefing) and full review meeting 19-23 May 2014. Developed background materials and presentation on how well NEFSC integrates ecosystem and climate considerations into stock assessments. Contributed to follow up and Center response.



- National Stock Assessment Improvement Plan (SAIP) writing team member for NEFSC (2013-2014). Contributed to chapters on incorporating ecosystem effects into stock assessments and future of stock assessment (including IEAs, multimodel inference, etc.).
- CB Forage Fish 2014
- Member of the Aleutian Islands Fishery Ecosystem Plan Team (2007-2011) and the Gulf of Alaska Fishery Management Plan Team (2000-2011) for North Pacific Fishery Management Council. Co-authored the Aleutian Islands Fishery Ecosystem Plan (2007) and regularly co-authored the Stock Assessment and Fishery Evaluation introduction and summary for the Gulf of Alaska. Authored Ecosystem Description and contributed analyses for management alternatives for the Arctic Fishery Management Plan (2009).
- Co-organizer of the Bering Sea Ecosystem Synthesis Team (2010), a multi-disciplinary group charged with identifying important ecosystem indicators for fishery management and writing an eastern Bering Sea ecosystem assessment for the North Pacific Fishery Management Council.
- Invited participant in Asia-Pacific Economic Cooperation International workshop on developing a network for deep sea research in Lima, Peru (2007). Presented information on North Pacific ecosystems, fisheries, and management, and helped develop a preliminary framework for an information-sharing network.

#### WORKSHOPS ORGANIZED/CHAired; SESSIONS ORGANIZED/CHAired AT PROFESSIONAL MEETINGS

##### In Progress

ICES/PICES Symposium Small Pelagic Fish: New Frontiers in Science and Sustainable Management (planned for Lisbon, Portugal November 2022); S6 Reconciling Ecological Roles and Harvest Goals: Development and Testing Management Strategies to Enhance Marine Ecosystem Services. <https://meetings.pices.int/meetings/international/2022/pelagic/program#S6> Convenors: Sarah Gaichas, Cecilie Hansen, Isaac Kaplan, Richard Nash

World Fisheries Congress (planned for Adelaide, Australia/Virtual September 2021); The land of plenty: Advances and future directions in population dynamics modeling to support fishery management. Six consecutive, non-overlapping sub-sessions are planned, including (conveners in parentheses): general stock assessment methodology and statistics (André Punt, James Thorson); spatial models (Daniel Goethel, Aaron Berger); ecosystem dynamics and climate change (Éva Plagányi, Caleb Gardner, Sarah Gaichas); data-limited methods (Kristen Omori, Jason Cope, Natalie Dowling); management strategy evaluation and biological reference points (Carryn de Moor, Richard McGarvey, Ann Preece); and a summary discussion (Mark Maunder, Patrick Lynch).

##### Completed

National Ecosystem Modeling Workshop (NEMoW) 2019 St Petersburg; Steering committee member and workshop planner – Developed NEFSC overview presentation (presented by Scott Large) – Developed atlantisom tool demonstration (presented by Christine Stawitz)

American Fisheries Society annual meeting (AFS) 2018 Atlantic City; Emergent Properties of Aquatic and Marine Ecosystems Due to Climate Change: An Overview of the Current State of Knowledge. Organizers: Michelle D. Staudinger, Abigail J. Lynch, and Sarah K. Gaichas

AFS 2017 Tampa; Closing the Loop: Stakeholder Involvement in the Management Strategy Evaluation (MSE) Process—Advancing Management Strategy Evaluation. Organizers: Sean M. Lucey, Sarah K. Gaichas, John F. Walter III, Daniel Goethel, Aaron Berger, and Patrick Lynch

AFS 2017 Tampa; Under Pressure: Defining Harvest Strategies that Account for Biological, Environmental or Anthropogenic Spatiotemporal Complexity—Advancing Management Strategy Evaluation. Organizers: Daniel Goethel, Aaron Berger, Patrick Lynch, Sarah K. Gaichas, John F. Walter III, and Sean M. Lucey

AFS 2015 Portland, OR; Multispecies models (including humans!)—where have we been and where do we need to go? Organizers: Sarah K. Gaichas, Kirstin Holsman, Alan Haynie and Geret DePiper

AFS 2011 Seattle; What Influences Fisheries Production? Comparing the Effects of Environmental, Fishing, and Food Web Forcing Across Large Marine Ecosystems. Organizers: Sarah Gaichas, William Stockhausen, Thomas J. Miller, Jason S. Link, Tim Essington, R. Ian Perry and Alida Bundy

AFS 2011 Seattle; Ecosystem Modeling: Joint Modeling of Human Behavior and Fish Populations; Ecosystem Models to Address Fishery Management Needs. Organizers: Eli Fenichel, Joshua Abbott, Thomas F. Ihde, Sarah K. Gaichas, Isaac C. Kaplan, Derek M. Orner, Yvonne L. deReynier and Howard M. Townsend

Comparative Analysis of Marine Ecosystem Organization (CAMEO) Stock Production Modeling Workshop II Woods Hole, 2011. Organizers: Alida Bundy, Ken Drinkwater, Tim Essington, Jason Link, Sarah Gaichas, Tom Miller, Erlend Moksness, and Ian Perry

Society for Conservation Biology's International Marine Conservation Conference (IMCC) 2009 Washington DC; Bridging the gap between fisheries and marine conservation to advance ecosystem-based management. Organizers: Anne Salomon, Olaf Jensen, Vera Agostini, Sarah Gaichas, and Norm Sloan

AFS 2007 San Francisco; Ecosystem modeling applications in fishery management. Organizers: Sarah Gaichas, John Field, Howard Townsend, Megan Tyrell, and Jason Link

## TEACHING AND MENTORING

Graduate-level

**Adjunct professor** *University of Massachusetts, Dartmouth*

One current College of William and Mary (Virginia Institute of Marine Science) PhD student committee  
One current UNH PhD student committee

2021 (Exam) PhD student committee at the University of Massachusetts, Dartmouth  
2020 External examiner for a PhD student at University of Iceland  
2019 (Exam) PhD student committee at the University of Massachusetts, Dartmouth  
2019 External examiner for a PhD student at Dalhousie University  
2016 External examiner for a PhD student at the University of Cape Town  
2016 (Exam) PhD student committee at the University of Washington  
2015 (Exam) PhD student committee at Oregon State University

Undergraduate-level

IN FISH program 2021 Internship mentor: diet data analysis and development of ecosystem indicators

Shoals Marine Lab summer course and lab guest lecturer 2021, 2019

WPI REU program (twice), organized lab visits and provided guidance, background, and data for student projects

Invited course and lab guest lecturer for Rutgers 2020 summer course (postponed due to COVID)

- Guest lecturer: Woods Hole Partnership in Education Program (PEP), June 2015; Worcester Polytechnic Institute Research Experience for Undergraduates in Applied Mathematics, June 2014; WHOI Fisheries Oceanography Course, April 2014, Rutgers Ecology and Evolution Dept. Seminar, March 2013, SMAST Fisheries Oceanography Dept. Seminar, February 2012.
- Regular participant in Alaska Fisheries Science Center scientific education and outreach activities, including Pacific Science Center programs, Minorities in Marine Science Undergraduate Program presentations, elementary, secondary, and college educator workshops, internship application review and placement.

## Agency Service

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### COMMITTEES

National Management Strategy Evaluation Working Group co-Chair (2016-present)

National EBFM workshop participant, July 2020 \* Contributed NEFSC info to ESR presentation \* Represented NEFSC in ESR and other discussions

IMR/NOAA bilateral meetings 2019, 2017

Regional IEA Working Group

### OTHER

## Other relevant information

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March 2020 - present: considerable time was needed for dependent care (elementary age kids and elder care), reducing available work hours. Regularly used the excused absence for dependent care.

## References

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