Highly Migratory Species Research Update
Southwest Fisheries Science Center

Presented by
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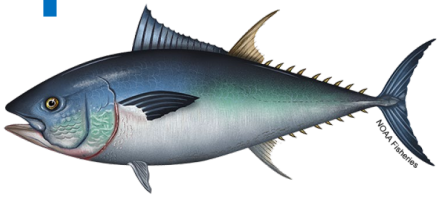
Presentation to Pacific Fishery Management Council *Nov 17, 2025*

Updates since September 2024

HMS Research Update: Outline

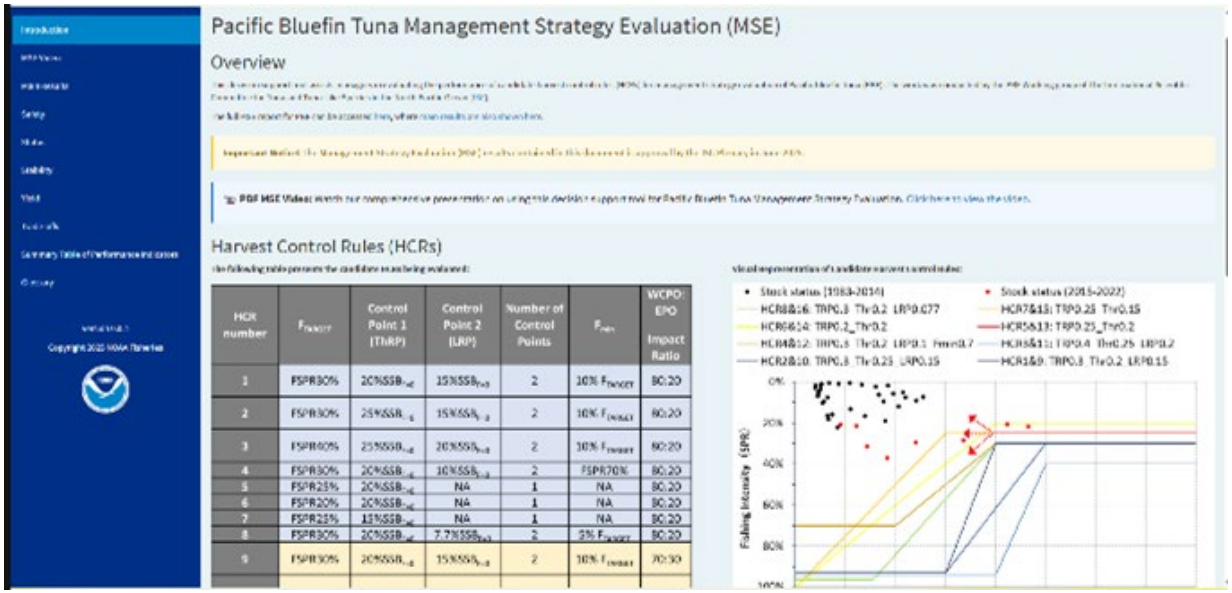
- **Assessments:**
  - 2025 assessment summaries: Pacific bluefin tuna MSE
  - 2026 assessment schedule
- **Genetics:**
  - Albacore sex ratios using genetic markers
  - Pacific Bluefin close-kin genetics
- **Life History:**
  - Age and growth: Albacore, Bluefin
  - Foraging: Bluefin
- **List of publications and presentations**

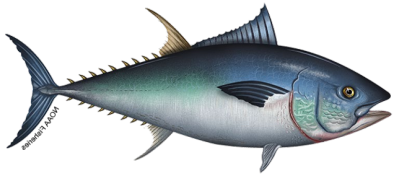
Pacific Bluefin Tuna MSE Completed in 2025

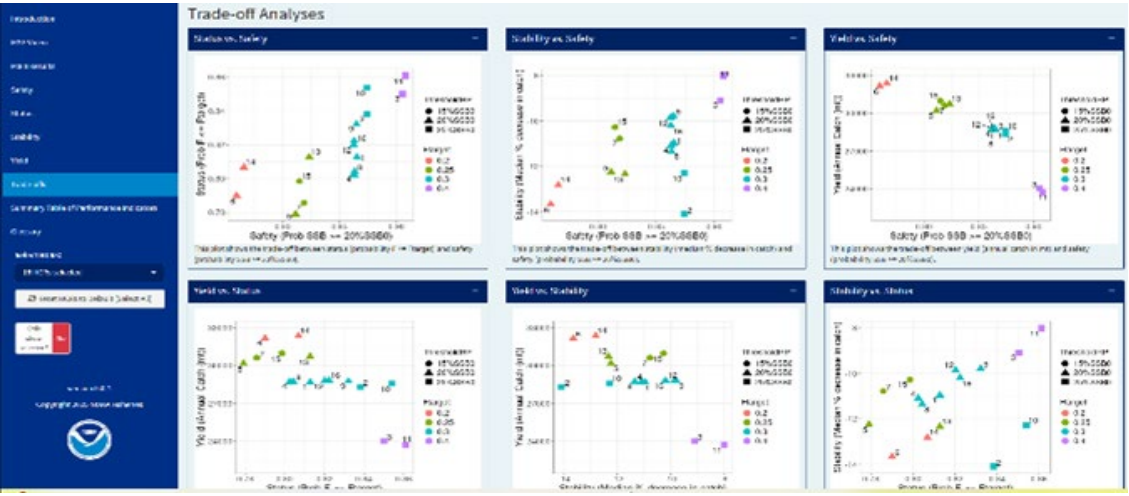


- Led by SWFSC scientists and completed through ISC PBF WG
- The PBF MSE was a vast undertaking:
  - 16 candidate harvest control rules
  - 32,000 simulations
  - 256,000 simulated stock assessments
  - More than 50 million MB of storage
- Presented results to the Joint IATTC and WCPFC-NC Working group on PBF
- Details in the MSE report, Video and Shiny app

Pacific Bluefin Tuna MSE Results







Shiny APP:
https://connect.fisheries.noaa.gov/ISCPBF-MSE-tool/

2026 Assessment Schedule

ISC

- NPO Albacore Tuna Benchmark - SWFSC lead
- Pacific Blue Marlin Benchmark - PIFSC lead
- Review of 2024 Pacific Bluefin Tuna Benchmark

WCPFC

- WCPO Bigeye Tuna Benchmark
- WCPO Yellowfin Tuna Benchmark

IATTC

- EPO Bigeye Tuna Update
- EPO Bigeye Tuna MSE (completion)
- EPO Yellowfin Tuna MSE (start)

Albacore Sex Ratios Using Genetic Markers

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HMS Genetics Research completed by the FRD Genetics, Physiology, and Aquaculture Group

What is it?

- A genetic assay allowing for individual sex assignment

Why pursue?

- Previous research has shown skewed sex ratios and possibly sex-specific growth rates in Albacore
- Faster sampling time, can sample from any part of fish (not just gonad)
- With enough data on sex ratios and sex-specific growth rates, could incorporate into assessments

North Pacific Albacore Sex Ratios

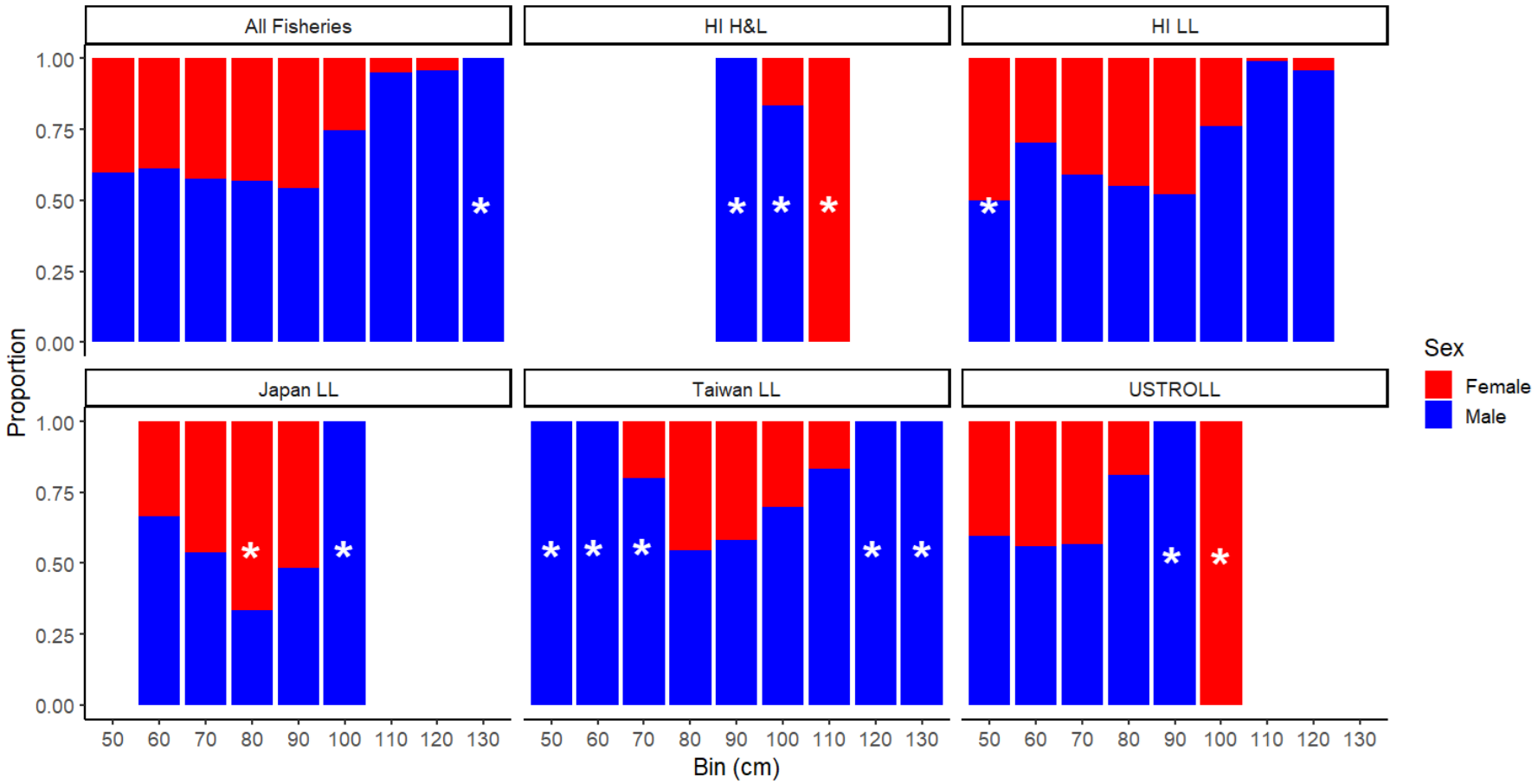

Figure 1 from Craig et al. 2025 ISC/25/ALBWG-01/08.
Proportion of Male (blue) to female (red) albacore by fishery as determined genetically. "*" indicates that size bin has fewer than 10 individuals. N = 1255.

North Pacific Albacore Sex Ratios are Male-Skewed

- Sex ratio in North Pacific albacore appears to be male-skewed at larger size classes (>90cm FL)
- Cause unknown
- Some possible causes:
  - Biological (e.g., differential mortality)
  - Ecological (e.g., differential distribution)
  - Sampling artifact (e.g., differential catchability or selectivity).

Figure 1 from Craig et al. 2025
ISC/25/ALBWG-01/08

Pacific Bluefin Tuna
Close-Kin Mark-Recapture (CKMR)

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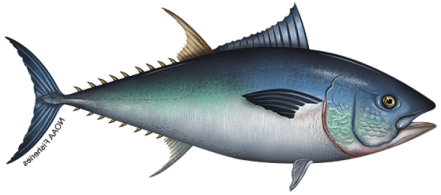
No updates on CKMR

- SWFSC had a dedicated CKMR collection from port samples for 5 years (2016-2020) and collection has since stopped.
- Japan continues to lead research and application including sample collection from their own fleets, and analysis.



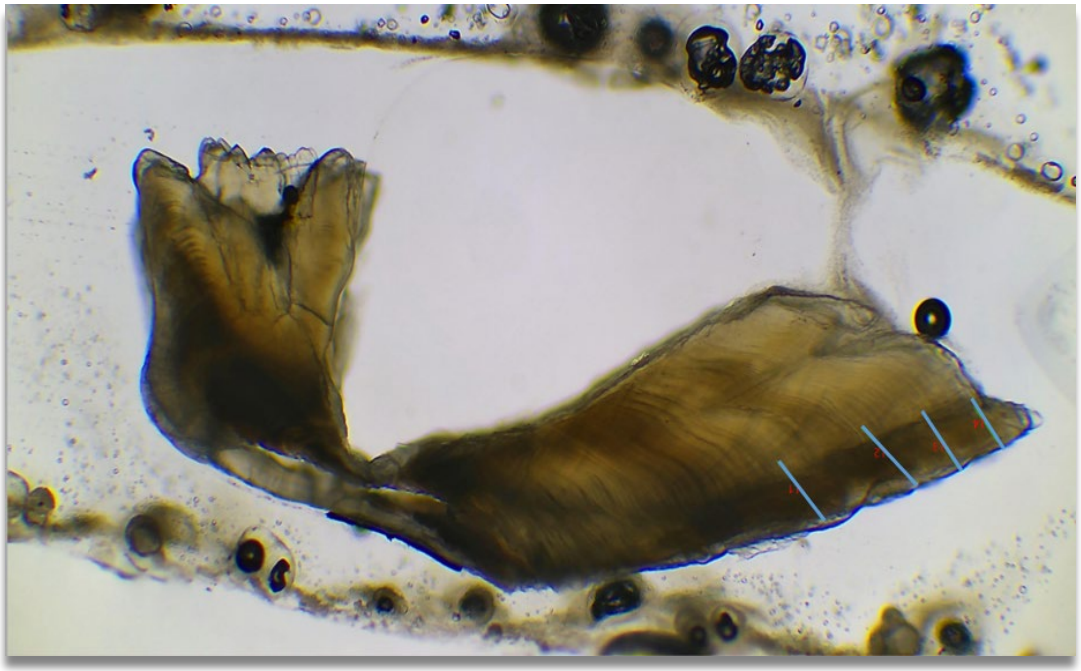
Year	2011	2012	2013	2014	2015	**2016**	**2017**	**2018**	**2019**	**2020**	2021	2022
#	195	396	220	133	262	**1040**	**672**	**1817**	**1119**	**392**	357	269

SWFSC PBF tissue samples by year of collection. Bolded values indicate years of dedicated sampling for CKMR. Note that 2020 sampling was interrupted by COVID.

North Pacific Albacore: Age and Growth

Goal: Evaluate sex-specific growth

- 412 fish sampled from Eastern and Central Pacific
- Length range: 48 to 124 cm FL
- Age range: 1 to 15 years old (sectioned otoliths)
- Results will be submitted for publication



Snodgrass et al. ISC Albacore Work. Gr. 10-14 March, 2025

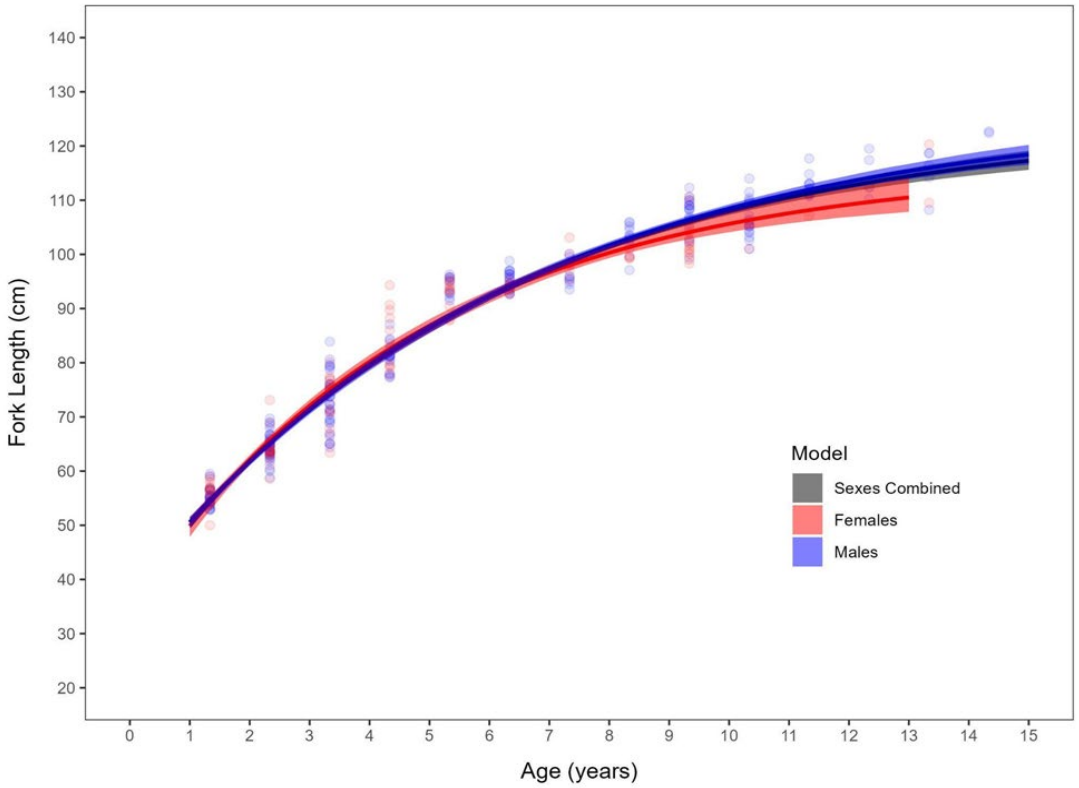
Unpublished data do not cite

Funded by NOAA Cooperative Research Program and EBFM/ WRAP

North Pacific Albacore: Age and Growth

Results:

- von Bertalanffy growth models of current dataset comparing growth patterns when sexes are combined versus treated separately
- A combined sexes model was slightly favored over a sex-specific model



Snodgrass et al. ISC Albacore Work. Gr. 10-14 March, 2025

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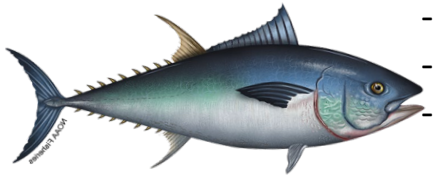
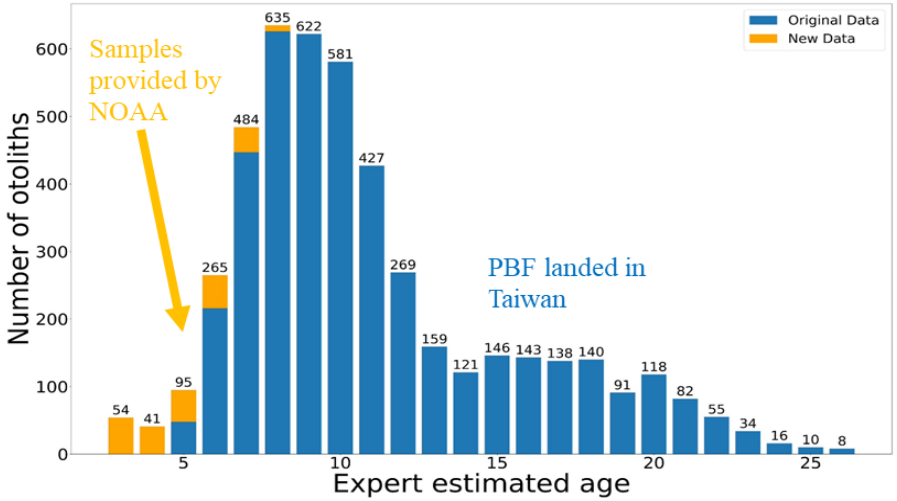
Pacific Bluefin Tuna: Age and Growth

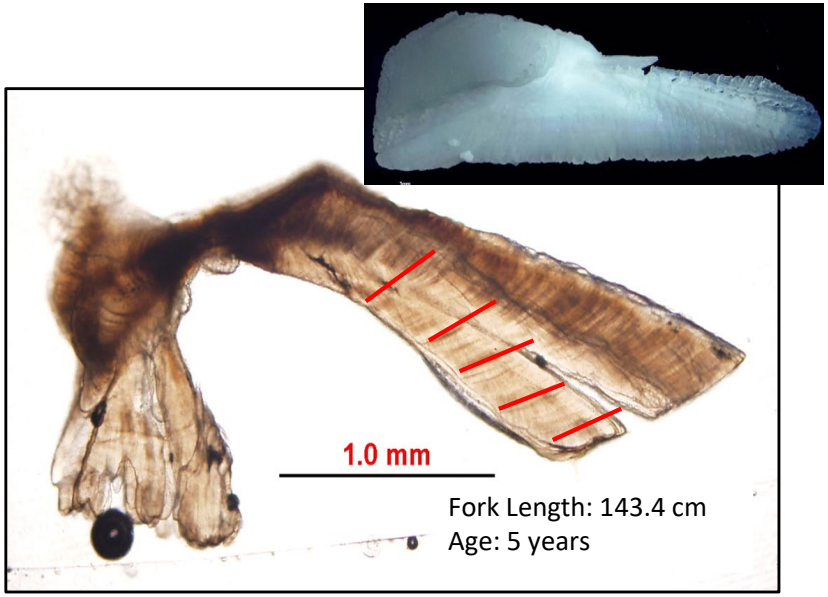
Goal 1:
Generate EPO-specific length-at-age estimates; potentially for stock assessments

Goal 2:
Collaborate with international scientists to standardize aging, and train an AI age-estimation model

- PBF otoliths collected from 2009 - 2025
- Otoliths from 629 PBF processed; 282 PBF aged
- Length range: 60 to 169.4 cm FL
- Age range: 2 to 8 years old







Funded by NOAA Cooperative Research Program and EBFM/ WRAP

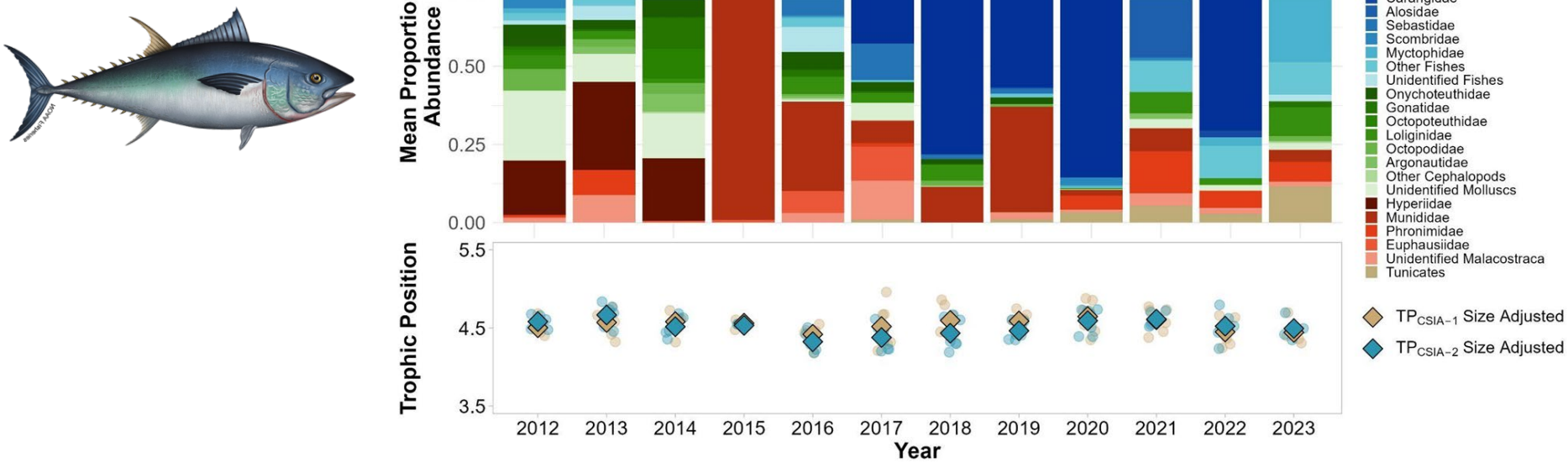
Unpublished data do not cite

Pacific Bluefin Tuna: Foraging Ecology

Goal:

Understand the trophic ecology (diet and trophic position) of PBF to support EBFM

- PBF diets show high interannual variability; shift towards fishes in recent years
- Despite high diet variability, mean trophic position remained stable (annual Δ ≤0.2)



Implications:

- PBF feed on wide variety of prey; diet shifts occur over short time scales
- PBF maintain trophic position by consuming prey with similar traits

Funded by NOAA Cooperative Research Program and EBFM/ WRAP

Unpublished data do not cite

Recent HMS Publications

1. Byrne, M.E., Dewar, H., Vaudo, J.J., Wetherbee, B.M. and Shivji, M.S. 2024. You Shall Not Pass: The Pacific Oxygen Minimum Zone Creates a Boundary to Shortfin Mako Shark Distribution in the Eastern North Pacific Ocean. Divers Distrib., 30: e13924. https://doi.org/10.1111/ddi.13924
2. Minte-Vera, C.V., Maunder, M.N., Aires-da-Silva, A., Xu, H., Valero, J.L., Teo, S.L.H., Barría, P., and Ducharme-Barth, N.D. 2024. The use of conceptual models to structure stock assessments: A tool for collaboration and for "modelling what to model". Fish. Res., 279: 107135. https://doi.org/10.1016/j.fishres.2024.107135
3. Dealy, D.D., Hilger, J.R., and Stohs, S.M. 2024. Economic information for Aquaculture Opportunity Areas off Southern California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-697. https://doi.org/10.25923/mcrz-7454
4. Lyons, K., Rackley, P., Preti, A., and Carlisle, A.B. 2025. Nearshore use increases propensity to accumulate persistent organic pollutants in two thresher shark species. Sci. Total Environ. 982: 179673.
5. Kelly, O.N., Craig, M.T., Feldheim, K.A., McMillan, M.N., Devloo-Delva, F., Bohnet-Dawson, E.J., Chabot, C.L., Hyde, J., and Nosal, A.P. 2025. Frequency of Multiple Paternity in Tope (Galeorhinus galeus) from California and Australia. Ichthyology & Herpetology 113(3), 445-452. https://doi.org/10.1643/i2025002
6. Leising, A., Hunsicker, M., Tolimieri, N., Williams,G., Phillips, A., et al. including Preti A. (2025) 2024-2025 CALIFORNIA CURRENT ECOSYSTEM STATUS REPORT: A report of the NOAA California Current Integrated Ecosystem Assessment Team (CCIEA) to the Pacific Fishery Management Council, March 2025. https://doi.org/10.25923/9t48- pb48
7. Luongo, S.M., Wegner, N.C., Skelton, Z.R., Ortega-García, S., Rodríguez-Sánchez, R., Fenix, H., Lake, M., O'Sullivan, J.B., Furukawa, S., Kawabe, R., and Papastamatiou, Y.P. (2025). Vertical energy seascapes and diving behaviour modulate metabolic scope in a pelagic predator. Proc. Roy. Soc. B. 292: 20250200. https://doi.org/10.1098/rspb.2025.0200
8. Muhling, B., Snyder, S., Hazen, E.L., Whitlock, R., Park, J.Y., Stock, C.A., and Block, B.A. 2025. Climate change impacts to foraging seascapes for a highly migratory top predator. Mov. Ecol. 13, 33. https://doi.org/10.1186/s40462-025-00558-1
9. Portner, E.J., Muhling, B.A., Preti, A., Snodgrass, O.E., Richards, T.M., Nickels, C.F., Dewar, H., Hazen, E.L., and Choy, C.A. 2025. Resource partitioning among pelagic predators remains stable despite annual variability in diet composition. J. Anim. Ecol., 94, 1014–1030. https://doi.org/10.1111/1365-2656.70032
10. Preti, A., Muhling, B.A., DiNardo, G.T., Pierce, G.J., Lyons, K., Stohs, S.M. 2025. Foraging ecology of swordfish in the California Current Large Marine Ecosystem during an ecosystem regime shift, ICES J. Mar. Sci., Volume 82, Issue 8, fsaf139. https://doi.org/10.1093/icesjms/fsaf139
11. Purcell, C., Volk, J., Hyde, J., and Blair, G. 2025. Science advice for genetic effects from marine finfish aquaculture in Southern California and the Gulf of Mexico. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC710. https://doi.org/10.25923/7cye-p074
12. Purcell, C., Volk, J., Hyde, J., and Blair, G. 2025. Using OMEGA to model risks of escaped fish associated with offshore finfish culture in Southern California: an evaluation of proposed Pacific Ocean AquaFarms operations. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-712. https://doi.org/10.25923/00tn-d344
13. Robinson, S., Wegner, N.C., Sepulveda, C.A., and Franck, J.P.C. 2024. Relative sarcolipin (SLN) and sarcoplasmic reticulum Ca2+ ATPase (SERCA1) transcripts levels in closely related endothermic and ectothermic scombrid fishes: Implications for molecular basis of futile calcium cycle non-shivering thermogenesis (NST). Comp. Biochem. Physiol. A. 295: 111667
14. Lee, H., Piner, K.R., Maunder, M.N., and Fukuda, H. 2025. Randomization method for evaluatingthe reliability of a recruitment index in an integrated assessment model. Fishery Bulletin. 123(3): 179-189. https://doi.org/10.7755/FB.123.3.4

Recent HMS Presentations

16th Meeting of the IATTC Scientific Advisory Committee, 2nd IATTC-WCFC NC Intersessional Meeting, ISC25 Plenary

- Results of the Pacific Bluefin Tuna Management Strategy Evaluation

California Current Integrated Ecosystem Assessment (CCIEA) Virtual Meeting

- Investigating the relative importance of pelagic forage species to the diets of key highly migratory predators in the California Current Large Marine Ecosystem

2025 National Cooperative Research Program Meeting

- Cooperative Research to Support Highly Migratory Species Management: FY25 Progress Report

Northeast Fisheries Science Center Seminar

- Future changes in migration paths, foraging grounds, and energy dynamics of North Pacific albacore

Pacific Fishery Management Council Scientific and Statistical Committee Meeting

- 2025 Re-evaluation of the recruits-per-spawner and CalCOFI SST relationship in Pacific sardine
- 2025 Update Assessment for Pacific sardine (Sardinops sagax)

West Coast Regional Office U.S. Stakeholder Meeting

- Translating Fishing Intensity, Exceptional Circumstances, and E-Logbooks for North Pacific Albacore

Western & Central Pacific Fisheries Commission Scientific Committee Meeting

- Overview of the Pacific Bluefin Tuna Management Strategy Evaluation