



**NOAA
FISHERIES**

Southwest Fisheries Science Center Highly Migratory Species Research Update

Presenter

Dale Sweetnam

Contributing researchers

Steve Teo, Huihua Lee, Ross Cooper, Antonella Preti¹, Cat Nickels², Heidi Dewar, Barb Muhling¹, Owyn Snodgrass, Kelsey James, Brad Erisman, Desiree Tommasi¹, (SWFSC), Elan Portner (NRC/SIO), Keith Bigelow (PIFSC)

1=CIMEAS, 2=NRC additional affiliation





**NOAA
FISHERIES**

Outline

HMS Research Update

- Collaborative Research
- Albacore
- Pacific Bluefin tuna
- Billfish
- Opah
- ISC Upcoming Activities
- Fishful Future



Collaborative Research

Partners: CDFW, SAC, AFRF, PSMFC, CIMEAS, PIER, Fishers, WCR, U.S. Coast Guard, PIFSC, Texas A&M, AFRF, AAFA, WFOA, NRIFSF/Japan, Catalina Offshore Products, Fish Processors, WCR, and CPFV's

Research:

- 1) Size composition of bluefin tuna landings in the CPFV fleet (SAC, Pacific States)
- 2) Length-Weight relationship bluefin tuna (CDFW, SAC)
- 3) Tuna Biosampling (SAC, AFRF, AAFA, CDFW, Processors, Fishers, WCR)
- 4) Archival tag deployments (AFRF)
- 5) Foraging ecology (SAC, PIER, AFRF)
- 6) Habitat use and life history of opah (PIER, PIFSC, WCR)
- 7) Opah, species-specific distribution and basic biology (PIER, PIFSC, Fishers, WCR)
- 8) Reducing waste and adding value across the seafood supply chain (COP)



- **Albacore Foraging Ecology:**

- *Juvenile Albacore are in the CCLME to Forage*

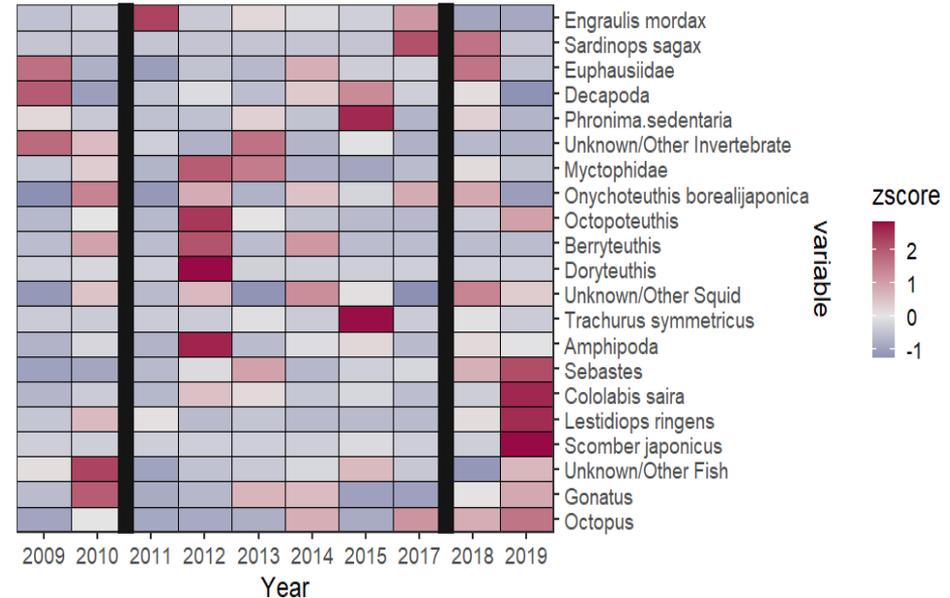


- **Critical to characterize trophic connections for:**

- 1) **Essential Habitat**
 - 2) **Quantify connections to CPS**
 - 3) **Ecosystem management and modeling**
 - 4) **Examine shifts in habitat quality**
 - 5) **Understand shifts in prey abundance and distribution**
- 1) **Project shifts with climate change**
 - 2) **Will inform movement models in MSE**

- **Current Data Products**

- 1) **Data incorporated into Atlantis**
- 2) **Included in CalCOFI Report**
 - a) **2020 albacore**
 - b) **2021 albacore and swordfish**
 - c) **2022 bluefin, albacore and swordfish (across regions and vertical habitat)**
- 3) **Data included in the CCIEA database**
- 4) **Current plan to include HMS diet data in the 2021 CCIEA report**



Heatmap of z-scores by year for prey contributing > 1% mean proportional abundance. Red is high and blue is low relative abundance. A Classification and Regression Tree analysis was used to identify shifts in diet (black vertical bars). (Weber et al . 2021)

KEY: Long-term time series, as called out in PFMC research and data needs, are critical to understanding shifts in diet and their associated forcing mechanisms.

- **Albacore Archival Tagging Efforts (AFRF, WFOA):**
- **Deployed final 78 archival tags with AFRF captain as surgeon:**
 - <https://www.kgw.com/video/news/local/oregon-fishermen-assisting-with-noaa-research-tracking-tuna/283-59658275-5f9b-482a-ace6-5e981a91a3a6>
- **Archival tags provide insight into**
 - 1) **Foraging ecology: When and where they forage**
 - 2) **Essential Habitat: Project shifts associated with short and long-term climate variability**
 - 3) **Gear vulnerability: Geographic and vertical**
 - 4) **And many more**

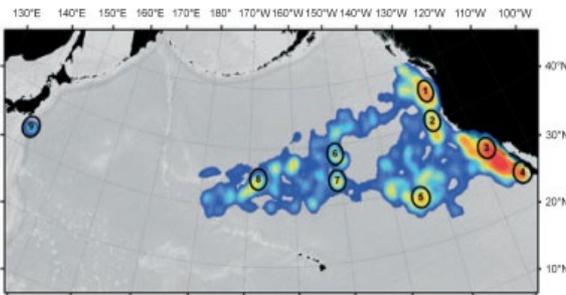
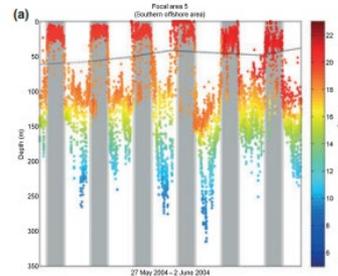


Figure 6. Kernel density composite created from all high-quality locations showing focal areas of high use. Focal areas are labeled as numbered in the text.

Figure 10. Behavior patterns for all fish residing in focal area five, April–June. See Fig. 7 legend for details.



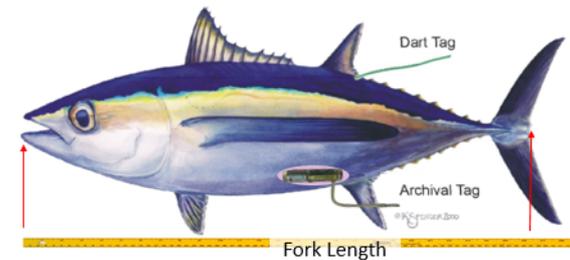
Childers et al. 2011

REWARD: TAGGED ALBACORE

Tagged Albacore have a green dart tag in their back

Archival tags are data recording devices that are implanted in the belly with a stalk sticking out.

\$500: Whole fish w/Archival tag/ **\$300:** Archival tag only/ **\$20:** Dart tag only



TO CLAIM YOUR REWARD

Record

- 1) Date
- 2) Catch latitude and longitude
- 3) Fork Length and unit (cm or in)
- 4) Dart and/or Archival Number
- 5) Fisherman/ gear type/ contact info

Contact

Ericka Carlson +1 (971) 209-2030
erickac@afrf.org OR
Owyn Snodgrass +1 (858) 546-7000
owyn.snodgrass@noaa.gov

- US Commercial: Fish and/or tags can be delivered to the nearest processor.
- US Recreational: Contact above to coordinate shipping and reward.
- Outside the US: Contact National Fishery Agency or people listed above.

NOTE: All shipping costs will be paid for by NOAA



Archival tag in belly with stalk sticking out.

To remove make shallow incision from ~6" to 1/2" towards head from stalk.

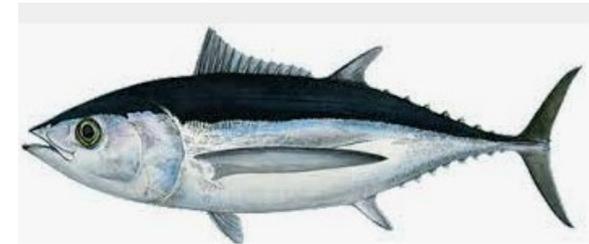
Tear tissue to open belly and expose tag.

Gently remove tag, it may be encased in tissue. Store it in a safe place.

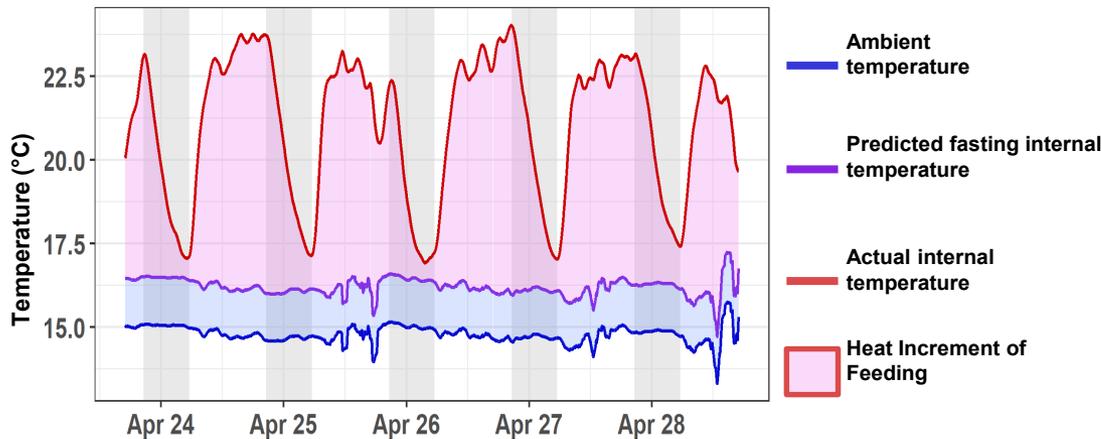
Research funded by the National Oceanographic and Atmospheric Administration and the American Fishermen's Research Foundation

Albacore:

- **Foraging Migrations Inferred from Archival Tags**
 - *Energy intake estimated from Heat Increment of Feeding (HIF)*
 - *Juvenile albacore may migrate offshore in anticipation of favorable spring foraging conditions*

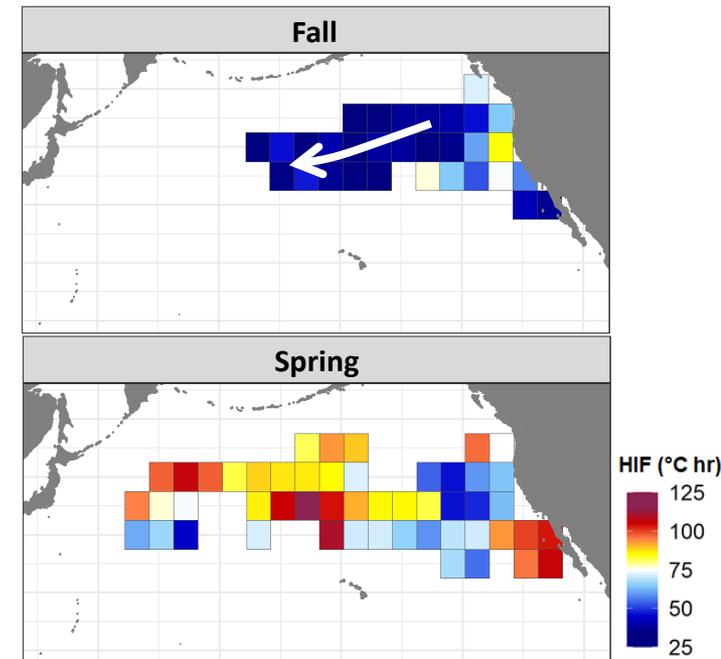


Heat Increment of Feeding for a 90cm albacore in April 2004



Muhling et al. in review

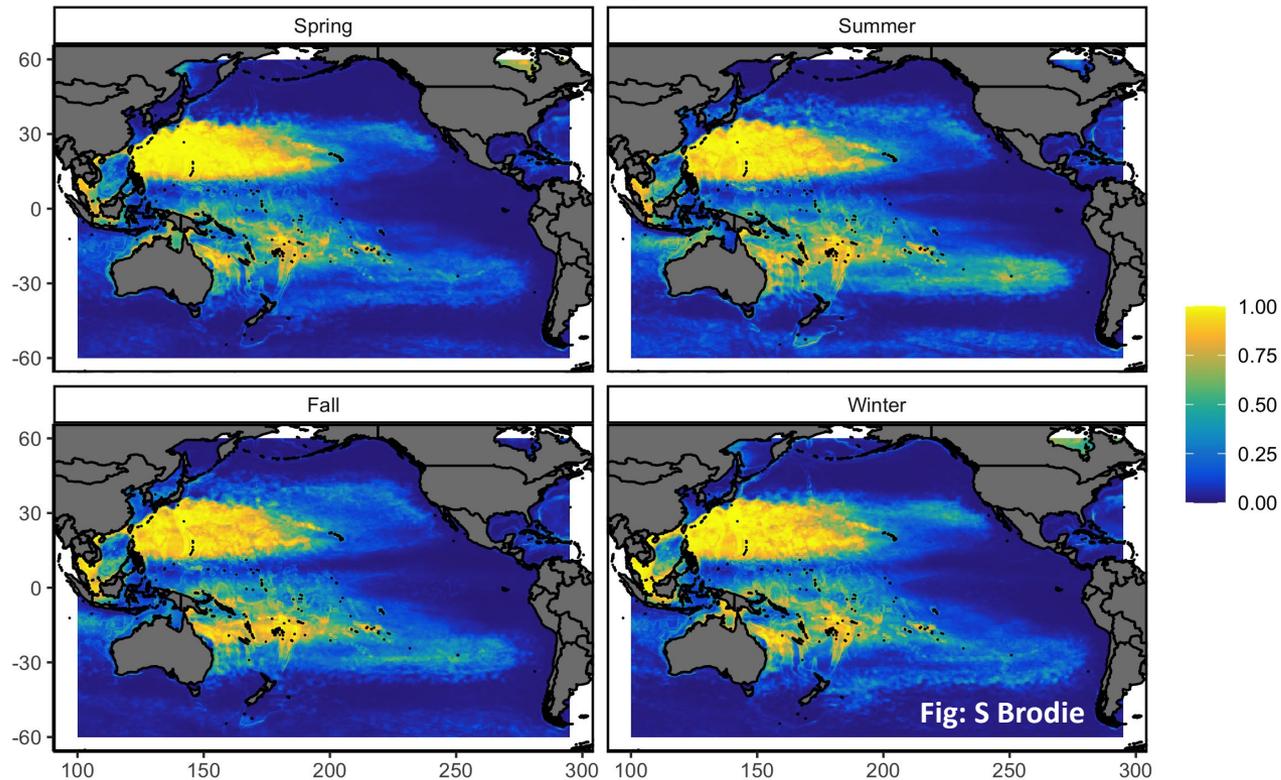
Mean HIF by season



North Pacific IUU

- *Build distribution models for juvenile and adult albacore*
- *Examine pelagic longline fleet dynamics from RFMO and AIS data (Frawley et al. in prep)*
- *Examine reported catch versus predicted species ranges*
- *Collaboration with OLE, USCG and industry*

Distribution model for adult albacore



OLE-funded project: *“Dynamic decision-support tools to counter IUU fishing for North Pacific albacore”*,
M Jacox, T Frawley, B Muhling, S Brodie, J Smith, D Tommasi, H Welch



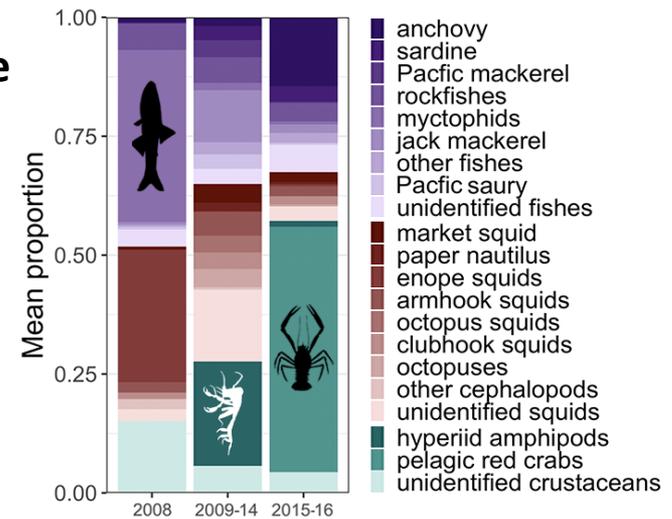
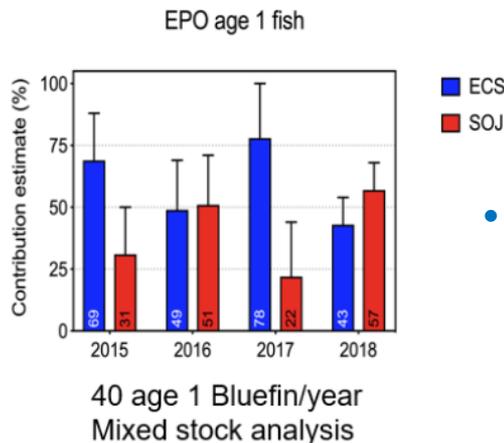
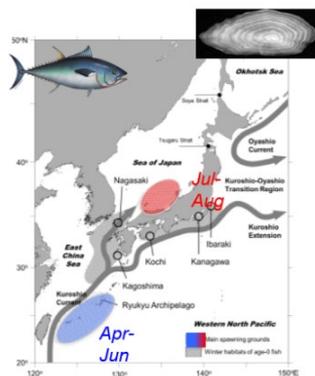
**NOAA
FISHERIES**

North Pacific Albacore MSE

- Results of the ISC NPALB MSE were presented to US and Canadian managers and stakeholders on March 22-25, 2021 during a virtual workshop. Similar stakeholder workshops were also held in Japan (March 17-19) and Taiwan (April 7-8)
- The ISC NPALB MSE report was reviewed at the virtual ISC21 Plenary Meeting on July 12-15, 2021
- The ISC Plenary endorsed the MSE results and reiterated that no additional NPALB MSE work is anticipated at this time
- NPALB MSE Report and recorded video presentation provided to SC17
- Results from the ISC NPALB MSE report were presented to the Northern Committee on October 4, 2021
- D. Tommasi advising Kit Dhal and Jessica Watson of the HMSMT on development of a Shiny app to present MSE results to stakeholders

Bluefin Research:

- **Length-Weight Curve for EPO: CDFW/ SAC/ NOAA**
 - **First step: compiling data and identifying data gaps**
- **Close Kin: Will provide a fisheries independent estimate of biomass**
 - **Have been collecting samples since 2015**
 - **Identifying both genetic technique and sample**
- **Foraging Ecology: Again, in the CCLME to Forage**
 - *Range of epi- and mesopelagic fish + squid*
 - *Opportunists predators can forage across taxa and habitats.*
 - *Distinct shifts in diet over time*
 - *Testament to the need for long-term studies*



- **Movement Dynamics/Otolith Microchemistry:**
 - *Use unique signature in the core to identify spawning ground.*
 - *Next step to link patterns over a decade environmental variability.*

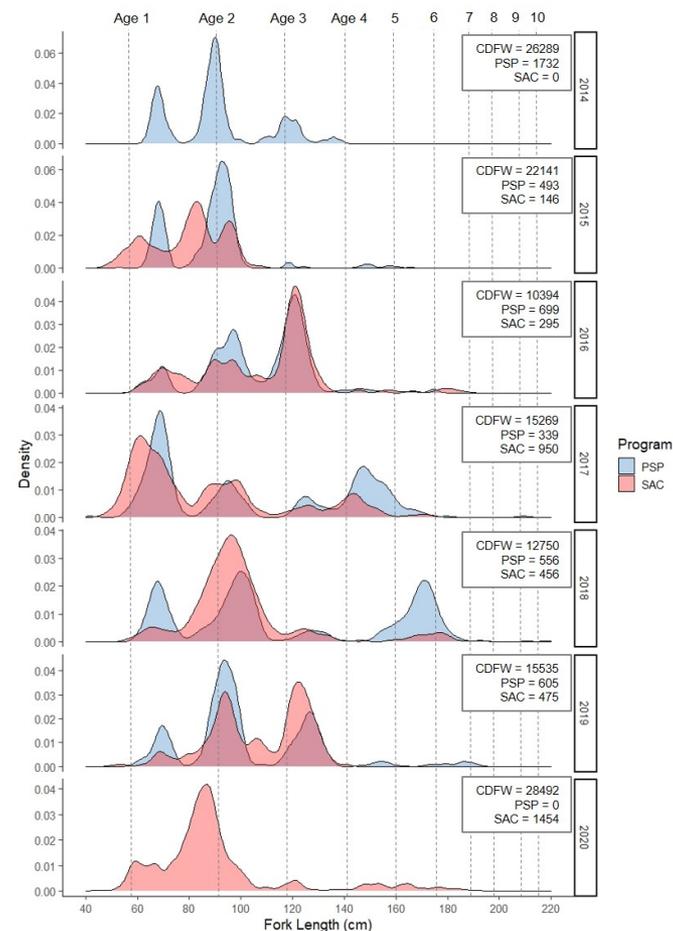
Bluefin: Comparison of NOAA and SAC Length Sampling Programs

The NOAA Port Sampling Program and Sportfishing Association of California (SAC) sampled PBF lengths from (2014-2020) from the CPFV fleet.

- Comparison

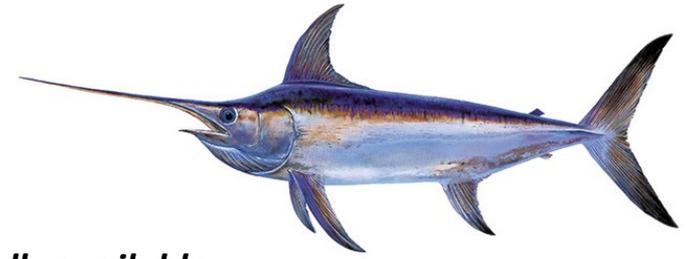
- % of fish sampled: NOAA 4.5%/ SAC 3.8%
- Length compositions were similar overall
- NOAA size composition was larger in some years/ may be linked to only sampling at the dock
- SAC sampled fewer vessels, but this had a minor effect the length compositions
- SAC able to sample in 2020 where as NOAA was not
- Both sampling programs sample main body of fish

Continued annual sampling is imperative to provide robust length distributions to the ISC stock assessment. Going forward SAC will be the primary source of the length composition data.

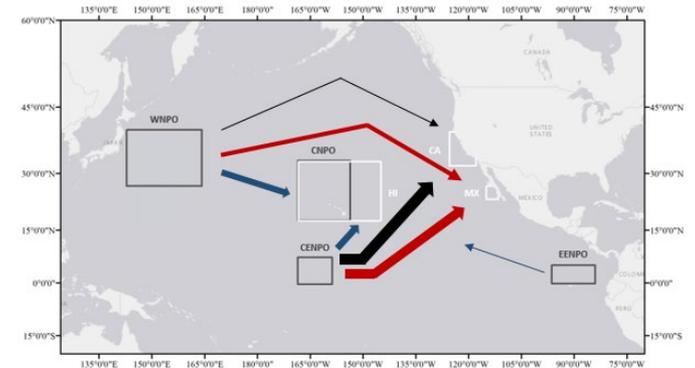


James, K.C., Heberer, L.N., Lee, H., and Dewar, H. 2021. Comparison of Length Sampling Programs for Recreational Fisheries of U.S. Pacific Bluefin Tuna from 2014 to 2020. NOAA-TM-NMFS-SWFSC-652.

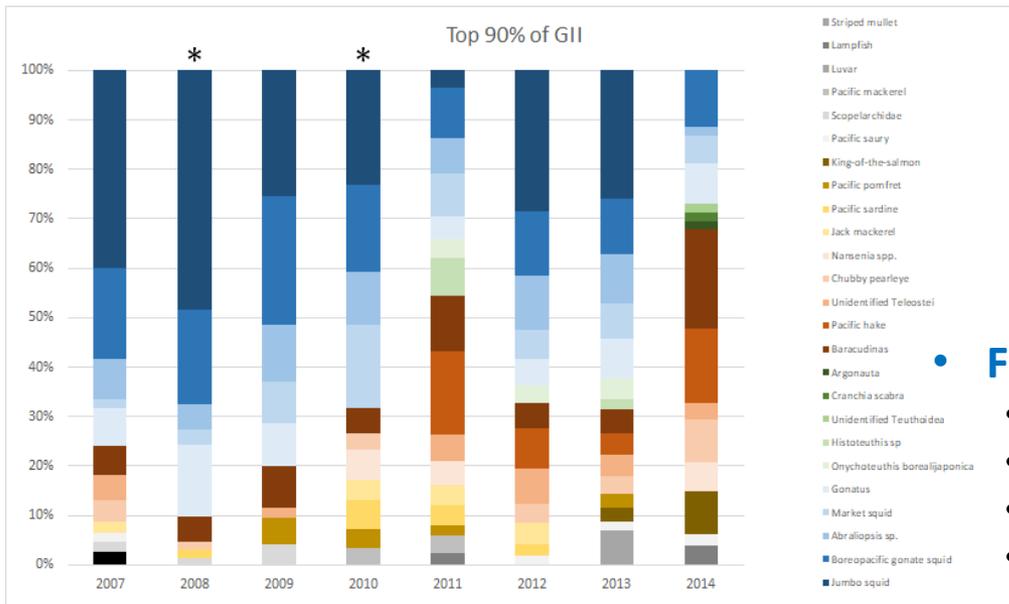
Billfish: Also in the CCLME to Forage



- **Sunset Conventional Tagging Program. Database publically available**
- **Movement Dynamics Using Otolith Microchemistry:**
 - *Compared signature of core in adults to that of nursery grounds.*
 - *Adults in CA, HI and Mexico recruit from multiple nursery grounds*



Relative contribution of nursery grounds to adult foraging ground. Black= CA, Red = Mexico and Blue=HI. Drawn from data presented in Wells et al. 2021



Percent GII (geometric index of importance) 2007-2014 (Prete et al. 2020).

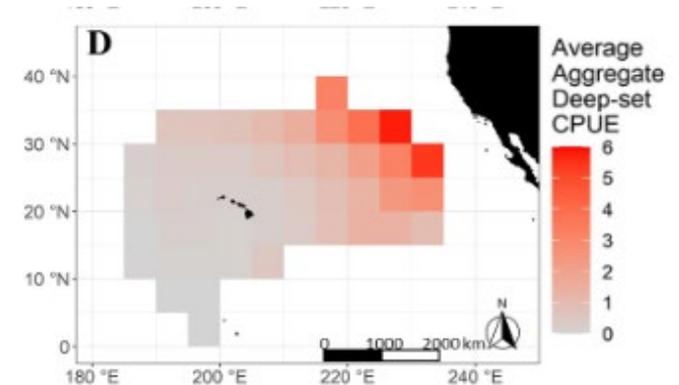
Foraging Ecology: Swordfish

- *Range of epi- and mesopelagic fish + squid*
- *High variability over time*
- *Opportunists*
- *Most similar to bigeye thresher sharks*

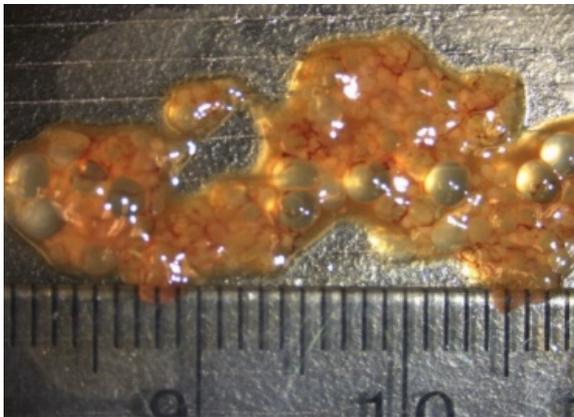
Opah: Landed in both coastal and high-seas fisheries



- **Species Specific Range and Gear Vulnerability (SWFSC/PIFSC)**
 - *Combining catch data and genetic analyses (Cooper et al. in prep)*
 - *Using satellite telemetry to examine vertical habitat use*
- **Working with PIRO to Collect Species-Specific Catch Data**
 - *Waiting on new species specific code for small- and bigeye opah*
 - *Collecting genetic samples*

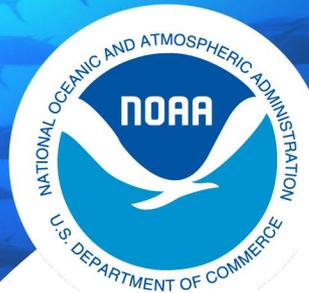


Average CPUE (fish / 1000 hooks) for U.S. deep-set longline fishery from 2014 to 2018 from blocks w > 3 vessels. Cooper et al. in prep



NOAA unpublished data

- **Basic Biology**
 - **Reproductive Biology:**
 - *Evidence of spawning off-shore*
 - **Age and Growth: Best Hard-Part?**



**NOAA
FISHERIES**

Upcoming ISC Activities

- November 9-19, 2021 SharkWG, Blue Shark Data Prep Mtg
- December, 14-21, 2021PBFTWG, Bluefin Tuna Data Prep Mtg

- February, 2022 Bluefin Tuna Assessment, TBD
- April, 2022 Blue Shark Assessment, TBD
- July 13-18, 2022 ISC22 Plenary Meeting - Hawaii, USA





Fishful Future:

fostering culinary and non-culinary solutions to undervalued or discarded products. [SWFSC/ COP/ Saltonstall-Kennedy](#)

Reducing Waste/ End Goal is ZERO waste:

- Organic Fertilizer
- High end pet food from low grade tuna
- Lobster and crab bait
- Jewelry

Adding Value \$\$\$:

- Minced fish products
 - (burger, sausage, spam)
- Smoked fish
- Dry aging

Feasibility Studies

- Fish Leather
- Fish skin bandages
- Biopharmaceuticals: Fish oil, tunas good candidate
- Collagen
- Fish Silage (animal feed)

Will be posted on <https://www.fishfulfuture.com>

Innovative recipes



Tuna Eyeball Sauce with Chef Davin Walke. Video by Sam Wells, Chef Epic.



Grilled Tuna Collar with Chef Christina Ng. Video by Sam Wells, Chef Epic.



Swordfish Marrow Done Chicken. Video by Sam Wells, Chef Epic.



SPAM from a Fish: How to make OPAH SPAM. Video by Sam Wells, Chef Epic.



Fertilizer for organic farms



SKIN: leather +bandages for burn victims



Dry aged tuna increase shelf life





NOAA
FISHERIES

Questions?



References:

- Childers, J., Snyder, S., & Kohin, S. (2011). Migration and behavior of juvenile North Pacific albacore (*Thunnus alalunga*). *Fisheries Oceanography*, 20(3), 157-173.
- Cooper, R., Dewar, H., Muhling, B., Teo², S., Hyde, J. and Bigelow, K. Spatiotemporal catch patterns and population distributions of bigeye Pacific opah (*Lampris megalopsis*) and smalleye Pacific opah (*L. incognitus*) in the eastern North Pacific. In prep.
- James, K.C., Heberer, L.N., Lee, H., and Dewar, H. 2021. Comparison of Length Sampling Programs for Recreational Fisheries of U.S. Pacific Bluefin Tuna from 2014 to 2020. NOAA-TM-NMFS-SWFSC-652.
- Muhling, B.A., Snyder, S., Hazen, E.L., Whitlock, R.E., Dewar, H., Park, J.Y., Stock, C.A., Block, B.A. (in review). Risk and reward in foraging migrations of North Pacific albacore determined from estimates of energy intake and movement costs. *Frontiers in Marine Science*
- Preti, A. (2020). *Trophic ecology of nine top predators in the California Current* (Doctoral dissertation, University of Aberdeen).
- Tomasi D. (2021) Report of the North Pacific Albacore Tuna Management Strategy Evaluation. International Statical Comitee for Tuna and Tuna-Like Species. http://isc.fra.go.jp/pdf/ISC21/ISC21_ANNEX11_Report_of_the_North_Pacific_ALBACORE_MSE.pdf ISC/21/ANNEX/11.
- Wells, R. D., Mohan, J. A., Dewar, H., Rooker, J. R., Tanaka, Y., Snodgrass, O. E., ... & Ohshimo, S. (2020). Natal origin of pacific bluefin tuna from the California current large marine ecosystem. *Biology letters*, 16(2), 20190878.
- Wells, R. D., Quesnell, V. A., Humphreys Jr, R. L., Dewar, H., Rooker, J. R., Alvarado Bremer, J., & Snodgrass, O. E. (2021). Nursery origin and population connectivity of swordfish *Xiphias gladius* in the North Pacific Ocean. *Journal of Fish Biology*.
- Weber, E. D., Auth, T. D., Baumann-Pickering, S., Baumgartner, T. R., Bjorkstedt, E. P., Bograd, S. J., ... & Zeman, S. M. (2021). State of the California Current 2019–2020: Back to the Future With Marine Heatwaves?. *Frontiers in Marine Science*, 1081.