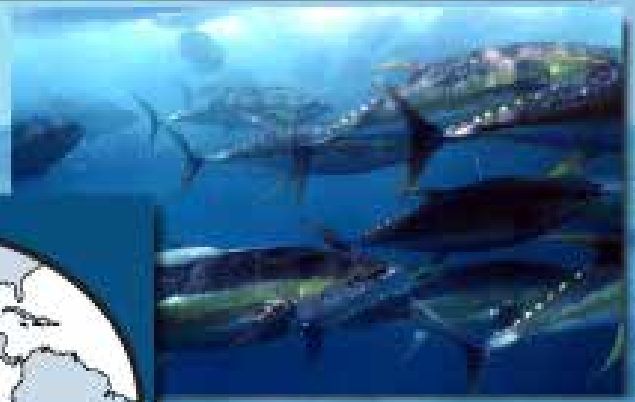
Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission



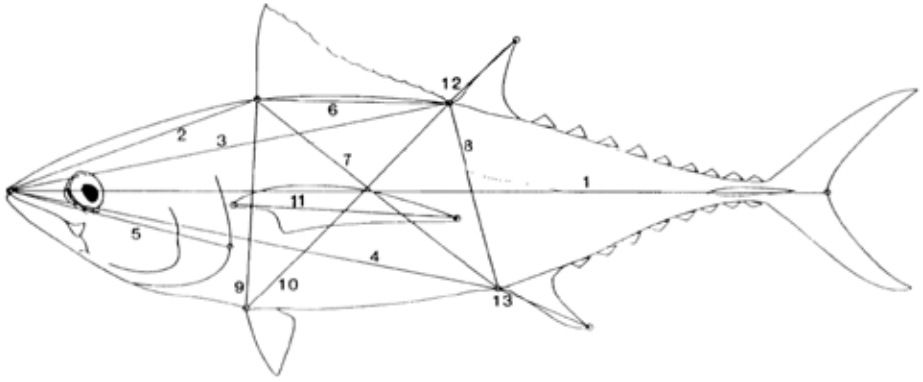
# IDENTIFYING DATA GAPS AND OPPORTUNITIES FOR UPDATING MORPHOMETRIC RELATIONSHIPS AND COLLECTING BIOLOGICAL SAMPLES FOR PRIORITY SPECIES IN EASTERN PACIFIC OCEAN TUNA FISHERIES (SAC-14 INF-J)

Staff collaboration

14a Reunión del Comité Científico Asesor - 15-19 de mayo de 2023
14th Meeting of the Scientific Advisory Committee, 15-19 May 2023

# Outline

- Background
- Objectives
- EPO data gaps – Morphometric relationships
  - § e.g., length-weight (L-W), length-length (L-L), weight-weight (W-W)
- EPO data gaps – Biological sampling
  - § e.g., tissues, stomachs, vertebral centra, otoliths, gonads
- Potential sampling opportunities
- Final considerations




Schaefer 1992, IATTC Bulletin Vol. 20, No.3

Enhanced Monitoring Program

# Background: Morphometric relationships

- Morphometric data are critical to several research and reporting activities
  - § Stock assessments
  - § Ecological assessments (e.g., EASI-Fish)
- Relationships vary by species, region, year
- Species and size composition of catches differs by fishing gear
- Variability may influence assessments and increase uncertainty
- Catch estimations are influenced by morphometric relationships
  - § L-W data are used to convert catch data in numbers to weights and vice versa
  - § W-W data required to convert processed weight to whole weight


Tuna Tagging


Enhanced Monitoring Program


Long-term sampling Program for catches of sharks in artisanal fisheries in Central America (Proj C.4.b)

# Background: Morphometric relationships

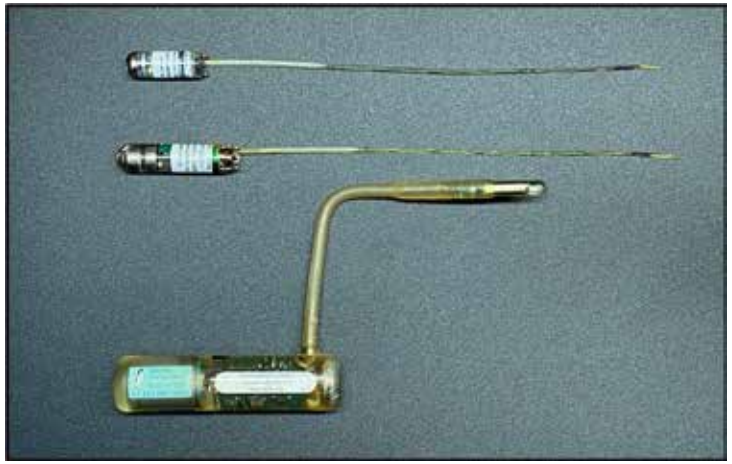
- Various weight metrics
  - whole weight
  - gilled and gutted weight
  - headed, tailed and gutted weight
- Various length metrics
  - fork length
  - total length
  - lower-jaw fork length (billfish)
  - eye-fork length (billfish)
  - precaudal length and interdorsal length (sharks)

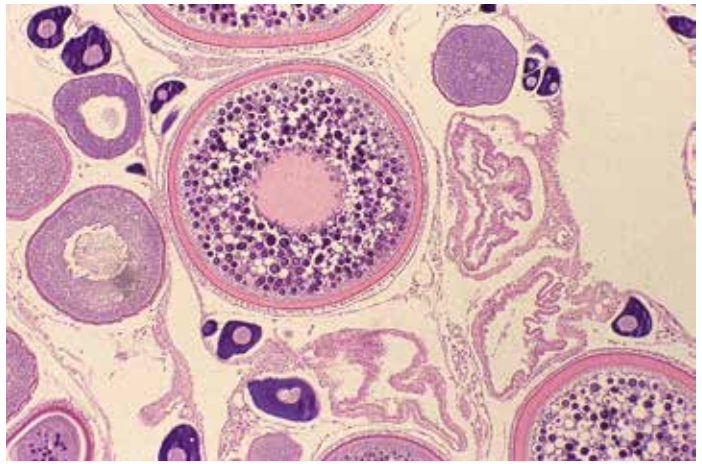
Long-term sampling Program for catches of sharks in artisanal fisheries in Central America (Proj C.4.b)

- Improvements to morphometric relationships are essential for improving precision

# Background: Biological sampling

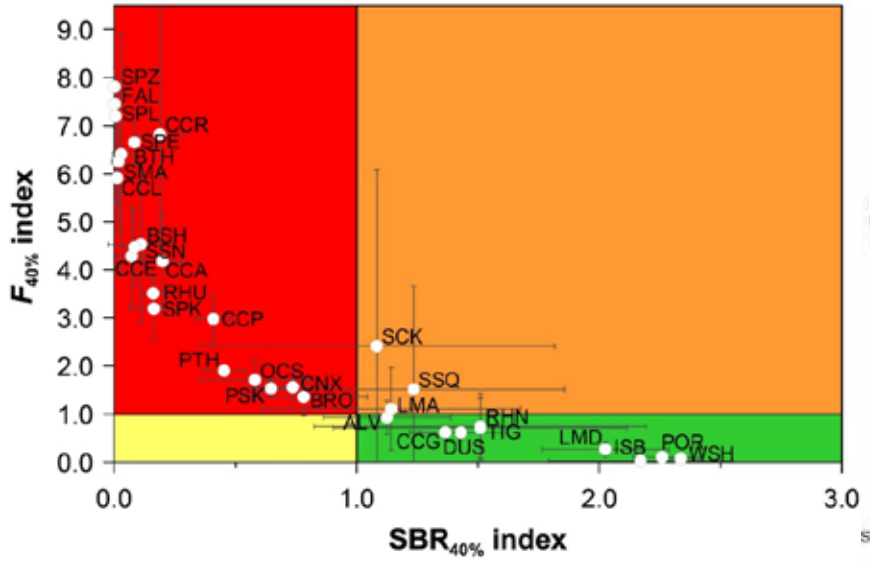
- Biological data needed to parameterize stock assessment models e.g.,
  - § stock structure (e.g., tagging and genetics)
  - § growth and longevity of tunas (e.g., otoliths and tagging)
  - § reproductive biology (e.g., histology)
  - § natural mortality (*M*) (e.g., tagging and growth parameters for *M* estimators)
  - § movement (e.g., conventional and electronic tagging)

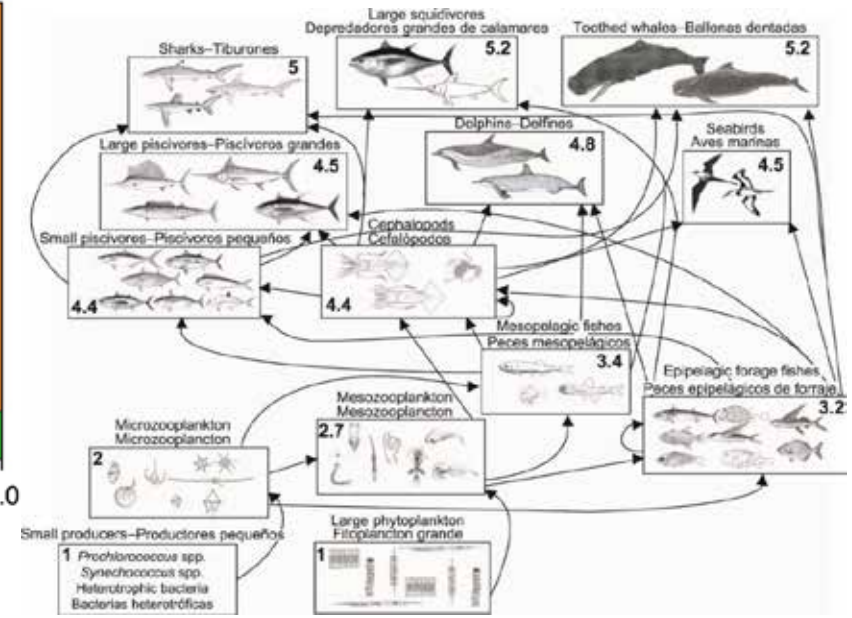


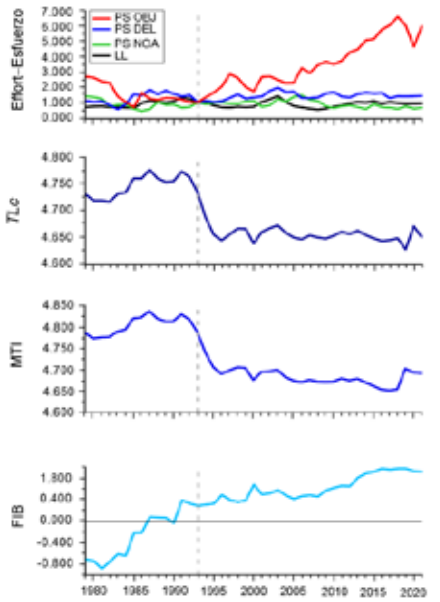


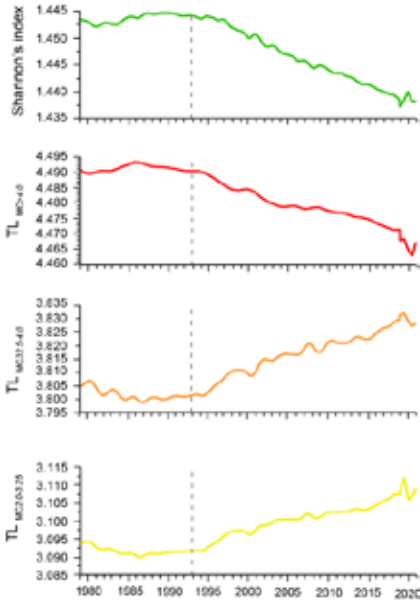
# Background: Biological sampling

- Biological data needed to parameterize ecological assessments e.g.,
  - § to characterize age, growth and reproduction (i.e., productivity component of EASI-Fish)
  - § stomach content data (foundation of ecosystem model)
  - § experiments on consumption rates (Q/B ratio parameter in ecosystem models)
  - § genetic information (e.g., CKMR for sharks, SAC-12-14)



# Initiation of Project F.3.a.

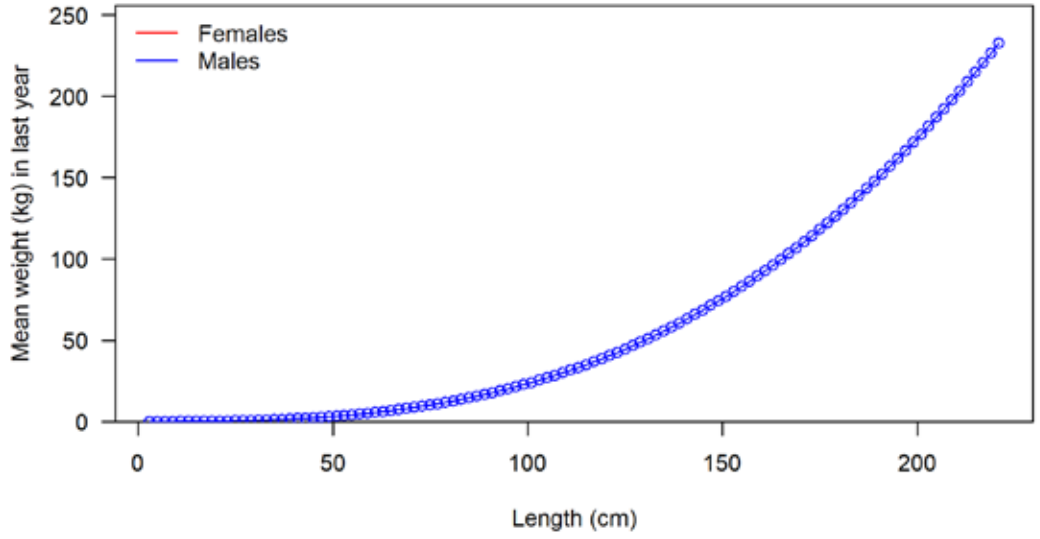
- Staff initiated Project F.3.a. to address data gaps and evaluate sampling feasibility
  - morphometric relationships
  - biological sampling
- Similar work conducted in WCPO (Project 90: SC18-ST-IP-04)
  - SPC Oceanic Fisheries Programme established PS and LL observer measurement protocols
  - developed measurement guidelines and forms (GEN-4 Conversion Factor)
  - record multiple measurements on the same fish (e.g., FL, TL, whole weight, processed weight)
  - purpose: to build comprehensive database of various length and weight types
  - database allows scientists to develop the morphometric relationship needed for assessments
  - established Pacific Marine Specimen Bank (biological samples)
- SAC-14 INF-J summarizes staff discussions on Project F.3.a
  - complementary to documents on data improvements (SAC-12-09, WSDAT-01-01, WSDAT-01-Report, SAC-14 INF-M, SAC-14 INF-L)
  - creating awareness of data deficiencies
  - seeking ways to improve data collection

# Objectives outlined in SAC-14 INF-J

- Objectives
  - § identify data gaps in morphometric relationships and biological sampling
  - § identify potential opportunities for morphometrics and opportunistic biological sampling (for tunas, billfishes, prioritized species)
  - § provide considerations that will determine the success of the project (F.3.a)
  - § improve data collection to better align with scientific research under the Antigua Convention

# Data gaps: Morphometric relationships $W=aL^b$

- Relationships for tropical tunas are outdated by several decades
  - YFT (Wild 1986)
  - BET (Nakamura and Uchiyama 1966)
  - SKJ (Hennemuth 1959)
  - not representative of current EPO populations and fisheries
  - there is indication of spatial variation in average sizes, temporal variation is expected
  - critical for improving estimation of annual catches for all fisheries
  - measurements of lengths and weights pre- and post-processing are required




Xu et al. BET benchmark assessment (SAC-11-06)

# Data gaps: Morphometric relationships

- Staff derive estimates of annual and total catch of tunas, by species, using
  - observer records, vessel logbooks, cannery records, port-sampling data (e.g., see WSBET-02-06)
- Data reported are not standardized
  - processed or whole weight and/or numbers and lengths
  - processing variability between fleets
  - some fishers remove operculum and tail, freeze fish in ultra-low temperatures (Langley et al. 2006)
  - others chill fish and land fresh fish with only viscera and gills removed (Langley et al. 2006)
- No EPO-specific conversion factors for gilled and gutted weight (SAC-07-04a)
  - stock assessment team use conversion factors for entire Pacific Ocean (Langley et al. 2006)
- Current catch estimates may be biased, due to:
  - outdated morphometric relationships used to convert from length to weight
  - processing methods (e.g., sampling frozen tunas vs. fresh tunas)
  - individual variability in the relationships not accounted for (important when fitting models to weight frequencies)

# Data gaps: Morphometric relationships

- Relationships for non-target species are: (see IATTC Special Report 25, SAC-13-11, SAC-09-12)
  - non-existent
  - outdated
  - borrowed from similar species within the region
  - based on data from other ocean basins
  - do not represent EPO populations

# Data gaps: Morphometric relationships

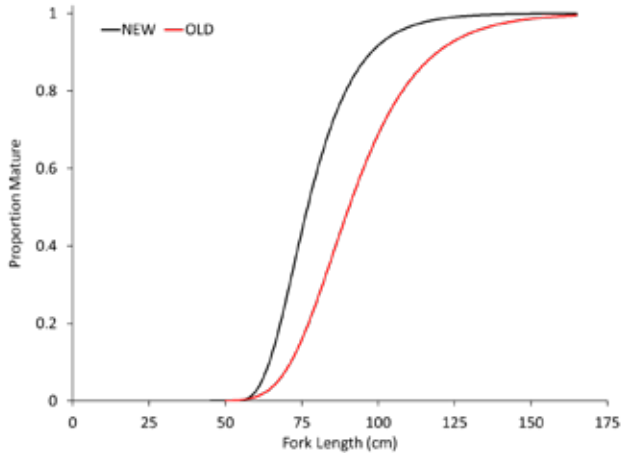
- EASI-Fish (e.g., SAC-14-12) & estimates of artisanal shark catches (SAC-14 INF-L):
  - different forms of L-W & W-W relationships available (literature review)
  - length measurements (e.g., type: PCL, FL, TL)
  - weight measurements (e.g., processed weight, whole weight)
  - $W = aL^b$ (e.g., EASI-Fish uses TL in cm; W in kg)
  - conversions needed to raise processed weights to whole weights (SAC-14 INF-L)
  - analyst must convert to the appropriate form

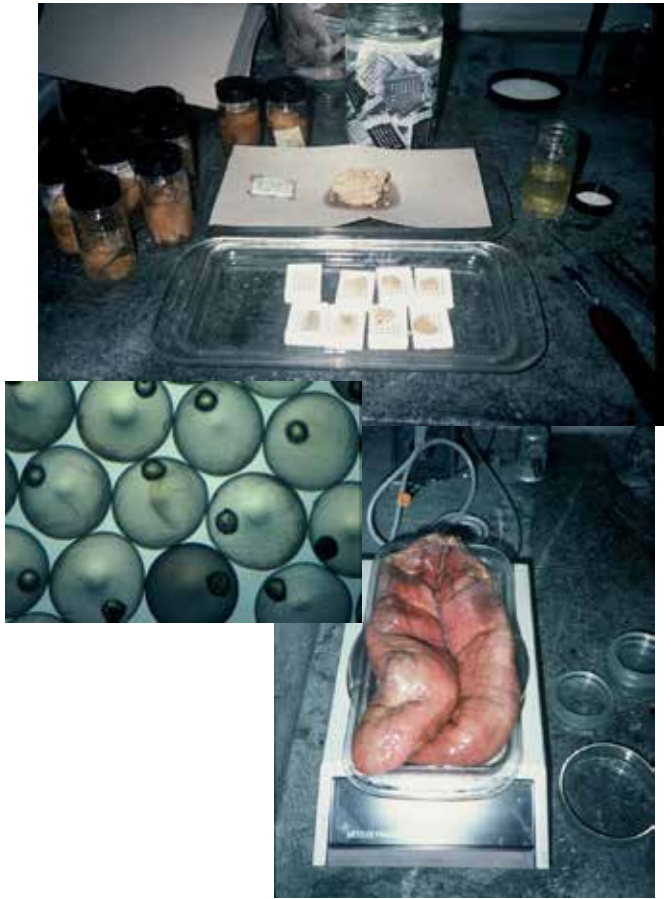


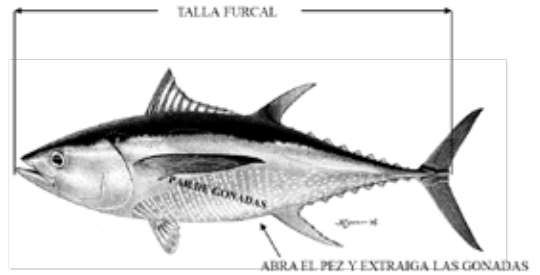

Photos from Project C.4.b. Long-term sampling Program for catches of sharks in artisanal fisheries in Central America

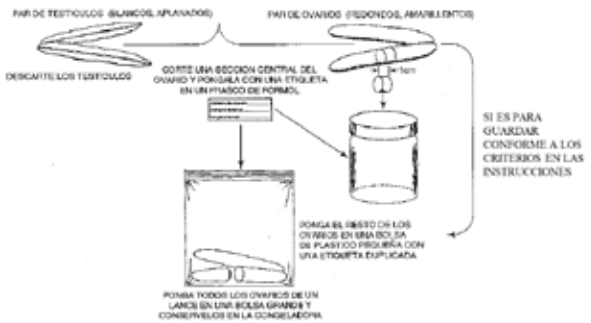
# Data gaps: Biological sampling

- Routine biological sampling is not conducted
- Routine sampling provides a means for monitoring fishing impacts
  - § decrease in YFT size at maturity (Schaefer and Fuller 2022; Schaefer 1998)
  - § such changes can impact productivity, subsequent stock status and management advice



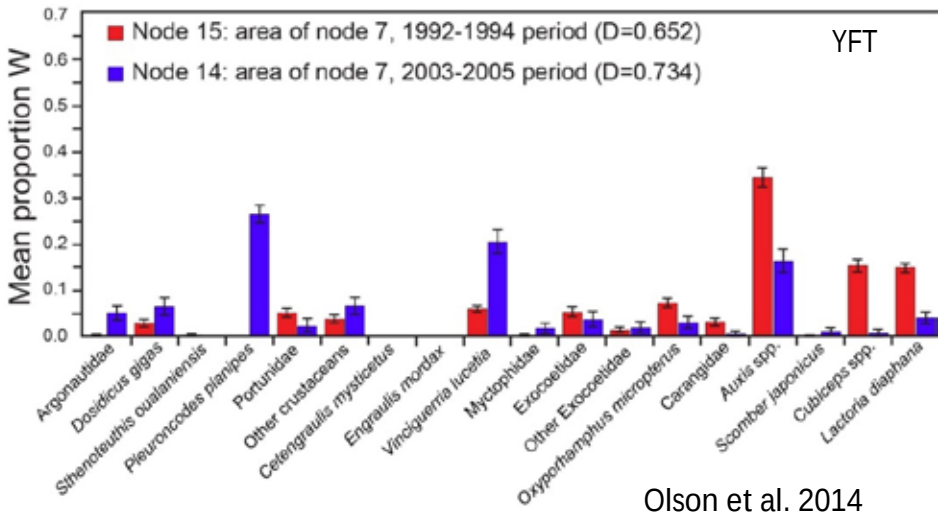





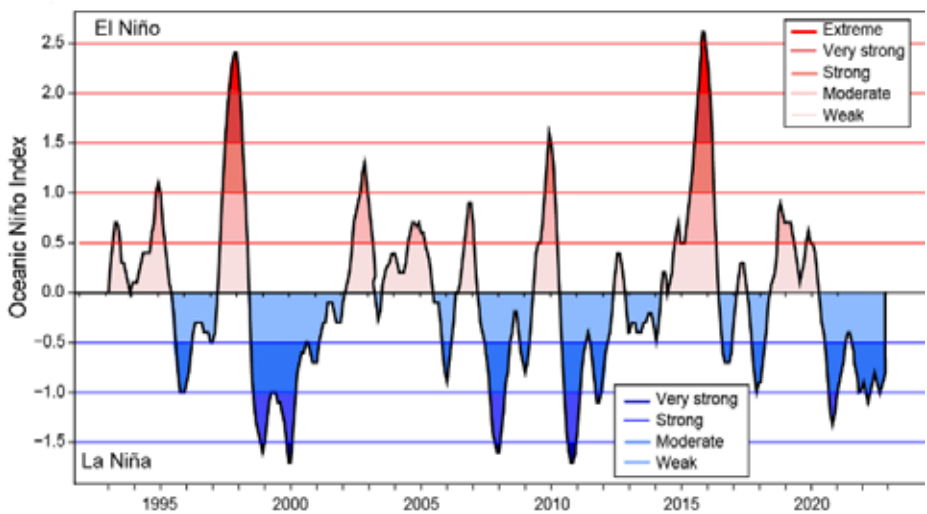



# Data gaps: Biological sampling

- Sampling has been limited to dedicated projects
  - § Miss changes in biological processes across dynamic conditions (e.g., ENSO events)
- Sampling has not kept pace with modern techniques
  - § e.g., tissue collection for genetic studies on stock structure and CKMR (sharks) SAC-12-14
- ETP ecosystem model based on antiquated stomach contents (1990s)
  - § ecological impacts include changes in feeding dynamics

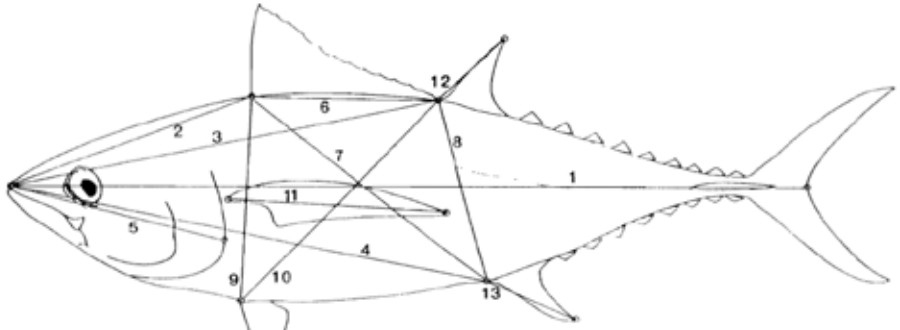



Olson et al. 2014



# Identification of sampling opportunities: Overview

- Size composition of catches varies by gear type
  - § aim to sample across gear and fleet types
  - § aim to maximize spatial range (coastal–offshore) & size distributions of fish (juveniles–adults)
- Propose hierarchical sampling approach
  - § feasibility study *(Phase 1)*
  - § pilot study *(Phase 2)*
  - § EPO-wide, statistically-robust sampling *(Phase 3)*
- Aim to collect different length and weight metrics on the same individuals
  - § allows for comprehensive database for development of conversions & to account for individual variability
- Opportunistically collect biological samples




Schaefer 1992, IATTC Bulletin Vol. 20, No.3

Enhanced Monitoring Program

# Identification of sampling opportunities: Feasibility study

| Phase 1 | Action | Outcome | Preliminary timeline | Collaborators |
|---|---|---|---|---|
| Feasibility (Part 1, planning) | Identify measurements to be taken and biological samples to be collected | List of morphological measurements (e.g., FL, TL, WW, GGW); List of biological samples (e.g., tissues, stomachs) | January–May 2024 | Stock assessment, Biology and life-history, Ecosystem and bycatch, and Data Programs; CPCs, fishing industry, SPC-WCPFC |
| | Identify priority species through literature review and meta-analysis | List of priority species to sample (e.g., silky sharks, hammerhead sharks) | | |
| | Design feasibility studies with sampling protocols for both PS and LL fisheries | Development of data collection forms and data/sample storage protocols | | |
| | Identify capacity building opportunities and potential collaborators | List of vessels to be used for sampling; List of external collaborators | | |
| | Identify storage opportunities for biological samples | List of potential storage facilities | | |
| | Preliminary design of a database for morphometric measurements and biological samples | Beta database structure developed | | |

# Identification of sampling opportunities: Feasibility study

| Phase 1 | Action | Outcome | Preliminary timeline | Collaborators |
|---|---|---|---|---|
| Feasibility (Part 2, implementation) | IATTC staff to execute feasibility studies aboard class 6 PS and coastal LL tuna fishing vessels | Evaluation of collected data and samples; Revision of sampling protocols prior to implementing pilot phase | June 2024–May 2025 | Stock assessment, Biology and life-history, Ecosystem and bycatch, and Data Programs; CPCs, fishing industry, SPC-WCPFC |
| | Pursue capacity building opportunities with potential collaborators within distant water LL fleets (in preparation for Phase 2, Pilot study) | List of potential distant-water LL fishing vessels for sampling | | |
| | Collaborate with statisticians to develop statistically robust sampling design for industrial fisheries (in preparation for Phase 2, Pilot study) | Development of sampling protocol for upscaling sampling to additional vessels in Phase 2, Pilot study | | |

# Identification of sampling opportunities: Pilot study

| Phase 2 | Action | Outcome | Preliminary timeline | Collaborators |
|---|---|---|---|---|
| Pilot sampling | Through collaborations, implement pilot study following lesson's learned and sampling design from Phase 1. Sample across all PS (i.e., class 1-6) vessels, coastal States LL tuna vessels, and distant-water LL vessels. Revise the sampling design as needed. Coordinate logistics for storing samples. | Development of sampling protocols for industrial fisheries; documentation of lesson's learned from Phase 1 and Phase 2 industrial fisheries. Compilation of a dataset to derive L-W relationships for tunas and prioritized species from industrial tuna fisheries; Collection and storage of biological samples (tissues, stomachs, gonads, otoliths, vertebrae) for tunas and priority species | June 2025–May 2026 | Stock assessment, Biology and life-history, Ecosystem and bycatch, and Data Programs; CPCs, fishing industry, SPC-WCPFC |
| | Pursue collaborations within coastal, multi-gear/multi-species fisheries; Work with statisticians to develop a sampling design for small coastal, multi-gear fisheries | Development of sampling protocols for coastal-multi-gear fisheries; documentation of lesson's learned from sampling these fisheries | | |
| | Implement sampling in small coastal fisheries. Revise the sampling design as needed. Coordinate logistics for storing samples. | Compilation of a data set to derive L-W relationships for tunas and prioritized species from coastal multi-gear fisheries; Collection and storage of biological samples (tissues, stomachs, gonads, otoliths, vertebrae) for tunas and priority species | | |

# Identification of sampling opportunities: EPO-wide study

| Phase 3 | Action | Outcome | Preliminary timeline | Collaborators |
|---|---|---|---|---|
| EPO-wide, statistically robust sampling | Expand sampling to additional vessels and areas across the EPO as is feasible. Continue sampling on PS class 1-6 vessels, coastal States LL tuna fisheries, distant-water LL fisheries, and coastal multi-gear fisheries | Collection of a robust data set to derive L-W relationships throughout the operational range of EPO fisheries. Store biological samples (tissues, stomachs, gonads, otoliths, vertebrae) for tunas and priority species. | January 2026–May 2030 | Stock assessment, Biology and life-history, Ecosystem and bycatch, and Data Programs; CPCs, fishing industry, SPC-WCPFC |
| Establishment of an EPO-wide morphometric and biological database for various fisheries | Analyze data; develop morphometric relationships and conversion factors. Process prioritized biological samples in-house and through collaborations | Development of EPO-wide database of morphometrics and biological data. Biological material storage. Publications of meta-data and morphometric relationships. Project-specific analysis of biological samples (e.g., stock assessments and ecological assessments) | January 2026–December 2030 | Stock assessment, Ecosystem and bycatch, Biology and life-history, and Data Programs |

# Final Considerations

- Success of the proposed sampling program predicated on collaborations, logistics and funding
- Therefore, staff has designed an iterative approach to the proposed project
  - § phased approach to upscaling sampling to additional vessels and areas
  - § biological sampling may occur opportunistically
  - § noting NOAA's Climate Prediction Center predicts transition to El Niño
- Project is complementary to others on data improvement
  - § e.g., SAC-12-09, WSDAT-01-01, WSDAT-01-Report, SAC-14 INF-M, SAC-14 INF-L



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# Questions

# PS sampling protocols: SPC-OFP 2021, GEN-4 Conversion Factor

## Weights and measurements collected

| DETAILS OF WEIGHTS AND MEASUREMENTS COLLECTED | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SET NO. | SHIP'S TIME | LABEL NO. | SPECIES CODE | LENGTHS (in cm.) | | | | | | WEIGHTS (in kg.) | | | | | PROCESSED WGT. | | LANDED WEIGHT | | COMMENTS |
| | | | | UF | US | LF | PF | PS | TL | WHOLE | HEAD | TAIL | GUTS | WET FIN | (kg.) | CODE | (kg.) | CODE | |
| | | | | | | | | | | | | | | | | | | | |
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