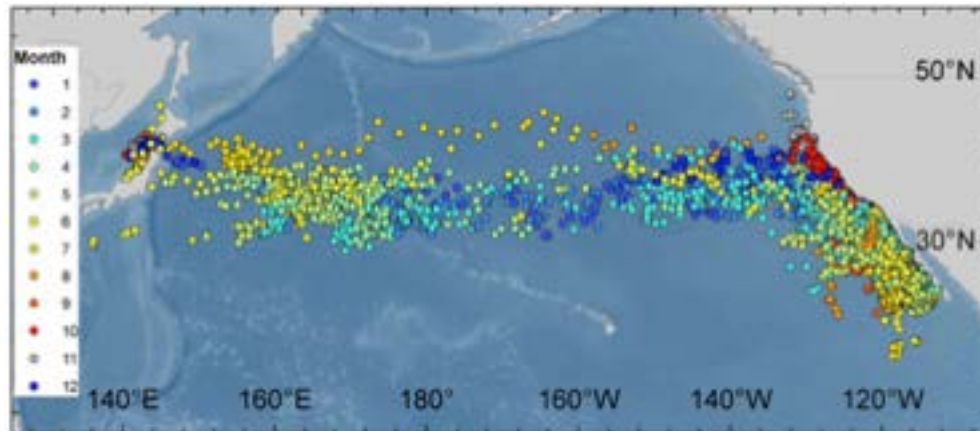# NMFS Report
SWFSC Activities
Highly Migratory Species

Gerard DiNardo
Director, Fisheries Resources Division

NOAA FISHERIES
Southwest Fisheries Science Center

Presentation Outline

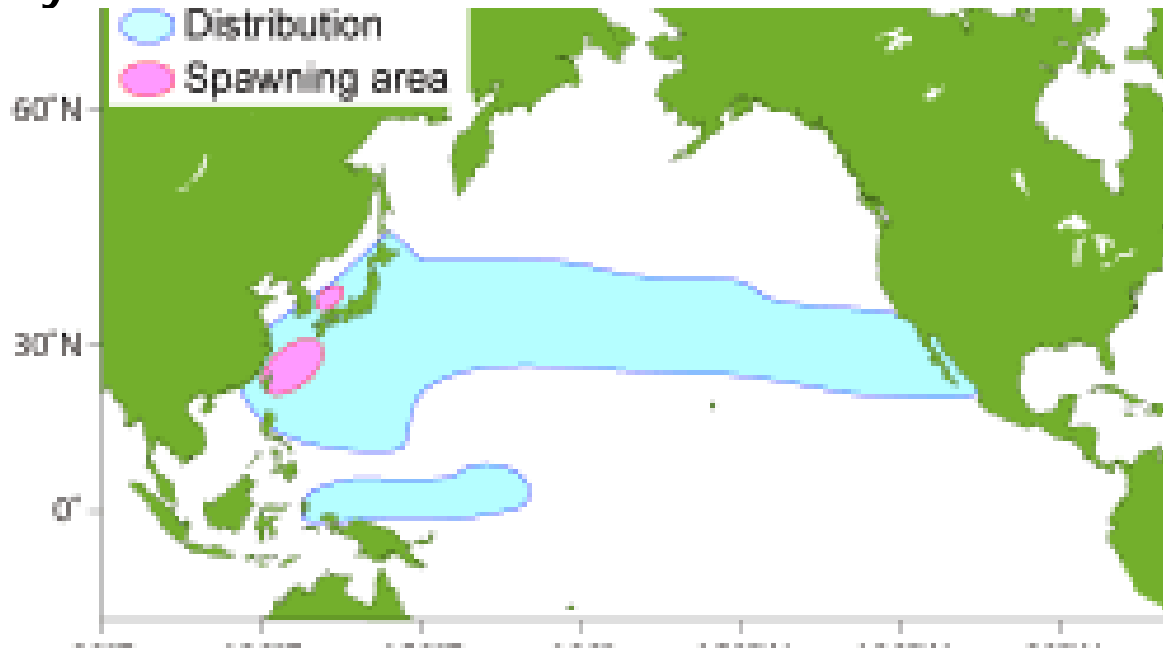- HMS Biological Research
- Stock Assessments
- Management Tools
- Collaborative Research Frameworks

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Highly Migratory Species Research

Pacific Bluefin Tuna
- Foraging ecology –
  - preferences
  - ecosystem changes
- Reproductive Biology
- Otolith microchemistry - movement
- Size Sampling - Rec
- Tagging
  - conventional
  - genetic
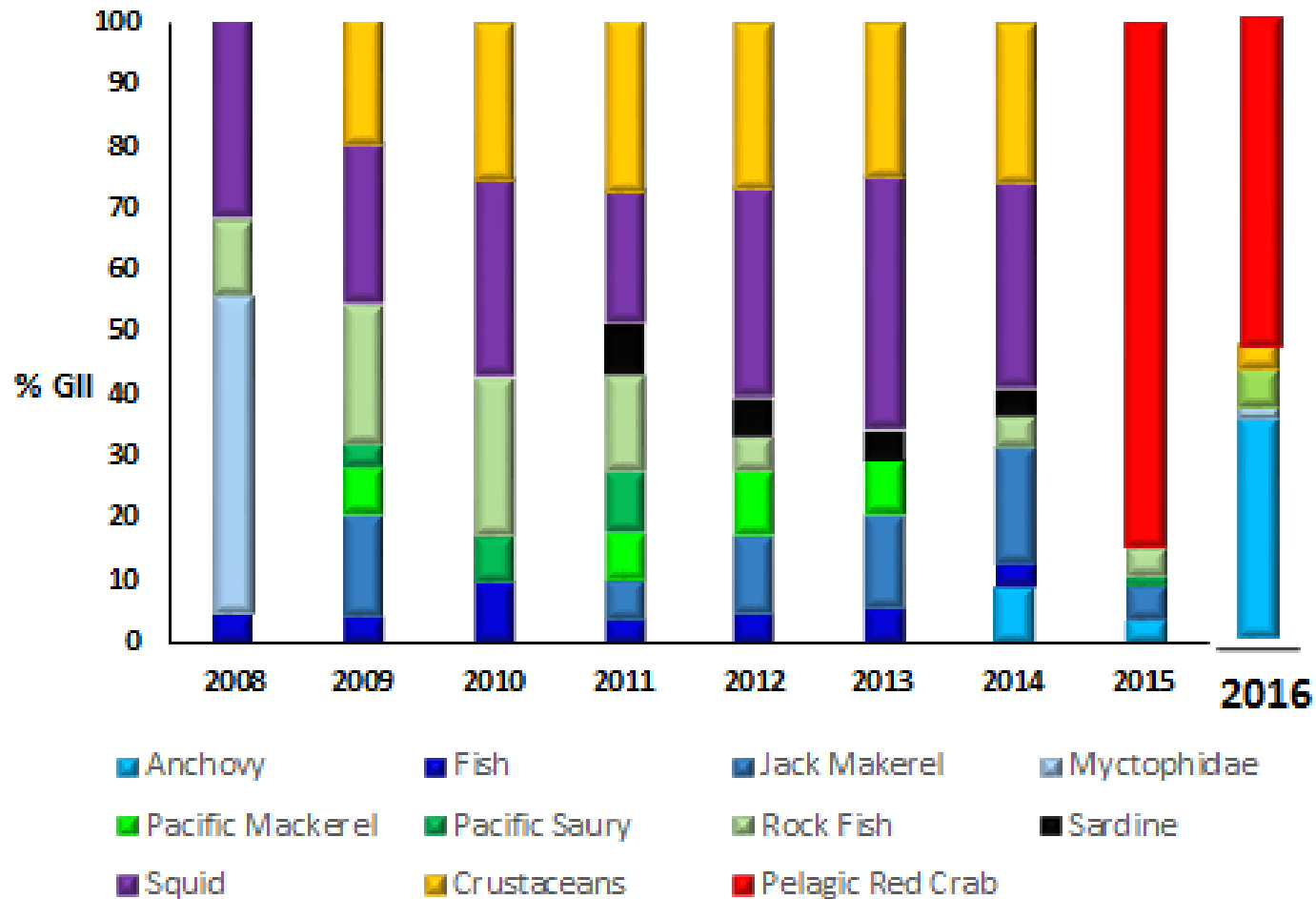- Recruitment Dynamics
- Population Modeling

Distribution
Spawning area

Bluefin Biological Sampling

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
PBT	0	75	78	54	189	294	171	156	120	276	1413

Provides data to support:

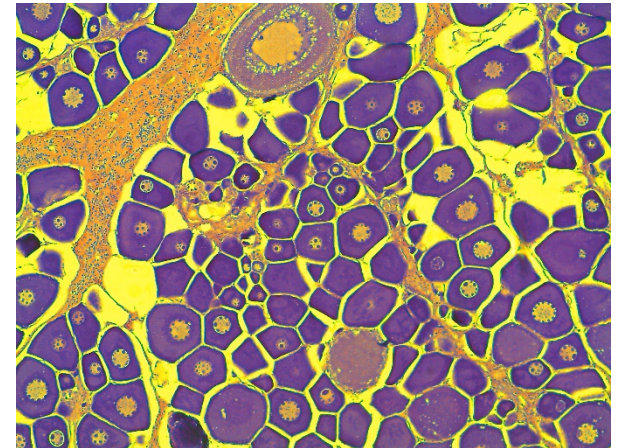- Foraging Ecology
- Reproductive Biology

Bluefin foraging ecology

PBF Reproductive Biology:
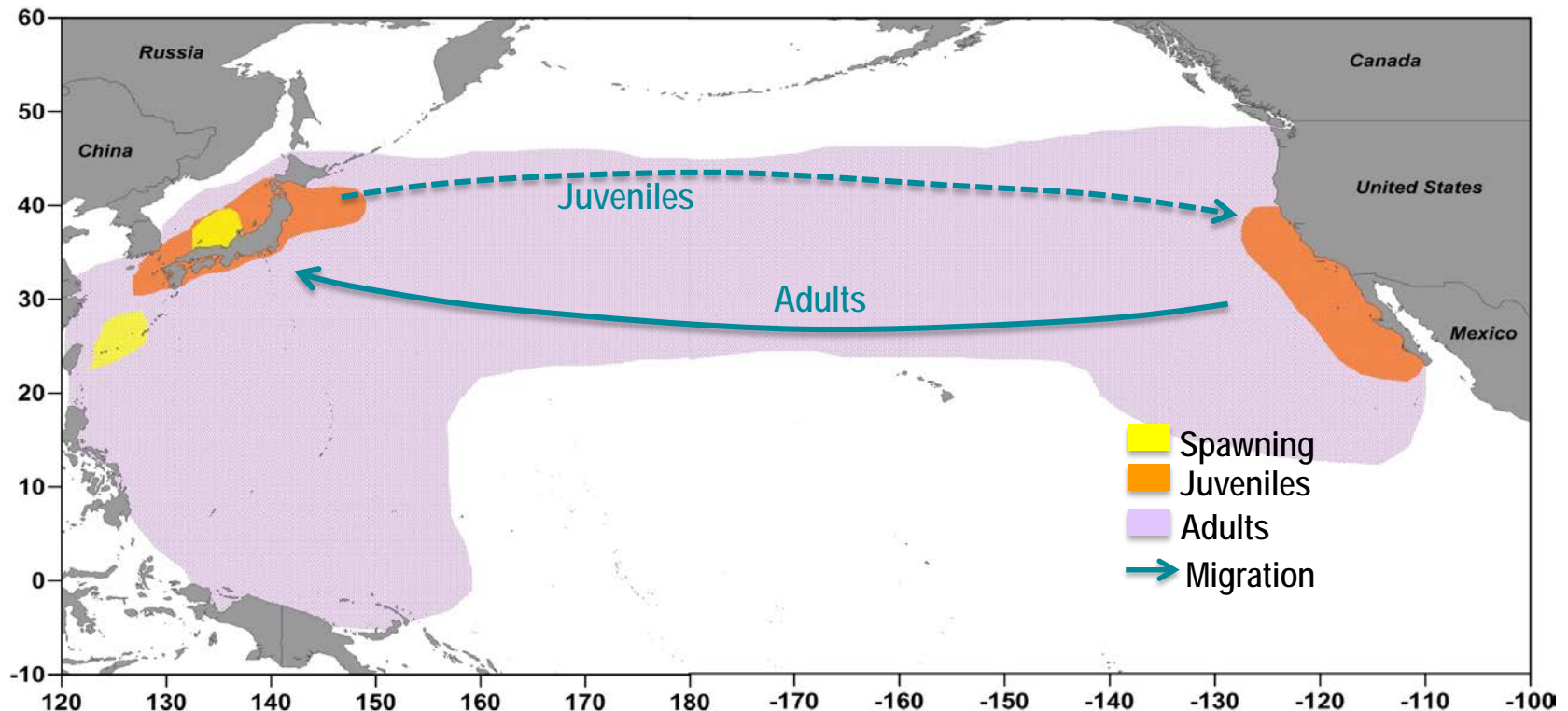# Are larger fish in the EPO Spawning?

- Samples sent out for histology
  - Females: N=11
  - Males: N=3
  - Length range: 134 to ~180 cm FL (~4-7 years old)
  - Weight range: 120-243 pounds

- Results:
  - Males: mature but inactive
  - Females: immature

PBF SWFSC-NRIFSF Joint Research
Chemical Tracers (Otoliths and Tissue)

Data Gaps

1. **What is the natal origin of fish in the EPO?**
2. **How and why does rate of movement to EPO change across years?**
3. **How are movements west linked to spawning grounds?**
4. **What is the relative contribution of eastern fish to spawning stock biomass?**

PBF Chemical Tracers: Preliminary Results of Otolith Stable Isotope Microchemistry

- Model results indicate correct classification success ranged from 80-90% each year, thus providing a proof of concept of the approach.

-In addition to trace elements, stable isotope analysis ($\delta^{18}O$ and $\delta^{13}C$) is underway on the same otoliths.
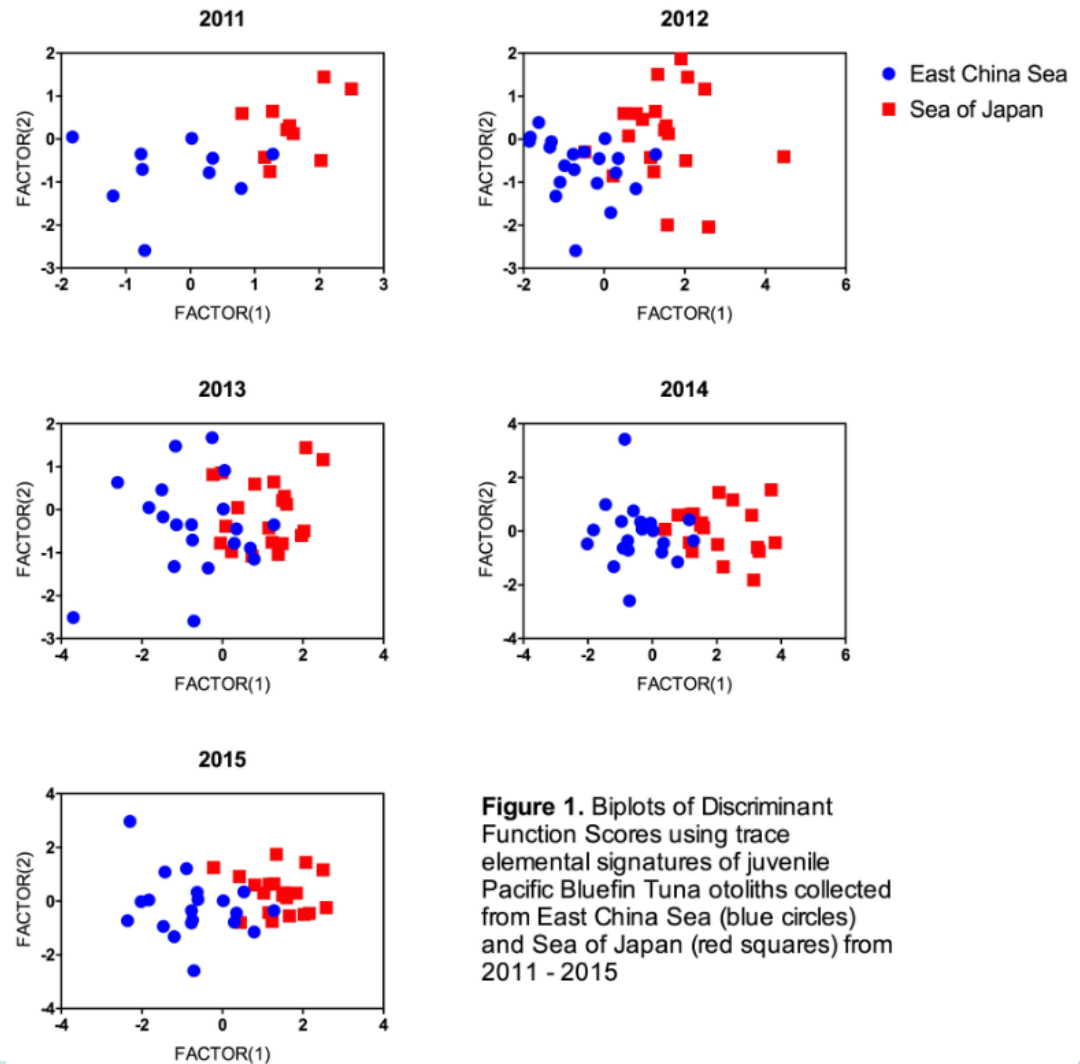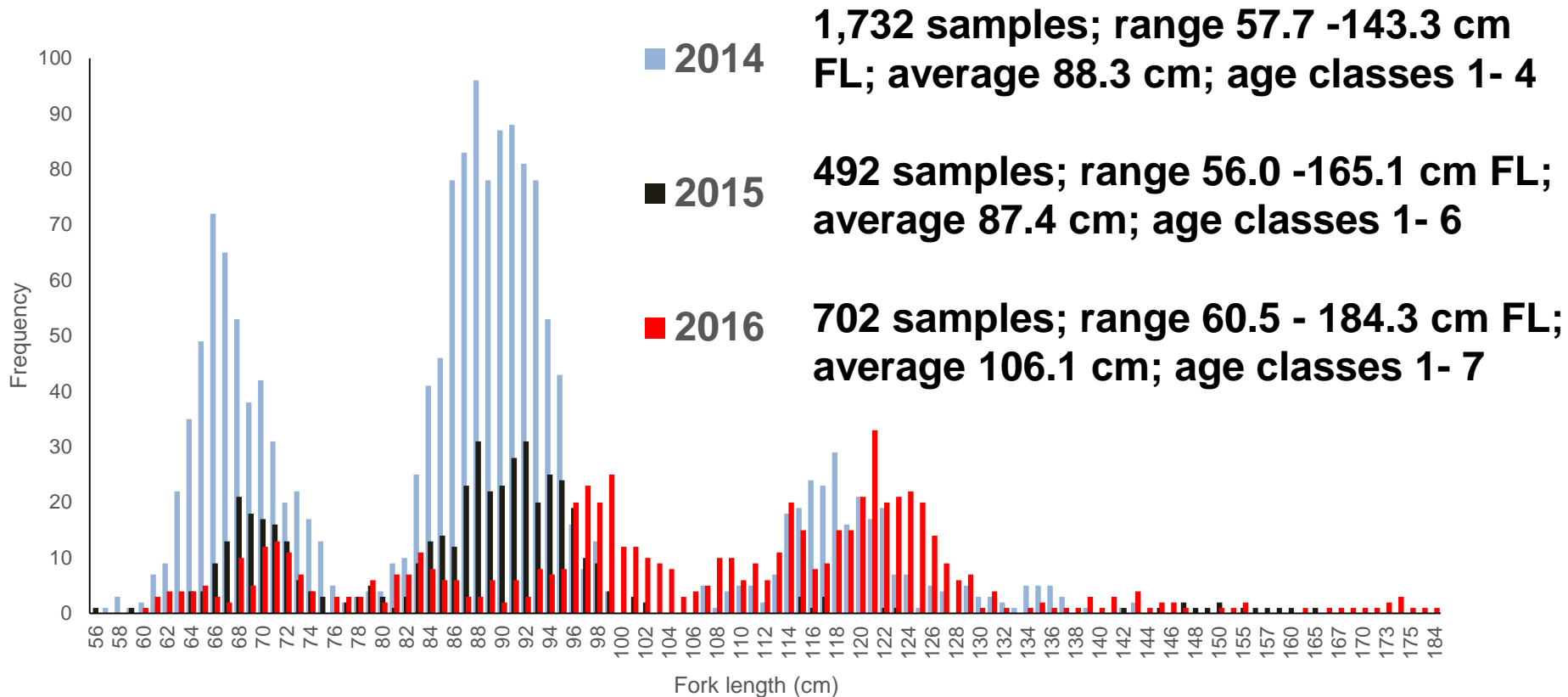

Figure 1. Biplots of Discriminant Function Scores using trace elemental signatures of juvenile Pacific Bluefin Tuna otoliths collected from East China Sea (blue circles) and Sea of Japan (red squares) from 2011 - 2015

Bluefin Recreational Catch Size Sampling

- 2,900 bluefin measured from long- and short-range CPFV trips
- In 2017 fish larger in size (up to 364 lbs) – data still being compiled

■ **2014** **1,732 samples; range 57.7 -143.3 cm FL; average 88.3 cm; age classes 1- 4**

■ **2015** **492 samples; range 56.0 -165.1 cm FL; average 87.4 cm; age classes 1- 6**

■ **2016** **702 samples; range 60.5 - 184.3 cm FL; average 106.1 cm; age classes 1- 7**
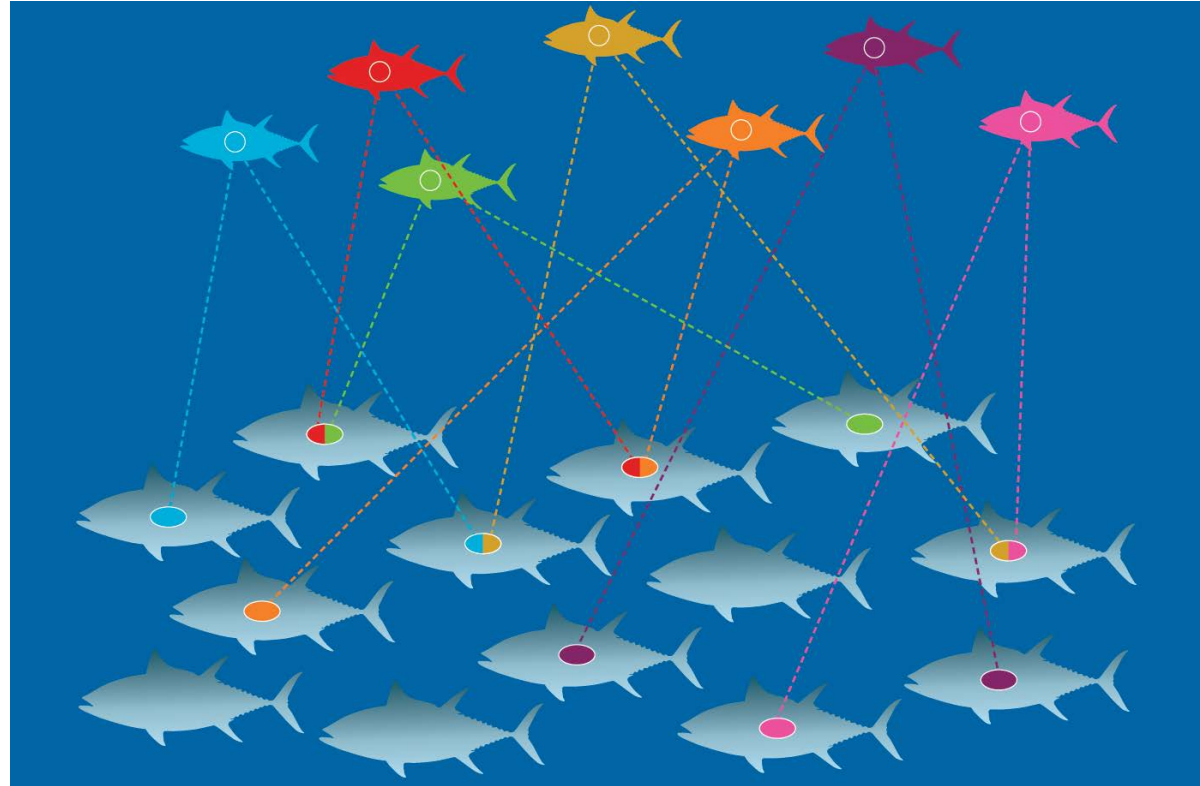
SAC is directing onboard collection of size data for all tunas. SWFSC scientists assisted with the size sampling protocols and is helping to verify data through independent observations.

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PBF Tagging - Close Kin Analysis (genetic tagging)
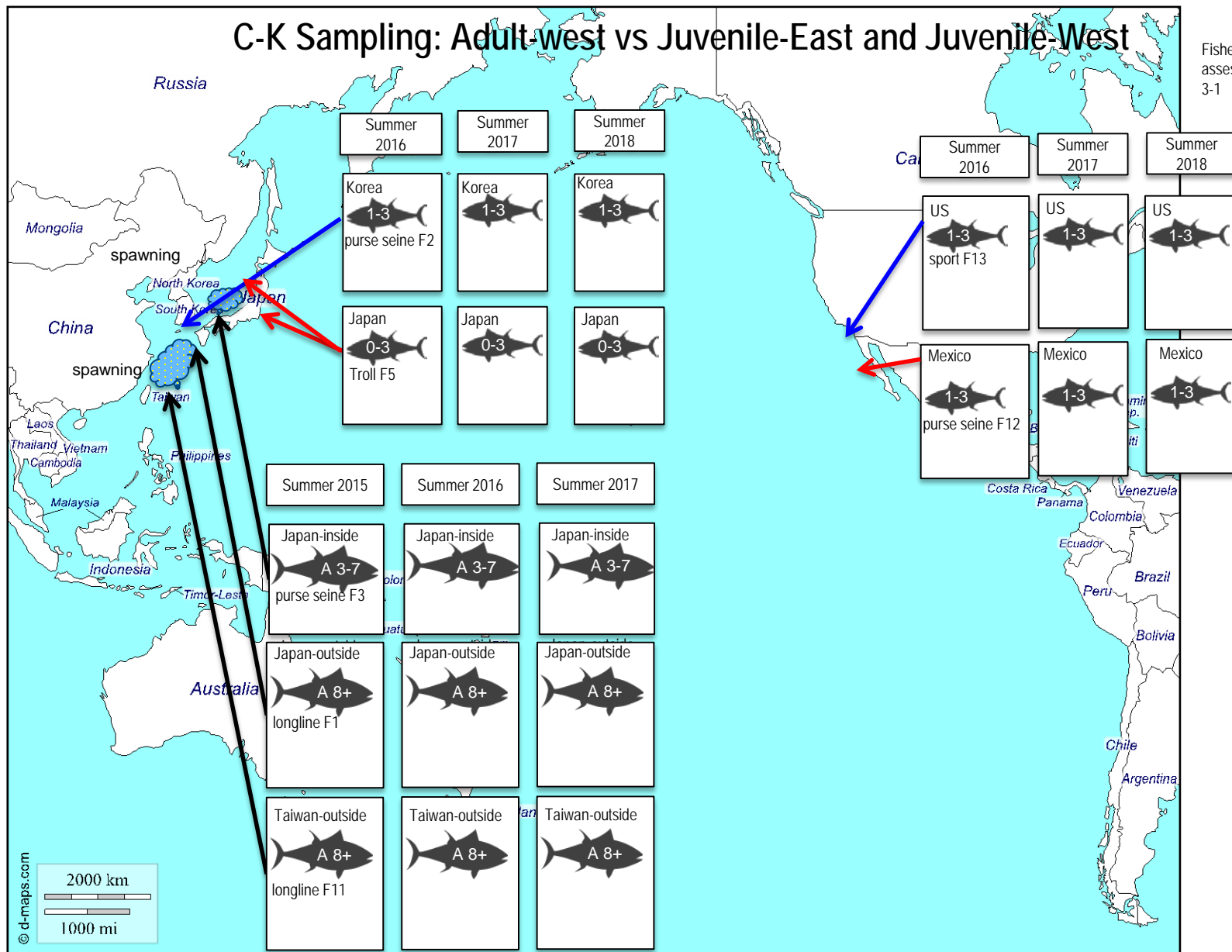
Background

- ISC15 (July 2015)
    - Independent estimate of SSB
    - Support close kin research
    - Decision to collect samples
    - Members process tissue samples (capacity building)

Schematic of parent-offspring pair (POP) relationships. Juveniles are shown in various colors at the top, and lines to larger fish represent parent-offspring connections.

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C-K Sampling: Adult-west vs Juvenile-East and Juvenile-West

Fishery Designations from 2014 assessment ISC web site Table 3-1

Summer 2016	Summer 2017	Summer 2018
Korea 1-3 purse seine F2	Korea 1-3	Korea 1-3
Japan 0-3 Troll F5	Japan 0-3	Japan 0-3

Summer 2016	Summer 2017	Summer 2018
US 1-3 sport F13	US 1-3	US 1-3
Mexico 1-3 purse seine F12	Mexico 1-3	Mexico 1-3

Summer 2015	Summer 2016	Summer 2017
Japan-inside A 3-7 purse seine F3	Japan-inside A 3-7	Japan-inside A 3-7
Japan-outside A 8+ longline F1	Japan-outside A 8+	Japan-outside A 8+
Taiwan-outside A 8+ longline F11	Taiwan-outside A 8+	Taiwan-outside A 8+

spawning

spawning

2000 km

1000 mi

© d-maps.com

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PBF Tagging - Close Kin Sample Sizes & Status (as of 2017)

Required PBF Sample Numbers:

1. East Pacific (Mexico-F12, USA-F13) – 1300 individuals from 1-3 years old. (USA: N=1100 fish)
 2. West Pacific (Japan-F5, Japan and Korea-F2) – 1300 individuals from 1-3 years old. (Korea: N=723)
3. West Pacific (Japan-F5) – 1300 individuals from age class zero (N=1000)
4. West Pacific (Taiwan-F11) – **740 individuals ≥4 years** old (N=1500)
5. West Pacific (Japan-F1) – **1480 individuals ≥4 years** old (N=350)
6. Sea of Japan (Japan-F3) – **1680 individuals ≥4 years** old (N=500)

-- Presently All Requested Samples Have Been Collected
-- Fall 2018 Workshop to Identify Tissue Processing Protocols

Opah Research

Current Efforts: Opah Landings to the U.S. West Coast are increasing, yet there is a lot about their biology we do not understand:

1) Stock structure
2) Age and growth
3) Reproductive Biology
4) Habitat use/ Foraging ecology

To fill these data gaps we are initiated a tagging program and are working with Catalina Offshore Products to obtain samples.

Opah Research

Results and ongoing work: 2017

Life history
- Stomachs: Diverse diet in the CA current including epipelagic and mesopelagic forage species
- Gonads: all samples appear immature off CA
- Hard parts: Ageing method needs to be determined
- Data mining - size composition in different fisheries

Stock structure and abundance
- PAT tagging: 13 tags deployed (2011-2014) and being analyzed

Speciation
- How many species? – recent genetic research
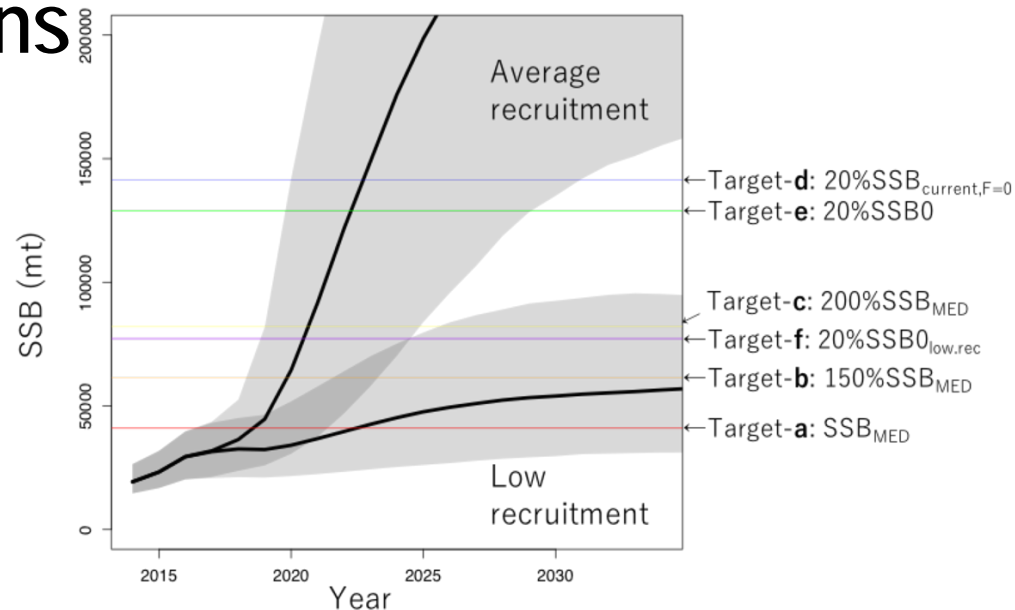
Stock Assessments

ISC Conducted 3 HMS Assessments (2017-2018)

- Pacific Bluefin Tuna – Update Assessment (July 2018) – no change in status ---- series of increased catch projections

- W-CPO Swordfish stock – Benchmark Assessment (July 2018) – not overfished; not experiencing overfishing

- Shortfin Mako Shark – Benchmark Assessment (July 2018) – not overfished; not experiencing overfishing
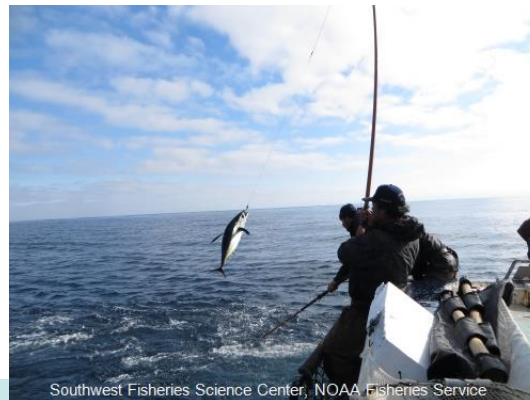
BRP have yet to be established

Management Tools

- ISC Tasks:
  - Management Strategy Evaluations
    - North Pacific Albacore Tuna
    - Pacific Bluefin Tuna
  - Population Projections
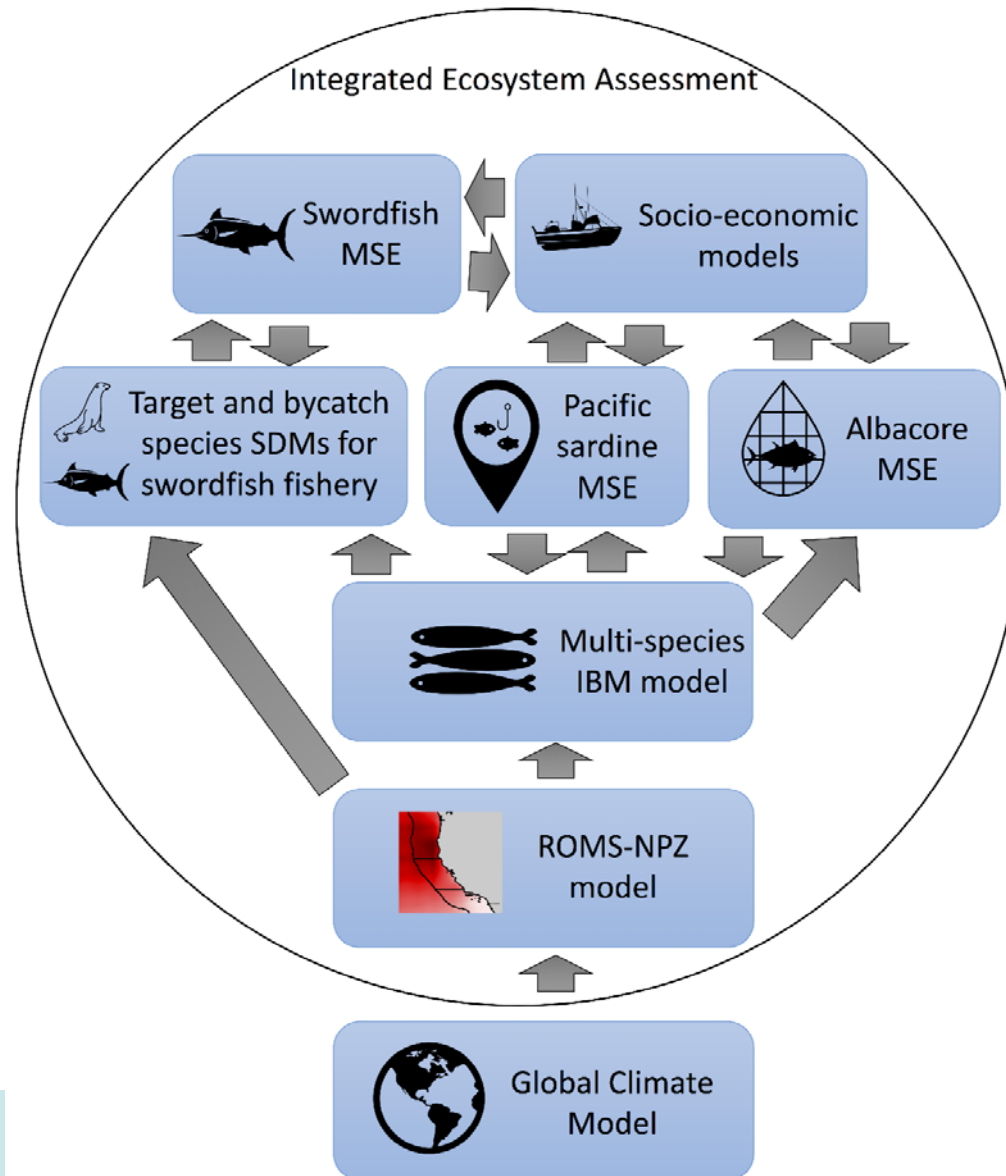 - BRP – HCR
- CCLME
  - Ecosystem MSE

From Physics to Fisheries: A Social-Ecological Management Strategy Evaluation for the California Current Large Marine Ecosystem
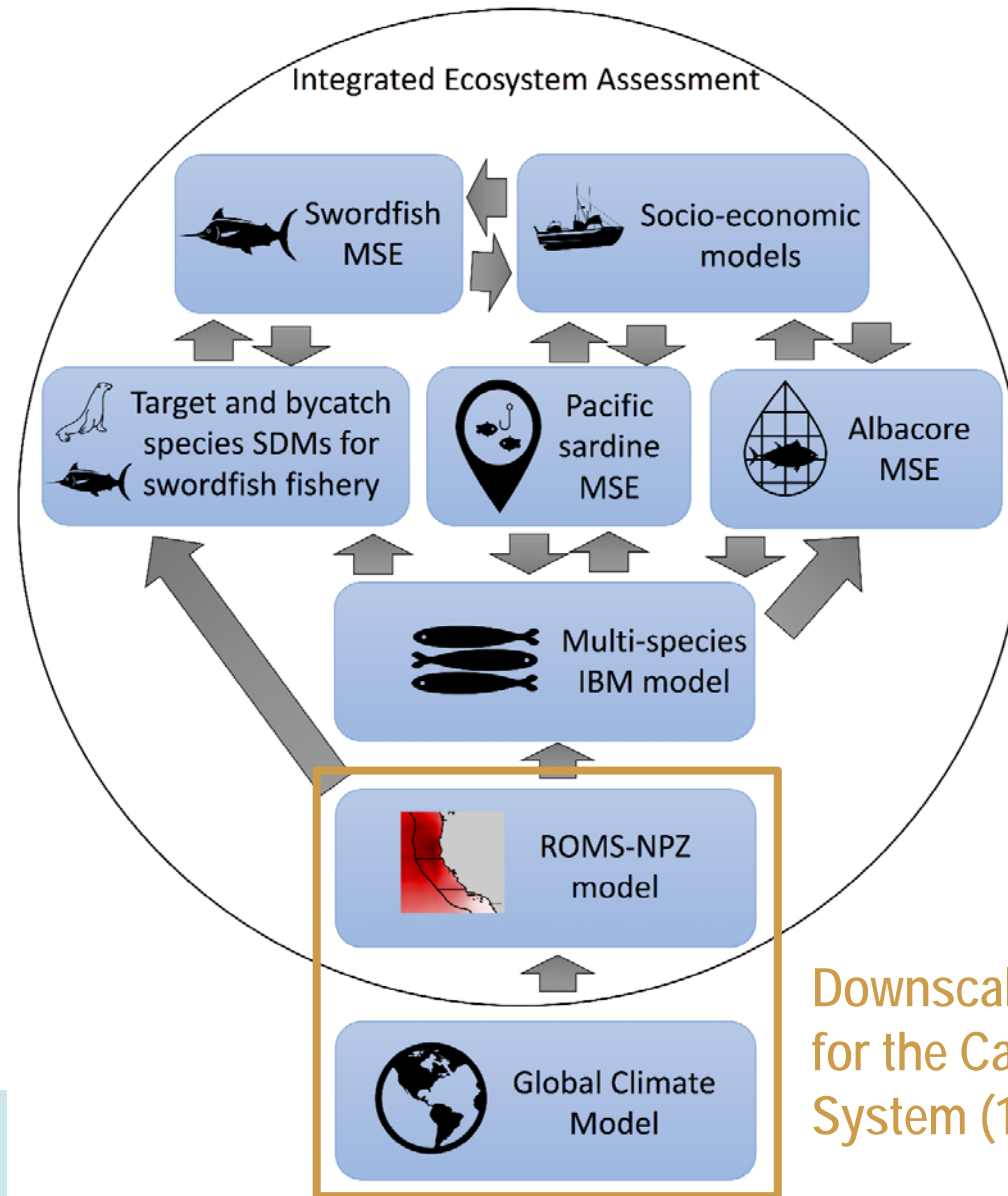
- Develop an end-to-end framework to identify climate-resilient management strategies for the California Current ecosystem

- Evaluate the impacts of climate change on US-managed marine species and fishing communities

- Focus on Pacific sardine, albacore, swordfish, and protected species

Southwest Fisheries Science Center, NOAA Fisheries Service

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From Physics to Fisheries: A Social-Ecological Management Strategy Evaluation for the California Current Large Marine Ecosystem

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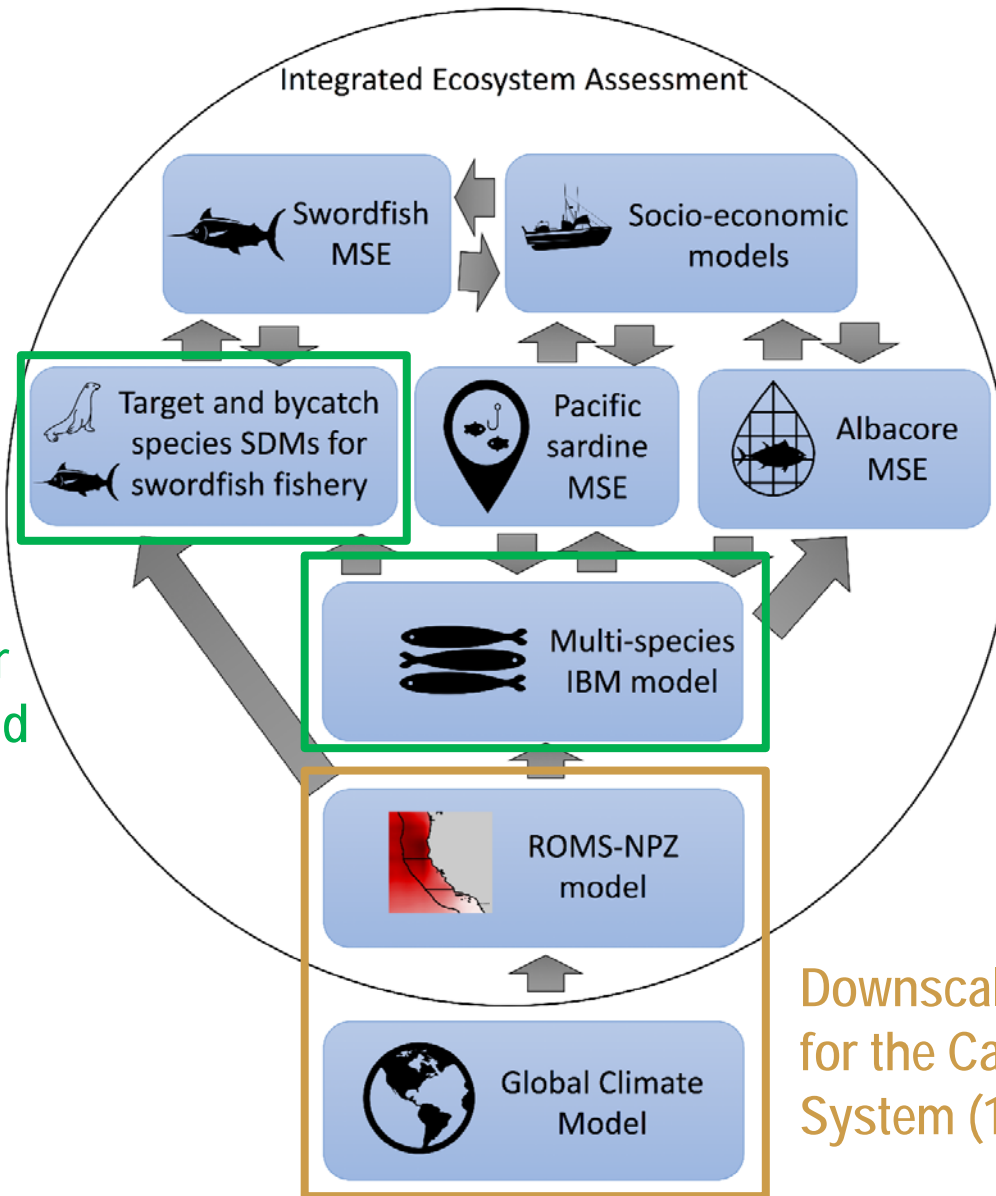Integrated Ecosystem Assessment

Swordfish MSE

Socio-economic models

Target and bycatch species SDMs for swordfish fishery

Pacific sardine MSE

Albacore MSE

Multi-species IBM model
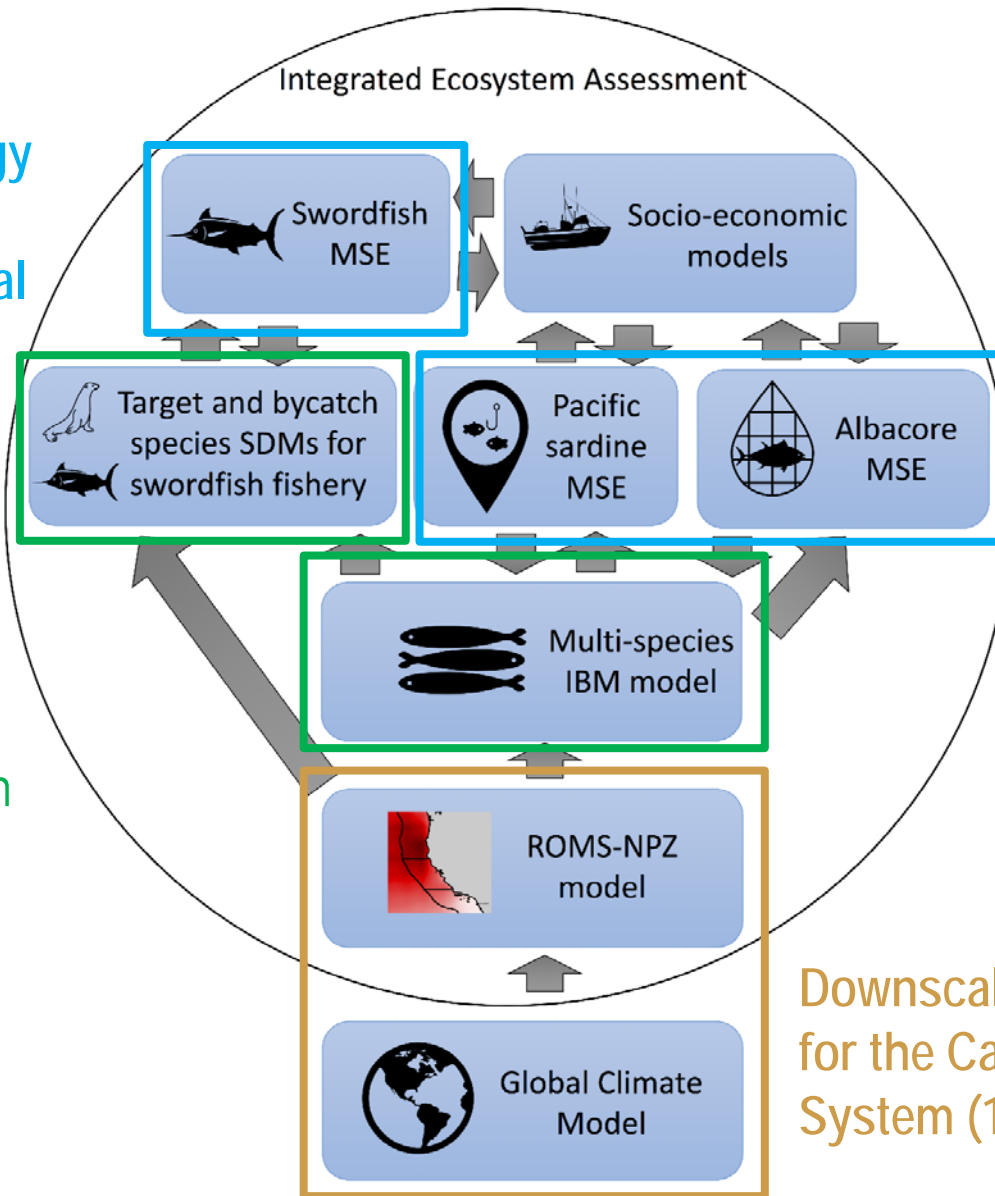
ROMS-NPZ model

Global Climate Model

Biological Models for sardine, albacore, and swordfish, and bycatch species

Downscaled Ocean Projections for the California Current System (1980 – 2100)

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From Physics to Fisheries: A Social-Ecological Management Strategy Evaluation for the California Current Large Marine Ecosystem

From Physics to Fisheries: A Social-Ecological Management Strategy Evaluation for the California Current Large Marine Ecosystem

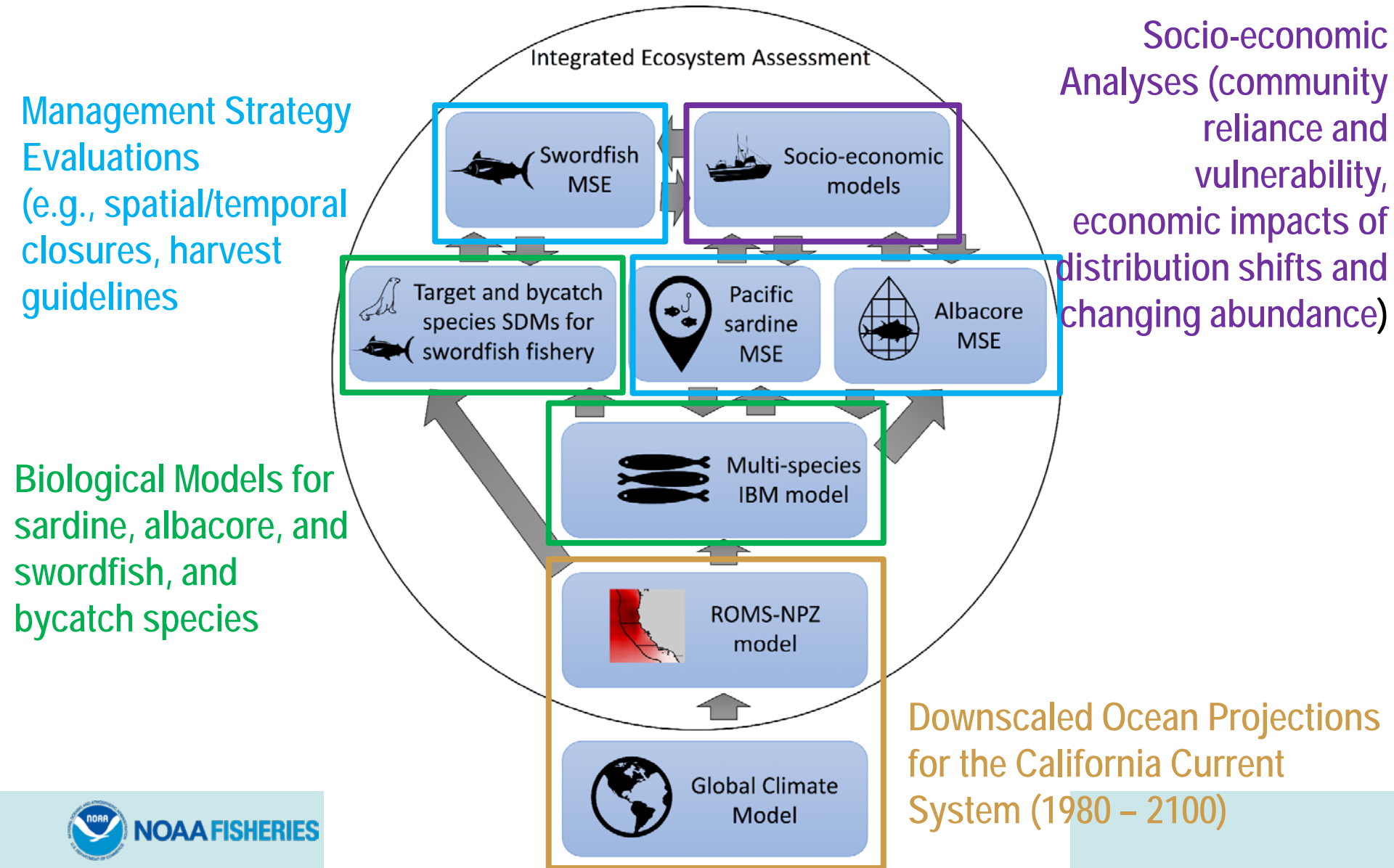**Management Strategy Evaluations** (e.g., spatial/temporal closures, harvest guidelines)

Socio-economic Analyses (community reliance and vulnerability, economic impacts of distribution shifts and changing abundance)

Biological Models for sardine, albacore, and swordfish, and bycatch species

Downscaled Ocean Projections for the California Current System (1980 – 2100)

Integrated Ecosystem Assessment

- Swordfish MSE
- Socio-economic models
- Target and bycatch species SDMs for swordfish fishery
- Pacific sardine MSE
- Albacore MSE
- Multi-species IBM model
- ROMS-NPZ model
- Global Climate Model

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Collaborative Research Frameworks

MEMORANDUM OF UNDERSTANDING
ON COOPERATION ON RESEARCH BETWEEN THE NATIONAL MARINE
FISHERIES SERVICE OF THE UNITED STATES OF AMERICA AND THE JAPAN
FISHERIES RESEARCH AND EDUCATION AGENCY – April 2017

Seeks to encourage and support scientific cooperation in five topic areas:

1. Joint sponsorship of workshops or symposia on the scientific assessment of living marine resources of the northern hemisphere and aquaculture
2. Exchange of expertise and information
3. Extended visits of scientists
4. Cooperative research on common scientific issues and methodological problems
5. Coordination and planning

Taiwan and China agreements - Planning stages

Thank You

Questions?