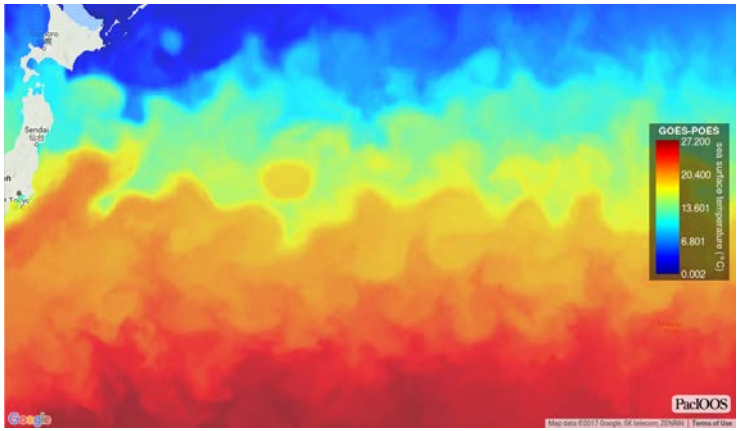
The North Pacific Transition Zone: A research and management retrospective



Jeffrey Polovina

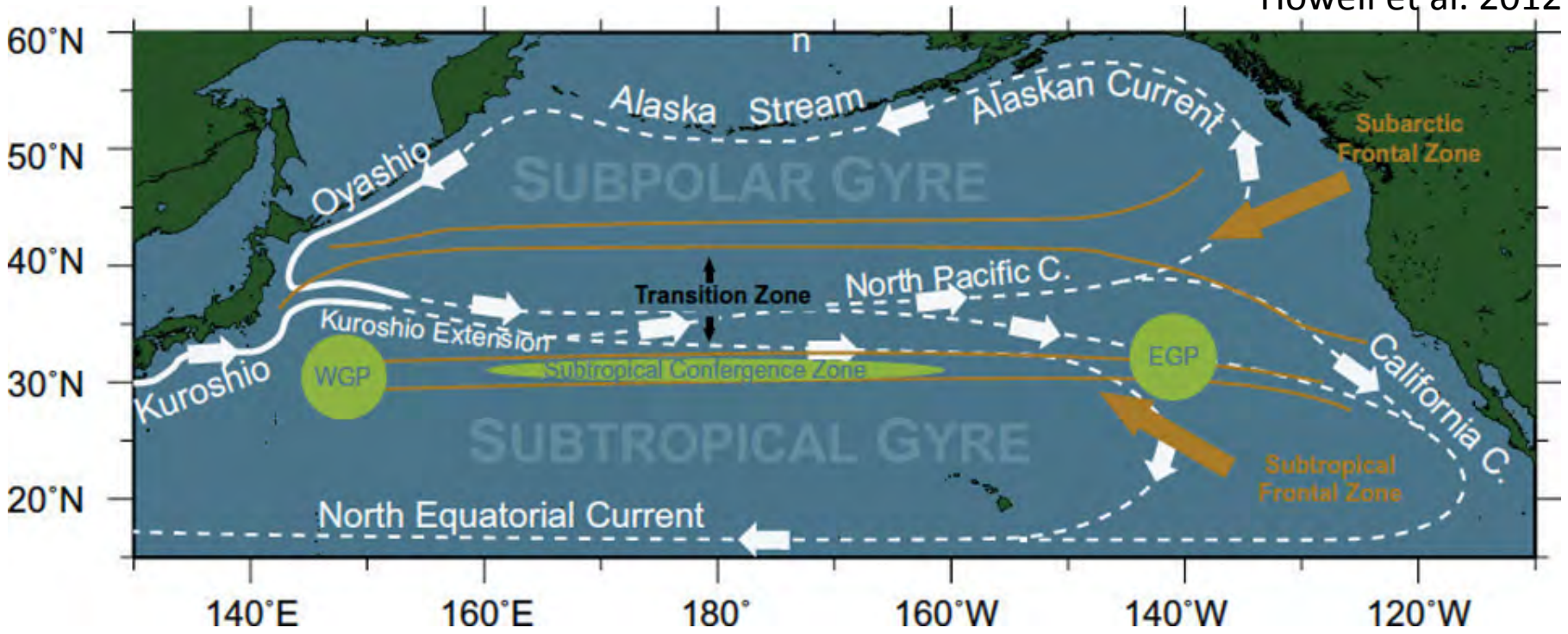
Scientist Emeritus

Pacific Islands Fisheries Science Center

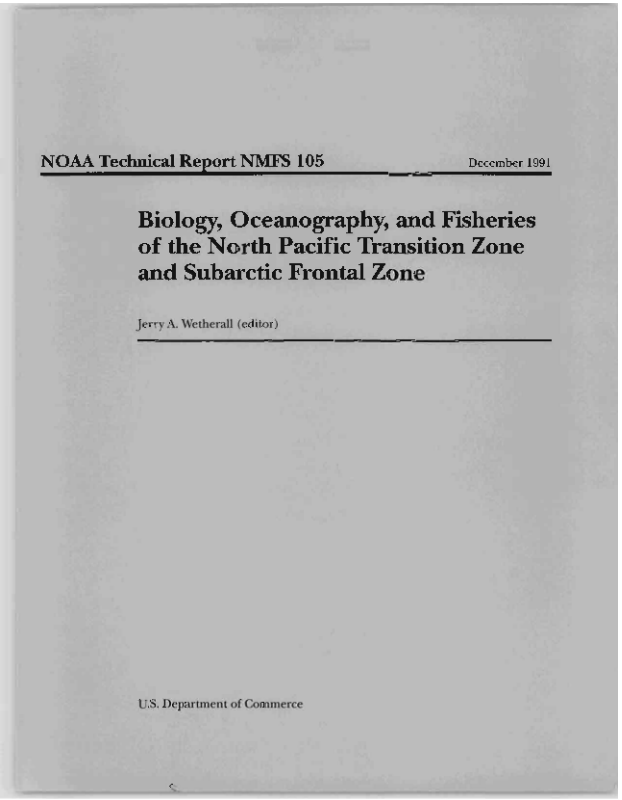
NOAA

North Pacific Transition Zone

Howell et al. 2012



North Pacific Transition Zone Workshop, May 9-11, 1988 Honolulu, HI



Oceanographically strong salinity and temperature gradients resulting in multiple fronts-Roden

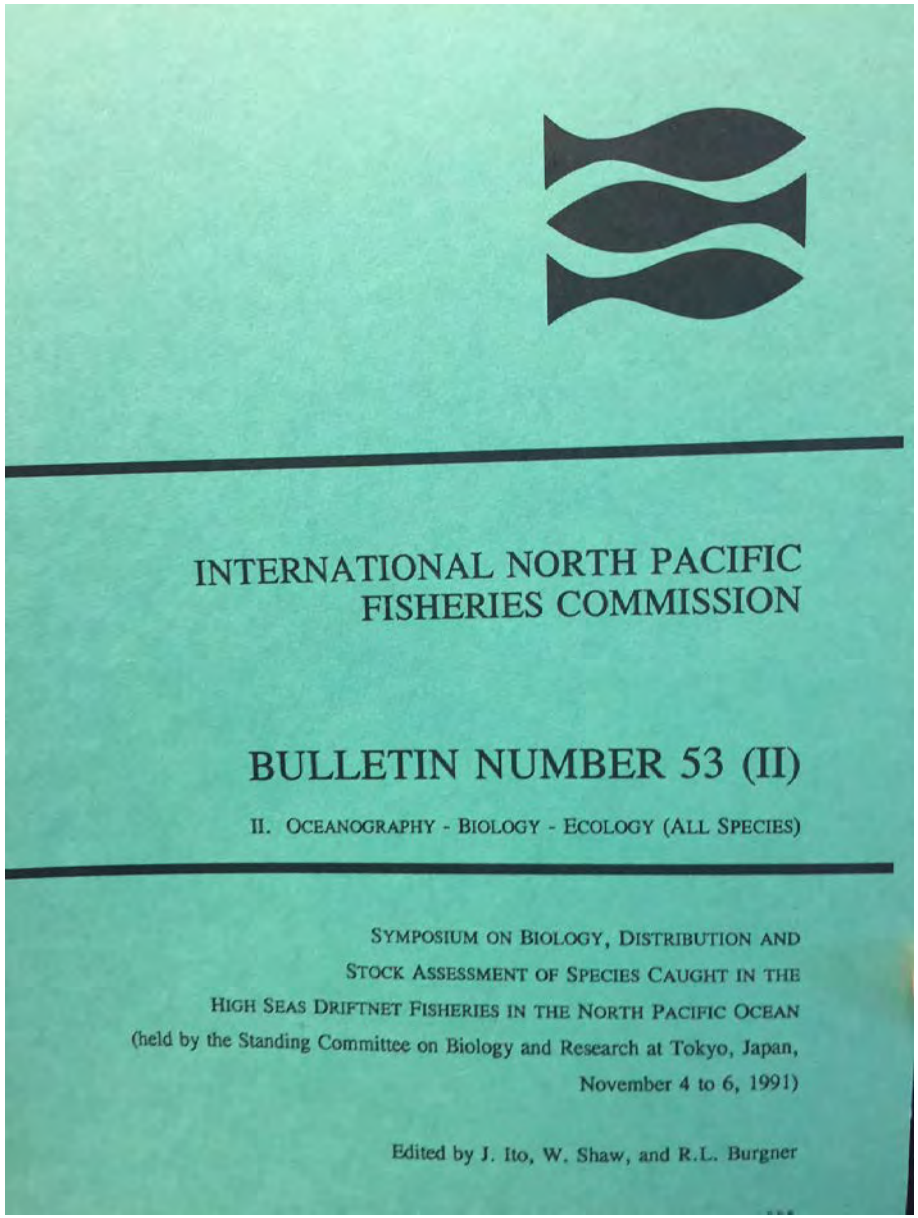
Represents northern range of subtropical species and southern range of subarctic species-Pearcy

Review the ecology and driftnet fisheries for squids, salmon, and albacore tuna – Sinclair, Ignell, Laurs, Lynn

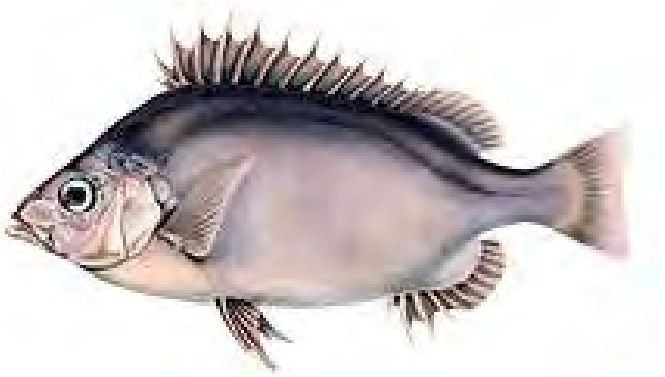
November 4-6, 1991 Symposium on the Biology, Distribution, and Stock Assessment of Species caught in the High Seas Driftnet Fisheries in the North Pacific Ocean

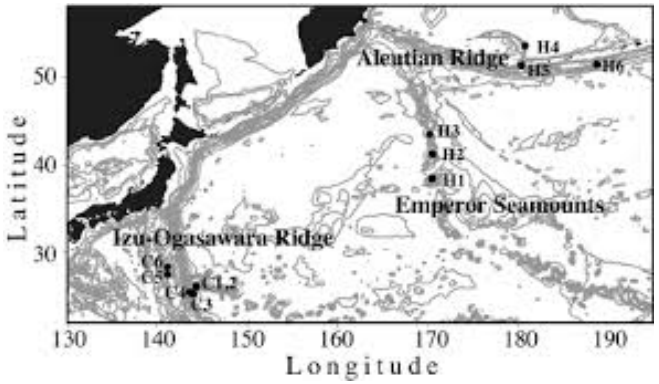
Brought together a wealth of fisheries observer and research data on the Driftnet Fishery and the NPTZ ecosystem and planned future research to address fisheries impacts on both target species and bycatch

United Nations Moratorium on large scale pelagic driftnet fishing December 31, 1992



NPTZ as spawning habitat- Pelagic Armorhead (*Pentaceros wheeleri)*

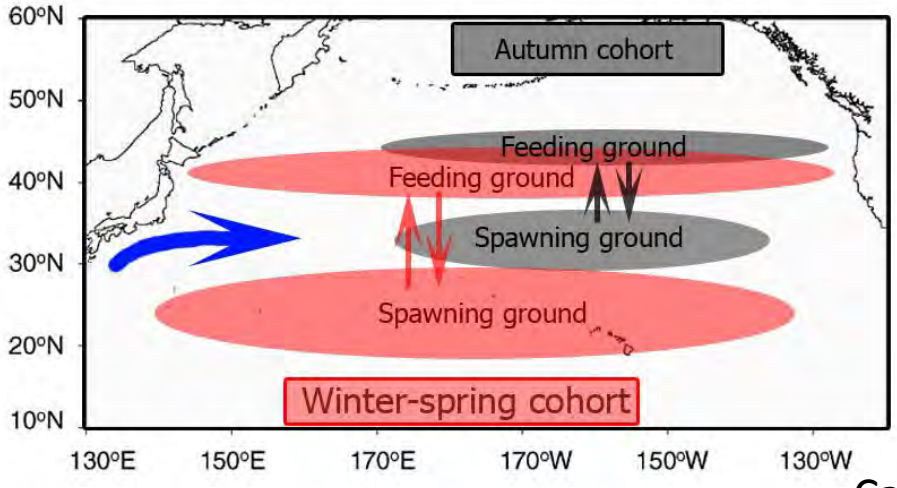




Spawns in NPTZ on the southern Emperor Seamounts and Northern Hawaiian ridge seamount. Juveniles forage in the subarctic gyre (Gulf of Alaska) for 1.5-2.0 years before recruiting back to the seamounts for spawning.

Trawlers fished the seamounts removing about 900,000mt between 1969-1984 leaving the stock depleted. (Boehlert and Sasaki. 1998. *Fish. Bull*.86:3)

NPTZ as forage habitat- Neon flying squid (Ommastrephes bartramii)

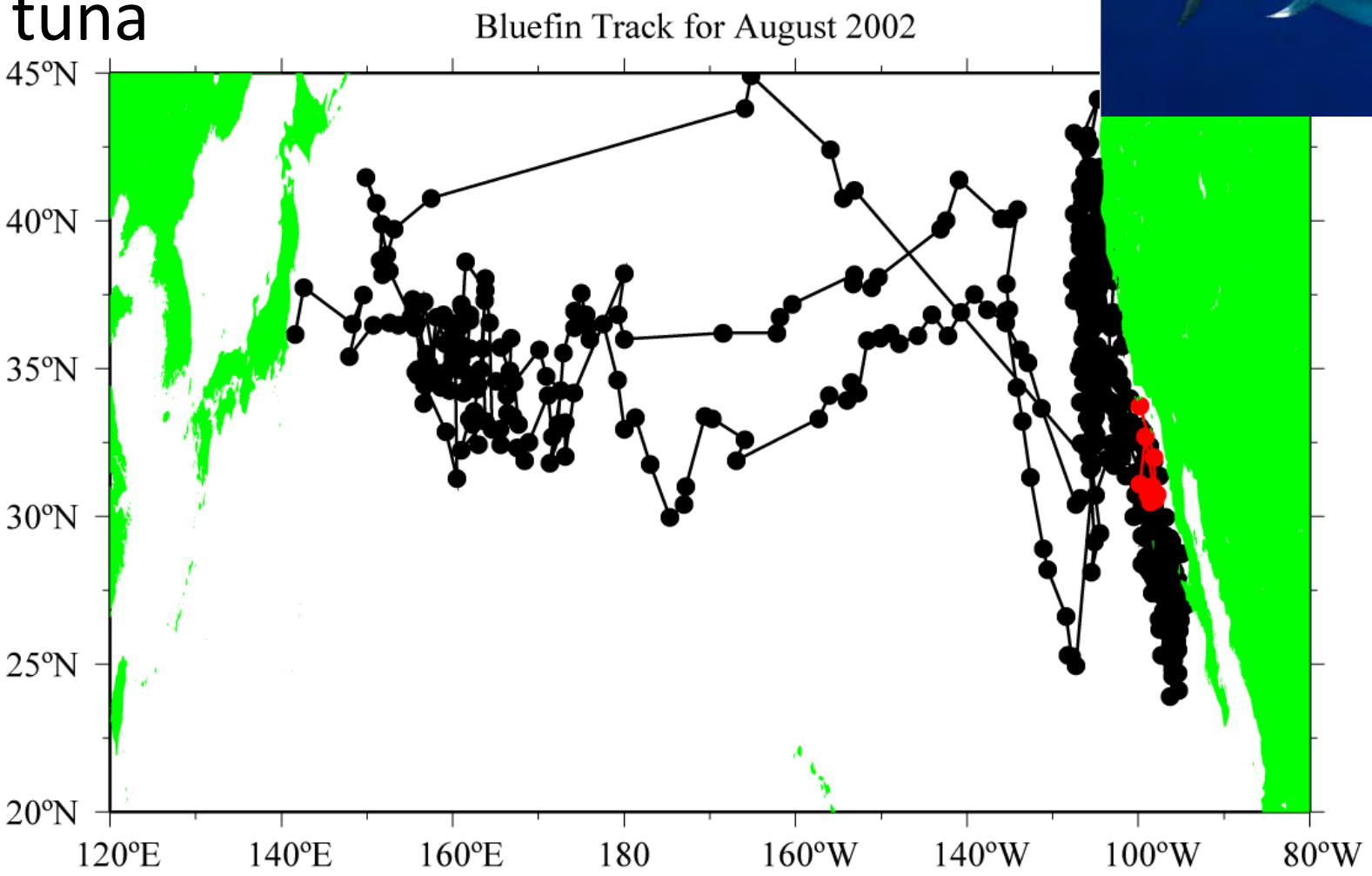


four stocks: (1) central stock of the fall cohort, (2) west stock of the fall cohort, (3) west stock of the winter–spring cohort, and (4) central-east stock of the winter–spring cohort.

Catches exceeding 350,000 mt during driftnet fishery 1978-1992, now caught by jig boats with catch <50,000 mt

Ichii, Taro, et al. “Life History of the Neon Flying Squid: Effect of the Oceanographic Regime in the North Pacific Ocean.” Marine Ecology Progress Series, vol. 378, 2009, pp. 1–11. JSTOR, JSTOR, www.jstor.org/stable/24873046.

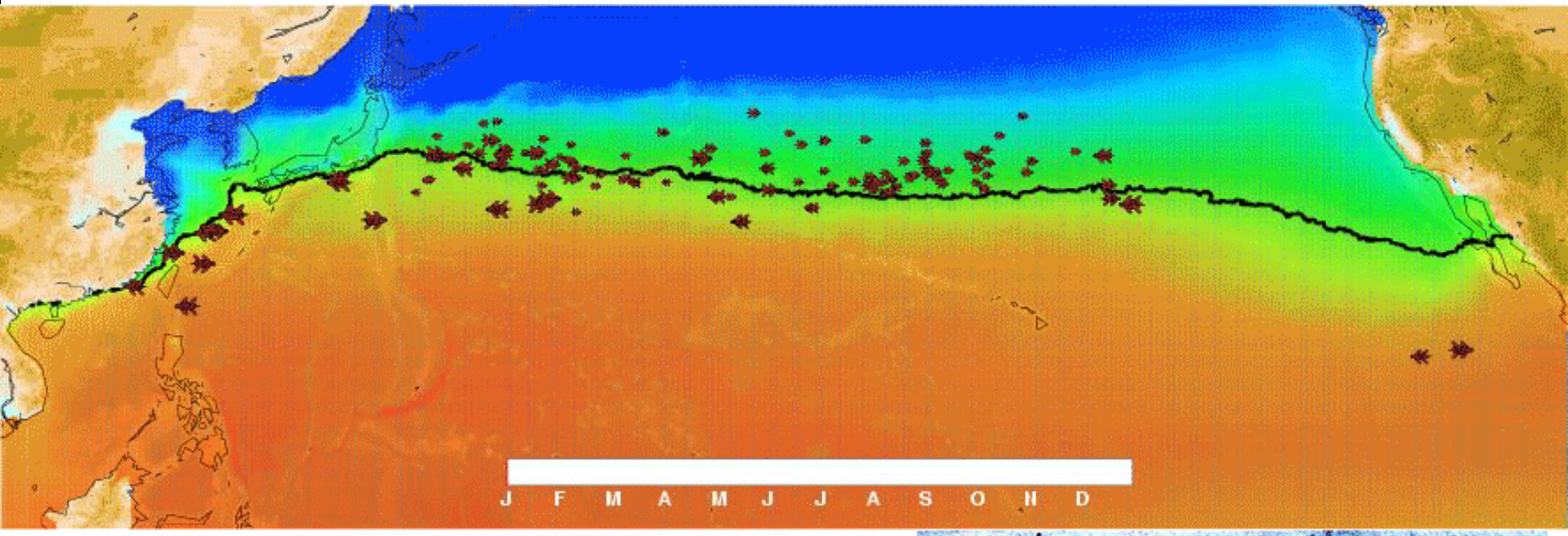
NPTZ as forage habitat- Bluefin tuna



Kuroshio Extension Bifurcation Region (KEBR) April – July 2003, April – June 2004

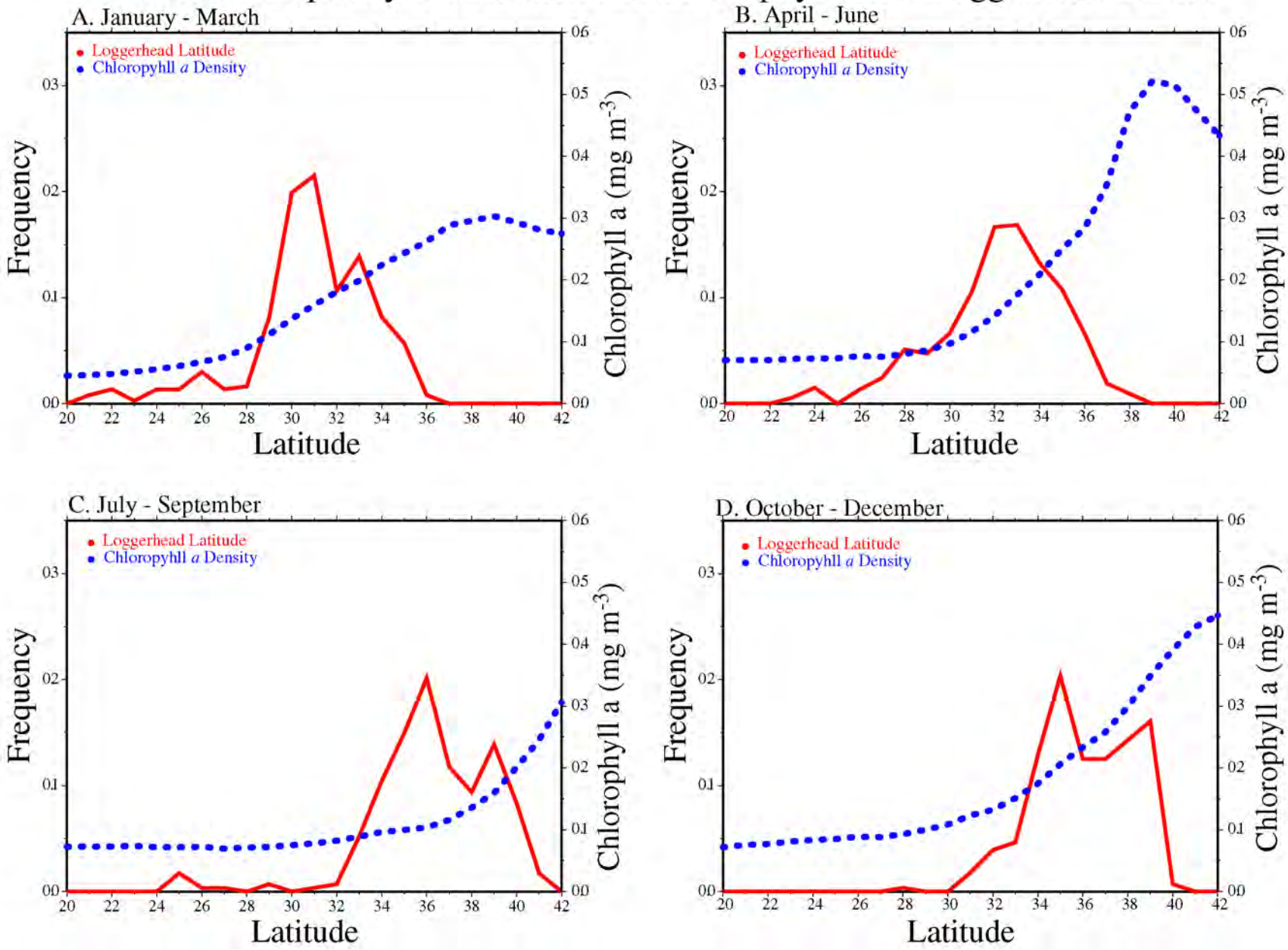
Courtesy B. Block, TOPP

NPTZ as forage habitat – Loggerhead sea turtles



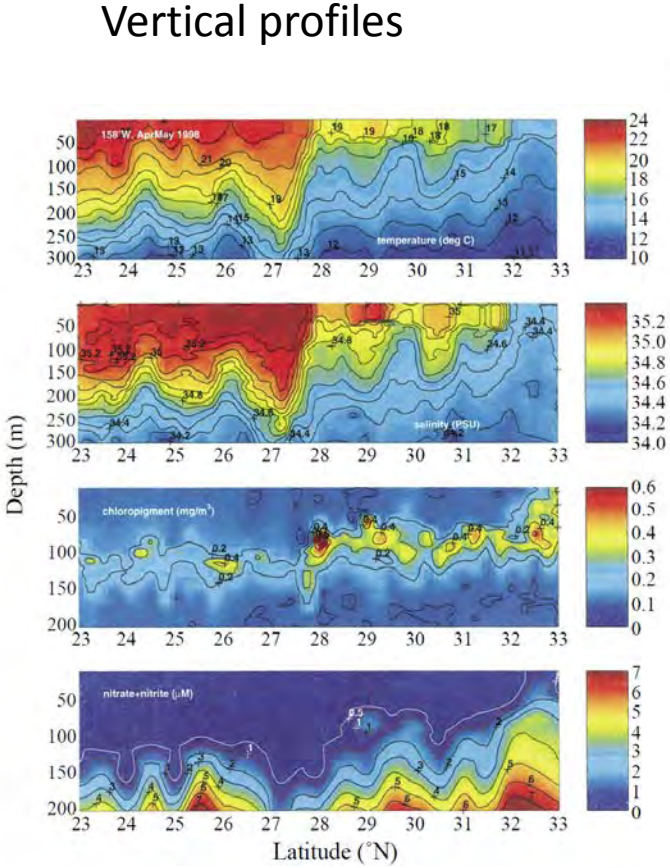
- All tracks remapped to a single calendar year
- Climatological SST field, contour at 18.5°C for reference

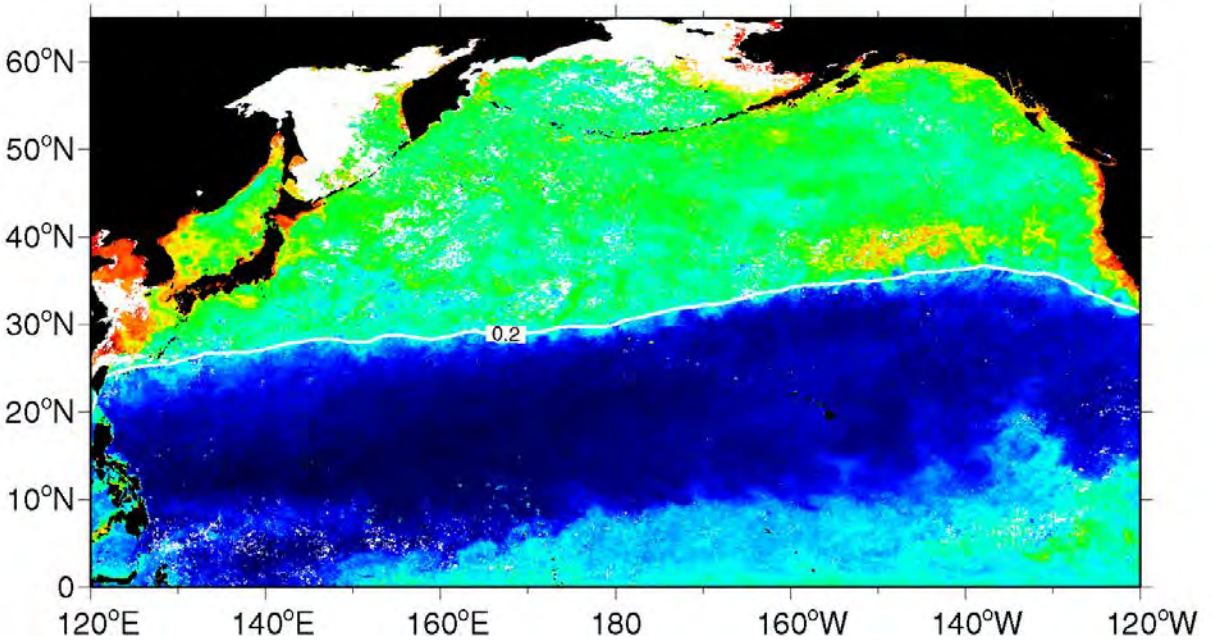
Latitude Frequency Distribution and Chlorophyll A for Loggerhead Turtles



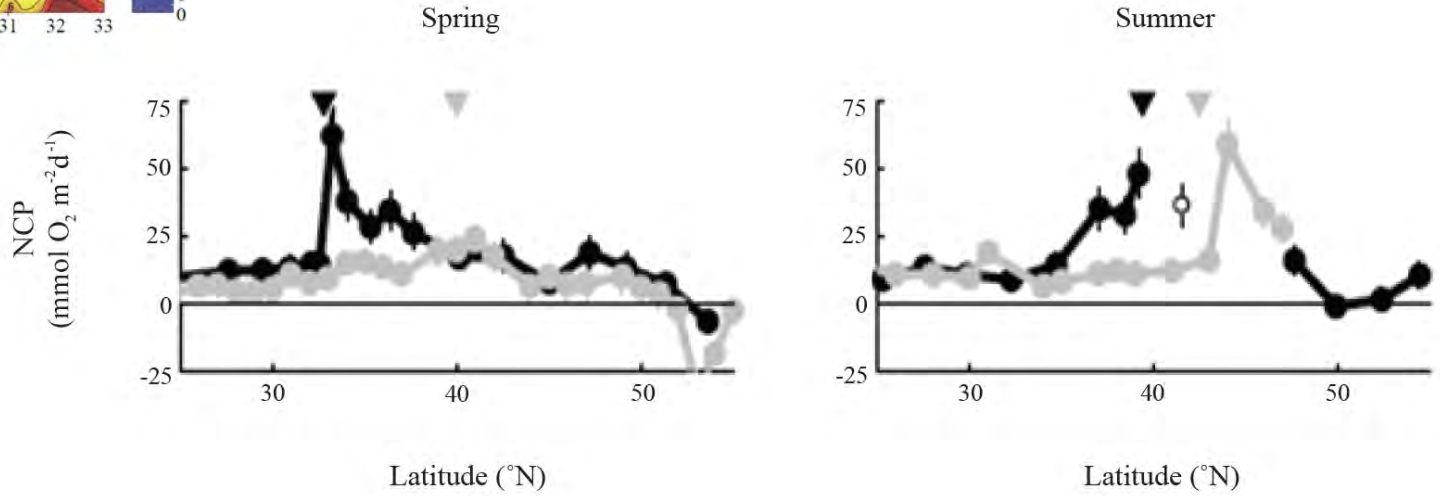
Transition Zone Chlorophyll Front (TZCF)

Vertical profiles





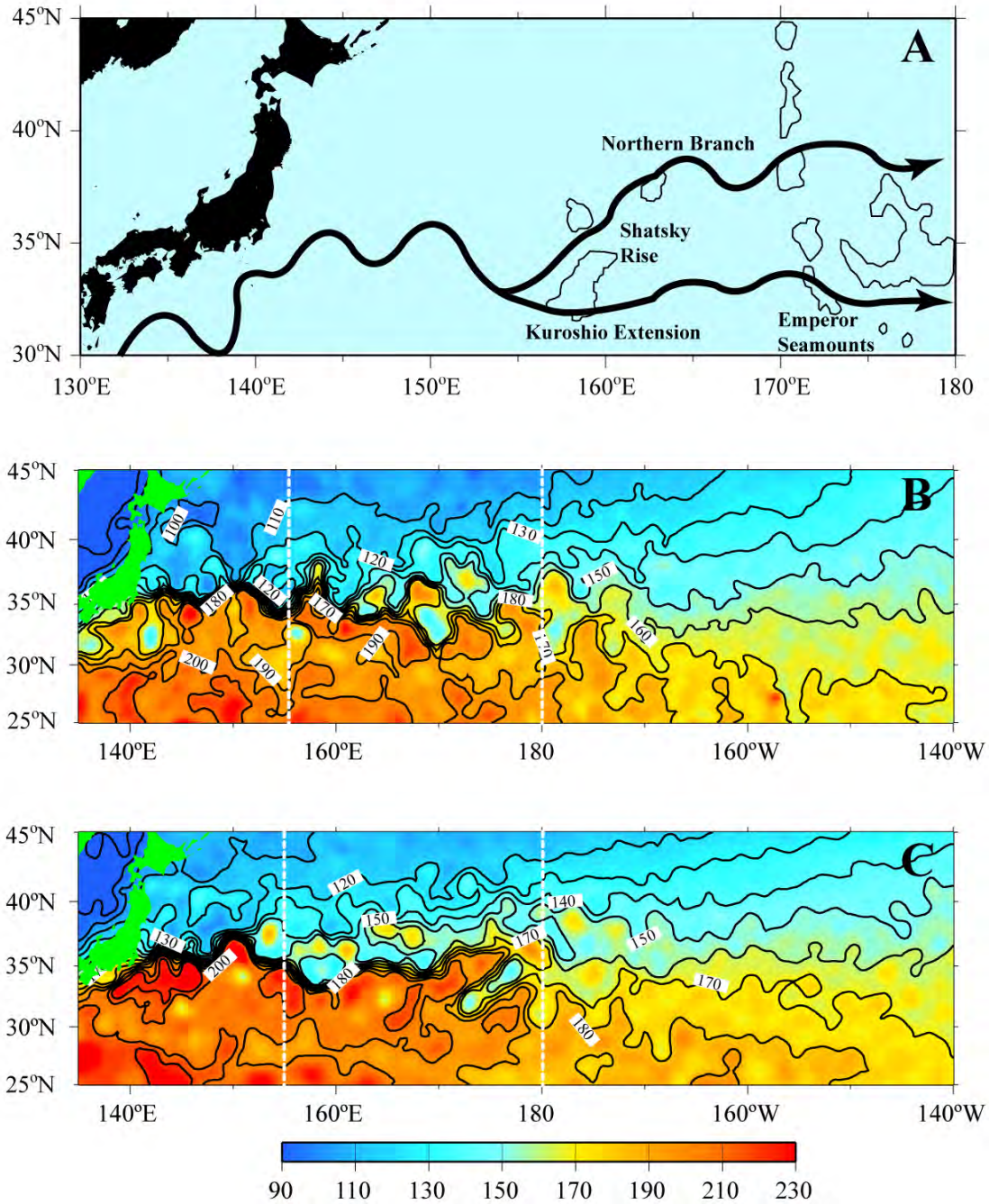
Net community maximum production (Juranek et al. 2012)



Schematic of the Kuroshio Extension Bifurcation region (A)

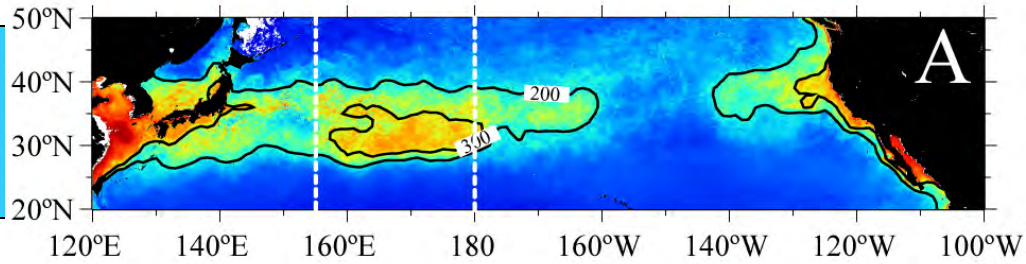
AVISO altimetry for March 2003

AVISO altimetry for September 2003

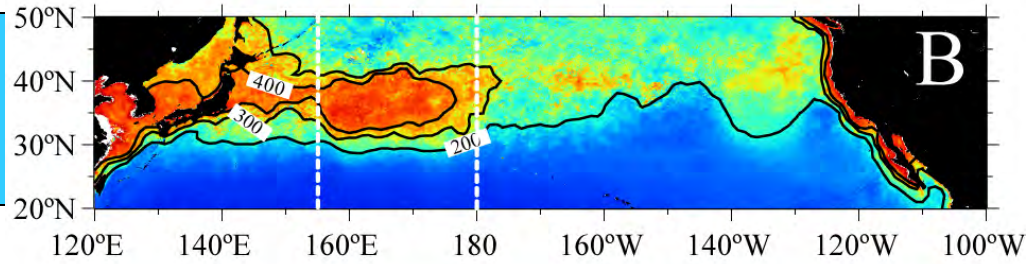


Polovina et al. 2006

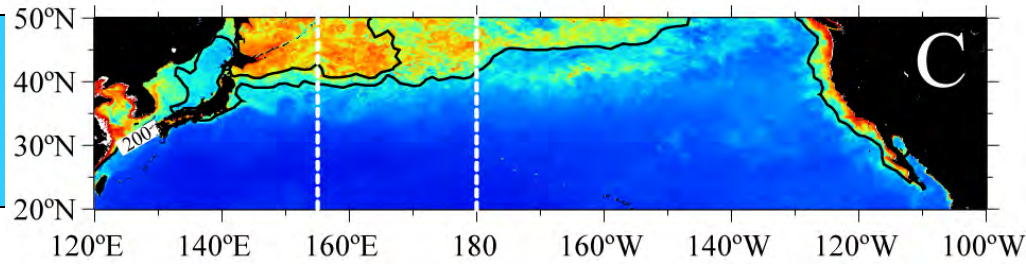
MODIS primary productivity (BF model) for Quarter 1 2003



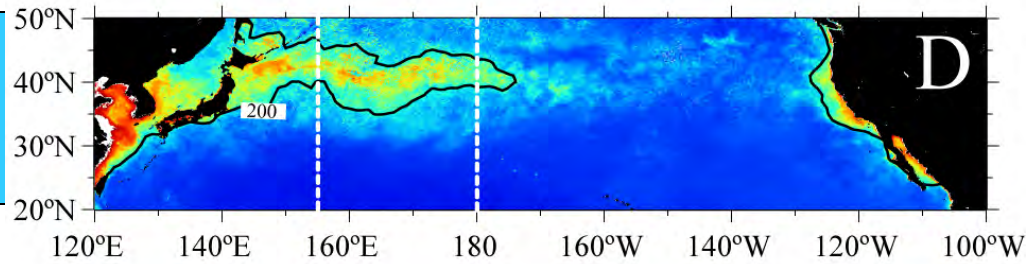
MODIS primary productivity (BF model) for Quarter 2 2003

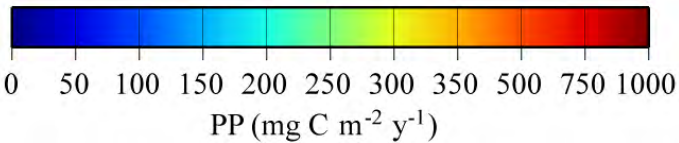


MODIS primary productivity (BF model) for Quarter 3 2003

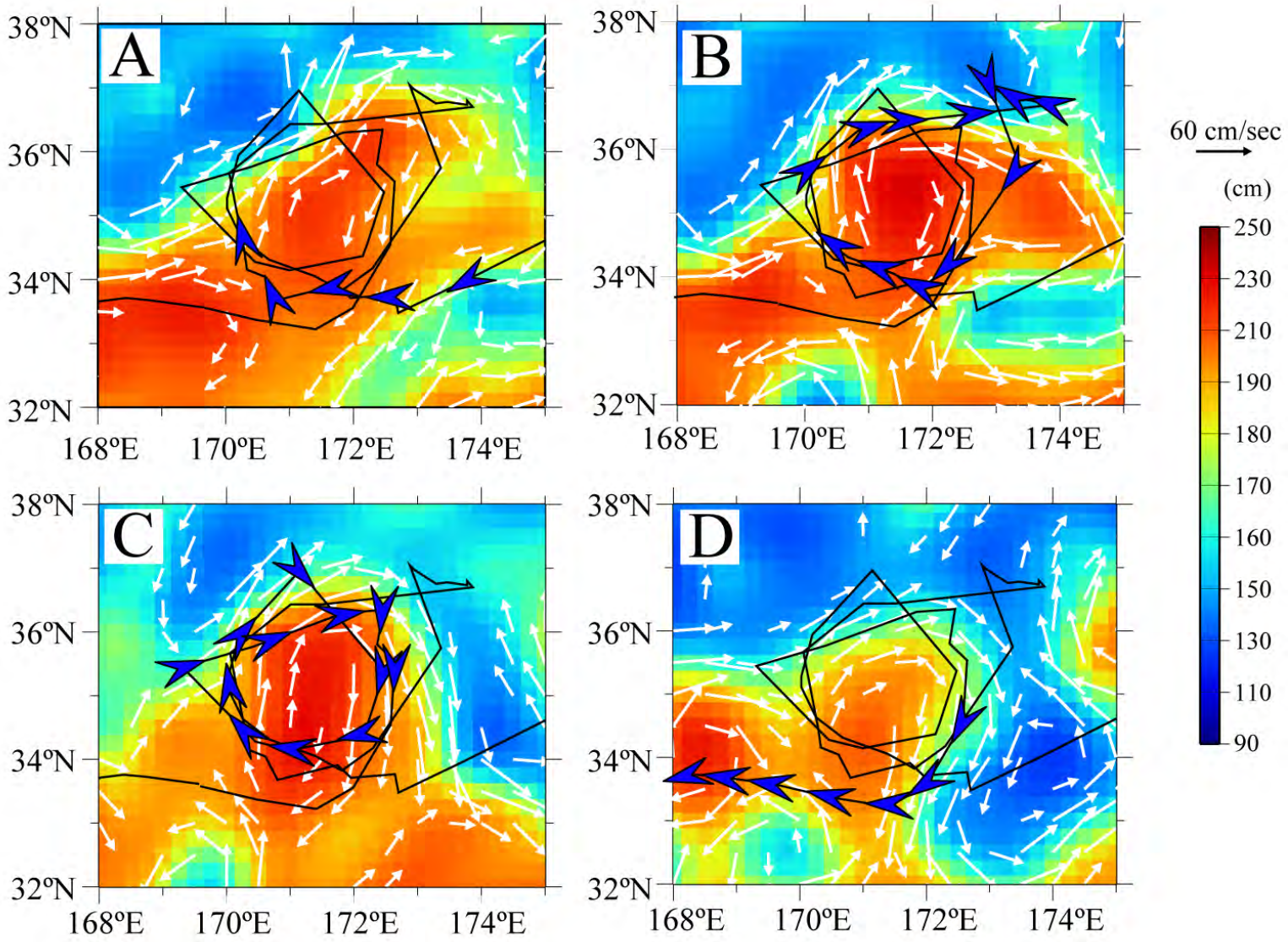


MODIS primary productivity (BF model) for Quarter 4 2003



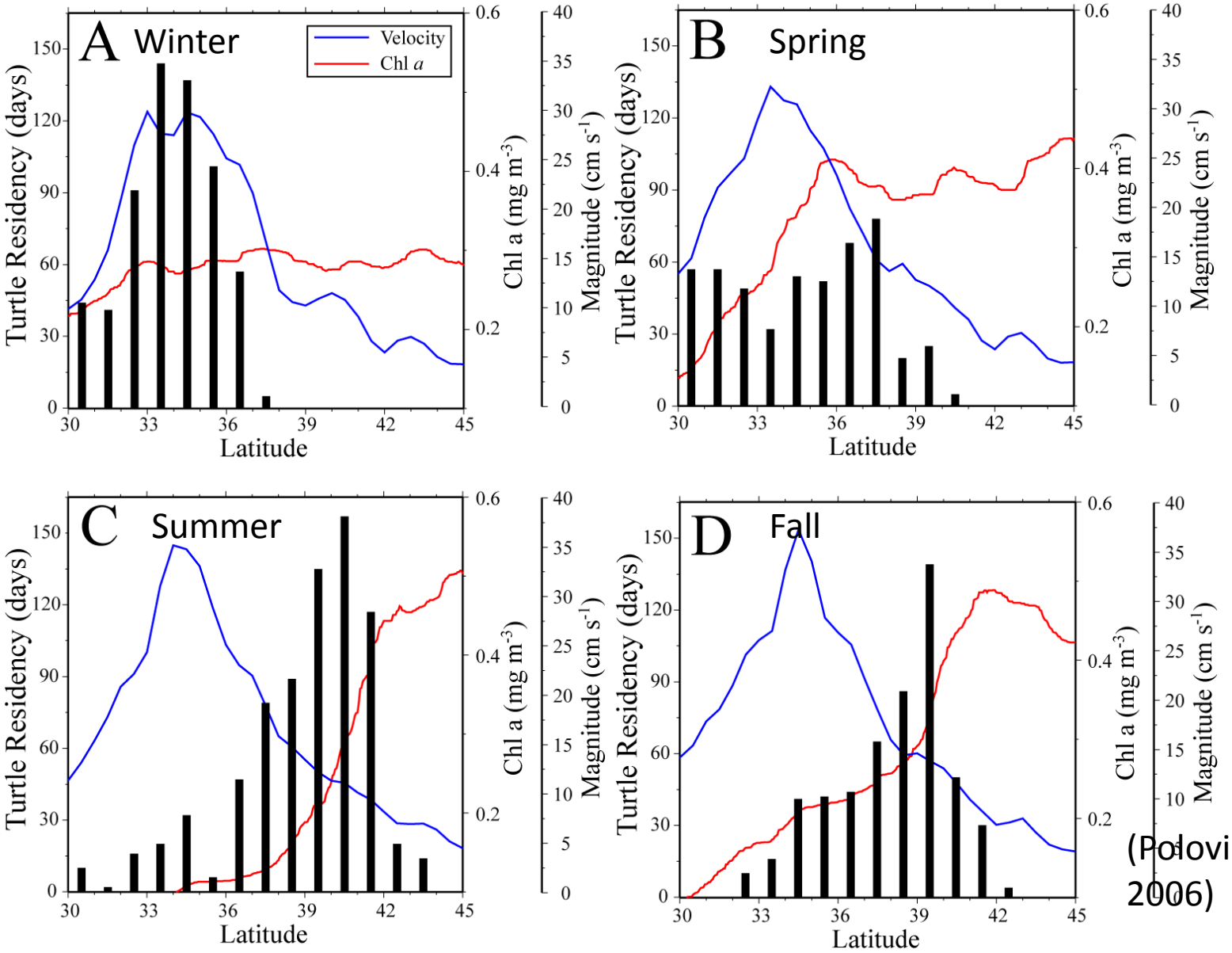


Loggerhead track over SSH and geostrophic currents for October 2003 (A), November 2003 (B), December 2003 (C), and January 2004 (D)



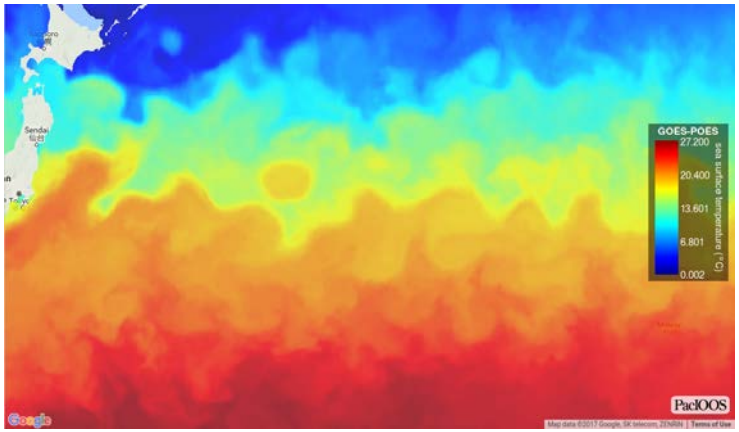
Polovina et al. 2006

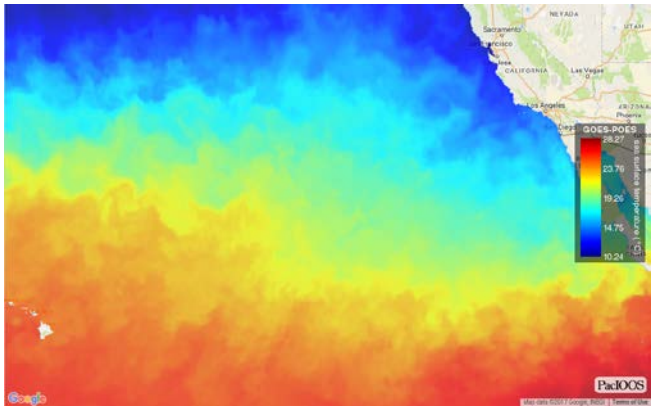
Latitudinal Frequency distributions for loggerhead turtles released from Japan by latitude



(Polovina et al. 2006)

Transitional Zones in the North Pacific – PICES, CIBNOR, CICMAR-IPN, April 2002, La Paz – 92 scientist, 34 oral and 30 poster presentation, examined dynamics by region, west, central, east.





Selected papers published in Journal of Oceanography, Vol 59 #4, 2003.

Brodeur et al. 2003. An east-west comparison TZ coastal pelagic nekton of the North Pacific –Different oceanography but many Identical species and similar species, but also differences with more squids in the west and more sharks and rays in the east.

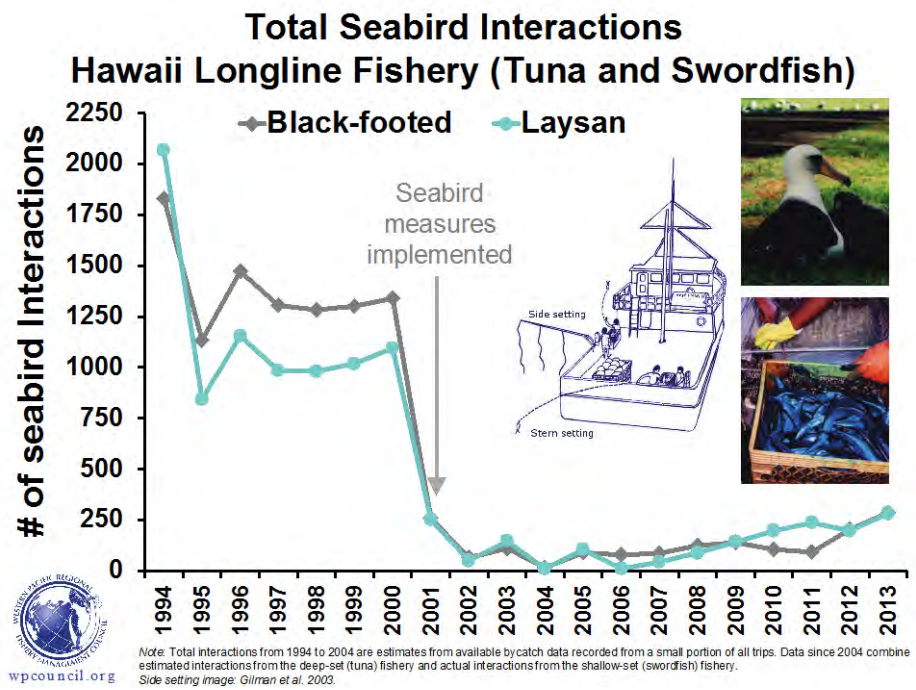
Western and Central Pacific Fisheries Management Commission (WCPFC)

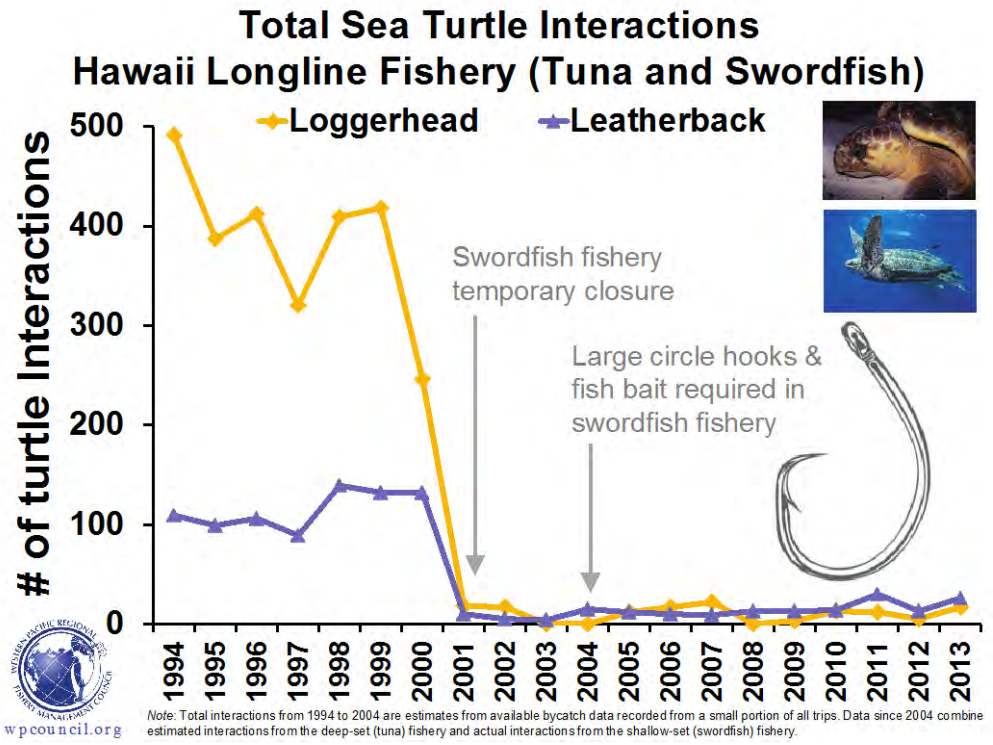
International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC)

- ISC formed 1995
- In recent years has conducted stock assessments for Albacore, Bluefin, Striped Marlin, Blue Marlin, Swordfish, Blue Shark, and Short-fin Mako Shark
- Provides scientific advice to the Northern Committee of Western and Central Pacific Fisheries Commission (WCPFC)

Pelagic Longline Bycatch

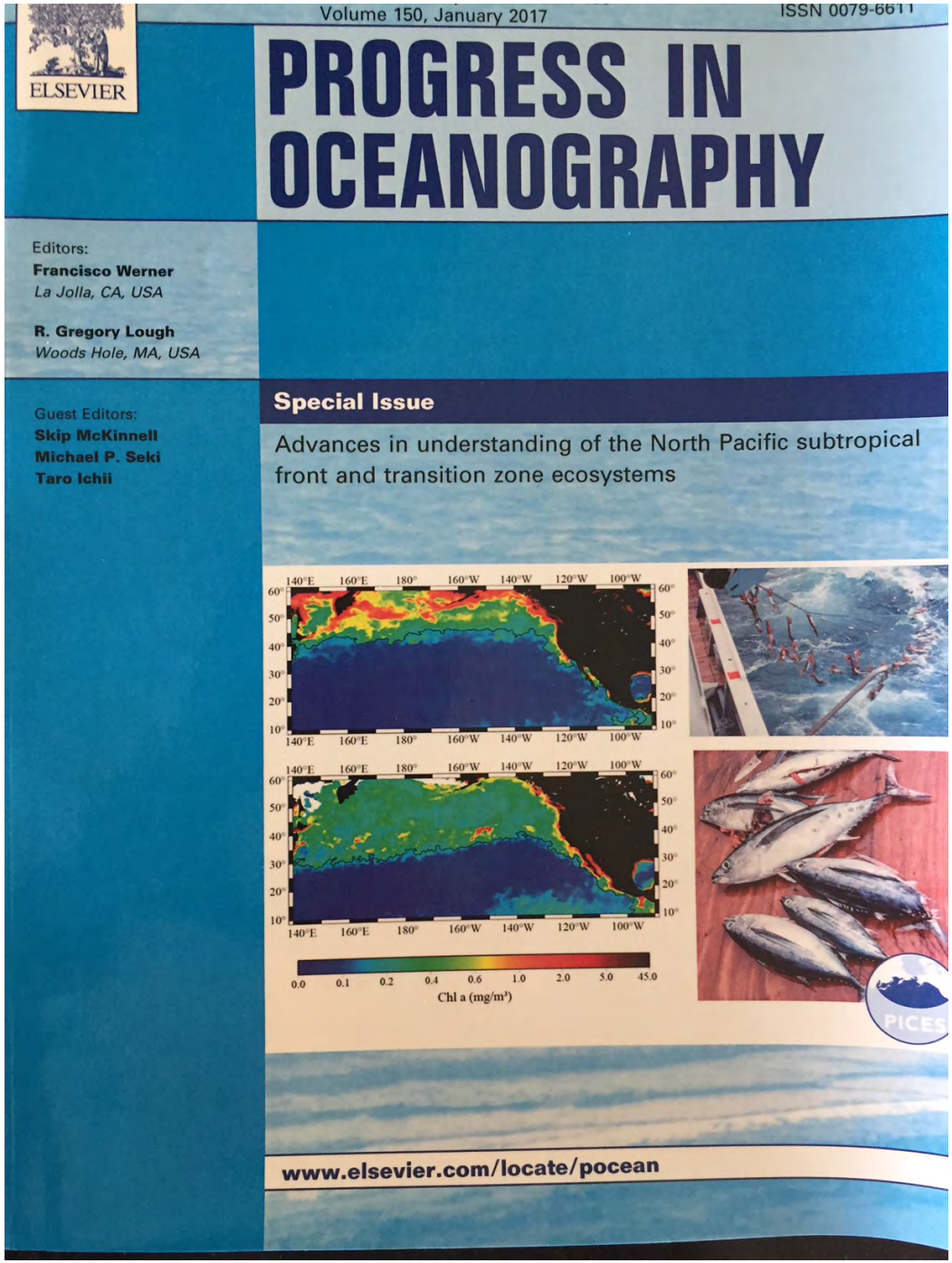
Gear modifications to reduce interactions with seabirds and sea turtles in longline fisheries



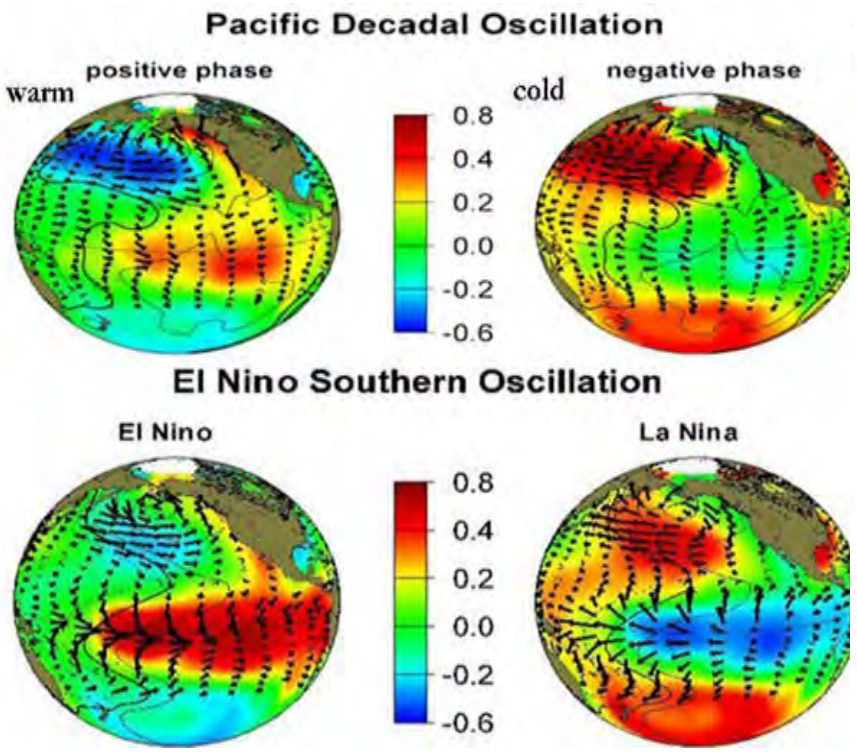


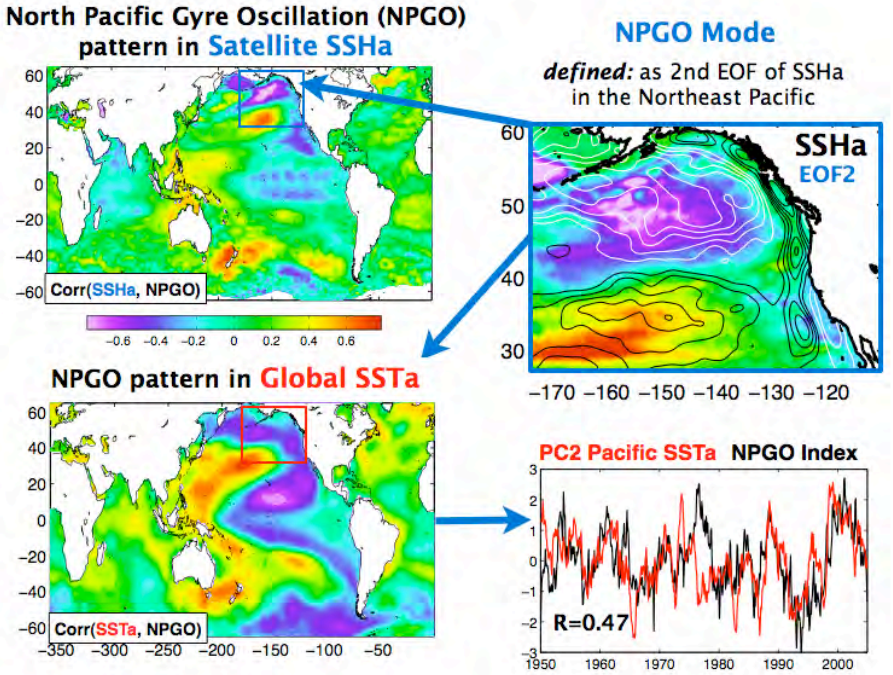
Topic Session at 2012 PICES Annual Meeting on Advances to our understanding of NP STFZ ecosystem. Selected papers in *Prog. Oceanogr*.2017 vol 150.

(Ichii et al. 2017). Fishery yields in the high seas squid driftnet fishery (1979-1992)
--neon flying squids at MSY
--bycatch species" juvenile blue shark below MSY, but pomfret exceeded MSY.
Squid and saury most susceptible to 1990 regime shift, These species would benefit from regime specific harvest rates

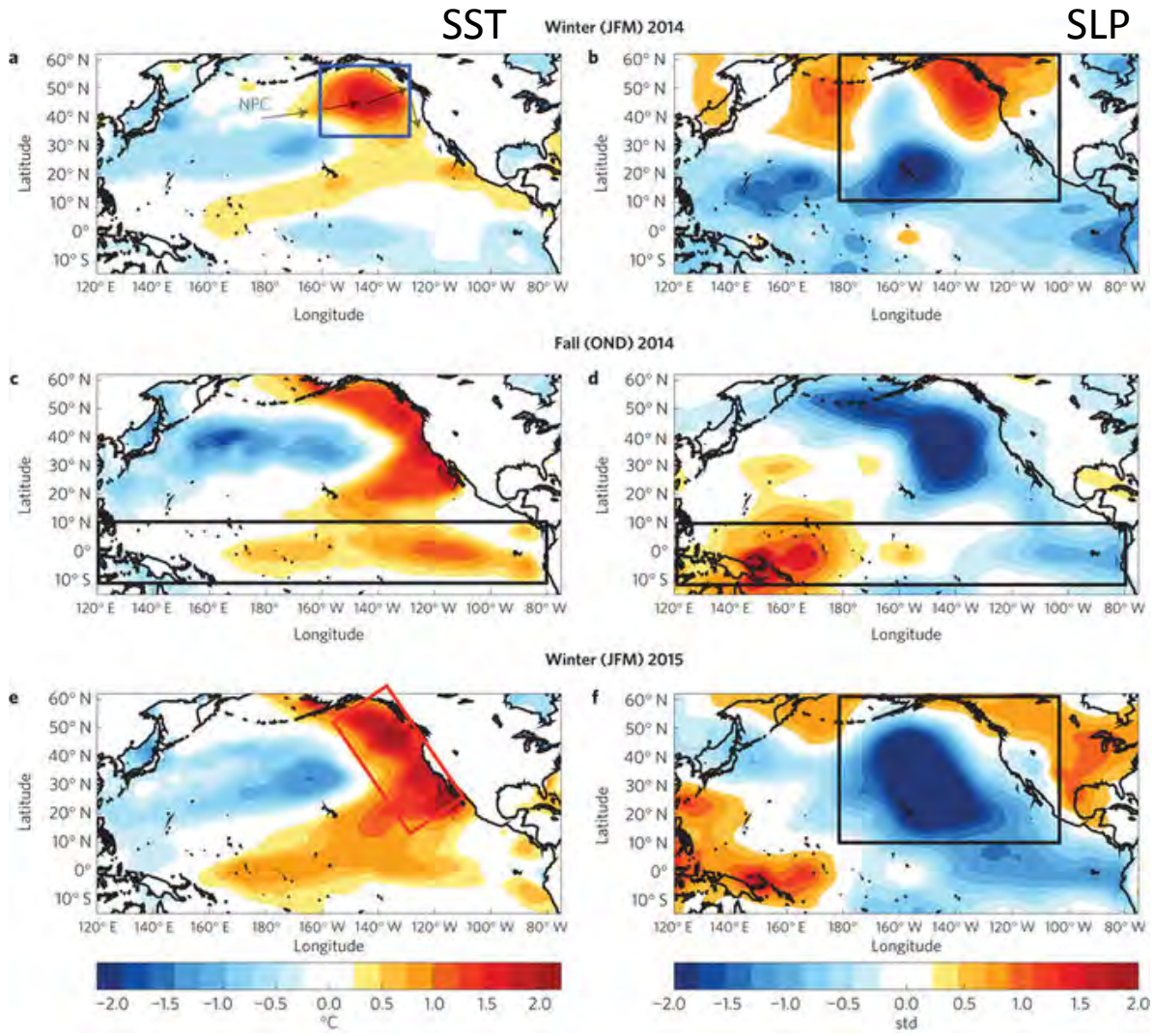


Modes of Pacific Climate Variation (ENSO, PDO, NPGO)





Marine Heat Wave 2014/2015



Anomalous winter winds decrease 2014 nutrients and chlorophyll in the NE Pacific Transition Zone to lowest levels since satellite measurements (1997)

(Whitney 2015)

DiLorenzo and Mantua 2016. *Nature Climate Change*
with NE NPTZ biological impacts Whitney 2015 *Geophys. Res Lett.*

Projected Climate Changes Over the 21st Century

Basin-wide warming

Tropical easterlies weaken

Westerlies and polar easterlies weaken and shift poleward

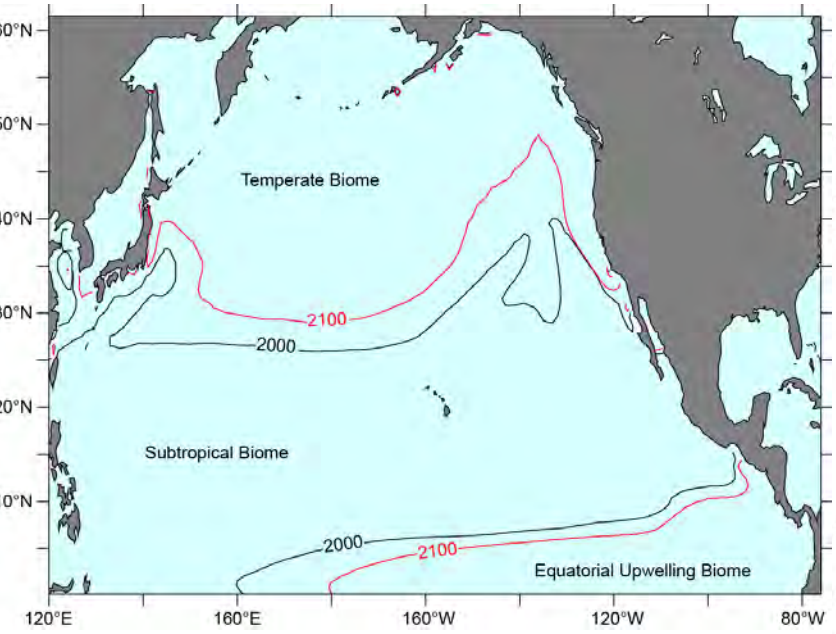
Reduced wind-stress curl

Weakened vertical velocities and increased stratification

Nutrient redistribution

Rykaczewski and Dunne 2010, Sarmiento *et al*. 2004, Vecchi *et al*. 2006, Yin 2005

Expansion of the subtropical gyre between the beginning and end of the 21st Century (GFDL ESM2.1)

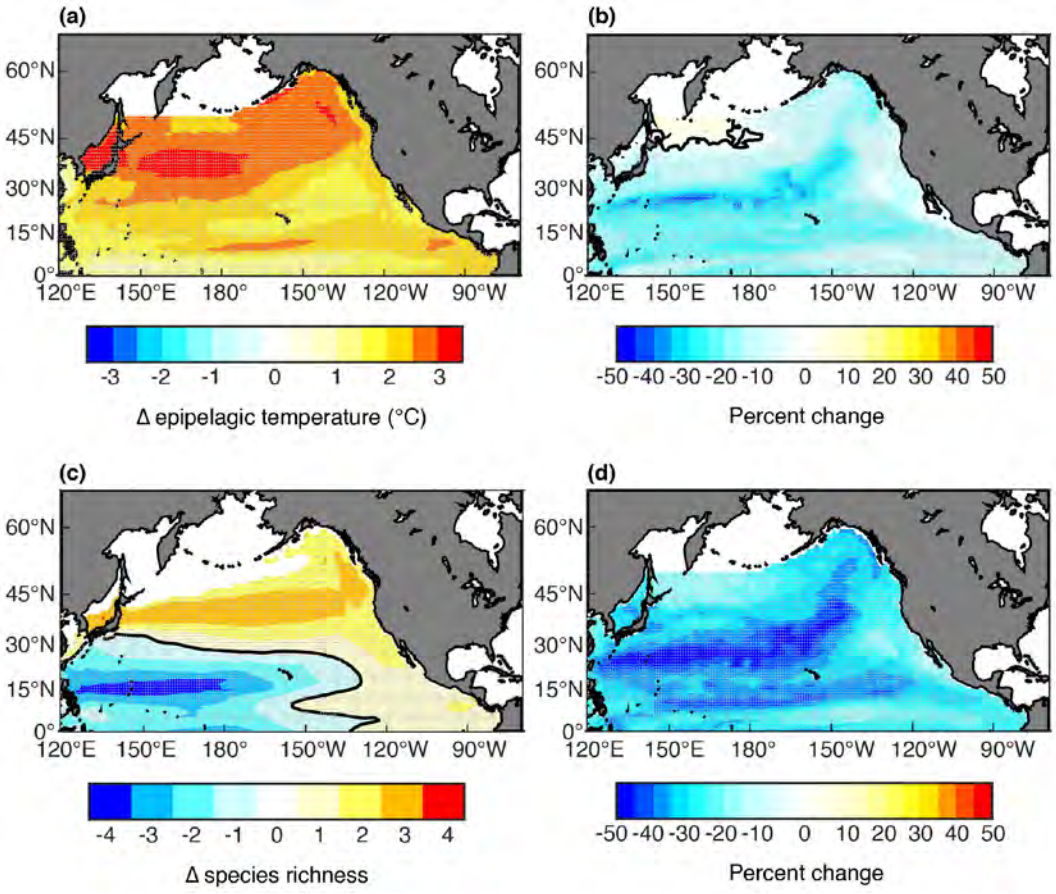


Polovina et al. 2011

Changes in physical and ecological variables over the 21st Century from 11 Earth System Models

Epipelagic Temp

zooplankton

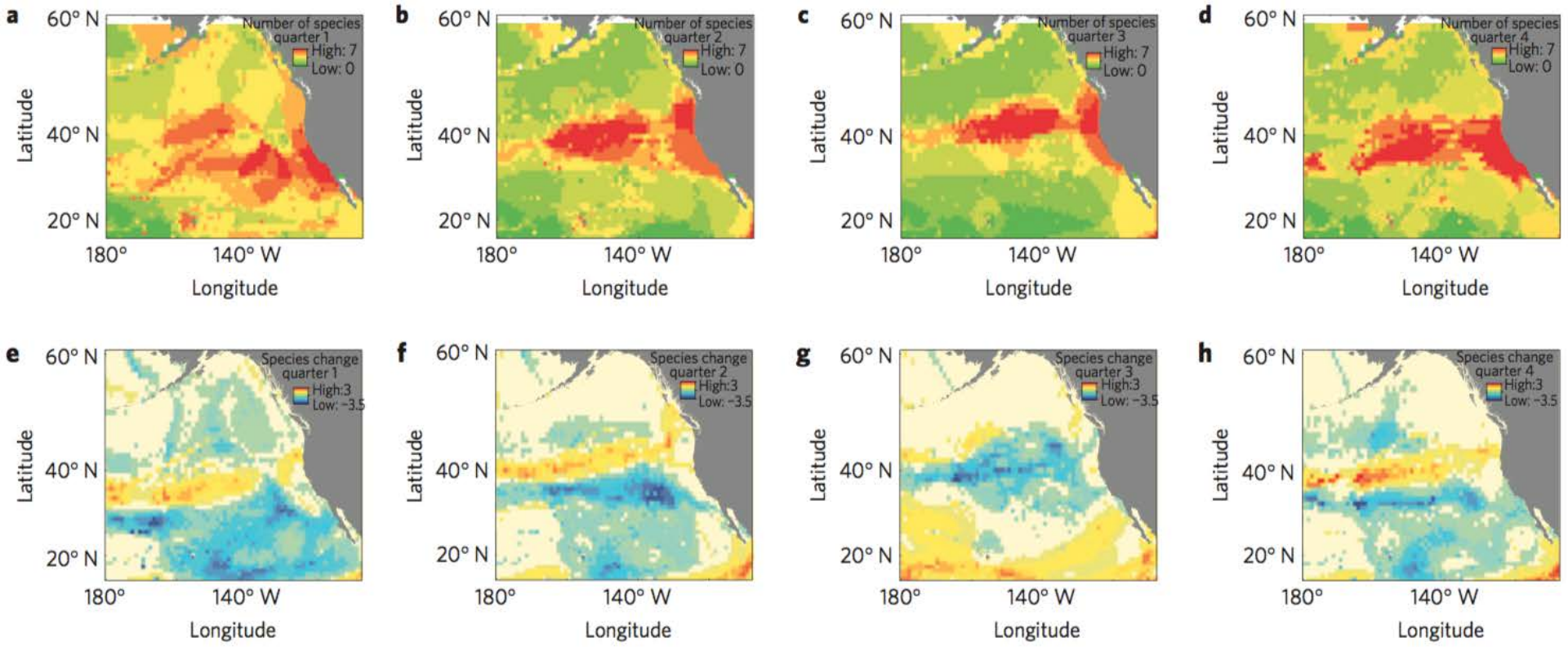


Tuna and Billfish species

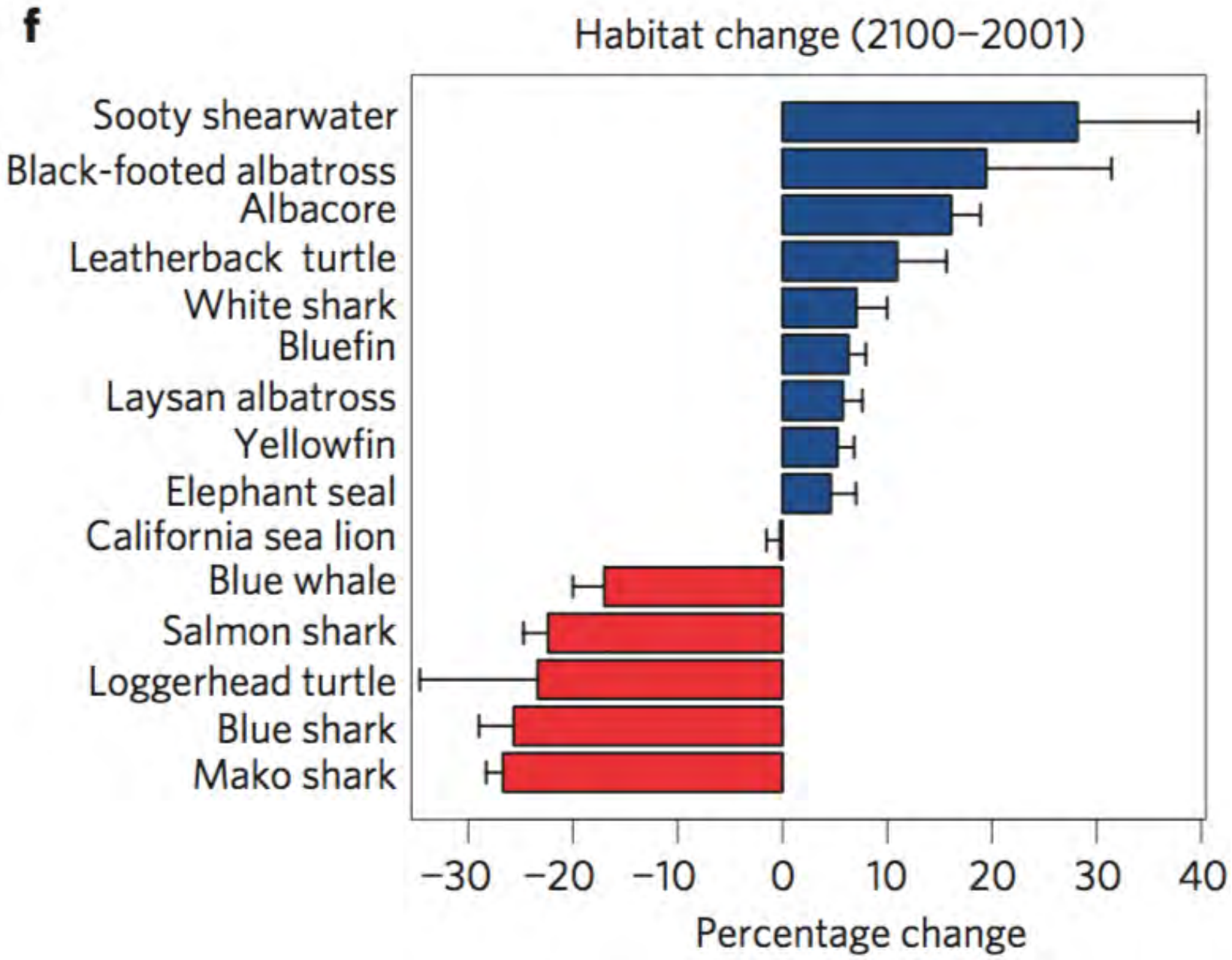
Carrying Capacity

Woodworth-Jefcoats et al. 2017

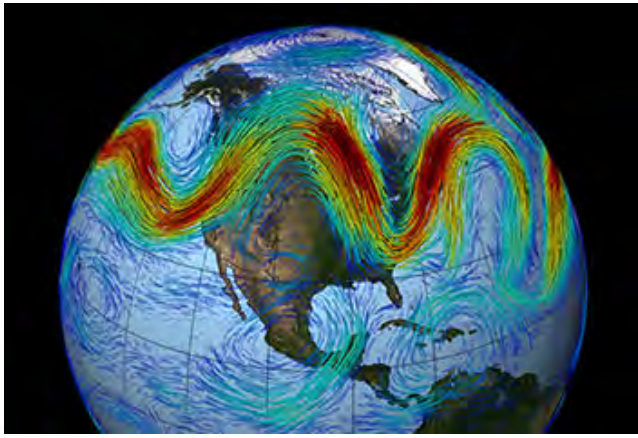
Quarterly species richness for 23 pelagic species by quarter 2000-2010,(top row) and change by 2081-2100 (bottom row)

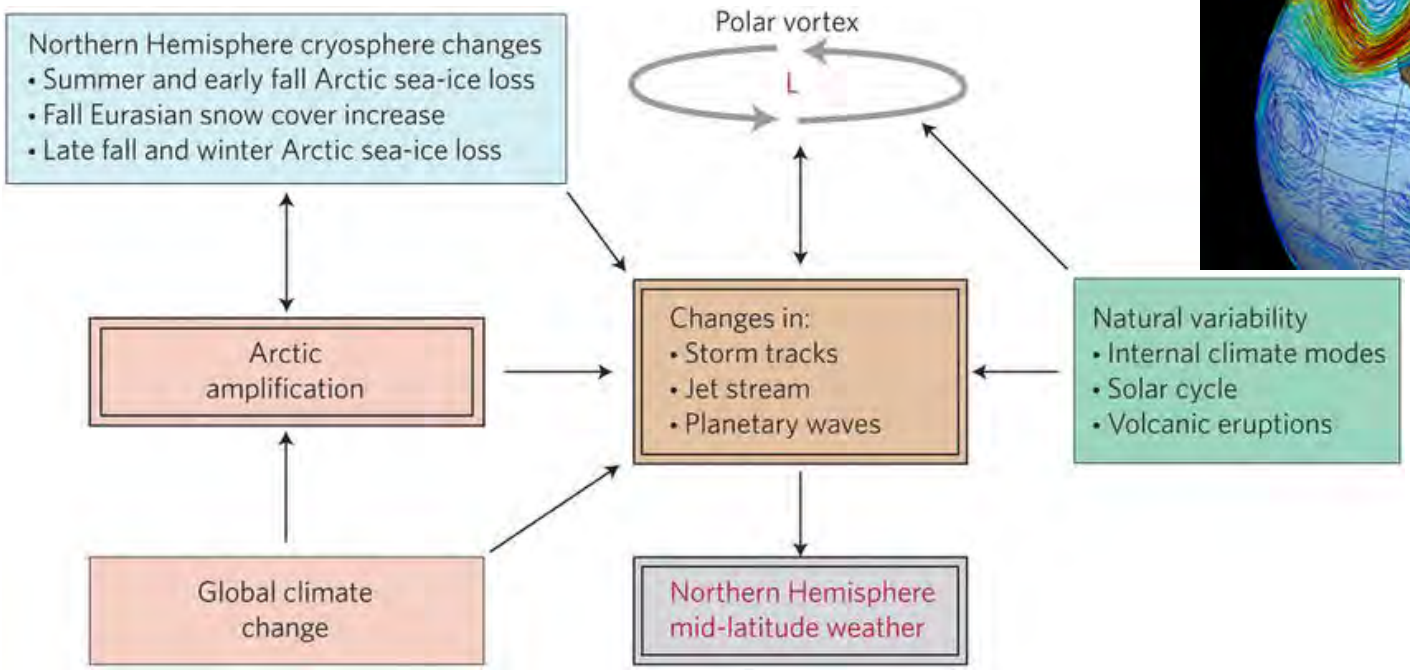


Based on 4300 electronic tags,, satellite SST and Chl-a, habitat models, and GFDL Earth Systems Model projections. (Hazen et al. 2012. Nature Climate Change)


f
Habitat change (2100–2001)
Sooty shearwater
Black-footed albatross
Albacore
Leatherback turtle
White shark
Bluefin
Laysan albatross
Yellowfin
Elephant seal
California sea lion
Blue whale
Salmon shark
Loggerhead turtle
Blue shark
Mako shark
−30
−20
−10
0
10
20
30
40
Percentage change

Arctic Amplification Impact on Mid-latitudes

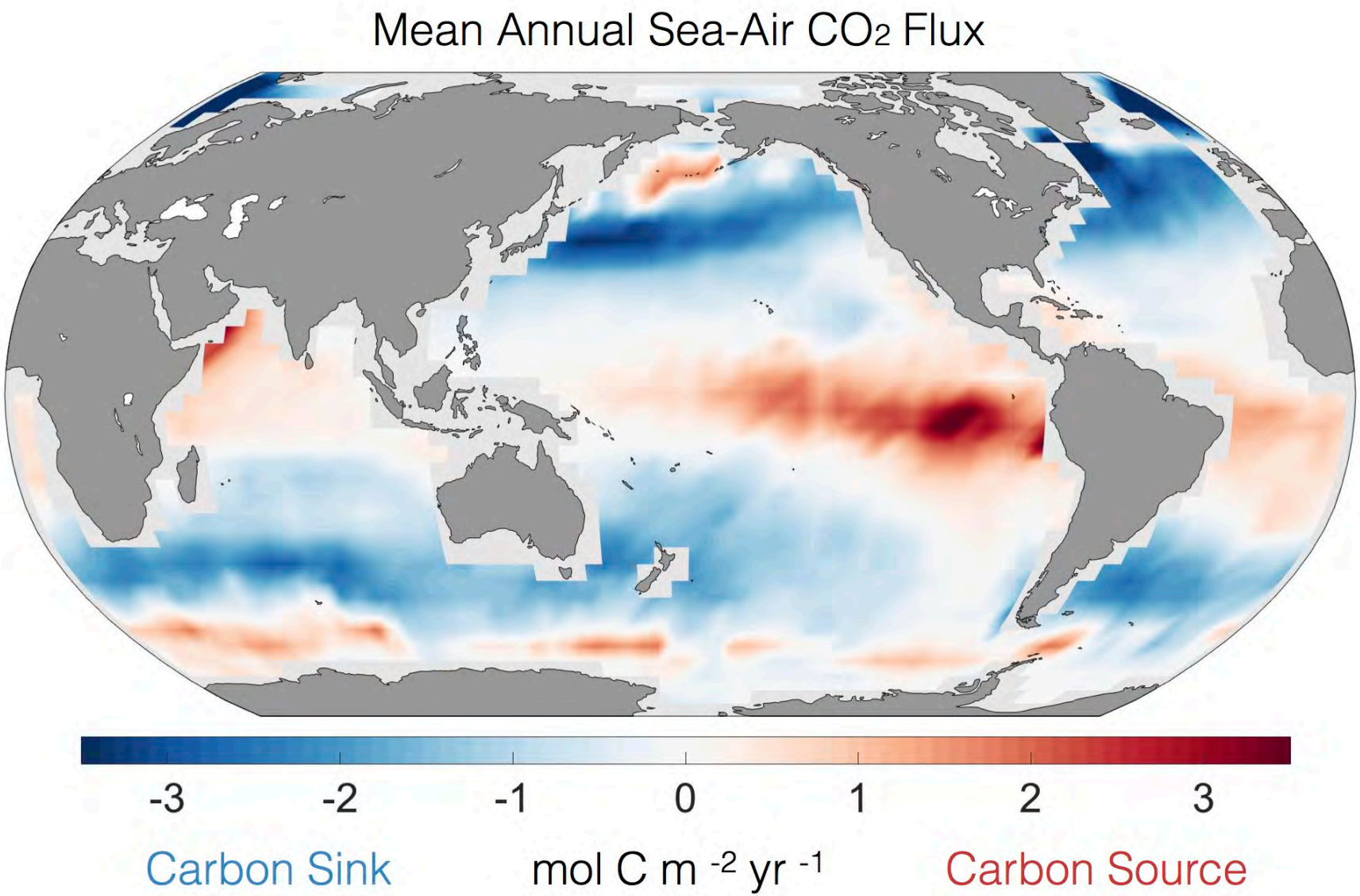




Cohen et al. 2014. Recent Arctic amplification and extreme mid-latitude weather. *Nature Geoscience*. 7. 627-637. 10.1038/ngeo2234.

Overland et al. 2016. Nonlinear response of mid-latitude weather to the changing arctic. *Nature climate Change*

Will the Modern Pattern of Ocean CO_2 Uptake Persist?



Slide from ppt by A. Fassbender et al 2017.

after Takahashi et al., 2002, 2009

We've learned:

The NPTZ is a very dynamic and heterogeneous region, providing important habitat for fisheries resources and protected species, a carbon sink, and influences North America's weather.

Both subtropical and subarctic species use the region at various life stages.

Management is critical and needs to address both target species and bycatch impacts as well as climate impacts.

Climate variability is an important source of ecosystem variation and climate change will likely have significant impacts as well.

Research has greatly benefited from a suite tools and data sets including satellite data, electronic tags, observer data, research cruise, climate and habitat models.

Going forward:

Understanding Climate impacts on the ecosystem is an important research theme. Will the eastern NPTZ become subtropical, will the 2014-2015 heat wave become a more common climate mode, how will the KEC respond, how will the food web change, will Arctic amplification have NPTZ impacts ?

Given impact of climate on the ecosystem plus fisheries bycatch concerns, an Ecosystem Approach to Fisheries Management is critical.

New tools including coupled spatial ecosystem (fisheries)-earth systems models, remote/autonomous vehicles, molecular genetics may be beneficial.

Are there overarching characteristics of TA that emerge from comparative studies?