


Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

CIAT
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An updated ecosystem model of the eastern tropical Pacific Ocean: Analysis of ecological indicators and the potential impacts of FAD fishing on ecosystem dynamics

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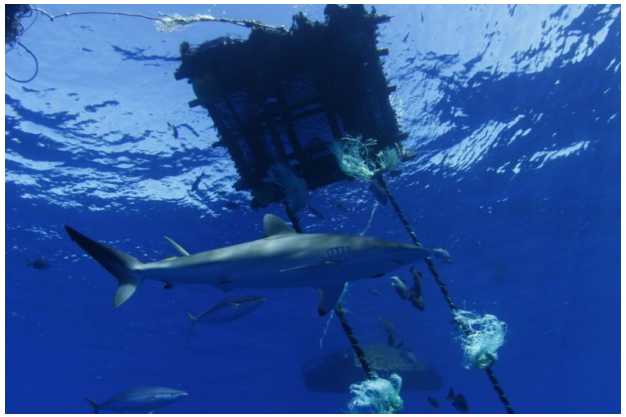
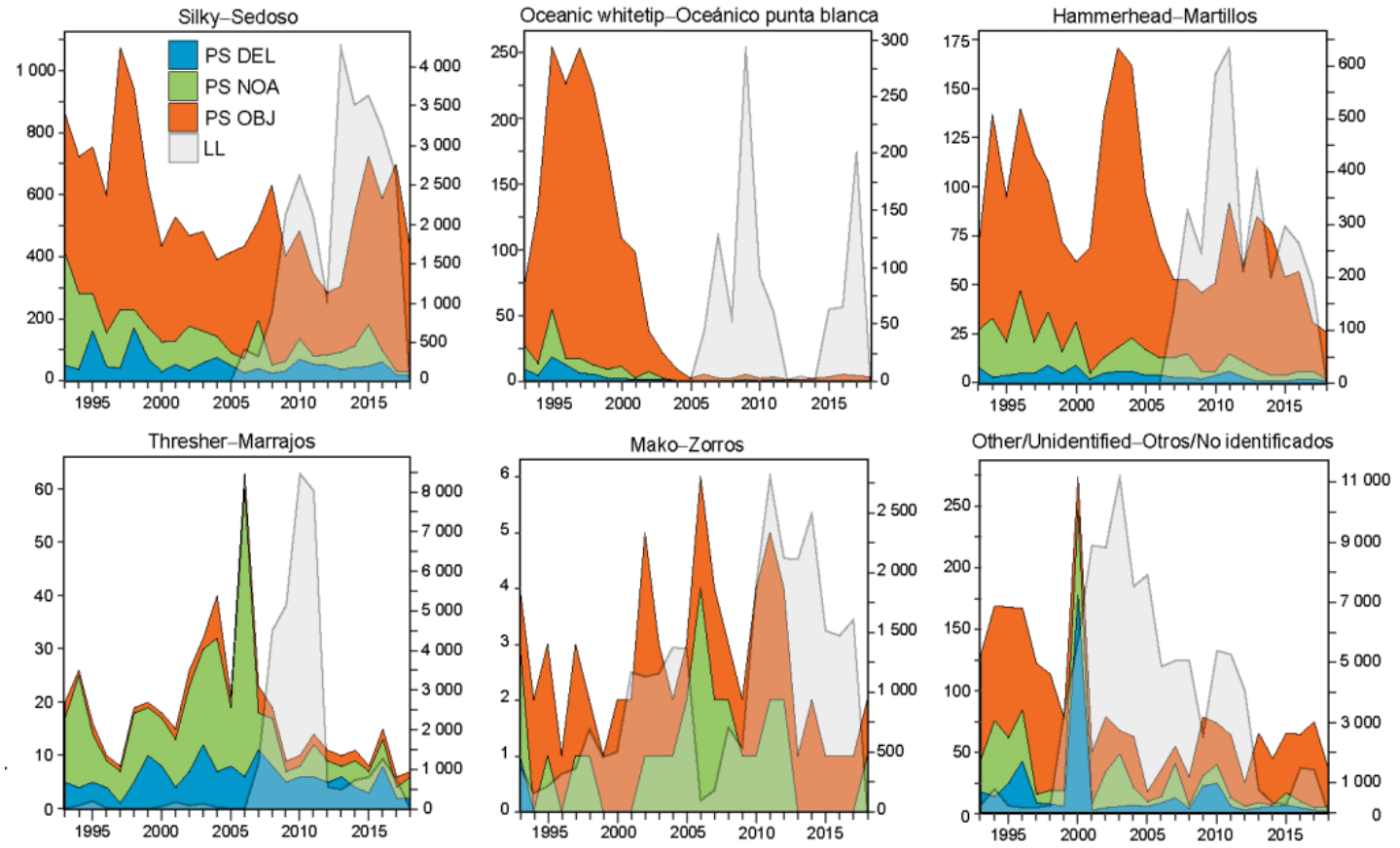
Outline

- IATTC's responsibilities and commitment to ecological sustainability
- Previous work on trophic ecology and ecosystem modelling to explore the ecological impacts of tuna fishing in the EPO
- Update of existing ecosystem model of the ETP to develop standardized ecological indicators to monitor ecosystem integrity
- Simulate the potential impacts of FADs in the EPO over the next 10 years
- Model caveats and recommendations for future research



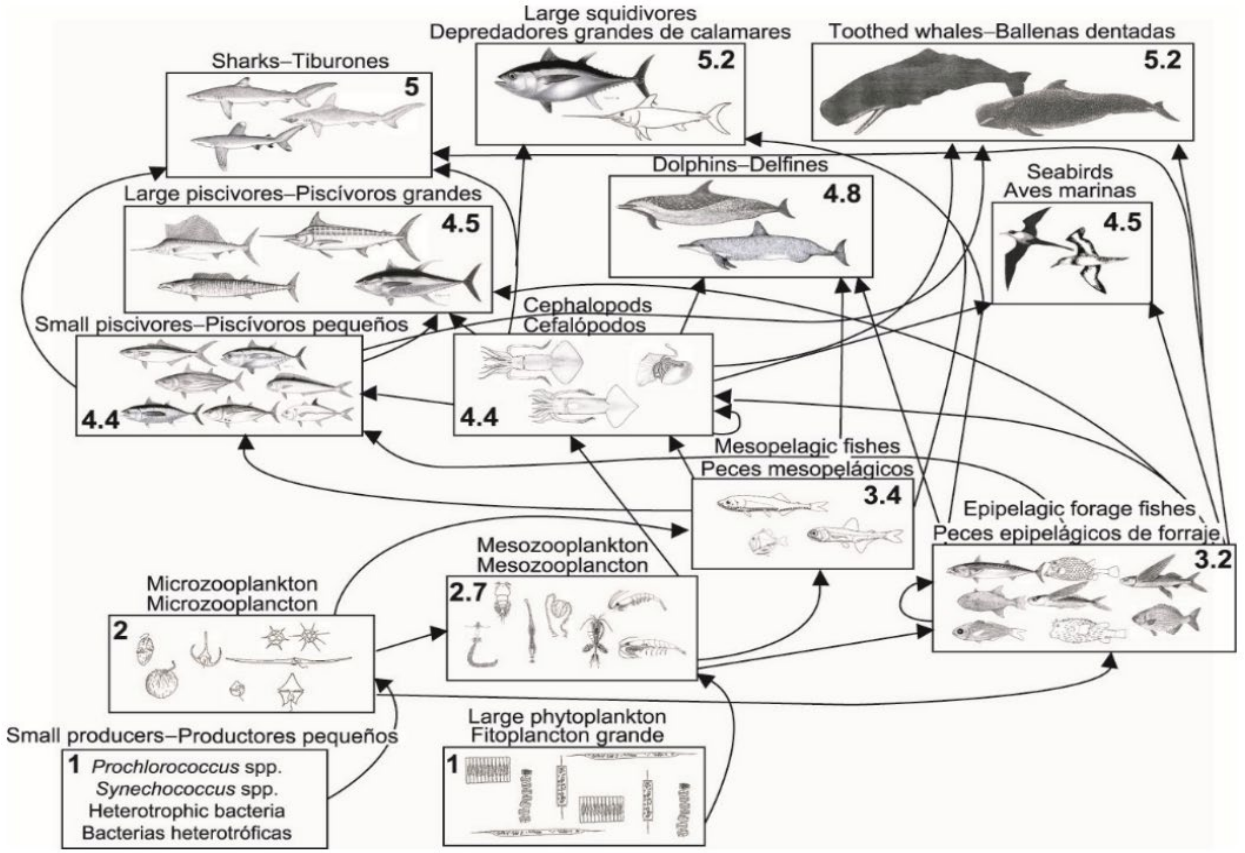
Ecological sustainability

- IATTC committed to ensuring ecologically sustainability of its fisheries
  - Antigua Convention, IATTC Resolutions, and improved ecosystem reporting (SAC-10-14)
  - Development of a quantitative ERA model for data-poor species (EASI-Fish)



Beyond single species

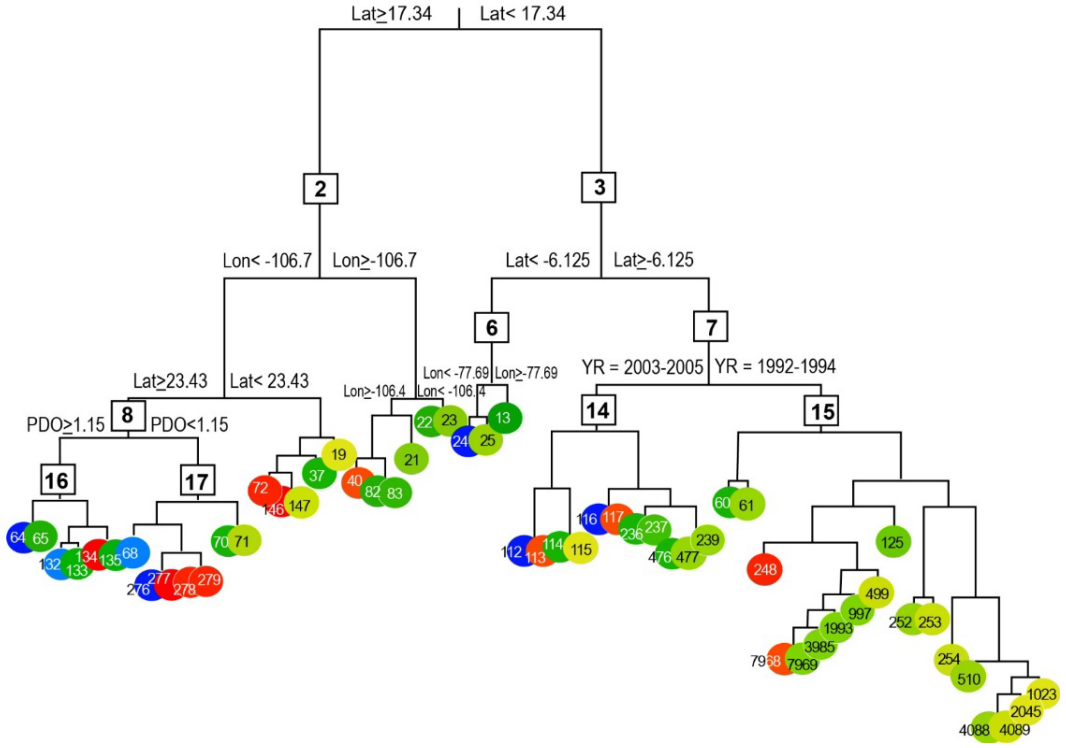
- Single species monitoring, reporting and assessment is valuable
- But these data do not tell us if fishing is impacting the structure and internal dynamics (e.g. strength of trophic flows) of complex ecosystems



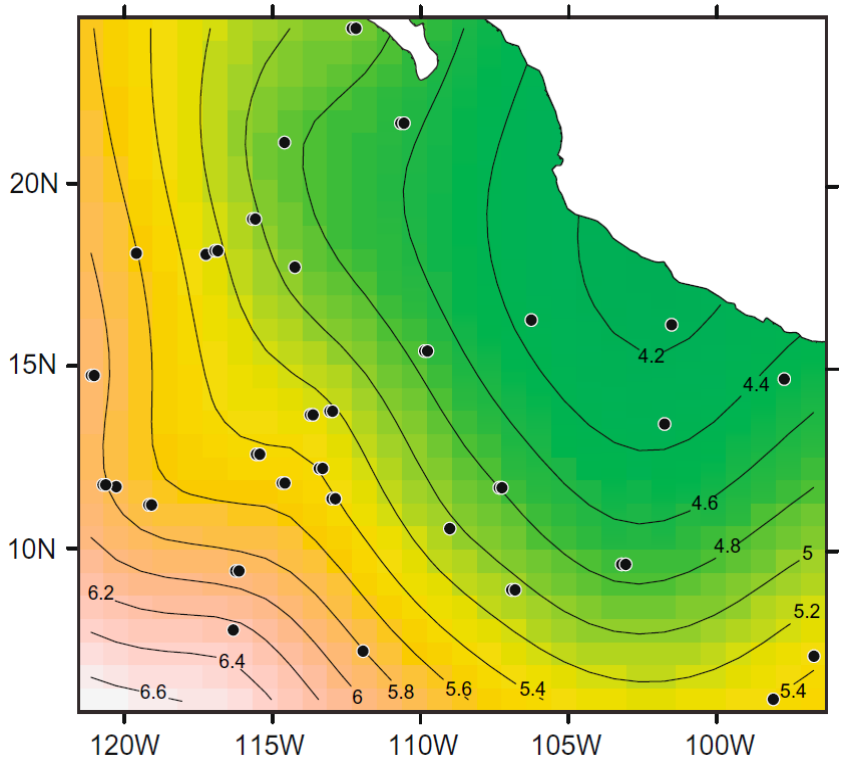
Beyond single species

- IATTC staff have undertaken studies to quantify trophic flows
- Stomach and stable sampling conducted in early 1990s and 2000s
- Allowed development of ETP ecosystem model (Olson & Watters, 2003)

Stomach content analysis



Stable isotope analysis

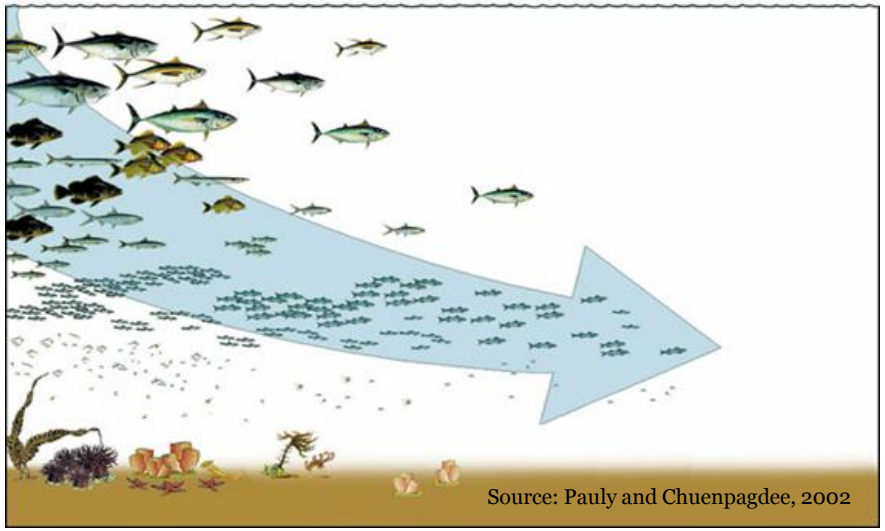


ETP ecosystem model

- ETP model existed in outdated software (EwE v5.1) since 2003 and never used for ecosystem reporting
- Previously, IATTC has reported only trophic level of the catch (TL_c)
- But complex marine ecosystems require several indicators to describe multidimensional changes to their structure and function
- EwE software (v6.5) now significantly more sophisticated
- Addition of several standardized ecological indicators
- In 2017, staff updated the ETP model with new data 1970-2014
- Staff annually update the model with new catch and effort data and report on ecological indicators in the *"Ecosystem Considerations"* report

Ecological indicators

- Fishing-based indicators
  - TL_c - >0.1 TL per decade is considered a significant change (e.g. “fishing down the food web”)
  - Marine Trophic Index (MTI) – TL_c of TL > 4.0
  - Fishing in Balance Index (FIB) – is the MTI changing as expected given available productivity? Also indicate whether a fishery is expanding

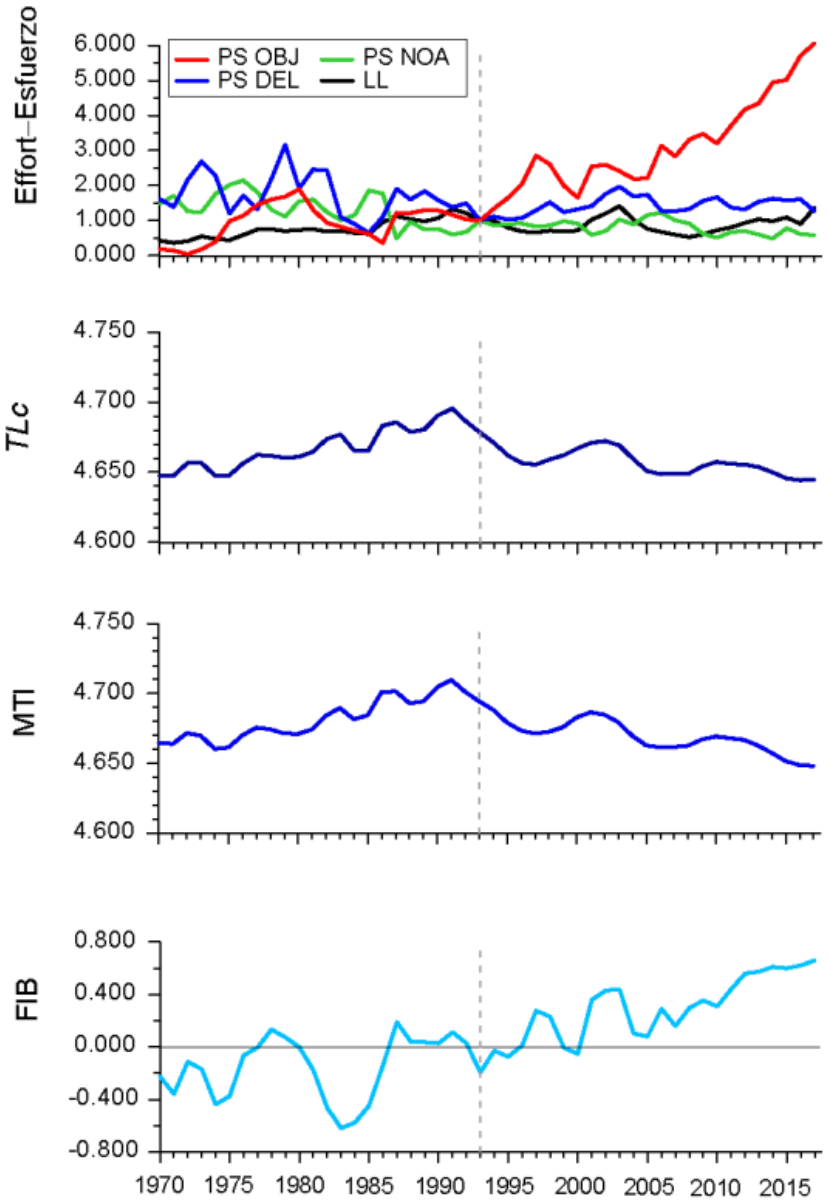


- Community-based indicators
  - Shannon’s index – “evenness” measure, relative biomass of functional groups in the ecosystem
  - Community biomass of low (TL 2.0-3.25), intermediate (TL 3.25-4.0), and high (TL > 4.0) trophic levels can provide indicators of trophic cascades.

Results

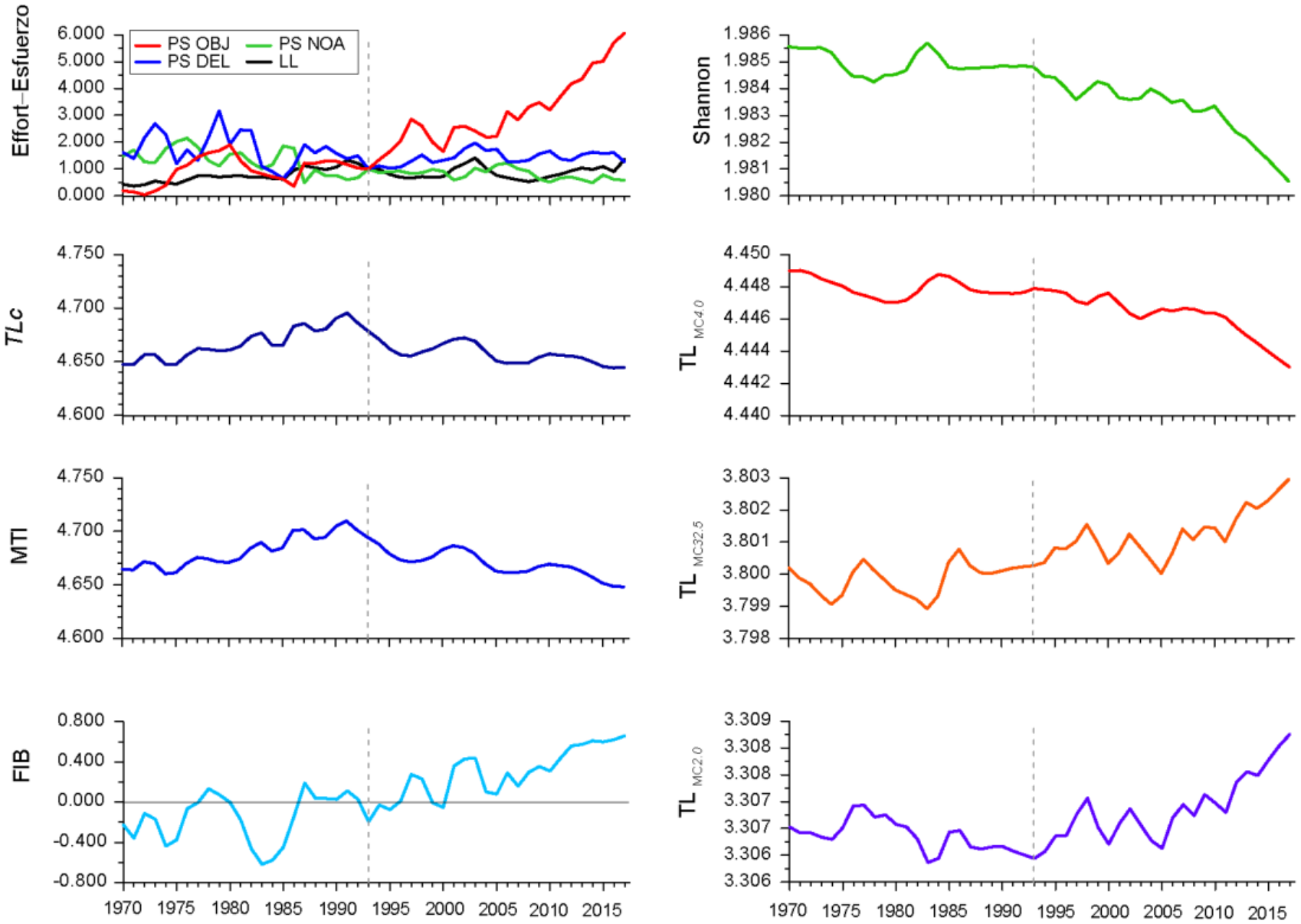
Historic changes in the structure of the ETP ecosystem for the period 1970-2018

Fishing-based indicators



- Nominal fishing effort scaled from 1993
  - Start of the artificial FAD fishery
- TL_c and MTI declined by 0.05 for 1991-2017
  - Change in TL_c of ≥ 0.1 per decade is significant
- FIB below zero since 2007
  - Catch lower than expected given available productivity 1992-96
  - Increasing FIB > 0 from 1993 indicates expansion of fishery

Community-based indicators



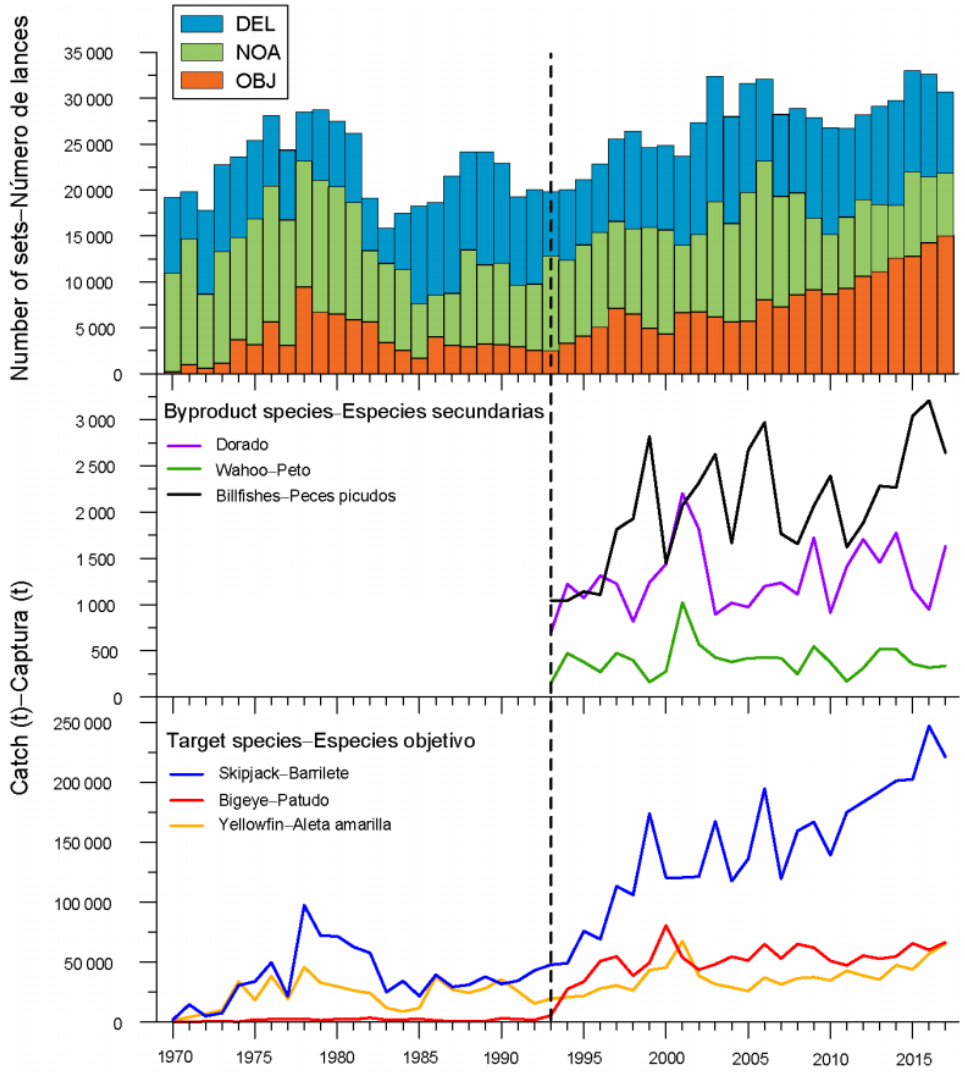
- Declining “evenness”
  - Changing relative biomass
- Alternating biomass trends by TL
  - Decline of predators (>4.0)
  - Increase of prey (3.25-4.0)
- Minor trophic cascade
- Continued trend from 2014, certainly requires monitoring

Results

Assessing the potential impacts of FAD fishing on the dynamics of the ETP ecosystem

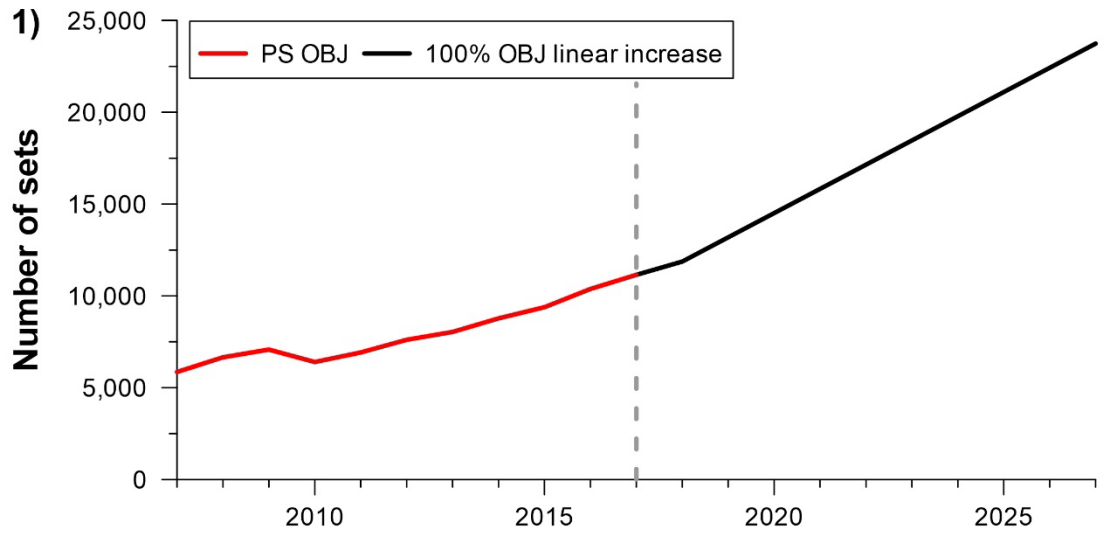
Potential ecological impacts of FADs

- OBJ sets have continued to increase by nearly 50% every 5 years
- Increase catch of SKJ, BET, YFT
- Increasing catch of bycatch species
  - Sharks (e.g. silky, hammerheads)
- Increasing retention of ‘byproduct’
  - Wahoo
  - Dorado
  - Rainbow runner
  - Billfishes
- EwE can explore ‘what if’ scenarios



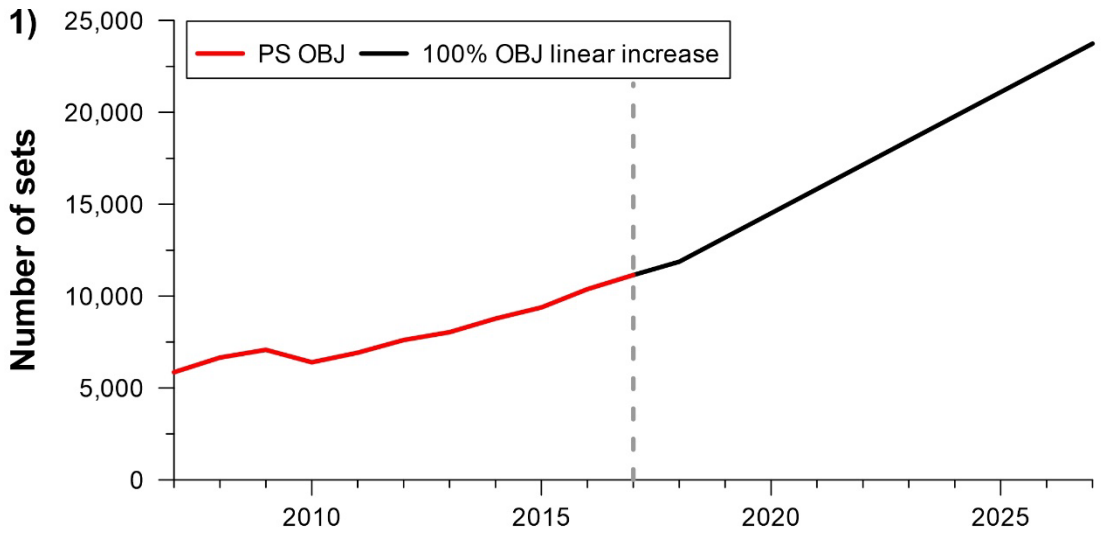
Modelled scenarios

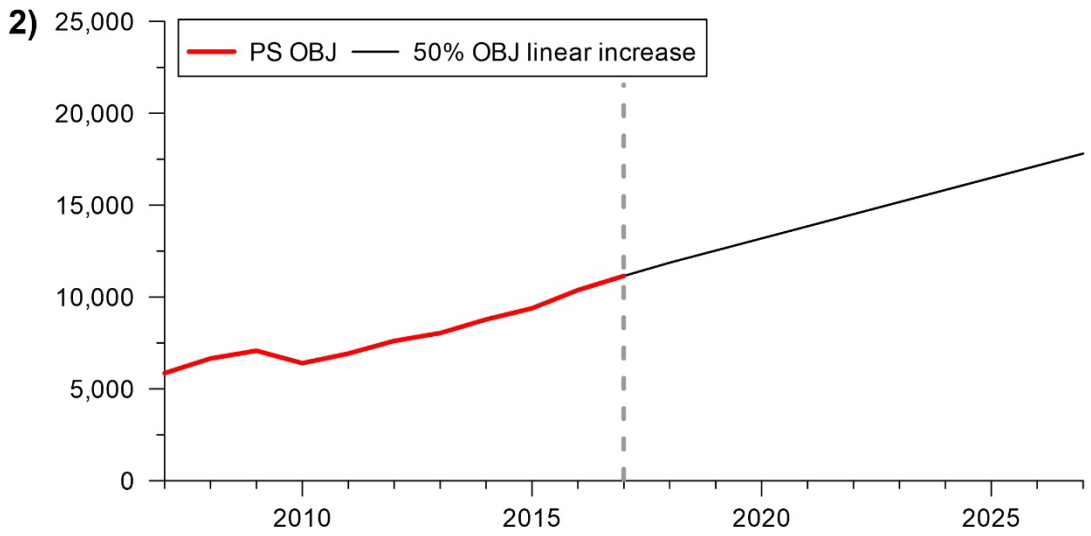
1. Continue current rate of increase in FAD effort: 100% over 10 yrs



Modelled scenarios

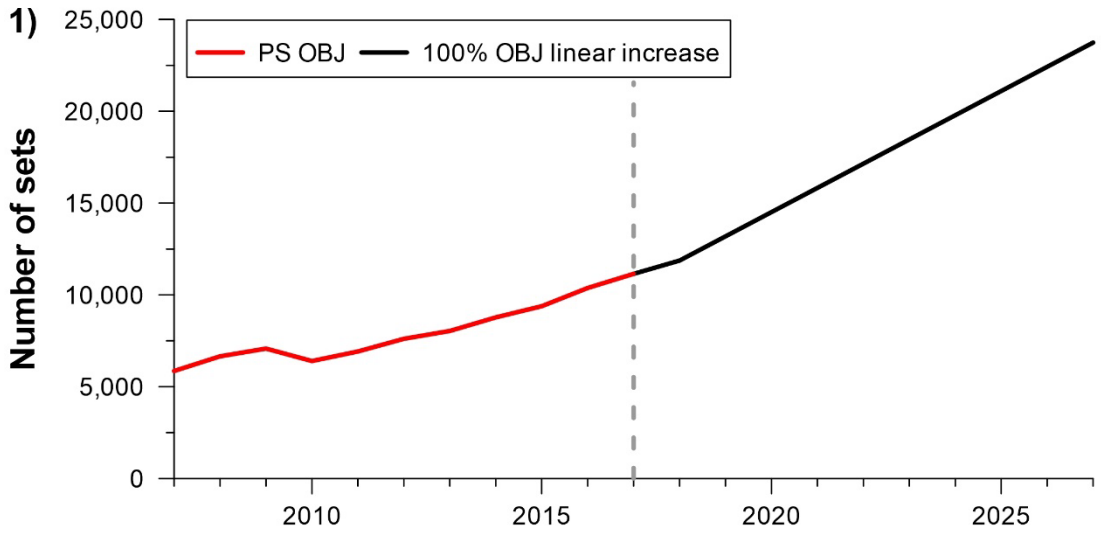
2. Halve the current rate of increase in FAD effort: 50% over 10 yrs

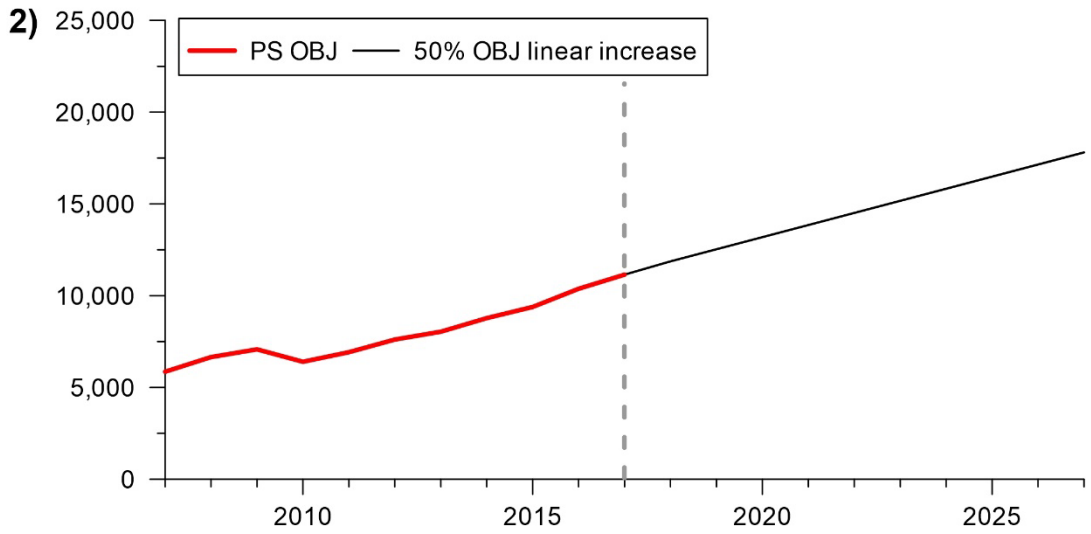


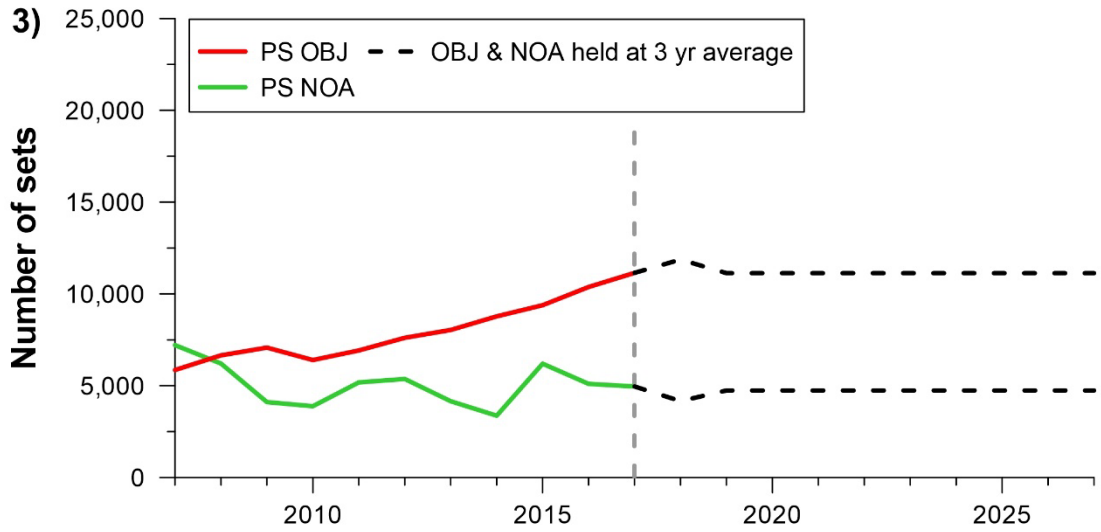


Modelled scenarios

3. Hold OBJ and NOA effort fixed at the average no. of sets in 2016-2018

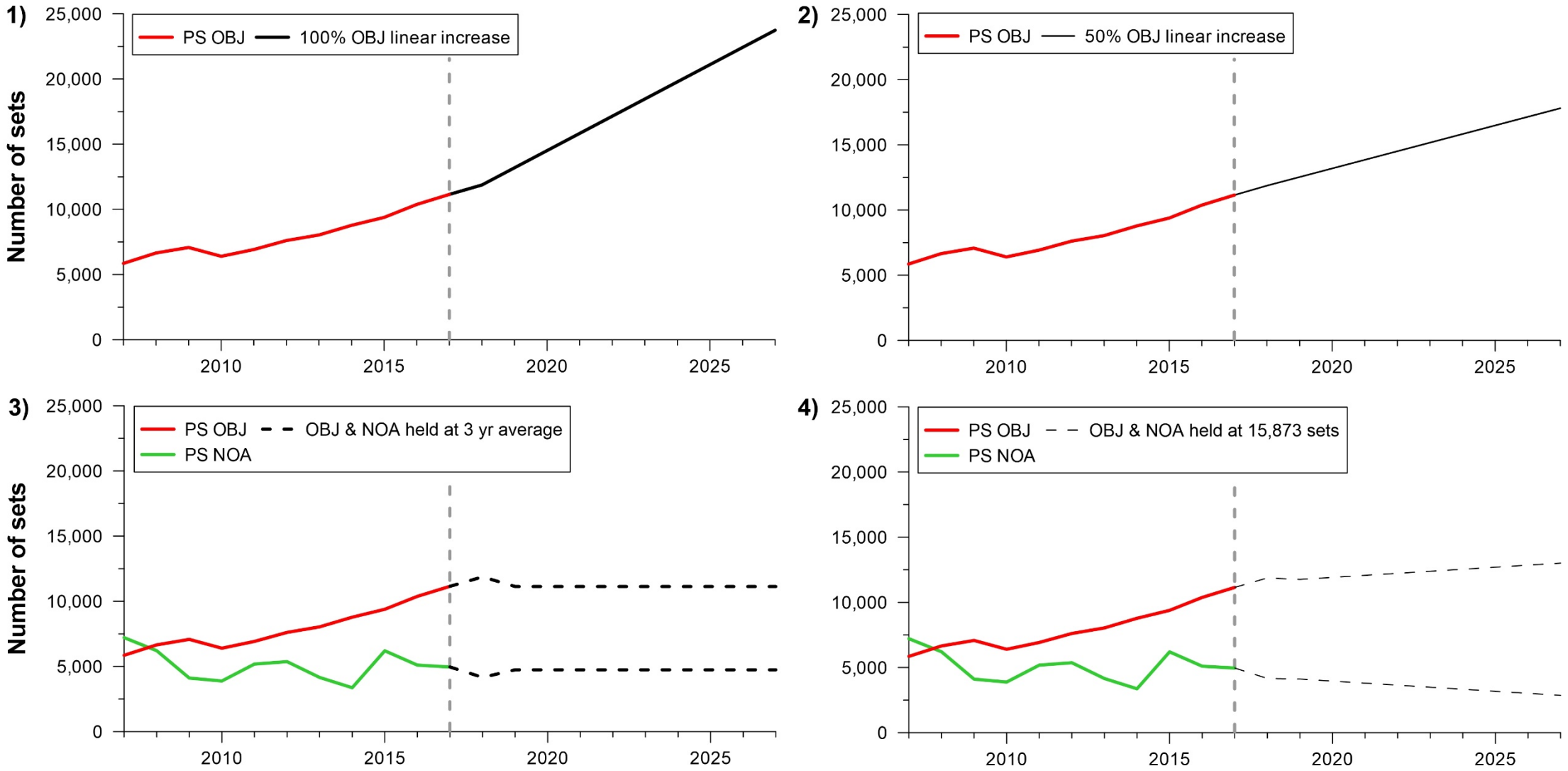






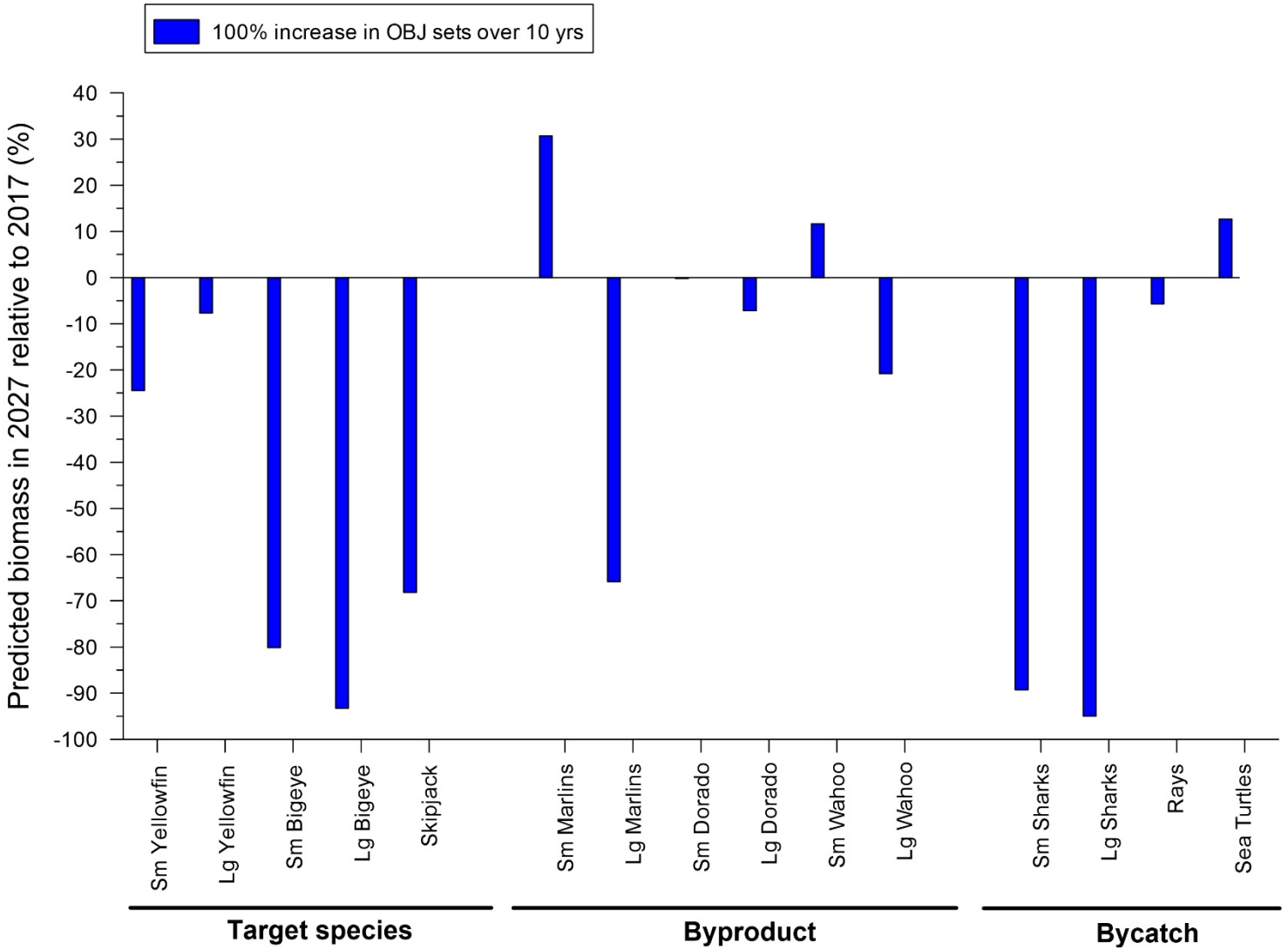
Modelled scenarios

4. Limit OBJ and NOA sets to 15,837; OBJ increase by 1% per yr, NOA decline



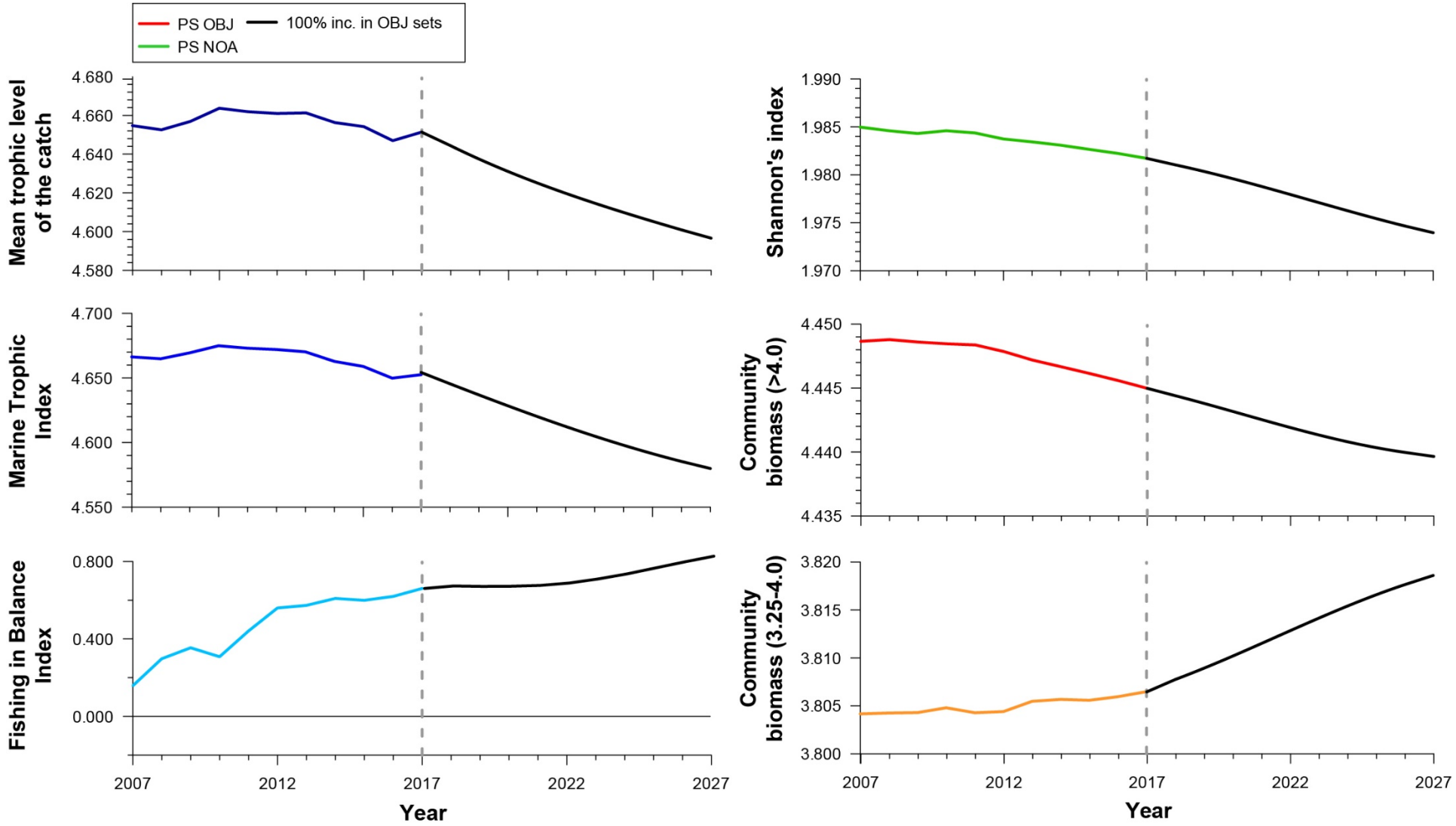
1) Increase FAD effort by 100% over 10 yrs

- Biomass of BET, SKJ, marlins and sharks decrease significantly



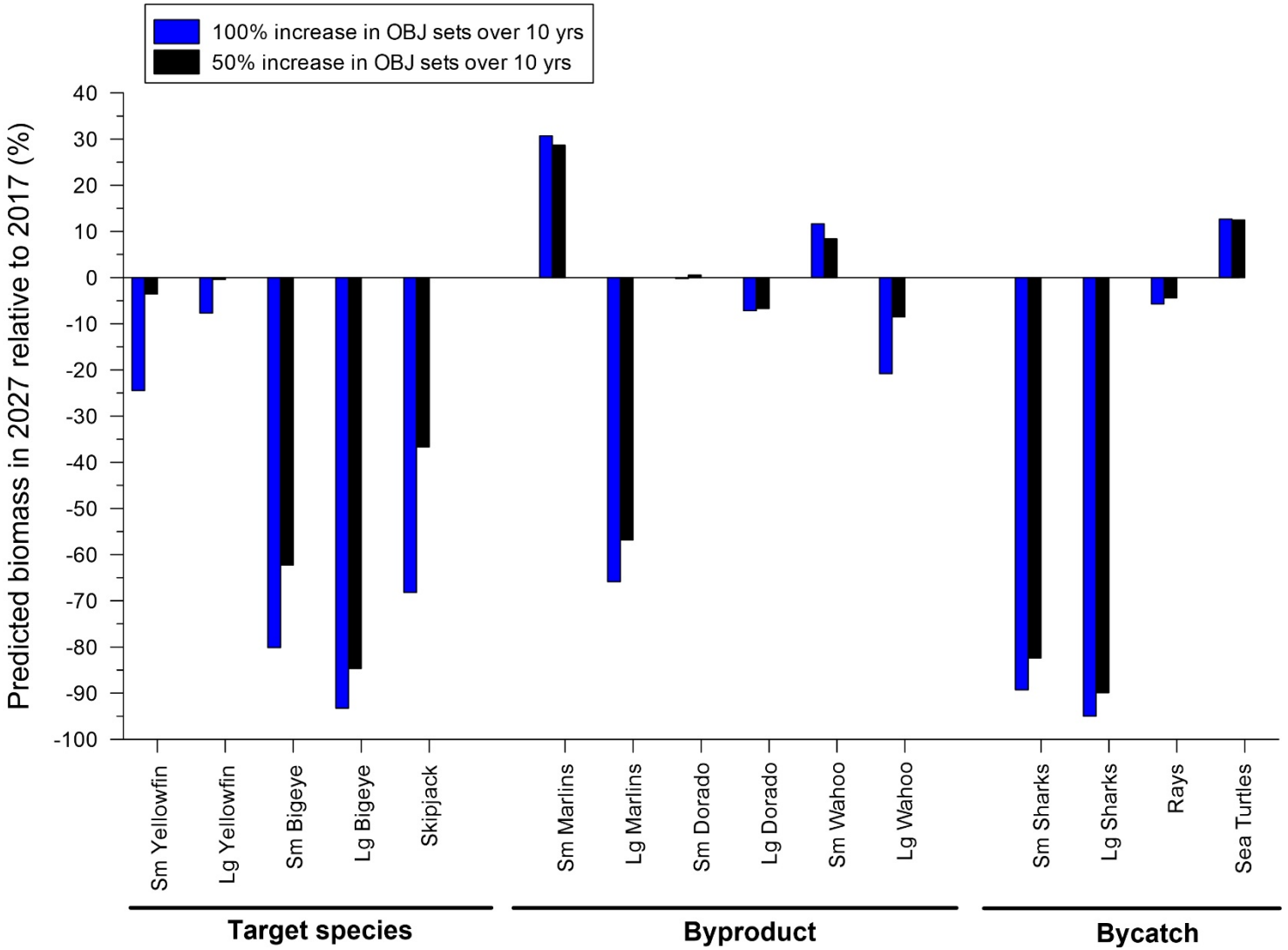
1) Increase FAD effort by 100% over 10 yrs

- Significant decline in TLc, MTI, Shannon's, TL>4.0; increase FIB & TL 3.25



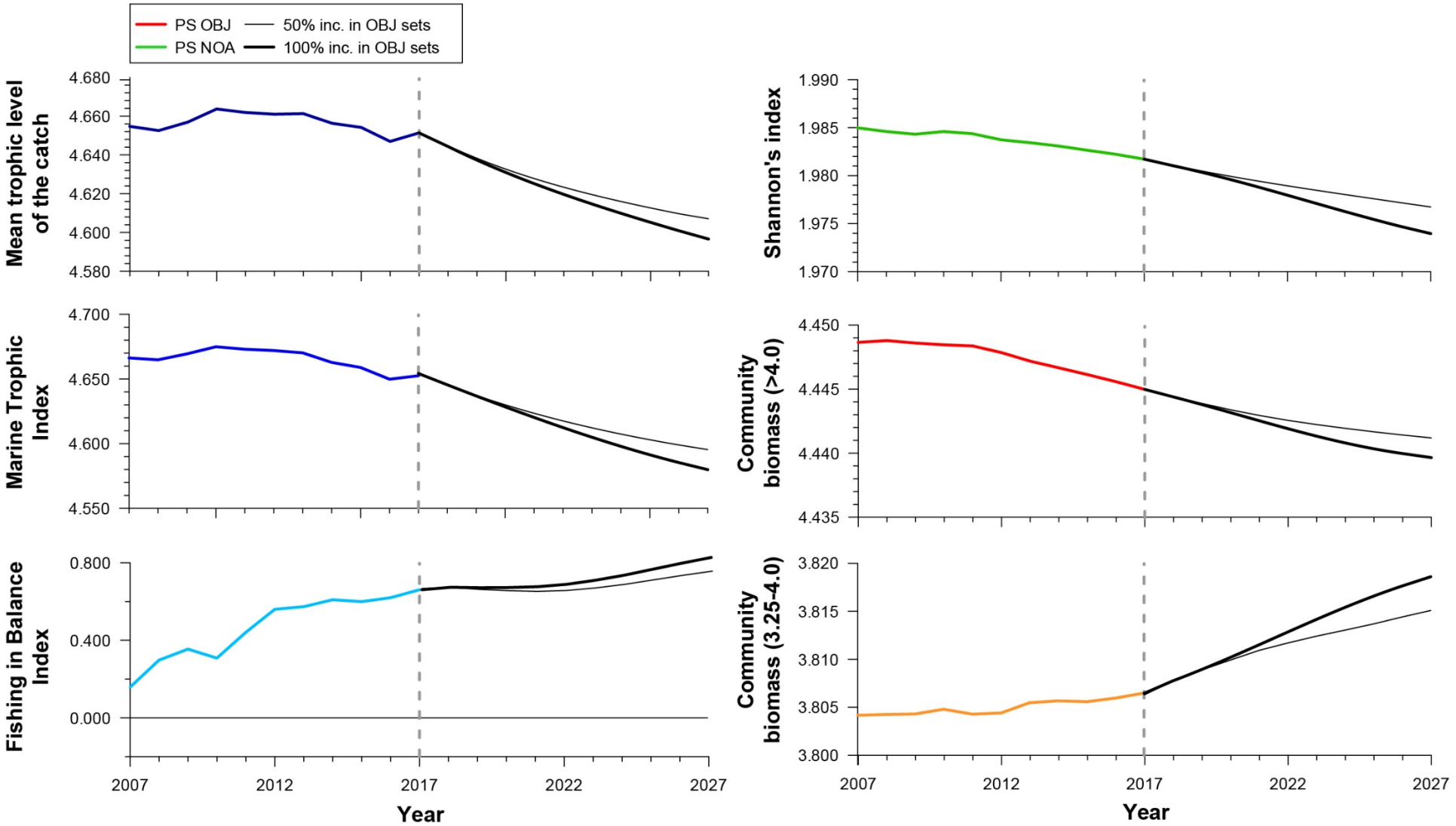
2) Decrease rate of FAD effort by 50% over 10 yrs

- Biomass of BET, SKJ, marlins & sharks decrease slightly less than Scenario 1



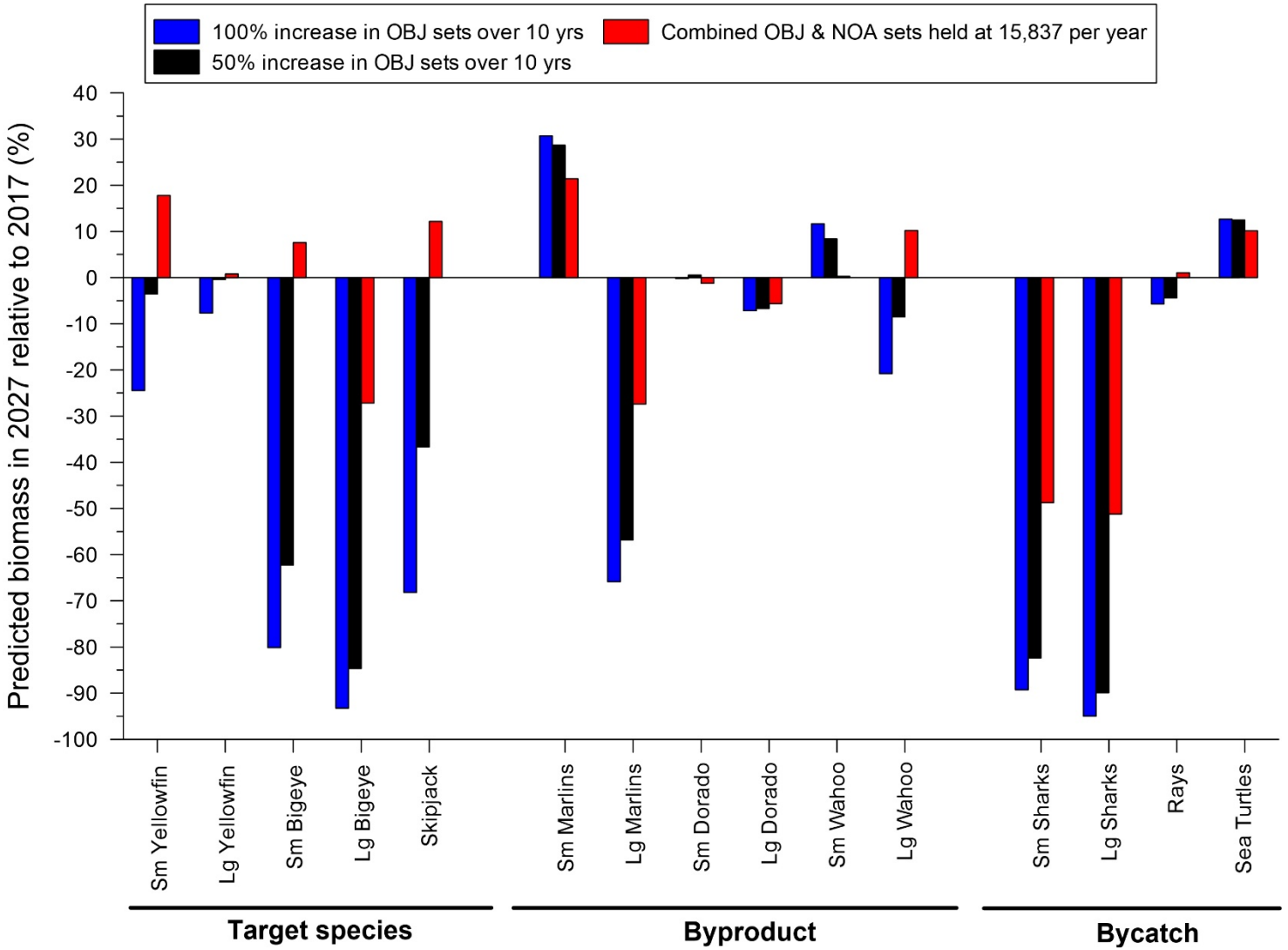
2) Decrease rate of FAD effort by 50% over 10 yrs

- Marginal improvement relative to Scenario 1



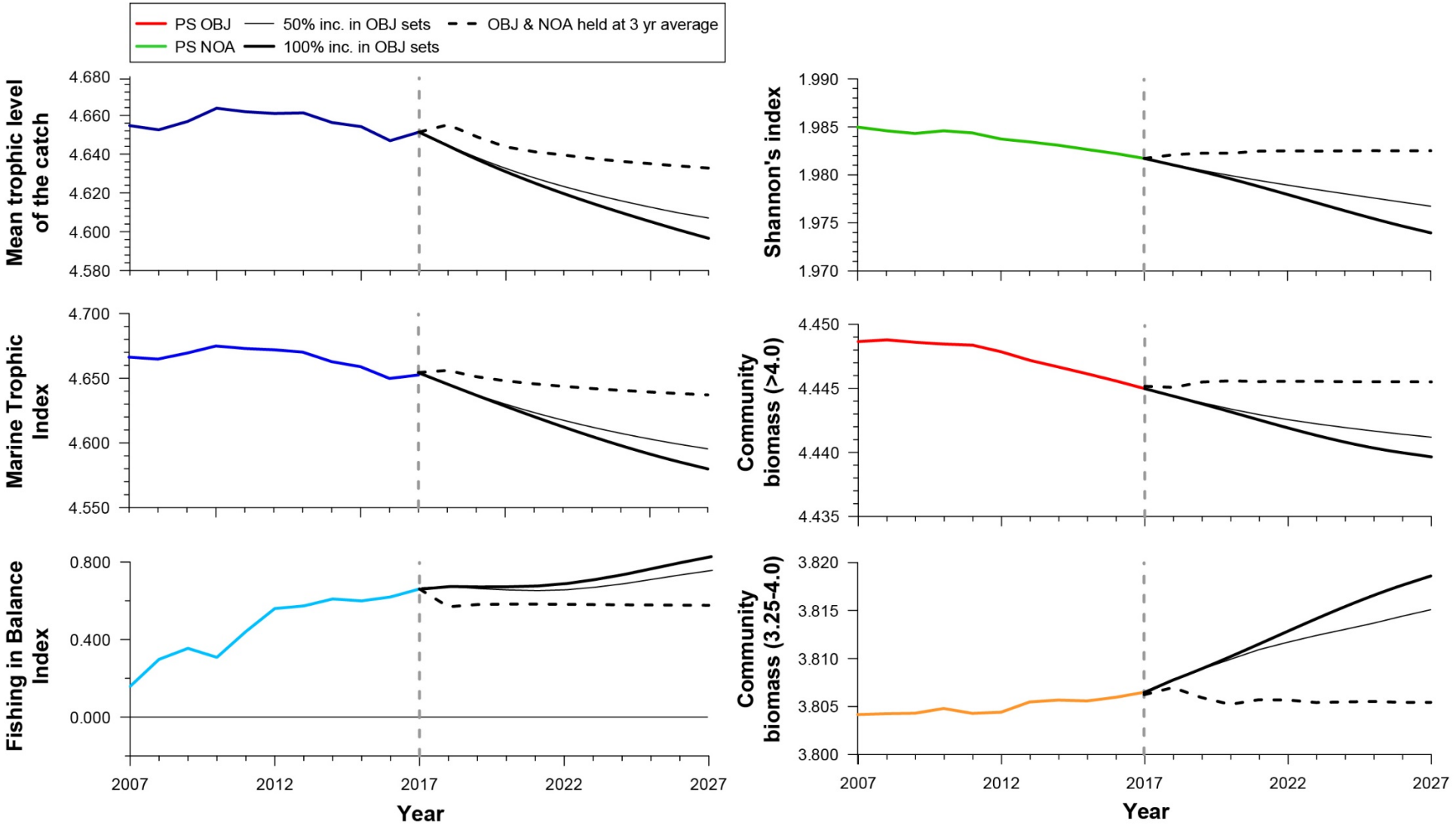
3) Combined OBJ & NOA sets fixed at 3-yr average

- Biomass of Lg BET, marlins & sharks decrease less than Scenarios 1 & 2



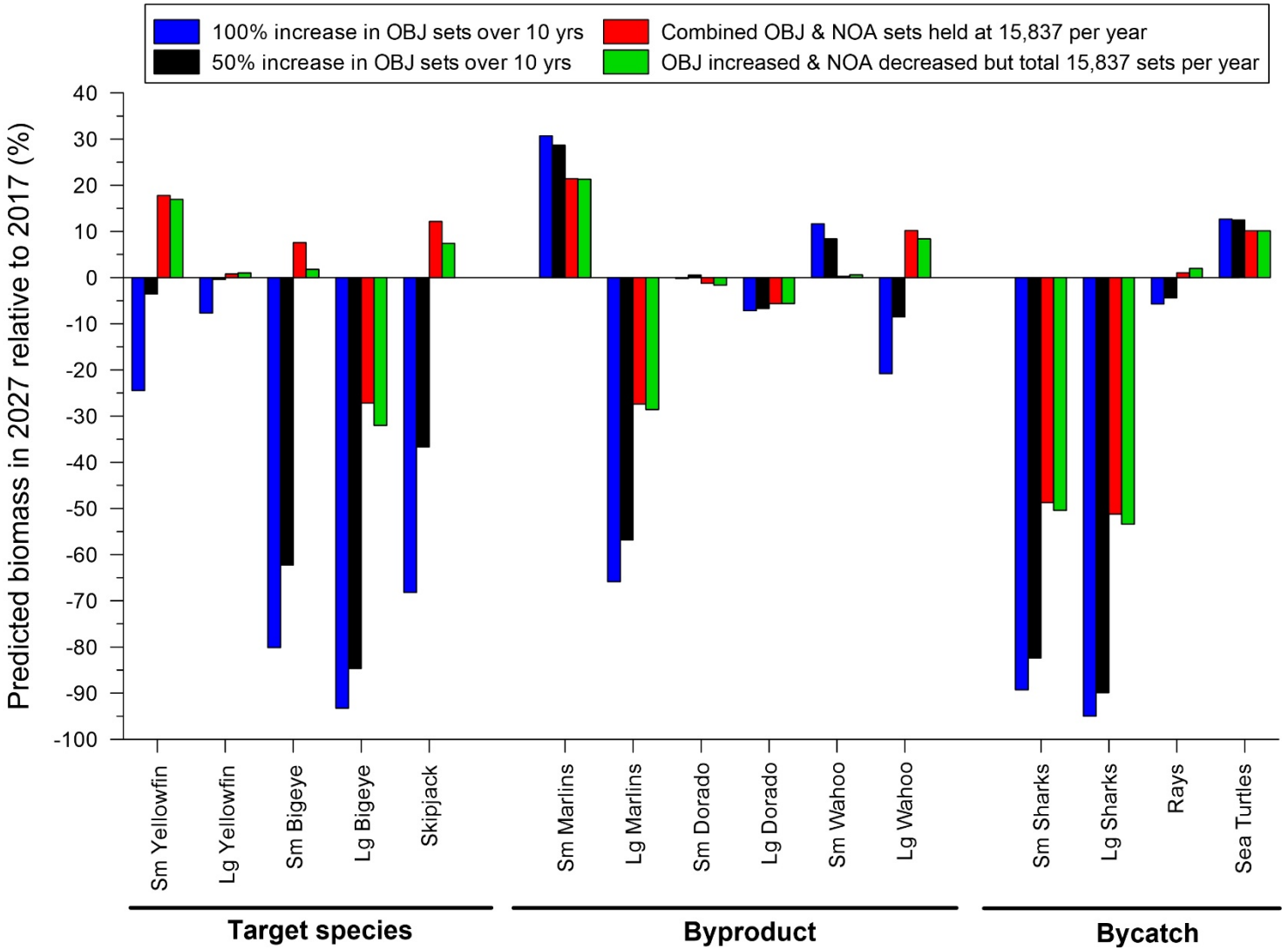
3) Combined OBJ & NOA sets fixed at 3-yr average

- Slight decline in TLc, MTI, but maintenance of other indicators



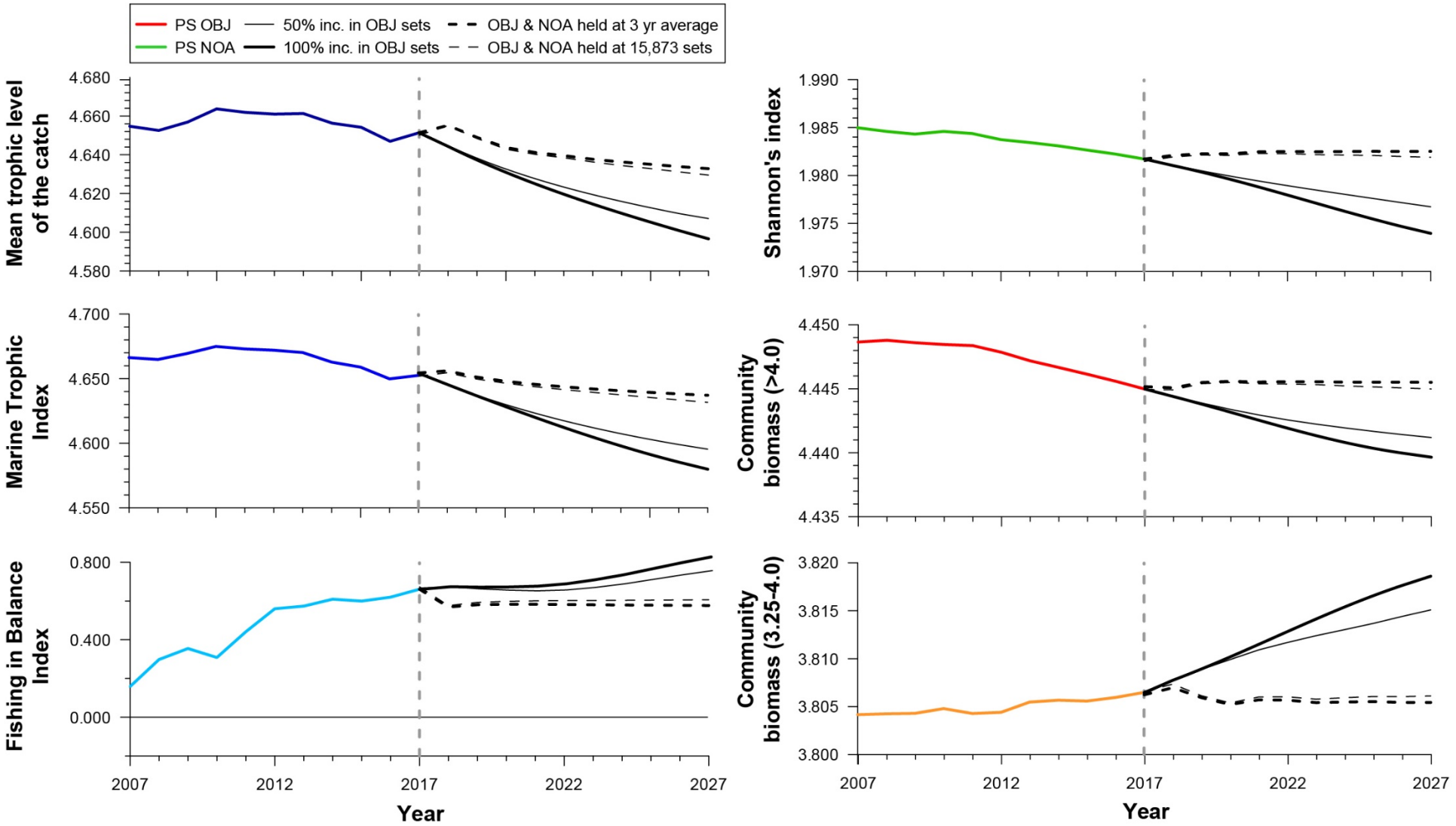
4) Combined OBJ & NOA sets fixed at 15,837

- Biomass of Lg BET, marlins & sharks decrease slightly more than Scenario 3



4) Combined OBJ & NOA sets fixed at 15,837

- Nearly identical results as Scenario 3, but slightly more pessimistic

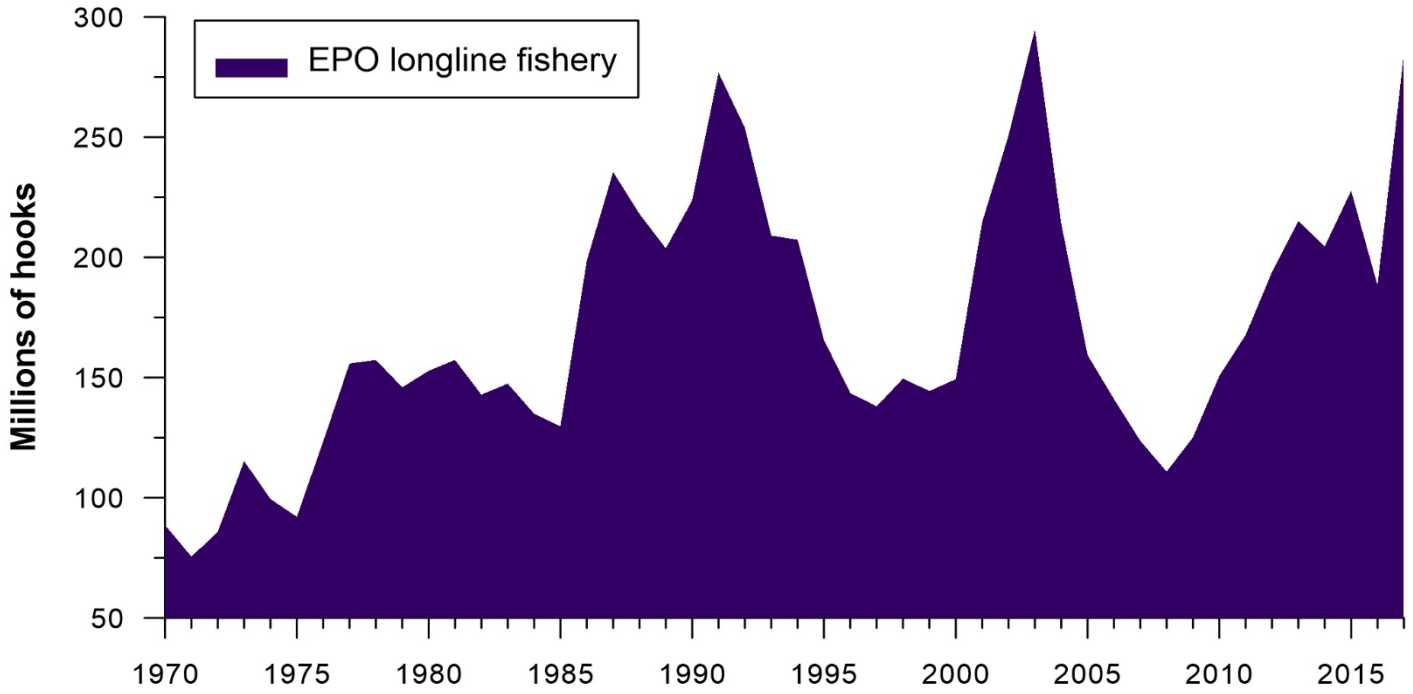


Summary

- The structure of the ecosystem has undergone substantial change over the history of the EPO tuna fishery.
- Changes most significant since the early 1990s coinciding with the dramatic increase in FAD sets, increasing by ~50% every 5 years.
- Increase in FAD effort at the current rate (even 50%) is unsustainable from an ecological viewpoint.
- Limiting FAD effort to recent levels (2016-19) is a significant improvement, but likely too high to allow the ETP to recover.

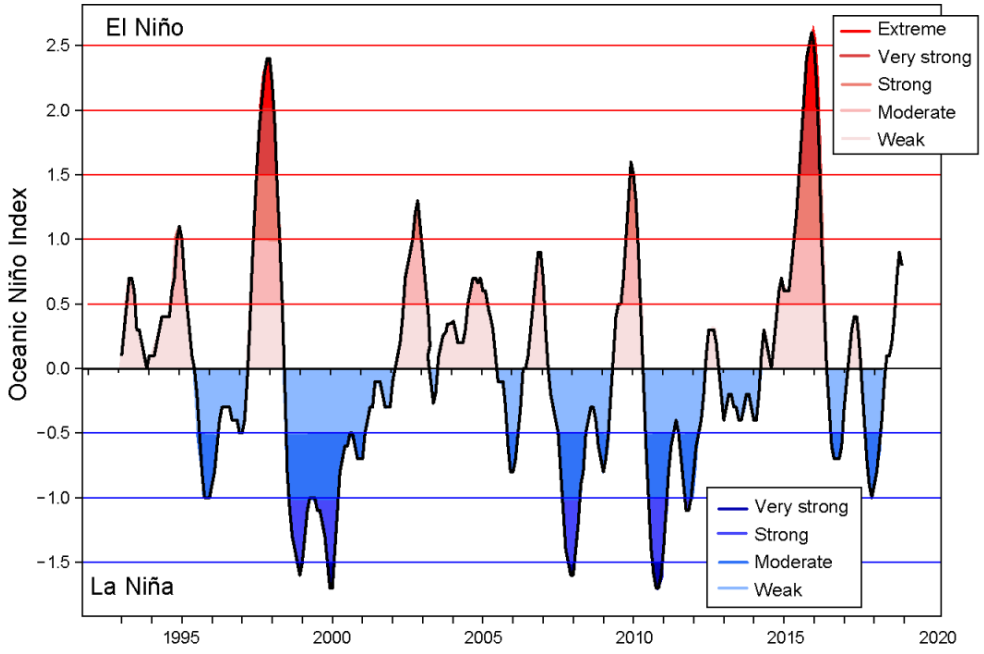
Important considerations

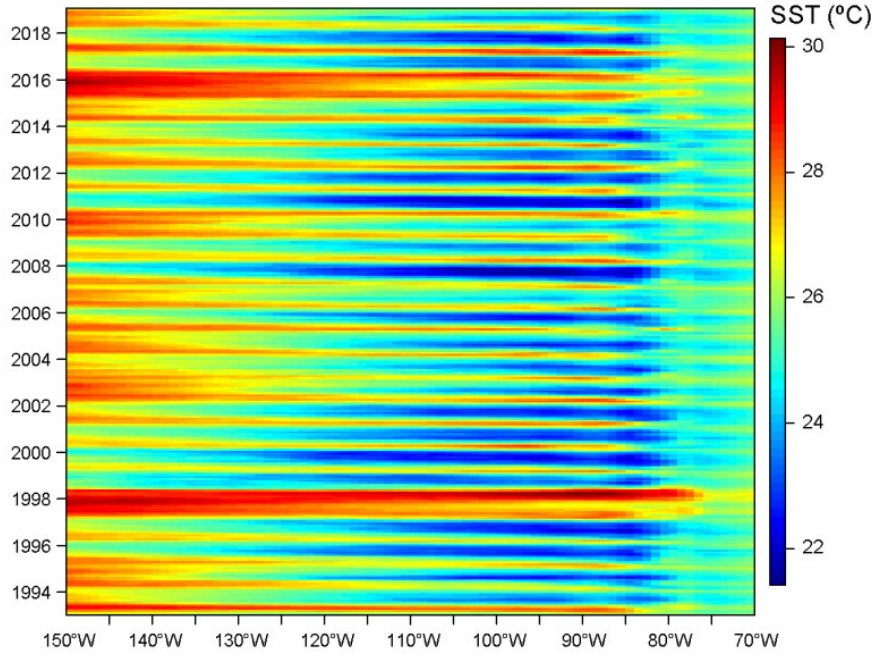
- Since our focus was on the FAD fishery, a strong assumption was effort by all other fisheries remained unchanged since 2017
- But, longline effort increasing since 2008, nearing historic high in 2017
- May explain the biomass decreases for Lg BET, marlins and sharks when FAD effort was reduced (Scenarios 3 & 4).



Important considerations

- Basis of the ecosystem model is outdated diet data from early 1990s
  - Since then FAD impacts may have altered predator-prey dynamics
  - EPO has experienced some of the strongest El Nino events on record
- A trophic ecology sampling program required to update diet matrix and other key model parameters (e.g. consumption rates - Q/B)





Questions?