Updated stock status indicators for the silky shark in the eastern Pacific Ocean (1994-2015)

SAC-07-06b(i)

Data and Methods

- Analyses based on purse-seine observer data, 1994-2015.

Floating-object sets

- Standardized "catch-per-unit-effort" trends estimated by:
  - area (north and south of the equator, and sub-areas within the north);
  - All silky sharks, and by total length (TL) category:
    - Small silky (< 90 cm TL)
    - Medium silky (90-150 cm TL)
    - Large silky (> 150 cm TL)
- Model used for standardization
  - Zero-inflated negative binomial generalized additive model (for number of sharks per set)
  - Predictors:
    - Year (factor);
    - Smooth terms: latitude, longitude, time of the set, day of the year;
    - Linear terms: net depth, floating-object depth, SST, log(non-silky bycatch), log(tuna catch), proxies for local object density.
- Indices are data-weighted indices.

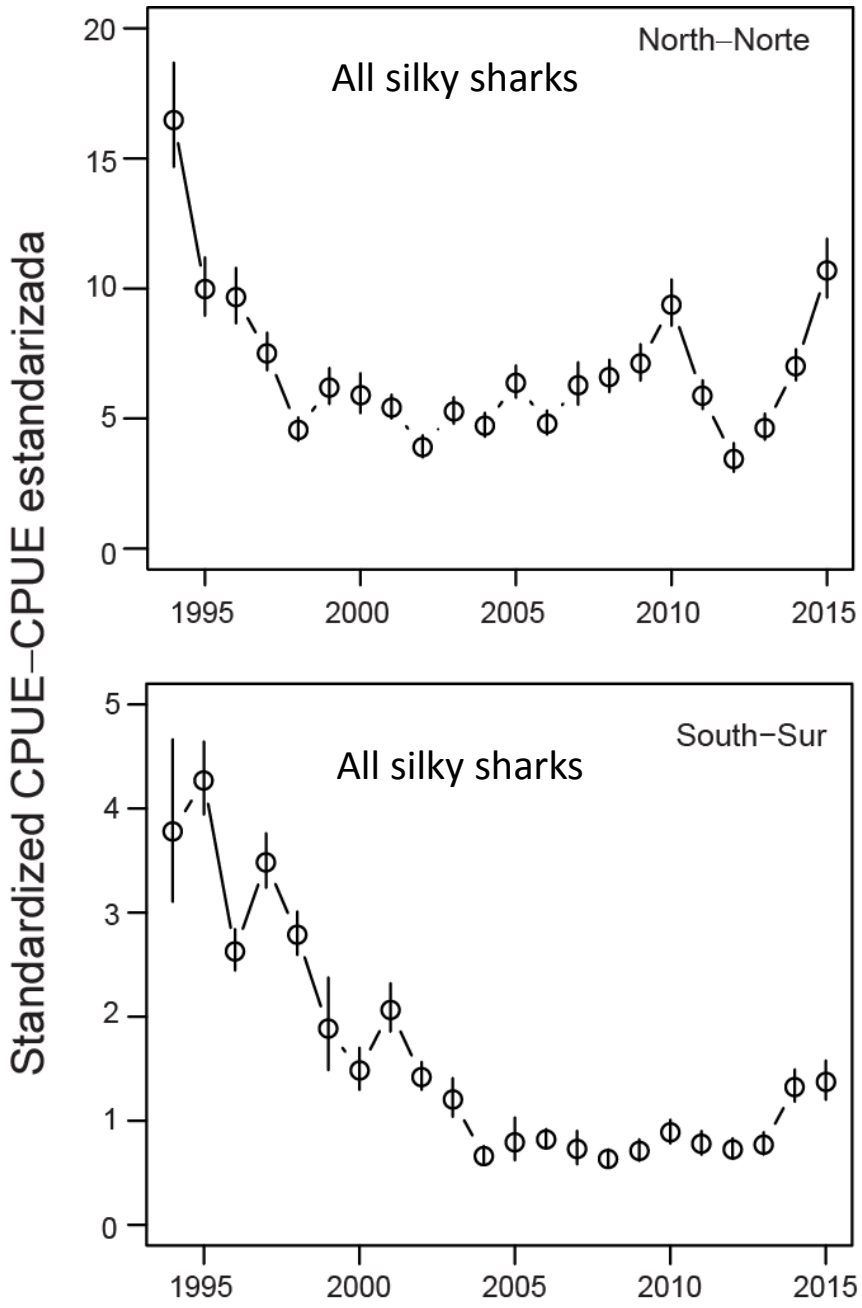
Data and Methods

Dolphin and unassociated sets

- Standardized presence/absence index for the northern EPO.

- Model used for standardization
  - Logistic regression model (for presence/absence of any silky sharks in the set)
  - Predictors:
    - Year (factor);
    - Smooth terms: latitude, longitude, time of the set, day of the year;
    - Linear terms: net depth, SST, duration of encirclement (and, duration of chase for dolphin sets).

- Indices are also data-weighted.

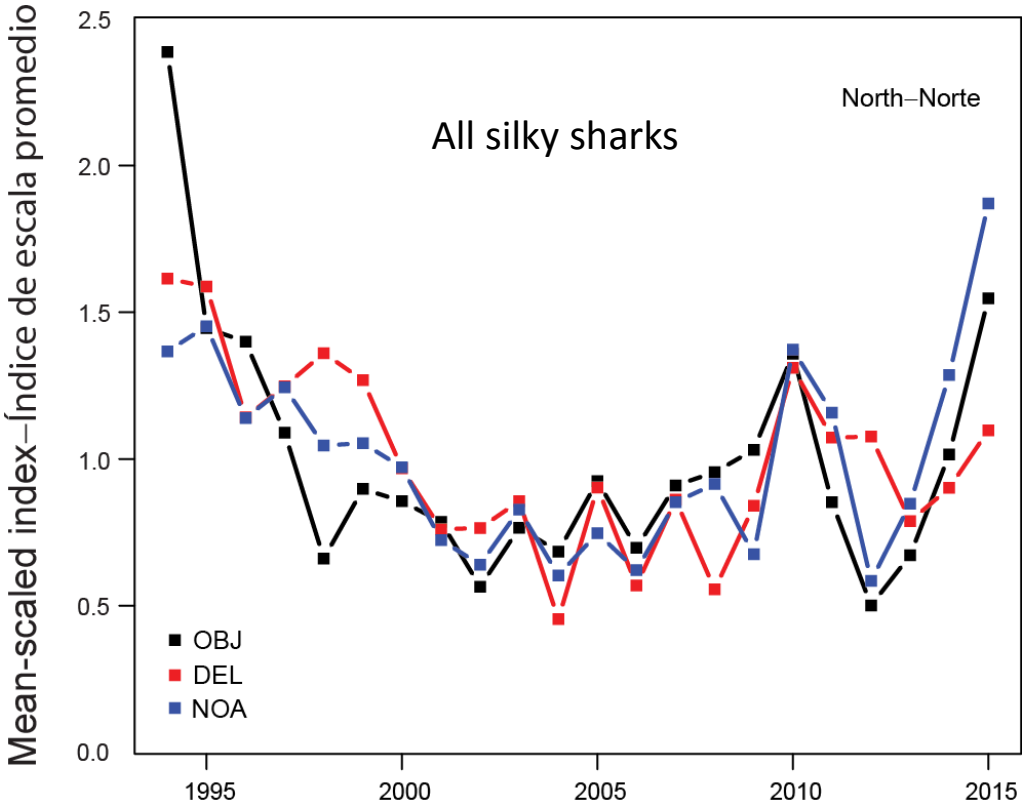


Northern EPO:

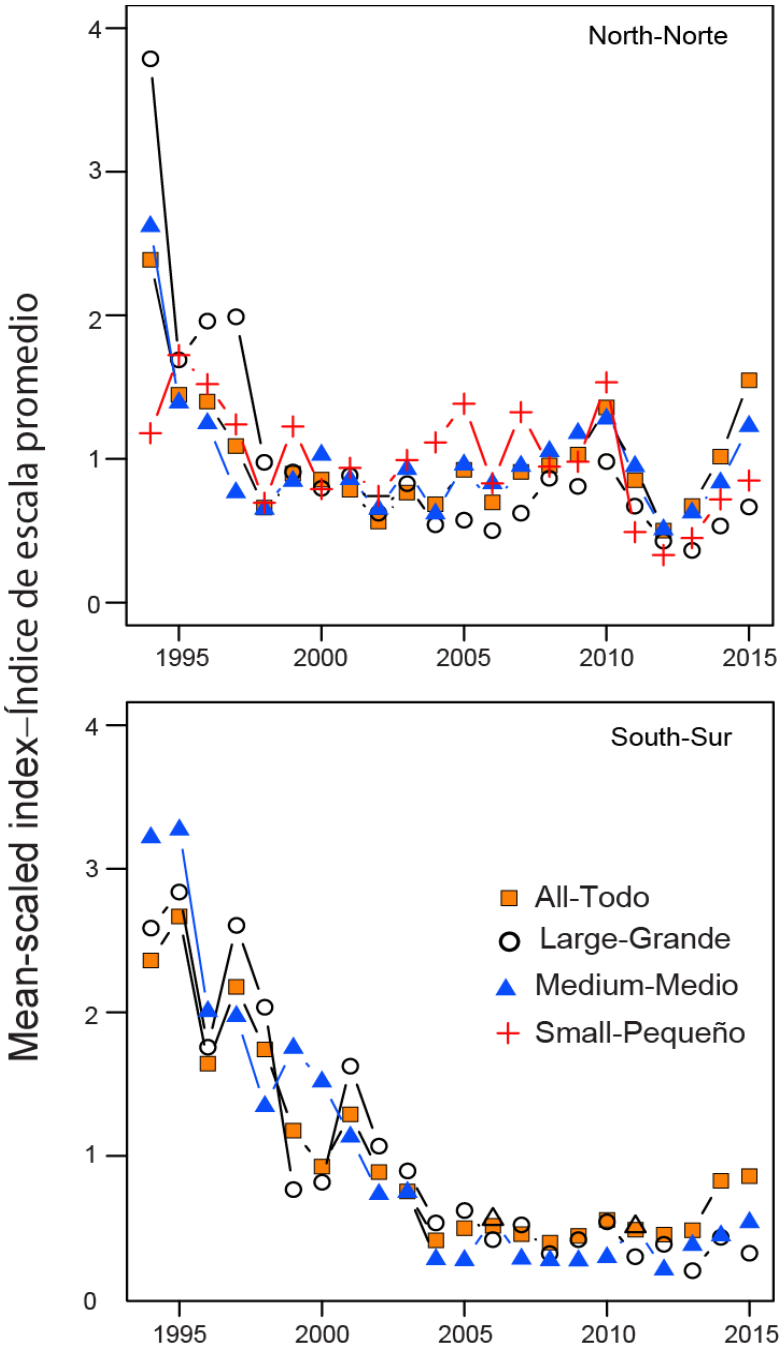
- Sharp decline, 1994-1998;
- Low level and relatively stable, 1999-2009;
- Sharp decrease and then increase, 2010-2015.

Southern EPO:

- Sharp decline, 1994-2004;
- Low level and relatively stable, 2005-2013;
- Slight increase, 2014;
- 2015 similar to 2014.



Northern EPO:
Presence/absence trends for dolphin and unassociated sets are, overall, similar to the floating-object set index.

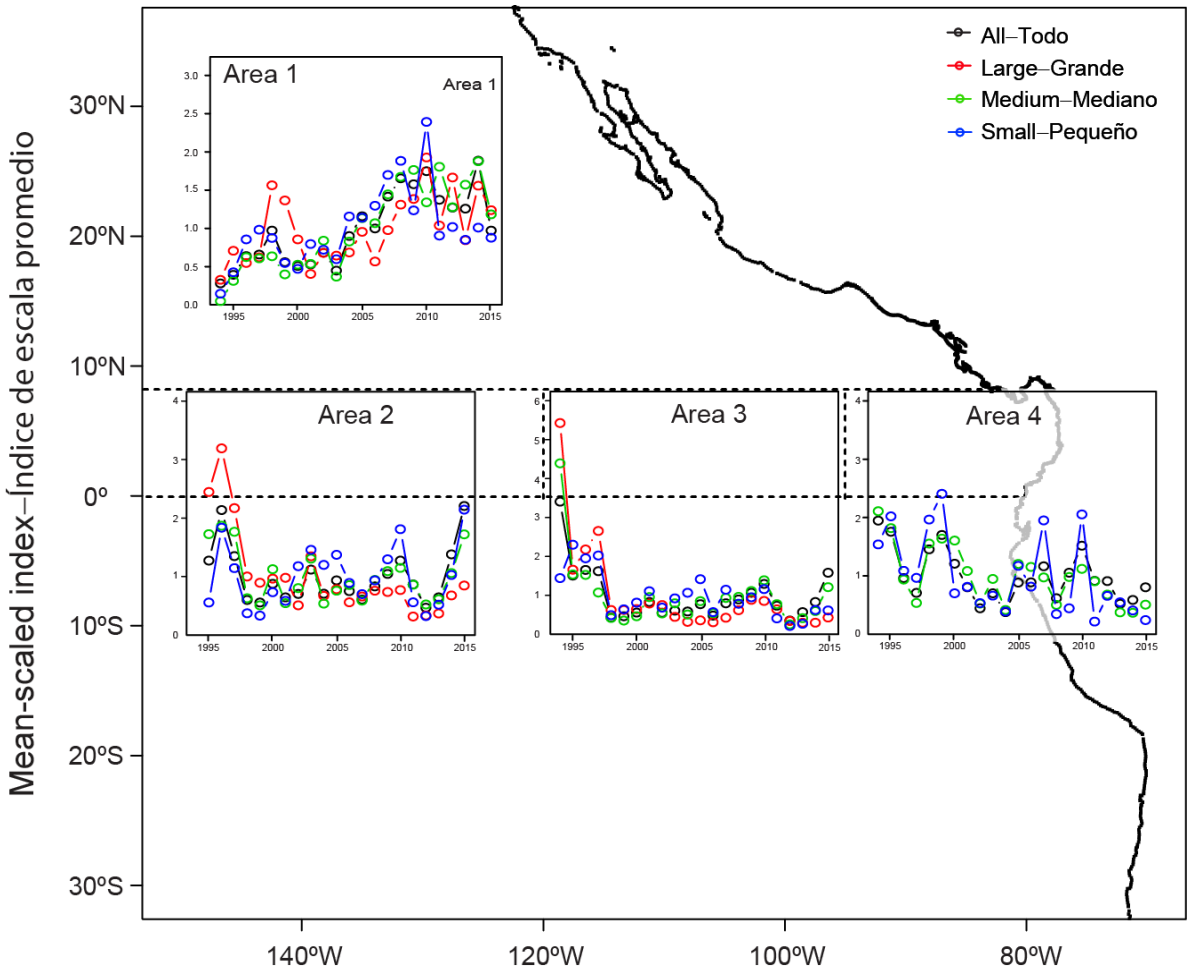


Northern EPO:

- Long-term trends by shark size category are similar;
- Year-to-year changes for small-shark trend differ somewhat prior to 2009;
- Might be expected if small-shark index is a proxy for recruitment;
- However, striking similarity between all three indices from 2009;
- Suggests that the recent changes in index may be due to movement and/or changes in catchability.

Southern EPO:

- Trends for medium and large sharks are similar;
- Trend for small sharks not computed due to low levels of bycatch.



- Floating-object set trends by sub-area in the north show differences.
- In particular, the recent increase is mostly occurring in offshore equatorial waters.
- Thus, the overall index likely reflects an integration of spatially-distinct processes, including increased fishing pressure closer to the coast and movement into the EPO from outside.

Conclusions and Future Work

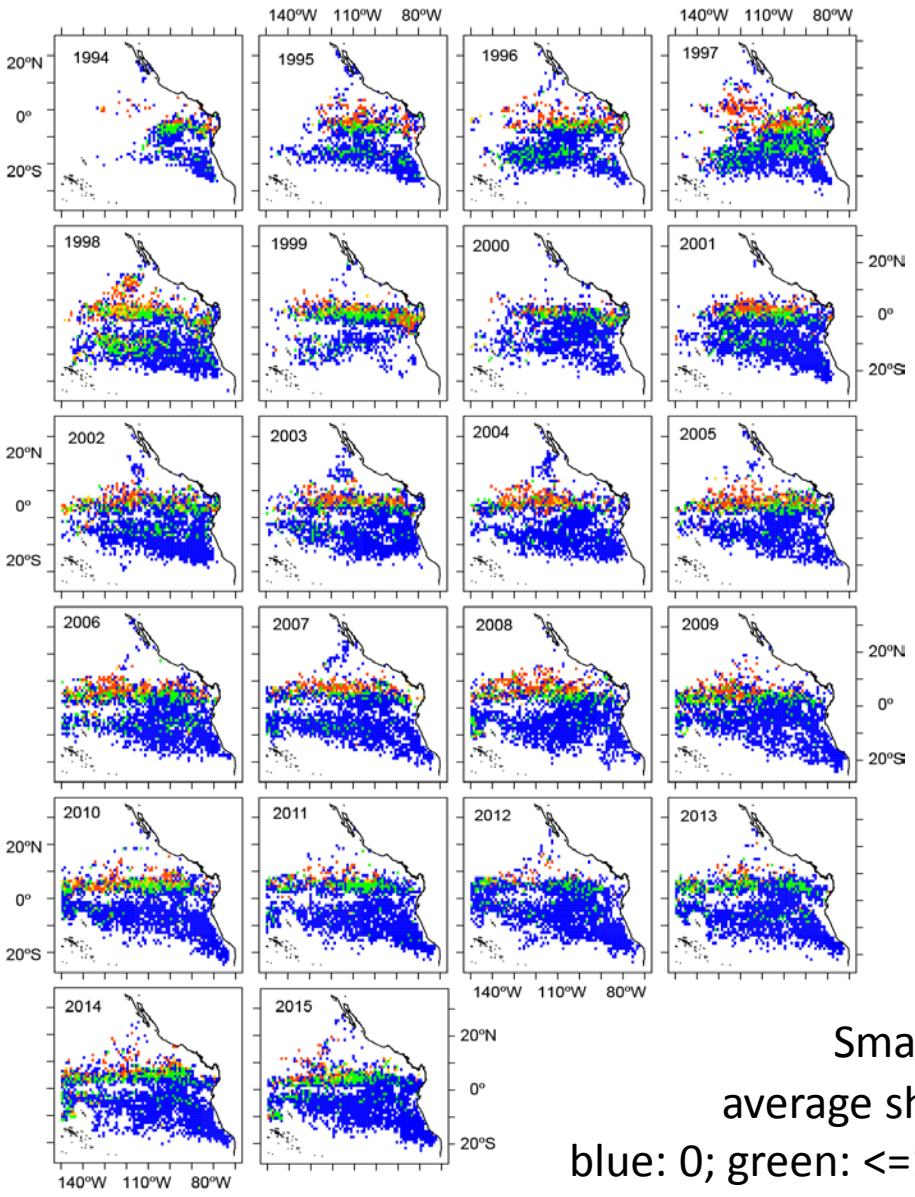
- Because of spatial differences in northern sub-area indices, and of similarity between indices by size category in recent years, the staff does not consider the recent increase in the indices to be sufficient grounds to change the recommendation for precautionary action.

- It is critical that data be collected from other sources in the EPO so that additional indices can be computed.

- Given spatial differences in the northern sub-area indices, future work will include:
  - Adding more environmental covariates to standardization models;
  - Developing an area-weighted index;
  - Comparing these indices to indices for other species groups.

- And, unconditional variance estimates also will be developed.

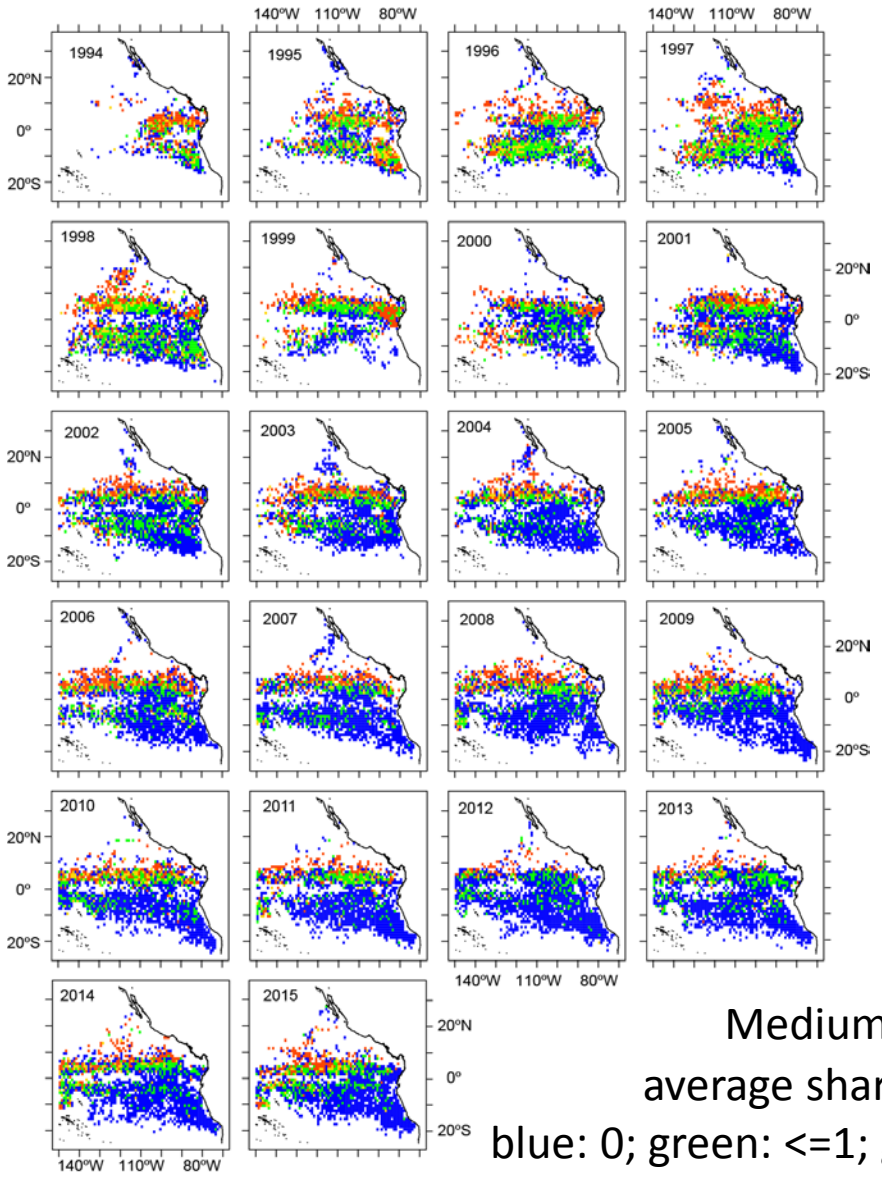
Extra slides



Small silky

average sharks-per-set

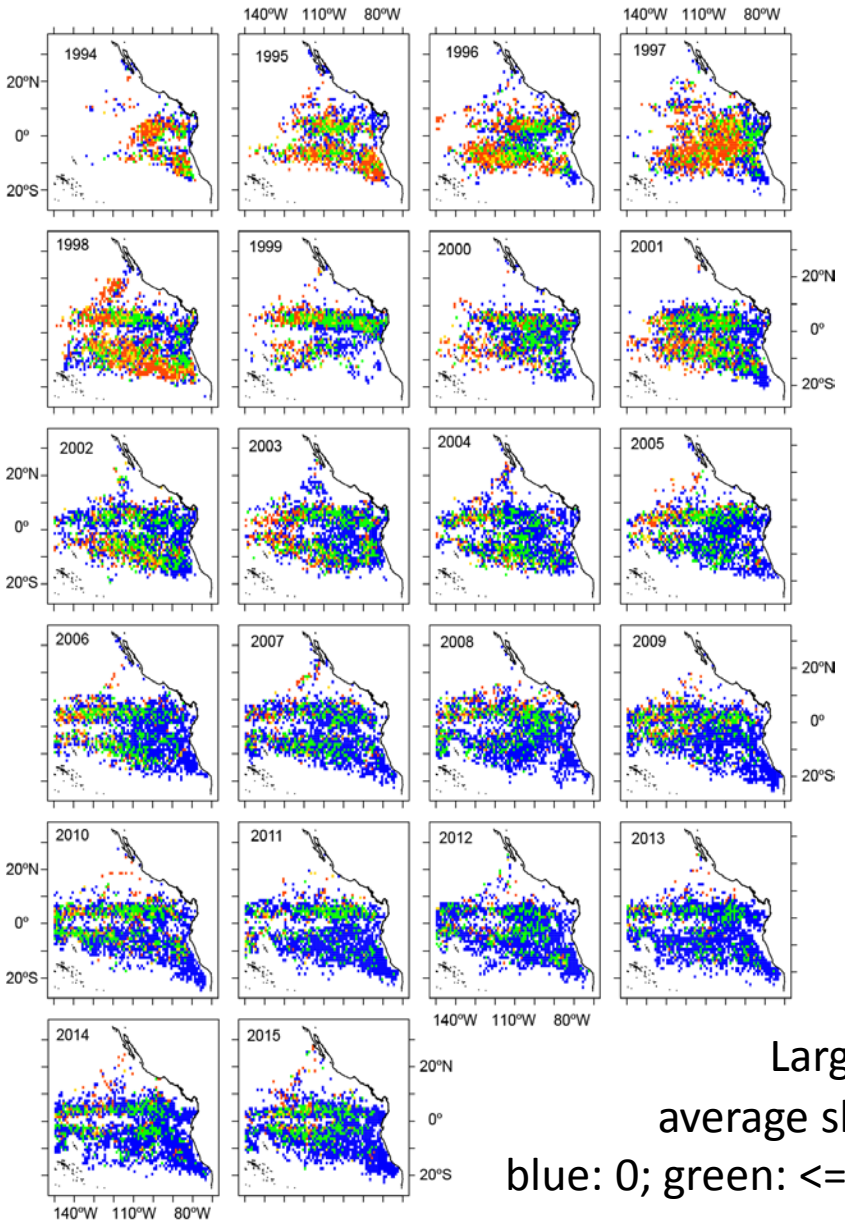
blue: 0; green: <=1; gold: 1-2; red: >2



Medium silky

average sharks-per-set

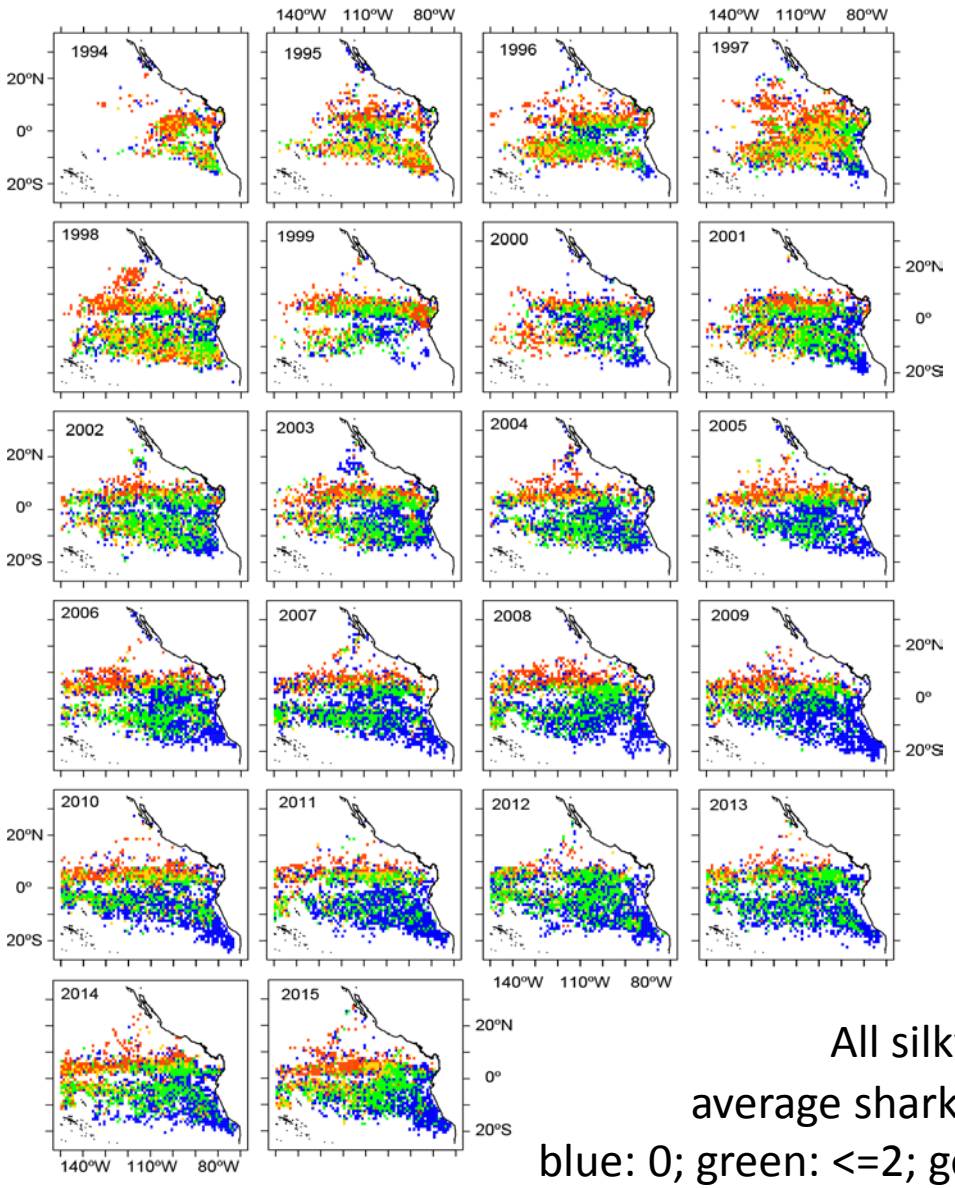
blue: 0; green: <=1; gold: 1-2; red: >2



Large silky

average sharks-per-set

blue: 0; green: <=1; gold: 1-2; red: >2



All silky

average sharks-per-set

blue: 0; green: <=2; gold: 2-5; red: >5