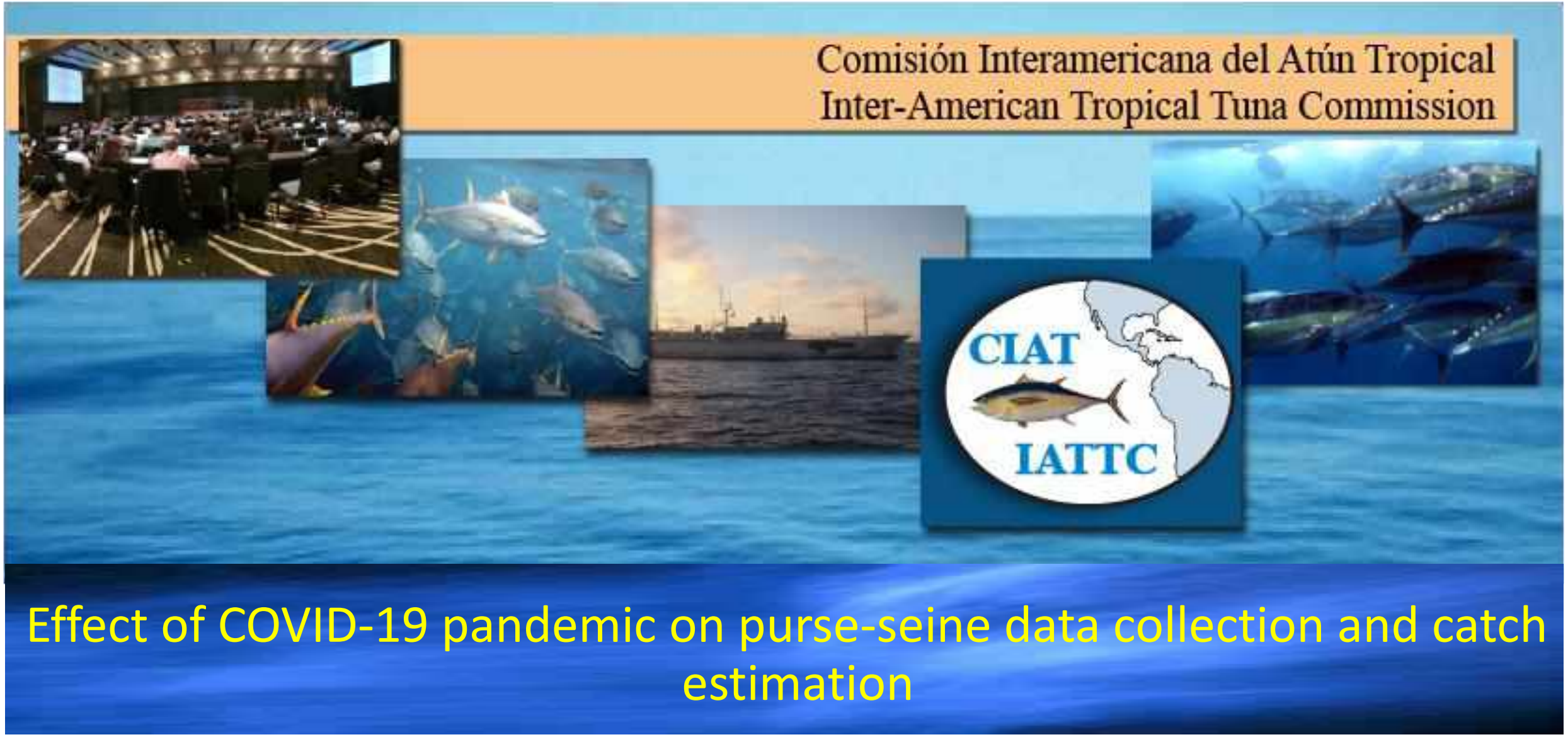


Effect of COVID-19 pandemic on purse-seine data collection and catch estimation

Data Review Workshop, La Jolla, California, USA, 2-6 October 2023

Presentation overview

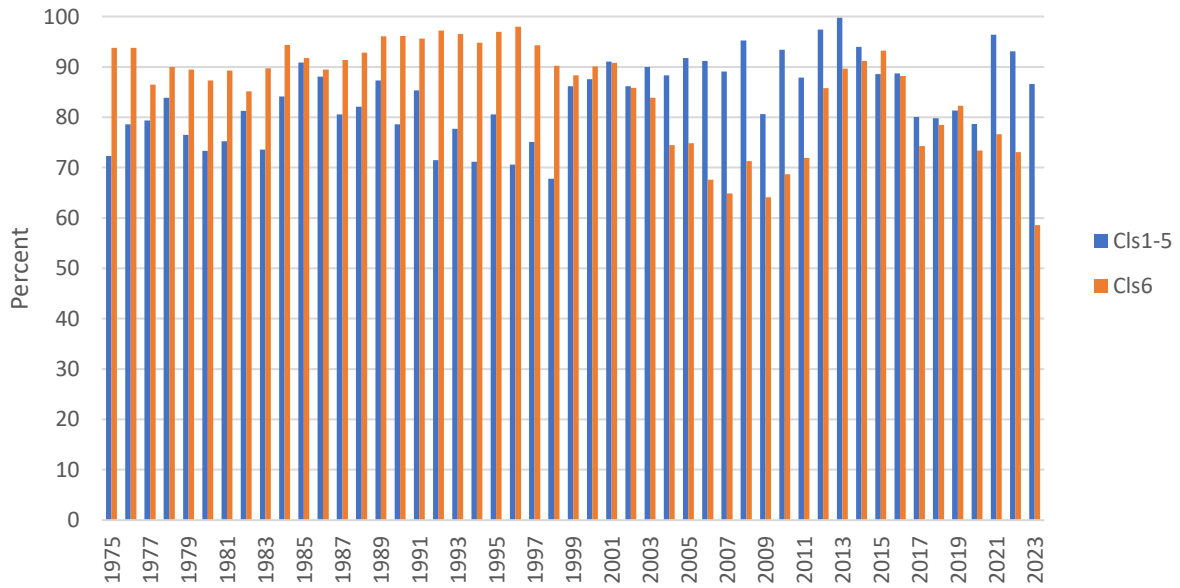
- Effect of pandemic on data collection
  - Canner/processor
  - Logbook
  - Observer
  - Port-sampling

- Effect of pandemic on catch estimation
  - Identifying effect of pandemic on bigeye (BET) catch estimation for the floating-object (OBJ) fishery
  - Estimating bias of OBJ catch estimates (all 3 species) due to pandemic-related data loss

Effect of pandemic on data collection

- The pandemic had limited effect on collection of observer, logbook, and Class-6 vessel cannery data.
- There appears to be more of an effect on Class 1-5 vessel cannery data.
- However, for catch estimation, logbook (observer) data would be used in place of cannery data, if no cannery data available.

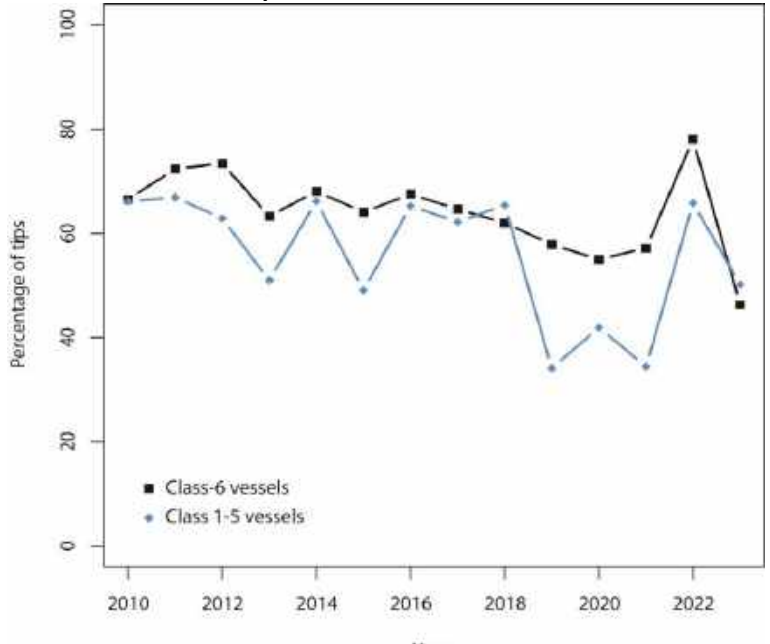
Logbook data: coverage of trips



Observer data (Class-6 vessels): coverage of trips

Year	Total Number trips	Percent Observed
2020	788	95%
2021	841	94%
2022	814	97%

Canner/processor data: Percentage of trips for which catch data were reported from at least one cannery

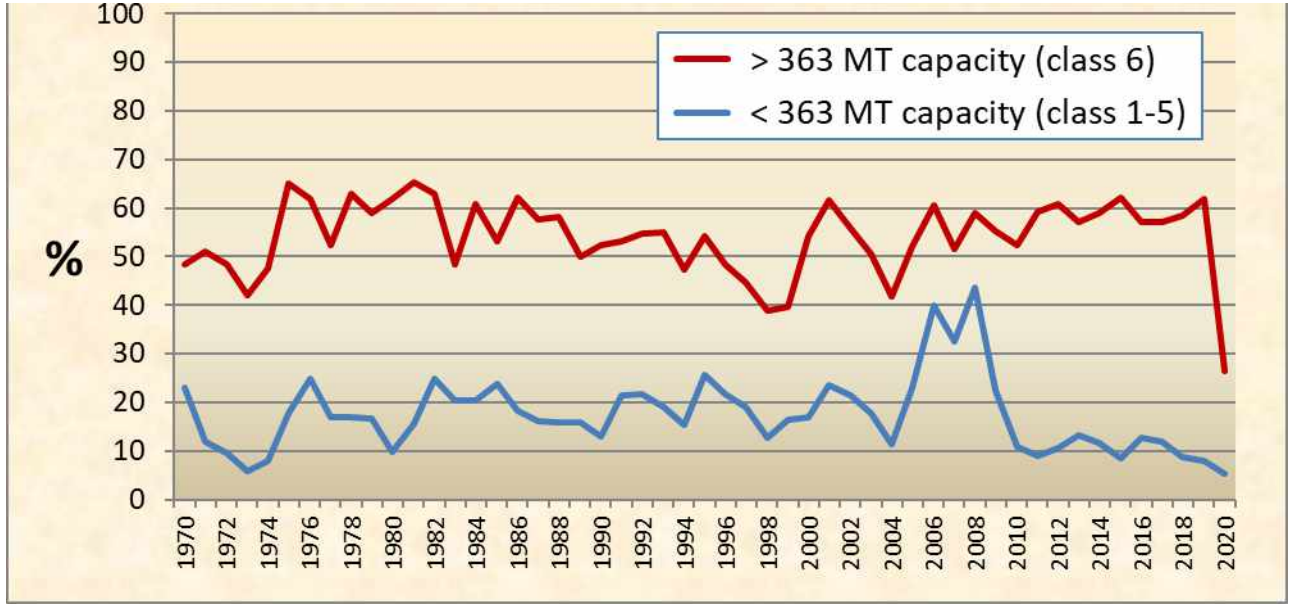


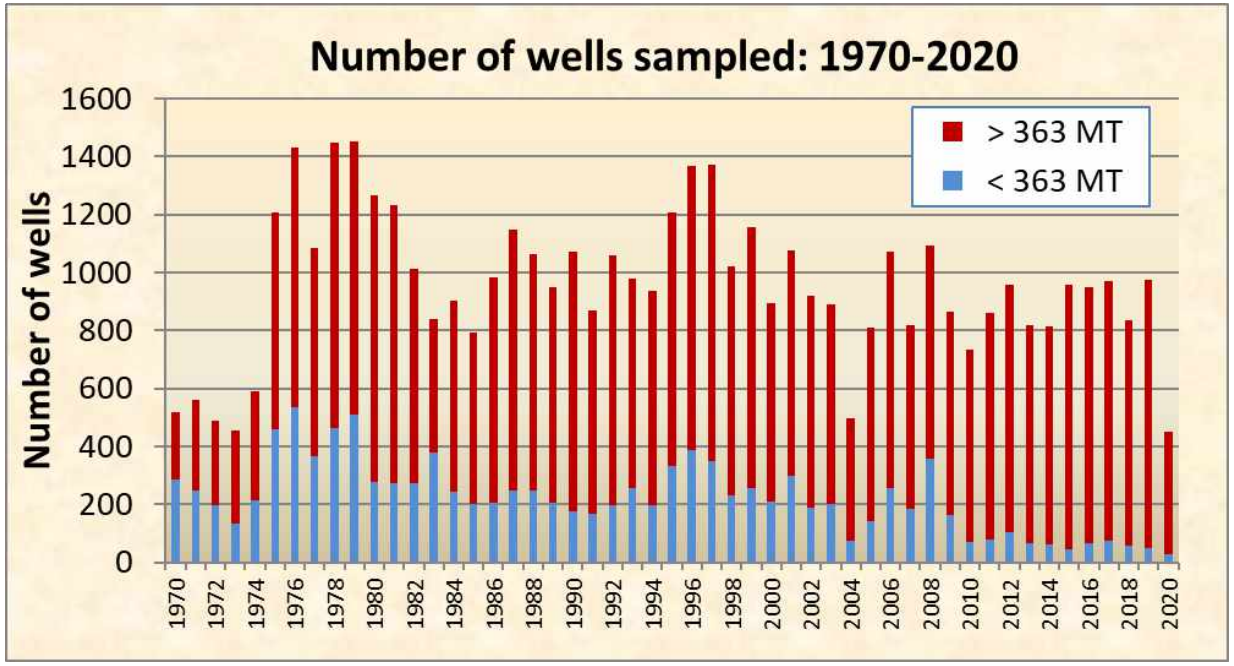
Effect of pandemic on data collection

Port-sampling data

- Typically, more than 800 wells sampled per year since 1975.
- In 2020 and 2021, only 456 and 634 wells, respectively, were sampled.
- Port-sampling data are the only data source used to estimate species composition (2000 onwards).

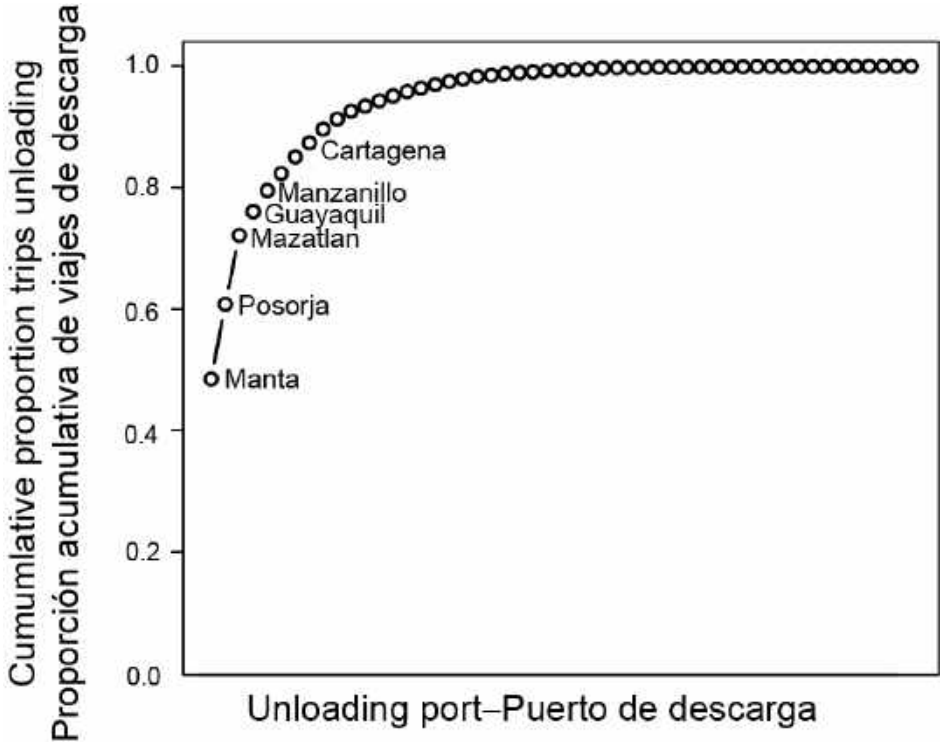
Percentage of trips sampled: 1970 - 2020

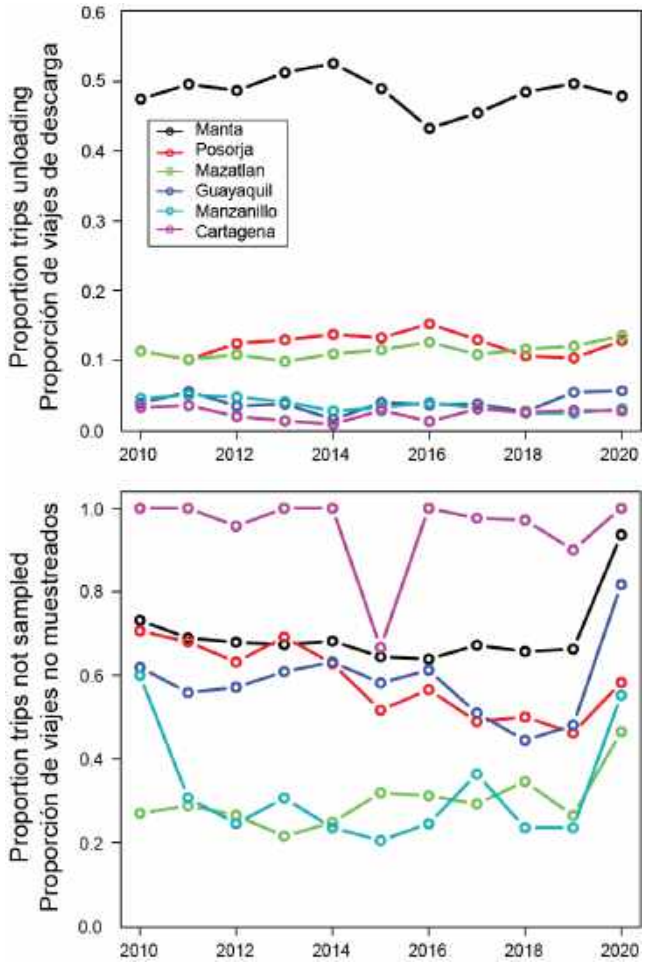




Effect of pandemic on data collection

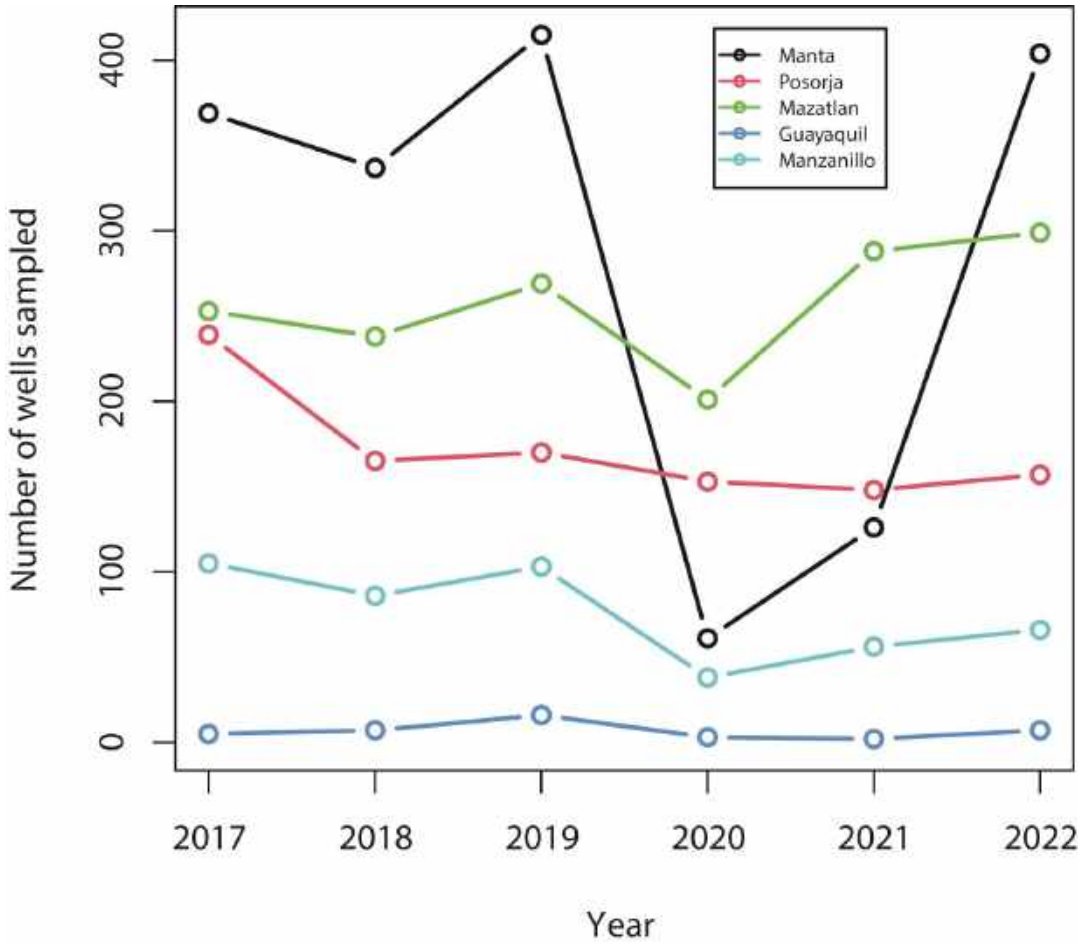
- Some details of the effect of the pandemic on collection of port-sampling data
  - Most unloadings in recent years have occurred in relatively few ports.
  - Of the 51 ports shown below (left-hand graph), there were only 6 ports where the proportion of trips *not* sampled in 2020 exceed that for 2017-2019.





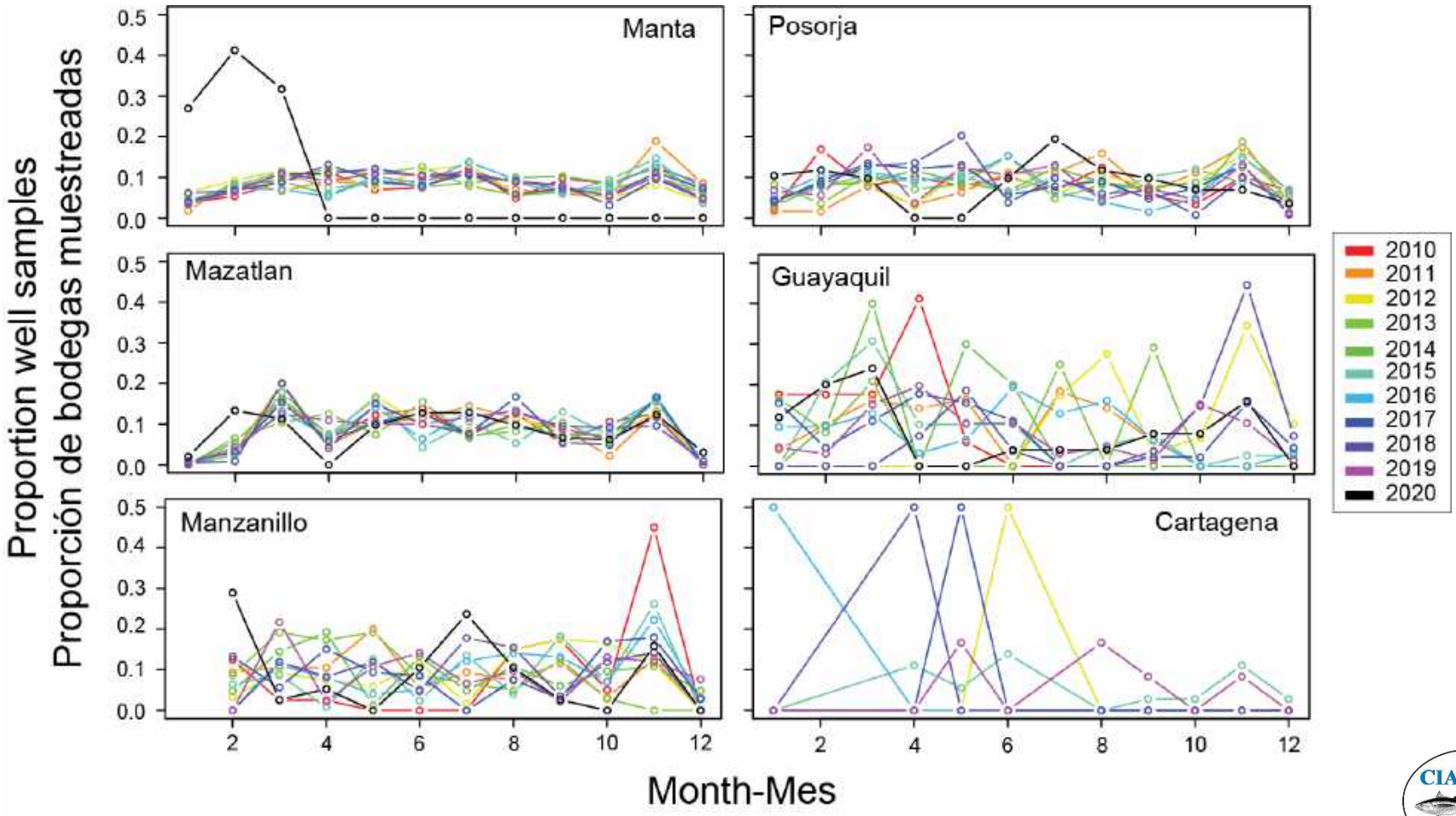
Effect of pandemic on data collection

- Of the 5 ports regularly sampled, the greatest reduction in port-sampling data collection occurred for Manta.
- Since 2017, an estimated 43% of the purse-seine fleet tropical tuna catch from OBJ sets was unloaded in Manta.
- Thus, the impact of the pandemic on catch estimation for the OBJ-set fishery is a concern.



Effect of pandemic on data collection

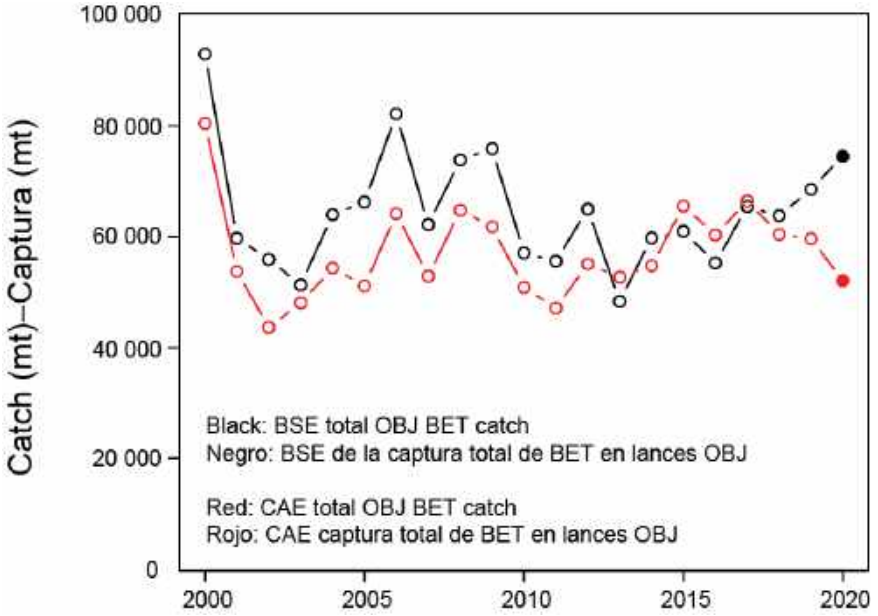
- Given the level of variability in sampling among months and years prior to the pandemic, only in Manta was a monthly effect clearly visible in 2020, with possible effect in Posorja.



Effect of pandemic on BET catch estimation for OBJ fishery

Background

- Divergence between 2020 reported and estimated BET OBJ-set catch suggested the pandemic might have affected catch estimation.
- Possible effects include:
  - overall lower sample sizes across all strata;
  - systematic undersampling of specific strata.
- Both will affect the 'substitution' used in catch estimation.
- In 2020, 82% of strata with catch, corresponding to 49% of the fleet catch of tropical tunas, did not have port-sampling data.
- Given spatial differences in species composition, seasonal variability in fishing activity, and tendency of fleet segments tend to unload in specific ports, it was assumed that systematic temporal gaps in data collection at some ports was the most problematic.



Material from IATTC Document SAC-13 INF-L

Effect of pandemic on BET catch estimation for OBJ fishery

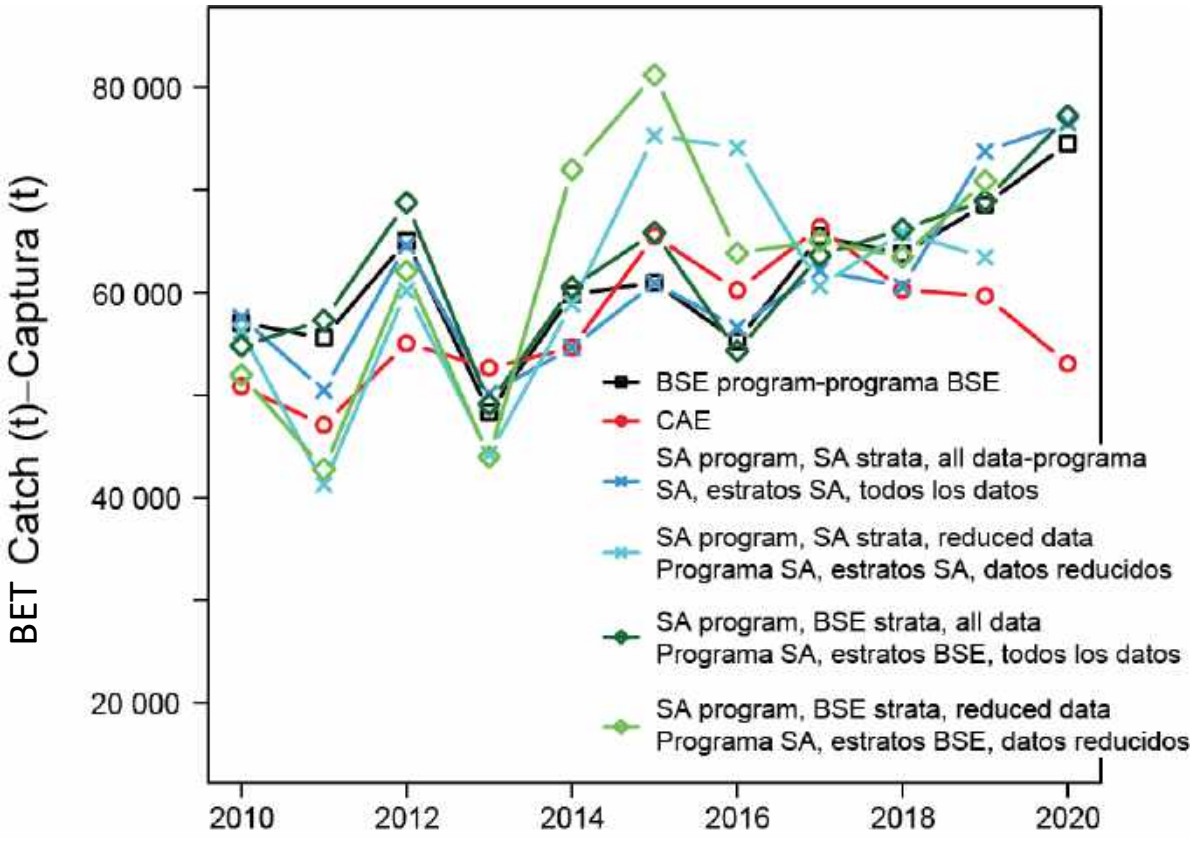
Simulation study for 2020

- Simulation conducted to quantify effect of pandemic-related data loss on catch estimation.
- Catch estimation programs run for 2010 – 2019 with all observer, logbook and cannery data, but only a subset of the port-sampling data.
- Port-sampling data of 2010 – 2019 trips that arrived to port in April through December in Manta, April through May in Posorja and April in Mazatlan were excluded from simulation to mimic 2020 data loss.
- Two different spatial stratifications were used (13 sampling areas of the “BSE” estimates; BET stock assessment areas).
- Focus was on BET because the ports most affected by the pandemic are also ports where much of the fleet catch of BET is unloaded and because of the conservation concerns related to BET.

Effect of pandemic on BET catch estimation for OBJ fishery

Simulation results

- Systematic loss of port-sampling data in 2020 may have led to a bias in the BET OBJ catch estimates.
- Although the median difference between estimates, with and without the simulated data loss, was close to 0, both negative and positive biases of about 20% or more occurred.
- Thus, while results indicate that the 2020 BET OBJ catch estimates may be biased, the exact magnitude and direction of that bias cannot be determined from this simulation study.



Estimating bias of OBJ catch estimates

- Remainder of presentation gives a summary of work done to estimate bias of OBJ catch estimates caused by pandemic-related data loss in 2020-2021.
- Overview of approach for estimating bias
  - Use observer (logbook) data, which had higher coverage during the pandemic, to 'supplement' port-sampling data.
  - However, concerns have been raised about accuracy of species amounts reported in observer (logbook) data.
  - Therefore, a spatio-temporal model was developed to predict the port-sampling species proportion in the catch, using the observer (logbook) species proportion. Model development focused on BET.
  - Focus was on the catch estimates presented in IATTC Fishery Status Reports (13 sampling areas) ("BSE" estimates).
  - Since only 2020 and 2021 were affected, desirable to have the model predictions for years prior to pandemic closely match the BSEs of those years so that the catch times series would be as consistent as possible.

Material from IATTC Document SAC-13-05

Estimating bias of OBJ catch estimates

Initial model

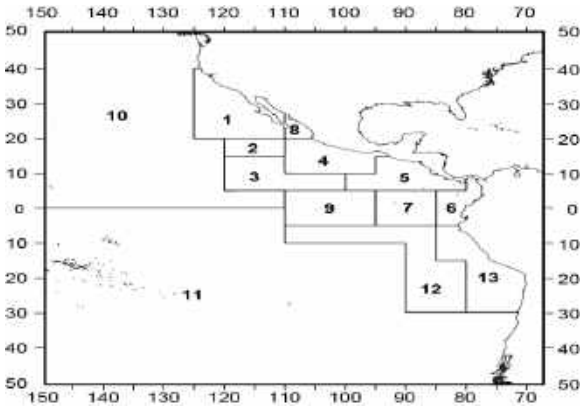
$$log(p_{kt}) = a + b\, log(q_{kt}) + spatio\text{–}temporal\ effects + e_{kt}$$

where

p_{kt} port-sampling proportions in k-th area and t-th time period

q_{kt} observer data proportions in k-th area and t-th time period

e_{kt} random error



- Initial modeling at a month x 5° resolution, however, data sparsity was considered a problem.
- Therefore, data were aggregated in space (to 13 sampling areas) and time (to year) to reduce sparsity.
- Spatial aggregation reduced variance – leading to better fitting models.
- Thus, final analyses were based on spatio-temporal models for areal data.

Estimating bias of OBJ catch estimates

- Final model type: spatio-temporal Conditionally Auto Regressive (CAR) model, where spatial neighborhood matrix was based on the spatial substitution rules of the catch estimation methodology.
- By incorporating data from multiple years into one model, possible to take advantage of spatial pattern evolving in a correlated manner through time to help mitigate pandemic-related data loss.
- Model formulation:

$$log(p_{kt}) = Y_{kt}$$

$$Y_{kt} \mid \mu_{kt} \sim Normal(\mu_{kt}, \nu^2)$$

$$\mu_{kt} = X^T\beta + \phi_{kt}$$

- X is a matrix of covariates and β is the regression coefficient vector
- $X^T\beta = a + b_1\, log(q_{kt})$
- ν^2 denotes the residual error variance
- ϕ_{kt} is the spatio-temporally autocorrelated random component
- Further details can be found in IATTC Document SAC-13-05

Estimating bias of OBJ catch estimates

- Estimate of total BET catch in OBJ sets
  - Species proportions estimates were obtained from the CAR model, by stratum.
  - These proportions were multiplied by the total fleet catch of tropical tunas to obtain the stratum estimates of BET.
  - The total BET estimate was the sum of the stratum estimates.
- Similar CAR modeling and estimation was done for skipjack tuna (SKJ).
- Yellowfin tuna (YFT) catch was estimated by subtracting the sum of the SKJ and BET estimates from the total fleet catch of tropical tunas.

Estimating bias of OBJ catch estimates

- The CAR models performed reasonably well in terms of:
  1) standard metrics for assessing model fit;
  2) correlation between CAR and BSE estimates; and,
  3) consistency between CAR estimates for 2010 – 2019 using all port-sampling data and CAR estimates using trimmed port-sampling data.

- Thus, the CAR models were used to estimate bias of 2020 -2021 BSEs for the OBJ fishery.
  - Bias = (BSE estimate – CAR estimate)/CAR estimate

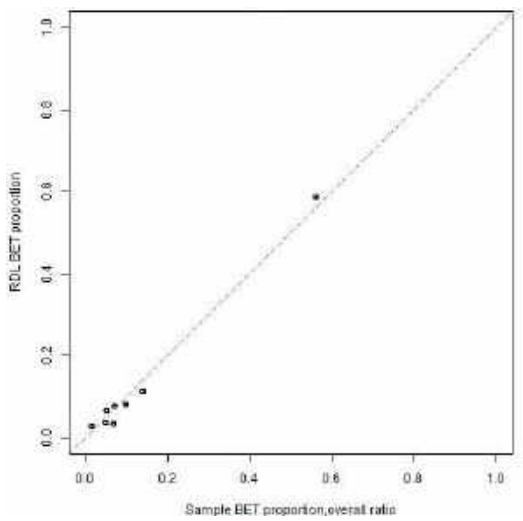
Bias	2020	2021
BET	12%	18%
SKJ	1%	-6%
YFT	-18%	10%

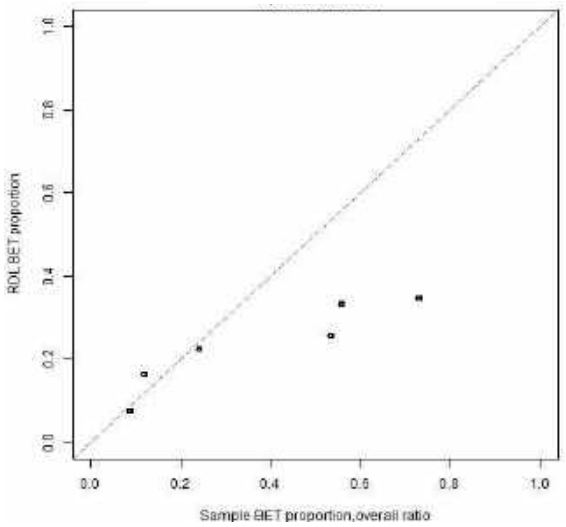
Estimating bias of OBJ catch estimates

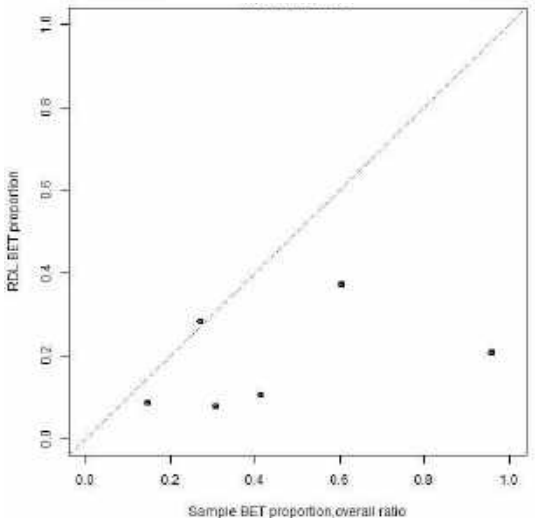
- How to correct for bias in the stock assessment catch estimates?
  - Short-term
    - For the OBJ fishery, the CAR bias estimates could be used to adjust the stock assessment catch estimates (under the assumption that bias did not vary in space or time within a year).
    - No bias estimates are available for the other two purse-seine fisheries (DEL, NOA).
    - However, the pandemic effect on catch estimation for those fisheries may be less than for the OBJ fishery if more catch of those fisheries is unloaded at ports other than Manta and Posorja.

Estimating bias of OBJ catch estimates

- How to correct for bias in the stock assessment catch estimates?
  - Longer term
    - More complete well-sample data are being collected for OBJ sets, and some NOA sets, under the new Enhanced Monitoring Program, established to support additional BET conservation measures in 2023-2024.
    - The possibility of using these sample data to ‘calibrate’ observers and adjust past observer estimates could be explored.
    - Not presently sampling wells with catch from DEL sets.

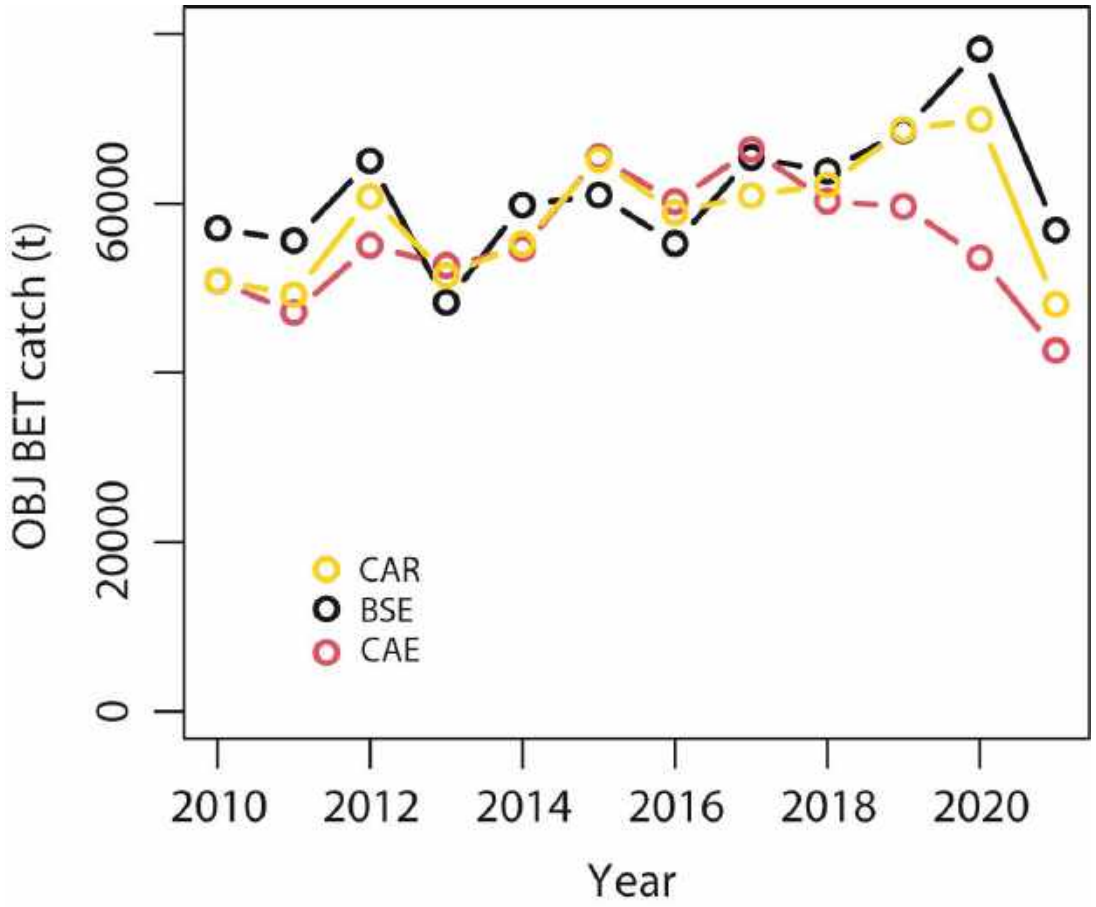






Thank you! Questions?

Updated figure requested



Effect of pandemic on estimation of BET for the OBJ fishery