Catch and CPUE inputs to the South Pacific blue shark stock assessment

WCPFC-SC12-2016/SA-WP-08

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Data inputs

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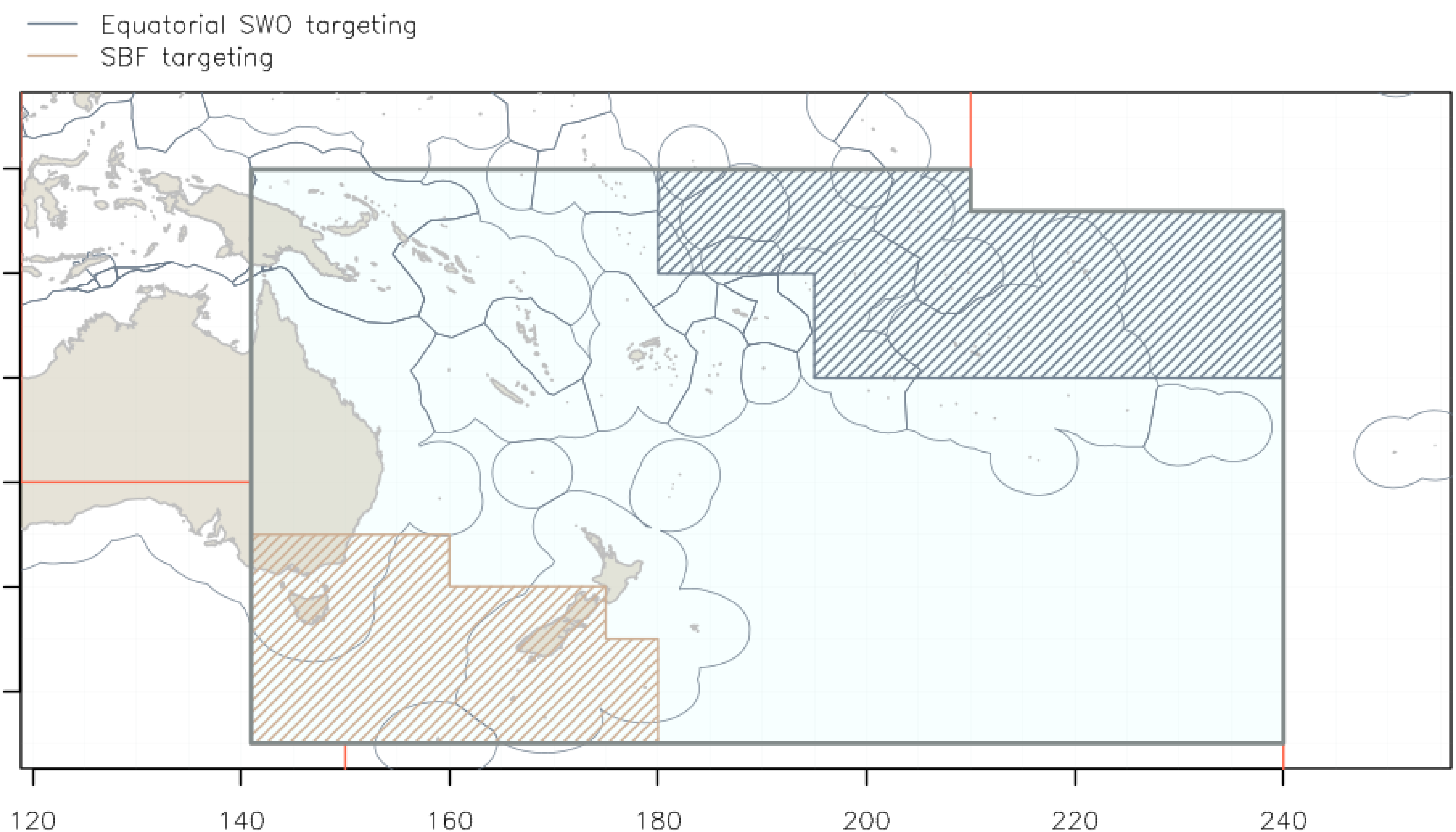
- ✓ Catch
- ✓ Temporal index of abundance (CPUE)
- ✓ Length frequency in the catch
- ✓ Tagging

- One major objective of this assessment: establish and examine key areas of uncertainty, and the impacts on estimates of stock status.

Stock assessment span

WCPFC Convention Area south of the Equator



Stock assessment span

1994-2014

- Time-span of 21 years was decided in consultation with the PAW;
- Challenges in reconstructing driftnet catches;
- Longline fleets only (top 16 based on longline effort).

Catch data available

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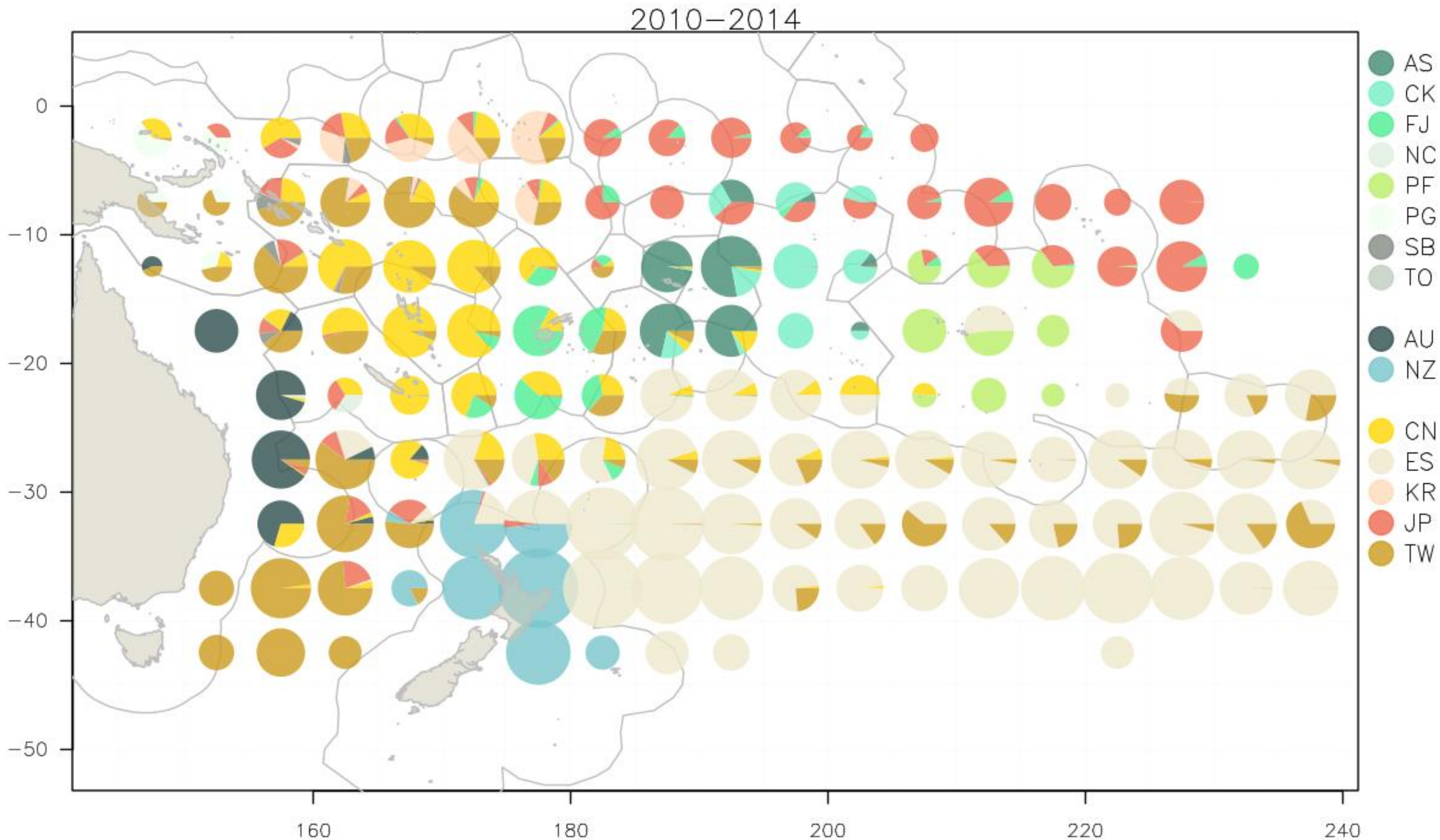
Operational logsheet data:
set-specific catches for the main target species (tuna and billfish), as well as catches for key shark species since CMM-2010-07 was enacted

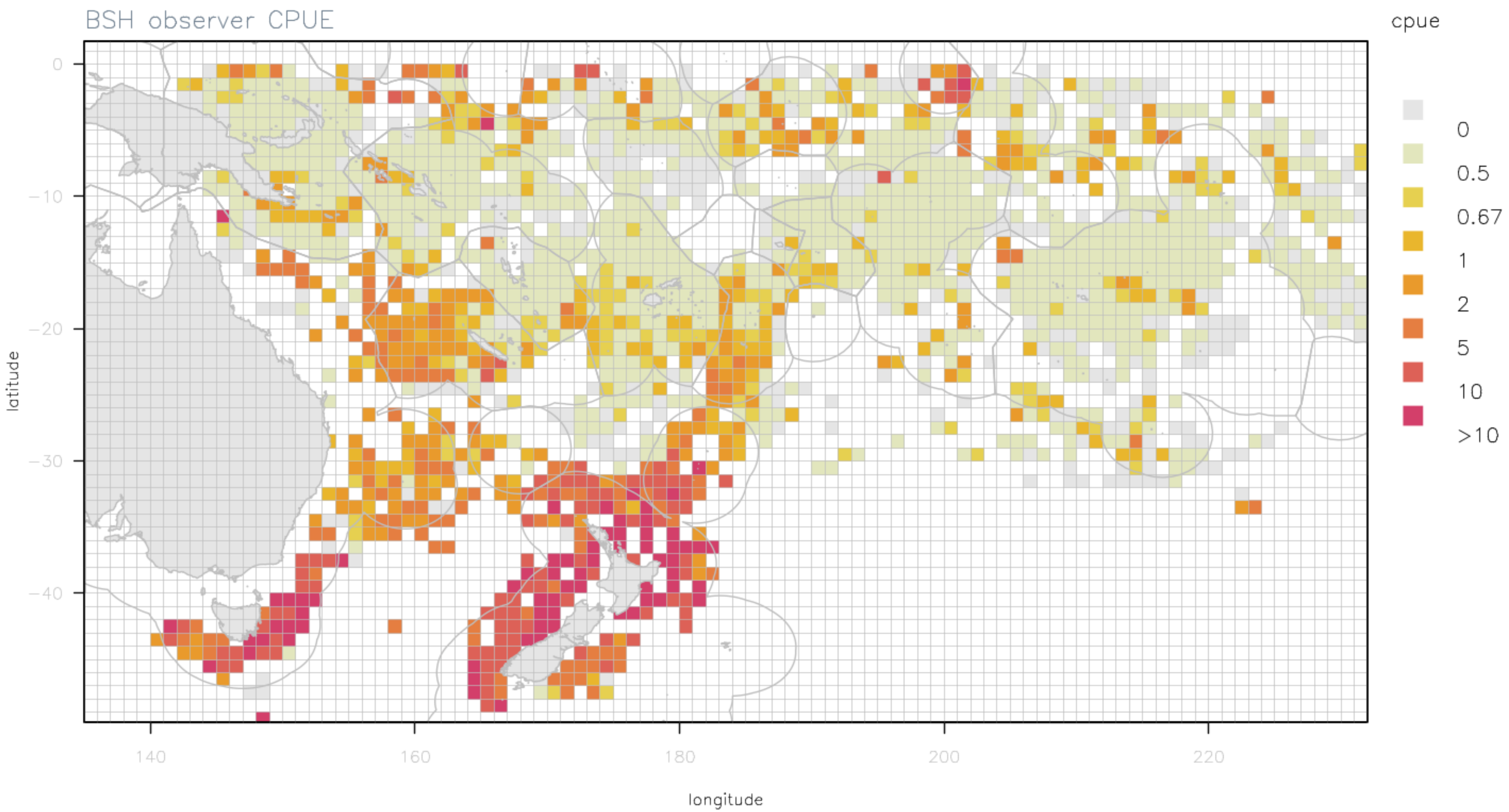
Raised 5 × 5 logsheet data:
best estimates of longline effort and catches at the five degree scale x month scale, as computed by the Oceanic Fisheries Data Management section of SPC. This dataset constitutes the most accurate estimate of longline fishing effort

SPC observer data holdings:
all observer entries from the early SPC/FFA observer programmes, the Regional Observer Program (ROP) + SPC-available data from national observer programs for Australia, China, Chinese Taipei, New Zealand and the United States

Raised 5 × 5 logsheet data:



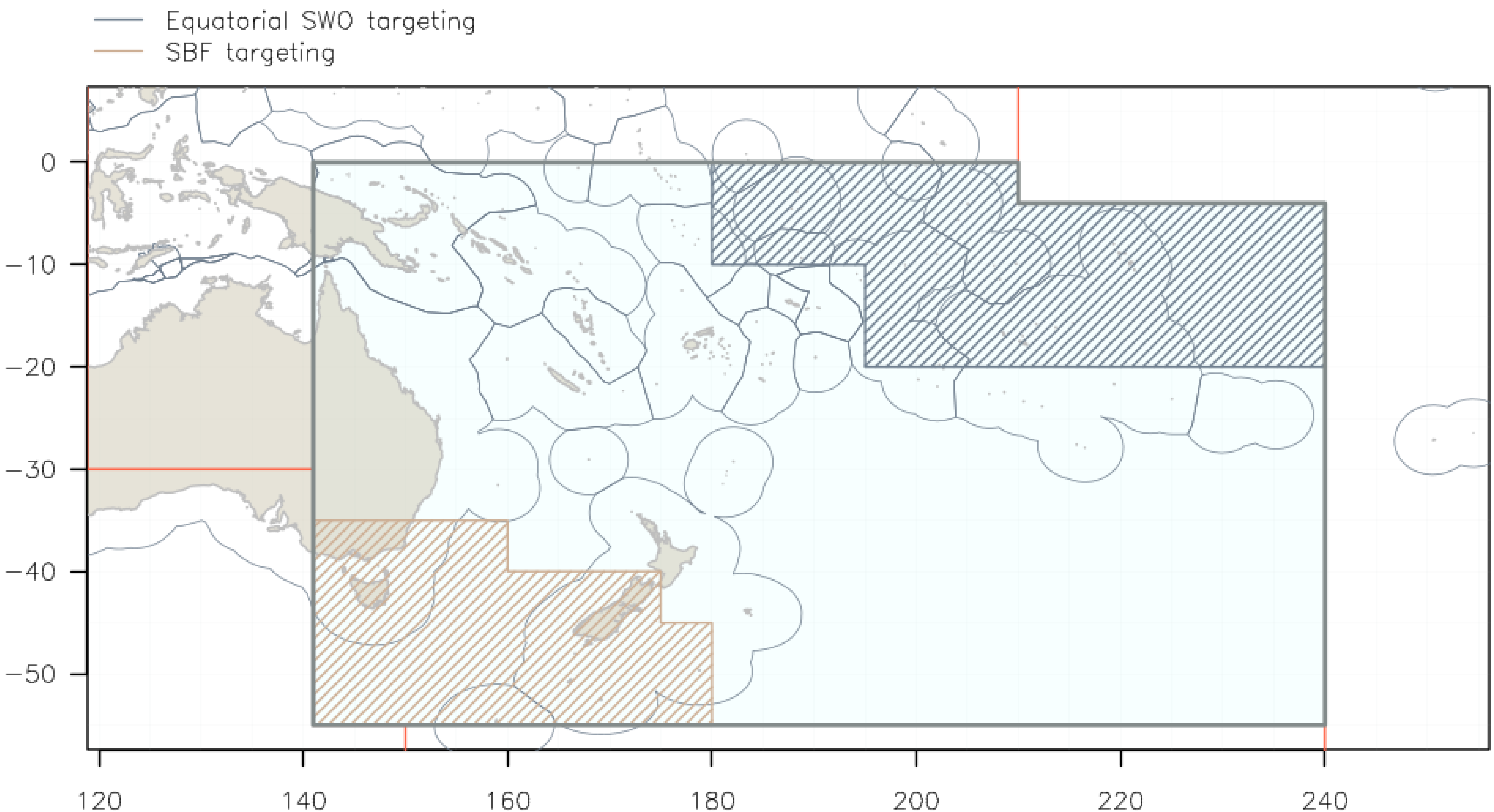
Spatial trends in observer CPUE



Stock assessment span

1994-2014

WCPFC Convention Area south of the Equator



Issues with catch data for sharks

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Lack of historical shark reporting unlikely to reflect an absence of shark catches, i.e. catch reconstruction required for all fleets

Where shark data were available, there was frequently limited breakdown to the level of shark species, particularly in historical data;

Low observer coverage rates for the longline fishery, in particular for wide-ranging DWFN fleets;

Catch reconstruction approach

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Three potential strategies for reconstruction when catch data are missing or unreliable:

1. If an observer program exists, use CPUE derived from on-board observer coverage and reported effort to estimate total catches for the fishery

2. Use trade data, e.g. from the international trade fin market

3. Use the ratio of catches of blue shark to catches of another species

All blue shark are correctly identified and reported by observers, and suffer 100 % mortality upon being caught.

Catch reconstruction strategy I

Catch scenario 1:

Use ratio to other species group, assume all sharks are reported but not identified to the species-level.

Catch = BSH2SHK x SHK catch

From raised 5x5 database

Observed ratio of blue shark to all sharks in longline observer per flag

Catch reconstruction strategy II

If an observer program exists, use CPUE derived from on-board observer coverage and reported effort to estimate total catches for the fishery

Catch = CPUE* x effort

Raised 5x5 logsheet effort

Observed blue shark catch rate (assume 100% reporting)

*catch rate per effort, CPUE = catch/effort

Catch reconstruction strategy II

Catch scenario 2:

Fleet-specific temporal trends can apply to effort by that same fleet in unobserved locations;

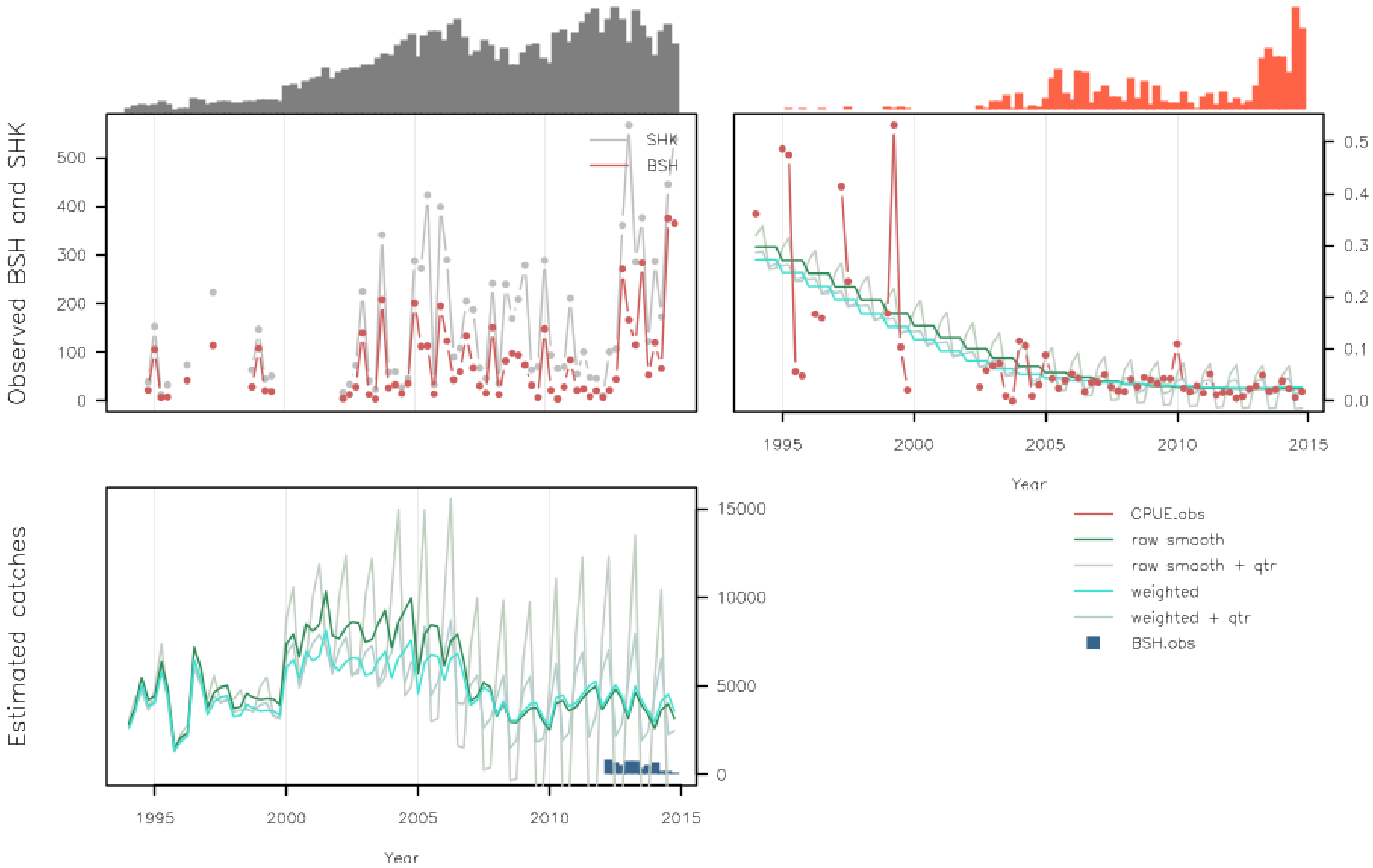
Annual catch rates for unobserved years can be interpolated from nearby observed years;

Catch rates are constant for the fleet in all fishing grounds for a given year;

Assume catch rates constant in space for a given flag.

Catch reconstruction strategy II

Scenario 2:



Catch reconstruction strategy II

Catch scenario 3

Trends in observer catch rates can be applied to unobserved effort in the same location by different fleets;

Abundance follows the same trend across the southwestern Pacific and is dependent on that of neighbouring years;

Predict observer catch rates over space and time given: Flag, year, oceanography variables, target species, etc.

BSH catch $_{\text{month, flag, 5x5 cell}}$ = $CPUE_{pred}$ x raised effort

Catch reconstruction strategy II

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Catch scenario 3

Prediction of CPUE surface:
semi-parametric GAM with delta-lognormal model

Covariates:

- Year (smooth)
- Flag (categorical)
- Sea surface temperature (SST) (smooth)
- Primary production (chl-a)* (smooth)
- Swordfish CPUE (smooth)
- Southern bluefin tuna CPUE (smooth)

Catch reconstruction strategy II

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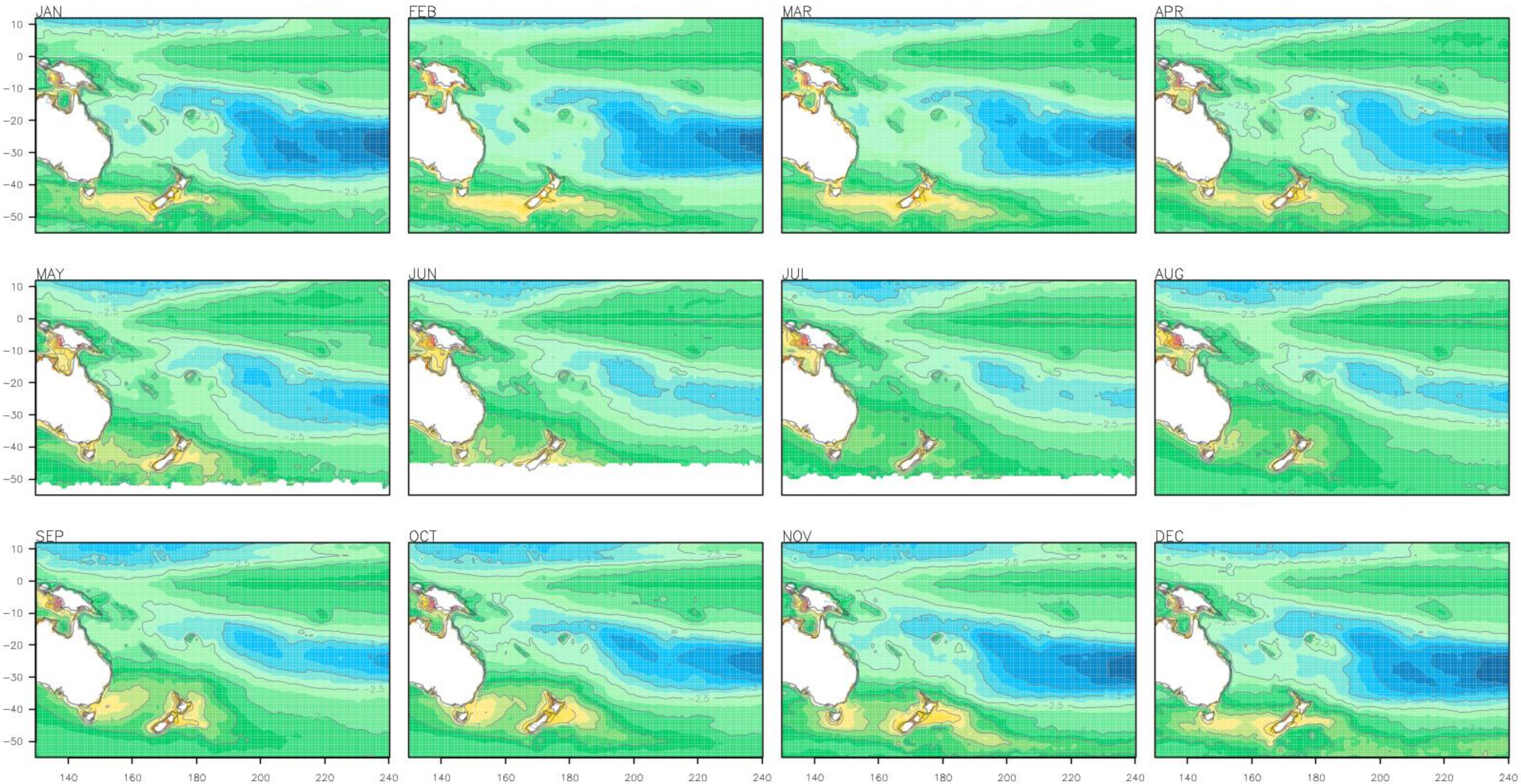
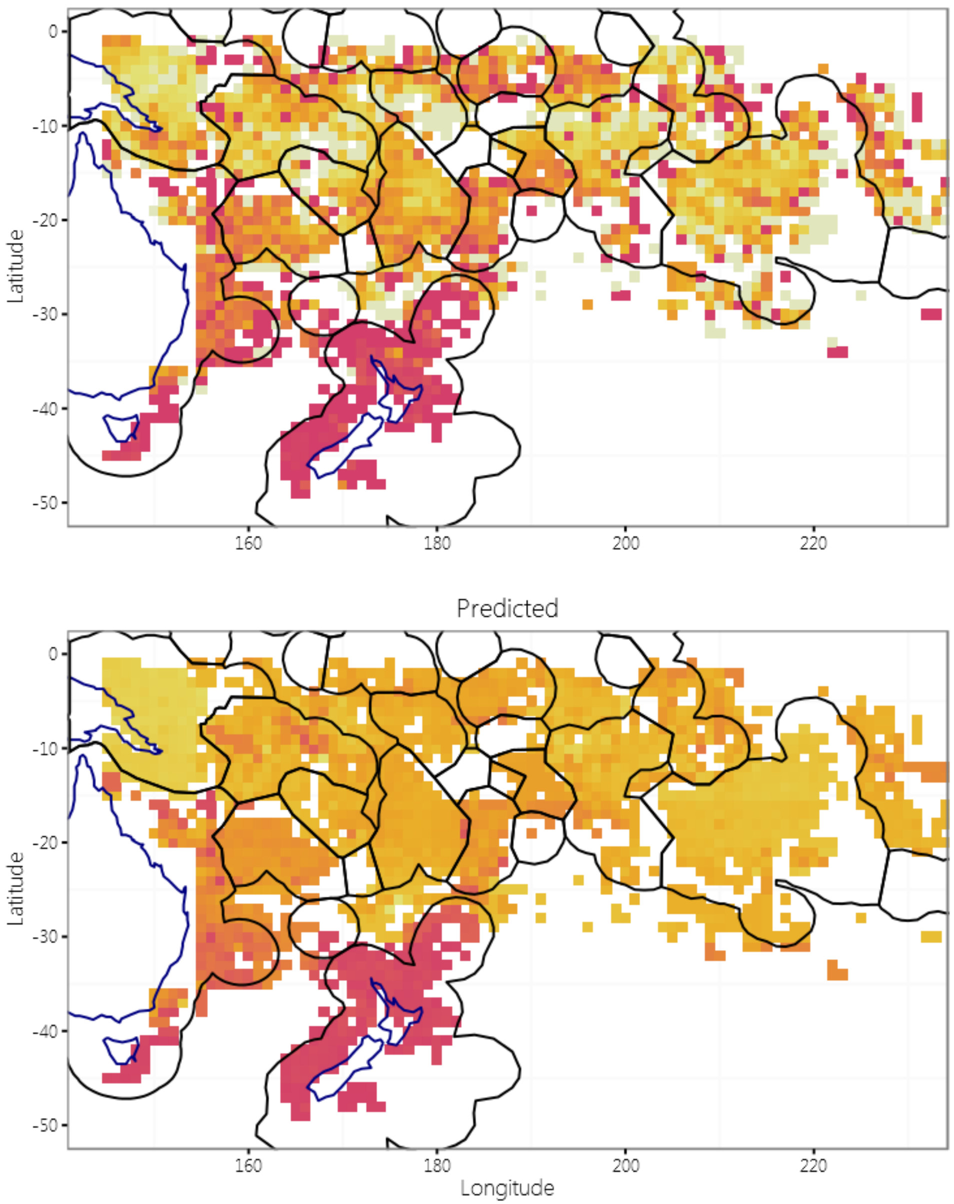
Scenario 3: use of oceanography at predictor variables

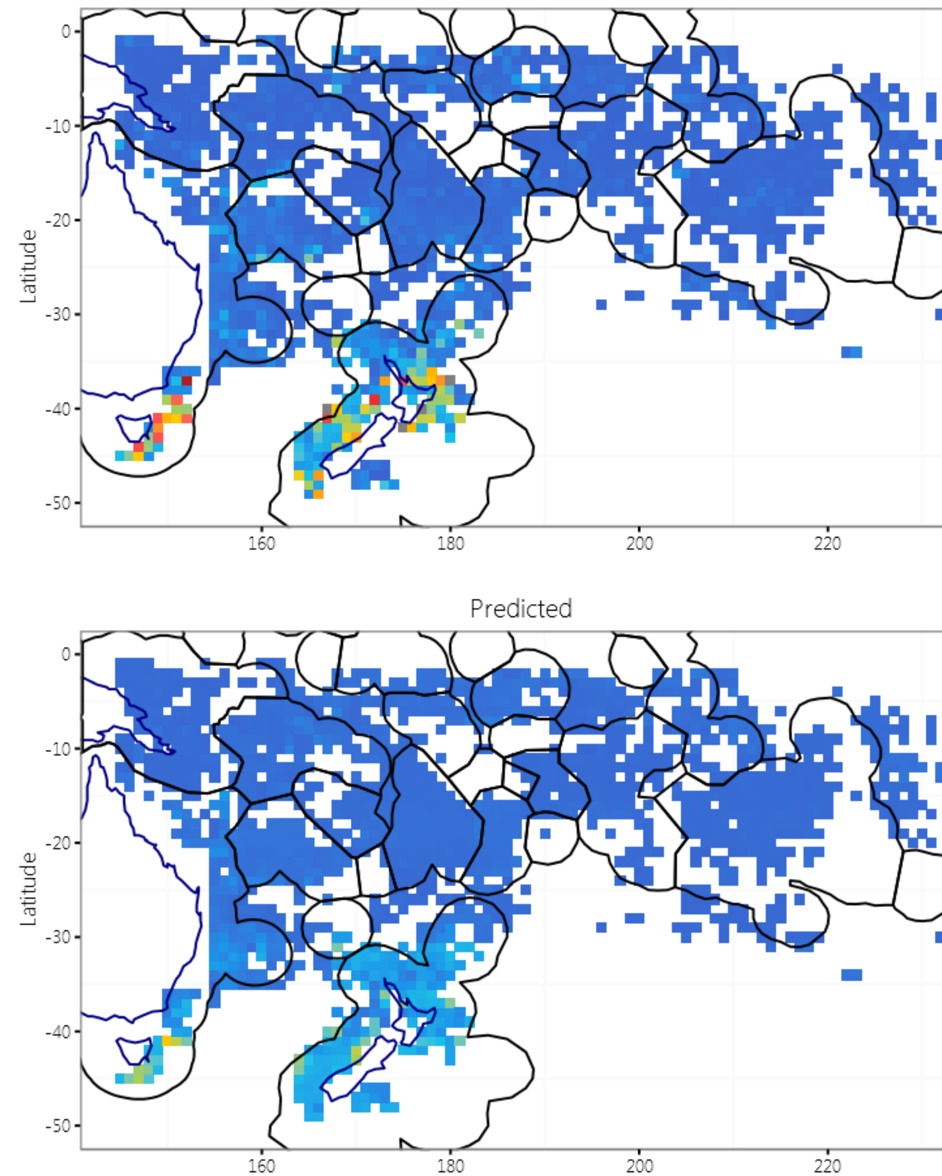


Scenario 3: Observed vs. predicted

Binomial



Lognormal



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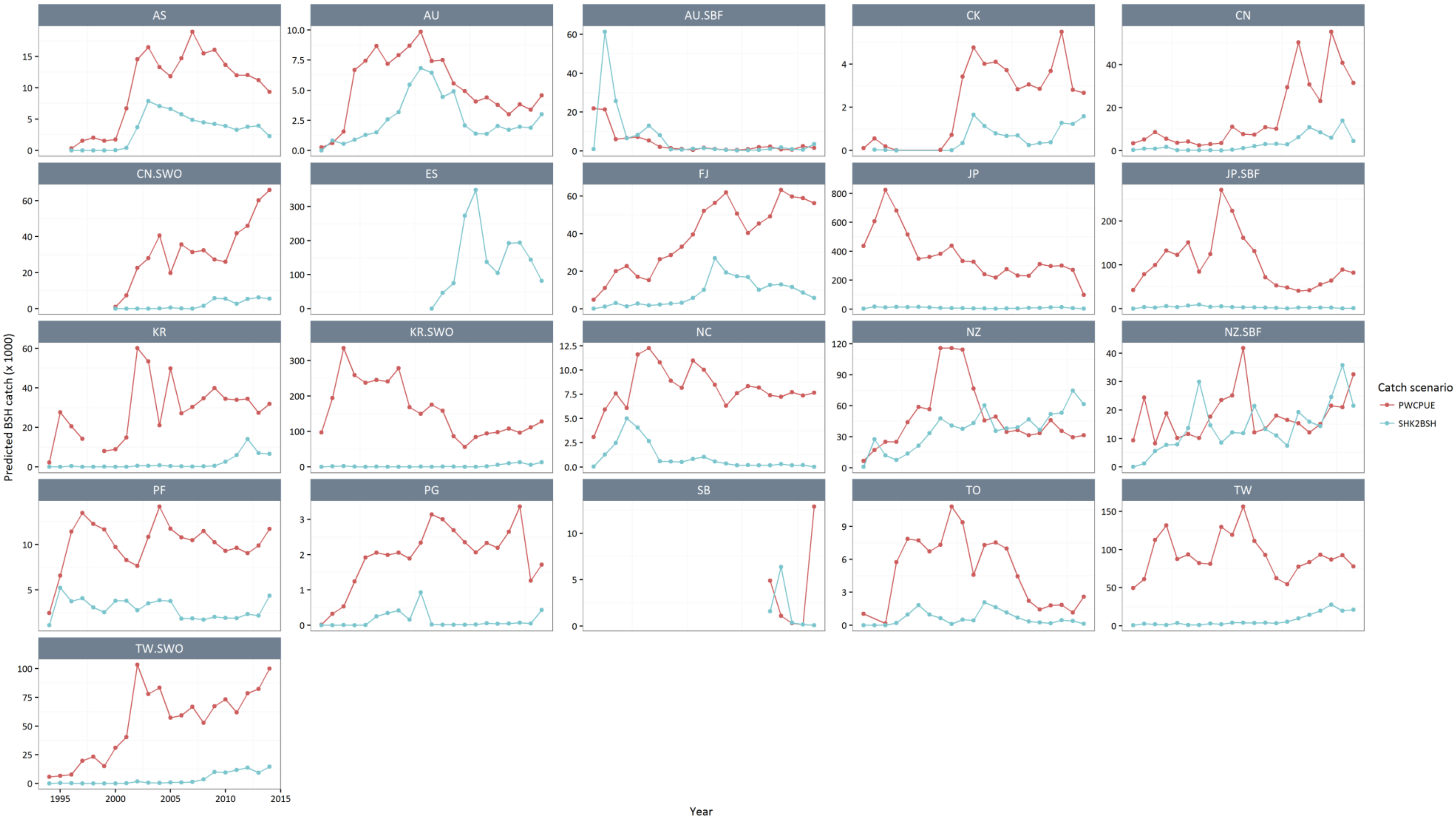
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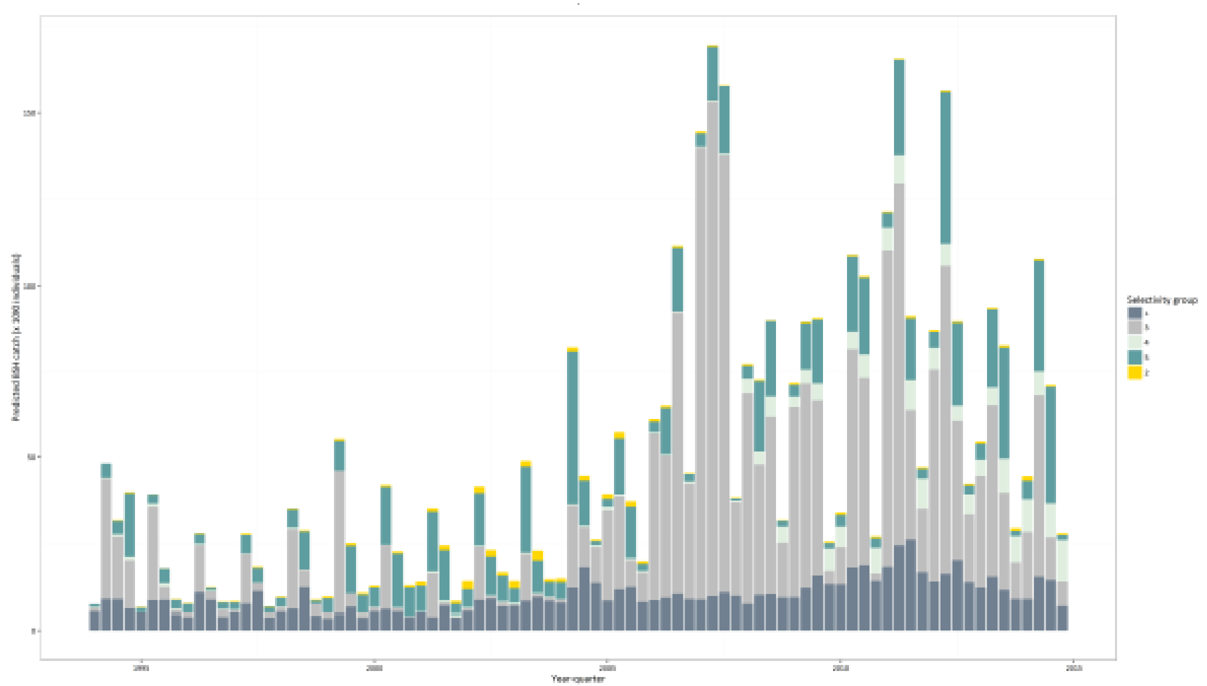
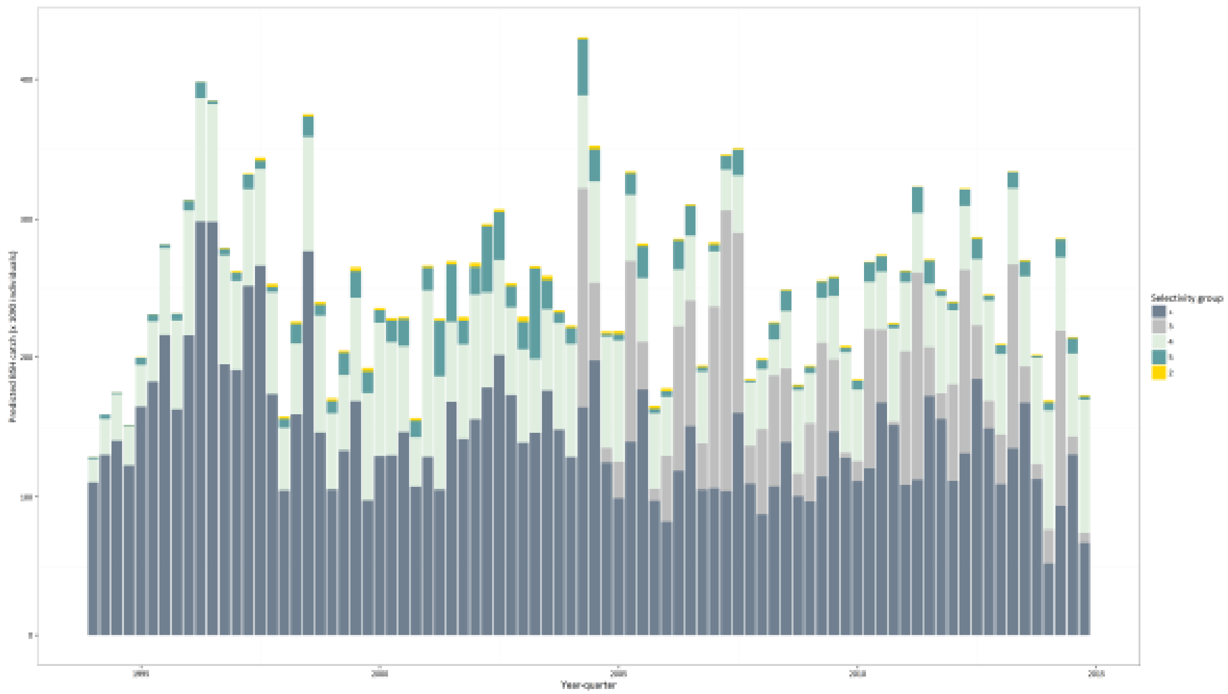
Predicted BSH catch (x 1000)
Year
Catch scenario
PWCPUE
SHK2BSH

Catch reconstruction

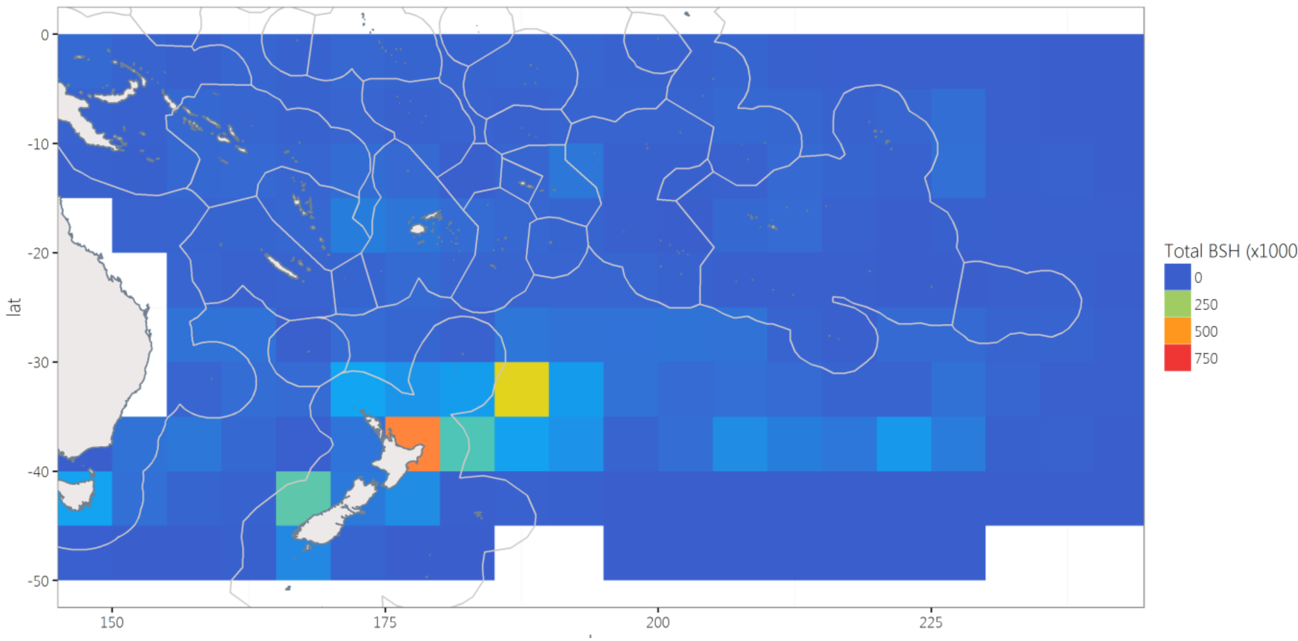
Blue shark to all shark – fleet specific

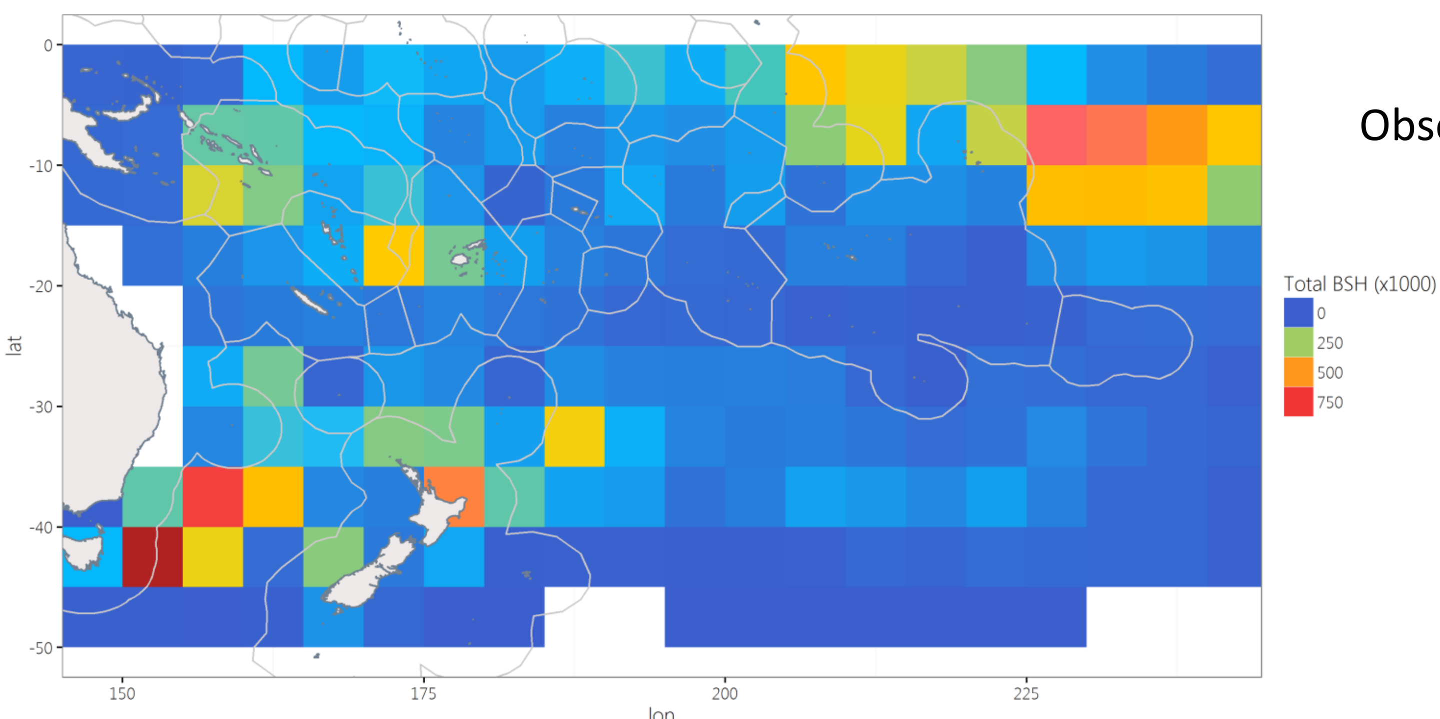


Observer CPUE surface



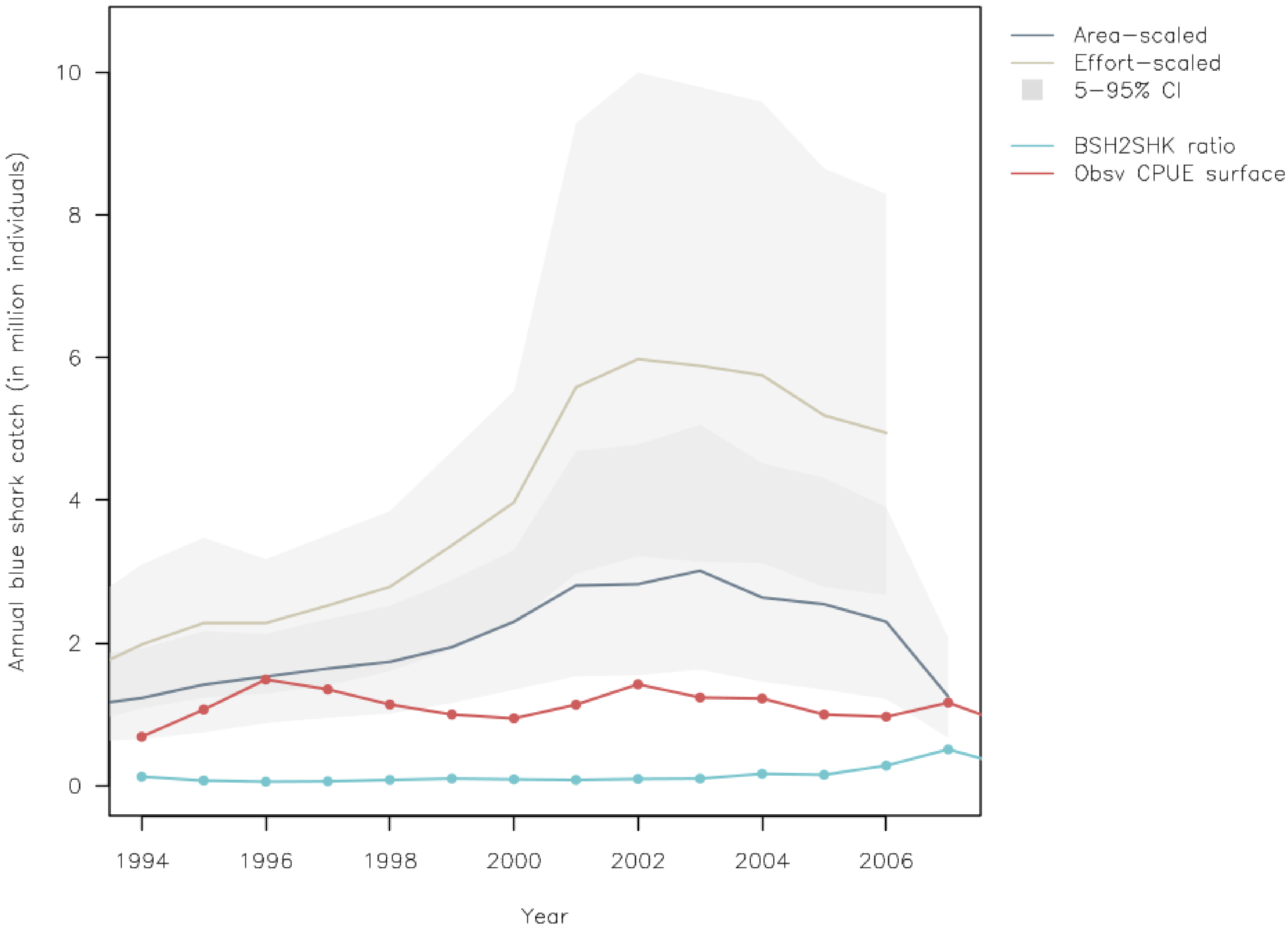
Blue shark to all shark – fleet specific





Observer CPUE surface

Comparison against WCPO-wide trade-based estimates*



Rationale for choice of CPUE

No 'ideal' series found, so instead created an index for the two fleet types with the highest catch rates, and an overall South Pacific one:

1. Distant-water fishing nations (DWFNs) with extensive fishing grounds, broad variations in catch rates for blue sharks within those grounds, and sparse or non-existent observer coverage;

2. Domestic fleets from PICTs with narrower fishing grounds, lower blue shark catch rates and relatively low rates of longline observer coverage;

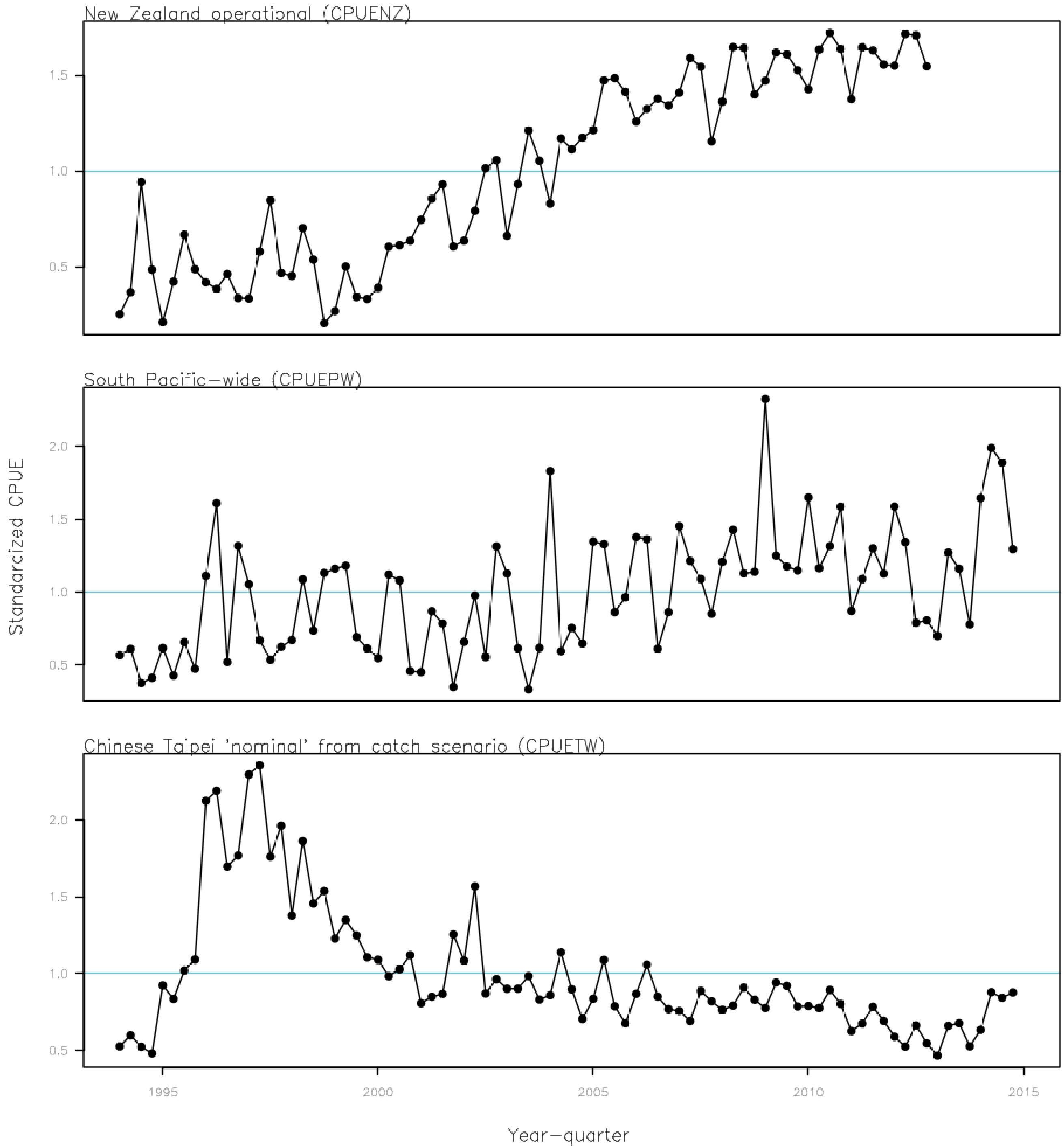
3. Fleets (domestic and DWFNs) with very high catch rates for blue sharks fishing in the South Pacific with varying levels of observer coverage and partial to full sets of logsheet fleet data available to the SPC.

CPUE: summary of methods

1. Distant-water fishing nations (DWFNs) with extensive fishing grounds:
   Chinese Taipei
   Fitted 'nominal' CPUEs from reconstructed catch surface

2. Fleets (domestic and DWFNs) with very high catch rates for blue sharks fishing in the South Pacific:
   New Zealand operational
   delta-lognormal semi-parametric GAMs
   Covariates: year-quarter, day time, s(hooks-between-floats)

3. **Pacific-wide observer**:
   Similar approach to 2015 indicator analysis (Rice et al. 2015)
   Negative binomial semi-parametric GAMLSS
   Covariates: *mu* ~ year-quarter, s(chl-a), s(bathymetry), effort
   sigma ~ observer program



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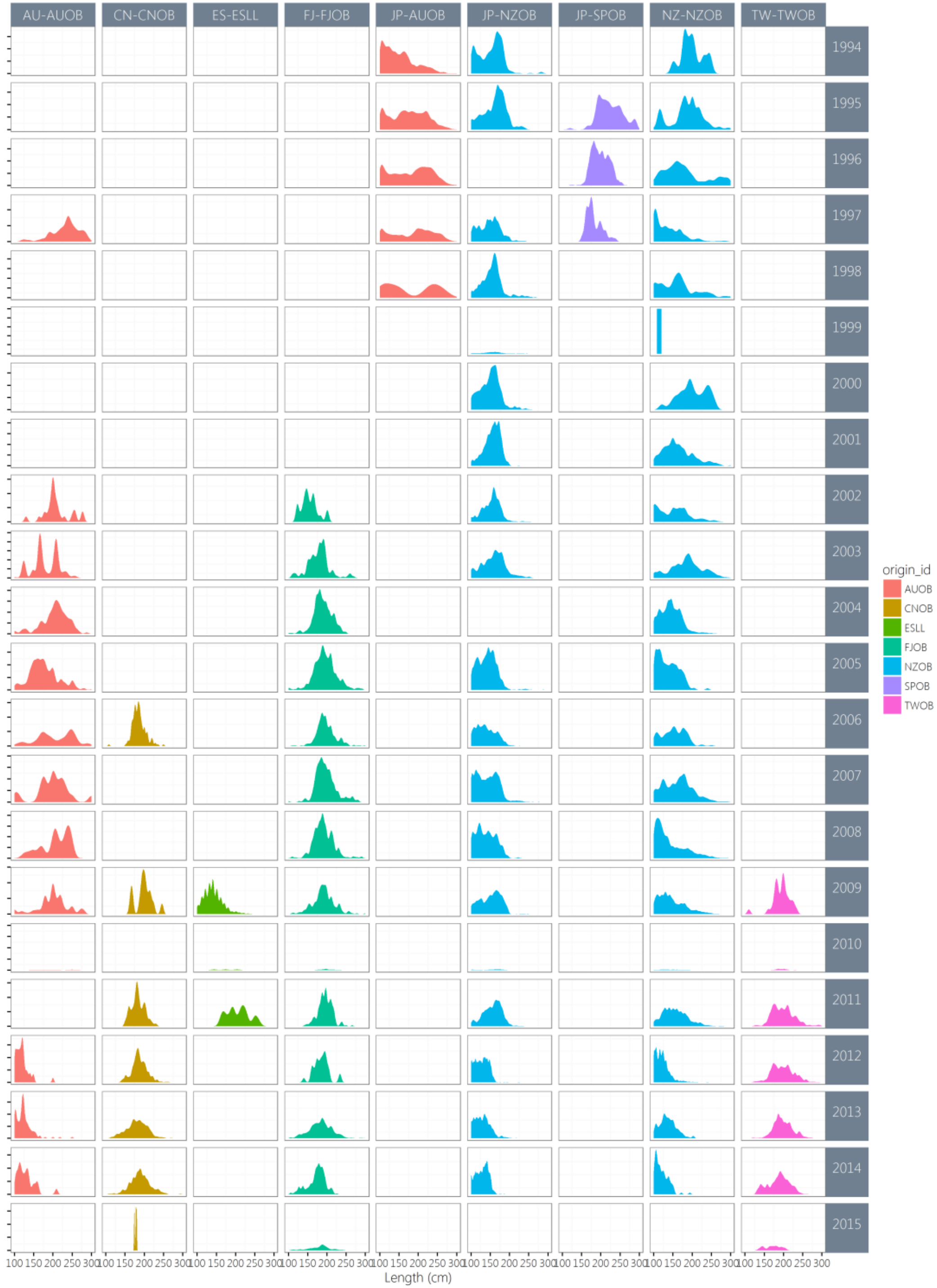
Catch-at-length by key fleet x observer program



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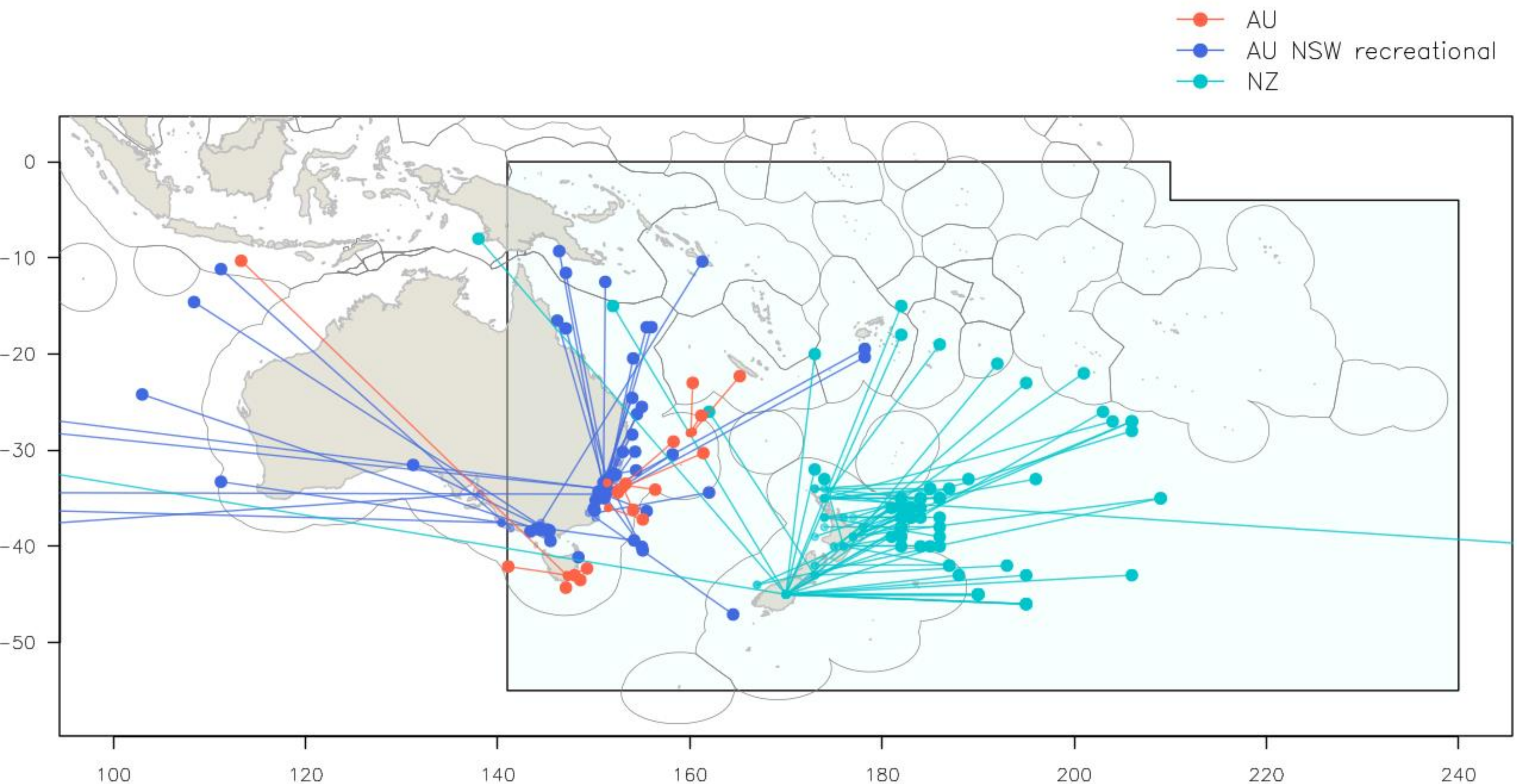
Tagging data



Recommendations: Observer program

- Pending availability of resources, SPC should undertake an analysis of the statistical power of WCPO observer coverage configurations to detect changes in spatio-temporal abundance of bycatch species;

- (Emphasis on improving the consistent collection of accurate observer effort during the set is needed);

- The continuation of ongoing efforts to expand observer coverage for longline fleets operating in the WCPO is encouraged;

- Noting the significant catch of blue sharks and other species of interest associated with the Southern bluefin tuna fishery within the WCPFC-CA, increased collaboration for the purpose of assessing WCPO stocks should be pursued;

Recommendations

Data

- Future catch reconstructions should utilise data sources additional to observer data, such as trade data;

- Noting the significant catch of blue sharks with the Southern bluefin tuna fishery within the WCPFC-CA, increased collaboration for the purpose of assessing WCPO stocks should be pursued;

- An investigation into catch, effort and length data prior to 1994 should be undertaken, particularly for the high seas driftnet fishery that was active in the South Pacific until the early 1990s;

- Noting the increase prevalence of regulations aimed at managing shark mortality across WCPO, future catch reconstruction should prioritize the inclusion of discard mortality scenarios.