INTERNATIONAL PACIFIC HALIBUT COMMISSION

FISS rationalisation

Agenda item 5.1

IPHC-2019-SRB015-06

Background

- Program of planned FISS expansions undertaken from 2014-19
- In each Regulatory Area, gaps in FISS coverage were sampled, providing data for the full geographic extent of North American Pacific halibut for the first time
- However, this full FISS footprint is too expensive to sample annually
- Need to establish a set of methods for determining annual FISS designs that meet sampling goals subject to FISS cost constraints

Summary of methods for FISS rationalisation

- Propose data quality targets
- Determine geographic sampling priorities and sampling frequency
- Test designs on simulated data sets
- Propose design options
- Estimate design costs

Precision targets

- To maintain data quality, we proposed the following targets on coefficient of variation (CV):

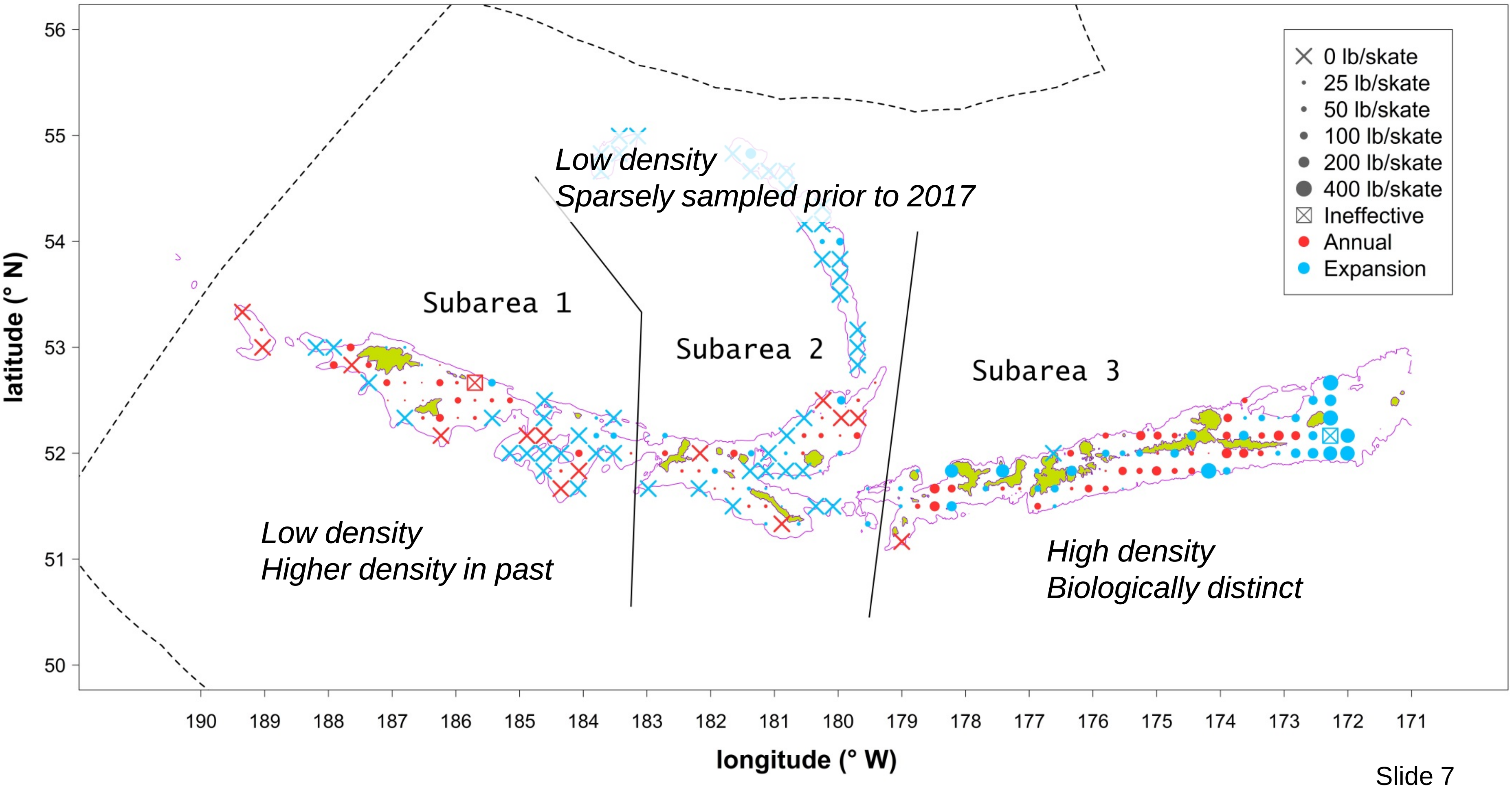
Management unit	O32 WPUE	All sizes WPUE	All sizes NPUE
Reg Area (all)	15%	15%	NA
Bio Regions 2, 3, 4	10%	10%	10%
Bio Region 4B	15%	15%	15%
Coastwide	NA	NA	10%

Potential for bias

- Failure to observe and account for changes in WPUE or NPUE in an unsurveyed subarea can lead to bias
- Therefore, it is important to undertake setline surveys frequently enough to keep any bias small
- In this, we are guided by estimates of past changes

Example: Regulatory Area 4B and 2A

- At SRB014, we looked at two examples
- Regulatory Areas 4B and 2A were each divided into three subareas
  - Subareas based on historical density and biological characteristics
- Subareas were prioritised for future sampling based on recent biomass proportions and potential for bias if unsampled



Low density
Sparsely sampled prior to 2017
Subarea 1
Subarea 2
Subarea 3
Low density
Higher density in past
High density
Biologically distinct
0 lb/skate
25 lb/skate
50 lb/skate
100 lb/skate
200 lb/skate
400 lb/skate
Ineffective
Annual
Expansion
latitude (° N)
56
55
54
53
52
51
50
longitude (° W)
190
189
188
187
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Reg Area 4B sampling priorities

1. Subarea 3: 70-80% of biomass since 2013
2. Subarea 1: Frequent changes of ≥10% of biomass % over short periods (3-4 years)
3. Subarea 2: Generally low and stable biomass % (but likely affected by sparse historic sampling)

Evaluation of options

- Fit models using simulated data for future years
- Models can take a long time to run: full simulation study using many data sets not practical
- Instead, for each year, single simulated sample data sets were taken from the posterior samples from the 2018 modelling

Results of simulations: are CV targets met?

Estimated CVs (%) by data input for Reg Area 4B. Target CV = 15%.

Data input	Sampled subareas	2017	2018	2019	2020	2021	2022
1993-2018 data		9	14				
+ 2019-20 simulated data	2020 Subarea 3	9	13	12	10		
+ 2019-21 simulated data	2020-21 Subarea 3	10	13	13	11	12	
+ 2019-22a simulated data	2020-22 Subarea 3	9	12	12	10	12	14
+ 2019-22b simulated data	2020-21 Subarea 3 2022 Subarea 1	9	12	12	10	11	17
+ 2019-22c simulated data	2020-21 Subarea 3 2022 Subareas 1, 2	9	11	11	9	9	14

IPHC-2019-SRB014-R

*The SRB **REQUESTED** analysis of past prediction patterns (a type of cross-validation analysis) to help assess the proposed methods' ability to meet precision targets while maintaining low bias. This should include an examination of spatio-temporal residual patterns for the appropriateness of estimated autocorrelation.*

Past prediction patterns

- Compare predictions of CVs from simulated data with observed CVs
- Undertaken for FISS year 2018
  - Models refit using simulated data (samples from 2017 posterior predictive distributions) in place of observed data for 2018
  - Undertaken for Reg Areas 4B and 2A
  - Repeated three times (i.e., using three simulated 2018 data sets) as a check for consistency

CVs (%) for 2018 O32 WPUE estimated using full 1993-2018 data series, and using simulated data for 2018

Reg Area	1993-2018 data	1993-2017 data, 2018 simulated		
		Sim 1	Sim 2	Sim 3
2A	11.7	10.8	10.3	11.0
4B	14.1	12.9	13.4	13.8

- CVs estimated using simulated data consistently lower than that estimated from observed data
- Differences are small (0.3-1.4%)
    - Does not imply the use of posterior samples to predict precision should affect comparison of future design options

Posterior predictive diagnostics

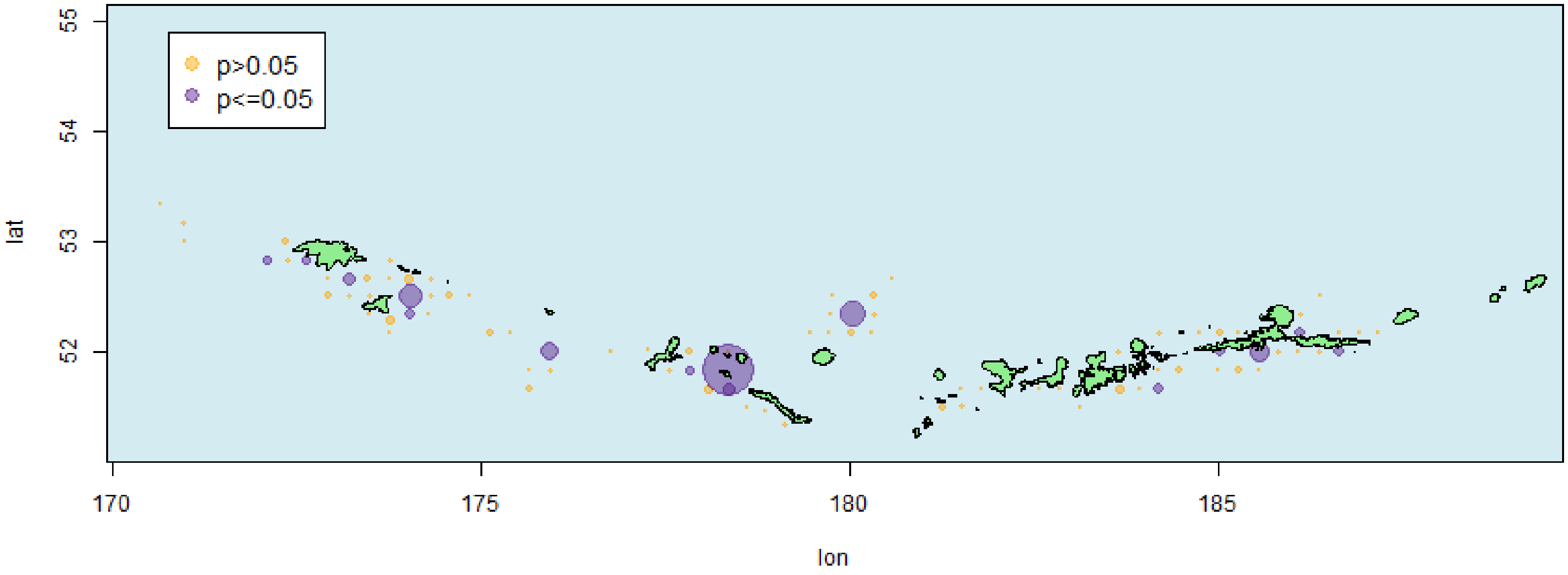
- Used discrepancy measure, *T*, to assess model fit (Cressie and Wikle, 2011):

$$T(Z_i;Y,\theta) = \frac{\left(Z_i - E(Z_i|Y,\theta)\right)^2}{\mathrm{var}(Z_i|Y,\theta)}$$

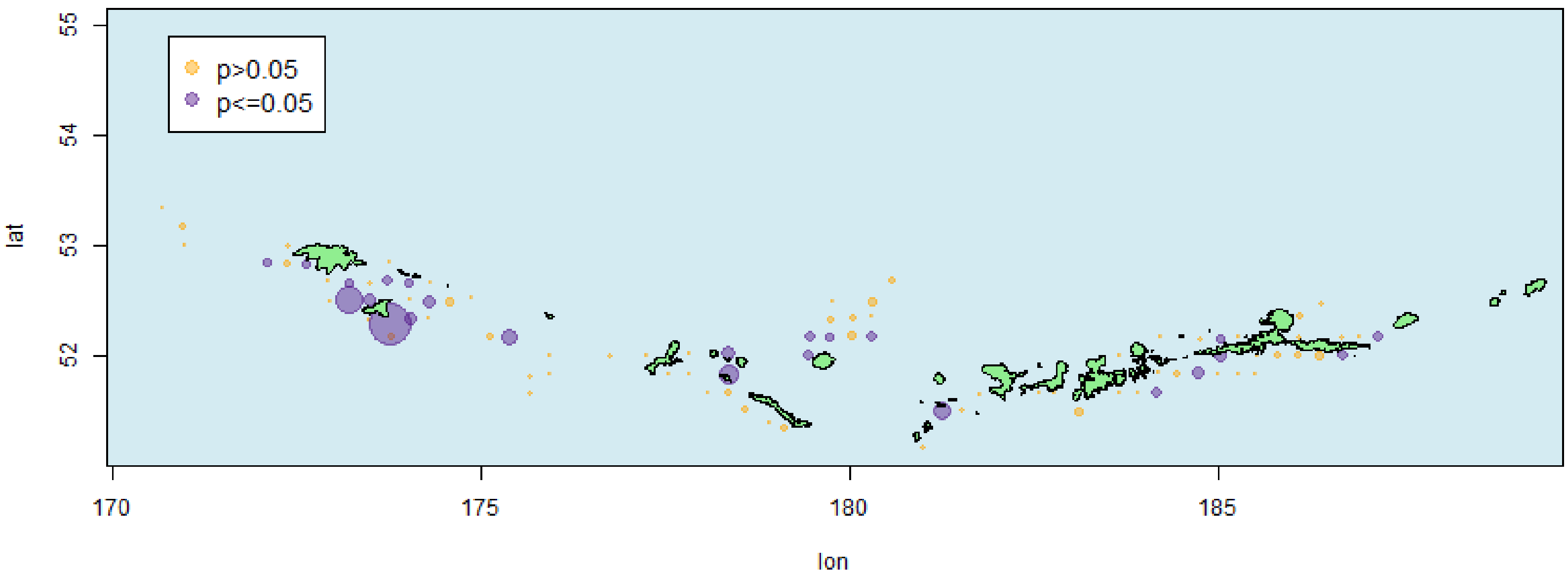
- Z_i is observed WPUE or WPUE, *Y* is the underlying process, and θ is the parameter vector.
- Value of *T* for each Z_i can be compared to distribution obtained by substituting the posterior samples for Z_i, denoted by $Z_{i,rep}$
- "Extremeness" of values of *T* measured using posterior predictive *p*-values:

$$P\left(T\left(Z_{i,rep};Y,\theta\right) \geq T(Z_i;Y,\theta)|Z_i\right)$$

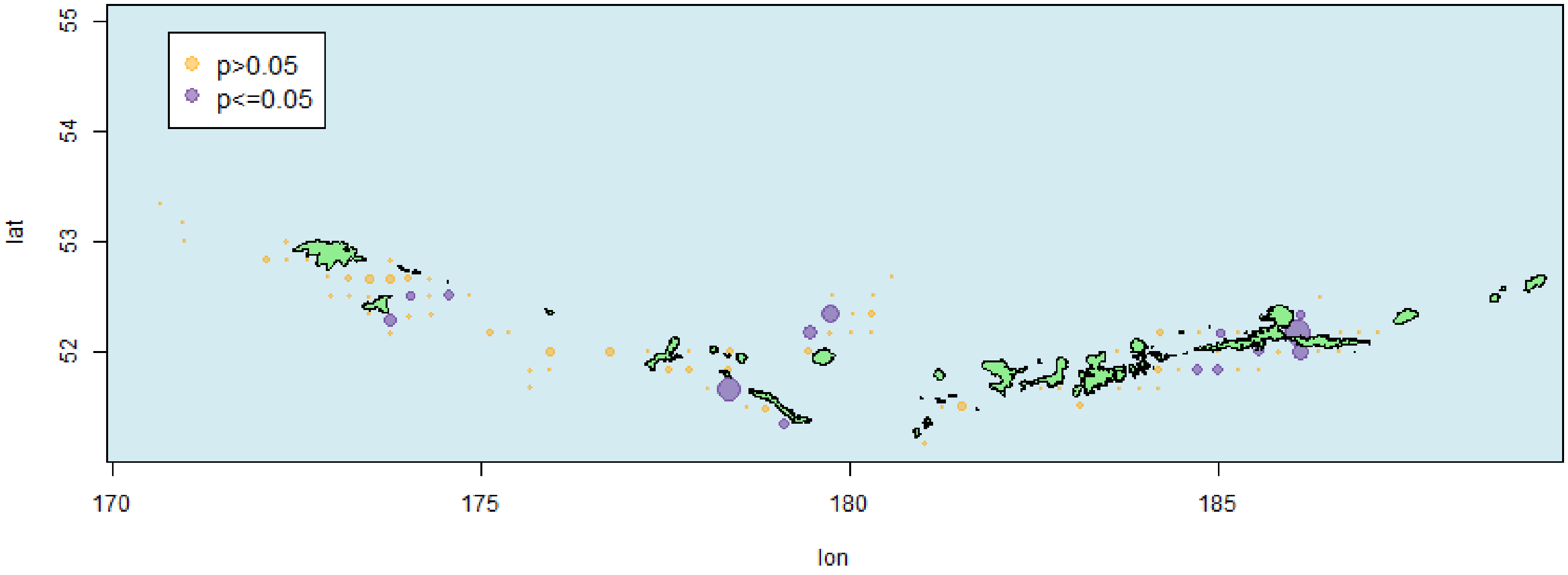
4B 2011



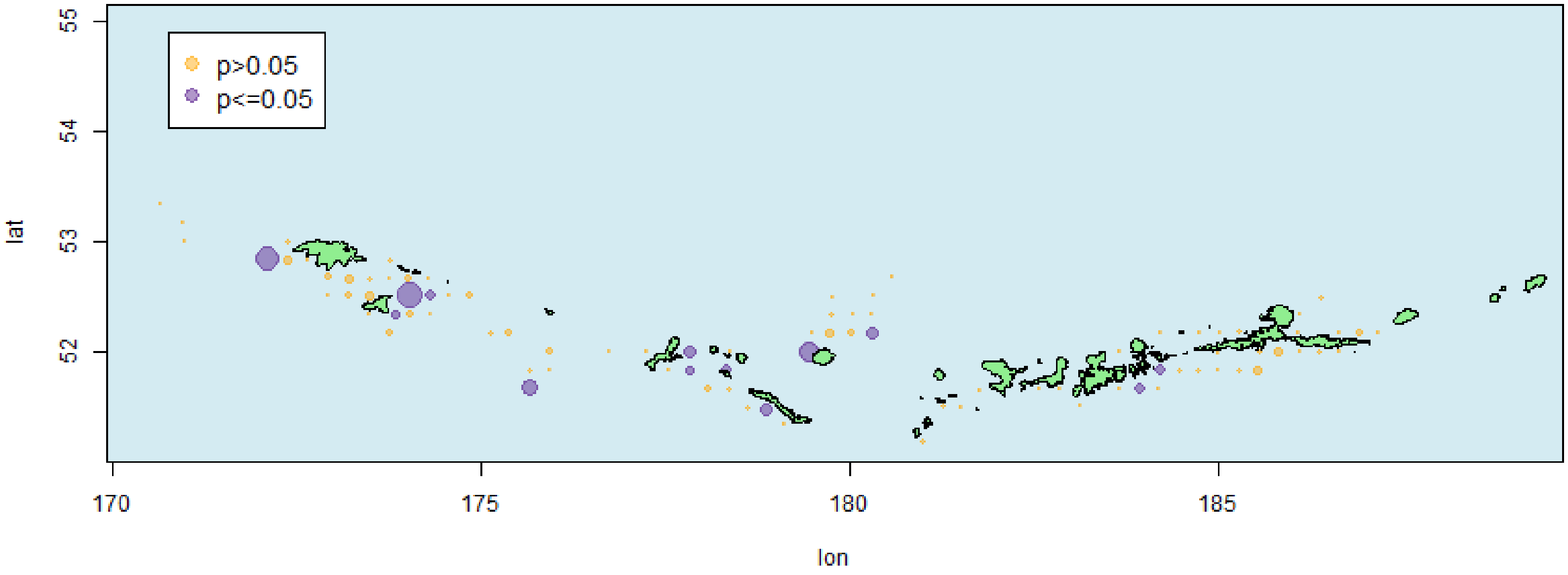
4B 2012



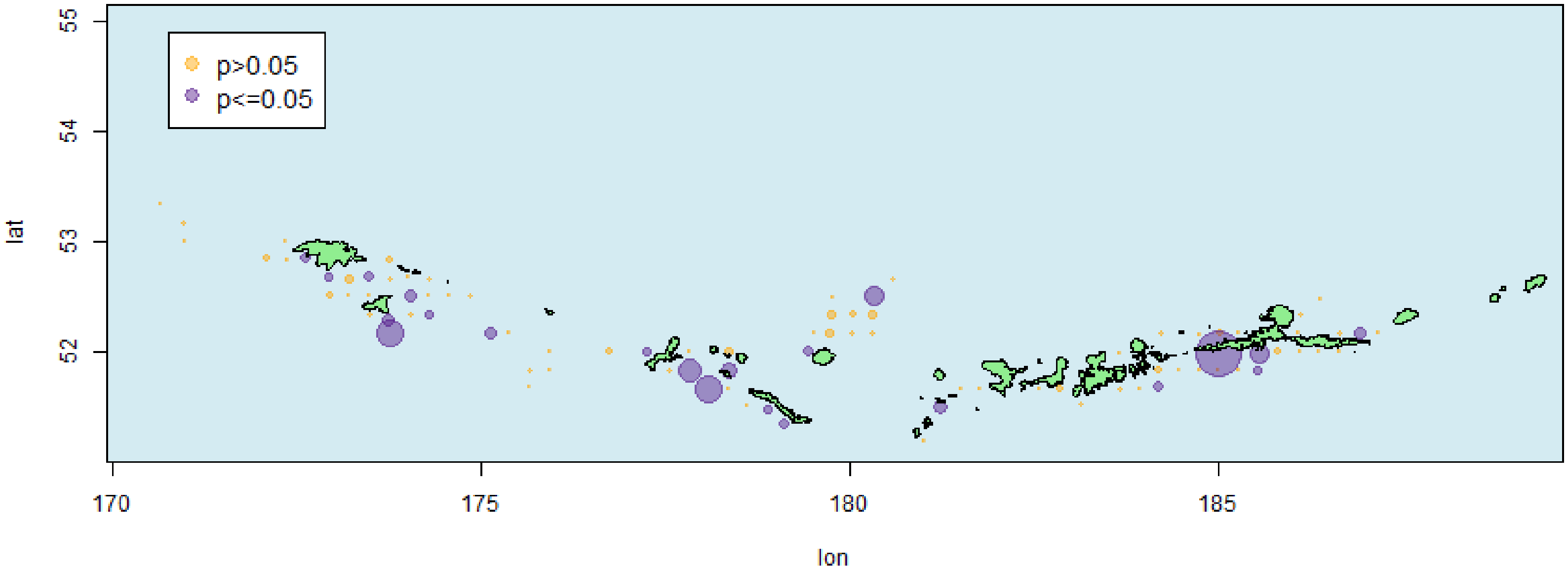
4B 2013



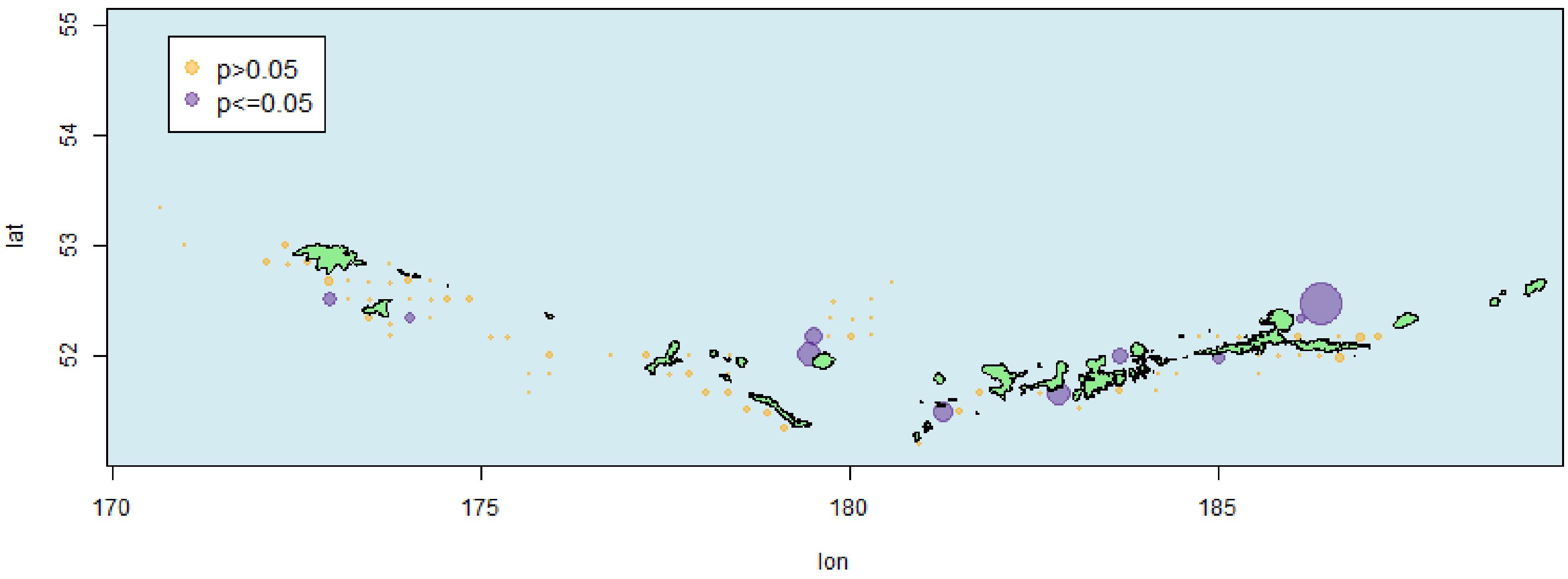
4B 2014



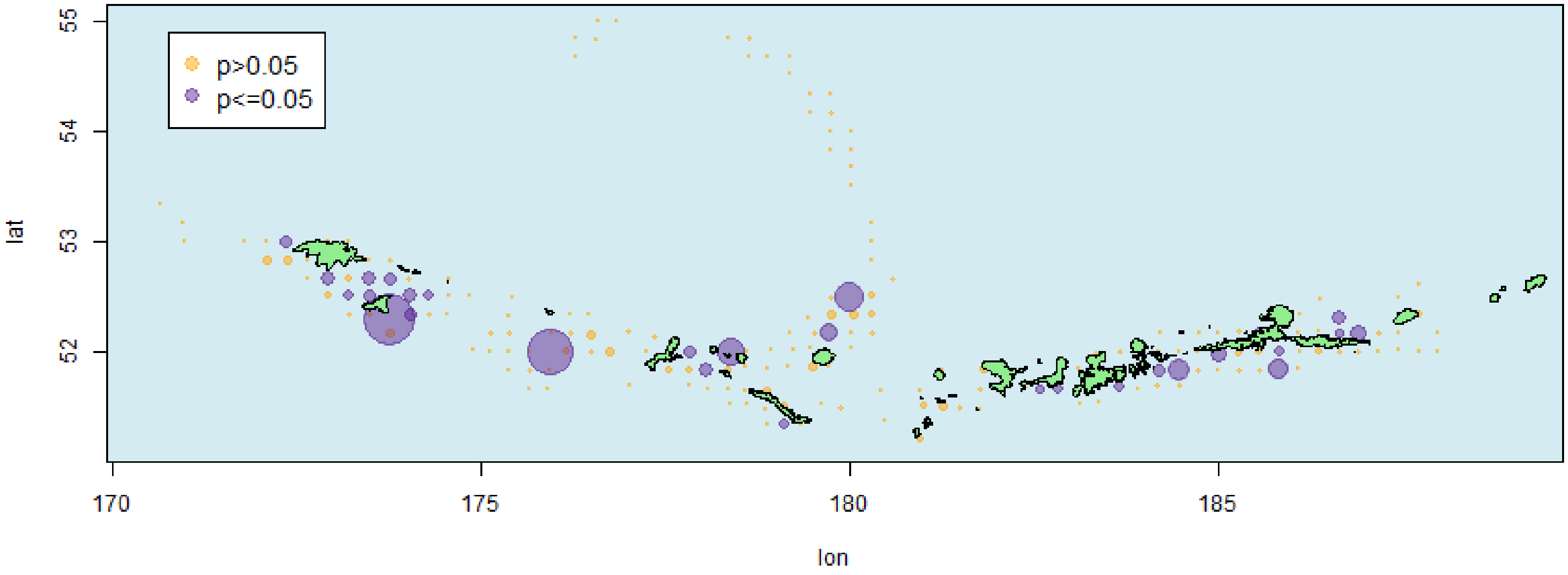
4B 2015



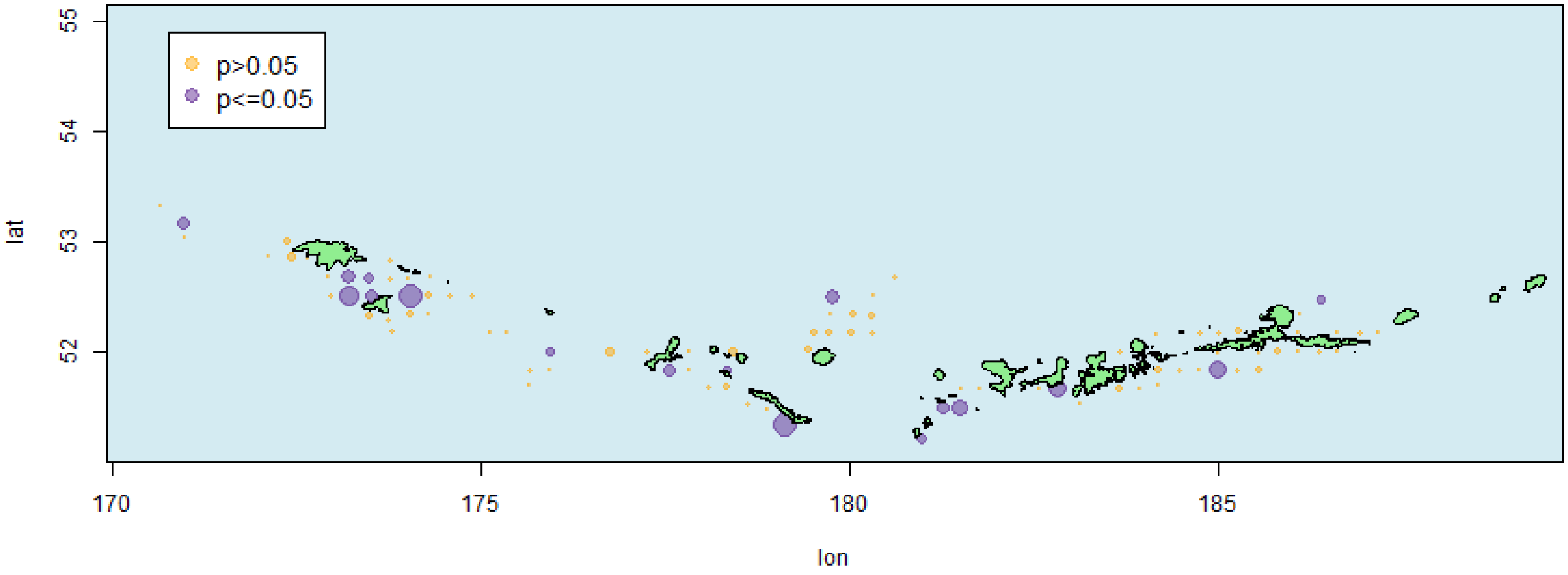
4B 2016



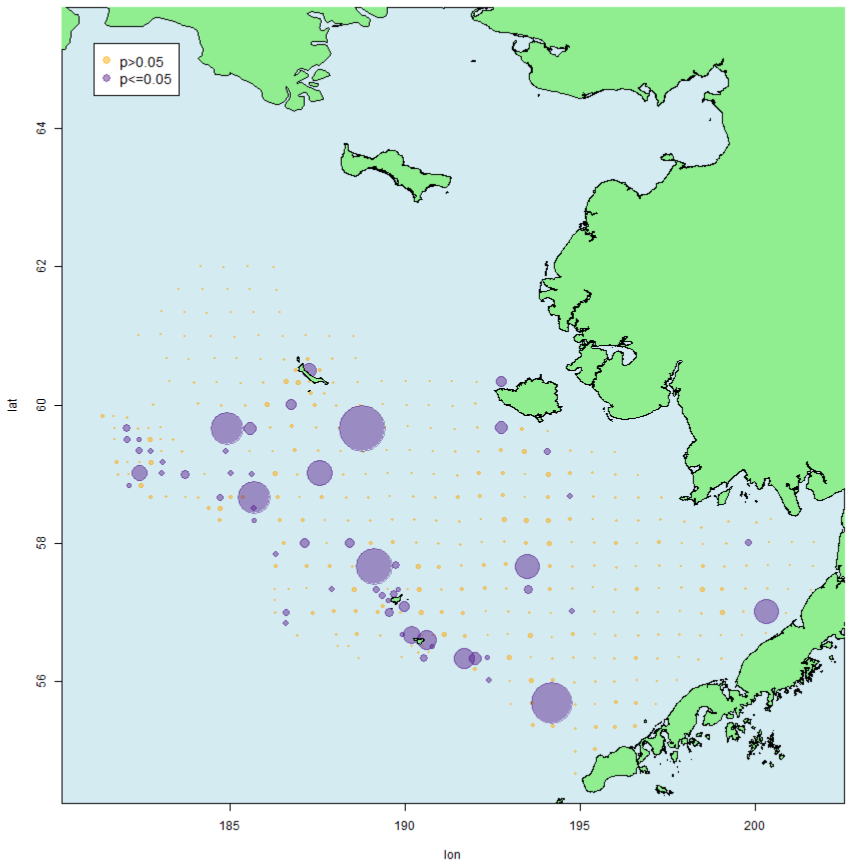
4B 2017

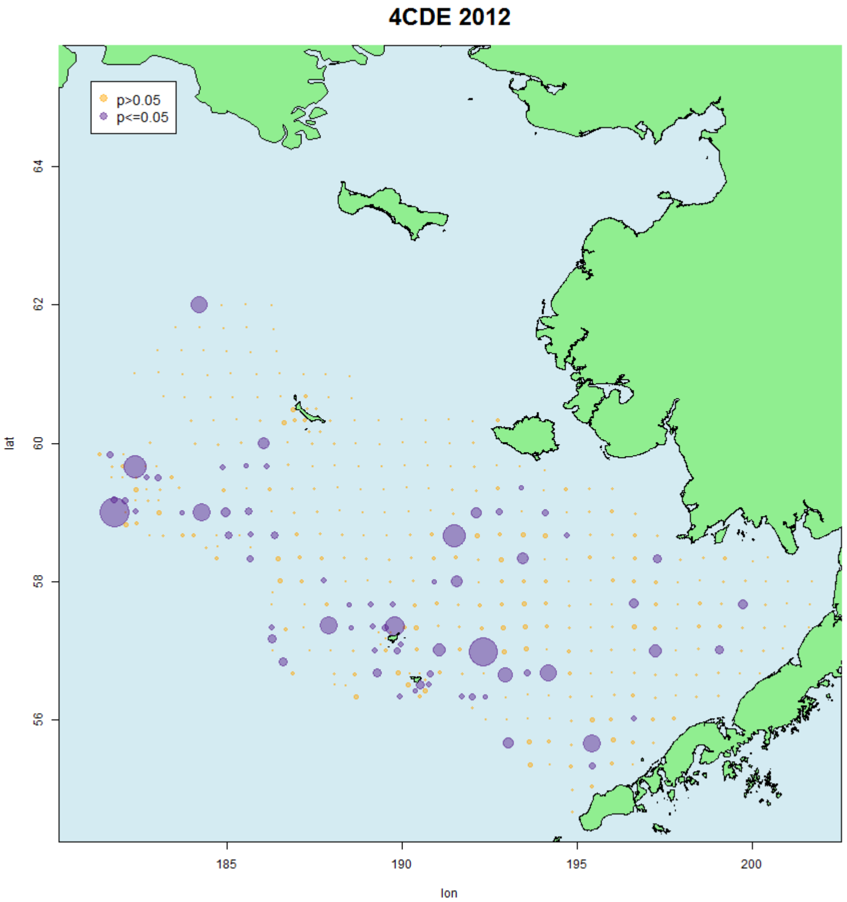


4B 2018

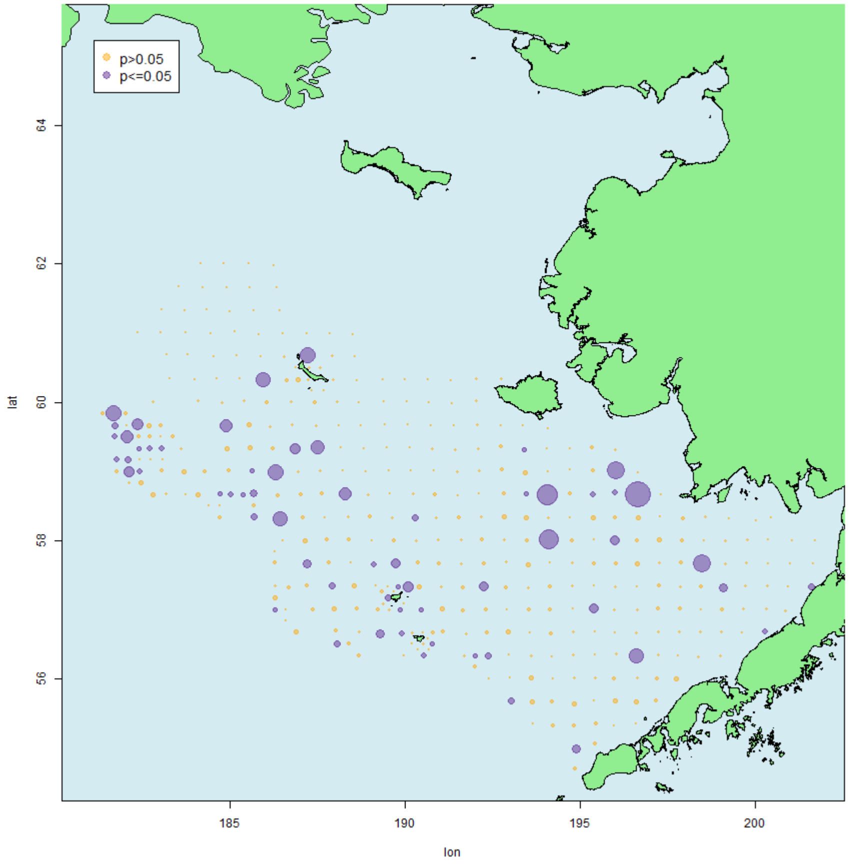


4CDE 2011

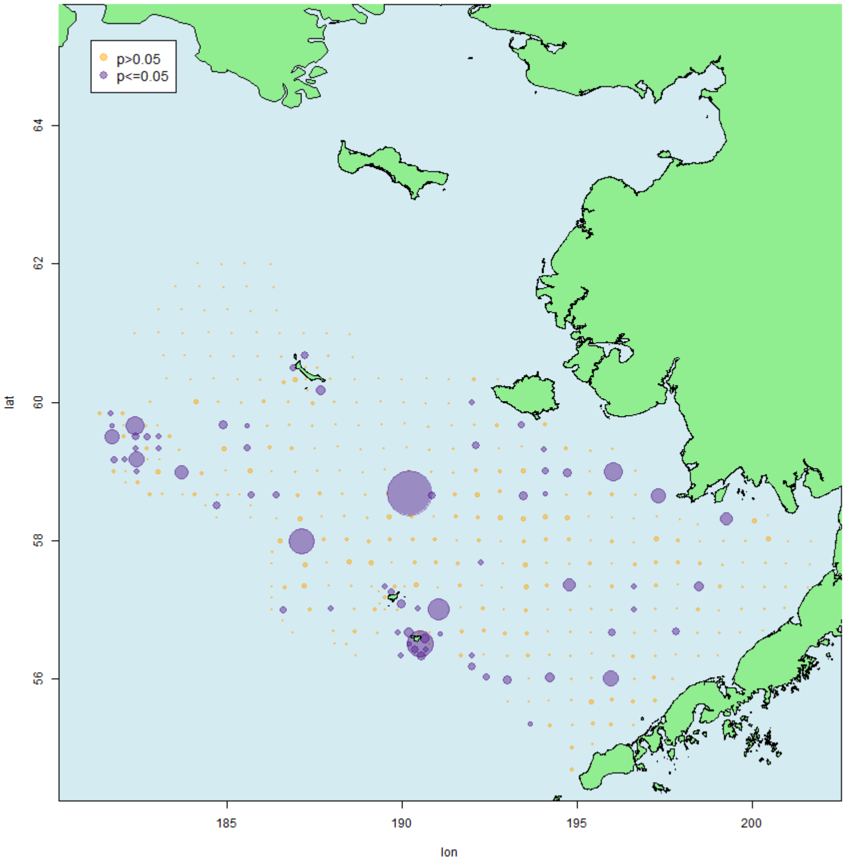



4CDE 2012
p>0.05
p<=0.05
lat
64
62
60
58
56
185
190
195
200
lon

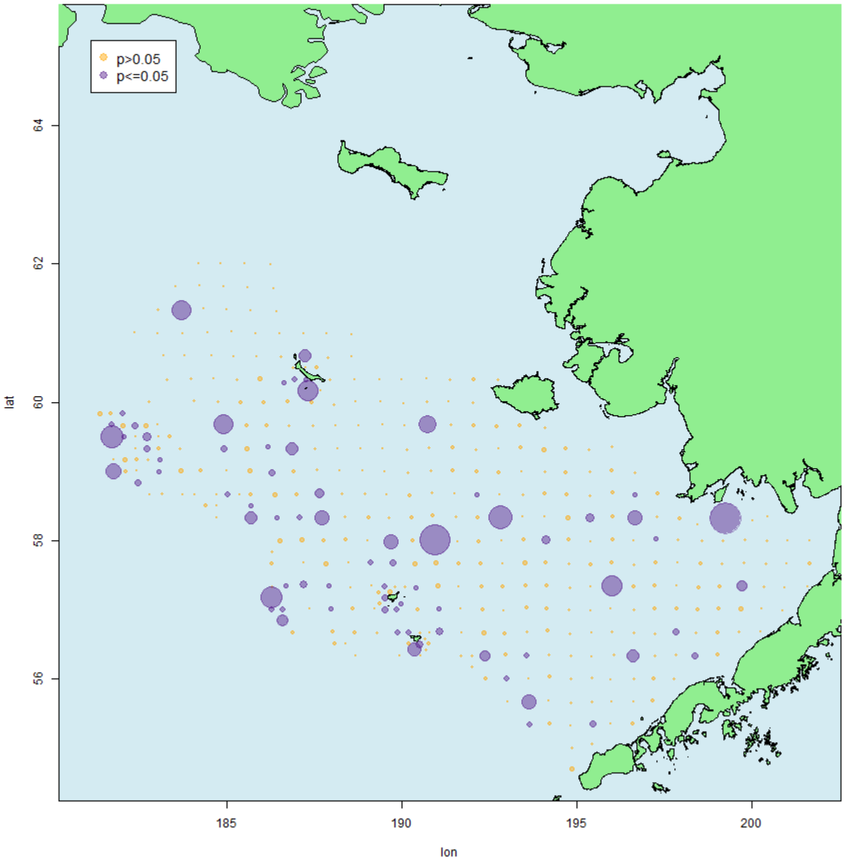
4CDE 2013



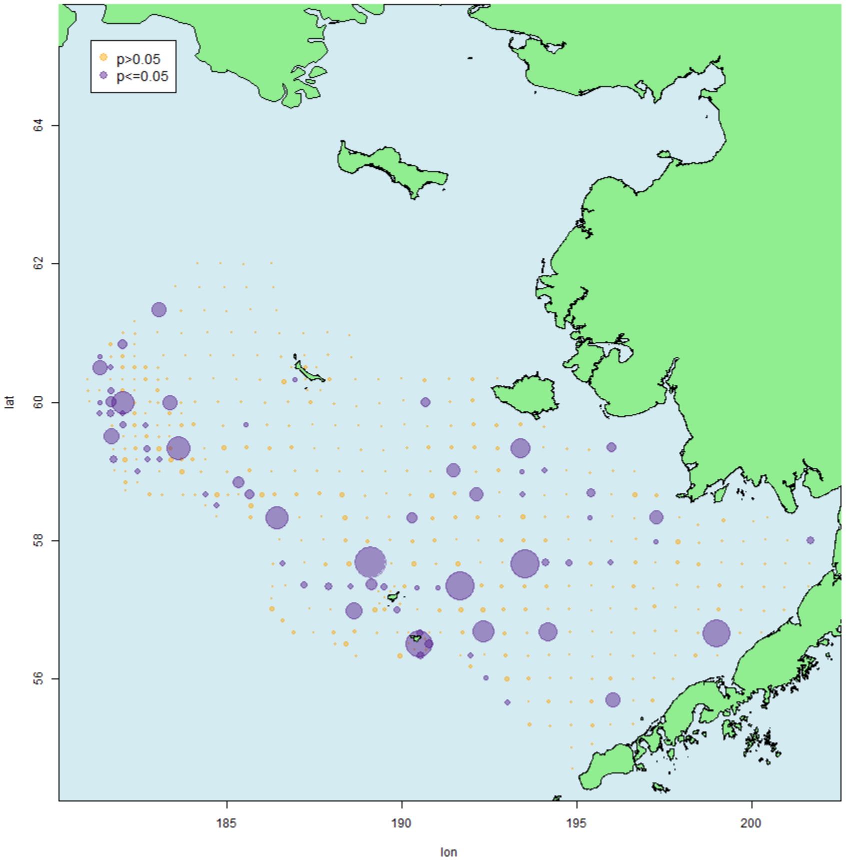
4CDE 2014



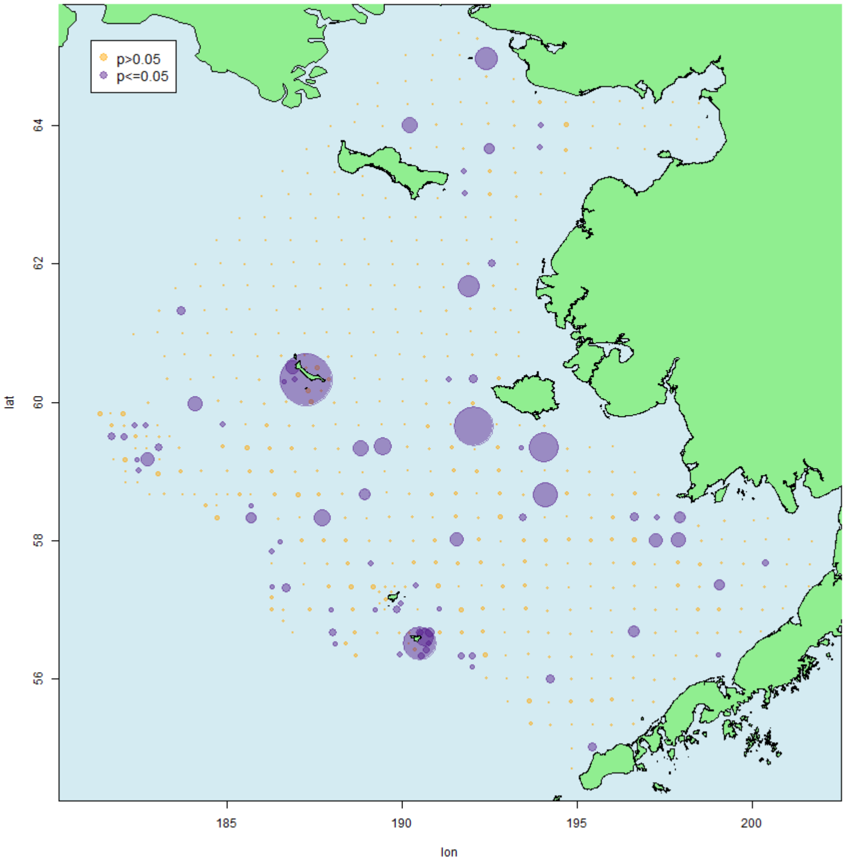
4CDE 2015



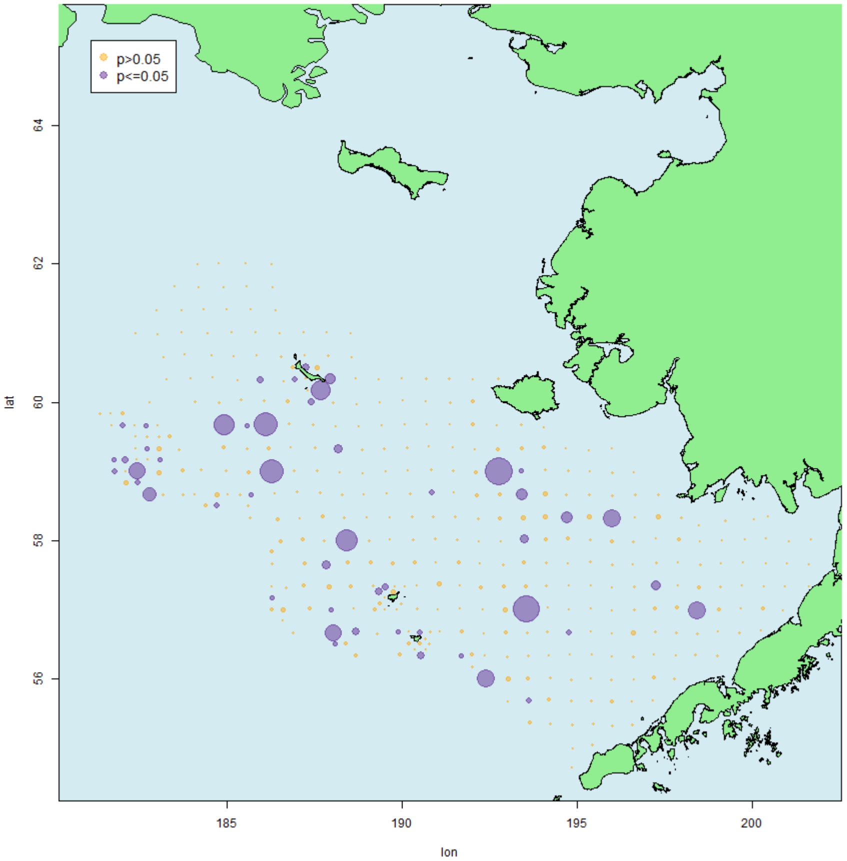
4CDE 2016



4CDE 2017



4CDE 2018



Map summary

- Evidence for localised lack of fit in space-time model
- No clear, consistent patches of lack of fit in Reg Area 4B
- Possible clusters of high discrepancy values on Bering Sea shelf edge and around islands in most years
  - Strength of spatial dependence may vary with habitat

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