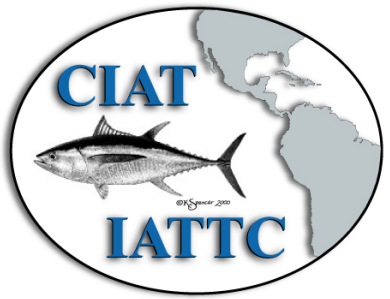
Management options for tropical tunas in the eastern pacific Ocean



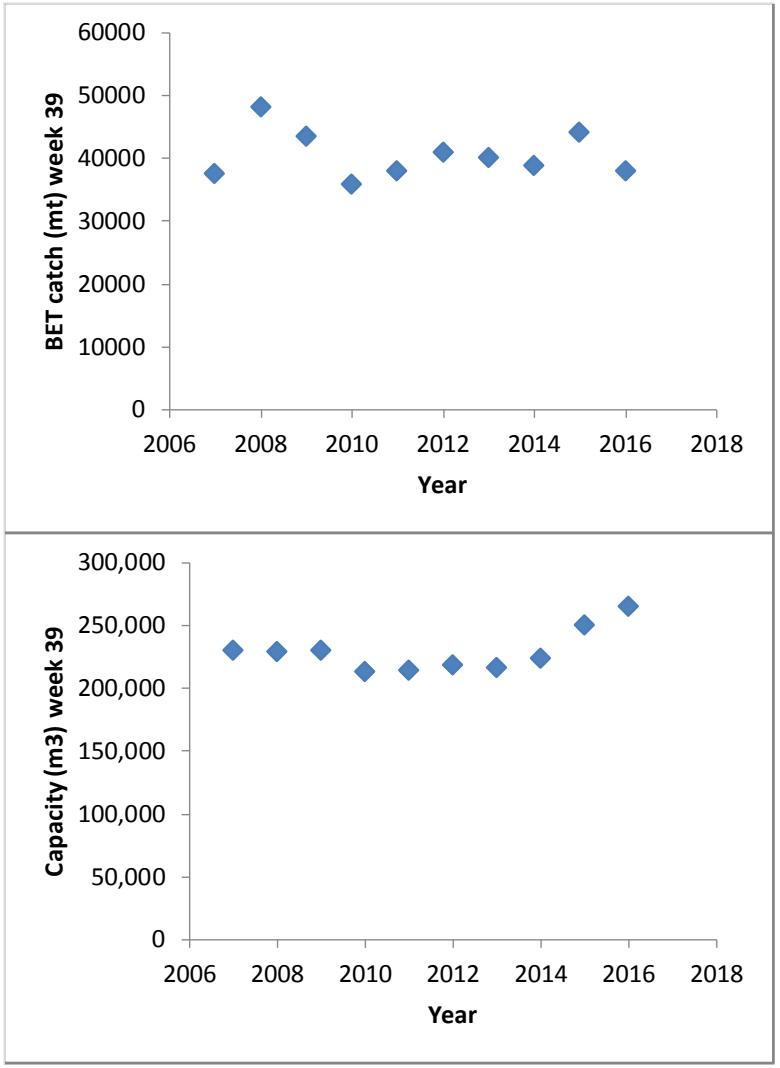
Current management: Resolution C-13-01

- 62 day purse seine closure
- Purse-seine fishing prohibited in “corralito” 96°W to 110°W between 4°N and 3°S from 29 September to 29 October.
- Annual longline country catch limits for bigeye tuna
- Purse-seine vessels are required to land all tropical tunas caught, except fish considered unfit for human consumption

Rationale for additional management

- Stock assessment estimates fishing mortality have remained around F_{MSY}
  - *YFT: F*multiplier (F_{MSY}/F_{cur}) = 1.02
  - *BET: F*multiplier (F_{MSY}/F_{cur}) = 1.05
- However, capacity of the purse-seine fleet has recently increased by about 25,000 m^3.
- Additional days of closure required to account for the capacity increase adjusted by the Fmultiplier
  - YFT= 25
  - BET= 17

Comparison of recent BET catch and capacity



Important

- The management options evaluated here are intended to be applied in conjunction with Resolution C-13-01
- This is a safeguard for untested conservation measures
- There is uncertainty in the effectiveness of the proposals
- They are alternatives to the 25 (or 17) additional days of closure
- Predicted consequences of the management options are expressed in equivalent additional days of closure.

Proposals

- Extending the current closure
- Reducing capacity
- Catch limits
- Individual vessel quotas
- Temporal closures
- Spatial closures
- Limitations on the number of purse seine sets
- Limitations on the number of FADS
- Other

Additional information

- IATTC-90 INF-B Addendum 1 Alternative management measures
- IATTC-90 INF-B Alternative management measures
- IATTC-90-04d(i) Options for measures for the conservation of tunas in the eastern Pacific Ocean, 2016
- SAC-07-07e Predicting catches of bigeye tuna
- SAC-04-11 Individual-vessel quotas for purse-seine vessels that fish on fish-aggregating devices (FADs)
- IATTC-82 INF-A Evaluation of a total allowable catch system for the purse-seine and longline tuna fisheries in the eastern Pacific Ocean

Extending the current closure

- The average capacity for the 2013-2015 period, which is the basis for the F multiplier calculated in the stock assessment, is 230,148 m3.
- The capacity as of 17 April 2016 was 255,972 m3, an increase of 11.2%.
- Additional closure days
  - YFT = 25
  - BET = 17
- The closure would be based on YFT (25 days)
- The impact on F will vary depending on the closure period chosen by the vessels and whether the additional days are added to the start or the end of the existing closures

Reducing capacity

- Reduction in purse-seine capacity to its 2013-2015 level
- This would require a reduction of about 25,000 m^3.
- This level is only an approximation of what is needed, because
  - not all capacity is equal
  - the capacity varied during the 2013-2015 period
  - capacity is changing all the time

Calculating equivalent days

- Account for the stock assessment results and change in capacity
- Proportional to F

$$\text{New\_Open} = \text{Fmult x } \frac{\text{Old\_Capacity}}{\text{New\_Capacity}} \text{ x Old\_Open} \qquad \text{Equation 1}$$

- Assuming that catch is proportional to effort, the equivalent in days of closure is proportional to the change in catch when the additional management measure is applied.

$$\text{Equivalent\_Days} = \frac{(C - C^*)}{C} \text{ x New\_Open} \qquad \text{Equation 2}$$

where C is the catch without additional management and C* is the catch with additional management.

Catch limits

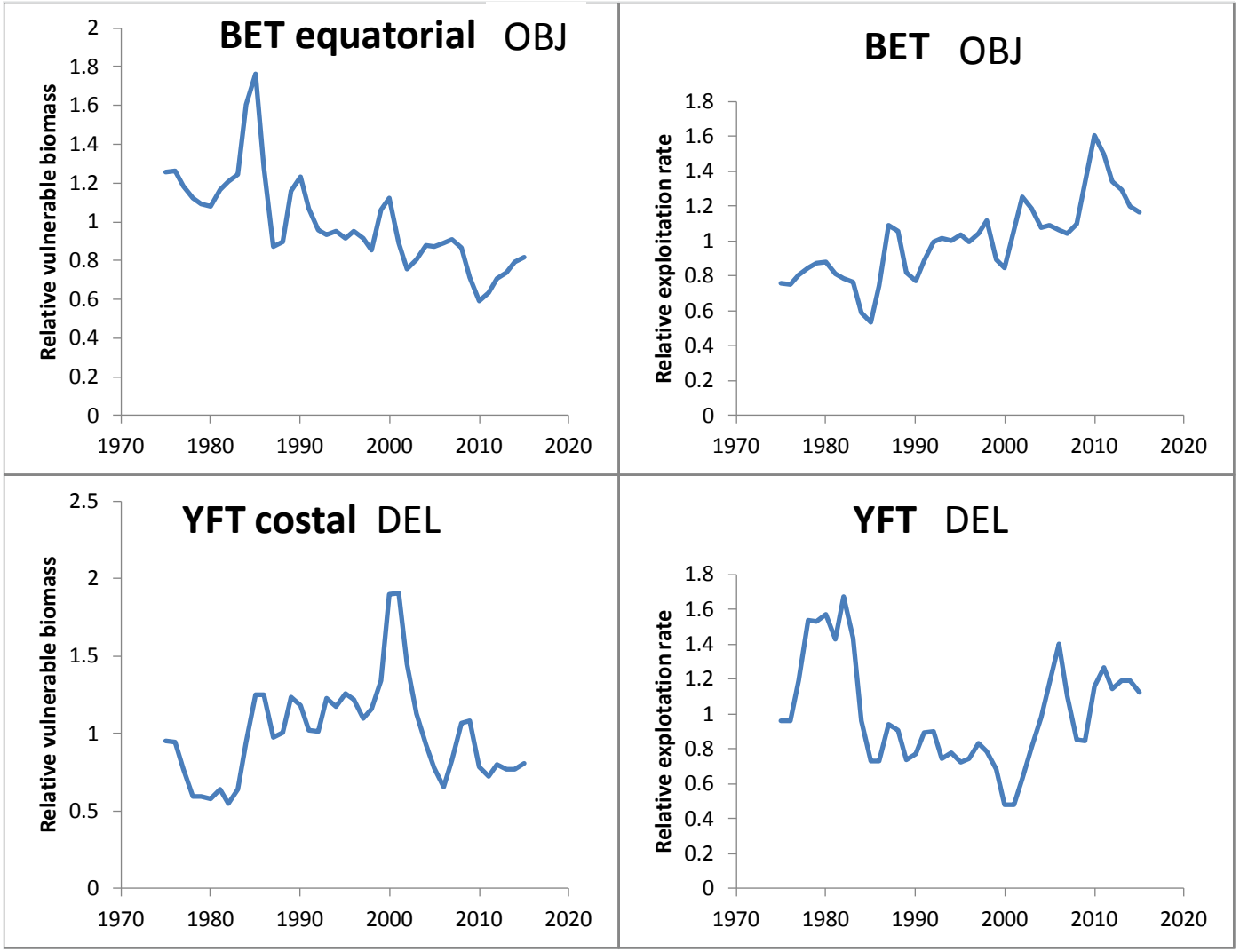
Catch limits

- Catch limits can be applied in a variety of ways
  - EPO (applied to YFT during 1962-1979)
  - Country (system for allocation of national capacity limits)
  - EEZ and high seas
  - Set type
  - Individual vessels (DMLs)
  - Country and vessel
  - Small fish
- Species specific or BET + YFT combined
  - Species composition
  - Protecting small YFT benificial
  - Change to targeting BET
  - Different species of tunas may have different prices in the market

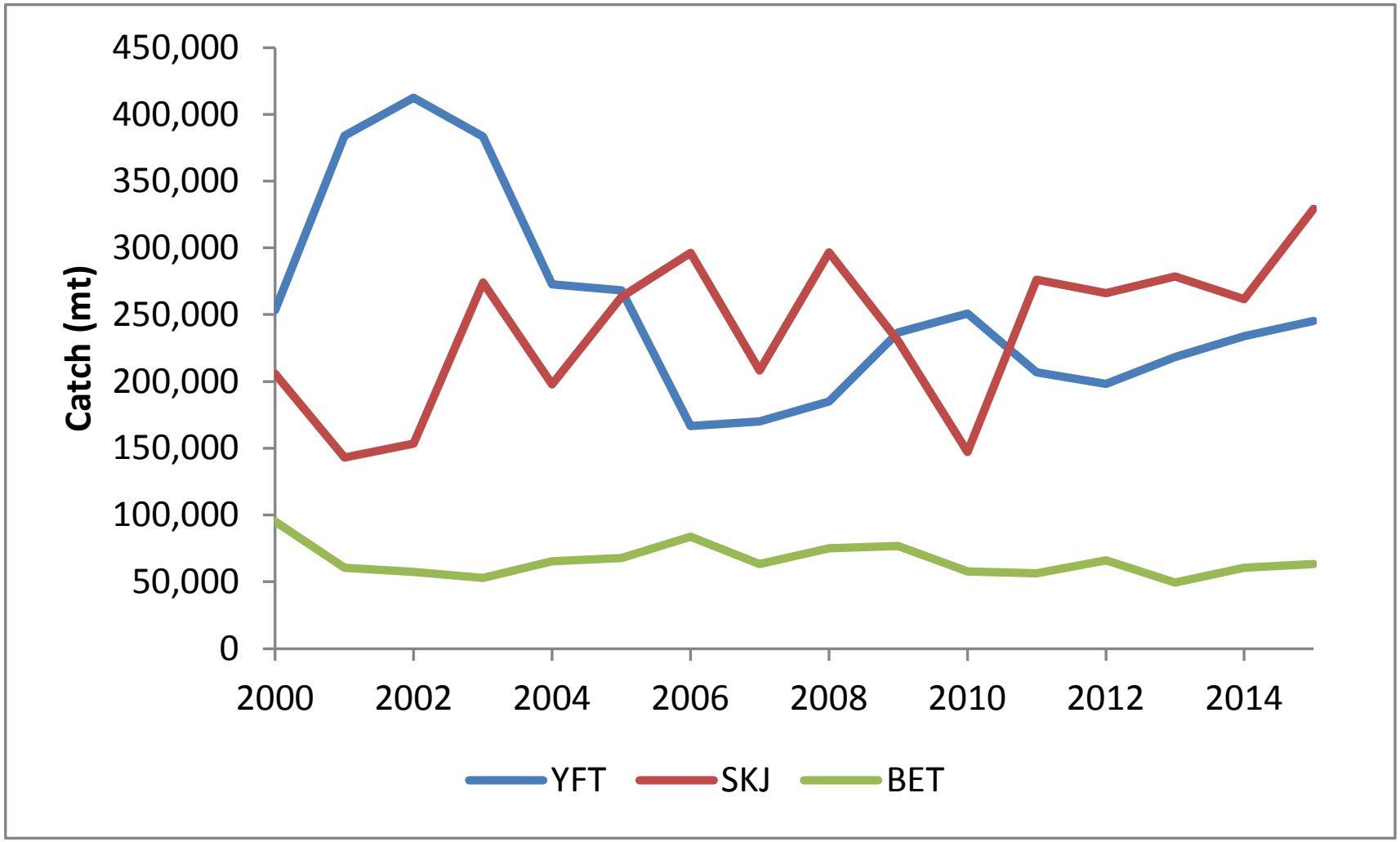
Setting the total quota

- MSY
  - MSY is target so use for total quota
  - Current status of a stock may not support long-term MSY
  - Use catch projected when fishing at FMSY
  - Requires accurate stock assessments
  - Poor predictions of future biomass (YFT) and thus catch
  - MSY sensitive to the age-specific pattern of selectivity and different allocation schemes for fishing effort
- Use average recent catch
  - Which years

Fluctuating abundance makes catch quotas risky



Fluctuating catch



Allocation complications

- More than 20 different national fleets fishing for tunas
- Two main fishing methods, purse-seine and longline
- Three main modes of purse-seine fishing
  - Unassociated schools
  - Associated with dolphins
  - Associated with floating objects
- More than one species is frequently caught in a single set

EPO catch limits

- Advantages
  - Catch limits are easy to understand
  - The IATTC has a long history of working with catch limits
  - Existing weekly report system could be used to monitor the catch
  - Automatically adjusts for capacity changes and set type
  - No allocation decisions

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  - No allocation decisions
- Disadvantages
  - A closure would start whenever the catch of either of the two species reached its limit
  - Could cause a “race” for fish
  - Closure could occur before 62+25 days
  - Makes current 2 period closure complicated
  - The resulting fishing mortality would be dependent on the population size, which may change over time.
  - Species composition issues
  - Which vessels
    - Pole-and-line, class 1-3 purse seiners, sport fishing vessels
    - Vessel registry

EPO catch limits

- Monitoring
  - Accuracy
  - Timeliness
  - Species composition
  - Method
    - Observer data, including at-sea radio reports (available in near real-time, used for weekly reports ,relies on vessel personnel, includes discards)
    - Logbooks
    - Cannery records (no position information)
    - Port-sampling data (used to adjust species composition for BSE)
  - Predict the approximate closure date based on the available information (weekly report)
- Limit setting
  - Dictated by monitoring
  - Observer, logbook and cannery data do not include species composition adjustments
  - Observer data does not include small vessels
  - Cannery records do not include detailed spatial information
  - Discard information only available from observer data

Action

- Immediate closure or complete trip
- Continue fishing
  - Bycatch allowance
  - Set type ban
  - Area closure
  - Gear restrictions

Species composition and discards

TABLE C. Retained purse-seine catches of yellowfin, skipjack, and bigeye tuna, in metric tons, by set type, 2013-2015. The data in the upper panel, from IATTC Fishery Status Report 14, Table A-7, have been adjusted to the species composition estimate; those in the lower panel, from the IATTC CAE database, have not.

	Dolphin			Floating object			Unassociated		
	YFT	**SKJ**	**BET**	**YFT**	**SKJ**	**BET**	**YFT**	**SKJ**	**BET**
Adjusted									
2013	157,432	4,272	0	35,089	194,372	48,337	25,666	79,916	1,150
2014	168,209	4,436	3	45,476	199,488	59,803	20,288	57,654	647
2015	160,901	5,651	2	43,152	205,976	61,277	41,130	117,653	1,950
2013-2015	162,181	4,786	2	41,239	199,945	56,472	29,028	85,074	1,249
Unadjusted									
2013	159,155	4,222	0	35,474	192,136	52,712	25,947	78,985	1,254
2014	172,914	4,447	3	46,751	200,013	54,574	20,856	57,796	590
2015	161,668	5,517	2	43,531	201,472	65,420	41,394	114,881	2,082
2013-2015	164,579	4,729	2	41,919	197,874	57,569	29,399	83,888	1,309

In-season adjusted catch limits

- Adjusted for changes in catch per unit of effort (CPUE).
- Advantages
  - Similar to the in-season catch increments used previously by the IATTC.
  - Takes into account the changes in biomass from one year to the next, which reduces the chances of overfishing.
- Disadvantages
  - Catchability might change over time
  - Catch per unit of capacity may not be proportional to abundance.

National catch limits

- Allocation
  - Fishing capacity
  - Installed processing capacity
  - Historical catches within zones of national sovereignty or jurisdiction
  - Landings of tuna
  - Contribution to the conservation program
  - Catch of national fleets during a particular period of years
- National capacity limits

EEZ and high seas catch limits

- Catch limits are established for each EEZ
- An additional limit for the high seas
- Once the catch limit in one of these areas is reached, fishing could continue in the other areas until the limit established for that area is reached.

Catch quotas by set type

- Average catches by all purse-seine vessels, by set type and species, can be used to calculate species quotas by set type.
- Which set type and species
- Combine YFT and BET for some set types
- Quotas by area as a proxy for set type
- Vessels assigned “main set type” and quota to follow
- Disadvantages
  - Difficult to enforce because many vessels use multiple set types
  - The proportion of unassociated sets varies considerably over time.

Catch by species and set type

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Limits on small tuna

- YPR improvements
- Adopted for 1998-2000, once the limit was reached, all purse-seine vessels were prohibited from setting on FADs.
- Impact on fishing mortality rate (F) requires taking the size of the fish into consideration, using the stock assessment model
- YFT
  - Restricting the catch in the area with a greater proportion of juveniles (see spatial closures)
  - Applied in 1962-1979 using CYRA
  - Applied in 1999, two areas, one off Baja California and the other off northern South America

Individual vessel quotas issues

- System similar to that used for assigning Dolphin Mortality Limits (DMLs)
- Determining when a vessel has reached its IVQ (quantity and species composition)
  - Real-time estimates by observer
    - Relies on advice from the vessel's personnel
    - No authority to stop fishing
  - Cannery
  - IATTC port sampling
    - Covers only a small percentage of the total catch
    - Does not cover discards
- Establishing consequences of reaching or exceeding an IVQ
  - Buy other vessels' residual IVQ
  - Penalized in a subsequent year
  - Restricted to setting on unassociated tuna schools
  - Required to remove its FADs from the water.
- Transferability
- Enforcement challenges
- Ownership of fishing rights if a vessel changes flag
- Catch reserve to cover reactivated vessels and new capacity

Individual vessel quotas

- Four methods were used to calculate IVQs:

  Method 1: Each vessel's historical average annual catch during the previous four years, adjusted for any increase (or decrease) in fleet capacity.

  Method 2: Total historical catch of a fleet of vessels during the previous four years adjusted for capacity change, distributed among the fleet based on each vessel's capacity.

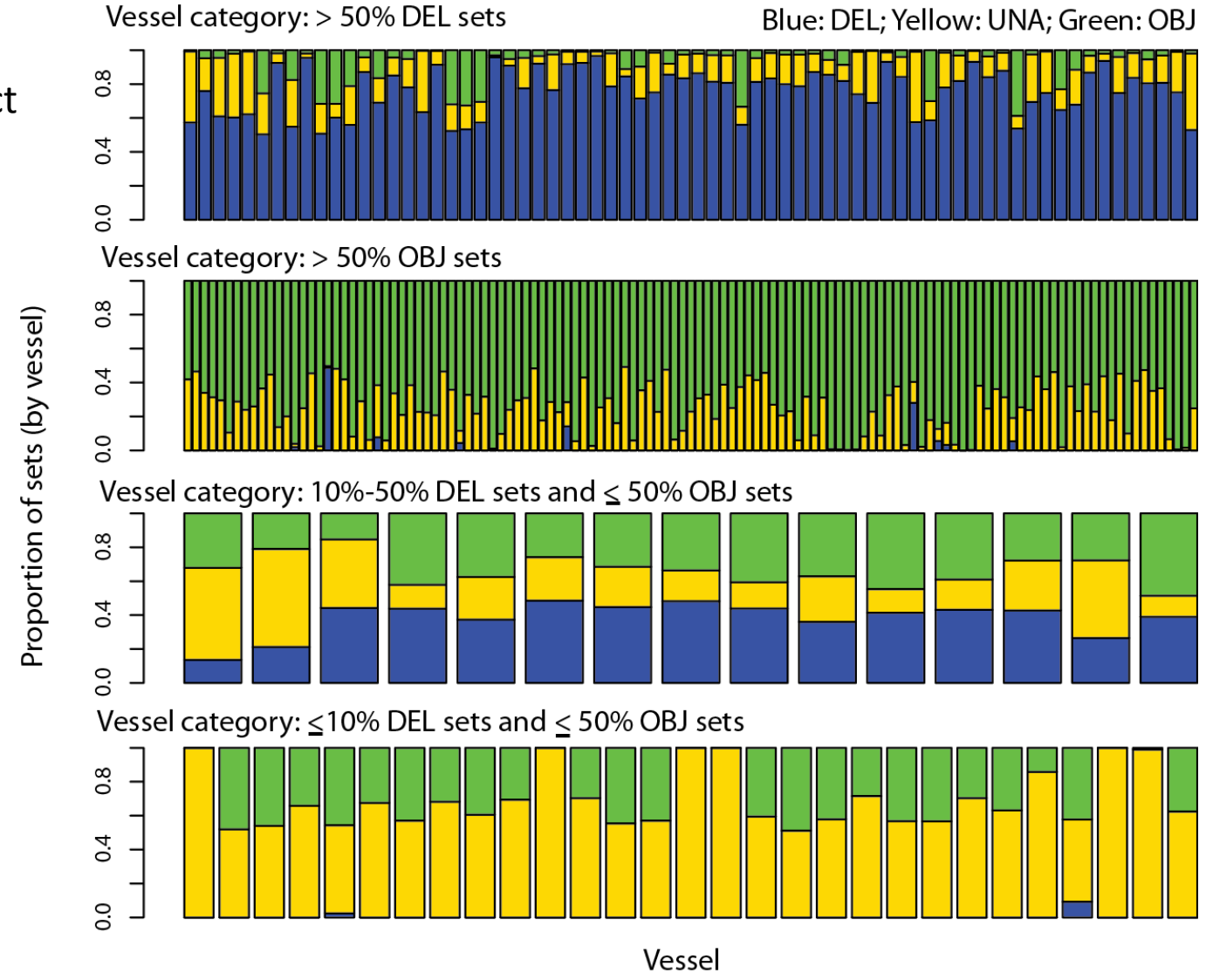
  Method 3: Combination of methods 1 and 2, split 70:30.

  Method 4: The average annual allocation, in tons (t) per cubic meter (m3) of vessel well capacity, that would have yielded the desired catch during the previous four years. (assumes all vessels will catch quota)

Data sets

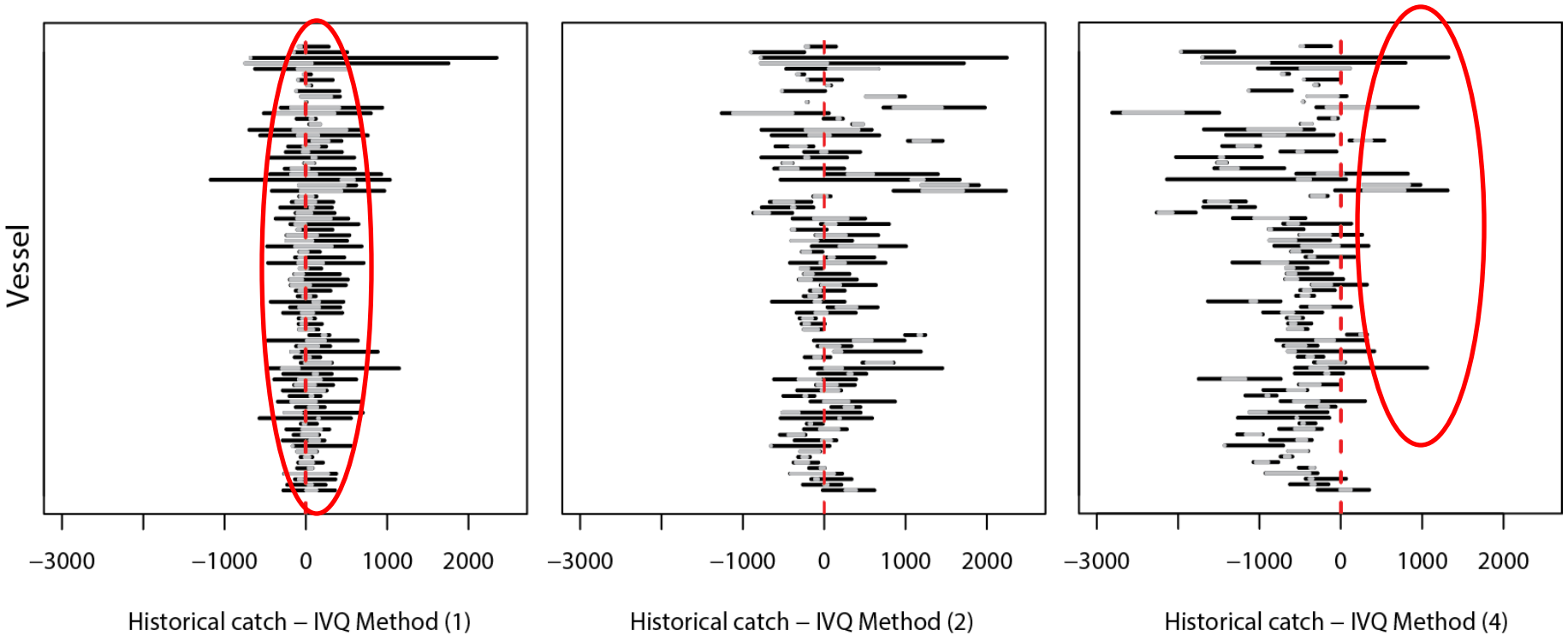
- Only size class 6 vessels that made more than 50% of their sets on floating objects (evaluated for BET and BET+YFT)
- Only size class 6 vessels that caught more than 50t of bigeye from 2012-2015 (evaluated for BET and BET+YFT)
- Only size class 6 vessels that made 50% or less of their sets on floating objects (evaluated for YFT)
- Only size class 6 vessels that made more than 50% of theirs sets on dolphins (evaluated for YFT)
- Only size class 6 vessels that caught 50t or less of BET (evaluated for YFT)
- All size class 6 vessels (only method 4)
- All vessels (i.e., the entire CAE dataset) (only method 4)

Blue: dolphin
Green: floating object
Yellow: school



Annual historical catch of bigeye *versus* IVQ

Size class 6 vessels that made more than 50% of their sets on floating objects.



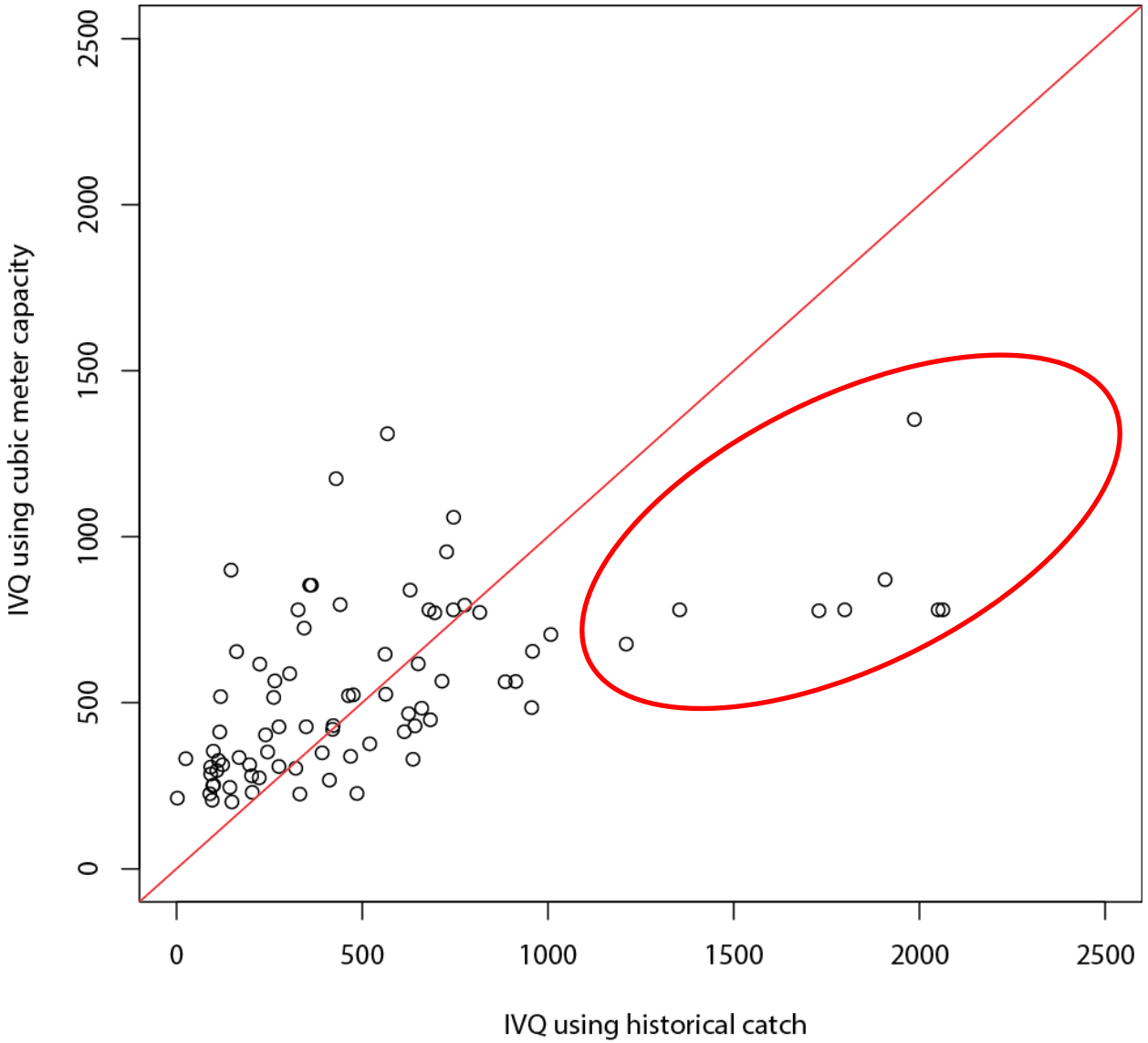
Method 1: vessels historical catch

Method 2: capacity

Method 4: capacity

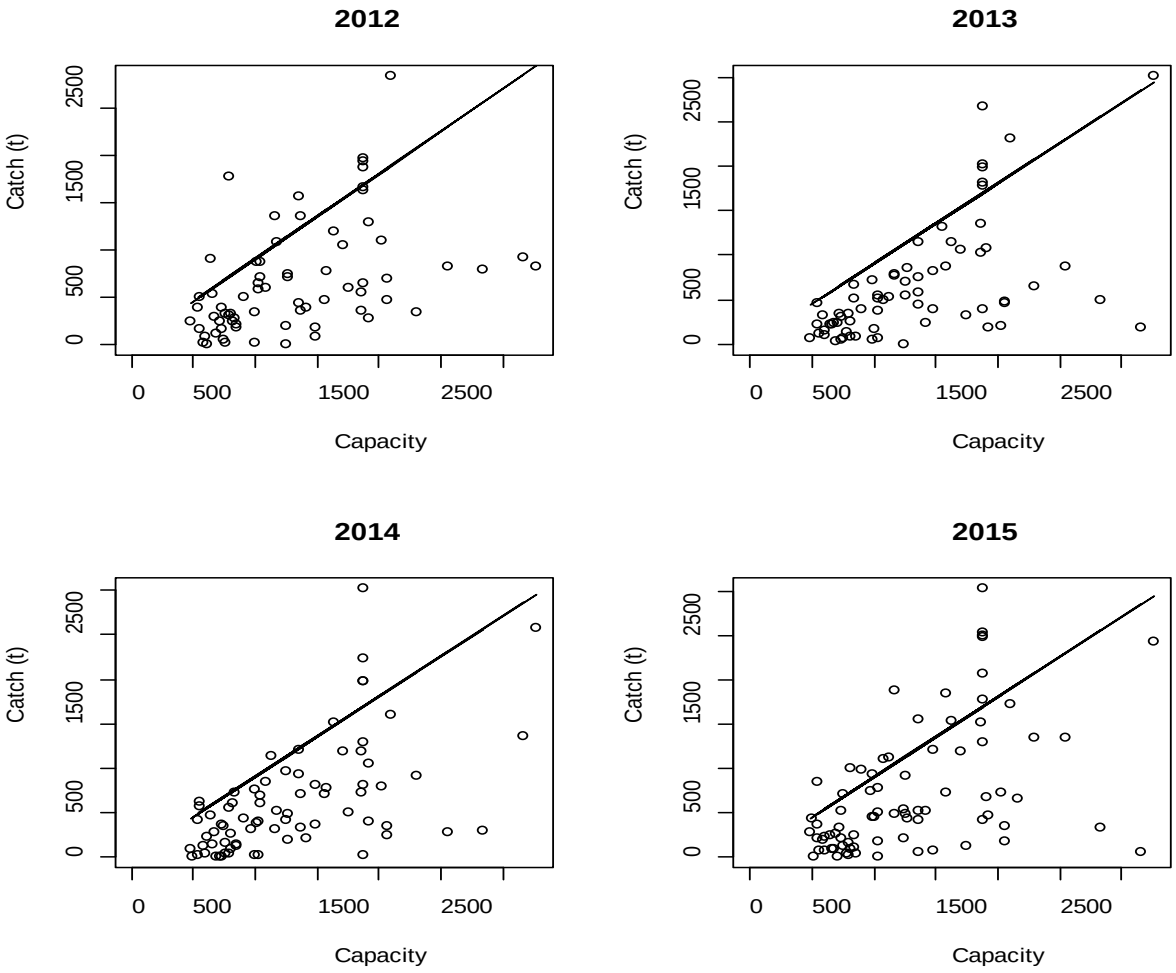
Bigeye IVQs based on historical catch versus IVQs based on capacity.

Class 6 vessels that made more than 50% of their sets on floating objects

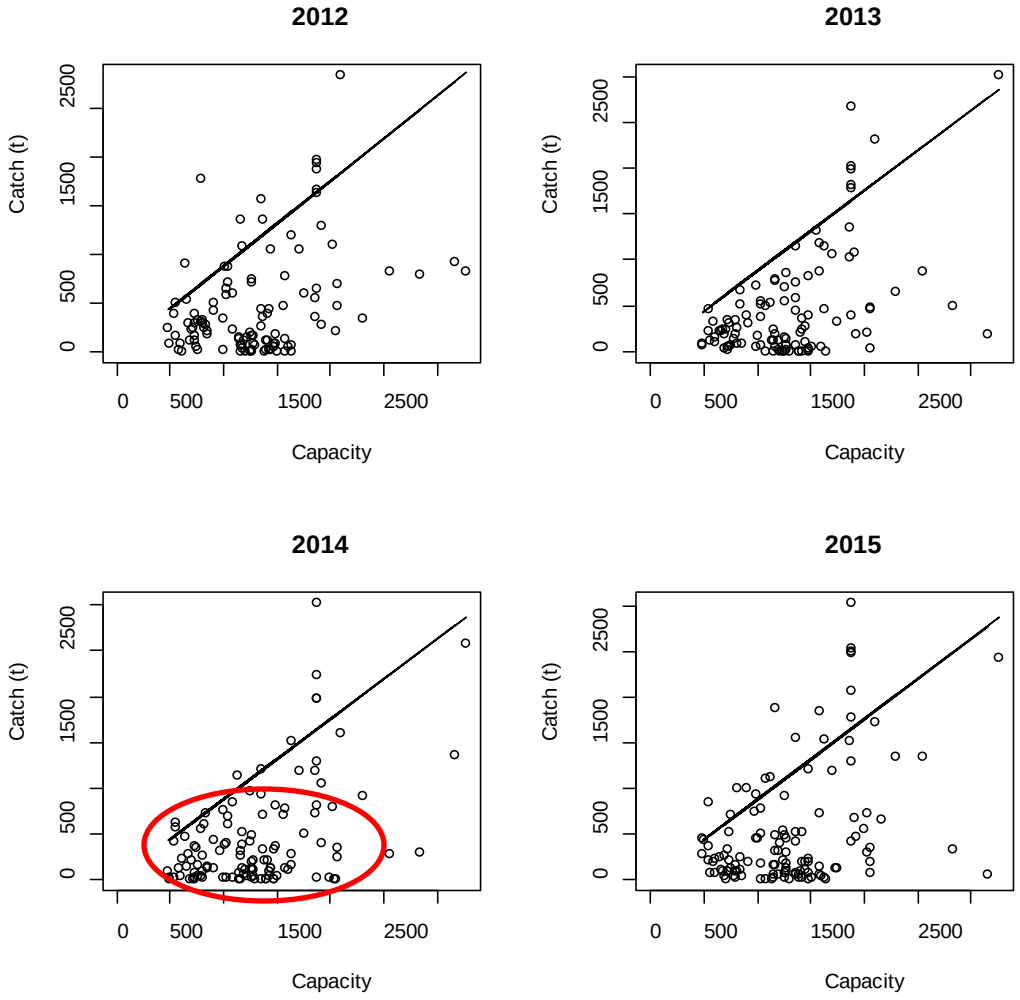


Historical bigeye catch plotted against vessel capacity (m^3) compared to the capacity based IVQ (line).

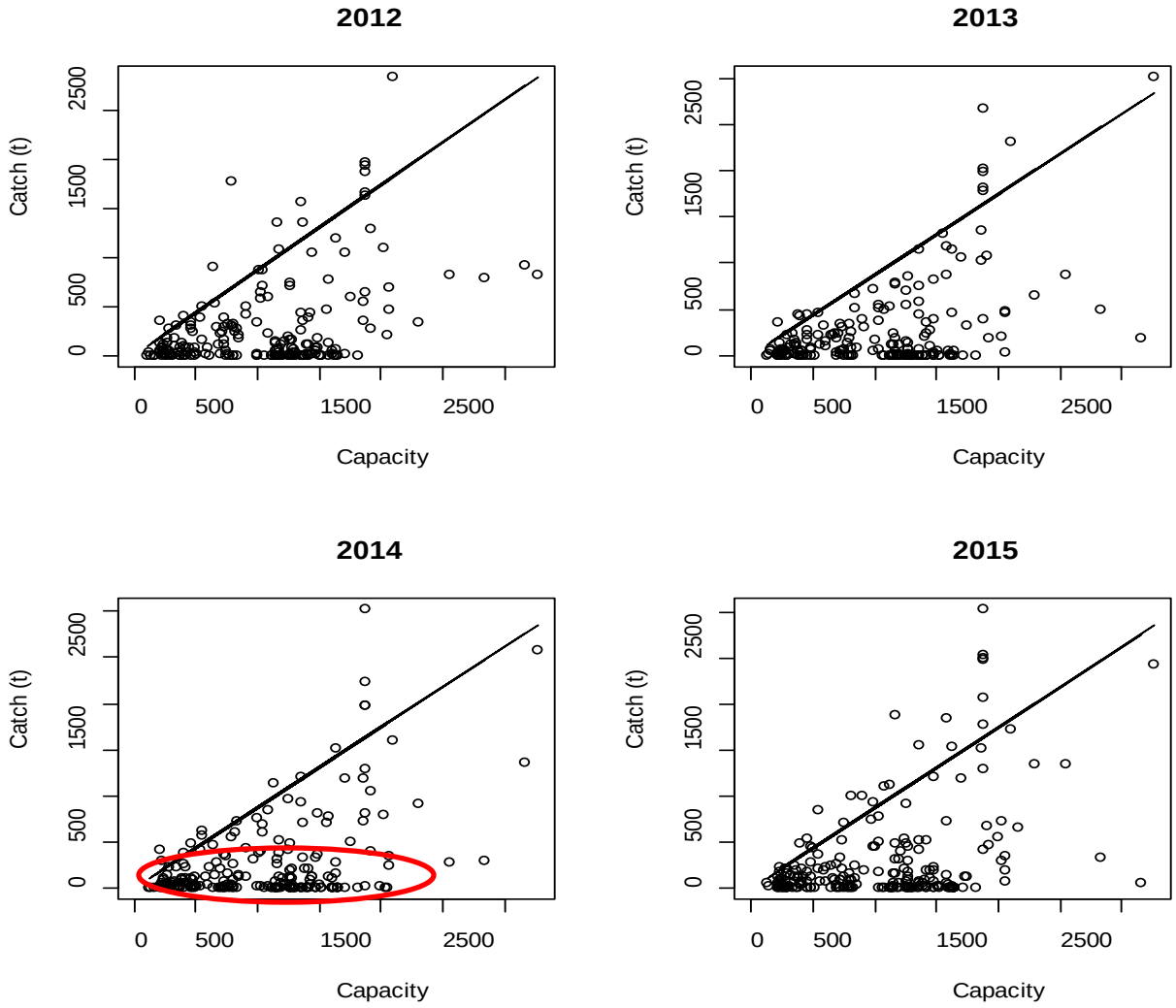
Calculated using method 4 based on size class 6 vessels that made > 50% sets on floating objects



Size class 6 vessels that captured more than 50t of bigeye (method 4)



Based on all vessel size classes (method 4)

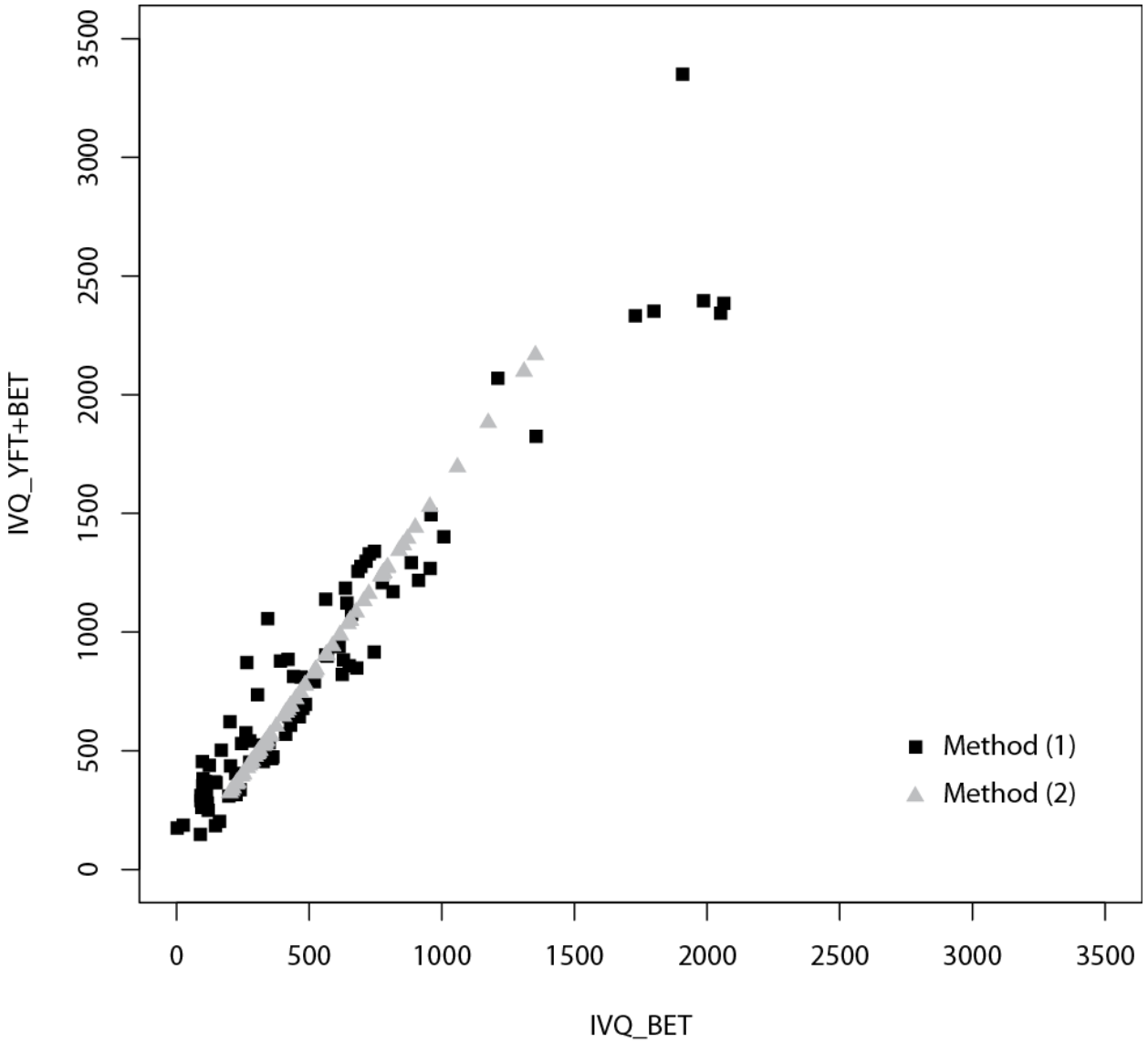


Using BET+YFT

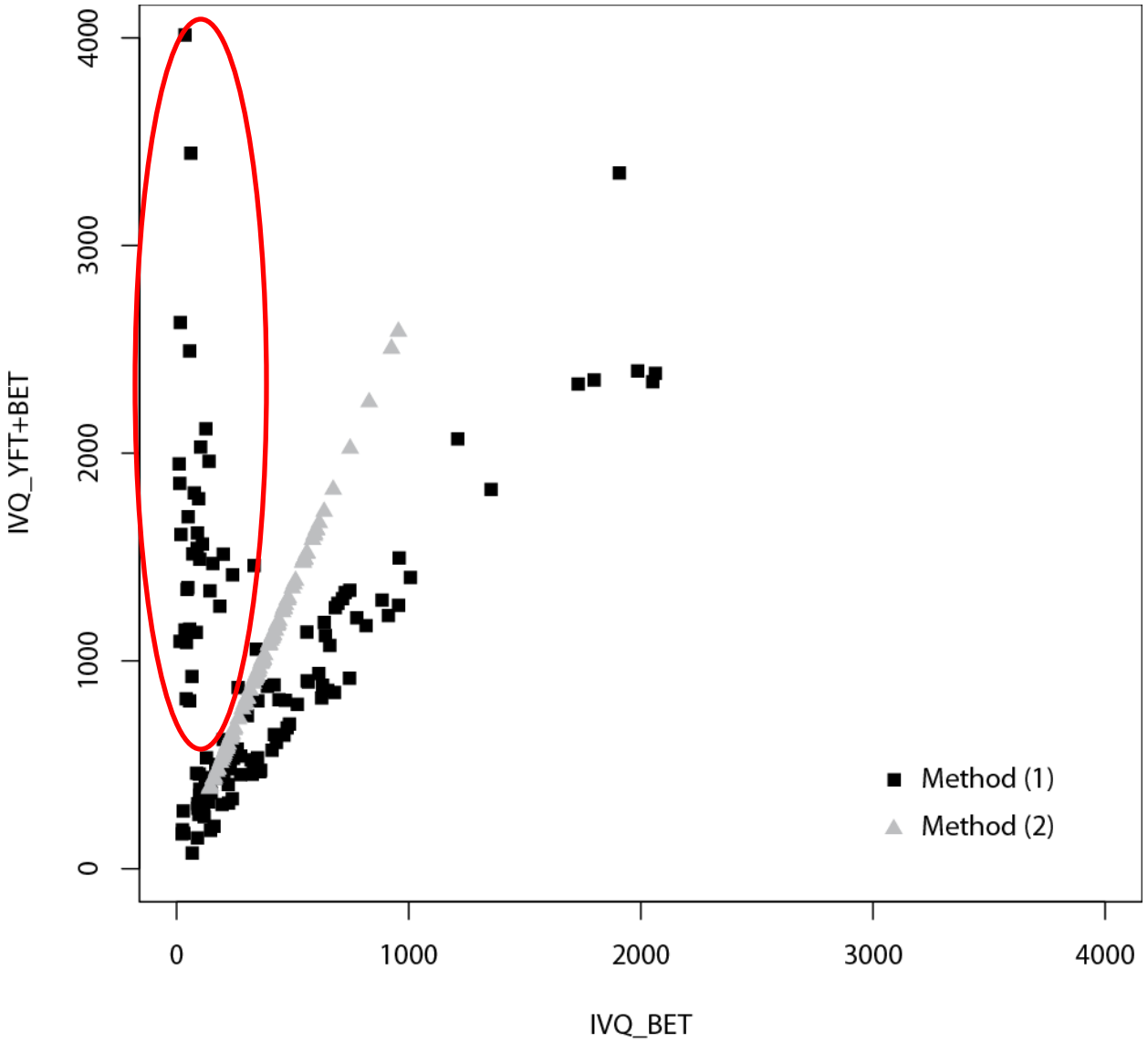
- Yellowfin could be included in the IVQ
  - Quantifying and distinguishing small yellowfin from bigeye can be difficult at sea;
  - Conservation of yellowfin of the small sizes generally caught in floating-object sets is an appropriate management goal.

Bigeye IVQ versus bigeye pus yellowfin combined IVQ

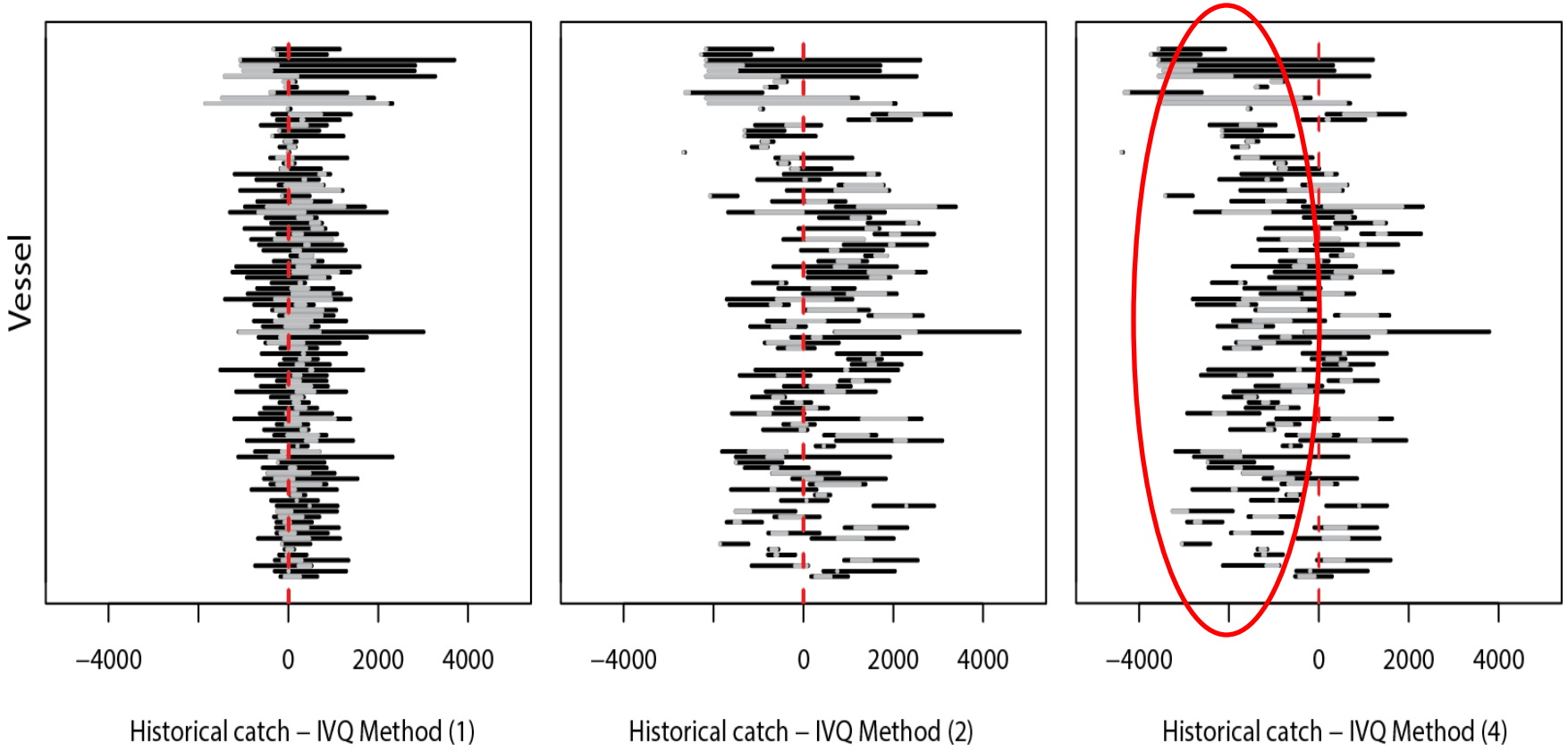
Class 6 vessel that made more than 50% of their sets on floating objects.



Class 6 vessels that caught more than 50t bigeye



YFT: Class 6 vessels that made 50% or less of their sets on floating objects



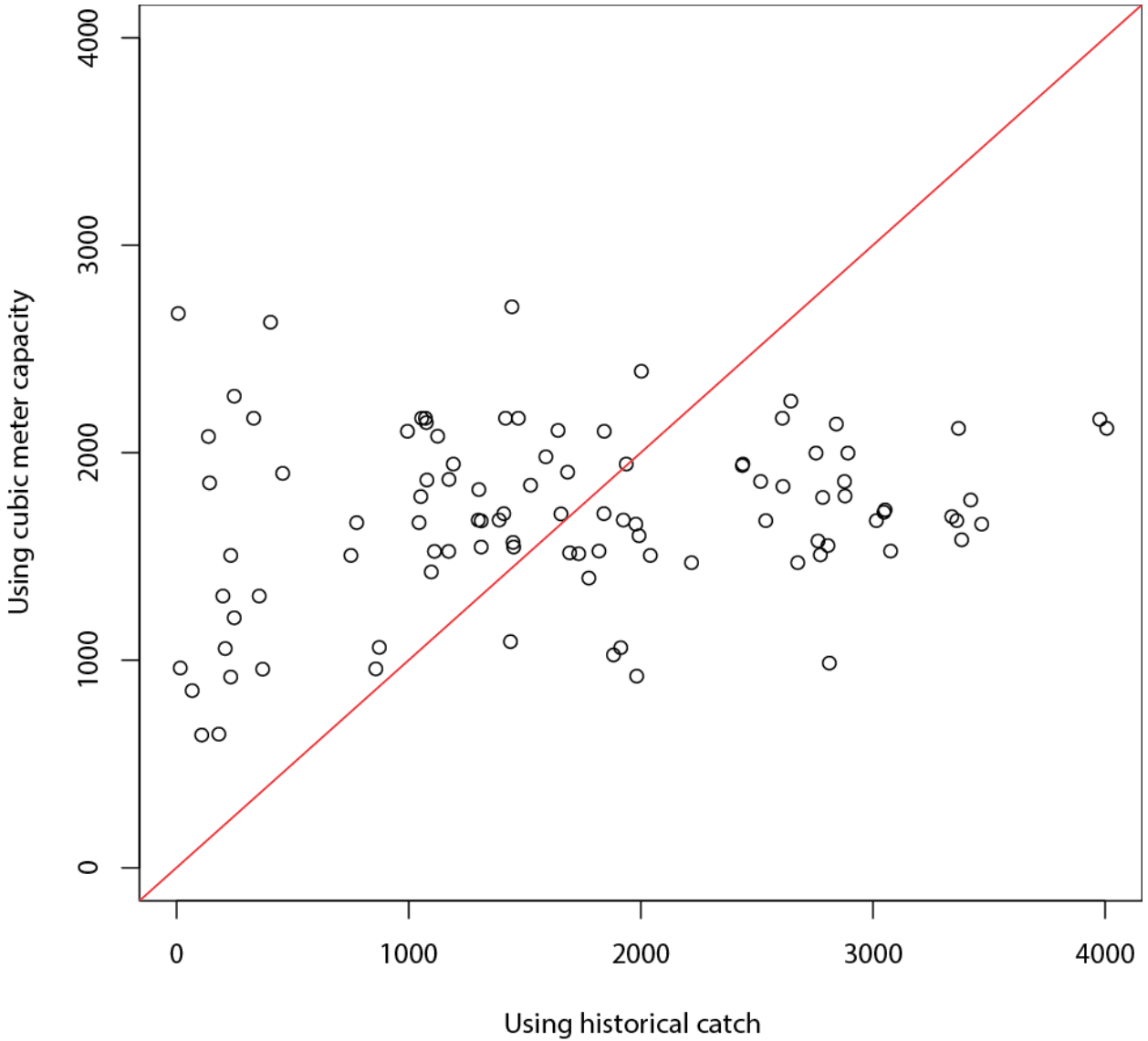
Method 1: vessels historical catch

Method 2: capacity

Method 4: capacity

Yellowfin IVQs based on historical catch versus IVQs based on capacity.

Class 6 vessels that made 50% or less of their sets on floating objects



IVQ consequences

- Consequences of IVQs based on vessel capacity (methods 2 and 4) show much more variability than those based on historical catch (method 1), with some vessels always having caught more than their IVQ and other vessels always having caught less.
- A few vessels that catch large amounts of bigeye tuna are much more restricted by the capacity-based IVQs than the catch-based IVQs.
- Method 4 establishes much less restrictive IVQs, but its success relies on vessels without much historical bigeye catch maintaining the same fishing behavior and not catching their capacity-based IVQ.
- Method 2 is more restrictive than needed because a large number of vessels would not catch their IVQ, and the resulting catch would be considerably less than the target catch.
- Method 2 is also very sensitive to which vessels are included in the set of vessels that will have IVQs.
- Method 4 could be combined with a historical catch based IVQ for an IVQ that is the minimum of the capacity-based IVQ and some scaled value (e.g. 120%) of the historical catch. This acts as an additional safeguard against vessels with historically low catches of bigeye targeting bigeye to reach their IVQ, but without being overly restrictive.
- Method 4 is not appropriate for target species (e.g. yellowfin tuna) because it assumes that vessels that did not catch their IVQ in the past do not catch it in the future, even though it is likely that vessels will try to maximize their target catch relative to the IVQ.
- Care needs to be taken when choosing the vessels to receive IVQs based on combined yellowfin and bigeye catch, because vessels with large yellowfin catches will get large IVQs, and could switch to catching more bigeye.

Temporal spatial closures

Temporal closure scenarios

- Eliminate the second closure period
  - All vessels must not fish from 29 July to 28 September.
- Eliminate the first closure period
  - All vessels must not fish from 18 November to 18 January.
- Divide the 62-day closure in two periods of 31 contiguous days each
  - All vessels must not fish in two periods of 31 contiguous days within the two current closure periods
  - Not evaluated
  - Results likely to be between the previous two options.

TABLE 2. Equivalent days of closure for each of the conservation measures. The capacity reduction and catch quota proposals are assumed to produce the required equivalent days of closure to compensate for the increased capacity.

Management measure	Equivalent days		
	YFT	BET	SKJ
25,000 m^3 capacity reduction	25	25	
Catch limits for bigeye (57,900 t) and yellowfin (232,800 t)	25	25	
In-season adjusted catch limits for bigeye and yellowfin	25	25	
Eliminate second closure period	0	2	-6
Eliminate first closure period	-2	-4	3
Reduce length of both closure periods to 31 days each	≈ -2 to 0	≈ -4 to 2	≈ -6 to 3

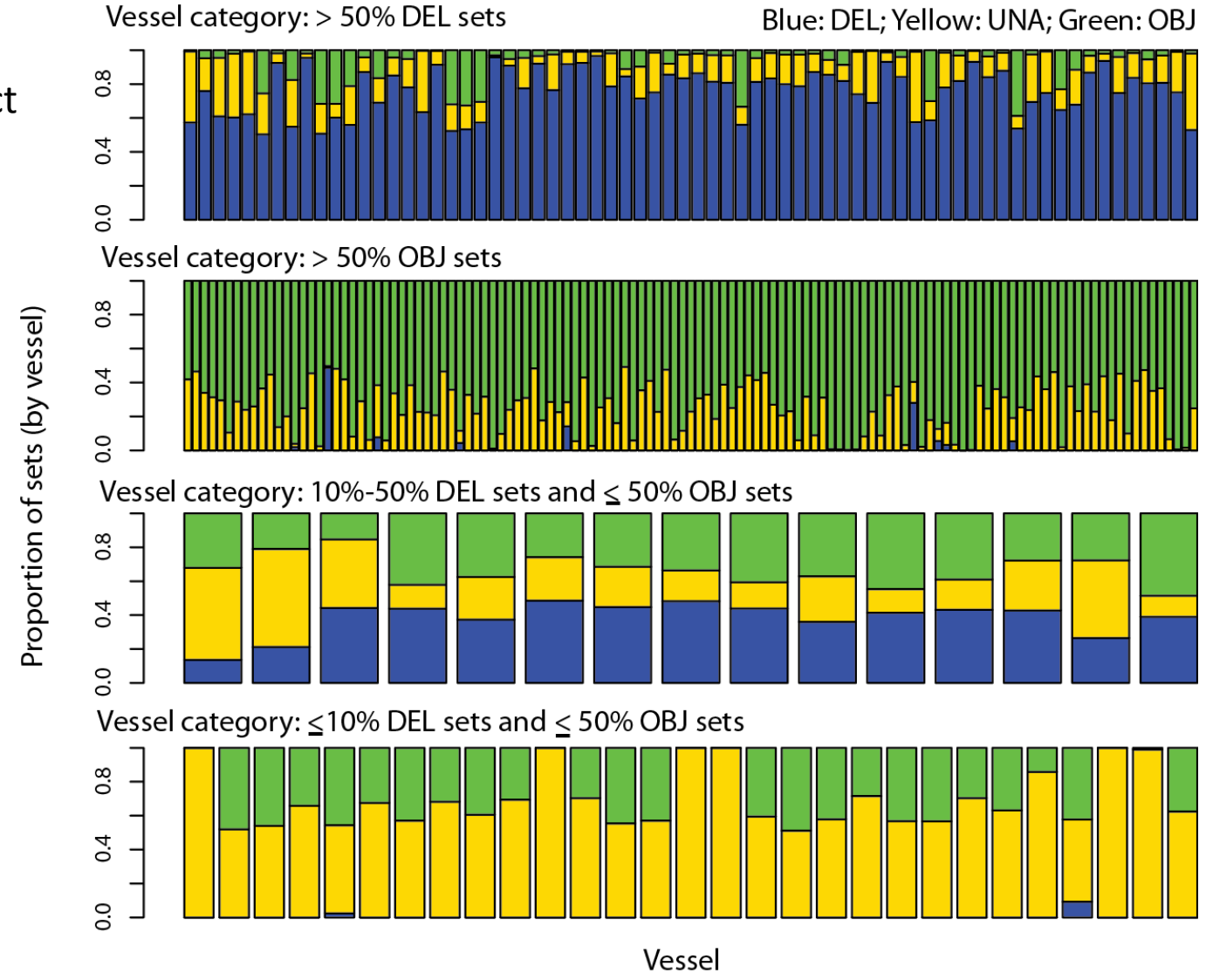
Spatial closures

- Advantages of spatial closures over temporal closures
  - Allow fishing outside the closure area,
  - Can be adapted to protect the species most in need of management.
- Disadvantages.
  - Unequal vulnerable, so additional measures would be necessary for the less vulnerable species.
  - Redistributed effort might cause local depletions
  - Temporal variations in the spatial distribution will cause variations in the effectiveness of the spatial closures.
  - Monitoring and compliance needs Vessel Monitoring System.
  - Assumes that vessels will not alter their behavior (such as species targeted, area fished, gear efficiency) as compared to their average behavior in recent years.

Spatial closure methods

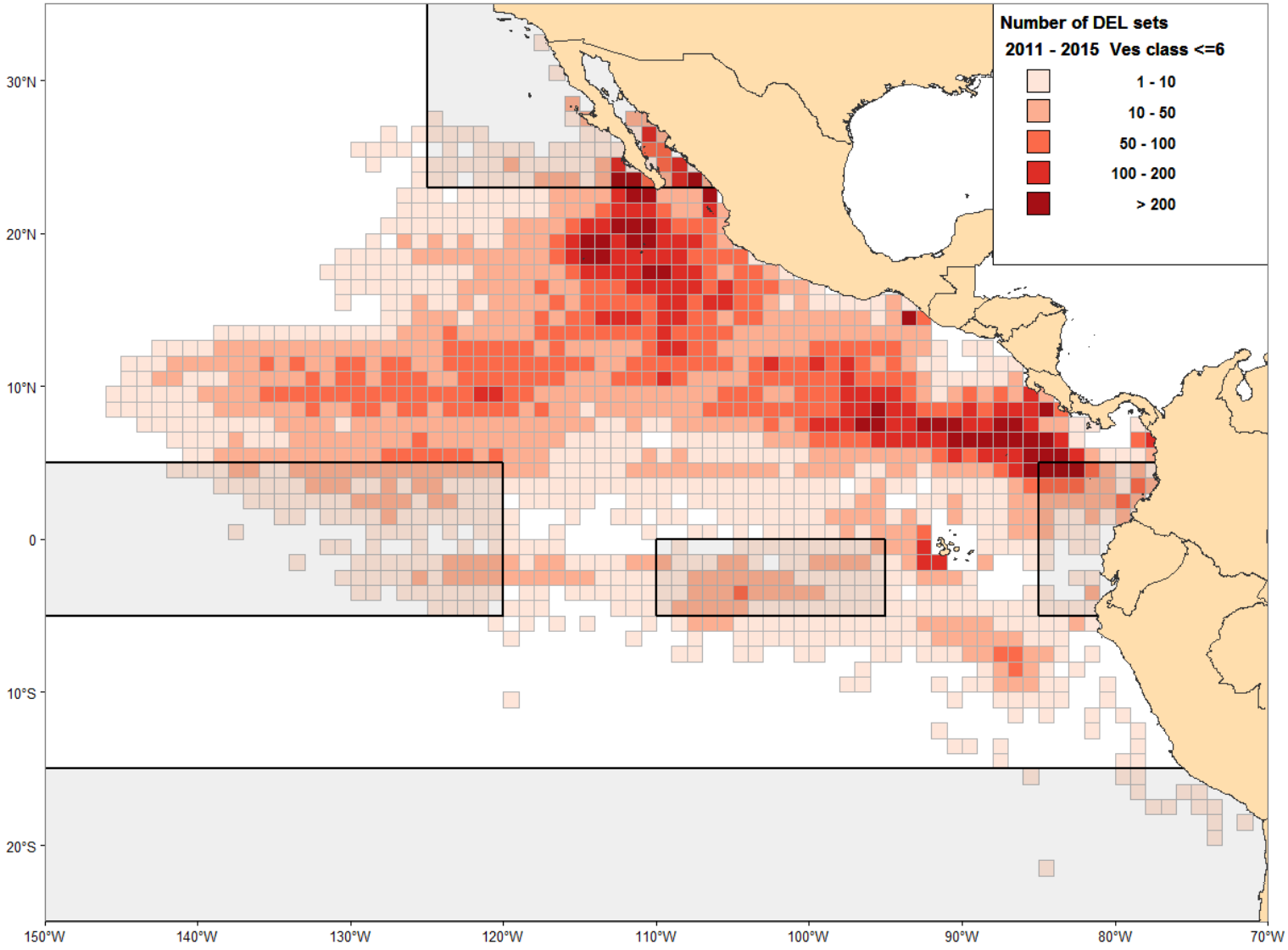
- Calculation
  - Effort is measured in days fished
  - Vessel category is taken into account
    - Vessels that make more than 50% of their sets on dolphin-associated fish;
    - Vessels that make more than 50% of their sets on floating objects;
    - Vessels that make a variety of sets, 10 to 50% of which are on dolphin-associated fish;
    - Vessels that make a mixture of floating-object and unassociated sets but few, if any, dolphin-associated sets.
- Results based on a “fishing” year
  - 19 January to 18 January of the following year.
  - Second closure extends to 18 January of the following year
- Unless otherwise noted, spatial closures are assumed to be in force for the period of 1 February to 30 June.

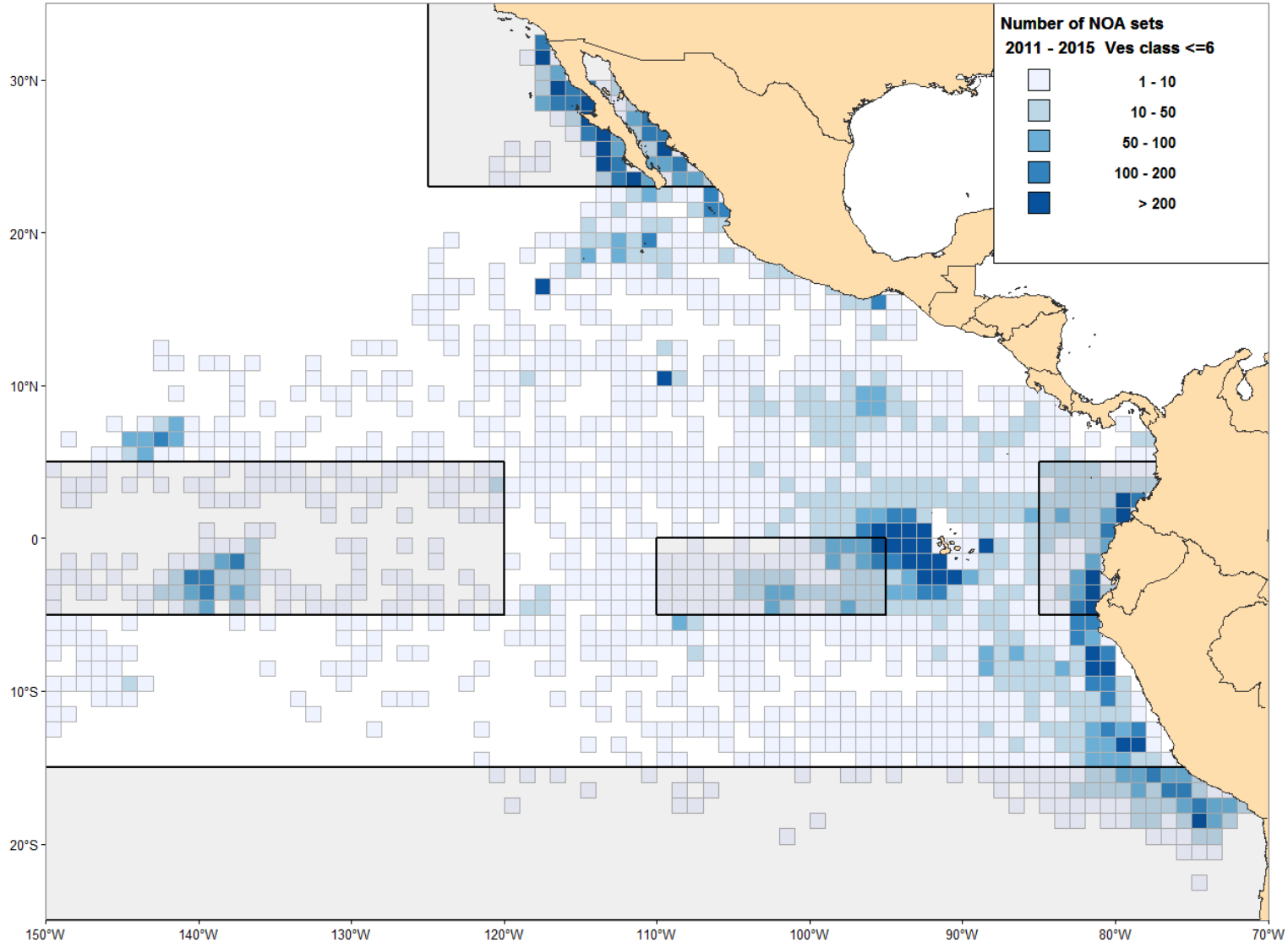
Blue: dolphin
Green: floating object
Yellow: school

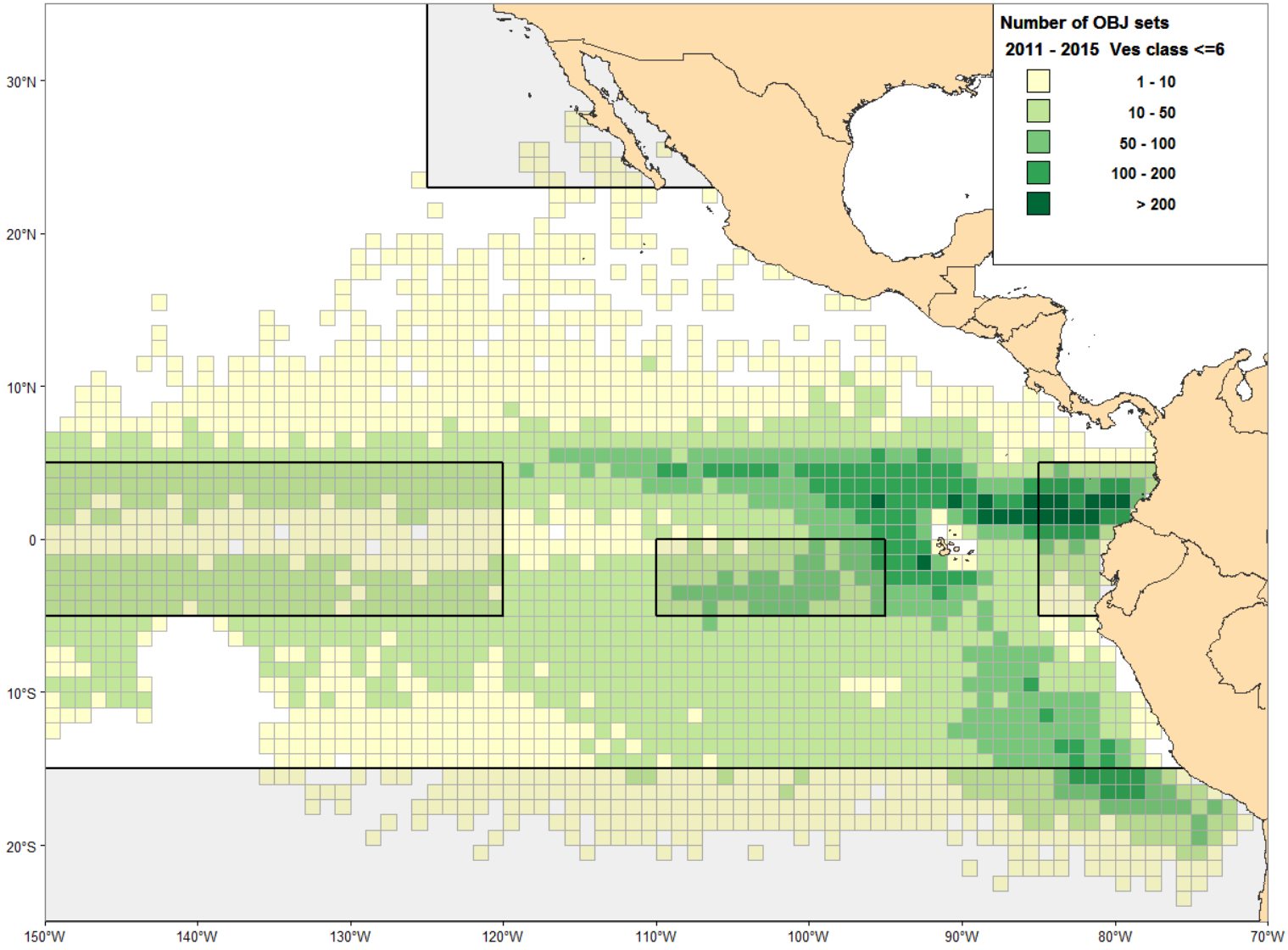


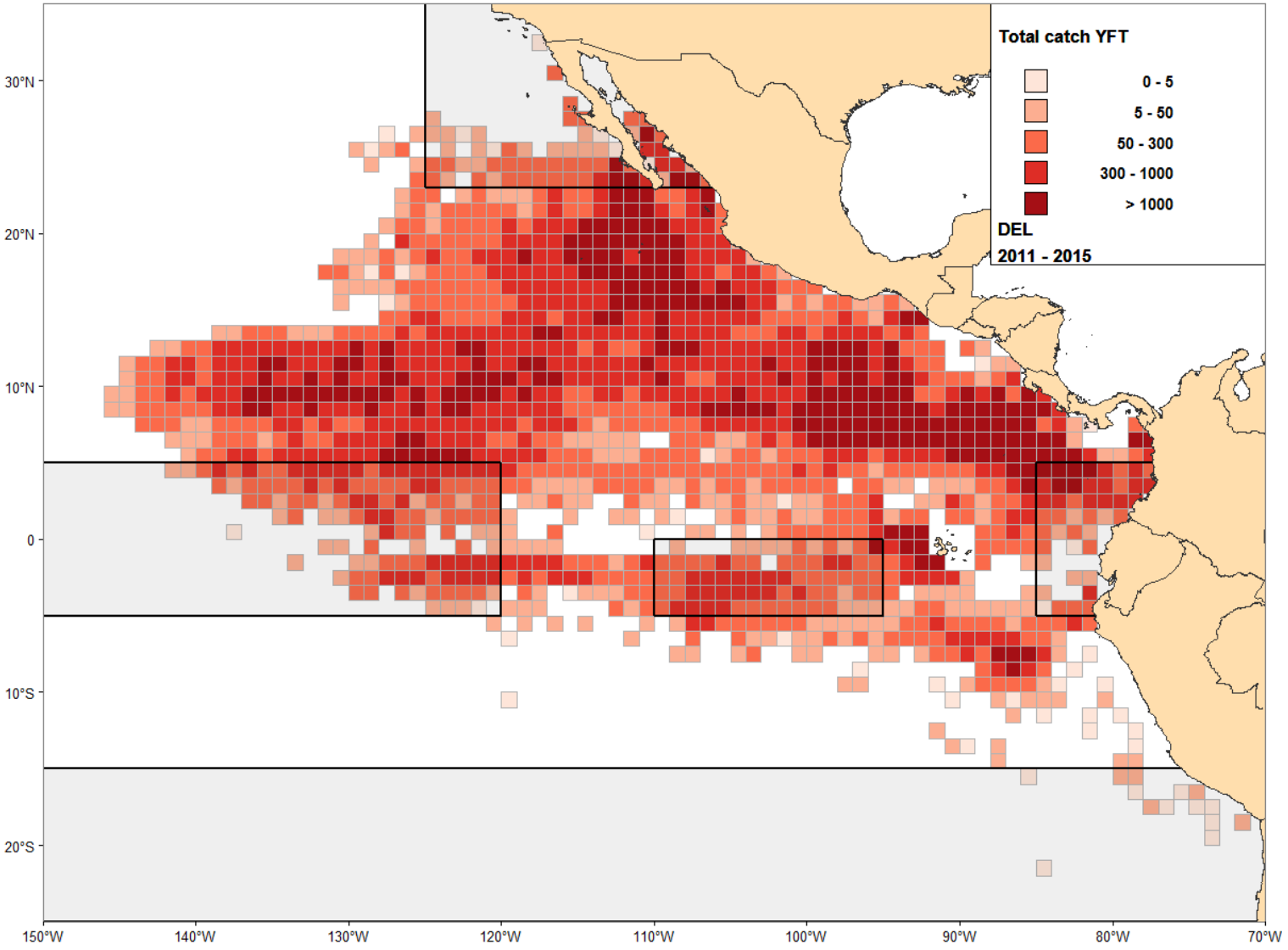
Scenarios

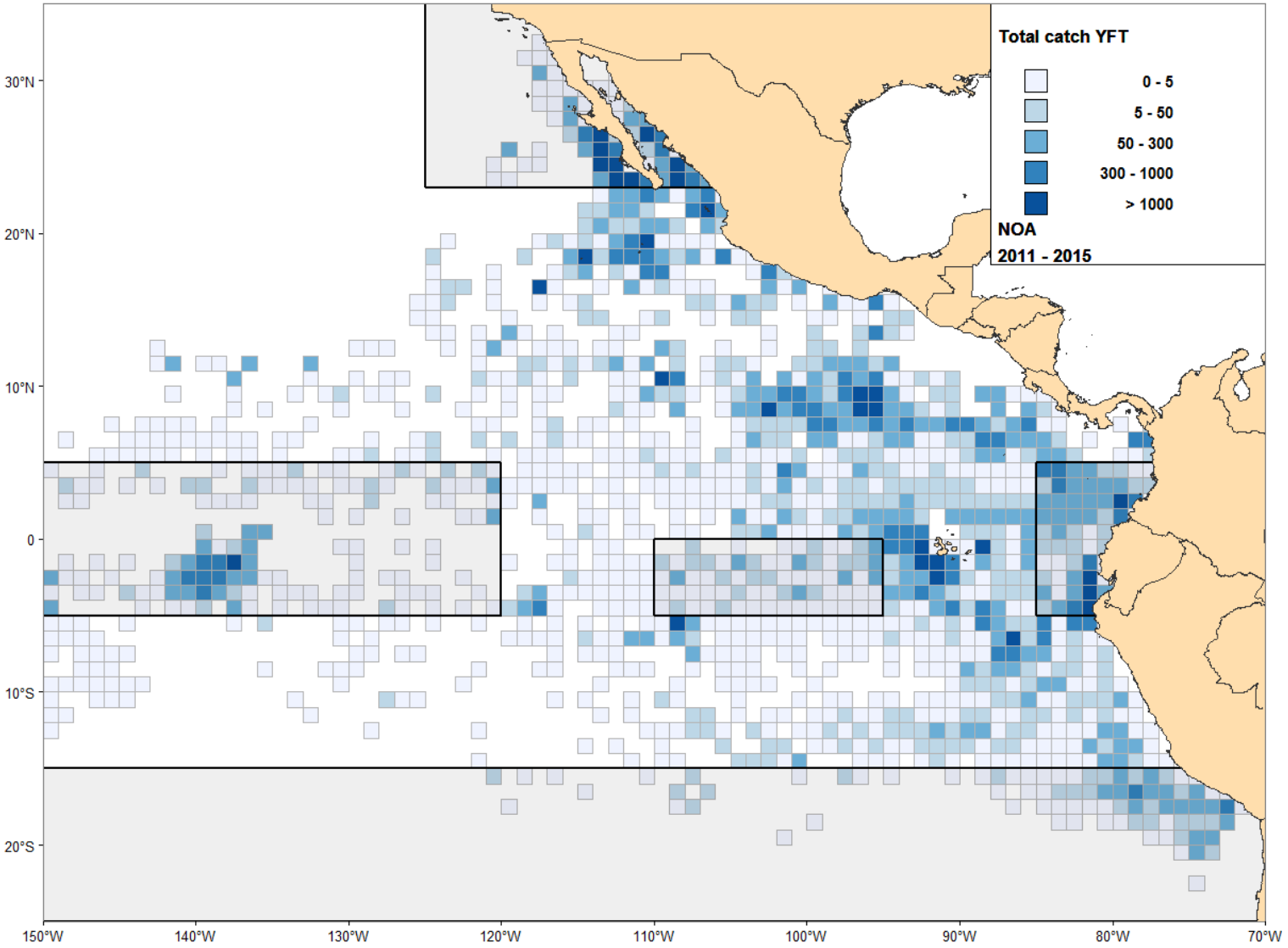
- Closure between 120° and 150°W and 5°N and 5°S
- Extend the duration of the closure of the corralito
- Closure of 5°S to the Equator, 95°W-110°W
- Closure south of 15°S
- Closure between the coast of Mexico and 125°W, north of 23°N
- Closure between the coast of South America and 85°W, 5°N-5°S.
- Guatemala EEZ closure (not evaluated)
- Closure of all EEZs
- High seas closure
- Extend the closure of the corralito in space and time
- Small YFT closure: 0-10N and 75W-110W

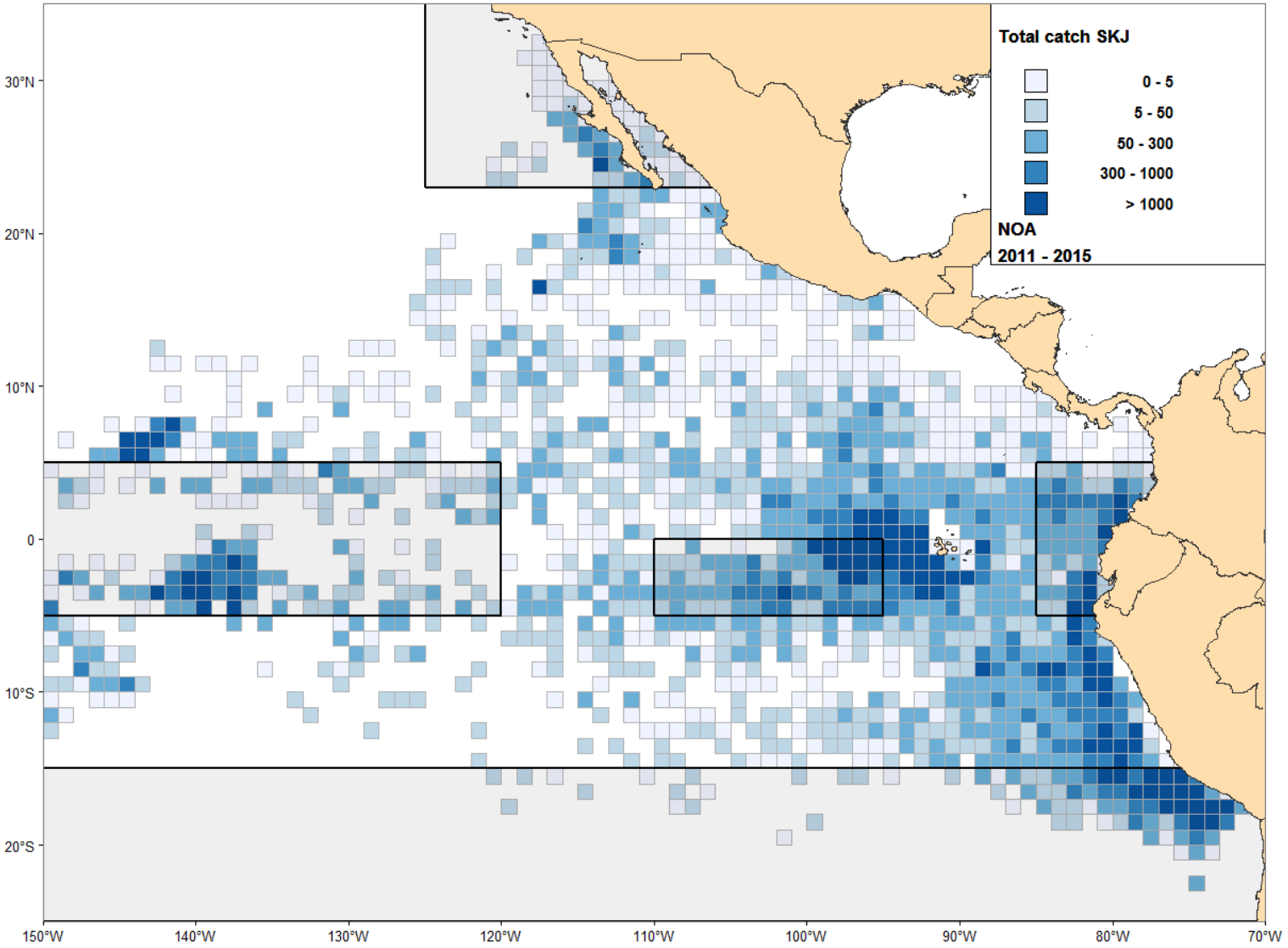

Number of DEL sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

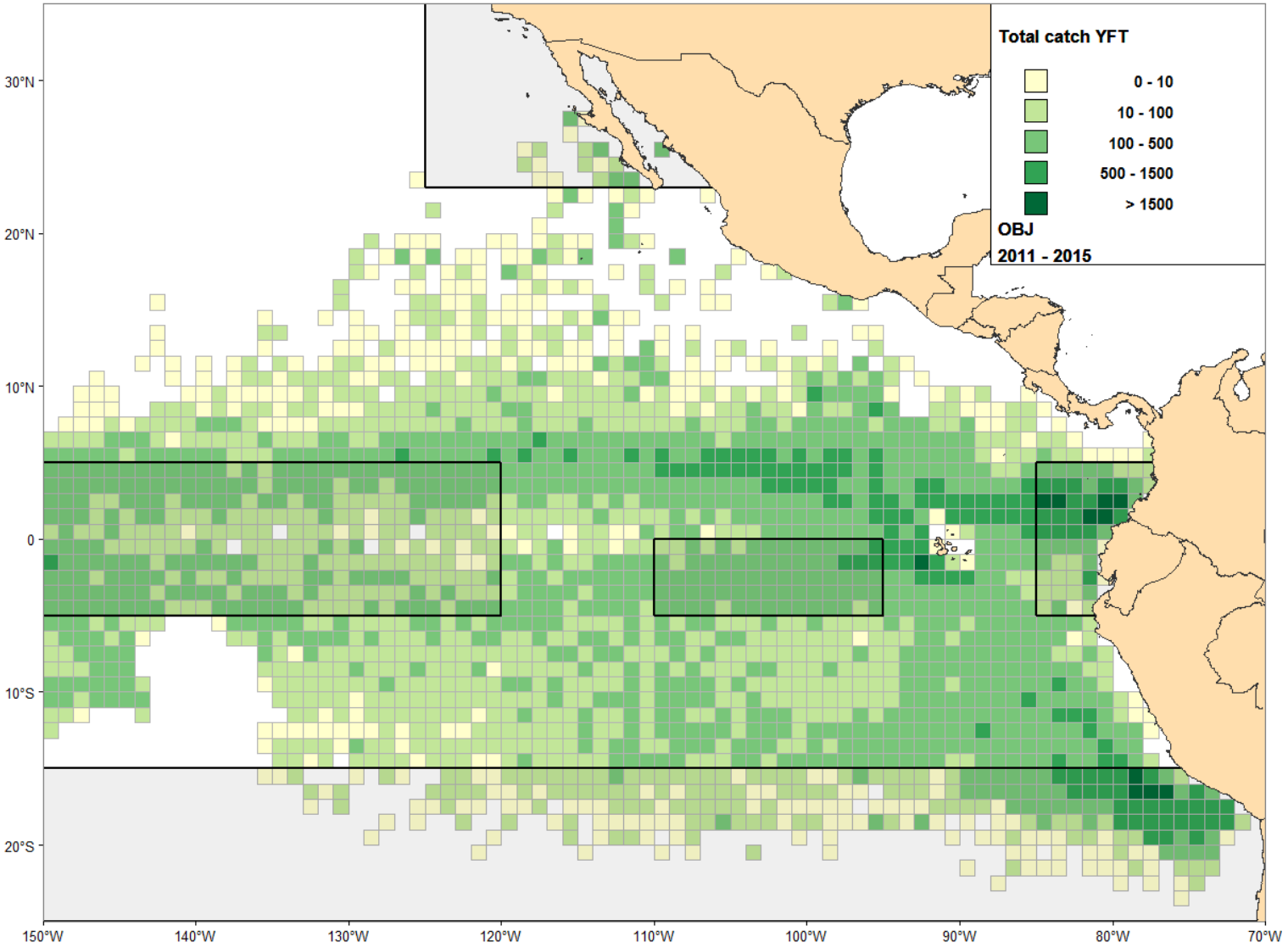

Number of NOA sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

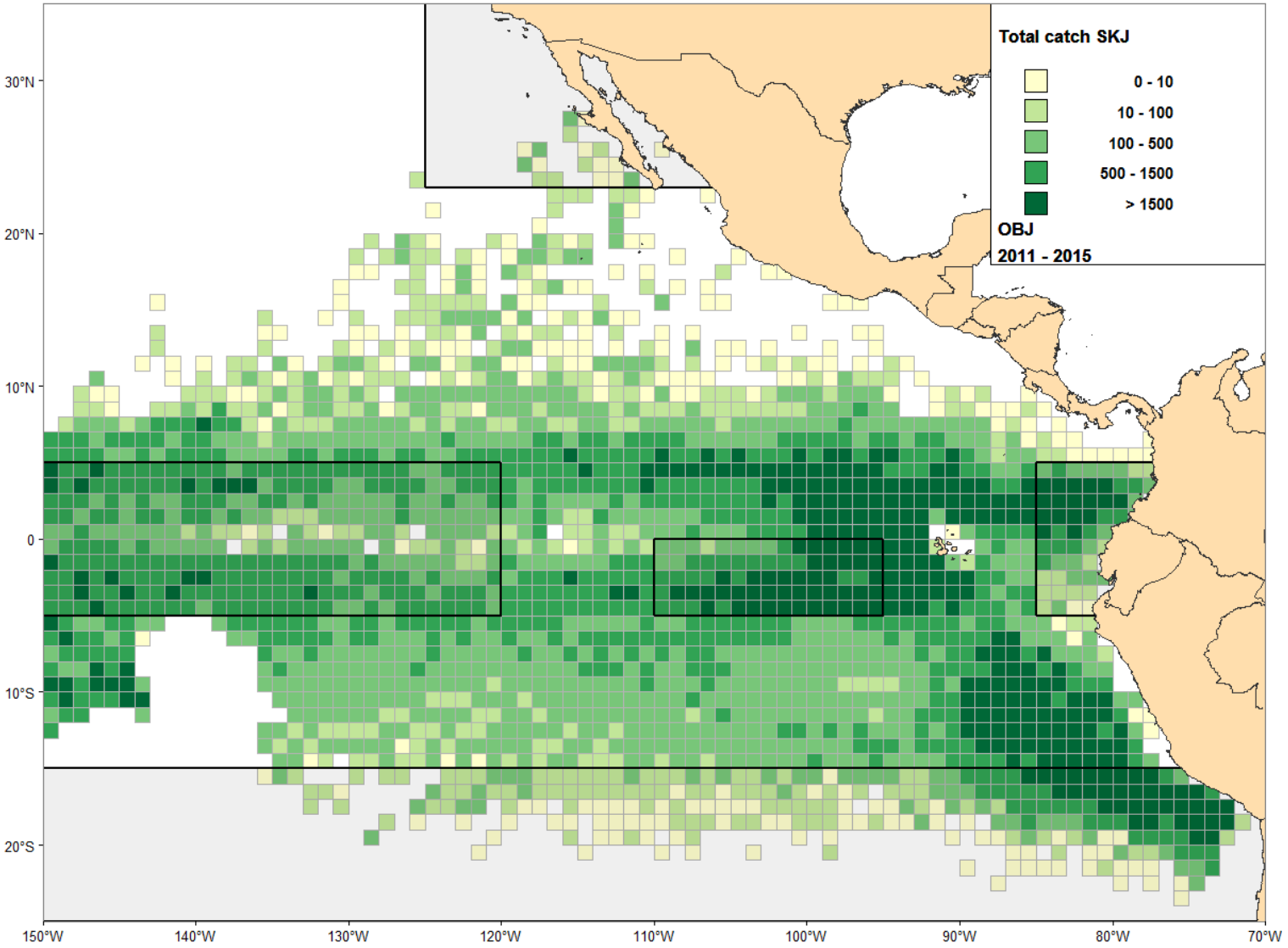

Number of OBJ sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch YFT
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
DEL
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch YFT
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
NOA
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch SKJ
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
NOA
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch YFT
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch SKJ
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

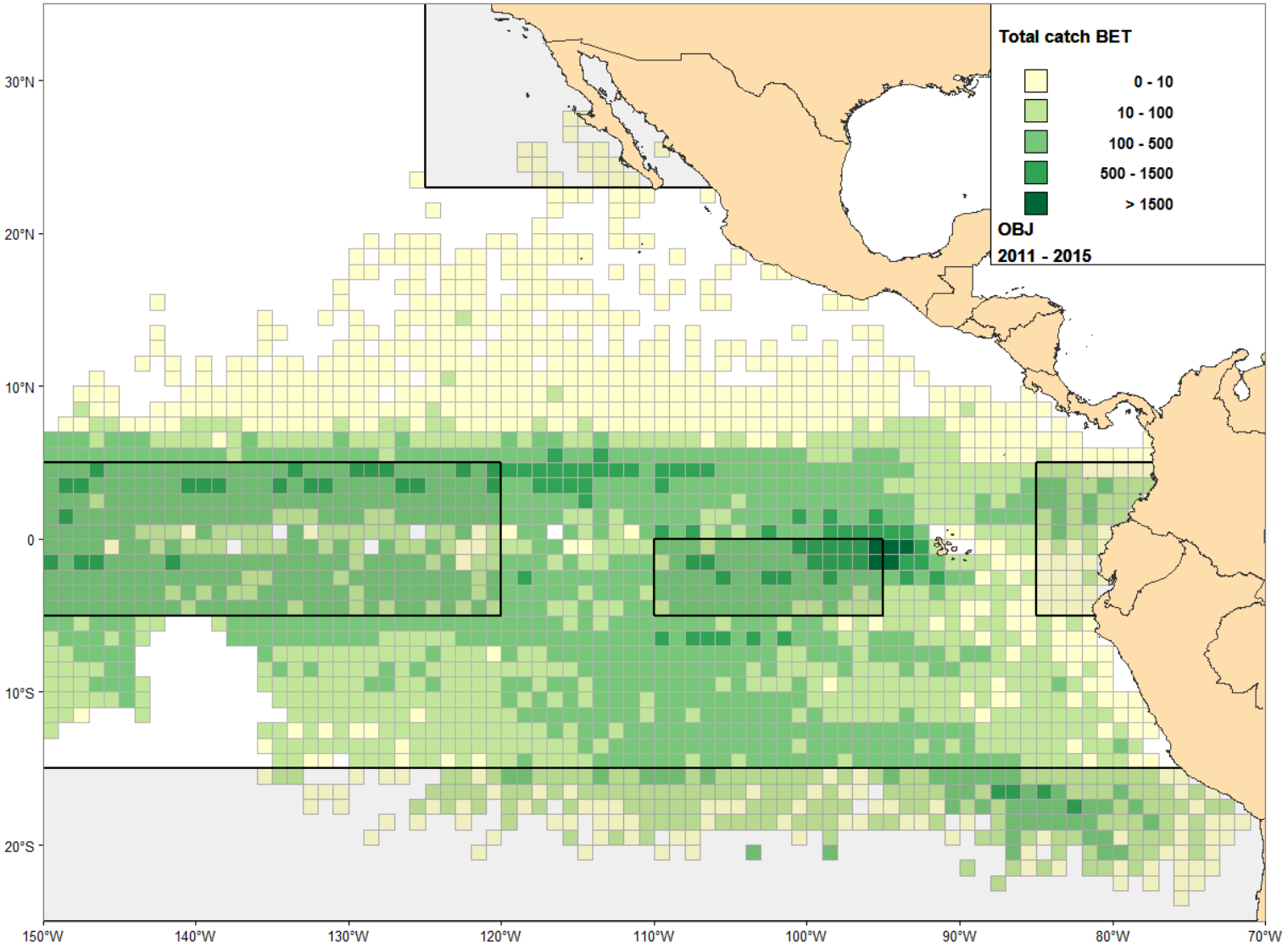
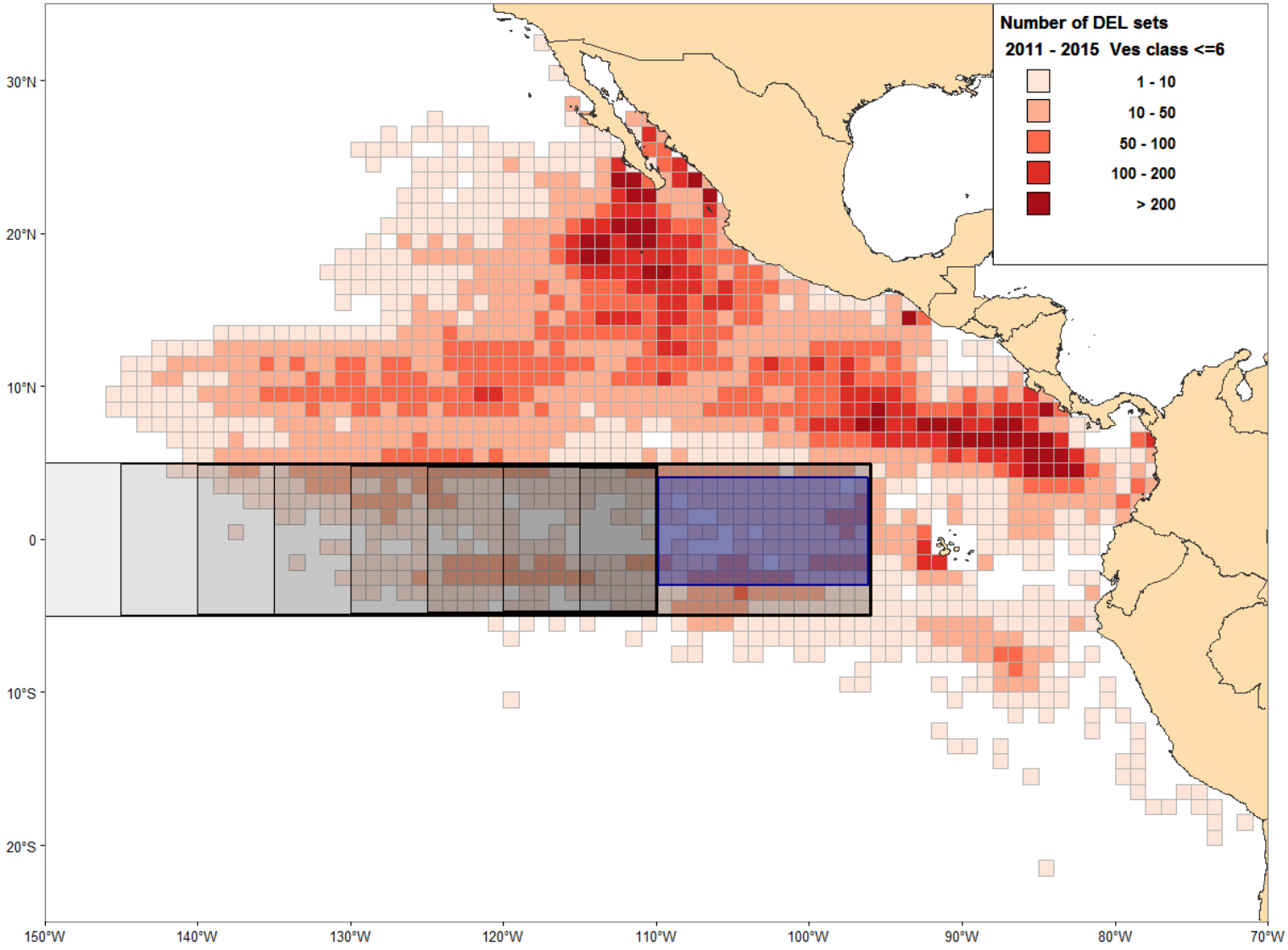

Total catch BET
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

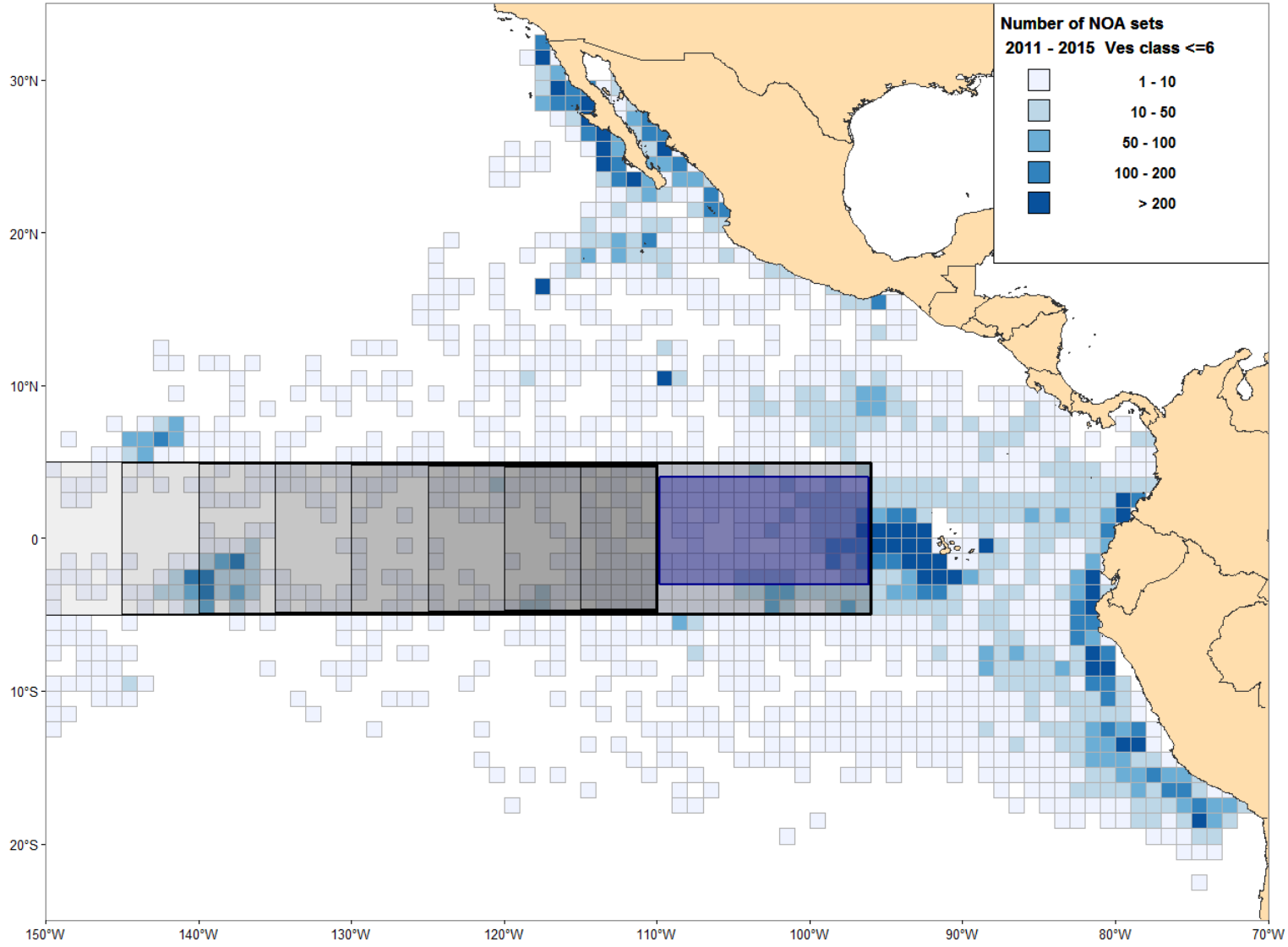
TABLE 2. Equivalent days of closure for each of the conservation measures. The capacity reduction and catch quota proposals are assumed to produce the required equivalent days of closure to compensate for the increased capacity.

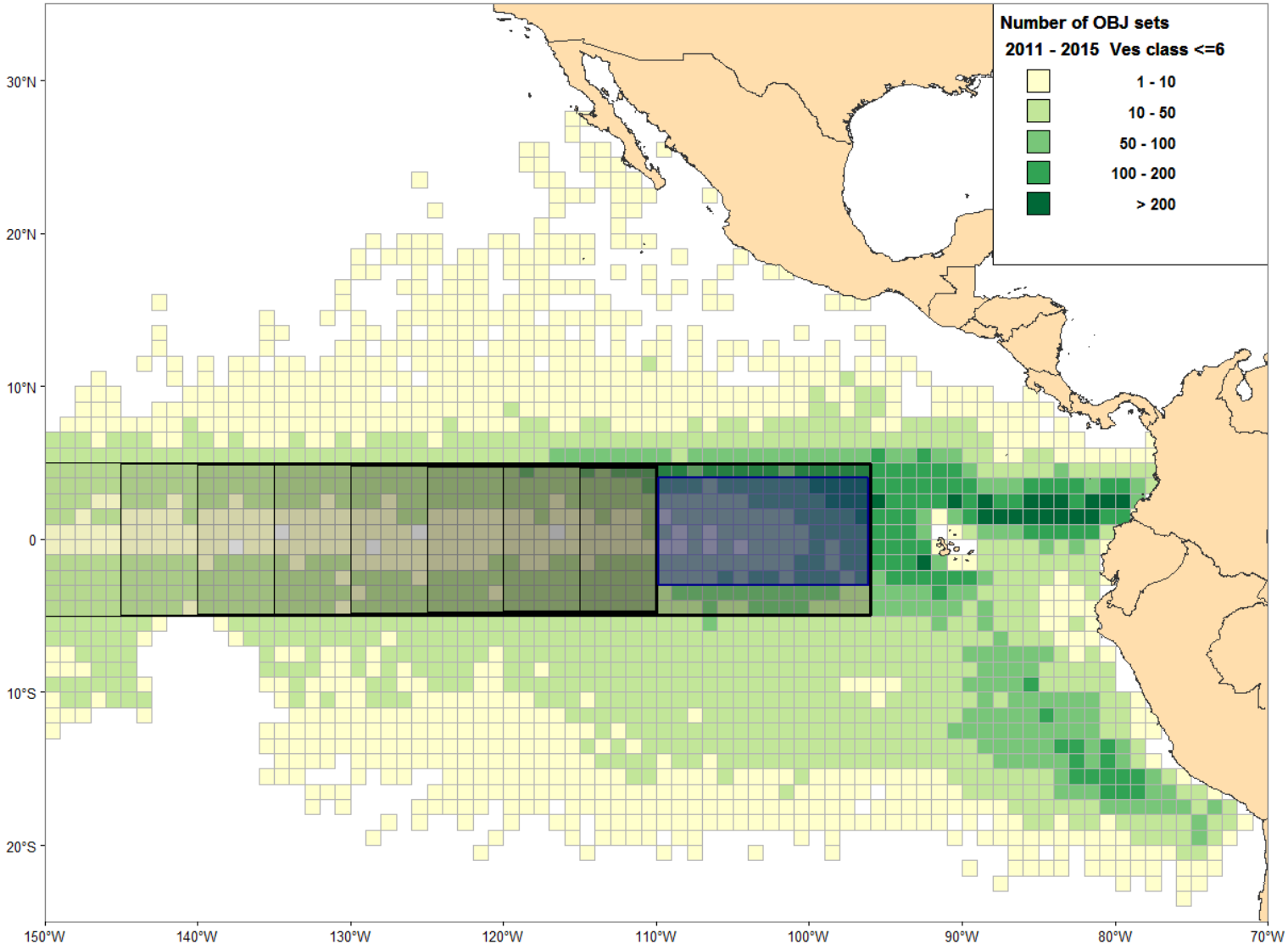
Management measure	Equivalent days		
	YFT	BET	SKJ
25,000 m^3 capacity reduction	25	25	
Catch limits for bigeye (57,900 t) and yellowfin (232,800 t)	25	25	
In-season adjusted catch limits for bigeye and yellowfin	25	25	
Eliminate second closure period	0	2	-6
Eliminate first closure period	-2	-4	3
Reduce length of both closure periods to 31 days each	≈ -2 to 0	≈ -4 to 2	≈ -6 to 3
Eliminate the vessel capacity exemption in paragraphs 1 and 4 of Resolution C-13-01	Not evaluated	Not evaluated	Not evaluated
Extending the correlito	-2	11	-2
Closure of 5°S to the equator, 95°W-110°W	-1	8	-2
Closure of 5°S-5°N, and 120°W-150°W	3	20	2
Closure of south of 15°S	-1	1	15
Spatial closure between the coast of Mexico and 125W north of 23N	-2	0	-2
Spatial closure between the coast of South America and 85W from 5N to 5S	0	-10	-4
Guatemala EEZ closure	Not evaluated	Not evaluated	Not evaluated
All EEZ's closure	0	-49	2
High seas closure	1	97	-9

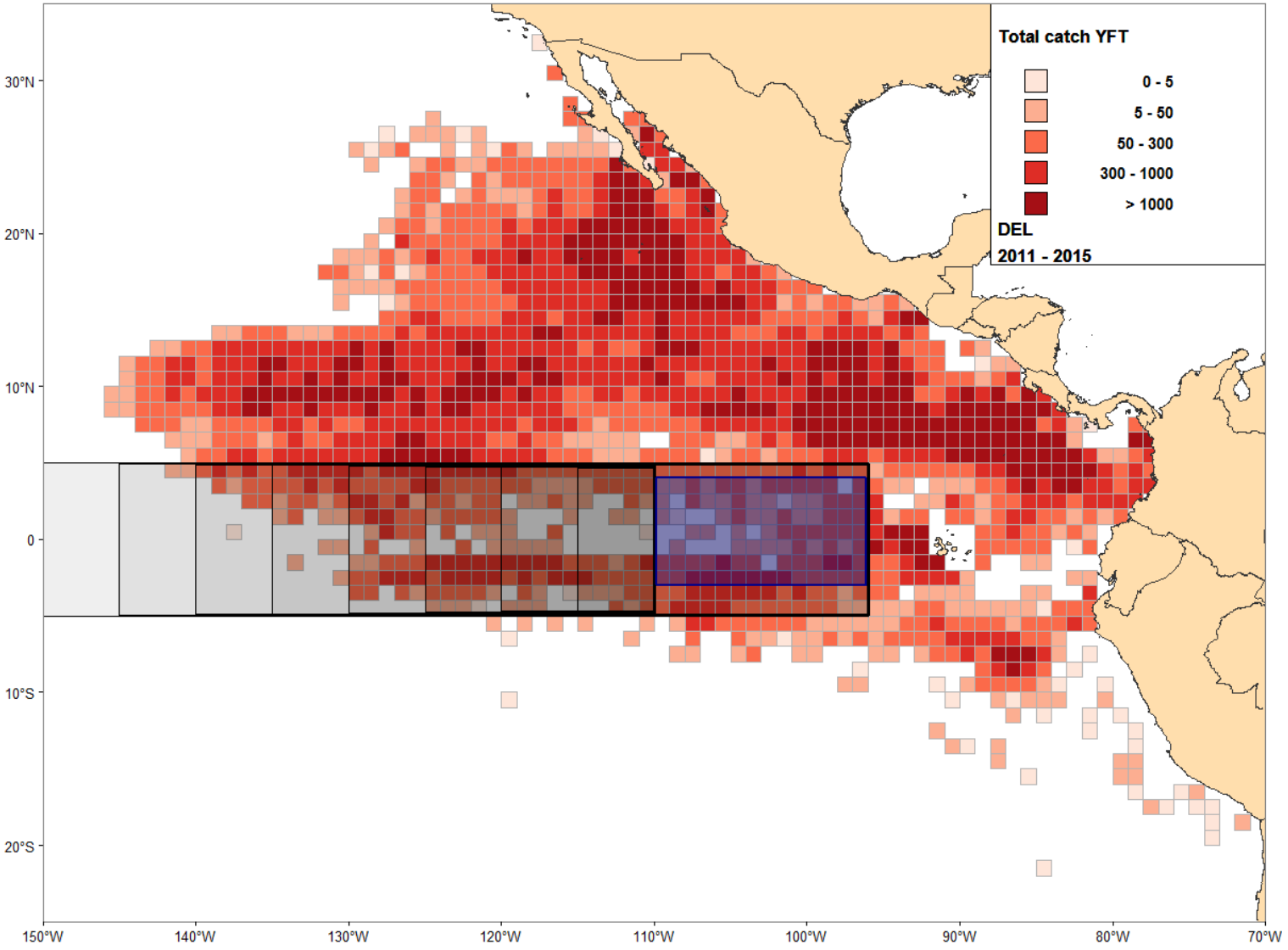
Extending the corralito in space and time

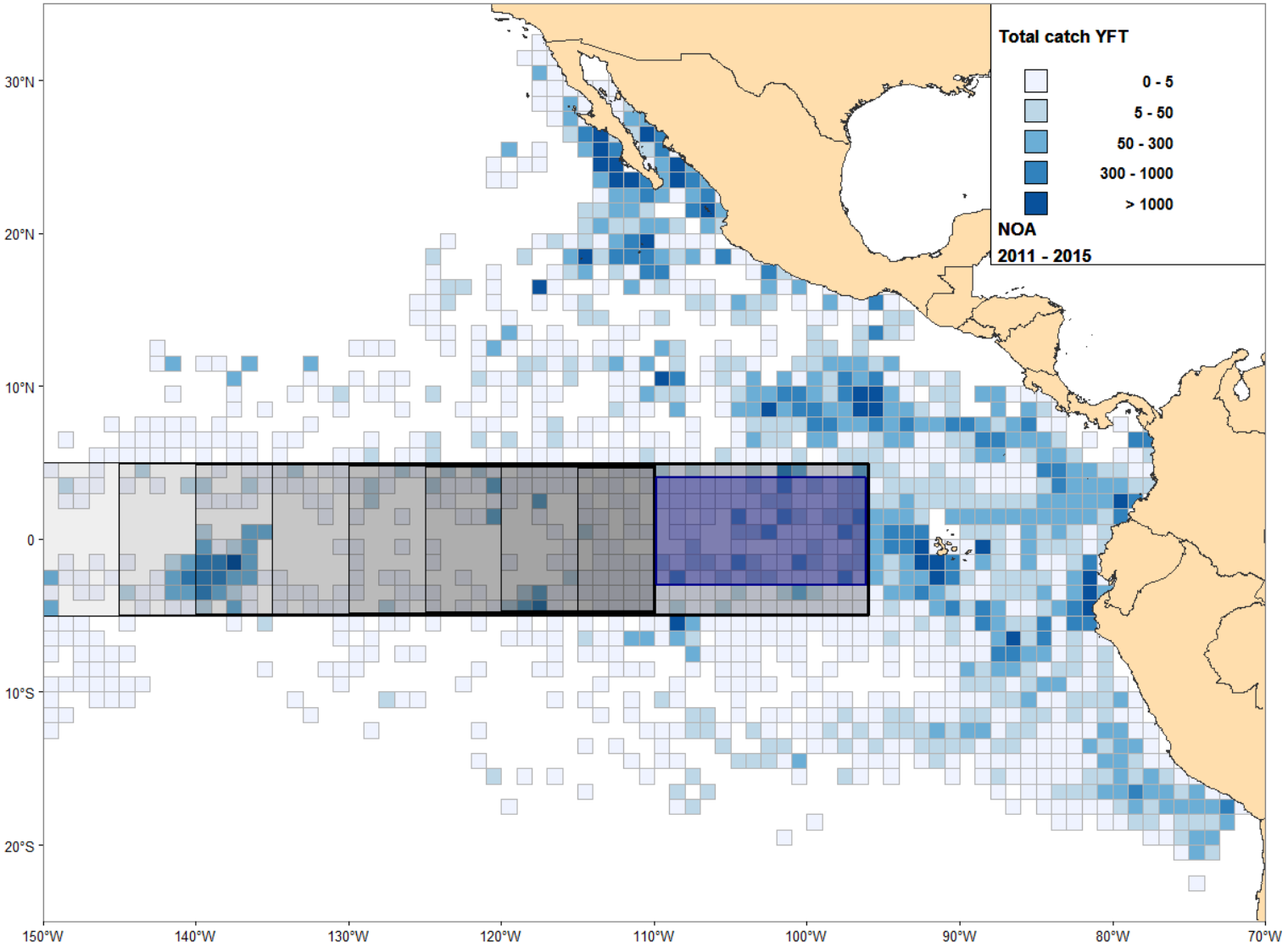
- The “corralito”
  - 96°W to 110°W between 4°N and 3°S
  - 29 September-29 October.
- Based on data for 2012-2015
- The northern and southern boundaries of the extended corralito were set at 5°N and 5°S
- 1 to 5 months during February-June
- Western boundary was moved westward, from 110°W to 150°W, in 5° increments.

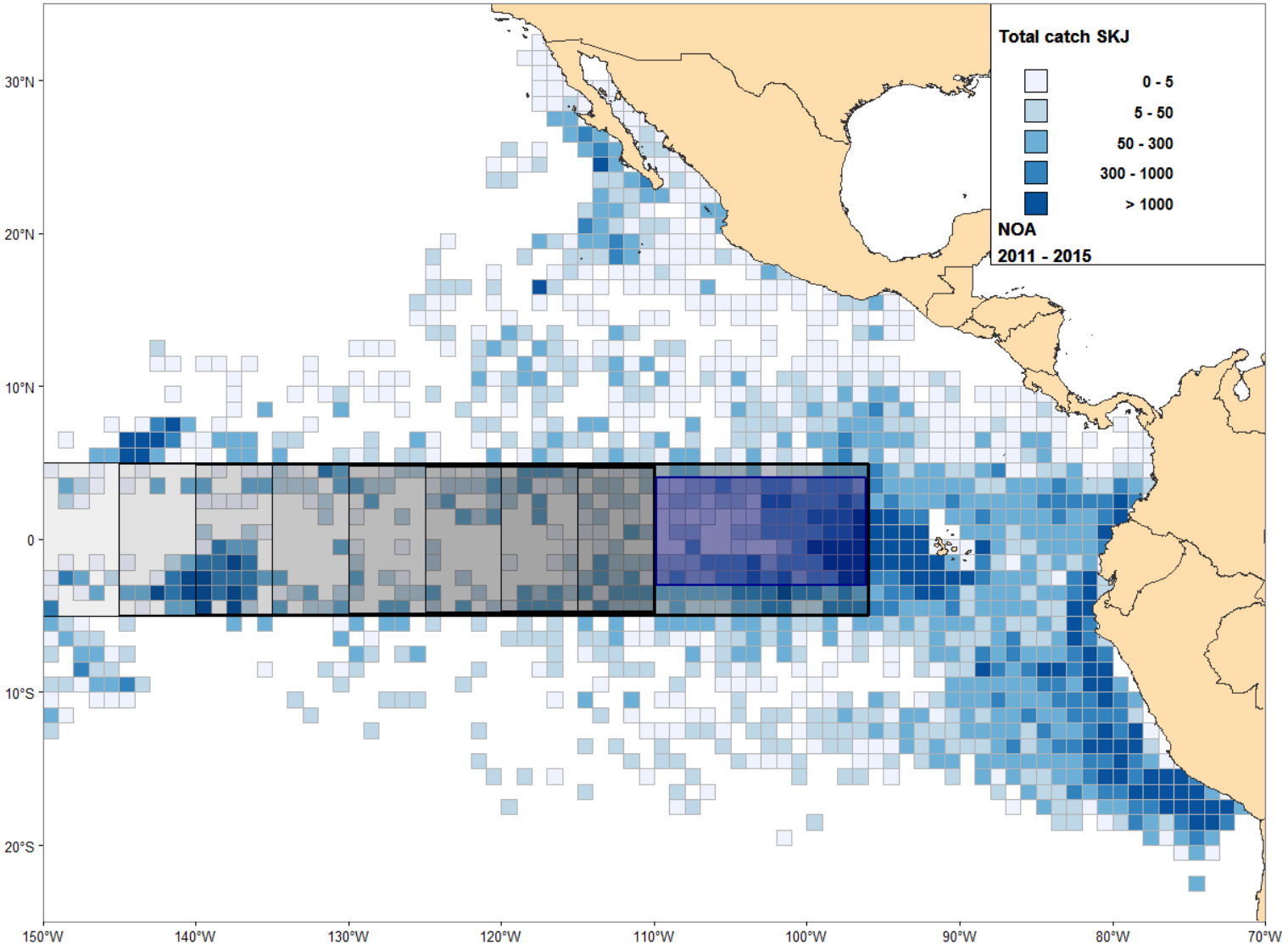

Number of DEL sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

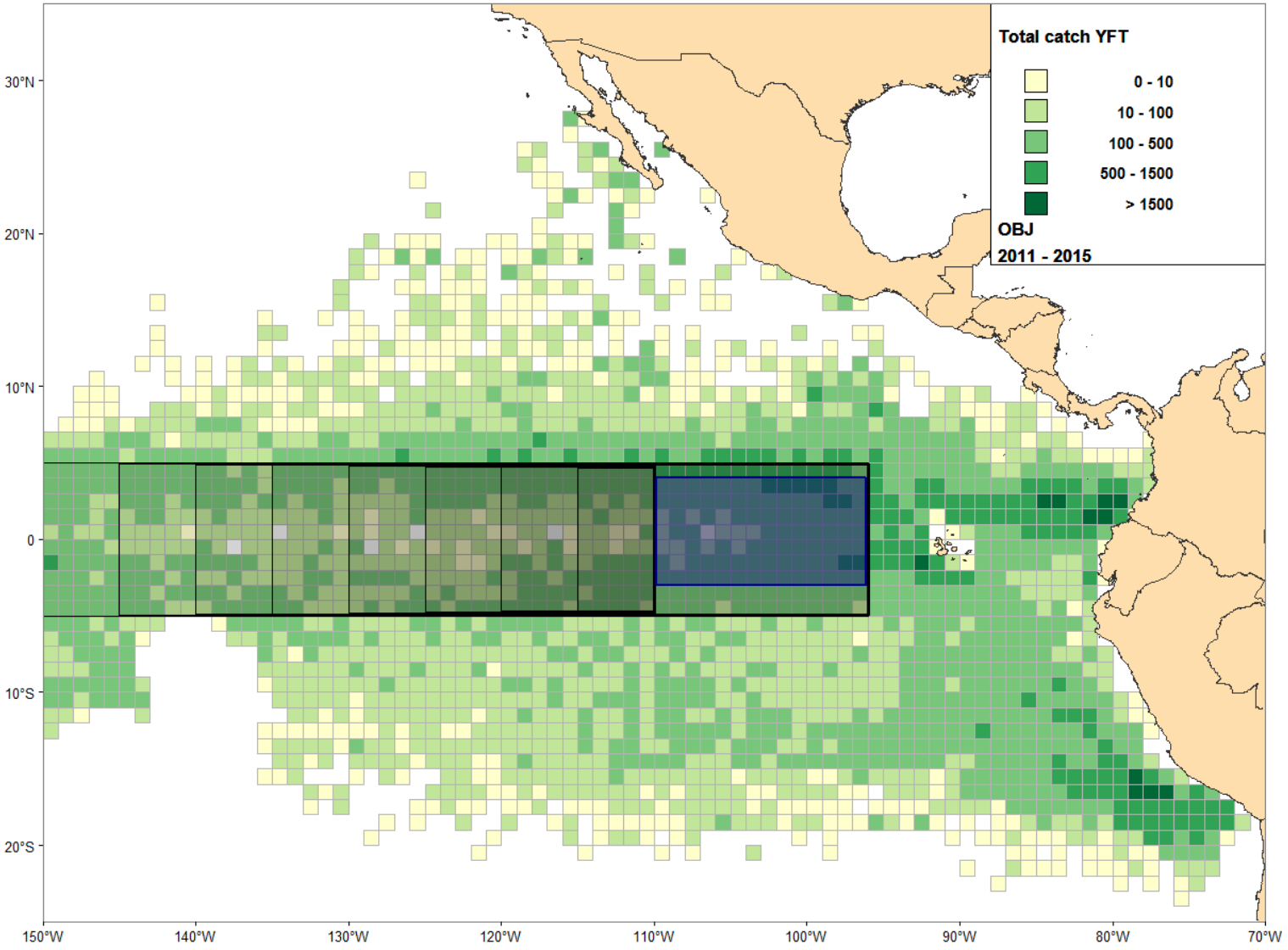

Number of NOA sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

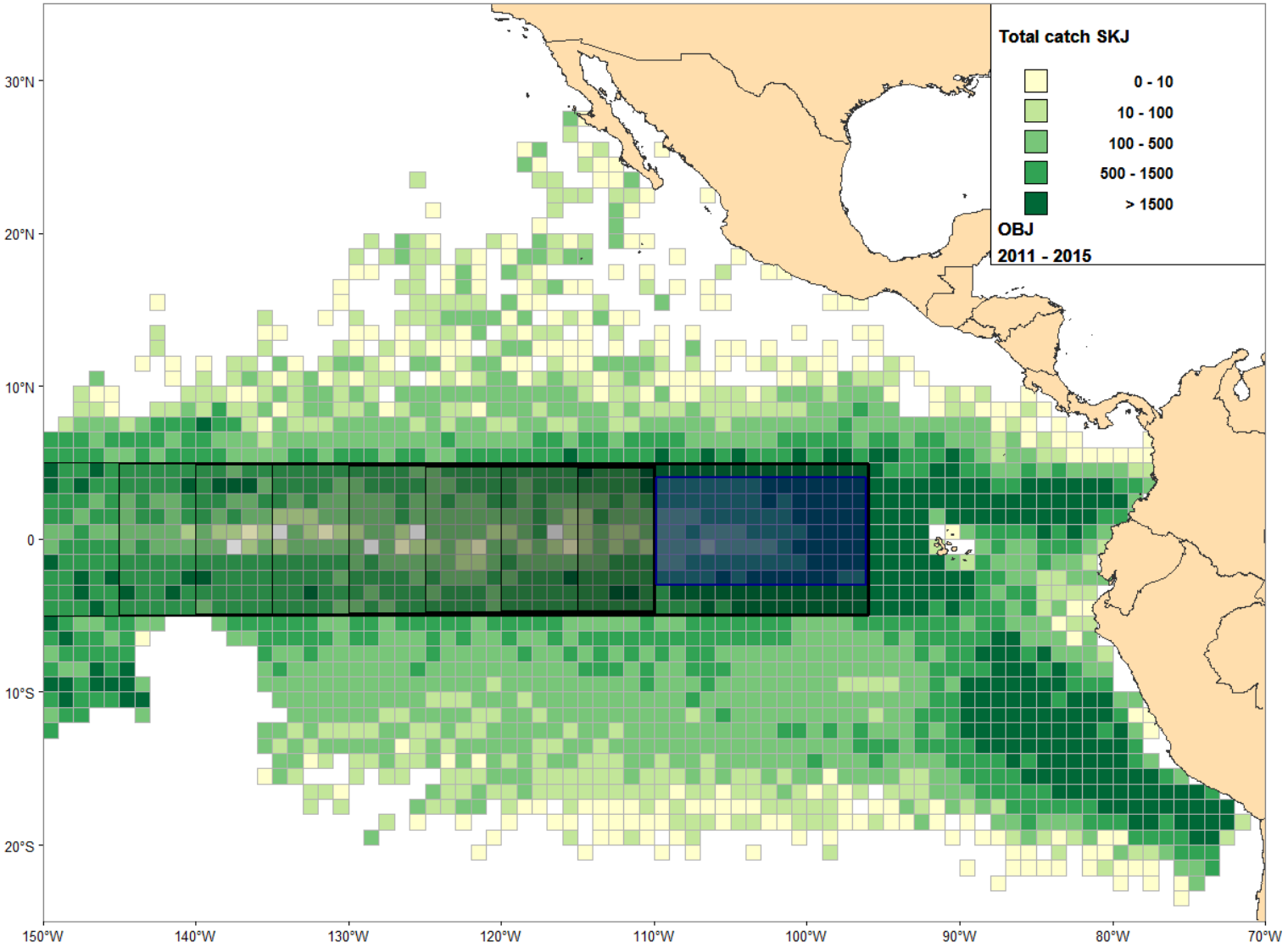

Number of OBJ sets
2011 - 2015 Ves class <=6
1 - 10
10 - 50
50 - 100
100 - 200
> 200
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

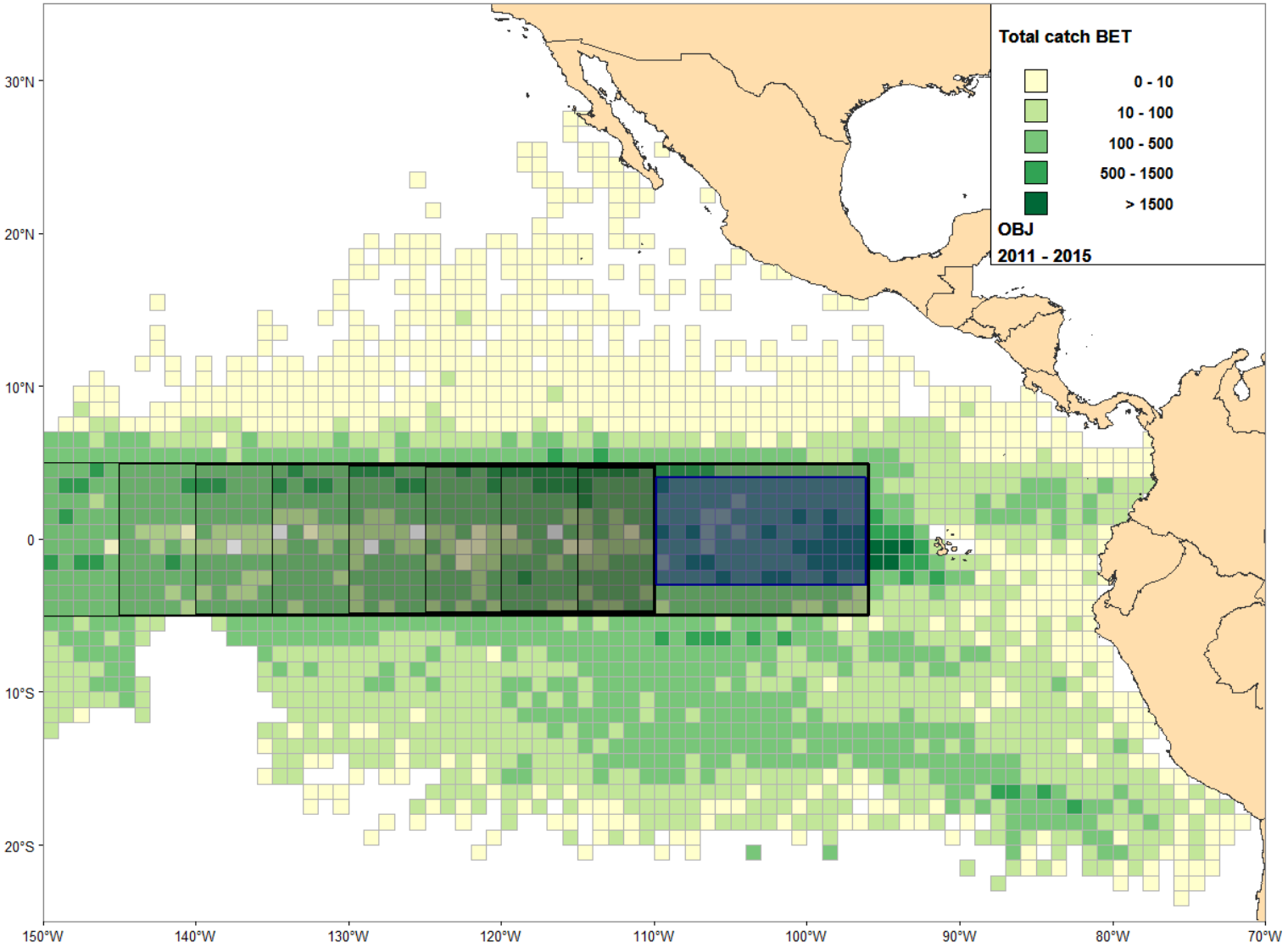

Total catch YFT
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
DEL
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

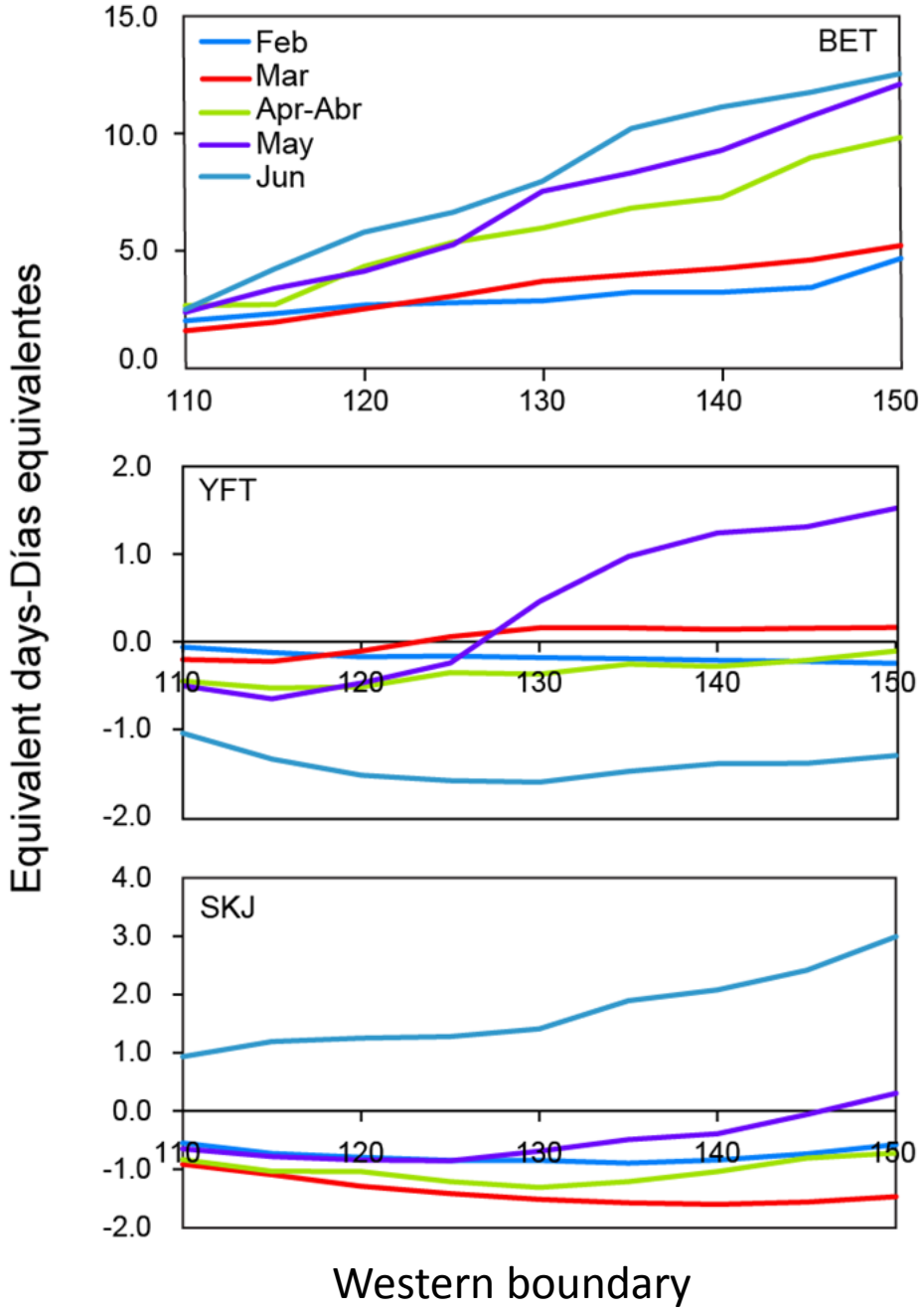

Total catch YFT
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
NOA
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch SKJ
0 - 5
5 - 50
50 - 300
300 - 1000
> 1000
NOA
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch YFT
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch SKJ
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Total catch BET
0 - 10
10 - 100
100 - 500
500 - 1500
> 1500
OBJ
2011 - 2015
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Equivalent days-Días equivalentes
15.0
10.0
5.0
0.0
Feb
Mar
Apr-Abr
May
Jun
BET
110
120
130
140
150
2.0
1.0
0.0
-1.0
-2.0
YFT
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
SKJ
Western boundary

Month specific equivalent days of changing the western boundary

	YFT					SKJ					BET				
°W	Feb	Mar	Apr	May	Jun	Feb	Mar	Apr	May	Jun	Feb	Mar	Apr	May	Jun
110	-0.1	-0.2	-0.4	-0.5	-1.0	-0.5	-0.9	-0.8	-0.6	0.9	2.0	1.6	2.7	2.4	2.5
115	-0.1	-0.2	-0.5	-0.7	-1.3	-0.7	-1.1	-1.0	-0.8	1.2	2.3	2.0	2.7	3.4	4.2
120	-0.2	-0.1	-0.5	-0.5	-1.5	-0.8	-1.3	-1.0	-0.8	1.3	2.7	2.5	4.3	4.1	5.8
125	-0.2	0.1	-0.4	-0.2	-1.6	-0.8	-1.4	-1.2	-0.9	1.3	2.8	3.1	5.4	5.3	6.6
130	-0.2	0.2	-0.4	0.5	-1.6	-0.8	-1.5	-1.3	-0.7	1.4	2.9	3.7	6.0	7.5	8.0
135	-0.2	0.2	-0.3	1.0	-1.5	-0.9	-1.6	-1.2	-0.5	1.9	3.2	4.0	6.8	8.3	10.2
140	-0.2	0.1	-0.3	1.2	-1.4	-0.8	-1.6	-1.0	-0.4	2.1	3.2	4.3	7.3	9.3	11.1
145	-0.2	0.2	-0.2	1.3	-1.4	-0.7	-1.6	-0.8	-0.1	2.4	3.4	4.6	9.0	10.7	11.8
150	-0.2	0.2	-0.1	1.5	-1.3	-0.6	-1.5	-0.7	0.3	3.0	4.7	5.2	9.8	12.1	12.5

Equivalent days of cumulative months

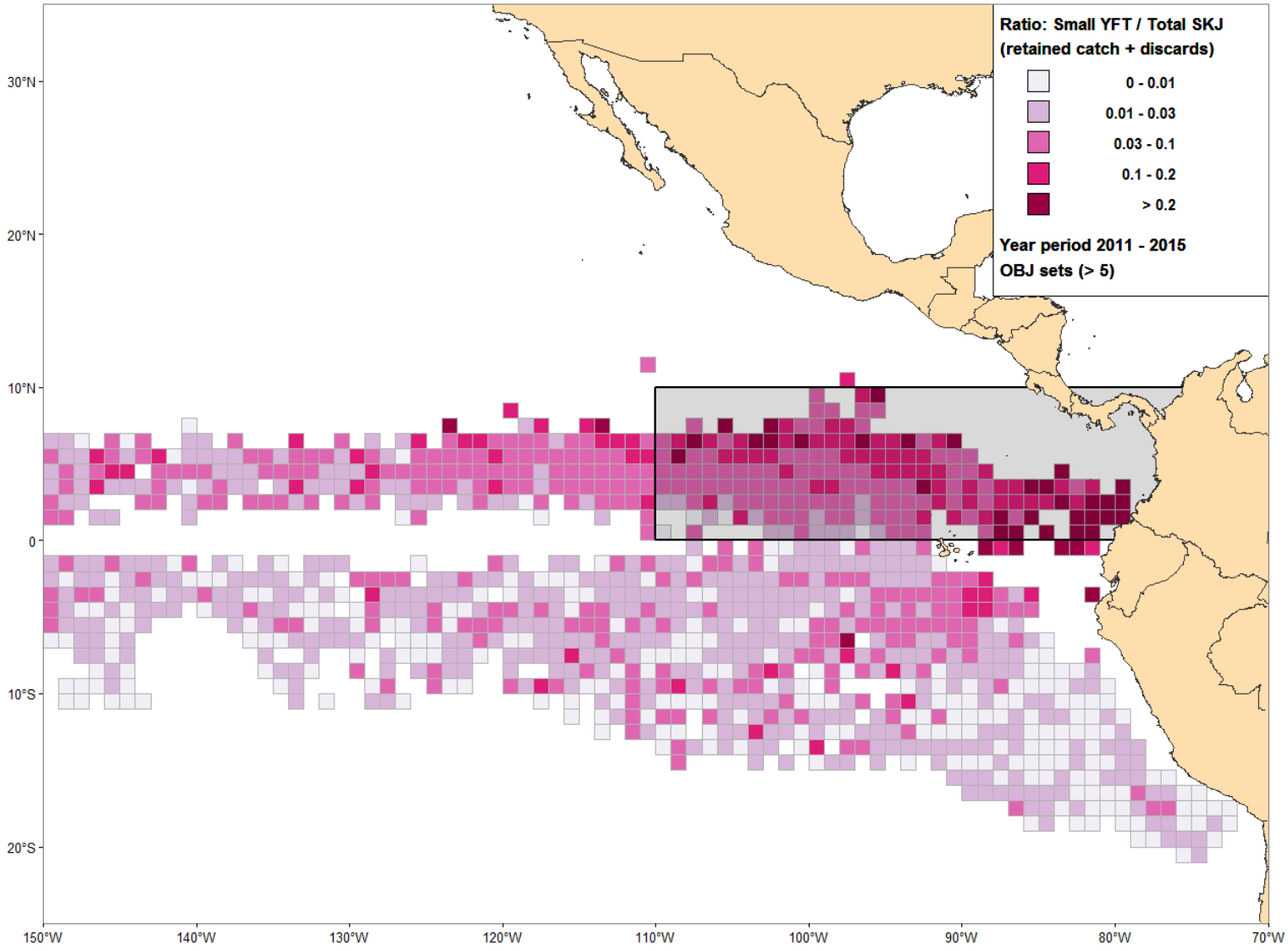
	BET				
°W	Feb	Feb-Mar	Feb-Apr	Feb-May	Feb-Jun
110	2.0	3.6	6.3	8.7	11.2
115	2.3	4.3	7.0	10.4	14.6
120	2.7	5.2	9.5	13.7	19.5
125	2.8	5.9	11.2	16.5	23.1
130	2.9	6.6	12.5	20.1	28.0
135	3.2	7.2	14.0	22.4	32.6
140	3.2	7.5	14.7	24.0	35.1
145	3.4	8.1	17.0	27.8	39.5
150	4.7	9.9	19.7	31.8	44.3

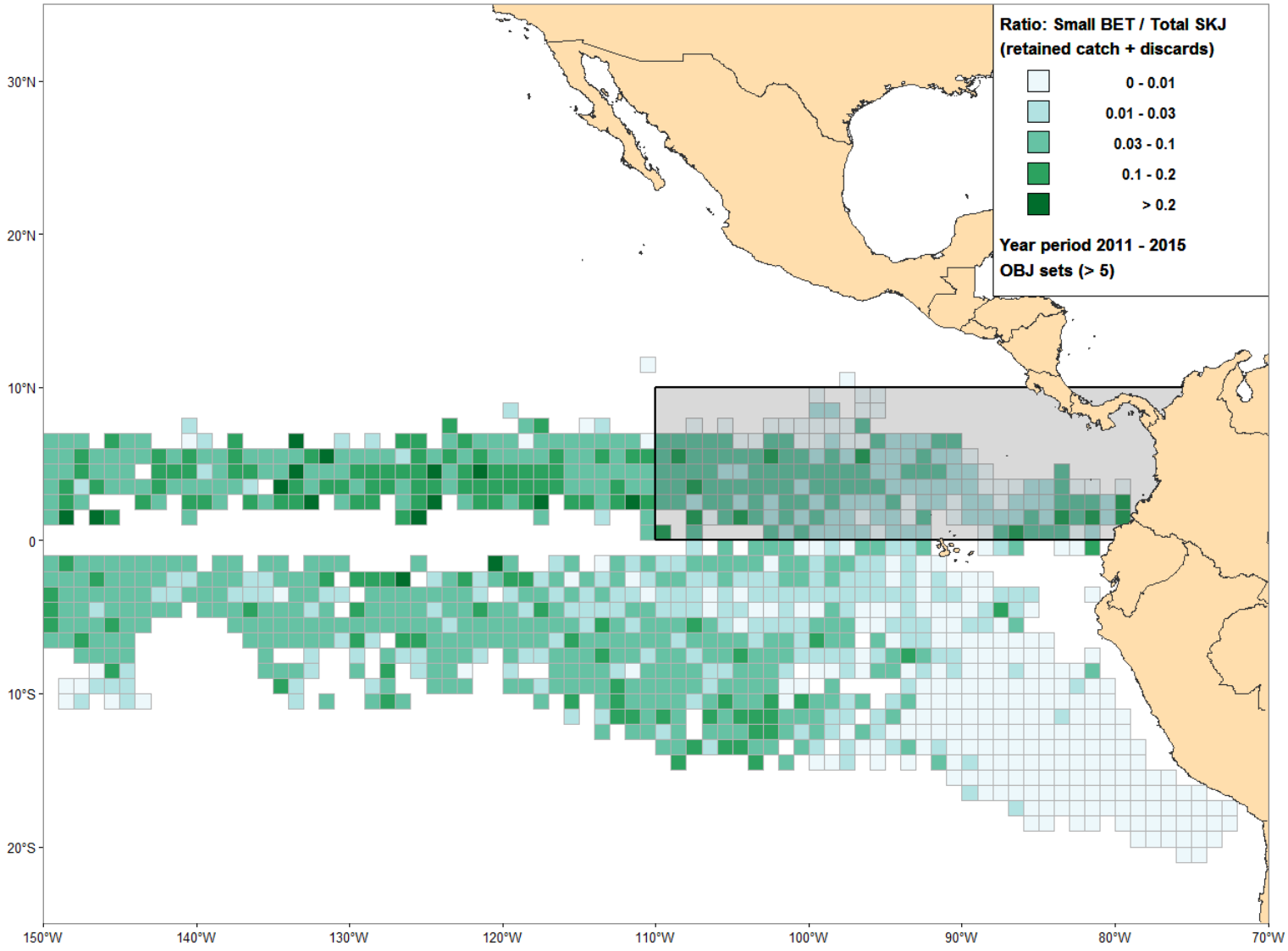
Extending the corralito in space and time

- The equivalent days of closure for bigeye increases linearly as the western boundary moves west, but the magnitude differs among months
- May and June reach about 12 equivalent days at 150°W
- Closure from February to June out to 110°W is equal to about 11 equivalent days
- Neither of which is enough to compensate for the increase in fishing capacity
- Therefore, the closure has to be extended both westward and for more than one month.
- Some examples worth about 17 days of equivalent closure
  - February-April out to 145°W
  - February-June out to 120°W
  - March-May out to 130°W
  - May-June out to 135°W
- The spatial closures have a much smaller impact on the catches of yellowfin and skipjack.

Spatial closures for small yellowfin

- 0-10N and 75W-110W
- Feb 01-Jun 30


Ratio: Small YFT / Total SKJ
(retained catch + discards)
0 - 0.01
0.01 - 0.03
0.03 - 0.1
0.1 - 0.2
> 0.2
Year period 2011 - 2015
OBJ sets (> 5)
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W


Ratio: Small BET / Total SKJ
(retained catch + discards)
0 - 0.01
0.01 - 0.03
0.03 - 0.1
0.1 - 0.2
> 0.2
Year period 2011 - 2015
OBJ sets (> 5)
30°N
20°N
10°N
0
10°S
20°S
150°W
140°W
130°W
120°W
110°W
100°W
90°W
80°W
70°W

Equivalent days of closure

- All sets types

Year	YFT	BET	SKJ
2011	0	-13	-5
2012	6	1	-5
2013	13	-14	4
2014	5	-7	-9
2015	13	1	-16

- Mainly floating object sets

Year	YFT	BET	SKJ
2011	0	-12	1
2012	-1	2	-3
2013	-2	-14	5
2014	2	-8	-4
2015	1	1	-12

Other options

62-DAY CLOSURE FOR ALL VESSELS

- Purse seine
  - Applies to purse-seine vessels of size classes 4-6, with an exception that allows size class 4 vessels to make a single fishing trip of up to 30 days duration during a closure.
  - The purse-seine vessels not covered by this measure catch a minor component of the bigeye catch, and the reduction in catch resulting from including these vessels in the closures would be negligible.
- Longline
  - The tuna caught by the longline fishery are larger than those caught by the purse-seine fishery, and therefore a reduction in longline catch will not have the same influence on fishing mortality as an equivalent reduction in the purse-seine catch.
  - Longline fishery is managed based on country-specific catch limits, and the limits are not reached by all countries.
  - Recent increases in fleet capacity, which led the staff to recommend an extension of the purse-seine closure, are due to purse-seine vessels, not longline vessels.
  - Fmultiplier exceeds 1.0 for both yellowfin and bigeye.
  - For illustrative purposes we determine the reduction in longline catch based on a 62-day closure
  - Reduce the total catch of yellowfin and skipjack by less than 0.1%
  - Reduction in bigeye catch is 10.7% of the purse-seine catch, which is equivalent to about 31 days of purse-seine closure.

Limitations on the number of purse seine sets

- By set type
- Vessels make more than one set type
- The proportion of unassociated sets varies considerably over time.
- Bigeye and yellowfin are also caught in the other set types, particularly yellowfin in floating-object and unassociated sets.
- Alternatively, the sets by set type could be allocated as IVQs based on the historical number of sets for each vessel.

Number of sets by set type and vessel size class

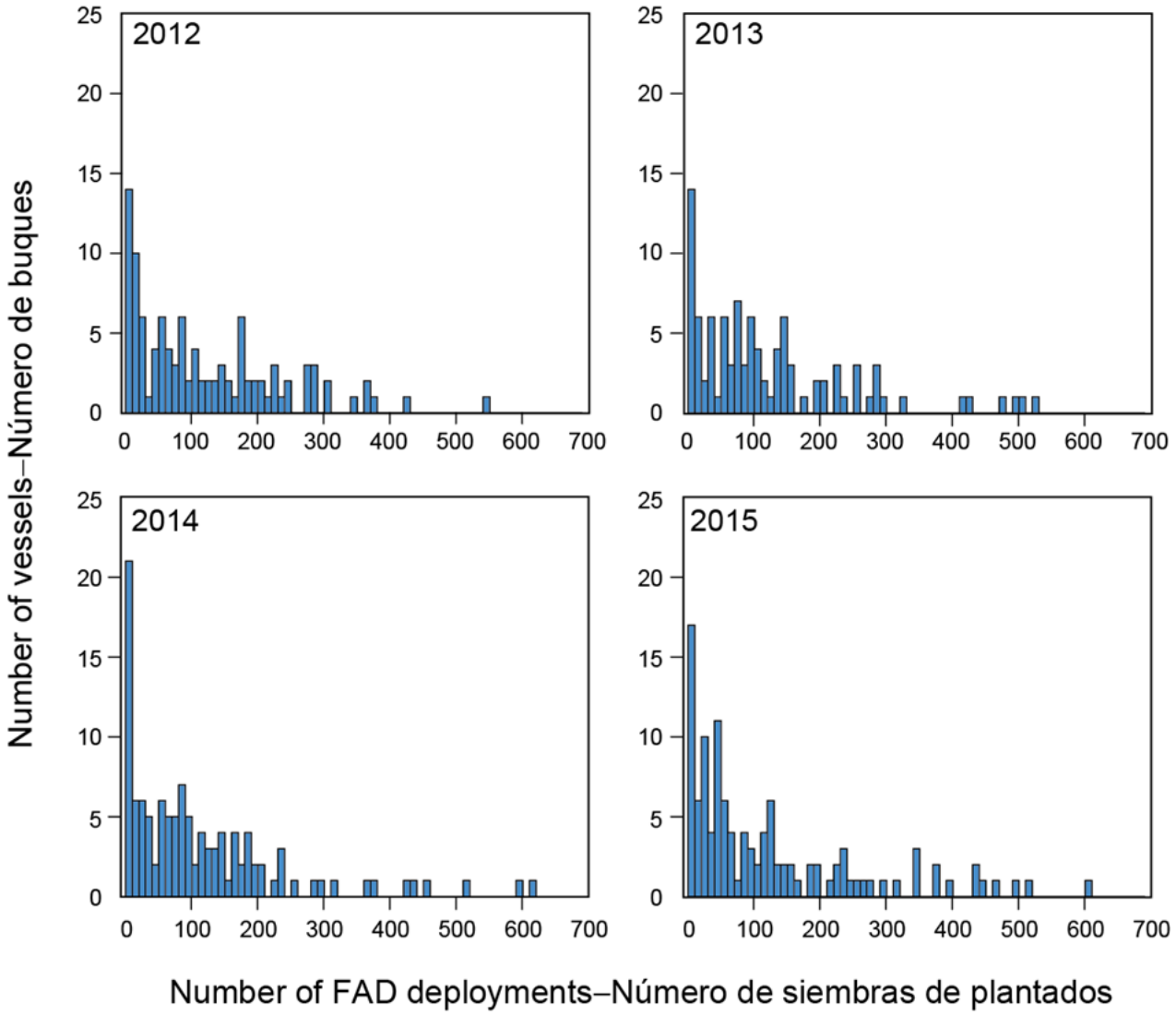
TABLE B. Number of floating-object and dolphin-associated sets, by vessel size category, 2000-2015. (from IATTC Fishery Status Report 14, Table A-7)

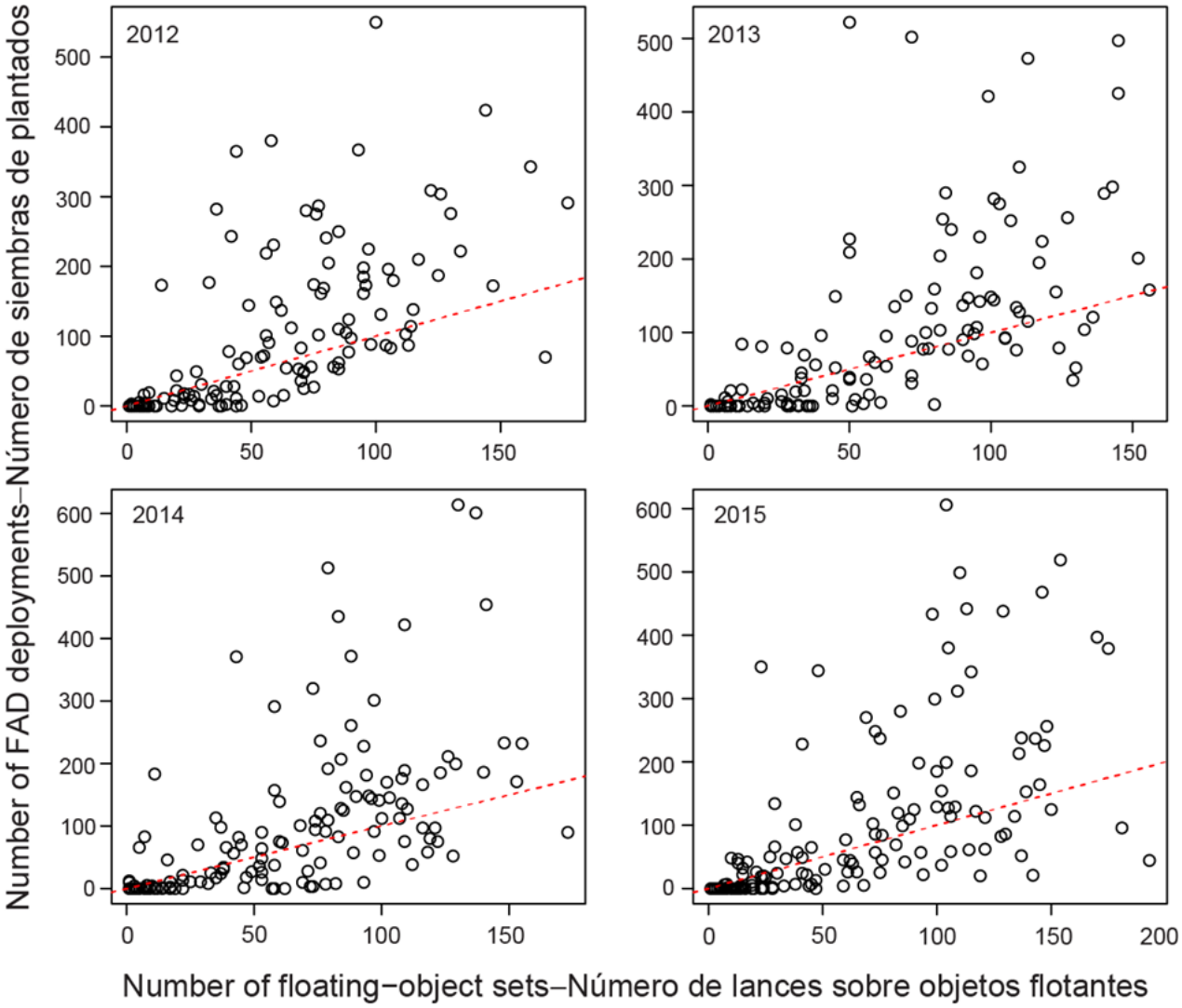
	Floating object			Dolphin		
	≤363 t	>363 t	Total	≤363 t	>363 t	Total
2000	508	3,713	4,221	0	9,235	9,235
2001	827	5,674	6,501	0	9,876	9,876
2002	867	5,771	6,638	0	12,290	12,290
2003	706	5,457	6,163	0	13,760	13,760
2004	615	4,986	5,601	0	11,783	11,783
2005	639	4,992	5,631	0	12,173	12,173
2006	1,158	6,862	8,020	0	8,923	8,923
2007	1,384	5,857	7,241	0	8,871	8,871
2008	1,819	6,655	8,474	0	9,246	9,246
2009	1,821	7,077	8,898	0	10,910	10,910
2010	1,788	6,399	8,187	0	11,645	11,645
2011	2,538	6,921	9,459	0	9,604	9,604
2012	3,067	7,610	10,677	0	9,220	9,220
2013	3,081	8,038	11,119	0	10,736	10,736
2014	3,858	8,777	12,635	0	11,382	11,382
2015	3,403	9,385	12,788	0	11,020	11,020
2013-2015	3,447	8,733	12,181	0	10,667	10,667

Limitations on the number of FADS

- Cannot be analyzed with the information available
  - More comprehensive data on FADs including unique identification, is required.
- The number of FADs or all floating objects used could possibly be limited in various ways
  - Number of FADs carried on the vessel
  - Number of FADs deployed
  - Number of floating objects a vessel has in the water at any given time
- It is very difficult to evaluate how effective these measures would be in reducing fishing mortality.
- The number of FAD deployments varies widely among vessels
- There is no simple relationship between the number of FAD deployments and the number of floating-object sets made
- Very few vessels make more than 500 FAD deployments within a year

Limitations on the number of FADS




2012
2013
2014
2015
Number of FAD deployments–Número de siembras de plantados
Number of floating–object sets–Número de lances sobre objetos flotantes

Other

- Eliminate exemptions in Resolution C-13-01 (not evaluated)
- Ban FADs in the ocean during the closure. (not evaluated)

Results

TABLE 2. Equivalent days of closure for each of the conservation measures. The capacity reduction and catch quota proposals are assumed to produce the required equivalent days of closure to compensate for the increased capacity.

Management measure	Equivalent days		
	YFT	BET	SKJ
25,000 m^3 capacity reduction	25	25	
Catch limits for bigeye (57,900 t) and yellowfin (232,800 t)	25	25	
In-season adjusted catch limits for bigeye and yellowfin	25	25	
Eliminate second closure period	0	2	-6
Eliminate first closure period	-2	-4	3
Reduce length of both closure periods to 31 days each	≈ -2 to 0	≈ -4 to 2	≈ -6 to 3
Eliminate the vessel capacity exemption in paragraphs 1 and 4 of Resolution C-13-01	Not evaluated	Not evaluated	Not evaluated
Extending the correlito	-2	11	-2
Closure of 5°S to the equator, 95°W-110°W	-1	8	-2
Closure of 5°S-5°N, and 120°W-150°W	3	20	2
Closure of south of 15°S	-1	1	15
Spatial closure between the coast of Mexico and 125W north of 23N	-2	0	-2
Spatial closure between the coast of South America and 85W from 5N to 5S	0	-10	-4
Guatemala EEZ closure	Not evaluated	Not evaluated	Not evaluated
All EEZ's closure	0	-49	2
Ban FADs in the ocean during the closure	Not evaluated	Not evaluated	Not evaluated
High seas closure	1	97	-9

Corralito expansion west

	BET				
°W	Feb	Feb-Mar	Feb-Apr	Feb-May	Feb-Jun
110	2.0	3.6	6.3	8.7	11.2
115	2.3	4.3	7.0	10.4	14.6
120	2.7	5.2	9.5	13.7	19.5
125	2.8	5.9	11.2	16.5	23.1
130	2.9	6.6	12.5	20.1	28.0
135	3.2	7.2	14.0	22.4	32.6
140	3.2	7.5	14.7	24.0	35.1
145	3.4	8.1	17.0	27.8	39.5
150	4.7	9.9	19.7	31.8	44.3

Spatial closure for small YFT

Year	YFT	BET	SKJ
2011	0	-12	1
2012	-1	2	-3
2013	-2	-14	5
2014	2	-8	-4
2015	1	1	-12

The End