

Comisión Interamericana del Atún Tropical Inter-American Tropical Tuna Commission



La relación entre la mortalidad por pesca y el número de lances OBJ para el patudo en el OPO
The relationship between fishing mortality and number of OBJ sets for bigeye tuna in the EPO

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Temario - Outline

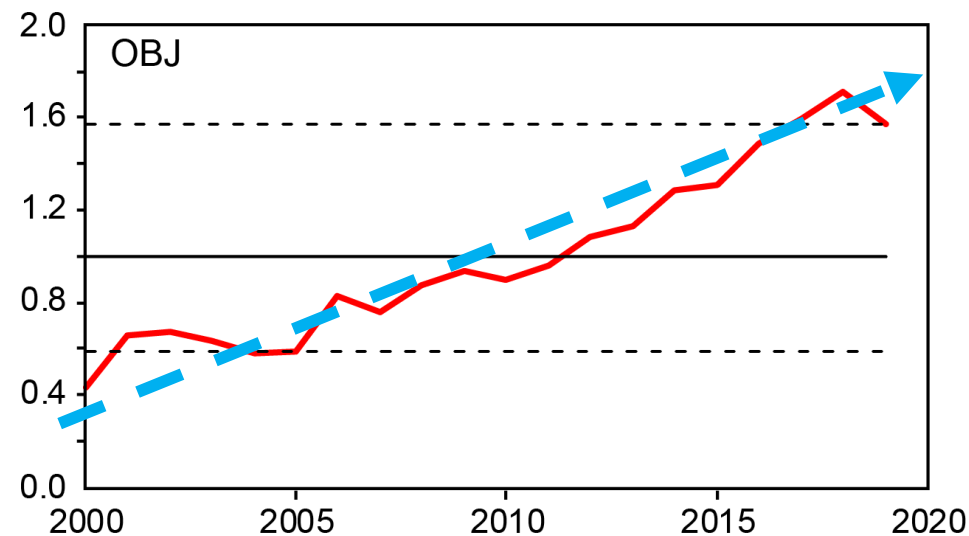
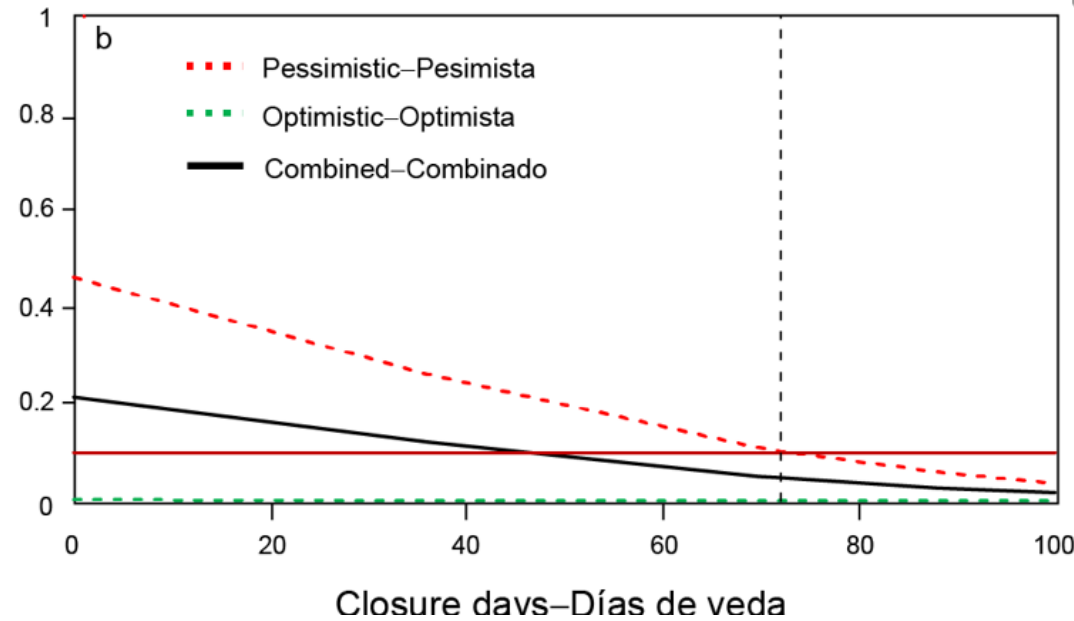
- Introducción
- Relación en el OPO entero entre la mortalidad por pesca y el número de lances OBJ
- Relación por área entre la mortalidad por pesca y el número de lances OBJ
- Comparación de la pesquería OBJ ecuatorial costera por clase de capacidad
- Resumen y conclusión

- Introduction
- EPO-wide relationship between fishing mortality and number of OBJ sets
- Area-specific relationships between fishing mortality and number of OBJ sets
- Compare the equatorial inshore OBJ fishery by vessel class
- Summary and conclusion

Medidas precautorias adicionales necesarias para mantener el *statu quo*

Additional precautionary measures needed to maintain *status quo*

- Por razones precautorias, la F no debería aumentar:
 1. Escenario pesimista de BET: la probabilidad de rebasar los PRL es de 10% o ligeramente superior
 2. La mayoría de los SSI indican que F ha aumentado, principalmente debido al aumento de los lances OBJ
 3. No hay evaluación o EE evaluada para el SKJ: la F no debería aumentarse



- For precautionary reasons, F should not increase:
 1. BET pessimistic scenario: the probability of breaching LRPs is 10% or slightly higher
 2. Most SSIs indicate F has increased, mainly due to increase in OBJ sets
 3. No assessment or evaluated HS for SKJ: F should not be increased



Introducción - Introduction

¿Por qué investigamos la relación entre la mortalidad por pesca del patudo y el número de lances OBJ?

- La relación entre la F del BET y el número de lances OBJ (N_{OBJ}) debe comprenderse mejor para poder proporcionar recomendaciones de ordenación orientadas a mantener el *statu quo* de F (se supone que el aumento de N_{OBJ} conduce al aumento de F del BET juvenil).

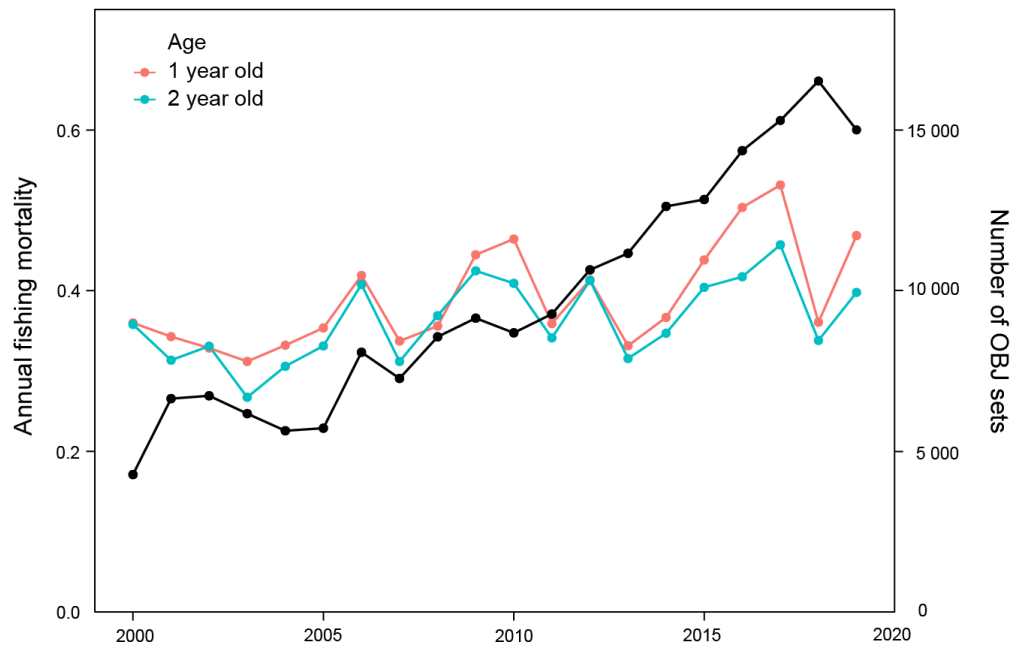
Why do we investigate the relationship between the fishing mortality for bigeye and the number of OBJ sets?

- The relationship between the F for BET and the number of OBJ sets (N_{OBJ}) needs to be better understood in order to provide management recommendations aiming to maintain the *status quo* F (It is assumed that the increase in N_{OBJ} leads to the increased F for juvenile BET).

Relación en el OPO entero entre F y N_{OBJ} EPO-wide relationship between F and N_{OBJ}

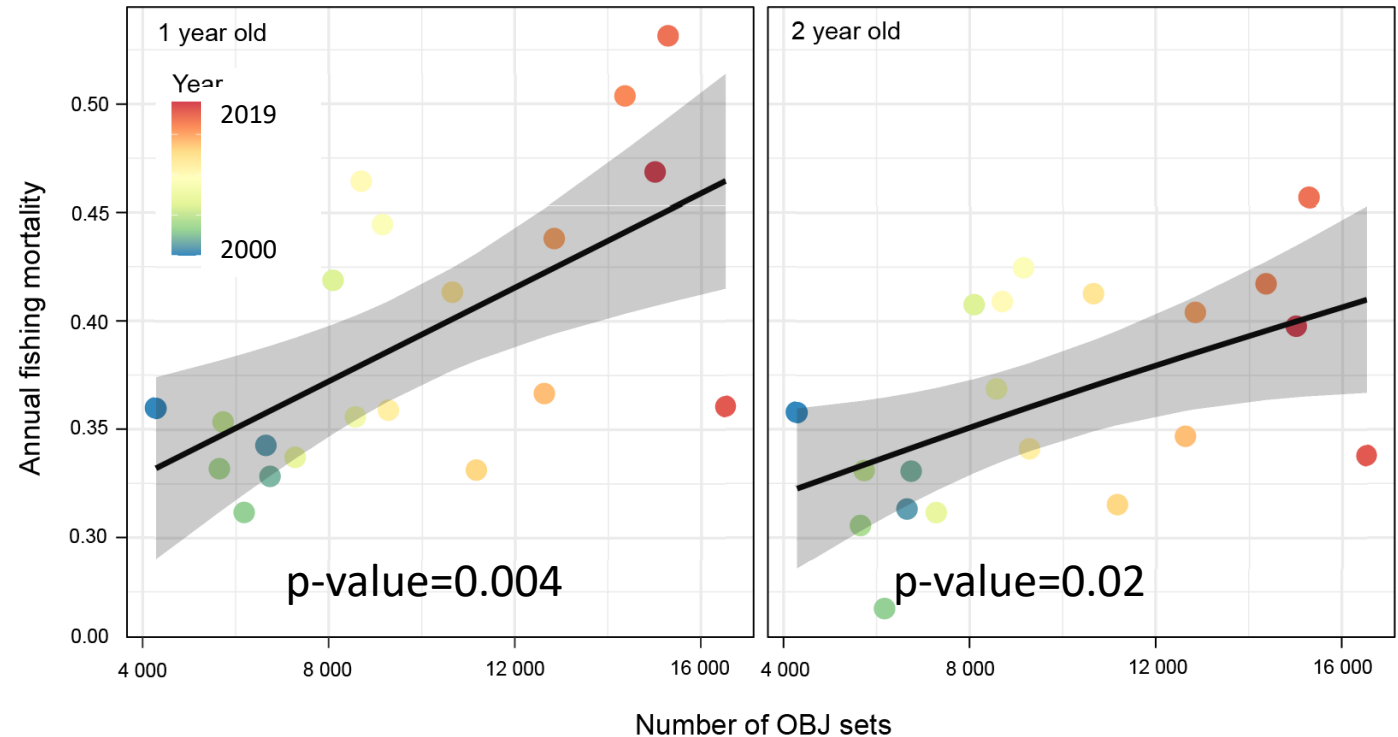
F por edad (1-4 y 5-8 trimestres) ponderada para el patudo juvenil en el OPO desde 2000

Weighted age-specific (1-4 and 5-8 quarters) F for juvenile bigeye in the EPO since 2000



Modelos aditivos generalizados

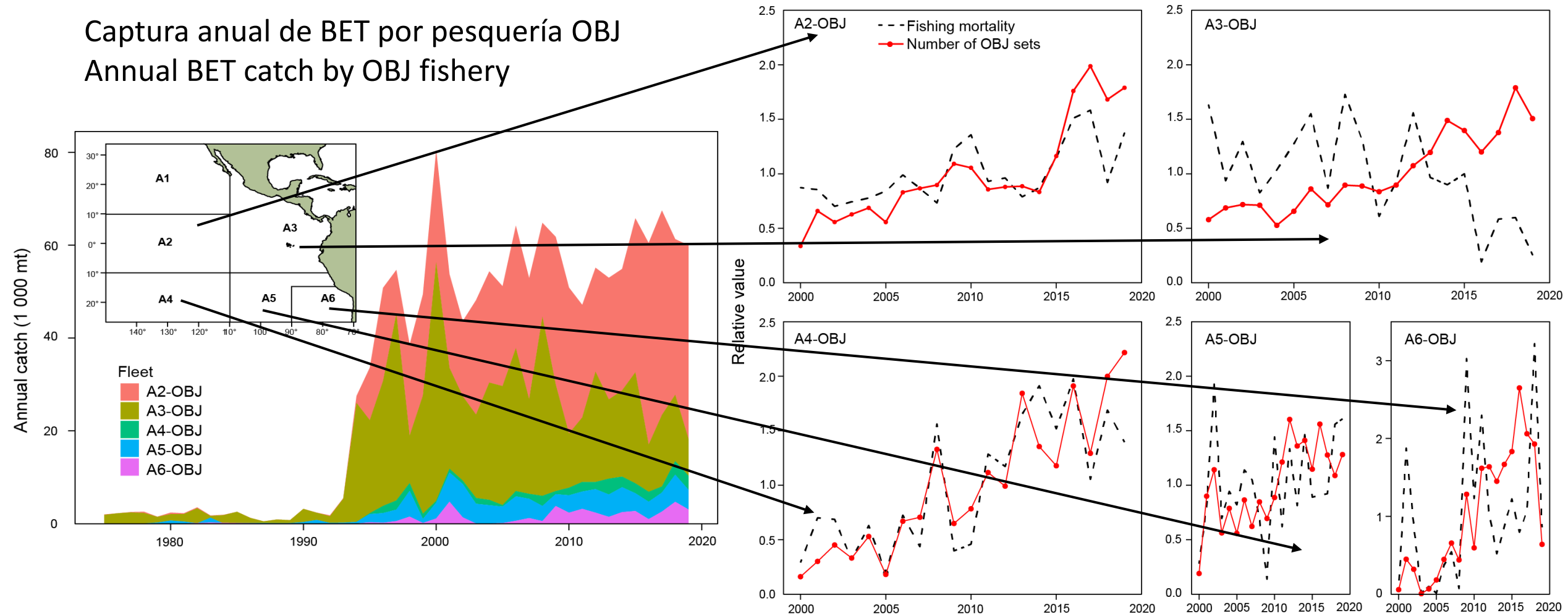
Generalized additive models



Relación por área entre F y N_{OBJ}

Area-specific relationship between F and N_{OBJ}

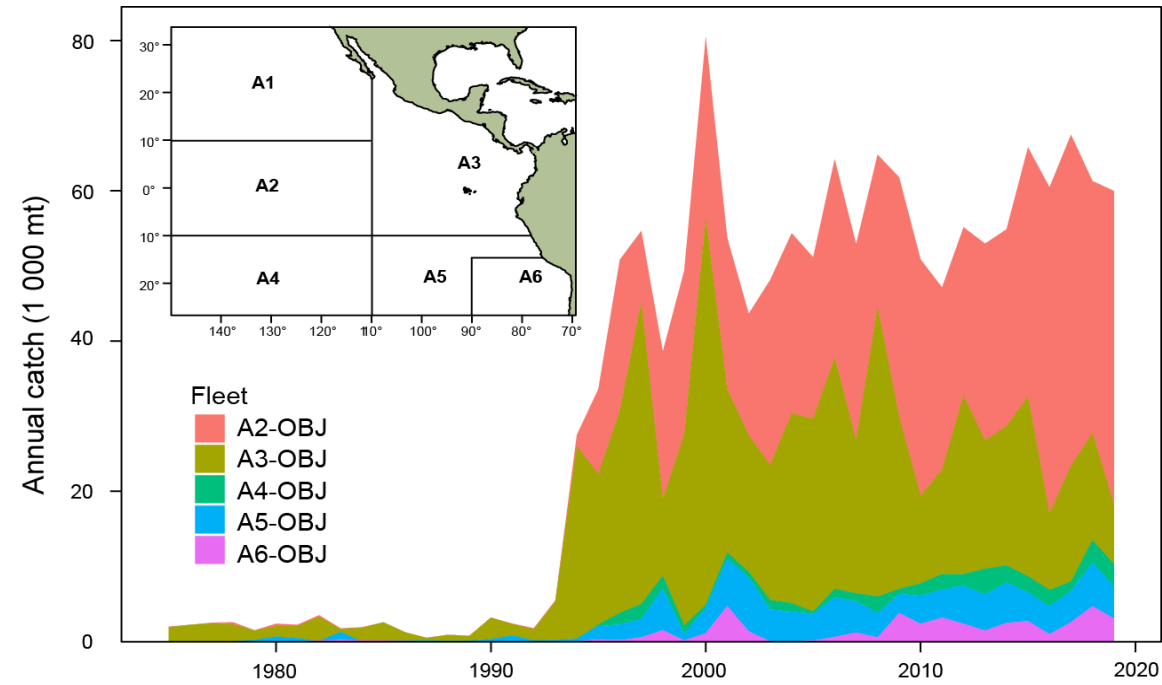
Captura anual de BET por pesquería OBJ
Annual BET catch by OBJ fishery



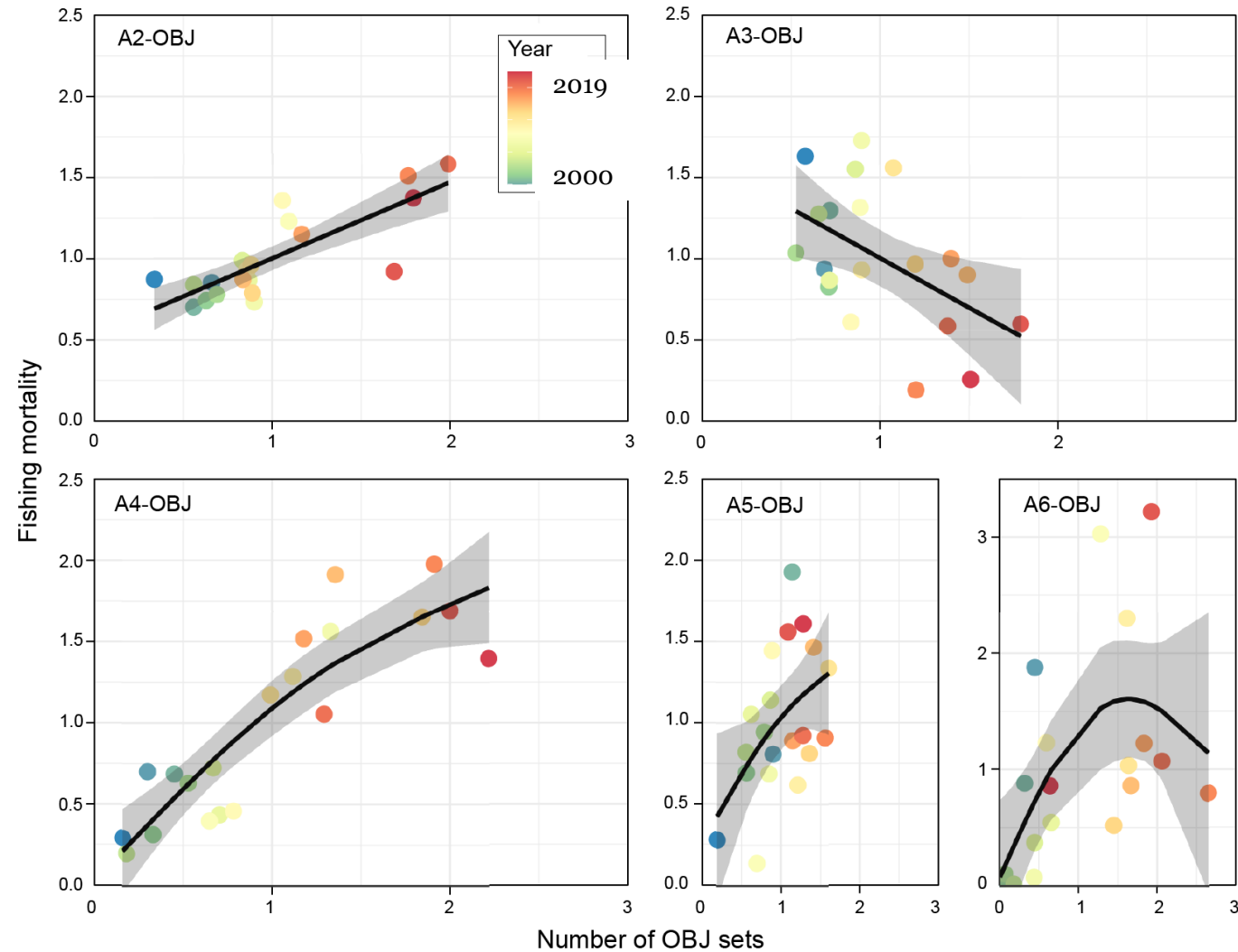
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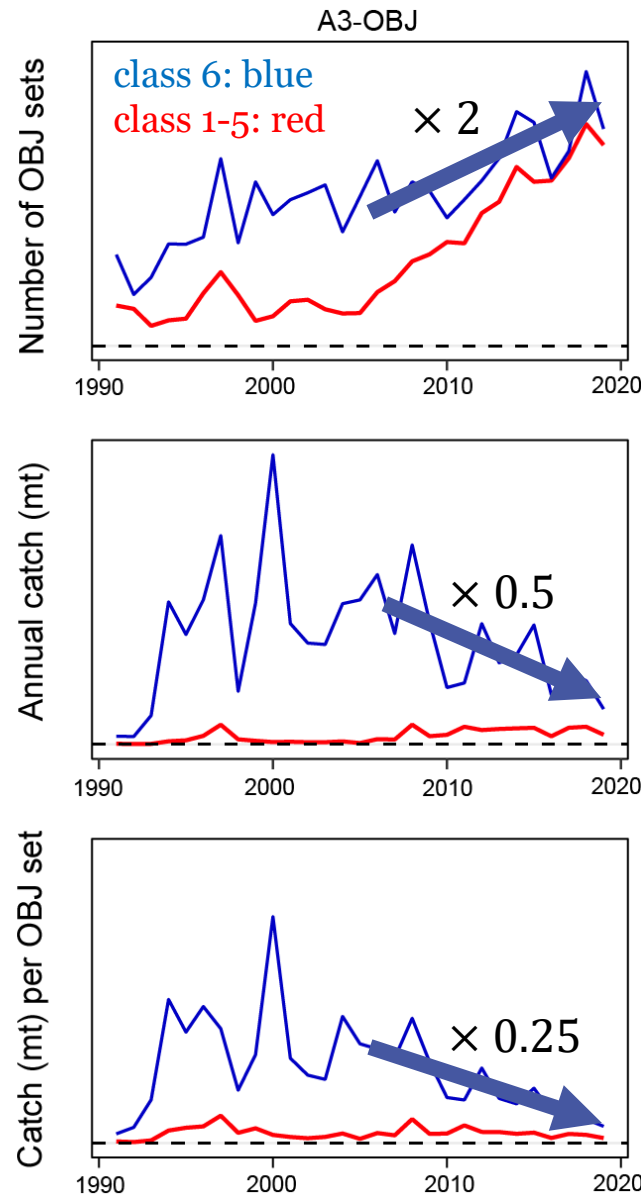
Modelos aditivos generalizados
Generalized additive models



A3-OBJ por clase de capacidad - A3-OBJ by vessel class

Al menos dos factores parecen ser responsables de la disminución de la captura de BET posterior a 2005 realizada por A3-OBJ, aunque el N_{OBJ} siguió aumentando en ese periodo:

1. Una proporción cada vez mayor de los lances OBJ en el Área 3 fue realizada por buques PS de clases 1-5 con una eficiencia mucho menor en la captura de BET en comparación con los buques PS de clase 6.
2. Si bien el número de lances OBJ realizados por buques PS de clase 6 en el Área 3 siguió aumentando desde 2005, la tasa de captura de los buques PS de clase 6 disminuyó a un ritmo más rápido durante ese tiempo.



At least two factors seem to be responsible for the decrease in post-2005 BET catch taken by A3-OBJ, even though N_{OBJ} continued to increase in that period:

1. An increasing proportion of the OBJ sets in Area 3 were made by Class 1-5 PS vessels with much lower efficiency in catching BET in comparison to Class-6 PS vessels.
2. While the number of OBJ sets made by Class-6 PS vessels in Area 3 continued to increase since 2005, the catch rate of Class-6 PS vessels dropped at a faster rate during that time.

Hipótesis de la relación negativa en el Área 3

Hypothesis for the negative relationship in Area 3

Hipótesis más probable: mayor grado de reducción local en el Área 3

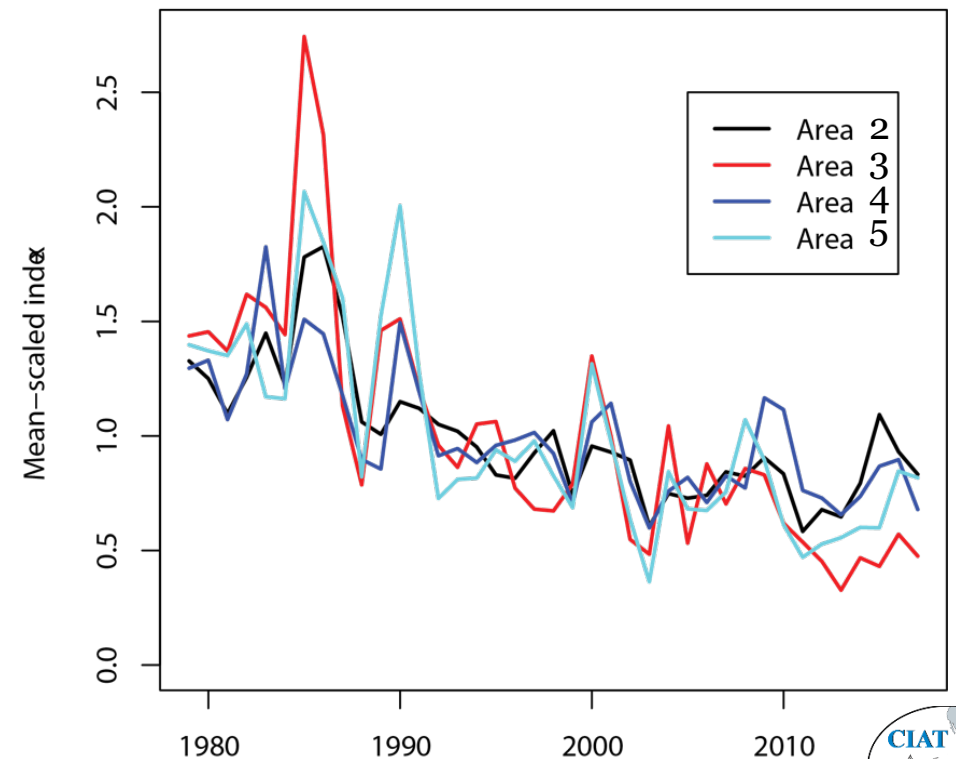
- Los modelos de evaluación para el BET no están estructurados espacialmente y utilizan el enfoque de “áreas como flotas”, por lo que la F por área se estima con respecto a toda la población del OPO.
- Una reducción de BET en el Área 3 más rápido que en otras áreas del OPO tiene como resultado una menor captura local que podría traducirse en una disminución de F .

Most likely hypothesis: higher degree of local depletion in Area 3

- The assessment models for BET are not spatially structured and use the “areas-as-fleets” approach, so area-specific F is estimated with respect to the whole population in the EPO.
- A faster depletion of BET in Area 3 than in other EPO Areas results in less local catch that could translate into a decreased F .

Los índices de palangre conjuntos (proporcionados por Simon Hoyle en el taller de CPUE LL) apoyan esta hipótesis

Joint longline indices (Simon Hoyle provided in the LL CPUE workshop) support this hypothesis

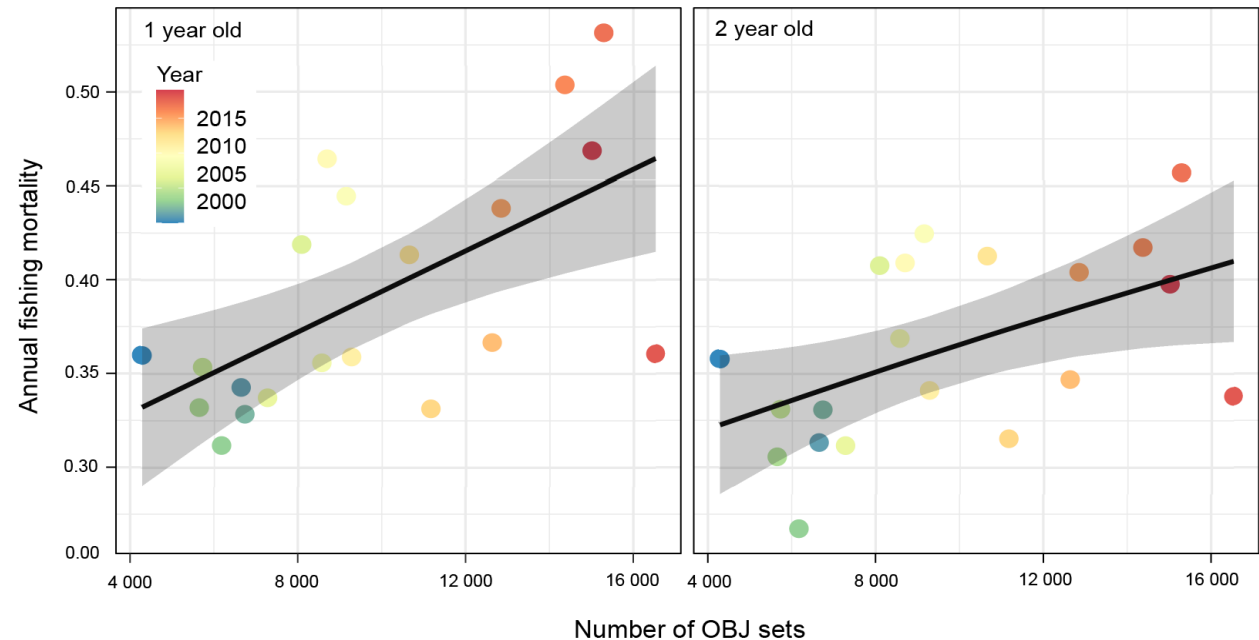
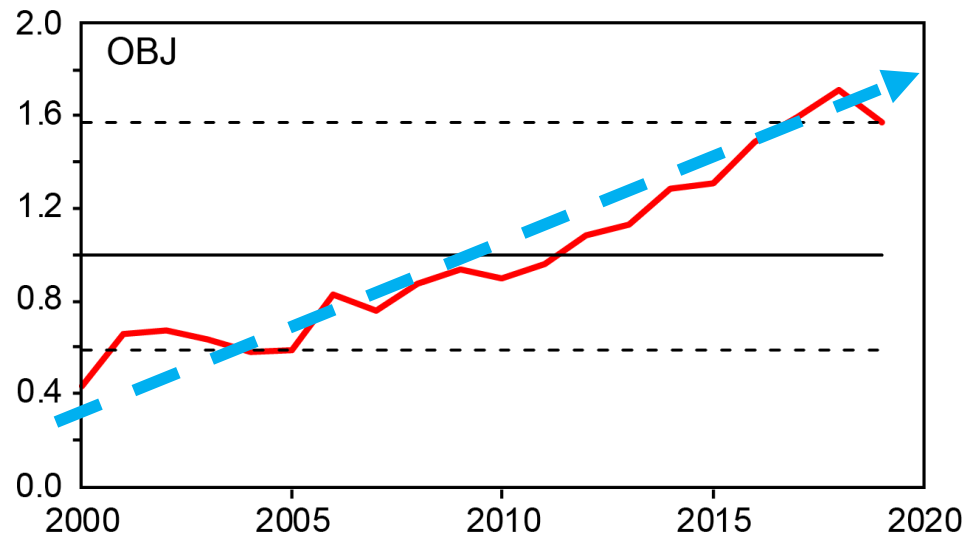


Resumen - Summary

- La relación en el OPO entero entre la F del BET juvenil (de 2 años o menos) y el N_{OBJ} es positiva y estadísticamente significativa (valores $p < 0.05$).
 - Las relaciones por área entre la F del BET y el N_{OBJ} también son estadísticamente significativas (valores $p < 0.05$). De las cinco relaciones por área, una (para el Área 3) es negativa y tres son estrictamente positivas, incluida la del Área 2 donde se realiza el 75% de la captura actual de patudo.
 - Se presentan tres hipótesis para explicar la relación negativa para el Área 3, siendo la más plausible un mayor grado de reducción local en esta área.
- The EPO-wide relationship between the F for juvenile (age 2 years and less) BET and N_{OBJ} is positive and statistically significant (p -values < 0.05).
 - The area-specific relationships between the F for BET and N_{OBJ} are also statistically significant (p -values < 0.05). Of the five area-specific relationships, one (for Area 3) is negative and three are strictly positive, including the one for Area 2 where 75% of the current bigeye catch is taken.
 - Three hypotheses are presented to explain the negative relationship for Area 3, the most plausible being a higher degree of local depletion in this area.

Conclusión - Conclusion

- La relación positiva y estadísticamente significativa en el OPO entero entre la F del BET juvenil (de 2 años o menos) y el N_{OBJ} indica que la F aumenta al aumentar el N_{OBJ} .
- Esta investigación muestra la evidencia de que necesitamos limitar el N_{OBJ} anual en el OPO al nivel promedio de 2017-2019 para mantener el *statu quo* de F para el BET.
- The positive and statistically significant EPO-wide relationship between the F for juvenile (age 2 years and less) BET and N_{OBJ} indicates that F increases as the N_{OBJ} increases.
- This research shows the proof of evidence that we need to restrict annual N_{OBJ} in the EPO to the 2017-2019 average level to maintain the *status quo* F for BET



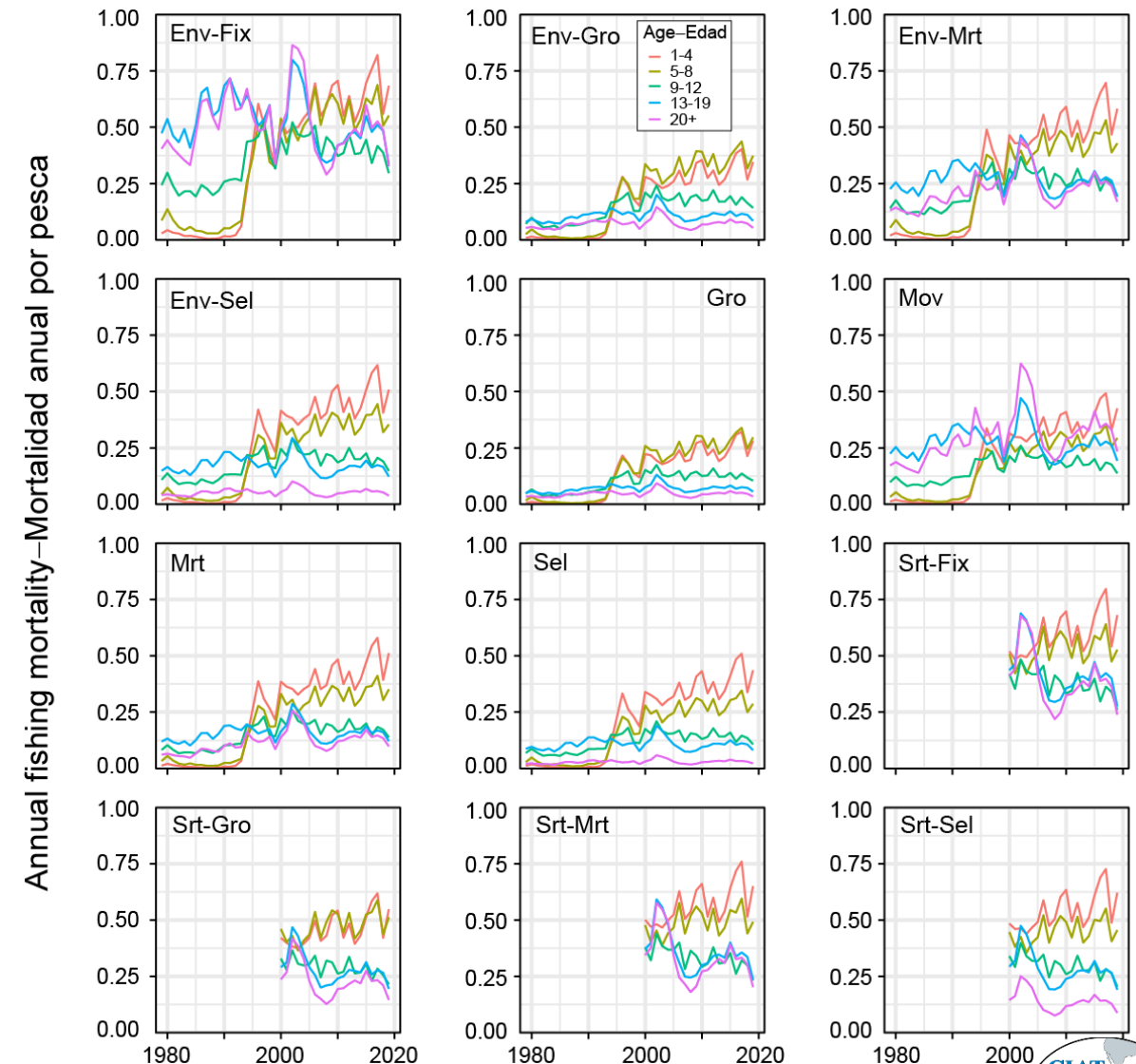


Preguntas-Questions

SPN

List of reference models for bigeye tuna

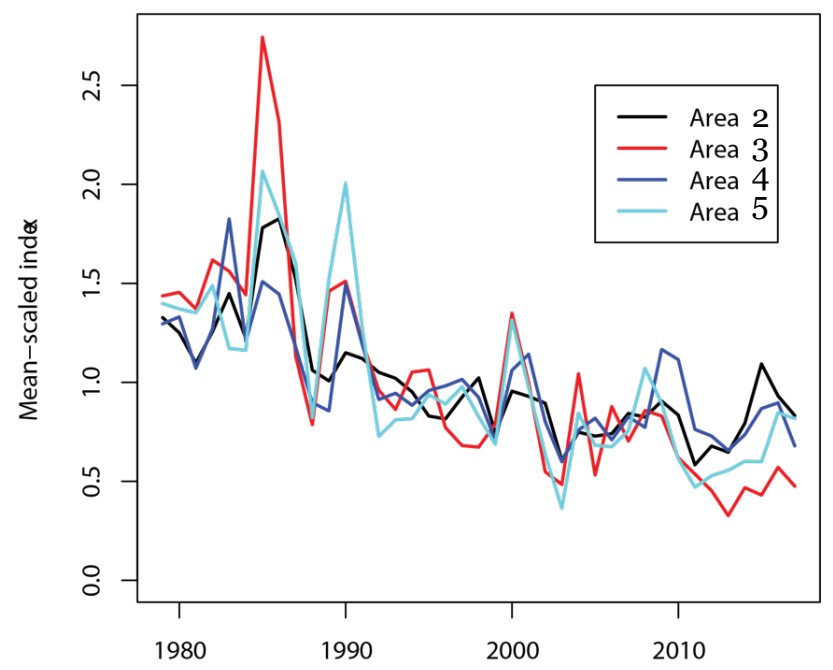
SPN Model name	Número Number	SPN- Description
Env-Fix	1	SPN-Environment, Fixed
Env-Gro	2	SPN Environment, Estimate growth
Env-Sel	3	SPN Environment, Dome selectivity
Env-Mrt	4	SPN Environment, Adult mortality
Srt-Fix	5	SPN-Short-term, Fixed
Srt-Gro	6	SPN Short-term, Estimate growth
Srt-Sel	7	SPN Short-term, Dome selectivity
Srt-Mrt	8	SPN Short-term, Adult mortality
Mov	9	SPN-Pre-adult movement
Gro	11	SPN-Estimate growth
Sel	11	SPN-Dome selectivity
Mrt	12	SPN-Adult mortality



SPN

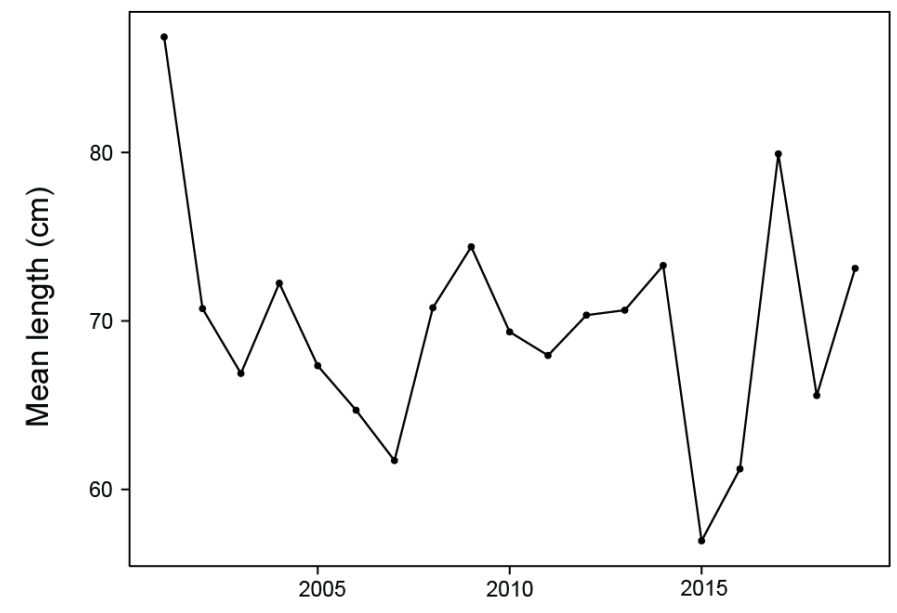
Hypothesis 1: Higher degree of local depletion

SPN
Joint longline indices from Simon Hoyle



SPN
Support hypothesis 1

SPN
Mean length of BET in the OBJ fishery in Area 3



SPN
Does not support hypothesis 1

As of now, the negative relationship between the F for BET and N_{OBJ} in the inshore equatorial area (Area 3) likely indicates that BET experienced faster depletion in Area 3 than in rest of the EPO.

- **Higher degree of local depletion**
- Deteriorated habitat conditions in local fishing grounds
- Gear evolution incidentally reduced the catch efficiency for BET

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SPN

Hypotheses for the negative relationship in Area 3

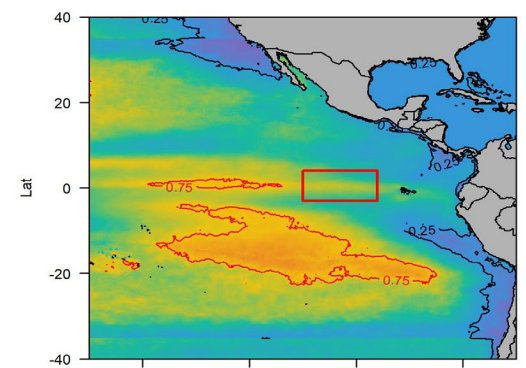
Hypothesis 2: Deteriorated habitat conditions in local fishing grounds

Habitat conditions in Area 3 have been deteriorating for BET

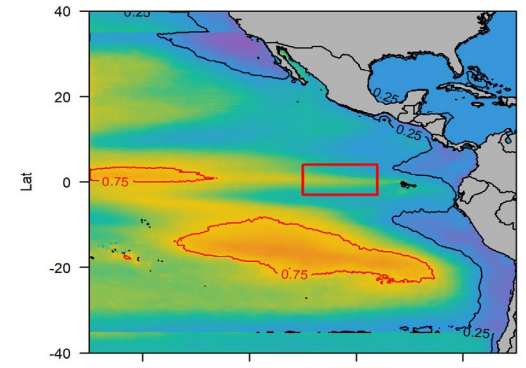
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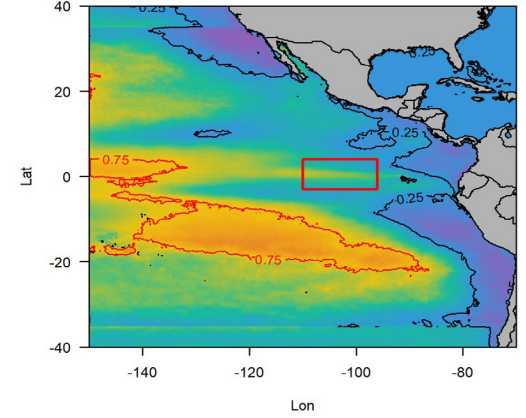
SPN
Habitat conditions for bigeye change greatly from year to year (SAC-10 INF-D):



SPN
El Niño condition



SPN
Normal condition



SPN
La Niña condition

SPN

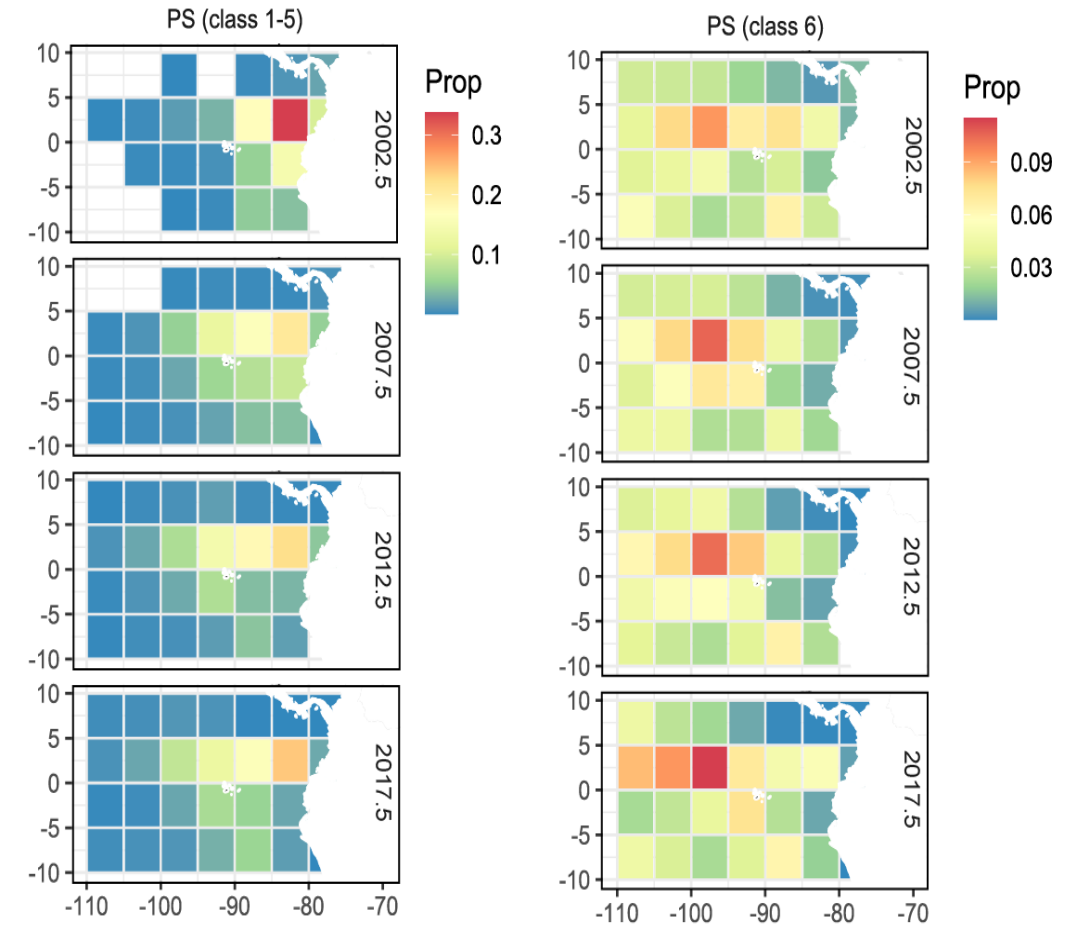
Hypotheses for the negative relationship in Area 3

Hypothesis 2: Deteriorated habitat conditions in local fishing grounds

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SPN
Spatial distribution of the OBJ sets in Area 3 also changes over time

SPN

Hypotheses for the negative relationship in Area 3

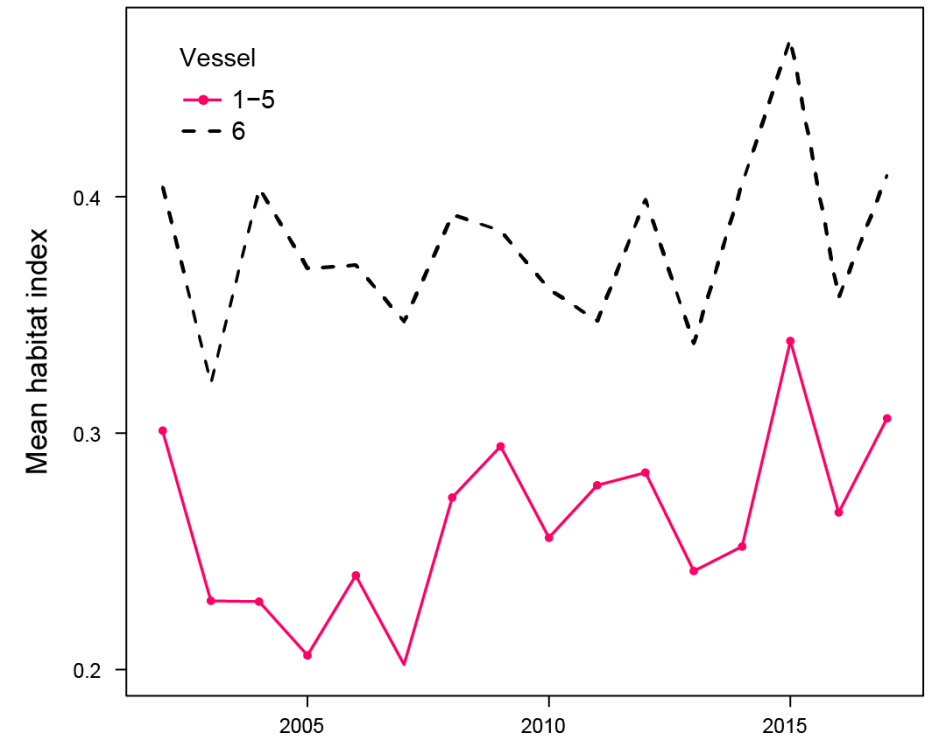
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SPN
Does not support hypothesis 2



SPN

Habitat index for BET (from SAC-10 INF-D) + OBJ set location:

SPN

Annual mean habitat index for BET based on the location and date of OBJ sets in Area 3



Hypothesis 3: Gear evolution incidentally reduced the catch efficiency for BET

- Skipjack is the main target species of the OBJ fisheries in the EPO
- It is possible that changed gear characteristics, likely aiming to improve the catch efficiency for skipjack, incidentally reduced the catch efficiency for bigeye in Area 3

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- Productivity and Susceptibility Analysis (PSA; Duffy et al. 2019) for the tropical tuna fishery in the EPO suggested that SKJ and BET have about the same susceptibility to the OBJ fishery.
- It seems unlikely that the evolution of the OBJ fisheries in the EPO can cause such a large degree of decrease in the catch rate for BET solely in Area 3.

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- **Higher degree of local depletion**
 - Longline indices of abundance supports this hypothesis
 - Mean length of bigeye in the OBJ fishery does not support the hypothesis
 - Francis (2011): indices of abundance are more reliable than length compositions in informing population trend
- **Deteriorated habitat conditions in local fishing grounds**
 - Habitat index for bigeye does not support this hypothesis
- **Gear evolution incidentally reduced the catch efficiency for BET**
 - Current evidence (Productivity and Susceptibility Analysis) does not support this hypothesis
 - More research regarding for example FAD operation and usage is needed in the future to further test this hypothesis

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