Current impacts of climate change on ocean productivity and skipjack tuna habitat





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27th Working Party on Tropical Tunas Data Preparatory Meeting (WPTT27(DP)), June 11-13 2025 Trend in sea surface temperature for 1993–2023 Data: ESA CCI SST v3.0 • Reference period: 1991–2020 • Credit: C3S/ECMWF



Figure 2. Trend^[5] in annual sea surface temperature anomalies (°C/decade) for the period 1993–2023. Data source: ESA SST CCI Analysis v3.0. Credit: ESACCI/EOCIS/UKMCAS and C3S/ECMWF.

https://climate.copernicus.eu/climate-indicators/sea-surface-temperature



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Outline

- 1- The productivity available to fish is decreasing in the warming Indian Ocean,
- 2- Links between the annual catch rates of skipjack tuna and size of feeding habitat,
- 3- The skipjack tuna feeding habitat is more and more affected by unsuitable sea surface temperature.











Climate change impacts on the oceans and marine ecosystems









Productive fronts at mesoscale can be daily tracked by satellite ocean color sensors ... and they are key to zooplankton production



https://marine.copernicus.eu/access-data/myocean-viewer Newly produced since November 2024!











Ocean Productivity available to Fish (OPFish) 2003-2024 [MODIS-Aqua sensor]



(relative units – seasonal maximum is 100)

What are the trends of potential fish production after the current effect of climate change?



Regional relative trends in the range -5% to -15%

per decade





SKJ presence data

French and Spanish purse seine data.



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A selected range for the physical variables describes the physical preference of the habitat. => The habitat model is deterministic.



⇒ Preferred feeding habitats show large seasonal North-South oscillations





- ⇒ Free schools are globally closer to feeding habitat than FADs (about twice more FADs further from 100km than free schools).
- => Maximum vulnerability to purse seine at minimum size of habitat,
- => FADs show the highest distances to preferred feeding habitat when habitat is at minimum size.





- SKJ is a fast reproducing species responding quickly to an environmental change (~0-2 years)
- SKJ is the third most-fished species in the world



SKJ habitat 2003-2024 [MODIS-Aqua sensor]



50°E

40°E

60°E

70°E

European

Commission



SKJ feeding habitat: comparing 2024 with 2012 and 2022

- Monthly SKJ feeding habitat in 2024,
- **30°C SST** iso-contour is shown as the warmer areas are avoided by SKJ (98th percentile of SKJ presence value of 29.9°C is used in the habitat modelling) and unsuitable for SKJ larvae;
- areas of Sea Surface Height anomaly avoided by SKJ (SSHa > 0.615 m, 98thpercentile of SKJ presence) are also shown (lower mesoscale activity),
- <u>Monthly 2024</u> habitat is compared to a recent high surface area of habitat (2022) and a previous medium year of habitat surface area, 2012).
- A latitudinal habitat discontinuity by high SST levels was observed in 2024 North of Madagascar from February to April, and then from May to December at a latitude of northern Madagascar by excessive levels of SSHa, i.e. high SST levels and low mesoscale activity.















> Spring 2024 conditions are impeding normal SKJ spawning in the northern Mozambique Channel.



Unsuitable conditions (SSHa) occurred more northward in 2024 in autumn.







> Spring 2025 is not as warm as spring 2024.

Summary

- Climate change is increasing the heat content of the upper Indian Ocean, leading to a reduction of the useful ocean productivity for the high trophic level feeding,
- A large marine heat wave particularly occurred in 2024 with SST levels over 30°C that are unsuitable to SKJ presence,
- This process **is likely to intensify** in the coming decades following the levels of GHG emissions (IPCC),
- **The SKJ feeding** habitat, and associated carrying capacity of the stock to grow, **is affected** by these unsuitable habitats in the range -5 to -20% per decade in the western Indian Ocean,
- The reproduction of skipjack was potentially disturbed in 2024 considering the unfavorable conditions in the northern Mozambique Channel in April, resulting of a plausible movement southward of the population, prior to moving back northward during summer,
- The overall resilience of pelagic ecosystems is likely reduced by climate change and fishing pressure,
- The record-high catches in 2020-2023 and the decreased catches in 2024, associated to lower habitat suitability for feeding in the long-term (although variable) may increase the risk of overfishing,
- The monitoring of suitable feeding habitats in real-time could limit the risk of both overfishing and shortage for the fish processing industry.



Chlorophyll-a fronts: the feeding connectivity of pelagic food webs From habitat to fisheries management



https://sustainable-fisheries.ec.europa.eu/spatial-fish-habitat-and-fishing-effort/fish-habitat_en