A fishery-impact-based management reference level for pacific bluefin tuna in the eastern Pacific Ocean

Issue

- Absolute levels of biomass and fishing mortality, and reference points based on maximum sustainable yield (MSY), are hypersensitive to the value of natural mortality
- Relative trends in biomass and fishing mortality levels are more robust to model assumptions.
- Management reference points based on relative biomass or fishing mortality should be considered
- Unlikely that these management measures can be designed to optimize yield

Relative reference levels

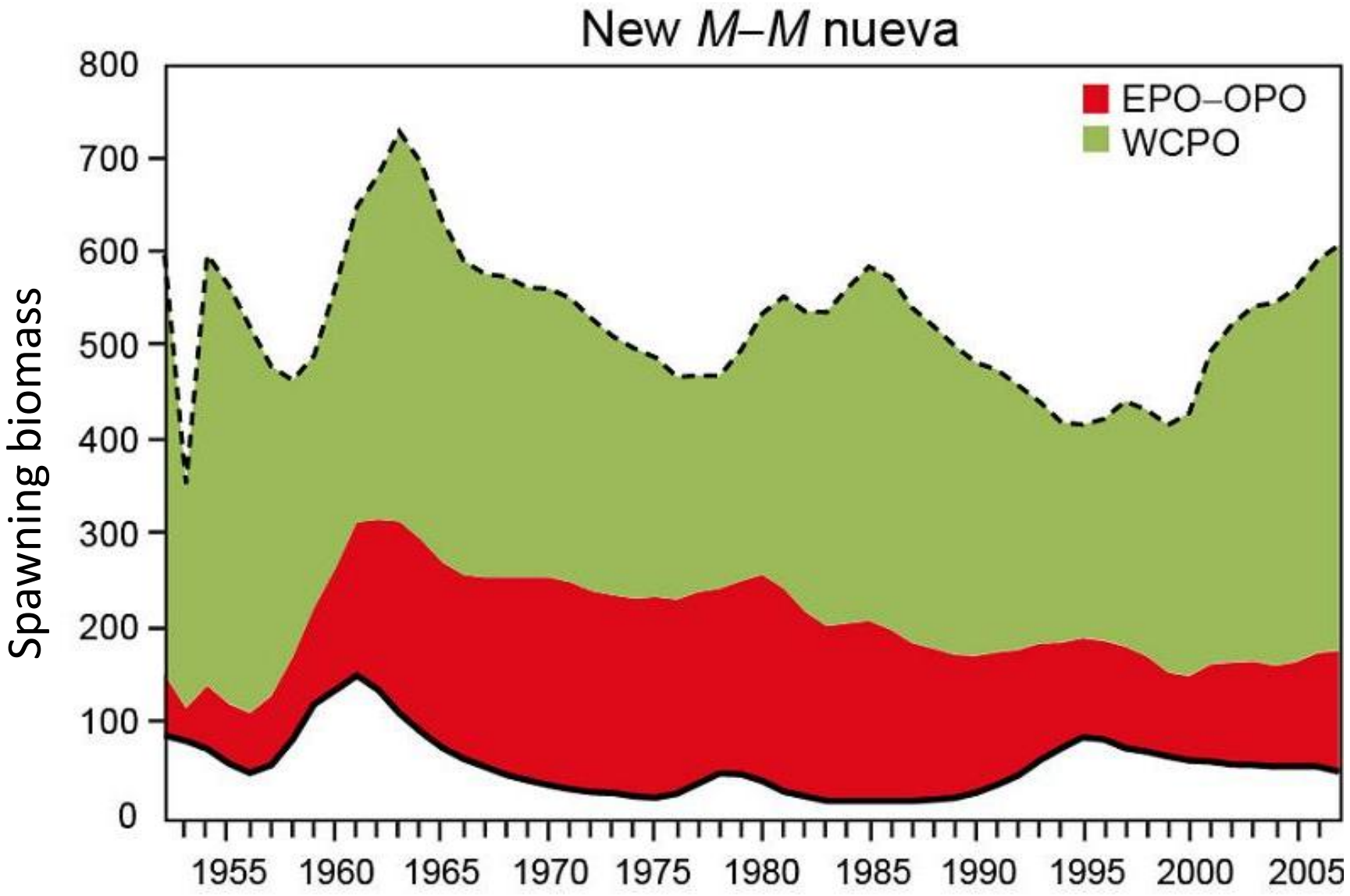
- Reference points based on historic levels of biomass, fishing mortality, or catch
- Historic catch limits are problematic because they do not take into consideration the current biomass compared to the biomass levels when the historic catch occurred.
- Historic biomass limits are problematic because biomass can vary independently of fishing and biomass is not a management quantity that can be managed directly.
- Fishing mortality is problematic because biomass levels are a function of multiple years of fishing mortality and the ages at which fish are caught, and these can change over time.

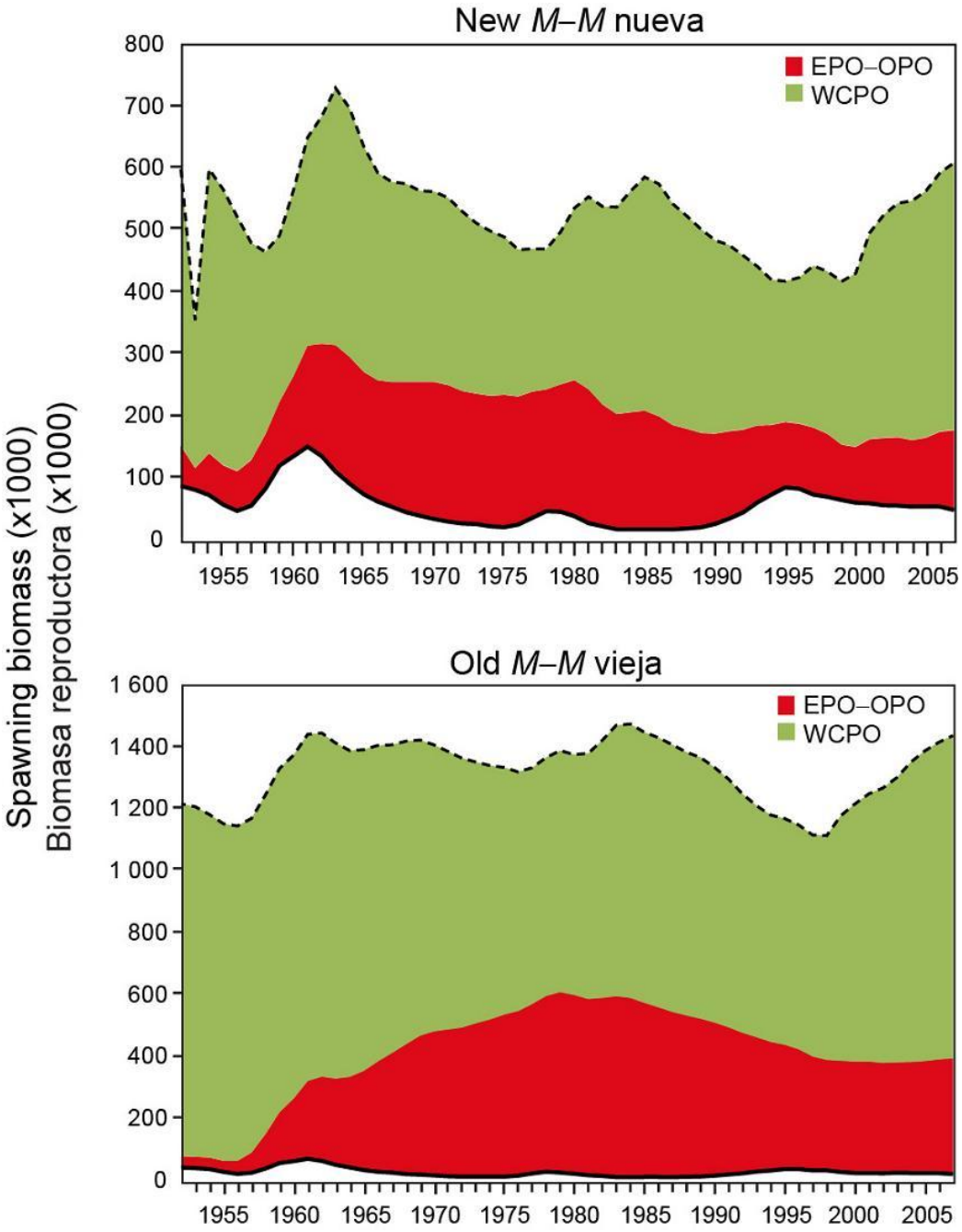
Our approach: fishery impact

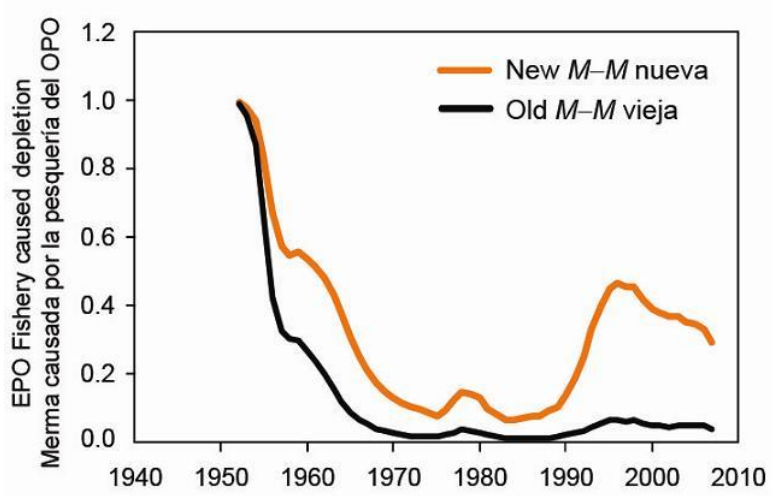
- Integrates multiple years of fishing mortality
- Takes the age structure of the fishing mortality into consideration
- Can be applied to individual or groups of fisheries
- Use the stock assessment model developed by the ISC

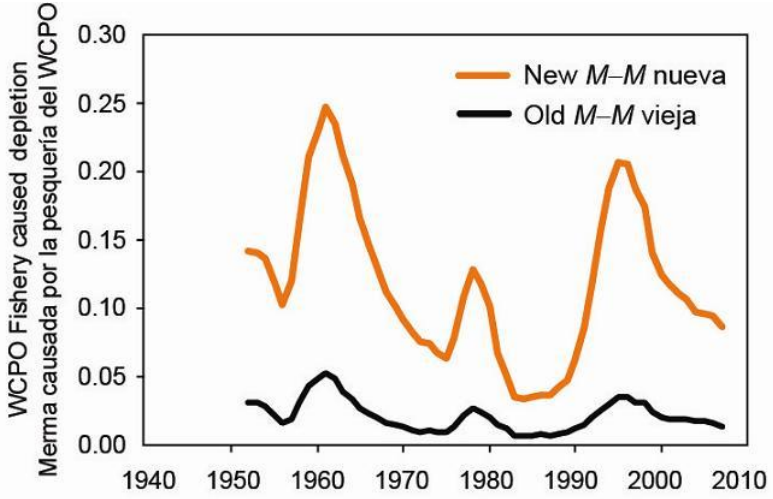
Fishery impact algorithm

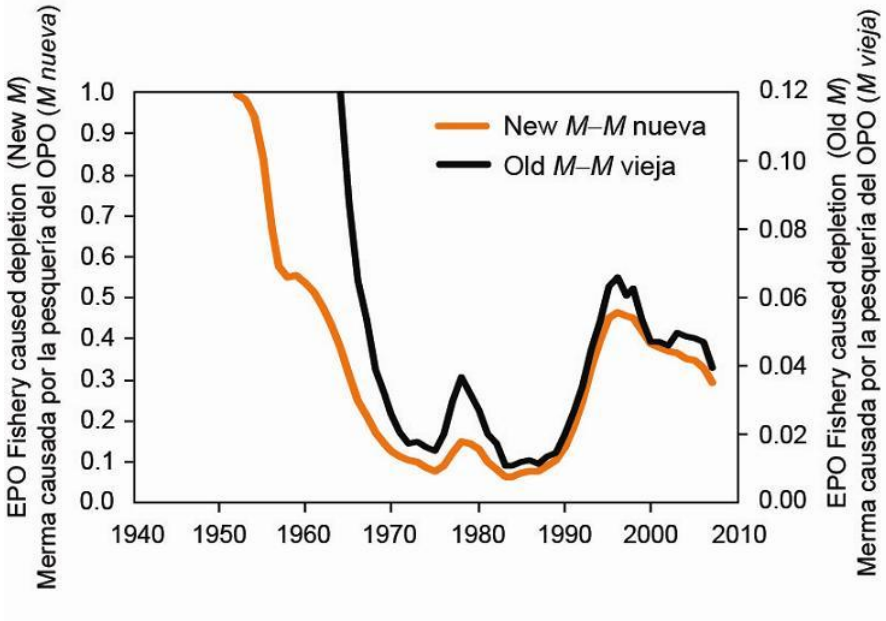
1. Set the catch for all fisheries and the initial exploitation rate parameters to zero. Simulate the dynamics from the estimated model parameters to estimate the dynamic unexploited stock size ($S_{0,t}$).
2. Calculate the difference between the estimated spawning biomass (S_t) and $S_{0,t}$ to estimate the impact of all fisheries combined.
3. Set the catch for a given fishery (or group of fisheries) and the initial exploitation rate parameters for that fishery group to zero. Simulate the dynamics from the estimated model parameters to estimate the unexploited stock size in the absence of that fishery group.
4. Repeat Step 3 for each fishery group. The sum of the fishery impacts for the fishery groups will not equal the impact for all fisheries combined that was estimated in Step 2. Assign the impact from all fisheries combined (Step 2) to each fishery group by using the ratios of the impacts estimated in Step 3.

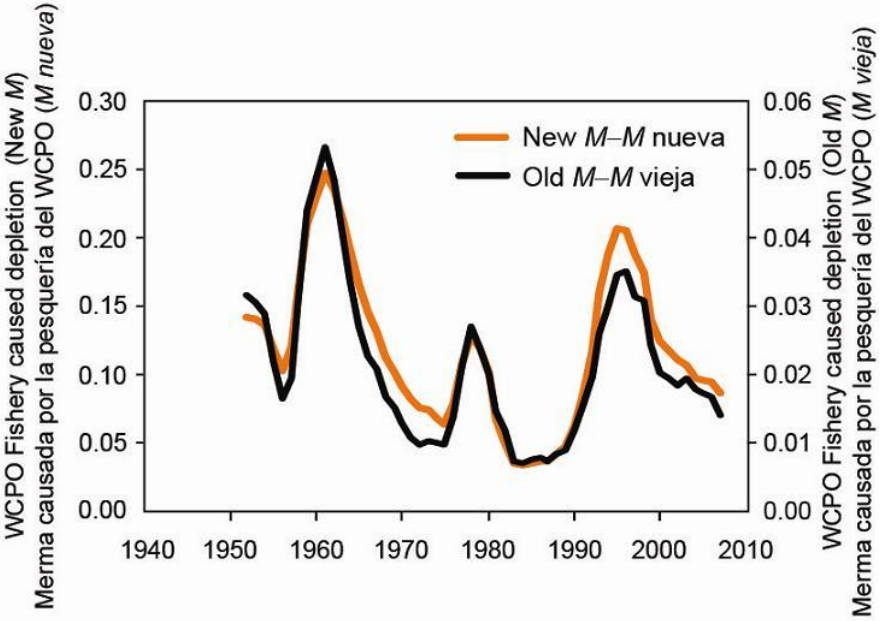

New M–M nueva
EPO–OPO
WCPO
Spawning biomass
800
700
600
500
400
300
200
100
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005


New M–M nueva
EPO–OPO
WCPO
800
700
600
500
400
300
200
100
0
1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
Spawning biomass (x1000)
Biomasa reproductora (x1000)
Old M–M vieja
EPO–OPO
WCPO
1 600
1 400
1 200
1 000
800
600
400
200
0
1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005

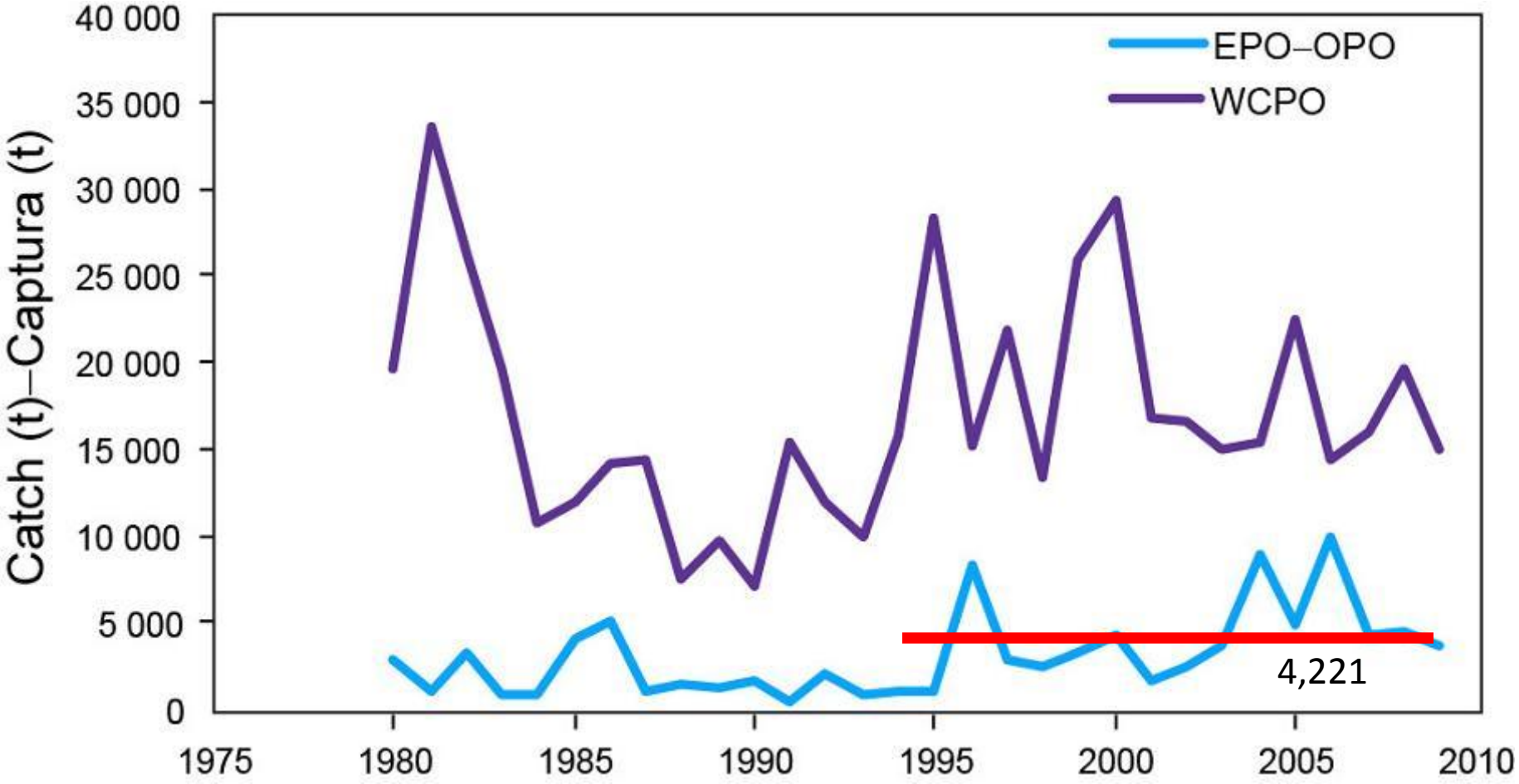

EPO Fishery caused depletion
Merma causada por la pesquería del OPO
New M–M nueva
Old M–M vieja
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1940
1950
1960
1970
1980
1990
2000
2010


WCPO Fishery caused depletion
Merma causada por la pesquería del WCPO
New M–M nueva
Old M–M vieja
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1940
1950
1960
1970
1980
1990
2000
2010


EPO Fishery caused depletion (New M)
Merma causada por la pesquería del OPO (M nueva)
EPO Fishery caused depletion (Old M)
Merma causada por la pesquería del OPO (M vieja)
New M–M nueva
Old M–M vieja
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1940
1950
1960
1970
1980
1990
2000
2010


WCPO Fishery caused depletion (New M)
Merma causada por la pesquería del WCPO (M nueva)
WCPO Fishery caused depletion (Old M)
Merma causada por la pesquería del WCPO (M vieja)
New M–M nueva
Old M–M vieja
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1940
1950
1960
1970
1980
1990
2000
2010

Catch


Catch (t)–Captura (t)
40 000
35 000
30 000
25 000
20 000
15 000
10 000
5 000
0
1975
1980
1985
1990
1995
2000
2005
2010
EPO–OPO
WCPO
4,221

Acknowledgments

- The stock assessment model developed by the ISC was used for the analysis