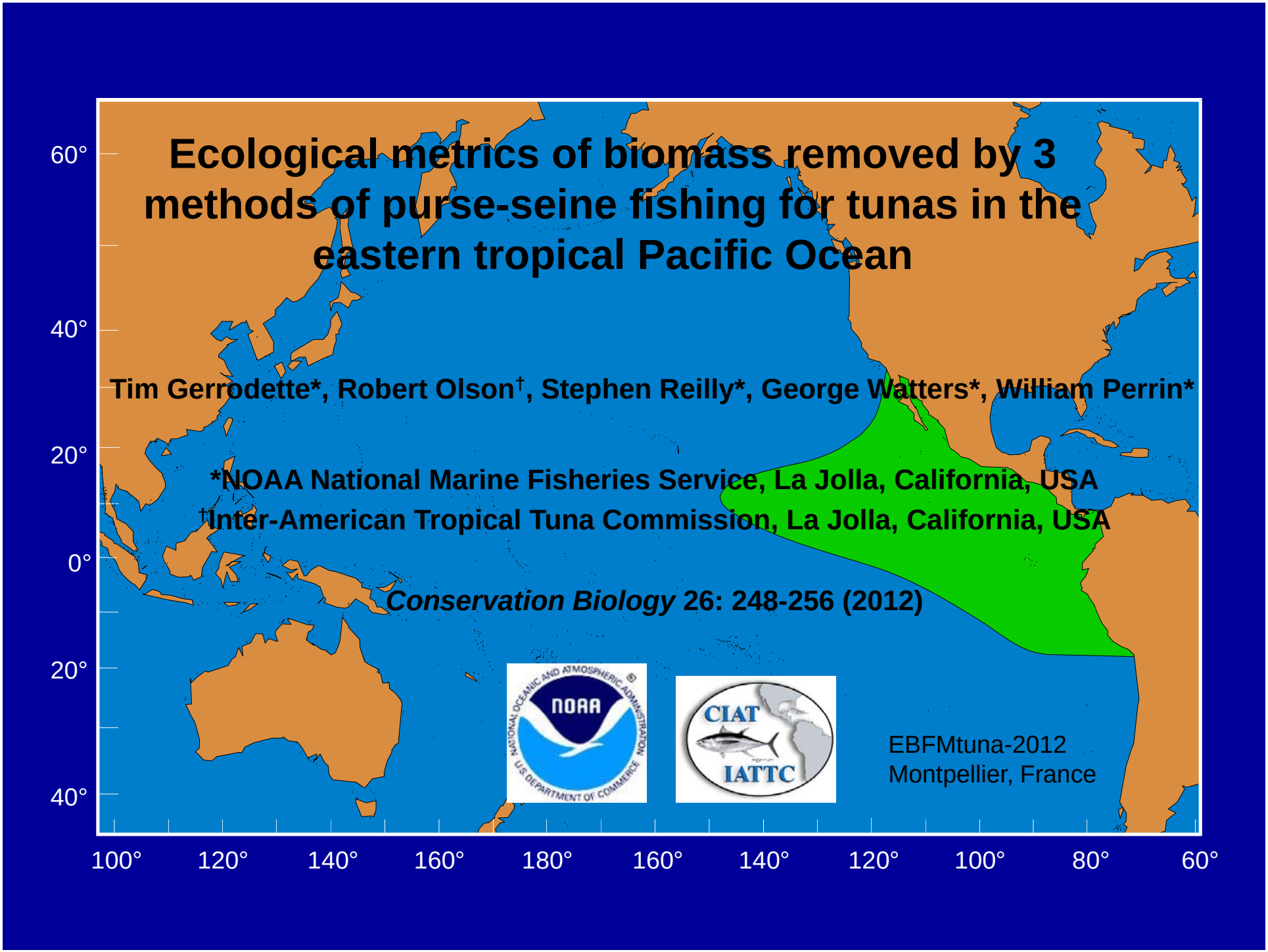

Ecological metrics of biomass removed by 3 methods of purse-seine fishing for tunas in the eastern tropical Pacific Ocean

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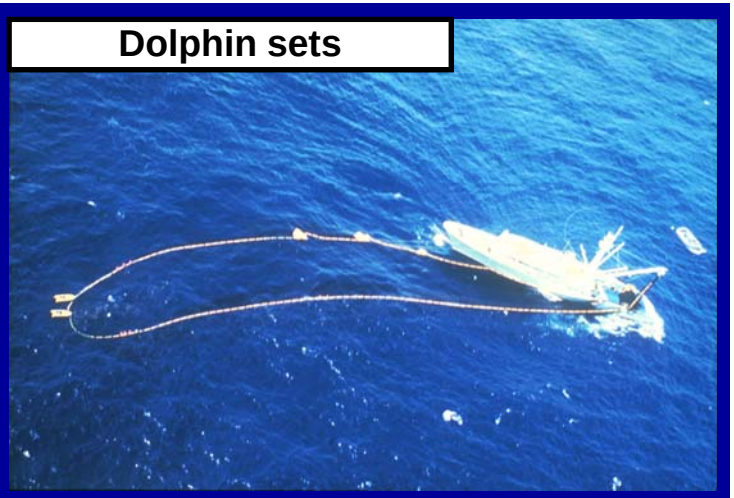
***Conservation Biology* 26: 248-256 (2012)**

EBFMtuna-2012
Montpellier, France

3 methods of purse-seine fishing for tunas in the eastern tropical Pacific Ocean

- Dolphin sets
  - Landings: large yellowfin
  - Discards (low): small yellowfin, dolphins
- Floating-object sets
  - Landings: bigeye, skipjack and yellowfin
  - Discards (large): misc. fish, sharks, billfishes
- Unassociated sets
  - Landings: skipjack and yellowfin
  - Discards (medium): small target fish, sharks

Dolphin sets



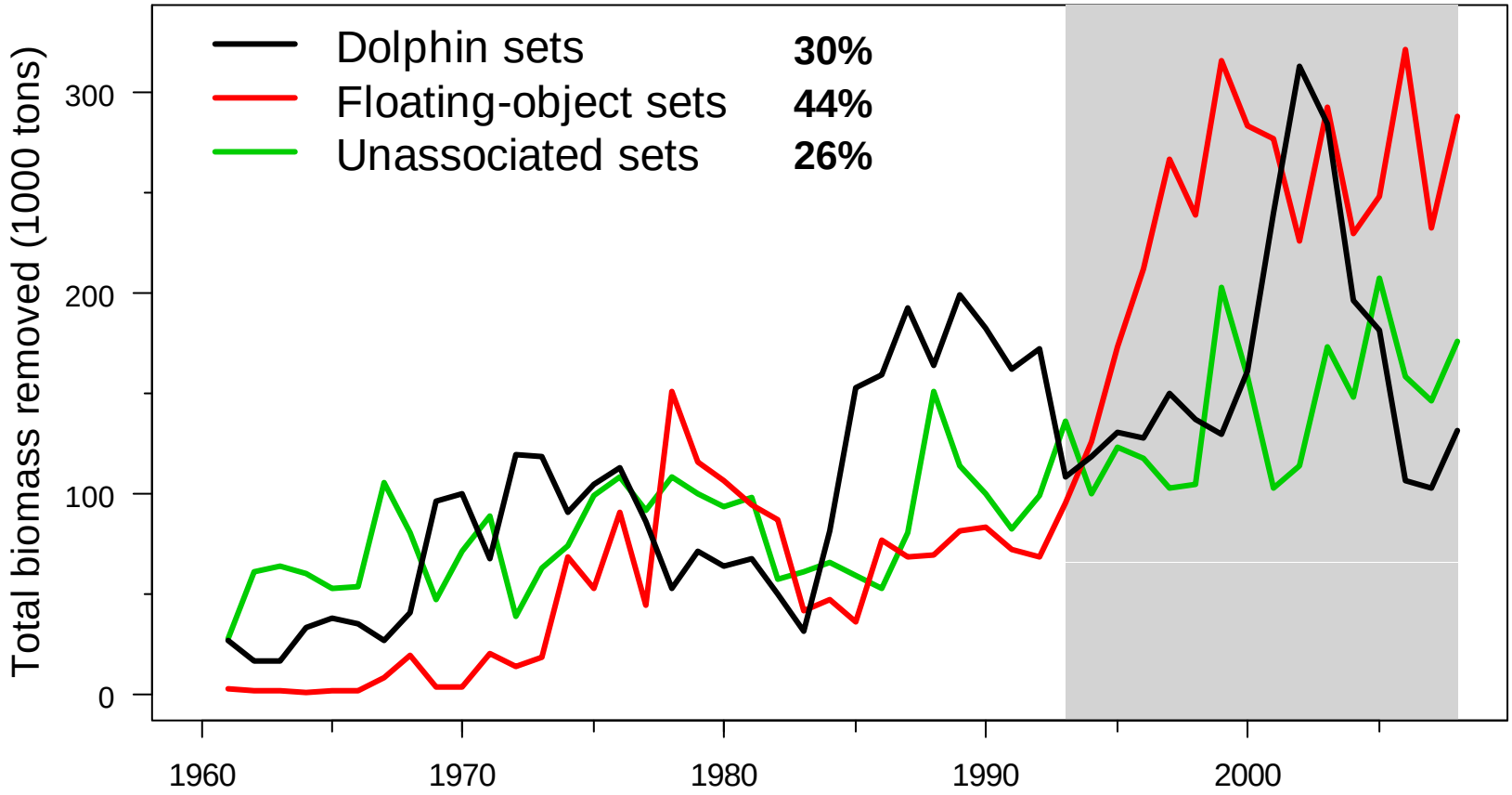
Floating- object sets

Unassociated sets

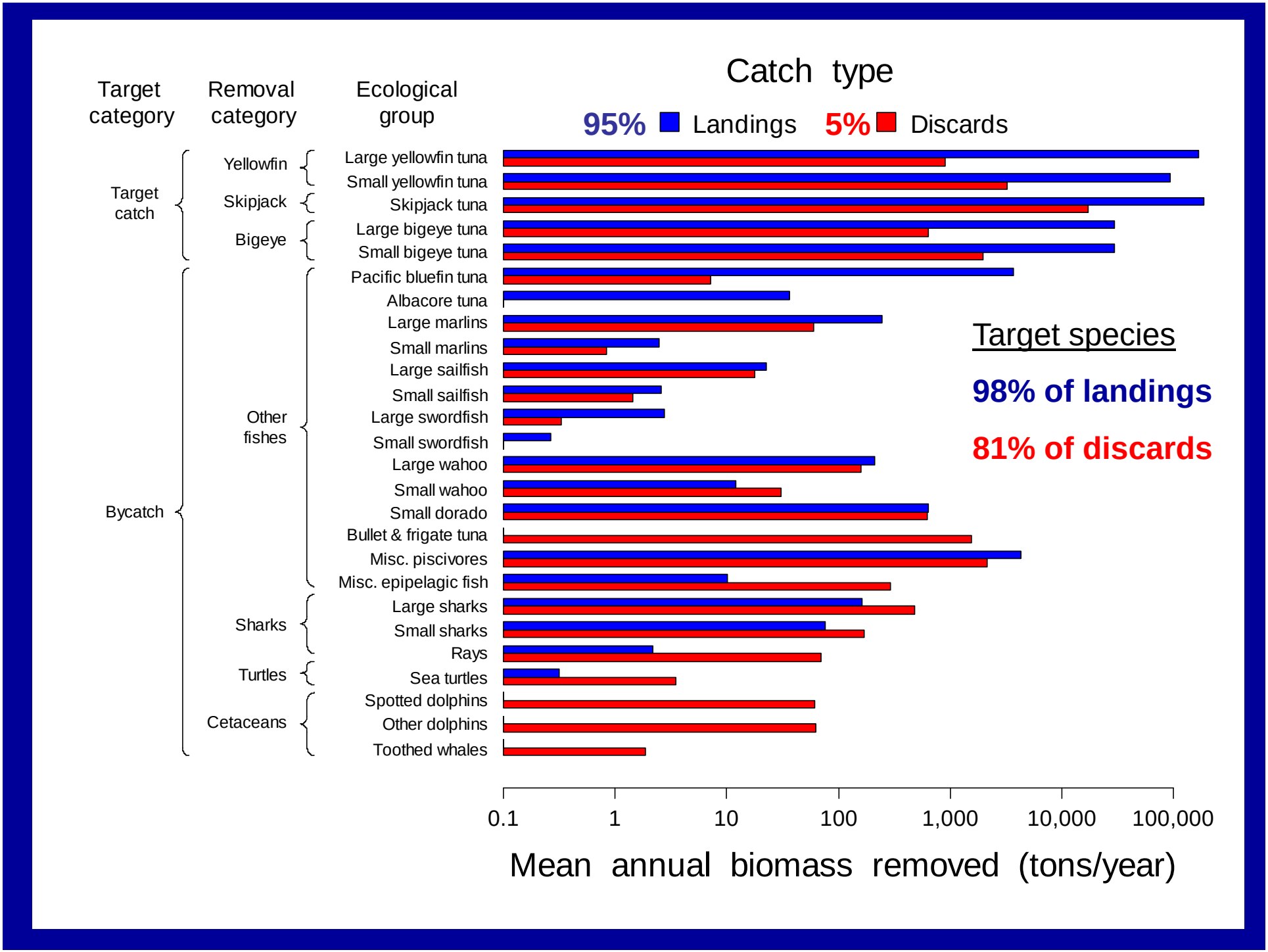
Ecosystem-based management

- Effects of fishery depend on total removals (landings + discards)
- Reduction of bycatch is a goal, but not the only goal
- Animals removed differ in size, life history, and ecological role
- Removals vary in type and amount, and can be measured as
  - Number
  - Weight
  - Trophic level (1+ weighted average TLs of prey)
  - Replacement time (= inverse of *P/B*)
  - Diversity (Shannon = $-\sum_i p_i \ln p_i$)
- Trophic levels and *P/B* ratios from model of Olson & Watters (2003)

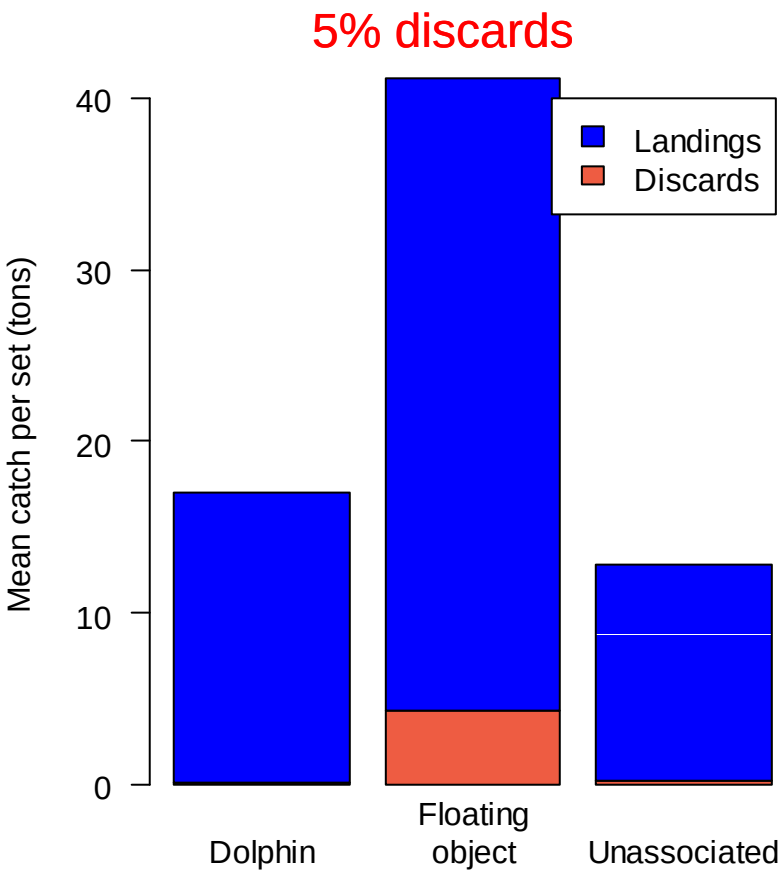
TOTAL ANNUAL BIOMASS REMOVALS
eastern tropical Pacific

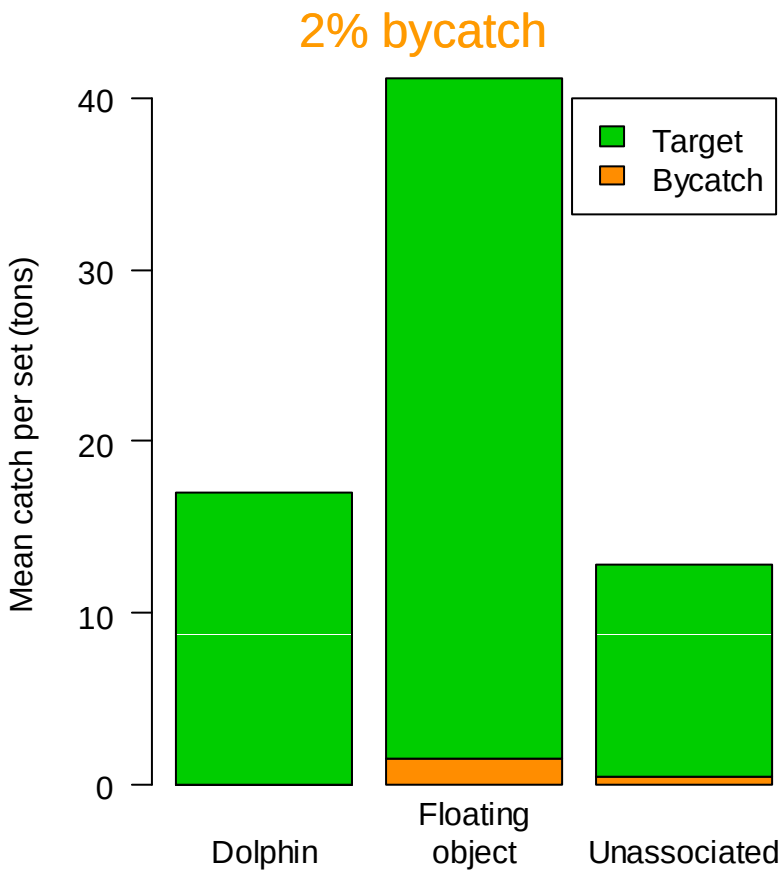


Data from ~94% of trips during 1993-2008

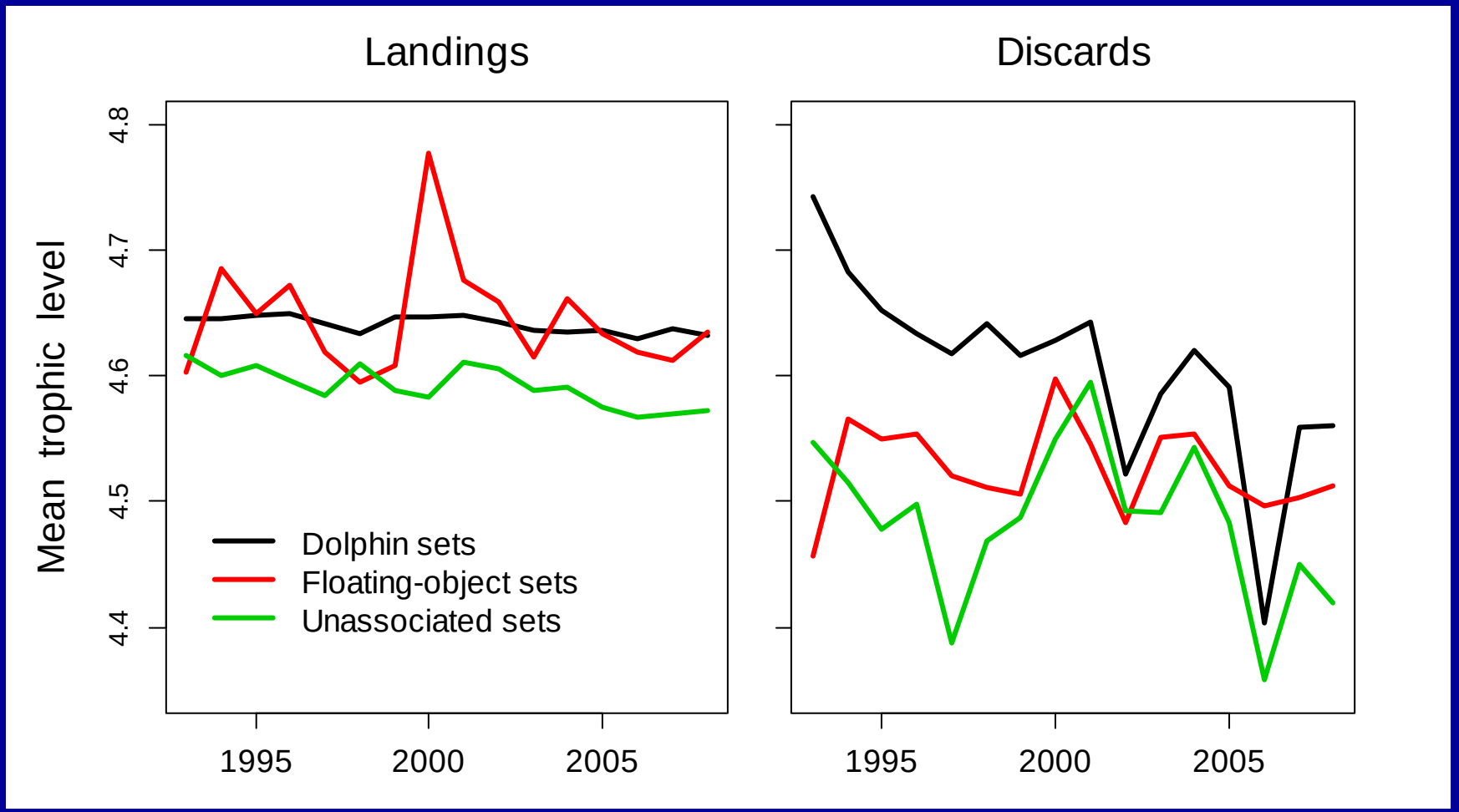

Target category
Removal category
Ecological group
Catch type
95% Landings
5% Discards
Target catch
Yellowfin
Large yellowfin tuna
Small yellowfin tuna
Skipjack
Skipjack tuna
Bigeye
Large bigeye tuna
Small bigeye tuna
Bycatch
Other fishes
Pacific bluefin tuna
Albacore tuna
Large marlins
Small marlins
Large sailfish
Small sailfish
Large swordfish
Small swordfish
Large wahoo
Small wahoo
Small dorado
Bullet & frigate tuna
Misc. piscivores
Misc. epipelagic fish
Sharks
Large sharks
Small sharks
Rays
Turtles
Sea turtles
Cetaceans
Spotted dolphins
Other dolphins
Toothed whales
Target species
98% of landings
81% of discards
0.1
1
10
100
1,000
10,000
100,000
Mean annual biomass removed (tons/year)

MEAN TOTAL REMOVALS PER SET

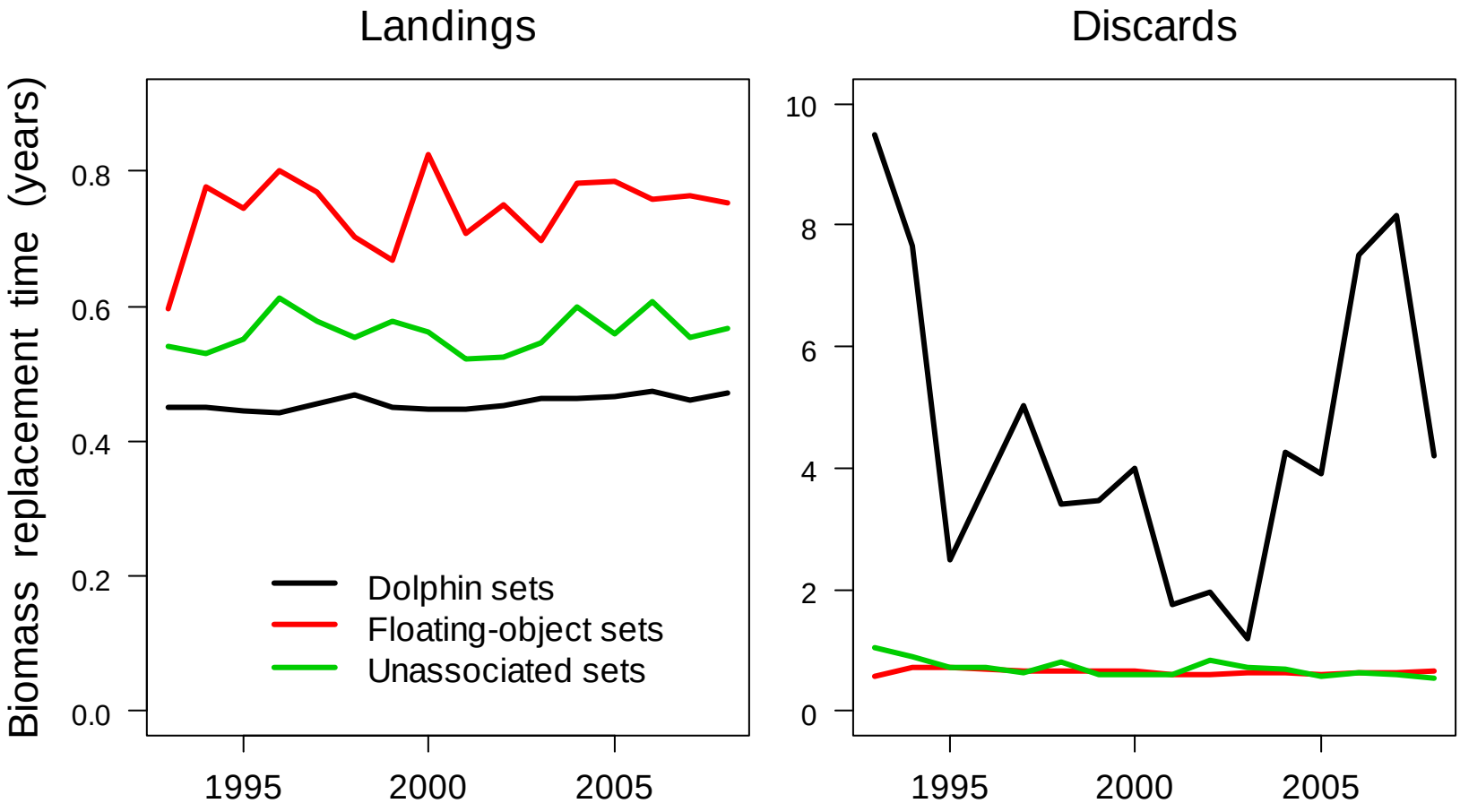




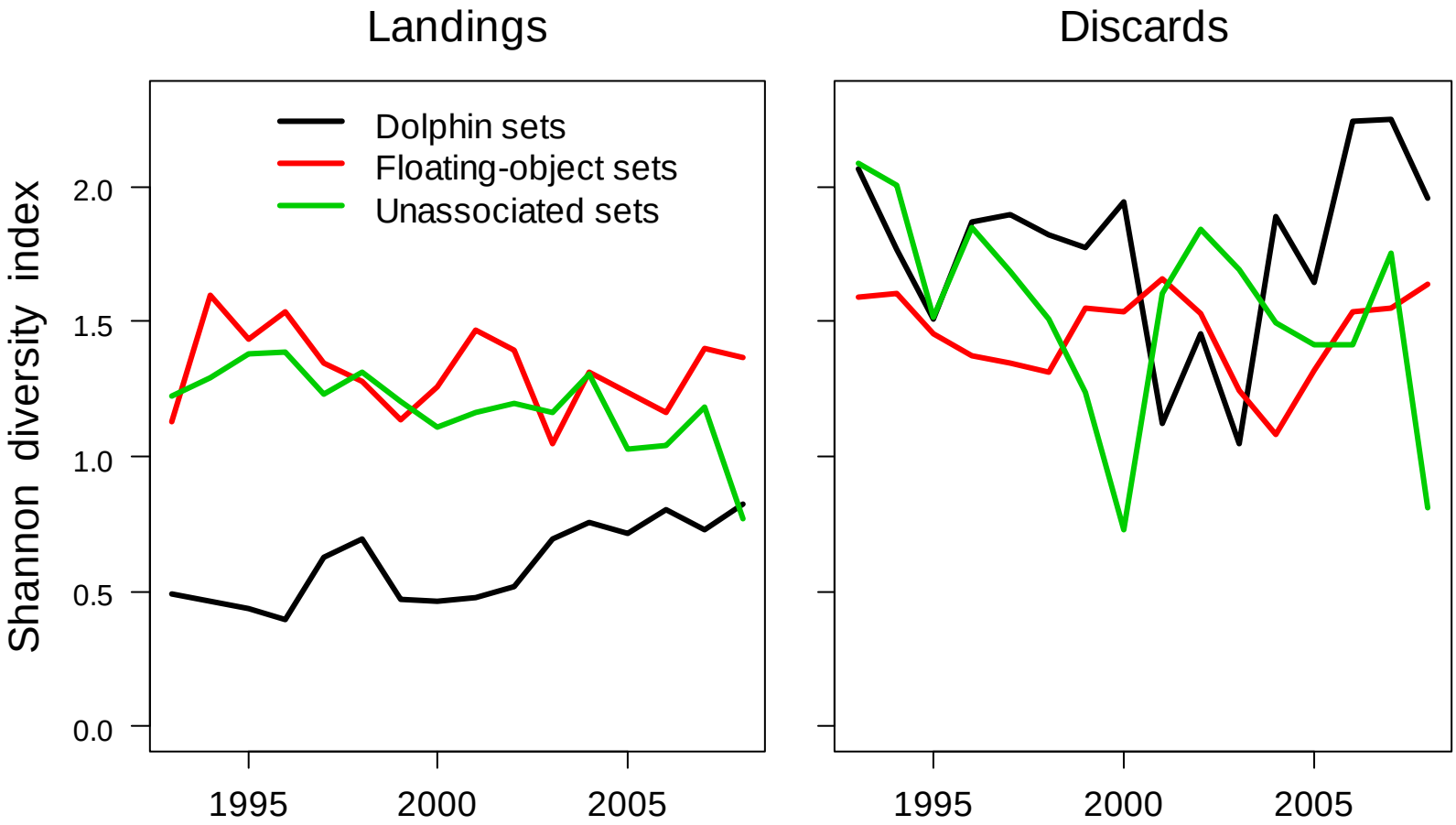
TROPHIC LEVEL



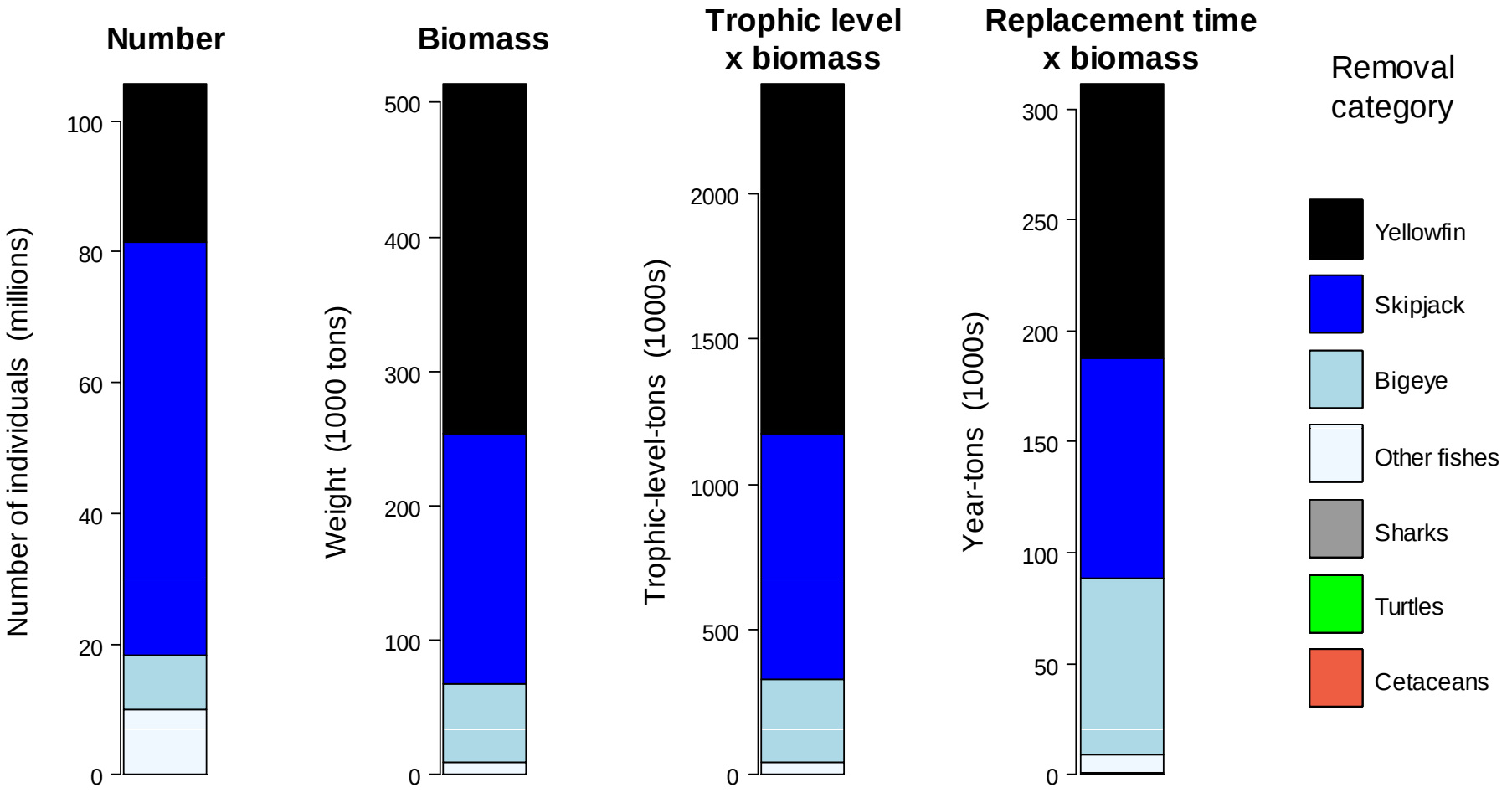
BIOMASS REPLACEMENT TIME



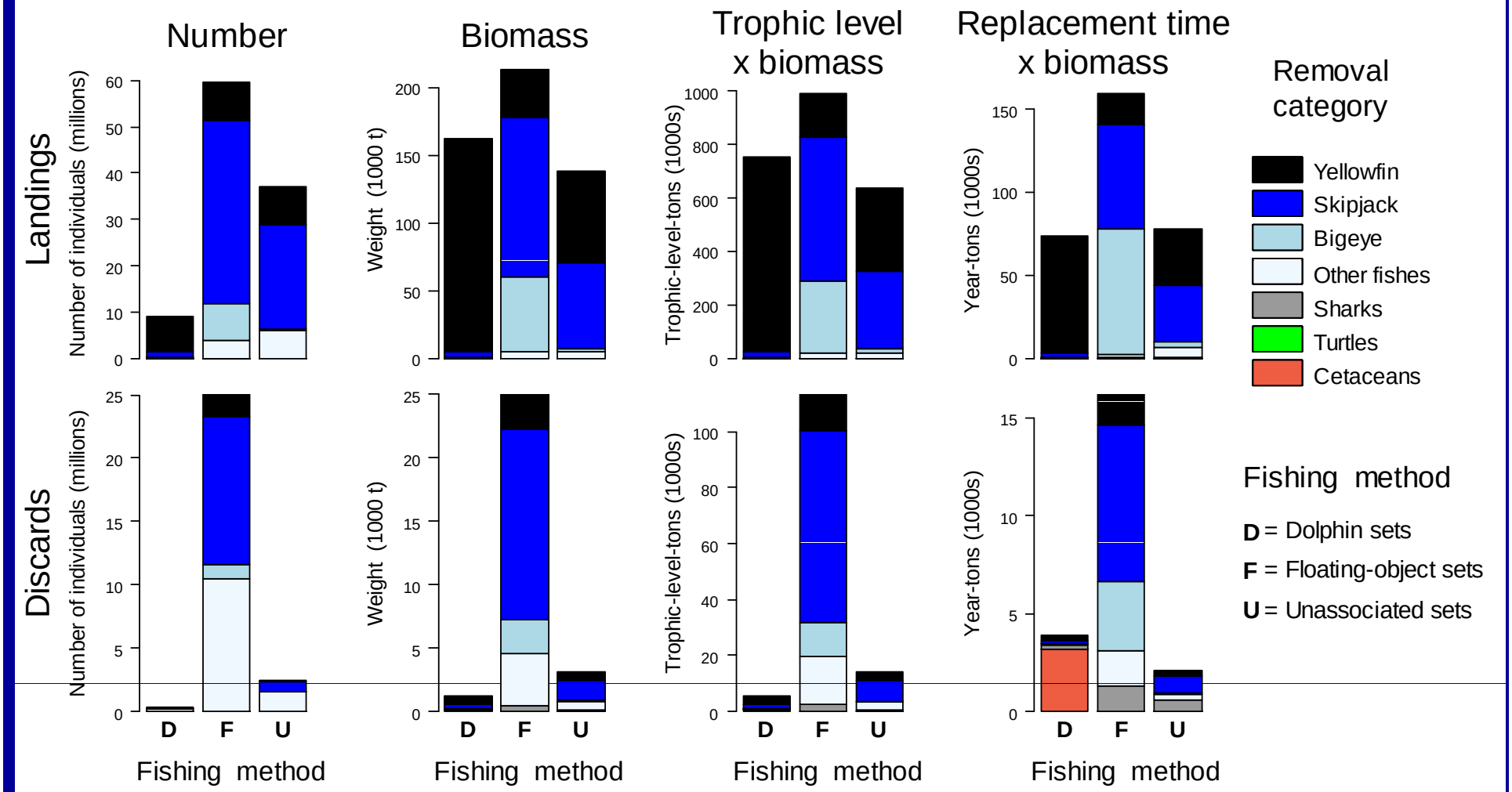
DIVERSITY


Landings
Discards
Dolphin sets
Floating-object sets
Unassociated sets
Shannon diversity index
2.0
1.5
1.0
0.5
0.0
1995
2000
2005
1995
2000
2005

4 METRICS OF TOTAL AMOUNT OF REMOVALS

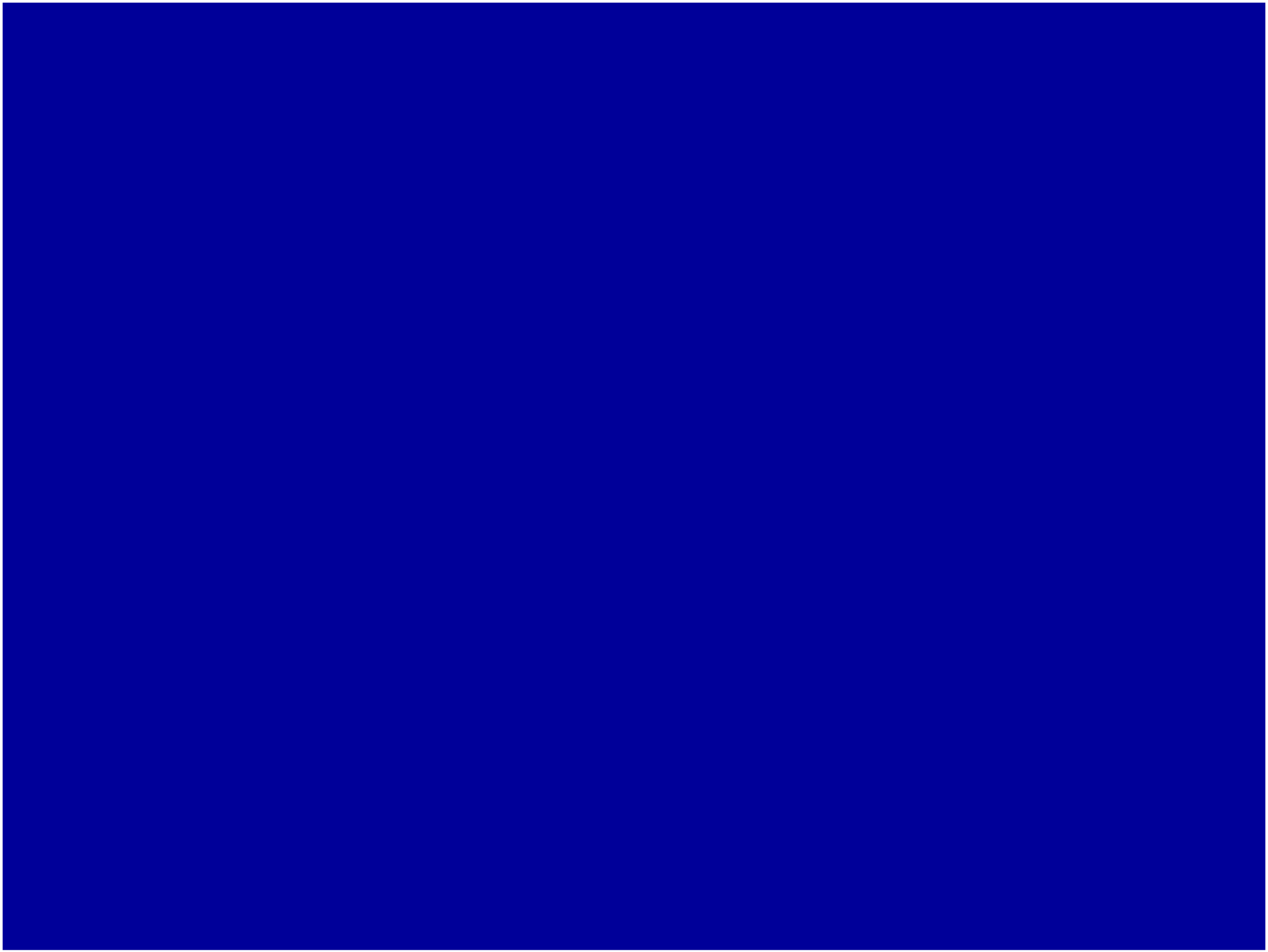


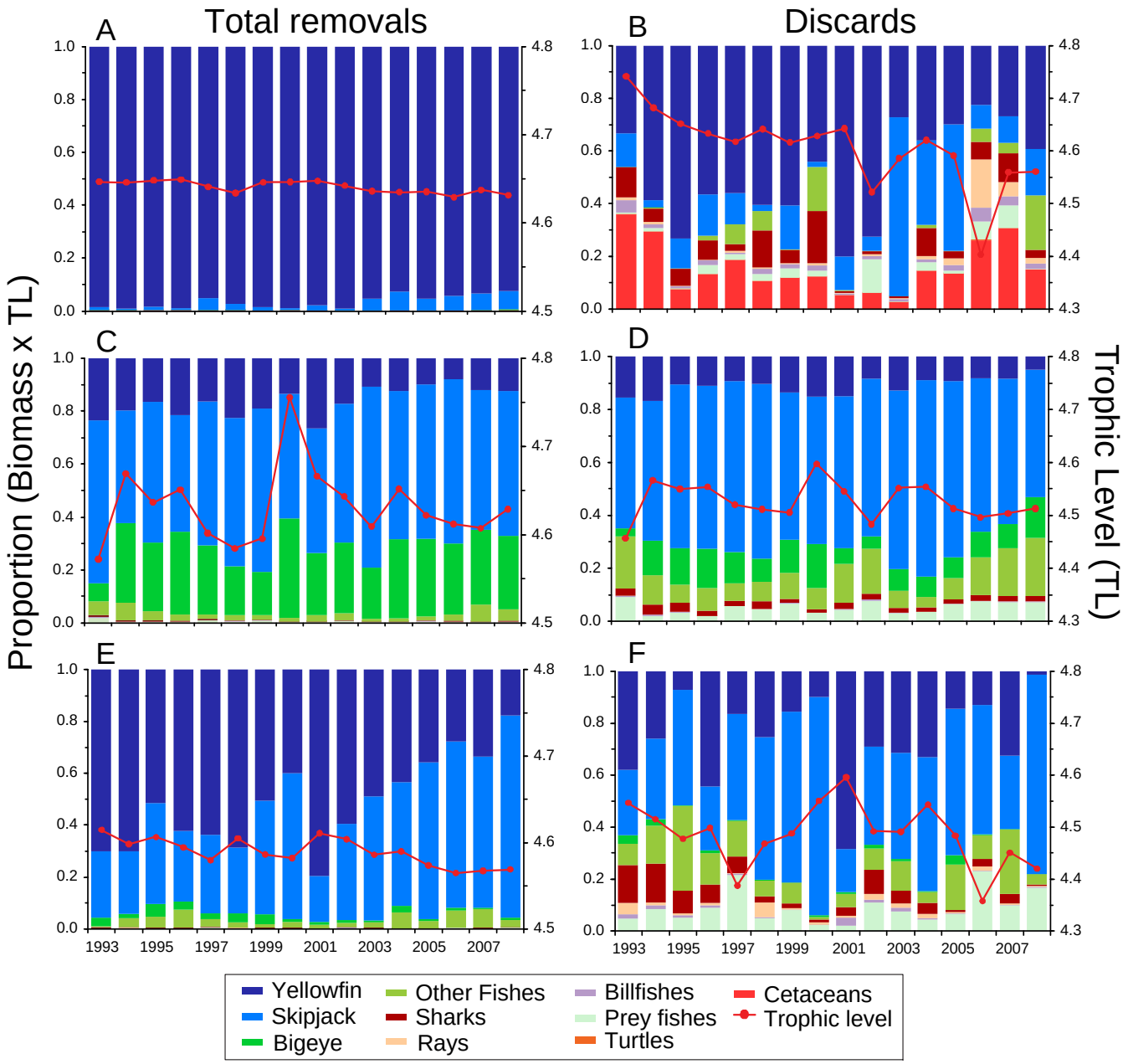
4 METRICS OF TOTAL AMOUNT OF REMOVALS

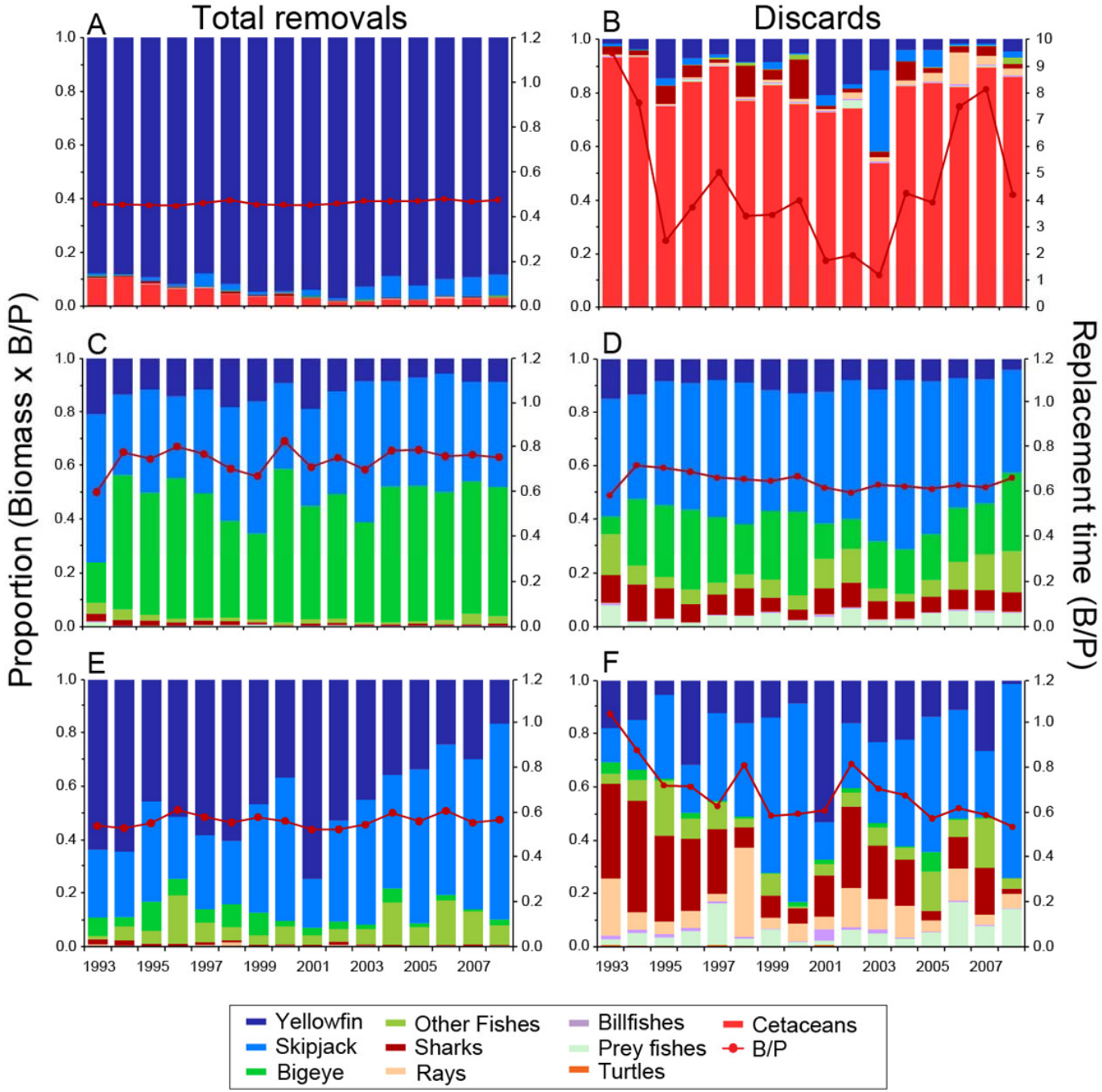


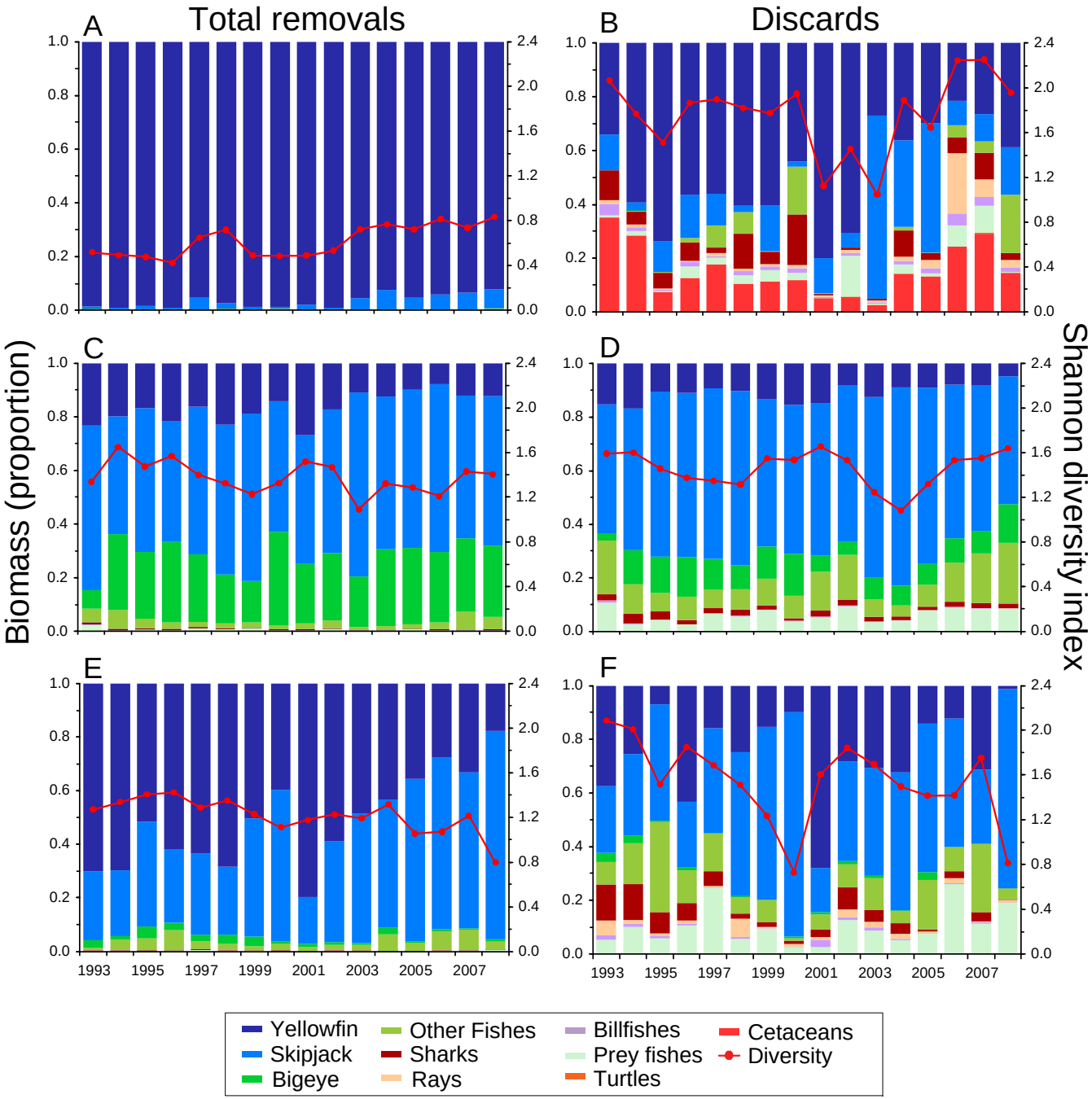
Concluding remarks

- EBFM takes account of total removals by fishery: landings + discards
- EBFM needs ecologically informative metrics
- Dolphin, floating-object and unassociated methods of fishing have different ecological consequences.
- Effects on individual populations may still be necessary for conservation reasons (*e.g.*, dolphins, sharks, bigeye tuna).
- EBFM is about what remains, not what is removed.




A
Total removals
B
Discards
C
D
E
F
Proportion (Biomass x TL)
Trophic Level (TL)
1.0
0.8
0.6
0.4
0.2
0.0
4.8
4.7
4.6
4.5
4.4
4.3
1993
1995
1997
1999
2001
2003
2005
2007
Yellowfin
Skipjack
Bigeye
Other Fishes
Sharks
Rays
Billfishes
Prey fishes
Turtles
Cetaceans
Trophic level


A
Total removals
B
Discards
C
D
E
F
Proportion (Biomass x B/P)
Replacement time (B/P)
1993
1995
1997
1999
2001
2003
2005
2007
Yellowfin
Skipjack
Bigeye
Other Fishes
Sharks
Rays
Billfishes
Prey fishes
Turtles
Cetaceans
B/P


A
Total removals
B
Discards
C
D
E
F
Biomass (proportion)
Shannon diversity index
1.0
0.8
0.6
0.4
0.2
0.0
2.4
2.0
1.6
1.2
0.8
0.4
0.0
1993
1995
1997
1999
2001
2003
2005
2007
Yellowfin
Skipjack
Bigeye
Other Fishes
Sharks
Rays
Billfishes
Prey fishes
Turtles
Cetaceans
Diversity

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