



IndiSeas1

Ecological indicators

Selection criteria (SCOR/WG 119, Rice & Rochet 2005)

- Theoretical basis/ecological significance: indicators should reflect well-defined ecological processes occurring under fishing pressure
- Sensitivity: trends in the indicator must be highly correlated to trends in fishing pressure
- Measurability: indicators must be measurable on a routine basis, and data series must be available
- Awareness of the general public: meaning of the indicator and its link with fishing must be intuitively understood

Evaluation of indicators

Indicator	Ecological significance	Sensitivity	Measurability	Public awareness	Management objective ^a
Size-based indicators (Link, 2005; Rochet and Rice, 2005; Shin <i>et al.</i> , 2005)					
Mean length/weight in community	x	x	x	x	EF
Maximum length in community	x	x		x	
Mean maximum length in community	x	x		x	
Slope of size spectrum	x	x			
Slope of diversity size spectrum	x				
Proportion of large fish	x	x		x	
Proportion of large species	x	x	x	x	CB
Trophodynamic indicators (Cury <i>et al.</i> , 2005; Fulton <i>et al.</i> , 2005; Link, 2005; Pauly <i>et al.</i> , 2000)					
TL landings	x	x	x	x	EF
TL community	x	x	x	x	EF
Fishing-in-Balance index	x	x			
Proportion of predatory fish	x	x	x	x	CB
Pelagic to demersal fish biomass ratio	x	x	x		
Piscivorous to zooplanktivorous fish biomass ratio	x	x	x		
Species-based indicators (Degnbol and Jarre, 2004; Fulton <i>et al.</i> , 2004; Link, 2005; Rochet and Rice, 2005; Yemane <i>et al.</i> , 2005)					
Species richness	x			x	
Shannon and Hill's index of diversity	x		x		
K-dominance, ABC curves, W-statistic	x	x	x		
Ratio of endangered to unendangered species	x	x		x	
Ratio of target to non-target species	x		x	x	
Proportion of sustainably or under-/moderately exploited stocks	x	x	x	x	CB
Mean lifespan	x	x	x	x	SR
Pressure indicators (Degnbol and Jarre, 2004; Fréon <i>et al.</i> , 2005; Fulton <i>et al.</i> , 2005)					
Overall fishing mortality rate	x	x	x	x	RP
Exploited fraction of ecosystem surface	x		x	x	
Mean distance of catches from the coast	x				
Catch rate by community	x	x			
Discard rate	x			x	
Biomass-related indicators (Blanchard and Boucher, 2001; Fulton <i>et al.</i> , 2005; Link, 2005; Rochet <i>et al.</i> , 2005)					
Total community biomass	x	x	x	x	RP
Coefficient of variation in biomass	x	x	x	x	SR

Final selection of indicators

Indicators	Headline label	Used for <u>S</u> or <u>T</u>	Management objective^a
Mean length	Fish size	S, T	EF
TL of landings	TL	S, T	EF
Proportion of under- and moderately exploited stocks	% healthy stocks	S	CB
Proportion of predatory fish	% predators	S, T	CB
Mean lifespan	Lifespan	S, T	SR
1/CV of total biomass	Biomass stability	S	SR
Total biomass of surveyed species	Biomass	T	RP
1/(landings/biomass)	Inverse fishing pressure	T	RP

^aCB, conservation of biodiversity; SR, maintaining ecosystem stability and resistance to perturbation; EF, maintaining ecosystem structure and functioning; RP, maintaining resource potential.

Mean length

$$\bar{L} = \sum_i L_i / N \text{ (cm)}$$

Data:

- scientific surveys
- individual size measures
- all surveyed species
- time series of size measures

TL landings

$$\overline{TL}_{\text{land}} = \sum_s (TL_s Y_s) / Y$$

Data:

- landings per species
- fixed TL estimate per species (Ecopath, diet data, Fishbase)
- all retained species
- time series of landings

Proportion of under- and moderately exploited stocks

$$\frac{\text{Number (under- + moderately exploited stocks)}}{\text{total number of stocks considered}}$$

Method:

- listing the stocks referenced by FAO in the area of concern
www.fao.org/docrep/009/y5852e/Y5852E10.htm#tbl
- cutting this FAO list according to what is effectively retained in the ecosystem
- adding expert knowledge to refine the FAO classification of stock status and fill the gaps

Proportion of predatory fish

biomass of predatory fish surveyed/biomass surveyed

Biomass surveyed = biomass (demersal fish + pelagic fish + commercially important invertebrates)

Data:

- scientific surveys
- biomass index per species
- all surveyed species
- time series of species biomass

Mean lifespan

$$\sum_S (\text{age}_{\text{max},s} B_S) / \sum_S B_S \text{ (years)}$$

Data:

- scientific surveys
- biomass index per species
- all surveyed species
- estimate of age max per species
- time series of species biomass

1/CV of total biomass

$$\frac{\text{Mean}(\text{total biomass for the past 10 years})}{\text{s.d.}(\text{total biomass for the past 10 years})}$$

Data:

- scientific surveys
- all surveyed species
- time series of biomass > 10 years

Total biomass of surveyed species

$B(t)$

Data:

- scientific surveys
- all surveyed species
- time series of biomass

1/(landings/biomass)

B/Y retained species

Data:

- scientific surveys
- landings
- all retained species
- time series of biomass and landings

Definition of species categories

Surveyed species

These are species sampled by researchers during routine surveys (as opposed to species sampled in catches by fishing vessels), and should include species of demersal and pelagic fish (bony and cartilaginous, small and large), as well as commercially important invertebrates (squids, crabs, shrimps...). Intertidal and subtidal crustaceans and molluscs such as abalones and mussels, mammalian and avian top predators, and turtles, should be excluded. Surveyed species are those that are considered by default in the calculation of all survey-based indicators.

Retained species (landed)

These are species caught in fishing operations, although not necessarily targeted by a fishery (i.e. include by-catch species), and which are retained because they are of commercial interest, i.e. not discarded once caught, although this does not imply that sometimes certain size classes of that species may be discarded. A non-retained species is considered to be one that would never be retained for consumptive purposes. Intertidal and subtidal crustaceans and molluscs such as abalones and mussels are to be excluded. Retained species are those that are considered by default in the calculation of all catch-based indicators.

Predatory fish species

Predatory fish are considered to be all surveyed fish species that are not largely planktivorous (i.e. phytoplankton and zooplankton feeders should be excluded). A fish species is classified as predatory if it is piscivorous, or if it feeds on invertebrates that are larger than the macrozooplankton category (> 2cm). Detritivores should not be classified as predatory fish.