



EXAMPLES OF INDICATORS AND PERFORMANCE MEASURES FOR USE IN EAF

(Extracts from Fletcher et al., 2003; Garcia et al, 2003).

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TARGET and BYPRODUCT SPECIES

Table 1& 2 Analyses of the robustness and effectiveness of different types of indicators, performance measures and management responses to manage the abundance of target species (from Fletcher et al., 2003).

Summary of Finfish

	Tropical Snapper	Mid size Pelagics	Temperate Snapper	Tuna & Billfish	Sharks (Short lived)	Sharks (long lived)
Characteristic						
Vulnerability to Fishing	MOD-HIGH	MOD	MOD-HIGH	LOW-HIGH	MOD	HIGH
Performance Measures						
Biological Reference Pts						
Spawning Biomass Limit	30% (WA)	Unknown	30% -40% suggested	20%	30%	40%
Lowest Level reached				5% Southern Bluefin		
Max. Expl. Rate		35% for Sth Africa & Oman		~ 10% (Atlantic)		
Economic Reference Pts						
MSY/MEY	40% (WA)		40% Shark Bay			
INDICATORS (robustness)						
Catch	LOW-MOD	LOW-MOD	LOW	LOW	LOW - MOD	LOW
Catch Rate	MOD	LOW-MOD	LOW	LOW	MOD	LOW - MOD
Independent Survey	HIGH	N/A	MOD-HIGH	LOW-MOD	MOD	MOD
Age/Size Models	MOD-HIGH	MOD	HIGH	MOD	MOD - HIGH	MOD - HIGH
Probability of Future	MOD-HIGH	-	-	HIGH	MOD	MOD
Recruit. Surveys	LOW-HIGH	N/A	LOW	LOW	NA	NA

Management Responses (EFFECTIVENESS OF TOOLS)						
Size Limits	LOW-MOD	MOD - HIGH	MOD-HIGH	MOD	LOW	LOW
Reproductive	MOD	N/A	LOW	N/A	N/a	N/a
Closures	MOD HIGH	LOW	MOD	NEG	LOW	LOW
Effort	MOD-HIGH	MOD	LOW-MOD	LOW-MOD	MOD	MOD
Output	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD	MOD

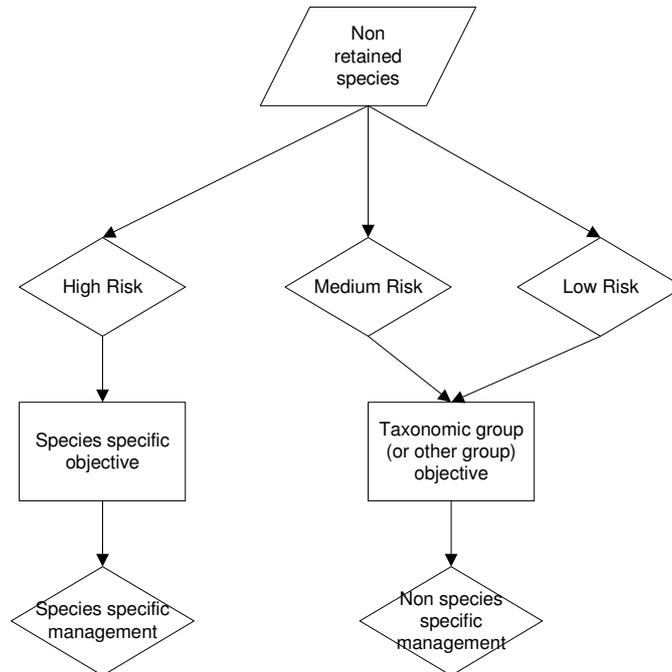
Summary of Invertebrates

Attribute	ROCK LOBSTER	ABALONE	CRABS (DEEP)	CRABS (Shallow)	PRAWNS
Vulnerability to Fishing	MOD – LOW	HIGH	MOD	LOW-MOD	LOW-MOD
BIOLOGICAL REFERENCE POINTS					
Spawning Biomass Limits	10-22% B ₀ Tas & WRL	Blacklip 40 –42% B _{unfished} egg production (Tas, NSW) 90% of 1992 B _{mature} (Vic)	40% B ₀ (VIC), 50% B ₀ (WA)	??	20-25% B ₀ Brown Tiger Prawns (WA and NPF)
Lowest Level Reached	<10% (Tas) 15% (WRL)				15%
Max. Expl. Rate	60% (WRL)			70% (NT Mud Crab)	
ECONOMIC REFERENCE POINTS					
MSY/MEY	MSY/MEY used for WRL	110% of B _{msy} (Vic)	MSY (TAS – giant crab)	MSY (mud & spanner crabs in Qld)	MSY (used for a number of fisheries)

Attribute	ROCK LOBSTER	ABALONE	CRABS (DEEP)	CRABS (Shallow)	PRAWNS
INDICATORS OF ABUNDANCE (Robustness)					
Catch	LOW-MOD	LOW	LOW	LOW	LOW-MOD
Catch Rate	MOD	LOW-MOD	MOD	MOD	LOW-MOD
Independent Survey	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD-HIGH
Current Stock Size (Models)	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD-HIGH	MOD-HIGH
Probability of meeting "target"	MOD-V HIGH	MOD - HIGH	MOD-HIGH	MOD-HIGH	MOD- V HIGH
Mean Size		MOD		MOD	
Recruit. Surveys	LOW-HIGH	MOD	MOD		LOW-MOD
MANAGEMENT RESPONSES (Effectiveness of tools)					
Size Limits	MOD-HIGH	MOD	MOD-HIGH	MOD-HIGH	LOW
Reproductive	MOD	N/A	MOD	MOD	LOW
Closures	LOW	LOW-MOD	LOW-MOD	LOW-MOD	MOD-HIGH
Effort	MOD-HIGH	LOW	LOW-MOD	MOD	MOD
Output	MOD-HIGH	MOD	MOD	MOD-HIGH	

BYCATCH (Discarded) SPECIES

Species of particular concern for whatever reason should be dealt with on an individual species or stock basis. The remaining species should be grouped or dealt with as individual stocks using a risk assessment approach as illustrated below.



Indicators

If the objective relates to a single species or a group of species then the indicator may need to be a direct measure of the levels of capture of these species.

Depending upon the species, the area of operation by the fishery compared to the area inhabited by the non-retained species may be a possibility to measure performance, with a justification that adequate refuge areas are available.

If the objective only relates to reducing a wastage problem or other perception issue, then processed based indicators relating to the percentage adoption of Bycatch Reduction Devices (BRDs), or some other fishing equipment based modification may be appropriate. These indicators are, however, unlikely to be appropriate in situations where the issue was related to specific concerns about one or more of the non-retained species.

Performance Measures

In general, precise performance measures for these objectives have not been developed so far. The most common form of limit/trigger used in the examples seen to date relate to using historical levels as the benchmark with some reduction on these levels used to gauge future performance. For example in some fisheries acceptable performance requires the amount of bycatch to be reduced to 40 per cent of current levels within five years.

Where there is specific concern about the stock status of a non-retained species, it is likely that a direct measure of their catch will be required and some threshold level of acceptable catch would need to be determined. This will be especially likely where 'icon' or highly threatened species are involved and would probably involve the use of observers.

ECOSYSTEM

Ecosystem Structure

Indicators

The type of indicators appropriate for these ecosystem issues includes:

Process/Pressure Indicators

- area trawled;
- effort levels;
- biomass reduction; and
- relative levels of biomass removed.

Direct Indicators

- Monitoring area of habitat; and
- Monitoring the community.

The latter group of indicators are only likely to be required if the impact of the activity is likely to be major and/or the fishery operates over a relatively wide area of the habitat (see Table 10). Precisely what can be measured beyond process/pressure-based indicators is not clear in most cases, except for the possibility to choose one or more 'indicator' species to measure overall performance.

The selection of these species would need to be justified. It is possible that the use of some multi-species analysis could be used, but this has not yet been seen in the completed studies to date.

Performance Measures

Trophic Interactions/Biodiversity

Whilst much has been written in general about the need to maintain the ecosystem and have ecosystem-based management, there are few quantitative studies available upon which to base sensible performance measures for management. This is most notable in trophic level interactions, where studies in this area show that interactions of this kind are usually non-linear and vary greatly amongst systems and species within a system. Thus, there is no precise 'state' that an ecosystem should be at, as natural systems vary (particularly the individual components) even without any human 'assistance'.

Of note is that there are very few examples of strong trophic interactions leading to major changes in function (see Jennings & Kaiser, 1998 for review)¹. Moreover, there are no examples of a fishery impacting indirectly on other trophic levels where the *initial* stocks targeted by the fishery are still in good shape.

¹ Jennings & Kaiser (1998) *Adv. Mar. Sci.* 34:203-352

The decision tree that could be used to assist in whether there is a high likelihood of interactions includes:

- Is there a single apical or keystone predator?
- Is there a keystone grazer in the system?
- Is there evidence or even a reasonable suspicion that strong interactions may be occurring in this system?
- Are there only one or two species within the affected trophic levels?

If all the answers to the above questions are “no”, then it *may* be possible to argue that the mere maintenance of reasonable levels of the harvested species should be sufficient to maintain general ecosystem function.

If the answer to one or more of these is “yes”, then there may be a need to directly monitor other elements of the ecosystem. Further, the level of reduction in target stocks may need to be set with this in mind – particularly with respect to minimising the risk of stock collapse.

SOCIAL and ECONOMIC Issues

Objectives – ‘Preferred Outcomes’

The decision to directly get involved in setting specific objectives for social and economic elements will vary amongst different countries. This is usually a reflection that most community level objectives are set by the government and fisheries agencies may only play one part of the achievement of adequate performance. So in many cases it may be that the operational objectives are better described as preferred outcomes.

Table 2 Possible Socio-economic objectives, indicators and data requirements (modified from Fletcher et al., 2003, Fletcher, 2010).

Component	Objective	Indicator(performance measures)	Data requirements
Effects of fishery on industry participants <ul style="list-style-type: none"> ▪ Economic 	Maintain or increase income to fishers	Change in level of poverty of fishers Value of production Economic return – Value minus costs Number of fishers going broke Number of new vessels being purchased Licence value (if limited entry)	Catch Beach Value Costs of fishing Bankruptcies – forced sale of licences Boat sales Licence values
<ul style="list-style-type: none"> ▪ Employment 	Maximise local employment in fishery	% of locals in the fishery	Employment figures for fishers and total
<ul style="list-style-type: none"> ▪ Food 	Ensure level of catch meets food requirements of sector	Estimate of subsistence catch Catch per participant Catch per community member	Estimate of Catch Number of participants

Component	Objective	Indicator(performance measures)	Data requirements
		Changes in the nutritional status of community	Number of people in community Health levels of community
<ul style="list-style-type: none"> ▪ Social ▪ Health 	Minimise death and accidents rate for fishers	No greater than national average for work-related injuries	Injury data from relevant government authority or community
<ul style="list-style-type: none"> ▪ Lifestyle benefits and costs 	Maintain or improve lifestyle for fishers	Change in the number of fisher complaints Change in the level of social problems associated with fishers	Submitted Complaints Community welfare records Police statistics
<ul style="list-style-type: none"> ▪ 	Crew separation	Number of complaints by wives of husbands being away too long	Wives coming to agency
Allocation	Acceptable levels of allocation of access among fishers and among sectors	Number of fights among different sectors, or between individuals of the one fishery Number of agreed allocation outcomes	Recorded conflicts Complaints received Police actions Records of meetings
Effects of fishery on communities <ul style="list-style-type: none"> ▪ Economic 	Maintain or increase jobs, profits and flow-on benefits to the community	Direct and flow-on contributions to the region Gross Value of product (beach price * quantity) Number of people employed in associated industries Multiply GVP by flow on multiplier (often use x 4)	Regional input-output analysis done periodically (e.g. 10 years) GVP Census data Estimate of flow on impacts
<ul style="list-style-type: none"> ▪ Social ▪ Social capital 	Maintain or increase the contribution the fishery makes to social capital at the local scale	Relative level of social problems in fishing based communities	Interaction of fishers, their families and people in closely-related industries (e.g. boat building) in local social fabric.
<ul style="list-style-type: none"> ▪ Employment 	Maintain or increase regional/local employment in the fishery and related	Employment in the harvesting and processing sectors, and flow-on employment in other industries	Employment numbers

Component	Objective	Indicator(performance measures)	Data requirements
	industries		
▪ Regional industry	Maintain or improve local/regional attitudes to the fishery	Positive and negative feelings to the fishery Number of complaints to agency/Minister/media	Attitudinal surveys done occasionally. Ad hoc media comments
Effects of fishery on national economic wellbeing	Maintain or increase the contribution of the fishery to the national economy	Net economic return for the fishery. (Achieving MEY)	Economic survey data gathered periodically (e.g. 5 years)
Import replacement	Maintain or increase the proportion of domestically-harvested fish consumed	Consumption per capita of local seafood. To achieve at least an average consumption level of locally-harvested seafood.	Consumption surveys Population census
Social ▪ Health benefits/risks seafood eaten	Improve human health/nutrition by increasing fish consumption	Consumption per capita of local seafood	Consumption surveys
▪ Seafood quality	Ensure seafood meets food safety requirements	Food safety reports	Food safety reports

Examples of economic criteria and indicators (Garcia et al, 2003)

Criteria	Example of Indicator	Structure	Reference Point
Harvest	· landing · by-catch	· by species; age groups · by area · by fishery sub-sector	· MSY · historical level · policy target level
Harvest capacity	· GT (decked vessels) · No of boats (undecked ves.) · total effort (see below)	· by fleet type · by fishery segment · age composition of vessels · fishing mortality/species	· capacity or effort of MSY · policy target level
Harvest value (in constant prices)	· total deflated value (landed price)	· by species groups · by sub-sector & fishery	· Selected historical level
Subsidies	· Tax rebates · Grants	· by sub-sector · by fleets/fishery	· historical level · zero level · target level
Contrib. to GDP ¹¹	· Fisheries GDP/Nat. GDP	· by species groups	· historical level
Exports	· Export/Harvest value	· by species groups · by fishery segment	· historical level
Investments	· Market or replacement value · Depreciation · Fleet age composition	· by fleet type · by fishery	· historical level
Employment	· Total employment	· sub-sector · fleet/fishery	· historical level (?) · realistic policy target
Net returns	· (profit + rent) · net return/ investment · value of entitlements	· by sub-sector · by fishery	· historical level · MEY
Effort (mainly at fishery level)	· No of vessels; Fishing time · Amount of gear used · Employment	· By fishery segment · In physical or monetary terms	

Commission of the European Community (2002). STECF's needs for socio-economic indicators. Fourteenth Report Brussels, 22-26 April 2002. Annex II Comprehensive socio-economic indicators by MS and by fleet segment

Table 1. National level indicators

Indicator	Explanation	Input Data Need
CONSUMPTION		
Weight Apparent Consumption	Gross consumption of fishing products per inhabitant expressed as weight of consumed fish per inhabitant	1. Harvest Production weight 2. Aquaculture Production weight 3. Import weight 4. Export weight 5. Population
Value Apparent Consumption	Gross consumption of fishing products per inhabitant expressed as expense per inhabitant	6. Harvest Production value 7. Aquaculture Production value 8. Import value 9. Export value 5. Population
TRADE		
Fish Commercial Balance	Whether exports or imports of fishing products are higher	8. Import value 9. Export value
Fish Coverage Rate	Rate of apparent consumption covered by the national production.	6. Harvest Production value 7. Aquaculture Production value 8. Import value 9. Export value
Extraversion Rate	What extent the fishing sector of a country depends upon foreign trade, both for imports and exports.	6. Harvest Production value 7. Aquaculture Production value 8. Import value 9. Export value
SOCIAL		
Ratio Fish Employment	Ratio of employment created directly by the fishing industry	10. Total Employment 11. Fish Employment
MACROECONOMIC		
Fish Contribution to the GNP	The importance of fishing production in the Gross National Product.	6. Harvest Production value 7. Aquaculture Production value 12. Gross Domestic Product
Ratio Harvesting Value	The importance of fishing in comparison to aquaculture in terms of income.	6. Harvest Production value 7. Aquaculture Production value
Ratio Harvesting Weight	The importance of fishing in comparison to aquaculture in terms of production weight.	1. Harvest Production weight 2. Aquaculture Production weight

Table 2. National level indicators by fleet segments

Indicator	Explanation	Input Data Need by Segment
PHYSICAL PRODUCTIVITY		
Vessel Physical Productivity	the average production of each vessel in terms of weight of landings.	- Weight per vessel
Capacity Physical Productivity	the average production in terms of weight of landings for each capacity unit (GT) of the vessels.	- Weight per vessel - GT per vessel
Power Physical Productivity	the average production in terms of weight of landings for each power unit (HP) of the vessels.	- Weight per vessel - HP per vessel
Per vessel fishing time	the average production in terms	- Weight per vessel

Physical Productivity	of weight of landings for each full fishing time. Is possible select the unit of fishing time (hour or day)	- Time fishing per vessel
Man Physical Productivity	the average production in terms of weight of landings for each man employed.	- Weight per vessel - Employment per vessel
PRODUCTIVITY		
Vessel Productivity	the average production in terms of market value in the first sale for each vessel.	- Value per vessel
Capacity Productivity	the average production in terms of market value in the first sale for each capacity unit installed (GT) in the vessels.	- Value per vessel - GT per vessel
Power Productivity	the average production in terms of market value in the first sale for each power unit (HP) of the vessels.	- Weight per vessel - HP per vessel
Per Vessel Hour Productivity	the average production in terms of market value in the first sale for each fishing hour.	- Weight per vessel - Time fishing per vessel
Man Productivity	the average production in terms of value in the first sale for each man used.	- Weight per vessel - Employment per vessel
SOCIAL		
Employment per segment	indicates the employment in a specific segment of vessels	- Employment per vessel
Average Wage	indicates the average salary obtained by each man employed.	- Salary Cost - Employment per vessel
MARKET		
Landing Prices	(LP) represents the average market price of landings.	- Weight per vessel - Value per vessel
INVESTMENT		
Capital Employed	a measure of the value of Vessel, Licence, Quota, etc. would provide information of the relative position of the industry. Values above a discounted sum of the returns they could provide would be an indication of an unsustainable industry.	- Invested Capital
Capital Investments	% of change in capital employed over time - normally a year. It indicates the future expectations of the enterprises. Often difficult to measure empirically in other ways than using the capital employed at two different points in time and subtracting them from one another.	- bis. Invest Capital in the precedent periode
COST		
Income to employees	serves to identify the return from fishing to the suppliers of labour. It may be used to compare and to estimate the effect of fishing on national and local economies. The fishing	- Salary Cost

	industry has traditionally been identified with low incomes. This is liable to create a shortage of skilled labour where there are alternative employment opportunities.	
Opportunity Cost	the yields that the owner could obtain should he invest his money in National Debt instead of investing in his business. This means that the owner is relinquishing that potential income. There is a profit in its economic sense when the yields of the invested capital surpass the opportunity cost.	<ul style="list-style-type: none"> - Invested Capital - Rate national debt
PROFITS		
Gross Profit	indicates the total profits obtained by the whole of the vessel owners, once the operating costs have been deducted.	<ul style="list-style-type: none"> - Value per vessel - Salary Cost - Cost per fishing day - Time fishing per vessel - Yearly Fixed Costs - Financial cost - Indicator on Opportunity Cost
Net Profit	profitability - would provide a direct comparison with returns available elsewhere in the economy. the total earnings obtained by the whole of the owners, once the depreciation cost has been deducted.	<ul style="list-style-type: none"> - Depreciation - Indicator on Gross profit
Profit Rate	indicates the percent ratio of yearly net profits plus the opportunity cost in relation with the investment. It should be borne in mind that this figure does not include the additional earnings obtained by the owner as an employee in artisanal fisheries.	<ul style="list-style-type: none"> - Indicator on Gross profit - Indicator on Opportunity cost - Invested Capital
Gross Added Value	expresses the Added Value that the segment in question contributes to the National Economy. This includes: salaries, profits, opportunity cost and depreciations.	<ul style="list-style-type: none"> - Salary Cost - Depreciation - Indicator on Gross profit - Indicator on Opportunity Cost
Contribution to the margin	output minus variable costs is a short run indicator of the incentive for the enterprise to carry on. Given the problem of sunken capital in fisheries (capital written off in the books but still capable of producing output) this is an important indicator to assist in assessing whether schemes to reduce capacity will be effective. With low liabilities and low opportunity costs of labour and capital the incentive to carry on in the long run is determined by	<ul style="list-style-type: none"> - Value per vessel - Salary Cost - Cost per fishing day - Time fishing per vessel - Yearly Fixed Costs

	this indicator.	
Return on Capital	(net profit plus interest payments relative to capital employed) - provides a simple and direct comparison of the opportunity cost of capital.	- Indicator on Net Profit - Financial cost
MANAGEMENT		
Value of Fish stock size	measured in value - gives an indication of the use of the production factor that is not subject to price determination on a market. Will indicate as to whether the output of fish is a result of surplus harvesting or a result of production factor reduction.	- Biological data on biomass - Prices by species
Subsidies and taxes	provide information about the dependency of the industry on public support and about the GDP in factor prices.	- Data on subsidies per segment
Capacity utilization	calculation would require distinction between long run and short run, and knowledge about the state of the fish stocks as to whether they are overexploited or not. In the short run the measure disregards fish stock effects.	- Time fishing per vessel - Maximum number of sea day

Governance issues

Table 3: Governance indicators (modified from Fletcher et al., 2003, Fletcher, 2010).

GOVERNANCE			
Component	Objective	Indicator(performance measures)	Data requirements
▪ Legislation	Ensure legislation allows the development of effective regulations and management arrangements	Number of proposed management arrangements that cannot be undertaken because the legislation will not allow it	Examination of legislation
▪ Management Plan	Having an effective management plan that will deliver the objectives of the fishery	Number of essential management plan elements that are included	Examination of plan
▪ Management Effectiveness	Ensure that the management is effective	Licence fees Complaints from Minister, fishers, public etc Number of objectives where performance is considered acceptable	Data from licence transactions Examination of indicators and PMs
▪ Compliance	Acceptable level of compliance	Estimate of illegal catch Estimate of compliance with rules	Surveys Estimates Operations
▪ Monitoring	Effective monitoring program	Percentage of indicators that are being measured to an acceptable level	No of indicators being measured
▪ Reporting	Appropriate reporting	Stakeholder satisfied	Stakeholder survey
▪ Consultation	Effective consultation with stakeholders	Number of stakeholder meetings held Number of stakeholder contacted Level of complaints from stakeholders	Stakeholder survey Records of mail outs Complaints Minister

Examples of governance criteria and indicators from Garcia (2003)

Criteria	Indicators
Global	
Compliance	Incentives to comply with the global agreements

regime	The existence of outstanding disagreements
<i>Property rights</i>	Compatibility with sustainability goals Acceptance by major stakeholders
<i>Transparency and participation</i>	Participation in the global agreements Incentives for participation in global agreements Involvement of major stakeholders in making and applying rules of the game Effective communication between stakeholders Capacity to elicit, receive, and use information from all stakeholders
<i>Capacity to manage</i>	Existence of a global management regime
Regional	
Compliance regime	Incentives to comply with the regional agreement The existence of a compliance regime Effectiveness of the regime The existence of outstanding disagreements Integration of global rules
<i>Property rights</i>	Existence of well defined and recognized property rights Compatibility with sustainability goals Acceptance by major stakeholders
<i>Transparency and participation</i>	Participation in the regional agreement Incentives for participation in regional agreements Involvement of major stakeholders in making and applying rules of the game Effective communication between stakeholders Capacity to elicit, receive, and use information from all stakeholders
<i>Capacity to manage</i>	Existence of a regional body with competence to manage Terms of regional agreements implemented Degree to which the regional agreement meets sustainable development objectives Existence of an effective dispute resolution process Resources availability at all levels
National	
Compliance regime	The existence of a compliance regime Effectiveness of the regime The existence of outstanding disagreements Integration of global rules Compatibility between local and higher level enforcement
<i>Property rights</i>	Existence of well defined and recognized property rights Compatibility with sustainability goals Acceptance by major stakeholders Incentives for cooperative behaviour
<i>Transparency</i>	Involvement of major stakeholders in making and applying rules of the game Effective communication between stakeholders Capacity to elicit, receive, and use information from all stakeholders
<i>Capacity to manage</i>	Resources availability at all levels Compatibility between formal and informal governance structures Higher level authorities facilitating lower levels of management Co-management

Fishery	
Compliance regime	The existence of a compliance regime Effectiveness of the regime The existence of outstanding disagreements Integration of global rules Compatibility between local and higher level enforcement
<i>Property rights</i>	Existence of well defined and recognized property rights Compatibility with sustainability goals Acceptance by major stakeholders
<i>Transparency and participation</i>	The transparency of fisheries management Involvement of major stakeholders in making and applying rules of the game Effective communication between stakeholders Capacity to elicit, receive, and use information from all stakeholders
<i>Capacity to manage</i>	Resources availability at all levels Compatibility between formal and informal governance structures Higher level authorities facilitating lower levels of management Co-management
Local	
Compliance regime	The existence of a compliance regime Effectiveness of the regime The existence of outstanding disagreements Integration of global rules Compatibility between local and higher level enforcement
<i>Property rights</i>	Existence of well defined and recognized property rights Compatibility with sustainability goals Acceptance by major stakeholders
<i>Transparency and participation</i>	The transparency of fisheries management Involvement of major stakeholders in making and applying rules of the game Effective communication between stakeholders Capacity to elicit, receive, and use information from all stakeholders
<i>Capacity to manage</i>	Resources availability at all levels Compatibility between formal and informal governance structures Higher level authorities facilitating lower levels of management Community-based management