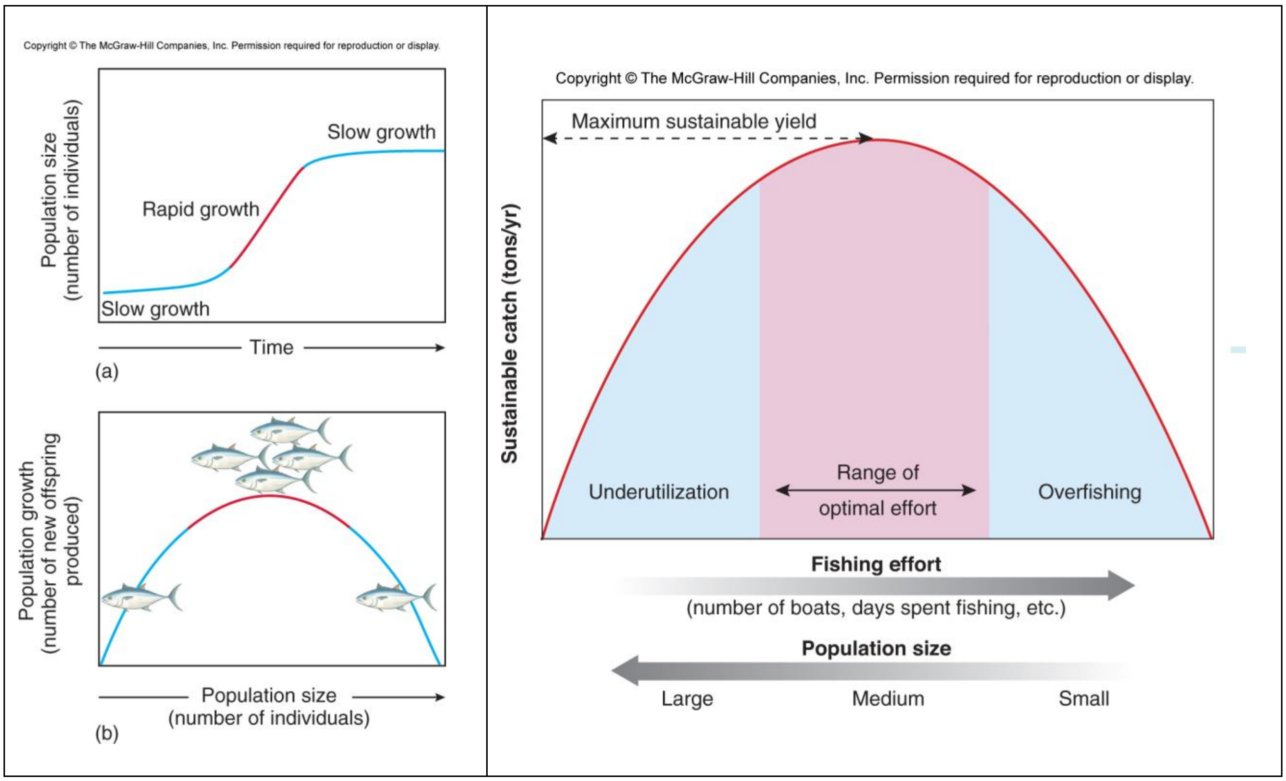
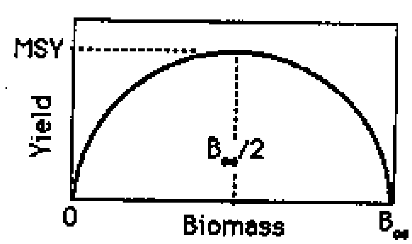
FISHERIES ASSESSMENT – A RECALL

- We have covered in chapter 5, how to evaluate the “total abundance” (in number or percentage) or “total biomass” (total weight) from fisheries-independent data (data gathered from the scientists themselves) and from fisheries dependent data (data of the total catches and total efforts obtained from the log sheets of fishers; from port sampling; and observers on board).
  - **Biomass -** is the total sum of weights of individuals (can be calculated by multiplying the average weight of an individual by the total number)

- As seen in chapter 4, in the Holistic models such as **Surplus Production Models** (Equilibrium model), the stock is regarded as a single unit (homogenous biomass). Once the “total biomass” is known, it can then used in fisheries assessment to calculate the “Maximum Sustainable Yield (MSY)” of the studied stock. It is represented by: $\mathbf{MSY = B_{max}/2}$.



(Reference: Taken from Castro & Huber, 2010. P.291)



- If the fishery is to last indefinitely, or to be **sustainable**, the number of fish caught can be no more than the number of new fish added through reproduction; if more are caught the population will decline.

- The highest catch that can be continued year after year without threatening the stock is called the **maximum sustainable yield.** It also is called the Biological optimum fishing rate or optimum yield. It corresponds to : *"the largest catches or yield that can be taken over the long-term without causing the population to collapse"*.
- It occurs at medium population size ($B_{max}/2$), when the natural growth rate is highest. This is represented by sets of figures shown above. **(see Figures from Castro &Huber, 2010, p.291)**

- The Holistic (surplus/equilibrium) models, are the most simple models. They are usually used in **data limited situations**, such as with newly exploited stocks where there is limited quantity and quality of available data; or with limited sampling capabilities…
  - Among the advantages of using the Holistic (equilibrium/surplus) models, is that they do not rely on complicated computer models and expensive fishery data. They equally produce useful guidance in fisheries where there are insufficient resources to do otherwise.

- On the other hand, the **Analytical models (Yield per recruit models/Ricker model…)** are more sophisticated and complex requiring the gathering of more population parameters. Other than the stock size (which were the basic data gathered in the Holistic models – i.e. total catch and total effort); the Analytical models equally have to gather information on: the age (size) composition of the catches (each cohort or year class); on recruitment levels, and both natural and fishing mortalities.
  - This Analytical approach permits to estimate: *the contribution to the yield of the fishery at various fishing intensities from each year class, or from one year class throughout its lifespan in the stock.*

- If you recall in chapter 4, we have explored the forces acting on an "exploited stock" as shown in the following figure **(Fig. 4.1).** You can notice from Figure 4.1, that the respective parameters enumerated above are reflected in how the total biomass of a stock is affected (parameters that contribute to augment the biomass versus those that tend to diminish the biomass.
-

(Fig. 4.1, p.172, King 2007 -- Forces acting on the stock)

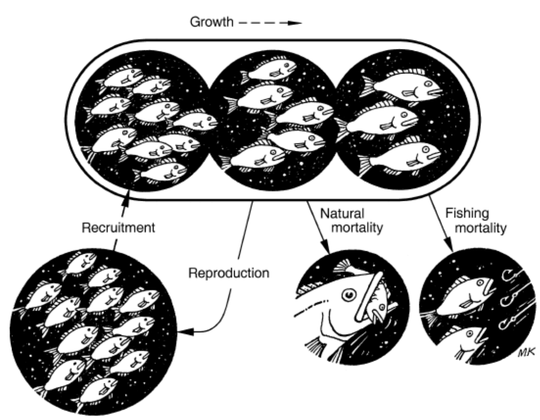


Fig. 4.1 An exploited fish stock viewed as a simple biological system. The stock biomass (top elongate shape) is increased by recruitment and growth (three age groups are shown), and is reduced by natural mortality and fishing mortality.

- Unfortunately because of time constraint, it will not be possible to cover these respective parameters (notably **growth** via size/age structures; **recruitment** levels via the mesh size; **natural and fishing mortality** via the catch rates); nor to integrate them into the models themselves.
  - It is hoped, that you will have the chance, in the near future, to undertake another course in Fisheries Biology where you will explore in detail each of these parameters and even go as far as integrating them into the models themselves.

- To complete this course, we will now explore the means by which the **fisheries are managed** and **how conservation options are applied.**

CSLO 10. *The student will be able to list fisheries management tools and explain their use.*

The student will be able to…

- **SLO 10.1** … to list some major tools used in fisheries management and highlight conflicts that can arise amongst stakeholders when dealing with a common resource.

FISHERIES MANAGEMENT AND CONSERVATION OPTIONS

(Refer to King 2007. Chapter 6: Fisheries Management. P. 273- 315)

1. INTRODUCTION

- We recognize that all fisheries are finite but "renewable". Given the danger of **overfishing** (**overexploitation** or **overharvesting**), most people agree that fisheries resources should be harvested in a way that does not deplete them beyond recovery. Fisheries must be managed to ensure their long-term value and to assure "sustainability".

- The purpose **of fisheries management** is to ensure that catches from a fish stock are **ecologically sustainable** in the long-term and benefits to fishers and communities are maximized.

- The **sustainable yield** (maximum sustainable yield –MSY) of a population is the amount that can be caught and just balance the growth (and recruitment) of the population (the catch equals the growth rate of the population). In other words, the *sustainable yield is the size of the annual catch that could be harvested indefinitely without a decline in the population of a species*.

- Fisheries can be classified as either **subsistence**, **artisanal**, or **industrial**. (Although the distinction between these categories is often blurred.)
- **Subsistence fishery** – is one in which a major part of the catch is used by the fishers and their families for food and a lesser part is often sold
- **Artisanal fishery** – is a small-scale, low-cost, and labour intensive fishery in which the catch is sold and consumed locally
  - **Subsistence and Artisanal fishery –** are frequently based on species that are spatially heterogeneous, that is, sedentary or less mobile species that are widely but unevenly distributed around coastlines.
  - The separation of sub-stocks, differing spatial densities and the concentration of fishing effort near towns and villages all contribute to making catch rates a poor index of overall stock abundance.
  - The usual collection of data through logbooks or port sampling in large-scale fisheries is not possible in most small-scale fisheries, in which fishers operate from small communities spread out over large areas.
  - Managing a large number of community or artisanal fisheries can only be done with those involved in fishing playing a key role (cooperative management or co-management and community-based fisheries management)
- **Industrial fishery** – involves large vessels taking catches that are marketed around the world.
  - The large, industrial fisheries usually involve highly efficient vessels equipped with gear including trawls, seines, and longlines to target open sea, continental shelf, or upwelling species.
  - The target species are often spatially homogeneous, more or less evenly distributed over fishing areas, and catch rates may be a reasonable index of abundance
  - Collection of data through logbooks or port sampling is common (and more recently, from observers on board)
  - Overexploitation may be less common because fishing is likely to cease once catch rates decrease below some break-even point. (far from being true)
  - Large commercial fisheries are often managed, by centralized government agencies (Ex: NORMA for the FSM)

(Refer to King 2007: Table 6.1, p.274)

Table 6.1 Characteristics of large-scale commercial fisheries and small-scale artisanal or community fisheries.

	Large-scale, industrial	**Small-scale, artisanal, community**
Resource	Often spatially homogeneous. Unit stocks or substocks of pelagic or demersal species.	Often spatially heterogeneous. Often less mobile or sedentary but dispersed along coasts.
Fishery	Commercial. Few units concentrated at landing sites and ports.	Artisanal; often subsistence. Many units, often spread out over coastlines.
Data collection	From logbooks, sampling etc.	Anecdotal information only.
Stock assessment	Estimates of stock size. CPUE useful as abundance index. Targets can be set.	Often not practicable. CPUE not useful as abundance index. Fisher information can be used.
Management	Often state-based or 'top-down'.	Community-based.
Regulations	Control of catch and effort. Quotas, licences etc.	Traditional measures and tabus. Closed seasons or areas.
Compliance	Strong enforcement required.	Self-regulation (by communities).

2. THE NEED FOR FISHERIES MANAGEMENT

- Governments and other authorities (fisher's unions and co-operatives…) manage fisheries to prevent the undesirable consequences of an unregulated fishery. Unregulated open access fisheries usually leads to overexploitation of the resources. This is due to the **Tragedy of the Commons.**
- **Tragedy of the Commons –** there is no incentive in open access fisheries for individual fishers to restrict their effort as long as costs remain less than revenues. Each individual will want to maximize his share of the common resource and will have little practice of conservation (if the individual does not fish the resource, someone else will). This way of seeing things will inevitably lead to ***overexploitation*** and ***overcapitalization***.
  - When ***overcapitalizing*** --- Individuals will tend to "invest" in their fishing techniques and equipment in order to be more efficient and be able to the better part of the resource before another harvests it. This is one of the factors that contribute to "overexploitation/overfishing".
  - Overcapitalization is common in nations with an "open sea access".

- **Also refer to Box 6.3 (*in* King 2007; p.281) – Development stages in an unmanaged fishery.**

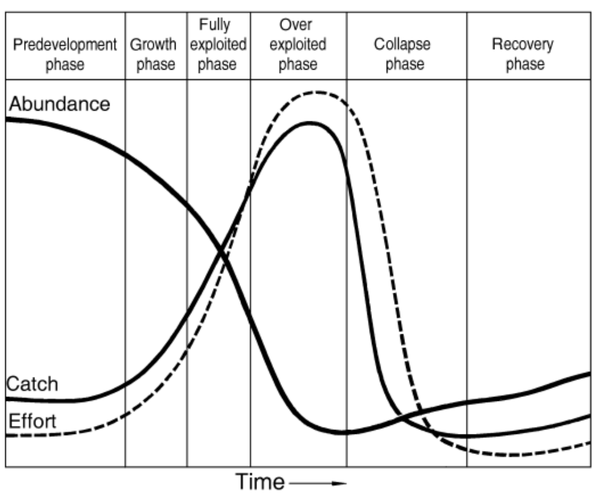


Fig. B6.3.1 Development stages of an unmanaged fishery. Adapted from several sources including Gulland (1983) and Csirke and Sharp (1984).

Development stages in an unmanaged fishery:

- *Predevelopment phase* – initial state of the stock before fishing occurs – the stock is in equilibrium at its "carrying capacity" (density-dependence)
- *Growth phase* -- After a resource is "discovered" (usually by fishers), a growth phase follows – more fishers, encouraged by high catch rates, enter the fishery.
- *Fully exploited phase* – At this phase, the abundance, and often catch rates, have decreased to about half their original values.
- *Overexploited phase* – catches are high and catch rates are low as fishers compete for fish that are low in abundance
- *Collapse phase* – total catches fall and this is followed by effort decreasing as fishers leave the fishery.
- *Recovery phase* – if fishing stops or continues at a low level, abundance may increase slowly.

3. MANAGEMENT OBJECTIVES, STRATEGIES AND ACTIONS

- In effective fisheries management we try to respect the following steps:
  - (1) Set clear **goals** or **objectives** (supported by the best scientific advice)
  - (2) Use appropriate **management actions** (putting the goals into action)
    - Use **tools/strategies** to assure that the objectives are attained
    - Use **enforcement procedures** to make sure that the tools are applied and the objectives are met

3.1 Management Objectives/Goals

- The objectives may be varied and can be loosely defined as "biological", "social", "economic" and "political" and even "international relations" (stocks that are harvested by one or more nations – such as the "straddling tuna stocks of the Western Central Pacific).
  - Because the objectives are varied, the overall objectives of fisheries management will almost always involve compromise.

Biological objectives:

- To protect the resource from overexploitation that would jeopardize future production (in the case of overexploited species, this means "rebuilding the stocks")
- Protecting species and habitats of conservation concern

Economic objectives:

- Maximization of economic benefits to harvesters, processors, distributors, marketers and consumers, provide foreign exchange (exports)…
  - For example, many nations heavily subsidize their fishing fleet--- in some cases, only to keep the people fishing when the fisheries were no longer viable; some subsidies were used to support ship building rather than the fishers themselves

Social objectives:

- This includes -- high employment, stability of coastal communities and safety at sea
  - For example, adopting an artisanal fishery which provides food and employment for a local community – which may ensure that as many individuals as possible have an opportunity to share the resource; -- in this case, a large number of smaller and less efficient units may be involved in the fishery but it will profit more the "social network".

Political objectives:

- May include the avoidance of conflict
  - For example, a nation decides to export most of the catches to maximize profitability --- this might lead to a small number of highly efficient fishing units in the fishery
  - Attributing "angler licences" for recreational fisheries because these groups of people have a great deal of lobby weight (often rich people with political influence)

Table 6.4 (p.288—King 2007) furnishes various examples of management objectives and strategies used to reach these objectives.

Table 6.4 Example objectives and strategies.

Example objective	Example strategies
Biological/ecological	
To maintain spawning stock biomass at 300 000 tonnes	Spawning areas or seasons closed to fishing Constant escapement harvesting strategy
To reduce catches of key bycatch species by 15%	Test exclusion devices and require installation on all commercial vessels
Economic	
To maximize profits by maintaining fishing effort at f_{MEY}	Remove (inefficiency) controls on fishing gear and reduce number of fishing licences
To increase export earnings by 12%	Conduct seafood handling training for fishers and implement seafood safety regulations
Social/political	
To increase participation (in an artisanal fishery) by 20%	Place bag limits (individual quotas) on fishing units Ban use of overly-efficient gear
To limit conflicts between recreational and commercial fishers by 35%	Ban commercial fishing at weekends and in depths of less than 10 m

3.2 Management Actions (Part 1- Tools/Strategies)

- Once the "objectives" or "goals" have been set, a "strategy" must be developed to attain the goals/ objectives by putting them into "action". The use of **tools** and **enforcement procedures** must be set.

Management tools are divided into:

- **Input controls (On fishing and fishing effort)** – limits the numbers of fishers and what they can do
- **Output controls (Catch controls)** – limits the catches of individual fishers or the fleet as a whole
- **Controls to protect marine ecosystems –** limits the impact of fishing activities on the environment

3.2.1 Input controls (On fishing and fishing effort)

Limited Entry (limiting the number of fishing units)

- Limit the number of boats or fishers who work in a fishery (by limiting the number of licences or permits)

Limiting the efficiency (vessel restriction) and types of fishing gear (Gear restrictions

- Try to limit the catching capacity of vessels or fishers by controlling the number, size and type of gear they use, and the time the gear can be left in the water
- Or by limiting the size or power of vessels and the periods when they fish. (The aim in the effort controls is to reduce the catching power of fishers and thus reduce fishing mortality.) – Often, there is the problem of "technological creep".
- **[Example: Box 6.8 (p. 300 – Licence buy-back schemes)]**

Minimum mesh size and escape gaps

- Control the minimum sizes of mesh **(Fig. 6.8, p.300)** and integrate escape gaps on gear to limit the number of unwanted individuals that the fishers have to sort or discard --- permits higher level of "escapement" from the fishing gear
- Escape gaps are often integrated in various fishing gear to permit the smaller individuals (usually the juveniles) to escape

3.2.2 Output controls (on the Catch-Biomass)

- Intended to control fishing mortality by limiting the weight of catch (biomass) that fishers can take

<u>Quotas (Bulk Harvest Restriction)</u>

- **Total allowable catches (TAC)** or **quotas (Q)** – are limits on the total catch to be taken from a specific stock, as well as **individual quotas (IQ)** and vessel catch limits where the TAC is divided between fishing units.
- In many cases, catch controls are really <u>landing controls</u>, since fishers may kill and discard unseen large numbers of fish of a size or quality that do not attract the highest prices
- **TAC** management tends to encourage a race to fish amongst fishers because the resource is still common property --- race to maximize their share of the TAC (consequences – shorter fishing seasons, reduced fish quality, higher bycatch and more dangerous working conditions; encourages overcapacity – larger and more powerful vessels; result in gluts of supply and markets; increases marketing and processing costs; TAC are good biologically but poor economically)
- **IQ** allow fishers to catch their quota at a rate that suits them rather than have to compete for their share of the TAC; tends to improve catch quality, increase stability of supply to markets and processors and increase safety for fishers (take less risks); main problem, is that they increase the risk of fishers high-grading their catch; enforcement have to be effective
  - **ITQ (Individual Transferable Quotas)** system gives fishers property rights in the fishery and allows them to trade those rights with other fishers; tends to stabilize the fishers income

<u>Size limits</u>

- Limiting the size of individuals retained is one of the oldest of regulations applied to fisheries.
- The regulation involves returning captured individuals smaller than a prescribed minimum size to the sea.
  - This is usually imposed to allow individual fish to spawn at least once before capture and to prevent marketing of fish considered too small.
- Restrictions on gear sizes (such as mesh size in nets or escape gaps) prevent the fish being caught in the first place. (see input controls)

<u>Rejection of females, or gravid females</u>

- Making illegal to retain females, or females bearing eggs (gravid females) from being landed.
- This approach benefits the female population and their fecundity contributes to future recruitment potential.

3.2.3 Controls to protect marine ecosystems

- limits the impact of fishing activities on the environment

<u>Closures as fisheries management tools (Spatial and temporal closing of an area)</u>

- Seasonal (time) closures and area closures can protect fished species at specific phases of their life history (Example: protection of juvenile nursery areas or adult spawning grounds)
- It is also use has a way to protect ecosystems within the fishing grounds
- Many scientists are now advocating that the narrowly-based management of a single resource species by replace by the more broadly-based management of ecosystems that support all marine species.

<u>Marine Protected Areas (MPAs)</u>

- One tactical approach in protecting ecosystem wide environments is to set aside zones called marine protected areas – which protect habitats, and in turn, provide refuges for marine flora and fauna.
- Serve to protect the critical ecological processes and components that are responsible for the maintenance of the valuable resources (stocks)
- May be more appropriate for less developed nations because, it can protect multispecies stocks; require less information on life history; require less enforcement capabilities; are less expensive overall than traditional tools
- MPAs can be used for different purposes and to this extent have varied names: "Fish reserves" when the objective is to protect the marine resources; "National Park" that can be used to preserve historical artefacts or used for other nation objectives; or called "Nature Reserve" where ecotourism is promoted.

<u>Ecosystem-based fisheries management --- Large Marine Ecosystems (LME)</u>

- Perhaps the best way to have sustainable fisheries and protected ecosystems is by the holistic management of large marine ecosystems or (LME).
- Perhaps the most useful of these is the setting aside of sub-areas in which fishing is either banned or restricted (Example:

having MPA within LMEs)

3.2.4 Other Management Tools:

Actions of the public, consumers and conservation groups

- Ex: World Wide Fund; Nature Conservancy; Marine Stewardship Council… "Eco-labelling --- as a public awareness program – Ex: Dolphin free tuna; Green Peace – red list of unsustainable species…)
- Public reactions are particularly strong when the incidental catching of endangered or charismatic species is involved (Ex: dolphins caught by seiners; catching turtles; hunting whales...)

Added Value Requirements

- Imposing higher quality control during the fishing processes or on the product is landed – for example, eviscerating the fish on board and placing it on ice; the gills and internal organs of tuna are removed once caught – this assures a higher quality product...

Royalty Fees

- Imposing taxes – such as landing fees; or exporting fees...

3.3 Management Action (Part 2- Compliance and Enforcement)

- The purpose of **monitoring, control, and surveillance (MCS)** systems is to ensure that rules put in place to address conservation and management issues are implemented.

3.3.1 Enforcement and compliance

- Management actions only help to meet an objective if they are **accepted** or **enforced**.
- **Fisheries regulation** (rules of conduct within the fishery/harvest sector) are imposed on a fishery to support a strategy designed to achieve predefined objectives
  - Fishers must comply with management actions and managers must enforce them.
- Enforcement is easier and cheaper if fishers can see that management actions benefit them (scientists and managers are working "for the fishers not against them")
  - Enforcement creates responsibility, creates consequences for actions – without the threat of enforcement, regulations would not be respected
- The choice of management action should also be sympathetic to the fisher's culture.

Fishery regulations are enforced in many ways:

- Monitoring, control and surveillance (MCS):
  - Many large fisheries (such as purse-seiners) have "**observers on board**" to record landings and by-catch
  - Many fisheries are **patrolled** by surveillance aircraft or patrol vessels
  - Other enforcement is conducted by **fisheries officers** at ports and fish markets
  - New technologies such as --- **satellite tracking** to provide positions in real time [Satellite-based **Vessel Monitoring Systems –(VMS)**]…
  - **Penalties** for breaking fishery regulations (vary variably within and between nations) --- monetary fines and confiscation of gear… (punishes greed; conviction creates respect)
- Enforcement can sometimes be difficult because enforcers are often poorly paid and may be tempted to by bribes.
- **Empowering fishers** to manage their own fisheries is often a good incentive to regulate the fisheries

3.3.2 Co-management (in commercial fisheries)

- **Co-management** means that fishers and the state share responsibility for fisheries management. Management and enforcement are usually more effective if managers and fishers work together.
- Co-management helps to minimize conflicts that impede management and allows fishers to indicate when regulations are inappropriate.(Usually works best with ITQs or tenure arrangements.)
- Co-management also helps communities to preserve their traditional conservation ethic and it improves understanding between fishers, managers and scientists.

3.3.3 Community-based Fisheries Management

- In many parts of the world, manly in the tropical regions, coastal communities are dependent on catches of seafood to provide essential protein.
- Typically, subsistence fisheries are characterized by a large number of fishers using many different fishing methods to make small individual catches of a great variety of species.
- Many isolated communities resent what they see as outside “interference” by central government.
- Fishing communities often are well versed in traditional knowledge concerning fish stocks and have a high level of awareness of the marine environment. In addition, many communities have some degree of control, either legal or traditionally assumed, of adjacent water.
- Collectively these factors provide an ideal basis on which communities can be encouraged and motivated to manage their own marine resources.
- Because communities play the key role, this type of management is referred to as “**community-based fisheries management**”