4. Defining regulatory measures and actions – A roadmap

Various regulatory measures and actions, or "tools", could be adopted when managing a sea cucumber fishery. This section presents a "roadmap", in the form of a series of three questions and a table, for making decisions about which combinations of tools are advisable in a sea cucumber fishery, depending on the fishery type, stock status and management capacity. Each regulatory measure and action in Tables 1 and 2 is linked to specific parts of Sections 5 and 6 of this paper.

Firstly, the fishery manager needs to answer three basic questions to characterize the sea cucumber fishery being managed:

1. What type of fishery is being managed?
- *Small-scale* – The fishers work from shore or use small boats in nearshore coastal waters. They would commonly involve modest technologies of fishing gears (e.g. simple breathing apparatuses and/or collection by hand).
- *Industrial* – The fishers work in groups from larger boats, capable of accessing distant fishing grounds. Those fisheries considered "semi-industrial", i.e. sharing elements of small-scale and industrial types, could be placed in this category.

2. What is the status of stock(s)?
- *Underexploited* – The fishery is new or the stocks of sea cucumbers are being exploited at low levels and believed to have a potential for expansion in annual production.
- *Fully exploited* – The fishery is operating at or close to an optimal yield level and there is no room for the fishery to expand further.
- *Depleted* – Catches are well below historical levels, irrespective of the fishing effort exerted, and sea cucumber populations are so sparse that the potential for stock abundance to recover through natural reproduction is limited.

  In some cases, there may be no recent data from fishery-independent surveys or managers may be unsure about the status of sea cucumber stocks in their fishery. The fishery manager should use simple indicators from looking at catches, export data, or by talking with fishermen (Box 1).

3. What is the management capacity in the country?
- *Strong capacity* – Management institutions have technical skills to analyze fisheries data and skills and equipment for monitoring stocks and fishing effort, and fishing capacity can be effectively controlled; there are effective systems for surveillance and enforcement of fishery management measures; and there is adequate funding to establish a complex suite of regulations. Consider a suite of some or all of the **Recommended** regulatory measures and apply **Recommended** actions for implementing management.
- *Modest capacity* – Management institutions lack the technical skills for complex fisheries analyses or modelling; expertise or equipment is lacking to monitor stocks; fishing effort and fishing capacity cannot be easily controlled; the systems for surveillance and enforcement of fishery regulations are insufficient; and there are insufficient funds to establish a complex suite of regulations. Use at least the **Minimum** regulatory measures and **Minimum** actions for implementing management.

BOX 1
Simple indicators to define stock status

The most useful tool in determining stock status is fishery-independent surveys; i.e. analyses of counts of animals underwater within replicated sampling units, e.g. transects (see Section 6.1.2). Underwater visual census of sea cucumber stocks should be conducted frequently, e.g. every 3–5 years. If data from fishery-independent surveys is old (i.e. >5 yrs) or unavailable, managers should endeavour to implement a stock assessment programme (using underwater visual censuses) and use simple indicators of stock status in the meantime while surveys are being conducted.

Friedman *et al.* (2008) propose six simple indicators of the status, or "health", of sea cucumber stocks. A combination of several, or all, of the following indicators would suggest that sea cucumber stocks were healthy (underexploited):

	Indicator	How to find out
1.	There are still areas where groups of adult sea cucumbers remain protected near the main fishing grounds	Underwater surveys and/or interviews with fishers
2.	Small-scale, traditional fishing methods are mostly used to harvest sea cucumbers	Observe the types of gear and boats used by fishers
3.	Abundances of sea cucumbers in the fishery are stable over long timescales	Records of exports and/or interviews with fishers
4.	High-value and medium-value species are still abundant in fishing grounds and well represented in catches	Records of exports and/or underwater visual census
5.	Large-sized sea cucumbers are still caught, and mostly "A" grade beche-de-mer is produced and exported	Records of exports and/or catch ("creel") surveys
6.	Economic benefits from the fishery flow mainly to fishing communities	Interviews and/or questionnaires to fishers and processors

Similarly, Froese (2004) proposed a set of just three simple indicators of stock status that can be obtained just by examining landings of fishers. These indicators apply to fisheries broadly, and could be adapted to gauge the status of sea cucumber stocks in the absence of underwater visual censuses:

1. Check the percentage of mature-sized sea cucumbers in catches. Any more than 5 percent of individuals under the size at first maturity would suggest that stocks are overexploited.
2. Check that the sea cucumbers in catches are mostly a size that would furnish A-grade beche-de-mer, or better. If fishers are collecting mainly small adults, stocks may be over-expoited.
3. Where upper size limits do not exist (e.g. there is only a minimum size limit), catches should comprise at least 30–40 percent "mega-spawners". These are defined as animals larger than the optimum trade length plus 10 percent – i.e. animals near the maximum size attained for each species, which have a high fecundity and contribute greatly to the population's reproductive output. Less than 20 percent of "mega-spawners" in catches would suggest gross overfishing and that stocks are moderately to fully exploited.

The three questions should lead to answers that characterize the fishery scenario (Table 1), which directs the fishery manager to a table of regulatory measures to impose and actions for implementing management in their situation (Table 2). These two tables were produced at the FAO-coordinated workshop in the Galápagos through working groups of the participant experts. The tables, therefore, represent a consensus of advice on minimum and recommended management measures from fishery managers, sociologists, ecologists and fisheries scientists.

The flowchart below illustrates the process. Each combination of answers to the three questions has a different set of recommended or minimum regulatory measures and actions for implementing management.
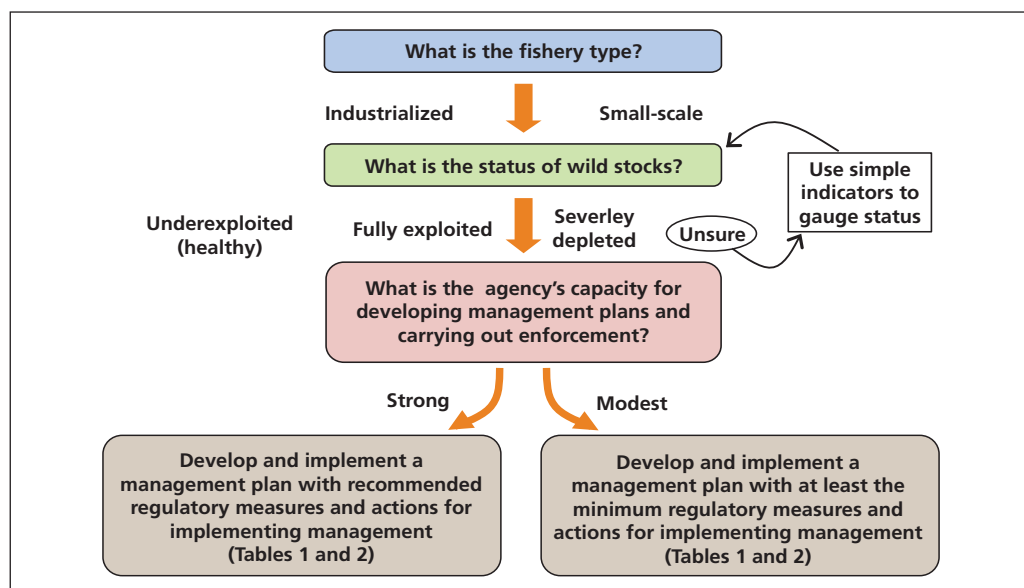
Below are two hypothetical examples of sea cucumber fisheries, with differing characteristics, to illustrate the decision-making process.

Example: Fishery 1 – A small number of fishers in groups of 6–8 persons use large boats of 15–20 m to access stocks of a single species of sea cucumber in deep waters using self contained underwater breathing apparatus (SCUBA) and hookah gear. The sea cucumbers have only been fished for a few years. Underwater surveys show that relatively dense populations exist, the animals are relatively abundant, and the annual catch of the fishery has been relatively stable. The management agency is relatively well funded with technicians and scientists, and there is a compliance department with fisheries officers to inspect catches and exports. Managers should treat this fishery as an **Industrialized** fishery, with **Healthy (Underexploited)** stocks. They should choose a suite of some of the **Recommended** regulatory measures and apply the **Recommended** actions for implementing management. The suite of regulatory measures could be: size limits (**1**), prohibit the use of nets and drags/dredges and authorize only the use of species-specific gear (**2**), limit the number of boats in the fishery (**3**), fishers are allocated an individual transferrable quota for each year (**4**), the fishers and processors pay for an annual licence and are required to record their catch and submit logbooks (**5**), a closed season during four months of the year when animals are less cryptic or during the spawning season(s) (**6**), no-take reserves (**8**), and plots of the fishing grounds could be allocated to fishing groups (**10**). Perhaps the seasonal closures are not needed and the manager decides not to allocate individual quotas, letting the fisher groups manage their harvest rates within their allocated plots (resulting in regulatory measures **1, 2, 3, 5, 8** and **10**). All of the **Recommended** actions for implementing management (**A, B, C, D, E, F, G, H, I, J, K, L**) should be

employed. But perhaps in this example, fisher groups already process sea cucumbers to a very high and consistent standard, so there is no need to promote training in processing methods (i.e. action **L** is redundant).

Example: Fishery 2 – A large number of mostly small-scale fishers collect a range of sea cucumber species from the shore or in small boats of 4–6 m in length. Most fishers use free-diving (mask and snorkel) but some have started using hookah breathing gear. In this fishery, the sea cucumbers have been fished for decades, but catches have declined in recent years and few high-value species are now collected. Underwater surveys showed reasonable densities of most species, but high-value species were rarely recorded. Managers should treat this fishery as a **Small-scale** fishery, with both **Fully-exploited** and **Depleted** stocks. Owing to limited funding and a lack of skilled scientists and sociologists in the management agency, the manager should at least use the **Minimum** regulatory measures and apply the **Minimum** actions for implementing management. The regulatory measures should be: size limits (**1**), forbid the use of compressed air diving (SCUBA or hookah) and nets or drags/dredges (**2**), issue licences to fishers and processors who are also required to make records and submit logbooks (**5**), bans on fishing should be placed on species for which stocks are depleted (**7**), no-take reserves (**8**), and allocate fishing communities the exclusive rights to certain fishing grounds (**10**). All of the **Minimum** actions (**B, C, D, F, G, H, L**) should be employed by the fishery manager.

TABLE 1
Regulatory measures and actions for implementing management to be applied in different sea cucumber fishery scenarios

Fishery type	Health of stock	Regulatory measures		Implementing management	
		Recommended	Minimum	Recommended	Minimum
Industrialized	Healthy (underexploited)	1, 2, 3, 4, 5, 6[1], 8, 10	1, 5, 10	A, B, C, D, E, F, G, H, I, J, K, L	A, B, C, D, K, L
	Fully exploited	1, 2, 3, 4, 5, 6, 8, 9, 10	1, 2, 4, 5, 8, 10	B, C, D, E, F, G, H, I, J, K, L	B, C, D, F, G,H, L
	Depleted	5, 7	5, 7	B, D, G, I, K, L, M	B, D, K, L
Small-scale	Healthy (underexploited)	1, 2, 3, 4, 5, 6, 8, 9, 10	1[2], 5, 8, 10	A,B, C, D, E, F, G, H, I, J, K, L	A, B, C, D, K, L
	Fully exploited	1, 2, 3[3], 4, 5, 6, 8, 9, 10	1, 2, 5, 8, 10	B, C, D, E, F, G, H, I, J, K, L	B, C, D, F, G, H, L
	Depleted	5, 7	5, 7	B, D, G, I, K, L, M	B, D, K, L

[1] Particularly in temperate fisheries.
[2] Particularly in multispecies fisheries.
[3] In well developed small-scale fisheries the limitation of effort may be difficult.

TABLE 2
Regulatory measures and actions for implementing management, corresponding to number and letter designations in Table 1

Regulatory measures	Section	Implementing management	Section
1 – Size limits	5.1	A – Overview of the harvested species	6.1.1
2 – Gear limitation and development	5.2	B – Fishery-independent stock surveys	6.1.2
3 – Effort and capacity control	5.3	C – Fishery-dependent stock surveys	6.1.3
4 – Catch quotas	5.4	D – Socio-economic surveys	6.1.4
5 – Market chain licensing and reporting	5.5	E – Price monitoring	6.1.5
6 – Seasonal and short-term closures	5.6.1	F – Support institutional arrangements for local-scale management	6.2.1
7 – Bans or moratoria	5.6.2	G – Establish management advisory committees	6.2.2
8 – Marine protected areas and no-take reserves	5.7.1	H – Legislation of management regulations	6.3.1
9 – Rotational harvest closures	5.7.2	I – Assign accountability	6.4
10 – Territorial user rights in fisheries	5.7.3	J – Enforcement	6.5
		K – Education and communication with stakeholders	6.6
		L – Improve quality of processing through training	6.7
		M – Restocking	6.8