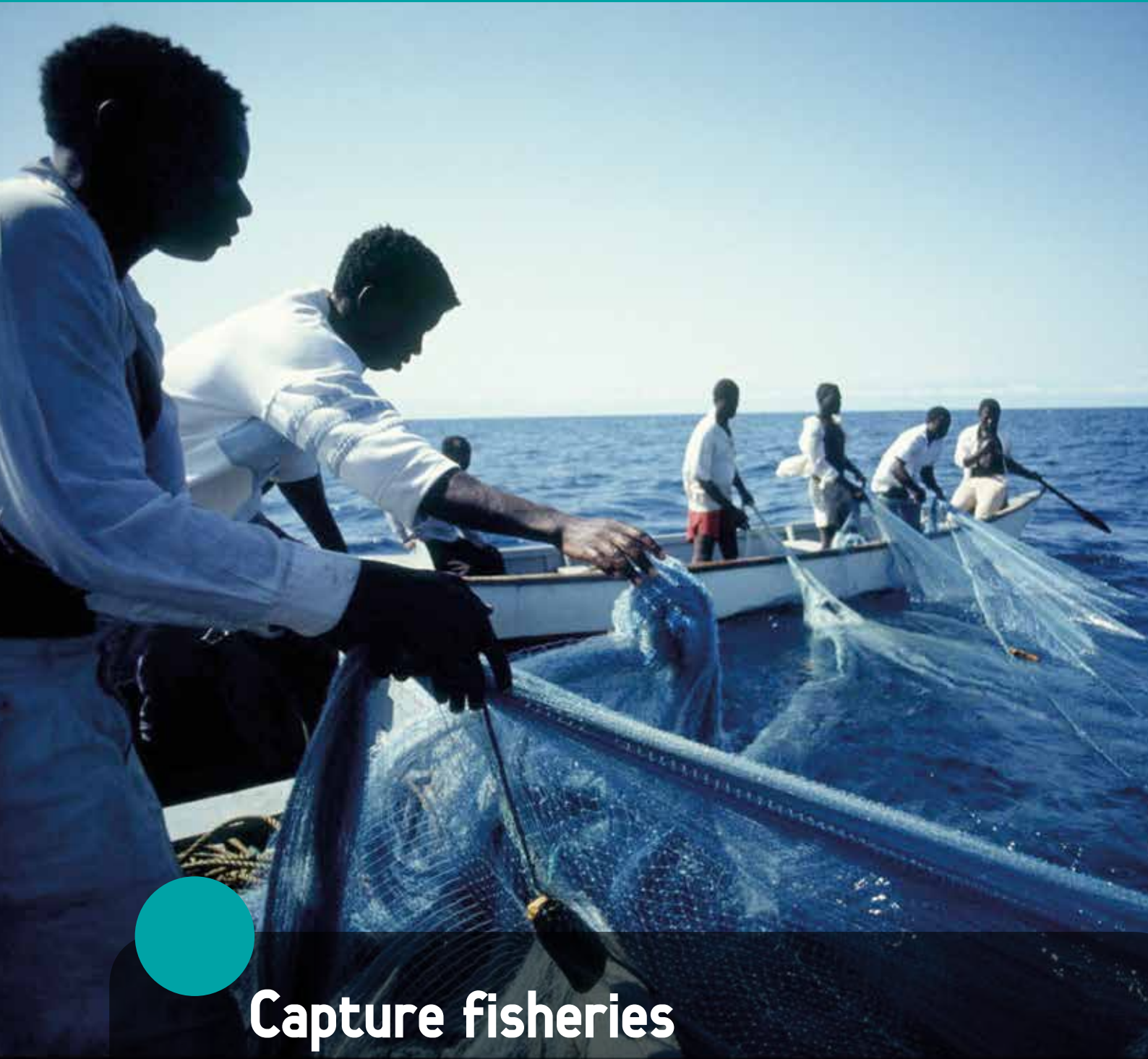




Food and Agriculture  
Organization of the  
United Nations



# Capture fisheries

Junior Farmer Field and Life School – Facilitator's guide

Photos: © FAO/Sergey Kozmin

# **Module: Capture fisheries**

Junior Farmer Field and Life School – Facilitator's guide

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# Module: Capture fisheries



## INTRODUCTION

Systems are all around us. Systems consist of different interacting or interdependent elements that together form a whole. Ecosystems are a good example of a natural system where plants, animals and non-living things are the elements that are connected. We do not always see the connections until one thing changes and we can then watch other things change in response.

Capture fisheries is also a system. It links fish and the aquatic environment – be it the sea, a river or a lake – with humans, as fish are captured, processed, sold and eaten. This sequence of interactions in the system starts with the fish and the ecosystem and goes through many different steps until it reaches the consumer. This chain is called the fish supply chain. It is important to understand the impact of an action or change on the whole system. Each element has a value and role in the system, and the system may not work well when one element is changed or missing. As ecosystems are always changing as a result of varying conditions, they have a limited life span. Therefore, ecosystem health is closely linked to the idea of sustainability. A sustainable ecosystem is one that has all the elements living in balance that are capable of surviving, functioning and renewing themselves over time.

We have many human needs that need to be met, for example, good nutritious food and employment that provides an income. Fishing is a way to meet these needs as we fish to eat and we fish to sell. So, how do we achieve balance between saving fish for tomorrow and having enough food and income for today? This is the question being asked all over the world and solutions are not easy or short term. We need to expand our thought process to the long term. This is not an easy shift and requires changes in behaviour with respect to the environment, with respect to care for the resource, and with respect to care for oneself and others.

This module contains sample exercises for each of the learning activities, plus a number of sample energizers and cultural activities that can be used to keep the participants engaged and reinforce their learning. The provided activities should serve as samples to be modified to suit the local context and applied as appropriate. The important thing is that all the main building blocks of a typical Junior Farmer Field and Life School (JFFLS) session are included in each learning session.

By the end of this module participants should:

1. understand the elements and interdependences in a fisheries ecosystem;
2. begin to reflect on the impact of human behaviour on fisheries resources and the wider ecosystem;
3. appreciate the benefits of responsible and safe behaviour;
4. understand the benefits of collective action.

The purpose of the module is to provide guidance, making available different exercises that facilitators can use as applicable, and adapt as necessary, to the specific socio-economic and cultural contexts and needs of each target group and country in which the module will be used. This JFFLS module is complementary to other JFFLS modules, in particular with *Aquaculture and Post-harvest issues in fisheries and aquaculture*, and can be combined with them to enhance economic opportunities.



## ➤ OPENING ENERGIZER

**OBJECTIVE:**

Get to know each other, help a group of individuals become a collaborative team, and help them feel comfortable together.

**TIME:**

About 1 hour.

**MATERIALS:**

Ball, music (chairs if available).

**STEPS:**

1. Ask the participants to stand in a circle.
2. Explain to the participants that they will play two rounds. In the first round, the person who catches the ball will say his/her name and throw the ball to another participant, who then says his/her name. This will continue until everyone has received the ball.
3. In the second round, the participant will say his/her name and the name of a local fish that starts with the same letter as his/her name. He/she will then throw the ball to another participant until all participants have answered.
4. The game starts when the facilitator throws the first ball to a participant.
5. The game ends when every participant has received the ball twice.



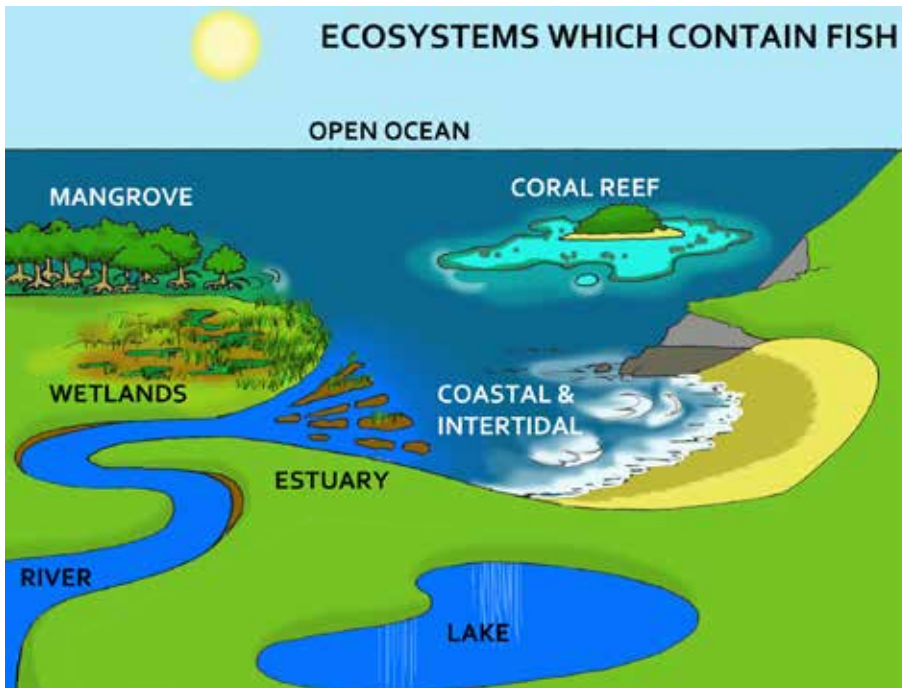


# Exercises



# WE ARE ALL PART OF THE ECOSYSTEM

All the plants and animals around you are part of the ecosystem of your area. The weather and the landscape in your area are also important elements of the system you live in too. Just think where your fish comes from: from the sea, from a river, from a lake? Wherever it comes from, the waterbody will be connected to the land and there will be some interaction. For example, if a polluting substance from an industry is discharged into a river, a lake or the sea, it can kill the plants and fish or make them sick. Therefore, we always need to think about the changes that our behaviour will cause in the whole system. So, how many fish can we catch? Fish are born, reproduce and die. In most cases, more fish are born than are necessary to replace their parents. That means we can harvest the excess fish for our own needs if we are careful not to take too many. However, many other factors affect the ability of fish to survive over time. Weather conditions, predators, disease outbreaks, pollution and habitat destruction are some examples. If we take too many, the system will lose its balance and no longer be sustainable and we will also lose our livelihoods that depend on it.



Source: <http://sciencewithme.com/learn-about-ecosystems-and-biomes/>



## 🔊 exercise 1

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### LIVING SYSTEMS

**OBJECTIVE:**

Visually demonstrate the linkages between different elements of a system in order to show that as one thing changes, many other changes occur, which may not be obvious.

**TIME**

15 minutes

**STEPS:**

1. Ask the group to stand in a circle.
2. Ask each person to choose two people in the group (ideally one female and one male), without telling anyone else their choice.
3. Have the group start moving randomly around the space.
4. Explain that each person has to stay an equal distance from the two people they have chosen (not necessarily between them but an equal distance away).
5. Explain that participants have to keep adjusting their position based on how the other two people move.
6. Ask the group to stop when they are all approximately at an equal distance.
7. Discuss what happened to illustrate the concept of cause and effect. What happened when you tried to stay at an equal distance from the two persons you selected at the beginning? How difficult was it to keep equal spacing?
8. **OPTIONAL:** Ask each person to identify themselves as part of the fisheries system (for example, a fisher or a fish). Ask what happens when one part of the system changes, for example, when the fish move closer to the fishers?

## 🗂️ exercise 2

---

### BUILDING OUR ECOSYSTEM

#### OBJECTIVE:

Simulate an ecosystem, understand interdependence and the importance of biodiversity.

#### TIME:

2 hours.

#### MATERIALS:

Before the session starts, prepare pictures of fish, animals, plants of the area (at least one per participant). Paper, pens.

#### STEPS:

1. Ask participants to pick (or alternatively to draw) a picture of fish, animals and plants that are caught by the fishers in the village, or animals and plants that live near their home.
2. Explain that each participant represents the fish, animal or plant that he/she picked (more than one student can play the same role).
3. Ask everyone to stand on one side of the classroom/area.
4. Then ask one “plant” or “animal” to step away from the group and to sit down.
5. Ask participants if any other species depends on this plant or animal. If any other species depends on the species you have asked to sit down, those participants will have to sit as well. Continue until there are no (or very few) participants left standing.
6. Discuss the implications of the simulation with the class by asking one of the following questions:
  - What happens to the plants and animals in an area when one type of plant or animal dies out?
  - Are any species in the area where you live in trouble, and do you know why?
  - In which ways may humans and our activities affect the lives of animals, fish and plants? What about the impact of natural hazards, such as floods, drought, storms or the warming of the oceans as a result of global warming on the animals, fish and plants, including coral?
7. Ask the group to think of their family or of their village:
  - Can you give an example of how one family member depends on other family members or how one person in the village depends on other persons in the village?
  - What can you do in your house and village to help make the ecosystem sustainable and diverse? (Help the group to think by providing some examples about recycling, reusing, caring for the environment [planting, etc.], taking only the surplus of populations when fishing or hunting, reduce pollution, etc.).

## exercise 3

### OH FISH! (POPULATION STUDY GAME)

#### OBJECTIVE:

Understand the concepts of habitat, population dynamics and survival of fish species.

#### TIME:

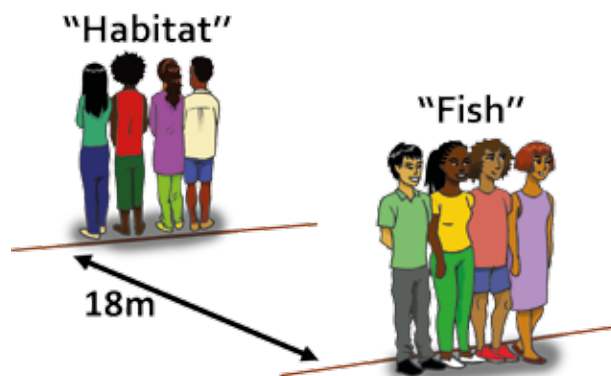
1.5 hours.

#### MATERIALS:

Rope, measuring tape, paper, pencils, clipboard.

#### STEPS:

1. Make two horizontal lines with rope or measuring tape on the ground about 18 m apart.
2. Divide the participants into two gender-mixed groups if possible. Explain that one group represents fish, the other represents their habitat.
3. Ask the "fish" to stand behind one line and the "habitat" behind the other, with their backs to one another so that they cannot see the other group.
4. Divide the people in the "habitat" group into two subgroups: one represents "food", the other "shelter". Note down the total number of "fish", "food" and "shelter".
5. Ask the "shelter" representatives to put their hands over their head like a little roof. Ask the "food" representatives to place their hands over their stomach. [add drawing]
6. Ask the "fish" to decide if they want to look for "food" or for "shelter". They only have to think about it and are not allowed to tell their choice.
7. Slowly count to three and have everyone turn around to face one another.
8. Ask all to move around in the space between the two lines.
9. "Fish" that are looking for "shelter" link hands with "shelter" and go back behind the fish line. The same happens with "fish" looking for "food".
10. Stop the round when all "shelter" and "food" representatives have linked with a "fish".
11. If a "fish" did not find "shelter", it will perish and become habitat in the next round.
12. The person who was a "shelter" or "food" and met with a "fish" becomes a "fish" in the next round.



13. Note down the number of “fish”, “food” and “shelter” at the end of the session.
14. Repeat this exercise until you start to see a limiting habitat item start to limit fish population. Usually, this will take 10–15 rounds. Each round counts as one year.
15. At the end, lead a discussion about what the participants observed and did during the game: What does fish need to survive (e.g. food and shelter)? How do these elements work as limiting factors that affect animal survival? How do the habitat and the fish population change over time? During the game, what was the effect of competition and the stress it placed on the fish? Imagine what would happen if there were a natural disaster that changed the habitat (e.g. mangroves, seagrass beds and coral reefs will cease to exist)? Would the system be resilient, that means, would it be able to respond and to return to previous conditions?
16. OPTIONAL: The exercise can then be run again with three small groups: as before, “fish”, “habitat” (“food” and “shelter”) and, as a new group, a small number of “fishers” who can catch one fish per round.
17. Discuss the effect of fishing on the fish. What would happen if fishers were allowed to catch more than one fish per round?

## facilitators' notes

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An ecosystem is the combination of physical and biological components of an environment and their interactions. A sustainable ecosystem is in balance and it is resilient. Resilience means that the system is able to cope with shocks, for example to recover from natural disasters.

**Biodiversity** increases the sustainability of ecosystems. Biodiversity is the variety of life on earth, e.g. the different plant and animal species. Biodiversity provides us with food and medicine and contributes to our economy. For example, we use plants and animals for food and medicine and we can harvest plants and animals and sell them to make money.

The greater the variety of species, the healthier a system is:

- more species = more links in food chains/webs = more stable
- more types of plants = more food for different animals
- more genes = better chances for survival through adaptation
- a variety of ecosystems = more habitat for different species

The natural ecosystem interacts with the human system, including, for example, through the exchange of materials (e.g. plants and animals for food) or energy (e.g. burning of wood for cooking) between these two systems. It is thus important to understand the impact of the human behaviour and actions on the natural environment.

**Resilience:** In ecology, resilience is the capacity of an ecosystem to respond to changes or disturbances by resisting damage and recovering quickly. Big disturbances (e.g. an earthquake, an oil spill) can profoundly affect an ecosystem and may force it into a rather different configuration of forces with a different regime of processes and structures. Human activities that hurt ecosystem resilience, such as reduction of biodiversity, overexploitation of natural resources, pollution, bad land use, and climate change caused, are more and more often causing regime shifts in ecosystems, often to less desirable and degraded conditions. For example, climate change is causing warmer water temperatures, which in turn cause coral bleaching. Corals provide important habitats for aquatic life. Once corals are lost, it is very difficult to bring them back.

## ☞ exercise 4 (optional)

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### BUILDING AN AQUARIUM<sup>1</sup>

#### OBJECTIVE:

Better understand the complexities and interactions of an ecosystem.

#### TIME:

2 hours for building the aquarium together, followed by several weeks of maintenance and observation.

#### MATERIALS:

- a large clean plastic container that can hold 2–3 buckets of water
- a large plastic bucket
- soil or peat moss as substrate from a local river or pond
- sand
- a few small branches of a tree
- small rocks
- freshwater (it has to be exposed to the air for at least 24 hours prior to use).
- several water plants from a local water source
- a thermometer
- one or two fish (low-oxygen-demand fish species such as catfish or tilapia)
- some snails and/or little shrimp

#### STEPS:

1. Ask the participants to layer the substrate on the bottom of the container, making it about 2.5 cm deep.
2. Add a thin layer of sand on top of it.
3. Let participants gently add the water so as to not make a hole in the bottom cover until the container is about half full.
4. Ask participants to add a few clean rocks, wood and plants making sure the plants are secure in the soil/gravel.
5. Then ask them to add at least two fish of different species, some snails and/or shrimp.
6. Choose a location for the tank that is away from heat and not in direct sunlight.
7. Create a note board to write or draw daily observations about what is happening in the aquarium.
8. Create teams of participants and let them chose a name for the team. Each day, one team will note down observations about what is happening in the aquarium over the coming days and weeks (e.g. water temperature, fish/shrimp/snail behaviour, plants).
9. Make sure to add water as it evaporates.
10. After a few weeks discuss the observations about the changes in the aquarium with the whole group.



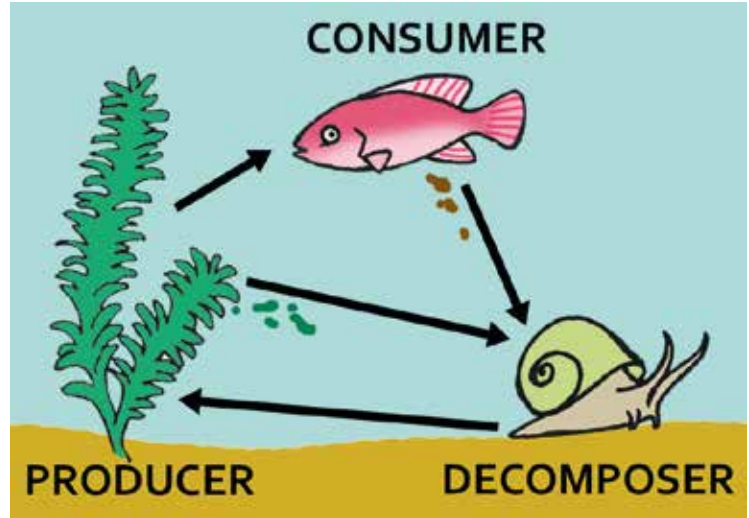
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<sup>1</sup> See JFFLS Module Aquaculture – Exercise 1: Pond in a bottle

## 🔄 facilitators' notes

All organisms in ecosystems, whether they are on land or in the water, are one of the following: producers, consumers or decomposers.

Producers are the plants, so named because they produce their own food and are at the base of the food web. They also produce oxygen, essential for the consumers. On land, trees, bushes and grasses are examples of plants; in the water, plants can be large (such as the ones you can see at the bottom of the sea, a river or a lake) or small (such as microalgae that you need a microscope to see clearly [phytoplankton]).



Consumers are the animals and living organisms that consume (e.g. eat) the producers (and other consumers). Consumers also contribute carbon dioxide and waste to the ecosystem. Humans are top consumers of both plants and animals.

Decomposers are the garbage cleaners of the ecosystem because they recycle the waste products. Decomposers include bacteria and worms. In a water system, snails and small shrimp are decomposers.

Producers, consumers, and decomposers must all remain in balance for the ecosystem to thrive. Too much of one of these will result in disaster. For example, if there are too many fish (consumers) and not enough plants (producers), the fish will starve or will suffocate from lack of oxygen. Therefore, it is important not to overcrowd the environment but to ensure the balance of a system.



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## SHARING THE FISH

Problems may arise when there is no control over how many people can fish, or how many fish they can take, or even what size of fish they should harvest. When anyone can go fishing without any regulation, it is called open access, and it can lead to overfishing. To prevent this from happening, many governments and communities control access and grant rights to fish to individuals or communities. Sometime, communities already have their own systems (often developed a long time ago) to manage access, and there are many examples of how, through cooperation, communities can successfully regulate resources and maintain their fish for everyone. Fisheries management and the sharing of fish is complex but there are many tools available. These tools include input and output controls. Input controls are restrictions put on the amount of allowed effort (e.g. the number of boats, the size of the engine, the gear mesh size, the fishing area, the fishing seasons). Output controls are limits to the amount of fish that that can be caught (e.g. by each fisher, boat or community or the size of each fish). Different situations require different solutions. It may be necessary to also engage in other economic activities such as agriculture to integrate income and food supplies in times when fishing is reduced (e.g. due to closed seasons).

## ☺ exercise 1

### TRAGEDY OF THE COMMONS

#### OBJECTIVE:

Understanding dynamics related to the use of common or shared resources.

#### MATERIALS:

Dried fruit, peanuts or other small nuts, forks, chopsticks / twigs, large plates, pen, paper, stop-watch or hourglass.

#### STEPS:

1. Tell the participants that each of them is the head of a family.
2. Explain that the aim of the exercise is to catch enough fish for their family to eat or enough fish to sell to support the family.
3. Divide the participants into groups of four.
4. Show them the area in which they fish: a small common area, in which only a limited number of fish can live. The fish are represented by dried fruit/peanuts/nuts on a large plate, which represents the lake or marine fishing areas for each group (start with the same number of "fish" per group).
5. Provide each participant with "fishing gear": the fork and the chopstick/small branches and explain that they will use this gear to catch the fish.
6. Explain that the game will be played for four rounds and that each round represents one year.
7. Tell participants that during the first three rounds they are not allowed not talk to one another.
8. Round/Year 1:
  - Ask each group to sit in a circle around their designated fishing area/lake.
  - Explain that one fishing season will last one minute and that the fork is the gear to be used.
  - The players can choose how many fish they take, but they have to know that if they only take one fish, their family will starve, while if they take more than two fish, they make a profit.
  - Explain that the fish in the lake will reproduce once a year, so the number of each remaining fish in the fishing area/lake will double (i.e. 4 remaining fish become 8).
  - Tell the players to keep the fish they catch in front of them for record-keeping, and count and note down names and numbers at the end of each round.

Fill out a table for each fishing area for each year:

Year	Team	Number of fish in area at the beginning	Number of fish in area at the end	Number of fish caught per person	Total number of fish caught per year
1					
2					
3					
4					



9. Round/Year 2:

- Explain that, in this round, the fishing season will also last one minute. However, this time, after the first 20 seconds, players have to switch from fork to chopsticks / twigs to fish. This will likely decrease their fishing capacity, representing a fisheries management measure to reduce fishing pressure during a certain time of the year.
- After another 20 seconds, the players are allowed to go back to using the forks.
- The same rule for the replenishment of the fish resources as in Year 1 applies – for each fish in the water, there will be one additional new fish.

10. Round/Year 3:

- This time, the fishing season will again last 1 minute. After 20 seconds, the players will have to stop fishing for 10 seconds. In addition, if players have caught all the fish in their area, they are allowed to move to the fishing area of another group and continue fishing there.

11. Round/Year 4: Participants are allowed to talk to one another.

- Ask participants to discuss the best strategy for managing their fishing to allow for maximum profit in the current year yet also taking into account maximum recruitment for the next year, based on the experiences from the past “years”. Ask them to consider the management options used before (e.g. gear restriction, temporary closure of fishing area).
- Replenishment will be allowed immediately at the end of the round with the same rule of one new fish per remaining fish to see which group managed their fishery best.

12. Lead the final discussion with the following questions:

- Compare each group’s catch: Who caught the most fish?
- Did anyone try to take as many as possible? Why or why not?
- Did anyone take a few as possible for the good of the community? Why or why not?
- Did switching gear type make a difference?
- If you moved to another fishing area after depleting your own, how did that make you feel?
- Did you decide not to fish in another area, and why?
- Is it possible to maximize the number of fish caught per person and the number of fish remaining in the fishing area at the same time? Why or why not?
- Did communication/collaboration in Year 4 make a difference? Why or why not?
- Are there any other important stakeholders who may have an interest in the sustainability of the fisheries?

## facilitators’ notes

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Year 1 represents an open-access fishery. Year 2 includes the use of an input control in the form of a more selective gear type. Input controls are regulations directed at controlling the fishing power and effort used to harvest fish. They can be in the form of limits to the number and size of fishing vessels, to the amount of time allowed to fish, and to the types, numbers or characteristics of gear used. In this instance, the use of chopsticks/branches represents a gear modification in the form of a more restrictive gear. Year 3 uses a time closures to reduce fishing pressure on the stock. In Year 4, communication is allowed among players. Management options that players could choose are endless. Other input controls they may use include limiting the total number of players allowed to fish and then dividing the catch and restricting the gear for each player (going back to the chopsticks/branches). Output controls are direct limits on the number or size of fish harvested regardless of the inputs used. They include such measures as a limit on harvest, total allowable catch, discards, and minimum and/or maximum allowable size. Output controls they may use include limiting the total catch for each player. Discussion after each year is very important.

## 🕒 exercise 2

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### PRISONER'S DILEMMA

#### OBJECTIVES:

Illustrate how cooperation and competition bring different payoffs but depend on how the whole system operates.

#### TIME:

1 hour.

#### MATERIALS:

Writing support, pens.

#### STEPS:

1. Divide people into groups of three people each. They have to agree which two of them are fishers and who is a judge.
2. Explain the situation. The fishers have been fishing for years according to certain rules. Now they receive a new set of rules for fishing. The two fishers must choose whether to follow the new rules and to cooperate with the fellow fisher or not to follow the rules and to compete with the other fisher.
3. Ask each fisher to decide on what to do and to write down the decision without telling anyone: a cross ('x') for respecting the rules, a circle ('o') for not respecting the rules.
4. The judge then has to look at the two choices and to score accordingly:
  - If both cooperate ('x', 'x'), both receive three fish
  - If one cooperates ('x') and one competes ('o'), the competitor ('o') receives five fish and the cooperator ('x') receives none
  - If both compete ('o', 'o'), both receive one fish
5. The results from each round are told to the players before starting the next round.
6. Play at least five rounds of this game.
7. Discuss the results: Which strategy worked? Why do you think this strategy worked and why did you make the choices you made? How stable is cooperation? What can destroy cooperative ventures?

## ☞ exercise 3

---

### COOPERATE AND ORGANIZE

#### OBJECTIVES:

Illustrate how cooperation may work in different scenarios.

#### MATERIALS:

As many cards as participants with symbols for the following roles on them: half of the cards symbolizing an independent fisher and half of the cards representing a fisher in a cooperative/association.

#### TIME:

2 hours.

#### STEPS:

1. Have a warm-up discussion by asking the participants if they or their parents are engaged in any sort of organizations. What do they think is good practice for cooperation?
2. Distribute the cards to the participants so that each participant has a role.
3. Set the stage: explain that the fishers in the village decided to form a cooperative to harvest fish 'A'. However, some fishers decided to remain independent.
4. Explain that for independent fishers the fishing season for fish "A" is from April to September. Each fisher has a preset quantity ("quota") that he/she is allowed to catch. The best fishing months are April, May and June.
5. *Fishers in a cooperative* also have a quota assigned and are allowed to fish all year until they reach their quota. The different members of a cooperative can also fish together, having a bigger quota.
6. Explain that through the game participants in the cooperative should convince those not in the cooperative to join the organizations by promoting the benefits, both to the fish stock and to themselves economically.
7. Introduce Scenario 1:
  - Explain that during the season, suddenly, one of the cooperative boats has developed a large hole and one fisher cannot fish. He/she communicates with other cooperative members to whom he/she allocates his/her quota. The other fishers catch that quota, sell the fish and give him/her a portion of the profits, although he/she did not go fishing. He/she was able to buy the repair material with the money and is now fishing again after a week.
  - At the same time, one of the independent boats has a hole and one fisher cannot fish. He/she has no money to fix the boat and he/she is still losing money because he/she is not fishing.
8. Ask the participants to discuss this scenario, from their point of view as independent fisher or as fisher of a cooperative: In these circumstances can you see the advantages of cooperation?
9. Introduce Scenario 2:
  - Explain that due to climate change, warmer water has caused a shift in the spawning

season which occurred earlier than usual. The season therefore has to end early to protect the recruitment of the stock. The independent boats are unable to catch the rest of their quota as they are not allowed to fish after the season. The cooperative boats stop fishing temporarily and restart after the spawning females leave the area.

10. Ask each team to discuss the following points and ask one representative to report to the entire group:
  - What are the challenges for cooperation?
  - How can those challenges be addressed?
  - How can youth become organized?
  - Quotas are one possible management tool, with pros and cons. For example what happens in a multispecies fishery where not only fish “A” is targeted?
  - What are good practices for cooperation?
  - Are local fishers involved in fisheries management?
  
11. Have a final discussion on the same points with the whole group.

## facilitators' notes

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Fish stocks are renewable living resources, but they cannot be harvested without limits. Through cooperation, communities can successfully regulate the use of resources. Elinor Ostrom, Nobel Prize for Economics 2009, developed some principles for successfully managing a common resource through communities:

1. Define clear group boundaries.
2. Match rules governing use of common goods to local needs and conditions.
3. Ensure that those affected by the rules can participate in modifying the rules.
4. Make sure the rule-making rights of community members are respected by outside authorities.
5. Develop a system, carried out by community members, for monitoring members' behaviour.
6. Use graduated sanctions for rule violators.
7. Provide accessible, low-cost means for dispute resolution.
8. Build responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system.

The government always plays a role in fisheries management but it can empower communities to take over part of the management responsibilities.

## exercise 4

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### ROLE PLAY ON COOPERATIVES<sup>2</sup>

#### OBJECTIVES:

Develop local solutions to local problems through cooperative problem solving.

#### TIME:

3 hours.

#### MATERIALS:

Scripts for three scenarios (depending on the size of the class).

#### STEPS:

1. Divide the group into three equal and ideally gender-balanced groups.
2. Each group receives a separate script. This script can be modified from the one supplied or made specific to the local situation.
3. Ask the groups to:
  - read, study and rehearse their script and then perform it; explain the script if they are unable to read
  - as the scripts have an open ending ask the audience to come up with possible solutions by improvising their roles, until a real solution has been reached
4. Have a final discussion: What best practices can contribute to success? What hinders or weakens organizations and collaboration?

Example script: Organize for power (example – this should be adapted to the local situation).

Characters:

- Victor: President of the cooperative
- Anna: Treasurer of the cooperative
- Luiz: Fisher
- Julia: Fisher woman
- Captain Rodrigues: Fisheries manager

The local river has suffered a strange environmental disaster, with the unexpected dying of various kinds of fish. Close to the river, there are intense monocultures of sugar cane and coffee. There is also a diamond mine and some weaving industries. The riverside community and especially artisanal fishers of that region are severely affected by both the environmental impact of the destruction caused by the monocultures and the industries as well as the economic impact, since fishing decreased. The marketing of fish is also affected because many people do not buy fish as they are afraid to eat the fish unless the cause of the dying fish is identified.

*The President of the Fishers Cooperative is Victor. He is talking to the Treasurer, Anna, about the difficulties they are experiencing. As there is no income, the cooperative does not have money to pay the bills for electricity, water and telephone. Some fishers enter the room to ask whether something is being done.*

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<sup>2</sup> Source: Kalikoski, D., Dias Neto, J., Glinfskoi Thé, A.P., Ruffino, M.L. & Marrul Filho, S. 2009. Gestão compartilhada do uso sustentável de recursos pesqueiros: refletir para agir. Brasília, Ibama. 184 pp.

*Luiz: Good morning, Anna and Victor. So what do we know about the fish disaster? Do we know who is responsible? Our wives are complaining that we have no money. It is the role of the cooperative to resolve these issues.*

*Julia: Really ... I heard that it was from the a farm Somewhere upstream Have you heard this Victor? Has the staff of the Forestry unit said anything?*

*Victor: Guys, you know how these government agencies are: they never say anything to us. But I went there right away to report the dead fish. It appears that the State Environmental Department came to collect water two months ago but the results still were not ready.*

*Julia: That's it, Victor? And you, Anna? And we don't do anything? Talk to a lawyer?*

*Anna: It is very difficult to mess with these things Julia. I have to go to the capital to talk to the prosecutor and we have no money.*

*Luiz: So nothing is done? Where is all the money?*

*Victor: What are you saying, Luiz? You think we are stealing from the cooperative? We have already paid the full year costs of the building here, mail and passage to go to the annual fishing federation meeting and money is collected only once a year from the cooperative members at the end of the year. Does anyone help out? Everyone disappears right after the election and no one comes to the meetings.*

*Julia: For what? The meetings do not solve anything, the problems are still here. Nobody says anything during the meeting, only Victor, and when they start talking, everyone only complains about the mess, and the meeting ends without resolving anything.*

*Luiz: The situation is this: The cooperative has no money, the fishers have no money, no one respects us, no one cares if we are starving!*

*Shortly thereafter, the phone rings and it is the Commander of Environmental Policing who wants to give news of a new ordinance for the state fishery, which had already been published five days ago in the Official Gazette.*

*Captain Rodrigues: Victor, how are you?*

*President Victor: I'm fine, captain. I am here talking with cooperative staff about the bad situation here. Have you any news, sir? Have you the seen the results of what caused the death of the fish?*

*Captain Rodrigues: Well, Victor I have not seen the results. It takes a lot of time because they have to send all to the laboratories, which then forward the results to the technical team who makes the report, and the board of the Institute of Waters of the State must approve the report. Only then do they publish the result of what probably happened, but it is not always possible to prove, because there is a lot of sewage in the river, industrial and domestic, there are the runoff from the farmland ... it will be difficult to find the cause.*

*Victor: Well, captain, but so what do we do?*

*Captain Rodrigues: Well, not wanting to cut you off Victor, but I'm calling to give you information about a new ordinance that has been issued. It is not for me to question the law, only to apply it. I am forwarding this law to you.*

*Victor: That's right, captain. We are here now. You can tell us now.*

*Captain Rodrigues: I'll talk, but no use questioning me because I only apply the laws. Since March 5, all fishing is prohibited in the entire stretch of the river, indefinitely.*

*Victor: What? But it cannot be? How is that?*

*Captain Rodrigues: I am forwarding the ordinance to you, Victor, so please warn all fishers, starting tomorrow, the patrol will be on the water fining anyone caught fishing in the river. Victor: Hold on, captain! But as it is ...!*

*Line goes dead.*

*Julia: What happened?*

*Luiz: Just tell me, what did the captain say?*

*Victor: There is a new ordinance from the state. The river is closed to fishing. We can no longer fish. It was already hard to sell at least we could eat, right? But now? Not so!*

*Anna: Ah! But we have our rights, we must receive unemployment insurance!*

*Julia: What do we do? Not right, no! Why are we getting punished when it wasn't our fault?*

Discussion: What can be done? How could the crisis of lack of money have been avoided? What can they do now?

## facilitators' notes

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It is important to use local scenarios so that the participants can identify with them. There usually are many situations like the one in the example where fishers are disempowered. Another common scenario is distrust and poor performance of organizations but a need to work together when an outside threat arises. Have a brief discussion with the participants to identify potential scenarios before the exercise.

## 🔄 exercise 5

### GOOD MANAGEMENT PRACTICES

#### OBJECTIVE:

Understand the basics of managing fish and fishers.

#### TIME:

1.5 hours.

#### MATERIALS:

Writing support, pens.

#### STEPS:

1. Divide participants into two or more groups.
2. Ask each group to find a way to balance the fishing activity with a limited available amount of fish.
3. Let them brainstorm as long as they need, also using what they learned in the previous two sessions.
4. Ask the participants to present their ideas to the groups.

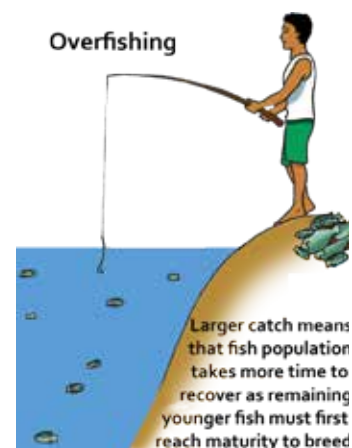
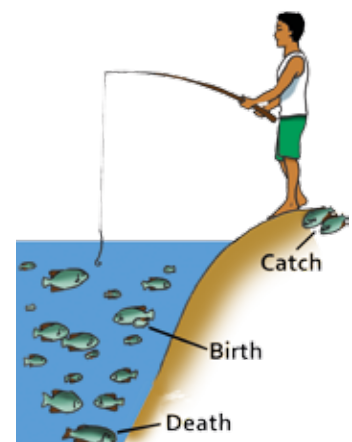
### 🔄 facilitators' notes

Fish populations will increase until they reach an environmental limit, the so-called carrying capacity. Once reached, population growth will level off. Population growth is the difference between new production (birth) and mortality (death). It is therefore important to fish when the population is between the initial small size and the limiting large size to obtain the best yield from the fish (known as maximum sustainable yield [MSY]). Fishing reduces the number of fish. If done correctly, the fishing rate will be balanced by the natural recruitment of the fish stock and not harm its survival.

If we overfish, it is possible to drive the population into low productivity mode until it can finally recover. However, if fishing does not decrease, the population will struggle to increase. If we keep fishing at high levels we will have only small fish that have limited reproductive potential. It is therefore very important to balance fishing rates with population growth rates.

There are many case studies available on best fishing practices. However the emphasis needs to be on local examples that make sense in the local context. These can include selective gear, closed seasons, closed areas, a restricted number of participants in the fishery, etc.

Natural disasters and climate change will also affect the fish growth rate. For example, changes in rainfall, wind patterns, cloud cover, currents and upwelling can influence water temperature, salinity and larval transport. As fish respond to all these factors changes in distribution and abundance are likely.







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## GOING TO SEA

Fish are mainly caught from boats. Sometimes people are hurt or die when they go to sea. Why is fishing so dangerous? One of the biggest challenges is working on a boat, which is a moving platform, under changing conditions such as weather and physical ocean movements (e.g. tides, currents and waves). With climate change, extreme weather events and natural hazards such as typhoons, tropical storms, heavy rainfall and tsunamis will further increase and will bring challenges. Engines can break down, especially if not maintained, and fires can break out with gasoline engines. Injuries at sea may become infected easily if not properly disinfected. On board, it is easy to become entangled in gear and to fall. If you fall overboard, remaining calm and knowing how to swim can be crucial to survive. Another risk are overloaded boats, which can become unstable. All these factors create dangerous conditions that people need to think about, prevent and prepare for to keep out of trouble. The need to know how to respond when things go wrong. Sometimes, children participate in fishing. They are even more vulnerable and should not engage in what is called “child labour”. Child labour is any activity that is mentally, physically, socially or morally dangerous and harmful for a child and interferes with schooling. A responsible fisher will be prepared to save the life of the crew, his/her own life and the boat, and will also not hire children. A life saved is worth the time spent to either learn a new skill (such as swimming and knot tying) or to remember to carry a small tool (such as a whistle) or paying attention to the signs of bad weather.

## 🗂 exercise 1

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### IDENTIFY SAFETY HAZARDS

**OBJECTIVES:**

Be able to identify safety hazards at sea, work as a team to minimize safety risks and learn about useful tools to maximize safety.

**TIME:**

1 hour.

**MATERIALS:**

Large writing support, blindfold, materials for a course (e.g. rope, net, wave/surf representation, rock, wind, dangerous animals representation, start and end point).

**STEPS:**

Set up a course with various obstacles through which two people (preferably gender-balanced) have to move together.

1. Establish pairs of participants by counting (A, B, A, B, etc.).
2. Assign one member of the pair to be crew and one to be captain.
3. Blindfold each crew member.
4. Explain the rules of the game:
  - The captain must guide the crew through the course from the beginning to the end point, using only the voice, without touching the crew
  - The rock, net, animal, waves and wind represent hazards at sea they must navigate through
  - The game ends when all pairs reach the end point safely or return back to the beginning
5. Have the captain of each pair lead the blindfolded crew through the course, one at a time.
6. When all teams have completed the exercise, ask participants to discuss the following questions:
  - How did it feel to be a captain?
  - How did it feel to be a crew member?
  - Were you afraid?
  - What hazards did you encounter during the course and what decision did you take to avoid them?
  - Are there other potential hazards to a boat you can think of?
7. Close the discussion by asking participants to list tools that may be available to help minimize hazards

## 🔄 facilitators' notes

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Participants should learn about the following concepts with regard to safety at sea:

What are safety hazards?

- Anything that affects your ability to fish, navigate and return home safely is a hazard. Some hazards are natural, such as changing weather, and some are the result of just being on the water (e.g. risk of drowning) or a result of the activity you are doing (becoming caught in fishing gear). Sometimes they are a result of lack of planning and preparation.

Why is it important to know hazards and how to minimize their impacts/risks?

- Accidents are preventable most of the time if the captain and crew are prepared and are paying attention. Loss of life and vessels is extremely high in the fishing occupation because of the hazards.

What are causes of accidents at sea?

- A major cause of accidents at sea is human error. Some of that error is caused by lack of education, some by not planning for emergencies at sea. Another major source of accidents is a sudden change in wind and ocean current patterns - winds can change direction quickly causing boats to capsize and sink.

Importance of planning and preparation.

- If possible, check the weather forecast before leaving the shore
- Let people know you are leaving, for how long, and where you are going
- It is important to take safety items with you (first aid kit, lifejacket or personal floating device, a whistle, a mirror a torch, a bailer)
- Know what the effect of tides and wind direction are, especially in certain areas
- Be aware of dangerous animals (fish spines, poisonous animals, etc.)
- Prepare against sun exposure (always take water)
- Bring some form of communication (radio and/or mobile phone)
- Be aware of who is your closest rescuer when out at sea (in case you encounter a problem) - be aware of your surroundings
- Maintain your gear properly and always check it before heading out
- Use the right knots
- Ensure regular engine and boat maintenance (including tools and spare parts)
- Check that fuel is sufficient for the trip
- Take care of injuries right away
- Know when to cancel a trip and return to port

Tools that would help with survival at sea: rags, knife, visible stuff, dye, compass, mirror/aluminium foil, buoys, first-aid supplies, sea anchor, rope, life preservers such as life vests, radio, mobile phone, lights, food and water, whistle, flares, tide plan.

Skills that would help with survival at sea: simple navigation, GPS, swimming skills, plan for potential emergencies, simple first aid.

Children are also often involved in fisheries and are particularly vulnerable to accidents. Child labour is harmful for the development of a child and interferes with schooling. There are international standards developed by the International Labour Organization to protect children and eliminate child labour.

More information can be found in the JFFLS module Child labour prevention in agriculture (available at [www.fao.org/docrep/013/i1897e/i1897e.pdf](http://www.fao.org/docrep/013/i1897e/i1897e.pdf)).

## ☺ exercise 2

### WHAT FLOATS YOUR BOAT?

#### OBJECTIVES:

Understand the concepts of stability and buoyancy and what makes a boat safe.

#### TIME:

1 hour.

#### MATERIALS:

Writing support, tub of water, a piece of wood, large long board of wood, a big rock, small rocks or coins, if possible a boat shaped container that can be rocked (to simulate the rolling period) and filled with water (free surface effect).

#### STEPS:

1. Pour water into the tub until it is about half full.
2. Ask the participants: Who thinks that wood will float? If you think wood floats, raise your hand. Who thinks that a rock will float? If you think rocks will float, raise your hand.
3. Gather the participants around the tub and first introduce the piece of wood and then the rock.
4. Ask the participants: Why do you think materials float? Do you know what buoyancy is? Discuss the concept with the class and ask them to give examples of something being buoyant.
5. Try to sink the piece of wood by pushing it down. Observe with the group what happens and let them describe it.
6. Try to make the rock float. Ask participants how this could be achieved.
7. Have participants look for other objects to test whether they sink or float.
8. Before putting the object in the water ask participants to predict whether it will sink or float.
9. Explain the simple principle of displacement-density versus buoyancy by asking these questions:
  - Are you going to float like a piece of wood or sink like a rock? Why? If you are a rock how do you become more buoyant?
  - How can you make sure that you float? Do you have the right tools?
10. Once these principles are understood, explain what changes the stability of a floating object:
  - Take the board and place it on a large rock. Have two participants of similar weight sit on each end of the board (like a see saw). Explain how the fact that the weights are equally distributed maintains the board stable. Then place two participants of different weights (or two on one side and one on the other) and talk about how this affects the board.
  - Next, take the floating boat object (something



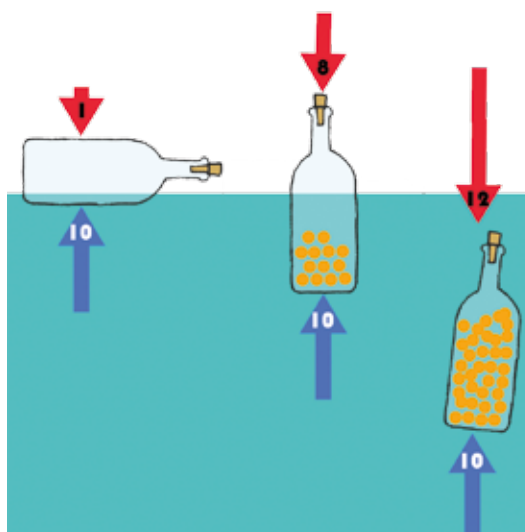
that is open and floats so you can fill it and displace the air with water) and put objects on one end until it becomes unstable. Relate it back to loading a boat with gear or catch on one side: the boat becomes unstable and can capsize. This is especially true in rough seas if a wave comes over the side of the boat.

## 🔄 facilitators' notes

Participants should have an understanding of these concepts with regard to buoyancy and vessel stability:

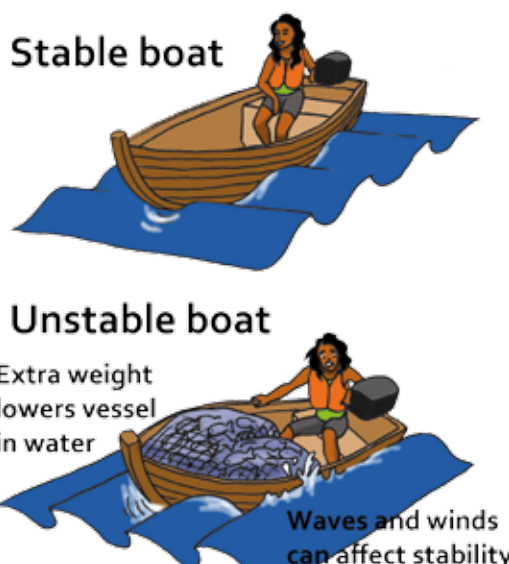
### Buoyancy

- Buoyancy is a rather complex principle. It is the tendency of an object to float or to rise when submerged in a liquid. The underlying fact is that every floating object displaces its own weight of the liquid in which it floats (Archimedes principle). It helps a duck float in the water! If the object has a density that is lower than that of the fluid, it will float at a level where its weight equals the weight of the liquid it is displacing. The buoyancy provided by the underwater parts of your vessel, coupled with the combined weight of its hull, equipment, fuel, and catch, determines the stability of your vessel.



### Stability

- Stability is the ability of a vessel to return to a previous position. The stability of your boat will not remain the same – it constantly changes throughout your trip. The directions of the sea and wind have a big effect on your stability. Be aware of the direction in which you steer your vessel and where the waves and wind are coming from. The centre of gravity will move in response to sea and wind and the weights you add and those you remove. It moves towards any added weights and away from weights that are removed. Loading extra fish on deck lowers the vessel in the water, limiting both its range of stability and the catch you can safely carry. It may also lift the centre of gravity dangerously. This limits the range of stability and could bring the boat much closer to a capsize condition. You should always be aware of how much extra weight you put on board your vessel.



## 🔄 exercise 3

### KEEP IT WORKING – SIMPLE MAINTENANCE

#### OBJECTIVES:

Understand the different maintenance requirements of the boat, engine and gear to ensure safety at sea.

#### TIME:

30 minutes.

#### MATERIALS:

If possible, print out pictures of local boats; if not prepare simple drawings such as below (one for each group).

#### STEPS:

1. Divide the group into smaller, ideally gender-balanced groups.
2. Provide each group with the picture. Ask each group to discuss the following questions:

- What is wrong with this picture?
- Is it safe to go to sea in this vessel?
- How could the situation be improved?



Option 2: Organize a field trip or use a picture from the local area to show the difference between a safe boat and one that needs critical maintenance.

## 🔄 facilitators' notes

#### Engine maintenance:

- After every trip, wash and flush out the engine. This does not only apply to trips in saltwater, but also to trips in freshwater.
- While the motor is being flushed, check the water pump to make sure you have good water flow.
- After flushing the engine, you should disconnect the fuel line and allow the engine to burn all the fuel in the carburettor.
- Ensure the cover of the engine is secure and not cracked or damaged.
- Check the lower unit oil and change if necessary.

#### Fuel:

- Check the fuel line for cracks and worn spots.
- Make sure the fuel primer bulb is not cracked and is pliable.
- Make sure the fuel line fittings seat properly and do not leak.
- Check the clamps on the fuel line for rust or corrosion.
- Check the fuel tanks for damage and corrosion.
- Check the tank vent to make sure it aspirates properly. Check for water in the fuel.

Other:

- Keep the interior of the boat free of standing water to avoid rotting.
- Keep the hull and decks of the boat clean and free of debris and trash. Dirt attracts moisture and moisture attracts rot.
- Make sure ropes on board are not frayed or weak.
- Inspect the chain and anchor to ensure that they are in good condition.
- Keep the general interior of the boat painted, varnished or oiled to repel moisture. The finish is a moisture barrier that keeps water from penetrating the wood.
- Check for scratches and thin spots in the finish and repair them to prevent the formation of holes.
- Replace any weak or loose boards or planks.

## exercise 4

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### S.O.S. (SAVE OUR SHIP)

#### **OBJECTIVES:**

Raise awareness about the importance of reacting quickly to emergencies.

#### **TIME:**

1.5 hours.

#### **MATERIALS:**

A small boat\* (one that holds at least two people) with a hole not larger than a fist below the waterline, a rag (about 1 m × 1 m), a large plastic bag, scrap fishing net, a bucket of dirt/sand, newspaper, location with at least waist-deep water (\* Every fishing village is likely to have at least one old boat on the beach in need of repair. These can be used in the water or just on the beach to simulate the activity. If you use a boat in the water, make sure there are additional adult helpers to assist participants in the water and ensure no one is at risk).

#### **STEPS:**

1. Start the exercise by placing all items in the boat on shore.
2. Plug the hole with a piece of wood or other materials that can be easily removed.
3. Ask the group to move the boat into shallow water.
4. Ask for two volunteers and ask them to sit in the boat while others hold it stable.
5. Tell the group that the boat has hit a submerged rock and the two volunteers must fix the leak before they lose the boat and become stranded at sea.
6. Have the rest of the group help pull the boat into waist-deep water, ensuring that no one risks drowning (see comment in the “material” part above).
7. Once in the water remove the plug from the hole and ask the two volunteers to plug the leak before the boat sinks to the bottom.
8. Once completed (the boat sinks or floats), bring everyone back to shore to discuss:
  - What items were used to plug the leak?
  - Were these items effective?
  - Could other available items have been used for better success?
  - If the leak was plugged: Did the volunteers try to empty the water that was in the boat?

- What are the implications of not plugging the leak?
- Was there time to think through all of the available options?
- Can you imagine any real-life scenarios where this exercise would be helpful?

## facilitators' notes

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Participants should have an understanding of the following concepts related to an emergency flooding situation at sea:

- Any breach in the hull of a vessel is dangerous, no matter how big or how small
- If a leak cannot be stopped completely it should be slowed by filling the breached area with any available materials
- All water that is in the vessel must be removed with a bailer (or container) or by hand, a flooded vessel is unstable and may capsize in rough seas

The key to saving a leaking vessel is quick thinking and ability to use available materials. A little creativity can make the difference in a dangerous situation.

## exercise 5 (optional)

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### KNOW YOUR KNOTS

#### **OBJECTIVES:**

Demonstrate proper knot tying techniques and understand the practical uses of knots.

#### **TIME:**

1 hour.

#### **MATERIALS:**

Pieces of line at least 2 m in length, a tree or pole fixed securely in the ground.

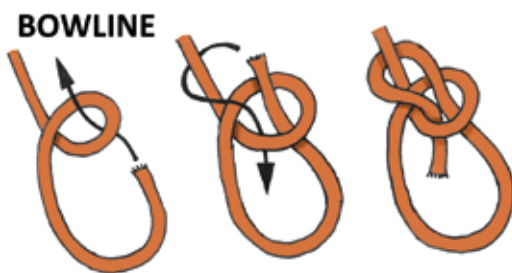
#### **STEPS:**

1. Ask a few of the participants to tie a loop in the line that secures them to the tree.
2. Have them pull on the loop tightly. What happens?
3. Ask them what the implications are if the knot slips.
4. If the knot does not slip, what are the implications?
5. Have them pull tightly on each knot, then have them try to untie the knots.
6. Discuss if it was difficult to do. Could it be done with one hand? Could it be done quickly?
7. Explain how to tie a *bowline knot* and give each participant a chance to practise the knot. Repeat the steps above using the bowline knot.
8. Discuss the benefits of the *bowline*.
9. What every day uses does this knot have?
10. What emergency uses does this knot have?

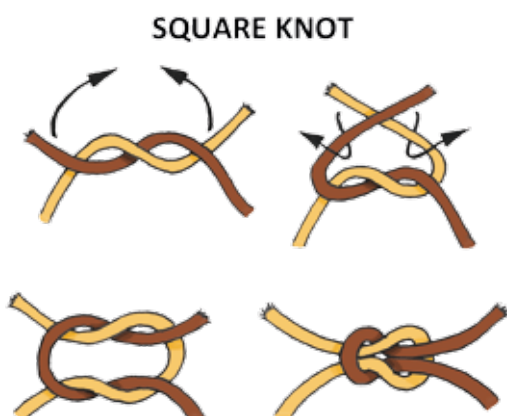


11. Secure one of the lines to the tree using a *bowline*, hand the end of the line and an additional line to one of the participants and ask them to connect them to make one continuous line.
12. Carefully pull on the line. What happens?
13. If the knot slips, what are the implications?
14. If the knot holds, what are the implications?
15. Have them pull tightly on the knot, then have them untie it. Was it difficult to do? Could it be done with one hand? Could it be done quickly?
16. Explain how to tie a *square knot* and give each of the participants a chance to practice the knot. Repeat the steps above using the *square knot*.
17. Discuss the benefits of the *square knot*.
18. What every day uses does this knot have?
19. What emergency uses does this knot have?

## 🔄 facilitators' notes



A **bowline** can be used in any situation that a secure loop is required. It will maintain about 65 percent of the line strength with which it was tied. A bowline is easy to take apart: once tied, the knot can be flipped over and bent in half at the centre point of the knot. This will loosen the knot so that it can be easily untied. A bowline is an excellent rescue loop when put over a person's head and under the arms. This loop will not slip and suffocate the person as a standard slip knot loop would.



A **square knot** can be used any time two line ends or separate lines need to be joined together. A square knot will maintain about 45 percent of the line strength with which it was tied. This makes it a weak knot that should not be used for continuous load bearing applications. By pushing the two sides of the knot together a square knot can be easily taken apart. In an emergency situation, this knot can be used to connect short pieces of line to throw to a person in the water. Do not use this knot to lift people out of the water.

## 🕒 exercise 6 (optional)

### LEARN TO SWIM

#### OBJECTIVES:

Learn two key swimming strokes through step-by-step instruction and practise treading water in water, for one minute with clothes on.

#### MATERIALS:

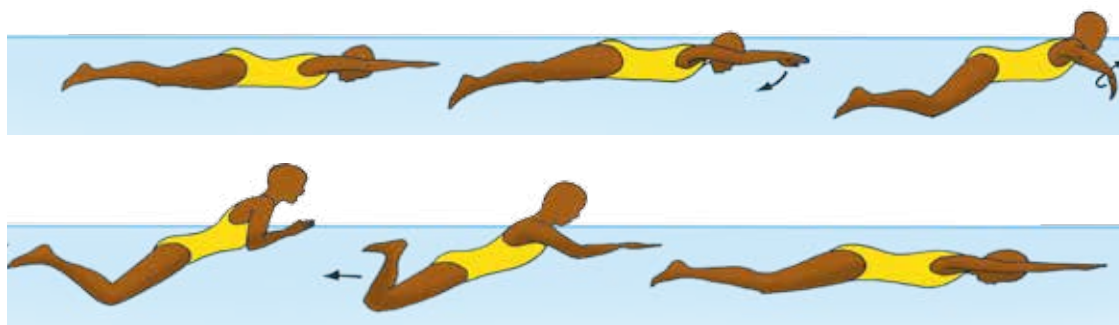
Access to shallow water.

#### STEPS

##### Breaststroke

The breaststroke is performed by leaning on the chest with the arms breaking the water slightly and the legs staying under water constantly. The body should be in line with the water surface and the shoulders and hips flat in the water. The arms are moved in a long circular motion and the legs are kicked in a movement similar to a frog's kick, which is what slows the swimmer down. The one difficulty in the breaststroke is that the legs and arms are used in synchronization.

1. Explain the different movements
  - **Arm movement:** Start out by placing your arms out in front just under the surface of the water. With your palms facing outwards push both hands out and around as if drawing a full circle. Your hands finish by stretching forwards again. Your arms and legs should stay in the water all of the time and you should not splash when doing the stroke correctly.
  - **Leg movement:** From the initial position move your feet and legs together, like a frog would. Simply bend your knees and lift your feet up as far as your posterior. Turn your feet out in preparation for pushing back with the bottom of your foot. Move your feet out and in again to meet each other, and straighten your legs with your knees touching. It is a good idea to practise this movement, for example at the side of the pool, by holding onto a support rail or somewhere close to the shore where you can hold on to something with your legs stretched out behind you.
  - **Breathing:** Once you have mastered the leg and arm movements you will notice that your head starts to lift naturally at the end of the cycle. When this occurs simply lift your face out of the water and take a breath in through your mouth. Put your face back into the water breathing out through your nose and mouth, as you stretch your arms forward to begin the circle again.
  - To put the stroke together, pull your arms and breathe in while pushing your legs back and stretching out with your body level in the water.
2. Without going into the water, practise the arm and leg movements with the group while sitting:
  - Sit with legs extended, turn feet up and out, bring knees in and make a kick like a frog
  - Ask participants to extend their arms out in front with their palms touching, then to bring the hands to the chest to mimic the stroke
  - If participants feel comfortable, add the head and breathing techniques

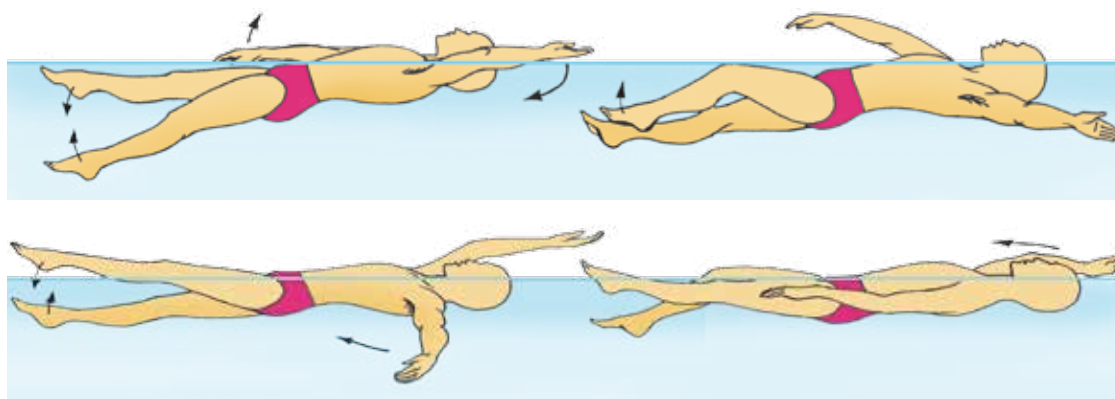


### Backstroke or back crawl

The advantage of the backstroke is the ability of easy breathing but the obvious disadvantage of this stroke is not being able to see where you are going. However, in a survival situation especially when a person is out of energy and stranded out in a body of water, the best things you can do is float on your back and gently kick and use your hands to propel yourself forward. The backstroke requires the swimmer to float on the back, body straight but relaxed.

#### 1. Explain the different movements

- The arms reach alternately over the head, in line with the shoulder and palms outward. The arms are then thrust outward at shoulder level and swept to the sides. To move more quickly through the water, the swimmer kicks the legs in a rapid thrashing movement, or flutter kick.
- The arm movements resemble a windmill. Keep one arm straight as you raise it out of the water from your waist to a fully extended position. The other arm should be bent and pulling a cupped hand along your side in the water, entering the water little finger first. Always keep your head floating back in the water with your eyes looking up and breathe normally.
- While floating on your back, kick your legs up and down. The legs are kept straight but not entirely rigid and toes should be pointed out. When kicking, churn the surface of the water but try not to make a big splash.



### Treading water

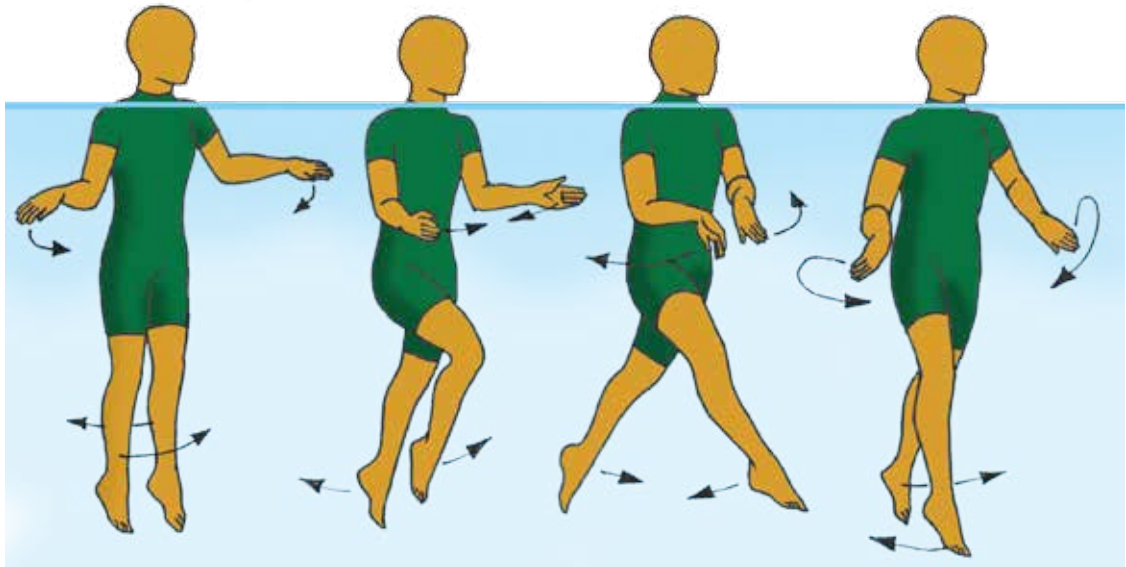
Treading water is a very important skill for water survival. It can be used while waiting for help to arrive after entering the water owing to an unforeseen event, i.e. falling overboard or ship capsizing. Treading water takes a lot of energy, so it should be used in appropriate survival situations such as heavy waves or currents that make other techniques difficult to utilize such as to back-float. Treading water can also be used to keep the body moving and warm while waiting for rescue in cold water.

#### STEPS

1. Describe the proper technique for treading water prior to participants entering the water:
  - Body position: keep your body upright with the head out of the water.
  - Hand and arm movements: make slow sculling movements (sculling is the term used to describe the rhythmic motion of the arms and hands to manipulate the water for upward thrust keeping the body vertically afloat) under water to maintain the vertical body position. A common sculling action is the figure eight.
  - With the fingers together and palms facing downward, draw a figure eight with each hand, pushing the water downward and outward during the motion. Keep the arms slightly bent in front of the chest. Use a minimum of effort to avoid excessive fatigue.
  - Leg movements: Make slow, continuous bicycle-like or scissor-kick type movements to support the body.

2. Have participants practise treading water: first perform the leg motion alone for 20 seconds or more, and then gradually add the arm movements.

Note that working legs and arms at the same time keeps the head well above water. Shoulders or chest may even be above water depending upon body weight, specific gravity, strength, etc. Safety tip: in an emergency, remove any heavy boots or coats that could hinder your movement, but retain the rest of your clothing to stay warm.





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## GETTING THE FISH

Fish can be caught in many different ways. How a fish is caught matters. It matters to the fish, the habitat, and ultimately to the processor and the consumer. The choice of fishing gear to use is a combination of factors such as materials available, type and size of boat and crew, seasons, weather conditions, distance to fishing grounds, cost of fishing, species behaviour, habitat, moon phases, and, ultimately, the traditional knowledge and skills of the fisher. The goal is to catch the size and species you want to keep while minimizing the fish you throw back (“discard”). The goal is also to reduce costs and the impact on the environment and to produce the highest-quality fish possible. It is very important to recognize that all gear types and fishing methods have some good and some bad features.

## 🗂️ exercise 1

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### CATCH IT!

#### OBJECTIVES:

Identify local gear.

#### TIME:

4 hours.

#### MATERIALS:

Pens, writing support.

#### PREPARATION:

Prepare a trip to the local fishing village by talking to experienced fishers. Identify a number of fishers willing to share their knowledge and to explain the gear and fishing techniques to the group. Give them some points that they should cover when the group visits them (along the lines of the questions here below).

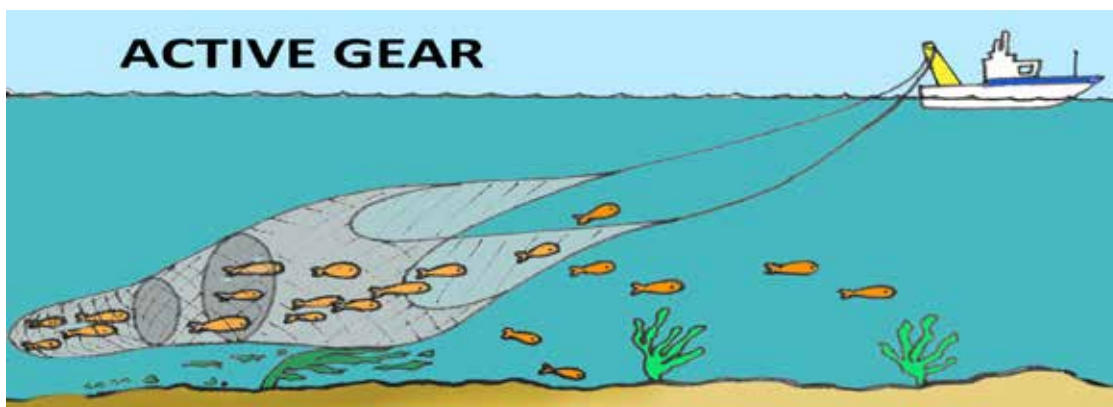
What other interesting things did you find out by talking to the fishers?

#### STEPS:

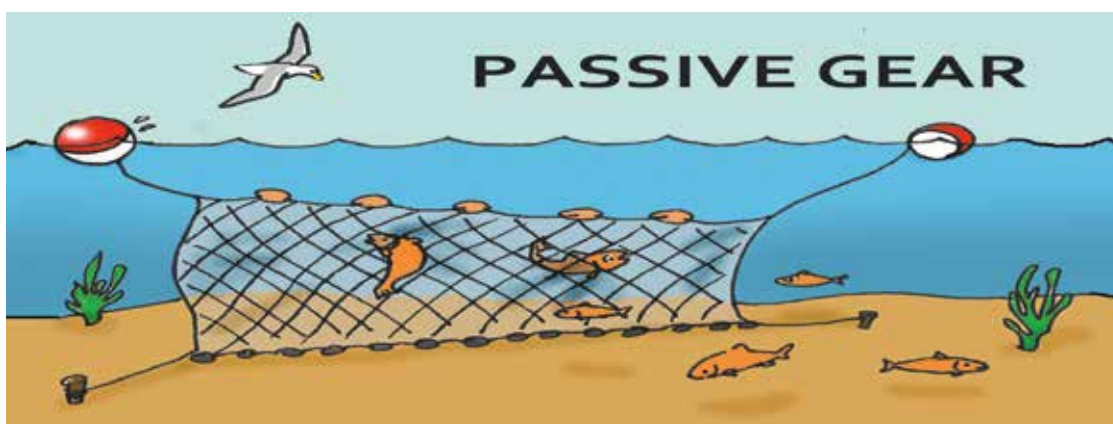
1. Ask the group what they know about fishing gear: Which gear do they know? How is it made? Which species does it catch?
2. Take the group to the local fishing village.
3. Divide the group in smaller teams, possibly ensuring gender balance.
4. Ask the participants to talk to the fishers and to find out about the following questions:
  - Does the gear move or does the fish come to the gear?
  - What material is the gear made of?
  - What fish behaviour allows the animal to be caught with this gear?
  - Which species are targeted with the gear? What happens to the ones that are not targeted?
  - Name some advantages and disadvantages of the gear
  - What are the chances the gear will be lost (high probability or low)?
  - How much does the gear cost?
  - What is the impact of the gear on the environment?
  - Who makes the gear? Who repairs it?
5. When back, ask each group to present what they learned.

## 🔄 facilitators' notes

Fishing gear is commonly divided in active gear and passive gear. In the case of active fishing gear, the fish is either swept up by gear from the sea bed or filtered from the water column [add illustration] by gear that is towed through the water or over the sea bed by a fishing vessel or a person. Passive fishing gear is usually stationary in the water or on the sea bed and only brought up on a periodic basis. Owing to the stationary nature of this gear, conflicts often arise in areas where mobile gear is prevalent.



Fishing gear is also divided into mobile gear and fixed gear. Mobile fishing gear is towed through the water or over the seabed by a fishing vessel. Fixed fishing gear is stationary in the water or on the seabed, and it is sometimes left unattended to capture fishery resources and only brought up on a periodic basis. Due to the stationary nature of this gear, conflicts often arise in areas where mobile gear is prevalent.



Fishing gear is commonly made of materials that fall into two groups, synthetic or natural. Synthetic materials take a long time to deteriorate, making them ideal for constructing gear that will last, but also causing problems related to pollution and ghost fishing when lost or discarded at sea. Synthetic materials can be made visible (polyester twine) or invisible in water (monofilament line) allowing for the construction of more efficient gear. Plastic coated wire is commonly used in the construction of pots and traps to prevent deterioration. Natural materials such as wood and cotton twine are often used as cheap or readily available alternatives to synthetic materials. Natural materials tend to degrade quickly and require more maintenance than synthetic materials. The advantage to natural materials is that they are biodegradable and will break down naturally if lost at sea.

It is important to emphasize that different species can be captured with various types of gear, while some species are gear specific. Knowing fish behaviour and habitat preference will help determine the type of gear. Fishing gear can be modified to prevent ghost fishing as well as be species selective to avoid unnecessary bycatch. Fishing gear can be constructed to accommodate the size of the fishing operation in which it will be used.



## 🔄 exercise 2

### DON'T CATCH IT!

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#### OBJECTIVE:

Demonstrate the selective properties of gear.

#### TIME:

1 hour.

#### MATERIALS:

Local gear – pieces of netting, several hook types and sizes, trap/pot; different types of fish with different mouth shapes and other seafood if available (e.g. crustaceans, molluscs).

#### STEPS:

1. Ask participants to look at the gear.
2. Ask the following questions:
  - If an object is too large, what happens?
  - If an object is small and passes through the mesh, what does this mean? Is any damage done to the fish even though it is not caught?
  - What can you do to reduce injury to fish?
  - What happens if the webbing is hung loose? Hung tight? Does it make a difference on selectivity?
3. Ask the participants to look at the fish and the hooks and the other gear.
4. Ask the following questions:
  - How can the fish become caught? Do they swallow a hook, are they hooked on their lip or on another part of their body?
  - What type of damage will be done to a fish that is caught? And to one that escapes?
  - How can you reduce injury to the fish you do not want to catch?
5. Explain hook size, treble hooks and circle hooks to the group.

### 🔄 facilitators' notes

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There are several approaches to reducing the amount of fish that you do not want to catch. They fall into three main categories: 1. keep fish out of gear by not catching it; 2. minimize damage to fish that are caught but will be released; and 3. help fish escape if they become caught.

Gear selectivity refers to the property of the gear that allows the actual catch to have a different composition from the fish population in which the gear is being used. It is the fishing method's ability to target and capture organisms by size and species during the fishing operation. Selectivity can be demonstrated by trying to pass objects of different sizes through the mesh.

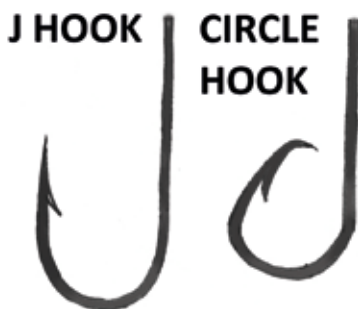
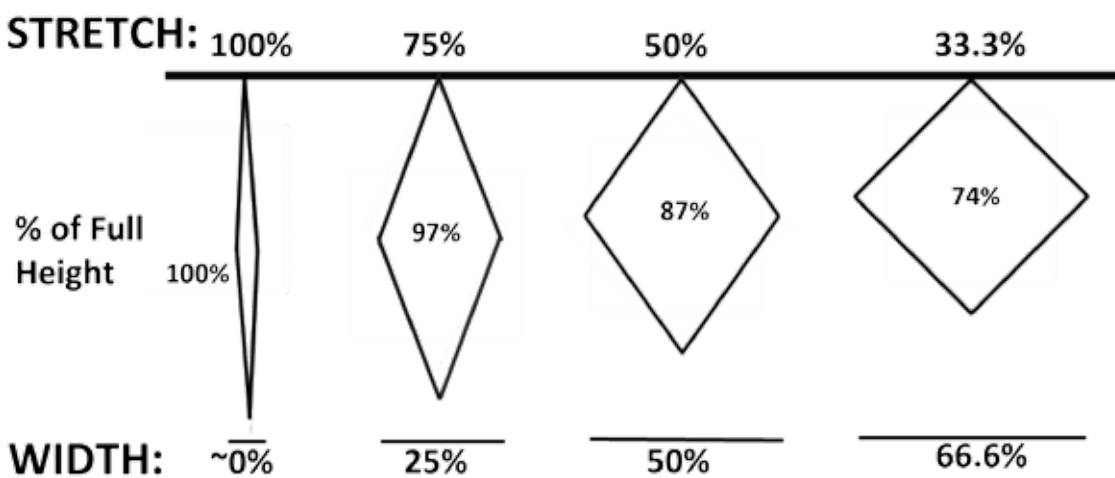
What makes a gear selective? Traditional fisheries management often uses a minimum fish length that can be caught legally as a way to protect species from overfishing. The established minimum length is usually based on the size of the fish at maturity – allowing a fish to reproduce at least once or twice before it becomes legal size. To avoid catching undersized fish, fisher can use gear with specific characteristics such as minimum mesh size, certain mesh shapes, minimum hook size and



appropriate shape, vent size, appropriate bar spacing and ring diameter to control the size of the fish caught.

Gillnets are considered to be one of the most selective gears available. The selectivity of a gillnet is controlled by the size of the meshes, the hanging ratio (HR) and size of the net. The shape of the meshes is controlled by the hanging ration (HR). The HR is on a scale from 0 to 1, with 0 being a mesh that has no width and 1 being a mesh that has no height. The body shape of the fish will help determine the necessary HR used to capture a particular species. Narrow bodied fish will require a smaller HR, whereas a wide bodied fish will require a larger HR. Knowing the behaviour and morphometric characteristics of the target species is also crucial in the design and type of gillnet chosen.

**RATIOS OF A MESH TO DIFFERENT HANGING PROPORTION**



A circle hook is a fishing hook that has been designed with its point bent towards the shank of the hook, creating a bend that is circular or oval in shape. How does it work? Fishing with circle hooks is quite different from fishing with traditional “J” hooks. The fisher does not have to “set” the hook but just to keep tension on the line when fish bites it. The design of the hook allows it to slide out of the fishes throat and gut cavity to the point of resistance on the lip, where it hooks the fish, avoiding gut hooking which is usually fatal for the fish. Circle hooks can be used to catch any species traditionally caught using hook and line.

## ☺ exercise 3

### WHERE IS MY FISHING GEAR?

#### OBJECTIVES:

Raise awareness about the risk of ghost fishing and the importance of marking fixed gear.

#### TIME:

2 hours.

#### MATERIALS:

Large plastic bottles, foam, rice bags or similar bags, plastic bags, rocks, pieces of scrap metal, long sticks or poles, scrap netting, pieces of twine, rags, large drum of water or body of water.

#### STEPS:

1. Divide the participants into groups of four (can be larger or smaller depending on available supplies and the size of group – if possible try to ensure gender balance!).
2. Explain to the groups that they will be making buoys to attach to fishing gear. They are allowed to use the supplies in front of them and will have 45 minutes to complete the task.
3. Instruct the participants to collaborate with the other members of their group to come up with a buoy design that is both durable and visible.
4. Explain to the groups that their designs will be tested for buoyancy and for visibility.
5. Once the groups have completed their buoys have one participant from each group explain their design.
6. Test all buoys:

#### Buoyancy test

- Go to any body of water (but avoid high current area) or use a drum of water
- Place the buoys in it
- For each buoy, ask the group who prepared it: Does the buoy stay on or above the surface? If so, how far? Is the buoy resistant enough (push it under water a few times to mimic rough ocean)?
- If a flag or pole was attached: Was any ballast used to keep the pole upright?
- Are there leaks, saturation or other design flaws that may cause the buoy to sink out of sight?
- How would the buoy stand up to rough seas and heavy currents?

#### Visibility test

- This test can be performed in a body of water or in a field that has low bushes or small mounds. The purpose of this exercise is to mimic conditions similar to a rolling sea or a windblown body of water
- Place all buoys next to each other in a position similar to how they floated on the surface in the previous test
- Have the groups stand side by side and keep walking backwards away from the buoys until they can no longer see them
- Ask the following questions: Which buoys disappear first? Why?
- What are the advantages of the buoy that disappeared last?
- Is there a practical reason for having tall buoys with flags on top?
- Could the buoy designs be altered to make them better?
- How could you make buoys unique so as not confuse them with other fishers' buoys?
- Would one type of buoy work better for certain fishing gear?

## facilitators' notes

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Any product that has buoyancy can be used to construct a buoy, as long as it does not leak or become saturated with water when placed in water for long periods of time. Metal, rocks and lead can be used as ballast at the base of buoys to keep them vertical, even in rough seas. Fixed gear without proper buoys is easily lost and can contribute to ghost fishing and pollution. Lost fishing gear is lost money. Lost fishing gear also threatens the sustainability of the fisheries resources if it floats without control. When lost fishing gear (nets, traps, etc.) continues capturing and killing fish this is called “ghost fishing”.

With regard to visibility, it is important to realize that changing weather patterns and increased storms caused by climate change may increase the need for visible buoys in some areas. Proper marker buoys will help prevent other boats from running over and cutting lines, which makes it difficult to find gear. In rough seas and heavy current, a surface buoy may be pulled under water, making it difficult to locate. Buoys with long poles with flags on top are visible from a much greater distance than surface buoys. Using bright paint, cloth or plastic can make it easier to see buoys and also create unique colour signatures to identify individuals' gear. Using properly tied knots can help ensure secure connections between your gear and the marker buoys.

## Ⓞ exercise 4

### WHY REPAIR MY GEAR?

#### OBJECTIVES:

Understand the importance of maintenance and the relationship between gear maintenance and income.

#### TIME:

3 hours.

#### MATERIALS:

Playing cards prepared based on the table below, three small square pieces of webbing/fabric, twine and mending needle.

Front	Back	Front	Back	Front	Back
<b>Week 1</b>		<b>Week 1</b>		<b>Week 1</b>	
Fisher 1 Day 1	New Gear Catch = 10	Fisher 2 Day 1	New Gear Catch = 10	Fisher 3 Day 1	New Gear Catch = 10
Fisher 1 Day 2	Storm Ruins Gear One Day Repair Catch = 0	Fisher 2 Day 2	Storm Ruins Gear No Repair Catch = 5	Fisher 3 Day 2	Storm Ruins Gear Waiting For New Net Catch = 0
Fisher 1 Day 3	Repaired Gear Catch = 10	Fisher 2 Day 3	Damaged Net Catch = 5	Fisher 3 Day 3	Storm Ruins Gear Setting Up New Net Catch = 0
Fisher 1 Day 4	Repaired Gear Catch = 10	Fisher 2 Day 4	Damaged Net Catch = 5	Fisher 3 Day 4	Traded Catch to Pay For New Net Catch = 0
Fisher 1 Day 5	Repaired Gear Catch = 10	Fisher 2 Day 5	Damaged Net Catch = 5	Fisher 3 Day 5	New Gear Catch = 10
<b>Week 2 Repaired Gear Maintains Catch Efficiency</b>		<b>Week 2 Damaged Net Becomes Less Efficient Over Time</b>		<b>Week 2 New Gear Maintains Catch Efficiency</b>	
Fisher 1 Day 6	Repaired Gear Catch = 10	Fisher 2 Day 6	Damaged Net Catch = 4	Fisher 3 Day 6	New Gear Catch = 10
Fisher 1 Day 7	Repaired Gear Catch = 10	Fisher 2 Day 7	Damaged Net Catch = 4	Fisher 3 Day 7	New Gear Catch = 10
Fisher 1 Day 8	Repaired Gear Catch = 10	Fisher 2 Day 8	Damaged Net Catch = 4	Fisher 3 Day 8	New Gear Catch = 10
Fisher 1 Day 9	Repaired Gear Catch = 10	Fisher 2 Day 9	Damaged Net Catch = 3	Fisher 3 Day 9	New Gear Catch = 10
Fisher 1 Day 10	Repaired Gear Catch = 10	Fisher 2 Day 10	Damaged Net Catch = 3	Fisher 3 Day 10	New Gear Catch = 10
<b>Total Catch</b>	<b>90</b>		<b>48</b>		<b>70</b>

#### STEPS:

1. Start a discussion about why it is important to take care of gear. How is gear repaired in the area? Who does it?
2. Choose three participants to represent fishers.
3. Give each of them a piece of webbing and label them fisher 1, fisher 2 and fisher 3.

4. Ask the fishers to walk around and to pretend to fish for 30 seconds.
5. After thirty seconds hand each fisher the appropriate card for their first day of fishing (see table above).
6. Have the fishers read the card aloud to the rest of the participants.
7. Repeat this step until the ten fishing days have passed.
8. Ask each fisher to count their total catch and to present the total to the rest of the group.
9. Ask each fisher to comment on their “week” of fishing.
10. Ask the whole group:
  - Who had the most catch? Why?
  - Is there a benefit to maintaining your gear?
  - Why not replace gear every time it is damaged?
  - If you still catch fish with a damaged net, why should you repair it and lose a day of fishing?

## facilitators' notes

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Maintaining gear is an essential part of becoming a profitable fisher. Properly maintained gear will last longer and be less likely to be lost at sea where it contributes to ghost fishing and pollution. The efficiency of properly maintained gear as opposed to damaged gear is very similar to new gear. Repairing gear will help prevent incidental catch of organisms the gear is not designed for. Gear maintenance is a skill that can be passed on for generations within a fishing community and it can create employment in the local community.



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## EVERY FISH COUNTS

Fish is a good source of high quality protein and other important micronutrients. In many countries it is the primary source of animal protein and contributes to the health of children and adults. In the rush to catch as many fish as possible, we sometimes forget to appreciate the value that each fish has. No fish caught should be wasted. Therefore, we need to be careful we only catch the fish we want to keep. If we catch fish that are too small or the wrong type, the fish needs to be returned to the water alive so that it becomes available at some later time. Once caught, we need to do everything possible to ensure it reaches the consumer in the best condition. Once a fish dies, its body starts to spoil and loses nutritional value. There are ways we can catch fish, store it and prepare it to ensure it is healthy and safe to eat.

## exercise 1

### FISH IS FOOD<sup>3</sup>

#### OBJECTIVE:

Understand the concepts of a supply chain.

#### TIME:

1.5 hours.

#### MATERIALS:

Writing support and pens.

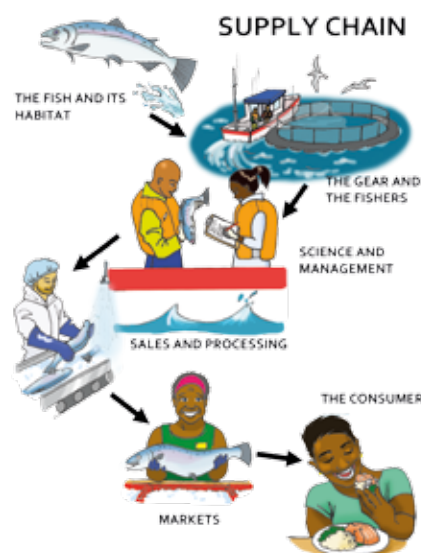
#### STEPS:

1. Draw out a sample supply chain and explain the role of the key players (e.g. habitat, fish, fisher, processors, traders, scientists, managers, consumers) and steps (see example below).

2. Ask students to draw out the supply chain from the sea to the consumer for two local species. Use two species that have different supply chains, i.e. one that is sold on the beach for direct consumption and one that is processed into a new product (you can ask a fisher to come and help the participants).

3. Discuss the roles of men and women in the supply chain. Some possible questions include:

- Who makes the boats?
- Who owns the boats?
- Who controls the money?
- Are there several supply chains for the species?
- Who buys the fish? Can they refuse to buy fish of a certain species or size?
- Who works in processing the fish?
- What happens to the parts of the fish that are not processed?
- Do men and women work in all parts of the supply chain? What is the role of children?
- What would happen to the system if a species or person or business disappeared?
- What happens to the fish that is not sold (at the landing site, at the market)?



### facilitators' notes

The supply chain includes all links from the point of production in the water to the final consumer. The supply chain for fish and fishery products can involve a large number of stakeholders between the fisher and the final consumer.

The supply of fish and fishery products is affected by a wide number of factors, such as market demand, prices, season, climatic conditions, population dynamics, economics status, fuel prices, and the policy and legal environment. The perishable nature of fish requires special attention to handling, grading and packing to avoid post harvest losses and the market price is usually dependent upon the quality of fish. Supply chains are concerned with how long it takes to present the good for sale. The main objectives of supply chain management are to reduce the number of links and to reduce friction such as bottlenecks, costs incurred, time to market, etc.

<sup>3</sup> This exercise is closely linked with the JFFLS module on Post-harvest issues in fisheries and aquaculture

## 🔄 exercise 2

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### HARVEST AND POST HARVEST LOSSES

#### OBJECTIVE:

Understand what food losses are and what causes them.

#### TIME:

1.5 hours.

#### MATERIALS:

One fresh and one spoiled fish for each small group, pans or trays to lay fish in.

#### STEPS:

1. Divide the participants into smaller groups of 5-6 people (ideally gender balanced!) and ask them to answer the following questions:
  - What does a fresh fish look like?
  - What does a non-fresh fish look like (e.g. eyes, gills, skin)?
  - What does a fresh fish smell like? A non-fresh fish?
  - How does a fresh fish feel? And a non-fresh fish?
  
2. With the whole group, encourage discussions by asking the following questions?
  - Where do harvest and post-harvest losses occur?
  - What could be done to improve the situation? In the boat? At the beach? During processing? At home?

## 🔄 facilitators' notes

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#### What are harvest losses?

Fish degrade rapidly after dying. Gear that damages fish, causes struggles or leaves it dying in the water for extended periods of time contribute to this degradation process. Once deterioration starts, the quality of the fish cannot be improved. Therefore, fishers should select the gear type that minimizes these negative impacts. For example, a trap that keeps fish alive is preferable to a gillnet that causes fish to struggle and suffocate and may only be retrieved after many hours or days. Fishing methods may need to be modified during extremely hot periods as fish may spoil rapidly while still in the water. Selective gear will avoid damage to undersized fish if used correctly. If fish are thrown back (discarded) with minimum damage, they have a better chance of survival. Hook size should be large enough so gut hooking does not occur.

#### What are post-harvest losses?

Post-harvest loss is the loss of fish or fish quality after the fish is captured. This may start to occur in the water and will continue until it is consumed. Any loss to fish quality will result in loss. If severe, the actual whole fish will be lost and must be disposed of. As the fish begins to spoil, there is loss of protein, vitamins and nutritious value. Yield of meat will also decrease. This will also cause economic losses as less fish can be sold.

#### Why do these losses happen?

After the fish die, irreversible degradation starts to occur caused by biochemical processes, microbial changes and chemical changes. This varies by fish size and type (for example fatter fish spoil faster than lean fish, smaller fish spoils faster than larger one). Temperature is the main factor in spoilage rates - the higher the temperature, the faster the spoilage. Cleanliness and handling conditions also contribute to quality. Many times, fish come in contact with dangerous contaminants such as gasoline and raw sewage during handling.



## 🔄 exercise 3

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### FISH IS MONEY

**OBJECTIVE:**

Identify the value chain.

**TIME:**

2.5 hours.

**MATERIALS:**

Field trip to local fishing area.

**STEPS:**

1. Divide the group into 2-3 smaller groups with male and female participants.
2. Ask participants to discover the value chain of a local fish: they have to follow the price per unit of a fish in the local area by interviewing fishers, intermediaries, processors and consumers.
3. Each group can interview the whole supply chain for a species. Some possible questions to ask are:
  - How much did you pay and receive for your product?
  - To whom do you sell your fish?
  - Did you process the fish before selling it?
  - Do you receive more money for a higher-quality fish?
  - Would you pay more money for a better-quality fish?
  - Did you need to go to market to find processed fish?
  - Does fresh fish bought at the landing site have the same price as the same fish when it is processed, preserved, dried or canned?
4. After the field visit, discuss with the whole group:
  - Which players are involved in the different value chains?
  - Where does the fish end up? Could there be other final markets?
  - Who makes the most money for the unit of fish along the chain? Is there a difference between the income for men and women?

### 🔄 facilitators' notes

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A value chain is a chain of activities that alter a product, increasing its value (e.g. filleted, smoked, packaged). Each market has different demands and needs, depending on food habits and consumption pattern and income levels of people in a country or region. The main objectives of value chain management are to maximize gross revenue and sustain it over time.

## ➤ CULTURAL ACTIVITY

### STORYTELLING

#### OBJECTIVE:

Use storytelling to learn about how fishing has changed in the village.

#### TIME:

2.5 hours.

#### MATERIALS:

Paper bags and pens for participants to create puppets, two containers: one with slips of paper (enough for the number of groups) with a different storytelling medium listed on each one (e.g. puppets, rap song, collage, dance) and one with slips of paper with a different genre and purpose on each one (e.g. comedy to entertain, mystery to frighten, romance to invite, science fiction to question, soap opera to exaggerate, etc.), writing support.

#### PREPARATIONS:

Invite community members (men and women) to collaborate with the participants in this exercise (one community member per group of participants).

#### STEPS:

1. Ask participants to form small groups of 3-5 people each.
2. Ask the community members to join a group. The task is to work together to “Create a story about the how fishing has changed in their village”. This story should include how change has affected the men, women and children in the village (e.g. has there been a decline in fishing that has reduced the amount of people that are needed on the beach?).
3. Ask each group to extract a piece of paper from each of the two containers which determine the medium and genre they should use for their story.
4. Each group will have one hour to create their story and to prepare to present it to the rest of the class. They should plan for a 5 minute presentation to the whole group.
5. Give a 3 minute warning when the time is almost up.
6. Bring the class back together and have one group at a time come to the front of the room and perform their story.
7. Ask participants about the underlying or related causes, actions, circumstances that brought about the changes in fishing in the village:
  - Did something happen in another village to change things?
  - Did the fish stop coming?
  - Did the weather change dramatically? What about the wet and dry seasons?
  - Did fuel prices go up so that the fishers could not afford to go fishing as often?
  - Did the women stop buying the fish the fishers were catching?
  - Which story would be most likely to influence someone to think about their actions and how they will affect others, nature and the environment? And how would they influence others? (e.g. scare, invite, etc.)?
8. Ask participants about the interconnectedness of actions and how they affected fishing. What type of storytelling did each group use?

## ↘ CULTURAL ACTIVITY 2

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### SING A SONG

**OBJECTIVE:**

Highlight gender issues in fisheries and effects of climate change.

**MATERIALS:**

Writing support, pens.

**STEPS:**

1. As a group, choose a popular children's song that is easy to modify.
2. Divide the participants into groups and assign each group part of the supply chain (refer to the section "Every Fish Counts", exercise 1).
3. Have participants create a verse to include in the song that is about four lines long, highlighting their assigned role in the supply chain (e.g. referring to gender, climate change).
4. With the whole group, have each group write their verse on a large piece of paper.
5. Order each contribution based on the sequence in the supply chain and read it aloud to the whole group.
6. As a group sing the completed song in the tune of the chosen song.

## ➤ CLOSING ENERGIZER: IT'S RAINING, IT'S POURING!

The group is going to make rain! Gather everyone in a circle. Explain that through an ancient series of movements, they would recreate the sounds of rain hoping for a plentiful crop and future growth. Ask the group to follow your example:

- Begin by gently rubbing your hands together back and forth to make a soft rustling sound. This is the misting/sprinkling part of the rainstorm. Gradually increase the intensity of the rubbing so that the sound grows louder
- Slowly, move to patting your hands against your lap to give the sound of drizzle. Again, you will want to increase the intensity of the sound as the storm grows
- While still patting your hands against your lap, begin to move your feet up and down to give the thunder and pouring rain
- Fade out the patting on your lap and increase the speed and loudness of your stomping to make a really big rainstorm
- Let the pouring rain subside, and let the storm drop back to a drizzle by patting your hands on your lap. As that subsides, go back to rubbing your palms together to make the sprinkling rain

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For more information on ecosystems:

[www.lessonplanet.com/search?keywords=Ecosystems&type\\_id\[\]=1&qclid=CNjGzvJ\\_7gCFZCe4Aod\\_VQApA](http://www.lessonplanet.com/search?keywords=Ecosystems&type_id[]=1&qclid=CNjGzvJ_7gCFZCe4Aod_VQApA)

[www.geography4kids.com/files/land\\_ecosystem.html](http://www.geography4kids.com/files/land_ecosystem.html)

[www.teachclimatechange.org/](http://www.teachclimatechange.org/)

For more information on systems:

[www.yayscienceclass.com/uploads/Pre-AP\\_Biology\\_Unit\\_05\\_-\\_Jar\\_Ecosystem\\_Lab.pdf](http://www.yayscienceclass.com/uploads/Pre-AP_Biology_Unit_05_-_Jar_Ecosystem_Lab.pdf)

[www.wizardscave.com/aquarium.html](http://www.wizardscave.com/aquarium.html)

<http://freshaquarium.about.com/cs/doityourself/a/dyi.htm>

For more information on vessel stability:

[www.maritimenz.govt.nz](http://www.maritimenz.govt.nz)

[www.youtube.com/watch?v=4UZXFekgK4U](http://www.youtube.com/watch?v=4UZXFekgK4U)

For more information on simple maintenance:

[www.fas.org/man/dod-101/navy/docs/swos/eng/62B-416.html](http://www.fas.org/man/dod-101/navy/docs/swos/eng/62B-416.html)

[www.yachtsurvey.com/maintenance\\_1.htm](http://www.yachtsurvey.com/maintenance_1.htm)

For more information on swimming and treading water:

Breaststrokes Technique: [www.breaststroketechnique.com/](http://www.breaststroketechnique.com/)

Encyclopaedia Britannica kids: <http://kids.britannica.com/elementary/art-89726>

Water-Shy Swimmer, Chapter Ten-A: Treading Water-Individual: [www.thewatershyswimmer.com/Ch10a.html](http://www.thewatershyswimmer.com/Ch10a.html)

.For more information on storytelling go to:

[www.rcowen.com/PDFs/CTS%20Ch%201%20for%20website.pdf](http://www.rcowen.com/PDFs/CTS%20Ch%201%20for%20website.pdf)

[www.planetesme.com/storytelling.html](http://www.planetesme.com/storytelling.html)

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