



net hti sa lantšivanja  
zaštiti trara

fish

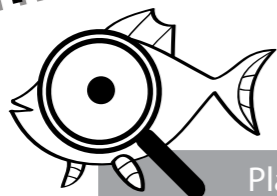




# Introduction

At first glance, the sea might seem like a big, monotonous chunk of water, spreading out into the distance until it reaches the horizon. However, if we take a look under the surface of this blue yonder, we are astonished by its depth and fullness of colours. The richness of different forms of life can be compared with the most colourful carnival, exposing the treasures of nature. Actually, nowhere else on Earth can we find so many different animal and plant species interacting and sharing their environment, with humans present only as occasional guests. Looking at the sea and all the life it supports, we can learn about its inhabitants, admire its harmony and compare ourselves to it. We might be tempted to try and learn how to swim like a dolphin or use sound to orient ourselves in the environment. In order to swim faster, we construct swimming suits resembling shark skin. We would like to hold our breath as long as sea turtles. We learn about ways sponges and starfish regenerate parts of their body or how planktonic sea algae create oxygen. People can learn a great deal from the sea, which is why we have to appreciate it and take care of it. Let's dive into the secrets of its inhabitants as real researchers of the marine world! Read the book, and have fun learning and playing!

## experiment



Play and learn!

In every chapter you'll find a section called "Play and learn!", with many interesting assignments to complete. These experiments make learning and understanding facts about fish much easier and more amusing.

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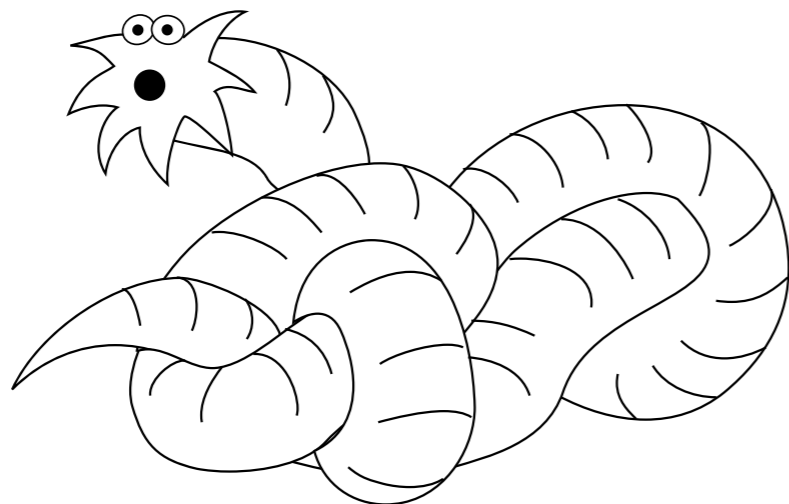


# Let's meet the fish!

Fish are vertebrates that live in water. They are cold-blooded animals and take up oxygen from the water through the gills. Their whole body is covered with scales and they use fins to move around.

We distinguish three different types of fish: jawless fish, cartilaginous fish and bony fish.

- 1 Jawless fish are unusual and have a round mouth with sharp teeth they use to adhere to prey. Their body is long and round. They are the closest relatives to ancient fish that lived in the seas 500 million years ago. Lampreys are parasites attaching to other fish while hagfish feed on dead fish.

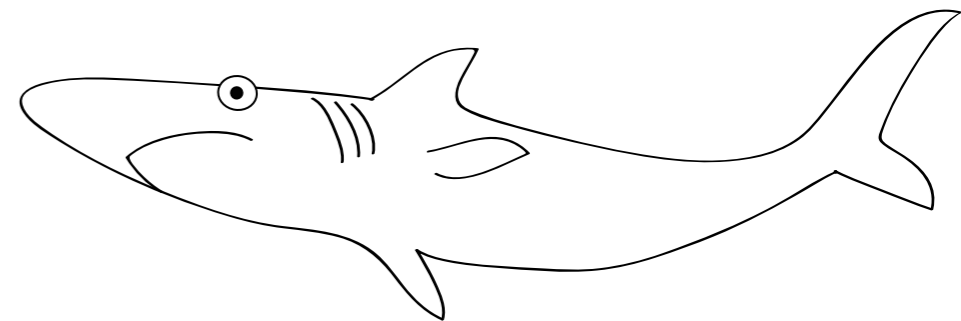


## exercise

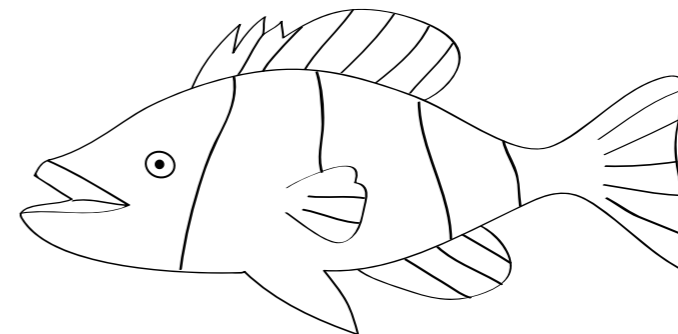
1

Think of three freshwater and three saltwater fish! Which ones do you usually eat? Which species can you find near your home?

- 2 Cartilaginous fish have an internal skeleton built out of flexible cartilage. They don't have a swim bladder, so they have to constantly swim to prevent being stuck on the sea bottom. Their gills are underneath their gill slits and are not covered with an operculum. The skin of cartilaginous fish is covered with tiny scales that are serrated, making it very rough. Sharks and rays are cartilaginous fish.



- 3 Most species are bony fish. Their skeleton is made out of real bones. Some species are adapted for living in diverse environmental conditions, ranging from freshwater to saltwater and cold to warm water. Some species live only in deep sea while others can survive in very shallow water, briefly even on land. There are so many fish it is very hard to choose one to describe. Still, they all share common characteristics.





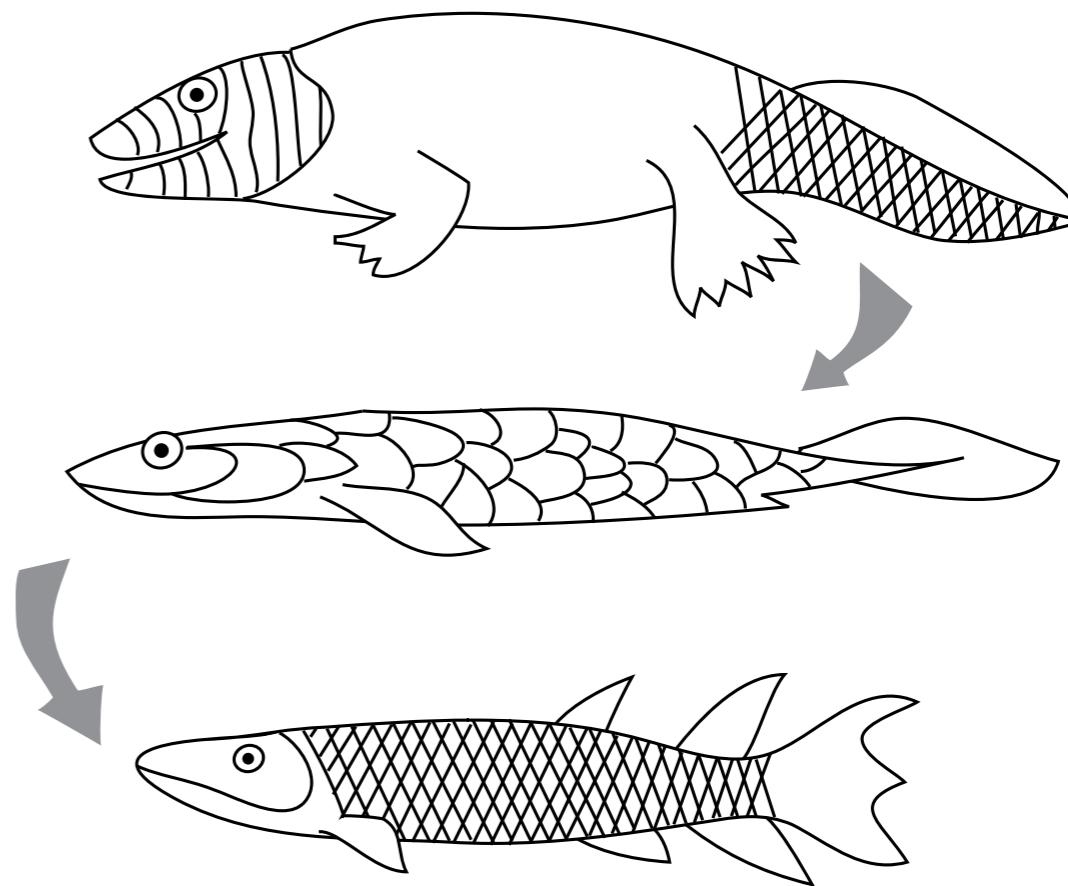
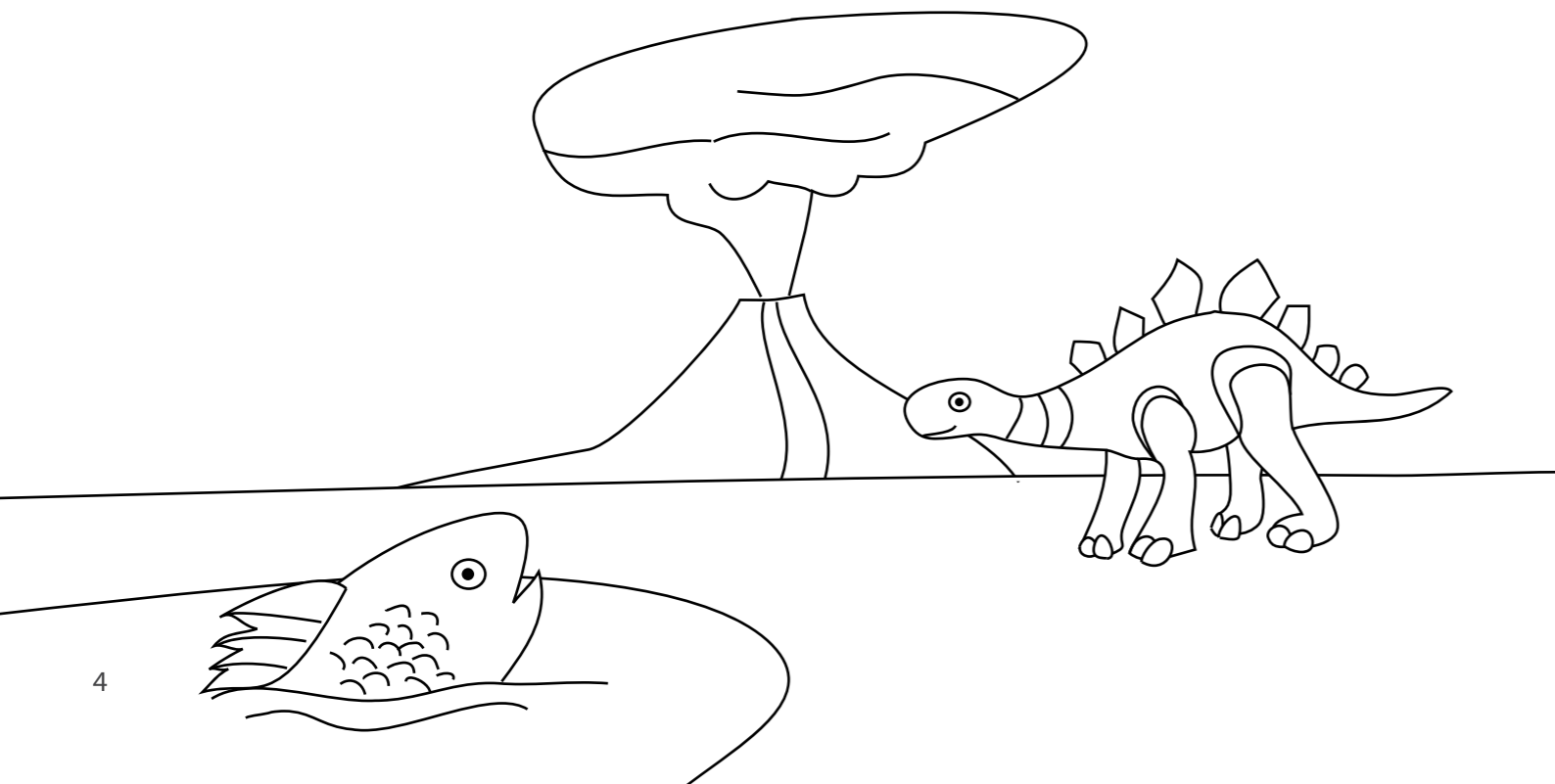
# Once there were fish

Fish are the first vertebrates that appeared on Earth 500 million years ago. The first fish were jawless, and some parts of their body were covered with bony plates. They evolved in more than 25 000 different species that are well adapted to their environment.

Some present species are called living fossils because they possess certain features specific to terrestrial vertebrates. An example is the coelacanth, first observed in 1938 near Madagascar. The internal structure of its fins resembles that of a terrestrial vertebrate. Freshwater lungfish live in South America, Africa and Australia and breath using their gills while in water, but can also use their swim bladder for breathing air if the water dries out. This is similar to having lungs like other vertebrates.

## exercise 2

Colour the picture showing the appearance of the first fish!



# Body shape

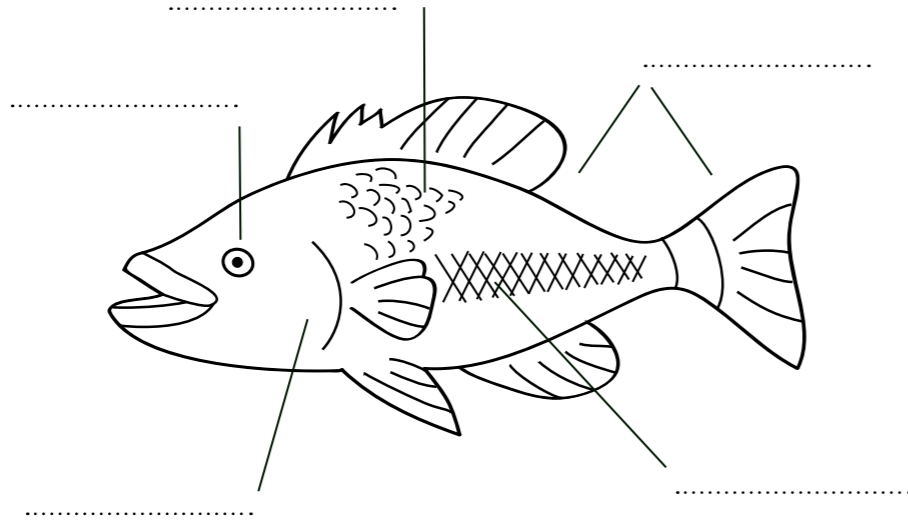
## External appearance

The body of most fish is elongated and covered with scales. They have a pair of pectoral and pelvic fins as well as one or more dorsal and caudal fins. Some species have one or more anal fins. The eyes and gills are located on the sides of their head. Bony fish have gills covered with a bony operculum. The lateral line runs along the body and can be more easily seen in some species than others.



### exercise 3

Put the right letter next to the correct body part in the picture. When you are done, connect the right description to the appropriate body part.

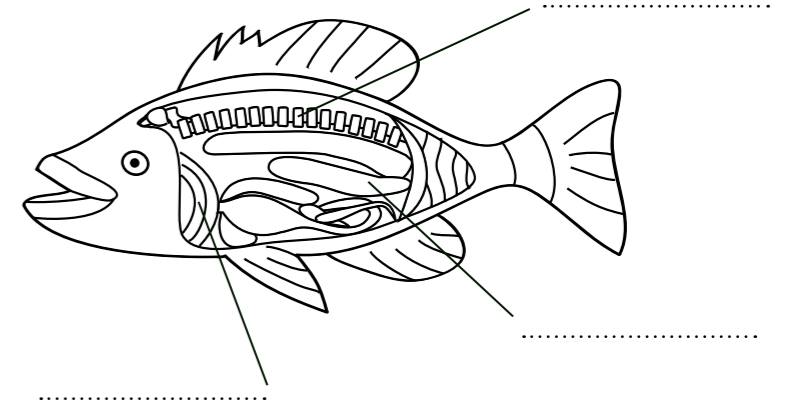


- |                   |  |
|-------------------|--|
| a) gills          | 1. It allows fish to feel the water currents                                   |
| b) fins           | 2. Body parts that fish use for moving   |
| c) swim bladder   | 3. It covers gills   |
| d) scales         | 4. It enables breathing  |
| e) eye            | 5. Organ filled with air that fish use to move up or down in the water column. |
| f) spine          | 6. Organ for sight   |
| g) gill operculum | 7. Small, almost invisible plates that cover the body                          |
| h) lateral line   |  |

## Internal appearance

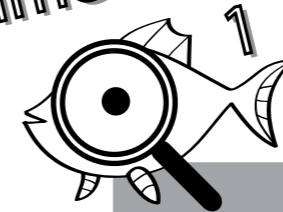


Bony fish have a spine that runs along their body. The dorsal fin is placed above it. The gills are placed on each side of the head and usually comprise of four gill arches with gill filaments. When the fish is swimming, it is swallowing water through its mouth and squeezing it out over the gills. Oxygen from the water gets into the blood through its gills. The intestines are placed on its ventral side, along with the swim bladder of bony fish.



### experiment 1

Play and learn:



You need to prepare: 1 fresh fish, scissors, knife, kitchen board

#### Fish anatomy

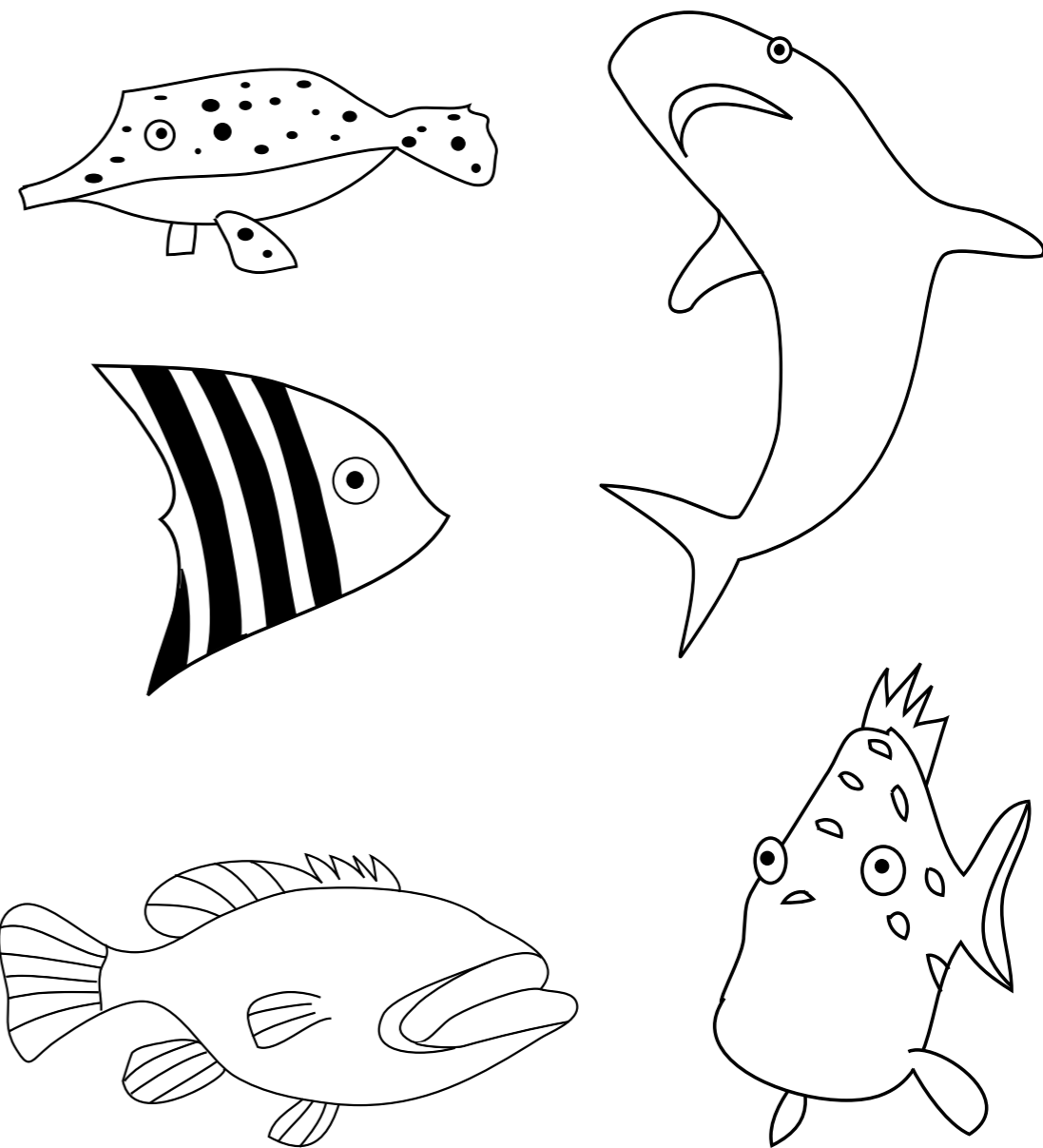
- 1 If you can, go to a fish market and buy a small fish, freshwater or marine.
- 2 When you come home, go near the kitchen sink, put it on a board and look at it for a while. Try to draw a sketch. Look at all the main parts - head, body, fins and scales. Find the lateral line.
- 3 Lift up the gill operculum with a knife and remove it using scissors. Look closely at the gills and count the gill arches. Think about why they are red?
- 4 Flip the fish over, holding its head and tail with the belly facing up. Cut the belly with scissors to see the organs. Cut and lift half of its body to expose the backbone. How many vertebrae can you count?



# Movement

Most fish propel themselves through water by sideways motion. They control their swimming speed with their tail fin. Pectoral fins are used for turning and steering their body. Other fins are used for maintaining balance, shifting direction and slowing down.

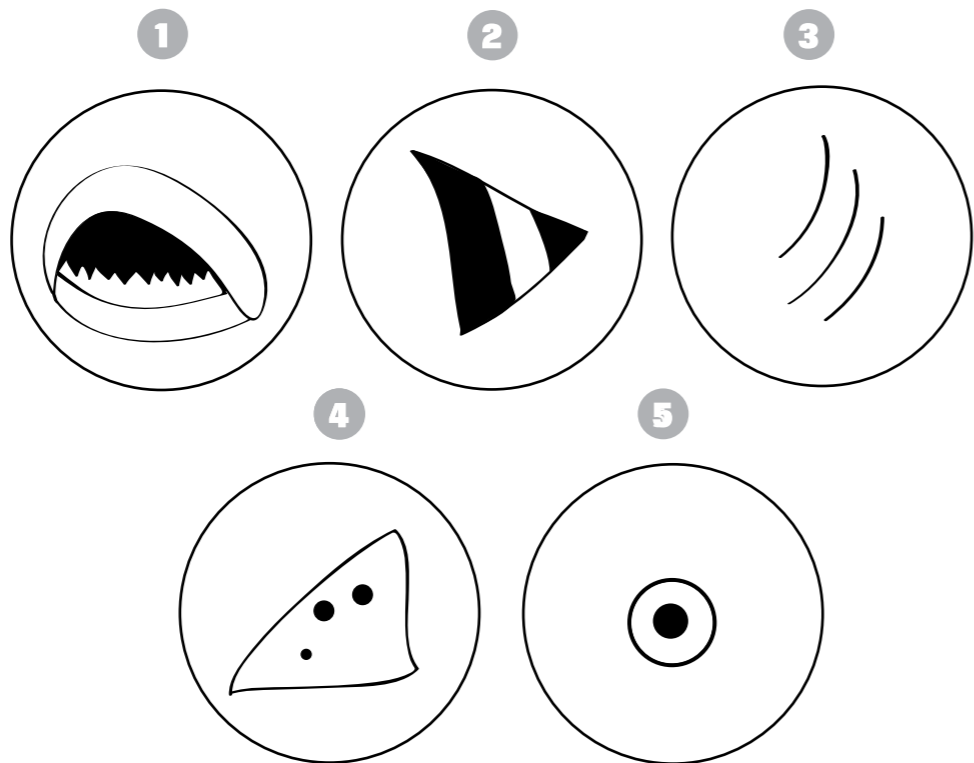
Bony fish use their swim bladder to go up and down in the water column. This organ is placed in the abdomen, beneath the spine and looks like a gas filled bag. When a fish wants to get closer to the surface, it fills up the bladder with a large amount of gas. If it wants to go deeper, it releases the gas from the bladder. This is why fish can appear to "float" at a certain depth in the water column.



## exercise

4

Search for missing body parts and draw them on the fish!



# Reproduction

Most fish species reproduce by external fertilization. The female lays the eggs (roe) into the water where a male fertilizes them with his sperm (milt). This is the process termed spawning. Out of millions of eggs, only a few develop into an adult fish. Most of them are left unfertilized or end up eaten by predators.

Some species of cartilaginous fish give birth to live young rather than laying eggs. This is the end of a process where eggs are fertilized and remain inside the female throughout development. The seahorse is an example of a fish where the male carries fertilized eggs in his belly pouch until they hatch.

Most fish species need to lay as many eggs as they can because very few larvae survive when left unattended. Still, there are some species that take care of their hatchlings and protect them from predators. This means they can raise as many young fish from fewer eggs.

Young fish usually look very different than the adults. After hatching, the larvae spend some time as part of the plankton until they form into young fish resembling adults.



## exercise 5

Help the worried seahorse dad to find his 8 lost babies!





# Sensitive fish

Fish have the same five senses as humans do: sight, hearing, smell, touch and taste as well as an extra special one - the lateral line.

The lateral line is a narrow stripe that stretches from the head to the tail on both sides of the body. It enables a fish to feel the direction and power of a water current as well as movements of water in general. In case of some fish species the lateral line is visible and easy to find. The lateral line is beneath the skin and consists of a thin tube filled with liquid and special cells able to detect pressure changes.

Fish focus their vision on an object by changing the position of their lens in a forward and backward motion, similar to a photographic camera. Most bony fish are able to see colours.

Even though fish have no external ears, they can hear very well because the vibrations made by sound travelling through water are picked up by their inner ear. Some species even produce different sounds for communication.

Most fish have a well developed sense of smell. They can discern which chemicals are dissolved in the water through sensory cells in small pits situated near the eyes on their head.

Fish usually have taste buds located inside their mouth, but some species have them on their fins and skin. Some fish living near the sea bottom have taste buds on barbels surrounding their mouth.

Many fish can feel electrical impulses as well. Some species have special organs that enable them to create an electrical field they use to discover objects or other fish when visibility is decreased.



Play and learn:

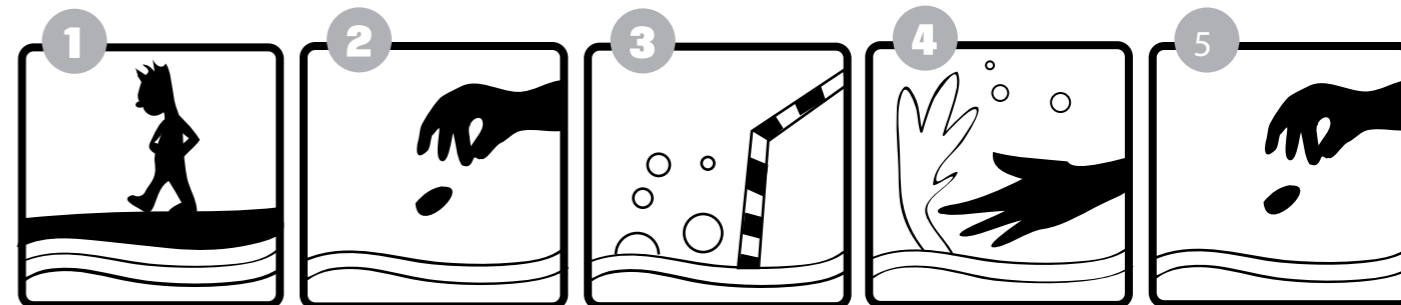
## experiment



You need to prepare: bread pieces, a little stone and a straw

### Careful fish

- 1 If you can, go to a seashore, lake or river and look at how fish move. If there are no natural habitats close to where you live, find an aquarium.
- 2 Throw bread pieces in the water to get their attention.
- 3 When fish gather, try to produce waves by blowing through a straw next to the water surface. Look at how fish behave. Did they escape?
- 4 Now try to splash the water with your palm. What happened with the fish? Try to figure out in what way the fish felt your presence? Which organ could they have used?
- 5 Again throw a piece of bread in the water to attract fish. When they appear, throw the small stone in the water and watch what will happen. When did fish respond fastest? Think about why.





## Living in a group

Many fish species live in the open sea and spend their life in groups that are called schools. Their movements are well synchronized which is possible due to their well-developed senses.

Life in a group has advantages. Defending from attack is easier because there is a greater chance of a fish spotting the incoming predator. The attacker will have trouble isolating one fish from the school that is swimming in all directions and splitting into smaller groups. In addition, this kind of behaviour makes it easier to find food or a suitable mate.

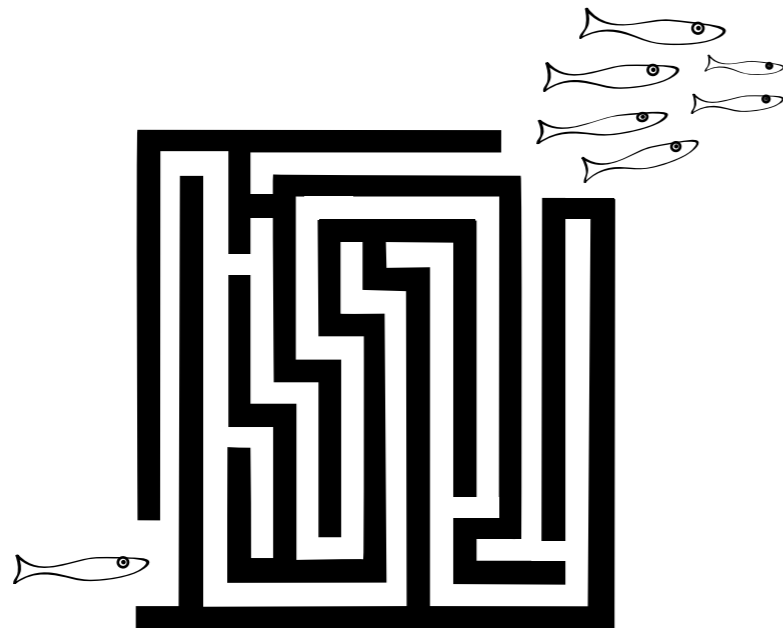
Unlike "social" fish living in the open sea, the ones living on the sea bottom are usually alone. These species are called demersal or benthic fish. In this case solitary life can be more advantageous when finding shelter or food on the sea bottom.



## exercise

6

Help the little anchovy find its way through the labyrinth and join its school!



## Deep sea fish

Due to their unusual and terrifying appearance, people sometimes call deep sea fish "monsters from the deep". Deep sea species are fish living at great ocean depths, where environmental conditions are very different from the surface - complete darkness and high pressure.

This is why these fish have many special adaptations like organs producing light or a big mouth. They can produce light through a series of chemical reactions in special cells or by using special bacteria living inside them. Light in the ocean deep can be used for prey detection, deterring predators, attracting prey or a partner for mating in the dark. Their big mouth enables them to catch prey with ease or to gather the pieces of food sinking from above.

Deep sea fish have interesting names due to their monster appearance. Some of them include Sloane's viperfish, hatchet fish, anglerfish, bristlemouth and cookiecutter shark.



# Defence and offence

## exercise 7

Write down the names of the fish next to their pictures!

Red scorpion-  
the spines in the dorsal fin are poisonous

European flounder-  
flatfish that lives on muddy sea bottom

Common stingray-  
it has a venomous tail spine

Puffer fish-  
it has poisonous scales protecting it from predators

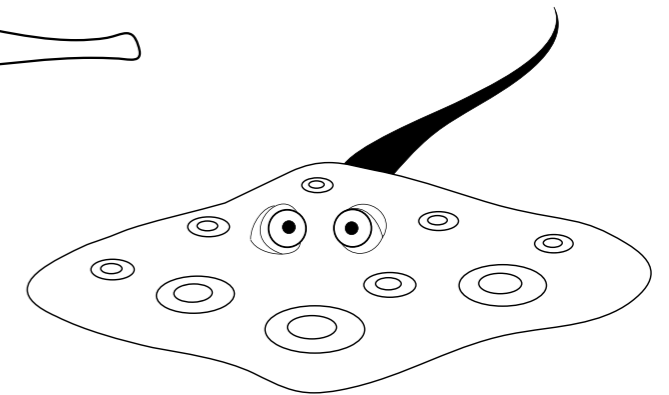
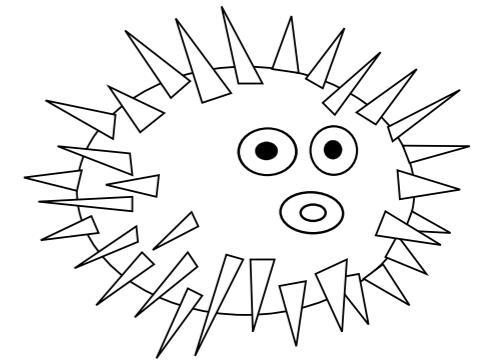
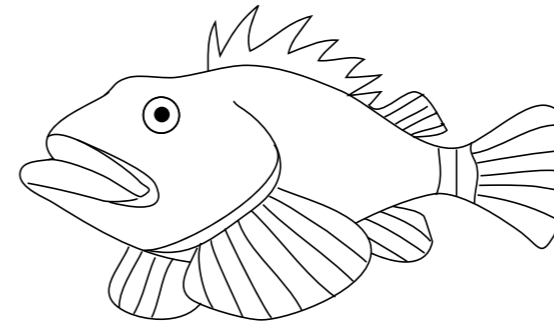
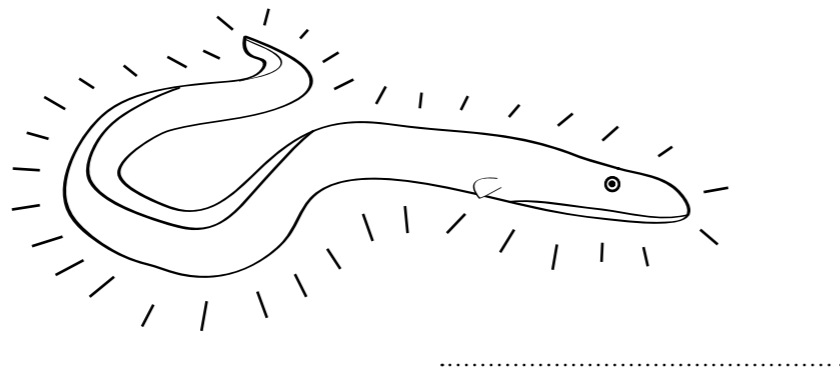
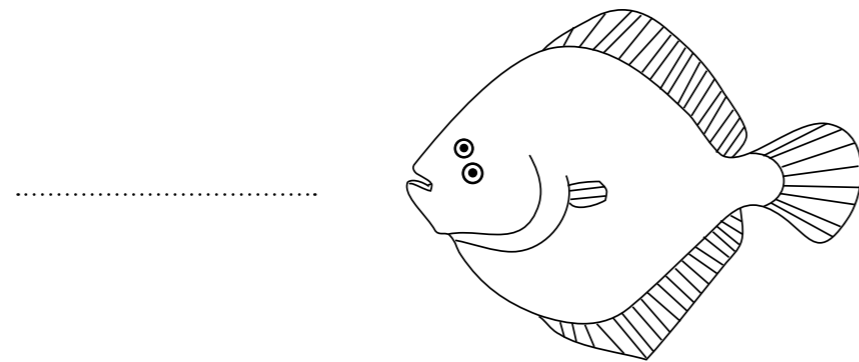
Electric eel-  
it creates an electrical current to stun prey and predators

Pipefish-  
it has a very slim and long body so it can hide in sea-grass meadows

"The law of the stronger" applies for aquatic environments just like it does for any other on Earth. Species that are best adapted to attack and/or defend themselves have a higher probability of survival due to the advantage in choosing their territory or acquiring food.

In addition, some species use camouflage to blend into their surroundings. Flatfish have flattened bodies, so they can easily burry in the sandy bottom and hide from predators, or prey on other fish and invertebrates. Some species that live in seagrass meadows have thin, narrow bodies just like the blades of seagrass and are able to hide and protect themselves.

There are many species that consider attack to be their best protection, and therefore possess sharp spines or very hard scales that are impossible to break through by the attacker. Some species are equipped with venomous spines that can be dangerous to humans. When you "meet" a red



scorpion fish or a great weever, you should watch out for the poisonous spines on the head and in their dorsal fin. If you see a ray, make sure you are at a safe distance from its venomous tail spine.

Some fish have special organs for creating electricity they can use to defend themselves from predators, or to stun prey. For example, the electric eel can produce an electric field strong enough to severely hurt a human.

# Threats



Overfishing is the biggest threat for the survival of many fish species. Fish meat has an important place in our diet. It is one of the most important sources of protein and contains many vitamins and minerals. This is why fishing is a very important and expanding branch of the food industry. There is an increasing number of fishing boats appearing every day, equipped with more efficient fishing tools, enabling them to catch huge amounts of fish simultaneously. The increasing demand for certain fish species resulted in their disappearance.

Many species are disappearing because their habitat is polluted due to human activities. Chemical pollution, industrial and household wastewater and debris are especially big threats for freshwater habitats. Biological communities in lakes, swamps or ponds can consequently disappear altogether.

The seas and oceans are overwhelmed with big ships and tankers carrying oil. Accidents happen, creating oil spills and resulting in ecological catastrophes. The oil floats on the surface, creates a barrier for light, stops gas exchange and other communication between the sea and the atmosphere. Many organisms perish due to these effects.

Many coastal and swamp habitats are destroyed to make room for new buildings or crop fields. This is a major threat for many animal and plant species that cannot survive in other types of habitat.

Due to climate change, the sea surface temperature is rising. Many fish species are very sensitive to temperature variations and lose their ability to reproduce. They can die even if there are only small changes in temperature.



return to the same area and catch more fish. They can now use the markings to determine how many have already been caught. This procedure is repeated a couple of times. Using this kind of data, it is possible to make an estimate of how many individuals live in a certain area.

- 1 Using a scalpel or sharp scissors make a hole with dimensions 1 x 3 cm on the box lid.
- 2 Put all tooth picks in a can or a plastic box. Tooth picks represent fish species.
- 3 Shut the box with the palm of your hand and shake it well 3 times.
- 4 Turn the box over 5 times so that just a few tooth picks fall out each time. Count the tooth picks that fell out and mark them with a highlighter. Make a note of the number of marked toothpicks. Let's say that number is 22.
- 5 Put the marked tooth picks back into the box, close it and shake well. Again, turn the box 5 times. Count the number of fallen tooth picks, and note the new number in the table. Let's say 20 dropped out, which is the total number of caught fish. Now count how many were marked, and make a note of it. Let's assume there were four.
- 6 Repeat this four more times, writing down all the numbers in the table.
- 7 Take your data and calculate the total number of individuals in your research area, using the example from the table:



Play and learn:

You need to prepare: a box of tooth picks, an empty 2-3 dl can or a plastic box with a plastic lid, scalpel or very sharp scissors, paper, pen and highlighter.

## How many fish are there?

Introduction: To determine how many fish of a particular species live in certain areas, scientists use a method of counting marked animals. It involves taking notes of how often they encounter the same animal. They catch a certain number of fish in a defined area, mark them and release them into the wild. After some time, they

TOTAL NUMBER OF MARKED FISH = 22				
Number of catch	Total number of fish in one catch (number of marked fish)	Total number of marked fish / number of marked fish in one catch = number of needed catches to catch all marked fish	Number of needed catches x total number of fish in one catch = assessment of the number of individuals	Total assessment / 5 (number of catch) = average assessment of number of individuals in that area
1.	20/4	$22 \div 4 = 5.5$	$5.5 \times 20 = 110$	
2.	9/2	$22 \div 2 = 11$	$11 \times 9 = 99$	
3.	30/7	$22 \div 7 = 3.1$	$3.1 \times 30 = 93$	
4.	25/5	$22 \div 5 = 4.4$	$4.4 \times 25 = 110$	
5.	22/5	$22 \div 5 = 4.4$	$4.4 \times 22 = 96.8$	
			Total assessment = 508.8	$509 \div 5 = 101.8$ or 102 fish



# Protection

Protected areas are being established around the world in order to preserve plant and animal species living in aquatic habitats. On land, these areas are often centered around freshwater lakes, swamps and rivers. In the ocean, special care is invested in protecting the biodiversity of marine habitats. Management programs and many strict rules of behavior ensure that human activities do not threaten the survival of plant and animal species.

Every country controls its fishing fleet by enforcing laws and regulations stating how many fish are to be caught every year and which tools can be used. Different countries sharing the same marine area can cooperate and come up with agreed rules for exploitation through international agreements.

## exercise

8

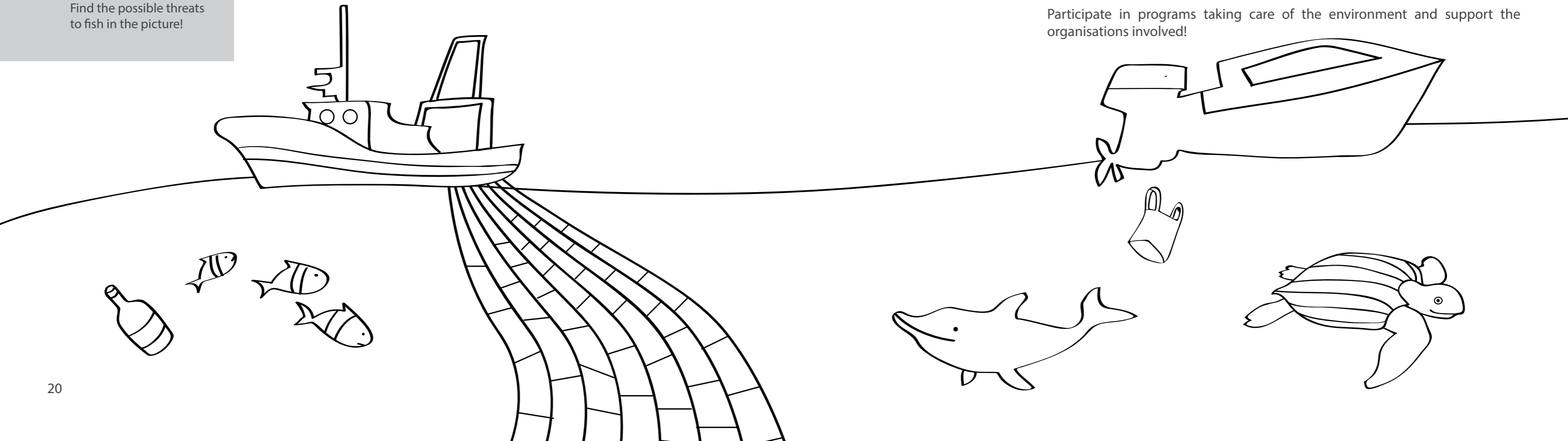
Find the possible threats to fish in the picture!

Never leave garbage on the shore and make sure no one throws it into the sea!

Avoid buying souvenirs made out of endangered marine animal body parts such as products made out of sea turtle shells, shark teeth, noble pen shells, etc. In addition to being illegal, buying these encourages further poaching of these animals.

Act in ways that decrease unnecessary consumption of water and energy! Use public transport, turn off the tap while you are brushing your teeth, turn off the lights when exiting a room and buy domestic products that need not be transported from other parts of the world, etc. Think about the environment that is all around us!

Participate in programs taking care of the environment and support the organisations involved!





Printing of this publication was funded by the National Foundation for Civil Society Development. The contents of this publication are the sole responsibility of the authors and do not necessarily express the opinion of the National Foundation.

Publisher: Blue World Institute of Marine Research and Conservation, Veli Lošinj, 2013.

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Design and illustration: Anton Horvatić

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