

Practical element - sensitive species

Manual

ResponSEable project WP 5, deliverable 5.5: Educational packages for professionals

Produced by: ProSea Foundation, marine education (www.prosea.info)

Manual

You will need:

- ✓ One shark per 15 participants;
For a list of suitable species and where to get them, see Appendix A
- ✓ Something to display the shark on (or in) during the practicum¹; *and optionally*
- ✓ Magnifying glasses

Duration: 20-30 minutes.

1. Start by looking at the shark.

****Ask the participants to investigate the shark by looking, feeling, smelling, ...**

What do they notice? What are the differences when you compare it to a fish? A ray? A whale? ****2**

Pectoral fin

The pectoral fins are large and broad and pointed outwards. Sharks use these to steer and they contribute to the sharks' buoyancy³ in the water, to prevent them from sinking to the ocean floor.

Caudal fin

The caudal fin propels the shark through the water and the shape of this fin indicates how the shark swims. Sharks who swim very fast and explosively, sprinting and bursting at high speed, have a short crescent-shaped, but broad and heavy caudal fin. Sharks who swim at lower speeds or from ambush, have a slimmer and elongated fin (especially the dorsal lobe).

**** What kind of swimmer would *this* shark be? ****

In all (modern) sharks⁴ the dorsal lobe of the caudal fin is larger and longer than the ventral lobe, this shape contributes to the buoyancy of the shark. By the greater resistance on the dorsal caudal lobe, the tail is pushed downwards which directs the shark's snout slightly upward causing the shark to continuously swim slightly upwards. Because of this adaption the shark can almost effortlessly swim at continuous depth.

¹ Enable participants to easily look at- and touch the shark, but make sure that furniture is protected from all fluids coming from ice or shark.

² Throughout this manual you will find asterisks, these indicate suggestions for interaction with the group.

³ Buoyancy: capacity to remain afloat in the water.

⁴ Some ancient species of shark had caudal fins with dorsal- and ventral lobe being the same size, but those have gone extinct.

Skin

** Encourage participants to feel the skin of the shark. How does this feel? And if you go in opposite direction? How does that feel? **

In the direction head-to-tail, the shark's skin feels smooth; but in the direction tail-to-head, the shark's skin feels rough. ** *Why is this?* **

The skin is covered by placoid scales, made of the same structure as the shark's teeth. These placoid scales are pointy, and the pointy side is directed towards the caudal fin. If you stroke the shark from tail-to-head, you move against the pointy sides of the placoid scales, hence the rough feeling. In the past shark's skin was even used as sand paper.

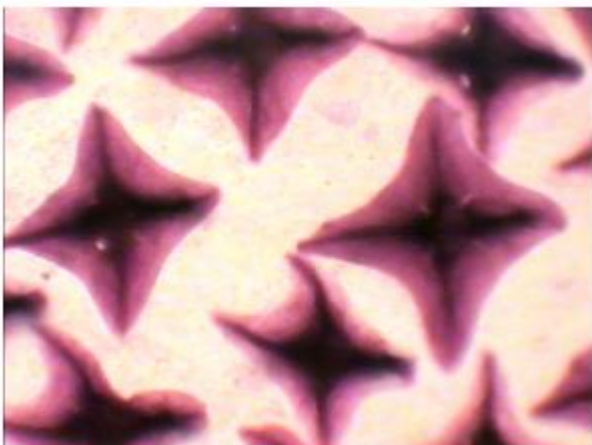
A shark has different types of placoid scales, depending on where on the shark's body the scale is and what function the scale has.

Every type of placoid scale has a specific function, this can be to:

- Cover and protect the body against the environment
 - The ventral side of the Angel Shark (*Squatina squatina*) is covered with thickened, enlarged placoid scales. This shark prefers rocky seafloors to lay on and these extra thick scales offer protection against the shark rocks.
- Reduce friction from water when swimming
 - The placoid scales act as tiny spoilers and reduce turbulence, and by doing so, reduce friction between the sharks body and the water, increasing its swimming-efficiency.
 - Comparison: a golf-ball is covered with dimples, this decreases friction with air and as result; the golf-ball with dimples shoots faster and further through air than a ball without.
 - There is a theory, which is still researched, that some of the fastest-swimming shark species (e.g. *Isurus oxyrinchus*) can alter the position of their placoid scales during swimming. By doing so, they can alter the friction their body has with the water. A race-car does something similar when it moves its spoiler up or down, but this is less advanced than the system the shark uses.
- Protect the sensory system
 - There is always one extra broad placoid scale before- and one after the nasal- and ear openings which offer protection.
 - Sharks have specific placoid scales which guide the water current towards the nasal opening and the olfactory organ (for smelling) or other sensory systems (e.g. the Ampullae of Lorenzini).
 - Scales near the eye are shaped in such a way that they decrease water pressure around the eye.
- Defend.
 - Some species have pointy and sharp placoid scales to such an extreme degree, that their body becomes a weapon, able to do harm.
- Offer protection during mating
 - To be able to mate, males from many species of shark bite in the female's neck or fins to position themselves. The females of these species have enlarged and thicker placoid scales on these areas to protect against this rough form of mating.

Mystery: sharks living in colder and/or deeper waters have generally sharper placoid scales than sharks living in warm waters. It is still a mystery what the reason is.

** Can you think of a theory? **



Photomicrograph of placoid scales 100X

Figure 1; a photograph (100 X) of the placoid scales of a shark.

2. Investigate and discuss the senses.

Eyes

The shark relies more on other senses (especially in dark or turbid waters) and its eyes aren't very well developed compared to other marine hunters, such as squid.

Sharks who hunt in dark or turbid waters have special 'crystals' in their eyes which reflect light. Cats have a similar adaption which is why they can see so well in the dark and their eyes 'light up' when light shines in them, it is the eye-crystals reflecting light.

Ears

The openings to the hearing organ are visible (on the dorsal side, behind the eyes), water enters through these openings in a chamber with tiny sensory hair-cells called 'cilia'. These cilia detect pressure differences and because sound-waves are differences in pressure, they can register sound. This organ is better adapted to hearing in the water than the hearing organ of humans. In addition, the shark has a sensory organ that humans don't have, the lateral line. (Video recommendation: A Shark's Entire Body Is an Ear. See appendix B).

Lateral Line

The lateral line is visible as tiny pores on the skin's surface on both sides of the shark, running from head-to-tail. Pressure waves running through the water, caused by sound or movement from animals, pass through these pores into a narrow tube, the lateral line. This main canal is lined with thousands of sensory hair-cells or 'cilia', similar to those found in the sharks' inner ear. These hairs are so sensitive that they can detect the slightest vibrations and turbulence in the water from hundreds of meters away.

The lateral line is used to find prey, detect predators and is even used for navigation. By their own movements, sharks and rays make their own pressure waves which bounce off the ocean floor and objects. These pressure waves give the shark/ray an accurate view of its surroundings, just like a sonar does. The shark/ray knows where the ocean floor is without having to look at it. (Video recommendation: A Shark's Entire Body Is an Ear. See appendix B).

Ampullae of Lorenzini

The Ampullae of Lorenzini are visible at the snout (dorsal and ventral side) as little dimples or pores. Every pore ends in a tube which is filled with a pudding-like goo which lead to pouches (called Ampullae) lined with sensory cells. With these, sharks can detect electromagnetic fields, produced by the earth's magnetic field but also by movement of animals. Every animal produces electromagnetic fields when they are constricting and extending muscles, that is, when they move.

This makes sharks and rays able to detect other animals, but also at which force, frequency and speed they move. A sudden movement may indicate a fleeing prey... or an attacking predator. The reach of this sensory system isn't that far, because the electromagnetic fields quickly dissipate. In general, a shark or ray has a reach twice its own body's diameter.

The Ampullae of Lorenzini are so sensitive, they can detect the magnetic field of the earth, which they use to navigate and find their migration routes. It is like they are having an in-built route planner.

(Video recommendation: How Do Sharks and Rays Use Electricity to Find Hidden Prey. See appendix B).

3. Optional, look at the organs

If you cut open the sharks' ventral side (make a cut from anus to the beginning of the head) you can take a look at the liver. The liver is at the dorsal side of the shark and is quite large. In some sharks, the liver is 30% of the sharks' total biomass.

** Why would this be? **

The liver's functions are various, just like in humans it detoxifies the blood, stores vitamins, produces bile, and more. On top of that, a shark's liver contains a lot of oil. This oil contributes to the buoyancy of the shark and the oil can be used as reserve energy-source, containing a lot of calories.

Basking sharks (*Cetorhinus maximus*) use their oily-liver reserves in winter-time, when they migrate to deeper and colder water and hardly eat. In the past, oil from shark livers (squalene) was used for vitamin A, oil-lamps and by whalers to better withstand the cold by drenching their underwear in the insulating oil.

Appendix A. Selecting a shark (or ray)

When selecting or buying a shark, think thoroughly about which species to use. Below you find some criteria to help you choose and tips on how to find the shark (or ray).

Population Status

When selecting shark or ray species to buy, select a non-endangered species. Check the status at the [IUCN Red List of Threatened Species](#).

Do realize that the IUCN status determines the global status of the species. It might very well be that the species has a healthy, stable population in the North Sea or Mediterranean but is globally declining, or the other way around.

Preferably, use species with a status of least-concern. Species with less-ideal statuses (up to near-threatened) may be suitable as well, as long as the shark is landed as by-catch and you are not promoting or stimulating the catch of sharks. Take care and buy responsibly.

- The following species are suitable for the North Sea area:
 - o Nurse Hound (*Scyliorhinus stellaris*) status: near-threatened
 - o Small Spotted Catshark (*Scyliorhinus canicula*) status: least-concern
 - o Common Smoothhound (*Mustelus asterias*) status: least-concern

- The following ray species are suitable for the North Sea area:
 - o Thornback ray (*Raja clavata*) status: near-threatened
 - o Spotted ray (*Raja montagui*) status: least-concern
 - o Small-eyed ray (*Raja microocellata*) status: near-threatened

How to get a shark or ray

Locations where you can buy a shark or ray are, among others:

- Fish monger
- Fish auction

Appendix B; Video's

Below is a list of video's that can be used in combination with the Educative Module Sharks and Rays. These videos are categorized based on the subject they discuss.

A Shark's Entire Body Is an Ear

Discusses the ear and the lateral line of a shark.

Producer: Smithsonian Channel.

Duration: 4 min 31.

Link: <https://www.youtube.com/watch?v=NnVfSjNxFnU>

How Do Sharks and Rays Use Electricity to Find Hidden Prey

Discusses the Ampullae of Lorenzini, how they use electricity to find prey and the research being done to better understand this sense.

Producer: Deep Look (YouTube Account)

Duration: 3 min 50.

Link: <https://www.youtube.com/watch?v=JDPFR6n8tAQ>

The Secret of Sharks Eyes

Discusses the anatomy of the eyes of a shark.

Producer: Smithsonian Channel.

Link: <https://www.youtube.com/watch?v=3pxZw-97VMU>

Thresher Sharks Kill Prey With Tail Like A Whip

Discusses the hunting technique of the Thresher shark, slapping its prey with its very long caudal fin.

Producer: Discovery

Duration: 1 min 38

Link: https://www.youtube.com/watch?v=ANjYYXII_C8

Alternative video (by Klemens Gaan), no narration, duration: 45 seconds. Link:

https://www.youtube.com/watch?v=QCXD_cIMLeA

Thornback Ray

Fragment of a Thornback Ray, one of the commonest rays encountered by divers.

Producer: Great White Shark, YouTube account

Duration: 1 min 2

Link: <https://www.youtube.com/watch?v=lrkmYxjkwNQ>

Appendix C; Background information

Below is a list of links to background information that be used in preparation of the module. The documents are categorized based on the subject.

Factsheets of shark and ray species in- and around the North Sea

Sharktrust, 2009, *Shark ID guides & Factsheets*, accessed at 5-5-2017,
<http://www.sharktrust.org/en/factsheets>

Dutch language:

Project HAROkIt, 2015, <http://vliz.be/nl/harokit>

Consisting of ID guides, video's on identification and a report.

Anatomy (exterior and interior)

Hall D.H., 1999, *An illustrated guide to the dissection of a shark*, accessed at 5-5-2017,
http://mrescience.com/images/pdf/pdf_life/guide_shark.pdf

Shark dissection instructions, accessed at 5-5-2017,
<http://dsapresents.org/staff/victoria-brown/files/2011/08/Shark-Dissection-Guide.pdf>