Let's Investigate Sharks: UK EDITION

Age range: 11 – 16 (Key Stage 3 & 4)

Presentation length: 30 – 45 minutes (depending on optional slides and level of detail)

Overarching objective: For students to be aware that a variety of sharks, skates and rays are present in British waters.

Learning objectives:

1. Students will be able understand the similarities of all sharks, skates, and rays (Chondrichthyans) and the difference between them and bony (teleost) fish.
2. Students will be aware of the diversity of shark, skate, and ray species and reflect on how each species may be adapted to suit its habitat and trophic role.
3. Students will understand that sharks, skates and rays have multiple reproductive systems, particularly focusing on the difference between live bearing and egg laying species.
4. Students will learn about the 'additional' senses that sharks, skates and rays have and how they may use them.
5. Students will be introduced to some methods that are used by researchers to study sharks. This will be a brief insight to a possible career as a biologist.
6. Students will understand the importance of sharks, skates and rays in maintaining a healthy ecosystem.
7. Students will be able to identify some key threats that sharks, skates and rays experience, leading to declining populations.

Skills: analysing, classifying, comparing and contrasting, defining, describing, evaluating, explaining

Materials needed:

- Computer/laptop
- Internet access (optional)
- Let's Investigate Sharks: UK EDITION PowerPoint
- Let's Investigate Sharks: UK EDITION teaching guide
- Let's Investigate Sharks: UK EDITION vocabulary list
- Overhead projector/smart board (encouraged but not required)

Before you dive in:

Did you know that a shark is classified as a fish and not a mammal? Can you name any special senses that sharks have?
Our educators and scientists have compiled the most important and up to date key facts pertaining to British sharks in an easy to follow lesson entitled Let's Investigate Sharks: UK EDITION.

The Let's Investigate Sharks: UK EDITION PowerPoint is packed with professional photographs and videos.

The lesson is broken down into the following eight sections: What is a shark? Where do we find sharks? Adaptations, Shark senses, How do we learn about sharks? Why are sharks so important? Threats to sharks, and Sharks need your help.

Furthermore, all of the sections include discussion points for each slide. The vocabulary words are highlighted, and definitions are included in the packet.

It is not necessary to discuss each and/or every key point. You have the freedom to personally select the points you wish to discuss or the ones that best coincide with your current curriculum.

Teaching Guide: Let's Investigate Sharks: UK EDITION Key Stage 3 & 4

This guide is for use with the Let's Investigate Sharks: UK EDITION PowerPoint. It provides key points to discuss for each slide as well as vocabulary words (highlighted in RED) that can be incorporated. It is not necessary to discuss each and everyone of the key points. Select the points you wish to discuss or the ones that best coincide with your current curriculum.

The PowerPoint is broken down into sections here (bold, underlined and lettered). Numbers indicate the slide number. ***A** and ***B** indicate alternatives to the same slide. When selecting an alternative slide, you can hide the slide you won't use in PowerPoint.

SQ: Indicates a question you can ask students to engage them in a discussion (student question).

Introduction

1. Sharks4Kids logo
2. Title slide 'Let's Investigate Sharks: UK EDITION'

What is a shark?

3. What is a SHARK? ***A**
   - **SQ** – Ask the class what is a shark? (image: Blue shark)
   - A shark is a cartilaginous fish but are different to many of the species we are most familiar with, e.g. those we have for dinner or in a fish tank = these fish are called bony fish (also known as teleost fish).
   - We will continue to compare and contrast between these two groups of animals.
4. What is a shark? ***B**
   - **SQ** – Ask the class what is a shark? (image: Blue shark)
   - Ask the class whether they think sharks are most similar to the fish shown (species called 'Jack') or the bottlenose dolphin. You can ask for specific responses from students or ask for them to vote by raising their hand.
   - Sharks are indeed a type of fish! Dolphins are instead a mammal, humans are also a mammal, so dolphins are more similar to humans than they are to sharks. This could be an opportunity to reinforce animal groups (mammals, fish, reptiles, birds, amphibians, invertebrates).
   - The fish shown is called a bony (teleost) fish, we will compare and contrast between bony fish and sharks over the next few slides.
5. Skeleton comparison
   - Slide shows the difference between bony fish and shark skeletons. Sharks are cartilaginous fish, which means they have a skeleton made from cartilage instead of bone.
   - **SQ:** Ask the students to feel the bones in their arms and hands, ask them how it feels – it feels hard and rigid.

- **SQ:** Ask the students to squeeze the end of their nose and bend the top of their ears. How do they feel? – Feels flexible.
- Bony fish have a skeleton made of bone, whereas sharks have a skeleton made of cartilage.
- Cartilage is lighter (less dense) than bone, so it helps sharks maintain neutral buoyancy (keeps them from sinking to the bottom).

6. DERMAL DENTICLES
   - Sharks do not have flat scales like other fish. Sharks have DERMAL DENTICLES (aka placoid scales), which mean 'skin teeth'.
   - The DERMAL DENTICLES are razor sharp tooth-like scales that reduce drag (hydrodynamic) and allow the sharks to swim faster.
7. DERMAL DENTICLES
   - Slide shows a close up of nurse shark skin under the microscope.
   - In most species of shark, the DERMAL DENTICLES are microscopic.
   - The shape and size of DERMAL DENTICLES is different between species of sharks.
8. Teeth
   - Now we're going to move on to cover some of the body parts of sharks.
   - Compare between humans and sharks. Humans have one row of teeth on the top and one row on the bottom (52 teeth total over our lives, 20 baby teeth that we lose, and 32 adult teeth).
   - Sharks have several rows of teeth and they are constantly falling out. Most sharks have about 5 rows of teeth.
   - Sharks will have thousands of teeth over their lifetime!
   - Sharks usually lose at least 1 tooth per week. Imagine losing a tooth every time you ate an apple.
   - Different sharks have different shaped teeth depending on what they eat, as you can see the variety between the four species pictured.
9. GILLS
   - Sharks use their GILLS to pull oxygen out of the water, they do not have lungs like humans.
   - Sharks have 5 to 7 GILLS slits on each side of their body.
   - Even though they live in the ocean they still need oxygen to live!
   - Water enters the shark's mouth and is expelled through the gill slits. This is the part of the GILLS we can see.
   - Most sharks have to swim to stay alive, but others can rest on the bottom and pump water over their GILLS in order to get oxygen = buccal pumping.

10. SPIRACLES

    - In addition to some sharks that can buccal pump, there are many species that have SPIRACLES. (image = thornback ray)
    - These are small opening located behind the eyes where water can be sucked into the mouth, before the water is expelled out passed the GILLS.
    - Not all species of sharks have SPIRACLES, but it is an ADAPTATION for those who are 'bottom dwelling' species, that rest on the seafloor often.

<u>Where do we find sharks?</u>

11. Where do we find sharks?

    - **SQ:** Ask the question to the class. Ask them if there are sharks in the UK?
    - Yes!
    - If the class is already very aware of sharks in the UK, as if they know of any specific species we find in the UK?

12. World map

    - Confirm that sharks are found in every ocean and are all over the world.

13. UK map

    - Highlight that this means we also have sharks in the sea around the UK.

14. British species

    - There are 19 species of sharks in the UK, photographed here are some of them.
    - You can see the sharks are different sizes, shapes and colours. This is because they are adapted to different HABITATS.

15. Comparing between migratory and non-migratory species.

    - Some species of sharks are only here in the summer, as they are migratory species. This means that they move to different areas of the world for different times of the year. Some examples are basking sharks, mako sharks, and blue sharks.
    - Some species do not migrate and can be found in British seas all year round. Some examples are small-spotted catsharks and angelsharks.
    - **SQ:** Ask the class if they can spot and similarities and differences between the pictured sharks between the migratory and non-migratory species.
    - You can see visual difference in the shape and colouration between the two groups.
    - Migratory sharks show COUNTERSHADING (darker on back side (dorsal), and pale belly (ventral)), this helps to camouflage them.
    - Non-migratory sharks here are more patterned, camouflaged with seaweed and sand for example. They are also much smaller than the migratory sharks.

16. Migration tracking example
    - An example of a migration of a tiger shark in the Caribbean.
    - Scientists can track sharks to see where in the world they travel, we can monitor their migration patterns.

Adaptations

17. ADAPTATIONS
    - Because we find sharks in different places and doing different things, they can look very different from one another. This is because they have adapted to their ENVIRONMENT/ HABITAT that they live in.
18. HABITATS
    - These are some examples of the types of HABITATS found in the UK.
    - Estuaries are nurseries for many fish and baby sharks.
    - Many of these HABITATS offer refuge for many animals so plentiful food can be found.
    - Most of the deep-sea shark species, have 6 or 7 gill slits, there is less dissolved oxygen in deeper water, so having more gill area increases the amount of oxygen they can absorb.
    - Let's look at a few examples of which sharks we may find in certain HABITATS.
19. Pelagic zone – examples show mako shark (top right) and basking shark (bottom left).
    - In the pelagic zone we find the larger species of sharks.
    - They often have COUNTERSHADING which you can clearly see in the picture of the mako shark.
    - Shortfin mako sharks are the fastest species of shark – reaching 60 mph – need to be fast to hunt their food.
    - Basking shark also adapted to pelagic zone, following plankton
20. Kelp forest – example is a small-spotted catshark.
    - Amongst the kelp (a type of seaweed) forests we find a lot of the smaller species of sharks.
    - The kelp offers places to hide.
    - There are lots of smaller animals living there, like crustaceans, molluscs, and fish.
    - Catsharks particularly lay their eggs and wrap them around the seaweed, they camouflage with the seaweed offering them protection.
21. Sand – example is an Angelshark.
    - Camouflage as they are sand coloured, even the patterns blend in with the sand.

- Burying behaviour, allows them to hide under the sand, protects them from predators, but also allows them to catch their food.
- Angelsharks are ambush predators and they can project their jaw further forward to catch their prey.

22. Fintastic ADAPTATIONS.
    - An example of an extreme ADAPTATION is the thresher shark.
    - Thresher sharks have very long tail FINS, sometimes longer than their body, you might think they use them to swim fast, but they can use them to catch their prey, by using their tail to hit the prey like a whip.
23. Flat sharks = SKATES and RAYS
    - SKATES and RAYS are the 'cousins' of sharks. They are also cartilaginous fish.
    - We can consider them as flat sharks.
    - Pictured: flapper skate (left) – largest species of SKATE worldwide, spotted ray (top right) and thornback ray (bottom right).
24. REPRODUCTION, mermaids purses and PUPS
    - Many species of sharks and all SKATES lay eggs.
    - Eggs are nicknames mermaid's purses.
    - Baby sharks, SKATES, and RAYS are all called PUPS.
    - SKATES have pointy horned EGG CASES (top, thornback ray).
    - Sharks have EGG CASES with curly tendrils at the ends (bottom, small spotted catshark).
25. EGG CASE video
    - When PUPS are in their EGG CASES, we can often see the developing embryo inside.
    - The video shows a Nursehound embryo developing inside the egg.
26. Live birth
    - But not all baby sharks/PUPS are born via EGG CASES, some have live births just like humans, which mean they have belly buttons, like in this picture.
    - This shark is a lemon shark *(not found in the UK)*.

<u>Shark senses</u>

27. Shark senses
    - So, we've learnt a lot about what makes a shark and how varied they are, but now let's learn about their senses, as sharks have some amazing ones.
    - Explain that sharks have all the same senses we do but they have extra ones.
28. Sight

- Image of nurse shark eye *(not found in the UK)*.
- Large variation in shark eye size, usually linked to life history strategy and how reliant they are on vision for feeding. Shark eyes are similar to our eyes in how they work.
- Shark eyes vary in size and shape depending on the HABITAT and depth they spend most of their time in.
- Some sharks have nictitating membranes, which protect their eyes when they are going after prey.
- Sharks without nictitating membranes can roll their eyes back in order to protect them.

29. Hearing
    - Sharks have ears on the top of their heads, but not external structure like ours.
    - Sound travels underwater four times faster than on land.
    - Lower frequencies dissipate slowed than higher ones.
    - Some species can locate their prey over several hundred metres.
    - An injured or struggling fish gives off a frequency around 20 hertz.
30. Smell
    - Sharks have an incredible sense of smell.
    - Imagine being able to smell a chocolate chip cookie in an area the size of a football field.
    - Some sharks can detect a single drop of fish blood within a million drops of seawater or from a quarter of a mile away.
    - Pictures: tiger shark (main image), nurse shark (top left), great hammerhead shark (bottom left). *(These three species do not occur in the UK)*.
31. Taste
    - Sharks have very sensitive taste buds in their mouth and will do a “test bite” to see if something is edible or part of their normal diet.
    - People are NOT part of the normal diet of sharks.
    - If you were to bite a crayon or t-shirt (or another item in the classroom the kids would not eat) would it taste good? Would you want to eat it?
    - Sharks do not have hands like we do, so they use their mouths to figure out what things are.
    - Accidents happen when sharks bite something (people) and then let go because it is not food.

- A chocolate bar tastes good, but the wrapper it comes in does not. We know the wrapper doesn't taste good because we have learned it is not food. A shark learns by doing a test bite.
- We don't taste good, so they let go, but sharks have a lot of teeth and sometimes the bite can harm a person, but it is not the shark hunting down a human and trying to eat them.
- This is a challenging section, but also a great opportunity to reiterate the fact that humans are not on the menu for sharks. Yes, accidents happen, but sharks do not hunt people and consider them food.

32. LATERAL LINE
    - Sharks have two components to their sense of feeling and touch.
    - The first is actually touching an object, including a test bite, where they not only taste, but also feel the potential prey.
    - The second is a bit more complex and includes a series of canals known as the lateral line.
    - The LATERAL LINE is a series of interconnected canals that run from the back of the shark's head to its tail.
    - Each canal is made up of tiny pores, which allow water to penetrate the skin.
    - Tiny hairs line the canal and allow the shark to detect movement in the water.
    - The shark does not have to see an animal to know it is there but can feel it by detecting movement or disturbance in the water.
    - If you are in a swimming pool and your friend does a cannon ball you feel the wave, right? Imagine if you were at the opposite end of the pool and your friend wiggled his or her fingers very gently and you were able to feel that.
33. AMPULLAE OF LORENZINI – 6th sense
    - Sharks have what is known as a 6th sense.
    - This 6th sense refers to their ability to detect electrical pulses in the water, called electroreception.
    - AMPULLAE OF LORENZINI (black pores you can see in the image) are sensory organs that can detect these pulses. Every living thing gives off an electrical pulse. This gives sharks another tool for finding food.
    - Metal objects such as boat propellers also give off pulses.
    - Sharks can actually detect the very faint pulse given off by prey hiding motionless while buried in sand on the bottom.
    - Sharks that are more active hunters will have more ampullae on their snout than less active species of sharks.
    - **SQ:** Do you think a healthy fish gives off the same pulse as an injured or dying fish?

- When you are scared or injured your heat rate gets faster. When an injured fish is hiding or swimming away from a predator, their heartbeat will be faster compared to a calm, healthy fish. This could help a shark seek out easier to catch prey by targeting prey with a faster heartbeat.

34. *Optional slide

- Shows an electron microscope image of the AMPULLAE OF LORENZINI of a Tiger shark *(not found in the UK)*.

<u>How do we learn about sharks?</u>

35. How do we learn about sharks?

- Summarise that we have learnt about the senses, ADAPTATIONS and diversity of British shark species so far. Now we will focus on how we learn about sharks.

36. TAGGING

- Slide shows PIT tags, ROTO tags and SPOT (satellite) tags.
- You might have heard about TAGGING if you have ever watched shark week, they are small devices that can be attached or implanted inside the shark.
- Some enable us to ID the shark, just like microchipping your dog/cat.
- Some allow us to see where the sharks are moving across the world.

37. Sample Collection

- Sometimes we catch, measure, and collect samples from sharks.
- We could collect BIOLOGICAL SAMPLES such as tissue (e.g. muscle, skin), mucus, blood, parasites or stomach contents.
- We can use tissue, mucus and blood to look at their DNA.
- We can use blood and parasites to see if they're healthy.
- We can do an ultrasound to see if they're pregnant.
- Record their sex.

38. Identify their sex

- We can easily identify between female and male sharks by looking at their pelvic fins.
- Males have an external organ, which is a modified part of their pelvic fins, called claspers. These are their sexual reproductive organs.
- Females do not have claspers.
- There is an opening called the cloaca between the pelvic fins.
- The images shown are from juvenile sharks. As animals become sexually mature, claspers will grow and calcify (harden). This helps scientists also record the sexual maturity of male sharks.

39. Snorkelling and scuba diving
    - We can get in the water with them to observe them, their behaviour, watch how individuals and species interact with each other.
    - Can record them on video and take pictures.
40. BRUVs
    - We can also put cameras in the water to observe them without us going in.
    - This is an example of what is called BRUV (baited remote underwater video) footage.
    - It is a camera with a bait box which attracts animals in. we can use this to see which shark species we have in the area, but also other marine animals too.
    - This is a still from footage that was taken off the coast of North Wales, pictured is a spider crab holding onto the bait box.
    - Opportunity to highlight other wildlife found in the UK, not just shark species.

<u>Why are sharks so important?</u>

41. **SQ:** Ask the class if and why they think sharks are important?
42. Food Web
    - Sharks are carnivores meaning they eat other animals.
    - Sharks eat (prey) fish, turtles, MAMMALS, birds, and even other sharks.
    - Explain a food web and that large predators like sharks are often at the top of the food chain. However, not all sharks are found at the top of the food chain, with smaller sharks lower down.
    - Scientists believe sharks are critical for maintaining ocean BIODIVERSITY.
    - Many are APEX PREDATORS meaning they are responsible for maintaining the health of ecosystems. They eat old, sick, dead or dying fish and keep the population of fish beneath them on the food chain from overpopulating. It is important for each level of the food chain to be in balance in order for the whole ECOSYSTEM to be healthy.
    - In some areas where shark populations are declining, scientists have found significant damage to coral reefs. Without sharks, fish species below them on the food chain swell in population and can overeat their food source, making those populations go down. These fish will die off and the next level has a swell in population and so on. It cascades down impacting all levels of the ecosystem.
    - Biodiversity is critical for healthy oceans. Scientists have found a decline in ocean biodiversity, and this has consequences on the stability of functioning ecosystems. This system is delicately balanced and when a component or multiple components are affected, the entire system and its interconnected parts feel the impact.

- Sharks are not always apex predators, but no matter where in the food chain they exist, they play a critical and necessary role in its balance. They help maintain healthy and sustainable populations of the animals they consume.

Threats to sharks

43. Threats to sharks
    - Approximately 100 million sharks are killed each year. This is a VERY large number and the point of the slide is to get their attention and to think about just how LARGE this number is.
    - We will cover some reasons why shark populations are declining, particularly in the UK.
44. Fishing and bycatch
    - Overfishing has been the largest driver of shark population declines worldwide and in the UK. This is still an issue for many species.
    - Some species cannot be targeted, however, many species are still caught as bycatch, which means that are accidentally caught. This is where animals that are not the target species are caught and even though cannot be landed or sold, they still die as a consequence.
    - Spurdog in a prawn fishery (top left), porbeagle in a whitefish fishery (bottom left), and spurdog landed in large numbers (right top and bottom).
45. HABITAT destruction
    - Despite fishing being the primary cause for decline, there are other threats to sharks and other marine species.
    - This picture shows removal of mangroves to clear land for construction. Mangroves are a key HABITAT for juvenile lemon sharks *(not found in the UK)* as well as many other marine species (including their prey items). Without this HABITAT there won't be food or protection for juvenile lemon sharks.
46. Pollution, including plastic pollution.
    - Plastic pollution harms marine wildlife often due to ingestion.
47. Entanglement
    - They can also become entangled and hurt by this pollution as shown on this Silky shark *(not found in the UK)*.
48. Climate change
    - Climate change will also be impacting sharks, as well as all other marine life.
    - Climate change is impacting water temperature and ocean chemistry. This effects the ability of marine animals to survive in these new conditions.
    - Changing dynamics such as sea level rise, weather patterns and increased frequency and severity of storms, as well as coastal erosion are all changing the marine landscape and

marine landscape and will impact the HABITATS and ENVIRONMENTS that sharks rely on and have adapted to.

We need your help

49. Sharks need your help! They are in deep trouble and many species are ENDANGERED and threatened with extinction.
    - Over 30 % of sharks, SKATES and RAYS are threatened with extinction.
    - Shark CONSERVATION involves protecting sharks and their HABITATS.
    - **SQ:** What do you think you could do to help sharks?
    - Recycle all items you can. Select recyclable items when purchasing goods.
    - Don't litter on land or in the water and pick up any littler you see.
    - Be a good junior scientist and ask good questions about sharks.
    - Encourage your family to use reusable items like shopping bags
    - Have a reusable water bottle instead of buying new bottles of water.
50. Spread the word
    - Be a shark advocate by telling other people how cool sharks really are and that they are NOT man-eating monsters.
    - If you learnt something new or interesting today, please share with your friends and family.
    - Helping sharks starts with changing perceptions.
51. Great EGG CASE hunt
    - Another way to get involved is to participate in the Shark Trust great EGG CASE hunt.
    - You can access the information to participate on the Shark Trust website.
    - It involves going to your local beach (or your next visit if you live further away) and looking along the beach (often amongst the washed-up seaweed) for dried up EGG CASES.
    - You can use the ID guides provided by the Shark Trust to identify which species the EGG CASES you've found belong to.
    - You can then report these to the Shark Trust and they will collect the data to survey where different species are found around the UK.
    - The bottom left picture shows EGG CASES found at a beach.
    - This is a way you can contribute to monitoring and research of sharks in the UK.
52. Good Fish Guide
    - Discuss how one of the ways to make positive choices for the ocean is by choosing to eat seafood from sustainable fisheries only.

- There is a website and app by the Marine Conservation Society (MCS) where you can see details of the sustainability of different species.
- Don’t be afraid to ask where your food is coming from, how its caught and what species it is.

53. Final closing slide.