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BIODIVERSITY
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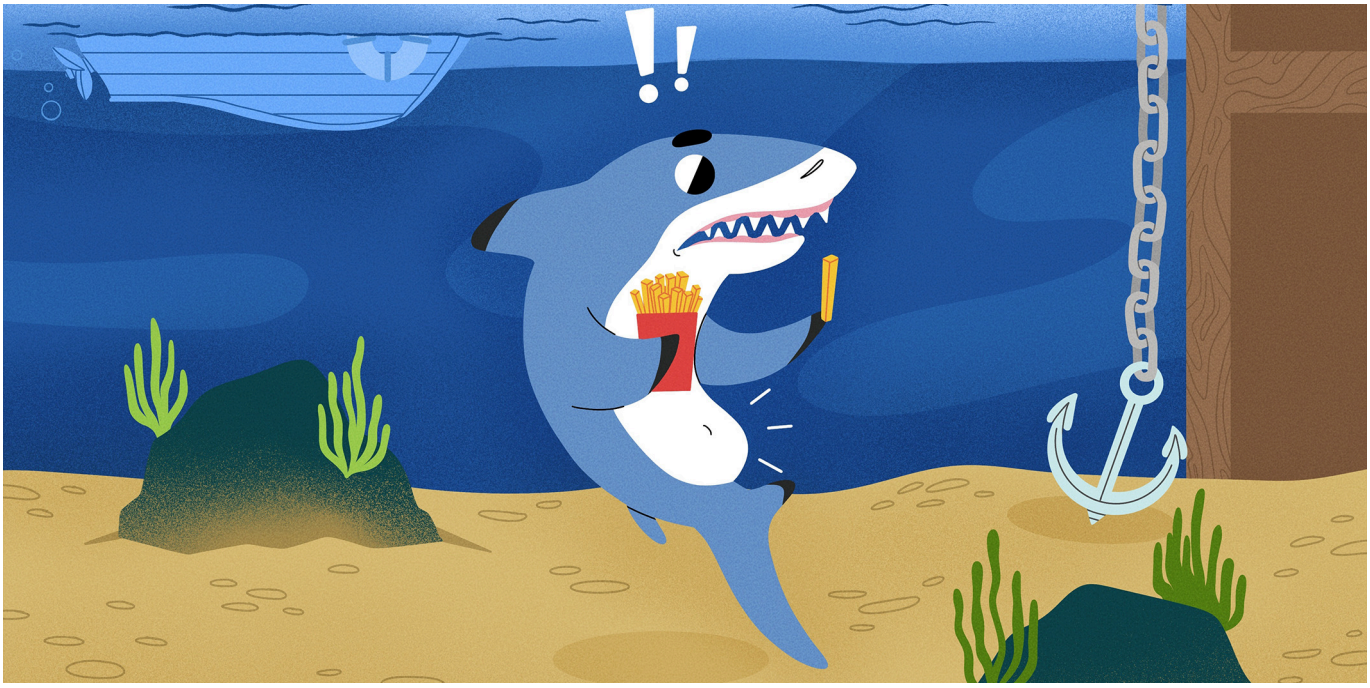

URBAN LIVING AFFECTS THE NUTRITION OF SHARKS

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YOUNG REVIEWERS:

ALICE
AGE: 12

YU
AGE: 14

It is common to see some wild animals in the city, like squirrels and raccoons, but have you ever thought about sharks in the city? While you will not see a shark hanging out on the streets of downtown, you may see one swimming along the shorelines of major seaside cities! Although living in coastal cities can bring many benefits to sharks, such as abundant food and protection from large predators, sharks can be negatively affected by pollution and fishing. We studied blacktip sharks living near the city of Miami, Florida, to see if urban living affected their diets and their health. We found that blacktip sharks living close the city (nicknamed urban sharks) were fatter than non-urban sharks. Urban sharks also showed signs of eating more saturated fats, which are unhealthy when in excess in an animal's body. This shows us that urban sharks are likely eating more food of lower quality, which can have negative consequences for their health.

URBAN SHARKS, IS THIS POSSIBLE?

Sharks live closer to people than we think [1]. Compared to the open ocean, coastal areas generally have more food for sharks, which makes these areas attractive to them. Young sharks often use shallow waters, which are protected from predators, as nursery grounds during their first few years of life, before moving to deeper water as adults. Shallow areas near shore also tend to be warmer, which helps speed up the growth of young sharks (Figure 1). However, the sharks that use coastal waters are also exposed to numerous human threats, especially near big cities. These threats include fishing, boat traffic, and pollution (Figure 2) [2]. For example, light pollution from cities can alter the behavior of sharks and their prey. **Contaminants** like metals and oil that leak into the ocean can directly affect shark health and reproduction [3].

CONTAMINANTS

Chemicals that are discharged from industries, including things like mercury, pesticides, and hydrocarbons (petroleum).

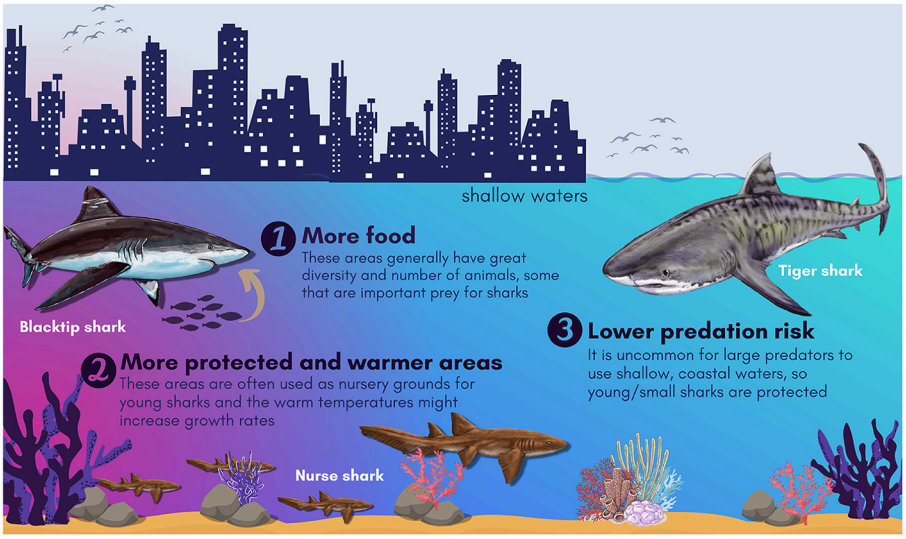

Figure 1

Sharks might choose to live near cities because shallow, coastal areas have several advantages, including more food; warm, protected areas; and fewer predators [Image credits: Kelly Quinn (tiger and nurse sharks), Alexandre Huber (blacktip shark), and www.canva.com].

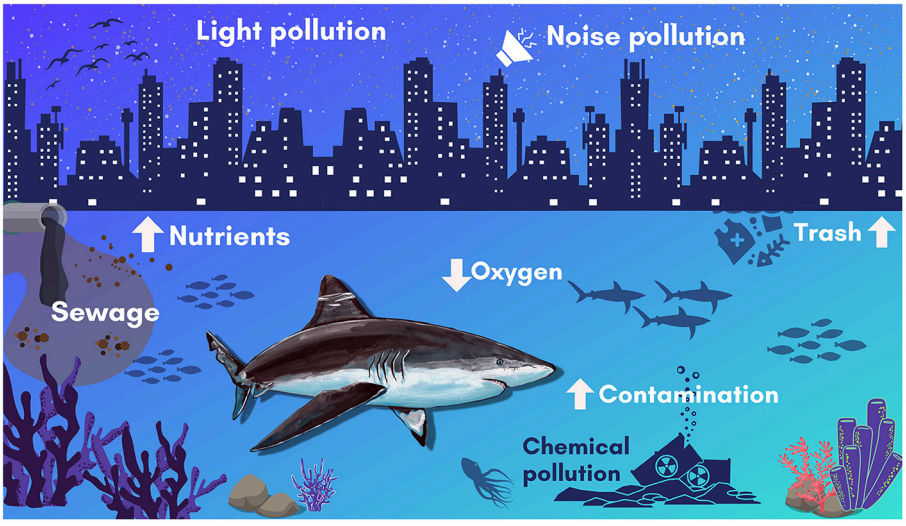

Figure 2

Human impacts from urban coastal areas, including various forms of pollution, can negatively affect sharks that live close to cities [Image credit: Alexandre Huber (blacktip shark) and www.canva.com].

STUDYING THE NUTRITION OF URBAN SHARKS

To better understand the influence of urbanization on shark nutrition, we studied 52 blacktip sharks in the waters off South Florida, close to the city of Miami, and in more pristine waters farther away from Miami. We measured shark girth (how wide they are around the waist) and we took small blood samples to check what they were eating. To do this, we carefully and temporarily trapped sharks using a shark-friendly fishing method called a **drumline** (Figure 3). We then brought the sharks alongside our boat, collected blood samples through a vein in the tail, recorded body-size measurements, and then released the sharks, which swam off. We tested shark blood to examine the types and proportions of substances called fatty acids, which told us about the sharks' nutrition (Figure 3). Individual sharks sampled close to Miami were classified as "urban sharks" and individuals sampled farther from Miami were classified as "non-urban sharks."

DRUMLINE

Shark-friendly fishing method, where the shark can constantly swim after being hooked.

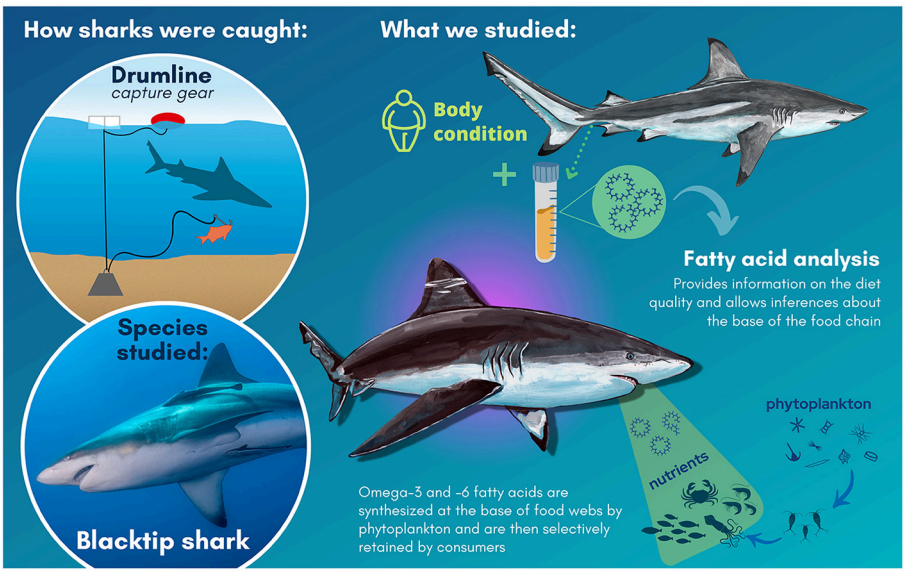

Figure 3

In our study, blacktip sharks were caught using a drumline. We studied their body proportions and the levels of fatty acids in their blood [Image credits: Alexandre Huber (fishing gear and shark) and www.canva.com].

WHAT ARE FATTY ACIDS AND WHY STUDY THEM?

You have probably seen the words "omega-3" written on products being sold in supermarkets, pharmacies, and grocery stores. **Omega-3 and–6 fatty acids** are a type of healthy fat that animals (including humans) need but cannot produce, and thus must get from their foods [4]. These healthy fats are essential for survival and health, since they help to form some of our cells. They are also essential for inflammatory and immunological processes—two ways that our bodies cope with diseases [5]. Omega-3 fatty acids differ from **saturated fats**, which are a type of fat that tends to be solid at room temperature and, therefore, unhealthy when in excess in an animal's body. Many processed and

OMEGA-3 AND–6 FATTY ACIDS

A group of essential fatty acids that is important for the survival and health of all animals.

SATURATED FATS

A type of fats derived from both animal fats and plant oils that tend to be solid at room temperature and are unhealthy when in excess in an animal's body.

deep-fried foods have high saturated fat content, which can cause **cardiovascular disease** in humans [4, 5].

In the marine environment, omega-3 fatty acids are produced by microscopic algae called **phytoplankton**. These omega-3 fatty acids are then passed along the **food chain** to animals, for example, when a small fish eats the phytoplankton, then a bigger fish eats the smaller fish, and then a shark eats the bigger fish (Figure 3) [4]. If sharks cannot feed on prey with high levels of omega-3 fatty acids, then they may have to eat foods with higher proportions of saturated fats, which is unhealthy.

CARDIOVASCULAR DISEASE

Are some conditions that affect the heart and blood vessels, like when there are high levels of blood lipids (fats).

PHYTOPLANKTON

Microscopic algae that like plants use nutrients, carbon dioxide, and sunlight to grow while releasing oxygen.

FOOD CHAIN

Feeding relationships between organisms, i.e., prey and predators. The chain consists of producers, consumers, and decomposers.

URBAN SHARK ARE CHUBBY!

We discovered that urban sharks had larger girths than non-urban sharks and also had higher levels of unhealthy saturated fats in their blood. We believe this means that urban sharks are eating more food, and food of poorer quality in terms of saturated fats. This may be equivalent to urban sharks feeding on lots of "fast food" in the city!

But why do urban sharks eat more food than non-urban ones? First, we suspect that increased nutrients coming from sewage are helping phytoplankton and smaller animals to proliferate, and these organisms serve as food for larger animals, including sharks [6]. Second, the waters around Miami have many fishing marinas, where anglers often cut the meat off their daily catches and discard the remaining carcasses in the water, where those leftovers can be consumed by urban sharks [1, 7]. Lastly, it is also possible that urban sharks do not have to swim as much, so they do not use up as much energy doing physical exercise.

We also expected to find that urban sharks were feeding on prey that was low in important nutrients, like the essential omega-3 and omega-6 fatty acids. In a previous study we did with nurse sharks—a species that does not move around a lot—we found a reduction in omega-6 fatty acids [8]. However, we did not detect a reduction in diet quality in urban blacktip sharks, which tend to move around a lot. This made us think that the lifestyles and behaviors of each urban shark species might influence the quality of the food they eat. Thus, we suspect that impacts of urbanization are stronger in sharks that *do not* move around a lot, because, compared to other species, they probably have increased exposure to the pollutants emanating from big cities.

In summary, our results and those from previous studies suggest that sharks living near cities may eat more, and the quality of their food may not be as good as that found in more pristine areas. We are not sure what this means for shark health, so we suggest that future

studies should continue to investigate the nutrition and health of urban sharks—an inadequate dietary intake of essential nutrients could compromise shark health and development.

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ORIGINAL SOURCE ARTICLE

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ALICE, AGE: 12
Hello, my name is Alice. I am 12 years old and my hobbies are art, listening to music, doing sports and learning chemistry in school. When I grow up, I want to become a food chemist and advocate for problems like racism.

YU, AGE: 14
I am a young motivated boy who likes playing in the green landscape and mountainous forest. My hobbies are swimming, playing with animals including beneficial insects, pets and flowers. I am the big fun and voice of agro-ecology, biodiversity conservation, and voice of climate change mitigation and adaptation actions in from childhood. I am an active member of the Climate environmental protection club. I like to pick plastic wastes and put them in their reserved place.

AUTHORS

BIANCA S. RANGEL

I am a biologist, Brazilian shark scientist, and a postdoctourate research in physiology at the Institute of Biosciences of the University of São Paulo. In my research, I use some molecules present in the blood and muscle of sharks to study these endangered and fascinating animals. I am particularly interested in how sharks interact amongst themselves and in their ecosystems. For that, I study how sharks use their energy for reproduction, how urbanization and tourism are affecting their nutritional quality, and the impact of fisheries on shark health and survival. I am also a volunteer of the Sharks4Kids and the NGO Sea Shepherd, where I lead two shark-defense campaigns. *biarangel.sharks@gmail.com

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I am a biologist and professor at the Institute of Biosciences of the University of São Paulo. My research is focused on understanding how fish live in contaminated environments and what happens to them when they are in these polluting environments. I also study how to improve fish farming for human consumption.

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I am a marine ecologist at the University of Miami (UM) and the director of UM's Shark Research & Conservation Program. I am studying how human threats to the oceans, such as climate change and overfishing, impact the behavior, health, and survival of sharks. I currently have projects underway in Florida, Bahamas, South Africa, and the Galapagos Islands. I love hockey and am a die-hard Pearl Jam fan. My favorite color is orange.