

PERUVIAN FOOD CHAIN JENGA

- TEACHER'S HANDOUT -

Main idea

All species play an important role in the ecosystem; however, some species (anchovies and sharks) have a large impact on other species.

Objectives

- Understand and use scientific models
- Explore the complexity of food chains
- Make predictions
- Use cause/effect statements
- Familiarize with marine concepts and species
- Generate awareness about marine ecosystems

Introduction

The Marine Ecoregions of the World (MEOW) is a nested system of 12 realms, 62 provinces and 232 ecoregions that classify coastal areas around the world (Fig. 1a). Ecoregions are areas that have similar species composition and are distinct from adjacent systems (Spalding et al. 2007). Peru's coast is allocated in the Tropical Eastern Pacific (TEP) and Temperate South America (TSA) realms (Fig. 1b).

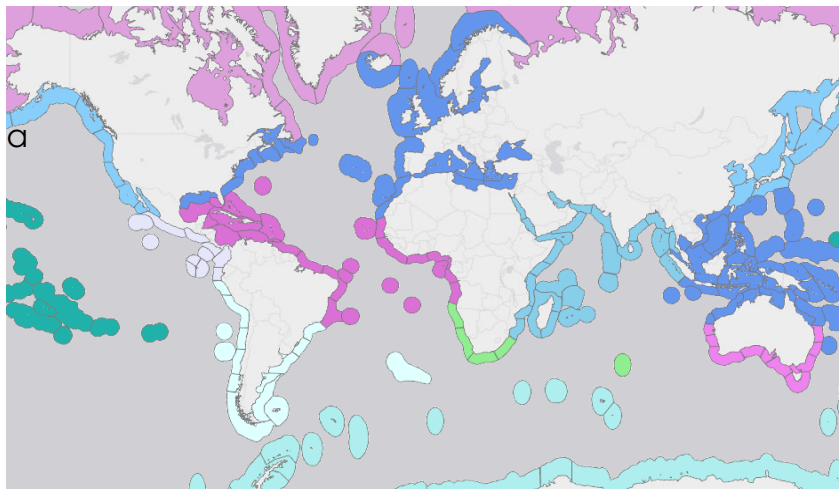


Figure 1. a) Realms with ecoregions outlined, (b) Peru's coast falls between the Tropical Eastern Pacific (purple) and Temperate South America (light blue) realms.

Peru's northern ecoregion, Guayaquil, is inside the TEP realm and is distinct from the southern ecoregions due to the warm surface temperatures, which range from 19-22 °C (Fig. 2). The TSA realm nests two ecoregions: Central Peru and Humboldtian (Fig. 2).

These ecoregions are formed by the Peruvian Current (also called the Humboldt Current) and has temperatures ranging from 13-14 °C in winter to 15-17 °C in summer.

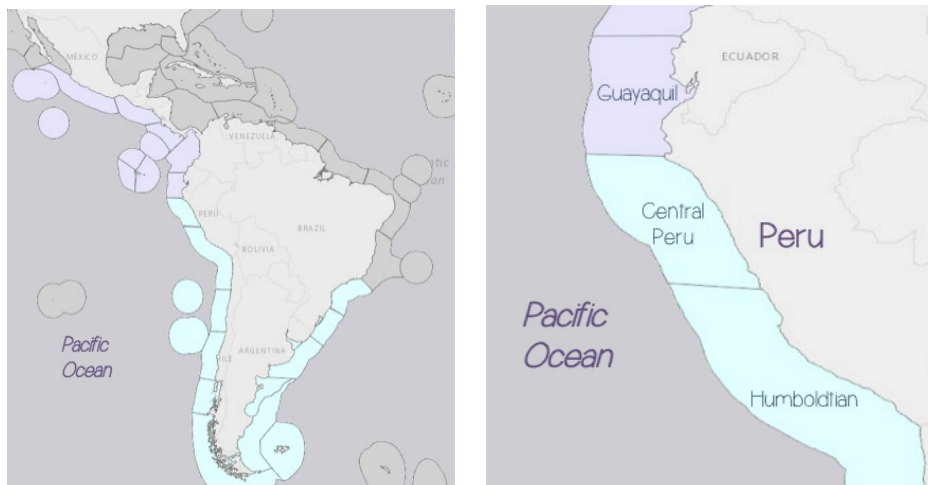


Figure 2. Marine provinces and ecoregions within Peru. The color denotes the province. *Purple* – Topical East Pacific province, *light blue* – Temperate South America province.

The Peruvian current produces an upwelling that transports deep waters full of nutrients to the surface. The upwelling process makes the Peruvian sea one of the most productive in the world. Scientists have identified 750 species of fish, 872 species of mollusks, 412 species of crustaceans, 45 species of echinoderms, and 240 species of algae. The anchovy is a small fish that can be found along the Peruvian Current, from Piura to southern Chile. The anchovy feeds mainly on phytoplankton but also feeds on zooplankton. Due to the high primary production in the ecosystem, the abundance of anchovy is very high, and a great variety of species like fish, mammals, and birds feed almost exclusively on this fish. The anchovy is considered a keystone species in this ecosystem because so many animals depend on them as a food source. If the anchovy disappears the whole ecosystem would collapse.

During an El Niño event, the waters along the Peruvian coast get warmer decreasing the upwelling. The anchovy, under normal conditions, can be found near the surface during the night and around 50 m deep during the day. So, during an El Niño event, the anchovy go deeper, 100 to 150 m, looking for colder waters. This makes the anchovy inaccessible to predator species and many individuals die from starvation. For instance, the sea lion population decreased 72% during the 1997/98 El Niño event.

Unfortunately, the anchovy has also been heavily exploited since the mid-1950s. Since 1960, the total catch by weight has exceeded any other single fishery in the world. The anchovy is mainly used to produce fishmeal as food for poultry. More than four tons of anchovy is needed in order to produce one ton of fishmeal. In past years, the direct

consumption of anchovy by people has been promoted since it possess good-quality proteins and essential fatty acids like Omega-3 and Omega-6.

Unfortunately, the anchovy has also been heavily exploited since the mid-1950s. Since 1960, the total catch by weight has exceeded any other single fishery in the world. The anchovy is mainly used to produce fishmeal as food for poultry. More than four tons of anchovy is needed in order to produce one ton of fishmeal. In past years, the direct consumption of anchovy by people has been promoted since it possess good-quality proteins and essential fatty acids like Omega-3 and Omega-6.

Sharks are also considered keystone species. As top predators, a trophic cascade may occur if sharks are removed from the food chain. The absence of top predators would affect not only the organisms at a lower trophic level but could affect significantly several lower trophic levels.

Vocabulary

- Bycatch: In fisheries, bycatch are non-target species that are trapped in fishing gear.
- Discards: Bycatch that is returned to the sea. Discards can be alive but they are mostly dead.
- Food chain: The linear sequence that unites animals to other animals based on their feeding choices. The food chain transfers energy among the different trophic levels.
- Food web: A complex network of several food chains.
- Global extinction: The complete disappearance of a species.
- Keystone species: Species whose importance in the ecosystem is large.
- Local extinction: The disappearance of a species in a particular area.
- Microplastics: Small plastic pieces that originated from fragmentation of bigger plastic objects or microbeads contained in cleaning products.
- Primary consumers: Organisms that eat producers.
- Producers: The species that produce their own food. They are the first level of the trophic chain.
- Secondary consumers: Animals that eat primary consumers.
- Top predator: Species that have no natural predators.
- Trophic cascade: Changes in the ecosystem after the addition or removal of top predators.
- Trophic level: The position of a species in the food chain or food web.

A **food chain** or food web describes the feeding relationships between different species in a community. The species are located at different **trophic levels**. The **primary producers** are at the lowest trophic level located at the base of the game. They are

called autotrophs since they do not feed on other organisms and instead take energy from the sun to grow. These organisms are usually small and abundant. The next level is the primary consumers, which feed on producers. The next level, the **secondary consumers**, feed on the primary consumers and so on. As the trophic chain levels increase in height, the abundance of the organisms decrease because the energy available to each successive level becomes less and less; this is why the food web is often called a food pyramid. The last trophic level is composed of animals known as **top predators**. These animals have no natural enemies. Humans are considered to be top predators in many communities. A **keystone species** is one that is critical to maintaining a balanced ecosystem. A keystone species is the glue that holds the food web together.

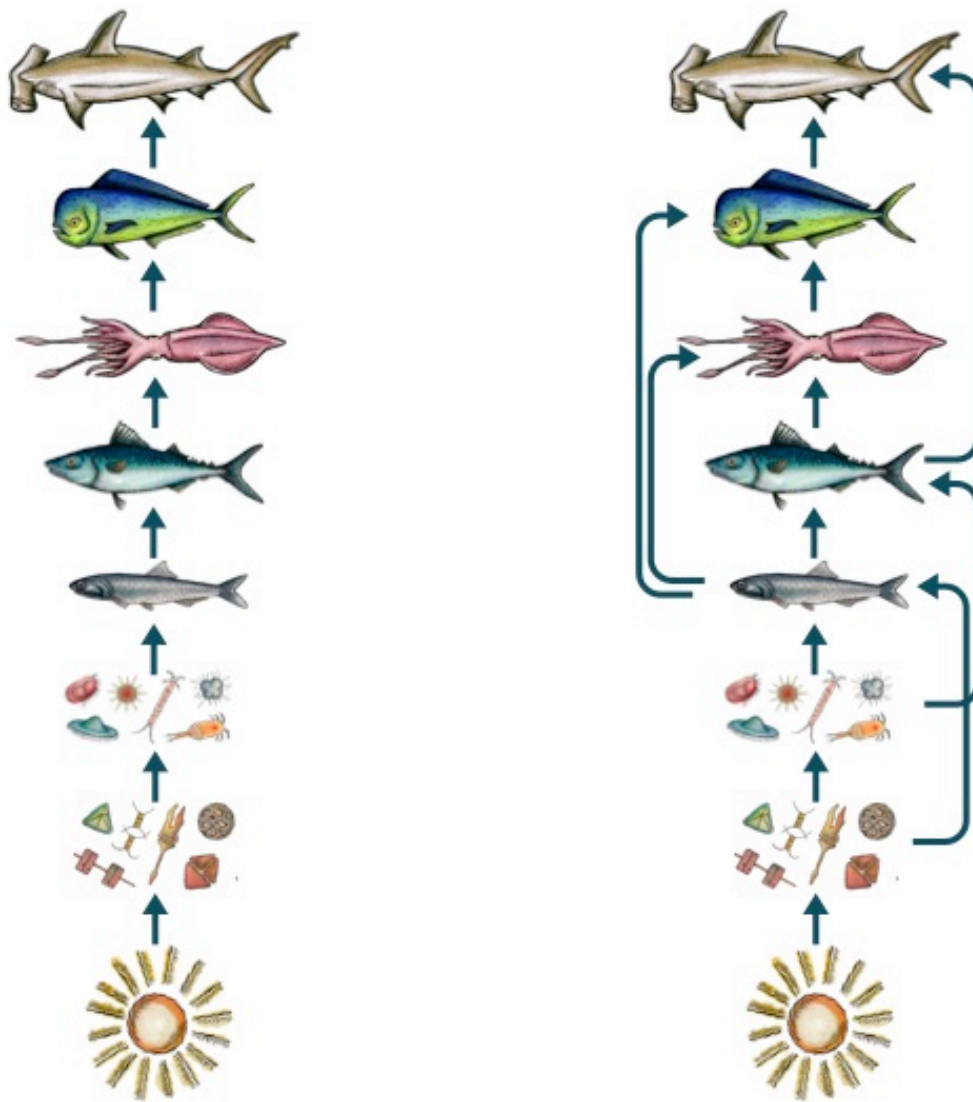


Figure 3. The food chain and food web of Temperate South America province.

Trophic levels

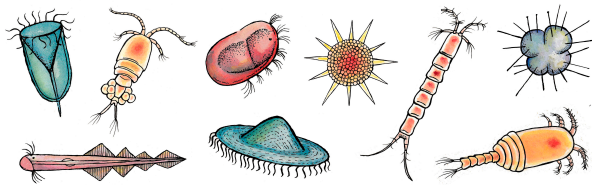
Trophic level 1 – Producers

Phytoplankton are microalgae (dinoflagellates and diatoms) that convert the energy from the sun into organic compounds.



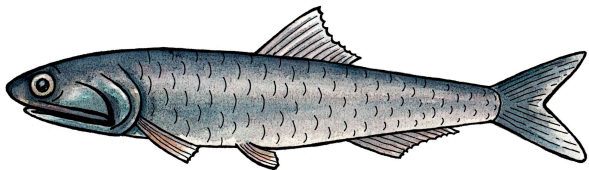
Trophic level 2 – Primary consumers

Zooplankton are small invertebrates and larvae of mollusks, fish, and crustaceans that get energy by feeding on phytoplankton.



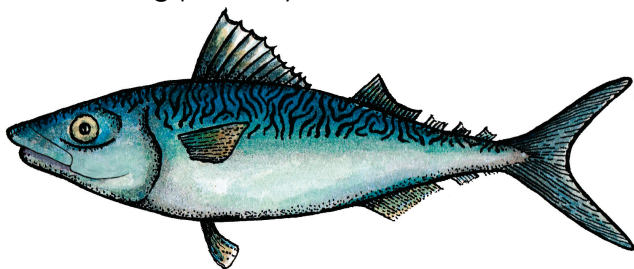
Trophic level 3 – Consumers

The Peruvian anchovy (*Engraulis ringens*) is a fish that can be found in the southeastern Pacific Ocean, and are regularly caught on the coasts of Peru and Chile. This fish gets energy by eating plankton.



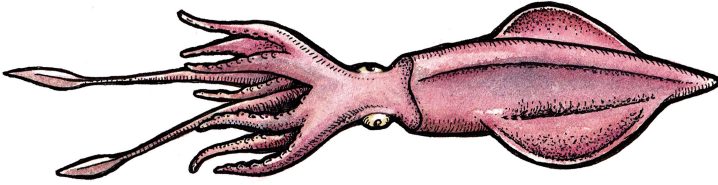
Trophic level 4 – Consumers

The chub mackerel (*Scomber japonicus*) is a medium-size fish species that gets energy from feeding primarily on anchovies.



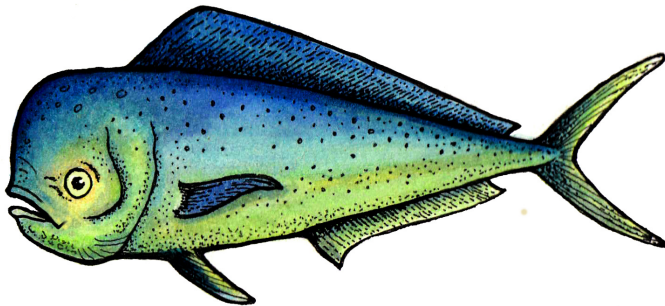
Trophic level 5 – Consumers

The jumbo flying squid (*Dosidicus gigas*) is the biggest and most abundant squid species in the East Pacific. It gets energy by feeding on a wide range of species including fish, crustaceans, and mollusks.



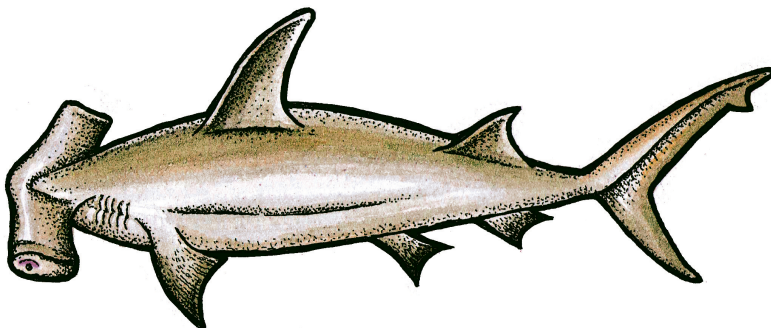
Trophic level 6 – Consumers

The mahi mahi or dolphinfish (*Coryphaena hippurus*) is a popular fish species in Peru. Mahi mahi get energy by feeding on a great array of species especially the flying fish, chub mackerel, and the jumbo flying squid.



Trophic level 7 – Top predator

The smooth hammerhead shark (*Sphyrna zygaena*) is one of the 60 species of sharks reported in Peru. This species is considered as Vulnerable by the IUCN (International Union for Conservation of Nature).



Discussion

1. What do you notice about the shape of the food chain?
Lower trophic level organisms are usually small and abundant while top predators are bigger and less abundant.
2. Where would you locate humans in this food chain?
Humans are located on top of the trophic chain.
3. Do you think that all organisms are important in the ecosystem?
Yes, every organism has a role in the food chain.
4. Are humans competing with other predators?
Yes, many of the fish that humans consume are important for other species. Species like the anchovy are being wasted on fishmeal for poultry.
5. How do changes in the food chain affect economic and social activities?
If one commercial species disappears from the food chain it would cause the disappearance of other species, and eventually affect the whole food chain.
6. How can you help keep the marine ecosystem healthy?
Being a responsible consumer. Becoming well informed is crucial in order to respect seafood bans and size limits.

Estimated time

Introductory video	5 minutes
Guide Sheet	10 minutes
Use the model	20 minutes
Wrap-up	10 minutes
Total time:	45 minutes

Alignment with Standards

National Standards, NGSS

Content Standards

5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

5-LS2-1- Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment

Crosscutting Concepts

Dimension 2-4 Systems and system models

Dimension 2-5 Energy and matter

Dimension 2-7 Stability and Change

Texas State Standards, TEKS

Grade 4

112.15(9) Organisms and environments. The student knows and understands that living organisms within an ecosystem interact with one another and with their environment.

The student is expected to:

(A) investigate that most producers need sunlight, water, and carbon dioxide to make their own food, while consumers are dependent on other organisms for food; and

(B) describe the flow of energy through food webs, beginning with the Sun, and predict how changes in the ecosystem affect the food web such as a fire in a forest.

Grade 5

112.16 (9) Organisms and environments. The student knows that there are relationships, systems, and cycles within environments. The student is expected to:

(B) describe how the flow of energy derived from the Sun, used by producers to create their own food, is transferred through a food chain and food web to consumers and decomposers; and

(C) predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways.

Others

Essential Principles of Ocean Sciences

(1) The Earth has one big ocean with many features.

(5) The ocean supports a great diversity of life and ecosystems

(6) The ocean and humans are inextricably interconnected.

Aichi Biodiversity Targets

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building.