Blue Tilapia Sea Pens

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MBAQ201: Form and Function of Unique Marine Ecosystems

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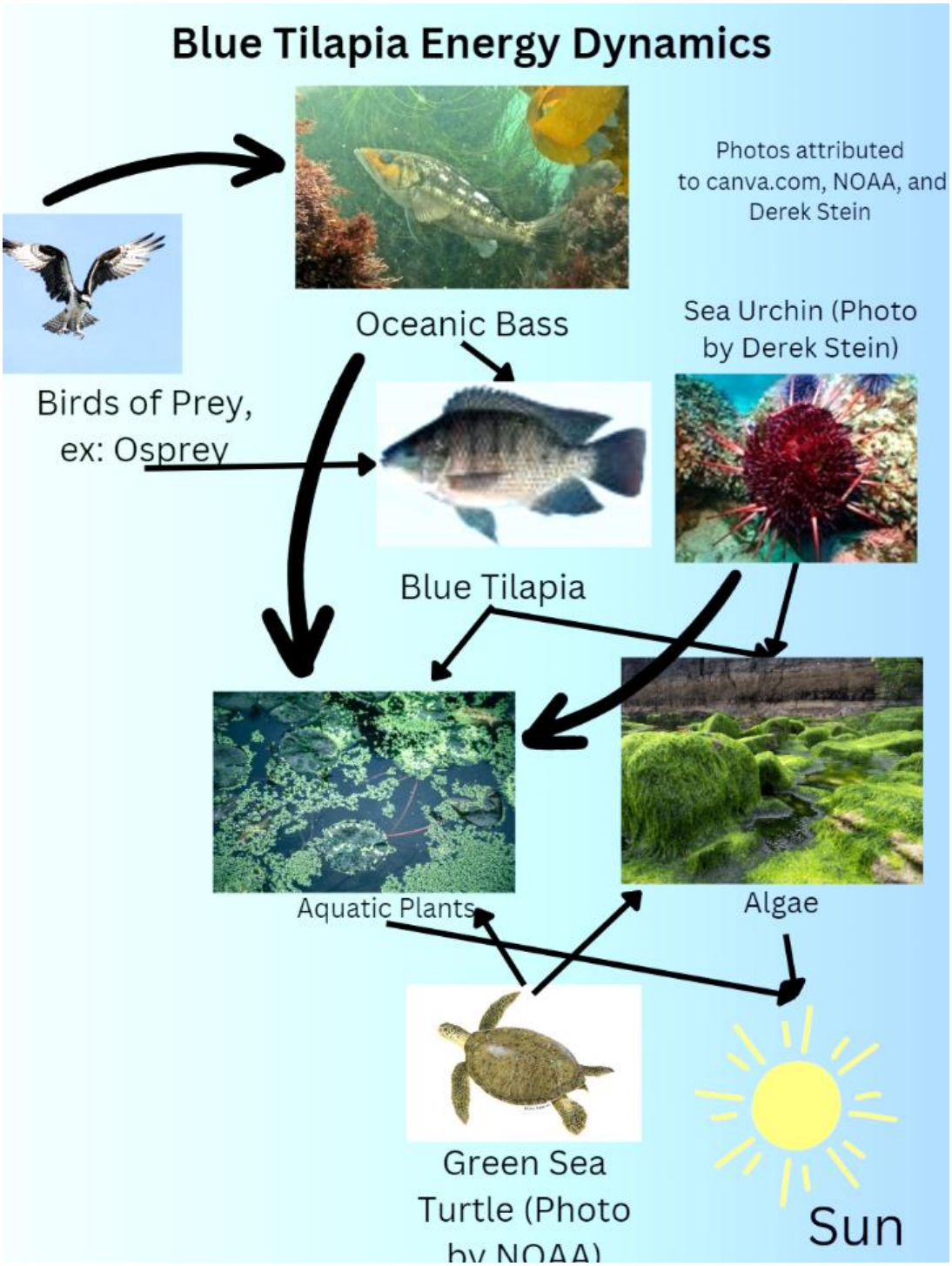
When finding the optimal locations along Santa Barbara, California, the first thing to consider is the different ecosystems and how they will be impacted. Some of the unique ecosystems of Santa Barbara's ocean are kelp forests, pelagic (open) ocean, rocky intertidal zones, and eelgrass beds.

The optimal option to house the blue tilapia sea pens is the pelagic ocean ecosystem. The pelagic ecosystem consists of the open ocean where the top predators are orcas, sharks, whales, and sea birds. The open ocean also houses various species of fish, marine mammals, and invertebrates. It is very biologically diverse. The primary producer of the pelagic ocean is phytoplankton, part of the diet of blue tilapia.

It is imperative to keep the population of plankton stable due to the number of animals that rely on it for food. Many species of fish, whales, invertebrates, etc. One animal that has a direct link to the increase in plankton is squid (S. Piontkovski, et. al., September 2003). As zooplankton population increases, so does that of the squid, which demonstrates how the population of one organism can impact another despite it being unexpected.

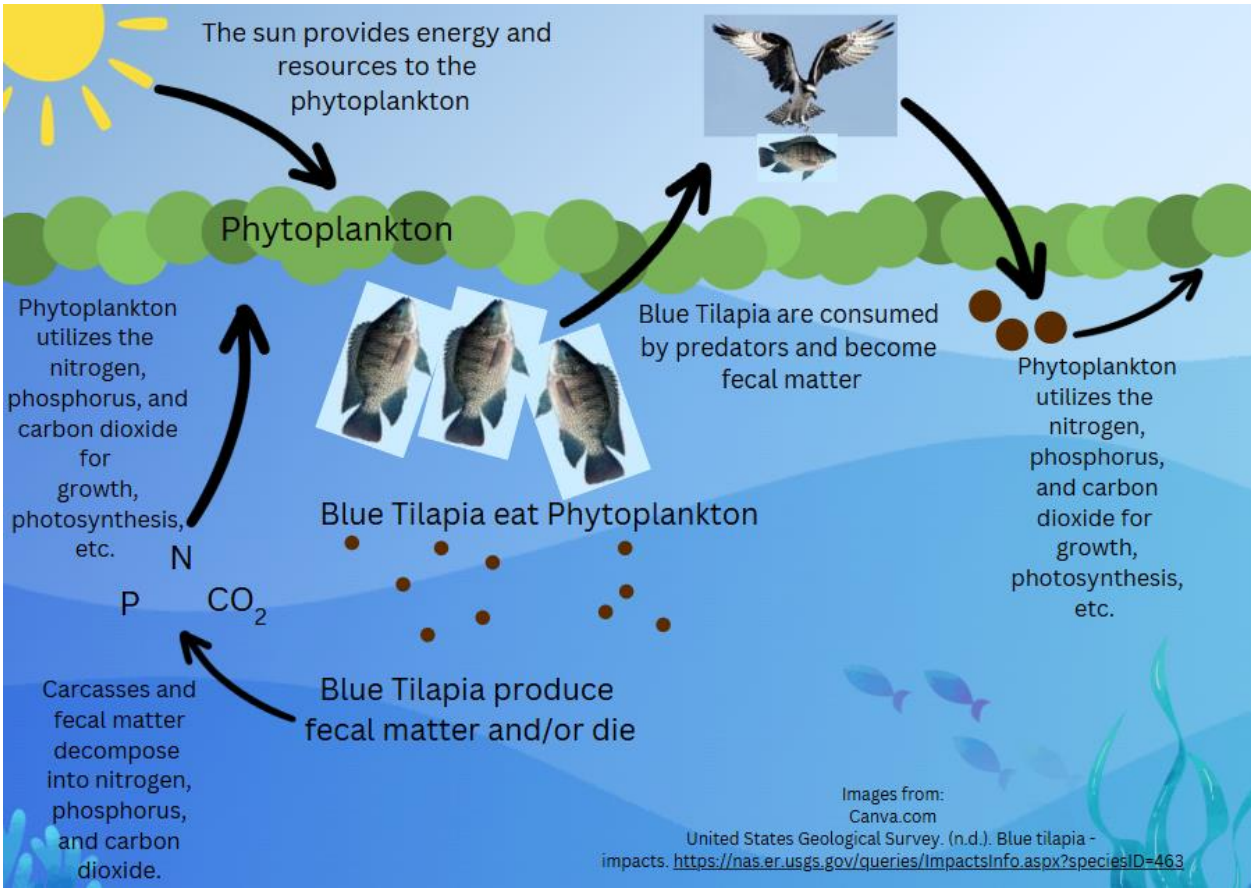
Functionally, the pelagic ecosystem is unique due to its primary producer being almost entirely plankton versus the kelp forest that has densely packed towers of kelp and vast varieties of aquatic flora. According to S. Piontkovski, et. al., another characteristic that makes the pelagic ecosystem unique is the high amount of vertical migration. While there are some species, such as flying fish, that do not migrate, there is a high population of fish that frequently travel vertically instead of horizontally. Structurally however, the pelagic ocean has the greatest depth of our ecosystemic options. Blue tilapia are not typically found in oceanic ecosystems, however they can tolerate sodium content up to three times that of sea water (UCANR).

Energy Dynamics Diagram



In the ocean, blue tilapia is predated upon by sea birds of prey, ex: Osprey, and larger fish such as Oceanic bass. Blue tilapias' diet consists of primary producers, aquatic plants, and phytoplankton (algae) (UCANR). Green sea turtles and sea urchins consume aquatic plants and algae as well.

Nutrient Dynamics Diagram



In the above energy dynamics diagram, is a demonstration of how blue tilapia will impact the local ecosystem. The phytoplankton that sustains the diet of the blue tilapia gets its energy from the sun, making it the primary producer. The blue tilapia consumes phytoplankton and excretes waste containing nitrogen, phosphorus, and carbon dioxide. When blue tilapia die, their carcasses decompose into similar gases. The waste produced from the tilapia is utilized by the phytoplankton to reproduce and grow. On the other side of the energy dynamics diagram,

predators consume the blue tilapia and produce waste that decomposes into nitrogen, phosphorus, and carbon dioxide.

Hypothesized Affects to Local Ecosystem

If blue tilapia were to be kept in an oceanic environment, ex: sea pens, they can be a threat to the local ecosystems. In many states, blue tilapia is considered highly invasive due to out competing local species for resources and reproducing too quickly for their few predators to keep up (USGS). It is more favorable to farm the blue tilapia in the pelagic ecosystem due to the population of natural predators of the tilapia. If a blue tilapia were to escape and reproduce, of our options, it is more likely that the predators of the pelagic ecosystem will check their population.

However, if the tilapia were to become invasive to the pelagic ecosystem, a trophic cascade would be likely. An example used earlier mentioned how squid populations directly correspond to the population of zooplankton, to further explain the impact of the squid populations, half of the species in the community are organisms that are preyed upon by squid (Zuyev, et. al., 1988 a,b). The diet of the blue tilapia is problematic for every ecosystem as well as their ability to rapidly reproduce. It is unlikely that the native species of the pelagic ocean would be able to compete with the tilapia.

However, according to S. Piontkovski, et. al., if the link between the turnover rate of community biomass, productivity, and metabolism is studied, it is possible to find a balance to compensate for the offset from fisheries and farms. While the blue tilapia does impact the population of plankton, it can also be utilized to sustain it due to the amount and composition of waste produced.

Large-scale implications of This Project on Global Marine Functions:

With the pelagic ocean being an offshore habitat due to its lack of proximity to the geographic coast, it can be highly impactful to the global marine system. An issue that is prevalent in both local ecosystems and global marine function is disease. If the blue tilapia were to gain a disease, it would have the prime conditions to rapidly multiply and mutate. Since sea pens utilize open waters, that can be especially threatening and become a multi-ecosystem hazard quickly from the volume of water and fish.

If the tilapia were to consume phytoplankton at a rate higher than it could be produced, there would be a population decline that would affect the entire ecosystem. Global impacts of that are:

- Species migrating towards other sources of food and invading other ecosystems
- Once populations decrease, there is an overabundance of algae causing more sunlight to be absorbed by the algae which in turn releases more heat into the ocean (U.S. EPA) and is carried elsewhere by global currents
- Economic decrease to Santa Barbara due to less fish available for both tourism and commercial use
- Tilapia population could spread to other ecosystems and cause the same scenario elsewhere

Despite there being many downsides, operating in the pelagic ecosystem is still the option with the lowest ecological impact. If attempted in an ecosystem with less top predators and lower water circulation the impact would be even more severe.

In an ecosystem that is nearly the opposite of of the pelagic ocean, e.g. the kelp forest, if one of the blue tilapia escaped it would guarantee a collapse of the ecosystem. One of the

tilapia's main predators, the osprey, has difficulty catching tilapia from the density of plants. The kelp forest also offers many places for tilapia to hide which makes it difficult for larger fish, like bass, to chase. The predator to the kelp is the sea urchin, whose population is kept in check by the sea otter. Due to having no predators and checking the population of sea urchin, the sea otter is the top predator. However, tilapia is not part of their diet.

Kelp is also used to provide homes and protection to various marine mammals: sea otters, sea lions, seals, etc. Kelp populations are already decreasing due to a rise in oceanic temperatures and sea urchin populations, adding another secondary consumer into that ecosystem could easily cause a trophic cascade. My hypothesis is supported by data collected by Wernbern, et. al. 2019, where the detrimental impact of sea urchins without population control was observed and recorded. If excessive sea urchins alone can heavily impact kelp populations, it is unadvisable to add in blue tilapia.

Not only is the blue tilapia very threatening to the ecosystem of the kelp forest, but all the prior concerns also still stand about disease, warming waters, and population control.

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