**Rise of the Jellyfish**

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**Introduction**

Jellyfish are just one of the many unique organisms that inhabit our oceans. They are more resilient than most to environmental changes and have a surprisingly simple physiologically. As global warming persists, and discussions of climate change continue to question what future is in store for our favorite marine species (the fish and organisms that are familiar to us from our dinner plates) the unassuming jellyfish is also making itself known in the discussion by reacting to climate change in way that most marine species do not. It has become depressingly common to read about how increasing ocean temperatures, ocean acidification, and marine pollutants are testing the resilience of marine species, pushing them dangerously close to a precipice that it is unknown if they can recover from. However! Jellyfish enter the scene with a different response to our changing underwater world (though whether this uncommon response is a welcome change of pace is yet to be determined). It turns out that the shift in oceanic conditions that are so unfavorable to most species that us humans love, are actually ideal for jellyfish. The warming waters and increased productivity of the oceans allow jellyfish to multiply at a startling rate, resulting in jellyfish blooms that are increasing both in size and frequency over the last few decades. Jellyfish blooms, although good for the jellies, have been shown to have negative impacts economically, ecologically, and industrially. The increasing frequency of jellyfish blooms is leading many researchers to ask the questions, why is this happening, what are the consequences now and down the line, and most importantly – what can we do about it? In this essay the authors will attempt to briefly address some of these questions by giving a synopsis of some perspectives of the issue found in recent academic literature.

**Synopsis of the main issue**

Jellyfish are exceptionally good at identifying the perfect conditions to reproduce in, so they do not need unnecessarily long lives. If the conditions are good for it to mature, it will likely be able to spawn the next generation quickly and efficiently too. Once they mature to medusae, many jellies will congregate to reproduce together. This is when the conditions come in; the light, the food abundance and the proximity to other jellies, is what makes the spawning of jellies enormous. This is why they gather in large groups to make sure the reproductive stage goes smoothly. To make sure they reproduce better and survive better they need to be bigger. Jellyfish are one of the most resilient animals in the ocean, but also one of the simplest. Their simple anatomy allows them to adapt to their environment extremely well. They lack a brain, heart, blood, and features that most other living creatures have and need to keep them alive. In fact, jellyfish are 95% water. It is this lack of complexity that makes them so resilient to environmental changes that would devastate the populations of other marine species. Jellyfish are able to adapt easily to even sudden and drastic changes in temperature, salinity, and acidity, and are able to survive in a wide range of habitats because of their indifference to light. When jellyfish blooms occur, they can cause damage to local ecosystems and industrial installations. As the threat of jellyfish blooms over human-made structures and industries is becoming greater and greater, scientists of fisheries as well as other fields are scrambling to find the cause as well as potential solutions to the rise of the jellyfish.

**Key Findings**

Jellyfish usually do not live for very long. There are several factors such as human interaction, competition, or habitat disturbances, which limits the size of their populations and sometimes causes them to move to areas outside of their normal range. The jellyfish that are unable to adapt to their new environment usually live up to 8-12 months, but those that cannot live shorter lives. What makes the jellyfish able to live and adapt so well to new environments? Well, they have many attributes that make them particularly skilled at adapting to change. They are made up of mostly water and they have protective layers that help them survive. Just like our skin that protects our bones and nerves, they have nerve nets that help them detect the light to know their surroundings and then respond to other stimuli in the area (such as other marine life). Their life cycle also helps them survive through unfavorable conditions. Depending on the species, jellies can remain in their polyp stage - in which they are not free floating and reproduce asexually- for years. This allows the jelly to wait for perfect conditions to mature when conditions are suitable for large numbers of their species to spawn before moving onto their final adult form.

Although jellies are able to adapt to almost any condition, there are some that are most ideal and allow them to reproduce in staggering numbers, creating what is known as a jellyfish bloom. As global oceanic conditions and human influence in the sea are changing, jellyfish blooms have increased in the last few decades for a number of different reasons. Although there is not enough evidence to definitively attribute the jellyfish increase to human activity, some human activity may have indirectly contributed to the issue of jellyfish’s spiking numbers.

* “Fishing down the food web” frees jellyfish from predation & competition. Jellyfish compete with other higher trophic level species such as salmon for resources, and they are preyed on by species such as sea turtles and tuna. With the declining populations of many of their competitors and predators, jellyfish are able to grow rapidly. (Lamb 2016) Jellies are also highly efficient predators capable of rerouting the food web to exclude competition, which compounds the above point. Fishing down the food web effectively frees jellyfish from both their predators and their competition for resources, both of which formerly kept jellyfish populations in check even when other environmental conditions were favorable for mass spawning. Without any restrictions on their population growth, there has been a reported increase in jellyfish blooms
* Also, “Jellyfish are uniquely poised to benefit from changing ocean conditions.” (Lamb 2016) One example of jellyfishes' advantage over other species in the face of global warming is dead zones. As stated previously, jellyfish are exceptionally resilient to changing environmental conditions, and can survive where most other species cannot due to their simplistic physiological structure. It is this simplicity that allows them to take advantage of habitats that are now devoid of life. In many parts of the ocean, “dead zones” are created where plankton grow explosively, depleting the water of oxygen and making it uninhabitable – but not to the jellyfish. Jellyfish do not need oxygen to survive, so they flourish in dead zones where the excess of plankton and complete lack of anything else allow them to eat, grow, and spawn uninhibited.

         When these jellyfish blooms occur, they can cause damage to local ecosystems and industrial installations. Due to the location of jellyfish’s habitat, the location of the bloom is often less than ideal for humans. Aquaculture is a huge resource for the human population. We often place the fish farms in open natural bodies of water that are shared with the jellyfish, and when the jellyfish and fish farm mix, the jelly fish can devastate the fish farm. All the jellies will flood into an area gradually, getting stuck in the fishnets and equipment usually used to keep a barrier between the farm and the natural ecosystem. As the nets are clogged and filled with jellyfish, the oxygen gets depleted in the farm pens. The process of suffocation by oxygen deprivation progresses rapidly once it begins. If the wild population of jellyfish's sheer numbers haven’t suffocated the fish, then the drive to feed will push the jellyfish to consume whatever they can get their stingers on. In many cases this happens to be larvae of the commercial fish species, spelling disaster for that industry.

The jellyfish live a lifestyle that has them flowing freely with ocean and river currents. Often water turbines used to create electricity can become clogged by jellyfish blooms spreading to the turbine water inlet. A great example of sheer jelly fish biomass causing life threatening situations to human industry is in the Oskarshamn nuclear reactor off the Baltic coast in Sweden. Nuclear reactors used for mass power generation are cooled by the constant flow of cooled water. Often these tanks are filled with inlets from the external water source to maintain temperatures for nuclear fusion without critical temperature breach. The jellyfish clogged the inlet to the nuclear reactor’s water feed and almost caused a critical melt down. The catastrophic failure that occurred in 2011 is a small glimpse at what can happen if the jellyfish bloom is left to grow to the scale of the entire ocean. As the warm season extends, sea levels rise, and predatory fish continue to be excessively harvested, we can expect the frequency of jellyfish blooms in coastal areas to increase in the years to come.

**Recommendations**

It is tempting to blame humans for the issue of jellyfish blooms, as it is true for so many other marine species, but some studies suggest that there is not enough evidence to make such a claim. Although it is true that many regions in our global oceans have seen an increase in jellyfish populations over the last few decades, there has not been definitively proven (due to a small number of data sets to analyze) that what we are witnessing is a linear global increase as opposed to natural oscillations (fluctuations). One study published by the National Academy of Sciences conducted one of the first and only analyses of long-term jellyfish fluctuation trends, which concluded that one particularly strong fluctuation which happened during the 1990s is what captured the attention of the public and created the perception of “the rise of the jellyfish”. However, by comparing and analyzing population fluctuations over a longer scale spanning several decades, the authors found that while there is a slight linear increase in jellyfish populations, most of the short term increases that the public is seeing are the result of regular fluctuations that span every decade. Although there is limited data available to analyze, these authors confidently claim that although rising jellyfish populations are something that we may very well see in the coming decades and that we should be prepared for, it is not as dramatic of an increase as the public seems to believe. Although the perceived increase in jellyfish blooms may be able to be explained by natural oscillations, there are still measures that we can take to minimize damage from jellyfish blooms on coastal establishments

* More carefully manage fisheries of commercial species with known predator/competitor relationships with jellyfish.
* New nets can be installed to limit bycatch and to prevent jellyfish infiltration of aquaculture pens. The new nets must be specifically designed to keep the target species in the net and all other species outside of the nets.

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