# Jellyfish Apocalypse: Problems, Causes and Opportunities

Authors: Joong Hyun Lee*(primary contact author),
Hannah Christian, Annie Looman, Lars Bodnar, Chellene Medina

The Elusive Jellyfish

Kodiak High School, 722 Mill Bay Rd, Kodiak, AK 99615
switgard@gci.net , jeisemann01@kibsd.org

# Jellyfish Apocalypse: Problems, Causes and Opportunities


**Abstract**

When does the future start with regards to the ocean? Rising sea levels, ocean acidification, and overfishing are problems that the ocean faces right now. An ocean full of jellyfish is a probable future. Jellyfish can be very beautiful with their movements and bioluminescence and have an interesting life cycle. Although they seem insignificant, in large aggregations, jellyfish have damaged the economic success of power plants and fisheries. They consume larvae of commercial fish species and prevent the recovery of overfished populations. Changing ocean temperatures and ocean acidification has caused a shift in biodiversity of the ocean and distribution of jellyfish populations around the world. We looked into uses for jellyfish; biofuels and foods. We experimented with making jellyfish food products. More experimentation is needed to improve taste.

**Introduction**

When does the future start with regards to the ocean? The future of the oceans begins now, by dealing with problems from past errors and being proactive in dealing with approaching issues (Gershwin, 2013).

Already, many problems exist that threaten the future of the oceans. Warmer surface waters due to global climate change threaten many species of animals and plants that depend on the cooler climate and waters. Global climate change will raise sea levels, which would flood farmlands, cities and entire island nations. Ocean acidification harms many species that use calcium to build shells, such as crustaceans. Both, empty oceans and habitat destruction result from human activities. For example, overfishing not only empties the ocean of important species of fish, but also some gear types such as bottom trawls scrape the ocean floor, damaging the habitat of other marine organisms. Toxic chemicals from factories and farms and trash from cities all degrade the world's ocean (Folger, 2013; Gershwin, 2013).

Some of these changes however, will present positive opportunities. Many traditionally isolated northern cities could become important transportation and fishing ports. New fisheries would open up in the Arctic Ocean to harvest species that were previously hidden by the sea ice. Easier access to Arctic oil would bring money to Northern economies and increase the productivity of those northern ports such as Barrow (Robert Foy, pers. comm. NMFS 2013). New environmental conditions in the ocean will provide new opportunities for other creatures (Gershwin, 2013).

With the change of one ecosystem, another one will form in its place. Jellyfish prefer the warmer waters that are a result of global climate change  (Richardson et al., 2009). With less competition for space and resources due to overfishing and habitat destruction, jellyfish have been able to bloom to record numbers (Gershwin, 2013). Around Kodiak, fishermen and beach goers observed an increase in the number of jellyfish around the island during the summer of 2013. Also, ocean acidification and toxic chemicals introduced by humans displace other species that compete with jellyfish (Gershwin, 2013). Marine debris that accumulates in the ocean actually helps to disguise jellyfish but damages species like the leather back turtle that prey on the jellies (Richardson et al., 2009).

All jellyfish are in the phylum Cnidaria and possess stinging cells. The word Cnidaria comes from the Greek word for nettle, a stinging plant. Within the Cnidaria phylum there are four subphyla. The first is the anthozoans, in which sea anemones belong. Next, there are the hydrozoans, which are colonies that form gelatinous creatures, for example hydroids. Box jellyfish fall under the new classification of cubozoans. What most people think of as true jellyfish fall into the subphylum of Scyphozoans (Gowell, 2004).

Just like there are positive aspects to a warmer world with higher sea levels, there could be positive aspects to an ocean full of jellyfish. Researchers have looked into using jellyfish in a number of different ways. Scientists have discovered age reduction powers in one type of jellyfish (Rich, 2012), a biomarker protein used in medical diagnostics (Stepanenko, 2008), and a protein to counter the symptoms of Alzheimer disease (Hsieh, 2001). In this paper we discuss the use of Alaskan jellyfish species for the production of biofuel and food products. For our group research we caught jellyfish and processed them to explore the food opportunities that a “jellyfish apocalypse” might present.

**Jellyfish are beautiful**

*Biology*

Jellyfish are typically described as hypnotic due to their graceful movements and, in some cases, beautiful bioluminescence. Their movements could be likened to ballet dancers because of the calm flow of their bodies and oral arms. Jellyfish move by contracting and expanding their bodies instead of using their oral arms to move. The jellyfish's tentacles do not participate in the movement of the creature from place to place. The tentacles' only purpose is to collect food and to sting enemies. As members of the plankton community, jellyfish mainly depend on ocean currents to move (Gowell, 2004).

The composition of jellyfish is 95% water, 5% protein, and small amounts of lipids and salt (Gowell, 2004). They have no digestive system. Rather, food stays in the gastrovascular cavity, which absorbs the nutrients. The jellyfish's waste exits through the anus, which also serves as its mouth. They have no respiratory or circulatory system, so oxygen is diffused through their epidermis. Jellyfish feed on plankton, eggs, small fish, crustaceans, and other jellyfish. Some creatures that prey on jellyfish are sunfish, sea slugs, sea turtles, and other jellies. (Gowell, 2004). Jellyfish are often described as "alien", which is curious because jellyfish have been on earth much longer than humans have. They have such simple structures but still manage to seem majestic. Most deep-sea jellyfish use bioluminescence as a form of defense to startle enemies or to attract a mate. Bioluminescence is considered a "cold light" because only 20% of it radiates heat. The chemical composition of bioluminescence is luciferin and photoprotein/luciferase (National Geographic Education, 2013).

*Life cycle*

The jellyfish goes through multiple stages of development before it reaches its adult form. First, the male and female's sperm and eggs are released into the water to unite and fertilize. Once the fertilized eggs hatch, they are called planula larvae, and drift around the ocean until they find a solid structure to attach themselves to on the ocean floor. At this point, they are called polyp (scyphistoma) and remain attached to the solid structure where they continue to grow and develop further. After a few years as sessile and stationary polyps they begin to transform and grow oral arms and a stump and become more round. Eventually, they detach themselves from the ocean floor (ephyra stage). The final stage of the jellyfish lifecycle is the medusa stage where the creature is fully grown and developed. (Figure 1; Gowell, 2004)

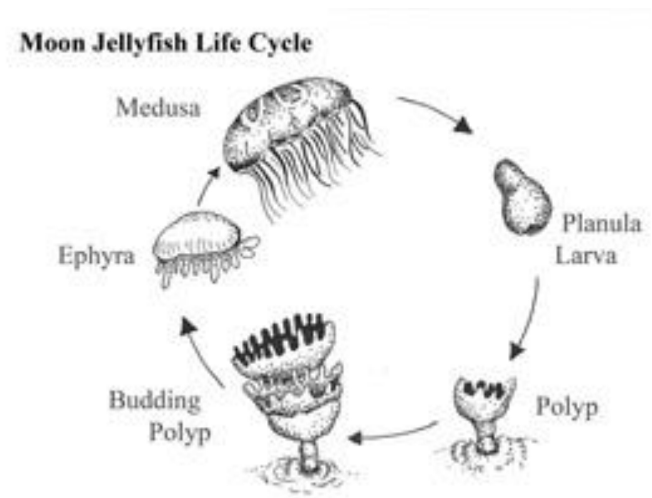


Figure 1: The Life Cycle of a moon jellyfish (http://www.westmeade.net/Library/jellyfish.htm)

*Kodiak Species*

Common Kodiak species of scyphozoan jellyfish include: Moon jelly, Lion's mane, and Red-eyed jelly, though other species are also present. In the summer of 2013, the people of Kodiak were able to witness a jellyfish bloom off the shore of White Sands Beach. At that bloom and around Kodiak Island during the summer several different species of jellyfish were present. The most prevalent was the translucent and edible Moon jellyfish (*Aurelia sp.),* which can be found throughout the summer. Also present in Kodiak waters are the stinging Lions Mane (*Cyanea capillata*) jellyfish that are a yellow-orange color and can be the size of a basketball. Other species of jellyfish around Kodiak are the Red-eyed jellyfish (*Polyorchis pencillatus*) and the Cross jellyfish (*Mitrocoma cellularia*). The white cross on the umbrella of the Cross jellyfish distinguishes it from the Moon jellyfish.

## Gelatinous Problems

Jellyfish are commonly known as the cockroaches of the ocean. They seem to have thrived for millions of years without major changes to their body plan. Although scientists have estimated that there are jellyfish blooms every 20 years, there have been growing interests and concerns in the massive jellyfish blooms. Shutting down nuclear power plants and harming the economy of fisheries, jellyfish trigger many conflicts that people do not have clear solutions for (Gershwin, 2013).

### *Disruption of power plants*

Although jellyfish may seem like powerless drifting plastic bags in the ocean, they could be devastating in large numbers. On December 10, 1999, the northern half of the Philippines suffered from a sudden power failure due to jellyfish. About 50 truckloads of jellyfish clogged the cooling system of the power station. Similar reports of jellyfish clogging power systems continued. On October 21, 2008, smacks of *Aurelia labiata*, a species of moon jellies, were sucked into the cooling water system of the Diablo Canyon nuclear power plant, shutting down the power plant for three days. Millions of dollars were lost due to this incident (Gershwin, 2013).

*Disruption of Fisheries*

Many fishermen expecting a catch of fish are disappointed to find a net full of jellyfish. The slime from the jellyfish causes delay in the fishing process because the gear needs to be cleaned. The water-filled medusae are extremely heavy in dense numbers, ripping the fishing nets (Moffett, 2007). Jellyfish suffocate desirable species essential to the fishing industry such as the pollock. A study in Prince William Sound, Alaska, found that "all seine catches that contained juvenile pollock also contained jellyfish" (Purcell, 2000). This ultimately reduces the profit of the fishing industry. Other negative effects of the jellyfish on fish include parasite transmission and competition for food. When a species of a fish declines, jellyfish have seemed to fill the empty niche. Overfishing usually triggers a chain reaction that affects different species. This aspect will be further discussed in the section of human impacts on jellyfish populations. Although they seem harmless and inconsequential, jellyfish are almost indestructible and very persistent. This is dangerous for the fish and the fishing industry (Purcell, 1990).

*Jellyfish aggregations*

Increasingly large jellyfish aggregations are indicators of declining health of the world's oceans (Gershwin, 2013). There is not enough evidence to explain the reasons for the increase of jellyfish aggregations; however, there are some explanations how aggregations form. "Reduced swimming, due primarily to frequent collisions among medusae in the aggregations, also may have caused the medusae to become concentrated" (Purcell, 2000). Although Purcell stated that the density of the aggregations did not affect the beat frequencies, it did affect the distance the jellyfish were able to travel per beat. Sometimes, these congested areas contain more jellyfish than water. The direction of each medusa's movement could affect the density of the aggregation. "Medusae swimming vertically were found in higher densities than medusae in mixed orientations" (Purcell, 2000). Most of these smacks of jellyfish were in areas where plankton organisms were abundant, near the shore.

The aggregations of jellyfish are becoming a major problem. The consequences of being oblivious to the steady increase could result in further severe conflicts. Nuclear power plants and fisheries could lose even more money than they already have. Perhaps human beings are causing the favorable environments for jellyfish to prosper.

**Do human impacts support a jellyfish apocalypse?**

*Climate change effects on ocean temperatures and effects on jellies*

Climate change is a real problem that is believed to cause many new global problems. "Over the past 50 years, temperatures across Alaska increased by an average of 3.4°F" (Karl, 2009). Increased sea surface temperatures are linked to the spread of invasive species. If an ecosystem becomes warmer, it becomes more suitable for outside species to thrive. This warming can lead to forced migrations due to early warming or cooling of the water and possible species extinctions. Scientists are also concerned that warmer water could disrupt the ocean conveyor belt, the system of global currents that is largely responsible for regulating Earth's temperature. Its collapse could trigger climate changes and change in ocean currents and gyres around the world (National Geographic, 2013).

Warmer water creates a situation in which the jellyfish's metabolism is higher; this will accelerate medusae growth and ephyrae production. E.J. Purcell found that 11 out of 15 temperate jellyfish species increased in numbers in warmer water (Purcell, 2007). Gibbons and Richardson studied jellyfish abundance over 50 years in the North Atlantic, and they found those species are temperature dependent. More jellyfish where found in warmer years (Gibbons, 2008).

*Likely effect of ocean acidification on ecosystems and responses of jellyfish populations*

Ocean acidification negatively affects calcium-based plankton, which opens up ecological space for other species. The first analysis suggesting that there were more jellyfish when conditions were more acidic was conducted in the North Sea (Attrill, 2007). This study sparked other groundbreaking research, the American Society of Limnology and Oceanography studied in other areas in the North Sea and beyond in the Northeast Atlantic using records from the Continuous Plankton Recorder and pH data from the International Council for the Exploration of the Sea for the period 1946–2003. In this study there was no significant relationship between jellyfish abundance and acidic conditions in any of the regions investigated (Richardson, 2009). Certain species of jellyfish have shown signs of being unable to expand their territory due to higher acidity. A study by Griffith showed that, while higher sea temperatures could provide an opportunity for adult Irukandji (a type of jellyfish related to the box jellyfish) to expand their range along the Queensland coastline in Australia, increasing ocean acidification may inhibit the development of juveniles (Griffith, 2013).

*Overfishing of the oceans*

With overfishing being a common occurrence recently jellyfish have taken advantage of the exploitation of small feeder fish and benefit from the excess of plankton left unconsumed. Sardines, herring, anchovies and many other marine predators compete with jellyfish for zooplankton. In areas where too many of these planktivorous fish are caught, they free up an ecological niche. In addition, the lack of feeder fish reduces the predation on the jellyfish's eggs and larvae (Figure 2, Science Daily, 2013). Other natural jellyfish predators are also disappearing: Bluefin tuna that have been overfished almost to the point of extinction, and sea turtles, particularly leatherbacks and loggerheads, both of which are on the endangered species list, are suffocating on all the plastic bags infesting the seas (Slow Food, 2013). Jellyfish now have free reign to thrive (Science Daily, 2013).

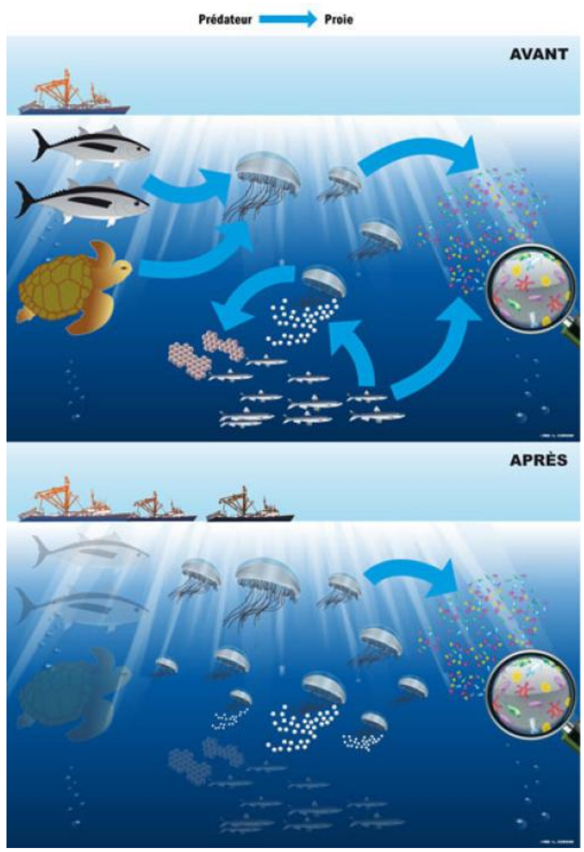


Figure 2: A before and after scenario of overfishing.

A feedback loop develops in areas affected by overfishing: Taking out a single species from an ecosystem results in effects on all trophic levels.

> "Overfishing can throw this complex relationship out of kilter. By removing a curb on jellyfish population growth, overfishing "opens up ecological space for jellyfish," says Anthony Richardson, an ecologist at CSIRO Marine and Atmospheric Research in Cleveland, Australia. And as jellyfish flourish, he says, their predation on fish eggs takes a heavier and heavier toll on battered fish stocks" (Stone, 2011).

To effectively restore an area that has been overfished and taken over by jellies, we have to find a way to remove the jellyfish out of the ecosystem to be able to successfully transplant new fish larvae.

**Embracing jellies: Change as opportunity**

The increase in jellyfish numbers could be an industrial opportunity. New research suggests a method of turning proteins into ethanol alcohol as well as carbohydrates and lipids (Hsieh et al., 2001). These components are the fundamental parts of most cells with additional small percentages of other elements. With this new technology we could turn jellyfish blooms into a valuable resource and an economic opportunity.

To harvest smacks of jellyfish, scuba divers with an air hose could blow bubbles in the umbrellas of jellyfish. This floats the jellies to the surface. Then a boat with a storage hold, in which the jellyfish are kept alive, can collect the jellies. Another more labor-intensive way to harvest jellyfish in smaller quantities and with low operational costs is to scoop them with dip nets into containers or directly into the hold. Because of how easy it is to harvest jellyfish, development of a fishery must be carefully managed and monitored to avoid overfishing. In Alaska, this fishery should be managed by the Department of Fish and Game, because it would primarily be conducted in state waters. In Kodiak, jellyfish fishing would likely be a small-scale operation and increase options for diversified fishing businesses.

However, in Japan a large-scale commercial operation is currently viable. Worldwide, there are many jellyfish in the bycatch of fisheries, and the jellyfish are a disaster to the fishermen (Moffett, 2007). Turning jellyfish into fuel could turn economic loss into economic gain. In order to begin jellyfish ethanol production, jellyfish must be cleaned in fresh water to remove most of the salt. While the protein is turned into ethanol (Huo, 2011), which can be converted to fuel cars or made into a drink, the salt could be marketed as jelly salt. Many people would likely buy jellyfish salt for more than the price of normal salt simply because it is different. Jellyfish alcohol could also be made into a drink. It would be inexpensive to make and would be marketable as a unique product. Ethanol is an amazing fuel; it burns well and works in the engines of most cars. Jellyfish could possibly provide economic opportunity through a combination of rising fuel prices, increasing jellyfish numbers, and a new kind of drink people may like. Due to the experimental status of the process using yeasts and bacteria to turn jellyfish protein into alcohol, more research is necessary to perfect the technology and this plan must be considered a concept for the future.

Jellies have been a favored food item in China for many years (Subasinghe, 1992). At present, the food market in China is under-saturated for high-grade jellyfish product (Lei Guo, pers. comm., UAF 2013). If Kodiak fishermen could develop the fishery, a correctly processed jellyfish food product may bring $10 per pound and more (Subasinghe, 1992). By developing jelly fisheries, some of the harvest opportunities may be recovered from fisheries that were shut down by jellyfish (this paper).

*Experimentation with Kodiak jellies for food product*

To experiment with the preparation of jellyfish for food product we fished and processed local jellyfish. Materials we used included: Ring net with 550 micrometer mesh size, tub/containers, and a GPS to track our course (Figure 3). To harvest jellyfish, we boarded the 42’ LeClercq seiner style vessel K-Hi-C on 11-9-13 at 1:00-3:00 pm. When we saw jellyfish, we dropped the net off the starboard side of the vessel to catch them (Figure 4). After hauling them onboard, we put them in a prepared container with seawater collected from the ocean in a bucket. When we had an adequate number of jellies we transferred the catch into a tote and kept them outside in chilled seawater until processing.

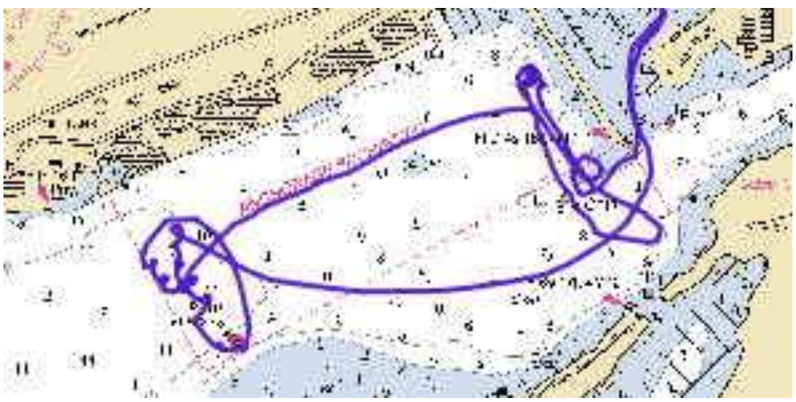

Figure 3: GPS track of the boat course during jellyfish sampling outside of St. Paul’s Harbor Kodiak, between cannery row and Near Island.

Two days later we went to process the jellyfish at the Kodiak Seafood and Marine Science Center (UAF). Professor Alex Oliviera guided the team through the processing steps. To start the preparation process, jellyfish were first cleaned in a 3% brine solution. Then, the oral arms and the gonads were removed.


Figure 4: Kodiak team catches jellyfish.

After the cleaning, we tried different preparations on the jellyfish: Some were dried with salt and others were freeze-dried. We tried tree different salts: fine salt; coarse salt, and a 1:1 fine salt and brown sugar mixture. After the whole jellyfish was salted we left it to dry in the freezer. Two days later, jellyfish were extracted from the salt. We found that washing the salt off the dried jellies with water made them turn into a substance with a resemblance to slime. Thus, the remaining freeze-dried jellyfish were cleaned by brushing off the excess salt. Then, we placed two smaller jellyfish, the oral arms that were cut off, as well as two larger jellyfish cut into strips into the freeze drier (Table 1). A taste test was conducted after the freeze-drying process was completed. We tried jellyfish dry and rehydrated, and vacuum packed the remainder. One package was saved for later presentation. More experimentation is needed in order to improve the taste of the product.

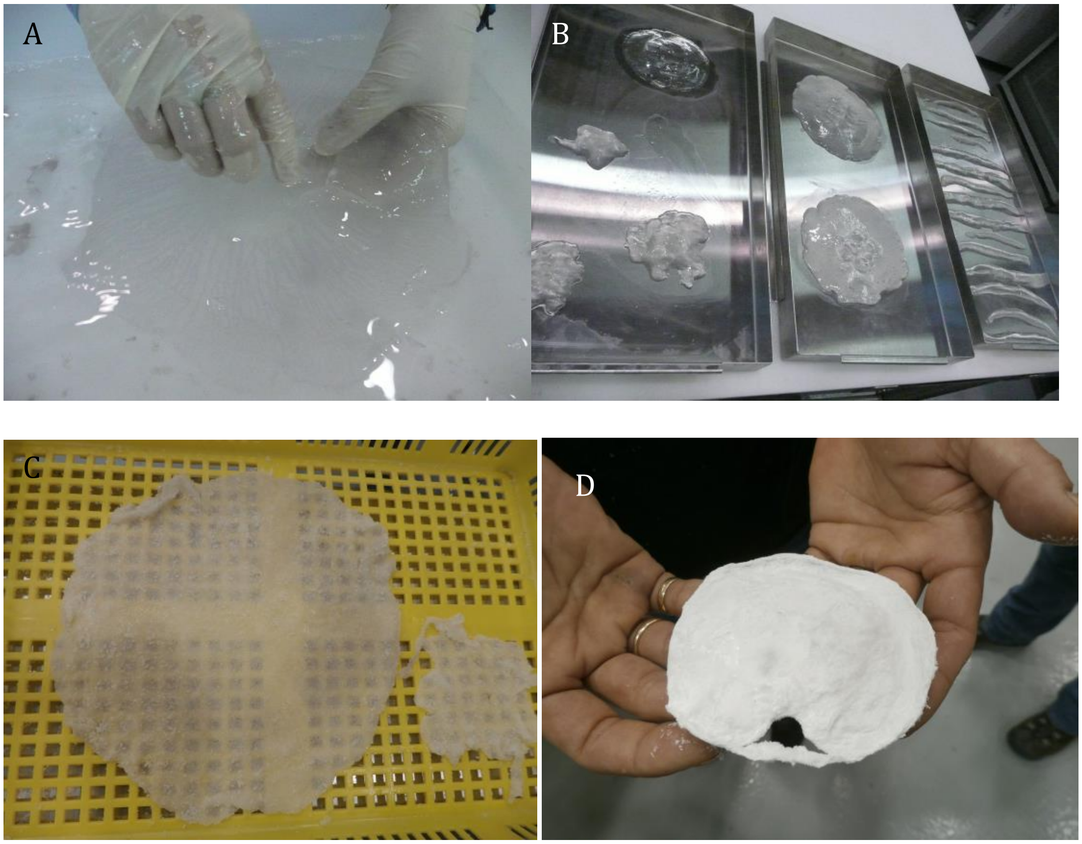


Figure 4: A. Cleaning the jellyfish, B. Cleaned jellyfish product before freeze drying, C. The dried by salt product, D. Freeze dried product.

Table 1: Results of experimental processing of *Aurelia sp*. from Kodiak

| Processing Method | Product description |
|---|---|
| Freeze – dried whole | Yellow tint, looks powdery, structural integrity |
| Freeze – dried strips | Narrow paper thin white strips, held shape |
| Salted – coarse grain | Small chunks of salt, product is cut up |
| Salted – fine grain | Sand paper texture, structural integrity |
| Salt-sugar mixture | Processing delayed because product still wet |

## Conclusions

Jellyfish biomass is most likely on the rise. Due to human activities such as overfishing, jellyfish are becoming one of the dominant organisms in coastal oceans. Overfishing allows jellyfish to occupy the niche that was once filled by other species. Human impacts cause many problems in the ocean ecosystem such as essential habitat loss and decreased biodiversity. While many species suffer from human impacts, jellyfish thrive and adapt to the situation very quickly. Humans could adapt to the increase of jellyfish by developing new uses. Food and biofuel are possible products that could change the jellyfish apocalypse to an opportunity. Although the success of the jellyfish fisheries in the United States is questionable, countries in Asia already have developed markets for jellyfish products. Could jellyfish be a feasible fishery in Alaska? At this time we think a jellyfish fishery has potential to provide economic opportunities to diversify fisheries in our hometown of Kodiak and other maritime communities in Alaska.

## References Cited

Attrill, M. J., J. Wright, and M. Edwards, 2007. Climate-related increases in jellyfish frequency suggest a more gelatinous future for the North Sea. Limonol. Oceanogr. 52: 480-485.

Folger, Tim, 2013. Rising Seas. National Geographic. Vol. 224 No. 3 pp. 30-57.

Gershwin, Lisa-Ann, 2013. Stung! : On Jellyfish Blooms and the Future of the Ocean. Chicago 60637: The University of Chicago Press. 456 pgs.

Gibbons, M.J. and Richardson, A.J., 2008. Are jellyfish increasing in response to ocean acidification? Limnol. Oceanogr., 53(5), 2008, 2040-2045.

Gowell, Elizabeth, 2004. Amazing Jellies: Jewels of the Sea. Bunker Hill Publishing. 43 pages.

Griffith University, 2013. Ocean Acidification Has A Perk: It Curbs Dangerous Jellyfish. http://www.laboratoryequipment.com/news/2013/10/ocean-acidification-has-perk-it curbs-dangerous-jellyfish. Nov. 30, 2013.

Hsieh, Y.-H., Fui-Ming Leong, and Jack Rudloe, 2001. Jellyfish as food. Hydrobiologia 451: 11-17.

Huo Yi-Xin, Kwang Myung Cho, Jimmy G Lafontaine Rivera, Emma Monte, Claire R Shen, Yajun Yan and James C Liao, 2011. Conversion of protein into biofuels by engineering nitrogen flux. Nature Biotechnology. Vol. 29 (4): 346-351.

Karl, T.R., J. M. Melillo, and T.C. Peterson, 2009. Global Climate Change Impacts in the United States. United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

Moffett, Sebastian, 2007. Invasion of Jellyfish Envelops Japan In Ocean of Slime. The Wall Street Journal. Nov. 27, 2007. http://online.wsj.com/news/articles/SB119612452419404666. Nov. 30, 2013.

National Geographic; Sea Temperature Rise. http://ocean.nationalgeographic.com/ocean/critical-issues-sea-temperature-rise/ Nov 30, 2013.

National Geographic Education, 2013. Bioluminescence. http://education.nationalgeographic.com/education/encyclopedia/bioluminescence/?ar_a=1/ Nov.30, 2013.

Purcell, J.E., Sin-ichi Uye, Wen-Tseng Lo, 2007. Anthoropgenic causes of jellyfish blooms and their direct consequences for humans: a review. Mar. Ecol. Prog. Ser. 350: 153-174.

Purcell, Jennifer E., Brown, Evelyn D., Stokesbury, Kevin D.E., Haldorson, Lewis H., and Shirley, Thomas C. 2000. Aggregations of the jellyfish *Aurelia labiata*: abundance, distribution, association with age-0 walleye pollock, and behaviors promoting aggregations in Prince William Sound, Alaska, USA. Marine Ecology Progress Series 195: 145-158.

Purcell, Jennifer E. and Jill J. Grover, 1990. Predation and food limitation as causes of mortality in larval herring at a spawning ground in British Columbia. Mar. Ecol. Prog. Ser. Vol. 59: 55-61.

Rich, Nathanial, 2012. Can a Jellyfish Unlock the Secret of Immortality? The New York Times. http://www.nytimes.com/2012/12/02/magazine/can-a-jellyfish-unlock-the-secret-of-immortality.html?ref=jellyfish&_r=0, November 28, 2012.

Richardson, Anthoy J., Bakun, Andrew, Hays, Graeme c., and Gibbons, Mark J., 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends in Ecology and Evolution 24:6.

Science Daily, 2013. Boom in Jellyfish: Overfishing Called Into Question. http://www.sciencedaily.com/releases/2013/05/13503094700.htm. Nov. 30, 2013.

Slow Food, 2013. Domino Effect: The Jellyfish Example. http://www.slowfood.com/slowfish/pagine/eng/pagina.lasso?-id_pg=172. Nov. 30, 2013

Stepanenko OV, Verkhusha VV, Kuzentsova IM, Uversky VN, Turoverov KK. 2008. Fluorescent proteins as biomarkers and biosensors: throwing color lights on molecular and cellular processes. Curr Protein Pept Sci. 9(4):338-69.

Stone, Richard, 2011. Massive Outbreak of Jellyfish Could Spell Trouble for Fisheries. Yale University. http://e360.yale.edu/feature/massive_outbreak_of_jellyfish_could_spell_trouble_for_fisheries/2359/. Nov. 30, 2013.

Subasinghe, S. 1992. Shark Fin, Sea Cucumber and Jelly Fish – A Processor's Guide. INFOFISH Technical Handbook 6. INFOFISH, Kuala Lumpur Malaysia. 31pp.

Personal communications

Dr. Lei Guo, postdoctorate research scientist. Marine Advisory Program, Kodiak Seafood and Marine Science Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 118 Trident Way, Kodiak AK 99615. lguo2@alaska.edu

Dr. Robert Foy, director. Kodiak Laboratory of the Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA. 301 Research Court, Kodiak, AK 99615. robert.foy@noaa.gov

Dr. Alex Oliviera, Associate Professor. Kodiak Seafood and Marine Science Center, University of Alaska Fairbanks, 118 Trident Way, Kodiak AK 99615. acoliveira@alaska.edu

**Acknowledgments**

We would like to thank Dr. Alex Oliviera for graciously showing us how to freeze dry and process jellyfish, Dr. Lei Guo for providing us with insight about jellyfish fisheries in China, Dr. Robert Foy for a presentation about the climate changes in the Arctic, Michelle Ridgeway for giving us a presentation about underwater technology, Andrew and Stephanie Buchinger for allowing us stay in the Chiniak School, Jane Eisemann for her generous support and for volunteering her time and for letting us borrow her classroom, Duesterloh Switgard for her wonderful dedication into coaching our team and providing us with expert guidance and insight.