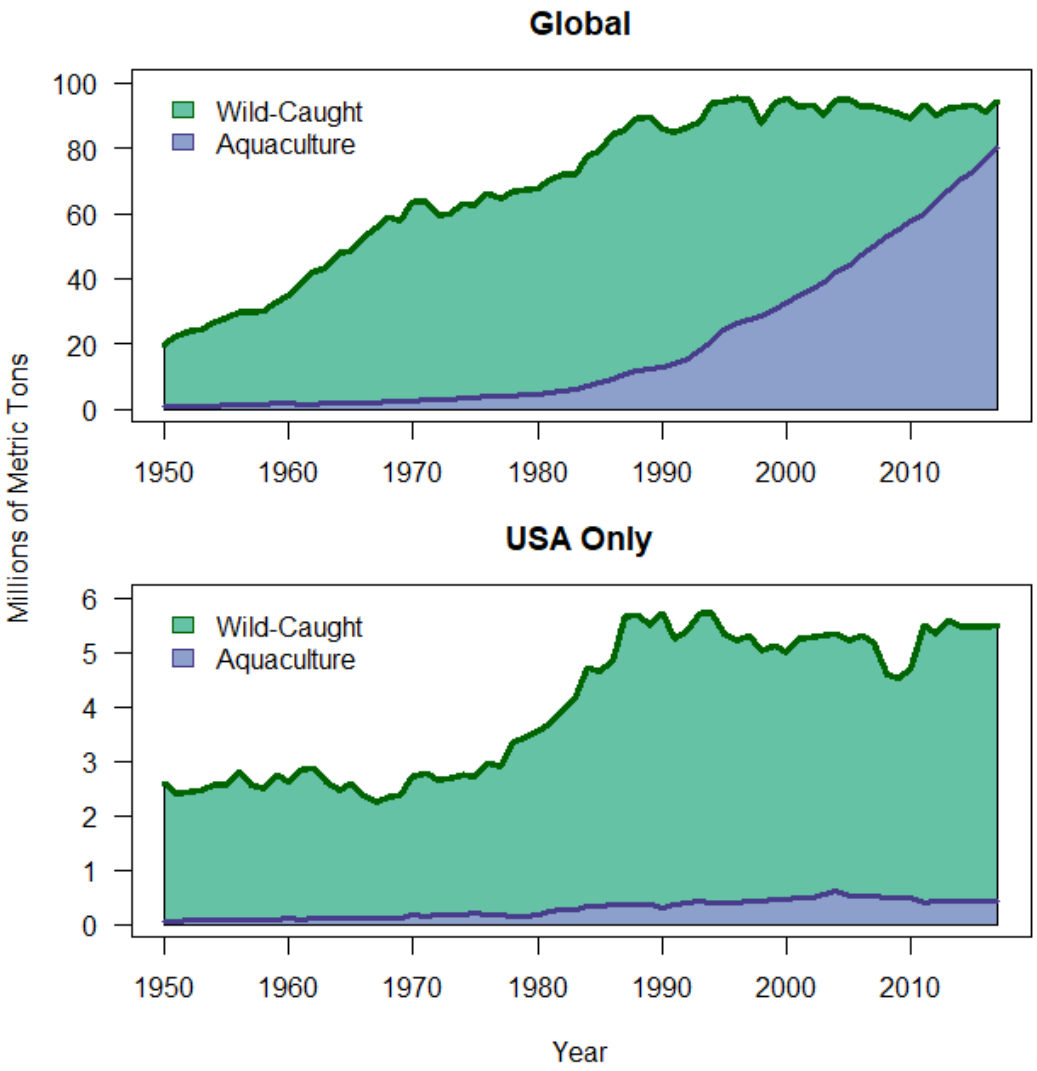
Issue 16, Winter 2019
MASGP-19-001-04

What is Aquaculture?



Above: Total global and domestic harvest of non-plant aquatic organisms obtained via wild-caught fisheries and aquaculture from 1950 – 2017 (data acquired from the Food and Agriculture Organization).

Seafood aquaculture is advantageous for many reasons. First, it improves the economy by creating jobs. Additionally, it benefits consumers by increasing the availability of domestic seafood, thereby reducing reliance on imported seafood. Seafood aquaculture can also lessen commercial fishing pressure on wild fish stocks, many of which are overfished or experiencing overfishing. Finally, since aquaculture bycatch is a nonissue, non-targeted species that would otherwise be caught as bycatch in commercial fisheries are rendered safe from fishing pressure. As global seafood demands rise with increasing populations, the importance of aquaculture will continue to grow.

Aquaculture is defined as the breeding, rearing, and harvesting of animals and plants in aquatic environments. Surprisingly, plant-based aquaculture actually

accounts for over 27% of global aquaculture production (by weight), but for the purposes of this newsletter, we'll focus on non-plant-based aquaculture (e.g. fish, mollusks, and invertebrates). Although wild-caught fisheries still outproduce aquaculture on a global scale, this margin is quickly diminishing, with aquaculture set to outproduce wild-caught fisheries within the next few years (see figure below). Interestingly, this trend is not reflected within the United States, though domestic aquaculture represents a billion-dollar industry.

Unfortunately, there are several disadvantages associated with aquaculture. In some instances, aquaculture can cause decreases in water quality due to waste discharge. Also, animals reared in open-water aquaculture environments may occasionally escape from their enclosures. This can harm native populations through the spread of invasive species, diseases, and non-evolutionarily selected genes (e.g. genes that make a species grow fatter for harvest may also make them slower or less intelligent). Lastly, several pounds of wild forage fishes (small fish species at the bottom of the food chain, e.g. Gulf menhaden and Atlantic croaker in the northern Gulf of Mexico) are required to produce just one pound of most piscivorous (fish-eating) fish, like salmon or tuna. Thus, the production of these large piscivorous species actually increases the fishing pressure on forage fishes, thereby negatively impacting the wild piscivorous species that prey upon those forage fish.

Despite these drawbacks, aquaculture, if practiced carefully and correctly, has the potential to provide all of the benefits listed above without generating any negative consequences. Many organizations that were once hesitant to endorse aquaculture, such as the Coastal Conservation Association, now view aquaculture as a promising field, provided technological developments and best industry practices are pursued with caution and oversight.

Read on to learn more about aquaculture and the production of oysters, freshwater fish, and saltwater fish.

Eastern Oyster, *Crassostrea virginica*

Above: Photo by Ryan Bradley, Mississippi Commercial Fisheries United

The eastern oyster, *Crassostrea virginica*, is one of the most ecologically important species found along our Gulf Coast. These oysters improve water quality, prevent erosion, and provide essential habitat for many aquatic species. They are also a sought-after type of seafood given their delectable taste. Regrettably, due to a combination of overfishing, disease, and pollution, today's wild oyster populations represent only a small fraction of their historical abundance. Fortunately, consumers can still enjoy these oysters thanks to aquaculture, which is responsible for producing 73% of the United States' oyster harvest. Domestically, eastern oysters are the most valuable marine species produced via aquaculture, generating over $100,000,000 every year.

The practice of oyster farming is over 2,000 years old. There are many ways to farm oysters, but traditional methods in the northern Gulf of Mexico involve placing cultch (oyster shell, limestone, etc.) on the seafloor and then waiting for wild oyster larvae to settle on the cultch. While this method allows for high levels of production, it is also sensitive to yearly fluctuations in the health of wild oysters. Consequently, some northern Gulf of Mexico farms have recently transitioned to off-bottom oyster aquaculture, in large part thanks to our colleagues ***Bill Walton*** and ***Rusty Grice*** at Mississippi-Alabama Sea Grant. Off-bottom oyster aquaculture involves suspending oysters, which are generally obtained when they are

just a few millimeters big from a hatchery, in mesh containers above the seafloor. As these oysters grow, the oyster farmers continuously clean, sort, and arrange them, so that they can grow to market size as quickly as possible. Oysters farmed using this technique have increased survival, as they are less susceptible to predation and less likely to become buried in mud. Moreover, since oyster hatcheries can prevent oysters from affixing themselves to structure, these oysters have an improved shell shape and appearance compared to those produced through other methods. This increases their value and places them in high demand for the half-shell market, where they fill consumers' appetite for pristine, deep-cupped oysters.

Oyster farming is a common industry in the northern Gulf of Mexico, especially given the long growing season. Sadly, many local oyster farms in Mississippi and Alabama experienced mass die-offs this year due to the prolonged opening of Louisiana's Bonnet Carre Spillway. The freshwater from the spillway caused the salinity to plummet in Mississippi Sound, which, in turn, killed many oysters. Despite the constant difficulty of rearing oysters in an environment with fluctuating salinity, oyster farming remains popular along the Gulf Coast. With new challenges have arisen improvements in technology and farming practices that will facilitate production and allow Gulf of Mexico oyster farming to continue for many generations to come.

For more information, visit http://masgc.org/oyster-farming/summary.

Catfish, *Ictalurus punctatus*

Above: Catfish aquaculture ponds are numerous in Noxubee County, MS. Photo by Amanda Jefferson.

Catfish farming dominates the aquaculture scene in the United States, with more catfish produced domestically than any other species. Domestic catfish aquaculture began during the early 1960s in Kansas, Oklahoma, and Arkansas. A few years later, the industry moved to the Mississippi Delta, where the clay-laden soils and warm climate were more conducive for catfish aquaculture. While other catfish species are farmed elsewhere, channel catfish (*Ictalurus punctatus*) – affectionately referred to as “channel cats” – are the main species of catfish farmed in the United States. These fish are prime aquaculture candidates because they thrive in a variety of habitats, tolerate a wide range of environmental conditions, adapt well to aquaculture systems, and retain their texture and flavor after processing.

In aquaculture settings, channel catfish are grown in man-made ponds. To ensure the health of the fish, the water quality (including levels of dissolved oxygen, carbon dioxide, ammonia, and nitrate) is closely monitored and managed. Channel catfish are fed a grain-based diet containing specific ratios of protein, carbohydrate, and fat, with additional vitamins and supplements. Once enough fish have been raised and the flavor quality has been assessed, the producers use haul seines to harvest the ponds. Most catfish producers sell directly to processors; in this case, the harvested fish are transported alive, in oxygenated water, to the processing plants.

Channel catfish aquaculture is vital to consumers and to our economy. According to the Food and Agriculture Organization, a whopping 150,000

metric tons of channel catfish were produced by the United States in 2017, which equates to approximately 34% of all non-plant-based domestic aquaculture by weight. If we omit invertebrates (oysters, crawfish, etc.) and focus solely on fishes, we find that channel catfish comprised 74% of all domestic farm-raised fishes by weight in 2017. Channel catfish is also the most valuable domestic farm-raised species, with a net value of more than $350,000,000 in 2017.

Although Alabama and Arkansas are important contributors to the farm-raised catfish industry, Mississippi leads the nation in catfish production with approximately 34,000 acres of catfish ponds! Mississippians are certainly proud of their catfish aquaculture. In fact, a town called Belzoni, Mississippi was named “Farm-Raised Catfish Capital of the World” in 1976 by Governor Cliff Finch. If you’re crazy for catfish, check out the World Catfish Festival on April 4, 2020 in Belzoni, Mississippi.

In the early 2000s, difficulties including high feed prices and inexpensive imported catfish (including non-catfish species misleadingly labeled as catfish) caused many Mississippi producers to sell their land. The acreage of Mississippi catfish ponds declined from a staggering 130,000 acres to just 34,000 during this time. Likewise, domestic catfish production dropped from 300,000 metric tons in 2003 to 140,000 metric tons in 2014, the lowest amount since 1985. Fortunately, the future looks brighter. Feed prices are declining, domestic catfish prices are increasing, and lawmakers are cracking down on mislabeled imports. Additionally, new water quality management and production system technologies are lowering production costs. Lastly, the production of genetic hybrids (channel catfish x blue catfish, *Ictalurus furcatus*) is resulting in fish with improved survival, growth, and yield. These recent advances, along with an improved market, have helped stabilize the catfish aquaculture industry and will hopefully enable it to continue into the future.

For more information about catfish aquaculture, visit Mississippi State University Extension.

One Fin, Two Fin, Yellowfin, Bluefin: Farm-Raising Tuna

Above: Farm-raised tuna. Photo credit: Kate on Unsplash

Over the past decade, new diet fads like sushi burritos and poke bowls have been popping up across the US, causing an increase in demand for raw tuna. Globally, however, most tuna populations are overfished or undergoing overfishing. In an effort to alleviate strain on wild tuna populations and increase efficiency of tuna production, companies in Australia, the Mediterranean, Japan, and more have developed and currently operate yellowfin and bluefin tuna ranches. Tuna ranching involves the capture of wild juvenile tuna from known spawning grounds, which are then transported to holding pens in the ocean where they live for the remainder of their lives (generally only a few months to a year) before going to market. This strategy benefits the fishermen-turned-ranchers, who are no longer obligated to spend fuel or time attempting to capture wild adult tuna. It also allows ranchers to control the diet of the farm-raised fish, resulting in increased fat content and thus, increased profit.

However, tuna ranching can be ecologically inefficient and unsustainable. First off, juvenile tuna are removed from their wild populations before they have a chance to breed, which may exacerbate declines in wild populations. Additionally, it takes an average of 15 pounds of feed - which usually consists of wild-caught mackerel and sardines - for a farm-raised tuna to gain one pound of body weight. Since farmed tunas are typically grown to ~130 pounds or more, this is incredibly inefficient. The extensive use of mackerel and sardines also rapidly depletes those marine

resources. Furthermore, as with other aquaculture species, what is put into the fish is just as important as what comes out of the fish. At tuna ranches, many fish exist in a small space (pens on average are about 70 meters across). Unlike with traditional land-based farming (e.g., cattle or poultry), there are no physical barriers in the ocean to contain any waste, chemical, or antibiotic leaks. Therefore, waste from unconsumed feed and fecal matter sinks to the ocean floor and the chance of disease outbreak is heightened, both within the resident tuna and among nearby wild fish populations. To increase the efficiency of aquaculture of these highly profitable species, efforts are continuing to push toward more cost-effective and environmentally sustainable farming methods.

In 2002, Kindai University in Japan successfully developed a closed aquaculture system for Atlantic bluefin tuna. This means the university does not take any wild tuna, but instead incubates eggs produced by spawning tuna within their farms. However, they are still reliant on baitfish captured from the environment for feed, which is currently unsustainable. Recently, a company called Ichthus Unlimited LLC from Iowa has developed a soybean-based feed that provides nutrients to tuna at a lower environmental cost. The company has a five-year plan to establish a Pacific bluefin tuna hatchery and closed-cycle farm operation in San Diego, California, which would be the first tuna hatchery in North America.

Sea of Acronyms

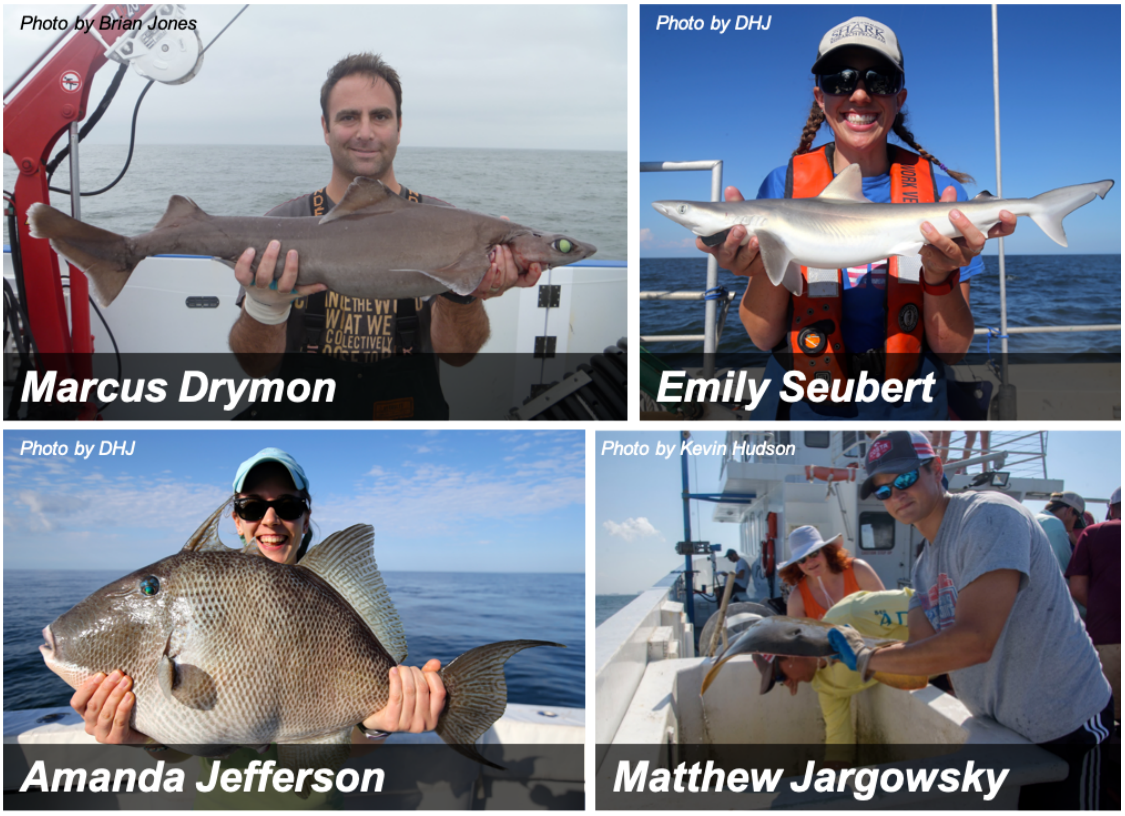
Being an informed angler begins with understanding the terminology used in fisheries management. This series helps demystify the concepts hidden beneath a sea of acronyms.

FAO

Food and Agriculture Organization

The Food and Agriculture Organization is a specialized branch of the United Nations. The Vision Statement of the FAO Fisheries and Aquaculture Department is to promote *a world in which responsible and sustainable use of fisheries and aquaculture resources makes an appreciable contribution to human well-being, food security and poverty alleviation*

Marine Fisheries Ecology Lab



I'm Marcus Drymon, an Assistant Extension Professor at Mississippi State University and a Marine Fisheries Specialist at Mississippi-Alabama Sea Grant. Emily Seubert, Amanda Jefferson, Matthew Jargowsky, and I comprise the Marine Fisheries Ecology Lab. We'd love to hear from you! Please reach out to us at marinefisheriesecology@gmail.com

Facebook Website