GREY MULLET – *Mugil cephalus*

The grey mullet is a catadromous species found across the world in coastal waters of tropical, subtropical, and temperate zones. It has been farmed for centuries, traditionally in ponds for subsistence farming. *Mugil cephalus* is an important species in the Mediterranean region, Southeast Asia, Taiwan, Japan, and Hawaii.

FAO FishStat reports 13,681 tonnes of total aquaculture production of *Mugil cephalus* in 2016. Countries with reported volumes of grey mullet produced through aquaculture include: 2,244 tonnes in Taiwan, 1,900 tonnes in Israel, 700 tonnes (estimated) in Italy, and 198 tonnes in Greece (as of 2017). Though official numbers are not reported, Egypt is the largest producer of cultured grey mullet, and it also traditionally farmed in the Philippines, India, and Russia.

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Aquaculture of grey mullet still predominantly depends on the collection of wild fry, with limited hatchery production in Israel and Egypt. This may impact the sustainability of the wild capture fisheries. Extensive polyculture farming, whereby the grey mullet is cultivated in freshwater and brackish water ponds often with carp, tilapia, or milkfish is the most common culture method. In these cases, the mullet will feed on leftovers and detritus from the other species, whereas in mullet monoculture the fish have been found to grow on chicken manure or rice or wheat bran to achieve proper growth rates (FAO, 2006-2020).
“Most, if not all, of the farmed mullet is consumed in the producing countries where increasing demand exists. There is no known export market.” (FAO 2006-2020). Depending on the part of the world, mullet is marketed fresh, dried, salted, and frozen; and roe sold fresh, dried, or smoked.


**Hong Kong**

Grey mullet, *M. cephalus*, were originally cultivated in Hong Kong as a polyculture fish species grown alongside rice, added to the flooded fields in the first half of the 1900s. Production peaked in the 1970s, by which time nearly half of rice paddies were also raising grey mullet, popular for their flesh and oil. Soon, grey mullet were being raised in ponds as a monoculture species, ultimately leading to a muddied flavor in the fish and a ruined reputation for several generations (Yung, 2017). Farmers have since adopted a strategy similar to crop rotation for grey mullet aquaculture, allowing ponds to dry up and lay fallow between ‘crops.’ To improve the taste, farmers have also adopted a strategy to grow mullet in brackish water to improve the flavor of the fish.

Culture of grey mullet takes place in the northwestern region of Hong Kong New Territories. Fishponds in use in the area total 1,131 hectares, and in 2019 produced 2,278 tonnes of freshwater fish valued at HK$52 million (Aquaculture, 2019). The majority of these pond fish farms are engaged in polyculture, about 96%, producing carp in combination with tilapia or grey mullet. Some ponds are part of a larger nature reserve and many act as living wetlands, providing habitat for millions of migratory birds every year.
In 2005, the Agriculture, Fisheries and Conservation Department of the Government of the Hong Kong Special Administrative Region implemented the Accredited Fish Farm Scheme (AFFS), a voluntary system of guidelines for aquaculture operations that wish to be deemed sustainable. For fish farmers that enroll in the AFFS, ongoing technical support and advice are provided to assist them with overcoming any related management problems. To ensure the quality of cultured fish as well as the culture environment at AFFS fish farms, sampling is conducted during regular visits. The hygiene, use of drugs and feed additives, as well as the health condition of aquatic products and water quality during the rearing period are closely monitored. Quality assurance tests on obtained samples are run, and certification is issued to fishery products that pass these tests. AFFS-certified products are sold under the AFFS brand and bear an AFFS traceable quick response (QR) code fish tag. By scanning the QR code with a mobile device, consumers can easily obtain information of the fishery product – such as its origin, its safety test results (such as ruling out the presence of malachite green, exceedances of drug residue limits and unsafe levels of heavy metals) and the contact number of the fish farm that supplied it. As of 2019, there were 49 freshwater fish farms engaged in the scheme.

**Risk Assessment**

- Farm Siting: Low Risk
  - *Farm locations are historic and there is minimal new development (if any).*
Hong Kong’s freshwater fish ponds were originally converted from farmlands and wetlands and now contribute to the coastal marsh environment.

*Mugil cephalus* is grown using both monoculture and polyculture pond systems; some operations use a system similar to crop rotation which allows ponds to lie fallow and dry out between uses.

**Nutrient Pollution: Low Risk**
- Farm certified against a government standard that addresses nutrient pollution/water quality issues. Water samples are collected at AFFS-registered farms by AFCD, and parameters, such as pH, dissolved oxygen concentration, nutrients, *Escherichia coli* and *Vibrio cholerae*, are tested for to ensure that they meet regulatory requirements.
- Most grey mullet farms are part of the AFFS, which describes management measures including 10 good pond fish culture practices (p.10, GAP3, AFCD):
  - Water quality management and possible issues are described (color, transparency, suspended solids, acidity, high alkalinity, ammonia, nitrite, water temperature, feeding management), with mitigation measures detailed.

**Feed source: Medium Risk**
- *The farm is using some fishmeal in feed though the quantity and source is unknown.* Grey mullet were historically raised as part of a polyculture system, which required no feed, though grey mullet grow quicker if fed meat protein. Because the grey mullet is an herbivorous fish, pelleted feed does not need to contain as much fishmeal. Further, ingredients can include organic waste that would otherwise be discarded.
- Hong Kong’s grey mullet farmers use commercial pellet feed or utilize organic matter as feed; common ingredients include rice bran, breads, peanut cake, instant noodles, grass, and soybean.
  - These ingredients alone have been found to be nutritionally insufficient (Mo, Man & Wong, 2019).

**Disease, medicine and chemicals: Low Risk**
- Most grey mullet farms in Hong Kong are part of the AFFS, which provides disease prevention and treatment guidelines (AFCD, 2019):
  - Farmers are educated in how to prevent and control fish diseases, including how to maintain a good culture environment
  - AFCD staff provide free fish health inspections and introduce fish disease prevention practices
  - “Fish farmers must not use any fish drugs not prescribed by the AFCD or a registered veterinarian, or any fish drugs with unknown ingredients.”
  - “The Harmful Substances in Food Regulations provide statue against any food containing prohibited substances or containing certain substances in excessive concentration,” (p.29, GAP4, AFCD).
  - AFCD provides guidance on permitted drugs and the rules fish farmers must adhere to (p.29, GAP4, AFCD).
  - The City University of Hong Kong’s veterinary services are supported by AFCD’s Sustainable Fisheries Development Fund and are available to local fish farmers.
Introductions/Genetics: Low Risk
  - The farm operation does not pose a risk to native species/populations as the species is already native to the country and farmed species genetics unlikely to establish in the wild.
  - *Mugil cephalus* is native to the region surrounding Hong Kong:
    - Considering fry are still collected from the wild and there is no hatchery technology, farmed fish do not have altered genetics.

Wild Seed: Medium Risk
  - Most of the seed comes from Mainland China (AFCD pers comms), and the status of the wild populations of *M. cephalus* is unknown.
  - A small percentage (<10%) of the wild seed collection may be having an impact on the wild *M. cephalus* population in Taiwan. However, sourcing of seed from Taiwan is relatively less common due to the high asking prices.
  - Grey mullet farmers collect *M. cephalus* from inshore waters and estuaries, or purchase wild caught fry mainly from Mainland China, and some from Taiwan (FAO 2006-2020).
  - In addition, there are very few farms that source fry from local Hong Kong waters; this is regarded as small scale given the laborious and non-guaranteed efforts associated with this.

Fish Welfare: Low Risk
  - The operation demonstrates good animal husbandry appropriate to the cultivated species. Though fish may become stressed in summer in periods of hot weather.
  - Majority of Hong Kong grey mullet farms are part of the AFFS, which provides guidelines for good pond management and how to mitigate any issues with environmental quality.
  - The hygiene, management, use of drugs and feed additives, as well as the health condition of aquatic products and water quality during the rearing period are closely monitored. During site inspections, AFCD provide farmers with technical support on farm management.
  - *M. cephalus* is treated with ice upon harvest and transported and sold as chilled fish; grey mullet are not sold live.

Taiwan

*Mugil cephalus* is highly prized in Taiwan for its roe, sold as a cured or dried delicacy. A grey mullet wild capture fishery was historically very productive in Taiwan, with increasing catches from the mid-1960s through the mid-1980s. Overfishing by Taiwan and China led to a drastic crash of the fishery after about 1985: in 2005, fewer than 100,000 fish were harvested (Whitfield, Panfili, & Durand, 2012). “The Taiwanese production of *M. cephalus* from aquaculture has shown a considerable increase, and is now approximately four times greater than the yield from capture fisheries,” (p.668, Whitfield, Panfili, & Durand, 2012).

Culture of *Mugil cephalus* in Taiwan began in the 1960s with polyculture methods, in which grey mullet were raised with carp in ponds. Research on grey mullet aquaculture was also undertaken during this decade, which achieved induced spawning and eventually the completion of its life cycle in 1976. However, despite these initial advancements in grey mullet aquaculture,
hatchery production never reached commercial scale and today grey mullet aquaculture still depends on the capture of wild fry and juveniles.

Grey mullet juveniles captured for aquaculture are harvested primarily from the northwest and southwest coasts of Taiwan, and cultured to maturity in order to harvest the valuable roe. The fish are raised in earthen ponds, either in a monoculture system with tens of thousands of juveniles, or a polyculture system with several thousand juveniles. “Fish farmers have gradually shifted from extensive culture to intensive culture in order to increase production. Most aquaculture farms are located in Hsinchu (northern Taiwan), Yilan (Northeastern Taiwan), and the coastal area of the middle and southern parts of western Taiwan,” (p.491, Liao, Chao, Tseng, 2016).

Risk Assessment
- **Farm Siting:**
  - Not enough information available to assess this criterion
- **Nutrient pollution:**
  - Not enough information available to assess this criterion
- **Feed source:**
  - Not enough information available to assess this criterion
- **Disease, medicine and chemicals:**
  - Not enough information available to assess this criterion
- **Introductions/genetics:** Low Risk
  - The farm operation does not pose a risk to native species/populations as the species is already native to the country and farmed species genetics unlikely to establish in the wild.
  - *Mugil cephalus* is native to the region surrounding Taiwan.
  - Considering fry are still collected from the wild, farmed fish do not have significantly altered genetics.
- **Wild Seed:** High Risk
  - The operation relies on wild seed collection and is likely having an impact on wild populations of the species.
  - Taiwan’s capture fishery for grey mullet collapsed in the early 2000s due to overfishing: catches generally increased from 1967 until 1985, after which the stock crashed resulting in less than 100,000 fish harvested in 2005. Aquaculture has become increasingly important for grey mullet production in Taiwan, “and is now approximately four times greater than the yield from capture fisheries,” (Whitfield, Panfili & Durand, 2012).
  - Artificial spawning for grey mullet was achieved in Taiwan in the 1960s and the completion of its life cycle in captivity was achieved in the 1970s; however, “production of hatchery fry has languished since then due to the long culture schedule, the high risk of failure, insufficient number of farmers, insufficient supply of wild specimens to be used as broodstocks, and the low price of hatchery produced fry.” (p.491, Liao, Chao, Tseng, 2016).
  - Grey mullet culture in Taiwan still depends on the limited wild populations for collection of fry and juveniles; most are collected from the northwest and southwest coasts of Taiwan.
- **Fish Welfare:**
  - Not enough information available to assess this criterion.
References

AFCD Pers Comms. (email 10th March 2021)


