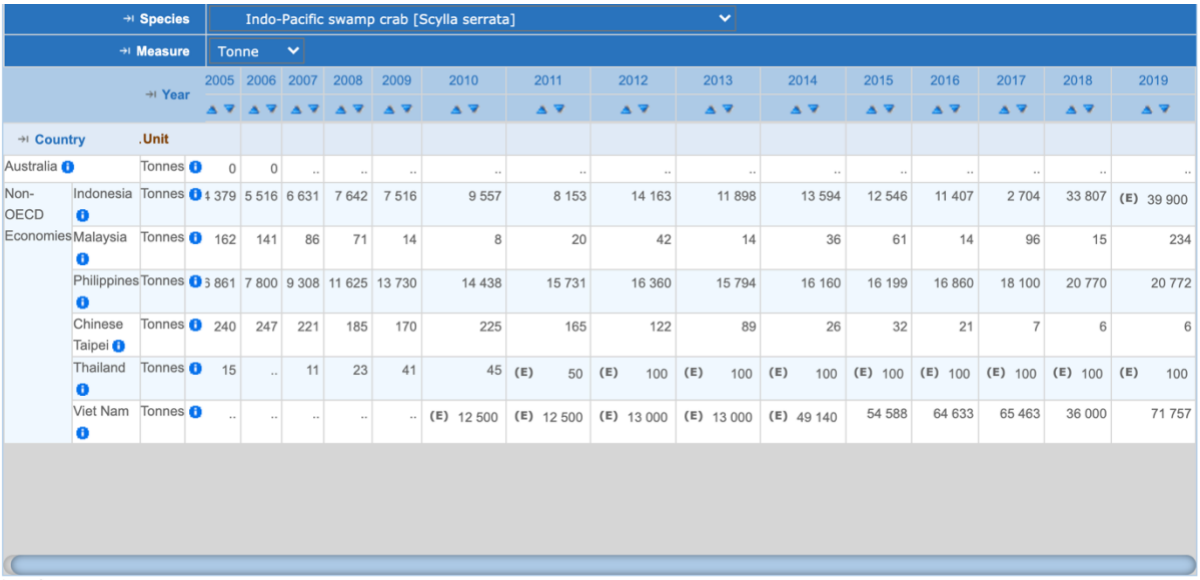
**SOFT-SHELL Crab - *Scylla serrata***

*Scylla serrata*, commonly known as Indo-Pacific swamp crab or mud crab, is found inhabiting mangroves and soft substrates in shallow or intertidal waters within the Indo-West Pacific region. The aquaculture industry of *S. serrata* began in the 1970s in Southeast Asia and started to gain increasing popularity in 1990s. FAO Fishstat reported nearly 133,000 tonnes of *S. serrata* production through aquaculture in 2019, with 54% from Vietnam, 30% from Indonesia and 16% from the Philippines. Though official numbers are not reported, China is the largest producer of cultured *S. serrata*. Both Malaysia and Thailand appear to be minor producers; it is unclear why FAO does not report on Bangladesh.



| Species | | Indo-Pacific swamp crab [Scylla serrata] | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Measure | | Tonne | | | | | | | | | | | | | | |
| Year | | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Country | Unit | | | | | | | | | | | | | | | |
| Australia | Tonnes | 0 | 0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Non-OECD Economies | Indonesia | Tonnes | 4 379 | 5 516 | 6 631 | 7 642 | 7 516 | 9 557 | 8 153 | 14 163 | 11 898 | 13 594 | 12 546 | 11 407 | 2 704 | 33 807 | (E) 39 900 |
| | Malaysia | Tonnes | 162 | 141 | 86 | 71 | 14 | 8 | 20 | 42 | 14 | 36 | 61 | 14 | 96 | 15 | 234 |
| | Philippines | Tonnes | 3 861 | 7 800 | 9 308 | 11 625 | 13 730 | 14 438 | 15 731 | 16 360 | 15 794 | 16 160 | 16 199 | 16 860 | 18 100 | 20 770 | 20 772 |
| | Chinese Taipei | Tonnes | 240 | 247 | 221 | 185 | 170 | 225 | 165 | 122 | 89 | 26 | 32 | 21 | 7 | 6 | 6 |
| | Thailand | Tonnes | 15 | .. | 11 | 23 | 41 | 45 | (E) 50 | (E) 100 | (E) 100 | (E) 100 | (E) 100 | (E) 100 | (E) 100 | (E) 100 | (E) 100 |
| | Viet Nam | Tonnes | .. | .. | .. | .. | .. | (E) 12 500 | (E) 12 500 | (E) 13 000 | (E) 13 000 | (E) 49 140 | 54 588 | 64 633 | 65 463 | 36 000 | 71 757 |

Legend:
E Estimated value

*(image source:* https://stats.oecd.org/Index.aspx?DataSetCode=FISH_AQUA#*)*

Although technology and knowledge regarding hatchery produced seed stock has been developed in certain countries such as Indonesia, the majority of the industries are still relying on wild-caught seeds for *S. serrata* aquaculture. Mud crab culture systems are commonly practiced as grow-out (culture from juveniles to market size crabs in ponds), fattening of lean crabs and recently the production of soft-shell crabs.

The term soft-shell crab refers to the physiological state of any crab that has just undergone moulting to replace their old hard exoskeleton with a new, slightly larger, hydrated and decalcified soft exoskeleton, which is the stage of crabs with the highest market value. As the exoskeleton would become very firm in about 3 hours, the short harvest timeframe makes soft-shell crab farming a labour-intensive aquaculture industry. The most common system is individual rearing, in which intact crabs are held in perforated plastic boxes, with several boxes being positioned in pontoons or floating platforms. The number of days to harvest and quantity per harvest in each crop cycle in soft-shell crab aquaculture is somewhat fluctuating in nature, as the harvest depends on different environmental variables and an unpredictable crab moulting stage. Therefore, the crop cycle generally has a large range of 25-45 days (Rahman et al., 2018), yet a relatively short period of time compared to other mud crab culture practises.

**Bangladesh**
Mud crab aquaculture has been practiced for many years in the coastal regions of Bangladesh with brackish water and marine coastlines (Chakraborty et al., 2018).

The export of crabs to international markets from Bangladesh first started in the late 1970s. Aquaculture and the crab export since then has been solely based on harvest from the wild (Rahman et al., 2017), and no success on sustainable mud crab production (with the production of seed) has been reported in Bangladesh so far (Rahman et al., 2020). About 70% hard-shell crabs are exported by harvesting them directly from wild source and another 30% comes from various aquaculture systems e.g., fattening of lean crabs (seedstock from depots/marketing points), grow-out production (wild seed) and crab production in shrimp ghers unintentionally (crablets enter shrimp ghers/ponds during water intake). The production of soft-shell crab with *S. serrata* first started in 2010 in south-east region of Bangladesh and gradually expanded to south-west region on a limited scale, accounting for 4% of total crab exports from Bangladesh (Rahman et al., 2018). The crab farms usually practise soft-shell crab aquaculture by stocking crab individually in separate plastic boxes in coastal areas (Rahman et al., 2018). Farmers cannot export soft-shell crabs directly. They sell their production to processing plants/facilities that have processing equipment and export licenses.

- Farm Siting: high risk
    - Most soft-shell crab farms take place in coastal water bodies that were formerly used for shrimp farming. Shrimp farming has long been criticized to account for mass mangrove forest destruction and numerous environmental concerns such as saltwater intrusion into nearby agricultural lands (Hossain et al., 2013). The newly established soft-shell crab farms may have inherited similar environmental risks.
    - One of the ecological objectives in the National Aquaculture Development Strategy and Action Plan of Bangladesh 2013–2020 was to set up a spatial planning for aquaculture development with an ecosystem approach in order to map desired locations for aquaculture farms expansion in consideration of carrying capacities for maximum production, preservation of ecosystem services and social carrying capacity (maximum level of recreational fisheries and aquaculture) (Ministry of Fisheries and Livestock & FAO, 2014). Yet the implementation of such plan is not evaluated, and seems to be not fully enforced or followed.
    - Other than that, existing laws are limited for mud crab fisheries and aquaculture.

- Nutrient Pollution: medium risk
    - Monitoring on water quality and feed use, including water temperature, salinity, pH and dissolved oxygen is practised in soft-shell crab farms (Lahiri et al., 2021; Rahman, M. M., pers comms, 28 August, 2022).
    - Up to 50% of water is exchanged with nearby rivers or canals every fortnight in most soft-shell crab farms (Lahiri et al., 2021; Rahman, M. M., pers comms, 28 August, 2022).
    - The impact of effluent produced by soft-shell crab farms has not been well documented.
    - Exchange of water from nearby common canals where many virus-affected shrimp ghers (ponds) discharge its water after operation could pose nutrient

pollution to soft-shell crab farms. Additionally, some crab farmers use boiled rice, entrails/guts of poultry as crab feed that has considerable risk of nutrient pollution.

- Feed Source: medium risk
    - Almost 95% of farmers feed stocked crabs with fresh tilapia (*Tilapia niloticus* and *T.mossambicus*) as crab feed, which may compete with the value chain of tilapia spp. for human consumption. This is followed by mudflat snails (*Batillaria* spp.), which are collected from shrimp ponds and other coastal waterbodies. Crab farmers also use trash fish of marine and freshwater origin. Apart from these protein sources, boiled rice, poultry entrails, wheat, maize, shrimp/prawn heads, etc. are often used as feed (Rahman et al., 2018).
    - The sustainability of the trash fish fishery in Bangladesh is not evaluated, including the impact of coastal trawling with small mesh size to the ecosystem. Therefore in the long term, the existing sources of crab feed pose considerable risks in respect of sustainable fisheries (trash fish issue) and value chain management.

- Disease, Medicine, Chemicals: medium risk
    - Potential impacts of infectious pathogens in intensive mud crab farming are not well established (Rahman et al., 2020)
    - Farmers use agricultural lime ($CaCO_3$), potassium permanganate and also a small amount of fertilizers (Urea, Triple Super Phosphate/TSP) etc. in crab ponds. Yet the amount and number of doses of these chemicals are not maintained and recorded properly.
    - Mortality due to poor quality seed stock, feed management, and water quality deterioration is the main problem in crab farming in Bangladesh (Rahman, M. M., pers comms, 28 August, 2022).

- Introductions & Genetics: low risk
    - As *S. serrata* farming is totally dependent on wild seed supply, it is unlikely to pose significant threats to the local *S. serrata* population genetically.
      Crab farmers use fencing (made of bamboo) and nylon nets on top of and on the inner sides of pond dikes to avoid stocked crabs escaping.
    -
- Wild Seed: high risk
    - The few initiatives of hatchery undertaken in Bangladesh have met with limited or no success so far (Rahman et al., 2020). Therefore, the *S. serrata* farming is totally dependent on wild seed supply and rejected *S. serrata* collected from depots/collection points of coastal areas. It was found that 62.12% of crabs were collected from coastal areas, including mangrove areas, 24.48% collected from Gher (an integrated prawn-fish-rice joint culture,) and rest of others 13.40% was collected from coastal river bank in certain regions (Chakraborty et al., 2018).
    - 80% of the crab fattening system in Bangladesh is based on stocking of juvenile crabs collected from depots/collection points. These juveniles are non-exportable as hard-shell crabs due to gonadal immaturity, being smaller in size and the soft condition of the shell. Rearing these crab individuals in soft-shell crab farms is one way to help the crab sector, otherwise these crabs would be wasted due to limited local consumption.

    - The catch statistics indicate that fishing pressure of coastal areas has increased rapidly in recent years and the decreasing trend in production percentage could be an indicator towards over-harvesting (Chakraborty et al., 2018).
    - Additionally, these soft-shell farms demand input crabs smaller in size (started from 60 g to 140 g) for stocking which is harvested from various wild sources mainly Sundarbans mangrove forests and associated tidal rivers and canals (Rahman et al., 2018). Recently, high seed demand for soft-shell farm operations creates high pressure of harvesting small crabs from wild stock.
    - The fishing ban for crabs over restricted periods (i.e., breeding season from January to February) in particular regions such as Sundarbans mangrove area has been regularly ignored by collectors (Rahman et al., 2020)
    - The level of awareness of the crab collectors, farmers, and traders was found to be poor with no knowledge of existing fisheries rules and regulations (Rahman et al., 2020).

- Fish Welfare: medium risk
    - There is no standard crab culture manual available in Bangladesh . Several problems including improper salinity and water quality deterioration have been reported in *S.serrata* farming (Rahman et al., 2020).
    - There is no policy/guideline for fish welfare in Bangladesh.
    - For wild-captured *S. serrata*, survival rate is affected by erratic handling, delayed landings, and poor transportation systems (poor post-harvest management) which negatively affect aquaculture output and national production.
    - As soft-shell crab farming practise usually involve stocking crab individuals in separate floating boxes, cannibalism is less likely to occur.
    - The processing, freezing, packaging, wrapping, labelling, and shipment of soft-shell crabs vary by countries as buyers usually have different requirements. USA, UK and Australia take account of 80% of overseas exportation (Rahman et al., 2018).
    - All *S. serrata* is shipped and exported in frozen form to other countries (Hungria et al., 2017).

**Indonesia**

In Indonesia, the mud crab has been an important fisheries commodity since the early 1980s. During the early years major mud crab producers were located in North Sumatra, East Kalimantan, West Kalimantan and East Java provinces (Cholik, 1999). Soft shell crab production was then introduced and developed in some areas of Indonesia, such as Barru and Takalar regency, South Sulawesi, as well as Pemalang and Brebes regency, Central Java (Parenrengi, 2014).

According to the Minister of Fisheries and Maritime Affairs Regulation no.16 in 2022, the capture of mangrove crabs for consumption purposes can only be carried out provided that no eggs are laid, the carapace width is above 12 cm and using static or passive fishing gear. Yet it is reported that almost no fishery management has been applied to this crab fishery up to the present time in several parts of Indonesia (Natan et al., 2021). The soft-shell crab aquaculture relies heavily on wild-sourced seedlings as hatchery production technique is still immature and insufficient to supply the high demands in the industry (Parenrengi, 2014).

Fishery improvement projects in selected areas are being carried out by Learning Center EAFM at Lambung Mangkurat University to evaluate the management status of mud crab fisheries using the Indonesian Ecosystem Approach to Fisheries Management (EAFM) Methodology (Syahdan et al., 2021). The Government organisation, BBPBAP Jepara, is also engaging in various mud crab programmes including cultivation, hatchery, restocking and pond maintenance to push for a more sustainable mud crab fishery (Nurcahyono, E., pers comms, 15 November, 2022).

- Farm Siting: low risk
    - Semi-closed systems are practised in Indonesia where floating cages with crabs inside are placed in aquaculture ponds built on land, filled with water pumped from an adjacent brackish or salt water source and returned to the environment after use (Tavares et al., 2018). Most aquaculture ponds are adjacent to mangrove or coastal areas.
    - The Ministry of Environment and Forestry launched the national mangrove map (PMN) as the national mangrove rehabilitation management baseline in 2013. The results show the existing mangrove area in 2021 is 3,364,080 Ha, with an increase of 52,835 Ha of mangrove area between 2013 and 2021.
    - The indoor crab boxes set-up with a recirculating water system (RAS) has been reported in Indonesia (Aquino, 2018), yet the degree of prevalence of such systems is not reported.

- Nutrient Pollution: medium risk
    - Observation and recording of water quality is carried out in soft shell crab cultivation, including water parameters such as salinity, temperature, pH, and dissolved oxygen (Nurcahyono, per comms, 1 December 2022).
    - The use of feed is recorded, including the type and amount of feed given during the crab cultivation period (Nurcahyono, per comms, 1 December 2022).
    - Water exchange from nearby public drains where the discharge water of many virus-affected shrimp aggregations (ponds) following operations can potentially contaminate the crab ponds. Yet, the cumulative impact of nutrient contamination from neighbouring farms in the area has not been quantified and documented (Nurcahyono, per comms, 1 December 2022).
    - Some crab farmers use poultry offal as crab feed, which has a risk of nutrient contamination. Yet , the impact of waste generated by soft shell crab ponds has not been well documented (Nurcahyono, per comms, 1 December 2022).

- Feed Source: high risk
    - Trash fish was used as the main feeding source for soft-shell crab farming in Indonesia (Agus et al., 2016). The feed is generally comprised of tilapia fish, shellfish, golden snail, and poultry entrails (Nurcahyono, per comms, 1 December 2022).
    - The sustainability of the trash fish fishery in Indonesia is not evaluated, including the impact of coastal trawling with small mesh size to the ecosystem.

- Disease, Medicine, Chemicals: medium risk

- Ectoparasites are found to be common among some of the soft-shell crab farms in Indonesia, with 50%-60% of crab individuals infected (Putra et al., 2021).
- Bacterial disease is also prevalent in *S.serrata* brackish ponds (Haditomo & Prayitno, 2018).
- There are no records of antibiotics being used in soft-shell crab cultivation in Indonesia so far (Nurcahyono, per comms, 17 November 2022).
- There are several national aquaculture regulations in Indonesia, including:
  - Regulations related to fish diseases, namely the regulation of the Minister of Maritime Affairs and Fisheries No. 13 of 2021, which regulates emergency response actions for handling disease outbreaks and controlling fish diseases;
  - The Decree of the Minister of Maritime Affairs and Fisheries No. 28 of 2021 which contains a list of types of fish diseases that have the potential to become fish disease outbreaks.

- Introductions & Genetics: low risk
  - As *S.serrata* farming is totally dependent on wild seed supply, it is unlikely to pose significant threats to the local *S.serrata* population genetically.

- Wild Seed: medium risk
  - The farmers rely solely on seedlings from capturing *S.serrata* in mangrove forests since hatchery-based reproduction has still not reached high quantities.
  - Signs of *S.serrata* resource depletion was found, as both number and body size of *S.serrata* harvested have decreased in the last 15-20 years (Natan et al., 2021).
  - Based on the Minister of Fisheries and Maritime Affairs Regulation Number 16 (2022), harvesting of Scylla spp. crabs in spawning condition and under 12 cm carapace length is prohibited and must be carried out using fishing gear that is static or passive. Yet in reality many fishermen do not comply with these regulations (Hapsari et al., 2020).
  - Fishery improvement projects in selected areas are being carried out by Learning Center EAFM at Lambung Mangkurat University to evaluate the management status of mud crab fisheries using an ecosystem approach, and BBPBAP Jepara, is also engaging in various mud crab programmes including cultivation, hatchery, restocking and pond maintenance to push for a more sustainable mud crab fishery.

- Fish Welfare: medium risk
  - 60% of *S.serrata* soft-shell crabs shipment is delivered in frozen form. The remaining 40% shipment is delivered and marketed in an unknown manner, in which it is unclear if the products are delivered in frozen, live or fresh form (Hungria et al., 2017).
  - With crab cultivation in Indonesia crabs are generally maintained individually in separate floating boxes, thus mortality of crabs in soft-shell crab culture are less likely to occur due to cannibalism, but more often due to local transportation and rearing.

**Thailand**

Commercial soft-shell crab farming has long been practiced in Thailand, with *S. serrata* juveniles for stocking sourced mainly from the wild. Major soft-shell crab farms were located in the Ranong District of southern Thailand.

- Farm Siting: high risk
    - Most soft-shell crab ponds were converted from shrimp ponds that were close to mangrove forests in Ranong District (AWF, 2010). The newly established soft-shell crab farms may had inherited similar environmental risks posed by shrimp farms, including mangrove destruction and saltwater intrusion.

- Nutrient Pollution:
    - Not enough information available to assess this criterion

- Feed Source: high risk
    - Trash fish is used to feed *S.serrata* being reared in individual cages (AWF, 2010).
    - The sustainability of the trash fish fishery in Thailand is not evaluated, including the impact of coastal trawling with small mesh size to the ecosystem.

- Disease, Medicine, Chemicals:
    - Not enough information available to assess this criterion

- Introductions & Genetics: low risk
    - As *S.serrata* farming is totally dependent on wild seed supply, it is unlikely to pose significant threats to the local *S.serrata* population genetically.

- Wild Seed: medium risk
    - Although hatchery production has been achieved, large-scale adoption by private farmers is yet to occur (Allan & Fielder, 2003).
    - The high demand of juvenile crabs for soft-shell crab production had led to crab imports from other countries such as Myanmar and Cambodia (Nooseng, 2015).
    - Fisheries policy regarding wild seed protection was set up to prohibit any collection of ovigerous females in the wild from October to December (Nooseng, 2015), yet the enforcement efficiency is not reported.
    - Decrease trends of crab stocks and average size of stocks were already found back in early 1990s (Macintosh et al., 1993)
    - The female population in the wild has been reported as decreasing (Chakraborty et al., 2018) and the contribution of bigger sized crab grades (such as XXL, XL, L and FF1) have decreased remarkably compared with the contribution from the same grades 10 to 20 years back.
    - While there is lack of up to date relevant data for Thailand, general information had suggested that the wild population had been significantly depleted in means of both in abundance and size throughout the natural resources (Kosuge, 2001) due to an increased harvesting effort by the growing population, indiscrimination in harvesting, overexploitation and habitat loss

(Lewis et al., 2008), overfishing throughout their distribution (Shelley, 2016), overall environmental degradation and climate change as well.

- Fish Welfare: medium risk
    - All *S.serrata* is shipped and exported in frozen form to other countries (Hungria et al., 2017).
    - With crab cultivation in Thailand crab is generally maintained individually in separate floating boxes, therefore there is no mortality of crabs in soft-shell crab culture due to cannibalism. No mortality occurs during local transportation but in some cases, the quality of crab may decrease when there is long distance of travel between soft-shell crab farms and processing plants (Rahman, M. M., pers comms, 1 September, 2022).

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