**Food Provision**

Measures the sustainably harvested and produced seafood from fisheries catch and aquaculture (local production of seafood including shrimp ponds and fishponds).

**Wild Caught Fisheries**

This sub-goal describes the amount harvested and sustainability of Hawaiʻi's fisheries. The model generally compares landings with Maximum Sustainable Yield. A score of 100 means that the region is harvesting seafood in a sustainable manner.

Where *Fishery* is the pelagic, bottomfish, coastal pelagic, or nearshore, *SS* is the stock status scores, *C* is the catch.

The goal status score for each region in each year was calculated as average scores from each fishery calculated as the geometric mean of the all stock status scores for each fishery (pelagic: tuna, swordfish, mahimahi, etc.; bottomfish: deep seven species mainly groupers and snappers; coastal pelagics: jacks, akule, opelu, etc.; nearshore: surgeonfish, parrotfish, etc.). The model assesses the amount of wild-caught seafood that can be sustainably harvested, with sustainability (stock status scores) based on formal stock assessments. Each stock is assessed separately based on stock status scores (Biomass at maximum sustainable yield: B/Bmsy; Spawning biomass at maximum sustainable yield: SB/SBmsy; and Spawning Potential Ratio: SPR). We applied a 0.05 upper and lower buffer on the stock status score allowing for error in the stock status.

Stock status reference points typically used in formal stock assessments vary by the fishery type in Hawaiʻi. Pelagic fish sustainability reference point is SB/SBmsy set to 1.0. Bottomfish species sustainability reference point is B/BMSY set to 1.0. Reef fish sustainability reference point is the spawning potential ratio (SPR) set to 0.30. The most recent stock assessments for pelagic fish species were 2012-2013 for most species. The ten most recent years of stock assessment data was used to run a linear regression model to predict stock status to 2016. If stock status was non-linear then the mean stock status was used. The stock indicator for pelagic species was SB/SBmsy. Bottom fish stock assessments were for the aggregated species complex for the Hawaiʻi deep 7 and we used B/Bmsy as the stock indicator (Brodziak et al. 2014). Reef fish stock assessment used the spawning potential ratio (SPR) as the stock indicator and only one assessment is available (Nadon, 2017) so the stock status was held constant over the 5 assessment years. We used median scores for each group (pelagic, bottom, coastal pelagic, and reef) to gap fill for species that lack formal stock assessments. To include these important harvest species, we made the assumption that the unassessed species within each fishery (pelagic, bottomfish, nearshore/reef, coastal pelagic) are faring similarly to the assessed fish stocks. There were no current formal stock assessments for coastal pelagic species and therefore they are not incorporated into the score for this goal but are included in the catch data for reference, comprising 2% of commercial catch. However, it is important to note that the status of many of these species are tracked in the Artisanal Fishing Opportunities goal.

*Data Layers & References*

* Commercial (pelagic, bottomfish, coastal pelagic, reef) catch data (2012-2016, DLNR Division of Aquatic Resources)
* Non-commercial catch data (used as a multiplier for commercial catch data)
* Reef fish stock assessment: Nadon, M. O. 2017. Stock assessment of the coral reef fishes of Hawaii, 2016. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-60, 212 p. doi:10.7289/V5/TM-PIFSC-60.
* Bottomfish stock assessment: Brodziak, J., A Yau, J. O’Malley, A. Andrews, R. Humphreys, E. DeMartini, M. Pan, M. Parke, and E. Fletcher. 2014. Stock assessment update for the main Hawaiian Islands Deep 7 bottomfish complex through 2013 with projected annual catch limits through 2016. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-42, 61 p. doi:10.7289/V5T151M8
* Pelagic fish stock assessments can be found at: Western & Central Pacific Fisheries Commission (<https://www.wcpfc.int/)> and the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (http://isc.fra.go.jp) .

*Data Gaps*

* Bottom fish taxonomic resolution for the stock assessment.
* Public perception of fisheries.
* Catch from recreational fisheries is estimated. The number of recreational fishers and the recreation catch remains unknown.
* Non-reported commercial catch.
* Dealer reporting.
* Lacking stock assessments for many of the harvested fish species and all of the coastal pelagic species.
* Invertebrates are not included such as opihi (limpets), sea cucumbers, heʻe (octopus), lobster, and others. They were excluded from the assessment because there is not an estimate of recreational catch, which is thought to be a large proportion of the catch, and there are not stock assessments for most of these species.

**Mariculture**

This subgoal measures the sustainable production potential of seafood from fishponds, known locally as loko iʻa, and current production of seafood weighted by a sustainability score.

The value of aquaculture products ($39,970,000 in 2011 USD), natural products and seafood is ranked 4th in the state following seed crops, flowers and nursery products, and cattle (USDA Annual Statistics Bulletin 2011). However, revenue from mariculture is incorporated into Livelihoods and Economies goal.

The scores are an average of the state reported seafood production (aquaculture) and fishpond potential.

The species that are reported on the State Department of Land and Natural Resources Division of Aquatic Resources that are produced locally for seafood consumption include: Abalone (*Haliotus sp)*, oysters (*Crassostrea gigas* and *Crassostrea sikamea*), clams (*Venerupis philippinarum*), kahala (*Seriola dumerili*), Pacific White Shrimp (*Penaeus vannamei*), and limu (Gracilaria sp.). Moi (Pacific Threadfin) is not on the State of Hawaii Department of Agriculture list but it is produced locally for out planting in fishponds. The sustainability of the species produced was assessed as the average of the feed sustainability score (0 protein based, 1 plant based; 0 imported feed, 1 local feed) and the biosecurity risk scored as species status (1 native, 0.75 introduced, or 0 invasive) and the pathogen and virus susceptibility (0 highly susceptible, 0.5 susceptible but preventative measures in place (biosecurity practices such as sterilization and wastewater treatment practices).

The production (lbs of seafood) is reported at the state level to prevent disclosure of sensitive information. To get county level estimates of production the lbs of finfish and shellfish produced at the state level were multiplied by the estimated number of finfish and shellfish operators by county. The number of operators are reported to USDA via census every 5 years (2002, 2007, 2012) ([https://www.nass.usda.gov/Statistics\_by\_State/Hawaii/](https://www.nass.usda.gov/Statistics_by_State/Hawaii/Publications/Annual_Statistical_Bulletin/index.php) ). To fill in annual data gaps linear regression models were used.

*Data Layers & References*

* Mariculture species list: HawaiʻI Department of Agriculture (<http://hdoa.hawaii.gov/ai/aquaculture-and-livestock-support-services-branch/aquaculture-in-hawaii/)>.
* Invasive species list - BRIAN
* Mariculture yield: US DOA. 2015. Hawaiʻi Aquaculture Annual Release.
* Number of mariculture operators: USDA (<https://quickstats.nass.usda.gov/)>
* Fishponds: TNC updated fishpond layer 2017

*Data Gaps*

* Kapuna knowledge on fishpond historical locations, practices, and production.
* Public perceptions of farmed seafood.
* Unknown total lbs produced some years and some counties due to non-disclosure requirements.

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| --- | --- | --- | --- | --- | --- | --- |
| Cultured Species | Species Name | Sustainable Feed (0=imported) | Feed Plant Based (0=protein based) | Susceptibility to Disease (0=highly susceptible) | Native (1), Introduced (0.5), Invasive (0) | Sustainability Score |
| Abalone | *Haliotus refens, Haliotus discus hanai* | 1 | 1 | 1 | 0.5 | 0.88 |
| Broodstock and juvenile shrimp | *Litopenaeus. vanamei, L. monodon, L. stylirostris* | 0 | 0 | 0 | 0.5 | 0.13 |
| Kahala (amberjack) | *Seriola dumerili* | 0 | 0 | 1 | 1 | 0.50 |
| Marine shrimp for food | *Penaeus vannamei* | 0 | 0 | 0 | 0.5 | 0.13 |
| Microalgae | *Spirulina sp, Hematococcus sp* | 1 | 1 | 1 | 1 | 1.00 |
| Seaweed/Limu | *Gracilaria sp* | 1 | 1 | 1 | 0.5 | 0.88 |
| Seed clams | *Mercenaria mercenaria* | 1 | 1 | 1 | 0.5 | 0.88 |
| Seed oysters and clams | *Crassostrea gigas, Venerupis Philippinarum, Crassostrea Sikamea* | 1 | 1 | 1 | 0.5 | 0.88 |
| Tilapia | *Oreochromis* sp | 0 | 0 | 0 | 0 | 0.00 |