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Digital small-scale fisheries in Penang, Malaysia

Initial findings and progress

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Background

Small-scale fish production supports nutritious diets of over 3 billion people worldwide, yet very poor tools exist to track fish production from small-scale and artisanal contexts. The invisible contributions from this sector also leads to small-scale fisheries workers having very limited say in decision making about the blue economy. Small-scale fishers need evidence of their activities and contributions to empower their voices in the clamour of coastal development and resource exploitation. Over the past 2 years, WorldFish have designed, built and field-tested a data system for small-scale fisheries in Timor-Leste. To scale this system to different geographies and contexts, further research and innovation is needed. This project leveraged WorldFish digital and analytical expertise to conduct a rapid assessment of the extent and production of small-scale fisheries in Penang, Malaysia.

The resolution and amount of data generated on effort and fish production over time and space allow the leveraging of big data approaches, using artificial intelligence and machine learning to optimise management processes and mitigate the livelihood risks of heightened climate variability into the future. The traceability that these data brings added value in the potential to access new markets and opportunities. In turn, associated monitoring will improve spatial management of marine and inland waterscapes, optimise sustainable and economic fisheries yields, and streamline priority setting for public spending. Most crucially, previously unobtainable data on small-scale fish production can identify opportunities to increase the access and availability of highly nutrition fish to malnourished households, especially children.

In February 2019, WorldFish convened the MuSIC Workshop on "*Small-scale fisheries, food security and wholesome nutrition: Understanding, appreciating and interrogating the linkages*" in Penang. The objectives of the workshop were to create an alliance to support small-scale fisheries in Asia, to share research and policy formulations being undertaken in WorldFish, FAO/UN and national research institutions, and to increase two-way communication between WorldFish, FAO/UN and larger sections of civil society about improving livelihoods, food and nutrition security through small-scale fisheries. Following this workshop, WorldFish invited a small group of representatives from the Malaysian Fisheries Research Institute, Penang State Fisheries Department, Malaysian Inshore Fishermen Association for Education and Welfare (JARING), Penang Institute, and Sahabat Alam Malaysia to discuss small-scale fisheries in Malaysia. Of particular interest was some current WorldFish innovation from East Timor on digital monitoring systems for small-scale fisheries[1]. In October 2019, WorldFish was awarded a scale up prize for digital fisheries monitoring by the Inspire Challenge of the CGIAR's Big Data Platform. This funding was used to pilot vessel tracking and a participatory digital fisheries monitoring in Penang, Malaysia. Due to the COVID pandemic, meetings with fisher organisations and government to develop integrated fisher facing technology were not possible. This report summarizes the findings from the preliminary work undertaken in Penang and the data obtained.

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[1] Tilley, Alexander, Joctan Dos Reis Lopes, and Shaun P. Wilkinson. 2020. "PeskAAS: A near-Real-Time, Open-Source Monitoring and Analytics System for Small-Scale Fisheries." *PloS One* 15 (11): e0234760.

Pilot study results

We report data collected between 1ˢᵗ September 2019 and 31ˢᵗ August 2021. During this period, we recorded information from 2,751 fishing trips in Penang. The information about these trips was contributed by a total of 53 local fishers and is a combination of tracking and landings.

Up to 31 August 2021, WorldFish installed solar-powered GPS trackers sourced from Pelagic Data Systems Inc. in 24 boats at six key landing sites of Teluk Bahang, Balik Pulau, Sungai Keluang, Kampung Binjai, Kuala Mudah and Sungai Batu. Most of the trackers were installed in July or August 2020, but three of them were installed in September or November 2019 which allow us to get a better picture of their activity across 2020. Until 31 August 2021 these units tracked a total of 2671 trips.

In addition to the tracking data, we also collected landings data. Data collection was performed informally through a WhatsApp group set up with participating fishers. In total, we collected landings information for 188 trips by 35 fishers. Landings data is available between 01 September 2019 and 19 September 2020.

Three of the fishers that contributed landings data also had a tracker installed on their boats. Consequently we have both tracking and landing data for 108 trips. Most of the landing data, however, comes from the single most active fisher in the group. This fisher alone contributed landing data for 106 trips which corresponds to about 32% of all their fishing trips over the reporting period.

A VISUAL SAMPLE OF 2671 FISHING TRIPS IN PENANG
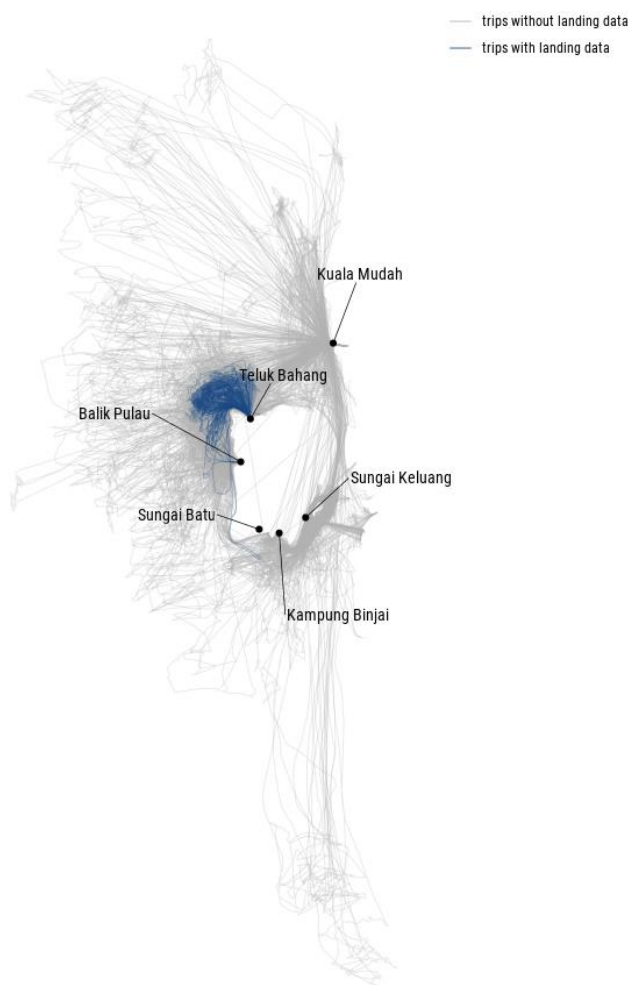
* Trips recorded between 01 September 2019 and 31 August 2021

Catch weight and income

We are interested in calculating the total catch from artisanal fisheries in Penang and the income it generates. We need four key components to perform these calculations. First, we need to estimate the expected catch weight from each trip. Second, we estimate the expected income that the catch provides to artisanal fishers. Third, we need to obtain an estimate of the vessel activity throughout the year. Fourth, we need an estimate of the number of fishers in Penang.

We use hierarchical Bayesian models as the framework to estimate these figures for four main reasons. First, Bayesian models perform particularly well with relatively small amount of data. Second, a hierarchical model allow us to minimise the biases that arise from unbalances in the contributed data; both across fishers and across time. Third, using models, instead of simple averages allow us to obtain estimates of the catch even for periods for which we have no comprehensive sampling. Lastly, and most importantly, a Bayesian framework allow us, not only to obtain an estimate of the numbers we are interested on, but also allow us to better understand the uncertainties involved in the calculation.
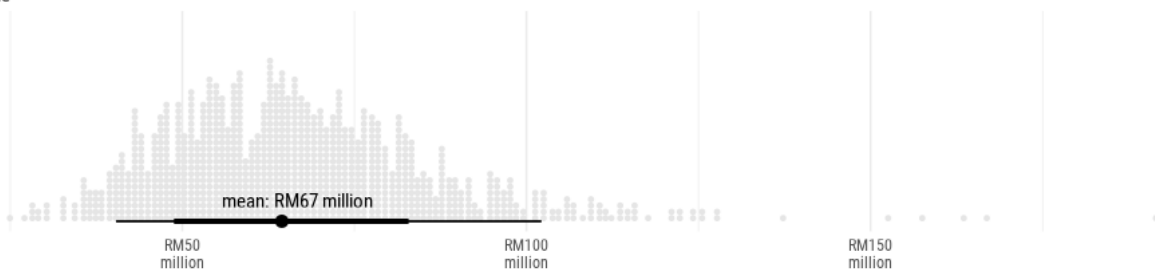
Expected trip catch weight

There was a lot of variability in the catch weight with some trips fishing as little as 0.4kg and some as much as 200kg. Nevertheless, using ten thousand Monte Carlo simulations in our Bayesian models, we found that the average catch was very likely between 10kg and 23kg (90% credible intervals, mean 15.7kg). The average catch showed important differences among fishers, with some consistently landing more catch by weight than the average. More data from a larger number of fishers will allow us to better understand what drives these differences.

ESTIMATED ANNUAL CATCH BY ARTISANAL FISHERS IN PENANG
Weight

mean: 3.8 thousand tonnes

5 thousand tonnes

10 thousand tonnes

Income

mean: RM67 million

RM50 million

RM100 million

RM150 million

* Each dot corresponds to a simulation in our model. Horizontal lines indicate the 66 and 90% credible intervals

Expected trip revenue

We found that each fishing trip was very likely to provide an income between RM170 and RM430 (mean RM283) to artisanal fishers. Similar as the catch weight, average income levels showed a large variation. Some trips returned with zero catch, while other trips provided as much as RM2013.

MONTHLY CATCH TOTALS BY ARTISANAL FISHERS IN PENANG

* Shaded areas indicate the 66 and 90% credible intervals
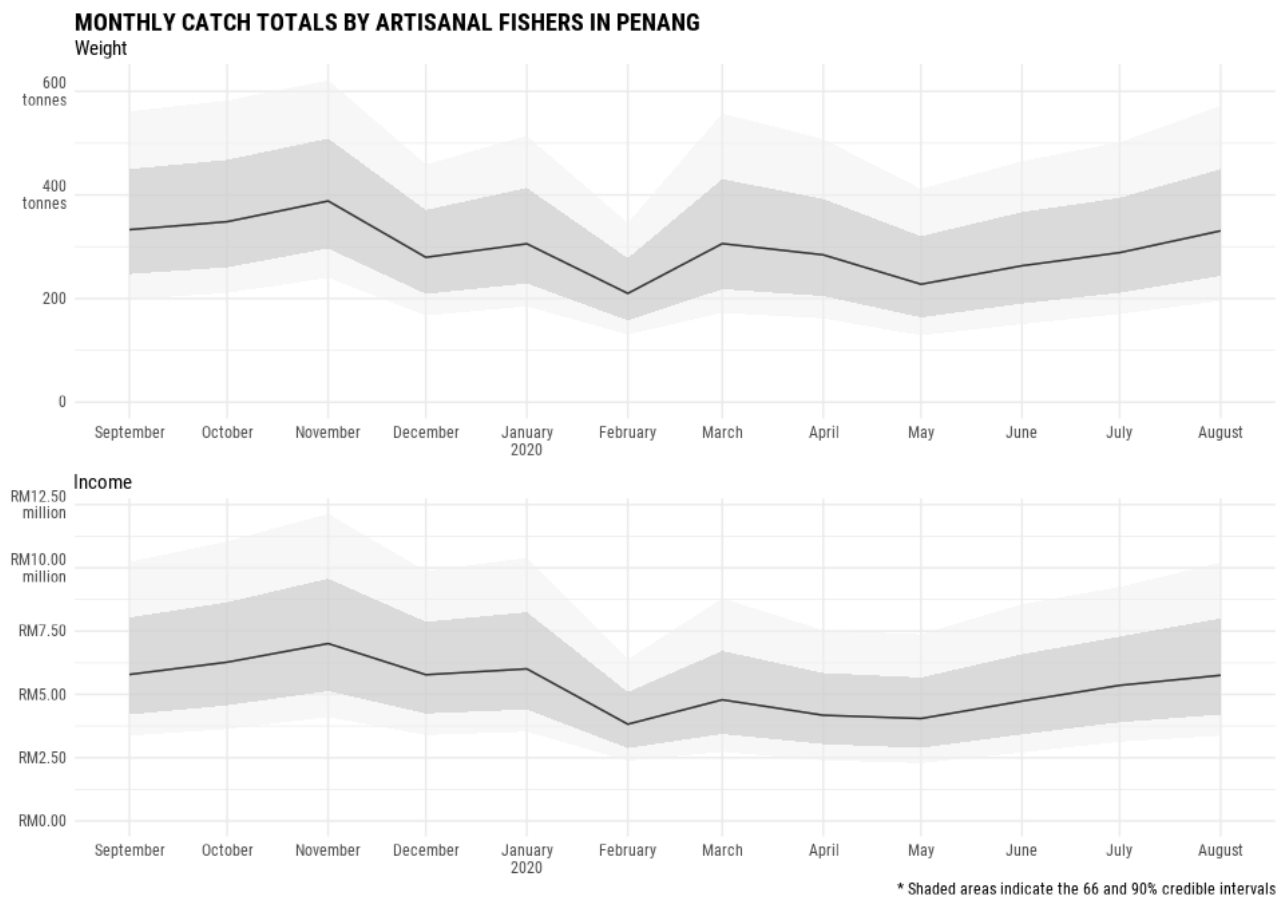
Vessel activity coefficient

The vessel activity coefficient is the value that represents how often fishers go fishing. We found that this coefficient was very likely to be between 0.28 and 0.44 (mean 0.36). Mathematically, this coefficient can be interpreted in two (equivalent) ways. When applied to a single boat, it can be interpreted as the probability that this boat would to a fishing trip on a given day. When applied to a group of boats, for example the Penang artisanal fishing fleet, it can be interpreted as the proportion of boats that can be expected to be going on a trip in a given day. Although some differences between fishers exist, the largest variations were across time. Vessel activity appeared to be less on Fridays and Sundays and in some particular weeks of the year, presumably in response to unsuitable weather events or popular religious festivals.

We obtained the information about Penang's fishing fleet based on the number of active and registered fishers. In 2018 there were 1,658 fishers registered. This number might differ from the number of fishers during the reporting period, but we expect the updated number to be within 50 fishers from the 2018 number. We incorporate this uncertainty in all estimates we present.

Because we only have landings information up until 19 September 2020, we present estimates for only the first year of our reporting period between 01 September 2019 and 31 August 2020.

Using all these pieces of information we estimate that for the period between the 1st September 2019 and 31st August 2020, **artisanal fishers were very likely (90% probability) to have caught between 2.3 and 5.7**
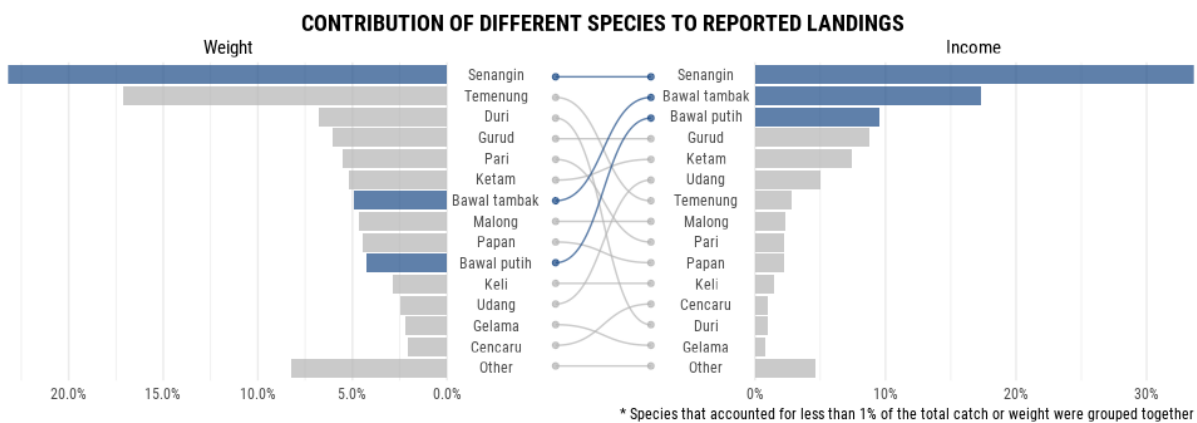
thousand tonnes in Penang waters. Based on current market prices from fishers, this represents a revenue of between RM40 and RM106 million to fishers and the local economy.

Although these wide ranges suggest a large uncertainty, it is actually a remarkable achievement considering the limited amount of data used to generate them. During the year we observe that the catch weight and income stayed within the credible intervals of our estimates.

A larger sample size, both for landings and tracking (which we use to determine vessel activity) will allow us to detect smaller variations across time and answer other questions to improve the management of the fisheries and improve the livelihoods of artisanal fishers.

Catch composition

We also looked at the catch composition in the trips where we recorded data. Detailed species composition analysis is hindered by a lack of identification of species. This will form part of the ongoing research. Although composition data is, so far, biased and should not be taken as indicative of Penang's catch, we can distinguish some interesting patterns in volume and income according to species and groups, where the most important species for small-scale fisheries livelihoods at present are threadfins, pomfrets, shrimp, crabs, grunts and mackerel.

CONTRIBUTION OF DIFFERENT SPECIES TO REPORTED LANDINGS

Weight	Income
Senangin	Senangin
Temenung	Bawal tambak
Duri	Bawal putih
Gurud	Gurud
Pari	Ketam
Ketam	Udang
Bawal tambak	Temenung
Malong	Malong
Papan	Pari
Bawal putih	Papan
Keli	Keli
Udang	Cencaru
Gelama	Duri
Cencaru	Gelama
Other	Other

* Species that accounted for less than 1% of the total catch or weight were grouped together

About WorldFish

WorldFish is an international, non-profit research organization that harnesses the potential of fisheries and aquaculture to reduce hunger and poverty. Globally, more than one billion poor people obtain most of their animal protein from fish and 800 million depend on fisheries and aquaculture for their livelihoods. WorldFish is a member of CGIAR, a global research partnership for a food-secure future.

For more information, please visit www.worldfishcenter.org