FISHACKATHON 2018
CHALLENGE STATEMENTS

A partnership of the U.S. Department of State and HackerNest.

Overview

Enforcement

1. There is a need for digitized worker registration on small-scale fishing vessels to help discourage worker exploitation and make labor/human rights enforcement more manageable and consistent. **Environmental Justice Foundation**

2. Language and literacy barriers get in the way of ship workers reporting problems to enforcement agents. There is need for something that helps workers communicate with officials/staff using universal visual or audio cues. **Environmental Justice Foundation**

3. A tool that helps make regions and species of fish that have high risks of illegal activities more visible to fish-buying company decision makers would help them either avoid or mitigate unsustainable purchases. **Stockholm Resilience Center**

4. There is need for a smart solution to make fishers aware of relevant laws and requirements that apply to the areas they work. This could likely be based on a vessel's location. **Sea Fisheries Protection Authority**

Marketplace

5. A low-cost "fish identification" tool would help minimize human errors, the need for expensive fish surveys on vessels, and allow smaller/poorly-funded fishers to better assess the nature/value of their catch. **USGS, ReelSonar, Inc.**

6. Small scale operators often lack the resources, technical knowledge, or research capabilities needed for them to qualify for sustainability certifications. How can we match them with academics/industry professionals who can help? **Marine Stewardship Council**

7. It's hard for fishers in less-developed regions to find information on buyer prices in the open market. A platform that allows fishers to report "received" prices and buyers to report "offered" prices in real time would optimize profitability and increase market transparency, leading to a more competitive, fairer marketplace. **Environmental Defense Fund**

Sustainability

8. Over 50% of fish consumed globally is "farmed" through aquaculture. The main "feed" used in aquaculture farming are the rapidly-declining populations of wild-caught fish, an unsustainable source due to issues like overfishing. Farmers (and our ecosystem) would benefit greatly from a tool that helps them identify and compare alternate feed options based on price, environmental impact, nutrient content, etc. **Forum for the Future, Kampachi Farms**

9. A way to identify, track, and/or monitor "ports" (areas with high vessel activity) would greatly improve supply chain transparency - for agencies, buyers, and suppliers - and help with the enforcement of environmental protection regulations. **Global Fishing Watch**

10. Protecting restricted fishing zones (e.g. marine reserves, remote areas) from illegal fishing is a huge challenge. A passive tool (maybe using sonar?) that helps identify fishing activity in restricted areas would help agencies monitor, track, and enforce laws more effectively. **University of Auckland Business School**

11. Inland freshwater areas are often overlooked when it comes to environmental monitoring. An open communication platform for freshwater 'users' to share real-time reports on environmental conditions and sightings (e.g. things like ice thickness and algal blooms) would provide data necessary to effectively navigate, manage, and protect these ecosystems. **American Fisheries Society**

1. Small-Scale Fisher Registration

Organization: Environmental Justice Foundation

Name: Dominic Thomson
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Challenge Statement:
Exploitative 'employers' often prey on unregistered, undocumented workers because:

- They are unknown to the authorities meaning they do not receive protections and are an 'invisible' workforce
- Employers can produce fake documents and change workers' identities as required
- Without official identification documents, workers are at the mercy of employers and can easily be abused or taken advantage of

Worker registration is a key component of increasing employer accountability and empowering workers in harsh working environments (e.g. fisheries). Registered workers can have more protection by regulatory authorities, can help authorities verify worker identities during inspections, can prevent employers from exploiting or redistributing workers if the authorities are alerted or suspicions are raised, and can enhance traceability in supply chains by linking catches to the actual fishers responsible for the fish landings.

Encouragingly, for many large-scale fisheries, worker registration is now a requirement. However, small-scale fishers – making up a considerable portion of the workforce in many fisheries – are often not included due to prohibitive costs. This can result in authorities not having accurate information on this important employment sector and can allow worker exploitation to continue due to this lack of critical identification and registration information.

Possible Solution:
The creation of a 'smart' universal worker registration database that could be tailored for individual countries. Workers could receive identification cards or electronic versions that are stored on smartphones. Built-in QR codes could be scanned by inspectors, employers, and subsequent elements of their supply chain. Potential elements to include:

- Identification card or electronic versions that would include basic worker information along with a photograph
- Built in QR code or barcode that could be scanned by relevant authorities or supply chain partners allowing easy identification and worker verification
- Simple worker registration code that could be sent via text message to utilise even the most basic telephone technology
- Cloud-based registered worker database that could be accessed by relevant stakeholders
- System could be able to perform data analysis to determine how many hours workers have worked per month – this information could be used to detect exceeding of working hours, and/or labour exploitation. The system could also input data on catches which could be used for traceability and also be used by individual workers so that they can see how their catches and performance have changed.

Resources:

- Sample identification cards and other commonly used forms of worker identification/documentation (http://hckrn.st/2AGHdnO)
- International Labour Office – Forced labour and trafficking in fisheries report (PDF: http://hckrn.st/2iFFrwj)
- Worker Identification card example information (http://hckrn.st/2jbb79Q)
- Training package on workplace risk assessment and management for small and medium-sized enterprises (http://hckrn.st/2kjbJgQ)
- Safety and health training manual for the commercial fishing industry in Thailand (http://hckrn.st/2zIJlHU)

2. Translation Services for Labor Inspections

Organization: Environmental Justice Foundation
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Email: dominic.thomson@ejfoundation.org

Challenge Statement:

Translation during labour inspections is an essential service to ensure that workers can communicate effectively with authorities, and that authorities can relay important information back to workers and ask accurate questions about living and working conditions.

The status quo relies heavily on employing translators in ports, factories, and patrol vessels. This can be very costly, stretching resources to their limit, especially in host countries with a wide range of migrant labourer populations. For example, a Thai fishing vessel might employ migrant labourers from Myanmar, Cambodia, and Laos, requiring three separate translators for an inspection.

Language translation apps exist, but due to limited demand for languages such as Burmese, Khmer, and Lao, the translation quality is not sufficient to be useful during inspections. Some workers may also have difficulty reading, meaning written surveys that they fill in themselves are unsuitable. An innovative solution is needed to address the translation capacity gaps that linger in many fishing industries around the world.

Possible Solution:

A versatile, intuitive, and secure service that can aid labour inspectors during vessel inspections, that could be loaded onto existing smartphone/tablet devices. Possible elements could include:

- Tablet or smartphone based application that could be downloaded to inspectors' devices to be used during inspections.
- Mainly visual/pictorial interface that workers could fill in themselves negating the need for the survey to be translated into different languages, and be accessible to workers who have difficulty reading.
- Solution that would allow workers to fill in the survey themselves so that they have a feeling of privacy without the need for interaction from inspectors. This could also allow multiple workers to fill out the survey at the same time on several devices, speeding up inspections and freeing up resources.
- Integration of video and audio elements that can quickly explain elements to workers.
- Incorporation of simple slider scales that workers could use to indicate their experiences.
- Real-time data analysis so that serious issues could be automatically flagged for further investigation without alerting the employer or vessel owner/operator.
- Alert system to notify inspectors about serious issues, and reminders to flag up previously identified issues at later inspections.

Data should be uploaded seamlessly to an online database which would store the data securely and could be analysed by labour inspectors at a later date. This would also digitize a predominantly paper-based inspection regime, allowing for better transparency and ability to analyse data.

Resources:

- Thai Ministry of Labour sample questionnaire (http://hckrn.st/2Bxwed7)
- EJF sample survey to determine living/working conditions for workers on-board fishing vessels (http://hckrn.st/2zZkhAC)
- Inspiration for visual logos/symbols (http://hckrn.st/2kicKG2)
- Training package on workplace risk assessment and management for small and medium-sized enterprises (http://hckrn.st/2kjbJgQ)
- Safety and health training manual for the commercial fishing industry in Thailand (http://hckrn.st/2zIJlHU)

3. IUU Fishing Risk-Assessment Tool

Organization: Stockholm Resilience Center, Stockholm University
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Challenge Statement:

IUU (illegal, unreported and unregulated) fishing and modern-day slavery are rampant within the fishing industry. Creating a tool for companies to use internally for risk assessment, where they could cross-check their production volumes and catch species with high risk regions where these activities are more likely to occur, would allow companies to to collect and synthesize data on the geographical occurrence of these activities, and hence work towards avoiding fishing and purchasing catch from these areas.

Possible Solution:

The idea is to develop a decision-making tool that allows a company representative to assess the risks associated with their activities (fishing, aquaculture and feeds production, sourcing of raw materials), particularly in relation to illegal fishing, modern slavery and related corruption risks. These are global risks, but tend to be concentrated around particular regions and/or in catching a particular fish stock.

Imagine the following reality for a transnational seafood corporation:
"We have a code of conduct for our own operations and for our suppliers (PDF: http://hckrn.st/2ACr6aJ). We source raw materials from 200 suppliers annually, which together provide 100 different species of fish from 50 countries. The value chains associated with these suppliers are long and complex. How do we ensure that we comply with our code of conduct and are prioritizing where, who and how we audit our suppliers? Is there a smart system of auditing that is based on risk – and is there a way to integrate and analyze different forms of risk?

More specifically:
I am evaluating if we should fish <species> in the <location> and wish to have information about the risks involved in doing so and whether or not we could do this in line with our commitments about illegal fishing and modern slavery.

If we do go forward with this decision, I wish to know what risks I am facing so we can design mitigation strategies to deal with those risks. Is this a region with a) high or low risk of IUU fishing, b) a region where there have recently been instances of human rights abuses, c) a region known for limited capacity among government agencies, or d) a region with widespread problems of corruption? I want a tool to be able to assess how large the risks are when I engage in trading suspect products.

I am considering working with <supplier> whose vessels have the following vessel numbers. Should I have any concerns about the operation of these vessels?

Resources:
There are two types of datasets that need to be meshed in order to achieve this outcome:

1. Risks datasets: there are datasets of the various 'bad' activities. This can include estimated levels of illegal fishing (http://hckrn.st/2zYcXoM), number of apprehended illegal vessels, recorded instances of human rights abuses (PDF: http://hckrn.st/2zZ3r56), indexes of corruption, and much more. Such data are not prepared on a standard basis and are not designed for use by individual decision makers. We are in the process of collecting and aggregating this type of data for use, but can for now provide one dataset for practice purposes (Google Sheet: http://hckrn.st/2jGy8Rv).
2. A second dataset including a list of species names and volumes sourced by a company (species name, catch location, volume caught, supplier name, vessel name, etc.) (http://hckrn.st/2AE8kjh). You can also check out the list of companies part of the Ocean Disclosure Project (http://hckrn.st/2iFNF7F).

What we wish to investigate is whether (or not - and if so how) these two datasets could be integrated together to support the decision maker. In plain language: "I have an excel sheet of all my purchases made during last year, how do I know which ones I should worry about? Is species X in region Y a problem? Is there a risk that I do not comply with my code of conduct?"

- There are scale issues to overcome in making this possible – that is, the risks dataset may be on a different scale than the operational datasets. Some mechanism by which this mismatch could be dealt with will be needed.
- Likewise, the datasets themselves are likely to be of a coarse/finer-grained nature and the extent to which different levels of detail can be accommodated in a decision tool would be a relevant consideration.
- Data quality in the risks dataset is likely to be variable. A way of evaluating the possible impact of different degrees of certainty in the datasets would be helpful – for example, we may wish to present users with some sense of the degrees of confidence in the output of the tool.
- The decisions that are being made by the users of any tool/tools may also want data at different levels of resolution from a strategic decision about a region or fisheries to operate in and/or to a specific supplier relationship. These different decisions might require different tools or nested tools.

Possible useful images:

- Anything off the keystone dialogues website (http://hckrn.st/2zYjPTi)
- Google searches like "modern slavery in fishing" to see examples of people being rescued

- Some front shots of articles that deal with these aspects, especially if they have great graphics

4. Easy-Access Regulations Database

Organization: Sea Fisheries Protection Authority
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Challenge Statement:

Fisheries laws are based on time and location, i.e. areas that can and cannot be fished between particular calendar dates, from open ocean areas into inshore bays and estuaries. A smart solution is required to allow fishers to access the relevant regulatory requirements for fishing in a given area, presented in text and graphically, to inform their actions. The solution should be based on the vessel-specific location and operate from oceanic fisheries to inshore waters, providing all the relevant rules that apply to each area.

Possible Solution:

Fishing vessels carry an array of multi-functional mapping tools onboard to indicate vessel location. Onboard mapping is generally done by way of GPS showing the vessel position against a standard mapping overlay, indicating vessel position against known geographic features or mapped seabed features, e.g. Porcupine Bank, etc.

The regulation of restricted areas within open ocean fishing regimes (Marine Protected Areas) should be set out spatially within the onboard mapping system, but the applicable prohibitions (i.e. what restrictions or requirements are imposed, such as increased reporting frequency) don't currently correspond with the map system. A visual overlay that is automatically generated or communicated by audio alerts upon crossing the external boundary of areas would be ideal.

For example, a specific area may be closed for "demersal trawling" (when large nets are pulled through the seabed to target bottom-dwelling species), but open for "Pelagic fishing" (fishing that is neither close to the seabed nor near the shore). It may not be clear to the fisher exactly what is restricted in a given area.

In inshore fisheries (generally within 0-6nm of the coast), while there are less restrictions due to the size of vessels operating in these waters and the lesser quality of their onboard electronic devices (if any), there are still areas that would be prohibited for specific gear and species.

Handheld/mobile devices would be the preferred instrument for something like this. Their geolocation features should be able to indicate the exact location of the handset unit within any restricted areas based on the gear onboard the vessel. Literacy issues may come into play, so the onboard system should have the ability to detail the restriction, and to have this verbally or visually communicated to the Captain in a pre-recorded message via the hand held unit, e.g. "You have crossed into an area currently restricted for netting of crayfish. Please ensure that you are not fishing using this gear in this area for this species." (The trigger for the message would be the geolocation of the onboard unit relative to the mapped closure area.) While the onboard unit would be primarily for fishers, it could also facilitate the regulatory agencies tasked to monitor and control the operations of fishing vessels actively fishing.

Resources:
- Global Fishing Watch data (http://hckrn.st/2jG2ELh)
- State of the world's fisheries and aquaculture report, FAO (http://hckrn.st/2jETq1X)
- Fisheries Catch Data & mMSY (http://hckrn.st/2j8u7FS)

5. Fish Identification

Organization: US Geological Survey National Climate Change and Wildlife Science Center; ReelSonar, Inc.
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Challenge Statement:
A key challenge in fisheries management is accurate identification of fish species. The current methods for identifying fish are time-consuming, expensive, and reliant on unreliable human expertise. While well-funded fisheries are able to hire specialized observers and conduct extensive population surveys, in most cases, these assessment methods are time- and cost-prohibitive. Additionally, technological advances have created a boom in the amount of angler-collected, or citizen-science, digital data in fisheries. The quality and accuracy of these data are often difficult to assess because there are no simple, automated ways to verify angler identifications of species.

Applying "facial recognition technology" to fish identification could more efficiently and effectively help identify fish. A tool or app that could do this would minimize the need for extensive, expensive fish surveys, reduce human error in identification, and allow poorly-funded fisheries better assessment options. Better assessments can lead to improved management and conservation strategies for economically and culturally important recreational and commercial fisheries.

Possible Solution:
To address this challenge, a standalone smartphone application (or feature that could be added to an existing application) could be developed with the following capabilities:
- Integrate with a phone camera to process a photo of a fish.
- Geo-tag the location of the fish.
- Limit the possible identification options to fish species present in the location of the photo.
- Use image recognition technology to identify a fish to family or species[1].
- Image recognition should work for all photos regardless of background or setting (i.e., should work with photos taken while fishing).

[1] It is not likely to achieve 100% identification accuracy to species level for all species; therefore, we expect the application to also provide family, genus, and species for all identified photographs. A successful application should have >80% identification accuracy to the family level.

- Provide a framework to interface with supplementary log features, such as length (See Fishackathon 2016 Problem Statement 4 - http://hckrn.st/2AknqtQ - and Fishing for Data - http://hckrn.st/2BsV4uC) and catch type.
- Output in various formats (SQL, JSON, etc.).

This application would likely be adopted by many regulatory and research agencies as well as the private sector to aid in the identification of fish species from citizen-science collected data. Ideally, this application would be flexible in implementation and allow for integration of other features.

Source database:
FishBase (http://hckrn.st/2jEZqrf), an open source global biodiversity information system on finfishes with 33,600 species, including species ranges, and 58,300 pictures. From this database:

- The pictures can be used to generate an image library to train the "recognition" feature of the tool.
- The species ranges can be used to limit the possible identifications to those species present at that location.

Test dataset:
The available test dataset of fish catch photographs is from ReelSonar Inc.'s NetFish mobile application (http://hckrn.st/2jEK860). This dataset is dominated by North American entries and includes 24,200 photos of catches. Each catch is geo-tagged with latitude/longitude as well as a timestamp. Furthermore, each catch includes a user (i.e., angler) defined species.

6. Technical Assistance to Aid Sustainability Practices/Accreditation

Organization: Marine Stewardship Council
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Challenge Statement:
Small scale operators often lack the resources, technical knowledge, and/or research capabilities needed for them to qualify for sustainability certifications (such as those from the Marine Stewardship Council[MSC]). They often need help with research, recommendations, and planning, but aren't connected with experts in the field. Meanwhile, experts, researchers, and PhD students around the world looking for ways to help make a real-world difference may not know where to start looking for opportunities to do so. A platform that could "matchmake" these two groups in happy partnerships could help foster ocean sustainability and fairness in the marketplace.

Possible Solution:
Researchers and fishers working together can lead to good outcomes in fishery management (http://hckrn.st/2zXcMdo). A platform that helps these two parties find and work with each other could contribute positively to global fishery sustainability. An app could match a fisher with a "research gap" with a researcher, and also enable messaging between them. Building those relationships could increase collaboration, knowledge-sharing, and efficiency in fishery management.

Fisheries included in the app could be those within a Fishery Improvement Project (FIP) (http://hckrn.st/2Amd9gD). A fishery in an FIP is in the process of bringing together multiple fishery stakeholders, fishers, managers, researchers, funders, and NGOs to improve a fishery's practices and management. In addition, fisheries and researchers could sign up to be part of the app database to find research collaborations.

I.e. A matchmaking app that matches fisheries and researchers.
Each researcher user makes a profile that includes a bio, references (if applicable), experience, research experience, and available time. Fishery bios would include information such as stock, vessels, geography, the research gaps they are looking to fill, and any other important information.

Just like a dating app, both parties could need to "OK" each other before making contact and messaging. This could reduce spam. Users could search by researcher specialty, geographic area, fish species, or gear type. The app could also guide fisheries to the fishery capacity-building tools offered by the MSC (http://hckrn.st/2BtKIdT). Fisheries could access these self-learning tools through the app and “level-up” based on the capacity-building units they complete.

Resources:

Fisheries

- A list of fisheries that are in the process of improving and may be looking for additional research to help them meet global best practice can be found on the Fishery Progress website (http://hckrn.st/2AQNcH6).
    - For a smaller set, use the comprehensive FIPs from this list.
- WWF also has a list of FIPs (http://hckrn.st/2zYh3xa).

Researchers

- Could there be a function where researchers, student researchers could sign up to be part of the app? People could add their names to the app from universities, research organisations and consultancies.
- Could Ecologists Without Borders (http://hckrn.st/2icdBE8) be interested?
- Could the Future of Fish (http://hckrn.st/2BH2yer) entrepreneurs be interested?

7. Crowd-Sourced Market Transparency

Organization: Environmental Defence Fund
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Challenge Statement:

It’s hard for fishers in less-developed regions to find information on buyer prices in the open market. A platform that allows fishers to report “received” prices and buyers to report “offered” prices in real time would optimize profitability and increase market transparency, leading to a more competitive, fairer marketplace.

Possible Solution:

A solution like this would help fishers from less-developed areas or smaller/poorly-managed fisheries to get accurate (and fair) market prices for their catches. The problem is that there is an “asymmetric flow” of information between fishers and seafood buyers. Fishers want to maximize their catch by selling it off as soon as possible (for freshness), which makes it difficult to spend time evaluating prices to choose buyers. Buyers want to buy catch as cheaply as possible while hiding their pricing information from fishers. This kind of bullying is easy in regions where fishers are not well-networked.

A solution could be a tool that lets fishers disclose and share buyer prices which would, over time, help stabilize the market price for various catches. Putting this information into the hands of fishers can help force buyers to offer fair/equal prices to them.

Rather than relying on static or time-lagged databases, we envision a mobile solution where fishers can self-report/share the “live” prices they received for their catch, increasing market transparency and allowing their peers to derive more value from their fishing businesses. The more fishers that participate, the easier it is to identify and optimize the market.

A secondary, but perhaps equally important, function would be to provide other seafood market stakeholders the ability to also contribute data – for example, by reporting prices for seafood at other points of the supply chain (e.g. in markets or at restaurants). This not only provides consumers with tangible and direct ways to support local fishers, it also increases the robustness of the database, allowing for higher resolution mapping of otherwise disconnected supply chains.

As an example, salmon canneries in many parts of Alaska now offer pretty much the same price to fishermen. They do this partly because fishermen have radios and communicate. Fishermen will even ‘strike’ when they don’t feel the minimum price has been set fairly.

Key challenges for developers to consider

- Functionality in both smart device (data/feature ‘rich’) and flip phone (data/feature ‘lite’) environments.
- Maximizing user (especially fisher) uptake through the bundling of customizable features – e.g. weather forecasts, nautical charts, distress calling, fuel prices, etc.
- The success of the tool is dependent upon good species identification and standardization:

- Fishers are likely to know the common names of the species they are catching/selling, so a feature that automatically populates scientific names (or a range of possible candidates) based on the entered common name would be especially useful (*see 'Cichlid' tab of attached spreadsheet*).
- Consumers may not know the common or scientific name of the fish that they are buying, so image recognition (of either whole fish or filets) may be a key feature for this subset of users (*note: this was a big focus of Fishackathon 2016*).

- Geo-tagging entries would improve data quality in a variety of ways, including:
    - Verification of fish identification by narrowing selections to geographically appropriate species.
    - Identifying geographically specific market trends.
    - Providing higher resolution catch data to fisheries managers.
    - Tracking end markets for different species.
- The greater degree of automation the better! Smart search and prepopulated lists will reduce the amount of manual text or numerical entry – and hopefully produce a higher quality end product.

Similar fisher data-gathering apps (for reference):

- EcoHub mFish (http://hckrn.st/2Aqit0q)
- Abalobi (http://hckrn.st/2Aq0CXE)

Resources:

- EDF Information List (Google Sheet: http://hckrn.st/2AqnlTm)

8. Aquaculture and Fish Feed Impacts

Organization: Forum for the Future / Kampachi Farms
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Challenge Statement:

Over 50% of fish consumed globally is "farmed" through aquaculture. The main "feed" used in aquaculture farming are the rapidly-declining populations of wild-caught fish, an unsustainable source due to issues like overfishing. Farmers (and our ecosystem) would benefit greatly from a tool that helps them identify and compare alternate feed options based on price, environmental impact, nutrient content, etc.

Possible Solution:

Design a tool/process that will give more visibility to the impacts of different fish feeds (maybe soya, fishmeal, algae, insects, etc.) for aquaculture farmers, customers, and fish feed suppliers. Something that combines information on different fish feeds available, their nutritional value, the type of fish they can feed (ex: carnivorous or not), locations where this type of feed is suitable, and possibly, nearby suppliers, would encourage farmers to make smarter, more sustainable fish feed purchases. In the long run, this incentivizes fish feed suppliers to work on creating more sustainable solutions.

Problem Background

Aquaculture is the most efficient source of animal protein production. All sectors of the industry (finfish, crustaceans, etc.) will need to rapidly expand sustainably to meet the protein demands of our growing global population. The one remaining constraint to the sustainable scale-up of many aquacultured species is their reliance on wild-sourced fishmeal and fish oil as feed ingredients. For example, fishermen use dragnets to maximize the catch of low grade 'trash' fish, which can be used as fishmeal (dragnets capture *everything* in their path). A staggering 20% of the total fish catch is used directly to make fishmeal or fish oil, instead of going to feeding people or other wild fish, for example.

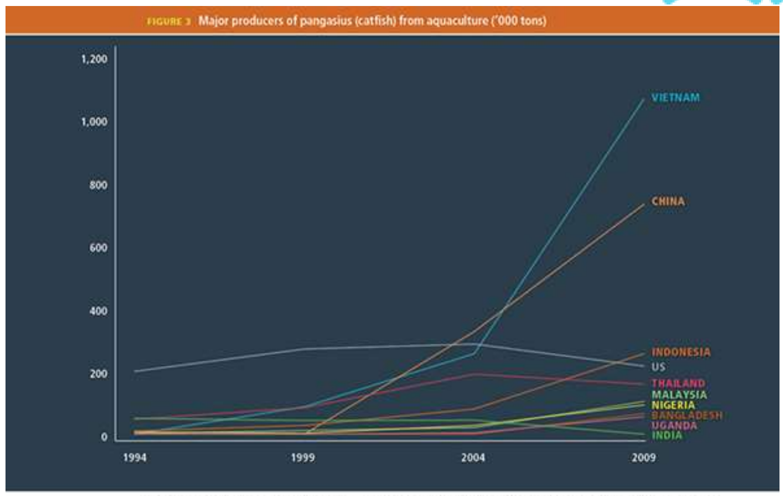
Many aquacultured species are carnivorous, requiring diets high in proteins and oils, which are most easily supplied through wild fishery ingredients. However, reliance on naturally limited wild fish stocks for fishmeal and fish oil is not only unsustainable but presents a bottleneck in growth of the aquaculture industry; alternatives must be found.

Technology for the production of alternative proteins is rapidly advancing, and it is now possible to formulate diets for many species which use these more sustainable alternatives to displace traditional fishmeal and fish oil ingredients.

Feed is the single most expensive component of any finfish culture operation (a reduction in feed cost is a reduction in the farmer's bottom line), and feed ingredients impact the environmental footprint of aquaculture operations. At the moment there is no visibility around the different environmental, nutritional, and cost impacts of different feed options for aquaculture.

This kind of solution would help fish farmers assess the different impacts of different fish feed types/ingredients on production and encourage them to make more sustainable feed choices for their aquaculture farms, ultimately helping to keep marine ecosystems healthy.

Aquaculture Facts & Data:



Source: Author calculations based on Food and Agriculture Organization of the United Nations, FIGIS—FishStat database (latest update: January 31, 2014), http://data.fao.org/ref/babf3346-ff2d-4e6c-9a40-ef6a50fcd422.html?version=1.0.

Regional Growth

Phenomenal growth of aquaculture production has occurred in Asia over the past 20 years, including the emerging economies of South and Southeast Asia. For example, countries like Thailand and Vietnam are global leaders in high-value aquaculture, supplying a significant share of global production for species like shrimp, tilapia, and pangasius (catfish) (see figure to the right).

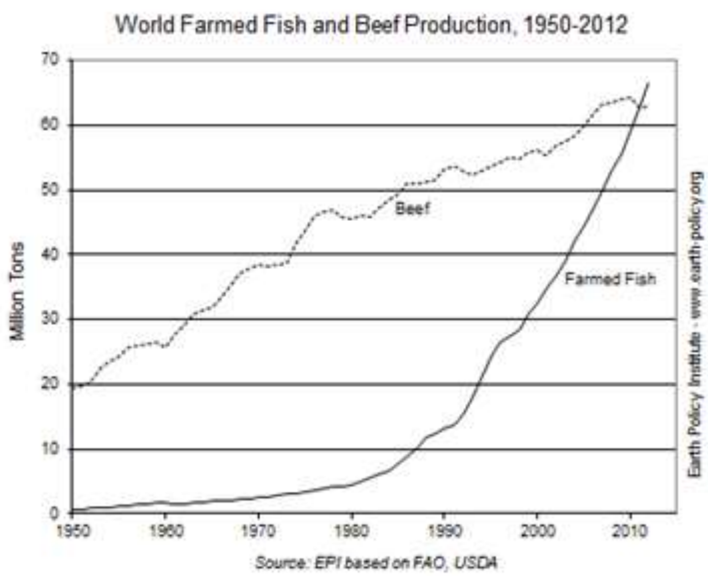
More than 80% of global aquaculture production is produced by small- to medium-scale enterprises heavily concentrated in Asia. The importance of fisheries to food security applies equally to small-scale aquaculture operations as well as to small-scale capture fisheries. In 2013, China alone produced 43.5 million tons of food fish (62% of global) and 13.5 million tons of aquatic algae.

India dominates farmed fish production in South Asia, the biggest share of which is carp production. Despite their low intensity and relatively low value in trade, carp remain a highly important source of food for fish-eating populations in both South and East Asia, and are important for food security in those regions. In Europe, aquaculture accounts for about 20% of fish production and directly employs some 80,000 people.

The U.S. ranks 15th in the world for aquaculture, behind much smaller economies like Egypt and Myanmar. Freshwater and marine aquaculture in the U.S. is worth $1 billion, compared to $100 billion globally. Approximately half of the seafood the U.S. imports is farmed.

Size and Scope

World aquaculture production continues to grow, but at a slowing rate, rising 5.8% from 2012 to 2013 (vs. 6.2% from 2000-2012, 9.5% from 1990-2000, and 10.8% from 1980-1990). In 2012, world aquaculture production attained another all-time high of 90.4 million tons (live weight equivalent) or $144.4 billion, including 66.6 million tons of food fish (valued at $137.7 billion) and 23.8 million tons of aquatic algae (mostly seaweeds, valued at $6.4 billion). For the first time in history, more fish for human consumption was farmed than wild-caught. Perhaps more astoundingly, global farmed fish production topped beef production for the first time in 2011 (see figure to the right).



The overall growth in aquaculture production remains relatively strong, owing mainly to the increasing demand for food fish among most producing countries. However, aquaculture output by some industrialized major producers has fallen in recent years, including the U.S., Spain, France, Italy, Japan and the Republic of Korea, due to the availability of fish imported from other countries where production costs are low (therefore increasing demand for farmed fish exports in said low-cost production countries).

Key Trends – Supply and Demand

- Given population growth and the nutritional needs of said population, the types of micronutrients found in fish-based proteins (e.g., omega-3 fatty acids), expanding urbanization, rising incomes in the developing world, the limits to expanding rangelands for livestock, and the ecological constraints to increasing wild-caught production, we will become more dependent on aquaculture in the future.
- According to the International Food Policy Research Institute (part of the Consultative Group on International Agriculture Research), aquaculture represents the next and perhaps even the last-remaining frontier of large-scale animal protein production
- Projected changes in per capita protein intake from fish show the greatest projected percentage increases are in South Asia (especially countries beside India, like Bangladesh) and China, with Southeast Asia increasing almost as much (in percentage) as North America, while Africa and Latin America show a significant decrease in per capita intake of protein from fish.
- Approximately half of the projected increase in aquaculture production (and thereby total fish production), is projected to take place in China alone, while all of Asia combined will comprise almost 90 percent of the growth in global fish production.
- A joint World Bank, FAO, and IFPRI report in 2014 estimated that in 2030, nearly two-thirds (62%) of the seafood we eat will be farm-raised to meet growing demand from regions such as Asia, where roughly 70% of fish will be consumed. The report also expects China to produce 37% of the world's fish and consume 38% of world's food fish.
- Global tilapia production is expected to almost double (from 4.3 million tons to 7.3 million tons a year) between 2010-2030.
- The region that possesses some of the greatest unexploited potential for future aquaculture growth is Africa. Significant levels of investments would be needed, in addition to successive years of sustained growth and mechanisms put in place, to meet the quality standards required for achieving the growth in exports needed to drive the future growth of the aquaculture sector in Africa (e.g., Egypt's development of exports of sea bream and sea bass significantly hindered by its inability to conform to the European market's phytosanitary standards).

Key impacts of aquaculture

- Depending on the production system used, key consequences associated with fish farming include waste and nutrient pollution, disease and parasites, excessive chemical use (e.g., antibiotics, pesticides), escapes and interbreeding/competition with wild species, additional pressure on wild-caught species for feed, and land conversion/degradation for feed.
- Infamous disease outbreaks in shrimp aquaculture in China, Thailand, and Vietnam and in salmon farming in Chile represent some of the industry's biggest challenges.
- Waste of feed and fish (smaller species are consumed whole, whereas larger species' bones and heads are often wasted) are two major impacts. However, compared to other animal proteins, fish have the best feed conversion ratio (FCR) which converts feed to weight; for fish, it's about 1:1 whereas for beef, it's about 7:1
- Numerous studies have shown that the food security of households engaged in small-scale aquaculture is enhanced through the cash generated, as well as from the increased availability of fish products for their consumption. This has been observed from Bangladesh and India to places in Africa south of the Sahara (like Malawi), where small-scale aquaculture has been taken up by local communities.

Issues to Consider in This Challenge

The following notes to challenge designers should be used as a guide only:

- An example of such a tool could be used by farmers, customers and others looking at the impacts of different fish feeds.
- Part of the challenge is that there is no traceability and transparency around the relative impacts of different fish feeds. We know soya and fishmeal based feed systems have a high environmental impact, and that we need to look at less damaging forms of fish feed (algae/insects etc.). We need to give visibility to farmers and customers so they start put pressure on fish meal suppliers to act.
- You may want to consider a wide variety of criteria around any tool. There will be a whole host of potential environmental criteria (land use, GHG emissions, etc.) but you may want to consider other criteria such as cost of different feedstocks (a big consideration for fish farmers) or health/nutritional impacts of different feeds.
- Access to data sets here will be key. Data should be publically available. You will need to consider how you present this data (e.g. an impact score for each aquaculture crop assessed) and if it should be coupled with a strategy to promote such tools/encourage its use, and whether a tool in itself will be enough to provide transparency around the impacts of different feedstocks.

9. Identifying Ports

Organization: Global Fishing Watch
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Challenge Statement:
A way to identify, track, and/or monitor "ports" (areas with high vessel activity) would greatly improve supply chain transparency - for agencies, buyers, and suppliers - and help with the enforcement of environmental protection regulations.

As many as one out of every five fish caught is IUU -- caught via Illegal, Unreported, or Unregulated practices. This lack of transparency and regulation leads to overfishing and poor management of the global fish stock. Tracking technologies such as Automatic Identification Systems (AIS) and Vessel Monitoring Systems (VMS) allow us to track the majority of the world's large industrial fishing vessels, and identify where they are fishing and where they land their catch.

Unfortunately, determining where vessels land their catch requires a good ports database, and no such global database exists. Ports are considered areas of high activity, such as fishing locations, resting spots, physical locations at shore where vessels land their catch, or areas where vessels go to get out of the wind. Anchorages are individual spots where vessels stop traveling, be it to fish, offload or trade catch, turn around, etc. Global Fishing Watch is developing a free and open database that will fill this gap for researchers, NGOs, and fisheries managers, which includes the locations of everywhere that at least 20 AIS-transmitting vessels have anchored for longer than 48 hours, but it lacks critical information such as the real names of the ports, and the infrastructure or various other characteristics of the ports. Completing this database, and identifying different types of ports based on which vessels visit them, increases transparency in the international fishing industry.

Possible Solution:

The solution to this problem could be to take the anchorages database that GFW has created, and build a program that clusters these anchorages into "ports," based on location, distance, visiting vessel types, potential infrastructure, vessel activities, and attaches correct names to them so that stakeholders can properly track vessels and their activities.

Creating a ports database would help to increase supply chain transparency and traceability. It would allow multiple stakeholders (like enforcement, transparency agencies, and fish purchasers) to identify vessel activity in specific areas, such as which anchorage they visit within a port, if there is infrastructure within that port, and what possible activities vessels could be engaging in. Currently, countries may have some physical ports listed, however clustering of these anchorages into ports has so far been a guessing game, and one that differs around the world. What is the best way to cluster this info? What are the different variables that could be considered (distance, proximity to each other, physical location, infrastructure, at sea vs. on land, types of vessels, etc.)?

Possible tasks include:

- Determining the real names of the anchorages. Should we use a nearby town name? Is it possible to crowdsource the naming of these ports by overlaying them on maps and producing a tool for people to label them?
- Based on which types of vessels visit the port/anchorage, classify ports/anchorages as:
  - Important for fishing.
  - Important for foreign fishing fleets (vessels flagged to a different country than where they land).
  - Important for transshipment vessels (vessels that rendez-vous with fishing vessels at sea and offload the catch -- this practice, known as transshipment, can obscure the supply chain of fish, and has historically been associated with IUU fishing).
  - Ports with actual infrastructure, and which ones are simply anchorages (for instance, some might be major ports, while others will be small coves where vessels might wait out a storm).
  - Many to one relationship between anchorages and ports (clustering many anchorages into a single labeled port).
- Visualizations of the classified ports data, which could potentially be incorporated back into Global Fishing Watch's public portal.
- Tools for crowd-sourcing this solution, including using publicly available databases, satellite imagery to aid in classification and naming.

A solution like this could help enforcement and transparency agencies, and buyers and suppliers with a vested interest in supply chain transparency. It could also potentially help fishers figure out what port they can visit based on the activity they want to accomplish (i.e. "where can I escape this wind" or "is there a place nearby with lots of salmon being caught?").

Resources:

- Global Fishing Watch's draft database of anchorages (http://hckrn.st/2iFPnpH), developed from four years of AIS data (2012-2016)
- World Port Index (note that this does not include all ports, and we also find that they are often in the wrong place, which is why we are developing our own database instead of using this one) (http://hckrn.st/2khEKcW)
- Geonames City Database (Pop. > 1000) (http://hckrn.st/2ADDrvh)
- Sentinel-1 imagery

10. Passive IUU Detection Device

Organization: University of Auckland Business School
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Challenge Statement:

Protecting restricted fishing zones (e.g. marine reserves, remote areas) from illegal fishing is a huge challenge. A passive tool (maybe using sonar?) that helps identify fishing activity in restricted areas would help agencies monitor, track, and enforce laws more effectively.

Possible Solution:

There are satellite means to provide additional data (Eyes on the Sea, Global Fishing Watch) but they depend on the fishers' cooperation because the tool that tracks AIS (automatic identification system) data can be spoofed by fishers. For example, fishing vessels can turn off their AIS transponder, feed it false position data, or switch AIS MMSI identity codes (Maritime Mobile Service Identity, which is a series of nine digits that are sent in digital form over a radio frequency channel in order to uniquely identify ships) between fishing vessel and factory ship when the two meet to transfer catch. Most commercial satellites don't have cameras to confirm that the identity code matches the vessel, or that the vessel is where it says it is. Even the best commercial satellite cameras cannot see whether a vessel is trailing nets or fishing lines.

The best independent data sources are fishery enforcement vessels operated by national governments. They can observe fishing activity and check whether it is legal, and can board vessels to enforce rules. However, keeping an enforcement vessel at sea is very expensive (>$1,000 USD/day for a Pacific Patrol Boat) and an enforcement vessel's crew can only detect fishing activity visually for a few kilometers around them during daylight. Aircrafts are also used to detect fishing, with increased visibility. An Australian maritime patrol aircraft costs around $18,000 USD per hour to operate, which makes this option inaccessible for most.

A network of unobtrusive, inexpensive, passive floating devices could be used to detect fishing activity in restricted/hard to monitor zones. They could "listen" to sounds in the water near them, and classify the sounds as being fishing activity or not. Fishing activity usually generates sounds up to 1 kHz, and includes both engine noises and intermittent winch sounds. Sound travels very far in the ocean. The sound of a fishing vessel's engine halves in intensity (3 dB) over around 50 km of open ocean, so a passive device could help police a large area. They could be moored at points of interest (such as Marine Protected Areas) or floating in predictable ocean currents. They would alert fishery managers to fishing activity, who could cross-reference this classification with all other available data, and dispatch an enforcement vessel if appropriate.

Teams could create a device that runs software on a battery powered microcomputer or microcontroller that detects the pattern of frequencies that characterize a fishing vessel and the different types of activities it engages in over time (i.e. actively fishing, netting, just passing through). It needs to record evidence that supports it having heard fishing activity.

Making the device waterproof is critical. Household shops sell glass or plastic food containers with waterproof seals of rubber or soft plastic. Don't worry if physical prototypes are not robust, made of plastic, or not ocean-worthy. The real challenge is to develop software for very low power devices to recognize sound patterns underwater.

A piezo disk is one useful microphone for listening in water. Piezo disks are used for guitar pickups, contact microphones, and also found in novelty devices that make sound as well as in electronics stores. A subsidiary challenge for a large technical team is to develop a protocol by which devices can create an ad hoc mesh network between themselves, to communicate a contact which may be fishing.

This would allow:

- multiple devices to share expensive resources such as satellite up-links
- multiple devices hearing the same contact to locate the contact precisely

The protocol should maximize the range that can be achieved between devices, and use the least costly hardware possible. You can assume that each device has a GPS receiver and can thus pass its position, exact time and the exact time span of the contact, on to others.

Resources:

- Abileah 1996 Monitoring high-seas fisheries with Long-range Passive Acoustic Sensors (http://hckrn.st/2j8vdkY)
- Sorensen 2010 Passive Acoustic Sensing for Detection of Small Vessels (http://hckrn.st/2zYc4wD)
- Ogden 2011 Extraction of Small Boat Harmonic Signatures from Passive Sonar (http://hckrn.st/2zYc7Zl)
- Erbe+2011+ Underwater Acoustics Pocket Handbook 3rd Edition (http://hckrn.st/2j8ecri)
- Sound samples:
    - http://hckrn.st/2AqNilO
    - http://hckrn.st/2iFnaPF

11. Freshwater Monitoring and Communication

Organization: American Fisheries Society
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Challenge Statement:

Inland freshwater areas are often overlooked when it comes to environmental monitoring. An open communication platform for freshwater 'users' to share real-time reports on environmental conditions and sightings (e.g. things like ice thickness and algal blooms) would provide data necessary to effectively navigate, manage, and protect these ecosystems.

In the U.S., limited regional or state-level monitoring of water occurs. When it does, it's often only chemical water quality or quantity that are monitored as these are easiest to measure. Monitoring is inadequate in most states due to limited funding and lack of infrastructure. Furthermore, many conditions that affect aquatic health, fishing quality, and environmental quality are difficult or impossible to measure. Some conditions that are short-lived which may be missed by typical monitoring efforts may be highly visible to anglers (for example, algal blooms). Other conditions, such as invasions of new species, are also hard to detect and, without the assistance of anglers, could go unnoticed and unmanaged for years.

An open communication platform for freshwater users to report hazardous conditions/sightings (i.e. like algal blooms, ice thickness, fish kills, etc.) with each other and resource managers (those in charge of managing/monitoring natural resources) could provide data critical to effectively managing freshwater ecosystems. In the U.S., this platform could help both recreational and commercial anglers who wanted to take advantage of real-time reporting of freshwater conditions, drastically improving resource managers' ability to respond to real-time condition changes. Similarly, places with extensive subsistence fishing would benefit from the ability to track environmental conditions that could affect public health or resource health, enabling resource managers to address issues such as algal blooms immediately and efficiently. For example, faster response time to fish kills could reveal chemical spills, and faster response time to algae blooms could reveal toxicity that prevents safe swimming. Angler reporting of invasive species could help contain new invasions and improve angler awareness of infected waters.

Unfortunately, many measures of current environmental conditions are 1) short-lived enough to be missed in standard agency monitoring, 2) difficult to "measure" (e.g. we do not have monitoring sondes - water quality logging systems - that measure ice thickness or algae mat thickness) though easy for an individual to observe, and 3) frequently changing. Resource managers (e.g. the state Department of Natural Resources) lack the bandwidth to continually monitor and measure these changing conditions even though the information would be very useful for anglers and others engaging in freshwater recreational activities.

Possible Solution:

An easy-to-use, easy-to-share application for anglers and other members of the public that records a variety of user-submitted environmental conditions and displays them spatially for users would help tremendously in protecting freshwater ecosystems. The creation of this application in a manner which can be easily adopted by a resource agency would help them keep track of conditions and quickly and effectively respond to issues that arise. They could also provide their own spatial layers (e.g. a "lakes" polygon layer).

The following capabilities should be considered:

- Connection of user's location to specific waterbody (probably a lake, but could be a river/stream)
- Ability to report a variety of conditions, events, and sightings that are otherwise difficult to monitor, including/not limited to:
  - Environmental conditions
    - Presence/absence of algae blooms, surface scum, trash, oil or other visible pollution, smells
    - Wind, wave action, water temperature
    - Ice thickness, quality, distance/disconnection from shore
    - Physical condition of boat ramps, docks, bathrooms; whether bathrooms are available or open
  - Biological conditions
    - Presence of a fish kill, including scope, species involved, and other comments
    - Presence and photo documentation of fish with deformities, disease, or injuries
    - Presence and photo documentation of fish with marks or identification tags
    - Presence and photo documentation of invasive fish, plants, or invertebrates (including but not limited to Asian carp, common carp, yellow bass, white perch, gizzard shad, goldfish, zebra mussels, quagga mussels, curlyleaf pondweed, brittle naiad, hydrilla, this list is unending and differs across the country)
  - Social conditions
    - The number of anglers and/or other boats were observed that day
    - How crowded the location is, on a scale of 1 to 10
    - How crowded the boat ramp is, on a scale of 1 to 10
    - Occurrence of poaching or illegal activity
- Ability to view a map of all reported conditions, with filters for each condition's visibility to be turned on and off
- Ability to store information locally and sync when possible (cellular service at lakes is often poor or unstable)
- Ability to subscribe to notifications when conditions at a specific location change

Deployment of this application would likely be accomplished by individual resource management agencies, which means they would need to be able to customize the conditions they monitor, to select measurement units for items such as ice thickness, to access and archive form submissions online, to remove outdated information, to receive poaching reports, and to define species to be included in various lists (e.g. invasive species). These customized applications could be released by management agencies as unique, downloadable, ecosystem-specific apps for anglers and others to use.

Resources:

- Official U.S. location names based on the National Hydrography Dataset (http://hckrn.st/2Bt0Mws)
- Example of a commercial app doing it for endangered species in partnership with US Fish & Wildlife (http://hckrn.st/2kihYSa)

Additional Resources

1. Landing Data: Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse (http://hckrn.st/2j99qcS)
2. Species, names, pictures, etc.: FishBase (http://hckrn.st/2AP8Uet)
3. Ecological data repositories: National Center for Ecological Analysis and Synthesis (NCEAS) (http://hckrn.st/2zXeStM)
4. Knowledge Network for Biocomplexity: KNB (http://hckrn.st/2ia8hRB)
5. DataONE: Data Observation Network for Earth (http://hckrn.st/2BsVv8s)
6. Long Term Ecological Research Network: LTER Network (http://hckrn.st/2iC5e8B)
7. Maritime data: SPIRE (http://hckrn.st/2kfZulj)
8. Fishing vessel database: Western and Central Pacific Fisheries Commission (http://hckrn.st/2APGiSn)
9. NOAA Fisheries: Service Permit Offices (http://hckrn.st/2j97hhq)
10. NOAA Fisheries: U.S. Fishing Vessel Documentation Search by name (http://hckrn.st/2AEU5dX)
11. NOAA Fisheries: Vessel Finder (http://hckrn.st/2AEU5dX)
12. FFA (Forum Fisheries Agency): Vessel Register (http://hckrn.st/2zYifRa)
13. IATTC (Inter-American Tropical Tuna Commission): Vessel Register (http://hckrn.st/2Bu31jo)
14. Marine Traffic: AIS Ship Tracking (http://hckrn.st/2zYnxfG)
15. Vessel Finder App: Vessel Finder (http://hckrn.st/2jFGtoo)
16. IHS Fairplay: Vessel Data Fields and Definitions (http://hckrn.st/2npcQNh)
17. U.S. Coast Guard Maritime Information Exchange: Vessel Search (http://hckrn.st/2zZ6NFe)
18. Example of a state commercial fishing vessel database (http://hckrn.st/2kihN9r)
19. Google search vessel name, MMSI, or IMO number, Google Images of vessel (construction)
20. FleetMon: Vessel Finder (http://hckrn.st/2jELnCc)
21. European Commission: Fishing Fleet Register (http://hckrn.st/2j8gWoA)
22. FAO: Fishing Vessel Finder (http://hckrn.st/2AFnN2D)
23. National Information Exchange Model: NIEM (http://hckrn.st/2Ankeha)
24. Vessel photos, locations, activity: ShipSpotting (http://hckrn.st/2zZxvx6)
25. Vessel safety information: Equasis (http://hckrn.st/2AQnoLl)
26. ISSF: Proactive Vessel Register (http://hckrn.st/2i9m22W)
27. Combined IUU Vessel List (http://hckrn.st/2jH3O9k)
28. Consolidated List of Authorized Tuna Vessels (http://hckrn.st/2BGXMOj)
29. Liberia Industrial Vessel License List (http://hckrn.st/2kirzbN)
30. Greenpeace International Blacklist (http://hckrn.st/2BDkwOR)
31. CCAMLR (The Convention on the Conservation of Antarctic Marine Living Resources) Licensed Vessels (http://hckrn.st/2i9m8rk)
32. IOTC (Indian Ocean Tuna Commission) Authorized Vessel List (http://hckrn.st/2zWdckb)
33. ICCAT (International Commission for the Conservation of Atlantic Tuna) Record of Vessels (http://hckrn.st/2jHFR1M)
34. SPRFMO (South Pacific Regional Fisheries Management Organization) Authorized Vessel List (http://hckrn.st/2BERi2c)
35. CCSBT (Commission for the Conservation of Southern Bluefin Tuna) Record of Authorized Vessels (http://hckrn.st/2jHll0X)
36. FishStatJ resources (marine and inland capture fishery production; aquaculture production; global population) (http://hckrn.st/2iG5ROe)
37. FAOSTAT (http://hckrn.st/2zGWFMX) (look at the 801mb bulk download to get the entire dataset), you can get an idea of the sort of data available here: http://hckrn.st/2AFuvFG (comprehensive agriculture indicators)
38. AQUASTAT regarding freshwater resources and their use in agriculture (http://hckrn.st/2j9HaGY)
39. FAO InFoods databases (nutrient composition of various foods) (http://hckrn.st/2khwA4g)
40. General Earth Data: Planet OS (http://hckrn.st/2BAu4Kx)