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Towards a Global Record of Stocks and Fisheries Benefits and role for FIRMS
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This document briefly describes the rational for the development of a Global Record of stocks and fisheries, which would build on a global unique identifiers protocol, the central role which FIRMS would play in this endeavour, and the benefits to FIRMS and to the global users community.

It is suggested that a FIRMS TWG could be convoked for examining the matter and discussing the requirements.

FAO expects to encourage participation of FIRMS partners; the FIRMS Steering Committee is invited to evaluate such proposal and provide guidance including type of contributions for those partners interested to join the project.

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1. WHY a global record of stocks and fisheries

FIRMS was launched with various objectives: foster reporting on the status and trends of individual stocks and fisheries at regional and national levels; provide general public with authoritative information on status and trends; support regional and global reviews in their regular updates of the status of fishery resources, in ways that enable to track the provenance of source statements.

Critical to these objectives, two major tasks were tackled by FIRMS:

Expanding data coverage:

Along 10 years of development, FIRMS had a relative success in expanding its geographic coverage. The partnership includes 14 intergovernmental organizations which together represent 17 RFBs. The Atlantic Ocean and Indian Ocean are quite well covered, while the Pacific Ocean is poorly covered in FIRMS. Developing regions such as Africa are well covered, and the Caribbean and Bay of Bengal will receive specific attention in the coming two years. FIRMS has Instead poor coverage in areas with no RFBs, and this includes EEZ waters of South America, North America, Australia and New Zealand, South East Asia, Asia (Japan, China, Korea, Russia).

With the above described geographic coverage, FIRMS contains a published inventory of 1082 stocks and 322 fisheries. Status reports exist for about 600 stocks and 200 fisheries.

Beyond the RFB membership which was meant to set the foundations of such reporting mechanism, the long standing question on the FIRMS agenda has been how to expand the reporting coverage to areas beyond RFB competences. In this respect, FIRMS identified the hypothetical NatFIRMS which would constitute a vehicle towards more comprehensive coverage by including national fisheries. NatFIRMS would be set-up as a separate framework albeit with close interactions with FIRMS. NatFIRMS information could be accessed and disseminated through e.g. FAO's FACP programme: links to countries with relevant resources and fisheries information would be listed. From the FIRMS website, an access to NatFIRMS information should be granted following an informational hierarchical process by which users are suggested to further link to NatFIRMS only as second search iteration, after getting a first chance to review FIRMS information.

Here it is worth to introduce University of Washington's Ramm Legacy Stock Assessment database, a development of Ransom A. Myer's Stock-Recruitment Database (Myers et al. 1995). RAM provides a database for stock assessment results for commercially harvested fish stocks around the world from 21 national and international management agencies for a total of 331 stocks, including nine of the world's ten largest fisheries. These are distributed across 27 large marine ecosystems in the Atlantic, Pacific, Indian, Arctic and Antarctic Oceans (Ricard et al. 2012). The database provides data (e.g. catch time series) and assessment results (including biomass, recruits and fishing mortality time series, life history information as well as biological reference points) for data-rich stocks that are assessed regularly.

A quick overview the RAM legacy database tells that it is in great part producing complementary information, both in the content of fact sheets and in terms of geographic coverage (e.g. includes also reporting of 21 national agencies).

FIN's FishBase database can finally be mentioned as another global source and interest's group for stock status.

Responding to target users' needs:

FSC7 and FSC8 acknowledged target users, and related information products:

1. RFBs and their member states: concerns mostly FIRMS partner RFBs.
2. Governmental fisheries agencies: concerns mostly states involved in producing FIRMS fisheries status reports through RFBs.
3. Global or Regional marine science networks in support to state of the environment and ecosystem: concerns FAO, and other UN agencies and processes such as LMEs.
4. INGOs and NGOs influencing seafood consumers and industry on sustainable fisheries, e.g. OceanTrust, or Sustainable Fisheries Partnerships: both presented their interest in FIRMS information at past FSC meetings

While the first categories of users are reasonably well served with today's FIRMS information products, the last two are still poorly served because of insufficient data coverage, and for the last one inadequacy of the status reports presentation formats in respect of the clients expectations.

In regards of target audience 3, it is recalled that FIRMS RFB partners have responded to the need to more systematically fulfil FAO's global monitoring mandate on the status of stocks and fisheries. FIRMS partners expect that their reporting investment contribute to such objective.

The expectations of target audience 4 were conveyed to FSC7 and FSC8:

At FSC7, Ocean Trust (Mr. Thor Lassen) indicated that they were interested by FIRMS as a reliable source of information on both resources status and fisheries management, while pointing on the need to have more information in the resource or fishery sheets in relation to sustainability. Ocean Trust is a US based NGO focussing on science-based guidance on stock status and fisheries management/sustainability, enhancement of public recognition/acceptance of management by management authorities and lastly, establishment of public tools to access competent science authorities: web portal/national labels.

At FSC8, Sustainable Fisheries Partnership (SFP), an international NGO whose work is focused on educating and assisting the seafood supply chain in efforts at improving fisheries and aquaculture grow-out regions, presented an overview of FishSource. FishSource has a buyer focus, and summarizes management plans into actionables. It serves major market parties (the buyers) such as Walmart, McDonalds, Tesco promoting sustainable sourcing both for capture fisheries and aquaculture, who in turn with their choices influence the industry. SFP has also developed FishSource with stocks and fisheries information, and today FishSource contains some 600 stocks, and 2000 fisheries, all identified with 16 characters unique codes. For their community, presentation focus is on fisheries, less on stocks. SFP presented current and planned collaborations between FishSource and FishBase, SeaLifeBase, and the RAM II Legacy Stock Recruitment Database. SFP also identified several areas of collaboration with FIRMS, which could take the form of mutual linking, cross-pollination, or linking and data sharing (similar

concept of Chimaera). A starting point could be interoperability at the Fisheries Metadata catalogue level, which would provide a technical avenue to a NatFIRMS implementation.

FSC8 recognized that publishing Management frameworks and measure is an important step for FIRMS as it responds to needs expressed by those interests groups. FIRMS should investigate possible meaning of Management indicator and the possibility of having something for management similar to the concept of Status and trend for Marine resources. There was a consensus that such indicators do not really exist at present and this is an area under development in which RFMOs are involved as part of their performance review. They are some attempts to develop scales against which management performance can be rated, and this could constitute indicators in the future. Simultaneously, Ocean Trust's Sustainability Science and policy forum, and SFP develop approaches towards such indicators. For example SFP evaluate fishery performance with algorithms to produce scores based on MSC Fishery Standards but less stringent. This evaluation includes 3 management indicators and 2 stock status indicators.

From the above analysis, there appears to exist various initiatives with distinct goals, remit, and coverage, organizing stocks and fisheries status reporting with a global ambition and in complementary ways: FIRMS information sharing partnership among RFBs, University of Washington's Ramm Legacy Stock Assessment database, FIN's FishBase database, and the Sustainable Fisheries Partnership's FishSource. A combined review of these sources indicate that few thousands of stocks and fisheries exist worldwide, but these cannot be viewed, queried or assessed from a single entry point. There would be potential strong benefits for the various initiatives to collaborate in sharing their respective information. Aggregating the existing knowledge across these sources in the form of a **Global Record of stocks and fisheries identifiers** would:

- significantly increase the data coverage on stocks and fisheries and de facto constitute a critical mass of information from which rules for further expansion could be strategically adopted;
- offer a wide-ranging array of reporting items, able to satisfy distinct target audience; that would be true for stocks and fisheries which are covered by the various initiatives.

From a FIRMS point of view, such strategic collaboration would allow complementing the geographic coverage (in particular for stocks within EEZs), constituting a way to concretize the NatFIRMS idea, and would allow to boost the capacity to respond to target audience needs. FIRMS playing a leading role would confirm its role in setting the foundations and standards of global reporting on status of stocks and fisheries.

2. WHAT - global unique identifiers (UIDs) of stocks and fisheries

Objectives

- improve the production of global/regional summary indicators on the status of fishery resources;
- facilitate traceability and certification of fishery products;

The **Global register of stocks and fisheries identifiers** will facilitate reliable reference to stocks and fisheries and their reported status and trends. These reports are essential to inform on the sustainability of exploited stocks and to understand the performance of fishery management schemes. The global register will rely on global unique identifiers which will be essential to mainstream the production of regional or global indicators of stock status, a key component of the state of the marine environment, and to define and implement policies that require the inclusion of provenance data, such as used for traceability of fishery products. It is expected to integrate fragmented (mostly complementary) data sets into a global dynamic register of spatio-temporal explicit knowledge base on fisheries stocks.

For its launch, such global record would need to rely on a critical mass of records assembled from distinct global databases; once functional, this critical mass will constitute a de-facto standard which is expected to constitute an invite for national research institutes and market actors to contribute their knowledge and join the global reporting community. Such a global system would provide a huge incentive to the fisheries sector to inform society of the provenance of aquatic products in the market chain, and this can only be managed with engagement from both producers and the trading sector.

The Global record of stocks and fisheries should rely on a protocol for assigning unique global identifiers. Building on the unique identifiers, the Global record will in addition provide information aggregation capacities across-sources. The resulting services will be exploited by various clients e.g. for achieving the objectives highlighted at the top of this paragraph.

3. HOW - Approach, tooling, products, and organizational aspects

The FIMES schema to support the logic for UIDs

Bringing together few distinct sources of stocks and fisheries information raises many questions related to data sharing.

The first question relates to the coherence of the records thus collated together as part of a single repository. Just like Vessel records which can be reported by various agencies (e.g. the Flag state, the RFMO which licenses the vessel) and for which current efforts are made to set-up protocols for unique global identifiers, a protocol should be figured out in order to assign unique stocks and fisheries identifiers building on the various initiatives reporting on stocks and fisheries status.

According to SFP, one of the problems affecting the production of this record is to have an agreed approach for fisheries identification. The issuing of unique identifiers in FishSource is technically simple, but practically difficult, as the information behind the UID has to be understood for the UID to have a meaning; were the assessments made similarly? Has the information been re-assessed?, etc. Commercial and managed fisheries can be easily assigned a UID, but for many multi-species and multi-stock fisheries, or coastal species (mussels) relevant and useful UID's are much more difficult to produce.

Indeed stocks and fisheries are abstract concepts and the uniqueness of their identity is not absolute, and relies on some human judgement. In shaping its shared reporting capacity, FIRMS

had to invest a lot in developing the FIMES Metadata standard for data exchange, which consists of an XML schema based on agreed concepts and definitions as well as semantic relationships among these concepts. These assets are described as part of the FIRMS Information Management Policy (IMP) and provide the mechanisms which can assist in such judgement:

- Reference data for geartypes, vesseltypes, waterareas , species etc. discussed and established in fora such as CWP are widely used in FIRMS database: these provide backbones/building blocks to construct unique stocks and fishery combined references. Their semantic use is codified in the FIRMS XML Schema (FIMES) and through this schema, stocks and fisheries are semantically identified in a quasi-unique way.
- Additionally, In order to maintain a consistent inventory over time, FIRMS has defined concepts such as the difference between 'true' and 'managed' stock, or the various "thematic approaches" to fisheries definition; FIRMS had also to set rules to identify distinct stock units when monitoring and reporting evolve over time (referred to as "Marine resource monitoring life-cycle"). For fisheries, an equivalent concept of "fisheries life-cycle" has been defined.
- In the FIRMS system, a unique numeric identifier (the FID) is applied to stocks and fisheries objects; these are however not published as Global Unique Identifiers.

This extensive experience capitalized through the FIRMS standards places FIRMS as a global reference and recognized central player for the development of a protocol for unique global identifiers.

The tooling

Yet a mechanism to access existing systems and interpret their content does not exist. The establishment of a global identification system for stocks and fisheries requires that a knowledge environment is made available where a variety of data formats can be accessed by various actors, and who can build on these stock identifiers to inform the public on provenance and additional information.

Additionally, a service will be required to support the collaborative building of the global record by integrating and enriching records on stock and fisheries with an ever growing number of attributes, e.g. status, species, boundaries, measures, agreements, maps, fishing nations. This service should help to map and align stocks and fisheries information in a spatial and time context and identify them uniquely; the semantic relationships captured in the FIRMS schema will be used as a central reference for structuring ontologies and mapping logic among the heterogeneous data sources on stocks and fisheries.

The capacity for delivering the above described tooling is available on the iMarine platform, a data infrastructure supporting the Ecosystem Approach to fisheries management and conservation of marine living resources (EA). This platform has been developed during a ten years period by a consortium of IT institutions, and its orientation to support the needs of the EA has been guided by the iMarine Board, chaired by FAO and composed of leading organizations in the EA.

iMarine will leverage its existing harvesting, web semantic and data mining technologies, and master data management and mapping capacities, to offer global registry services enabling participating stakeholders to assign unique global identifiers to existing records, process newly submitted records, and generally manage and maintain the registry.

The resulting product: a iMarine VRE for the Global Record

The description of the services expected to be delivered are described as part of the BlueBRIDGE project, which was formulated in response to EU H2020 call for funding.

A Virtual Research Environment (VREs) will serve the Global record, producing a valuable, unique and authoritative information source. In particular, the VRE will offer the following Services:

- a service to support the collaborative building of the global record by integrating and enriching records on stock and fisheries with an ever growing number of attributes, e.g. status, species, boundaries, measures, agreements, maps, fishing nations;
- a service to easily have access and discover the rich global record information related to stocks and fisheries, including maps, statistics, species identifiers and names; this service will support both human-as-end-users and programmatic accesses;
- the prototype of a service exploiting the above resources for computing regional or global summary indicators of stock status. This will contribute to systematize a yearly production of FAO's Global State of world Marine fishery resources (*http://www.fao.org/fishery/topic/426/en*)

This knowledge base will be instantiated under FAO's leadership, in collaboration with voluntary FIRMS partners, the University of Washington (RAM Legacy), Geomar (Fishbase) and the Sustainable Fisheries Partnership (FishSource). It will serve the needs of regional and global policy makers to compile a global overview of stocks and provide them with a platform to negotiate the content of the register, and the rules for inclusion of stock and fisheries identifiers and their descriptive metadata.

The knowledge base of the global record will contain stocks and fisheries information from the source databases that will be mapped through unique identifiers as equivalent, affiliated, or historical data. The unique identifiers of stocks and fisheries will be linked to sections of annotated source documents (e.g. reports in external repository pdf files). The knowledge base will also expose information that is processed, combined, or aggregated (e.g. as regional or global summary indicators of stock status). In addition to that, data will be exposed via machine readable formats including LOD. Every research product will be accompanied with rich and comprehensive metadata fully characterising it in accordance with Science 2.0 practices, e.g. provenance, attribution, and licences details will be collected and made available for every single piece of information contributing to the product.

Once this knowledge base is made available, any organization in need to publish information on stocks will have (a) an authoritative source to use to univocally refer to stock via global identifiers, and (b) authoritative information further describing their stocks. This knowledge base will be adapted to policy makers in needs of a global understanding on the distribution and status of stocks and fisheries, including regional and global stock status overviews, and to main trade actors and seafood distributors that are in need to inform their market chains on fisheries data provenance and to improve the traceability of fishery and aquatic products.

Organizational and funding aspects

During the second half of 2014, the FIRMS Secretariat met with representatives from SFP and Washington University, who expressed their support in principle for being associated to a project that would aim at a Global Records of stocks and fisheries building on FIRMS, Ram Legacy stocks database, FishSource, and Fishbase. Such project would require that in-kind contributions from partners be articulated around a dedicated funded project.

At the end of 2014, FAO exploited the BlueBRIDGE project opportunity, a project formulated as a response to EU H2020's call on research data infrastructures (EINFRA-9-2015 – e-Infrastructures for virtual research environments - VRE), to include the objective of a Virtual Research Environment that would support the Global Record of stocks and fisheries. The BlueBRIDGE project builds on services of the iMarine platform, and will deliver Virtual Research Environments (VREs) in different domains (e.g. fisheries, biology, economics, statistics, environment, mathematics, social sciences, natural sciences, computer science) that support knowledge production from data collection and aggregation to the production of indicators and indices or other information products such as fact-sheets, reports, and repositories. BlueBRIDGE combines the forces of European and International renowned institutions (e.g. ICES, IRD, FAO, UNEP) who share the goal of providing scientifically sound advice on the sustainable use of marine resources to their member countries, international organizations and relevant Commissions, but also at local or individual level for national academic institutions and SMEs.

During the project formulation, FAO invited SFP, University of Washington, and a few FIRMS partners to be associated to the project with the goal of supporting the development of the Global Record of stocks and fisheries. Together with SFP and University of Washington, NAFO, CCAMLR, WECAFC and BOBLME sent official letters of support to the projects' objective to collaboratively with holders of other relevant data sources (e.g. Ramm Legacy stock assessment database, FishSource) set-up a global record of unique stocks and fisheries identifiers.

The project is currently in proposal phase, and should the project be retained for European Commission support and funding, the anticipated launch of the project would take place end 2015 for a 30 months duration. The Technical Working group of the project's External Advisory Board will provide the participatory mechanism for gathering requirements, defining plans and validating the delivered solution.

4. Conclusion - Benefits to FIRMS

Federating these various sources as part of a Global Record of Stocks and Fisheries is seen as a critical step towards achieving a comprehensive coverage of status reports on aquatic resources, their exploitation and management.

Consistently with FIRMS Steering Committee recommendations, this capacity should contribute to avoid duplicated reporting, to expand the knowledge base on status of stocks and fisheries, and to boost the use of the FIRMS database by facilitating its use (together with other complementary sources) by various market segments interested in: generating regional or global indicators on the status of stocks; informing seafood distributors and consumers about status of individual stocks, and the status of fisheries and their improved management capacities.

The collaboration which this Global Record would foster might contribute to FIRMS making fishery data more accessible and understanding to non-technical audiences, and also in concisely summarised (albeit reduced) form to researchers seeking such easily digested snapshots.

It would also provide a mechanism to FIRMS partners such as ICES who mentioned at FSC8 that they would be keen to see their contribution to FIRMS streamlined to FishSource so to avoid duplication of inputs, and the existing risks of distorted information considering that currently FishSource places an interpretation on the materials that it uses on the web.

Finally, the global record of stocks and fisheries has the potential to become an important resource for the market segments mentioned above, and thus may attract future financial and development support from public and private sector parties.

Suggestions on the way forward

Beyond the few FIRMS Partners' that are planned to actively contribute to the BlueBRIDGE project and who can to some extent represent FIRMS interests, it seems desirable to set-up a mechanism that ensures that the view of the FIRMS partnership is well represented.

It is **suggested that a FIRMS TWG could be convoked** for examining the matter and discussing the requirements, including:

- the method to define a fishery across the various sources; the TWG could examine the results of a case study that would work on a trial basis on a small subset;
- meaningful methods to compute summary indicators of stock status at regional or global level across the various sources;
- bases for a data sharing protocol for federating, sharing and disseminating various reporting sources (including intellectual property, licence or copyright, etc…).