Catch Reconstruction Database & its Application in Climate Change Study

by

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Economics
Research
Unit

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Outline

A. Catch Reconstruction Database

1. Rationale (Pauly 1998, EC Fisheries Cooperation Bulletin);
2. Method (Zeller et al. 2007, Fishery Bulletin);
3. Examples: Arctic, USSR and West African countries;
4. Structure of reconstruction catch database;
5. Additional input data
   - Species distribution
   - Fishing access
   - Spatial GIS layers
6. Spatial allocation;
7. *Sea Around Us* website.

B. Using reconstructed catch data for climate change study

Marine capture fisheries in the Arctic: winners or losers under climate change and ocean acidification? (Lam *et al.* (2014) Fish & Fisheries)

Background

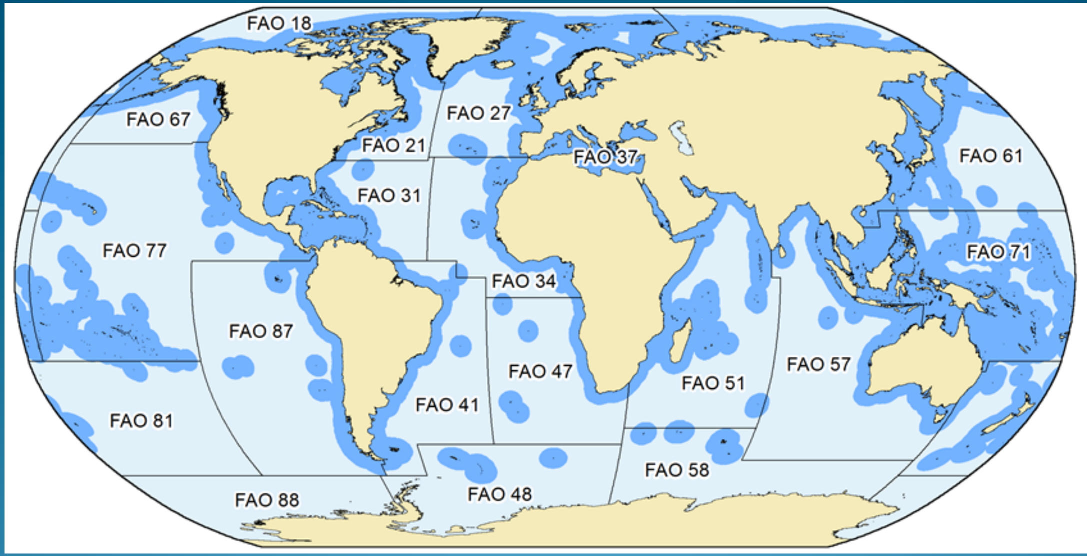
- Dr. Daniel Pauly started Sea Around Us in 1999…….
- Interested in answering a list of questions related to marine ecosystem;
- Fisheries of their own country – National data with less problems on accuracy;
- Fisheries of foreign countries or international comparison – FAO statistics;
- FAO data are misleading & strongly biased downward.

What are catch reconstructions?

Estimates of all withdrawals from the ecosystem, based on:

- Baseline catches to 1950 (to be able to compare present with earlier system state);
- All sectors: industrial, artisanal, subsistence, recreational;
- Landings as well as discards;
- National or other information complementing the data submitted to regional organization such as ICES or CCAMLR and/or to FAO.

The *Sea Around Us* and about 400 colleagues throughout the world have completed about 280 reconstructions for the EEZs (or 'chunks' thereof) for about 203 maritime countries and their territories, by sector and species, for 1950 to 2010 (updates will follow), covering all marine fisheries of he world.



This will allow for a re-assessment of fishery trends in the world. Some examples will be presented - but first some methodological pointers:

How do we estimate unreported catches?

"6-steps to data heaven"

1. Review/compare existing reported catch time series data
    - FAO & national data
2. Identify 'missing' components
    - Sectors, time periods, gears, areas etc.
    - Lit. reviews, local consultations
3. Seek alternative information & data sources
    - Literature & local experts
4. Develop data anchor points
    - Sectors, time periods, gears, areas etc.
    - Expand country-wide estimates
5. Interpolate between anchor points
6. Combine with reported data = total catch

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Zeller *et al.* (2007) Fishery Bulletin 105(2): 266-277

“No data….”

- “But…. there are no data…!” fallacy
  - Historical studies (literature archives)
  - Grey literature (Gov. & NGO reports)
  - Household, health & nutrition surveys
  - Stock assessment reports (ICES)
  - Media stories…
  - Local language (-> local collaborators)
- → ‘shadow’ that no one looks at
- > 4000 publications used
- Approx. 35 source per country (excl. online)
- Over 200 collaborators

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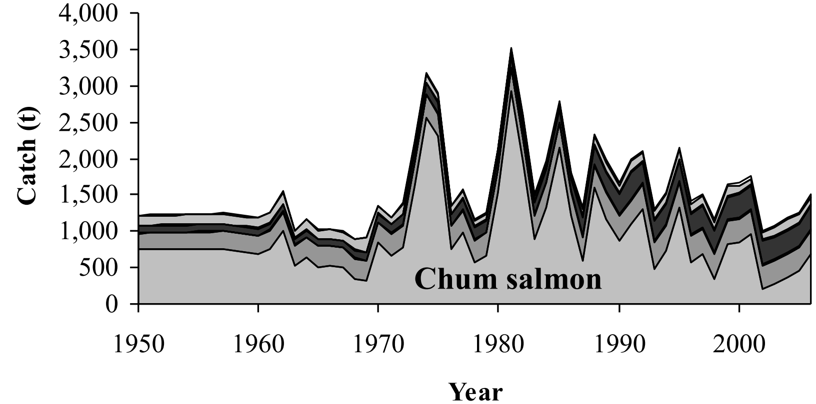
FAO Area 18

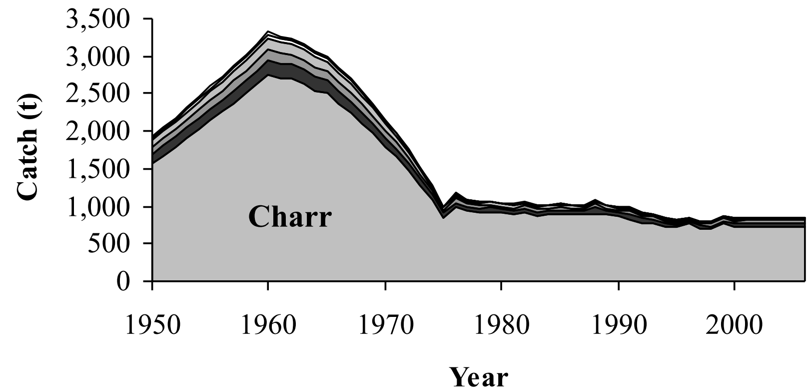
Example of catch reconstructions for an area from which Russia, the USA and Canada report zero or near zero catch

Zeller *et al.* (2011, *Polar Biology*)

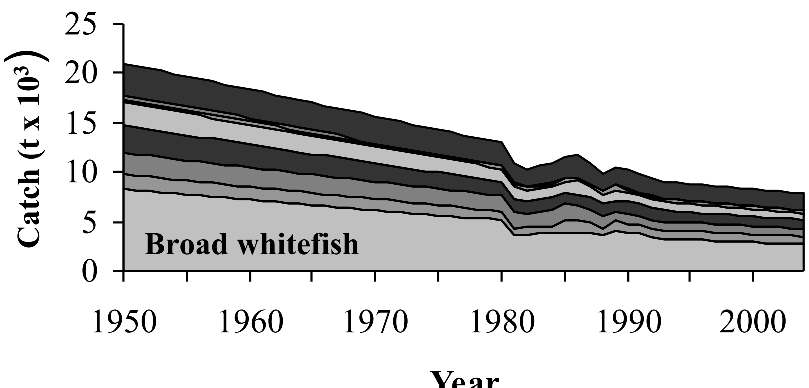
Alaska, USA



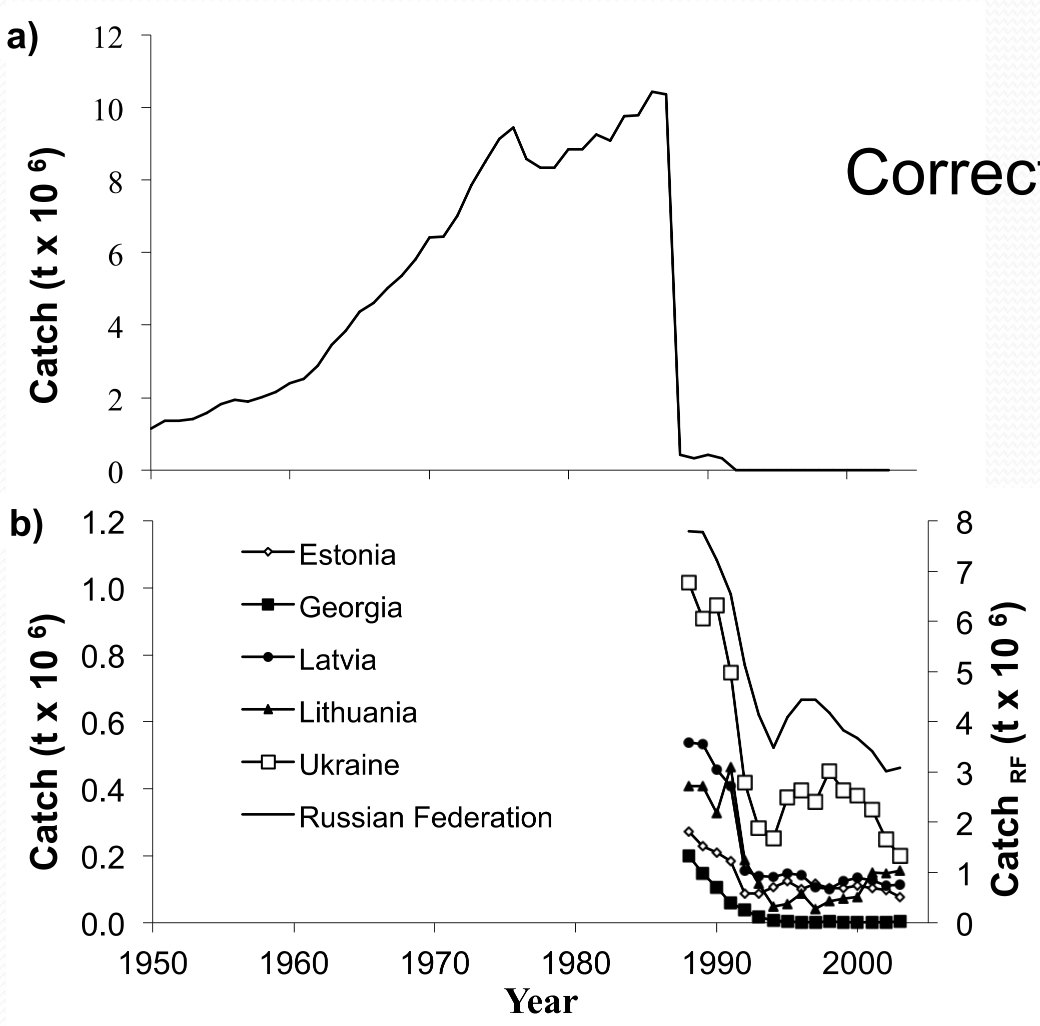
Arctic Canada



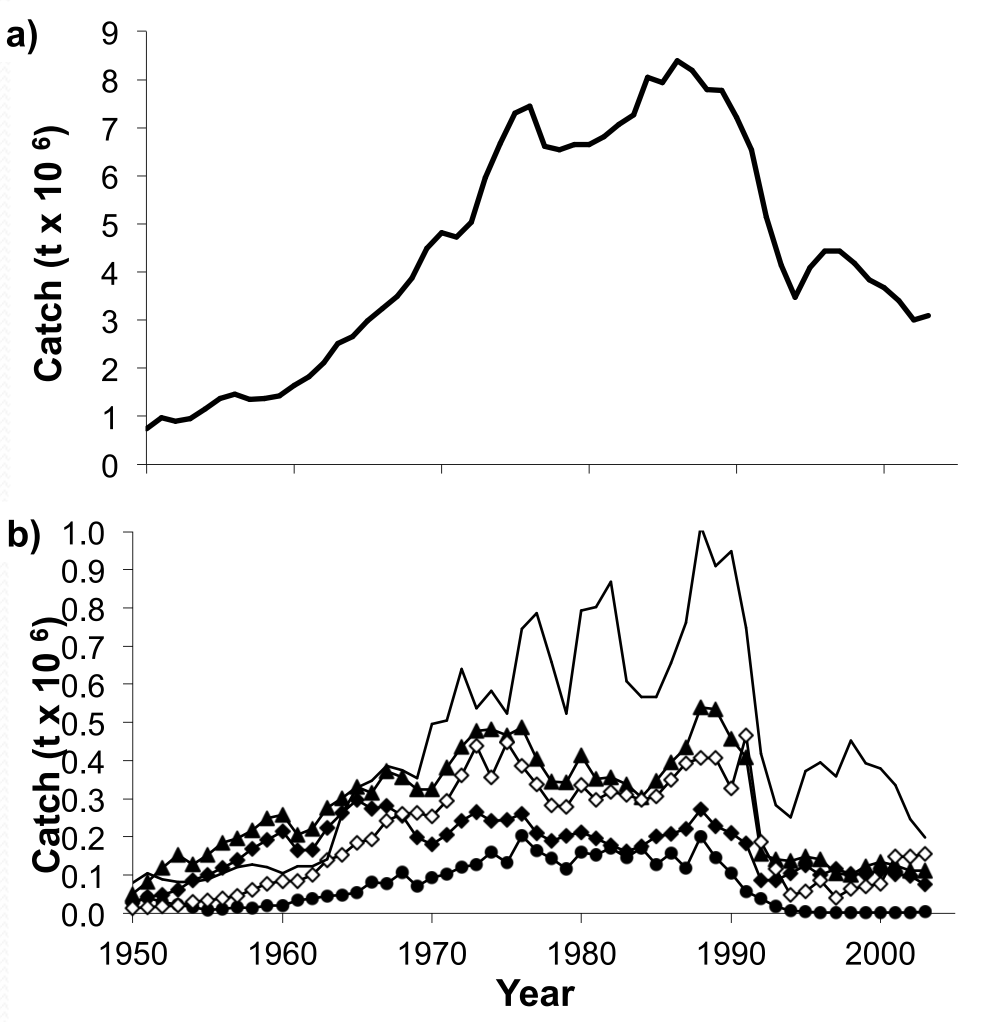
Siberia, Russia



Correcting FAO data

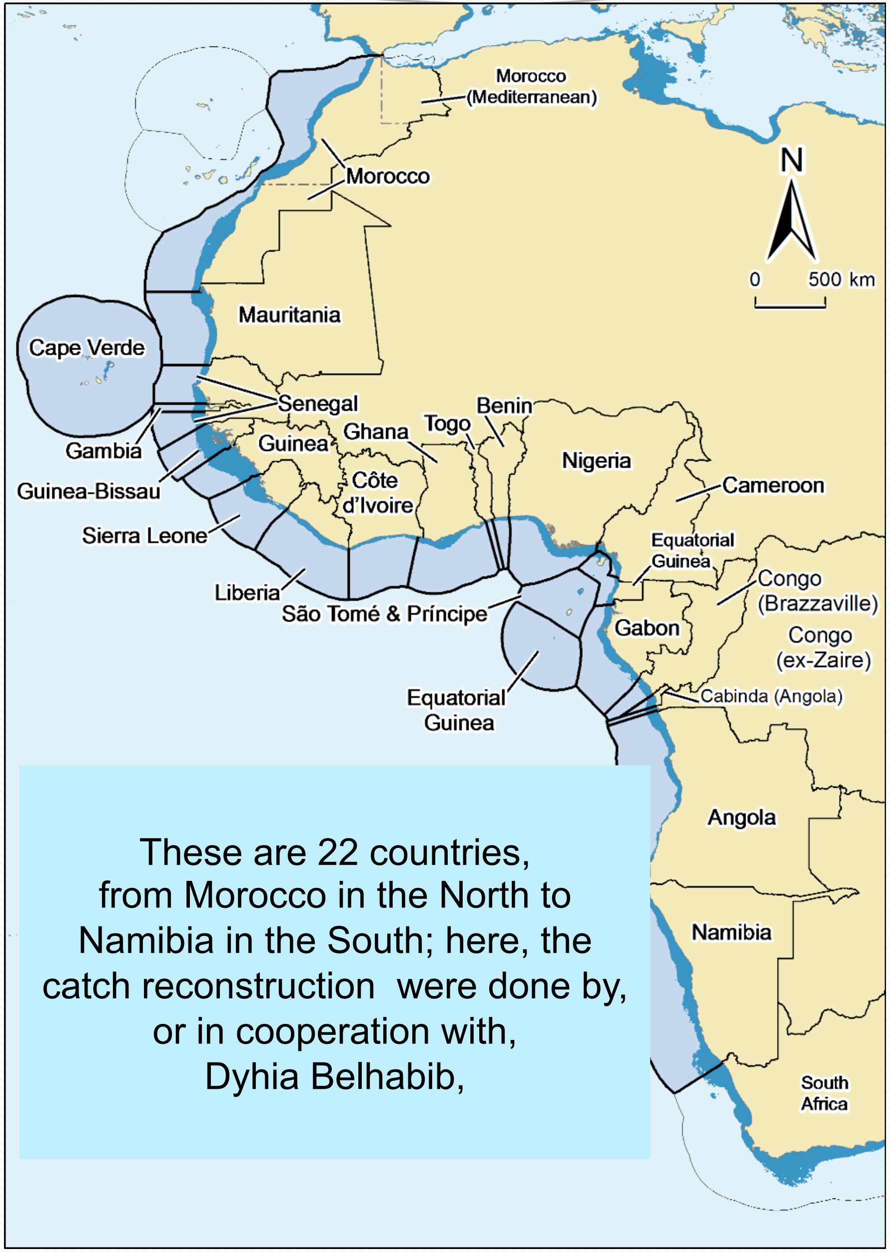


FAO data for a) USSR and b) FAO data for the six countries, formerly part of the USSR.
(Zeller and Rizzo, 2007, *FCRR 15(2)*).



FAO data prior to 1991 disaggregated to derive a complete time series from 1950-2007 for each of the six independent entities (a) Russia; and (b) Estonia, Georgia, Latvia, Lithuania, Ukraine. (Zeller and Rizzo, 2007, *FCRR 15(2)*).

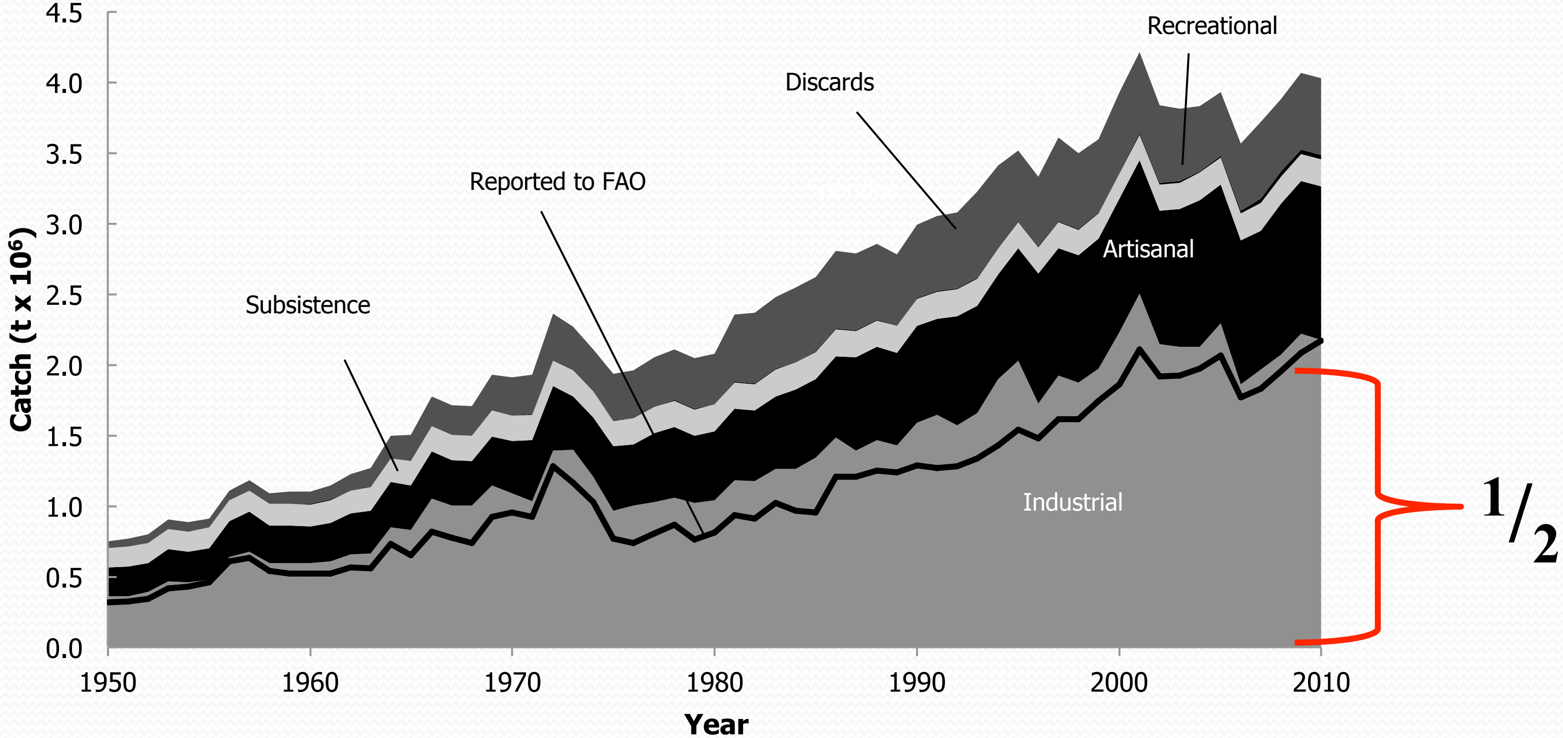
Let's look at the countries in West Africa, as defined on this map.



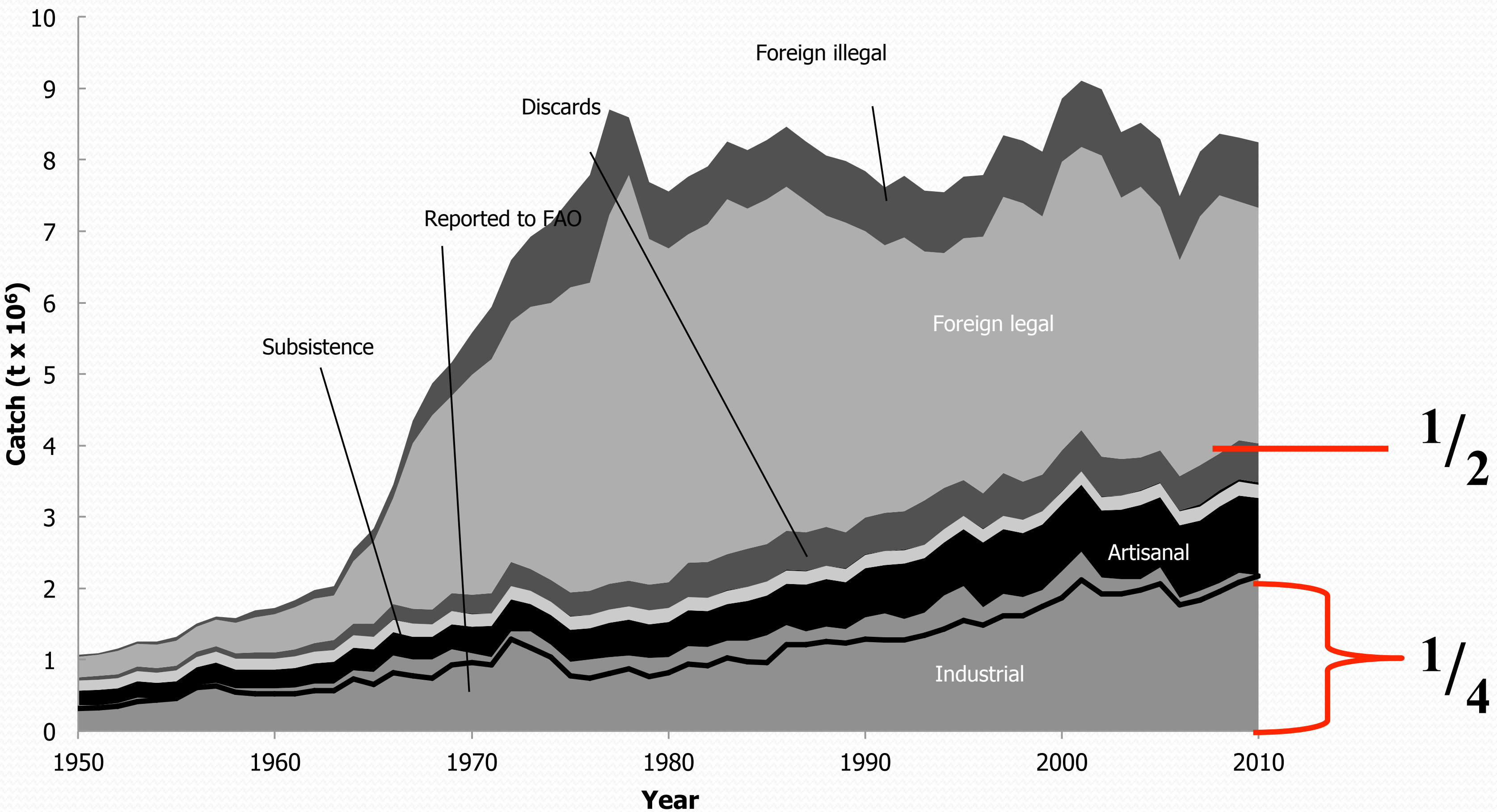
These are 22 countries,
from Morocco in the North to
Namibia in the South; here, the
catch reconstruction were done by,
or in cooperation with,
Dyhia Belhabib,

SEA AROUND US

Total reconstructed catches for West Africa: domestic



Total reconstructed catches for West Africa: domestic & foreign



Catch reconstruction vs FAO catch data

Catch Reconstruction database

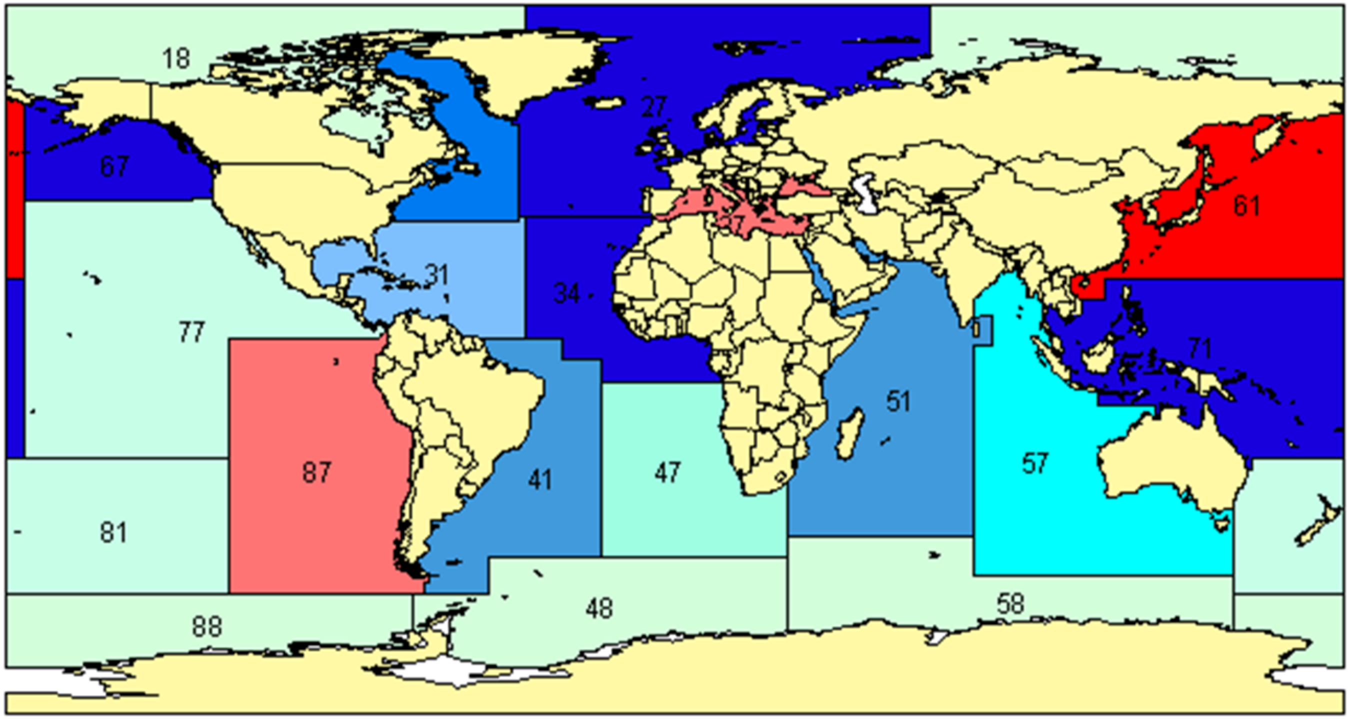
- Catch
- Year of catch
- Flag country
- Taxa
- FAO areas
- EEZ (incl. High Sea areas)
- Fisheries sector
- Catch type
- Reporting status
- Gear information (if any)

VS

FAO data

- Catch
- Year of catch
- Flag country
- Taxa
- FAO areas

The FAO assembles marine fisheries catch data from its member countries, and assigns them to 19 large statistical areas.

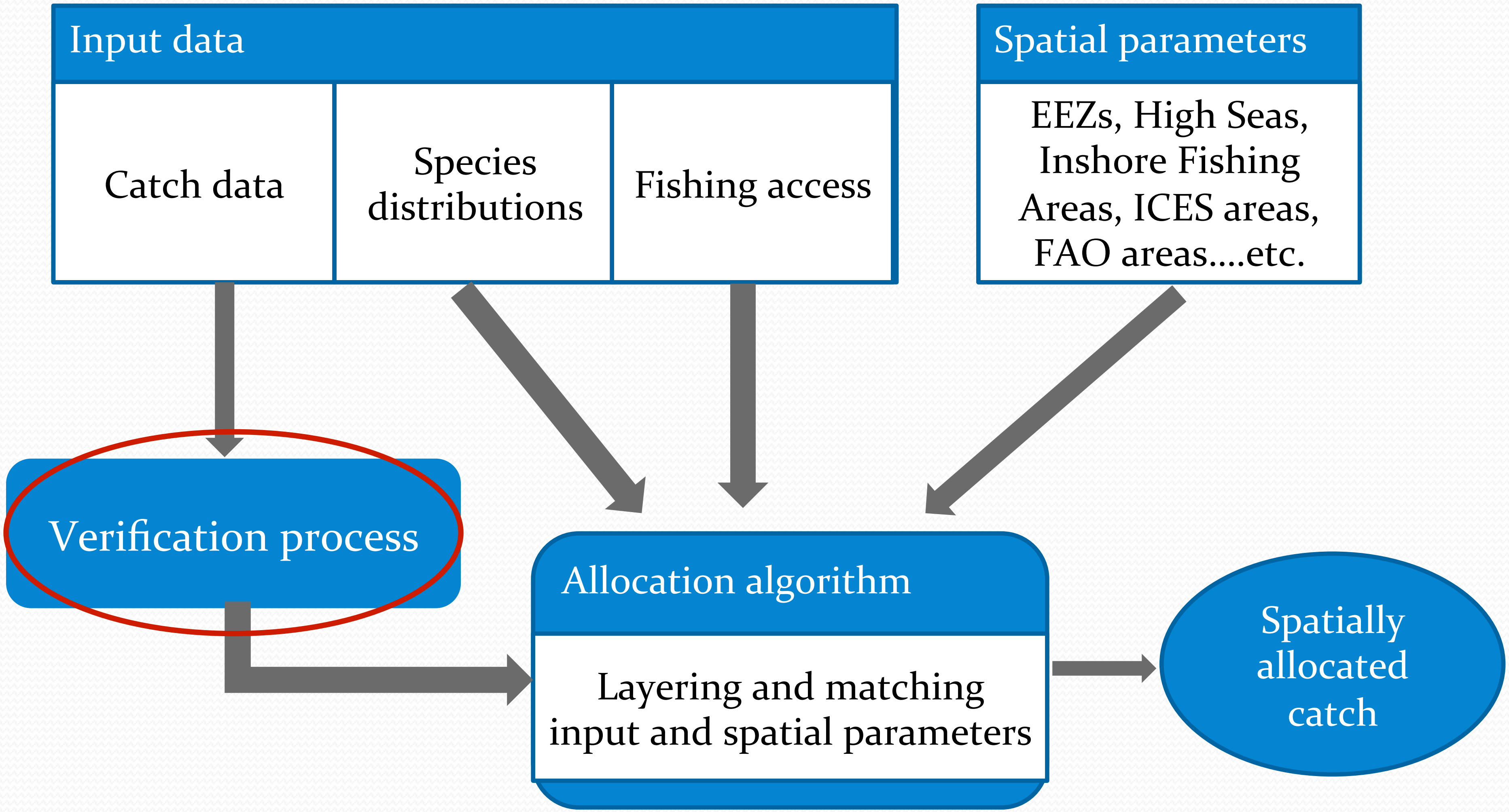


- Little policy relevance (not by EEZ);
- Little ecosystem relevance.

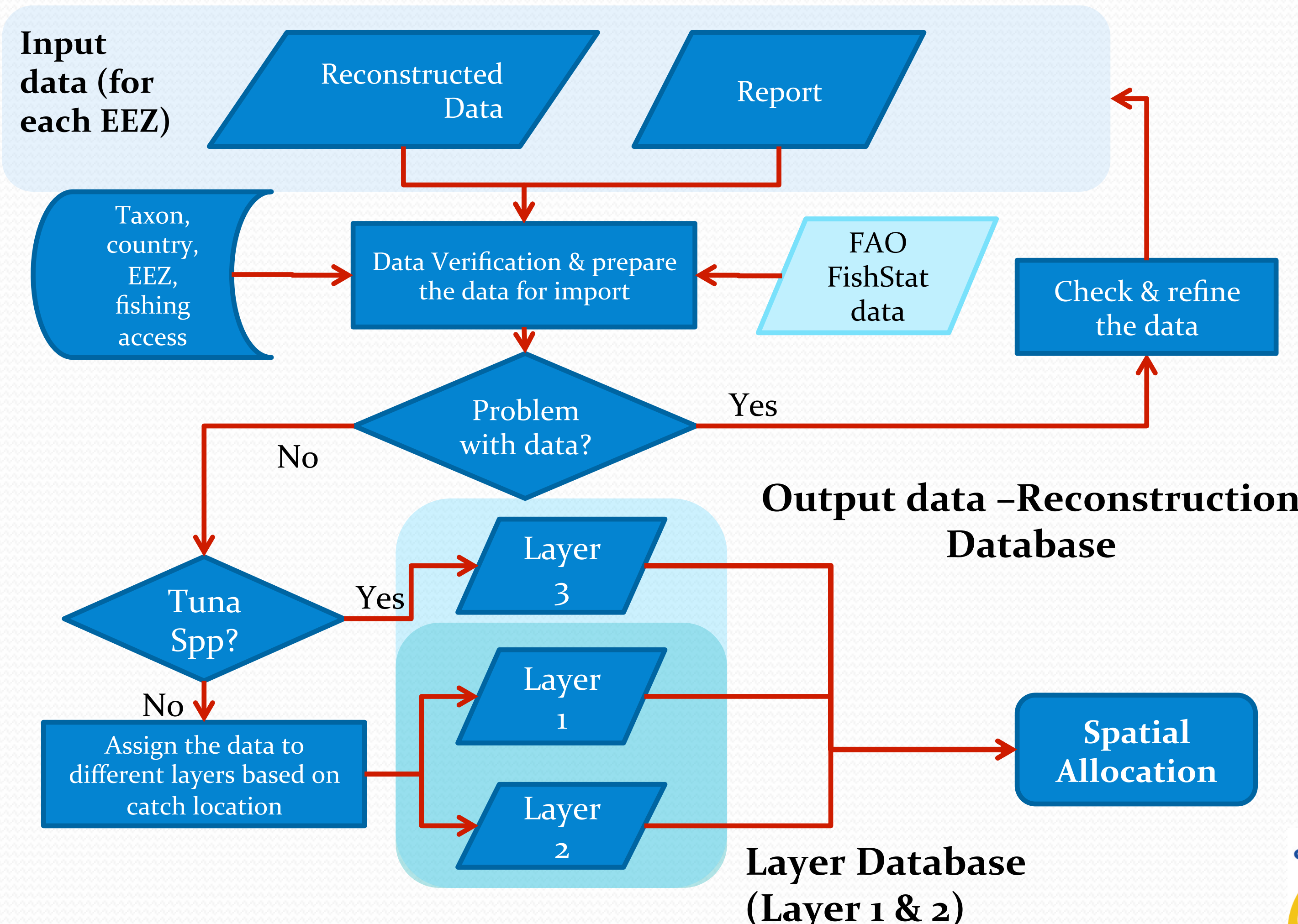
Our uniqueness:

Catch Reconstruction	FAO
Total catch (reported + unreported)	Reported landings
All fishing sectors (industrial, artisanal, subsistence, recreational, discards)	Generally, industrial or major commercial fisheries
1/2 degree cells (180,000)	FAO statistical areas (19)

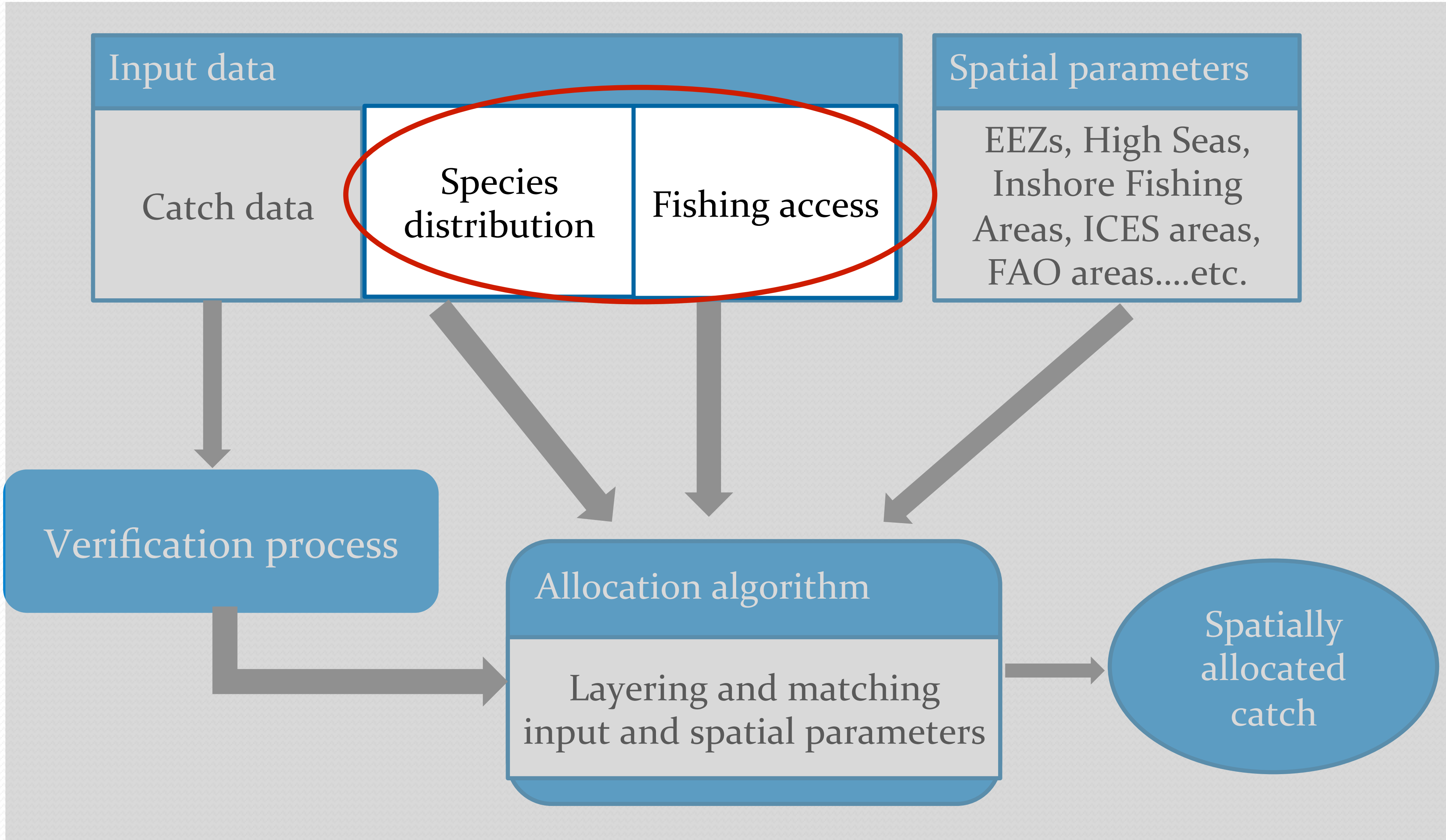
Sea Around Us global data (overview)



Data verification



Sea Around Us global data (overview)



Input data: Species distributions created by FishBase/SeaLifeBase & *Sea Around Us*

1) FAO area occurrence

2) Latitudinal range and distribution

3) Range limiting polygon

   - published

   - expert input

4) Depth range

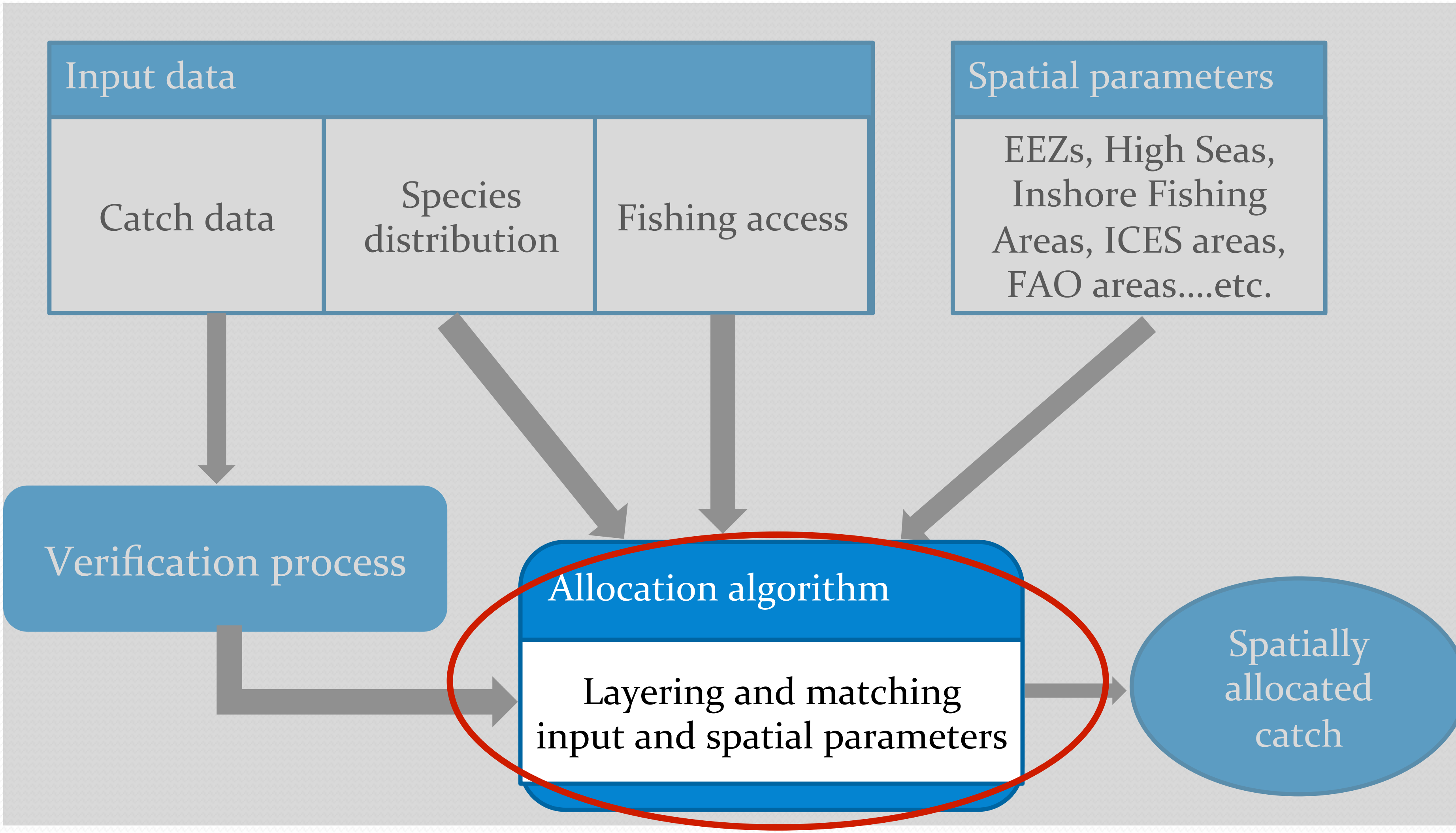
5) Habitat preference

   - fuzzy logic probability function

Input data: Fishing Access

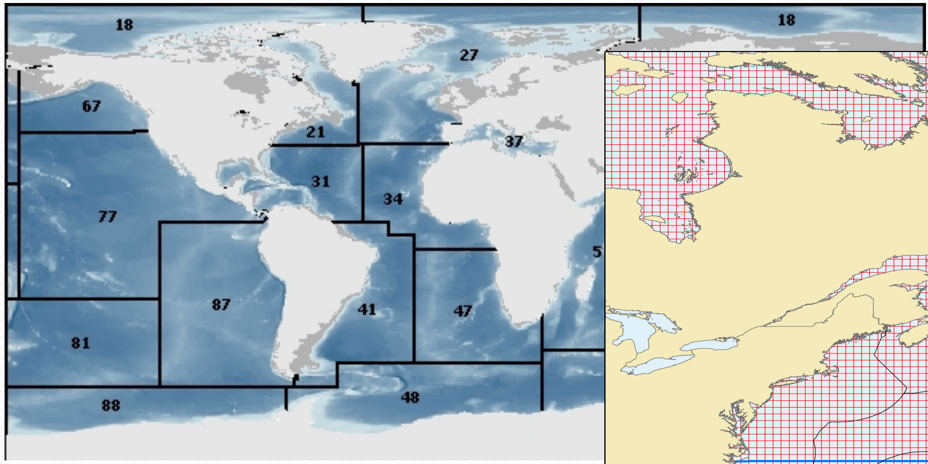
- Over 4,000 records of access (agreements + ‘observed’ access);
- Fishing country and the EEZ;
- Duration details, start year & end year of the agreement/observed access;
- Type of access: AA = actual agreement, OA or OF = observed agreement or observed fishing without ‘legal’ document, IF = illegal fishing;
- Type of access: 1 = assumed unilateral, 2 = assumed reciprocal, 3 = unilateral, 4 = reciprocal;
- Other information on access.

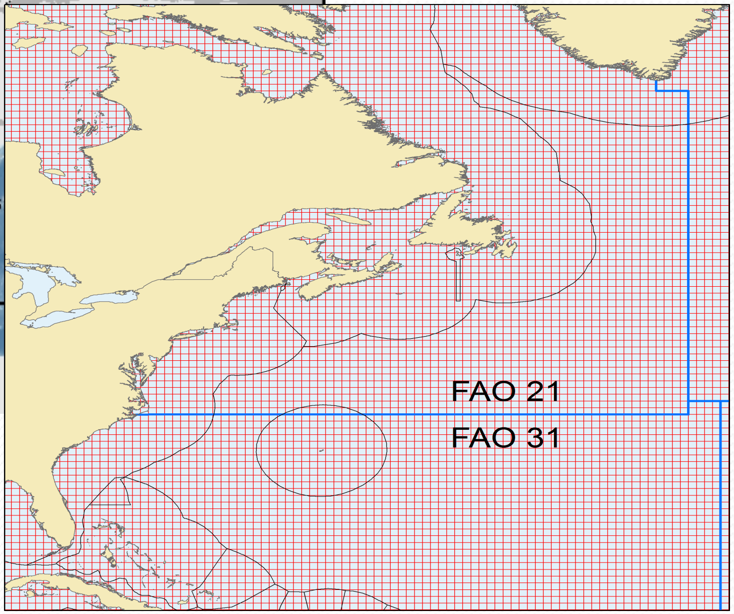
Sea Around Us global data (overview)



Allocation algorithm

FAO statistical areas vs. *Sea Around Us* ½ degree



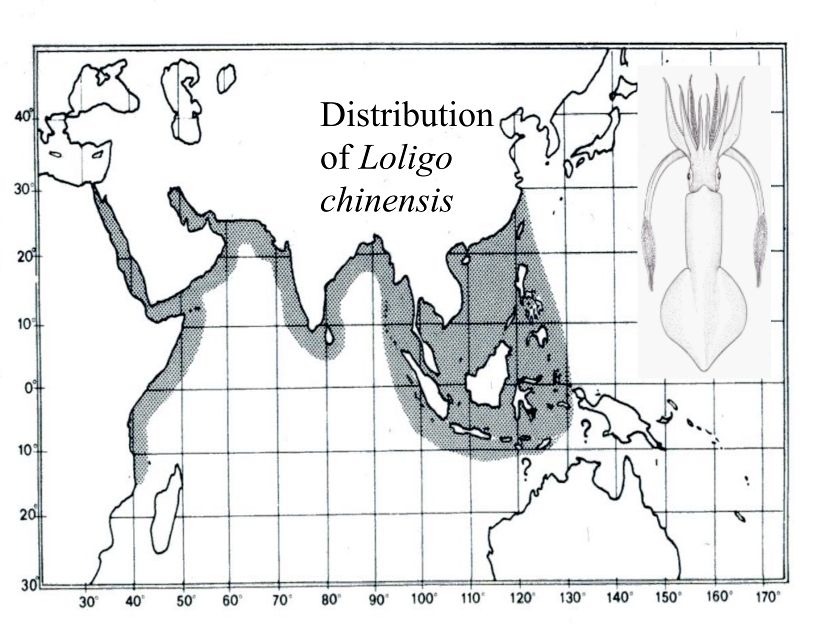


19 FAO areas:
-coarse resolution
-limited policy relevance (EEZ vs. HS)
-limited ecosystem relevance

180,000 *Sea Around Us* cells:
-fine-scale resolution
-policy relevance (e.g., EEZs)
-ecosystem relevance (e.g., LMEs)

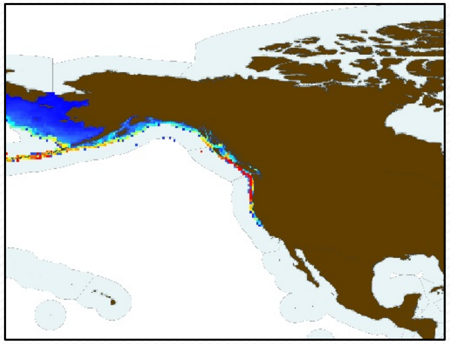
Here is one of the examples of over 1,200 taxa in the database for which a distribution area had been published. Combining all these, we could…

- Assess where the catch of a given taxon can possibly have come from;
- Identify the overlap area between this distribution and the EEZs to which a given country's fleet has access;
- Assign the catch to the only ½ degree lat./long. cells from which the catch can have originated.



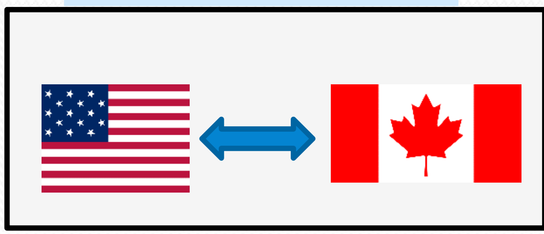
(Source: FAO)

Examples of Alaska pollock



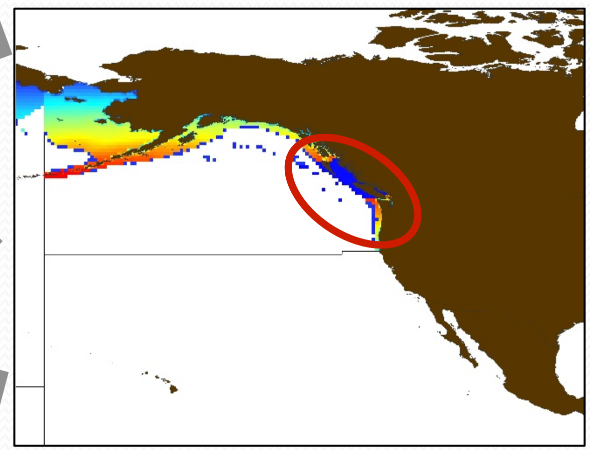
Distribution of Alaska Pollock (*Theragra chalcogramma*) in East Bering Sea (*Sea Around Us*)

Access Agreement

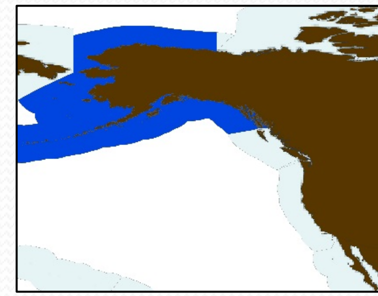


FAO catch data

Inaccurate previous spatial allocation

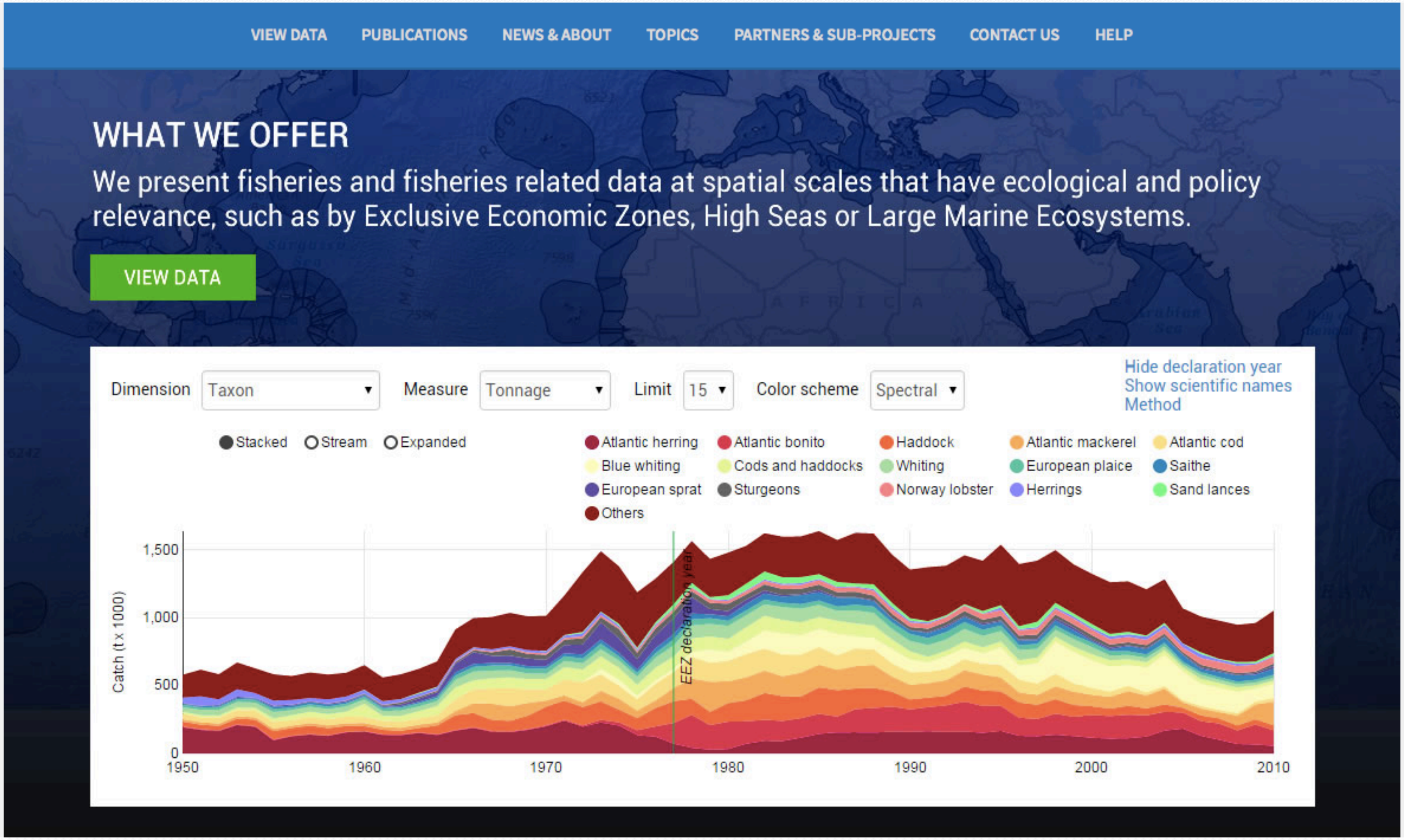


New allocation limited by EEZ

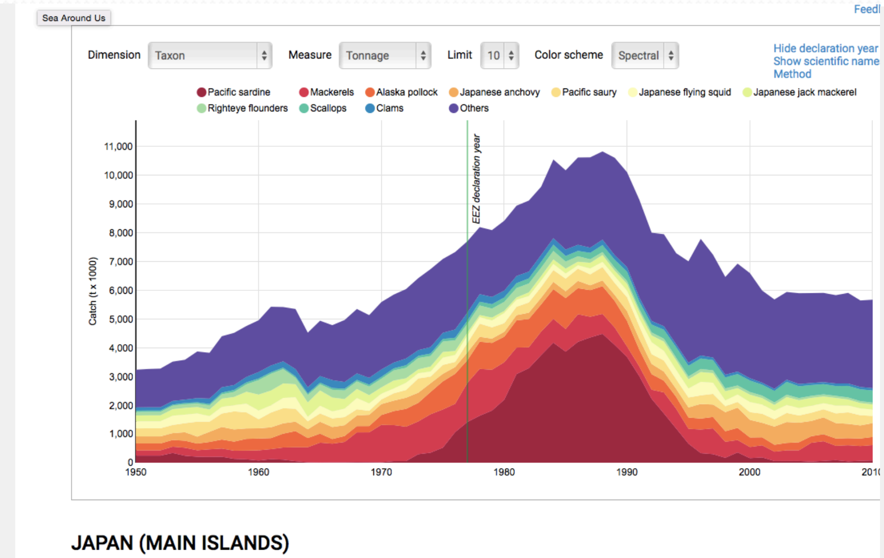


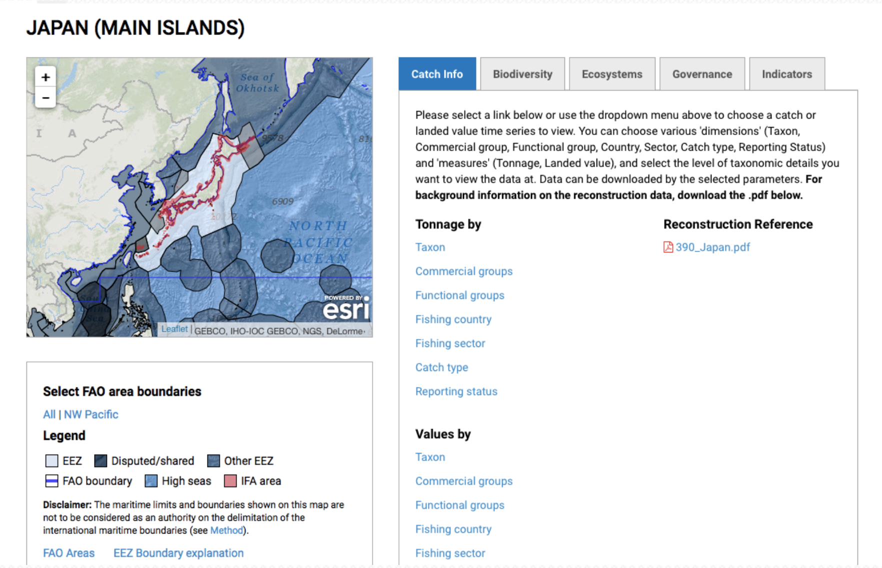
No massive Alaska pollock catches in BC and further south

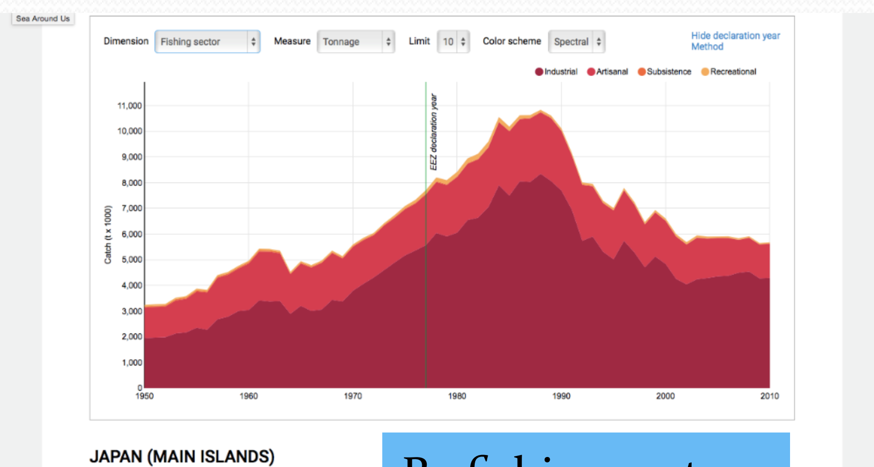
www.seaaroundus.org



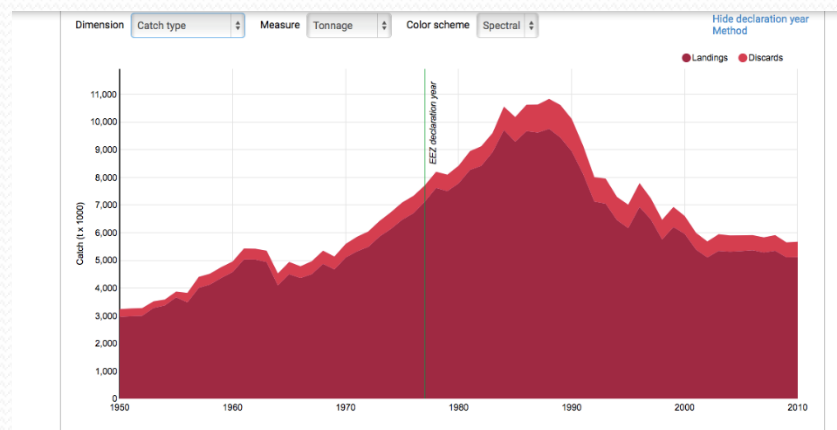
View data at different spatial scale







By fishing sector



By catch type

Application of reconstructed catch data on climate change study

- Impact of climate change and OA on the fisheries of Arctic Ocean;

- The Arctic Ocean is bordered by Canada, Denmark/ Greenland/Faeroe Islands, Finland, Iceland, Norway, Russia, Sweden, the United States and several small islands, and is partly covered by sea ice throughout the year.

Marine capture fisheries in the Arctic: winners or losers under climate change and ocean acidification?

Research objective:
To analyze how change in climate and ocean acidification under scenarios of anthropogenic CO_2 emission is expected to affect the economics of marine fisheries in the Arctic.

Ocean acidification (OA) in the Arctic:

- Globally, ocean pH level ↑ by **0.3 to 0.4 units** under high range GHG emission scenario by the end of the century;
- Arctic Ocean – experience the most rapid decrease in pH globally;
- Induce an adverse impact on the aragonite secreting organisms in the high latitude region;
- Alter higher trophic level species and hence the structure and biodiversity of the polar ecosystem.

Methods

1. Multi-model ensemble (GFDL, IPSL, CSM 1.4, CCSM3) under IPCC SRES A2 scenario to explore model uncertainty of the assessment;
2. 62 species of exploited Arctic marine fishes and invertebrates are included;
3. Modeling economic impacts on commercial fishing;
4. Monte Carlo method to determine the level of uncertainty;
5. OA scenarios (based on Kroeker *et al.* 2010):

	Doubling of $[H^+]$			
	NOT sensitive to OA		Sensitive to OA	
	Fish	Invertebrate	Fish	Invertebrate
Basal metabolic rate	Unchanged	Unchanged	↑15%	↑15%
Larval mortality	Unchanged	Unchanged	↑25%	↑25%
Adult mortality	Unchanged	Unchanged	Unchanged	↑25%

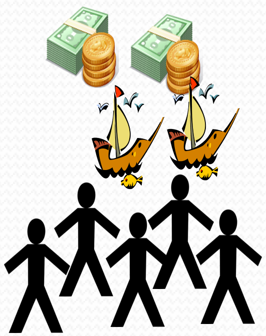
Change in catch & landed values relative to the current status in the Arctic region

- Current catch in the 2000s = 2.3 million tonnes
- Current landed values in the 2000s = US$ 1,950 million
- that means OA causes the landing to decrease by about 11 % and LV to decrease by 15 % that means OA causes the landing to decrease by about 11 % and LV to decrease by 15 %

	Projected catch (million tonnes)	Projected landed values (million USD in 2005 real values)
Climate change (SRES A2)	3.26 (+39%)	2,700 (+39%)
Climate change with ocean acidification	3.16 (+35%)	2,588 (+33%)

Current & projected household income impact in the Arctic countries

Current status (2000s)



Current income impact =
USD 1,523 million
212,000 jobs

CC only

Total income impact increase by
38%
Job increase by **20,000**

CC + OA

Total income impact increase by
32%
Job increase by **17,000**

With OA

3,100 jobs
USD 90 million
(-7%)

Current & projected economic impacts in the Arctic countries

Current Status
USD 6,677 million

Climate change scenario (A2)
↑ by 38%

Climate change + OA scenario
↑ by 32%

Limitations

- Open up marine resources for other fishing nations;
- Adaptive capacity of fishers;
- Higher investment and/or running cost;
- Increase trend of energy prices;
- Changes in demand/supply (fish price may fluctuate);
- Safety issue in the ocean.

Future plan

- Use the reconstructed catch data to identify countries with the highest catches by Distant Water Fleet (DWF);
- Analyze the temporal and spatial change in the routes of DWFs;
- Impact of climate change on global fisheries economic using reconstructed catch data.

Summary

- More accurate spatial information of catch (e.g., by EEZ);
- Differentiation into different sectors (industrial, artisanal, subsistence and recreational);
- Differentiation into landings and discards;
- Differentiation into reported and unreported catch;
- Developed countries (30-50% (discards, recreational));
- Developing countries (100-500% (small-scale, discards, illegal));
- Catch reconstruction database provides important data for ecosystem and fisheries studies;
- Reconstructed catch data will help us to project the impact of climate change and OA on different fisheries sector more accurately.

Thank you

Acknowledgement

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- All the contributors and collaborators in the catch reconstruction