The Nippon Foundation - University of British Columbia
NEREUS PROGRAM
Predicting Future Oceans

Projected change in global fisheries revenues and effort under climate change

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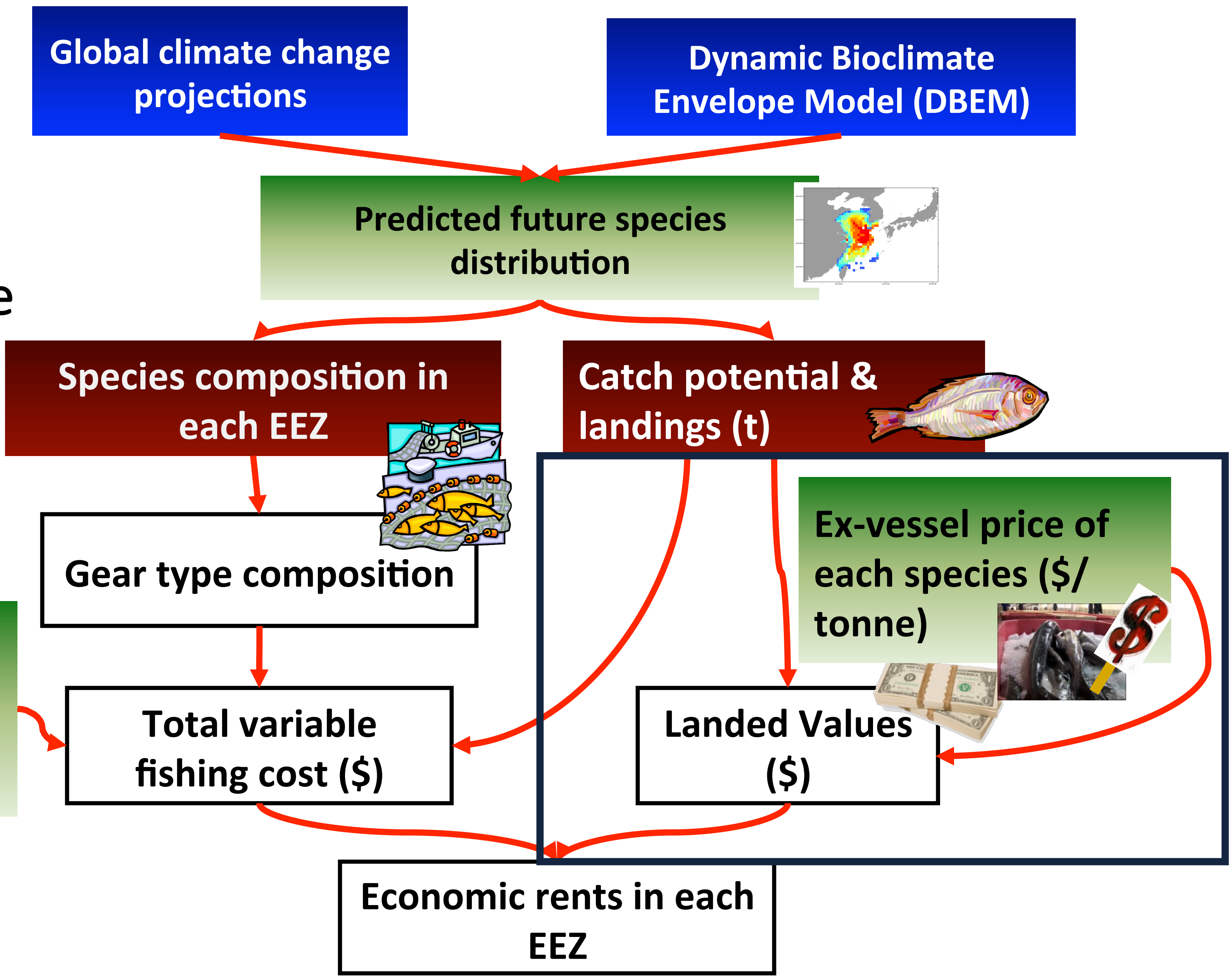
Outline:

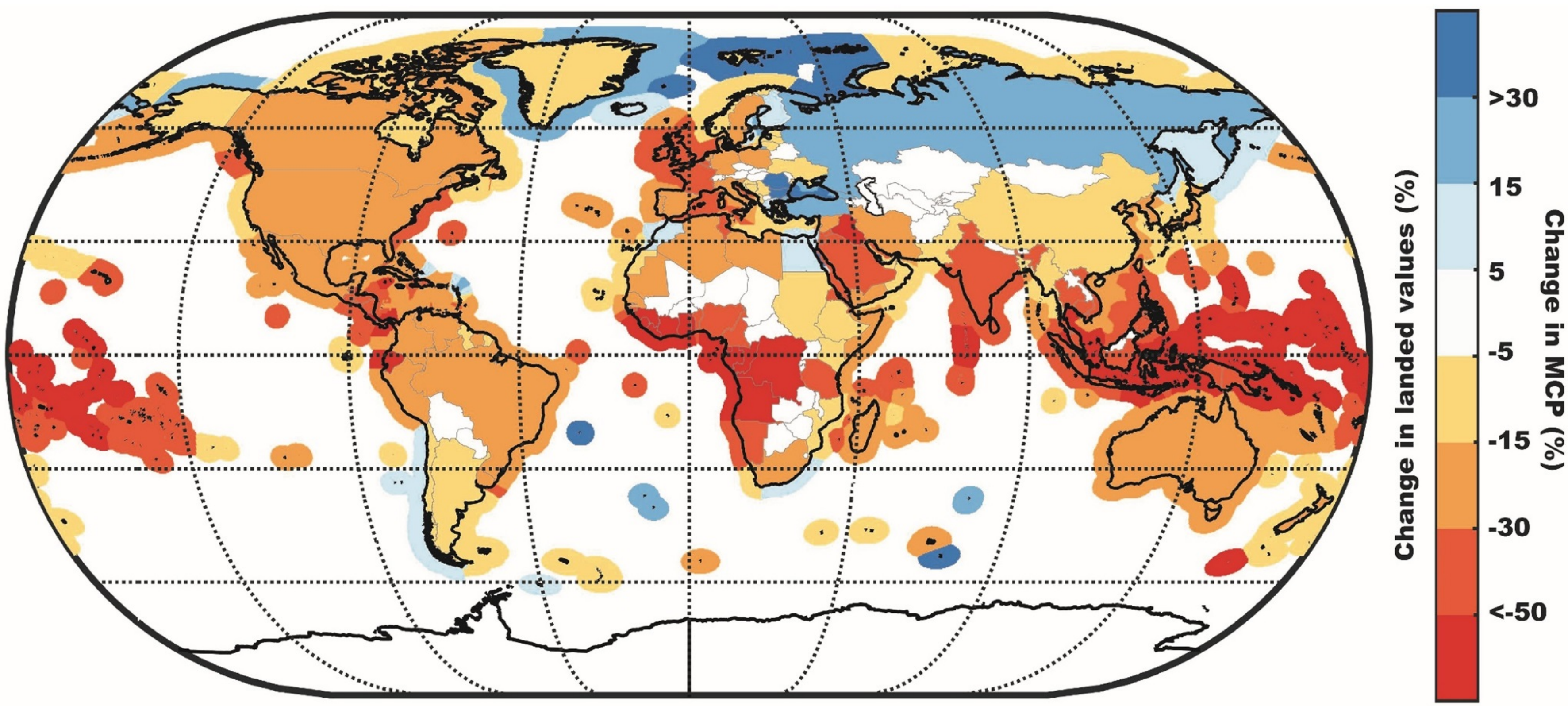
Part 1: Projected changes in global fisheries revenues under climate change;

Part 2: Predicting fishing effort.

Model Structure



Mean percentage change in maximum catch potential (MCP) and revenues in the 2050s relative to current status under RCP 8.5 scenario



The map is created using MATLAB R2012b, http://www.mathworks.com

	Mean	Standard deviation
% change in MCP	-7.71	4.36
% change in revenues	-10.37	4.20

% change in revenues is 35% more than % change in MCP

Lam, Cheung, Reygondeau, Sumaila. (in revision)

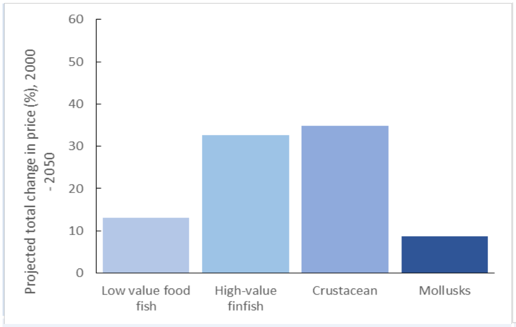
Price Scenarios (RCP 8.5)

Scenarios	Brief descriptions
Baseline	Most plausible assumptions
Faster aquaculture expansion	The aquaculture output of the seafood commodities **increased by 50%** relative to baseline scenario
Lower China production	Income demand elasticities, production growth trends, and feed conversion ratios are **adjusted downward**.
Fishmeal and oil efficiency	Feed conversion efficiency for fishmeal and fish oil improves = **2 x baseline scenario**
Slower aquaculture expansion	The aquaculture output of the seafood commodities **decreased by 50%** relative to baseline scenario

Price Scenarios (RCP 8.5)

Baseline

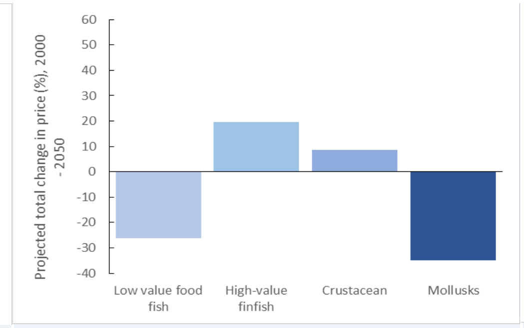
Projected change in price (%)



% change in revenue: 13%

Faster aquaculture expansion

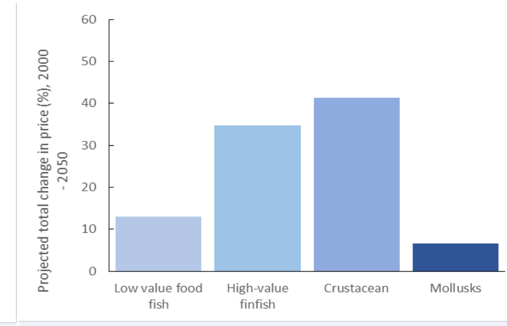
Projected change in price (%)



% change in revenue: -15%

Lower China production

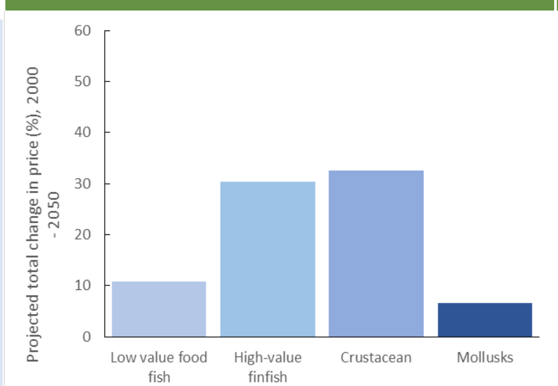
Projected change in price (%)



% change in revenue: 14%

Fishmeal & fish oil efficiency

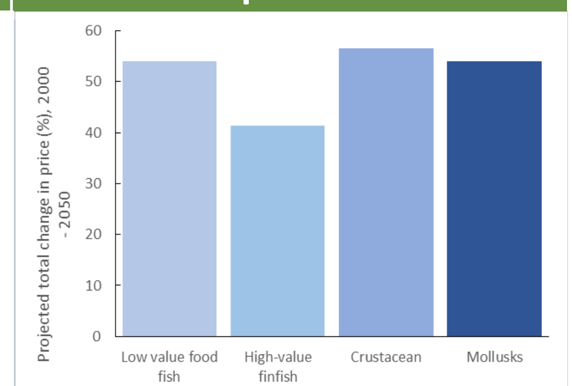
Projected change in price (%)



% change in revenue: 11%

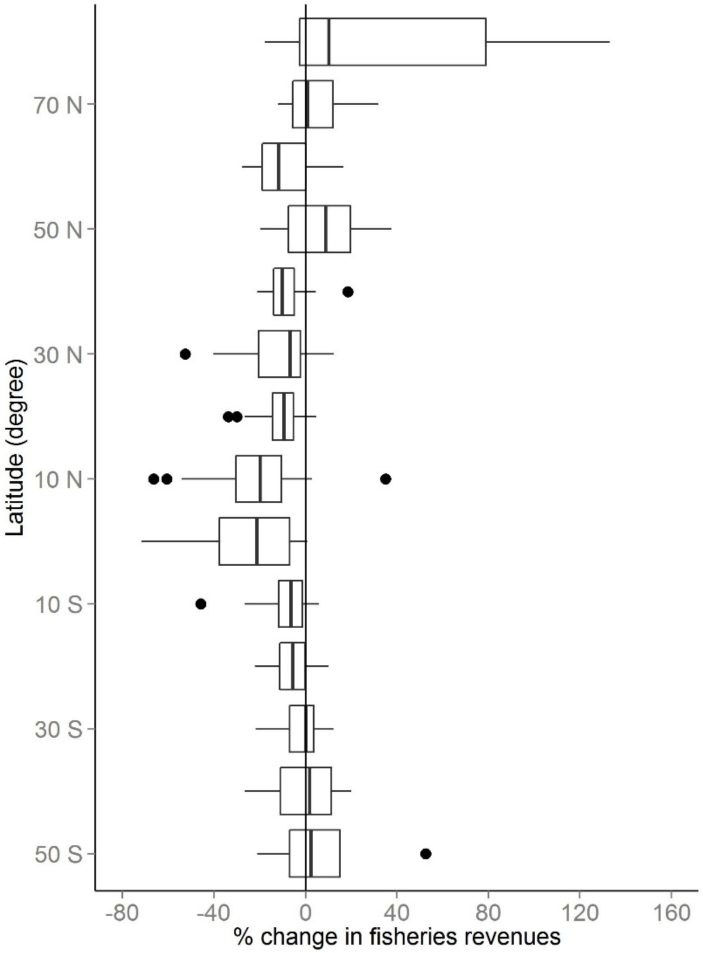
Slower aquaculture expansion

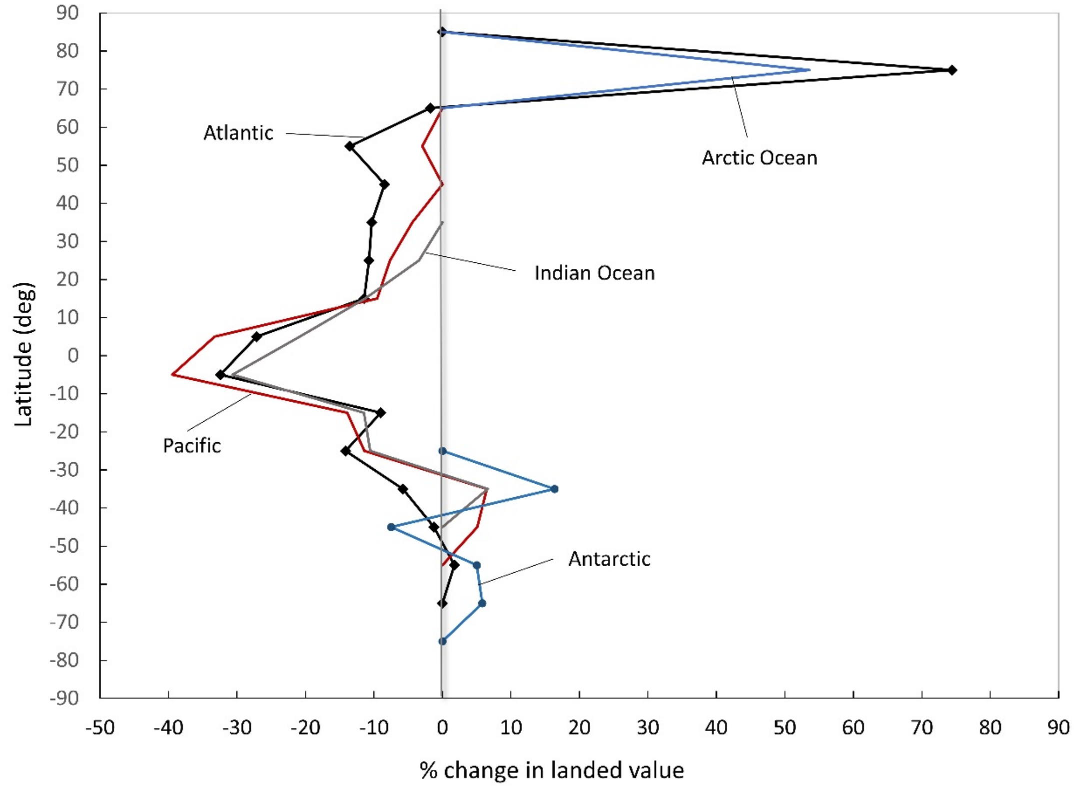
Projected change in price (%)



% change in revenue: 40%

Latitudinal and regional patterns of impact on fisheries revenues



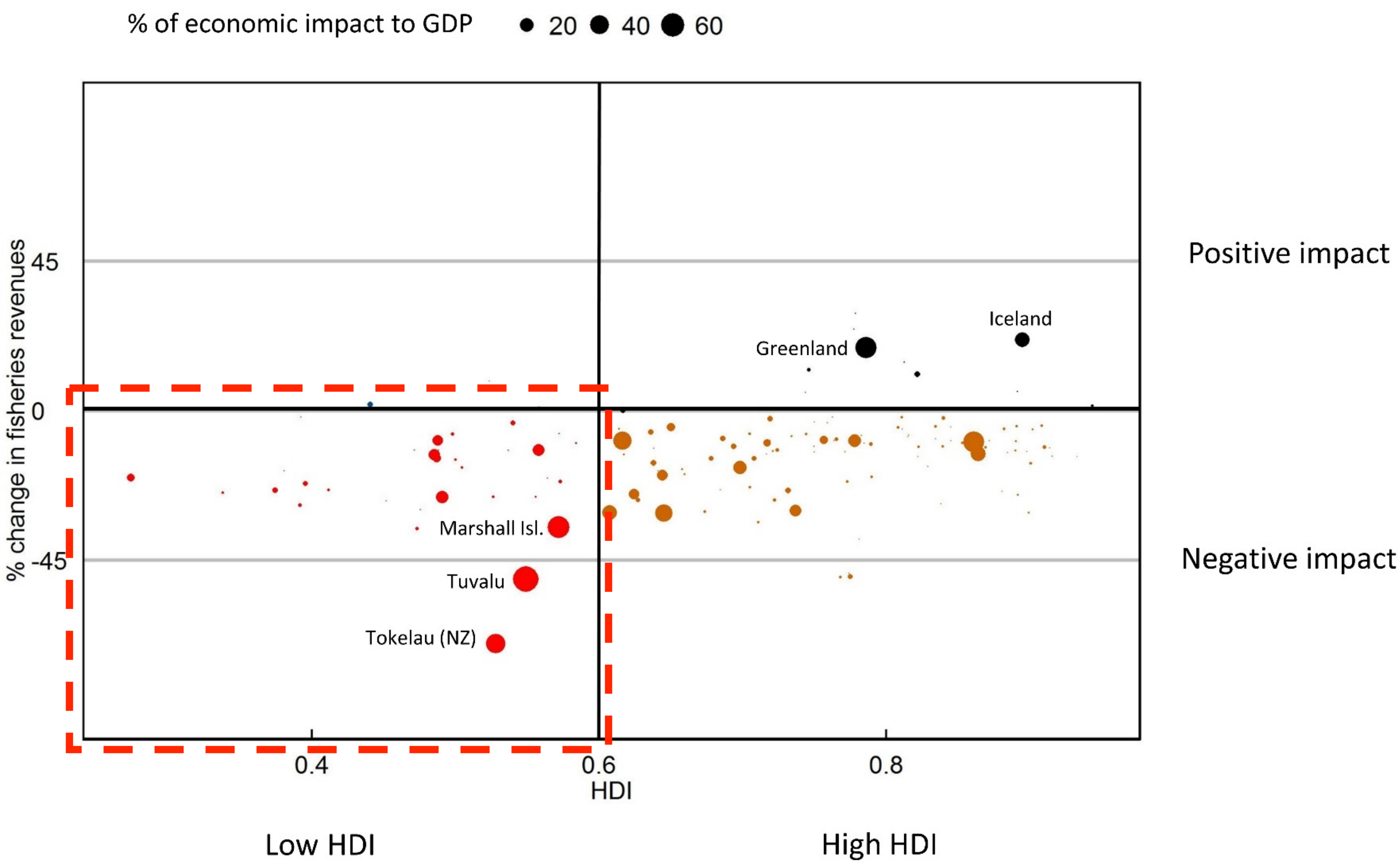


Latitudinal pattern

Change at different ocean basins

Lam, Cheung, Reygondeau, Sumaila. (in revision)

Are the impacts equally important in different countries?



Lam, Cheung, Reygondeau, Sumaila. (in revision)

Challenges

1. Price dynamics;

2. Degree of economic impact also depends on how people value the future (i.e., the discount rate);

3. Uncertainties (Model and structural uncertainties).

Uncertainties

Model uncertainty

Different Earth System Models (ESMs)

	Model uncertainty				
	% change in maximum catch potential				
	GFDL	IPSL	MIP	**Mean**	**S.D.**
RCP 2.6	-1.66	-8.49	-2.03	**-4.06**	**3.84**
RCP 8.5	-4.44	-12.66	-6.02	**-7.71**	**4.36**
	% change in fisheries revenues				
RCP 2.6	-5.07	-11.15	-5.12	**-7.11**	**3.50**
RCP 8.5	-6.88	-15.03	-9.21	**-10.37**	**4.20**

Different structure of fish models

	% change in global fisheries revenues in the 2050s from the current status (2000s)				
Earth System Model	GFDL			**Mean**	**S.D.**
Spatial distribution models	Basic	AquaMaps	Maxent		
Maximum catch potential	-5.8	-8.2	-3.6	**-5.9**	**2.3**
Fisheries revenues	-10.1	-9.6	-4.1	**-7.9**	**3.4**

Future studies

1. Should include other metrics such as monetized utility (e.g., consumer surplus) and resource rents (e.g., producer surplus);

2. Actual catch may not equal to MCP. Future studies should consider the influence of different policies;

3. Other human and socio-economic responses to climate change should also be considered e.g., adaptation responses.

Outline:

Part 1: Projected changes in global fisheries revenues under climate change;

Part 2: Predicting fishing effort.

However, the earlier version DBEM did not include:

- Δ the catch amount and profit → the investment → the fishing effort;

- Δ effort → biomass and catches.

(Nereus workshop on effort dynamic in 2015)

Predicting fishing fleet dynamics using a simple bioeconomic model

Assumption: that active effort will seek to maximize profits from a fishery given yearly price and cost information.

- Within a given year, enter a fishery vs remain at the dock;

- Over longer time spans, the total fleet size will change depending on the profitability of the fishery;

Parameters and variables in the effort dynamic model

Effort dynamic model

Biology
- Biomass
- Carrying capacity
- Intrinsic population growth rate
- Density-dependent distribution

Economics
- Ex-vessel price
- Unit cost of fishing
- Cost of each new vessel
- Reinvestment ratio

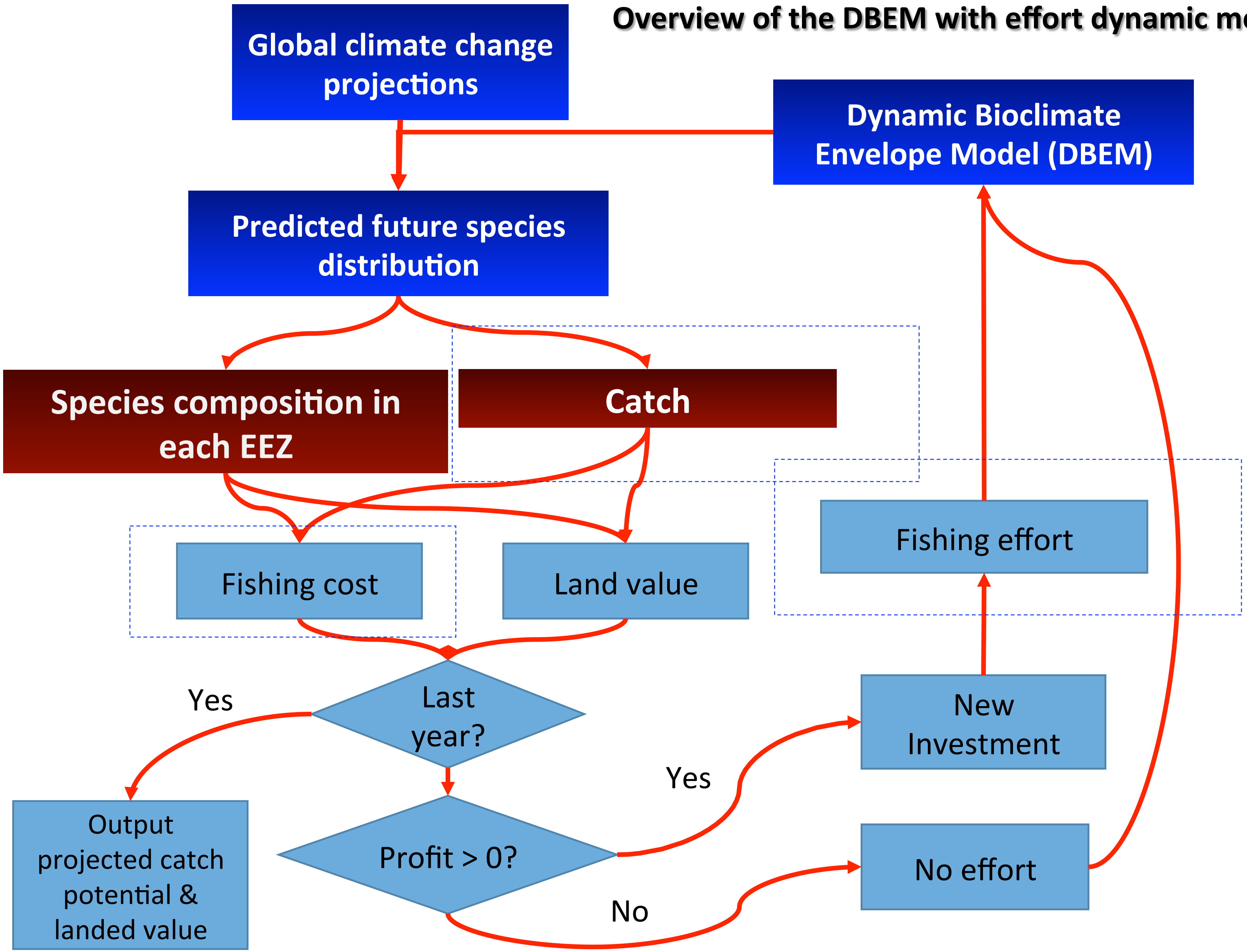
Fisheries
- Initial fleet size and active effort
- Number of new vessel
- Effort response to catch
- Capital depreciation
- Catchability

Source of parameters

Some examples:

Parameters	Sources	Notes
Active fishing effort, *E*	SAU fishing effort database	The fishing effort data is by country, year, sector and gear type (not by spp and no spatial information)
Ex-vessel price, *p*	SAU price database	Assume the price keep constant after 2010
Unit cost of fishing, *c*	Global fishing cost dB (Lam *et al*. 2011)	No time series data
Effort response to profit, *ρ*	Assumed	
Reinvestment ratio, *I*	Assumed	Proportion of profit reinvested into fishery
Catchability, *q*	Estimated from the current values	

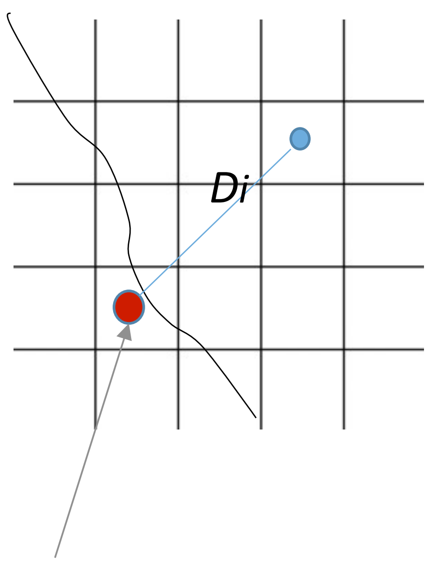
Overview of the DBEM with effort dynamic model



Spatial distribution of fishing effort (Gravity Model)

$$\hat{c} = \sum_{i=1}^{n} h * p * Prop \Big/ \sum_{i=1}^{n} D$$

- $\hat{c}$ is the average fishing cost per km;
- *Prop* is the proportion of operational cost to the total landed value of a sector.



centre point of the coast of a country

<u>In each cell:</u>

$$G_i = K * \sum_{j=1}^{n} (p_j * q_j * B_j) \,/\, c_i$$

- *G* is the weighted “attractiveness” of a cell to fleet;
- K = if cell is open to that fleet, then 1, otherwise 0;
- c_i = fishing cost = $\hat{c} * D_i$;

$$F_i = F_T * G_i \Big/ \sum_{i=1}^{n} G_i$$

- F_T is the total fishing effort in a EEZ.

Way forward

- Testing model implementation of the linkages between DBEM and fishing dynamic model;

- Application of case studies e.g., Bangladesh, Solomon Islands, with the focus on nutritional security;

- Linkages to macro-economic model (University of Akansas).

Conclusions

1. Global revenues could drop by 35% more than the projected decrease in catches by 2050 under RCP8.5;
2. Projected increase in fish catch in high latitude countries may not translate into increase in revenues;
3. Most developing countries (low HDI) with high fisheries dependency are negatively impacted;
4. These results provide further justification for the need to begin to decarbonize the global economy by implementing the Paris Agreement;
5. The inclusion of fishing effort dynamic into the DBEM allows us to project the future MCP and revenues in a more realistic way.

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Source: FERU website (http://www.feru.org)