Can there be stable, cooperative management of a transboundary fish stock under climate variability?

A case study of the Pacific sardine fishery in the California Current

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Motivation

Management of transboundary fish stocks

Transboundary fish stocks
exclusively shared/fished by multiple countries.

Sustainable management of transboundary fish stocks requires cooperative agreements on:

1. the size of the fish stock left behind (escapement);
2. shares of catch.

by participating fishing countries .

Motivation

Climate variability affects shared fishery resources

Climate variability affects
food availability and critical habitats for fish.

This results in:

- ✓ Local availability changes;
- ✓ Unstable fish stock share per country

(based on distribution or migration patterns).

Motivation
Legal regime would not work!

The UN Convention on the Law of the Sea imposes a duty on participating fishing countries of a shared fish stock to negotiate cooperative management.

This does not impose requirements for these countries to

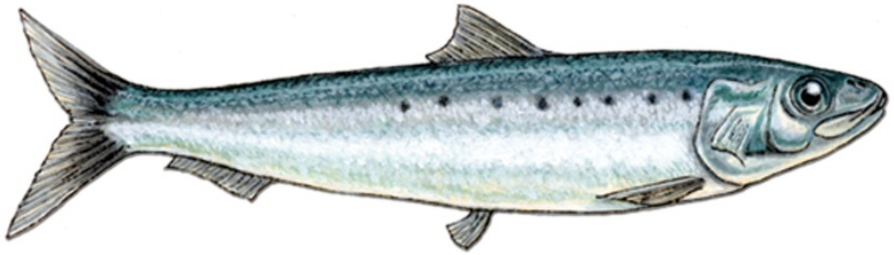
1) reach a cooperative agreement or
2) prescribe penalties for deviations from once-reached agreements on cooperative management.

(Munro et al. 2004)

Pacific Sardine in the California Current

Pacific sardine in the California Current ecosystem

- Inhabits the California Current ecosystem (from Vancouver Island, Canada to Baja California, Mexico);
- Exclusively fished by Canada, US and Mexico;
- Extremely sensitive to warm/cold climate regime shifts of the California Current ecosystem.

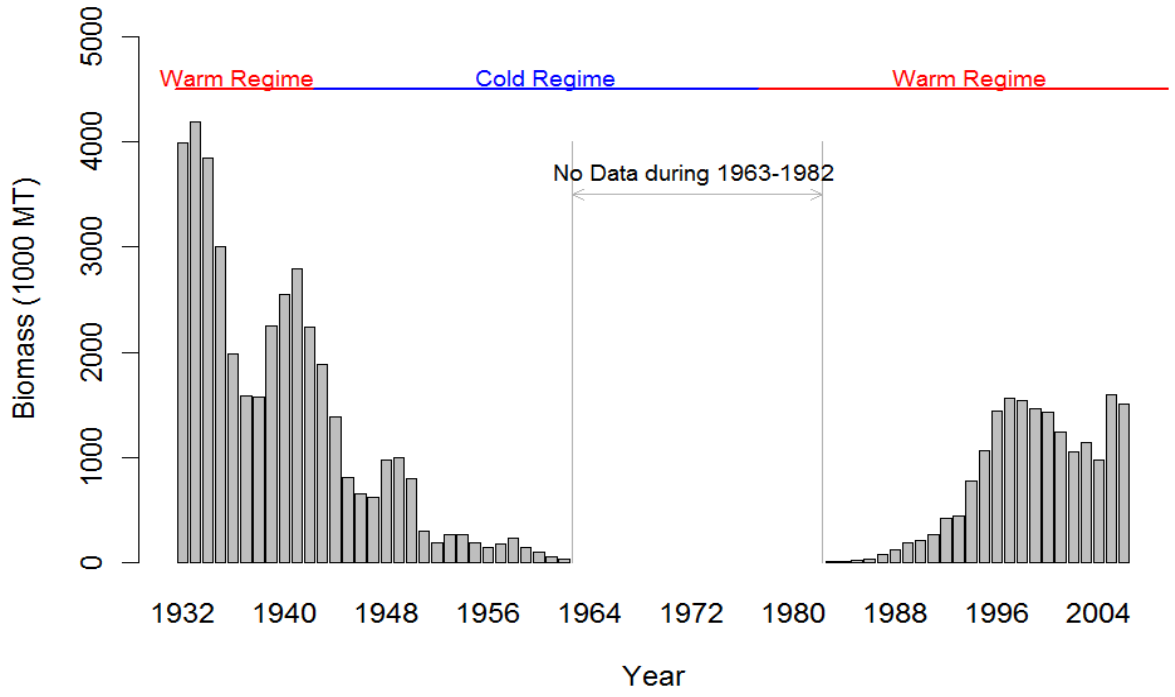


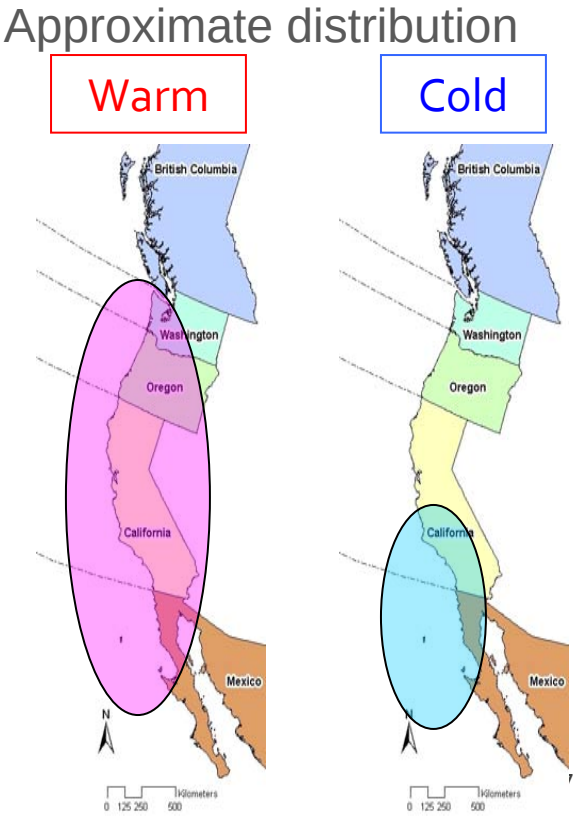
From http://www.darrp.noaa.gov/southwest/montrose/images/pacific_sardine_fishid2.jpg

Pacific sardine stock and warm/cold regimes in the California Current

Warm regimes - High biomass abundance, distribution extends from Baja California, Mexico to Vancouver Island, Canada.

Cold regimes - Low biomass abundance, distribution is limited to southern California and Baja California.





Issues of Pacific sardine under climate variablity

- Coastal wide abundance changes;
- Distributions changes over three countries EEZ;
- No established cooperative management.

Purpose

Can there be stable, cooperative management?

Climate variability change fish distributions and bring free-riding opportunities by deviating from cooperative management.

Purpose:

Explore the stability of full and partial cooperative management under different climate variability scenarios (warm and cold) with a case of Pacific sardine in the California current ecosystem.

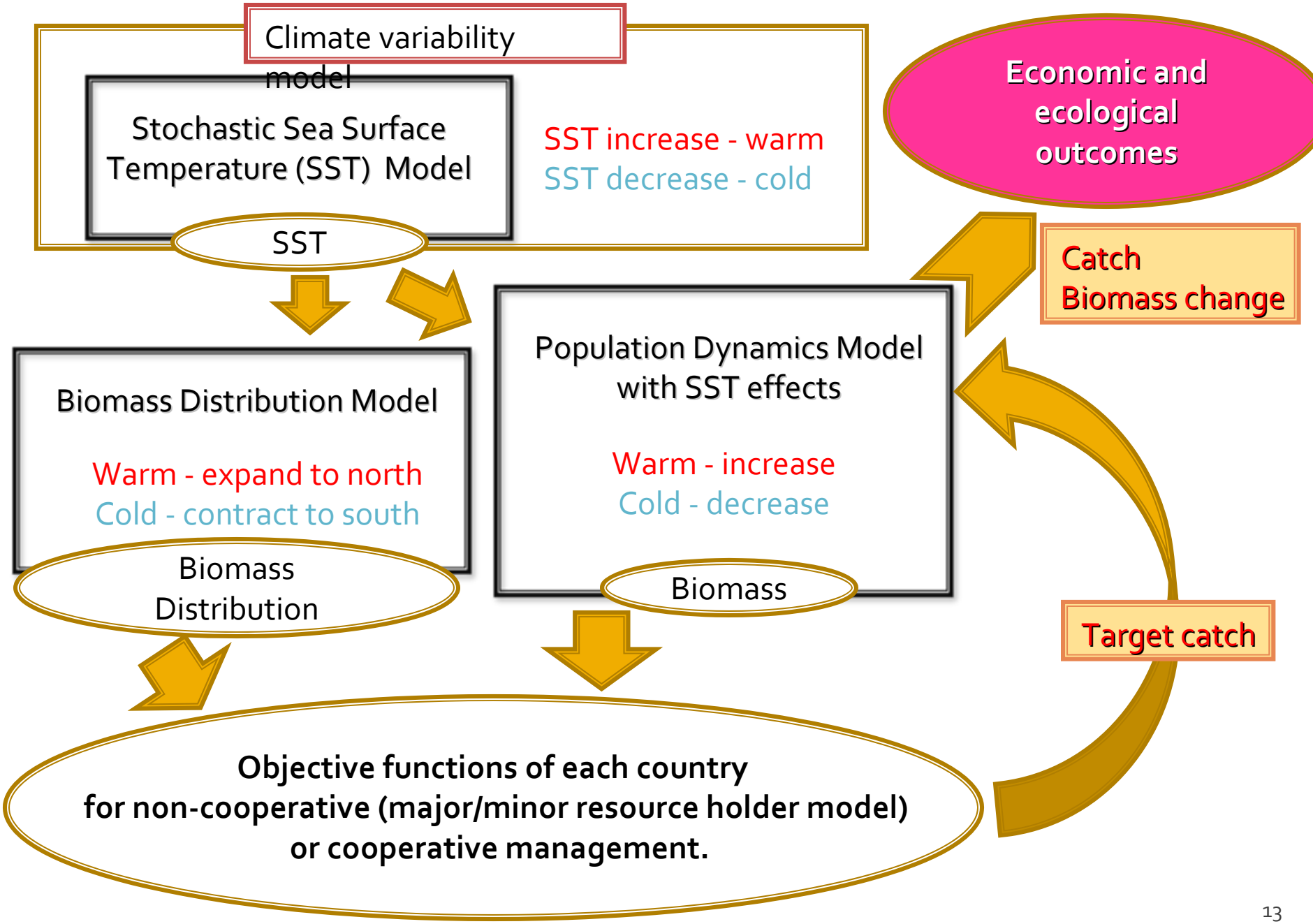
Can there be stable, cooperative management?

How to judge stability of cooperative management?

Stand-alone stability of a cooperative management is such that no country finds it profitable to deviate from cooperative management .

Model

Overview of the model



Full/partial cooperative and non-cooperative management by Canada, US and Mexico

	Cooperative structure	Free rider	
1	{CA,US,MX}d		Full cooperation with dynamic share of quota up to the distribution changes.
2	{CA,US,MX}f		Full cooperation with fixed share of quota as the initial distribution.
3	{CA,US}	{MX}	Partial cooperation; Canada and US.
4	{US,MX}	{CA}	Partial cooperation; US and Mexico.
5	{CA}{US}{MX}		Non-cooperation.

Some results

Can there be stable, cooperative management?
Full coopelation maximize benefits !

Result (Warm climate regime base case):

		Economic outcomes				Ecological outcomes
		Present value of net benefits from 35-year simulation (million USD)				Conservation Risk
	Cooperative structure	Mexico	US	Canada	Total	Probability of biomass less than $0.1*B_{t=0}$
1	Full cooperation with dynamic share quota	89	191	181	461	0.00
2	Full cooperation with fixed share quota	40	322	61	424	0.00
3	Partial cooperation of US and CA	175	105	156	436	0.01
4	Partial cooperation of MX and US	74	94	253	422	0.03
5	Non-cooperation	108	68	152	327	0.44

Can there be stable, cooperative management?
Free-rider values exceeded to full cooperation!

Result (Warm climate regime base case):

		Present value of net benefits from 35-year simulation (million USD)				Conservation Risk
	Cooperative structure	Mexico	US	Canada	Total	Probability of biomass less than $0.1*B_{t=0}$
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Can there be stable, cooperative management?
US/CA cooperation has stand-alone stability !

Result (Warm climate regime base case):

		Present value of net benefits from 35-year simulation (million USD)				Conservation Risk
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Can there be stable, cooperative management?
Side payment can make stability!

Result (Warm climate regime base case):

	Cooperative structure	Present value of net benefits from 35-year simulation (million USD)				Conservation Risk
		Mexico	US	Canada	Total	Probability of biomass less than $0.1*B_{t=0}$
1	Full cooperation with dynamic share quota	89	191	181	461	0.00
2	Full cooperation with fixed share quota	40	105	156	261	0.00
3	Partial cooperation of US and CA	175	105	156	436	0.01
4	Partial cooperation of MX and US	74	94	253	422	0.03
5	Non-cooperation	108	68	152	327	0.44

461-175=286

105+156=261

Some conclusions

- Climate variability prevents the formation of stable, full cooperative management of Pacific sardine fisheries by Canada, US and Mexico;
- Side payments would be a tool to encourage stable full cooperative management;
- Need flexible benefit and right transfer systems to maximize benefits and minimize the conservation risk under climate variability.

Thanks you!

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Copper sharks and a school of sardines off South Africa
Photograph by David Doubilet

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