Sustainable Management of a Transboundary Fishery Resource under Climate Variability

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A view of Fishery system

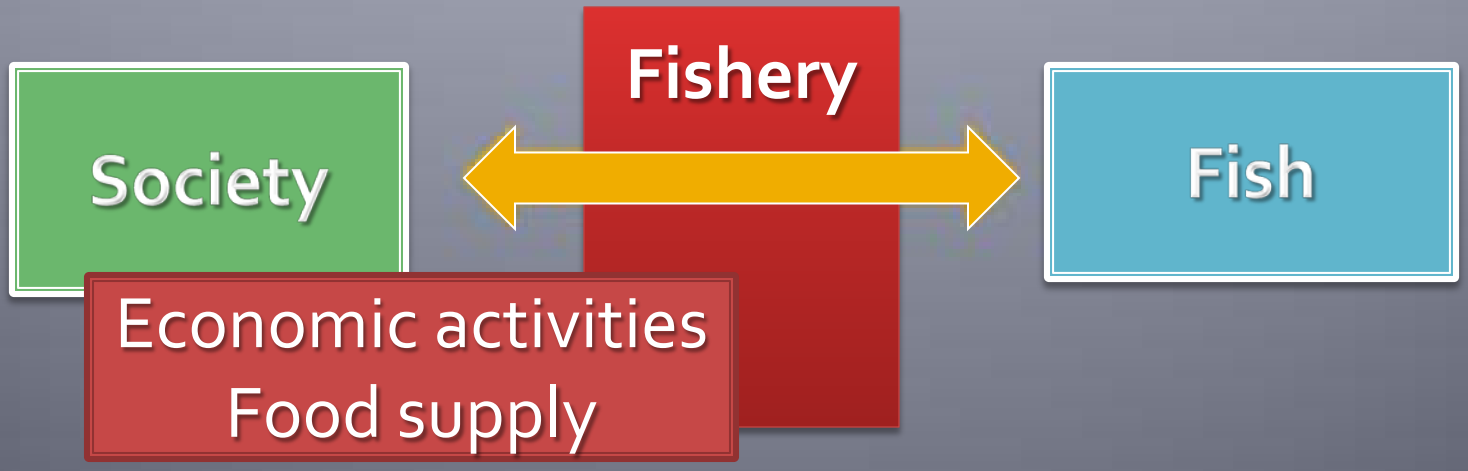
Fishery system?

Society

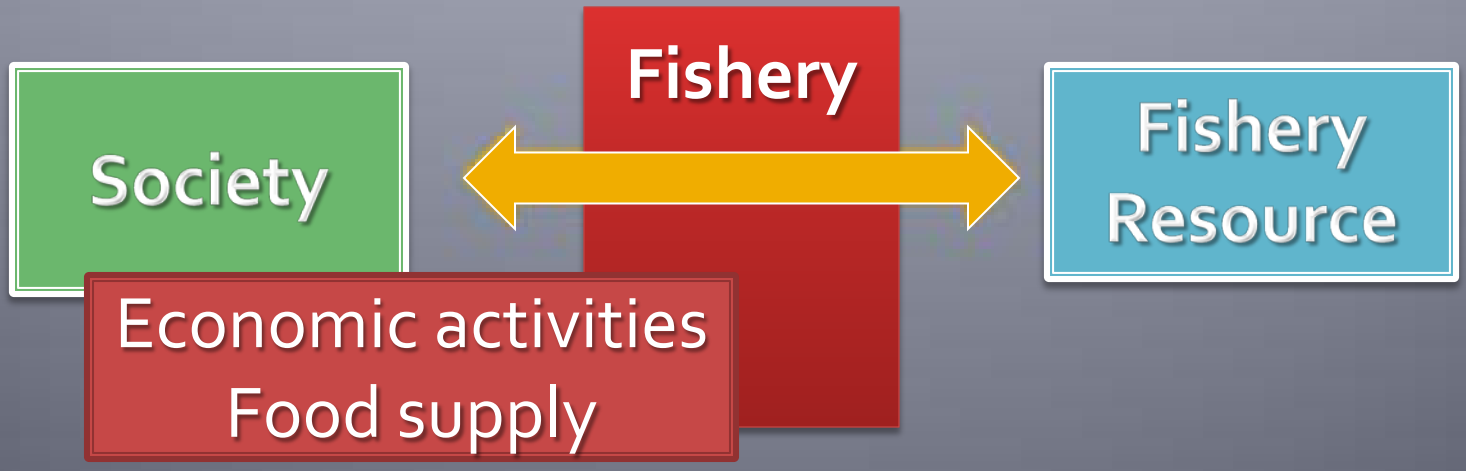
Fish

Fishery system?

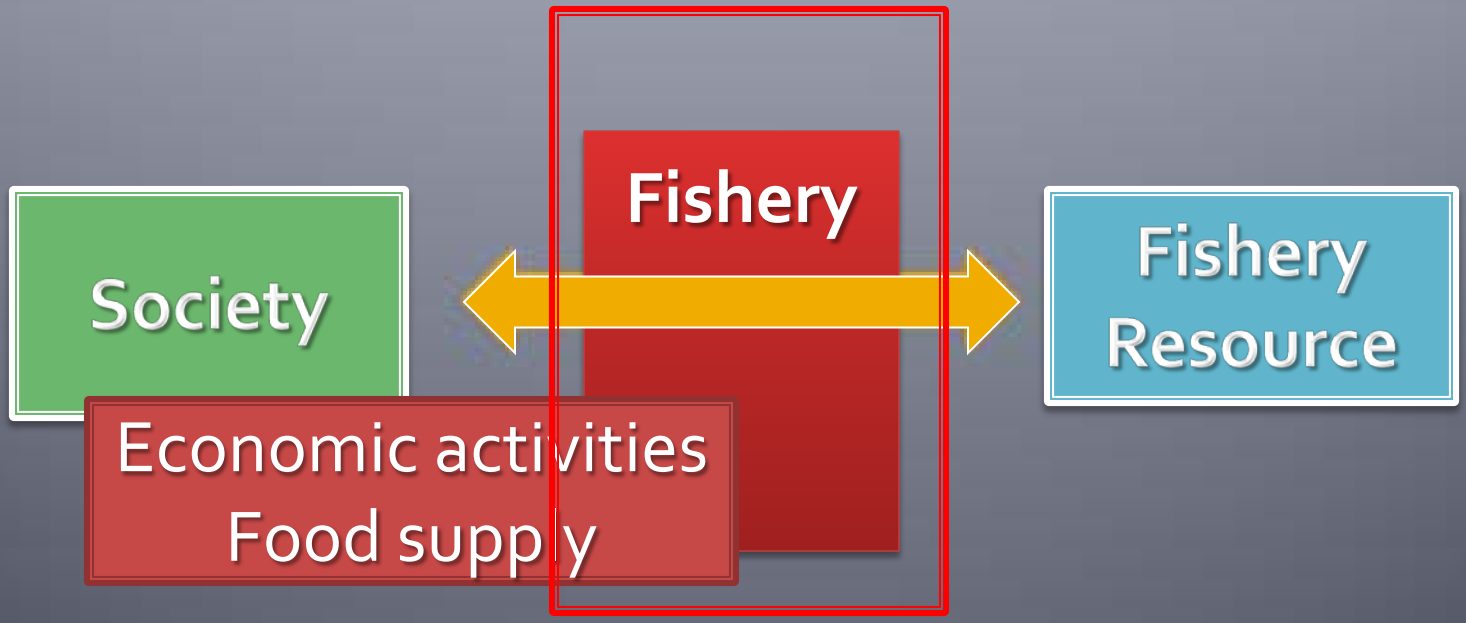
Fishery system?



Fishery "resource" system?



Fishery "resource" system?



What fishery resource management aim for?

Maintain the renewability
of the fishery resources to insure recursive flows of benefits, food and economic activities, to the society.

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of the fishery resources to insure recursive flows of benefits, food and economic activities, to the society.

Maintain Biomass and Industries!

Climate variability and Fishery resource

Challenges for the management of a transboundary fish stock under climate variability

Climate variability affects food availability and the critical habitats for fish, and change;

1) abundance of fishery resources
2) distributions/ migration patterns of fishery resources

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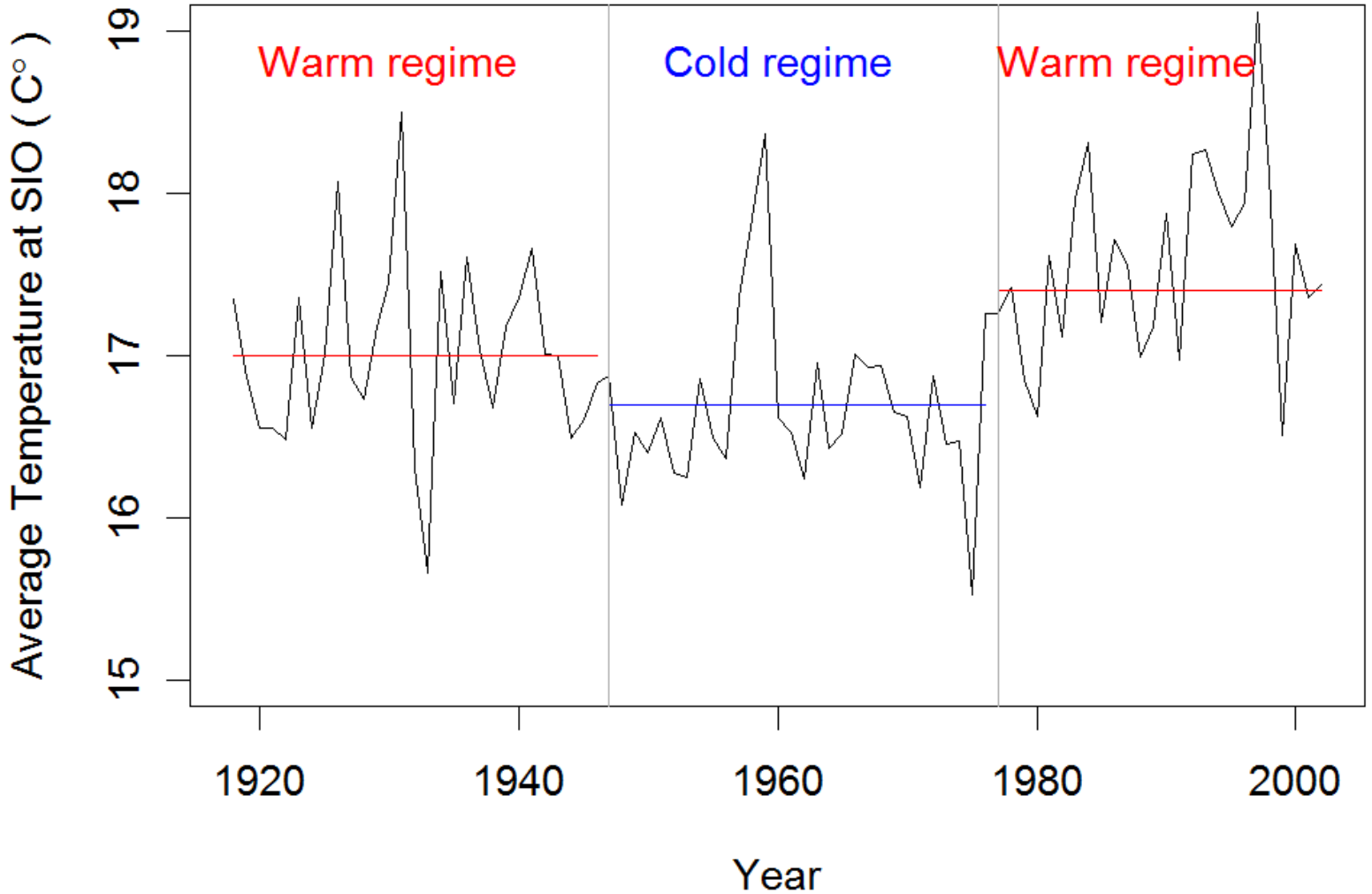
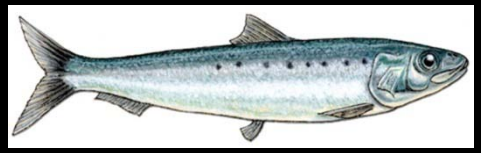
This is a critical issue for **a transboundary fish stock** exclusively shared by multiple countries.

Pacific Sardine in the California Current

Warm/cold regimes in the California current system





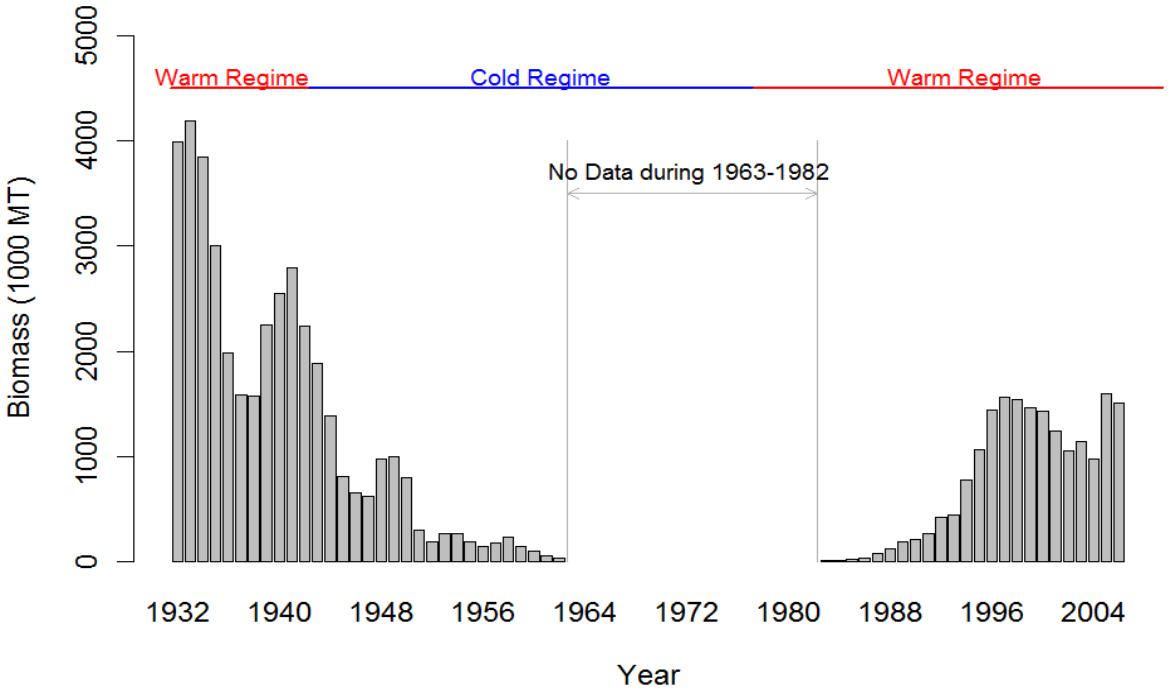
Pacific sardine stock and warm/cold regimes in the California current

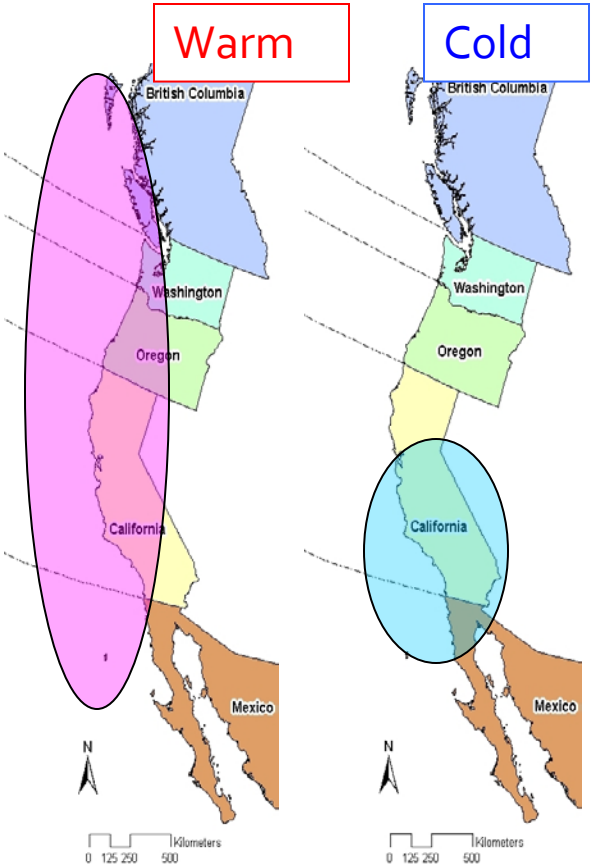
Warm regimes -

high abundance in biomass, the distribution extends to Canada, U.S. and Mexico.

Cold regimes -

low abundance in biomass, the distribution is limited to Southern U.S. and Mexico.





Pacific sardine under climate variability

- Coastal wide abundance changes;
- Distributions changes over three countries EEZ;
- No established cooperative exploitations ;
- Rising economic interest.

Examine the economic and biological outcomes from cooperative/non-cooperative exploitations of Canada, U.S. and Mexico.

- ✓Modeled Pacific sardine fishery and Pacific sardine population dynamics driven by climate variability.
- ✓Carried stochastic game theoritic simulations with various climate variability scenarios.

Full and partial cooperation structures of Canada, U.S. and Mexico.

	Cooperative exploitation	Non-cooperative exploitation	
1	{CA,US,MX}		Full cooperation exploitation
2	{CA,U.S}	{MX}	Partial cooperative exploitation ; Canada and the U.S
3	{US,MX}	{CA}	Partial cooperative exploitation; Mexico and the U.S
4	{CA,MX}	{US}	Partial cooperative exploitation ; Canada and Mexico
5		{CA}{US}{MX}	Absolute no-cooperative exploitation

Cooperative exploitation;
maximize the joint benefits of participating countries;
Non –cooperative exploitation; maximize individual benefits.

Payoffs (billion USD) in a warm scenario
Shift distribution from Mexico to Canada

Cooperative	Non-cooperative	CA	US	MX	Total payoff	Biological Risk
{CA,US,MX}					460	0.0%
{CA,U.S}	{MX}				429	36.3%
{US,MX}	{CA}				416	44.0%
{CA,MX}	{US}				411	46.3%
	{CA}{US}{MX}				309	96.8%

Ishimura, Sumaila and Herrick (2009)

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Payoffs (billion USD) in a warm scenario
Shift distribution from Mexico to Canada

Cooperative	Non-cooperative	CA	US	MX	Total payoff	Biological Risk
{CA,US,MX}		183	210	68	**460**	0.0%
{CA,U.S}	{MX}	150	86	*194*	429	36.3%
{US,MX}	{CA}	*260*	104	51	416	44.0%
{CA,MX}	{US}	138	*144*	128	411	46.3%
	{CA}{US}{MX}	148	50	112	309	**96.8%**

There are significant benefits to be a free-rider!!

Some conclusions

- Ocean climate variability in the California current prevents the formation of stable full cooperative exploitations of the Pacific sardine fisheries.

- Free-rider is a key player in achieving desirable economic outcomes by forming cooperative exploitations.

Some conclusions …and Solution!

- Ocean climate variability in the California current prevents the formation of stable full cooperative exploitations of the Pacific sardine fisheries.

- Free-rider is a key player in achieving desirable economic outcomes by forming cooperative exploitations.

Our research reveled potential disasters, and push countries forward toward cooperative exploitations!

One more

Take-home message…

Academic research
have significant impacts to
lead the fishery resource sustainable.

Motivation
Stability of cooperative exploitations under climate variability

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

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 exploitation.

(Munro et al. 2004)