TECHNICAL EXPERTS WORKSHOP ON THE MANAGEMENT OF THE CAPACITY OF THE TUNA –FISHING FLEET IN THE EPO, Cartagena de Indias, Colombia, 23-25 April 2014

Bio-Economic Tradeoffs among Gears and Fleet Dynamics of Tuna Purse-Seiner Fishery

Jenny Sun, Ph.D.
Senior Marine Resource Economist
Gulf of Maine Research Institute
350 Commercial Street, Portland,
Maine 04101, USA
jsun@gmri.org

Gulf of Maine Research Institute
Science. Education. Community.

Objective of this research is twofold

1. Bioeconomic Tradeoffs among Gears

- different combinations of PS/LL effort that could produce the target shared biomass of tuna stocks.

2. Analysis of the Fleet Dynamics of PS Fisheries

- investigating the impacts of economic, regulatory, and oceanographic conditions as determinants of the spatial-temporal distribution of the tuna fleets.

Global Tuna Demand, Fisheries Dynamics and Fisheries Management in the EPO

May 13-14, 2010 , San Diego, CA

Coordinators

Jenny Sun, Mark N. Maunder, Minling Pan, and Dale Squires

Global Tuna Demand, Fisheries Dynamics and Fisheries Management in the EPO
May 13-14, 2010 , San Diego, CA

Increasing the Economic Value of the Eastern Pacific Ocean Tropical Tuna Fishery:

Tradeoffs between Longline and Purse-seine Fishing

Jenny Sun
Mark N. Maunder
Alexandre Aires-da-Silva
and
William H. Bayliff

CIAT IATTC

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

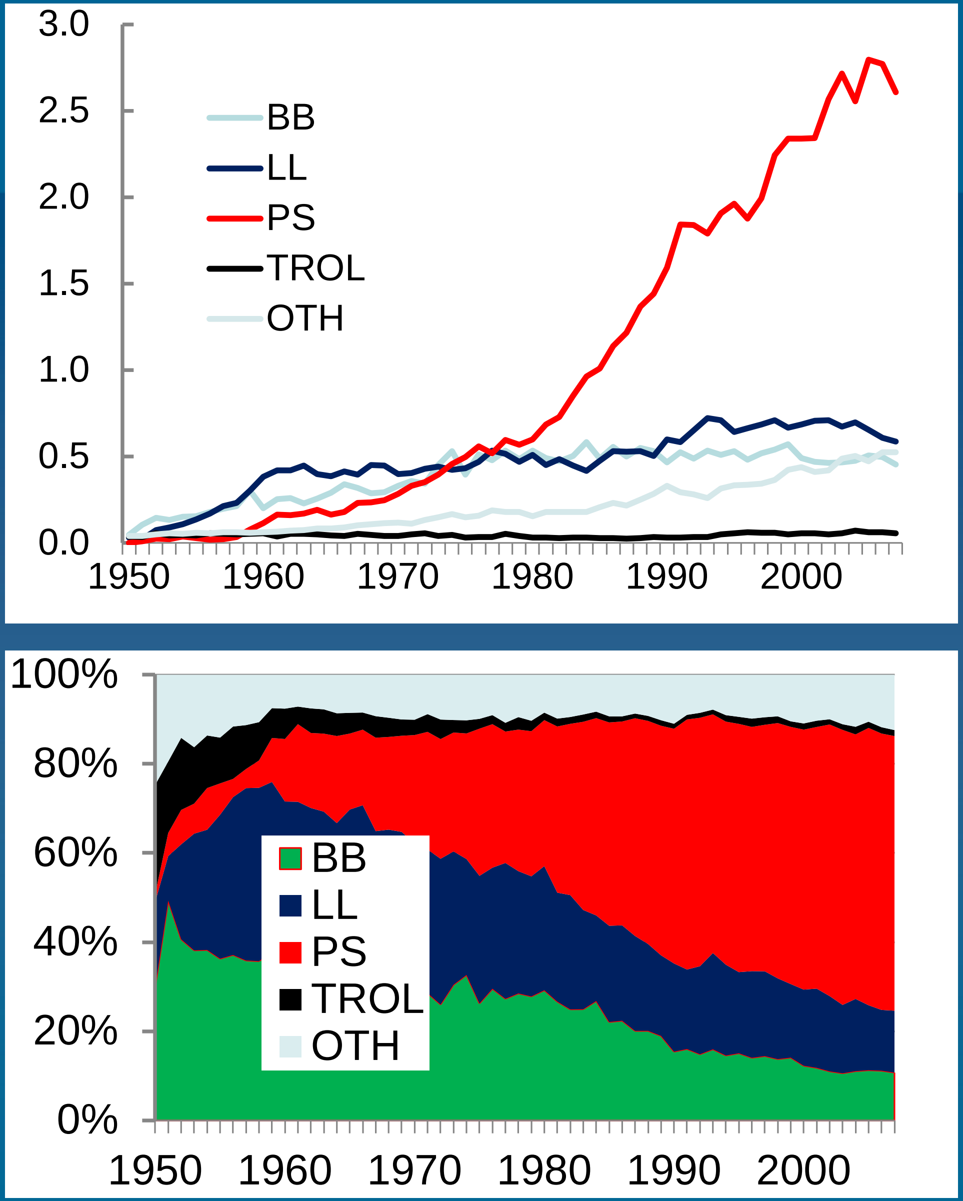
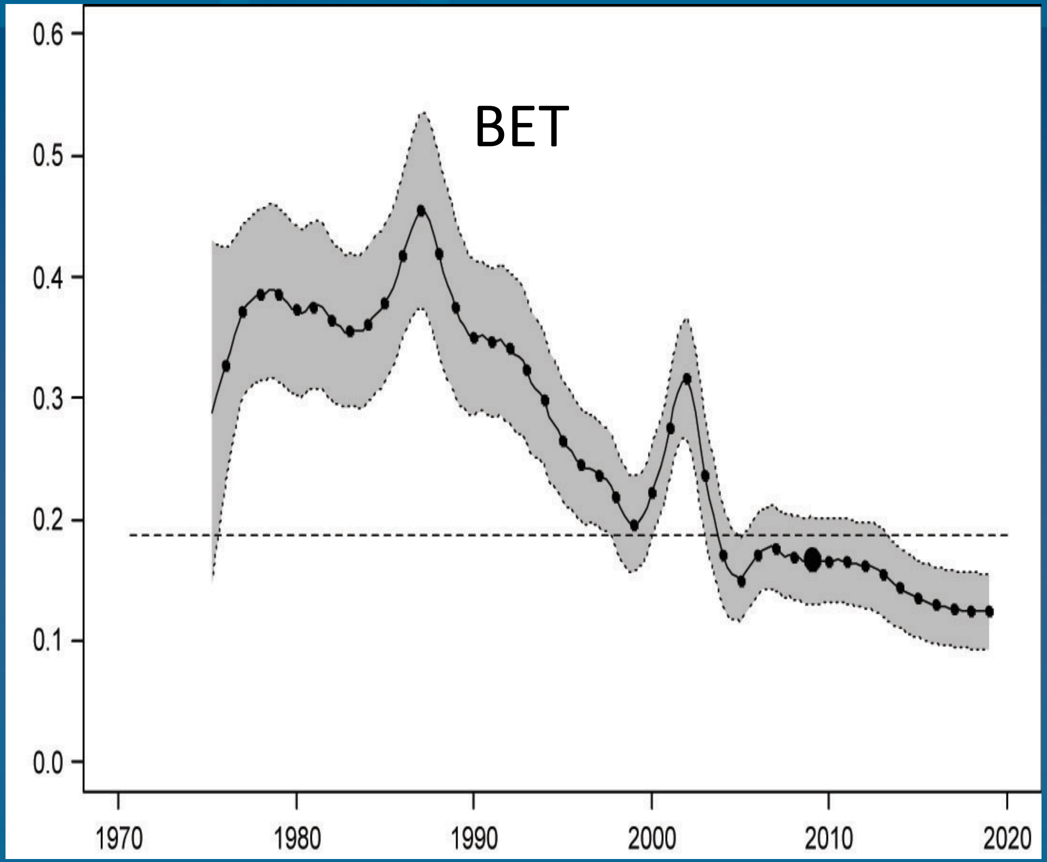
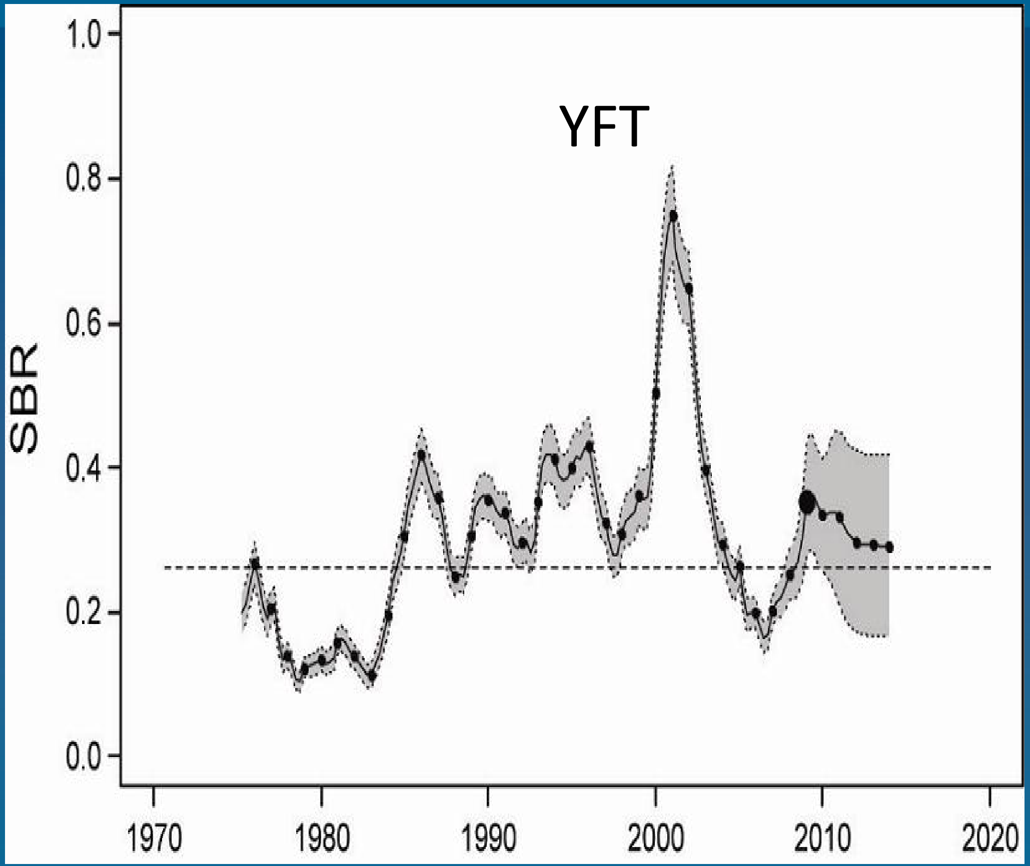


Fig. 5 World tuna catch by species and share (Source: FAO and RFMO databases)

Spawning biomass ratio (SBR)





- **Reducing both the LL and PS fishing effort proportionally by 20.5% during 2009-2011 is recommended by IATTC in 2008.**

Tuna Landings by Gear in the EPO

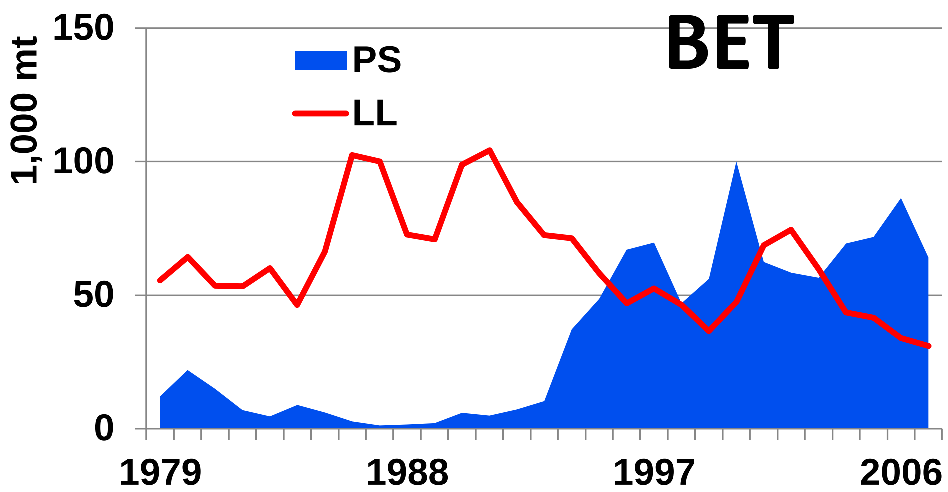


Fig. 2a Catches of bigeye tuna

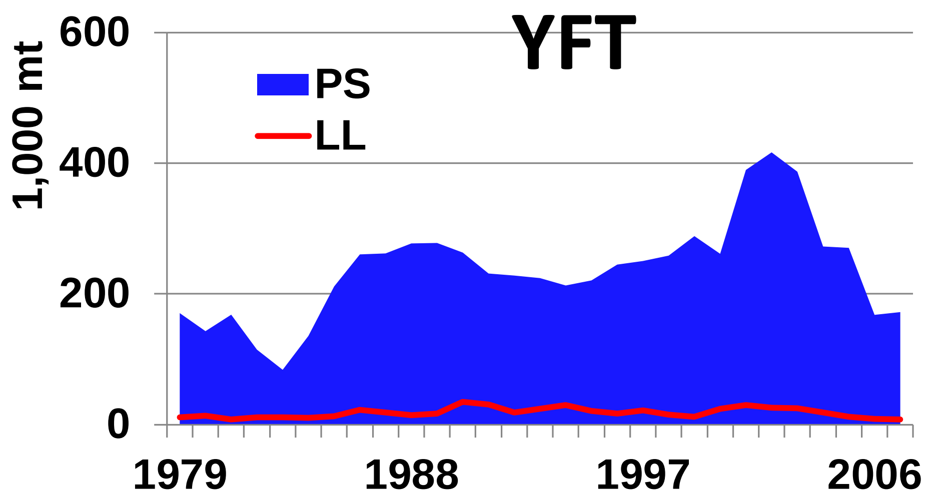


Fig. 3a Catches of yellowfin

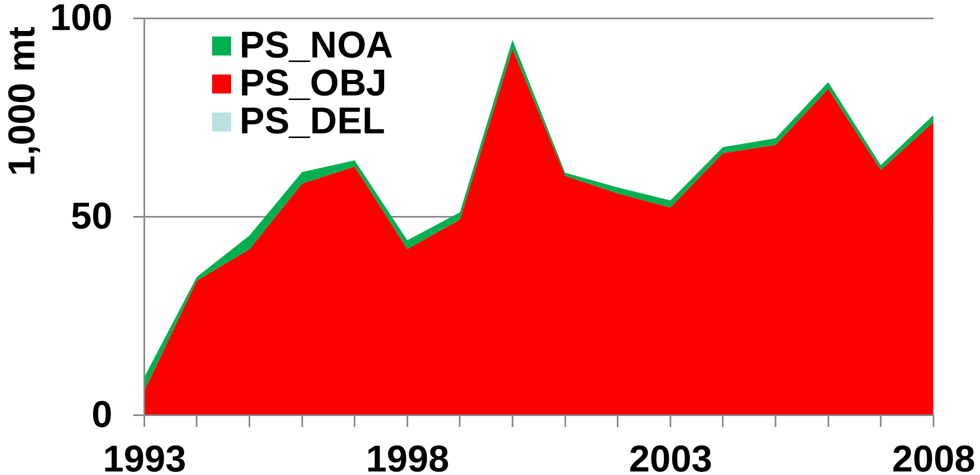


Fig. 2b BET by PS Gears

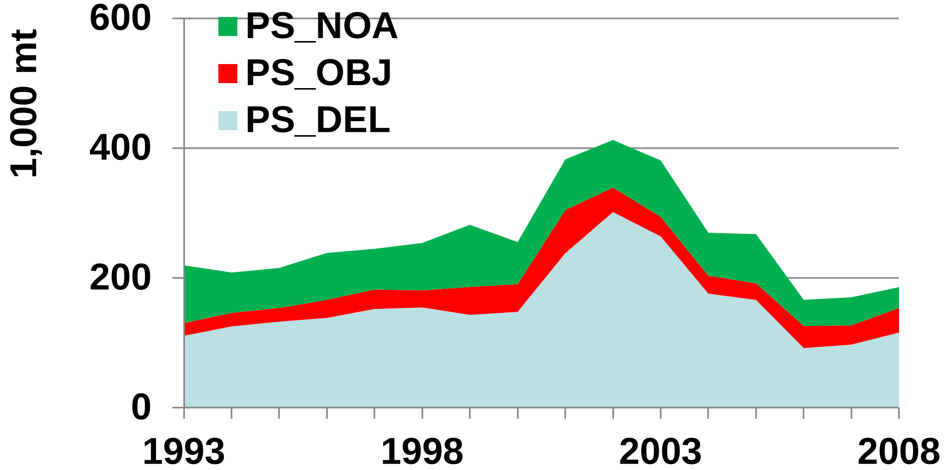
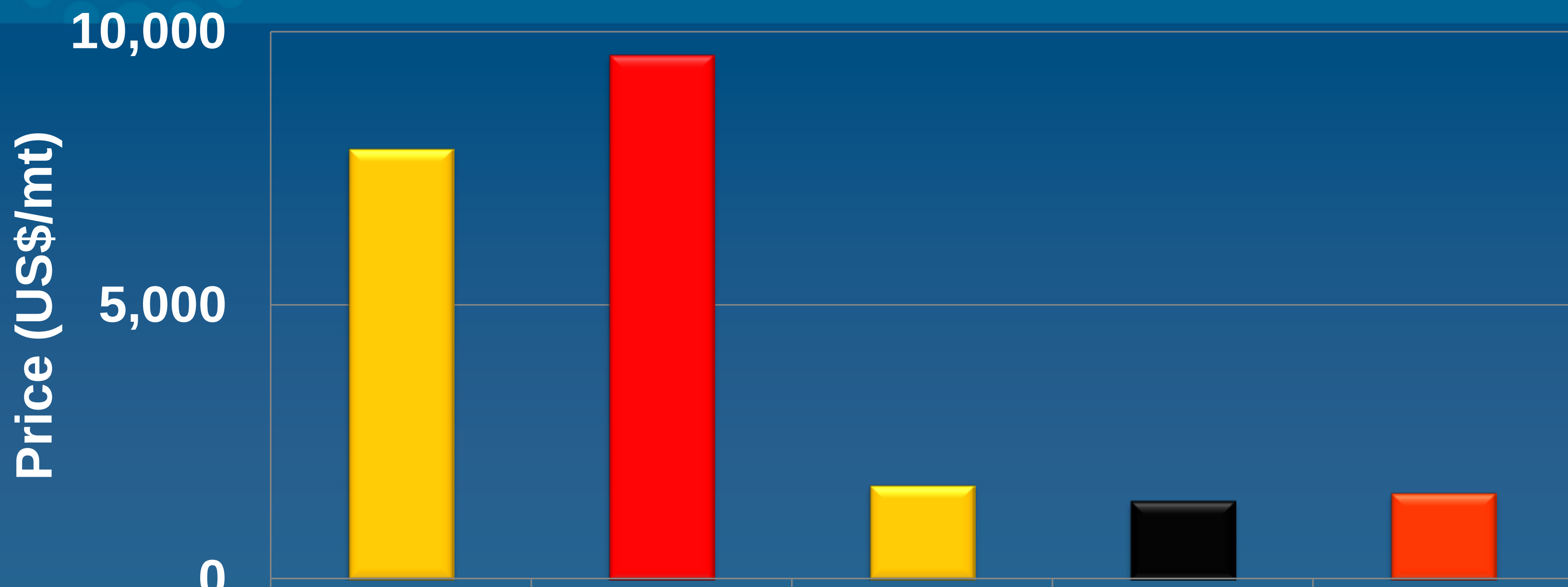


Fig. 3b YFT by PS Gears

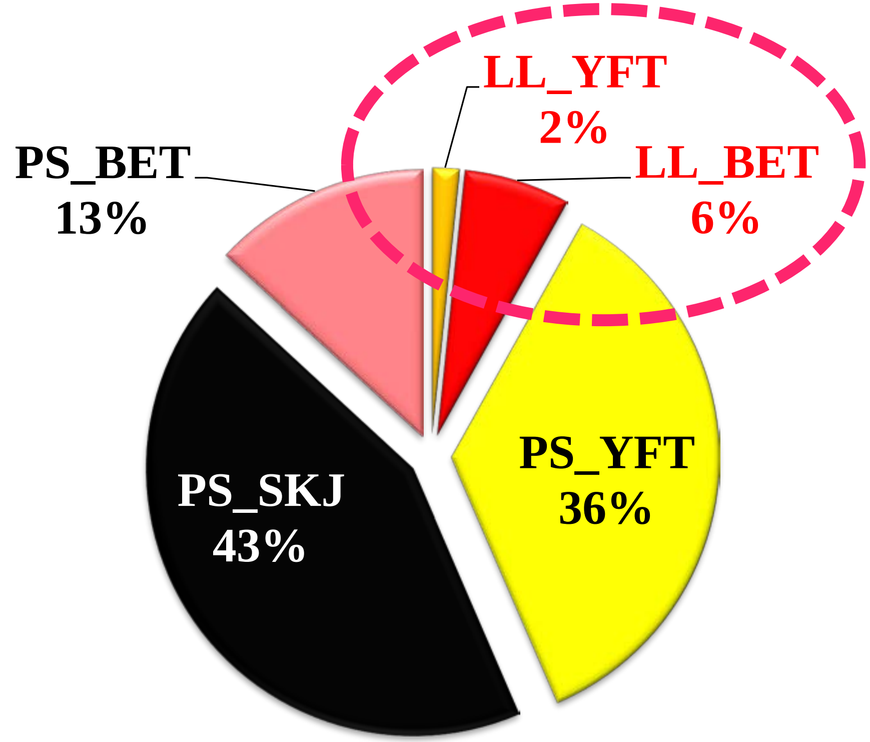
Ex-vessel Prices in 2007-2011 (US$/MT)



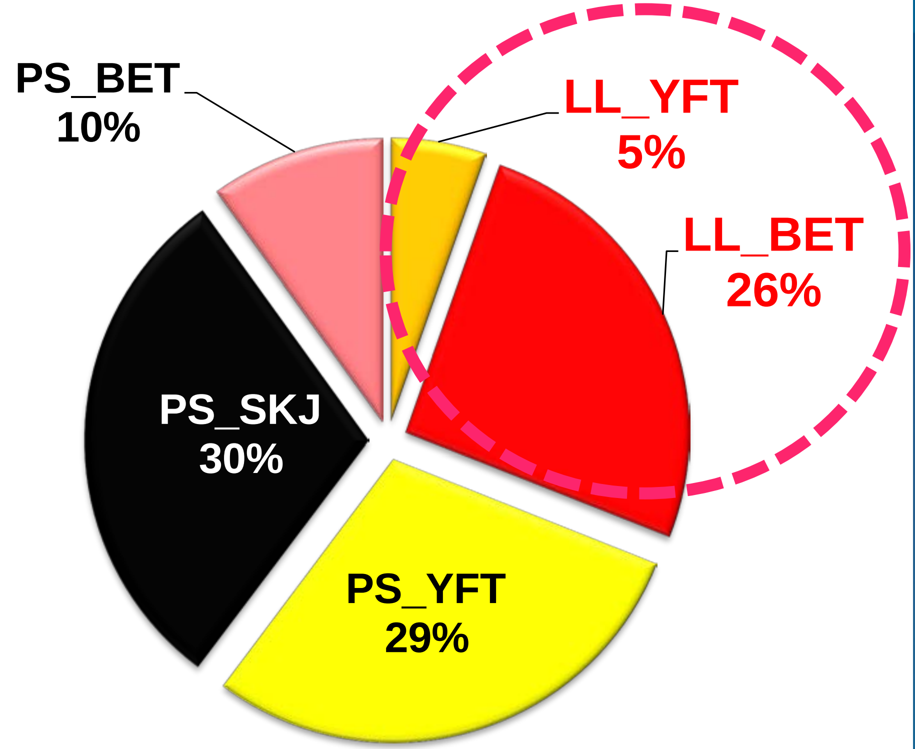
	LL_YFT	LL_BET	PS_YFT	PS_SKJ	PS_BET
Price ($/MT)	7,858	9,576	1,710	1,425	1,568

Both yellowfin and bigeye tuna in EPO are caught at sizes too small to take full advantage of their individual growth and the higher price obtained for large fish in the sashimi market.

Landings & Values by Gear & Species



Landings
(excluding discards)
(Total: 480,562 MT)



Landings Value
(Total: US$ 1 Billion)

Optimizing revenue therefore requires an understanding of both economic and biological tradeoffs among different management actions.

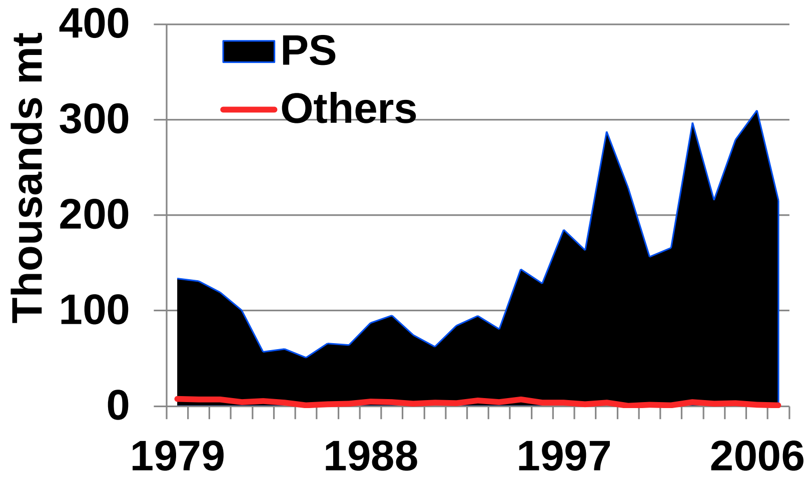


Fig. 4a SKJ Catches

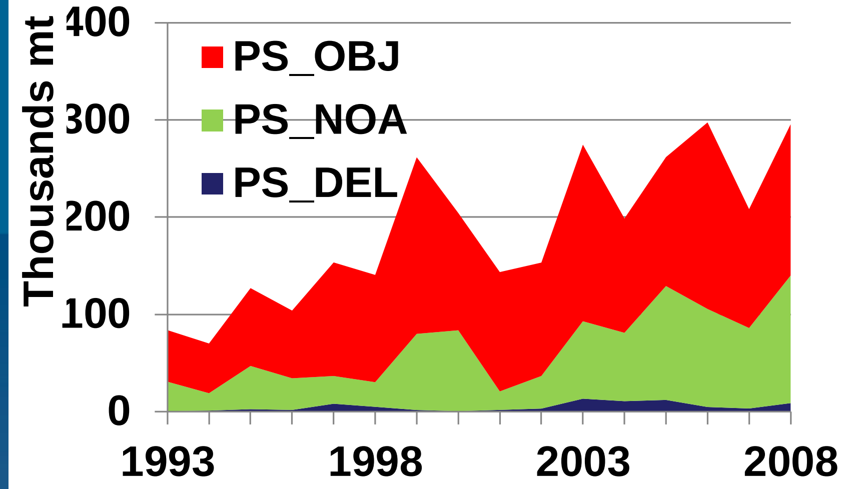


Fig. 4b PS SKJ catches

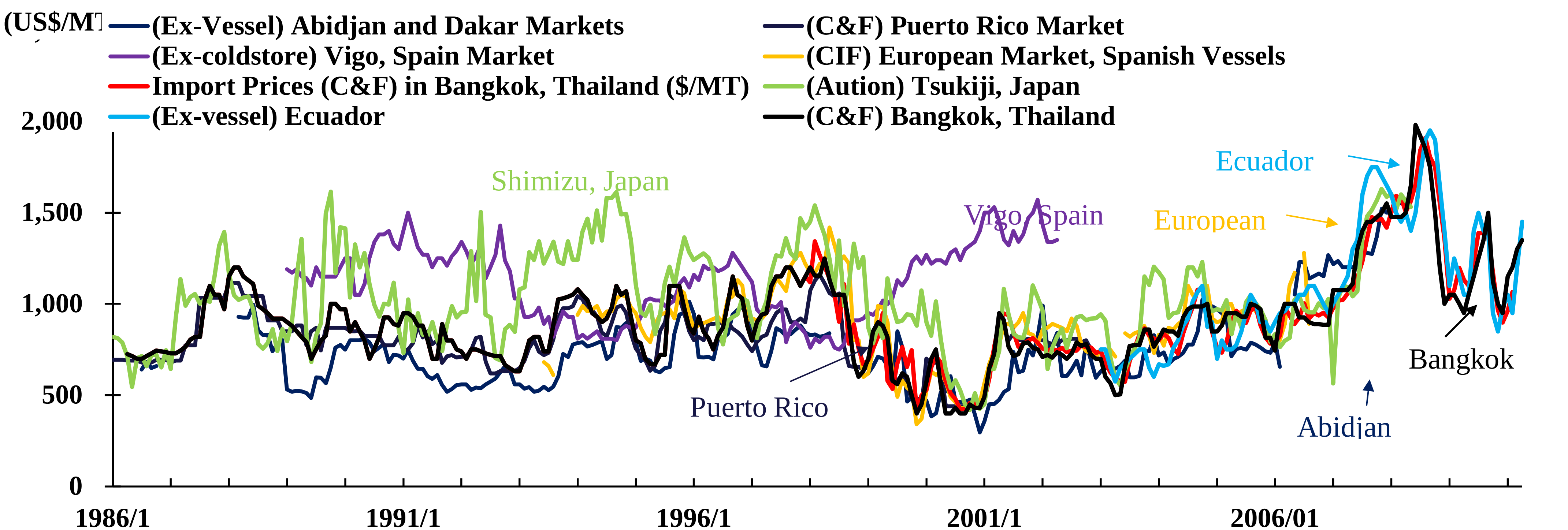


Fig. 2 Ex-vessel Prices of Frozen Skipjack for Canning (1986-2010)

Equilibrium (long-term) yield

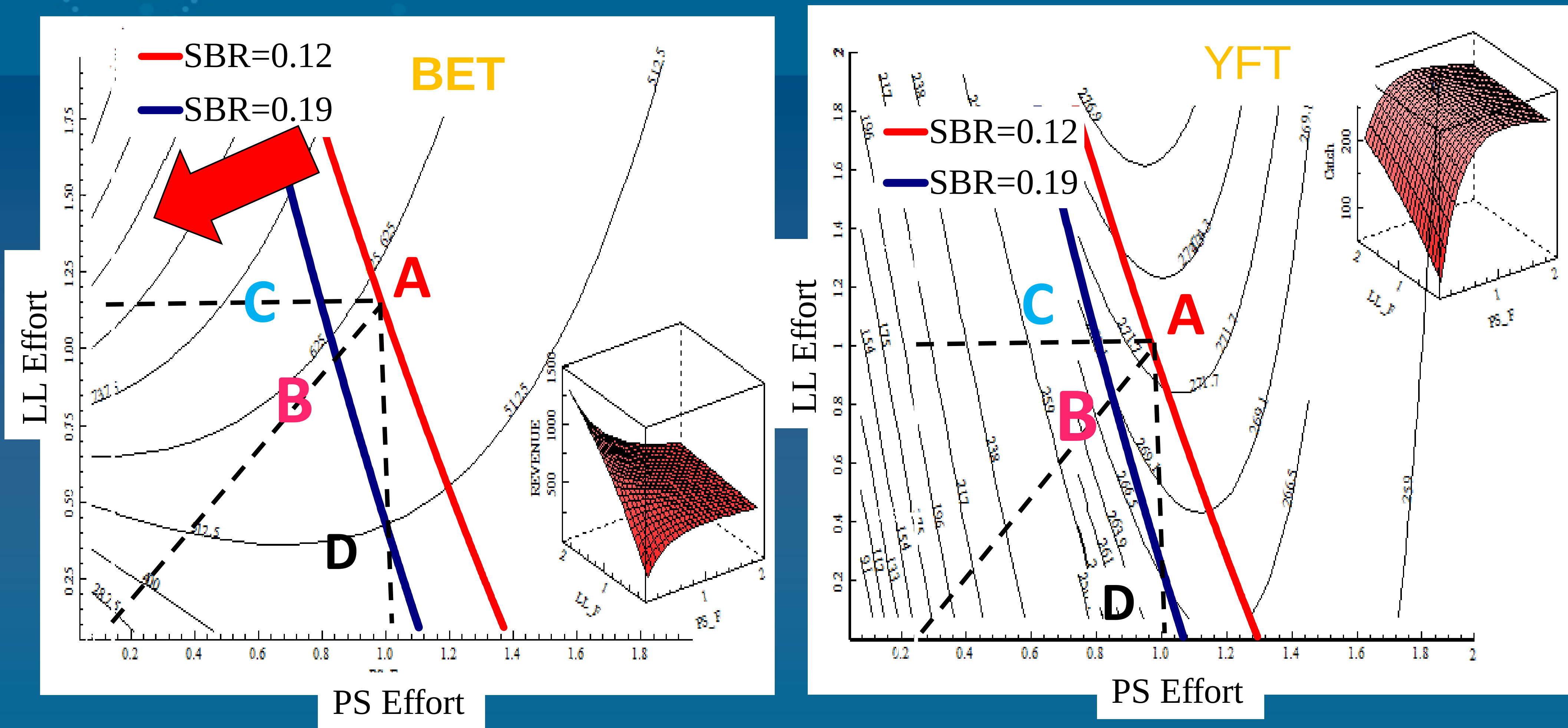


Figure 4 Contour plot of BETand YFT steady-state Catches

Gulf of Maine Research Institute

Revenue (Million $)

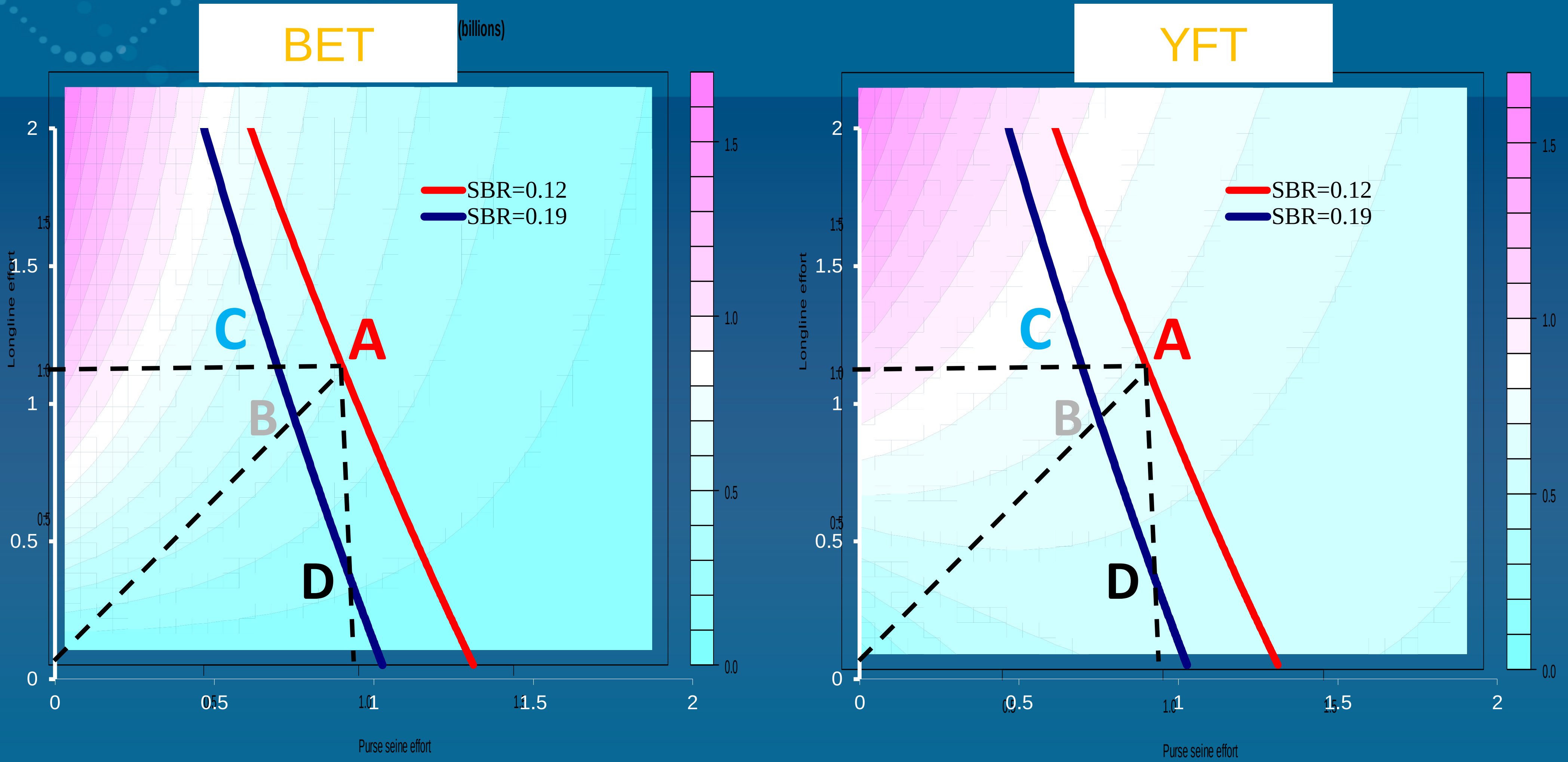


Figure 5 Contour plot of BET and YFT steady-state yield

Gulf of Maine Research Institute

Tradeoff Under Target SBR of Bigeye Tuna

1-ton of BET not caught by the PS:

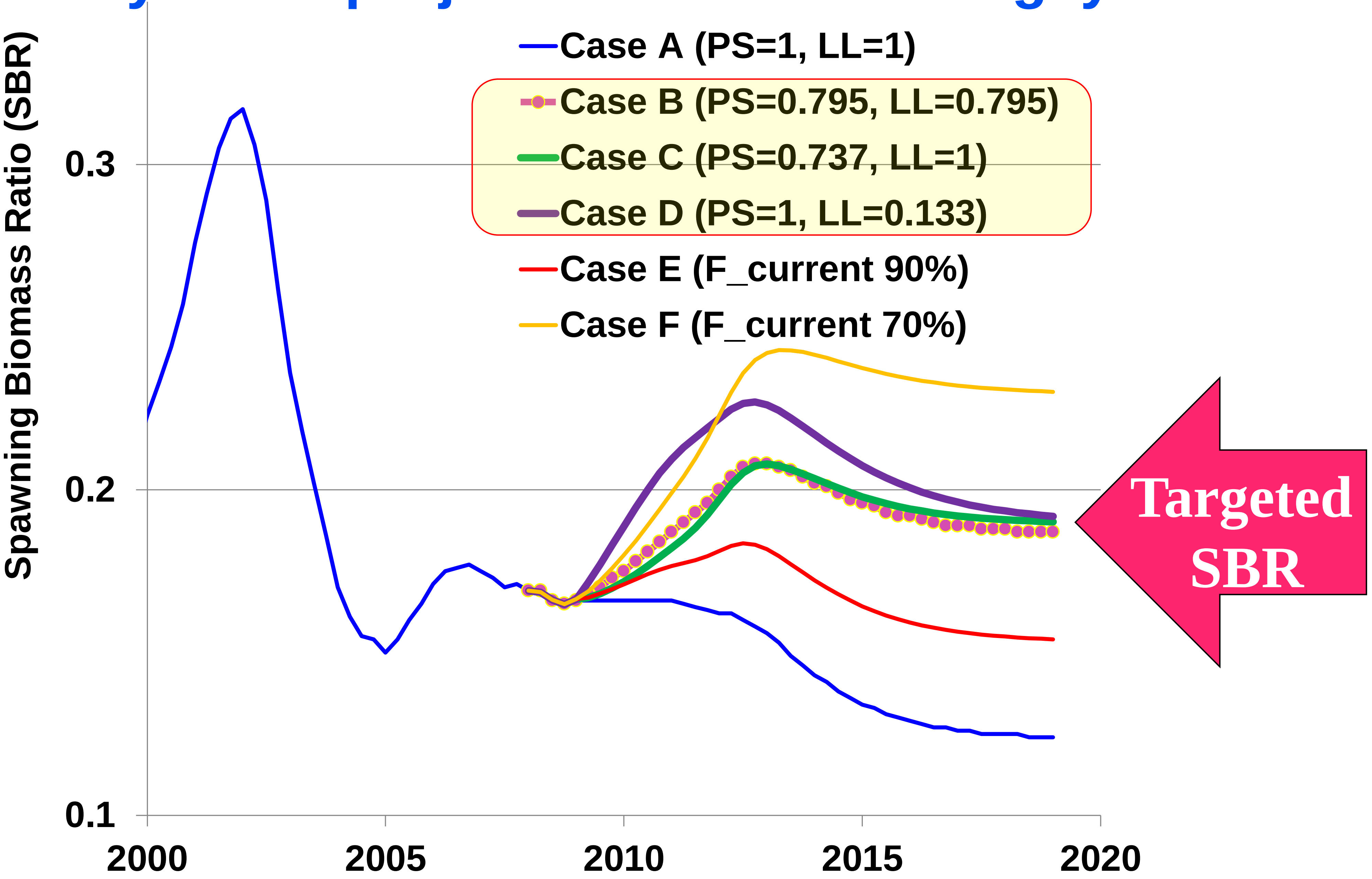
1. **$36,878 gain in LL revenue.**
2. **after providing $1,540 compensation to the loss of PS's BET landings value,**
3. **the total BET landings value would increase to $35,340.**

1% reduction in PS effort associated with FOB (roughly 84 sets) would

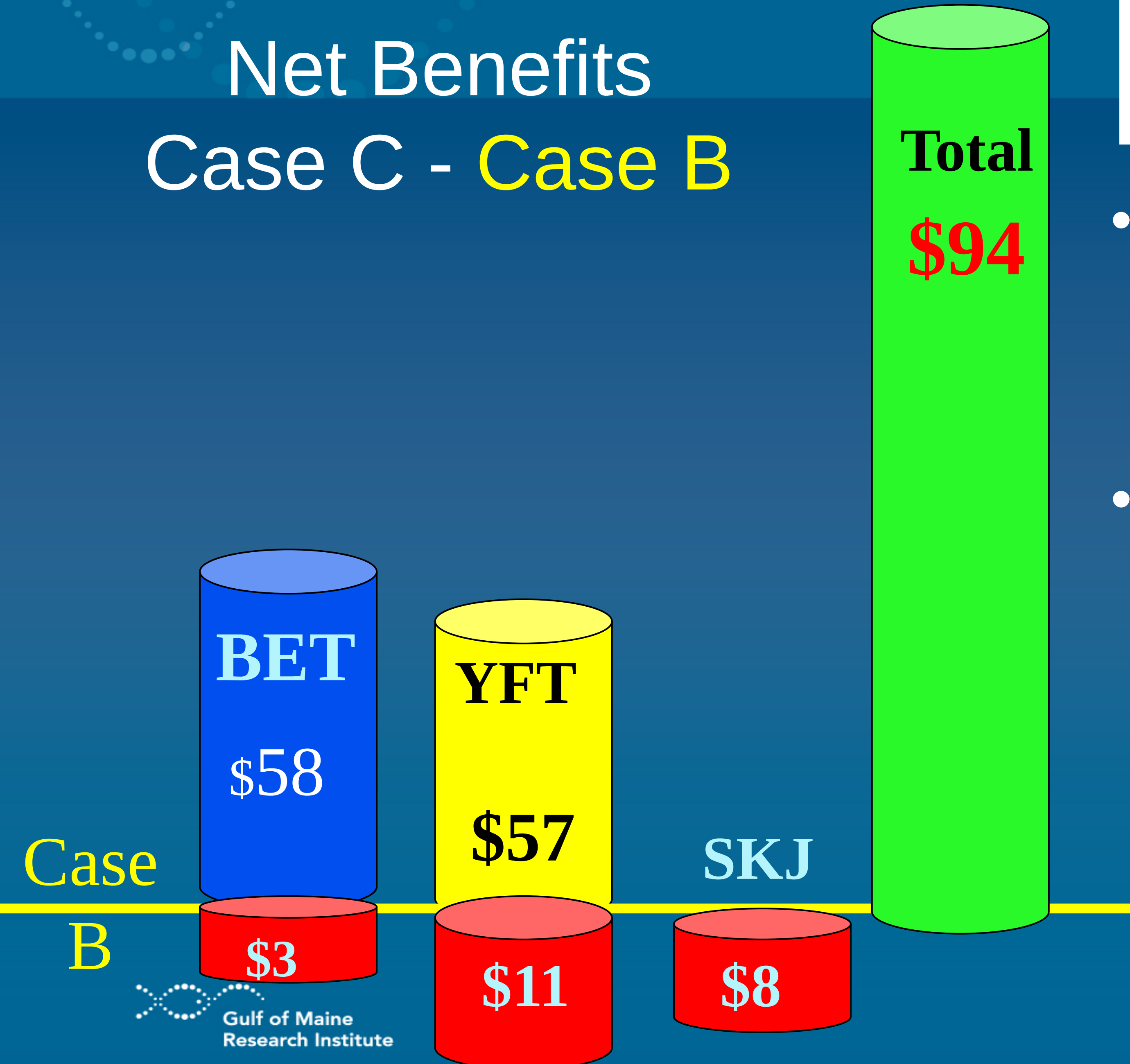
1. **reduce the PS catch by 301 tons,**
2. **allows a 1,170-ton increase in the LL catch, and**
3. **increase the total revenue by $10.74 million after compensating for the loss of catches by the PS.**

Gulf of Maine Research Institute

Dynamic projections of SBR of bigeye tuna



Net Benefits
Case C - Case B



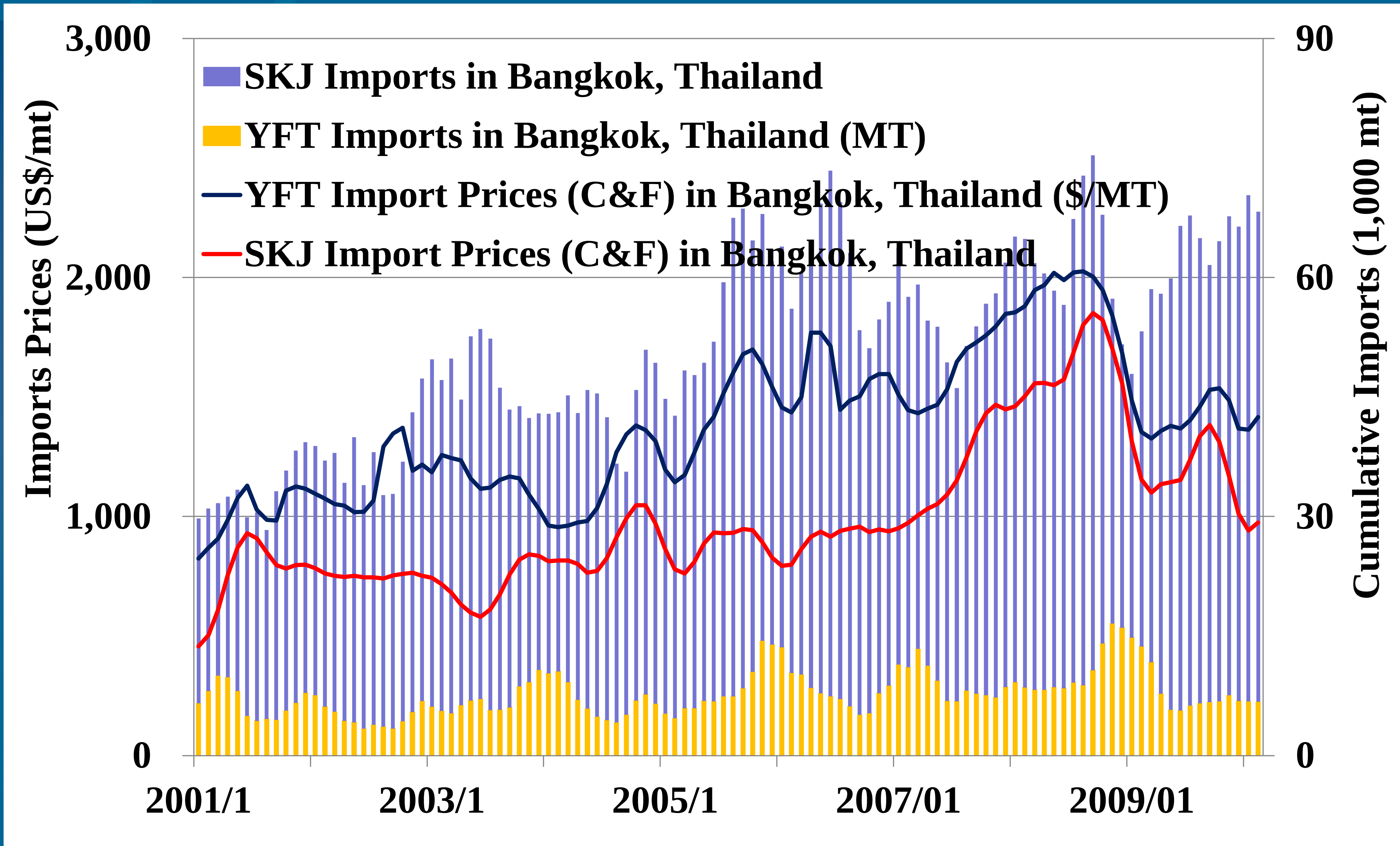
Case B (PS=0.795, LL=0.795)

Case C (PS=0.737, LL=1)

- **Reach the targeted SBR_{BET} = 19%**

- **Net = $94 million**

Figure 1 Imports and Imports Prices of Frozen Skipjack and Yellowfin Tuna for Canning in Bangkok, Thailand



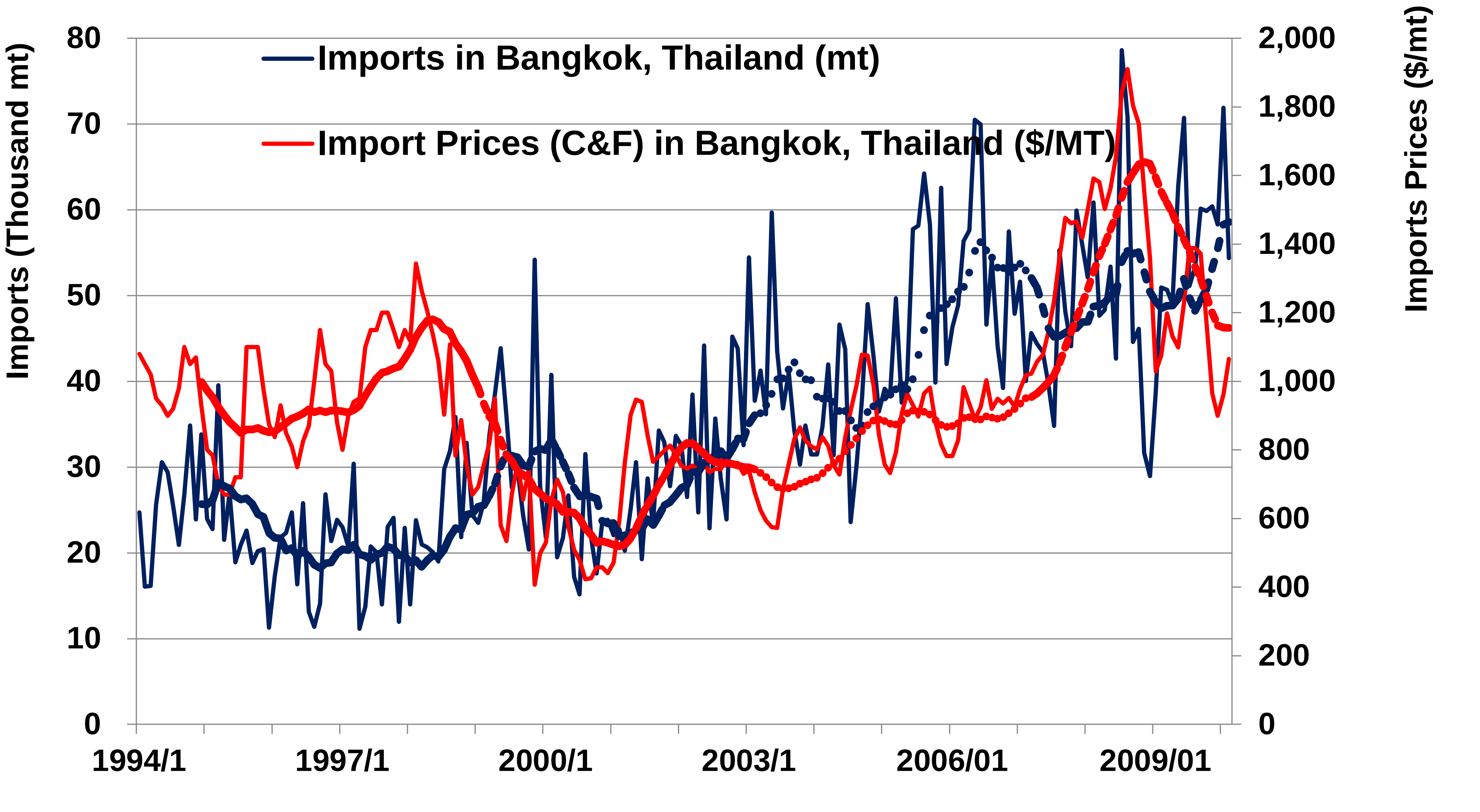


Fig. 3 Imports and Prices of Skipjack Tuna in Bangkok

Gulf of Maine Research Institute

Table 3 Scale Flexibility and Uncompensated Own-Quantity and Interaction Price Flexibility for Bangkok Cannery Market

	Scale Flexibility	Uncompensated Price Flexibility	
		Frozen Skipjack	Frozen Yellowfin
Frozen Skipjack	-0.995***	-0.797***	-0.198***
	(0.009)	(0.009)	(0.006)
Frozen Yellowfin	-1.021***	-0.801***	-0.220***
	(0.036)	(0.097)	(0.029)

The results show that both the frozen bigeye and yellowfin tunas show unity in absolute value for their scale flexibility, which means price is responsive to changes in catch when the supply changes.

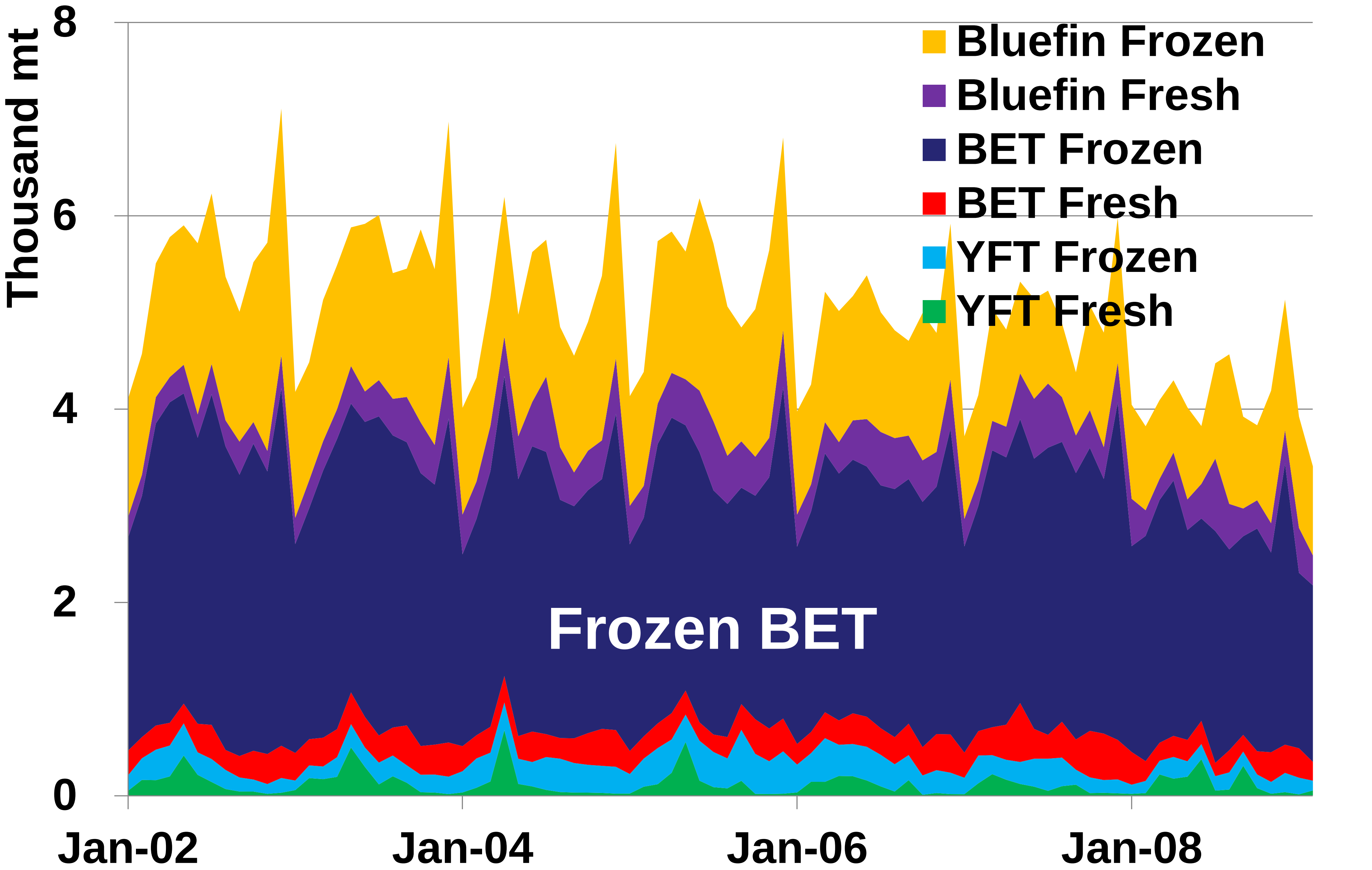


Fig. 1 Tuna Sashimi Sales at Tsukiji Central Market

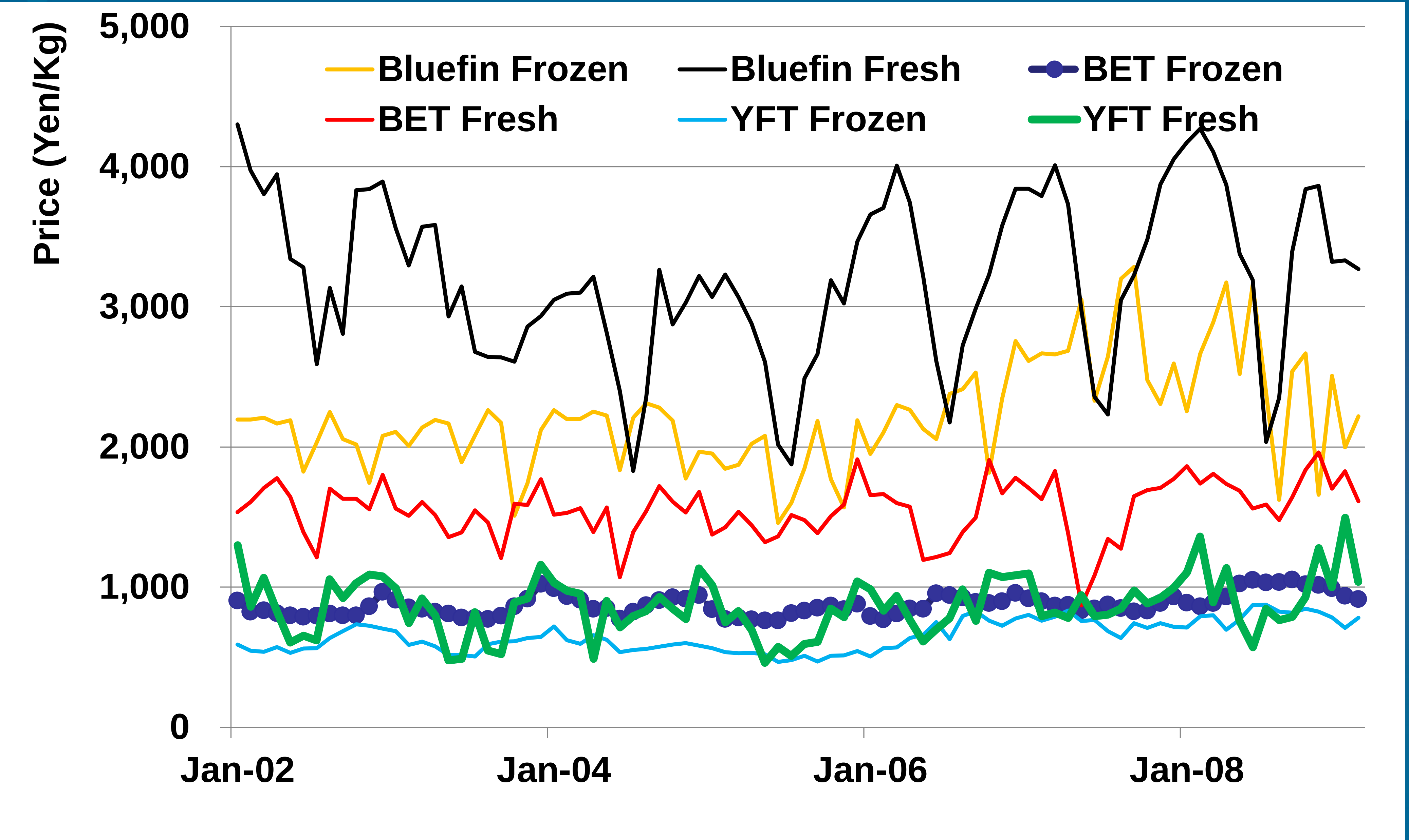


Fig2. Wholesale price at Tsukiji Central market

Table 1 Scale, own-quantity flexibilities, and Allais interaction intensity coefficients

	Flexibility		Allais interaction intensity a12 = 0					
	Scale	Own-quantity	Fresh Bluefin	Frozen Bluefin	Fresh Bigeye	Frozen Bigeye	Fresh YFT	Frozen YFT
Fresh Bluefin	-0.76	-0.33	-1.00	0.00	-0.15	0.05	-0.09	0.00
Frozen Bluefin	-0.88	-0.39		-1.00	0.09	0.08	-0.10	-0.06
Fresh Bigeye	-1.04	-0.34			-1.00	-0.19	-0.13	-0.03
Frozen Bigeye	**-1.23**	**-0.48**				-1.00	-0.02	-0.28
Fresh Yellowfin	-1.52	-0.40					-1.00	-0.27
Frozen Yellowfin	-1.29	-0.22						-1.00

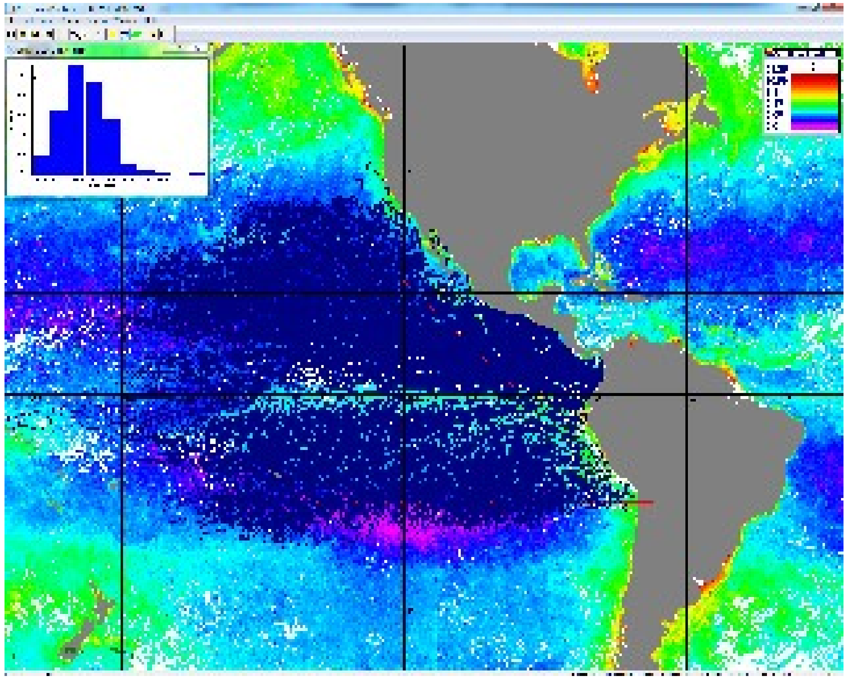
The results show that the frozen bigeye tuna show less than unity in absolute value for their scale flexibility, which means price is less responsive to changes in catch when the supply changes.

Summary

- It is assumed that if the catches of small bigeye and yellowfin were reduced, the gains to the biomass of those species due to growth would exceed the losses to it due to natural mortality.
- This would increase the availability of large bigeye and yellowfin to the longline fishery, which, in turn, would increase the total catches of those species, provided there was sufficient fishing effort by longliners.
- It is further assumed that bigeye and yellowfin are well mixed within the EPO, in which case reductions in the catches of small tunas anywhere in the EPO would be beneficial to longliners operating anywhere in the EPO.

2. Complex Fleet Dynamics of PS Fisheries

Feet dynamics model is used to identify variation in environment, fisher behavior, capital and production markets, and from governmental policies, economic, and regulatory conditions.

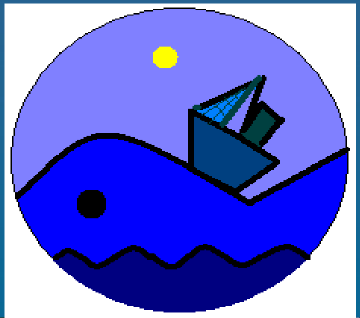


NSF/CNH (2011-14) FISHSCAPE

National Science Foundation
WHERE DISCOVERIES BEGIN

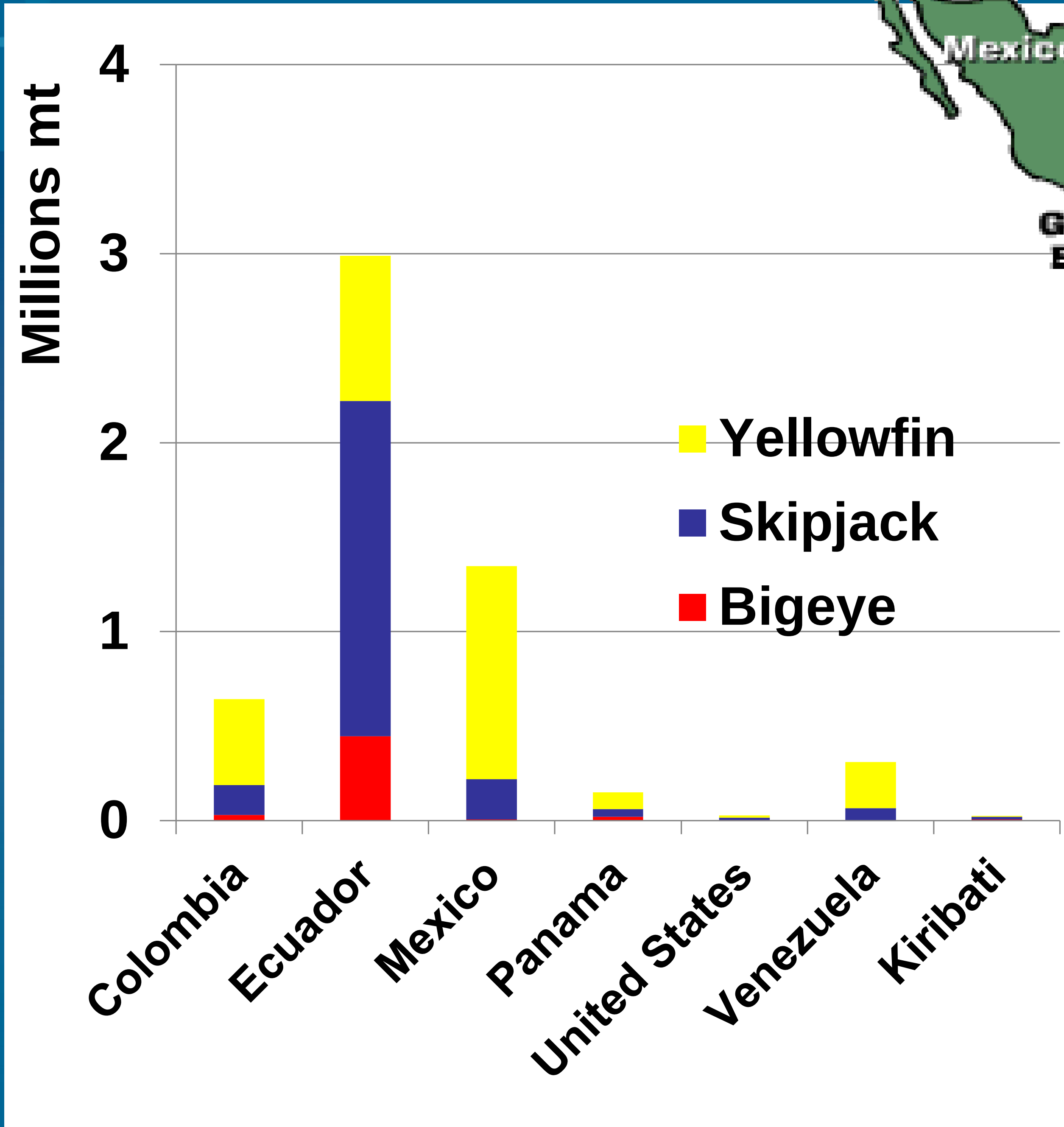
Principal Investigators (Pis)

- Dartmouth
  - D.G. Webster (PI)
- GMRI
  - Jenny Sun (PI)
- USC
  - Dale Kiefer (PI)
- SSA
  - Frank O’Brien
- IATTC
  - Mike Hinton (PI)
- SWFSC
  - Dale Squires (PI)
- RAND Pardee
  - Rob Lempert (PI)



1. Climate change
2. Increasing price of oil
3. Technological improvements

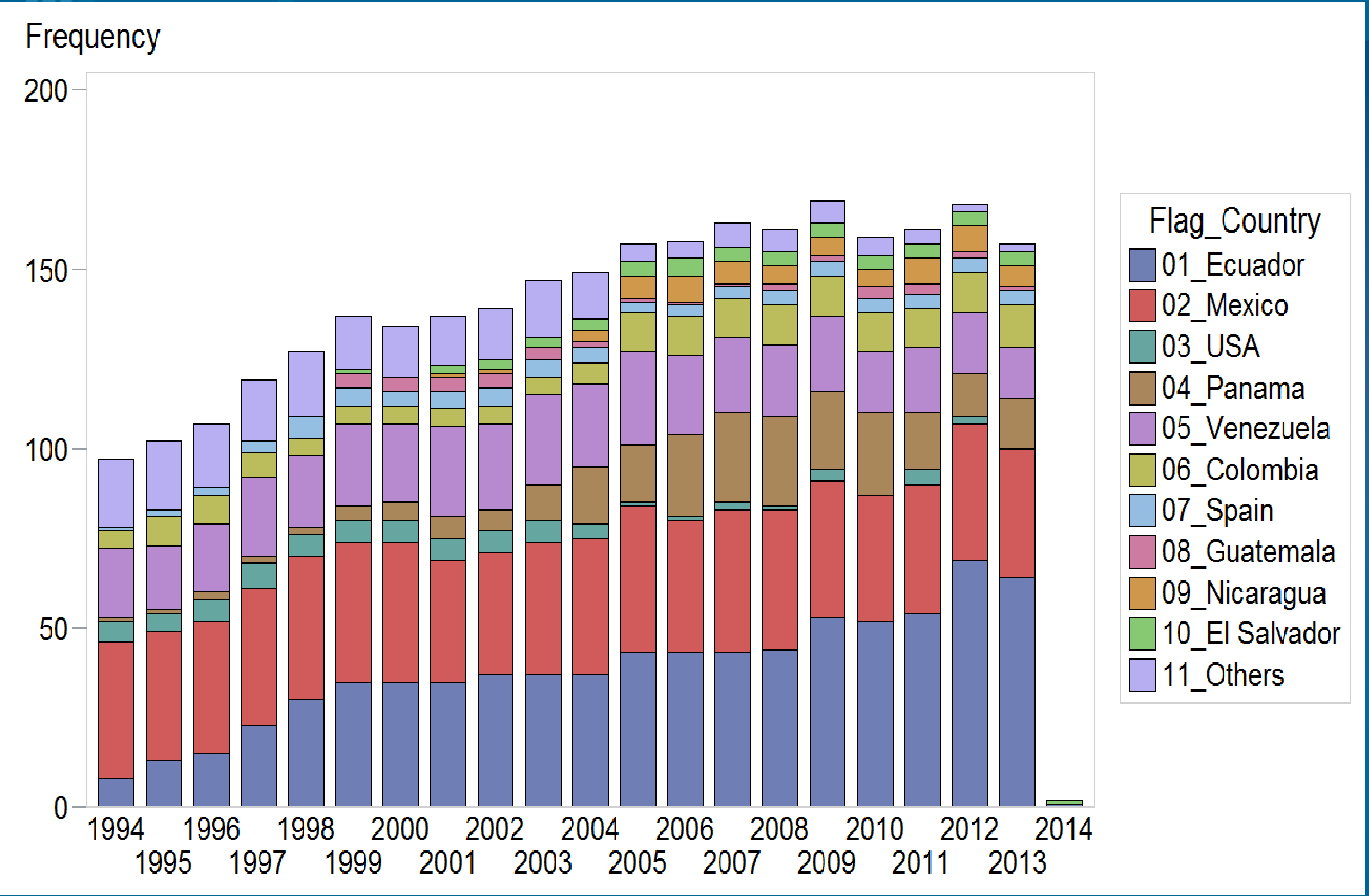
Gulf of Maine Research Institute



Millions mt
4
3
2
1
0
Yellowfin
Skipjack
Bigeye
Colombia
Ecuador
Mexico
Panama
United States
Venezuela
Kiribati

Mexico
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Panama
Venezuela
Columbia
Ecuador
Peru
Bolivia
Chile
Argentina

Fig. 1 Number of Active PS Vessels



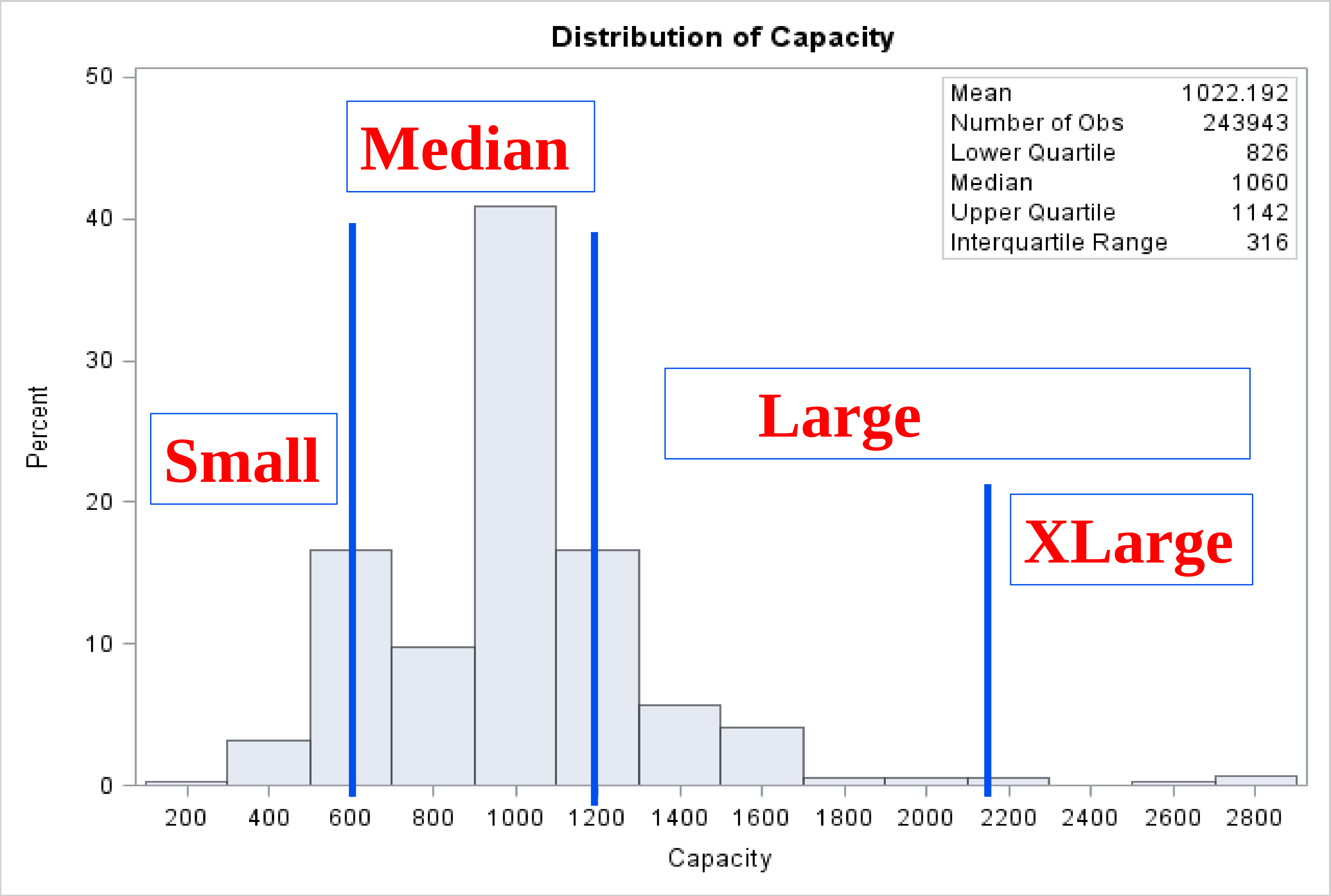

Distribution of Capacity
Mean 1022.192
Number of Obs 243943
Lower Quartile 826
Median 1060
Upper Quartile 1142
Interquartile Range 316
Median
Small
Large
XLarge
Percent
Capacity
0
10
20
30
40
50
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

Fig. 2 Number of Vessels by Vessel Size

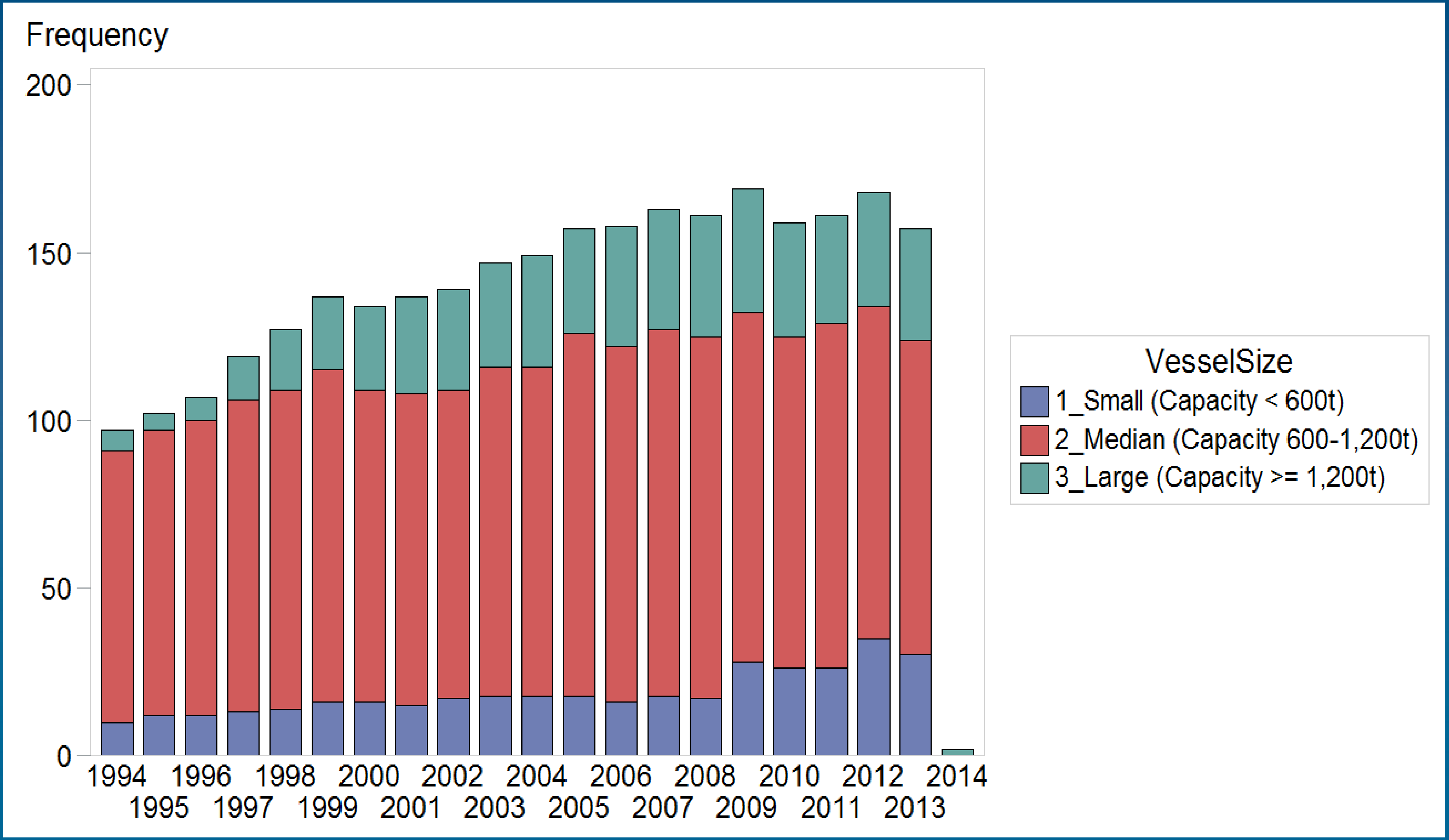


Fig. 3 Number of Large Vessels (>1,2000 tons) by Country

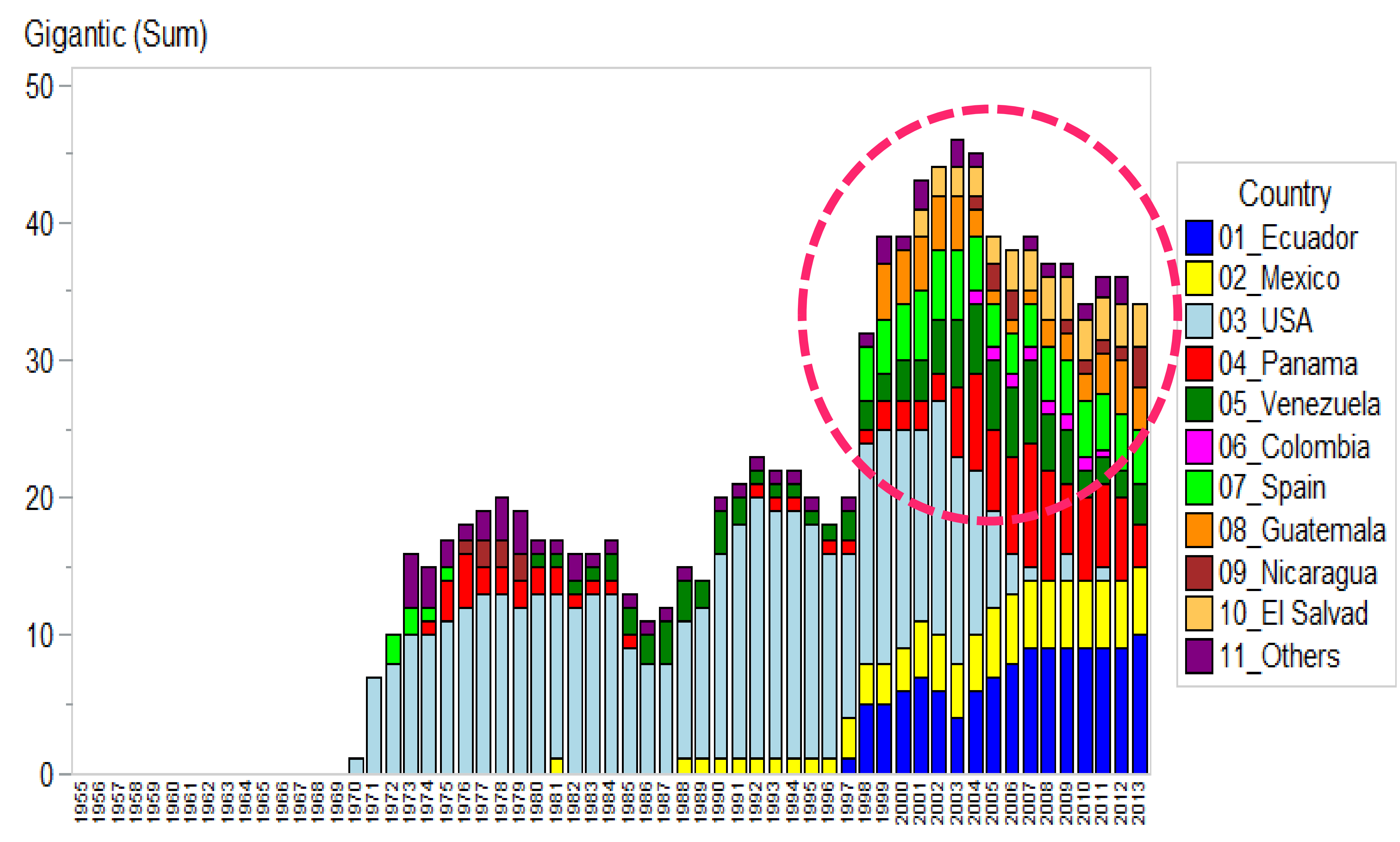


Fig. 4 Average Fishing Days by Vessel Size

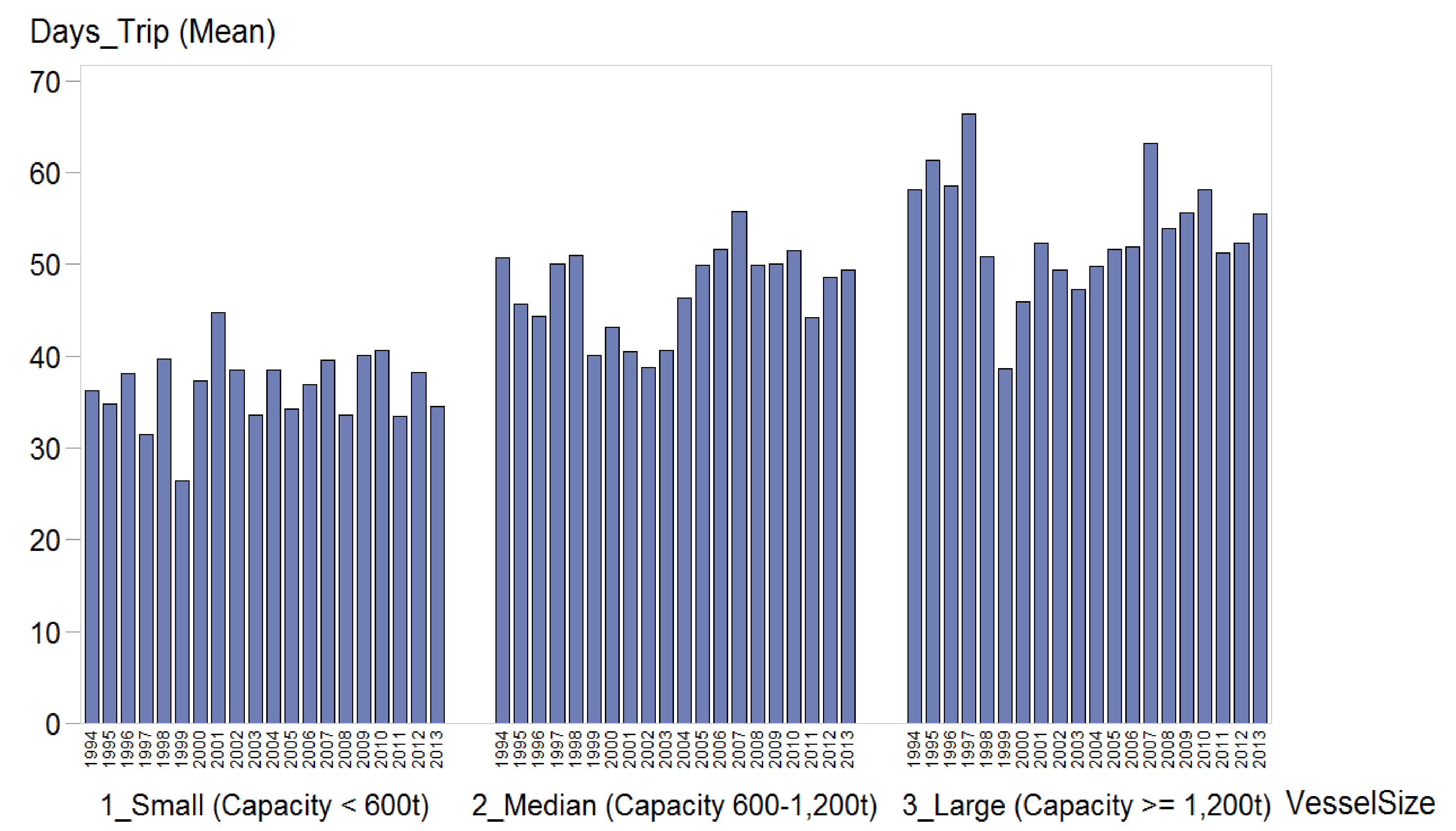
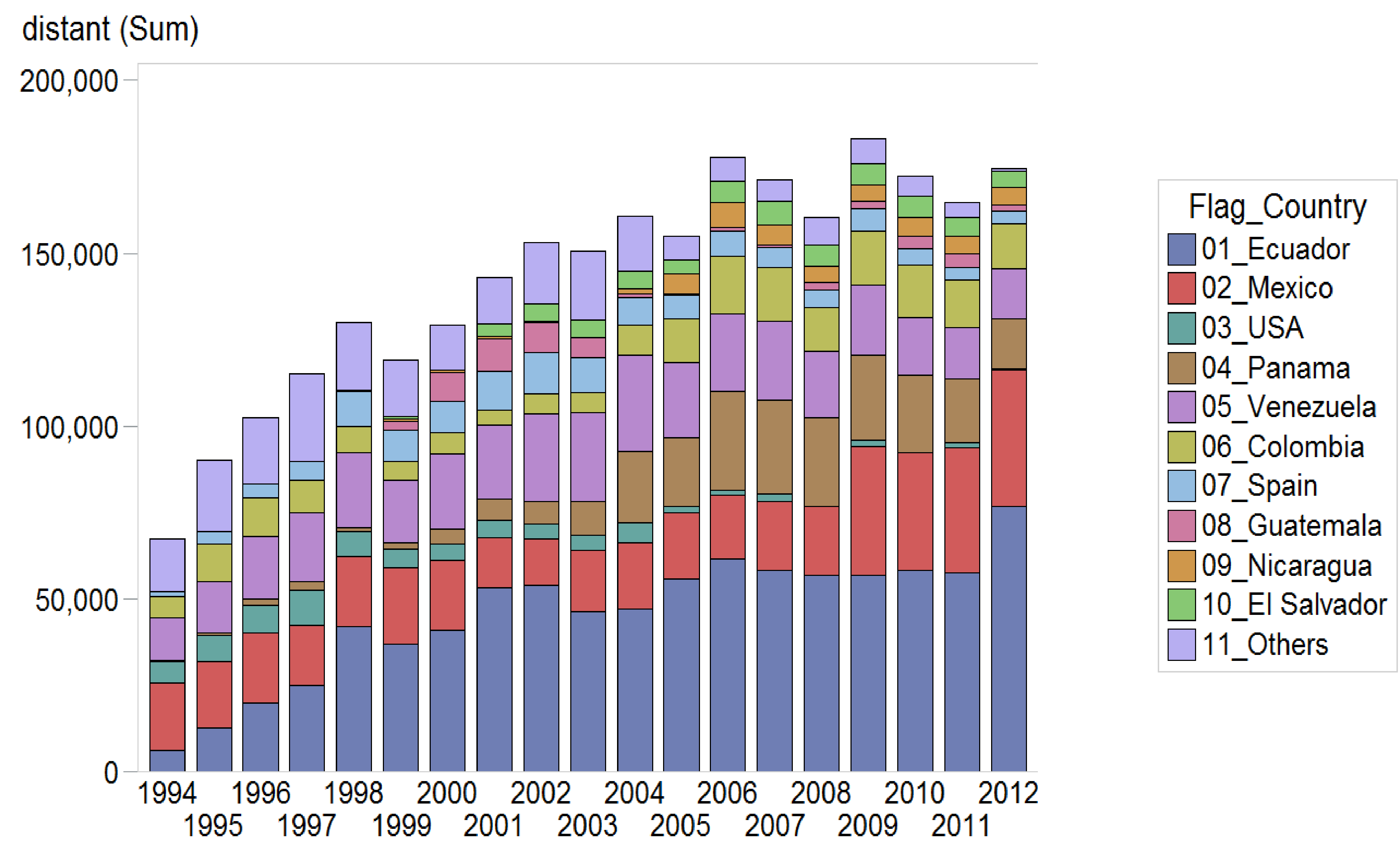


Fig. 5 Total Distant Travelled



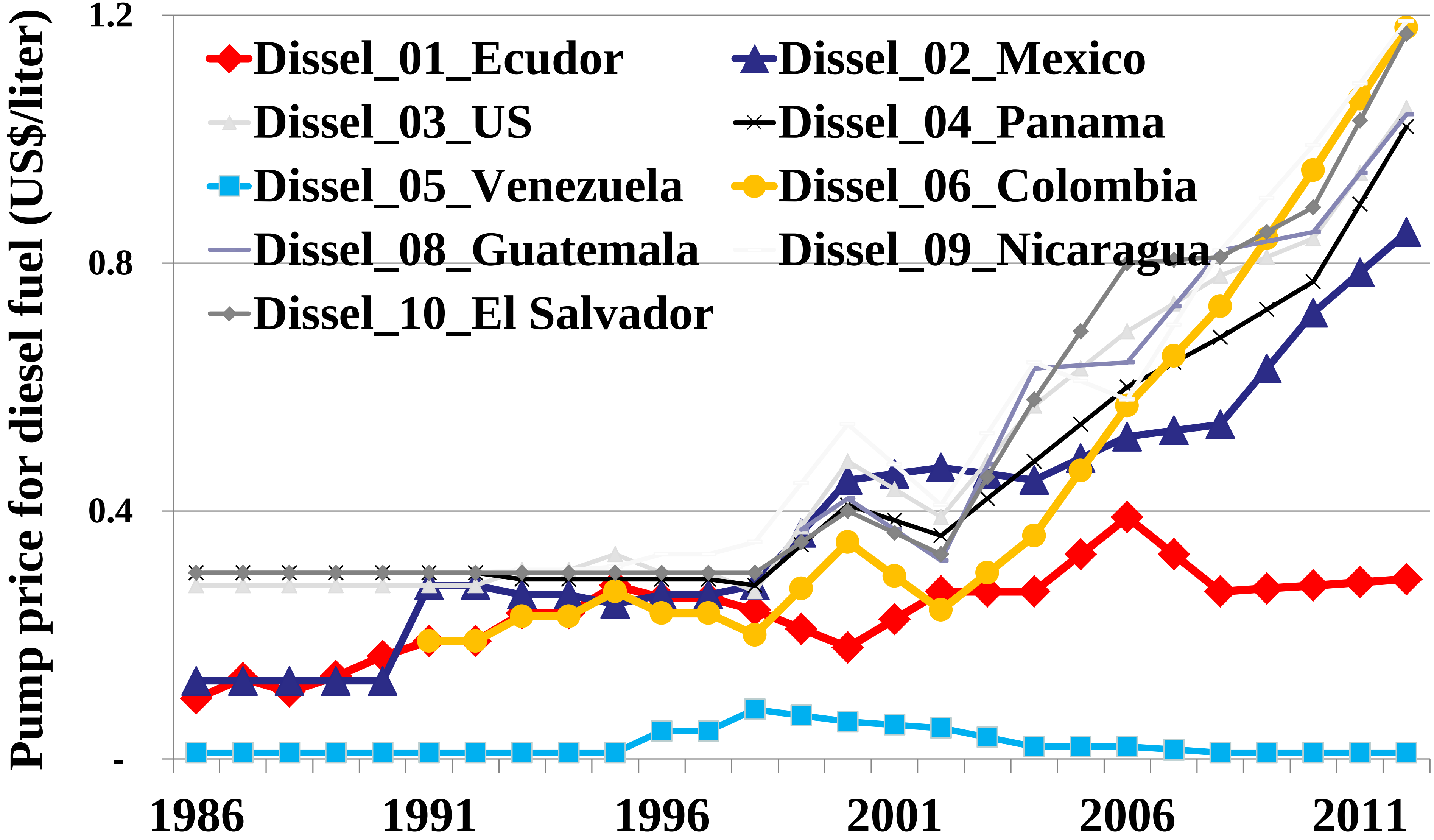
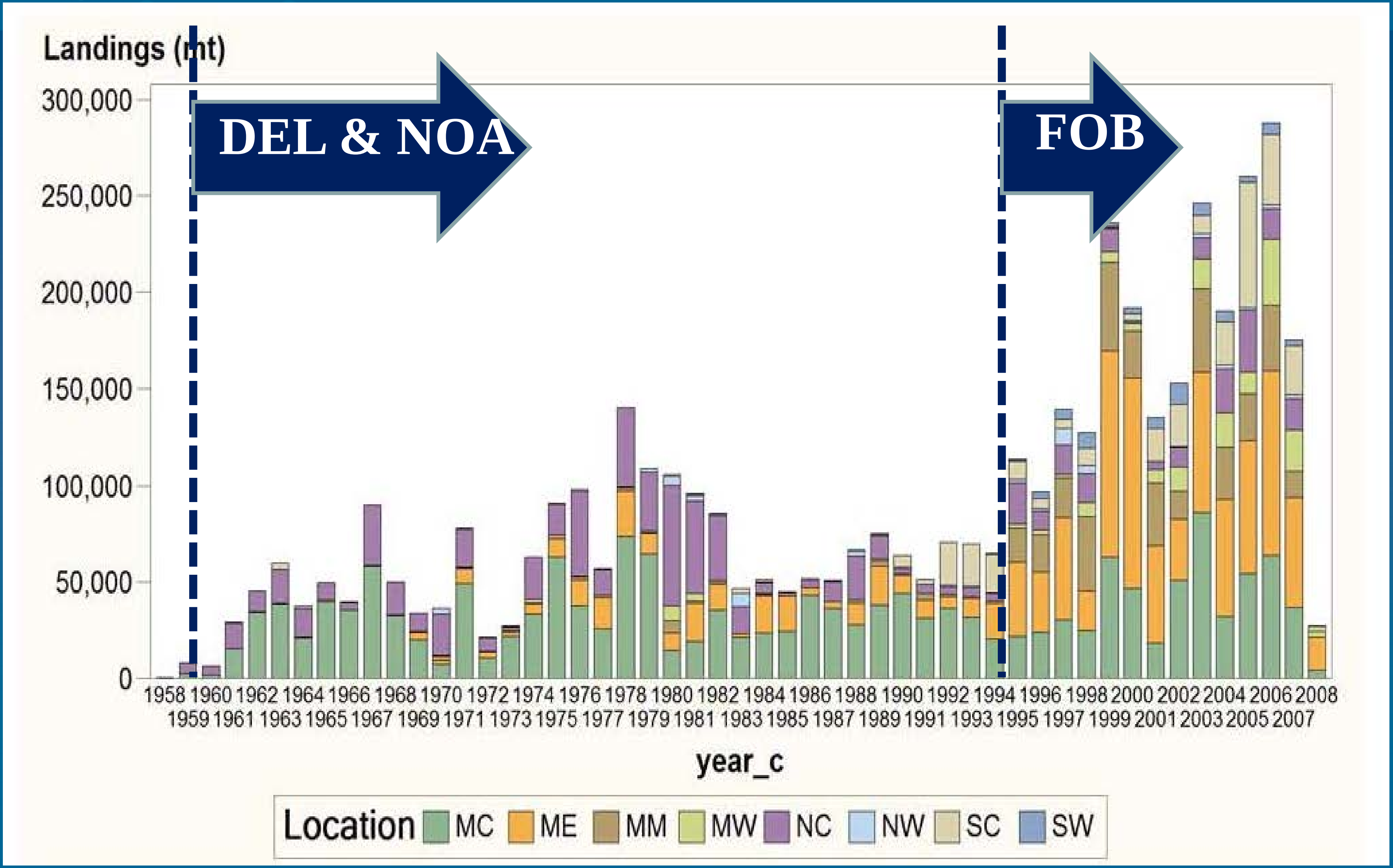
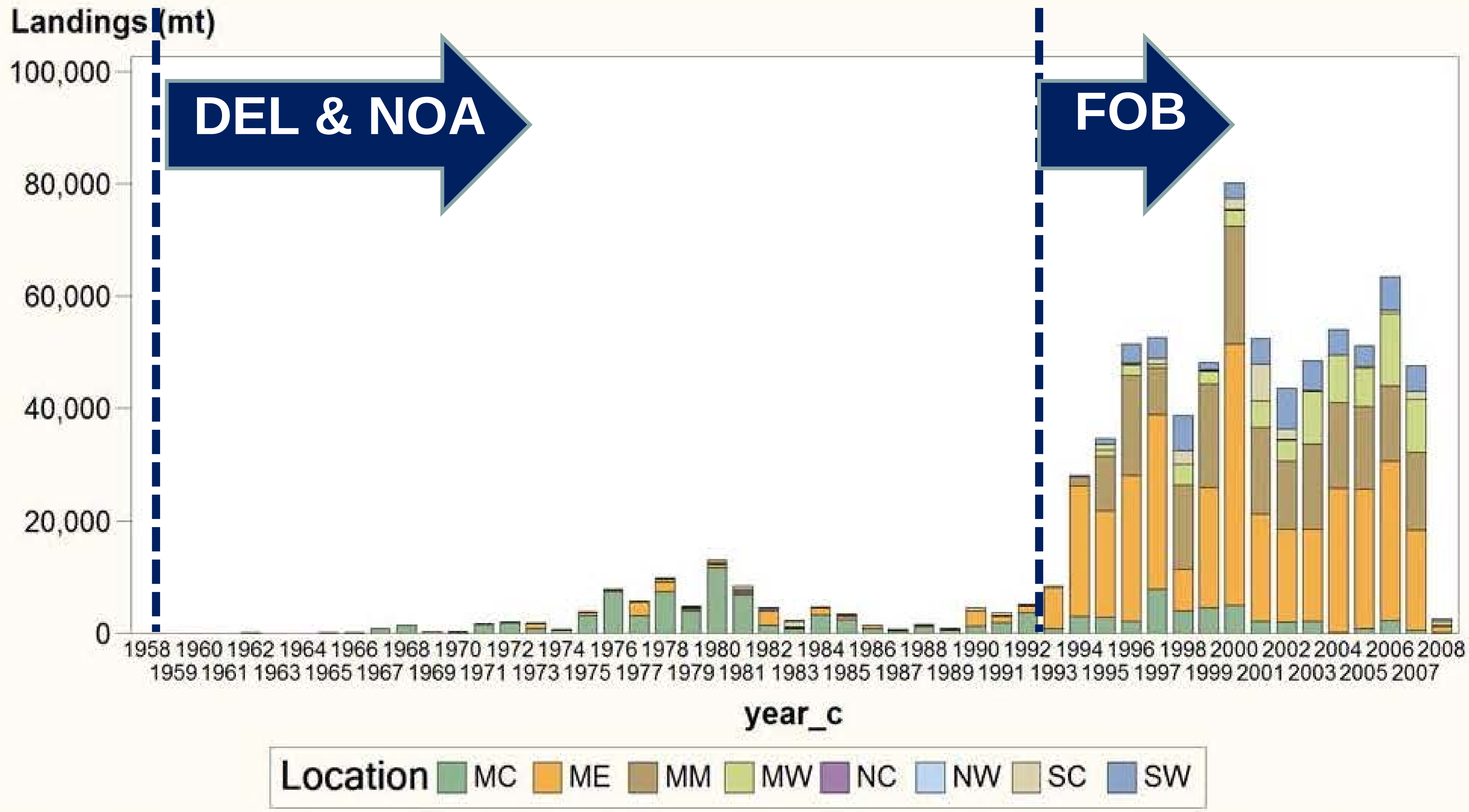


Fig. 6 Pump Prices of Diesel Fuel by Country (World Bank Dataset)

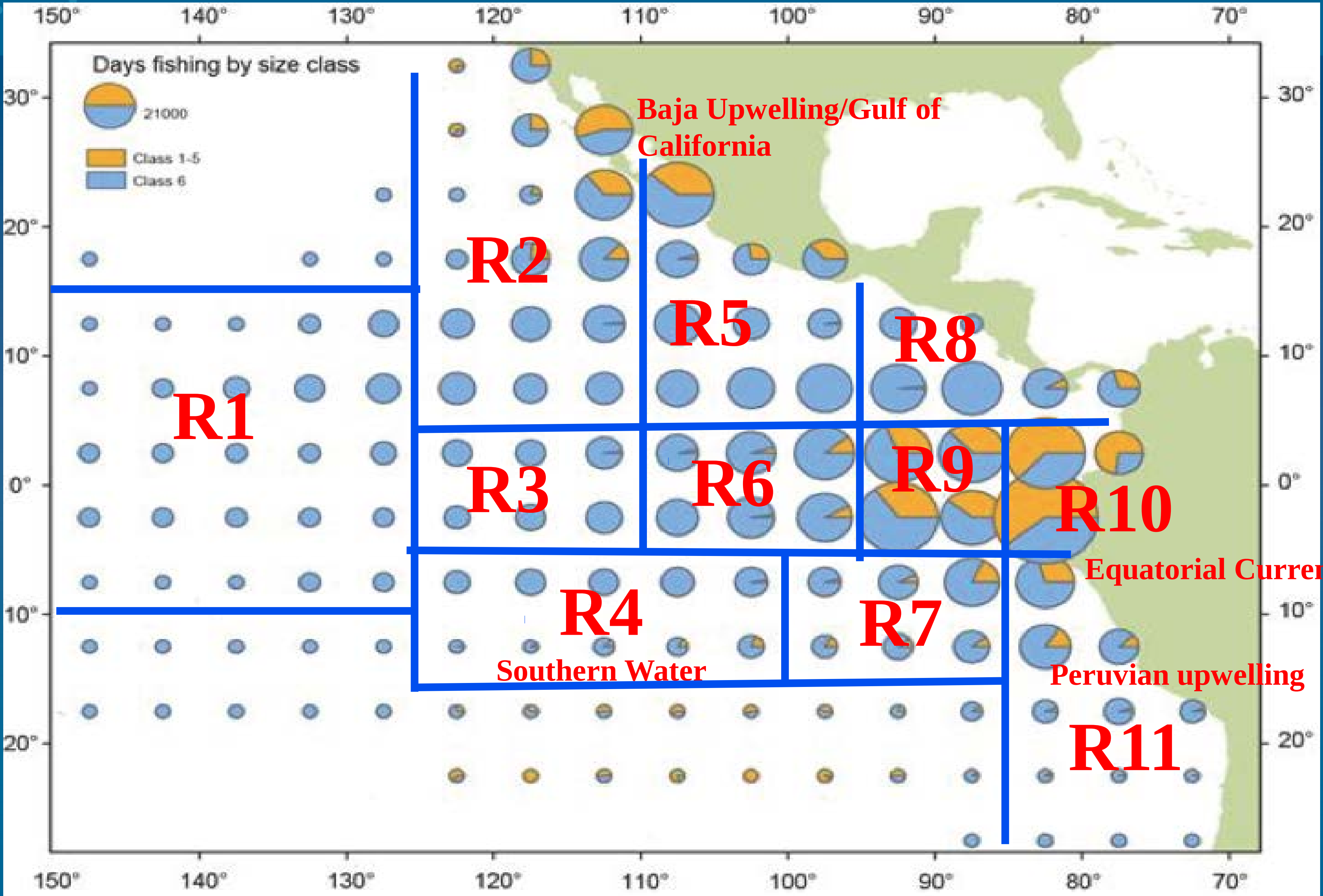
Skipjack Tuna Landings by Regions



Bigeye Tuna Landings by Regions



Days fishing in 1995-2012 by size class



Departing Country=1_MEX_GTM_SLV; Vessel Size=3_Large (Capacity >= 1,200t)

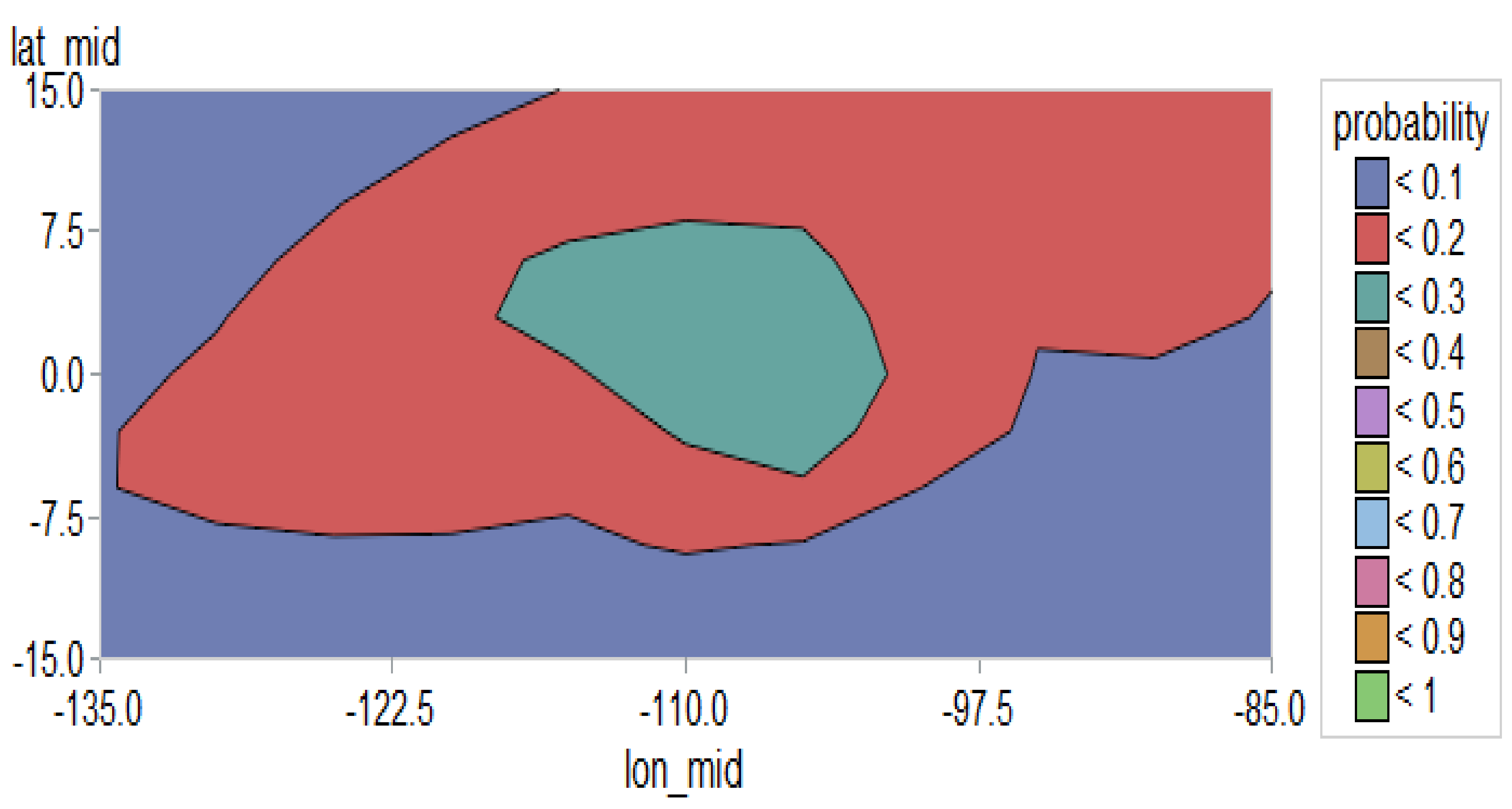


Fig. 7 Contour Plot of Predicted Probability of Setting the Following Set in Each of the Region by Various Vessel Size of Tuna Purse Seine Fleet in EPO

Departing Country=3_ECU; Vessel Size=3_Large (Capacity >= 1,200t)

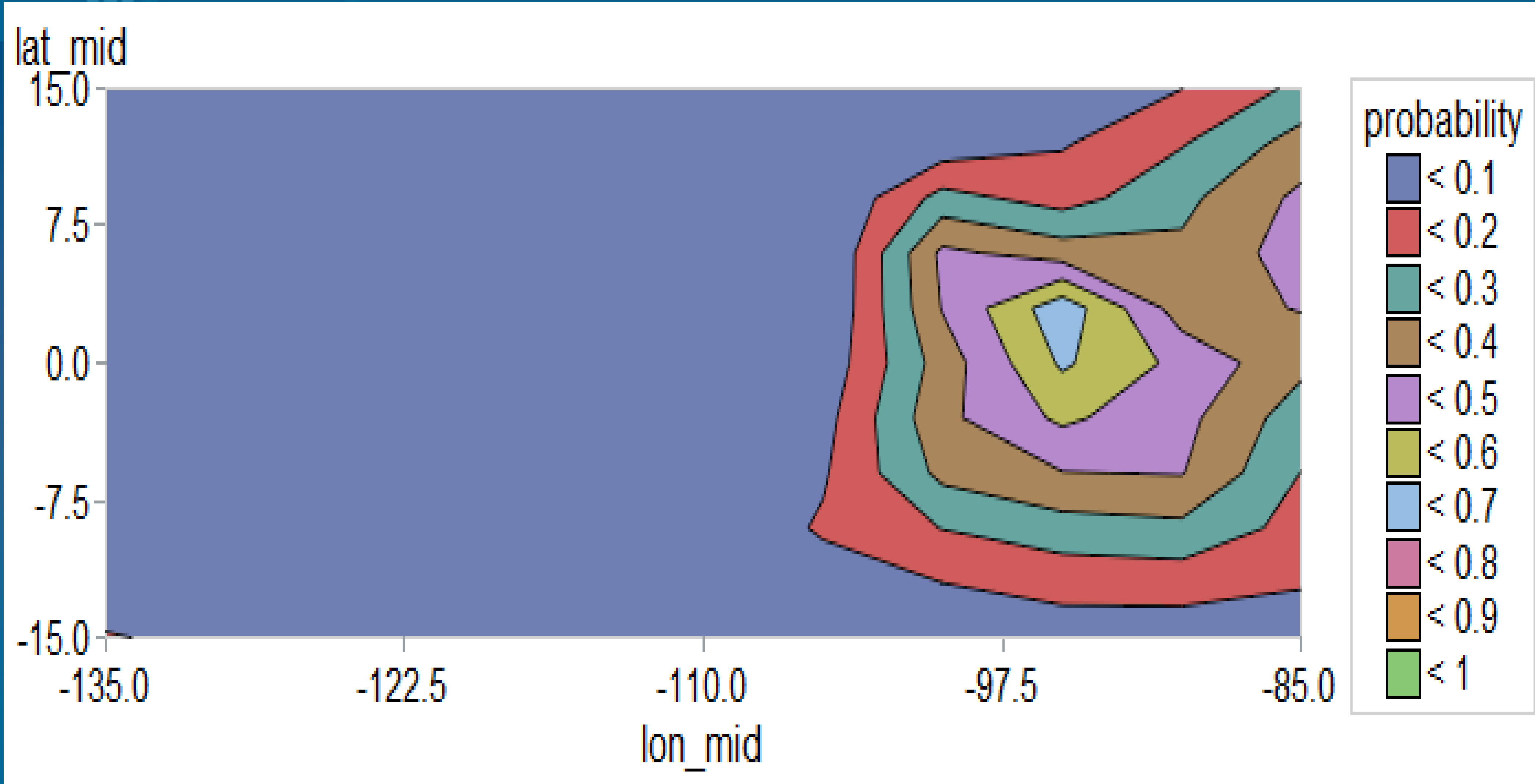


Fig. 8 Contour Plot of Predicted Probability of Setting the Following Set in Each of the Region by Various Vessel Size of Tuna Purse Seine Fleet in EPO

DISCUSSION

- **Management objectives differ among resource users, and there are a multitude of factors that need to be considered.**

- **We have shown that the economic value of the resource is highly dependent on the allocation of effort.**

- **Economic and social considerations have not been formally integrated into management of the fisheries for tropical tunas in the EPO.**

Gulf of Maine Research Institute

Jenny Sun, Ph.D.

Education:

1994 Ph.D., Applied Economics, Cornell University

Professional Positions:

2011 - present Senior Marine Resource Economist, GMRI
2009 - 2011 Research Scholar, Inter-American Tropical Tuna Commission
2008 - 2009 Visiting Professor, Department of Economics, UC, San Diego
1994 - 2011 Professor and Director (2003-2006), Inst. of Applied Econ., NTOU

Current Projects:

2011 - 2014 Fishscape: Complex Dynamics of the Eastern Pacific Tuna Fishery, NSF/Coupled Natural and Human Systems (CNH)
2011 - 2014 New England Groundfish Sector Business Model, NMFS/NEFSC
2013 - 2017 Resilience and Adaptation of a Coastal Ecological-Economic System of Maine Lobster in Response to Increasing Temperature, NSF.

Gulf of Maine Research Institute

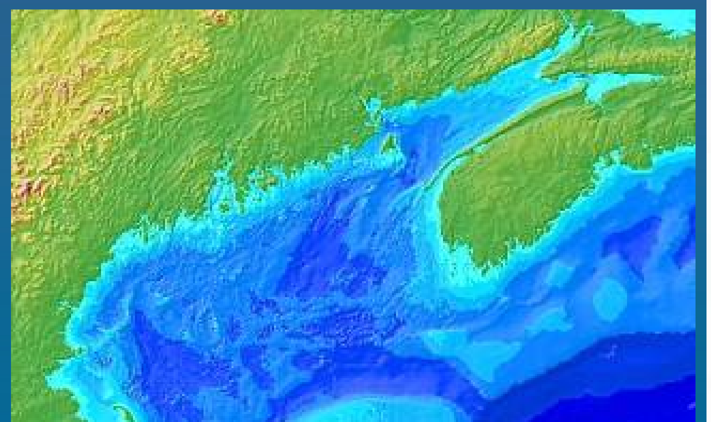
Gulf of Maine Research Institute

John Annala

Andy Pershing

Former Chief Scientific Officer	Fish Ecology	Fish Ecology	Fishing Gear & Practices	Ecosystem Modeling	Resource Economics	Biological Oceanography

- **Bounded by three New England states and two Canadian provinces**
- **Non-profit marine science center located in Portland, Maine, US**



Gulf of Maine Research Institute

Thank You

The study is sponsored by NSF/CNH and is developing means to understand and perhaps predict relationships and outcomes in complex coupled human and natural systems.

Gulf of Maine Research Institute