Exploring optimum economic efficiency of fishing: Shall we move from the tradition in the post-tsunami fishery?

Gaku Ishimura
Tomoaki Goto
Faculty of Agriculture
Iwate University

Keita Abe
Department of Economics
University of Washington

FISHERY SYSTEMS SCIENCE LAB
AT MORIOKA, IWATE UNIVERSITY

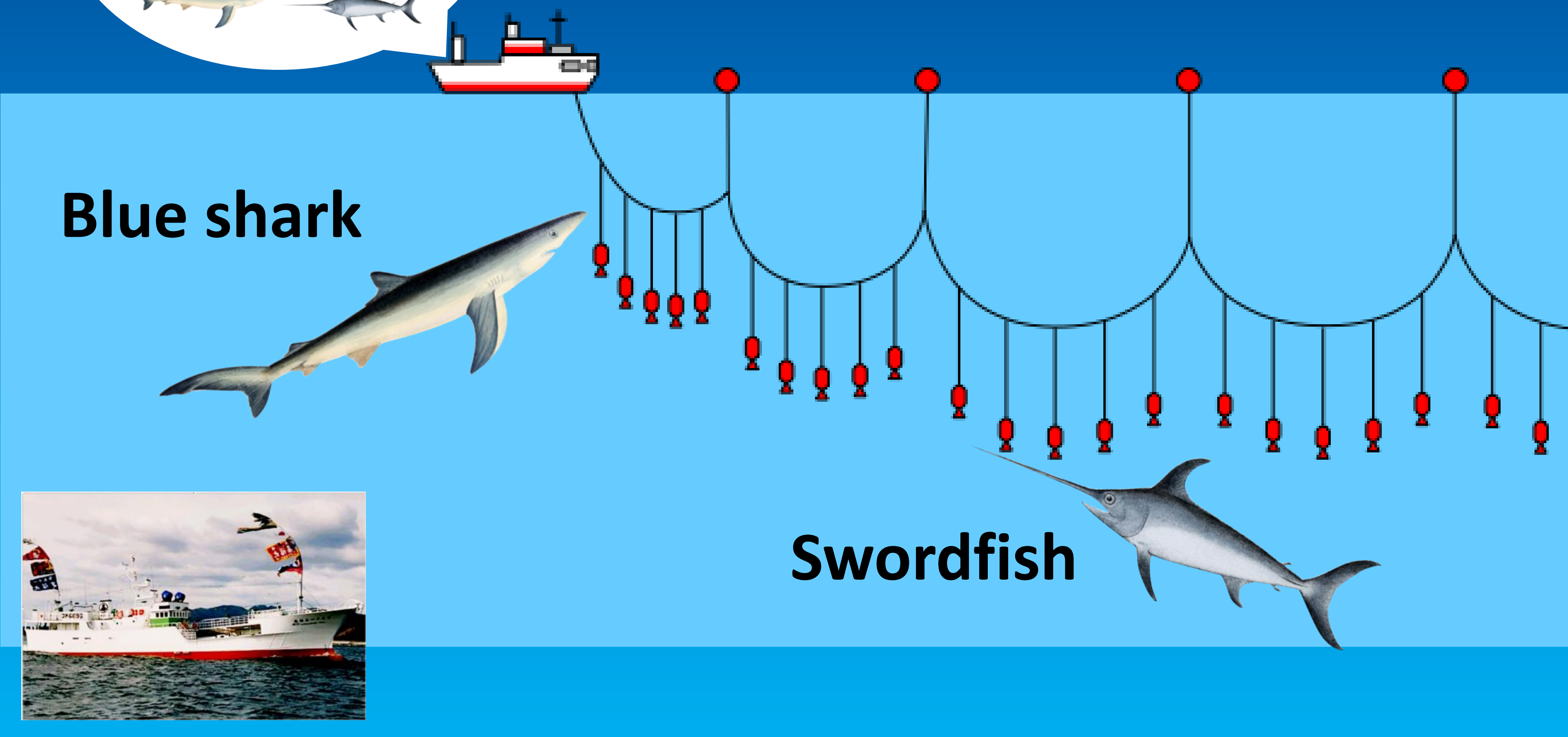

March 11
2011
東北大震災
East Japan Earthquake Picture Proje

Kesennuma
気仙沼

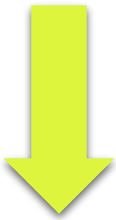
- The 9th largest fishery landig values in Japan.
- A base port for distant water tuna fisheries.

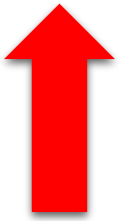
Photo: Yuma Sugawara

In Kesennuma.
16 119MT-distant water longline fishing vessels survived.



After the 2011 Earthquake/Tsunami

Ex-vessel Price 

Fuel Price 

Kesennnuma Longline Fisheries

Society
社会

Employment generated by the processing industries

Fishery
漁業

Economic Motivations

Fish
魚

North Pacific swordfish & blue shark resources

Moving from the competitive individual operations to the group operations after the 2011 Earthquake/tsunami

Combine Catch, Cost, Revenue and Profit Analysis with 2005-2010 data under the competitive individual operation (limited open access) to explore optimum fishing efforts to maximize economic benefits from Swordfish fisheries .

Fishing Efforts(Days per Trip)

=

Move/Search Days → Define fishing grounds – where you fish?

+

(longline) Operation Days → Define Fishing opportunities

Ex-vessel Price Model for Swordfish

Estimating the equation is

$$\ln PriceSF_{it} = const + \beta_1 \ln SFCatch_{it} + \alpha_2 \ln TripDays_{it} + m_t + v_i + \varepsilon_{it}$$

Estimation Result

	Dependent variable:
	Price_LN
Ln(SF Landing Weight)	-0.111***
	(0.009)
Ln(Trip Days)	-0.095***
	(0.023)
Constant	8.075***
	(0.094)
Vessel FE	Yes
Month FE	Yes
Observations	825
R^2	0.539
Adjusted R^2	0.512
F Statistic	19.804*** (df = 46; 778)
Note:	*p<0.1; **p<0.05; ***p<0.01

PriceSF: price per kg
SF Catch : Swordfish landing per day (kg)
D: trip days (freshness indicator)
M: month effect
V: vessel effect

- **Price elasticity on landing**
- **Price has the freshness premium**

Cost Model
Variable cost per day operation (effort)

- Day as the unit of fishing effort
- Fuel cost is dominated in the cost structure

	JPN	Fuel (KL)	unitl price
Fuel Cost for Operation Day (per day)	114,800	1.64	70
Fuel Cost for Move/Search Days (per day)	189,000	2.7	70
Bait (per operation day)	120,000		
Food and Other Cost for Crews (per day)	15,000		
Ice (per trip)	300,000		

Swordfish landings and profit upon Trip days (Move/Searching days + Operation days) Catch Model Estimation

Swordfish Catch (MT) =
Days for move/search for fishing grounds+
Days for Fishing Operations +
Abundance Index (others CPUE) +
Vessel Effects +
Month Effect

Model 1: Operation Days with varying parameter

Cobb-Douglas The harvest function is

$$Y = qOpeDays^{\beta_1} CPUE^{\beta_2(MoveDays)}$$

where we specify

$$\beta_2(MoveDays) = \beta_{21} + \beta_{22} MoveDays$$

The estimating equation is

$$\ln Y_{it} = \ln q + \beta_1 \ln OpeDays_{it} + \beta_{21} \ln CPUE_{it} + \beta_{22}(MoveDays) \times \ln CPUE_{it} + \varepsilon_{it}$$

Model 1_ves: Cobb-Douglas

The vessel fixed effect

The estimating equation is

$$\ln Y_{it} = (q + v_i) + \beta_1 \ln OpeDays_{it} + \beta_{21} \ln CPUE_{it} + \beta_{22}(MoveDays) \times \ln CPUE_{it} + \varepsilon_{it}$$

Model 1_mon: Cobb-Douglas

Add Monthly fixed effects

The estimating equation is

$$\ln Y_{it} = (q + m_t) + \beta_1 \ln OpeDays_{it} + \beta_{21} \ln CPUE_{it} + \beta_{22}(MoveDays) \times \ln CPUE_{it} + \varepsilon_{it}$$

Model 1_full: Cobb-Douglas

Add Monthly and Vessel Fixed effects

The estimating equation is

$$\ln Y_{it} = (q + m_t + v_i) + \beta_1 \ln OpeDays_{it} + \beta_{21} \ln CPUE_{it} + \beta_{22}(MoveDays) \times \ln CPUE_{it} + \varepsilon_{it}$$

Swordfish landings and profit upon Trip days (Move/Searching days + Operation days) Catch Model Estimation

Model 1,2,3
Cobb-Douglas
Production Function

Model 4,5,6
Translog
Production Function

	Dependent variable:					
	Ln(SF Landing Weight)					
	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)	Model 5 (5)	Model 6 (6)
Ln(Trip Days)	0.888***					
	(0.079)					
Ln(Operation Days)		0.798***	0.759***	3.981**	5.755***	6.806***
		(0.070)	(0.071)	(1.798)	(1.801)	(1.764)
Ln(Others' CPUE)	0.881***	0.940***	0.879***	1.354	3.152***	3.860***
	(0.078)	(0.078)	(0.079)	(2.984)	(0.909)	(0.872)
Ln(Others' CPUE) x Move/Search Days			0.002***	0.088***	0.021***	0.002***
			(0.001)	(0.015)	(0.007)	(0.001)
Ln(Operation Days)2				-0.030		
				(0.067)		
Ln(Others' CPUE)2				0.134		
				(0.218)		
Ln(Others' CPUE)2 x Move/Search Days				-0.010***		
				(0.002)		
Ln(Others' CPUE) x Ln(Operation Days)				-0.414	-0.720**	-0.938***
				(0.288)	(0.285)	(0.274)
Ln(Operation Days) x Ln(Others' CPUE) x Move/Search Days				-0.007***	-0.006***	
				(0.002)	(0.002)	
Constant	0.086	0.388	0.755	-9.489	-15.085***	-18.505***
	(0.585)	(0.571)	(0.576)	(10.885)	(5.768)	(5.643)
Vessel FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	825	825	825	825	825	825
R^2	0.421	0.423	0.433	0.469	0.446	0.441
Adjusted R^2	0.387	0.389	0.399	0.433	0.411	0.407
Residual Std. Error	0.458 (df = 778)	0.458 (df = 778)	0.454 (df = 777)	0.441 (df = 772)	0.449 (df = 775)	0.451 (df = 776)
F Statistic	12.304*** (df = 46; 778)	12.401*** (df = 46; 778)	12.625*** (df = 47; 777)	13.087*** (df = 52; 772)	12.758*** (df = 49; 775)	12.778*** (df = 48; 776)
Note:						*p<0.1;* ***p<0.05;*** p<0.01

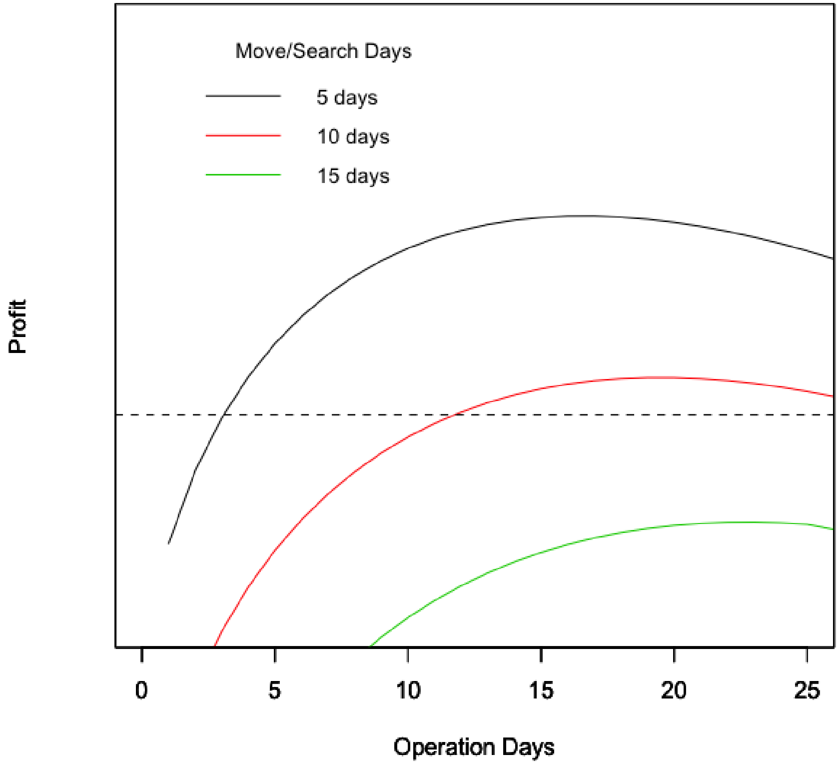
Combine Ex-vessel Price, Cost and Catch to find the optimal fishing strategy for the maximum profit (model 3 Cobb-Douglas)

Move/Search Days	5	10	15
Operation Days	16	19	25
Days per Trip	21	29	40
Catch(MT)	10	12	16
Profit(USD)	9497	6114	-9694

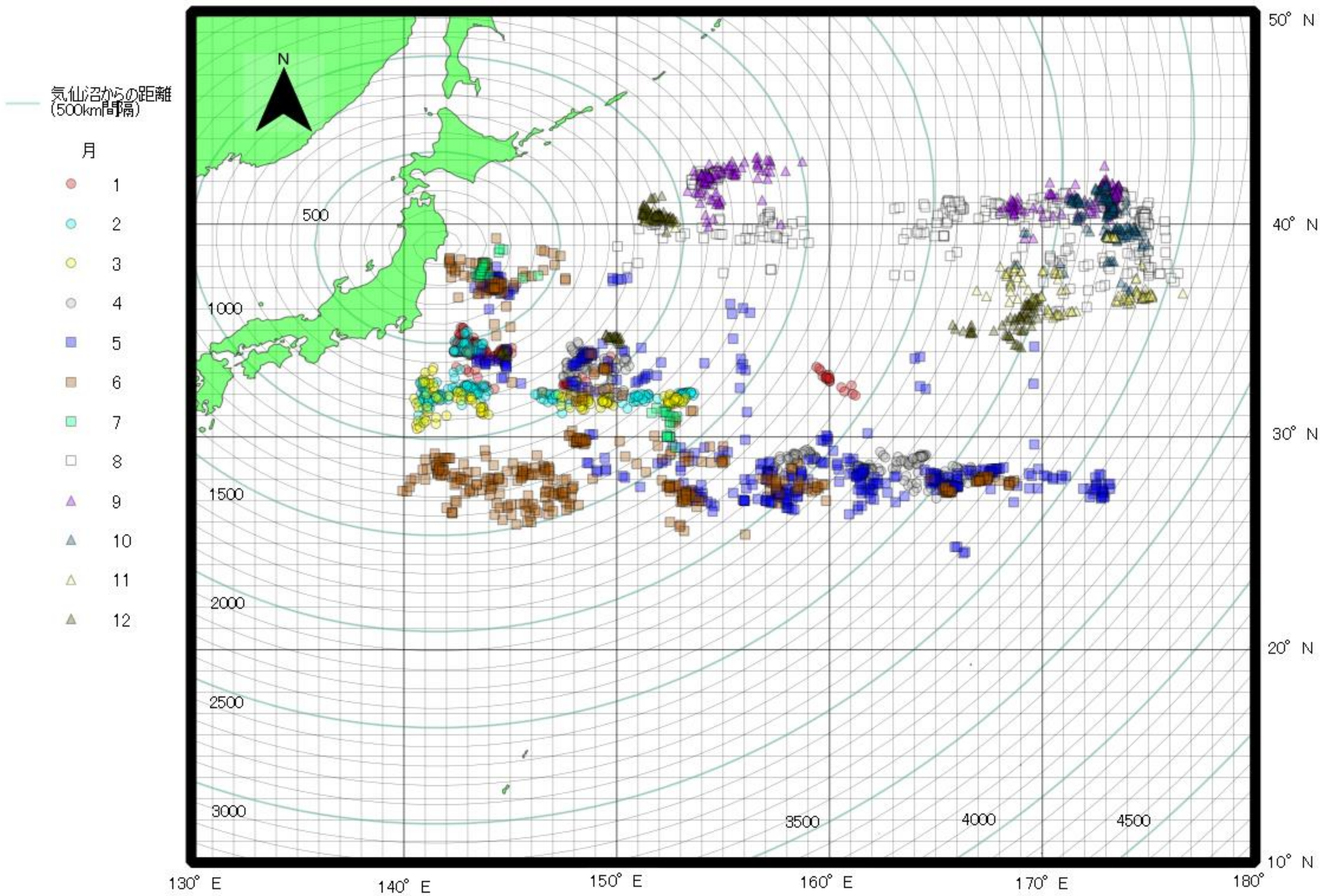
Average under limited open -access before 2011

Competitive individual operation with 40 days trip can not materialize a profit (negative profit).

21 Days per Trip with 16 operation Maximize the profit.

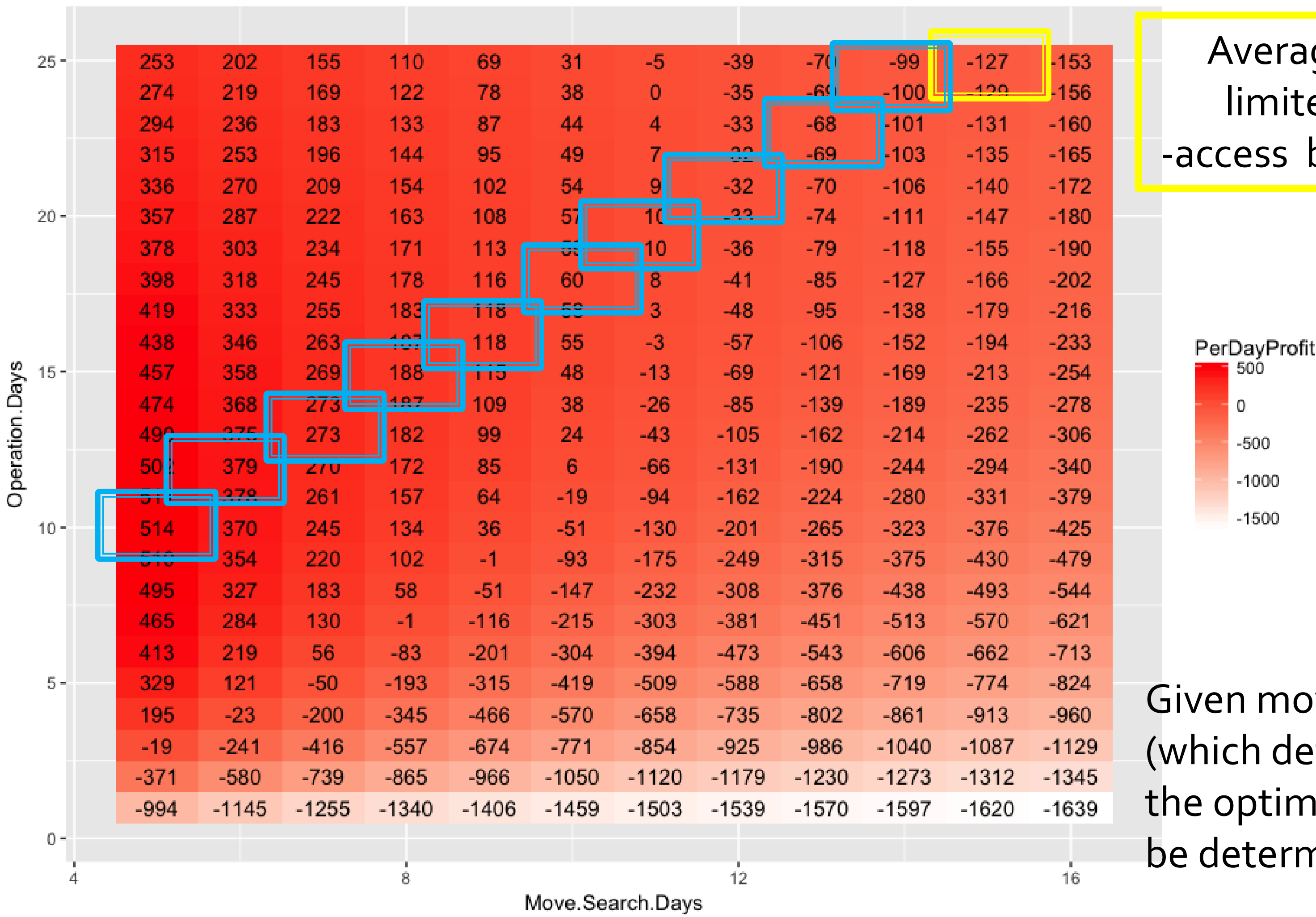


Spatial Distributions of Operations



全月　操業位置間の距離に対するクラスター解析の結果（5%以上）

Moving form profits per trip to profit per day



Average under limited open -access before 2011

Given move/search days (which defines fishing grounds), the optimal operations should be determined.

Conclusion

- Shorter search/move days would better off to maximize the profit.
- Need to explore optimal schedule by considering potential fishing grounds for each month.

FISHERY SYSTEMS SCIENCE LAB
AT MORIOKA, IWATE UNIVERSITY

Thanks!