Potential Fishing Zones as "hotspots" of skipjack tuna (*Katsuwonus pelamis*) and albacore (*Thunnus alalunga*) in the western North Pacific

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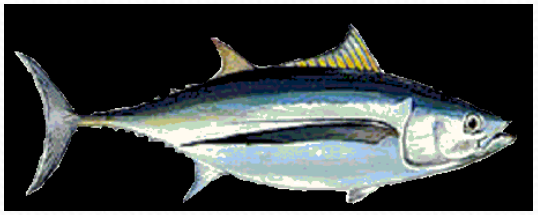
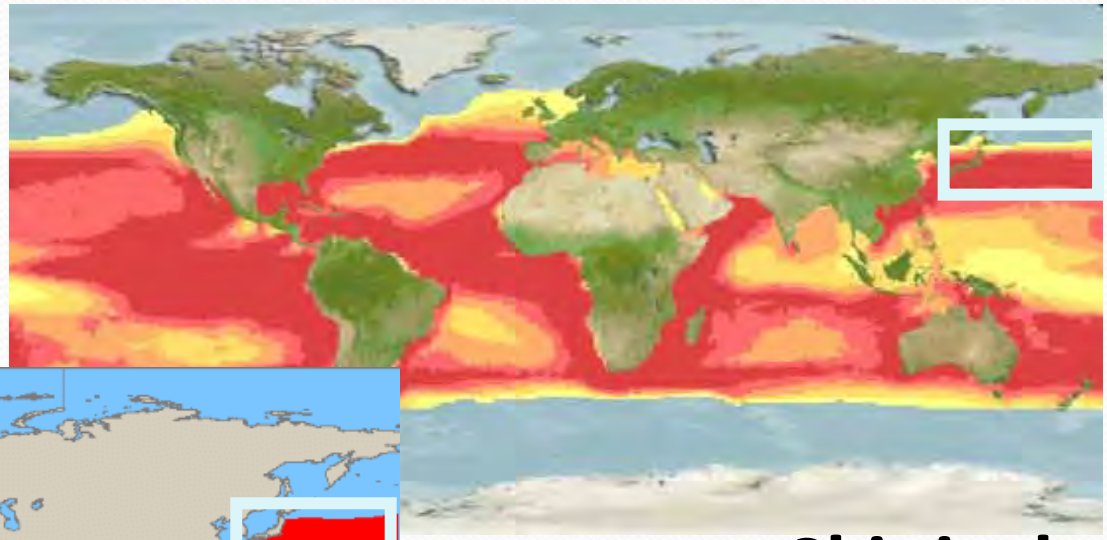
Outline

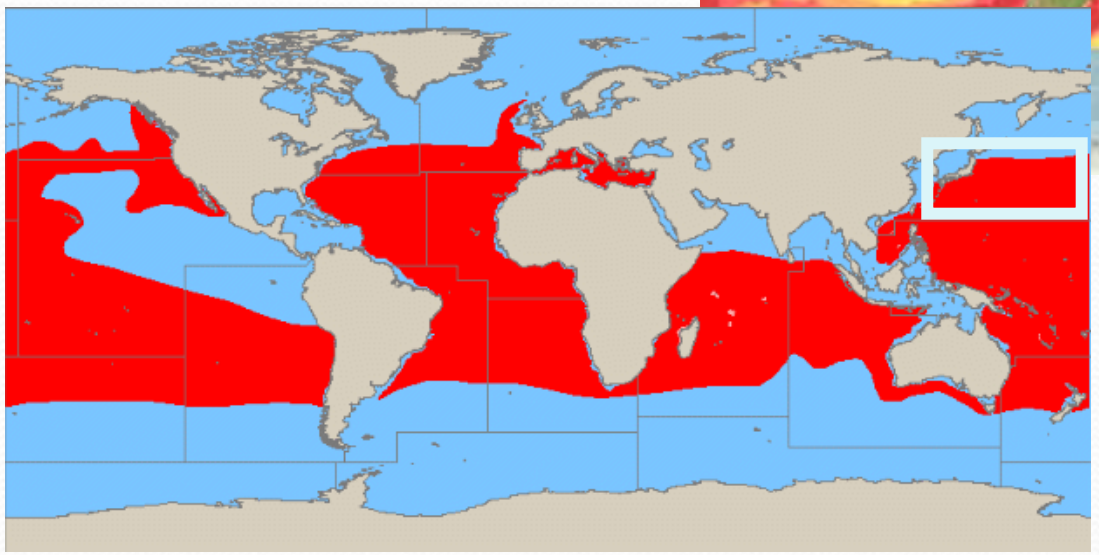
- **Introduction (Tuna Production)**
- **How to get Potential Fishing Zone**
- **Operational Fisheries Oceanography**
- **Commercial Fisheries Services (TOREDAS)**
- **VMS application for understanding fishing activities**
- **Global Warming Scenarios**
- **Concluding Remarks**

Habitats of skipjack tuna (*Katsuwonus pelamis*) and albacore (*Thunnus alalunga*)



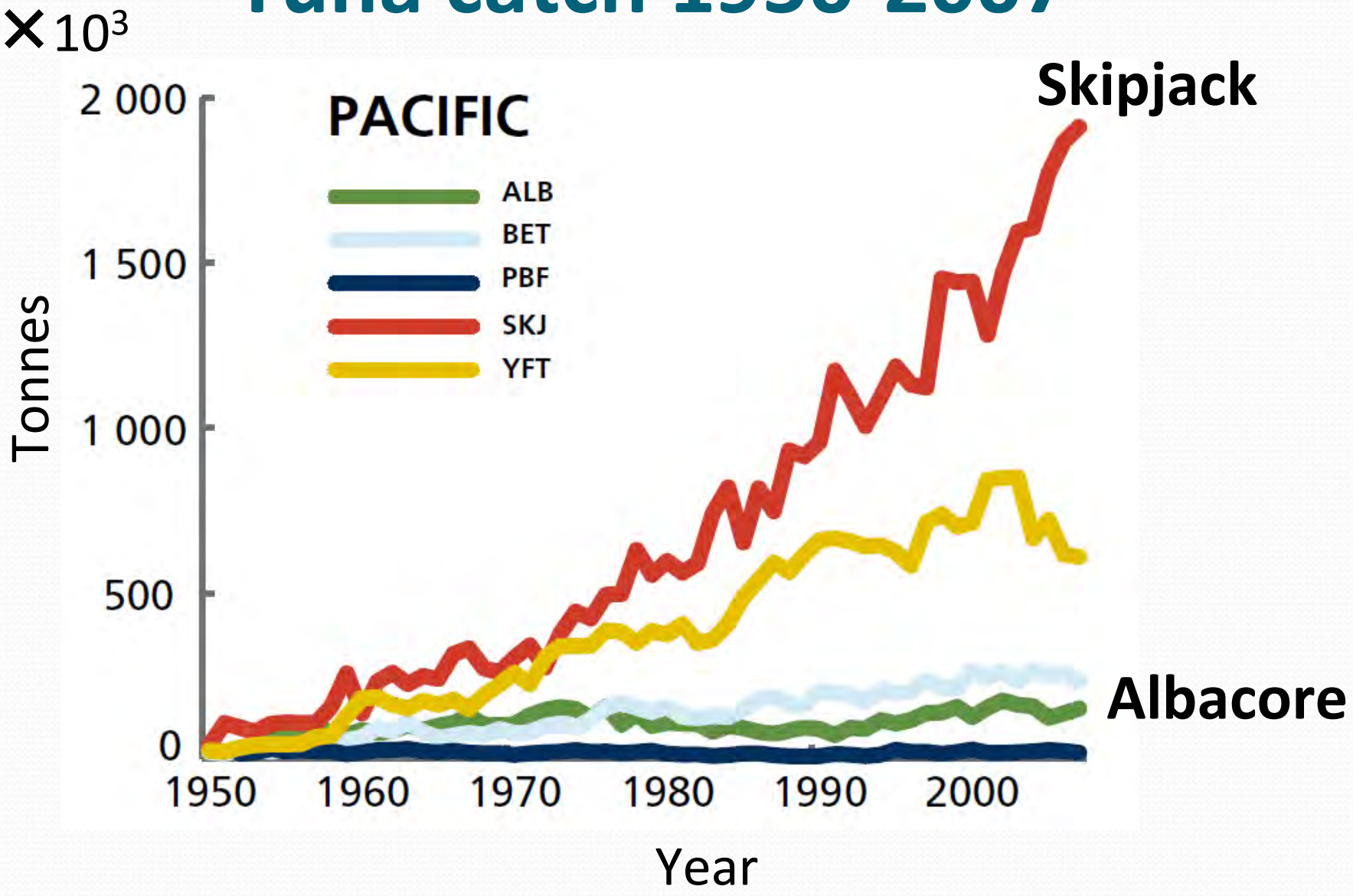
Albacore



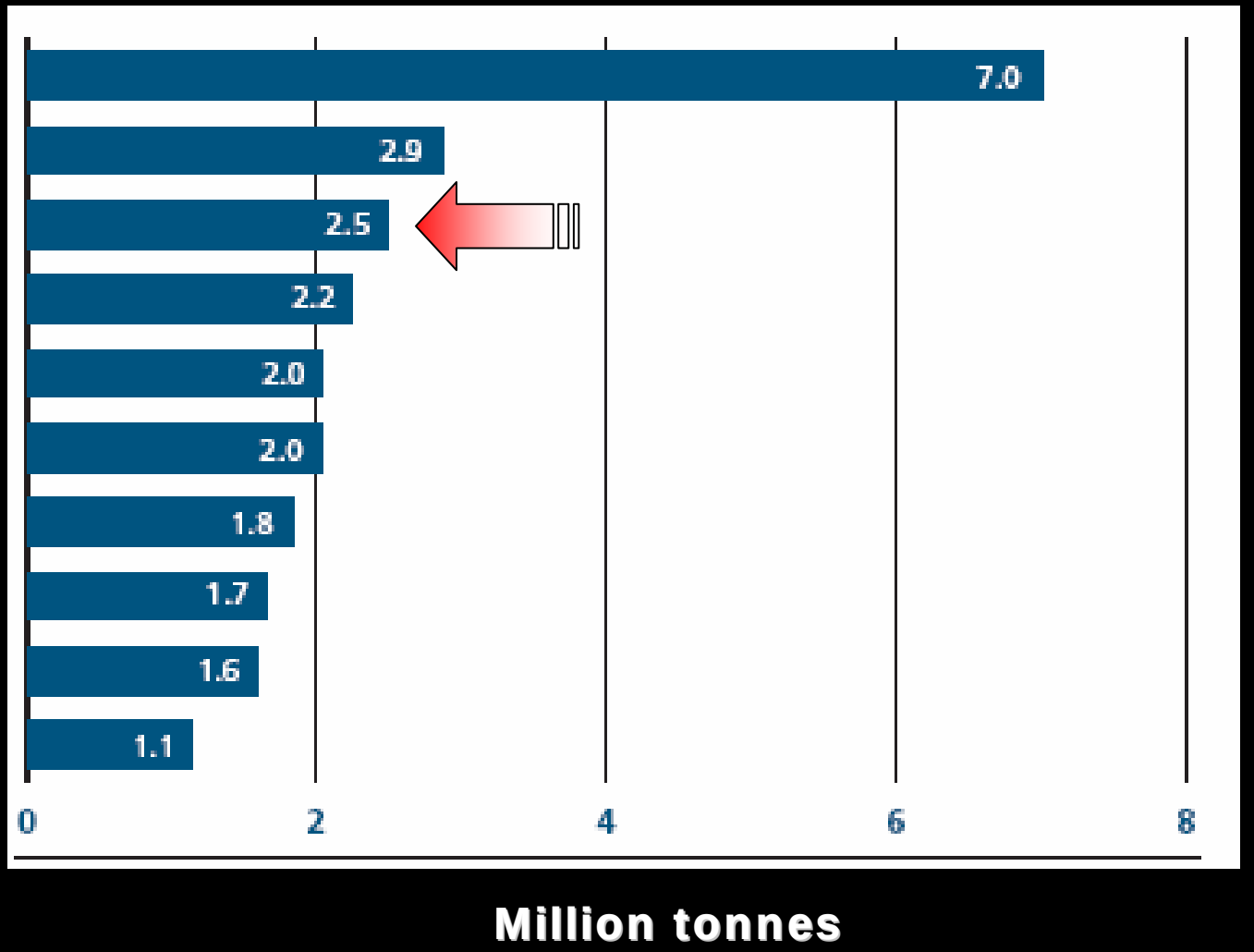


Skipjack

Tuna catch 1950-2007



Skipjack tuna ranks 3rd in catch volumes



FAO, 2009

Catch of skipjack tune in the western and central Pacific

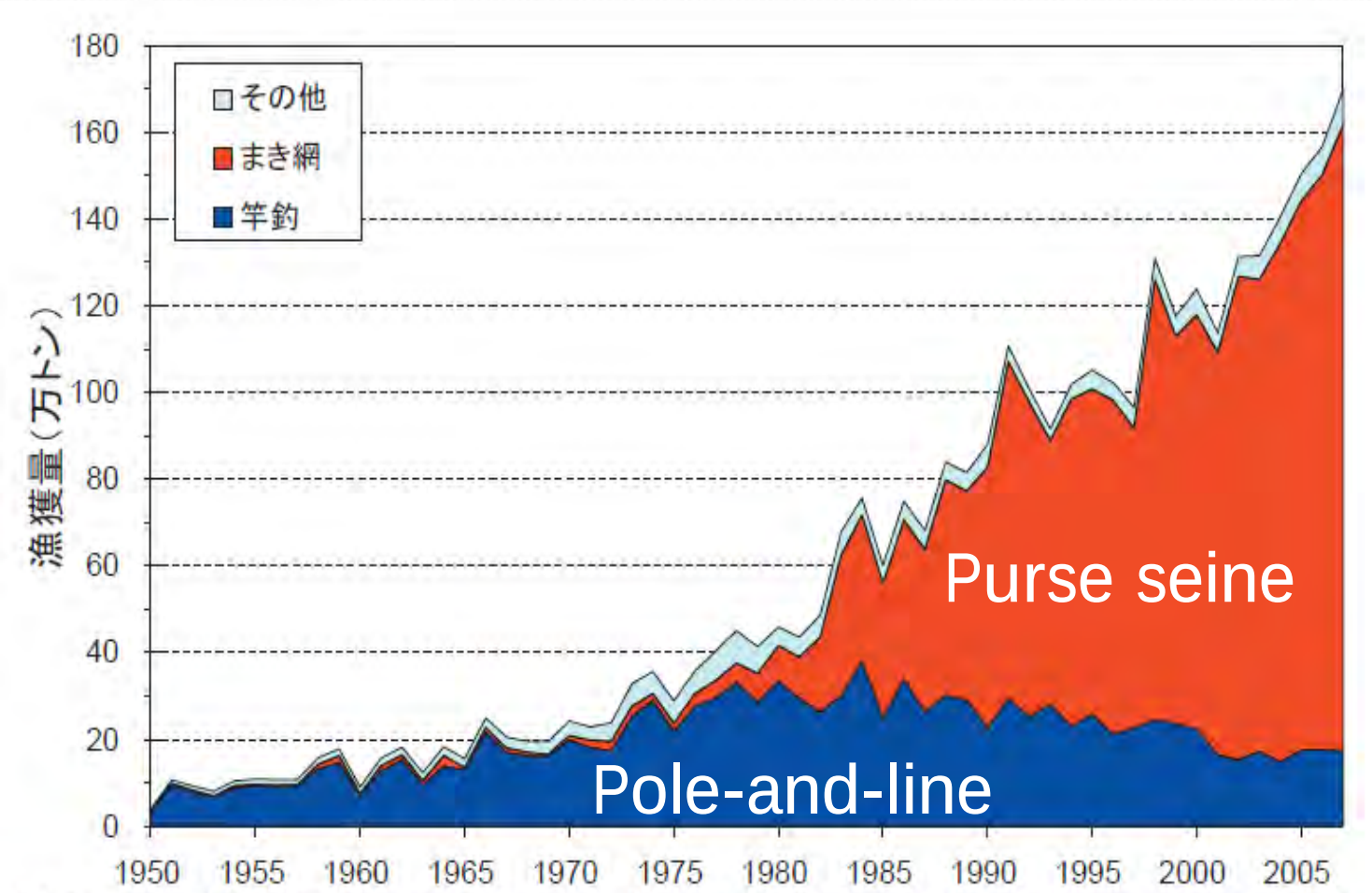


図1. 中西部太平洋カツオの主要漁法別漁獲量の経年変化（万トン）（SPC. 2008）。

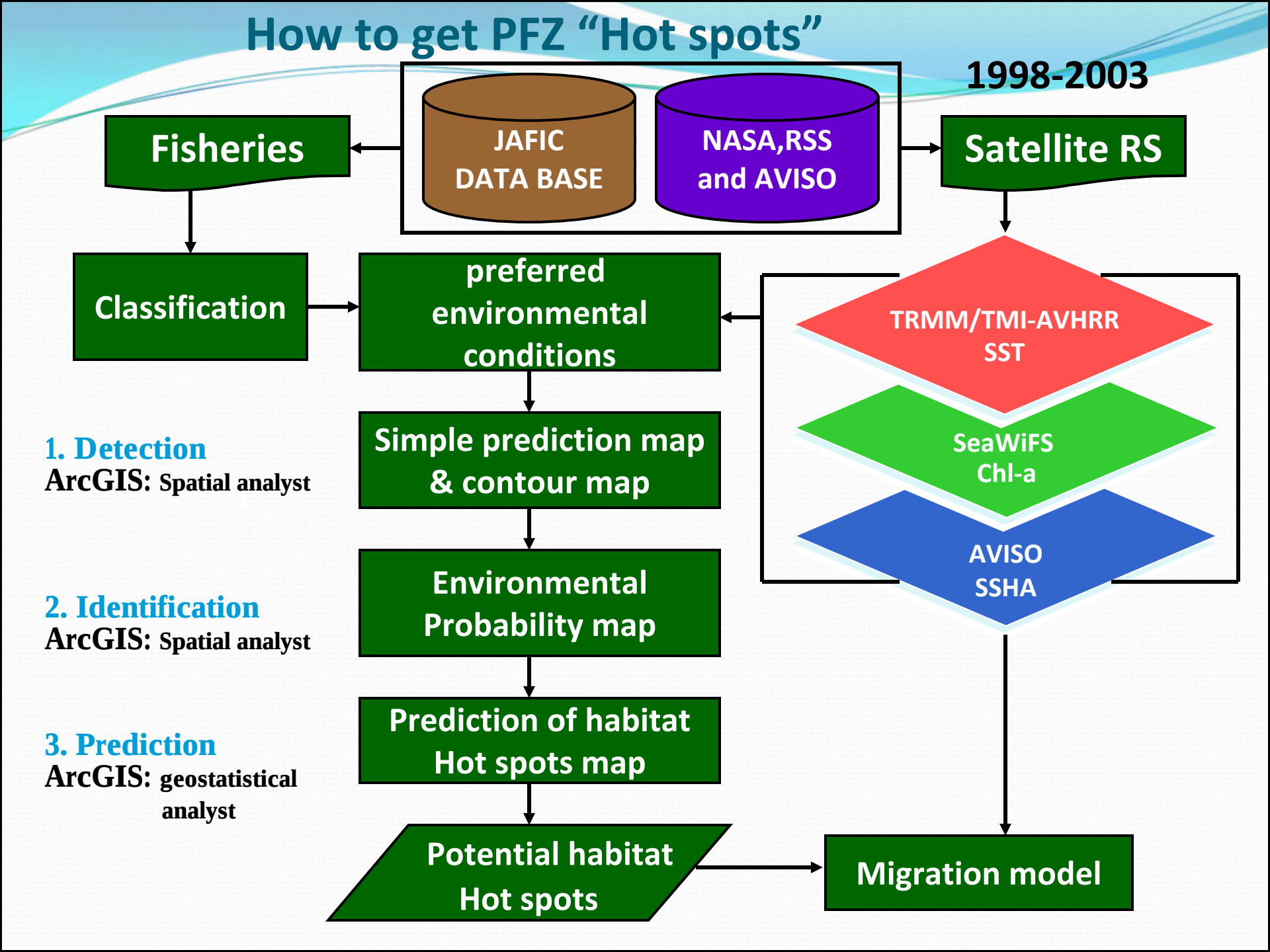
Skipjack pole-and-line fisheries

More ecological method

Miyojin-Suisan
Kochi, Japan

MSC eco-label

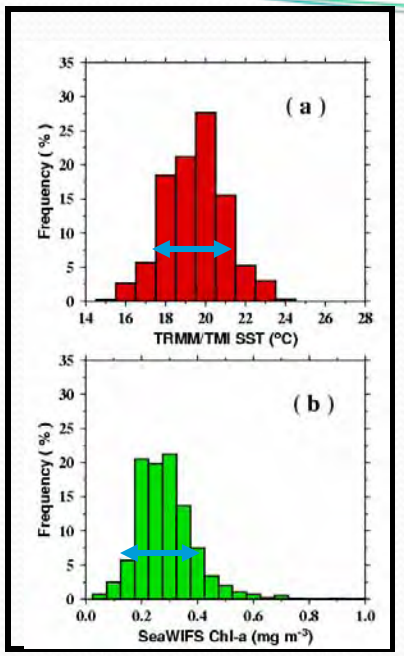
How to get PFZ "Hot spots"



Detection of potential habitat

Histogram high catch data (mean ± one

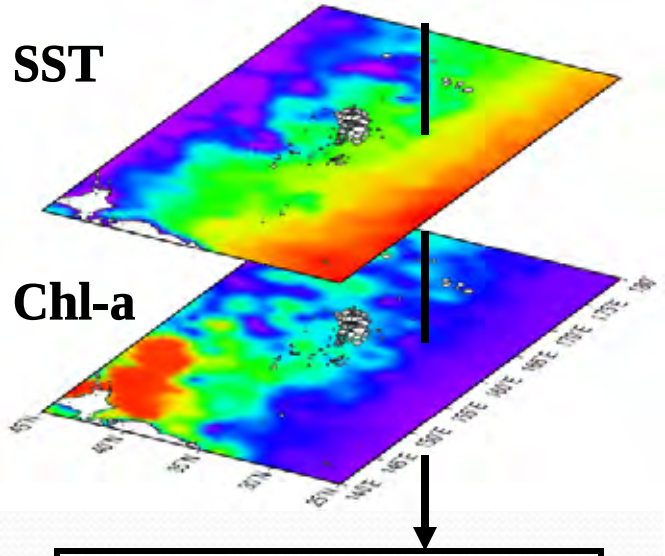
Using preferred ranges



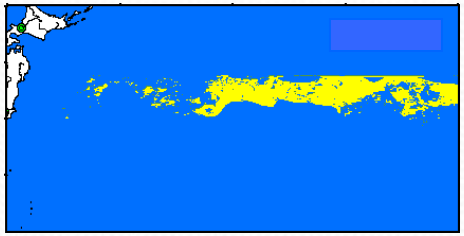
Oceanographic variables

SST

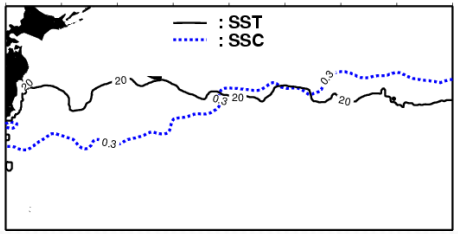
Chl-a



Simple prediction map

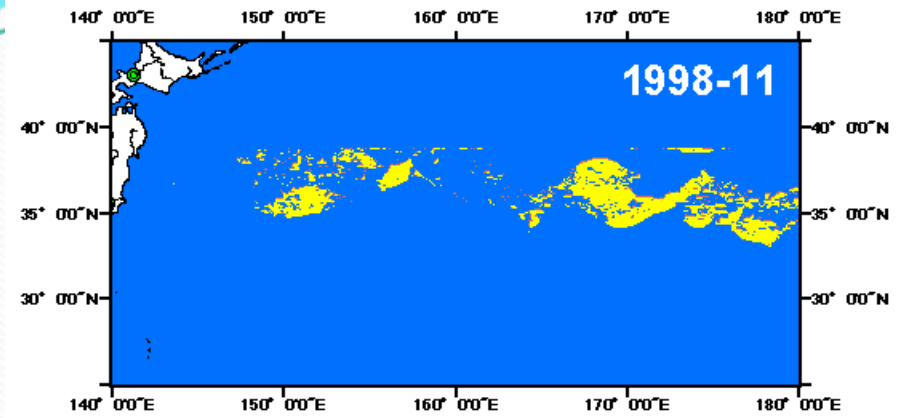


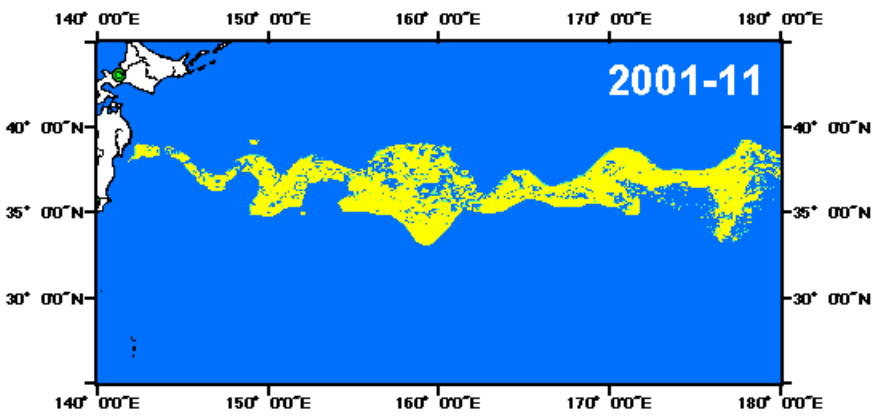
Contour map

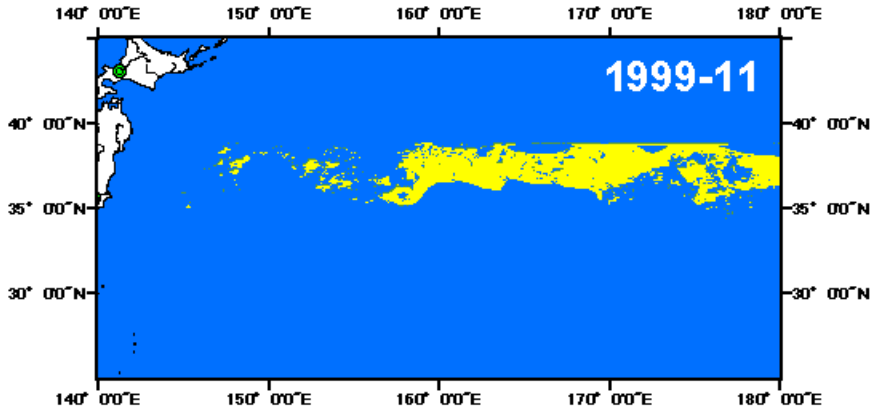


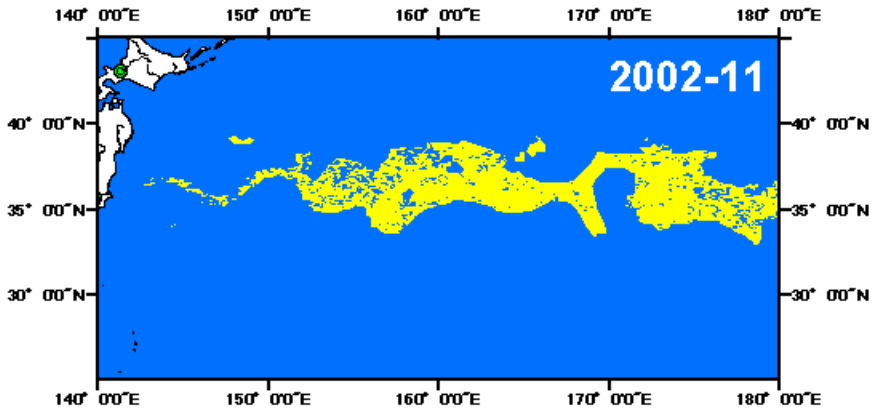
Output map

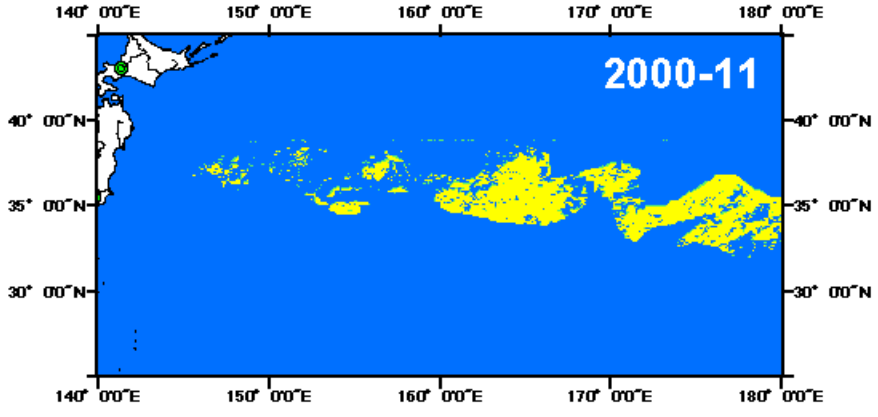
Simple prediction map

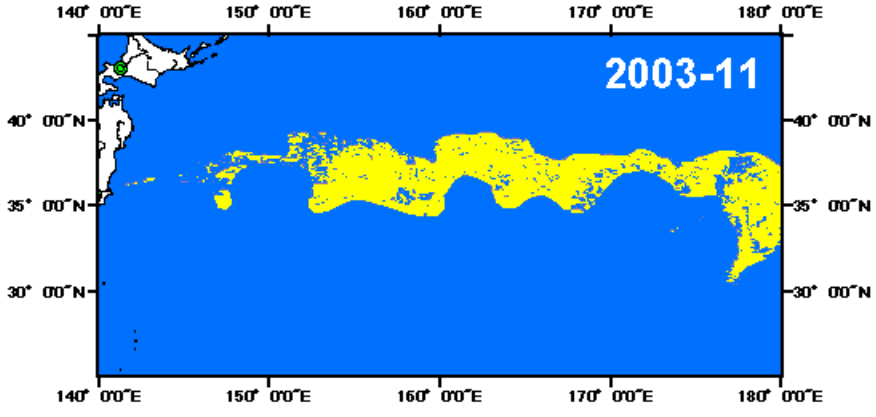




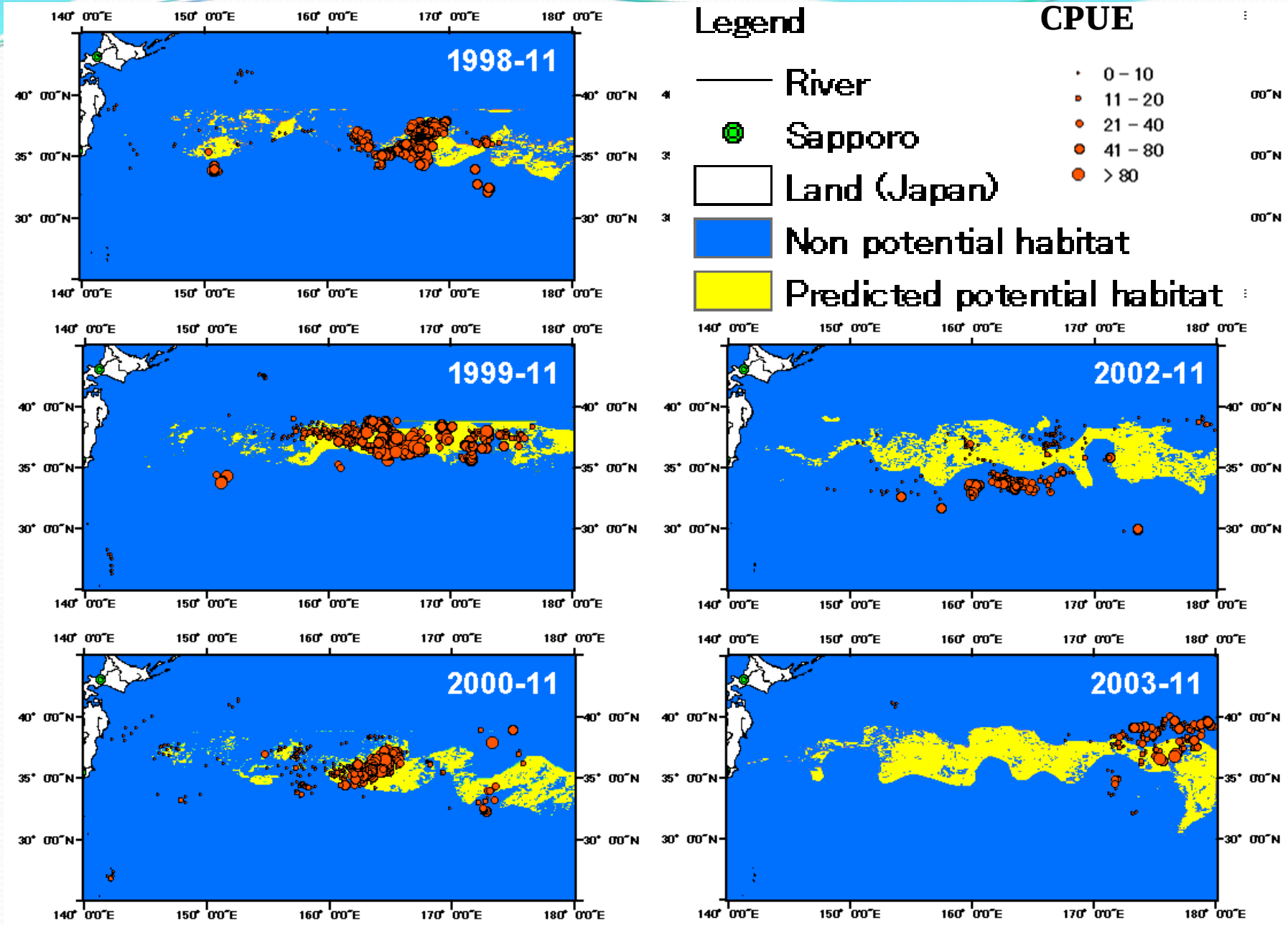




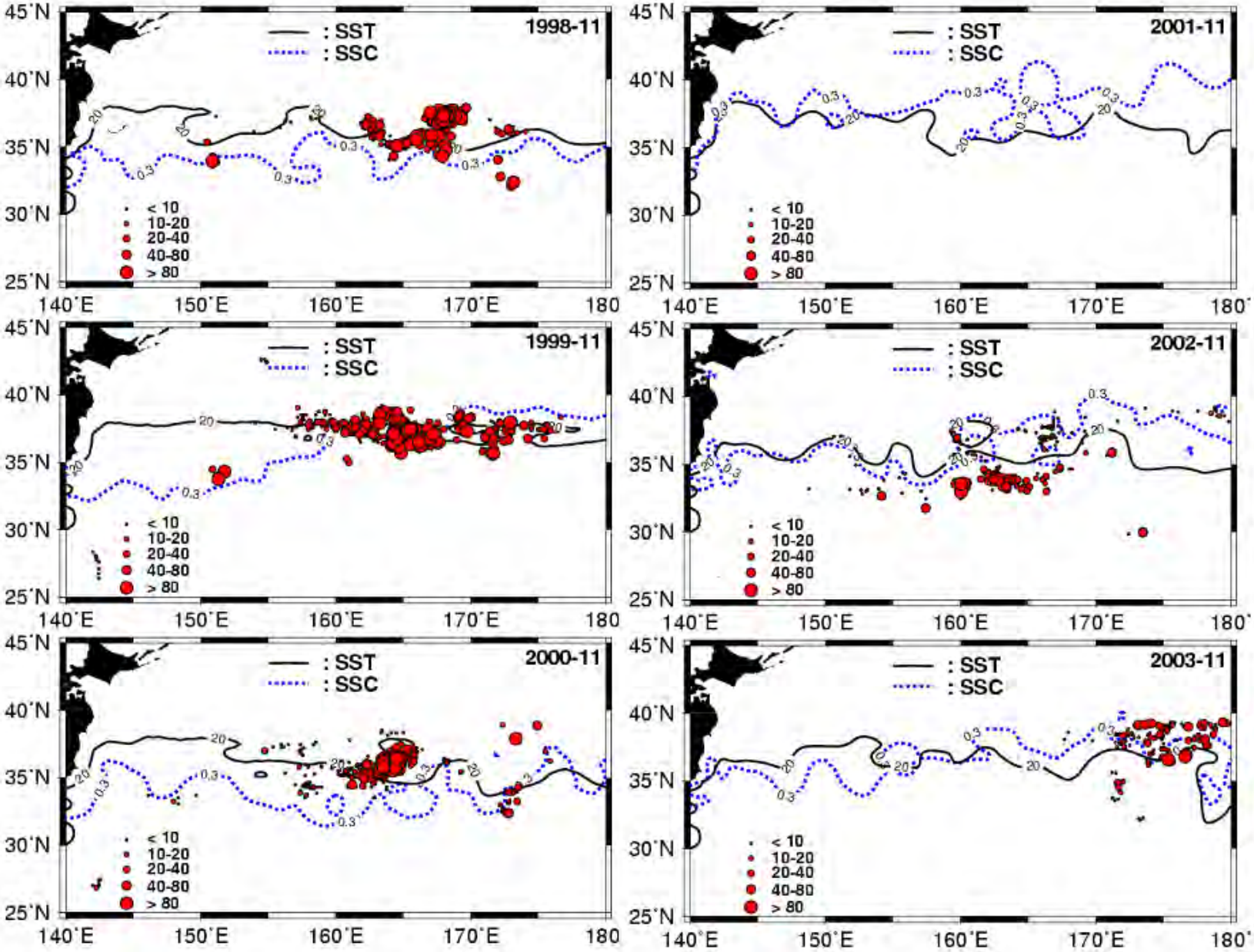




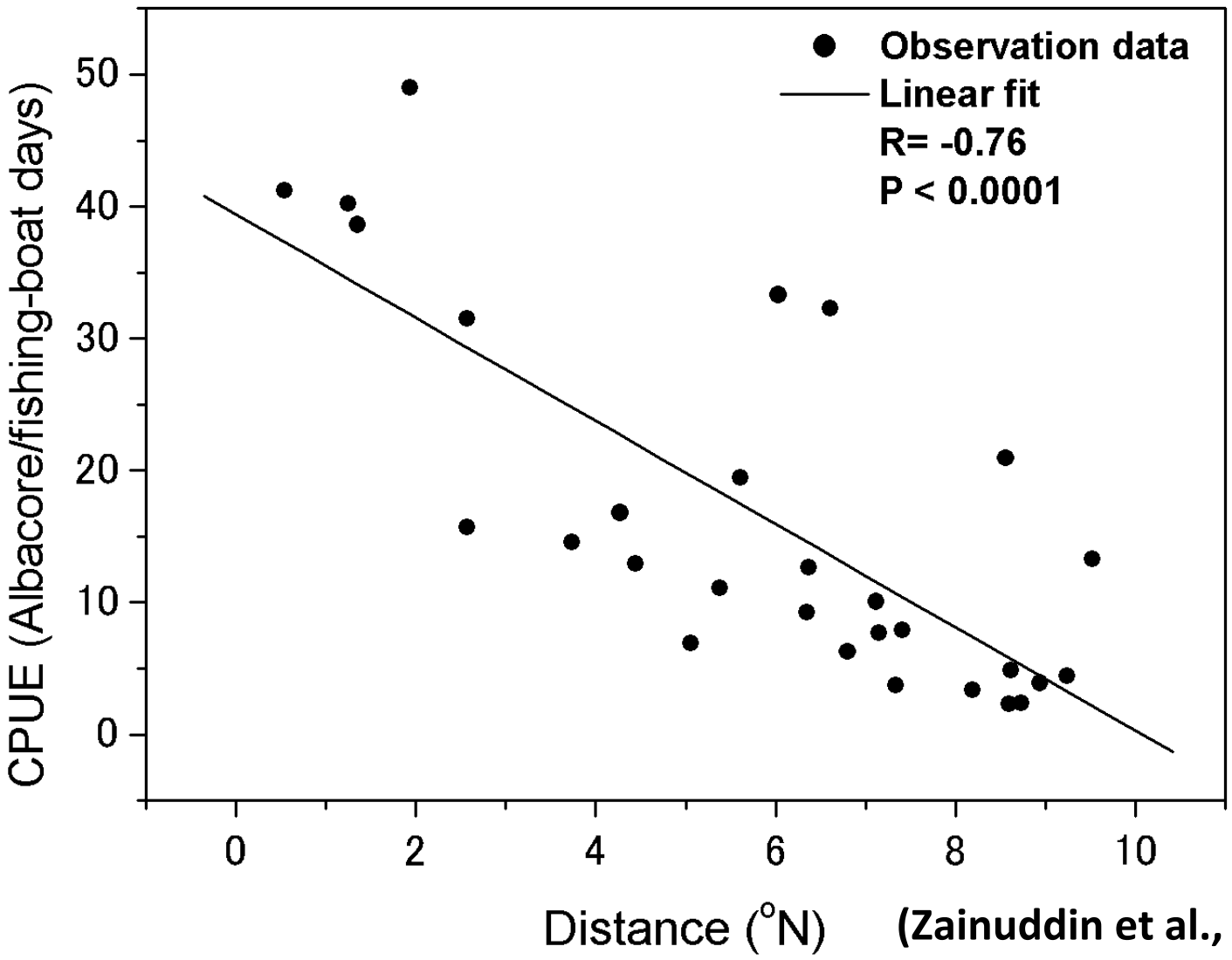
Simple prediction map



Contour map

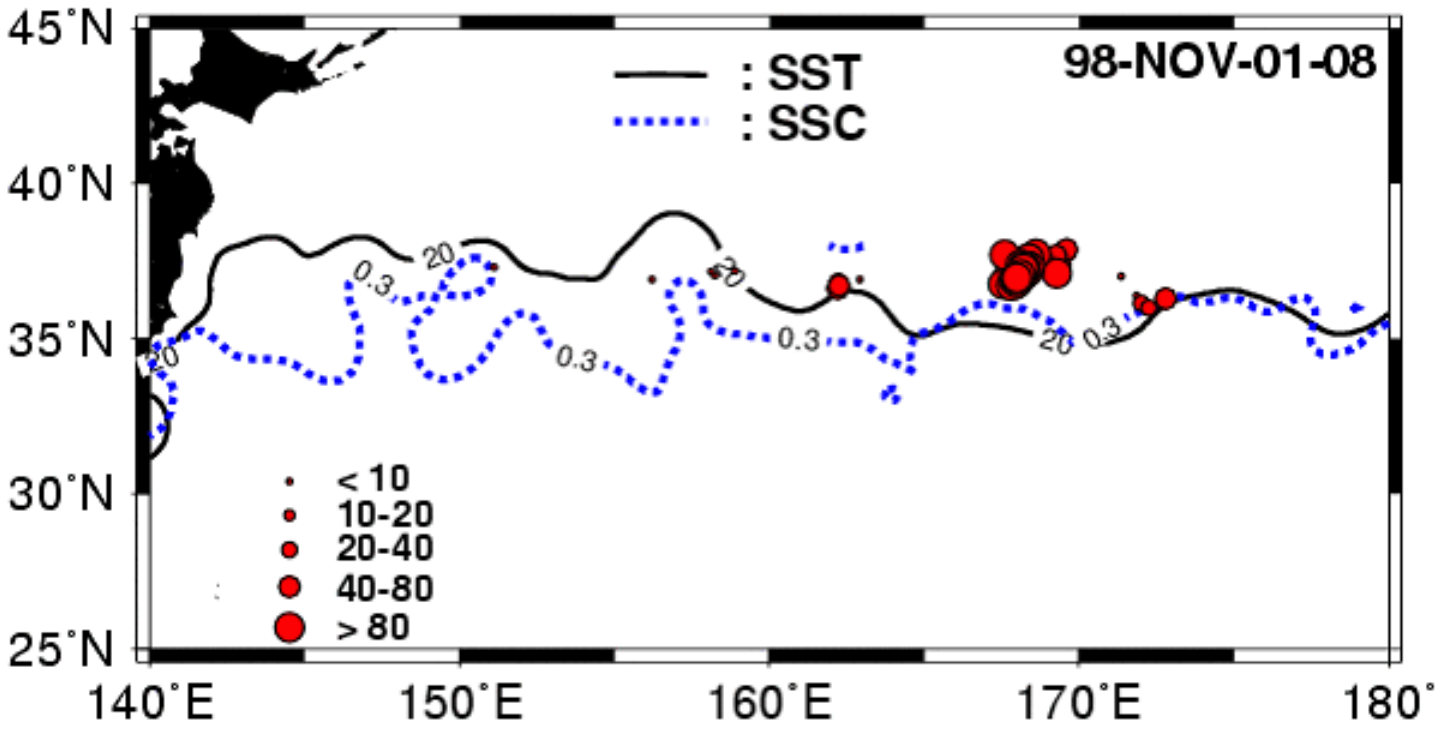

1998-11
2001-11
1999-11
2002-11
2000-11
2003-11
: SST
: SSC
< 10
10-20
20-40
40-80
> 80
45°N
40°N
35°N
30°N
25°N
140°E
150°E
160°E
170°E
180

Relationship between CPUE and distance of contour lines of SST and chl-a



(Zainuddin et al., FO 2008)

Dynamics of albacore fishing ground in relation to the movement of ocean hot spots by contour map



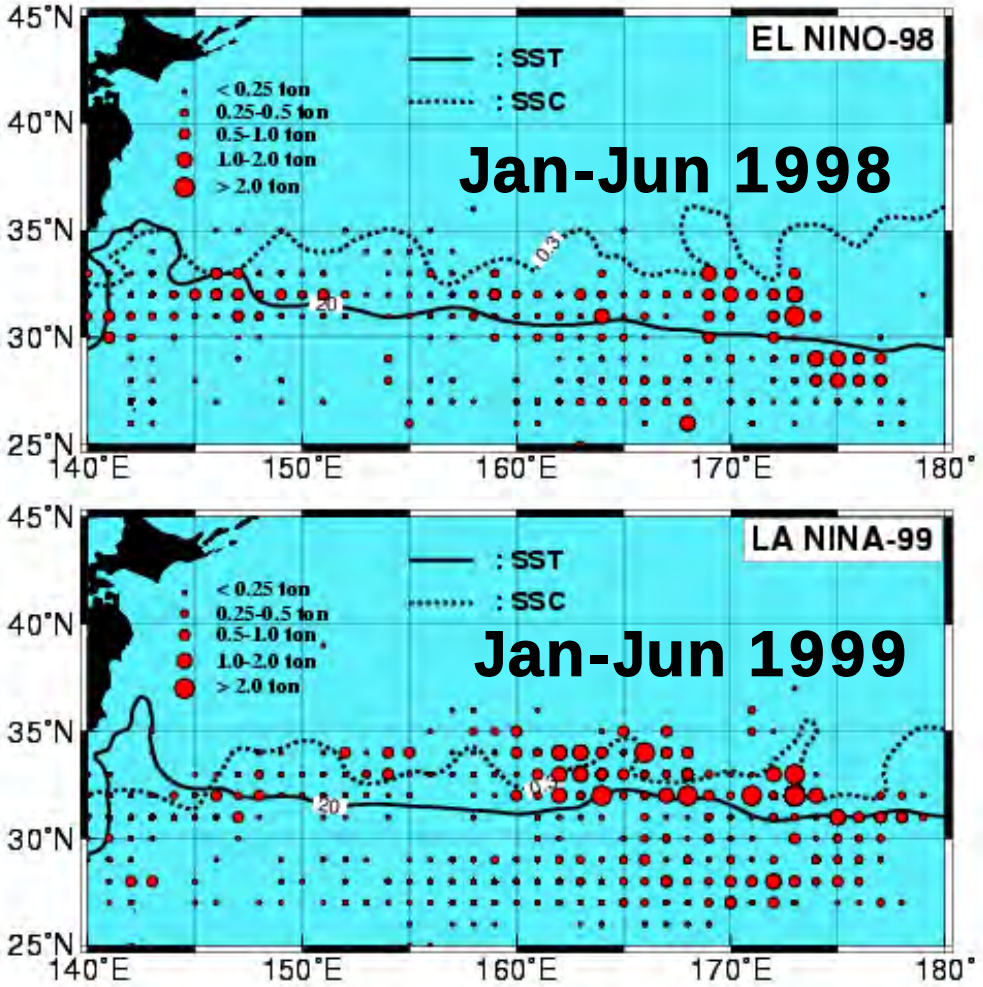
Affect to Albacore PFZ "Hot spots"
El Niño 1998 and La Niña 1999

Contour Map

Suitable Ocean Variables

SST 20℃

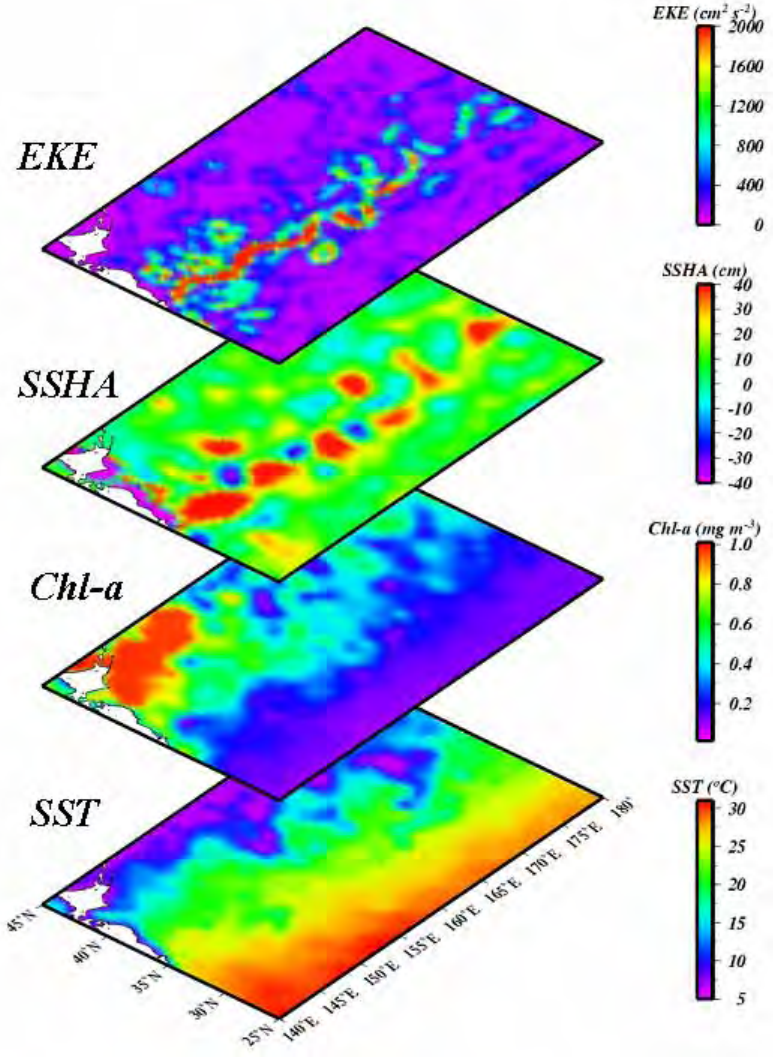
SSC 0.3mgm^{-3}



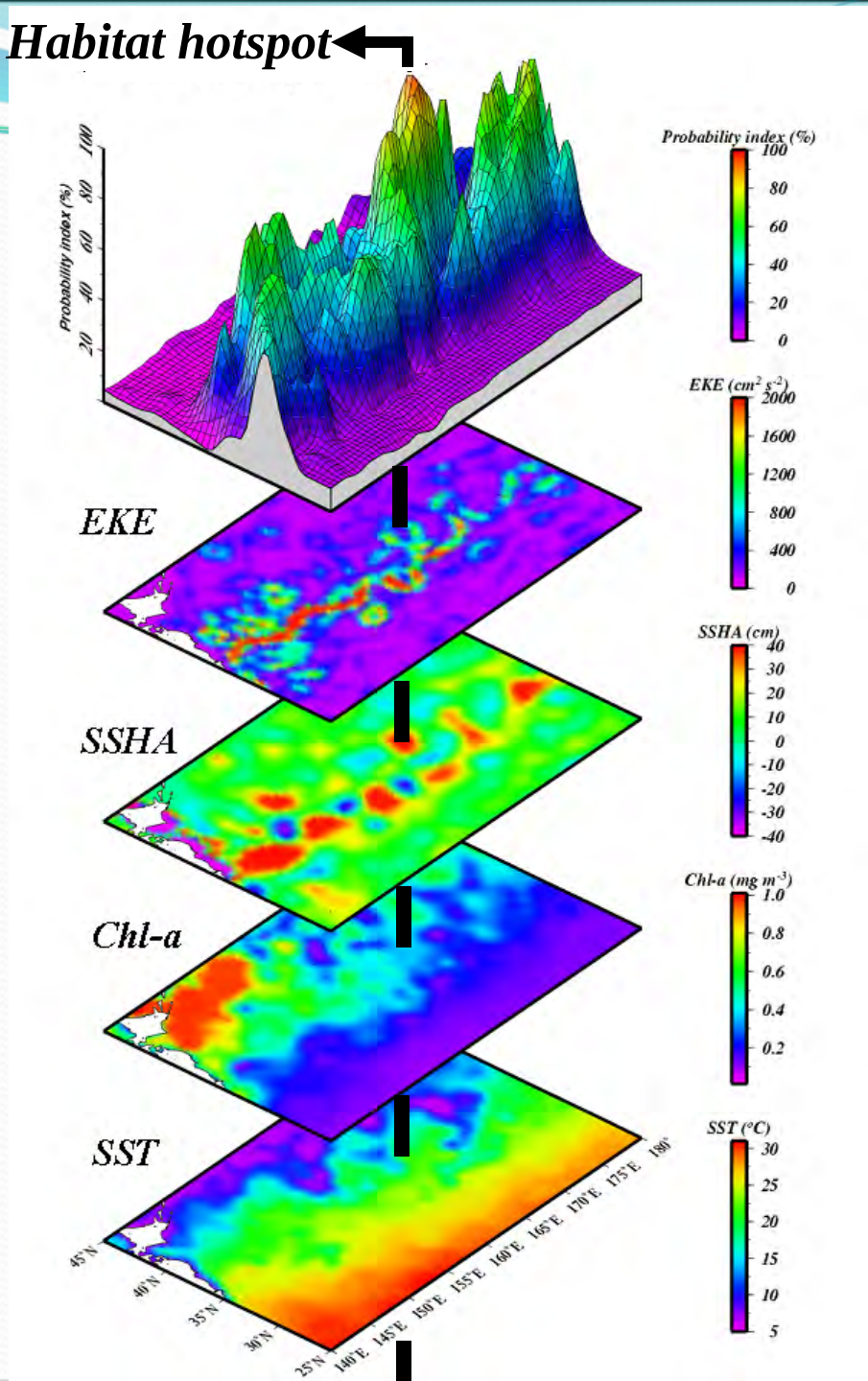
PFZ: La Niña

Well developed – High CPUE (Zainuddin et al., GRL 2004)

The interconnection: albacore fishery and environments

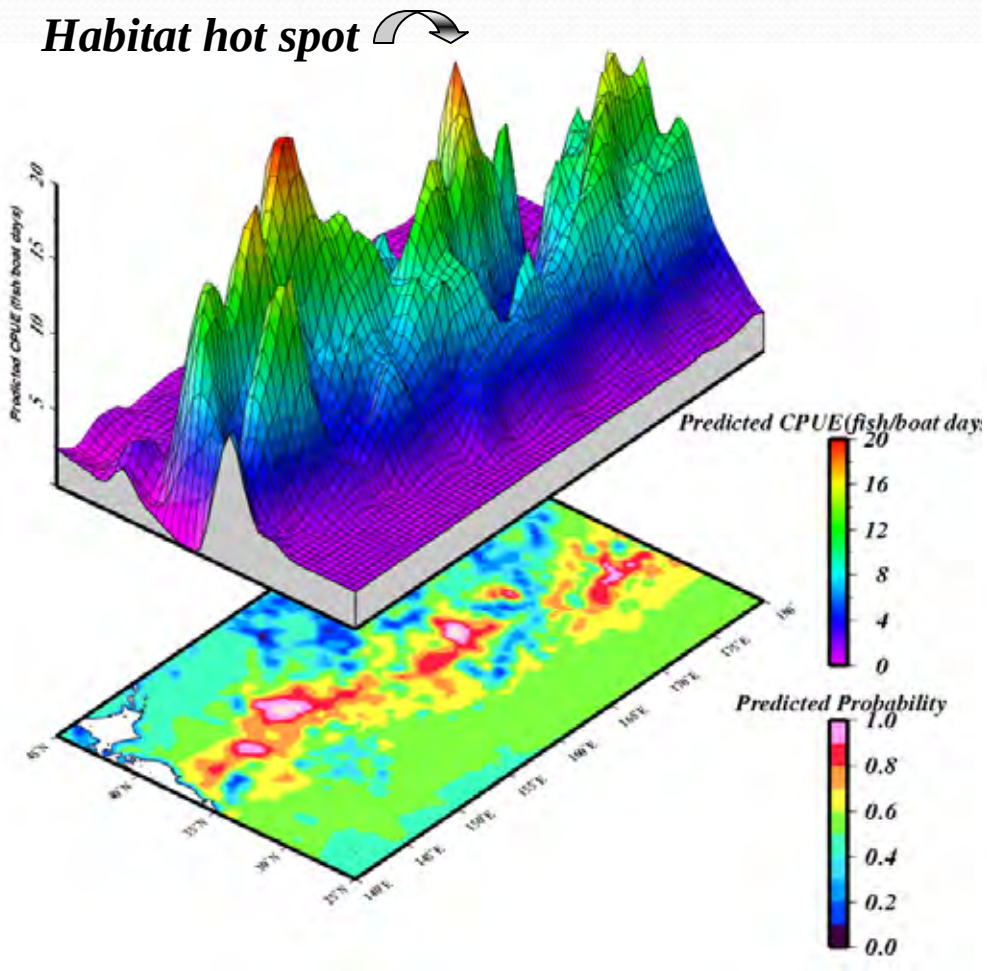


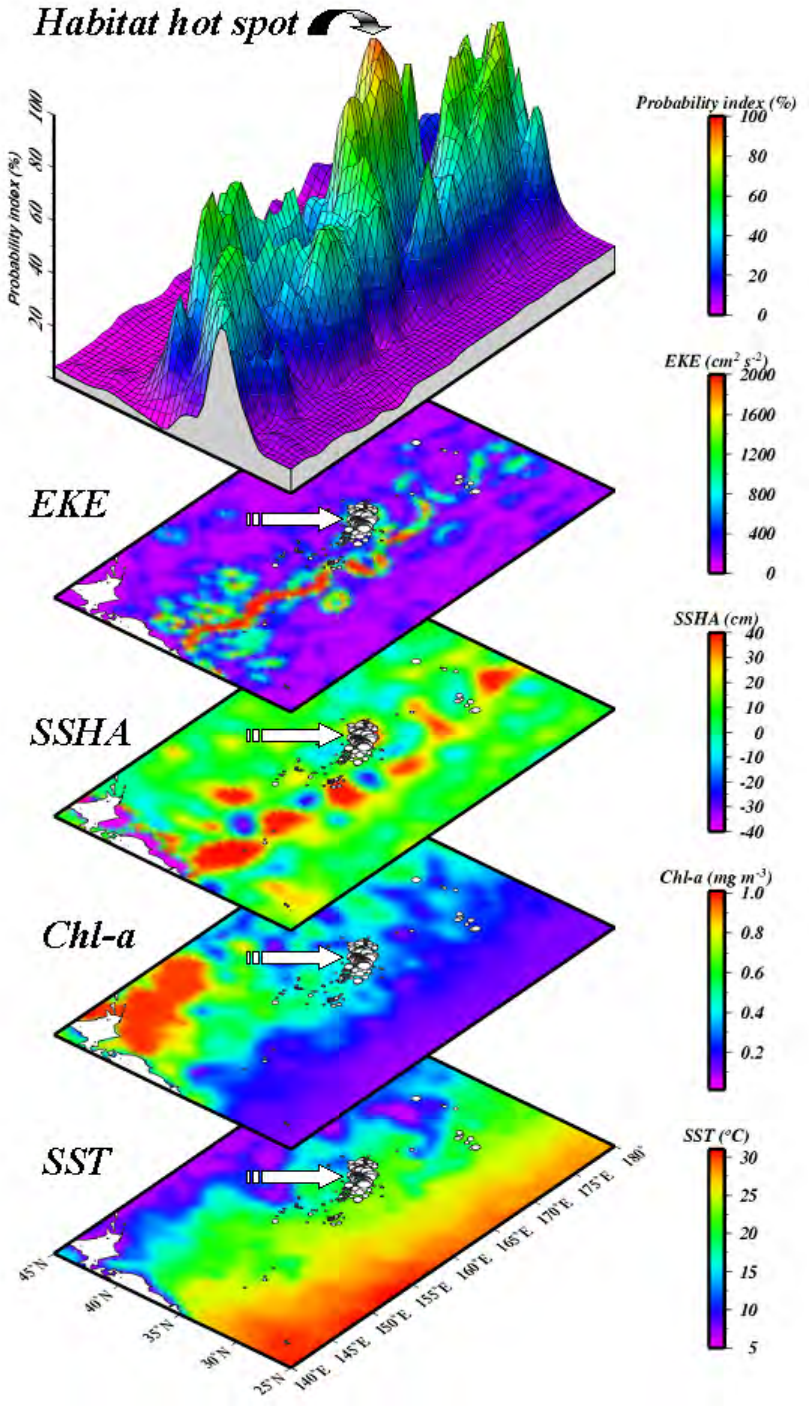
The interconnection: albacore fishery and environments



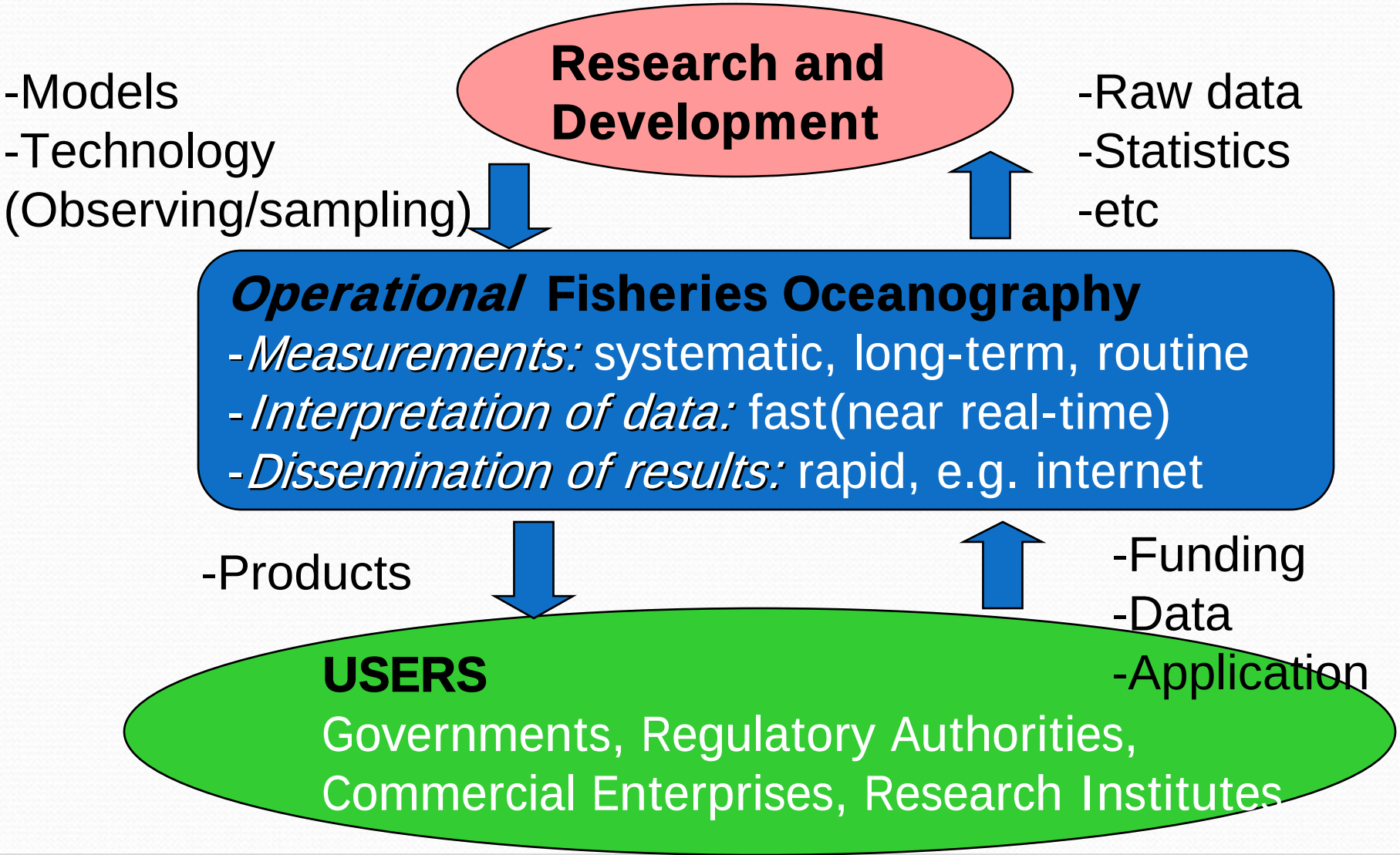
The interconnection: albacore fishery and environments

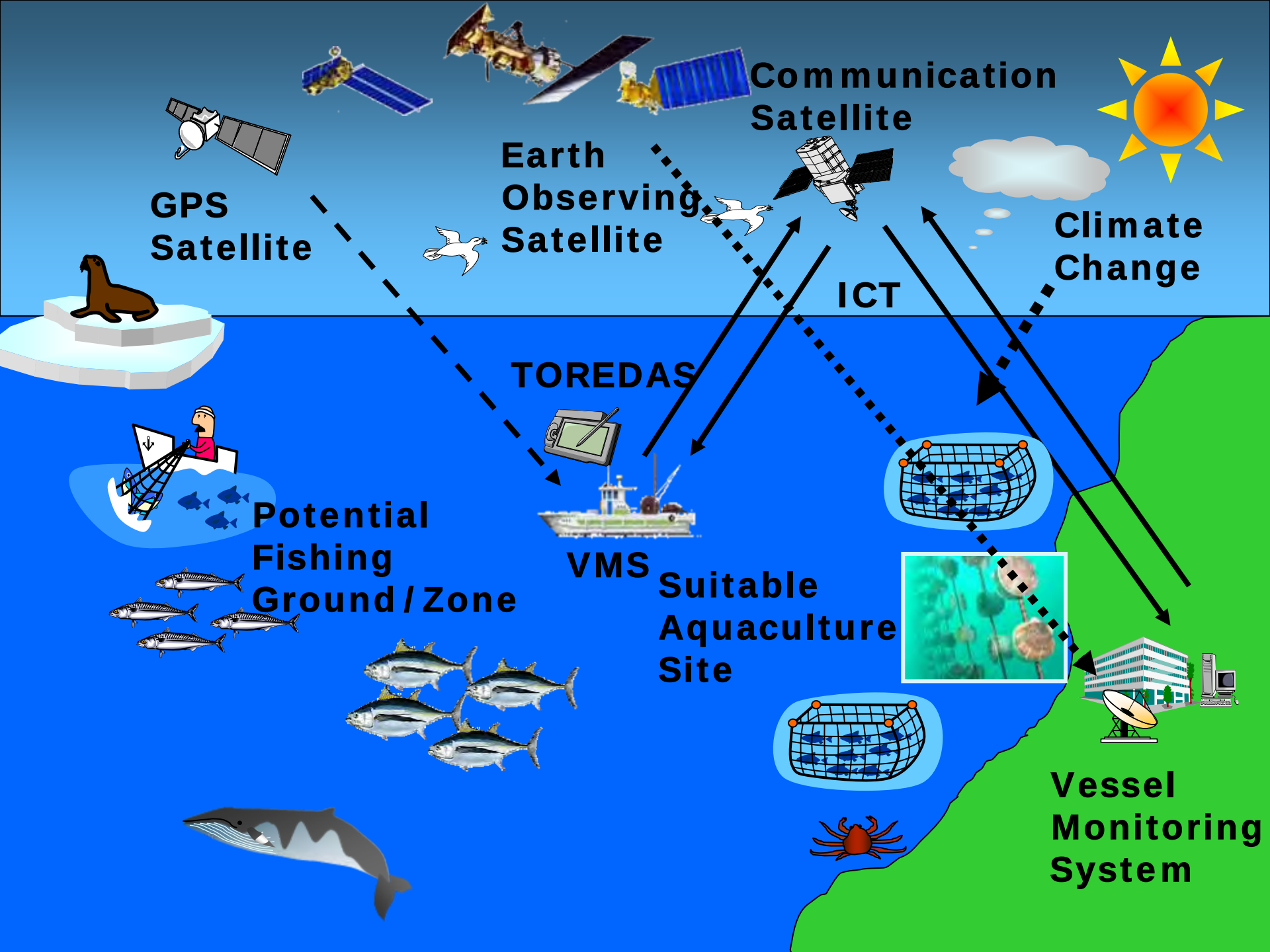
Statistical model





"Operational" Fisheries Oceanography




Communication Satellite
GPS Satellite
Earth Observing Satellite
Climate Change
ICT
TOREDAS
Potential Fishing Ground / Zone
VMS
Suitable Aquaculture Site
Vessel Monitoring System

TOREDAS: start to fish

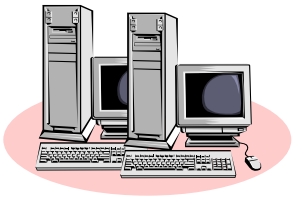
G&LI
Green & Life Innovation, Inc

Traceable
Operational
Resources
Environment
Data
Acquisition
System

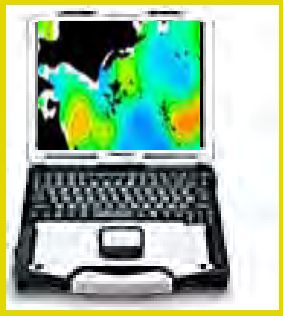
Overview of Information Transfer

Communication satellite

MODIS Database Analysis

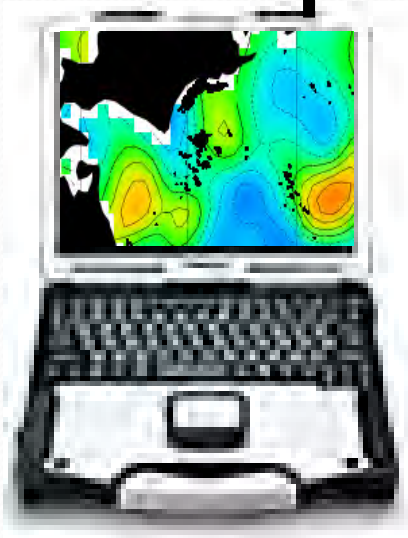


WIDE-
STAR(64Kbps)
SUPERBIRD(6Mbps)
JSAT(3Mbps)
Inmarsat(64Kbps)



GPS
Display
Overlay
Measure

Internet



WebTOREDAS(Land)

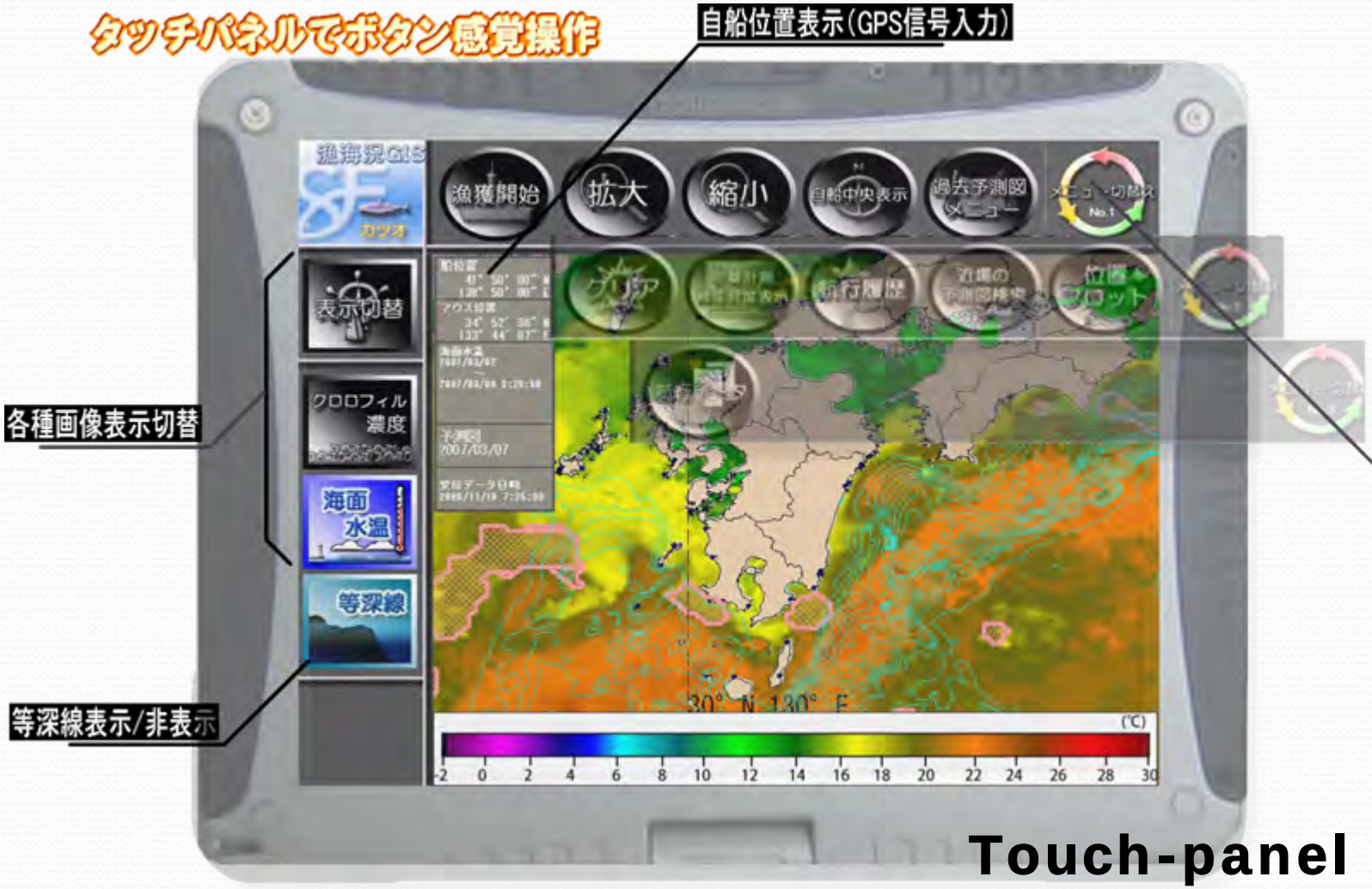
Onboard TOREDAS
(Offshore)

OnBoard TOREDAS

G&LI
Green & Life Innovation, Inc

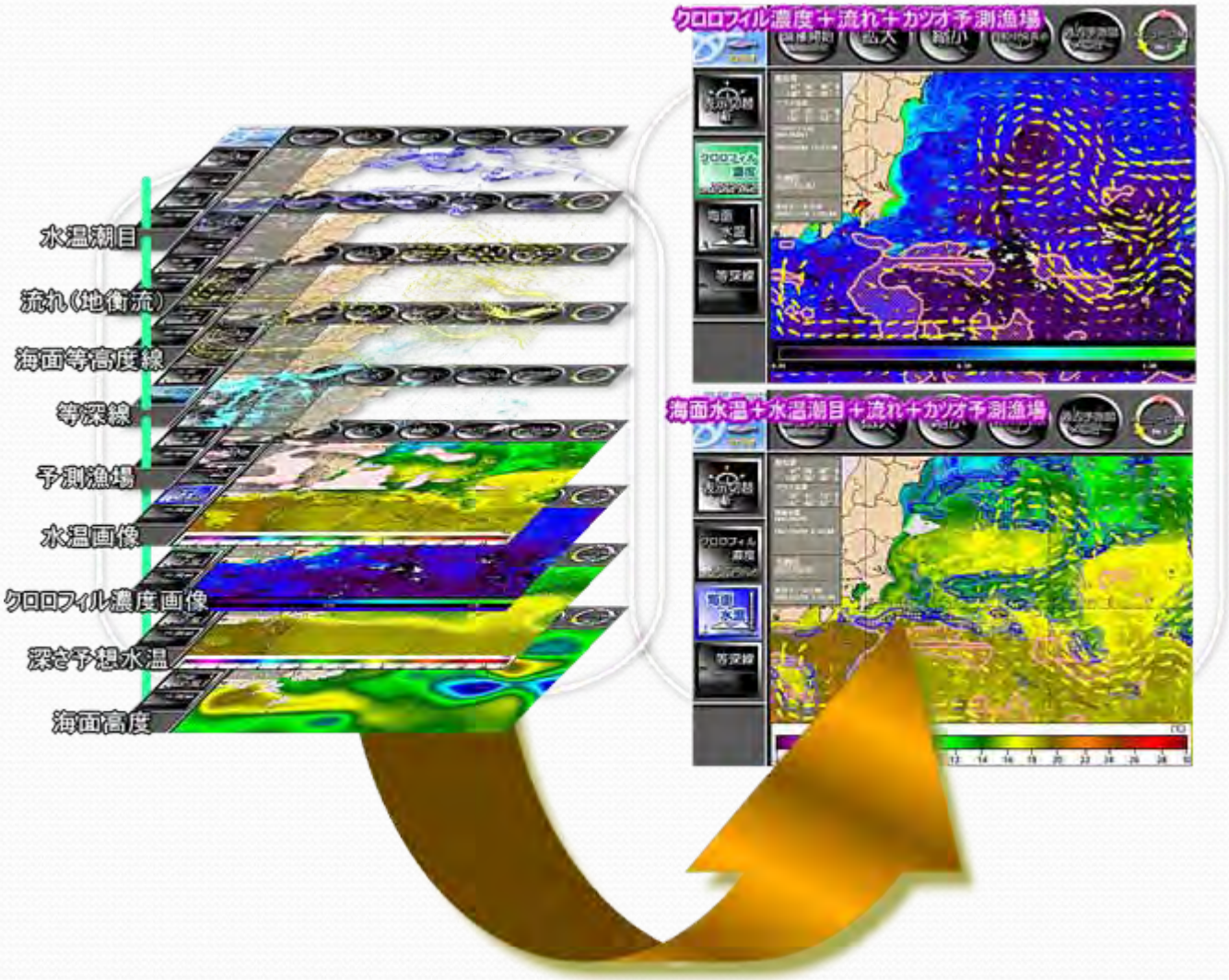
Distribution of Easy-use satellite Information to Laptop PC onboard

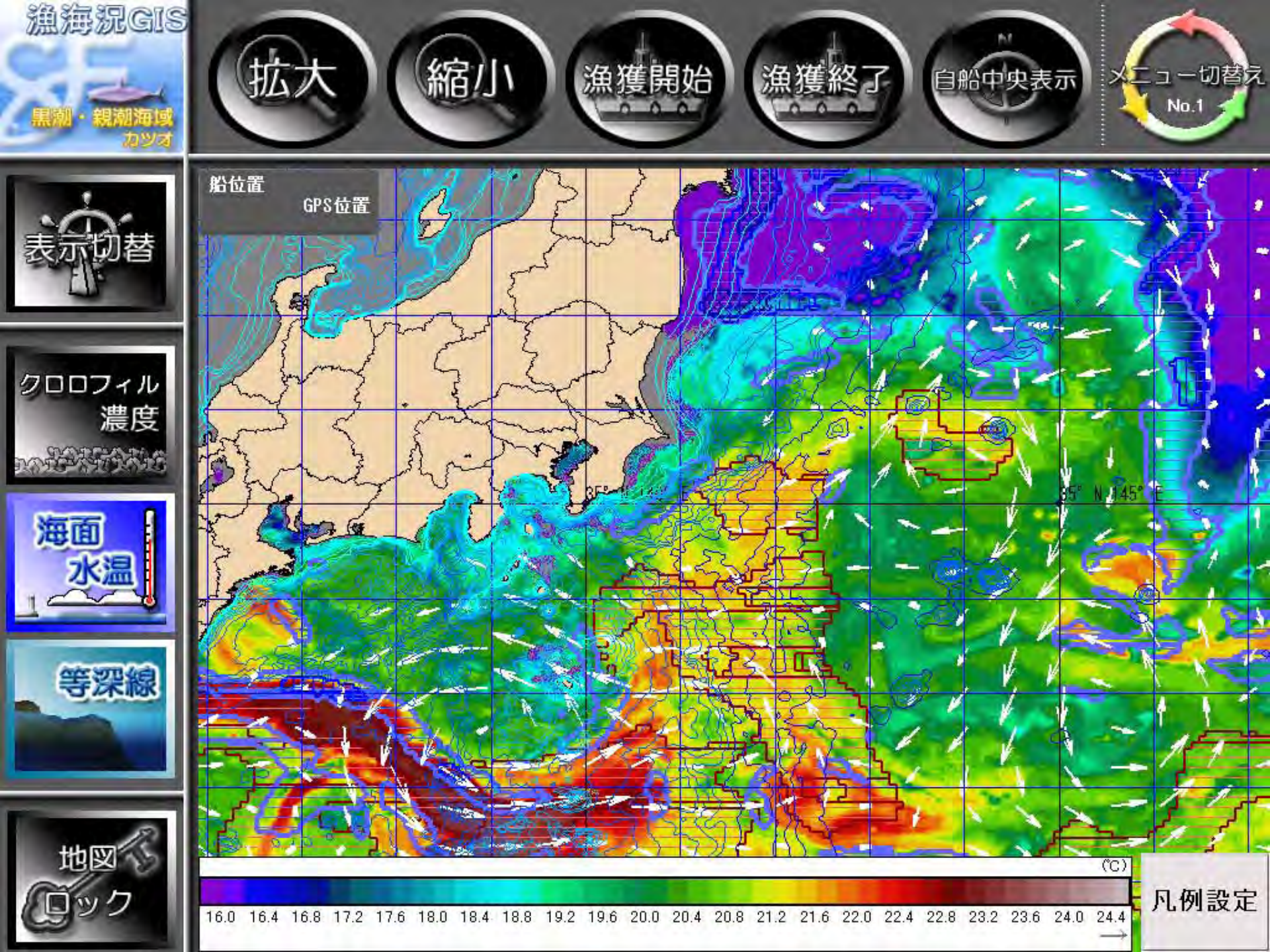
G&LI
Green & Life Innovation, Inc



Multiple datasets including image (raster) and vector information

G&LI
Green & Life Innovation, Inc



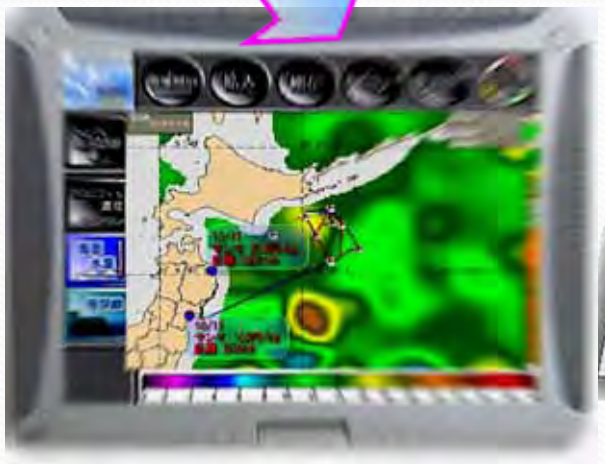

漁海況GIS
黒潮・親潮海域
カツオ
拡大
縮小
漁獲開始
漁獲終了
自船中央表示
メニュー切替え
No.1
表示切替
クロロフィル濃度
海面水温
等深線
地図ロック
船位置
GPS位置
35° N 145° E
(℃)
16.0 16.4 16.8 17.2 17.6 18.0 18.4 18.8 19.2 19.6 20.0 20.4 20.8 21.2 21.6 22.0 22.4 22.8 23.2 23.6 24.0 24.4
凡例設定

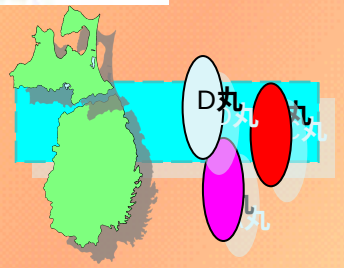
VMS for sustainable fisheries

Position Information

Two-way Communication

Market Price
TOREDAS

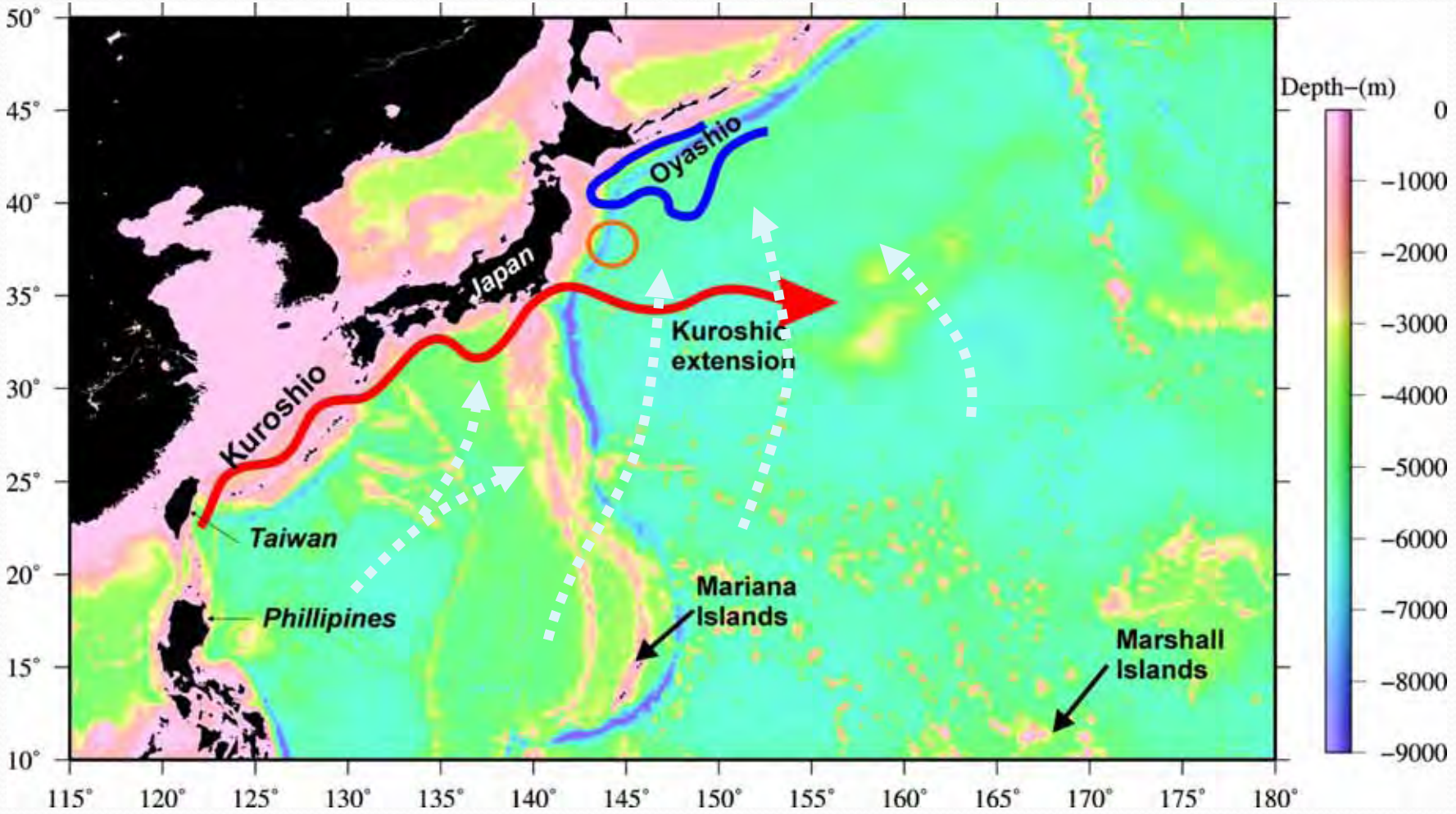




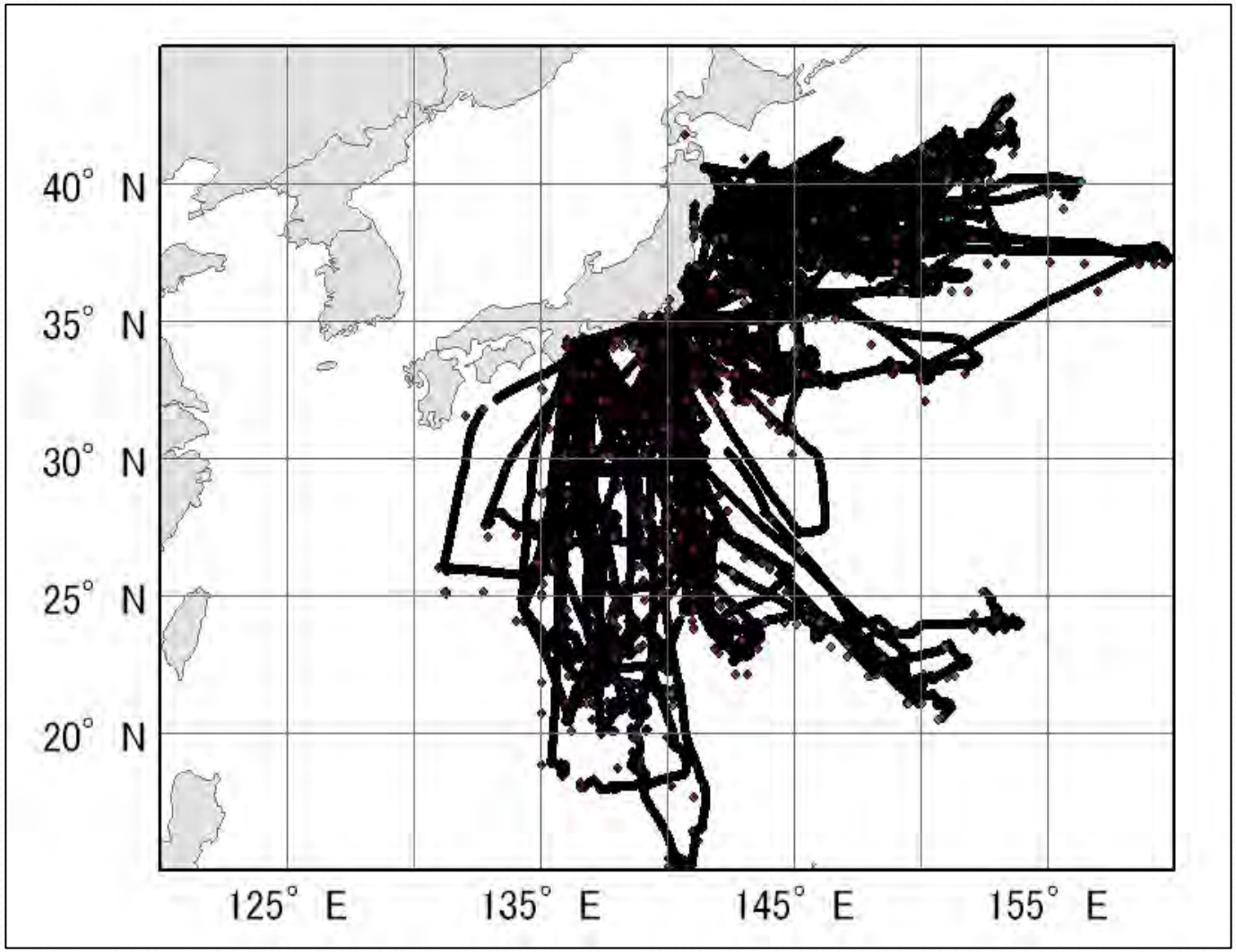
Fisheries Management
Traceability (IC tag)

VMS: Vessel Monitoring System

Skipjack tuna Northern migration off the east coast of Japan (Nihira, 1996)



A trajectory of skipjack tuna fishing boat (Sept. 2007 – Sept. 2009)

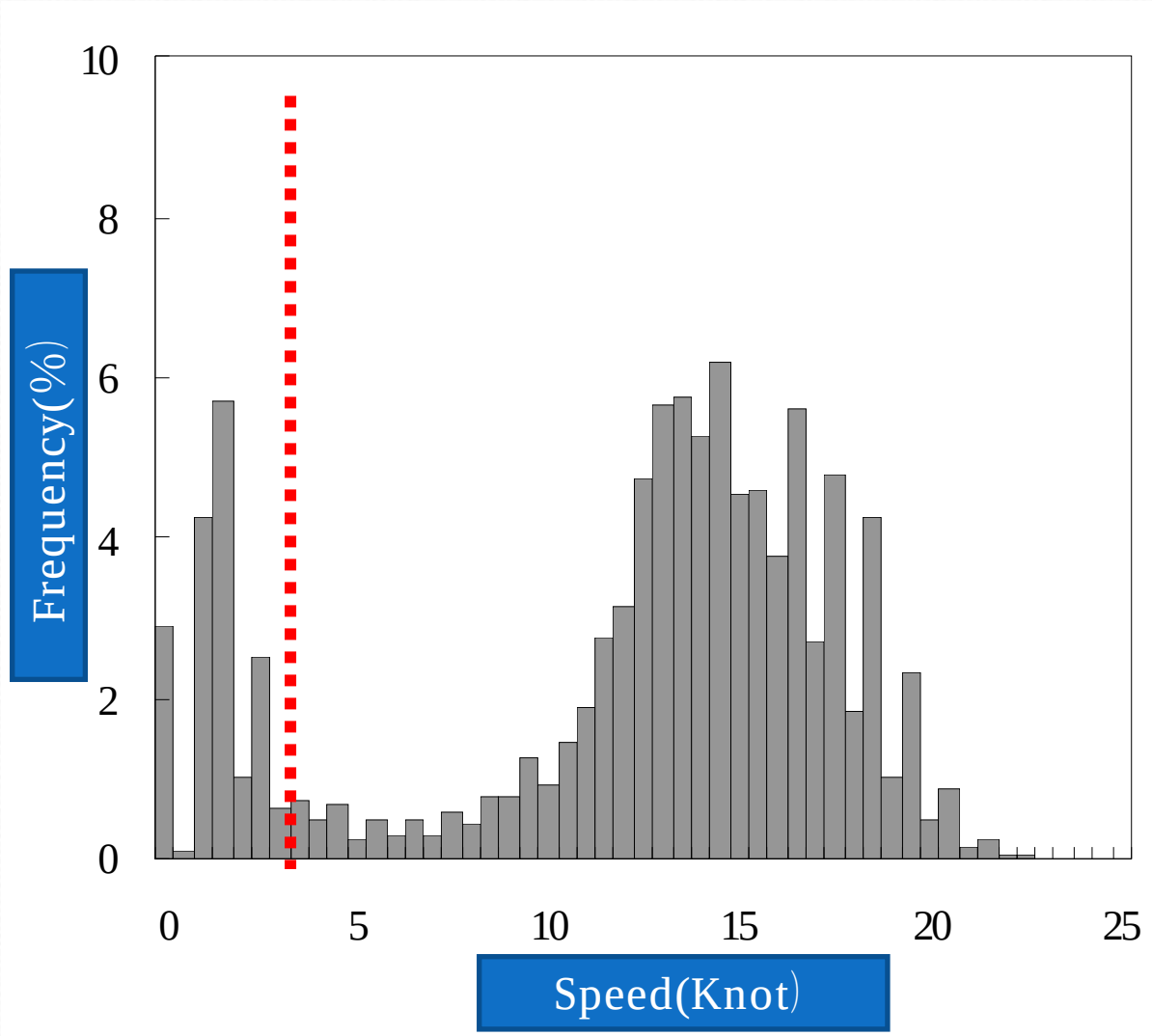


Definition of fishing ground

- 0.1-3.0 knot (Mullowney and Dawe 2009)
- Day time (Sun rise - Sun set)
- Continuous
- Within 60 min.
- Over 10km from land

(Saitoh et al., ICES-JMS 2008)

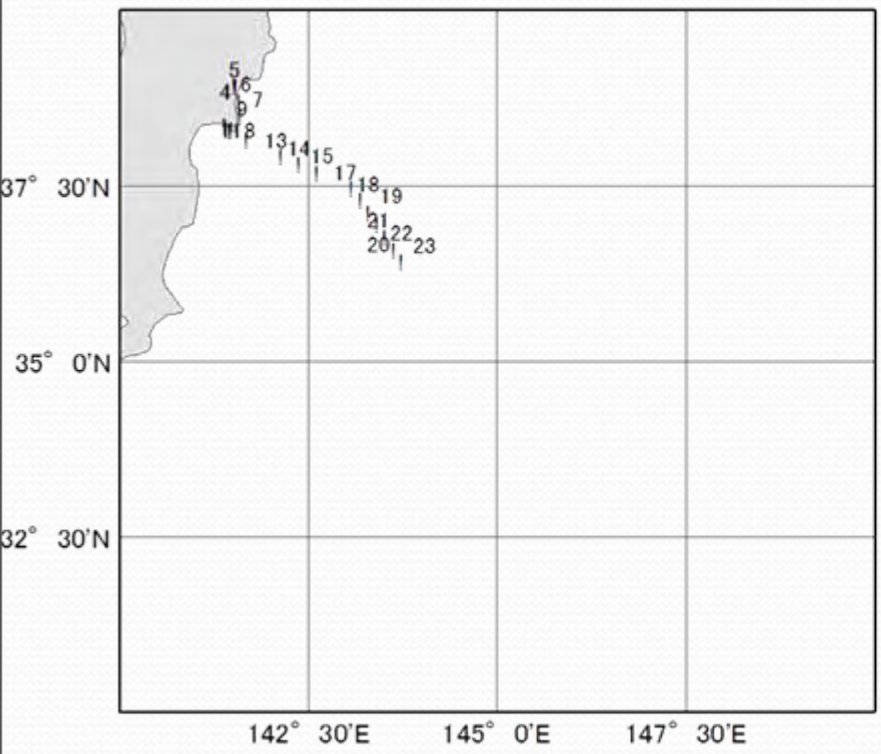
Definition of fishing ground

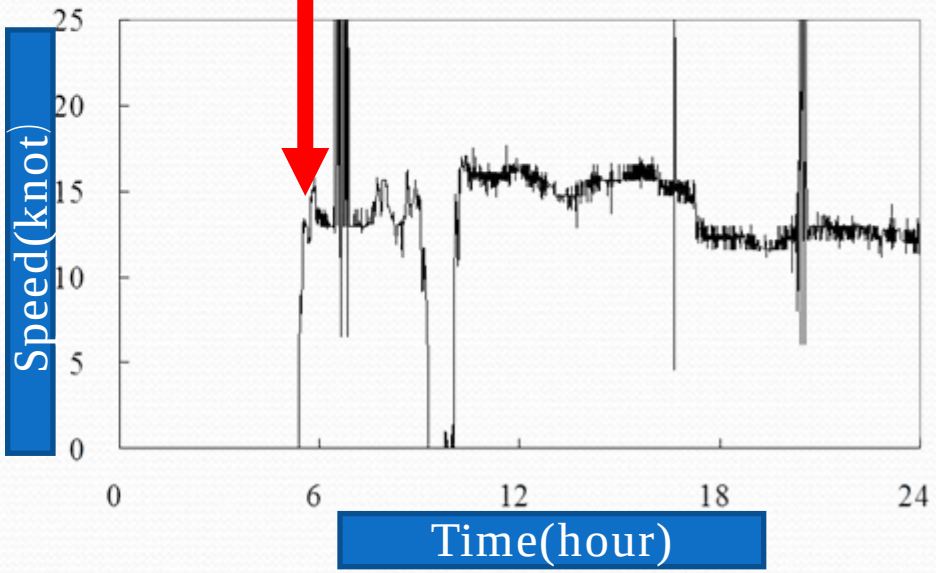


(Saitoh et al., ICES-JMS 2008)

Positions and speed: June 19 -23, 2008

June 19, 2008

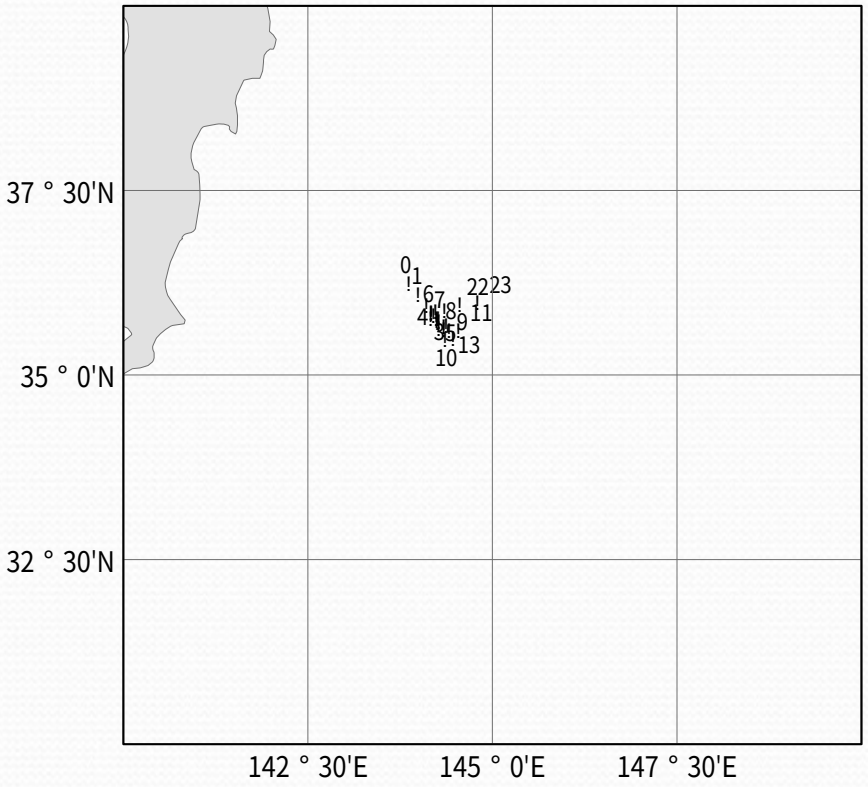


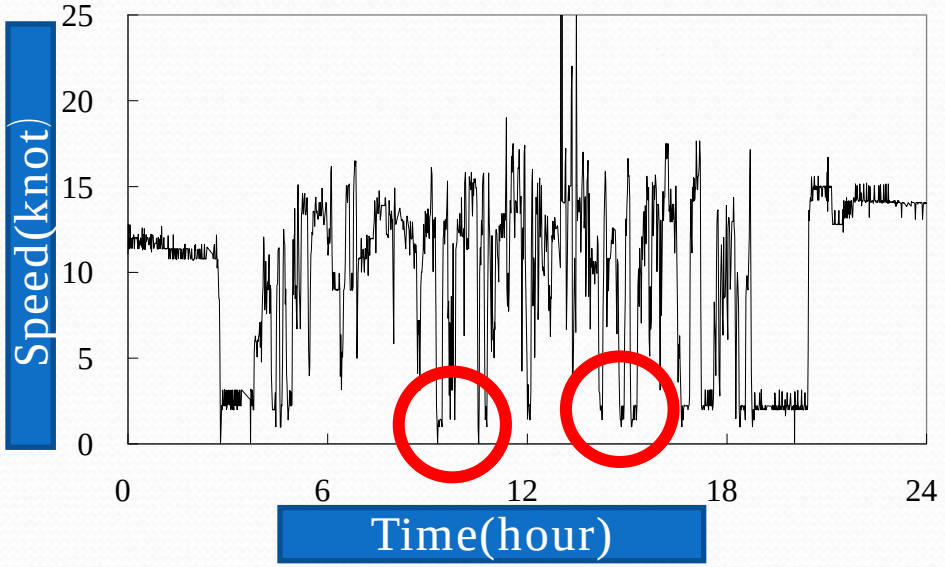


(Saitoh et al., ICES-JMS 2008)

Positions and speed: June 19 -23, 2008

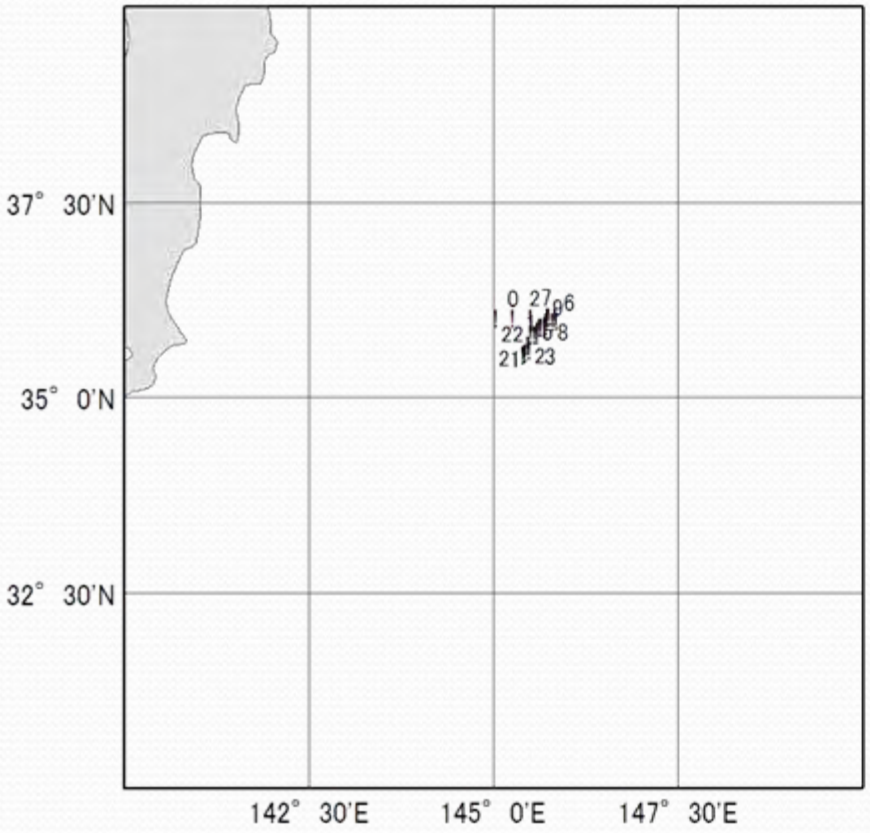
June 20, 2008



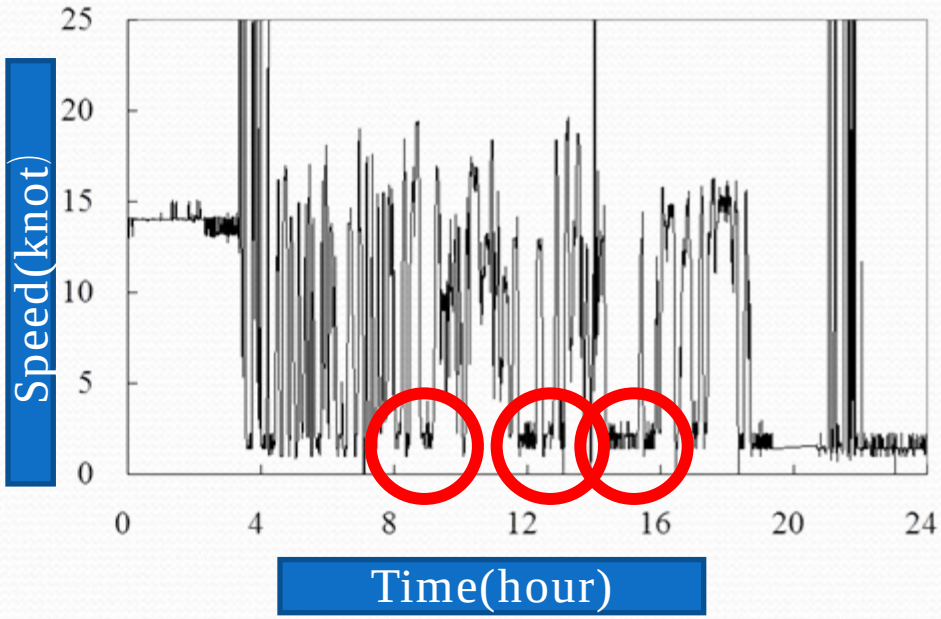


(Saitoh et al., ICES-JMS 2008)

Positions and speed: June 19 -23, 2008

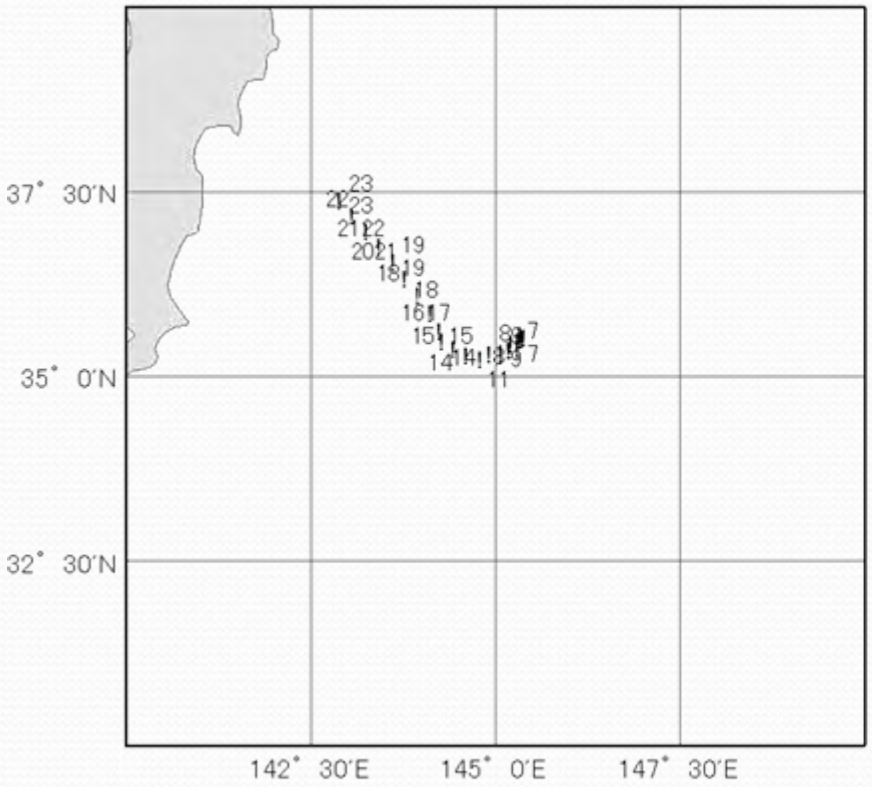


June 21, 2008



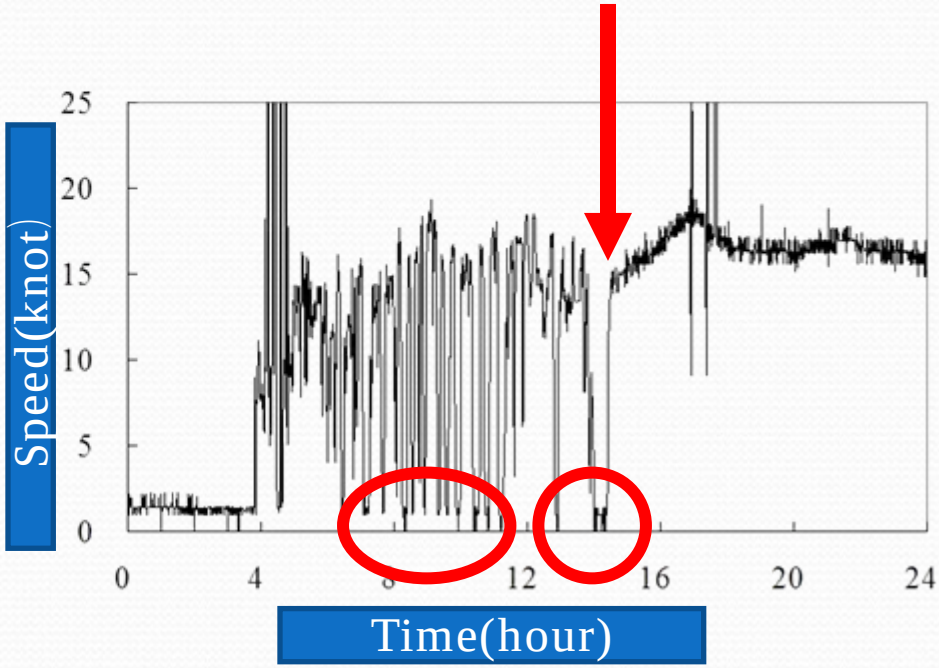
(Saitoh et al., ICES-JMS 2008)

Positions and speed: June 19 -23, 2008



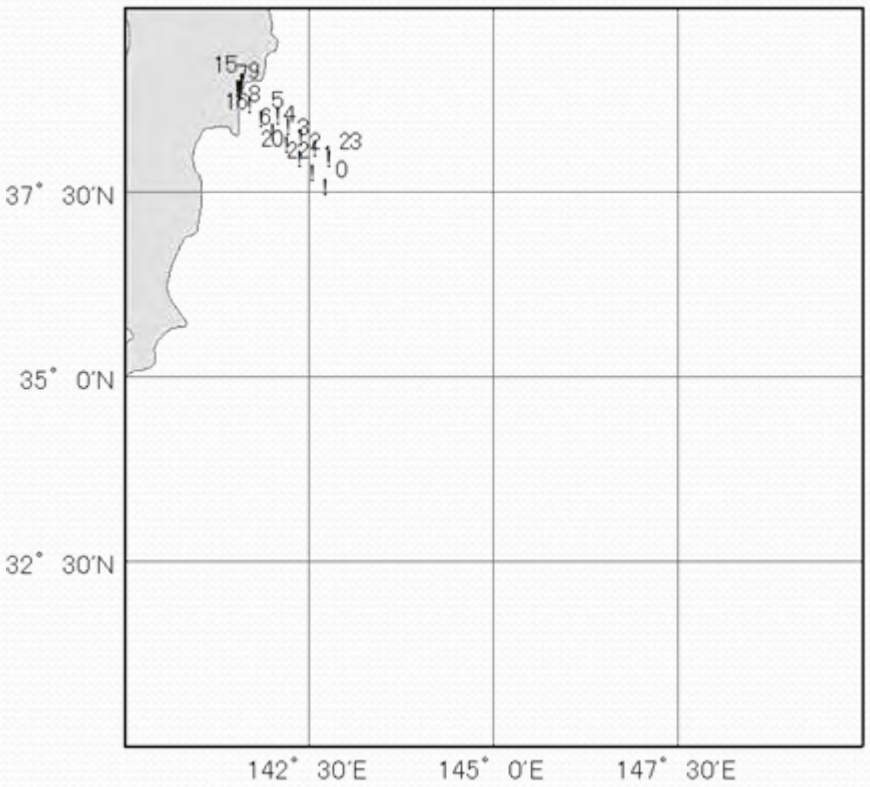
June 22, 2008

decide to return



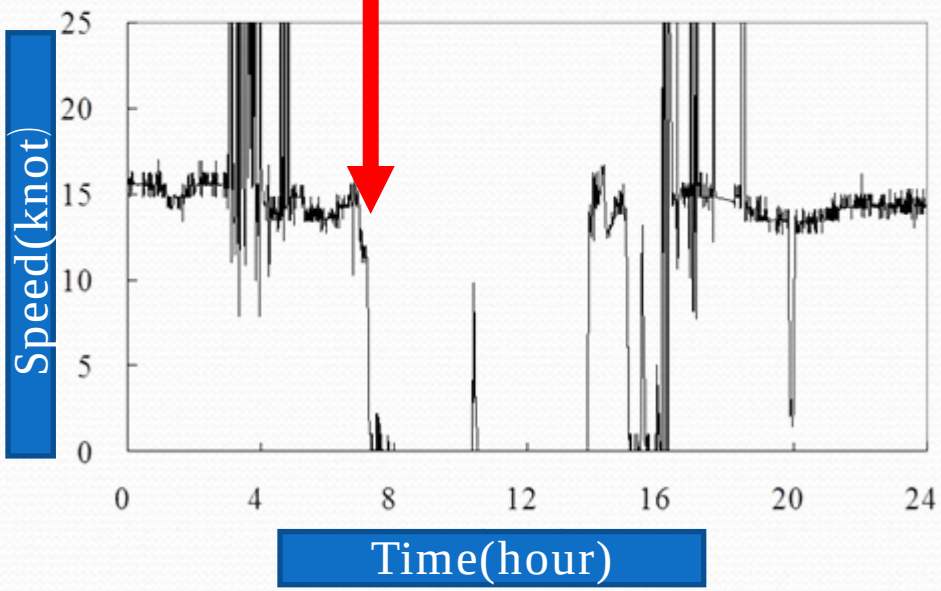
(Saitoh et al., ICES-JMS 2008)

Positions and speed: June 19 -23, 2008



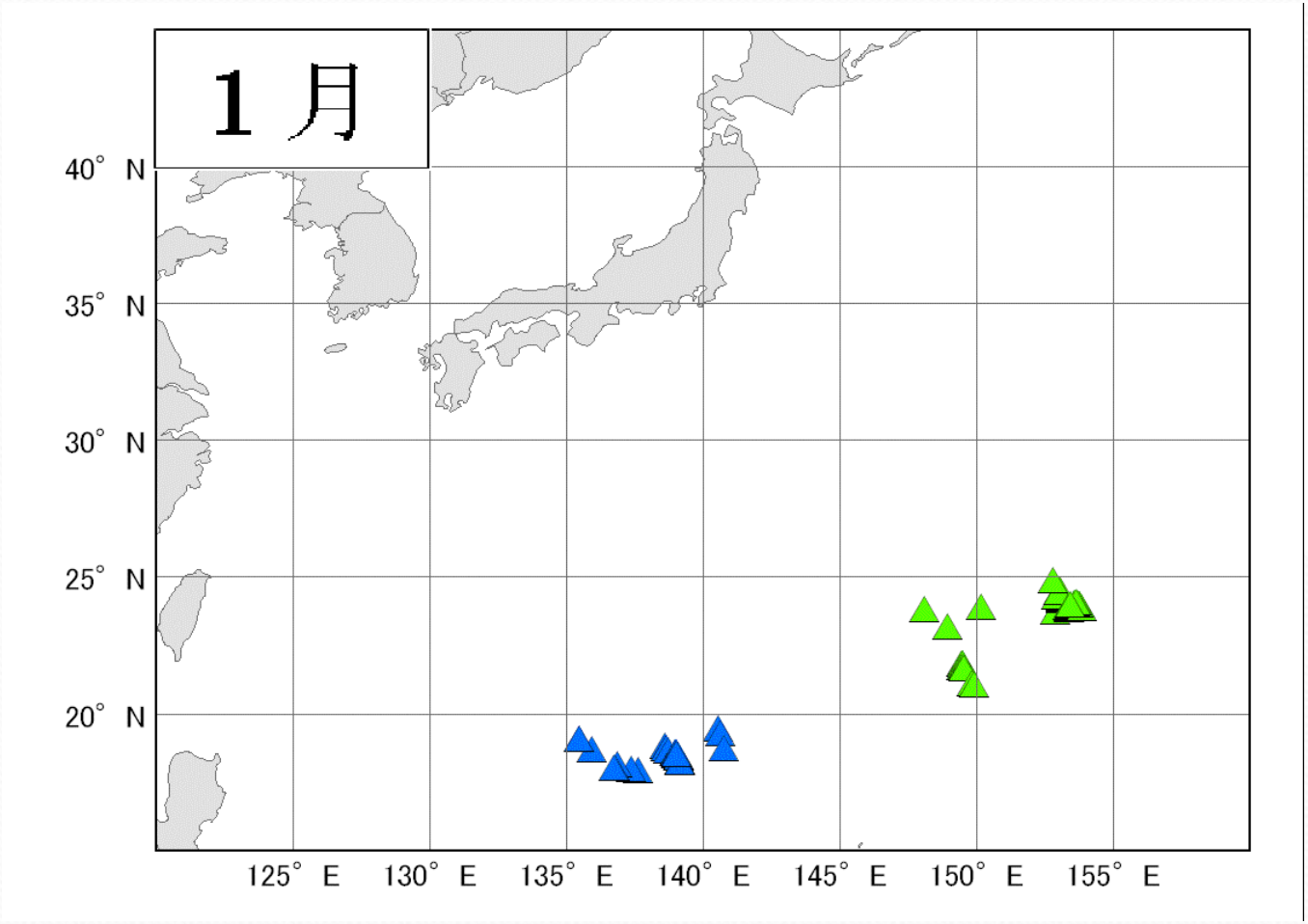
June 23, 2008

Enter to port



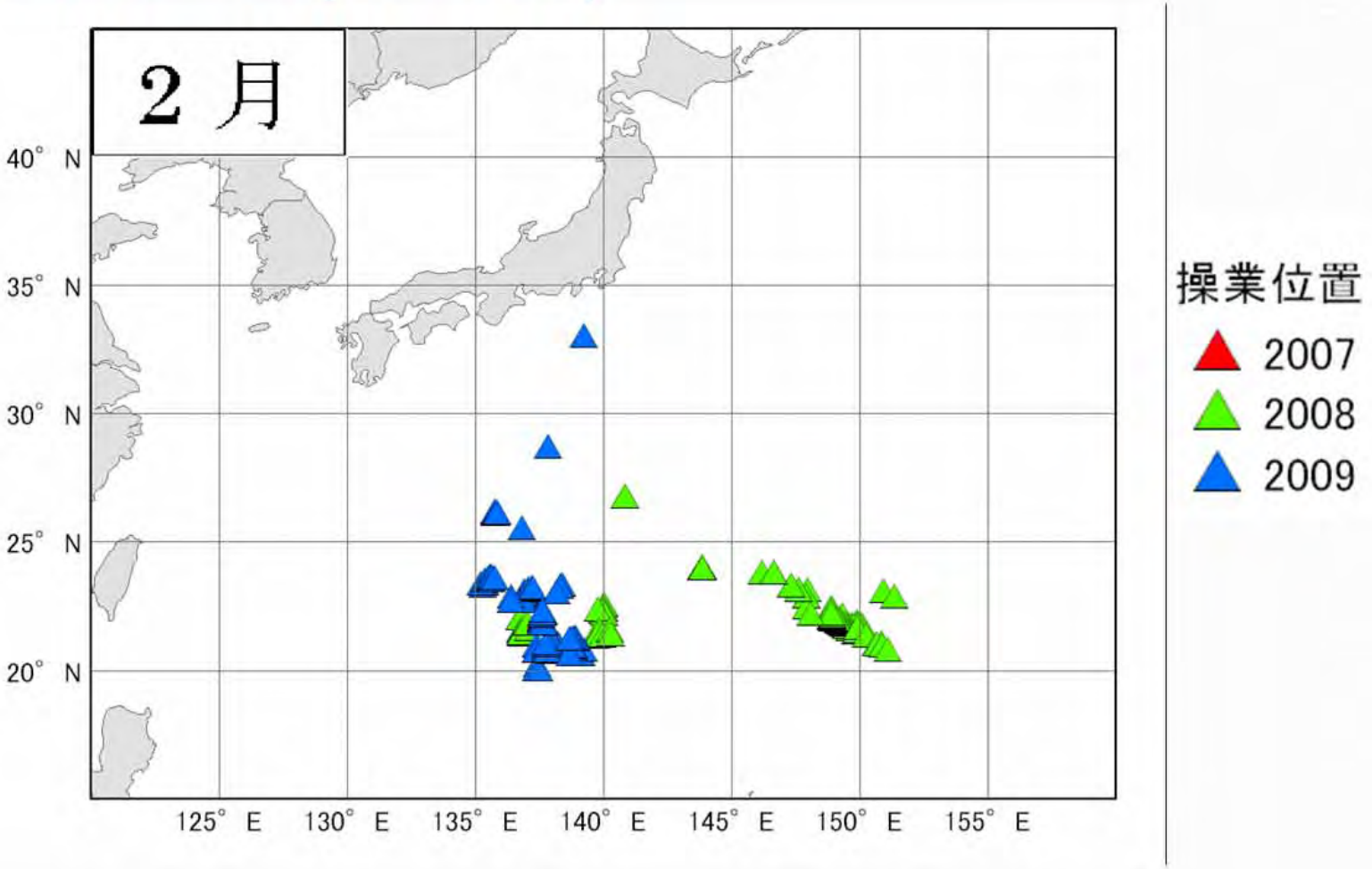
(Saitoh et al., ICES-JMS 2008)

Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)

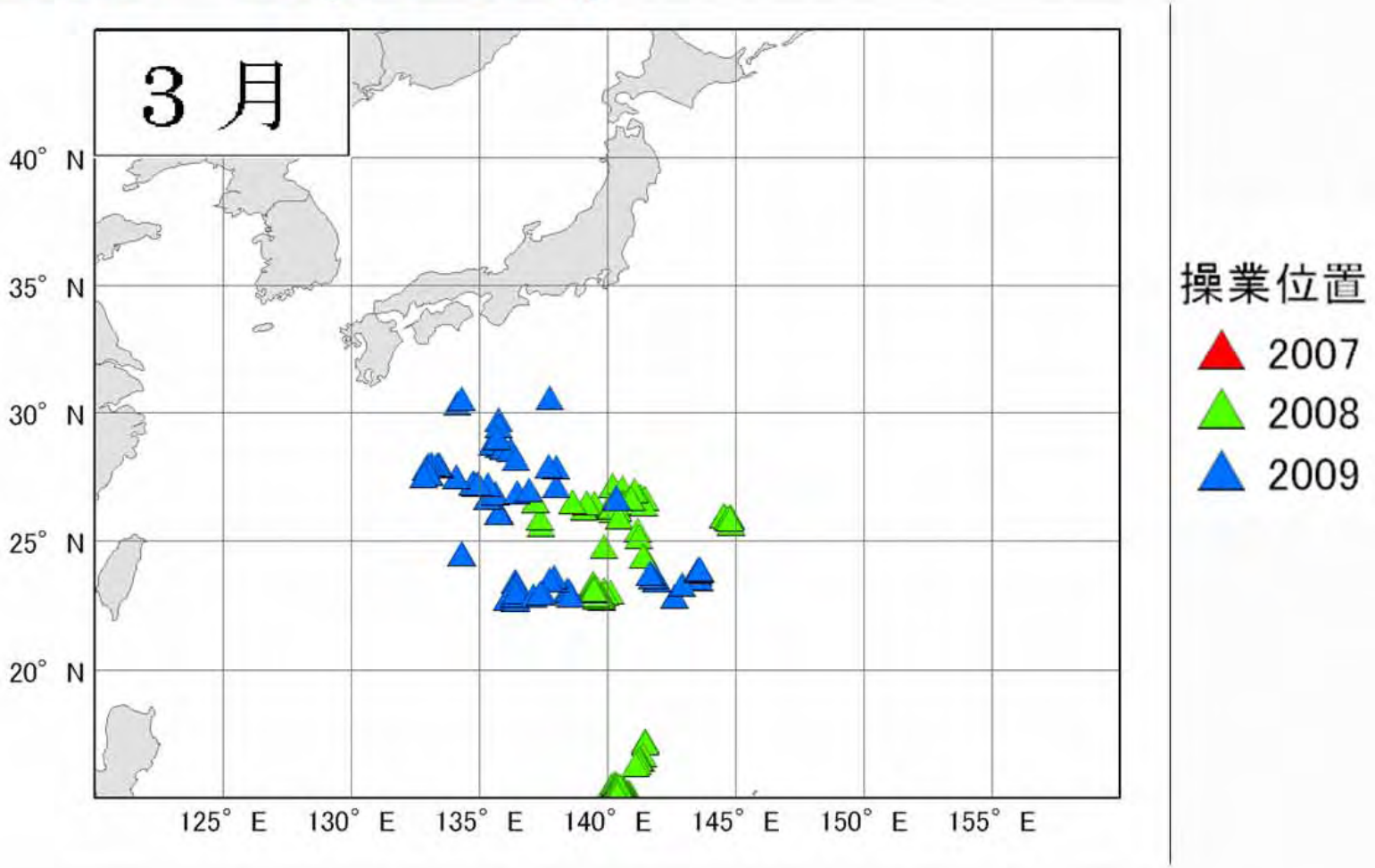


推定した操業場所

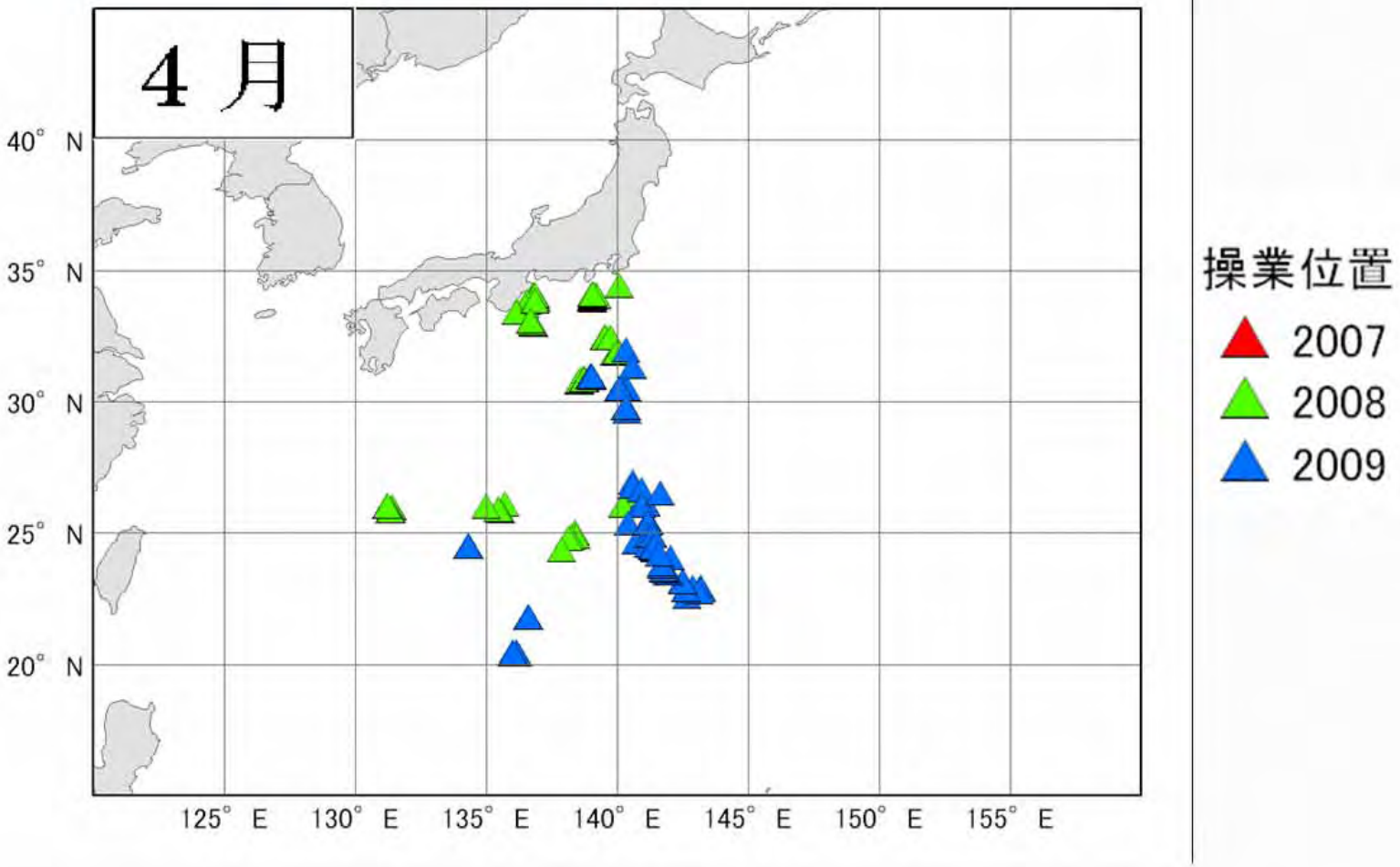
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



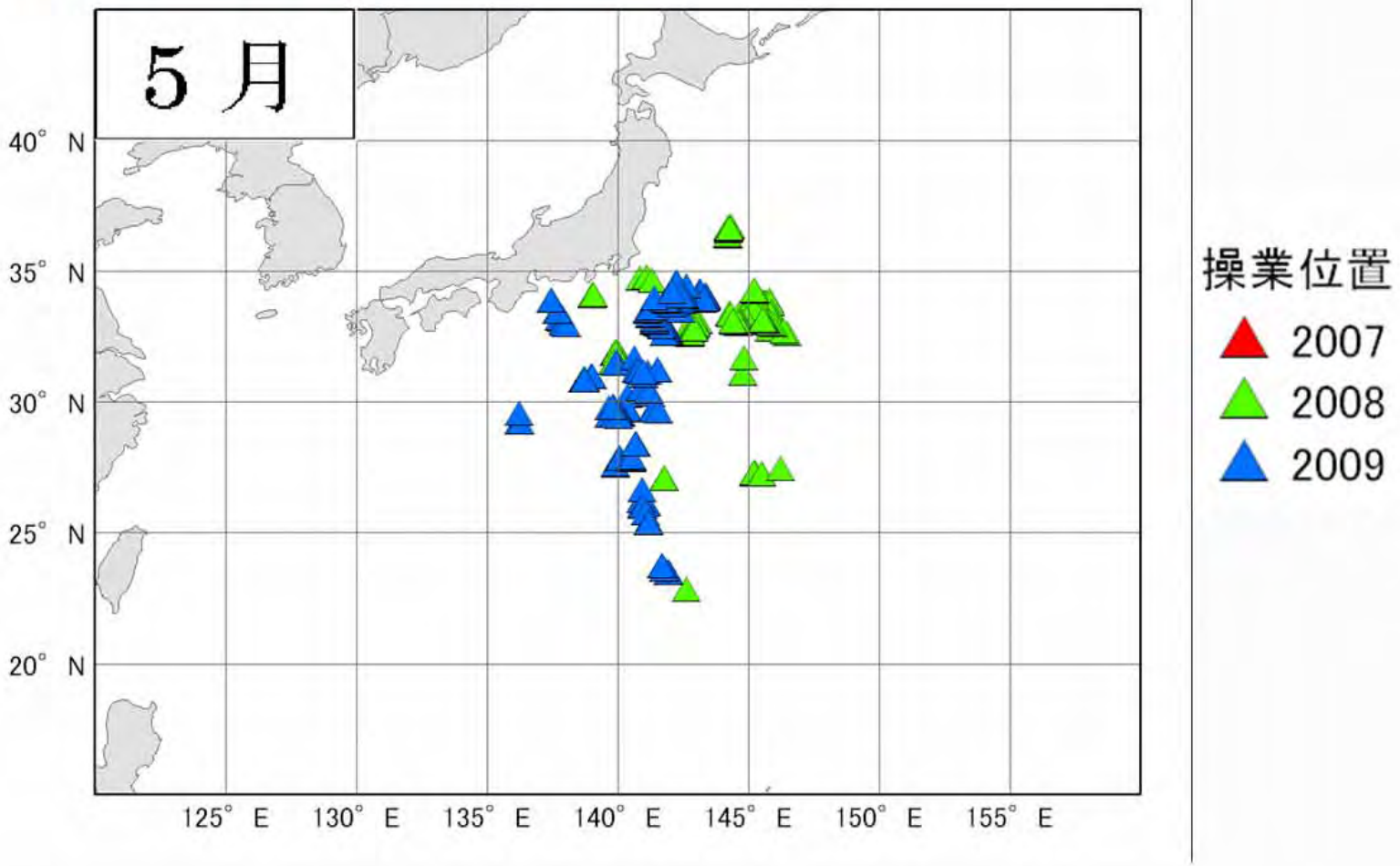
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



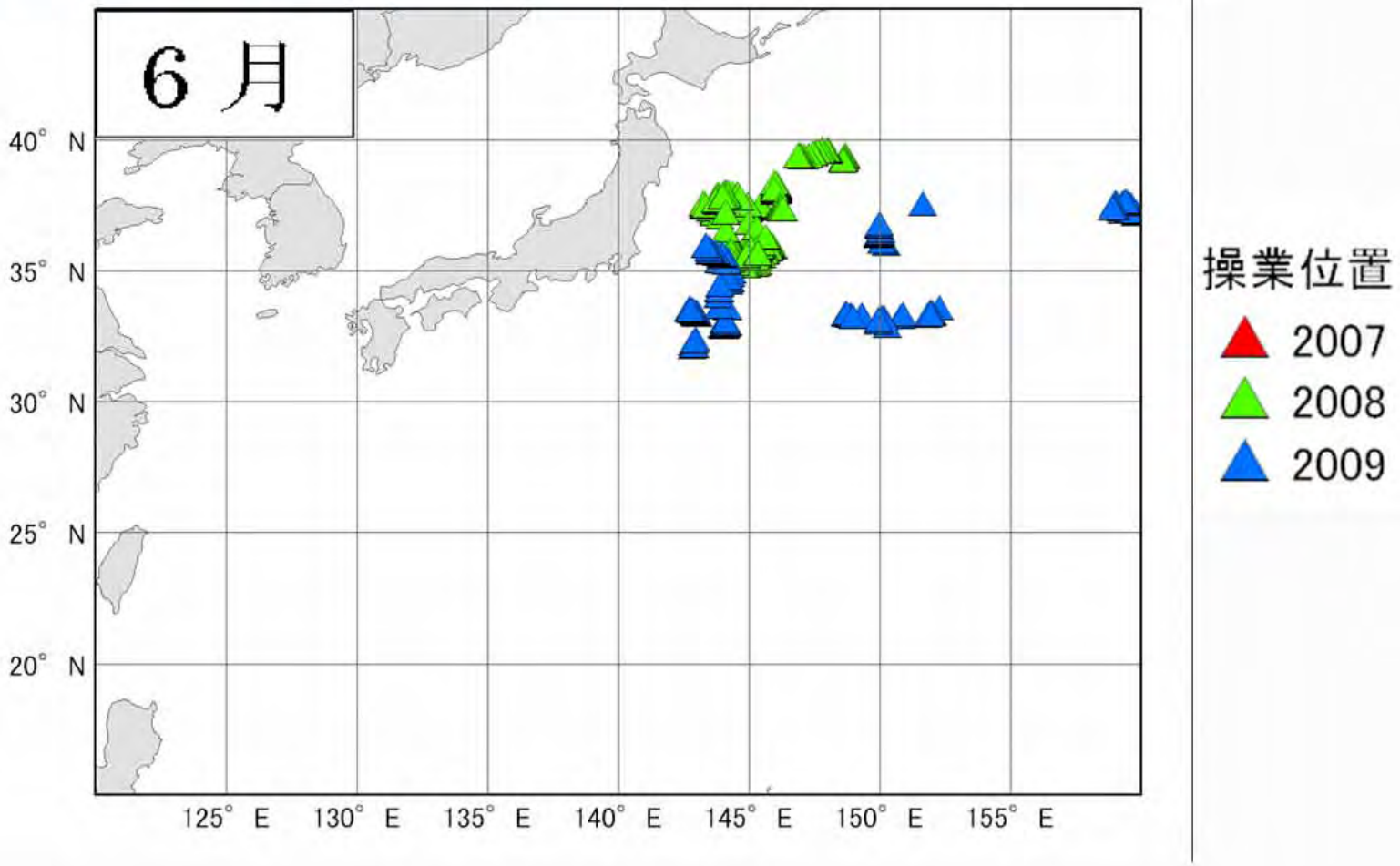
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



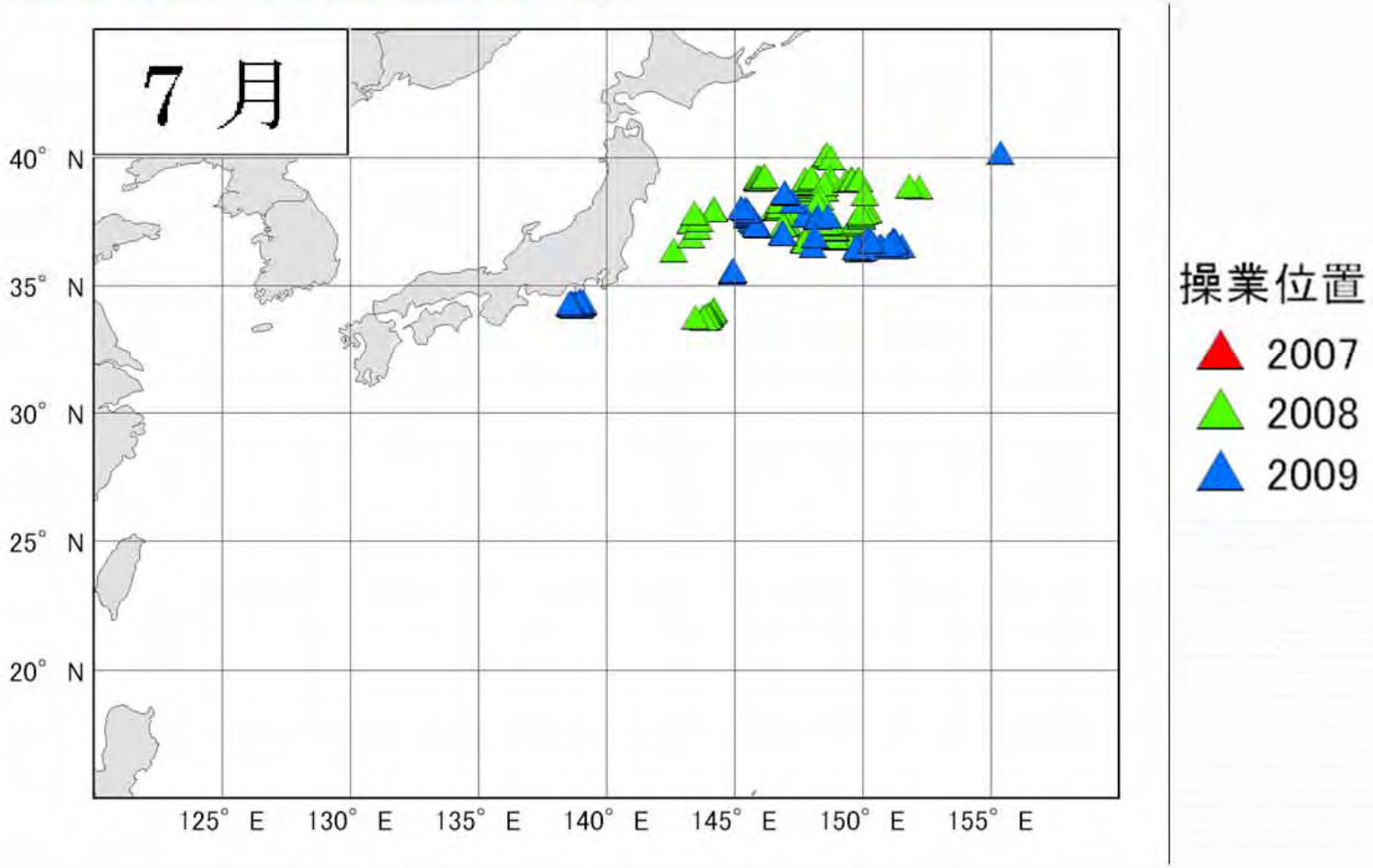
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



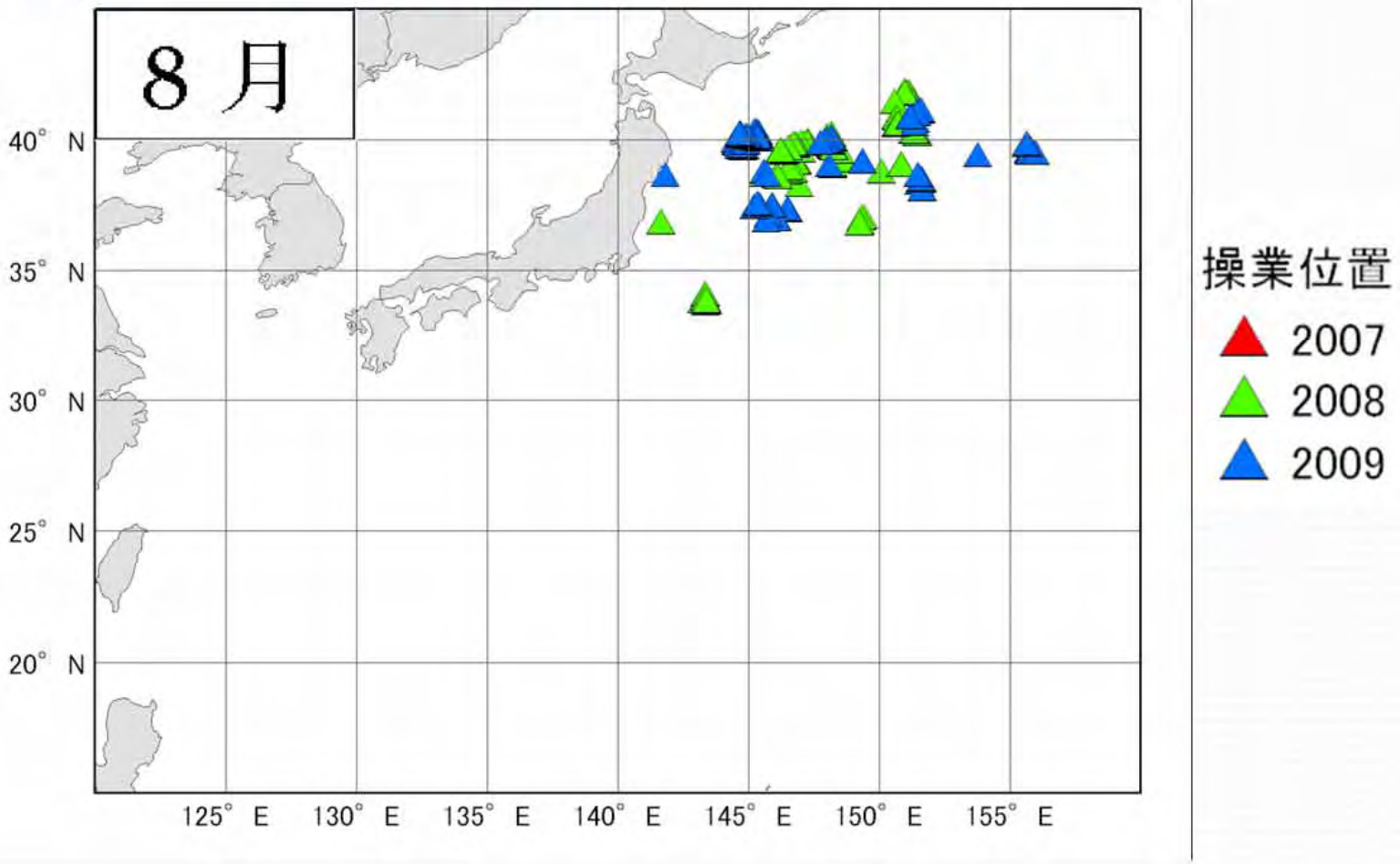
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



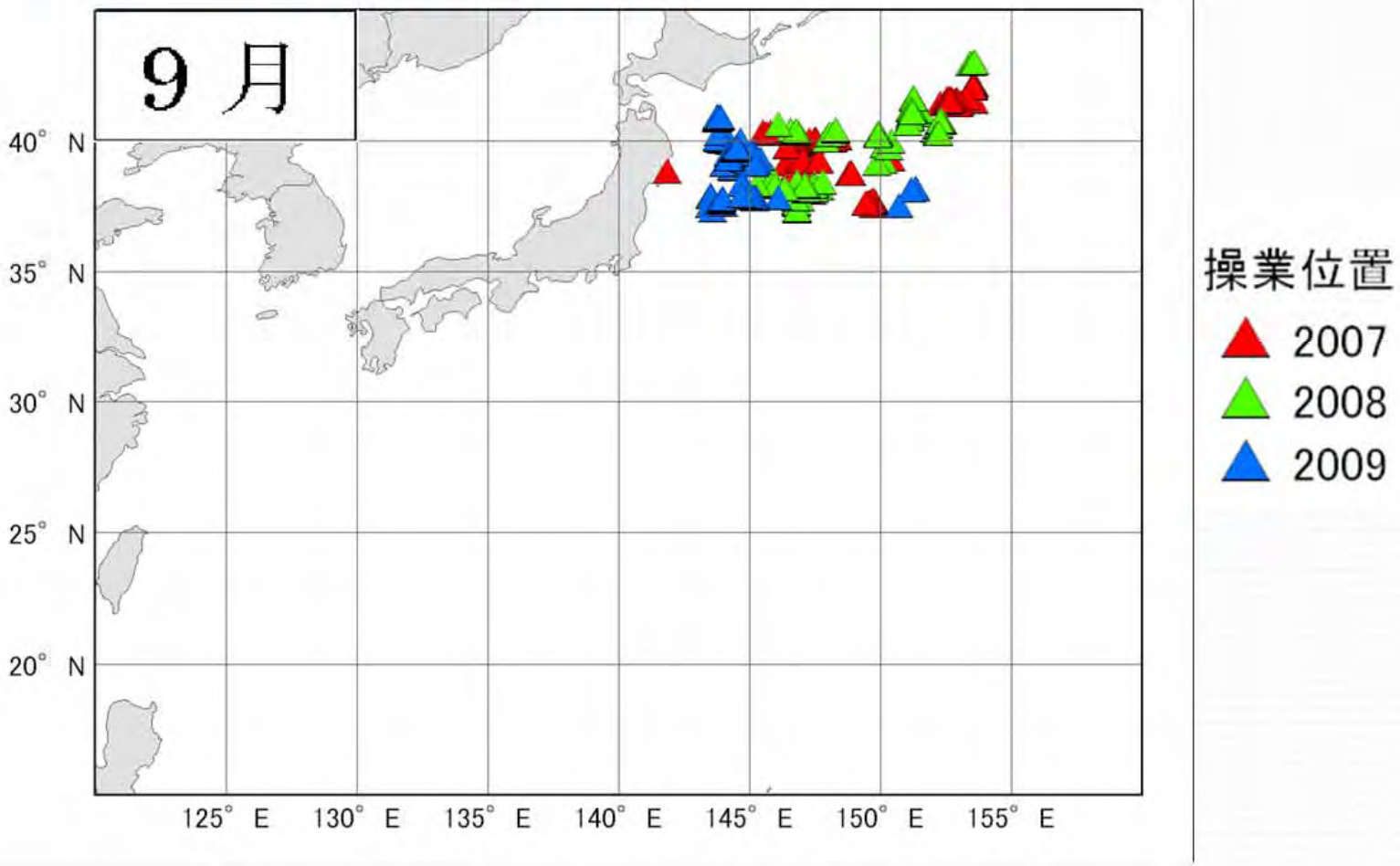
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



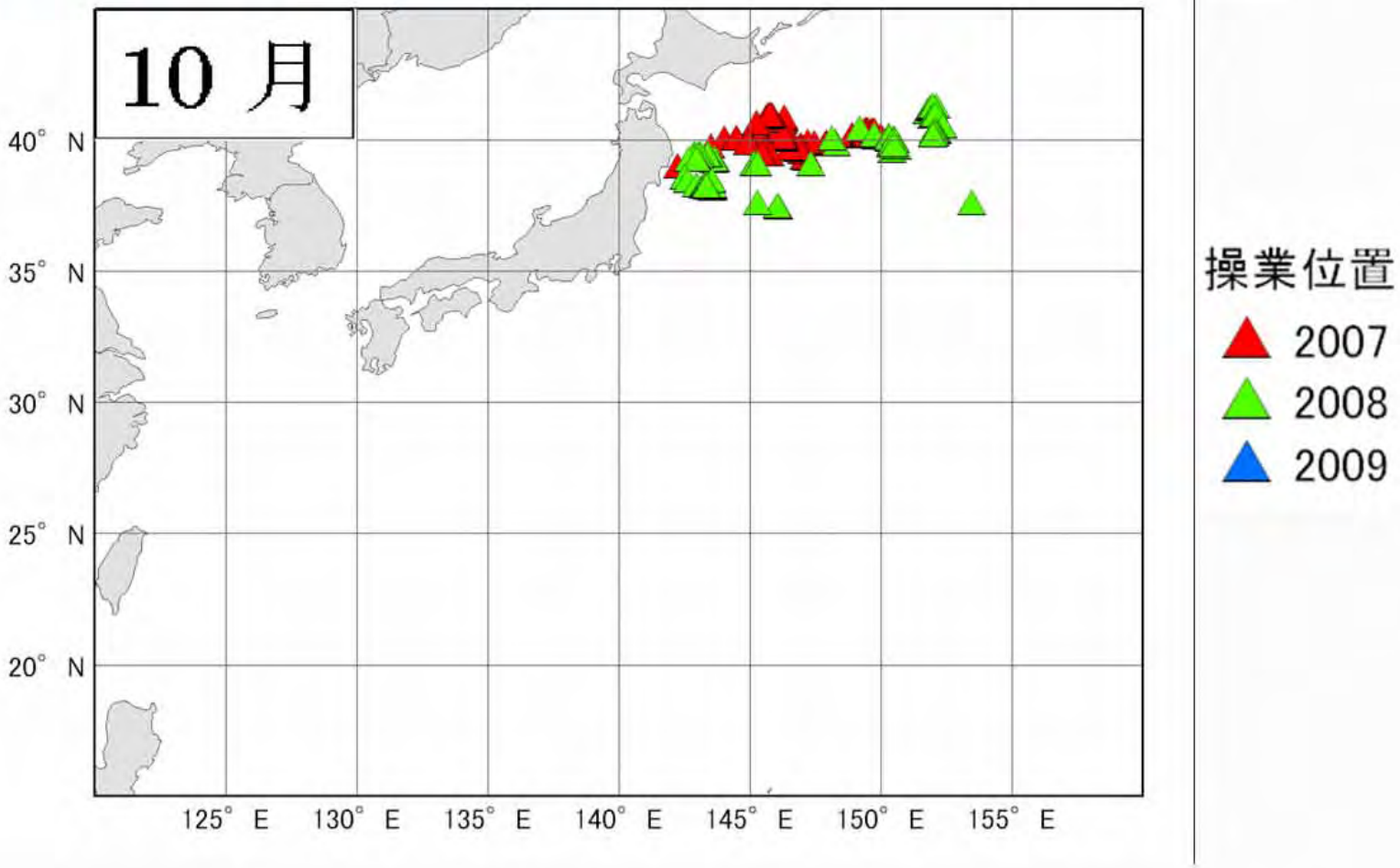
Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



Fishing ground movement detected by VMS (Sept. 2007 – Sept. 2009)



Day of fishing = 366 / 25 months

Fishing activities = 4064 / 25 months

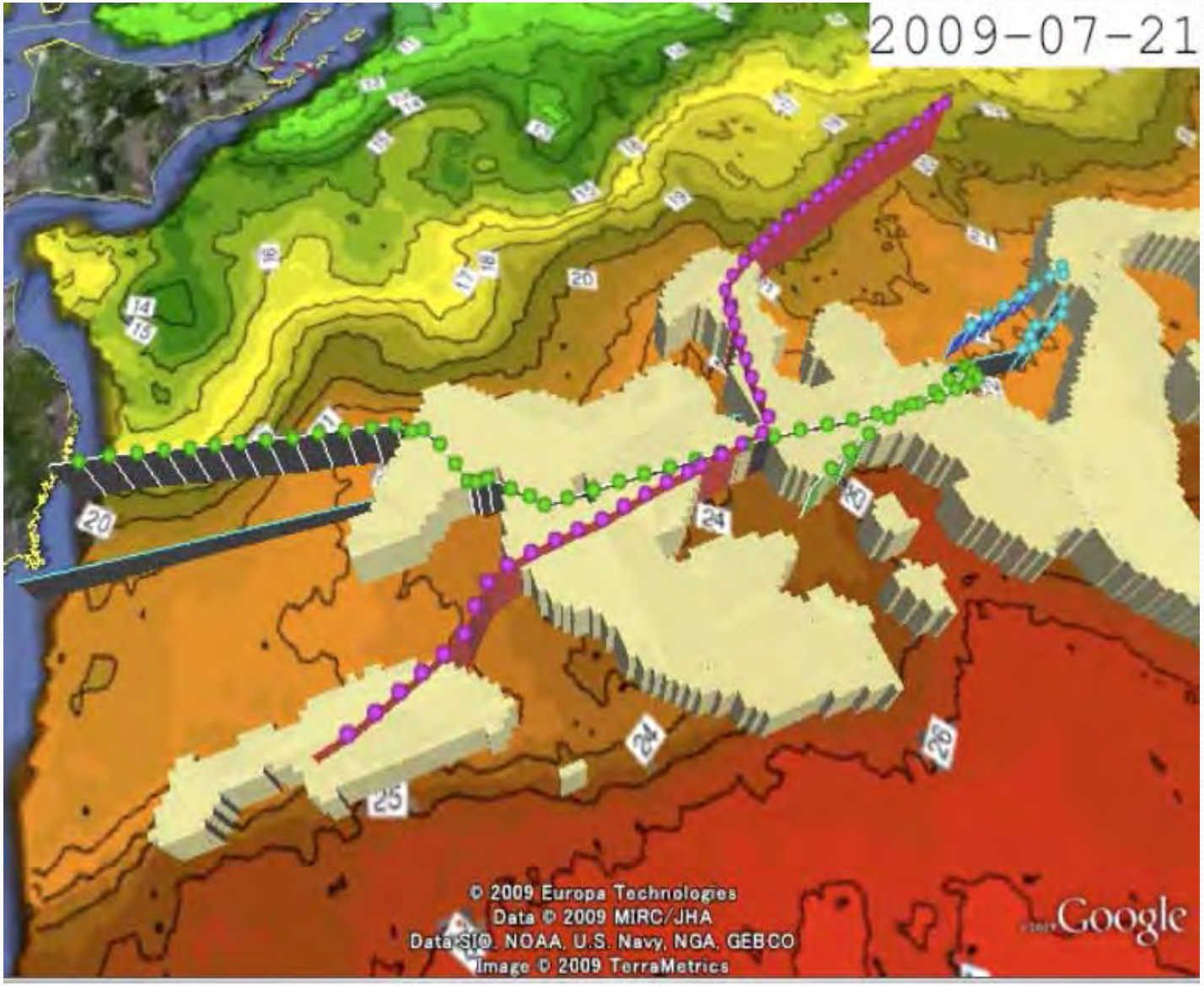
Mean fishing activities in a day = 11.1

推定した操業場所

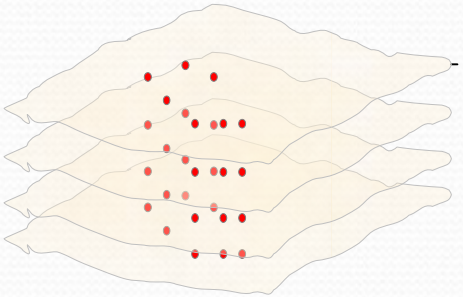
Visit to TOREDAS user

Photo by S. Matsumura

Fishing Activities of Skipjack Tuna Fishing Boats

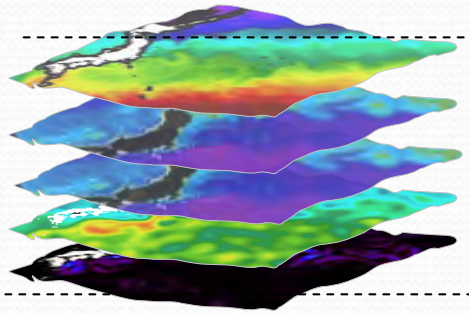


Global Warming Scenarios DESIGN



SKIPJACK 0.25º

GRIDDED



SATELLITE 0.25º

ENFA BASE MODELS

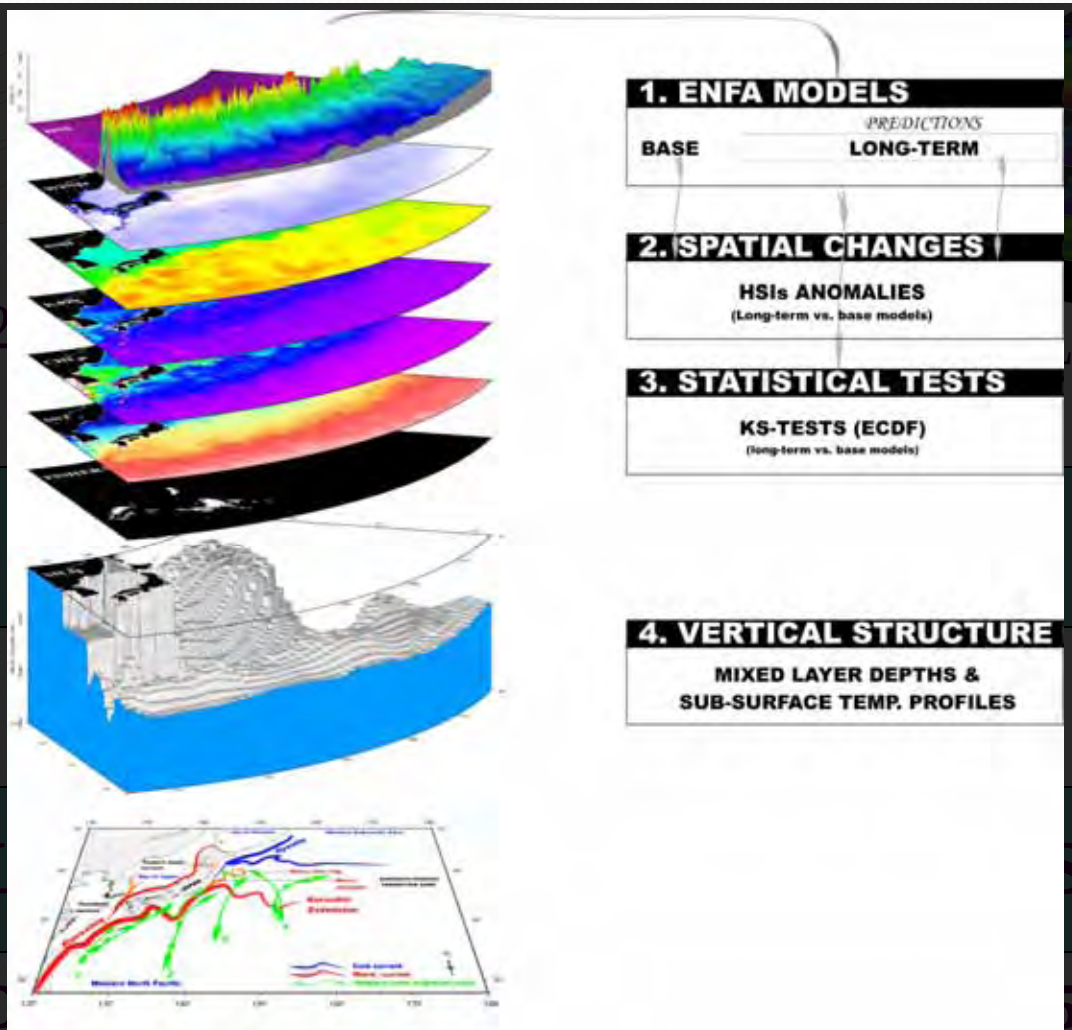
PREDICTIONS

GLOBAL WARMING SCENARIOS

SST VARIED USING HIRES MIROC3.2 - 2025; 2050; 2100

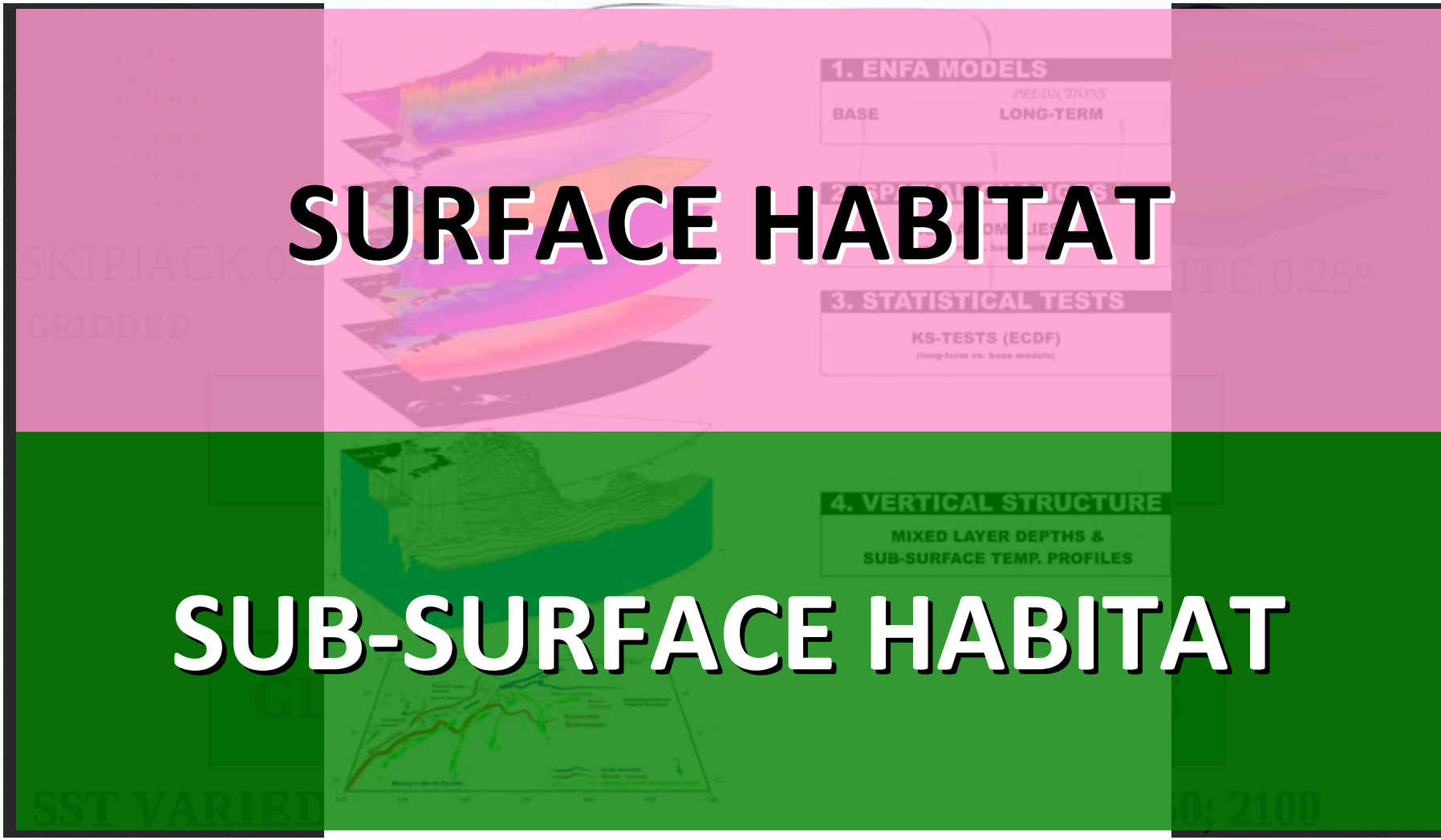
Global Warming Scenarios

DESIGN



Global Warming Scenarios

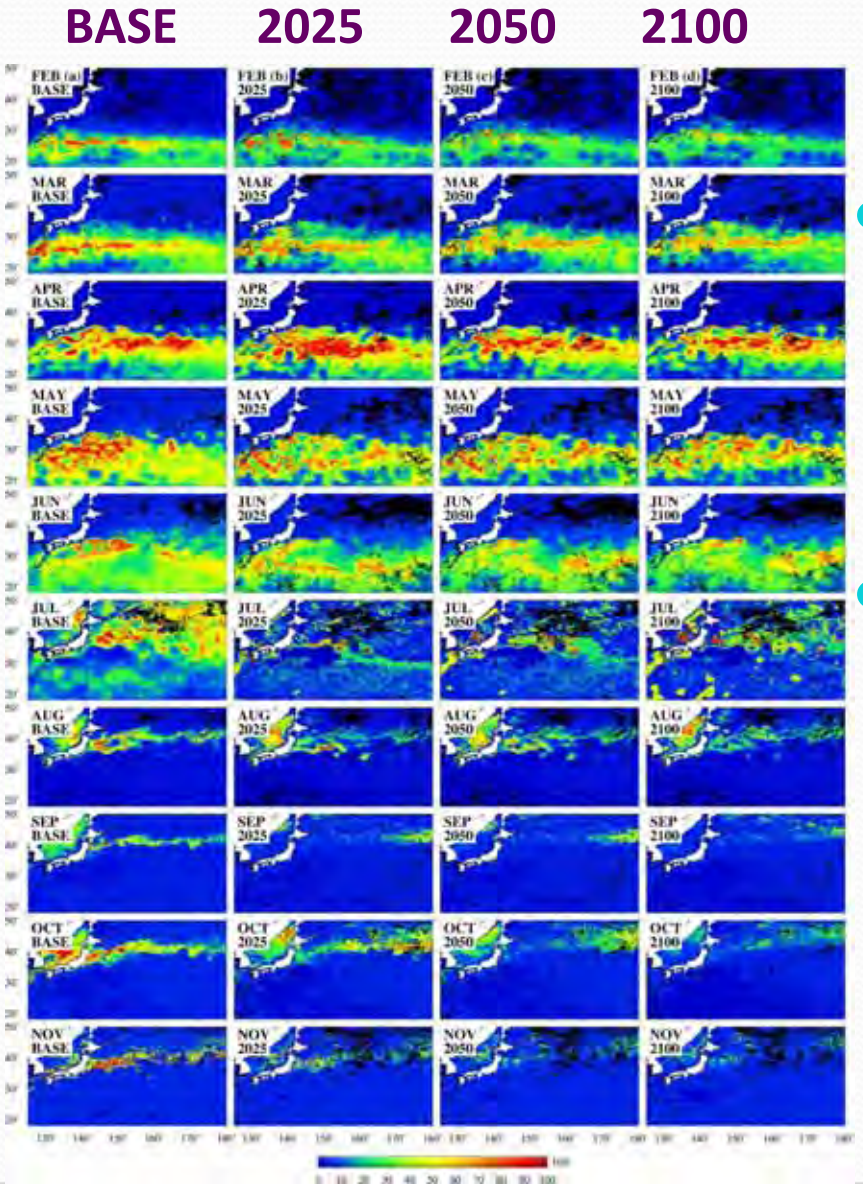
DESIGN



SURFACE HABITAT

SUB-SURFACE HABITAT

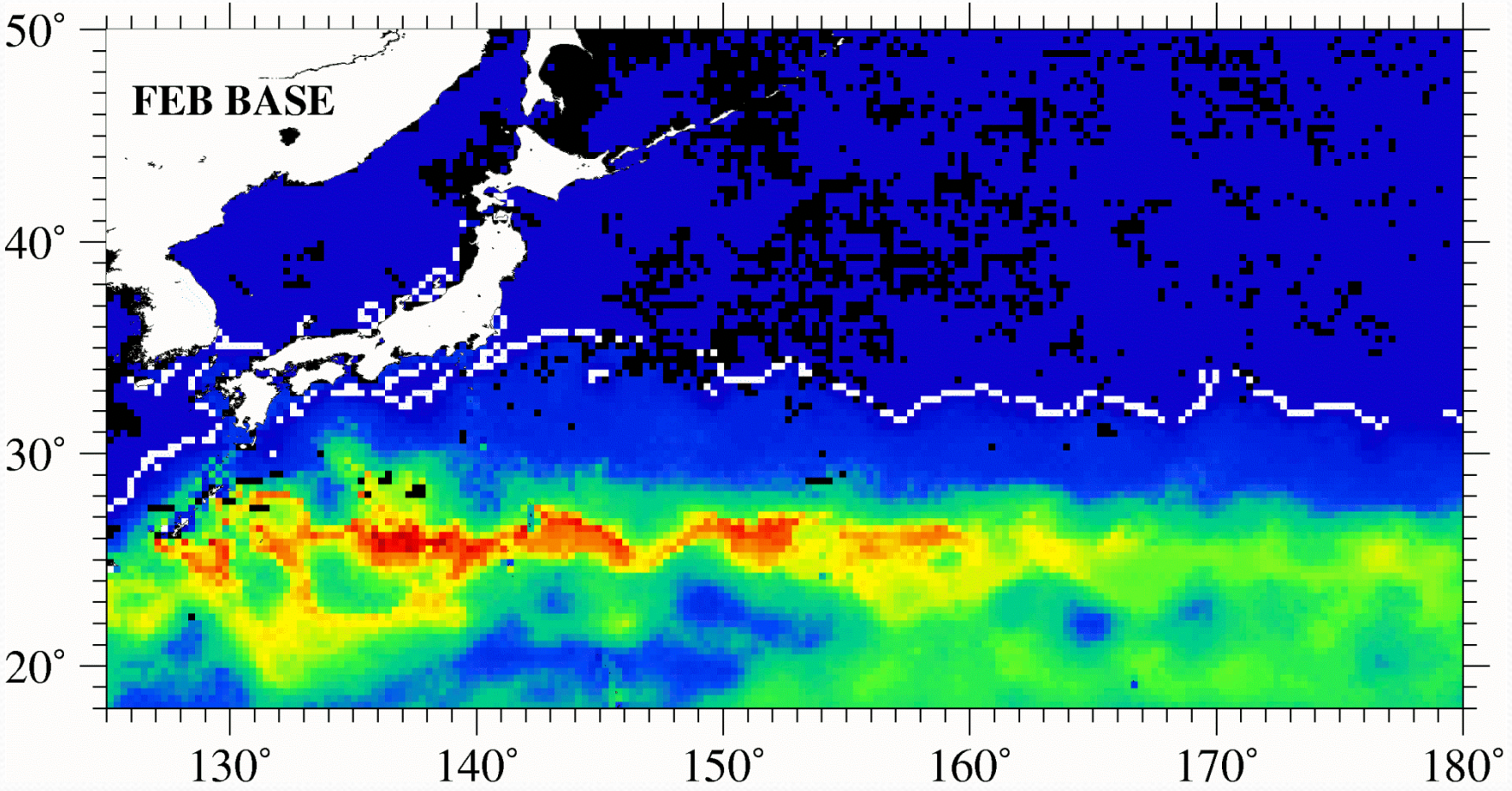
Global Warming Scenarios



LONG-TERM PRED

- Predictions on global warming models using HIRES MIROC 3.2.
- Patterns show declining habitat quality as temperature rises & also some northward shift of high quality habitat.

Global Warming Scenarios



Concluding Remarks

- Multi-sensor satellite remotely sensed data is applicable for Prediction of PFZ "hotspots"
- We demonstrate TOREDAS as implication of operational fisheries oceanography
- VMS is useful tool to understand not only fishing activities but also tuna migration patterns
- Global warming is likely to trigger migration of skipjack tuna to higher latitudes 1-2 months earlier than is observed today.