

Adaptive improvement of habitat suitability index (HSI) model for neon flying squid in central North Pacific by using ocean forecasts and real-time fishery reports

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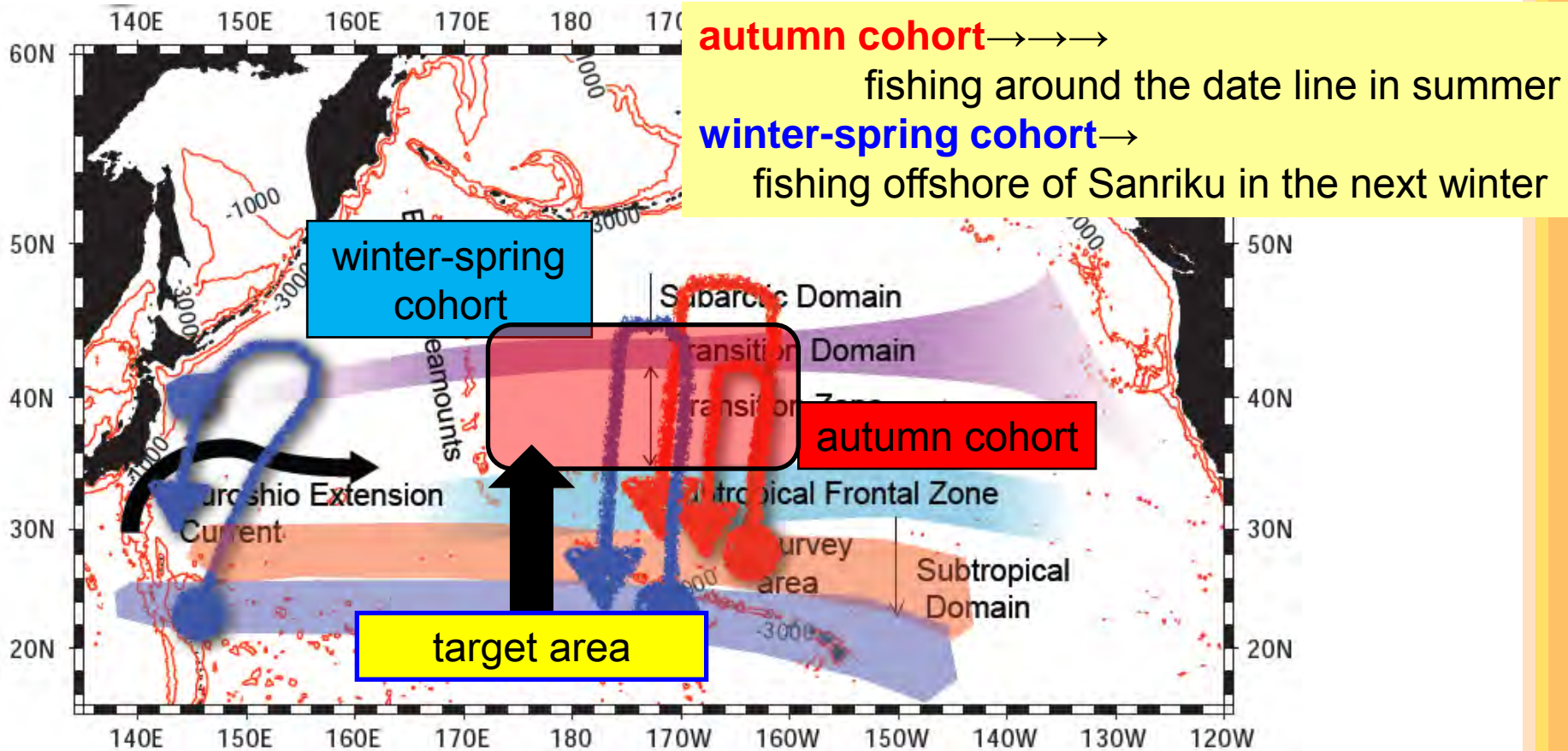
outline

1. Introduction
2. Purpose
3. Methodology – model construction
4. Results
5. Concluding remarks

neon flying squid

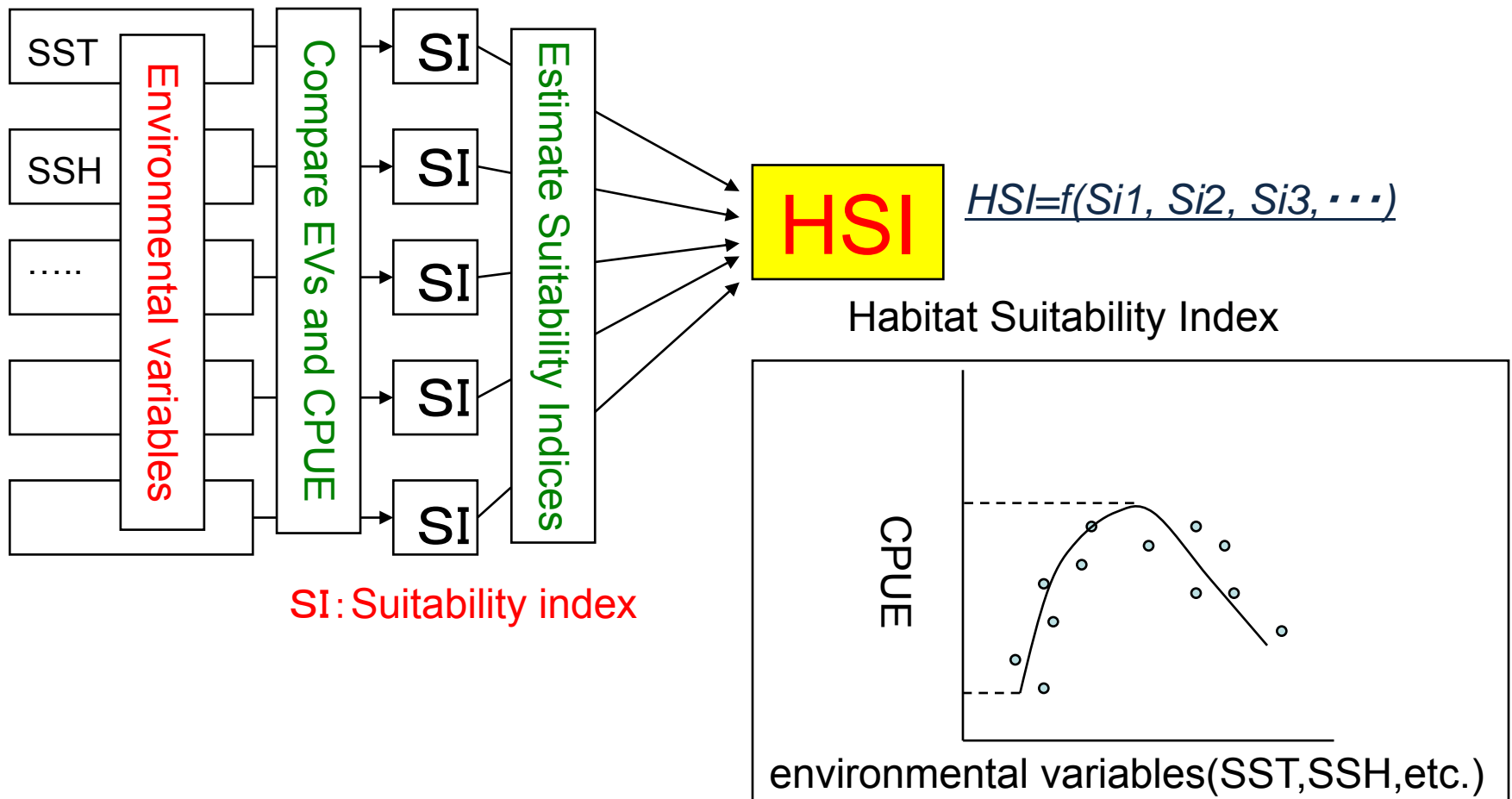
(*Ommastrephes bartramii*)

- widely distributed in the North Pacific
- 1-year lifespan and seasonal migration
- important for pelagic ecosystem and Japanese fisheries



Habitat Suitability Index (HSI) model

- is widely used as a tool for ecological impact assessment.
- describes the relations between fish abundance and environmental variables, estimates the level of habitat suitability as an HSI score.



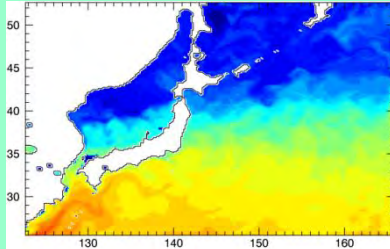
For predicting squid HSI ...

HSI model development



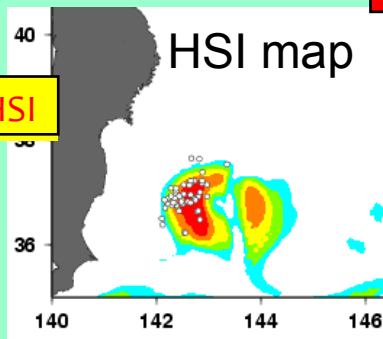
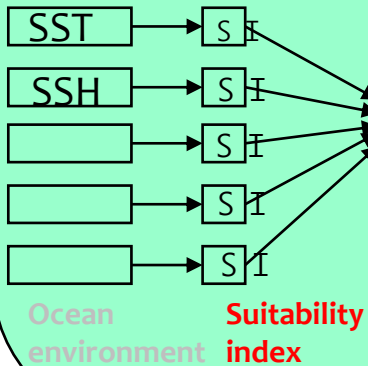
squid catch data

×



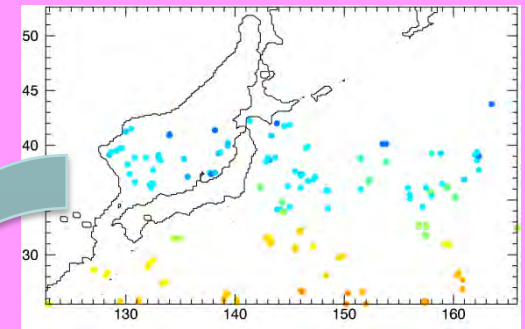
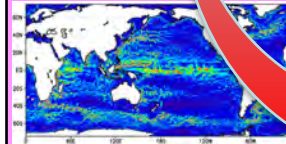
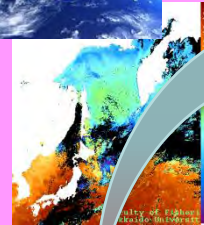
ocean environmental data in the past

integration analysis

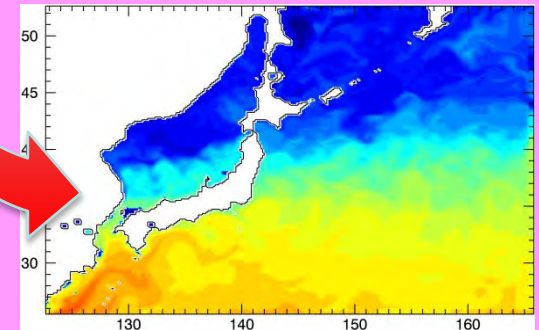


ocean state prediction

data assimilation & forecast

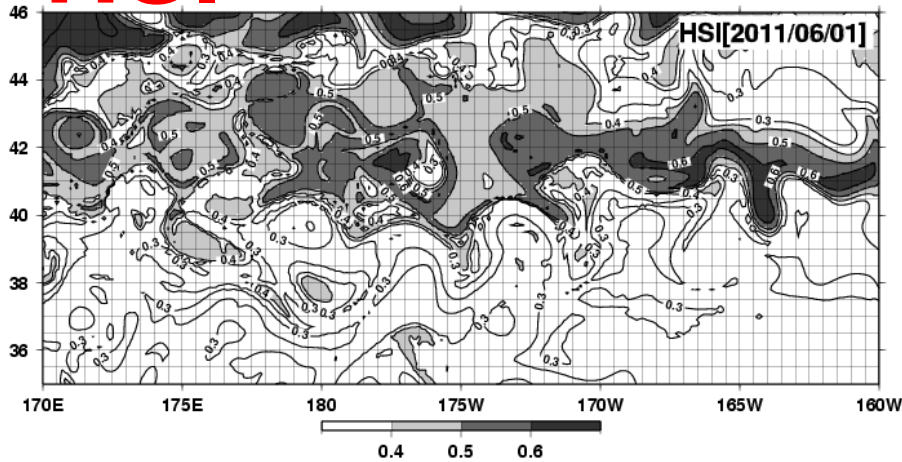


real-time prediction

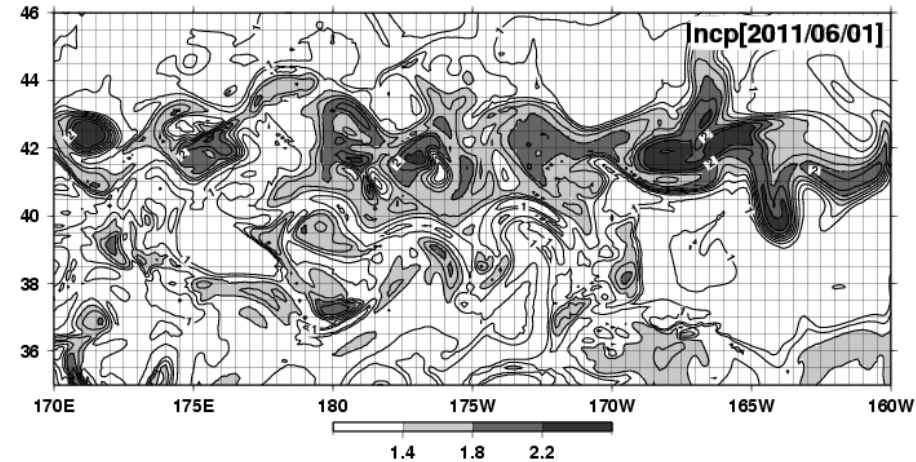


four habitat models

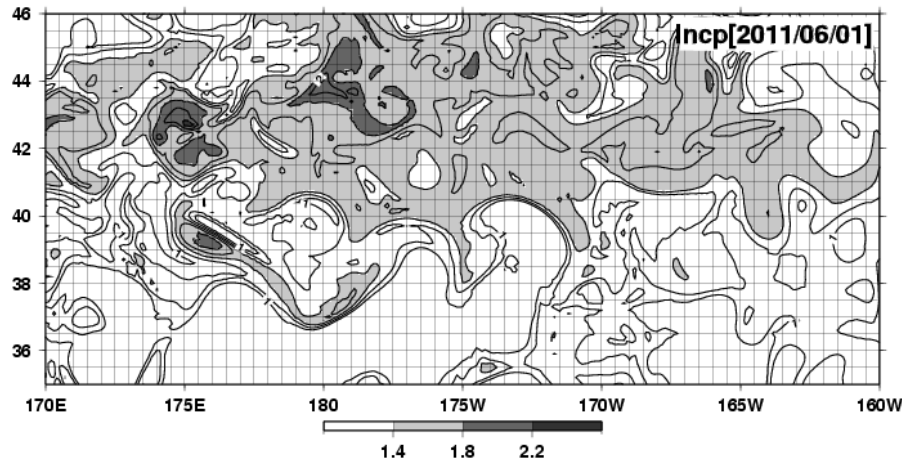
HSI



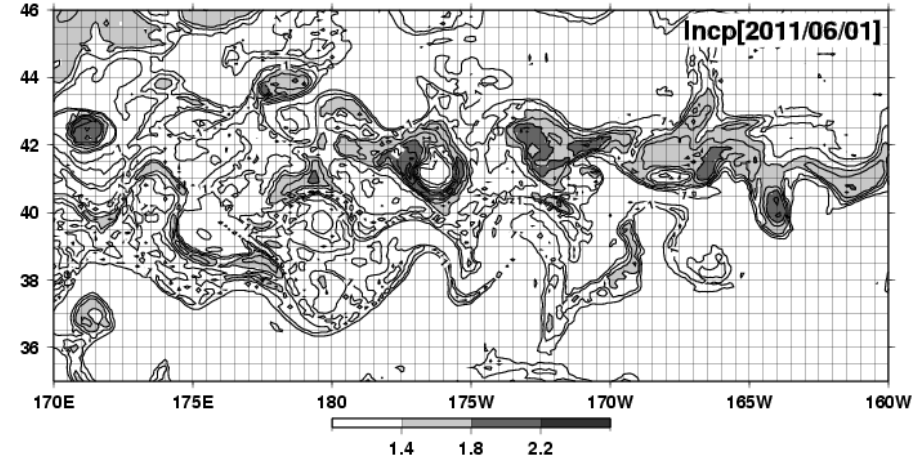
SVM



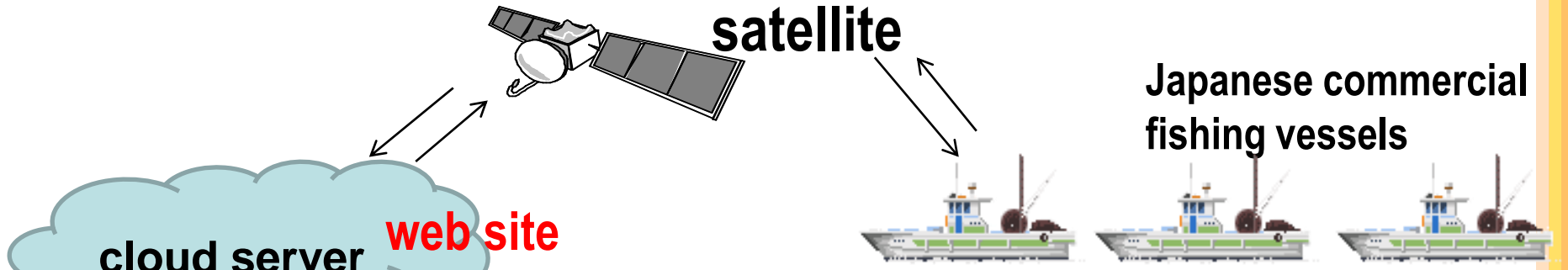
GAM



RF



Operational prediction and web delivery



cloud server **web site**

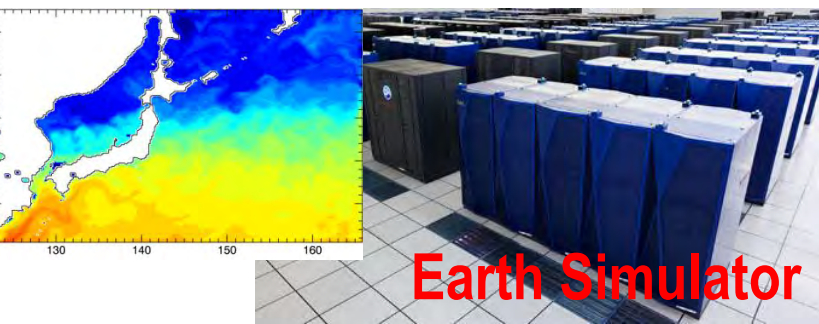
HSI mapping

JAMSTEC OPeNDAP server
real-time ocean state prediction

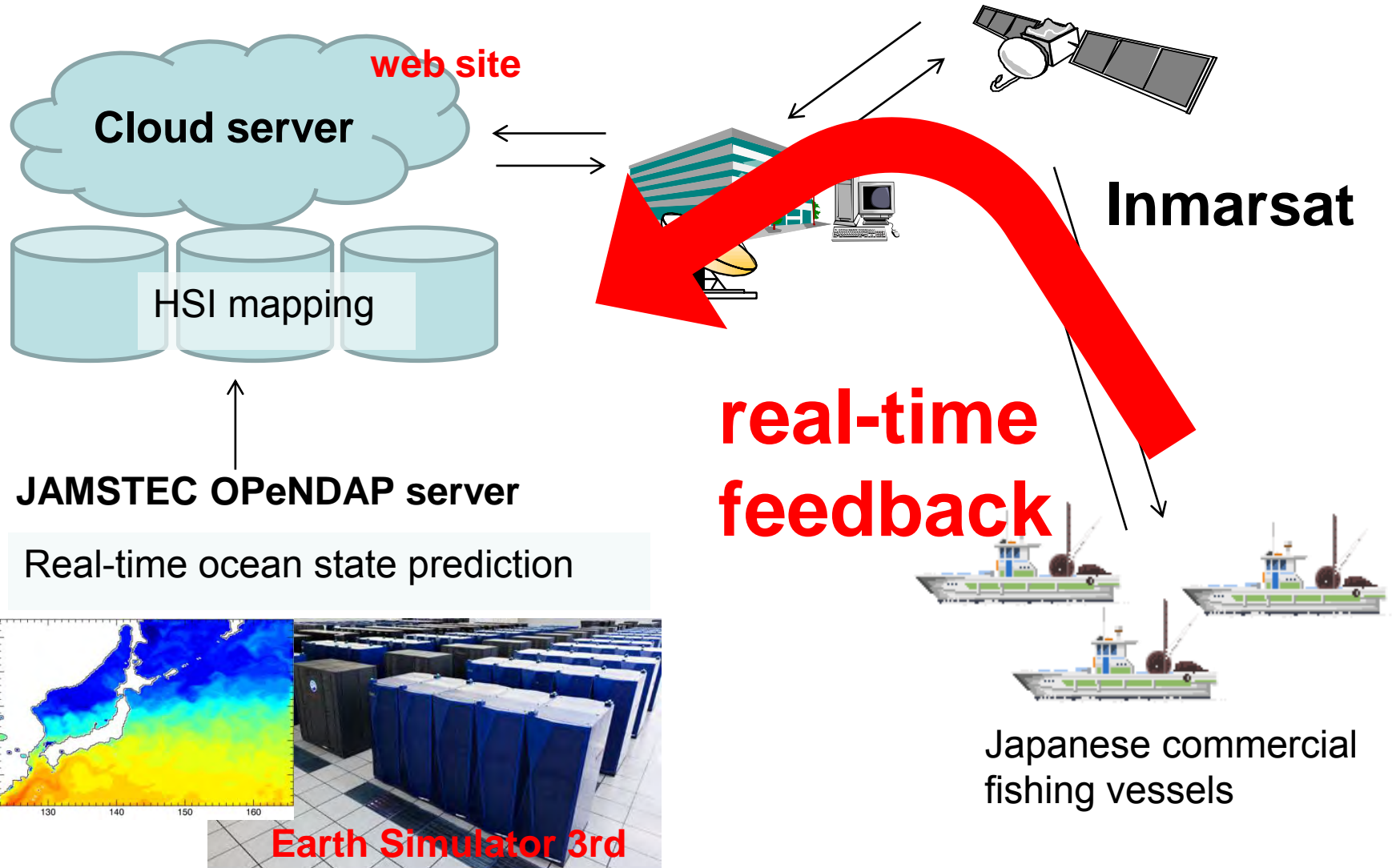
The screenshot shows a web browser displaying a RECCA website. It features two maps: an HSI map on the left and a 200m-d temperature map on the right. The HSI map is titled 'HSI[2013/06/21]' and shows a contour plot of the sea surface. The 200m-d temperature map shows isotherms at 200m depth. Both maps include a '表示日' (display date) dropdown menu with options for '最新' (latest) and '1日後' through '5日後'. There are also buttons for '画面変更' (change screen), '印刷' (print), and 'メニューに戻る' (return to menu).

- 100-400m temperature
- SST, SSH, EKE, chl-a
- squid HSI map

HSI map **200m-d temperature**



operational prediction system for neon flying squid HSI



real-time report of squid catch from fishermen

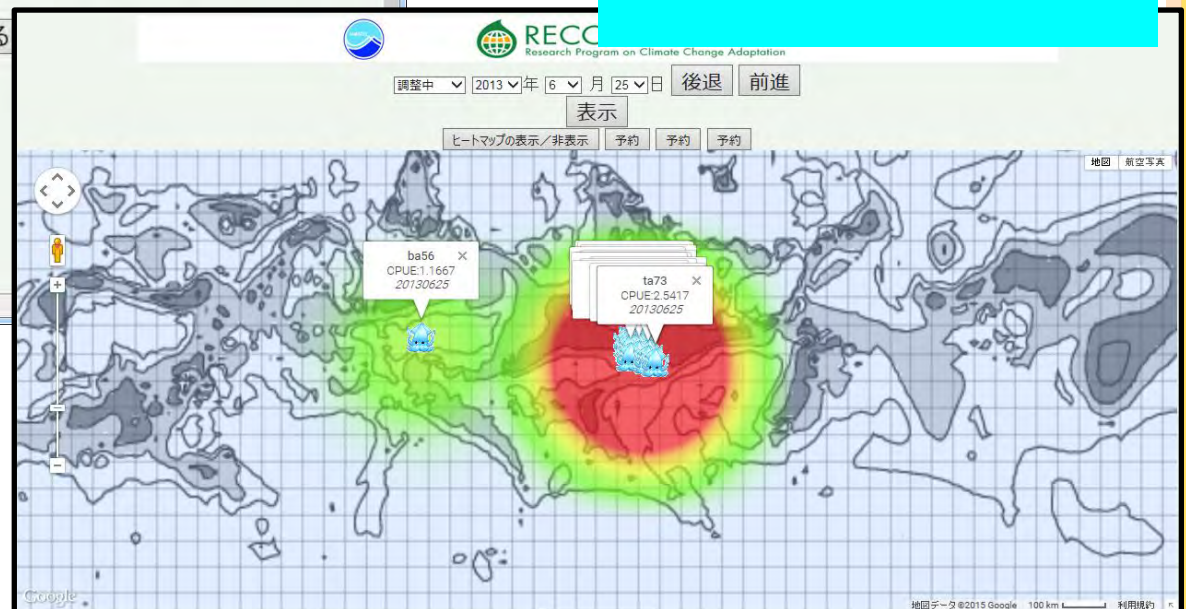
input

- fishing location (lat.,lon.)
- fishing date
- catch (N. of boxes)

monitor and access fishery report data

The screenshot shows the RECCA website interface. On the left is a map of the Kuroshio region with a red 'X' marking a fishing location. The map includes latitude (36N to 46N) and longitude (170W to 180W) coordinates. The main part of the page is a '漁獲量報告' (Fishing Report) form. Two sections of the form are highlighted with red boxes: '作業場所日時' (Fishing location and date) and '作業開始時刻' (Fishing start time). The '作業場所日時' section contains dropdown menus for latitude (40 degrees 59 minutes), longitude (172W degrees 19 minutes), and a date of 2013/06/21. The '作業開始時刻' section contains dropdown menus for start time (10:00), end time (10:00), and a 0-hour interval. To the right of the form is a table for reporting catch counts.

尾数(箱内)	
1- 5尾	0
6- 10尾	0
11- 15尾	0
16- 20尾	0
21- 25尾	0
26- 30尾	0
31- 40尾	0
41- 50尾	0
51- 60尾	0



We would like to make good use of these fishery report data to improve the habitat model.

purpose

- to develop a method of an adaptive improvement of the habitat model for the neon flying squid for practical use using real-time daily fishery report data provided from the squid fishermen

data

- Fishery data

Commercial fisheries data of neon flying squid
from June to July during **1999-2012**

(by Aomori Prefectural Industrial Technology Research Center)

the dates of fishing, fishing locations, CPUE(No./hour/machine)

- 4D-VAR ocean data assimilation product

FORA(Four-dimensional variational Ocean ReAnalysis)

Temperature, Salinity, Current velocity(U,V),

Sea surface height (0.1deg, vertical 54 levels, daily)



FORA is now available.

<http://synthesis.jamstec.go.jp/FORA/e/>

methodology

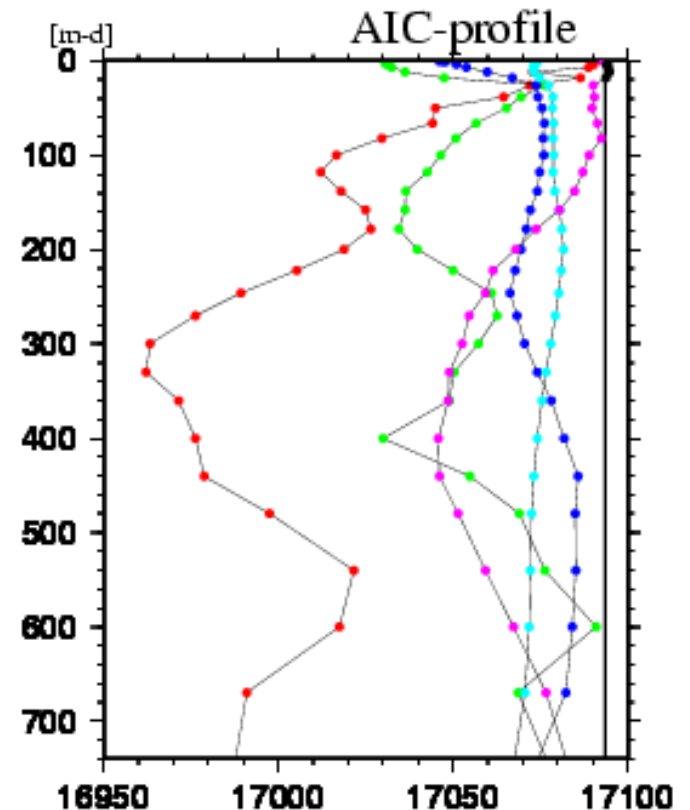
Support Vector Machine (SVM)

$$\ln(CPUE) = f(p_1, p_2, \dots, p_m) + \varepsilon$$

p_i : ocean environmental variables
 ε : error

Selected 10 ocean environmental variables

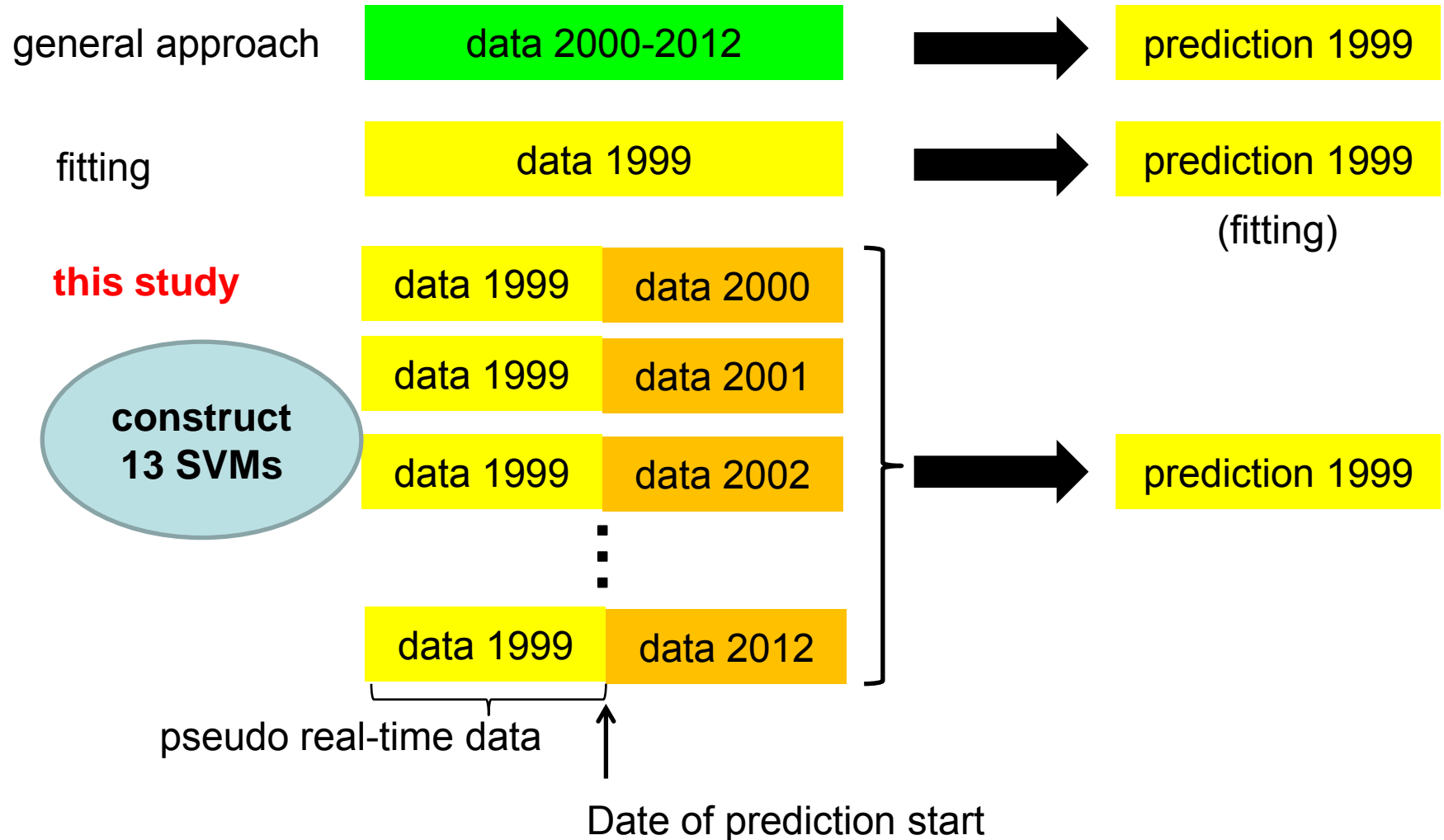
- sea surface temperature (SST)
- sea surface height (SSH)
- horizontal gradient of SSH (∇ SSH)
- mixed layer depth (MLD)
- T330m (temperature)
- T118m
- S400m (salinity)
- S178m
- U246m (zonal velocity)
- Vs400m (scalar velocity)



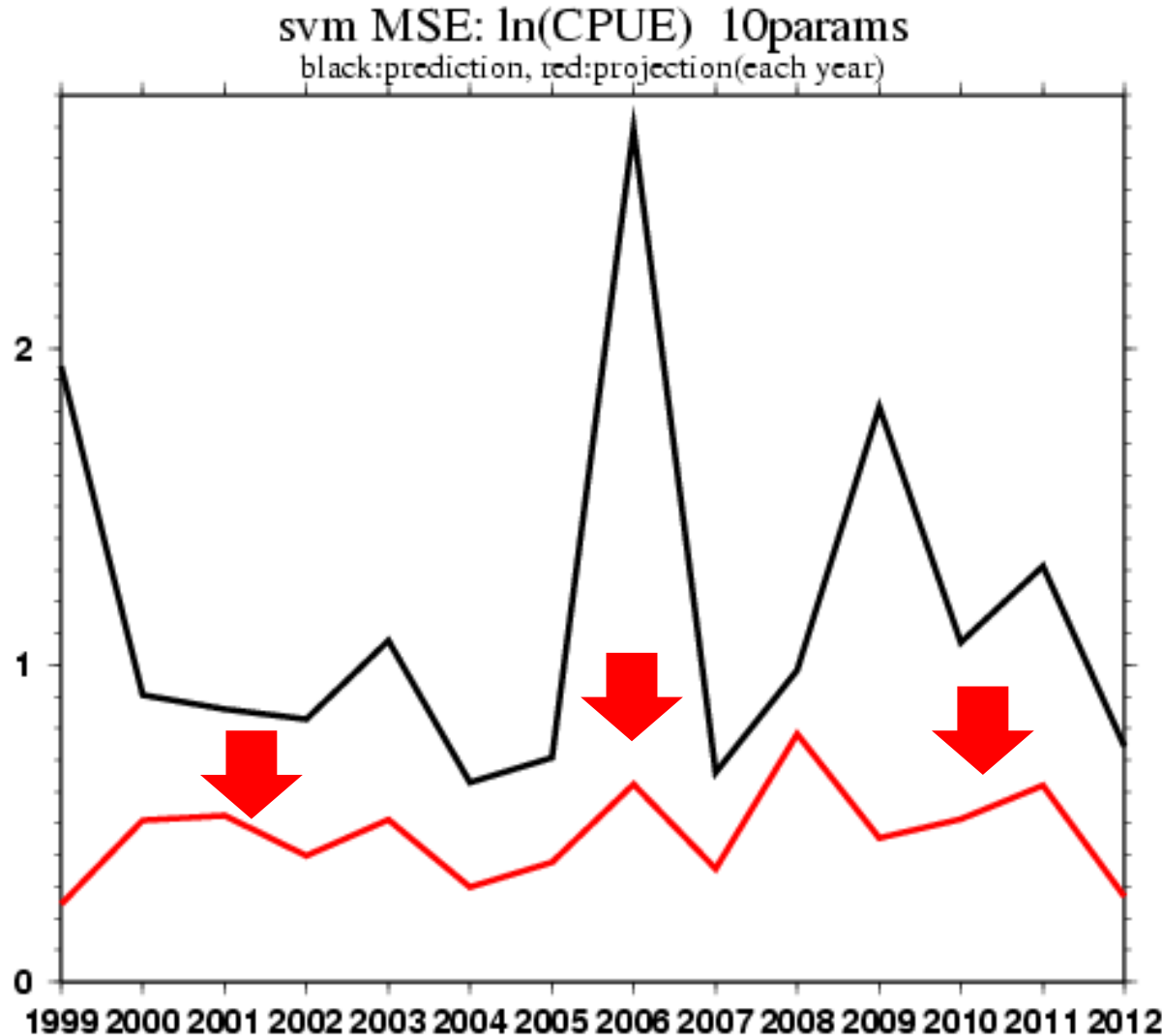
red:temperature, green:salinity,
blue:zonal velocity, aqua:meridional
velocity, pink:scalar velocity

SVM construction

prediction of 1999



mean square errors of SVM prediction



Black: general SVM
(MSE of 1999 was calculated by SVM using 2000-2012 data.)

Red: fitting SVM
(MSE of 1999 was calculated by SVM using 1999 data.)

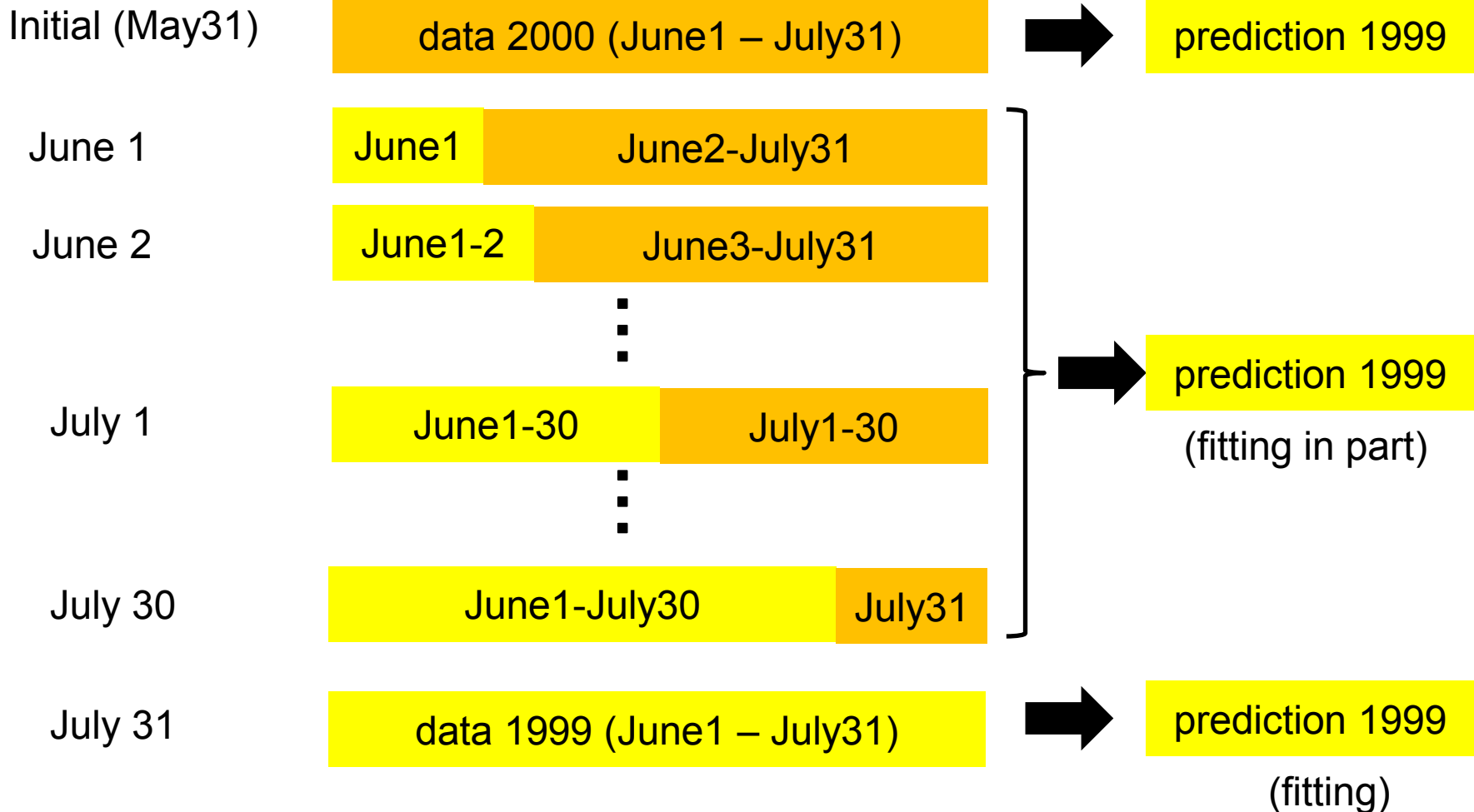
develop a method to approximate the MSE from black to red quickly

sequential model updating

prediction of 1999 by yr-2000 SVM

data 1999

data 2000



We constructed 13 models for predicting a target year.

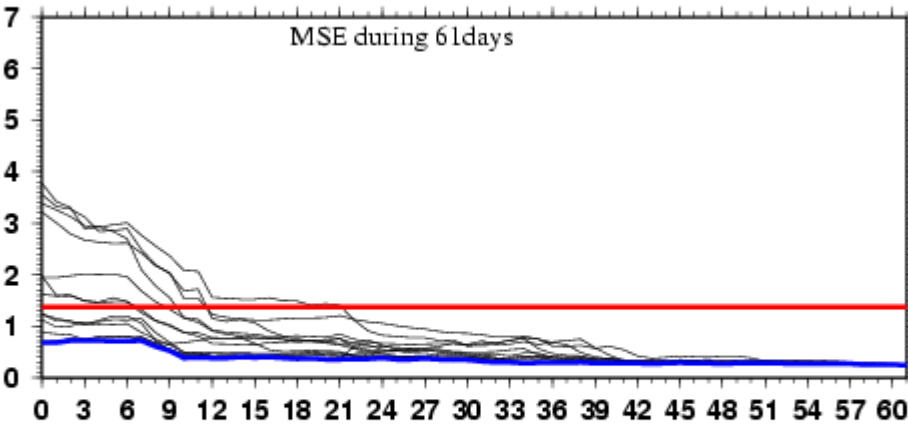
results

svm-10val MSE: 1999

Mean Square Errors of 1999 prediction

data 1999

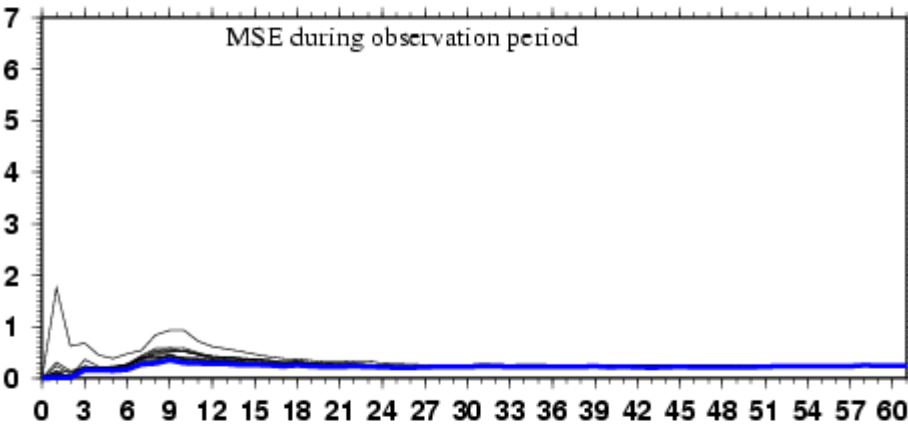
data (another year)



(top) MSE from June 1 to July 31

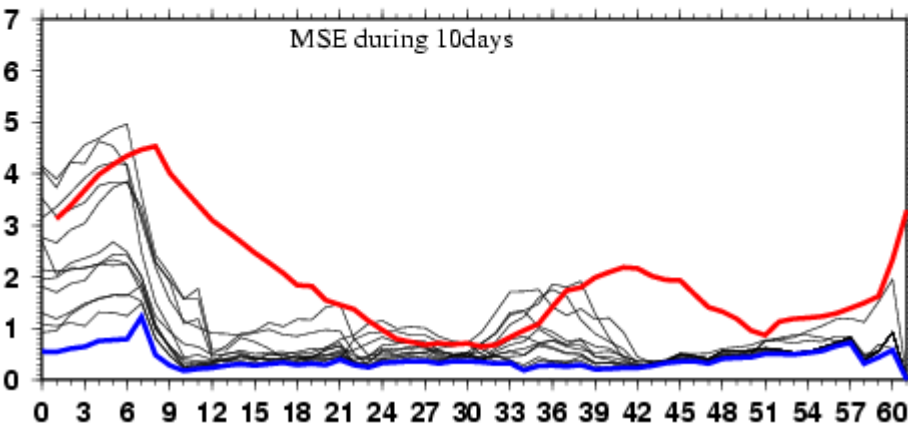
red line : MSE of general SVM

blue line: the least MSE in 13 SVMs



(middle) MSE during fitting period

blue line: the least MSE in 13 SVMs



(bottom) MSE during first 10 days in prediction period

red line : MSE of general SVM

blue line: the least MSE in 13 SVMs

svm-10val MSE: 1999

Mean Square Errors of 1999 prediction

(top) MSE from June 1 to July 31

red line : MSE of general SVM

green line: selected cases of the least MSE in projection (middle)

(middle) MSE during fitting period

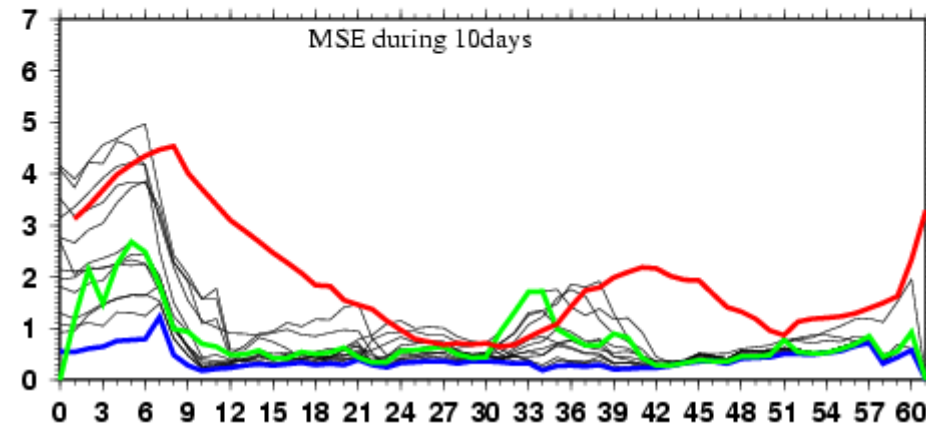
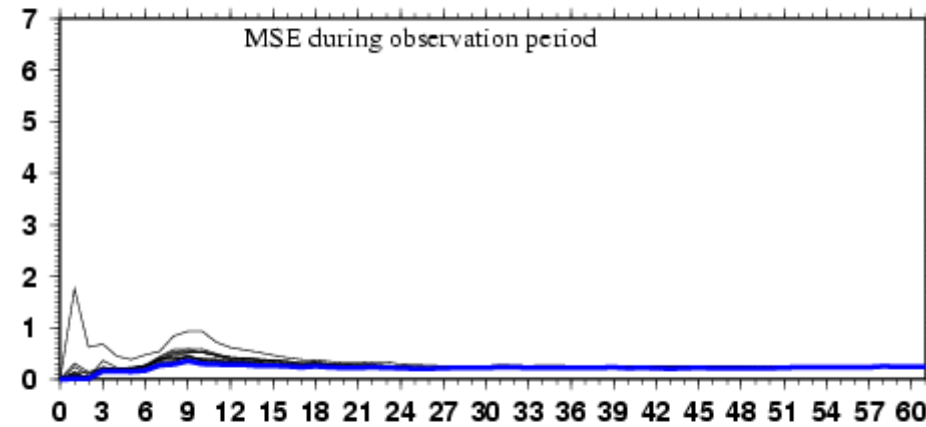
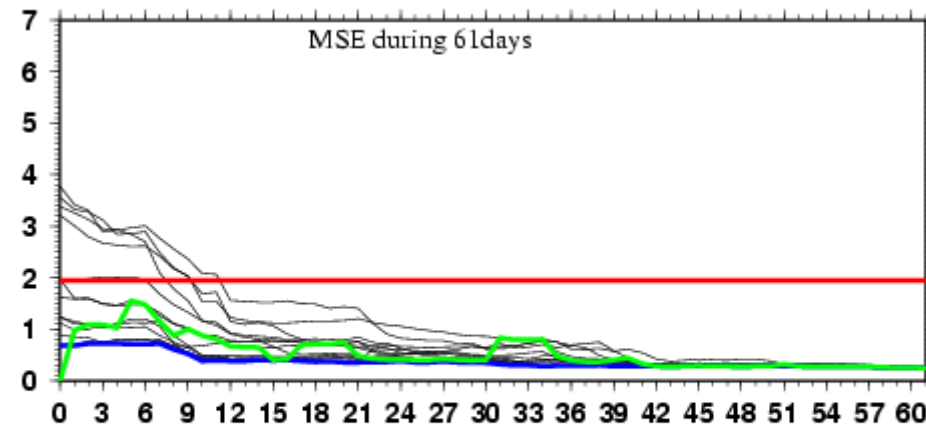
blue line: the least MSE in 13 SVMs

(bottom) MSE during first 10 days in prediction period

red line : MSE of general GAM

green line: selected cases of the least MSE in projection (middle)

We do not always detect the least MSE case from the fitting results!



1-day prediction and ensemble

prediction of 1999 by yr-2000 SVM

data 1999

data 2000

June 2

June1

June2-July31

SVM construction

June2

1-day prediction

→ ensemble member selection
(10 members)

June1-2

June3-July31

13 SVMs updating

June3 – July31

ensemble prediction

data 1999

data 2000

data 1999

data 2005

data 1999

data 2008

data 1999

data 2012

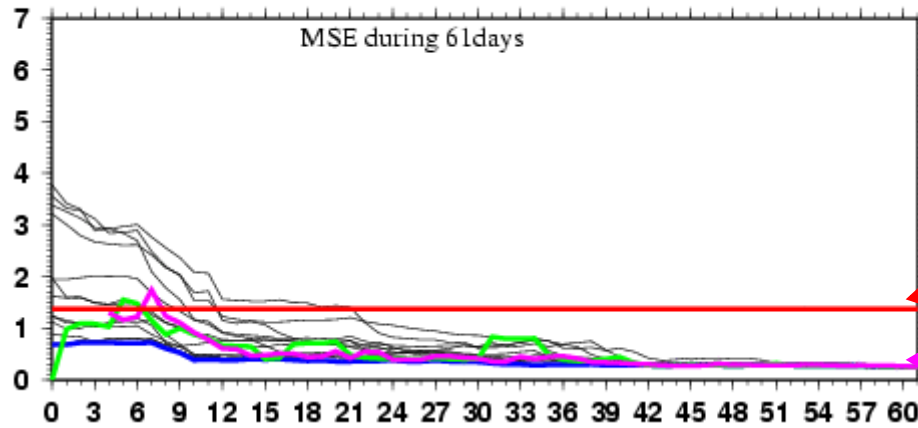
⋮

Ensemble mean fields of predicted squid CPUE were calculated from the selected SVMs.

svm-10val(ens10) MSE: 1999

Mean Square Errors of 1999 prediction

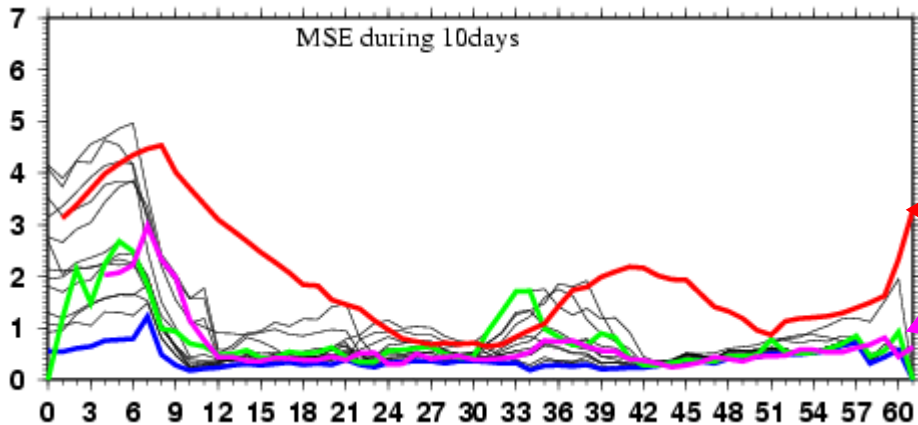
(top) MSE from June 1 to July 31



red line : MSE of general SVM

pink line: MSE of ensemble mean SVM

(bottom) MSE during first 10 days in prediction period

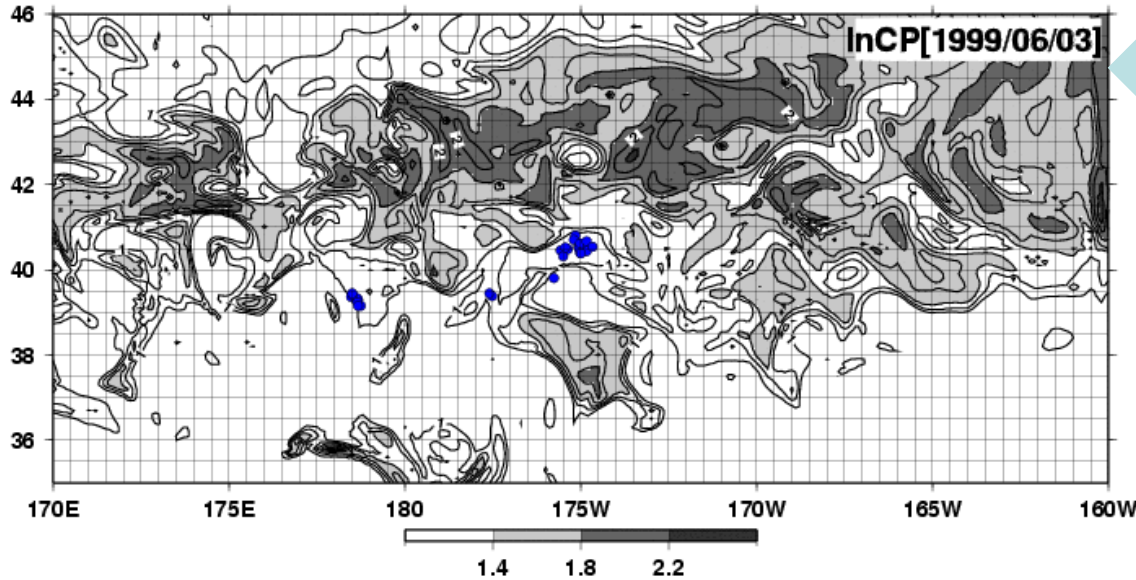


red line : MSE of general SVM

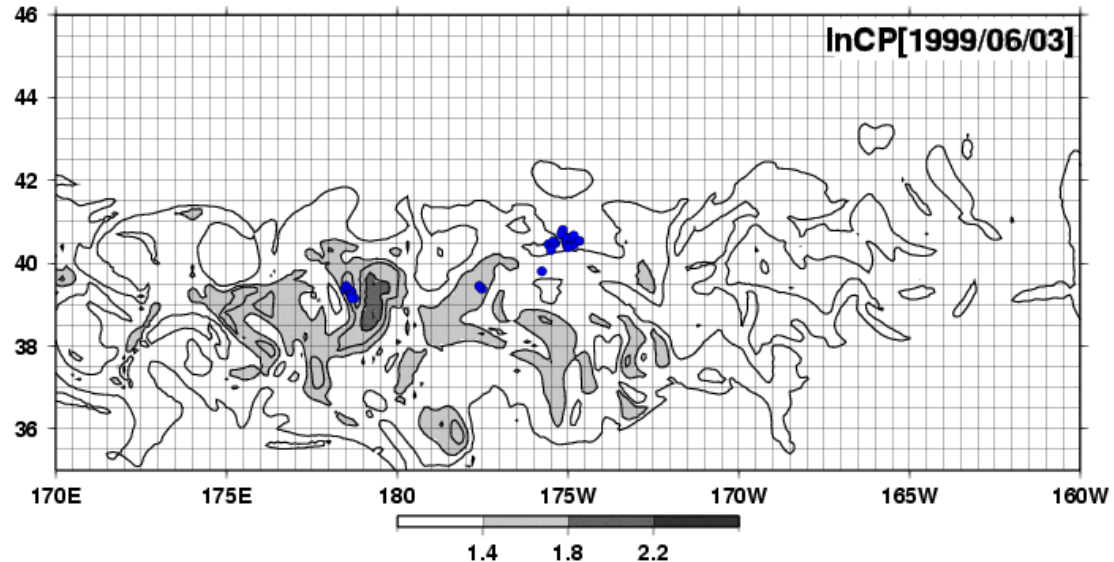
pink line: MSE of ensemble mean SVM

MSE of the ensemble SVM is smaller than that of the general SVM during the fishing season.

Comparison of habitat maps



blue dot: actual fishing point

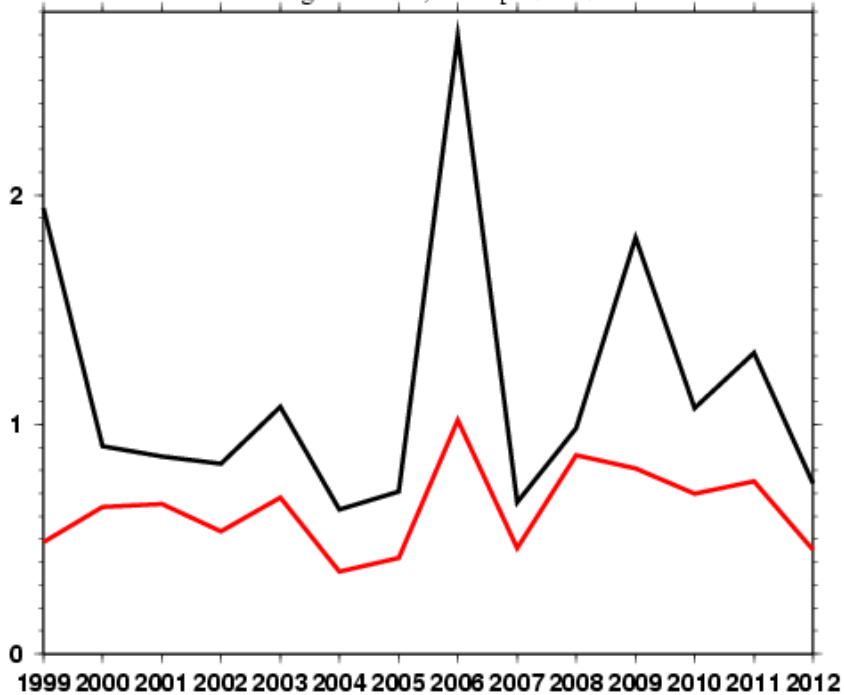


ensemble SVM

MSE of each year

total period (June3-July31)

svm MSE: ln(CPUE) total period
black:general svm, red:improved svm



10 days

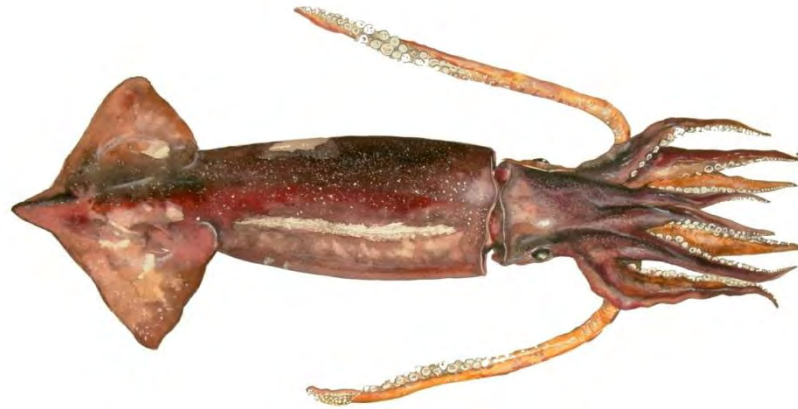
svm MSE: ln(CPUE) 10-days
black:general svm, red:improved svm



Black: general SVM, red: improved SVM

Concluding remarks

- We developed a method of an adaptive improvement of HSI model by using real-time daily fishery reports provided from the squid fishermen. The HSI model constructed in advance were sequentially modified by updating the fishery report data.
- The remarkable improvement can be seen in the sequentially modified HSI model in which the information of ocean environments in the actual fishing ground was reflected.
- The results suggest that the adaptive modification of the HSI model could be practically useful for the accurate estimate of the potential fishing zone.



Thank you