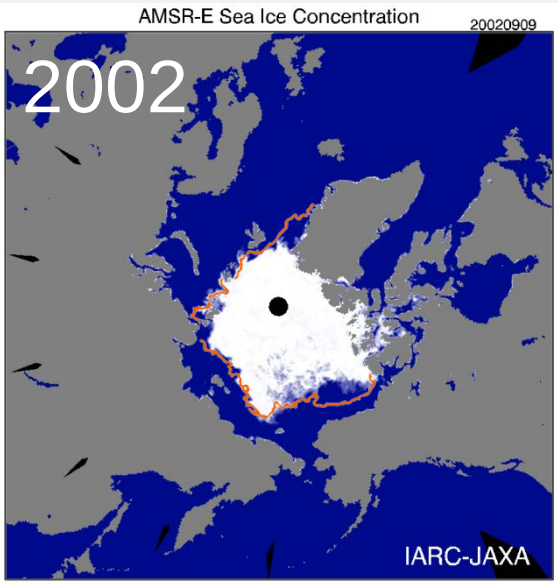
Japan Arctic Research Activities

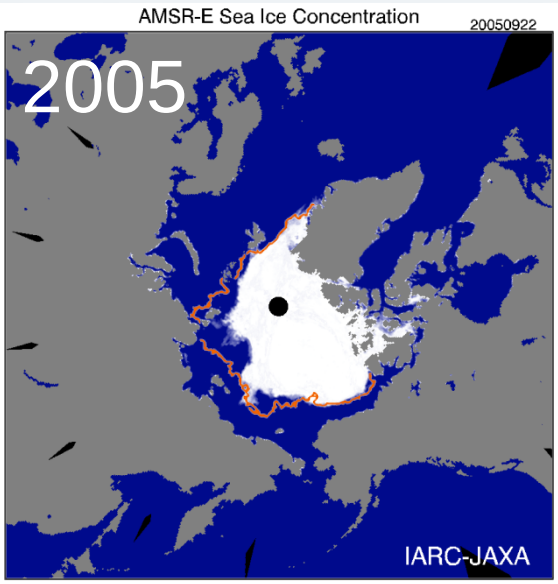
Ecosystem studies of the Arctic Ocean declining Sea ice (ECOARCS/GRENE) 2011-2016

Takashi Kikuchi (JAMSTEC), Toru Hirawake (Hokkaido Univ.), and (more than) 40 co-researchers & collaborators

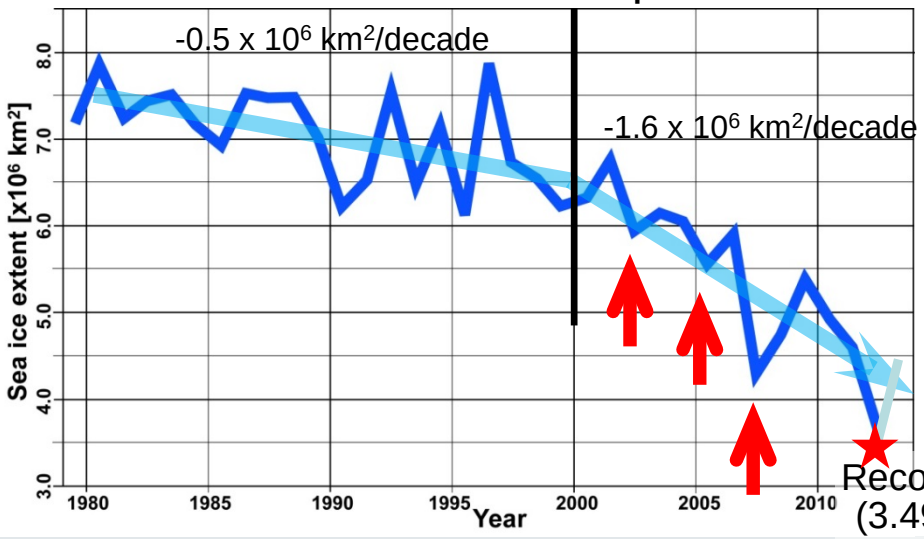
GRENE: Green Network of Excellence Program

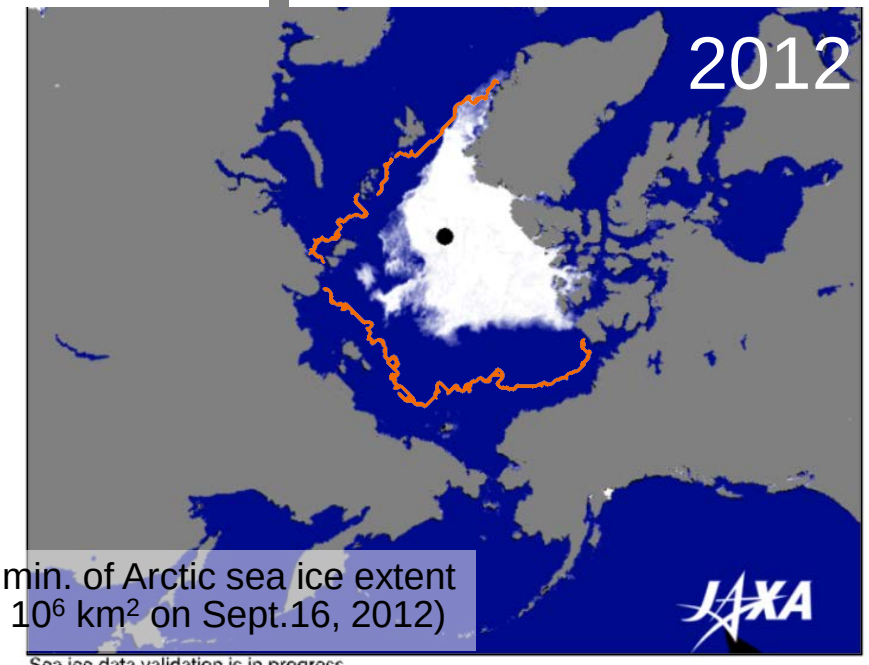
Introduction of ECOARCS/GRENE project





Arctic sea ice extent in Sept.



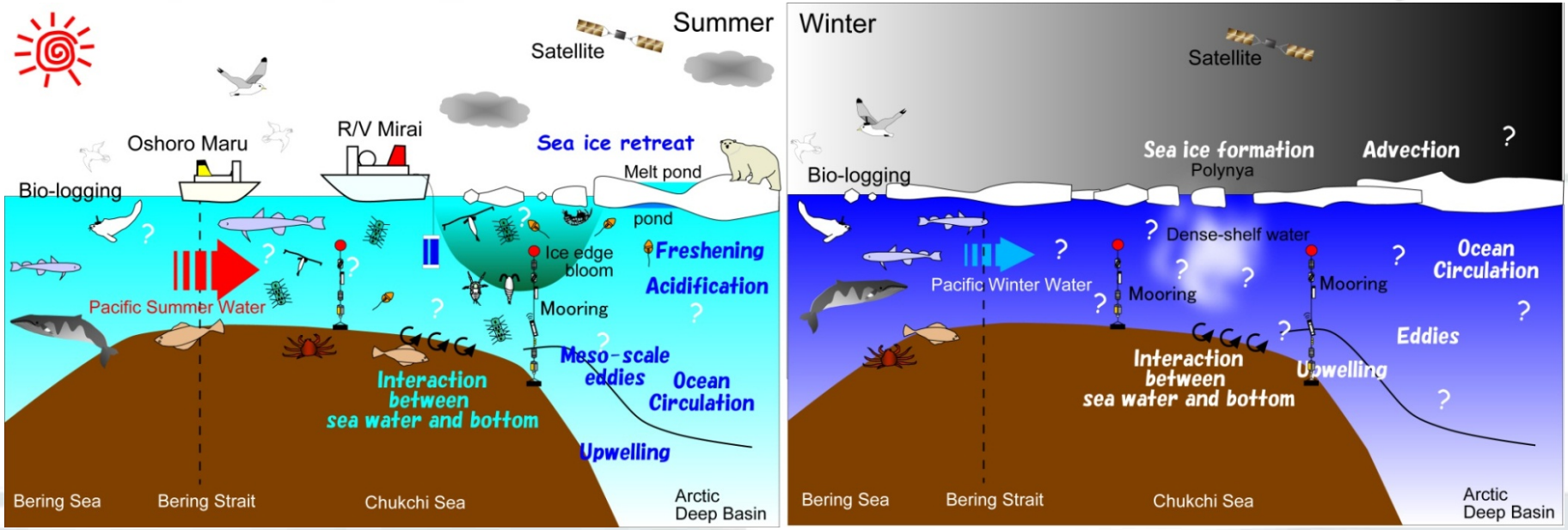


Record min. of Arctic sea ice extent
(3.49 x 10^6 km² on Sept.16, 2012)

Introduction of ECOARCS/GRENE project

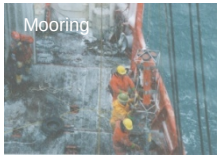
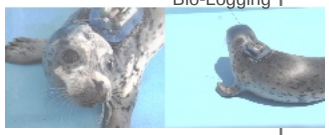
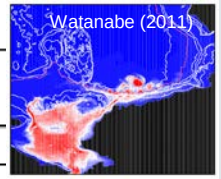
Question: How does sea ice variability (melting/formation, motion, seasonal cycle, recent inter-annually rapid decrease) affect the Arctic Ocean environments (physical, chemical, and biological)?

Key issue:
1. High primary production?
2. Pelagic-Benthic v.s. Pelagic-Pelagic scheme of the marine ecosystem
3. Influence of rapid sea ice reduction not only to spices that are inherent to the Arctic but also those from the Pacific Ocean



For better understanding of these changes in Arctic climate and ecosystems, we will conduct multi-disciplinary studies examining not only biological but also physical and chemical aspects of the drastically changing Arctic environments.

Introduction of ECOARCS/GRENE project

	2011	2012	2013	2014	2015
1) Ship-based Observation	Preparation	Sept.-Oct. R/V Mirai Arctic Ocean cruise  	July Oshoro-Maru Cruise R/V Mirai Arctic Ocean Cruise Aug.-Oct.	**Sept.-Oct.** R/V Mirai CCGS Amundsen cruise  	
2) Mooring	Preparation 	① Jul. Deployment by SWL; Sept. Recoveries & Deployments by Mirai	Mooring measurement ② July Recoveries & Deployments by SWL	③ July Recoveries & Deployments by SWL	④ R/V Mirai Arctic Ocean Cruise Aug.-Oct.
3) Bio-Logging	Preparation	Bio-Logging 	Oshoro-Maru Cruise Alaska & Bering Is.	Bio-Logging Alaska & Bering Is.	
4) Satellite	(GCOM-W)	Collaboration with ship-based observations	Satellite monitoring Collaboration with ship-based observations	Collaboration with ship-based observations	
5) Numerical simulation			Model development & simulation		

Observational activity in ECOARCS/GRENE project

T/S Oshoro-maru cruise in June-July 2013

Goal;

Using data from cruises in 1991, 1992, 2007, 2008 and this year,

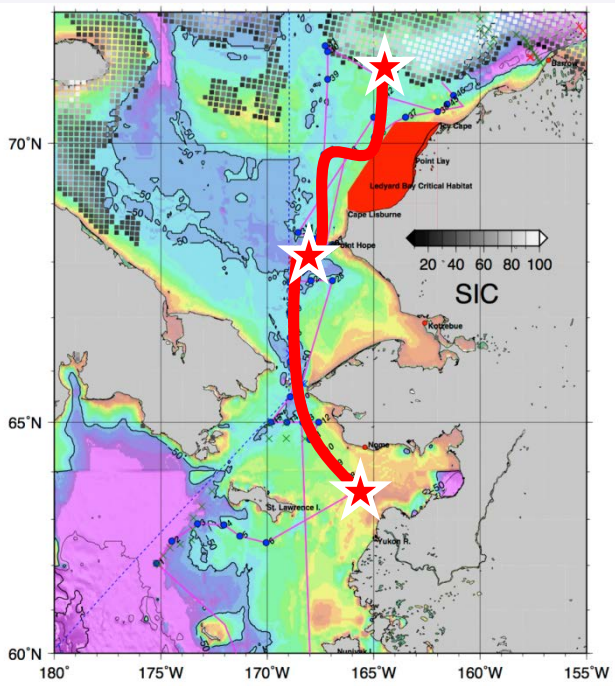
1) To reveal relationship between biology at higher trophic levels and oceanographic condition (sea ice, physio-chemical, primary and secondary production).

2) To construct habitat model of biology under current condition to consider future reaction of fish and mammals.

- CTD/CMS (Normal and Clean Niskin)
- Air sampling (VOC gas)
- Sea ice sampling and incubation
- Optics
- ADCP
- Plankton net
- Grab type bottom sampler
- Bottom corer
- Dredge
- Bottom/midwater trawl
- ROV
- Eye observation
- Tagging to whale
- Fish finder

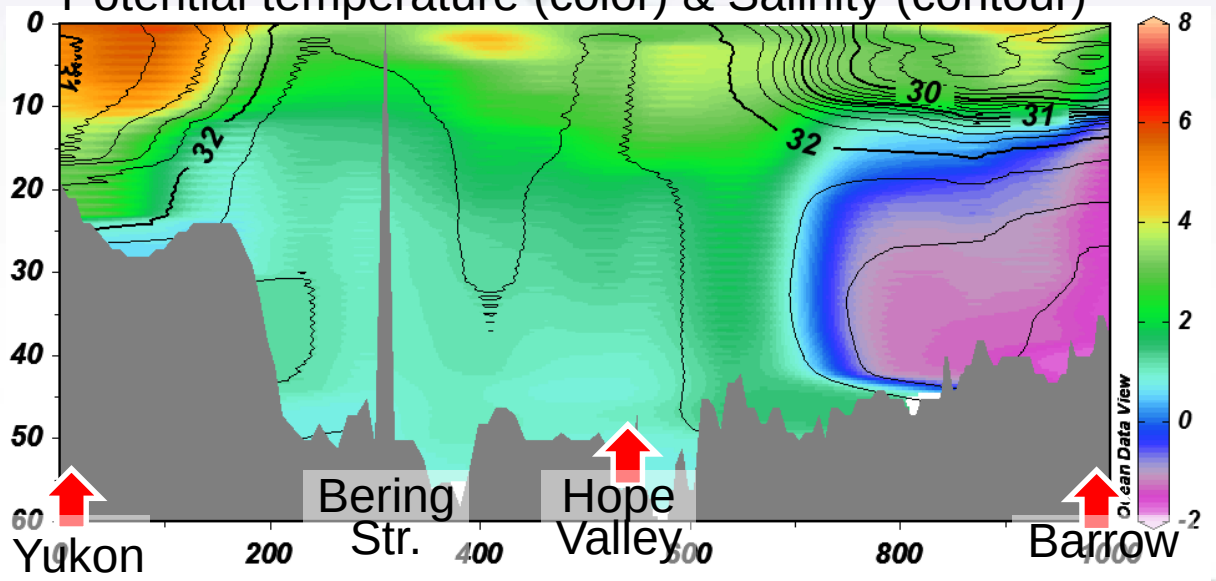
Observational activity in ECOARCS/GRENE project

T/S Oshoro-maru cruise in June-July 2013



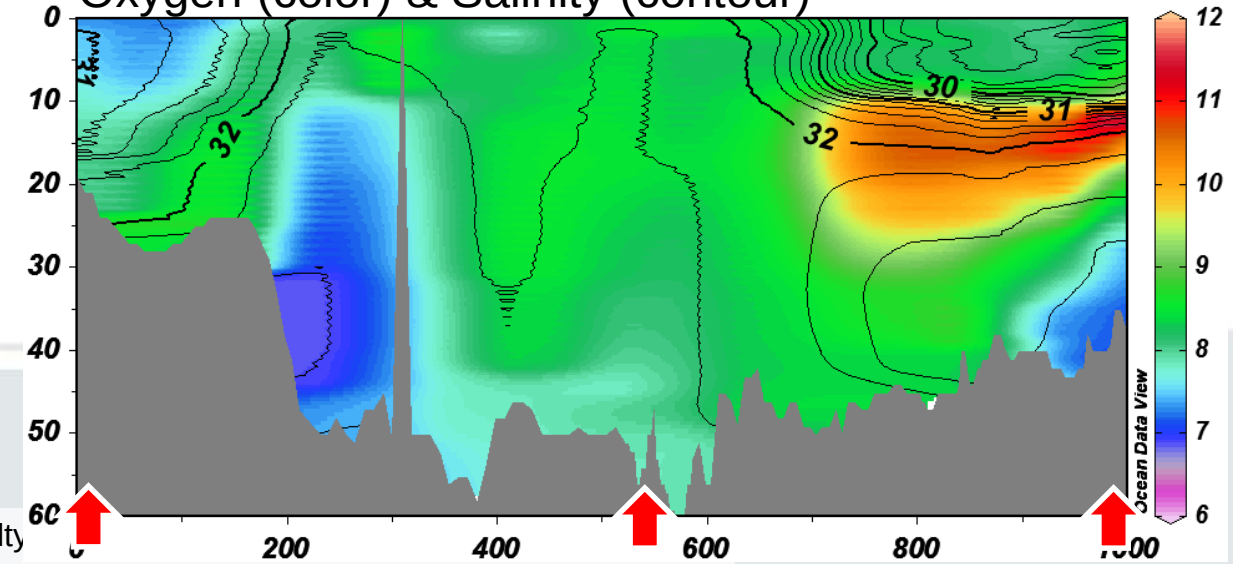
Courtesy from Dr. Hirawake (Faculty

Potential temperature (color) & Salinity (contour)

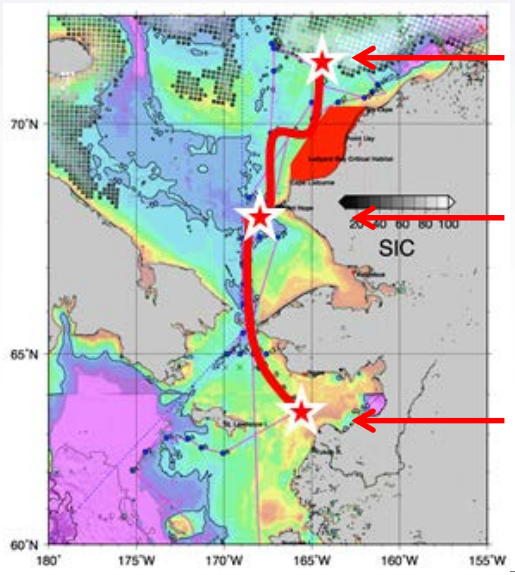


Yukon Bering Str. Hope Valley Barrow

Oxygen (color) & Salinity (contour)



Observational activity in ECOARCS/GRENE project



Ice edge

Biological hotspot

Yukon river mouth

Biological hotspot station

Arctic staghorn sculpin (カジカ)

Snow Crab (ズワイガニ)

Station near Yukon river mouth

Capelin
(カラフトシシャモ)

Walleye pollock (スケソウタラ)

Arctic Cod
(北極タラ)

Photos: Dr. T. Abe

Courtesy from Dr. Hirawake (Faculty of Fisheries Sciences, Hokkaido University)

Ice edge station

Arctic cod and saffron cod (コマイ)

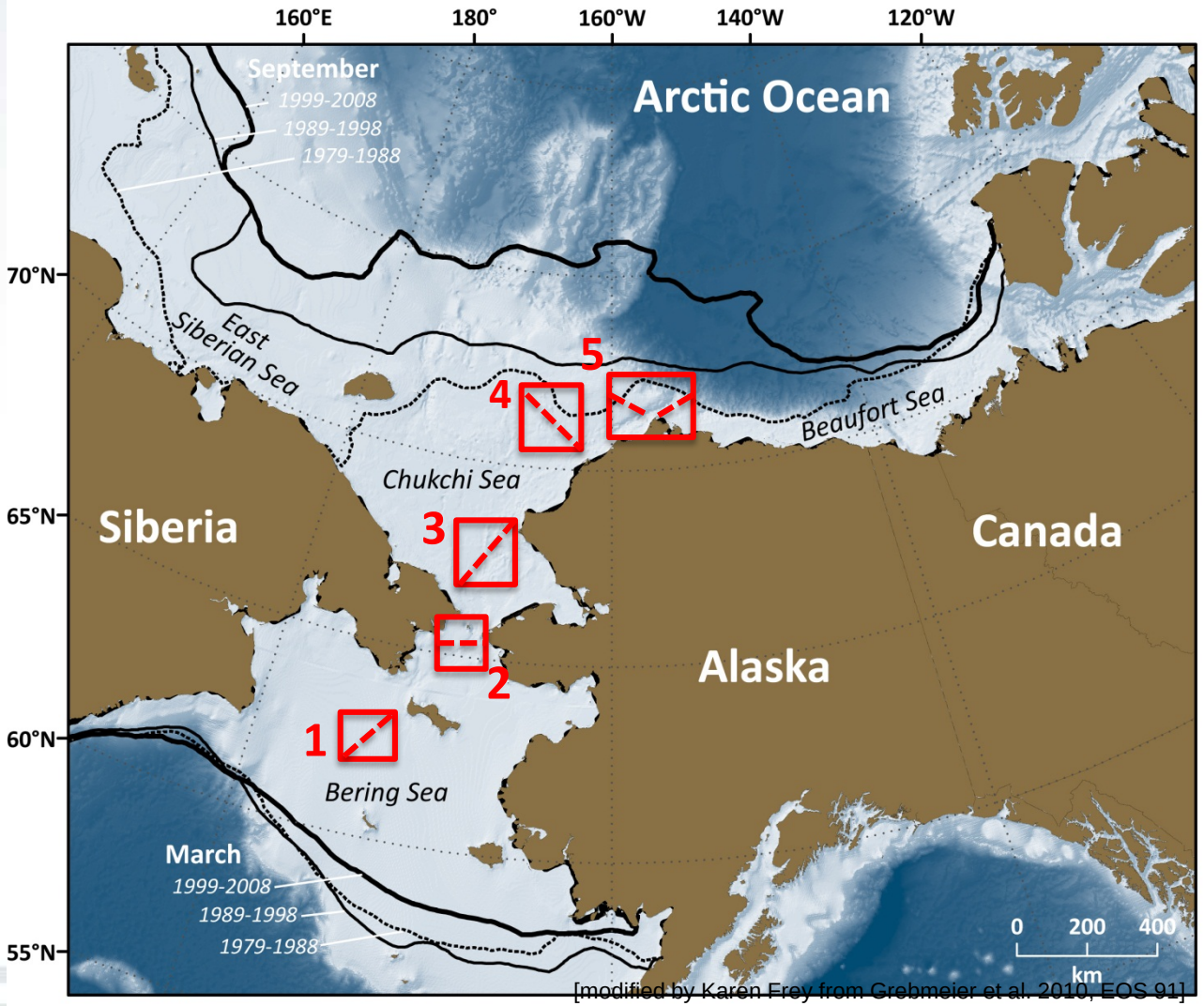
Arctic staghorn sculpin

Anti freeze protein is required to survive

Photos: Dr. T. Abe

Courtesy from Dr. Hirawake (Faculty of Fisheries Sciences, Hokkaido University)

Linking Physics to Biology: the Distributed Biological Observatory (DBO)

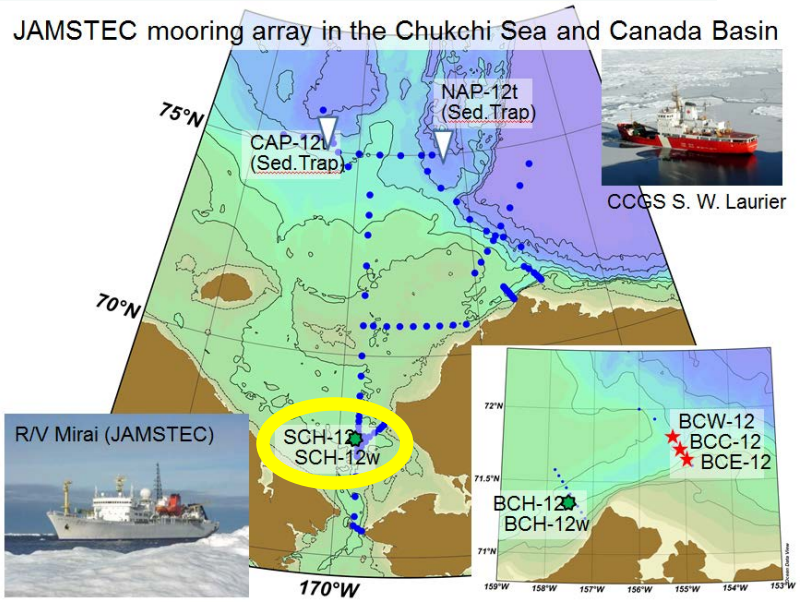


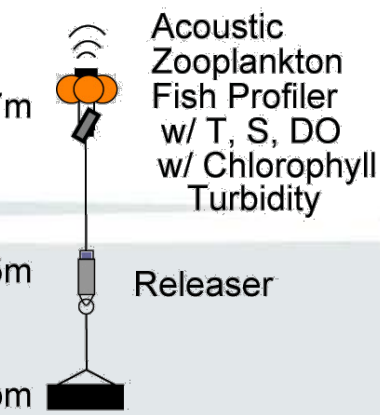
[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

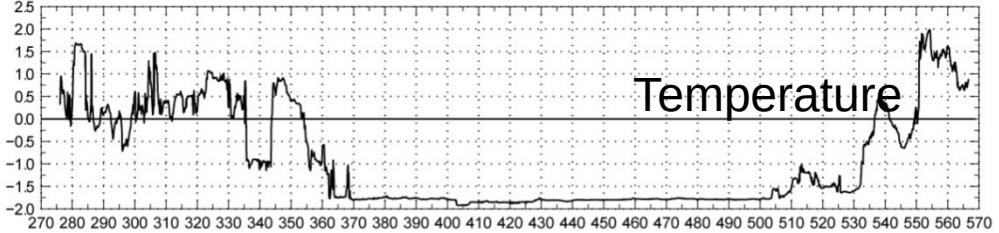
- DBO sites (red boxes) are regional "hotspot" transect lines and stations located along a latitudinal gradient
- DBO sites are considered to exhibit high productivity, biodiversity, and overall rates of change
- DBO sites will serve as a change detection array for the identification and consistent monitoring of biophysical responses
- Sites occupied by national and international entities with shared data plan

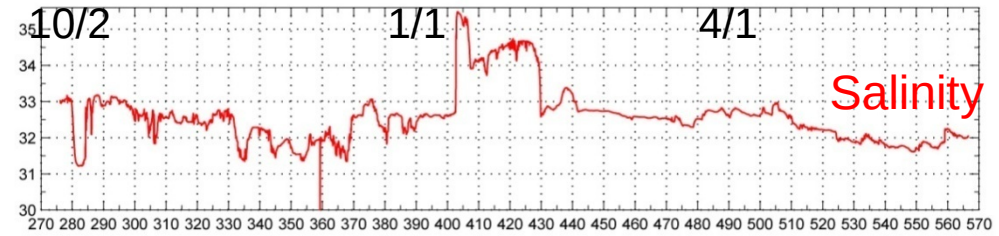
SCH mooring

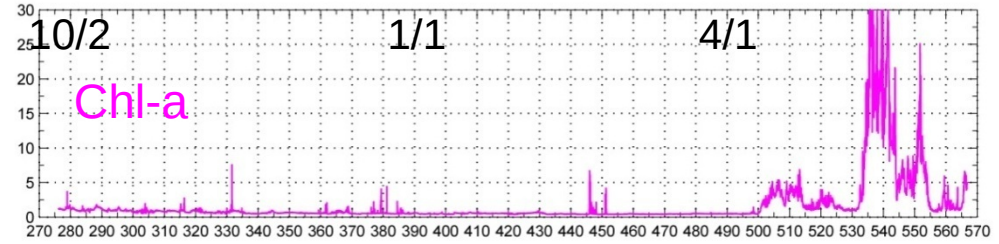
Time series of T, S, Chl-a, Turbidity, and Oxygen Saturation (Oct. 2, 2012 to Jul.20, 2013)

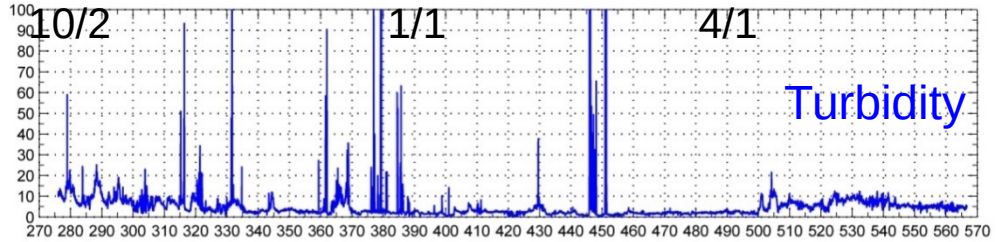


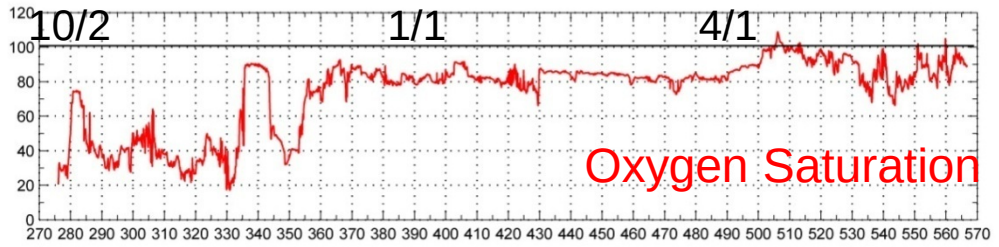






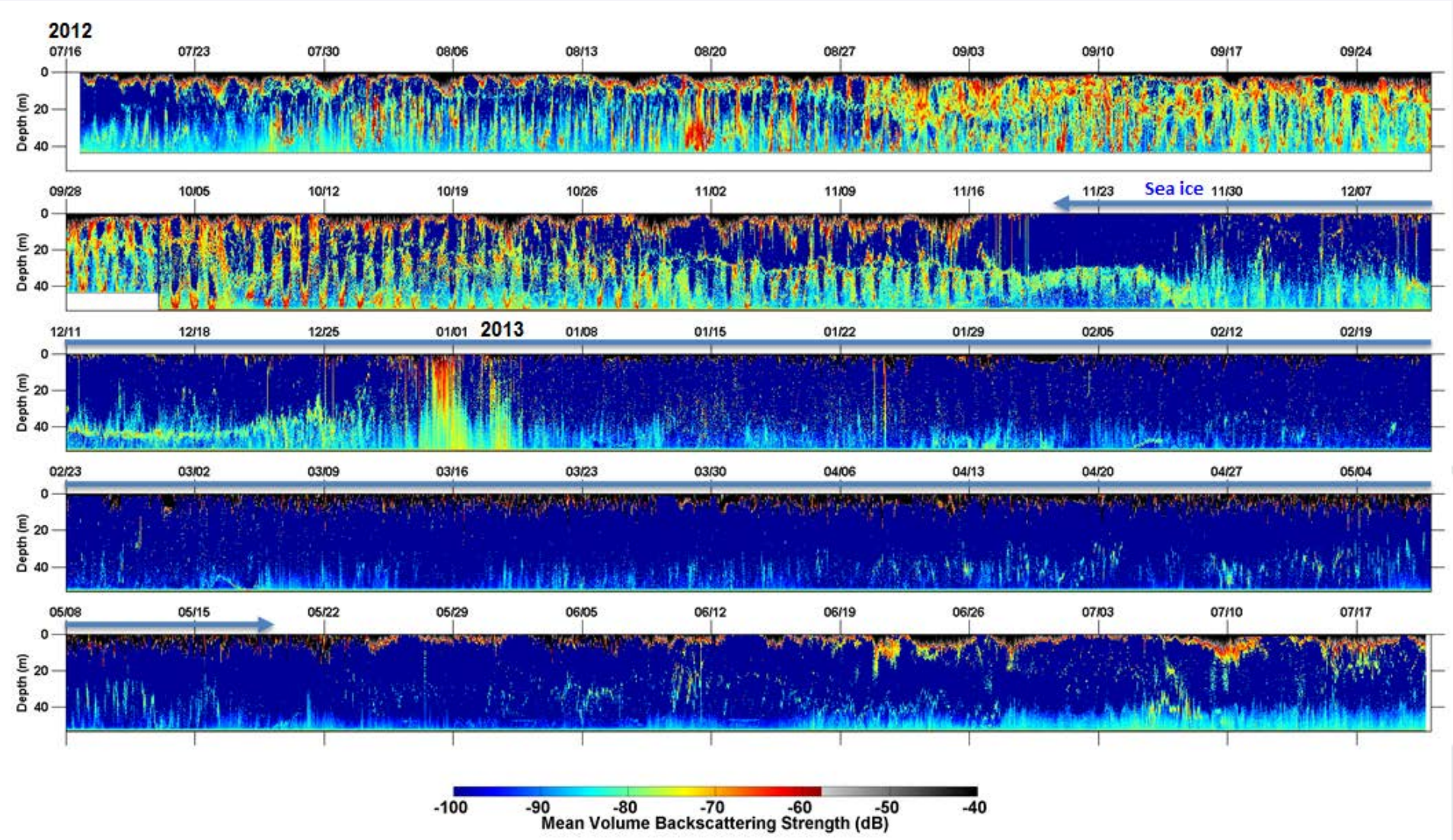






SCH mooring

Time series of AZFP 125 kHz Echogram (Oct. 2, 2012 to Jul.20, 2013)



Courtesy from Dr. Amakasu (Tokyo University of Marine Science and Technology) and Dr. Kitamura (JAMSTEC)

A comparison of reproductive characteristics and strategies between walleye Pollock (*Theragra* (*Gadus*) *chalcogramma*) and Arctic cod (*Boreogadus saida)*

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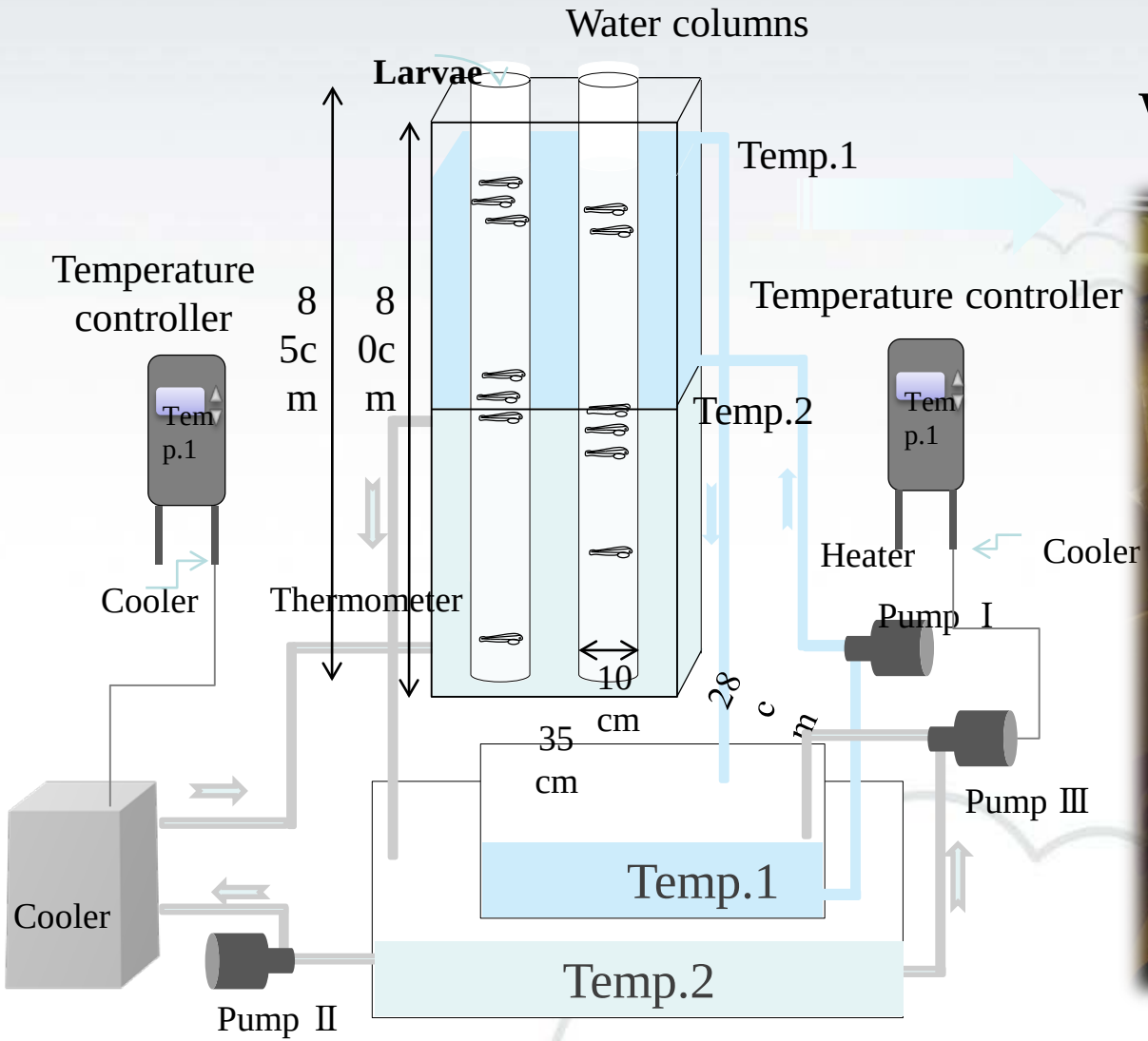


Water column

Two water column and the temperature controlling system. The column were surrounded by two water tanks, which contained circulating, temperature-controlled water.

Response to temperature change

Results

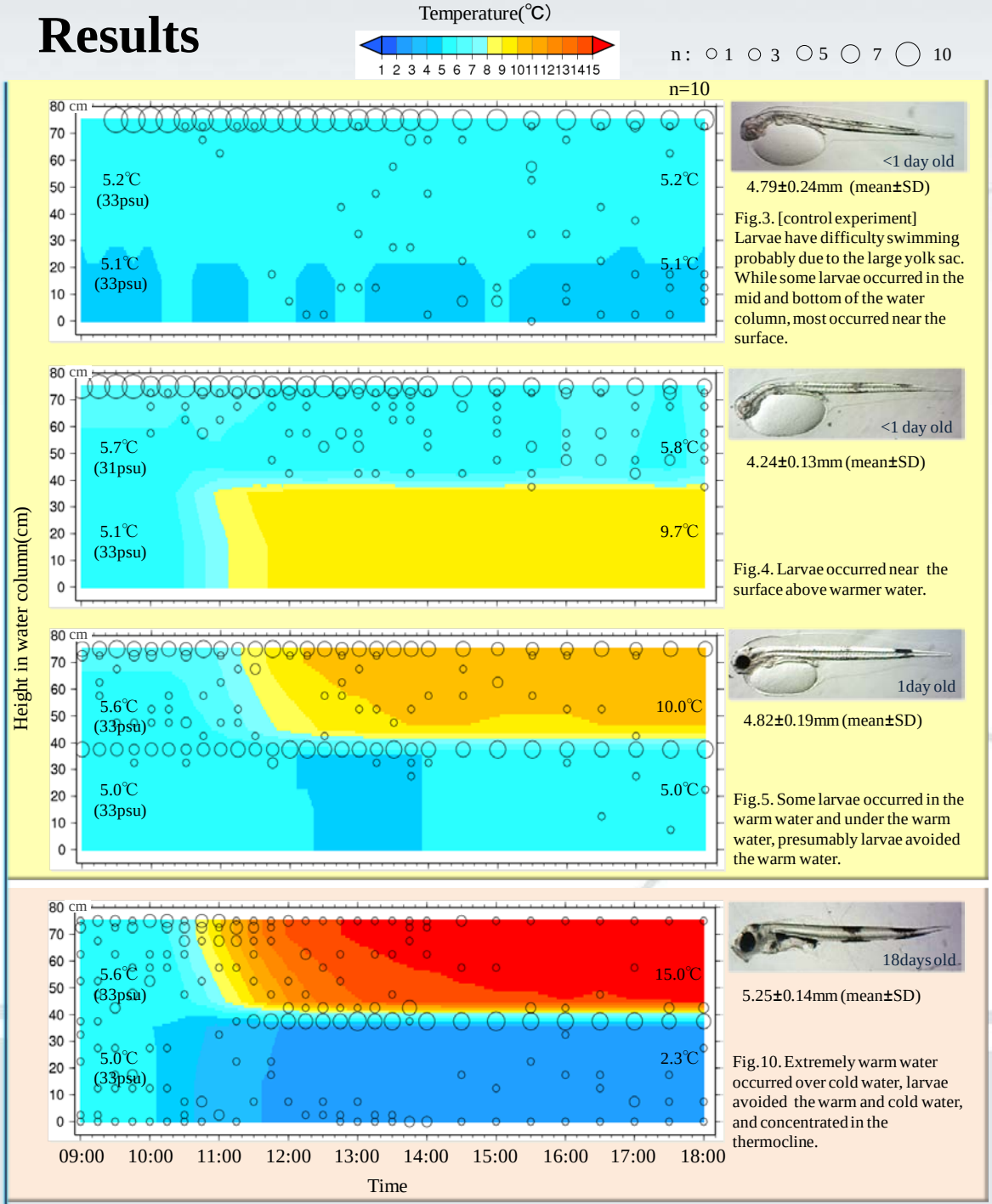


Fig.3. [control experiment] Larvae have difficulty swimming probably due to the large yolk sac. While some larvae occurred in the mid and bottom of the water column, most occurred near the surface.

Fig.4. Larvae occurred near the surface above warmer water.

Fig.5. Some larvae occurred in the warm water and under the warm water, presumably larvae avoided the warm water.

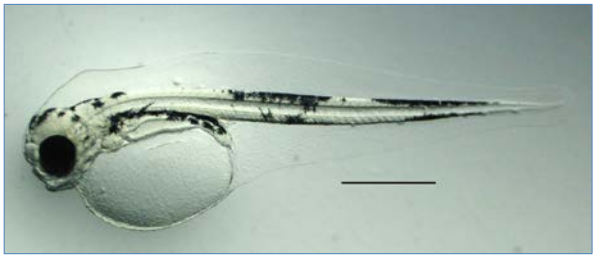
Fig.10. Extremely warm water occurred over cold water, larvae avoided the warm and cold water, and concentrated in the thermocline.

An example results of the thermocline experiments of walleye pollock larvae

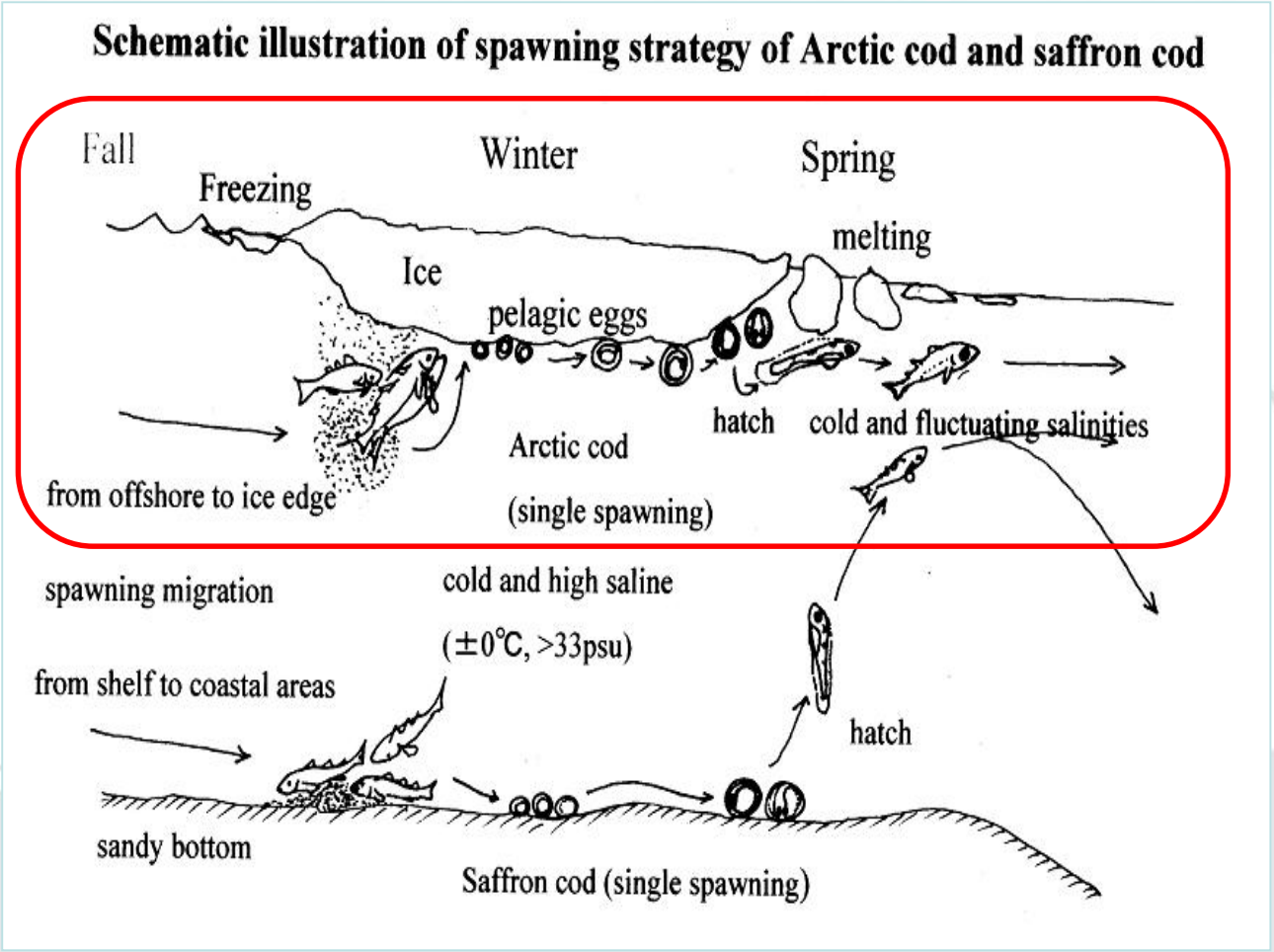
larvae≤1 day old showed less vertical change than older larvae

larvae≤15 days old avoided warm and cold water, and selected near the thermocline

Ongoing experiments: the response of Arctic cod eggs and larvae to temperature and salinity change, which use the captive Arctic cod collected at the Chukchi Sea in the summer cruise 2013 by T/S Oshoro-maru, Hokkaido University.



Arctic cod egg and larva incubated at 0 °C, April 1, 2014



Japan Arctic Research Activities

ECOARCS/GRENE　project：

Future plan (2017-）is under consideration

JAMSTEC and Hokkaido Univ.