Past, present and future of Japanese common squid, *Todarodes pacificus* (Cephalopoda: Ommastrephidae)

俵屋宗達作
『風神雷神図屏風』

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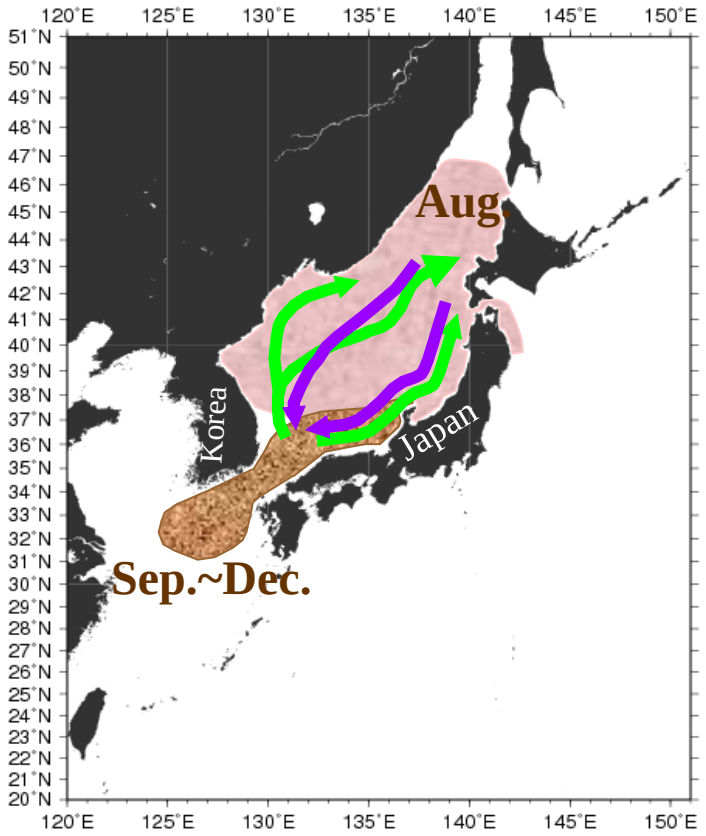
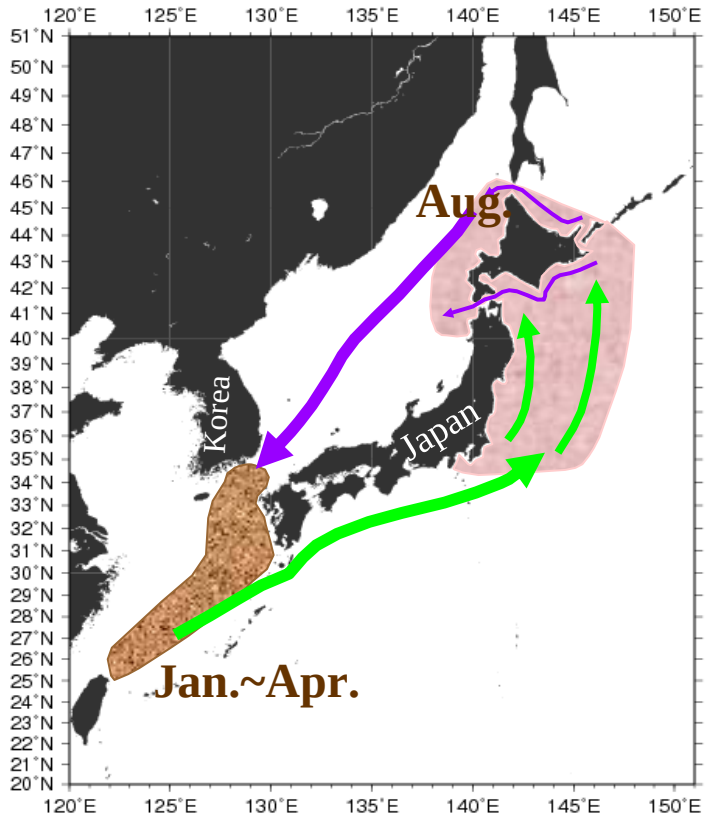
3 annual cohorts: autumn, winter and summer

Autumn



Winter



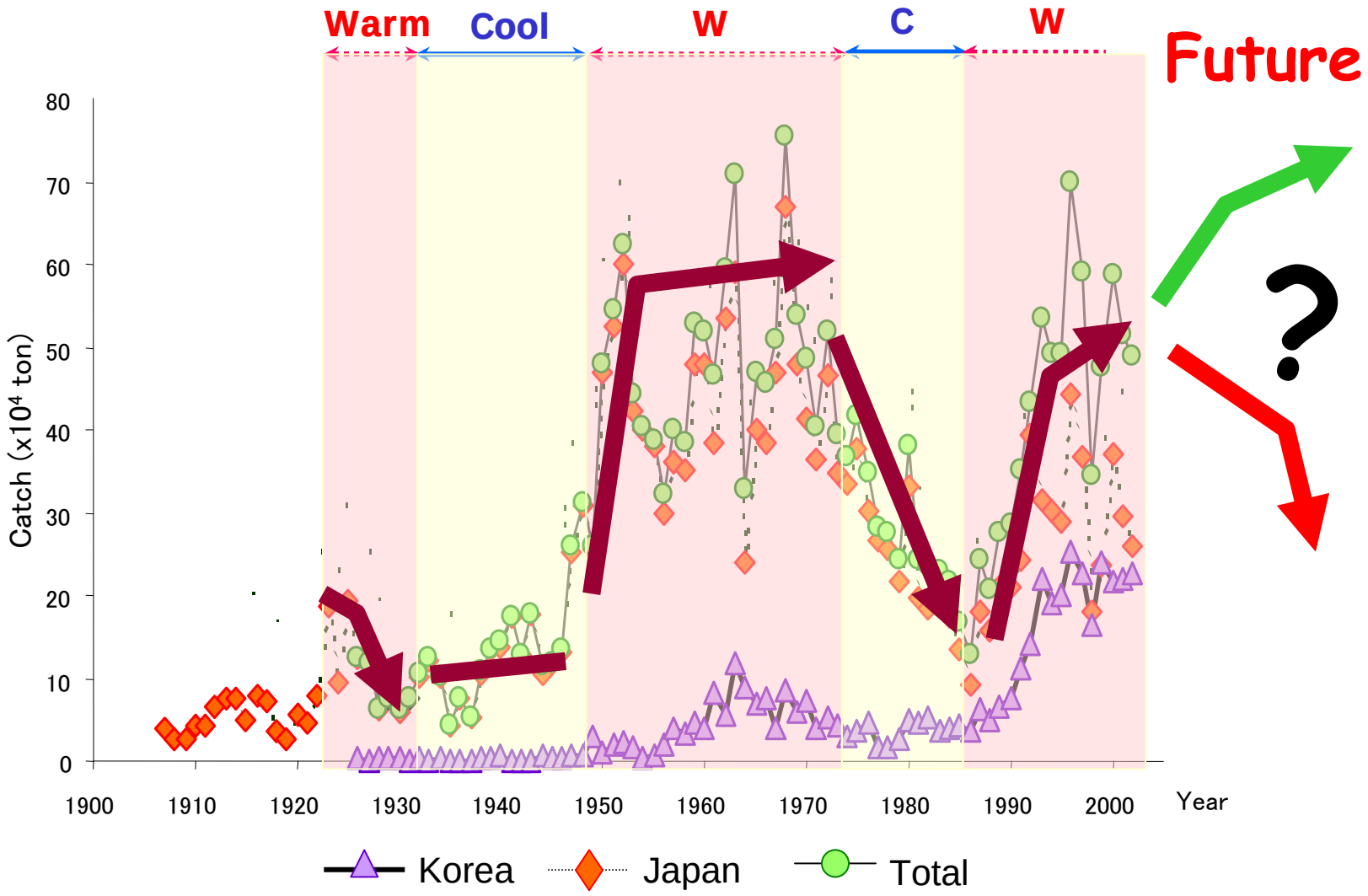
Spawning ground

Feeding migration

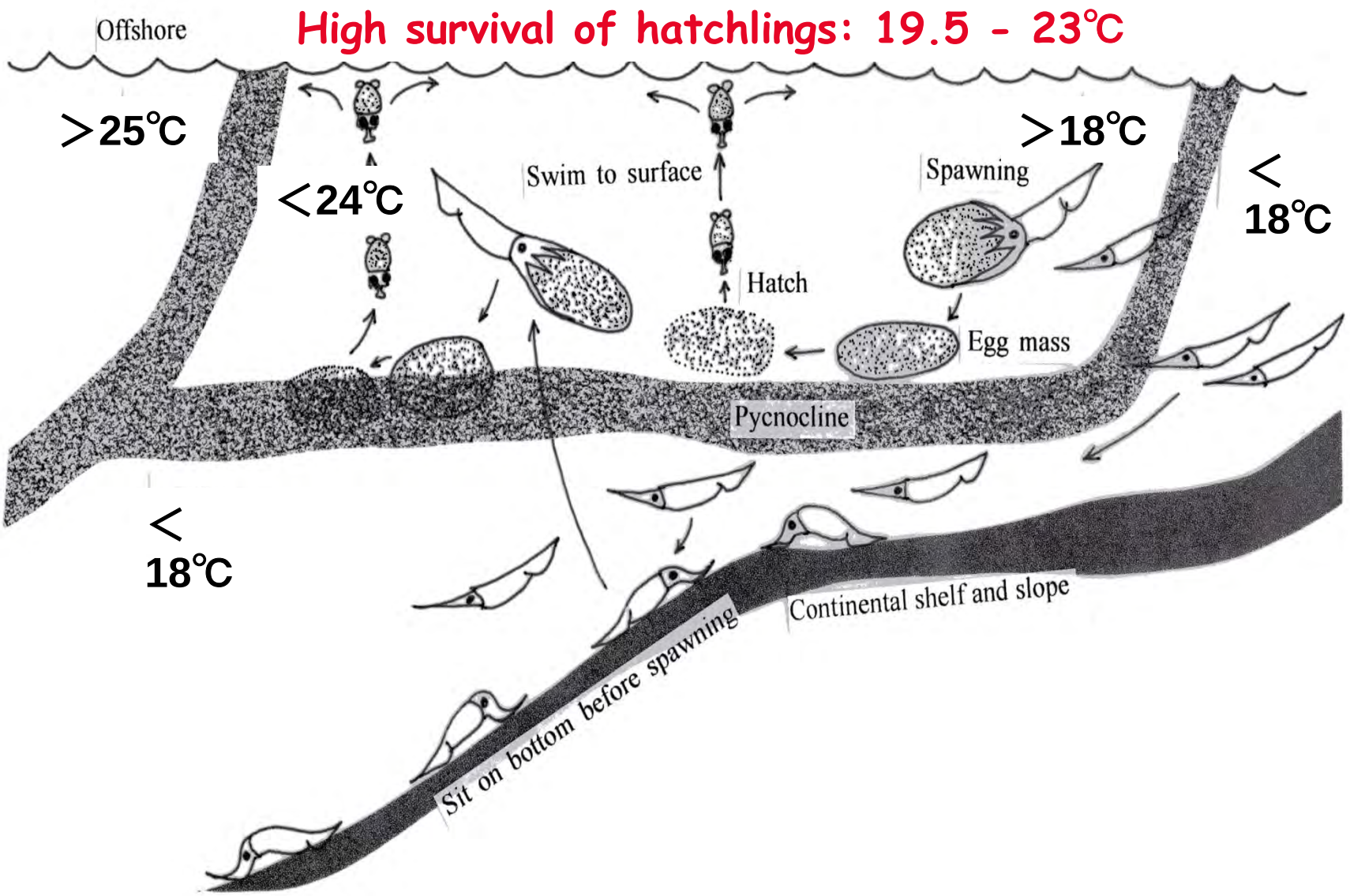
Spawning migration

Feeding ground

Past and present Commercial Catch of *T. Pacificus*

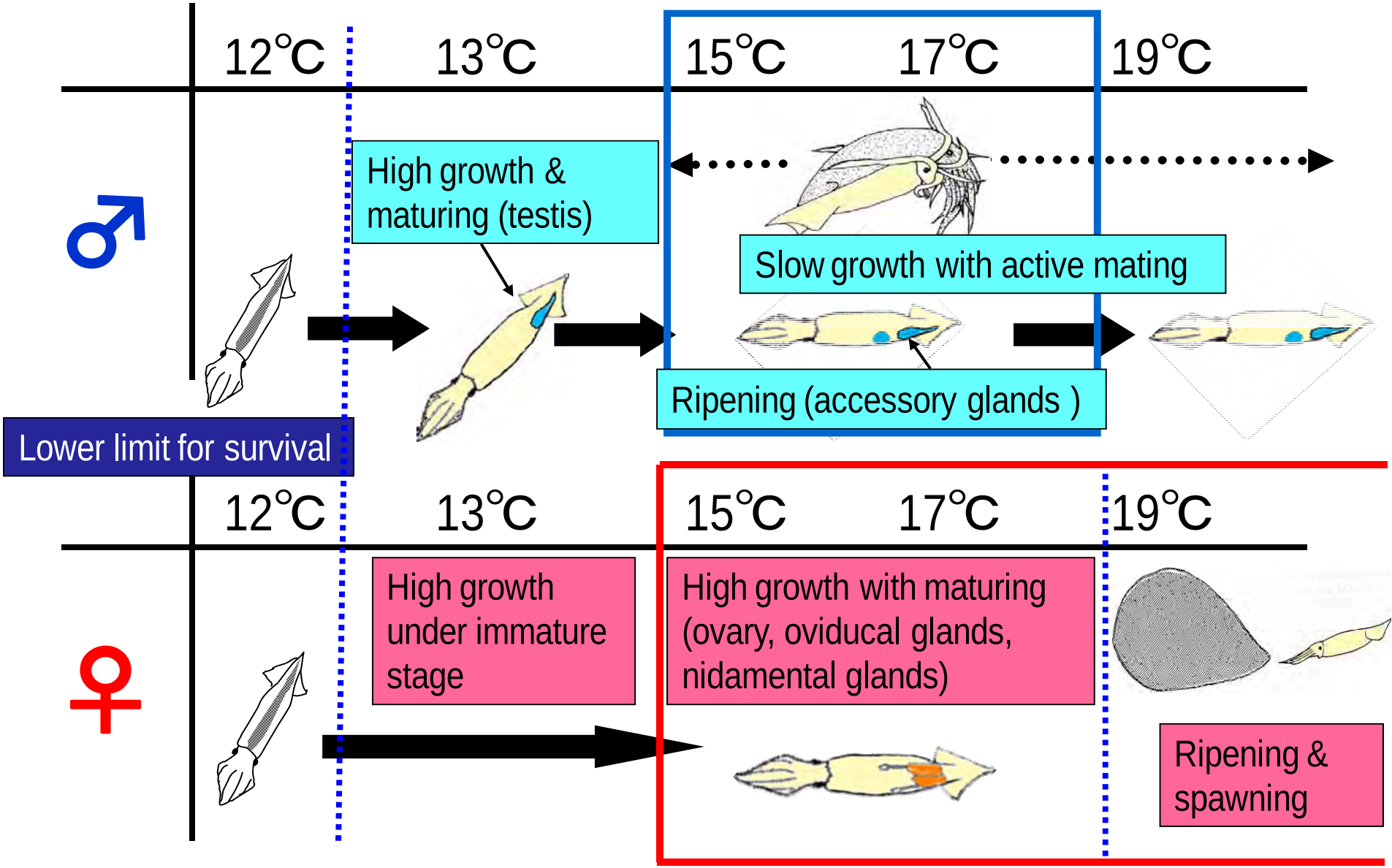


(Adapted from Sakurai, 2001)

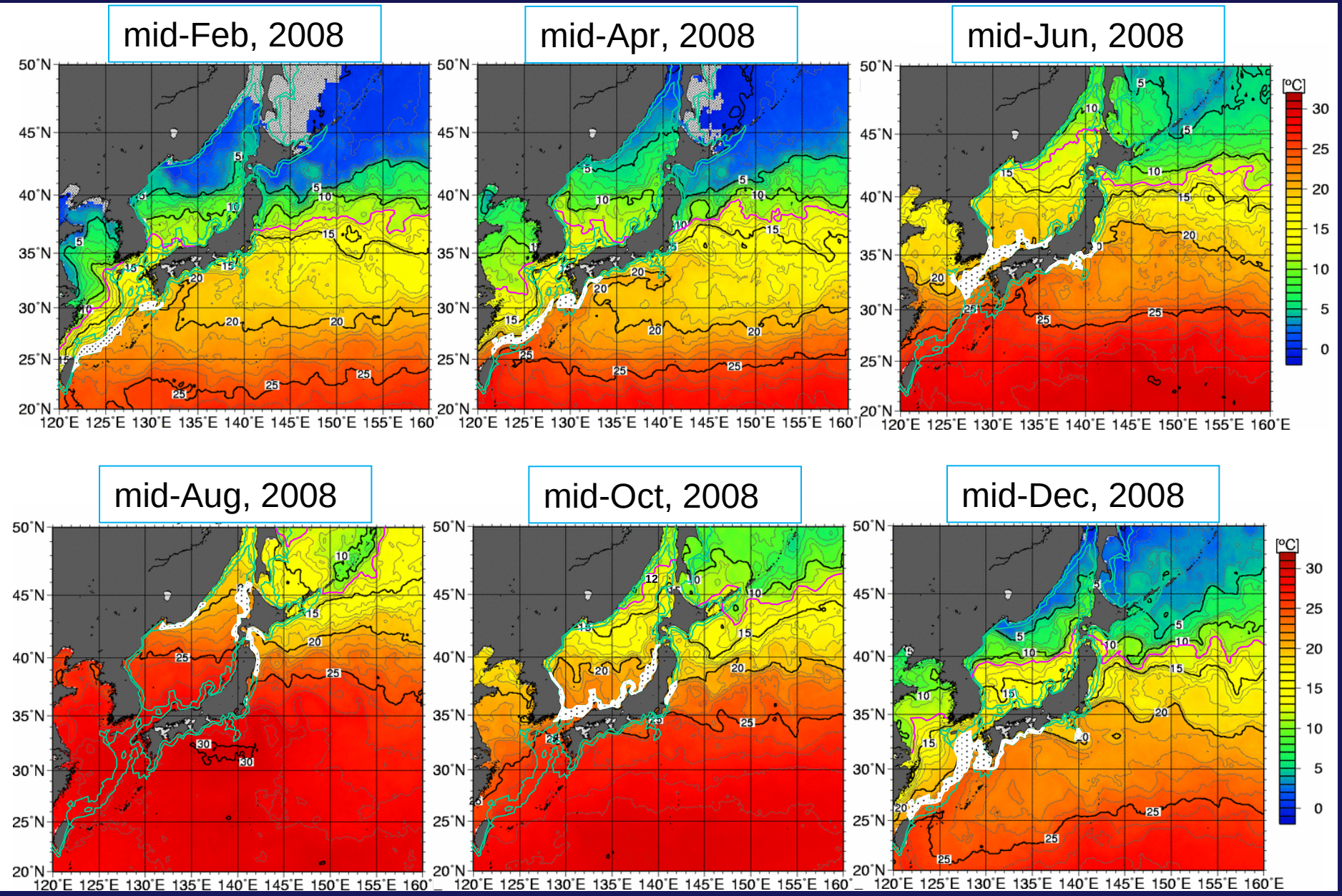


Schematic view of reproductive processes of Japanese common squid, *T. pacificus*

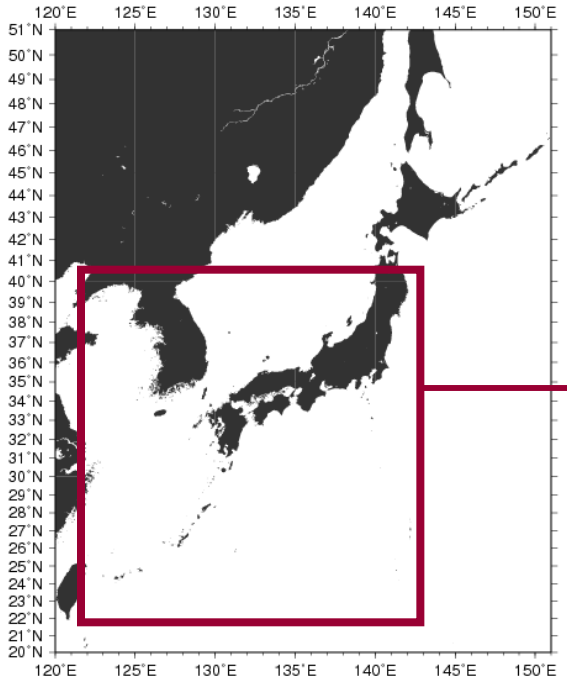
Summary of effects of different temperature to growth and maturation of *T. pacificus* by captive experiments during 2006–2009 (p.c. Sakurai)



Seasonal shifts of inferred spawning areas and northern limit of feeding areas

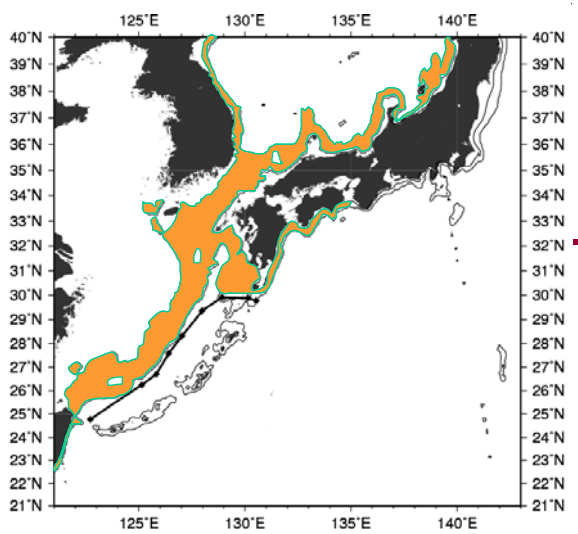


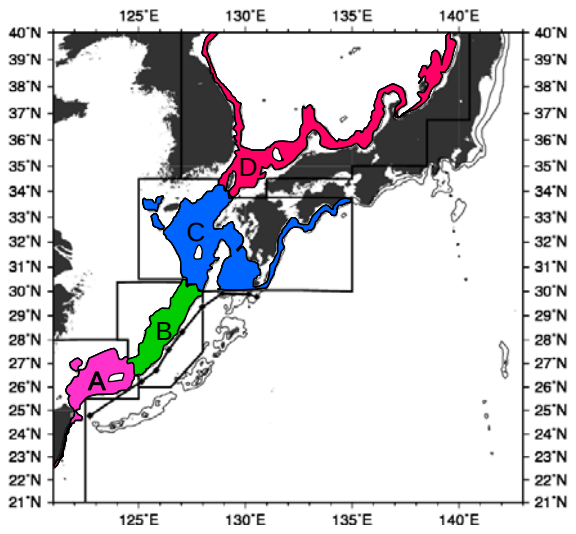
Data and Methodology



21°-40°N

121-143°E





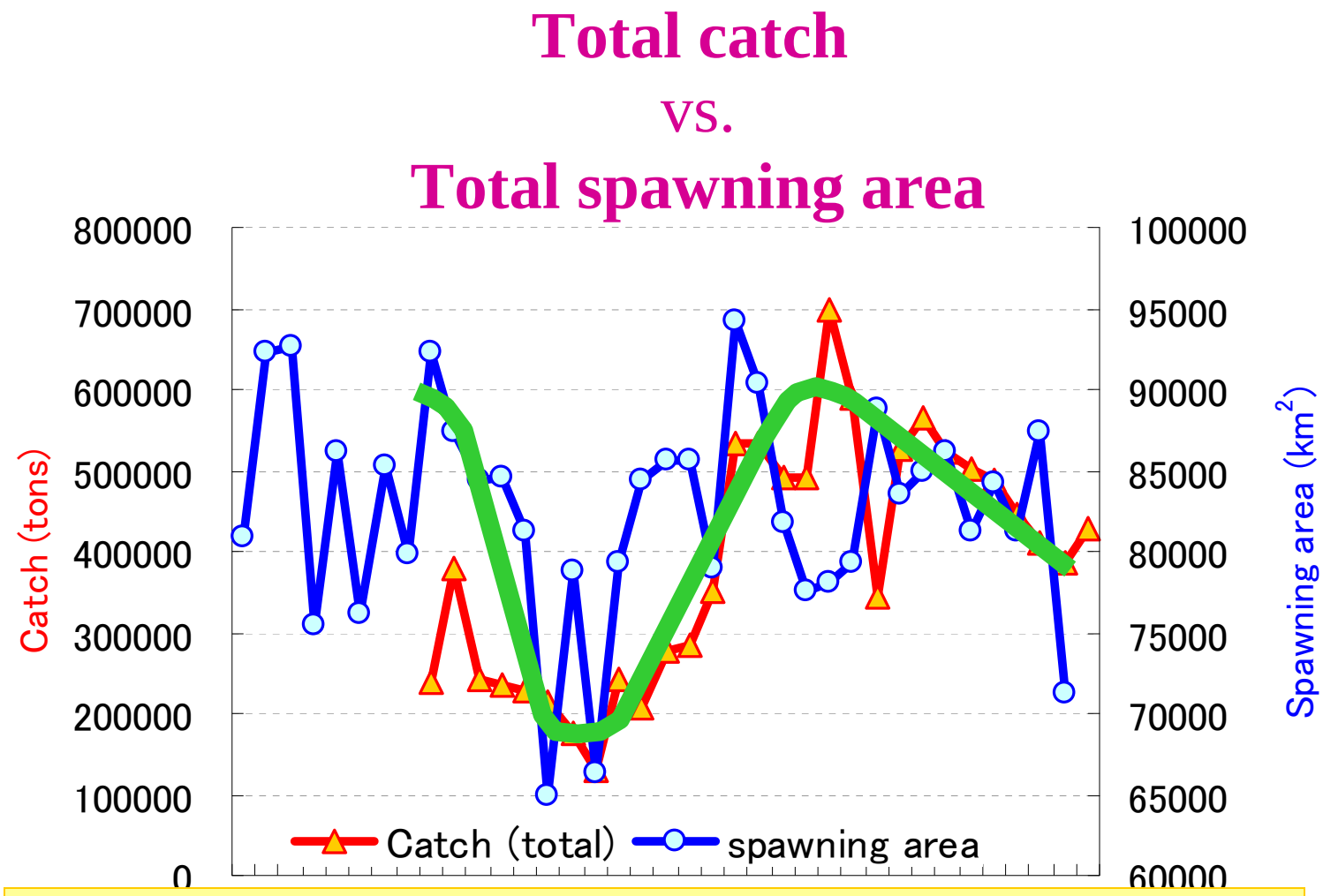
- 100-500m depth range
- 19.5<SST<23°C

  (JMA; 1x1°-1970~84; 0.25x0.25°-1985~06)
- Kuroshio axis

  (mean position as defined by Yamashiro *et al.*,1993)
- Japanese and Korean commercial catch

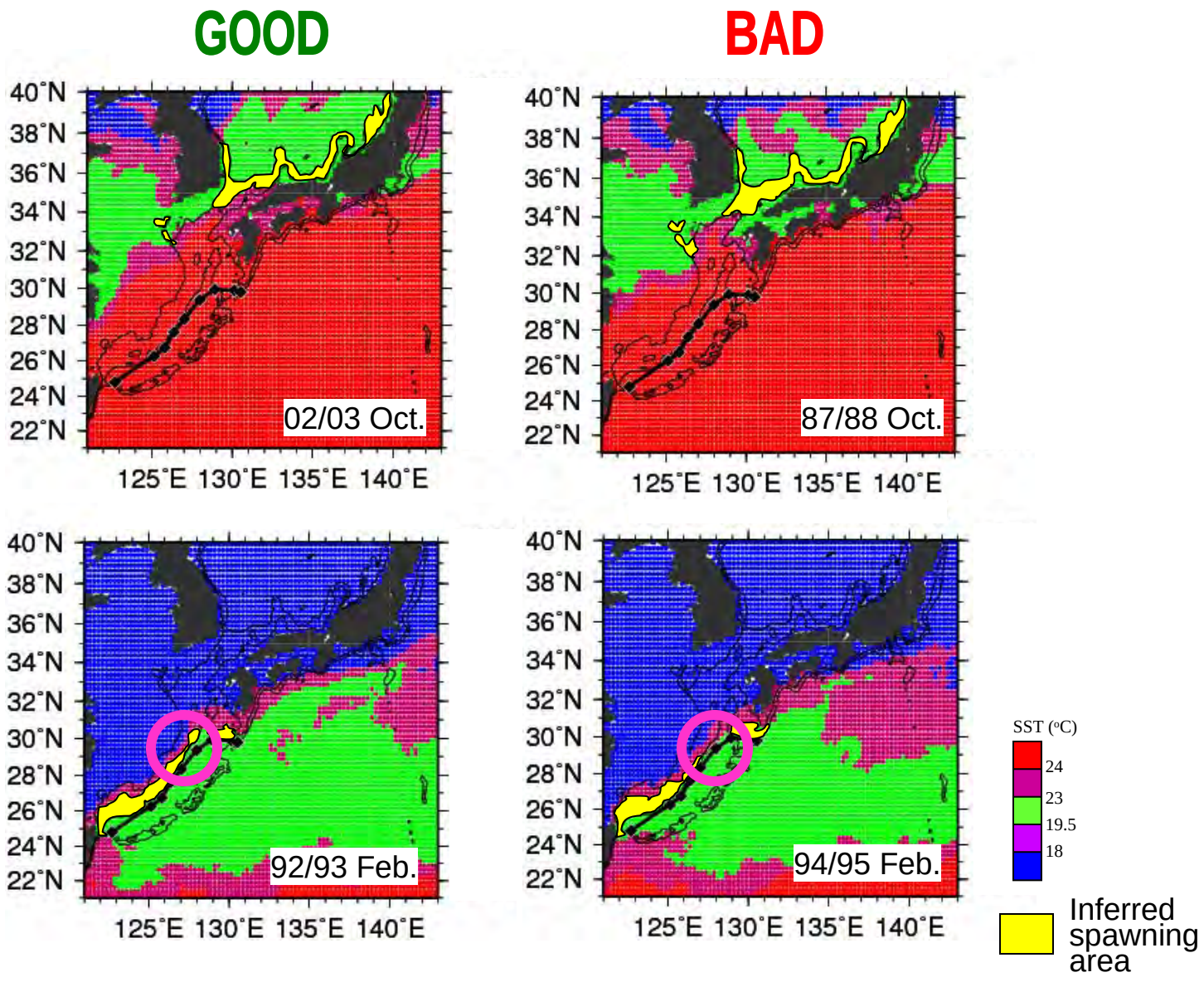
  (monthly; 1979~2007; source: JMA)

Results$_1$

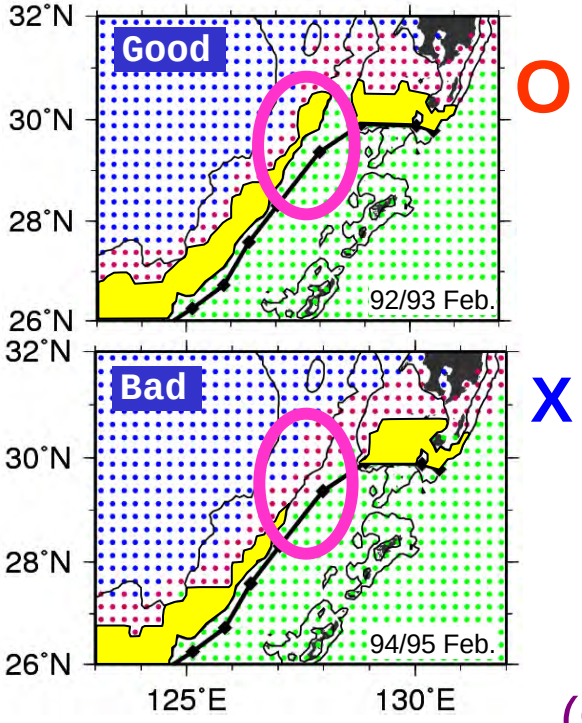


The spawning ground geometrical area and total catch present similar long-term pattern

Results$_2$


GOOD
BAD
Autumn cohort
Winter cohort
40°N
38°N
36°N
34°N
32°N
30°N
28°N
26°N
24°N
22°N
125°E 130°E 135°E 140°E
02/03 Oct.
87/88 Oct.
92/93 Feb.
94/95 Feb.
SST (°C)
24
23
19.5
18
Inferred spawning area

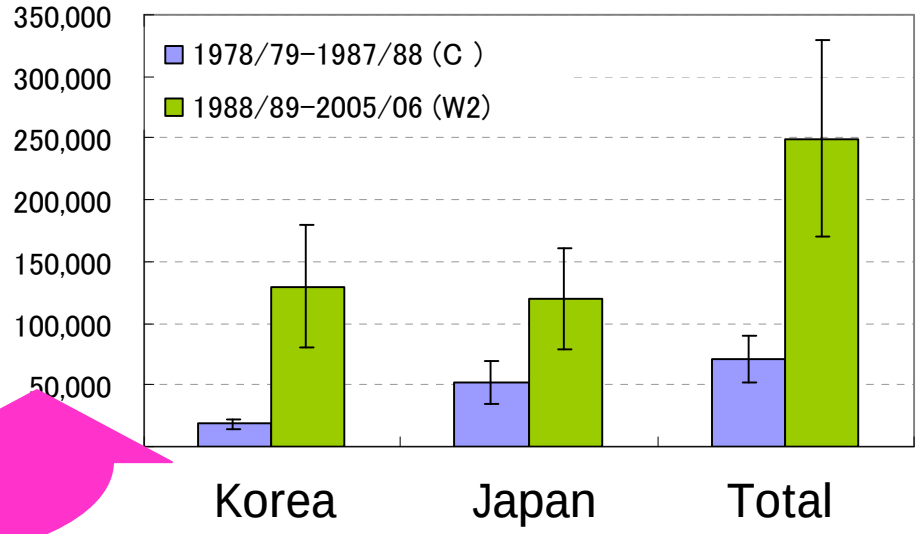
Results$_3$

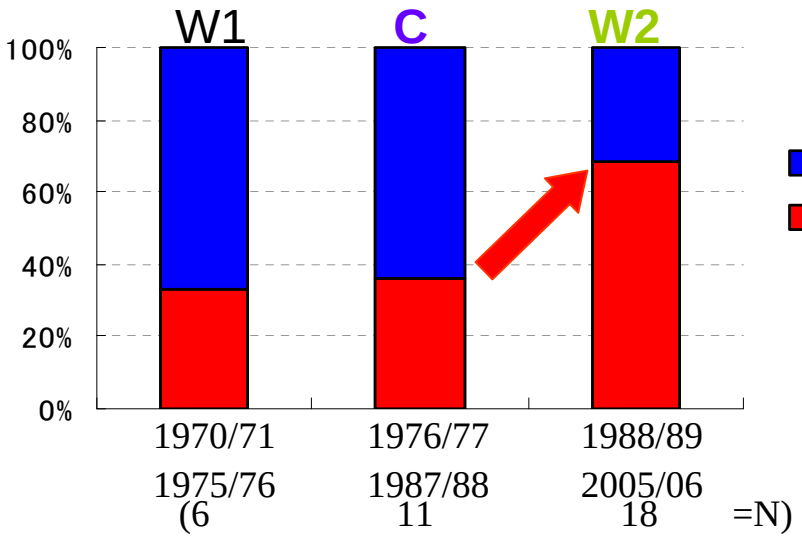


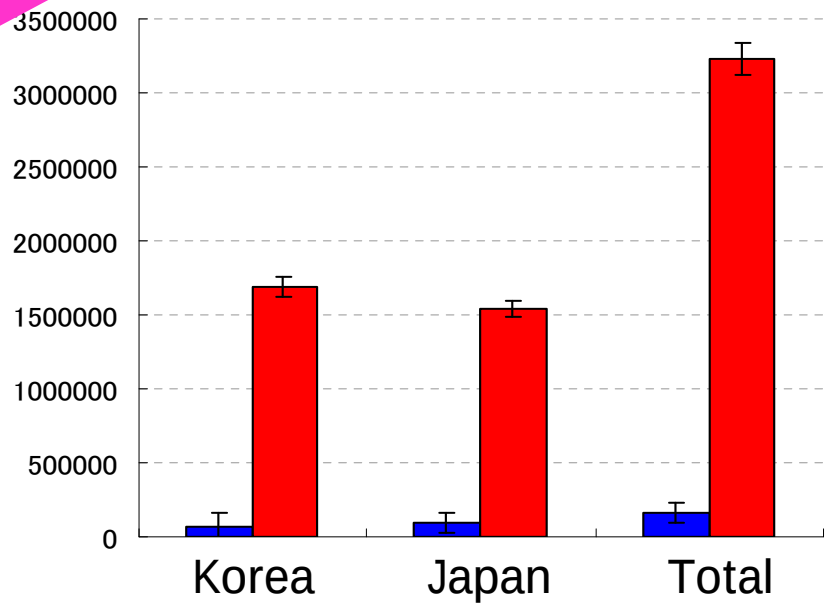
O

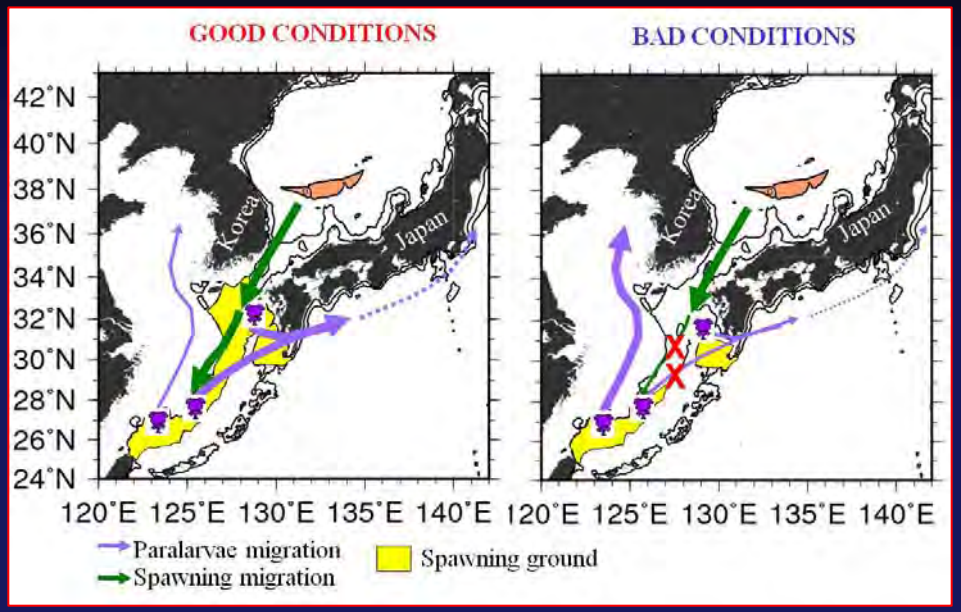
X

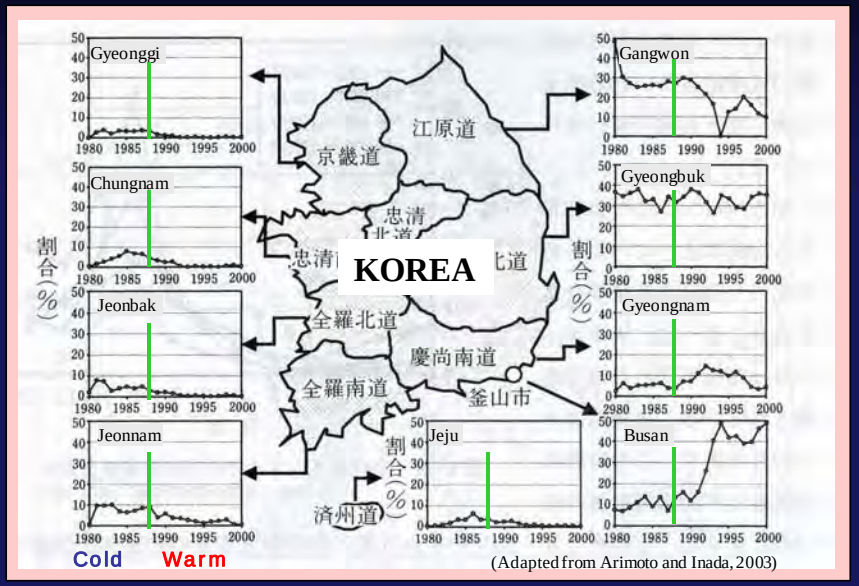
Winter cohort catch (Oct.~Jan.)

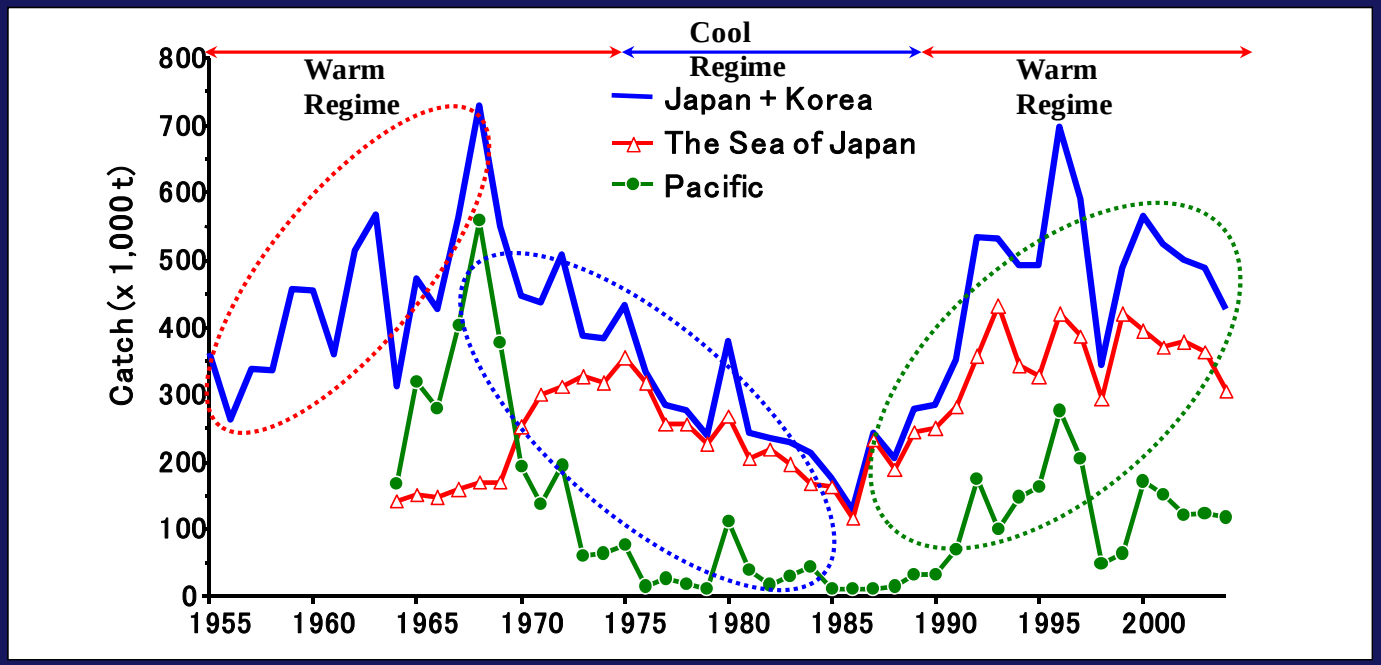






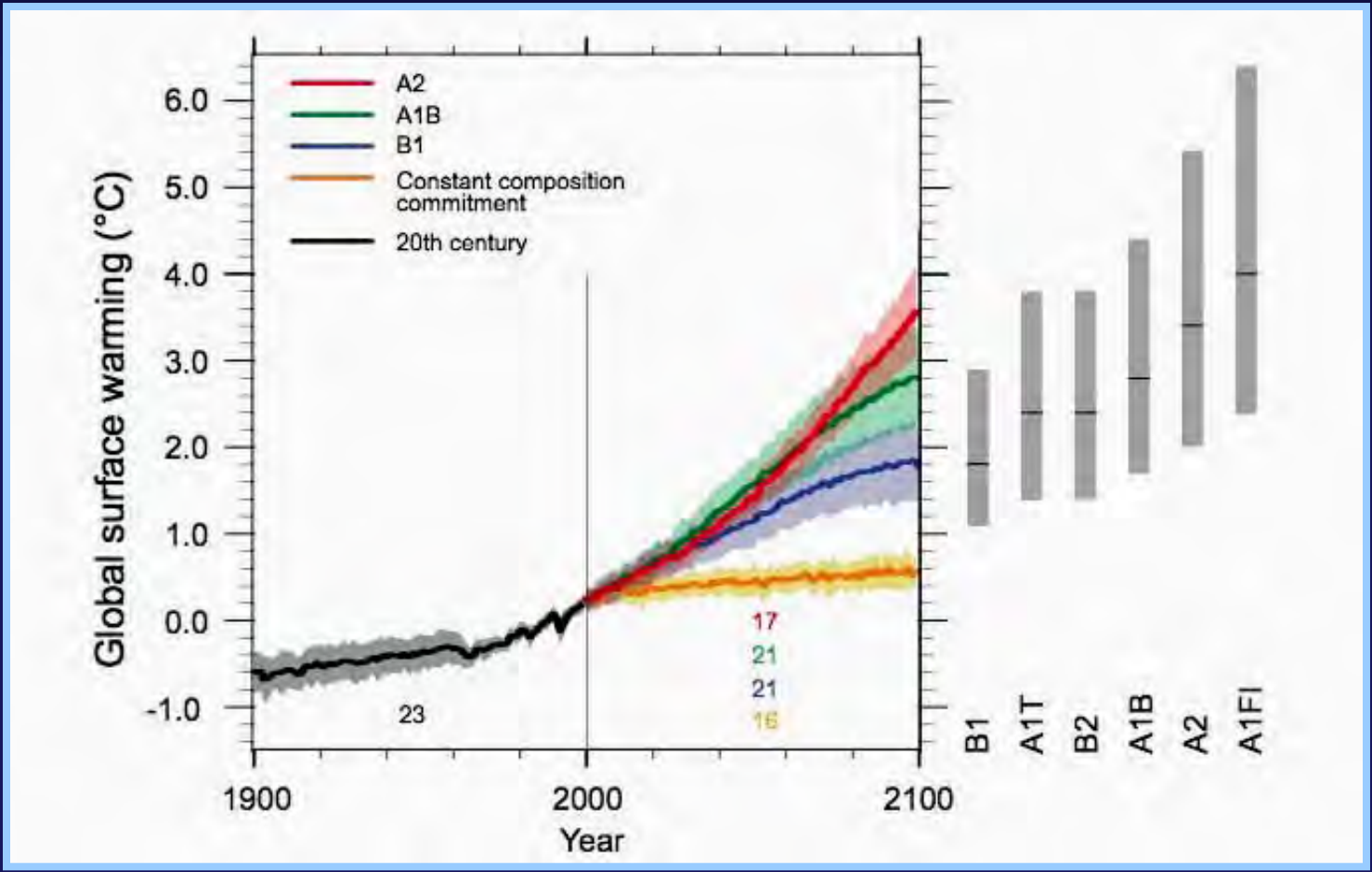






Annual fluctuation in common squid, *T. pacificus* catches of Korea and Japan during 1955 - 2004. (Data derived from the Japan Sea Research Institute, Japan and the National Fisheries Research and Development Institute, Korea).

IPCC WG1 AR4 highlights



- For the next two decades, a warming of about 0.2˚ C per decade is projected for a range of SRES emission scenarios.
- Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1˚ C per decade would be expected.
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century.

○ Qualification of distribution and spawning areas, *Todarodes pacificas* （Nakazima & Kishi, 2007）

Distribution: Topography & SST：cell ranged between 12～23℃ except for Kuroshio Current and the subtropic ocean each
-January to December：at each month -Topography： each cell including water

Inferred spawning area: above 100～500m bottom depth along the coast (yellow cell in the figure)
-SST：18～24℃
-January to December：at each month

Figure in each cell indicates the maximum depth.
Green cell: land area, yellow cell: inferred spawning area,
red cell: disappeared distribution area with global warming

-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	170	-100	-100	-100	600	1900	1900	2150	2150	2650	2650	2650	2150	2900
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	250	-100	250	100	1100	2650	2650	2650	2650	2650	2650	2650	3400	4150
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	750	750	-100	1650	2650	2650	2900	2900	2900	2900	2900	3400	3400	4150	4900
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	1050	900	-100	-100	-100	2650	2650	2900	2900	2900	2900	3400	4150	4150	4900	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	1650	1650	1200	-100	-100	1650	2650	2650	2900	2900	-100	3400	4150	4900	4900	5400	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	2650	2650	2650	1400	-100	-100	-100	2150	2150	-100	-100	4150	4150	4900	5400	5400	5400	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	2900	2900	2900	2650	-100	-100	-100	-100	-100	-100	3650	4150	5150	5150	5400	5400	5400	5400	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	2900	2900	3400	3400	3400	-100	-100	-100	-100	-100	-100	3500	4900	5150	5400	5400	5400	5400	5400	5400	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	2650	3400	3400	3400	3400	3400	3400	3400	3400	2900	-100	500	500	4900	5150	5150	5400	5400	5400	5400	5400	5400	5400	5400	5400
-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	2900	3400	3400	3400	3400	3400	3400	3400	3400	2650	-100	-100	1750	4900	5150	5150	5400	5400	5400	5400	5400	5400	5400	5400	5400
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55	55	65	65	65	65	-100	-100	-100	-100	900	900	-100	-100	-100	-100	-100	-100	-100	-100	-100	4900	4900	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400
55	55	65	65	75	75	-100	-100	-100	250	400	-100	-100	-100	-100	-100	-100	-100	-100	600	5150	5150	5150	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400
-100	55	65	75	85	85	-100	120	120	-100	-100	-100	-100	-100	-100	-100	3400	3400	3400	3400	5150	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5400
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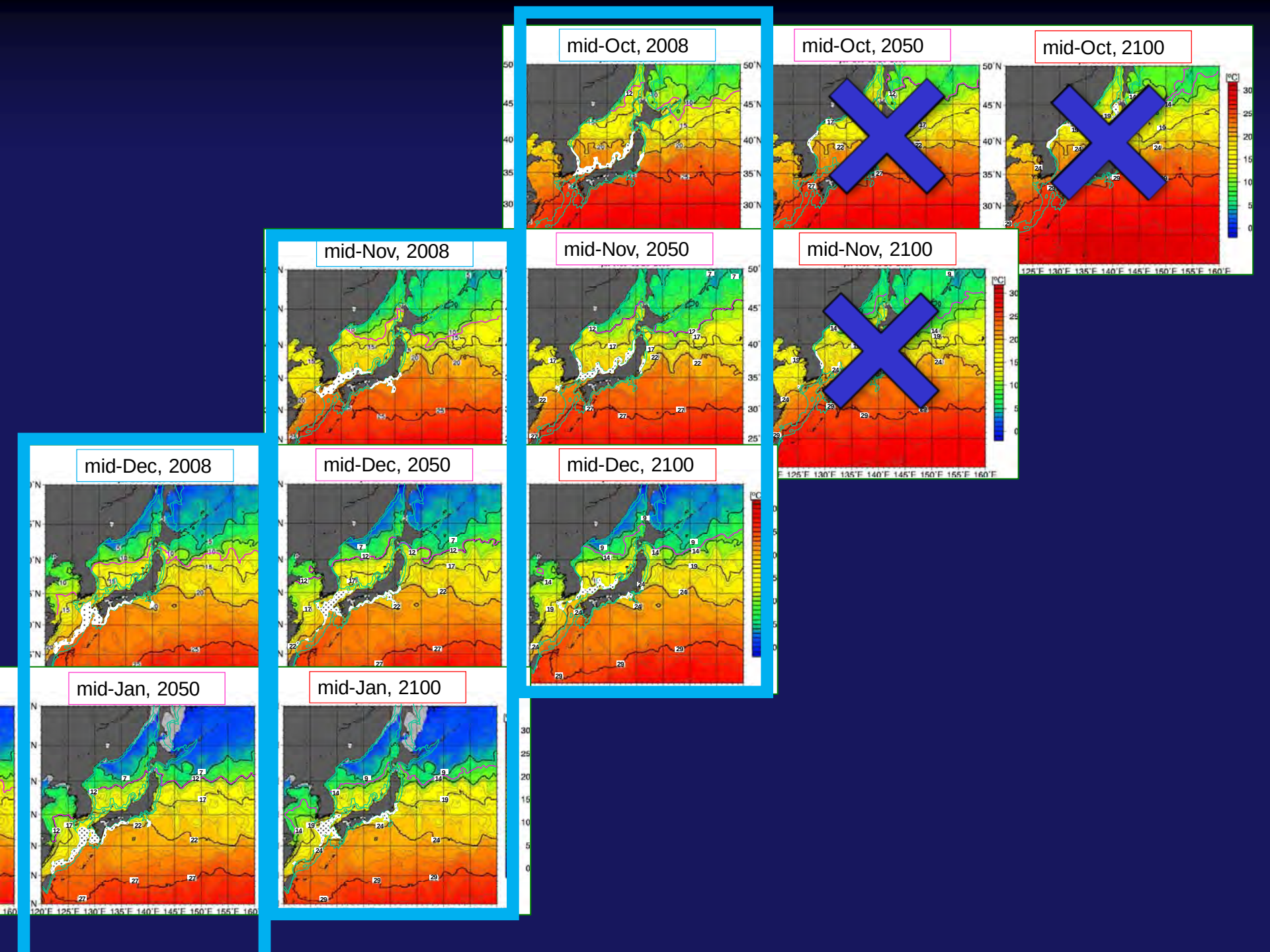
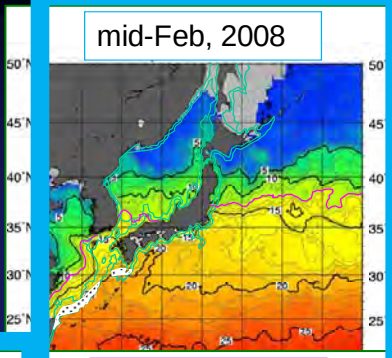
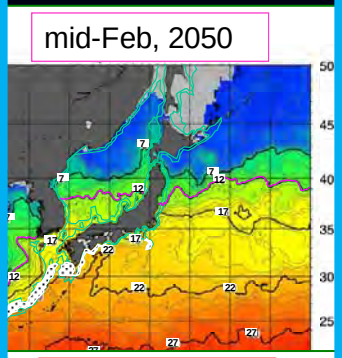
750	-100	1650	2150	2900	2900	3900	4900	4900	4900	4900	4900	4900	4900	4900	4900	4900	4900	4900	4900	3900	3650	3650	4900	5150	5150	5400	5400	5400	5400	5400	5400	5400	5400	5400

Inferred spawning areas of *Todarodes pacifica* is limited by the bottom depth of continental self and slope (100-500 m)


mid-Oct, 2008
mid-Oct, 2050
mid-Oct, 2100
mid-Nov, 2008
mid-Nov, 2050
mid-Nov, 2100
mid-Dec, 2008
mid-Dec, 2050
mid-Dec, 2100
mid-Jan, 2050
mid-Jan, 2100


mid-Feb, 2008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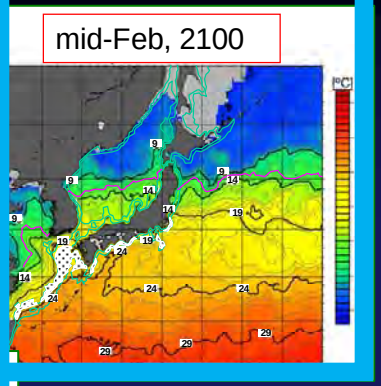
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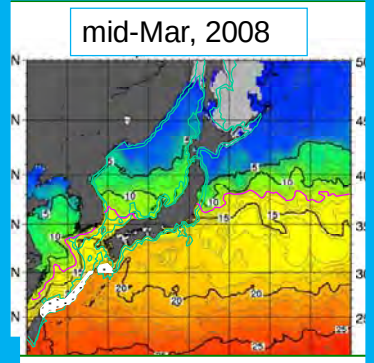
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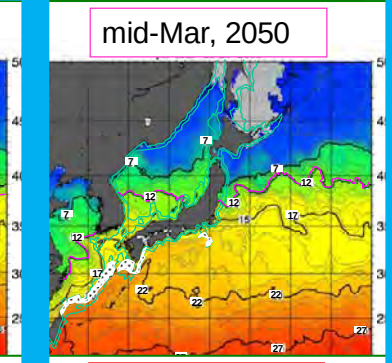
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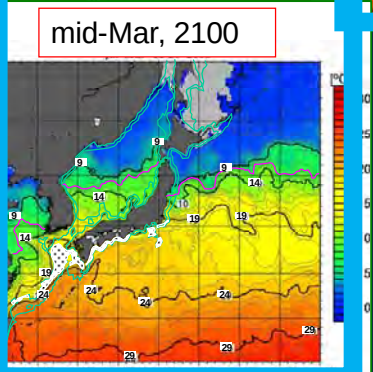
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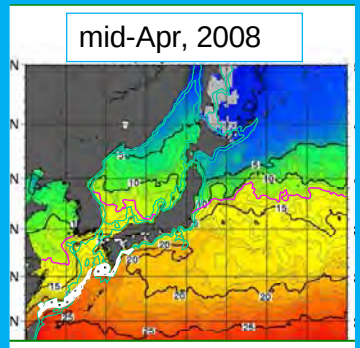
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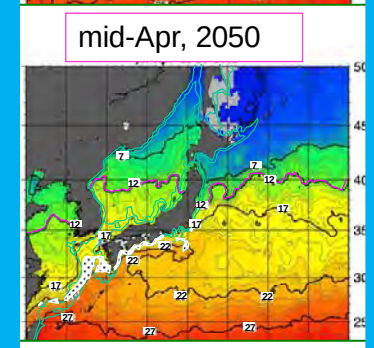
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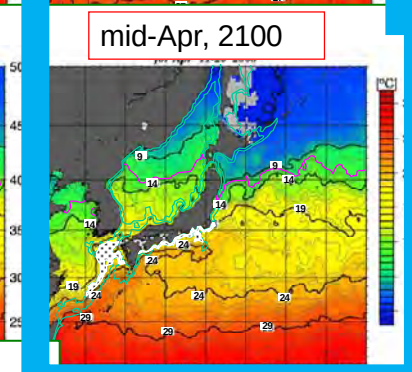
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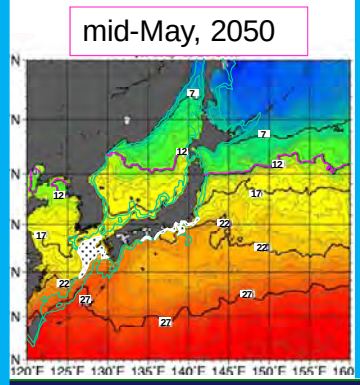
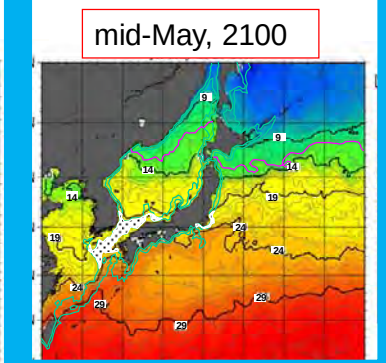
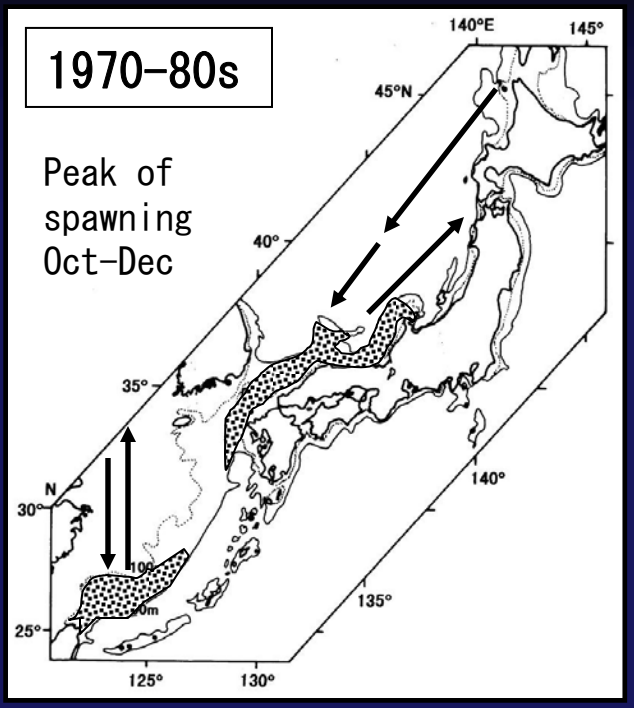
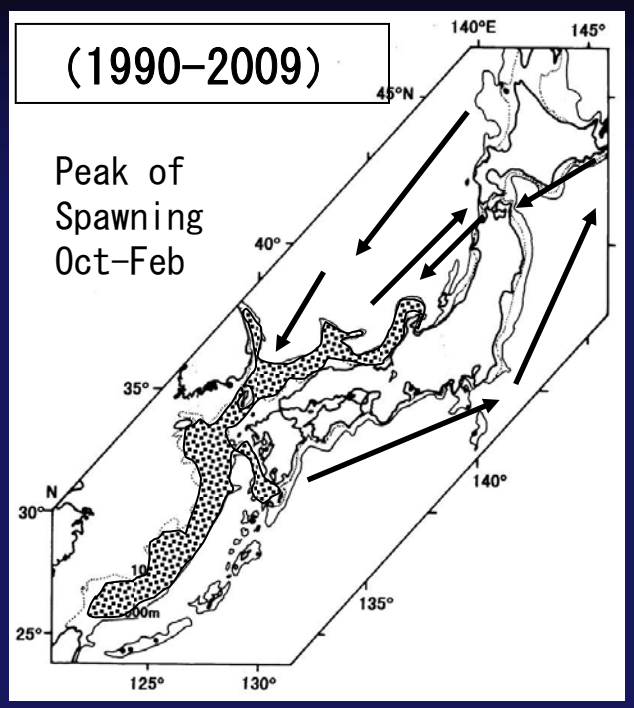
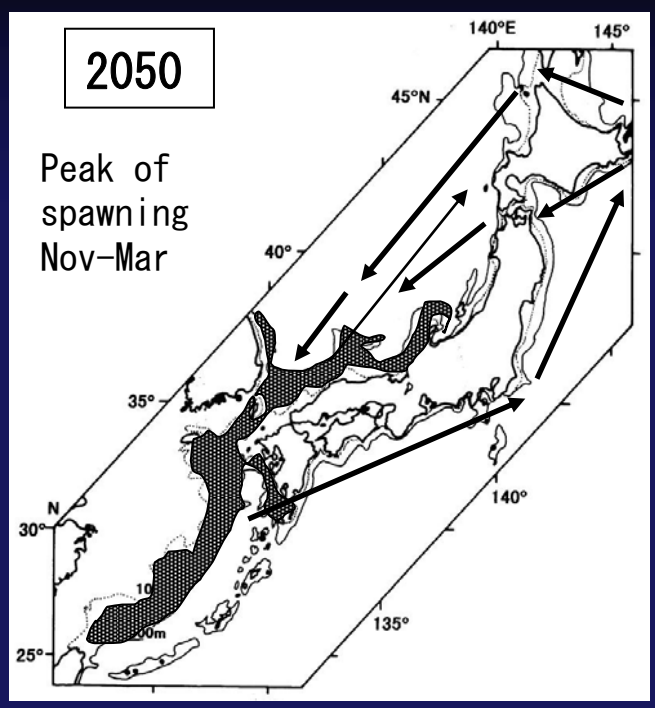
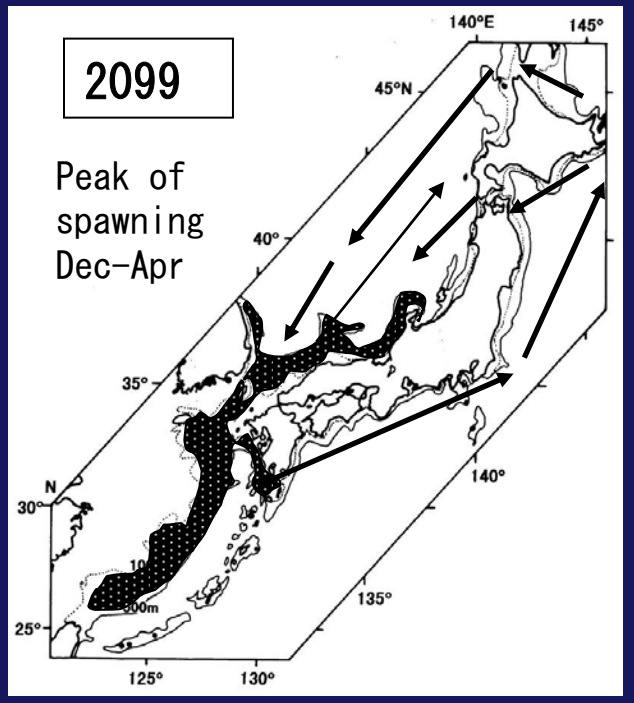

mid-May, 2050


mid-May, 2100

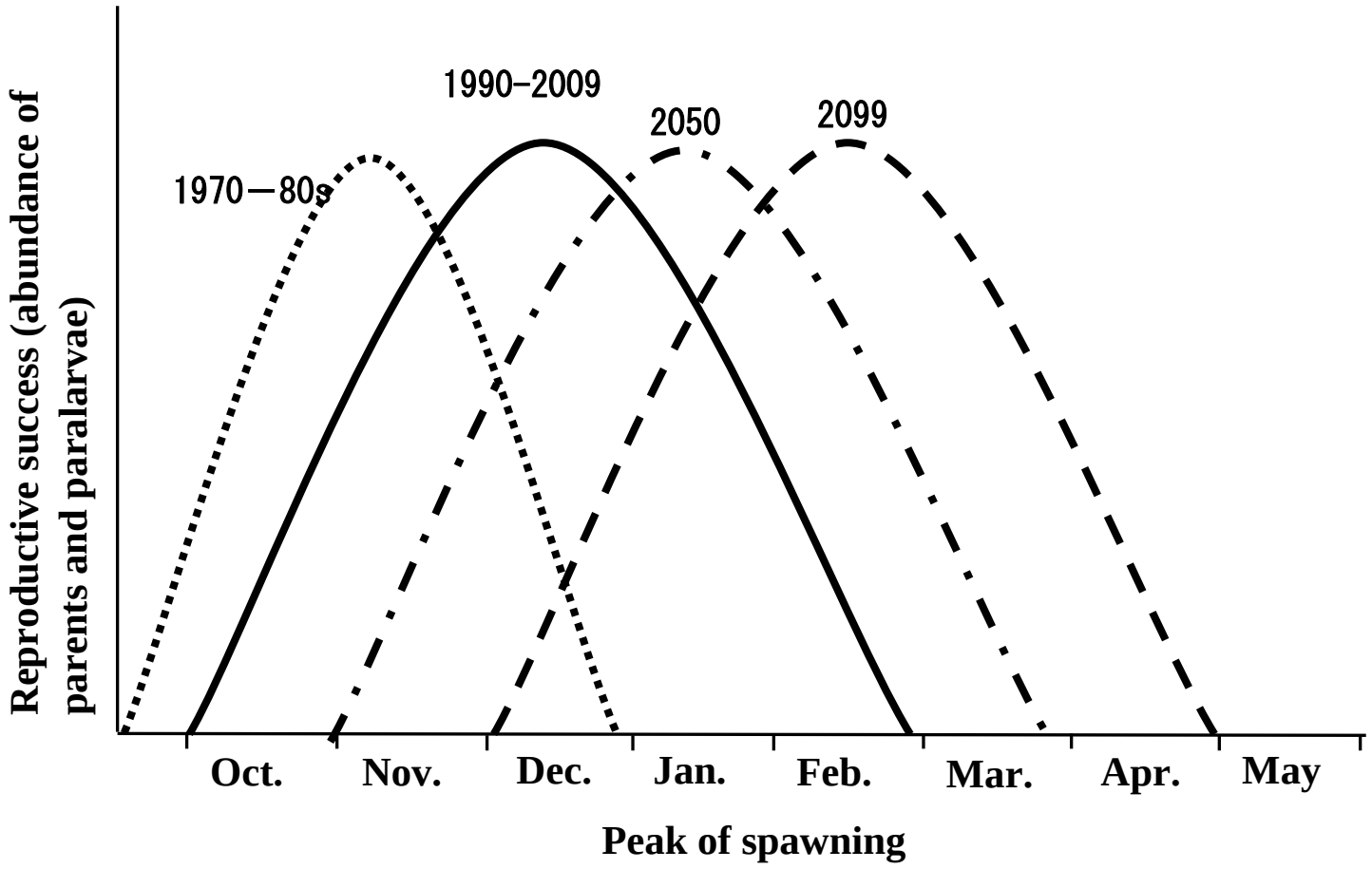








Predicted spawning periods, areas, and migration routes of *Todarodes pacificus* during 1970-80s(cool regime),1990-2009(warm regime), 2050(SST: 2℃ increase) 2099(SST: 4℃ increase). Estimated environmental changes in waters around Japan based on the IPCC global warming scenario (Kawamiya et al., 2007)



Predicted spawning periods of *Todarodes pacificus* during 1970-80s (cool regime), 1990-2005 (warm regime), 2050 (SST: 2℃ increase), 2099 (SST: 4℃ increase). Estimated environmental changes in waters around Japan based on the IPCC global warming scenario (Kawamiya et al., 2007)

Thanks from the squid!