

Survivals of Hokkaido chum salmon affected by coastal seawater temperatures during their early ocean life

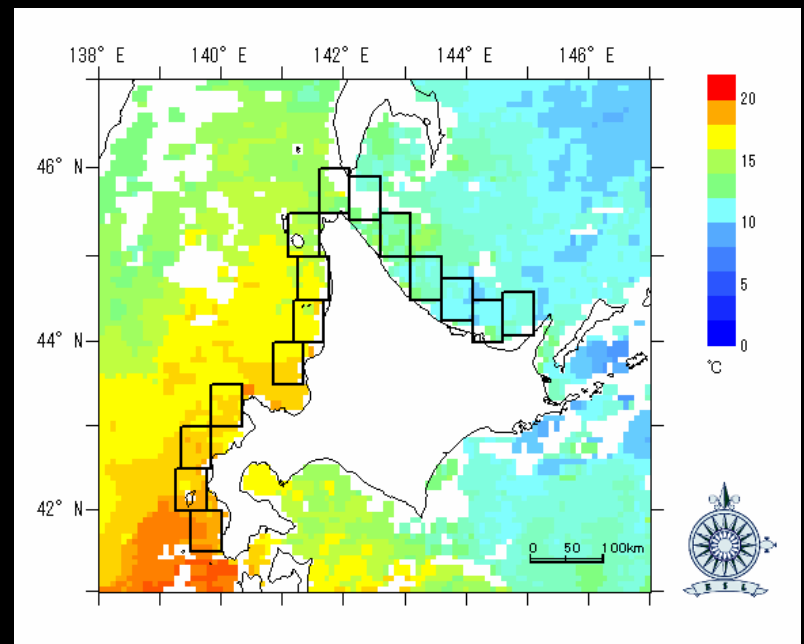
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¹East Research Branch, Hokkaido Fish Hatchery,

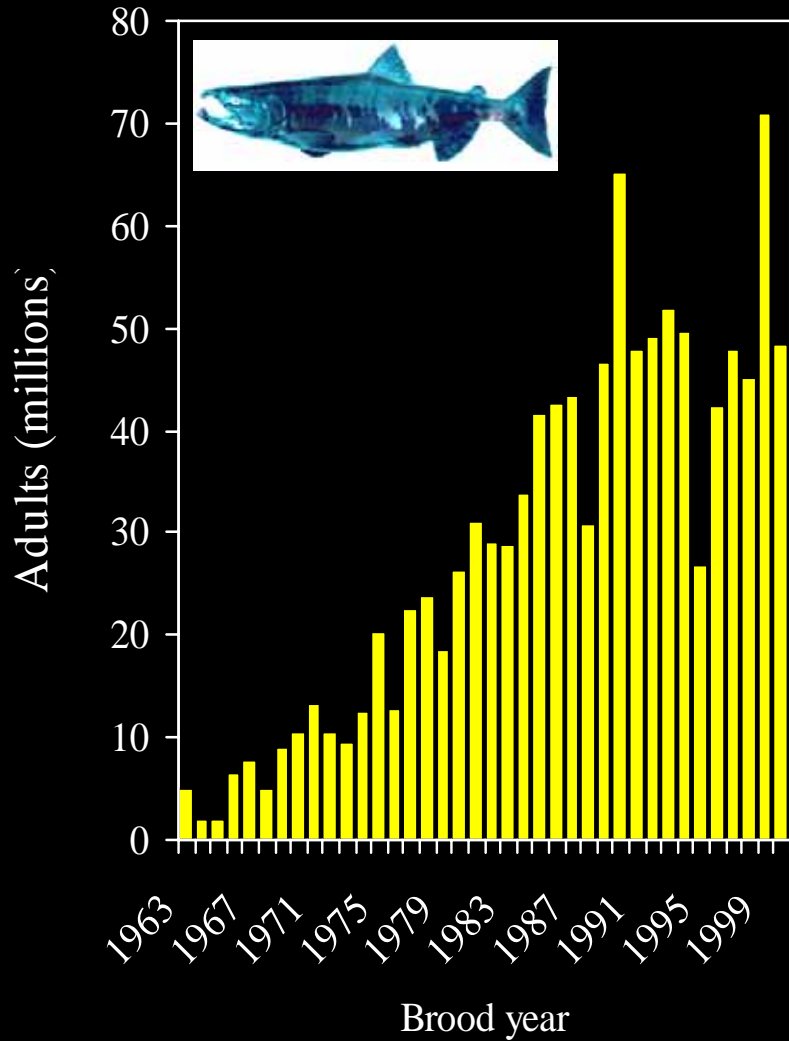
²Hokkaido Fish Hatchery,

³Kobe Marine Observatory JMA

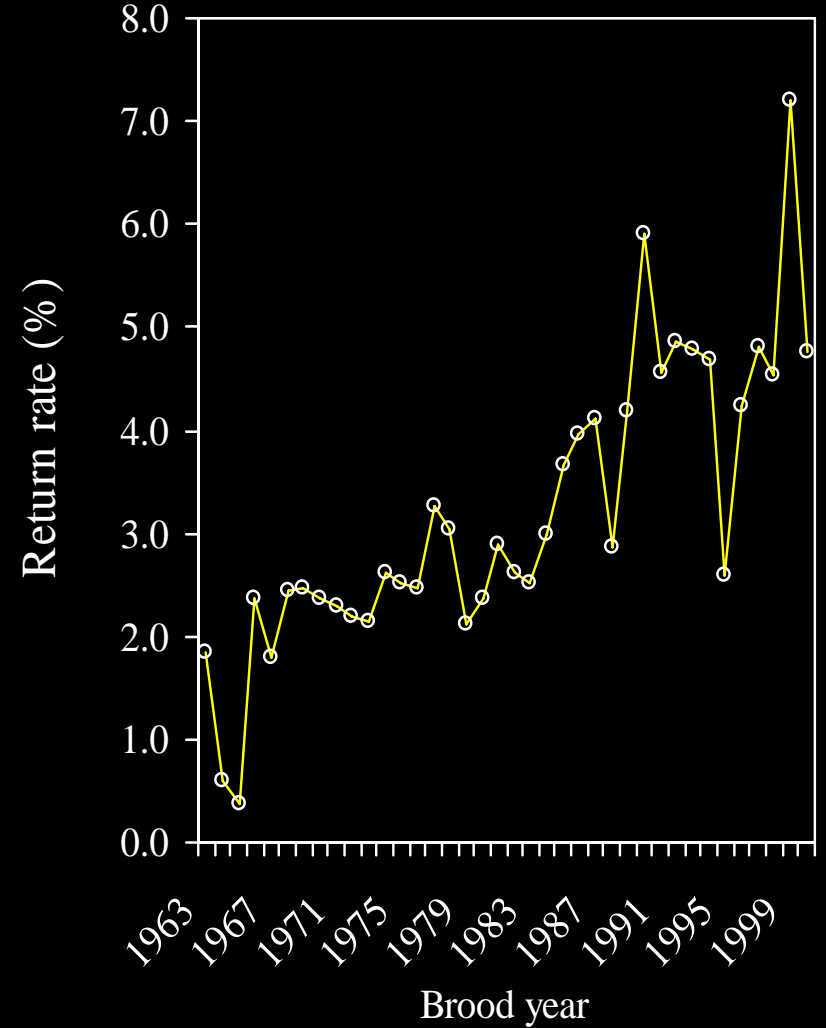
⁴Graduate School of Fisheries Science, Hokkaido University



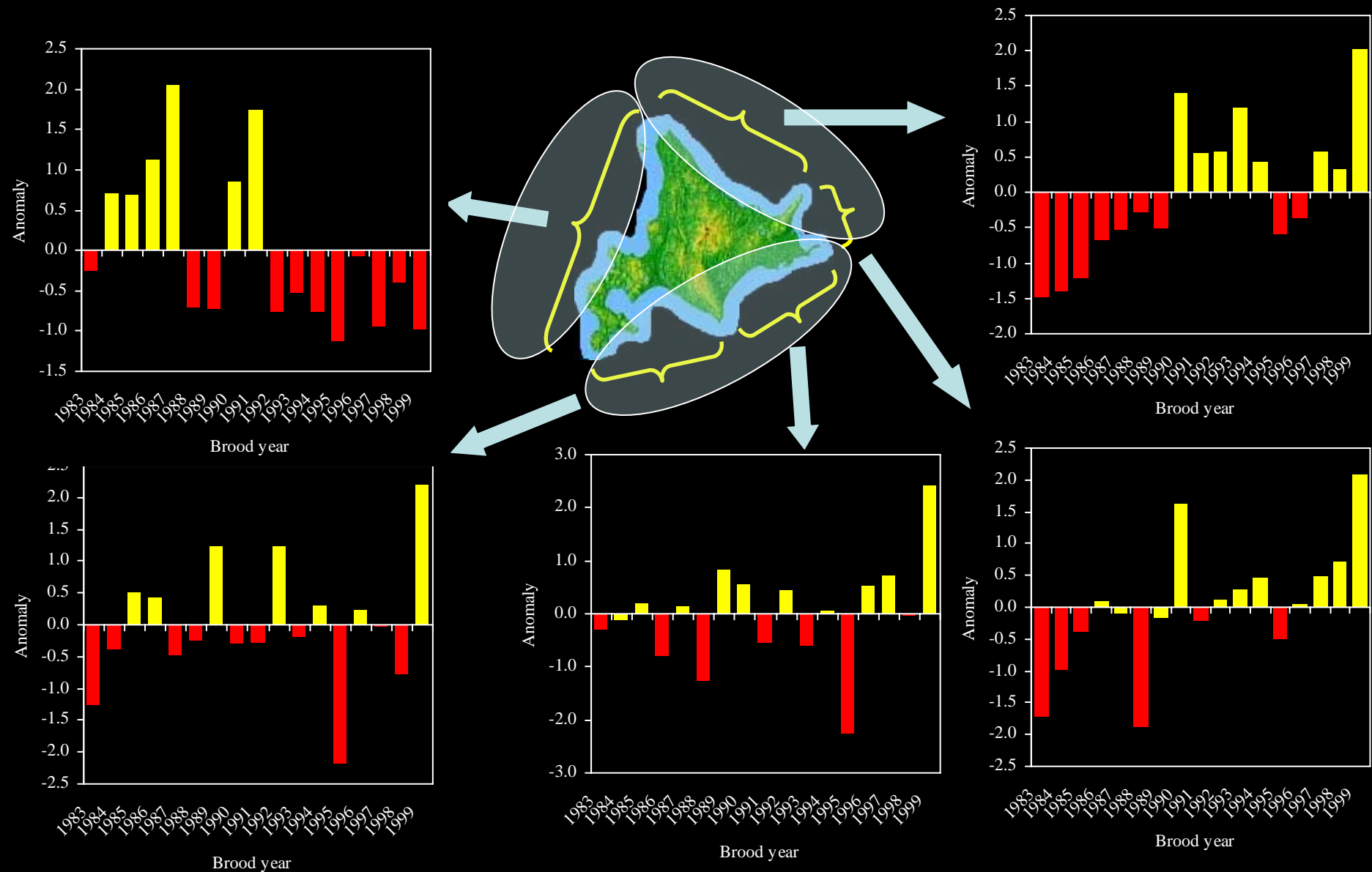
Changes in returned adults of Hokkaido chum



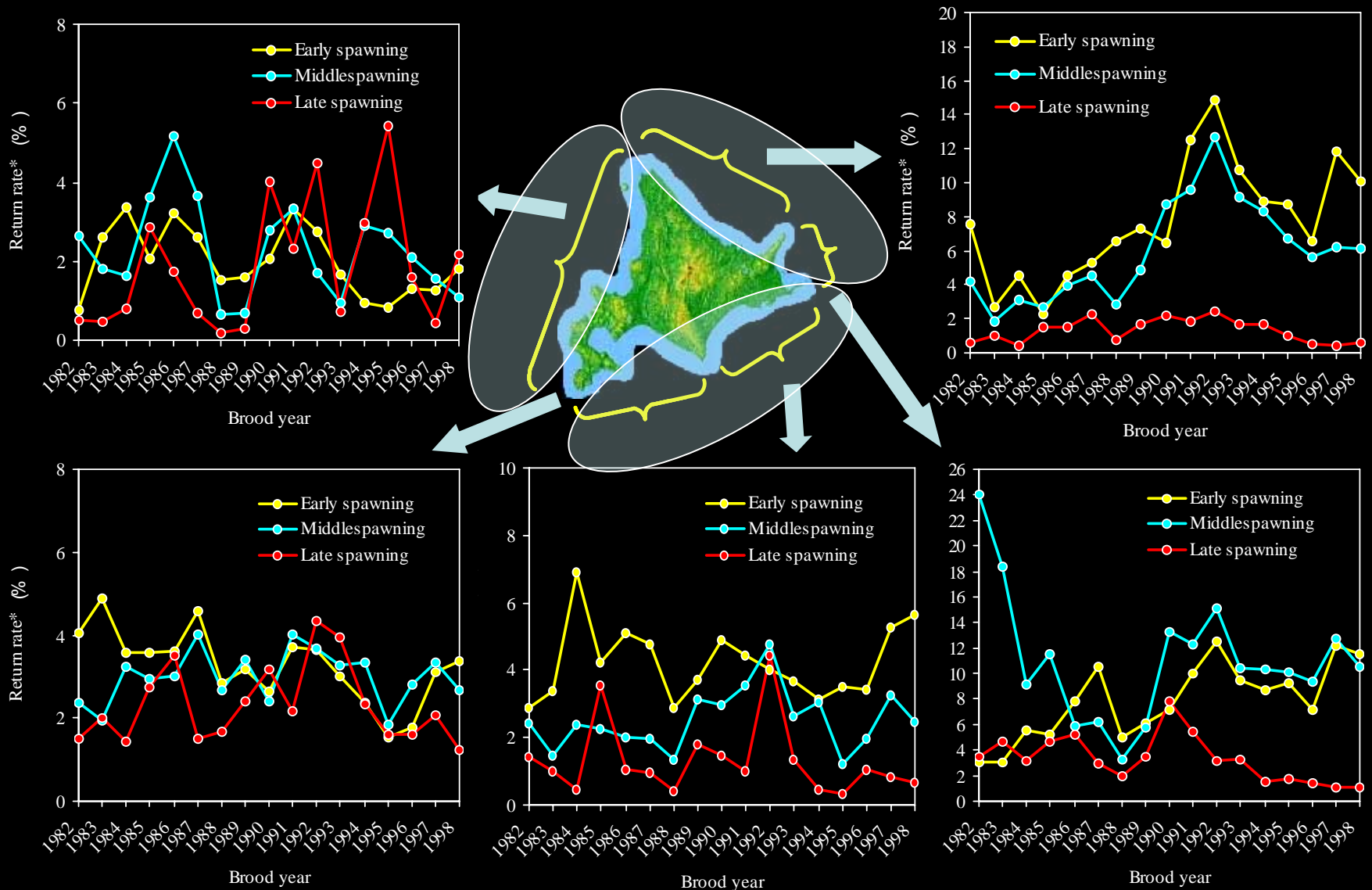
Changes in return rate of Hokkaido chum



1983-1999 anomaly time series of chum salmon return rates in five coastal regions.



Changes in return rates of early, mid and late spawning groups in Hokkaido.



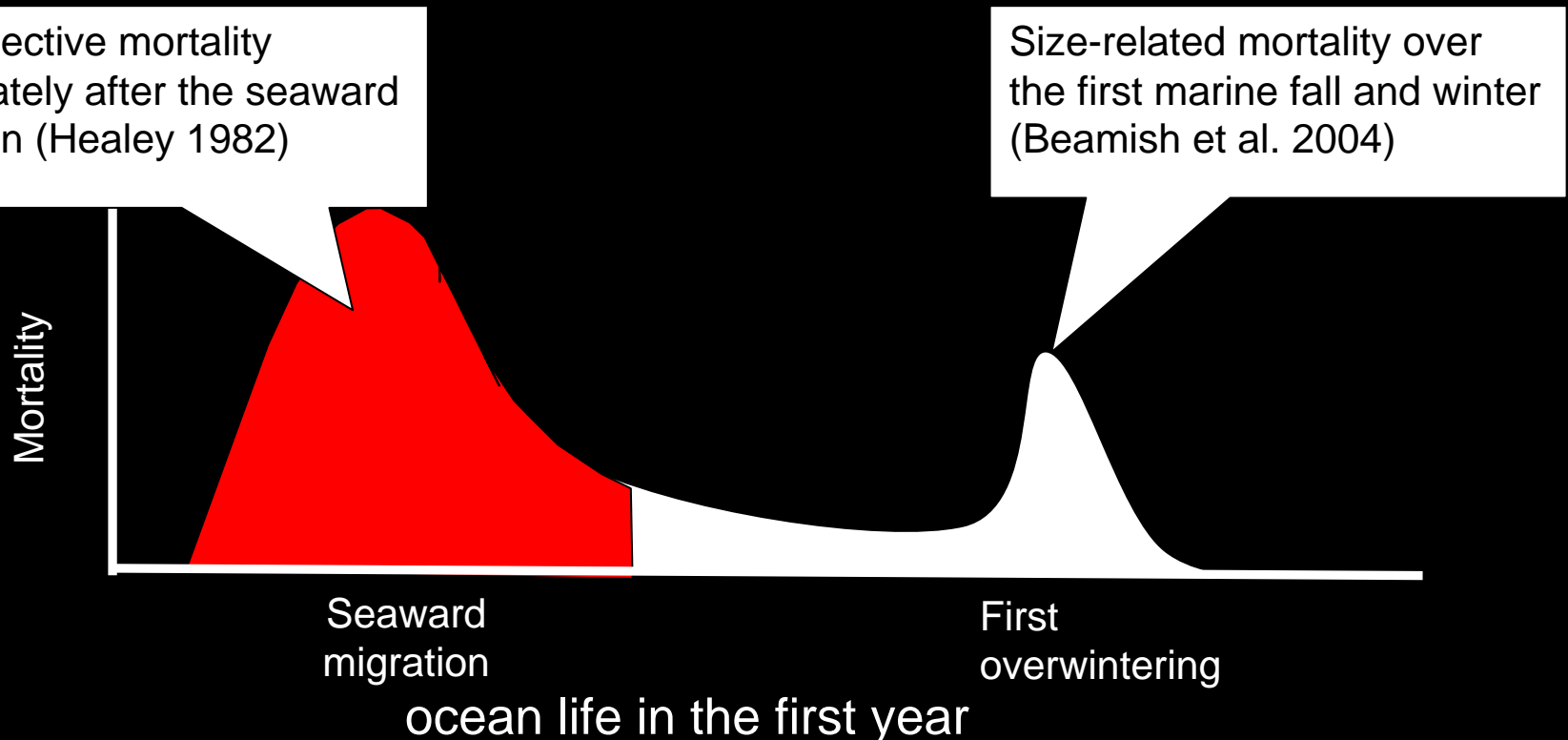
* Return rate was estimated by dividing adults number returned 4 years later by stocked number of juveniles ; stocked number at each period was estimated using the proportion of eggs artificially-spawned.

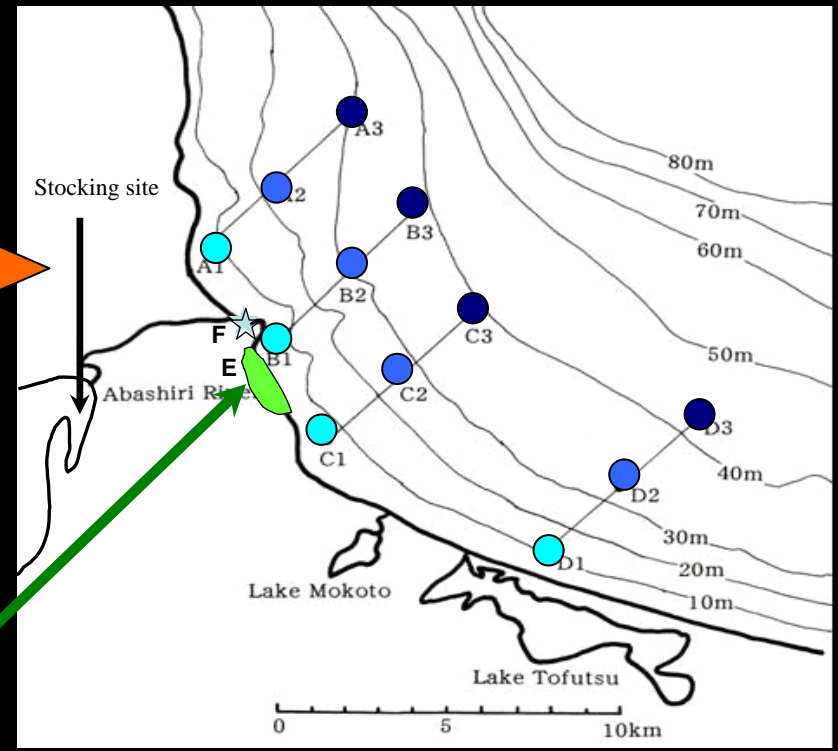
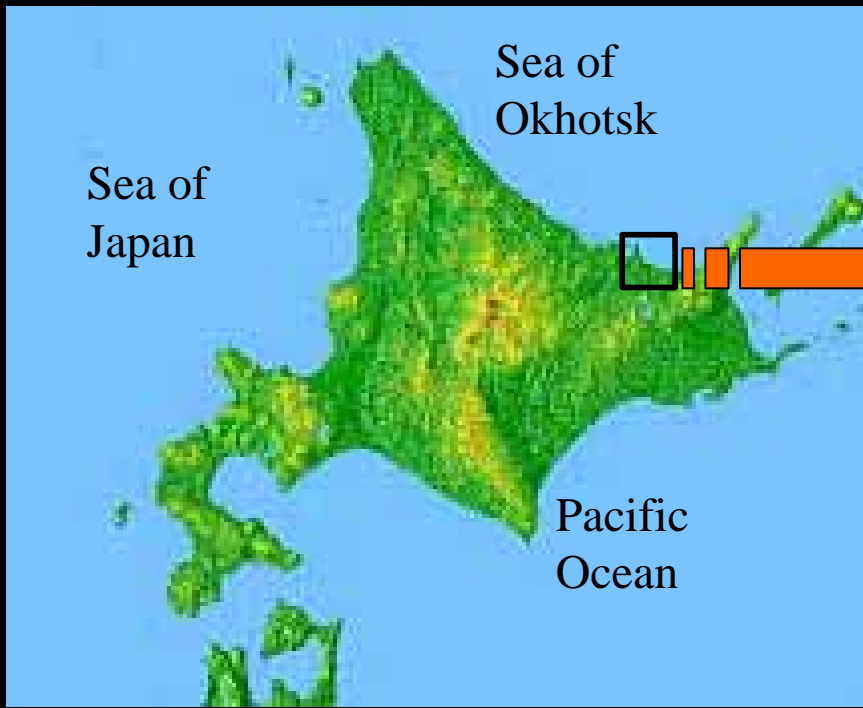
- There were great differences in survival (productivity) of chum salmon among different areas, runs and brood years in Hokkaido as well as north American chum, pink and sockeye salmons (Muter et al., 2002; Pyper et al., 2005).

>> When does high mortality of chum occur?

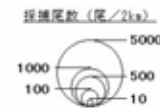
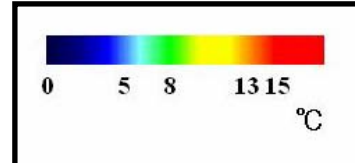
- In general, high mortality of Pacific salmon is known to occur several months after seaward migration and/or over first marine fall and winter. High mortality of chum seems to occur in coastal water during their early sea life (Healy, 1982).

>>> What causes high mortality ?





Spatial distribution of chum juveniles in relation to SST



Early May

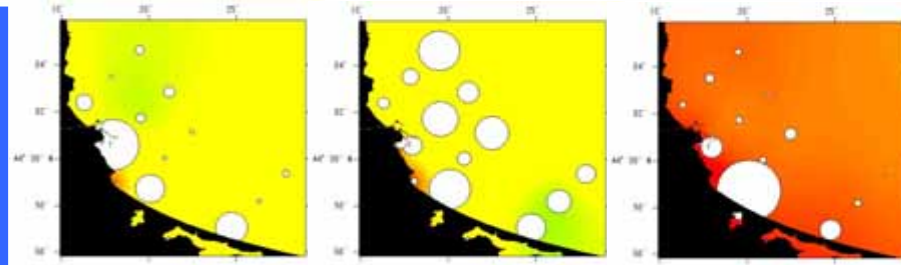
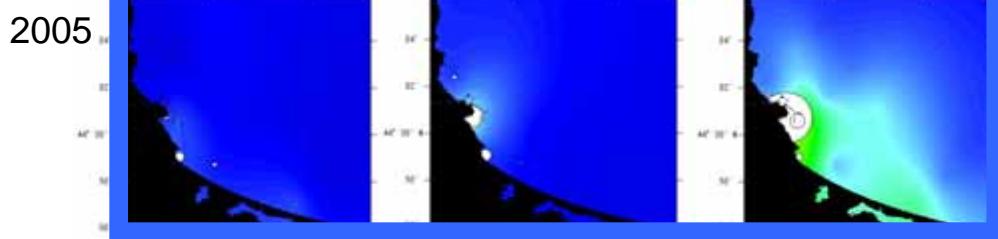
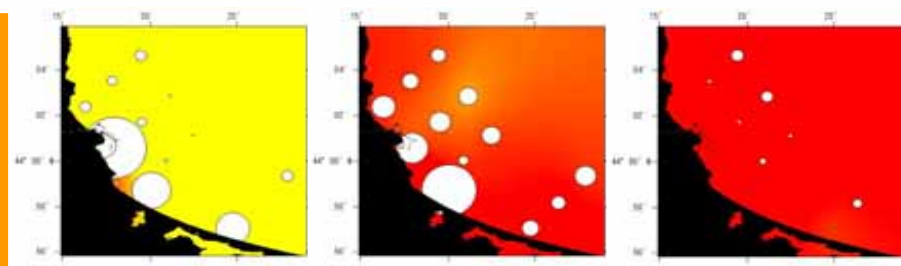
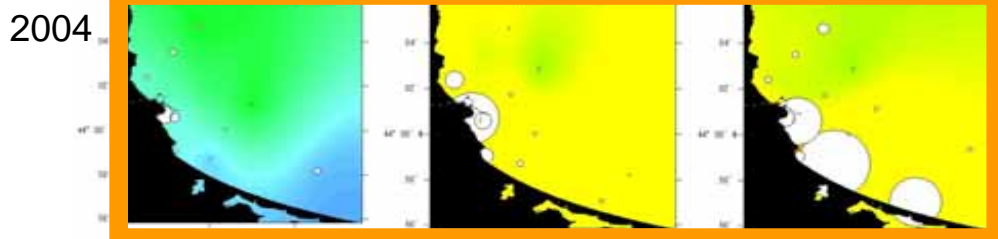
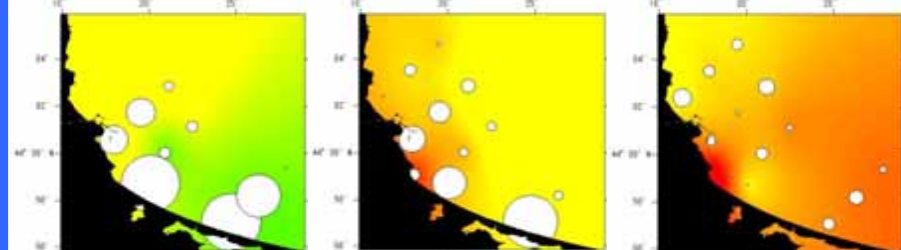
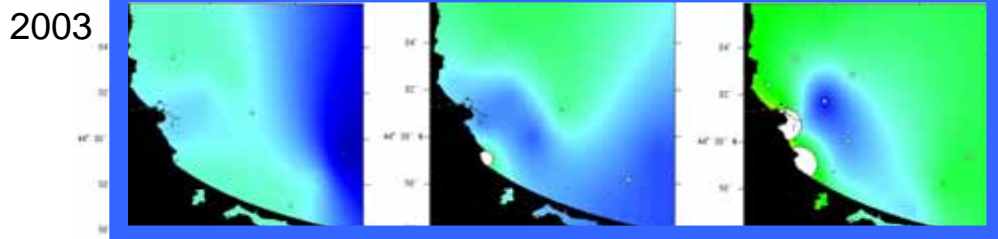
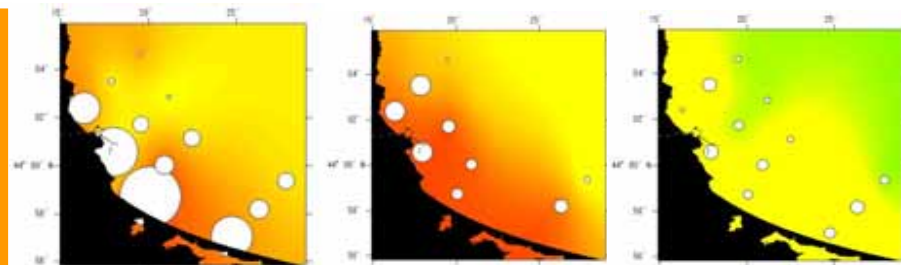
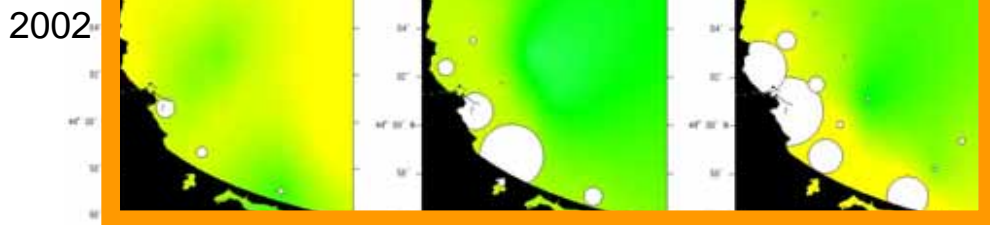
Mid May

Late May

Early June

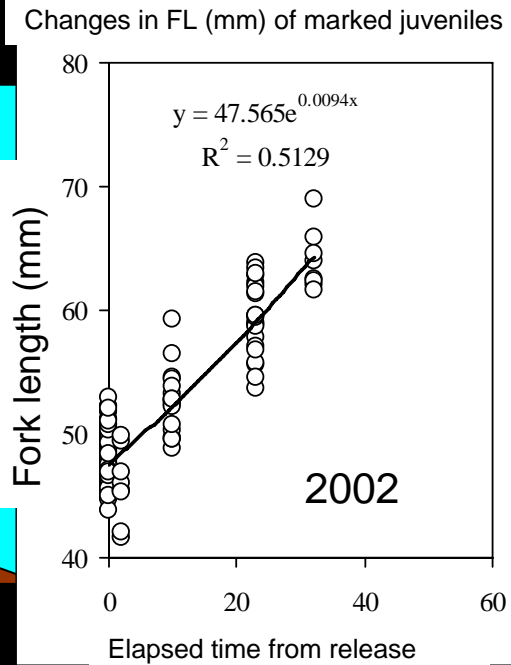
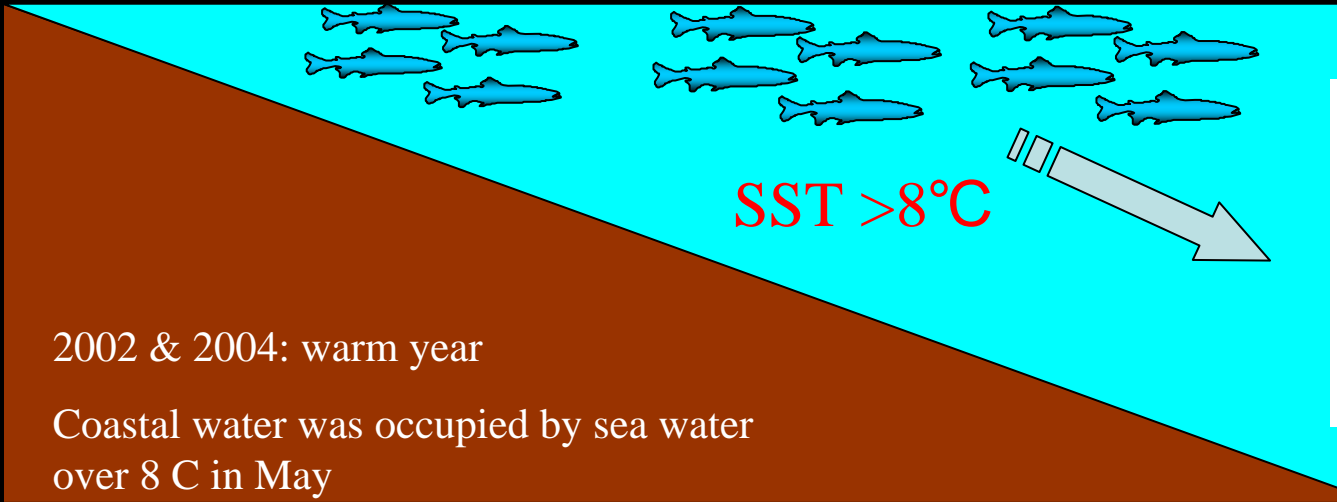
Mid June

Late June

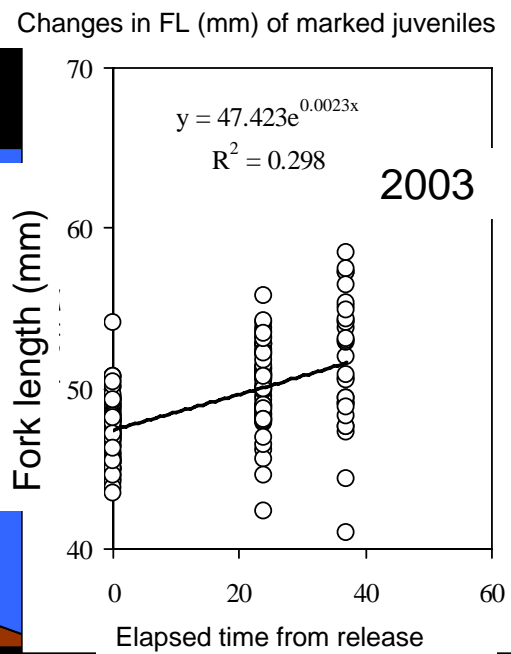
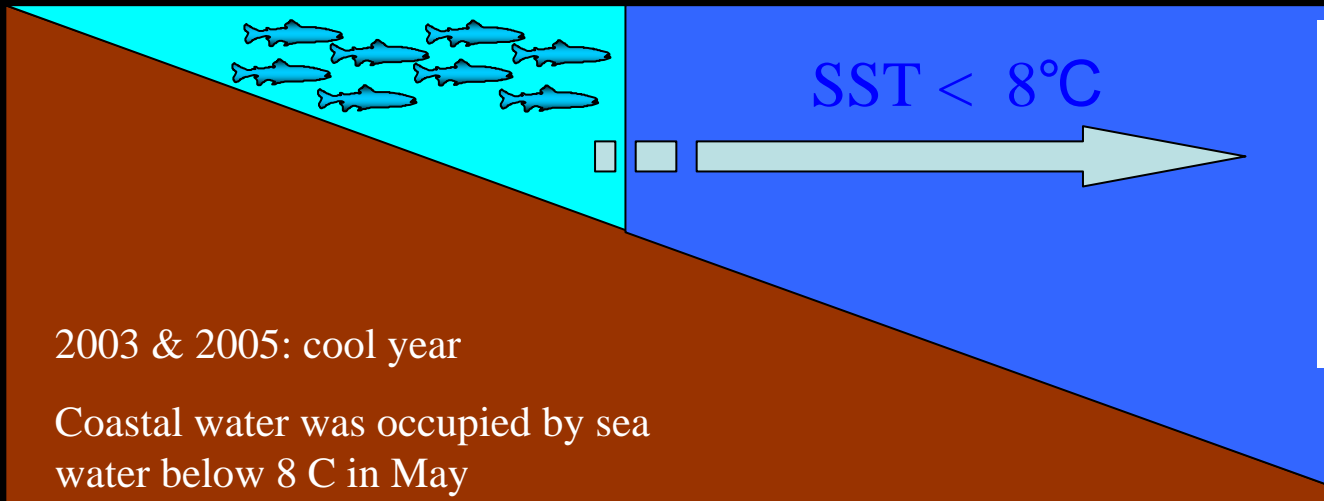


Littoral water

Coastal water



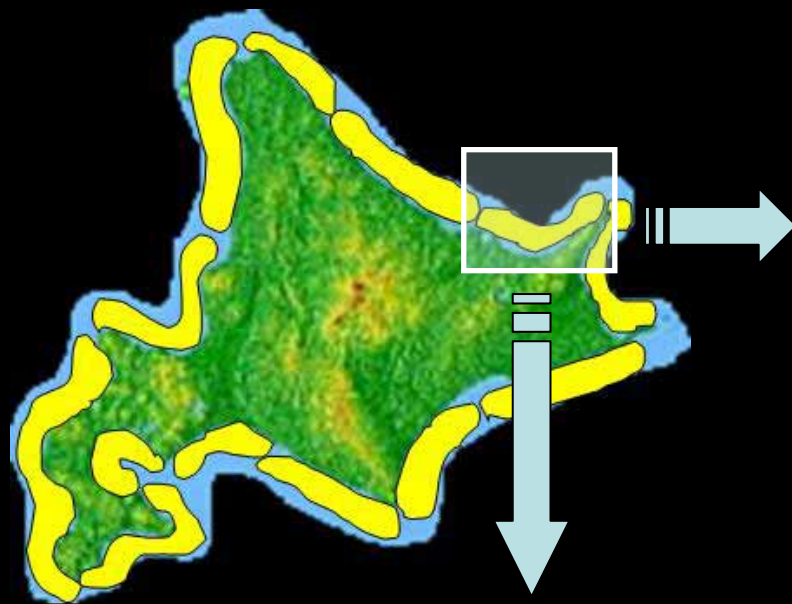
Behavior of chum juveniles after seaward migration depends on seawater temperature.



- In Okhotsk Sea, when seawater temperature was below 8 C, moving to 1km offshore was restricted, and eventually they densely aggregated in the littoral waters for long time before moving to 1km offshore.
- As the results of thermal-dependent migration, chum juveniles may grow slowly, and eventually suffer high mortality in the cool year.

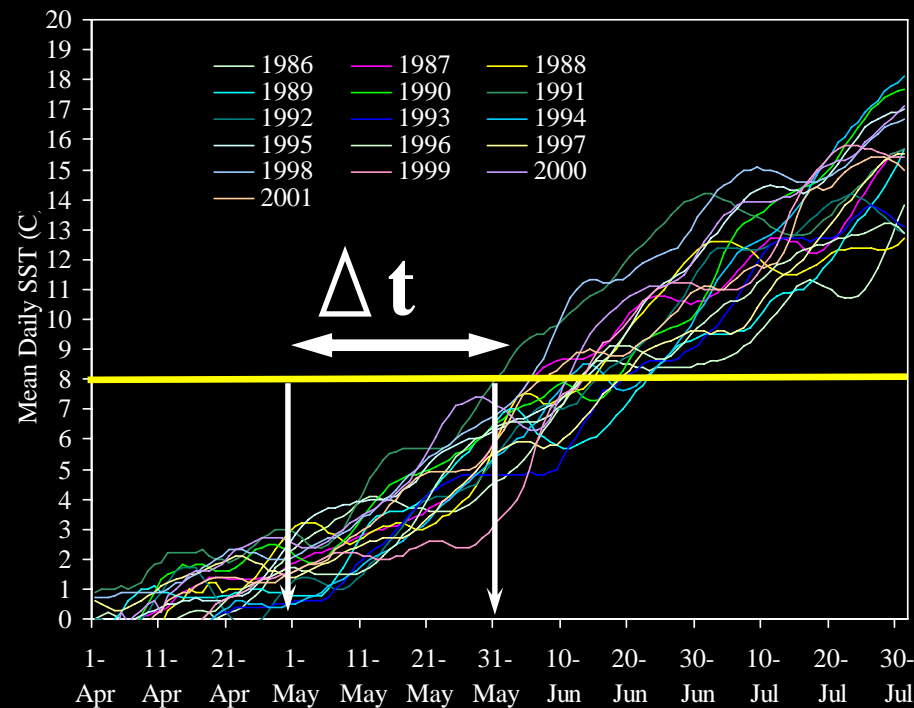
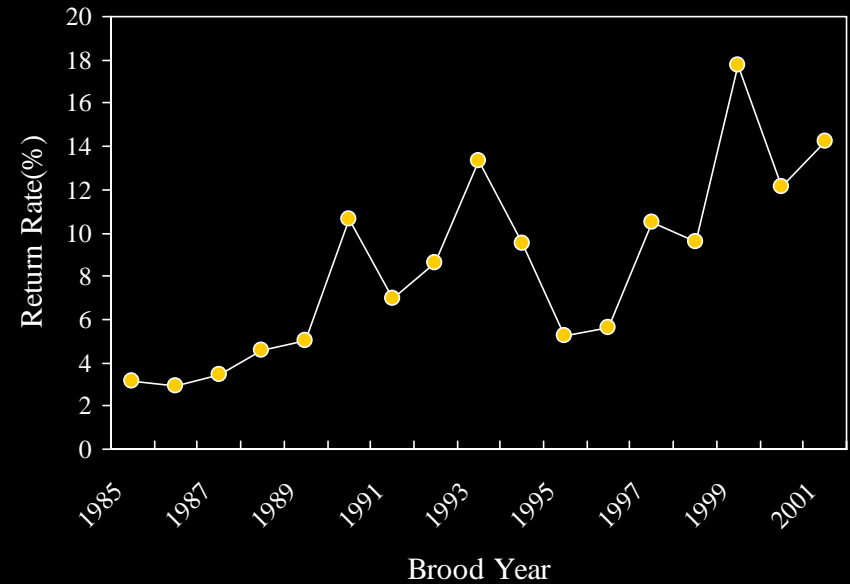
We made a scenario to cause a high mortality of chum during early life: **survivals of chum salmon may be strongly affected by the seawater temperature during their early sea life.**

>>>In order to test this scenario, we investigate the relationship between previous return rates and seawater temperatures during their early sea life.



Changes in the mean daily SST in the Eastern Okhotsk Sea

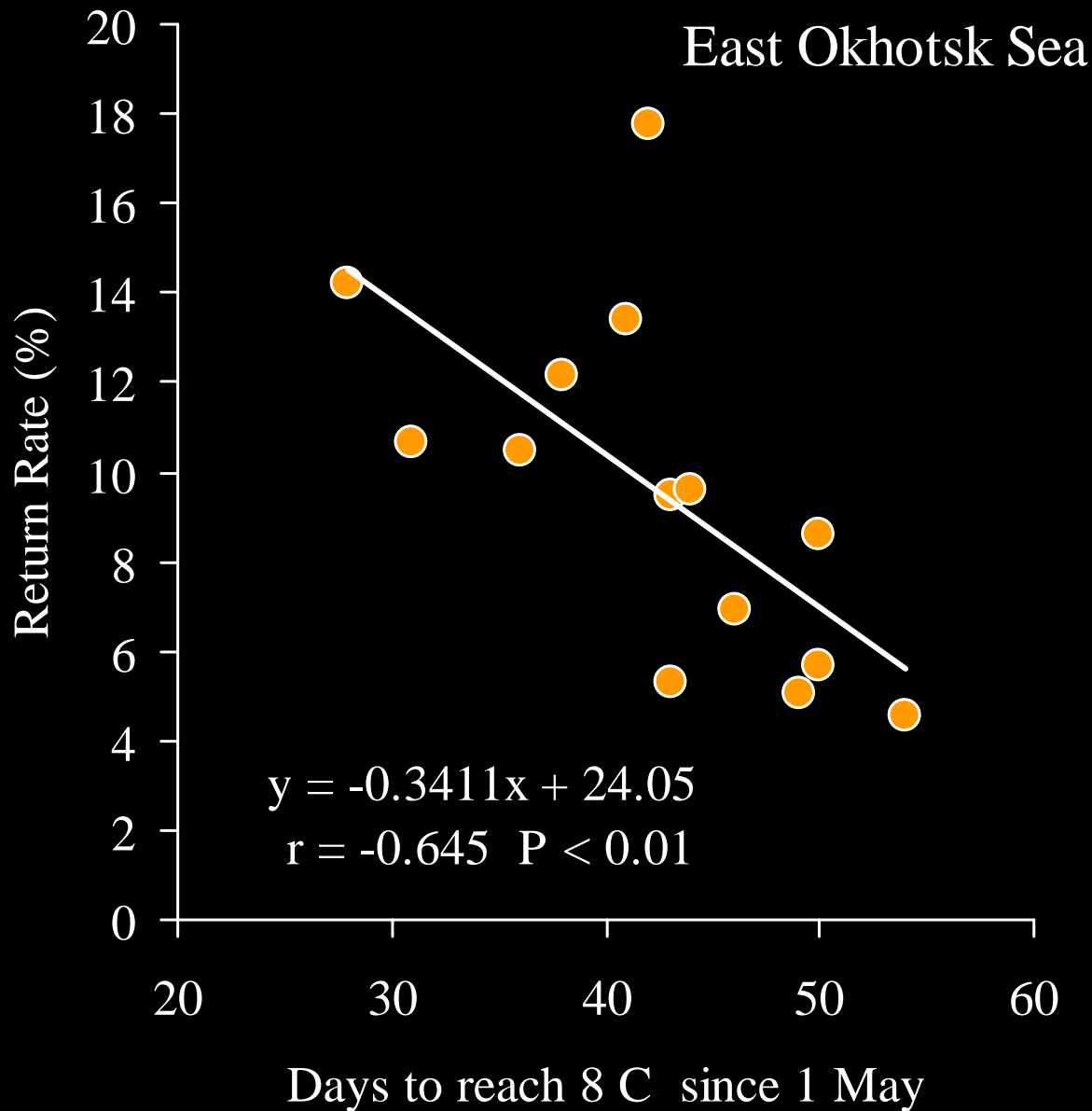
Return rate of chum salmon in the Eastern Okhotsk Sea



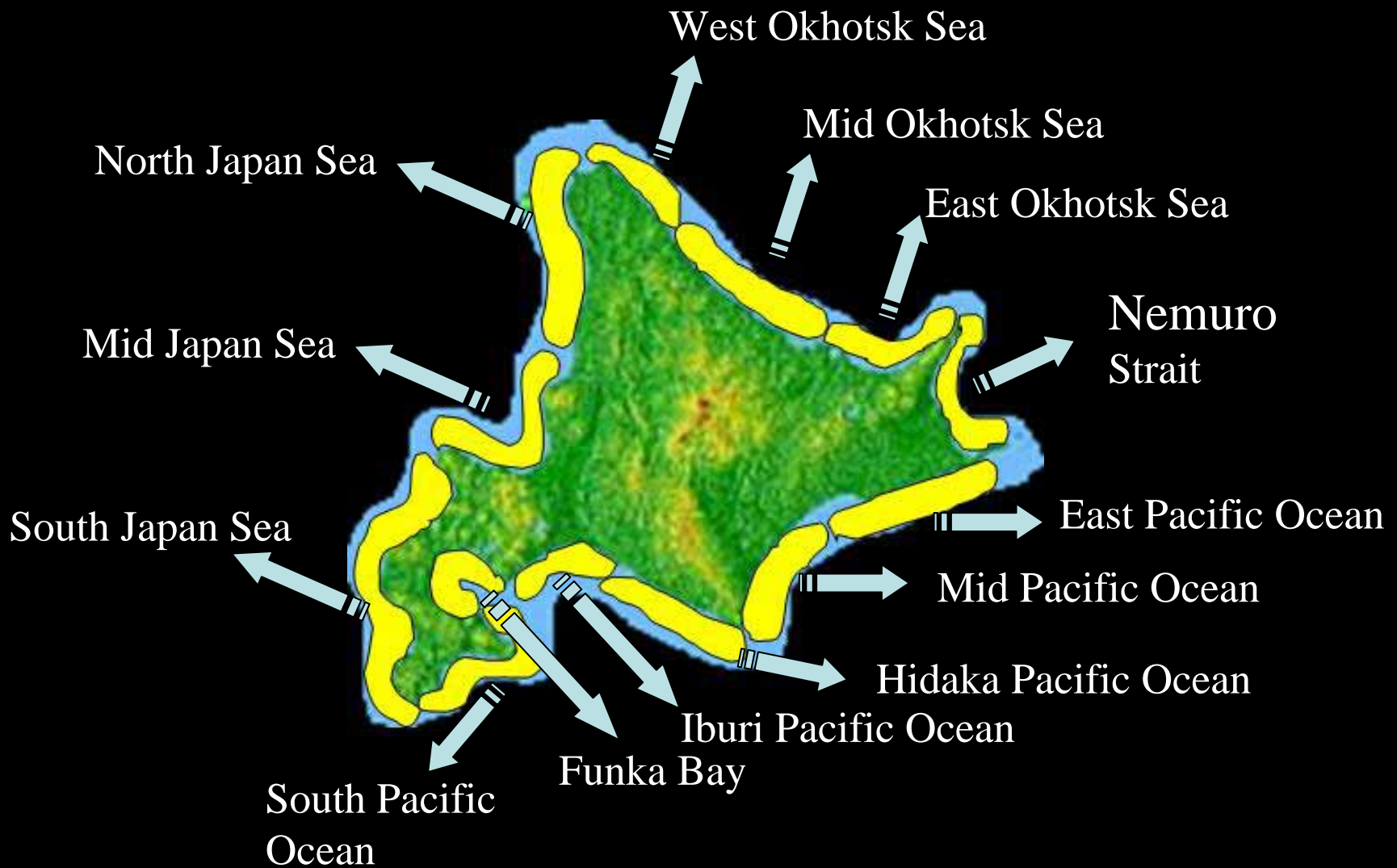
1. We used average daily-SST data set in the coastal water from 4km to 37km offshore, which were analyzed and estimated by JMA using satellite data (NOAA and MTSAT) and in-situ observations.

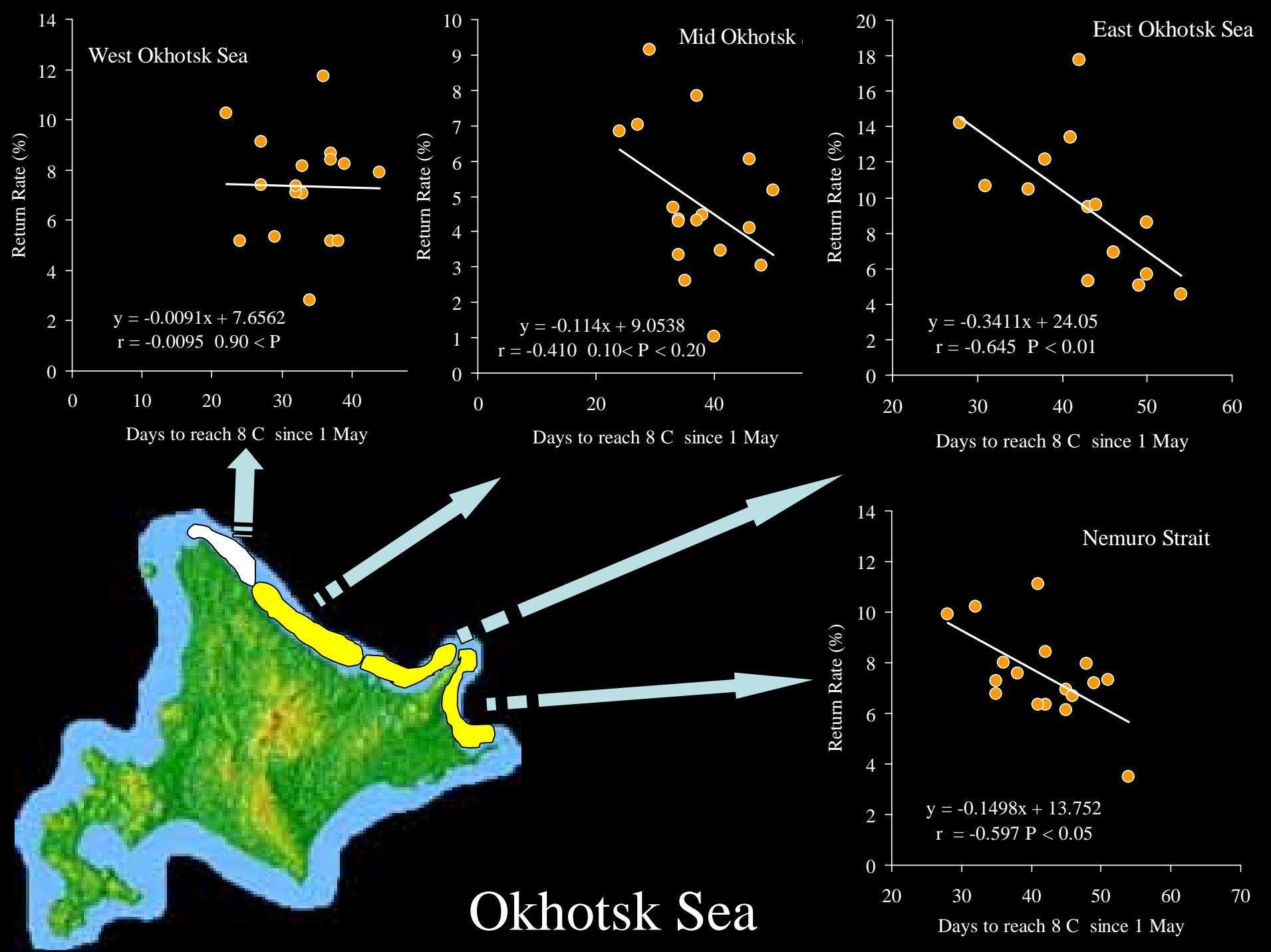
2. We calculated days (t) to reach 8 C in the coastal water since 1 May.

3. Relationship between return rate from 1985 to 2001 brood year and days to reach 8 C during their early life.

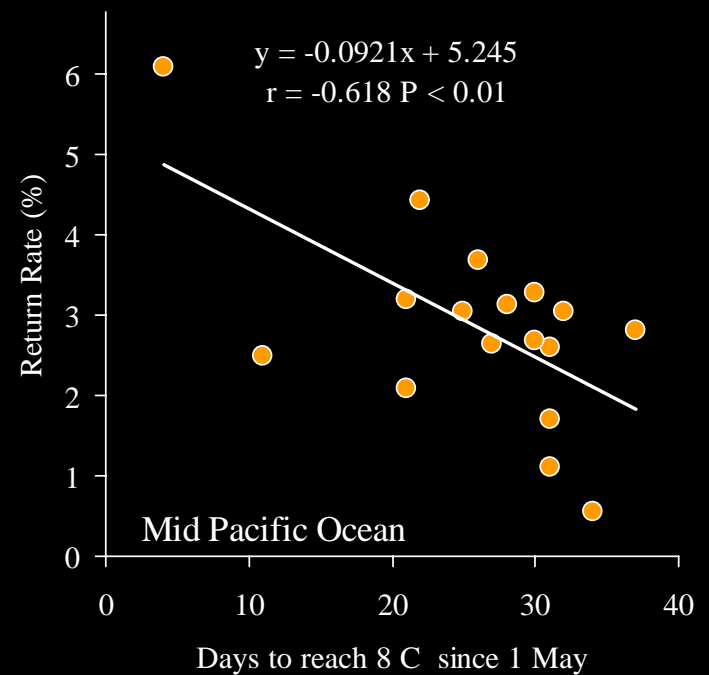
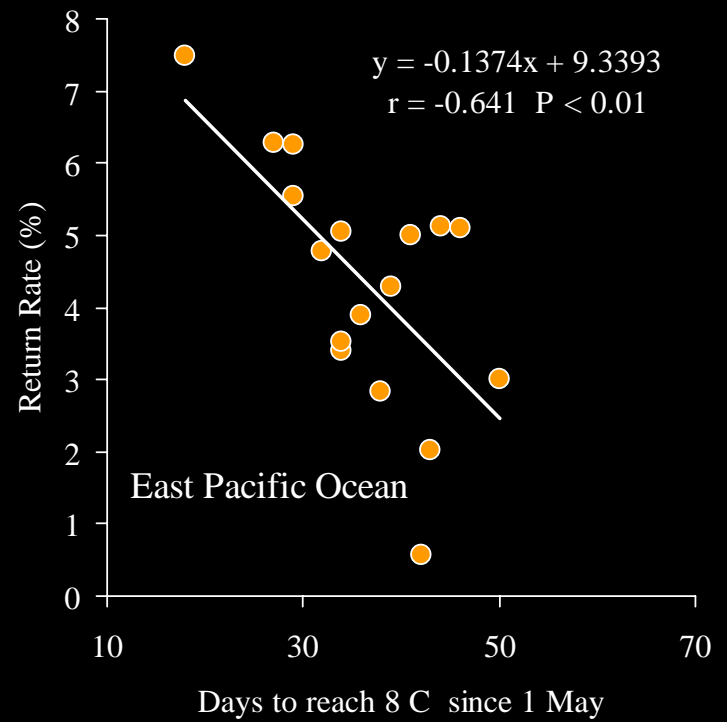
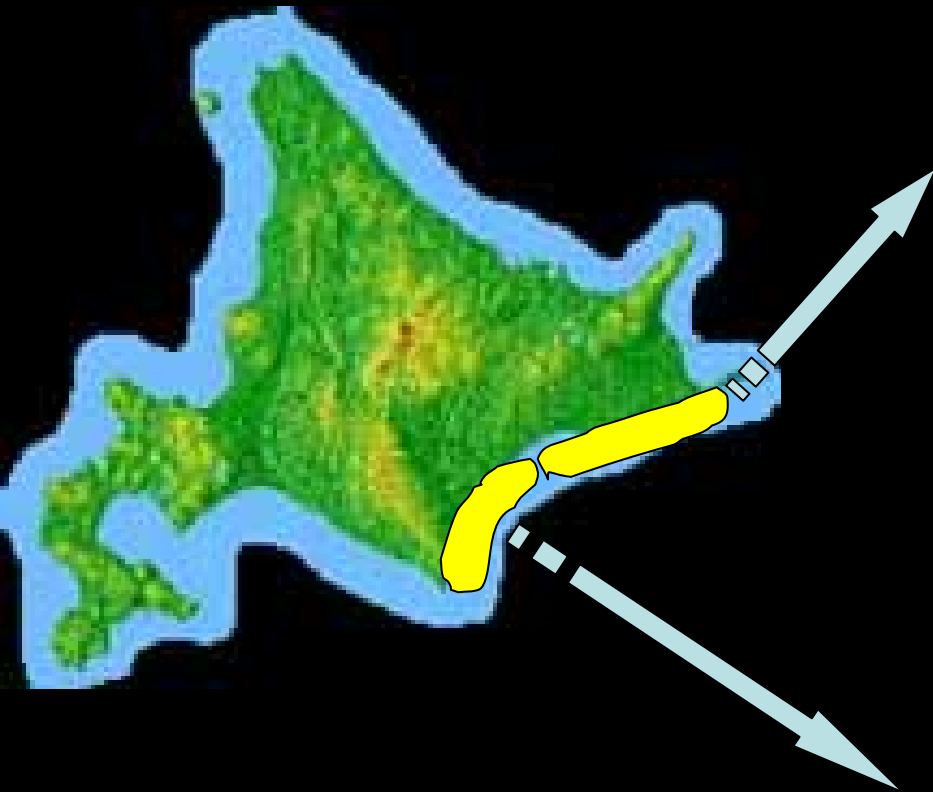


A relationship between return rate and days to reach 8 C since 1 May in the coastal water of eastern Okhotsk Sea of Hokkaido.

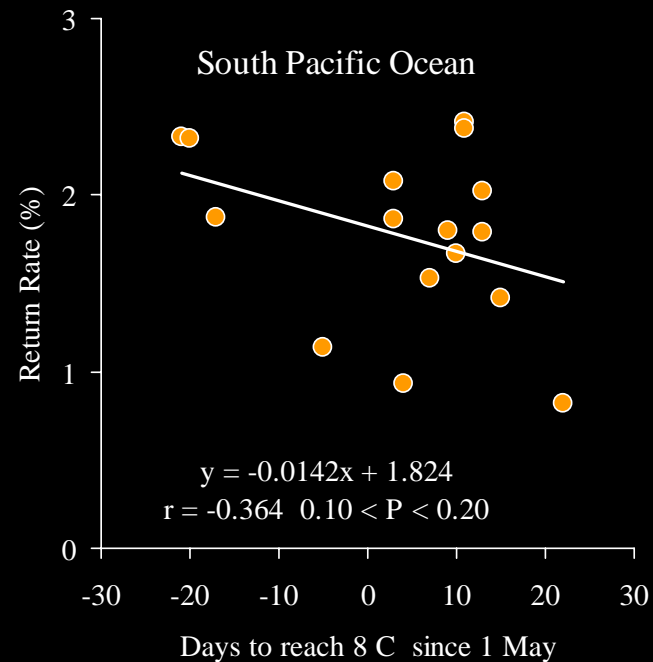
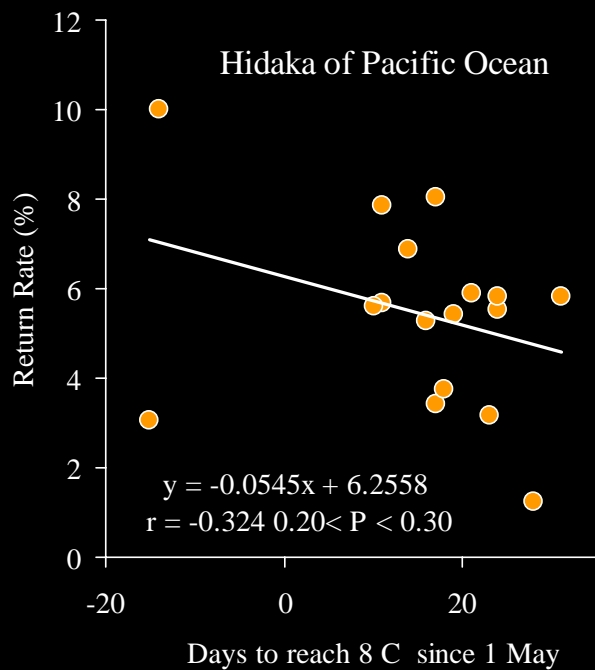
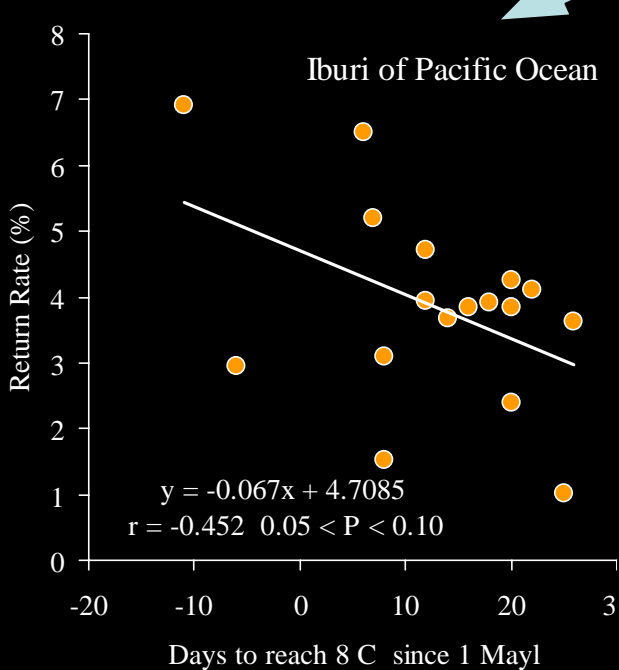
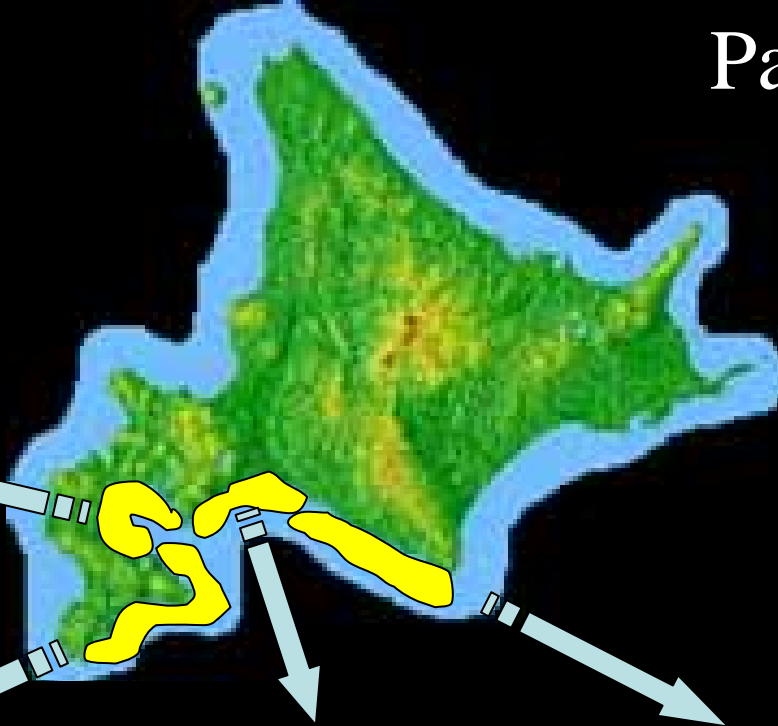
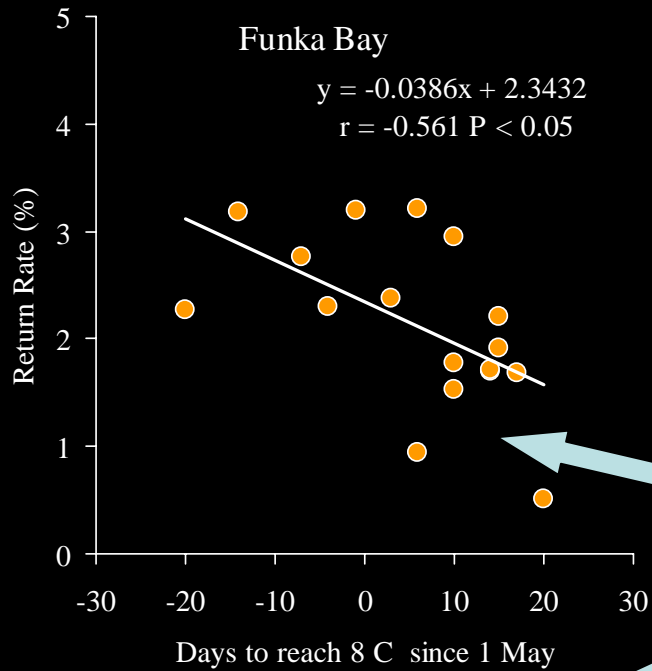


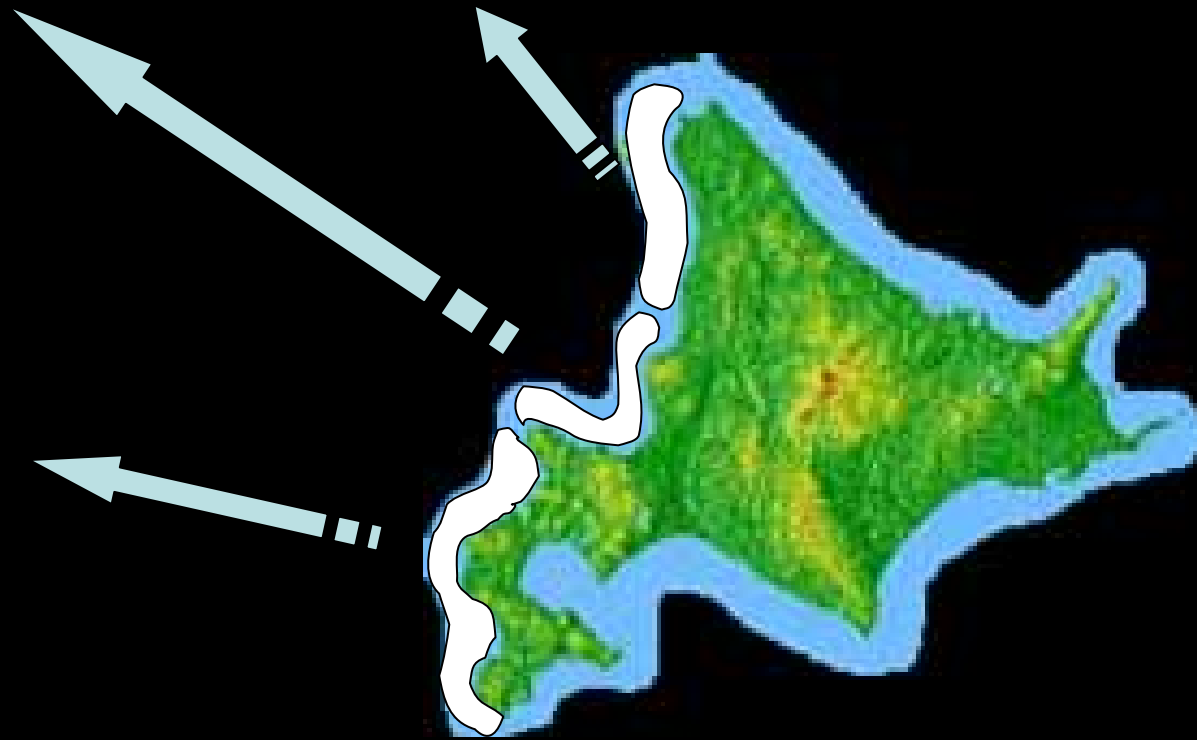
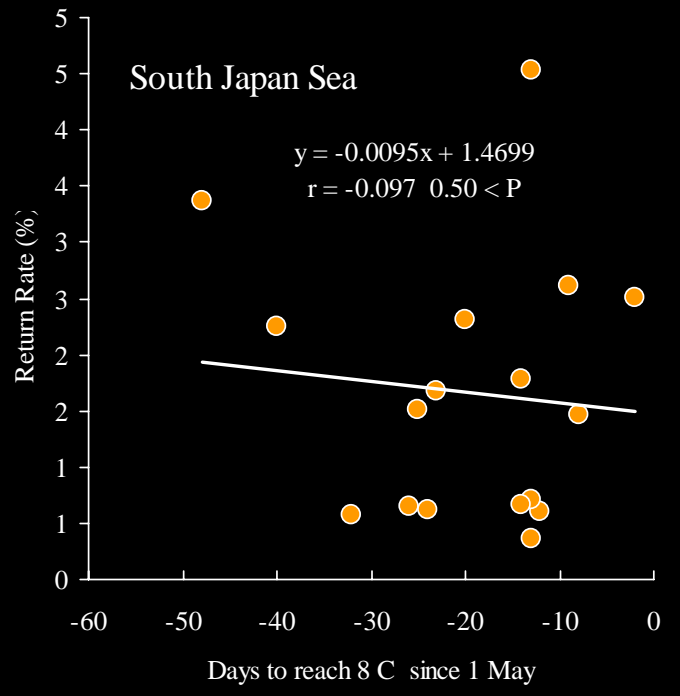
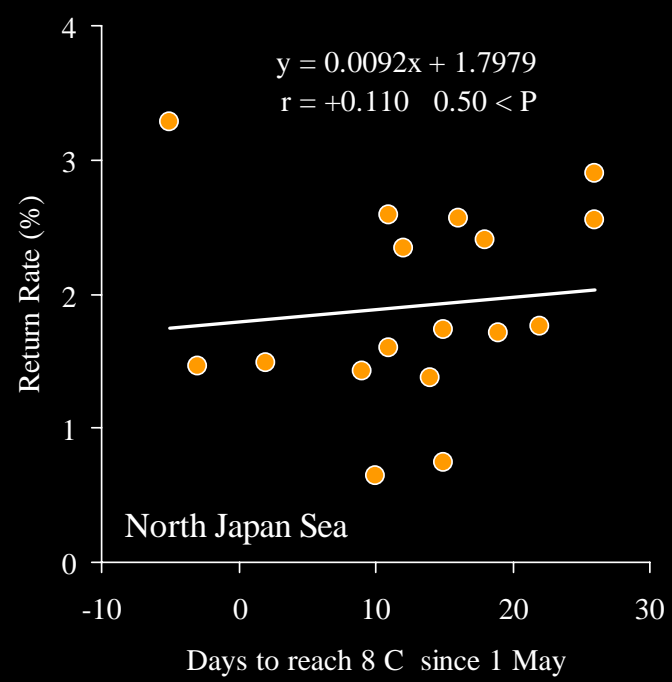
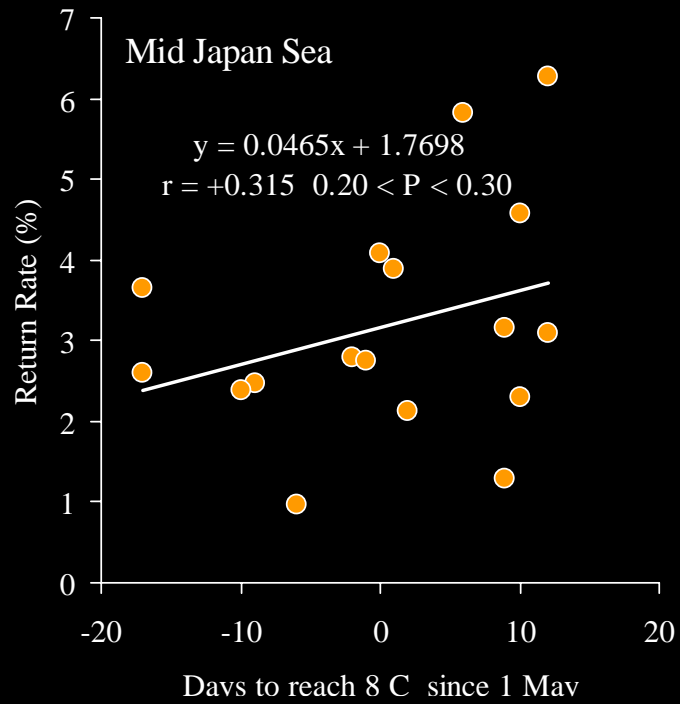


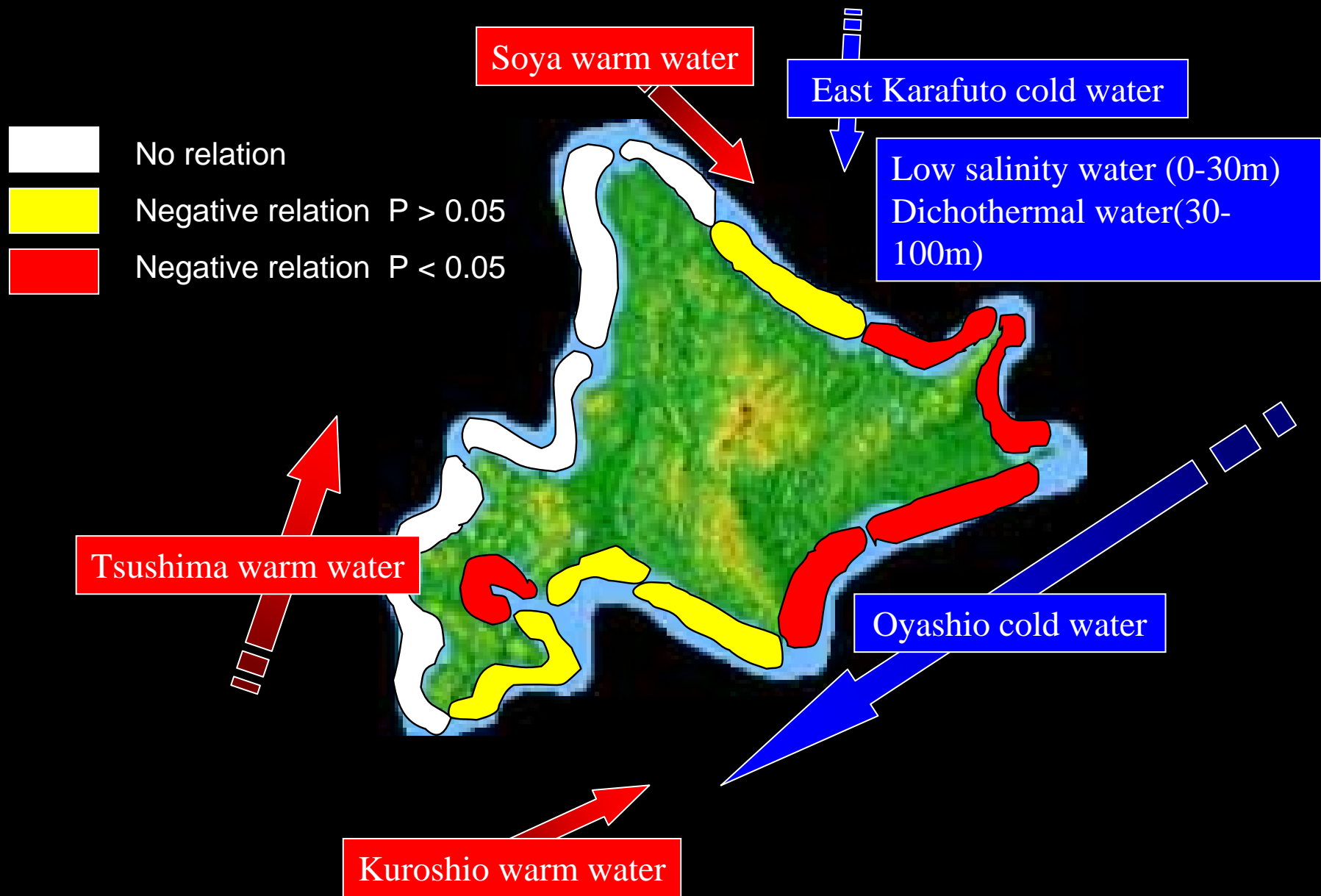
Pacific Ocean



Pacific Ocean







The results of statistical analyses on the relationships between return rates and the days to reach 8 C after 1 May. Structures of water currents and water mass around Hokkaido.

In conclusions

- There were negative relationships between return rates and days to reach 8 C in the coastal water around Hokkaido with exception of the Japan Sea and westernmost part of the Okhotsk Sea which are strongly affected by the warm current in spring.
- Therefore, when the seawater temperature reach 8 C earlier in the coastal water of Okhotsk Sea and Pacific Ocean, chum salmon juveniles may have a better chance to survive because their nursery is expanded.