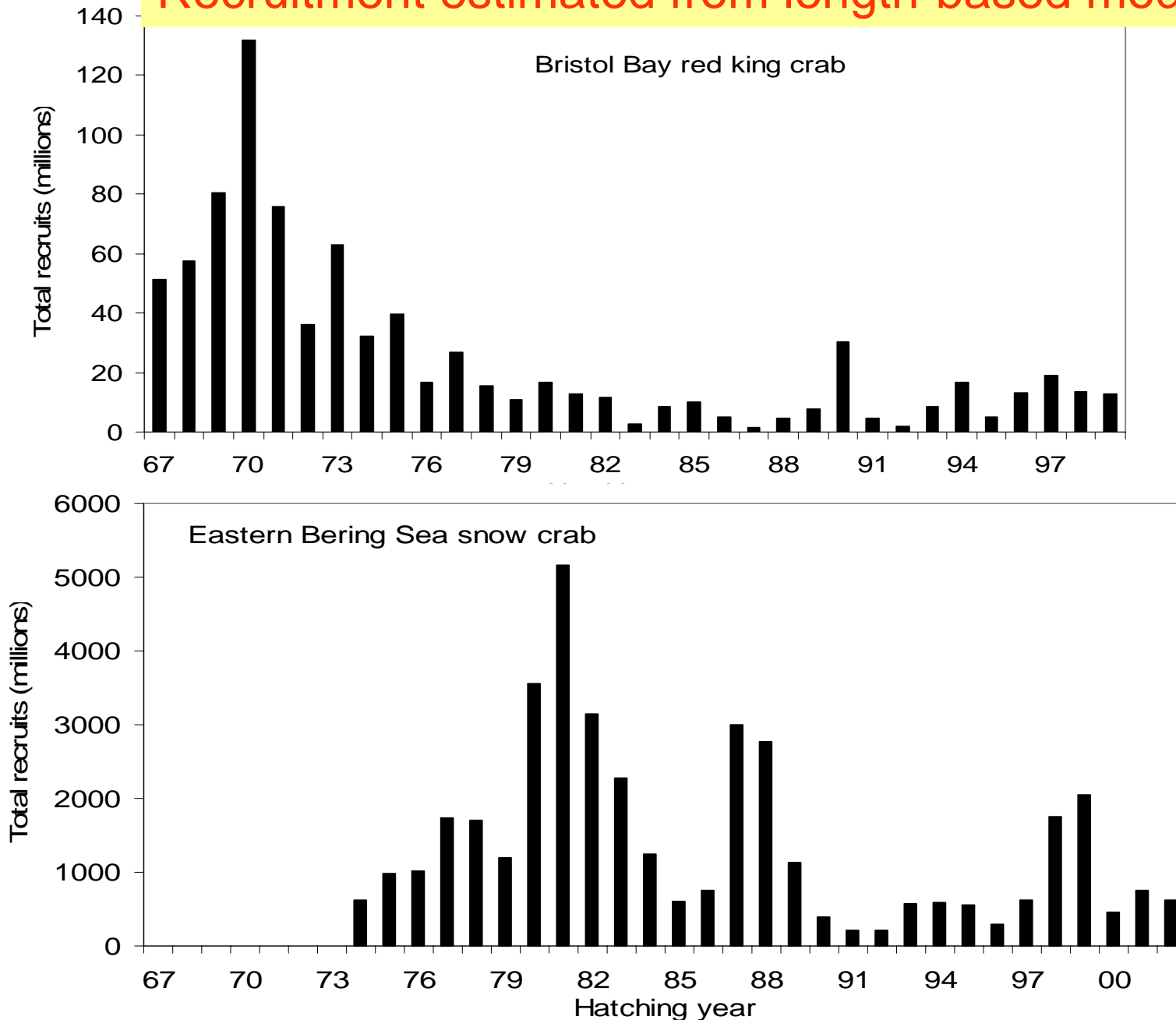# Crab Larval Advection and Recruitment in the Eastern Bering Sea
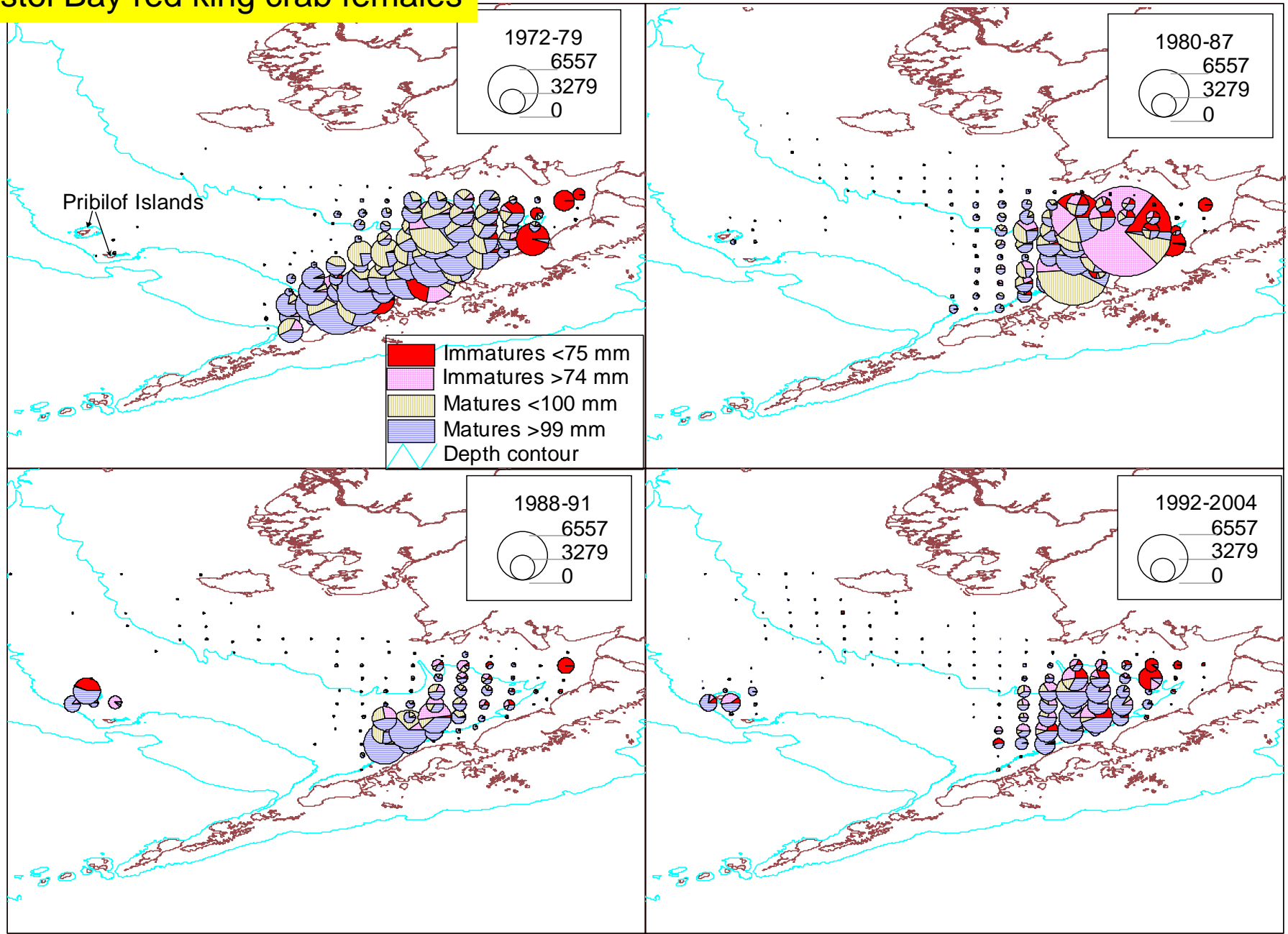

Jie Zheng and Gordon Kruse
Juneau, Alaska, USA
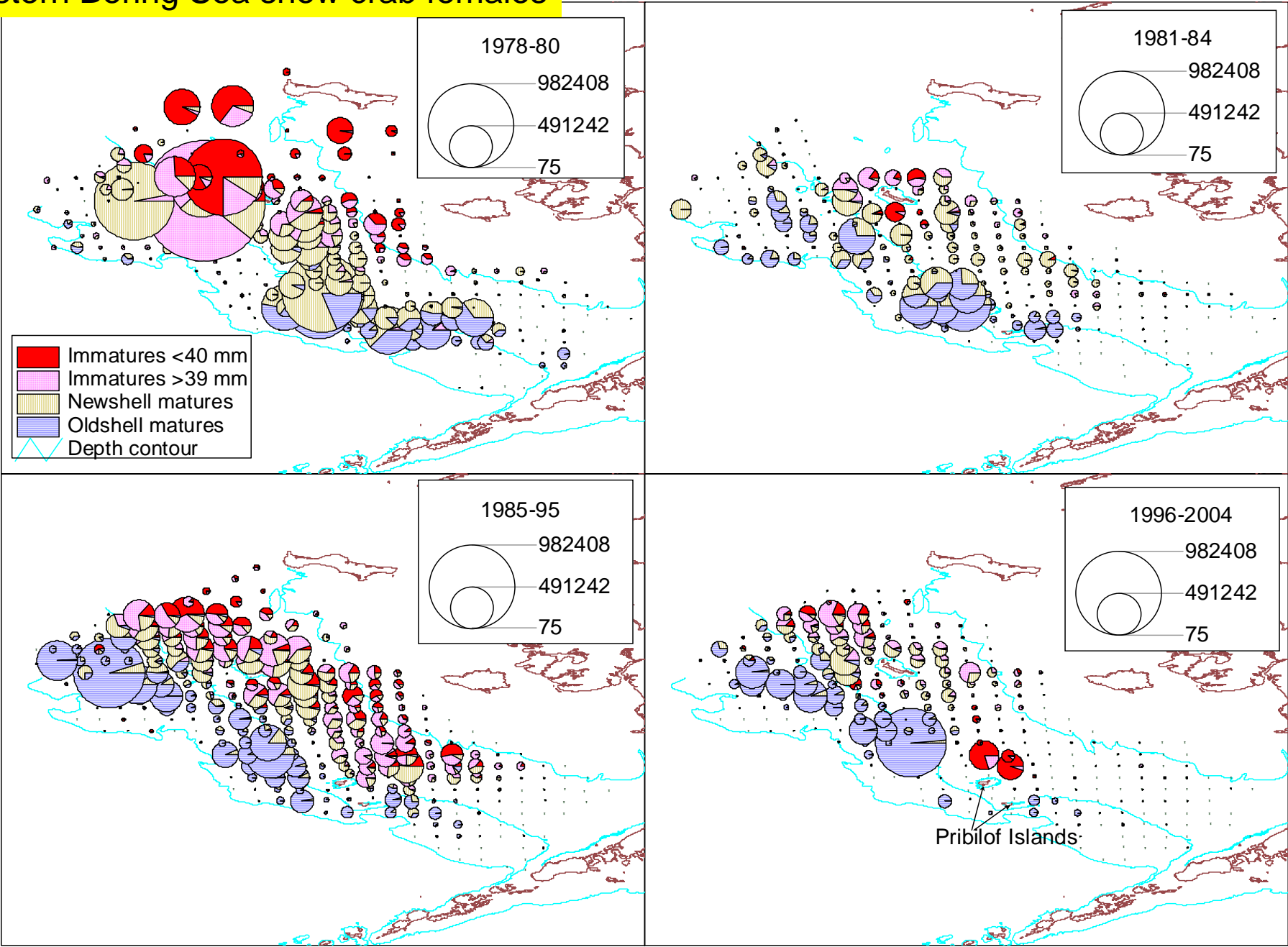
Recruitment estimated from length-based models

Bristol Bay red king crab

Eastern Bering Sea snow crab

Bristol Bay red king crab females

Legend:
- Immatures <75 mm
- Immatures >74 mm
- Matures <100 mm
- Matures >99 mm
- Depth contour

Panel labels: 1972-79, 1980-87, 1988-91, 1992-2004

Pribilof Islands

Size scale: 6557, 3279, 0

Eastern Bering Sea snow crab females

Legend:
- Immatures <40 mm
- Immatures >39 mm
- Newshell matures
- Oldshell matures
- Depth contour

1978-80
982408
491242
75

1981-84
982408
491242
75

1985-95
982408
491242
75

1996-2004
982408
491242
75

Pribilof Islands

Annual centers of female crab distributions from summer trawl surveys

The shifts of distributions to the northeast for mature female red king crab occurred right after the 1976/77 regime shift, while the shifts of mature female snow crab to the northwest started during the mid and late 1970s

Currents and annual distribution centers of matures and small juveniles

Legend:
- # Immature SC <40 mm
- # Mature SC
- # Immature RKC <75 mm
- # Mature RKC
- Depth contour
- Currents

Snow crab

Red king crab

Coastal Domain

Middle Domain

Outer Domain
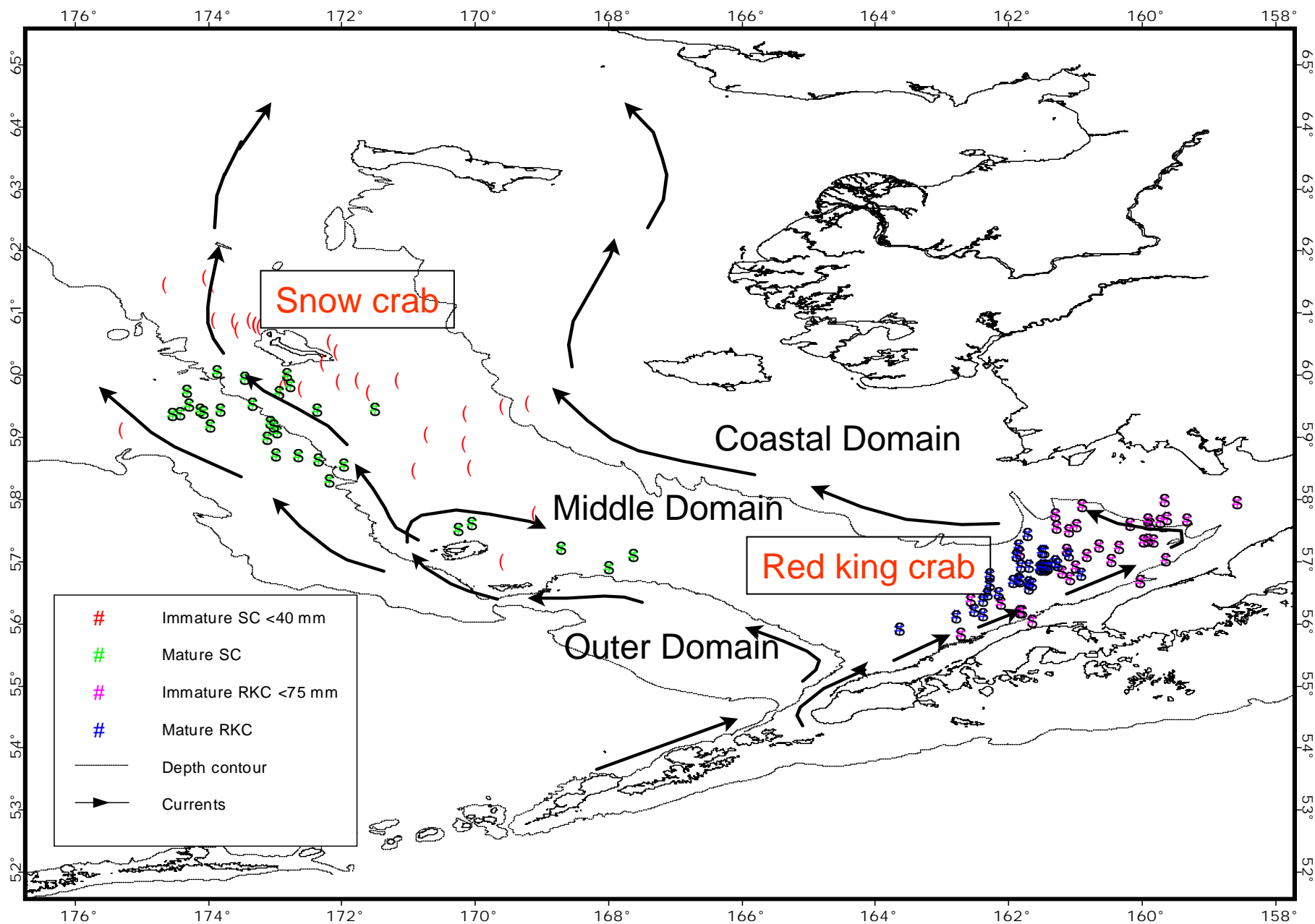
Hypotheses

- Northward shifts of spatial distributions of Bristol Bay red king crab and eastern Bering Sea snow crab may be related to the regime shift in 1976-77.

- The shifts of spatial distributions of mature females make it difficult to supply larvae to the southern ranges of their spatial distributions.

- Because distribution centers of small juvenile red king and snow crabs are generally located downstream of the mature females, advection may be an important process for red king and snow crabs.

Retrospective Analyses

- Using OSCURS model to perform retrospective analyses of crab larval drifts from 1967 to 2004.

- Assuming crab larvae to travel 35% as fast as the surface currents.

- Three starting dates: 4/15, 5/15, & 6/15.

- Larval durations: estimated from SST.

- Starting locations: annual distribution centers of mature females >99 mm CL for red king crab and mature females for snow crab.

Monthly SST from 1967-2002

- Based on the Comprehensive Ocean-Atmosphere Dataset (COADS) from the National Climate Data Center,

- Extrapolated and interpolated the COADS data by kriging,

- Calculating average temperatures at each 1 degree longitude and 0.5 degree latitude grid cell.
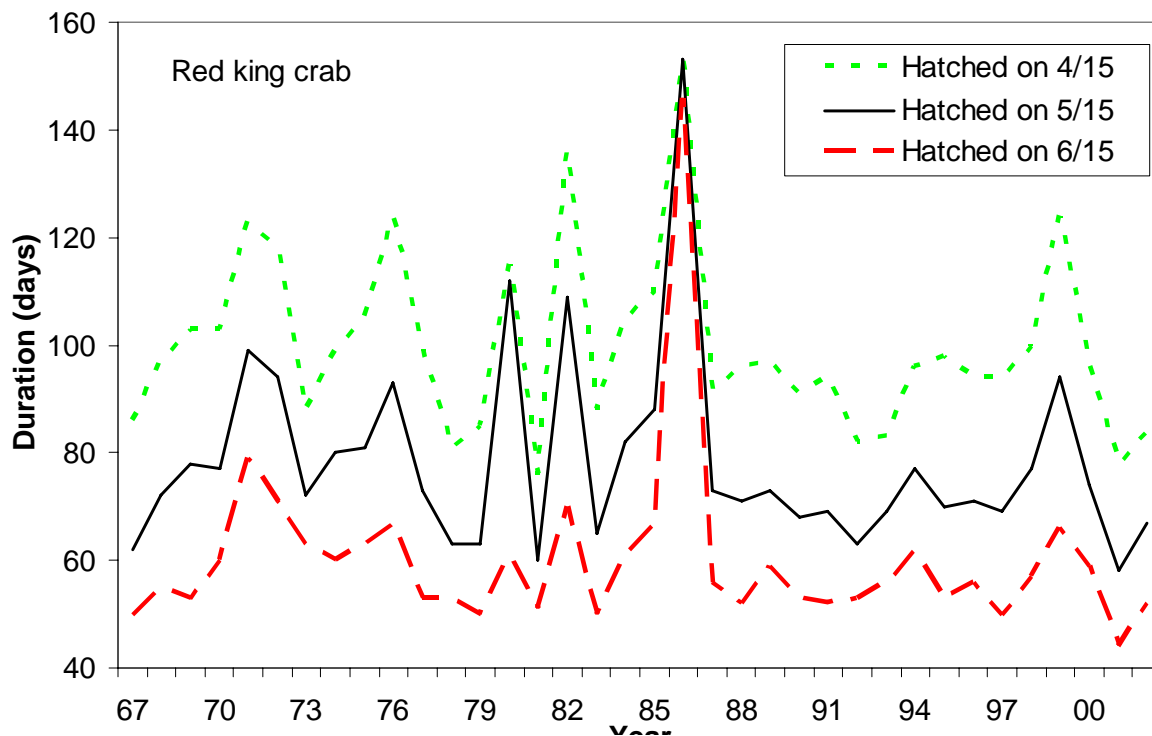
Larval Durations

- Red king crab:

  460 degree-days.

- Snow crab: (T is SST in degree C^{o}):

  Days = $300.89/T^{1.1117}$ for the first zoeal stage,

  Days = $367.45/T^{1.1610}$ for the second zoeal stage.

Larval movements during three months after hatching on May 15, 1975, 1987, and 2004 from three different locations for Bristol Bay red king crab
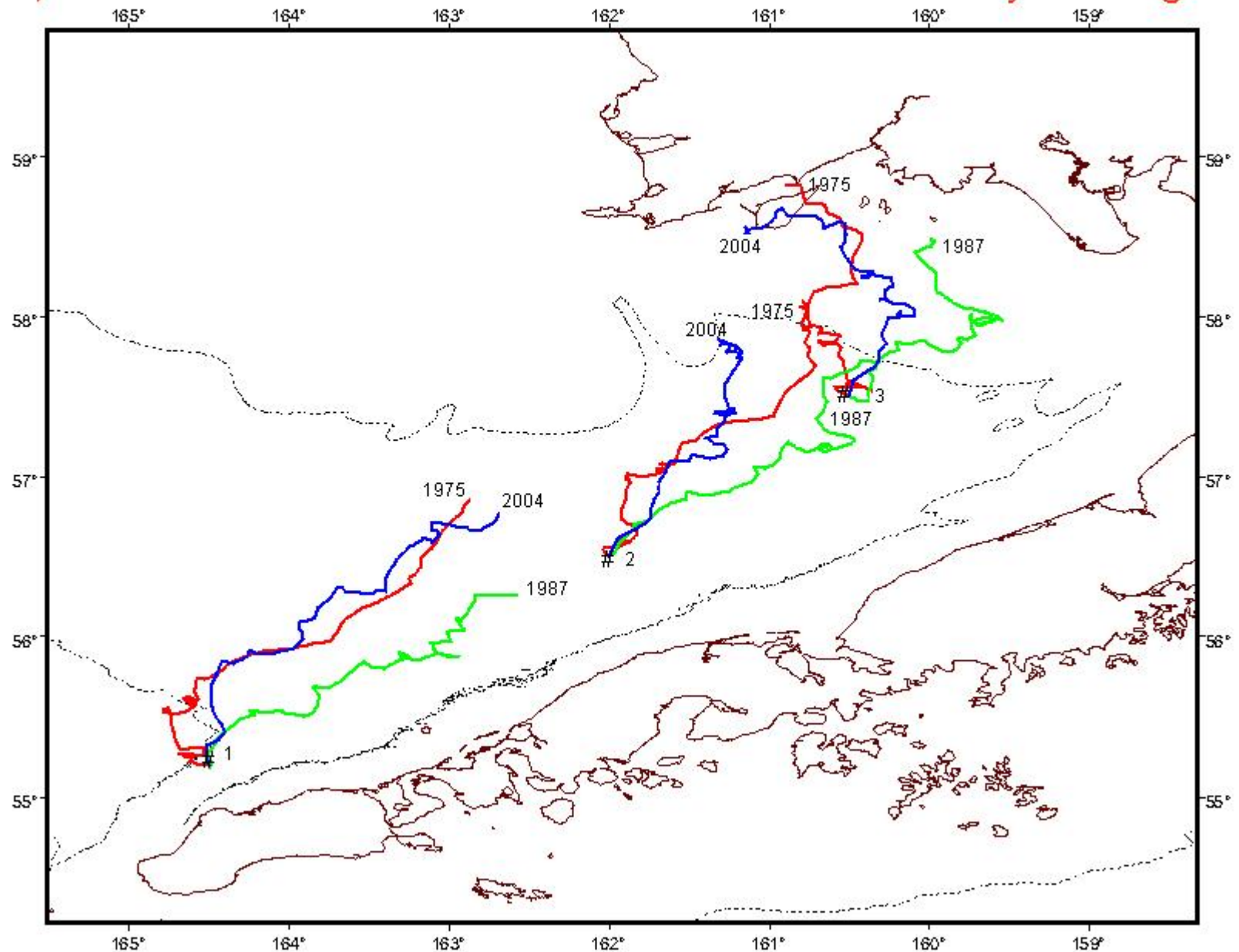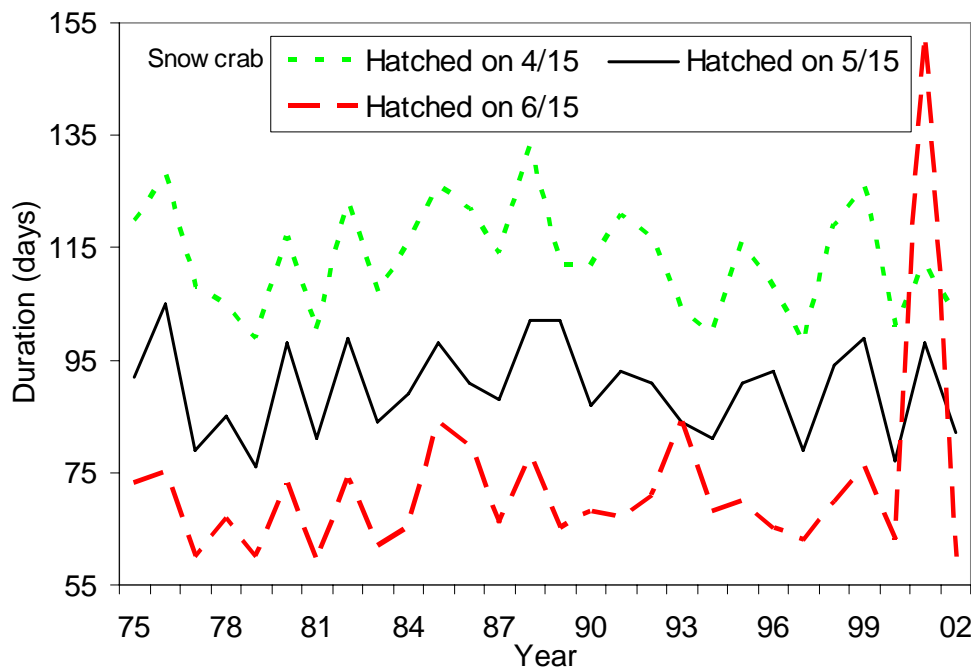
Larval movements during three months after hatching on May 15, 1975, 1987, and 2004 from five different locations for EBS snow crab
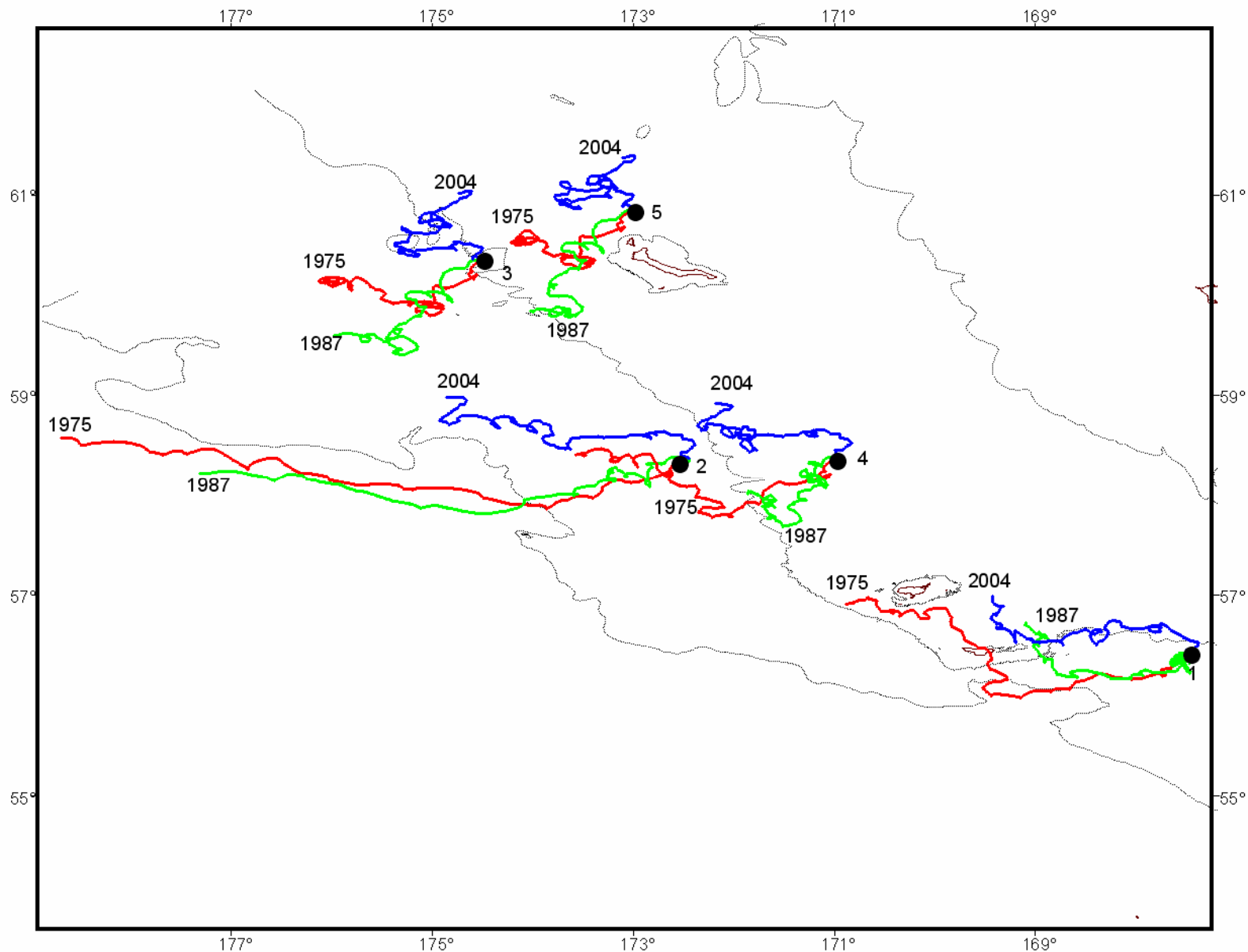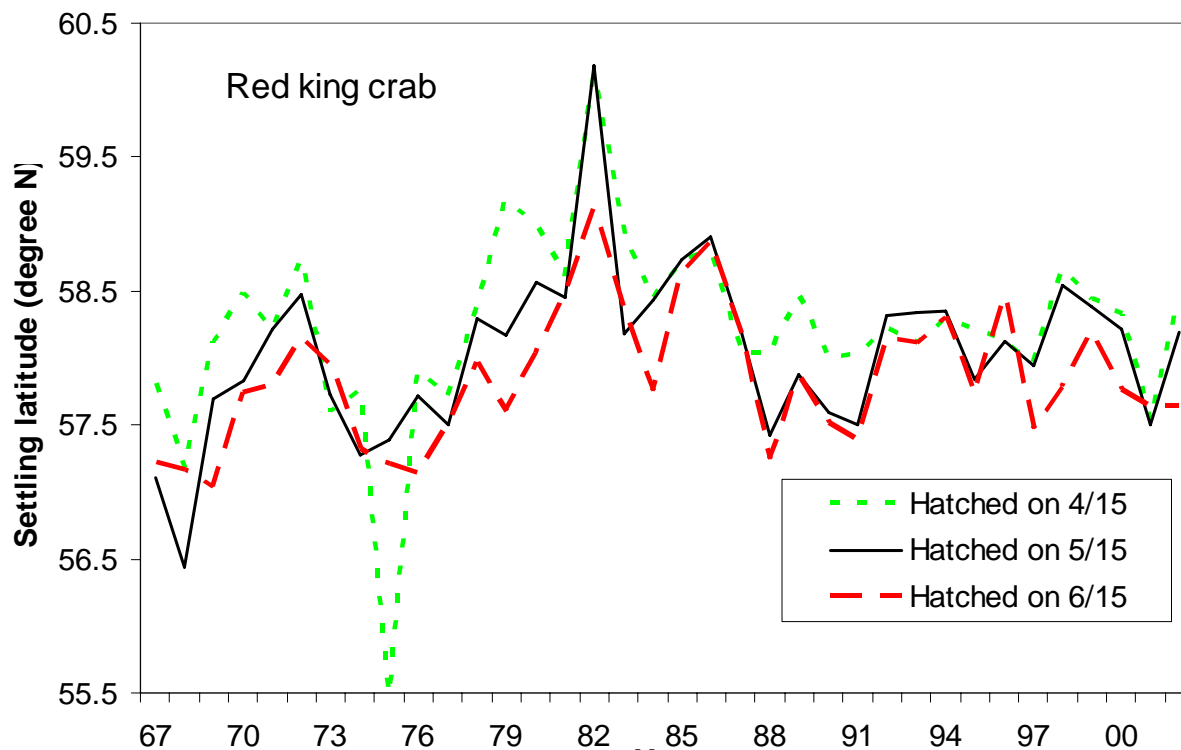
Larval durations:

For red king crab, the larval durations were averaged to be 60, 78, & 100 days when hatched on June 15th, May 15th, & April 15th.
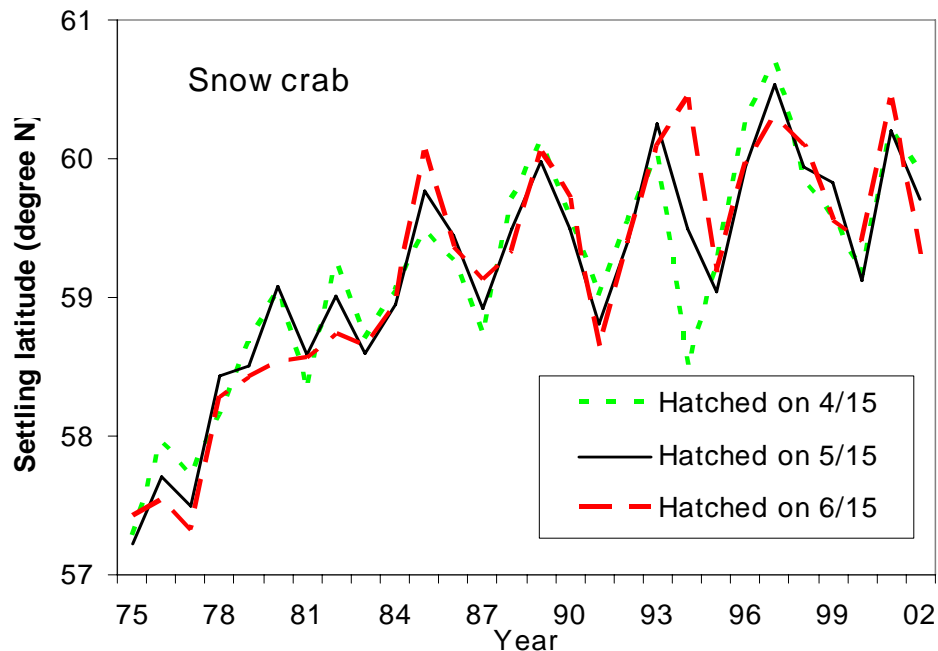
For snow crab, the larval durations were about 12 or 13 days longer than red king crab with the same hatching dates.
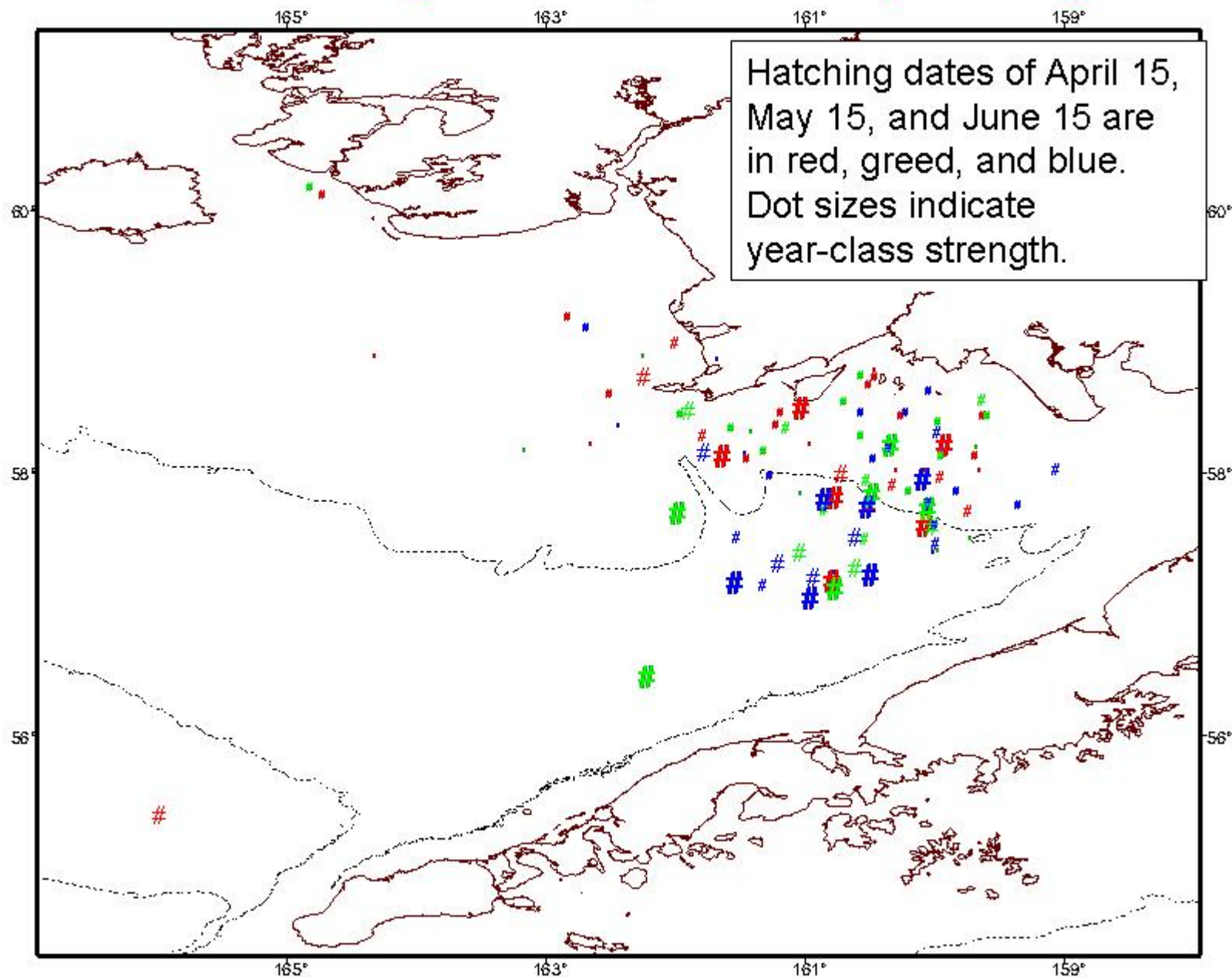
Settling locations:

For red king crab, the larvae tended to settle more in the north in the early and mid 1980s and more in the south in the late 1960s and mid-1970s.
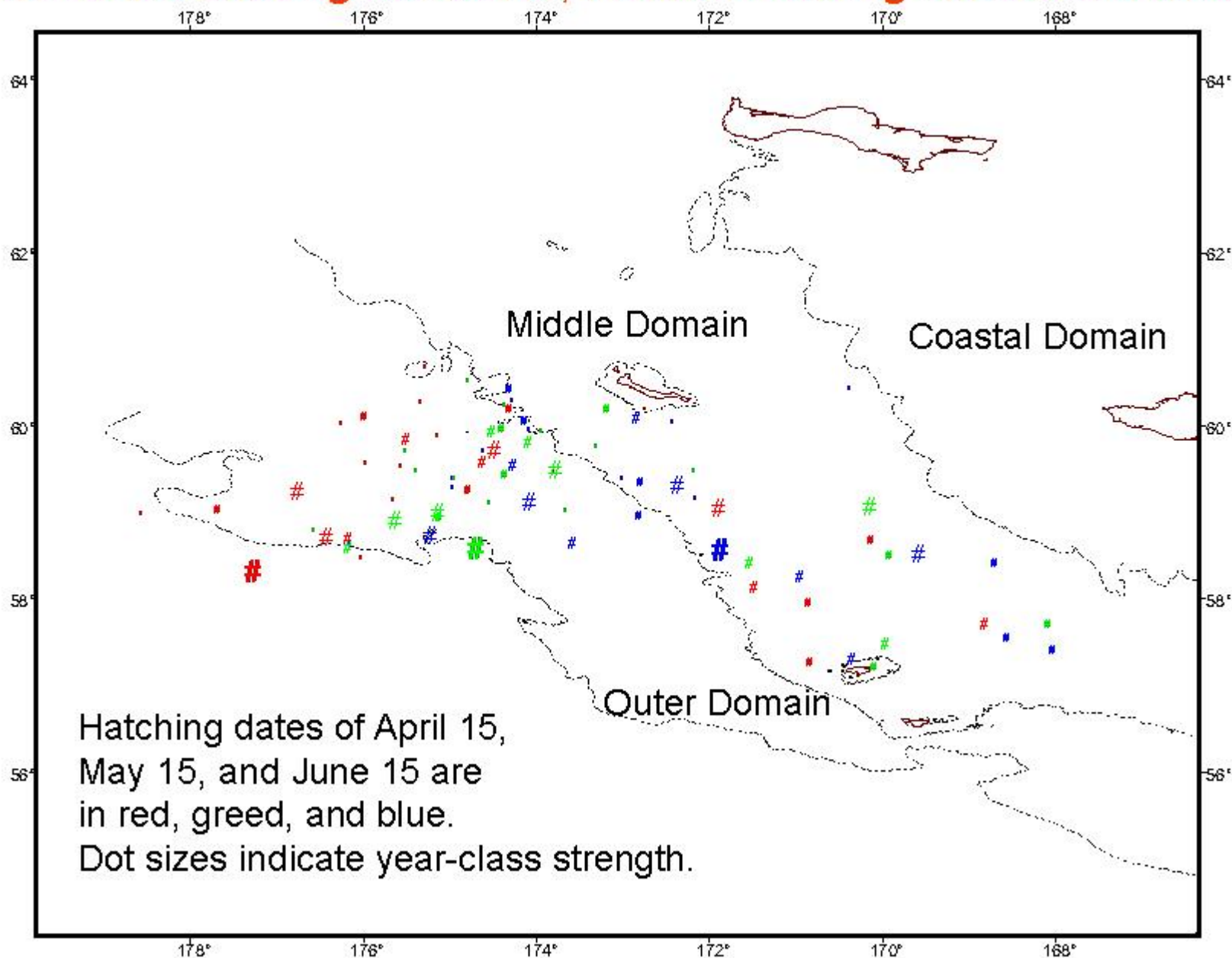
For snow crab, settling locations shifted to the north greatly during the late 1970s and gradually during the 1980s and 1990s.

Estimated settling locations, Bristol Bay red king crab

Hatching dates of April 15, May 15, and June 15 are in red, greed, and blue. Dot sizes indicate year-class strength.

Estimated settling locations, Eastern Bering Sea snow crab

Middle Domain

Coastal Domain

Outer Domain

Hatching dates of April 15,
May 15, and June 15 are
in red, greed, and blue.
Dot sizes indicate year-class strength.

Estimated settling locations, Bristol Bay red king crab

Hatching date: May 15. Drifting speeds of larvae relative to the surface currents are 35% (green), 70% (red), & 100% (blue). Dot sizes indicate year-class strength.
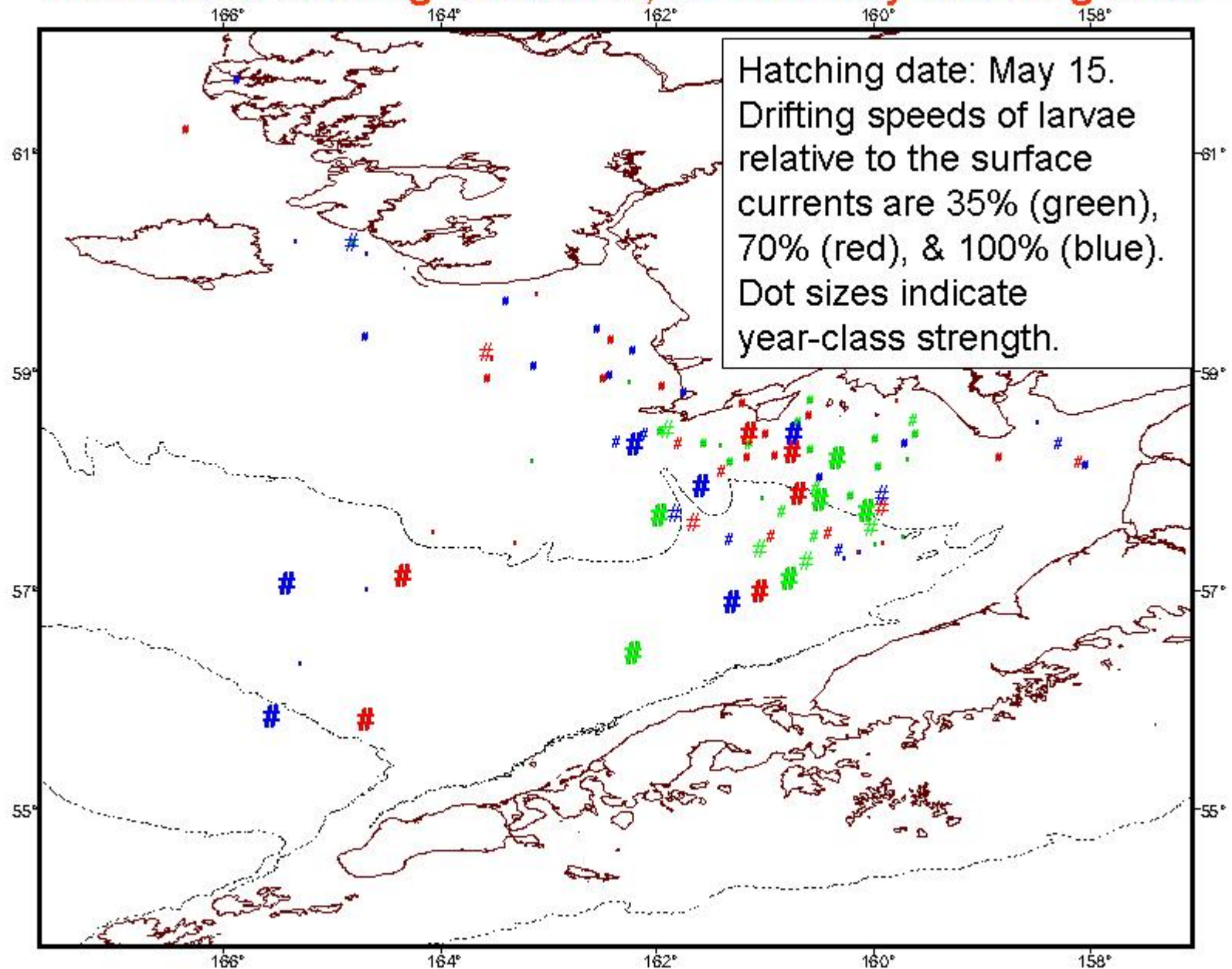
Summary

➢ *Larvae hatched in the north of their habitat might have greater chances of settling on unfavorable habitats than in those hatched in the south*

➢ *Larvae hatched earlier in a season could have longer larval duration and drift further away*

➢ *Snow crab larvae hatched in the Outer Domain have high chances to be advected away from their favorable habitats.*

➢ *The northward shifts of spatial distributions of mature females made it difficult to supply larvae to the southern portions of their ranges*

➢ *Changes in settling locations over time might have affected recruitment strength for Bristol Bay red king crab: larvae associated with strong year classes were dispersed to suitable nursery areas throughout Bristol Bay*

➢ *Simulated larval advections cannot consistently explain the strong and weak year classes for snow crab: highly uncertainty of recruitment estimates and other factors may play a very important role on recruitment success.*

Thank You!