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Ecological feasibility of red king crab stock enhancement in Kodiak, Alaska

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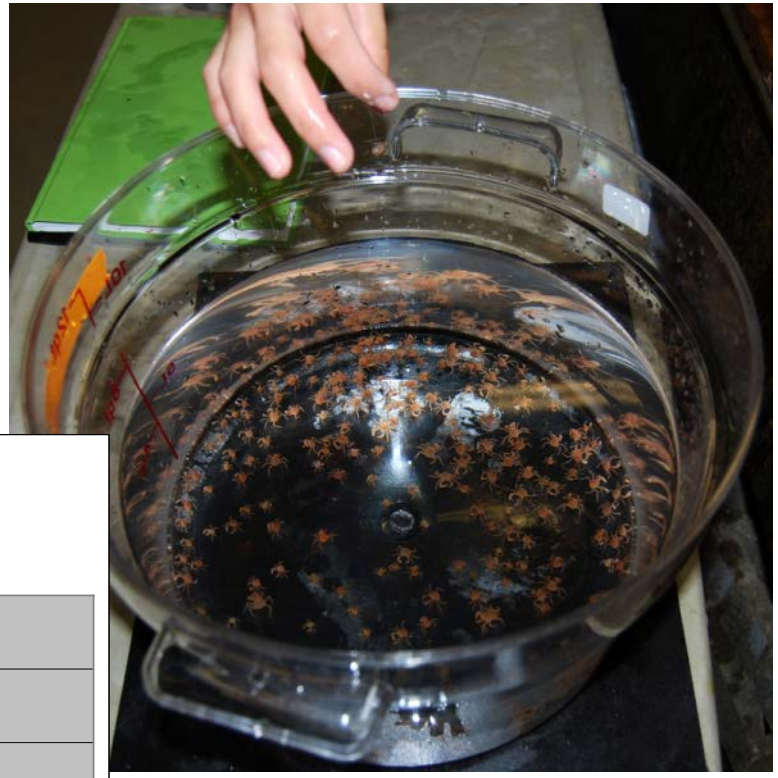
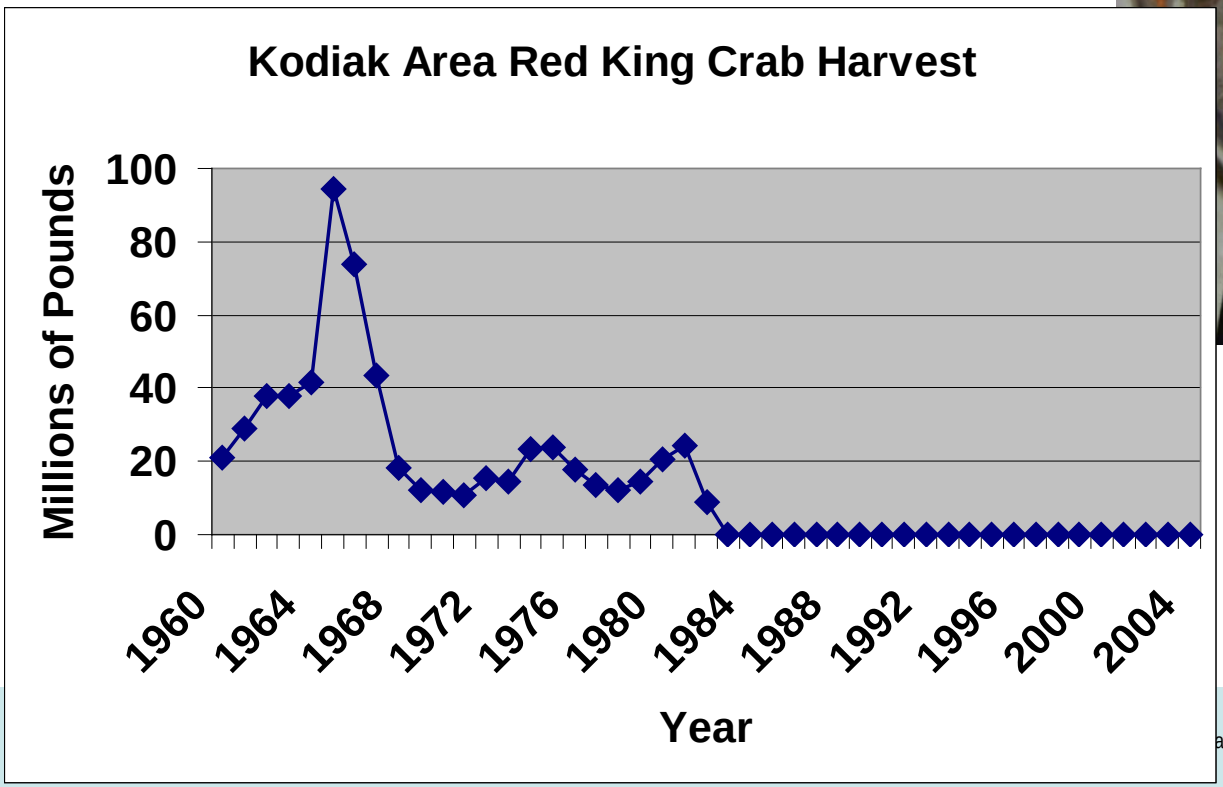
AKCRRAB

Alaska King Crab Research, Rehabilitation and Biology

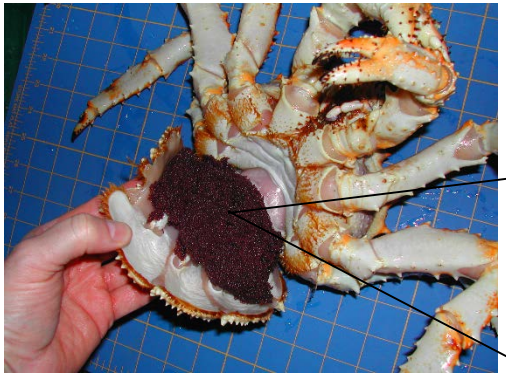
- Gulf of Alaska fishery closed in ’80s
- No recovery since
- Stock enhancement?

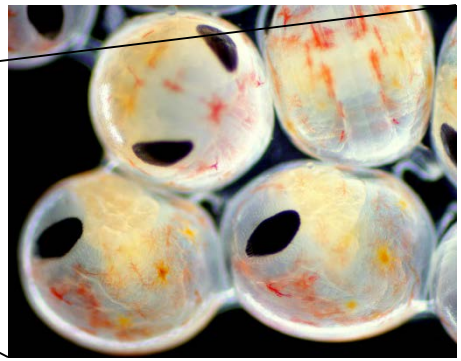




Sagalkin, N. H. 2008. Annual management report for the shellfish fisheries of the Kodiak, Chignik and Alaska Peninsula Areas, 2007. Alaska Department of Fish and Game, Fishery Management Report No. 08-72, Anchorage.

Red king crab life history

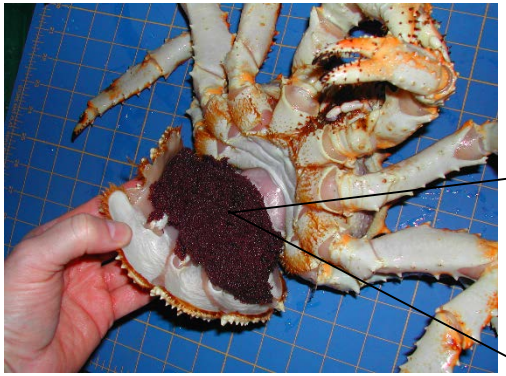


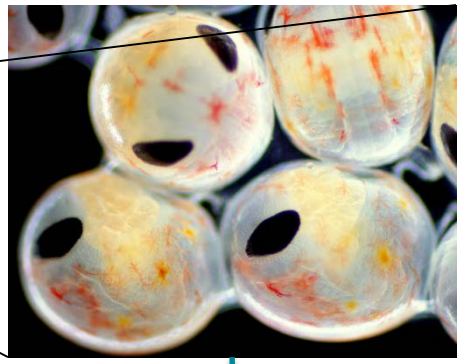


Embryos:

- Carried under abdominal flap
- Brooded for a year
- Hatch in late spring to early summer

Red king crab life history

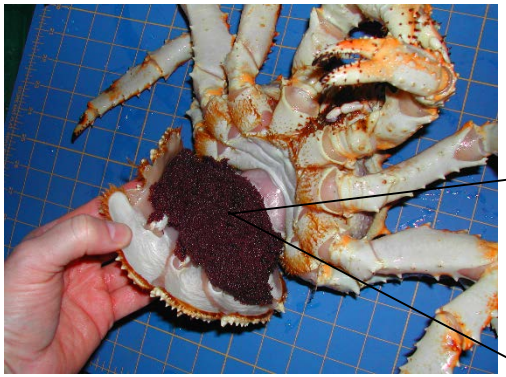


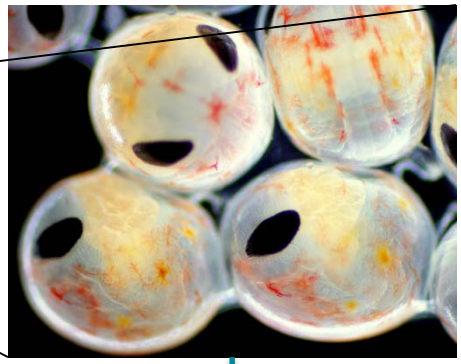


Larvae:

- Planktonic
- 4 zoeal stages
- ~2 months depending on temperature

Red king crab life history

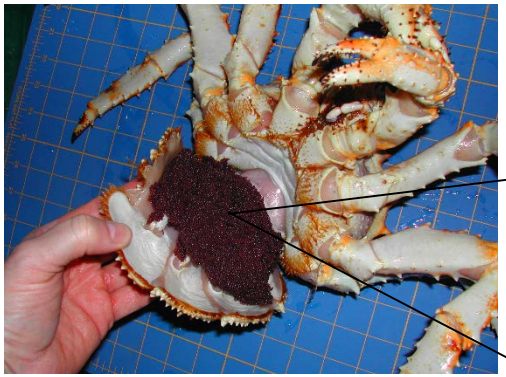


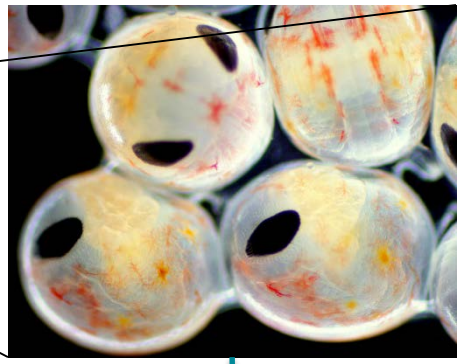


Glaucothoe

- Settling stage (like megalopa)
- Stays in the water column till it finds complex habitat
- Glaucothoe that don't find good habitat are *very* vulnerable to predation

Red king crab life history

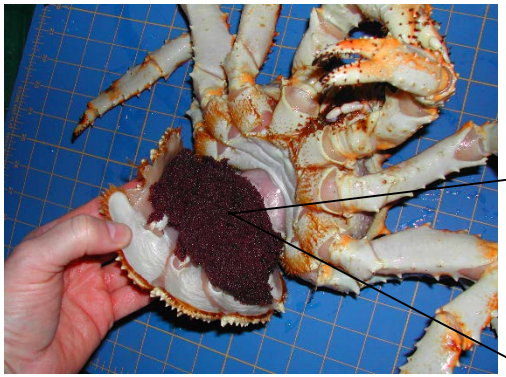


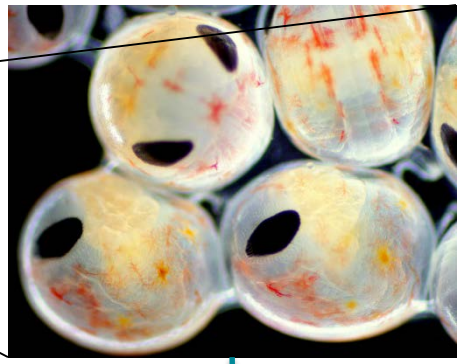


Juveniles

- Cryptic for about 2 years
  - Biogenic habitat (algae, hydroids
  - Non-biogenic (shells, gravel)
- Pod after 2 years when they outgrow habitat

Red king crab life history

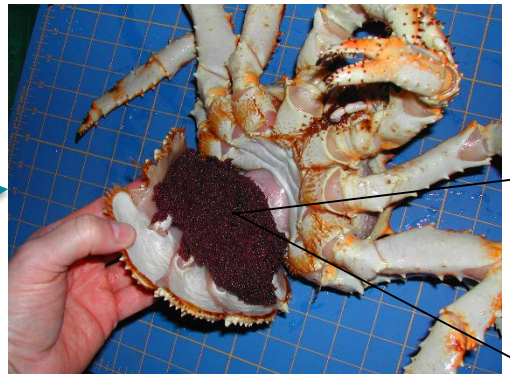


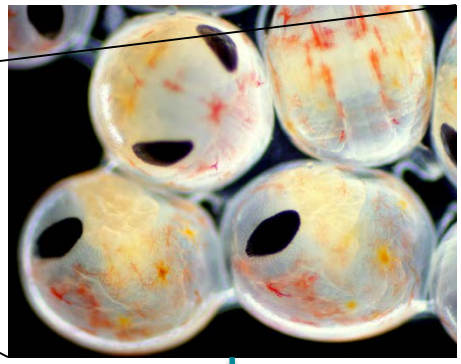


Adults:

- Mature after ~6-7 years
- Move into deeper waters
- Generally not vulnerable to predation (except after molting)

Red king crab life history

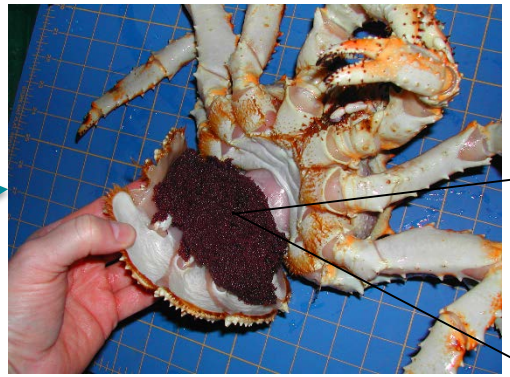


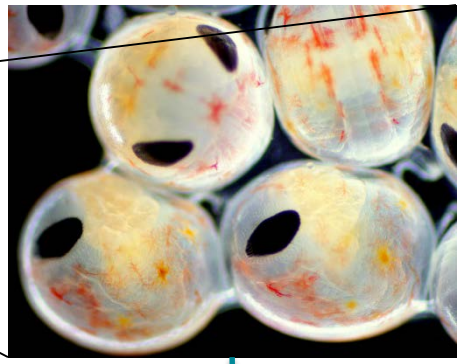


Mating

- Females molt after larvae hatch
- Extrude a new batch of eggs
- Males guard females and fertilize eggs

Red king crab life history





(Potential) Population bottlenecks

- Larvae
  - Starvation
  - Predation
- Glaucothoe- currents and habitat
- Juveniles to adults
  - Predation
  - Food

Field release questions

How do we maximize release success?

Is enhancement ecologically feasible?

Is enhancement economically feasible?
(Won't get to this one today)

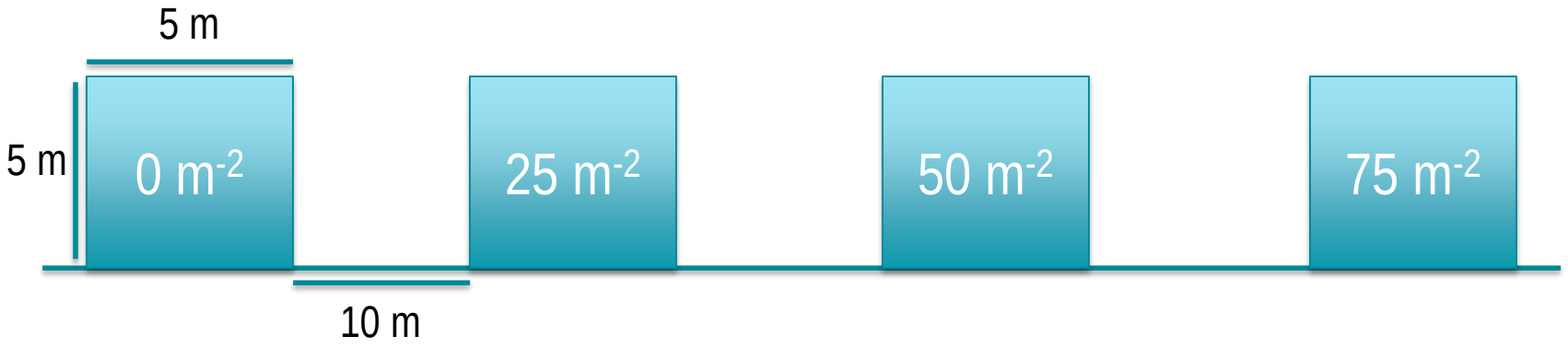
- What could influence release success?
  - Density (2014)
  - Time/Size of release (2015)

Methods: Site

- Trident basin
- 25-30 ft depth
- Complex habitat
  - Cobble
  - Shells
  - Macroalgae

Methods

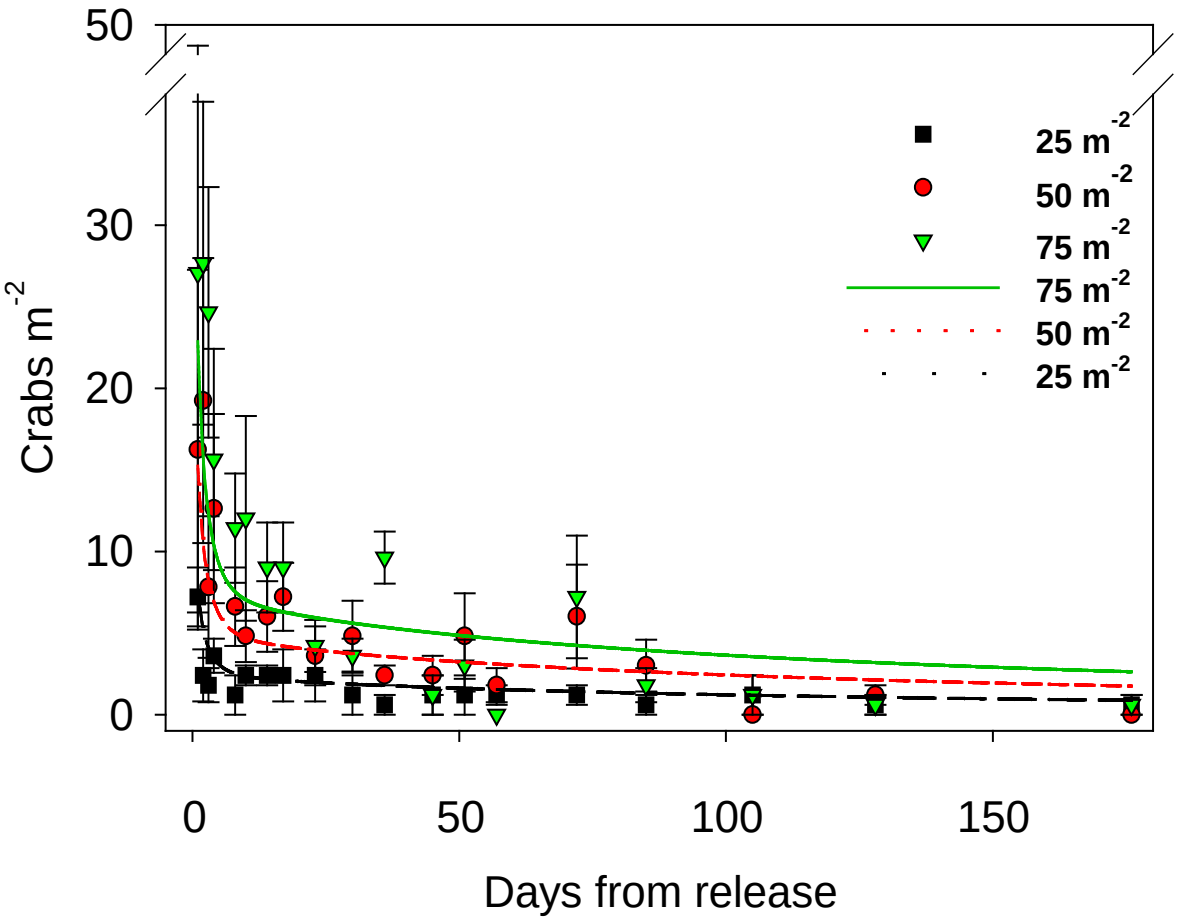
- Crabs reared at Alutiiq Pride Shellfish Hatchery
- Transect
  - 5 x 5m plots
  - Three release Treatments
    - 2014: 3 densities
    - 2015: 3 times: June (C1), Aug (~C3), Sept (~C5)
  - Three replicates of each
  - Randomized order
  - Crabs counted out for each plot



Methods

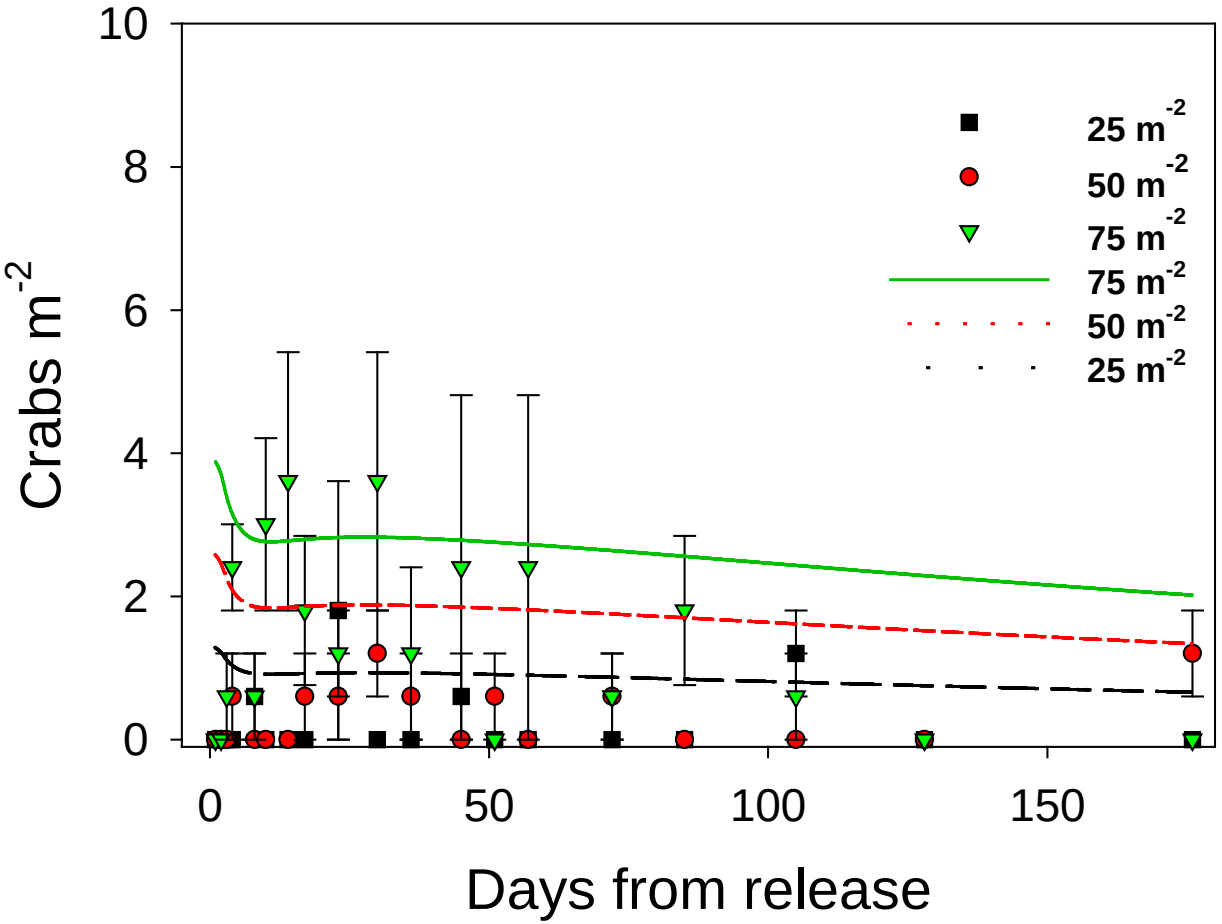
- Density
  - 50 x 50 cm quadrat
  - Counts by diver
  - 3 inside, 3 outside plots
  - Habitat and predators noted
- Predation
  - Tethering
    - 15 cm tether
    - Put out
      - Late afternoon (2014)
      - Morning (2015)
    - Checked 2x in the next 24 h
  - Predator transects for larger mobile ones

Result 2014: Density over time



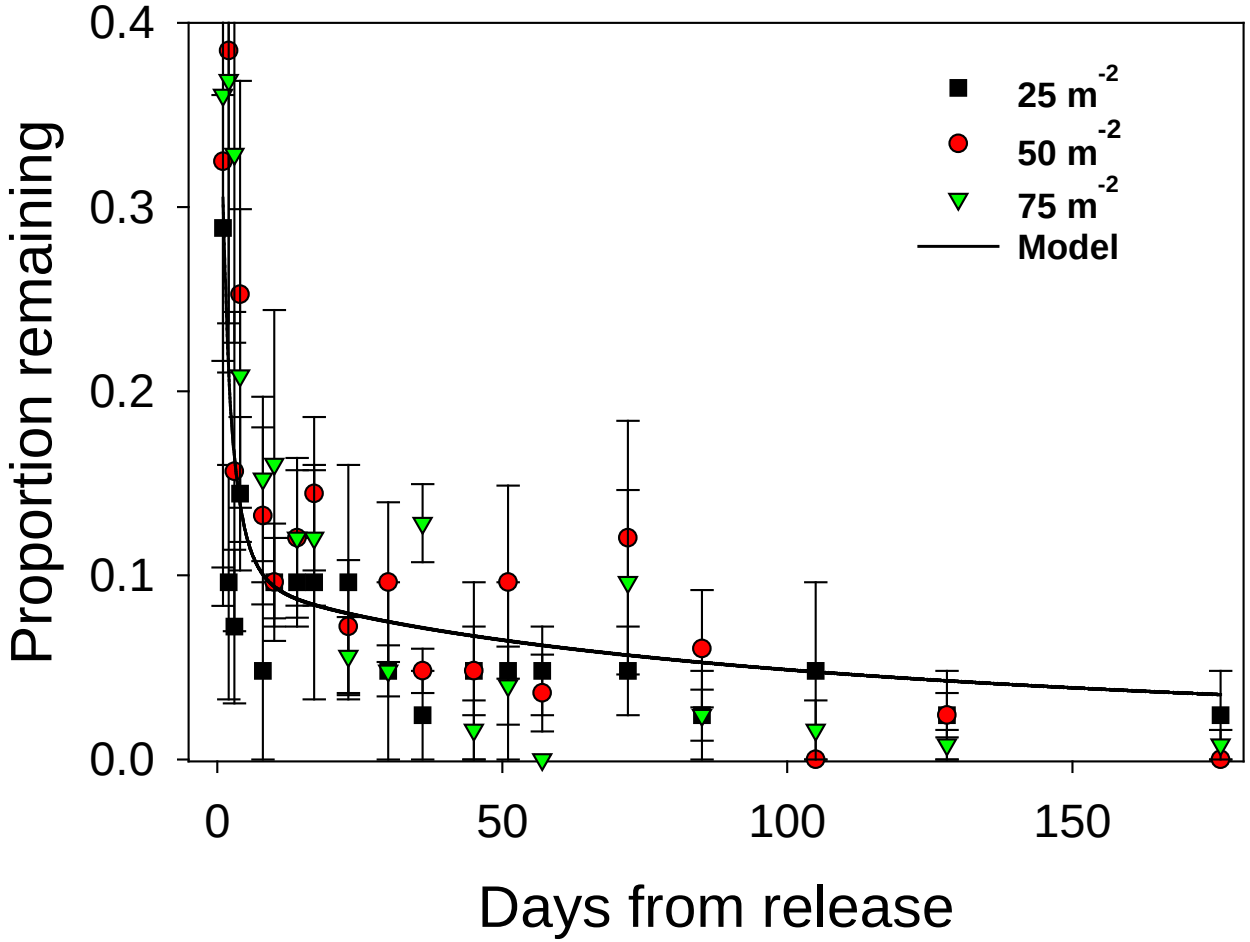
- Fit to model with migration (diffusion) and mortality
- High mortality on the first day
- Combination of migration and mortality

Results 2014: Emigration



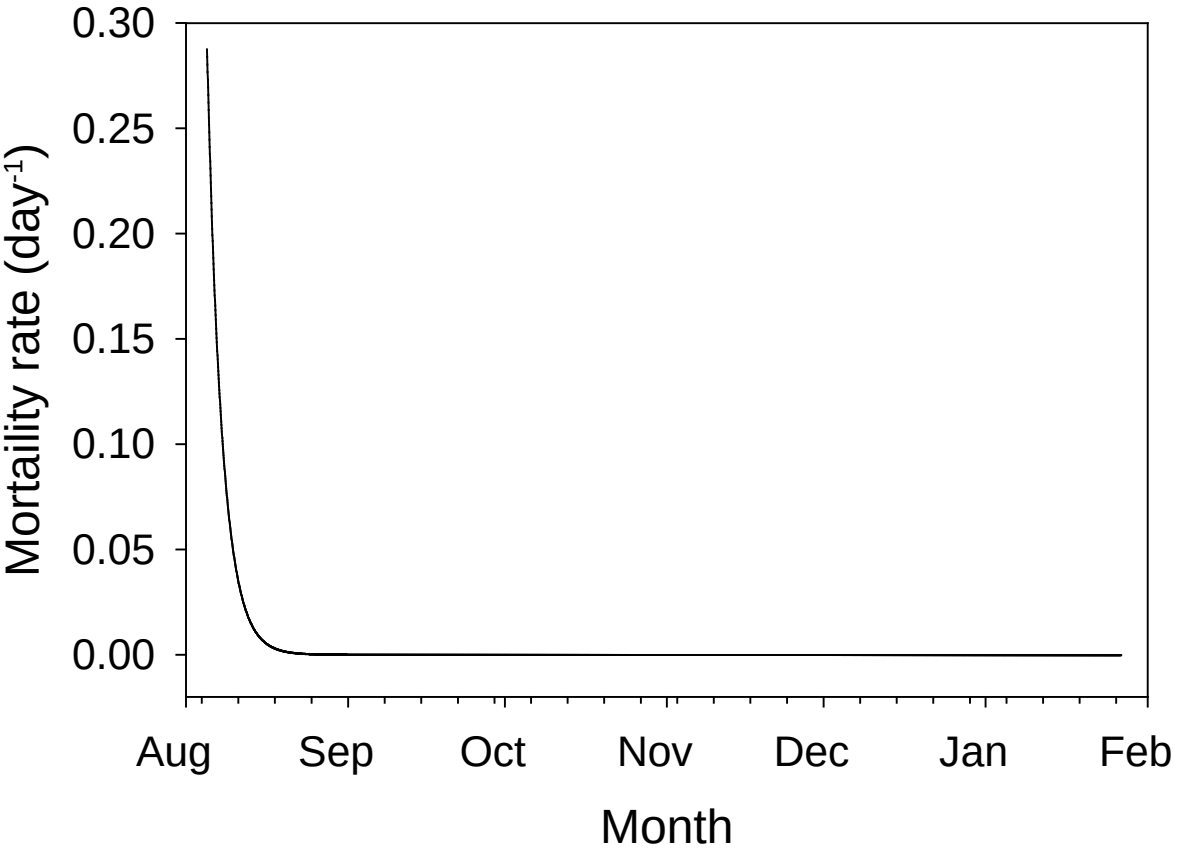
- Emigration detectable in 3-4 days
- Substantial portion of crabs lost from plots due to emigration
- No difference among treatments

Results 2014: Proportion remaining



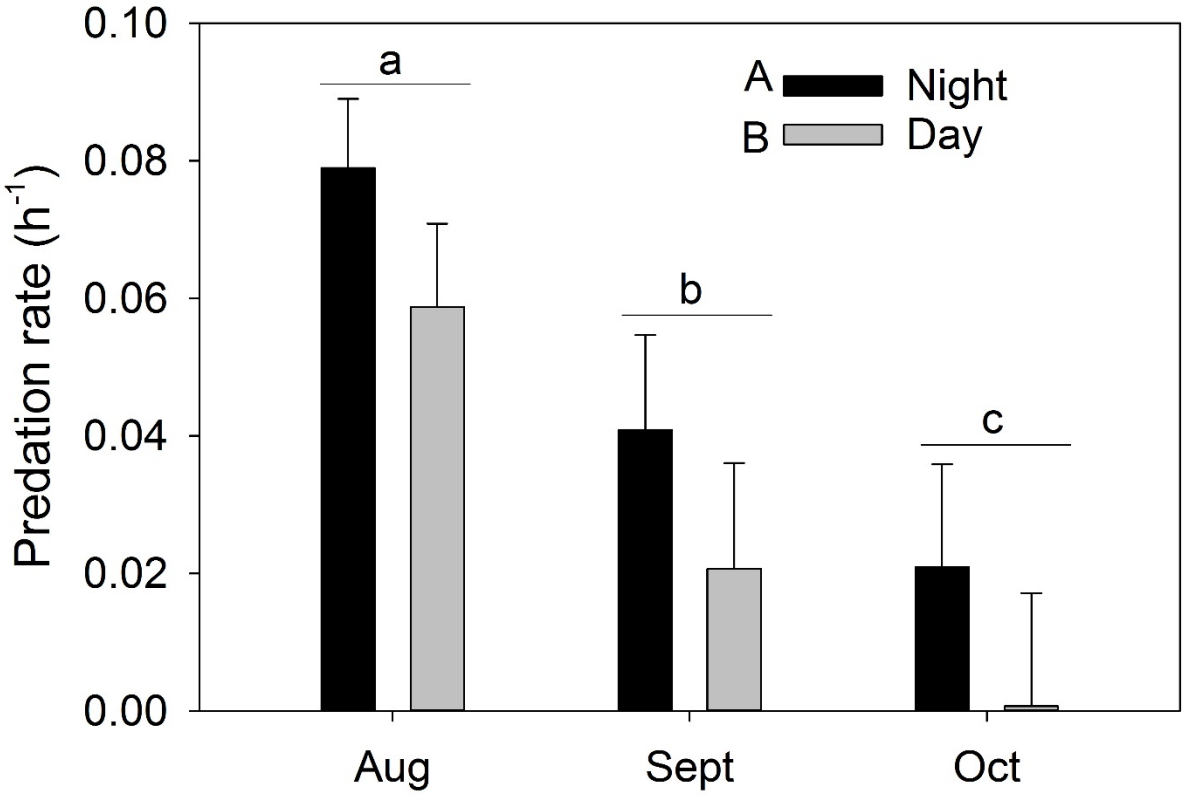
- Very low loss during last couple months
- No difference among treatments
- Estimated mortality would lead to ~34% survival after 6 months

Results 2014: Mortality rate



- Mortality rate decreased with time
- Reduced by about 90% in the first 2 weeks
- No difference among density treatments

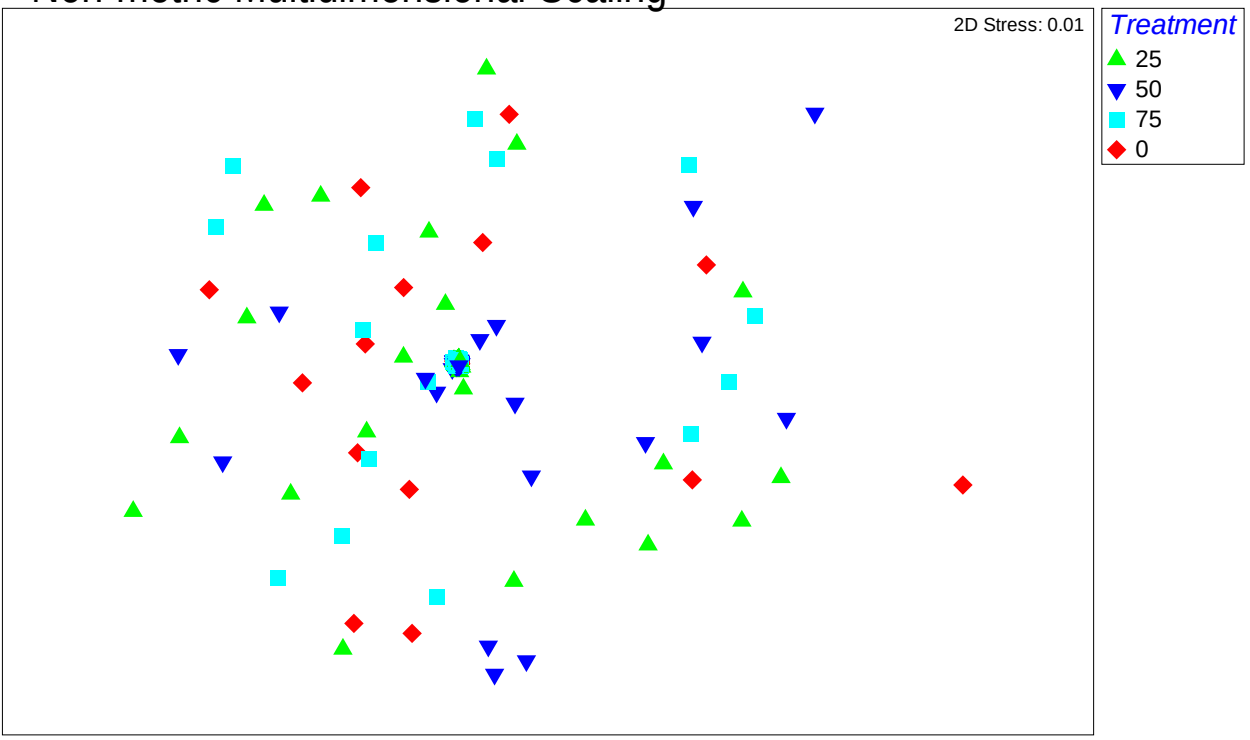
Results 2014: Tethering



- No effect of release density
- Decrease over time
  - Predator density?
  - Temperature?
  - Crab size?
- Night/Day
  - Initial vulnerability?
  - Crepuscular predators?

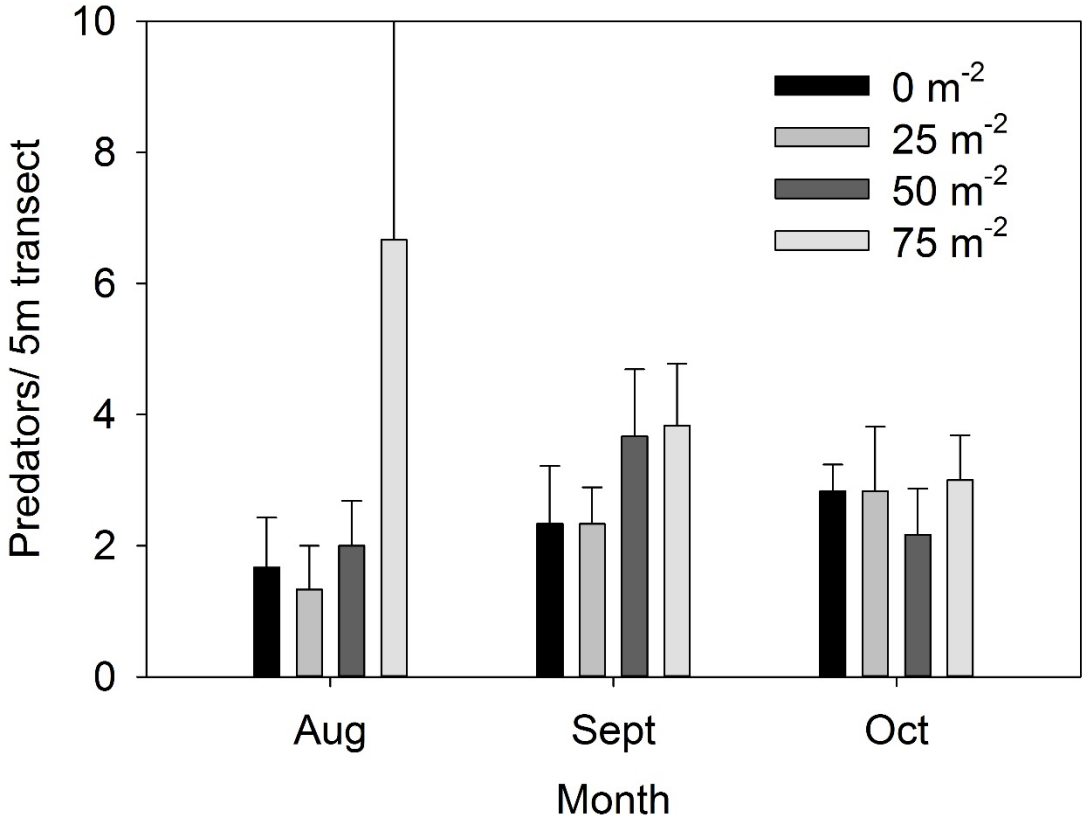
Results 2014: Predators inside quadrats

Non-metric Multidimensional Scaling



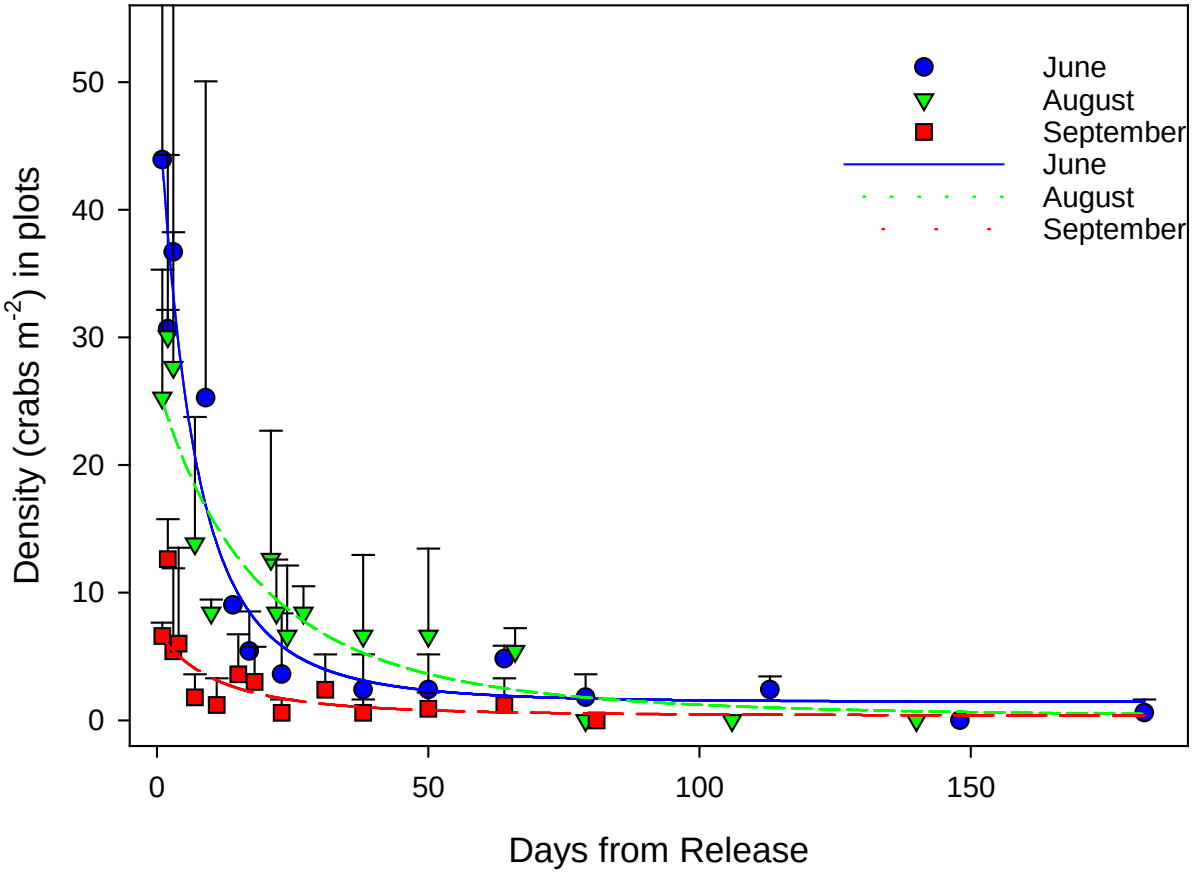
- No difference among treatments
- Common predators
  - Hermit crabs
  - Shrimp
  - Gunnel
  - Arctic shanny
  - Ronquil

Results 2014: Mobile Predators



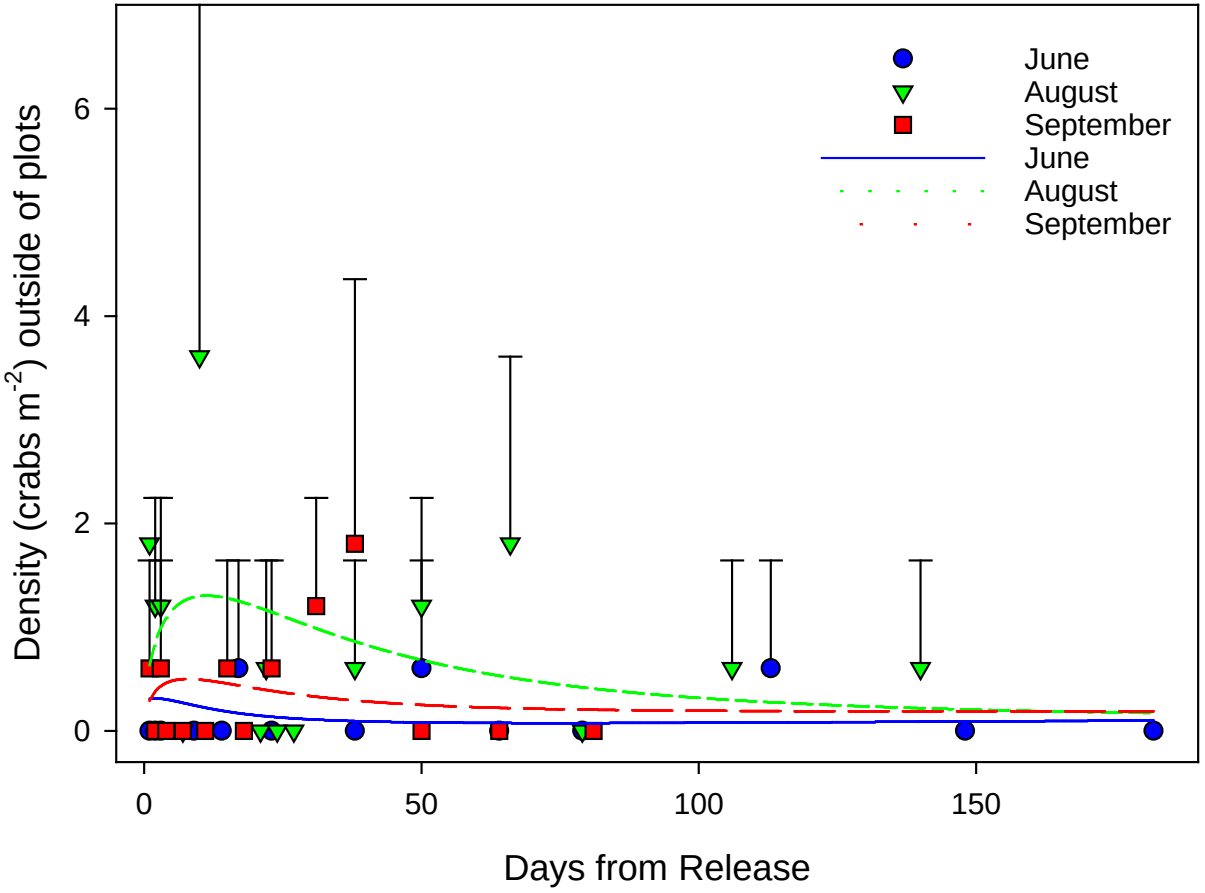
- No difference among treatments
- No difference among months
- Common predators
  - Rockfish
  - Ronquil
  - Greenlings
  - Sculpins

Result 2015: Density over time



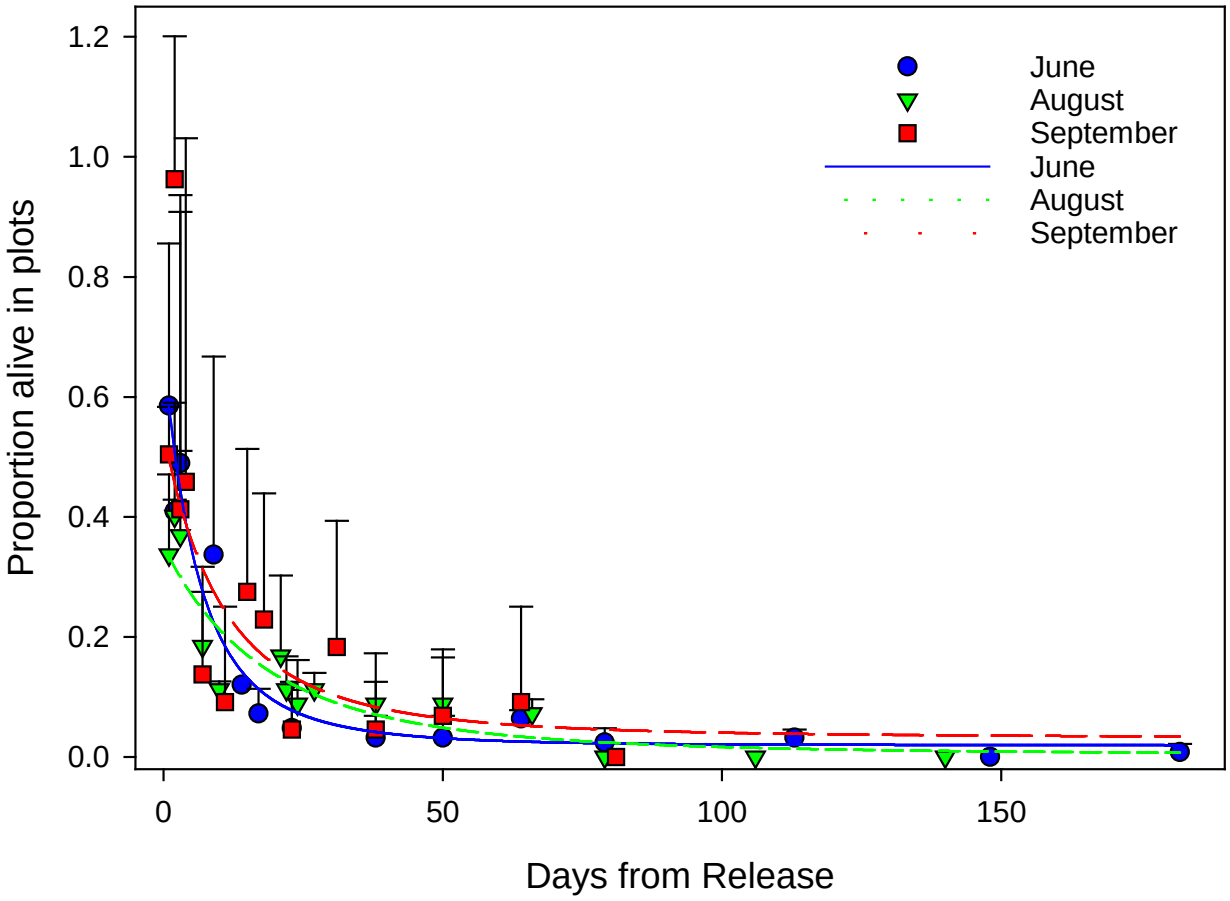
- Fit to model with migration (diffusion) and mortality
- Mortality on the first day lower than 2014
- Combination of migration and mortality

Results 2015: Emigration



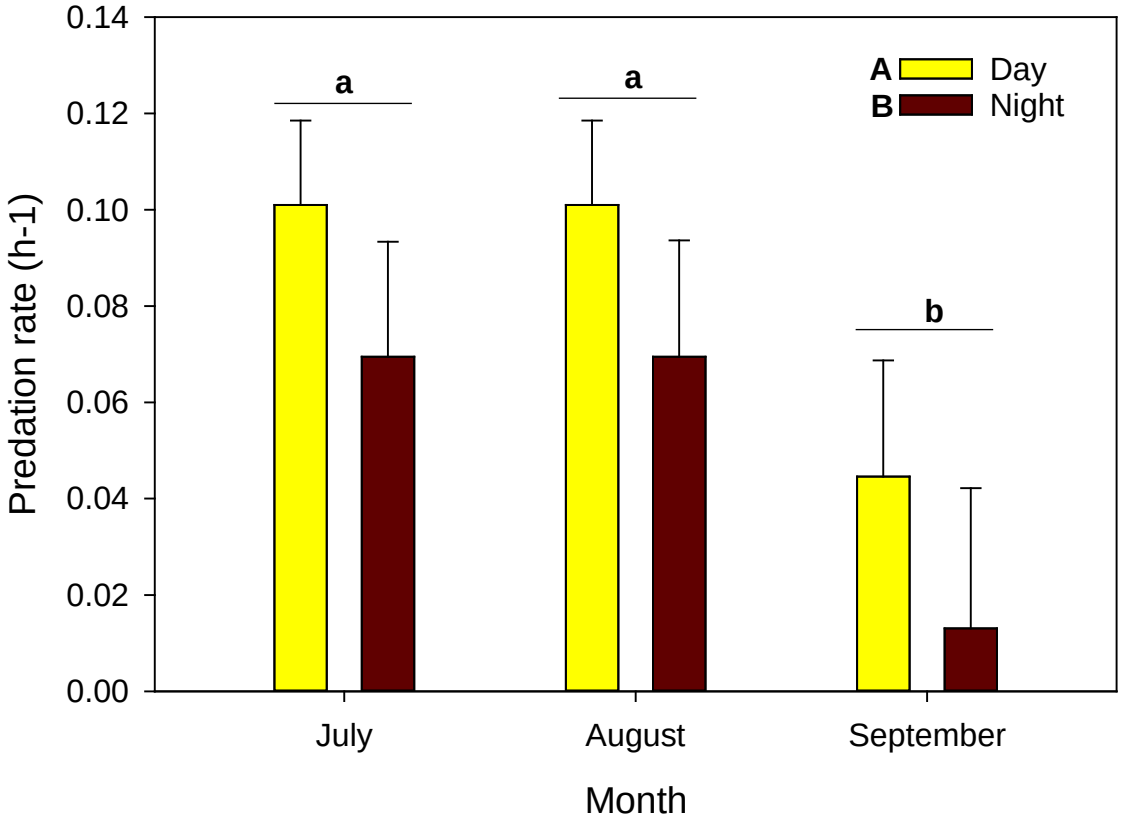
- Substantial portion of crabs lost from plots due to emigration
- Emigration rates increased with release time: lowest in June, highest in Sept

Results 2015: Proportion remaining



- Lower survival than 2014
- Difference among treatments
- Estimated mortality would lead to ~3-8% survival after 6 months

Results 2015: Tethering



No effect of release Treatment

Decrease over time

Night/Day

- Reverse from 2014
- Initial vulnerability

Higher predation rate than 2014

Conclusions Part

- High mortality right after release, ~50-70%
- Lower mortality rate afterwards
  - ~66% total mortality over 6 months (2014)
  - Better survival than SE Alaska (Loher et al. 2000)
  - Lower survival in 2015
- Crabs emigrate
  - Random walk a good fit
  - No density dependence
  - Movement increases with size

Loher, T., and Armstrong, D. A. 2000. Effects of habitat complexity and relative larval supply on the establishment of early benthic phase red king crab (*Paralithodes camtschaticus* Tilesius, 1815) populations in Auke Bay, Alaska. Journal of Experimental Marine Biology and Ecology, 245: 83-109.

Conclusions Part II

- Densities tested do not affect
  - Mortality rates
  - Emigration rates
  - Predation risk
  - Predator abundance
- Releases can occur at high densities
- Timing
  - Overall survival best in September (2.5x better than June release)
  - BUT very high mortality in tanks
  - Best strategy is probably to release at C1 stage

Next steps

- How do we increase initial survival?
  - Netting or predator exclusion cages
  - Release at night
  - Condition crabs

Thanks!

Alutiiq Pride Shellfish Hatchery

All AKKCRAB Partners

Nikki Gabriel

Nick Sisson

Kathy Swiney

Robert Foy

Lacy Harver

Kodiak Wet Lab Staff

NOAA Aquaculture Program