Evaluating the Key Factors that Influence the Efficacy of Transplanting to Supplement Recruitment

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Presentation Overview

- Background
  - Why enhancement?
  - Transplanting Efforts Worldwide
  - Transplanting Efforts in the Northeast US
- Objectives
- Project Design
- Feedback for Success

Why enhancement?

The sea scallop fishery's resilience is currently being impacted by:

- Unpredictable recruitment
- A dependence upon the strength of incoming year classes

These issues are being exacerbated by a changing climate and offshore energy development.

Transplanting Efforts Worldwide

Japan - Yesso scallops

- Prior to 1969:
  - Entirely dependent upon wild sets
  - Landings fluctuated every 2-3 years
  - Average landings never exceeded 43,000 mt
- Following the implementation of bottom seeding:
  - 70% of the landings originate from seeding efforts
  - Landings average 500,000 mt. annually

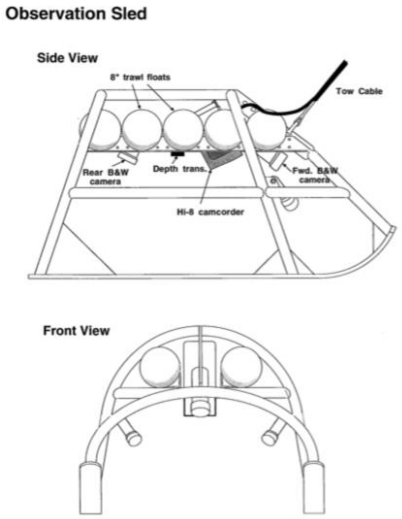
Eastern Canada – Sea scallops

- Spurred on by a decline in nearshore (<10 miles) sea scallop fisheries
- Large-scale research programs to examine sea scallop recruitment
  - Evolved to encompass all aspects of sea scallop culture & enhancement
- Enabled the development aquaculture enterprises

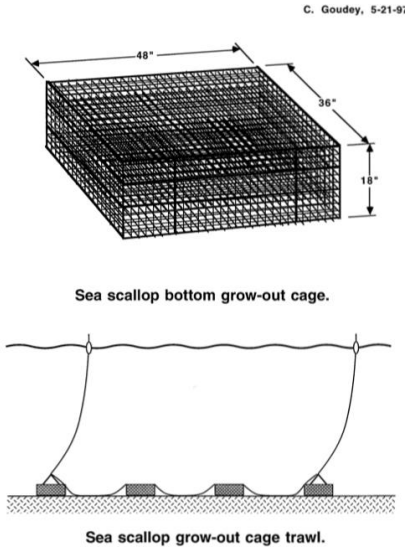
Greenland – Icelandic scallops

- An alternative for enhancing fishing grounds without readily available seed
- Capitalize upon differential growth rates across small areas
  - "Fast-growing" beds and "Slow-growing" beds
- Juvenile Icelandic scallops experienced a significant increase in growth when transplanted

Transplanting Efforts in the US



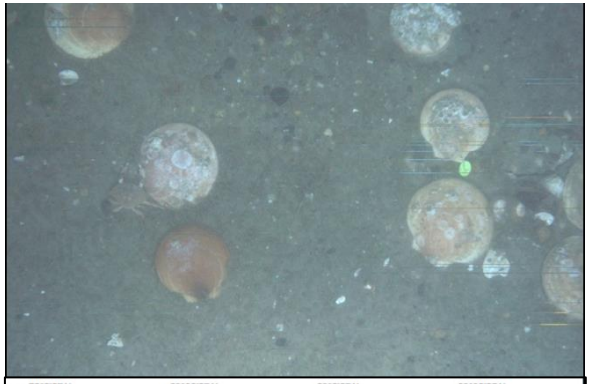

The Crop's Underwater And Harvest Hopes Are High

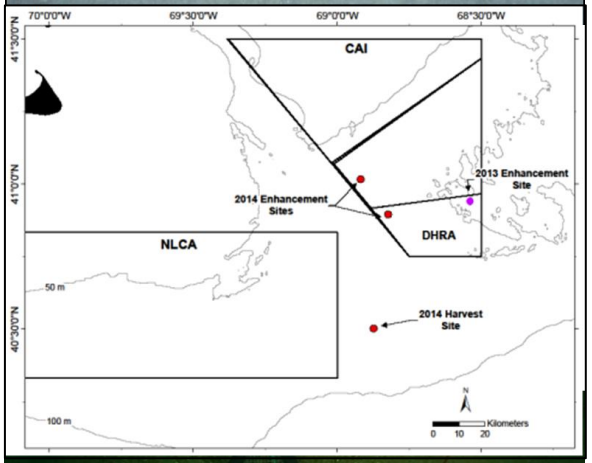


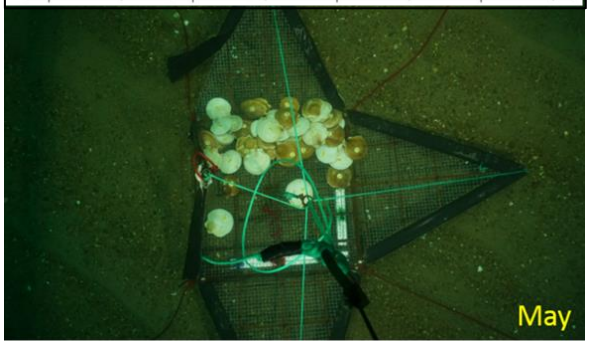
- The Seastead Project (1995-1998)
  - Responsible for:
    - Sea Scallop Working Group in MA
    - Aquaculture Committee within the NEFMC
    - Developing and promoting awareness of enhancement and area management
    - Establishing the first working aquaculture site in federal water

Transplanting Efforts in the US

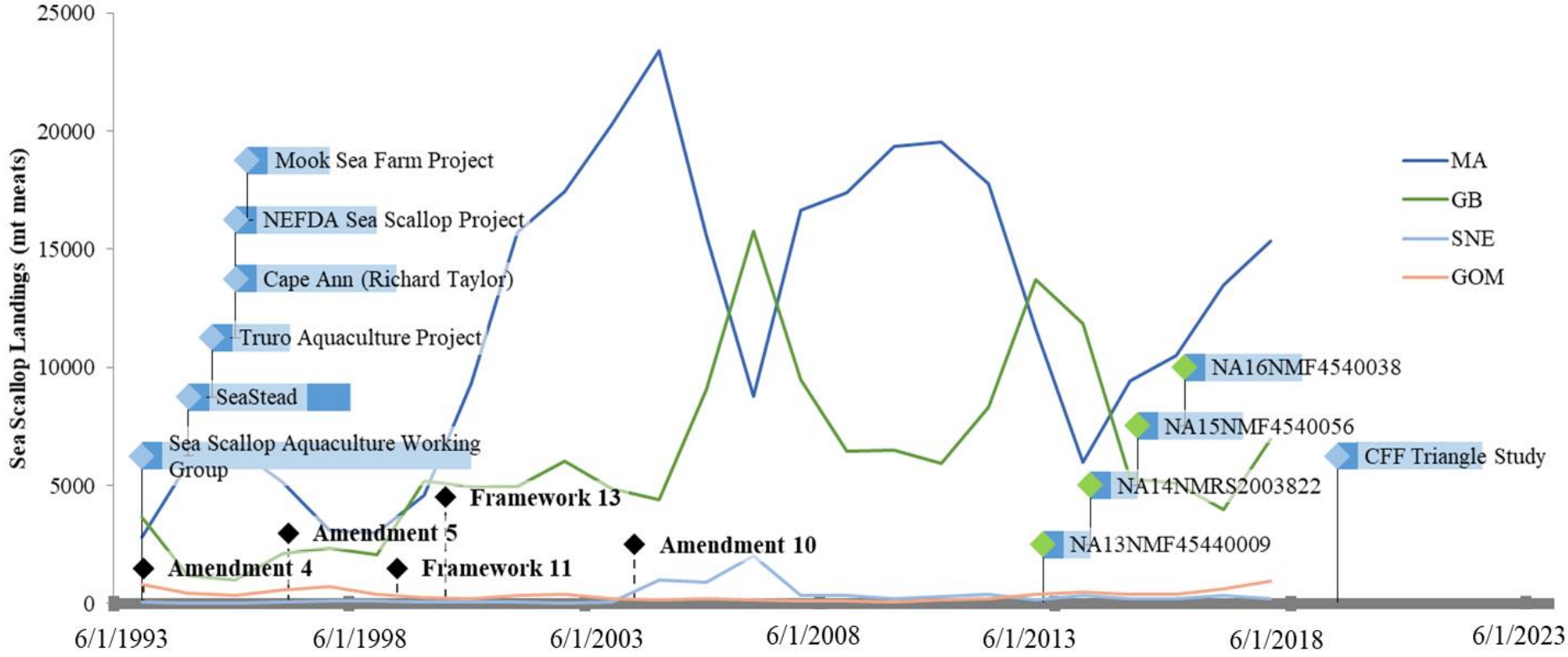
- RSA Enhancement Studies (2013-2017)
  - Year 1: A large quantity of scallops were transplanted in the DHRA south of CAI and multiple monitoring methods were evaluated.
  - Year 2: Dispersal from transplanting sites was found to be significantly higher than thought
  - Year 3: Camera stands and methods for releasing sea scallops closer to the seafloor were developed.
  - Year 4: With a time-lapse camera system we observed that transplanted scallops:
    1. Experience no immediate mortality
    2. 34-66% emigrated from the FOV over an 11-48 hour period
    3. 3% were predated upon
    4. Dispersal at this scale was non-directional







Timeline of Sea Scallop Enhancement Research since 1994



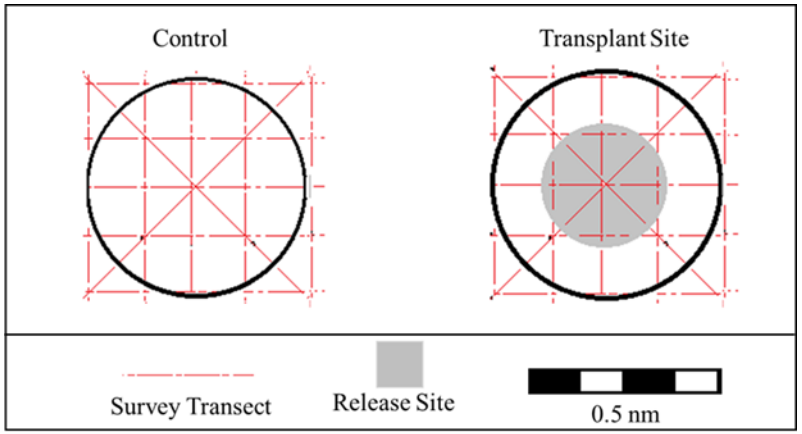
- All past and recent research has indicated that transplanting:
  - Did not result in significant mortality
  - Is economically viable
- Transplanting and enhancement research in the US can be characterized as sporadic and reactive
  - Interest in enhancement follows years with poor landings

Objectives of Upcoming Research

Build upon previous transplanting research by monitoring a transplanted sea scallop bed over the course of a 1-year period

Specific goals:

- Evaluate growth, dispersal, and mortality of transplanted scallops
- Compare the transplanted bed to a nearby natural bed



Project Design: Data Collection

Select an optimal study site

Closed to mobile bottom tending gear

Distinct regions of high and low densities

Pre-survey the control and transplant sites

Control site will be the area of origin of the transplanted scallops

Release ~2,000 baskets of sea scallops within a 0.125 nm area within the pre-surveyed area

50,000 will be tagged with ¾” Floy flexible shellfish tags

Four post-release optical surveys

Within 1-month of release

Within 3-months of release

Within 6-months of release

Within 1-year of release

Project Design: Analysis

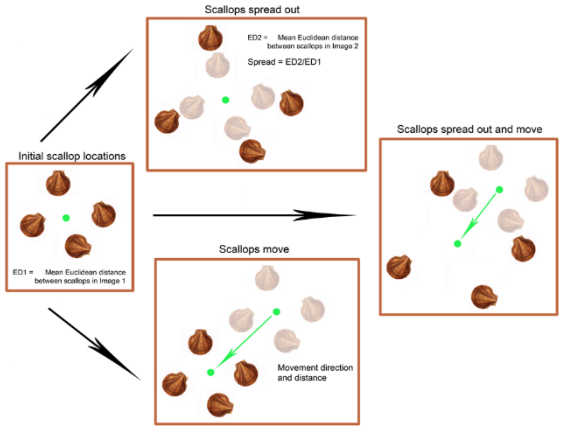
- The rate of sea scallop loss between surveys due to dispersion, incidental mortality, and predation will be evaluated
  - A key-factor analysis (Barbeau et al. 1996).
    - Dispersion
    - Incidental Mortality
    - Predation
- The relative contribution of these factors provides information about their role in the persistence of both natural and transplanted sea scallop beds

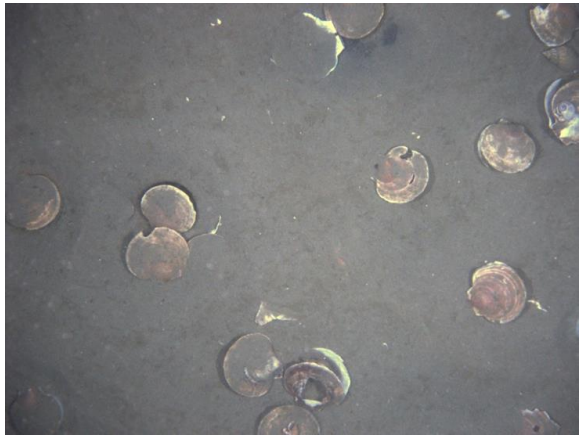
Project Design: Key Factor Analysis

- The *k*-values of each of the factors ($k_{dispersion}$, $k_{incidental}$, and $k_{predators}$) reflect the rate of scallop loss from the sites between surveys
- The summation of these values k_{total} is the observed total loss within a site
- The k-values will be calculated for each k-factor as:

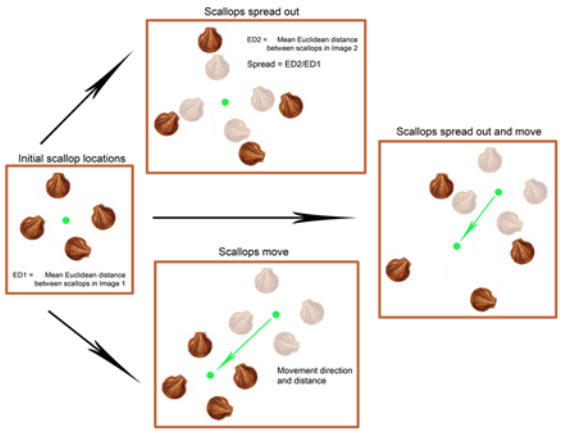
$$k_{value}=\log_{10} A_1-\log_{10}(A_2)$$

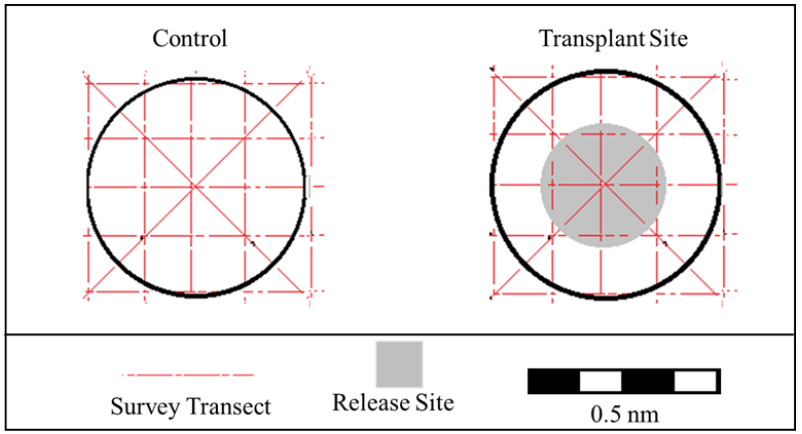
  - Where A_1 is estimated scallop abundance at a survey, and A_2 is estimated scallop abundance after a *k*-factor has acted.





Loss due to dispersion: $k_{dispersion}$





Calculated as a longitudinal (F_x) and latitudinal (F_y) flux across the 0.125 nm region surrounding the Transplant Site:

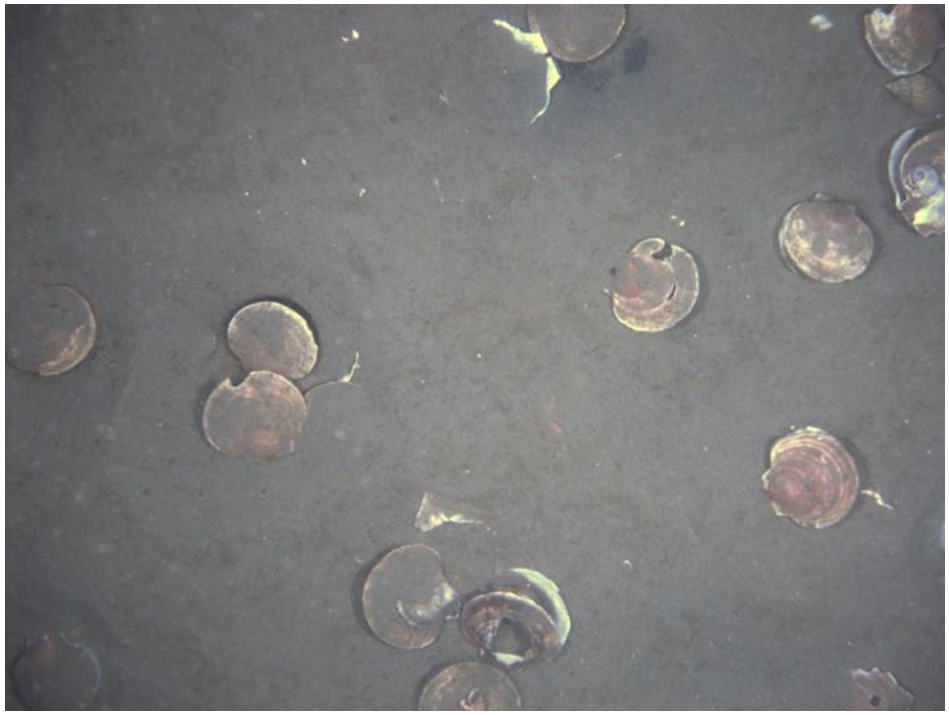
$$F_x = -C_y(\text{density}/x) \text{ and } F_y = -C_y(\text{density}/y)$$

The diffusion coefficients (C_x and C_y) will be calculated as:

$$C_x = (2_{x,\,s+1} - 2_{x,s})/[2(ts+1-ts)] \text{ and } C_y = (\sigma^2_{y,\,s+1} - \sigma^2_{y,s})/[2(ts+1-ts)]$$

Where σ^2 is the variance in displacement longitudinally (x) or latitudinally (y), *t* is the time in days from the release event, and *s* is the survey.

Loss due to Incidental Mortality: $k_{incidental}$



Loss due to incidental mortality will be estimated following the equation:

$$I=\mu_{damaged} * R$$

Where $\mu_{damaged}$ is the mean proportion of damaged to undamaged scallops observed during transplanting and *R* is total scallops released.

Loss due to predation: $k_{predators}$

Predation losses will be estimated by:

$$P=A_{predator}*(\#\ of\ scallops\ eaten^{-1\ day})\ *\ t$$

A is the estimated abundance of the predator species and *t* is the number of days between surveys. Published estimates of a species predation rate (number of scallops eaten per day) will be used for the proposed research.

Questions?