Fish movement and commercial fishing impacts on Steller sea lions

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Goal – investigate the potential impact of commercial groundfish fishing

Impacts – distribution, abundance, biological characteristics, community characteristics

Purpose – provide advice re: effects of management actions on fish community, marine mammals, seabirds and etc.
Steller sea lion (*Eumetopias jubatus*)

http://nmml.afsc.noaa.gov/gallery/pinnipeds/pinniped_gallery3.htm
Decline of the western stock of sea lions

1997 SSL declared endangered (ESA)

Sease & Gudmundson 2002
FIT’s current mission

1. Do commercial fisheries result in localized depletion and/or disruption of Steller sea lion prey fields?
2. What is the efficacy of existing protection measures (trawl exclusion zones)?
Groundfish species

- Atka mackerel (*Pleurogrammus monopterygius*)
- Pacific cod (*Gadus macrocephalus*)
Pacific cod

- Family Gadidae
- Spawning aggregations in Aleutian Islands and SE Bering Sea during winter
- 11% of commercial catch
- Large portion of sea lion diets in winter
Pacific cod project overview

- Field test for localized depletion of cod due to commercial trawling
- Before-after-control-impact design
• Cape Sarichef no-trawl zone intersects historically trawled area, provides “Treatment” and Control”
• Surveys “Before” (Jan) and “After” (March) main trawl season
• 2004, 2005

• Pot catch used as index of local cod abundance. Pots provide good sample size and spatial precision.
• Compare change in pot catch (After/Before) between treatment and control areas.
Measured Variable: Ratio of Average Catch After/Before

- $X_B =$ Avg. catch over 3-5 pots in “Before” survey
- $X_A =$ Avg. catch over 3-5 pots in “After” survey
- Percentage change $\delta$

$$\delta_i = \frac{(X_A - X_B)}{X_B} = \frac{X_A}{X_B} - 1$$

$\delta \sim 0$ No change in abundance
$\delta > 0$ Increased abundance
$\delta < 0$ Decrease abundance

- Compare $\delta$ between control and treatment
N= 40 sites trawled, 40 sites untrawled
Cod catch increased from January to March
Wilcoxin Rank-Sum Test for difference in means:  p=0.981
If localized depletion, expect less of an increase in trawled
Power: 75-95% chance of detecting 30% reduction in catch
Distribution of Pct Change - 2005

Wilcoxin Rank-Sum Test for difference in means:  p=0.807
Power: 75-95% chance of detecting 20% reduction in catch
Possible Reasons for Observed Result:

1. Fishery removals not enough to significantly affect local abundance
2. Effect disperses in <2 weeks
3. Spatial scale of effect larger than scale of experiment
4. Directional migration of fish – spatially displaced effects
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Tags released in Trawl Exclusion Zone (Control Area) at Cape Sarichef and recovered less than 8 days at liberty (n = 42).
Tags released in Trawl Exclusion Zone (Control Area) at Cape Sarichef and recovered between 7 to 14 days at liberty (n = 73).

Legend
- February 2003 Releases
- April 2002 Releases
- Cape Sarichef Research Area
- Trawl Exclusion Zones
Summary

• Pacific cod
  – Localized depletion due to commercial fishing was not observed
  – Movement through study area was great
  – Suggest that commercial fishing effect was dispersed or displaced
Atka mackerel

- Family Hexagrammidae
- One of the most abundant groundfish in the Aleutian Islands
- Large portion of SSL diets during summer and winter
Atka mackerel project overview

• Evaluate efficacy of trawl exclusion zones (TEZ)
  – Do fish move from inside to outside?
  – What is the abundance of fish inside?
• Tag release-recovery model
  – Local abundance
  – Movement rates
Atka mackerel – Study site
Study sites

Amchitka
Tanaga
Seguam
Movement rate

In- to Outside TEZ
Out- to Inside TEZ

Segment (2000)
Segment (2002)
Tanaga E
Tanaga W
Amchitka S
Amchitka N

Area

Movement rate (day⁻¹)
Management implications?

- Efficacy of trawl exclusion zones varies geographically
  - Seguam and Tanaga
    - High biomass, low movement, more effective
  - Amchitka
    - Low biomass, high movement, less effective
Conclusions

- **Pacific cod**
  - Suggest that a localized commercial fishing effect was dispersed or displaced due to fish movement
  - Need to consider fish movement when designing studies of fishery effects
- **Atka mackerel**
  - Suggest that trawl exclusion zones at sites where movement from inside to outside is great are less effective
  - Need to consider fish movement when designing trawl exclusion zones or marine protected areas
Contact information

http://www.afsc.noaa.gov/refm/stocks/fit/FIT.htm

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