Killer whale research through 2006 and implications for potential predation on Steller sea lions

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Outline

- Summary of new literature responding to Springer et al. paper
- Update on killer whale tagging and movement studies
- Update on killer whale chemistry
- Abundance estimates for killer whales
- Energetic demands of the killer whale population and potential impact on Steller sea lions

Springer et al. 2003

- Hypothesized that great whales were an important prey resource for killer whales
- Removal of great whales (primarily fin and sperm whales) by commercial whaling in the North Pacific in the late 1960s and 1970s removed this killer whale prey resource
- That precipitated prey switching by killer whales and a sequential decline of populations of harbor seal, northern fur seal, Steller sea lion and northern sea otter.
- Several papers have been published recently critiquing this hypothesis

Demaster et al. 2006

The Sequential Megafaunal Collapse Hypothesis: Testing with Existing Data

(Progress in Oceanography Vol. 68:329-342)

- Fin and sperm whales (the primary species taken post WWII) are not important prey for KW
- The biomass of all whale species was not in decline (e.g., gray whales)
- Trends are not sequential

  (performed statistical test (unlike Springer et al.)

Mizroch and Rice 2006

Have North Pacific killer whales switched prey species in response to depletion of the great whale populations?

(Marine Ecology Progress Series 310:235–246)

- Any whaling-related prey shifting should have started by the 1960s (not the mid-1970s) (after examining timing of whaling at high latitudes)
- In data available prior to 1968, less than 3% of mammal-eating killer whale stomachs contained great whale remains
- Minke and gray whales were not depleted by post WWII whaling, and have been available as prey

Trites et al. 2007

Killer whales, whaling and sequential megafaunal collapse in the North Pacific: A comparative analysis of the dynamics of marine mammals in Alaska and British Columbia following commercial whaling

(Marine Mammal Science)

- Populations of seals, sea lions, and sea otters increased in British Columbia following commercial whaling
- A more likely explanation is that the seal and sea lion declines and other ecosystem changes in Alaska stem from a major oceanic regime shift that occurred in 1977

Wade et al. 2007

Killer whales and marine mammal trends in the North Pacific – a re-examination of evidence for sequential megafauna collapse and the prey-switching hypothesis

(Marine Mammal Science. Published online)

- Large whale biomass in the Bering Sea did not decline as much as suggested by Springer et al., and much of the reduction occurred 50–100 yr ago
- With the sole exception that the sea otter decline followed the decline of pinnipeds, the reported declines were not in fact sequential
- Observed killer whale predation has largely involved pinnipeds and small cetaceans; there is little evidence that large whales were ever major prey item in high latitudes.
- Small cetaceans (ignored by Springer et al.) were likely abundant throughout the period
- The spatial and temporal patterns of pinniped and sea otter population trends are more complex than suggested by Springer et al. and are often inconsistent with their hypothesis.

Wade et al. 2007, cont.

- West coast of North America (Southeast Alaska to California)
  - No declines – all species of pinniped and sea otters increased
- Gulf of Alaska
  - SSL and HS declined simultaneously, then sea otters declined in some areas but not others
- Bering Sea and Aleutian Islands
  - NFS and SSL declined simultaneously, largest biomass of HS (in Bristol Bay) was roughly stable, sea otters declined after others species
  - Although NFS declined, their biomass was still several orders of magnitude greater than sea otters, so there was no logical reason that KWs would switch to sea otters because NFS biomass was too rare
- Commander Islands
  - Only one species (SSL) declined, NFS increased and HS and Sea otters were stable

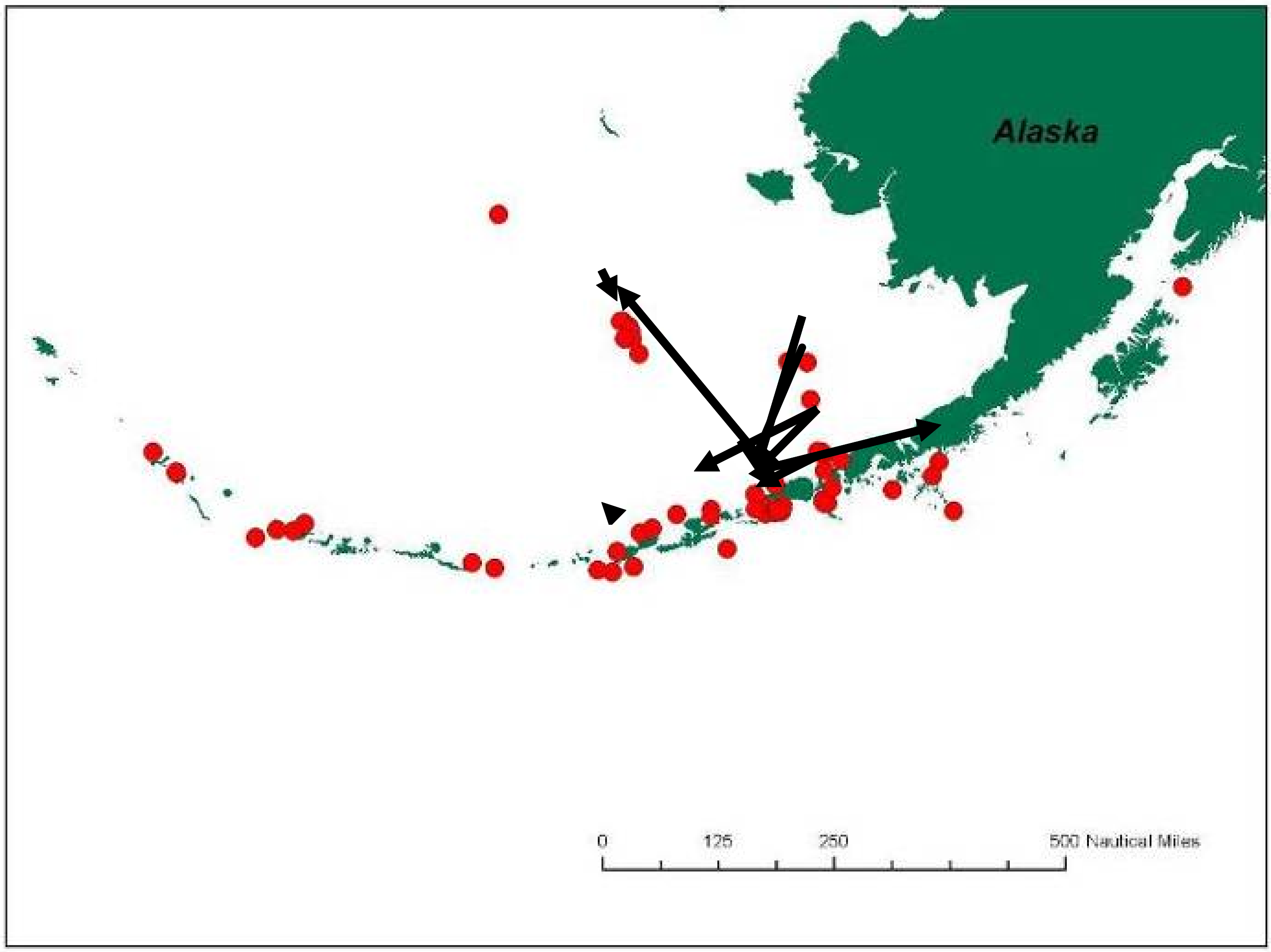
Maniscalco et al. 2007

Assessing killer whale predation on steller sea lions from field observations in Kenai fjords, Alaska

(Fishery Bulletin)

- 59 Steller sea lions preyed on 2002-2005
- Caloric requirements (ala Williams et al. 2004) would predict 103 predations over that time period
- The difference may be that transient killer whales in this region spend a large proportion of their daily behavior "resting", and therefore have a lower caloric demand than estimated by Williams et al.
- They suggest their study indicates that GOA transients are having a minor effect on the recovery of Steller sea lions in the GOA.

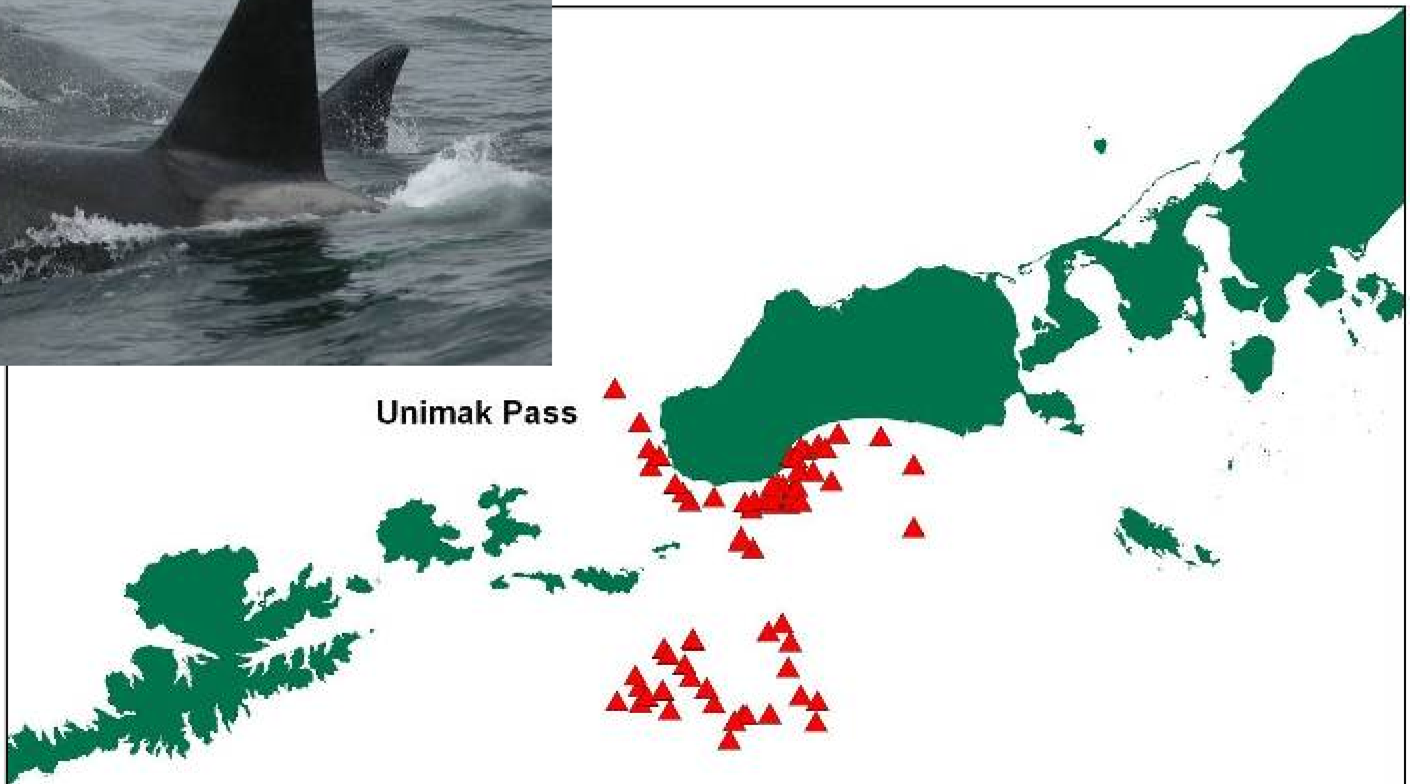
60 Transient encounters with all movements identified by photo-identification



Examining movements with satellite tagging

Durban (NMML), Andrews (ASLC) and Matkin (NGOS). Unpublished Data.

2006 Satellite tagging from NMML Survey



- Tag locations mid-June to mid-July close to Unimak Island
- Mid-July to Mid-August moved offshore to the south

Durban (NMML), Andrews (ASLC) and Matkin (NGOS). Unpublished Data.

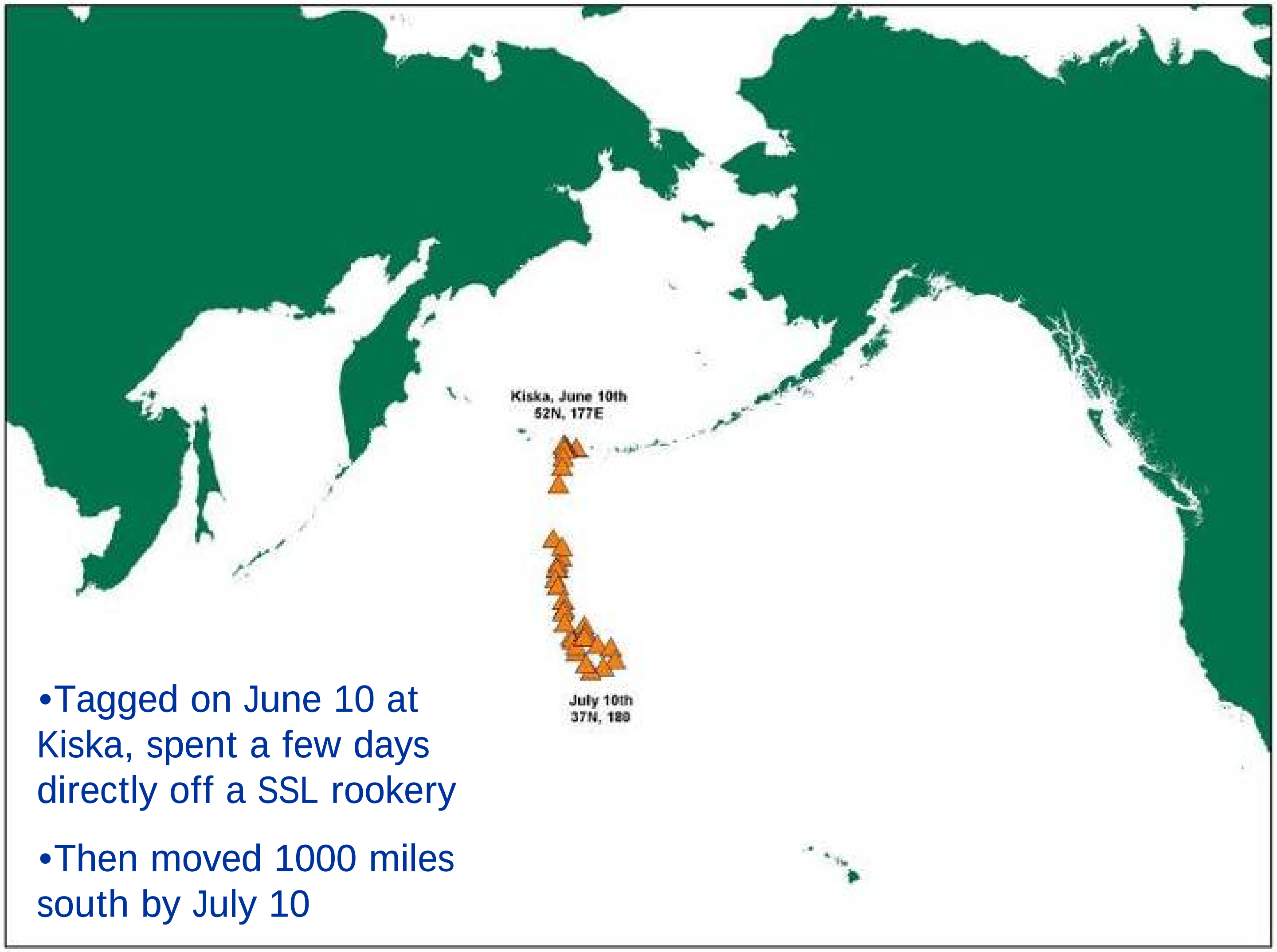
Scarring data (Duban, Pitman et al. in prep)

Bull seen August 2000 and June 2005 near Adak (including this fresh wound in 2005)

Cookie-cutter shark scars – implies movements to warm pelagic waters

2006 Satellite tagging from NMML Survey

Aleutian transient transitions!



- Tagged on June 10 at Kiska, spent a few days directly off a SSL rookery
- Then moved 1000 miles south by July 10

Durban (NMML), Andrews (ASLC) and Matkin (NGOS). Unpublished Data.

Movement summary

- A substantial portion of the Aleutian Island and Bering Sea transients make large scale movements into warmer waters
  - Their foraging range (and prey base) may be much larger than we previously thought
  - Starting to look at scarred versus non-scarred groups – different feeding strategies?
- Why go to the transition zone (circa 37-42 degrees N)?
  - Could represent whales following fur seals that move there in winter (e.g., the lion-wildebeast analogy)
  - But could alternatively represent movements to the transition zone to prey on large populations of Dall's porpoise, Pacific white-sided dolphins, northern right whale dolphins, or minke whales. Additionally, there are large numbers of juvenile fur seals there in summer

Movement and foraging conclusions

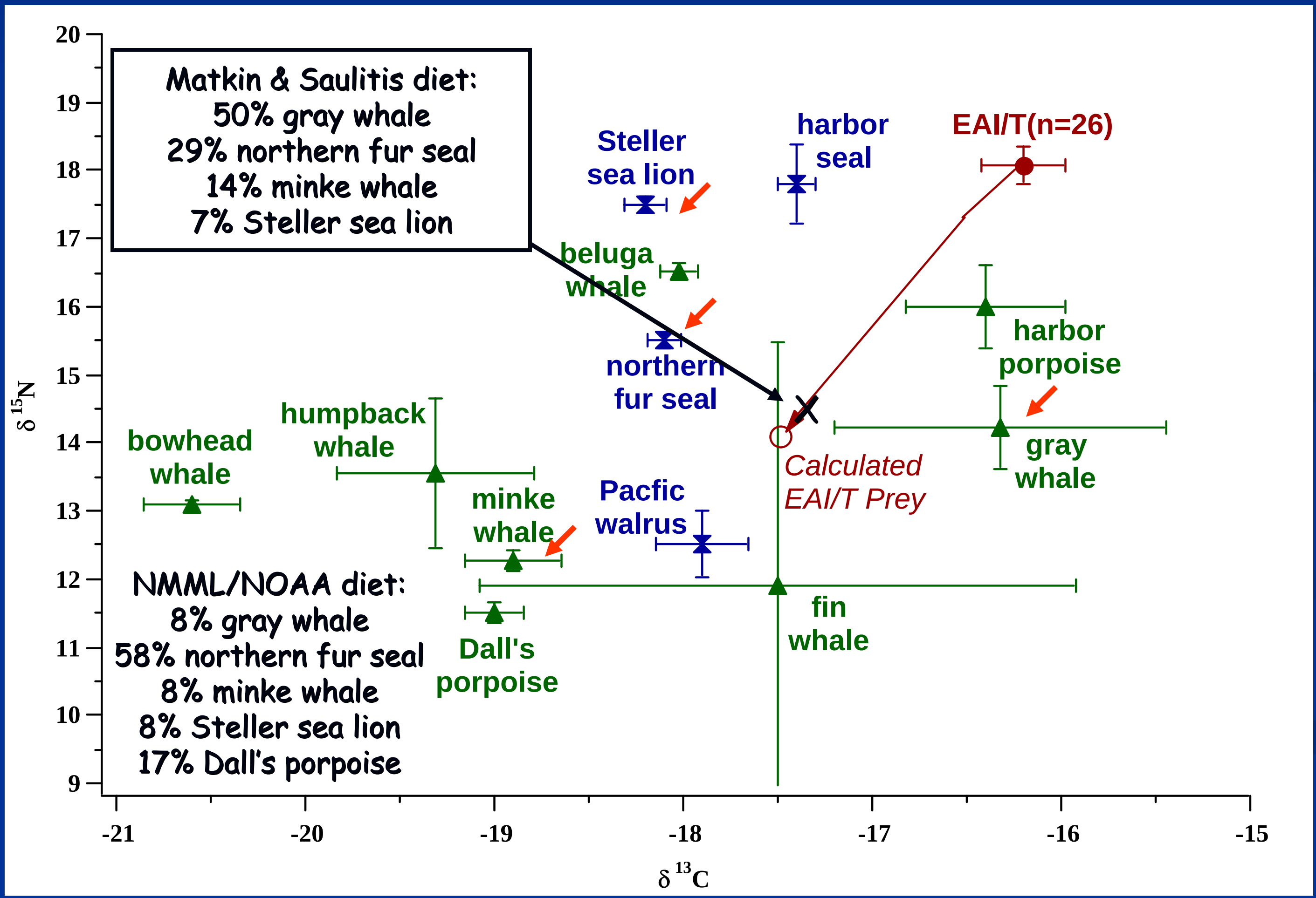
- The transient killer whales in the Aleutian Islands and western Gulf of Alaska spend some proportion of the year outside of the range of Steller sea lion
- Estimation of predation rates needs to take account of the fact that for some portion of the year Steller sea lions are not available as prey

Krahn et al. 2007

Use of chemical profiles in assessing the feeding ecology of eastern North Pacific killer whales

(Marine Environmental Research. 63:91–114)

Comparison of stable isotope values of eastern Aleutian Islands transient killer whales with predicted value from visual observations of predation



Krahn et al. conclusions

- Overall, Steller sea lions are not a dominant component of transient killer whale diet (consistent with observations that SSLs are 7% of diet)

Matkin et al. 2007

Ecotypic variation and predatory behavior among killer whales (Orcinus orca) off the eastern Aleutian Islands, Alaska

(Fish. Bull. 105:74–87 2007)

- Identified 114 transient killer whales in False Pass in spring (2001-2004)
  - Preying exclusively on calf/juvenile gray whales on migration
  - Great majority of these whales are not seen in area in summer, and it is not known where they go (follow gray whales to the Bering Strait?)
- Identified 51 transient killer whales in the eastern Aleutians in summer (with only 6 whales also seen in False Pass)
  - Preying on:
    - 57% N. fur seals
    - 29% minke whale
    - 14% Steller sea lion
    - Attacks on Dall's porpoise also seen

Abundance of transient killer whales (Kenai Peninsula – Tanaga Pass)

- Line transect estimate 251 (97-644)
  - Zerbini et al. 2006
  - 226 Shumagins to Tanaga Pass
  - 27 east of Shumagins
- Mark-recapture estimate 370 (283-515) Durban et al. in review
  - But includes 100+ whales seen only in False Pass in spring feeding on gray whales
  - Provides similar number of whales potentially feeding on SSL in summer as does the line transect estimate once False Pass animals are subtracted

Energetic calculations of SSL predation in the Aleutians and western GOA (Wade, Fadely et al. in prep)

- Used Trites and Pauly (1998) estimate of average weight of killer whale across all age and sex classes (2281kg)
  - Williams et al 2004 used average weight of an adult female and male (3767kg)
- Used Zerbini et al. 2006 estimate of 226 killer whales from Shumagins to Tanaga Pass
- Used same energy content of SSL and Field Metabolic Rate (energy demand per kg) of killer whales as Williams et al. 2004
- Assume average body mass of SSL based on females less than age 7 and males less than age 5

Energetic calculations assuming killer whales prey on smaller SSL (females<age 7 and males< age 5)

- Killer whales spend ¾ year in range of SSL
  - 4% predation SSL using all sources (Wade et al. 2007 and Matkin et al. 2007)
  - 2707 SSL predated, 51% of natural mortality
- Killer whales spend ½ year in range of SSL
  - 7% predation SSL (Matkin et al. 2007 spring/summer)
  - 3158 SSL predated, 60% of natural mortality
- Killer whales spend summer (4 months) in range of SSL
  - 14% SSL predation (using Matkin et al. summer only (NMML value is lower))
  - 4234 SSL predated, 81% of natural mortality

Energetic calculations

- Under these assumptions, killer whale predation does not exceed more than 100% of the natural mortality of a stable population of Steller sea lions
- Killer whales would not cause a decline of Steller sea lions under these assumptions
- If one assumes that killer whales prey on all age and sex classes of Steller sea lions, the numbers of SSL preyed on would be lower (because of more energy in larger animals) and the impact would be spread across more SSL, and would represent a lower percent of natural mortality