Sea Otters

History, Population Structure & Demography, Threats, Trends and Status Relative to K: California, Washington, and Southeast Alaska

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Overview: History of Sea Otters, NE Pacific

- Fur trade had catastrophic effect on all sea otter populations

Between 1750 and 1911...

Distribution prior to 1750

Legend

Remnant colonies (circa 1900)
Recovery (piecemeal) over 20th century

~125,000 sea otters today
~ 32,000 resulted from 4 successful translocations of 708 individuals 50 years ago

Mystery: Variable rates of recovery

Mystery reflected a mis-understanding of scale, and confusion over what a “sea otter population” was...

Overview: Population Structure & Demography

- Population growth & regulation in sea otters: carrying capacity \((K)\) determined by prey resources
  * occasionally other factors

- Question: what is relevant scale?

- Adult sea otters have small home ranges and limited dispersal

- Sea otter populations are regulated **locally**, due to
  - high site fidelity of females
  - fine-scale variation in abundance of invertebrate prey

![Carrying Capacity Graph](image)

![Map of Monterey, California](image)
Overview: Population Structure & Demography

How we used to think about regional sea otter populations:

Population grows rapidly at low density (max growth rate $r_{max}$)

Population growth slows at high density, "K" occurs at scale of entire region (e.g. California, SE Alaska)

WRONG!
Overview: Population Structure & Demography

How we *now* think about sea otter population dynamics:

<table>
<thead>
<tr>
<th>Un-colonized habitat:</th>
<th>Recently colonized sub-populations, high growth rate (&quot;r_max&quot;)</th>
<th>Long-established sub-populations, at &quot;K&quot;: population regulation occurs at local scales</th>
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<td>rate of colonization depends on mobility</td>
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Spatially structured population (meta-population)
Summary: Population Structure & Demography

- Small-scale demographic structure supported by tagging studies and by recent genetic analyses (see Gagne et al 2018, Evolutionary Applications)

- Relevance for conservation and management:
  - population regulation occurs locally, not regionally
  - $K$ density varies by habitat and prey productivity
  - Non-density-dependent threats (predation mortality, oil spills, fishing entanglements, harvest) can also have very strong local effects
Recent Trends & Threats in California

- Variation in growth rates across range, pre-2013:
  - at range center, higher density & low growth: sub-pop’s close to K
  - at range peripheries, low density/rapid growth
Status at range center vs peripheries

• In addition to survey data, several indices suggest that otters in range center are food-limited, at “K”

**Survival vs. Condition, Female**

Activity budgets, body condition, survival suggest nutritional limitation: also, increased dive depth/duration in range center (Thometz et al 2016), and higher rates of “end lactation” mortality in females (Chinn et al 2016)


Last 5 years, trends have changed.

Regional trends in abundance of southern sea otters along the mainland coast of central California

- North (Pigeon Pt - Seaside)
- Central (Seaside - Cayucos)

Range center increasing
Range peripheries declining

In Range center, unexpected food subsidy: urchin boom starting 2013
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Uptick in sea otter density, Monterey: increased juvenile survival (“urchin millennials”)

![Graph showing sea otter density from 1991 to 2016.](chart.png)
At range peripheries, shark-bite mortality is limiting growth/expansion

Southern Sea Otter Population Trends (3-yr Avg Index)

Number of otters (3-yr avg. count), San Nicolas Island

Year

Number of otters (3-yr avg. count), mainland / range wide

California Summary

Washington Primary Range

Individual sea otter sightings reported south to Newport, OR and east into Puget Sound
Population Estimate & Trend

Growth = ~5%/year

Growth = ~9.5%/year  2,058 otters

Growth = ~22%/year

Distribution within Primary Range

- Unequal distribution across range
- More otters/rapid growth; higher density?
- Pups produced in the north?

79% of total count
1,561 adults
58 pups

21% of total count
383 adults
57 pups
Distribution south of La Push

- Large Rafts: 685 adults, 39 pups
- Open Water
- Males, females, and pups

Credit: Steve Jeffries, WDFW
Carrying Capacity

• No viable estimate of K

• Previous estimates: Laidre et al. 2002, 2011
  - Relied on otter WA population estimates from 1 habitat type (Rocky) taken before areas reached K
  - Used CA density estimates for sandy/mixed habitat types
  - Do not account for exponential growth in sandy/mixed habitats

• Research Needs
  - Prey availability
  - WA-specific densities for all habitat types
  - Why not expanding range southward or into Straits of Juan de Fuca?
Causes of Mortality 2002-2017*

Parasitic - *Sarcocystis neurona*

*Toxoplasma gondii, dual infections*

Bacterial – Leptospirosis, septicemia

Viral - Morbillivirus (canine)

Other - Oiling, Drowning, Birth complications, Pneumonia, Severe head trauma, Shark bite, Gunshot, Poisoning (domoic acid, PSP)

Cardiac disease, Hepatitis

*Sources: White et al. 2018, Lynch unpublished*
Threats & Emerging Issues

- Increased risk of catastrophic event (e.g., oil spill, disease) resulting from population concentration
- Fisheries interactions – increasing overlap with Dungeness crab and razor clam
- Continuation of population estimates

- Information Needs
  - Fisheries & Bycatch
Southeast Alaska: Status and Trend

~ 25,000 (2012) or 20% of the N Pacific sea otters resulted from translocation of 403 individuals about 50 years ago

Bodkin 2015
History: SE Alaska

Trend: SE Alaska 1969-2012

Annual Growth = 0.12/year
Trend SSE Alaska 2003-2010

Annual Growth = 0.13/year
Trend: NSE Alaska 2002-2012 (w/o GB)

Annual Growth = 0.07/year
Trend: Glacier Bay 1999-2012

Annual Growth = 0.27/year
Carrying Capacity: Southeast Alaska

- Fit state-space model to survey data to estimate $K$ at sub-regional scale
  - No habitat covariates
  - True abundance estimates
  - Accounts for harvest mortality

Demographically distinct sub-regions: SE Alaska
SE Alaska: Variation in sub-region growth rates
SE Alaska: Variation in Density at K
Summary

- Uncompromised habitat facilitated recovery of about ½ of SE Alaska
- As sea otters recover in vacant habitat, population growth rates appear to moderate as densities approach “K”
- This is a prolonged process requiring decades
- Sea otter populations in SE Alaska (and elsewhere) appear demographically structured at spatial scales on the order of 100’s of km2 of nearshore habitat
- Recognizing appropriate spatial scales will enable more effective sea otter management and conservation
- Energy recovery rates (foraging studies) effective in evaluating population status