Developing Carrying Capacity Estimates for Sea Otters (Enhydra lutris kenyoni) in Washington State

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Habitat Characterization and Availability

An aerial survey of the outer coast of Washington and Strait of Juan de Fuca was conducted on 21 March 2000. Sea otter habitat was classified as rocky, sandy, or mixed depending on the amount of kelp and subtidal rocky substrate in the area.

ESRI ARC/INFO® and ArcView® were used to estimate amounts habitat (rocky, sandy, or mixed) available to sea otters along Washington's outer coast. This included surface area between the coastline and the 10, 20, 30, and 40 m depth contours in km^2 and shoreline distance along the coast and within each coastal estuary (grays Harbor, Willapa Bay, and Columbia River) type in km. An ARC/INFO® script was built to create polygons between the coastline, each depth contour, and the northern and southern habitat boundaries.

Offshore Habitat Delineation

Sea otter spatial habitat use patterns were determined from radio telemetry data collected from 68 sea otters, which had been captured, radio tagged, and tracked off the Washington coast from 1995 to 1998 (USGS, unpublished data).

Location coordinates were imported into ARC/INFO® and ArcView® to delineate the extent of offshore habitat use by sea otters in Washington. Each location was both attached to a depth value in a bathymetric grid to determine mean depths and was spatially joined with the mainland coast to determine a mean and maximum distance to the shore for all sex and age groups.

Density Estimates

Densities with respect to all available habitat types cannot be calculated using present population data from Washington because sea otters have been established in only one habitat type (rocky) long enough for a reliable estimate of density to be calculated. As a result, the equilibrium densities in sandy and mixed habitat types represent a proportional density based on current counts in the rocky equilibrium region in Washington and available data from the California sea otter population (Laidre et al. 2001).

Density estimates for 1996-99 were calculated by dividing the number of sea otters between Petroleum Creek and Little James Island by the surface area to each depth contour, or by the kilometers of coastline between the Petroleum Creek and Little James Island. A mean density was calculated for each depth contour and the linear estimate for 1996-99.

A bootstrapping approach was used to estimate the variability around the point estimate of K by randomly selecting sea otter counts within 0.5 km segments along the coast (with replacement). The variance estimated from this approach incorporated variability in density caused by temporal and spatial factors. The delta method was used to estimate variance around the sandy and mixed density estimates in Washington.

Contour	Rocky (CV 0.17)	Sandy (CV 0.21)	Mixed (CV 0.31)
10 m	9.19	1.92	1.40
20 m	4.55	0.95	0.69
30 m	2.38	0.50	0.36
40 m	0.97	0.20	0.15
Linear	7.04	2.29	2.28

Table 1. Estimates of mean equilibrium density for sea otters in rocky, sandy, and mixed habitat types in Washington State.
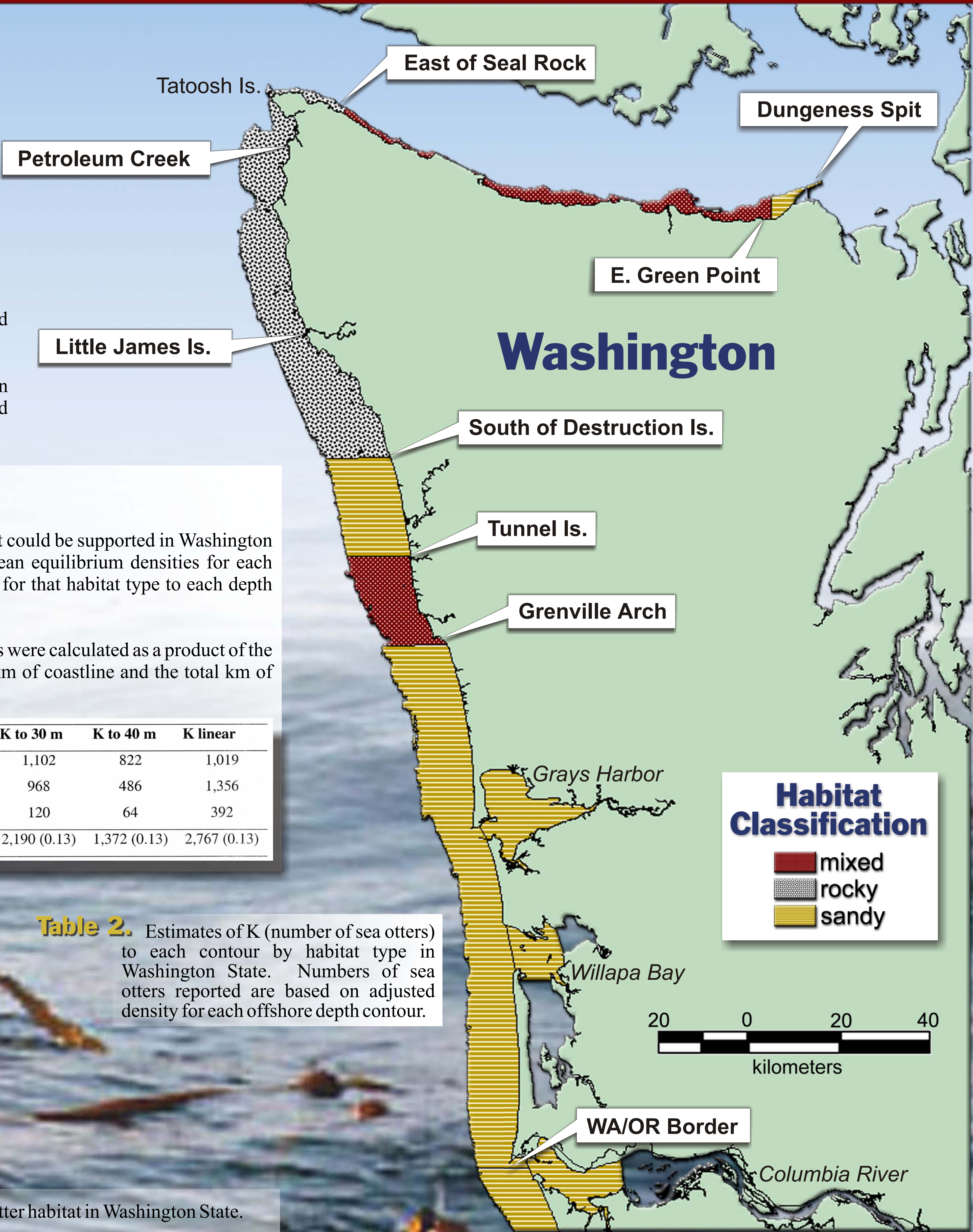
Estimates of K

The estimated number of sea otters that could be supported in Washington was calculated as a product of the mean equilibrium densities for each habitat type and the total surface area for that habitat type to each depth contour in square kilometers.

Estimates of K based on linear densities were calculated as a product of the equilibrium density of sea otters per km of coastline and the total km of coastline available for that habitat type.

	K to 10 m	K to 20 m	K to 30 m	K to 40 m	K linear
Rocky	807	955	1,102	822	1,019
Sandy	2,088	1,450	968	486	1,356
Mixed	121	146	120	64	392
Total	3,016 (0.15)	2,551 (0.14)	2,190 (0.13)	1,372 (0.13)	2,767 (0.13)

Table 2. Estimates of K (number of sea otters) to each contour by habitat type in Washington State. Numbers of sea otters reported are based on adjusted density for each offshore depth contour.

Washington

Labels on map: Tatoosh Is., East of Seal Rock, Dungeness Spit, Petroleum Creek, E. Green Point, Little James Is., South of Destruction Is., Tunnel Is., Grenville Arch, Grays Harbor, Willapa Bay, WA/OR Border, Columbia River

Habitat Classification
- mixed
- rocky
- sandy

20 0 20 40 kilometers

Conclusions

- The radio telemetry results support the selection of the 20 or 30 m contour as the maximal offshore limit of suitable sea otter habitat in Washington State.
- Given the data and information we currently have, the best estimate of K for the Washington sea otter population is approximately 2,190 to 2,551 sea otters.
- This results in an OSP (60% of K) of 1,314-1,531 sea otters.

Literature cited: Laidre, K.L., R.J. Jameson and D.P. DeMaster. 2001. An estimation of carrying capacity for sea otters along the California coast. Marine Mammal Science 17(2):114-147.