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Science Advisory Report 2020/036

TRENDS IN GROWTH OF THE SEA OTTER (*ENHYDRA LUTRIS*) POPULATION IN BRITISH COLUMBIA 1977 TO 2017

Sea Otters. Photo by J. Pilkington

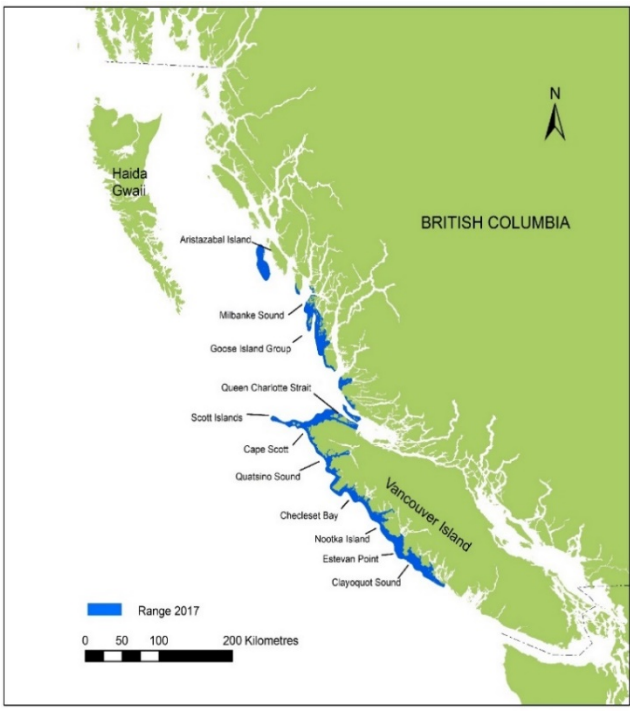

Figure 1. Map of sea otter range in British Columbia

Context

Sea otter (Enhydra lutris) populations were driven to the brink of extinction throughout their range in the North Pacific as a result of the maritime fur trade that commenced in the late 1700s. In British Columbia (BC), the last two reported sea otters were killed in 1929 and 1931 after which the species was considered extirpated from Canada. In an effort to re-introduce the species to Canada, 89 sea otters from Alaska were relocated to Checleset Bay (Vancouver Island) in 1969, 1970 and 1972. The sea otter has been listed as a species of Special Concern under the Species-At-Risk Act (SARA) since 2009. The SARA Sea Otter Management Plan identifies the undertaking of "annual surveys of the sea otter population in index areas, areas of range expansion, and other portions of their range as needed, as well as a total population survey every five years, to monitor population trends and distribution". In 2017, a range-wide boat survey was completed in BC. The results provide an index of abundance for 2017 and contribute to an update of population growth trends, and the estimation of Potential Biological Removal, to provide requested science advice about the sea otter population in BC.

This Science Advisory Report is from the October 21-26, 2019 National Peer Review on Trends in population growth of sea otters (Enhydra lutris) in British Columbia 1977 to 2017. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- During a range-wide survey in 2017, 7,696 sea otters were counted and 414 sea otters were estimated for three areas not completed due to weather, for total of 8,110 sea otters in British Columbia (BC).
- The survey provides an index of abundance and a report of range expansion. The data allow for analysis of population growth trends in the region overall, as well as at a sub-regional scale.
- Extensive reconnaissance survey effort in 2017 along the north coast of BC found no evidence of expansion north of the previously documented range limit (i.e. Aristazabal Island).
- The annual rate of increase across the whole BC region was 6.4% per year from 2008 to 2012 and 5.2% per year for the period 2013 to 2017.
- Sea otters occupy small home ranges and exhibit limited dispersal with the result that density-dependent processes, linked to food availability, operate at sub-regional scales. Therefore, growth trends vary geographically across the population with lower growth rates in areas that have been occupied for longer periods of time.
- Annual rates of increase for the period 2013-2017 in long-occupied areas were low (e.g. 1.6% to 2.9% per year), suggesting these sub-regions were approaching carrying capacity. In more recently occupied areas, growth was exponential with several sub-regions exhibiting growth rates of 20.4% to 24.5% per year; rates that are within the theoretical maximum for this species in the absence of density dependent factors.
- In some sub-regions, growth rates have been in excess of the theoretical maximum indicating that immigration had contributed to the observed growth rates.
- Potential Biological Removal (PBR) for the entire population was estimated to be 534 animals. Recognition of the sub-regional spatial scale at which the population is structured has implications for conservation and management of this species. For instance, the population-wide PBR may not be precautionary if applied without taking this structure into account.

BACKGROUND

Sea otters occupy shallow coastal areas and are limited with respect to habitat by their diving abilities and preferred foraging depth (<40 m) with the result that most sea otters are found within 1 to 2 km of shore. Sea otters occupy small home ranges within which sea otters forage on invertebrates and spend a large amount of time resting in floating aggregations called rafts. Rafts may number over 200 animals and are segregated into male rafts and female and pup rafts. The aggregating behaviour of sea otters results in a clumped distribution. Because rafts form habitually in the same locations, their distribution is an indicator of range expansion events in growing populations. The periphery, or frontal edge of the occupied range, tends to be first occupied by male rafts. In subsequent years, females appear and form rafts in the new area.

The BC sea otter population was first surveyed in 1977 and subsequently at 1-3 year intervals thereafter to assess whether the re-introduced animals had survived and reproduced. Immediately following re-introduction the BC sea otter population grew rapidly at a rate equivalent to the maximum rate for the species. This rapid growth was supported by abundant invertebrate prey, which had increased in the absence of sea otters.

Multiple lines of evidence from research in other regions examining individual diets, movements and genetics indicate that sea otters exhibit strong site fidelity, have small home ranges and exhibit limited dispersal. These characteristics mean that intrinsic demographic processes (density-dependent natural mortality and emigration events) are expected to operate at smaller spatial scales than the entire BC coast.

ASSESSMENT

Methods

Since 1988, a standardized approach has been used to survey sea otters by small boat. Sea otters are counted in their known range along consistent routes that follow the coastline and cover preferred habitats. This approach relies on characteristics of sea otter behaviour and biology that result in their distribution being predictable. Thus an underlying assumption of the survey methodology is that by carrying out the surveys in a consistent manner among years, sampling error is relatively constant over time and therefore the counts provide a reliable index of population abundance and trends.

For logistical reasons to collect survey data, the sea otter range in BC was divided into *segments* that can typically be surveyed in a single day. Surveyed areas in which at least one raft of sea otters was observed during a survey were considered occupied. This criterion was used to identify range expansion events. Newly surveyed areas where occasional single sea otters were encountered were not considered occupied and not included in the population count.

Counts from the 24 segments that make up the BC region in 2017 were summed to obtain a minimum population estimate. For segments that could not be surveyed due to weather, an estimate of the number of animals missed was made and these were added to the counts.

Segment counts were grouped into *sub-regions* to assess sub-regional patterns of population growth. Segments were grouped into sub-regions according to contiguous geography and similar years of occupancy. Sub-regions do not represent distinct populations (nor do segments), however it was assumed that otters within segments that are geographically contiguous can be considered to experience similar demographic processes as well as environmental and density-dependent conditions. Time series of survey counts within sub-regions were fitted with two alternative growth models, one assuming exponential growth and the other assuming logistic growth. The best model was selected for each sub-region and to compute an annual finite growth rate for the 5-year periods 2008-2012 and 2013-2017. An overall annual growth rate was also estimated by summing the expected values from the sub-regional models.

Results

Index of Abundance

During a range-wide survey in 2017, 7,696 sea otters were counted and 414 sea otters were estimated for three areas not competed due to weather, for total of 8,110 sea otters in BC.

Range expansion

Extensive reconnaissance survey effort in 2017 along the north coast of BC found no evidence of expansion north of the previously documented range limit (i.e. Aristazabal Island). Within the range, there had been some in-filling of gaps since the previous survey in 2013. This occurred on the north coast of Price Island (north of Milbanke Sound), in eastern Queen Charlotte Strait, and in Clayoquot Sound.

Sub-regional trends

There are differences in population growth trends at a sub-regional scale across the geographical range. Annual rates of increase for the period 2013-2017 were lowest in long-occupied areas (e.g. 1.6% to 2.9% per year). The better fit of logistic growth models in those areas confirmed that density-dependent processes were acting as sea otter numbers approached carrying capacity. In contrast, in more recently occupied areas, exponential models fit best with several sub-regions exhibiting growth rates of 20.4% to 24.5% per year; rates that are within the theoretical maximum for this species in the absence of density dependent factors. In some recently occupied sub-regions, rates had been in excess of the theoretical maximum (e.g. 29.1% to 33.6% per year) for the period 2008-2012, indicating that immigration was contributing to the observed growth rates.

Region-wide population growth trend

The annual rate of increase over the region was 6.4% per year (*SE* = 2.6) during the period 2008-2012 and 5.2% per year (*SE* = 1.2) during the period of 2013-2017 .

Potential Biological Removal (PBR)

We calculated the maximum number of animals, excluding natural mortality, that may be removed per year while still allowing the population to reach or sustain to its optimum sustainable level, using:

$PBR = N_{min} \times ½ R_{max} \times F_R$

where N_{min} = 7087 (the 20th percentile of the estimated population size in 2017 obtained from the aggregated results of sub-regional growth models), ½ R_{max} = 10.05% (one-half the maximum estimated rate of increase of 20.1% for the BC population in 1977-1995), and F_R = 0.75 (the recommended recovery factor for a species listed as Special Concern and not considered to be declining). With these parameters, PBR was equal to 534 sea otters per year.

Sources of uncertainty

The process used to group survey segments into sub-regions was ad hoc although relying on knowledge of the population distribution and spatial structure. Nonetheless, the resulting growth rate estimates, including the overall growth rate estimate for the region, may be sensitive to the grouping decisions. Future work could include a data-driven approach to defining or supporting sub-regional selection.

Fitting population models to the survey counts allowed for the estimation of “expected” counts based on plausible population dynamics. These models assumed that the deviation between observed and expected values was primarily the result of observation error rather than process error. Although this error estimation was an important improvement upon previous advice, it did not take into account the observer error that is associated with raft counts. Examination of replicate raft counts suggests that although observer error is low, it does increase with the size of the rafts. Since raft counts comprised 60% of the 2017 survey result, future work should try to incorporate an estimate of this error. A consequence of not incorporating this uncertainty is that PBR may be over estimated. Future work could also include hierarchical models that would allow process error to be distinguished from observer error.

There are no estimates of availability bias (how many otters are at the surface while the boat is in visual range) and perception bias (missing otters that are available) for small boat surveys in BC. Both biases are believed to be more relevant for single individuals than for large rafts. The lack of correction for these two biases results in under-estimating true abundance and the PBR

would be underestimated. Unmanned Aerial Vehicles could be used in future surveys to estimate correction factors and provide estimates of abundance based on the raft counts.

CONCLUSIONS

The sea otter population in BC has grown and its geographic distribution has expanded since re-introduction into areas assumed to have historically been occupied by the species. Sea otter numbers are near carrying capacity in long occupied areas, but growth is exponential in more recently occupied areas. These sub-regional patterns reflect the expected pattern of density-dependent growth for this species.

Recognition of the sub-regional scale at which sea otter populations are structured has important implications for conservation and management of this species. Threats may affect different areas in different ways, and their effects may be mediated by small scale differences in population dynamics. Furthermore, the nature of sea otter dispersal means that the potential for a recolonization in the event of local extirpation would be slow. These same characteristics of population structure mean the population-wide PBR may not be precautionary enough if applied without taking this structure into account.

OTHER CONSIDERATIONS

A challenge for long-term monitoring of a recovering population is maintaining a consistent level of effort as the population increases and expands its range. Surveying the entire range of sea otters now requires a considerable effort under good weather conditions. With an analytical assessment approach that places more emphasis on the use of sub-regional time series, it would be appropriate (and more logistically feasible) to perform multiple sub-regional surveys rather than a synchronous survey of the whole BC region in a single year. Moreover, estimating growth using sub-regional data sets makes it possible to use more years of survey data than in previous assessments. Population assessments would still provide range and years of occupation, sub-regional growth rates and abundance estimates.

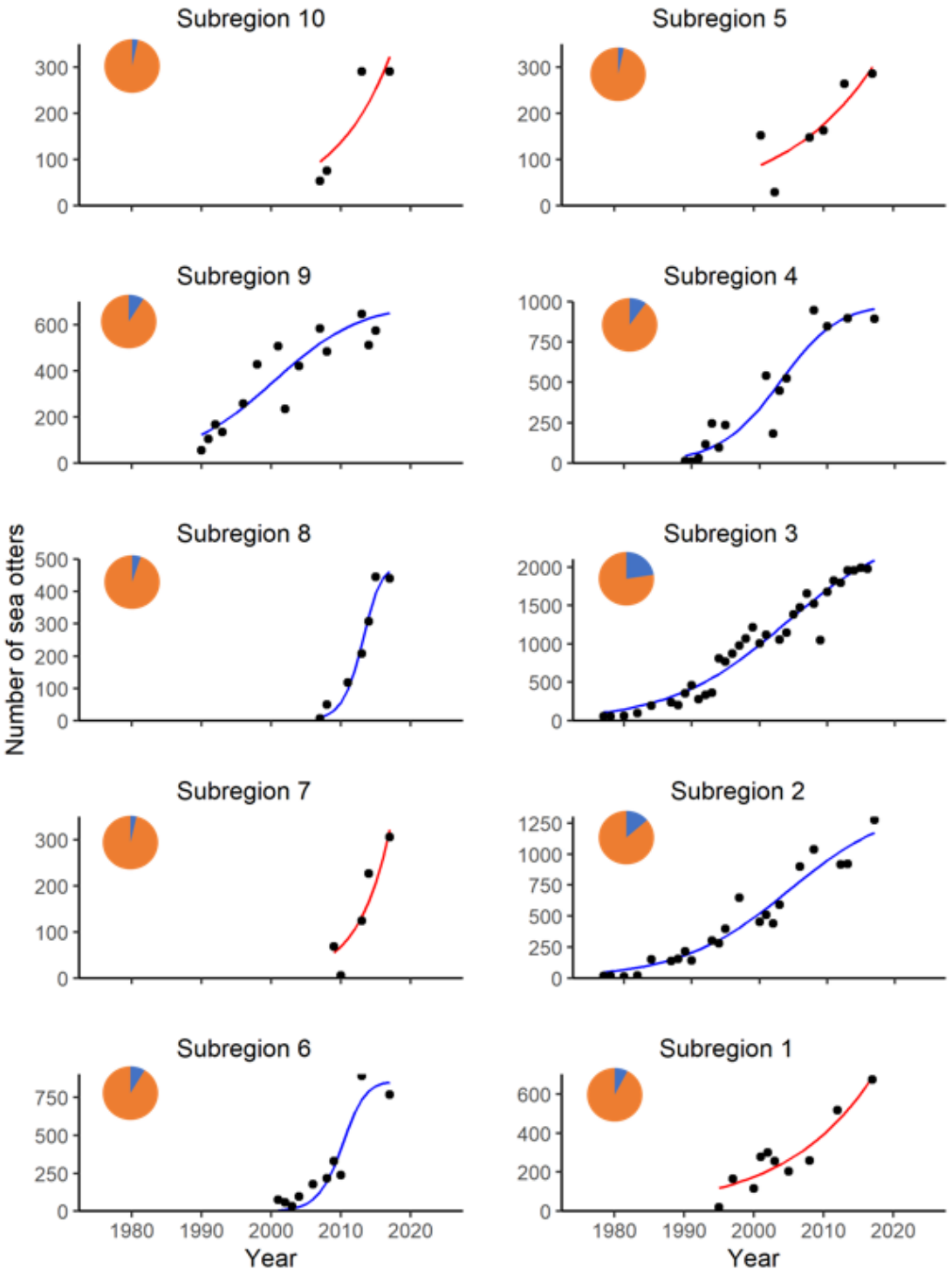

Figure 2. Population models fitted to time series in 10 sub-regions encompassing the occupied range in BC 1977 to 2017. Blue lines are logistic models, red lines are exponential models. Inset pie chart show proportions of 2017 estimate (8,110 sea otters) by sub-region.

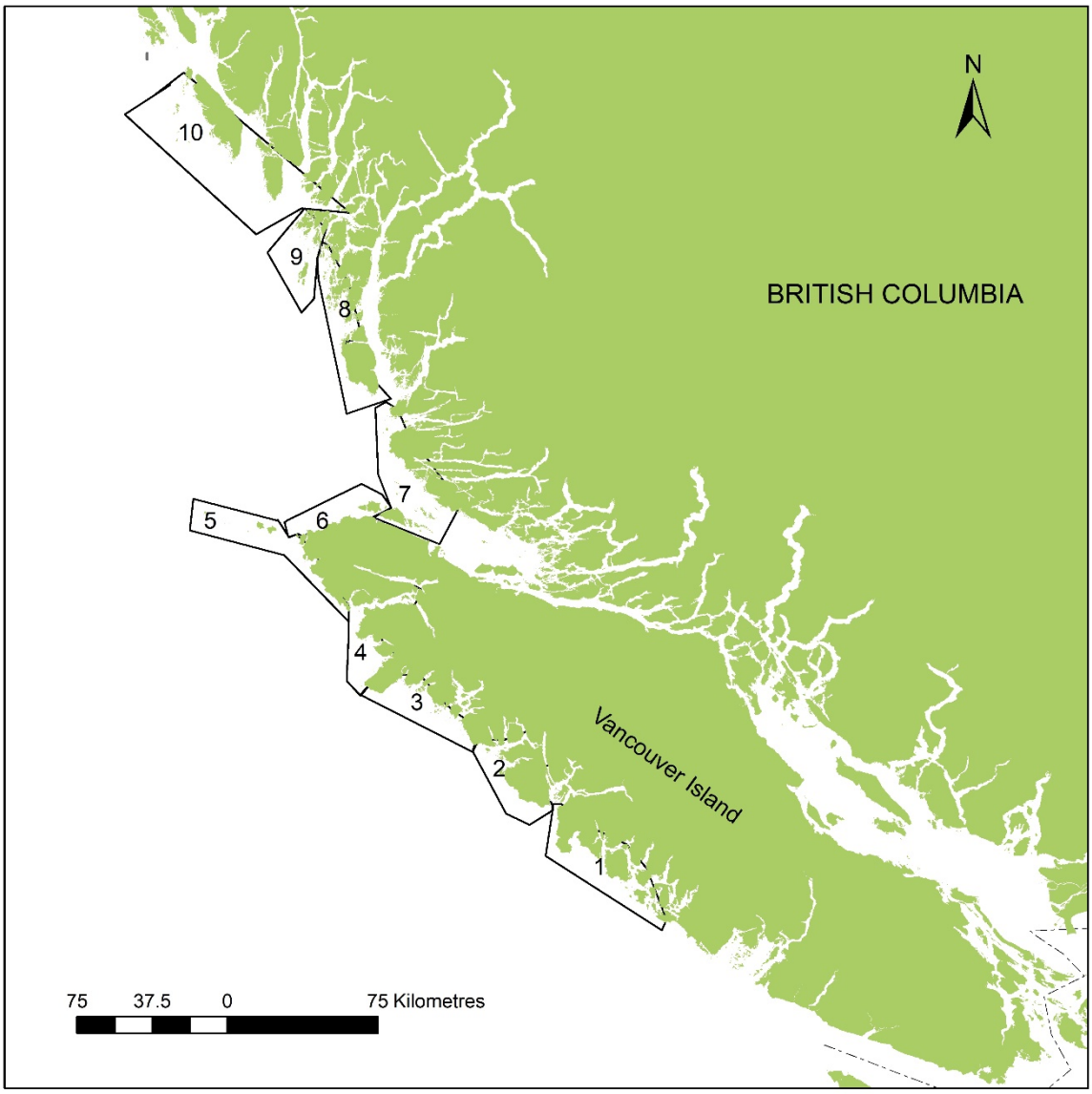

Figure 3. Distribution of sub-regions. Numbers correspond to sub-region labels in Figure 2.

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SOURCES OF INFORMATION

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Nichol, L.M., Doniol-Valcroze, T., Watson J.C., Foster, E.U. 2020. Trends in growth of the sea otter (*Enhydra lutris*) population in British Columbia 1977 to 2017. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/039. vii + 28 p.

Nichol, L.M., Watson J.C., Abernethy, R, Rechsteiner, E., Towers, J. 2015. Trends in the abundance and distribution of sea otters (Enhydra lutris) in British Columbia updated with 2013 survey results. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/039. vii + 31 p.

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