UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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DATE:	June 5, 2019
MEMORANDUM FOR:	Tom Gelatt (Program Leader, AEP, MML)
FROM:	Rod Towell Mathematical Statistician, AEP, MML)
SUBJECT:	Population effects of proposed subsistence mortality of northern fur seals on St. Paul Island, Alaska

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In response to the Alaska Regional Office, I have been modeling potential effects of alternative subsistence harvest scenarios resulting from the Aleut Community of St. Paul Island's petition to National Marine Fisheries Service to change harvest regulations for northern fur seals. Several alternatives to the current regulation have been proposed that allow for a greater length (age) class of males to be available for subsistence use along with allowing the take of pups (young of the year). Alternatives had varying limits on different age classes of males to be taken and different limits to accidental female mortality. I used two different population models to evaluate potential impacts to the population under the various alternatives. The foremost result was that the younger the seal at the time of harvest, the less impact on the population. Some scenarios resulted in larger impacts to the adult male population, but are unlikely since it assumes that the maximum harvest is taken from the oldest age class males available for harvest. Accidental female mortality was of minimal impact other than the alternative with the most liberal allowance of female take. Please note that "harvest" refers to the killing of a fur seal for subsistence purposes. While the word "harvest" has referred to the method of take post commercial sealing, the presented analysis is not concerned with method, only mortality of fur seals.

INTRODUCTION

Northern fur seals are a traditional food source for native Alaskans on the Pribilof Islands, Alaska. However, the harvest of fur seal pups has been prohibited on the Pribilof Islands since 1891. The St. George Island Traditional Council petitioned National Marine Fisheries Service (NMFS) in September of 2006 to change the northern fur seal harvest regulations to authorize a harvest of 150 male pups. The harvest regulations were changed in 2014 to authorize a subsistence harvest of male northern fur seal pups. The Aleut Community of St. Paul Island (ACSPI) petitioned NMFS in February of 2007 to change the northern fur seal harvest regulations to authorize a harvest of male pups and hunting of juvenile male seals less than 7 years old. The Alaska Region (AKR) requested the Marine Mammal Laboratory (MML) analyze the potential population impacts of the proposed subsistence use changes being considered for St. Paul Island using methods similar to that used for the environmental analysis of subsistence regulatory changes on St. George Island (Towell and Williams 2016). The

National Environmental Policy Act requires that all federal agencies must analyze a reasonable range of alternatives to the proposed action of authorizing subsistence use changes to include pups and older non-breeding male fur seals on St. Paul Island. Since there are more animals at younger age classes, typically with lower survival than adults, population dynamics suggest that there is less of an impact on the population if younger, non-breeding animals are killed.

NMFS developed a reasonable range of alternatives in the FSEIS (NMFS 2019) including the petitioned alternative from ACSPI. For the purposes of the modeling we distinguished the alternatives based on the number of annual mortalities by age and sex. Alternative 1, authorizes the subsistence mortality of up to 2,000 sub-adult fur seals less than 124.5 centimeters (cm) in length, and prohibits the mortality of pups and adult male and female fur seals. NMFS determined that male seals less than 124.5 cm in length correspond to 2- through 4-year old seals. Alternatives 2 through 5 prohibit the mortality of adult male fur seals (i.e., defined as at least 7 years old). This prohibition on adult male fur seals effectively removes the less than 124.5 cm restriction and defines a juvenile fur seal as a non-breeding seal (i.e., less than 7 years old for males) including pups. Alternative 2 authorizes the mortality of up to 2,000 juvenile male fur seals and 20 female fur seals. Alternative 3 authorizes the mortality of up to 1,500 male pups, 500 juvenile males, and 5 females. Alternative 4 authorizes the mortality of up to 1,500 male pups, 500 juvenile male, and 20 female fur seals. Alternative 5 authorizes the mortality of up to 3,863 juvenile male and up to 200 female fur seals.

Analysis of model results examined the loss of adult seals among the alternative male harvest scenarios and estimated accidental female mortality.

Alternative 5 sets an upper limit on the St. Paul Island harvest based on an estimated PBR for the Eastern Pacific Stock (Muto et. al., In press). Since PBR is technically a term in regards to stock, the relative contribution of St. Paul Island estimated pup production to the estimated pup production for the Eastern Pacific Stock was used to estimate an upper harvest limit. Recognizing that a St. Paul PBR does not exist, this determined a greater harvest limit than other alternatives for subsistence use of fur seals on St. Paul Island.

METHODS

To assess the impacts of subsistence harvest alternatives when compared to no harvest, age-, and sex-specific population projections were modeled. Population impact was quantified by removing pups and sub-adult / juvenile males under various harvest alternatives. While the subsistence harvest is directed at males, harvesters occasionally misidentify young females and they are accidentally killed. Sex-specific models were included due to the potential for the incidental mortality of females and to analyze the effects of harvesting females compared to males. Several assumptions went into the models, including:

sex ratio of pups born was 1:1,
survival, fecundity and pup production were time invariant over the projection period,
the proportion of adult males counted during the annual July counts was time invariant,
and the subsistence harvest and the age distribution of the harvest were constant.

Lander's (1981) and Towell's (2007) age- and sex-specific survival estimates were used to project the population composition into the future and compare subsistence harvest alternatives to no harvest. Lander's survival estimates for males were adjusted up to remove the commercial harvest mortality impact in his original estimates. The final time period of the selected model's survival estimates from Towell (2007) were applied to the simulations. Both Towell and Lander estimates were used to establish a range of outcomes since they result in very different simulated population sizes.

Lander's (1981) estimates of fecundity were used with both survival curves when modeling accidental female mortality scenarios. Models were initiated using one half of the pup production estimate for 2016 (Towell et. al., 2013) Survival and fecundity schedules were applied to each year for 25 years allowing the population to equilibrate and to assess the impacts for harvest alternatives.

The projection runs assume that pup production, number killed from the age group, fecundity and survival are the same each and every year for 25 years. The population prediction in year 25 of the projection of each harvest alternative was compared to the population projection without harvest for assessing the probable range of impact. Age 7 and older males are the males available to breed in the population so comparisons were made of this class between harvest and no harvest alternatives.

In addition to the modeling of the effects of the male harvest different levels of accidental female mortality were examined. Alternatives considered in the FSEIS for subsistence harvest management on St. Paul Island include an accidental mortality of up to 5, 10, 20, or 200 females across the entire subsistence season. For the comparison of lost pup production, only the result of the last year is compared. Therefore, the pup production in year 25 with no harvest was compared to the pup production in year 25 with a harvest.

RESULTS

Current regulations allow for up to 2,000 sub-adult males to be harvested annually on St. Paul Island during the subsistence harvest season that ends August 8. ASPCI requests to harvest up to 2,000 male fur seals annually for subsistence use which would include: a spring hunt of up to 6 year old males; and summer and fall harvesting by stunning of juvenile males and male pups. In order to assess the potential impacts to the population, extreme scenarios were simulated.

The harvest of males older than pups caused a greater loss to the population than a harvest of an equal number of pups (Table 1). The Towell model projects a smaller population size than Lander creating a much larger percentage loss of 7+ males.

Table 1. – Projected total male population, % loss of total males given harvest under each alternative, projected age greater than 7 years, and % loss of age 7+ years given harvest for St. Paul Island.

Harvest Alternatives (Male)	Total Males	% Loss	Age 7+	% Loss
Towell 2007 Survival Estimates				
No Harvest	92,327		11,301	
2,000 Males (<124.5 cm)	85,429	7.47	7,741	31.50
2,000 Pups	87,748	4.96	10,740	4.96
2,000 Age 6	83,302	9.78	2,275	79.87
500 <124.5 cm & 1500 pups	87,168	5.59	9,990	11.60
500 age 6 & 1500 pups	86,636	6.16	8,624	23.69
3,863 pups	83,482	9.58	10,218	9.58
3,863 age 6	81,027	12.24	0	100.00
Lander 1981 Survival Estimates				
No Harvest	135,151		20,453	
2,000 Males (124.5 cm)	128,004	5.29	17,532	14.28
2,000 Pups	128,448	4.96	19.438	4.96
2,000 Age 6	128,959	4.58	14,261	30.27
500 <124.5 cm & 1500 pups	128,337	5.04	18,962	7.29
500 age 6 & 1500 pups	128,576	4.87	18,144	11.29
3,863 pups	122,203	9.58	18,493	9.58
3,863 age 6	123,192	8.85	8,493	58.48

Table 2. – Projected total female population, % loss of total females given harvest, projected pup production, and % loss of pup production given harvest for St. Paul Island.

Harvest Alternatives (Female)	Total Females	% Loss	Production	% Loss
Towell 2007 Survival Estimates				
No female mortality	108,462		22,166	
5 Pups	108,449	0.01	22,164	0.01
5 Juvenile	108,424	0.04	22,141	0.12
20 Pups	108,410	0.05	22,156	0.05
20 Juvenile	108,309	0.14	22,063	0.47
200 Pups	107,943	0.48	22,063	0.47
200 Juvenile	106,931	1.41	21,132	4.67
Lander 1981 Survival Estimates				
No Harvest	225,020		87,792	
5 Pups	224,993	0.01	87,781	0.01
5 Juvenile	224,972	0.02	87,758	0.04
20 Pups	224,911	0.05	87,749	0.05
20 Juvenile	224,828	0.09	87,658	0.15
200 Pups	223,927	0.49	87,365	0.49
200 Juvenile	223,094	0.86	86,448	1.53

The impact of accidental female mortality of either 5, 10 or 20 animals was negligible (Table 2) and resulted in less than a 1% reduction of the female population when counting the difference in the population of females and their associated pup production in the final projection year. Alternative 5 allowed for up to 200 females accidentally killed. The different population models yielded a reduction in females of ~0.86 and 1.41% and a ~1.53 and 4.67 reduction in pup production.

Very little recent female age structure data was available (12 aged tooth samples from accidentally killed females on both islands since 1994) but this estimate was applied based on that data.

DISCUSSION

Two survival models were used with the same fecundity schedule which produced notable differences in the population projections after 25 years. Lander's (1981) survival schedule projected a population of males 1.5 times greater, and a population of females 2 times greater than the Towell (2007) survival schedule. While the Towell (2007) model results in pup production that was 55% of the 2016 estimate St. Paul Island; the Lander (1981) schedule was slightly higher (109%) than the St. Paul Island 2016 estimate. Neither survival schedule was likely to be an accurate description of the current population due to the lack of current survival and reproduction estimates. The survival schedule was fixed for the 25 year projection period for simplicity; however, it would be more probable for those parameters to vary annually. The impact to the population of harvesting older animals, regardless of sex, was greater than equivalent mortality of younger animals.

Given the model assumptions and proposal for St. Paul Island, the proposed harvest would have a minimal impact on the female population and its pup production (< 1.0%) for all projected scenarios, except Alternative 5. As of 2018 the estimated pup production on St. Paul Island has been declining at a rate of 4.04% annually since 1998 (Towell et. al. 2019).

While the ACSPI's petition includes a maximum of 20 female mortalities due to harvest, various projections were run to investigate the potential impact of female mortality under subsistence use alternatives. Alternative 5 would allow for up to 200 females to be accidentally taken. For various scenarios, less than 2% loss of females in the population would be expected and a 5% or less loss of pup production (both sexes). Great care should be taken with any harvest scenario that has the potential to kill females to avoid exacerbating the current decline in pup production.

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