

# Wildlife Restoration OPERATING GRANT FINAL PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME  
DIVISION OF WILDLIFE CONSERVATION  
PO Box 115526  
Juneau, AK 99811-5526

## Alaska Department of Fish and Game Wildlife Restoration Grant

**GRANT NUMBER:** AKW-B-R1-2020 Amendment #1 SFY21

**PROJECT NUMBER:** 1.70

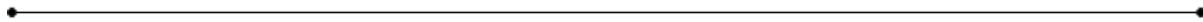
**PROJECT TITLE:** Moose population dynamics in southeastern Alaska

**PERIOD OF PERFORMANCE:** 1 July 2020–30 June 2021

**REPORT DUE DATE:** 1 September 2021

**PRINCIPAL INVESTIGATOR:** Kevin S. White

**COOPERATORS:** Glacier Bay National Park



### **I. PROGRESS ON PROJECT OBJECTIVES DURING PERIOD OF PERFORMANCE**

#### **OBJECTIVE 1: CONDUCT 1 INVESTIGATION BY 06-30-2021**

##### **ACTIVITY 1A:** Estimate reproductive performance of radio-marked adult female moose

**ACCOMPLISHMENTS:** During May-June 2021, we conducted aerial (Gustavus,  $n = 2$ ; Berners Bay,  $n = 2$ ) surveys to determine calf status of radio-marked adult female moose. Ground-based surveys were not conducted. We determined that 62% (16/26) of radio-marked female moose in Gustavus had calves at heel during the late-May parturition season; 31% of parous females had twins. In Berners Bay, 38% (6/16) of adult females had calves. Of the 8 calves observed in Berners Bay, 38% were twins. We successfully accomplished all activities associated with this objective that were planned for this reporting period.

##### **ACTIVITY 1B:** Estimate survival of radio-marked adult female moose.

**ACCOMPLISHMENTS:** We monitored survival of radio-marked adult female moose (Gustavus,  $n = 33$ ; Berners Bay,  $n = 28$ ) each month via ground- or air-based radio- telemetry surveys, weather permitting. During 2020–2021, we investigated 16 mortality events involving radio-marked moose (Gustavus,  $n = 6$ ; Berners Bay,  $n = 10$ ). Estimated annual survival for adult female moose in Gustavus during the 2020/2021 biological year was low (annual survival, 2020/21 =  $0.87 \pm 0.07$ ,  $n = 33$ ), relative to the long-term average (annual survival, 2003-2021 =  $0.88 \pm 0.01$ ,  $n = 620$ ; Table 1). In Berners Bay, annual survival of adult females during

2020/2021 was very low (annual survival, 2020/21 =  $0.64 \pm 0.08$ ,  $n = 28$ ), relative to the long-term average (annual survival, 2006-2021 =  $0.86 \pm 0.02$ ,  $n = 458$ ; Table 1). We attribute the low adult female survival rates during 2020/2021 to severe late-winter snow conditions; predation (wolf and bear) and population age structure may also be important factors. We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**ACTIVITY 1c:** Estimate survival of calves associated with radio-marked adult female moose

**ACCOMPLISHMENTS:** We monitored survival of calves associated with radio-marked adult female moose (Gustavus,  $n = 32$ ; Berners Bay,  $n = 10$ ) during May–June 2020, November 2020 and April 2021 via ground- or air-based radio-telemetry surveys, weather permitting. Estimated annual survival for calves in Gustavus during 2020/2021 was very low (annual survival, 2020 =  $0.00 \pm 0.00$ ,  $n = 32$ ) to the long-term average (annual survival, 2004-2021 =  $0.25 \pm 0.02$ ,  $n = 440$ ; Table 2). In Berners Bay, annual survival of calves during 2020/2021 (annual survival, 2020 =  $0.00 \pm 0.00$ ,  $n = 10$ ) was very low relative to long-term estimates (annual survival, 2007-2021 =  $0.25 \pm 0.02$ ,  $n = 299$ ; Table 2); most calf mortality occurred during summer yet causes are unknown. We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**ACTIVITY 1d:** Estimate moose population size and composition.

**ACCOMPLISHMENTS:** We conducted two aerial surveys during fall/winter in order to estimate moose population size and composition (Gustavus,  $n = 1$ ; Berners Bay,  $n = 1$ ). During surveys, moose sighting probabilities were estimated using mark-resight techniques based on data collected from radio-marked adult female moose. In Gustavus, we observed 148 total moose (25 bulls, 100 cows, 23 calves) and 63% (17/27) of the radio-collared adult females resulting in a mark-resight population estimate of  $231 \pm 58$  moose. In Berners Bay, we observed 42 total moose (0 bulls, 5 cow, 1 calf, 36 unknown sex adults) and 33% (4/12) radio-collared females (that could be accounted for; sightability status was not determined for 7 radio-collared females). Since the survey was conducted after antler drop (January 2021) it was not possible to distinguish adult sex status of adults. The mark-resight population estimate for the Berners moose population was  $111 \pm 66$  moose. We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**ACTIVITY 1E:** Capture and radio-mark adult female moose

**ACCOMPLISHMENTS:** We conducted moose capture activities during this reporting period in the Berners Bay area during March 2021; captures were not conducted in Gustavus because existing sample size of radio-marked animals was deemed sufficient. In Berners Bay, we captured 6 adult females using helicopter darting methods. Following capture, we collected biological samples (i.e., blood, tissue, fecal pellets, hair), recorded body condition (via ultrasonography) and morphological characteristics. Biological samples were analyzed and/or archived for this (i.e., pregnancy, age, nutrition) and other related projects (i.e., genetics, health/disease assessment). We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**ACTIVITY 1F: Prepare final report.**

**ACCOMPLISHMENTS:** We prepared a progress report detailing activities conducted in the Gustavus and Berners Bay areas, to satisfy ADF&G Federal Aid reporting requirements.

**ACTIVITY 1G: Synthesize population-specific demographic data.**

**ACCOMPLISHMENTS:** We synthesized annual and seasonal survival (adult female and calf) and reproductive (calving, twinning and fecundity) rates for radio-marked adult female moose and associated calves monitored in Gustavus (adult females, 2003–2021,  $n = 121$ , 620 moose years; calves, 2004–2021,  $n = 440$ ) and Berners Bay (adult females, 2006–2021,  $n = 103$ , 458 moose years; calves, 2007–2021,  $n = 299$ ). We also estimated reproductive rates for each population (Gustavus, 2004–2021, calving =  $0.58 \pm 0.02$ , twinning =  $0.37 \pm 0.02$ , fecundity =  $0.80 \pm 0.02$ ,  $n = 575$ ; Berners Bay, 2007–2021, calving =  $0.55 \pm 0.03$ , twinning =  $0.47 \pm 0.03$ , fecundity =  $0.81 \pm 0.02$ ,  $n = 394$ ). We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**ACTIVITY 1H: Develop a moose population model for management applications**

**ACCOMPLISHMENTS:** We developed and validated a 2-stage matrix population model parameterized using vital rate data summarized in Objective 2a. In 2015, the model was extended to estimate the proportion of legal (spike/fork and 3-brow tine/50 inch) and non-legal bulls in the population. In 2019–2020, in collaboration with Dan Eacker (ADFG/DWC, Douglas), we developed an integrated population model. This model builds on the existing matrix population model and involves further synthesis and explicit integration of multiple sources of demographic data. This model is completed but further computer programming is planned to facilitate use more easily for routine management applications, as well as expand its utility for other regional moose populations. Development of this model represents a promising advance in our ability to monitor moose populations and evaluate routine harvest management scenarios. We successfully accomplished all activities associated with this objective that were planned for this reporting period.

**II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.**

Since 2010, we have captured and handled 241 moose in the Gustavus ( $n = 174$ ) and Berners Bay ( $n = 67$ ) study areas. In each area, we have annually conducted aerial surveys to derive population estimates via mark-resight analytical techniques, weather permitting. In addition, we have conducted monthly, and seasonally, monitored survival and reproduction of radio-collared moose in order to derive estimates of survival and fecundity. Vital rate estimates (i.e., survival and reproduction) along with population estimates have enabled development of population models that have been routinely used

to project population trajectories into the future and evaluate harvest scenarios in management and research contexts.

**III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.**

None.

**IV. PUBLICATIONS**

None.

**V. RECOMMENDATIONS FOR THIS PROJECT**

This project is completed however continued data analyses and final reporting is planned for FY22.

**Prepared by:** Kevin White

**Date:** 1 September 2021

Table 1. Estimated annual survival for radio-collared adult female moose in Berners Bay and Gustavus, Alaska during 2003-2021. "At Risk" sample sizes reflect maximum number of animals monitored during the period of interest. Staggered-entry statistical design includes animals that were not monitored the entire year for annual estimates.

Year	Summer Survival				Winter Survival				Annual Survival			
	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE
<u><i>Berners</i></u>												
2006	--	--	--	--	33	5	0.85	0.06	--	--	--	--
2007	30	2	0.93	0.05	33	4	0.87	0.06	33	6	0.81	0.06
2008	28	1	0.96	0.04	33	2	0.94	0.04	33	3	0.91	0.05
2009	31	0	1.00	0.00	37	2	0.94	0.04	37	2	0.94	0.04
2010	33	2	0.94	0.04	32	4	0.88	0.06	33	6	0.82	0.06
2011	25	1	0.96	0.04	30	0	1.00	0.00	30	1	0.96	0.04
2012	29	1	0.97	0.03	28	2	0.93	0.05	29	3	0.90	0.06
2013	27	0	1.00	0.00	35	4	0.89	0.05	35	4	0.89	0.05
2014	30	1	0.97	0.03	29	2	0.93	0.05	30	3	0.90	0.05
2015	27	0	1.00	0.00	31	3	0.90	0.05	31	3	0.90	0.05
2016	29	2	0.93	0.05	27	1	0.96	0.04	29	3	0.90	0.06
2017	26	1	0.96	0.04	31	1	0.97	0.03	31	2	0.93	0.04
2018	30	0	1.00	0.00	30	3	0.90	0.05	30	3	0.90	0.05
2019	27	1	0.96	0.04	29	9	0.70	0.07	29	10	0.67	0.07
2020	28	1	0.96	0.04	27	9	0.66	0.08	28	10	0.64	0.08
Last 3 yrs.	85	2	0.98	0.02	83	21	0.76	0.04	85	23	0.74	0.04
All Years	400	14	0.97	0.01	458	50	0.89	0.01	458	64	0.86	0.02
<u><i>Gustavus</i></u>												
2003	--	--	--	--	21	0	1.00	0.00	--	--	--	--
2004	21	0	1.00	0.00	26	0	1.00	0.00	26	0	1.00	0.00
2005	27	0	0.98	0.02	39	3	0.93	0.04	39	3	0.91	0.05
2006	37	0	1.00	0.00	37	6	0.84	0.06	37	6	0.84	0.06
2007	34	1	0.97	0.03	37	3	0.91	0.05	37	4	0.88	0.05
2008	36	2	0.94	0.04	44	5	0.89	0.05	44	7	0.84	0.05
2009	40	0	1.00	0.00	42	3	0.93	0.04	42	3	0.93	0.04
2010	40	2	0.95	0.03	38	2	0.95	0.04	40	4	0.90	0.05
2011	35	3	0.91	0.05	35	0	1.00	0.00	35	3	0.91	0.05
2012	40	1	0.98	0.02	39	4	0.90	0.05	40	5	0.88	0.05
2013	36	3	0.92	0.05	36	2	0.94	0.04	36	5	0.87	0.05
2014	35	1	0.97	0.03	37	3	0.92	0.04	37	4	0.89	0.05
2015	36	2	0.94	0.04	39	1	0.97	0.02	39	3	0.92	0.04
2016	42	2	0.95	0.03	40	3	0.93	0.04	42	5	0.88	0.05
2017	40	1	0.98	0.02	39	3	0.92	0.04	40	4	0.90	0.05
2018	40	5	0.88	0.05	36	4	0.89	0.05	40	9	0.78	0.06
2019	34	5	0.85	0.06	34	2	0.94	0.04	34	7	0.80	0.06
2020	33	5	0.85	0.06	28	1	0.96	0.04	33	6	0.82	0.07
Last 3 yrs.	107	15	0.86	0.03	97	7	0.93	0.03	107	22	0.80	0.04
All Years	605	33	0.95	0.01	620	44.6	0.93	0.01	620	78	0.88	0.01

Table 2. Estimated annual survival for calves associated with radio-collared adult female moose in Berners Bay and Gustavus, Alaska during 2003-2021. "At Risk" sample sizes reflect maximum number of animals monitored during the period of interest. Staggered-entry statistical design includes animals that were not monitored the entire year for annual estimates.

Year	Summer Survival				Winter Survival				Annual Survival			
	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE
<u>Berners</u>												
2006	--	--	--	--	15	8	0.47	0.08	--	--	--	--
2007	13	8	0.39	0.08	4	1	0.75	0.19	13	9	0.29	0.12
2008	27	20	0.26	0.04	7	2	0.71	0.14	27	22	0.19	0.06
2009	24	17	0.29	0.05	7	1	0.86	0.12	24	18	0.25	0.08
2010	18	9	0.50	0.08	9	0	1.00	0.00	18	9	0.50	0.12
2011	24	16	0.33	0.06	8	1	0.88	0.11	24	17	0.29	0.09
2012	25	16	0.36	0.06	9	1	0.89	0.10	25	17	0.32	0.09
2013	16	11	0.31	0.06	5	3	0.40	0.14	16	14	0.13	0.05
2014	33	17	0.48	0.06	16	4	0.75	0.09	33	21	0.36	0.07
2015	24	15	0.38	0.06	9	1	0.89	0.10	24	16	0.33	0.09
2016	21	6	0.71	0.08	15	8	0.47	0.09	21	14	0.33	0.07
2017	24	20	0.17	0.03	4	1	0.75	0.19	24	21	0.13	0.06
2018	21	13	0.38	0.07	7	2	0.71	0.14	21	15	0.27	0.09
2019	19	18	0.05	0.01	1	0	1.00	0.00	19	18	0.05	0.05
2020	7	7	0.00	0.00	0	0	0.00	0.00	10	10	0.00	0.00
Last 3 yrs.	47	38	0.19	0.03	8	2	0.75	0.13	50	43	0.10	0.03
All Years	296	193	0.35	0.02	116	33	0.72	0.04	299	221	0.25	0.02
<u>Gustavus</u>												
2003	--	--	--	--	7	0	1.00	0.00	--	--	--	--
2004	13	3	0.77	0.10	10	2	0.80	0.11	13	5	0.62	0.12
2005	9	5	0.44	0.11	6	2	0.67	0.16	9	7	0.30	0.10
2006	20	11	0.45	0.07	8	1	0.88	0.11	20	12	0.39	0.11
2007	21	10	0.52	0.08	10	0	1.00	0.00	21	10	0.52	0.11
2008	27	22	0.19	0.03	11	7	0.36	0.09	27	29	0.07	0.02
2009	29	21	0.28	0.04	9	3	0.67	0.13	29	24	0.18	0.06
2010	23	17	0.26	0.05	12	3	0.75	0.11	23	20	0.20	0.05
2011	30	18	0.40	0.06	12	1	0.92	0.08	30	19	0.37	0.08
2012	29	20	0.31	0.05	9	1	0.89	0.10	29	21	0.28	0.08
2013	30	21	0.30	0.05	10	3	0.70	0.12	30	24	0.21	0.06
2014	21	12	0.43	0.07	13	1	0.92	0.07	21	13	0.40	0.09
2015	30	19	0.37	0.05	10	3	0.70	0.12	30	22	0.26	0.07
2016	35	25	0.29	0.04	10	3	0.70	0.12	35	28	0.20	0.06
2017	29	22	0.24	0.04	7	0	1.00	0.00	29	22	0.24	0.08
2018	29	15	0.48	0.06	15	4	0.73	0.10	29	19	0.35	0.07
2019	33	24	0.27	0.04	8	1	0.88	0.11	33	25	0.24	0.07
2020	32	28	0.13	0.02	4	4	0.00	0.00	32	32	0.00	0.00
Last 3 yrs.	94	67	0.29	0.03	27	9	0.67	0.07	94	76	0.19	0.03
All Years	440	293	0.33	0.01	127	27	0.79	0.03	440	332	0.25	0.02