



United States Department of Commerce  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Alaska Fisheries Science Center  
Marine Mammal Laboratory  
7600 Sand Point Way NE  
Seattle WA 98115  
206-526-4507 FAX: 206-526-6615

4 December 2018

Memorandum To: The Record  
From: Kathryn Sweeney, Rod Towell, and Thomas Gelatt  
Subject: Results of Steller Sea Lion Surveys in Alaska, June-July 2018

The Marine Mammal Laboratory (MML) conducted aerial- and ship-based surveys to count Steller sea lion (*Eumetopias jubatus*) pups (~1 mo old) and non-pups (adults and juveniles  $\geq 1$  year old) on terrestrial rookery and haulout sites in Alaska in June-July 2018. The occupied aircraft survey team conducted their survey from 23 June to 11 July between the Shumagin Islands (161°W) in the western Gulf of Alaska (GULF) region and Tanaga Island (178°W) in the central Aleutian Islands (ALEU) region. The ship-based survey team conducted visual counts and used an unoccupied aircraft system (UAS or drone), to survey from 21 June to 4 July in the Aleutian Islands between Adak Island (176°W) and Attu Island (172°E). In addition, the Alaska Department of Fish and Game (ADFG) counted Steller sea lions from land on Round (Walrus) Island in Bristol Bay (eastern Bering Sea) on 27 June 2018.

## METHODS

Abundance surveys to count Steller sea lions are conducted in late June through mid-July starting ~10 days after the mean pup birth dates in the survey area (4-14 June) after ~95% of all pups are born (Pitcher et al. 2001; Kuhn et al. 2017). MML's objectives for 2018 were to survey all terrestrial rookery and haulout sites in the Aleutian Islands and western Gulf of Alaska, as well as opportunistically in the eastern and central GULF regions (especially rookeries and major haulouts) because of the anomalous pup decline observed in these regions during the 2017 survey (Sweeney et al. 2017).

The occupied aircraft survey team operated from a NOAA Twin Otter fixed-wing aircraft equipped with three high-resolution digital cameras (as in 2009-2017; see Fritz et al. 2016). The team captured imagery or conducted visual counts (when less than 10 sea lions were present) from west of the Shumagin Islands to Tanaga Island, and two major haulouts in the central Gulf of Alaska (Fig. 1). The ship-based survey team worked off the U.S. Fish and Wildlife Service (USFWS) *R/V Tiġlax* to survey the Aleutian Islands from the Delarof Islands to Attu Island. Observers conducted sea lion counts from the research vessel offshore (either a single counter or mean counts of 2-3 observers are reported); or from aerial images captured using the UAS (i.e., APH-22 hexacopter). MML analyzed aerial images captured with the UAS and Twin Otter camera array as in previous years (see Fritz et al. 2016).

Field camp observers conducted non-pup counts from an overlook on Round Is. (also known as, Walrus Is.; personal communication from E. Weiss, Lands and Refuge Manager, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518). We used their counts that were conducted on the same day the Twin Otter team surveyed the eastern Aleutian Islands region (27 June).

We modeled raw count data from 1978 to 2018 using the agTrend R package (Johnson and Fritz 2014). We modeled count and trend estimates east and west of Samalga Pass, by region, for the four Rookery Cluster Areas (RCA) in the central Aleutian Islands region (RCAs 2-5), and for the western DPS in Alaska.

## RESULTS

The Twin Otter-based crew surveyed a total of 114 sites in the eastern and central Aleutian Island regions, western Gulf of Alaska region, and two major haulouts were surveyed opportunistically in the central GULF (Table 1). The crew missed 50 sites within their survey area due to weather and logistics (timing, duty days, etc.), 18 of which in recent history have had very few or no sea lions present. The crew intended to survey the Delarof Islands (central ALEU region) but were unable to make it west of Tanaga Is.

The *R/V Tiġlâx* crew surveyed Tag and Ulak/Hasgox Point rookeries in the Delarof Islands. In total, the *R/V Tiġlâx* crew surveyed 21 sites in the Aleutian Islands: observers conducted counts from the research vessel offshore at nine sites and the UAS hexacopter was used to survey 12 sites (Table 2). The *R/V Tiġlâx* crew missed 24 sites in their survey area due to timing and weather, 19 of which have had very few or no sea lions present in recent history.

### **Steller sea lion raw counts**

*Non-pup counts*—We counted 18,018 live non-pups on 91 sites that had at least one non-pup present (Tables 1 and 2). We missed seven sites in the western ALEU, six of which historically have had very few or no sea lions present, and the seventh was Buldir/NW Rocks, where we have observed five to 14 sea lions annually over the past decade. We counted 532 non-pups in the western ALEU, which is 55 fewer than what we counted in 2016 (the last Aleutian Island survey; Sweeney et al. 2016).

Excluding the 15 sites in the Bering Sea that are not surveyed regularly (with the exception of Round [Walrus Is.] by ADFG field camps), only six sites were not surveyed in the eastern ALEU region. Four of these sites have historically had very few or no sea lions present. The other two were Avatanak which has ranged from two to 69 non-pups in the last four years and Unimak/Cape Lazaref, which historically has had no sea lions present during the summer breeding season except for the most recent survey in 2016 when we counted 201 non-pups. We counted 8,818 non-pups in the eastern ALEU region, which is 576 more than what we counted in 2016 (Sweeney et al. 2016—from this point forward this citation applies to all references to the 2016 Aleutian Island survey data and trends for the period of 2003-2016). Since the surveys in the central ALEU and GULF regions were not nearly complete, we cannot compare raw counts to past survey counts.

*Pup counts*—We counted 6,215 live pups from aerial images captured at 43 sites that had at least one pup present (Tables 1 and 2). In the western ALEU, we didn't miss any sites where sea lion pups have been observed in a decade or more. We counted 170 pups in this

region, down 19 from our 2016 count. We counted 2,812 pups in the eastern ALEU region which is 54 more pups than what was counted in 2016 (excluding Bering Sea sites). Since the surveys in the central ALEU and GULF regions were not near complete, we cannot compare raw counts to past survey counts.

### **agTrend modeled estimates**

Our method for modeling raw counts (agTrend) produces trend and count estimates which are used for monitoring the population. This model produces two types of count estimates: predicted and realized counts. Predicted counts are used to estimate trends, and account for both observation and process errors. Realized counts use the standardized variance of raw counts at each site throughout the time series to estimate survey counts we could expect to collect if we had completely surveyed all sites. Therefore, the more complete the survey, the more similar raw counts are to realized counts, which is shown by smaller confidence intervals.

The year with the lowest non-pup and pup counts in the western DPS (in Alaska) was 2002 and the estimated annual abundance trends were calculated from 2002 to 2018 (Johnson and Fritz 2014).

*Non-Pup modeled counts and trends*—Non-pup counts increased at a rate of 2.05%  $y^{-1}$  between 2002 and 2018 in the western DPS in Alaska (95% credible interval of 1.46-2.66%  $y^{-1}$ ; Table 3 and Fig. 2). This rate of increase is lower than what we reported for 2017 (2.14%  $y^{-1}$ ; Sweeney et al. 2017) and for 2016 (2.24%  $y^{-1}$ ) trend estimates. The total model-predicted 2018 non-pup count estimate for the western DPS in Alaska was 41,782 (95% CI 37,370 – 46,822) which is 533 more non-pups than what we reported for 2017. Non-pups increased ~1,600 between 2016 and 2017 (Sweeney et al. 2017—from this point forward this citation applies to all references to 2017 survey data and trends for the period of 2002-2017).

Non-pups increased at 3.07%  $y^{-1}$  east of Samalga Pass from 2002 to 2018 (Table 3; Fig. 3), similar to what was reported in 2017 (3.09%  $y^{-1}$ ). The 2018 survey was focused in the Aleutian Islands; there were limited, or no, new data collected in the GULF regions. Therefore, there was little change in the annual trends of non-pup counts for these regions from the previous year (Fig. 4). The eastern ALEU survey was nearly complete and non-pups increased 1.76%  $y^{-1}$ , which is a slightly lower rate than what we reported in 2017 (1.85%  $y^{-1}$ ).

Counts west of Samalga Pass for the period 2002 – 2018 declined at a rate of -1.22%  $y^{-1}$  (-2.2 – -0.25%  $y^{-1}$ ). This area had been reported as statistically stable in 2017 (-0.84%  $y^{-1}$  [-0.84 – 0.26%  $y^{-1}$ ]) and for the previous Aleutian Island survey in 2016 (-1.42%  $y^{-1}$  [-2.99 – 0.27]). Non-pup counts in the central ALEU remained statistically stable at -0.53%  $y^{-1}$  (-1.64 to 0.50%  $y^{-1}$ ; Fig. 4), a lower rate than what we reported in 2017 (-0.07%  $y^{-1}$  [-1.26 to 1.15%  $y^{-1}$ ]). RCAs 2 and 3 (central ALEU) declined from 2002 to 2018 at -4.16%  $y^{-1}$  and -3.05 %  $y^{-1}$ , respectively (Fig. 5). These are slightly steeper rates of decline than what we reported in 2017 and 2016. RCA 4 remained statistically stable while RCA 5 increased (2.41%  $y^{-1}$ ) at a much lower rate than what we reported in 2017 (3.81%  $y^{-1}$ ). Western ALEU non-pups declined at a rate of -6.47%  $y^{-1}$  through 2018, a slightly less steep rate of decline than what we reported in 2017 (-6.73%  $y^{-1}$ ).

*Pup modeled counts and trends*—Pups in the western DPS in Alaska increased at 1.52%  $y^{-1}$  (0.94 – 2.08%  $y^{-1}$ ) between 2002 and 2018 (Table 3 and Fig. 6)—this is lower than

the 2017 (1.78%  $y^{-1}$ ) and 2016 (2.19%  $y^{-1}$ ) trend estimates. The total estimated pup count for the western DPS in Alaska in 2018 was 11,842 (95% CI 10,659 – 13,238) which is 111 less pups than what we reported for 2017 and 789 less than 2016.

Pup counts east of Samalga Pass between 2002 - 2018 increased at 2.90%  $y^{-1}$ , a lower rate than reported in 2017 (3.18%  $y^{-1}$ ; Table 3; Fig. 7). This is mostly because of the anomalous decline in pup counts from 2015 to 2017 in the eastern (-33%) and central (-18%) GULF, and we collected no new pup data in these regions—and limited pup data for the western GULF region—in 2018 (Fig. 8). The western GULF and eastern ALEU increased 3.36%  $y^{-1}$  and 2.54%  $y^{-1}$ , respectively. These annual rates of change are lower than what we estimated in 2017 (3.65 and 2.79%  $y^{-1}$ , respectively).

Pup counts west of Samalga Pass declined at a rate of -2.08%  $y^{-1}$ , a steeper rate of decline than we reported for 2017 (-1.90%  $y^{-1}$ ) and 2016 (-1.89%  $y^{-1}$ ). Though non-pup counts in the central Aleutian Islands remained relatively stable, pup counts significantly declined in this region (-1.60%  $y^{-1}$ ), steeper than the 2016 and 2017 rate (both were -1.33%  $y^{-1}$ ). Within the central ALEU, pup counts declined in RCAs 2 (-4.43%  $y^{-1}$ ) and 3 (-3.44%  $y^{-1}$ ) while RCAs 4 and 5 remained relatively stable, though the annual rates of change were lower than 2016 and 2017 estimates (Fig. 9). The western ALEU declined -6.47%  $y^{-1}$  which is a slightly less steep rate than we reported for 2016 (-6.94%  $y^{-1}$ ) and 2017 (-6.83%  $y^{-1}$ ).

## DISCUSSION

Overall counts of Steller sea lions in the western DPS in Alaska increased between 2002 and 2018 at lower rates than estimated for 2016 and 2017, especially for pups. This can be explained by two factors: (1) the continued declines in the western ALEU and RCAs 4 and 5 (central ALEU); and (2) there were no—or limited—new data collected for the GULF regions in 2018 to update the anomalous stable and lower counts of non-pups and pups (respectively) from 2015 to 2017. General trends in pup and non-pup counts from 2002-2018, east (increasing) and west (generally decreasing) of Samalga Pass in the Aleutian Islands were similar to what we have observed in previous years.

Non-pups and pups continued to decline in the western ALEU region. Modeled realized counts (count estimates if we had surveyed all sites) show steep declines until a brief period of stability between 2014 and 2016 (with a slight increase in pup counts). However, both non-pup and pup counts continued to decline between 2016 and 2018.

In 2018, virtually none of the eastern and central GULF was surveyed and therefore, the most recent counts conducted in 2017 informed the model. In 2017, we observed anomalous low pup counts in the eastern and central GULF (-33% and -18%, respectively) and stable non-pup counts for these regions combined, despite continuous increases observed until 2015 (Sweeney et al. 2017). In 2017 we observed that there was likely movement of non-pups from the eastern to the central GULF (opposite the general pattern; Fritz et al. 2016). Presumably, this area was impacted by the low availability of prey associated with warm ocean temperatures that occurred in the northern Gulf of Alaska during 2014-2016 (Bond et al. 2015; Peterson et al. 2016). Data collected during the 2019 survey, which will be focused in the Gulf of Alaska, should yield more precise and accurate estimates of counts and trends for this area.

Both Steller sea lions and northern fur seals, as well as large aggregations of sea birds, inhabit Bogoslof Island in the eastern ALEU region (168°W). This Island began to erupt in December of 2016 with almost 50 eruptions reported by Alaska Volcano Observatory until the final eruption on August 27, 2017 (AVO 2018). The last Steller sea lion survey we conducted at Bogoslof Island was on 1 July, 2016, when we counted 308 non-pups and 328 pups. In 2017, we approached Bogoslof on 3 July, during the research cruise, and observed hundreds of Steller sea lions, northern fur seals, and sea birds. In 2018, the aerial survey crew conducted their survey on 30 June and counted 366 non-pups and 342 pups (Fig. 10). The survey crew also observed a large number of northern fur seals and sea birds. We have observed what seems to be very limited impact to Steller sea lion abundance on Bogoslof Island, similar to what we observed with the 2008 eruption of Kasatochi Island in the central ALEU region.

### **ACKNOWLEDGMENTS**

We thank D. Keith, F. Centinello, R. Pauley, and the entire NOAA Aircraft Operations Center (AOC) for conducting the occupied aircraft survey, and Captain John Faris and the crew of the USFWS *R/V Tiglax* for their continued support of our Aleutian Island Steller sea lion research project. Each survey presents a unique set of logistical, mechanical and weather-related challenges, and because of their dedication, we are able to squeeze in as much survey time as possible. Thank you to NOAA AOC's UAS Section for their part in our continued successful implementation of UAS. MML also greatly appreciates the commitment of Morgan Lynn, Jim Gilpatrick and Wayne Perryman, SWFSC, and Don LeRoi (Aerial Imaging Solutions LLC) to making aerial surveys possible, and the Bureau of Land Management (DOI) for being the 'eye in the sky' for the occupied aircraft flights. B. Hou and K. Luxa (MML), and M. Lynne (SWFSC) conducted the Twin Otter survey, while K. Sweeney and R. Towell (MML) piloted the UAS. J. Cutler and K. Sweeney analyzed and counted sea lions from imagery, and B. Fadely, T. Gelatt, K. Sweeney, and R. Towell (MML) conducted the ship-, skiff-, and land-based counts. Alaska Department of Fish and Game field campers stationed on Round Island conducted ground counts. Research was conducted under authority of U.S. Marine Mammal Protection Act/Endangered Species Act Permit 18528 and NMFS IACUC Protocol A/NW2010-04.

## LITERATURE CITED

- AVO. 2018. Bogoslof reported activity. Alaska Volcano Observatory. Retrieved on 11 November, 2018 from:  
<https://avo.alaska.edu/volcanoes/activity.php?volcname=Bogoslof&page=basic&eruptionid=1301>
- Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. *Geophys. Res. Lett.*, 42, 3414–3420. doi: 10.1002/2015GL063306.
- Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. 2016. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) conducted in Alaska in June-July 2013 through 2015, and an update on the status and trend of the western distinct population segment in Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-321, 72 p
- Johnson, D. S., and L. W. Fritz. 2014. agTrend: A Bayesian approach for estimating trends of aggregated abundance. *Methods in Ecology and Evolution* 5(10): 1110-1115.
- Kuhn C. E., K. Chumbley, D. Johnson, and L. Fritz. 2017. A re-examination of the timing of pupping for Steller sea lions *Eumetopias jubatus* breeding on two islands in Alaska. *Endang Species Res* 32:213-222. <https://doi.org/10.3354/esr00796>
- Peterson, W., N. Bond, and M. Robert. 2016. The blob (part three): Going, going, gone? PICES Press, 24(1), 46-48. Retrieved from  
<https://search.proquest.com/docview/1785278412?accountid=28257>
- Pitcher, K. W., V. N. Burkanov, D. G. Calkins, B. J. LeBoeuf, E. G. Mamaev, R. L. Merrick, and G. W. Pendleton. 2001. Spatial and temporal variation in the timing of births of Steller sea lions. *J. Mammalogy* 82(4): 1047-1053.
- Sinclair, E. H., D. S. Johnson, T. K. Zeppelin, and T. S. Gelatt. 2013. Decadal variation in the diet of Western Stock Steller sea lions (*Eumetopias jubatus*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-248, 67 p.
- Sweeney, K. L., L. Fritz, R. Towell, and T. Gelatt. 2016. Results of Steller sea lion surveys in Alaska, June-July 2016. Memorandum to D. DeMaster, J. Bengtson, J. Balsiger, J. Kurland, and L. Rotterman, December 5, 2016.  
[https://www.afsc.noaa.gov/NMML/PDF/SSL\\_Aerial\\_Survey\\_2016.pdf](https://www.afsc.noaa.gov/NMML/PDF/SSL_Aerial_Survey_2016.pdf).
- Sweeney, K. L., L. Fritz, R. Towell, and T. Gelatt. 2017. Results of Steller Sea Lion Surveys in Alaska, June-July 2017. Memorandum to The Record. November 29, 2017.  
[https://www.afsc.noaa.gov/NMML/PDF/SSL\\_Aerial\\_Survey\\_2017.pdf](https://www.afsc.noaa.gov/NMML/PDF/SSL_Aerial_Survey_2017.pdf).
- Tollit, Dominic, Lowell Fritz, Ruth Joy, Kristi Miller, Angela Schulze, James Thomason, William Walker, Tonya Zeppelin, and T. S. Gelatt. 2017. Diet of endangered Steller sea lions in the Aleutian Islands: New insights from DNA detections and bio-energetic reconstructions. *Can. J. Zool.* 95(11): 853-868.

## TABLES & FIGURES

*Table 1*—Counts of live Steller sea lion non-pups and pups on sites surveyed in Alaska (western DPS) in 2018 by the occupied aircraft survey team. Rookery sites are noted with a ‘1’ ( $\geq 50$  pups in any year since 1970) in the ‘rook’ column. The region and rookery cluster area (RCA; for the central Aleutian Island region) is described. The count type “image” indicates the count is a mean of two independent counters from aerial imagery while the “visual” indicates this was a visual observation by one or both of the observers positioned at the aircraft bubble windows.

SITE	REGION	RCA	ROOK	DATE	NON-PUP	PUP	COUNT TYPE
LATAK ROCKS	C GULF			11-Jul	262	11	IMAGE
SUTWIK	C GULF			11-Jul	456	24	IMAGE
CLUBBING ROCKS NORTH	W GULF		1	11-Jul	522	290	IMAGE
CLUBBING ROCKS SOUTH	W GULF		1	11-Jul	707	510	IMAGE
PINNACLE ROCK	W GULF		1	11-Jul	1126	667	IMAGE
SOUTH ROCKS	W GULF		1	11-Jul	664	49	IMAGE
SUSHILNOI ROCKS	W GULF		1	11-Jul	444	43	IMAGE
ADUGAK	E ALEU		1	1-Jul	518	288	IMAGE
AIKTAK	E ALEU			11-Jul	19	0	IMAGE
AIKTAK/S	E ALEU			11-Jul	0		VISUAL
AKUN/AKUN BAY	E ALEU			28-Jun	0		VISUAL
AKUN/AKUN HEAD	E ALEU			23-Jun	0		VISUAL
AKUN/BILLINGS HEAD	E ALEU		1	27-Jun	790	162	IMAGE
AKUN/JACKASS POINT	E ALEU			28-Jun	0		VISUAL
AKUTAN/BATTERY POINT	E ALEU			27-Jun	0		VISUAL
AKUTAN/CAPE MORGAN	E ALEU		1	27-Jun	1082	744	IMAGE
AKUTAN/NORTH HEAD	E ALEU			23-Jun	0		VISUAL
AKUTAN/REEF-LAVA	E ALEU			23-Jun	344	18	IMAGE
AMAK+ROCKS	E ALEU			27-Jun	831	3	IMAGE
AVATANAK/NE	E ALEU			28-Jun	2		VISUAL
AVATANAK/S	E ALEU			28-Jun	0		VISUAL
BABY	E ALEU			23-Jun	1		VISUAL
BASALT ROCK	E ALEU			28-Jun	0		VISUAL
BOGOSLOF/FIRE ISLAND	E ALEU		1	30-Jun	366	342	IMAGE
EGG	E ALEU			23-Jun	5		VISUAL
EGG/SE TIP	E ALEU			23-Jun	16	0	IMAGE
EGG/West	E ALEU			23-Jun	0		VISUAL
EMERALD	E ALEU			28-Jun	0		VISUAL
INNER SIGNAL	E ALEU			23-Jun	112	0	IMAGE
KALIGAGAN	E ALEU			27-Jun	0		VISUAL
OGCHUL	E ALEU		1	30-Jun	191	87	IMAGE
OLD MAN ROCKS	E ALEU			23-Jun	27	0	IMAGE
OUTER SIGNAL	E ALEU			23-Jun	20	0	IMAGE
POLIVNOI ROCK	E ALEU			28-Jun	61	0	IMAGE
ROOTOK/EAST	E ALEU			28-Jun	23	0	IMAGE
ROOTOK/NORTH	E ALEU			28-Jun	6	0	IMAGE
SEA LION ROCK (AMAK)	E ALEU		1	27-Jun	584	286	IMAGE
TANGINAK	E ALEU			28-Jun	62	0	IMAGE
THE PILLARS	E ALEU			30-Jun	12	0	IMAGE
TIGALDA/ROCKS NE	E ALEU			27-Jun	250	1	IMAGE
TIGALDA/SOUTH SIDE	E ALEU			28-Jun	44	0	IMAGE

SITE	REGION	RCA	ROOK	DATE	NON-PUP	PUP	COUNT TYPE
UGAMAK/NORTH	E ALEU		1	11-Jul	548	496	IMAGE
UGAMAK/ROUND	E ALEU		1	11-Jul	220	135	IMAGE
UGAMAK/SW	E ALEU		1	11-Jul	0		VISUAL
UGAMAK/UGAMAK BAY	E ALEU		1	11-Jul	200	204	IMAGE
UMNAK/AGULIUK POINT	E ALEU			30-Jun	2		VISUAL
UMNAK/CAPE ASLIK	E ALEU			30-Jun	200	1	IMAGE
UMNAK/CAPE CHAGAK	E ALEU			30-Jun	0		VISUAL
UMNAK/CAPE IDAK	E ALEU			30-Jun	0		VISUAL
UMNAK/REINDEER POINT	E ALEU			30-Jun	0		VISUAL
UNALASKA/BISHOP POINT	E ALEU			27-Jun	336	2	IMAGE
UNALASKA/BRUNDAGE HEAD	E ALEU			23-Jun	0		VISUAL
UNALASKA/CAPE IZIGAN	E ALEU		1	28-Jun	212	41	IMAGE
UNALASKA/CAPE SEDANKA	E ALEU			23-Jun	0		VISUAL
UNALASKA/CAPE STARICHKOF	E ALEU			30-Jun	27	0	IMAGE
UNALASKA/CAPE WISLOW	E ALEU			23-Jun	0		VISUAL
UNALASKA/KOVRIZHKA	E ALEU			30-Jun	0		VISUAL
UNALASKA/MAKUSHIN BAY	E ALEU			30-Jun	30	0	IMAGE
UNALASKA/POINT KADIN	E ALEU			27-Jun	0		VISUAL
UNALASKA/PRIEST ROCK	E ALEU			23-Jun	10	0	IMAGE
UNALASKA/SPRAY CAPE	E ALEU			30-Jun	68	0	IMAGE
UNALASKA/W OF MAKUSHIN BAY	E ALEU			30-Jun	81	0	IMAGE
UNALASKA/WHALEBONE CAPE	E ALEU			28-Jun	92	0	IMAGE
UNIMAK/CAPE SARICHEF	E ALEU			27-Jun	565	0	IMAGE
UNIMAK/CAPE SARICHEF N	E ALEU			27-Jun	0		VISUAL
UNIMAK/CAVE POINT	E ALEU			27-Jun	0		VISUAL
UNIMAK/OKSENOF POINT	E ALEU			27-Jun	3	0	IMAGE
UNIMAK/S OF OKSENOF POINT	E ALEU			27-Jun	429	1	IMAGE
UNIMAK/SCOTCH CAP	E ALEU			28-Jun	0		VISUAL
UNIMAK/SENNETT POINT	E ALEU			27-Jun	0		VISUAL
UNIMAK/SENNETT POINT N	E ALEU			27-Jun	98	0	IMAGE
VSEVIDOF	E ALEU			30-Jun	107	1	IMAGE
AMLIA/EAST CAPE	C ALEU	5	1	10-Jul	616	118	IMAGE
CARLISLE	C ALEU	5		1-Jul	21	0	IMAGE
CHAGULAK	C ALEU	5		1-Jul	30	0	IMAGE
SEGUAM/FINCH POINT	C ALEU	5		10-Jul	47	3	IMAGE
SEGUAM/FINCH POINT W	C ALEU	5		10-Jul	62	24	IMAGE
SEGUAM/LAVA COVE	C ALEU	5		10-Jul	42	0	IMAGE
SEGUAM/LAVA POINT	C ALEU	5		10-Jul	1		VISUAL
SEGUAM/MOUNDHILL POINT	C ALEU	5		10-Jul	72	0	IMAGE
SEGUAM/SADDLERIDGE	C ALEU	5	1	10-Jul	639	424	IMAGE
SEGUAM/SW RIP	C ALEU	5		10-Jul	54	0	IMAGE
SEGUAM/TURF POINT	C ALEU	5		10-Jul	5		VISUAL
SEGUAM/WHARF POINT	C ALEU	5		10-Jul	0		VISUAL
ADAK/ARGONNE POINT	C ALEU	4		3-Jul	0		VISUAL
ADAK/CAPE MOFFET	C ALEU	4		3-Jul	0		VISUAL
ADAK/HEAD ROCK	C ALEU	4		1-Jul	0		VISUAL
ANAGAKSIK	C ALEU	4		10-Jul	2		VISUAL
ATKA/CAPE KOROVIN	C ALEU	4		5-Jul	0		VISUAL
ATKA/NORTH CAPE	C ALEU	4		5-Jul	0		VISUAL
ATKA/SE OF NORTH CAPE	C ALEU	4		5-Jul	185	0	IMAGE

SITE	REGION	RCA	ROOK	DATE	NON-PUP	PUP	COUNT TYPE
ATKA/SW OF NORTH CAPE	C ALEU	4		5-Jul	0		VISUAL
CHUGUL	C ALEU	4		10-Jul	0		VISUAL
FENIMORE	C ALEU	4		10-Jul	95	0	IMAGE
GREAT SITKIN	C ALEU	4		3-Jul	0		VISUAL
IGITKIN/SW POINT	C ALEU	4		10-Jul	0		VISUAL
IKIGINAK	C ALEU	4		10-Jul	9	0	IMAGE
KAGALASKA	C ALEU	4		1-Jul	0		VISUAL
KAGALASKA/RAGGED POINT	C ALEU	4		10-Jul	12	0	IMAGE
KASATOCHI/NORTH POINT	C ALEU	4	1	5-Jul	653	460	IMAGE
KONIUJI/NORTH POINT	C ALEU	4		3-Jul	0		VISUAL
LITTLE TANAGA STRAIT	C ALEU	4		10-Jul	16		IMAGE
OGLODAK	C ALEU	4		10-Jul	128	1	IMAGE
SALT	C ALEU	4		3-Jul	0		VISUAL
SALT/SE	C ALEU	4		3-Jul	7		VISUAL
SILAK	C ALEU	4		10-Jul	80	0	IMAGE
TAGALAK	C ALEU	4		10-Jul	159	0	IMAGE
TAGALAK/PASS	C ALEU	4		10-Jul	234	20	IMAGE
BOBROF	C ALEU	3		5-Jul	70	0	IMAGE
KANAGA/CAPE MIGA	C ALEU	3		5-Jul	0		VISUAL
KANAGA/N CAPE	C ALEU	3		3-Jul	0		VISUAL
KANAGA/S OF CAPE MIGA	C ALEU	3		3-Jul	0		VISUAL
KANAGA/SHIP ROCK	C ALEU	3	1	3-Jul	327	225	IMAGE
TANAGA/BUMPY POINT	C ALEU	3		5-Jul	8		VISUAL

*Table 2*—Counts of live Steller sea lion non-pups and pups on sites surveyed in Alaska (western DPS) in 2018 by the research vessel-based team. Rookery sites are noted with a ‘1’ ( $\geq 50$  pups in any year since 1970) in the ‘rook’ column. The region and rookery cluster areas (RCA; for the central Aleutian Island region only) are noted. The count type “ship” indicates it is a visual observation from the ship from a single or mean of up to 3 observers, “ground” for the field camp count from ADFG, and those sites surveyed with the drone are indicated with ‘UAS.’

SITE	REGION	RCA	ROOK	DATE	NON-PUP	PUP	COUNT TYPE
ROUND (WALRUS IS)	E ALEU	6		27-Jun	224		GROUND
TAG	C ALEU	3	1	3-Jul	162	68	UAS
ULAK/HASGOX POINT	C ALEU	3	1	3-Jul	292	116	UAS
AMCHITKA/BIRD	C ALEU	2		29-Jun	7		SHIP
AMCHITKA/COLUMN ROCK	C ALEU	2	1	29-Jun	34	18	UAS
AMCHITKA/EAST CAPE	C ALEU	2		30-Jun	100	16	UAS
AYUGADAK	C ALEU	2	1	29-Jun	110	52	UAS
KISKA/CAPE ST STEPHEN	C ALEU	2	1	28-Jun	95	44	UAS
KISKA/LIEF COVE	C ALEU	2	1	28-Jun	96	50	UAS
KISKA/PILLAR ROCK	C ALEU	2		22-Jun	0		SHIP
KISKA/SIRIUS POINT	C ALEU	2		22-Jun	3		SHIP
KISKA/WITCHCRAFT POINT	C ALEU	2		28-Jun	0		SHIP
KISKA/WOLF POINT	C ALEU	2		22-Jun	14		SHIP
SEGULA/CHUGUL POINT	C ALEU	2		22-Jun	0		SHIP
AGATTU/CAPE SABAK	W ALEU	1	1	26-Jun	114	47	UAS
AGATTU/GILLON POINT	W ALEU	1	1	26-Jun	113	80	UAS
AL Aid	W ALEU	1		27-Jun	58	7	UAS
ATTU/CAPE WRANGELL <sup>1</sup>	W ALEU	1	1	24-Jun	182	36	UAS
ATTU/CHICHAGOF POINT <sup>1</sup>	W ALEU	1		25-Jun	57	0	UAS
ATTU/KRESTA POINT <sup>1</sup>	W ALEU	1		23-Jun	0		SHIP
NIZKI	W ALEU	1		27-Jun	0		SHIP
SHEMYA	W ALEU	1		27-Jun	8		SHIP

<sup>1</sup> Attu sites are aggregated for agTrend modelling but Attu/Massacre Bay was not surveyed. However, this site has historically had very few or no sea lions present. Cape Wrangell, Chichagof Point, and Kresta Point counts were aggregated for the “Attu” count and model input.

Table 3—Annual rates of change (%  $y^{-1}$  with  $\pm$  95% credible intervals) in counts of Steller sea lion pups and non-pups from west to east in the western DPS (U.S.), for the period 2002-2018 modeled using agTrend.

	Non-Pup			Pup		
	Rate	-95% CI	+95% CI	Rate	-95% CI	+95% CI
<b>W ALEU</b>	-6.47	-7.81	-5.21	-6.47	-7.42	-5.57
<b>C ALEU</b>	-0.53	-1.64	0.50	-1.60	-2.75	-0.21
<b>RCA 2</b>	-4.16	-6.19	-2.03	-4.43	-6.50	-2.25
<b>RCA 3</b>	-3.05	-4.19	-1.73	-3.44	-4.66	-2.15
<b>RCA 4</b>	-0.23	-2.17	1.96	-0.84	-2.31	2.92
<b>RCA 5</b>	2.41	0.14	4.78	0.19	-2.19	2.51
<b>W of Samalga Pass</b>	-1.22	-2.20	-0.25	-2.08	-3.13	-0.79
<b>E ALEU</b>	1.76	0.50	3.07	2.54	1.67	3.46
<b>W GULF</b>	2.92	1.48	4.36	3.36	2.12	4.64
<b>C GULF</b>	4.16	3.13	5.23	3.01	1.53	4.58
<b>E GULF</b>	3.99	1.88	6.15	2.29	0.58	4.11
<b>E of Samalga Pass</b>	3.07	2.35	3.82	2.90	2.23	3.55
<b>Western DPS (US)</b>	<b>2.05</b>	<b>1.46</b>	<b>2.66</b>	<b>1.52</b>	<b>0.94</b>	<b>2.08</b>

Figure 1—Steller sea lion terrestrial rookeries and haulouts surveyed in June-July 2018. Survey regions, rookery cluster areas (RCAs) and boundary of the eastern and western distinct population segments (DPSs) in Alaska are also shown along with missed sites (small, black symbols). The various colors indicate the survey mode for each site haulout (circle) or rookery (triangle).

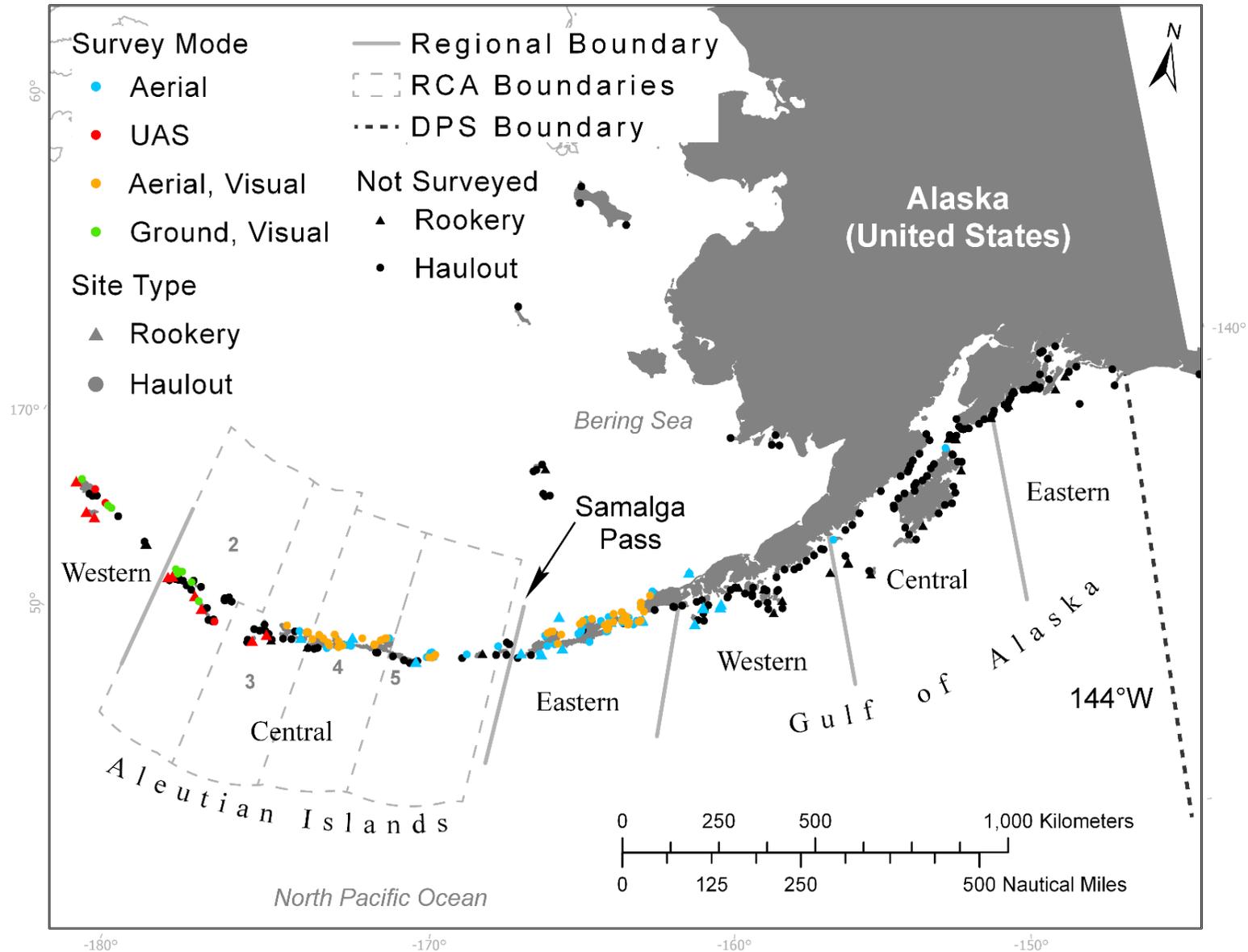


Figure 2—Realized and predicted counts of western Steller sea lion non-pups in Alaska, 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

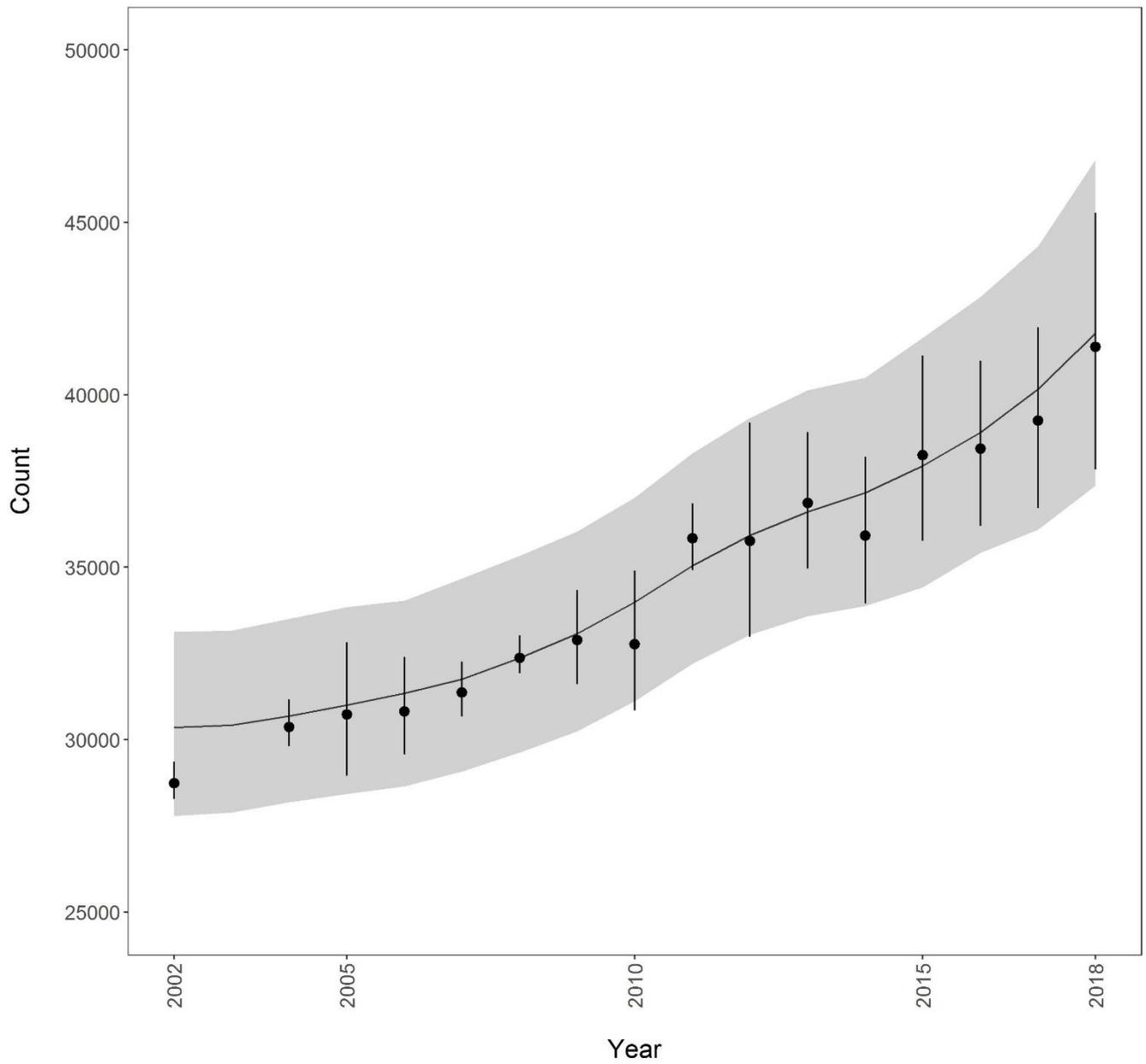


Figure 3—Realized and predicted counts of western Steller sea lion non-pups east and west of Samalga Pass (Figure 1); 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

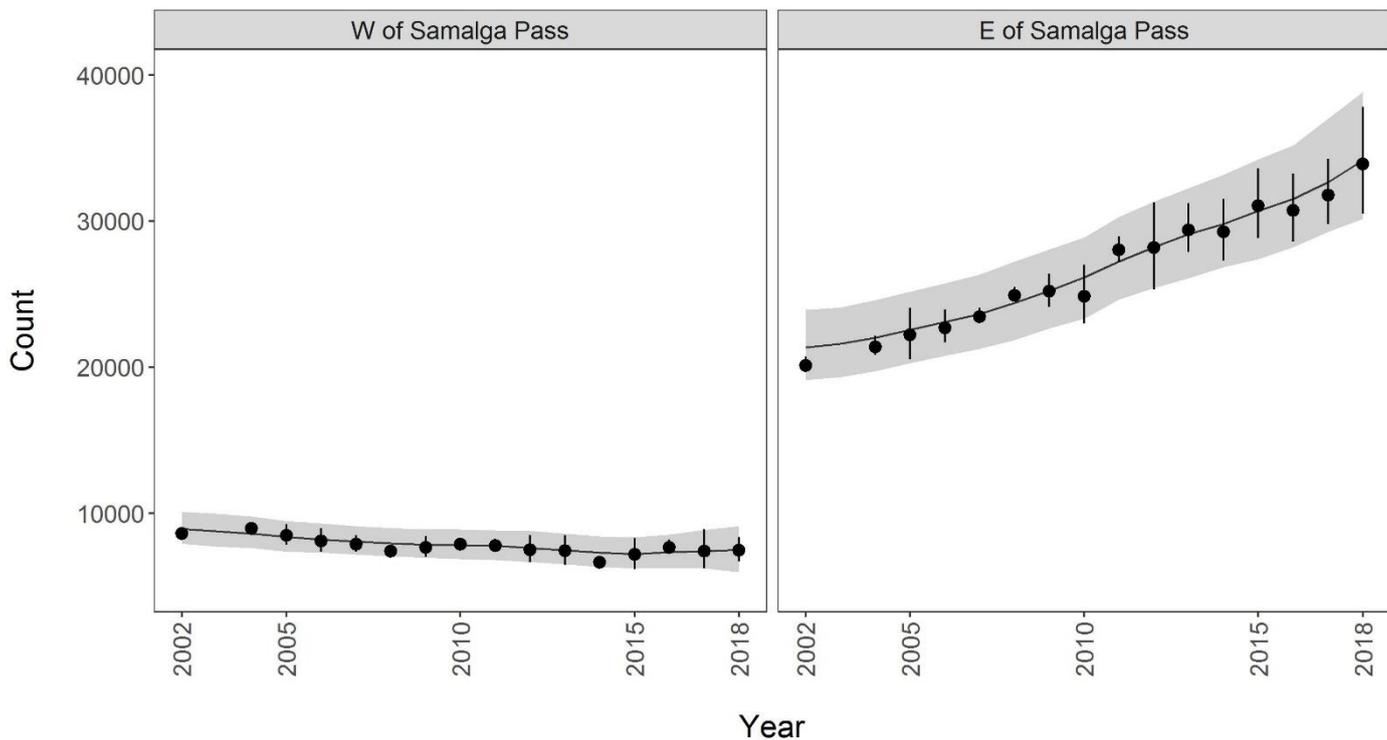


Figure 4—Realized and predicted counts of western Steller sea lion non-pups by region; 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

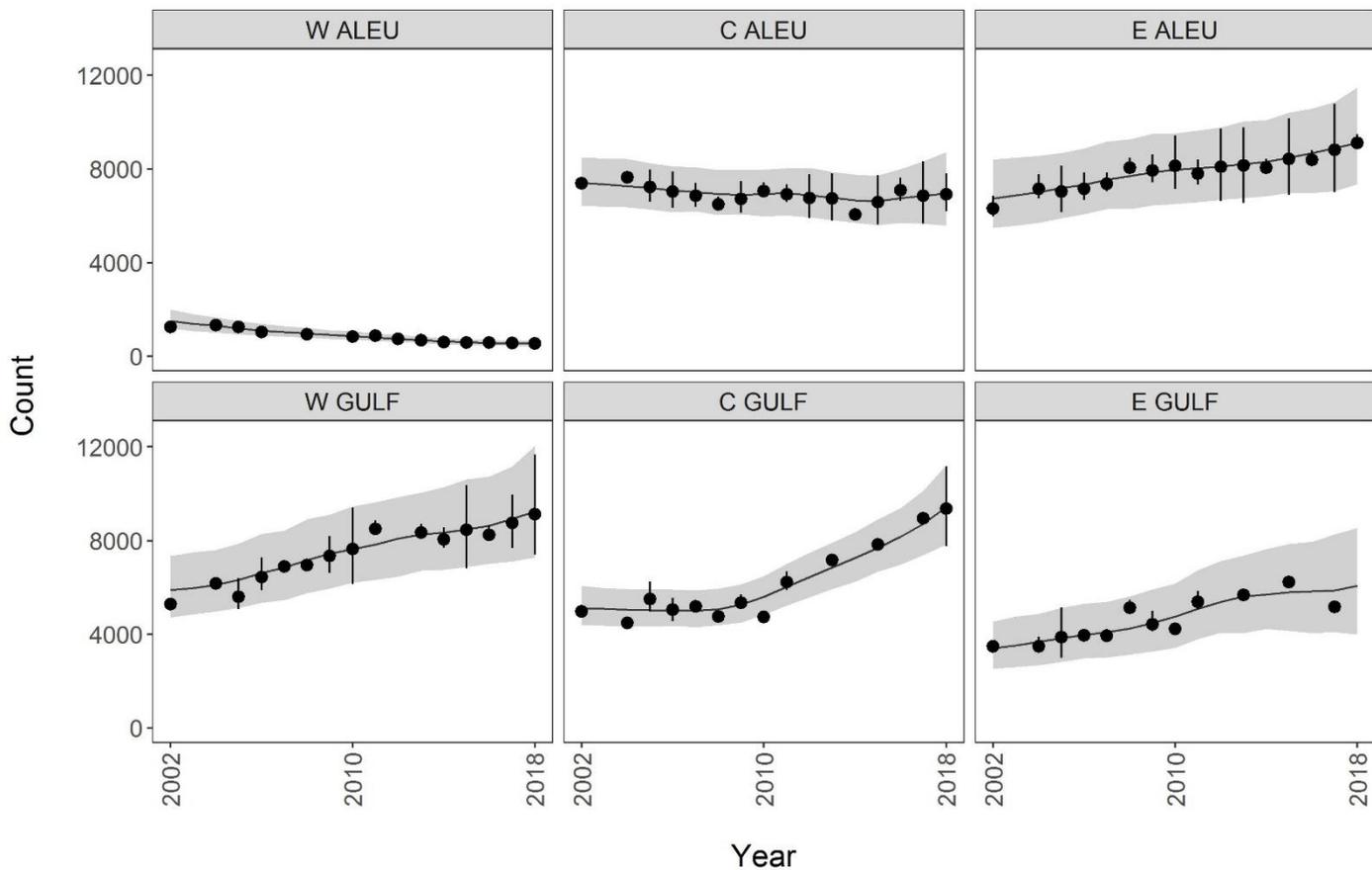


Figure 5—Realized and predicted counts of western Steller sea lion non-pups by rookery cluster area (RCA) in the central Aleutian Island region; 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

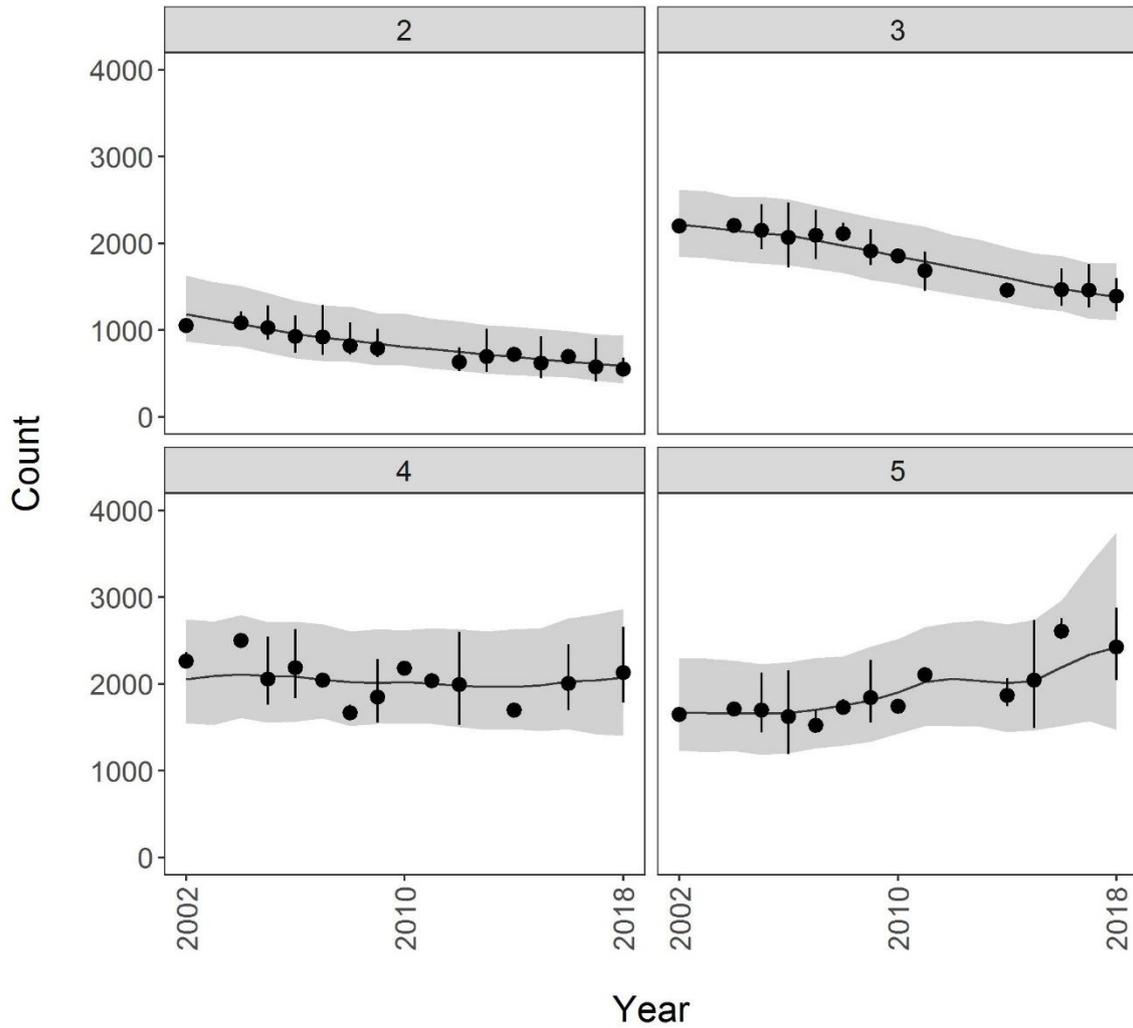


Figure 6—Realized and predicted counts of western Steller sea lion pups in Alaska, 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

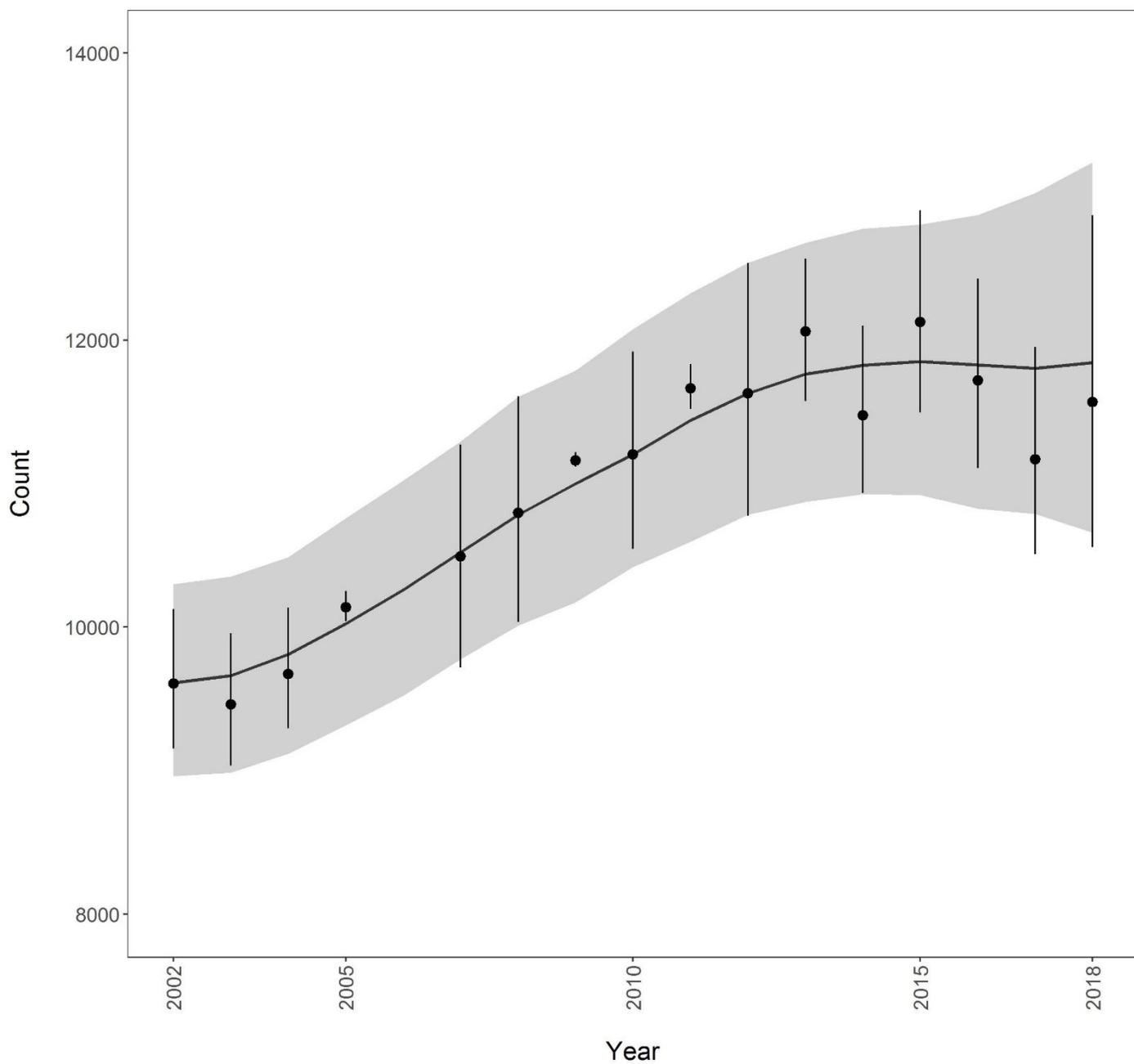


Figure 7— Realized and predicted counts of western Steller sea lion pups east and west of Samalga Pass (Figure 1); 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

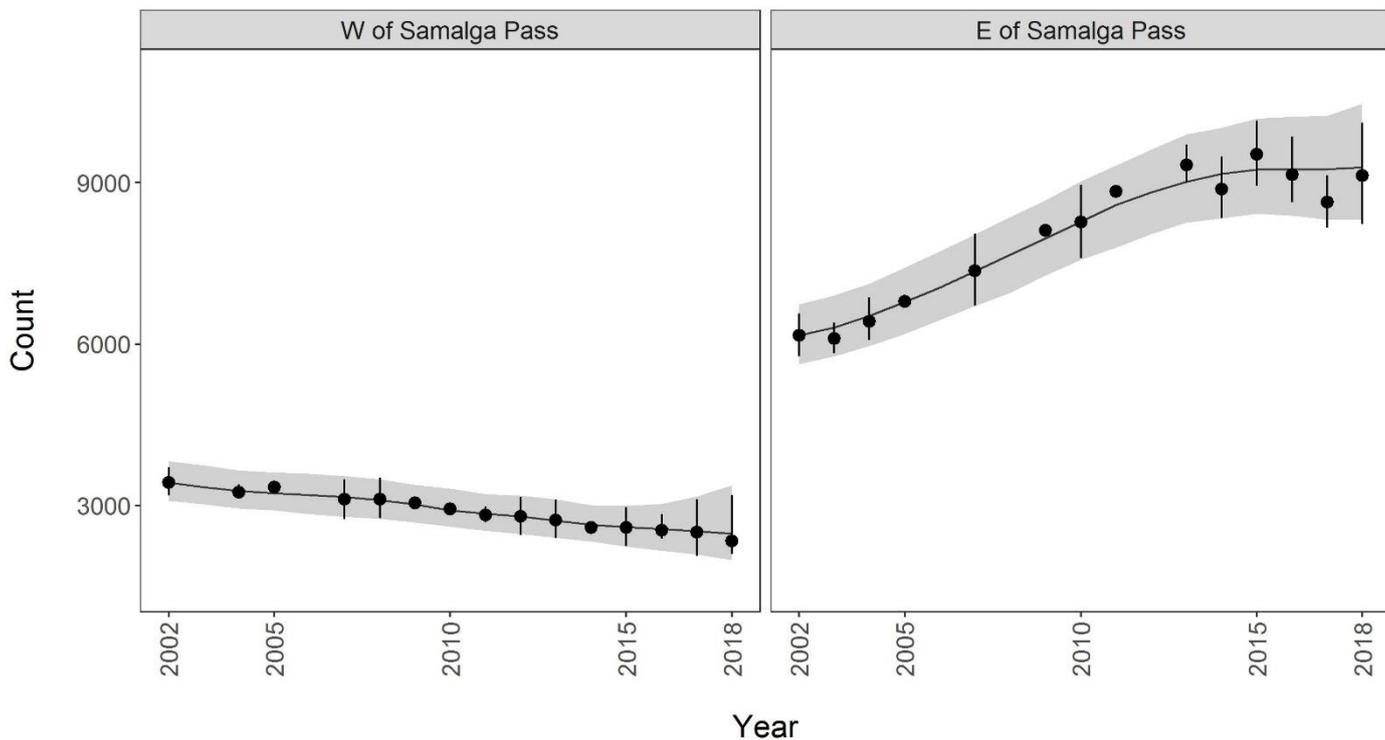


Figure 8— Realized and predicted counts of western Steller sea lion pups by region; 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

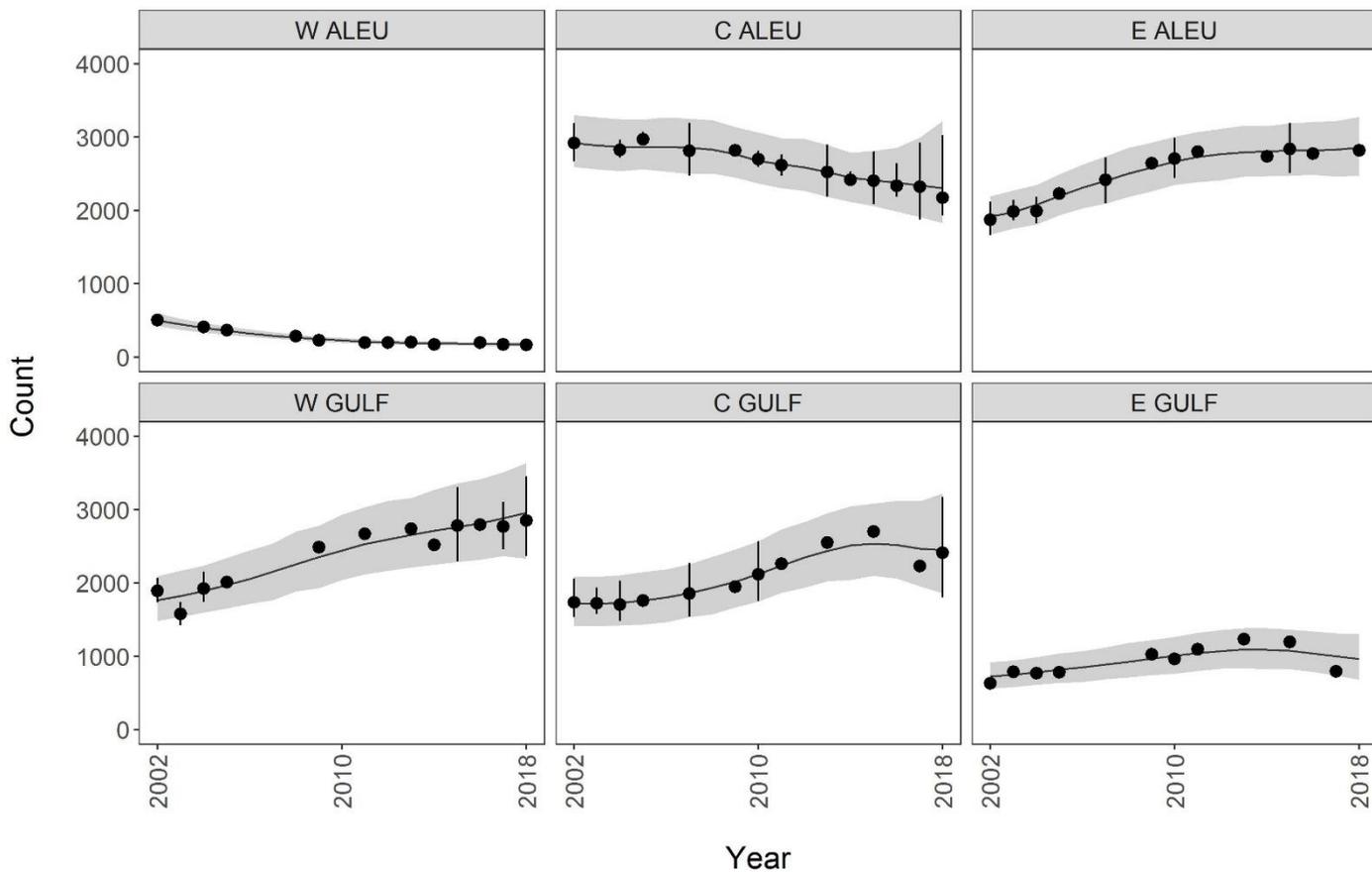
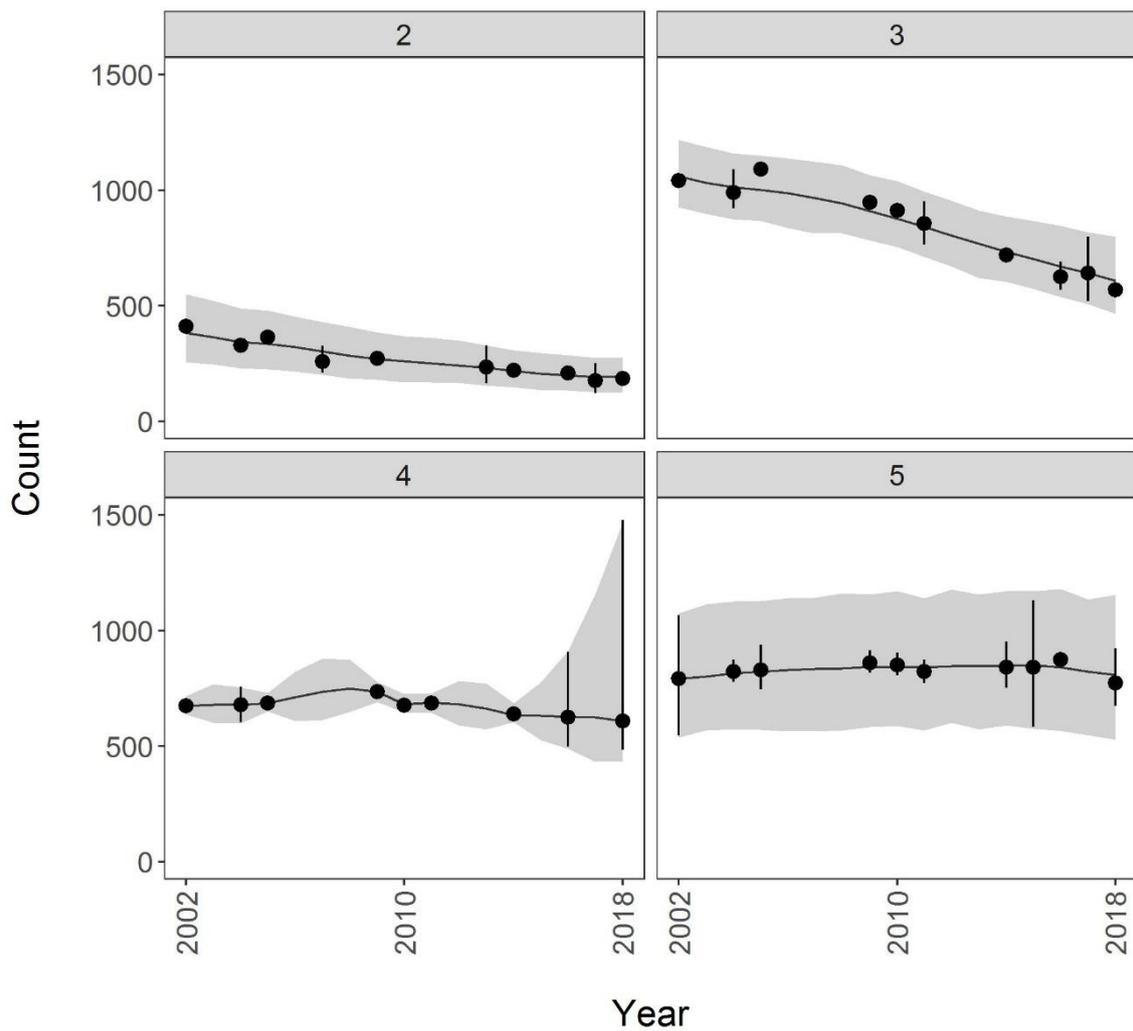


Figure 9—Realized and predicted counts of western Steller sea lion pups by rookery cluster area (RCA) in the central Aleutian Island region; 2002-2018. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.



*Figure 10*—Part of Bogosof Island photographed from the NOAA Twin Otter on 30 June, 2018 with sea lions and northern fur seals present (image credit: Morgan Lynn, NOAA Fisheries).

