ABUNDANCE ESTIMATION OF ALASKAN HARBOR SEALS: ASSESSING THE EFFECTS OF TIDE AND ANIMAL MOVEMENT

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Introduction

Many phocids use haulouts that are exposed for only limited periods each day. Coupled with extreme variability in height and diel timing of tides, this behavior makes difficult reliable estimation of population size. Our goal was to examine sources of variability in seal abundance, namely tide height, time relative to low tide, and time of day. We used a subset of 56 haulout sites in Southeast Alaska surveyed daily over an 8-day period from 2 h before low tide to 2 h after; surveys were conducted in August 1998 during the lowest monthly tide. Employing multiple regression, we assessed the contribution of each variable, first for individual haulouts, and then at the scale of haulout groupings. Estimating the effect of these variables at two scales allowed us to minimize the effect of inter-site movement on seal abundance. We hypothesize that by reducing the effect of small-scale seal movement, existing relationships with environmental factors will become more apparent.

Individual Haulouts

Findings:

- There was a high degree of collinearity (0.95) between tide height and time relative to low tide; diagnostics further suggested that tide height was a slightly better predictor of seal abundance, and that simultaneously using time of day did not explain significantly greater variability in seal numbers.
- Regardless, only four of fifty-four sites (7%) exhibited a statistically significant relationship between seal abundance and tide height.

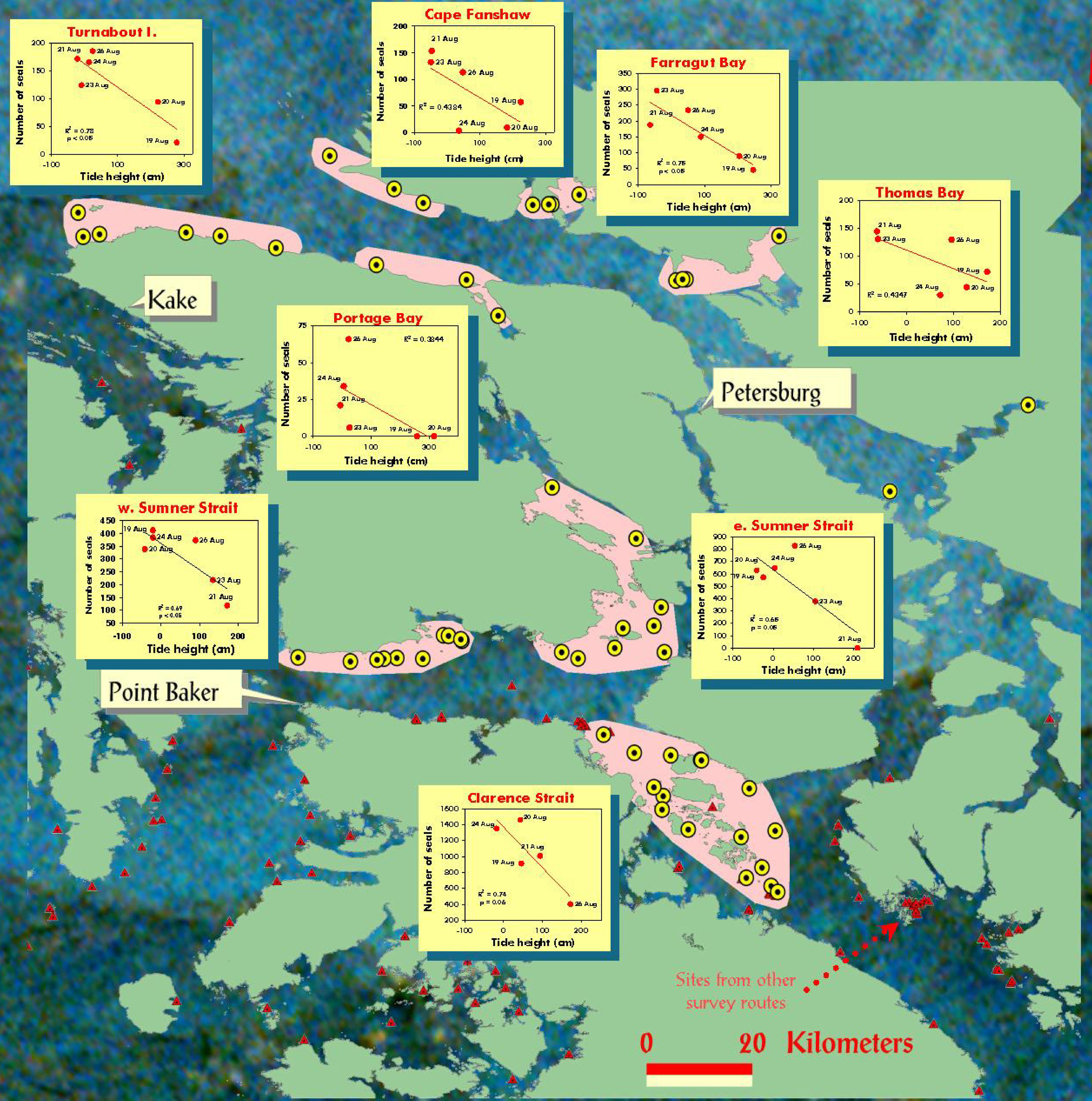
Highlighted haulouts showed a relationship with tide height. 126 = max count

Group	Haulout Site	Daily Counts: 19 Aug	20 Aug	21 Aug	23 Aug	24 Aug	26 Aug	Mean
Cape Fanshaw	Pt. Highland-E.	0	0	11	14	0	0	4
	Pt. Highland-W.	0	0	0	9	0	8	3
	Storm I-Bird rk	57	9	142	109	3	105	71
Clarence Strait	Blashke I.-NE rks	25	0	200		25	25	55
	Blashke I.-NW rks	33	252	43		61	0	78
	Blashke I.-S	30	208	43		0	0	56
	Bushy I.-NE	0	106	0		0	0	21
	Bushy I.-NW	0	10	0		0	0	2
	Bushy I.-E	137	0	52		184	191	113
	Echo I.-off S. end	218	0	165		404	57	169
	Key Reef-marker rk	97	109	88		89	3	77
	Nesbitt reef	140	210	191		160	0	140
	Rose I./Rose rks	6	0	0		25	0	6
	Seal rks	7	0	0		0	0	1
	Shrubby I.-SW	13	342	0		0	0	71
	Tide I.		52	0		0	0	13
	Triplets Is.-Deichman rk	78	0	123		164	126	98
	West I.-Marker rk	77	237	103		238	0	131
e. Sumner Strait	Grief I.-N		35	0	0	37	77	30
	NW of Big Level I.-inner	0	14	0	0	30	30	12
	NW of Big Level I.-outer	47	0	0	0	5	0	9
	Rookery I.-Duncan Canal		0	0	80	166	154	80
	S. Woewodski I.-w. of mr	20	104	0	172	173	183	109
	SE of Mitchell pt.-E. rks	5	50	0	0	0	170	38
	SE of Mitchell pt.-W. rks	208	157	0	48	48	7	78
	Vichnefski Rk	83	269	0	79	188	207	138
	White rks	3	0	0	0	0	0	1
Farragut Bay	Faragut Bay-Francis Anch.	0	0	80	76	0	60	36
	Farragut Bay- E. bay	0	10	3	71	8	39	22
	Farragut Bay-W. bay	46	80	104	148	142	135	109
NA	Coney I.-sand flats	0	0	8			0	2
Portage Bay	N. Kupreanof I.-near B.R.	0	0	9	0	34	37	13
	Portage I.	0	0	0	6	0	12	3
	Stop I.-Portage Bay	0	0	12	0	0	17	5
Thomas Bay	Baird Glacier	3	0	131	64	0	4	34
	Pt. Vandeput-central	0	0	0	0	30	65	16
	Pt. Vandeput-E.	69	44	14	43	0	47	36
	Pt. Vandeput-W.	0	0	0	24	0	14	6
Turnabout I.	E. Pinta rks	0	0	0	0	5	0	1
	N. Kupreanof I.	0	0	0	11	0	13	4
	N. Kupreanof I.	0	0	3	4	0	16	4
	N. Kupreanof-Turn Mtn.	0	0	10	0	12	10	5
	Turnabout I-W. rks	21	94	147	86	127	113	98
	W. Pinta Rks-E. of marker	0	0	11	23	21	33	15
w. Sumner Strait	E. of Yellow I.-Central	7	20	0	0	0	0	5
	E. of Yellow I.-E.	81	127	74	121	88	66	93
	E. of Yellow I.-W.	169	0	0	0	162	229	93
	N. of Shingle I.	8	0	0	0	0	0	1
	Outer Totem Bay-E rks	0	0	8	57	56	52	29
	Outer Totem Bay-W. rks	31	55	0	0	0	0	14
	Pt. Barrie	36	45	0	0	40	9	22
	S. of Shingle I.	0	3	0	0	0	0	1
	S. of Yellow I.	10	0	3	0	0	5	3
	W. of Shingle I.	70	88	34	40	37	12	47
	Sum	1835	2730	1812	Incomplete survey	2762	2331	2319

Grouped Haulouts

Approach:

- We clustered sites based on proximity and natural geographic boundaries in order to reduce the likely variability in abundance due to a daily exchange of animals between individual sites. Daily seal abundance was summed within groups and then related to environmental factors that were also averaged within groups. The haulout sites comprising a group were surveyed within a 30-minute period so that errors associated with conditions changing during a survey were minimized.



Findings:

- Again, collinearity between tide height and time relative to low tide precluded an assessment of each factor's relationship to seal abundance; for all of the groups, diagnostic regressions on the principle components suggested that tide height explained slightly more variance in the model; time of day explained the least.
- Multiple regressions using tide height and time of day – conducted for each census group – showed that the combination did not explain proportionally greater variability than a single variable; we assessed the relationships of each variable to seal abundance using separate regressions.
- In contrast to individual haulouts, seal abundance in five of eight census groups representing > 90% of the population showed a significant relationship with tide height; two of the remaining three census groups showed a significant relationship with time of day.

Conclusions

- Tide height and time relative to low tide were highly correlated due at least in part to centering the survey around the lowest monthly tides; tide height explained the greatest amount of variability in seal abundance whether at the scale of individual haulouts or census groups.
- Tide height was related to abundance at only 4 individual haulouts that comprised < 10% of seals; at least 90% of seals in census groups (5 of 8 groups) showed a significant relationship with tide height (all $R^2 > 0.65$).
- At most census groups, the combination of time of day and tide height did not explain seal abundance as well as tide height alone; time of day best explained variation at two smaller groups.

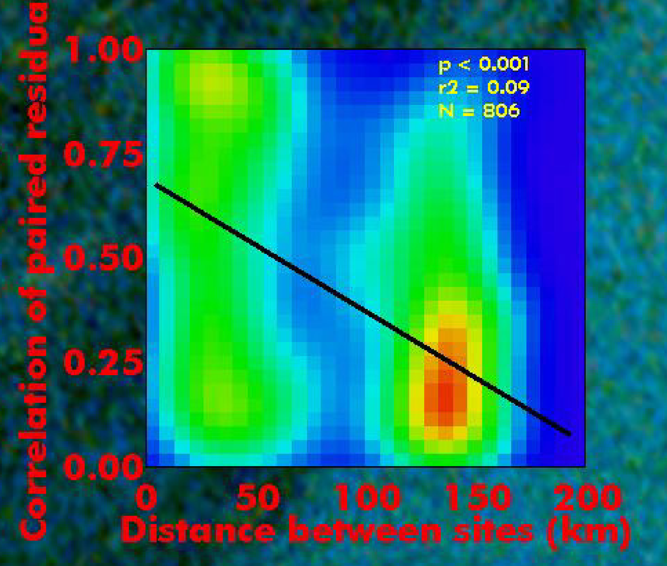
From here....

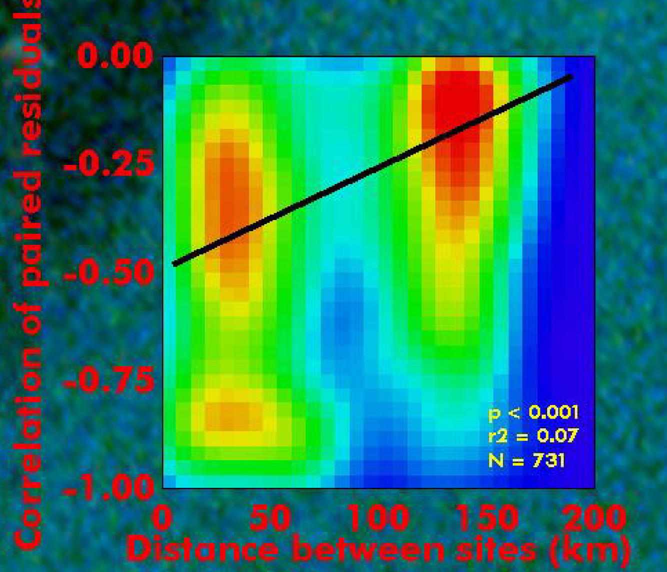
Recommendations:

This study suggests that small-scale movement of animals between sites is enough to confound the relationships between seals and their environment that are operating on regional scales. Such relationships – if unable to control for during surveys – will cause an underestimation of population size when site counts are used as replicates and averaged. Independent knowledge of actual seal movements in these areas is necessary to confirm our hypotheses and may ultimately allow for improvements in survey design and estimations of population size and trends

Future Directions:

To further our understanding of the extent to which movement influences daily fluctuations in seal abundance, we examined whether the residual variability at pairs of sites sites (after accounting for tide height) related to the distance between those sites. Using a "least-cost" script in *Arc Info* (A. Greig, REFM, AFSC), we were able to calculate the shortest distance by sea between all pairs of individual sites (N=1540) and then relate those distances to the correlation coefficients for each site-pair. The degree of correlation between the residual variability at one site and that at another – both positive (top) and negative (bottom) – was significantly related to the proximity of the two groups. The two distinct clusters in each figure reflect a natural separation between haulouts in the north and south of our area.





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