Oikos

OIK-07256

Swift, R. J., Anteau, M. J., Roche, E. A., Sherfy, M. H., Toy, D. L. and Ring, M. M. 2020. Asymmetric benefits of a heterospecific breeding association vary with habitat, conspecific abundance, and breeding stage. – Oikos doi: 10.1111/oik.07256

Appendix 1

Table A1. Top daily nest survival models for piping plovers nesting on the Garrison River Reach (2007, 2012-2016). AICc for top model is 2608.37.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**pp:tp** + age × year + date × year	21	0.00	1.00	2566.19	3
2	age × year + date × year	18	48.20	0.00	2620.43	2
3	age + date	3	201.94	0.00	2804.31	1
4	constant	1	257.31	0.00	2863.68	1

Table A2. Top daily nest survival models for piping plovers nesting on Lake Sakakawea (2007-2008, 2012-2016). AICc for top model is 1999.33.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**pp:tp** + age × year + date × year + elevation × year	31	0.00	1.00	1936.74	3
2	age × year + date × year + elevation × year	28	22.86	0.00	1965.71	2
3	age + date + elevation	4	156.30	0.00	2147.61	1
4	constant	1	307.72	0.00	2305.05	1

Table A3. Top daily nest survival models for piping plovers nesting on the Gavins Point Reach (2008-2009). AICc for top model is 1300.05.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**pp:tp** + age × year + date × year + sandbartype × year	11	0.00	1.00	1277.96	3
2	age × year + date × year + sandbartype × year	8	31.57	0.00	1315.57	2
3	age + date + sandbartype	4	49.01	0.00	1341.04	1
4	constant	1	101.22	0.00	1399.27	1

Table A4. Abundance buffer nest survival models for piping plovers nesting on the Garrison River Reach (2007, 2012-2016). AICc for top model is 2514.24.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**tn500** + **pn500** + age × year + date × year	20	0.00	1.00	2474.07	4
2	**tn200 + pn200** + age × year + date × year	20	35.92	0.00	2509.99	4
3	**tn100** + **pn100** + age × year + date × year	20	70.12	0.00	2544.19	4
4	pp:tp + age × year + date × year	21	94.13	0.00	2566.19	3
5	**tn50** + **pn50** + age × year + date × year	20	104.50	0.00	2578.58	4
6	**tn5** + **pn5** + age × year + date × year	20	141.74	0.00	2615.81	4
7	age × year + date × year	18	142.32	0.00	2620.43	2
8	**tn10** + **pn10** + age × year + date × year	20	143.34	0.00	2617.42	4

Table A5. Abundance buffer daily nest survival models for piping plovers nesting on Lake Sakakawea (2007-2008, 2012-2016). AICc for top model is 1999.33.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	pp:tp + age × year + date × year + elevation × year	31	0.00	0.70	1936.74	3
2	**tn100** + **pn100** + age × year + date × year + elevation × year	30	3.59	0.12	1942.36	4
3	**tn500** + **pn500** + age × year + date × year + elevation × year	30	4.23	0.08	1943.01	4
4	**tn50** + **pn50** + age × year + date × year + elevation × year	30	4.26	0.08	1943.04	4
5	**tn200** + **pn200** + age × year + date × year + elevation × year	30	7.12	0.02	1945.9	4
6	**tn10** + **pn10** + age × year + date × year + elevation × year	30	14.34	0.00	1953.12	4
7	**tn5** + **pn5** + age × year + date × year + elevation × year	30	17.56	0.00	1956.34	4
8	age × year + date × year + elevation × year	28	22.86	0.00	1965.71	2

Table A6. Abundance buffer nest survival models for piping plovers nesting on the Gavins Point Reach (2008-2009). AICc for top model is 1219.04.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**tn500** + **pn500** + age × year + date × year + sandbartype × year	10	0.00	1.00	1198.97	4
2	**tn200**+**pn200** + age × year + date × year + sandbartype × year	10	30.28	0.00	1229.25	4
3	**tn100** + **pn100** + age × year + date × year + sandbartype × year	10	63.97	0.00	1262.94	4
4	pp:tp + age × year + date × year + sandbartype × year	11	81.01	0.00	1277.96	3
5	**tn50** + **pn50** + age × year + date × year + sandbartype × year	10	91.82	0.00	1290.79	4
6	**tn10** + **pn10** + age × year + date × year + sandbartype × year	10	110.90	0.00	1309.87	4
7	age × year + date × year + sandbartype × year	8	112.58	0.00	1315.57	2
8	**tn5** + **pn5** + age × year + date × year + sandbartype × year	10	113.68	0.00	1312.65	4

Table A7. Top ranked models for the daily apparent survival of piping plover chicks hatched on the Garrison River Reach. For all models detection probability was parameterized as [*p*(prefledge:age × year + prefledge:year + postfledge)]. QAICc for top model is 5893.02. Measure of overdispersion is 2.15.

#	Model (ϕ)	K	$\Delta QAIC_c$	w_i	QDeviance	Step
1	**tp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	33	0.00	0.55	5826.49	4
2	**tp:prefledge** + **pp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	34	0.96	0.34	5825.42	4
3	age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	32	3.80	0.08	5832.03	3
4	**pp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	33	5.51	0.03	5831.99	4
5	age:prefledge + date:prefledge + prefledge + postfledge	17	102.65	0.00	5961.53	2
6	prefledge + postfledge	15	102.68	0.00	4500.67	2

Table A8. Top ranked models for the daily apparent survival of piping plover chicks hatched on Lake Sakakawea. For all models detection probability was parameterized as [*p*(prefledge:age + prefledge:year + postfledge)]. QAICc for top model is 2636.79. Measure of overdispersion is 3.17.

#	Model (ϕ)	K	$\Delta QAIC_c$	w_i	QDeviance	Step
1	**tp:prefledge** + year:prefledge + postfledge	18	0.00	0.48	2600.58	4
2	**tp:prefledge** + **pp:prefledge** + year:prefledge + postfledge	19	0.84	0.31	2599.39	4
3	**pp:prefledge** + year:prefledge + postfledge	18	3.25	0.09	2603.83	4
4	year:prefledge + postfledge	17	3.46	0.08	2049.94	3
5	prefledge + postfledge	11	5.46	0.03	2064.04	2

Table A9. Top ranked models for the daily apparent survival of piping plover chicks hatched on Gavins Point Reach. For all models detection probability was parameterized as [*p*(prefledge:age + prefledge:year + postfledge)]. QAICc for top model is 4208.05. Measure of overdispersion is 2.36.

#	Model (ϕ)	K	$\Delta QAIC_c$	w_i	QDeviance	Step
1	age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	11	0.00	0.53	4185.97	3
2	**pp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	12	1.93	0.20	4185.88	4
3	**tp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	12	1.97	0.20	4185.92	4
4	**tp:prefledge** + **pp:prefledge** + age:year:prefledge + date:year:prefledge + year:prefledge + postfledge	13	3.92	0.07	4185.86	4
5	age:prefledge + date:prefledge + prefledge + postfledge	8	11.76	0.00	4203.76	2
6	prefledge + postfledge	6	21.63	0.00	2796.71	2

Table A10. Top daily nest survival models for least terns nesting on the Garrison River Reach (2007, 2012-2016). AICc for top model is 640.96.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**pp:tp** + age × year	15	0.00	0.66	607.22	3
2	age × year	12	1.34	0.34	614.65	2
3	age	2	21.68	0.00	655.15	1
4	constant	1	22.57	0.00	658.05	1

Table A11. Top daily nest survival models for least terns nesting on Lake Sakakawea (2007-2008, 2012-2016). AICc for top model is 111.76.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	age + date	3	0.00	0.86	105.68	1
2	**pp:tp** + age + date	6	4.12	0.11	103.59	3
4	constant	1	6.80	0.03	116.55	1

Table A12. Top daily nest survival models for least terns nesting on Gavins Point Reach (2008-2009). AICc for top model is 239.49.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	age + date	3	0.00	0.75	233.47	1
2	**pp:tp** + age + date	6	2.32	0.23	229.76	3
4	constant	1	7.34	0.02	244.83	1

Table A13. Abundance buffer distances daily nest survival models for least terns nesting on the Garrison River Reach (2007, 2012-2016). AICc for top model is 636.24.

#	Model (*S*)	K	ΔAIC_c	w_i	Deviance	Step
1	**pn100** + **tn100** + age × year	14	0.00	0.38	608.02	4
2	pp:tp + age × year	15	1.24	0.20	607.22	3
3	**pn200** + **tn200** + age × year	14	1.40	0.19	609.41	4
4	age × year	12	2.57	0.10	614.65	2
5	**pn500** + **tn500** + age × year	14	3.86	0.05	611.87	4
6	**pn50** + **tn50** + age × year	14	4.75	0.03	612.77	4
7	**pn10** + **tn10** + age × year	14	5.27	0.03	613.29	4
8	**pn5** + **tn5** + age × year	14	6.67	0.02	614.38	4

Table A14. Top ranked models for the daily apparent survival of least tern chicks hatched on the Garrison River Reach. For all models detection probability was parameterized as [*p*(age:year:prefledge + prefledge:year + postfledge)]. AICc for top model is 5278.43. Measure of overdispersion is 1.

#	Model (ϕ)	K	AIC_c	w_i	Deviance	Step
1	**tp:prefledge** + date:year:prefledge + year:prefledge + postfledge	27	0.00	0.57	5218.55	4
2	**pp:prefledge** + **tp:prefledge** + date:year:prefledge + year:prefledge + postfledge	28	1.02	0.34	5117.50	4
3	date:year:prefledge + year:prefledge + postfledge	26	4.97	0.05	5225.59	3
4	**pp:prefledge** + date:year:prefledge + year:prefledge + postfledge	27	5.42	0.04	5223.97	4
5	date:prefledge + prefledge + postfledge	16	123.84	0.00	5364.97	2
6	prefledge + postfledge	15	126.47	0.00	3446.30	2

Table A15. Top ranked models for the daily apparent survival of least tern chicks hatched on Lake Sakakawea. For all models detection probability was parameterized as [*p*(prefledge + postfledge)]. AICc for top model is 404.74. Measure of overdispersion is 1.

#	Model (ϕ)	K	ΔAIC_c	w_i	Deviance	Step
1	age:prefledge + postfledge	5	0.00	0.54	310.65	3, 4
2	prefledge + postfledge	5	1.31	0.28	311.96	4
3	**pp:prefledge** + age:prefledge + postfledge	6	2.12	0.18	394.29	2

Table A16. Top ranked models for the daily apparent survival of least tern chicks hatched on the Gavins Point Reach. For all models detection probability was parameterized as [*p*(age:prefledge + year:prefledge + postfledge)]. QAICc for top model is 2762.45. Measure of overdispersion is 1.79.

#	Model (ϕ)	K	$QAIC_c$	w_i	Deviance	Step
1	**tp:prefledge** + year:prefledge + postfledge	20	0.00	0.36	2720.91	4
2	**pp:prefledge** + **tp:prefledge** + year:prefledge + postfledge	21	0.43	0.30	2719.29	4
3	**pp:prefledge** + year:prefledge + postfledge	20	1.05	0.21	2721.97	4
4	year:prefledge + postfledge	19	2.03	0.13	2214.59	3
5	prefledge + postfledge	12	17.66	0.00	2244.48	2

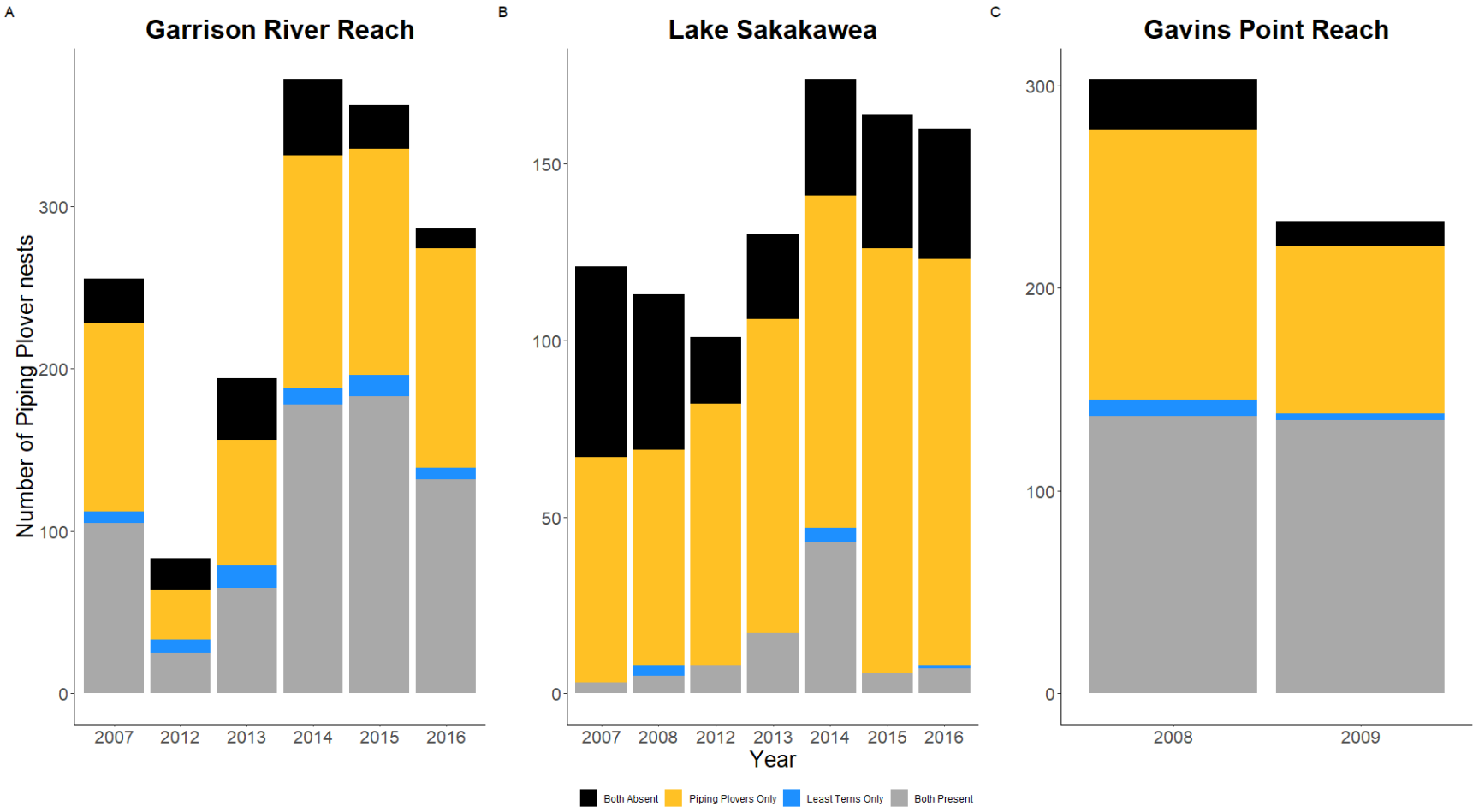

Figure A1. Number of piping plover nests initiated on sandbars/segments relative to the presence of breeding least terns and other breeding piping plovers a) on the Garrison River Reach (2007, 2012-2016), b) on Lake Sakakawea (2007-2008, 2012-2016), and c) on Gavins Point Reach (2008-2009). Note the y-axis scale changes has breeding abundances differ among study areas.

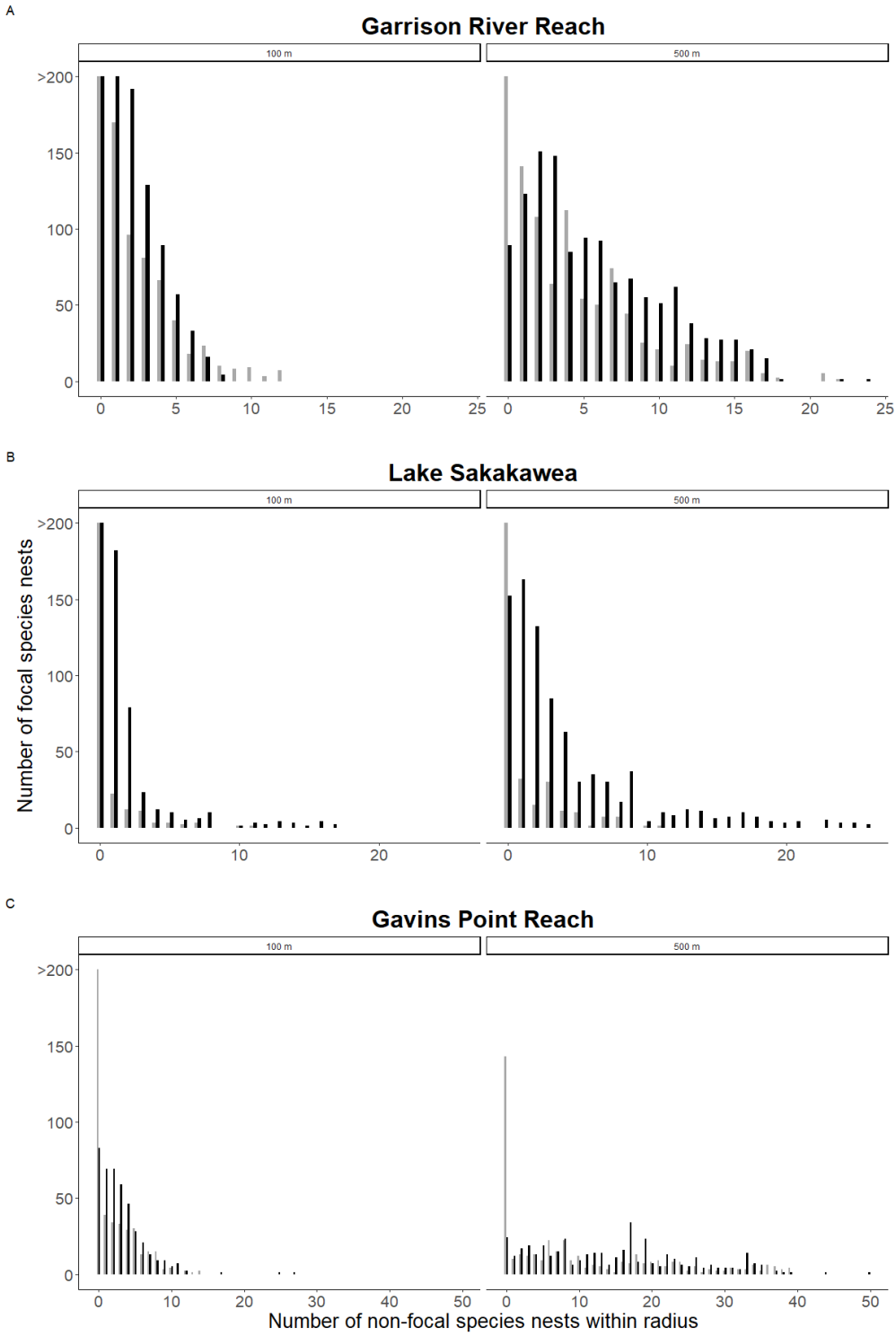

Figure A2. Number of non-focal species nests within 100 meters and 500 meters of the focal species nest for a) Garrison River Reach, b) Lake Sakakawea, and c) Gavins Point Reach. For example, on Garrison River Reach, for 40 least tern nests (gray), five piping plover nests were within 100 m; for 57 piping plover nests (black), five least tern nests were within 100 m. Note the x-axis scale changes has breeding abundances differ among study areas.

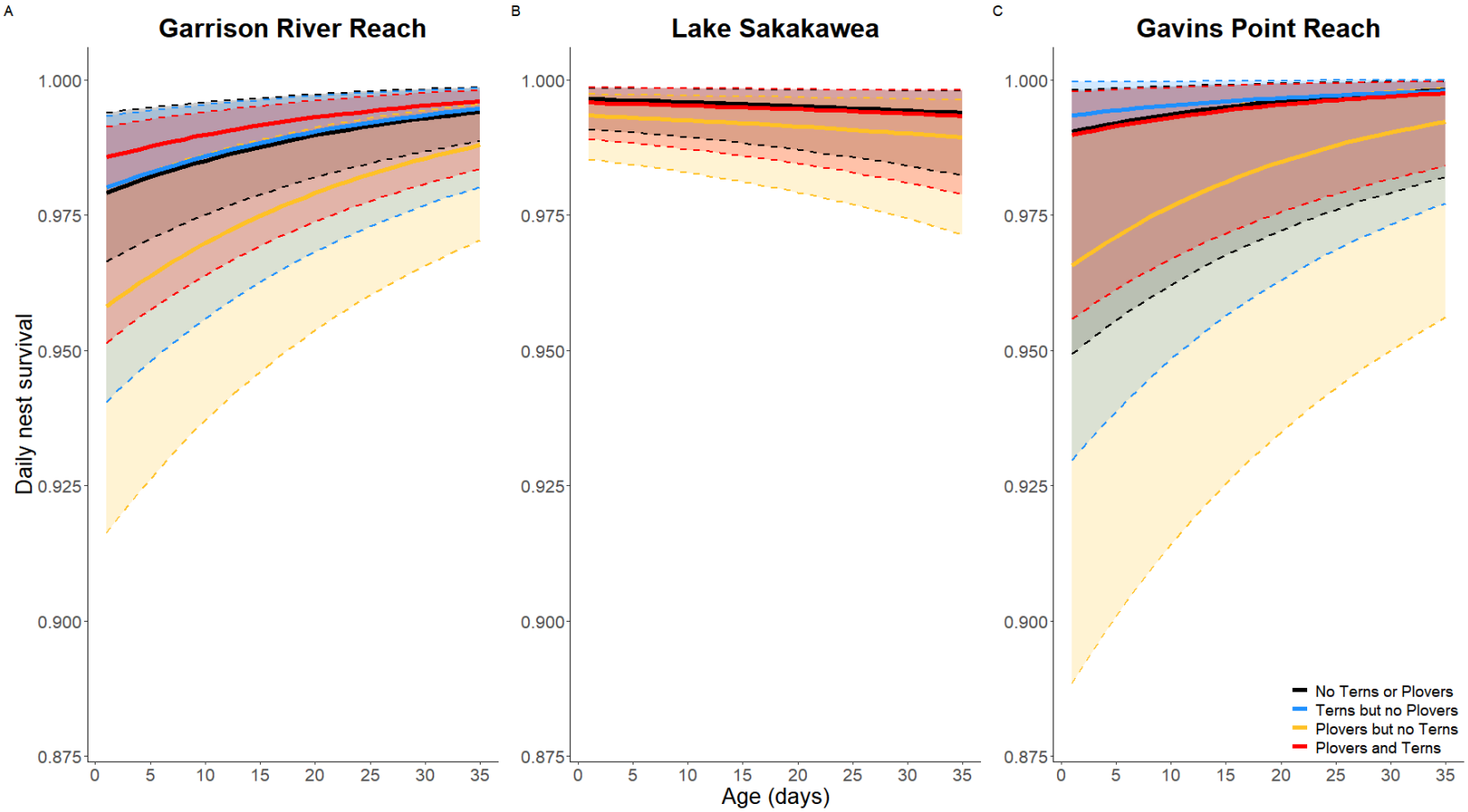

Figure A3. Daily nest survival to hatching (35 days) of Piping Plover nests on a) the Garrison River Reach, b) Lake Sakakawea, and c) Gavins Point Reach relative to the presence of other piping plovers and least terns during the nesting period by nest age. Shaded polygons represent 95% confidence envelopes for the predicted daily apparent survival values for nest survival when terns and plovers were both present (red), when only other plovers were present (yellow), only terns were present (blue) and when no terns nor other plovers were present (black). Daily nest survival estimates were generated using the top-supported model with covariates set to their mean values a) [*S*(pp:tp + age × year + date × year)], b) [*S*(pp:tp + age × year + date × year + elevation × year)], and c) [*S*(pp:tp + age × year + date × year + sandbartype × year)].

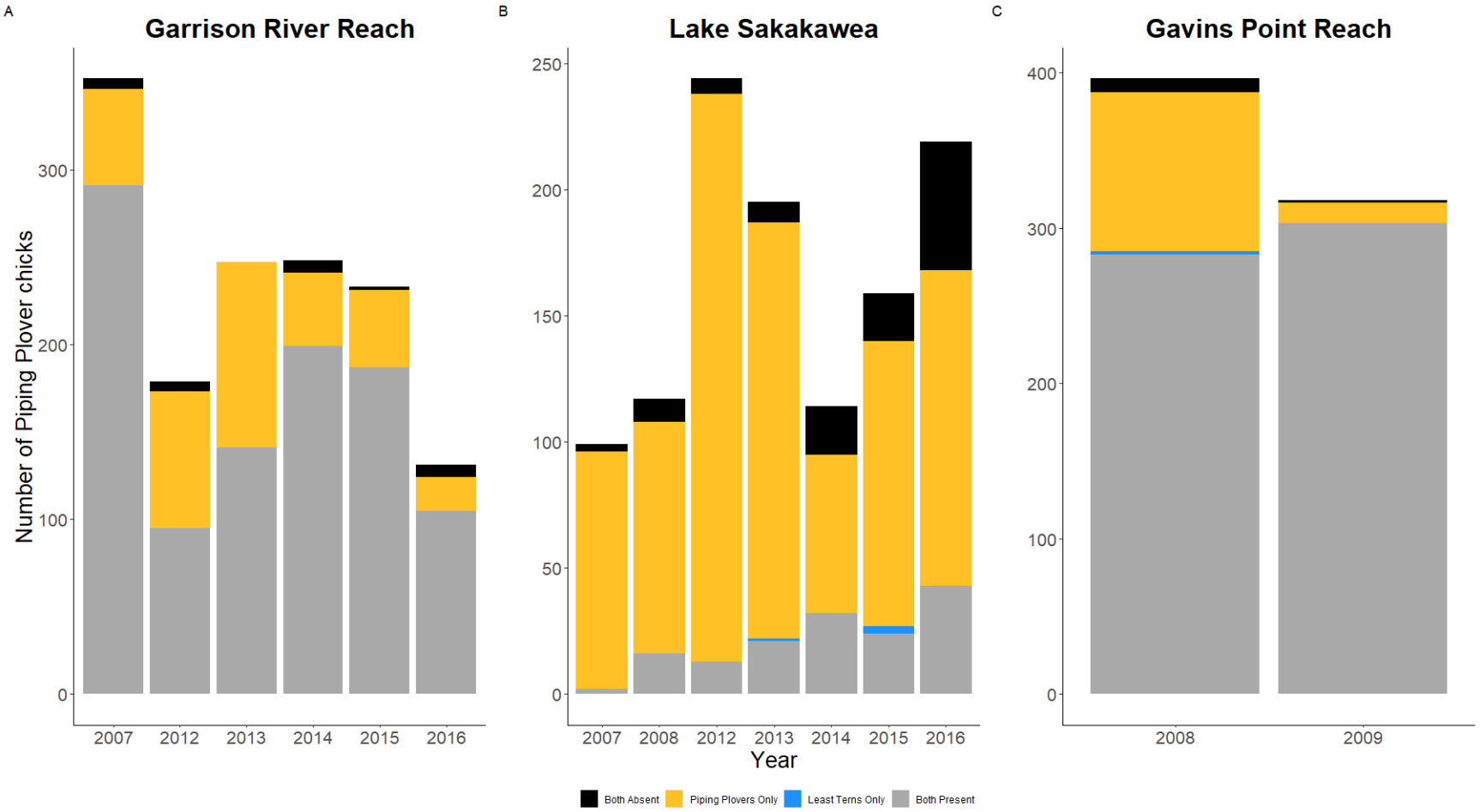

Figure A4. Number of piping plover chicks raised on sandbars/segments in the presence of breeding least terns and/or piping plovers on the a) Garrison River Reach (2007, 2012-2016), b) Lake Sakakawea (2007-2008, 2012-2016), c) Gavins Point Reach (2008-2009). Note the y-axis scale changes as breeding abundances vary among study areas.

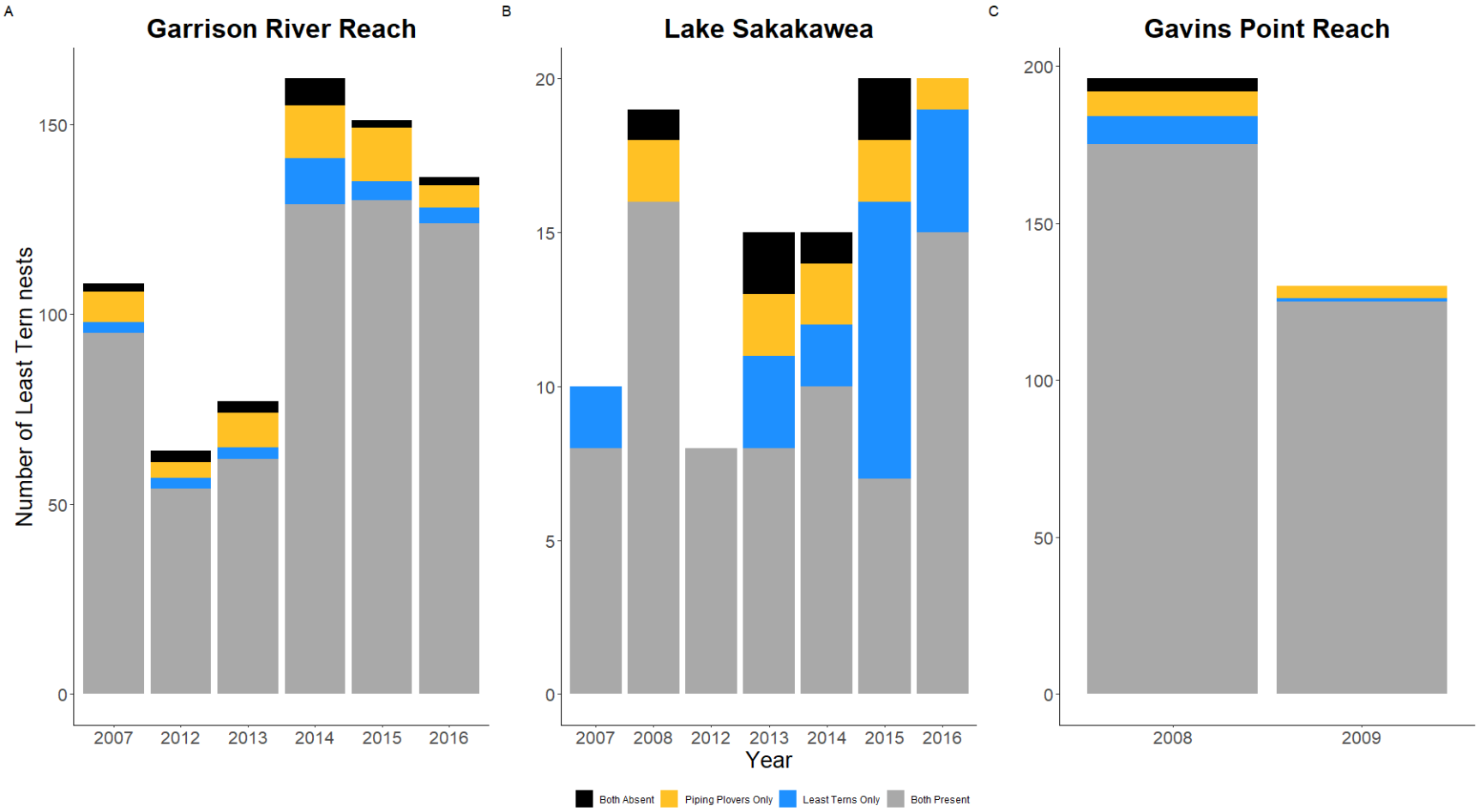

Figure A5. Number of least tern nests initiated on sandbars/segments relative to the presence of breeding piping plovers and other breeding least terns a) on the Garrison River Reach (2007, 2012-2016), b) on Lake Sakakawea (2007-2008, 2012-2016), and c) on the Gavins Point Reach (2008-2009). Note the y-axis scale changes as breeding abundances vary among study areas.

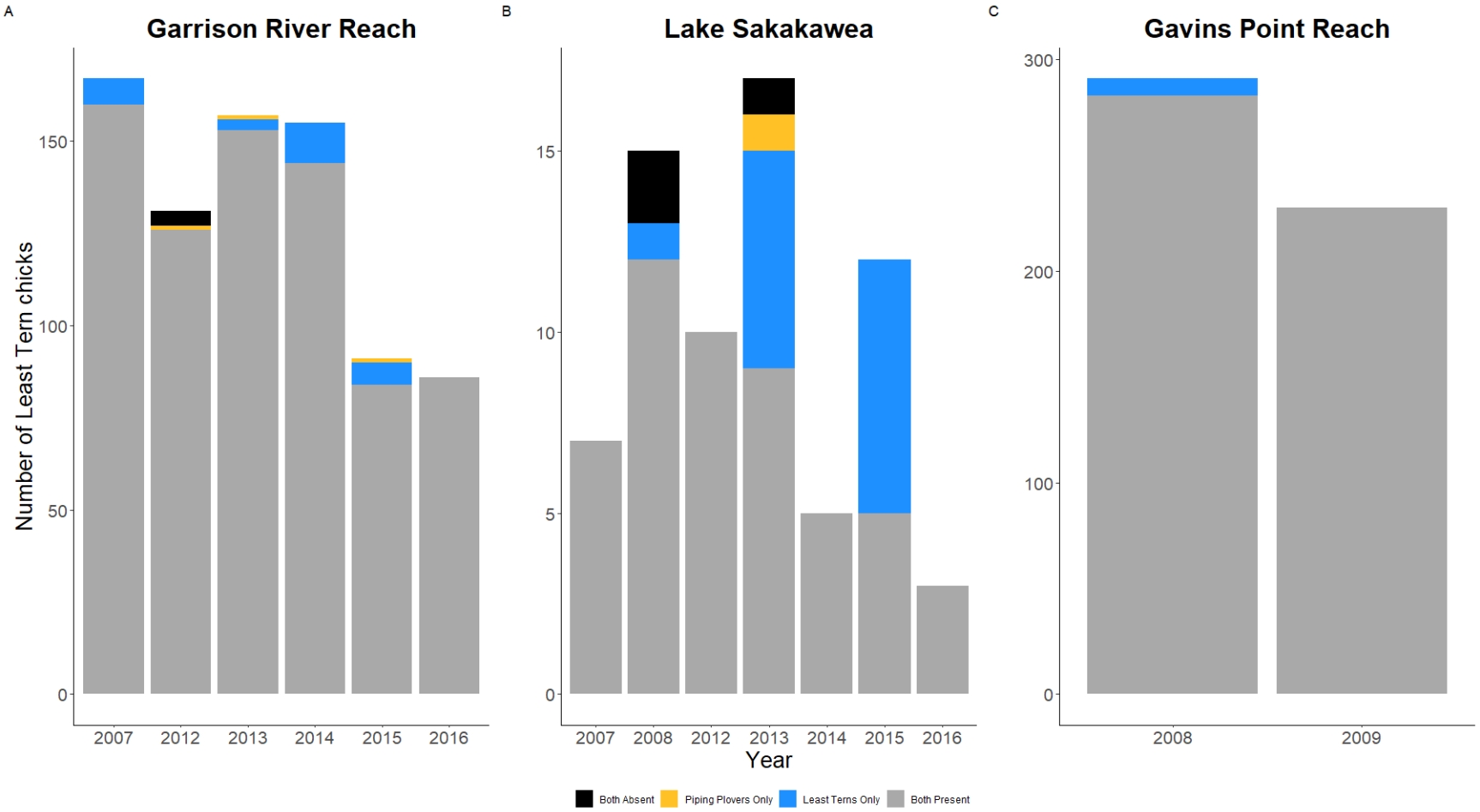

Figure A6. Number of least tern chicks raised on sandbars/segments in the presence of breeding least terns and/or piping plovers on the a) Garrison River Reach (2007, 2012-2016), b) Lake Sakakawea (2007-2008, 2012-2016), c) Gavins Point Reach (2008-2009). Note the y-axis scale changes has breeding abundances differ among study areas.