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South Marsh avian habitat monitoring program: Survey results (2001-2003)

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ABOUT THIS DOCUMENT
S. Fork compiled a report summarizing results from bird surveys at restored South Marsh; biweekly surveys were carried out by volunteers from Dec 2001 – Sept 2003.

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Introduction

When Elkhorn Slough was established as a NERR in 1979 the event portended a much brighter future for inhabitants of the slough and adjacent areas. Of primary concern to reserve managers was the loss of salt marsh to human endeavors, such as occurred in early 1900s when the parts of the slough were diked and drained to convert marsh to pasture. Slough restoration activities in the early 1980s included dredging Parsons Slough to create channels and emergent "islands" potentially beneficial to salt marsh species in South Marsh. Following this restoration to create muted flow to the area, in an unanticipated event in 1982 the original dikes that separated the restored South Marsh area from the main channel were breached during heavy winter rains. What was once a slow and meandering flow became increasingly tidally flushed. The problem of greater tidal flow had originated when the slough mouth was dredged in the late 1940s to create a boat harbor. Observing that a variety of marine birds use South Marsh and concerned about the effects of local tidal erosion, we decided to conduct a series of bird surveys to assess the extent of bird usage of this area.

Surveys

From Dec 2001 to Sept 2003, docents, volunteers, and staff conducted biweekly timed observations of part of restored South Marsh. The area surveyed consisted of a group of emergent mostly vegetated islands just east of the new Parsons railroad bridge as well as the mudflats they enclose. We chose broad categories of birds to make the survey user-friendly and accessible to those with basic birding skills by counting cormorants, gulls, Brown Pelicans, White Pelicans, Caspian Terns, Great Egrets, Snowy Egrets, and Great Blue Herons. In determining species richness each bird group consisted of a single species with the exception of gulls, of which several species were undoubtedly lumped into "gulls", although many were probably Western Gulls. We attempted to coincide observation times with either high or low tide in order to detect any correlations between tide height and bird abundance. Other birds such as shorebirds were included in total abundance tallies but not individual species counts and were not further addressed. To determine potential disturbance by railroad activity, numbers of birds that flew in response to passing trains were also noted during each survey.

Results

94 surveys were completed during the two year period, half at low tide and half at high tide (tides of 2.5' or greater were considered "high", while tides less than 2.5' were assigned as "low") using the tide predicted for the Elkhorn Slough RR bridge. Many species of birds used the restored South Marsh including diving birds such as cormorants and pelicans, waders (egrets and herons), as well as many shorebirds (Fig.1, 2). Cormorants were the most abundant bird, averaging 44 individual per count, while gulls averaged 33 birds and Caspian Terns 20 birds. Brown Pelicans and White Pelicans each averaged about 10 birds per survey. Overall per survey, an average of 94 birds was counted on islands and 27 on mudflats (Fig.3). In terms of taxon richness per survey, islands averaged twice the number of species as mudflats (Fig.4).

Both habitat type and tide level affected total bird abundance when analyzed using a 2-way ANOVA (Fig.5). Species richness was affected by habitat ($p<.0001$) but not by tide height ($p=.35$) (Fig.6). Cormorants were more abundant on islands than mudflats ($p>.0001$) and more abundant at high tide than at low tide ($p=.04$) (Fig.7). Waders (egrets and herons) were affected by tidal height only ($p<.001$) (Fig.8). Pelican and Caspian Tern abundances (Fig.9, 10) were affected by habitat only (p<.0001). In contrast, gull abundance was not significantly affected by habitat type or tidal height (Fig.11). On islands, bird abundance increased with increasing tide when tidal height was plotted as a continuous variable (Fig.12). In terms of the individual species, abundance of cormorants, gulls, waders, and pelicans each increased significantly with increasing tide (Fig.13, 14, 15, 16), while Caspian Tern abundance did not appear to fluctuate with changes in tide height (Fig.17). Out of the 38 surveys during which a train passed, 70% of the time birds did not fly in response to the disturbance (Fig.18).

The South Marsh restored area is rich in birdlife and at higher tides many birds appear to use the islands when the mudflats are submerged. Unfortunately, Parsons Slough has relatively high rates of erosion in terms of a slough-wide average. Results from this basic survey suggest that reducing tidal erosion may be necessary to preserve the remaining emergent island habitat for these birds in the slough.

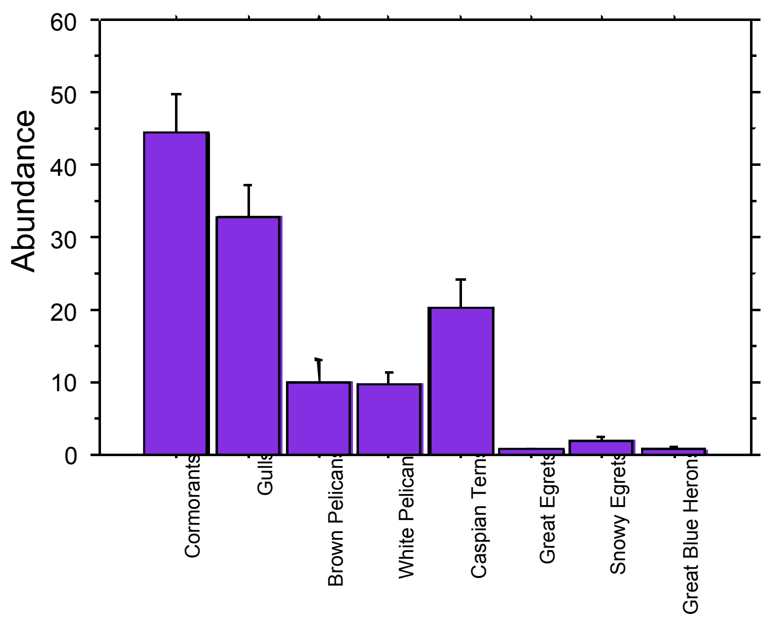


Fig.1. Average abundance (per survey) of birds (Dec 2001 -Sept 2003).

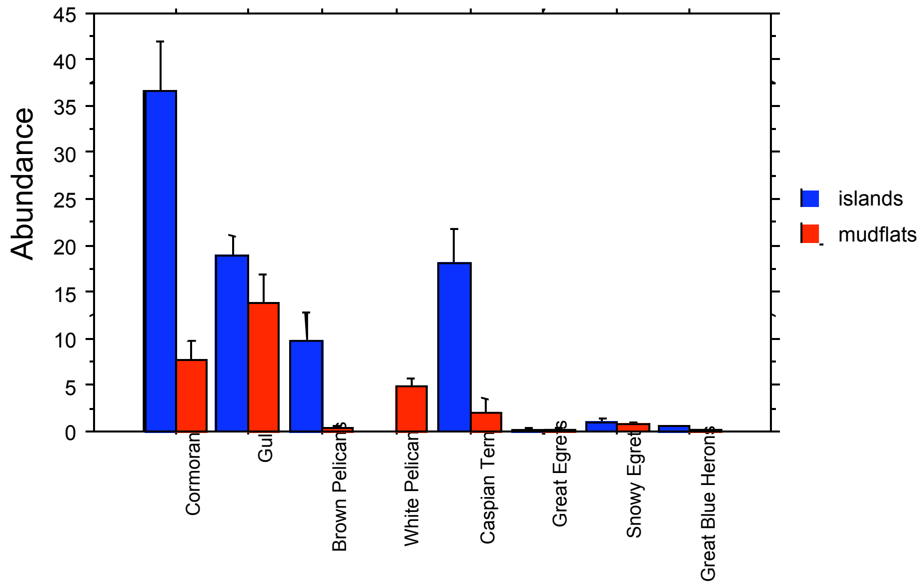


Fig.2. Average bird abundance (per survey) split by habitat typ e (Dec 2001-Sept 2003).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Habitat	1	211586.431	211586.431	55.253	<.0001	55.253	1.000
Residual	186	712265.798	3829.386				

	Count	Mean	Std. Dev.	Std. Err.
Island	94	93.787	77.271	7.970
Mudflat	94	26.691	41.086	4.238

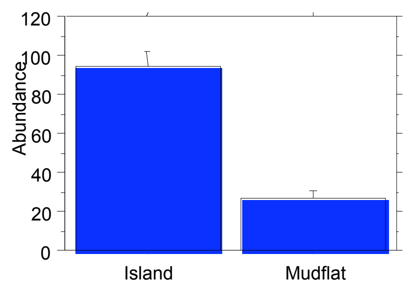


Fig. 3. Average bird abundance (per survey) was greater on isla nds than on mudflats (1-way ANOVA, p<.0001).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Habitat	1	180.085	180.085	102.554	<.0001	102.554	1.000
Residual	186	326.617	1.756				

	Count	Mean	Std. Dev.	Std. Err.
Island	94	3.713	1.258	.130
Mudflat	94	1.755	1.389	.143

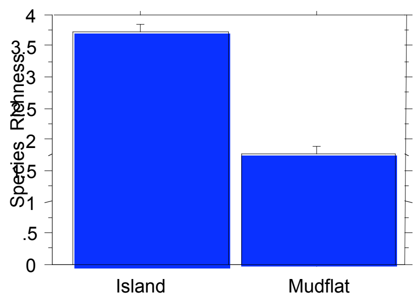


Fig 4. Average species richness (per survey) was greater on islands than on mudflats (p<.0001, 1-way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	28113.835	28113.835	8.124	.0049	8.124	.824
Habitat	1	211586.431	211586.431	61.141	<.0001	61.141	1.000
Tide (high vs low) * Habitat	1	47394.814	47394.814	13.695	.0003	13.695	.973
Residual	184	636757.149	3460.637				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	121.894	80.121	11.687
high, Mudflat	47	23.043	45.117	6.581
low, Island	47	65.681	63.542	9.269
low, Mudflat	47	30.340	36.743	5.359

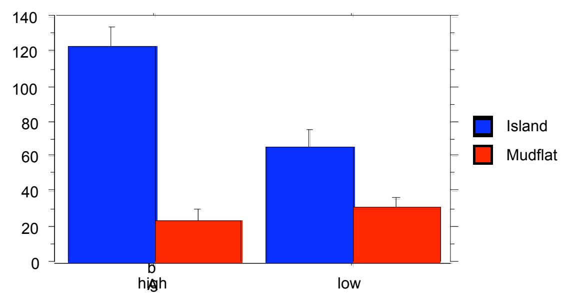


Fig.5. Average total bird abundance (per survey) was greater on islands than on mudflats (p<.0001). Abundance was also greater at high tide than at low tide (p<.01, 2-way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	1.362	1.362	.866	.3534	.866	.145
Habitat	1	180.085	180.085	114.462	<.0001	114.462	1.000
Tide (high vs low) * Habitat	1	35.766	35.766	22.733	<.0001	22.733	.999
Residual	184	289.489	1.573				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	4.234	1.165	.170
high, Mudflat	47	1.404	1.484	.216
low, Island	47	3.191	1.135	.166
low, Mudflat	47	2.106	1.202	.175

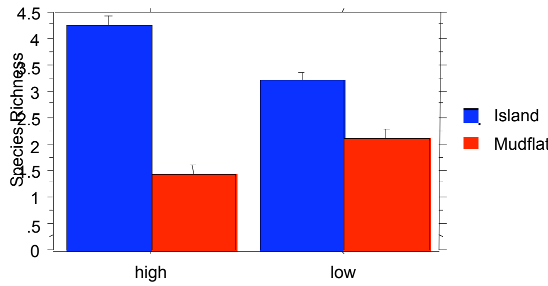


Fig.6. Average species richness (per survey) was greater on isl ands than on mudflats (p<.0001, 2 -way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	5842.043	5842.043	4.336	.0387	4.336	.533
Habitat	1	39411.085	39411.085	29.249	<.0001	29.249	1.000
Tide (high vs low) * Habitat	1	12944.681	12944.681	9.607	.0022	9.607	.888
Residual	184	247924.809	1347.417				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	50.574	57.602	8.402
high, Mudflat	47	5.021	16.892	2.464
low, Island	47	22.830	36.349	5.302
low, Mudflat	47	10.468	21.567	3.146

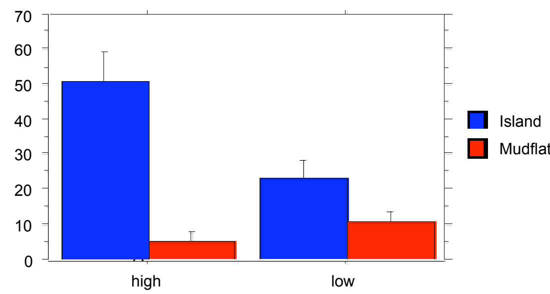


Fig.7. Average cormorant abundance (per survey) was greater on islands than on mudflats (p<.0001). Abundance was also greater at high tide than at low tide (p=.04) (2-way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	134.473	134.473	12.782	.0004	12.782	.962
Habitat	1	25.324	25.324	2.407	.1225	2.407	.321
Tide (high vs low) * Habitat	1	60.899	60.899	5.789	.0171	5.789	.667
Residual	184	1935.787	10.521				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	3.468	4.620	.674
high, Mudflat	47	1.596	4.148	.605
low, Island	47	.638	1.241	.181
low, Mudflat	47	1.043	1.414	.206

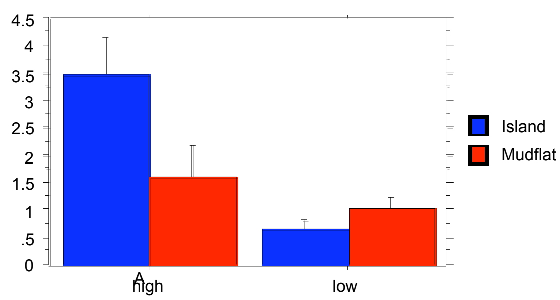


Fig.8. Average wader abundance (per survey) (Great Egrets, Snowy Egrets, and Great Blue Herons) was greater at high tide than at low tide (p<.001, 2-way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	1783.197	1783.197	2.706	.1017	2.706	.356
Habitat	1	12500.473	12500.473	18.972	<.0001	18.972	.997
Tide (high vs low) * Habitat	1	2144.814	2144.814	3.255	.0728	3.255	.418
Residual	184	121234.000	658.880				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	24.426	39.169	5.713
high, Mudflat	47	1.362	5.562	.811
low, Island	47	11.511	31.583	4.607
low, Mudflat	47	1.957	8.536	1.245

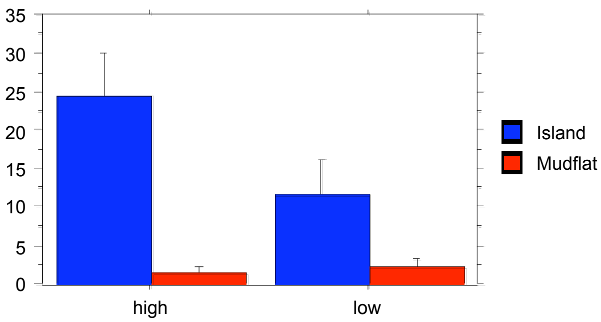


Fig.9. Average pelican abundance (per survey) (Brown Pelicans a nd White Pelicans) was greater on islands than on mudflats ($p<.0001$, 2 -way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	35.766	35.766	.056	.8139	.056	.056
Habitat	1	12064.021	12064.021	18.740	<.0001	18.740	.997
Tide (high vs low) * Habitat	1	354.064	354.064	.550	.4593	.550	.110
Residual	184	118450.553	643.753				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	19.085	35.432	5.168
high, Mudflat	47	.319	1.617	.236
low, Island	47	17.213	31.409	4.581
low, Mudflat	47	3.936	18.178	2.652

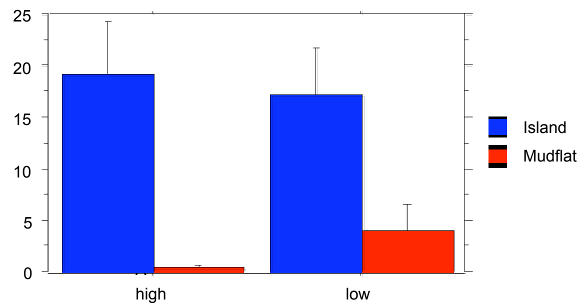


Fig.10. Average Caspian Tern abundance (per survey) was greater on islands than on mudflats (p<.0001, 2 -way ANOVA).

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Tide (high vs low)	1	1883.112	1883.112	2.898	.0904	2.898	.378
Habitat	1	1210.261	1210.261	1.863	.1740	1.863	.258
Tide (high vs low) * Habitat	1	960.771	960.771	1.479	.2255	1.479	.214
Residual	184	119552.043	649.739				

	Count	Mean	Std. Dev.	Std. Err.
high, Island	47	24.340	26.074	3.803
high, Mudflat	47	14.745	35.812	5.224
low, Island	47	13.489	11.079	1.616
low, Mudflat	47	12.936	22.669	3.307

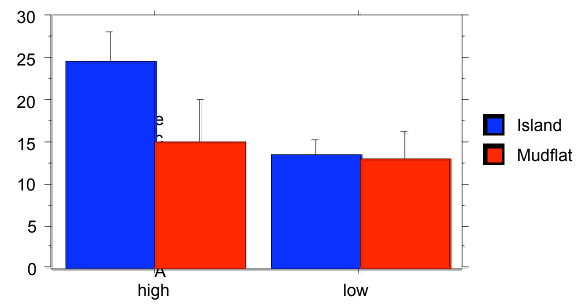
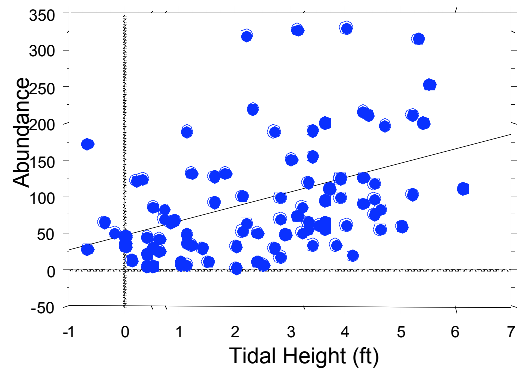


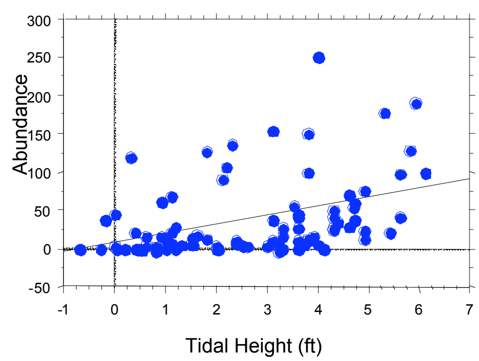
Fig.11. Average gull abundance (per survey) is not significantly affected by either habitat type (p=.17) or tide height (p=.09) (2 -way ANOVA).



Y = 46.377 + 19.452 * X; R^2 = .186

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	103127.647	103127.647	20.984	<.0001
Residual	92	452152.098	4914.697		
Total	93	555279.745			

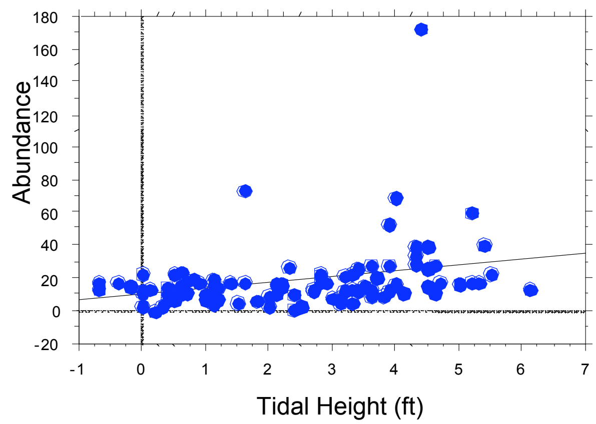
Fig.12. Total bird abundance on islands increased as tidal height increased (p<.0001).



Y = 8.392 + 11.616 * X; R^2 = .159

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	36772.355	36772.355	17.374	<.0001
Residual	92	194721.305	2116.536		
Total	93	231493.660			

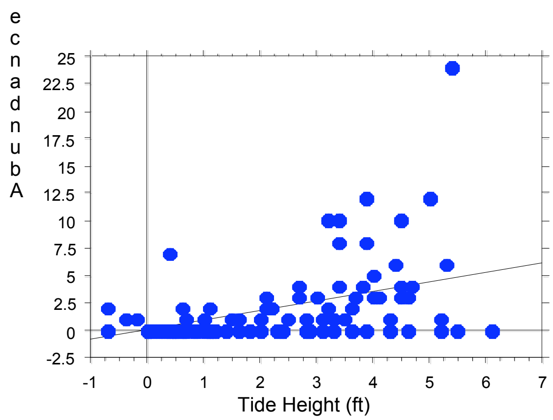
Fig. 13. Cormorant abundance on islands increased with increasing tide (p<.0001).



Y = 9.936 + 3.684 * X; R^2 = .093

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	3699.324	3699.324	9.458	.0028
Residual	92	35985.995	391.152		
Total	93	39685.319			

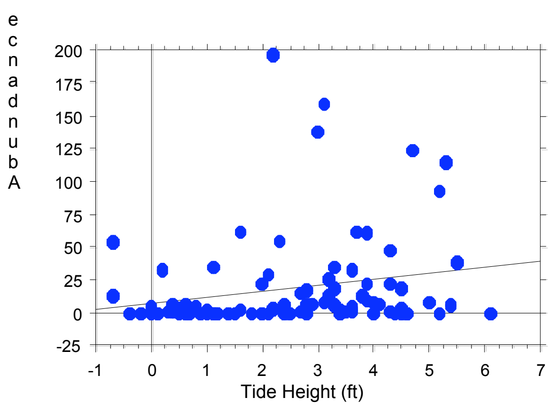
Fig. 14. Gull abundance on islands increased with increasing tide (p<.01).



Y = -.108 + .887 * X; R^2 = .173

Fig.15. Wader abundance on islands increased with increasing tide ($p < .0001$).

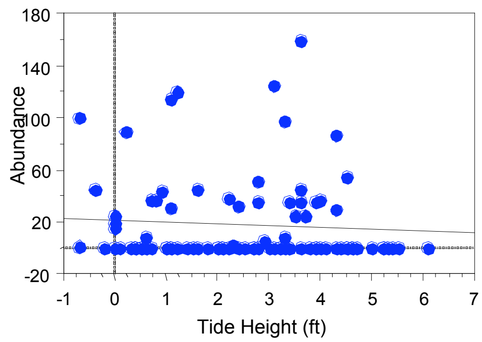
	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	214.375	214.375	19.216	<.0001
Residual	92	1026.359	11.156		
Total	93	1240.734			



Y = 6.676 + 4.633 * X; R^2 = .049

Fig.16. Pelican abundance on islands increased with increasing tide ($p = .03$).

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	5850.307	5850.307	4.700	.0328
Residual	92	114528.597	1244.876		
Total	93	120378.904			



Y = 21.482 - 1.368 * X; R^2 = .005

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	509.728	509.728	.457	.5009
Residual	92	102702.187	1116.328		
Total	93	103211.915			

Fig.17. Caspian Tern abundance did not appear to be tide dependent.

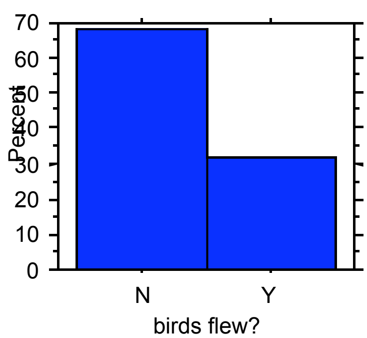


Fig.18. Nearly 70% of trains passing by survey site did not appear to cause birds to fly away (N = 38).