

PELICAN, CORMORANT, AND PINNIPED USE OF PILE DIKES AND JETTIES AT THE MOUTH OF THE COLUMBIA RIVER ESTUARY, 2000

2000 Final Data Report

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The purpose of this study was to monitor brown pelican, cormorant (i.e., double-crested, pelagic, and Brandt's), and pinniped (i.e., Steller and California sea lions) use of pile dikes and jetties located at the mouth of the Columbia River (see Figure 1 for map of the study area). This study was carried out from 31 July to 31 October, 2000. This time period generally coincided with post-breeding for brown pelicans and sea lions, and late chick rearing to post-breeding for cormorants.

Distribution and Behavior of Pelicans and Cormorants on Pile Dikes

Methods: We observed and recorded the distribution and behavior of California brown pelicans (*Pelecanus occidentalis californicus*), double-crested cormorants (*Phalacrocorax auritus*), pelagic cormorants (*P. pelagicus*), and Brandt's cormorants (*P. penicillatus*) on five pile dikes located between river miles 3.00 and 6.37 (see Figure 1) each week throughout the study period. Observations were conducted primarily from shore immediately adjacent to the dike (pile dikes 1, 2, and 4), from a channel marker located at the offshore end of the dike (pile dike 3), or from a boat on either side of the dike (pile dike 5). In each case, the observer was either concealed using a plastic tarp (pile dike 3) or located far enough away from the dike (pile dikes 1, 2, 4, and 5) so as not to affect the distribution or behavior of birds on or near the pile dike. Each pile dike was observed for a total of eight hours/week. At pile dike 5, observations were split evenly between a downstream and upstream vantage (4 hrs vantage⁻¹ week⁻¹) and were conducted randomly with respect to tide stage. At each pile dike, pelican and cormorant counts were conducted every 15 minutes throughout the 8-hr period. All birds counted were assigned to one of three behavioral categories: perching, foraging, or nesting. Birds were classified as foraging if they were observed on the water within 50 meters of the pile dike (both upstream and downstream from the pile dike). With the exception of pile dike 5, both upstream and downstream foraging areas were visible from the vantage used by observers. The vantages at pile dike 5 allowed us to see foraging birds on only one side of the pile dike at a time (downstream or upstream). Hence, the total number of foraging birds at pile dike 5 was estimated by doubling the count of foraging birds for each 15-minute observation period. Seasonal and weekly summaries presented here were based on mean number of birds counted per 15-minute observation period. Missing bars in the attached histograms indicate insufficient sample size or no data.

Results and Discussion – Brown pelicans: Brown pelican use of pile dikes was greatest on pile dikes 2 and 3, even when differences in pile dike length were taken into account (Figure 2). These two pile dikes are the closest to the west end of East Sand Island, where the largest numbers of night roosting pelicans were observed. Pile dike 5 had the lowest average number of perching pelicans, and it is the furthest of the five pile dikes from the night roost at the west end of East Sand Island (Figure 1). The mean number of pelicans observed on each pile dike over the entire study period ranged from 3.2 to 18.4, or 0.002 to 0.034 pelicans per meter of pile dike (Figure 2). Most pelican activity at pile dikes was observed from mid-August to mid-September, with generally less pelican activity observed prior to and after this period (Figures 3 and 4). The great majority of pelicans observed at pile dikes were perching, although a few pelicans were observed foraging (pelicans have not been recorded nesting in the Columbia River estuary; Figure 5). Pelican perching and foraging was concentrated on the nearshore portion of pile dike 1, and on the offshore portion of pile dikes 2 and 5 (Figure 6). At pile dike 3 and 4, pelican use was more evenly distributed along the length of the pile dike, as compared to the other pile dikes (Figure 6). More pelican use of the pile dikes for both perching and foraging was recorded during high tide than during low tide (Figure 7).

Results and Discussion – Cormorants: Cormorant use of pile dikes was greatest on pile dike 5, even when differences in pile dike length were taken into account (Figure 8). The mean number of cormorants observed on each pile dike over the entire study period ranged from 28.8 to 259.9, or 0.05 to 0.18 cormorants per meter of pile dike (Figure 8). Nearly all cormorants using the pile dikes were double-crested cormorants, presumably associated with the large double-crested cormorant breeding colony of East Sand Island. Compared to pelican use of pile dikes, cormorant use of pile dikes was more consistent over the study period, especially for perching. Cormorant foraging activity at pile dikes was generally greatest from late July to late August, with the exception of pile dike 5 where foraging activity was greatest in September (Figures 9 and 10). The great majority of cormorants observed at pile dikes were perching double-crested cormorants (Figure 11). A notable exception was a small nesting colony of Brandt's cormorants on pile dike 3, (30-45 pairs; S. Lehmann, University of Washington, pers. comm.). Brandt's cormorants were observed on the pile dike up until the end of October (Figures 9 – 11), when the last young fledged. This was the only instance of cormorants nesting on these pile dikes in 2000, and the first documented breeding record of Brandt's cormorants in the Columbia River Estuary (S. Lehmann, University of Washington, pers. comm.). The only other breeding colony of Brandt's cormorants in the vicinity of the Columbia River Estuary is on Cape Disappointment, where it was estimated that 600-700 pairs nested in 2000 (S. Lehmann, University of Washington, pers. comm.). Cormorant activity along the pile dikes was concentrated on the nearshore portion of pile dike 1, and on the offshore portions of pile dikes 2 and 3 (Figure 12). At pile dikes 4 and 5, cormorant activity was more evenly distributed along the length of the pile dike (Figure 12). There were no apparent differences in numbers of foraging or perching cormorants at pile dikes as a function of stage of the tide cycle, with the exception of pile dike 5 where more foraging occurred at high tide (Figure 13).

Distribution of Pelicans, Cormorants, and Sea Lions on Jetties

Methods: Weekly aerial surveys were conducted throughout the study period to determine the numbers of brown pelicans, cormorants (i.e., double-crested, pelagic, and Brandt's), Steller sea

lions (*Eumetopias jubata*), and California sea lions (*Zalophus californianus*) using the jetties at the mouth of the Columbia River (see Figure 1). Pelican, cormorant, and sea lion use of the jetties was monitored using fixed-winged aircraft flying at low air speeds at an elevation of 400-600 feet. Most flights were conducted at or near low tide, because this is when sea lion haul outs tend to be most crowded (R. Brown, ODFW, pers. comm.). Each jetty was flown from end to end and visual counts were made of all pelicans, cormorants, and sea lions on the jetties. In addition, each sea lion haul out was photographed using a 35mm camera to verify visual counts and identify sea lions to species (i.e., Steller or California). This species identification was based primarily on pelage color (i.e., Steller sea lions are lighter in color compared to California sea lions).

Results and Discussion: Of the three jetties located at the mouth of the Columbia River (see Figure 1), the south jetty was the only one where cormorants and sea lions were commonly observed (Figure 14). The sea lions using the jetty were almost entirely Steller sea lions until the end of September, after which California sea lions were also observed (R. Brown, ODFW, pers. comm.). Sea lions were not observed on either the north jetty or A jetty during the study period. Brown pelicans were observed on the south jetty on only two occasions, 6 and 21 September, when 120 and 100 pelicans were counted, respectively, on the seaward end of the jetty (Figure 14). The other two jetties at the mouth of the river (north and A) were used infrequently by cormorants and brown pelicans. Five brown pelicans and 60 cormorants were counted on the north jetty on 16 August and 20 cormorants were counted on the north jetty on 21 September. The only birds observed perching on jetty A were 30 cormorants on 16 August. All sea lion and cormorant use of the jetties was restricted to the offshore portion of each jetty; in the case of sea lions, all hauling out was restricted to the extreme western tip of the south jetty.

Distribution of Radio-Tagged Cormorants in the Columbia River Estuary

Methods: As part of this study, the late- and post-breeding movements of radio-tagged double-crested cormorants were monitored during August and September, 2000. These birds were tagged in May at the East Sand Island colony site as part of another study (C. Anderson, OSU, unpublished data). Radio-tagged individuals were relocated during weekly aerial tracking surveys from a fixed-winged aircraft flying at low air speeds over the Columbia River Estuary from Pillar Rock (river mile 27) to the mouth. Transects were flown such that the entire estuary was covered. A mobile tracking receiver was programmed with the radio frequencies of all radio-tagged cormorants believed to be still within the survey area. As transects were being flown the receiver scanned through each radio frequency at a rate of one frequency every 2-3 seconds. When a signal was detected, the receiver was fixed on that frequency so that the exact location of the bird could be determined. Bird locations were determined by listening to signal strength and signal direction based on antennas located on the left and right wing struts of the aircraft. Once a bird was boxed in (i.e., signal remained on same side of aircraft while circling), the Global Positioning System (GPS) coordinates were recorded. Radio-telemetry flights were discontinued on 27 September when it was suspected that most relocations were either from tags that had been dropped from birds that had molted their tail feathers or from radio-tagged birds that had died (i.e., GPS coordinates for individual radio-tagged birds were identical week after week). The relocations of all radio-tagged cormorants were plotted on digitized maps using GIS software (ArcView).

Results and Discussion: A total of 21 different radio-tagged cormorants were relocated during the study period (Figure 15). Seven birds were relocated more than once, with one bird relocated during eight different flights (Figure 15). In total, there were 53 relocations of radio-tagged cormorants, with most of these relocations (38 detections or 71.7% of all detections) occurring outside the primary study area and hence removed from the jetties and pile dikes investigated as part of this study (Figure 15). Of those relocations that were in the primary study area (15 detections), the majority (10 detections or 66.7% of detections in the primary study area) were relocations from early in the study period (i.e., 3 August flight). The apparent subsequent dispersal of radio-tagged cormorants from the East Sand Island area could have reflected the general post-breeding dispersal of nesting cormorants from the East Sand Island colony site. Relocations were primarily concentrated around East Sand Island and Baker Bay (birds 2, 10, 12, 13, 15, 16, 17, 20, and 21), Desdemona Sands (birds 1, 3, 8, 11, 18, and 19), Rice Island (birds 5, 6, and 7), and directly south of Rice Island on the opposite side of the shipping channel (bird 4, 9, and 14; Figure 15). Most of these areas are quite shallow, especially during low tide, and are places where large numbers of cormorants are often seen foraging and loafing. All of the relocations plotted in Figure 15 appeared to be from live, radio-tagged cormorants, but it is possible that a few of the relocations could have been either from tagged birds that had dropped their radio-tags during tail feather molt or from tagged birds that had died.

FIGURES

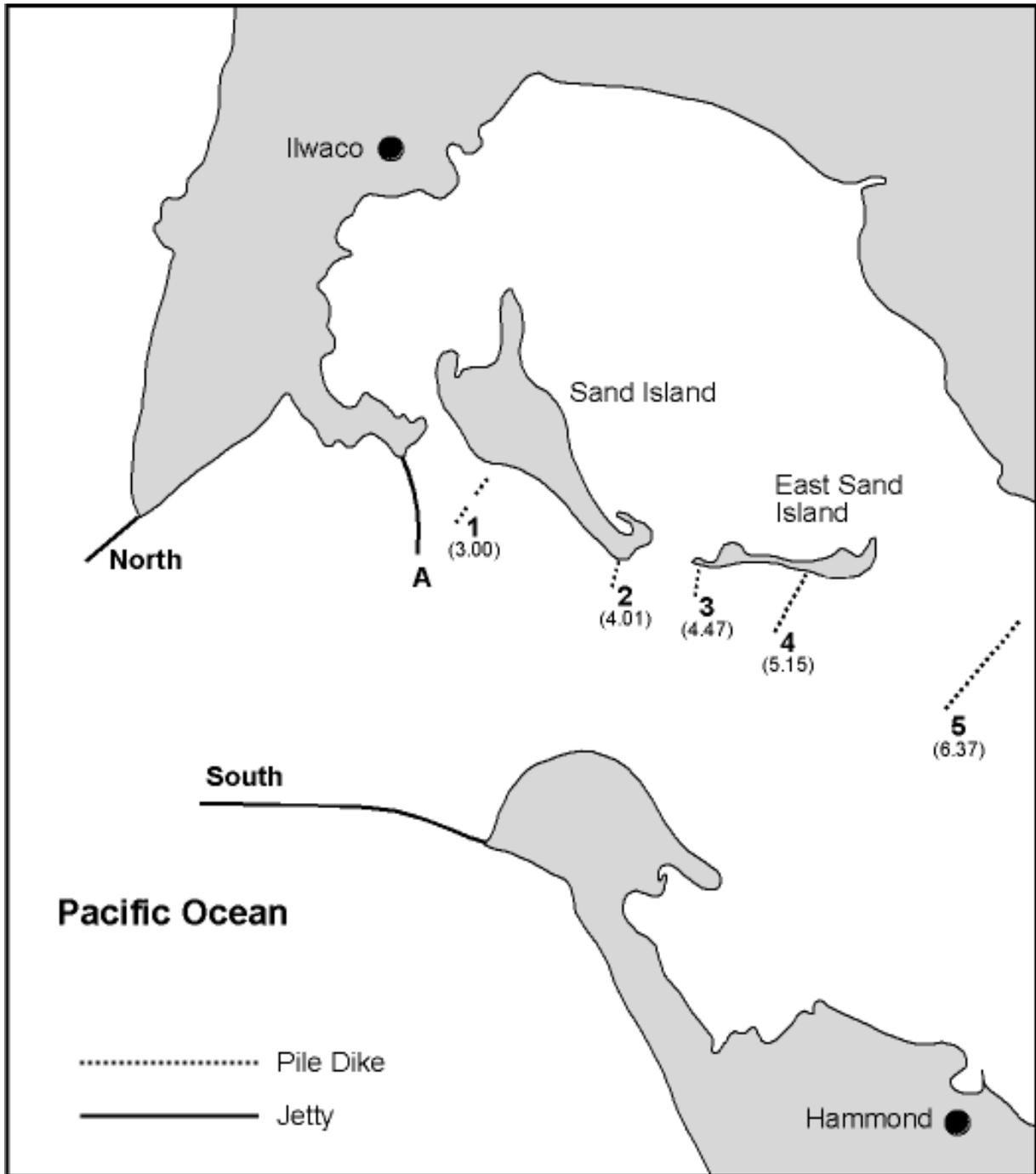


Figure 1. The jetties and pile dikes at the mouth of the Columbia River. The river mile for each pile dike is shown in parentheses under the dike number.

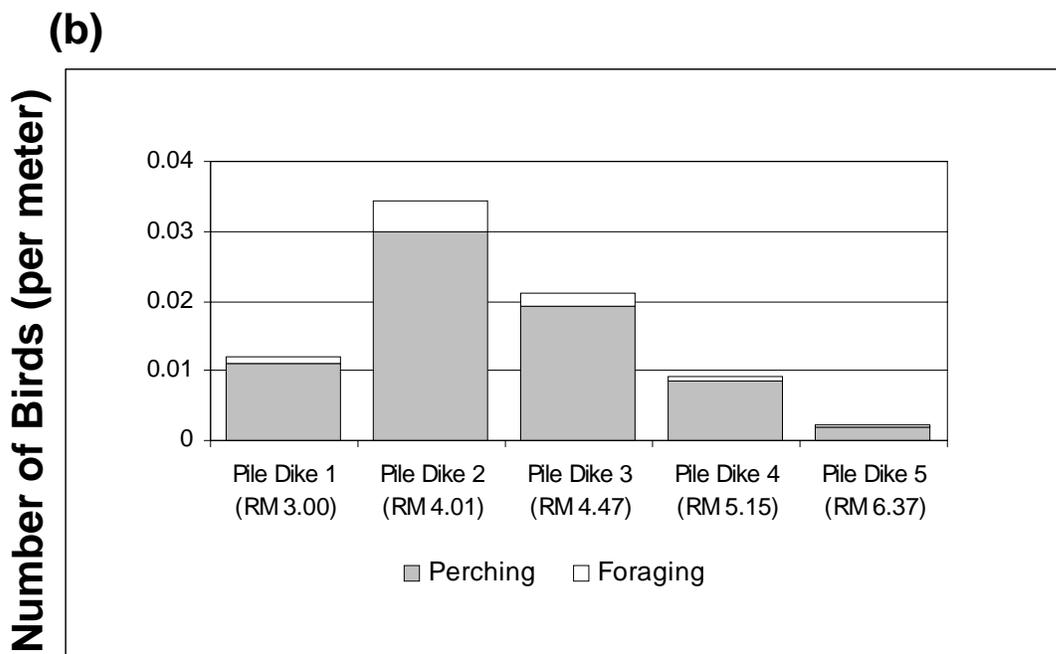
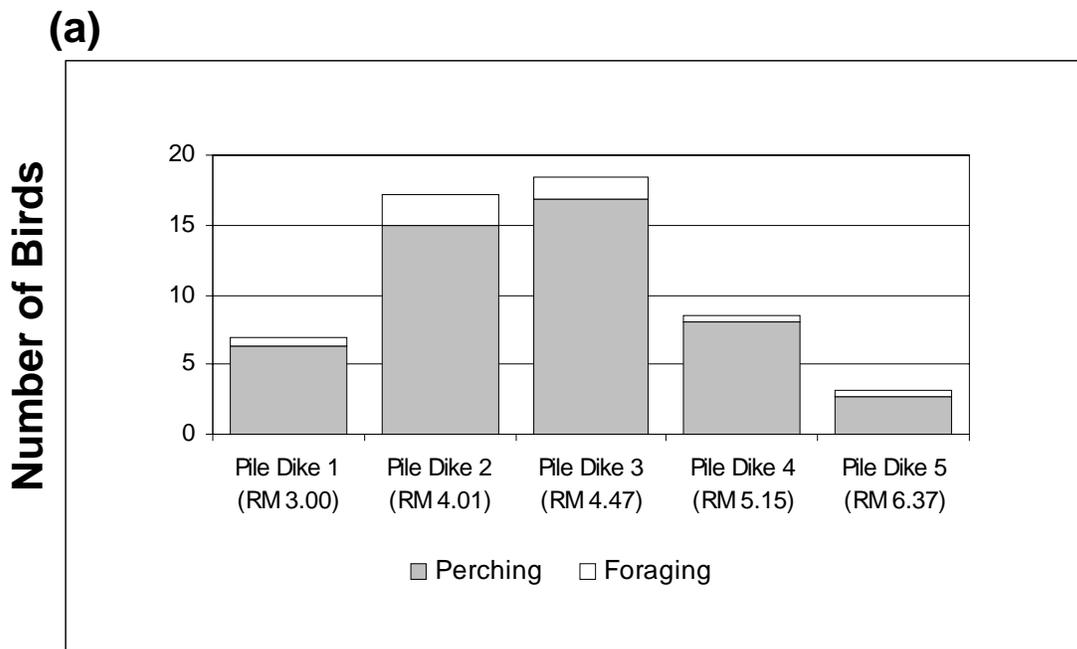


Figure 2. Mean number of perching and foraging brown pelicans counted (a) on or near pile dikes and (b) per meter of pile dike near the mouth of the Columbia River, August-October 2000.

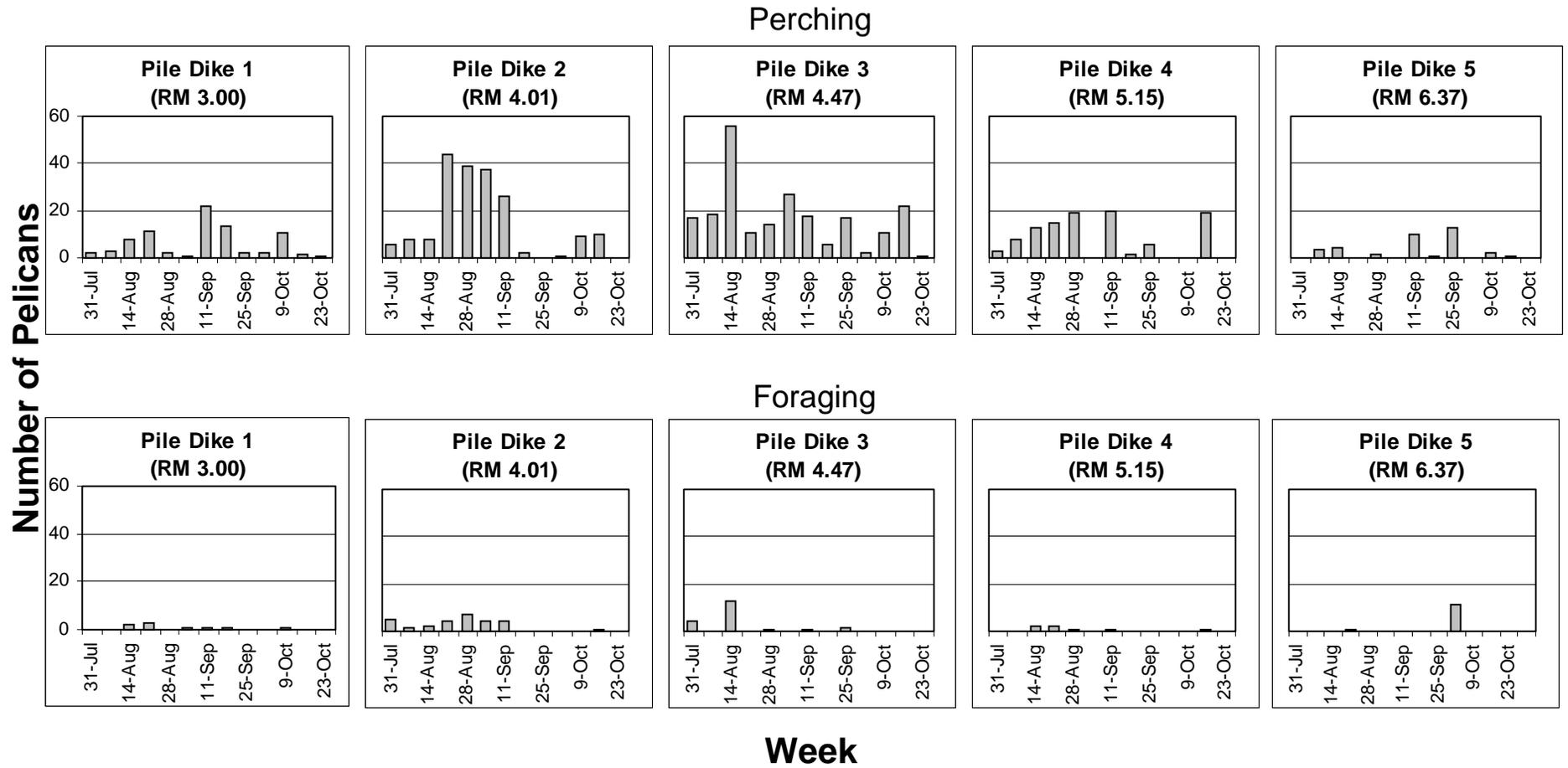


Figure 3. Mean number of perching and foraging brown pelicans counted per week on or near pile dikes near the mouth of the Columbia River, August-October 2000.

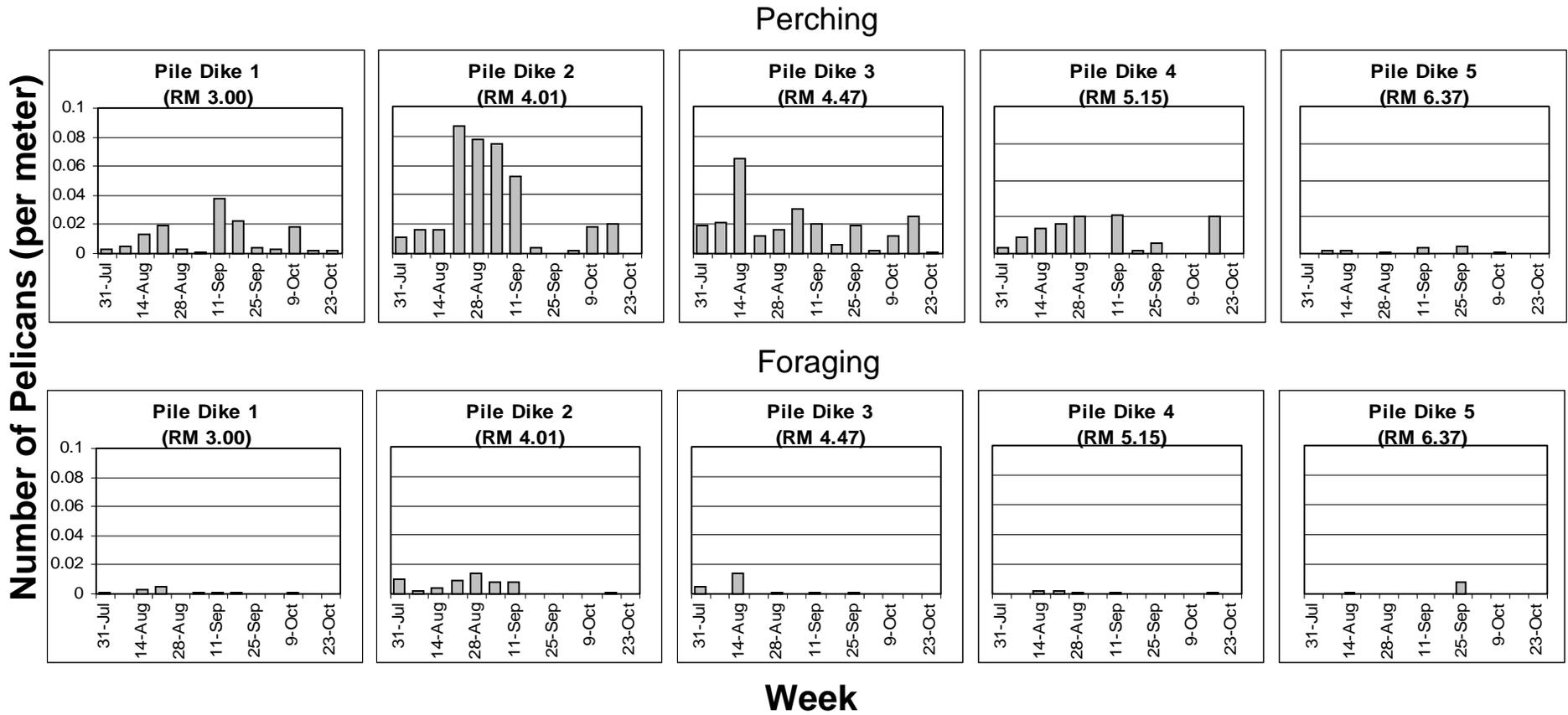


Figure 4. Mean number of perching and foraging brown pelicans counted per meter of pile dike per week near the mouth of the Columbia River, August-October 2000.

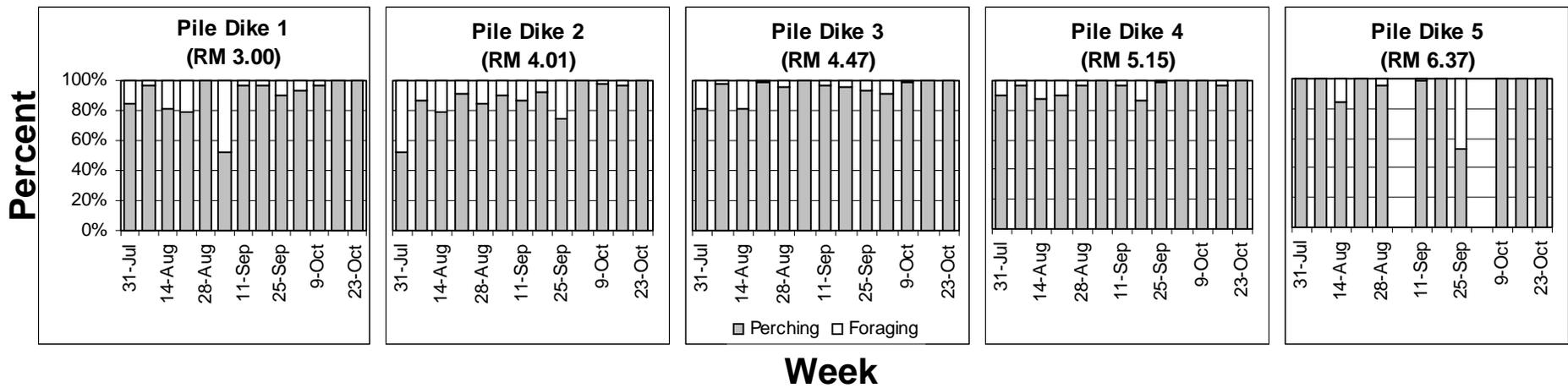


Figure 5. Percent of brown pelicans counted per week on or near pile dikes near the mouth of the Columbia River that were perching and foraging, August-October 2000.

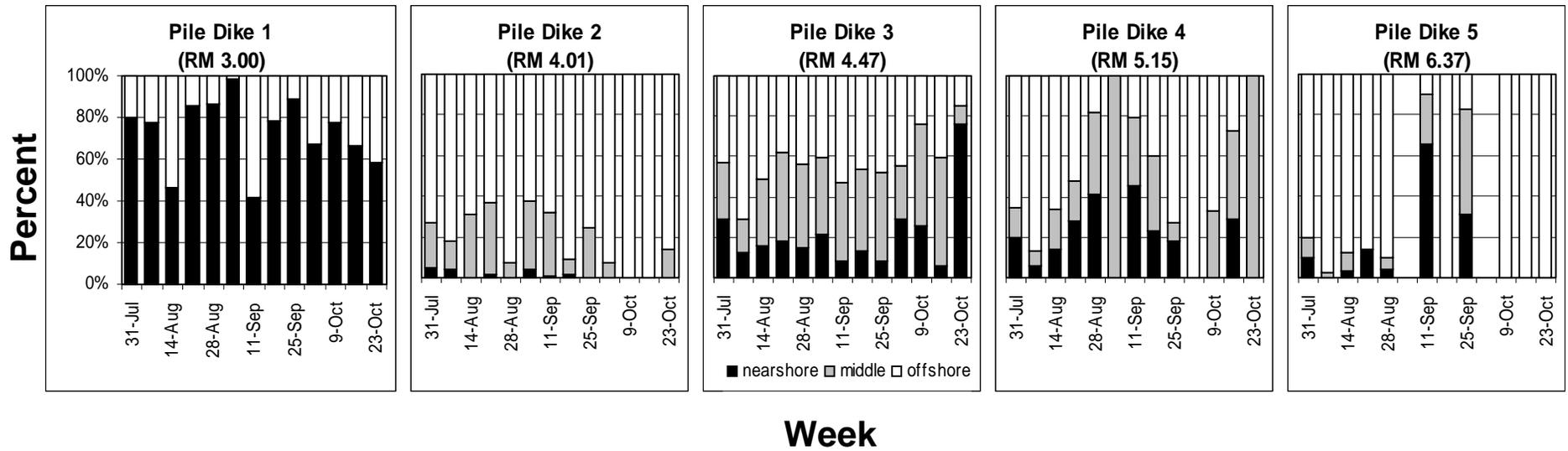


Figure 6. Percent brown pelicans counted per week on or near pile dikes near the mouth of the Columbia River that were located on the nearshore, middle, and offshore portion of the pile dike, August-October 2000. There was no middle portion for pile dike 1 (see figure 1).

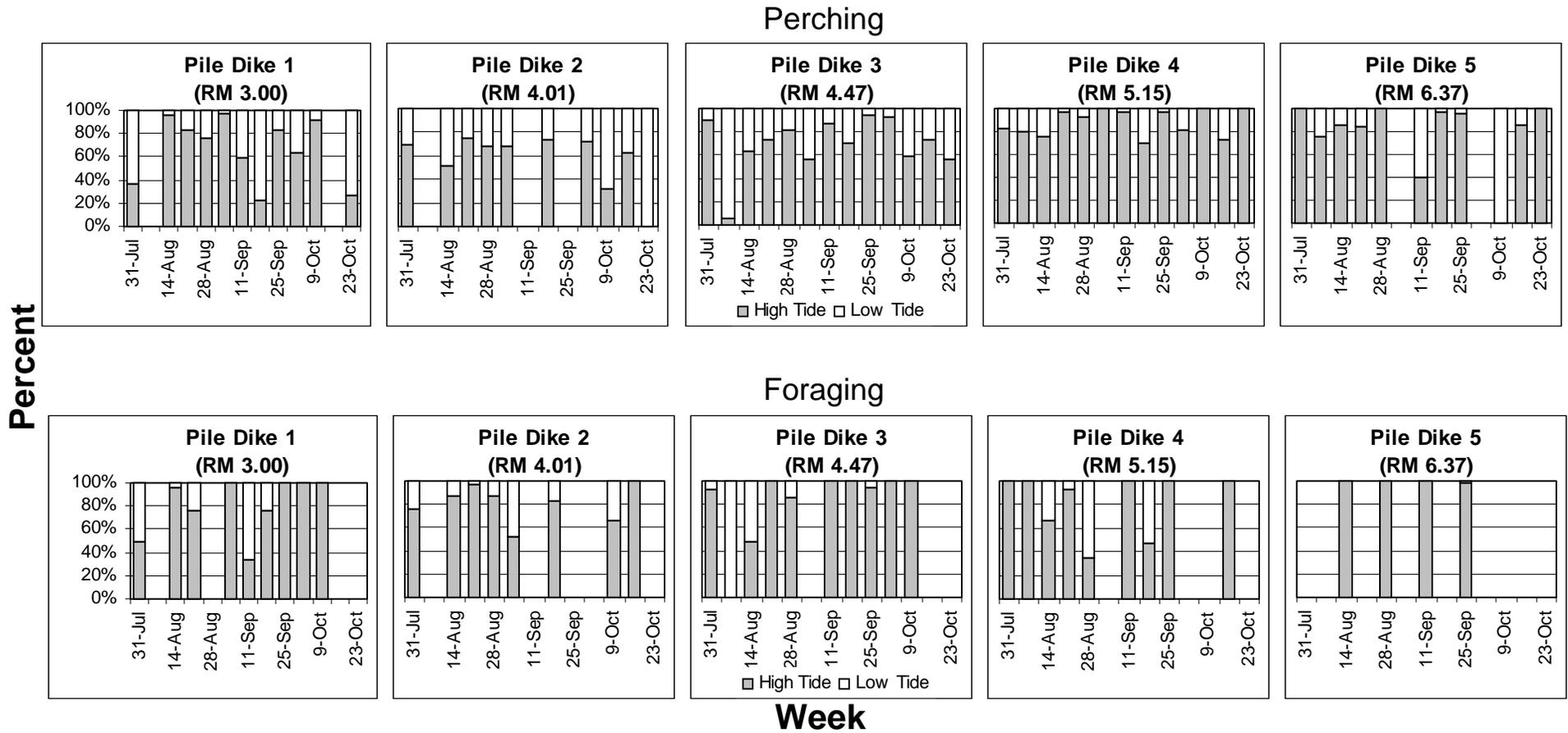


Figure 7. Percent of perching and foraging brown pelicans counted per week that were on or near the pile dikes near the mouth of the Columbia River at high and low tide, August-October 2000.

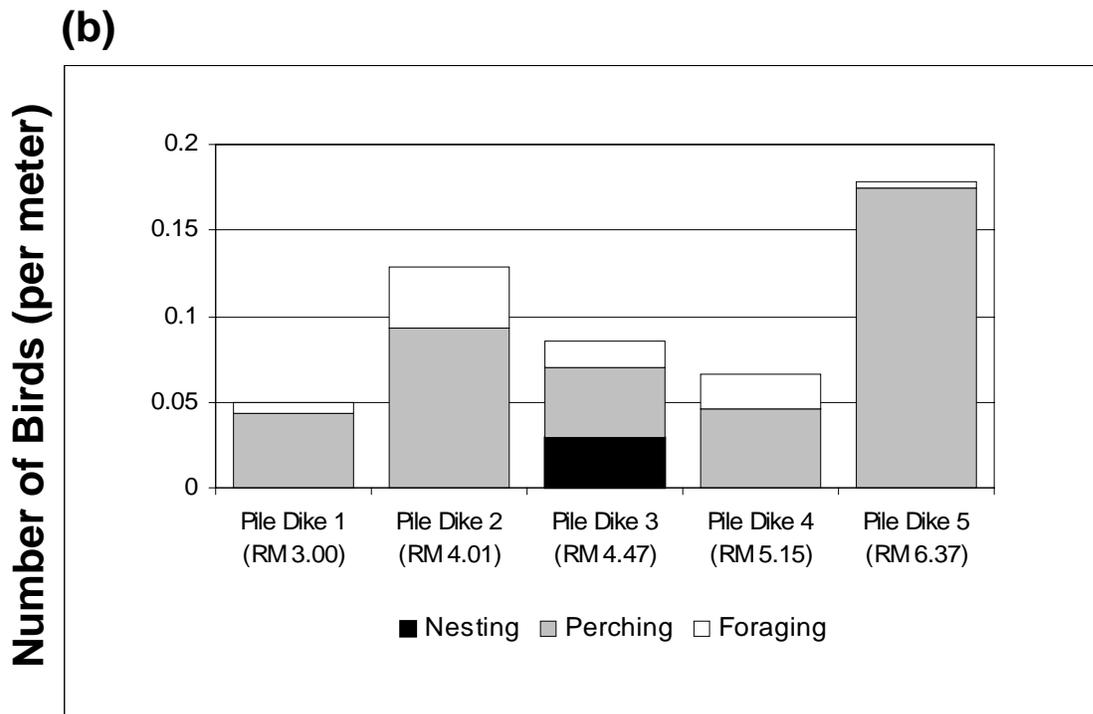
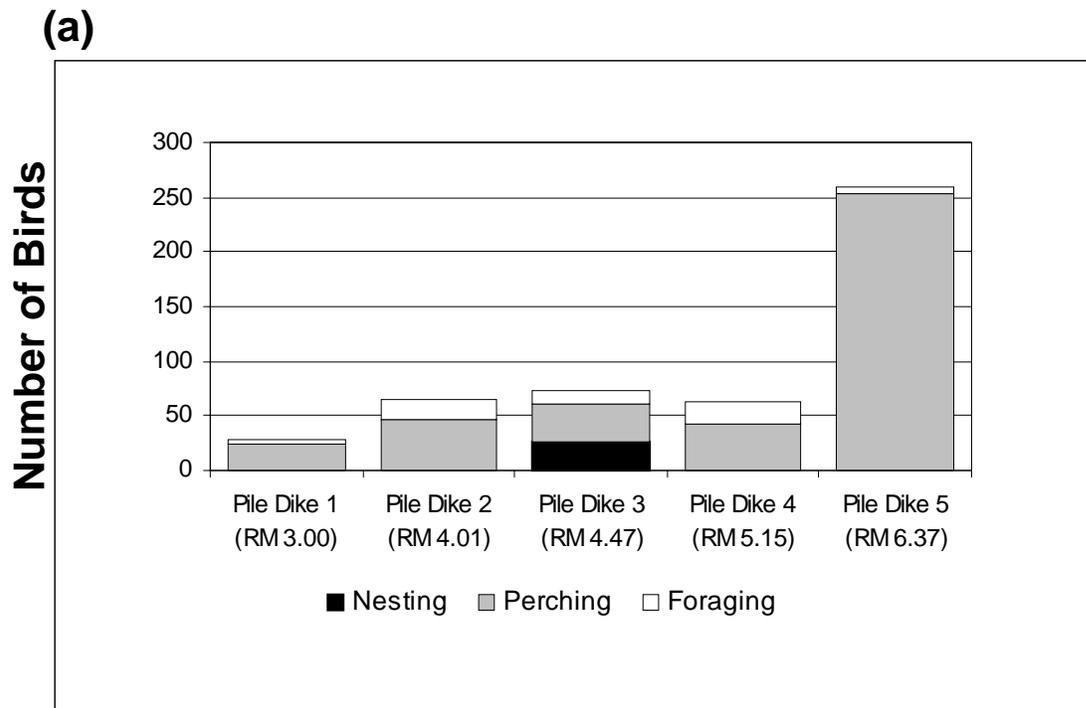


Figure 8. Mean number of nesting, perching, and foraging cormorants counted (a) on or near pile dikes and (b) per meter of pile dike near the mouth of the Columbia River, August-October 2000.

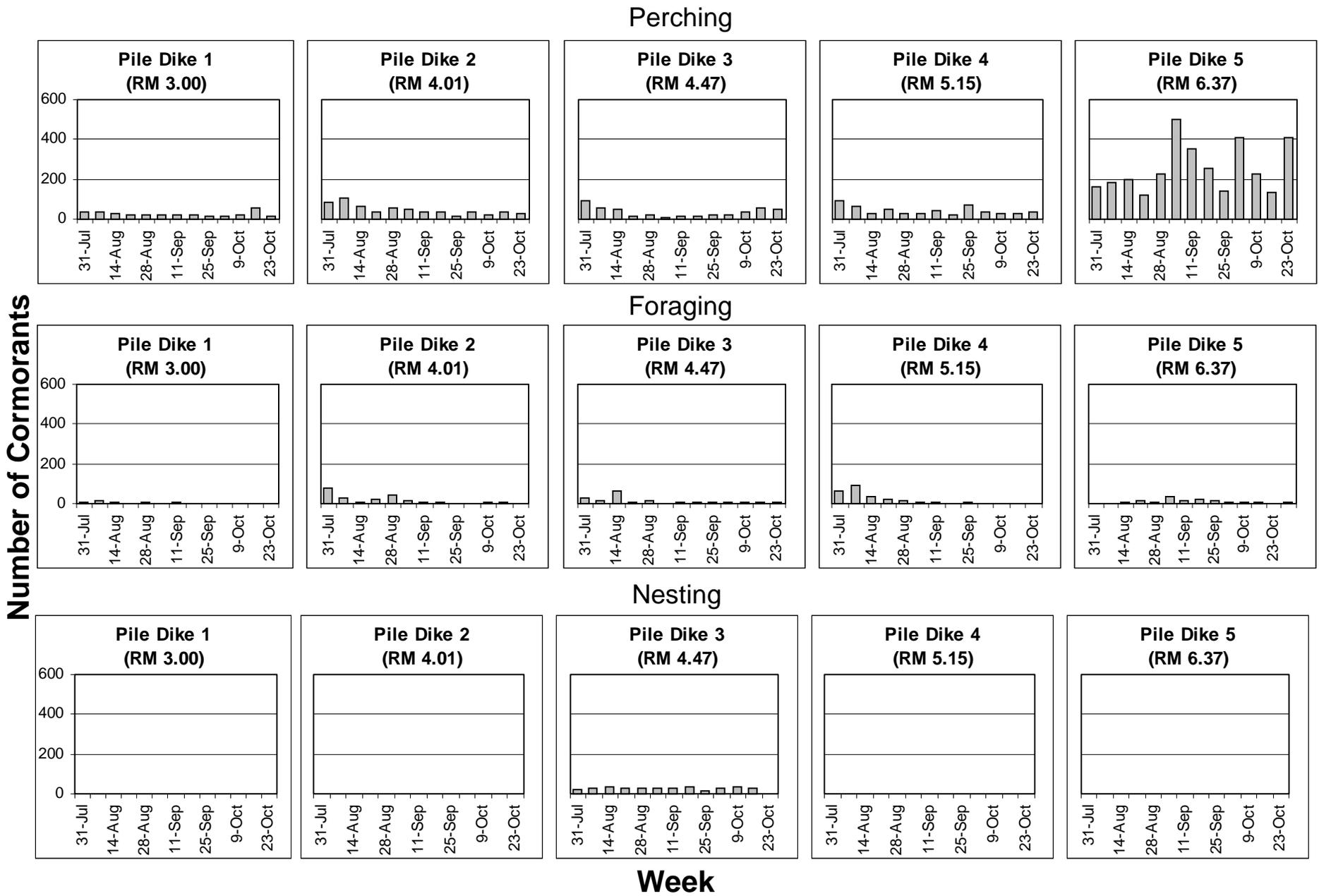


Figure 9. Mean number of nesting, perching, and foraging cormorants counted on or near pile dikes near the mouth of the Columbia River, August-October 2000.

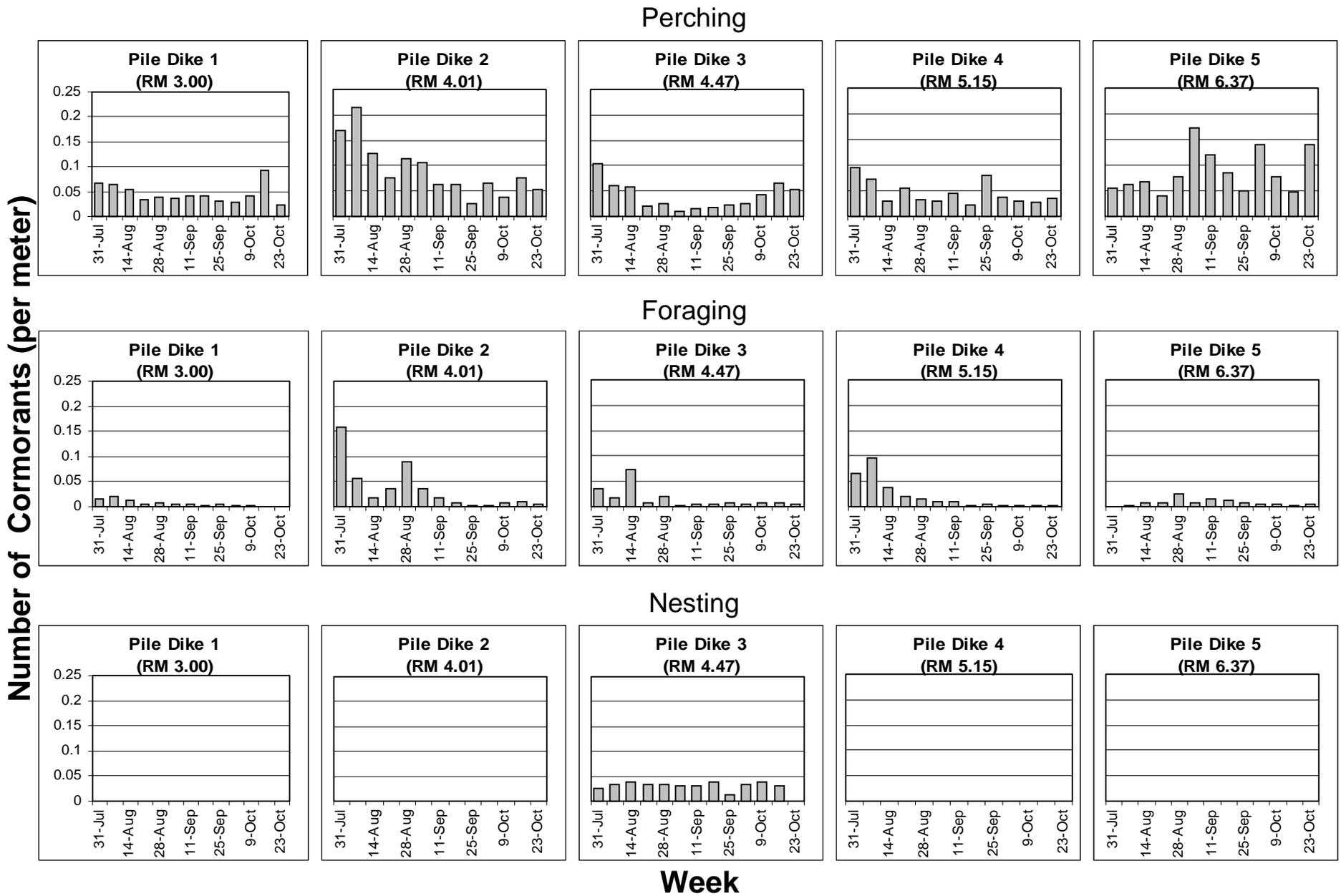


Figure 10. Mean number of nesting, perching, and foraging cormorants counted per meter of pile dike near the mouth of the Columbia River, August-October 2000.

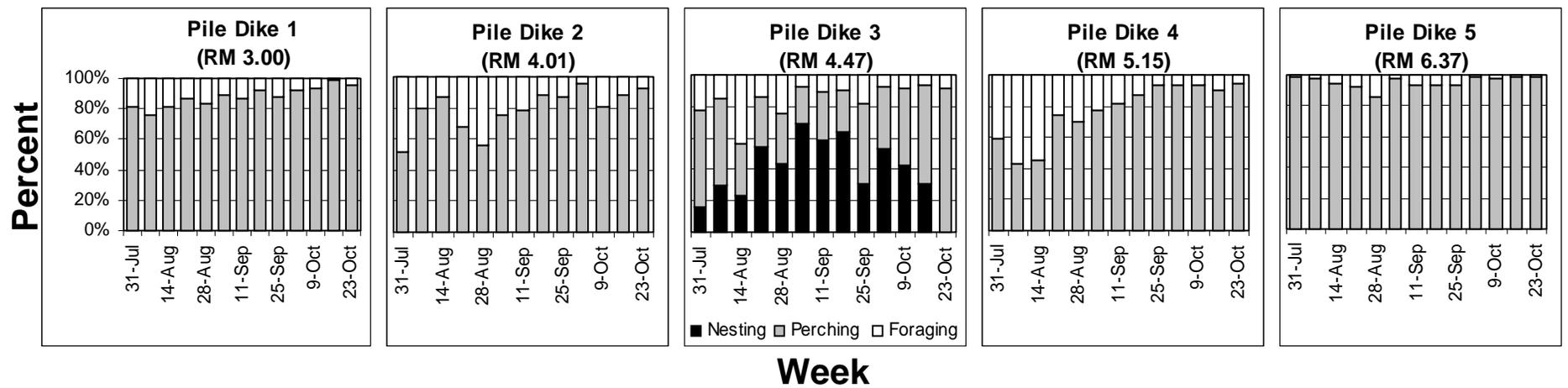


Figure 11. Percent of cormorants counted per week on or near pile dikes in the Columbia river estuary that were nesting, perching, and foraging, August-October 2000.

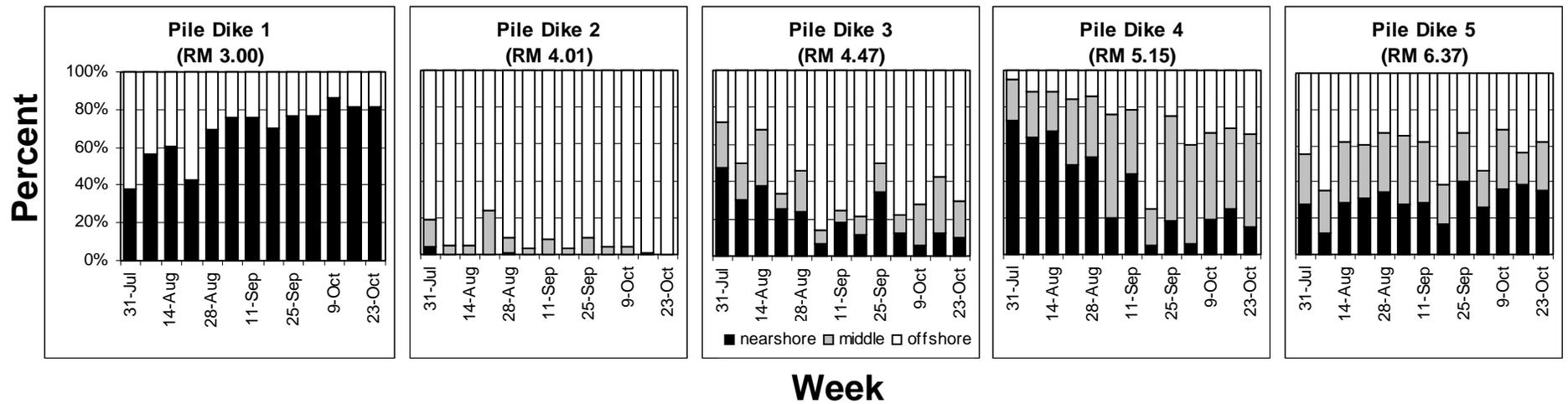
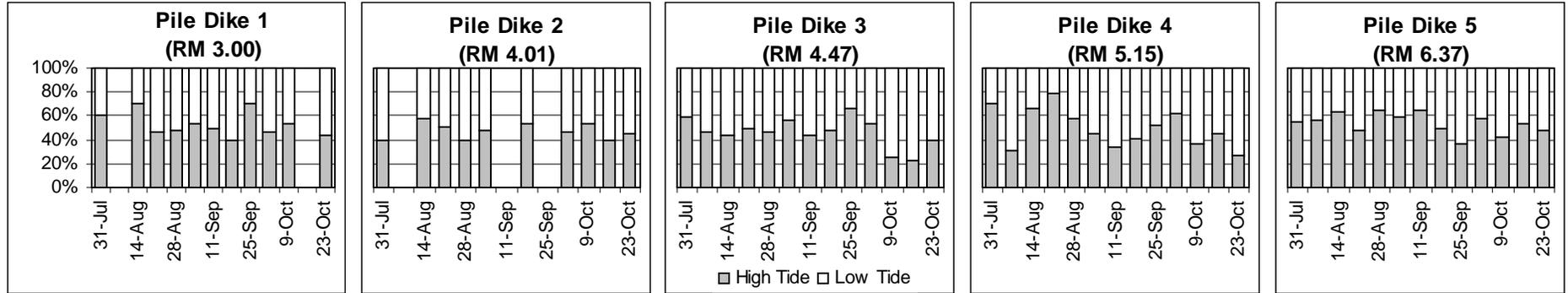
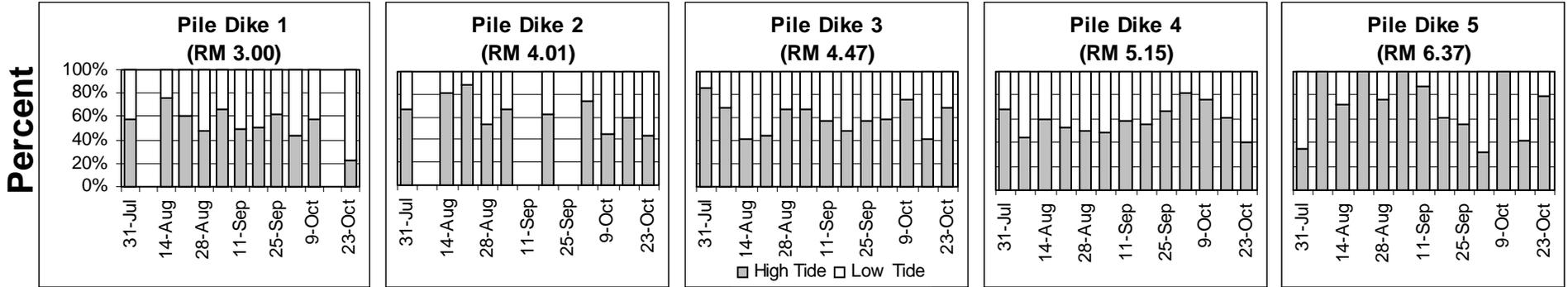


Figure 12. Percent of cormorants counted per week on or near pile dikes near the mouth of the Columbia River that were located on the nearshore, middle, and offshore portion of the pile dike, August-October 2000. There was no middle portion for pile dike 1 (see figure 1).

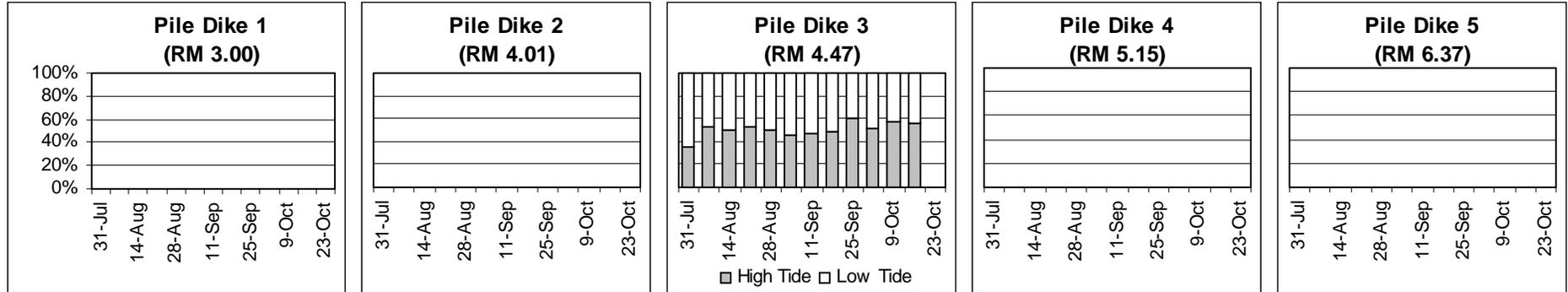
Perching



Foraging



Nesting



Week

Figure 13. Percent of perching, foraging, and nesting cormorants counted per week that were on or near the pile dikes near the mouth of the Columbia River at high and low tide, August-October 2000.

South Jetty

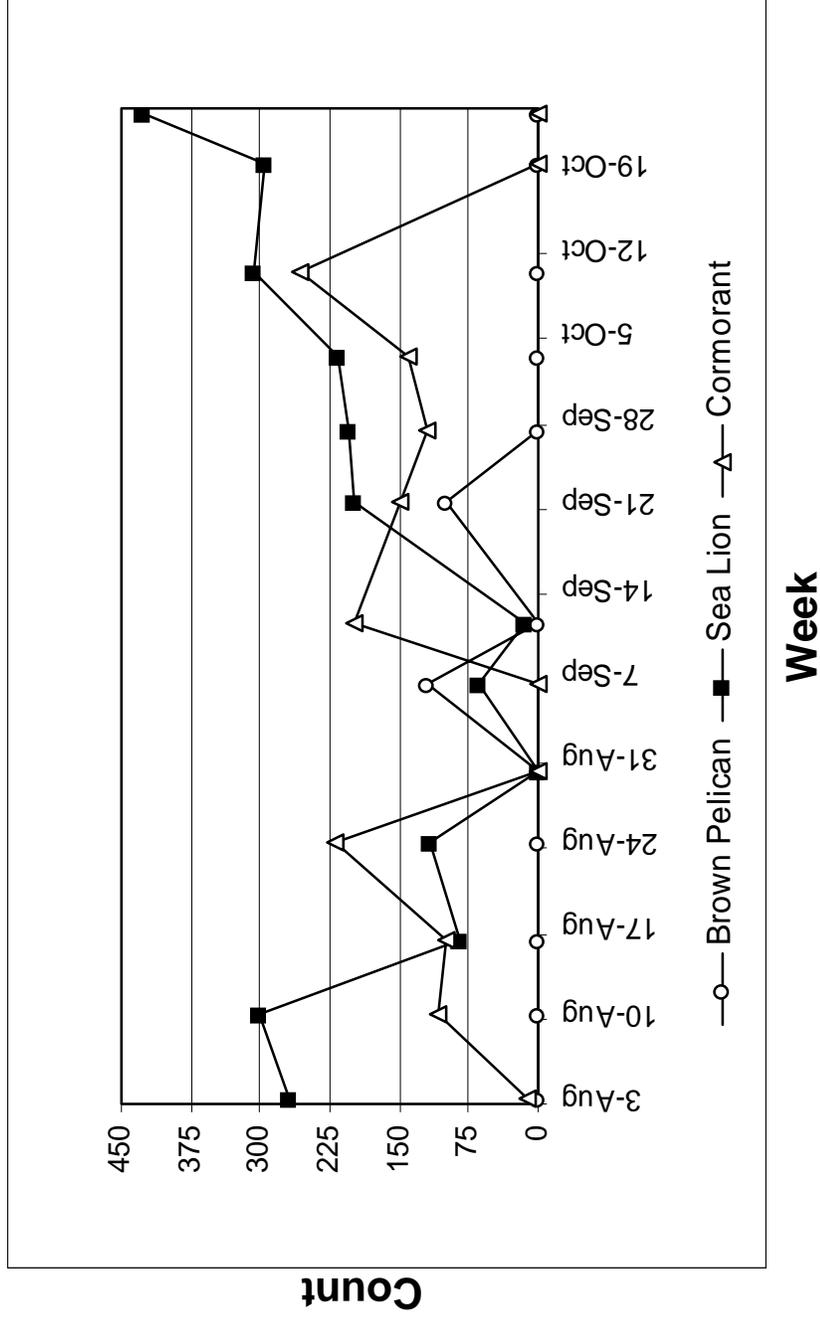


Figure 14. Weekly counts of cormorants, brown pelicans, and sea lions on the south jetty near the mouth of the Columbia River, August-October 2000.

APPENDIX TABLES

Sampling Week	Pile Dike 1 (RM 3.00)	Pile Dike 2 (RM 4.01)	Pile Dike 3 (RM 4.47)	Pile Dike 4 (RM 5.15)	Pile Dike 5 (RM 6.37)
7/31 - 8/06	31	33	33	32	32
8/07 - 8/13	32	32	33	32	32
08/14 - 08/20	32	32	32	32	32
08/21 - 08/27	32	32	32	32	32
08/28 - 09/03	32	32	32	32	31
09/04 - 09/10	32	32	34	32	32
09/11 - 09/17	32	32	32	32	32
09/18 - 09/24	32	32	32	32	32
09/25 - 10/01	32	21	32	32	32
10/02 - 10/08	32	32	32	32	32
10/09 - 10/15	32	32	32	32	32
10/16 - 10/22	12	32	32	32	32
10/23 - 10/29	32	32	32	32	32

Appendix A. Number of observations of brown pelicans and cormorants taken per week at pile dikes near the mouth of the Columbia River, August-October 2000.

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev
7/31 - 8/06	1.77	± 1.86	5.58	± 7.25	17.03	± 20.20	2.88	± 3.82	0.31	± 0.59
8/07 - 8/13	3.06	± 2.97	8.09	± 16.86	18.16	± 30.79	8.00	± 7.59	3.72	± 5.26
08/14 - 08/20	7.59	± 12.64	8.03	± 7.55	55.91	± 48.13	12.94	± 10.76	4.19	± 7.72
08/21 - 08/27	11.09	± 11.93	43.53	± 31.05	10.38	± 9.09	14.91	± 14.72	0.22	± 0.49
08/28 - 09/03	1.94	± 3.03	38.66	± 20.83	14.38	± 17.99	18.78	± 27.04	1.55	± 2.28
09/04 - 09/10	0.84	± 1.55	37.28	± 50.74	26.68	± 37.11	0.06	± 0.25	0.00	± 0.00
09/11 - 09/17	22.03	± 11.87	26.09	± 16.89	17.94	± 15.15	19.97	± 23.04	9.94	± 18.94
09/18 - 09/24	13.09	± 11.06	2.19	± 4.03	5.31	± 5.52	1.16	± 1.46	0.41	± 1.07
09/25 - 10/01	2.09	± 2.58	0.14	± 0.36	16.88	± 35.15	5.48	± 6.38	12.53	± 18.58
10/02 - 10/08	1.81	± 2.44	0.85	± 2.09	2.06	± 3.19	0.19	± 0.47	0.00	± 0.00
10/09 - 10/15	10.84	± 11.55	8.97	± 10.31	10.34	± 5.73	0.28	± 0.92	1.81	± 4.43
10/16 - 10/22	1.25	± 0.75	9.94	± 13.45	21.63	± 17.37	18.88	± 31.93	0.41	± 1.10
10/23 - 10/29	0.91	± 2.23	0.22	± 0.55	1.03	± 0.86	0.16	± 0.37	0.09	± 0.53
Seasonal Mean and StDev	6.28	± 9.92	14.92	± 24.77	16.79	± 26.99	7.97	± 16.22	2.71	± 8.75

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.32	± 1.05	5.12	± 10.06	4.09	± 9.66	0.31	± 0.82	0.00	± 0.00
8/07 - 8/13	0.09	± 0.39	1.25	± 3.48	0.34	± 1.12	0.31	± 1.12	0.00	± 0.00
08/14 - 08/20	1.78	± 4.79	2.16	± 3.74	12.63	± 19.39	1.88	± 2.06	0.81	± 4.60
08/21 - 08/27	3.06	± 5.88	4.31	± 8.64	0.16	± 0.45	1.78	± 2.93	0.00	± 0.00
08/28 - 09/03	0.00	± 0.00	6.84	± 14.48	0.75	± 1.50	0.56	± 1.27	0.06	± 0.36
09/04 - 09/10	0.78	± 1.50	3.94	± 8.92	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00
09/11 - 09/17	0.78	± 1.41	3.94	± 5.32	0.56	± 1.39	0.66	± 3.36	0.06	± 0.35
09/18 - 09/24	0.41	± 0.80	0.19	± 0.47	0.22	± 1.07	0.19	± 0.74	0.00	± 0.00
09/25 - 10/01	0.22	± 0.79	0.05	± 0.22	1.22	± 5.67	0.09	± 0.29	11.13	± 35.70
10/02 - 10/08	0.13	± 0.49	0.00	± 0.00	0.19	± 1.06	0.00	± 0.00	0.00	± 0.00
10/09 - 10/15	0.41	± 1.19	0.22	± 0.87	0.06	± 0.35	0.00	± 0.00	0.00	± 0.00
10/16 - 10/22	0.00	± 0.00	0.38	± 1.16	0.00	± 0.00	0.59	± 1.56	0.00	± 0.00
10/23 - 10/29	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00
Seasonal Mean and StDev	0.65	± 2.43	2.24	± 6.73	1.55	± 7.02	0.49	± 1.63	0.46	± 5.14

Totals										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	Mean	StDev								
Perching	6.28	± 9.92	14.92	± 24.77	16.79	± 26.99	7.97	± 16.22	2.71	± 8.75
Foraging	0.65	± 2.43	2.24	± 6.73	1.55	± 7.02	0.49	± 1.63	0.47	± 5.14
Seasonal Mean and StDev	6.92	± 10.89	17.16	± 28.63	18.35	± 31.49	8.46	± 16.84	3.17	± 11.42

Appendix B. Tabular data for figures 2a and 3. Mean number of perching and foraging brown pelicans counted on or near pile dikes per week near the mouth of the Columbia River, August-October 2000.

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.003	± 0.003	0.011	± 0.015	0.020	± 0.023	0.003	± 0.004	0.000	± 0.000
8/07 - 8/13	0.005	± 0.005	0.016	± 0.034	0.021	± 0.035	0.009	± 0.008	0.003	± 0.004
08/14 - 08/20	0.013	± 0.022	0.016	± 0.015	0.064	± 0.055	0.014	± 0.012	0.003	± 0.005
08/21 - 08/27	0.019	± 0.021	0.087	± 0.062	0.012	± 0.010	0.016	± 0.016	0.000	± 0.000
08/28 - 09/03	0.003	± 0.005	0.077	± 0.042	0.017	± 0.021	0.020	± 0.029	0.001	± 0.002
09/04 - 09/10	0.001	± 0.003	0.075	± 0.102	0.031	± 0.043	0.000	± 0.000	0.000	± 0.000
09/11 - 09/17	0.038	± 0.021	0.052	± 0.034	0.021	± 0.017	0.021	± 0.025	0.007	± 0.013
09/18 - 09/24	0.023	± 0.019	0.004	± 0.008	0.006	± 0.006	0.001	± 0.002	0.000	± 0.001
09/25 - 10/01	0.004	± 0.004	0.000	± 0.001	0.019	± 0.041	0.006	± 0.007	0.009	± 0.013
10/02 - 10/08	0.003	± 0.004	0.002	± 0.004	0.002	± 0.004	0.000	± 0.001	0.000	± 0.000
10/09 - 10/15	0.019	± 0.020	0.018	± 0.021	0.012	± 0.007	0.000	± 0.001	0.001	± 0.003
10/16 - 10/22	0.002	± 0.001	0.020	± 0.027	0.025	± 0.020	0.020	± 0.034	0.000	± 0.001
10/23 - 10/29	0.002	± 0.004	0.000	± 0.001	0.001	± 0.001	0.000	± 0.000	0.000	± 0.000
Seasonal Mean and StDev	0.011	± 0.017	0.030	± 0.050	0.019	± 0.031	0.009	± 0.017	0.002	± 0.006

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.001	± 0.002	0.010	± 0.020	0.005	± 0.011	0.000	± 0.001	0.000	± 0.000
8/07 - 8/13	0.000	± 0.001	0.003	± 0.007	0.000	± 0.001	0.000	± 0.001	0.000	± 0.000
08/14 - 08/20	0.003	± 0.008	0.004	± 0.007	0.015	± 0.022	0.002	± 0.002	0.001	± 0.003
08/21 - 08/27	0.005	± 0.010	0.009	± 0.017	0.000	± 0.001	0.002	± 0.003	0.000	± 0.000
08/28 - 09/03	0.000	± 0.000	0.014	± 0.029	0.001	± 0.002	0.001	± 0.001	0.000	± 0.000
09/04 - 09/10	0.001	± 0.003	0.008	± 0.018	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000
09/11 - 09/17	0.001	± 0.002	0.008	± 0.011	0.001	± 0.002	0.001	± 0.004	0.000	± 0.000
09/18 - 09/24	0.001	± 0.001	0.000	± 0.001	0.000	± 0.001	0.000	± 0.001	0.000	± 0.000
09/25 - 10/01	0.000	± 0.001	0.000	± 0.000	0.001	± 0.007	0.000	± 0.000	0.008	± 0.024
10/02 - 10/08	0.000	± 0.001	0.000	± 0.000	0.000	± 0.001	0.000	± 0.000	0.000	± 0.000
10/09 - 10/15	0.001	± 0.002	0.000	± 0.002	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000
10/16 - 10/22	0.000	± 0.000	0.001	± 0.002	0.000	± 0.000	0.001	± 0.002	0.000	± 0.000
10/23 - 10/29	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000
Seasonal Mean and StDev	0.001	± 0.004	0.004	± 0.013	0.002	± 0.008	0.001	± 0.002	0.000	± 0.004

Totals										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	Mean	StDev								
Perching	0.011	± 0.017	0.030	± 0.050	0.019	± 0.031	0.009	± 0.017	0.002	± 0.006
Foraging	0.001	± 0.004	0.004	± 0.013	0.002	± 0.008	0.001	± 0.002	0.000	± 0.004
Seasonal Mean and StDev	0.012	± 0.019	0.034	± 0.057	0.021	± 0.036	0.009	± 0.018	0.002	± 0.008

Appendix C. Tabular data for figures 2b and 4. Mean number of perching and foraging brown pelicans counted per meter of pile dike per week near the mouth of the Columbia River, August-October 2000.

Brown Pelican										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Perching	Foraging								
7/31 - 8/06	84.6%	15.4%	52.1%	47.9%	80.6%	19.4%	90.2%	9.8%	100.0%	0.0%
8/07 - 8/13	97.0%	3.0%	86.6%	13.4%	98.1%	1.9%	96.2%	3.8%	100.0%	0.0%
08/14 - 08/20	81.0%	19.0%	78.8%	21.2%	81.6%	18.4%	87.3%	12.7%	83.8%	16.3%
08/21 - 08/27	78.4%	21.6%	91.0%	9.0%	98.5%	1.5%	89.3%	10.7%	100.0%	0.0%
08/28 - 09/03	100.0%	0.0%	85.0%	15.0%	95.0%	5.0%	97.1%	2.9%	96.0%	4.0%
09/04 - 09/10	51.9%	48.1%	90.4%	9.6%	100.0%	0.0%	100.0%	0.0%		
09/11 - 09/17	96.6%	3.4%	86.9%	13.1%	97.0%	3.0%	96.8%	3.2%	99.4%	0.6%
09/18 - 09/24	97.0%	3.0%	92.1%	7.9%	96.0%	4.0%	86.0%	14.0%	100.0%	0.0%
09/25 - 10/01	90.5%	9.5%	75.0%	25.0%	93.3%	6.7%	98.4%	1.6%	53.0%	47.0%
10/02 - 10/08	93.5%	6.5%	100.0%	0.0%	91.7%	8.3%	100.0%	0.0%		
10/09 - 10/15	96.4%	3.6%	97.6%	2.4%	99.4%	0.6%	100.0%	0.0%	100.0%	0.0%
10/16 - 10/22	100.0%	0.0%	96.4%	3.6%	100.0%	0.0%	97.0%	3.0%	100.0%	0.0%
10/23 - 10/29	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

Appendix D. Tabular data for figure 5. Percent of brown pelicans counted per week on or near pile dikes near the mouth of the Columbia River that were perching and foraging, August-October 2000.

Brown Pelican															
Sampling Week	Pile Dike 1 (RM 3.00)			Pile Dike 2 (RM 4.01)			Pile Dike 3 (RM 4.47)			Pile Dike 4 (RM 5.15)			Pile Dike 5 (RM 6.37)		
	nearshore	middle	offshore												
7/31 - 8/06	80.0%		20.0%	5.1%	22.1%	72.8%	29.3%	27.5%	43.2%	19.6%	14.7%	65.7%	10.0%	10.0%	80.0%
8/07 - 8/13	77.2%		22.8%	4.3%	13.4%	82.3%	12.5%	16.4%	71.1%	6.0%	7.5%	86.5%	0.0%	2.5%	97.5%
08/14 - 08/20	46.2%		53.8%	0.3%	30.7%	69.0%	15.8%	32.8%	51.4%	14.3%	19.8%	65.8%	3.4%	8.8%	87.8%
08/21 - 08/27	85.7%		14.3%	1.8%	34.8%	63.4%	18.4%	43.3%	38.3%	28.3%	20.0%	51.7%	14.3%	0.0%	85.7%
08/28 - 09/03	86.7%		13.3%	0.1%	7.5%	92.4%	15.1%	41.1%	43.8%	41.0%	40.9%	18.1%	4.1%	6.1%	89.8%
09/04 - 09/10	98.1%		1.9%	3.9%	33.7%	62.3%	21.4%	37.9%	40.7%	0.0%	100.0%	0.0%			
09/11 - 09/17	41.2%		58.8%	1.0%	30.7%	68.3%	8.6%	38.7%	52.7%	45.6%	34.1%	20.3%	65.2%	25.1%	9.7%
09/18 - 09/24	78.2%		21.8%	1.3%	7.9%	90.8%	13.0%	40.7%	46.3%	23.3%	37.2%	39.5%	0.0%	0.0%	100.0%
09/25 - 10/01	89.2%		10.8%	0.0%	25.0%	75.0%	8.1%	43.7%	48.2%	17.8%	9.7%	72.4%	31.4%	51.1%	17.4%
10/02 - 10/08	67.0%		33.0%	0.0%	7.1%	92.9%	29.2%	26.4%	44.4%	0.0%	0.0%	100.0%			
10/09 - 10/15	77.8%		22.2%	0.0%	0.0%	100.0%	25.8%	50.2%	24.0%	0.0%	33.3%	66.7%	0.0%	0.0%	100.0%
10/16 - 10/22	66.7%		33.3%	0.0%	0.0%	100.0%	5.9%	53.3%	40.8%	28.6%	44.0%	27.4%	0.0%	0.0%	100.0%
10/23 - 10/29	58.6%		41.4%	0.0%	14.3%	85.7%	75.8%	9.1%	15.2%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%

Appendix E. Tabular data for figure 6. Percent brown pelicans counted per week on or near pile dikes near the mouth of the Columbia River that were located on the nearshore, middle, and offshore portion of the pile dike, August-October 2000. There was no middle portion for pile dike 1 (see figure 1).

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	High Tide	Low Tide								
7/31 - 8/06	36.3%	63.7%	70.1%	29.9%	90.2%	9.8%	82.8%	17.2%	100.0%	0.0%
8/07 - 8/13					6.3%	93.7%	79.7%	20.3%	75.7%	24.3%
08/14 - 08/20	95.3%	4.7%	51.4%	48.6%	63.5%	36.5%	75.9%	24.1%	85.1%	14.9%
08/21 - 08/27	82.7%	17.3%	75.5%	24.5%	73.0%	27.0%	96.5%	3.5%	84.1%	15.9%
08/28 - 09/03	75.7%	24.3%	67.7%	32.3%	81.2%	18.8%	92.3%	7.7%	100.0%	0.0%
09/04 - 09/10	97.7%	2.3%	68.4%	31.6%	56.2%	43.8%	100.0%	0.0%		
09/11 - 09/17	58.5%	41.5%			88.0%	12.0%	96.7%	3.3%	39.7%	60.3%
09/18 - 09/24	23.1%	76.9%	74.3%	25.7%	70.4%	29.6%	70.4%	29.6%	97.7%	2.3%
09/25 - 10/01	83.4%	16.6%			94.5%	5.5%	97.0%	3.0%	95.7%	4.3%
10/02 - 10/08	62.9%	37.1%	72.7%	27.3%	93.6%	6.4%	81.3%	18.8%		
10/09 - 10/15	91.8%	8.2%	32.5%	67.5%	58.6%	41.4%	100.0%	0.0%	0.0%	100.0%
10/16 - 10/22			62.9%	37.1%	73.3%	26.7%	72.7%	27.3%	86.4%	13.6%
10/23 - 10/29	26.5%	73.5%	0.0%	100.0%	55.8%	44.2%	100.0%	0.0%	100.0%	0.0%

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	High Tide	Low Tide								
7/31 - 8/06	48.8%	51.2%	75.7%	24.3%	92.9%	7.1%	100.0%	0.0%		
8/07 - 8/13					0.0%	100.0%	100.0%	0.0%		
08/14 - 08/20	95.5%	4.5%	87.1%	12.9%	47.7%	52.3%	66.3%	33.7%	100.0%	0.0%
08/21 - 08/27	75.4%	24.6%	97.6%	2.4%	100.0%	0.0%	92.8%	7.2%		
08/28 - 09/03			87.7%	12.3%	86.6%	13.4%	34.4%	65.6%	100.0%	0.0%
09/04 - 09/10	100.0%	0.0%	52.3%	47.7%						
09/11 - 09/17	33.2%	66.8%			100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
09/18 - 09/24	76.7%	23.3%	83.3%	16.7%	100.0%	0.0%	46.9%	53.1%		
09/25 - 10/01	100.0%	0.0%			94.5%	5.5%	100.0%	0.0%	98.8%	1.2%
10/02 - 10/08	100.0%	0.0%			100.0%	0.0%				
10/09 - 10/15	100.0%	0.0%	66.1%	33.9%	100.0%	0.0%				
10/16 - 10/22			100.0%	0.0%			100.0%	0.0%		
10/23 - 10/29										

Appendix F. Tabular data for figure 7. Percent of perching and foraging brown pelicans counted per week that were on or near the pile dikes near the mouth of the Columbia River at high and low tide, August-October 2000.

Sampling Week	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	High Tide	Low Tide								
7/31 - 8/06	22	9	9	24	22	11	21	11	27	5
8/07 - 8/13	0	32	0	32	3	29	19	13	3	29
08/14 - 08/20	18	14	17	15	25	7	18	14	16	16
08/21 - 08/27	10	22	20	12	19	13	26	6	17	15
08/28 - 09/03	24	8	15	17	25	7	21	11	27	4
09/04 - 09/10	12	20	14	18	25	9	26	6	23	9
09/11 - 09/17	23	9	32	0	24	8	25	7	25	7
09/18 - 09/24	20	12	16	16	17	15	17	15	7	25
09/25 - 10/01	17	15	21	0	22	10	19	14	22	10
10/02 - 10/08	14	18	9	24	13	19	6	26	14	18
10/09 - 10/15	24	8	13	19	13	19	21	11	16	16
10/16 - 10/22	0	12	21	11	12	20	15	17	11	21
10/23 - 10/29	15	17	10	22	25	7	20	12	20	12

Appendix G. Number of observations of brown pelicans and cormorants taken per week at pile dikes near the mouth of the Columbia River at high and low tide, August-October 2000.

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	38.35	± 12.90	84.24	± 42.83	89.27	± 51.48	89.44	± 55.80	159.31	± 47.46
8/07 - 8/13	36.91	± 8.35	106.63	± 31.36	53.58	± 21.82	66.66	± 31.48	183.75	± 82.31
08/14 - 08/20	31.06	± 30.92	62.06	± 19.37	50.00	± 25.39	28.78	± 13.10	194.78	± 103.47
08/21 - 08/27	19.31	± 4.71	37.88	± 14.53	16.97	± 6.97	51.97	± 55.41	118.22	± 36.65
08/28 - 09/03	21.97	± 8.94	56.34	± 20.73	21.38	± 6.11	31.09	± 12.42	223.19	± 127.38
09/04 - 09/10	20.38	± 4.97	52.84	± 14.33	8.76	± 4.08	29.16	± 5.85	501.34	± 179.18
09/11 - 09/17	23.94	± 6.89	32.03	± 25.39	14.19	± 4.92	42.38	± 22.95	352.13	± 152.18
09/18 - 09/24	23.66	± 14.71	32.16	± 10.86	14.28	± 5.15	21.72	± 9.21	250.75	± 159.61
09/25 - 10/01	17.19	± 9.05	12.24	± 13.10	19.97	± 6.99	74.06	± 30.60	142.66	± 59.61
10/02 - 10/08	16.97	± 4.91	32.84	± 4.02	21.44	± 10.57	34.31	± 9.94	406.13	± 88.77
10/09 - 10/15	24.44	± 5.44	18.63	± 7.24	37.31	± 25.71	28.00	± 18.16	227.03	± 88.71
10/16 - 10/22	53.83	± 59.01	37.78	± 17.39	57.31	± 56.79	25.34	± 25.82	136.03	± 61.08
10/23 - 10/29	13.75	± 4.99	26.06	± 8.96	46.50	± 15.08	32.22	± 18.59	409.47	± 152.50
Total	24.86	± 17.71	46.51	± 32.58	34.74	± 33.63	42.70	± 34.76	254.29	± 162.26

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev
7/31 - 8/06	8.68	± 4.66	78.55	± 86.83	31.36	± 40.83	61.38	± 47.47	1.69	± 1.72
8/07 - 8/13	11.97	± 7.81	27.84	± 23.23	14.97	± 10.44	89.69	± 74.86	4.56	± 2.14
08/14 - 08/20	7.19	± 9.57	9.31	± 9.02	64.13	± 69.72	34.81	± 18.75	11.94	± 6.05
08/21 - 08/27	2.94	± 3.19	17.81	± 22.03	6.94	± 3.62	18.50	± 7.99	10.19	± 7.82
08/28 - 09/03	4.38	± 3.97	43.97	± 20.34	16.47	± 15.85	13.44	± 8.03	37.74	± 28.99
09/04 - 09/10	2.59	± 2.43	17.44	± 19.74	2.76	± 3.05	8.38	± 4.14	11.44	± 6.88
09/11 - 09/17	3.53	± 2.21	9.03	± 6.21	4.88	± 3.55	9.19	± 14.30	22.81	± 17.74
09/18 - 09/24	1.88	± 2.21	4.16	± 3.35	5.44	± 3.17	3.13	± 3.18	17.50	± 11.02
09/25 - 10/01	2.25	± 2.16	1.86	± 2.10	7.00	± 5.51	5.19	± 3.86	9.31	± 5.57
10/02 - 10/08	1.41	± 1.34	1.44	± 1.88	3.97	± 2.97	2.28	± 2.70	5.75	± 2.32
10/09 - 10/15	1.59	± 2.17	4.44	± 3.69	6.81	± 7.19	1.81	± 2.75	5.56	± 4.43
10/16 - 10/22	0.33	± 0.65	4.97	± 5.59	5.59	± 7.05	2.69	± 2.53	2.06	± 1.53
10/23 - 10/29	0.59	± 0.80	2.13	± 2.21	4.19	± 3.72	1.72	± 1.49	6.50	± 4.62
Seasonal Mean and StDev	3.96	± 5.37	17.71	± 34.93	13.42	± 28.26	19.40	± 36.42	5.62	± 11.55

Appendix H. Tabular data for figures 8a and 9. Mean number of perching and foraging cormorants counted on or near pile dikes per week near the mouth of the Columbia River, August-October 2000.

Nesting										
Sampling Week	Pile Dike (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev
7/31 - 8/06	0.00	± 0.00	0.00	± 0.00	22.18	± 8.59	0.00	± 0.00	0.00	± 0.00
8/07 - 8/13	0.00	± 0.00	0.00	± 0.00	29.09	± 11.92	0.00	± 0.00	0.00	± 0.00
08/14 - 08/20	0.00	± 0.00	0.00	± 0.00	34.53	± 1.48	0.00	± 0.00	0.00	± 0.00
08/21 - 08/27	0.00	± 0.00	0.00	± 0.00	28.03	± 4.34	0.00	± 0.00	0.00	± 0.00
08/28 - 09/03	0.00	± 0.00	0.00	± 0.00	28.94	± 1.32	0.00	± 0.00	0.00	± 0.00
09/04 - 09/10	0.00	± 0.00	0.00	± 0.00	26.18	± 6.53	0.00	± 0.00	0.00	± 0.00
09/11 - 09/17	0.00	± 0.00	0.00	± 0.00	27.09	± 4.01	0.00	± 0.00	0.00	± 0.00
09/18 - 09/24	0.00	± 0.00	0.00	± 0.00	34.31	± 4.52	0.00	± 0.00	0.00	± 0.00
09/25 - 10/01	0.00	± 0.00	0.00	± 0.00	12.06	± 4.23	0.00	± 0.00	0.00	± 0.00
10/02 - 10/08	0.00	± 0.00	0.00	± 0.00	28.94	± 8.09	0.00	± 0.00	0.00	± 0.00
10/09 - 10/15	0.00	± 0.00	0.00	± 0.00	32.53	± 9.14	0.00	± 0.00	0.00	± 0.00
10/16 - 10/22	0.00	± 0.00	0.00	± 0.00	27.78	± 8.80	0.00	± 0.00	0.00	± 0.00
10/23 - 10/29	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00	0.00	± 0.00
Seasonal Mean and StDev	0.00	± 0.00	0.00	± 0.00	25.52	± 11.25	0.00	± 0.00	0.00	± 0.00

Totals										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	Mean	StDev								
Perching	24.86	± 17.71	46.51	± 32.58	34.74	± 33.63	42.70	± 34.76	254.29	± 162.26
Foraging	3.96	± 5.37	17.71	± 34.93	13.42	± 28.26	19.40	± 36.42	5.62	± 11.55
Nesting	0.00	± 0.00	0.00	± 0.00	25.52	± 11.25	0.00	± 0.00	0.00	± 0.00
Seasonal Mean and StDev	28.82	± 20.45	64.23	± 53.05	73.68	± 48.94	62.10	± 58.27	259.91	± 163.57

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.067	± 0.022	0.169	± 0.086	0.103	± 0.059	0.096	± 0.060	0.055	± 0.033
8/07 - 8/13	0.064	± 0.015	0.213	± 0.063	0.062	± 0.025	0.071	± 0.034	0.063	± 0.056
08/14 - 08/20	0.054	± 0.054	0.124	± 0.039	0.058	± 0.029	0.031	± 0.021	0.067	± 0.071
08/21 - 08/27	0.034	± 0.008	0.076	± 0.029	0.020	± 0.008	0.056	± 0.016	0.041	± 0.025
08/28 - 09/03	0.038	± 0.016	0.113	± 0.042	0.025	± 0.007	0.033	± 0.022	0.077	± 0.087
09/04 - 09/10	0.035	± 0.009	0.106	± 0.029	0.010	± 0.005	0.031	± 0.015	0.172	± 0.123
09/11 - 09/17	0.042	± 0.012	0.064	± 0.051	0.016	± 0.006	0.045	± 0.027	0.121	± 0.104
09/18 - 09/24	0.041	± 0.026	0.064	± 0.022	0.016	± 0.006	0.023	± 0.012	0.086	± 0.109
09/25 - 10/01	0.030	± 0.016	0.025	± 0.026	0.023	± 0.008	0.079	± 0.014	0.049	± 0.041
10/02 - 10/08	0.029	± 0.009	0.066	± 0.008	0.025	± 0.012	0.037	± 0.004	0.139	± 0.061
10/09 - 10/15	0.042	± 0.009	0.037	± 0.014	0.043	± 0.030	0.030	± 0.008	0.078	± 0.061
10/16 - 10/22	0.093	± 0.102	0.076	± 0.035	0.066	± 0.065	0.027	± 0.019	0.047	± 0.042
10/23 - 10/29	0.024	± 0.009	0.052	± 0.018	0.054	± 0.017	0.034	± 0.010	0.140	± 0.105
Total	0.043	± 0.031	0.093	± 0.065	0.040	± 0.039	0.046	± 0.035	0.174	± 0.111

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.015	± 0.008	0.157	± 0.174	0.036	± 0.047	0.066	± 0.051	0.001	± 0.001
8/07 - 8/13	0.021	± 0.014	0.056	± 0.047	0.017	± 0.012	0.096	± 0.080	0.003	± 0.001
08/14 - 08/20	0.012	± 0.017	0.019	± 0.018	0.074	± 0.080	0.037	± 0.020	0.008	± 0.004
08/21 - 08/27	0.005	± 0.006	0.036	± 0.044	0.008	± 0.004	0.020	± 0.009	0.007	± 0.005
08/28 - 09/03	0.008	± 0.007	0.088	± 0.041	0.019	± 0.018	0.014	± 0.009	0.026	± 0.020
09/04 - 09/10	0.005	± 0.004	0.035	± 0.040	0.003	± 0.004	0.009	± 0.004	0.008	± 0.005
09/11 - 09/17	0.006	± 0.004	0.018	± 0.012	0.006	± 0.004	0.010	± 0.015	0.016	± 0.012
09/18 - 09/24	0.003	± 0.004	0.008	± 0.007	0.006	± 0.004	0.003	± 0.003	0.012	± 0.008
09/25 - 10/01	0.004	± 0.004	0.004	± 0.004	0.008	± 0.006	0.006	± 0.004	0.006	± 0.004
10/02 - 10/08	0.002	± 0.002	0.003	± 0.004	0.005	± 0.003	0.002	± 0.003	0.004	± 0.002
10/09 - 10/15	0.003	± 0.004	0.009	± 0.007	0.008	± 0.008	0.002	± 0.003	0.004	± 0.003
10/16 - 10/22	0.001	± 0.001	0.010	± 0.011	0.006	± 0.008	0.003	± 0.003	0.001	± 0.001
10/23 - 10/29	0.001	± 0.001	0.004	± 0.004	0.005	± 0.004	0.002	± 0.002	0.004	± 0.003
Seasonal Mean and StDev	0.007	± 0.009	0.035	± 0.070	0.015	± 0.033	0.021	± 0.039	0.004	± 0.008

Appendix I. Tabular data for figures 9b and 10. Mean number of nesting, perching, and foraging cormorants counted per meter of pile dike near the mouth of the Columbia River, August-October 2000.

Nesting										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	Mean	StDev								
7/31 - 8/06	0.000	± 0.000	0.000	± 0.000	0.026	± 0.010	0.000	± 0.000	0.000	± 0.000
8/07 - 8/13	0.000	± 0.000	0.000	± 0.000	0.034	± 0.014	0.000	± 0.000	0.000	± 0.000
08/14 - 08/20	0.000	± 0.000	0.000	± 0.000	0.040	± 0.002	0.000	± 0.000	0.000	± 0.000
08/21 - 08/27	0.000	± 0.000	0.000	± 0.000	0.032	± 0.005	0.000	± 0.000	0.000	± 0.000
08/28 - 09/03	0.000	± 0.000	0.000	± 0.000	0.033	± 0.002	0.000	± 0.000	0.000	± 0.000
09/04 - 09/10	0.000	± 0.000	0.000	± 0.000	0.030	± 0.008	0.000	± 0.000	0.000	± 0.000
09/11 - 09/17	0.000	± 0.000	0.000	± 0.000	0.031	± 0.005	0.000	± 0.000	0.000	± 0.000
09/18 - 09/24	0.000	± 0.000	0.000	± 0.000	0.040	± 0.005	0.000	± 0.000	0.000	± 0.000
09/25 - 10/01	0.000	± 0.000	0.000	± 0.000	0.014	± 0.005	0.000	± 0.000	0.000	± 0.000
10/02 - 10/08	0.000	± 0.000	0.000	± 0.000	0.033	± 0.009	0.000	± 0.000	0.000	± 0.000
10/09 - 10/15	0.000	± 0.000	0.000	± 0.000	0.037	± 0.011	0.000	± 0.000	0.000	± 0.000
10/16 - 10/22	0.000	± 0.000	0.000	± 0.000	0.032	± 0.010	0.000	± 0.000	0.000	± 0.000
10/23 - 10/29	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000	0.000	± 0.000
Seasonal Mean and StDev	0.000	± 0.000	0.000	± 0.000	0.029	± 0.013	0.000	± 0.000	0.000	± 0.000

Totals										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	Mean	StDev								
Perching	0.043	± 0.031	0.093	± 0.065	0.040	± 0.039	0.046	± 0.035	0.174	± 0.111
Foraging	0.007	± 0.009	0.035	± 0.070	0.015	± 0.033	0.021	± 0.039	0.004	± 0.008
Nesting	0.000	± 0.000	0.000	± 0.000	0.029	± 0.013	0.000	± 0.000	0.000	± 0.000
Seasonal Mean and StDev	0.050	± 0.036	0.129	± 0.106	0.085	± 0.056	0.066	± 0.062	0.178	± 0.112

Sampling Week	Pile Dike 1 (RM 3.00)			Pile Dike 2 (RM 4.01)			Pile Dike 3 (RM 4.47)			Pile Dike 4 (RM 5.15)			Pile Dike 5 (RM 6.37)		
	Nesting	Perching	Foraging												
7/31 - 8/06	0.0%	81.6%	18.4%	0.0%	51.7%	48.3%	15.5%	62.5%	22.0%	0.0%	59.3%	40.7%	0.0%	99.0%	1.0%
8/07 - 8/13	0.0%	75.5%	24.5%	0.0%	79.3%	20.7%	29.8%	54.9%	15.3%	0.0%	42.6%	57.4%	0.0%	97.6%	2.4%
08/14 - 08/20	0.0%	81.2%	18.8%	0.0%	87.0%	13.0%	23.2%	33.6%	43.1%	0.0%	45.3%	54.7%	0.0%	94.2%	5.8%
08/21 - 08/27	0.0%	86.8%	13.2%	0.0%	68.0%	32.0%	54.0%	32.7%	13.4%	0.0%	73.7%	26.3%	0.0%	92.1%	7.9%
08/28 - 09/03	0.0%	83.4%	16.6%	0.0%	56.2%	43.8%	43.3%	32.0%	24.7%	0.0%	69.8%	30.2%	0.0%	85.5%	14.5%
09/04 - 09/10	0.0%	88.7%	11.3%	0.0%	75.2%	24.8%	69.4%	23.2%	7.3%	0.0%	77.7%	22.3%	0.0%	97.8%	2.2%
09/11 - 09/17	0.0%	87.1%	12.9%	0.0%	78.0%	22.0%	58.7%	30.7%	10.6%	0.0%	82.2%	17.8%	0.0%	93.9%	6.1%
09/18 - 09/24	0.0%	92.7%	7.3%	0.0%	88.6%	11.4%	63.5%	26.4%	10.1%	0.0%	87.4%	12.6%	0.0%	93.5%	6.5%
09/25 - 10/01	0.0%	88.4%	11.6%	0.0%	86.8%	13.2%	30.9%	51.2%	17.9%	0.0%	93.5%	6.5%	0.0%	93.9%	6.1%
10/02 - 10/08	0.0%	92.3%	7.7%	0.0%	95.8%	4.2%	53.2%	39.4%	7.3%	0.0%	93.8%	6.2%	0.0%	98.6%	1.4%
10/09 - 10/15	0.0%	93.9%	6.1%	0.0%	80.8%	19.2%	42.4%	48.7%	8.9%	0.0%	93.9%	6.1%	0.0%	97.6%	2.4%
10/16 - 10/22	0.0%	99.4%	0.6%	0.0%	88.4%	11.6%	30.6%	63.2%	6.2%	0.0%	90.4%	9.6%	0.0%	98.5%	1.5%
10/23 - 10/29	0.0%	95.9%	4.1%	0.0%	92.5%	7.5%	0.0%	91.7%	8.3%	0.0%	94.9%	5.1%	0.0%	98.4%	1.6%

Appendix J. Tabular data for figure 11. Percent of cormorants counted per week on or near pile dikes in the Columbia river estuary that were nesting, perching, and foraging, August-October 2000.

Cormorant															
	Pile Dike 1 (RM 3.00)			Pile Dike 2 (RM 4.01)			Pile Dike 3 (RM 4.47)			Pile Dike 4 (RM 5.15)			Pile Dike 5 (RM 6.37)		
Sampling Week	nearshore	middle	offshore												
7/31 - 8/06	37.9%		62.1%	4.0%	14.9%	81.1%	47.8%	24.3%	27.9%	72.9%	21.9%	5.3%	27.5%	27.6%	45.0%
8/07 - 8/13	56.4%		43.6%	0.0%	5.2%	94.7%	30.4%	19.7%	49.9%	63.3%	25.3%	11.3%	11.9%	23.4%	64.7%
08/14 - 08/20	60.1%		39.9%	0.0%	4.9%	95.1%	37.8%	30.5%	31.7%	66.7%	21.9%	11.4%	28.6%	33.1%	38.2%
08/21 - 08/27	43.1%		56.9%	0.0%	23.8%	76.2%	25.6%	7.7%	66.7%	49.1%	35.3%	15.6%	31.4%	28.8%	39.8%
08/28 - 09/03	69.0%		31.0%	0.5%	8.3%	91.3%	23.7%	22.1%	54.2%	52.8%	32.9%	14.3%	34.4%	32.5%	33.2%
09/04 - 09/10	75.6%		24.4%	0.0%	3.6%	96.4%	6.3%	7.3%	86.3%	20.0%	56.4%	23.6%	28.0%	37.3%	34.7%
09/11 - 09/17	75.4%		24.6%	0.0%	8.4%	91.6%	18.3%	6.4%	75.3%	44.1%	34.3%	21.6%	28.5%	33.8%	37.7%
09/18 - 09/24	70.3%		29.7%	0.0%	2.9%	97.1%	11.3%	10.2%	78.4%	4.9%	19.7%	75.3%	16.6%	22.1%	61.3%
09/25 - 10/01	76.4%		23.6%	0.0%	9.5%	90.5%	34.7%	15.5%	49.8%	18.6%	56.5%	24.9%	40.2%	26.8%	33.0%
10/02 - 10/08	76.5%		23.5%	0.0%	4.3%	95.7%	12.0%	10.1%	77.9%	6.0%	53.6%	40.4%	25.8%	20.0%	54.2%
10/09 - 10/15	85.9%		14.1%	0.0%	3.9%	96.1%	5.7%	22.2%	72.1%	19.3%	47.0%	33.8%	36.0%	32.9%	31.1%
10/16 - 10/22	81.1%		18.9%	0.0%	0.7%	99.3%	12.5%	30.4%	57.1%	25.2%	43.6%	31.2%	38.8%	17.5%	43.7%
10/23 - 10/29	81.7%		18.3%	0.0%	0.3%	99.7%	10.0%	19.1%	70.9%	14.7%	50.9%	34.3%	35.6%	26.8%	37.6%

Appendix K. Tabular data for figure 12. Percent of cormorants counted per week on or near pile dikes near the mouth of the Columbia River that were located on the nearshore, middle, and offshore portion of the pile dike, August-October 2000. There was no middle portion for pile dike 1 (see figure 1).

Perching										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	High Tide	Low Tide								
7/31 - 8/06	60.3%	39.7%	39.9%	60.1%	58.9%	41.1%	71.1%	28.9%	54.5%	45.5%
8/07 - 8/13										
08/14 - 08/20	71.0%	29.0%	57.9%	42.1%	43.4%	56.6%	66.3%	33.7%	63.2%	36.8%
08/21 - 08/27										
08/28 - 09/03	47.9%	52.1%	39.4%	60.6%	46.4%	53.6%	57.1%	42.9%	65.0%	35.0%
09/04 - 09/10										
09/11 - 09/17	49.7%	50.3%			44.1%	55.9%	33.9%	66.1%	65.5%	34.5%
09/18 - 09/24							39.4%	60.6%	48.7%	51.3%
09/25 - 10/01	70.9%	29.1%			65.8%	34.2%	52.4%	47.6%	37.3%	62.7%
10/02 - 10/08	46.1%	53.9%	47.4%	52.6%	53.3%	46.7%	61.9%	38.1%	58.2%	41.8%
10/09 - 10/15	54.2%	45.8%	53.2%	46.8%	69.9%	30.1%	36.6%	63.4%		
10/16 - 10/22	23.7%	76.3%	39.1%	60.9%	22.8%	77.2%	76.9%	23.1%	53.2%	46.8%
10/23 - 10/29	73.7%	26.3%	69.1%	30.9%	39.8%	60.2%	27.4%	72.6%	48.5%	51.5%

Foraging										
	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
Sampling Week	High Tide	Low Tide								
7/31 - 8/06	57.7%	42.3%	66.8%	33.2%	85.3%	14.7%	68.4%	31.6%	34.6%	65.4%
8/07 - 8/13										
08/14 - 08/20	75.7%	24.3%	81.4%	18.6%	41.3%	58.7%	59.8%	40.2%	72.8%	27.2%
08/21 - 08/27										
08/28 - 09/03	47.2%	52.8%	53.3%	46.7%	66.6%	33.4%	49.4%	50.6%	76.8%	23.2%
09/04 - 09/10										
09/11 - 09/17	48.7%	51.3%			57.3%	42.7%	58.3%	41.7%	87.5%	12.5%
09/18 - 09/24							47.0%	53.0%	60.5%	39.5%
09/25 - 10/01	62.4%	37.6%			56.5%	43.5%	67.0%	33.0%	56.2%	43.8%
10/02 - 10/08	43.8%	56.2%	53.5%	46.5%	59.0%	41.0%	65.7%	34.3%	32.4%	67.6%
10/09 - 10/15	57.7%	42.3%	44.3%	55.7%	38.4%	61.6%	76.6%	23.4%		
10/16 - 10/22	0.0%	100.0%	59.3%	40.7%	41.2%	58.8%	53.6%	46.4%	41.7%	58.3%
10/23 - 10/29			26.9%	73.1%			40.1%	59.9%	79.4%	20.6%

Appendix L. Tabular data for figure 13. Percent of perching, foraging, and nesting cormorants counted per week that were on or near the pile dikes near the mouth of the Columbia River at high and low tide, August-October 2000.

Nesting										
Sampling Week	Pile Dike 1 (RM 3.00)		Pile Dike 2 (RM 4.01)		Pile Dike 3 (RM 4.47)		Pile Dike 4 (RM 5.15)		Pile Dike 5 (RM 6.37)	
	High Tide	Low Tide								
7/31 - 8/06					35.8%	64.2%				
8/07 - 8/13										
08/14 - 08/20					50.2%	49.8%				
08/21 - 08/27										
08/28 - 09/03					49.9%	50.1%				
09/04 - 09/10										
09/11 - 09/17					46.7%	53.3%				
09/18 - 09/24										
09/25 - 10/01					60.3%	39.7%				
10/02 - 10/08					52.2%	47.8%				
10/09 - 10/15					52.5%	47.5%				
10/16 - 10/22					56.6%	43.4%				
10/23 - 10/29										

Sampling Date	Brown Pelican	Sea Lion	Cormorant
8/3	0	270	12
8/10	0	302	107
8/16	0	85	100
8/24	0	117	218
8/30	0	0	0
9/6	120	65	0
9/11	0	15	200
9/21	100	200	150
9/27	0	205	119
10/3	0	217	140
10/10	0	308	258
10/19	0	295	0
10/23	0	426	0

Appendix M. Tabular data for figure 14. Weekly counts of cormorants, brown pelicans, and sea lions on the south jetty near the mouth of the Columbia River, August-October 2000.

Bird Reference	Date	Frequency	Lat	Long
Bird 1	8/3	151862	461180	1235259
Bird 1	8/10	151862	461489	1235669
Bird 1	8/16	151862	461280	1235212
Bird 1	8/24	151862	461179	1235123
Bird 1	8/30	151862	461235	1235114
Bird 1	9/11	151862	461183	1235110
Bird 1	9/21	151862	461186	1235142
Bird 1	9/27	151862	461209	1235083
Bird 2	8/3	151622	461545	1235745
Bird 2	8/10	151622	461629	1235736
Bird 2	8/16	151622	461800	1240279
Bird 2	8/24	151622	461732	1246165
Bird 2	9/6	151622	461590	1240146
Bird 3	8/3	151524	461545	1235745
Bird 3	8/10	151524	461229	1235170
Bird 3	8/16	151524	461205	1235245
Bird 3	8/24	151524	461378	1235274
Bird 3	8/30	151524	461248	1235209
Bird 4	8/10	151314	461220	1234046
Bird 4	8/16	151314	461643	1234200
Bird 4	8/24	151314	461143	1233980
Bird 4	8/30	151314	461305	1234360
Bird 4	9/6	151314	461455	1234613
Bird 4	9/11	151314	461178	1234181
Bird 4	9/21	151314	461119	1234276
Bird 5	8/10	151443	461454	1233992
Bird 5	8/24	151443	461484	1234014
Bird 5	8/30	151443	461472	1234038
Bird 5	9/11	151443	461499	1233932
Bird 5	9/21	151443	461489	1233756
Bird 5	9/27	151443	461508	1233810
Bird 6	8/16	151935	461535	1234225
Bird 6	8/24	151935	461482	1234486
Bird 6	9/11	151935	461530	1234340
Bird 6	9/21	151935	461527	1234329
Bird 6	9/27	151935	461526	1234329
Bird 7	8/3	151755	461435	1233715
Bird 7	8/16	151755	461784	1234155
Bird 7	8/24	151755	461540	1234189
Bird 8	8/10	151054	461162	1234895
Bird 9	8/3	150784	461228	1234755
Bird 10	8/3	151014	461596	1245774
Bird 11	8/3	151174	461430	1235162
Bird 12	8/3	151233	461545	1235745
Bird 13	8/3	151253	461545	1235745

Appendix N. Tabular data for figure 15. Relocations of radio-tagged double-crested cormorants in the Columbia River Estuary, August – September 2000.

Bird Reference	Date	Frequency	Lat	Long
Bird 14	8/3	151274	461217	1234496
Bird 15	8/3	151294	461545	1235745
Bird 16	8/3	151484	461618	1240272
Bird 17	8/3	151502	461545	1235745
Bird 18	8/3	151643	461080	1235212
Bird 19	8/3	151733	461370	1235165
Bird 20	8/3	151944	461545	1235745
Bird 21	8/3	151953	461545	1235745