A Marine Bird Census of Aquatic Park

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Introduction

Berkeley's Aquatic Park is situated at the western edge of the city, separated from San Francisco Bay by the Eastshore Freeway. It is mainly comprised of two man-made bodies of water, a lake and a smaller model boat pond, totalling 100 acres in size. Although the water is surrounded by paved paths, lawns and vegetation providing the public with a recreational setting in which to picnic, jog or bike, the park is plagued with problems which result in its underuse (Montgomery, pers. comm.). Noise from the freeway and poor accessibility are only two of such issues.

In addition to its recreational uses, the park provides habitat for large numbers of resident and migratory birds due to its proximity to the bay and its location along the Pacific Flyway, an avian migration route. Residential species are those birds which occupy the site during part of the year or year-round, while migrants pass through as they move seasonally to and from breeding sites (Pettingill, 1983). As the destruction of the Bay Area's wetlands continues the value of such a habitat for birds increases.

The city of Berkeley is currently developing a master plan for the park's future development, with emphasis on increasing its use by city residents. The implementation of the plan would have the potential to affect the birds of Aquatic Park as well as the people. Because the park is an important bird habitat, it is necessary that the city consider these potential impacts in its decision-making. The goal of my study is to assist the city by providing baseline data on the usage of the park with respect to species diversity and changing habitat availability over time. I examine management policies contributing to these changes and make recommendations for policy changes.

Past Studies

There is no published bird census specific to the Aquatic Park. However, the park is incorporated into the Golden Gate Audubon Society's annual Christmas Bird Count which covers the greater Oakland area. Species and number of individuals are recorded by volunteers. The data are published each year and are available in the bimonthly journal

American Birds (Audubon Society, 1982). Gary Page, Director of Coastal Estuarian Research at Point Reyes Bird Observatory, states its first annual Seabird Count took place September 9th through 11th, 1988, from Point Reyes, California to the Oregon border. This survey included the margins of the San Francisco Bay, which were divided into segments and observed by volunteers. The data have yet to be published. Lastly, although no official notes or lists are available, students from the Department of Zoology at the University of California Berkeley have used the Aquatic Park for field identification exercises; the location has considerable educational value.

Background

Site Description: The park consists of approximately 100 acres. Of this, roughly two-thirds is covered with brackish water. The water averages five to seven feet in depth and is maintained by a tidal gate and channel that originates in the bay (Montgomery, pers. comm.). There are several buildings situated around the lake, including a boat house and ramp, a clubhouse and an office (Figure 1). In the middle of the lake there are two stilted observation chairs and a ski jump. Lawn, cypress trees, shrubbery (principally *Ribes* sp. and *Raphiolepis* sp.), and a small amount of pickleweed and cattails encircle the lake.

The model boat pond, about one-sixteenth the size of the lake, is, in turn, fed by two culverts running under the road from the lake. The pond appears to have diminished water circulation and more submerged vegetation than the lake. Its entire eastern bank supports a growth of cattails and pine trees. In addition, there is a small beach and a row of partially submerged pylons along the southeastern end. The other shores are lined predominantly with trees (cypress and pine) and grasses.

A third pond, slightly smaller and privately owned by the KRE Corp., is adjacent to the south end of the boat pond. This area is included in the study as it is heavily used by the birds and it contributes to our knowledge of how they use the park. Bordered by willow trees, pines and cattails, nearly one-fourth of it is mudflat, an area of intermittently submerged pickleweed and unvegetated sediment. It has a row of partially submerged pylons at the eastern end. For an in-depth discussion of the vegetation in the park see Renee Jacob's paper.

Uniqueness: The park is locally unique as a refuge for birds because it offers a variety of habitats. In comparison, Bay Area wetlands are primarily comprised of just two habitat types, marshes and mudflats, which support fewer species. As a result of its multiple habitats, the park may sustain a greater number of species.

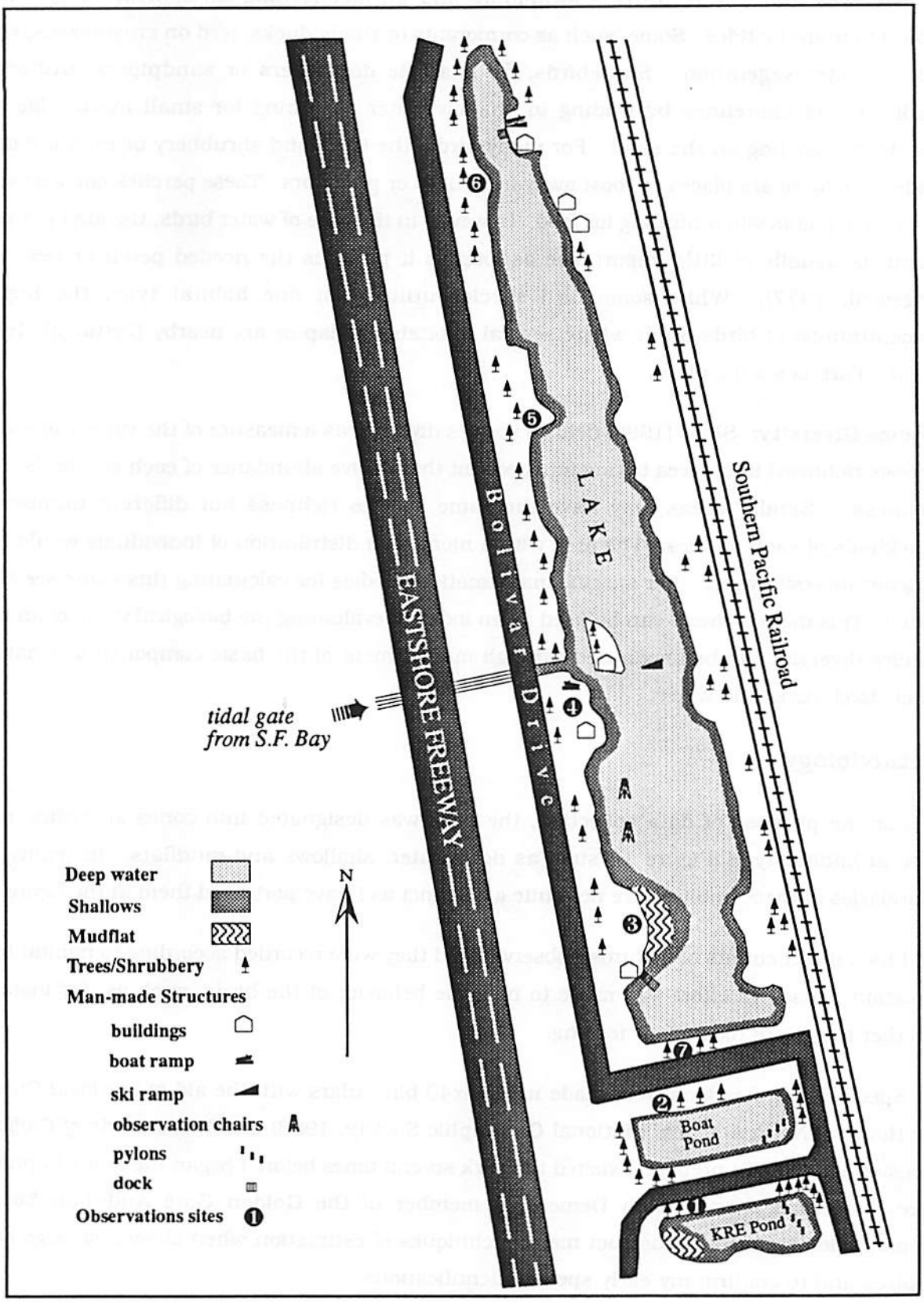

Figure 1. Aquatic Park Habitats (adapted from Ferlin, 1983); not drawn to scale.

The lake and ponds provide swimming and surface-feeding birds with "deep" water protected from the tides. Some, such as cormorants or ruddy ducks, feed on crustaceans, small fish or water vegetation. Shorebirds, for example dowitchers or sandpipers, utilize the mudflats and shorelines by wading in shallow water searching for small marine life and insects, or roosting on the sand. For many birds, the trees and shrubbery or even the man-made structures are places to roost away from tides or predators. These perches can also serve as vantage points when hunting for food. However, in the case of water birds, the kind of tree or shrub "is usually of little importance as long as it provides the needed perch or nest site" (Cogswell, 1977). While some bird species utilize just one habitat type, the highest concentrations of birds occur where several habitats overlap or are nearby (Pettingill, 1983). Aquatic Park is such a place.

Species Diversity: Shaw (1985) defines species diversity as a measure of the variety of species (species richness) in an area taking into account the relative abundance of each species (species evenness). Similar areas may have the same species richness but different numbers of individuals of each species. The area with a more even distribution of individuals would have a higher diversity value. For specific mathematical models for calculating this value see Shaw (1985). This measurement can be used as an index in evaluating the biological value of an area. Species diversity can be maximized through management of the basic components of habitat: space, food, cover and water.

Methodology

For the purpose of data collection, the park was designated into zones according to its general habitat type (Figure 1), such as deep water, shallows and mudflats. In reality, the boundaries of these habitats are not quite as distinct as I have portrayed them in the figure.

I took direct counts of all birds I observed and they were recorded according to habitat by an assistant. Also, an effort was made to note the behavior of the birds, such as, for instance, whether they were roosting or feeding.

Species identifications were made using 8x40 binoculars with the aid of the *Field Guide to the Birds of North America* (National Geographic Society, 1983) and *Water Birds of California* (Cogswell, 1977). To prepare, I visited the park several times before I began the study to practice species identification. Ruth Dement, a member of the Golden Gate Audubon Society, accompanied me once to instruct me in techniques of estimation when observing large flocks of birds and to confirm my early species identifications.

I began taking counts in November 1988 and continued through mid-February 1989. These were taken during varying weather conditions and at different tide levels. Though the tides have little direct effect on the park, most of the bay is affected, thus affecting the birds.

Originally, the park was observed in one hour divided into six observation points. A seventh position was added after the second count to improve observation of the southern end of the lake. In addition, I increased the time spent at each location to twenty minutes as it was necessary to count the growing number of birds as the season wore on. All seven sites were located along the western side of the park for several reasons. First, most of the marine birds were concentrated on that side. Secondly, it is less frequented by the public, which reduced the chance of interference. Lastly, the less time taken in changing positions minimized the error of counting birds twice when they moved from one observation zone to the next.

Results

Three counts were taken each month except in December when only two counts were made. Monthly averages were calculated from the data and are presented in Tables 1-4 according to species and habitat.

November: A total of thirty species were observed in November (Table 1), excluding domestic ducks and geese and apparent hybrids. The dominant species were mallards (161), short-billed dowitchers (140), American coots (116), and dunlins (73). Also observed in abundance were buffleheads (49), ring-billed gulls (54), double-crested cormorants (38), and American avocets (37). There were moderate numbers of pied-billed grebes (31), snowy egrets (30), and western sandpipers (29). Low numbers were tabulated for great egrets (4), red-breasted mergansers (2), black-bellied plover (2), and herring gulls (2). Fewer than one individual was averaged of western grebe, brown pelican, great blue heron, belted kingfisher, and mew gull. Four species observed once were not to be seen again: brown pelican, great blue heron, black-bellied plover, and Bonaparte's gull.

The "deep" water habitat of the lake and two ponds were used by a November average of 231 birds, the majority of which were mallards, coots, buffleheads, and surf scoters. Although it covers much less surface area, the mudflat habitat was occupied by a mean of 307 birds, mainly dowitchers and dunlins. The shallows and man-made structures were utilized respectively by an average of 195 birds (mostly mallards) and 71 birds (cormorants, mallards, gulls). Only nine birds on average were observed both in the trees (black-crowned night herons) and along

	Deep water	Shallow water	Shoreline	Mudflat	Trees/ shrubs	Man-made structures	Island	Air	Species Total
Western Grebe	<1								21
Pied-billed Grebe	31								31
Brown Pelican						<1			<1
Double-crested Cormorant	13					17	8		38
Gtreat Blue Heron		<1	<1						<1
Great Egret		3	1				<1		4
Snowy Egret		22	5		<1	2		1	30
Black-crowned Night Heron		<1			9	1		<1	10
Mallard	4	127	2			17	11		161
Northern Pintail	10								10
Common Goldeneye	3							2	5
Bufflehead	36							13	49
Surf Scoter	22							1	23
Red-breasted Merganser	2								2
American Coot	100	15		<1		1	<1		116
American Avocet				37					37
Black-necked Stilt				6				<1	6
Killdeer			<1	1		<1	<1		2
Black-bellied Plover				2					2
Willet				4					4
Short-billed Dowitcher				140					140
Western Sandpiper				29					29
Least Sandpiper				3					3
Dunlin				73					73
Herring Gull	1					1			2
Ringed-billed Gull	4	13		4		21	<1	12	54
Mew Gull		<1							<1
Bonaparte's Gull	2			2					4
Forster's Gull	1		<1	6				11	18
Belted Kingfisher						<1			<1
Domestic Goose	2					8			10
Domestic Duck		<1				<1	1		1
Hybrids		14				2	<1		16
Habitat Totals	231	195	9	307	9	71	21	40	

Table 1. November Monthly Averages: Species counts by habitat at Aquatic Park.

Note: The averages tabulated for the month of November consist of three counts. The first was taken on November 11 from 2:30 to 4:19 p.m. under cloudy skies. On November 12, the second count was conducted in a light rain. We began at 9:30 a.m. and left the last observation point at 11:17 a.m. The third count took place November 19, from 9:26 to 11:50 a.m. The sky was clear and sunny with a slight breeze. All three counts were taken between tidal extremes.

the shoreline (snowy egrets). The island was used by 21 birds, the most seen there throughout the study.

December: Thirty-one species were seen (again with the exclusion of domestics and hybrids) (Table 2). As in November, dowitchers (127), coots (92), mallards (88), ringed-billed gulls (82), and dunlins (60) were the predominant species with the addition of buffleheads (132) and

	Deep water	Shallow water	Shoreline	Mudflat	Trees/ shrubs	Man-made structures	Island	Air	Species Total
Western Grebe	6								6
Pied-billed Grebe	17	3							20
Double-crested Cormorant						1			1
Great Egret						1			1
Snowy Egret		2	4		1		1		8
Black-crowned Night Heron					13	1			14
Mallard	7	71	8			2			88
Northern Pintail	12								12
Redhead	14					2			16
Canvasback	<1								<1
Lesser Scaup	3								3
Common Goldeneye	72	18							90
Bufflehead	132								132
Surf Scoter	32							1	33
Ruddy Duck	22			1					23
Red-breasted Merganser	5								5
American Coot	44	44		1		1	2		92
American Avocet				4					4
Black-necked Stilt		1		6					7
Semipalmated Plover				12					12
Killdeer			1	3					4
Willet			1	1					2
Short-billed Dowitcher				127					127
Western Sandpiper				16					16
Least Sandpiper				6					6
Dunlin				60					60
Glaucous-winged Gull		1		1		1		1	4
Western Gull				1					1
Herring Gull	1					1			2
Ringed-billed Gull	27	7	4	14		29		1	82
Belted Kingfisher					1				1
Domestic Goose	3					7			10
Domestic Duck	2	2				3			7
Hybrids	1	20	3			1			25
Habitat Total	400	169	21	253	15	50	3	3	

Table 2. December Monthly Averages: Species counts by habitat at Aquatic Park.

Note: Both counts in December were taken on sunny days between maximum and minimum tides. On Saturday, December 3, the count was carried out between 9:55 a.m. and 12:19 p.m. The other count occurred 10:46 a.m. to 1:30 p.m. on December 18.

common goldeneyes (90). Surf scoters (33), ruddy ducks (23), pied-billed grebes (20), redhead ducks (16), and western sandpipers (16) were fairly common. There was a decline in the populations of cormorants (1), snowy egrets (8), and avocets (4). One individual canvas back was observed on December 3, but the species was not to be seen in the park again. The average for semipalmated plover was calculated from a single sighting of 24 individuals, also on December 3.

There was no significant difference in the total mean number of birds of any species seen in December compared to November. There was an increase in the average number of birds using the deep water from 231 in November to 400 in December. At the same time a decrease from November to December was evident in those using the mudflats (307 to 253), the shallows (195 to 169), and man-made structures (71 to 50). The numbers of birds spotted on the island (3) or flying over the park (3) dropped dramatically from 40 and 21. The slight increase in usage of trees (15) was due only to the number of night herons observed.

January: I identified a total number of thirty species in January (Table 3), excluding domestics and hybrids. Generally, western sandpipers (396), dunlins (200), avocets (110), and coots (92) predominated. Ringed-billed gulls (82), mallards (80), buffleheads (67), ruddy ducks (64), and least sandpipers were seen frequently. The number of pied-billed grebes (7) and common goldeneyes (13) decreased significantly compared to December averages. No dowitchers or glaucous-winged gulls were observed the entire month. Nine European widgeons were seen for the first and last time on January 20, resulting in an average of three for the interval.

Approximately 400 more individual birds used the study site than did in December. This was due to a large increase in the use of the mudflats, preponderantly by sandpipers, dunlin, and avocets. The other habitats were occupied by nearly the same averages as were in December: 301 in deep water (ducks); 117 in the shallows (mallards, coots), 57 on the shorelines (mallards, coots); 12 in trees (night herons), 45 on man-made structures (mallards, gulls), four on the island and eleven in the air.

February: Virtually all the numbers in February declined (Table 4). There were only 25 species identified besides domestic and hybrids. Ring-billed gulls (138), coots (125), and mallards were the dominant species followed by ruddy ducks (67) and buffleheads (44). The average sightings of avocets dropped from 110 in January to 27. Short-billed dowitchers were observed but the western sandpiper had disappeared. Northern pintails, red-breasted mergansers, and killdeer were also absent.

The total average number of individuals dropped by approximately 700 birds, lower than at any other time of the study, with the majority (234) seen in deep water (ruddy ducks, mallards, and coots). Mallards and coots used the shallows (133) and shorelines (97). The mudflats were occupied by almost equal numbers of shorebirds and gulls. Only one bird, on average, was seen on the island; the night herons still used the trees.

	Deep water	Shallow water	Shoreline	Mudflat	Trees/ shrubs	Man-made structures	Island	Air	Species Total
Western Grebe	<1								<1
Pied-billed Grebe	7								7
Double-crested Cormorant	<1								<1
Great Egret			<1						<1
Snowy Egret		1	1			<1	<1	1	3
Black-crowned Night Heron					12	2	1		15
Mallard	3	43	13			20	1		80
Northern Pintail	4	1				<1			5
European Widgeon	3								3
Redhead	11								11
Lesser Scaup	14								14
Common Goldeneye	11	2							13
Bufflehead	66	<1						1	67
Surf Scoter	25	3							28
Ruddy Duck	64								64
Red-breasted Merganser	2								2
American Coot	51	20	17	2		1	1		92
American Avocet				110					110
Black-necked Stilt		<1	<1	4					4
Killdeer							<1		<1
Willet			1	2			<1	1	4
Western Sandpiper		6		390					396
Least Sandpiper				64					64
Dunlin		3		197					200
Western Gull	<1	<1							<1
Herring Gull	1	<1				1			2
Ringed-billed Gull	38	11	13	1		13		6	82
Mew Gull		1							1
Forster's Tern	<1							2	2
Belted Kingfisher						<1			<1
Domestic Goose		2	3			5			10
Domestic Duck		3							3
Hybrids		20	9			2			31
Habitat Totals	301	117	57	770	12	45	4	11	

Table 3. January Monthly Averages: Species counts by habitat at Aquatic Park

Note: The January averages were derived from counts taken on the 18th from 9:22 a.m. to 11:48 a.m. (sunny, clear), the 20th from 11:38 a.m. to 1:22 a.m. (grey sky), and the 21th from 12:05 p.m. to 1:49 p.m. (hazy, cool wind). All were taken after extreme high tides.

Behavior: Throughout the entire study, all species were observed both foraging and roosting except mergansers, which only foraged. Courtship behavior was noted only for a few mallards though other species appeared to be paired (pintail, surf scoter, European widgeon).

Discussion

Potential error in my study may lie in two areas. The identifications of shorebirds and ducks may be inaccurate in some cases. Especially at a distance, these birds are difficult to distinguish to species level. Consequently, many least sandpipers may have been counted as western sandpipers.

	Deep water	Shallow water	Shoreline	Mudflat	Trees/ shrubs	Man-made structures	Island	Air	Species Total
Western Grebe	2								2
Pied-billed Grebe	7								7
Double-crested Cormorant	1								1
Great Egret			<1						<1
Snowy Egret		<1	1		<1			<1	2
Black-crowned Night Heron					14	<1			14
Mallard	2	50	41			2			95
Redhead	21								21
Lesser Scaup	13								13
Common Goldeneye	10								10
Bufflehead	44	<1						<1	44
Surf Scoter	9	3							12
Ruddy Duck	67								67
American Coot	44	51	28	<1		1	1		125
American Avocet				27					27
Black-necked Stilt				3					3
Semipalmated Plover				1					1
Willet			<1	2					2
Short-billed Dowitcher				7					7
Least Sandpiper				<1					<1
Dunlin				8					8
Glaucous-winged Gull	<1			<1				<1	1
Western Gull		<1							<1
Herring Gull		<1				<1			<1
Ringed-billed Gull	13	8	15	5		40		7	88
Belted Kingfisher						<1		<1	<1
Domestic Goose		2	2			5			9
Domestic Duck			3						3
Hybrids		18	7			2			27
Habitat Totals	234	133	97	53	14	15	1	8	

Table 4. February Monthly Averages: Species counts by habitat at Aquatic Park

Note : The first was conducted on Saturday, the 4th in sunny but cold weather, from 11:10 a.m. to 12:36 p.m. after an extreme high tide. The February 12 count was taken on a sunny day in a mild breeze from 12:14 to 1:33 p.m. just after a low tide. The final census day was also sunny, with less wind. It was conducted from 12:51 p.m. to 1:08 p.m.after an extreme high tide on Friday the 17th.

All scaups were assumed to be lesser scaups though there may have been some greater scaups present. Also, there tends to be an underestimation of the number of birds in large groups (Dement, pers. comm.). Whenever possible, actual counts were made after an initial estimation of large flocks. On the whole, I believe my numbers and identifications to be accurate.

Species diversity: Of the thirty-eight species (non-domestic, non-hybrid) I encountered in the park, seven (brown pelican, great blue heron, canvasback, European widgeon, Bonaparte's gull, semipalmated and black-bellied plover) were seen only once which suggests they may have been unable to benefit over time from the park's resources. I know this is not true in the case of

the pelican because I repeatedly counted over 30 a day foraging or roosting in the park in the month before I began the study. Thus, except for the pelican, I would not include these species in this measurement unless further studies showed more consistent use of the area. The remaining 32 species might then be used in measuring the species richness of water birds in the park. Because evenness of numbers of individuals of each species should also be considered when measuring species diversity the average relative numbers are given for each month according to habitat (Tables 1-4). What may be just as interesting is that some species' numbers stay fairly constant while others fluctuate. The reasons for this can be complex; for example, it could be due to regional species concentration or migrational habits. The relative increase in numbers of most shorebirds in counts taken at high tide is a clear example of how tides affect them. The shorebirds use the park and the KRE pond during extreme high tides. However, I believe that management policies with regards to dogs, boats, people, landscaping and water circulation have a definite influence on the birds of the park by affecting the availability of habitat.

Dogs: The effects of dogs running (generally unleashed) through the park are probably the most obvious. More dogs were seen during November counts than in other months. At that time, many more birds used the island, slightly more were seen on man-made structures and fewer were noted onshore than in succeeding months. The positions of these birds may have been related to the degree of security each offers. In addition, there seems to be a general concentration of all species towards the southern end of the park, except for the mallards and gulls that stay on the boat ramp at the north end. The cause of this is not certain though it could be related to the width or depth of the lake and ponds at the south end that provides a place to retreat to should they be chased into the water by swimming dogs. While the dogs may only create a temporary nuisance to many of the birds, which have become accustomed to them, they may have a greater impact on more sensitive species. It is even possible that certain species avoid the park for this reason.

Boats: Water skiers are allowed to use the lake except from November through February to allow for bird usage. Kayakers or rowers use the lake whenever the skiers are absent, and were noted during almost all counts, but seemed to present little more than a passing disturbance to the birds. A significant decrease in the total number of birds, as well as the disappearance of some species, can be correlated with the appearance of motor boats on the lake at end of January and through February. The boats affected the usage of virtually all the water habitats though they were only operated in the deep portions of the lake. Some birds that normally utilize the shallows, shorelines or mudflat may simultaneously need the potential protection

that the deeper water offers. The only species which increased in numbers at this time were coots, mallards and some gulls. These species are characteristically very tolerant of human presence and were not disturbed by being forced toward the shallows and shores by the boats. More sensitive species, however, may have found this squeeze intolerable and been excluded from the park, thus accounting for the significant decrease in bird use seen in the February data.

People: The occupation of the island by humans during and after the removal, modification, and subsequent replacement of the stilted observation chairs at the end of January may have had an even greater impact than the boats. This occurred at the same time as the appearance of motor boats and it completely removed any potential refuge in the park that was beyond the reach of humans. Both numbers of species and individuals dropped drastically compared to prior months, possibly due to a reduction of undisturbed space.

Most species showed no pronounced reaction to normal human presence except hybrids, domestics, and some mallards which stayed at the north end of the lake in order to maximize interaction. People frequently feed these ducks bread at this end of the lake and they appear to be conditioned to this mode of subsistence. This probably increases the numbers of these birds but may have long term impacts on their health.

Landscaping: The landscaping in the park also seems to influence its marine bird diversity. The vegetation is kept relatively manicured and open, reducing the amount of cover available to birds. This contrasts sharply with the landscape of the KRE pond. As a result, black-crowned night herons are virtually confined to one area, the stand of willows by the KRE pond. On rare occasions, they were also seen perched on other tree types and shrubbery on the island or around the lake. While a person can stand within fifteen feet of these birds as they roost in the willows, the herons are easily disturbed by human proximity when near the lake. This leads me to suspect that the willows offer the herons more in the way of protection than the conifers. The stand is very dense and would slow predators down as well as produce a lot of warning noise in the event of an attack. The lack of this type of protection on city property, in effect, excludes night herons and possibly other species.

Water Circulation: The flow of water in the park is dependent on the tidal gate and interconnecting culverts between the water bodies. These devices are maintained by the city and may have contributed to the differences in the diversity within areas of the park itself. While ruddy ducks were seen on all three ponds, the vast majority of them occurred on the two smaller ponds. At the same time the cormorants, mergansers, kingfishers, and terns showed

the opposite preference. I believe this may be a function of the different biota contained in the water bodies due to the conditions fostered by circulational differences. The ruddy duck feeds on small organisms in the water, often filtering water through its bill. The others mentioned subsist on diets mainly consisting of small fish; I saw these birds take prey from the lake several times.

Conclusion

Berkeley Aquatic Park was found to provide habitat for 32 species of marine birds on a regular basis, many of which occurred in large numbers. The main factor affecting the park's marine bird species diversity seems to be competition for space with dogs, people and boats. The landscaping and water circulation in the park may also have some effect on the birds. In order to protect and possibly increase the present level of species diversity in the park some changes should be considered in the development of the park for increased public usage. I recommend that the area of the park along the west side of the lake and pond should be completely fenced from public use to provide a permanent and relatively undisturbed bird refuge, free from intruders and roaming dogs. A few stands of dense vegetation, similar to the one on the northeast end of the KRE pond, introduced at the edges of the lake and model boat pond would provide roosts. It would also effectively reduce the size of the refuge area needed by making more space inaccessible to dogs and humans. In order to maximize sources and quality of the birds' food, a further understanding of the benthic communities in the park is necessary. Finally, the banning of all motor boats would have the most favorable effects on marine bird use.

There is a finite amount of suitable habitat left for these animals and therefore consideration should be given to develop the site in ways that are sensitive to the needs of its wildlife. Acquisition of the land owned by the KRE Corporation would maintain its present value as bird habitat. The park and its health may be very important to future populations of water birds.

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