Habitat Use and Behavioral Ecology

of American Avocets

(Recurvirostra americana)

Wintering at Humboldt Bay, California

by

Thomas J. Evans

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HABITAT USE AND BEHAVIORAL ECOLOGY
OF AMERICAN AVOCETS
(Recurvirostra americana)
WINTERING AT HUMBOLDT BAY, CALIFORNIA

by

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Population trends, habitat use, and behavioral ecology of American Avocets (Recurvirostra americana) wintering at Humboldt Bay, California were studied from 1 October 1982 to 15 May 1983, from 3 October 1983 to 8 May 1984 and from 19 December 1984 to 29 April 1985.

Between November and February populations of American Avocets at Humboldt Bay averaged 706 ± 35.6 and 567 ± 67.0 birds in 1982-83 and 1983-84 respectively. Fall migrants began to arrive at Humboldt Bay in late August and by mid-November most of the wintering population was present. Spring migration began in February and ended in late April or early May.

American Avocets used only 23.6 percent (868 ha.) of North Humboldt Bay. Within the northeast corner of Humboldt Bay 4 major habitats were used: (1) Intertidal mudflats, used mainly for feeding and resting, (2) Sewage Oxidation Pond, used mainly for feeding and secondarily as a source of fresh water, (3) Islands in Klopp Lake, used as principle high tide roosts and (4) a section of high elevation mudflat north of Jacoby Creek, used as an alternate high tide roost.

American Avocets usually roosted in shallow water. Islands adjacent to deep, non-tidal ponds were important components of roosting habitat. Use of roosts was tidally controlled. An average of 87.3 percent of all birds observed rested when tide levels were between 5.0 and 7.5 feet.
American Avocets were the only common wintering shorebird to feed on the high concentrations of *Daphne magna* at the Oxidation Ponds. This food source was used mainly in October.

Intertidal mudflats within 3 km. of the roost were the principle feeding areas during most of the winter. American Avocets used tactile feeding methods primarily and fed most often on the wettest substrates. Avocets usually concentrated near the tide edge when feeding. Greatest proportions of the flock was observed feeding when tide levels were between 1.6 and 4.0 feet.

Most other shorebirds avoided American Avocets that were feeding. Interspecific and intraspecific competition probably was not ecologically important.

Avocets foraged an average of 45–60 percent of the daylight hours in March and April and 84 percent between November and February. Avocets fed at night from November to March but not during October, April or May.

American Avocets rested more on the intertidal mudflats and at the roosts during strong winds, during heavy rains, and when temperatures were less than 11°C than under other conditions. A greater proportion of Avocets fed on invertebrates found on exposed mudflats with visible surface water when temperatures were greater than 10°C than below 10°C. During light rains and under overcast skies American Avocets fed primarily on invertebrates found on flooded mudflats where the water covered their feet or on exposed mudflats with visible surface water.
ACKNOWLEDGEMENTS

I want to thank members of my graduate committee: Dr. Dave Kitchen and Dr. Warren J. Houck for their advice and manuscript review. I would especially like to thank my major professor, Dr. Stanley Harris, who consistently provided advice, criticism, and encouragement during all phases of the project. In addition to his ability to critically review manuscripts his enthusiasm and interest in wildlife biology and conservation and his has helped me become a more competent biologist as well as a better person.

I wish to thank Dr. Barry Noon for taking time out of his busy schedule to advise me on statistical analysis. Patrick Collins not only provided invaluable computer assistance but was a good friend as well.

Dr. Paul Springer of the United States Fish and Wildlife Service provided me with the necessary permits to work at Humboldt Bay National Wildlife Refuge. Dr. Frank L. Klopp provided me with the permit and keys to the Oxidation Ponds at the Arcata Sewage and Treatment Facility.

I would especially like to thank Patricia O'Connor who made me take time off from my thesis to enjoy life as well as her helpful criticism, assistance, encouragement, and companionship throughout the study. Other friends who offered helpful advice, criticism, and encouragement in various aspects of the study were: Lynn Roberts, Patrick Ward, Gary Fredrickson, Alan Franklin, Rema Sadak, Jeff Waters, John Fisher, and Lisa Posternak.
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INTRODUCTION

Although shorebirds typically spend up to three-quarters of the year on migration routes and at wintering areas (Recher 1966, Kelly and Cogswell 1979) relatively little is known about their basic wintering ecology. Abiotic environmental factors have helped shape the evolution of life history and migratory patterns of shorebirds (Burger 1984). The geographic distribution of breeding and wintering shorebirds has been influenced by temperature, wind, daylength, prey availability, and the availability of suitable habitats (Pitelka et al. 1974, Pienkowski and Evans 1984). Documentation of habitat use under different environmental conditions and time of year may indicate the relative importance of different areas to survival.

The amount of resources available for survival and reproduction of shorebirds is difficult to measure. One way to study relationships between abiotic factors is through time and activity studies. Proper allocation of time by shorebirds may be critical for growth, maintenance, reproduction and survival (Altmann 1974, Herbers 1981). The amount of time devoted to one activity (i.e. feeding) affects the amount of time that can be invested in other activities (i.e. resting). In the absence of disturbance the diurnal routine of wintering shorebirds generally consists of a more or less regular pattern of feeding and resting interspersed with less frequent flight, preening, comfort movements, and alert behaviors (Evans 1976). Deviations in a
activity budget may profoundly affect a shorebirds' energy uptake and expenditure and hence its' welfare. Wintering shorebirds require energy to (1) maintain body temperatures and normal metabolic processes (2) to fly between roosting and feeding areas or to escape predators and (3) to procur food (Evans 1976).

The American Avocet breeds in western United States and southern Canada and winters from southwestern United States to Guatemala (Hamilton 1975). Prior to 1950, wintering American Avocets were rare in northwestern California (Davis 1939, Grinnell and Miller 1944), but since the late 1950's wintering American Avocet numbers have increased at Humboldt Bay, California (Yocom and Harris 1975).

Humboldt Bay, California is the northern-most wintering area for American Avocets in North America (A.O.U. 1983). Although the behavior (Hamilton 1975) and breeding ecology (Gibson 1971) of American Avocets has been studied, relatively little is known about their behavior and use of wintering habitats.

I studied the wintering ecology of American Avocets at Humboldt Bay, California from 1 October 1982 to 15 May 1983, 3 October 1983 to 8 May 1984, and from 19 December 1984 to 29 April 1985. My study had the following objectives.

1. To determine the population size and seasonal trends of American Avocets wintering at Humboldt Bay, California.

2. To map the general and specific areas used by wintering American Avocets at Humboldt Bay, California.

3. To determine habitat use by wintering populations of American Avocets at Humboldt Bay, California.
4. To determine the daily activity patterns and movements of wintering American Avocets at Humboldt Bay, California.

5. To determine how temporal, tidal, and weather-related factors influenced activities of wintering American Avocets at Humboldt Bay California.
STUDY AREA

Humboldt Bay consists of two large shallow tidal basins, North (Arcata) and South Bay, connected by a narrow passage (Figure 1). The climate is characterized by high humidity, wet season from October to May and a summer dry season.

The tides at Humboldt Bay are semi diurnal and mixed, with two highs and two lows of unequal height each day. "Spring tides", those occurring during the full or new moon, generally have the greatest tide ranges and "neap" tides, those occurring during the first and last moon quarters, have decreased tide ranges. Because the time and height of low tide varies from day to day the amount of mudflat area available to feeding shorebirds varies daily and seasonally.

The entire surface of Humboldt Bay was searched for Avocets regularly from 19 observation points (11 in North Bay and 8 in South Bay) in an effort to describe American Avocet spatial distribution at Humboldt Bay (Figure 1). The detailed behavioral observations of American Avocet habitat use and behavior were conducted on seven study areas established near the intertidal mudflats at Jacoby Creek delta, and at ponds consisting of the southernmost oxidation ponds of the Arcata Public Works sewage treatment facility and the Klopp Lake Unit of the Arcata Marsh Project (Figure 2, Table 1). The tidal mudflats were dissected by various channels. Adjacent to and elevated 5-100 cm. above the mudflats are salt marshes dominated by common pickleweed (Salicornia...
Figure 1. A Map of the Study Area and Census Locations, Humboldt Bay, California.
pacific, salt grass (*Distichlis spicata*), and cord grass (*Spartina densifolia*) (Gerstenberg 1972). The Oxidation Pond was roughly rectangular in shape, covered 9.3 hectares in surface area and was 1-1.5 meters deep (Frodge 1985). The pond was bounded by earthen-filled dikes. Treated sewage effluent entered the pond through four openings in the dike and was discharged from the pond through a chlorination-dechlorination unit into Humboldt Bay. Klopp Lake was 6.8 hectares in size, averaged 1 meter deep and contained 3 small bare islands used by shorebirds as high tide roosts (Table 1). The lake contained fresh to brackish water and was separated from the tidal mudflats by a dike.
Figure 2. Location of Seven American Avocet Study Sites in the Northeastern Corner of North Humboldt Bay, California (1982-1985).
Table 1. Descriptions of Seven American Avocet Study Sites at North Humbolt Bay, California, 1982-1985.

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<td>(1) West of the Arcata Marsh Project</td>
<td>Mudflat</td>
<td>531.39</td>
<td>215.13</td>
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<td>(2) South of Klopp Lake</td>
<td>Mudflat</td>
<td>186.94</td>
<td>75.68</td>
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<td>(3) Jacoby Creek</td>
<td>Mudflat</td>
<td>378.30</td>
<td>153.15</td>
</tr>
<tr>
<td>(4) Oxidation Pond</td>
<td>Pond</td>
<td>23.00</td>
<td>9.31</td>
</tr>
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<td>(5) South of the Oxidation Pond</td>
<td>Mudflat</td>
<td>60.35</td>
<td>24.43</td>
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<td>(6) Klopp Lake</td>
<td>Pond</td>
<td>17.00</td>
<td>6.88</td>
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<td></td>
<td>A) West Island</td>
<td>0.0032</td>
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<td></td>
<td>B) Middle Island</td>
<td>0.0042</td>
<td>0.0017</td>
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<td></td>
<td>C) East Island</td>
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<td>0.0012</td>
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<tr>
<td>(7) Bracut</td>
<td>Mudflat</td>
<td>731.58</td>
<td>296.19</td>
</tr>
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</table>
METHODS

All data were gathered by direct observations using a 25X Bushnell spotting scope and 9 X 36 Bushnell "Custom" binoculars. The total numbers and locations of Avocets present at Humboldt Bay were recorded by counting actual numbers present from 19 observation stations on the survey route (Figure 1) at high and low tides weekly in North Bay and bimonthly in South Bay. Low tide counts were begun on falling tides after 30-50 percent of the tidal mudflat was exposed. It was sometimes difficult to actually count the number of individuals in densely packed roosting flocks. Under such conditions, flock size was estimated by blocking the population into smaller groups and counting the number of individuals in each group. The accuracy of these estimates was verified by taking photographs (color slides) of 59 densely-packed roosting flocks using an Olympus 35mm camera with a 300mm telephoto lens. These slides were projected on a white sheet of paper and actual counts made of the projected images.

Behavioral Studies

A total of 970 hours of behavioral observations was made between 3 October 1983 and 3 May 1984 and 197 hours were made between 1 October 1982 and 12 January 1983. All behavioral observations were made between 0600 and 1700 hours. On five occasions I attempted to monitor and observe Avocets at night but the night vision scope available did not
have adequate resolution and light gathering qualities to be useful. Thus the night work was limited to counts made on 32 dark nights (cloudy nights or nights with a new moon) and on 25 bright nights (clear nights with 3/4 to a full moon) at peak feeding tide heights to determine whether or not American Avocets were feeding or resting at night. All field notes were recorded on a portable Centrex cassette tape recorder and transcribed later.

To determine daily and seasonal patterns of habitat use, I measured the amount of time spent at daytime roosts at high water, the proportion of time spent on feeding grounds during the day, and the occurrence of feeding at night. The amount of daylight that mudflats were available for feeding was calculated from days when observations were made continuously from dawn to dusk. The time that mudflats were covered at high water during daylight hours was subtracted from the total daylength, as calculated from nautical sunrise to nautical sunset. This yielded the number of hours the mudflats were actually available to feeding shorebirds. Nautical sunrise (Goss-Custard 1969) was defined as the time when the sky first became light enough to see American Avocets at least 100 yards away and nautical sunset was the time when it became too dark to see American Avocets 100 yards away.

For the behavioral work, a goal was to observe the greatest number of Avocets at any one time. Consequently, each day prior to data collection, all study sites were examined and the site chosen for detailed behavioral studies was the one which held more than 250 birds. If more than one site held more than 250 Avocets, the site to be observed was chosen by flipping a coin. If none of the sites had 250 birds the site with the greatest number of Avocets was observed. Observations
continued at the chosen site until either the observer became fatigued or greater than 50 percent of the Avocets originally present had left the area. The observation sessions averaged 4 hours in length (range 10 minutes to 5 hours). I analyzed daytime budgets and activity patterns using scan sampling (Altmann 1974, Lehner 1979). This method assumed that all individuals present on the study sites were equally visible (Harcourt and Stewart 1984). Avocets were observed only on one study site at a time. The length of individual scans varied with the number and density of Avocets under observation. Approximately 30 seconds were needed to scan about 60 birds. On any particular date the length of scans was determined by the initial time needed to scan all the birds present. Once a scan length was determined it was used throughout the observation period. I scanned the flock from left to right each time.

The interval between scans was equal to the scan length. Although scan lengths ranged from 20 seconds to 18 minutes, 96.22 percent of the scans were 5 minutes long. Only 5 minute scans or less were used in the analysis. To assess changes in the diurnal and tidal activity patterns an attempt was made to obtain scans at all hours of the day between sunrise and sunset and at all stages of the tide.

The pattern of American Avocet distribution on the study area was described only in general terms. Flocks were described as either compact or loosely knit (Goss—Custard 1969).

The tidal areas were divided into five zones, according to water depth, and the number and behavior of Avocets in each zone were recorded. Modifying the system used by Hamilton (1975) the zones were as follows: Zone A—exposed mudflats without standing water, Zone B—exposed mudflats with visible surface water, Zone C—flooded mudflats
with water covering the Avocet's feet, Zone D-flooded mudflats with water between the feet and abdomen, and Zone E-flooded mudflats with water deeper than an Avocet's abdomen.

**Male/Female Interactions**

A study was made to determine if there were any differences in behaviors between males and females between 19 December 1982 and 6 February 1983, 29 October and 5 November 1984, and between 8 February 1985 and 15 February 1985. Twenty hours of behavioral observations were made during each period. Only birds that could be sexed reliably (Praeter et al 1977) were included in these short-term studies.

**Behavioral Definitions**

Except for slight modifications, the definitions of the behaviors were the same as described by Hamilton (1975).

**Resting**

Stationary American Avocets with bills tucked under their scapulars were considered resting. No distinction was made between Avocets resting on one or two legs or with the eyes open or closed.

**Feeding**

Feeding was indicated by any of the following. Avocets used both visual and tactile methods while feeding in the water column or on exposed mudflats (Hamilton 1975, Appendix A). Visual feeding methods included pecking, plunging, snatching, and bill pursuit (Hamilton 1975). Tactile feeding methods included filtering, scraping, and single and multiple scythe (Hamilton 1975). Between 19 December 1982 and 6
February 1983, 29 October 1984 and 5 November 1984, and 8 February to 15 February 1985 observations of the feeding methods were recorded as either visual or tactile.

**Preening**

Preening consisted of manipulating and arranging the feathers with the bill (Hamilton 1975). Water was often picked up and used during preening (Appendix B).

**Comfort Movements**

Comfort movements included bathing, two-wing stretch, wing and leg stretch, hop and flap, direct and indirect scratching, shaking and ruffling feathers, and foot shaking (Hamilton 1975, Appendix B).

**Alert**

Alert behavior was indicated when Avocets ceased all other activities and had their head in an upright position with their eyes open. The neck may or may not have been extended. This behavior is very similar to the upright posture described below under aggressive behavior and it was sometimes difficult to make the distinction. I separated the two behaviors on the basis of whether or not the birds seemed to be directing intraspecific or interspecific aggression towards other birds within 0.5 meters.

**Aggression**

Behavior recorded as aggressive included birds in an upright posture, crouch and run or walk, supplanting, pursuits during flight, and direct physical contact with the wings or beak (Hamilton 1975, Appendix C).
Aggressive interactions were considered terminated when one bird, the "loser", was either chased away, turned its head away so as to avoid eye contact, or walked away slowly while making pecking movements as if feeding in the manner described as "displacement feeding" by Hamilton (1975).

**Locomotion**

Locomotion included wading, walking, running, swimming and flying when these activities were not obviously associated with some other activity such as feeding or aggression. Walking, wading, and running were lumped into one category.

**Habitat Studies**

The following environmental parameters were measured between scans at each observation point: air and water temperatures, percent cloud cover, rain conditions, wind speed, wind direction, tide height, and wave action at each observation point between scans. Wind speed was taken with a hand-held Dwyer (Michigan City, Ind. 46360) wind meter at a distance of five feet above the ground. Wind direction was separated into the 8 cardinal compass points using a Silva (La Porte, Ind. 46350) compass.

Measurements of tide height were taken from stakes placed at each study site location. These tide markers were marked in feet and calibrated to tide heights calculated from the tide schedule charts. This allowed me to document water levels and determine when tide reversal occurred. Tide markers were calibrated during periods of three to four hours long on 10 calm days, following two to three days of no
rainfall. Averages were taken from these ten days. Tide heights were also calculated from tide schedules for each scan.

Initially water temperatures were taken with a Peabody-Ryan Model J-90 Hydro-thermograph (Kirkland, Washington 98033) submerged 10" under the surface of the water at mean low water in the western-most channel in Study Site 1. This unit accurately recorded temperatures to \( \pm 0.6^\circ C \) with a time accuracy of about \( \pm 3 \) minutes per day for 82 days. The unit became damaged in some way resulting in a hairline crack in the lower half. Consequently I discontinued using the instrument and measured water temperature at 10-12" below the water surface with a hand-held pocket thermometer with an accuracy of \( \pm 0.5^\circ C \). Temperatures were taken in the largest channels closest to the observation points. At low tides water temperatures could not be taken at some of the observation points. Air temperatures were taken 12-14" above the mudflats.

Cloud cover was divided into four categories: clear (less than 10 percent cloud cover), scattered clouds (10-59 percent cloud cover), broken clouds (60-89 percent cloud cover), and overcast (greater than 90 percent cloud cover). Precipitation was divided into the following categories: 0, foggy, light rains, moderate rain, heavy rains and snow/sleet. Wave action was divided into three categories: flat (wave height 0-2.5cm), ripples (wave height > 2.5 < 5cm), and white caps (wave height > 5cm). Precipitation during the previous 24 hours was measured daily with a rain gauge with a precision of 1/100 of an inch. The gauge was located on a post by Jacoby Creek on Humboldt Bay.

A compensating polar planimeter (Model No. 3651-30, Leitz, Japan) and a dot grid with 64 dots to a square inch was used to
determine the total hectares in the study areas on United States Geologic Survey 7.5 minute Topographic Map (Arcata, South—California) and National Oceanic and Atmospheric Administration Nautical Chart (18622 Humboldt Bay). I used data from the weekly (North Bay) and bimonthly (South Bay) surveys and a modified version of the modified minimum area method (Harvey and Barbour 1965) to plot the "wintering home range" of the Humboldt Bay American Avocet population. Since American Avocets were never observed in upland sites, upland sites were excluded and the outermost points adjacent to the upland areas were connected when drawing the "home range" boundary near the shoreline.
Statistical Analysis

Assumptions of normality and homoscedasticity of parametric models were tested by inspecting scatter and residual plots, skewness and kurtosis coefficients, and by comparing sample variances. Non parametric methods were used when the assumptions were violated.

Variables were classified as nominal (behavior and location) or ordinal (wind speed, wind direction, cloud cover, water and ambient temperatures, precipitation, month, day, year, time of day, tide height, wave action, and depth). Non parametric statistical programs from SPSS (Nie et. al 1975, Hull and Nei 1981) and BMDP (Dixon and Brown 1979) were used for data analysis. All analysis was done at Humboldt State University on the CDC 17720 computer.

Guidelines for sampling methods were found in Altmann (1974) and Lehner (1979). Since the number of American Avocets observed on roost sites was much greater than on the intertidal mudflats data for the roosting areas and feeding areas were analyzed separately.

Chi-square tests were used to determine if relative frequencies of males and females engaged in various behavioral activities at the same tide height were the same and to compare population counts made with the aid of a camera (actual) and without the aid of the camera (estimated). Because many feeding methods (Hamilton 1975) have a zero chance of occurring at some water depths, and because some feeding behaviors occurred so infrequently the individual feeding behaviors were lumped into visual and tactile categories for the analysis.
A Kruskall-Wallis one way ANOVA followed by Dunn's Distribution Free, Multiple Comparison procedure (Zar 1984 p. 200) was used to test for significant differences in the number and proportion of the flock engaged in a particular behavior with the independent environmental variables such as habitat, tide height, tide direction, wind velocity and direction, temperature, cloud cover, rainfall, precipitation in the last 24 hours, time of day, and time of year. A significance level of .05 was used for the Kruskal-Wallis test. To provide more rigor due to the Type I error (i.e. behaviors were correlated with each other) all comparisons were made at a lower (Range .003-.0008) significance level as suggested by Bon Ferroni (Bray and Maxwell 1986). Alpha values for each comparison between a behavior (i.e. resting) and an environmental variable (i.e. air temperature) using Dunn's Distribution Free, Multiple Comparison test are indicated in the text as follows (i.e. alpha=.0003).

The proportion of time American Avocets spent in an activity was analyzed using a test for comparing more than two proportions followed by a Tukey type multiple comparison test (Zar 1984, p. 400). When I compared the proportion of the total flock engaged in a particular activity against independent variables significant differences occurred even when the differences between the proportions of time were only one percent. The highly significant results were due to the very large sample sizes, which often differed by an order of magnitude, and thus extremely high chi-square values resulted. Unfortunatley my sampling design was not rigorous enough to use the Block design utilized in McNemars' test of proportions (Zar 1984 p. 158): Therefore , when
comparing the results with respect to proportion of time biological relevancy versus statistical significance was used.

Statistical analysis of flight directions was based upon nonparametric measures (Zar 1984 p. 429) and circular statistics (Batschelet 1981). A high r value (Zar 1984) represents low variability in flight directions used. To obtain homogenous variances among means of flight directions the mean flight directions were transformed to square roots.
RESULTS

The Physical Environment

Tidal Characteristics

The highest and lowest tide levels encountered in this study were +9.6 feet (2.65m) and -1.7 feet (-.518m) M.L.L.W.(Mean Lower Low Water). The most frequent tidal ranges during the study were between 3.1 and 7.0 feet (Figure 3). Low tides particularly in mid-winter rarely receded lower than +3.0 feet M.L.L.W., thus, severely restricting the amount of time and area of mudflats and shallows potentially available to feeding shorebirds. The lowest tidal ranges occurred during October, November, and December and the highest ranges occurred during April and May (NOAA 1982-1984).

Daylength

The number of daylight hours for which part of the mudflat was exposed and potentially available for shorebird use varied from a low of 5 hours and 23 minutes in December 1982, to 10 hours 52 minutes in April 1984 (Table 2).
Figure 3. Frequency of Tidal Ranges Encountered During Behavioral Observations of American Avocets at Humboldt Bay, California, Winters 1982-83 and 1983-84.
Table 2. The Number of Daylight Hours Mudflats Were Exposed and the Number of Hours American Avocets Spent Feeding at Humboldt Bay, California. Winters 1982-83 and 1983-84.

<table>
<thead>
<tr>
<th>Date</th>
<th>Hours Mudflat Available</th>
<th>Time Avocets Spent Feeding</th>
<th>Date</th>
<th>Hours Mudflat Available</th>
<th>Time Avocets Spent Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td># Hours</td>
<td>% Total</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>8.9</td>
<td>3.8</td>
<td>42.0</td>
<td>3 Oct 1983</td>
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</tr>
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<td>14 Oct 1982</td>
<td>8.5</td>
<td>3.1</td>
<td>35.9</td>
<td>14 Oct 1983</td>
<td>7.3</td>
</tr>
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<td>25 Oct 1982</td>
<td>5.8</td>
<td>2.3</td>
<td>39.6</td>
<td>24 Oct 1983</td>
<td>7.8</td>
</tr>
<tr>
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<td>5.1</td>
<td>68.2</td>
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<td>7.5</td>
</tr>
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</tr>
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<td>3.2</td>
<td>42.6</td>
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<td>7.0</td>
</tr>
<tr>
<td>3 Dec 1982</td>
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<td>3.2</td>
<td>47.9</td>
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</tr>
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<tr>
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<td>6.2</td>
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<tr>
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<td>6.7</td>
<td>5.6</td>
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<td>8.8</td>
<td>5.3</td>
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<td>26 Mar 1984</td>
<td></td>
<td>9.4</td>
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Table 2. The Number of Daylight Hours Mudflats Were Exposed and the Number of Hours American Avocets Spent Feeding at Humboldt Bay, California. Winters 1982-83 and 1983-84. (continued)

<table>
<thead>
<tr>
<th>Date</th>
<th>Hours Mudflat Available</th>
<th>Time Avocets Spent Feeding</th>
<th>Date</th>
<th>Hours Mudflat Available</th>
<th>Time Avocets Spent Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Hours</td>
<td>% Total</td>
<td></td>
<td># Hours</td>
<td>% Total</td>
</tr>
<tr>
<td>2 Apr 1984</td>
<td>9.6</td>
<td>45.0</td>
<td>16 Apr 1984</td>
<td>9.3</td>
<td>46.3</td>
</tr>
<tr>
<td>23 Apr 1984</td>
<td>10.9</td>
<td>47.3</td>
<td></td>
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</table>
**Water Temperatures**

Water temperatures in the upper 10-12 inches in the water column were correlated with air temperatures ($r=.9321$, df=1306, $p<.001$) and because the effects of water temperature and air temperatures on all behaviors were similar, the effect of water temperatures on the behaviors was not discussed in detail.

Generally higher water temperatures occurred in areas without tidal flow such as in the Oxidation Ponds ($X=16.21\, ^\circ C$) and Klopp Lake ($X=14.10\, ^\circ C$). The coldest water temperatures on the mudflats were recorded at Jacoby Creek ($X=11.89\, ^\circ C$) and Bayside ($X=11.18\, ^\circ C$) where small creeks flowed into Humboldt Bay.

**Air Temperature**

During this study air temperatures ranged from $-0.55\, ^\circ C$ to $25\, ^\circ C$ with an average of $11.5\, ^\circ C$ (NOAA 1972-1984). The mean diurnal air temperatures were warmest in October, decreased from November to January, and gradually increased from February to May except that in 1984 the mean air temperatures during April were colder than in March (NOAA 1972-1984, Appendix D). Overall, cooler air temperatures were associated with strong winds ($X=11\, ^\circ C$) and moderate winds ($X=12.17\, ^\circ C$) than during winds below 12 miles per hour ($X=13.87\, ^\circ C$).

Air temperatures were warmest when the winds were from the southwest and about equal from all other directions ($H=64.274$, df=6, $p<.01$, Zar 1984). Colder temperatures often accompanied northerly
storms and warmer temperatures were often associated with southerly storms.

Air temperatures were significantly lower under conditions of moderate rain \((X=11.9^\circ C)\) and snow/sleet \((10.0^\circ C)\) than when skies were clear \((14.6^\circ C)\) or under overcast skies \((14.2^\circ C)\) \((H=111.726, df=1, p<.01, Zar 1984)\).

**Population Trends**

No significant differences were detected between my ocular population estimates at roosts and counts made using photographs of the same flocks \((X^2=4.416, df=59, p<.001)\). Data in this paper were based on 76 population surveys in North Bay and 42 in South Bay and 6638 behavioral scans taken on 292 days of field work.

Fall migrant American Avocets began to arrive in August in 1982 and 1983 (S. Harris, pers. comm.), and by the time my counts began on October 1, the population had reached about 200 birds in 1982 and 511 birds in 1983. Between late October and early February overall population numbers remained fairly constant (Figure 4). Between November and March the population averaged \(706.4 \pm 35.6\) birds in 1982-83 and \(566.8 \pm 67.0\) birds in 1983-84. Peak population counts of 827, 667, 736 were obtained on 27 November 1982, 22 January 1984, and 22 January 1985 respectively. Fluctuations of as much as 200 birds occurred in successive weeks, especially in October 1983 and January 1985. These fluctuations were probably due to migrants moving through the area. Population declines started in February and continued through late April and early May. Last spring dates for Avocets at
Humboldt Bay were 8 May 1984 and 29 April 1985. Fifty seven American Avocets were still present when I left the area on 15 May 1983.

The only apparently migratory flight of American Avocets I actually observed occurred at 1736 hours on 7 February 1984 when I saw about 140 birds leave the wintering area. Prior to departure a group of about 60 birds resting at low tide on a mudflat suddenly became alert and very excited as if a predator was nearby, but no avian predators were observed. This group took flight and made 8 to 10 circles over the mudflats calling constantly and gaining altitude on each pass. During this time other small groups joined the flock and after about 10 minutes the entire flock of about 140 flew off toward the northeast. I never observed any apparently arriving flights of migrants. From this, I presume most American Avocet migration occurs at night.

Courtship

The salmon color of the head and neck, characteristic of the breeding plumage, became apparent in a few individuals as early as the fourth week in January. By 5 March 1984, 89 percent of the birds recorded had molted to breeding plumage. Four percent of the birds still present on 15 May 1984 were in non-breeding plumage. Obvious pairs were first seen during early February. By 19 February 1984, the population had declined to about 420 birds, and of these, only 24 (5.7 percent) were paired (Table 3). By 11 March 1984, the population had declined to 192 birds but 58 (30.2 percent) of these were paired. Most of the paired American Avocets left Humboldt Bay by 21 April 1984. Because the number of pairs at Humboldt Bay never exceeded 30.2
Table 3. Number of Paired American Avocets observed in North Humboldt Bay, California. February to May 1984.

<table>
<thead>
<tr>
<th>Date</th>
<th>Estimated Total Population</th>
<th>Number Paired</th>
<th>Percent Paired</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 February</td>
<td>420</td>
<td>24</td>
<td>5.7</td>
</tr>
<tr>
<td>11 March</td>
<td>192</td>
<td>58</td>
<td>30.2</td>
</tr>
<tr>
<td>21 April</td>
<td>109</td>
<td>16</td>
<td>7.3</td>
</tr>
<tr>
<td>5 May</td>
<td>84</td>
<td>6</td>
<td>3.5</td>
</tr>
</tbody>
</table>
percent of the wintering flock, I believe that pairing also occurs during migration or on the breeding grounds. My observations indicate that the paired males and females defend the space around each other rather than a defined area of mudflat. Paired females reacted aggressively to other females and often chased intruding females 20 yards or more before returning to their mate. Seven copulations were seen during the first three weeks of April.

Distribution and Habitat Use of American Avocets at Humboldt Bay

Both the weekly/bimontly surveys and the detailed behavioral work showed that nearly all American Avocets at Humboldt Bay, California used only the northeastern portion of North Bay (Figure 5, Table 4). In 42 surveys of South Bay, no American Avocets were ever seen. Moreover, American Avocets were recorded at only 5 of the 11 census locations around the perimeter of North Bay (Table 4). American Avocets were seen outside the "wintering home range" as determined by the modified minimum area method only 30 times and no groups greater than 52 birds were seen away from the "wintering home range" area. None of the 30 times occurred during regular surveys. Twenty six of these 30 observations were made of birds along the eastern shoreline of North Bay on the intertidal mudflats south of the study area. The portion of Humboldt Bay, as determined by the modified minimum area method, used by American Avocets in this study encompassed only 868 ha (Figure 5). American Avocets confined their activities to only 23.6 percent of the entire surface of North Bay and
Figure 5. "Wintering Home Range" of American Avocets in North Humboldt Bay, California. Area Boundaries Drawn Using the Modified Minimum Area Method (Harvey and Barbour 1965).
Table 4. Average Number of American Avocets Recorded Each Month per Census at Survey Stations in North Humboldt Bay, Humboldt Co., California. Censuses Were Taken Each Week During High and Low Tides from October to May in 1982-1983 and 1983-1984 and from January to May, 1985.
N - Number of Surveys. HT- High Tide. LT- Low Tide.

<table>
<thead>
<tr>
<th>Survey Station</th>
<th>October (N=10)</th>
<th>November (N=8)</th>
<th>December (N=9)</th>
<th>January (N=12)</th>
<th>February (N=9)</th>
<th>March (N=11)</th>
<th>April (N=12)</th>
<th>May (N=5)</th>
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<tr>
<td>1) McDaniel Mudflat</td>
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<td>106.4</td>
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<td>0.0</td>
<td>666.8</td>
<td>0.0</td>
</tr>
<tr>
<td>3) Oxidation Pond</td>
<td>0.0</td>
<td>173.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>4) Jacoby Creek</td>
<td>0.0</td>
<td>112.5</td>
<td>0.0</td>
<td>157.8</td>
<td>0.0</td>
<td>159.7</td>
<td>0.0</td>
<td>128.4</td>
</tr>
<tr>
<td>5) Bracut</td>
<td>0.0</td>
<td>58.6</td>
<td>0.0</td>
<td>286.8</td>
<td>0.0</td>
<td>178.6</td>
<td>0.0</td>
<td>312.9</td>
</tr>
<tr>
<td>6) Survey Stations</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6 thru 11</td>
<td>477.0</td>
<td>559.9</td>
<td>630.0</td>
<td>551.0</td>
<td>629.1</td>
<td>581.4</td>
<td>666.8</td>
<td>472.2</td>
</tr>
</tbody>
</table>
used a much smaller proportion of the Bay than other major populations of shorebirds wintering at Humboldt Bay (Gerstenberg 1979).

American Avocets used four major habitat types: (1) intertidal mudflats (Study sites 1, 2, 3, and 7) used mainly for feeding and resting, (2) the wastewater treatment Oxidation Pond (Study Site 4), used as a feeding area and secondarily as a source of fresh water and resting area, (3) islands in Klopp Lake (Study Site 6) used as the major high tide roost and (4) a section of high elevation mudflat just north of Jacoby Creek delta (In Study Site 3, Figure 2) used as an alternate high tide roost site. Gerstenberg (1972) subdivided the tidal mudflats based on tidal exposure into high-level, mid-level, and low-level mudflats. Within this framework American Avocets spent the greatest proportion of time on the high-level mudflats in the northeast corner of Humboldt Bay.

Roosting Studies

American Avocets used two main roost (resting) sites: Islands in Klopp Lake (Study site 6, Figure 2, Table 1: Survey Station 2, Table 4) and a high elevation intertidal mudflat just north of the Jacoby Creek delta (Part of Study site 3, Figure 2, Table 1). They also sometimes rested for short periods out on the intertidal mudflats where the main activities were foraging. Typically American Avocets congregated on flood tides at the alternate roost site at Jacoby Creek where they roosted in a long line at the water's edge until they were forced off by high water. They then flew to islands in Klopp Lake. The alternate roost site consisted of the highest elevation intertidal mudflat in North Bay and was covered entirely on most high
tides. I saw American Avocets roost during high tide at the alternate roost on only two occasions out of 292 days of observation.

Resting was the main behavior observed at the roost sites. American Avocets usually slept in bouts of short duration (i.e. 2-15 minutes) interrupted by periods when they opened their eyes to scan the surroundings. The mean number of American Avocets engaged in resting behavior was significantly (alpha=.002) greater at roost sites than on the mudflats or the Oxidation Ponds. About 66 percent of all American Avocets present on the roosts were recorded as resting (Table 5). This compares to only 20.5 and 0.6 percent recorded as resting on the intertidal mudflats and the Oxidation ponds respectively. At Klopp Lake, American Avocets used the middle island most (74.3 percent of all birds scanned), followed by the eastern island (17.4 percent) and the western island (8.3 percent). They roosted in dense groups at the edge of the islands. The higher, dryer center portions of the islands were usually occupied by Marbled Godwits (*Limosa fedoa*), Black-bellied Plovers (*Pluvialis squatarola*), Least (*Caladris minutilla*) and Western (*Caladris mauri*) Sandpipers, and Willets (*Catoptrophorus semipalmatus*). At the main Klopp Lake roost American Avocets rested mainly (43.5 percent of all birds scanned) on exposed portions of the islands and along the edges of the islands where the water depth was between the feet and abdomen (51.4 percent of all birds scanned). Klopp Lake was the only location where substantial numbers (greater than 50 birds) of American Avocets were observed to rest on areas that were high and dry (Zone A). At the Jacoby Creek roost American Avocets rested on
Table 5. Effects of Habitat on Behavior and Mean Number of American Avocets per Scan, in North Humboldt Bay, California During the Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>Habitats</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mainly Roosting Sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Klopp</td>
<td>26.5</td>
<td>27.8</td>
<td>2.5</td>
<td>38.2</td>
<td>27.8</td>
<td>0.71</td>
<td>1.5</td>
<td>47.3</td>
<td>411.3</td>
</tr>
<tr>
<td></td>
<td>Lake</td>
<td>65.6</td>
<td>6.9</td>
<td>0.63</td>
<td>9.4</td>
<td>5.2</td>
<td>0.17</td>
<td>0.38</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jacoby</td>
<td>209.8</td>
<td>16.8</td>
<td>2.4</td>
<td>12.2</td>
<td>5.3</td>
<td>3.8</td>
<td>13.5</td>
<td>39.2</td>
<td>321.0</td>
</tr>
<tr>
<td></td>
<td>Creek</td>
<td>65.4</td>
<td>5.2</td>
<td>0.74</td>
<td>3.78</td>
<td>1.66</td>
<td>1.20</td>
<td>9.8</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mainly Feeding Areas</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxidation</td>
<td>2.6</td>
<td>0.08</td>
<td>0.04</td>
<td>1.4</td>
<td>71.7</td>
<td>0.08</td>
<td>327.3</td>
<td>16.5</td>
<td>424.0</td>
</tr>
<tr>
<td></td>
<td>Ponds</td>
<td>0.63</td>
<td>0.02</td>
<td>0.01</td>
<td>0.32</td>
<td>16.9</td>
<td>0.02</td>
<td>77.2</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intertidal</td>
<td>57.4</td>
<td>12.9</td>
<td>1.0</td>
<td>12.0</td>
<td>1.2</td>
<td>2.6</td>
<td>171.5</td>
<td>23.0</td>
<td>280.2</td>
</tr>
<tr>
<td></td>
<td>Mudflats</td>
<td>20.5</td>
<td>4.6</td>
<td>0.37</td>
<td>4.3</td>
<td>0.42</td>
<td>0.94</td>
<td>61.2</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kruskal-Wallis H-Value</td>
<td>46.8</td>
<td>15.72</td>
<td>2.75</td>
<td>5.01</td>
<td>62.60</td>
<td>16.76</td>
<td>52.69</td>
<td>17.92</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test</td>
<td>(.01)</td>
<td>(.001)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.001)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td></td>
</tr>
</tbody>
</table>
flooded mudflats with water covering their feet (32.4 percent of all birds scanned), flooded mudflats with water depths between the feet and abdomen (35.1 percent) and on exposed mudflats with visible surface water (31.9 percent, Table 6). High winds caused increased wave action which often forced American Avocets to move to higher ground.

Intraspecific and interspecific aggressive interactions involving American Avocets occurred rarely (less than 5 percent of all scans) at the roost sites despite the high densities of shorebirds using the islands. The only interaction between American Avocets and Herons occurred at the roost and on all occasions all species of Herons displaced American Avocets and all other shorebirds.

Effect of Season and Time of Day on Use of Roosts

During the winter between 55 percent (November 1982) and 84 percent (December 1983) of American Avocets observed at roosts were recorded as resting (Table 7). The number of American Avocets observed resting was significantly (alpha=.0005) greater during December 1982, December 1983, and January 1984 than in November 1982.

No significant (alpha=.0012) differences were detected in the number of American Avocets resting according to time of day. Analysis of time of day with behavioral activities were performed separately for each tide height category in order to minimize the effects of tide height on activities.
Table 6. Effects of Water Depth on Number of Resting American Avocets per Scan in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly Roosting Sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klopp Lake (N=1860)</td>
<td>X #</td>
<td>115.4</td>
<td>2.3</td>
<td>8.7</td>
<td>136.8</td>
<td>1.8</td>
</tr>
<tr>
<td>(±10.4)</td>
<td>(±0.12)</td>
<td>(±1.2)</td>
<td>(±12.1)</td>
<td>(±0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jacoby Creek (N=96)</td>
<td>X #</td>
<td>1.5</td>
<td>73.1</td>
<td>73.9</td>
<td>78.0</td>
<td>0.04</td>
</tr>
<tr>
<td>(±0.34)</td>
<td>(±12.7)</td>
<td>(±11.8)</td>
<td>(±12.5)</td>
<td>(±&lt;.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainly Feeding Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxidation Ponds (N=854)</td>
<td>X #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.03</td>
<td>0.18</td>
<td>1.1</td>
</tr>
<tr>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±&lt;.01)</td>
<td>(±&lt;.01)</td>
<td>(±&lt;.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertidal Mudflats (N=3828)</td>
<td>X #</td>
<td>0.64</td>
<td>37.8</td>
<td>9.0</td>
<td>10.9</td>
<td>0.04</td>
</tr>
<tr>
<td>(±0.03)</td>
<td>(±8.3)</td>
<td>(±2.0)</td>
<td>(±2.1)</td>
<td>(±&lt;.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kruskal-Wallis H-Value Test Significance ( )</td>
<td>57.56</td>
<td>8.73</td>
<td>61.47</td>
<td>43.78</td>
<td>8.55</td>
<td></td>
</tr>
<tr>
<td>(&lt;.01)</td>
<td>(.013)</td>
<td>(&lt;.01)</td>
<td>(&lt;.01)</td>
<td>(.036)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zone A - Exposed Mudflats without Standing Water
Zone B - Exposed Mudflats with Visible Surface Water
Zone C - Flooded Mudflats with Water Covering the Feet
Zone D - Flooded Mudflats with Water between the Feet and Abdomen
Zone E - Flooded Mudflats with Water Deeper than an Avocet's Abdomen.
Table 7. Effects of Season on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. 

\(N\) = Number of Scans. \(X \#\) = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Month</th>
<th>Rest</th>
<th>Preen</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 1982</td>
<td>(224.3)</td>
<td>(4.6)</td>
<td>(0.45)</td>
<td>(7.6)</td>
<td>(0.78)</td>
<td>(0.08)</td>
<td>(&lt;0.01)</td>
<td>(5.3)</td>
</tr>
<tr>
<td>(N=175)</td>
<td>71.3</td>
<td>7.8</td>
<td>0.99</td>
<td>11.1</td>
<td>1.3</td>
<td>0.17</td>
<td>0.0</td>
<td>7.4</td>
</tr>
<tr>
<td>November 1982</td>
<td>(28.5)</td>
<td>(9.1)</td>
<td>(0.80)</td>
<td>(11.1)</td>
<td>(12.2)</td>
<td>(0.39)</td>
<td>(&lt;0.01)</td>
<td>(16.1)</td>
</tr>
<tr>
<td>(N=206)</td>
<td>54.8</td>
<td>9.2</td>
<td>1.00</td>
<td>9.4</td>
<td>1.1</td>
<td>0.46</td>
<td>0.0</td>
<td>13.8</td>
</tr>
<tr>
<td>December 1982</td>
<td>(231.1)</td>
<td>(6.3)</td>
<td>(0.39)</td>
<td>(14.1)</td>
<td>(11.7)</td>
<td>(0.26)</td>
<td>(&lt;0.01)</td>
<td>(16.2)</td>
</tr>
<tr>
<td>(N=173)</td>
<td>59.5</td>
<td>5.7</td>
<td>0.49</td>
<td>10.8</td>
<td>10.1</td>
<td>0.30</td>
<td>0.0</td>
<td>13.0</td>
</tr>
<tr>
<td>October 1983</td>
<td>(29.7)</td>
<td>(6.0)</td>
<td>(0.51)</td>
<td>(7.8)</td>
<td>(4.2)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(10.1)</td>
</tr>
<tr>
<td>(N=162)</td>
<td>67.4</td>
<td>7.2</td>
<td>0.68</td>
<td>8.5</td>
<td>5.0</td>
<td>0.02</td>
<td>0.24</td>
<td>11.0</td>
</tr>
<tr>
<td>November 1983</td>
<td>(29.2)</td>
<td>(8.5)</td>
<td>(0.24)</td>
<td>(10.3)</td>
<td>(1.9)</td>
<td>(0.05)</td>
<td>(0.10)</td>
<td>(8.7)</td>
</tr>
<tr>
<td>(N=202)</td>
<td>66.9</td>
<td>10.2</td>
<td>0.34</td>
<td>10.8</td>
<td>2.0</td>
<td>0.07</td>
<td>0.70</td>
<td>9.0</td>
</tr>
<tr>
<td>December 1983</td>
<td>(34.3)</td>
<td>(1.6)</td>
<td>(0.06)</td>
<td>(5.5)</td>
<td>(0.83)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(4.4)</td>
</tr>
<tr>
<td>(N=219)</td>
<td>84.4</td>
<td>2.4</td>
<td>0.11</td>
<td>7.37</td>
<td>0.95</td>
<td>0.05</td>
<td>0.19</td>
<td>4.6</td>
</tr>
<tr>
<td>January 1984</td>
<td>(34.1)</td>
<td>(5.8)</td>
<td>(0.47)</td>
<td>(7.0)</td>
<td>(6.3)</td>
<td>(0.14)</td>
<td>(0.01)</td>
<td>(9.9)</td>
</tr>
<tr>
<td>(N=196)</td>
<td>71.1</td>
<td>5.8</td>
<td>0.62</td>
<td>6.6</td>
<td>6.7</td>
<td>0.18</td>
<td>0.03</td>
<td>8.9</td>
</tr>
</tbody>
</table>
## Table 7. Effects of Season on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California.

*N* = Number of Scans. *X #* = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Month</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 1984 (N=179)</td>
<td>396.0 (±47.7)</td>
<td>34.9 (±6.2)</td>
<td>3.4 (±0.49)</td>
<td>42.1 (±7.6)</td>
<td>23.8 (±4.1)</td>
<td>1.0 (±0.13)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±7.9)</td>
<td>540.5</td>
</tr>
<tr>
<td>March 1984 (N=193)</td>
<td>172.7 (±15.8)</td>
<td>16.6 (±2.8)</td>
<td>1.8 (±2.6)</td>
<td>25.7 (±4.7)</td>
<td>21.8 (±3.8)</td>
<td>0.7 (±0.08)</td>
<td>0.0 (±0.0)</td>
<td>22.1 (±4.9)</td>
<td>261.4</td>
</tr>
<tr>
<td>April 1984 (N=171)</td>
<td>84.0 (±7.6)</td>
<td>9.6 (±1.7)</td>
<td>0.62 (±0.08)</td>
<td>10.1 (±1.8)</td>
<td>10.7 (±0.04)</td>
<td>0.25 (±&lt;.01)</td>
<td>0.32 (±4.7)</td>
<td>22.1 (±4.7)</td>
<td>137.7</td>
</tr>
<tr>
<td>May 1984 (N=80)</td>
<td>52.7 (±4.4)</td>
<td>5.7 (±0.95)</td>
<td>0.47 (±0.06)</td>
<td>6.0 (±1.2)</td>
<td>4.1 (±0.68)</td>
<td>0.15 (±0.02)</td>
<td>0.07 (±&lt;.01)</td>
<td>8.3 (±1.5)</td>
<td>77.4</td>
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</table>

Kruskal-Wallis H-Value

<table>
<thead>
<tr>
<th>Test</th>
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</tr>
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<tbody>
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<tr>
<td>6.57</td>
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</tr>
<tr>
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<td>(.004)</td>
</tr>
<tr>
<td>17.02</td>
<td>(.048)</td>
</tr>
<tr>
<td>28.38</td>
<td>(&lt;.01)</td>
</tr>
<tr>
<td>7.46</td>
<td>(.281)</td>
</tr>
<tr>
<td>10.76</td>
<td>(.096)</td>
</tr>
<tr>
<td>15.53</td>
<td>(.077)</td>
</tr>
</tbody>
</table>

---

38
Effects of Tide Level and Tide Action on Use of Roosts

The use of roosts by American Avocets was controlled by tides. Although American Avocets were observed at the two roost sites at all tide levels, an average of 87.3 percent of all birds observed were resting when tide levels were between 5.0 feet and 7.5 feet. Significant differences (alpha=.0003) between the number of American Avocets resting at different tide levels were detected (Table 8). No significant (alpha=.0003) differences between the number of American Avocets resting at tide levels between 5.0 and 7.5 feet were detected. Although tide did not affect the water levels at Klopp Lake activity patterns of American Avocets were controlled by tidal factors. American Avocets rarely (less than 3 percent of all scans) rested at Jacoby Creek when tide levels were greater than 5.0 feet. On 21 November 1983 heavy rains flooded the roosting islands in Klopp Lake forcing the birds to roost elsewhere. I was unable to locate most of the flock at that time but 52 Avocets were found roosting in a flooded field near the mouth of Mad River Slough 4.5 km from the roost. The following day, after the islands again became available the entire population of 547 American Avocets was again observed at Klopp Lake.

No significant relationships were detected between the number of resting American Avocets and tide action (Table 9).

Effects of Weather on Use of Roosts

The number of American Avocets observed resting at the two roost sites was significantly (alpha=.0006) greater when air temperature was between 0°C-11°C than when temperatures were greater
Table 8. Effects of Tide Level on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Height (Feet)</th>
<th>Rest (4)</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
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<td>±0.02</td>
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<td>Comfort</td>
<td>Alert</td>
<td>Swim</td>
<td>Walk</td>
<td>Feed</td>
<td>Fly</td>
<td>Total Birds</td>
</tr>
<tr>
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<td>---------</td>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>------</td>
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<td>(±0.05)</td>
<td>(±0.09)</td>
<td>(&lt;0.01)</td>
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<td>0.09</td>
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<td>(±7.2)</td>
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<td>(±8.9)</td>
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Table 8. Effects of Tide Level on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height (Feet)</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
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<td>(±0.11)(±&lt;0.01)(±15.1)</td>
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<td>12.3</td>
<td>0.20</td>
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<td>% Total</td>
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<td>6.3</td>
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<td>0.12</td>
<td>0.07</td>
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<tr>
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<td>0.0</td>
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<td>30.7</td>
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</table>

Kruskal-Wallis N-Value Test
                            526.67 | 44.24 | 25.61 | 26.92 | 14.37 | 11.57 | 10.06 | 16.93
Significance ( )
                        (<.01) | (<.01) | (.029) | (.059) | (.278) | (.481) | (.435) | (.110)
Table 9. Effects of Tide action on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N-1860) and Jacoby Creek Roost (N-96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Action</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
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<td>0.76</td>
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<td>9.5</td>
<td>0.18</td>
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<tr>
<td>X #</td>
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Kruskal-Wallis H-Value: 0.02  1.30  1.73  1.94  4.89  0.01  3.53  4.36
Test: (.888) (.069) (.189) (.163) (.027) (.963) (.060) (.037)
Significance ( )
than 11°C (Table 10). No significant (alpha=.0006) comparisons were detected in the number of American Avocets that were alert, preening, engaged in comfort movements or flying at different air temperatures (Table 10).

During strong winds 97.3 percent of American Avocets observed at roost sites were resting and, except for a few birds preening, no other behaviors were observed (Table 11). Winds greater than 32 mph occurred only 6 times when I made observations at roost sites. The dikes and upland areas surrounding Klopp Lake provided some protection from strong northwesterly winds. During moderate winds 81.4 percent of all American Avocets observed were resting whereas an average of only 62.6 percent of the birds was resting during calm or light winds (Table 11). The number of American Avocets performing comfort movements and preening was significantly (alpha=.0015) lower during moderate winds than during calm or light winds (Table 11). Winds greater than 16.1 kmh caused white caps on Klopp lake which caused American Avocets to move to higher ground or to the lee side of the roosting islands.

American Avocets rested in significantly (alpha=.0007) greater numbers when winds were from the northwest compared to easterly winds (Table 12). The average proportion of the flock recorded as resting was greatest when the winds were from the north (97.5 percent), south (88.5 percent), and northwest (76.1 percent, Table 12). Air temperatures were colder when winds were from the north and northwest and stronger winds were more common when they were from the south and northwest.
Table 10. Effects of Air Temperature on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Air Temperature (°C)</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Moves</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10°C (N=174)</td>
<td>425.1</td>
<td>14.7</td>
<td>0.43</td>
<td>4.0</td>
<td>0.0</td>
<td>0.04</td>
<td>2.4</td>
<td>0.4</td>
<td>487.4</td>
</tr>
<tr>
<td></td>
<td>(±32.6)</td>
<td>(±2.1)</td>
<td>(±0.04)</td>
<td>(±0.72)</td>
<td>(±0.0)</td>
<td>(±&lt;0.01)</td>
<td>(±0.06)</td>
<td>(±7.1)</td>
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<tr>
<td>X Total</td>
<td>87.2</td>
<td>3.0</td>
<td>0.08</td>
<td>0.83</td>
<td>0.0</td>
<td>0.01</td>
<td>0.49</td>
<td>8.4</td>
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</tr>
<tr>
<td>11°C (N=133)</td>
<td>400.0</td>
<td>19.8</td>
<td>0.65</td>
<td>1.9</td>
<td>39.0</td>
<td>0.82</td>
<td>0.0</td>
<td>11.2</td>
<td>473.4</td>
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<tr>
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<td>(±29.1)</td>
<td>(±2.8)</td>
<td>(±0.06)</td>
<td>(±0.34)</td>
<td>(±6.5)</td>
<td>(±0.08)</td>
<td>(±0.0)</td>
<td>(±1.9)</td>
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<tr>
<td>X Total</td>
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<td>2.1</td>
<td>0.09</td>
<td>0.32</td>
<td>3.1</td>
<td>0.06</td>
<td>0.0</td>
<td>4.6</td>
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<td>0.19</td>
<td>57.4</td>
<td>465.8</td>
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<tr>
<td></td>
<td>(±25.0)</td>
<td>(±4.3)</td>
<td>(±0.38)</td>
<td>(±6.4)</td>
<td>(±5.5)</td>
<td>(±0.09)</td>
<td>(±&lt;0.01)</td>
<td>(±10.4)</td>
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<tr>
<td>X Total</td>
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<td>6.7</td>
<td>0.89</td>
<td>9.4</td>
<td>11.1</td>
<td>0.23</td>
<td>0.03</td>
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<tr>
<td>13°C (N=334)</td>
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<td>0.86</td>
<td>30.6</td>
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<td>(±0.26)</td>
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<td>9.9</td>
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<td>0.06</td>
<td>0.07</td>
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<tr>
<td>14°C (N=233)</td>
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<td>50.0</td>
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<td>(±21.4)</td>
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<td>(±0.27)</td>
<td>(±6.5)</td>
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<td>(±0.01)</td>
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<td>X Total</td>
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<td>10.4</td>
<td>0.53</td>
<td>9.3</td>
<td>5.8</td>
<td>0.14</td>
<td>0.01</td>
<td>12.7</td>
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<tr>
<td>15°C (N=231)</td>
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<td>35.2</td>
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<td>63.9</td>
<td>79.8</td>
<td>0.80</td>
<td>0.08</td>
<td>81.5</td>
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<td>(±25.8)</td>
<td>(±5.6)</td>
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<td>(±11.3)</td>
<td>(±13.4)</td>
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<td>(±&lt;0.01)</td>
<td>(±14.8)</td>
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<tr>
<td>X Total</td>
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<td>0.80</td>
<td>11.3</td>
<td>14.1</td>
<td>0.14</td>
<td>0.01</td>
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<td>16°C (N=92)</td>
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<td>18.9</td>
<td>122.9</td>
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<td>(±26.3)</td>
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<td>(±0.03)</td>
<td>(±0.36)</td>
<td>(±22.4)</td>
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<tr>
<td>X Total</td>
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<td>0.29</td>
<td>4.1</td>
<td>0.0</td>
<td>0.06</td>
<td>4.0</td>
<td>25.6</td>
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Table 10. Effects of Air Temperature on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Air Temperature (°C)</th>
<th>Behaviors</th>
<th>Rest (x̄)</th>
<th>Preen (x̄)</th>
<th>Comfort Movements (x̄)</th>
<th>Alert (x̄)</th>
<th>Swim (x̄)</th>
<th>Walk (x̄)</th>
<th>Feed (x̄)</th>
<th>Fly (x̄)</th>
<th>Total Birds (x̄)</th>
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<td>17°C (N=167)</td>
<td>X #</td>
<td>236.6</td>
<td>34.2</td>
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<td>1.3</td>
<td>0.11</td>
<td>56.5</td>
<td>404.5</td>
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<td>±1.9 (±5.5)</td>
<td>±0.28</td>
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<td>±8.7</td>
<td>±0.18</td>
<td>±0.01</td>
<td>±10.3</td>
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<tr>
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<td>0.56</td>
<td>5.1</td>
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<td>0.32</td>
<td>0.02</td>
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<tr>
<td>18 - 24°C (N=260)</td>
<td>X #</td>
<td>315.1</td>
<td>27.5</td>
<td>4.3</td>
<td>91.5</td>
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<td>1.7</td>
<td>2.8</td>
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<td>±30.4 (±4.1)</td>
<td>±0.59</td>
<td>±16.0</td>
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<td>±0.22</td>
<td>±0.07</td>
<td>±5.6</td>
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<td>X Total</td>
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<td>5.8</td>
<td>0.90</td>
<td>19.3</td>
<td>1.1</td>
<td>0.36</td>
<td>0.60</td>
<td>5.7</td>
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</table>

Kruskal-Wallis H-Value: 42.22 10.66 4.08 8.39 13.24 7.74 9.21 23.28
Test: (< .01) (.222) (.850) (.396) (.039) (.459) (.238) (.003)
Significance ( )
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<tbody>
<tr>
<td>Calm X #</td>
<td>284.6 (±24.1)</td>
<td>32.8 (±5.3)</td>
<td>2.5 (±0.36)</td>
<td>38.5 (±7.2)</td>
<td>27.6 (±4.0)</td>
<td>0.76 (±0.11)</td>
<td>1.7 (±0.05)</td>
<td>54.3 (±9.9)</td>
<td>442.7</td>
</tr>
<tr>
<td>(1-3 mph)</td>
<td>64.2 (±7.4)</td>
<td>7.4 (±0.57)</td>
<td>0.7 (±0.7)</td>
<td>6.2 (±0.71)</td>
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<td></td>
</tr>
<tr>
<td>Light X #</td>
<td>27.4 (±23.1)</td>
<td>4.9 (±4.2)</td>
<td>2.9 (±0.37)</td>
<td>51.2 (±9.1)</td>
<td>43.1 (±7.2)</td>
<td>0.61 (±0.08)</td>
<td>1.9 (±0.60)</td>
<td>50.4 (±9.3)</td>
<td>449.4</td>
</tr>
<tr>
<td>(4-12 mph)</td>
<td>61.0 (±5.5)</td>
<td>5.5 (±0.64)</td>
<td>11.4 (±9.6)</td>
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<td></td>
<td>0.13 (±0.13)</td>
<td>0.41 (±0.41)</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>Moderate X #</td>
<td>367.9 (±31.0)</td>
<td>22.6 (±3.6)</td>
<td>3.3 (±0.41)</td>
<td>24.0 (±4.2)</td>
<td>8.0 (±1.3)</td>
<td>1.2 (±0.18)</td>
<td>1.4 (±0.84)</td>
<td>19.9</td>
<td>448.2</td>
</tr>
<tr>
<td>(13-31 mph)</td>
<td>81.4 (±14.5)</td>
<td>4.5 (±1.2)</td>
<td>7.4 (±7.4)</td>
<td></td>
<td></td>
<td>0.35 (±0.35)</td>
<td>0.19 (±0.19)</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Strong X #</td>
<td>469.5 (±9.4)</td>
<td>13.0 (±1.9)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0</td>
<td>482.5</td>
</tr>
<tr>
<td>(32-46 mph)</td>
<td>97.3 (±9.4)</td>
<td>2.7 (±2.7)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0 (±0.0)</td>
<td>0.0</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Kruskal-Wallis</td>
<td>7.35 (0.53)</td>
<td>9.65 (0.012)</td>
<td>6.94 (0.031)</td>
<td>4.51 (0.105)</td>
<td>0.67 (0.715)</td>
<td>1.29 (0.524)</td>
<td>1.69 (0.430)</td>
<td>5.80</td>
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</tr>
<tr>
<td>N-Value Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Significance (</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</table>
Table 12. Effects of Wind Direction on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Wind Direction</th>
<th>Rest (X #)</th>
<th>Freen (±22.2)</th>
<th>Comfort (±30.0)</th>
<th>Movements (±0.02)</th>
<th>Alert (±0.61)</th>
<th>Swim (±0.0)</th>
<th>Walk (±0.0)</th>
<th>Feed (±0.0)</th>
<th>Fly (±4.1)</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (N=41)</td>
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<td>20.7</td>
<td>0.21</td>
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<td>4.1</td>
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</tr>
<tr>
<td>East (N=104)</td>
<td>234.1</td>
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<td>402.0</td>
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<tr>
<td>% Total</td>
<td>58.2</td>
<td>10.6</td>
<td>0.70</td>
<td>20.9</td>
<td>0.26</td>
<td>0.01</td>
<td>0.01</td>
<td>9.3</td>
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<tr>
<td>Southeast (N=331)</td>
<td>367.0</td>
<td>32.4</td>
<td>4.7</td>
<td>64.2</td>
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<td>Southwest (N=256)</td>
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<td>439.9</td>
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<td>% Total</td>
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<td>Northwest (N=347)</td>
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<td>22.8</td>
<td>1.6</td>
<td>4.1</td>
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<td>470.4</td>
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<tr>
<td>Kruskal-Wallis H-Value</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The number of American Avocets resting was significantly (alpha=.0006) greater during moderate rains than under clear or cloudy skies, foggy conditions, or during light rains (Table 13). American Avocets rested more (81.1 percent of all birds scanned) and were engaged less in preening, comfort movements, and alert behaviors during moderate rains (Table 13) than during other conditions.

**Flight Patterns from the Klopp Lake Roost**

Flight directions from the roost at Klopp Lake were not distributed uniformly around a circle ($X^2=837.33$, df=7, $p<.001$) and had a mean angle of $177.97^\circ \pm 6.0^\circ$ which is approximately south. The dispersion of flight directions indicated that relatively all the flights from the roost were to the south ($r=0.815$). The mean distance flown from Klopp Lake roost to feeding areas on the intertidal mudflats was 1922 ± 214 meters ($n=463$ flocks) and to the Oxidation Ponds, 300 meters ($n=19$ flocks). It is my impression that American Avocets avoided flying over upland areas when leaving the roosts.

**Foraging Studies**

Pecking accounted for 93.3 percent (females) and 92.9 percent (males) of all visual feeding events recorded. Assuming an equal probability of Avocets using tactile or visual feeding methods, tactile feeding methods were used much more frequently ($X^2=18.261$, df=1, $p<.001$). Single scythe was the primary tactile feeding method used (91.45 percent females; 87.75 percent males). Males predominantly used tactile feeding methods at all depths except in Zone A (Zone A: $X^2=.707$, N.S., Zone B: $X^2=998.77$, df=1, $p<.001$).
Table 13. Effects of Precipitation and Cloud Cover on Behavior and Number of American Avocets per Scan on Klopp Lake Roost (N=1860) and Jacoby Creek Roost (N=96) in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>State of the Weather</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear (N=605)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>233.7</td>
<td>35.4</td>
<td>2.9</td>
<td>52.0</td>
<td>27.3</td>
<td>0.69</td>
<td>0.02</td>
<td>44.3</td>
<td>396.3</td>
</tr>
<tr>
<td>% Total</td>
<td>58.9</td>
<td>8.9</td>
<td>0.72</td>
<td>13.1</td>
<td>6.9</td>
<td>0.17</td>
<td>0.01</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>Scattered Clouds (N=246)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>327.6</td>
<td>24.1</td>
<td>2.4</td>
<td>55.9</td>
<td>5.9</td>
<td>1.5</td>
<td>8.3</td>
<td>24.2</td>
<td>449.9</td>
</tr>
<tr>
<td>% Total</td>
<td>71.3</td>
<td>5.4</td>
<td>0.60</td>
<td>15.8</td>
<td>0.70</td>
<td>0.44</td>
<td>1.6</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Broken Clouds (N=427)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>X #</td>
<td>248.7</td>
<td>33.9</td>
<td>4.2</td>
<td>32.5</td>
<td>36.3</td>
<td>0.99</td>
<td>0.76</td>
<td>59.0</td>
<td>416.3</td>
</tr>
<tr>
<td>% Total</td>
<td>59.7</td>
<td>8.1</td>
<td>0.99</td>
<td>7.8</td>
<td>8.8</td>
<td>0.23</td>
<td>0.18</td>
<td>14.2</td>
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<tr>
<td>Overcast Clouds (N=429)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>X #</td>
<td>318.5</td>
<td>22.4</td>
<td>1.6</td>
<td>39.0</td>
<td>41.1</td>
<td>0.43</td>
<td>4.0</td>
<td>60.1</td>
<td>487.1</td>
</tr>
<tr>
<td>% Total</td>
<td>65.3</td>
<td>4.6</td>
<td>0.33</td>
<td>8.0</td>
<td>8.5</td>
<td>0.08</td>
<td>0.81</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>Fog (N=31)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>X #</td>
<td>328.3</td>
<td>53.2</td>
<td>0.10</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>382.3</td>
</tr>
<tr>
<td>% Total</td>
<td>85.9</td>
<td>13.9</td>
<td>0.02</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Light Rain (N=47)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>264.2</td>
<td>38.4</td>
<td>6.0</td>
<td>71.2</td>
<td>6.6</td>
<td>2.3</td>
<td>0.0</td>
<td>55.7</td>
<td>382.3</td>
</tr>
<tr>
<td>% Total</td>
<td>59.4</td>
<td>8.6</td>
<td>1.3</td>
<td>16.0</td>
<td>1.5</td>
<td>0.5</td>
<td>0.0</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>Moderate Rain (N=171)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>421.0</td>
<td>13.3</td>
<td>0.81</td>
<td>2.0</td>
<td>36.6</td>
<td>0.04</td>
<td>0.75</td>
<td>57.3</td>
<td>444.4</td>
</tr>
<tr>
<td>% Total</td>
<td>81.1</td>
<td>2.6</td>
<td>0.15</td>
<td>0.38</td>
<td>4.6</td>
<td>0.01</td>
<td>0.14</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Kruskal-Wallis H-Value</td>
<td>34.47</td>
<td>20.47</td>
<td>9.07</td>
<td>3.57</td>
<td>10.42</td>
<td>5.90</td>
<td>6.79</td>
<td>11.77</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>(&lt;.01)</td>
<td>(.002)</td>
<td>(.170)</td>
<td>(.612)</td>
<td>(.064)</td>
<td>(.316)</td>
<td>(.147)</td>
<td>(.067)</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C: $\chi^2=137.80$, df=1, p<.001, Zone D: $\chi^2=1066.80$, df=1, p<.001, Zone E: $\chi^2=256.97$, df=1, p<.001). Females predominantly used tactile methods at all depths (Zone A: $\chi^2=65.06$, df=1, p<.001, Zone B: $\chi^2=315.25$, df=1, p<.001, Zone C: $\chi^2=25.26$, df=1, p<.001, Zone D: $\chi^2=839.58$, df=1, p<.001, Zone E: $\chi^2=219.74$, df=1, p<.001). Males used visual methods more frequently than females in Zone A ($\chi^2=21.89$, df=4, p<.001, Zone C ($\chi^2=14.04$, df=4, p<.001), and Zone E ($\chi^2=28.52$, df=4, p<.001). Females used tactile feeding methods more frequently than males in Zone C ($\chi^2=79.18$, df=4, p<.001) and less frequently than males in Zone B ($\chi^2=11.81$, df=4, p<.001) and Zone D ($\chi^2=28.31$, df=4, p<.001). No significant differences were found between males and females using tactile feeding methods in Zones C and E.

Except for December 1982 and December 1983 American Avocets fed for a greater proportion of the available daylength periods suitable for feeding as the winter progressed (Table 2).

Data on the occurrence of nocturnal foraging at the "optimal" foraging tide heights were combined for the two winter seasons 1982-83 and 1983-84. No American Avocets were found feeding in Humboldt Bay on dark or bright nights in October (4 counts-2 dark,2 bright) or April (6 counts-4 dark, 2 bright) but an average of 172 American Avocets was seen feeding on dark (28 counts) and 217 on bright nights (19 counts) between November and March.

Because of the difficulty of making comparable nighttime observations the bulk of the data were taken during daylight hours. American Avocets fed at the Arcata Sewage Oxidation Pond (Study Site 4, Figure 2, Table 1; Survey Station 2, Figure 1) and at the intertidal mudflats (Table 5).
American Avocets used the Oxidation Ponds primarily for feeding in October and the first 10 days of November. The few birds seen there at other times principally swam and drank water (Table 14). American Avocets feeding in the Oxidation Ponds arrived there either from the roost or from the mudflats in Study Sites 2, 3, or 5. A greater proportion of American Avocets fed at the Oxidation Pond in October 1983 (87.4 percent) than in October 1982 (49.7 percent, Table 14). American Avocets feeding at the Oxidation Ponds congregated over dense concentrations of invertebrate prey and fed intensively from 2 to 43 minutes. Feeding would stop suddenly apparently until the next concentration of prey was located by American Avocets. They often fed in concentrations of up to 360 birds. The distance between feeding individuals was often less than one body length (18\textquotedbl{}). All individuals in a dense flock usually tended to use the same feeding method. Birds feeding in dense flocks used single and multiple scythe (784 observations) or picked up (=pecking) individual prey from the water surface (37 occasions).

Effects of Tide Level on Use of Oxidation Ponds. Since tide levels did not influence water levels in the Oxidation Ponds American Avocets could potentially have fed there any time. Thus they might have switched from the tidally-controlled feeding routine to one determined more by the time of day. However this was not the pattern observed as they still roosted at high tide as did other species of shorebirds (Table 4). American Avocets tended to feed at higher tide
Table 14. Effects of Season on Behavior and Number of American Avocets per Scan on the Oxidation Pond in North Humboldt Bay, California. \( N \) = Number of Scans. \( X \# \) = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td></td>
<td></td>
<td>Movements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October 1982 (N=378)</td>
<td>0.10</td>
<td>0.21</td>
<td>0.10</td>
<td>3.0</td>
<td>36.5</td>
<td>0.0</td>
<td>422.8</td>
<td>21.3</td>
<td>484.0</td>
</tr>
<tr>
<td>(±0.01) (±0.03) (±0.01)</td>
<td></td>
<td></td>
<td>(±0.53)</td>
<td>(±6.6)</td>
<td>(±0.0) (±20.1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October 1983 (N=367)</td>
<td>0.02</td>
<td>0.04</td>
<td>0.0</td>
<td>0.62</td>
<td>7.6</td>
<td>0.0</td>
<td>87.4</td>
<td>4.4</td>
<td>468.4</td>
</tr>
<tr>
<td>(±0.0) (±0.0) (±0.0)</td>
<td></td>
<td></td>
<td>(±0.0)</td>
<td>(±2.0)</td>
<td>(±9.6)</td>
<td>(±0.0) (±36.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November 1983 (N=30)</td>
<td>0.0</td>
<td>0.88</td>
<td>0.0</td>
<td>11.1</td>
<td>52.6</td>
<td>0.0</td>
<td>387.3</td>
<td>37.1</td>
<td>429.0</td>
</tr>
<tr>
<td>(±0.0) (±0.13) (±0.0)</td>
<td></td>
<td></td>
<td>(±2.0)</td>
<td>(±9.6)</td>
<td>(±0.0) (±36.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remainder of the Year</td>
<td>17.2</td>
<td>5.4</td>
<td>0.10</td>
<td>4.0</td>
<td>169.3</td>
<td>0.0</td>
<td>15.0</td>
<td>5.6</td>
<td>216.6</td>
</tr>
<tr>
<td>(N=36)</td>
<td>7.9</td>
<td>2.5</td>
<td>0.04</td>
<td>1.9</td>
<td>78.2</td>
<td>0.0</td>
<td>2.3</td>
<td>2.6</td>
<td></td>
</tr>
</tbody>
</table>

53
heights at the Oxidation Ponds (3.1 ft - 5.0 ft) than when they fed on the mudflats (1.6 ft - 4.0 ft, Table 15, Appendices E and F). No significant (alpha=.0012) patterns were detected in the use of the Oxidation Ponds by American Avocets feeding according to time of day. Avocets fed at the Oxidation Ponds at tide heights between 0.6 and 7.0 feet (Table 15) and sometimes fed almost exclusively at the Oxidation Ponds. During October 1983 American Avocets typically left the roost and fed at the Oxidation Ponds until tides dropped below 4.0 feet when they moved to mudflats. Although the proportion of American Avocets observed feeding at the Oxidation Pond was greatest when tides were between 4.1 feet and 5.5 feet the number of birds feeding and swimming did not vary significantly at different tide heights (alpha=.0003). American Avocets fed at the Oxidation Ponds on higher tide heights in October 1983 (4.1 ft - 6.0 ft) than in October 1982 (2.6 ft - 5.0 ft).

Effects of Weather on Use of Oxidation Ponds. The proportion (97.8 percent) of American Avocets feeding at the Oxidation ponds was greatest when temperatures were above 16°C than below 16°C (2.2 percent). Clear conditions prevailed during October. The portion of the total flock of American Avocets recorded as feeding at the Oxidation Ponds was greater under scattered (92.2 percent) or broken clouds (78.9 percent) than under clear skies (58.6 percent).

Intertidal Mudflats

Feeding was the main activity of American Avocets when they were on the intertidal mudflats (Study Site 1, 2, 3, 5, and 7,
Table 15. Effects of Tide Levels on Number of Feeding and Swimming American Avocets per Scan on the Oxidation Ponds in North Humboldt Bay, California. October 1983 and 1984. 

N = Number of Scans. X̄ # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>October 1982</th>
<th></th>
<th></th>
<th></th>
<th>October 1983</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feed</td>
<td>Swim</td>
<td>All Others Behaviors</td>
<td>Feed</td>
<td>Swim</td>
<td>All Others Behaviors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minus</td>
<td>X̄ #</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>0.0</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0-0.5</td>
<td>X̄ #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.6-1.0</td>
<td>X̄ #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>474.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±32.4)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>100.0 (N=2)</td>
<td>0.0</td>
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</tr>
<tr>
<td>1.1-1.5</td>
<td>X̄ #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>432.0</td>
<td>7.2</td>
<td>60.0</td>
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</tr>
<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±29.8)</td>
<td>(±0.8)</td>
<td>(±6.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>86.5 (N=10)</td>
<td>1.4</td>
<td>12.0</td>
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</tr>
<tr>
<td>1.6-2.0</td>
<td>X̄ #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>452.5</td>
<td>0.0</td>
<td>15.5</td>
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<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±33.7)</td>
<td>(±0.0)</td>
<td>(±1.6)</td>
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</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>97.1 (N=8)</td>
<td>0.0</td>
<td>2.9</td>
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</tr>
<tr>
<td>2.1-2.5</td>
<td>X̄ #</td>
<td>253.4</td>
<td>111.6</td>
<td>15.9</td>
<td>417.6</td>
<td>58.0</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(±29.7)</td>
<td>(±26.9)</td>
<td>(±2.7)</td>
<td>(±29.7)</td>
<td>(±6.1)</td>
<td>(±0.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>66.5 (N=6)</td>
<td>29.3</td>
<td>4.2</td>
<td>87.5 (N=14)</td>
<td>12.2</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>2.6-3.0</td>
<td>X̄ #</td>
<td>212.6</td>
<td>81.1</td>
<td>107.1</td>
<td>429.8</td>
<td>17.4</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(±24.8)</td>
<td>(±19.5)</td>
<td>(±18.4)</td>
<td>(±29.9)</td>
<td>(±1.9)</td>
<td>(±0.51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>53.1 (N=27)</td>
<td>20.2</td>
<td>26.72</td>
<td>95.2 (N=20)</td>
<td>3.8</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>
Table 15. Effects of Tide Levels on Number of Feeding and Swimming American Avocets per Scan on the Oxidation Ponds in North Humboldt Bay, California. October 1983 and 1984. N = Number of Scans. X # = Mean Number (+ S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>October 1982</th>
<th></th>
<th></th>
<th>October 1983</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Feed</td>
<td>Swim</td>
<td>All Others</td>
<td>Feed</td>
<td>Swim</td>
</tr>
<tr>
<td></td>
<td>X #</td>
<td>(±34.8)</td>
<td>(±14.1)</td>
<td>(±4.5)</td>
<td>(±28.6)</td>
<td>(±1.9)</td>
</tr>
<tr>
<td>3.1-3.5</td>
<td>Total</td>
<td>(N=10)</td>
<td>77.8</td>
<td>15.3</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>3.6-4.0</td>
<td>X #</td>
<td>(±28.0)</td>
<td>(±19.0)</td>
<td>(±11.8)</td>
<td>(±27.4)</td>
<td>(±1.8)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=33)</td>
<td>61.1</td>
<td>20.9</td>
<td>14.6</td>
<td></td>
</tr>
<tr>
<td>4.1-4.5</td>
<td>X #</td>
<td>(±35.4)</td>
<td>(±17.3)</td>
<td>(±6.7)</td>
<td>(±27.3)</td>
<td>(±4.0)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=39)</td>
<td>73.1</td>
<td>17.2</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>4.6-5.0</td>
<td>X #</td>
<td>(±33.9)</td>
<td>(±15.6)</td>
<td>(±6.5)</td>
<td>(±30.6)</td>
<td>(±2.5)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=48)</td>
<td>73.2</td>
<td>16.9</td>
<td>10.0</td>
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</tr>
<tr>
<td>5.1-5.5</td>
<td>X #</td>
<td>(±16.9)</td>
<td>(±44.9)</td>
<td>(±10.1)</td>
<td>(±31.7)</td>
<td>(±1.0)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=81)</td>
<td>146.2</td>
<td>47.1</td>
<td>16.1</td>
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</tr>
<tr>
<td>5.6-6.0</td>
<td>X #</td>
<td>(±18.6)</td>
<td>(±44.2)</td>
<td>(±11.3)</td>
<td>(±26.2)</td>
<td>(±4.0)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=63)</td>
<td>38.9</td>
<td>64.4</td>
<td>14.7</td>
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<tr>
<td>6.1-6.5</td>
<td>X #</td>
<td>(±41.1)</td>
<td>(±74.1)</td>
<td>(±3.4)</td>
<td>(±24.1)</td>
<td>(±12.7)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(N=51)</td>
<td>54.1</td>
<td>307.5</td>
<td>19.6</td>
<td></td>
</tr>
</tbody>
</table>

56
Table 15. Effects of Tide Levels on Number of Feeding and Swimming American Avocets per Scan on the Oxidation Ponds in North Humboldt Bay, California. October 1983 and 1984. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Feed</th>
<th>Swim</th>
<th>All Others Behaviors</th>
<th>Feed</th>
<th>Swim</th>
<th>All Others Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.6-7.0</td>
<td>X #</td>
<td>0.0</td>
<td>0.0</td>
<td>470.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±35.5)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>92.5</td>
<td>(N-20)</td>
<td>0.0</td>
</tr>
<tr>
<td>7.1-7.5</td>
<td>X #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>7.6-8.0</td>
<td>X #</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Figure 2, Table 4) and at the Arcata Oxidation Pond (Study site 4, Figure 2, Table 4). They typically left the main roost at Klopp Lake when the tide was between 4.0 and 5.0 feet and flew to Jacoby Creek (Study site 3, Figure 2, Table 1) where they began to feed near the tide edge. Typically (greater than 90 percent of all scans) they followed the tide out until they apparently became satiated or tide levels became too low for profitable feeding. Although most American Avocets frequently followed the tide edge out while feeding, some individuals or small groups remained behind on the exposed mudflats with visible surface water where they continued to feed even after most of the flock had left. It is my impression that American Avocets generally (greater than 95 percent of the time) dispersed and formed loosely knit groups while foraging on the intertidal mudflats although sometimes large compact groups fed along the tidal edge or on flooded mudflats in water deeper than an Avocet's abdomen. On ebb tides American Avocets moved south from Jacoby Creek to Bracut (Study Site 7, Figure 2, Table 1). Although Avocets sometimes started to feed at the mudflats west of Klopp Lake (Study Site 1, Figure 2, Table 1) they usually moved to Jacoby Creek or Bracut within 30 minutes (range 10 minutes to 2 hours).

On tides lower than 1.6 feet American Avocets alternated periods of feeding with periods of resting, preening and comfort movements. These birds usually remained out on the mudflats throughout the tide cycle. When the tide began to rise, the birds generally resumed feeding, once again concentrating near the water's edge. The pattern of movement on the flood tide was similar to the ebb tide except in reverse. Avocets feeding on tides below 1.6 feet
usually occurred at the water's edge in the main tidal channels. This pattern of feeding resulted in a bimodal pattern of foraging activity with one peak occurring on ebb and one occurring on the flood tide. When the tide became too high to feed, American Avocets gathered at the Jacoby Creek roost. They flew to the roosting islands in Klopp Lake as the rising tides flooded them off the Jacoby Creek site.

American Avocets fed mainly on flooded mudflats with water covering their feet (43.3 percent of all birds scanned), on flooded mudflats with water between the feet and abdomen (34.3 percent) or on exposed mudflats containing visible surface water (21.7 percent) (Tables 16 and Table 17). At Bracut 40.1 percent of all birds scanned were recorded as feeding on mudflats with visible surface water (Zone B) whereas at Study Sites 1, 2, and 3 only 20.5 percent fed in Zone B.

American Avocets sometimes rested in or near shallow water in open, exposed sites on the intertidal mudflats. These areas often were adjacent to tidal channels. The average proportion of the flock recorded as resting within 100 feet of water (84.1 percent) was significantly greater than the proportion resting at distances greater than 100 feet from water (15.9 percent) \((X^2=5.02, df=1, .01<p<.05)\). These Avocets typically rested in loosely knit flocks of 2 to 75 birds. Occasionally, birds which had fallen asleep found themselves alone when they awakened. These birds immediately became alert and flew off to join other Avocets.

Some 64.7 percent of all American Avocets recorded as resting were on exposed mudflats with visible surface water (Table 5). About equal proportions of a flock were recorded resting on exposed mudflats with visible surface water (Zone B) and flooded mudflats with water
Table 16. Effects of Water Depth on Number of Feeding American Avocets per Scan in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X $\bar{X}$ = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Mainly Roosting Sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Klopp Lake (N=1880)</td>
<td>0.16</td>
<td>0.44</td>
<td>0.86</td>
<td>0.12</td>
<td>0.01</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>(±&lt;.01) (±&lt;.01) (±&lt;.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jacoby Creek (N=96)</td>
<td>0.04</td>
<td>3.3</td>
<td>5.9</td>
<td>4.1</td>
<td>0.16</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>(±&lt;.01) (±0.65) (±1.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Mainly Feeding Areas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxidation Ponds (N=854)</td>
<td>0.03</td>
<td>0.07</td>
<td>1.9</td>
<td>5.5</td>
<td>319.7</td>
<td>327.3</td>
</tr>
<tr>
<td></td>
<td>(±&lt;.01) (±&lt;.01) (±&lt;.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intertidal Mudflats (N=3828)</td>
<td>0.14</td>
<td>21.8</td>
<td>43.3</td>
<td>34.3</td>
<td>0.49</td>
<td>176.5</td>
</tr>
<tr>
<td></td>
<td>(±&lt;.01) (±&lt;.01) (±&lt;.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kruskal-Wallis H-Value</td>
<td>8.31</td>
<td>2.86</td>
<td>73.60</td>
<td>36.95</td>
<td>141.71</td>
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<tr>
<td></td>
<td>Test Significance (</td>
<td>(.040) (.413) (&lt;.01) (&lt;.01) (&lt;.01)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zone A - Exposed Mudflats without Standing Water
Zone B - Exposed Mudflats with Visible Surface Water
Zone C - Flooded Mudflats with Water Covering the Feet
Zone D - Flooded Mudflats with Water between the Feet and Abdomen
Zone E - Flooded Mudflats with Water Deeper than an Avocet's Abdomen
Table 17. Effects of Water Depth on Behavior and Number of American Avocets per Scan on the Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A (N=204)</td>
<td>X #</td>
<td>16.6</td>
<td>1.3</td>
<td>0.04</td>
<td>0.48</td>
<td>0.0</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>±(4.1)</td>
<td>±(0.35)</td>
<td>±(0.01)</td>
<td>±(0.07)</td>
<td>±(0.0)</td>
<td>±(0.42)</td>
<td>±(0.12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>58.0</td>
<td>3.7</td>
<td>0.18</td>
<td>2.2</td>
<td>0.0</td>
<td>6.2</td>
<td>29.7</td>
</tr>
<tr>
<td>Zone B (N=2034)</td>
<td>X #</td>
<td>57.2</td>
<td>6.0</td>
<td>0.82</td>
<td>10.0</td>
<td>0.0</td>
<td>2.3</td>
<td>74.0</td>
</tr>
<tr>
<td></td>
<td>±(15.8)</td>
<td>±(1.1)</td>
<td>±(0.23)</td>
<td>±(2.1)</td>
<td>±(0.0)</td>
<td>±(0.74)</td>
<td>±(7.9)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>44.7</td>
<td>4.5</td>
<td>0.51</td>
<td>6.9</td>
<td>0.0</td>
<td>1.4</td>
<td>42.0</td>
</tr>
<tr>
<td>Zone C (N=2694)</td>
<td>X #</td>
<td>25.2</td>
<td>8.2</td>
<td>0.57</td>
<td>5.2</td>
<td>0.0</td>
<td>1.0</td>
<td>98.6</td>
</tr>
<tr>
<td></td>
<td>±(6.6)</td>
<td>±(1.7)</td>
<td>±(0.11)</td>
<td>±(1.1)</td>
<td>±(0.0)</td>
<td>±(0.36)</td>
<td>±(10.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>18.0</td>
<td>5.9</td>
<td>0.40</td>
<td>4.1</td>
<td>0.0</td>
<td>0.71</td>
<td>72.7</td>
</tr>
<tr>
<td>Zone D (N=1950)</td>
<td>X #</td>
<td>43.6</td>
<td>5.6</td>
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<td>5.5</td>
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<td>1.0</td>
<td>102.0</td>
</tr>
<tr>
<td></td>
<td>±(11.3)</td>
<td>±(1.1)</td>
<td>±(0.2)</td>
<td>±(1.1)</td>
<td>±(0.01)</td>
<td>±(0.20)</td>
<td>±(11.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>27.3</td>
<td>5.6</td>
<td>0.46</td>
<td>4.5</td>
<td>0.0</td>
<td>0.58</td>
<td>61.1</td>
</tr>
<tr>
<td>Zone E (N=393)</td>
<td>X #</td>
<td>0.70</td>
<td>0.34</td>
<td>0.25</td>
<td>2.2</td>
<td>0.0</td>
<td>0.0</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>±(0.21)</td>
<td>±(0.02)</td>
<td>±(0.04)</td>
<td>±(0.4)</td>
<td>±(0.87)</td>
<td>±(0.0)</td>
<td>±(0.81)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>1.1</td>
<td>0.70</td>
<td>0.48</td>
<td>5.9</td>
<td>0.0</td>
<td>0.0</td>
<td>21.8</td>
</tr>
<tr>
<td>Kruskal-Wallis H-Value</td>
<td></td>
<td>55.98</td>
<td>18.75</td>
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<tr>
<td>Test</td>
<td></td>
<td>(&lt;.01)</td>
<td>(&lt;.01)</td>
<td>(0.37)</td>
<td>(0.26)</td>
<td>(0.18)</td>
<td>(&lt;.01)</td>
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</tr>
<tr>
<td>Significance (</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zone A - Exposed Mudflats without Standing Water
Zone B - Exposed Mudflats with Visible Surface Water
Zone C - Flooded Mudflats with Water Covering the Feet
Zone D - Flooded Mudflats with Water between the Feet and Abdomen
Zone E - Flooded Mudflats with Water Deeper than an Avocet's Abdomen
between the feet and abdomen (Zone D) at Study Site 7 (Zone D- 41.8 percent, Zone B- 39.1 percent) and Study Site 3 (Zone D- 35.1 percent, Zone B- 31.9 percent). A greater proportion of the flock was recorded as resting on exposed mudflats with visible surface water (Zone D) at Study Site 1 (81.1 percent) and Study Site 2 (89.9 percent) than at Study Site 3 (35.1 percent) or 7 (41.8 percent).

Acts of interspecific aggression were observed very infrequently (39 of 277 recorded events) on the intertidal mudflats. On 19 occasions American Avocets were observed to displace Marbled Godwits from a feeding location using the crouch and run behavior and American Avocets twice were displaced by Willets. Smaller shorebirds usually avoided feeding near American Avocets.

Intraspecific aggressive behavior was more common (238 recorded events) than interspecific aggression (39 recorded events) but still relatively uncommon. The behaviors seen most frequently were the crouch run and walk (173 of 238 recorded events), and supplanting behavior (65 of 238 recorded events). One Hundred and ninety one of the 238 (80.3 percent) intraspecific aggressive encounters were observed between 21 January and 15 May when pair formation was underway.

Effects of Season on Use of Intertidal Mudflats. Except for October when American Avocets also fed at the Oxidation Ponds, the percentage of Avocets recorded as feeding at the mudflats was less during December 1983 than all other months (Table 18). In December
Table 18. Effects of Season on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84.  
N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Month</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>X #</td>
<td>77.6</td>
<td>34.0</td>
<td>1.5</td>
<td>25.2</td>
<td>0.82</td>
<td>6.8</td>
<td>95.0</td>
<td>34.2</td>
</tr>
<tr>
<td></td>
<td>(±20.4)</td>
<td>(±7.2)</td>
<td>(±0.41)</td>
<td>(±5.8)</td>
<td>(±0.32)</td>
<td>(±1.6)</td>
<td>(±13.1)</td>
<td>(±8.7)</td>
<td></td>
</tr>
<tr>
<td>(N=210)</td>
<td>X Total</td>
<td>28.2</td>
<td>12.4</td>
<td>0.51</td>
<td>9.2</td>
<td>0.29</td>
<td>2.5</td>
<td>34.3</td>
<td>12.4</td>
</tr>
<tr>
<td>November</td>
<td>X #</td>
<td>55.6</td>
<td>15.6</td>
<td>0.62</td>
<td>11.9</td>
<td>0.12</td>
<td>1.7</td>
<td>163.0</td>
<td>46.7</td>
</tr>
<tr>
<td></td>
<td>(±14.5)</td>
<td>(±3.2)</td>
<td>(±0.17)</td>
<td>(±2.5)</td>
<td>(±0.02)</td>
<td>(±0.41)</td>
<td>(±17.3)</td>
<td>(±11.7)</td>
<td></td>
</tr>
<tr>
<td>(N=359)</td>
<td>X Total</td>
<td>18.8</td>
<td>5.3</td>
<td>0.21</td>
<td>4.0</td>
<td>0.03</td>
<td>0.56</td>
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<tr>
<td>December</td>
<td>X #</td>
<td>54.4</td>
<td>9.5</td>
<td>0.74</td>
<td>12.5</td>
<td>0.27</td>
<td>1.6</td>
<td>189.3</td>
<td>25.1</td>
</tr>
<tr>
<td></td>
<td>(±13.2)</td>
<td>(±1.9)</td>
<td>(±0.22)</td>
<td>(±2.5)</td>
<td>(±0.02)</td>
<td>(±0.11)</td>
<td>(±19.1)</td>
<td>(±6.1)</td>
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<tr>
<td>(N=600)</td>
<td>X Total</td>
<td>18.5</td>
<td>3.2</td>
<td>0.23</td>
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<td>0.09</td>
<td>0.54</td>
<td>64.5</td>
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<tr>
<td>October</td>
<td>X #</td>
<td>38.8</td>
<td>14.8</td>
<td>0.65</td>
<td>4.7</td>
<td>2.2</td>
<td>1.3</td>
<td>219.2</td>
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<td>(±10.1)</td>
<td>(±3.0)</td>
<td>(±0.10)</td>
<td>(±1.1)</td>
<td>(±0.42)</td>
<td>(±0.30)</td>
<td>(±24.3)</td>
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<td>X Total</td>
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<td>1.6</td>
<td>0.74</td>
<td>0.42</td>
<td>73.5</td>
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<td>X #</td>
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<td>0.56</td>
<td>188.0</td>
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</tr>
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<td>(±1.9)</td>
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<td>(±0.42)</td>
<td>(±0.28)</td>
<td>(±0.10)</td>
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<td>14.7</td>
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<td>0.20</td>
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<td>1.0</td>
<td>17.8</td>
<td>0.44</td>
<td>2.5</td>
<td>133.2</td>
<td>37.0</td>
</tr>
<tr>
<td>1983</td>
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<td>(±18.7)</td>
<td>(±1.31)</td>
<td>(±0.20)</td>
<td>(±3.7)</td>
<td>(±0.04)</td>
<td>(±0.60)</td>
<td>(±13.8)</td>
<td>(±8.8)</td>
</tr>
<tr>
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<td>31.4</td>
<td>2.4</td>
<td>0.35</td>
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<td>0.85</td>
<td>45.9</td>
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<tr>
<td>January</td>
<td>X #</td>
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<td>5.2</td>
<td>0.50</td>
<td>2.6</td>
<td>210.4</td>
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<td>1984</td>
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<td>(±2.3)</td>
<td>(±0.3)</td>
<td>(±1.1)</td>
<td>(±0.09)</td>
<td>(±0.63)</td>
<td>(±22.3)</td>
<td>(±3.3)</td>
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<tr>
<td>(N=366)</td>
<td>X Total</td>
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<td>4.1</td>
<td>0.56</td>
<td>1.9</td>
<td>0.17</td>
<td>0.92</td>
<td>75.6</td>
<td>4.6</td>
</tr>
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</table>
Table 18. Effects of Season on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. 

$N =$ Number of Scans. $X \# =$ Mean Number ($\pm$ S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Month</th>
<th>Rest ($\pm$)</th>
<th>Preen ($\pm$)</th>
<th>Comfort ($\pm$)</th>
<th>Alert ($\pm$)</th>
<th>Swim ($\pm$)</th>
<th>Walk ($\pm$)</th>
<th>Feed ($\pm$)</th>
<th>Fly ($\pm$)</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>50.4 ($\pm$13.1)</td>
<td>10.2 ($\pm$2.5)</td>
<td>0.49 ($\pm$0.14)</td>
<td>4.2 ($\pm$1.0)</td>
<td>0.13 ($\pm$0.02)</td>
<td>2.6 ($\pm$0.65)</td>
<td>175.0 ($\pm$18.6)</td>
<td>10.2 ($\pm$2.6)</td>
<td>253.1</td>
</tr>
<tr>
<td>March</td>
<td>31.9 ($\pm$8.3)</td>
<td>7.5 ($\pm$1.5)</td>
<td>0.48 ($\pm$0.15)</td>
<td>10.9 ($\pm$0.20)</td>
<td>0.30 ($\pm$0.06)</td>
<td>2.4 ($\pm$0.58)</td>
<td>86.7 ($\pm$9.4)</td>
<td>8.0 ($\pm$2.0)</td>
<td>148.2</td>
</tr>
<tr>
<td>April</td>
<td>21.7 ($\pm$5.7)</td>
<td>6.9 ($\pm$1.5)</td>
<td>0.52 ($\pm$0.11)</td>
<td>12.7 ($\pm$2.9)</td>
<td>0.51 ($\pm$0.10)</td>
<td>1.3 ($\pm$0.31)</td>
<td>52.1 ($\pm$5.7)</td>
<td>7.2 ($\pm$1.9)</td>
<td>103.0</td>
</tr>
<tr>
<td>May</td>
<td>19.2 ($\pm$5.1)</td>
<td>2.3 ($\pm$0.50)</td>
<td>0.42 ($\pm$0.14)</td>
<td>6.2 ($\pm$1.3)</td>
<td>0.0 ($\pm$0.0)</td>
<td>0.10 ($\pm$0.02)</td>
<td>43.8 ($\pm$4.7)</td>
<td>2.3 ($\pm$0.59)</td>
<td>74.3</td>
</tr>
</tbody>
</table>

Kruskal-Wallis H-Value: 57.29, Test (<.01) (<.01) (<.01) (<.01) (<.01) (<.01) (<.01) (<.01) (<.01) Significance ( )
1983, 35.9 cm of rain were recorded. This was about 2 times the average December monthly rainfall from 1972 to 1982 (NOAA 1972-1984, Appendix G).

The percentage of American Avocets recorded as resting and alert at the mudflats was greatest during October 1982 (Resting 28.2 percent, Alert 9.2 percent) and December 1983 (Resting 31.4 percent, Alert 6.1 percent). A greater percentage of American Avocets also was recorded as preening (12.4 percent) and flying (12.4 percent) in October 1982 than during the other months (Table 18).

Effects of Tide Level and Tide Action on Use of Intertidal Mudflats. An average of 69.6 percent of all American Avocets were feeding when tide levels were between 1.6 feet and 4.0 feet. Significantly (alpha=.0003) greater numbers of Avocets fed when tides were between 1.6 feet and 4.0 feet than at the other tide heights. American Avocets seldom fed on the mudflats in large numbers at tides above 4.5 feet (Table 19). I observed swimming American Avocets feeding on invertebrates at the mouth of Butcher Slough (Figure 2) at tide heights between 6.6 feet and 7.5 feet on 3-4 November, 1983. The range of tides used for feeding was greater at Study Site 1 where more American Avocets fed along the channels at tide heights below 1.6 feet than at the other sites. The average range of tide heights used by feeding Avocets in Study Sites 2, 3, and 7 was 2.6-4.5 feet.

Although I did not record the distance Avocets fed from the tide edge it is my general impression that they generally selected foraging locations near the tide edge. American Avocets switched feeding depths as the tide height changed. They fed primarily on
Table 19. Effects of Tide Levels on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest (±)</th>
<th>Preen (±)</th>
<th>Comfort Movements (±)</th>
<th>Alert (±)</th>
<th>Swim (±)</th>
<th>Walk (±)</th>
<th>Feed (±)</th>
<th>Fly (±)</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minus</td>
<td>X #</td>
<td>255.4</td>
<td>2.6</td>
<td>0.61</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.30</td>
<td>13.6</td>
</tr>
<tr>
<td>(N=38)</td>
<td>% Total</td>
<td>92.6</td>
<td>0.94</td>
<td>0.22</td>
<td>1.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.11</td>
<td>5.0</td>
</tr>
<tr>
<td>0.0-0.5</td>
<td>X #</td>
<td>122.9</td>
<td>11.0</td>
<td>0.65</td>
<td>53.5</td>
<td>0.0</td>
<td>0.65</td>
<td>60.4</td>
<td>29.5</td>
</tr>
<tr>
<td>(N=134)</td>
<td>% Total</td>
<td>44.1</td>
<td>4.0</td>
<td>0.23</td>
<td>19.2</td>
<td>0.0</td>
<td>0.23</td>
<td>21.7</td>
<td>10.6</td>
</tr>
<tr>
<td>0.6-1.0</td>
<td>X #</td>
<td>69.4</td>
<td>18.8</td>
<td>0.44</td>
<td>28.0</td>
<td>0.39</td>
<td>0.64</td>
<td>157.9</td>
<td>14.3</td>
</tr>
<tr>
<td>(N=165)</td>
<td>% Total</td>
<td>25.4</td>
<td>6.9</td>
<td>0.16</td>
<td>10.2</td>
<td>0.14</td>
<td>0.23</td>
<td>57.7</td>
<td>5.2</td>
</tr>
<tr>
<td>1.1-1.5</td>
<td>X #</td>
<td>110.3</td>
<td>23.4</td>
<td>7.2</td>
<td>18.1</td>
<td>0.15</td>
<td>3.6</td>
<td>123.1</td>
<td>3.2</td>
</tr>
<tr>
<td>(N=173)</td>
<td>% Total</td>
<td>38.2</td>
<td>8.1</td>
<td>2.5</td>
<td>10.6</td>
<td>0.05</td>
<td>1.3</td>
<td>42.6</td>
<td>1.1</td>
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<tr>
<td>1.6-2.0</td>
<td>X #</td>
<td>56.8</td>
<td>10.7</td>
<td>0.86</td>
<td>10.6</td>
<td>0.31</td>
<td>5.0</td>
<td>181.3</td>
<td>19.2</td>
</tr>
<tr>
<td>(N=252)</td>
<td>% Total</td>
<td>20.0</td>
<td>3.8</td>
<td>0.30</td>
<td>3.7</td>
<td>0.11</td>
<td>1.8</td>
<td>63.6</td>
<td>6.7</td>
</tr>
<tr>
<td>2.1-2.5</td>
<td>X #</td>
<td>48.3</td>
<td>8.3</td>
<td>0.14</td>
<td>7.2</td>
<td>0.46</td>
<td>1.8</td>
<td>207.7</td>
<td>11.7</td>
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<tr>
<td>(N=240)</td>
<td>% Total</td>
<td>16.9</td>
<td>2.9</td>
<td>0.05</td>
<td>2.5</td>
<td>0.16</td>
<td>0.63</td>
<td>72.7</td>
<td>4.1</td>
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<tr>
<td>2.6-3.0</td>
<td>X #</td>
<td>39.1</td>
<td>15.4</td>
<td>0.73</td>
<td>3.4</td>
<td>0.20</td>
<td>3.4</td>
<td>204.0</td>
<td>12.4</td>
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<tr>
<td>(N=447)</td>
<td>% Total</td>
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<td>5.9</td>
<td>0.26</td>
<td>1.2</td>
<td>0.07</td>
<td>1.2</td>
<td>72.9</td>
<td>4.4</td>
</tr>
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</table>
Table 19. Effects of Tide Levels on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X $\# = \text{Mean Number (± S.D.) of Birds. (continued)}$

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Behaviors</th>
<th>Rest (± SD)</th>
<th>Preen (± SD)</th>
<th>Comfort Movements (± SD)</th>
<th>Alert (± SD)</th>
<th>Swim (± SD)</th>
<th>Walk (± SD)</th>
<th>Feed (± SD)</th>
<th>Fly (± SD)</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1-3.5 (N=600)</td>
<td>X $#$</td>
<td>38.5 (±9.4)</td>
<td>10.3 (±2.3)</td>
<td>0.67 (±0.13)</td>
<td>6.7 (±1.3)</td>
<td>0.21 (±0.04)</td>
<td>2.1 (±0.46)</td>
<td>190.4 (±20.6)</td>
<td>8.2 (±2.0)</td>
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<td>0.08</td>
<td>0.80</td>
<td>74.1</td>
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<tr>
<td>3.6-4.0 (N=711)</td>
<td>X $#$</td>
<td>47.9 (±12.4)</td>
<td>12.1 (±2.3)</td>
<td>1.2 (±0.21)</td>
<td>14.8 (±3.3)</td>
<td>1.7 (±0.33)</td>
<td>3.1 (±0.66)</td>
<td>175.0 (±18.3)</td>
<td>23.5 (±5.1)</td>
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</tr>
<tr>
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<td>Total</td>
<td>17.1</td>
<td>4.3</td>
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<td>5.3</td>
<td>0.62</td>
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<tr>
<td>4.1-4.5 (N=511)</td>
<td>X $#$</td>
<td>102.0 (±66.8)</td>
<td>15.2 (±3.0)</td>
<td>2.0 (±0.42)</td>
<td>8.1 (±1.7)</td>
<td>2.7 (±0.54)</td>
<td>2.1 (±0.49)</td>
<td>118.7 (±2.6)</td>
<td>34.9 (±8.3)</td>
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<td>0.96</td>
<td>0.72</td>
<td>41.5</td>
<td>12.2</td>
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<tr>
<td>4.6-5.0 (N=269)</td>
<td>X $#$</td>
<td>118.8 (±30.2)</td>
<td>24.9 (±5.0)</td>
<td>1.7 (±0.32)</td>
<td>18.3 (±3.0)</td>
<td>5.1 (±1.0)</td>
<td>3.0 (±0.74)</td>
<td>65.8 (±6.98)</td>
<td>74.4 (±18.6)</td>
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<td>38.1</td>
<td>8.0</td>
<td>0.56</td>
<td>5.9</td>
<td>1.6</td>
<td>0.96</td>
<td>21.1</td>
<td>23.9</td>
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</tr>
<tr>
<td>5.1-5.5 (N=135)</td>
<td>X $#$</td>
<td>105.0 (±27.1)</td>
<td>17.3 (±3.7)</td>
<td>40.4 (±8.6)</td>
<td>10.1 (±2.0)</td>
<td>6.4 (±1.5)</td>
<td>7.9 (±1.9)</td>
<td>56.8 (±6.0)</td>
<td>71.9 (±17.9)</td>
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<td>20.3</td>
<td>25.7</td>
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<tr>
<td>5.6-6.0 (N=85)</td>
<td>X $#$</td>
<td>179.2 (±46.6)</td>
<td>12.1 (±2.3)</td>
<td>1.3 (±0.27)</td>
<td>17.4 (±3.4)</td>
<td>11.8 (±2.2)</td>
<td>9.1 (±2.0)</td>
<td>17.8 (±1.9)</td>
<td>30.8 (±7.9)</td>
<td>279.5</td>
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<td>Total</td>
<td>64.1</td>
<td>4.3</td>
<td>0.45</td>
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<td>4.2</td>
<td>3.2</td>
<td>6.4</td>
<td>11.1</td>
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</table>
Table 19. Effects of Tide Levels on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1-6.5</td>
<td>X %</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(N-23)</td>
<td>208.3</td>
<td>7.1</td>
<td>3.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>70.6</td>
<td>0.0</td>
</tr>
<tr>
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<td>(±54.1)</td>
<td>(±1.40)</td>
<td>(±0.61)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±7.5)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6.6-7.0</td>
<td>X %</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(N-20)</td>
<td>95.9</td>
<td>1.8</td>
<td>0.99</td>
<td>0.0</td>
<td>60.6</td>
<td>0.0</td>
<td>98.9</td>
<td>73.0</td>
<td>331.1</td>
</tr>
<tr>
<td></td>
<td>(±22.9)</td>
<td>(±0.36)</td>
<td>(±0.220)</td>
<td>(±0.0)</td>
<td>(±14.2)</td>
<td>(±0.0)</td>
<td>(±11.8)</td>
<td>(±24.1)</td>
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</tr>
<tr>
<td></td>
<td>% Total</td>
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<td></td>
<td></td>
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<td>(.017)</td>
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<td>(.131)</td>
<td>(&lt;.01)</td>
<td>(&lt;.01)</td>
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exposed mudflats with visible surface water at tide levels below 1.0 feet, but fed on flooded mudflats with water covering the feet when tides were between 2.1 feet and 3.5 feet, and on mudflats with water between the feet and abdomen when tides were between 3.6 feet and 5.0 feet (Table 20).

Significantly (alpha=.0003) fewer American Avocets rested when tide levels were between 2.6 feet and 4.0 feet (Table 19) than at other tide levels. At tide heights above 4.0 feet the number and proportion of the flock recorded as resting increased, but they were seldom seen resting on feeding areas when tides exceeded 6.5 feet (Table 19). Rather at these higher tides they moved to roosts.

The number and percentage of American Avocets recorded as resting on flooded mudflats with water covering the feet was highest when the tides were between 2.1 feet and 6.1 feet (Table 21). The proportion of the flock recorded as resting on flooded mudflats with water between the feet and abdomen increased at tide above 3.1 feet, and peaked at levels between 4.6 and 5.0 feet (Table 21). After 5.0 feet they flew to the roosting islands in Klopp Lake. American Avocets were never observed resting on flooded mudflats with water levels between the feet and abdomen when tides were below 0.6 feet. American Avocets were observed to rest on exposed mudflats with visible surface water at all tide heights including high tides. Significantly (alpha=.0003) fewer American Avocets rested on exposed mudflats with visible surface water when tides were between 2.1 feet and 4.0 feet than when tides were less than 1.0 feet (Table 21). The percentage of American Avocets recorded as resting on mudflats with
Table 20. Effects of Water Depth on Number of Feeding American Avocets per Scan in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
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<tr>
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<tr>
<td>X #</td>
<td>5.0 (±0.63)</td>
<td>0.02 (±0.01)</td>
<td>0.0 (±0.0)</td>
<td>55.4 (±6.8)</td>
<td>0.0 (±0.0)</td>
<td>60.4</td>
</tr>
<tr>
<td>% Total</td>
<td>8.3</td>
<td>0.03</td>
<td>0.0</td>
<td>91.7</td>
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</tr>
<tr>
<td>0.6-1.0 (N=165)</td>
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<tr>
<td>X #</td>
<td>61.8 (±7.6)</td>
<td>4.3 (±0.65)</td>
<td>0.10 (±0.02)</td>
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<td>0.0 (±0.0)</td>
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<td>1.1-1.5 (N=173)</td>
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<tr>
<td>X #</td>
<td>56.4 (±6.9)</td>
<td>8.1 (±1.9)</td>
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<td>58.4 (±6.2)</td>
<td>22.2 (±4.4)</td>
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<tr>
<td>X #</td>
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<td>5.1 (±0.73)</td>
<td>0.02 (±&lt;0.01)</td>
<td>119.5 (±12.5)</td>
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<tr>
<td>X #</td>
<td>123.5 (±11.8)</td>
<td>6.1 (±0.85)</td>
<td>0.08 (±&lt;0.01)</td>
<td>77.2 (±6.3)</td>
<td>0.83 (±0.11)</td>
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<td>0.04</td>
<td>37.7</td>
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<tr>
<td>X #</td>
<td>117.6 (±8.7)</td>
<td>25.0 (±2.9)</td>
<td>0.05 (±&lt;0.01)</td>
<td>56.5 (±5.8)</td>
<td>0.40 (±0.07)</td>
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<tr>
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<td>12.5</td>
<td>0.02</td>
<td>28.3</td>
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Table 20. Effects of Water Depth on Number of Feeding American Avocets per Scan in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
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<td>(±0.09)</td>
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<td>(±0.63)</td>
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Table 20. Effects of Water Depth on Number of Feeding American Avocets per Scan in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
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<tr>
<th>Water Depth</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
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Table 21. Effects of Water Depth on Number of Resting American Avocets per Scan in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
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<th>Water Depth</th>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
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<td>X #</td>
<td>(±2.3)</td>
<td>(±0.14)</td>
<td>(±0.0)</td>
<td>(±10.3)</td>
<td>(±1.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Total</td>
<td>15.9</td>
<td>1.0</td>
<td>0.0</td>
<td>75.7</td>
<td>7.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6-3.0</td>
<td>(N=447)</td>
<td>7.4</td>
<td>2.0</td>
<td>0.0</td>
<td>29.3</td>
<td>1.8</td>
<td>40.5</td>
</tr>
<tr>
<td>X #</td>
<td>(±2.0)</td>
<td>(±0.66)</td>
<td>(±0.0)</td>
<td>(±7.7)</td>
<td>(±0.33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Total</td>
<td>18.3</td>
<td>4.9</td>
<td>0.0</td>
<td>72.4</td>
<td>4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 21. Effects of Water Depth on Number of Resting American Avocets per Scan in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X $\bar{=} =$ Mean Number ($\pm$ S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1-3.5</td>
<td>X $\bar{=} =$ (1.9) (1.2) (0.0) (5.9) (0.19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37.8</td>
</tr>
<tr>
<td>(N-600)</td>
<td>X Total</td>
<td>19.2</td>
<td>12.7</td>
<td>0.0</td>
<td>67.4</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>3.6-4.0</td>
<td>X $\bar{=} =$ (4.3) (4.8) (0.0) (2.0) (0.02)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.9</td>
</tr>
<tr>
<td>(N-711)</td>
<td>X Total</td>
<td>36.8</td>
<td>39.9</td>
<td>0.0</td>
<td>22.9</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>4.1-4.5</td>
<td>X $\bar{=} =$ (10.7) (12.5) (0.0) (2.9) (0.49)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125.5</td>
</tr>
<tr>
<td>(N-511)</td>
<td>X Total</td>
<td>34.6</td>
<td>42.5</td>
<td>0.0</td>
<td>21.1</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>4.6-5.0</td>
<td>X $\bar{=} =$ (11.3) (11.6) (0.0) (2.6) (0.01)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>118.8</td>
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<tr>
<td>(N-269)</td>
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<td>43.7</td>
<td>44.7</td>
<td>0.0</td>
<td>11.5</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>5.1-5.5</td>
<td>X $\bar{=} =$ (7.2) (9.2) (0.0) (8.1) (0.0)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>105.0</td>
</tr>
<tr>
<td>(N-135)</td>
<td>X Total</td>
<td>29.3</td>
<td>37.4</td>
<td>0.0</td>
<td>33.3</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>5.6-6.0</td>
<td>X $\bar{=} =$ (8.7) (20.2) (0.0) (14.7) (0.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>179.2</td>
</tr>
<tr>
<td>(N-85)</td>
<td>X Total</td>
<td>23.2</td>
<td>43.3</td>
<td>0.0</td>
<td>31.5</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>6.1-6.5</td>
<td>X $\bar{=} =$ (13.1) (5&lt;.01) (0.0) (38.9) (0.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>208.2</td>
</tr>
<tr>
<td>(N-23)</td>
<td>X Total</td>
<td>29.7</td>
<td>0.18</td>
<td>0.0</td>
<td>70.1</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>
Table 21. Effects of Water Depth on Number of Resting American Avocets per Scan in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X $\bar{\theta}$ = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Habitat</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Zone E</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.6–7.0</td>
<td>X $\bar{\theta}$</td>
<td>2.5</td>
<td>0.0</td>
<td>0.0</td>
<td>93.4</td>
<td>0.0</td>
<td>95.9</td>
</tr>
<tr>
<td>(N=20)</td>
<td></td>
<td>(±0.04)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±24.3)</td>
<td>(±0.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>1.7</td>
<td>0.0</td>
<td>0.0</td>
<td>97.3</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>7.1–7.5</td>
<td>X $\bar{\theta}$</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.2</td>
<td>0.0</td>
<td>1.2</td>
</tr>
<tr>
<td>(N=15)</td>
<td></td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±0.0)</td>
<td>(±&lt;.01)</td>
<td>(±0.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kruskal-Wallis H-Value</td>
<td>54.87</td>
<td>120.70</td>
<td></td>
<td>89.85</td>
<td>7.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test</td>
<td>(&gt;.01)</td>
<td>(&gt;.01)</td>
<td></td>
<td>(&gt;.01)</td>
<td>(.241)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>(~)</td>
<td>(~)</td>
<td></td>
<td>(~)</td>
<td>(~)</td>
<td></td>
</tr>
</tbody>
</table>
visible surface water was greatest when tides were below 4.0 feet (Table 21).

No significant (alpha=.0003) comparisons were detected in the number of alert American Avocets according to tide height (Table 19). The percentage of American Avocets recorded as alert was lowest when tides were between 2.6 and 4.5 feet (tide heights used primarily for feeding, Table 19).

American Avocets preened in significantly (alpha=.0003) greater numbers when the tide was between 0.6 and 1.5 feet and between 4.6 and 5.5 feet than at the other tide levels (Table 19). Preening activity seemed to increase before and after periods of resting. At the higher tide levels (between 4.6 and 5.5 feet) American Avocets began to fly to roosts but at the lower tide levels (between 0.6 and 2.0 feet) they remained on the flats where they rested, fed and preened. No significant (alpha=.0003) differences were detected in the number of American Avocets engaged in comfort movements or walking relative to tide height (Table 19).

During ebb tides 61.3 percent of the birds scanned were recorded as feeding (Table 22). American Avocets fed at lower tide heights on flood compared to ebb tides at Study Sites 1 (Figure 1, Flood 0.6-4.0 feet, Ebb 2.6-5.0 feet), Study Site 2 and 3 (Figure 1, Flood 2.6-4.0 feet, Ebb 3.1-4.5 feet) than at Study Site 7 (Figure 1, Flood and Ebb 1.6-4.0 feet, Table 22).

Although the number of American Avocets resting was significantly (alpha=.003) greater on flood tides than ebb tides the average proportion of the flock resting was about equal on flood and ebb tides (Table 22). The number and percent of American Avocets
Table 22. Effects of Tide Action on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Action</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood (N=2089)</td>
<td>77.5 (±20.2)</td>
<td>15.7 (±3.2)</td>
<td>1.2 (±0.25)</td>
<td>14.4 (±3.1)</td>
<td>1.6 (±0.12)</td>
<td>3.5 (±0.84)</td>
<td>140.3 (±14.8)</td>
<td>24.6 (±6.0)</td>
<td>278.7</td>
</tr>
<tr>
<td>Ebb (N=1739)</td>
<td>68.6 (±17.5)</td>
<td>11.7 (±2.2)</td>
<td>1.6 (±0.34)</td>
<td>7.6 (±1.6)</td>
<td>2.7 (±0.53)</td>
<td>3.0 (±0.72)</td>
<td>175.0 (±18.6)</td>
<td>15.4 (±3.8)</td>
<td>285.4</td>
</tr>
</tbody>
</table>

Kruskal-Wallis H-Value Test

<table>
<thead>
<tr>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.009)</td>
<td>(&lt;0.01)</td>
<td>(0.733)</td>
<td>(0.004)</td>
<td>(0.395)</td>
<td>(0.009)</td>
<td>(0.054)</td>
<td>(&lt;0.01)</td>
<td></td>
</tr>
</tbody>
</table>
recorded as preening or being alert was greater on flood than ebb tides (Table 22).

**Effects of Weather on Use of Intertidal Mudflats.** No significant (alpha=.0006) comparisons were detected in the number of feeding American Avocets at different air temperatures (Table 23). At temperatures greater than 18°C, the average proportion of the flock recorded as feeding was only 37.4 percent. The proportion of the flock recorded as feeding on exposed mudflats with visible surface water was greater between 11°C and 16°C (average proportion of flock-24.7 percent) than at temperatures below 10°C (12.5 percent) and above 18°C (4.6 percent, Table 23). At temperatures above 18°C the greatest proportion of the flock fed on flooded mudflats with water between the feet and abdomen (60.9 percent, Table 23).

No significant (alpha=.0006) comparisons were detected in the number of resting American Avocets on the intertidal mudflats at different air temperatures (Table 23). The proportion of the flock resting remained fairly equal at all air temperatures except at 16°C and 17°C when the proportion resting was lower (Table 23).

The number of American Avocets and the proportion of the flock recorded as alert or preening was less at temperatures below 10°C than when temperatures were between 11°C and 24°C (Table 23).

American Avocets were never observed to feed in strong winds. During moderate winds 22.9 percent of the total flock was recorded as feeding whereas 50.6 percent and 59.3 percent of the flock fed during light and calm winds respectively (Table 24).
Table 23. Effects of Air Temperature on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Air Temperature (°C)</th>
<th>Behaviors</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 10°C (N=584)</td>
<td>X #</td>
<td>84.8</td>
<td>7.5</td>
<td>4.6</td>
<td>5.3</td>
<td>5.0</td>
<td>2.5</td>
<td>147.3</td>
<td>23.2</td>
<td>280.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±14.8)</td>
<td>(±1.1)</td>
<td>(±0.86)</td>
<td>(±0.94)</td>
<td>(±0.44)</td>
<td>(±0.53)</td>
<td>(±13.6)</td>
<td>(±5.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>30.3</td>
<td>2.7</td>
<td>1.7</td>
<td>1.9</td>
<td>1.8</td>
<td>0.91</td>
<td>52.6</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>11°C (N=504)</td>
<td>X #</td>
<td>80.0</td>
<td>10.7</td>
<td>0.81</td>
<td>23.9</td>
<td>0.12</td>
<td>3.1</td>
<td>141.1</td>
<td>31.5</td>
<td>291.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±15.2)</td>
<td>(±2.8)</td>
<td>(±0.14)</td>
<td>(±4.3)</td>
<td>(±0.03)</td>
<td>(±0.77)</td>
<td>(±14.9)</td>
<td>(±7.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>27.4</td>
<td>3.7</td>
<td>0.27</td>
<td>8.2</td>
<td>0.04</td>
<td>1.1</td>
<td>48.5</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>12°C (N=376)</td>
<td>X #</td>
<td>83.2</td>
<td>11.0</td>
<td>0.46</td>
<td>18.1</td>
<td>1.1</td>
<td>3.1</td>
<td>145.5</td>
<td>20.7</td>
<td>283.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±22.6)</td>
<td>(±2.3)</td>
<td>(±0.10)</td>
<td>(±3.8)</td>
<td>(±0.22)</td>
<td>(±0.77)</td>
<td>(±15.8)</td>
<td>(±5.3)</td>
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</tr>
<tr>
<td></td>
<td>% Total</td>
<td>29.4</td>
<td>3.9</td>
<td>0.16</td>
<td>6.4</td>
<td>0.38</td>
<td>1.1</td>
<td>51.4</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>13°C (N=668)</td>
<td>X #</td>
<td>80.7</td>
<td>14.3</td>
<td>0.76</td>
<td>15.2</td>
<td>3.0</td>
<td>2.6</td>
<td>139.4</td>
<td>33.7</td>
<td>289.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±21.9)</td>
<td>(±2.9)</td>
<td>(±0.15)</td>
<td>(±3.2)</td>
<td>(±0.61)</td>
<td>(±0.64)</td>
<td>(±14.8)</td>
<td>(±8.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>27.8</td>
<td>5.0</td>
<td>0.26</td>
<td>5.3</td>
<td>1.1</td>
<td>0.90</td>
<td>48.1</td>
<td>11.6</td>
<td></td>
</tr>
<tr>
<td>14°C (N=516)</td>
<td>X #</td>
<td>58.1</td>
<td>15.4</td>
<td>1.7</td>
<td>9.1</td>
<td>0.38</td>
<td>2.1</td>
<td>183.1</td>
<td>17.7</td>
<td>287.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±15.2)</td>
<td>(±2.2)</td>
<td>(±0.34)</td>
<td>(±1.9)</td>
<td>(±0.07)</td>
<td>(±0.51)</td>
<td>(±19.4)</td>
<td>(±4.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>20.2</td>
<td>5.3</td>
<td>0.58</td>
<td>3.2</td>
<td>0.13</td>
<td>0.72</td>
<td>63.7</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>15°C (N=616)</td>
<td>X #</td>
<td>76.5</td>
<td>9.5</td>
<td>0.72</td>
<td>7.2</td>
<td>0.09</td>
<td>2.1</td>
<td>163.0</td>
<td>19.7</td>
<td>278.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±19.9)</td>
<td>(±1.9)</td>
<td>(±0.16)</td>
<td>(±1.1)</td>
<td>(±0.01)</td>
<td>(±0.51)</td>
<td>(±17.4)</td>
<td>(±5.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>27.4</td>
<td>3.4</td>
<td>0.26</td>
<td>2.6</td>
<td>0.03</td>
<td>0.74</td>
<td>58.5</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>16°C (N=317)</td>
<td>X #</td>
<td>57.3</td>
<td>20.3</td>
<td>2.0</td>
<td>14.2</td>
<td>13.1</td>
<td>3.3</td>
<td>153.6</td>
<td>19.2</td>
<td>282.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(±14.9)</td>
<td>(±4.1)</td>
<td>(±0.42)</td>
<td>(±2.9)</td>
<td>(±2.7)</td>
<td>(±0.81)</td>
<td>(±18.3)</td>
<td>(±4.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Total</td>
<td>20.4</td>
<td>7.2</td>
<td>0.69</td>
<td>6.5</td>
<td>1.7</td>
<td>1.8</td>
<td>54.8</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>
Table 23. Effects of Air Temperature on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Air Temperature (°C)</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>17°C (N=291)</td>
<td>45.3 (±11.8)</td>
<td>18.7 (±5.2)</td>
<td>0.77 (±0.16)</td>
<td>8.1 (±1.8)</td>
<td>5.1 (±1.0)</td>
<td>1.8 (±0.44)</td>
<td>193.0 (±21.5)</td>
<td>13.0 (±3.4)</td>
<td>285.7</td>
</tr>
<tr>
<td>X Total</td>
<td>15.9</td>
<td>6.3</td>
<td>0.27</td>
<td>2.8</td>
<td>1.8</td>
<td>0.63</td>
<td>67.5</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>18°C - 24°C (N=356)</td>
<td>79.2 (±21.5)</td>
<td>25.5 (±5.2)</td>
<td>1.6 (±0.35)</td>
<td>7.7 (±1.7)</td>
<td>0.13 (±0.02)</td>
<td>2.9 (±0.68)</td>
<td>102.0 (±19.8)</td>
<td>34.4 (±8.7)</td>
<td>253.5</td>
</tr>
<tr>
<td>X Total</td>
<td>29.0</td>
<td>9.4</td>
<td>0.59</td>
<td>2.8</td>
<td>0.04</td>
<td>1.1</td>
<td>37.3</td>
<td>19.8</td>
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</tr>
<tr>
<td>Kruskal-Wallis H-Value</td>
<td>40.13</td>
<td>17.96</td>
<td>20.98</td>
<td>15.17</td>
<td>18.39</td>
<td>16.34</td>
<td>27.00</td>
<td>12.94</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>(&lt;.01)</td>
<td>(.022)</td>
<td>(.007)</td>
<td>(.056)</td>
<td>(.016)</td>
<td>(.038)</td>
<td>(.001)</td>
<td>(.114)</td>
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<tr>
<td>Significance ( )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Table 24. Effects of Windspeed on Behavior and Number of American Avocets per Scan on the Intertidal Mudflats in North Humboldt Bay, California. Winters of 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Wind Speed (mph.)</th>
<th>Rest</th>
<th>Fren</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm (1-3 mph)</td>
<td>63.7</td>
<td>12.0</td>
<td>1.4</td>
<td>10.3</td>
<td>1.9</td>
<td>2.2</td>
<td>168.0</td>
<td>23.7</td>
<td>283.0</td>
</tr>
<tr>
<td>(N=2660) % Total</td>
<td>22.5</td>
<td>4.2</td>
<td>0.49</td>
<td>3.6</td>
<td>0.66</td>
<td>0.79</td>
<td>59.3</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Light (4-12 mph)</td>
<td>77.0</td>
<td>12.3</td>
<td>0.9</td>
<td>15.2</td>
<td>3.6</td>
<td>5.3</td>
<td>118.9</td>
<td>31.5</td>
<td>264.7</td>
</tr>
<tr>
<td>(N=934) % Total</td>
<td>26.1</td>
<td>4.2</td>
<td>0.30</td>
<td>5.2</td>
<td>1.2</td>
<td>1.8</td>
<td>50.6</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>Moderate (13-31 mph)</td>
<td>149.1</td>
<td>7.9</td>
<td>0.55</td>
<td>32.0</td>
<td>1.3</td>
<td>2.9</td>
<td>64.2</td>
<td>21.3</td>
<td>280.2</td>
</tr>
<tr>
<td>(N=231) % Total</td>
<td>53.1</td>
<td>2.8</td>
<td>0.19</td>
<td>11.8</td>
<td>0.50</td>
<td>1.1</td>
<td>22.9</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>Strong (32-46 mph)</td>
<td>202.0</td>
<td>59.0</td>
<td>4.0</td>
<td>13.0</td>
<td>0.0</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
<td>281.0</td>
</tr>
<tr>
<td>(N=3) % Total</td>
<td>71.9</td>
<td>21.0</td>
<td>1.4</td>
<td>2.5</td>
<td>0.0</td>
<td>1.1</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Kruskal-Wallis H-Value Test</td>
<td>46.61</td>
<td>4.61</td>
<td>1.37</td>
<td>5.18</td>
<td>2.56</td>
<td>6.49</td>
<td>10.67</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Significance ( )</td>
<td>(&lt;.01)</td>
<td>(.245)</td>
<td>(.526)</td>
<td>(.076)</td>
<td>(.277)</td>
<td>(.044)</td>
<td>(.005)</td>
<td>(.583)</td>
<td></td>
</tr>
</tbody>
</table>
Strong winds occurred only 3 times during behavioral observations at the intertidal mudflats. During moderate winds 53.1 percent of the total flock was resting compared to 26.1 percent and 22.5 percent during light and calm winds respectively (Table 24).

No significant (alpha=.0015) comparisons were detected in the number of American Avocets recorded as flying, preening, swimming, and performing comfort movements at different wind speeds (Table 24).

No significant (alpha=.0007) differences were detected in the number of American Avocets feeding under different wind directions (Table 25). Except when winds were from the east, (only 33 times out of 2389 scans) the proportion of the flock observed feeding remained about equal (range 47.8 percent to 58.2 percent, Table 25).

No significant (alpha=.0007) differences were detected in the number of American Avocets resting on mudflats under different wind directions. The average proportion of the flock recorded as resting was about equal under northerly (20.7 percent), southeasterly (27.4 percent), southwesterly (21.9 percent), westerly (26.9 percent), and northwesterly (20.8 percent) winds (Table 25).

The proportion of the flock recorded as preening was less when winds were from the South (1.9 percent) and Southeast (2.4 percent) than when they were from the North (7.8 percent), East (7.2 percent), West (6.5 percent), and Northwest (4.6 percent, Table 25).

American Avocets were never observed feeding during heavy rains even at tide heights (1.6 to 4.0 feet) normally selected for feeding (Table 26). American Avocets resumed feeding if the rain stopped or lessened in intensity. The number of American Avocets feeding during foggy conditions was significantly greater
Table 25. Effects of Wind Direction on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Wind Direction</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (H-141)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>58.6</td>
<td>22.1</td>
<td>4.8</td>
<td>8.2</td>
<td>11.7</td>
<td>2.5</td>
<td>154.0</td>
<td>39.8</td>
<td>282.6</td>
</tr>
<tr>
<td>± Total</td>
<td>20.7</td>
<td>7.8</td>
<td>1.7</td>
<td>2.9</td>
<td>4.1</td>
<td>1.4</td>
<td>47.8</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>East (H-33)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>X #</td>
<td>26.0</td>
<td>20.5</td>
<td>0.12</td>
<td>0.0</td>
<td>0.0</td>
<td>0.62</td>
<td>234.4</td>
<td>2.9</td>
<td>284.5</td>
</tr>
<tr>
<td>± Total</td>
<td>9.1</td>
<td>7.2</td>
<td>0.04</td>
<td>0.0</td>
<td>0.0</td>
<td>0.21</td>
<td>82.4</td>
<td>1.0</td>
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</tr>
<tr>
<td>Southeast (H-72)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>78.1</td>
<td>6.8</td>
<td>1.1</td>
<td>7.5</td>
<td>0.08</td>
<td>3.5</td>
<td>154.7</td>
<td>33.1</td>
<td>284.8</td>
</tr>
<tr>
<td>± Total</td>
<td>27.4</td>
<td>2.4</td>
<td>0.38</td>
<td>2.6</td>
<td>0.02</td>
<td>1.2</td>
<td>54.3</td>
<td>11.6</td>
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</tr>
<tr>
<td>South (H-474)</td>
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</tr>
<tr>
<td>X #</td>
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<td>5.6</td>
<td>0.66</td>
<td>6.9</td>
<td>0.71</td>
<td>4.3</td>
<td>144.7</td>
<td>30.5</td>
<td>293.4</td>
</tr>
<tr>
<td>± Total</td>
<td>34.1</td>
<td>1.9</td>
<td>0.22</td>
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<td>0.25</td>
<td>1.3</td>
<td>49.4</td>
<td>10.4</td>
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<tr>
<td>Southwest (H-351)</td>
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</tr>
<tr>
<td>X #</td>
<td>62.8</td>
<td>17.7</td>
<td>1.5</td>
<td>10.0</td>
<td>0.07</td>
<td>0.69</td>
<td>167.0</td>
<td>22.0</td>
<td>281.7</td>
</tr>
<tr>
<td>± Total</td>
<td>21.9</td>
<td>6.2</td>
<td>0.52</td>
<td>3.5</td>
<td>0.02</td>
<td>0.24</td>
<td>58.2</td>
<td>7.6</td>
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</tr>
<tr>
<td>West (H-528)</td>
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<td></td>
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<td></td>
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<tr>
<td>X #</td>
<td>75.6</td>
<td>18.3</td>
<td>0.72</td>
<td>5.3</td>
<td>2.9</td>
<td>3.8</td>
<td>156.3</td>
<td>17.6</td>
<td>280.5</td>
</tr>
<tr>
<td>± Total</td>
<td>27.0</td>
<td>6.5</td>
<td>0.3</td>
<td>1.9</td>
<td>1.1</td>
<td>1.4</td>
<td>55.7</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Northwest (H-837)</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>X #</td>
<td>58.8</td>
<td>13.1</td>
<td>0.76</td>
<td>23.6</td>
<td>0.88</td>
<td>3.0</td>
<td>164.5</td>
<td>22.3</td>
<td>286.8</td>
</tr>
<tr>
<td>± Total</td>
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<td>4.6</td>
<td>0.27</td>
<td>8.4</td>
<td>0.31</td>
<td>1.1</td>
<td>56.7</td>
<td>7.9</td>
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</tbody>
</table>

Kruskal-Wallis H-Value Test
Significance ( )

20.14  48.23  10.75  10.73  9.72  2.89  14.38  16.28
(.003)  (<.01)  (.096)  (.057)  (.083)  (.822)  (.026)  (.012)
Table 26. Effects of Precipitation and Cloud Cover on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters 1982-83 and 1983-84.  
N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>State of the Weather</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>X #</td>
<td>85.5</td>
<td>14.4</td>
<td>0.97</td>
<td>11.2</td>
<td>0.24</td>
<td>3.7</td>
<td>144.9</td>
<td>25.9</td>
<td>286.8</td>
</tr>
<tr>
<td></td>
<td>(±22.3)</td>
<td>(±2.6)</td>
<td>(±0.22)</td>
<td>(±2.4)</td>
<td>(±0.05)</td>
<td>(±0.88)</td>
<td>(±15.5)</td>
<td>(±6.7)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>X Total</td>
<td>29.8</td>
<td>5.0</td>
<td>0.33</td>
<td>3.9</td>
<td>0.08</td>
<td>1.3</td>
<td>50.5</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>Scattered</td>
<td>X #</td>
<td>49.1</td>
<td>17.3</td>
<td>1.1</td>
<td>14.9</td>
<td>3.8</td>
<td>2.2</td>
<td>178.7</td>
<td>21.3</td>
<td>288.2</td>
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<tr>
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<td>(±3.9)</td>
<td>(±0.23)</td>
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<td>(±0.53)</td>
<td>(±18.9)</td>
<td>(±5.3)</td>
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<tr>
<td></td>
<td>(N-419)</td>
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<td>0.38</td>
<td>5.2</td>
<td>1.3</td>
<td>0.75</td>
<td>62.0</td>
<td>7.4</td>
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<tr>
<td>Broken</td>
<td>X #</td>
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<td>22.2</td>
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<td>9.2</td>
<td>0.86</td>
<td>2.3</td>
<td>116.5</td>
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<td>261.5</td>
</tr>
<tr>
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<td>(±4.7)</td>
<td>(±0.27)</td>
<td>(±1.8)</td>
<td>(±0.16)</td>
<td>(±0.49)</td>
<td>(±13.6)</td>
<td>(±6.8)</td>
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</tr>
<tr>
<td></td>
<td>(N-632)</td>
<td>29.0</td>
<td>7.8</td>
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<td>3.3</td>
<td>0.30</td>
<td>0.81</td>
<td>48.9</td>
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<td>13.3</td>
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<td>19.2</td>
<td>4.9</td>
<td>4.2</td>
<td>166.8</td>
<td>25.7</td>
<td>291.3</td>
</tr>
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<td></td>
<td>(±12.1)</td>
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<td>(±0.47)</td>
<td>(±3.7)</td>
<td>(±0.88)</td>
<td>(±0.94)</td>
<td>(±15.2)</td>
<td>(±6.4)</td>
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<tr>
<td></td>
<td>(N-1100)</td>
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<td>4.6</td>
<td>0.98</td>
<td>6.6</td>
<td>1.7</td>
<td>1.4</td>
<td>57.2</td>
<td>8.8</td>
<td></td>
</tr>
<tr>
<td>Fog</td>
<td>X #</td>
<td>52.7</td>
<td>13.3</td>
<td>2.9</td>
<td>19.2</td>
<td>4.9</td>
<td>4.2</td>
<td>166.8</td>
<td>28.2</td>
<td>289.7</td>
</tr>
<tr>
<td></td>
<td>(±13.9)</td>
<td>(±2.7)</td>
<td>(±0.63)</td>
<td>(±4.10)</td>
<td>(±0.93)</td>
<td>(±1.0)</td>
<td>(±18.7)</td>
<td>(±7.2)</td>
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<td>(N-240)</td>
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<td>0.45</td>
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<td>9.7</td>
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</tr>
<tr>
<td>Light</td>
<td>X #</td>
<td>41.7</td>
<td>21.6</td>
<td>1.3</td>
<td>10.2</td>
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<td>3.0</td>
<td>122.4</td>
<td>10.4</td>
<td>210.6</td>
</tr>
<tr>
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<td>(±10.9)</td>
<td>(±4.2)</td>
<td>(±0.30)</td>
<td>(±2.1)</td>
<td>(±0.0)</td>
<td>(±0.82)</td>
<td>(±14.9)</td>
<td>(±2.7)</td>
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<td></td>
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<tr>
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<td>(N-76)</td>
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<td>7.7</td>
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<td>3.6</td>
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<td>1.1</td>
<td>68.6</td>
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<td>Moderate</td>
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<td>0.62</td>
<td>1.1</td>
<td>0.09</td>
<td>0.70</td>
<td>128.6</td>
<td>20.9</td>
<td>282.5</td>
</tr>
<tr>
<td>Rain</td>
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<td>(±1.2)</td>
<td>(±0.13)</td>
<td>(±0.23)</td>
<td>(±0.01)</td>
<td>(±0.19)</td>
<td>(±14.8)</td>
<td>(±5.3)</td>
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</tr>
<tr>
<td></td>
<td>(N-193)</td>
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<td>0.22</td>
<td>0.40</td>
<td>0.03</td>
<td>0.24</td>
<td>45.6</td>
<td>7.4</td>
<td></td>
</tr>
</tbody>
</table>
Table 26. Effects of Precipitation and Cloud Cover on Behavior and Number of American Avocets per Scan on Intertidal Mudflats in North Humboldt Bay, California. Winters 1982-83 and 1983-84. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>State of the Weather</th>
<th>Behaviors</th>
<th>Total Birds</th>
</tr>
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<td></td>
<td>Rest</td>
<td>Preen</td>
</tr>
<tr>
<td>Heavy</td>
<td>249.2</td>
<td>3.9</td>
</tr>
<tr>
<td>(N=32)</td>
<td>(±4.41)</td>
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</tr>
<tr>
<td>Snow/Sleet</td>
<td>76.8</td>
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<td>(±11.9)</td>
<td>(±0.12)</td>
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Kruskal-Wallis H-Value Test

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<td>(.01) (.01) (.057) (.01) (.01) (.01) (.352)</td>
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<tr>
<td>45.04</td>
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(alpha=.0006) than under clear skies or broken clouds. No significant (alpha=.0006) differences were detected in the number of American Avocets feeding under various conditions of cloud cover and rainfall (Table 26).

During light rains and under overcast skies American Avocets fed primarily on flooded mudflats where the water covered their feet (33.2 percent of all birds scanned) or on exposed mudflats with visible surface water (46.9 percent).

Significantly (alpha=.0006) greater numbers rested during moderate and heavy rains than at other times (Table 26). The proportion of the flock recorded as resting was also greater during moderate and heavy rains (Table 26). Significantly (alpha=.0006) fewer birds preened or exhibited alert behavior during moderate rains than under scattered or broken clouds (Table 26).

The presence of precipitation in the previous 24 hours was not significantly (H=13.6, df=19, p>.05) related with any of the behaviors measured.

**Disturbances**

American Avocets were disturbed easily. The entire flock usually responded when one bird or a small group of birds became alert. In this study American Avocets were seen to take flight in response to cars and trucks, motorcycles and mopeds, planes, humans, dogs, tide height, wind and/or waves, shooting, motorized model speed boa₃, visual presence of Northern Harriers (*Circus cyaneus*), Peregrine Falcons (*Falco peregrinus*), Merlins (*Falco columbarius*), Short-eared
Owls (*Asio flammeus*), movements and alarm calls by Marbled Godwits, alarm calls by Willets, Greater Yellowlegs (*Tringa melanoleuca*), and Lesser Yellowlegs (*Tringa flavipes*), alarm calls and movements by groups of smaller shorebirds including Western Sandpipers, Least Sandpipers, Long-billed Dowitchers (*Limnodromus scolopaccus*), Short-billed Dowithchers (*Limnodromus griseus*), and Black-bellied Plovers, and displacement by Great Blue Herons (*Ardea herodias*), American Egrets (*Casmerodius albus*), and Snowy Egrets (*Egreta thula*) at the roost sites (Figure 6).

American Avocets roosted at Jacoby Creek until high tide or hunters caused them to move to Klopp Lake. Four times American Avocets were observed flying to the main roost before the alternate roost was covered by high tide, only to be disturbed at the main roost, causing them to return to the alternate roost.

Human-related disturbances on the tidal mudflats were of minor importance except when hunters were present. Duck hunting occurred on portions of the study area. Most duck hunters used small boats and concentrated their activities near the main channels in Study Areas 1 and 2. The only shoreline location regularly used by hunters was near the alternate roost at Jacoby Creek. Hunting in this location was limited to periods around high tide. American Avocets were never observed within 100 meters of any boat. Several times Avocets were seen swimming among hunters' decoys. They were not usually disturbed if the hunters remained concealed and still. On days when hunters were actively shooting from shore or from boats, Avocets avoided locations 1, 2, and 3 and concentrated at location 7. When hunters were active the alternate roost was rarely used.
Figure 6. Number of Disturbance Events per 1000 Scans for American Avocets at Humboldt Bay, California, Winters 1982-83 and 1983-84.
**Human Activity**

My presence often caused the Avocets closest to me to become alert and sometimes to fly away. After I had set up my tripod and stopped moving, the Avocets usually resumed normal behavior within 5 minutes. Human-related disturbances at the main feeding areas near the roost were minimal. The most common human-related disturbances were shouting or honking of horns. I observed remote-control model speed boats in Klopp Lake seven times. All shorebirds either flew away or changed roosting islands in response to these model speed boats. On two such occasions American Avocets left the area entirely and flew to the Oxidation Ponds to rest.

**Dogs**

Dogs running loose commonly chased shorebirds at the marsh project and I saw them pursue Avocets feeding on the mudflats adjacent to Klopp Lake nine times. The dogs usually bogged down in the mud and were never seen to catch any birds.

**Planes**

On 12 of 292 observation days I saw small fixed-wing aircraft fly low over the mudflats, causing Avocets to become extremely agitated. Typically all the American Avocets became alert, formed groups, called constantly, and moved away from the plane. After the plane had left American Avocets typically remained alert for 5-10 minutes before returning to their normal behaviors. This was in contrast to their behavior following most other disturbances when they
resumed former activities within a minute after the disturbance had ceased.

Crowded

Occasionally, a roosting island in Klopp Lake became so crowded with shorebirds that some Avocets were forced to roost on one of the other islands.

Alarm Calls

Alarm calls from a variety of shorebirds, mainly Willets, Marbled Godwits, Lesser Yellowlegs, and Least and Western Sandpipers caused American Avocets to become alert. Alarm calls given by Willets and Lesser Yellowlegs were most often in response to disturbances by humans, dogs, Northern Harriers, or falcons.

Northern Harrier

Northern Harriers flying along the shore or over the islands in Klopp Lake often caused American Avocets to fly away en masse. Sometimes the Avocets remained on the ground or moved closer to the water despite repeated passes by the Harriers. Marbled Godwits and smaller shorebirds always flew at the approach of Northern Harriers. When American Avocets were flushed from the roost by some disturbance factor, they often landed in the water of Klopp Lake, where they remained until the danger had passed. They remained in tight groups when disturbed. On 26 April 1984 one American Avocet was repeatedly harrassed and prevented from flying by a Northern Harrier. Although the Avocet was not struck by the Harrier, it emitted distress calls,
which were faster and more emphatic than normal, as it flopped around in the water apparently unable to take off. Within 3 minutes a flock of about 230 American Avocets had gathered, and they flew repeatedly at the Northern Harrier making tighter and tighter circles over the stressed Avocet. Two of the attacking Avocets struck the Northern Harrier with their bills. After about 5 minutes, the stressed Avocet took flight and joined the others and the Northern Harrier abandoned the pursuit. Although I saw Northern Harriers catch smaller shorebirds, this was the only time I saw a Northern Harrier make a determined effort to catch an Avocet.

Falcons

Both Peregrine Falcons and Merlins were seen regularly in the study area. The Merlin posed little threat to Marbled Godwits or American Avocets but these species nevertheless often flew when the smaller shorebirds suddenly took flight upon the approach of a Merlin. The larger shorebirds usually returned to the roost sooner, within approximately 5 minutes, than the smaller shorebirds following Merlin attacks.

Although Peregrine Falcons usually chased the smaller shorebirds they occasionally chased Godwits and Avocets. On 19 November 1983, I saw a Peregrine Falcon surprise a group of Avocets feeding near the tide edge. When they took flight, the Peregrine struck one Avocet about 30 feet off of the water. The American Avocet fell into the water and struggled for a few minutes before dying. The Peregrine Falcon made 4 passes over the injured Avocet but did not retrieve it from the water. Glaucous-winged Gulls (Larus glaucescens)
fed on the carcass. When Avocets were disturbed by falcons at the main roost, the usual response was to fly en masse from the island out to the open water of Klopp Lake where they landed and swam in a tight flock until the falcon departed.
DISCUSSION

Population Trends

The first record of an American Avocet in Humboldt Bay was on 27 November 1943 (Anderson 1943-47). C. I. Clay, an active birder in the Humboldt Bay Region since 1909, sighted his first American Avocet on 26 January 1944. From 1943 to March 1961 there were only 15 sightings of American Avocets (ranging from 1 to 75 birds) in Humboldt Bay (Clay 1909-53, Anderson 1943-47, Harris pers. comm., Unpublished files, Department of Wildlife, Humboldt State University). The city of Arcata created a 55 acre sewage oxidation pond in the northeast corner of Humboldt Bay in 1957 (Marsh Enhancement Plan 1979). Avocet numbers at Humboldt Bay since the early 1960's increased from 30-40 (Unpublished files, Department of Wildlife, Humboldt State University) to 250 in 1970 (Gerstenberg 1972), to 400-500 in 1979 (Harris pers. comm.), to 827 on 27 November 1982 (Figure 4). Kelly and Cogswell (1979) found that populations of Black-necked Stilts (*Himantopus mexicanus*) and American Avocets increased following the construction of salt evaporation ponds in the San Francisco Bay Region. Within the Northern California Coastal Region there have been only a few scattered records of American Avocets outside Humboldt Bay. For the Lake Talawa/Lake Earl area, Del Norte county, there are 11 fall records representing 1-26 Avocets each (Peters 1971, Stallcup and Winter 1976, Widrig 1977, Funderberk 1979) and 1 spring record of 28 birds on 28 April 1985 (Unpublished files,
Department of Wildlife, Humboldt State University). For the Eel River Area there are 2 fall records representing 2-13 birds (Unpublished files, Department of Wildlife, Humboldt State University). There are only 3 records for South Humboldt Bay, 1 bird on 28 Dec 1969 (Cruickshank 1969), 1 bird on 4 Jan 1976 (McCaskie 1976), and 1 bird at Hookton Slough, South Bay on 23 Oct 1985 (Nelson pers. comm.). All other records for Humboldt Bay are from North Humboldt Bay (Clay 1909-1953, Anderson 1943-1947, Unpublished files, Department of Wildlife, Humboldt State University, Harris pers. comm., Gerstenberg 1972, Tousley 1982, Spitler 1984).

Population fluctuations in fall suggest Avocets migrate through the Humboldt Bay area, especially in October. Avocets began to arrive at Humboldt Bay in August and by November most of the wintering population was present (Figure 4). At Bolinas Lagoon (1971 to 1976) the population of Avocets began to increase in November (150 birds) reaching a peak in January (578 birds, Page et. al. (1979). At Palo Alto Avocets began to arrive in October and November (100 birds) and gradually increased with population peaks occurring in February (1100 birds, Recher 1966). Greater population numbers were recorded at earlier dates for Humboldt Bay in the fall than at central California locations as reported by Recher (1966) at Palo Alto and Page et. al. (1979) at Bolinas Lagoon. I do not believe that any substantial number of birds migrates through the Humboldt Bay area in spring. Beginning in February, the Humboldt Bay population steadily declined.
General Habitat Use

American Avocets used islands in Klopp Lake and a section of high elevation mudflats near Jacoby Creek as major roosting sites. Roosting sites were on open exposed sites and near deep non-tidal ponds.

American Avocets used the Oxidation Ponds and Intertidal Mudflats as major feeding areas. The Oxidation Pond was used as a feeding area only during October. Between November and May the Oxidation Pond was used sporadically for drinking, bathing, and sanctuary while the intertidal mudflats were used primarily for feeding. American Avocets fed most often on the sections of intertidal mudflats that had a slow rate of superficial drainage, were adjacent to their roosts, and contained major drainage channels. These areas were best characterized by Study Sites 1, 3, and 7.

Roosting Studies

Migrating shorebirds require roost sites on staging areas (Pienkowski and Evans 1984) and wintering areas (Myers 1984). Typically shorebirds in tidal areas roost at high tide and at night (Goss-Custard 1969, Wolff 1969, Heppleston 1971, Thomas and Dartnell 1971, Praeter 1972, Goss-Custard 1977b, Hartwick and Blaylock 1979, Kelly and Cogswell 1979, Puttick 1979, and Pienkowski 1982). In this study Avocet populations consistently used two roost sites: At moderately high tides some Avocets used the high elevation mudflats for varying periods of time, but when rising tides forced them off these areas they moved to the islands in Klopp Lake approximately 1400
meters to the west. The islands in Klopp Lake were the primary roost sites for the bulk of the population throughout the winter. The primary roost consisted of unvegetated islands with a shallow submerged bar at the edge where the water was 2-13 cm. deep. Generally the Avocets roosted on the flooded bar and actually stood in the water while the higher, dryer portions of the islands were occupied by Marbled Godwits, Black-bellied Plovers, and other shorebirds. The area encompassed by the submerged bar was limited due to the abrupt nature of the island contours, causing some Avocets to rest on the higher areas. This was the only location I observed Avocets on high, well-drained sites. At tides below 1.6 feet Avocets sometimes rested on intertidal mudflats near tidal channels. The tendency of Avocets to roost near or in shallow water, to avoid flying over land, and to land in water when disturbed or threatened emphasizes that islands are superior to shoreline as roosts and that deep, non-tidal ponds adjacent to roosts are important components of roosting habitat.

In this study Avocets used the northeast corner of North Humboldt Bay even though apparently suitable intertidal mudflats and other islands were potentially available as high tide roosts. It would be advantageous for roost sites to be adjacent to foraging areas (Zwarts and Wanink 1984). The known foraging areas of American Avocets were located within 3 km of the roosts. As food resources near winter roosts are depleted, shorebirds have to either shift roost locations or increase energy expenditure moving greater distances from roosts to more distant feeding areas (Zwarts and Wanink 1984). Because I did not detect a seasonal shift in foraging patterns or
roost locations I believe the food resources on the mudflats remained adequate throughout the winter period. My Avocets never fed at high tide even though theoretically they might be capable of doing so. I suspect that the pattern of habitat use recorded in this study may be related more to tradition than to actual differences between areas within Humboldt Bay. The earliest wintering populations of American Avocets at Humboldt Bay were recorded in the northeast corner of the Bay (Unpublished files, Department of Wildlife, Humboldt State University, Harris pers. comm.). Despite increasing wintering populations since the early 1960's the pattern of habitat use has not changed (Harris pers. comm.). The construction of Arcata's Sewage Oxidation Pond with its discharge into the northeast corner of North Bay may have contributed to the type of food resources attractive or needed by American Avocets on the adjacent mudflats. The later creation of the islands in Klopp Lake has reinforced this pattern of habitat use by providing secure, suitable islands for roosts.

**Foraging Studies**

**Oxidation Ponds**

Avocets used the Oxidation Ponds for feeding, drinking, and sanctuary. Except for occasional phalaropes (*Phalaropus* spp.) American Avocets were the only major shorebird recorded feeding on the high concentrations of *Daphne magna* in the Oxidation Ponds. This food source was used mainly in October. Although American Avocets fed primarily at the intertidal mudflats from November to May it is
possible that they met some critical nutritional need by feeding in the Oxidation Ponds following fall migration. Since the timing and magnitude of the population blooms of *Daphne magna* vary depending upon their food supply (Frodge 1985) use of this food source by American Avocets may also vary. In October 1983, a greater proportion of the birds fed at the Oxidation Ponds and mudflats than in 1982. Conversely, fewer birds engaged in rest/preen behaviors in 1983. This suggests that food may have been more abundant in October 1982, since they spent more time in non-feeding behaviors in 1982. Frodge (1985) reported that *Daphne magna* populations occurred in patches in the southern most Oxidation Pond. Lee (1980) investigated the "swarming" behavior of waterfowl at the Oxidation Ponds and found *Daphne* spp. in higher concentrations beneath feeding swarms than in adjacent areas where no waterfowl were present. My Avocets fed in a pattern similar to that reported by Lee (1980) for waterfowl.

American Avocets occasionally visited the Oxidation Ponds to drink fresh water or to bathe. Jacoby Creek and Klopp Lake also were used for drinking and bathing. In spite of this, I do not believe that fresh water areas are critical to Avocet survival because they can exist in hypersaline or alkaline environments without using fresh water for long periods of time (Mahoney and Jehl 1985).

Avocets initially may have been attracted to the northeast corner of North Humboldt Bay by the locally abundant food source and deep fresh water ponds afforded by the Oxidation Ponds. When this food source became depleted they could have shifted to feeding on the adjacent intertidal mudflats rather than migrating elsewhere, thus establishing the nucleus of a wintering population. In 1969 the
high-level mudflats adjacent to the Oxidation Pond were used by Avocets at 3 times the rate as moderate-elevation mudflats and 10 times the rate as the low-elevation mudflats (Gerstenberg 1972).

**Intertidal Mudflats**

Tides exert great influence on the distribution, abundance, and behavior of estuarine organisms (Heppleston 1971, Praeter 1972, Burger et. al. 1977, Evans 1979, Hartwick and Blaylock 1979, Puttick 1979, Conners et. al. 1981, Burger 1984). For shorebirds, tides affect the amount of foraging space, length of time mudflats were available, and availability of prey (Recher 1966, Smith 1975, Evans 1979, Puttick 1979, Puttick 1981, Myers et. al. 1984, Evans and Dugan 1984). Although the number of shorebirds foraging generally peaks around low water (Heppleston 1971, Burger et al. 1977) the bimodal foraging pattern observed for American Avocets in this study has been noted for other shorebirds (Burger et. al. 1977, Hartwick and Blaylock 1979). Because of the very gradual contour at Humboldt Bay, large expanses of high-level intertidal mudflats become exposed with a relatively small drop in the water level as the tide recedes. Although American Avocets were dependent on the tide height for exposure of the mudflats, the extent of the mudflat area may not be critical because Avocets used only a portion of the mudflats in the study areas. I believe that prey availability near the tide edge influenced habitat use by Avocets more than the total area of mudflat exposed mudflat.

The intertidal mudflats were used primarily for feeding. American Avocets generally selected the wettest substrates when
foraging. Moisture content on the mudflats was controlled by tidal fluctuations. High tides covered these mudflats twice daily. Avoidance of dry areas by shorebirds and the influence of substrate wetness on prey behavior and availability to shorebirds was emphasized by Recher (1966), Praeter (1972), Smith (1975), Burger et al. (1977), Evans (1979), Dugan (1981), Pienkowski (1981), and Goss-Custard (1984). Carrin (1973) found that 93.5 percent of the individuals and 60.0 percent of the biomass of benthic invertebrates occurred in the wettest substrates in Humboldt Bay. In addition to wetness of the substrate, other factors such as depletion of available prey, prey avoidance, and variations in prey activity may explain why American Avocets generally used foraging locations near the tide edge. Smith (1975) found that the density of the available worms, the primary food of the Bar-tailed Godwits (*Limosa lapponica*), was highest at the tide edge and consequently they followed the tide edge on both ebb and flood tides.

Although Marbled Godwits and American Avocets often fed in the same water depths on the high-level mudflats I do not believe the two species significantly compete for food. American Avocets fed both visually and tactiley in the upper 3 cm of the mudflats or in shallow water just above the mudflat-water interface. Conversely Marbled Godwits probed 0 to 15 cm. into the substrate (pers. obs., Recher 1966). Recher (1966) found that Avocets fed on smaller prey items (primarily one species of amphipod *Genima genima*, one species of polychaete *Neanthes succinea*, and one species of ostracod *Ilyanassa obsoleta* (less than 0.7 cm.)) but on a greater diversity of prey than Marbled Godwits. Holmberg (1975) found that polychaetes and
gastropods (*Philliplysea talori*) were the principle foods of Marbled Godwits in Humboldt Bay. *Philliplysea talori* was most commonly found clinging to eel grass (*Zostera maritima*) turions (Carrin 1973) but eelgrass seldom occurs on the high-level mudflats. Carrin (1973) found that small amphipods *Leptochelia dubia* and *Amisogammarus pugettenses* and the small clam *Transennella tantilla* were very abundant at Humboldt Bay and I suspect these may important Avocet foods, but I did not collect Avocets for food studies. Many workers have pointed out that one way multispecies flocks of shorebirds avoid competition is for each species to feed on a slightly different prey species/size class complex (Recher 1966, Goss-Custard 1981, Evans and Dugan 1984, Evans et. al. 1984, Goss-Custard 1984, Zwarts and Wanink 1984).

Many shorebirds have adapted to tidal and seasonal rhythms in prey behavior by altering feeding methods (Goss-Custard 1969, Zwarts and Wanink 1984) or foraging locations (Goss-Custard 1970a, Conners et. al. 1981, Evans 1981a, Myers 1984). Many shorebirds exhibit sexually dimorphic bill lengths or shapes (Evans 1979), and males and females might conceivably use different foraging techniques, permitting a species to exploit available resources efficiently (Smith and Evans 1973, Puttick 1981). American Avocet females have a shorter and more recurved bill than males (Praeter et. al. 1977). In Curlew Sandpipers, females have a longer bill, take fewer prey species, but a wider size range of prey (Puttick 1979) and have a higher success rate than males (Puttick 1981). Because my Avocets fed so rapidly and on such small prey I was unable to identify prey or measure the success rate of American Avocets in this study. Males and females frequently
foraged in the same water depths, occurred in mixed groups, and both sexes primarily used tactile feeding methods. Females used visual feeding methods less than males when feeding on exposed mudflats with visible surface water ($X^2=11.81$, df=4, p<.001) but this difference was probably not very important ecologically considering the overall dominance of tactile feeding methods by both sexes.

**Effects of Daylength on Use of Intertidal Mudflats.** Wintering shorebirds respond to decreasing daylengths in winter months, particularly at the northern latitudes by changing their foraging patterns (Goss-Custard 1969). In December, when hours of daylight are the shortest, diurnal species may have difficulty finding enough food. Also many high tides occur during the middle of the day, making mudflats unavailable to diurnal feeding birds. In order to meet the daily energy requirements in mid-winter shorebirds forage for longer periods of the day than at other seasons and they frequently forage in alternate habitats at high tide (Heppleston 1971, Praeter 1972, Burger et. al. 1977, Goss-Custard 1977b, Page et. al. 1979, Kelly and Cogswell 1979, Conners et. al. 1981, and Townshend 1981).

Goss-Custard (1969, 1977a, 1979a, 1979b) and Baker (1981) reported that shorebirds fed during almost all the available daylight hours in winter. Puttick (1979) reported that Curlew Sandpipers foraged 55-65% of the daylight hours in spring and summer but spent 80% of the day foraging in autumn and winter and that in fall and winter they shifted to marshes at high tide. My Avocets foraged 45-65 percent of the daylight hours in spring (March and April) and an average of 84 percent during the winter (November to February excluding December
1983) (Table 2). Unlike Curlew Sandpipers (Puttick 1979), the Avocets did not feed at high tides (Table 2). Despite having fewer available daylight hours of exposed mudflat available in winter, Avocets increased the actual number of hours they fed in winter as well as the percentage of the total available daylight hours.

While several shorebird species have been reported to show a preference for feeding during the day and to forage at night only because they could not find enough food during the day (Goss-Custard 1969, Heppleston 1971, Smith 1975, Evans 1976, Goss-Custard et al. 1977), Dugan (1981) and Pienkowski and Evans (1984) found that shorebirds may obtain more than 50 percent of their food at night in mid-winter. Many invertebrates are more active at the surface at night than in daytime (Vader 1964, Fincham 1970a and 1970b, Jones and Naylor 1970, Dugan 1981, Pienkowski 1982). Swanson and Sargent (1972) found that waterfowl fed at night in response to increased insect activity, and Goss-Custard (1970a), Hulscher (1976) and Dugan (1981) found that shorebirds respond in a similar way. Visual feeders may have reduced success at night due to decreased abilities to detect cues given by prey or to locate suitable sites for foraging (Smith 1975, Evans 1976, Pienkowski 1981, Sutherland and Moss 1985, Pienkowski 1983a, Zwarts and Drent 1981). Goss-Custard (1969) noted that Redshanks not only changed feeding areas at Ythan Estuary but used tactile feeding methods almost exclusively at night whereas by day they used visual feeding methods primarily. Since American Avocets primarily used tactile feeding methods and were observed feeding in the same locations at night as during the day it would be reasonable to expect that American Avocets could forage effectively at
night. This prediction is based on the assumption that prey availability remained fairly constant between day and night.

Many shorebirds feed at night (Burger 1984) and if food requirements are higher in winter than summer the food obtained at night might be critical for survival (Goss-Custard 1969, Heppleston 1971, Baker and Baker 1973, Britton et. al. 1986). Nocturnal foraging may have been extremely important during December 1983 when the proportion of the flock recorded as foraging in daylight and the number of hours spent foraging decreased dramatically compared to other months (Table 2). If American Avocets can collect food at night efficiently the amount of daylight hours available for feeding may not be as important to their survival as tidal fluctuations on prey availability.

Effects of Weather on Use of Intertidal Mudflats. Low temperatures have been shown to increase the energetic costs of thermoregulation (Evans 1976, Puttick 1979, Dugan et. al. 1981, Pienowski and Evans 1984), and to decrease the prey availability (Smith 1975, Evans 1979, Dugan et. al. 1981). At low temperatures, some invertebrates are less active (Goss-Custard 1969, Smith 1975, Evans 1976, 1979, Dugan 1981, Pienkowski 1981, Goss-Custard 1984) and often move deeper into the substrate (Evans 1981a, Townshend 1981). The feeding rates and foraging success of Redshanks (Goss-Custard 1969) and Bar-tailed Godwits (Smith 1975) decreased in response to reduced prey availability and low temperatures. The proportion of Avocets feeding on exposed mudflats containing surface water was greatest when air temperatures were between 11°C and 17°C compared to
temperatures both above and below these levels. No similar effect was shown by birds feeding over flooded substrates. It is possible that prey availability was affected by temperature changes on the exposed mudflats more than in the water column. Water or mud-profile temperatures may influence prey availability (Goss-Custard 1970a, Pienkowski 1983a), but my sampling design was not adequate to test any differences that would have had biological meaning.


In this study, I recorded three occasions when strong southerly or southwesterly winds accelerated the time of high tide by approximately 1 hour and caused the highest tide to exceed predicted levels by 0.4 meters. The subsequent ebb tide was also delayed by approximately 50 minutes. This had the effect of reducing the surface area and the total time mudflats were exposed which decreased the amount of available foraging time to shorebirds. Strong westerly gales had similar, but increased, effects on tide levels at Wattenmeer, northwestern Germany (Evans 1981a). Large long-legged waders may be able to partially overcome these problems because they can feed in deep water and do not usually need to feed as long in each
tide cycle as smaller shorebird species (Evans 1981a). Strong northwesterly winds (11 December 1984) accelerated the time low tide by about 45 minutes and caused a lower than predicted low tide.

Another effect of wind was increased wave action. This may decrease foraging efficiency (Evans 1976, Taylor 1982, Rodgers 1983, Pienkowski 1983b). When white caps were present, Avocets rested more and fed less because wave action physically interfered with foraging and because prey availability may have been reduced. Because Avocets used tactile methods primarily, they may have been less affected by distortion of the water surface and turbidity than shorebirds feeding by visual cues.

Although Robertson and Dennison (1979) and Berger (1984) reported that some shorebird species move to areas sheltered from strong winds, my Avocets did not seek shelter during strong winds. Rather they stopped feeding and faced into the wind. Wishart and Sealy (1980) reported that Marbled Godwits had lower feeding rates but greater success rates on protected compared to exposed sites on windy days. I suspect Avocets experienced lower success rates and reduced feeding efficiency during high winds at Humboldt Bay.

Many species of shorebirds are known to feed on upland sites, especially when rain forces worms to the surface (Gerstenberg 1972, Kelly and Cogswell 1979, Townshend 1981). I never recorded Avocets feeding in upland sites. Even after heavy rains, Avocets continued to feed on the intertidal mudflats. Avocets did not feed during heavy rains probably because increased water and mudflat distortion and turbidity reduced prey availability or because the rain interfered
physically with the birds. Rainfall has been found to reduce surface activity of prey (Goss-Custard 1969, Smith 1975) and prey capture rates of shorebirds (Goss-Custard 1970b, Pienkowski 1983c). During light rains or under overcast skies Avocets fed primarily on mudflats with visible surface water and on mudflats flooded with less than 3 cm. of water. Small amounts of rain water may cause prey to become more active because marine invertebrates avoid fresh water (Page et al. 1979). Prey availability may increase because mudflats remain wet under rainy conditions.

Foraging success of Great Blue Herons was greater on overcast days possibly because glare on the water surface was reduced (Bovino and Burtt 1979). Possibly shorebirds feeding visually on wet mudflats or flooded areas may have a greater foraging success under cloudy skies when glare is reduced but I do not believe glare reduced foraging success of Avocets because they used primarily tactile feeding methods. Hynes (1970) found that some species of benthic invertebrates, which were probably negatively phototactic, moved closer to the surface and were more mobile under low illumination. Thus prey availability may have increased under overcast skies.

Dobinson and Richards (1964), Evans (1981a), and Dugan et. al. (1981) have reported that shorebirds suffered increased mortality when high winds were combined with rain and low temperatures than under conditions of cold temperature alone. The accumulation of fat or the ability to feed at night may be critically important during periods of inclement weather. Potential wintering areas north of Humboldt Bay may not be suitable as wintering areas for American Avocets because of more extreme weather conditions.
Shorebirds probably require periods of undisturbed sleep or rest (Herbers 1981). Animals spend most of their time either foraging or resting (Herbers 1981). Time spent on roosts allows for digestion of food, predator avoidance, maintenance activities, thermoregulation, and social interactions (flock cohesiveness). Although animals in communal roosts may be able to detect predators more readily or exchange information necessary for survival (information center hypothesis – Ward and Zahavi 1973) better than smaller groups of animals, the benefits vary between species and ecological settings. Blick (1980, in Myers 1984) found that the proportion of American Avocets that were alert decreased with increasing flock size. At Humboldt Bay the largest flocks occurred at the Klopp Lake roosts where the proportion of the flock exhibiting alert behavior was greater than for smaller flocks on intertidal mudflats (Table 5).

Burger (1981) found that human-related disturbances caused shorebirds to shift between two freshwater mudflats areas. Burger (1981) also noted that shorebirds were more sensitive to disturbances than gulls. Most recorded disturbances of Avocets at Humboldt Bay were caused by raptors (Figure 6). I do not believe that at present levels, human-related disturbance factors are a major problem but future increases in human visitation to the Arcata Marsh Project might prove detrimental to roosting shorebirds at Klopp Lake.
LITERATURE CITED


Widrig, R.S. 1977. Spring nesting and fall migration observations of shorebirds at Lake Talawa, Del Norte County, California. Unpubl. rep. on file Humboldt State University Library 6 pp. plus appendicies.


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Visual

**Pecking** is the primary method used by birds feeding visually. Sighted objects are grabbed quickly with a jab of the bill. Prey items may be captured on the mud or in the water. Only the bill or part of the bill enters the water.

**Plunging** is performed at a greater depth than pecking. Often the head and sometimes the neck and upper breast feathers enter the water. There is no sideways component to this movement.

**Snatching** involves catching a flying insect with the bill. The bird usually pursues the insect by flying or running a short distance.

**Bill Pursuit** occurs when a bird rapidly opens and closes its bill, while simultaneously moving it erratically along the water's surface. The bird is apparently chasing some rapidly moving aquatic organism. The bill is opened to about 1 cm.

Tactile

**Filtering** is performed on mudflats with visible surface water. The bill is opened and closed rapidly, while being moved over the mud for a duration of 3-5 seconds. The bird then raises its head and swallows.

**Scraping** involves placing the lower mandible on the mud directly in front of the bird and is moved 5-20 cm. in an anterior-posterior plane by extending the neck. Swallowing often occurs afterwards.

**Single Scythe** is performed either on the mudflats or in the water. The bird performs this activity between steps. The bird places the recurved tip of the bill on the substrate on one side of the midline of the body and moves the bill very rapidly to the other side of the body. The bill is slightly opened during this activity, after which the head and bill are raised and swallowing occurs.

**Multiple Scythe** is similar to the Single Scythe feeding movements except the bill and head is not raised after each movement but is returned to the other side and perhaps back again without a pause.

Preening

Preening consists of manipulating and arranging the feathers with the bill. Oil from the uropygial gland is spread from the top of the head over the back and sides. Avocets often use water while preening, especially the breast feathers. Typical sequence: Avocet dips bill into the water, raises head high extending the neck, and lowers the bill and preens the breast.

Comfort Movements

Bathing occurs when the bird lowers itself into ankle to knee-deep water and rocks rapidly forward several times, while bending the neck forward and submerging the head when at the lowest position. After bathing the bird often shakes and/or ruffles its feathers.

Two-wing Stretch occurs when a bird lowers the head and extends the neck forward below horizontal, while extending their wings to their full extent vertically above the back. This is usually done slowly and deliberately and often occurs before birds take flight.

Hop and Flap occurs while a bird is standing on one leg. The bird usually hops to the side while flapping its wings.

Comprehension Movements (cont)

Wing and Leg Stretch consists of stretching a leg backwards at a 30-45° angle from the ground while partially extending and stretching the wing on the same side backwards. The head and neck are tilted slightly forward with the neck being only partially extended. Most commonly performed before resting.

Direct Scratching occurs when a bird brings a foot directly to the head without moving the wing.

Indirect Scratching occurs when the bird lowers a wing and brings the foot and leg on the same side over the shoulder to scratch the head.

Foot Shaking occurs when an Avocet pauses at each step to shake the trailing foot.

Shaking or Ruffling Feathers is self explanatory. Tail feathers may be shaken independently of back or flank feathers. Occurs most frequently after bathing and on occasions just before and after preening.

Aggressive

**Upright Posture** occurs when birds are facing each other or standing parallel with their heads and necks partially extended. Avocets are usually within 0.5 meters of each other, and may be looking directly at each other indicating an aggressive action, or looking away which indicates appeasement.

**Crouch and Run or Walk** is indicated when an Avocet retracts the neck and lowers the head so that the top of the head is at the same level as the back. The tail end of the back is usually slightly higher than the area between the scapulans. The bird then rushes, usually running, toward another bird. Initially the top of the head is usually at the same level as the back with the neck retracted but when within close range the Avocet may further lower the head and extend the neck as if to strike an opponent. Crouch and Run may be directed at conspecifics as well as other species.

**Supplanting** occurs when an aggressive bird runs or flies to the location of another bird forcing the target bird to leave its position.
Appendix D. Monthly Rainfall (cm) for 1982-83 and 1983-84 and Mean Monthly Rainfall from 1972-73 to 1982-83 at Eureka, Humboldt County, California.

<table>
<thead>
<tr>
<th>Rainfall</th>
<th>1982-83</th>
<th>1983-84</th>
<th>1972 through 1982 (mean ± S.D. (g))</th>
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<td>Month</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Oct.</td>
<td>12.42</td>
<td>4.75</td>
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</tr>
<tr>
<td>Nov</td>
<td>19.89</td>
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<tr>
<td>Dec</td>
<td>26.16</td>
<td>35.89</td>
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</tr>
<tr>
<td>Jan</td>
<td>21.54</td>
<td>1.93</td>
<td>12.04 ± 5.61 (10)</td>
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<tr>
<td>Feb</td>
<td>23.32</td>
<td>13.16</td>
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<td>Mar</td>
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<td>Apr</td>
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<td>7.01</td>
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<tr>
<td>May</td>
<td>2.84</td>
<td>6.38</td>
<td>2.51 ± 1.88 (10)</td>
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</table>
Appendix E. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1982. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest (±0.0)</th>
<th>Preen (±0.0)</th>
<th>Comfort Movements (±0.0)</th>
<th>Alert (±0.0)</th>
<th>Swim (±0.0)</th>
<th>Walk (±0.0)</th>
<th>Feed (±0.0)</th>
<th>Fly (±0.0)</th>
<th>Total Birds</th>
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122
Appendix E. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1982. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
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<td>3.6-4.0 (N-33)</td>
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<td>78.9 (±19.0)</td>
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<td>0.84</td>
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<td>0.0 (±0.0)</td>
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<td>0.0 (±0.0)</td>
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<td>28.1 (±33.9)</td>
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</table>
Appendix E. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1982. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
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Appendix F. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1983. N = Number of Scans. X # = Mean Number (± S.D.) of Birds.

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<th>Preen</th>
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<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
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<td>(±0.0)</td>
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<td>(±0.0)</td>
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<td>(±0.0)</td>
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<td>(±1.9)</td>
<td>(±0.01)</td>
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Appendix F. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1983. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest</th>
<th>Preen</th>
<th>Comfort</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
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<td>3.7</td>
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<td>(±3.5)</td>
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<td>0.09</td>
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<td>0.0</td>
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<td>92.5</td>
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Appendix F. Effects of Tide Levels on Behavior and Number of American Avocets on the Oxidation Ponds in North Humboldt Bay, California. October 1983. N = Number of Scans. X # = Mean Number (± S.D.) of Birds. (continued)

<table>
<thead>
<tr>
<th>Tide Height</th>
<th>Rest</th>
<th>Freen</th>
<th>Comfort Movements</th>
<th>Alert</th>
<th>Swim</th>
<th>Walk</th>
<th>Feed</th>
<th>Fly</th>
<th>Total Birds</th>
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<td>0.0</td>
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Appendix G. Mean Daily Maximum and Minimum Temperatures (°C)
1982-83 and 1983-84 and for the Years 1972 to 1982 at
Eureka, Humboldt County, California.

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<tr>
<th>Month</th>
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<th>1983-84</th>
<th>1972 through 1982 (mean ± S.D. (g))</th>
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<td>Oct</td>
<td>18.7/9.4</td>
<td>17.8/10.9</td>
<td>16.0 ± .22/9.1 ± .26 (10)</td>
</tr>
<tr>
<td>Nov</td>
<td>15.6/6.7</td>
<td>16.1/7.9</td>
<td>14.3 ± .47/7.0 ± .30 (10)</td>
</tr>
<tr>
<td>Dec</td>
<td>13.9/5.7</td>
<td>13.3/7.3</td>
<td>13.3 ± .64/5.9 ± .43 (10)</td>
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<tr>
<td>Jan</td>
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<td>13.8/5.4</td>
<td>12.6 ± .67/8.1 ± .45 (10)</td>
</tr>
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<td>13.4 ± .69/6.3 ± .36 (10)</td>
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<td>Mar</td>
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<td>13.0 ± .65/6.2 ± .39 (10)</td>
</tr>
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<td>Apr</td>
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<td>16.6/8.8</td>
<td>14.4 ± .40/8.2 ± .16 (10)</td>
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