How individuals/organizations can help in the flyway network:

1. Inform others about your present and future activities.

2. Suggest potentially important sites which need further surveys. Help organize and support expeditions to these sites.

3. Send to AWB regular counts of shorebirds at different sites taken during the migration and winter season in your area.

4. Send in reports, articles and papers about shorebirds.

5. Provide banding (ringing) reports and totals of shorebirds banded, and if required send in recoveries to be followed up.

6. Provide information about threats to shorebirds and their habitats in your area.

7. Promote conservation of key sites and species.

8. Provide information to other network members.

Please address all information and enquiries to Taej Mundkur (Waterbird and Flyway Projects Officer) at the Asian Wetland Bureau, Institute for Advanced Studies, University of Malaya, Lambah Pantai, 59100 Kuala Lumpur, Malaysia.

WESTERN HEMISPHERE SECTION

Conservation of stop–over areas for migratory waders: Grays Harbor, Washington

W. Herbert Wilson

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INTRODUCTION

The migratory patterns of waders along corridors with stop–overs at traditional staging areas is now widely appreciated (Myers *et al.* 1987). Environmentalists are aware of the conservation challenges that migratory waders present by concentrating at stop–over areas. In the Americas, the Western Hemisphere Shorebird Reserve Network is an attempt to identify areas of high significance for migrating waders and to promote public awareness of their importance.

One major stop–over area along the western coast of North America is Grays Harbor, one of two embayments along the outer coast of Washington state (Figure 1). The importance of Grays Harbor for waders was first demonstrated by the work of Herman & Bulger (1981). By censusing waders at high tide simultaneously at many sites, these workers documented that over a million waders pass through Grays Harbor during the spring migration. The most common migrant species is Western Sandpiper *Calidris mauri,* with Dunlin *C. alpina* and Short–billed Dowitcher *Limnodromus griseus* being the next most common. A total of 39 species of waders have been recorded. A small embayment within Grays Harbor, Bowerman Basin, consistently held the largest numbers of waders during these counts. At low tide, 1,400 ha of mudflat are exposed at Bowerman Basin. The total area of exposed mudflat at low tide in Grays Harbor is 14,800 ha (Herman & Bulger 1981).

The spectacle of up to 400,000 waders crowded by the rising tide onto the flats of Bowerman Basin attracts hundreds of birders each spring. This spectacle stimulated conservationists, politicians and local government officials to seek protection for Bowerman Basin. These efforts culminated in the establishment of a National Wildlife Refuge in 1988 which includes Bowerman Basin. The establishment of this refuge is regarded as a major conservation victory. While I applaud the creation of this necessary National Wildlife

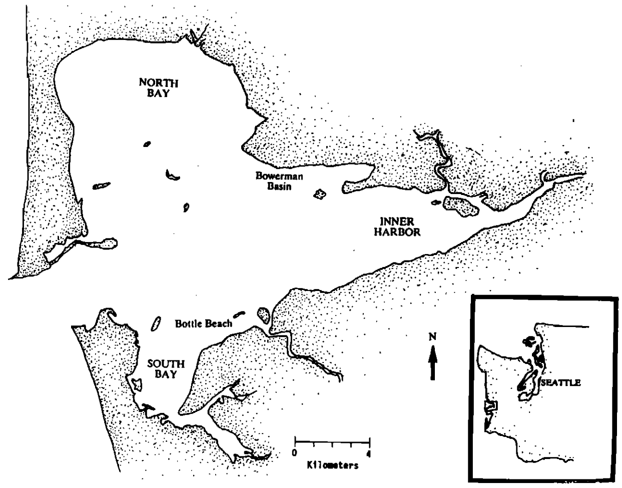

Figure 1. Map of Grays Harbor, Washington, USA showing the location of Bowerman Basin and the important feeding area at Bottle Beach.

Refuge, I believe that this refuge is insufficient to guarantee the safety of migratory waders in Grays Harbor.

My concerns stem from the fact that Bowerman Basin is only used by waders for a fraction of the tidal cycle; birders know that field trips to Bowerman Basin must be timed within an hour or two of high tide. I documented this phenomenon by conducting wader counts at Bowerman Basin over a tidal cycle on 1 May 1990. Arriving about an hour after high tide, I counted total waders as the tide fell and subsequently rose to fill the Basin in the late afternoon (Figure 2). For the 13 hr, 42 min interval between successive high tides, waders were present in greatly reduced numbers in Bowerman Basin for nine hours, being absent entirely for five hours. Clearly, waders concentrate in Bowerman Basin at high tide but most disperse to other areas of Grays Harbor within two hours past high tide.

Why do birds leave Bowerman Basin as the tide begins to fall? As Herman & Bulger (1981) point out, Bowerman Basin is located quite high in the intertidal zone and is one of the last intertidal areas to be covered by a flooding tide. The departure of waders from the basin as the tide falls implies that recently exposed areas are more favorable feeding areas. Bottle Beach (Figure 1) appears to be the most important feeding area for these waders although the birds disperse widely (pers. obs.).

METHODS AND RESULTS

To evaluate Bowerman Basin as a feeding area, I sampled the invertebrate prey at Bowerman Basin on 12 April and on 15 May 1990. The sampling was designed to determine prey abundance just before the waders arrived on migration and abundance just after their departure on their northward journey to their breeding grounds. I chose a site of 100 m^2 near the center of the Basin where the waders seemed to concentrate their feeding activities. The upper reaches of the Basin are characterized by an extremely flocculent mud which harbors few invertebrates of any species. Six samples, randomly taken within the site, were taken on each date with a 10 cm diameter core (sampling an area of 0.008 m^2). Each sample was independently sieved through a 500 μm sieve. All retained organisms were fixed in 10% formalin and later sorted and identified under a dissecting microscope (Table 1).

Table 1. Comparison of invertebrate abundance at Bowerman Basin shortly before the arrival and just after the departure of migratory waders. The mean of six cores (0.008 m^2) is given with the standard error given in parentheses. Means of 12 April. are not significantly different from those of 15 May by Student's t-tests ($p > 0.05$)

Species	12 April	15 May
Manayunkia aestuarina (Polychaeta)	101.6 (21.86)	130.7 (48.54)
Chironomid larvae (Insecta)	26.3 (2.32)	47.2 (10.1)
Oligochaeta	24.5 (7.94)	10.5 (3.13)
Eteone heteropoda (Polychaeta)	14.17 (2.39)	9.3 (2.16)
Corophium salmonis (Crustacea)	4.5 (1.28)	2.2 (0.98)
Cumella vulgaris (Crustacea)	3.5 (1.82)	3.0 (1.21)
Heteromastus filiformis (Polychaeta)	2.7 (0.80)	2.0 (0.89)
Streblospio benedicti (Polychaeta)	1.7 (0.56)	2.3 (0.92)
Leptochelia dubia (Crustacea)	0.3 (0.21)	1.0 (0.82)

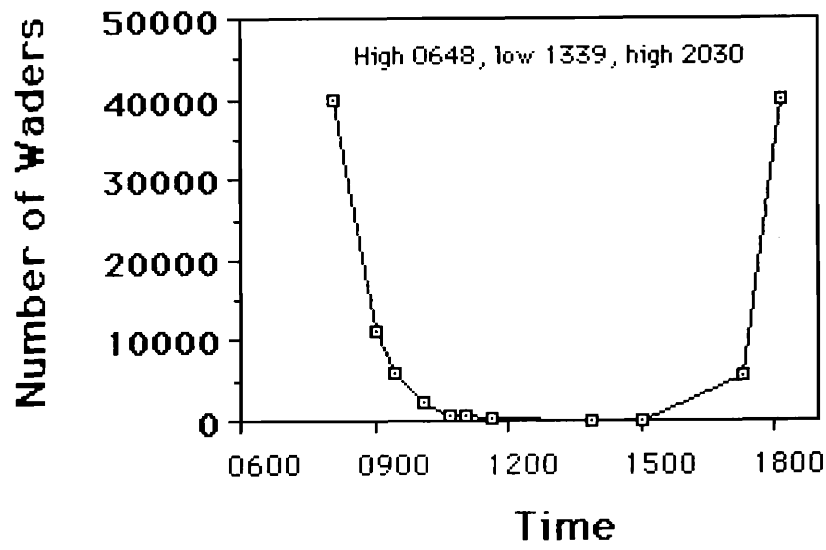

Figure 2. Wader numbers at Bowerman Basin over a tidal cycle. The counts began shortly after high tide and continued until the tide had nearly reached the next maximum. The times of high and low tides are given on the figure.

DISCUSSION

Two points emerge from these data. First, invertebrate abundances are low in Bowerman Basin. Low densities are to be expected in extremely high intertidal areas where prolonged aerial exposure is too stressful for most invertebrates. Previous sampling on the intertidal flats at Bottle Beach, 5 km southwest, where many waders forage at low tide, provides data for comparison (Wilson 1991). At Bottle Beach, the density of the tanaid crustacean *Leptochelia* is 120 animals per core and *Corophium spinicorne* (a congener of *C. salmonis* which occurs at Bowerman Basin) is 140 per core. Furthermore, the spionid polychaete *Streblospio* occurs at a density of six worms per core and two other species of spionid polychaetes, absent from Bowerman Basin, are found in densities of 8 and 10 worms per core. These spionids are taken frequently by waders at Bottle Beach (pers. obs.). The most abundant invertebrate, the sabellid polychaete *Manayunkia*, in the Bowerman Basin flat is too small (two millimeters long as an adult) to be a significant source of food for foraging waders. It is doubtful that a wader could even manipulate a worm this small. These data suggest that Bowerman Basin is relatively depauperate in prey for foraging waders.

The second point is that the feeding intensity of waders at Bowerman Basin is low. One expects a depression of prey abundance where the intensity of wader predation is high (Schneider 1978; Wilson 1989). Comparison of the data in Table 1 between dates indicates that Bowerman Basin is not heavily used by foraging waders, despite the low total prey density. For none of the prey species listed in Table 1 is there any significant change in density between the two sampling dates (t-tests, $p > 0.05$ for all species). The use of a relatively coarse sieve ensured that juveniles were not sampled. Otherwise, recruitment into the population between 12 April and 15 May might have masked a depression of prey abundance caused by the feeding waders. Although waders were observed to feed in Bowerman Basin, they spent a significant amount of their time roosting (pers. obs.). The data in Table 1 indicate that their foraging success in Bowerman Basin was probably limited.

I conclude from these data that Bowerman Basin is an extremely important high–tide roosting area for migratory waders. However, it does not appear to be an important feeding area. As soon as the tide falls enough to expose other intertidal areas, waders depart from Bowerman to feed elsewhere.

The concentration of large numbers of waders into Bowerman Basin at high tide creates a striking display, easily appreciated by the public and politicians. This awareness has led to the preservation of this important roosting site as a National Wildlife Refuge. However, waders spend significantly less than half of their time in Grays Harbor at Bowerman Basin. For about four hours before to four hours after a low tide (Figure 1), the birds are dispersed broadly over intertidal areas to feed and fatten before continuing their migration. These feeding activities at sites other than Bowerman Basin are critical to waders using Grays Harbor. However, these foraging sites are presently unprotected, posing a potential threat for migratory waders which use Grays Harbor as a stop–over area. To adequately protect waders at a major stop–over area, it is essential that a comprehensive plan be realized (e.g. Stroud *et al.* 1990). The protection of roosting areas without consideration of feeding areas leaves the waders in Grays Harbor at risk.

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ERRATA

Unfortunately the full details of unfaithful Curlew Sandpiper were erroneously omitted from the published version of Martin, Uttley and Underhill's paper in Bulletin 66 : 41-42. Our apologises. Table 1 should have read

Table 1. Measurements (mm), masses (g) and primary moult scores of Curlew Sandpiper BB46542 (SAFRING) when ringed (first line) and recaptured (second line)

Date	Place	Age	Wing	Bill	Head	Foot	Mass	Moult
22 Feb 1985	Swartkops estuary (33 52 S, 25 37 E)	Ad	133	37.0	60.8	53	60	all new
4 Sept 1987	Khor Dubai (25 15 N, 55 19 E)	Ad	132	37.5	61	55	80	NNNNN20000