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IN the United States there is breeding ecology information available on the Great Blue Heron (*Ardea herodias*), but large-scale distributional and productivity information is lacking. In the lake regions of the Canadian provinces of Alberta, Manitoba, and Saskatchewan, regional surveys of Great Blue Heron nesting sites have been done by Vermeer and Reynolds (1970) and Vermeer (1969). Breeding biology studies were done in California (Pratt 1970, Page 1971), Canada (Vermeer 1969, McAloney 1973), and Oregon (Henny and Bethers 1971). In 1974 a survey of Great Blue Heron heronries on the Oregon Coast was completed through a National Science Foundation grant (McMahon et al. 1974). The only other extensive survey in the United States dealing with Great Blue Heron habitat and nesting success was done by Miller (1943). In general, large-scale surveys of colonial-nesting herons is lacking in the literature. No regional data are available concerning inland breeding sites in Oregon. This type of information is essential for historical perspective and management, especially in terms of identification and inventory of critical avian habitats as a part of future land-use and preservation plans.

Oregon's Willamette River and adjacent riparian lands recently became part of a concentrated land-use plan called the Willamette River Greenway. In the plan, wildlife areas are given high priorities for inclusion in preservation categories, and Great Blue Heron habitat is specifically mentioned.

The main goals of my project were to study the distribution of Great Blue Heron colonies along the Willamette River with emphasis on: (*1*) heron productivity (i.e., number of active nests, number of young produced, nesting chronology, feeding data, and effects of weather and pesticides on nesting success); (*2*) physical description of heronries and related habitat (i.e., description of nesting trees and riparian habitat, availability of nesting habitat, location of and distance between heronries, and ownership — land-use information); and (*3*) effects of logging on Horseshoe Island during the beginning of the breeding season.

Study Area

The Willamette Valley (Fig. 1) is essentially a level lowland formed by the accumulation of sediments in a great structural trough lying between the Coast Range and the Oregon Cascades. Because of the gentle gradient of much of the valley, the Willamette River is fundamentally a depositional, rather than erosional, stream. The river drops only 100 m from Eugene to Portland, a distance of 328 km. Through time the river has meandered back and forth across the valley floor, creating many channels and sloughs. These channels, sloughs, and fluviatile lakes are extremely productive and provide the bulk of the Great Blue Heron's food during the breeding season.

Bordering the Willamette River and its sloughs are luxuriant stands of riparian forests. When seen from the air, the forests do not appear as a continuous belt of vegetation but rather as patches of floodplain forest separated by large expanses of cleared land (Fig. 2). Pioneer accounts describe the cottonwood forests as a continuous belt of vegetation stretching from Eugene to Portland (Johannessen et al. 1962). These moist hardwood forests are typically thick, dense stands of black cottonwood (*Populus trichocarpa*), ash (*Fraxinus latifolia*), maple (*Acer macrophyllum*), and willow (*Salix lasiandra*) associations. The understory consists of canary grass (*Phalaris arundinacea*), nettle (*Urtica lyallii*), and blackberries (*Rubus* sp.) (Fig. 3). The deciduous forests are diverse, moist, and stratified and as such provide habitat for herons and a variety of other avifauna and mammals. The herons nest exclusively in these patches of riparian forest, and the tall black cottonwoods are the preferred nesting trees.

Study Methods

The use of a light aircraft for wildlife censusing is quite common, but regional aerial searches for heronries are uncommon. Hopkins and Dopson Jr. (1967) employed an aerial search for colonies in south-central Georgia, and Vermeer used a float plane for locating heronries in Canada (1969).

Between 4 February and 23 April 1975, aerial searches were made for Great Blue Heron nesting sites along the Willamette River from Dexter and Cottage Grove reservoirs in the south to the Columbia River in the north. Twenty-five hours were spent in the air, and a distance of 4,000 air km was traversed. The river and adjacent lands were divided into five geographic sections, and each section was searched at least three times. Areas containing large patches of riparian forests and located next to river sloughs were considered as likely habitat and were flown over many times. Such factors as size of trees, density of stand, oblique flight angle, and direction of sunlight also were considered when looking for possible heronries.

Most flying was done in the late morning and early afternoon. A Cessna 150 flying at 145 kph and at an altitude of 300 m was used in the first part of the survey. Later a Champ (Aeronca) was used, and most flying was done from 150 m at a speed of 105 kph. The slower cruising speed and low-level capabilities of the Champ proved to be more effective. A map of the river was used for orientation during flight, and oblique photographs were taken of the river. These photographs were later compared to standard aerial photos, and the locations of the heronries and other land features related to habitat description (e.g., feeding areas, disturbances) were pinpointed. After locating the heronries on aerial photos, I boated or drove to the nesting sites.

Windsor Island special study site was observed nine times; the six study areas were visited at least three times, and the remaining 24 heronries were studied twice.

The forest area encompassing each heronry was determined by the dot planimeter method, which involved placing tracing paper over 1/4-inch grid paper and drawing a dot for every square. This overlay was then placed over an aerial mosaic of the Willamette River (scale: 1 in = 400 ft), and each dot (representing 1/4 acre) falling with a patch of riparian forest was counted. The area was then converted to hectares. The forested areas surrounding each heronry and having a minimum width of 100 m were measured.

Nesting activity was determined by direct observation (i.e., presence of whitewash, sounds coming from the nest, herons sitting in the nest, or by counting the

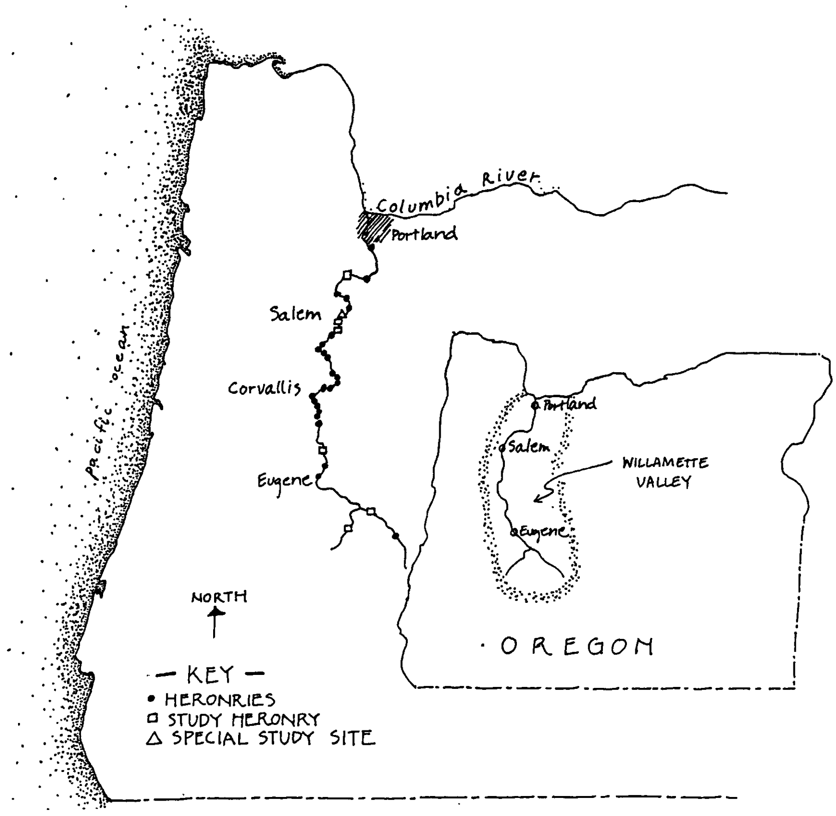

Figure 1. Map of the Willamette River depicting the location and distribution of 31 heronries.

Figure 2. The Willamette River Valley and its floodplain forests.

Figure 3. A moist hardwood forest of the Willamette River Valley.

Table 1. Nesting data of study sites.

Name & Location	Number of Nests (Active–Inactive)	Number of Nesting Trees	Sites Within 100 m of Feeding Areas	Average Ht. and D.B.H.
East Island 45°29′N RK 24[2]	2–0	2		26.0 m–110 cm
Molalla 45°18′N RK 56	59–3	11	X	26.2 m–110 cm
Candiani Island[3] 45°16′N RK 93	47–3	18	X	25.0 m–105 cm
Jackson Bend 45°09′N RK 105	30–2	18	X	22.5 m–85 cm
Eldriedge Slough 45°06′N RK 109	13–2	10	X	20.0 m–58 cm
Wheatland[3] 45°04′N RK 114	54–3	20	X	22.5 m–85 cm
Windsor Island[4] 45°30′N RK 117	53–5	30	X	20.0 m–58 cm
Minto Island 44°57′N RK 137	10–4	5	X	22.5 m–85 cm
Hayden Island[3] 44°56′N RK 143	22–2	22	X	20.0 m–48 cm
Budds Chute 44°55′N RK 148	0–5	5		18.7 m–60 cm
Independence Bend 44°54′N RK 153	31–2	10	X	26.2 m–105 cm
Tyson Island 44°50′N RK 161	22–2	9	X	25.0 m–100 cm
Judson Rock 44°49′N RK 163	10–1	5	X	20.0 m–58 cm
Luckiamute 44°46′N RK 174	2–0	2		27.5 m–110 cm
Lower Santiam Bar 44°45′N RK 177	4–0	1		21.2 m–90 cm
Black Dog Island 44°41′N RK 179	12–1	6	X	25.0 m–103 cm
Bowers Rock 44°38′N RK 196	23–2	6	X	25.0 m–105 cm
North Corvallis 44°37′N RK 200	28–2	12	X	22.5 m–95 cm
Corvallis 44°33′N RK 212	2–0	1		22.5 m–97 cm
Upper John Smith Is. 44°30′N RK 221	6–0	4	X	23.7 m–95 cm
Horseshoe Island 44°29′30″N RK 222	destroyed	destroyed		
John Smith Island 44°29′N RK 223	22–1	3	X	27.5 m–105 cm
Daws Bend 44°25′N RK 233	55–4	20	X	27.5 m–105 cm
American Island 44°23′N RK 237	25–5	10	X	22.5 m–85 cm
Harrisburg 44°17′N RK 256	0–8	8		13.7 m–45 cm
Harpers Bend[3] 44°15′N RK 266	24–2	10	X	22.5 m–85 cm
Marshall Island 44°11′N RK 270	10–1	3	X	26.2 m–100 cm
McKenzie Island 44°07′N RK 282	75–5	24	X	23.7 m–90 cm
Mount Pisgah[3] 44°01′N RK 310	37–4	32	X	18.7 m–45 cm
Camas Swale[3] 43°57′N RK 315	14–1	5	X	25.0 m–95 cm
Dexter Island 43°55′N RK 328	30–2	10	X	22.5 m–75 cm

[1] Location of each site by latitude
[2] RK refers to river km measured from 0 (Columbia River confluence) upstream to Dexter Reservoir (river km 328).
[3] Indicates a heronry where nesting success data was gathered.
[4] Indicates the study site where nesting trees were climbed.

eggs or young). Inactive nests showed none of the above signs of activity and were not used by the herons during the breeding season.

Two nesting trees were climbed on Windsor Island to observe and monitor reproductive chronology. The trees were climbed six times, and each time notes and photographs were taken to determine nest activity and to record nestling growth. Observations from the ground were made with 7×50 binoculars. Tree height was determined with an Abney level.

The chemical analyses were made by gas liquid chromatography, using electron capture detection. The analyses were done by the Department of Agricultural Chemistry at Oregon State University.

Climatological data were obtained from the National Oceanic and Atmospheric Administration, Asheville, North Carolina. The data were recorded at McNary Field, Salem, Oregon, which is 12 km from the Windsor Island special study site.

Results

From 2 April through 15 August 1975, a ground census was conducted of the 31 heronries that had been located from the air. The count revealed 722 active and 72 inactive nests along 328 river km (Tables 1 and 2). The productive sloughs and lakes of the river system were the prime feeding areas for the herons. Twenty-four of the 31 heronries were located within 100 m of a known feeding area. The six heronries that were not close to sloughs (feeding areas) were comparatively smaller (Table 1, col. 4).

Table 2. Habitat descriptions of study sites.

Name	Island Sites	Dominant Upperstory	Dominant Understory	Ha of Riparian Forest	Inundated (periodically)	Land Use & Ownership
East Island	X	C–W	CG–BB	5.67	X	Corporate gravel site
Molalla		C–W	CG–BB–N	42.51	X	State park
Candiani Island[3]	X	C–W	CG–BB	23.07	X	Private, unknown
Jackson Bend	X	C–W–A	CG–N	21.85	X	Private agriculture
Eldriedge Slough		C–W	CG–BB–N	34.00	X	Private agriculture
Wheatland[3]		C–A–M	CG–BB–N	15.38		State Greenway
Windsor Island[4]	X	C–W	CG–N–BB	30.35	X	Corporate gravel site
Minto Island	X	C–W	BB–CG–N	14.16	X	Corporate, unknown
Hayden Island[3]		C–W	CG–N	107.24	X	State Greenway
Budds Chute	X	C–W	CG–BB	13.67	X	Private, unknown
Independence Bend		C–W–A	CG–N–BB	55.84	X	Private agriculture
Tyson Island	X	C–W–M	CG–N–BB	20.64	X	Private agriculture
Judson Rock		C–W	CG	28.34	X	Private agriculture
Luckiamute		C–W–A	CG–BB–N	114.39	X	State Greenway
Lower Santiam Bar		C–W	BB–N	4.05	X	Private agriculture
Black Dog Island	X	C–W	CG–N	28.73	X	State Greenway
Bowers Rock	X	C–W–M	CG–BB	62.32	X	Private agriculture
North Corvallis		C–W–A	CG–BB–N	78.51	X	State Greenway
Corvallis		C–W	BB–H–F	1.00	X	Private agriculture
Upper John Smith Is.		C–A	BB–CG	1.00		Private agriculture
Horseshoe Island		C–W	CG–BB	2.00	X	Private agriculture
John Smith Island		C	BB–H	1.00		Private agriculture
Daws Bend		C–M–A	CG–BB–H	80.35	X	State Greenway
American Island	X	C–W–A	CG–BB–N	55.47	X	Private agriculture
Harrisburg		O–A	H–BB	5.00		Private agriculture
Harpers Bend		C–W	CG–BB–N	44.92	X	State Greenway
Marshall Island		C–W	CG–BB–N	25.50	X	State Greenway
McKenzie Island	X	C–W–A	CG–BB–F	65.00	X	Corporate gravel site
Mount Pisgah		C–W	CS–BB–F	76.05		Corporate gravel site
Camas Swale		C–F–O	BB–F	22.26		Private agriculture
Dexter Island	X	C–F–C′–O	BB–F–N	60.70	X	Corps of Eng. unknown

Key to Upperstory
C′ –Red Cedar (*Thuja plicata*)
C –Black Cottonwood (*Populus trichocarpa*)
W –Pacific Willow (*Salix lasiandra*)
A –Oregon Ash (*Fraxinus latifolia*)
M –Bigleaf Maple (*Acer macrophyllum*)
F –Douglasfir (*Pseudotsugo menziesii*)
O –Oregon White Oak (*Quercus garryana*)

Key to Understory
CG–Canary Grass (*Phalaris arundinacea*)
H –Evergreen Huckleberry (*Vaccinium ovatum*)
N –Nettle (*Urtica lyallii*)
BB –Evergreen Blackberry (*Rubus sp.*)
Himalaya Blackberry (*Rubus sp.*)
S –Scotch Broom (*Cytisus scoparius*)
F –Sword Fern (*Polystichum munitum*)

Samples taken from beneath the nests revealed that the major sources of food were white crappie (*Pomoxis annularis*), northern squawfish (*Ptychocheilus oregonensis*), large-scale sucker (*Catostomus macrocheilus*), and carp (*Cyprinus carpio*).

Nesting success information was gathered from seven heronries (Table 3). The number of young fledged per nest was determined by counting young that were at the fledging stage. A lot of the nests and fledglings were quite visible in these heronries; however, the number fledged per nest may be conservative because I might have missed young that were not visible or young that had already fledged. The nests were counted in late June and early July, when the young were six to eight weeks old. According to Pratt (1970), Henny and Bethers (1971), and my observations, this is the time for young to hop about on branches and take short flights (prefledgling activity).

Windsor Island was one of the seven study heronries, and nesting success data were recorded there with more detail than at the other six sites because two nesting trees were climbed. The Windsor Island heronry was the only site from which data were gathered on numbers of young produced per nesting attempt. Fifty percent of the 54 active nests were observed six times over a seven-week period. The site was visited on 4 May, and 52 percent of the observed nests contained eggs. It is estimated that peak hatching occurred at about this time. Because I arrived late at the heronry I was unable to determine accurately the average clutch size, but according to Henny and Bethers (1971) the average clutch size of a heronry 80 km upstream from the study area was 4.19 eggs (Table 4).

Table 3. Nesting success information for seven heronries on the Willamette River (RK=river k.)

Name & Location	Number of nests	Average number fledged per nesting attempt	Average number fledged per nesting pair	% of Total Active Nests
Candiani (RK 93)	11	2.37	-	25%
Wheatland (RK 114)	14	2.45	-	28%
Windsor Is. (RK 117)	27	2.32	1.96	51%
Hayden Is. (RK 143)	10	2.30	-	45%
Harpers (RK 266)	14	2.71	-	56%
Mount Pisgah (RK 310)	25	2.68	-	67%
Camas Swale (RK 315)	6	2.17	-	43%

On the 4 May visit, nests containing four eggs, four recently hatched young, or various combinations of eggs and young in groups of four totaled 49 percent of the observed nests.

I estimated the age of the largest nestling to be about 15 days. This estimation was based on photographing the largest nestling in the study site and then a clutch of eggs containing an egg that had just pipped. After two weeks the clutch that contained the previously pipped egg was again photographed, and the results were compared with the first nestling photographs.

The incubation period of 28 days (Bent 1926, Palmer 1962) is generally accepted, and by back-dating and extrapolating I calculated that incubation started around 23 March. Because of asynchronous hatching (Pratt 1970), the first eggs probably were laid around 15 March.

The date the first eggs were laid at Windsor Island was 15 March. This egg-laying date was three weeks

Table 4. A comparison of reproductive success for the Great Blue Heron.

Location and Latitude	Years	Mean Clutch Size	Percent of nests successful	Average number fledged per nesting attempt	Average number fledged per nesting pair	Source
Southern Alberta (49° 55′N)	1967–68	5.00(11)[1]	-	2.51	2.2 – 2.3	Vermeer (1969)
Nova Scotia (45°N)	1971	4.17(36)	81%	3.09	2.84	McAloney (1973)
Western Oregon (44°N)	1970	4.19(32)	78%	2.61	2.04	Henny & Bethers (1971)
Central California (38°N)	1967–68	3.66(41)	76–82%	-	1.5 – 1.7	Pratt (1970)
Northwestern Oregon (45°N)	1975	-	85%	2.32[3]	1.96[2]	This paper

[1]Sample size in parentheses
[2]Windsor Island (Salem) heronry

later than indicated by Henny and Bethers in their 1970 study of a Willamette River heronry. I believe the disparity was caused by an unusually cold and wet spring (Fig. 4). Pratt (1970), Prestt (1970), and Page (1971) indicate that prolonged periods of rain and cold can cause lags in the breeding cycle. The unusually cold temperatures and high amounts of precipitation could have been a major cause for the abandonment after egg hatching of one southern heronry (American Island).

The average number of young fledged from the seven sample heronries was 2.43 per nest. Windsor Island was the only heronry that was observed closely enough to determine fledging success per nesting pair. No young were produced from four nests (eggs were laid but did not hatch); one bird was produced in each of two nests; two young fledged from 13 pairs; seven nests each contained three fledglings; and four young fledged in one nest. The total number of young produced from 27 nesting pairs was 53. Renesting did not occur, and there were 1.96 young fledged per nesting attempt (Windsor Island).

The Horseshoe Island heronry was cleared of its

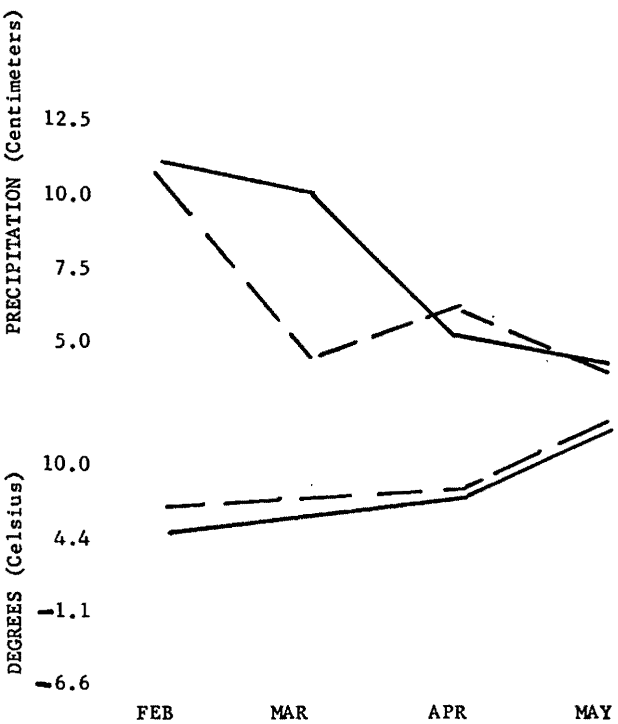

Figure 4. Monthly precipitation and average mean daily temperatures for the breeding seasons of 1970 (broken line) and 1975 (solid line).

estimated 50 nesting trees at the beginning of the 1975 breeding season. The site was first observed from the air in late February when I estimated 60 nests, 50 percent of which contained herons. The heronry was flown over again in early April, and it was evident that the nesting site had been cleared of trees and other vegetation. I boated to the remains of the colony on 10 April and found the heron population split up: 15 pairs did not attempt renesting, the majority (22 pairs) relocated in a sparse, exposed cottonwood grove on John Smith Island 1 km south of the previous site, and the remaining herons (12 pairs) moved 1 km north of the previous heronry to a small cottonwood grove on Upper John Smith Island. The larger of the newly constructed heronries at John Smith Island contained 22 active nests in three cottonwood trees and was observed four times during April, May, and late June. I had a fairly clear view of all the nests, so my observations were accurate. Nest construction was still being carried out at the end of April, and on 23 June I saw evidence of young in four nests, 18 percent of the total of 22 active nests. It was evident that the destruction of the original heronry on Horseshoe Island plus harassment by landowners caused nearly complete failure of this dispersed population. The owner of John Smith Island had plans to clear the small strip of nesting trees prior to the 1976 nesting season.

The 31 heronries all were located in tall cottonwood stands with the exception of a heronry near Harrisburg, which was situated in a stand of oak (*Quercus garryana*). All nesting trees except three were alive. Twelve of the heronries were situated on islands, and 25 of the nesting sites were inundated during winter and early spring.

The average height of the nesting trees was 23 m (minimum 13.2 m, maximum 27.5 m), and the average DBH was 90 cm (minimum 45 cm, maximum 110 cm). The average area of each heronry was 36.8 ha (minimum 1 ha, maximum 114 ha). (See Tables 1 and 2 for detailed habitat description of each heronry.)

Pesticide Analysis

Two Great Blue Heron eggs were analyzed for polychlorinated biphenyls (PCBs) and the chlorinated hydrocarbon DDT and its metabolites. Although two egg samples were not statistically significant, the results did have comparative value. The eggs contained fairly well developed chicks and were selected from two different nests.

The levels of DDE ranged from .005 to 1.46 ppm wet weight, and the mean was 0.78 ppm. The level of DDE was low compared with one study site in Albany 80 km upstream (Henny and Bethers 1971), from which two eggs were analyzed. The results of that study showed a mean of 3.90 ppm (range 3.30 to 4.50). Ives (1972) analyzed six Great Blue Heron eggs for DDE on Indian Island, California, and his results showed a mean of 2.00 ppm (range 1.19 to 3.53 ppm wet weight). In Alberta (Chip Lake), studies done by Vermeer and Reynolds (1970) showed that herons laid thin-shelled eggs. In this case ten eggs were sampled, with a mean of 37.01 ppm wet weight (range 0.7 to 234.4).

PCB residues (Aroclor 1254) were detected in the two egg samples. The mean was .323 ppm wet weight (range .065 to .581). Comparisons of PCB levels are not available for Great Blue Herons, but Prestt et al. (1970) analyzed 101 Gray Heron (*A. cinerea*) eggs from the British Isles and found a mean PCB level of 5.0 ppm wet weight (range 0 to 80).

Discussion

Feeding sites could be a limiting factor for heronries, but the Willamette River and its floodplain have many shallow, productive sloughs and wetlands which provide abundant food sources for herons during the breeding season. The lack of nesting habitat, mainly large patches (35+ ha) of riparian wetland forest situated close to feeding areas, appears to be a limiting factor.

Beyond the southernmost heronries, the steep stream gradients in the Coast Range and the Cascades limit the available aquatic feeding areas with the exception of ponds, several large reservoirs, and a few lakes. The northernmost active heronry in the study was located near Oregon City (Molalla). From the Molalla heronry to the Columbia River confluence is 80 river km. The presence of the Portland metropolitan area could account for the lack of heronries along 32 river km; the remaining 48 km (around Sauvie Island) consists of a delta region abundant in feeding areas but lacking extensive riparian forests. Many Great Blue Herons feed on the delta, which is a state game refuge. A heronry (500+ nests) is located on Bachelor Island, on the north side of the Columbia River, 11 km from Sauvie Island.

There are greater distances between heronries where there is no suitable nesting habitat (Table 1). This is especially true around metropolitan areas, such as Eugene and Portland, where the riparian habitat has largely been eliminated for urban development. For instance, the distance between the Mount Pisgah site (south of Eugene) and the McKenzie Island heronry (north of Eugene) is 29 km (Table 1). Large amounts of agricultural clearing could account for the lack of heronries outside the urbanized areas. The lack of habitat is especially evident north of Salem, where the distance between the Candiani heronry and the Molalla heronry is 37 km.

With the exception of the Eugene, Salem, Albany, and Portland metropolitan areas, the Willamette River is relatively undeveloped. At present, most of the heronries are relatively undisturbed, but that situation is changing rapidly: There is increased logging in the riparian forest wetlands, and considerable amounts of habitat are being lost as a result of agricultural clearing, gravel mining, and housing construction.

Horseshoe Island was a prime example of a location where habitat clearing pressure is occurring along the Willamette River. Three years prior to the logging of Upper Horseshoe Island, the same landowner logged a heronry (50+ nests) on the lower end of the island about 2 km south of the upper Horseshoe Island heronry. Presently, gravel operations and agricultural clearing are encroaching on at least five other heronries, and the Nature Conservancy is involved in possible land negotiations to preserve the nesting sites.

At this time the Oregon Division of State Parks and the Greenway Commission own land on which there are nine heronries (totaling 276 active nests); private interests, mainly agricultural, own land on which there are 16 heronries (246 active nests); corporate interests (gravel operators) control land on which there are five heronries (170 active nests); and the U.S. Army Corps of Engineers controls land on which there is one heronry (30 nests) (Table 2). Of the four categories of land ownership (two public agencies, two private), the state appears to be in the best position to initiate active management through the Greenway Plan or through the Oregon Department of Fish and Wildlife.

Under the Migratory Bird Act, heron nests are protected during the nesting season, but that protection should be extended to the sites permanently. In the event that an entire nesting site cannot be preserved, then a substantial buffer zone should be left around each heronry. During the breeding season (February through August), the herons are extremely sensitive to disturbances (McMahon et al. 1974, and pers. obs.); therefore gravel mining, logging, and other human disturbances should not occur in the vicinity of the heronry. In the event that needs require cutting existing habitat, an active management plan should be initiated through wildlife and planning agencies to preserve patches of riparian forest for alternative nesting sites. Additionally, riparian lands that are now cleared should be set aside so they could be regenerated (by planting and so forth) into future riparian forest habitat suitable for Great Blue Herons and other wildlife.

Habitat loss is crucial because of the construction of a system of dams on the upper Willamette River during the last 50 years and because of extensive rebuttment programs initiated along the main stem. The dams and the riprap have halted much of the river's meandering and depositional forces, and consequently little new riparian land is being created. This means that any riparian habitat clearing will be fairly permanent.

Red-tailed Hawks (*Buteo jamaicensis*) and Great Horned Owls (*Bubo virginianus*) were observed nesting near the edges of heronries. This nesting association was evidenced at Jackson Bend, Windsor Island, American Island, Independence Bend, Daws Bend, Harrisburg, and Camas Swale. There was no direct evidence of predation by Great Horned Owls or Red-tailed Hawks on Great Blue Heron nests, but Red-tailed Hawks were seen circling over 21 heronries. In one instance, a Red-tailed Hawk was driven away from a group of nests by several adult herons.

It is of note that the largest heronries are on islands located at the confluences of large rivers. This was the case at McKenzie Island heronry (McKenzie River confluence), Molalla heronry (Molalla River confluence), and Bachelor Island heronry (Willamette and Columbia rivers confluence).

The organochlorine residues at Windsor Island were low (.78 ppm), especially when it is considered that two eggs sampled 80 km upstream in Albany by Henny and Bethers in 1970 contained higher levels of DDE (3.90 ppm) than the Windsor Island heronry. The levels of DDE were also low when compared to those at the site of Indian Island, California (2.00 ppm). The number of young produced per successful nest at the three previously mentioned heronries was 2.43 (Windsor Island), 2.61 (Albany, Oregon), and 2.20 (Indian Island, California). Studies done in Canada by Vermeer and Reynolds (1970) and in Great Britain by Prestt et al. (1970) showed that herons are maintaining stable populations despite high levels of organochlorine residues because of their apparent adaptability to the chemicals and their repeated renesting attempts.

The overall nest productivity figure of 2.43 fledged per successful nest of the Willamette River Great Blue Heron population in 1975 compares closely to other productivity figures from the Northwest (Table 4).

As indicated by the distance between some heronries and the amount of recent riparian forest clearing, it is evident that in some areas of the Willamette Valley suitable nesting habitat is widely distributed and may be limiting. Suitable feeding areas are abundant, and Great Blue Heron productivity is comparatively good with seemingly little effect from organochlorine residues.

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Summary

An aerial and ground survey of Great Blue Heron colonies located in the riparian forests of the Willamette River was completed during late winter and early summer of 1975. Along 328 river km, 31 heronries were located, 15 of which were previously unknown. In the survey 722 active and 72 inactive nests were counted. One heronry was abandoned early in the nesting season (after hatching); one site was destroyed by agricultural clearing; two sites were inactive, and 27 heronries were active.

The herons began laying eggs around 15 March, which, because of a cold, wet spring, was three weeks later than reported from a previous study of a Willamette River heronry. Peak hatching and fledging occurred around 4 May and 4 July, respectively.

The number of young produced per successful nest

(average from seven heronries) was 2.43, and the number fledged per nesting attempt was 1.96 (Windsor Island site).

The organochlorine and polychlorinated biphenyl residue analysis of two eggs was 0.78 ppm DDE and 0.322 ppm PCB (mean wet weight), revealing comparatively low levels.

The herons, with one exception, nested in the tall cottonwood stands located alongside the river and its adjacent sloughs. The average patch of riparian forest wetlands surrounding each heronry was 36 ha. Feeding areas are abundant, and the eutrophic fluviatile lakes, which are part of the Willamette River system, provide an extremely productive feeding habitat for the herons during the nesting season.

The heronry on Horseshoe Island (50+ nests) was logged around the egg-laying stage (15 March); 15 pairs did not attempt renesting, and the remainder of the colony split up to form two smaller colonies (six and 22 nests). The larger colony was observed over the breeding season, and only four nests produced fledglings.

Nesting habitat could be a limiting factor in some areas. Agricultural clearing and gravel mining are the most detrimental forces acting upon the Willamette River Great Blue Heron population. The heron population, when compared to other studies, is probably stable, but the continued clearing of riparian forests would no doubt result in the loss of Great Blue Herons as breeding birds along the Willamette River.

Literature Cited

Bent, A. C. 1926. Life histories of North American marsh birds. U.S. Natl. Mus. Bull. 135:101–114.

Henny, C. J., and M. R. Bethers. 1971. Population ecology of the Great Blue Heron with special references to western Oregon. Tech. Paper no. 2975, Oregon Agric. Exper. Stn., Corvallis.

Hopkins, M. N., and W. C. Dopson Jr. 1967. An aerial search for rookeries in south central Georgia. Oriole 4:39–45.

Ives, J. H. 1972. Common Egret and Great Blue Heron nest study, Indian Island, Humboldt County California. Publ. no. 72-9, Calif. Dep. Fish Game.

Johannessen C., W. Davenport, A. Millet, and S. McWilliams. 1962. The vegetation of the Willamette Valley. Ann. Assoc. Am. Geogr. 286–302.

McAloney, K. 1973. The breeding biology of the Great Blue Heron on Tobacco Island, Nova Scotia. Can. Field-Nat. 87:137–140.

McMahon, E. et al. 1974. A survey of Great Blue Heron rookeries on the Oregon coast. Natl. Sci. Foundation Grant Study, Biol. Dep. Univ. Oregon, Eugene.

Miller, F. 1943. The Great Blue Heron. The breeding birds of the Philadelphia region, part 2. Proc. Delaware Valley Ornithol. Club, Cassinia no. XXXIII.

Page, P. J. 1971. San Joaquin River study rookery. 2nd Prog. Rep., Calif. Dep. Fish Game, Los Barros.

Palmer, R. S. 1962. Handbook of North American birds I. Yale Univ. Press, New Haven, Connecticut.

Pratt, H. M. 1970. Breeding biology of Great Blue Heron and egrets in central California. Condor 72:407–416.

Prestt, I. 1970. The heron *Ardea cinerea* and pollution. Ibis 112:147–148.

Prestt, I., D. J. Jeffries, and H. W. Moore. 1970. Polychlorinated biphenyls in wild birds in Britain and their avian toxicity. Environ. Pollut. 1:3–26.

Vermeer, K. 1969. Great Blue Heron colonies in Alberta. Can. Field-Nat. 83:237–242.

Vermeer, K., and L. M. Reynolds. 1970. Organochlorine residues in aquatic birds in the Canadian prairie provinces. Can. Field-Nat. 84:117–130.