

CANADA GOOSE PRODUCTION
ON LAKE WALLULA AND
THE LOWER SNAKE RIVER,
1974 - 1987

BY

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Introduction

Western Canada goose (Branta canadensis moffitti) production has been monitored through nest searches and brood surveys on the mid-Columbia and lower Snake rivers since before the 1950's (Ball et al. 1981). Between 1954 - 1975, U.S. Army Corps of Engineers (COE), Walla Walla District, completed 5 dams on the study area: McNary (1954), Ice Harbor (1962), Lower Monumental (1969), Little Goose (1970), and Lower Granite (1975) creating a 180-mile long chain of impoundments.

Dozens of goose nesting islands were lost and replaced by a relatively few new ones. Inundated islands in Lake Wallula (McNary Reservoir) were probably similar to islands described by Hanson and Eberhardt (1971) in the free-flowing Columbia River. Culbertson et al. (1971) described island nesting habitats in an inundated portion of the free-flowing Snake River.

New islands formed from partially submerged sand hills and bluffs presented different nesting habitats from inundated islands. The most important new nesting islands are covered with loamy soils, support subirrigated vegetation, are at least 0.5 mile from shore, and are not subject to seasonal flooding. Shoreline nesting habitats also changed, with miles of cliffs replacing riparian habitat adjacent to water, especially along the lower Snake River.

The COE holds fee title to islands and most shoreline habitat within the study area. On Lake Wallula (McNary Reservoir), COE management objectives relating to wildlife habitat fall under the concept of good land stewardship. On the lower Snake River, COE

management objectives relating to wildlife habitat fall under provisions of the Lower Snake River Fish and Wildlife Compensation Plan. The COE, U.S. Fish and Wildlife Service (USFWS), and Washington Department of Wildlife (WDW) managed all islands and most brooding habitat discussed in this report.

Nearly all islands and artificial nesting structures were searched twice annually. Cliffs were searched during a 3-year period, 1978 - 1980. Over the years nest searches have been conducted by an assortment of Federal and state biologists, private consultants, college and high school students, and members of conservation groups. Agencies involved include COE, USFWS, Oregon Department of Fish and Wildlife, and WDW. Opinions, conclusions, and recommendations in this report represent a distillation of those provided by biologists from participating agencies.

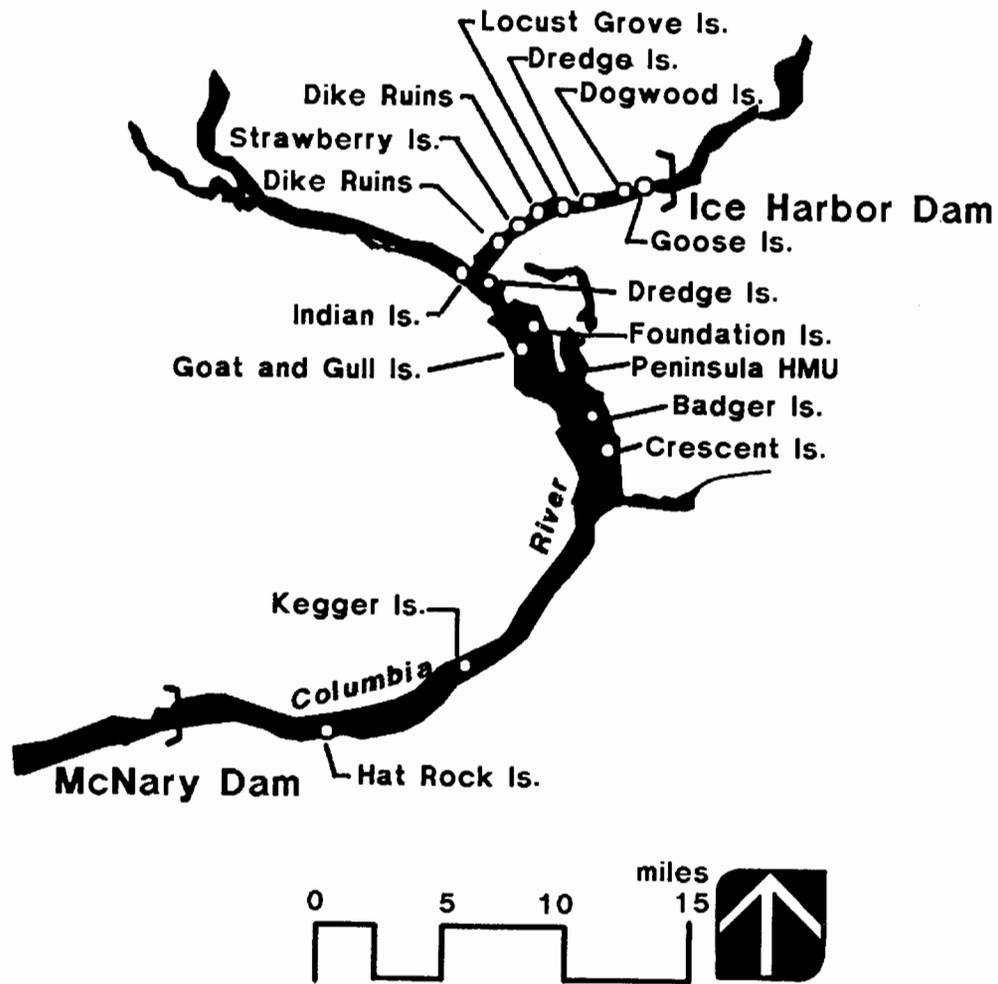
Data discussed in this report are from the 14-year period, 1974 - 1987. Tabulated field data are presented in Appendices A and B. Names given to newly created islands are taken from inundated geographical features, man-made features, and representative plants and animals.

Discussion

Lake Wallula (McNary Reservoir)

Figure 1 shows the Lake Wallula (McNary Reservoir) study area which runs from McNary Lock and Dam on the Columbia River upstream 44 miles to Ice Harbor Lock and Dam on the Snake River. This stretch of the Columbia and Snake rivers flows through the

Figure 1. Islands in Lake Wallula (McNary Reservoir) searched for Canada goose nests, 1974-1987.



southeast portion of the Columbia Plateau. The climate is semi-arid. Summers are hot and dry, winters are cool and moist, and annual precipitation is 7 inches.

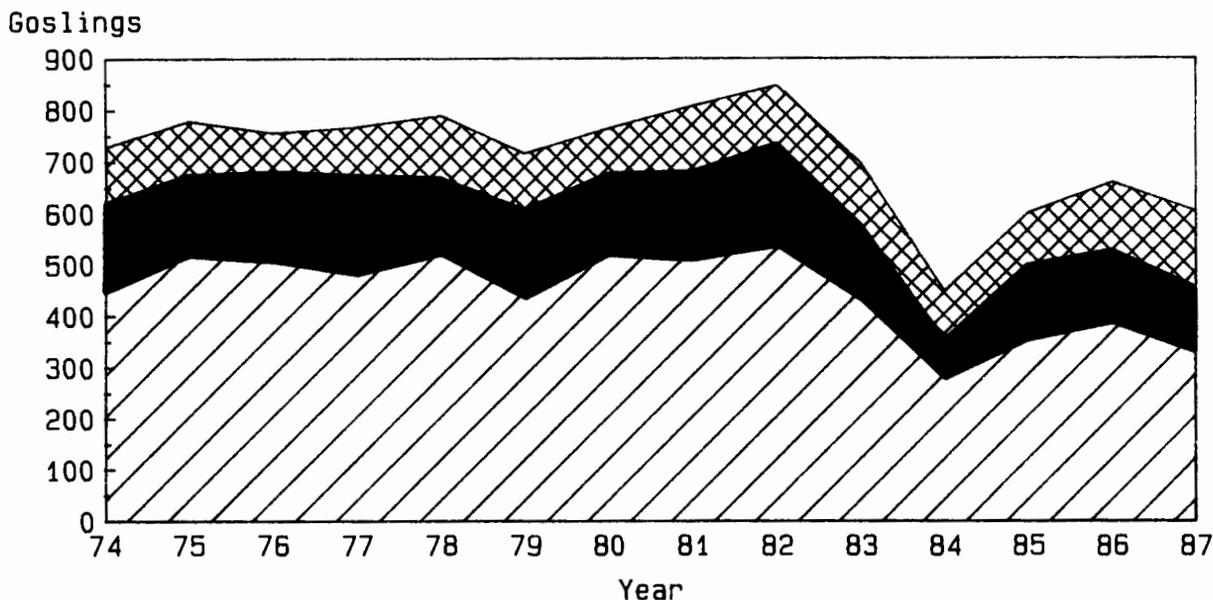
All study sites are islands, except the Peninsula Habitat Management Unit (HMU). The USFWS manages Strawberry Islands in the Snake River below Ice Harbor Dam. The COE manages all other islands in Figure 1 and designated shoreline wildlife habitat. From 1955 - 1985, WDW managed Badger and Foundation islands and Peninsula HMU. In 1985 WDW relinquished management of these sites to COE.

To better isolate nesting islands in Lake Wallula, soft constraints were placed on reservoir operations between 1 March - 15 May. While normal pool operating levels fluctuated between 335 - 340 feet elevation; under the soft constraint, pool operating elevations were maintained continuously between 337 - 340 feet with 339 feet maintained at least once every 3 days to inhibit goose nesting below maximum operating elevation.

Nearly all potential nesting sites on Lake Wallula were visited annually. Figure 2 presents observed gosling production for the 14-year period. Thirty-seven-acre Badger Island and 19-acre Foundation Island accounted for an average 63 and 22 percent, respectively, of observed gosling production. Both islands are long, narrow remnants of sand hills oriented on a north-south axis and situated 0.5 mile from shore.

Badger Island was named for a lone badger WDW trapped on the newly created island in 1955. Over 80 black-tailed jack rabbits were also removed to eliminate their potential impact on the vegetation. No mammalian predators and only an occasional

Figure 2. Observed gosling production on Lake Wallula, 1974 - 1987.



Crosshatch - All Other Islands
 Solid - Foundation Island
 Right Hatch - Badger Island

cottontail have been observed on the island since 1955.

Badger Island's undisturbed vegetation, dominated by big sagebrush, grew to where it was believed to inhibit goose nesting. Most nesting occurred on the island's north half prior to the mid-1970s. Gradually, nesting geese increasingly used the south half. In 1986, Badger Island was cover-mapped. It was found that three-fourths of 1985 - 1986 nesting occurred on the south half in rabbitbrush and sagebrush-bitterbrush associations. Vegetation on the north half consisted mostly of subirrigated sagebrush-forb associations and shoreline willows. It appeared that nesting geese avoided lodged forbs (e.g., peavine, knapweed) and shoreline willows on saturated soils. Forb cover, minimal in the island's early years, had increased on the north half on low-elevation

sites.

The COE burned Badger Island's north half in October 1986. Fire carried where ground cover was continuous and eliminated most forbs and shoreline vegetation. Burning left the north half with mostly bare sandy soil and discontinuous patches of unburned sagebrush. In 1987, 50 percent of the island's nests were found on the north half, mostly in unburned sagebrush. This redistribution of nesting suggested a preference for erect vegetation as a nest site and an easy path to water from the nest.

Foundation Island supported a variety of cover-types: prickly pear, grasses, forbs, and trees. A Chinese elm grove dominated the south end and supported a great blue heron - black-crowned night-heron rookery, under which geese seldom nested. The tree-grass ecotone and shrub-grass-forb associations provided goose nesting habitat. No mammalian predators and only occasional cottontails were observed on the island. At a pool elevation of 336 feet, mud flats connected Foundation Island to the lake shore. No mammalian predators are known to have crossed the flats.

Some potentially productive nesting islands in Lake Wallula, especially Hat Rock Islands (5, 1 - 5 acres) and Strawberry Islands (2 totaling 100 acres), suffered serious predator problems. Siltation linked 4 Hat Rock Islands with the shoreline at low pool making easy access for predators.

Strawberry Islands averaged 44 goose nests annually, prior to the arrival of raccoons in the mid-1960's (Ball et al. 1981). The islands are 200 yards from shore and offered year-round

habitat for raccoons in cottonwood groves. Tree removal in 1974 and trapping both proved unsuccessful in eliminating the raccoons. In response, USFWS biologists erected about 30 nest baskets. Nesting between 1974 - 1987 took place in baskets at an average rate of 6 per year.

Between 1974 - 1986, 6 islands and 8 berms composed of dredged materials (gravel, silt, shot rock) were deposited in shallow water sites. Sites selected for islands were at least 100 yards from shore with a 10-foot deep channel between the site and shoreline. Berms were developed on the mid-channel side of Strawberry Islands.

In 1974, 2 islands composed of gravel were developed in the lower Snake River (river mile 7.4, 0.0). The upstream island is 1,100 by 100 feet and supported an average of 2.5 goose nests annually. The downstream island is 100 feet by 25 feet and supported less than 1 nest per year. Vegetation has been slow to establish on either island, as neither was covered with topsoil.

Between 1978 - 1982, 3 islands (9, 10, 12 acres) composed primarily of shot rock were developed at the mouth of the Snake River. The upstream island was the only one covered with topsoil and the only island of the 3 to support nesting geese, an average of less than 1 nest per year. This island was seeded to grasses; however, an average elevation exceeding 10 feet prevented subirrigation and satisfactory growth. Invading rabbitbrush may eventually establish perennial ground cover. The topsoiled island was the only one to support nesting geese, an average of less than 1 nest per year.

In 1985, 6-acre Crescent Island, named for its shape, was

developed from dredged silt and cobbles by Boise Cascade Corp. The island was developed 0.5 mile from shore and 0.5 mile downstream from Badger Island and was configured to attract geese. The WDW and COE provided design recommendations. The leeward shore is a protected cove with a cobble shoreline. The remaining shoreline is riprap. Elevation is less than 6 feet at full pool, and the interior is silt with subirrigated vegetation (seeded grasses, annual weeds). In 1987, Crescent Island supported 6 goose nests and an estimated 75 Forster's tern nests.

Between 1984 - 1986, 8 berms composed of shot rock were developed off Strawberry Islands: 2 connected to the upper island and 6 off the lower island. Total length of the 8 berms is 0.9 mile. No goose nests have been found on the berms.

The remaining islands in Figure 1 are less than 0.25 acre, supported little vegetation, and/or were subject to inundation during spring pool fluctuations. The Peninsula HMU, a low subirrigated sand hill, juts 2 miles into Lake Wallula which provided a degree of isolation for nesting geese.

Of perhaps equal importance to nesting geese on Lake Wallula were scattered brooding areas. Historically the southeast portion of the Peninsula HMU was the premier brooding pasture for the study area, supporting up to over 400 goslings in the 1960's. The peninsula's proximity to Badger and Foundation islands places it within 1 mile of over 80 percent of Lake Wallula's observed goose nesting. Since 1955, the peninsula's lower half has been occasionally burned in late February or March and seeded in different years to winter wheat, annual rye, and perennial grass mixtures (Alta tall fescue, Troy Kentucky bluegrass, Linn

perennial rye). Based on ocular estimates, grazing geese preferred annual rye over winter wheat and Kentucky bluegrass and perennial rye over tall fescue.

Pasture management was intended to attract geese from October through July. Biologists assumed, during the 1960's, the peninsula attracted broods from as far as Strawberry Islands, 8 miles upstream. Bittler and Passmore (in review) documented brood travel up to 6 miles downstream from natal sites in Lake Wallula.

Brood use on the peninsula has declined over the last 10 years, possibly because of increased availability of irrigated park and industry lawns and/or reduced quality pasture on the peninsula (Bittler and Passmore, in review). Recent studies on the Hanford Reach (Eberhardt 1987) examined gosling survival in an environment with poor quality brooding habitat. It was possible that declining brooding habitat on the peninsula contributed to higher gosling mortality rates. In 1987 during 3 surveys, fewer than 100 goslings were counted on the peninsula at any time, and 2 freshly killed goslings (probably by mink) were found. Gosling predation was not noticed when the peninsula's brood pasture was more intensively managed and shoreline vegetation was more frequently burned.

It was suspected that lack of quality brooding habitat on the peninsula and/or hunting were primarily responsible for declines in goose nesting on Badger and Foundation islands since 1982. In response, COE burned and seeded 40 acres on the southeast portion to perennial rye in October 1987. Perennial rye was selected based on the desire to establish perennial pasture of proven palatability.

The extended goose season in January may have contributed to the decline in nesting through excessive harvest and by leaving insufficient time for surviving adults to bond prior to nesting. No data were available to prove either hypothesis. Banding studies have been proposed to examine effects of hunting on the resident goose population.

Lower Snake River

Figure 3 shows the 130-mile long lower Snake River study area. Canyon depth and precipitation increase from 200 feet and 7 inches at Ice Harbor Lock and Dam to 2,000 feet and 19 inches at Lower Granite Lock and Dam. Precipitation declines to 14 inches at the upstream end in Clarkston, WA. Temperatures are similar to the Lake Wallula study area.

The COE managed all islands and designated wildlife habitat units. Between 1980 - 1986 WDW participated in wildlife habitat development and operation and maintenance under both a contract and a cooperative agreement with COE.

There were no soft constraints on any of the 4 reservoir operating levels during goose nesting. Normal operating pool fluctuations were 3 feet for the 2 downstream reservoirs and 5 feet for the 2 upstream reservoirs.

Most islands and artificial nesting structures on the lower Snake River were visited annually. Cliffs were searched when manpower and equipment were specifically allocated. Figure 4 presents observed gosling production for the 14-year period.

Following inundation, during which over 50 islands larger than 5 acres were lost, the lower Snake River was left with 2

Figure 3. Islands in Lower Snake River searched for Canada goose nests, 1974-1987.

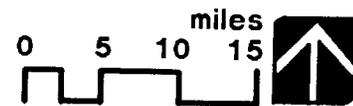
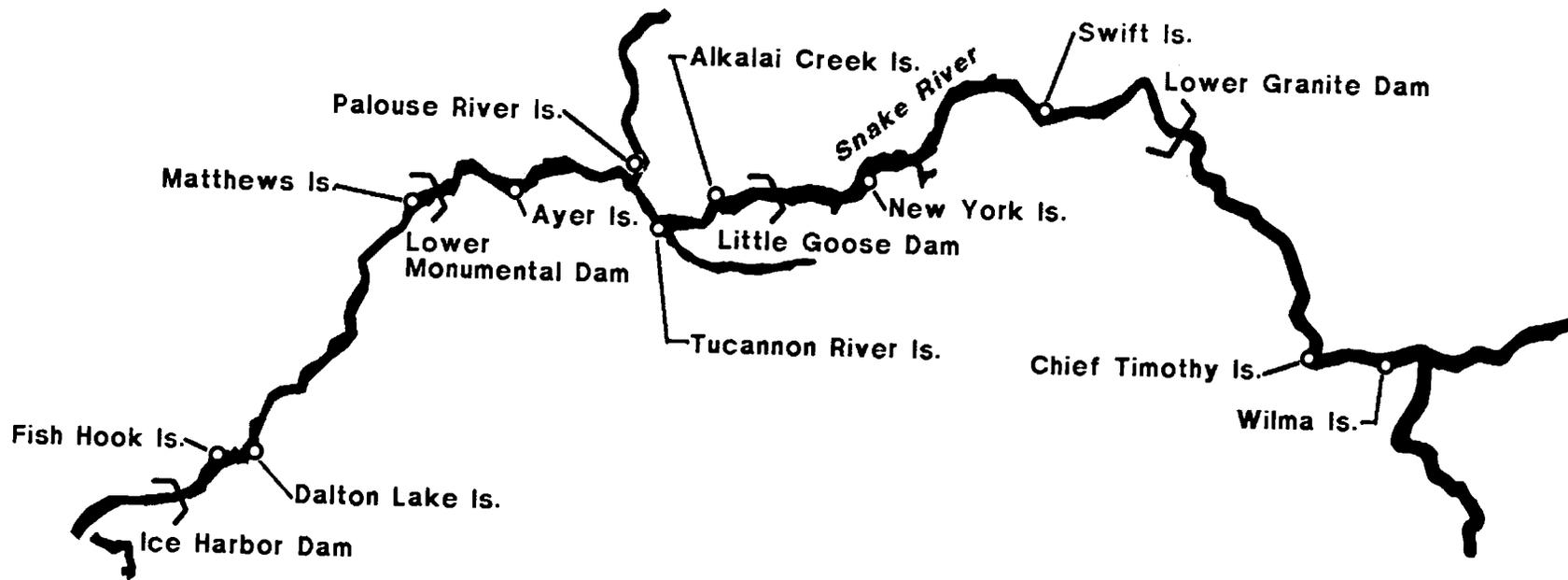
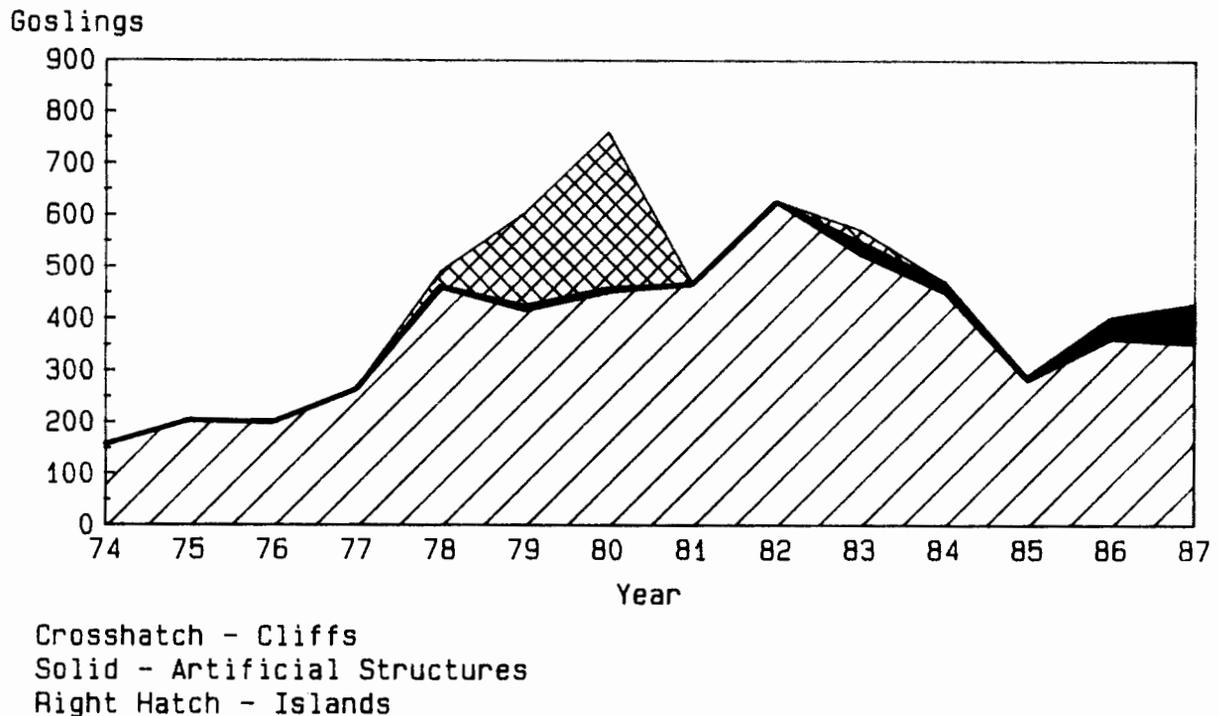


Figure 4. Observed gosling production on the lower Snake River, 1974 - 1987.



large isolated islands: 123-acre Silcott Island and 48-acre New York Island. Silcott Island is downstream from Chief Timothy Islands and 200 yards off shore. A causeway was built to the island and a state park was established in 1975. Silcott island was searched in 1978 - 1980, and no nests were found.

New York Island was the only island in the 130-mile-long study area to support over 6 nests a year. It was also the only island which was both larger than 0.1 acre and far enough from shore to be considered safe from predatory mammals. Like Badger and Foundation islands, New York Island is long, narrow, situated 0.5 mile from shore, and oriented on a north-south axis. The COE drilled wheatgrass on the island in 1974 and rip rapped the south end in 1980 to reduce erosion.

New York Island was the only Snake River site searched every year since 1974. Early in its history, consultants (U.S. Army 1975b) predicted the island would probably not support much more than an average of 28 nests, less than 1 per acre. In later searches New York Island, like Badger and Foundation islands, supported over 2 nests per acre.

New York Island's vegetation changed from mostly sparse annual forbs to shoreline pockets of willow, subirrigated wheatgrass, and rabbitbrush on the remaining drier sites. The only observed terrestrial predators capable of killing goslings were gopher snakes.

About 1976, falconers reportedly released European rabbits on New York Island. The subsequent rabbit population explosion dramatically impacted the island's vegetation. In addition, waterfowl hunting opened for the first time in 1983 on the downstream portion of Lake Bryan (Little Goose Reservoir) which includes New York Island. It was suspected that hunting combined with diminished nesting cover on New York Island reduced the local goose population. No data were available to prove either hypothesis. Banding studies have been proposed to examine effects of hunting on the resident goose population.

Other islands in the lower Snake River supported a combined annual average of about 10 nests. Two islands (Matthews, Swift) were developed from dredged materials. Both are less than 0.1 acre and composed of cobbles. Swift Island was contoured in 1981 by COE with a small bulldozer and supported an average of 4 nests between 1985 - 1987.

Non-island nesting geese used either cliffs or artificial

nesting structures. The miles of basalt cliffs and bluffs along the river supported substantial goose nesting before dam construction (Culbertson et al. 1971). Because of the difficulty in searching basalt cliffs, most observations involved broods not documented through island counts. As part of a habitat study, WDW searched cliffs along the 260 miles of shoreline by helicopter in 1979 - 1980 (Boe, et al. 1980). Helicopter searches verified the importance of cliff nesting, when WDW counted 36 nests in 1979 and 61 in 1980. Sightability was estimated at 80 percent based on the 1979 search. Of 5 cliff nests located from boat and ground searches, 4 were spotted by different observers from the helicopter.

Cliff-nest sites varied from 10 to over 200 feet above water in shear cliffs and over 200 yards inland on rock bluffs. All nest sites had a common feature; the goose was protected from above by a cliff. Many nests were potentially accessible to coyotes from below. The COE plans to resume helicopter searches in 1988 to update the status of cliff nesting.

As part of the effort to replace lost nesting sites along the Snake River, over 100 artificial nesting structures were placed on shorelines and islands. The COE and WDW set up the first structures, approximately 20 split oil drums welded on tripods in about 1969. Biologists from both agencies occasionally replaced nesting material. Still, the structures received little use, and most eventually fell over.

In 1974, COE biologists set out 6 surplus, anchored life rafts filled with nesting material. These received some use; however, all eventually worked loose or sank.

Since the early 1980s, COE and WDW erected 109 new structures, mostly fiber glass tubs on tripods. Tubs were placed generally no closer than 0.25 mile apart unless visually isolated by vegetation or land forms. Through attrition the number was reduced to 75 by spring 1987. The newest structures, galvanized wash tubs on metal pipes, were a superior design and are expected to last longer.

Every functional structure received fresh nesting material annually since 1978. Since 1986, it appears that geese have increasingly accepting tubs. Although no data exist, it seemed that tub-nesting geese gathered in clusters, suggesting that goslings imprinted on tubs. There is speculation that some were offspring of geese hatched in tubs maintained by Idaho Department of Fish and Game in the lower Clearwater River.

To compliment nesting on the lower Snake River, 77.7 acres of irrigated pasture were established on 9 HMU's since 1980. These pastures were intended to provide high quality brooding sites, were planted to grass-legume mixtures, and were periodically mowed throughout spring and summer. All HMU brooding areas are somewhat isolated from parks and other intensive recreation areas. These high-quality pastures, combined with irrigated lawns in 9 parks, annually attracted hundreds of brooding geese. Some park lawns received considerable grazing, and geese swam away and returned in response to human activity. Scattered cattle-watering corridors with closely cropped, dryland vegetation also attracted goose broods. One such corridor located 0.5 mile from New York Island received heavy use from newly hatched broods.

Comparison With Other Studies

From a comparison of pre-impoundment estimates (USFWS 1952, U.S. Army 1975a) and present production estimates, it appears that Lake Wallula and the lower Snake River can sustain a resident goose population approximately equal to pre-impoundment levels.

This study was compared with studies on the free-flowing Columbia and Snake rivers (Table 1). Both nesting and hatching success were similar for the 3 studies. Nest destruction was low for this study which reflected the importance of the 3 large islands (Badger, Foundation, New York). Gosling production for the study area would probably have been higher were it not for the presence of mammalian predators on Strawberry, Hat Rock, and other smaller islands.

Table 1. Comparison of Canada goose nesting studies on mid-Columbia and lower Snake rivers, 1953 - 1987.

Study area	Years	Nests found		Nest fate (yearly mean percent)						Eggs (yearly mean)		
		Total	Mean	Hatched	Abandoned	Destroyed	Flooded	Incomplete	Unknown	Clutch	Hatched	Percent
Columbia River (RM 340-370) ^a	18 (1953-70)	3,824	212	71	14	12	2	1	-	5.5 ^b	729	89 ^b
Snake River (RM 83-111) ^c	17 (1954-70)	320	20	69	12	18	-	-	1	6.0 ^d	71	90 ^b
Lake Wallula ^e	14 (1974-87)	2,179	156	83	17 ^f	-	-	-	-	5.6 ^d	712	93 ^{bg}
Lower Snake River ^e	14 (1974-87)	1,237	88	90	10 ^f	-	-	-	-	5.3 ^d	425	93 ^{bg}

^a Hanford Reach, Hanson and Eberhardt 1971.

^b From successful nests in which at least 1 egg hatched.

^c Free-flowing river, Gibson and Buss 1972.

^d All nests.

^e This study.

^f All causes.

^g Lake Wallula and lower Snake River combined, data from 1984 - 1986 only.

Summary and Recommendations

1. The resident Canada goose population along Lake Wallula and the lower Snake River can be maintained at estimated pre-impoundment levels. This will involve predator control, maintaining quality nesting and brooding habitat, restricting human access, and banding studies.

2. Badger, Foundation, and New York islands supported over 80 percent of observed island nesting during the 14-year period. Target predators (e.g., coyotes), if detected, should be removed immediately by the appropriate agency. Indiscriminant predator control is not necessary. To maintain isolation, the soft constraint on Lake Wallula's operating elevation should be evaluated to determine if 337 feet is still the appropriate elevation to prevent formation of land bridges.

3. Important islands should be cover-mapped and nests plotted by cover-type. Appropriate agencies should be consulted prior to any vegetation manipulation designed to improve nesting cover for geese. Consideration should be given to colonial nesting birds and other wildlife species dependent on island habitats. On islands in the lower Snake River designated as wildlife habitat, mitigation goals should be considered with goose nesting considered a high priority.

4. On New York Island, gosling production increased to over 600 goslings in 1982 and has since fallen. European rabbits on the island should be eliminated to allow re-establishment of nesting cover. The method of removal should be determined by appropriate agencies. Additional procedures (e.g., reseedling)

may be needed.

5. The importance of Badger, Foundation, and New York islands to the resident goose population can not be overstated. All supported over 2 successful goose nests per acre within the last 14 years. This level of production is a reasonable management objective for the 3 islands.

6. It would be desirable that future islands constructed of dredged materials be placed and designed to benefit wildlife species of concern which may include geese. Current policy of fish and wildlife agencies working with COE on dredging discourages developing islands from dredged materials. Fish and wildlife agencies believe these islands reduce shallow water habitat essential for migrating, subyearling, spring chinook salmon. If current studies result in policy changes, the appropriate agencies would be involved in island placement and design.

7. Existing dredged material islands that have not supported any known nesting by geese or other species may need to be recontoured and topsoiled if feasible. Consideration should be given to species of concern which may include geese. Appropriate agencies would be involved in design recommendations.

8. Goose tubs support an increasing portion of observed gosling production on the lower Snake River. All functional goose tubs should be maintained annually. Unusable structures should be replaced.

9. Quality brooding habitat and safe gosling access on the Peninsula HMU must be maintained. The 40 acres allocated to improved pasture can be increased to 80 acres, if necessary, to

accommodate the anticipated increase in brood use.

10. The quality and quantity of irrigated pasture along the lower Snake River is probably not a limiting factor unless access is a problem. Shoreline erosion continues which may form steep banks, thus reducing access to affected sites. Some slopes may need to be contoured.

11. Human access on important nesting islands should be restricted between 1 February - 1 June. These dates are flexible and may be expanded to protect additional species. Important islands are secure from development, and all involved agencies make an effort to keep the public off during nesting season.

12. Banding studies to examine hunting mortality should be initiated by appropriate agencies where goslings can be congregated (e.g., Peninsula HMU, New York Bar).

13. Annual nest searches and occasional brood surveys should continue. These are perhaps the most accurate methods of monitoring the resident goose population. Annual searches also provide an opportunity for biologists from different agencies to examine habitat and exchange information on management.

Acknowledgments

Monitoring gosling production and brooding activity on the study area over the last 14 years required well over 500 man-days of field work. The number of participants are too numerous to acknowledge individually. I would like to thank those biologists who volunteered their observations and opinions in preparation of this report. Thanks to Lisa Brisbane, Jan Hanf, Lonnie Mettler, John Mckern, and Darrel Sunday (COE); John Annear and Lawrence Dudley (USFWS); Dale Litzenberger (retired), Pat Fowler, David Mudd, Richard Parker, and Rocky Ross (WDW). Jim Athearn, John McKern, Mike Passmore, and Al Sutlick reviewed the report. Special thanks to Jim Athearn and Jack Ardner for providing the opportunity to write the report.

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APPENDICES A AND B

Tabulated field data in Appendices A and B present nest numbers, clutch size, and nesting success. Totals are calculated by columns; means are calculated by rows. Clutch size calculations are weighted toward numbers of nests on each site. "NC" and "M" indicate not counted or missing. Blanks during first and second checks indicate dredge spoil islands or Lower Granite Reservoir not existing at that point in time. Any readers wishing to contribute data, either as additions or corrections, may send theirs to the Walla Walla District Office, ATTN: CENPW-OP-RM.

APPENDIX A. OBSERVED CANADA GOOSE NESTING ON ISLANDS IN LAKE WALLULA (MCNARY RESERVOIR), 1974 - 1987

	Number of Nests Found First Check														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Hat Rock Island 1	2	3	0	1	0	0	0	0	0	0	0	0	1	1	0.6
Hat Rock Island 2	3	2	1	0	0	0	0	0	1	0	0	0	1	0	0.6
Hat Rock Island 3	6	4	3	1	1	1	0	1	1	2	0	0	2	0	1.6
Hat Rock Island 4	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0.1
Hat Rock Island 5	2	4	5	3	2	2	3	3	2	2	2	3	4	6	3.1
Kegger Island	0	0	0	NC	1	NC	NC	0	NC	NC	0	0	0	NC	0.1
Crescent Island													0	4	2.0
Badger Island	93	98	92	88	96	95	109	110	103	95	64	77	69	61	89.3
Foundation Island	39	30	32	30	29	34	36	33	38	28	15	25	23	21	29.5
Goat Island	2	2	1	1	2	2	2	0	1	2	0	2	1	1	1.4
Gull Island	1	1	0	1	0	1	0	1	0	0	1	1	3	3	0.9
Peninsula Habitat Unit	NC	3	1	NC	NC	6	8	3	4	NC	NC	NC	0	0	3.1
Indian Island	4	1	2	1	3	3	4	4	4	1	4	2	1	2	2.6
Dredge Is., RM 0.0-0.5	1	0	1	1	1	0	NC	0	0	1	1	1	0	0	0.5
Dike Ruins, RM 4.1	1	2	NC	1	2	1	0	0	0	NC	NC	NC	0	NC	0.9
Strawberry Islands	5	7	4	3	5	4	NC	7	4	9	6	5	7	7	5.6
Dike Ruins, RM 5.9	1	2	1	0	0	1	0	0	0	NC	0	NC	0	NC	0.5
Locust Grove Island	2	1	NC	0	0	NC	1	0	0	0	1	NC	0	NC	0.5
Dredge Island, RM 7.6	0	0	1	1	2	1	3	4	3	6	3	3	4	3	2.4
Goose Island	5	4	6	1	4	1	5	0	0	1	0	NC	0	NC	2.3
Dogwood Island	0	0	0	0	0	0	0	0	0	0	1	NC	0	NC	0.1
Total	168	164	150	133	148	152	172	166	161	147	98	119	116	109	143.0

	Number of Nests Found Second Check														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Hat Rock Island 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1
Hat Rock Island 2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.1
Hat Rock Island 3	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.1
Hat Rock Island 4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1
Hat Rock Island 5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.1
Kegger Island	0	0	0	NC	0	NC	NC	0	NC	NC	0	0	0	NC	0.0
Crescent Island													0	2	1.0
Badger Island	4	8	13	20	14	10	5	0	13	0	13	8	12	2	8.7
Foundation Island	0	2	4	8	2	4	2	0	1	0	1	5	0	0	2.1
Goat Island	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0.1
Gull Island	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1
Peninsula Habitat Unit	NC	0	0	NC	NC	0	0	0	0	NC	NC	NC	0	0	0.0
Indian Island	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Dredge Is., RM 0.0-0.5	0	0	0	0	0	0	NC	0	0	0	0	0	0	0	0.0
Dike Ruins, RM 4.1	0	0	NC	2	0	0	0	0	0	NC	NC	NC	0	NC	0.2
Strawberry Islands	0	NC	0	1	0	0	1	0.3							
Dike Ruins, RM 5.9	0	0	0	NC	0	NC	0	0	0	NC	0	NC	0	NC	0.0
Locust Grove Island	0	0	NC	NC	0	NC	0	0	0	0	0	NC	0	NC	0.0
Dredge Island, RM 7.6	0	0	0	1	0	NC	0	0	0	0	0	2	0	0	0.2
Goose Island	0	1	0	5	0	NC	0	0	0	0	0	NC	0	NC	0.5
Dogwood Island	0	0	0	0	0	NC	0	0	0	0	0	NC	0	NC	0.0
Total	4	11	17	39	16	14	7	0	14	0	15	16	15	8	12.6

APPENDIX A. CONTINUED

	Estimated Number of Successful Nests														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Hat Rock Island 1	2	1	0	1	0	0	0	0	0	0	0	0	1	1	0.4
Hat Rock Island 2	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0.2
Hat Rock Island 3	4	0	0	1	1	1	0	1	1	1	0	0	1	1	0.9
Hat Rock Island 4	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1
Hat Rock Island 5	2	3	4	3	2	2	3	3	2	2	2	3	4	6	2.9
Kegger Island	0	0	0	NC	1	NC	NC	0	NC	NC	0	0	0	NC	0.1
Crescent Island													0	6	3.0
Badger Island	84	95	82	77	91	83	101	103	95	93	44	67	71	60	81.9
Foundation Island	37	29	31	27	27	32	34	30	37	27	12	25	23	20	27.9
Goat Island	1	2	1	0	1	2	1	0	1	2	0	2	1	1	1.1
Gull Island	1	1	0	1	0	0	0	1	0	0	1	1	3	1	0.7
Peninsula Habitat Unit	NC	3	1	NC	NC	6	7	3	4	NC	NC	NC	0	0	3.0
Indian Island	1	0	1	1	3	3	2	4	4	1	4	2	1	2	2.1
Dredge Is., RM 0.0-0.5	1	0	1	1	1	0	NC	0	0	1	1	1	0	0	0.5
Dike Ruins, RM 4.1	1	1	NC	1	2	1	0	0	0	NC	NC	NC	0	NC	0.7
Strawberry Islands	1	0	1	1	4	4	NC	7	4	9	5	4	6	7	4.1
Dike Ruins, RM 5.9	0	2	0	0	0	1	0	0	0	NC	0	NC	0	NC	0.2
Locust Grove Island	1	1	NC	0	0	NC	1	0	0	0	0	NC	0	NC	0.3
Dredge Island, RM 7.6	0	0	1	1	2	1	3	4	3	6	3	5	4	2	2.5
Goose Island	4	4	4	4	4	1	3	0	0	1	0	NC	0	NC	1.8
Dogwood Island	0	0	0	0	0	0	0	0	0	0	1	NC	0	NC	0.3
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Total	142	142	127	119	139	137	155	156	151	143	73	110	118	107	129.9
	Mean Clutch Per Nest														
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	Mean
Hat Rock Island 1	6.0	5.3		6.0									8.0	6.0	6.2
Hat Rock Island 2	6.0	M	M						6.0				6.0	2.0	5.0
Hat Rock Island 3	5.3	M	M	5.0	5.0	3.0		7.0	7.0	5.5			3.0	9.0	5.5
Hat Rock Island 4	5.0						2.0						6.0		4.3
Hat Rock Island 5	7.0	5.3	5.8	4.7	6.0	3.5	5.0	5.7	6.5	6.5	6.0	5.0	6.5	5.6	5.7
Kegger Island					2.0										2.0
Crescent Island														4.8	4.8
Badger Island	5.6	5.6	5.6	5.8	5.1	4.8	5.6	5.7	5.6	5.9	5.2	5.3	6.0	6.0	5.6
Foundation Island	5.1	5.9	6.0	6.0	5.0	4.8	5.8	5.9	5.8	5.5	4.9	5.8	6.2	6.3	5.6
Goat Island	5.5	8.0	6.0	M	5.0	5.5	6.5		6.0	6.0		6.0	7.0	7.0	6.2
Gull Island	5.0	6.0		6.0		6.0		8.0			6.0	6.0	5.7	6.8	6.2
Peninsula Habitat Unit		5.7	4.0			6.5	5.3	4.7	5.6						5.3
Indian Island	6.0	M	5.0	7.0	6.3	6.3	4.3	8.0	6.5	6.0	6.3	5.5	6.0	5.5	6.1
Dredge Is., RM 0.0-0.5	5.0		8.0	8.0	7.0					7.0	7.0	7.0			7.0
Dike Ruins, RM 4.1	5.0	5.0		5.0	5.0	7.0									5.6
Strawberry Islands	5.0	5.5	6.0	6.0	6.0	5.8		5.6	5.6	5.0	5.6	5.7	5.6	5.3	5.6
Dike Ruins, RM 5.9	6.0	6.0	M			6.0									6.0
Locust Grove Island	3.0	4.0					3.0								3.3
Dredge Island, RM 7.6			6.0	5.0	7.0	M	5.7	4.5	6.3	6.7	6.3	5.5	5.8	4.3	5.7
Goose Island	6.3	4.5	6.0	M	6.0	1.0	3.6			5.0					4.6
Dogwood Island											6.0				6.0
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Mean	5.5	5.6	5.7	5.8	5.2	4.9	5.5	5.8	5.7	5.8	5.2	5.4	6.0	5.9	5.6

APPENDIX A. CONTINUED

	Estimated Number of Goslings Hatched														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Hat Rock Island 1	12	5	0	6	0	0	0	0	0	0	0	0	7	6	2.6
Hat Rock Island 2	6	0	0	0	0	0	0	0	0	0	0	0	12	0	1.3
Hat Rock Island 3	19	0	0	10	5	3	0	7	7	6	0	0	5	9	5.1
Hat Rock Island 4	3	0	0	0	0	0	0	0	0	0	0	0	6	0	0.6
Hat Rock Island 5	14	16	20	14	12	7	14	17	13	13	12	15	24	31	15.9
Kegger Island	0	0	0	NC	2	NC	NC	0	NC	0	0	0	0	NC	0.2
Crescent Island													0	29	14.5
Badger Island	448	521	510	483	524	436	522	512	539	433	279	355	389	331	448.7
Foundation Island	173	155	172	191	145	171	156	170	197	145	72	145	140	125	154.1
Goat Island	5	16	6	0	5	11	7	0	6	12	0	12	7	6	6.6
Gull Island	5	6	0	6	0	0	0	3	0	0	6	6	13	6	3.6
Peninsula Habitat Unit	NC	17	4	NC	NC	39	32	12	21	NC	NC	NC	0	0	15.6
Indian Island	6	0	3	7	18	14	5	30	26	6	24	11	6	10	11.9
Dredge Is., RM 0.0-0.5	5	0	7	8	7	0	NC	0	0	7	7	7	0	0	3.7
Dike Ruins, RM 4.1	5	5	NC	5	10	5	0	0	0	NC	NC	NC	0	NC	3.3
Strawberry Islands	4	0	6	5	24	19	NC	39	22	34	29	23	31	39	21.2
Dike Ruins, RM 5.9	0	12	0	0	0	5	0	0	0	NC	0	NC	0	NC	1.5
Locust Grove Island	3	4	NC	0	0	NC	1	0	0	0	0	NC	0	NC	0.8
Dredge Island, RM 7.6	0	0	6	8	14	5	17	18	17	37	16	28	20	12	14.1
Goose Island	21	22	22	25	24	1	11	0	0	4	0	NC	0	NC	10.8
Dogwood Island	0	0	0	0	0	0	0	0	0	0	4	NC	0	NC	0.3
Total	729	779	756	768	790	716	765	808	848	697	449	602	660	604	712.2

APPENDIX B. OBSERVED CANADA GOOSE NESTING ON LOWER SNAKE RIVER, 1974 -1987

	Number of Nests Found First Check														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Lake Sacajawea (Ice Harbor Reservoir)															
Fishhook Island	2	1	NC	NC	6	4	5	3	NC	1	1	NC	1	1	2.5
Dalton Lake Island	NC	NC	NC	NC	0	0	0	0	NC	0	0	NC	NC	0	0.0
Matthews Island	NC	NC	NC	NC	0	0	0	NC	NC	1	0	0	0	0	0.1
Cliffs	NC	NC	NC	NC	1	13	18	NC	NC	NC	NC	NC	NC	NC	10.7
Goose Tubs	NC	NC	NC	NC	0	0	0	0	NC	1	2	1	1	1	0.7
Lake West (Lower Monumental Reservoir)															
Ayer Islands	NC	NC	NC	NC	3	3	4	0	NC	2	0	0	1	1	1.6
Palouse River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Tucannon River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Alkalai Creek Islands	NC	NC	NC	NC	1	1	1	NC	NC	NC	NC	NC	0	NC	0.8
Cliffs	NC	NC	NC	NC	4	16	30	NC	NC	4	NC	NC	NC	NC	13.5
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	0	0	0	0	0	0.0
Lake Bryan (Little Goose Reservoir)															
New York Island	28	36	51	42	72	67	92	89	110	106	76	43	69	54	66.8
Swift Island						1	2	1	NC	1	2	5	4	4	2.5
Cliffs	NC	NC	NC	NC	1	6	10	NC	NC	NC	NC	NC	NC	NC	5.7
Goose Tubs	NC	NC	NC	NC	1	1	2	NC	NC	0	1	0	0	7	1.5
Lower Granite Lake (Lower Granite Reservoir)															
Chief Timothy Islands		NC	NC	NC	1	1	1	2	1	2	4	4	6	5	2.7
Wilma Island		NC	NC	NC	1	2	1	1	1	0	0	0	0	0	0.6
Cliffs		NC	NC	NC	0	1	3	NC	NC	NC	NC	NC	NC	NC	1.3
Goose Tubs		NC	NC	NC	0	0	0	0	1	4	3	0	6	7	2.1
Total	30	37	51	42	91	116	169	96	113	122	89	53	88	80	84.1

	Number of Nests Found Second Check														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Lake Sacajawea (Ice Harbor Reservoir)															
Fishhook Island	0	0	NC	NC	0	0	0	0	NC	0	0	NC	0	0	0.0
Dalton Lake Island	NC	NC	NC	NC	0	0	0	0	NC	0	0	NC	NC	0	0.0
Matthews Island	NC	NC	NC	NC	0	0	0	NC	NC	0	0	1	0	0	0.1
Cliffs	NC	NC	NC	NC	0	0	0	NC	0.0						
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	0	0	0	0	0	0.0
Lake West (Lower Monumental Reservoir)															
Ayer Islands	NC	NC	NC	NC	0	0	0	0	NC	0	0	0	0	0	0.0
Palouse River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Tucannon River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Alkalai Creek Islands	NC	NC	NC	NC	0	0	0	NC	NC	NC	NC	NC	0	NC	0.0
Cliffs	NC	NC	NC	NC	0	0	0	NC	NC	0	NC	NC	NC	NC	0.0
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	0	0	0	0	0	0.0
Lake Bryan (Little Goose Reservoir)															
New York Island	0	2	0	9	9	0	0	0	17	7	0	11	0	1	4.0
Swift Island						0	0	0	NC	0	0	0	0	0	0.0
Cliffs	NC	NC	NC	NC	0	0	0	NC	0.0						
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	0	0	0	0	1	0.1
Lower Granite Lake (Lower Granite Reservoir)															
Chief Timothy Islands		NC	NC	NC	0	0	0	0	0	0	0	0	0	0	0.0
Wilma Island		NC	NC	NC	0	0	0	0	0	0	0	0	0	0	0.0
Cliffs		NC	NC	NC	0	0	0	NC	0.0						
Goose Tubs		NC	NC	NC	0	0	0	NC	0	0	0	0	0	2	0.2
Total	0	2	0	9	9	0	0	0	17	7	0	12	0	4	4.3

APPENDIX B. CONTINUED

	Estimated Number of Successful Nests															Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87		
Lake Sacajawea (Ice Harbor Reservoir)																
Fishhook Island	1	1	NC	NC	4	3	3	3	NC	1	1	NC	1	1	1.9	
Dalton Lake Island	NC	NC	NC	NC	0	0	0	0	NC	0	0	NC	NC	0	0.0	
Matthews Island	NC	NC	NC	NC	0	0	0	NC	NC	1	0	1	0	0	0.3	
Cliffs	NC	NC	NC	NC	0	12	18	NC	10.0							
Goose Tubs	NC	NC	NC	NC	0	0	0	0	NC	1	0	1	1	1	0.4	
Lake West (Lower Monumental Reservoir)																
Ayer Islands	NC	NC	NC	NC	2	3	4	0	NC	1	0	0	0	1	1.2	
Palouse River Islands	0	0	NC	NC	0	0	0	0	NC	NC	0	NC	0	NC	0.0	
Tucannon River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0	
Alkalai Creek Islands	NC	NC	NC	NC	1	1	1	NC	NC	NC	NC	NC	0	NC	0.8	
Cliffs	NC	NC	NC	NC	3	14	30	NC	NC	4	NC	NC	NC	NC	12.8	
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	0	0	0	0	0	0.0	
Lake Bryan (Little Goose Reservoir)																
New York Island	26	34	44	42	58	64	78	87	123	99	75	48	68	54	64.3	
Swift Island						1	1	1	NC	1	2	5	4	4	2.4	
Cliffs	NC	NC	NC	NC	1	6	8	NC	5.0							
Goose Tubs	NC	NC	NC	NC	1	1	2	NC	NC	0	1	0	0	6	1.4	
Lower Granite Lake (Lower Granite Reservoir)																
Chief Timothy Islands		NC	NC	NC	1	1	1	1	1	2	4	1	6	5	2.3	
Wilma Island		NC	NC	NC	1	2	1	1	1	0	0	0	0	0	0.6	
Cliffs		NC	NC	NC	0	1	3	NC	1.3							
Goose Tubs		NC	NC	NC	0	0	0	0	0	3	3	0	6	8	2.0	
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Total	27	35	44	42	72	109	150	93	125	113	86	56	86	80	79.9	
	Mean Clutch Per Nest															
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	Mean	
Lake Sacajawea (Ice Harbor Reservoir)																
Fishhook Island	6.0	5.0			5.4	5.8	5.3	6.7		4.0	6.0		7.0	6.0	5.7	
Dalton Lake Island																
Matthews Island										7.0		5.0			6.0	
Cliffs					6.0	5.1	5.8								5.6	
Goose Tubs										6.0	7.0	5.0	8.0	6.0	6.4	
Lake West (Lower Monumental Reservoir)																
Ayer Islands					5.0	4.0	6.3			5.5			6.0	6.0	5.5	
Palouse River Islands																
Tucannon River Islands																
Alkalai Creek Islands					5.0	5.0	6.0								5.3	
Cliffs					5.8	5.2	4.8			5.5					5.3	
Goose Tubs																
Lake Bryan (Little Goose Reservoir)																
New York Island	6.0	5.7	4.4	5.4	5.7	5.6	5.3	5.2	5.3	4.6	5.5	4.9	4.6	5.3	5.3	
Swift Island						6.0	5.0	8.0		3.0	7.0	6.8	4.3	5.8	5.7	
Cliffs					5.0	5.8	5.3								5.4	
Goose Tubs					3.0	7.0	4.0				4.0			5.3	4.7	
Lower Granite Lake (Lower Granite Reservoir)																
Chief Timothy Islands					6.0	5.0	6.0	6.3	9.0	6.0	5.8	5.8	5.3	6.4	6.2	
Wilma Island					9.0	6.0	8.0	M	5.0						7.0	
Cliffs						5.0	5.2								5.1	
Goose Tubs									1.0	5.5	5.3		5.0	5.3	4.4	
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Mean	6.0	5.7	4.4	5.4	5.7	5.5	5.3	5.3	5.3	4.7	5.6	5.1	4.7	5.4	5.3	

APPENDIX B. CONTINUED

	Estimated Number of Goslings Hatched														Mean
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	
Lake Sacajawea (Ice Harbor Reservoir)															
Fishhook Island	6	5	NC	NC	17	16	10	20	NC	4	6	NC	6	6	9.6
Dalton Lake Island	NC	NC	NC	NC	0	0	0	0	NC	0	0	NC	NC	0	0.0
Matthews Island	NC	NC	NC	NC	0	0	0	NC	NC	7	0	5	0	0	1.5
Cliffs	NC	NC	NC	NC	0	59	104	NC	54.3						
Goose Tubs	NC	NC	NC	NC	0	0	0	0	NC	6	0	5	7	6	2.7
Lake West (Lower Monumental Reservoir)															
Ayer Islands	NC	NC	NC	NC	11	12	25	0	NC	5	0	0	0	6	6.6
Palouse River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Tucannon River Islands	0	0	NC	NC	0	0	0	NC	NC	NC	0	NC	0	NC	0.0
Alkalai Creek Islands	NC	NC	NC	NC	4	5	6	NC	NC	NC	NC	NC	0	NC	3.8
Cliffs	NC	NC	NC	NC	23	83	140	NC	NC	22	NC	NC	NC	NC	67.0
Goose Tubs	NC	NC	NC	NC	0	0	0	NC	NC	NC	0	0	0	0	0.0
Lake Bryan (Little Goose Reservoir)															
New York Island	152	200	201	265	416	362	389	425	613	498	411	240	311	293	341.1
Swift Island						6	7	8	NC	3	14	31	17	19	13.1
Cliffs	NC	NC	NC	NC	5	33	41	NC	26.3						
Goose Tubs	NC	NC	NC	NC	3	7	7	NC	NC	0	4	0	0	27	6.0
Lower Granite Lake (Lower Granite Reservoir)															
Chief Timothy Islands		NC	NC	NC	6	5	8	9	9	11	23	7	32	31	14.1
Wilma Island		NC	NC	NC	7	12	8	7	5	0	0	0	0	0	3.9
Cliffs		NC	NC	NC	0	5	16	NC	7.0						
Goose Tubs		NC	NC	NC	0	0	0	0	1	16	15	0	30	41	10.3
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Total	158	205	201	265	492	605	761	469	628	572	473	288	403	429	424.9

APPENDIX C. COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS

Kentucky bluegrass	<i>Poa pratensis</i>
Tall fescue	<i>Festuca</i> sp.
Rye	<i>Secale cereale</i>
Perennial rye	<i>Lolium perenne</i>
Wheat	<i>Triticum aestivum</i>
Wheatgrass	<i>Agropyron</i> sp.
Bulrush	<i>Scirpus</i> sp.
Cattail	<i>Typha</i> sp.
Knapweed	<i>Centarua</i> sp.
Peavine	<i>Swainsona salsula</i>
Prickly pear	<i>Opuntia</i> sp.
Big sagebrush	<i>Artemisia tridentata</i>
Rabbitbrush	<i>Chrysothamnus</i> sp.
Bitterbrush	<i>Purshia tridentata</i>
Cottonwood	<i>Populus</i> sp.
Willow	<i>Salix</i> sp.
Chinese elm	<i>Ulmus parvifolia</i>
Chinook salmon	<i>Oncorhynchus tshawytscha</i>
Gopher snake	<i>Pituophis melanoleucus</i>
Western canada goose	<i>Branta canadensis moffitti</i>
Great blue heron	<i>Ardea herodias</i>
Black-crowned night-heron	<i>Nycticorax nycticorax</i>
Forster's tern	<i>Sterna dougallii</i>
Cottontail	<i>Sylvilagus nuttallii</i>
European rabbit	<i>Oryctolagus cuniculus</i>
Black-tailed jack rabbit	<i>Lepus californicus</i>
Coyote	<i>Canis latrans</i>
Raccoon	<i>Procyon lotor</i>
Mink	<i>Mustela vison</i>
Badger	<i>Taxidea taxus</i>
