ARTIFICIAL PROPAGATION OF THE GIANT CANADA GOOSE IN TENNESSEE

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Abstract: A total of 1073 giant Canada geese (*Branta canadensis maxima*) was artificially propagated and flighted from the Buffalo Springs Research Center during 7 breeding seasons. Annual production increased from less than 50 goslings during the first 2 years to over 300 goslings in the final year. The progressive increases in success were attributed to recognizing and accommodating for behavioral characteristics of the species and through the use of sterile technique throughout the procedure.

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In 1970, the Tennessee Wildlife Resources Agency (TWRA) and the Tennessee Valley Authority (TVA) agreed to venture into a cooperative project to propagate giant Canada geese artificially. The progency of this propagation project were to be used for establishing free-flying resident Canada goose populations in the Tennessee Valley. Gore and Barstow (1969) reported on the successful establishment of a free-flying resident Canada goose flock on the Old Hickory reservoir in middle Tennessee, and Bednarik (1965) and Brakhage (1965) reported on the successful establishment of resident flocks in Ohio and Missouri. The resident flocks in Ohio have contributed significantly to goose hunting in that state. In Missouri, surplus geese were used to establish colonies on other state game management areas. Our goal was to establish free-flying resident flocks of Canada geese in Tennessee to off-set the effects of "short-stopping" in northern states.

There was very little knowledge about propagating Canada geese in an artificial or hatchery environment when this program was begun. Our initial efforts were not very successful but as we learned more about breeding and behavior of this species and the hatchery techniques required, annual production increased over five-fold. The purpose of this paper is to describe techniques that have been successful in propagating geese in Tennessee.

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STUDY AREA

The Buffalo Springs Wildlife Research Center located in Grainger County near Rutledge, Tennessee was selected for this project. This Research Center was originally constructed as a bobwhite quail (*Colinus virginiana*) propagation facility and later used for propagation of exotic game birds. Surrounding land types are typical of the gently rolling uplands of East Tennessee. There was no standing water of any kind prior to the goose project. The major factor qualifying the area for a waterfowl propagation facility was the presence of Jamesway incubators used for 35 years to propagate upland game birds.

TECHNIQUES AND RESULTS

The first geese arrived in January of 1971. They were placed behind a 3 m high predator-proof fence built around a 4 ha orchard grass, Ladino clover pasture in which two .05 ha ponds had been constructed.

Management of the Non-breeding Colony

The initial colony arrived in poor condition due to improper care, feeding and rigors of the journey. They were placed on breeder and winter maintenance diet of 2/3 Purina

Pro-Lay (18% protein) and 1/3 whole-kernal corn until grasses became available in early April. After several weeks on the commercial feed-corn diet, the geese exhibited marked improvement in overall appearance with a noticeable weight gain. Oyster shell and grit were provided and two .05 ha ponds provided adequate bathing and drinking water.

After the first 2 years, the ground cover in the permanent pens was in poor condition and highly contaminated. There was concern that this contamination was affecting fertility rates of the eggs. New portable pens were constructed for the 1973 breeding season. These pens were slightly longer than the original breeding pens, measuring 12 x 3 x 1.3 m. It was originally planned to move the pens to new locations each year. However, after it was discovered that moving the pens appreciable distances would upset established nesting territories and lower production, other improvements were investigated to reduce contamination. A major source of contamination was the old-fashioned bathtubs. These were replaced with 1.2 x 1.2 m metal tubs 30 cm high. Each tub was equipped with a water spigot and connected to an underground drainage system to permit fresh water to continuously flow through the water tanks. Water flow rates were adjusted to completely change the water in each tank each 24-hour period. In addition to changing the water tanks, a corrugated tin roof 1.5 m long and 0.7 m wide was placed over the nesting tub and pig feeder to prevent rains from washing the feed out of the feeders and to keep the nest dry. Surplus parachute material was used as sight barriers between the new breeding pens. These pens proved to be satisfactory for the duration of the project.

Each year, geese were moved from the 4 ha enclosure into the breeding pens during the first 15 days of February. This moved them into their prior nesting territory before the more dominant pairs would begin occupying nesting territories in the large enclosure. The breeding pairs remained in the breeding pens until egg laying ceased. Egg laying usually ceased by the middle of May and the geese were moved back into the large 4 ha enclosure.

Egg Collection – Daily egg production records maintained on each pair of geese indicated that the geese layed 2 eggs every 3 days. The typical pattern followed by nearly every goose in the colony was the lay 1 egg, then another egg the following day, then skip a day, and so on, until the clutch was completed. Eggs were collected daily and transported to the incubators in a styrafoam cooler filled with hay to prevent egg breakage. Originally, 3 egg collection trips were made daily, early morning, mid-day and evening. The evening trips did not yield eggs and were discontinued.

A wax crayon was used to make the first egg in each nest. The first egg was removed after the second egg was laid and marked. This procedure left each egg in the field nests for 1 to 3 days during which time they were exposed to a great deal of contamination in and around the nests associated with the unavoidable crowded conditions in the pens.

A change to the use of artificial eggs instead of marking and leaving the newest egg in 1976 reduced the length of time each egg remained in the contaminated nests from days to hours. The annual hatchability rates of eggs significantly increased (Table 1) from an average of 65% experienced during the first 5 years to 81% during the last 2 years following the use of the artificial eggs. Contamination absorbed by the eggs in the nest had apparently been a major cause of embryonic death.

The timing of removal of the last egg and destruction of the nests was found to be one of the important factors in the program. The completed clutch was indicated by the presence of an appreciable amount of down in the nest. Actually the geese placed some down in the nest when the next to last egg was layed. In the beginning, care was taken to make sure that enough down had been placed in th est before the last egg was removed and the nest destroyed. Occasionally, the nest was destroyed a little early and the goose would randomly drop the egg out in the pen. If the goose was allowed to sit on the nest 1 or 2 days after the last egg was layed, she would become broody and not make any attempt to renest. It was very important to remove and break up nests on precisely the right day.

After 3 years of recording egg production data on individual pairs, we found that practically all of the geese that dropped their last egg after nest destruction renested. Also, the incidence of renesting was very low in the group of geese that were allowed to complete clutches before nests were destroyed. Our data also indicated that the hatchability of the aborted, last egg was good. To encourage renesting the fourth year of

Table 1. Summary of annual goose propagation efforts showing significant production increases caused by changes in propagation techniques.

	Total Eggs Layed	*Egg Fertility*		*Fertile Eggs Hatched*		*Hatched Goslings Flighted*	
Year	(*N*)	(*N*)	%	(*N*)	%	(*N*)	%
1971	106	71	67	46	61	40	87
1972	135	71	52	33	46	18	54
1973	266	150	56	119	79[f]*	63	53
1974	354[a]*	277	78[c]*	175	63	173	99[e]*
1975	419[b]*	360	86	236	66	223	94
1976	406	325	80	266	82[d]*	255	96
1977	532	402	76	319	79	301	94

[a]Increase resulting from returning geese to same breeding pens
(Two-tailed z value = 11.45)

[b]Increase resulting from destroying nest before final egg was layed
(Two-tailed z value = 44.35)

[c]Increase resulting from egg washing
(Two-tailed z value = 5.70)

[d]Increase resulting from use of artificial eggs
(Two-tailed z value = 3.87)

[e]Increase resulting from limiting the maximum number of goslings in a group to 15
(Two-tailed z value = 3.29)

[f]Increase resulting from placing sign barriers between breeding pens
(Two-tailed z value = 4.92)

*Significant at .01 level (z at .01 = 2.58)

the project, all of the nests were broken up as soon as the first sign of down appeared in the nests. Following the adoption of this procedure, the percentage of birds renesting increased significantly from an average of 42% in 1972 and 1973 to over 75% during the last 4 years of production. One year later, use of this technique resulted in the first incidence of third clutches. During the last 3 years, from 8 to 24% of the pairs produced 3 clutches of eggs (Table 2). The recognition of this behavioral aspect of renesting geese was extremely important to overall egg production.

Egg Production – Clutch sizes of individual geese ranged from 1 to 8 eggs. As many as 3 clutches of eggs were produced by individual pairs of geese. In case of multiple clutches, there was a 10-day to 2-week period between nest destruction and laying of the first egg of the subsequent clutch. The average clutch size for first, second and third clutches was 5.6, 5.2 and 4.1 respectively (Table 3).

Table 2. Numbers and percentages of geese producing first, second, and third clutches.

Year	*Number of Breeding Pairs*	*First Clutches*		*Second Clutches*		*Third Clutches*	
		Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1971	23	23	100	0	0	0	0
1972	18	18	100	5	28	0	0
1973	32	32	100	18	56	0	0
1974	32	32	100	30	94	0	0
1975	41	41	100	31	76	5	16
1976	49	48	100	26	54	2	8
1977	55	55	100	42	76	10	24
Total	249	249	100	152	61	17	11

Table 3. Number of clutches and average clutch sizes for first, second, and third clutches.

Year	*First Clutches*		*Second Clutches*		*Third Clutches*		*All Clutches*
	No. of Clutches	*Avg. No. Eggs*	*No. of Clutches*	*Avg. No. Eggs*	*No. of Clutches*	*Avg. No. Eggs*	
1971	23	5.3	0	--	0	--	5.3
1972	18	5.6	5	5.8	0	--	5.7
1973	32	5.5	18	5.1	0	--	5.4
1974	32	5.9	30	5.1	0	--	5.5
1975	41	5.9	31	5.1	5	4.2	5.2
1976	48	5.6	26	5.0	2	4.2	5.2
1977	55	5.3	42	4.8	10	4.0	5.0
Total	249	5.6	152	5.2	17	4.1	5.3

A total of 2223 eggs were produced during the 7-year period. Almost two-thirds of the eggs (61.3%) resulted from first clutches. Second and third clutches contributed 35.5% and 3.2% of the eggs, respectively (Table 4).

Seventy-four percent (1639) of all eggs produced were fertile as determined by candling after 15 days of incubation; and 70% (1145) of the fertile eggs hatched. Records maintained on performance of eggs by nesting periods indicated that fertility and hatchability of first, second and third clutches were very similar. The fertility of first, second, and third clutches was 70, 80, and 77% respectively, and hatchability was 67, 73 and 67%, respectively (Table 4).

Hatching Techniques

Decontamination – During the first 3 years, fertility rates determined by candling after 15 days of incubation was about 60%. In the third year, a sample of the eggs candled as infertile were broken and the contents were examined ina petri dish. It was found that a significant percentage of those eggs had actually been fertile but suffered an early embryonic death that chandling of the eggs alone did not detect. Prior to this time, eggs had not been washed; afterwards, all eggs were washed in a 1 to 2% solution of Environ (Vestal Laboratories, St. Louis) and water heated to 37.7 to 48.8 C. Egg fertility increased significantly from 60 to 80% after egg washing was initiated (Table 1).

Table 4. Number of total, fertile, and hatched eggs produced in first, second, and third clutches.

	First Clutches			*Second Clutches*			*Third Clutches*		
Year	*Total Eggs*	*Fertile Eggs*	*Hatched Eggs*	*Total Eggs*	*Fertile Eggs*	*Hatched Eggs*	*Total Eggs*	*Fertile Eggs*	*Hatched Eggs*
1971	108	54	46						
1972	106	45	15	29	26	18	--		
1973	176	77	30	91	73	42			
1974	179	131	72	175	146	103			
1975	241	205	133	157	136	88	21	19	11
1976	259	217	173	137	104	89	10	4	4
1977	294	218	173	201	152	126	40	32	22
TOTAL	1363	947	642	790	637	466	71	55	37
Percent of total eggs that were fertile and hatched during each nesting period		69.4	67.6	--	80.6	73.2	--	77.5	67.3
Percent of observations over all clutches		61.3	57.8	56.1	35.5	38.8	40.7	3.2	3.4

Egg Storage — After washing, the eggs were stored in a cooler that was maintained between 10 to 12.8 C. This kept the eggs below physiological (72 C) above which embryonic growth begins.

Incubation — Each Monday morning, eggs gathered during the previous week were placed longitudinally in the incubator cradles and placed in the Jamesway incubators. The incubators were maintained at 37.5 C dry bulb and 30 C wet bulb temperature. The incubator was inspected 5 times daily; 0500, 0900, 1300, 1700 and 2100. Wet and dry bulb temperatures were checked and the eggs were rotated 120 degrees during each inspection. During 0500 and 1700 inspections, eggs were briefly removed from the incubator and turned end for end. Eggs were sprayed with distilled water at 0500 daily. This was necessary because the incubators could not maintain the 31.1 to 33.3 C wet bulb temperature required for hatching waterfowl eggs. On the 15th day of incubation, eggs were candled and infertile eggs were removed.

On the 28th day, eggs were placed in an adjacent incubator maintained at the same temperature and humidity. They were taken out of this incubator every 4 hour inspection and sprayed with distilled water and checked for pipping. The pipped eggs were placed in a hatching cabinet maintained at 37.5 C dry bulb and 34.4 C wet bulb temperature and allowed to hatch. If pipped eggs did not hatch after 20 hours in the hatching cabinet, the goslings were physically removed from the shell. This was done because goslings would consume their egg sack 24 hours after pipping and die if not extracted. A slight deviation in this procedure was followed for inverted embryos. A naturally positioned embryo will pip the large end of an egg. An inverted embryo will pip the small end of the egg. The inverted embryos died until we discovered that about 75% could be saved by removing the shell from around the goslings head 4 hours after it was placed in the hatching cabinet. When goslings hatched, they were left in the hatching cabinet until dry.

Gosling Rearing

Brooding — When removed from the hatching cabinet, goslings were banded with a temporary plastic band for identification purposes. They were then placed in a .6 m x .6 m x .6 m draft-free brooder box heated to 23.9-26.7 C with a 100-watt light bulb.

Temperature in the brooder box was regulated by raising and lowering the light bulb. Goslings were given food and water and kept in the brooder box for 4 hours.

Occasionally a defect we called spraddle leg would show up among individual birds in the brooder box. This was corrected by hobbling their legs about 3 cm apart with a soft cotton string for 1 hour.

After the 4 hour conditioning period, goslings were moved into a 3.7 m x 3.7 m brooder pen located inside a building. The brooder pen contained food, water, an absorbent litter and a heat lamp suspended 46 cm from the floor. Goslings would move to and from the lamp as heat was needed. Food and water was changed daily. Goslings were in the brooder pen until they were 1 week old.

Rearing Groups (Brood Size) – During the first 3 years of rearing, all the goslings of the same age were kept together throughout the rearing stage. Group sizes ranged up to 50 or more goslings. When excited, groups would generally flow in unison similar to the way a flood light spot moves across a stage. At the first sign of danger, the group would quickly tighten. The greater the danger, the tighter the group. Larger groups would move together and pile up in pyramid fashion, and goslings stayed in this tight group until the danger ceased. In the case of lightning storms or some other prolonged period of danger, groups would stay together for a longer period of time. This caused goslings in the middle of the group to become trampled or suffocate. Trampling and suffocation was the chief cause of gosling mortality during the first 3 years.

A policy to never place more than 15 goslings in a group was instituted in the fourth year. Gosling survival increased significantly (Table 4) from 56 to 96% following the adoption of this policy. The recognition of this behavioral aspect of the geese almost doubled gosling production. These groups (broods) of 15 or less were maintained throughout the gosling finished period.

Finishing – At 1 week of age, the groups were rebanded with larger bands and moved into an intermediate ground and avian predator-proof fly pen. These structures consisted of a 3.7 m x 3.7 m house equipped with food, water, absorbent litter on the floor, and a heat lamp. The house was attached to a 2.4 m x 3.7 m grass area that was fenced on all sides and the top. Each pen contained a .9 x .9 x 1.8 m water tank that was continually filled and drained at a rate so that the water in the tank would completely change every 24 hours. The goslings were kept in the intermediate fly pens until they were 2 weeks of age.

At the beginning of the third week, goslings were moved to a larger field fly pen that measured 10.2 x 7.3 x 3 m high. An open corrugated roof shelter 3 m long and 1.8 m wide was built in each pen to provide shade, if needed, and to protect goslings from heavy rains. Food was offered in metal pig feeders. Each pen contained a 1.2 x 1.8 x 2.4 m high metal water tank that was constantly filled and drained at a flow rate to completely change the water every 24 hours. Goslings were left in these pens until they were 4 weeks old, at which time they were moved into the large 4 ha enclosure containing the adult geese. Goslings remained in the large enclosure with the adult geese for 6 to 8 weeks before they were released in the wild.

Feeding – Regulation of nutrition was extremely important to proper growth and development of the goslings. The best starter feed was a 30% protein diet (Purina Game Bird Startina). It was found that continuing the 30% protein diet longer than 2 weeks resulted in a high percentage of gout and a wing crippling condition called "Airplane Wing." Both of these maladies almost always occurred during the first 4 weeks.

Gout was the result of too much urea in the system from the high protein diet. Groups exhibiting signs of gout were immediately changed to a 12.5% diet (Purina Game Bird Maintenance) which usually corrected the problem.

"Airplane Wings" resulted from excessive growth of the flight feathers before the wings were strong enough to support feather weight. This caused the distal portions of the wings to permanently flop out resulting in deformed growth of the wings and a flightless bird. If detected soon enough, this condition could be corrected by reducing intake of protein and taping the wings into their natural position for several days.

Very few problems with gout and "Airplane Wings" occurred when the diet was switched to 20% protein (Purina Game Bird Layena) at the beginning of the third week. Goslings continued to receive the 20% protein diet through the fourth week. At the beginning of the fifth week, the birds were switched to a 12.5% diet (Purina Game Bird Maintenance) that they supplemented on their own with grasses in the 4 ha enclosure.

SUMMARY

The results of the artificial propagation project are summarized in Table 1. Annual production increased consistently throughout the years in terms of eggs produced, fertility of eggs, fertility eggs hatched and goslings flighted. The consistent increases were attributed to a good data records system and recognition of problems and behavioral characteristics of the species. Accommodation for natural behavioral characteristics in the breeding program and incorporation of improved techniques into the hatching and rearing process resulted in significant increases in production throughout the program.

The annual costs for producing the geese are listed in Table 5. Overall costs of the entire project over the 7 year period was $125,440.00. This amounted to an average cost of $116.91 for each gosling flighted over the 7-year period.

Table 5. Annual and total goose production costs for artificial propagation at the Buffalo Springs Research Center, Tennessee 1971-77.

Year	*Salaries*	*Construction*	*Feed and Maintenance*	*Total*	*Total Goslings Flighted*	*Cost per Gosling Flighted*
1971	$ 8,130.00	$ 2,300.00	$ 1,760.00	$ 12,190.00	40	$304.45
1972	8,130.00	0.00	1,500.00	9,630.00	18	535.00
1973	8,430.00	787.00	2,756.00	11,973.00	63	190.05
1974	14,152.00	536.00	4,973.00	19,661.00	173	113.65
1975	13,914.00	10,743.00	4,097.00	28,754.00	223	128.94
1976	13,896.00	1,382.00	4,319.00	19,597.00	255	76.85
1977	16,620.00	1,421.00	5,594.00	23,635.00	301	78.52
Total Costs	$83,272.00	$17,369.00	$24,799.00	$125,440.00	1,073	$116.91

The artificial propagation produced a total of 1073 giant Canada geese to flight age. These goslings were used to establish successfully 26 different, resident free-flying flocks of geese in the Tennessee Valley, 19 in Tennessee, 4 in Georgia, and 1 each in Kentucky, Alabama and Virginia. Studies of the survivorship of released birds indicated that once the goslings reached breeding age, the population grew at a rate of 24% per year with a doubling every 3 years (Hubbard 1976). Hubbard further reported that social organization and reproductive behavior developed simultaneously in artificially propagated Canada geese to conform to the social and reproductive behavior familiar to wild Canada geese.

LITERATURE CITED

Bednarik, K. E. 1965. Canada goose management in Ohio. Game Research in Ohio. 3:180-206.

Breakhage, G. K. 1965. Biology and behavior of tub-nesting Canada geese. J. Wildl. Manage. 29(4):751-771.

Gore, J. F., and C. J. Barstow. 1969. Status of a free flying, resident flock of Canada geese in Tennessee. Proc. SE Assoc. of Game and Fish Comm. 23:101-103.

Hubbard, J. A. 1976. Social organization, dispersion, and population dynamics of a flock of pen-reared wild Canada geese. Ph.D. Dissertation, Univ. of Tenn., Knoxville. 124 pp.