The Gander's Distance from the Nest as a Function of the Stage of the Female's Incubation Period Examined in a Captive Wild Flock of Giant Canada Geese (*Branta canadensis maxima*)

by

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CORY JOHN LINDGREN

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF ARTS

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Abstract

The purpose of this study was to determine if the gander's distance from his nest changed as a function of the stage of the female's incubation period. The Field Station of the Avian Behaviour Laboratory, maintained and operated by the Avian Behaviour Laboratory in the Department of Psychology at the University of Manitoba, was the study area for this project. A flock of giant Canada geese (*Branta canadensis maxima*) were used as experimental subjects. For each individual gander, a single daily mean calculated from four daily randomly chosen data collection periods represented his distance from his nest on any given day. Data was collected from all nesting pairs. Data collected upon nesting pairs that successfully hatched one or more goslings was used in the data analysis. For the purpose of this study, four hypotheses were evaluated: (1) the gander's distance from the nest would increase as a function of the female's incubation period, (2) the gander's distance from the nest would decrease as a function of the female's incubation period, (3) there would be no change in the size of the gander's territory as a function of the female's incubation period, and (4) the size of the ganders territory would fluctuate as the female's incubation period progresses. A one-way analysis of variance with repeated measures over days was used to analyze the data. A

significant main effect was obtained for the gander's distance from the nest (F (23, 322) = 2.88, $p < 0.001$). Post-hoc comparisons using the Tukey studentized range test on all main effect means indicated that the mean of Day 0 differed significantly ($p < 0.05$) from all other 23 day means. These data indicate that the gander decreased his distance from his nest to a statistically significant degree as a function of the first gosling to hatch. It is hypothesized that the goslings may provide a "timing mechanism" for the gander who reacts by reducing his distance from his nest. Presumably, the biological significance of this reduction in the gander's distance from his nest would be a higher degree of nest/gosling protection against potential predators.

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Introduction

Unicum arbustum haud alit duos erithacos
(One bush does not shelter two robins)
Zonodotus (Third century B.C.)

Territory in Avian Species: Theory and Definitions.

For each avian species, it is evident that the concept of territory, as well as the functions of territory, are as diverse as the species involved. Howard (1948) was one of the first researchers to examine the importance of territory in the life of birds. Armstrong (1965), interprets Howard's (1948) theory of territory thusly:

> The guarding of a specific area, usually around the nest, is of value to birds because it distributes them regularly, thereby reducing the chances of birds remaining unmated; it also serves to strengthen the bond or union between the pair and guarantees the family's food supply, especially at the actual time when the chicks are newly hatched (p. 271).

Apparently, Howard (1948) associates territory with the breeding portion of the annual cycle of a bird. Howard emphasizes the spacing of individuals - "distributes them regularly" - as a important component and possible function of a territory, as well as a mechanism to "strengthen the bond" and to assure a food source. Lack (1965) stated that Howard's (1948) theory had survival value for two main reasons. The first was acquiring and retaining a mate while the second was ensuring a food supply. Howard (1948) realized that males fight to secure a territory, not to secure a mate.

Aristotle makes reference to 'food territory' in birds in his book Historica Animalium (cited in Lack, 1965). Aristotle stated "that a pair of eagles demands an extensive space for its maintenance, and consequently cannot allow other birds to quarter themselves in close neighourhood" (Lack, 1965, p. 130). Berger (1961) reported "that the concept of territoriality was developed in Germany by Bernard Altum in 1868, and independently in England by Eliot Howard during the period from 1907 to 1920" (p. 195). Altum, a German ornithologist, stated all the criteria of territory theory, "including the modern view of song as a threat to other males and an invitation to a female" (Balham, 1954, p. 37). Bernard Altum published seven editions of his book, "Der Vogel und sein Leben" (translation: The Bird and his Life) between 1868 and 1903 (Mayr, 1935). Altum, considered the true father of the concept of territory, was not recognized outside Germany because of the language barrier and the inaccessibility of his book outside of Germany (Stokes, 1974). Altum's principle was "animal non agit, agitur" (translation: an animal does not act by its own volition, but reacts to stimuli) (Mayr, 1935). Altum believed the function of territory was to insure an adequate supply of food for the young. Howard (1948) also believed that the function of territory was to insure a supply of food for the young. However, differences existed between Howard and Altum with respect to how they applied their theories. "Altum included only those cases in which all the activities of a pair were confined to a territory, whereas Howard regarded territory as a general law of bird life" (Balham, 1954, p.38).

Noble (1939) stated that a territory is any defended area. Noble's definition, perhaps one of the most concise and simple, does not account for the mechanisms of territorial defense, the possible function(s) of the territory, or any temporal or seasonal component that may help qualify a territory. As Armstrong (1965) suggests, "it errs on the side of vagueness" (p. 273). Perhaps Noble, in constructing this generalized formula, realized the complexity and diverse nature of avian territories, and purposely left his definition 'open-ended' in order to account for the diversity within avian species. Although short and concise, it may be the most generalizable definition of territory.

David Lack (1939) described territoriality as an isolated area defended by one individual of a species or by a breeding pair, against intruders of the same species, and in which the owner of the territory makes himself conspicuous. Lack does not allude to how the area is defended nor does he define an isolated area. Davis (1940) describes territorial behavior as the defense of an object (territory) which serves in reproduction. Reproduction may play an indirect role in the establishment of a territory, however, other types of territories do exist (i.e. food related).

Extensive work by Mayr (1935) and Nice (1941) elaborated the theory of territory, and perhaps elucidated the theory by categorizing the different types of territory with reference to a temporal and functional component. Mayr (1935) originally defined four types of territories based upon mating, nesting, and foraging location. Nice (1941) extended Mayr's classifications and suggested six types of territories. Pettingill (1985) and Morse (1980) illustrate Nice's categories:

I. Breeding Territory:

Type A: Mating, nesting, and feeding area for adults and young.

Type B: Mating and nesting (but not feeding area).

Type C: Mating area only.

Type D: Restricted mating and nesting area.

II. Non-Breeding Territory:

Type A: Feeding territory.

Type B: Winter territory.

Type C: Roosting territory.

This type of classification goes a long way towards bringing the types of territories into perspective and introduces an important breeding - nonbreeding dichotomy to the concept. Nevertheless, ambiguous and vague concepts of territoriality still appeared in the literature. Jenkins (1944) defined territory as any area in which despotism is shown resulting in the defence against other organisms, and is usually formed around some site or object such as a nest, offspring, mate, food, etc.. Pitelda (1959) defined a territory as any exclusive area. Several authors have defined a territory as a simple area of dominance (Emlen, 1957; Murray, 1969; Willis, 1967). These definitions lack any recognition of a temporal or functional element.

Morse (1980) reports that the essential characteristics of a territory are (1) that it is a fixed area (which may shift over time), (2) it is actively defended, and (3) the holder has exclusive use of it (with regard to a given set of individuals). The key words emphasized by Morse are 'fixed area', 'defended', and 'exclusive use'. The criteria presented by Morse (1980) allows the researcher to assess the associated functional element(s) of the territory that are particular to that individual or individuals of a species. Morse (1980) further adds that overt defense (attacking, chasing, threatening intruders) identify the territory holder and make it conspicuous to rivals.

A number of researchers have expanded upon Noble's (1939) concept of territory as 'any defended area'. Emlen (1957), dissatisfied with the accepted and repeated definition of territory as 'any defended area', stated that there is no evidence that the area is the object of aggression and asks for a useful concept of territory that is limited to observable phenomena and expressed in operational terms focused upon happenings rather than entities. Emlen (1957) defines a territory as a space within which an animal is aggressive toward and usually dominant over certain categories of intruders. Etkin (1964) defined territoriality as any given behavior on the part of an animal which tends to confine the movements of the animal to a particular locality. Eible-Eibesfeldt (1970) considered any space associated intolerance as territoriality.

Brown (1975) presented a behavioral definition of territory, stating that a territory is a fixed area from which intruders are excluded by some combination of advertisement, threat and attack. Wood (1964) describes territoriality as having three stages; (1) protection of the female alone, with location and boundaries of the territory being indeterminate, (2) protection of the female after the selection of the nest site but prior to the first egg being laid and, finally, (3) protection of the female incubating in the nest with a fixed area and well defined boundaries.

Davies (1978) defined a territory as a situation which exists whenever individual animals or groups are spaced out more than would be expected from a random occupation of suitable habitats. Whenever 'spacing out' is due to interactions between individuals or groups, the occupied area will be referred to as a territory (Davis, 1978). Brown and Orians (1970) defined a territory as a fixed area which is defended for the purpose of excluding rivals.

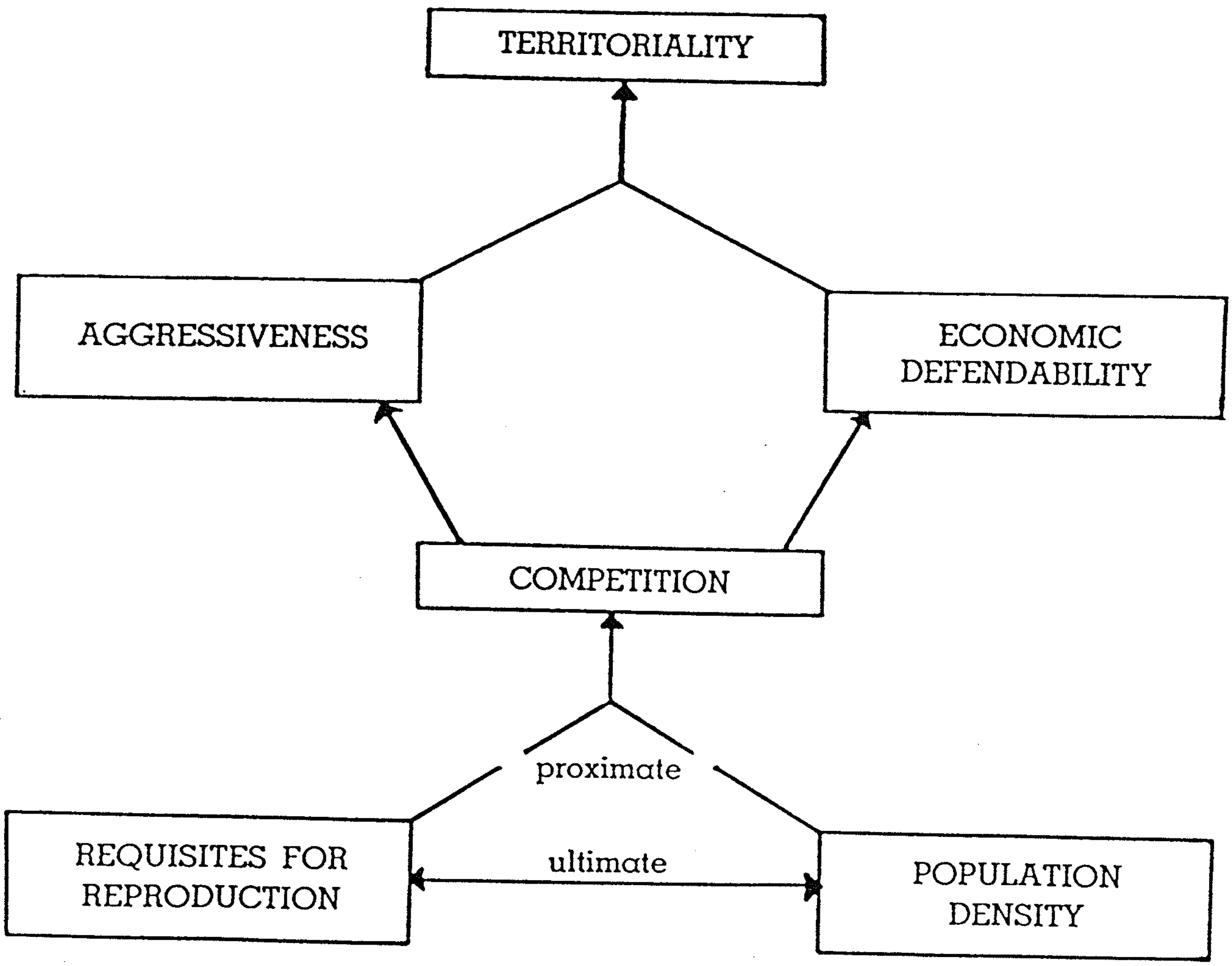
It is evident that no strict definition of the term territory can be arrived at that is generalizable across all avian species. Each species presents a different complex of functions, under different environmental conditions. Therefore each has its own specific definition of territory. Davis (1978) noted that as more and more examples of territory are described it becomes clear that there is no single function of a territory, for territories are used for a wide variety of different activities.

Brown (1964) postulated an economic model of the defence of territory, a cost-benefit approach to territorial behavior. His economic model suggests that we would only expect an animal to defend a territory when there will be a net benefit in terms of fitness by doing so. Whether defence of a territory will be economical or not will depend upon whether the energy saved by gaining exclusive use of an area exceeds the energy expended in its defence. Brown's (1964) general theory stated that aggressive behavior employed by individuals in acquisition of goals maximize individual survival and reproduction. Aggressiveness is a behavioral response to competition for ecological resources in short supply (i.e. mates, food, territory). Those that obtain a balance between the positive values (mate, nesting area, food, etc.) and the negative values (time lost in defence, energy loss, opportunities lost, risk of injury) reproduce and pass on this genetic balance (or degree of aggression) through natural selection (Figure 1).

Functions of Territory in Geese.

Ryder (1975) examined the functions of territory in Ross's Geese (*Anser rossii*) and the Canada Goose (*Branta canadensis*) under natural and semi-natural conditions.

Figure 1. A general theory of the evolution of diversity in avian territorial systems (Brown, 1964).


TERRITORIALITY
AGGRESSIVENESS
ECONOMIC DEFENDABILITY
COMPETITION
proximate
REQUISITES FOR REPRODUCTION
ultimate
POPULATION DENSITY

Ryder (1975) hypothesized that "within the selected territory, the gander appears to have two functions; to ward off potential predators, and to protect the female and the nest from intruding conspecifics" (p. 114). Ryder (1975) felt that for the gander to defend the territory effectively, two conditions must be met. First, food must be available within the boundaries of the territory so that the male does not need to leave often for long periods of time and, secondly, the gander must be able to defend the territory against surrounding territorial males.

Ryder (1975) further hypothesized "that the size of the territory defended may have evolved in relation to the reserves accumulated by the gander before the nesting season" (p. 114). The territory must then be large enough to provide food required by the male to enable him to protect the nest site against conspecifics. The size of the territory that the individual defends is determined by the balance between the need to defend a large enough area for feeding purposes and the need to be able to defend it successfully. The larger the area, the more time and energy the gander needs to defend it. Ryder felt that in order to stay near his mate for as long as possible the male must defend an area around the nest large enough to sustain his food requirements.

Ryder (1975) found that male geese lost weight throughout the laying and incubation period. He suggested that the ganders used body reserves to defend the territory. Males which defended an area too small to supply sufficient food and water would have to leave the territory and, hence, expose their mates to attack. Ewaschuk and Boag (1972) reported that Canada geese have two basic types of territories; larger ones bordering on water and smaller inland ones. They speculated that the smaller territories were initiated by younger and less experienced geese and they observed the absence of ganders from smaller territories in which the females were unsuccessful at nesting.

Inglis (1976) examined agonistic territorial behavior in breeding Pink-footed Geese (Anser brachyrhynchus) and questioned Ryder's hypothesis. Inglis concluded that agonistic behavior in Pink-footed geese "serves mainly to preserve a supply of food around the nest site particularly for the use by the female during the early part of the nesting period" (p. 98). Hence, the territory would serve to be more important as a food source to the female rather than to the male (Inglis, 1976). This interpretation of territory contradicts Ryder's (1975) hypothesis. Inglis concluded that territory serves to safeguard a supply of food near the nest when overall food is scarce.

Owen and Wells (1979) examined territory size and function in Barnacle Geese (_Branta_ _leucopsis_) both in the wild and in captivity. They concluded "that agonistic behavior in this species serves mainly to preserve a supply of food around the female during the early part of the nesting period. As the eggs are safe from predators for as long as the female is incubating, anything which can increase the time spent on the eggs is important" (p. 98).

Mineau and Cooke (1979) re-examined Ryder's and Inglis's hypothesis in relation to the Lesser Snow Goose (_Anser_ _caerulescens_ _caerulescens_). Mineau and Cooke (1979) pointed out that there exists little evidence to suggest that aggressiveness in the male serves to "defend anything but the actual nest site and the female" (p. 18). They concluded that territoriality in geese serves in part to provide a buffer-zone between the nest and potential intruders and, more importantly, between the female goose and potential male rapists. They suggested that it was the defense of the female from rape attempts by neighboring males which was the primary function of territoriality. Owen (1980) points out that rape attempts are not uncommon in Snow geese, however, rape attempts have not been recorded in any other species.

Cooper (1978) concluded that there are three functions of territory in Canada geese. First, the primary function of territorial defence is to isolate the female from sexually active birds of the same species during the copulation phase of the reproductive cycle. The second function of territorial defense is to provide protection to the laying and incubating female at the nest site. The third function is to provide protection to the female during her incubation recesses.

Collias and Jahn (1959) reported that the size of territories in Canada geese varied greatly between individual birds. "The size and shape of the territory changed with time and circumstance" (Collias and Jahn, 1959, p. 487). They noted that, in general, once a bird defeated its neighbor in a fight, the territorial boundary moved in the direction of the loser's ground. They noted the importance of the gander with respect to the territory and its defense. In one situation a female lost her mate (by death) late in her incubation period. As a result, she was dominated and disturbed by other pairs and unmated individuals who repeatedly drove her from her eggs, resulting in the death of the developing embryos.

Ogilive (1978) stated that the main purpose of a nesting territory is to prevent harassment of the female by other geese since she is at a critical time, having expended much energy in producing the clutch of eggs. Wormer (1968) suggests that the purpose of nesting territories is to ensure successful reproduction.

Displays and Defence of Territory: Canada Geese

> Everything is in whole-part relationships, and, part by part, the parts of each part operate according to their function.
>
> - Hippocrates.

Animals do not develop or utilize vocal language to the same degree as humans. Instead, many animals have evolved elaborate patterns of movements that are species-specific and are used to transmit information between concerned individuals. Information transmitted from one individual to another is coded into a signal, and the coding varies from animal to animal (Frings and Frings, 1977). "This ritual is a code, so artificial that its purpose can hardly ever in the ordinary course of events be mistaken by those for whom it is intended; an ancient, esoteric, dramatic language which says by gestures that for which we human beings have to employ many words" (Armstrong, 1965, p.317). Krebs and Dawkins (1984) stated that ritualized signals have evolved through the manipulation of conspecific behavior by the sender of the signals and through detecting the sender's intentions by the receivers of the signals.

The ethological unit that is central to communication among animals is the display. Displays are specialized acts that are performed by individuals (Sebeok, 1977). Sebeok (1977) suggests that Darwin viewed displays as a way of making information available about an individual's internal emotional state. Moynihan (1956) defined a display as an act specially adapted in physical form or frequency to subserve social signal functions.

Displays play a prominent role in communication among geese. With geese, displays serve as visual signals. Visual signals are defined as a movement emphasized by a feature which has evolved to serve in visual communication usually by releasing certain patterns of behavior in conspecific individuals (Fabricius, 1975). Canada geese use a variety of head movements that enhance their white on black cheek patch. These cheek patches serve as visual signals during agonistic and triumph ceremony situations. They are thought to be adaptive in that they aid in the reinforcement of pairbonds and possibly enhance both the establishment of nesting territories and breeding success (Black and Barrow, 1985).

Although the means of defence are highly variable, visual signals or displays usually serve to maintain a territory and physical contact is rarely exhibited except when the territorial boundaries are being initiated (Morse, 1980). Actual fighting rarely occurs. Releasers that intimidate without causing damage have evolved (Tinbergen, 1951), and this ritualized fighting maintains territorial spacing (Frings and Frings, 1977). Hence, maintenance of territorial boundaries is established by visual signals that take the form of displays (Pettingill, 1985) and announce that a particular territory will be defended.

Defense of territory in breeding Canada geese is best represented by two behavior patterns; (1) outright attack upon the intruder(s) by the defending gander, characterized by chasing, biting and wing thumping and, (2) threatening displays or gestures, communicated by head and neck movements emphasizing the white on black cheek patch. Hochbaum (1944) suggested two similar forms of territorial behavior in ducks: (1) direct attack without preliminary movements and (2) display accompanied with threat posturing followed by attack if the intruder fails to depart. Balham (1954) suggests that four behavior patterns are commonly used in defense of territory in Canada geese: (1) display prior to attack, (2) triumph ceremony, (3) territorial call, and (4) attack.

Once territories have been established, fighting rarely occurs between adjacent defending ganders and territorial boundaries are maintained by threatening displays and postures (C. Lindgren, personal observation, April, 1988). Sherwood (1966) stated that the defended area was initially one of threatening head movements by the gander. Lamprecht (1986) reported that threat displays are the most frequent conspicuous social display in a goose flock. Cooper (1978), Collias and Jahn (1959), Balham (1954), Klopman

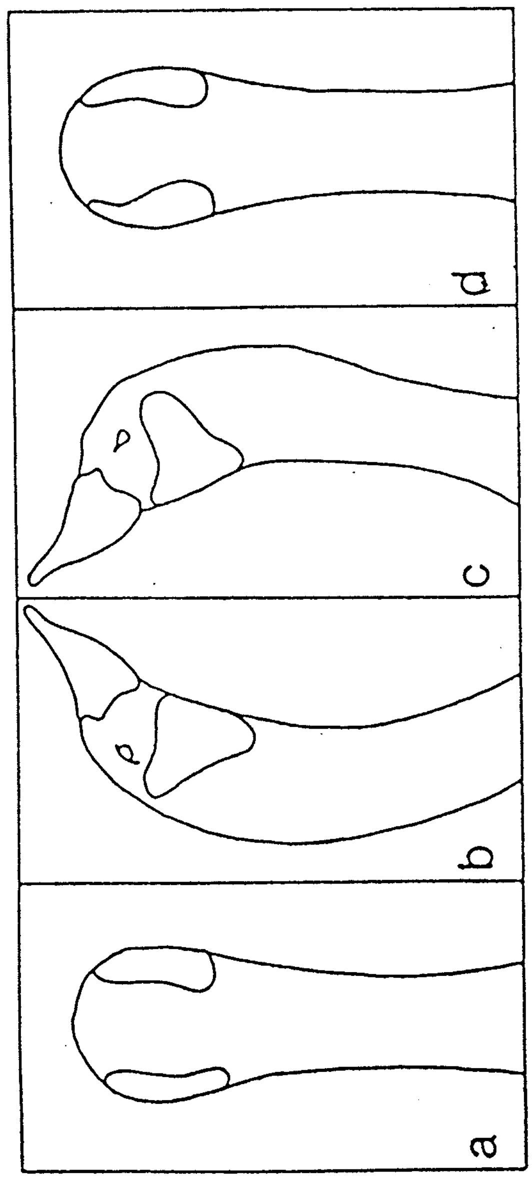
(1961), Black and Barrow (1985), Radesator (1974), and Akesson and Raveling (1982) also note the importance of threat displays and head-posturing with respect to territorial defence in geese.

Threat, and other displays, are communicated primarily, and perhaps solely, by the position and motion of the head and neck of a goose. The white on black cheek patch may play a vital role in these displays and, hence, a prominent role in the defense of the territory. Balham (1954) speculated that the white cheek patch functions as a releaser in aggressive displays. Black and Barrow (1985) stated that Canada geese use a variety of head movements that are enhanced by their white on black cheek patch. Cowan (1973) suggests that the cheek patch, when it is made conspicuous by head movements, may be a directing stimulus. Radesator (1974) reported that the white cheek patch of Canada geese serves to make behavior conspicuous and distinguishable at great distances. Collias and Jahn (1959) reported a special display engaged in by the gander with respect to intruders that shows off the white cheek patches to his advantage.

Head-pumping and head-tossing are the behavior patterns that dominate displays during the breeding season and function to maintain territorial boundaries by threatening intruders. Collias and Jahn (1959) noted a special display given by the gander to intruders. With neck stretched up, the gander would flip his beak upwards simultaneously rolling his head. They concluded that this head-flipping serves a threat function and is associated with the white cheek patches which are brighter and clearer in the spring (see Collias & Jahn, 1959). Cooper (1978) described a typical defence sequence which consists of a side to side rotary motion of the head with the beak and neck extended upwards. Black and Barrow (1985) defined these lateral, vertical, or rotary head movements which are associated with an extended vertically straight neck, as a head toss. They are also indicative of conflicting tendencies to either stay in one place or to flee from an aggressor (Figure 2).

Akesson and Raveling (1982) reported that head tossing occurred most frequently in breeding males, while Radesator (1974) stated its functional significance is a movement prior to attack and presumed a warning connotation as well as a threat and mild alarm. Head-pumping, the lowering of the head towards the breast and raising it again to the vertical position, transmits a warning to approaching conspecifics, thereby advertising the status position of the family (Black and Barrow, 1985). Blurton-Jones (1960) and Raveling (1970) concluded that head-pumping was an outcome of balanced conflicting tendencies to attack and to flee.

Figure 2. A typical Canada goose head-toss (Black & Barrow, 1985).


a
b
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d

Balham (1954) suggests that aggressive contacts and displays function to prevent the disturbance of the incubating female and to provide social stimulation between the pair. Black and Barrow (1985) suggest the functional adaptations associated with signals in Canada geese to be (1) transmission of threat or warning to conspecifics, (2) obtaining the attention of the family members in order to synchronize travel, (3) facilitating inconspicuous retreat from predators during the flightless stage, and (4) a specialized system of communication for terrestrial and aquatic locomotion.

Table I outlines and describes Canada goose behavior patterns and displays (also see Radesator (1974) and Akesson and Raveling (1982) for lists of Canada goose behavior patterns).

Table I. Categories and descriptions of Canada Goose behaviors (after Radesator, 1974; Akesson & Raveling, 1982).

Table 1.

Canada Goose Behavior Patterns.

Category of Behavior	Specific Behavior	Description of Behavior
Aggressive Behavior		
	Overt attack	Locomotion towards an opponent, head and neck aimed at opponent, bill open (Radesator, 1974).
	Head-tossing	Threat display prior to attack. Warning connotation, neck and bill extended upwards with rotary head movements. Frequently seen during breeding season (Radesator, 1974; Akesson and Raveling, 1982; Black and Barrow, 1985).
		Behavior communicating intention to move to a new location (Raveling, 1970)
	Head-pumping	Transmits a warning to approaching conspecifics. Vertical bobbing of the head (Blurton-Jones, 1960; Radesator, 1974; Black and Barrow, 1985).

Category of Behavior	Specific Behavior	Description of Behavior
	Upright	Head and neck erect. Adopted by a goose on guard or disturbed (Radesator, 1974).
	Coil forward	Neck coiled and head horizontal. Head and neck pointed at opponent (Radesator, 1974).
	Extended forward	Neck protruded forward from the coil position. Neck and head under level of carpal joint (Radesator, 1974).
Retreat		
	Escape	Neck held upright, sometimes vertical to ground. Goose swims or runs away from an opponent (Radesator, 1974; Akesson and Raveling, 1982).
	Submissive	Neck tightly coiled, bill closed and pointing downward (Radesator, 1974).
	Hiding	Body flat to the ground, neck extended vertical along ground. Goose silent and motionless (Balham, 1954).

Category of Behavior	Specific Behavior	Description of Behavior
Triumph Ceremony Behaviors		
Male	High intensity Crackling	Head and neck obliquely extended forward orientated to the female, bill open with prolonged snoring sounds emitted (Radesator, 1974; Akesson and Raveling, 1982).
	Low intensity Cackling	Neck extended forward with a slight coil. A bowing of the head is observed (Radesator, 1974).
Female	Facing away	Submissive posture in response to male's cackling (Akesson and Raveling, 1982).
	Yipping	Vocalization of paired female in presence of male. Irregular staccato sound of variable pitch (Akesson and Raveling, 1982).

Category of Behavior		Description of Behavior
Sexual Behavior		
	Precopulatory	Head dipping; repeated stereotyped immersion of the head and neck into water (Klopman, 1962).
	Copulation	Male mounts female while on the water (Klopman, 1962).
	Postcopulatory	Breast, neck and head tilted back, breast protruded outwards, bill upturned. (Klopman, 1962).
General Activities		
		Resting, grazing, nibbling, preening oiling - comfort movements (Radesator, 1974).

Size of Breeding Territory in Geese

Territorial shape and size in breeding geese is highly variable, varying between individual pairs (Collias and Jahn, 1959; Ewaschuck and Boag, 1972; Mineau and Cooke, 1979) and variable with respect to the stage of the reproductive cycle. Ewaschuk and Boag (1972) suggested that territorial boundaries and size were apparently affected by vegetation, the more vegetation, the larger the size of the territory. Hochbaum (1944) stated that natural obstructions blocking vision are natural boundaries of territory" (p. 75), with territories generally larger in open areas such as lake shores and open bays. Ewaschuk and Boag (1972) reported larger territories associated with open vegetation.

Ogilive (1978) and Brakhage (1965) add that the size and shape of the breeding territory will depend upon how naturally aggressive the birds are, how much food is required, and the configuration of the ground. Dow (1943) and Wood (1964) observed that the most aggressive birds held the largest territories. Personal observations of breeding geese at the Field Station of the Avian Behaviour Laboratory at Glenlea, Manitoba, during the 1986 and 1987 nesting seasons support the observation that very aggressive ganders defended the largest territories.

The size of breeding territories may change as a function of the stage of the reproductive cycle. Armstrong (1965) noted that many birds initially establish larger territories than they will ultimately defend. He suggests that this is due to a complex of factors, with the primary advantage being freedom from interference attained during the early stages of the reproductive cycle. Allen (1942), for example, found the Roseate spoonbill (*Ajaia ajaia*), initially establishes a territory which extends as much as twenty feet from the nest but during the incubation period the territory dwindles to an area surrounding the immediate nest site. Allen suggested that the necessity for preserving the bond between the pair early in their attachment, when it is not as strong as it is later, and the presence of large numbers of unattached males in the colony early in the reproductive cycle, establishes the need for an initially large territory. He speculated that promiscuity and confusion may occur if the territories were smaller in the initial stages because this situation would permit the female to accept the advances of other males.

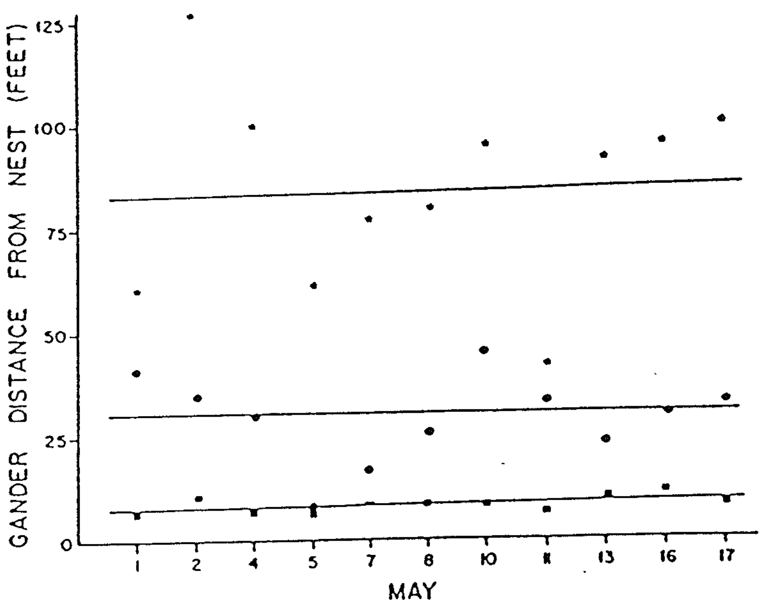
Territory size of breeding geese has been examined by a number of researchers who have studied the behavior of geese during the entire reproductive cycle. The reproductive stages begin with pair formation and nest site selection and continues through the laying and incubation periods of the female. Three general, mutually exclusive, territory size shifts are frequently reported: (1) an increase in the size of the territory as incubation progresses (Mineau and Cooke, 1979), and (2) a decrease in the size of the territory until at hatching, only the area around the immediate nest site is defended (Balham, 1954; Brakhage, 1965; Mickelson, 1975; Sherwood, 1966; Stroud, 1982; Wormer, 1968), and (3) no change in the territory size during incubation (Cooper, 1972; Ewaschuk and Boag, 1972; Ogilive, 1978; Owens and Wells, 1979). Evidence for each of these hypotheses appears in the literature and will be examined below.

Within the Lesser Snow goose (Anser caerulescens caerulescens), territory size increased as the breeding season progressed, with the male moving further away from the nest site (Mineau and Cooke, 1979). Mineau and Cooke (1979) based their conclusions upon an "intensive observational study" at La Perouse Bay, near Churchill, Manitoba. They calculated the daily home range and plotted it against the stage of the nesting cycle. They concluded that the male ranges further away from the nest and his mate as the breeding season progresses.

Ewaschuk and Boag (1972) examined territory size in a wild population of Canada geese nesting in high densities at Dowling Lake, Alberta, between 1967 and 1969. They recorded the distance that each gander was from his nest and mate at hourly intervals. They then compared the mean daily position of the ganders relative to their respective nests over the incubation period of their mates'. They reported no correlation between the distance from the nest and the stage of incubation, thus concluding that there was no decrease in the size of the territory defended (Figure 3). However, Ewaschuk and Boag (1972) based thier conclusion upon data collected from three ganders, a relatively small sample size. Ewaschuk and Boag (1972) also found that ganders defending larger territories displayed more variable boundary lines than those defending smaller territories. Cooper (1978), as well as Ogilive (1978), concluded that territory size in geese remains constant throughout the reproductive cycle. Once the nest site is established, the male defends it as well as the area around the female if the pair move off their selected territory (Ogilive, 1978). Ogilive (1978) states that prior to egg laying the territorial boundaries are fluid and vary with intrusions but become less flexible until one week prior to egg laying when they become fixed in position and remain so until the young hatch.

Cooper (1978) examined territory size in wild breeding Canada geese at Marshy Point, Manitoba. Cooper concluded that, based upon the relationship between the distance the waiting gander was from the nest over the period of

Figure 3. Fitted regression lines for mean daily distances of three ganders from their nests during the period of incubation. Top pair (Y = 82.32 + 0.26X), middle pair (Y = 29.64 - 0.07X), and bottom pair (Y = 8.46 + 0.07X) (Ewaschuk & Boag, 1972).


GANDER DISTANCE FROM NEST (FEET)
125
100
75
50
25
0
1
2
4
5
7
8
10
11
13
16
17
MAY

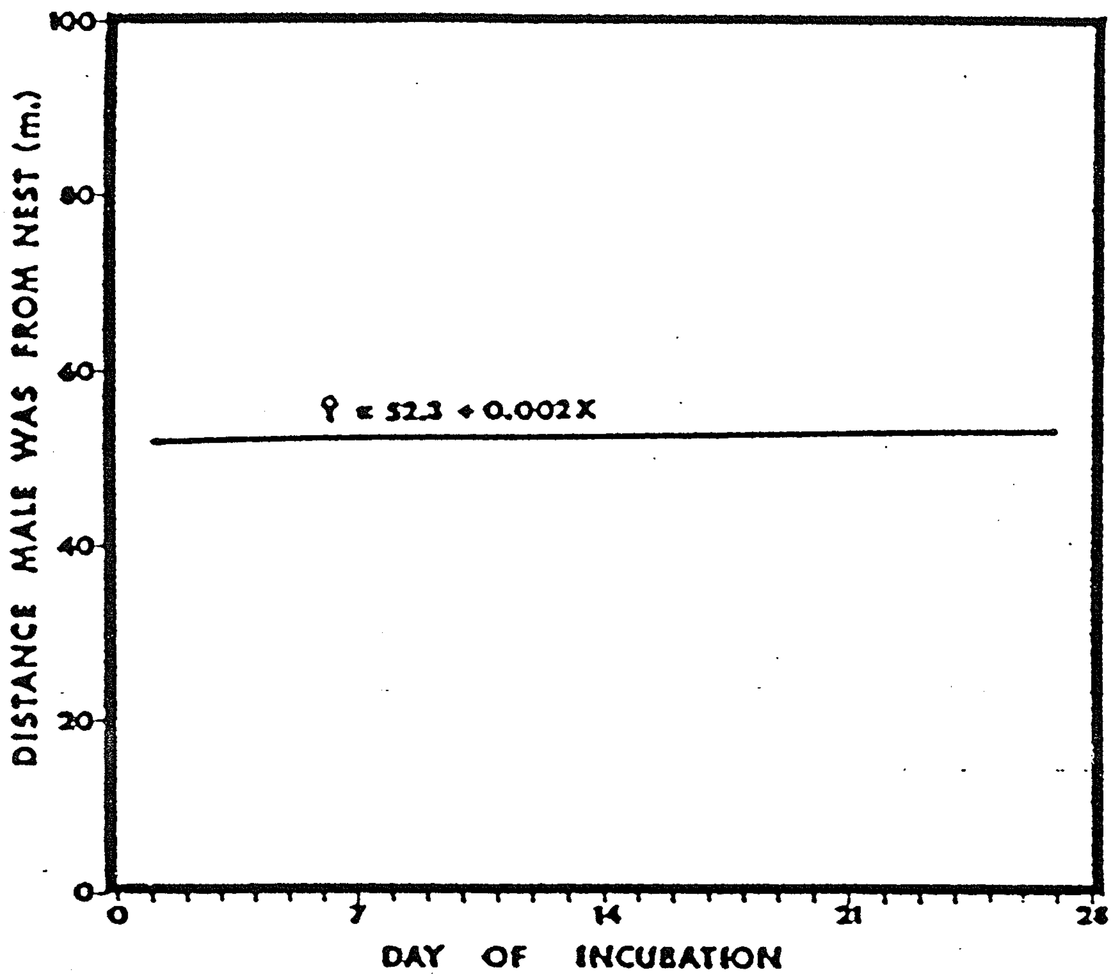
incubation, no evidence was found to support the contention that territory size declined as incubation progressed. In fact, it remained constant (Figure 4).

Owen and Wells (1979) examined territorial behavior of both wild and captive Barnacle geese (Branta leucopsis) at Slimbridge, Gloucestershire, between 1975 and 1978. They concluded that "territorial boundaries rarely changed once the female started to incubate" (p. 20). Territorial boundaries were mapped during repeat visits throughout the nesting period.

It appears that the initial research of Balham (1954) dealing with the behavior of Canada geese in Manitoba sparked subsequent research dealing with territory size changes (as discussed above and below) in breeding geese. Balham (1954) gathered data on 5 nesting pairs at Oak Point, Manitoba. The geese used by Balham (1954) were all 4 - 5 years of age and progeny of wild geese from Island Park, Portage la Prairie, Manitoba. Balham (1954) gave no indication of how many times a day he checked the nests nor how he measured the distance the gander was from the nest.

Balham reported that the sphere of influence (or size of territory) of a pair varied in three respects: (1) a slow change during the nesting period, (2) changes during incubation relief, and (3) brief fluctuations related to the level of the threshold of the fighting reaction. Balham

Figure 4. Relationship between the gander's distance from the nest and the female's day of incubation (Cooper, 1978).



Ŷ = 52.3 + 0.002X
DISTANCE MALE WAS FROM NEST (m.)
100
80
60
40
20
0
0
7
14
21
28
DAY OF INCUBATION

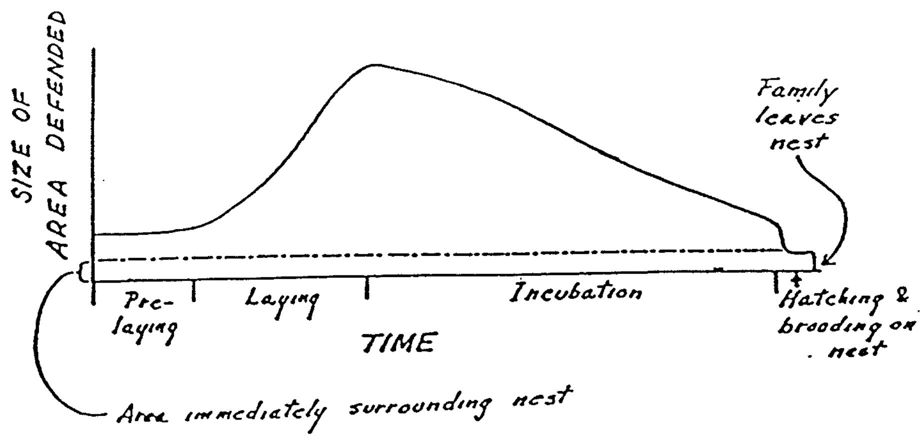
(1954) stated that the threshold of tolerance was lowered by recent conflicts and hence the area defended was increased.

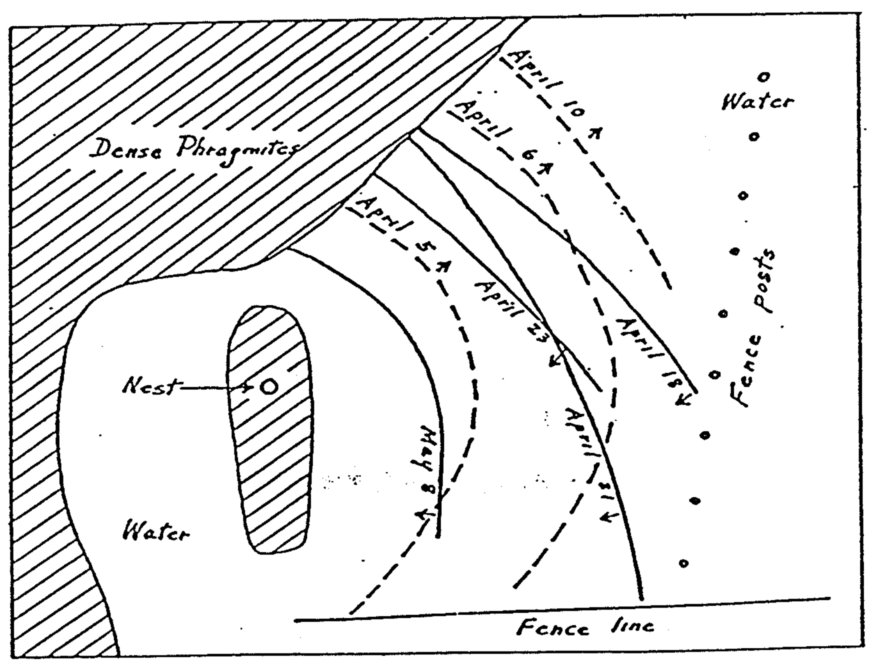
Balham (1954) reported that "it will be seen that a small area was defended prior to laying the first egg. Thereafter the area increased rapidly until incubation began. From then on, the territory gradually decreased until hatching time, when it encompassed only the nest mound. The territory ceased to exist after the young left the nest" (p. 118). Balham described an inverse relationship between the size of the territory and the intensity of the reaction of the defending pair to intruders, as well as a reduction in territory size during incubation (Figure 5).

Balham noted that associated with the reduction in size of the territory during incubation was a reduction in the number of waiting sites (or loafing sites) utilized by the defending gander. "As territory decreased in size, the waiting male took up stations closer and closer to the nest, it they were available. Under optimum conditions the males' station by the third week of incubation was close to, and in full view of the nest" (p. 120). Balham reported that if the female left the territory the male defended an area around her.

Observations by Brakhage (1965) concur with those of Balham (1954). Brakhage (1965) examined both captive and

Figure 5. Changes in the gander's territory during the nesting period. This figure demonstrates the gander's decreasing distance from the nest during the nesting period (Balham, 1954).


SIZE OF
AREA DEFENDED
Family
leaves
nest
Pre-
laying
Laying
Incubation
Hatching &
brooding on
nest
TIME
Area immediately surrounding nest


Dense Phragmites
Water
Nest
Water
April 10
April 6
April 5
April 23
April 18
April 21
May 8
Fence posts
Fence line

wild flocks of tub-nesting giant Canada geese at the Trimble Wildlife Area in Missouri over a three year period. He found that as "incubation progressed, the size of the nesting territory decreased and the female became less active in its defence" (p. 757). However, Brakhage did not refer to the methods he used to arrive at his conclusion, nor does he describe any statistical data he might have obtained.

Brakhage (1965) speculated that a timing mechanism existed which controlled the position of the gander with respect to the stage of the incubation period. "Ganders anticipated hatching and became attentive to their females. A day or so before hatch, they forsook their dry loafing sites and swam around the tub supports. This behavior was an almost infallible indicator of hatching time. The ganders appeared to have a timing mechanism coinciding with the incubation period" (p. 758). Brakhage reported that when hatching was overdue by one or two days (due to dead or infertile eggs), the ganders returned to their normal loafing sites. Thus, gosling peeping from inside the egg may not act as a stimulus or a timing mechanism for the gander. Brakhage does not allude to other possible stimuli that may explain the "timing mechanism" that controls the gander's distance from the nest.

Sherwood (1966) examined the behavior of giant Canada geese at the Seney National Wildlife Refuge in Michigan between 1962 and 1965. Sherwood (1966) witnessed the decline of the territory defended by the gander as the incubation period progressed. He reported that he could tell when the goslings began to hatch when the gander had moved to within a few feet of the nest. Sherwood postulated that the timing mechanism hypothesized by Brakhage (1965) is in fact an "innate timing mechanism". Sherwood observed a female incubating a clutch of sterile eggs and stated that the gander still moved to the nest site on the thirtieth day in anticipation of the hatch. Sherwood (1966) provides no empirical data to support his contention that territory decreased as the incubation period progressed or to support his postulation of an "innate timing mechanism".

Wormer (1968) also stated that toward the end of the female's incubation period, the parent birds stay close to their nests. As if aware of the coming event, the ganders become more attentive. Little evidence is provided by Brakhage or Sherwood, and none by Wormer, to support the postulation of a timing mechanism controlling the gander's behavior with respect to his distance from his nest.

Evidence for a decrease in territory size as the incubation period lengthens exists in other species of geese. Mickelson (1975) stated that once Cackling geese (Branta canadensis minima) selected a nest site, their territory size increased abruptly, reaching a peak during the egg laying period. Mickelson (1975) reported that for Brant geese (Branta bernicla) territory increased in size, reaching a peak when incubation first started. He added that for both species, territory size decreased as incubation proceeded until only the nest with its goslings was defended.

Stroud (1982) reported that with the Greenland White-fronted goose (Anser albifrons flavirostris) the male spent the duration of the incubation period about 300-500m from the nest but then moved to within 2m of the nest during the hours preceding the hatch. Stroud did not attempt a detailed examination of this phenomenon.

Purpose of Study.

Territorial shape and size in breeding geese is highly variable (Collias and Jahn, 1959; Ewaschuk and Boag, 1972; Mineau and Cooke, 1979). The literature indicates that the size of a gander's breeding territory may change as a function of the stage of the female's incubation period. Mineau and Cooke (1979) provided evidence that territory increased as incubation progressed. Cooper (1978), Ogilive (1978), and Ewaschuk and Boag (1972) contend that territory size remains constant throughout incubation. Balham (1954), Sherwood (1966), Wormer (1968), Mickelson (1975), and Stroud (1982) conclude that territory size decreases as a function of the female's incubation period. It may be concluded that no consensus has been arrived at with respect to potential changes in the size of the gander's territory. The purpose of this study was to examine if the gander's distance from his nest changes as a function of the female's stage of incubation.

Territory in breeding Canada geese involves the defense of an area of land or water surrounding the nest site. The area defended by the gander may fluctuate as a function of the female's stage of incubation. Knowledge of how the territory defended by the gander fluctuates would be of significant use to individuals or groups who manage Canada geese. For example, it would be important to know how much land is needed for each breeding pair of Canada geese in order to appropriately manage them.

Objective. The objective of this study was to determine whether the size of the gander's territory changes in relation to the female's incubation period. Data was collected from the beginning of the female's incubation period (defined as beginning the day after the last egg was laid) to the hatching of the first gosling. The independent variable was the stage of the female's incubation period (measured in days) while the dependent variable was the gander's distance from his nest (measured in meters).

Justification. A review of the literature revealed that no study has directly examined changes in the size of the gander's territory as a function of the female's incubation period. The reviewed studies which dealt with the changing size of the gander's territory was always part of a larger study which did not have as its primary objective an examination of potential changes in territory size. Some of the research simply gives "witnessed accounts" while some provide no empirical support whatsoever. This study will have as it's fundamental goal an empirical examination of the ganders territorial size shifts as a function of the female's incubation period.

Testable hypotheses. For the purposes of this study four testable hypotheses were evaluated. They were:

(1) the gander's territory would increase as a function of the female's incubation period.

(2) the gander's territory would decrease as a function of the female's incubation period.

(3) there would be no change in the size of the gander's territory as a function of the female's incubation period.

(4) the size of the ganders territory would fluctuate as the female's incubation period progressed.

Design. The design that was used to analyze the data collected in this study was a one-way analysis of variance with repeated measures over one factor (days).

Method

Subjects

Species used. The subjects observed and measured during this experiment were a captive flock of wild giant Canada geese (Branta canadensis maxima) residing at the Field Station of the Avian Behaviour Laboratory at Glenlea, Manitoba. Plastic neck collars numbered from 4 to 300 provided individual identification of all flock members. Initially, all neck collars were yellow. Green neck collars were later used to replace broken yellow neck collars. The numbers on the replaced green neck collars did not match the initial number on the broken yellow neck collar. Each flock member has a leg band on its right leg, around the tarsus bone. The right wing of each goose is pinioned. Information regarding the measurements of individual flock members in 1987 and the nesting history of the flock can be found in Appendix A and Appendix B. In

1987 the flock consisted of 38 males and 43 females, with a mean age of 6.85 years.

<u>History of the Avian Behaviour Laboratory's Goose Flock</u>. The initial flock of giant Canada geese consisted of eight geese brought from Bowling Green State University to the University of Manitoba by Dr. L. James Shapiro in 1971. This flock was previously part of the Kellogg Bird Sanctuary flock operated by Michigan State University. The birds were initially housed in the basement of the Duff Roblin building at the University of Manitoba and were later moved to the Fort Whyte Cement Plant for the winters of 1971 and 1972. During the winter of 1973, the flock resided at Island Park in Portage la Praire, Manitoba.

In 1974, the flock consisted of 22 birds. In an effort to increase the size of the flock, 109 goose eggs were obtained from the Canadian Wildlife Service from the Wascana Waterfowl Park in Regina, Saskatchewan, on 3 May 1975. Of the 109 eggs that were placed into incubators, 52 goslings were produced. The records indicate that in 1975 the flock consisted of 19 adult geese and 52 goslings.

The flock was moved from Island Park, Portage la Praire, to an unused Fur Farm that was located on the campus of the University of Manitoba. The flock of geese resided here during the winter from 1974 to 1977. The records indicate that in 1975 the flock consisted of 71 birds and in 1977 it consisted of 46 birds. In 1977 and 1978 the flock was divided into two portions for the summer months only. One portion was housed at the Charleswood Sewage Lagoon in Winnipeg, Manitoba, and the other portion was located at the Field Station of the Avian Behaviour Laboratory at Glenlea, Manitoba. The entire flock, however, was returned to the Fur Farm during the winter of 1977. In 1978 the entire flock consisted of 78 birds, 24 adults and 48 goslings obtained from Wascana. The entire flock was moved to the Field Station of the Avian Behaviour Laboratory on a permanent basis in the fall of 1978.

In 1978 a caboose was obtained and was permanently located at the Field Station. The caboose acts as a data collection center for researchers using the facility and is presently equipped to accommodate researchers year round. During the spring of 1979 the Red River flooded its banks and forced an emergency evacuation of the flock on April 18th. The flock, now numbering 95 birds, was moved from the Field Station to a safe location adjacent to the dairy barn compound at the Glenlea Agricultural Research Station. The flood resulted in the loss of 33 geese and the subsequent rebuilding of the field station.

In 1980 the flock consisted of 62 geese. In 1981 the records indicate that it had grown to 87 geese, with an average weight of 4.95 kg (10.89 lbs) per goose. In 1981, a rip-rap shore-line was constructed around the 0.33 hectare pond in the middle of the Field Station of the Avian Behaviour Laboratory.

In 1987, the goose flock consisted of 82 birds. Of these 82, 39 were known to be males, 42 were known to be females, and the sex of one goose was unknown (see Appendix A). Individual histories of the geese and nesting data pertaining to the years 1982 through 1988 can be found in Appendix B.

The Study area

Location. The Field Station of the Avian Behaviour Laboratory, maintained and operated by the Avian Behaviour Laboratory in the Department of Psychology at the University of Manitoba, was used as the study area for this project. The Field Station of the Avian Behaviour Laboratory is located 20 km south of the University of Manitoba and is situated on the grounds of the larger Glenlea Agricultural Research Station located at Glenlea, Manitoba, at latitude 49 39' North and longitude 97 07' West, at an elevation of 234 meters above sea level. The field station is situated within the Red River Valley portion of the Mississippi flyway.

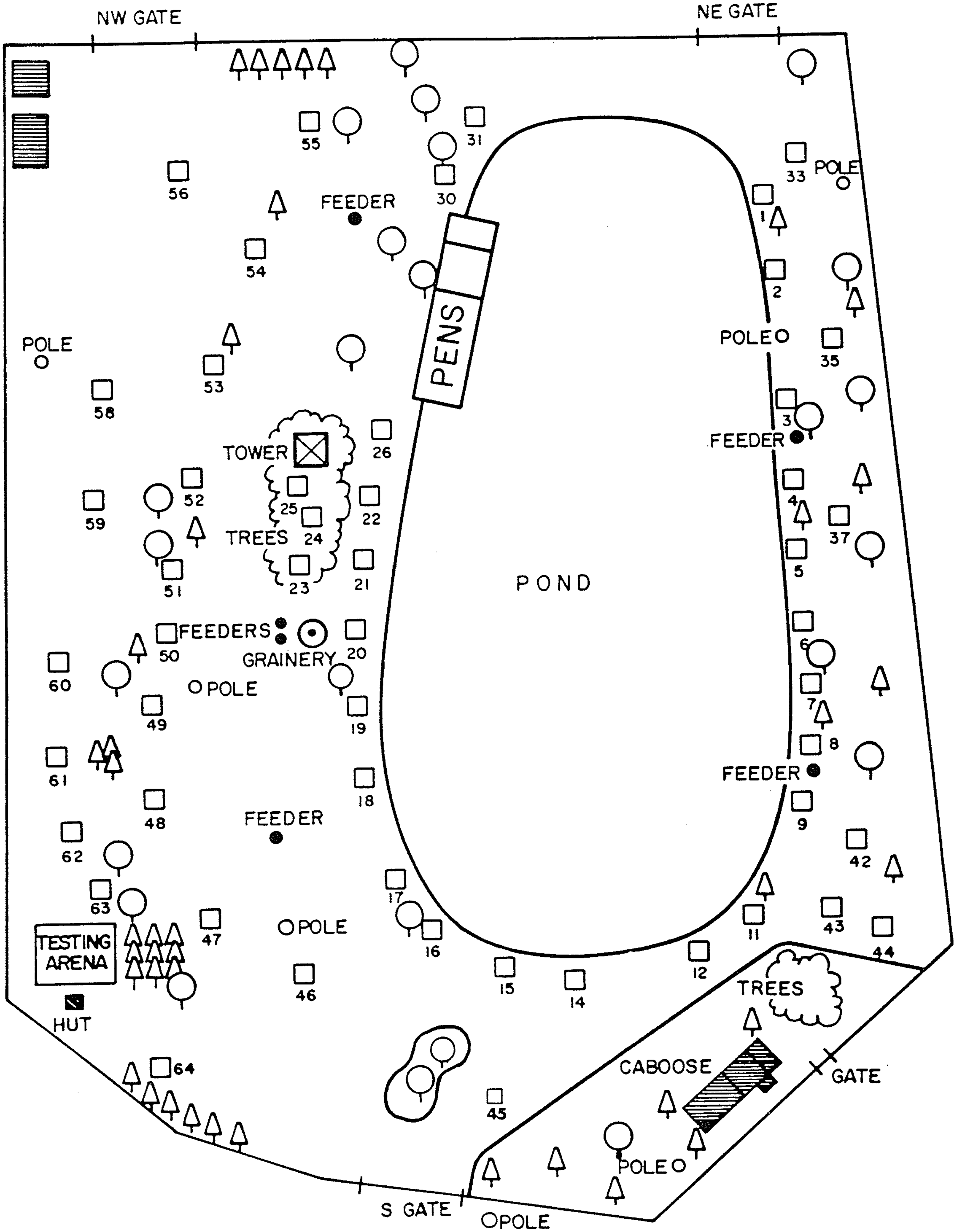
Predator-proof fence. The field station is home to a captive pinioned flock of giant Canada geese (*Branta canadensis maxima*) as well as a captive pinioned flock of mallard ducks (*Anas platyrhynchos platyrhynchos*). The area is enclosed by a 2 m high 5.08 cm chain-link fence that was erected in 1979-1980. Two strands of electric wire encircle the fence, 31 cm from the top and 57 cm from the bottom. The fence has three rows of barb-wire strung along the top of it and, at the bottom of the fence, smaller 2.54 cm wire mesh extends 60.96 cm out from the chain-link fence and then continues up it for 60.96 cm. The main objective of this fence is to contain the resident flocks and to protect them from predators. Predators at the field station include great-horned owls (*Bubo virginianus*), crows (*Corvus brachyrhynchos*), magpies (*Pica pica*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), fox (*Vulpes fulva*), woodchucks (*Marmota monax*), weasel (*Mustela erminea*), mink (*Mustela vison*), and muskrat (*Ondatra zibethica*). During this study, crows (*Corvus brachyrhynchos*) were observed foraging on the mallard duck eggs, and at least one mink (*Mustela vison*) killed several mallards.

A caboose, obtained in 1978, functions as a base of operations while researchers are at the field station. The enclosed portion of the field station is 1 hectare in area and contains a 0.33 hectare pond in the center. The birds can feed from one of six Model TF1 800 lb. turkey range feeders (Hurst Equipment Ltd., 75 Archibald Street, Winnipeg, Manitoba, R2J 0V7) which contain pelleted food along with various grains (i.e. oats, wheat, barley, corn, triticale). For the major portion of the year a developers ration in pellet form (15% protein) is provided. In mid-January, a breeders ration in pellet form, which contains an increase in the amount of protein (18% protein) which is needed by the geese for the breeding season, is gradually introduced into the diet of the geese. It is gradually introduced to prevent digestive disturbances that might occur from an abrupt change in diet. A 7.62 m high observation tower provides a clear view of the entire field station (see Figure 6 for a map of the field station).

During the winter months, an over-wintering facility was erected to provide shelter and open water for the goose flock. The over-wintering facility consisted of a modular wood hothouse covered with plastic. Electric stock tank heaters were hung from the roof of the hothouse in an open area of the pond. The electric stock tank heaters were available if they were needed to keep an area of water inside the hothouse open and free from ice. During the winter of 1987 the stock tank heaters were not used at all.

Nest sites. Three straw-bales were placed at each of 52 nest sites at the field station 11 March 1988. At this

Figure 6. Map of the Field Station of the Avian Behaviour Laboratory situated at Glenlea, Manitoba.


NW GATE
NE GATE
55
31
56
FEEDER
30
33
POLE
1
54
2
PENS
POLE
POLE
35
53
58
3
FEEDER
TOWER
26
4
52
25
22
37
59
TREES
24
5
23
21
POND
51
FEEDERS
50
GRAINERY
20
6
60
POLE
7
49
19
8
61
FEEDER
18
9
48
FEEDER
62
42
17
63
11
43
TESTING ARENA
47
POLE
16
44
12
46
15
14
TREES
HUT
CABOOSE
GATE
64
45
POLE
S GATE
POLE

time, the ground was still frozen. The straw bales were placed upon two wooden pallets (1.2m x 1.2m) that were stacked one on top of the other. The wooden pallets served as a base for the nest site and are left out year round. Ordinary roofing shingles were placed on top of the pallets to prevent the goose eggs from dropping through the slats of the wooden pallets. The straw-bales formed the actual nest site. These bales are usually put in place in mid-March and removed mid-June. The three straw-bales were placed at right angles to one another, on top of the wooden pallets. The open side of the nest site faced the pond. The straw-bales were tied to the pallets, and to each other, with binder-twine, to prevent nest site destruction (i.e., by the high winds in April). Straw nesting material were placed inside each nest site.

Apparatus

A 30 m measuring tape with a 2.54 cm nail attached to the end was used to measure a gander's distance from the nest. A map of the field station was used to plot each individual gander's postion with respect to his nest on each data collection day.

Procedure.

Data were collected from all nesting pairs. Only data collected from nesting pairs that successfully hatched one or more goslings was used in the data analysis. Data collected from nesting pairs that did not hatch a gosling or abandoned a clutch of eggs was not included in the data analysis.

Behavioral observations began the second week of March 1988. Data collection began as soon as a gander's female began laying eggs and data collection continued until the last mated pair hatched goslings. For each successful nesting pair, data was collected from the date the first egg was laid up until the family left the nest site. In general, 1987 nesting records indicated that April 1st is the approximate date by which the first goose egg can be expected at the Field Station of the Avian Behaviour Laboratory. The first goose egg was found March 30th, 1988. Wild geese returning from their southern wintering grounds were first sighted over the field station April 1st 1988.

Daily checks of all nest sites began the first day of April, 1988. Daily checks on individual nests terminated after the goose family left their nest with their goslings. Goose eggs were marked with a non-toxic "Flo-marker" (a felt marker designed for safe-use for children - washed off easily with water). The first egg was marked #1, the second marked #2, etc., The date on which an egg was laid was recorded. Daily checks provided information about which pairs had begun laying eggs and which females had begun incubating their clutches. Incubation began after a female laid her final egg. Incubated nests were characterized by a female sitting on warm eggs, a down lined nesting bowl, and a gander defending the nest site. Non-incubated nests were characterized by cold eggs left unattended by the female who remained in her gander's defended territory. Dropped eggs (i.e. not found in a nest site but on the ground) and abandoned clutchs were taken to the indoor facilities of the Avian Behaviour Laboratory on the main campus of the University of Manitoba where they were placed into incubators. One gosling from each successful nest was pinioned (right wing) and added to the goose flock. The remainder were sold to permit holders licensed by the Canadian Wildlife Service.

The ganders's distance from the nest was measured and plotted on a map of the field station during four daily data collection periods. Each day's data collection periods were randomly determined with the stipulation that consecutive data collection periods must be at least one hour apart. All data was collected during daylight hours. For each individual gander a single daily mean was calculated from the four data collection periods which represented a gander's distance from his nest on any given day.

During a data collection period, the experimenter would carefully record a gander's distance from his nest by using a 30 m measuring tape. In doing so, the experimenter did not displace a gander, i.e., observations on the gander's position were initially taken from a distance and the position of the gander was recorded. After the gander moved the experimenter approached the gander's previous location and measured the distance between that location and the gander's nest site.

A 2.54 cm nail was attached to the end of the measuring tape. The nail was placed into the ground on the spot where the gander had been located. The gander's distance from his nest was measured from the gander's previous location to the nearest point of the wooden pallet upon which sat the nest of the gander. If a gander was in his nest site, or on top of his nest site, the distance was recorded as zero.

During periods when the female was off the nest feeding or drinking the gander would accompany her, often to the other end of the field station. During these female off-the-nest-periods (see page 68 for definitions of 'off-the-nest-periods) the gander's distance from the nest was not recorded. Such data would not have reflected a gander's true distance from his nest. If a gander was not within his territory, i.e., he was feeding or bathing, his distance from his nest was not recorded. When female or gander off periods occurred, the daily mean was calculated from the three remaining data collection periods.

A number of cues were used as reference points to ensure that a gander's distance from his nest was accurately measured. Objects in the environment such as trees, rocks, poles, pens, and fences were used to plot the position of a gander. Frequently, a gander would leave a scrape or indentation in the ground were he had sat. In addition, footprints in the soil and fecal droppings also provided cues leading to an accurate measurement of a gander's position with respect to his nest. The use of colored stakes at pre-measured intervals placed around a gander's nest was considered. It was felt that colored stakes could be adopted as unnatural territory boundaries by a gander, affecting the gander's distance was from his nest.

The independent variable in this study was the stage of the female's incubation period. The dependent variable was the gander's distance from his nest site. No controls were used in this study. The use of control pairs was considered but rejected in favour of a larger anticipated sample size on which to collect experimental data.

Behavioral observations on individual flock members were recorded in a log book and indexed according to the nest site that the individual member had chosen. For example, behavioral observations on gander #4 were recorded under the nest site #11. A Minolta Model X-700 35mm camera was also used to record behaviors.

Results and Discussion

Nesting Phenology

Pre-Nesting Period. The pre-nesting period was defined as the period from the beginning of February, 1988, (flock disintegration - see below) to the end of March, 1988, (when the first egg was laid). Observations on the goose flock began the first week in January, 1988. Table 2 presents the climatological data collected during this study.

Canada geese are a gregarious species. The goose flock exhibited allelomemetic behavior (Scott, 1968), congregating outside the over-wintering facility on warm days and inside on cold days (warm and cold being subjective observations - no temperatures were recorded). While outside the hothouse, individual flock members maintained a resting position (Balham, 1954), sitting on the snow covered ice with their head tucked underneath one wing and their feet elevated to the side of their body, off the ice. This posture serves a thermoregulatory function.

During periods of warmer weather in late February and early March flock disintegration was observed with

Table 2. Climatological Data Recorded at the Glenlea Research Station from January through May, 1988.

Table 2

<u>Climatological Data Recorded at the Glenlea Research Station from January through May, 1988.</u>

Month	Temperature Extremes Maximum (C)	Minimum	Temperature Mean (C)	Precipitation (cm)
January	0.0	- 33.5	- 19.0 (-19.7)*	12.0 (25.6)
February	+ 6.5	- 33.0	- 16.5 (-16.4)	7.0 (27.3)
March	+ 11.5	- 18.0	- 5.0 (- 9.0)	25.3 (23.9)
April	+ 26.0	- 13.0	+ 5.3 (+ 3.4)	0.2 (37.4)
May	+ 34.5	- 7.0	+ 15.0 (+11.4)	43.2 (56.1)

* Figures in brackets represent Canadian Climate Norms for the prairie provinces from 1951-1980 (Environment Canada, 1981).

individual pairs inspecting potential nest sites. Canada geese remain in close physical contact over the winter (Raveling, 1969). In the spring the flock breaks into two groups. One flock consists of adult breeding pairs and their yearlings while the other flock is a mixed flock of potential breeders and single adults (Balham, 1954). The flock at the Field Station of the Avian Behaviour Laboratory disintegrated into two groups also, however, no yearlings were present in the 1987 flock because the previous year's goslings had been sold.

The over-wintering facility was disassembled and removed from the ice 12 March 1988. Fifty-two nest sites were prepared 11 March 1988. Adult pairs were observed selecting potential nesting sites 12 March 1988.

Nest building Behavior. On 30 April 1988, observations were made on a female goose (#19 neck collar) while she was constructing her nest. The female built her nest with no assistance from the gander (#168 leg band - no neck collar). Brakhage (1965) also reported that the male plays no role in nest building. Female #19 built her nest on the ground rather than in a provided nest site. The female build her nest in less than two hours, and had laid her first egg within one hour after nest completion. Nest construction consisted of alternating between two nest building behaviors: (1) gathering nesting material available within a

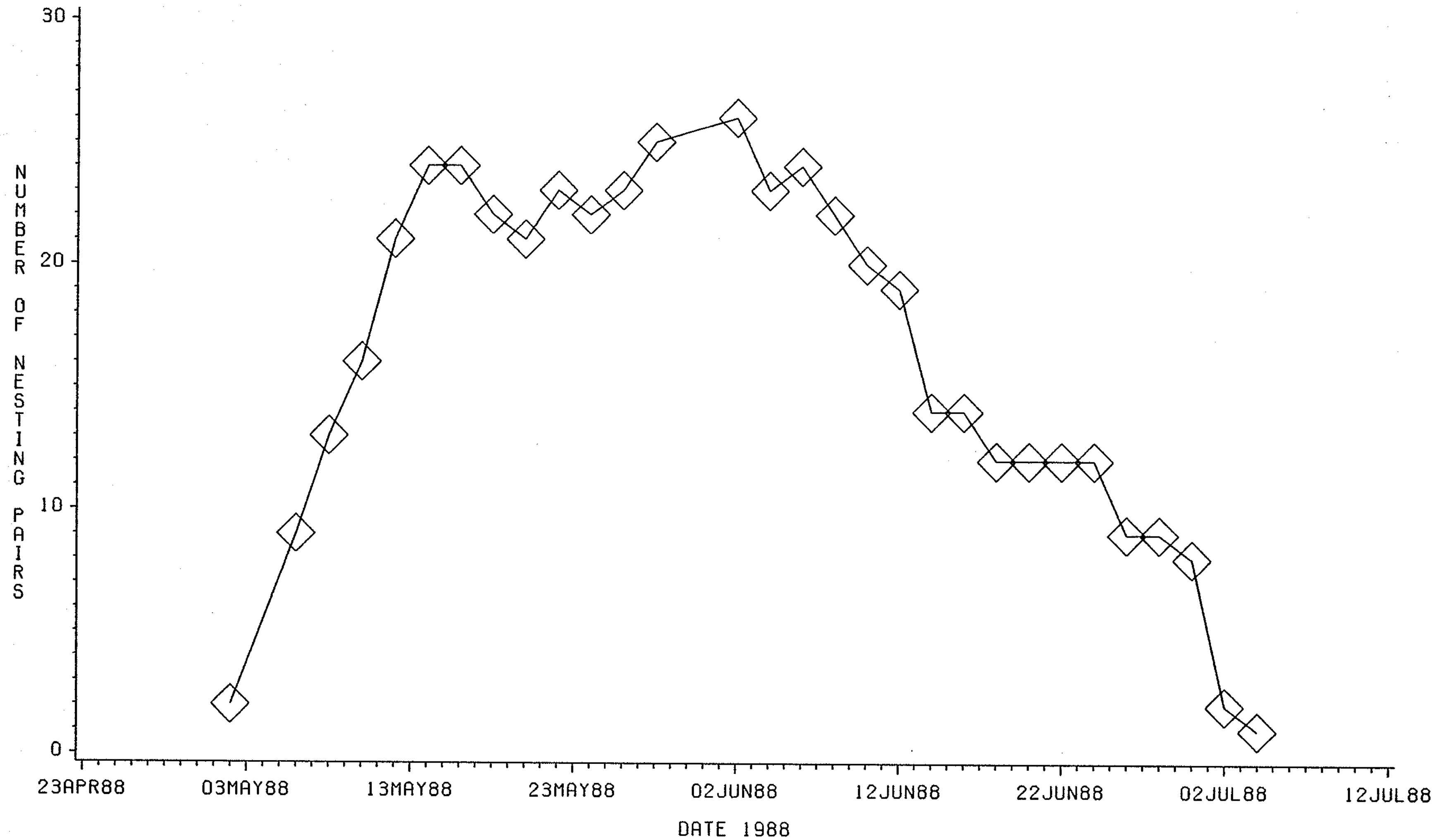
360 radius around the nest area and within her reach as she stood in the center of the nest and (2) formation of the nest bowl by sitting in the center of the nest and moving from side to side. Kossack (1950) referred to the formation of the nest bowl by side to side motions as "wallowing".

Nest Site Modifications. During very windy days (i.e., 1 May & 2 May, winds of 60 kph) nesting material was blown out of the nest sites. In response to these circumstances, one of two modifications were made to nest sites which contained a clutch: (1) a barrier of three to four rocks was piled up at the entrance to a nest site or (2) a rubber tire was placed inside the nest site with nesting material placed inside the tire. These modifications prevented eggs from rolling out of the nest and prevented nesting material from being blown out of the nest. Both modifications provided the added advantage of restraining the hatched goslings inside the nest while the remainder of the clutch hatched.

Nesting Period. The nesting period began as soon as the first Canada goose egg was laid. The first goose egg was laid March 30th, 1988, and marked the beginning of the 1988 nesting period. The last eggs (N=6) were laid 6 May 1988. Egg laying, therefore, occurred over a period of 38 days. Figure 7 plots the number of nesting pairs during the 1988 nesting period.

Figure 7. Number of Nesting Canada geese in 1988.

NUMBER OF NESTING CANADA GEESE – 1988



Nesting Attempts

A nesting attempt refers to a breeding pair that has laid at least one egg in a nest. During the egg-laying period 42 nesting attempts were made with seven nest sites being utilized more than once. Thirty-four of 52 available nest sites (65%) were used, while three additional nesting sites were created by nesting geese (see Appendix B). During the nesting period, 177 goose eggs were laid (see Table 3), of which four eggs were laid outside of a nest site and abandoned by the female (i.e., dropped). Another four eggs were laid by unmated females in unused nests.

Incubation

Welty and Baptista (1988) state that "the incubation period may be defined as the time interval between the laying of the first egg of a clutch and the hatching of the last egg (assuming that all eggs hatch)" (p. 350). The Welty and Baptista (1988) definition of incubation was used by this author. Only the Canada goose female incubates the clutch (Brakhage, 1965). The mean incubation period for the fifteen females observed in this study was 29.3 days. The longest incubation period (N=2) was 33 days in duration and the shortest was 24 days in duration. Various authors report different lengths of time for the female's incubation period. Dow (1943) reported incubation periods ranging

Table 3. Canada Goose Production Summary in 1988

Table 3

Canada Goose Production Summary in 1988

	Total	% of Total
Total Number of Eggs Laid :	177	
Breakdown		
Taken to University of Manitoba :	66	37 %
Hatched at the Field Station of the Avian Behaviour Laboratory :	49	28 %
Left on nest by successful pairs :	41	23 %
Broken during nesting period :	13	7 %
Dropped :	4	2 %
Laid by unmated females :	4	2 %
Eggs Left in Nest by Successful Pairs:	41	
Breakdown		
Died while pipping :	2	5 %
Died in shell late in development:	8	2 %
Decomposed contents :	30	73 %
Infertile :	1	2 %

from 28 to 33 days. Kossack (1950) reported 25 to 28 days, with a mean of 26 days, while Brakhage (1965) reported incubation periods of 28 days.

During daily data collection periods, females well into incubation usually remained on their clutch (also see Raveling & Lumsden, 1977). Females still laying eggs would evacuate their nest site but immediately return to their nest when the experimenter left their nesting territory. Females covered their eggs (also see Brakhage, 1965) when leaving their nest for off-the-nest-periods. Skutch (1962) refers to off-periods as a "recess". Brakhage (1965) reports that the female leaves the nest twice daily for an average of 15 min., usually during the first and last two hours of daylight ('off-periods' will be used to describe this behavior). During cold days (-20 C and below) some females buried their eggs well into the nesting material. During pipping, females kept the pipped area of the shell to the bottom of the nest (see Kossack, 1950).

Hatching

Fifteen pairs of giant Canada geese were successful in hatching out at least one gosling. Successful pairs laid 85 eggs with a mean clutch size of 5.6 eggs and a range of 4 to 8 eggs per clutch. Successful pairs hatched out a total of 45 goslings with a mean of 3.0 goslings per nest and a range of one to six goslings per nest. The hatch rate of successful pairs of geese was 52.9 percent. Klopman (1958) stated that "hatchability of Canada goose eggs in the wild usually approaches 90%" (p.181). Table 4 summarizes various hatch rates found in similar studies.

The reason for the relatively low hatch rate for this flock during the 1988 nesting season is not known. The low hatch rate for 1988 may have been due to the high winds experienced in the first week of May which may have disrupted the female's incubation. The low hatch rate may have been the result of the drought conditions that occurred during the spring and summer of 1988 (see Table 2). The low hatch rate may have also been the result of eggs being laid early in April. These eggs were subject to freezing when not incubated by a female. Table 5 summarizes the various hatch rates of the Avian Behaviour Laboratory's Canada goose flock from 1982 to 1988. Table 5 indicates that the hatch rate of successful pairs in this flock has decreased between 1982 and 1988.

Nest Desertion. Of the 42 nesting attempts, 15 attempts were abandoned at various stages of egg laying, resulting in a 35% desertion rate. Eggs from abandoned nests were taken to the Avian Behaviour Laboratory on the Fort Gary Campus of the University of Manitoba where an

Table 4. Hatchability of Canada Goose Eggs
as Reported in the Literature

Table 4.
Hatchability of Canada Goose Eggs

as Reported in the Literature.

Study	Clutch Size	Hatchability
Brakhage (1965)	5.50	-
Dow (1943)	5.09	60.0 %
Hanson & Eberhardt (1971)	5.50	88.7 %
Klopman (1958)		
1954	5.00	95.0 %
1955	5.20	97.0 %
Kossack (1950)		
1945	4.60	60.0 %
1946	5.30	77.0 %
Naylor (1953)	-	79.3 %
Raveling & Lumsden (1977)		
1967	4.37	85.0 %
1968	4.73	78.0 %
1969	4.51	79.0 %
Sherwood (1966)	-	95.0 %
Steel, Dalke, & Bezean (1957)	4.6-5.2	86-88 %
This Study (1988)	5.6	52.9 %

Note: Years not in brackets represent the years in which the author(s) collected their reported data.

Table 5. Hatch Rate History of Successful Pairs of the Avian Behaviour Laboratory Goose Flock from 1982 through 1988.

Table 5.

Hatch Rate History of Successful Pairs of the Avian Behaviour Laboratory Goose Flock 1982 through 1988.

Year	Number of Successful Pairs	Number of Eggs Laid	Number of Goslings	Hatch Rate
1988	15	85	45	52.9 %
1987	10	61	39	63.9 %
1986	14	81	44	54.3 %
1985	16	86	60	69.7 %
1984	17	102	75	73.5 %
1983	16	85	69	81.1 %
1982	10	54	39	72.2 %

attempt was made to continue their incubation. Three nests were classified as abandoned after the incubating female died (autopsy's indicated death due to viral infections). In each case the male continued to protect the nesting territory for several days after the death of his mate. Williams and Marshall (1937) reported a 4% desertion rate, Dow (1943) reported a 6.5% (1939) and a 7.3% (1940) desertion rate, while Steel, Dalke, and Bezean (1957) reported a 15% desertion rate and Naylor (1953) reported a 23.9% desertion rate.

Polygamy. Canada geese are generally monogamous. Polygamy has been reported in captive or semi-tame flocks (Kossack, 1950; Balham, 1954; Collias and Jahn, 1959; Brakhage, 1965) and in free flying geese (Fabricius and Boyd, 1985). Raveling (1969) reports that in the majority of cases, the sex ratio is one male to two females, with the male attending to one dominant female (Brakhage, 1965).

One case of polygamy was observed during the course of this study. It resulted in a female abandoning a clutch of eight eggs. Initially, one male (#102) protected two different nest sites containing two separate females (neck collars #275 and #282). The initial result was that the male defended a very large territory that encompassed the nest sites of two different females. The first female (#282) laid eight eggs in nest site 59 and subsequently abandoned her clutch April 14th, 1988. The second female (#275) laid her first egg April 10, in nest site #51 (see Figure 6 for nest site location). As a result of female #282 abandoning her clutch, male #102 shifted his territorial boundaries in the direction of female #275's nest site, who had also abandoned her eggs. However, female #275 remained within the nesting territory surrounding her nest, and was defended by gander #102. Female #275 and male #102 remained within this nesting territory for the remainder of the nesting season. In this case, female #275 was the "dominant female". Female #282 spent the rest of the 1988 nesting season as a single goose and did not initiate another clutch.

The present researcher has observed other cases of polygamy in this flock during the 1986 and 1987 nesting seasons. In 1987, the sex-ratio of the goose flock was 39 males to 42 females (see Appendix A). This slightly skewed ratio may explain the presence of polygamous relationships within this breeding colony.

Nesting Density. The Field Station of the Avian Behaviour Laboratory is one hectare in area, with a 0.33 hectare pond in the center portion, leaving 0.67 hectares available for nesting Canada geese. Reports of nesting densities differ across authors. Johnson (1947) stated that at the Seney National Wildlife Refuge in Michigan, nesting birds cannot be crowded, and should be limited to one nesting pair per each 0.2 ha of nesting territory. Hanson and Smith (1950) reported one nesting pair per lake, however, they do not specify the size of the lakes. Janson and Nelson (1948) reported 54 nests per 0.4 ha, on small islands in an irrigation reservoir in Southeastern Idaho, while Naylor (1953) reported 31 nests on 0.2 ha. Klopman (1958), at Dog Lake, Manitoba, stated that "each breeding unit may evolve a pair distance that is specific to the colony" (p. 175). Balham (1954) also stated that "the fact geese tolerate crowding in some cases and not in others may be due to racial differences" (p. 117).

In the present study, the distance from a successful nest to the next closest successful nest represented the nearest nesting neighbour distance. The mean distance to the nearest nesting neighbour was 15.35 m (measured from the center of the nest) with the closest successful nesting pairs being 10.52 m apart and the farthest 20.05 m apart (SD = 3.20). Unsuccessful nests averaged 16.87 m apart (SD = 5.03).

Distance of Nests From Water. The mean distance that each successful nest was from water was 15.44 m, the shortest distance was 5.59 m and the greatest distance from water was 44.95 m (SD = 11.57). Unsuccessful nests (defined as nest sites that had eggs laid in them but did not hatch) averaged 24.12 m from water (SD = 14.33). Kossack (1950) found that breeding Canada geese under refuge conditions were between 0.76 cm and 31 m from water, with the majority being within 2.13 m from water. Klopman (1958) reported that 12 of 104 nests were more than 36.4 m from water and 13 nests were within 18.2 m of water. Dow (1943) reported that 90% of all nests were surrounded by water or within 9.41 m of water.

Klopman (1958) states that nest sites near water provide better visability for the gander and a quick escape route and an immediate food source for the goslings. Williams and Marshall (1937) concluded that it is "difficult to evaluate the real significance of nearest to water . . . because of the complex interrelationships of environment factors in general" (p. 84). This author agrees that it was difficult to determine the significance of the distance each nest site was from water.

Distance From the Nest. Data collection began mid-April and continued through the first week in June. Data were collected upon all nesting pairs. Fifteen nesting pairs were classified as successful (by hatching out at least one gosling) and were included in the data analysis. The first successful nesting pair hatched their first gosling on May 10th, while the fifteenth pair hatched out their clutch June 1st. Table 6 contains data collected from the successful nesting pairs during the 1988 nesting season.

The data were analyzed using a one-way analysis of variance with repeated measures over days. For statistical purposes, only data collected from the last 24 days of incubation was included in the data analysis. This procedure was followed so that an equal number of observations was obtained on each of 24 days. Data collected from the last 24 days of the females' incubation period included the day of gosling hatch. Day 0 represented the day that the first gosling hatched. The days of incubation prior to hatch were referred to as 'days prior to hatch'. Hence, one day prior to hatch was represented by -1.

A significant main effect was obtained for the ganders' distance from the nest, $\underline{F}$ (23,322) = 2.88, $\underline{p} < 0.001$. The mean distance from the nest over 24 days was 5.11 m, ranging from 1.95 m to 6.28 meters (see Figure 8). With the exception of the Day 0 mean (1.95 m), the means between Day -23 and Day -1 indicated a very restricted range within which the ganders' distance from the nest varies. Table 7 provides the mean distance (and range) for fifteen ganders' distance from the nest over the 24 days of data collection and the standard deviation for each day. Post-hoc comparisons using the Tukey's studentized range test (HSD) on all main effect means indicated that the mean of Day 0

Table 6. Data Collected From Successful Nesting Pairs

Table 6

Data Collected From Successful Nesting Pairs

Pair #'s Male	Female	Hatch Date	E/G	Incub (days)	GMD (m)	NN (m)	DP (m)
185	295	May 10	6/5	30	3.30	10.52	6.49
Wild	104	May 12	8/1	27	2.98	10.52	6.07
231	46	May 11	8/5	31	6.23	18.68	5.78
10	120	May 13	5/1	31	7.69	17.10	24.85
195	186	May 14	5/3	29	4.25	12.42	7.30
173	206	May 15	6/5	30	1.71	17.10	7.75
286	296	May 16	6/1	29	8.01	15.15	20.46
291	109	May 17	4/1	33	1.80	13.05	26.94
4	223	May 19	4/3	32	6.05	16.00	5.59
192	197	May 24	8/6	24	2.60	18.53	44.95
31	248	May 25	5/1	29	9.76	16.00	18.00
285	27	May 25	5/4	28	3.52	19.72	8.26
14	277	May 29	5/1	33	6.19	13.05	26.94
17	6	May 31	5/3	26	8.69	20.05	16.05
210G	254	June 1	5/5	27	5.11	12.42	6.18

Key:
- Pairs : Number represents neck collar number
- E/G : Eggs laid/goslings hatched
- Incub : Length of female's incubation period
- GMD : Gander's mean distance from the nest over female's incubation period.
- NN : Distance to nearest neighbour from nest
- DP : Distance to pond's edge from nest

differed significantly ($p > .05$) from all of the other 23 day means. There were no other statistically significant comparisons.

The Huynh-Feldt Epsilon test, which measures sequential effects of the independent variable, was 0.5520. The value of the Huynh-Feldt Epsilon test should be over 0.75, indicating independence between days. The type III sums of squares (error term) was very large, indicating the potential presence of an outlier within the data.

The Dixon criterion (a small sample ($n < 25$) test for outliers) indicated that the Day 0 mean (1.95 m) was an outlier. However, the Day 0 mean was not an outlier due to an error, but a meaningful outlier in terms of the collected data.

The data were then investigated further to find the significance of the Day 0 mean. A one-way analysis of variance with repeated measures over days with the mean of Day 0 (day of gosling hatch) removed from the data set was used to analyze the data. The results indicated no significant main effect, $F(22, 308) = 0.94$, $p > 0.05$. The results indicated that most of the variabilty within the data, which resulted in a significant overall F ($F = 2.88$, $p < 0.001$) with the Day 0 mean included in the analysis, can be attributed to the Day 0 mean. When the Day 0 mean is removed from the analysis, the one-way analysis of variance becomes non-significant. The mean distance from the nest over 23 days became 5.24 m, ranging from 4.40 m to 6.28 meters. All of the 23 mean distances (excluding Day 0) from the nest are within or less than 1.88 m of each other, indicating a very restricted range of means.

These results indicate that with the mean of Day 0 included in the analysis, there is a significant ($p < 0.0001$) main effect. When the mean of Day 0 is removed from the analysis, there is no main effect. The removal of the mean of Day 0 also results in a narrower range of values (4.32 m to 6.45 m vs. 1.97 m to 6.54 m).

The full set of data were subsequently analyzed using a regression analysis. The data indicated no significant ($F(1,22) = 1.83$, $p < 0.189$) relationship between the ganders' distance from the nest and the female's incubation period when using the full model ($Y = 4.73 - 0.032X$). Figure 9 represents the regression line for the full model. The coefficient of determination (i.e., r) was 0.03.

The data was further analyzed using simple regression procedures with the mean of Day 0 removed from the data set. The results indicated a non significant ($F(1, 21) = 0.003$, $p < 0.9546$) slope of the regression line, under the restricted model ($Y = 5.25 + 0.0008X$). The coefficient of determination was 0.0002 (see Figure 10). The coefficient of determination measures how much variation in the dependent variable can be accounted for by the independent variable. The removal of the mean of Day 0 in the regression analysis resulted in a change in the slope of the regression line from slightly negative under the full model (- 0.032) to slightly positive (+ 0.0008) under the restricted model.

The regression line (full model) indicated that the ganders' distance from their nest 23 days prior to gosling hatch varied randomly around the mean distance, except on day 0 (day of gosling hatch) where it significantly differed from the mean and was classified as a meaningful outlier. For the twenty-three days prior to gosling hatch the ganders' distance from their nest randomly varies between 4.40 m and 6.28 m. On the day of gosling hatch (Day 0) the mean distance from the nest is significantly reduced to 1.95 meters. These data indicate that the gander significantly decreased his distance from his nest as a function of the first gosling to hatch, as shown in Figure 8.

The distance a gander was from his nest did not decline gradually (Balham, 1954; Brakhage, 1965; Mickelson, 1975; Sherwood, 1966; Stroud, 1982; Wormer, 1968) or increase (Mineau and Cooke, 1979) as a function of the female's incubation period. Rather, it remained constant until the

Figure 8. Plot of Gander's mean distance from his nest. Day 0 indicates day of gosling hatch.

GANDER'S MEAN DISTANCE FROM HIS NEST

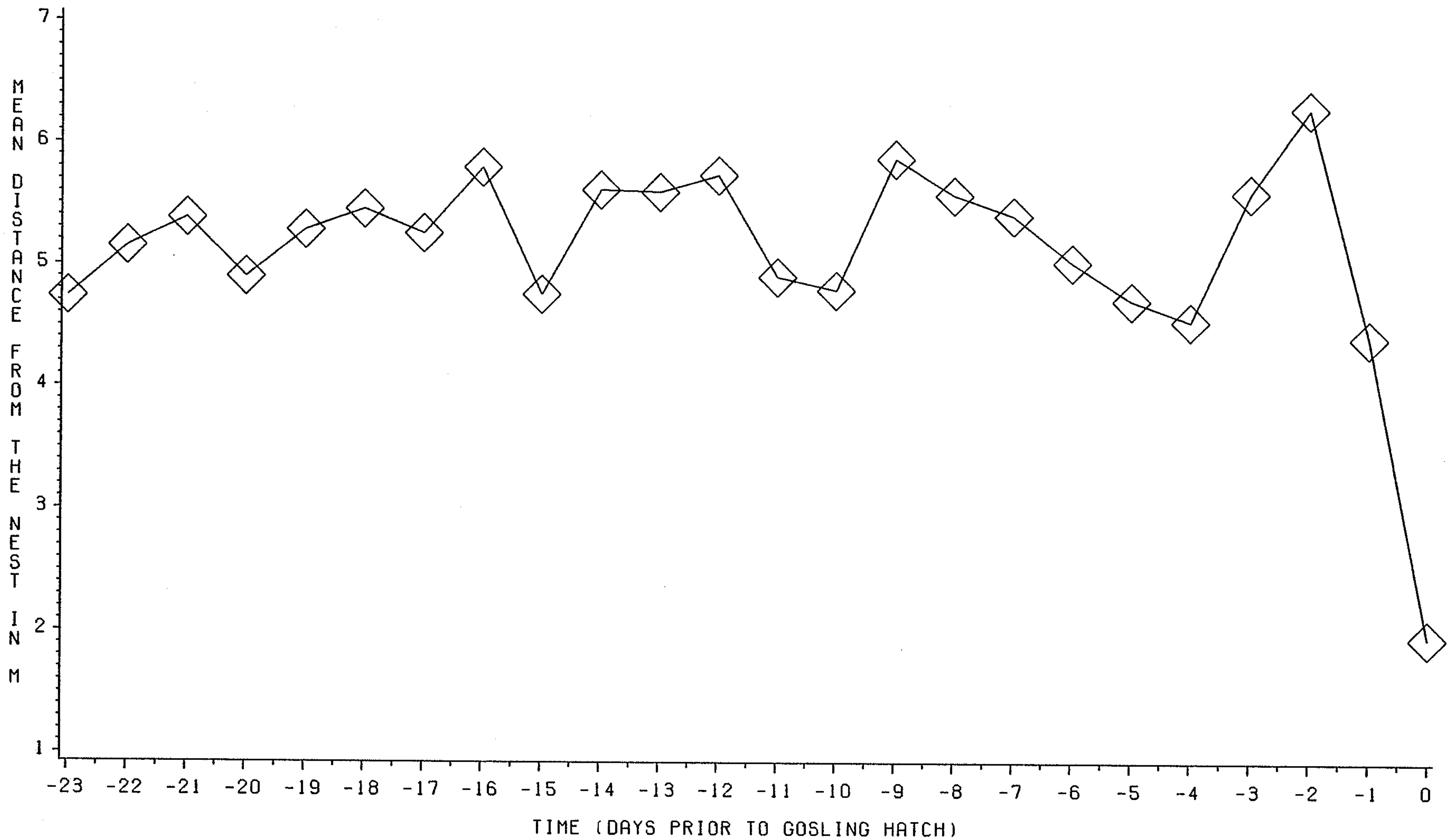


Table 7. Data for Fifteen Ganders' Mean Distance From the Nest During the Female's Incubation Period.

Table 7

Data for Fifteen Ganders' Mean Distance From the Nest During the Female's Incubation Period.

Days Prior to Hatch	Mean Distance	Range (m) Minimum	Range (m) Maximum	Standard Deviation
(hatch) 0	1.95 m	0.00	9.10	2.52
-1	4.40 m	0.00	10.45	3.85
-2	6.28 m	0.78	14.10	3.98
-3	5.62 m	1.34	11.01	2.60
-4	4.54 m	0.07	9.14	3.08
-5	4.71 m	0.15	9.11	2.48
-6	5.02 m	1.72	10.67	2.69
-7	5.40 m	0.30	11.11	3.07
-8	5.57 m	0.16	14.15	3.72
-9	5.87 m	0.75	12.33	3.43
-10	5.46 m	2.17	12.92	3.06
-11	4.90 m	0.00	11.69	3.43
-12	5.73 m	0.72	16.54	4.16
-13	5.59 m	0.73	11.01	3.43
-14	5.61 m	0.00	10.71	3.29
-15	5.42 m	0.31	11.40	3.18
-16	5.79 m	0.22	11.08	3.41
-17	5.25 m	0.38	11.73	3.57
-18	5.45 m	0.00	11.11	3.19
-19	5.28 m	0.00	10.34	3.30
-20	4.87 m	0.00	12.06	3.36
-21	5.38 m	0.00	11.05	3.33
-22	5.15 m	0.00	12.53	3.43
-23	4.74 m	0.26	9.82	2.86

Figure 9. Fitted regression line for Ganders mean distance from the nest. Full Model ($Y = 4.73 - 0.032X$) with 95% confidence limits.

REGRESSION LINE FOR 15 GANDERS

95% CONFIDENCE LIMITS–FULL MODEL

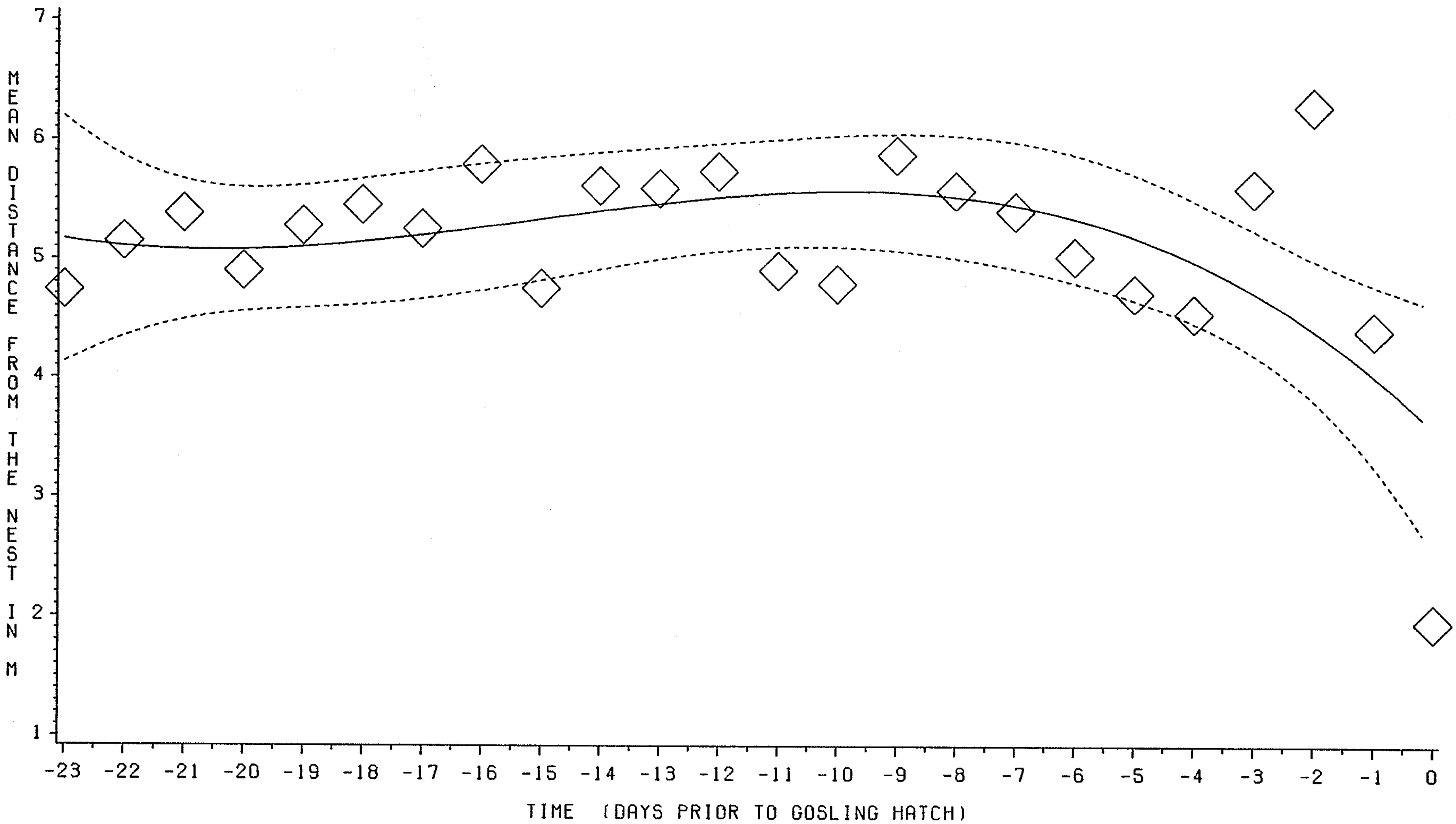
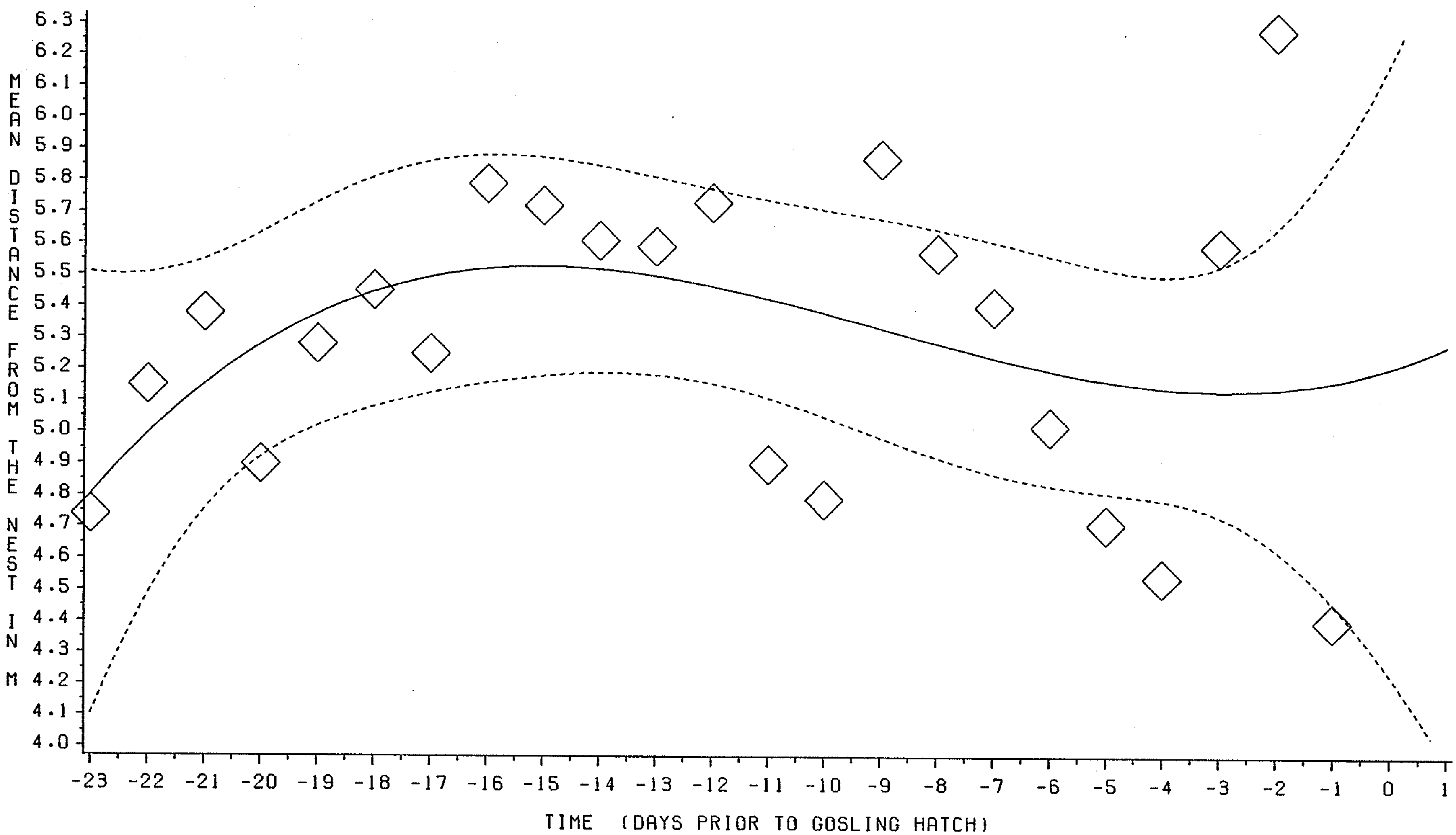


Figure 10. Fitted regression line for Ganders mean distance from the nest. Restricted Model ($Y = 5.25 + 0.0008X$) with 95% confidence limits.

REGRESSION LINE FOR 15 GANDERS

95% CONFIDENCE LIMITS–RESTRICTED MODEL



time of hatching when it decreased to within 1.97 m of the gander's nest site. The distance a gander was from his nest did not remain constant during the female's entire incubation period (Cooper, 1978; Ewaschuk and Boag, 1972; Ogilive, 1978; Owens and Wells, 1979). The ganders' did not decrease their distance from their nest until at least one gosling had hatched. This decrease was related to the time of gosling hatching, and not to gosling pipping. Peeping of goslings can be heard in the shell 48 to 60 hours before hatching, with the gosling taking 6 to 24 hours to emerge from the egg once pipping had begun (Kossack, 1950). Other authors report that 24 hours are required for the clutch to hatch (Brakhage, 1965; Collias and Jahn, 1959; Kossack, 1950; MacInnes, 1962). The data indicate that the gander's distance from his nest did not diminish during the gosling's pipping period.

Balham (1954) reported that the area the gander defended increased rapidly until incubation and then gradually decreased until hatching when it encompassed only the nest (as shown in Figure 5). The results of the present study do not support Balham's (1954) conclusions.

Brakhage (1965) reported that the size of the nesting territory decreased as incubation progressed. However, Brakhage provided elevated wash tubs to be used as nest sites and, furthermore, provided logs to be used as artificial loafing sites for the ganders. The positioning of the artificial loafing sites may have resulted in the reduction of the ganders' territory. Brakhage (1965) stated that "a day or so before the eggs were to hatch, they (gander's) forsook their dry loafing sites and swam around the tub supports" (p. 762). Brakhage postulated an "innate timing mechanism coinciding with the incubation period" (p. 762). The results of this study do not lend support to Brakage's (1965) position for the ganders' did not decrease their distance from the nest until at least one gosling had hatched. Evidence to support the idea of an "innate timing mechanism coinciding with the incubation period" was not obtained in this study.

In a similar study, Cooper (1978) concluded that the territory size of the gander remained constant (see Figure 4). Cooper (1978) based his conclusions on a very large sample size (N=611) and plotted the gander's distance from his nest during a 28 day female incubation period. Cooper's results indicate that for 611 ganders, the incubation period of each of their 611 females was 28 days. The results of the present study indicate a mean incubation period of 29.3 days, ranging from 24 days to 33 days of incubation. Other authors report incubation periods ranging from 25 days to 33 days (see pp. 65-68 of this study).

This information leads one to question the validity of Cooper's (1978) results. Specifically, one has to question how Cooper (1978) obtained 611 female Canada geese who all incubated for 28 days. Cooper states, within the same article, that he measured the incubation period for 34 nests, reporting that "23 completed hatching in 27 days, 8 in 28, and 3 in 26 days" (p. 51). Cooper (1978) also states that he estimated the time of laying of the last egg. It seems highly improbable that Cooper (1978) obtained 611 female Canada geese which all incubated for exactly 28 days. The fact that Cooper himself reports, within the same article, incubation periods between 26 and 28 days leads one to question the validly of his results.

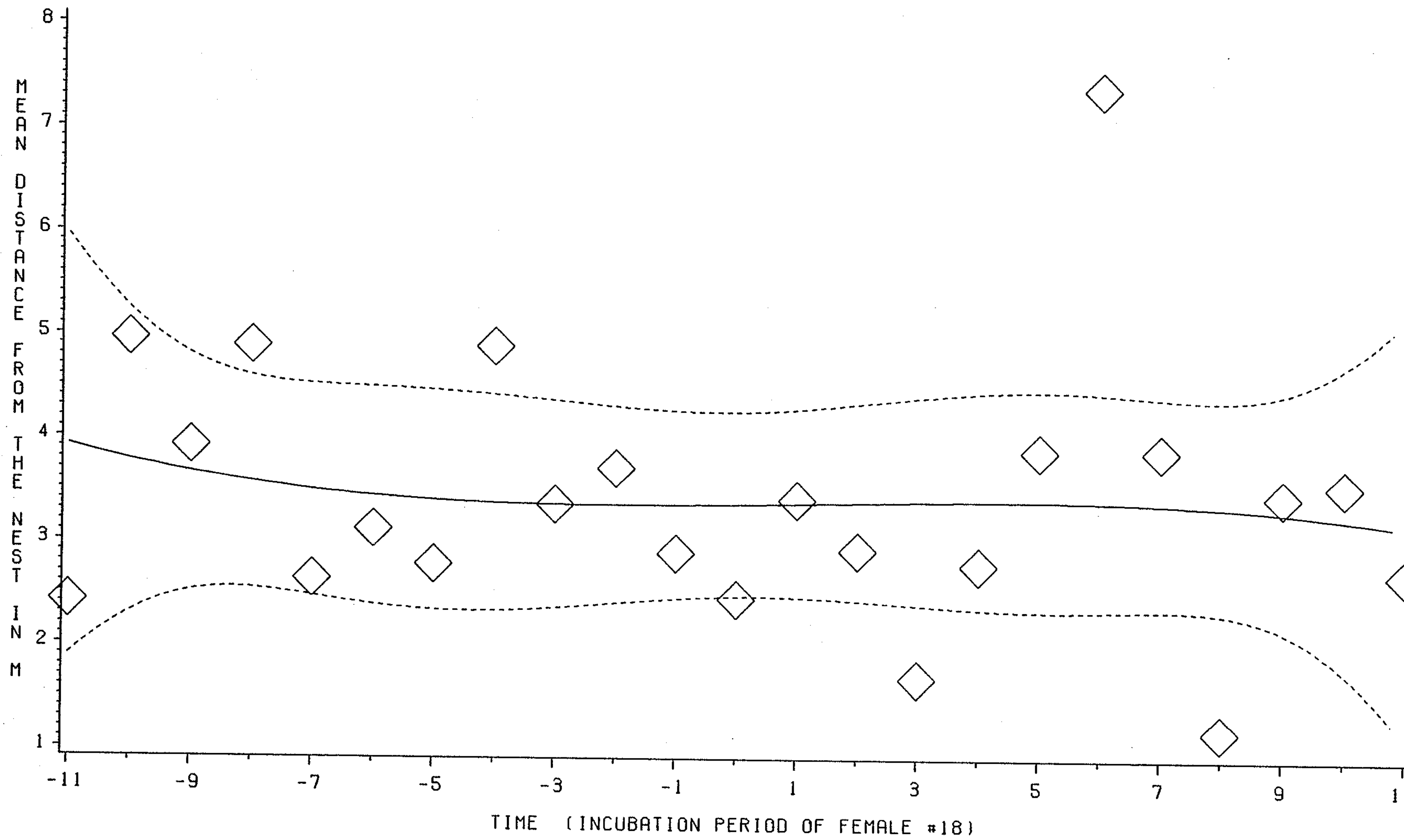
It is hypothesized that the goslings provide the stimulus which causes the gander to decrease his distance from his nest. The goslings may provide a "timing mechanism" for the gander who reacts by reducing his distance from his nest site. The ganders' distance from the nest decreased as the goslings hatched, not prior to their hatching, and failed to occur when the female's clutch was overdue (i.e., did not hatch on day 28 of incubation). Ganders' associated with females who remained on the clutch weeks after the expected hatching date did not reduce their distance from the nest. For example, female #18 (neck collar) who is the mate of male #152g (green neck collar) incubated her eggs several days after the expected hatch date. Figure 11 demonstrates that male #152g did not reduce the size of his territory on or near the expected day of gosling hatch. A regression analysis indicated that the distance gander #152 was from his nest remained constant 11 days prior to and 11 days after the expected gosling hatch date ($F_{(1,21)} = 0.23$, $p < 0.6383$). The regression model was $Y = 3.42 - 0.01X$. These results do not lend support to the suggestion of an "innate timing mechanism" controlling a gander's distance from his nest.

The results of the present study indicate that some sort of stimulus is needed before the gander will decrease his distance from the nest. Presumably, the biological significance of this reduction in territory size is that it would bring the gander closer to the nest, enabling the gander to provide better protection for the incubating female and the hatching goslings. Secondly, with the gander closer to the nest, the family unit would be together in anticipation of nest exodus. During gosling hatching, the vocalizations of the newly hatched goslings increase the vocal output emanating from the nest. Hence, the nest becomes more perceptible to potential predators. The immediate physical presence of the gander allows for an increased level of nest/gosling defence.

Figure 11. Gander #152's mean distance from his nest. Figure demonstrates no reduction in territory size when eggs of female #18 did not hatch.

GANDER #152'S MEAN DISTANCE FROM HIS NEST

95% CONFIDENCE INTERVALS



<u>Sentry Positions</u>. Each nesting gander occupied one or more sentry positions or guard posts during the female's incubation period. Balham (1954) referred to loafing sites of the gander as "waiting sites" and, as the territory decreased, the waiting gander took up waiting sites that were closer and closer to the nest. Brakhage (1965) reported that at the Trimble Wildlife Area every nesting territory included waiting sites or sentry positions.

Sentry positions were always on land. A sentry position was a preferred location within the gander's territory from which the gander initiated territorial defense. Preferred positions were evident by the accumulation of gander fecal matter at that position. Sentry positions were not random positions within the gander's territory, but strategic points within this area. In general, the locations of the sentry postions were between the incubating female or nest site and the nearest neighbour's sentry position.

Sentry positions were influenced by climatological conditions and topographical factors. For example, on hot sunny days many gander's moved their sentry positions under trees or behind nest sites in an effort to reach shaded areas away from the sun. Under these conditions, a sentry position took on a thermoregulatory function.

Sentry postions also changed as a result of nest exodus or nest abandonment of the nearest pair. Such a situation usually resulted in the gander moving towards the previously occupied territory. Minor changes (less than 2 m) in sentry positions occurred as the result of aggressive encounters or threats between neighbouring ganders. These changes resulted in small deviations around the preferred sentry position. Balham (1954) reported similar observations.

The sentry position moved within 2 m of the nest site during hatching. Some ganders moved their sentry position to the top of the straw bales which comprised their nest site or into the nest site itself, in which case both the gander and the female were inside the nesting structure during hatching.

Function of Breeding Territory. Ryder (1975) hypothesized that the ganders territory must be large enough to provide sufficient food supplies during the incubation period yet small enough to enable the gander to protect the nest site from conspecifics. Food was available for the geese at the field station. Therefore, for this flock of giant Canada geese, food was not a resource affecting territorial size or boundaries (expect in one instance, where a gander defended one feeder of food against all other geese). The author hypothesizes that the function of the breeding territory was to provide a sanctuary for the female, where she was free from harassment from other geese. The role of the gander was to defend the female. When a female left the nesting territory, the gander would accompany her off the territory and would not remain to defend the nest site. In one instance, a gander (#47) abandoned a female (#12) on a nesting territory with four eggs. The female remained on the eggs, but was continually harrassed by other nearby nesting pairs until she abandoned her clutch.

Territory Size and Boundaries. The largest territory, as calculated from a gander's mean distance from his nest over the entire incubation period was 9.76 m , while the smallest was 1.71 m (see Table 6), the average mean distance from the nest for this flock was 5.19 m (SD=2.75; N = 15). Territories were classified by the researcher as small, medium or large (criteria: small 0.00 to 3.99 m, medium 4.00 to 6.99 m, large 7.00 to 9.99 m). Six ganders were classified as having small territories, five had medium territories, and four had large territories. This data supports the view that the size of the breeding territories in giant Canada geese is highly variable between individual pairs (Collias and Jahn, 1959; Ewaschuk and Boag, 1972; Mineau and Cooke, 1979).

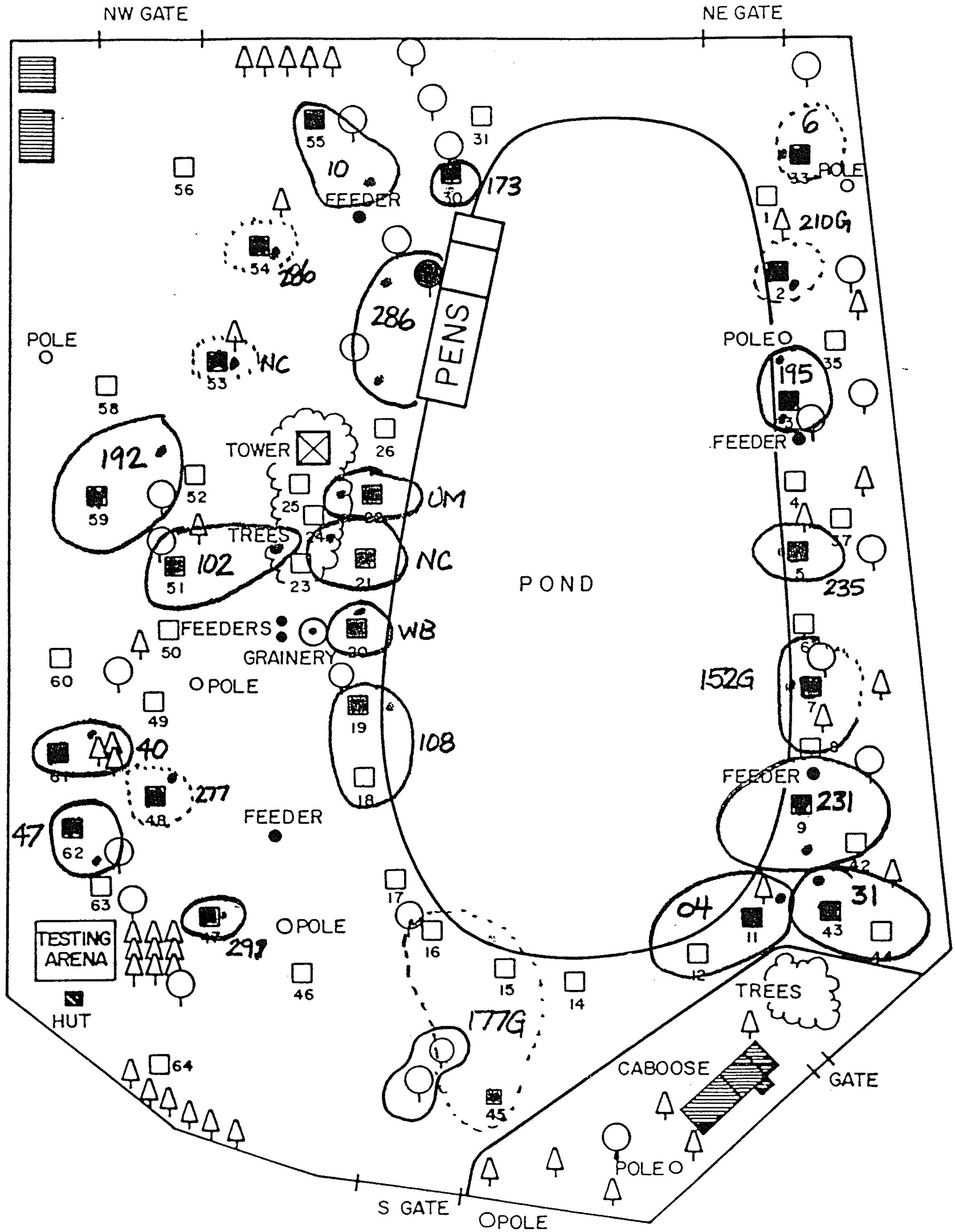
Territory size was affected by environmental heterogeneity, with items in the environment providing natural boundary lines between some pairs. Environmental obstructions that were utilized as natural boundaries included large trees, telephone poles, stacked hay bales, feeders, the predator proof fence, and the pens for holding waterfowl (see Figure 12).

Summary

Fifty-two nest sites were prepared March 11, 1988. Adult pairs were observed selecting nest sites March 12, 1988. The first goose egg was laid March 30th, 1988, and marked the beginning of the 1988 nesting period. The last eggs (N=6) were laid May 6, 1988. Thirty-four of 52 available nest sites (or 65%) were used, while three additional nesting sites were created by nesting geese.

During the nesting period, 177 goose eggs were laid. The mean incubation period for fifteen females was 29.1 days. The longest incubation period (N=2) was 33 days in duration and the shortest incubation period was 24 days. Successful pairs laid 85 eggs with a mean clutch size of 5.6 eggs with a range of 4 to 8 eggs per clutch. Successful pairs hatched out a total of 45 goslings with a mean of 3.0 goslings per nest and a range of one to six goslings per nest.

Figure 12. Territorial Boundaries of Successful Ganders


NW GATE
NE GATE
55
10
FEEDER
31
173
30
6
33
POLE
56
54
286
210G
2
286
PENS
POLE
53
NC
58
POLE
195
35
FEEDER
192
TOWER
26
59
52
25
20
UM
4
TREES
37
102
24
21
NC
5
235
51
23
POND
FEEDERS
50
GRAINERY
30
WB
60
POLE
152G
7
49
19
108
40
8
FEEDER
231
277
18
48
FEEDER
9
47
62
63
04
31
17
POLE
11
43
TESTING ARENA
16
297
15
12
46
14
TREES
HUT
177G
64
CABOOSE
GATE
45
POLE
S GATE
POLE

The objective of this study was to determine whether the size of the gander's territory changed in relation to the female's incubation period. The subjects observed during this experiment were a flock of wild giant Canada geese. Data was collected from all nesting pairs. Fifteen nesting pairs were classified as successful (by hatching out at least one gosling) and were included in the data analysis. The data were analyzed using a one-way analysis of variance with repeated measures over days. A significant main effect was obtained for the gander's distance from the nest, F (23,322) = 2.88, $p < 0.001$. With the exception of the Day 0 mean (the day of gosling hatch), the means between Day -23 and Day -1 indicated a very restricted range within which the ganders' distance from the nest varied. Post-hoc comparisons using the Tukey's studentized range test on all main effect means indicated that the mean of Day 0 differed significantly ($p < .05$) from all of the other 23 day means. There were no other statistically significant results.

These data indicate that the gander significantly decreased his distance from his nest as a function of the first gosling to hatch. It was hypothesized that the goslings provide the stimulus which causes the gander to decrease his distance from his nest.

References

Akesson, T.R., & Raveling, D.G. (1982). Behaviors associated with seasonal reproduction and long term monogamy in Canada Geese. Condor, 84, 188-196.

Allen, R.P. (1942). The Roseate Spoonbill (Report No. 2: 1-142). Audubon Society Research Report.

Armstrong, E.A. (1965). Bird display and behavior. New York: Dover Publications.

Balham, R.W. (1954). The behavior of the Canada goose in Manitoba. Unpublished doctoral dissertation, University of Missouri.

Berger, A.J. (1961). Bird Study. New York: Dover Publications.

Black, J.M., & Barrow, J.H. (1985). Visual signaling in Canada geese for the coordination of family units. Wildfowl, 36, 35-41.

Blurton-Jones, N. G. (1960). Experiments on the causation of the threat postures of Canada geese. Wildfowl Trust Annual Report, 11, 46-52.

Brakhage, G.K. (1965). Biology and behavior of tub nesting Canada geese. Journal of Wildlife Management, 29, 751-771.

Brown, J.L. (1964). The evolution of diversity in avian territorial systems. Wilson Bulletin, 76, 160-169.

Brown, J.L. (1975). The evolution of behavior. New York: Norton & Company.

Brown, J.L., & Orians, G.H. (1970). Spacing patterns in mobile animals. Annual Review of Ecological Systems, 1, 239-262.

Collias, N.E., & Jahn, R.R. (1959). Social behavior and breeding success in Canada geese (Branta canadensis maxima) confined under semi-natural conditions. Auk, 76, 478-509.

Cooper, J.A. (1978). The history and breeding biology of the Canada geese of Marshy Point, Manitoba. Journal of Wildlife Management Monograph, 42 (Suppl. 61).

Cowen, P. T. (1973). Parental calls and behavior in Canada geese. Canadian Journal of Zoology, 51, 647-650.

Davis, D.E. (1940). Social nesting habits of the smooth-billed ani. Auk, 57, 179-217.

Davies, N.B. (1978). Ecological questions about territorial behavior. In J.R. Krebs and N.B. Davies (Eds.), Behavioral ecology: An evolutionary approach (pp. 317-350). Oxford: Blackwell Scientific Publications.

Dow, J.S. (1943). A study of nesting Canada geese in Honey Lake Valley, California. California Game and Fish, 29, 3-18.

Eibl-Eibesfeldt, I. (1970). Ethology. New York: Holt, Rinehart and Winston.

Emlen, J.T. Jr. (1957). Defended area? - a critique of the territory concept and of conventional thinking. Ibis, 99, 353.

Environment Canada. (1981). Canadian climatic normals Temperature and precipitation, 1951 - 1980, for the prairie provinces. Atmospheric Environment Service.

Etkin, W. (1964). Social behavior from fish to man. Chicago: The University of Chicago Press.

Ewaschuk, W., & Boag, D.A. (1972). Factors affecting hatching success of densely nesting Canada geese. Journal of Wildlife Management, 36, 1097-1106.

Fabricius, E. (1975). Visual signals in animal behavior. In Animal Signals. Sweden: Kungl Fysiografiska Sallskapet Lund.

Fabricius, E., & Boyd, H. (1985). A case of bigamy in the Canada goose. Wildfowl, 36, 29-34.

Frings, H., & Frings, M. (1977). Animal communication. Norman: University of Oklahoma Press.

Hanson, W.C., & Eberhardt, L.L. (1971). A Columbia River goose population, 1950-1970. Journal of Wildlife Management Monograph, (Suppl. 28).

Hanson, H.C., & Smith, R.H. (1950). Canada geese of the Mississippi flyway with special reference to Illinois flock. Bulletin of Illinois Historical Survey, 25, 67-210.

Hochbaum, H.A. (1944). The Canvasback on a prairie marsh. Baltimore: The Monumental Printing Company.

Howard, E. (1948). Territory in bird life (2nd ed.). London: Williams Collins Sons & Co.

Inglis, I.R. (1976). Agonistic behavior of breeding Pink-footed geese with reference to Ryder's hypothesis. Wildfowl, 27, 95-99.

Janson, G.H., & Nelson, N. (1948). Goose breeding grounds - Utah and southeastern Idaho. U.S. Fish and Wildlife Service Special Science Report, 10, 152-155.

Jenkins, D. W. (1944). Territory as a result of depotism and social organization in geese. Auk, 61, 30-47.

Johnson, C.S. (1947). Canada goose management, Seney National Wildlife Refuge. Journal of Wildlife Management, 11, 21-24.

Klopman, R. B. (1958). The nesting of the Canada goose at Dog Lake, Manitoba. Wilson Bulletin, 70, 168-183.

Klopman, R. B. (1961). The greeting ceremony of Canada geese. Magazine of Ducks and Geese, 12, 6-9.

Klopman, R.B. (1962). Sexual behavior in the Canada goose. The Living Bird, 1, 123-129.

Kossack, C. W. (1950). Breeding habits of Canada geese under refuge conditions. American Midland Naturalist, 43, 627-649.

Krebs, J.R. & Dawkins, R. (1984). Animal signals: mind reading and manipulation. In J.R. Krebs and N.B. Davies (Eds.), Behavioral Ecology. Oxford: Blackwell Scientific Publications.

Lack, D. (1939). The behavior of the robin. Proceedings of the Zoological Society of London, 109, 169-178.

Lack, D. (1965). The life of the Robin. London: Fontana New Naturalist.

Lamprecht, J. (1986). Structure and causation of the dominance hierarchy in a flock of Bar-headed geese (Anser Indicus). Behaviour, 96, 28-48.

MacInnes, C. D. (1962). Nesting of small Canada geese near Eskimo Point, Northwest Territories. Journal of Wildlife Management, 26, 247-256.

Mayr, E. (1935). Bernard Altum and the territory theory. Proceedings of the Linneaus Society. New York, 45-46; 24-38.

Mickelson, P.G. (1975). Breeding biology of Cackling Geese and associated species on the Yukon-Kuskokwim Delta, Alaska. Journal of Wildlife Management Monograph. (Suppl. 45).

Mineau, P. & Cooke, F. (1979). Territoriality in

Snow geese or the protection of parenthood - Ryder's and Inglis's hypothesis re-assessed. Wildfowl, 30, 16-19.

Morse, D.H. (1980). Behavioral mechanisms in ecology. Cambridge, Massachusetts: Harvard University Press.

Moynihan, M.H. (1956). Notes on the behavior of some North American gulls. I. Aerial hostile behavior. Behaviour, 10, 126-178.

Murray, B.R. Jr. (1969). A comparative study of the LeContes and sharptailed sparrows. Auk, 86, 199-231.

Naylor, A. E. (1953). Production of Canada geese on Honey Lake Refuge, Lassen County, California, California Fish and Game, 39, 83-94.

Nice, M. M. (1941). The role of territory in bird life. American Midland Naturalist, 26, 441-487.

Noble, G.K. (1939). The role of dominance in the life of birds. Auk, 56, 262-273.

Ogilive, M.A. (1978). Wild Geese. Vermillion, South Dakota: Buteo Books.

Owen, M. (1980). Wild geese of the world. London: B. T. Batsford.

Owen, M. & Wells, R. (1979). Territorial behavior in breeding geese - a re-examination of Ryder's hypothesis. Wildfowl, 30, 20-26.

Pettingill, O.S. Jr. (1985). Ornithology in the laboratory and Field (5th ed.). Minneapolis: Burgess Publishing Company.

Pitelda, F.A. (1959). Numbers, breeding schedules, and territoriality in pectoral sandpipers of Northern Alaska. Condor, 61, 223-264.

Radesator, T. (1974). Form and sequential associations between the triumph ceremony and other behavior patterns in the Canada goose Branta canadensis L. Ornis Scandinavica, 5, 87-101.

Raveling, D.G. (1969). Preflight and flight behavior of Canada geese. Auk, 86, 617-618

Raveling, D.G. (1970). Dominance relationships and agonistic behavior of Canada geese in winter. Behaviour, 37, 291-319.

Raveling, D.G., & Lumsden, H. G. (1977). Nesting ecology of Canada geese in the Hudson Bay Lowlands of Ontario: Evolution and population regulation (Research report No. 98). Ottawa: Ministry of Natural Resources.

Ryder, J.P. (1975). The significance of territory size in colonial nesting geese - a hypothesis. Wildfowl, 26, 114-116.

Scott, J. P. (1968). Early experience and the organization of behavior. Belmont, California: Wadsworth Publishing Company, Inc..

Sebeok, T.A. (1977). How animals communicate. Bloomington: Indiana University Press.

Sherwood, G.A. (1966). Canada geese of the Seney National Wildlife Refuge. Unpublished Doctoral Dissertation, Utah State University, Utah.

Skutch, A. F. (1962). The constancy of incubation. Wilson Bulletin, 74, 115-152.

Steel, P.E., Dalke, P.D., & Bizeau, E.G. (1957). Canada goose production at Gray's Lake, Idaho, 1949-1951. Journal of Wildlife Management, 21, 38-41.

Stokes, A.W. (1974). Territory. Stroudsburg: Dowden, Hutchinson & Ross.

Stroud, D.A. (1982). Observations on the incubation and post-hatching behavior of the Greenland White-fronted Goose. Wildfowl, 33, 63-72.

Tinbergen, N. (1951). The study of instinct. Oxford: Oxford University Press.

Welty, J.C. & Baptista, L. (1988). The Life of birds (4th ed.). New York: Saunders College Publishing.

Williams, C. S., & Marshall, W. H. (1937). Goose nesting studies of Bear River Migratory Waterfowl Refuge. Journal of Wildlife Management, 1, 77-86.

Willis, E.O. (1967). The behavior of bicolored ant birds. University of California Publications in Zoology, 79, 1-127.

Wood, J.S. (1964). Some associations of behavior to reproductive development in Canada geese. Journal of Wildlife Management, 29, 237-244.

Wormer, J.V. (1968). The world of the Canada goose. New York: J.B. Lippincott Company.

APPENDICES

Appendix A

Avian Behaviour Laboratory's Goose Flock 1987

KEY TO APPENDICES

KEY	EXPLANATION
*	indicates that a neck collar and/or leg band has been replaced with a different numbered band/collar (i.e. the previous band/collar had been lost). The number in brackets represents the previous band/collar number.
(M)	Indicates Mike Mahoney's geese hatched in 1982.
(D)	Indicates death of a goose.
LB	Indicates leg band number
UM	Indicates an unmarked goose (no neck collar/leg band) that is pinioned.
WB	Indicates a wild free flying goose (unpinioned).
AB	Abbreviation for "Abandoned"; indicates that a nesting pair had abandoned a clutch of eggs.
HATCH	Refers to the date the first gosling in a clutch hatched.
??	Incomplete data
NMALE	Female goose laid an egg in a nest site, without a male present.

Appendix A

Avian Behaviour Laboratory Goose Flock

October 1987

Male Geese

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2(cm)	CULMEN WIDTH(cm)	TOTAL TARSUS(cm)	WEIGHT (LBS)
* 4 (150g)	24	10	7.12	2.48	12.60	13.1
* 5 (184)	184	5	7.10	2.20	12.60	11.1
* 10 (139)	139	8+	6.96	2.40	13.44	12.3
* 14	290	5	6.96	2.32	11.45	13.5
* 17	49	8+	6.86	2.28	12.00	12.8
21	21	10	6.65	2.30	12.14	13.2
28 (204)	204	7+	7.42	2.43	12.11	12.0
31	31	13	6.56	2.44	11.38	11.1
* 40(17g)(D)	* 40(295)	5	6.85	2.34	11.57	10.8
44 (M)	44	4	7.01	2.26	11.31	11.4
47	47	13+	7.36	2.54	11.76	12.3
102	?	7	6.89	2.34	12.14	15.3
121	121	7	6.98	2.38	11.41	12.4
122	??	??	??	??	??	??
130G	286	??	??	??	??	??
*132 (D)	114	7	7.33	2.43	11.40	11.2

Male Geese 1987 (continued)

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
136	185	5	7.30	2.52	11.88	13.7
143	?	–	6.52	2.14	9.95	12.0
147g	138	12	6.98	2.24	12.48	14.2
148g (128)	128	7	7.02	2.51	12.20	16.3
152g	242	8+	7.54	2.36	12.15	9.9
165	165	7	7.38	2.31	12.99	12.1
172g (231)	231	8+	7.04	2.48	11.94	13.6
173	173	10	6.63	2.27	12.00	12.3
177g (161)*	150(161)	12	7.01	2.41	11.94	13.9
186	186	5	6.42	2.28	10.28	12.0
190 *	168	5	7.49	2.39	12.04	13.9
191	191	5	7.30	2.40	12.25	12.8
192	192	5	6.91	2.28	11.72	11.6
196	??	?	??	??	??	??

Male Geese 1987 (continued)

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
200g (291)	291	5	7.35	3.37	12.34	12.0
203g	195	5	6.75	2.36	11.38	12.9
209g	285	6	6.74	2.44	11.74	13.5
210g (124)	124	7	7.72	2.52	11.59	11.6
256	256	8+	6.92	2.56	10.46	13.5
261 (M)	261	4	7.54	2.33	12.17	11.6
274	??	?	??	??	??	??
292	292	5	7.29	2.48	11.36	13.5
296	296	6	6.50	2.32	10.73	10.5

Appendix A

Avian Behaviour Laboratory Goose Flock

October 1987

Female Geese

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
6	6	8+	6.27	2.10	10.64	11.0
* 11 (250)	250(M)	10	7.33	2.24	12.29	8.4
12	12	13	6.52	2.48	11.14	10.4
* 13 (D)	122	7	6.40	2.27	10.67	12.1
18	18	10	6.75	2.11	11.75	12.2
* 19 (288)	288	5	6.45	2.23	10.82	9.3
22 (D)	22	10	6.45	2.30	11.30	11.4
* 24 (193)	193	5	6.90	2.22	11.62	10.6
* 27	240	8+	6.26	2.17	10.28	10.6
* 35 (119)	119	7	7.02	2.20	10.84	8.9
46	46	10	6.46	2.10	10.72	11.3
104	104	7	6.55	2.54	10.51	10.7
108	108	7	6.94	2.46	12.04	14.2
109	109	7	6.81	2.19	11.28	14.0
115	115	7	6.43	2.19	11.08	9.4
120	120	7	5.39	2.22	10.58	10.5

Female Geese 1987 (continued)

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
130g	286	5	6.42	2.02	11.78	9.7
186	186	5	6.42	2.28	10.28	12.0
187	187	5	6.36	2.04	10.63	9.6
189 (D)	189	5	7.06	2.30	11.02	11.8
196	196	5	6.50	2.28	10.42	10.6
197	197	5	6.72	2.17	11.24	11.9
201g (182)	182	5	6.20	2.28	10.50	10.0
206g (220)	220	8+	7.25	2.46	12.79	14.1
206	206	8+	6.57	2.16	10.84	9.6
223	223	8+	6.91	2.29	11.34	10.2
248	248	8+	6.56	2.20	11.13	9.8
254 (M)*	162	4	6.45	2.11	11.89	9.7
274	274	6	6.57	2.16	11.10	11.4
275	275	6	6.77	2.19	10.34	10.3
277	277	4	6.29	2.39	10.89	10.6

Female Geese 1987 (continued)

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
281	281	6	6.66	2.12	11.11	10.2
282	??	6	??	??	??	??
283	283	6	6.54	2.12	10.48	9.9
287	287	5	6.38	1.99	10.96	11.0
289	289	5	6.35	2.24	10.76	11.7
292	??	?	??	??	??	??
293	293	5	6.44	2.30	10.74	12.8
296	296	5	6.50	2.32	10.73	10.5
298	298	5	6.28	2.29	10.64	11.7
299	??	?	??	??	??	??
300	300	5	6.78	2.16	11.72	12.2

Appendix A

Avian Behaviour Laboratory Goose Flock

October 1987

Sex Unknown

NECK COLLAR	LEG BAND	AGE (YEARS)	CULMEN 2	CULMEN WIDTH	TOTAL TARSUS	WEIGHT (LBS)
* 15 (D)	213	8+	6.90	2.27	12.45	13.4

Appendix B

Goose Nesting Records 1988 - 1982

1988 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
2	124LB	254	APR 30	MAY 6	JUNE 1	26	5	5
3	195LB	186LB	APR 8	APR 17	MAY 14	27	6	3
4	NMALE	187	APR 28	APR 28	-	0	1	0
5	285LB	27	APR 8	FROZE	-	0	1	0
5	285BL	27	APR 20	APR 29	MAY 25	26	6	4
7	152G	18	APR 5	APR 15	-	0	6	0
9	231LB	46	APR 2	APR 12	MAY 11	29	8	5
11	4	223	APR 15	APR 19	MAY 19	30	4	3
13	NMALE	201G	MAY 3	MAY 3	-	0	1	0
16	154LB	13	APR 28	APR 30	FEMALE DIED		2	0
19	128LB	300	APR 5	APR 10	ABANDON	0	4	0
19	274	108	APR 22	APR 22	-	0	1	0
20	WILD	104	APR 5	APR 15	MAY 12	27	8	1
21	261LB	119LB	APR 6	APR 12	ABANDON	0	6	0
22	185UM	293	APR 5	APR 12	MAY 10	28	6	5
24	24	143G	APR 29	APR 29	ABANDON	0	1	0
26	??	??	MAY 2	MAY 08	-	0	6	0
30	173	206	APR 8	APR 16	MAY 14	28	6	5
33	17	6	APR 26	MAY 6	MAY 31	25	5	3
PENS	286LB	296	APR 12	APR 19	MAY 16	27	6	1
42	210G	254	APR 12	APR 16	ABANDON	0	4	0
43	31	248	APR 10	APR 10	ABANDON	0	1	0

1988 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
43	31LB	248	APR 24	APR 29	MAY 25	26	5	1
45	154LB	13	APR 8	APR 8	ABANDON	0	1	0
47	291LB	109	APR 10	APR 17	MAY 17	30	5	1
48	14	277	APR 14	APR 29	MAY 29	30	7	1
51	102	275	APR 11	APR 15	ABANDON	0	6	0
52	143G	24	APR 12	APR 12	ABANDON	0	1	0
53	21	22	APR 5	APR 10	ABANDON	0	4	0
53	191	299	APR 12	APR 18	FEMALE DIED		4	0
53	128LB	300	APR 22	APR 28	REMOVED	0	5	0
54	256	283	APR 13	APR 21	ABANDON	0	4	0
55	10	120	APR 6	APR 14	MAY 13	29	5	1
56	256	283	APR 12	APR 17	ABANDON	0	4	0
56	256	283	APR 29	MAY 6	JUNE 2	27	5	5
59	102	282	APR 3	APR 12	ABANDON	0	8	0
59	192LB	197	APR 19	MAY 2	MAY 24	22	8	6
61	40LB	298	APR 10	APR 18	ABANDON	0	4	0
62	47	12	APR 19	APR 25	ABANDON	0	4	0
63	196	292	APR 17	APR 22	ABANDON	0	5	0
STRAW	168LB	19	APR 12	APR 19	ABANDON	0	2	0
STRAW	168LB	19	APR 30	MAY 9	ABANDON	0	4	0

1988 SUMMARY

NEST SITE:	USED :	34/52	(65%)
	CREATED :	3	
	UNUSED :	18/52	(35%)

TOTAL EGGS :	177
TOTAL GOSLINGS :	45
TOTAL FLOCK SUCCESS :	25.4%

	SUCCESSFUL PAIRS (N=15)	UNSUCCESSFUL PAIRS (N=22)
TOTAL EGGS :	85	87
TOTAL GOSLINGS :	45	0
HATCH SUCCESS :	52.9%	0%
AVG CLUTCH SIZE :	5.66	3.95

TOTAL NUMBER OF INCUBATION DAYS :	437
NUMBER OF SUCCESSFUL PAIRS :	15
AVERAGE INCUBATION PERIOD (FROM LAST EGG TO HATCH) :	29.1
LONGEST INCUBATION PERIOD :	33 DAYS
SHORTEST :	24 DAYS
FIRST EGG LAID :	MARCH 30 1988
LAST EGG LAID :	MAY 6 1988

1987 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
2	139	120	APR 6	APR 18	MAY 12	24	7	5
4	203G	186	APR 29	MAY 1	ABANDON	–	2	0
6	290	277	APR 11	APR 20	MAY 24	34	6	2
8	231	46	MAR 30	APR 15	MAY 10	25	7	6
9	150G	223	APR 6	APR 18	ABANDON	–	5	0
11	UM	104	APR 7	APR 16	MAY 12	26	5	5
19	148G	300	APR 6	APR 15	ABANDON	–	7	0
21	192	197	APR 6	APR 11	MAY 10	29	7	6
22	185	293	APR 6	APR 16	ABANDON	–	7	0
23	191	299	APR 7	APR 18	MAY 17	29	7	?
26	191	299	APR 9	APR 16	ABANDON	–	5	0
PENS	130G	296	?	??	?	?	?	?
TIRE	190	288	APR 16	APR 26	ABANDON	–	6	0
TIRE	17G	298	APR 16	MAY 11	ABANDON	–	6	0
30	173	206	APR 10	APR 27	MAY 16	19	5	1
37	152G	18	MAR 28	APR 25	ABANDON	–	3	0

1987 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
43	31	248	APR 2	APR 11	MAY 10	29	7	2
45	117G	122	APR 8	APR 16	MAY 11	25	6	5
47	138	115	APR 4	APR 18	ABANDON	–	8	0
48	47	12	APR 4	APR 27	ABANDON	–	13	0
48	47	189	APR 30	MAY 4	ABANDON	–	3	0
49	275	102	MAR 29	MAR 29	ABANDON	–	1	0
50	275	102	APR 5	APR 27	ABANDON	–	20	0
52	21	22	APR 4	APR 11	MAY 8	28	6	3
54	165	6	APR 8	APR 14	MAY 12	28	5	4
55	121	281	APR 10	APR 27	ABANDON	–	6	0
56	256	283	APR 9	APR 18	ABANDON	–	6	0
59	114	283	APR 19	APR 27	?	?	5	?
61	292	201G	APR 13	APR 21	ABANDON	–	3	0
62	292	201G	APR 9	APR 25	ABANDON	–	5	0
64	44	196	APR 8	APR 15	?	?	5	?

1987 SUMMARY

NEST SITES: USED = 27 OF 50 (54%)

CREATED= 4 (TIRE, TIRE, PENS, BESIDE 48)

UNUSED = 23 OF 50 (46%)

TOTAL EGGS = 184

TOTAL GOSLINGS = 39

TOTAL FLOCK SUCCESS = 21.2 %

	SUCCESSFUL PAIRS (N=10)	UNSUCCESSFUL PAIRS (N=17)	UNKNOWN (N=4)
TOTAL EGGS :	61	106	17
TOTAL GOSLINGS :	39	0	?
HATCH SUCCESS :	63.9%	0%	?
AVG CLUTCH SIZE :	6.1	6.2	4.25

TOTAL NUMBER OF INCUBATION DAYS : 296

NUMBER OF SUCCESSFUL PAIRS : 10

AVERAGE INCUBATION PERIOD : 29.6 DAYS

(FROM LAST EGG TO HATCH)

LONGEST INCUBATION PERIOD: 34 DAYS

SHORTEST : 19 DAYS

FIRST EGG LAID : MARCH 30TH 1987.

1986 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
1	139	120	APR 23	MAY 1	MAY 29	29	5	2
2	190	288	APR 30	MAY 8	JUNE 5	28	7	1
5	NC	18	APR 1	–	ABANDON	–	7	0
6	290	277	APR 25	MAY 2	JUNE 2	31	5	2
7	231	46	APR 1	–	ABANDON	–	7	0
8	231	46	APR 29	–	ABANDON	–	5	0
9	NC	223	APR 11	APR 17	ABANDON	–	6	0
12	144	104	APR 11	APR 22	ABANDON	–	4	0
14	144	254	MAY 1	MAY 7	ABANDON	–	5	0
18	108	274	APR 5	–	ABANDON	–	4	0
19	NC	300	APR 1	APR 11	MAY 27	46	8	1
20	204	119	APR 3	APR 17	ABANDON	–	4	0
21	192	197	APR 10	APR 16	MAY 15	29	4	3
22	185	293	APR 3	APR 11	ABANDON	–	6	0
23	NC	193	APR 21	–	ABANDON	–	6	0
26	121	NC	APR 14	–	ABANDON	–	7	0

1986 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
30	173	206	APR 18	APR 23	MAY 20	27	4	4
35	286	296	APR 7	-	ABANDON	-	6	0
44	31	248	APR 3	APR 11	MAY 7	26	6	5
46	246	122	APR 5	APR 11	MAY 12	31	5	1
47	NC	109	APR 5	APR 11	MAY 13	32	6	5
48	47	12	APR 8	APR 16	MAY 12	26	7	1
49	102	275	APR 2	-	ABANDON	-	5	0
51	216	289	MAY 29	-	ABANDON	-	3	0
53	21	22	APR 2	-	ABANDON	-	6	0
54	114	282	APR 3	APR 11	MAY 11	30	5	4
55	165	6	APR 5	APR 13	MAY 11	28	6	4
56	195	186	APR 20	APR 30	ABANDON	-	5	0
59	256	283	APR 15	APR 28	MAY 19	21	7	5
60	NC	298	APR 10	APR 25	ABANDON	-	6	0
62	138	115	APR 14	-	ABANDON	-	6	0
PENS	NC	287	APR 18	-	ABANDON	-	3	0
STRAW	292	182	APR 15	APR 23	ABANDON	-	6	0
PENS	286	296	APR 21	APR 30	MAY 29	29	6	6

DEATHS: 123

181

1986 SUMMARY

NEST SITES: USED = 31 OF 50 (62 %)

CREATED= 3 (2 PENS, 1 STRAW)

UNUSED = 19 OF 50 (38 %)

TOTAL EGGS = 188

TOTAL GOSLINGS = 44

TOTAL FLOCK SUCCESS = 23.4%

	SUCCESSFUL PAIRS (N = 14)	UNSUCCESSFUL PAIRS (N = 20)
TOTAL EGGS :	81	107
TOTAL GOSLINGS :	44	0
HATCH SUCCESS :	54.3 %	0%
AVG CLUTCH SIZE :	5.78	5.35

TOTAL NUMBER OF INCUBATION DAYS: 413

NUMBER OF SUCCESSFUL PAIRS : 14

AVERAGE INCUBATION PERIOD : 29.5 DAYS

(FROM LAST EGG TO HATCH)

LONGEST INCUBATION PERIOD: 46 DAYS

SHORTEST : 21 DAYS

FIRST EGG LAID : APRIL 30TH 1986

1985 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1ST EGG	LAST EGG	HATCH	#DAYS	#EGGS	#GOS
3	190	288	APR 17	APR 23	MAY 22	29	5	5
4	290	277	APR 18	APR 23	ABANDON	–	3	0
5	203	18	MAR 29	APR 9	ABANDON	–	8	0
7	231	46	APR 2	APR 11	MAY 10	29	6	2
9	209	223	MAR 30	APR 5	ABANDON	–	5	0
20	204	119	APR 1	APR 9	MAY 8	29	6	4
21	192	197	APR 13	APR 18	MAY 16	28	5	4
22	144	169	APR 7	APR 12	ABANDON	–	3	0
23	272	104	APR 10	APR 22	ABANDON	–	6	0
24	185	293	APR 17	APR 22	ABANDON	–	5	0
27	114	282	APR 1	APR 13	ABANDON	–	8	0
28	191	299	APR 13	APR 22	MAY 18	26	6	6
29	294	300	APR 7	APR 14	ABANDON	–	5	0
30	173	206	APR 10	APR 18	MAY 16	28	7	7

1985 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
33	111	120	APR 13	APR 20	ABANDON	-	5	0
44	31	248	MAR 30	APR 9	MAY 6	27	6	4
45	246	122	APR 5	APR 24	MAY 13	19	5	3
47	47	12	APR 13	APR 20	ABANDON	-	6	0
50	102	275	APR 6	APR 12	ABANDON	-	6	0
53	21	22	APR 6	APR 12	MAY 13	31	5	3
54	286	296	APR 12	APR 18	MAY 18	30	5	4
55	165	6	APR 7	APR 26	MAY 27	31	5	4
59	256	283	APR 15	APR 24	MAY 22	28	5	3
60	295	298	APR 20	APR 26	ABANDON	-	4	0
62	23	170	APR 7	APR 16	MAY 13	27	7	1
63	-	189	APR 17	APR 24	ABANDON	-	4	0
64	138	115	APR 7	APR 15	MAY 21	36	4	3
STRAW	271	186	APR 6	APR 12	MAY 11	29	4	4
STRAW	292	182	MAY 9	MAY 13	JUN 10	28	5	3

1985 SUMMARY

NEST SITES: USED = 27 OF 65 (41.5 %)

CREATED= 2 (STRAW)

UNUSED = 38 OF 65 (58.4 %)

TOTAL EGGS = 155

TOTAL GOSLINGS = 60

TOTAL FLOCK SUCCESS = 45.3 %

	SUCCESSFUL PAIRS (N = 16)	UNSUCCESSFUL PAIRS (N = 12)
TOTAL EGGS :	86	62
TOTAL GOSLINGS :	60	0
HATCH SUCCESS :	69.7 %	0%
AVG CLUTCH SIZE :	5.37	5.17

TOTAL NUMBER OF INCUBATION DAYS: 455

NUMBER OF SUCCESSFUL PAIRS : 16

AVERAGE INCUBATION PERIOD : 28.4 DAYS

(FROM LAST EGG TO HATCH)

LONGEST INCUBATION PERIOD: 36 DAYS

SHORTEST : 19 DAYS

FIRST EGG LAID : MARCH 29TH 1985

1984 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
1	294	300	APR 22	APR 16	AB	-	3	0
2	111	120	APR 8	APR 11	MAY 12	31	6	4
4	203	18	MAR 30	APR 15	AB	-	8	0
5	186	271	APR 14	APR 21	MAY 18	27	5	5
7	231	46	APR 4	APR 13	MAY 10	27	6	4
12	209	223	MAR 30	APR 5	AB	-	5	0
14	122	246	APR 8	APR 15	MAY 11	27	6	6
17	108	274	APR 12	APR 12	AB	-	1	0
20	204	119	MAR 30	APR 13	MAY 11	28	8	3
21	NC	197	MAY 1	MAY 1	JUN 4	29	4	3
22	144	169	APR 3	APR 7	MAY 9	32	4	3
23	161	6	APR 8	APR 13	AB	-	6	0
24	222	188	APR 16	MAY 3	AB	-	6	0
26	104	272	APR 8	APR 19	MAY 11	22	7	3
27	220	109	APR 9	APR 23	MAY 14	20	7	5

1984 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
28	121	281	APR 13	APR 23	MAY 22	28	8	3
29	114	282	APR 6	APR 11	MAY 10	29	5	5
31	173	206	APR 13	APR 19	MAY 17	28	6	6
43	31	248	APR 9	APR 17	MAY 14	27	6	5
48	47	12	APR 13	APR 21	MAY 19	28	6	6
49	102	275	APR 5	APR 13	AB	-	6	0
51	25	139	APR 26	APR 26	AB	-	1	0
52	191	299	APR 19	MAY 1	AB	-	6	0
53	21	22	APR 3	APR 14	MAY 10	26	6	5
54	165	28	APR 9	APR 16	MAY 14	22	6	5
58	256	283	APR 17	APR 25	AB	-	5	0
62	23	170	APR 10	??	MAY 14	-	6	3
64	138	115	APR 7	??	AB	-	8	0

1984 SUMMARY

NEST SITES:	USED = 28 OF 65	(43.1 %)	
	CREATED= 0		
	UNUSED = 37 OF 65	(56.9 %)	

TOTAL EGGS = 157

TOTAL GOSLINGS = 75

TOTAL FLOCK SUCCESS = 47.7 %

	SUCCESSFUL PAIRS (N = 17)	UNSUCCESSFUL PAIRS (N = 11)
TOTAL EGGS :	102	55
TOTAL GOSLINGS :	75	0
HATCH SUCCESS :	73.5 %	0%
AVG CLUTCH SIZE :	6.0	5.0

TOTAL NUMBER OF INCUBATION DAYS: 458

NUMBER OF SUCCESSFUL PAIRS : 18

AVERAGE INCUBATION PERIOD : 25.4

(FROM LAST EGG TO HATCH)

LONGEST INCUBATION PERIOD: 32 DAYS

SHORTEST : 20 DAYS

FIRST EGG LAID : MARCH 30TH 1984

1983 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
7	231	46	APR 4	APR 14	MAY 13	29	8	7
9	209	223	APR 18	APR 24	MAY 22	28	5	5
14	122	246	APR 14	APR 24	MAY 20	26	6	4
17	108	274	APR 28	APR 28	ABANDON	-	1	0
19	47	12	APR 17	APR 26	MAY 23	29	5	4
20	204	119	APR 9	APR 20	MAY 17	27	6	6
21	42	248	APR 7	APR 11	ABANDON	-	7	0
22	144	169	APR 10	APR 14	MAY 13	19	5	2
23	242	251	APR 24	APR 24	ABANDON	-	1	0
25	135	141	APR 10	APR 19	ABANDON	-	4	0
26	104	272	APR 19	APR 26	MAY 23	27	5	2
27	220	109	APR 10	APR 10	CRACKED	-	1	0
28	220	109	APR 14	APR 19	MAY 16	25	5	4
29	114	282	APR 25	MAY 4	MAY 29	25	6	5
31	173	206	APR 14	APR 21	MAY 19	28	6	6

1983 GOOSE NESTING RECORDS (CONTINUED)

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
35	203	18	APR 6	APR 10	ABANDON	-	8	0
42	14	174	MAY 2	-	ABANDON	-	4	0
43	209	223	APR 5	-	ABANDON	-	6	0
43	31	248	MAY 1	-	ABANDON	-	6	0
47	139	25	APR 6	APR 19	ABANDON	-	7	0
49	102	275	APR 20	APR 24	MAY 21	27	4	3
53	21	22	APR 10	APR 14	MAY 19	25	3	2
54	165	28	APR 28	MAY 2	ABANDON	-	6	0
55	161	6	APR 7	APR 16	MAY 12	26	6	6
58	256	283	APR 28	-	ABANDON	-	6	0
61	23	170	APR 11	APR 20	MAY 17	27	4	3
64	138	115	APR 8	APR 16	MAY 13	27	7	7
STRAW	111	120	APR 25	APR 29	MAY 27	28	4	3

DEATHS: 42
219

MIKE MAHONEY'S GEESE : 44 261
45 262
250 254

1983 SUMMARY

NEST SITES:	USED =	27 OF 65 (41.5 %)
	CREATED=	1
	UNUSED =	38 OF 65 (58.46 %)

TOTAL EGGS	=	142
TOTAL GOSLINGS	=	69
TOTAL FLOCK SUCCESS	=	48.6 %

SUCCESSFUL PAIRS (N = 16)			UNSUCCESSFUL PAIRS (N = 12)
TOTAL EGGS	:	85	57
TOTAL GOSLINGS	:	69	0
HATCH SUCCESS	:	81.2 %	0%
AVG CLUTCH SIZE	:	5.3	4.75

TOTAL NUMBER OF INCUBATION DAYS	:	423
NUMBER OF SUCCESSFUL PAIRS	:	16
AVERAGE INCUBATION PERIOD (FROM LAST EGG TO HATCH)	:	26.4 DAYS
LONGEST INCUBATION PERIOD	:	29 DAYS
SHORTEST	:	19 DAYS
FIRST EGG LAID	:	APRIL 4TH 1983

1982 GOOSE NESTING RECORDS

NEST	MALE/FEMALE		1STEGG	LASTEGG	HATCH	#DAYS	#EGGS	#GOS
2	203	18	APR 21	APR 27	MAY 25	28	5	2
3	259	260	APR 18	APR 18	ABANDON	–	1	0
6	231	46	APR 16	APR 24	MAY 22	28	7	1
9	14	174	MAY 5	–	ABANDON	–	3	0
11	209	202	APR 18	APR 24	ABANDON	–	6	0
18	164	28	APR 28	MAY 3	MAY 29	–	5	4
20	42	248	APR 18	APR 21	MAY 20	–	5	5
21	154	9	–	–	–	–	0	0
22	144	169	APR 14	APR 27	INFERTILE	–	6	0
23	242	23	APR 23	–	INFERTILE	–	7	0
25	225	223	APR 14	APR 30	ABANDON	–	9	0
27	220	109	APR 30	MAY 2	MAY 29	27	4	4
28	3 23	170	APR 24	APR 28	MAY 31	35	2	1
29	173	206	APR 24	APR 30	MAY 29	30	5	5
46	161	6	APR 17	APR 26	INFERTILE	–	6	0
49	139	25	APR 10	APR 21	MAY 21	30	10	9
58	47	12	APR 23	MAY 1	MAY 29	28	6	3
59	21	22	MAY 1	MAY 5	MAY 30	25	5	5
61	138	115	MAY 17	MAY 21	ABANDON	–	4	0

DEATHS:	29	103	202
	45	125	225
		127	228
			273

NOTE: TRIO 3 - 23 - 170

1982 SUMMARY

NEST SITES:	USED =	19 OF 65	(29.2 %)
	CREATED=	0	
	UNUSED =	46 OF 65	(70.8 %)

TOTAL EGGS = 96

TOTAL GOSLINGS = 39

TOTAL FLOCK SUCCESS = 40.6 %

	SUCCESSFUL PAIRS (N = 10)	UNSUCCESSFUL PAIRS (N = 9)
TOTAL EGGS :	54	42
TOTAL GOSLINGS :	39	0
HATCH SUCCESS :	72.2 %	0%
AVG CLUTCH SIZE :	5.4	4.6

TOTAL NUMBER OF INCUBATION DAYS: 286

NUMBER OF SUCCESSFUL PAIRS : 10

AVERAGE INCUBATION PERIOD : 28.6 DAYS

(FROM LAST EGG TO HATCH)

LONGEST INCUBATION PERIOD: 35 DAYS

SHORTEST : 25 DAYS

FIRST EGG LAID : APRIL 10TH 1982

FIRST GOSLING : MAY 20TH 1982

THE END