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AN EVALUATION OF PRODUCTIVITY AND MORTALITY FACTORS INFLUENCING GOOSE POPULATIONS — a status report of the 1983 waterfowl effort on the Yukon Delta NWR, Alaska

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Executive Summary

Seven field camps (North Marshall, Kokechik West, Tutakoke, Manokinak, Whitefront Survey, Kigigak Island and South Nelson Island) documented the nesting chronology, predation and productivity of four species of geese on the Yukon-Kuskokwim delta from April 27th to July 15th, 1983. The primary objectives of this study were to monitor productivity and to determine the impact of animal and human predations on goose populations on the delta.

Nesting chronology during the season was within the usual range but was advanced over 1982. Clutch sizes for all species were within the normal range (brant: $\bar{x}$= 3.6, n= 971; cacklers: $\bar{x}$= 5.0, n= 213; emperors: $\bar{x}$= 5.5, n=121; and white-fronts: $\bar{x}$= 4.6, n= 237). Nesting success during 1983 was similar to 1981 when species are compared between years. Both brant and cacklers exhibited improved nesting success during 1983 when compared to their respective poor productivity in 1982. Overall, however, nesting success was mediocre to poor for brant and cacklers, fair to good for emperors and very good for white-fronts.

Preliminary analysis indicates that there are different levels of predator activity at different locations on the delta, and that the lower-than-normal production may be attributed to nest depredation caused by animal predators and spring hunting. There is little indication that monitoring efforts contributed substantially to nest depredation, as the combined (seven-camp) monitoring effort directly involved less than 3.5% of the brant, 1% of the cackler, 0.5% of the emperor and 0.5% of the white-front populations.

Preliminary analysis of brant populations indicates that nesting failure was greatest in areas where spring hunting occurred; however, this pattern was not clear for cacklers. High levels of predation (greater than 50%) for cacklers and emperors occurred in some areas but predation was low (less than 10%) in other areas. White-fronts experienced proportionately less predation than the other goose species, perhaps as a result of their dispersed and solitary nesting behavior. The high level of predation on brant may be explainable in terms of the general vulnerability of their coastal nesting colonies.

Future work will involve monitoring the pre-nesting and nesting periods; the post-nesting period will receive increased attention during 1984 due to the potential for substantial mortality during that period of the reproductive cycle.

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Introduction

For a number of years now the U.S. Fish and Wildlife Service has conducted nesting waterfowl inventories on the Yukon Delta National Wildlife Refuge [(YDNWR); Lensink 1965, 1967a,b; Dau 1976, 1978a,b; Smith 1980; King and Conant 1982]. These inventories were limited in scope and were geared to provide minimum data for making flyway management decisions. While these past efforts were limited, biologists were able to make some qualitative assessments of waterfowl productivity, and in 1979 field biologists reported their concerns over the future well-being of several goose populations which nest almost exclusively on the Yukon-Kuskokwim delta (Jarvis and Bartonek 1979). From these modest beginnings emerged an understanding that Arctic nesting geese were exhibiting symptoms of severe population decline. It was clear that the Service needed to understand this problem, and in 1980 a modest annual increase in "field effort" was initiated. The refuge objectives, however, remained nominally the same up until 1983.

During the spring of 1983, the "field effort" was undergirded by both substantial increases in "dollars and manpower". Additionally, the 1983 "field effort" was designed to confront a "new" set of objectives. In brief, the "field effort" was to provide insight both qualitatively and quantitatively into the question, "to what extent is spring mortality affecting the security of nesting goose populations on the Yukon-Kuskokwim delta"? The purpose of this annual report is to delineate as clearly as possible the "new" objectives, to provide a brief rational which identifies the breadth of the issues, and lastly to report the outcome of our findings during the 1983 field season -- a general synthesis of the overall effort.

A. <u>The Problem</u>

1. At least three species of geese -- Pacific black brant, cackling Canada geese, and Pacific white-fronted geese and perhaps a fourth species emperor geese -- exhibit significant numerical decreases in their respective populations. Winter and spring monitoring efforts have yielded data which in several cases substantiate the allegation that these populations have sustained losses, chronic losses, since the 1960's (Kramer 1976; Norman et al. 1977; Timm and Dau 1979; Ely and Raveling 1980, 1981, 1982; Derksen 1983; Lensink 1983a,b). The aforementioned goose populations nest primarily within the tidal zone of the YDNWR, and it is from this temporal and spatial usage of the refuge that an assessment of these uses logically follows.

2. While it is clear that there are numerous logical explanations for declines in populations, there are two broad categories of causative factors namely, <u>habitat loss</u> and <u>mortaltity</u>. In assessing what is understood both generally and specifically about "goose biology" it is intuitively recognized that YDNWR's contribution would be temporally limited, i.e., roughly limited to the time period May 1st through September 30th, and would be specifically limited to:

a. Assessing the likelihood of nesting habitat losses.
b. Assessing the extent of mortality while the geese utilize the variety of habitat which occurs throughout the Yukon-Kuskokwim delta.

The purpose of this report is to provide a perspective relative to the issue of direct mortality. The question of assessing the likelihood of nesting habitat losses is the subject of another management study.

B. Mortality — fundamental considerations

1. Three aspects of mortality are of particular importance. These aspects are addressed by answering three basic questions with respect to each species:

   a. What are the direct and indirect causes of mortality?
   b. When does the mortality occur?
   c. Where is the mortality occurring?

   These questions are basic -- who, when and where. And as our understanding of these three questions is clarified, a fourth question can be dealt with:

   d. How much mortality occurs?

2. WHAT? Who or what are the direct and indirect causes of mortality? The probable sources of goose mortality may be profitably delineated in outline form. The following sources of mortality are differentially influential (both temporally and spatially) throughout the Yukon-Kuskokwim delta. They are:

   a. Predators:
      1. avian, e.g., gulls and jaegers
      2. mammals:
         a. non-human, e.g., fox and mink
         b. human

   b. Disease

   c. Environmental Factors:
      1. weather:
         a. sequence, e.g., early spring versus late spring
         b. intensity:
            1. temperature, e.g., cold snaps, prolonged trend, etc.
            2. precipitation
            3. wind
      2. tide
      3. others

   For a variety of reasons, e.g., timing of depredation, location of occurrence, density of target, etc., any one set of factors may or may not be particularly the important factor during the periods of potential vulnerability. Thus, depredation of geese probably follows the generalized Vulnerability Pattern shown in Table 1. While this vulnerability pattern is theoretical, it is a useful estimator and assists in logically addressing the remaining questions (3 and 4, below) by helping to identify timing and location.

3. WHEN? When does the mortality occur? There are five general time periods when geese are particularly vulnerable to the several potential sources of mortality. The time periods are described as:

   a. pre-nesting period
   b. early incubation period
   c. late incubation period
   d. post-hatching and flightless period
   e. pre-fall migration period

   The specific dates of these periods vary between years and by species. Thus, the timing (e.g., When the "pre-nesting" phase might occur) is in large measure dependent upon the general climatological pattern which prevails during any given year. Subsequent events, particularly b, c and d (above), follow in their "prescribed" time frames.

4. WHERE? Where is the mortality occurring? To be sure, the location of various types of mortality depend upon the "time period" to which we are referring. For example, during the "pre-nesting phase", the four goose species of special concern and waterfowl in general are susceptible to spring hunting throughout the delta (Klein 1966). The extent of harvest, however, is ultimately dependent upon how many birds are returning to the "hunt area"; the amount of time spent hunting; and the weather conditions. These examples serve to underscore only a few components of "successful" spring hunting, but they do dramatize the extent to which the problem is both dynamic and intimately interrelated.

C. An ecological explanation of goose vulnerability to depredation

1. Refuge focus. From the outset our field efforts have focused upon brant, cacklers and white-fronts. Our concerns for emperors have been in part addressed by members of the F&WS Research Division (Petersen 1982 and 1983). The refuge emperor goose effort, therefore, is designed to supplement ongoing research by obtaining a stratified random assessment of emperor goose productivity over a broad geographic area.

2. The role of elevation in nest site selection. Perhaps the single most important factor which ultimately influences where geese nest is elevation -- the height above mean high tide (Eisenhauer and Kirkpatrick 1977, Raveling and Lumsden 1977, Ely 1979, Petersen 1982 and 1983). While this should be no

surprise to knowledgable observers it is important - perhaps critical - to reiterate and underscore the dramatic "functional role" that elevation "plays" in animal distribution in general and nest site selection on the Yukon-Kuskokwim delta specifically. Furthermore, it is elevation that functionally maintains the successional identity of the various plant associations. In turn, it is these plant associations which field observers see and subsequently attempt to correlate with observed patterns of goose nesting. While this maybe a simplification of the ecological and physiographic "drivers", we are describing the ecology of goose nesting on the delta in general terms.

The salient fact is that most goose nesting occurs only a few centimeters to a few meters above mean high tide. In plain terms, geese nest in areas that are highly susceptible to "natural" disturbance -- in short, geese are "high risk" nesters. Furthermore, the extent of susceptibility differs between species; nonetheless, elevation is the principal consideration although some local microhabitat factors undoubtedly "mediate" or "fine tune" the process of nest site selection.

3. <u>The general nesting strategy of geese.</u> In assessing the goose problem it was immediately apparent that several sources of mortality were probably involved (Table 1). Additionally, each goose species exhibits markedly different degrees of vulnerability. It is our view that differential depredation of nesting geese can be explained in large measure by the general but characteristic nesting strategy of each species involved.

To be more specific, <u>brant</u> are colonial nesters (Mickelson 1975, Eisenhauer 1977). They nest adjacent to areas that are significantly influenced by tidal waters. The elevation of the coastal landscape brant occupy is low, only a few centimeters above mean high tide. Further, they nest in relatively dense aggregations. They are highly visible, and thus they are very vulnerable to discovery.

<u>Emperors</u> in contrast tend to nest in loose aggregates or as widely dispersed isolates (Mickelson 1975, Eisenhauer and Kirkpatrick 1977, Petersen 1982 and 1983). Emperors are most vulnerable to discovery when nesting in loose aggregates, for example, as at Kokechik Bay. They are least vulnerable to discovery when nesting as isolates, and they are on the average less vulnerable to discovery than brant.

<u>Cacklers</u> seem to favor nesting on relatively small islands surrounded by water, and in some situations on peninsulas along pond or lake edges (Mickelson 1975, Raveling et al. 1978, Petersen 1982 and 1983). In past years, cacklers tended to be somewhat clumped in their nest distribution; although, these nesting aggregates occur in a clearly patchy distribution. It is difficult to say at this time whether cacklers are more

vulnerable to discovery than emperors; but it is clear, however, that once a cackler area has been located, one can count on finding them occupying the area in subsequent years.

White-fronts tend to be widely dispersed solitary nesters (Mickelson 1975, Ely 1979). The available evidence supports the idea that white-fronts nest principally along sloughs and in areas which were "high and dry" during the "nest site selection" phase of reproduction. Because of their nesting behavior, white-fronts are difficult to study. Their nests are difficult to locate, and they occur at considerable distances from one another.

Thus, in sum it is reasonable to assume at this point in time that brant are more vulnerable to depredation than cacklers, emperors and white-fronts. Cacklers and emperors are a "toss-up", but clearly they are more vulnerable to depredation than white-fronts. White-fronts appear to be highly resistant to depredation when compared to the three other species of coastal nesting geese simply because they are widely distributed. They rarely occur in tightly clumped nesting groups; although, loose aggregations of several pairs do occur.

4. The pattern of nesting distribution. Nest partitioning of the landscape by the four goose species provides a second line of collaborative evidence which tends to support the general understanding of vulnerability to depredation. For example, brant nest on the "coastal edge".

Emperors tend to nest adjacent to brant, although their nesting distribution continues inland perhaps 20 miles. As suggested previously, emperors tend to occur in aggregations coastally and in general become more widely separated as one moves inland. Thus, emperors may be generally described as maintaining a semi-clumped nesting pattern coastally and an isolated nesting pattern at the inland-most point of their nesting distribution on the delta. Between these two extremes of nesting densities a theoretical continuum appears to be in place; while such is a reasonable generalized explanation, the various characteristics of land form probably mediate the actual densities according to the irregularities of microhabitat.

Islands are the principal nesting place of cacklers; not solely, but exclusively enough. The "collective wisdom" of several decades of field work cannot be denied (Olson 1951, Mickelson 1975, Raveling et al. 1978, Petersen 1982 and 1983). Thus, interspersed, usually one or two miles from the coast, at an elevation that sustains islands surrounded by relatively shallow water, cacklers are often the predominate nester. Cacklers also nest further inland, and to be sure it is exceedingly difficult to explain the "whys" of their nesting distribution. Nonetheless, it does appear that for cacklers, nesting islands are the single most important factor; although it has come to our attention that after hatch, cackler goslings exhibit selective food preference for arrow grass (Triglochin palustrus)(Sedinger 1984). Thus, the combination of islands of "prescribed" characteristics and the proximity to specific food resources may indeed be the "least common denominator" which characterizes cackler nesting habitat. In any event, cacklers tend to exhibit a patchy nesting distribution, typically beginning slightly inland from emperors and continuing inland on a generalized density gradient that appears to be greatest in the middle portions of their nesting distribution, i.e., west to east.

White-fronts in general nest along sloughs and water ways. They occur inland of the first observed nests coastally perhaps by 100-200 yards; as one observes subsequent inlandward nests, it is apparent that there is a pattern of association -- slough bank habitat seems to be a critical selection factor.

D. Some general conclusions with respect to previous field work. As early as 1976 biologists had stated their concerns for goose populations that nest on the delta in reports and at various meetings (Jarvis and Bartonek 1979; Anonymous 1981a,b; Pacific Flyway Council 1981; Bartonek 1982; Derksen 1983; Lensink 1983a,b). The extent and rapidity of response to these concerns has been slow; nonetheless, progress was made. Perhaps the salient contributions stemming collectively from field work on the delta may be cryptically summarized as follows:

1. Brant:

   a. The brant population has sustained substantial numerical declines, particularly during the past several seasons. Both the number of wintering and nesting birds appear to be decreasing; but additionally, there has been a clear shift in utilization of winter habitat along the Pacific coast. Nesting brant have exhibited chronic symptoms of atypical reproductive behavior and productivity problems. Prior to 1966, nesting brant apparently occupied the coastal fringe in what has been described as a continuous pattern of occupancy between Cape Romanzoff and Nelson Island. While the pattern of occupancy was not uniform in density, it does appear that early observers were struck by the continuous character of brant nesting distribution. The number of brant was great, and it was determined to be impossible to realistically "guesstimate" their numbers.

   b. Observers during the early to mid-1970's reported that they did not observe a continuous pattern of occupancy, but rather embraced the notion that brant exhibited a patchy nesting distribution. During this period, colonies were identified and named. Some effort was made to estimate nesting densities and a few attempts were made to develop sampling approaches. Brant numbers appeared to be large.

c. Presently, 1983, the nesting distribution of brant is clearly aggregated. There is no evidence whatsoever of a continuous nesting pattern. Today brant exhibit sharply definable nesting colonies, at least at the four, perhaps five, remaining colonies which sustain more than 2,000 birds (1,000 pair). The remaining 15-20 "colonies" -- loose aggregations -- sustain fewer that 1,000 brant (500 pair) each.

d. It seems that since 1950 there has been a continuous loss of nesting brant on the Yukon-Kuskokwim delta. The loss has been observed incrementally by various observers, but determined to be a "non-loss observation" because each successive biologist, 1964-1966 versus 1982-1983 has suggested at least privately that the earlier work was "not quantitative" or "they over estimated" what was really present. Both views are misrepresentations of what the history of similar types of situations have proven to be. First, quantification in the case of brant was judged "near impossible"; there were simply too many birds to count; the problem was where to begin. In contrast, today we can count the smaller colonies from both the standpoint of an aerial survey and a plot sampling with tight statistical confidence. Second, estimates are typically less than the actual; this is particularly the case when the sampling population is very large and mobile. It is difficult to miss seeing even relatively loose aggregations of nesting brant over large expanses of landscape. Our experience confirms the view that when you fly over nesting brant at reasonable altitudes, you see them on their nests. One is not confused about whether the brant are nesting at a particular spot or in an area; one can see the changes in nesting densities. What we do believe is critical is that we can see where brant are absent or at least in such low densities we cannot detect them because they occur outside our "visual field". Pointedly, if we can see today the general pattern of nesting, it seems quite reasonable to conclude that past descriptions of general nesting distribution are reasonably accurate. Therefore, in all probability brant nesting was continuous or at least nearly so; albeit, densities throughout the length of the Yukon-Kuskokwim delta coastline varied, annually and perhaps markedly.

e. The location of brant colonies is dynamic. It appears that a certain proportion of the breeding pairs utilize different areas. The apparent dynamics of colony formation may be viewed from several points of view. <u>One point of view</u> would state that brant pairs are simply less traditional than biologists tend to think is the case for geese in general. A <u>second point of view</u> states that geese, including brant, exhibit strong fidelity to "nesting place" in general (e.g., within the bounds of a physiographic unit such as Kigigak Island which is approximately 20 km^2). And furthermore, in the case of some goose species, there is a tendency to exhibit strong fidelity to a "nesting territory" in which there may be several potential or alternate nest sites.

Thus, the "fidelity point of view" maintains that the apparent infidelity to nesting place is a symptom of a much larger problem.

It is beyond the scope of this paper to discuss the potential ramifications of either point of view; although, this topic is the subject of future reports. For the time being, however, it is sufficient to recognize that there is a serious void in our understanding of brant colony dynamics. It is particularly important to understand the mechanics of "brant nesting behavior" in the context of waterfowl resource decision making. Such an understanding is of critical concern to both the Service and those individuals that are affected by such decisions.

The salient point at this juncture of the "prospectus", however, is the fact that in order to "minimally" monitor the sources of mortality delineated in Table 1, sampling the same plots (whether rectangle, circular or irregular polygons) or sampling standing transects will not provide results which are obtainable in a repeatable fashion. The only repeatable aspect of the sampling effort is the location of the plot or transect. The fallacy of such an approach is that the object being sampled is moving around year after year and in varying degrees between years. In short, brant functionally do not exhibit specific nest site fidelity. The assumptions of past plot sampling or transect sampling depend upon fidelity to a colony area. Past sampling strategies are reviewed elsewhere (Aldrich et al. 1981). It is clear, therefore, that one needs to be able to identify very early in the nesting season where the brant are likely to nest "that year".

2. Cacklers:

a. Cacklers tend to exhibit a clumped nesting distribution as referred to previously and summarized in item c below.

b. The number of areas which sustain nesting cacklers was dramatically lower during the 1982 nesting season, both in the context of general distribution and the number of birds that utilize an area (Byrd et al. 1982). This statement must be quickly qualified, with emphasis added, and placed into context -- the 1982 nesting season was substantially retarded because of the lateness of spring break-up, which is generally believed to the the cause for the poor production.

During 1982, biologists observed the poorest overall production that has been observed in recent history. Additionally, this season of poor production coincided with a period in the history of cacklers when the total population was substantially reduced below historic levels. As predicted, the 1982-83 mid-winter survey was extremely low (Derksen 1983). The best estimate to our knowledge is 50,000 to 60,000 cacklers. This represents a highly significant reduction in the total number of potential breeding pairs -- ranging roughly between 25,000 and 30,000 pairs.

c. Fortuitously, an initial attempt at characterizing what was believed to be favored cackler nesting habitat had been completed during the 1981 field season (Raveling et al. 1978, Byrd and Smith 1981). As a first cut at stratifying cackler nesting habitat, the following criteria were used:

   1. Cacklers tend to nest throughout the tidal zone of the Yukon Kuskokwim region, apparently

   2. preferring islands and secondarily peninsulas which are

   3. surrounded or adjacent to relatively shallow water.

   The net result at this first cut at identifying cackler nesting habitat was to provide the biologists approximately 85 areas from which to develop a survey effort.

d. In years prior to 1982, goose production was a "guesstimate" based upon a few plots and, in later years, from one pre-break-up field camp. The limiting factors were manpower and dollars. Further, goose populations were numerically in reasonably good shape. For these reasons there was no significant effort to establish methodologies which would increase confidence statistically and biologically in the data gathering. The effort was generalized, and it was functional for a number of years.

3. <u>Emperors</u>:

   a. A generalized model of emperor nesting strategies has been described earlier, as well as noting that intensive research is being carried out by the F&WS Research Division (Petersen 1982 and 1983).

   b. Our immediate interest in emperor geese, therefore, is limited to questions concerning general productivity. Because of the ongoing research effort, the refuge inventory plan reflects opportunistic strategy; data are obtained primarily while conducting inventory of other goose species or monitoring depredation at various study plots.

4. White-fronts:

   a. The number of white-front nests located during any single field season (for a given study effort) has not exceeded 100 (Ely 1979). White-fronts are difficult to locate because they are widely distributed throughout their nesting habitat.
   b. White-fronts nest along slough and river banks and in areas that were "high and dry" at the time of nest site selection which occurred during spring flooding following break-up.

5. Overview

Ultimately, the problem has been an inability to maintain continuity of field observations. Simply stated, no one observer has seen the whole spectrum of "events". What we "see" is something analogous to viewing the extinction of dinosaurs, in that a catastrophe occurred. But here, most notably for brant, the evidence is not locked in "geological graves", it is lost in the "mental grave" of tradition. The brant "event" for example has occurred in something less than 40 years; but unlike the extinction of the dinosaurs, we do not have solid calcareous remnents. We have several "soft" reports which describe the "magic" of "moments of observations" made by a few field biologists at different points in time. It is doubtful that "their" general descriptions of what they saw are fabrications. Further, it is doubtful that "they" had poor vision.

What people have reported has been "serial sections", i.e., intermittent observations through time. The loss has occurred at a rate which is slow and thereby difficult to distinguish as a part of the continuum of events. Unfortunately today in 1983, whether we speak of brant, cacklers, emperor or white-fronts, it is reasonable to conclude that almost any level of mortality occurring on the nesting grounds is a significant cause of "population failure".

We have concluded from our analysis that we need the ability to first identify the general sources of depredation and simultaneously we need to minimally be able to distinguish between "animal" predation, human predation (spring hunting), and environmental sources of depredation.

Secondly, the methodology (field data gathering strategy) should "crosswalk" in such a fashion that productivity estimates could be used by the Flyway, i.e., in the regulation setting process. Further, the same approach should have potential for evolving into a highly reliable method for estimating productivity; yielding high-confidence-level estimates of the Yukon-Kuskokwim delta's contribution of geese to the annual fall flight. We believe that these are reasonable goals, particularly in light of the concern shown for Arctic nesting geese.

Field Camp Locations and Objectives

A. Locations

The location of YDNWR and the six refuge field camps and two cooperator camps are identified in Figures 1 and 2. The white-fronted goose survey camp initiated field work at Onumtuk and the after break-up-plan was to survey slough and river banks. This field crew is highly mobile and utilized a number of locations as temporary camp sites (Byrd and Paniyak 1983).

B. Field Camp Objectives

1. Kigigak, Tutakoke, Kokechik West and Manokinak (pre-break-up) Camps:

    a. Determine the chronology of goose nesting, with particular emphasis being placed upon brant and cacklers. These data are utilized first to establish efficient field inventory schedules for prescribed population sampling, and secondly for comparative purposes, i.e., comparisons between locations and between years.

    b. Determine the sources and rates of depredation on nesting geese at the various nesting areas.

    c. Obtain phenological, production and depredation data on other nesting species as opportunity allows.

    d. Provide to the biological staff preliminary productivity statistics for geese by the second Monday in July.

2. North Marshall (post-break-up) Camp:

    a. Develop a strategy for inventorying Taverner's Canada geese -- a pilot effort.
    b. If successful in locating 25 pair or more, then objectives as applicable in "item 1" above.

3. South Nelson Island (post-break-up) Camp:

    a. Determine if nesting goose densities are sufficient to justify an in-depth monitoring effort.
    b. If "item a" is affirmative then objectives as applicable in "item 1" above.

4. White-fronted goose survey (pre-break-up) "Camp":

   a. Coordinate search strategy for nesting white-fronts in monitoring areas of the other delta field camps for nest characterization analysis.
   b. Search river and slough banks for the occurrence of nesting white-fronts in Hazen Bay region.

   c. If successful in locating 50 pair or more in addition to those pairs discovered at other field camps, the objectives as applicable in "item 1" above.

Methodologies

A. <u>Spring aerial survey of brant nesting areas</u>

The annual aerial spring survey of brant colonies was conducted June 8th using a Cessna 185 aircraft. The aircraft was flown at an altitude of 300 feet at speed of 90 miles per hour. Visability was good, approximately 25 miles. During the course of the flight, winds were light, less that 10 miles per hour. The two person crew flew the coastal fringe including portions of the lower stretches of the larger rivers inland approximately 10 miles. The survey was initiated on the northern coastal fringe of Nelson Island and terminated at Kokechik Bay. The survey lasted 3.75 hours, and the weather held favorable throughout the flight.

Colonies were identified with the aid of U.S.G.S. one inch to the mile topographic maps. Estimates were made of the number of nesting brant that were in each area; these data were recorded in standard fashion. The survey results (i.e., location and colony size) were compared with location data (Aldrich et al. 1981) and numerical estimates were compared with field crew judgements where possible.

B. <u>Monitoring Strategies - Physical Environment</u>

1. Atmospheric Conditions

   Atmospheric conditions such as: wind direction, wind speed, visibility, barometric pressure, percent cloud cover and type of clouds were recorded at least once daily. The daily maximum and minimum temperatures, and the occurrence and quantity of rainfall and snowfall were also recorded; as well as other environmental occurrences (e.g., wind, tides, tornadoes, etc.). At Kigigak Island and Tutakoke River field camps atmospheric conditions were recorded at even numbered hours. At Manokinak River field camp they were recorded at 0800 hours and 2000 hours, at Kokechik West field camp at 0800 hours and at Nelson Island field camp in the morning and again in late afternoon.

2. Spring Break-up Sequence

Snow cover transects were established to measure the changes in the amounts of snow, ice and meltwater that covered the ground at selected locations. Data were collected in two ways. In one procedure, the percent of uncovered ground, snow-covered ground and ground covered by meltwater were recorded at sampling sites along each transect. In addition, notes were kept regarding areas inundated by high tides, date meltwater began to form on ponds, date when ponds were ice-free, sequence of river ice break-up, and date when rivers were ice-free. Transects were usually monitored every other day but less frequently if the prevailing weather conditions resulted in a decrease in the rate of snowmelt. In the second procedure, photographs were taken at all or selected sampling sites along each transect. The number, lengths and monitoring procedure for these transects are contained in the respective field camp reports.

C. Monitoring Strategies - Biological

The 1983 goose nesting survey was designed to provide accurate data that were obtained using methodologies that are repeatable. In order to accomplish these objectives, four strategies of data gathering were used to gain the kind and quality of data required -- namely, Calibration Plots, Validation Plots, Primary Census Plots, and Secondary Census Plots. These strategies represent a synthesis of established monitoring procedures (Mayfield 1975, Johnson 1979, Hensler and Nichols 1981, Bart and Robson 1982, Klett and Johnson 1982).

1. Calibration Plots

Calibration Plots are the most intensely studied areas. Each plot is intended to be thoroughly searched in a systematic fashion every third day beginning prior to nest initiation and continuing through hatch. Located nests therefore are to be visited every third day. All nests are flagged (codified) with field markers, located and identified on field maps, and all pertinent biological data are recorded in field notebooks. The purpose of the Calibration Plot is to provide the "quantitative standard" for the chronology of reproductive events and the occurrence of depredation. Specifically, when does egg laying begin, when does incubation begin, when does egging occur, where does depredation occur, and so on. Calibration Plots are adjusted in size so that they are searched in four to eight hours by two field people. This works out to be roughly 200-300 acres in the case of cackler plots and may represent approximately 10% or less of the total study area. Brant areas are smaller due to their colonial nesting behavior and thus search time is less. An additional consideration is that the number of nesting pairs of geese in the plot must be sufficiently large to produce an accurate picture of the reproductive chronology. A general rule of thumb is that 25 nests would be the minimum number and 50 nests the maximum number for cacklers, and up to 100 nests for brant. Other nesting species are assessed as spinoff of cackler or brant efforts.

2. Validation Plots

Validation Plots are thoroughly searched on two occasions prior to hatch and on one occasion shortly after hatch. The first pre-hatch search occurs shortly after the onset of incubation (as calculated from observations made on the Calibration Plots); the second pre-hatch search occurs just prior to the calculated hatch date. The post-hatch search is made as soon as possible after the goslings have departed the nesting area. At each nest, the procedures for field marking, map identifying and recording of biological information are the same as those for Calibration Plots. Validation Plots are designed to contain approximately 20% of the study area and therefore monitor the chronology of reproductive events and the occurrence of depredation for a larger number of nests.

3. Primary Census Plots

Primary Census Plots are thoroughly searched on two occasions (once prior to hatch and once shortly after hatch). The pre-hatch search occurs during mid to late incubation. The post-hatch search is made as soon as possible after the goslings have departed the nesting area. Data recording procedures follow those for Calibration Plots. Primary Census Plots are intended to contain approximately 70% of the nesting area to be sampled. These plots sustain minimal investigator disturbance and facilitate the extrapolation of the chronology of events over a larger sampling area.

4. Secondary Census Plots

Secondary Census Plots are thoroughly searched as soon as possible after the goslings have departed the nesting area. These searches are dependent upon suitable weather conditions and the availability of field crew time. Secondary Census Plots provide estimates of nest density and nesting success.

D. Assessment of Productivity

Nest initiation dates were calculated by back-dating nests found in Calibration Plots using either the laying sequence, float angle of the egg or observed hatch date. It was assumed that one egg was laid per day up to four eggs and then one day was skipped for clutches of five or more. Float angle of the egg and back-dating were not used to calculate initiation dates in Validation or Primary Census Plots because the frequency that nests were revisited did not allow determination of the hatch date. Back-dating occurred from the day the nest was found for nests in Calibration Plots. For nests found after egg-laying had ended, initiation dates were determined by back-dating from the observed hatch date. Incubation periods were assumed to be 23 days for brant, 26 days for cacklers and white-fronts and 24 days for emperors.

Nests found during the egg-laying period in Calibration Plots were used to determine "complete" clutch size. Typically these nests contained between one and three eggs. A clutch was considered "complete" if the number of eggs present did not change on two subsequent, successive visits to the nest. Clutches found after the egg-laying period had ended were termed "incomplete" because "complete" clutch size would probably be underestimated due to the potential for egg loss occurring prior to locating the nest. For nests in Validation Plots, "complete" clutch size was calculated on the basis of the most eggs observed at either of the two pre-hatch visits. Since nests in Primary Census Plots had only one pre-hatch visit, only "incomplete" clutch size was determined.

A successful nest is defined as a nest for which at least one egg hatches. The Yukon-Kuskokwim delta is subsampled on the basis of coastal field camps (including the white-fronted goose survey "camp") which span the length of the coastal fringe. On the basis of camp distribution, weighted means for nesting success were calculated for each species. This is the only method available at this time for interspecific comparison of nesting success.

1. Brant

Aerial surveys are used in part to delineate the general distribution of nesting brant on the Yukon-Kuskokwim delta. The area occupied by each nesting colony is, therefore, a proportion of the total brant nesting area on the delta; thus, Nesting success is then calculated as a weighted mean based upon the proportion of nesting area and the respective nesting densities of each colony.

2. Cacklers

Unlike brant, the geographic boundary of nesting cacklers is not quantifiable at this time. Recognizing that the subtleties of stratification are not well understood, nesting success values for each study area (Kokechik West, Kokechik East, Manokinak, Old Chevak, Kigigak Island, South Nelson Island, and the 1982 Cackler Study Plots) are weighted equally and averaged to produce a mean nesting success value.

3. Emperors

For emperor geese, all the nests located at each field camp (Kokechik West, Kokechik East, Manokinak, Old Chevak, Kigigak Island, South Nelson Island, white-fronted goose survey, and 1982 Cackler Study Plots) are totaled. Nesting success is expressed as a percentage of this total and is a simple mean of the number of nests found at each camp.

4. White-fronts

The same procedure for calculating nesting success for emperor geese is used for white-fronts.

E. Assessment of Depredation

1. Environmental Factors

Documentation of potential causative factors (temperature, wind tide, etc.) was stated previously (see Methodologies, section B).

2. Biological Factors

Biological data obtained from the multi-staged sampling regimes described previously (Methodologies, section C) allow quantification of depredation in time, space, and magnitude (i.e., when, where, and how much). In addition, documentation of the chronology of events (goose nesting behavior and human activity) in Calibration Plots allows detection of any "pattern response" that occurs.

Results and Discussion

A. Spring Aerial Survey of Brant Nesting Areas

The maximum estimated number of brant observed while conducting the spring aerial survey was 30,000 individuals, plus 2,000-3,000 brant at Kigigak Island which were not counted during the aerial survey (Wege and Garrett 1983), yielding a total of 33,000 brant. As during previous years, the 33,000 estimate assumes an equal sex ratio and this estimate represents the lower bound of the actual population size (Table 2). While these data for the past three years are not strictly comparable, there appears, nonetheless, to be a trend emerging which indicates that the number of nesting brant on the Yukon-Kuskokwim delta may be declining. As illustrated in Table 2, a 34% reduction in the number of birds occurred between 1981 and 1982 (Aldrich et al. 1981; Byrd et al. 1982). A further 26% reduction occurred between 1982 and 1983. When comparing the numerical changes which occurred at the three major brant nesting colonies (i.e., Kokechik Bay, Tutakoke River and Kigigak Island) a sharp 47% reduction occurred between 1981 and 1982. The change was marked and apparently quite real according to local residents and field observers that worked the areas during both years (Byrd et al. 1982). The reduction in total nesting birds is credited to losses of birds utilizing Tutakoke River and Kigigak Island. Kokechik Bay, in contrast, has maintained an approximate nesting population of 14,000 (7,000 pair) during this three year period. Between 1982 and 1983 only a one percent change was noted at the three major colonies. This observation is in contrast with what was reported for the entire refuge.

Not surprisingly, the mid-winter survey showed some indications of decreased numbers during the past several years, but did not reflect a severe problem. While the nesting ground composition of brant wintering in the Lower 48 and Mexico is unknown, numerically these wintering populations have not exhibited catastrophic numerical changes.

At this time we have very little data which either accepts or rejects the notion that other goose populations are numerically stable. Some plots, however, do show a long term decline in the number of nesting pairs, but the data base for making general conclusions for the Yukon-Kuskokwim delta nesting geese is meager (Raveling et al. 1978, Ely et al. 1979, Aldrich et al. 1980, Butler 1983, Raveling 1983).

B. Atmospheric Conditions

Spring climatic patterns during 1983 resulted in generally favorable nesting conditions for migratory birds. From early spring through early summer, weather conditions were moderate and were characterized by warmer than normal temperatures and an increased frequency of relatively clear skies. Warm temperatures (52°-62° F.) during the second week of May reduced continuous snow cover on the nesting areas to relatively open landscape by the last seven to 10 days of May. Snow machine travel ended between May 10th and 15th, and boat travel on most large sloughs and rivers began after May 29th (Tables 3, 4 and 5). In general, the chronology of the 1983 breakup was 15-20 days ahead of 1982 (Byrd et al. 1982) and appeared to be several days ahead of an "average year". Environmentally, therefore, conditions tended to strongly favor successful reproduction. Furthermore, the reproductive effort was not hampered by wind tides, i.e., flooding due to strong winds occurring concurrently with the highest tides of a particular lunar cycle.

C. Productivity

Between April 27th and May 2nd (prior to spring break-up) seven field camps were established on the YDNWR (Figure 1). These field camps were established to assess goose production in conjunction with monitoring environmental conditions. Each camp location (Figure 2) was in an area which provided the greatest opportunity for assessing brant, cackler, emperor and white-front nesting chronology and production (Figures 3, 4, 5 and 6, respectively). Two additional camps were established immediately after break-up and 41 Primary Census Plots were searched in order to collect data from a wider array of geographic areas within the principal goose nesting area (Figure 2).

1. Brant

Initial arrival was earliest by six days at Kigigak Island, and essentially the same at other field camps. Peak migration-arrival for brant was 11-14 days earlier at Kigigak Island than at other areas (May 18th to 22nd, Table 6). Nest initiation was earliest at Kigigak Island and Kokechik Bay West and was latest inland at Old Chevak, i.e., ranging between May 20th through May 25th. Peak periods for initiation of incubation and hatch were similar at all camps and occurred between May 24th and 27th, and June 15th and 20th, respectively. The average "complete" clutch size (3.6 eggs, n=964) was also similar at all camps where sample size was large enough to allow statistical comparison. The 1983 value is slightly less than the 15-year (1965-1979) average (3.7 eggs per clutch n=1,457) but greater than the 2.9 and 2.5 eggs per clutch observed in 1982 (n=3,230) and 1981 (n=1,349), respectively. The 1980 average was 4.1 eggs per clutch (n=196), a season which was four to five days "earlier" than the 1983 season.

The Old Chevak data, however, are atypical on two counts. First, the colony is small and is located inland about 10 miles rather than coastally. And second, the number of nesting attempts (n=15) and the number of "complete" clutches (n=7) are insufficient to make reasonable comparisons between areas. Further, the Old Chevak data do not alter the overall descriptive statistics. For example, the average "complete" clutch size is about 3.6 eggs per clutch with or without the inclusion of Old Chevak data (Table 6). The differences seen for "incomplete" clutch size, in contrast, reflect different levels of depredation at the various field camps, as obtained from sub-plot sampling.

Overall, for the 16,500 pair of brant, nesting success was estimated to be 53% on the YDNWR (Table 7). This represents a moderate increase over 1982 (36% nesting success) and only a slight decrease from the 58% nesting success in 1981 (Aldrich et al. 1981, Byrd et al. 1982). Class I brood size averaged 2.8 birds (n=1,454) and was similar for all camps reporting this information. This statistic is identical to the 15-year average (n=2,353). For the past three years (1980, 1981 and 1982), 2.7 (n=269), 3.0 (n=310) and 2.3 (n=160) goslings per brood were produced, respectively. Comparisons of average clutch size and Class I gosling data show that there is substantial mortality occurring between completion of the clutch and the appearance of Class I goslings, approximately 28%. Thus, in coarse terms the delta brant population was a calculated 57,024 birds (adults and Class I goslings) on or about June 20th.

2. Cacklers

Initial arrival was earliest by seven days at Kigigak Island (Table 8). Peak migration arrival was earliest at Kigigak Island and Old Chevak, but for all locations peak arrival occurred during a six day period, May 7th to 12th. Nest initiation occurred earliest on the Cackler Plots. The "coastal camps" exhibited slightly earlier initiation dates than did "interior" camps. Similarly, the peak nest initiation period (May 19th to 25th) appeared to be earlier and less protracted at "coastal camps", but there are not sufficient data at this time to make firm judgements.

Peak periods for initiation of incubation and hatch occurred between May 25th and 29th, and June 19th and 27th, respectively and may be varying in relation to differences in methods of observation or methods of calculating the respective dates. Cacklers showed a similar "complete" clutch size pattern as brant with respect to "early years" versus "late years". The 1983 average was 5.0 eggs per clutch compared to the 15-year (1965-1979) average of 4.8 eggs per clutch. The average in 1980, 1981 and 1982 was 5.2, 4.0 and 4.4 eggs per clutch, respectively. Statistics on clutch size are essentially identical for all areas. The sum of the data from South Nelson Island, both "complete" and "incomplete" clutch size, probably represents the area relatively well. Further, these data do not alter the overall descriptive statistics. Even if the 30 clutches from South Nelson Island are included in the calculation of the average clutch size, the 1983 average clutch size for cacklers remains approximately 5.0 eggs per clutch.

Nesting success, 64% in 1983, was more than twice the 1982 level and represented a slight increase from 1981 (Table 7). From a limited sample (n=46), Class I broods averaged 5.0 goslings. The sample size from previous years was too small for analysis. It appears superficially that no appreciable mortality occurs in those clutches that remain intact between peak of incubation and the subsequent observation of Class I goslings. This observation is of course an artifact of the data reporting process on two counts. First, overall cackler nesting success is 64% (Table 7). The subjective assessment of the field situation is that there is a great deal of predator activity in some areas, and modest predator activity in other areas plus relatively heavy spring hunting activity (Tables 3, 4, 5 and 9). There are numerous potential combinations (Table 9), all of which contribute to a clouding of our understanding of what constitutes a solid estimator of productivity. Second, and perhaps of greater immediate importance, is the fact that the calculated 5.0 goslings per pair that had young (n=47) is far too small of a sample. Further, there is a need to increase the geographic representation (stratification) of the Class I gosling sample.

As in 1982, we censused 40 field plots to monitor cackler productivity, and secondarily to help us characterize cackler nesting habitat. A total of 489 and 554 cackler nests were located on these plots in 1982 and 1983, respectively. The difference between years appears explicable in terms of the high variation in the data sets (Butler 1983). Additionally, eight of these plots have been censused for the past three years (1981, 1982 and 1983) and are located within the general area of Hazen Bay between the Kashunuk and Azun Rivers. Unlike the gross comparison made between the past two years for all plots, the total number of observed nesting cacklers on these eight plots has been 138, 132 and 103 during 1981, 1982 and 1983, respectively. Lastly, we have data for two 240 acre plots on the Onumtuk study area (Figure 2). The nesting data are available for 14 years (1969-1983, excluding 1974) and represent the best long term nesting data taken from the same plots (Table 13). It appears from graphic analysis (Sokal and Rohlf 1969) that both Onumtuk plots exhibit negative (downward) trends in the number of nesting pairs.

Of moderate interest is the relative similiarity of clutch size from Kokechik Bay East (Petersen 1983) and South Nelson Island (Boyce et al. 1983). Both areas report approximately 5.5 eggs per clutch and appear to be similiar in their proximity to the coast and relatively low levels of predation and spring hunting. We shall want to watch these two areas closely in order to determine whether this correllary is valid.

While it is very tempting to calculate nesting density for each plot, there is particular hazard in doing so. First, as expected, the "habitat" variation is great. Plot selection at this phase of the effort is based upon "subjective selectivity" as exercised by highly experienced goose biologists. Our caution is justified by the large variance observed in these data sets (Butler 1983). Secondly, environmental factors which "cause" early availability of nest sites (as during 1983) versus average or late availability of nest sites (1982 was a "late year") tend to further cloud our understanding of what is occurring. The problem is that we have had too few "calibration field camps" in the past; as a result, we have a poor overall understanding of what constitutes an "average" situation for nesting cacklers. As stated previously, we have taken steps to remedy the problem of too few calibration camps. For example, the cackler nesting area is roughly 725,000 acres; it is not unreasonable to have one camp every 64,000 acres (one camp per 100 square miles). During 1983, five camps contributed some data to the cackler effort, and four camps contributed substantially (one camp per 283 square miles). Perhaps in 1984 we will be able to improve the ratio of camps per square mile. Given current projected staff, dollars and "level of priority" 11 to 12 camps represent a reasonable logistical burden; nonetheless, each level of field effort has subsequent follow-through burdens, i.e., data preparation and management, data analysis, write-up, etc. In short, fundamental support services also increase markedly.

3. Emperors

Initial arrival was earliest by eight to nine days at Kigigak Island. Peak periods for migration-arrival, nest initiation, initiation of incubation and hatch were between four and eight days "earlier" at the southern-most camps (South Nelson Island

and Kigigak Island: April 29th to May 1st, May 15th to 17th, May 21st to 23rd, and June 14 to 16th, respectively) than at Manokinak and Old Chevak (May 7th to 12th, May 20th to 21st, May 28th, and June 21st respectively; Table 10). The southern-most camp (South Nelson Island) exhibited a mean nest initiation date of May 16th, while the northern-most camp (Kokechik Bay East) exhibited a mean nest initiation date of May 21st (Petersen 1983). Apparently we also have progressively later mean dates of nest initiation as the population establishes inland from the coastal zone, May 16th through May 21st respectively (Table 10). While we lack large samples for any single year, the general pattern (sequence) of biological events is strongly indicative of a south to north progression, as well as coastal to inland. As shown in Table 10, the same general pattern is apparent for peak of hatch at South Nelson Island and Kigigak Island, but the data are too sparce to "hammer down" a convincing picture of what is occurring.

Emperors did not exhibit the same pattern of clutch size relationships for the same time period as brant and cacklers. The average "complete" clutch size (5.5 eggs, n=121) during 1983 was slightly larger than the 15-year average (5.0 eggs, n=1,175). Averages for 1980 (n=16) and 1981 (n=61) 5.3 and 4.9 eggs per clutch, respectively, were well below the 6.5 eggs per clutch (n=89) recorded for the "late year" which occurred in 1982. The relatively high 1982 value may be an artifact of emperor breeding biology (more than one female laying in a nest). A fuller explanation is forthcoming from F&WS Research Division (M. Petersen, Anchorage, AK.). Statistics on average clutch size show a modest tendency to be larger (5.9 eggs per clutch) on the coast and progressively smaller (about 5.2 eggs per clutch) as one moves inland, i.e., Kigigak Island compared to Manokinak and Old Chevak (Figure 2 and Table 10). It should also be noted that the sequence simultaneously exhibited a south to north relationship.

At this stage of data gathering and analysis, the data sets are viewed as suggestive and no substantive conclusions are being made. Nonetheless, we have reasonably good nesting success data, and these data show that 73% of the nests produced at least one gosling (Table 7). This calculation, however, includes 119 nests that were censused at Kokechik Bay East (Petersen 1983). The calculated nesting success excluding Kokechik Bay East is 67% for 278 nests, which is slightly below 1981 and 1982 levels. Class I broods averaged 3.7 birds (n=52). This value is numerically identical to the 15-year average (n=960) and similar to data of sufficient sample size available after 1979 (i.e., 3.8 goslings per brood, n=47, 1980).

4. White-fronts

White-fronts exhibited a chronological pattern which is similar to emperors (Table 11). Initial arrival was earliest by six days at Kigigak Island. Peak periods for migration-arrival, nest initiation, initiation of incubation and hatch occurred between May 7th and 12th, May 15th and 22nd, May 21st and 27th, and June 15th and 22nd, respectively. The peak arrival date is similar and earliest for Kigigak Island and Old Chevak. Peak nest initiation appears to be earliest at the southern-most camp, South Nelson Island. We lack, however, comparative data for the more northern coastal areas. For Manokinak and Old Chevak, both north of South Nelson Island and inland approximately 10 miles, it is not clear whether their peak nest initiation interval exhibits a south to north or a coastal to inland relationship or both. "Incomplete" clutch size (4.6 eggs per clutch, n=237) was similar to the 16-year (1964-1979) average (4.7 eggs per clutch, n=617) and not markedly different from the available "complete" clutch size data. This relationship is reasonable in view of the relatively high nesting success, 88% (Table 7). From a limited sample (n=16) Class I broods averaged 2.9 birds.

D. Mortality

Both egging and jump shooting of nesting birds occurred in 1982 and 1983. The level at which these activities occurred appears greater in 1983 when compared with similiar data sets for 1982 (Byrd et al. 1982). Cacklers and emperors appear to have sustained less shooting and egging pressure than brant because they are less accessible. White-fronts are vulnerable to hunters traveling sloughs and may sustain relatively high mortality locally, but probably not to the extent sustained by cacklers and emperors (Tables 3-5). Lower values for "incomplete" clutch size for brant at Kigigak Island and at Cackler Plots when compared to Kokechik Bay West and Tutakoke camps reflect the relatively high predator density on some Cackler Plots and a moderate level of predator and/or subsistence activity at Kigigak Island (Table 6). In addition, the between-camp differences in nesting success for each species support the impression of relatively high predator density at Manokinak, Old Chevak and Kokechik Bay West camps and moderate levels at Kigigak Island and Tutakoke camps. The relatively low nesting success for white-fronts at Kokechik Bay West may indicate an increased density of mammalian predators as one proceeds inland from the coast.

During the spring aerial survey and subsequent flights, we observed footprints in 25 of 33 brant nesting areas. The footprints appeared to establish a trail from nest to nest in each of the areas we observed; this was also the case at the plots where we conducted field surveys.

Subsistence activity for three field camps is reported chronologically in Tables 3, 4 and 5. The results of observations made at Kokechik Bay West (Table 3) are not comparable with data reported in 1982 (Byrd et al. 1982) because 1983 subsistence activities are reported for an area approximately five miles west of the 1982 study area. Nonetheless, spring hunting and egging occurred in the area of the Kokechik Bay East camp (Petersen 1983); observations are reported as follows:

> On 23-25 May 1983, the study area was visited by two groups of people. One group (two people) gathered gull eggs, and did not take brant eggs from the nests we were studying. The other group came through the area about midnight on 24 May, and remained in the area throughout most of the day on 25 May. They took most of the eggs from 21 brant nests we were studying. We requested that they not shoot birds from the nests on our intensive study area, and they moved to an adjacent area. They remained in the area hunting and egging throughout most of the day on 25 May.
>
> Because of the disruption from hunting and the loss of eggs from nests, the number of geese nesting on our intensive study area, the east side of sections 12 and 13, and the north side of section 7 was reduced from 277 pairs in 1982 to 25 pairs in 1983. Brant that were present on the area during early nest initiation (21-24 May) did not remain in the area to continue egg laying or initiate nests.

In contrast, Kokechik Bay West (Table 3) field crews observed several types of human activity between May 10th and May 29th. Shooting was observed or heard 21 times during this two week period, but only seven direct observations of shooting or egging were seen. Indirect evidence of spring hunting was relatively common; for example, much of the nesting area was searched prior to the field crew arrival as evidenced by fresh footprints leading to goose nests.

The Tutakoke field crew observed seven groups of people visiting the area between May 7th and July 9th, 1983. Four groups were clearly engaged in spring harvest of waterfowl and the remaining three appeared to be reconciled to some other kind of activity (Table 4). In contrast, field crews in 1982 observed only two groups of people that may have potentially engaged in spring harvest of waterfowl (Byrd et al. 1982). Between April 27th and June 29th, six spring harvest groups were observed hunting and/or egging on Kigigak Island. Shooting was heard on numerous occasions throughout this period (Table 5). In contrast, in 1982 people were observed traveling by snow machine and boat towards the Naskanat Peninsula before and after break-up, respectively. Hunting was observed on and in the vicinity of the Kinlunak Peninsula; the field crew obtained evidence that only two groups hunted the island in 1982. It was concluded that the presence of the field crew probably discouraged hunting and egging activity on the island (Byrd et al. 1982).

In looking at depredation data gathered in 1983, it is important to recognize that the search strategy was designed to obtain statistics on reproduction and to monitor general sources of mortality. But perhaps of greater importance is to realize that the search strategies themselves are also a form of "treatment" from which various kinds of disturbance can be measured and compared between areas and years.

The "functional treatment level" of one of our goose study plots is based upon the frequency of searches that occurs on a particular plot (Figure 3). Thus for example, a Calibration Plot may sustain three (3) or more scheduled searches and also exhibit an undetermined potential for unscheduled searches by "spring hunters". While it is usually assumed that the amount of "insult" caused by a single search made by a cautious field crew is less that the amount of "insult" caused by a single hunting effort, the "functional treatment level" is defined herein as equal to the number of scheduled searches plus the number of unscheduled searches. The categories of search are independent of the validity of the assumption. Thus, for any particular monitoring strategy, there is a potential gradient of "realized treatment". The "realized treatment level" begins at the level prescribed by the particular monitoring strategy. For example, in the case of Calibration Plots, the lowest level might be three (3) or more scheduled searches, whereas the lowest level for Validation Plots would be two (2) scheduled searches, and only one (1) scheduled search for Primary Plots. In all cases unscheduled human activities are an ever-present potential event. Because there is no predictable estimate of what the potential rate of unscheduled human activity might be, the number of Calibration and Validation Plots must be maximized. Further, some of these plots are strategically located to optimize the opportunity to detect and to determine the relative amount of unscheduled activity. The remaining plots are located to minimize the opportunity for unscheduled human activity. Thus, the study plots are stratified first on the basis of an annual determination of where the geese are nesting, and second on the basis of vulnerability of the nesting location to access by hunters, i.e., high vulnerability versus low vulnerability. By stratifying in this fashion we optimize our opportunity to "trap" regimes of "functional treatment levels" which range from a single scheduled search; one (1) scheduled search plus one (1) unscheduled search; through three (3) or more scheduled searches plus several unscheduled searches. The resultant regime is a theoretical gradient. If there is a gradient of effect the "searches" are said to provoke an accumulative effect. If, however, the pattern of effect is associated with (a) scheduled searches and (b) scheduled searches plus unscheduled searches, then the effect is associated with scheduled searches and may be either additive or synergistic. If the pattern of effect is associated solely with scheduled searches plus unscheduled searches, then the unscheduled search (spring hunting) is the significant contributing factor causing nest failure.

In summary, when a search in a nesting area occurs there are two general types of situations that may occur following scheduled searches. The two general cases are:

Case I: scheduled searches of a plot followed by either:

options: a. no subsequent act of animal predation, or
b. one incident of animal predation, or
c. repeated acts of animal predation.

Case II: scheduled searches plus spring harvest on a plot followed by either:

options: a. no subsequent act of animal predation, or
b. one incident of animal predation, or
c. repeated acts of animal predation.

A cursory inspection of the field camp data sets reveals several patterns of predation associated with the two cases (Case I and Case II) described above. For example, brant nesting at Kigigak Island, Tutakoke River, and Kokechik Bay West (examples of Case I situations) seemingly sustained "randomized" occurrences of animal predation at a frequency of less than 25% (Table 12; Wege and Garrett 1983; West et al. 1983; Masteller et al. 1983). In contrast, the <u>scheduled searches</u> on cackler areas exhibited two kinds of responses (Table 9). First, at Manokinak and Old Chevak camps, both examples of a Case I situation, cackler nesting success was particularly low, 62% and 30%, respectively (Janik et al. 1983, Raveling 1983). Observers at these two camps also reported that predator activity (particularly mammalian) appeared to be great. These observations are in sharp contrast to those observed on South Nelson Island (Case I) where animal predation was thought to be very low (Boyce et al. 1983) and at Kigigak Island (Case II) where cacklers sustained moderated levels of animal predation and spring hunting (Wege and Garrett 1983). What appears to be the common denominator is the role of predator abundance (i.e., high, medium and low levels) on a particular plot. Nonetheless, one cannot totally rule out on rigorous grounds the influence of the data gatherers. The observers at Manokinak and Old Chevak were more experienced investigators of nesting geese when compared to observers at Kigigak Island and South Nelson Island; and being more experienced observers, one might tend to favor the view that such observers would contribute minimally to animal predation. The available evidence at this writing tends to support the view that while cacklers may be more sensitive to disturbances, the frequency of observed predation was independent of the number of searches made on a particular plot. The frequency of predation which is reflected in the differences between nesting success levels is explicable in terms of the normal correlation that exists between predator density and the number of captures (nesting loss) per unit area.

At South Nelson Island where predators were reportedly in low numbers, the frequency of predation on all nesting geese was quite low, about six percent (n=86). Kigigak Island reported moderate predator activity. The frequency of predation on all nesting geese was 21% (n=805), but in plots where no spring hunting occurred it was 13% (n=602). In contrast, for plots where spring hunting occurred, the frequency of predation was 42% (n=203).

In 1983, the nesting biology of four species of geese was monitored on the YDNWR. Seven field camps documented the chronology of nesting, identified sources of depredation and estimated productivity. In summary, the dates of various biological events shown in Tables 6, 8, 10 and 11 appear to be within the "usual" range, but clearly advanced over 1982. While "normal" clutch sizes were produced, brant and cackler production in 1983 was mediocre to poor when compared to past years. Emperor production decreased substantially and white-fronts appeared to have had a good year when compared to 1982. The principal factor contributing to lower than perhaps expected production is nest depredation caused by both "predators" and "humans". While all data have not been analyzed in detail at this time, it appears that the level of predator activity differed at various locations on the delta and that substantial nesting loss occurred as a result of "animal" and subsistence hunting (egging and shooting of birds) and was not investigator-related (i.e., to the level of intensity of the monitoring effort). For all field camps combined, the percent of the population that was disturbed while monitoring mortality and productivity was low for each species (Table 13). Together the monitoring effort disturbed between 0.2% and 3.5% of the nesting population of brant, cacklers, emperors and white-fronts on the delta, respectively (Table 14). For brant, preliminary analysis shows that nesting failure was greatest where spring hunting occurred; however the pattern is not clear for cacklers. Cacklers and emperors sustained high levels of predation in some areas (e.g., greater than 50%) and less than 10% in other areas.

White-fronts exhibited proportionately less predation (Tables 7 and 11). It appears that hunting and egging of geese on the nesting areas was greatest on brant because they are abundant in colonies and are highly accessible.

While there is a need to continue monitoring the pre-nesting and nesting periods, the post-nesting period (from hatch to flight) requires immediate attention in light of the many unknowns (e.g., identification of the corridors of movement to brood-rearing areas, location of these brood-rearing areas, habitat and food utilized during this period, etc.) and the potential for mortality that exists.

During 1984 we intend to monitor goose production and mortality over a wider geographic area. Minimally 11-12 field crews should be ascertaining representative data over the 750,000 acres of <u>prime</u> coastal zone nesting habitat; this represents roughly one crew per 100 square miles. We will not at this time initiate monitoring efforts into areas that are viewed as secondary zones of goose production. There is more than five million acres minimally of secondary nesting (low density) habitat.

Additionally, identification of corridors of immigration to brood rearing areas will be attempted during 1984. It is anticipated that the field crews will also obtain better data on the ratio of goslings to adults for all age classes of goslings. These kinds of data are needed to help determine the period in the life cycle where mortality is occurring.

Lastly, there is a need to band and neck collar geese from known nesting areas. This effort will address questions of nesting fidelity and colony dynamics on the nesting ground and simultaneously provides a basis for continuity of wintering ecology studies of geese of known nesting orgin.

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Attachment 3: Pacific white-fronted goose.
Attachment 4: Cackling Canada goose.
Attachment 5: Fall goose survey report - 1982.
Attachment 6: White-fronted geese - harvest and mid-winter surveys.
Attachment 7: White-fronted and Canada goose harvests.
Attachment 8: White-fronted goose banding and survey data.
Attachment 9: Cackling goose fall peak population trend 1965-1982.
Attachment 10: Recent changes in waterfowl use in the Klamath Basin.
Attachment 11: Canada goose mid-winter surveys and harvest recommendations.

Attachment 12: Cackling goose nesting density, fall counts, and research and management recommendations.
Attachment 13: Cackling Canada goose and white-fronted goose - nesting densities and production, brood observations.
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Attachment 17: Bartonek, J.C. 1979. Recommendations for changes in regulations governing goose harvests in portions of Oregon and California.
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TABLE 1. Intuitively preceived levels of depredation on geese.

				Predators				
				birds		Mammals non-human		
		weather	wind tide	gull	jaeger	fox	mink	human
A.	Spring birds:							
	1. breeders	1	1	1	1	1	1	3
	2. non-breeders	1	1	1	1	1	1	3
	Nesting birds:							
	1. bird laying eggs	1	1	1	1	2	2	3
	2. one week incubation	1	1	1	1	4	3	4
	3. two weeks incubation	1	1	1	1	3	3	4
	4. three weeks incubation	2	1	1	1	3	2	4
	5. four weeks incubation	2	1	1	1	2	2	4
B.	6. fresh laid eggs	2	4	2	2	3	3	4
	7. one week old eggs	2	4	2	2	4	2	4
	8. two week old eggs	3	4	2	2	4	2	3
	9. three week old eggs	3	4	2	2	3	2	3
	10. four week old eggs	2	4	2	2	2	2	3
C.	Goslings:							
	1. Class 1a	3	1	3	2	2	2	1
	2. Class 1b	2	1	2	2	1	1	1
	3. Class 2	2	1	1	1	1	1	1
	4. Class 3	1	1	1	1	1	1	2
	Flightless birds:							
	1. adults	1	1	1	1	1	1	4
	2. immatures	1	1	1	1	1	1	3
D.	Fall flight birds:							
	1. adults	1	1	1	1	1	1	3
	2. immatures	1	1	1	1	1	1	3

Subjective levels of depredation: 1 = trace; 2 = low; 3 = medium; 4 = high.

TABLE 2. Estimated number of brant nesting on the Yukon Delta NWR.

Year	Number of brant nesting at three major colonies[1]	Total number of brant nesting on the refuge
1981	45,301[2]	67,783[2]
1982	24,005[3] (-47%)	44,700[4] (-34%)
1983	22,508[5] (-1%)	33,000 (-26%)

1 Kokechik Bay, Tutakoke River and Kigigak Island.
2 Aldrich et al. 1981.
3 Byrd et al. 1982.
4 Calculated estimate: the sum number of brant nesting at the three major colonies (1982) plus the number of brant nesting elsewhere on the Yukon-Kuskokwim delta as based upon the 1981 census of brant nesting areas.
5 Masteller, M.A. et. al. 1983; Wege, M.L. and R.L. Garrett 1983; and West, W.L., S. Kon-no and R.L. Garrett 1983.

TABLE 3a. The chronology of spring harvest at Kokechik West, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
126	Migration arrival							
127	of cacklers, emperors							
128	and white-fronts							
129								
130		1, 1, 2, 2, 1, 1						1, 1, 1 snow machines going east along bluff; 2, 1, 1 snow machines going west along bluff; 1 shot heard
131		2, 2, 1, 2						2, 1 snow machines going east along bluff; 2, 2 snow machines going west along bluff (1 shot heard)
							NE of camp	5 shots heard
							West of camp	4 shots heard
							2 mi W of camp	1 person walking, no gun visible
							NW of camp	1 boat in Bay
132		1, 3, 1, 1						1, 3 (with sleds) snow machines going east along bluff; 1, 1 snow machines going west along bluff
							Along coast N of camp	4 snow machines with sleds going SW along the coast, much disturbance of geese
							N of camp	6 shots heard
133		1, 2, 4, 5						1, 2 (with sleds), 5 (4 with sleds) going east along bluff; 4 (2 with sleds, 1 with 2 sleds) snow machines going west along bluff
							West of camp	3 shots heard
134		2, 5, 3						3 snow machines going east along bluff; 1, 5 (4 with sleds) going west along bluff
							E and NE of camp	9 shots heard
135		3						3 snow machines going west along bluff
							E of camp	10 shots heard
136							NE of camp	12 shots heard
								Herring fishery opened, 4 herring processor boats in the Bay indicating the presence of fishermen who may engage in spring harvest activity
137	Nest initiation						N and NW of camp	46 shots heard
138							E of camp	2 shots heard
							N of camp	10+ shots heard; Herring fishery closed
139		5					Mouth of slough camp is on	37+ shots heard which may be from fishermen or others
							N and NW of camp	7 shots heard
							E of camp	13 shots heard
140		3					Mouth of slough camp is on	12 shots heard and 3 men observed Herring fishery opened
							N of camp	55+ shots heard, heard an outboard motor
141							N of camp	2 shots heard

TABLE 3b. The chronology of spring harvest at Kokechik West, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
142		4					2 mi NW of camp	31 shots heard and they had tents (blinds?) set up; Herring fishery closed
143	Incubation initiation	3	Hooper Bay	X	X		Near mouth of slough camp is on	3 men with a motorboat hunted off the slough near the mouth. As we approached them in our canoe, an oldsquaw jumped up. One man stood up to shoot, but did not fire because his friend nudged him and pointed to us. We talked with them, but they were not friendly. Heard 20+ shots and did find a dead oldsquaw (female) on our way back up the slough. These men appeared to be in their late teens or early twenties.
		1		X			1 mile east of main slough	10+ shots heard and observed a person (with a bucket) egging
144		3	Hooper Bay	?	?		1 mile east of main slough	Possibly egging/hunting, they left when we approached the area to work on one of our plots
								Herring fishery opened for 12 hours
							NW of camp	1 shot heard
145		1		9+	1+		one eighth mile N of camp	This man had an emperor and fired at another as it flew off the nest. He missed, but collected at least 5 eggs. Continuing west, he fired twice at something, but must have missed. He then shot a parasitic jaeger. The shot flushed an emperor and he collected 4 eggs. He then collected the dead jaeger and disappeared beyond the pingo to the N
146		2		X			1.5 mi E of main slough	2 people egging (no buckets observed)
								Herring fishery opened for 12 hours
147							NW of camp	7 shots heard
148								
149		13		X	?		2 mi NW of camp	3 shots heard, most carried buckets, some had guns
150								
151								
152								
153								
154								
155								
.								
.								
.								
165	Hatch							

TABLE 4a. The chronology of spring harvest at Tutakoke, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
127		2	Chevak?					Although they appeared to be seal hunters, I am sure they would have taken waterfowl at the opportunity
128	Migration arrival of brant							
129								
130								
131							N of study area	Shots heard
132							N bank of Kashunak	1 camp observed with a tent similar to the Nanning family who we talked to on day 147
133							N of study area	Shots heard
134							N of study area	Shots heard
135		2			X			Success unknown
136								
137								
138								
139	Nest initiation							
140								
141								
142	Incubation initiation							
143								
144								
145								
146								
147		4	Hooper Bay	X	X	X	200 yds up slough 2 on both sides for 200 yds	We talked with the Nanning family prior to their egging and hunting. They were courteous, asking where they could hunt without disturbing our study. They traveled up slough 2 (south) during high tide and stayed until the early morning high tide. Three people collected 26 gallons of eggs in 3 hours. One person shot 9-10 brant, 1 crane and 1 glaucous gull in 2.5 hours. Three people gathered 1 trash bag of

TABLE 4b. The chronology of spring harvest at Tutakoke, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	birds	down	Area of colony	Remarks
								down in 1.5 hours. They collected half of the eggs and birds and then ate dinner. Later they filled their buckets again and shot other birds. We surveyed the area the next day and found that most or many birds had returned if eggs remained in the nest. Since this party did not jump-shoot in the colony, we were unable to measure maximum disturbance because they were careful not to disturb. Duration of hunt - 5 hours.
148								
149		4	Hooper Bay	X			NE from slough 1	Party of 4 (a family with parents in mid-fifties and children 12-16). No guns, egging only. No down taken. They left one egg in each nest. Four people gathered 4 gallons of eggs in 2 hours. Duration of hunt - 5 hours.
150								
151								
152								
153								
154								
155								
156								
157								
158								
159		7 1	Chevak Hooper Bay	X	X	X	NE from slough 1	Party of 8 (3 adults and 5 children). Five guns, all were jump-shooting. They were unsuccessful on their traditional area so they moved to our study area. Before we could approach them to leave, they shot 5 brant and collected 8 gallons of eggs. The eggs were two-thirds developed. Dead embryo. They also collected 2 sacks of down.
160								
161								
162								
163								

TABLE 4c. The chronology of spring harvest at Tutakoke, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
164								
165								
166								
167								
168								
169								
170								
171								
172								
173								
174								
175	Hatch							
176								
177								
178								
179		2	Chevak					This party of 2 (ages 25 and 30) had been fishing and they planned to hunt. We discussed the bad timing of such a hunt since goslings were just beginning to leave the colony. They were persuaded not to hunt and one was intoxicated so they spent the night and left.
180								
.								
.								
.								
200		3	Chevak	X			Kashunak	Party of 3 males (ages 14-18). They left Chevak at 1400 hours with 4 guns in a 16 ft boat with a 25 hp motor. They had arrived at our camp at 0900 hrs and had 80 brant and 5 female common eiders. Seventy of the brant were brood patch females. They indicated they had 28 more brant back at camp on the Kashunak. Duration of hunt - 5 hours (One banded bird).

TABLE 5a. The chronology of spring harvest at Kigigak Island, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
117			Newtok		X			Last snow machine travel - set up field camp.
118								
119	Migration arrival of emperor geese							Heard 4 shots toward southwest.
120								
121								
122								
123								
124								
125	Migration arrival							
126	of brant, cacklers							
127	and white-fronts							Heard 10 shots toward north - most shooting so far this spring.
128								Heard 15 shots toward north - most shooting so far this spring.
129		2, 3						Heard two boats traveling north along west coast.
130		2			X		1982 Cackler Plot	Heard shots and observed 1 goose in possession.
131		2	Tununak		X		SE of SW brant colony	Hunted all day - heard 15 shots - found dead brant in SW colony.
132								
133								
134								
135								
136								
137								Few shots heard past 3 days - today a lot from north and south.
138								No shots heard.
139								

TABLE 5b. The chronology of spring harvest at Kigigak Island, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs	Harvest birds	Harvest down	Area of colony	Remarks
140		4			X		W and SW part of island	Hunted morning and early afternoon - heard 25 shots.
141								
142	Nest initiation	2					SW part of island	Hunted all day - heard 25 shots.
143								Heard 5 shots - found a dead emperor in SW part of island.
144								
145		2	Tununak	X	X		E of SW brant colony	Egging first observed - hunter carrying .22 rifle and bucket.
146								Heard 10 shots toward south - observed a boat traveling N along W coast.
147	Incubation initiation							Heard boats on E and W coasts but few shots heard - egging?
148								Heard 5 shots - observed footprints in mud near flagged nests in SW colony.
149								Observed footprints near flagged nests - heard boat - last observation of egging.
150								
151								
152								Found dead brant in SW colony.
153								
154								
155								
156								
157								Old footprints of eggers S of SW brant colony.
158								
159								Found dead brant in central part of island.
160								
161								Found dead crane and glaucous gull S of SW brant colony.
162								

TABLE 5c. The chronology of spring harvest at Kigigak Island, 1983.

Julian day	Chronology of arrival and nesting	Number in party	Home village	Harvest eggs birds down	Area of colony	Remarks
163						
164						
165						
166						
167						
168						
169	Hatch					
170						
171						
172						
173						
174						
175						
176						
177						Heard a few shots toward south - first shots in a long time.
178						
179						
180						Heard a few shots toward east.
181						
182						
183						
184						
185						

TABLE 6. Chronology of Pacific black brant nesting at waterfowl field camps on the Yukon Delta NWR, 1983.

Event	Kokechik West	Tutakoke	Old Chevak	Manokinak	Kigigak Island	South Nelson Is.	Cackler Plots	Whitefront Survey
Initial arrival	Prior to 5/9	5/8	-	Prior to 5/8	5/2	-	-	-
Peak arrival	5/18-5/21	5/18-5/21	5/18-5/22	5/19-5/21	5/7-5/8	-	-	-
Nest Initiation	5/17	5/19	5/21	-	5/17	-	-	-
Peak nest initiation	5/21-5/22	5/21-5/22	None	-	5/20-5/25	-	-	-
Initiation of incubation	5/23	5/22	-	-	5/21	-	-	-
Peak initiation of incubation	5/24-5/25	5/25-5/27	-	-	5/26-5/27	-	-	-
First clutch to hatch	6/14	6/14	-	-	6/12	-	-	-
Peak of hatch	6/15-6/16	6/16-6/18	-		6/15-6/20	-	-	-
Nesting attempts	1,096	2,229	15	0	601	0	53	0
Nests for which no eggs were laid	33	18	0	-	5	-	23	-
Nests for which no eggs hatched	369	416	11	-	126	-	8	-
Nests for which one or more eggs hatched	667	1,790	4	-	429	-	15	-
Nest status undetermined	27	5	0	-	41	-	7	-
"Complete" clutch size	3.6 (n=348)	3.6 (n=322)	3.1 (n=7)	-	3.6 (n=294)	-	-	-
"Incomplete" clutch size	3.3 (n=86)	3.2 (n=47)	-	-	2.2 (n=57)	-	1.8 (n=33)	-
Class I brood size	2.8 (n=864)	2.8 (n=485)	-	-	3.0 (n=105)	-	-	-

TABLE 7. Nesting success[1] estimates of geese on the Yukon Delta NWR.

	Species			
Year	Brant[2]	Cacklers	Emperors[3]	White-fronts
1983	53% (n=3,914)	64% (n=724)	73% (n=397)	88% (n=282)
1982	36% (n=4,080)	25% (n=586)	70% (n=178)	NA
1981	58% (n=1,016)	61% N=196)	78% (n=90)	NA

1 Nesting success equals the number of nests for which one or more eggs hatched divided by the number of nests for which productivity status was determined.

2 Kokechik Bay West contains 19% of the total known brant nesting area, and Tutakoke River and Kigigak Island contain 10% and 26%, respectively. The remaining 45% are areas that sustain colonies ranging between 50-1,000 birds; on these areas nesting success averaged 29% (n=161)).

3 Includes data from Kokechik Bay East (Petersen 1983).

TABLE 8. Chronology of cackling Canada geese nesting at waterfowl field camps on the Yukon Delta NWR, 1983.

Event	Kokechik West	Tutakoke	Old Chevak	Manokinak	Kigigak Island	South Nelson Is.	Cackler Plots	Whitefront Survey
Initial arrival	Prior to 5/9	-	-	Prior to 5/8	5/1	-	-	-
Peak arrival	Prior to 5/9	-	5/7-5/9	5/10-5/12	5/7-5/8	-	-	-
Nest initiation	-	-	5/20	5/18	5/15	5/16	5/13	-
Peak nest initiation	-	-	5/20-5/27	5/24-5/25	5/22-5/23	5/20-5/22	5/17-5/19	-
Initiation of incubation	-	-	-	5/22	5/20	5/23	-	-
Peak initiation of incubation	-	-	-	5/26-5/29	5/28	5/25-5/29	-	-
First clutch to hatch	-	-	6/20	6/15	6/14	6/18	-	-
Peak of hatch	-	-	6/20-6/27	6/19	6/20-6/22	6/22	-	-
Nesting attempts	-	-	90	187	193	34	436(1)	-
Nests for which no eggs were laid	-	-	0	42	0	0	-	-
Nests for which no eggs hatched	-	-	58	5	24	4	124	-
Nests for which one or more eggs hatched	-	-	29	78	169	29	162	-
Nest status undetermined	-	-	3	62	0	1	150	-
"Complete" clutch size	-	-	5.0 (n=38)	5.0 (n=68)	4.9 (n=105)	5.5 (n=2)	-	-
"Incomplete" clutch size	-	-	-	4.5 (n=10)	3.6 (n=18)	5.5 (n=28)	5.0 (n=397)	-
Class I brood size	-	-	-	4.9 (n=44)	6.5 (n=2)	-	-	-

1 The data reported here are from plots which were not reported by other field camps; during 1983, we located a total of 554 cackler nests in a total of 40 census plots, ranging between 81-313 acres in area.

TABLE 9. Effects of scheduled and unscheduled searches on nesting success of cackling Canada geese on the Yukon Delta NWR, 1983.

Treatment levels			Density of predators per unit area[1]	
		Low	Medium	High
Plot strategy A+B	A+B			
1+0		-	Kigigak I[2] & II (98%, 89%)[3]	Manokinak I, II, III[4] (61%, 47%, 90%)
	1+1x	-	-	-
2+0		-	Kigigak I (86%)	Manokinak I (33%)
	2+1x	-	Kigigak II ( )[5]	-
3+0		South Nelson Is. (93%)[6]	Kigigak II (83%)	Manokinak I, II, III (0%, 24%, 14%)
	3+1x	-	Kigigak I & III (67%, (7))	-

1 At this stage of field assessment, predator densities are subjective estimates.
2 Roman numerals correspond to individual Calibration Plots at the respective camps.
3 Numbers in parentheses are nesting success values.
4 These data are not strictly comparable as Primary Plots I, II, III; they are Cackler Plots 22A, 22B, 22C, respectively.
5 This plot was egged prior to the first search. Subsequent to egging, six nests were located which contained an average clutch size of 5.2 eggs . All nests were successful.
6 The number of visits to each nest ranged between 2-7 with approximately 75% of the nests sustaining 4-6 visits during the incubation period.
7 This plot was selectively egged for brant. Prior to egging, six nests were located (six cackler nests and 108 brant nests). The average clutch size was 5.5 eggs and there was an 83% nesting success.

Legend: Terms and symbols used in describing human disturbance

Case I: A: equals the number of scheduled searches conducted by field data gatherers in a nesting plot
B: equals the number of unscheduled searches conducted by spring hunters in a nesting plot

Treatment schedule in terms of level of human disturbance
1+0: signifies that a Primary Plot sustained one (1) scheduled search and no (0) unscheduled searches.
1+1x: signifies that a Primary Plot sustained one (1) scheduled search and one (1x) unscheduled searches.
2+0: signifies that a Validation Plot sustained two (2) scheduled searches and no (0) unscheduled searches.
2+1x: signifies that a Validation Plot sustained two (2) scheduled searches and one (1x) unscheduled searches (spring hunt).
3+0: signifies that a Calibration Plot sustained three (3) scheduled searches and no (0) unscheduled searches.
3+1x: signifies that a Calibration Plot sustained three (3) scheduled searches plus one (1x) unscheduled searches (spring hunt).

Case II A+B: 3+1x, 2+1x, and 1+1x are the Case II levels of human disturbance.

TABLE 10. Chronology of emperor geese nesting at waterfowl field camps on the Yukon Delta NWR, 1983.

Event	Kokechik West	Tutakoke	Old Chevak	Manokinak	Kigigak Island	South Nelson Is.	Cackler Plots	Whitefront Survey
Initial arrival	Prior to 5/9	-	-	Prior to 5/8	Prior to 4/29	-	-	-
Peak arrival	Prior to 5/9	-	5/7-5/9	5/9-5/12	4/29-5/1	-	-	-
Nest initiation	-	-	5/17	5/16	5/12	5/11	-	-
Peak nest initiation	-	-	None	5/20-5/21	None	5/15-5/17	-	-
Initiation of incubation	-	-	-	5/22	5/20	5/18	-	-
Peak initiation of incubation	-	-	-	5/28	5/23	5/21-5/23	-	-
First clutch to hatch	-	-	6/16	6/15	6/12	6/11	-	-
Peak of hatch	-	-	None	6/21	6/14-6/16	6/16	-	-
Nesting attempts	0	0	44	122	48	24	156	-
Nests for which no eggs were laid	-	-	0	28	0	-	-	-
Nests for which no eggs hatched	-	-	24	2	10	0	28	-
Nests for which one or more eggs hatched	-	-	19	74	38	23	32	-
Nest status undetermined	-	-	1	18	0	1	96	-
"Complete" clutch size	-	-	5.0 (n=30)	5.4 (n=55)	5.9 (n=35)	6.0 (n=1)	-	-
"Incomplete" clutch size	-	-	-	2.8 (n=4)	3.8 (n=5)	6.5 (n=21)	5.3 (n=136)	-
Class I brood size	-	-	-	3.7 (n=50)	3.5 (n=2)	-	-	-

TABLE 11. Chronology of Pacific white-fronted geese nesting at waterfowl field camps on the Yukon Delta NWR, 1983.

Event	Kokechik West	Tutakoke	Old Chevak	Manokinak	Kigigak Island	South Nelson Is.	Cackler Plots	Whitefront Survey
Initial arrival	Prior to 5/9	-	Prior to 5/5	Prior to 5/8	Prior to 4/29	-	-	-
Peak arrival	Prior to 5/9	-	5/7-5/9	5/9-5/12	5/7-5/8	-	-	-
Nest initiation	-	-	5/16	5/17	-	5/13	-	-
Peak nest initiation	-	-	5/18-5/22	5/21-5/22	-	5/15-5/17	-	-
Initiation of incubation	-	-	-	5/23	-	5/18	-	-
Peak initiation of incubation	-	-	-	5/24-5/27	-	5/21-5/22	-	-
First clutch to hatch	-	-	6/16	6/15	-	6/12	-	-
Peak of hatch	-	-	6/18-6/22	6/18-6/19	-	6/15	-	-
Nesting attempts	13	4	32	38	4	31	52	153
Nests for which no eggs were laid	0	0	0	5	-	-	-	-
Nests for which no eggs hatched	3	0	11	1	1	1	0	11
Nests for which one or more eggs hatched	7	4	21	27	3	29	18	140
Nest status undetermined	3	0	0	5	0	1	34	2
"Complete" clutch size	3.0 (n=1)	-	5.4 (n=23)	-	-	6.5 (n=2)	-	-
"Incomplete" clutch size	4.8 (n=5)	4.2 (n=4)	-	4.8 (n=4)	4.0 (n=3)	4.7 (n=27)	4.2 (n=52)	4.7 (n=142)
Class I brood size	-	-	-	2.9 (n=16)	-	-	-	-

TABLE 12. Effects of scheduled and unscheduled searches on nesting success of Pacific black brant on the Yukon Delta NWR, 1983.

Treatment levels			Density of predators per unit area[1]		
			Low	Medium	High
Plot strategy	A+B	A+B			
	1+0		-	Kigigak I[2] & II (92%, 100%)[3]	Kokechik I & III (60%, 72%)
		1+1x	-	-	Kokechik II (12%) Brant Plot I (30%)
	2+0		Tutakoke I & II (87%,90%)	Kigigak I (78%)	Kokechik I, II & III (59%, 67%, 54%)
		2+1x	-	Kigigak II (67%)	-
	3+0		Tutakoke I & II (80%, 83%)	Kigigak II (83%)	-
		3+1x	-	Kigigak I & III (46%, 60%)	Kokechik I & II (76%, 9%)

1 At this stage of field assessment, predator densities are subjective estimates.
2 Roman numerals correspond to individual Calibration Plots at the respective camps.
3 Numbers in parentheses are nesting success values.

TABLE 13. Cackling Canada goose nesting data from two Onumtuk study plots on the Yukon Delta NWR from 1969-1983 (1974 omitted).

	Onumtuk 1	Onumtuk 2
Year	No. of Nests	No. of Nests
1969	34	50
1970	31	52
1971	30	39
1972	29	23
1973	18	39
1975	15	26
1976	17	50
1977	22	47
1978	26	48
1979	22	44
1980	25	43
1981	25	32
1982	17	25
1983	17	18

TABLE 14. Number of nests located on the Yukon Delta NWR, 1983.

	Field effort			
	numbers of nests which sustained one or more[1] visits			
Field camp	brant	cacklers	emperors	white-fronts
Kokechik Bay (West)	657	-	-	-
Tutakoke River	676	-	-	-
Kigigak Island	601	193	48	4
Manokinak River	-	187	122	38
South Nelson Island	-	34	24	31
Total number of nests	1,934	414	194	73
Maximum number of geese directly disturbed	3,868	828	388	146
Population estimate 1983	109,314	55,000	79,155	90,000
Percent of total population disturbed by effort	3.5%	1.5%	0.5%	0.2%

[1]sustained one or more visits <u>prior to hatch</u>.

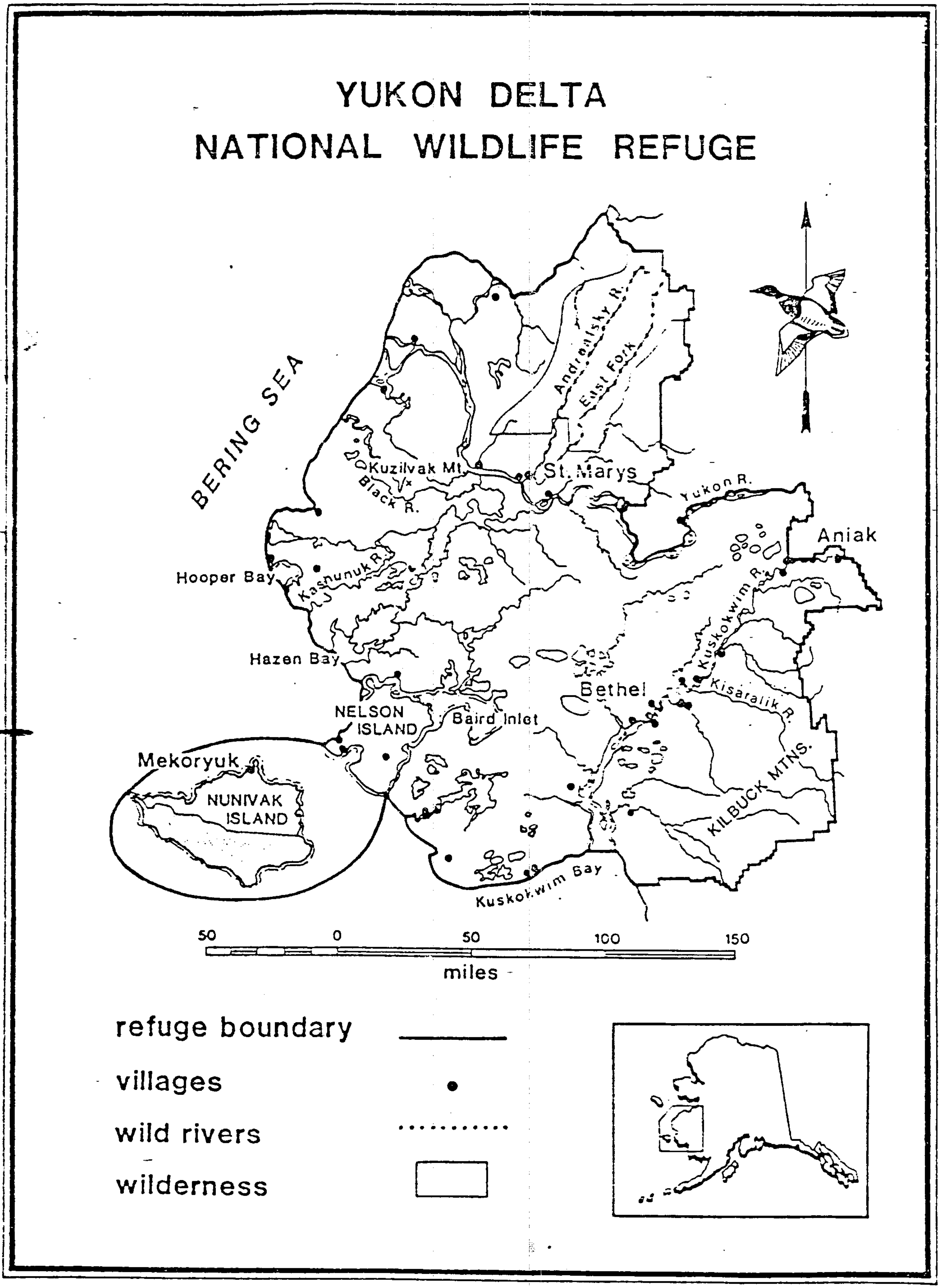

Figure 1. Location of Yukon Delta National Wildlife Refuge

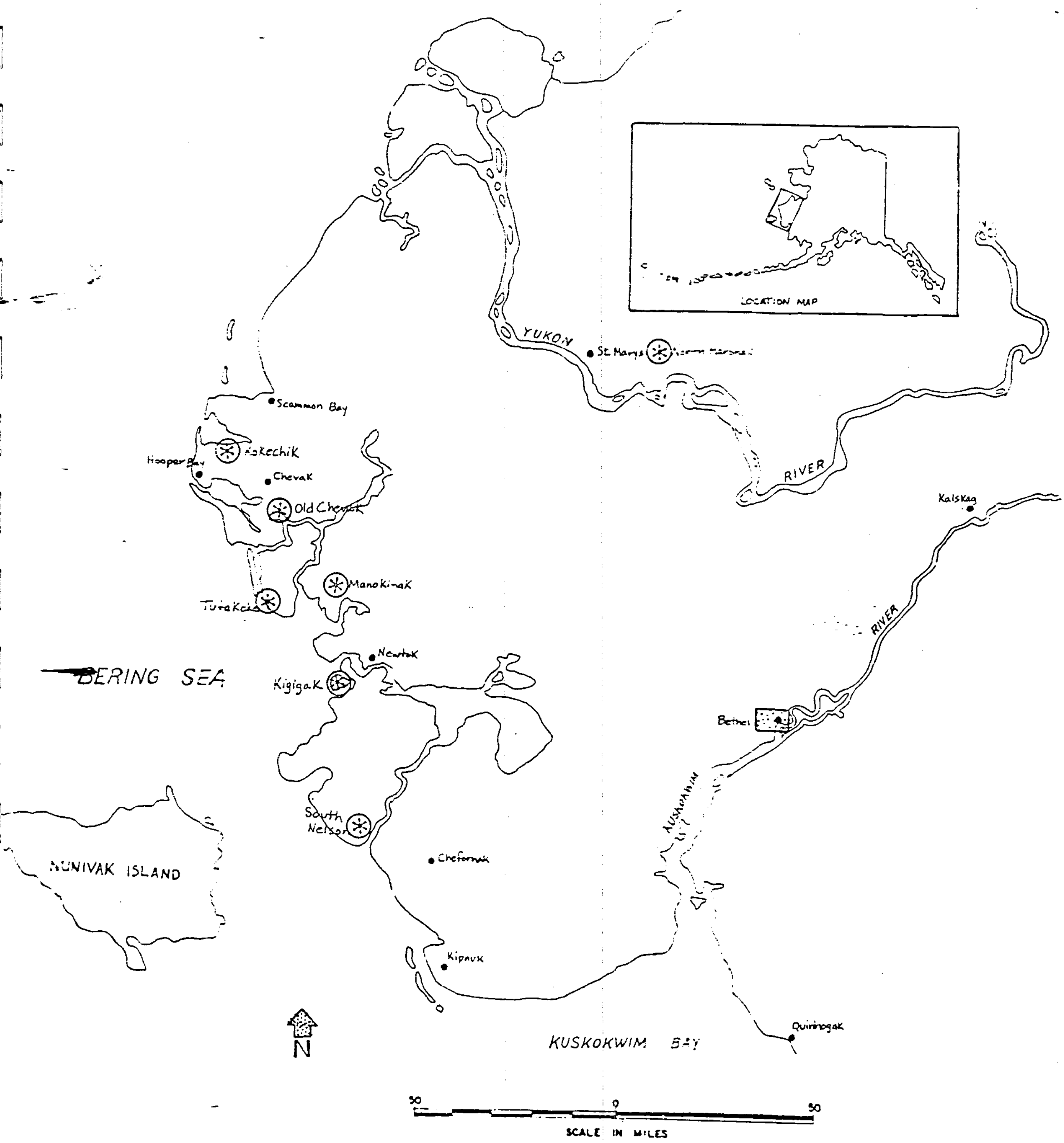

Figure 2. Distribution of field camps throughout the principal goose nesting area of the Yukon Delta NWR. Camps designated by the symbol ⊛

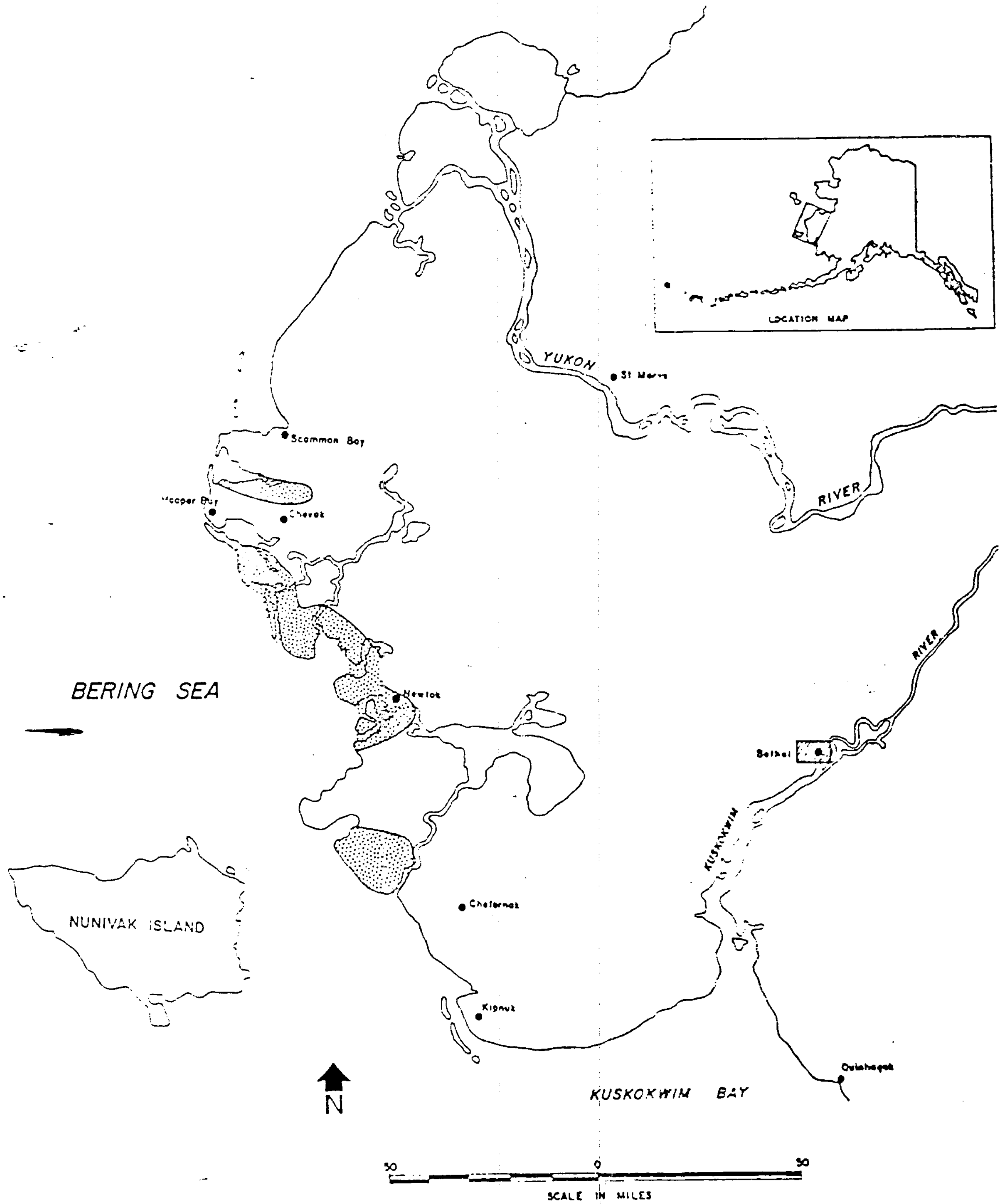

Figure 3. Distribution of nesting Pacific black brant on the Yukon Delta NWR.

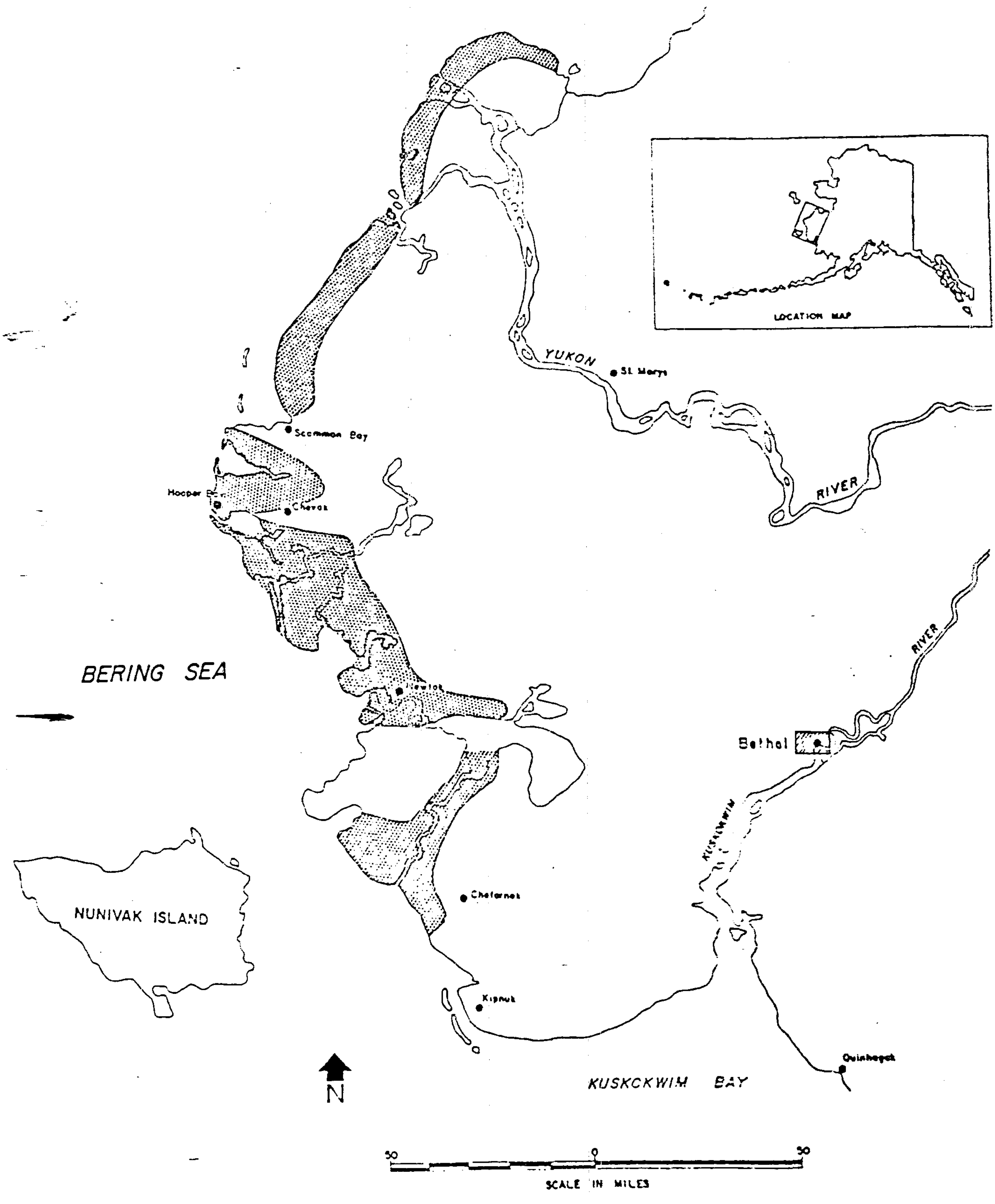

Figure 4. Distribution of nesting cackling Canada geese on the Yukon Delta NWR.

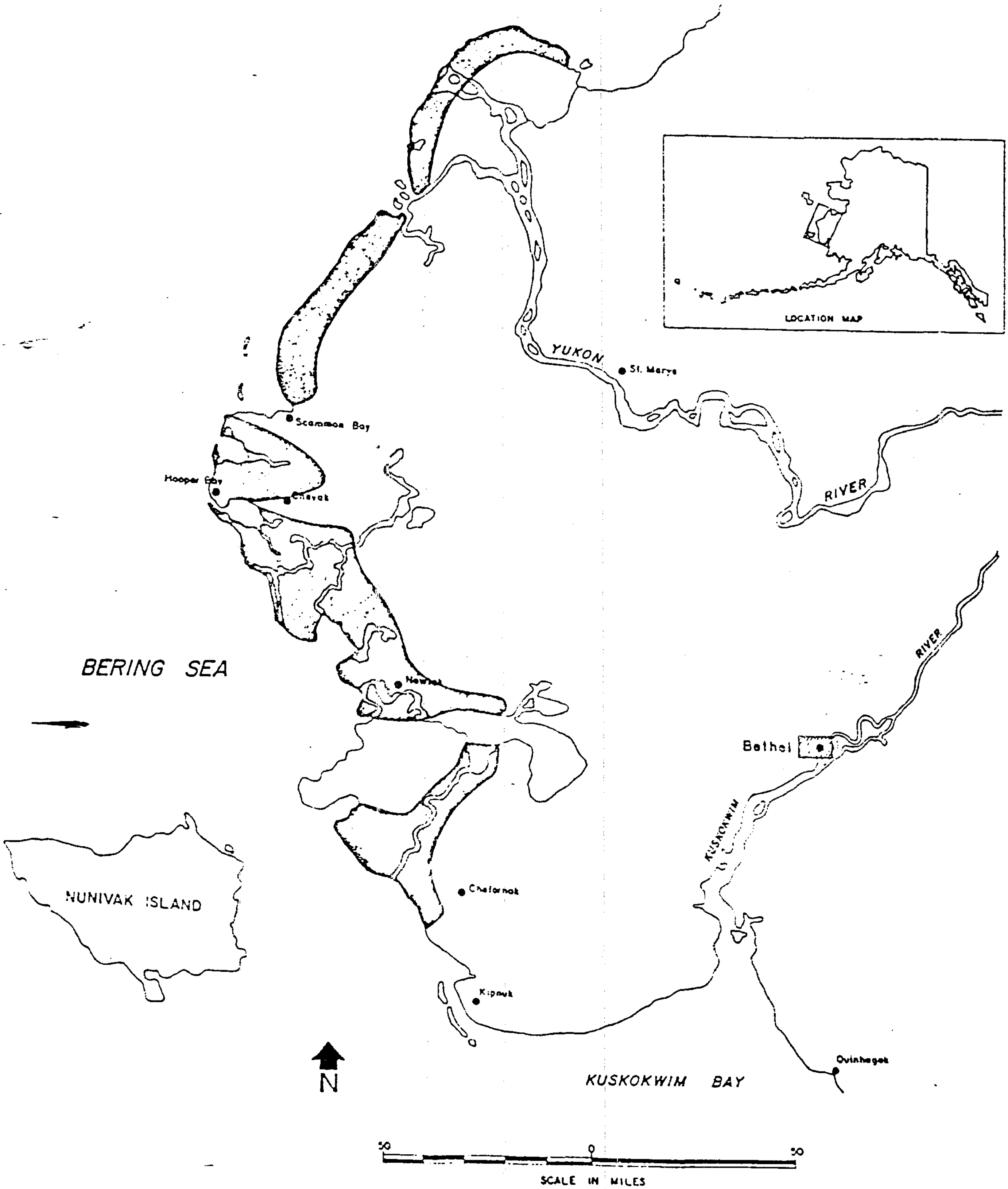

Figure 5. Distribution of nesting emperor geese on the Yukon Delta NWR.

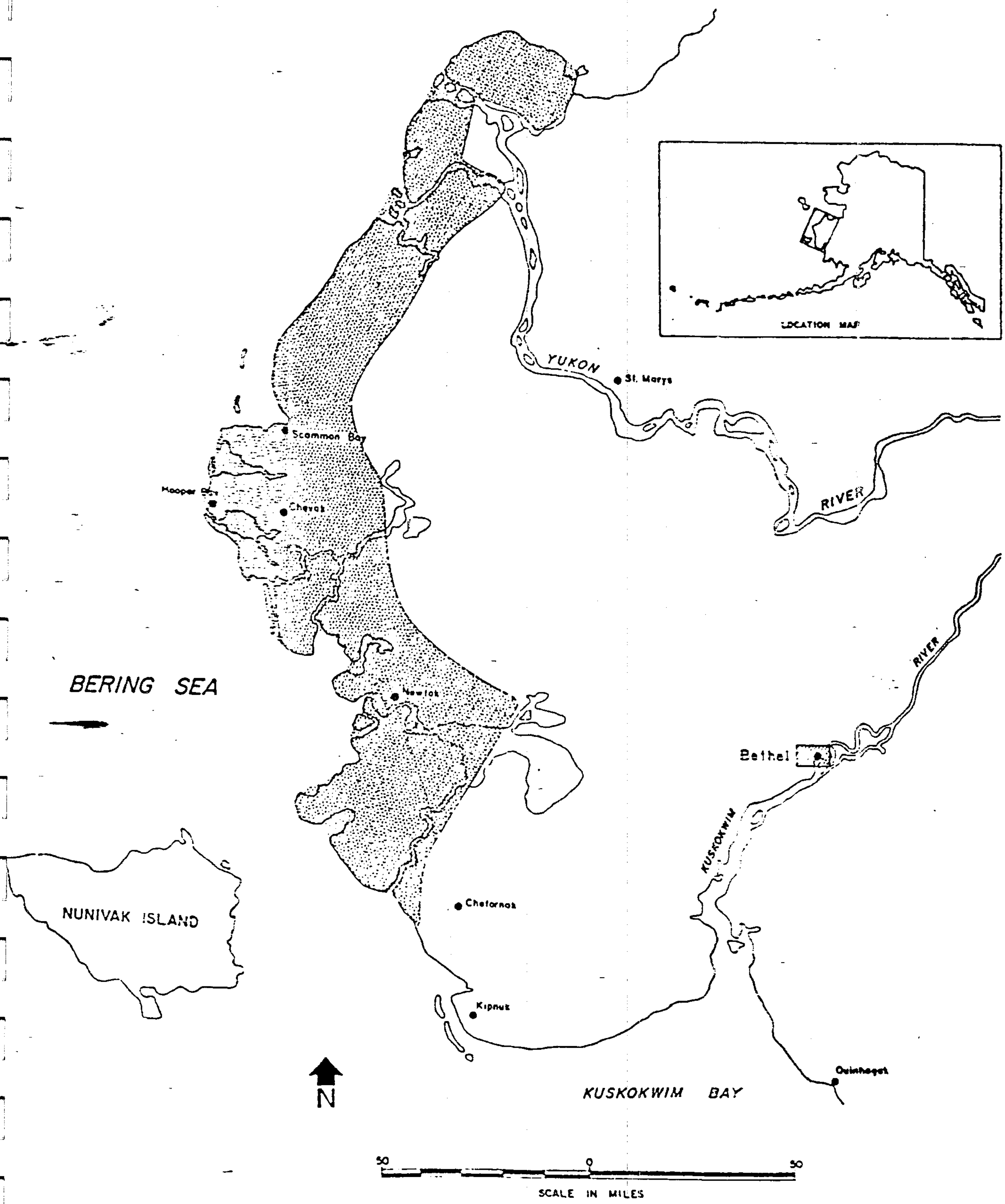

Figure 6. Distribution of nesting Pacific white-fronted geese on the Yukon Delta NWR.

Scheduled and Unscheduled Human Activity (time and activity budget generalized)

Julian days

```
           140        150        160        170        180
:.........:.........:.........:.........:.........:.........:.........:.........:.........:.........:
   initiation    incubation                          hatch
```

Scheduled dates or time periods of human activity:

```
Calibration   ......:...X.....X.....X...:.X.....X.:...X.....X.....X...:.X.....X.:.........:.........:.........:

                            1st search period         2nd search period    3rd search period
Validation                  _________________         _________________    _________________

                                                      1st search period    2nd search period
Primary                                               _________________    _________________

                                                                           1st search period
Secondary                                                                  _________________ - - - - - - -

           140        150        160        170        180
:.........:.........:.........:.........:.........:.........:.........:.........:.........:.........:
```

The salient characteristics of sampling strategies relative to the "treatment level" are:

1. scheduled human activities:
   a. Calibration: (1) Time is expressed in Julian days. Reference date, day 152: June 1, 1983; "X" represents one visit into the plot; (2) during nest initiation, days 137-143, or up to that point where incubation is first observed, the Calibration Plot may sustain several searches; (3) during incubation, days 145-168, the Calibration Plot may sustain three or more searches prior to hatch, i.e., one search every three days per plot.

   b. Validation: (1) under item "Validation" above, a horizontal interval (search period) symbolizes one visit into the plot; (2) between incubation and hatch two (2) searches are conducted per plot.

   c. Primary: (1) under item "Primary" above, a horizontal interval (search period) symbolizes one visit into the plot; (2) between incubation and hatch one (1) search is conducted per plot.

   d. Secondary: there are no scheduled human activities planned for these plots prior to hatch.

2. unscheduled human activities:

   a. shooting geese in the nesting areas (days 135-169)
      1. jump shooting
      2. pass shooting

   b. egging the nesting areas (days 145-165)
      1. egging only
      2. egging and jump shooting

   c. shooting or driving flightless geese (days 179-200)

FIGURE 7. Schedule of human activity -- "Functional Treatment".