Spring Raptor Migration Studies at Cape Flattery, Washington in 1990-1997

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ABSTRACT

Cape Flattery, situated on Washington State's Olympic Peninsula, is a concentration point for raptors in northward spring migration before crossing the 13+ mile Strait of Juan de Fuca water barrier. It is also immediately exposed to Pacific weather systems that dominate Northwest weather. Cape Flattery is a part of the Makah Indian Nation lands, and these migration studies have been facilitated by the Makah Tribe's generosity and interest.

Field observations at Cape Flattery were begun in 1983 by Bud Anderson and the Falcon Research Group, with full-season studies in 1985-1987. D Byrne assumed responsibility for the studies in 1989, and provided technical direction through 1993. Beginning in 1993 HawkWatch Int'l (HWI) has collaborated in the studies, with an HWI observer providing day-to-day continuity and expertise. The authors have coordinated and reported the studies since 1991, together with a group of Ad Hawk volunteer hawkwatchers.

Full-season coverage (30 days or more) of the spring migration in the past eight years, 1990 –1997, is reported here. Red-tailed Hawks are the dominant species observed at the Cape, and the numbers sighted have not evidenced any obvious trends over 12 seasons, but substantial year-to-year fluctuations. Bald Eagle observations at Cape Flattery are not included in the reported data due to substantial numbers of resident birds.

The large variability in raptor sightings day-to-day and year-to-year is examined, and year-to-year variations in spring weather conditions in the Northwest are concluded to be a major source of variations in timing, duration, and magnitude of the migration passage observed. The studies of recent years have focussed on sighting counts and observation of the flight behaviors resulting from significant topographical features and major influences of local and regional weather. A model to account for the impact of weather-pattern variation is presented and explored.

A Discussion section ending this report focuses on the accomplishments of these Cape Flattery studies in light of objectives stated in 1991. The large day-to-day and year-to-year variations in sightings are found to relate well to regional weather patterns affecting flight conditions in the Cape Flattery region, but a major puzzle lies in accounting for the raptors not seen in low-count years. A search for complementary and/or alternative flyways is needed, as well as data from further south on the presumed coastal flyway route.

CONTENTS

TABLES and FIGURES

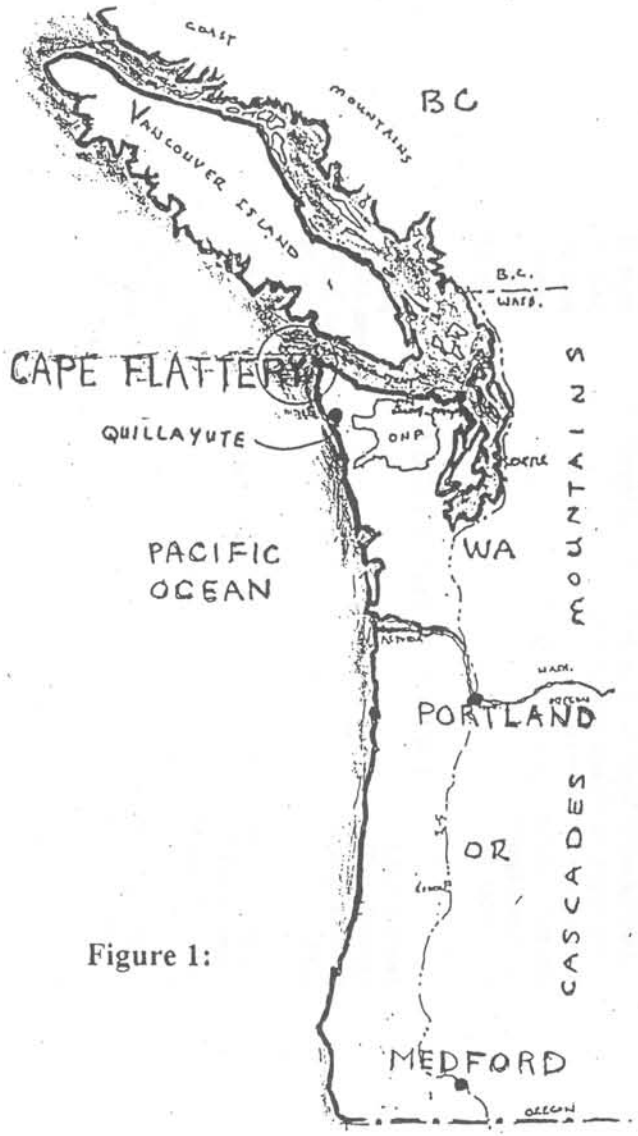


Figure 1:

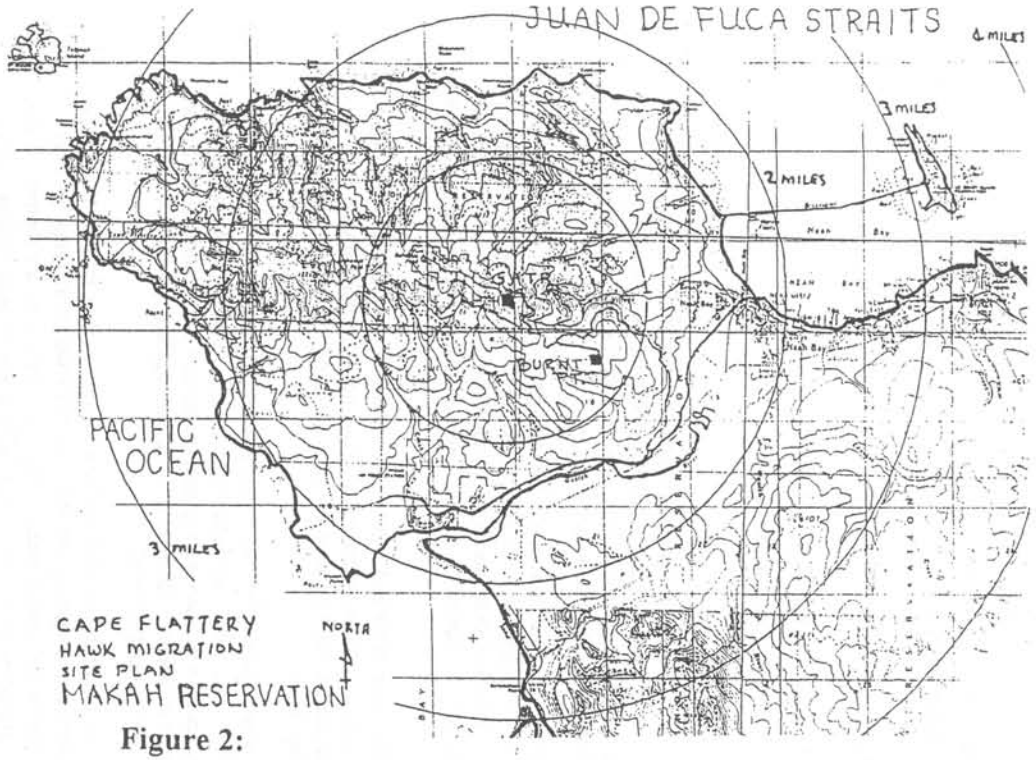
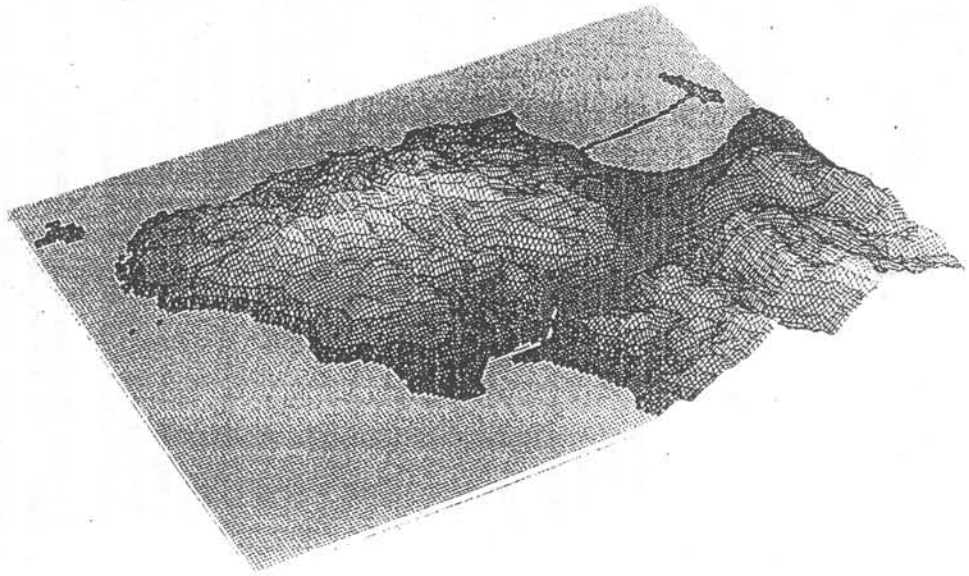


Figure 2:



Looking northeast across Cape Flattery towards the Vancouver Island coast near San Juan Point and Port Renfrew

Figure 3:

SPRING RAPTOR MIGRATION STUDIES AT CAPE FLATTERY, WASHINGTON -- 1990-1997

Geography and Background

The locale

Cape Flattery is a mountainous mass that forms the northwest tip of the Olympic Peninsula, the most westerly part of Washington state. It rises to about 1400 ft elevation at Bahokus and Archawat Peaks and extends about 4 1/2 miles west to east and 3 miles north to south. This rocky prominence is separated from the bulk of the Peninsula by the Waatch Valley, a near-sea-level tidal- river plain connecting Makah Bay on the Pacific Ocean with Neah Bay on the Strait of Juan de Fuca. Cape Flattery forms perhaps 1/4 of the Makah Indian Reservation.

The Strait of Juan de Fuca is a remarkably uniform water barrier about 13 miles wide separating the Olympic Peninsula and Vancouver Island, BC, and extending east from Cape Flattery about 60 miles to Port Angeles, WA and Victoria, BC. The Strait connects the inland seas of Puget Sound and Georgia Strait with the Pacific Ocean, at Cape Flattery. Its centerline is the international boundary between the U. S. and Canada. The 13 mile water barrier of the Strait of Juan de Fuca is the most significant water barrier north of Mexico for northward migration of raptors in the West.

Figure 1* is a map illustrating the portion of northwest North America presumed to contain the flyway for the raptor spring migration that appears over Cape Flattery. **Figure 2** illustrates the Cape Flattery area and locations of the principal observation sites, and shows distances with a set of concentric circles. **Figure 3** is a computer-generated aerial view of the Cape and the Waatch valley with its tidal river and near-sea-level connection between Makah Bay on the Pacific Ocean and Neah Bay on the Strait of Juan de Fuca. The view in Figure 3 is toward the Canadian coastline of Vancouver Island, about 13 miles distant..

Background of the Cape Flattery raptor migration studies

Field observations at Cape Flattery were begun in 1983 by Clifford (Bud) Anderson and the Falcon Research Group, with full-season studies at the Bahokus Peak sites in 1985-1987. D Byrne of the Northwest Raptor Center directed the studies from 1989 through the early 1990s, with a group of volunteer hawkwatchers providing the principal observer corps beginning in 1991. HawkWatch International, led by Steve Hoffman, has collaborated in the studies since 1993, and beginning in 1997 has formalized a research agreement with the Makah Nation for the work.

An account of the history and participants in 14 years of Cape Flattery raptor migration studies and the reporting of results is provided in the Appendix of this report.

Table 1* summarizes, briefly, 11 years of documented full-season migration studies at Bahokus Peak sites. The present report presents data from only the most recent 8 years, 1990-1997.

(* Figures 1, 2 & 3 are located on page 2, facing this text. The remaining Tables and Figures are grouped together at the end of the report, with page numbers identified on page 1. Tables and Figures are identified in **bold** typeface on their first mention in the text.)

Selection of Data for Summaries and Analyses

Sightings vs confirmed migration crossings

The emphasis in the Cape Flattery data is on ***sightings*** of raptors. There are several reasons for this:

- Cape Flattery serves as a concentrating area for raptors facing a significant over-water flight of 13+ miles – presumably the longest unavoidable over-water crossing between Mexico and northern Canada/Alaska. The predominant species seen at the Cape are not considered to undertake over-water crossings much greater than this, so "testing the air" and trial or abortive crossing flights are evident, but not always distinguishable from successful crossings.
- Even with the clear air and good visibility of better days at the Cape, one can only hope to observe birds crossing over the 13+ mile width of the Strait with long minutes of undivided attention and a good 'scope, and even then successful landfall is not ascertainable. Anything approaching confirmation, from Cape Flattery, of crossings for large and changing kettles of raptors on a busy day is impracticable. The landfall areas along the Vancouver Island BC coast across the Strait are mostly inaccessible to vehicle access, and the logistics of any extensive observation along many miles of the destination coastline are forbidding.
- A complex variety of wind currents and lift conditions greets raptors arriving to the area as a result of (a) the topography of the Cape with its steep bluffs and Bahokus and Archawat Peaks, (b) the marine exposures to the Pacific Ocean and the 60-mile long Strait, and (c) the succession of Pacific weather systems crossing through in the spring months. The consequence for field observation is that on one day the soaring birds may appear from the south gaining altitude rapidly, and cross in large kettles, while on another they may work back and forth across the Cape, sometimes out of sight, and finally find lift nearby, or at the western end of the Cape, or far to the east over the mainland, to attempt crossing. The falcons, harriers, and others (for example, the flocks of Sandhill Cranes) that power across are obviously easier to ascertain.
- Observers become proficient in keeping track of individuals or kettles that are in the area for protracted periods on days with uncertain lift, but inevitably some double-counting occurs. Presumably there are missed sightings, especially on days with many birds almost out of sight to the east, to offset. Likewise, counting of birds that are not currently at crossing altitudes and headed north may result in double-counting of those that are temporarily staging in the area, but the alternative would miss counting those that flew by and subsequently crossed from east or west of the observation site.

Exclusion of Bald Eagles from reported counts

None of the data and analyses in this report include Bald Eagle sightings. A discussion of raptor activity in the Northwest that excludes Bald Eagles may seem curious, but the reasoning is sound. Bald Eagles do migrate northward past the Cape, but substantial numbers are also resident on the Cape and on nearby coastlines to the east and south (As many as five active nests on the Cape is common). Observation of these locals is both fascinating and instructive, as their flight behaviors help to indicate flight conditions for other, migrating raptors. The Bald Eagles are tallied on the field data logs, and age-identified according to plumage characteristics, but substantial multiple-counting of individual birds is unavoidable even for an astute observer over the course of an active day, and is almost certain over the span of the season. Therefore the Bald Eagle data have been consistently excluded from reported Cape Flattery results over the years.

Description of Raptor Sightings by Day and by Species

Sightings by day over the years 1990-1997

Figure 4 summarizes the raptor sightings counts by day from eight full-season studies (1990-1997) of the spring hawk migration at Cape Flattery. The graph of Figure 4 illustrates the large variability in numbers of raptor sightings, from year-to-year. No obvious long-term trend is evident, however, as the 1994, 1995 and 1997 totals are comparable to the 1985-7 totals from the earlier Falcon Research Group studies noted in Table 1.

Not only are the year-to-year totals variable, the day-to-day counts also show large fluctuations. In addition, the daily distributions are highly skewed, with a few very high days and many days of low sightings counts. **Figure 5** provides some insight into the distribution of daily sightings counts. The median daily count (half of the days had more, half had fewer) for each of the eight years is quite low, between 11 and 66 sightings in a day, as shown by the circle symbols connected by a bold line. The other graph lines and symbols show the 25th, 75th, and 90th percentiles of daily sightings.

Figures 6a and **6b** show the pattern of sightings over the study periods of the eight years 1990-1997. The horizontal axis is constant for all eight graphs, covering the period from 14 March through 3 May. The actual starting day and number of days observed varied from year to year, with the study days numbered and days outside of the study period marked "X". The actual contiguous observation periods varied from a low of 31 days in 1990 to a high of 49 days in 1992 with a median span of 44 days.

The vertical axis, number of sightings per day, has the same scale on all eight graphs for easy comparability. The 1990 graph is discontinuous at the top, however, to accommodate the peak 3864 sightings day, nearly double that of any other day over the eight years.

The eight graphs or Figures 6a and 6b illustrate not only the variability day-to-day but differences in the timing of the most-concentrated sightings and in the dispersion of sightings across the time period.

The field observation results shown in Figures 4, 5, and 6 illustrate graphically the large year-to-year and day-to-day variability that occurs in the Cape Flattery observations. The implication from these graphs is that the sightings of raptors at Cape Flattery (primarily at the GATR site on Bahokus Peak) occur mostly in short several-day pulses spaced irregularly throughout the spring seasons. The evidence for this variability being associated with regional weather patterns is discussed in a later section of this report.

Analysis of Species Distribution by year -- 1990-1997

Figure 7 illustrates, for the data over the past eight years, 1990-1997, the percentages of overall sightings for groupings of species. The message here is that since about ¾ of the sightings are accounted for by Buteos, only limited conclusions can be drawn from observed year-to-year variations in proportions among the least-sighted migrants.

Sightings of various species by year, both as individual species counts and as percentages of overall raptor sightings, are presented in **Table 2**. Caution is in order in comparisons. The distribution by species for the 1990 study may be distorted by the record number of buteos observed, as it appears that the other species were not sighted in inordinately large numbers.

A statistical analysis has been done to determine changes in species composition of the sightings over the 8 study years 1990-1997. Regressions were calculated using the percentage of all sightings in each year by eight species groupings (buteo, accipiter, falcon, Golden Eagles, Northern Harriers, Osprey, Turkey Vulture, and unidentified other) and the total sightings by year. The clearest indication of change over the 1990-1997 period was an increase in percentage of Turkey Vulture sightings (significant at $p=0.024$). Only a few were sighted in 1990, near 90 in 1991 and again in

1992. Since 1994 the spring sightings have increased rapidly, with over 300 sightings in each of the past two years.

The 1996 sightings of Turkey Vultures are especially noteworthy, in that overall sightings including our most-often-observed soaring raptor, the Red-tailed Hawks, were inordinately low in numbers in 1996.

From 1991 onward the use of standardized field log forms, the larger observer corps, and ongoing communication among observers has perhaps resulted in more consistent reporting across species, but the concentration on two Bahokus Peak observation sites has possibly reduced sightings of species seen in other than soaring flight conditions. The participation since 1993 of trained HWI observers has probably improved discriminations. The number of rarely-observed *Other Buteos* (OB) is perhaps understated, as they could be mis-identified in mixed kettles of Red-tails, accipiters, TVs and Eagles at high altitudes, long distances, and poor visibilities. Similarly, some mis-identifications between Sharp-shinned and Cooper's Hawks are inevitable.

The data for raptor sightings at Cape Flattery by species and day are included here for all eight study years 1990-1997, as **Tables 3a** through **3h**. The tables also show observation hours per day, total sightings (excluding the Bald Eagles) by day, and total observation hours and species-sightings totals for each study year.

The Impact of Weather Pattern Variation

Weather observations for the Cape Flattery studies

No regular land-based official weather observations are available at Cape Flattery or Neah Bay. Hourly surface marine-environment wind, temperature and barometric-pressure data from Tatoosh Island off the northwest end of Cape Flattery have become available via Internet in the past several years from the National Data Buoy network, but have not yet been analyzed in detail for relevance. Reliable surface and upper-air data from the National Weather Service station at Quillayute (located about 30 miles south of Cape Flattery and with near-ocean exposure) are available and in our data archives. The intraday temperature-rise values discussed in detail later in this report have been derived from Quillayute data.

In the next two sub-sections, ***Observation-site weather data*** and ***Interpretation of the observation-site weather data,*** we describe and analyze weather data taken at the observation sites by those observing the raptors. A third sub-section, ***Consideration of barometric pressure and upper-level winds***, adds to understanding of the observation-site spring weather conditions. Then, in the ***Implications of weather patterns*** sub-section we consider weather patterns as they may affect the flight of soaring raptors in general. Finally, in ***A proxy indicator of flight conditions*** and the following sub-sections ***A model for weather-related variation in raptor sightings in the Northwest*** and ***Agreement between observation-site weather and Quillayute intraday temperature rise*** we suggest and test a simple model derived from readily-available weather data to explain the variability of sightings at Cape Flattery.

Observation-site weather data

Limited weather data have been recorded on the field data sheets by the observers at the active observation sites, typically hourly. The qualitative observations generally include wind direction and speed, temperature, sky condition, visibility and precipitation. Detailed quantitative meteorological measurements on-site have not been feasible, and not considered valuable or representative of the range of microclimates of the Cape Flattery area..

The weather conditions at the observation site in use are presented for each study day for the eight years 1990-1997, in **Tables 4a** and **4b**. Days with marginal weather conditions often required observations at the lower, Burnt Point, site during hours when the higher, GATR, site was obscured.

The most useful data obtained at the observation sites are hourly qualitative observations of sky condition and visibility, wind direction and intensity, and presence of precipitation or fog (obscuration of the upper Bahokus Peak site at GATR, as well as lower fog conditions). Temperature data have also been obtained for some years, but are not included here. The format for these observations, at the bottom of the main field data form, has been constant since 1991, though individual judgments and recording of conditions have not been closely controlled. Generalizing and coding of the data for Tables 4a and 4b have been done over all data years by one individual familiar with the field conditions. Typically the dominant condition over the active observation period of the day is coded. Thus, "ptcl" for "partly cloudy" represents a varying sky condition as opposed to an essentially "clear" or "overcast" observation day. Precipitation or fog during any appreciable part of the observation day is coded, however.

Wind intensity is coded as a 3-letter code for the dominant intensity over the observation day, with an additional one-letter code for significant but less persistent conditions. Only the dominant wind intensity is reported in the narrative analysis which follows. The direction *(from which the wind blew)* was recorded in the field for the 16 common compass points, oriented to *true north*, with the eight points *n, ne, e, ...* used most. Wind direction often shifted during the observation day, and the significant different directions are coded on Tables 3a and 3b. Over the 8 years' data these amount to about 1.5 wind directions per day on average.

Interpretation of the observation-site weather data

The daily data over the 340 days of 8 years' studies 1990-1997 have been ordered according to the number of raptor sightings, from lowest to highest, and divided into four equal groups, or *quartiles*, for the discussions that follow. The 4th or highest quartile of days represents about 85% of the raptor sightings, the 3rd quartile slightly over 12%, and the 2nd quartile and lowest quartiles very small fractions of the total sightings.

- **Sky condition and precipitation**: About 80% of days in the 4th or top quartile of sightings per day were *clear or partly cloudy*, about half of these being *clear*. The percentage being *clear or partly cloudy* decreased to about 50%, 30% and under 10% respectively in the lower quartiles, and about 75% of days were *overcast* in the lowest quartile. About 25% of days in the 4th or top quartile of sightings included some *fog* or *precipitation*. The obscuration or precipitation increased in the lower quartiles, to about 85% of days in the lowest quartile. Rain, showers, or drizzle predominated, with snow and hail occurring also. Some confusion exists in the field recording between fog in the lowlands and marine waters and obscuration of the Bahokus Peak sites in fog (stratus).

- **Wind intensity**: In the 4th or top quartile of sightings, *calm or light* wind intensities prevailed in about 65% of days, *moderate* intensities for about 25%, and *strong* for about 10%. The lower intensity proportions decreased and the *strong* intensities increased through the lower quartiles until the *strong* winds occurred in about 35% of days in the lowest quartile of raptor sightings days.

- **Wind direction** (from): Three sectors are important, representing different topography, exposure and wind characteristics. An *East Sector* covers true compass directions from NE clockwise through SE and winds coming from inland and out the Strait. A *South-&-West Sector* covers winds from compass directions SSE clockwise through WNW, being marine winds from offshore and open ocean. A *North Sector* includes the remaining compass points from NW clockwise through NNE and covers winds from over Vancouver Island across the Strait. For the 4th or top quartile of sightings days, nearly 75% of wind directions were from the *East Sector* , somewhat over 15% from the *South-&-West Sector*, and about 10% from the *North Sector*. (And note as

mentioned above that about 65% of wind intensities in the 4th quartile of days were *calm or light*.) For the lower quartiles, representing a minority of the sightings, the wind direction distribution changes dramatically. In the 3rd quartile of days the *East Sector* winds drop to under 35% and the *South-&-West Sector* winds increase to about 55%. At the lowest quartile of signtings days the *East Sector* winds are under 25% and winds from the *South-&-West Sector* account for about 70% of the observed directions.

Consideration of barometric pressure and upper-level winds

We estimated daily sea-level atmospheric (barometric) pressure data for the vicinity of Cape Flattery as of 0400 Pacific Standard Time by interpolating between isobars on the surface weather maps of the National Weather Service's Daily Weather Maps series, which we have for all of the spring migration periods. (These data are now available from the hourly Tatoosh Island data buoy reports, but we have not acquired archive data.) These pressure data were analyzed for the past 3 years, 1995-1997, to test our understanding that relatively high pressure patterns inland would result in fair skies, easterly winds and good soaring conditions for the raptors. Indeed, relatively high pressures prevailed for the 4th or top quartile of raptor-sightings days compared to the 3 lower quartiles, and the difference was statistically significant ($p<0.01$).

Wind data at the 850 millibar level (about 5000 ft altitude) are available from the twice-daily upper-air soundings at Quillayute, and would likely be helpful. We have captured the soundings data via Internet intermittently over the past several years but have no analysis yet. (The archive data available from NOAA on CD-ROM for all upper-air sounding sites is pricey!)

Upper winds at the 500 millibar level (about 17,000 feet altitude) are available from the historic Daily Weather Maps series, but probably have limited value here, except possibly as they might indicate potential mountain wave conditions over high terrain southeast of the Cape and over Vancouver Island that could assist or hinder raptor migration at moderate altitudes.

Implications of weather patterns

Wind direction, wind speed, barometric pressure, pre-frontal and post-frontal conditions, and other particular aspects of weather as observed on the ground have been considered in studies elsewhere as having observable or hypothesized impacts on migration flight behavior. Reliable associations between such individual weather factors and raptor sightings at the Cape have been difficult to pin down, perhaps because of the unusual exposure of the coastal terrain to the variety of Pacific storm systems and the absence of prior land expanses to moderate those storm systems. Eight years of experience with the vagaries of spring weather at the Cape, several recent years' research into weather and climate throughout the Olympic Peninsula in conjunction with water-resource studies, and past years of light-plane flying have impressed us with these points:

- Small-scale local features (topography, land cover, land/water boundaries) affect local flight conditions and behaviors, both for soaring raptors and those more reliant on powered flight. Consequent local (observation site) weather conditions have bearing on where birds pop up in sight, where local lift sources develop, etc., but less correlation with variations in the fluctuating numbers of sightings. This situation at Cape Flattery differs from more inland, arid, southern sites where extended mountain ridges can provide more predictable flight routes, and weather conditions are relatively unchanging over longer distances and times.
- Large-scale geographic/topographic features (broad coastal plains and low hills backed by higher mountain ranges, persistence of on-shore marine cloud cover, impacts of forest clear-cutting, etc) probably strongly influence choice of migration flyways for the soaring raptors.
- Large-scale weather patterns, upper-air and surface, are probably key influences in the migration activity of soaring raptors in the Northwest. The characteristics of spring weather patterns in the Northwest are in part a consequence of the seasonal transition of Pacific weather systems (storm tracks) from the southwest Pacific coast in winter to the British Columbia and Alaskan region in

summer. The complexity of atmospheric and oceanic interactions that give rise to these systems (jet-stream dynamics, El Nino/Southern Oscillation, etc.) lead to extreme year-to-year variability and large day-to-day variations at the Cape Flattery latitude and exposure.

- The importance of single weather phenomena such as cold-front passage and wind direction that are evident in migration studies elsewhere are less obvious at Cape Flattery. Sometimes a storm system moving inland farther north, across northern British Columbia, results in a text-book frontal passage at the Cape. Other spring storms cross the West Coast south of Cape Flattery, striking northern Oregon and tracking northeast south of the Olympic mountains and across the Puget Lowlands. Often, the Cape bears the brunt of the vortex center or a secondary wave of a spring low-pressure storm system. The surface-level wind circulation influenced by the 60-mile-long Strait of Juan de Fuca bordered by coastal hills also complicates matters. Spring surface-wind conditions at the west entrance to the Strait at Cape Flattery often seem to alternate between easterly gales and westerly gales, channeled by the Vancouver Island and northern Olympic Peninsula landforms.

A proxy indicator of flight conditions

One weather factor that we have found strongly associated with raptor sightings at Cape Flattery is intraday temperature rise -- a proxy measure for good soaring flight conditions of buoyancy/thermal lift and good visibility (first discussed in our 1993 report (Ref 3), with a tentative explanation for the anomalous 1990 peak day). There are several justifications for considering intraday temperature rise (the difference in degrees Fahrenheit between the prior night-time low temperature and the day-time high) as a predictor. In west-coast marine environments, a small intraday temperature rise is often associated with flow of air onshore from the ocean, offshore high pressure, stable air mass and marine stratus cloud layers, and often with rain or storm events. Large intraday temperature rises, in contrast, generally equate with clear skies, ground-heating by the sun, and buoyant air masses and thermals. The predominant raptors in the Cape Flattery migration are soaring birds -- 70% or so are Red-tail Hawks, a small percentage are Golden Eagles and Turkey Vultures, and perhaps 15% are accipiters which, although capable of powered flight across the Strait, are seen to be quick to utilize thermal lift opportunities.

Figure 8 shows histograms illustrating the distribution of intraday temperature rise over the study periods of the eight years 1990-1997. The vertical bars indicate the percentage of days in each 5-degree category of temperature rise. A labeled arrow on each graph identifies the percent of days in that year's study period that had intraday temperature rise exceeding 15 degrees Fahrenheit. Only 21% of days in 1993 and 1996 study periods exceeded 15 degrees rise, while 55% of days in 1992 and 42% in 1990 and 1997 exceeded 15 degrees rise.

The temperature rise data are from regular observations at the Quillayute facility of the National Weather Service, located about 30 miles south of Cape Flattery, with near-ocean exposure. The temperature-rise data as a proxy for flight conditions generally agree well with observation-site weather conditions obtained by the raptor observers at Bahokus Peak., as can be noted on Tables 4a and 4b.

The terrain and weather environment at Quillayute is probably typical of that traversed by the raptors shortly before reaching Cape Flattery and of the coastal-plain environment of much of western Washington and Oregon. The Quillayute site is also an important measuring site (together with Port Hardy, BC, and Salem and Medford, OR, along the west coast) for upper-air soundings, taken twice daily, that can help to define flight conditions.

A Model for Weather-related Variation in Sightings in the Northwest

Analysis of the intraday temperature-rise values for the 8 study years 1990-1997, for days ordered into four quartiles of raptor sightings (as with the on-site observations discussed above) substantiate the association between temperature rise and sightings. Median temperature rise was 22 degrees

Fahrenheit for the 85 days in the 4th or top quartile of sightings (85% of all sightings). Median temperature rises were 14 degrees, 10 degrees and 8 degrees for the three successively lower quartiles with dramatically fewer raptor sightings.

Figures 9a and **9b** illustrate the correlation day by day between intraday temperature rise (at Quillayute -- 30 miles south of Cape Flattery) and spring raptor sightings at Cape Flattery for the eight years 1990- 1997. We have explored the use of this simple proxy model for past years' data (Ref 3). These graphs have for the first time shown sightings per day on a logarithmic scale (log10) to accommodate the skewed distributions of daily sightings. (Sightings per day are increased by one so that the plotted value is equivalent to log10 of (sightings+1) to avoid the problem with log10 of zero.). Line graphs of the daily values of temperature rise (as measured at nearby Quillayute) are superposed on the log-scale bar graphs of sightings. These graphs illustrate the good correspondence between raptor sightings and a proxy for soaring-flight conditions.

Statistical analyses performed only for the 1995, 1996 and 1997 years, show a good linear relationship between the log-sightings and the intraday temperature rise, as detailed in **Table 5**. Inspection of the graphs of Figures 9a and 9b suggests that statistical analyses of the other years should be similar to the 1995-1997 years. Note that the 1997 analyses included precipitation as a significant independent variable. Precipitation was not found as significant in the 1995 or 1996 analyses. Inspection of the graphs of Figures 9a and 9b suggests that statistical analyses of the other years should be similar to the 1995-1997 years.

Agreement between observation-site weather and Quillayute intraday temperature rise

Agreement between the Quillayute intraday temperature-rise data and Cape Flattery flight conditions is good, as evidenced by several quick analyses over the eight years' data.

- 80% of raptor sightings occurred on days with intraday temperature rise exceeding 15 degrees Fahrenheit.
- 32% of days reported as "clear" sky conditions by observers corresponded to temperature-rise exceeding 15 degrees, while only 2% were reported as "clear" by observers when temperature rise was 0 to 15 degrees. 66% of days observed as "clear or partly cloudy" had rise exceeding 15 degrees, while only 24% were observed as "clear or partly cloudy" when temperature rise was low.
- 60% of days with temperature rise exceeding 15 degrees were observed to have "calm or light winds" at Bahokus Peak sites against 40% for low-temperature-rise days. Only 13% of high-temperature-rise days were reported as having "strong or gusty winds" against 27% of low-temperature-rise days.

Discussion and Summary

Focus of the early studies

Since 1983 when Bud Anderson and colleagues first focused on Cape Flattery, the spring hawk migration studies have explored several aspects. One sees in the early studies by Anderson's group an intense interest in the biology and behaviors of the bird species, an attempt to understand how the various species differed in their migration activities, and experimentation in the use of trapping and banding techniques to satisfy those interests. In the middle years D Byrne kept that focus but added her concentration on the "critters" and their individual actions.

Objectives of the later studies

The single-minded intensity and expertise of the early years was diffused somewhat as a broader mixture of volunteers became active in the '90s. In planning for the 1991 field work we identified five objectives for continuing studies, paraphrased here:

- A ***census objective***: How many birds appear at the Cape each spring? of what species?
- A ***scientific objective***: What bird behaviors steer the birds in our direction? Do regional and local weather conditions affect the timing of the over-water hop to Vancouver Island? Is the Cape Flattery route the flyway or perhaps one of several alternative routes north?
- An ***ecological objective***: Can the studies provide early warning of natural or human-caused changes that threaten the migrants? Can our data show trends in raptor populations?
- An ***educational objective***: Can we share with others our personal gain from studying the hawks -- scientific, spiritual, aesthetic, curiosity, or whatever? Can we recruit others?
- An ***operational objective***: Can we allocate our resources in future years to cope with weather and travel impediments, and to broaden our search for flyway variations?

Are we accomplishing those objectives?

- The ***census*** is being partially satisfied, given the limitations of distance and unpredictable weather. The 1991 study introduced standardized data log forms tailored to the site and field conditions and usable by different observers. Later years' studies have amassed a coherent database. The main limitations to the census data relate to our judgmental "sightings" criteria and lack of verification of actual migration crossings, and our possible missed overflights during periods of low overcast conditions at the Cape.
- The ***scientific*** task is a tough one. We've made some progress in identifying the extreme variability in raptor sightings at one location, Cape Flattery, with flight conditions severely impacted by regional weather patterns, but much work remains.

  Consider the 1997 and 1996 seasons, with a factor of 2 difference in number of sightings, 7255 vs 3586. Observation periods were identical, and both seasons were covered full-time by experienced observers with excellent skills.

  1) Did the population double in one year? Surely not!

  2) Did different fractions of the population migrate to summer regions north of here? Ideas of breeding site fidelity argue against, but do we know enough about these raptors, primarily Red-tails -- some of which are resident all-year at various locations over western North America?

  3) Are substantial numbers of migrating raptors overflying without our sighting them? Of course it is possible, given the possible flight altitudes of migrants, the limitations of human sight, even with good binoculars and search patterns, and coastal stratus conditions. But, these constraints are operative every year, except for some variation in weather conditions. And the full-time HWI observer in low year 1996 had executed a very successful several-month observation the prior year at Whitefish Point on the Great Lakes -- hardly a piece of cake for observing conditions.

  Radar-assisted observation may be the best hope for putting this question to rest. Rhonda Millikin of the Canadian Wildlife Service has had good results in songbird migration studies with portable radar, and in 1997 did some work in the Olympic Peninsula with Ken Wiersema's assistance. Frank Peace reported, at the 1997 HMANA meeting, work in the Southeast using fixed Weather Service radar to study raptor migrations. Perhaps support can be found to pursue radar studies, for raptor migration, at the Cape and elsewhere on the Peninsula.

4) Are we only observing one of several complementary or alternative flyways? Early explanations of the Cape Flattery concentrations suggested "leading lines" -- the northern Peninsula coastline of the Strait and the parallel sharp ridges of the "peripheral rocks" basalt and sedimentary formations behind the Strait coastline -- and strong east winds in the Strait. We have no substantial evidence of other comparable concentrations of raptors in spring migration on the eastern Olympic Peninsula. In spring there are numbers of experienced birders afield practically every day in the northeast Olympic Peninsula, and scant reporting of any raptor concentrations even remotely approaching those at Cape Flattery.

Our best assumption at this time is that the raptors we see at the Cape are migrating up the coastal plains and foothills between the Olympic mountains and the Pacific coastline, and there are few observations -- or observers -- in that area. Indeed, there are apparently no other substantial spring migration studies of raptors along the coastal regions of western North America, save for the Cape Flattery and Vancouver Island work. We'll need information from other locales to explore what brings the birds to Cape Flattery -- or to alternate flyways. Trapping and banding studies provide useful information at other sites, but the Falcon Research Group studies of the 1980s concluded that trapping was not practicable at Cape Flattery except for small raptors, primarily Kestrels in the Waatch valley. Perhaps satellite tracking such as Brian Woodbridge's highly successful documentation of the Swainson's Hawk migration down South America could work. But, contrary to the plight of the Swainson's our Red-tails seem not to be in imminent danger, and satellite tracking is pricey!

- The ***ecological*** objective can probably not be achieved with the Cape Flattery studies, except as part of a "western North American" multi-site effort. Year-to-year fluctuations in the numbers and timing of raptors sighted and the logistical difficulties in executing more-controlled field surveys limit what can be learned from Cape Flattery alone.
- We've had some success with the ***educational*** purpose -- both for the individuals involved and in the increased attention that has been focussed on the raptors in the programs and publications of birding groups. But the difficulties with the educational objective are several: a) the distance from population centers and the uncertainties in weather conditions and raptor sightings make organized field trips and individual visits problematical; and b) the observation sites are on limited-access lands away from the public-accessible areas of the sovereign Makah Nation.
- The ***operational*** objective has been met by great willingness and flexibility on the part of the volunteers; by the reality of a full-time observer staying at the Cape over the entire season; by the housing provided by the Makah Nation and tribal members and by NOAA Olympic Coast National Marine Sanctuary, and by improvements in communications and availability of weather data. We have not yet made any substantial progress on coverage of other sites concurrent with observations at the Cape.

In summary

Continuing studies at the Cape will certainly contribute to the personal experience and enjoyment of the individuals taking part. But, for pursuing the broader objectives stated above we must integrate the Cape Flattery studies with others to understand what populations of birds we are sighting, where they are coming from, where they are heading, and how they cope along the way. The continuing leadership of HWI and the execution in 1997 of a research Memorandum of Agreement between the Makah and HWI is an important step, and better ties with other Washington and British Columbia birders and educational programs would help. Finally, though, other west-coast studies to the south and to the north need to be undertaken to pin down the flyway(s) and explain the whereabouts of the raptors not accounted for in the puzzling year-to-year variations.

Appendix: History and Participants

Bud Anderson and Jim Fackler first brought birders' attention to the Cape Flattery migration in 1983, intending initially to focus on falcon activity at Tatoosh Island. Anderson, founder and director of the Falcon Research Group (FRG) of Bow, WA, and his FRG colleagues studied the spring migration from 1983 to 1987, with major full-season field observations in 1985, 1986, and 1987. (see Ref 1). There are no known records of organized observation in 1988.

D Byrne, founder of the Northwest Raptor Center (NRC) in Clallam Bay, WA, assumed responsibility and directed the research studies beginning in 1989, assisted principally by Janet Partlow in 1989 and 1990 and Matt Irinaga in 1990 (Ref 2). Byrne provided technical direction in 1991 and 1992 and continued an advisory role through 1993. Virginia and Welden Clark assisted with analysis and reporting of the 1990 study. The Clarks have coordinated and reported the studies beginning in 1991 as part of a group of volunteers (Ref 3), and have been joined by Ken Wiersema in the past several years. The 1993 spring study marked the beginning of collaboration with HawkWatch International (HWI), initiated by HWI's Steve Hoffman to integrate our Cape Flattery data with that from other ongoing spring and fall migration studies undertaken by HWI in the west. The 1997 study is the first under a formal research agreement between HWI and the Makah Nation.

In the field-study years since 1983 many serious volunteers have contributed major effort to the field work, and have been credited in the reports. The coalition of volunteers loosely banded together as the Ad Hawk group has been instrumental in planning and performance of the spring field studies since 1991 (predominantly from the Sequim/Port Angeles area but including hawkwatchers from Neah Bay and elsewhere in the West End, the Port Townsend area, Seattle and the east side of Puget Sound, Olympia, Portland, and elsewhere). Les and Roberta Jones, Pat Holden, Don and Kate Myers, Pat and Jack Fletcher, among others, have been active participants for the seasons in the '90s. In the 1996 and 1997 seasons Ken Wiersema and Bob Norton were key participants. The studies since 1993 have benefited from the day-to-day continuity of dedicated observers from HWI – Aaron Geis (1993), Sharmila Prendas (1994), Susan Salafsky time-sharing with Mari Remsberg (1995), Ulf Konig (1996), and Len Liu in this latest year (1997). Ned Currence, former Timber. Fish, and Wildlife Biologist for the Makah Tribe, and Bobby Rose, tribal member, Makah Museum board director, and founder of the ***house of ?akwati.d*** nature preserve, have been key resources at Neah Bay. Denise Dailey, Fisheries Biologist for the Natural Resources unit of the Makah Nation, has represented the Makah this past season and has formalized a research agreement with HWI for the studies.

Related studies by others

Canadian hawkwatchers have studied the fall concentrations of raptors on the southern portion of Vancouver Island for some years -- a phenomenon not unlike the spring concentrations found at Cape Flattery. Some joint-observation efforts have been attempted during recent spring studies, with cross-strait radio contact and frequent Email communications.

Related cross-strait collaboration with the Canadians has also helped Diann MacRae and her associates in the Olympic Vulture Study of cross-strait fall migration of the Turkey Vultures, another manifestation of raptor migrations in the coastal Northwest.

Rhonda Millikin of the Canadian Wildlife Service studied passerine spring migrations along the north Olympic Peninsula coast in 1997 as part of her research in British Columbia, assisted by Ken Wiersema and others, and has contributed insights and radar-enhanced observation techniques that may help in our future spring raptor migration studies.

Data from the early years

The Cape Flattery spring migration studies encompass a 14-year field-study history over a 15-year span since 1983. Differences in study objectives and focus, and in team complement, over three

periods of the studies must be recognized, however, in interpretation of the findings. As noted above, the first period of studies – 1983 to 1987 -- began in 1983 with a focus on falcon studies on Tatoosh Island, and included some reconnaissance of the entire Cape. The second year, 1984, consisted of pilot studies over a few days. In the third to fifth years – 1985 to 1987 -- full-season field studies were team efforts that evidenced strong focus on falcon species, on capture/banding activities, and on exploration of a variety of sites. The summary data on numbers of sightings, by species, have been reported in FRG newsletters, as referenced in (Ref 1), and the overall totals by year have been reported in our past analyses.. The skilled field observers of those early studies explored a number of sites and gained understanding of the complexity of local flight behaviors resulting from microclimate and topographic variations that has helped in later studies. We lack the first hand knowledge to presume to interpret further the details of those studies (although Bud Anderson of the Falcon Research Group has generously provided field notes to help us in our early years of involvement).

Data from the middle years

No spring studies were done in 1988. The studies of 1989 & 1990 were largely single-observer efforts, with individuals each covering several days at a time, and still exploring a variety of sites. Only summary data for 1989 are available, as part of the field records have been lost.

Field notes for 1990 are complete, we have discussed the season with all three of the primary observers, we visited the site during the study period, and we analyzed the field data and prepared the report for the season **(Ref 1)**. Further, the record number of buteo sightings and the anomalous peak day's activity needs to be included in analysis for understanding of the year-to-year variability at Cape Flattery. We have therefore included 1990 data in all analyses of this report.

Data from the recent years

Beginning in 1991 a larger group of volunteers has staffed the study. Field data logs customized for the observations, pre-study planning and ID-familiarization sessions and feedback between observers have offset the variability introduced by multiple observers. A trained observer from HWI has participated, full-time in 1993, 1994, and 1996, and two HWI observers time-shared to participate during the last half of the 1995 season. The HWI-trained observers have been helpful in maintaining the real and perceived quality level of observations and assisting in difficult calls. Even more important has been the benefit from day-to-day continuity in observations..[These are subjective judgments only, any statistical analysis of observer variability has been precluded by the large variability in numbers and conditions of raptor sightings, the weather variability, and the logistics of scheduling volunteer observers for a location 50 to 100+ miles distant.]

Reporting of the studies

Data from the early years' studies (1983-1987) were reported in newsletters of the Falcon Research Group (Ref 1). Beginning with the 1990 year reports of the field studies have been prepared and privately distributed by the Clarks on behalf of the Northwest Raptor Center, the Ad Hawk group of volunteers, and HawkWatch Intl (Refs 2,3). Complete reports have previously been distributed for the 1990-1994 studies, but only brief preliminary accounts of the 1995, 1996 and 1997 years have been circulated (Ref 4). Ann van de Geld and Diann MacRae of the Hawk Migration Association of North America (HMANA) have ensured that results from the studies were regularly reported in HMANA Journal summaries, and the complete 1992 report was published in the HMANA Journal (see the 1992 study citations in Ref 3). HawkWatch Int'l newsletters have also included reporting of the studies since 1993 (Ref 5)..

A paper was presented at the 1997 HMANA raptor migration conference, providing background on the Cape Flattery studies and summary results, including discussion of the regional weather pattern effects (Ref 6). This present report provides previously unpublished detail for the 1995-1997 studies as well as consistent presentation of findings over the eight years 1990-1997.

Acknowledgments

The generosity and interest of the Makah Indian Tribe has made possible this series of annual studies of raptor migrations through the Cape Flattery area. The observers wish to thank the Makah for welcoming us onto the reservation and allowing unencumbered access to the Bahokus Peak area and the Waatch Valley for bird observations over the entire spring period. Thanks also to Denise Daily, Makah Biologist , Ned Currence, former TFW Biologist for the Makah,, and Bobby Rose, founder of the house of ?akwati.d, board member of the Makah Research and Cultural Center, and veteran hawkwatcher, for liaison and continuing interest, and to the Makah Research and Cultural Center and Janine Bowechop, Director, for providing observer housing in 1996.

The Olympic Coast National Marine Sanctuary provided housing for the 1997 full-tine observer at the residential unit on the Neah Bay Coast Guard Station. We are grateful to Todd Jacobs, Ed Bowlby, Bob Steelquist and Nancy Beres of the Sanctuary staff for their assistance and continuing interest in the studies, and to the Coast Guard personnel for access and administrative help. The collegial benefit of shared housing with other researchers has been valuable.

We are pleased with the several years of collaboration with HawkWatch International (HWI) participants to integrate the Cape Flattery studies with others in the west, and with the now-established research agreement between the Makah Nation and HWI and its founder Steve Hoffman for the studies.

Finally, major acknowledgment is due the dedicated group of volunteer observers who have contributed time and insight to the field observations and spent days on Bahokus Peak in sunshine, wind and rain to spot the hawks. The Ad Hawk volunteers are individual hawkwatchers who have been coordinating their field observations of the spring hawk migrations at Cape Flattery in order to provide extended coverage through the migration season. There has been no formal group structure, membership, financial or other obligation involved or implied in the activities. Volunteers were identified in the reports of studies through 1995 (Ref 3) and many of these have continued their support in the more recent years, accompanied by some newer participants. Special acknowledgment is due to Bob Norton who has provided critical expertise in field observations and counseling of observers at Cape Flattery, and to our colleague Ken Wiersema who has shared in coordination duties over the past three years.

Many of the volunteer observers are active members of the Olympic Peninsula Audubon Society (OPAS) and, although these migration studies are not an OPAS function, OPAS has contributed in earlier years to the Northwest Raptor Center and in recent years to HawkWatch Int'l in support of the studies.

And these volunteers share an appreciation for the tutelage from Bud Anderson, D Byrne, Bobby Rose and Ned Currence, and the seasoned observers from HWI, in attempting to understand the raptor migration phenomenon.

References

1. Data from the Falcon Research Group, P O Box 248, Bow WA 98232, and Clifford (Bud) Anderson, president and founder. Data were obtained from Newsletters of Winter 1985/1986 and Spring 1987 and in personal communications from Anderson in 1990 and 1991, including field notes from FRG spring studies, and course notes.

2. Field Study of the 1990 Spring Hawk Migration at Cape Flattery, WA, January 1992, A Research Project of the Northwest Raptor Center, P O Box 11, Clallam Bay, WA 98326, 12 pages. The report, prepared by Welden & Virginia Clark, analyzed and reported the field data obtained by D Byrne, study director, and principal

observers Janet Partlow and Matt Irinaga. Information about useful maps of the region was also presented, as well as reprise of the prior years' work of the Falcon Research Group.

3. Reporting of the spring migration studies of 1991-1994:

- Field Study of the 1991 Spring Hawk Migration at Cape Flattery, WA, January 1992, reported by Welden & Virginia Clark, A Research Project of the Northwest Raptor Center, P O Box 11, Clallam Bay, WA 98326, 14 pages.

- Field Study of the 1992 Spring Hawk Migration at Cape Flattery, WA, September 1992, reported by Welden & Virginia Clark, A Research Project of the Northwest Raptor Center, P O Box 11, Clallam Bay, WA 98326, 10 pages. Also published as pp 8-13 in HMANA Hawk Migration Studies, The Journal of the Hawk Migration Association of North America, Vol XVIII, No. 2, February 1993.

- Field Study of the 1993 Spring Hawk Migration at Cape Flattery, WA, October 1993, reported by Welden & Virginia Clark, A Research Project of the Northwest Raptor Center and the Ad Hawk Volunteers in collaboration with HawkWatch International, 15 pages. The HWI full-time field observer was Aaron Geis. Also: Geis, Aaron, The 1993 Spring Raptor Migration at Cape Flattery, Washington, September 1993 [draft], prepared for HawkWatch International, Inc., P O Box 660 Salt Lake City, UT 84110.

- Report on the Cape Flattery Spring Hawk Migration Studies, paper presented by D Byrne and Virginia & Welden Clark, 1 May 1992, for the Annual Meeting of the Washington Ornithological Society. The presentation included discussion of raptor flight behaviors at the Cape as related to local weather conditions, and initial explorations of the impact of regional weather patterns on the spring migration sightings.

- Field Study of the 1994 Spring Hawk Migration at Cape Flattery, WA, reported by Welden & Virginia Clark, A Research Project of the Ad Hawk Volunteers in collaboration with HawkWatch Int'l, 11 pages. The full-time HWI field observer was Sharmila Prendas.

4. Interim reports on the 1995, 1996, and 1997 field studies;

- Spring Hawk Migration study at Cape Flattery, WA in 1995, of the Ad Hawk volunteers in collaboration with HawkWatch Int'l, 3 pages. The HWI field observers, time-sharing, from 14 April, were Susan Salafsky and Mari Remsberg.

- 1996 Spring Hawk Migration Study at Cape Flattery, of HawkWatch Int'l in collaboration with the Ad Hawk volunteers, 4 pages. The HWI full-time field observer was Ulf Konig.

- Spring Raptor Migration at Cape Flattery 1997: A Good Year, A Research Project of HawkWatch Int'l with the Ad Hawk volunteers, 4 pages. The HWI full-time field observer was Len Liu.

5. Reports of Cape Flattery spring migration studies in HawkWatch Int'l publications: Migration study results for every spring observation since 1992 have been published in the RaptorWatch newsletter.

6. Spring Raptor Migration Studies at Cape Flattery, Washington, Welden and Virginia Clark, Kenneth Wiersema, and Len Liu, presented at HMANA (Hawk Migration Association of North America) Conference VIII, Snowbird, Utah, June 12-15, 1997, (an abbreviated oral presentation of material in the present report).

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Table 1: History of Full-season Spring Studies at Cape Flattery

Study period			raptor sightings*		field studies
Year	dates	# days	peak day	total	
1985	4/1-5/15	45	1743	6781	Falcon Research Group
1986	3/28-5/28	62	890	5230	Falcon Research Group
1987	3/26-4/24	30	944	4536	Falcon Research Group
1990	3/22-4/21	31	3864	8842	NW Raptor Center
1991	3/14-4/27	45	1020	3325	NW Raptor Center & Ad Hawk
1992	3/16-5/3	49	580	4978	NW Raptor Center & Ad Hawk
1993	3/17-5/3	48	486	2042	HawkWatch & Ad Hawk
1994	3/25-4/29	36	734	4893	HawkWatch & Ad Hawk
1995	3/18-5/1	45	1103	6758	HawkWatch & Ad Hawk
1996	3/20-5/1	43	924	3586	HawkWatch & Ad Hawk
1997	3/20-5/1	43	2130	7255	HawkWatch w/ vol's

(* Excluding Bald Eagles)

Table 2: a) Sightings by species for each of the 8 years 1990-1997

(see Table 3 for species coding)

year	observ hours	RT	OB	UB	SS	CH	NG	UA	GE	AK	ML	PG	UF	NH	OS	TV	UU	total sightings excl BE,UE
1990	120.5	7270	0	262	1097	28	3	45	20	45	8	10	10	3	8	12	21	8842
1991	175.3	2539	1	39	311	42	3	101	43	42	4	26	14	29	10	89	32	3325
1992	228.6	4023	1	98	411	68	20	67	76	33	9	17	9	15	16	87	28	4978
1993	189.6	1480	3	15	302	40	11	36	9	16	1	3	1	9	12	50	54	2042
1994	330.1	3745	0	39	771	72	4	21	5	23	3	6	5	17	8	154	19	4892
1995	196.7	4844	1	18	1255	71	6	20	78	40	8	12	4	18	29	214	140	6758
1996	225.8	2406	2	18	647	39	0	7	15	33	26	18	0	26	25	306	18	3586
1997	215.9	5746	3	3	783	65	27	61	43	25	28	23	4	21	32	342	49	7255
total		32053	11	492	5577	425	74	358	289	257	87	115	47	138	140	1254	361	41678

b) Totals and percentages of all sightings, by species groups, over the 8 years

RT Hawk & other Buteos	32556	78.1%
SS Hawk & other Accipiters	6434	15.4%
Kestrel & other Falcons	506	1.2%
Turkey Vulture	1254	3.0%
Golden Eagle, N Harrier, Osprey	567	1.4%
Un-identified raptors	361	0.9%
	41678	

Table 3a: 1990 Raptor Sightings at Cape Flattery by Species and Day

study day	observ date	observ hours	RT	UB	SS	CH	NG	UA	GE	AK	ML	PG	UF	NH	OS	TV	UU	total sightings excl BE,UE
1	3/22/90	1.2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	3
2	3/23/90	7.3	55	5	2	1	0	1	0	3	0	0	0	0	0	1	0	68
3	3/24/90	6.8	50	2	4	2	0	4	0	0	1	0	0	0	0	3	0	66
4	3/25/90	6.2	148	21	26	3	0	6	7	0	0	0	0	0	0	0	0	211
5	3/26/90	5.8	103	2	1	0	1	0	6	0	0	0	0	0	0	0	0	113
6	3/27/90	5.7	186	3	0	0	0	0	1	0	0	0	0	0	0	0	0	190
7	3/28/90	6.0	189	1	21	0	0	0	0	0	0	0	0	0	0	0	0	211
8	3/29/90	6.7	0	2	9	1	0	0	0	0	1	0	0	0	0	0	0	13
9	3/30/90	1.7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
10	3/31/90	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	4/1/90	2.5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
12	4/2/90	5.5	300	90	22	0	0	12	0	0	0	1	1	0	0	0	0	426
13	4/3/90	7.5	3374	70	406	2	0	0	0	0	1	0	0	1	0	0	10	3864
14	4/4/90	7.8	1330	44	138	2	0	3	0	0	1	2	1	0	0	0	11	1532
15	4/5/90	7.9	399	2	151	4	1	6	0	0	1	2	3	0	0	2	0	571
16	4/6/90	3.6	10	0	1	1	0	1	0	1	0	0	0	0	2	0	0	16
17	4/7/90	5.1	132	0	43	0	0	1	0	3	0	2	1	0	0	0	0	182
18	4/8/90	2.7	12	0	2	0	0	0	0	3	0	1	0	0	1	0	0	19
19	4/9/90	2.8	152	6	26	0	0	1	0	5	0	0	0	0	0	0	0	190
20	4/10/90	5.0	91	12	134	3	0	1	0	5	1	0	0	1	0	0	0	248
21	4/11/90	2.2	0	0	5	1	0	0	0	2	1	0	0	0	0	0	0	9
22	4/12/90	3.6	11	1	7	1	1	0	0	5	0	0	0	0	0	0	0	26
23	4/13/90	0.5	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	5
24	4/14/90	3.8	84	1	47	2	0	3	6	5	0	1	2	1	0	6	0	158
25	4/15/90	3.8	97	0	25	0	0	5	0	0	0	1	2	0	0	0	0	130
26	4/16/90	3.8	532	0	16	3	0	0	0	2	0	0	0	0	1	0	0	554
27	4/17/90	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0
28	4/18/90	1.0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	2
29	4/19/90	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0
30	4/20/90	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0
31	4/21/90	2.7	13	0	9	1	0	0	0	6	1	0	0	0	2	0	0	32
	totals	120.5	7270	262	1097	28	3	45	20	45	8	10	10	3	8	12	21	8842

KEY:

RT = Red-tailed Hawk	SS = Sharp-shinned Hawk	AK = American Kestrel	NH = Northern Harrier
UB = Unidentified Buteo	CH = Cooper's Hawk	ML = Merlin	OS = Osprey
	NG = Northern Goshawk	PG = Peregrine Falcon	TV = Turkey Vulture
GE = Golden Eagle	UA = Unidentified Accipiter	UF = Unidentified Falcon	UU = Unidentified raptor

Table 3b: 1991 Raptor Sightings at Cape Flattery by Species and Day

study day	observ date	observ hours	RT	SW	UB	SS	CH	NG	UA	GE	AK	ML	PG	UF	NH	OS	TV	UU	total sightings excl BE,UE
1	3/14/91	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3/15/91	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3	3/16/91	3.4	35	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	39
4	3/17/91	3.0	21	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	25
5	3/18/91	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6	3/19/91	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7	3/20/91	4.9	40	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	41
8	3/21/91	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	3/22/91	2.3	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74
10	3/23/91	5.8	116	0	0	1	1	0	2	0	0	0	0	0	0	0	0	2	122
11	3/24/91	5.5	22	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	25
12	3/25/91	3.4	8	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	10
13	3/26/91	5.5	51	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	55
14	3/27/91	3.5	8	0	6	2	0	0	0	0	0	0	1	0	0	0	0	0	17
15	3/28/91	4.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
16	3/29/91	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	3/30/91	8.0	323	1	0	51	0	0	1	2	0	0	2	0	1	0	14	0	395
18	3/31/91	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	4/1/91	3.3	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	7
20	4/2/91	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	4/3/91	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
22	4/4/91	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	4/5/91	4.1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
24	4/6/91	5.1	57	0	9	6	2	0	1	3	0	0	1	0	0	0	10	0	89
25	4/7/91	4.0	5	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	7
26	4/8/91	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	4/9/91	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	4/10/91	5.8	16	0	0	5	0	0	0	3	0	0	0	0	0	0	0	5	29
29	4/11/91	6.5	161	0	0	42	4	0	0	2	0	0	4	0	3	0	0	2	218
30	4/12/91	6.5	189	0	0	20	3	0	1	0	0	0	0	0	2	0	4	2	221
31	4/13/91	6.3	10	0	11	2	1	1	2	0	1	0	5	1	1	0	0	0	35
32	4/14/91	5.6	10	0	2	2	0	0	0	0	3	0	0	0	1	3	2	0	23
33	4/15/91	7.4	151	0	0	47	3	0	0	11	1	0	3	2	3	0	9	0	230
34	4/16/91	6.3	116	0	0	3	0	0	1	0	0	0	0	0	0	0	14	1	135
35	4/17/91	4.5	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	6
36	4/18/91	6.3	164	0	3	15	1	0	0	1	0	0	2	0	0	0	6	0	192
37	4/19/91	6.2	130	0	1	14	4	0	3	5	0	0	0	0	2	0	7	0	166
38	4/20/91	6.7	770	0	2	50	19	1	79	8	4	0	0	4	12	0	3	4	956
39	4/21/91	6.0	20	0	0	10	3	1	6	0	2	0	1	0	0	0	0	0	43
40	4/22/91	6.2	1	0	2	2	1	0	0	2	7	0	1	0	2	1	4	5	28
41	4/23/91	2.0	0	0	0	1	0	0	0	1	9	0	1	0	0	1	0	1	14
42	4/24/91	6.8	8	0	2	25	0	0	0	4	7	4	2	7	0	4	0	2	65
43	4/25/91	4.2	6	0	0	5	0	0	0	0	0	0	0	0	1	1	0	4	17
44	4/26/91	3.0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
45	4/27/91	*	16	0	0	0	0	0	0	0	5	0	2	0	0	0	12	0	35
	total	175.3	2539	1	39	311	42	3	101	43	42	4	26	14	29	10	89	32	3325

KEY:

RT = Red-tailed Hawk	SS = Sharp-shinned Hawk	AK = American Kestrel	NH = Northern Harrier
SW = Swainson's Hawk	CH = Cooper's Hawk	ML = Merlin	OS = Osprey
UB = Unidentified Buteo	NG = Northern Goshawk	PG = Peregrine Falcon	TV = Turkey Vulture
GE = Golden Eagle	UA = Unidentified Accipiter	UF = Unidentified Falcon	UU = Unidentified raptor

Table 3c: 1992 Raptor Sightings at Cape Flattery by Species and Day

			observed raptor species																		excluding
study day	observ date	observ hours	RT	RL	UB	SS	CH	NG	UA	BE	GE	UE	AK	ML	PG	UF	NH	OS	TV	UU	BE, UE
1	3/16/92	3.5								7											0
2	3/17/92	3.5								2											0
3	3/18/92	2.2	77			6				13											83
4	3/19/92	4.5	9			3	1		2	8					1						16
5	3/20/92	2.8	16		2	29	1			7	1										49
6	3/21/92	6.0	382			46	1		1	19					1	1					432
7	3/22/92	4.9	323			9	1			53	2				1				1		337
8	3/23/92	1.6	4			1				8				1							6
9	3/24/92	8.1	166			6	1			17			1								174
10	3/25/92	5.3	494			10	1		3	29		1	1						16		525
11	3/26/92	5.1	34		1	3				34		2									38
12	3/27/92	7.0	10						1	19	2	2									13
13	3/28/92	6.0	281		14	29	5		2	31	11	3							2		344
14	3/29/92	8.0	501		11	54	2		8	80					1	1			1	1	580
15	3/30/92	4.0	1							1											1
16	3/31/92	4.5	116						1	22											117
17	4/1/92	5.3	270			3	6		3	8											282
18	4/2/92	4.0	17								1										18
19	4/3/92	6.8	6				1			45					1				1		9
20	4/4/92	3.5								3											0
21	4/5/92	3.6								5											0
22	4/6/92	0.8													1			1			2
23	4/7/92	5.5	119		1	13			2	19							2				137
24	4/8/92	6.0	313		7	27		4		26	1				1				8	2	363
25	4/9/92	5.8	196		1	3	4	1		21	1								6		212
26	4/10/92	5.7	3					1		20											4
27	4/11/92	3.8	22		1	6	2			6				1		2					34
28	4/12/92	5.7	122		23	7	6	1	24	20	1					1				8	193
29	4/13/92	3.3	7			1				2			1					1			10
30	4/14/92	6.5	1							1		3		1							2
31	4/15/92	3.5	1							5			2					3			6
32	4/16/92	5.3				1				1			4					1			6
33	4/17/92	4.7								2			2								2
34	4/18/92	6.2	10			2	3		1	40	3	5	1	1	2		2		1	4	30
35	4/19/92	3.0	51		1	13			6	7			1						5		77
36	4/20/92	6.0	36			6	2			24	3		4		1	2	1	3		2	60
37	4/21/92	6.3								1			5	1							6
38	4/22/92	5.0	4		1	4			1	5	1	4	5					3		2	21
39	4/23/92	5.7	83	1	3	14	3	2	1	44	6			1	3		4		5		126
40	4/24/92	6.0	69			18	6	1	4	8	19				2	1	1		1		122
41	4/25/92	4.7	93		2	48	2			9	7	3		1			5	2	4	7	171
42	4/26/92	2.1											1								1
43	4/27/92	4.3	6		20	2		2	1	19		1		1	2						34
44	4/28/92	2.5	1			7				12	3								5		16
45	4/29/92	4.3																			0
46	4/30/92																				na
47	5/1/92	6.2	11			6	5	5		36	5										32
48	5/2/92	3.6	49		9	10	3	3	2	11	1	1	2			1		1	15		96
49	5/3/92	6.4	119		1	24	12		4	19	8	1	3	1				1	16	2	191
	total	228.6	4023	1	98	411	68	20	67	769	76	26	33	9	17	9	15	16	87	28	4978

KEY:
- RT = Red-tailed Hawk
- RL = Rough-legged Hawk
- UB = Unidentified Buteo
- BE = Bald Eagle
- GE = Golden Eagle
- UE = Unidentified Eagle
- SS = Sharp-shinned Hawk
- CH = Cooper's Hawk
- NG = Northern Goshawk
- UA = Unidentified Accipiter
- AK = American Kestrel
- ML = Merlin
- PG = Peregrine Falcon
- UF = Unidentified Falcon
- NH = Northern Harrier
- OS = Osprey
- TV = Turkey Vulture
- UU = Unidentified raptor

clarks: ..\Cf_migr\migr92\Cfbops92.xls: format edited & reprinted 1/12/97

Table 3d: 1993 Raptor Sightings at Cape Flattery by Species and Day

study day	observ date	observ hours	observed raptor species																			sightings excl BE,UE
			RT	RL	FH	UB	SS	CH	NG	UA	BE	GE	UE	AK	ML	PG	UF	NH	OS	TV	UU	
1	3/17/93	2.8																				0
2	3/18/93	5.0	5								1											5
3	3/19/93	5.0	2					1														3
4	3/20/93	5.0																				0
5	3/21/93	5.0																				0
6	3/22/93	5.0																				0
7	3/23/93	5.0	4				3				8										2	9
8	3/24/93	4.2	6					1			11	2									3	12
9	3/25/93	5.4	143				24	1		2	14	2						2		1	2	177
10	3/26/93	5.0	118	2		1	16		1		13	2								2	3	145
11	3/27/93	6.0	306				17	3		5	16	1								8		340
12	3/28/93	3.5	53				11	1		1	10					1				2		69
13	3/29/93	6.0	10				4			1	13											15
14	3/30/93	6.0	10				2				17				1							13
15	3/31/93	4.0	13				3			1	4									1		18
16	4/1/93	6.0	167				29	4		2	7	1						1	1			205
17	4/2/93	6.0	2					1			2	1										4
18	4/3/93	6.0	2				3	1			3		1									6
19	4/4/93	4.3	9			1	3	1			22					2					4	20
20	4/5/93	5.0	10				2				13			1								13
21	4/6/93	1.3									3			1								1
22	4/7/93	4.5	31				6				5											37
23	4/8/93	0.5	10				1				2											11
24	4/9/93	1.8	4				4				3											8
25	4/10/93	2.0																				0
26	4/11/93	6.0	1			2	7			6	30									3	30	49
27	4/12/93	7.0	9				10	1	1		13			4					1	2		28
28	4/13/93	6.3	8				1	1			3							1	2		1	14
29	4/14/93	6.7	378		1		70	4	3	3	26		3	3			1	2	2	21		488
30	4/15/93	3.5	5				2			3	3										1	11
31	4/16/93	1.5																1				1
32	4/17/93	2.0	1								5								1			2
33	4/18/93	1.1																				0
34	4/19/93	6.0	108				43	9	2	1										7		170
35	4/20/93	5.0	21			1	15	1	1	2	7		1	3				1	1			46
36	4/21/93	1.5					1				1								2			3
37	4/22/93	3.0	7			3	5	1		2	7		2								2	20
38	4/23/93	0.3																				0
39	4/24/93	2.2																			1	1
40	4/25/93	4.5	2			2		1													3	8
41	4/26/93	0.5																				0
42	4/27/93	4.0	4			5		2			5								1		1	13
43	4/28/93	0.5																				0
44	4/29/93	5.0	9				5	3		6												23
45	4/30/93	4.5	4				10	1	1	1	9			2				1		1	1	22
46	5/1/93	0.5																				0
47	5/2/93	4.8	18				5	2	2					2					1	2		32
48	5/3/93	3.0																				0
totals		189.6	1480	2	1	15	302	40	11	36	276	9	7	16	1	3	1	9	12	50	54	2042

KEY:

RT = Red-tailed Hawk	BE = Bald Eagle	SS = Sharp-shinned Hawk	AK = American Kestrel	NH = Northern Harrier
RL = Rough-legged Hawk	GE = Golden Eagle	CH = Cooper's Hawk	ML = Merlin	OS = Osprey
FH = Ferruginous Hawk	UE = Unidentified Eagle	NG = Northern Goshawk	PG = Peregrine Falcon	TV = Turkey Vulture
UB = Unidentified Buteo		UA = Unidentified Accipiter	UF = Unidentified Falcon	UU = Unidentified raptc

clarks: ..\Cf_migr\migr93\Cfbops93.xls: format edited and reprinted 1/12/97

Table 3e: 1994 Raptor Sightings at Cape Flattery by Species and Day

			observed raptor species																		
study day	observ date	ob-server hours	RT Ad	RT imm	RT unag	UB	SS	CH	NG	UA	BE	GE	UE	AK	ML	PG	UF	NH	OS	TV	UU	sightings excluding BE & UE (1)
1	3/25/94	7.3	42	0	15	0	33	3	1	1	9	0	0	0	0	0	0	0	0	3	0	98
2	3/26/94	7.0	244	0	0	8	79	0	0	4	5	0	0	0	0	0	0	0	0	0	0	335
3	3/27/94	7.8	148	1	100	2	37	0	0	7	15	0	0	0	0	0	0	0	0	0	1	296
4	3/28/94	5.8	630	0	0	16	86	0	0	1	19	0	1	0	0	0	0	0	0	0	1	734
5	3/29/94	5.5	283	0	0	0	39	1	0	0	12	1	0	0	0	0	0	0	0	0	1	325
6	3/30/94	3.1	87	0	0	0	2	0	0	0	4	0	0	1	0	0	0	0	0	0	0	90
7	3/31/94	2.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	4/1/94	6.1	83	0	0	0	5	1	0	0	3	0	0	0	0	0	0	0	0	0	4	93
9	4/2/94	3.7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10	4/3/94	3.5	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
11	4/4/94	5.8	17	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	0	25
12	4/5/94	5.3	495	0	0	0	42	5	0	0	4	0	0	0	1	0	0	0	0	6	0	549
13	4/6/94	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	4/7/94	6.0	44	0	0	0	14	3	0	0	4	0	0	1	0	1	0	0	0	0	0	63
15	4/8/94	4.2	8	1	1	0	4	2	0	1	7	0	0	0	0	0	0	0	0	4	0	21
16	4/9/94	4.0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
17	4/10/94	0.8	32	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	43
18	4/11/94	4.5	1	0	0	0	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	6
19	4/12/94	6.8	12	1	0	0	3	0	0	0	2	1	0	2	0	0	1	1	1	0	0	22
20	4/13/94	1.0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
21	4/14/94	5.8	42	3	0	0	17	4	1	0	5	0	0	7	0	2	1	2	4	25	0	108
22	4/15/94	5.8	523	1	0	0	122	13	0	1	6	1	0	4	0	0	0	1	0	36	0	702
23	4/16/94	6.8	231	1	1	0	140	15	1	3	8	0	0	0	0	0	0	5	0	7	0	404
24	4/17/94	5.7	86	3	0	0	6	1	0	0	3	0	0	0	0	0	0	2	0	0		98
25	4/18/94	4.3	88	34	0	0	39	9	0	1	12	0	0	0	1	1	0	4	1	7	0	185
26	4/19/94	2.8	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
27	4/20/94	5.8	169	31	11	0	21	3	0	0	0	0	0	3	0	0	0	0	1	17	0	256
28	4/21/94	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	4/22/94	5.8	6	13	0	1	10	0	0	1	1	0	0	2	0	1	0	2	0	1	1	38
30	4/23/94	3.8	35	40	45	0	17	0	0	0	1	0	0	0	0	0	0	0	0	24	1	162
31	4/24/94	4.0	0	5	5	0	7	1	1	0	0	0	0	1	0	0	0	0	0	0	0	20
32	4/25/94	5.5	12	72	6	0	11	3	0	1	14	1	0	0	1	0	1	0	0	20	3	131
33	4/26/94	6.3	12	7	1	9	9	3	0	0	16	0	1	0	0	0	2	0	0	0	1	44
34	4/27/94	5.0	6	1	0	3	10	0	0	0	23	1	0	0	0	1	0	0	1	0	6	29
35	4/28/94	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	4/29/94	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
totals		161.3	3342	216	187	39	771	72	4	21	173	5	2	23	3	6	5	17	8	154	19	4892

Note: edited 1/12/97 to remove 1 GE on 4/16/94 per re-screenng of field data sheets.

KEY:
- RT Ad = Red-tailed Hawk adult
- RT imm = Red-tailed Hawk imm.
- RT unag = Red-tailed Hawk (age ?)
- UB = Unidentified Buteo
- BE = Bald Eagle
- GE = Golden Eagle
- UE = Unident. Eagle
- SS = Sharp-shinned Hawk
- CH = Cooper's Hawk
- NG = Northern Goshawk
- UA = Unidentified Accipiter
- AK = American Kestrel
- ML = Merlin
- PG = Peregrine Falcon
- UF = Unidentified Falcon
- NH = Northern Harrier
- OS = Osprey
- TV = Turkey Vulture
- UU = Unidentified raptor

clarks: ..\Cf_migr\migr94\Cfbops94.xls: edited & reprinted 1/12/97

Table 3f: Spring 1995 raptor sightings at Cape Flattery by species and day

			observed raptor species																				
study day	observ date	hrs on site	RT Ad	RT imm	RT unag	OB	UB	SS	CH	NG	UA	GE	BE	UE	AK	ML	PG	UF	NH	OS	TV	UU	sight's excl BE & UE
1	3/18/95	1.5											1										0
2	3/19/95	3.0	5						1				1										6
3	3/20/95	0.0																					storm
4	3/21/95	0.0																					storm
5	3/22/95	0.0																					storm
6	3/23/95	3.3	6					1					44	1			1					15	23
7	3/24/95	5.5			39			9	2		6		4	3								50	106
8	3/25/95	5.0	2		7			1					1									24	34
9	3/26/95	4.3	32					5					5										37
10	3/27/95	4.0	438	1	5			87	1			1	21						1				534
11	3/28/95	6.0	604					67	1			1	32				1				1		675
12	3/29/95	5.5	287					30	2				20						1				320
13	3/30/95	4.0	148		1			6	1	1	2	4	23				1					1	165
14	3/31/95	3.0											1										0
15	4/1/95	5.5	17				3	4					24										24
16	4/2/95	2.7																					0
17	4/3/95	4.2	155				7	13				1	38					1		1	3	2	183
18	4/4/95	4.0											5										0
19	4/5/95	5.0	40				3	4	1				3			1					1		50
20	4/6/95	3.7	8		73			17	2				4								1		101
21	4/7/95	4.5						1							1								2
22	4/8/95	4.7											1										0
23	4/9/95	4.3	8					2					9		1								11
24	4/10/95	1.7																					0
25	4/11/95	5.2	4		4					1				2							1		10
26	4/12/95	2.5	1										7		1			1		1		9	13
27	4/13/95	3.0	1					1					2										2
28	4/14/95	5.3	3		2			10	1		1		47	2	5		1			1		1	25
29	4/15/95	5.8	57	8	27			76	1		4		51		2				1		16	6	198
30	4/16/95	4.8	190	26	43			82	1			2	93			1					1		346
31	4/17/95	6.3	6					4	1			1	12		2				1				15
32	4/18/95	6.0	1	1	1			12				1	15		1		1						18
33	4/19/95	2.5	4	4				1	1				25	2							1	2	13
34	4/20/95	4.8	57	20	85			95	4	1			35						1		10	1	274
35	4/21/95	6.8	7	8	13			28	3			6	43		4	1			2	4	16		92
36	4/22/95	7.8	109	100	52	1		214	7	1	2	10	32	4	1			2	6	4	33	8	550
37	4/23/95	6.5	42	16	23		2	55	1			6	24		5	2	1			2			155
38	4/24/95	6.0	104	210	373		1	117	1			14	64		2	2	1			2	22	2	851
39	4/25/95	6.5	330	429	94			180	31			23	64		3	1	1		1	1	8	1	1103
40	4/26/95	4.0	18	10	3			5					12										36
41	4/27/95	6.3	21	89	333			70	3	2	2	6	28		3				2		97	1	629
42	4/28/95	7.0	3	2	7			28	1		1	2	25		8		4		1	3		10	70
43	4/29/95	6.2	1	3	1			22	1		1		25	3	1					5	1	2	38
44	4/30/95	4.8	1	1	2		2	7	2		1		2	1						5			21
45	5/1/95	3.2	3	10	5			1	1				3						1		2	5	28
totals		196.7	2713	938	1193	1	18	1255	71	6	20	78	846	18	40	8	12	4	18	29	214	140	6758
				All RT =		4844																	

Note: OB sighting on 4/22 was a Broad-winged Hawk, confirmed by several observers

Note: Summary is 6758 raptor sightings in 196.7 hours on site, ~ 34 sightings per hour

Note: revision on 1/12/97: 1 AK was added to 4/17, per re-screening of field data sheets.

KEY:
RT ad = Red-tailed Hawk adult; RT imm = Red-tailed Hawk juvenile; RT unag = Red-tailed Hawk (age ?); OB = Other Buteo
UB = Unidentified Buteo; GE = Golden Eagle; BE = Bald Eagle; UE = Unidentified Eagle
SS = Sharp-shinned Hawk; CH = Cooper's Hawk; NG = Northern Goshawk; UA = Unidentified Accipiter
AK = American Kestrel; ML = Merlin; PG = Peregrine Falcon; UF = Unidentified Falcon
NH = Northern Harrier; OS = Osprey; TV = Turkey Vulture; UU = Unidentified rap

clarks: ..\Cf_migr\migr95\Cfbops95.xls: revised & reprinted 1/12/97

Table 3g: Spring 1996 Raptor Sightings at Cape Flattery by Species and Day

			observed raptor species																			
study day	observ date	hrs on site	RT Ad	RT imm	RT unag	OB	UB	SS	CH	NG	UA	GE	BE	UE	AK	ML	PG	UF	NH	OS	TV	UU	excl BE & UE
1	3/20/96	5.3	10									2	7										12
2	3/21/96	6.0	9			1		2					2		1	1							14
3	3/22/96	7.8	15					3					16				2			2			22
4	3/23/96	7.0	40					4	1				15		2		3						50
5	3/24/96	7.0	30	2	11			10					20								4	1	58
6	3/25/96	6.0	140	2	2			31					15				1				1		177
7	3/26/96	6.0	3	1	3			3					8										10
8	3/27/96	5.3	15	2	1			1	1				8			1							21
9	3/28/96	6.5	4										1		1				1				6
10	3/29/96	6.0	6		4		1	1				1	8										13
11	3/30/96	6.0	6										8		1		1						8
12	3/31/96	1.8	5		3								6										8
13	4/1/96	2.0							1													1	2
14	4/2/96	7.5	19		3		2	11	1				7		2		1						39
15	4/3/96	6.5	84	1	11			19	1			1	8						2				119
16	4/4/96	7.0	558	5	101		1	134	1				9		1	1			1	1	120		924
17	4/5/96	1.5			1																		1
18	4/6/96	2.5													1								1
19	4/7/96	8.3	40		3	1		39	1				6		3				1		30	1	119
20	4/8/96	4.3	55	2	3			13					3				1				1	1	76
21	4/9/96	3.5	60		11			8	1				7			1						2	83
22	4/10/96	5.0	4					2					6		2	2							10
23	4/11/96	4.5	7		5								3										12
24	4/12/96	4.9	3		3			1				1	16							1	7		16
25	4/13/96	5.9	17	1	2			4	3				6		1					2			30
26	4/14/96	5.0	117	4	59		13	28	4		4	6	25		1							8	244
27	4/15/96	6.5			1			3					1										4
28	4/16/96	6.0	20	3	70			17	2				6			1			1		2		116
29	4/17/96	4.0	44		8			34	1										3		6		96
30	4/18/96	6.4	11		6			11			1		4		1						8		38
31	4/19/96	3.6						1															1
32	4/20/96	6.9	276	5	79			60	2			3	28		1	2			2	2	7		439
33	4/21/96	8.8	172	17	87			121	3		1	1	28						1	1	10	1	415
34	4/22/96	1.5																					0
35	4/23/96	2.4			1								1		1								2
36	4/24/96	6.0		2				2	1				9			1	1			3			10
37	4/25/96	1.5											1										0
38	4/26/96	6.5	1	5	3		1	13							5	6	1		4	7			46
39	4/27/96	7.0	6	7	21			16	1				7		8	5	2		3	3	9	3	84
40	4/28/96	6.0	1	11	1			19					2						7	1	7		47
41	4/29/96	5.0	1	1				4	4		1		6			1	2				30		44
42	4/30/96	5.5	9	1	36			27	9						1	4	3			2	59		151
43	5/1/96	3.5	1	5	1			5	1				18								5		18
totals		225.8	1789	77	540	2	18	647	39	0	7	15	321	0	33	26	18	0	26	25	306	18	3586

All RT = 2406; Other Buteos = 1 Rough-leg on 3/21, 1 Ferruginous on 4/7

KEY:
RT ad = Red-tailed Hawk adult; RT imm = Red-tailed Hawk juvenile; RT unag = Red-tailed Hawk (age ?); OB = Other Buteo
UB = Unidentified Buteo; GE = Golden Eagle; BE = Bald Eagle; UE = Unidentified Eagle
SS = Sharp-shinned Hawk; CH = Cooper's Hawk; NG = Northern Goshawk; UA = Unidentified Accipite
AK = American Kestrel; ML = Merlin; PG = Peregrine Falcon; UF = Unidentified Falcon
NH = Northern Harrier; OS = Osprey; TV = Turkey Vulture; UU = Unidentified rapt

clarks: ..\Cf_migr\migr96\Cfbops96.xls: verified 5/5/96, reprinted 1/12/97

Table 3h: 1997 Raptor Sightings at Cape Flattery by Species and Day

			observed raptor species																			
study day	observ date	hrs on site	RT Ad	RT imm	RT unag	OB	UB	SS	CH	NG	UA	GE	BE	UE	AK	ML	PG	UF	NH	OS	TV	UU	excl BE & UE
1	3/20/97	1.9											7										0
2	3/21/97	3.8	4		4			1					7				1					1	11
3	3/22/97	5.8	119		11	2		24	2		1		2								9		168
4	3/23/97	6.0	4		6				1				9										11
5	3/24/97	6.3	54		12			26	1				4										93
6	3/25/97	2.3	13		2			3			1		12				2					1	22
7	3/26/97	2.7	2		2								6			1							5
8	3/27/97	2.1						2					2										2
9	3/28/97	6.3	6	1	4			2					14								2		15
10	3/29/97	6.4	46		64			14	1		2		20								6	8	141
11	3/30/97	5.3	83		103		1	38					10								2	4	231
12	3/31/97	5.8	3								1		25										4
13	4/1/97	7.5	24	2	3			13	1	13	3		47		1	1					5	1	67
14	4/2/97	6.3	56		4			11	2		3		33		2	1	1				3		83
15	4/3/97	5.0	23					1					8										24
16	4/4/97	7.8	342	5				28	3	10	13	3	56					1			3	6	414
17	4/5/97	7.5	886	9	151			68	1	1	3	2	36		1						3		1125
18	4/6/97	7.3	1860	4	187			53			1	4	25			1					20		2130
19	4/7/97	5.8	55	1	12			13					30		1		1		2				85
20	4/8/97	5.0	60		2		1	7	3			3	14	1		1					3	1	81
21	4/9/97	6.8	23	1	4			4	1		2		14										35
22	4/10/97	6.2	177	4	23			30	2	1			40			1	2			2	4		246
23	4/11/97	6.7	252	13	33			38		1	4		46		2	4	3		4	2	9	8	373
24	4/12/97	6.2	60	11	66			18				2	16		2	1	1	1	1		47		210
25	4/13/97	5.8	2	1	3			3	1		1		9						1				12
26	4/14/97	0.0																					0
27	4/15/97	4.2	1								1		14									1	3
28	4/16/97	5.0	2						1				4					1	2			2	8
29	4/17/97	6.5	25	11	35			28	3		1	3	35		2	6	5			2		3	124
30	4/18/97	6.5	165	55	89			107	14		7	7	24		2	2			2	5	24	4	483
31	4/19/97	0.0																					0
32	4/20/97	4.9	2	1	4			3					7					1				1	12
33	4/21/97	7.8	127	57	38			135	19		9	7	45		1	1			3	4	151	1	553
34	4/22/97	5.5	73	16	44			60	2	1	4	7	18		2				3	1		2	215
35	4/23/97	6.0	3				1	1				2	7	2							1		8
36	4/24/97	6.8	6	5	7	1		7				1	31			2	5			2	6	1	43
37	4/25/97	5.1	5	4				12					4		3					2	5		31
38	4/26/97	2.3	7	2	2			7	2		1		5		1	1			1	4		1	29
39	4/27/97	4.3	3	3	1			4					8	1		1					16	2	30
40	4/28/97	0.7		1	2			5					4			1					1		10
41	4/29/97	6.3	8	4	11			7	1		1		25		3	3	1			6	9	1	55
42	4/30/97	1.8		2	1			2	2				9						2		2		11
43	5/1/97	4.4	5	13	4			8	2		2	2	14		2		1			2	11		52
totals		215.9	4586	226	934	3	3	783	65	27	61	43	746	4	25	28	23	4	21	32	342	49	7255

OB includes 3 Swainson Hawks.

KEY:
RT ad = Red-tailed Hawk adult
RT imm = Red-tailed Hawk juvenile
RT unag = Red-tailed Hawk (age ?)
OB = Other Buteo
UB = Unidentified Buteo
GE = Golden Eagle
BE = Bald Eagle
UE = Unidentified Eagle
SS = Sharp-shinned Hawk
CH = Cooper's Hawk
NG = Northern Goshawk
UA = Unidentified Accipite
AK = American Kestrel
ML = Merlin
PG = Peregrine Falcon
UF = Unidentified Falcon
NH = Northern Harrier
OS = Osprey
TV = Turkey Vulture
UU = Unidentified rapt

CFbops97.xls: 5/97, V. Clark

Table 4a: Observation site weather and Quillayute intraday temperature rise by study day for 1990, 1991, 1992, and 1993 years

1990						1991						1992						1993					
study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise
1	3/22/90	NE		ov	1	1	3/14/91	clm		ptcl	7	1	3/16/92	SW	lgt	ptcl	10	1	3/17/93	SE	lgt	ov	10
2	3/23/90	E, NE	mod	ov	8	2	3/15/91				11	2	3/17/92	WNW	mod	ov	9	2	3/18/93	SW	lgt	ptcl	12
3	3/24/90	E, NE	str	c	20	3	3/16/91	SE	mod	ov	23	3	3/18/92	ENE	l-mod	c	22	3	3/19/93	S	str	ov,r,f	12
4	3/25/90	E, NE	mod	c	23	4	3/17/91	NE	mod	c	27	4	3/19/92	clm		c	23	4	3/20/93	SE,S	l-mod	r,f	5
5	3/26/90	E, W	lgt	c	31	5	3/18/91				21	5	3/20/92	NNE	gusts	ptcl	32	5	3/21/93	SSE	str	ov,r,f	4
6	3/27/90	E	lgt	ptcl	20	6	3/19/91				10	6	3/21/92	NE	mod	c	30	6	3/22/93	S	str	r,f	6
7	3/28/90	W,E,S	lgt	f	24	7	3/20/91	NE	mod	ptcl	17	7	3/22/92	NE	lgt	c	21	7	3/23/93	SW	l-mod	ov	6
8	3/29/90	W	lgt	ov	4	8	3/21/91	SW	mod	ov	8	8	3/23/92	WSW	l-mod	ov	15	8	3/24/93	NE	lgt	ptcl	17
9	3/30/90	W	lgt	ov	8	9	3/22/91	E	mod	ptcl	14	9	3/24/92	clm		ptcl,f	17	9	3/25/93	NNE	mod	c	18
10	3/31/90	W,NW	lgt	f	7	10	3/23/91	ESE	mod	ov	12	10	3/25/92	ENE	lgt	c,f	22	10	3/26/93	N,SE	lgt	c	21
11	4/1/90	SW	lgt	f	3	11	3/24/91	NE	lgt	ov	4	11	3/26/92	W	gusts	ov,f	17	11	3/27/93	E	lgt	c	27
12	4/2/90	W, NW-SW	lgt	ptcl	17	12	3/25/91	NE	str	c	14	12	3/27/92	NW	lgt +	ptcl	11	12	3/28/93	S	lgt	c	22
13	4/3/90	E	mod	c	29	13	3/26/91	E	str	c	13	13	3/28/92	E	str	ptcl	28	13	3/29/93	S,SE	lgt	r,f	11
14	4/4/90	E	lgt	c	32	14	3/27/91	SW	lgt	ptcl	21	14	3/29/92	E	gusts	ptcl	25	14	3/30/93	var	l-mod	r,f	13
15	4/5/90	E	lgt	c	26	15	3/28/91	WNW	mod	ov	14	15	3/30/92	SSW	mod	ptcl,shw	16	15	3/31/93	E,NE	str	ov,r	11
16	4/6/90	SE,SW	lgt	f	14	16	3/29/91	S	lgt	ov	8	16	3/31/92	W,NW	mod	ptcl	14	16	4/1/93	SE	lgt	ov,r	14
17	4/7/90	SW	mod	f	12	17	3/30/91	E	mod	c	19	17	4/1/92	NE	mod	c	28	17	4/2/93	SW	lgt	ov,f	7
18	4/8/90	NW	mod	f	5	18	3/31/91	W	mod	ov,f	7	18	4/2/92	S,W	m-str	ov	20	18	4/3/93	W	lgt	ov,f	6
19	4/9/90	calm		ptcl,rain	16	19	4/1/91	W	lgt	ov,f	4	19	4/3/92	WSW	gusts	ptcl	7	19	4/4/93	NE	lgt	ptcl	18
20	4/10/90	N,NE	gusty	oc	27	20	4/2/91	W	mod	ov,r	12	20	4/4/92	SE,SW	l-mod	ov,sno	8	20	4/5/93	SE,SW	mod	ov,r,f	12
21	4/11/90	SW	lgt	ov,f	4	21	4/3/91	W		ov,r	8	21	4/5/92	SW,W	l-mod	sno	12	21	4/6/93	S	mod	ov,r,f	6
22	4/12/90	S,SW	mod	ptcl	13	22	4/4/91	SW		ptcl,r	3	22	4/6/92	na		hail,sno	17	22	4/7/93	E	mod	ptcl,r,f	10
23	4/13/90	NE	lgt	rain,f	6	23	4/5/91	WSW	str	ov,shw	5	23	4/7/92	NE	lgt	ptcl	23	23	4/8/93	SW	str	r,f	2
24	4/14/90	E-NE	gusty	ov	11	24	4/6/91	SSW	mod	ov,shw	8	24	4/8/92	NE	gusts	ptcl	22	24	4/9/93	SW	l-str	ov,r	10
25	4/15/90	E	mod	ptcl,rain	28	25	4/7/91	SW	lgt	ov,ptcl	13	25	4/9/92	NE	gusts	ptcl	21	25	4/10/93	N	lgt	ov,r	9
26	4/16/90	N,E	l-mod	ptcl	10	26	4/8/91	W	str	ov	8	26	4/10/92	S,SW	gusts	ov	24	26	4/11/93	W,SW	lgt	ptcl	6
27	4/17/90	clm,SW	lgt	ov,drz	3	27	4/9/91	W	str	r	7	27	4/11/92	E,ESE	gusts	ov	20	27	4/12/93	SW	lgt	ptcl	12
28	4/18/90	NE	lgt	ov	8	28	4/10/91	W	lgt	c	18	28	4/12/92	E	gusts	squalls	16	28	4/13/93	SW	lgt	ov,r,f	11
29	4/19/90	NW	lgt	ov,f,r	7	29	4/11/91	E	lgt	c	27	29	4/13/92	E	lgt	ov,r,f	10	29	4/14/93	E,SE	l-mod	var	21
30	4/20/90	NW	mod	ov,f,r	11	30	4/12/91	E	lgt	c	28	30	4/14/92	SW	lgt	ov,r,f	10	30	4/15/93	SW	l-str	ov.r,f	7
31	4/21/90	SW	lgt	ov	17	31	4/13/91		mod	ov	20	31	4/15/92	SW	str	ov,r	4	31	4/16/93	E	l-mod	ov,r,f	8
						32	4/14/91	SSW	lgt	ptcl	7	32	4/16/92	S	str +	ov,r,f	3	32	4/17/93	NE,SE	m-str	ov,r,f	7
						33	4/15/91	SE	lgt	c	22	33	4/17/92	SE,SW	l,str	ov,r,f	6	33	4/18/93	SSW	lgt	ov,r,f	12
						34	4/16/91	clm		c	19	34	4/18/92	W,S	lgt	ptcl	8	34	4/19/93	NE,E	l-mod	ov	25
						35	4/17/91	SW	lgt	ov	11	35	4/19/92	E	mod	ov,r	21	35	4/20/93	E,NE,W	str	ov,sqll	16
						36	4/18/91	SW	lgt	ptcl	15	36	4/20/92	S,NW	mod	ov,shw,f	11	36	4/21/93	S	mod	ov,r,f	7
						37	4/19/91	E	lgt	c,f	17	37	4/21/92	clm		ov,r	10	37	4/22/93	E,S	mod	ov.r	5
						38	4/20/91	NNE	lgt	c	40	38	4/22/92	SW,W	mod	ptcl	13	38	4/23/93	NE	m-str	r,f	8
						39	4/21/91	SW	str	ov	5	39	4/23/92	NNE,E	lgt	ptcl	26	39	4/24/93	SW	m-str	ov,r,f	6
						40	4/22/91	W	lgt	ov,f	7	40	4/24/92	NE,SE	mod	ptcl	21	40	4/25/93	SE	str	ov,r	8
						41	4/23/91	SE	lgt	ov,f	8	41	4/25/92	NW,NE	lgt	ptcl	18	41	4/26/93	S	str	ov,r	5
						42	4/24/91	SW	lgt	oc,ptcl	9	42	4/26/92	clm		ov,r,f	6	42	4/27/93	SW	lgt	ov,f	10
						43	4/25/91	SW	lgt	ptcl	13	43	4/27/92	W,NW	mod	ptcl	6	43	4/28/93	SW	l-mod	ov,r,f	5
						44	4/26/91	SE	lgt	ov,drz	12	44	4/28/92	SE,SW	mod	ptcl	11	44	4/29/93	S	lgt	ov	8
						45	4/27/91	na		na	10	45	4/29/92	na		storm	0	45	4/30/93	SW	lgt	r	11
												46	4/30/92	na		storm	11	46	5/1/93	SE	l-mod	r,f	5
												47	5/1/92	SW,SE	lgt	ov	19	47	5/2/93	S	lgt	ov,r	17
												48	5/2/92	SW,NW	lgt	ptcl	21	48	5/3/93	E	l-mod	ov	10
												49	5/3/92	NE	mod	c	40						

Abbreviations:

Wind: clm,c = calm; lgt,l = light: mod,m = moderate; str,s,gusty = strong

Weather:

Sky conditions:c = clear; ptcl = partly cloudy; ov = overcast; f = fog, stratus obscuring sites

Precipitation: r = rain; drz = drizzle; shw = showers; sno = snow; hail, slt (sleet) = rain & freezing

Site observation data are generalizations from hourly reporting by observers (generally at GATR, less often Burnt Point)

Table 4b: Observation site weather and Quillayute intraday temperature rise by study day for 1994, 1995, 1996, and 1997 years

1994						1995						1996						1997					
study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise	study day	date	wind dir	wind speed	wthr	Quil temp rise
1	3/25/94	NE	mod	c	32	1	3/18/95	S	lgt	ov,r,f	7	1	3/20/96	S,SSW	l-mod	ov	9	1	3/20/97	SW	mod	ptcl	9
2	3/26/94	NE	mod	c	27	2	3/19/95	SW,NE	l-mod	ptcl	7	2	3/21/96	S,SSW	lgt	ov,drz	15	2	3/21/97	S	l-str	ov,f,r	14
3	3/27/94	NE	mod-c	c	35	3	3/20/95	na		storm	6	3	3/22/96	SW,NW,SE	m-lgt	f,ov	8	3	3/22/97	SE,SW	lgt	ov	23
4	3/28/94	NE,S	mod-c	ptcl,f	24	4	3/21/95	na		storm	3	4	3/23/96	SSW,SW	c-lgt	ptcl	14	4	3/23/97	NW,SW	lgt	ptcl	14
5	3/29/94	NE,S,SW	l-mod	ptcl,r	25	5	3/22/95	na		storm	15	5	3/24/96	NE	str-m	c	12	5	3/24/97	E,S	lgt	ov	19
6	3/30/94	NW,SW	l-str	ov,f	11	6	3/23/95	E,NW	lgt	ptcl	13	6	3/25/96	NE	lgt	c	26	6	3/25/97	S	mod	ov,r	10
7	3/31/94	SW	clm	ov,r,f	5	7	3/24/95	NW	l-mod	c	11	7	3/26/96	SW,var	lgt	ov	19	7	3/26/97	SW	str	ov,f	5
8	4/1/94	SW	mod	oc,f	8	8	3/25/95	W,NW	clm	ptcl	14	8	3/27/96	E,NE	m-str	ptcl	14	8	3/27/97	SSW	m-str	ov,r	7
9	4/2/94	SW	str	ov,r,f	7	9	3/26/95	NE	lgt	ptcl	26	9	3/28/96	SW	mod	ptcl	24	9	3/28/97	WSW	l-mod	ov,f	12
10	4/3/94	SW,W	str	ov,f	5	10	3/27/95	E	lgt	c	26	10	3/29/96	N,S	l-mod	ptcl	13	10	3/29/97	SSW	str-m	f,ov	10
11	4/4/94	NW,SW	clm	ov,r	6	11	3/28/95	E	lgt	c	31	11	3/30/96	S,NW,var	l-mod	ov	17	11	3/30/97	SE,S	str	ov,f,r	13
12	4/5/94	SE,NE	lgt	ov,r	12	12	3/29/95	NE,E	lgt	c	25	12	3/31/96	N,NE	str-m	ov,r	10	12	3/31/97	WSW,W	lgt	hail,ptcl	10
13	4/6/94	SW	str	ov,r,f	6	13	3/30/95	SE,SW	lgt	ptcl	24	13	4/1/96	S	lgt	ov,r	5	13	4/1/97	W	lgt	ptcl	12
14	4/7/94	SW	lgt	ptcl,f	10	14	3/31/95	SW	mod	ov,r,f	13	14	4/2/96	N,SW	lgt	ov,sno	17	14	4/2/97	NW,SSW	lgt	ptcl	24
15	4/8/94	SE	str	ov,r,f	5	15	4/1/95	SW	mod	ov,r,f	14	15	4/3/96	SW	mod	ov,r,f	13	15	4/3/97	NW	m-str	c	8
16	4/9/94	SE,S	lgt	ov,r,f	8	16	4/2/95	SW	m-lgt	ov,r,f	12	16	4/4/96	SE	m-lgt	ov	15	16	4/4/97	E,NE	lgt	c	29
17	4/10/94	SE	lgt	ov	14	17	4/3/95	NE,S,SW	m-lgt	c	22	17	4/5/96	SW	mod	ov,r	13	17	4/5/97	NE	lgt	c	33
18	4/11/94	SE,SW	m-lgt	ov,r	18	18	4/4/95	W,NW,SW	s-mod	r,f,ptcl	6	18	4/6/96	S	lgt	ov,r,f	3	18	4/6/97	E,NE	lgt	c	33
19	4/12/94	NW,SW	mod	ptcl	10	19	4/5/95	E,NE,SE	lgt	f,ov	19	19	4/7/96	S	lgt	ov,f	15	19	4/7/97	S,SW	lgt	ptcl	18
20	4/13/94	SW	str	ov,r	7	20	4/6/95	S,SE	m-lgt	ptcl,r	10	20	4/8/96	S,SE,S	lgt	ov,f	10	20	4/8/97	SW,NE,NW	l-med	ptcl	25
21	4/14/94	SW	m-str	ov,r	16	21	4/7/95	S	str	ov,r	6	21	4/9/96	S	str-m	ov,f	4	21	4/9/97	S	c-lgt	ptcl	20
22	4/15/94	E,NE	l-mod	ptcl,f	16	22	4/8/95	S	str	ov,r	8	22	4/10/96	S,W,SW	l-clm	ov,f,r	7	22	4/10/97	S,W,SW	c-lgt	ptcl	19
23	4/16/94	NE,N,NW	clm	ptcl	23	23	4/9/95	NW,SW	lgt	ptcl	14	23	4/11/96	S,SE	m-str	ov,r	6	23	4/11/97	E,NE	l-clm	ptcl	32
24	4/17/94	SW	lgt	ov,f	20	24	4/10/95	SE	str	ov,r,f	8	24	4/12/96	S,SE	mod	ov,r,f	8	24	4/12/97	E,SW	lgt-m	ov	21
25	4/18/94	S,SE	clm	ov,r	15	25	4/11/95	SW	clm	ptcl	21	25	4/13/96	S	m-str-l	ov,f,r	10	25	4/13/97	W,SW	lgt-m	ptcl	10
26	4/19/94	SW	l-mod	ov-r,f	10	26	4/12/95	W	m-str	ov,r	9	26	4/14/96	SE	str-m	ov high	21	26	4/14/97	na			11
27	4/20/94	E	c-lgt	ptcl	20	27	4/13/95	NW	str	ov,r,hail	12	27	4/15/96	S,NE	lgt	ov,r,f	5	27	4/15/97	S,SSW	l-mod	ov,f,r	5
28	4/21/94	NW		r	7	28	4/14/95	W,SW	clm	ptcl	13	28	4/16/96	SE	str-m	ov,r	4	28	4/16/97	SW	str	ov,f	5
29	4/22/94	SE,S,SW	c-lgt	ptcl	16	29	4/15/95	NE	lgt	ptcl	19	29	4/17/96	SE	mod	ptcl,f,r	9	29	4/17/97	NW,SW	lgt	f,ptcl	18
30	4/23/94	NE,SE	lgt	ov,r	17	30	4/16/95	NE	clm	c	24	30	4/18/96	SE	str-m	r,ov	11	30	4/18/97	NE,E	lgt	ptcl	23
31	4/24/94	SW	lgt	ptcl	10	31	4/17/95	SW,NW	c-mod	ov,r,slt	8	31	4/19/96	SE,NE	mod	r,f,ov	5	31	4/19/97	na			11
32	4/25/94	E,NE,NW	c-lgt	ptcl	23	32	4/18/95	NW,SW	lgt	ov,r	16	32	4/20/96	NE	m-lgt	ptcl,r	15	32	4/20/97	W,SW	mod-s	ov,f	13
33	4/26/94	SW,S	l-mod	ov,f	12	33	4/19/95	S,SW	m-str	ov,r	13	33	4/21/96	NE	mod	ptcl	24	33	4/21/97	NE	lgt	c	21
34	4/27/94	NW,SW	c-lgt	ptcl	13	34	4/20/95	NE,E	lgt	f,ptcl	14	34	4/22/96	SW	m-str	ov,r	3	34	4/22/97	E,NE	lgt	c	23
35	4/28/94	na			6	35	4/21/95	S,SW	clm	f,ptcl	21	35	4/23/96	NE,SE	mod-s	ov,f,r	8	35	4/23/97	SW,S	lgt	f,ov	10
36	4/29/94	sw	mod	ov,r,f	11	36	4/22/95	E	l-mod	c	31	36	4/24/96	NW,NE,SW	mod-l	ov,hail,r,	9	36	4/24/97	SW	lgt	ptcl	26
						37	4/23/95	NE,SE,S	l-clm	ptcl	29	37	4/25/96	S	str	ov,r,f	9	37	4/25/97	NE,E	lgt	f,ov	11
						38	4/24/95	S	c-lgt	c,f	22	38	4/26/96	S,N,SW	c-mod	r,ov	10	38	4/26/97	E,S	lgt	ov	11
						39	4/25/95	SE,NE,E	clm	c,ptcl	16	39	4/27/96	N,S,W	lgt	c	17	39	4/27/97	SSE,S	m-str	r,ov	19
						40	4/26/95	SW	l-mod	ptcl,f	12	40	4/28/96	NNE	mod	ov,r	17	40	4/28/97	SE,S	lgt	r,ov	8
						41	4/27/95	E	l-mod	ptcl,f	13	41	4/29/96	SW	mod	ov	9	41	4/29/97	SW	lgt	ptcl	12
						42	4/28/95	S,SE	c-lgt	ptcl,f	11	42	4/30/96	E,W,SW	clm-m	ov	12	42	4/30/97	E	mod	ov,f	9
						43	4/29/95	W	c-lgt	ov,f	16	43	5/1/96	N,W	l-mod	ptcl	9	43	5/1/97	SW,W	lgt	ptcl	15
						44	4/30/95	S,SW	c-lgt	ov,f,r	11												
						45	5/1/95	NE,E,SE	l-mod	ov,shw	11												

Abbreviations:

Wind: clm,c = calm; lgt,l = light: mod,m = moderate; str,s,gusty = strong

Weather:

Sky conditions:c = clear; ptcl = partly cloudy; ov = overcast; f = fog, stratus obscuring sites

Precipitation: r = rain; drz = drizzle; shw = showers; sno = snow; hail, slt (sleet) = rain & freezing

Site observation data are generalizations from hourly reporting by observers (generally at GATR, less often Burnt Point)

Table 5: Regression Analyses of Raptor Sightings, temperature-rise and precipitation data from 1995, 1996, and 1997 Studies

1997 Sightings

Regression equation: Log(sightings+1) = 0.54 + 0.07 (Quil-rise) - 0.40 (Quil-prcp)
Multiple R = 0.69
Sightings: Mean = 169, Median = 35 raptors per day
Quil-rise: Mean = 15.8, Median= 13 degrees F.
Quil-prcp: Mean = 0.29, Median = 0.06 inches precipitation per day

1996 Sightings

Regression equation: Log(sightings+1) = 0.71 + 0.06 (Quil-rise)
Multiple R = 0.47
Sightings: Mean = 83, Median = 22 raptors per day
Quil-rise: Mean = 11.7, Median= 10 degrees F.
Quil-prcp: Mean = 0.30, Median = 0.12 inches precipitation per day

1995 Sightings

Regression equation: Log(sightings+1) = 0.16 + 0.09 (Quil-rise)
Multiple R = 0.69
Sightings: Mean = 161, Median = 35 raptors per day
Quil-rise: Mean = 15.2, Median= 13 degrees F.
Quil-prcp: Mean = 0.19, Median = 0.05 inches precipitation per day

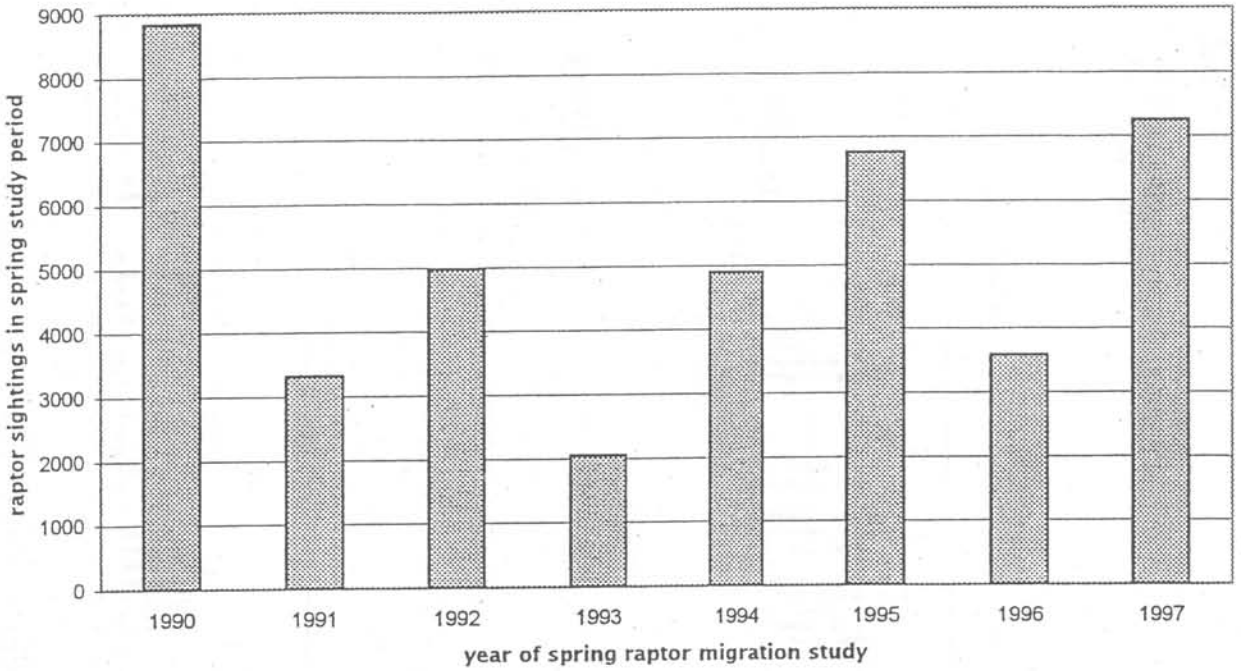

Figure 4: Total raptor sightings by year
(excluding Bald Eagles)

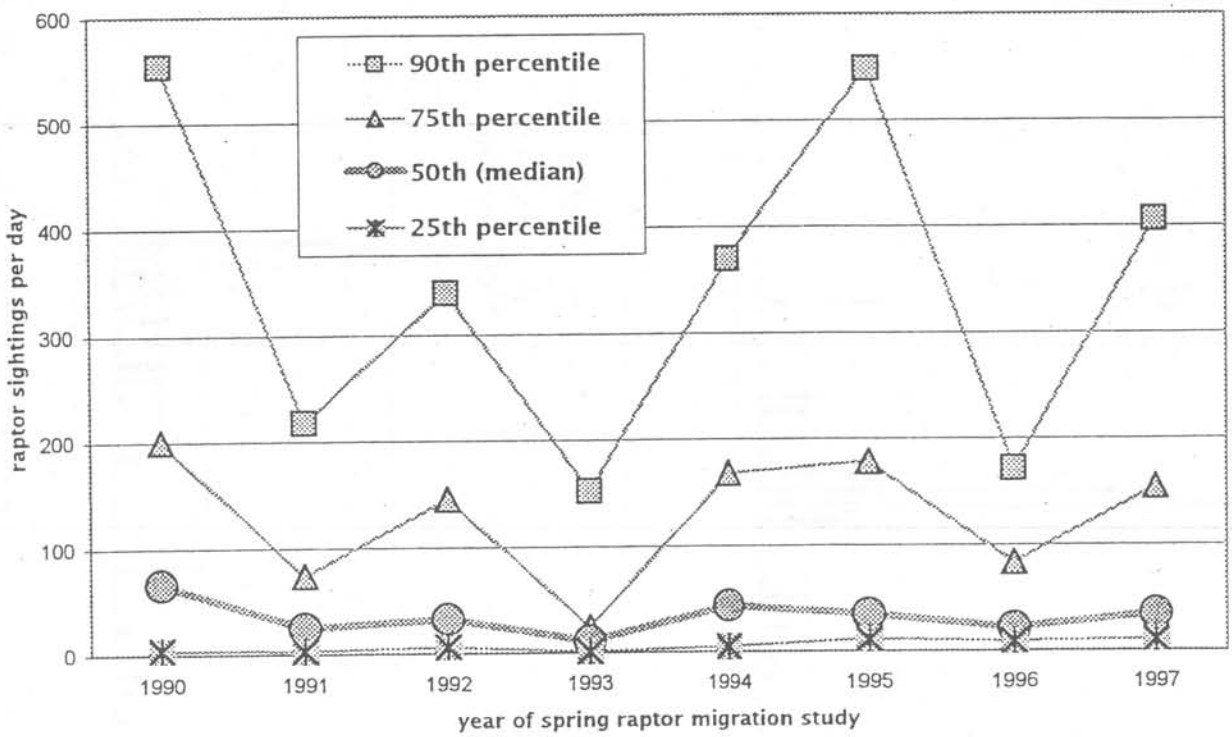

Figure 5: Percentiles of daily raptor sightings by year
(excluding Bald Eagles)

Note: The daily sightings distributions are highly skewed. The median is 24 sightings per day over the 340 days of observations, while the arithmetic mean ("average") is 123 sightings per day and 27.5 sightings per hour.

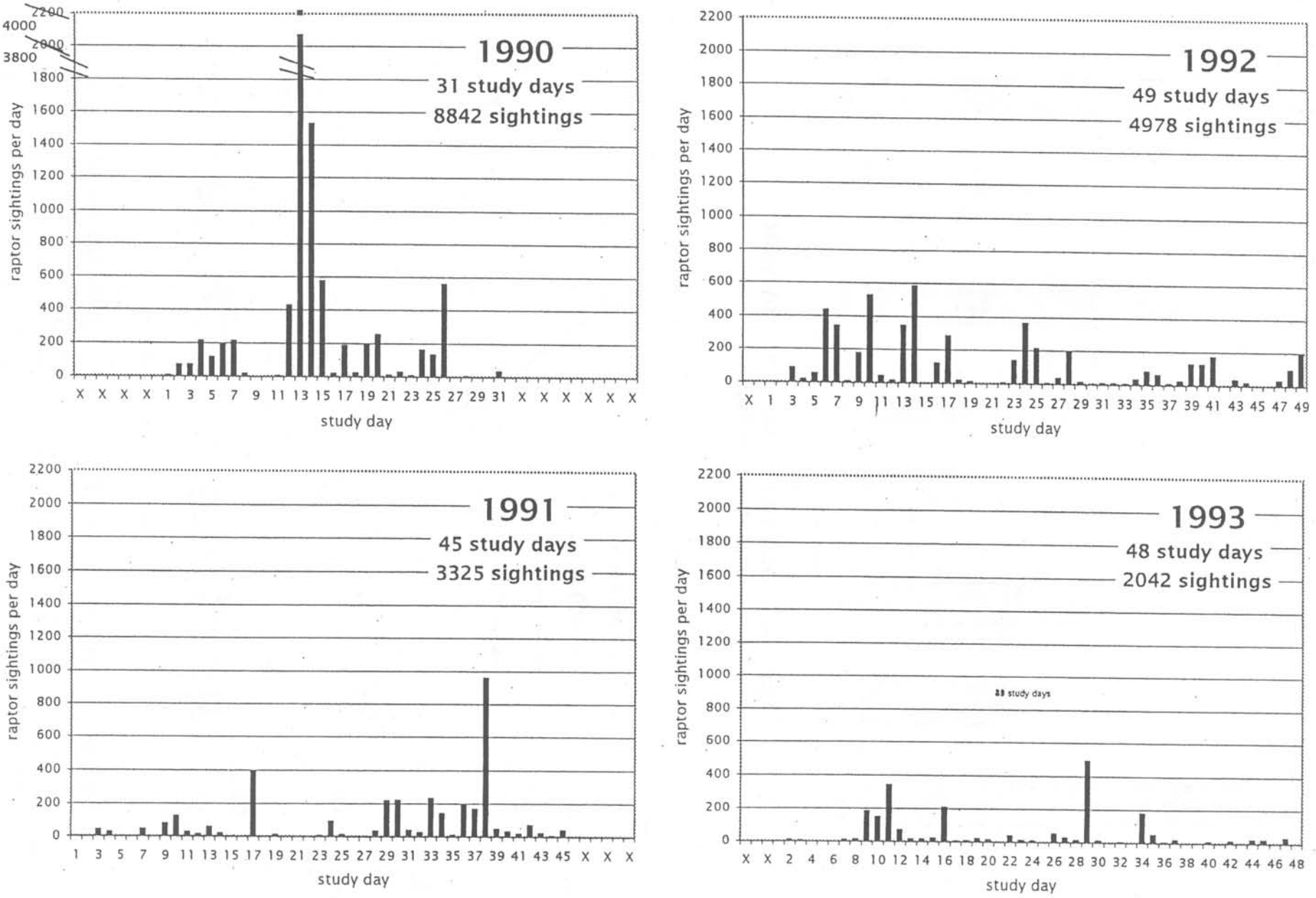

Figure 6a: Graphs of raptor sightings by study day, for 1990, 1991, 1992, and 1993 years

Bald Eagles are excluded. The horizontal graph axis scale is 14 March through 3 May for all graphs, with actual study days numbered. Note the discontinuous vertical scale for 1990, to accommodate the 3864 sightings day.

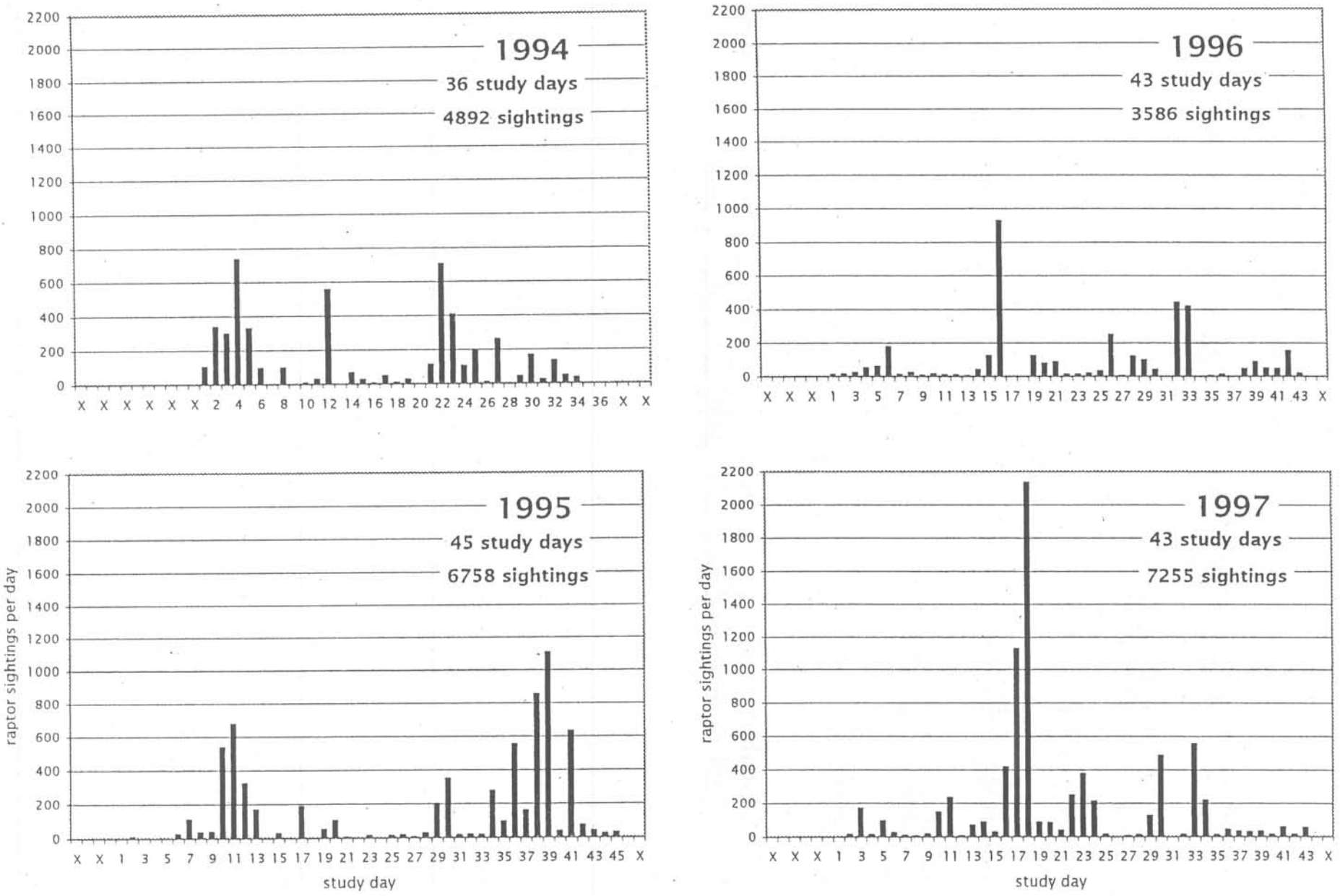

Figure 6b: Graphs of raptor sightings by study day, for 1994, 1995, 1996, and 1997 years

Bald Eagles are excluded. The horizontal graph axis scale is 14 March through 3 May for all graphs, with actual study days numbered.

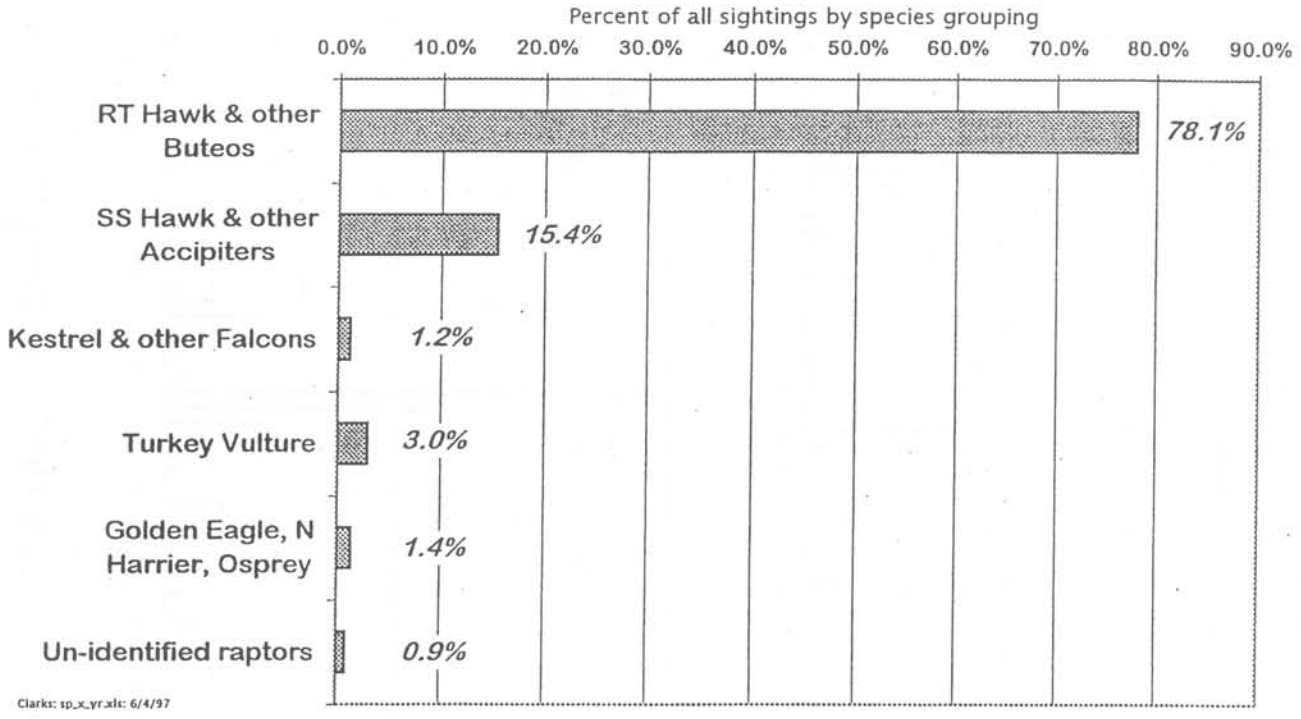

Figure 7: Distribution of raptor sightings by species groupings (excluding Bald Eagles) for 1990-1997 spring migration studies

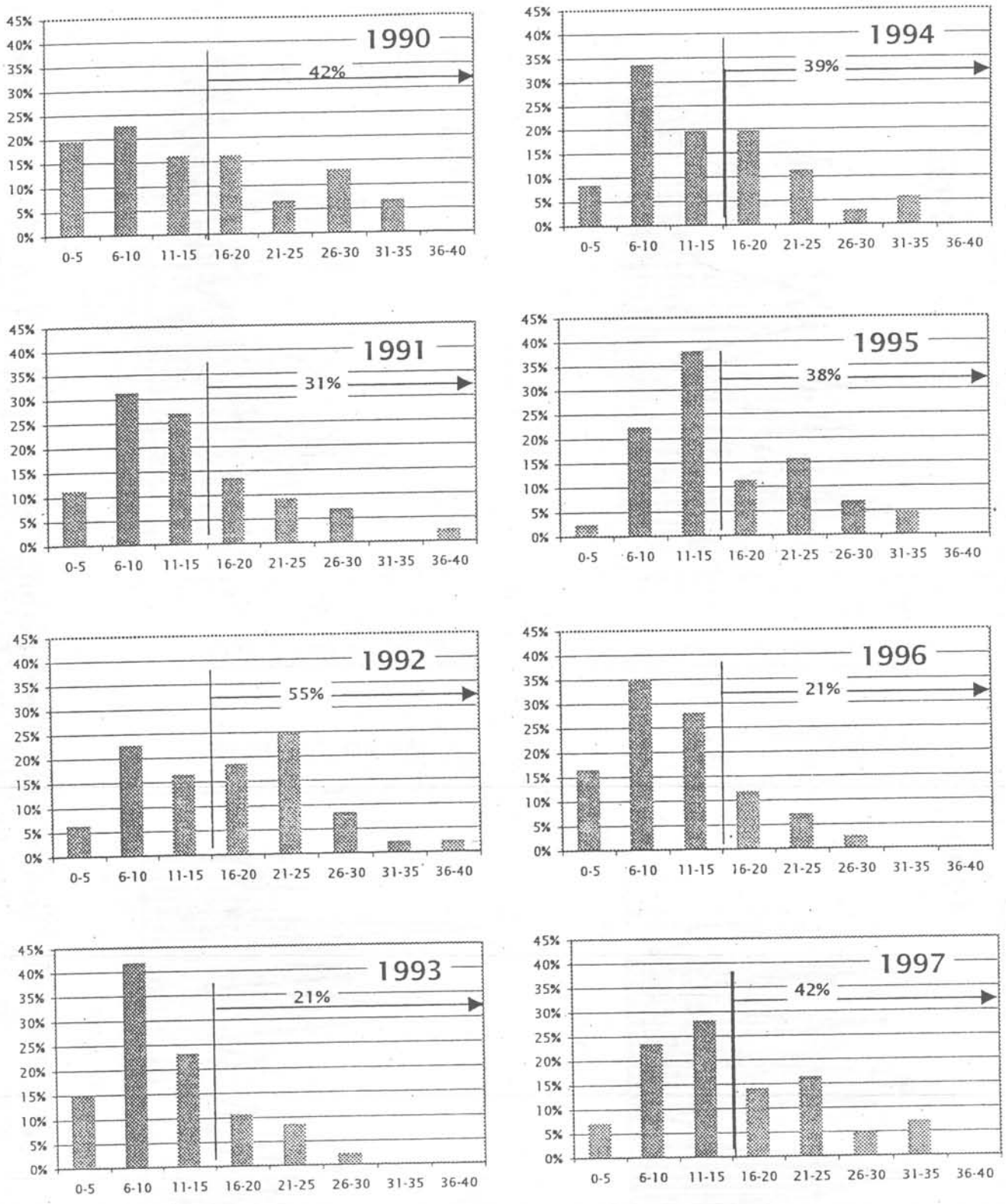

Figure 8: Histograms illustrating the distribution of intraday temperature rise over the spring study periods of 8 years 1990-1997.

Temperature rise categories shown on the horizontal axes are determined from observations at the NWS station at Quillayute. Percent of days in each category are shown on the vertical axes. The percent of days with greater than 15 degrees F intraday rise is shown for each year. Approximately 80% of raptor sightings over the 8 years occurred during these "good flight conditions".

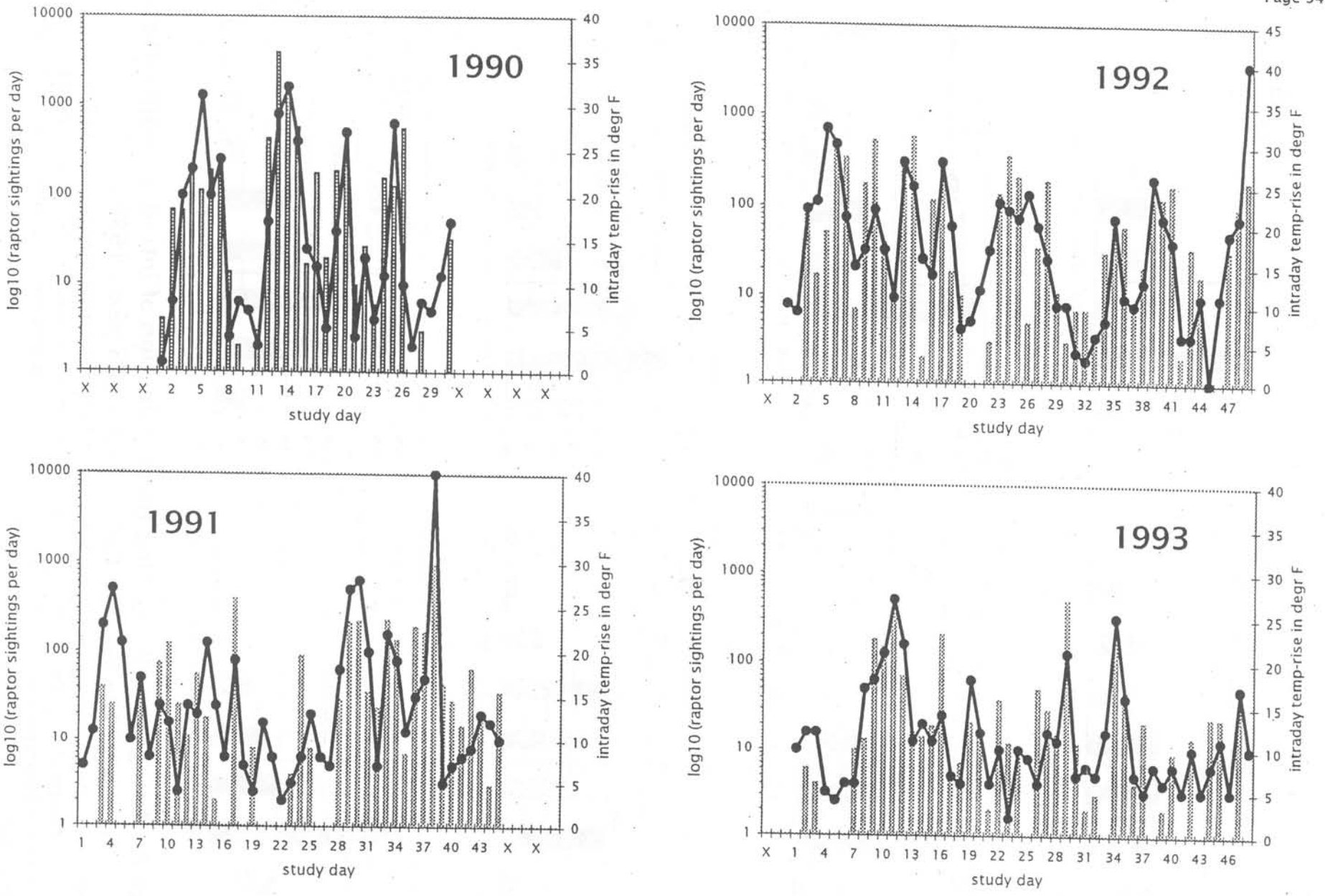

Figure 9a: Line graphs of intraday temperature rise superimposed on vertical bar graphs (plotted on a log scale) of raptor sightings by study day, for 1990, 1991, 1992, and 1993 years

The temperature rise data are from the Nat'l Weather Service Quillayute station. The horizontal graph axis scale is 14 March through 3 May for all graphs, with actual study days numbered. Bald Eagles are excluded.

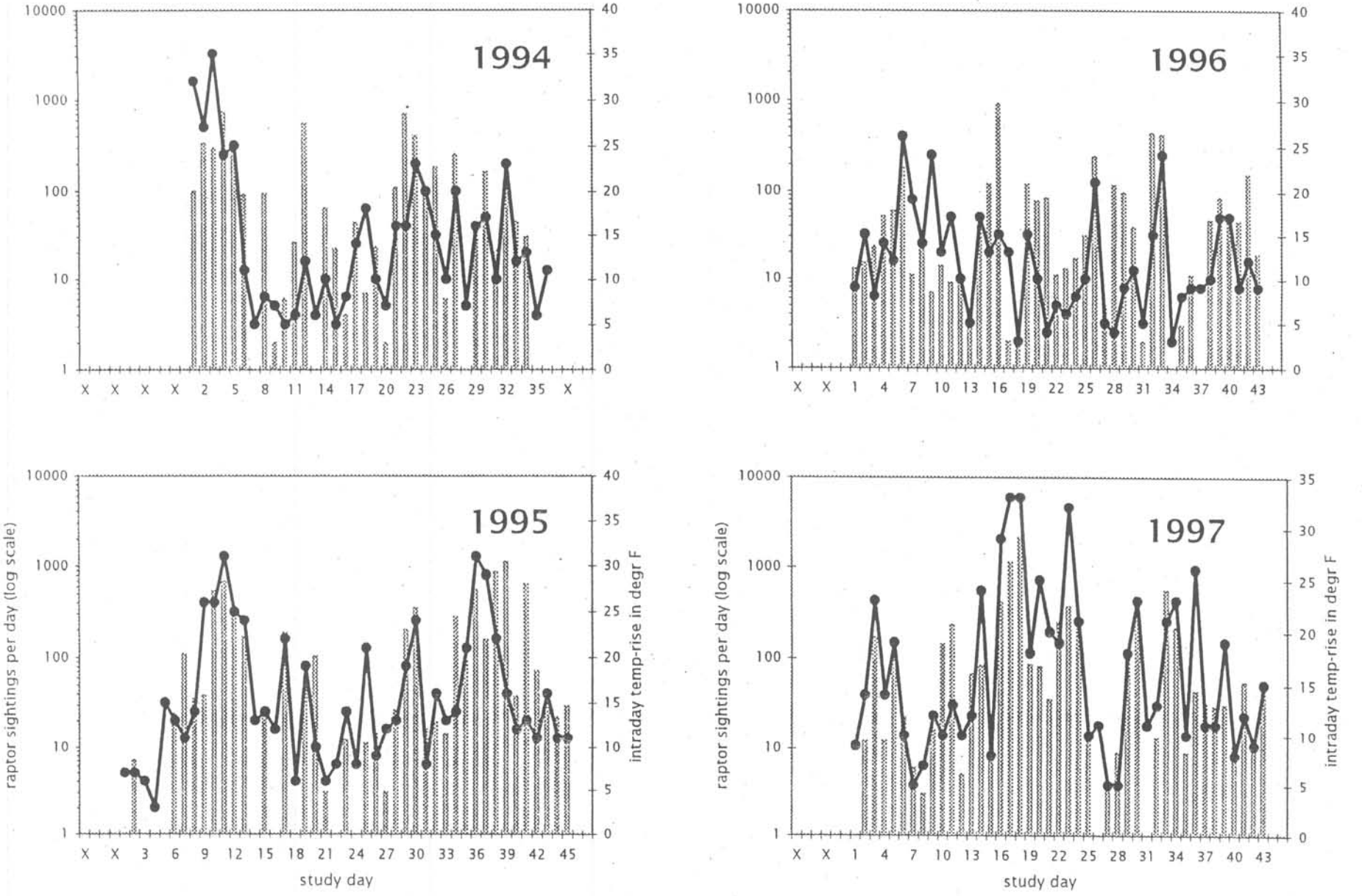

Figure 9b: Line graphs of intraday temperature rise superimposed on vertical bar graphs (plotted on a log scale) of raptor sightings by study day, for 1994, 1995, 1996, and 1997 years

The temperature rise data are from the Nat'l Weather Service Quillayute station. The horizontal graph axis scale is 14 March through 3 May for all graphs, with actual study days numbered. Bald Eagles are excluded.