Population Size, Phenology And Productivity Of Seabirds On Santa Barbara Island, 1999

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Table of Contents

	page
List of Tables	3
List of Figures	4
Executive Summary	6
Introduction	7
Methodology And Results	7
Double-Crested Cormorant	7
Methodology,	
Phenology	
Population Size And Productivity	
Nest Abandonment.	
Brandt's Cormorant	8
Methodology.	
Phenology	
Population Size And Productivity	
Pelagic Cormorant	9
Methodology	
Phenology	
Population Size And Productivity.	
Pigeon Guillemot	10
Methodology	
Phenology	
Population Size And Productivity.	
Ashy, Black, And Leach's Storm-Petrels	10
Methodology	
Phenology.	
Population.	
Western Gull	11
Methodology).	
Phenology	
Population Size	
Xantus' Murrelet	13
Methodology	
Phenology..	
Population Size.	
Occupancy And Productivity	
Causes Of Reproductive Failure	
Predation On Xantus' Murrelets As Adults And Subadults And Predator Numbers	

Discussion 16

Research, Monitoring, And Management Recommendations 19
Cormorants
Pigeon Guillemot
Storm-Petrels
Western Gull
Xantus' Murrelet
General
Acknowledgements

Literature Cited 24

Appendix 1 Documentation for Santa Barbara Island 1999 Databases 26

Appendix 2 Re-sighted and recovered bands of Western Gulls, Santa Barbara Island, 1999 32

Appendix 3 Documentation for determining clutch sizes and egg fates based on field data from Xantus' Murrelet nesting sites. 33

Tables 37

Figures 43

List of Tables

page

Table 1. Number of breeding pairs and reproductive success for Double-crested Cormorants on Santa Barbara Island, 1999, from land-based surveys. 37

Table 2. Number of breeding pairs and reproductive success for Brandt's Cormorants on Santa Barbara Island, 1999, from land-based surveys. 37

Table 3. Brandt's Cormorant and Pelagic Cormorant nests observed during a boat survey on 24 April 1999. 38

Table 4. Number of breeding pairs and reproductive success for Pelagic Cormorants on Santa Barbara Island, 1999, from land-based surveys. 38

Table 5. Total captures and breeding status of Ashy, Black, and Leach's Storm-petrels on five netting nights on Santa Barbara Island, 1999. 39

Table 6. Development of the "k" correction factor used to convert the number of adult Western Gulls counted into breeding pairs. Correction Factor = nests x 2/ number of adults counted in the plot on the survey date, 24 May 1999. 40

Table 7. Estimates of population size for Western Gulls on Santa Barbara Island, 1999. 40

Table 8. Reproductive Effort by Western Gulls on Santa Barbara Island, 1999. 40

Table 9. Reproductive performance of Western Gulls on Santa Barbara Island, 1999. 41

Table 10. Western Gull chick growth rates on Santa Barbara Island, 1999. 41

Table 11. Reproductive Effort and Causes of Reproductive Failure of Xantus' Murrelets on Santa BarbaraIsland, 1999 42

Table 12. Reproductive performance of Xantus' Murrelets on Santa Barbara Island, 1999 42

List of Figures

page

Figure 1. Locations of Double-crested Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black. 43

Figure 2. Locations of Brandt's Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black. 44

Figure 3. Locations of Brandt's and Pelagic Cormorant nests observed during a whole-colony boat survey, 24 April 1999. 45

Figure 4. Locations of Pelagic Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black. 46

Figure 5. Pigeon Guillemot raft counts during March-August 1999. 47

Figure 6. Storm-petrel netting sites on Santa Barbara Island, 1999. 48

Figure 7. Western Gull clutch initiation dates on Santa Barbara Island, 1999. 49

Figure 8. Xantus' Murrelet clutch initiation dates on Santa Barbara Island, 1999. 50

Figure 9. Differences in selected breeding parameters between Cat Canyon and Nature Trail on Santa Barbara Island, 1999 (a) occupied sites/total sites; b) hatching success; c) eggs depredated/total failed eggs; d) eggs abandoned/total failed eggs. 51

Figure 10. Trends in sea surface temperature (°C) taken at the Landing Cove, Santa Barbara Island, 1999. *Temperatures taken from a bucket of ocean water off the dock.* 52

Figure 11. Trends in Double-crested Cormorant productivity and population size on Santa Barbara Island, 1985-1999. *Productivity and population size data from 1985-1992 taken from Ingram and Jory-Carter 1997, Appendix B. Data from 1993-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 53

Figure 12. Trends in Brandt's Cormorant productivity and population size on Santa Barbara Island, 1993-1999. *Data from 1993-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 54

Figure 13. Trends in Pelagic Cormorant productivity and population size on Santa Barbara Island, 1996-1999. *Data from 1996-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 55

Figure 14. Trends in Western Gull population size and productivity on Santa Barbara Island, 1972-1999. *Productivity and population size data from 1972-1992 taken from Ingram and Jory-Carter 1997, Figure 23. Data from 1996-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 56

Figure 15. Trends in Western Gull breeding parameters on Santa Barbara Island, 1990 to 1999. *Data from 1990-1992 taken from Roth and Sydeman 1996, Table 1. Data from 1993-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 57

Figure 16. Trends in Xantus' Murrelet breeding parameters on Santa Barbara Island, 1993 to 1999. *Data from 1993-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 58

Figure 17. Trends in Xantus' Murrelet productivity on Nature Trail and Cat Canyon, 1983-1999. *Data from 1983-1992 taken from Ingram and Jory-Carter 1997, Figure 26. Data from 1993-1999 taken from annual PRBO report contributions on Santa Barbara Island seabird monitoring.* 59

EXECUTIVE SUMMARY

(1) We monitored population size, phenology and productivity of Double-crested, Brandt's, and Pelagic Cormorants, Pigeon Guillemots, Western Gulls, and Xantus' Murrelets on Santa Barbara Island, California, during the 1999 breeding season. We also continued a capture-recapture study to assess population trends of Ashy, Black, and Leach's Storm-petrels.

(2) The Double-crested Cormorant population numbered approximately 143 pairs and productivity was estimated at 0.59 chicks per pair.

(3) The Brandt's Cormorant population included 537 pairs and productivity was estimated at 1.74 chicks per pair.

(4) The Pelagic Cormorant population numbered 33 pairs and productivity averaged 1.23 chicks per pair.

(5) A maximum number of 75 Pigeon Guillemots was observed near the island this year. (6) We mist-netted storm-petrels on 5 nights and caught 99 unbanded birds and 2 previously banded birds. Ashy Storm-petrels constituted the majority of our captures.

(7) We estimated the Western Gull population to contain 5035 breeding pairs, demonstrating that the gull population continues to expand. Western Gull productivity in Grids A and E averaged 0.94 chicks per pair.

(8) We did not estimate the population size of Xantus' Murrelets due to the difficulties in censusing this nocturnal, crevice-nesting species. However, we attempted to assess the factors limiting the Xantus' murrelet population. Murrelets produced an average of 0.81 chicks per pair.

(9) Critical management recommendations in order of priority include:

(a) expanding demographic studies of Xantus' Murrelets

(b) supporting two researchers involved in seabird monitoring on SBI

(c) intensifying netting effort of Ashy Storm-petrels

INTRODUCTION

Seabird monitoring studies attempt to compile time-series data on chosen aspects of seabird distribution, abundance, demography, and behavior. These studies have the potential to provide useful information to resource managers from a variety of perspectives. First, seabirds respond quickly to fluctuations in the marine environment, both natural and human-induced. Changes in seabird species distribution and reproductive success thus provide timely information on the abundance of lower trophic-level organisms, such as zooplankton and forage fishes (Croxall et al. 1988). Second, monitoring provides baseline information on the population dynamics and reproductive ecology of seabird species over long time scales. Such data are needed by wildlife managers to detect long-term population trends and to investigate factors responsible for observed population dynamics. This information is critical for making informed management decisions about responsible resource use, habitat protection, and restoration priorities.

In 1985, Channel Islands National Park (CINP) established a Seabird Monitoring Program. This program was initiated due to concern for the welfare of southern California seabirds which face potential threats from offshore oil drilling, and in recognition of the contribution seabird science can make to understanding marine ecosystems. Continuing threats to CINP seabirds include: mortality from native and introduced predators, oil and chemical pollution, and incidental take (i.e. bycatch) by commercial fisheries. Alterations of coastal food webs by over-exploitation of fisheries and by climate change may also be detrimental to populations of seabirds in southern California (Roemmich and McGowan 1995, Sydeman et al. manuscript).

This report summarizes annual studies of Double-crested (*Phalacrocorax auritus*), Brandt's (*Phalacrocorax penicillatus*), and Pelagic (*Phalacrocorax pelagicus*) Cormorants, Pigeon Guillemot (*Cepphus columba*), Leach's (*Oceanodroma leucorhoa),* Ashy *(Oceanodroma homochroa),* and Black *(Oceanodroma melania)* Storm-petrels, Western Gull (*Larus occidentalis*) and Xantus' Murrelet (*Synthliboramphus hypoleuca*) on Santa Barbara Island, Channel Islands National Park, 1999. Shaye Wolf and Marie DesLauriers collected data under Cooperative Agreement CA8120-95-003 between Point Reyes Bird Observatory (PRBO) and CINP. Shaye Wolf, Jennifer Roth, and William Sydeman summarized and analyzed data. The CINP Seabird Monitoring Handbook provides a synopsis of methodology (Lewis et al. 1988). We provide specific methodologies pertaining to our analyses in each species account. This is PRBO contribution no. 877.

METHODOLOGY AND RESULTS

Double-crested Cormorant

Methodology. Double-crested Cormorants nested on North Peak Cliffs, West Cliffs, and Sutil Island in1999. We conducted 29 land-based censuses from vantage points on the island at five-day intervals between 8 March and 26 July, and in addition, 3 follow-up censuses on 9 August, 31 August and 5 September. Data are contained in file "SB_Double-crestedCormorant" (see Appendix 1 for file structure). Vantage point and

sub-colony locations are mapped in Figure 1. We assessed the total number of adults, well-built nests (nests with incubating or brooding adults and/or chicks), nests with chicks, and the number of large chicks (fledglings) at each sub-colony by scanning cliff sides with a Questar 60x spotting scope. To facilitate and improve the accuracy of our counts, we mapped the locations of nests in each sub-colony and recorded the number of large chicks per nest on overlayed photographs of the North Peak Cliffs and West Cliffs areas. We also noted numbers of failed nests, displaying birds, pairs, and roosting birds. Portions of the population are not visible from land and regular boat censuses were not feasible during 1999; consequently, the population estimate reflects the minimum number of pairs on SBI in 1999. Only data from land-based surveys was used to calculate productivity.

Phenology. Clutch initiation and hatch dates were asynchronous within and among sub-colonies in 1999. Double-crested Cormorants were first observed displaying on Santa Barbara Island on 1 April. Observations indicated a bimodal distribution of nesting. Clutch initiation first began during mid-to-late April in the majority of sub-colonies (North Peak 1, 6, and 7; Sutil Island; and West Cliffs 2 and 3). Another wave of clutch initiation began in mid-May and continued through early June at two smaller sub-colonies (North Peak 2 and West Cliffs 1). The egg-laying period was seemingly protracted within most sub-colonies, possibly due to nest desertion followed by relay attempts, as well as the sporadic initiation of new nests throughout the season. Egg-laying extended into late June on West Cliffs 2 and 3, into early July on Sutil and North Peak 2, and into early August on North Peak 1. Hatching dates were also asynchronous. The first chicks hatched during mid-to-late May at the majority of sub-colonies. Hatching peaked from late June to early July and was followed by a second peak in hatching during August on North Peak 1 and 7 and West Cliffs 2 and 3.

Population Size and Productivity. We estimated a Double-crested Cormorant breeding population of 143 pairs in 1999 (Table 1). Breeding pairs failed to establish nests in several traditional breeding areas on North Peak Cliffs 3, 4, and 5; Shag Rock; and South Signal Peak. Overall productivity for nesting Double-crested Cormorants was estimated at 0.59 chicks fledged per pair.

Nest Abandonment. Nest abandonment appeared to occur at 56% of well-built nests. We defined "well-built nests" as those on which an adult had been observed in incubating posture during at least one check. "Abandoned nests" were defined as well-built nests at which the adults abandoned the nesting attempt at any stage of nesting. However, because we were unable to view nest contents, we could never ascertain that "abandoned nests" had ever received eggs. Therefore, our estimates of nest abandonment may be inflated and should be viewed as rough approximations.

Brandt's Cormorant

Methodology. Brandt's Cormorants nested on Webster Point, Arch Point, Elephant Seal Point, North Peak Cliffs, Sutil Island, West Cliffs, and Webster Cove Cliffs. We conducted censuses at five-day intervals on 29 dates between 8 March and 25 July, as well as three follow-up censuses on 7 August, 9 August, and September 5. We monitored colonies until we could not distinguish large chicks from adults. Data are contained in file "SB_BrandtsCormorant" (see Appendix 1 for file structure). Sub-colony

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monitored colonies until we could not distinguish large chicks from adults. Data are contained in file "SB_BrandtsCormorant" (see Appendix 1 for file structure). Sub-colony locations and vantage points are mapped in Figure 2. During each survey, we counted the number of adults, well-built nests, nests with chicks, and large chicks in each sub-colony using a Questar 60x spotting scope, noting displaying birds, pairs, and roosting birds. For the smaller colonies (Arch Point, Elephant Seal Point West, North Peak 1, Sutil Island, West Cliffs 3 and Webster Cove Cliffs), we mapped the locations of nests and recorded the number of fledged chicks per nest when possible. To estimate the population not visible from land, we conducted a whole-colony survey by boat on 24 April. Nests initiated after 24 April on cliffs not visible from land are not reflected in nest totals. Only data from land-based surveys was used to calculate productivity.

Phenology. Brandt's Cormorant nesting was early and asynchronous in 1999. The first nests were likely initiated in mid-to-late February on lower Webster Point, Upper Webster Point 1, Arch Point Cliffs, the west side of Elephant Seal Point, and the north side of Sutil Island; these pairs began nesting before our surveys began. We estimated this chronology by assuming that eggs are laid 30 days before chicks hatch, and that we first observed chicks when they were about 10 days old. Brandt's Cormorants continued to form sub-colonies throughout March (North Peak 1, Northeast Elephant Seal Point, Sutil Island, West Cliffs 3, and Webster Cove Cliffs), April (Sutil Island and Upper Webster Point), May (Sutil Island and Upper Webster Point), and June (Upper Webster Point). On Upper Webster Point alone, five distinct sub-colonies were initiated in late February, April 26, May 21, June 10, and June 25 respectively.

The first chicks hatched in mid-March on Lower Webster Point; peak hatch spanned early-to-mid April in this sub-colony with the last chicks hatching in June. For the majority of sub-colonies, peak hatch occurred in April or May. The latest chicks hatched during mid-August in Upper Webster Point Sub-colony 5.

Population Size and Productivity. From land-based surveys, we estimated the Brandt's Cormorant population at 501 breeding pairs in 1999 (Table 2). During the whole-colony survey on 24 April (Table 3, Figure 3), we observed an additional 36 nesting pairs along the north, west, and south cliffs of Santa Barbara and Sutil Islands, raising the total number of nesting pairs to 537. The majority of the population (70%) nested in 6 distinct sub-colonies on Webster Point. The distribution of Brandt's Cormorants on SBI in 1999 also expanded to two new areas; pairs nested in small numbers on West Cliffs (not observed during 1993-1998) and established a relatively large sub-colony on Northeast Elephant Seal Point where only small groups had previously been observed (1993-1998). Productivity averaged 1.74 chicks fledged per pair.

Pelagic Cormorant

Methodology. Pelagic Cormorants nested on Arch Point, Elephant Seal Point, North Peak Cliffs, Webster Cove Cliffs, and West Cliffs. We collected population data from land-based vantage points on 30 dates between 8 March and 25 July and on 7 August, using the same methodology described for Brandt's Cormorants. Data are contained in file "SB_PelagicCormorant" (see Appendix 1 for file structure). Vantage

point and sub-colony locations are mapped in Figure 4.

Phenology. Based on observations of large chicks, Pelagic Cormorants apparently began nesting in late February on Arch Point Cliffs, North Peak 4, and West Cliffs 3, with the majority of pairs laying in early to mid-March. We estimated that the first chicks hatched in late March, that peak hatch occurred in April, and the last chicks hatched in June.

Population Size and Productivity. There were at least 33 breeding pairs of Pelagic Cormorants on SBI in 1999, including 17 pairs observed from land-based vantage points (Table 4) and 16 pairs observed during the boat survey along the north, east, and west sides of the island (Table 3, Figure 3). Productivity averaged 1.23 chicks fledged per pair (Table 4).

Pigeon Guillemot

Methodology. We censused rafting Pigeon Guillemots gathered on the water on 28 dates between 12 March to 25 July and once on 7 August. Summary data are contained in file "SB_PigeonGuillemot"(see Appendix 1 for file structure). We conducted surveys in the morning, when guillemots are likely to be near the island. The area north and west of Arch Point (AP) and the area below the Nature Trail slopes south to Cave Canyon (NT) were counted consistently. Guillemots were also observed, in smaller numbers, in Elephant Seal Cove, Webster Cove, and around Sutil Island, but these areas were not included in surveys due to time constraints. Guillemots were observed flying into the cave just west of Arch Point, into Cave Canyon, and into crevices on Sutil Island, indicating probable nesting sites in these areas.

Phenology. Numbers peaked from mid-March to late April, when birds were presumably arriving and staging near the island (Figure 5). A decline in guillemot numbers during May and June suggests incubation during this time. A second peak in Pigeon Guillemot numbers during late June to mid-July indicates the beginning of the nestling period when adults were foraging in nearshore waters to provision young. Adults were observed carrying fish into the cave west of Arch Point beginning late June and continuing through early August, indicating the presence of chicks at those times. No fledglings were observed on any checks.

Population Size and Productivity. A total of 75 guillemots was counted near the island on 6 April, including 66 adults from the Arch Point vantage point and 9 adults from the Nature Trail vantage point. This number represents the maximum number of birds observed rafting near the island during the breeding season. Pigeon Guillemots nest in the crevices and caves along the periphery of the island, making population estimates difficult using other methods. Due to the difficulty in accessing nest sites from land, we were unable to obtain any information on productivity.

Ashy, Black, and Leach's Storm-Petrels

Methodology. We mist-netted storm-petrels during 5 nights on SBI between 12 May and 14 July for a total of 14 net-hours. Netting sessions lasted 3 hours per night, with the exception of May 12 when we closed nets after 2 hours because of light interference from the squid fishery (see Research, Monitoring, and Management

Recommendations). We were unable to mist-net in March, April, and August due to high winds. Data are compiled in file "ASSP99" (see Appendix 1 for file structure). We conducted mist-netting at standardized locations in proximity to appropriate nesting habitat (Figure 6) and played taped vocalizations to attract storm-petrels to netting sites. We banded new captures with a metal FWS band, measured wing chord to aid in distinguishing the dark-rumped morph of the Leach's Storm-petrel from the Ashy Storm-petrel, and looked for presence or absence of brood patches. Brood patches were rated as downy (no incubation patch evident), partly downy (patch forming or receding), and bare (brood patch evident). We considered all birds with bare or partly downy brood patches as breeding birds and those with downy incubation patches as non-breeders. To assess the phenology of storm-petrel species, we looked at changes in brood patch condition over time. For this analysis, we grouped storm-petrels into those captured during 2 nights in May, 2 nights in June, and 1 night in July.

Phenology. Of the 25 Ashy Storm-petrels captured in May, 68% (17/25) had bare brood patches indicating that they were incubating eggs. Slightly fewer adults had bare brood patches in June (50%, 20/40) and July (40%, 4/10), signaling a gradual switch to the chick-rearing period. For Black Storm-petrels, 60% (3/5) of adults captured in June had bare brood patches and 58% (11/19) in July suggesting that the majority were incubating eggs. We captured 2 Leach's Storm-petrels in June, both with downy brood patches.

Population. We captured a total of 101 storm-petrels including 99 new captures and 2 recaptures (Table 5). Ashy Storm-Petrels constituted the majority of birds caught (74%, n=75, including 2 recaptures), with lesser numbers of Black Storm-Petrels (24%, n=24, no recaptures), and Leach's Storm-Petrels (2%, n=2, no recaptures). More Black Storm-petrels were caught as the season progressed: 0% of May captures, 11% of June captures (5/47) and 66% (19/29) of July captures. Eighty-eight percent of the Black Storm-petrels caught were in breeding condition (bare or partly downy brood patches) as compared to 65% of Ashy Storm-petrels and 0% of the Leach's Storm-petrels. The two Ashy Storm-petrel recaptures were originally banded on Santa Barbara Island, one on 13 April 1991 on Arch Point, and the other on 24 June 1995 on Elephant Seal Point.

Western Gull

Methodology. We monitored Western Gull breeding phenology, nesting success and chick growth in two 1 ha study plots (Grids A and E). Between 9 April and 24 July we made 22 visits at five day intervals to each of the plots. We made a final visit to each plot on 8 and 9 August to look for dead banded chicks. Summary data are contained in file "SB_WesternGullNesting" (see Appendix 1 for file structure). During peak incubation, we measured the lengths and widths of eggs from 60 nests selected randomly from Grids A and E; the proportion of nests (x/60) sampled in each grid was equivalent to the percentage of nests each grid contributed to the total nest count. (Egg measurements are contained in the database but are not reported here). We banded all chicks weighing 100g or more, at approximately 10 days of age, with metal FWS bands. Chicks were weighed every five days during the linear phase of growth between 100g and 600g to ascertain growth rates. Chick weight data are contained in file

"SB_WesternGullCkWeights" (see Appendix 1 for file structure).

Monitoring of Grid D was diminished in 1997 with the aim of generating nest counts and productivity estimates comparable with previous years, while reducing effort. We surveyed Grid D on 23 May (during peak incubation) and counted 81 nests, walking transects through the plot and applying a dot of spray paint next to each nest counted. On July 1, we counted chicks in Grid D by walking transects through the plot and marking chicks with green food color on their right wing feathers and/or down. We counted 104 chicks, the majority of which were mostly feathered and close to fledging. To account for chicks that might die before fledging, we modified the Grid D chick count using two methods. Both methods yielded similar estimates for the number of fledged chicks: 1) On July 17, when most chicks had fledged but were still visiting their territories, we resighted 101 chicks in Grid D. Observations were made in the late afternoon from a vantage point above the plot on the North Peak switchback trail. 2) On July 24, we searched Grid D for dead chicks and found 6 carcasses, none of which bore any trace of green food color; however, we assumed they were from Grid D because they were well within plot boundaries. This method yielded an estimate of 98 fledged chicks: (104 marked chicks – 6 dead chicks). We averaged the estimates from these two methods to generate the number of chicks fledged from Grid D: (101 + 98)/2 = 100 chicks fledged. We located the flagged northwest corner post of Grid D during the July 1 chick count, and augmented it with a taller rebar stake to aid in future location efforts.

From 22 to 24 May, during peak incubation, we conducted a whole-colony survey of adults from traditional vantage points. To convert the number of adults counted to an estimate of total breeding population size, we developed a "k" correction factor to account for birds away from the colony at the time of the survey. The "k" correction factor was developed by assessing the ratio of adults to nests in two study plots (A and E) at the time of the census (see Table 6).

We made an effort to re-sight banded gulls in Grid A, where the lower height of the grasses permitted some success in band-reading (see Appendix 2 for band numbers). Re-sighting in Grid E was difficult given the taller, denser vegetation that obscured gull legs. We did not resight bands on every pair in Grid A, so the data is useful for incidental reporting of juvenile recruitment and adult survivorship, but is not appropriate for statistical analysis.

Phenology. Egg laying stretched from late April to early June, with peak lay in early to mid May (Figure 7).

Population Size. We estimated the breeding population of Western Gulls at 5035 breeding pairs (Tables 6 and 7). Counts from traditional vantage points (Lewis et al. 1988) did not permit the observer to adequately view one area where adults were nesting; therefore, in addition to the traditional census points, adults were counted on the slope between North Peak and Cliff Canyon (125 adults, 0 roosting) above the Landing Cove sub-colony. Gulls colonizing this area may be part of the expanding breeding population. The nest numbers in Grids A, D, and E increased substantially from previous years (1991-1998). Grid A showed a 39% increase in nest numbers from the previous high nest count of 70 nests in 1998, Grid D a 17% increase from the high 1993 nest count of 69 nests, and Grid E an 11% increase over the high 1998 count of 100 nests.

Productivity. Clutch size averaged 2.44 eggs per nest (Tables 8 and 9). There was no significant difference in clutch size between plots (χ^2=3.35, df=2, p=0.19). Hatching success (the proportion of eggs laid that hatched) averaged 0.72 for both grids (Table 9). Fledging success (the proportion of chicks hatched that fledged) was estimated at 0.53 (Table 9). Hatching success and fledging success were not significantly different between plots (χ^2=2.95, df=3, p=0.34; χ^2=7.10, df=3, p=0.069 respectively). Productivity (the number of chicks fledged per nest attempt) averaged 0.94 chicks fledged per breeding pair for both plots and was significantly higher in Grid E (1.1 chicks fledged per pair) than in Grid A (0.79 chicks fledged per pair) (Table 9; χ^2=8.50, df=3, p=0.037). We counted 81 nests in Plot D and estimated that 100 chicks fledged from the grid, yielding a productivity of 1.23 chicks fledged per nesting attempt.

Most eggs that failed in Grids A and E either disappeared before hatching (46% in Grid A and 51% in Grid E) or were addled because they were heat stressed or never fertilized (52% in Grid A and 47% in Grid E) (Table 8). Chicks found dead before fledging were either pecked in the head by adult gulls or died of unknown causes, although 8 dead chicks were likely preyed upon by Peregrine Falcons or Barn Owls.

We calculated chick growth rates using three to five weights per chick during the linear phase of growth between 100 and 600 grams (Table 10). The average growth rate for all chicks was 24.48 grams per day. Chicks in Grid E (including both those that died and those that survived to fledge) grew at a significantly higher rate than chicks in Grid A (t= -2.12, df=190, p=0.036). The average growth rate for chicks that fledged from both grids was significantly higher than the growth rate of chicks that did not fledge (t= 5.07, df=190, p<0.01).

We gathered information on chick diet by categorizing components of 48 chicks regurgitations accidentally induced in the field during weighing. We analyzed the percent occurrence of prey species present in samples and found that the majority of samples (73%) contained fish (unidentified to species because of its typically digested appearance). Squid was present in 19% of samples, followed by krill (4%), human garbage (4%), barnacles (2%), kelp (2%), and gull chick (2%).

Xantus' Murrelet

Methodology. We monitored 138 (n = 126 identified prior to 1995) potential nest sites in the Cat Canyon (CC) and Nature Trail (NT) study areas. We checked sites in CC on 25 dates between 5 March and 3 July at 5-day intervals; we also checked two sites with late relay attempts on four additional dates between 8 July and 23 July. In mid April, California Brown Pelicans began nesting on the slopes of CC, and to avoid disturbing them, we stopped checking CC sites 62-71 and site 155 between 14 April and 23 July. However, we were able to visit these sites on 8 August to follow-up on site activity. NT sites and Disturbed sites (including sites at the both the dock and the house) were checked on 23 dates between 6 March and 24 June at 5-day intervals. All sites were monitored for a minimum of 3 checks after the last new activity in *any* study area was observed (i.e. the last relay attempts were initiated on June 8 in CC, so all sites were checked until at least June 24) after which only the remaining active sites were followed on the 5-day check schedule until completion. Summary data are contained in file

"SB_XantusMurrelet" (see Appendix 1 for file structure). Appendix 3 provides a thorough summary on interpreting clutch size and egg fates from field data.

The CC study area (n=78 sites) has little vegetation and murrelets nest almost exclusively in rock crevices: 77 sites are in crevices and 1 is under *Erioganum*). In contrast, the NT study area (n=60 sites) has few rock crevices and murrelets nest almost entirely under shrubs: 13 sites are in crevices, 46 under *Eriophyllum,* and 1 under *Hemizonia*. We photographed all monitored sites in NT and CC in 1999 and photos will be electronically scanned into CINP seabird monitoring database. We monitored 29 Disturbed nest sites located around the bunkhouse and dock areas which are exposed to high levels of human activity; these sites were associated with man-made structures (e.g., decks, stairs, pallets, etc.). Individual Disturbed sites have been monitored from 1995 to the present.

Only sites monitored prior to 1995 (n=52 in NT, n=74 in CC) were included in calculations of occupancy. These include NT sites 1-51 and 3a, and CC sites 1-71, 99, 151, and 155. "New" sites (sites identified in 1995 or later) were included in other estimates of breeding parameters; these include NT sites 21 a,b,c, 25a, 36a, 47a, 49a, and 52 (n=8) and CC sites 61b, 72, 96 and 99 (n=4). All sites with unknown clutch size and egg fates were excluded from estimates of breeding parameters. Disturbed sites were excluded from overall estimates of breeding parameters. Relay attempts were also excluded from all breeding parameter estimates except productivity. Any activity in a nest site subsequent to the first attempt was defined as a relay attempt.

During March-August 1999, we also gathered information on factors that may be limiting the population of Xantus' Murrelets on Santa Barbara Island. We recorded the number of predated Xantus' Murrelets found dead along trails, in study areas, and at known Barn Owl roosts. We attempted to quantify the number of Barn Owls and Peregrine Falcons (predators of Xantus' Murrelets) present throughout the season. We also recorded nightly numbers of light boats assisting the squid fishing fleet that operated offshore during spring and summer.

Lastly, we initiated an experimental nest box project in areas of high human disturbance in 1999. In mid-March we installed 8 nest boxes along the pilings under the dock and 7 nest boxes in shaded areas near the house (6 under the solar panels and 1 under the boardwalk). These boxes were checked for occupancy and nesting effort on the same 5-day check schedule as the Disturbed sites using the standard monitoring protocol.

Phenology. Breeding apparently began in mid-February (Figure 8). Eggs were found in 8 sites on our initial check of Cat Canyon and Nature Trail on March 5 and 6, and we estimated that the 10 eggs that hatched in March must have been laid in mid-to-late February. Egg laying appeared to peak in late March and decline in April (Figure 8). Hatching from first attempts peaked in late April but extended from March 20 to May 24. Relay attempts (second and third attempts) began as early as March 10 and continued until July 3, with the earliest chicks from these efforts hatching on April 19 and the latest hatching on July 18.

Population Size. We have no information on the size of the breeding population of Xantus' Murrelets on SBI in 1999. Indications are that this population has declined

(Carter et al. 1992, Sydeman et al. 1998b), yet population estimates from SBI, the major colony of this species in California, are unavailable for recent years.

Occupancy and Productivity. There was more than one nest attempt at 15 sites, including 2 attempts at 13 sites and 3 attempts at 2 sites. At two sites in NT, two different pairs may have attempted to nest simultaneously in the same site (assumed because of the presence of 3 and 4 eggs in the site); these were counted as separate attempts. Second and third attempts are excluded from all calculations except productivity. Xantus' Murrelets occupied 44% of monitored sites in 1999 (Tables 11 and 12). Murrelets nested in 58% of the established sites in CC and in 23% in NT (Table 12, Figure 9). There were significant differences in occupancy rates between the two study areas (χ^2=15.24, df=1, p<0.01). Clutch size averaged 1.76 in CC, 1.75 in NT, and 1.76 overall (Table 12). Hatching success (the proportion of eggs laid that hatched) averaged 0.50 for CC, 0.33 for NT, and 0.46 for the two areas combined (Table 12, Figure 9). There were no significant differences in hatching success between the two areas (χ^2=5.45, df=2, p=0.066). However, there were significant differences in productivity between CC and NT (χ^2=7.39, df=2, p=0.025). Productivity (the number of eggs hatched per nest attempt) averaged 0.90 for CC, 0.50 for NT, and 0.81 for the two areas combined (Table 12). Productivity for the 17 relay attempts was not significantly different than that of first attempts (χ^2=3.84, df=4, p=0.43). Productivity for murrelets is calculated as the number of eggs hatched per nest attempt because the chicks are reared and fledge at sea.

Xantus' Murrelets nested in 6 sites under the dock and at 11 sites around the house (Tables 11 and 12). Although one site on the dock (under a lumber pile) was altered and subsequently abandoned (site excluded from analysis), productivity at the dock sites was relatively high (0.88 chicks per attempt). At sites around the house, frequent egg abandonment and predation of chicks by mice lowered productivity to 0.46 chicks per attempt. Overall productivity for Disturbed sites, averaging both dock and house sites, was 0.62 (Table 12).

Murrelets did not nest in any of the nest boxes. However, we installed nest boxes in mid-March during the peak of egg-laying when many prospecting murrelets may have already selected nesting sites. We anticipate that occupancy in nest boxes will increase next year, as prospecting birds will be able to visit the boxes during January and February.

Causes of Reproductive Failure. Egg predation by deer mice (*Peromyscus maniculatus*), indicated by the proportion of failed eggs that were broken, accounted for the majority (57%) of failed eggs in CC, but a lower number in NT (15%) (Table 11; Figure 9). Significantly more reproductive failure in CC resulted from egg predation than in NT; in contrast, NT sites had significantly more failures attributable to egg abandonment, disappearance, and addling (Fisher exact test, p=0.006). We suspect that deer mice were also responsible for predation on murrelet chicks during or shortly after hatching. Six murrelet chicks were apparently preyed upon in their nest crevices in CC, accounting for 17% of reproductive failures. Egg abandonment was the most common cause of egg failure in NT, accounting for 38% of failed eggs, while in CC only 9% of failed eggs were abandoned. Additionally, 31% of failed eggs disappeared in NT and 6% in CC. A small percentage of eggs were also addled or cracked in Nature Trail and Cat

Canyon. In the Disturbed sites, most of the reproductive failure was attributable to egg abandonment (72%) followed by predation (6% as eggs and 17% as chicks)(Table 11).

Predation on Xantus' Murrelets as Adults and Subadults and Predator Numbers. We found remains from 165 adult Xantus' Murrelets while working in the monitored areas, while walking island trails and checking six Barn Owl roosts (five roosts are accessible along the island cliffs). Most of what we recovered were wings attached to bare keels, beheaded bodies, and heads, suggesting predation by Barn Owls or Peregrine Falcons. We also noted five instances of Western Gulls picking at murrelet carcasses in the intertidal zone of the Landing Cove. We identified remains from a minimum of 69 individuals (4 banded) from six Barn Owl roosts and collected hundreds of owl pellets containing murrelet feathers, heads, and bones that accounted for additional casualties. (Pellets containing feathers and small bones were not considered when tallying predated murrelets; however, beheaded bodies, keels, and pellets containing heads were included in the tally of 69 predated murrelets reported from owl roosts. For example, if 3 keels and 2 heads were found in a roost, 3 predated murrelets were reported).

Throughout the season, we noted the presence of a pair of Peregrine Falcons that may have attempted to nest on the island. In an effort to estimate the population size of the Barn Owl population on the island, we conducted two Barn Owl censuses early in the seabird breeding season in March and April and one census at the end of the season in late June. Following the censusing methods of Drost (1989), one to two observers walked all of the island trails, beginning 1 hour after sunset. The observers counted the number of individual Barn Owls detected through sight and sound, attempting not to recount the same birds. The censuses conducted on March 17 (a New Moon evening) and April 2 (a Full Moon evening) resulted in similar counts of 31-33 and 29-32 owls respectively. The June 30 census at the end of the murrelet nesting season estimated 21-25 owls.

Nightly observations of light boats assisting the squid fishing fleet indicated that light boats were present in the highest numbers in April and May and dropped off in June through August (personal observation, S. Wolf and M. DesLauriers). Peak counts in both April and May reported up to 12 light boats working an average of 25m to 150m offshore. Light boats were most concentrated off the north and east sides of the island.

DISCUSSION

Most nesting seabird species on Santa Barbara Island responded to the more favorable oceanographic conditions of the 1999 La Niña year through increases in breeding effort (greater numbers of nesting pairs) and productivity as compared to 1998. Sea surface temperatures recorded from the Landing Cove on Santa Barbara Island (Figure 10) and from buoy data taken in the Channel (National Buoy Data Center at http://seaboard.nbdc.noaa.gov/index.html) reflect significantly lower sea surface temperatures during the spring of 1999 than 1998. Lower sea surface temperatures and more persistent northwesterly winds accompany increases in upwelling and primary production, making copious food resources available to upper trophic-level predators such as seabirds.

Double-crested, Brandt's, and Pelagic Cormorants nested in substantially higher numbers in 1999 compared to levels of the previous El Niño year. Nevertheless, the 1999 Double-crested Cormorant population estimate of 143 nesting pairs was still much lower than the breeding populations reported between 1987-1997 (Figure 11). In general, land-based population surveys appear to underestimate Double-crested Cormorant population size on Santa Barbara Island. For example, in 1991, data contributed by US Fish and Wildlife Service aerial surveys indicated that the population was nearly twice as large as that based on land surveys (Ingram and Jory-Carter 1997). We are not sure if this is still the case, but the population may be slightly larger than that what we have reported above.

The estimated productivity for Double-crested Cormorants in 1999 was equivalent to that observed in 1998 and represents no real improvement from the downward trend in productivity observed since 1985 (Ingram and Jory-Carter 1997, Feldman and Sydeman 1995, Shultz and Sydeman 1996, Roth et al. 1997, Roth and Sydeman 1998, Roth and Sydeman 1999) (Figure 11). Productivity was substantially lower than that observed for Brandt's and Pelagic Cormorants nesting on the island. The decline in Double-crested Cormorant productivity may be related to their nesting phenology. Double-crested Cormorants initiate nesting several months later than Pelagic and Brandt's Cormorants and may face more limited or fluctuating food resources toward the end of the nesting season. Human disturbance may be partly responsible for nest failures in 1999 and in prior years. Double-crested Cormorants nest higher up on cliff sides than either Pelagic or Brandt's Cormorants. In 1999 Coast Guard helicopters circled the island periphery at low altitudes of 200-400 ft, often level with nesting Double-crested Cormorants on Sutil Island, West Cliffs, and North Peak Cliffs, as frequently as once per week, and periodically flushed nesting pairs (personal observation, S. Wolf and Marie DesLauriers).

Brandt's Cormorant population levels fluctuated between 1993 and 1999 (range = 55 to 537) (Figure 12). In some years (1993, 1994, 1996, and 1999), boat surveys increased population estimates by allowing more complete surveys of nesting pairs for areas of the island not visible from land; however, this does not account for much improvement in population estimates and is certainly not responsible for the inter-annual variation observed in population size. The large number of nesting Brandt's Cormorants (n = 537 pairs) and relatively high productivity observed this season was most likely associated with the cooler sea surface temperatures and higher food abundance of the 1999 La Niña year. Brandt's Cormorants nested very asynchronously in 1999 with colony initiation stretching from February until late June. Pairs nesting late in the season may have been new nesters taking advantage of continuing food supplies or pairs that failed during a prior nesting attempt.

Pelagic Cormorants also nested in higher numbers than observed in previous years, although a boat survey in 1999 may have increased the population estimate (Figure 13). The small population of 33 nesting pairs experienced a higher productivity than during any year between 1996-1998 (the period when Pelagic Cormorant nests were first monitored on Santa Barbara Island). Compared to the high productivity of Brandt's and Pelagic Cormorants, Double-crested Cormorants seem to be recovering more slowly than the other cormorant species from the effects of the El Niño event.

Estimates of Western Gull population size have varied considerably, perhaps due

in part to observer differences; however, there has clearly been a rapid increase in gull numbers since the early 1990s (Figure 14). Population estimates ranged between 400-1500 pairs during the 1970s, between 500-2000 pairs during the 1980s, and between 1800-5000 pairs during the 1990s. In 1999, we recorded the highest gull population estimate yet of 5035 breeding pairs. Western Gulls appear to be colonizing new areas of the island, notably on the east side of North Peak. In addition, nest numbers in all plots increased substantially during 1999, paralleling the island-wide population growth (unpublished data).

Western Gull hatching success, fledging, success, and productivity have fluctuated since 1990 (Figure 15). A high hatching success combined with an average fledging success led to a minor increase in productivity in 1999 from previous years, although productivity was still lower than values in 1994 and 1991. Productivity in Grid D was substantially higher than that of the monitored grids (A and E) (Table 9); we are uncertain of the reasons for these differences. Chick growth rates were slightly higher in 1999 than 1998 (Roth and Sydeman 1999), and higher than rates in all years since 1991 with the exception of 1996 (Roth and Sydeman 1997, Martin and Sydeman 1998). From the diet samples analyzed, it appears that chicks were fed a high quality diet composed primarily of fish and squid in 1999 which may account for higher growth rates.

Occupancy of Xantus' Murrelets has been decreasing during the 1990s. Occupancy rates have significantly decreased in the Nature Trail study area since 1995 ($b=-0.028$, $t=-5.61$, $p=0.001$) and have been declining in Cat Canyon since 1991 ($b=-0.034$, $t=-2.72$, $p=0.030$), although we observed a slight increase in occupancy of Cat Canyon crevice sites in 1999. We believe that habitat changes could be affecting the occupancy rate in Nature Trail. Two of the monitored shrubs (sites 44 and 45) have died completely, and several others (sites 24, 25, 27, 30, and 41) now provide so little cover that they could be considered marginal murrelet nest sites. The lack of rain during the winter of 1999 also seems to have stunted new growth on most of the Nature Trail shrubs, which provided patchy cover to nesting birds. The occupancy rate for Nature Trail becomes 0.24 (versus 0.23) if the two completely inviable sites are excluded. Long-term changes in the structure of the shrubs on Nature Trail will be reflected in annual archived photographs.

Xantus' Murrelets began breeding earlier in 1999 than in any other year between 1991-1998, most likely to take advantage of food resources provided by cold waters. Peak lay occurred in March, two months earlier than in 1998 (Roth and Sydeman 1999).

Hatching success and estimates of mouse predation fluctuate in an inverse relationship (Figure 16). Productivity fluctuated between 1993 and 1999, with similar estimates in 1998 and 1999 at mean values (Figures 16). Long-term trends in productivity between 1983 and 1999 suggest that productivity has declined on Nature Trail (marginally significant, $b=-0.026$, $t=-2.04$, $p=0.060$) and remained relatively stable in Cat Canyon ($b=0.0094$, $t=0.91$, $p=0.38$) (Figure 17). This year, none of the shrub site in Nature Trail were successful. The rate of egg abandonment has increased slightly since 1993 (Figure 16). Egg abandonment in Nature Trail is especially high. Researcher disturbance is unlikely, because many sites are abandoned before an adult is observed (i.e. they abandon before initiating incubation). A strong possibility is that the poor coverage

provided by shrubs, and possibly disturbance by squid light boats, exposes nesting murrelets, thereby causing abandonment.

The number of Xantus' Murrelets found dead during the past 4 years has increased dramatically; 8 carcasses were found in 1996, 16 in 1997, 35 in 1998 and 165 in 1999 (Roth et. al 1997, Roth and Sydeman 1998, Roth and Sydeman 1999). We document the number of dead birds during the course of all fieldwork when carcasses are discovered randomly along trails and in monitored areas. Because our searches are not systematic, nor do they cover all areas of the island, these numbers represent the minimum number of dead birds. The increase in the observed number of kills is partially due to the discovery of Barn Owl roosts, 1 in 1997 and 5 more in 1999. However, if carcasses found in Barn Owl roosts are eliminated from the tally, the total number of dead murrelets discovered in 1999 still totals 96, a tremendous increase over previous years. Drost (1989) systematically surveyed the island and collected pellets from accessible owl roosts during 6 years from 1982-1987. He found a range of 16 (in 1983) to 130 (in 1982) predated murrelets per year, with an average of 57.2 kills per year (Sydeman et. al 1998b). The 1999 total of 165 murrelets discovered non-systematically (and presumably at fewer owl roosts) indicates that murrelets faced more predation pressure this season. Our Barn Owl censuses suggest that the owl population in 1999 averaged 30 individuals during the height of the murrelet breeding season, a number sufficient to account for the observed casualties. Two Peregrine Falcons have been present since 1996 (and possibly before) and may have added to high levels of predation.

Light and noise disturbance from the squid fishing fleet operating near the island during spring may have compounded the murrelets' vulnerability to predators. The squid fishery uses high-wattage light boats to illuminate the surface waters at night to attract squid. Light beams project long distances horizontally and cast extremely bright light on the waters surrounding the island and on the slopes where murrelets nest. Lights illuminate murrelets staging in nearshore waters, as well as individuals prospecting for nest sites and coming and going from nests. Murrelets visit the island nocturnally to avoid predation and are apparently more visible and vulnerable to predators when light boats are working near the island. Barn Owls, in particular, are attracted to light sources at night (personal observation, S. Wolf and J. Roth). Additionally, murrelet chicks attempting to fledge may not only be more perceptible to predators, but also may become disoriented and separated from their parents during the fledging process by bright lighting. Murrelet chicks have been attracted to the relatively low-wattage porch lights on SBI while trying to fledge (personal observation, S. Wolf and J. Roth). Unfortunately, this year light boats were present in high numbers, often very close to the island, during the peak of the murrelet breeding season in 1999 (March through May). Murrelets nesting in the Nature Trail study plot, adjacent the most intensive levels of light pollution during the breeding season, experienced low productivity and high rates of egg abandonment in 1999; however, causality is difficult to prove.

RESEARCH, MONITORING, AND MANAGEMENT RECOMMENDATIONS

Cormorants

We recommend comparing population estimates with available aerial survey data to validate our assessments of variation in cormorant populations. Boat surveys circling the island, Shag Rock, and Sutil are useful tools in assessing total population size of all three cormorant species. If possible, one survey should be conducted during the peak incubation period for Brandt's and Pelagic Cormorants and a second survey should be attempted later in the season during the peak of Double-crested Cormorant incubation.

To further investigate Double-crested Cormorant productivity, we recommend continuing to look for an observation point from which a sample of individual nests can be observed. Observations of nest contents would provide detailed information concerning chronology and components of reproductive performance, thereby allowing CINP to further explore the reasons behind poor reproductive success in recent years. Moreover, estimates of abandonment are poor because we cannot be sure that "abandoned" nests ever received eggs. Monitoring of nest contents is stipulated in the CINP Seabird Monitoring Handbook (Lewis et al. 1988), however, there does not appear to be an observation point from which disturbance would be minimal. Nesting locations vary each year so this may be an option in the future. The Signal Peak sub-colony is most easily observed, but those birds generally initiate breeding later than other sub-colonies and may not be representative of the entire breeding population. Another possibility is the overlook of the North Peak 1 sub-colony (n = 47 nests in 1999) just north of the upper portion of the switchback trail connecting North Peak and Elephant Seal Point; however, nesting pairs here were aware of observer presence when this vantage point was tested in 1999 (personal observation, S. Wolf), necessitating a blind at this location if observations are to made here in the future.

We also recommend that CINP obtain compliance from the Coast Guard to assure that helicopters respect altitude restrictions when flying over Santa Barbara Island in order to prevent disturbance to nesting cormorants. Flushing cormorants from their nests increases the likelihood of nest abandonment and predation on exposed eggs and chicks.

Pigeon Guillemot

We recommend continuing Pigeon Guillemot surveys as the best method of assessing population fluctuations for this species. Population trends should be evident from raft counts taken every year from designated observation points.

Storm-petrels

Due to the status of Ashy Storm-Petrel as a U.S. Fish and Wildlife Service Species of High Priority Management Need and a candidate for "threatened species" in 1994, we recommend continuing to band storm-petrels as often as possible. Mark-recapture data within years may be analyzed to estimate population size; data between years can be used to detect population trends. We recommend concentrating mark-recapture sessions at two netting locations and netting at each location a minimum of four nights per season (Nadav Nur, personal communication). Long-term banding of storm-

petrels at specific locations will provide information on population trends for all three storm-petrel species at these locations and contribute to our overall understanding of their distribution and abundance.

The impetus behind intensifying the capture-recapture program on Santa Barbara Island is justified. The last population estimate for Ashy Storm-petrels on Santa Barbara/Sutil Island was conducted in 1991 and indicated that these colonies represent 15-20% of the worldwide population that extends from Baja California to the Oregon border (Ainley 1995). Currently, no information is available on colony trends on Santa Barbara and Sutil Islands. However, capture-recapture studies of Ashy Storm-petrels on Southeast Farallon Island (SEFI) have reported large population declines over the past two decades (Sydeman et. al 1998a). Factors influencing the population decline on SEFI may also be operating on Santa Barbara and Sutil Islands, namely increased predation by an expanding Western Gull population, predation by Burrowing Owls (present on SBI during the winter), and mouse predation on eggs and chicks (Sydeman et. al 1998a).

Added impacts on storm-petrels on Santa Barbara Island may arise from the large Barn Owl population, which area known predators of storm-petrels (Drost 1989) and mounting levels of nighttime light pollution produced by the squid fishery in recent years. Storm-petrels, who return to their nests at night to avoid predation, may be more vulnerable to predators when light boats are working near the island. Illumination of light boats during 1999 interfered with nighttime capture-recapture studies of storm-petrels on SBI, making the net more visible to petrels and thus more easily avoided (personal observation, S. Wolf, M. DesLauriers, and P. Martin). Prioritizing capture-recapture studies to monitor changes in the Ashy Storm-petrel population is warranted given its species status and the downward population trends observed elsewhere.

Western Gull

The gull population has been expanding on Santa Barbara Island, with substantial increases during the 1990s. Concurrently, the number of breeding pairs has been growing in the three study grids, particularly during 1999, which has necessitated a greater input of monitoring effort and time to collect comparable data. The information provided by Plots A and E is sufficient to provide an index of Western Gull reproductive dynamics. If Grid D is to be monitored in the future, minimal effort should be invested to conduct a peak nest count and chick count from which nesting effort and an index of productivity can be obtained.

When estimating the number of fledged chicks in Grid D, we recommend placing numbered stakes next to all nests during the peak nest count; stakes should be oriented so their numbers can be read from a designated vantage point. When re-sighting chicks from this vantage point, the observer should be able to associate a specific number of chicks with each nest rather than attempting a whole-grid count, which is extremely challenging.

Xantus' Murrelet

We recommend expanded efforts to the study of the population ecology of Xantus' Murrelet on SBI. Given the Xantus' Murrelet's status as a U.S. Fish and

Wildlife Service "Species of Special Management Concern," an updated population estimate and increased demographic studies merit high priority. In 1997, 1998, and 1999, we attempted to obtain a more thorough assessment of site occupancy by identifying all "potential" nest sites in the Cat Canyon and Nature Trail study "plots." For this effort, all sites are found, mapped, and monitored. Results of these efforts will provide a less biased estimate of occupancy values than data provided by monitored sites in Cat Canyon and Nature Trail alone (Sydeman et al. 1998b). We permanently marked all additional sites in these areas and recommend that they are checked for occupancy in the future, perhaps every 3 to 5 years. In addition, we also established two extra study plots in lower slope shrub habitat where declines in occupancy have been large; a report on these findings could be prepared if additional funding is available.

To further our understanding of occupancy and abandonment, particularly in the Nature Trail area, we recommend investigations into the characteristics of nest sites. Knowledge of the size and configuration of sites occupied by murrelets could be used as criteria to estimate the number of potential sites island-wide. This will facilitate a more up-to-date population estimate, which is also long overdue.

Both Peregrine Falcons and Barn Owls have the potential to significantly affect the Xantus' Murrelet population (Sydeman et. al. 1998b) and we recommend that these predators are monitored. We began surveys of the Barn Owl population in 1999, following protocols used on Santa Barbara during 1982-1987 (Drost 1989). Continuing formal surveys of both predators' populations and murrelet casualties will aid in assessing long-term impacts on the murrelet population.

To mitigate any detrimental effects on Xantus' Murrelets nesting in disturbed areas, we recommend continuing to reduce the movement of construction materials and supplies during the breeding season. Murrelets readily nest under boards, coils of rope, and other similar materials that provide small cavities. Removing any materials during the breeding season can result in birds abandoning sites and leaving eggs open to predation. In addition, murrelets easily trap themselves and die in materials stored on the island.

We anticipate that the nest boxes installed in 1999 will help protect nesting murrelets from human disturbance and will allow CINP to assess the potential of nest boxes as a management tool. From a demographic standpoint, we are missing critical information on survival, age-at-first-breeding, and recruitment. Such data are needed to develop accurate population viability assessments for this population (Sydeman et al. 1998b). We strongly recommend that a protocol be developed for trapping, marking, and monitoring marked birds through time. Methods to mark and monitor chicks should also be investigated. Nest boxes may facilitate trapping without abandonment, as demonstrated by studies of other alcid species (PRBO, unpublished data). At least 100 birds should be banded to facilitate demographic studies. Therefore, we recommend placing a minimum of 120 nest boxes on SBI for this purpose (assuming that no more than 80% of boxes will be occupied). Researchers should make an effort to choose nest box locations protected from excessive overheating and to utilize insulating materials in nest box design.

Since light pollution from the squid fishery may be negatively impacting nesting

murrelets, we recommend thorough monitoring of light boat presence, activity, and repercussions during the murrelet nesting season in 2000. Seabird biologists stationed on the island should continue to conduct nightly counts of squid boat numbers, locations, and duration of activities. Biologists could also attempt nighttime observations of light boat, murrelet, and predator interactions, documenting predation events on shore or on the water, and any potential increases in gull and owl activity in lighted vicinities. An infrared video camera and night vision binoculars would be helpful for this purpose. Additionally, we suggest that CINP, Channel Islands National Marine Sanctuary, or California Department of Fish and Game initiate a shipboard observer program. Observers stationed on light boats at night could provide objective data on critical issues: whether disoriented Xantus' Murrelets and storm-petrels are landing on light boats; whether fledging murrelet chicks are attracted light boats; and whether murrelets are predated on the water more frequently in the vicinity of light pollution.

General

We strongly support CINP in its efforts to obtain funding for two biologists to conduct seabird monitoring on SBI. Maintaining two seabird researchers allows for uninterrupted data collection and, therefore, provides more complete and more accurate data on seabird population size, chronology, and reproductive performance (i.e. to fulfill objectives of the CINP Seabird Monitoring Program). Interaction and overlap on SBI between seabird biologists is essential to ensure consistency in data collection and efficiency, so that a minimum amount of time is spent collecting the maximum amount of data.

As discussed in previous reports (Roth and Sydeman 1998, Roth and Sydeman 1999), we encourage CINP to supplement displays in the visitor center on how visitors can reduce impacts on breeding seabirds (e.g. by staying on the trails, obeying trail closures, and not lingering too long in areas populated by Western Gulls) while maximizing their enjoyment of SBI and its resources.

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Appendix 1. Documentation for Santa Barbara Island 1999 databases in Access97.

Filename: SB_Double-crestedCormorant:
Double-crested Cormorant population and productivity data.

ProgramCode:	SB
Year:	1999
Event Code:	C
IslandCode:	SB
SiteCode:	WC1 to WC3 (WC1 = section 1 of West Cliffs sub-colony, WC2 = section 2 of West Cliffs sub-colony, etc.) NP1 to NP7 (NP1 = section 1 of North Peak sub-colony, NP2 = section 2 of North Peak sub-colony, etc.) SUTI (Sutil Island sub-colony) SIPE (Signal Peak sub-colony) SHG (Shag Rock sub-colony)
Date:	date of observation
Observer:	initials of observer
TotalAdults:	total number of adults
OccupiedNests:	total number of well-built nests, nests with incubating or brooding birds, or nests with chicks
NestsWithChicks:	total number of nests observed with chicks
TotalChicks:	field not used prior to 2000
BigChicks:	total number of big chicks observed
AbandonedNests:	total number of abandoned nests observed
AD:	field not used prior to 2000
NoOfPairs:	total number of pairs observed
Displaying:	total number of displaying adults observed
Loafing:	total number of "loafing" adults not associated with nesting activity
Comments:	notes on observations, usually current weather and time of observation

Filename: SB_BrandtsCormorant:
Brandt's Cormorant population and productivity data.

ProgramCode:	SB
Year:	1999
Event Code:	C
IslandCode:	SB
SiteCode:	WPLO (Webster Point lower sub-colony) WPUP to WPU5 (WPUP = Webster Point upper sub-colony 1, WPU2 = Webster Point upper sub-colony 2; etc.) ARPO (Arch Point sub-colony) ESNE (Northeast Elephant Seal Point sub-colony) ESPT (West Elephant Seal Point sub-colony) NP1 (North Peak 1 sub-colony) SUTI (Sutil Island sub-colony) WC3 (West Cliffs 3 sub-colony) WCC (Webster Cove Cliffs sub-colony)
Date:	date of observation

Observer:	initials of observer
TotalAdults:	total number of adults
OccupiedNests:	total number of well-built nests, nests with incubating or brooding birds, or nests with chicks
NestsWithChicks:	total number of nests observed with chicks
TotalChicks:	field not used prior to 2000
BigChicks:	total number of big chicks observed
AbandonedNests:	total number of abandoned nests observed
AD:	field not used prior to 2000
NoOfPairs:	total number of pairs observed
Displaying:	total number of displaying adults observed
Loafing:	total number of "loafing" adults not associated with nesting activity
Comments:	notes on observations, usually current weather and time of observation

Filename: SB_PelagicCormorant:
Pelagic Cormorant population and productivity data.

ProgramCode:	SB
Year:	1999
Event Code:	C
IslandCode:	SB
SiteCode:	ARPO (Arch Point sub-colony) ESPT (West Elephant Seal Point sub-colony) NP4 (North Peak 4 sub-colony) WC3 (West Cliffs 3 sub-colony) WCC (Webster Cove Cliffs sub-colony)
Date:	date of observation
Observer:	initials of observer
TotalAdults:	total number of adults
OccupiedNests:	total number of well-built nests, nests with incubating or brooding birds, or nests with chicks
NestsWithChicks:	total number of nests observed with chicks
TotalChicks:	field not used prior to 2000
BigChicks:	total number of big chicks observed
AbandonedNests:	total number of abandoned nests observed
AD:	field not used prior to 2000
NoOfPairs:	total number of pairs observed
Displaying:	total number of displaying adults observed
Loafing:	total number of "loafing" adults not associated with nesting activity
Comments:	notes on observations, usually current weather and time of observation

Filename: SB_Pigeon Guillemot:
Pigeon Guillemot census data.

ProgramCode:	SB
Year:	1999
Event Code:	E
IslandCode:	SB

SiteCode:	NT (on the water below the Nature Trail slopes north to Arch Point and south to Cave Canyon) ARPO (on the water north and west of Arch Point)
Date:	date of observation
TotalAdults:	total number of adults
Comments:	notes on observations, usually current weather and time of observation

Filename: SB_WesternGullNesting:

Western Gull productivity data are summarized for grids A and E.

ProgramCode:	SB
Year:	1999
EventCode:	D
IslandCode:	SB
SiteCode:	A = Grid A, E = Grid E
NestNo:	nest number
AttemptNo:	attempt number: 1 or 2
EggOrderKnown:	yes or no
ChickOrderKnown:	yes or no
Egg1Length:	length of first egg
Egg1Width:	width of first egg
E1DateFirstSeen:	lay date of first egg
E1ExactFirstSeen:	exact lay date of first egg 0 = not applicable 1 = known within 5 days 2 = not known within 5 days
E1DateHatched:	hatch date of first egg
E1ExactHatched:	exact hatch date of first egg 0 = not applicable 1 = known within 5 days 2 = not known within 5 days
Egg1Fate:	fate of first egg 0 = not laid 1 = hatched 2 = stolen 3 = did not hatch (addled or cracked); dead pipped egg; dead fractured egg) 4 = disappeared before hatch 5 = disappeared at hatch (wet chick seen half inside egg shell on one check and gone the next) 6 = died at hatch (dead, wet chick seen in nest or partially out of the shell) 7 = found outside nest 8 = crushed by human 9 = unknown
Egg2Length:	length of second egg
Egg2Width:	width of second egg
E2DateFirstSeen:	lay date of second egg
E2ExactFirstSeen:	exact lay date of second egg (see codes for E1ExactFirstSeen)

E2DateHatched: hatch date of second egg
E2ExactHatched: exact hatch date of second egg (see codes for E1ExactHatched)
Egg2Fate: fate of second egg (see codes for Egg1Fate)
Egg3Length: length of third egg
Egg3Width: width of third egg
E3DateFirstSeen: lay date of third egg
E3ExactFirstSeen: exact lay date of third egg (see codes for E1ExactFirstSeen)
E3DateHatched: hatch date of third egg
E3ExactHatched: exact hatch date of third egg (see codes for E1ExactHatched)
Egg3Fate: fate of third egg (see codes for Egg1Fate)
Ck1BandPrefix: prefix of band number of first chick
Ck1BandNumber: suffix of band number of first chick
Ck1BandDate: date when first chick banded
Ck1Fate: fate of first chick:

0 = never hatched
1 = disappeared at hatch
2 = stolen before banding
3 = stolen after banding
4 = dead before banding, unknown cause
5 = dead after banding, unknown cause
6 = dead before banding, pecked in head
7 = dead after banding, pecked in head
8 = disappeared before banding
9 = disappeared after banding
10 = fledged (seen fully-feathered)
11 = never laid
12 = assumed fledged (seen mostly-feathered)
13 = unknown, not banded
14 = assumed fledged (seen gawky-downy)
15 = presumed fledged (seen partly-feathered)
16 = dead (see notes)
17 = deformed or injured, not fledged
19 = unknown fate
20 = dead after fledging, pecked in head
21 = dead after fledging, not pecked in head
22 = no data after chick banding
24 = assumed fledged (not found dead)

Ck2BandPrefix:prefix of band number of second chick
Ck2BandNumber: suffix of band number of second chick
Ck2BandDate: date when second chick banded
Ck2Fate: fate of second chick (see codes for Ck1Fate)
Ck3BandPrefix:prefix of band number of third chick
Ck3BandNumber: suffix of band number of third chick
Ck3BandDate: date when third chick banded
Ck3Fate: fate of third chick (see codes for Ck1Fate)
Comments: notes

Filename: SB_WesternGullCkWts:
Western Gull chick weight data.

CkBandPrefix:	prefix of band number
CkBand:	suffix of band number
WeightDate:	date when weight taken
WeightAmount:	weight recorded

Filename: SB_XantusMurrelet:
Xantus' Murrelet productivity and phenology data are summarized by area.

ProgramCode:	SB
Year:	1999
EventCode:	A
IslandCode:	SB
SiteCode:	CC = Cat Canyon NT = Nature Trail HOUS = house sites DOCK = dock sites
NestNo:	nest number
AttemptNo:	attempt number: 1, 2, or 3
AdultDateFirstSeen:	date adult first observed at site
AdultDateLastSeen:	date adult last observed at site
ChicksObserved:	number of chicks observed at site
EggOrderKnown:	yes or no
Egg1Length:	length of first egg
Egg1Width:	width of first egg
Egg1DateLaid:	lay date of first egg
Egg1ExactLaid:	exact lay date of first egg 1 = egg seen 2 = assumed (bird seen)
Egg1DateHatched:	hatch date of first egg
Egg1ExactHatched:	exact hatch date of first egg 1 = shell fragments found 2 = assumed (appropriate incubation time)
Egg1Fate:	fate of first egg 0 = not laid 1 = hatched 2 = broken 3 = disappeared 4 = abandoned 5 = addled / not hatched 6 = other - see notes 9 = unknown
Egg2Length:	length of second egg
Egg2Width:	width of second egg
Egg2DateLaid:	lay date of second egg
Egg2ExactLaid:	exact lay date of second egg (see codes for Egg1ExactLaid)
Egg2DateHatched:	hatch date of second egg

Egg2ExactHatched:	exact hatch date of second egg (see codes for Egg1ExactHatched)
Egg2Fate:	fate of second egg (see codes for Egg1Fate)
Comments:	notes

Database provided in Microsoft Excel 97 format to CINP:
Filename: ASSP99:
Storm-Petrel mark-recapture data for 1999.

SITE:	location of mist-netting AP = Arch Point, WC = West Cliffs, ESP = Elephant Seal Point
DATE:	date of netting session
TIME:	time of capture
CODE:	1 = new capture 2 = recapture
BNDPRE:	band prefix = first 3 or 4 digits of band number
BAND:	last 5 or 6 digits of band number
RECAP:	band number of recaptured bird
SPCODE:	AOU species code
AGE:	1 = adult
WING:	wing chord measurement (in mm)
BP:	brood patch condition: D = downy, no brood patch evident PD = partly downy, patch receding or re-feathering B = bare, brood patch evident
BDR:	bander initials: SW = Shaye Wolf, MD = Marie DesLauriers

Appendix 2. Re-sighted and recovered bands of Western Gulls, Santa Barbara Island, 1999.

Band number	Location sighted in 1999	Status when sighted	Year banded	Age banded	Location banded
936-38705	Grid A, nest 75	Breeding adult	1988	Chick	Grid A, nest 2
936-38783	Grid A, nest 7	Breeding adult	1988	Chick	Grid A, nest 22
976-89023	Grid A, nest 38	Breeding adult	1989	Chick	Grid A, nest 2
966-36032	Grid A, nest 78	Breeding adult	1993	Chick	Grid E, nest 54
966-36187	Grid A, nest 93	Breeding adult	1993	Chick	Grid A, nest 53
966-36212	West of Grid A	Dead; unknown cause	1994	Chick	Grid A, nest 3
966-36225	Grid A, nest 76	Breeding adult	1994	Chick	Grid A, nest 21
966-36427	Badlands bordering Grid A	Dead; botulism	1994	Chick	Grid A, nest 9

Appendix 3. Documentation for determining clutch sizes and egg fates based on field data from Xantus' Murrelet nesting sites.

Hatched eggs (HE)

Hatched eggs have a dry, papery membrane separated from the eggshell and often lined with blood vessels; you may also find pieces of eggshell with no membrane at all; hatched eggs are often broken in half across the width of the egg.

The average incubation time for murrelet eggs is 6 or more 5-day checks (approximately 30 days), although the range has been reported as 27-44 days (Murray et al. 1983).

The two eggs are laid an average of 8 days apart, and the first egg is frequently unattended before the laying of the second egg. Both eggs should hatch at roughly the same time (Murray et al. 1983).

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E B B B B B B B 1HE,HE	2	hatched	hatched
1E B B B B B B B 1HE	1	hatched	not laid

Broken Eggs (BE)

Broken eggs have been depredated by mice. They have shiny, adherent membranes, are often broken length-wise, and may show traces of yolk. Teeth marks are usually evident on the edges of the eggshell.

Mice may drag pieces of broken eggshell out of crevices. Be careful not to associate broken eggshells with a crevice unless the eggshell is found in the site or at the entrance.

Mice may also drag pieces of eggshell into a site from an unrelated source, so once again be aware of these possibilities when evaluating eggshells.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
BE 0 B B B B B B B HE	2	broken (BE)	hatched (HE)
0 B B,BE B B B B B HE	2	broken (BE)	hatched (HE)

Abandoned Eggs (ABE)

Abandoned eggs are interpreted as eggs left unattended by the pair for 3 or more successive checks.

1) During the egg-laying period, the first egg is frequently left unattended for an average of 8 days (up to 12 days) before the female lays the second egg. Therefore, once both eggs are laid, they are considered abandoned only after both eggs are left unattended for 3 or more successive checks:

a) Pairs will occasionally leave both eggs unattended for 2 checks before returning to incubate.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E 1E,2E 1E,2E B B B B HE,HE	2	hatched	hatched

b) Two eggs left unattended for 2 successive checks are not considered abandoned.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E,2E 1E,2E 1BE,2BE 0 0.....	2	broken	broken

c) The second egg was left unattended for 3 successive checks and is considered abandoned. The first egg disappeared before the typical length of time to be deemed abandoned.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 2E 2E 2E 2E 2E 2E.....	2	disappeared	abandoned

2) During the incubation period (i.e. after the bird has been seen on eggs at least once), eggs are considered abandoned only after they have been left unattended for 3 or more successive checks:

a) Pairs may occasionally leave their eggs unattended for 1-4 days at a time during incubation. Two successive periods of egg neglect (as in the example below) are not uncommon.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E B B B B 1E,2E 1E,2E B B B HE, HE	2	hatched	hatched

b) An example of egg abandonment; egg left unattended for 3 successive checks.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B B 1E 1E 1E 1BE....	1	abandoned	not laid

c) Eggs that are depredated after they have been left unattended for 3 successive checks are considered abandoned (the primary fate) rather than broken (a secondary fate).

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 1BE 2E B 2E 2E 2E 2BE...	2	broken	abandoned

Disappeared Eggs

A disappeared egg has been seen but disappears mysteriously without any evidence that it has been broken or abandoned.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E B 0 0.....	1	disappeared	not laid
1E 1E 1E,2E 2BE 0.....	2	disappeared	broken

Addled Eggs/Not Hatched

Addled eggs have been incubated for an appropriate incubation length but never hatched because they were infertile, were heat stressed, etc.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E B B B B B B B HE,1E 1E 1E...	2	addled	hatched
NC B B B B B B 1E 1E 1E...	unknown	addled	unknown

Unknown Fate

The presence of the egg and/or its fate are indeterminate; several cases apply:

1) Adults are seen but eggs are never seen:

a) Bird present during only one check; very likely that the bird was prospecting and did not lay.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B 0 0.....	0	not laid	not laid

b) Bird present during 2 or more checks but less than appropriate incubation period. Likely that female has laid an egg.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B B B 0	unknown	laid; unknown fate	unknown if laid; unknown fate

c) Bird present for appropriate incubation period.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B B B B B B B 0	unknown	laid; presumed hatched	unknown if laid; unknown fate

Note: Eggs presumed hatched if incubated for 6 or more checks, based on evidence from Murray et. al (1983) that only 5% of the eggs incubated to the full term failed to hatch.

d) Additional examples

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B,BE B B 0.....	2	broken	laid; unknown fate
0 B,BE B B B B B B 0.....	2	broken	presumed hatched

2) Eggs are seen initially but are missing on final check:

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E,2E B B B B B B 1HE	2	hatched	presumed hatched
BE 0 1E 1E B B B B B B 0	2	broken	presumed hatched

Multiple Attempts

Each attempt subsequent to the first attempt is defined as a relay attempt.
During the egg-laying period, two separate attempts may be differentiated as follows: if the first egg is unattended for more than 3 checks, then any eggs laid subsequently are considered as part of different attempt (based on data that murrelets leave the first egg unattended for an average of 8 (up to 12) days before laying the second egg):

Field data	Attempt	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E 1E 1E,2E 1E,2E,3E 1E,2E,3E 1E,2E,3E 1E,2E,3E....	1	1	abandoned (1E)	not laid
	2	2	abandoned (2E)	abandoned (3E)
BE * 1E B B B B B 1HE, HE	1	1	broken (BE)	not laid
	2	2	hatched (1HE)	hatched (HE)

*BE found during first check of the season

According to Murray et. al (1983), murrelets normally do not replace lost eggs during a single attempt. However, pairs may lay a second clutch after the first clutch fails. Or two different pairs may nest in the same site during a season, either simultaneously (evidenced by the presence of 3 or 4 eggs in the site) or successively:

Field data	Attempt	Clutch size	Egg 1 fate	Egg 2 fate
1E 1E B 1E,2E B B B B B 1E (addled) 0 0 0 1E B1E B B B B B B B HE	1	2	addled (1E)	hatched (2E)
	2	2	broken (B1E)	hatched (HE)
1E 1E 1E 1E 1E 1E 0 0 0 0 0 1E 1E,2E,3E* B 1E,2E,3E,4E 1E,2E,3E,4E 1E,2E,3E,4E 1E,2E,3E,4E 1E,2E,3BE.....	1	1	abandoned (1E)	not laid
	2	2	abandoned (1E)	abandoned (2E)
	3	2	abandoned (3E)	abandoned (4E)

*second and third attempts are probably by two pairs attempting to nest in the same site

Dead Chicks (DC)

During 1999, we encountered several cases where dead chicks were found in sites beside hatched eggshells and were most likely predated by mice. These eggs were not given the hatched fate (1) because the chicks never survived to fledge the nest; instead they were given the other fate (6) and details were explained in the notes.

Field data	Clutch size	Egg 1 fate	Egg 2 fate
0 B B B B EA, EB EA,EB B BEA,BEB, DC,DC	2	other*	other*

** both eggs broken into during or just before hatching (fate = 6; other)*

Field data	Clutch size	Egg 1 fate	Egg 2 fate
1E B B B B B B B,DC 0	1	other*	not laid
0 B B B B B B HE,HE,DC 0.....	2	hatched	other*

**egg hatched but chick died/predated*

Note about evaluating eggshells:
When looking at eggshell pieces to decide the number of eggs laid at a site, pay attention to the color and pattern of shell pieces (are they different?), the amount of eggshell and/or membrane (is there enough shell to come from 2 eggs?, how many tops and bottoms are there?), and the numbers written on eggshells which often fade after several weeks.

Reference
Murray, K.G., K. Winnett-Murray, Z. Eppley, G.L. Hunt, JR, and D. Schwartz. 1983. Breeding biology of the Xantus' Murrelet. Condor 85: 12-21.

Egg Fate Codes
0 Not laid
1 Hatched
2 Broken
3 Disappeared
4 Abandoned
5 Addled/Not Hatched
6 Other/See Notes
9 Unknown Fate

Abbreviations
B = bird (adult or subadult)
0 = nothing at site
1E = egg 1 (egg order known)
2E = egg 2 (egg order known)
EA = egg A (egg order unknown)
EB = egg B (egg order unknown)
BE = broken egg
HE = hatched egg
DC = dead chick
C = chick
NC = site not checked

Table 1. Number of breeding pairs and reproductive success for Double-crested Cormorants on Santa Barbara Island, 1999, from land-based surveys.

Subcolony	Maximum Number of Nests	Estimated Number of Young Fledged[1]	Productivity[2] Mean ± s.d. (N)
Sutil Island	30	13	0.43
Signal Peak	0	0	0.00
West Cliffs 1	1	1	1.00
West Cliffs 2	5	2	0.40
West Cliffs 3	33	24	0.73
North Peak 1	47	31	0.66
North Peak 2	2	0	0.00
North Peak 3	0	0	0.00
North Peak 4	0	0	0.00
North Peak 5	0	0	0.00
North Peak 6	8	2	0.25
North Peak 7	17	11	0.65
Shag Rock	0	0	0.00
Total	**143**	**84**	**0.59 ± 0.16 (143)**

[1]Number of big chicks seen in nests.
[2]Estimated number of chicks fledged/total number of nests.

Table 2. Number of breeding pairs and reproductive success for Brandt's Cormorants on Santa Barbara Island, 1999, from land-based surveys.

Subcolony	Maximum Number of Nests	Estimated Number of Fledged Young[1]	Productivity[2] Mean ± s.d. (N)
Webster Point, Lower Colony	201	410	2.04
Webster Point, Upper Colony 1	46	106	2.30
Webster Point, Upper Colony 2	3	1	0.33
Webster Point, Upper Colony 3	68	79	1.16
Webster Point, Upper Colony 4	10	12	1.20
Webster Point, Upper Colony 5	23	4	0.17
Arch Point	16	13	0.81
Elephant Seal Point, NE Colony	78	150	1.92
Elephant Seal Point, West Colony	16	31	1.94
North Peak 1	1	3	3.00
Sutil Island	32	54	1.69
West Cliffs 3	2	4	2.00
Webster Cove Cliffs	5	5	1.00
Total	**501**	**872**	**1.74 ± 0.53 (501)**

[1]Number of big chicks seen in nests.
[2]Estimated number of chicks fledged/total number of nests.

Table 3. Brandt's Cormorant and Pelagic Cormorant nests observed during a boat survey on 24 April 1999.

Brandt's Cormorants

Site	Total Adults	Total Nests	Nests w/chicks	Large Chicks
Arch Point Sea Cave	2	2	0	0
Cliff Opposite Shag Rock	5	4	3	0
Northwest Shag Rock	3	1	0	0
Elephant Seal Point Cave	9	5	0	0
Elephant Seal Point West	13	10	0	0
Webster Cove Cliffs	1	1	0	0
Sutil Island North Cave	4	2	0	0
Sutil Island Northwest Ledge	7	5	5	3
Sutil Island West Ledge	5	4	0	0
South Cliff	7	2	1	2
Total	**56**	**36**	**9**	**5**

Pelagic Cormorants

Site	Total Adults	Total Nests	Nests w/chicks	Large Chicks
Arch Point Under Arch	1	1	0	0
Arch Point East Cliff	3	3	0	0
Arch Point West Cliff	10	5	5	2
Cliff Opposite Shag Rock	2	2	1	0
North Peak Cliff 4	1	1	0	0
West Cliff 3	1	1	0	0
Cave Canyon	4	3	2	0
Total	**22**	**16**	**8**	**2**

Table 4. Number of breeding pairs and reproductive success for Pelagic Cormorants on Santa Barbara Island, 1999, from land-based surveys.

Subcolony	Maximum Number of Nests	Estimated Number of Fledged Young[1]	Productivity[2] Mean ± s.d. (N)
Arch Point	3	3	1.00
Elephant Seal Point	1	0	0.00
North Peak 4	7	12	1.71
West Cliff 3	3	3	1.00
Wesbster Cove Cliffs	3	3	1.00
Total	**17**	**21**	**1.23 ± 0.47 (17)**

[1]Number of big chicks seen in nest.
[2]Estimated number of chicks fledged/total number of nests.

Table 5. Total captures and breeding status of Ashy, Black, and Leach's Storm-petrels on five netting nights on Santa Barbara Island, 1999.

Species	Netting date	Netting site[1]	Total captures	Total recaptures	Bare brood patch	Partly-downy brood patch	Downy brood patch	Total breeding birds[2]
ASSP	12-May	WC	1	0	1	0	0	1
	21-May	ESP	24	0	16	3	5	19
	10-Jun	AP	22	2	12	2	8	14
	11-Jun	WC	18	0	8	1	9	9
	14-Jul	AP	10	0	4	2	4	6
Total			***75***	***2***	***41***	***8***	***26***	***49 (65%)***
BLSP	12-May	WC	0	0	0	0	0	0
	21-May	ESP	0	0	0	0	0	0
	10-Jun	AP	3	0	1	0	2	1
	11-Jun	WC	2	0	2	0	0	2
	14-Jul	AP	19	0	11	7	1	18
Total			***24***	***0***	***14***	***7***	***3***	***21 (88%)***
LESP	12-May	WC	0	0	0	0	0	0
	21-May	ESP	0	0	0	0	0	0
	10-Jun	AP	1	0	0	0	1	0
	11-Jun	WC	1	0	0	0	1	0
	14-Jul	AP	0	0	0	0	0	0
Total			***2***	***0***	***0***	***0***	***2***	***0 (0%)***

[1]Netting sites: WC = West Cliffs, ESP = Elephant Seal Point, AP = Arch Point

[2]Breeding birds are those with either bare or partly-downy brood patches.

Table 6. Development of the "k" correction factor used to convert the number of adult Western Gulls counted into breeding pairs. Correction Factor = nests x 2/ number of adults counted in the plot on the survey date, 24 May 1999.

Grid	Number of Nests	Number of Adults During Census	Correction Factor
A	92	94	1.96
E	108	121	1.79
Average[1]			**1.88**

[1]Average correction factor was used to estimate population size.

Table 7. Estimates of population size for Western Gulls on Santa Barbara Island, 1999.

Subcolony Name	Total Adults Counted	Number of Roosting Birds	Estimated Breeding Pairs[1]
Landing Cove	581	0	546
Upper Landing Cove[2]	125	0	118
Arch Point	286	12	258
Shag Rock	82	3	74
Elephant Seal Cove/ North Cliff	377	15	340
Webster Point	400	17	360
A1 Cliff	48	21	25
A1 Area	72	5	63
West Colony	1482	34	1361
Badlands/Cat Canyon	1475	33	1355
Sea Lion Rookery	595	26	535
Total	**5523**	**166**	**5035**

[1]Estimated by subtracting the number of roosting birds (i.e. birds in non- breeding clubs and others apparently not associated with nest sites) from the total number of adults counted, multiplying this estimate by the "k" correction factor (1.88, see Table 6), then dividing this product by two to estimate breeding pairs.
[2]"New" sub-colony on the slope between Cliff Canyon and North Peak.

Table 8. Reproductive Effort by Western Gulls on Santa Barbara Island, 1999.

Grid	Nests[1]	Eggs Laid	Eggs Hatched	Chicks Fledged	Dead Eggs	Dead Chicks
A	97	228	178	77	26	18
E	111	279	204	119	35	26
Total	**208**	**507**	**382**	**196**	**61**	**44**

[1]Relay attempts not considered.

Table 9. Reproductive performance of Western Gulls on Santa Barbara Island, 1999.

Area	Clutch Size[1] Mean ± s.d. (N)	Hatching Success[2] Mean ± s.d. (N)	Fledging Success[3] Mean ± s.d. (N)	Productivity[4] Mean ± s.d. (N)
Grid A	2.35 ± 0.69 (97)	0.73 ± 0.38 (97)	0.45± 0.41 (81)	0.79 ± 0.87 (97)
Grid E	2.51 ± 0.62 (111)	0.72 ± 0.34 (111)	0.58 ± 0.40 (99)	1.06 ± 0.93 (112)
Grid D[5]				1.23 (81)
Overall	**2.44 ± 0.66 (208)**	**0.72 ± 0.36 (208)**	**0.53 ± 0.41(180)**	**0.94 ± 0.91 (209)**

[1]Clutch size = eggs laid/nest attempt. Only first attempts considered.
[2]Hatching success = chicks hatched/eggs laid. Only first attempts considered.
[3]Fledging success = chicks fledged/chicks hatched. Only first attempts considered. Sample sizes (N) are smaller because this calculation does not include nests in which no chicks hatched.
[4]Productivity = chicks fledged/nest attempt. Considers all nesting attempts. Grid D was not included when calculating overall productivity.
[5]Only number of nest attempts (81 nests) and number of chicks fledged (100 chicks) were estimated in Grid D generating a productivity estimate.

Table 10. Western Gull chick growth rates on Santa Barbara Island, 1999.

Grid	Fledged[1] Mean ± s.d. (N)	Not Fledged[1] Mean ± s.d. (N)	All Chicks[1] Mean ± s.d. (N)
A	24.60 ± 5.90 (66)	19.44 ± 8.9 (19)	23.44 ± 6.98 (85)
E	25.89 ± 4.52 (97)	19.62 ± 7.77 (10)	25.30 ± 5.19 (107)
Total	**25.37 ± 5.14 (163)**	**19.50 ± 8.40 (29)**	**24.48 ± 6.10 (192)**

[1]Three or more weights between 100 and 600 grams were used.

Table 11. Reproductive Effort and Causes of Reproductive Failure of Xantus' Murrelets on Santa Barbara Island, 1999.

Area	Number of Sites Checked[1]	Number of Sites Occupied[1]	Number of Eggs Laid	Number of Eggs Hatched	Number of Eggs Broken[2]	Number of Eggs Disappeared[2]	Number of Eggs Abandoned[2]	Number of Eggs Addled[2]	Number of Eggs Cracked[2]	Number of Chicks Found Dead[2]
Cat Canyon	78 (74)	44 (43)	74	39	20 (57%)	2 (6%)	3 (9%)	4 (11%)	0	6 (17%)
Nature Trail	60 (52)	12 (12)	21	8	2 (15%)	4 (31%)	5 (38%)	0	2 (15%)	0
"Disturbed"	29	17	29	11	1 (6%)	0	13 (72%)	1 (6%)	0	3 (17%)
Total	**138 (126)**	**56 (55)**	**124**	**58**	**23**	**6**	**21**	**5**	**2**	**9**

[1]Number of sites identified prior to 1995 are in parentheses (i.e. numbers used in occupancy calculations). Disturbed sites are not used in occupancy calculations and are not reflected in occupancy site totals. Activity at all sites used in remaining totals except relay attempts and sites with unknown clutch sizes and egg fates.
[2]Numbers in parentheses represent the percentage of the total number of failed eggs.

Table 12. Reproductive performance of Xantus' Murrelets on Santa Barbara Island, 1999.

Area	Occupancy[1] Mean ± s.d. (N)	Clutch Size[2] Mean ± s.d. (N)	Hatching Success[3] Mean ± s.d. (N)	Productivity[4] Mean ± s.d. (N)
Cat Canyon	0.58 ± 0.50 (74)	1.76 ± 0.43 (42)	0.50 ± 0.44 (42)	0.90 ± 0.85 (51)
Nature Trail	0.23 ± 0.43 (52)	1.75± 0.45 (12)	0.33 ± 0.49 (12)	0.50 ± 0.89 (16)
"Disturbed"		1.71 ± 0.47 (17)	0.42 ± 0.49 (17)	0.62 ± 0.86 (21)
Overall[5]	**0.44 ± 0.50 (126)**	**1.76 ± 0.43 (54)**	**0.46 ± 0.45 (54)**	**0.81 ± 0.87 (67)**

[1]Sites monitored after 1995 (n = 12) were not included in occupancy calculations; all sites considered in remaining calculations.
[2]Clutch size = number of eggs laid/nest attempt. Sites with unknown egg fates and relay attempts were not included.
[3]Hatching success = number of eggs hatched/eggs laid. Sites with unknown egg fates and relay attempts were not included.
[4]Productivity = number of eggs hatched/total nest attempts. All attempts included. Sites with unknown egg fates not included.
[5]"Disturbed" sites were not included in overall calculations.

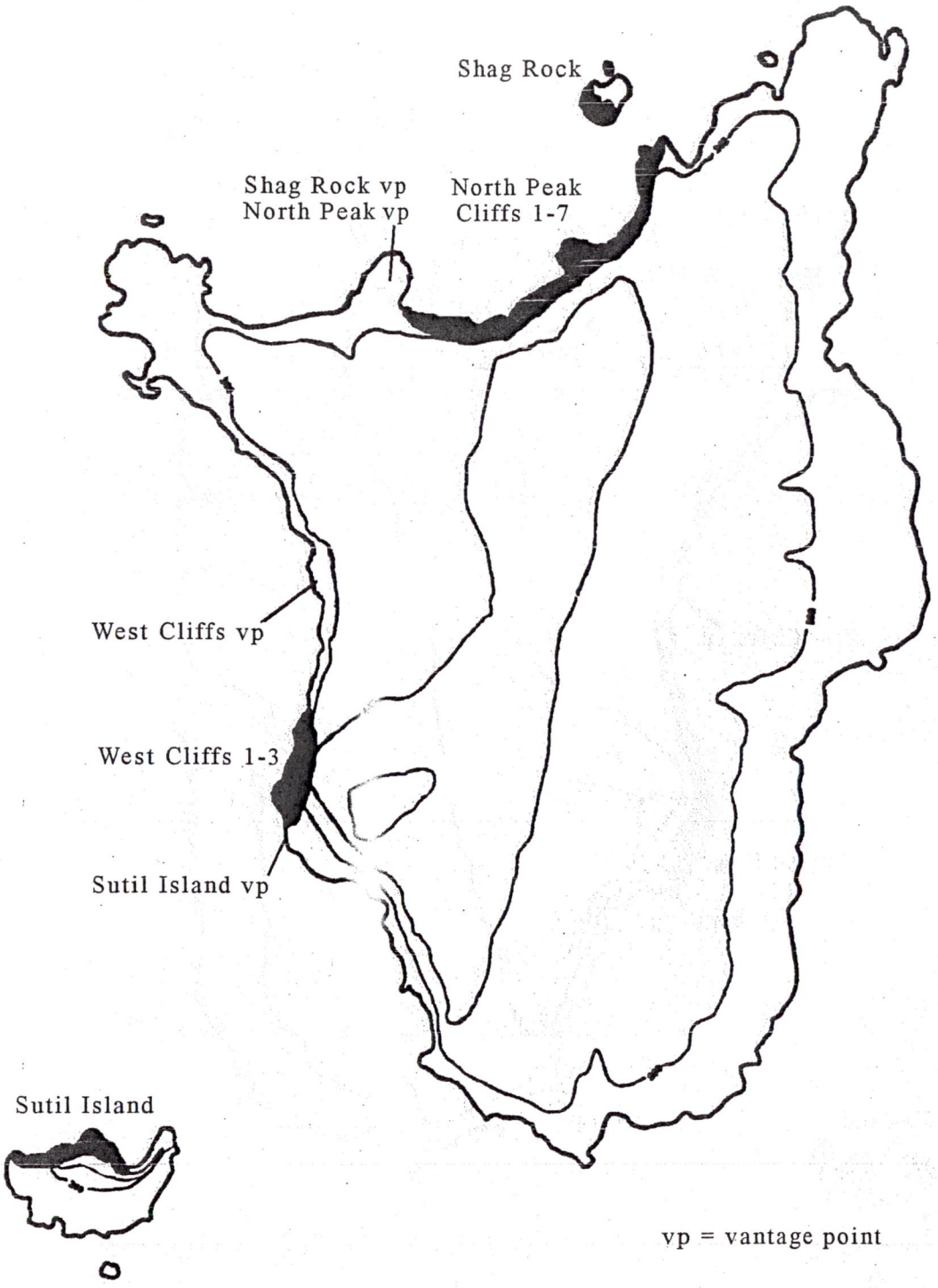


Figure 1. Locations of Double-crested Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black.

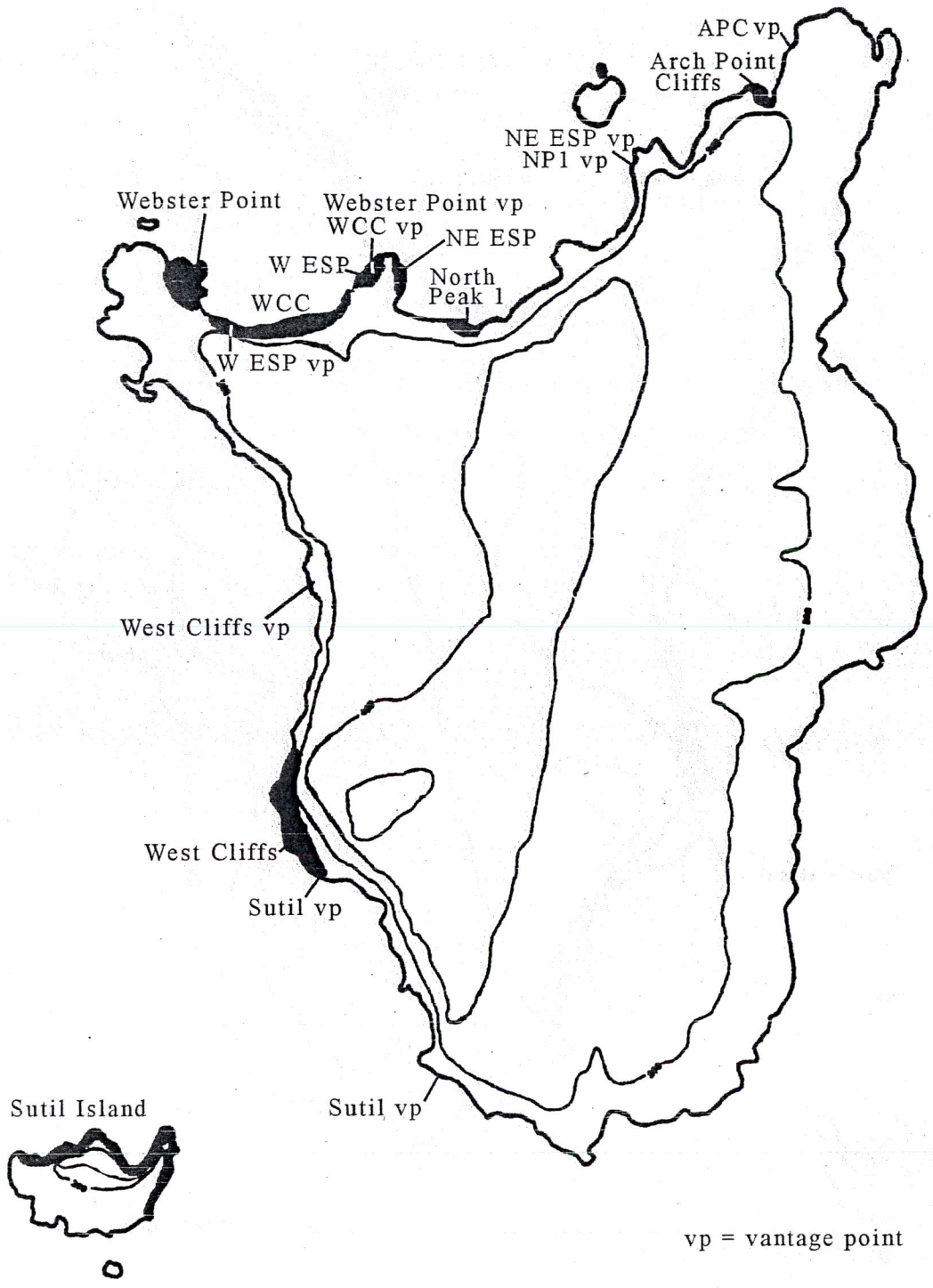


Figure 2. Locations of Brandt's Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black.

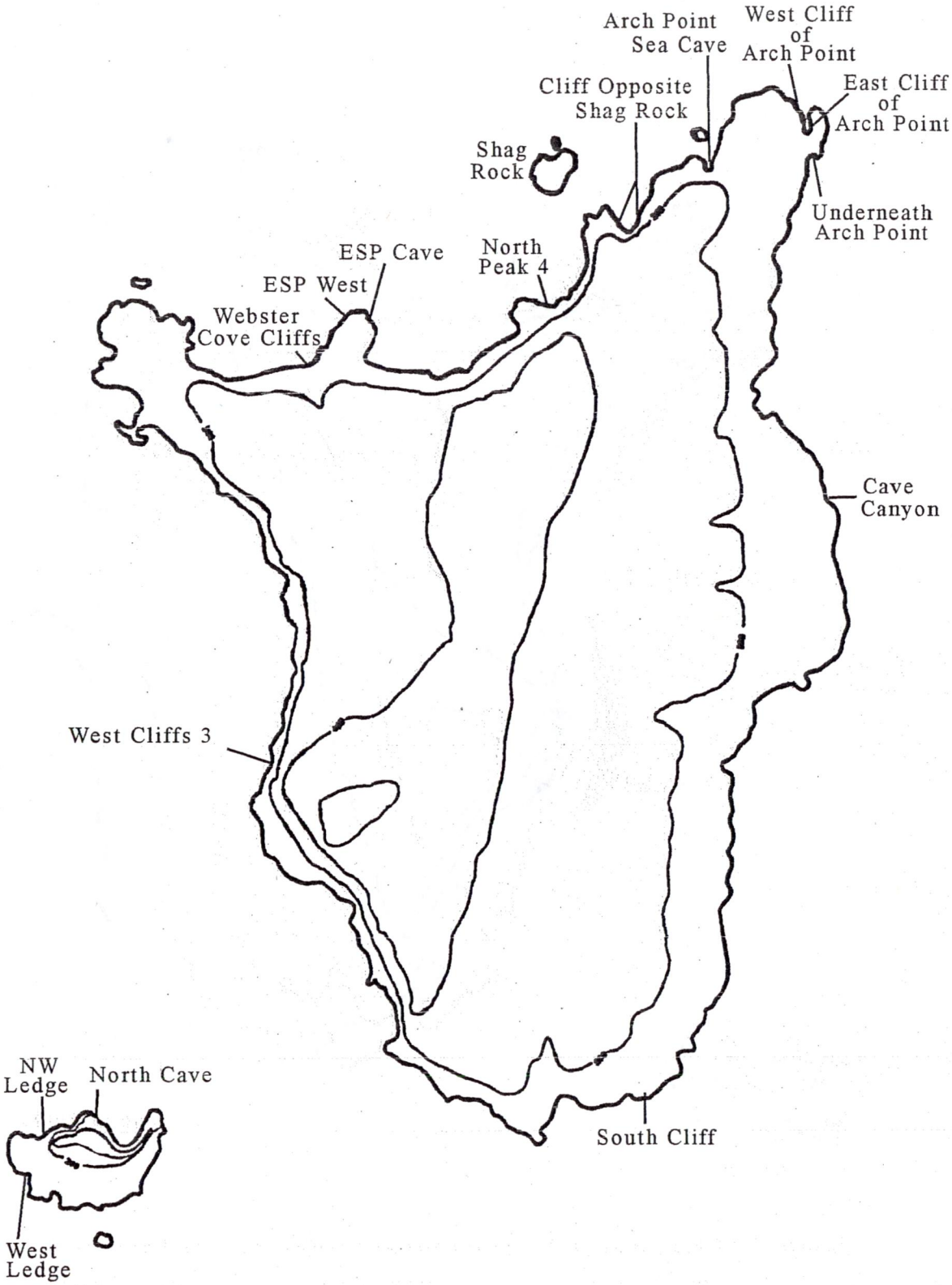


Figure 3. Locations of Brandt's and Pelagic Cormorant nests observed on an around-the-island boat census, 24 April 1999.

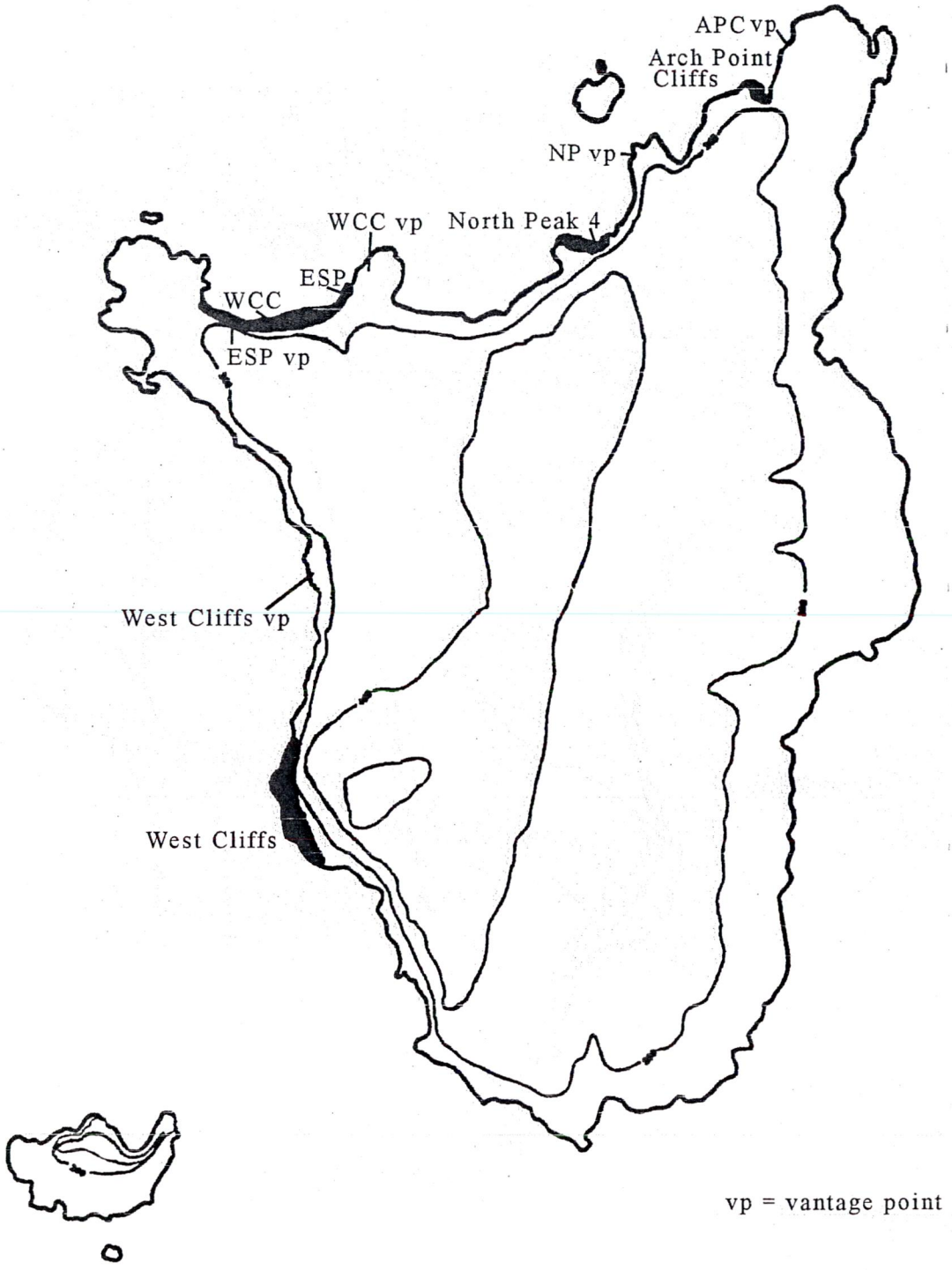


Figure 4. Locations of Pelagic Cormorant colonies and vantage points on Santa Barbara Island, 1999. Approximate colony boundaries are shaded in black.

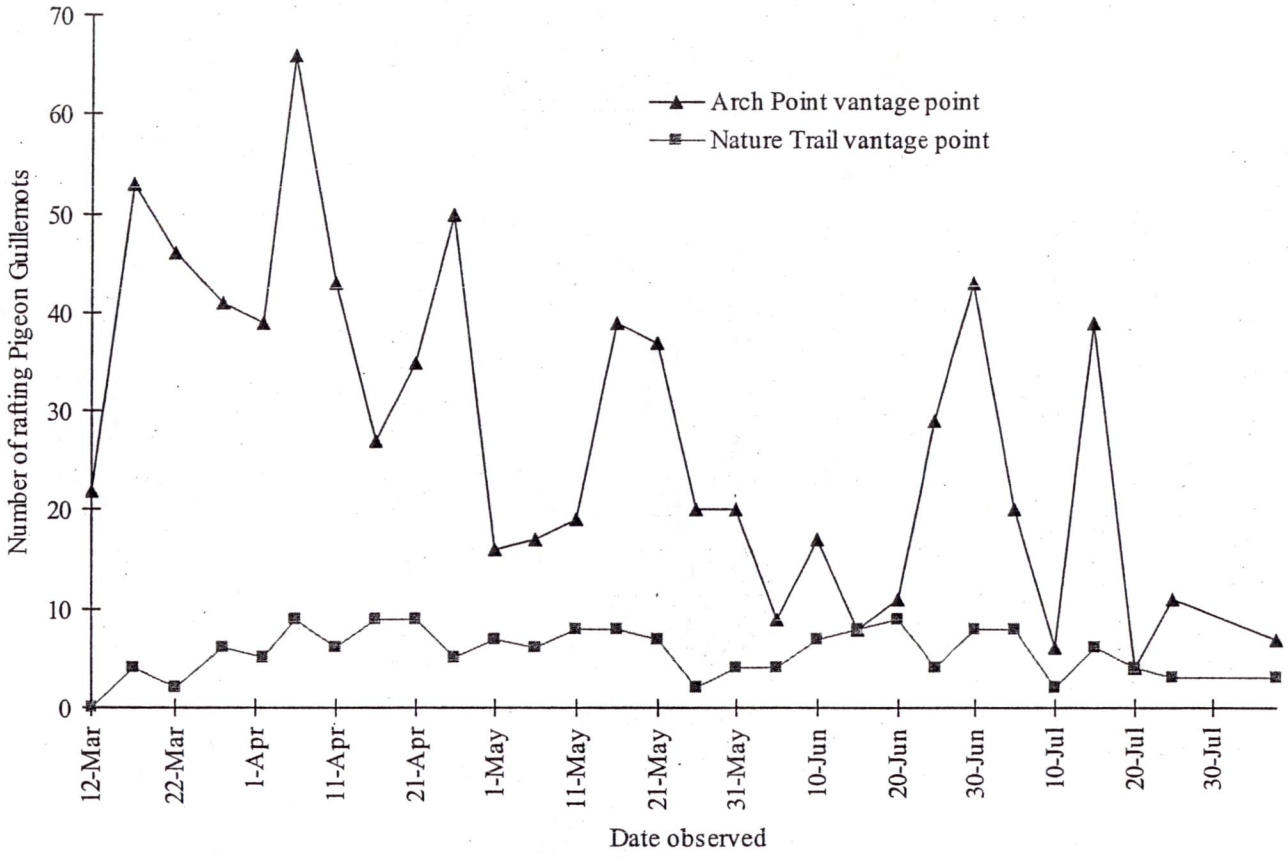


Figure 5. Pigeon Guillemot raft counts during March-August 1999.

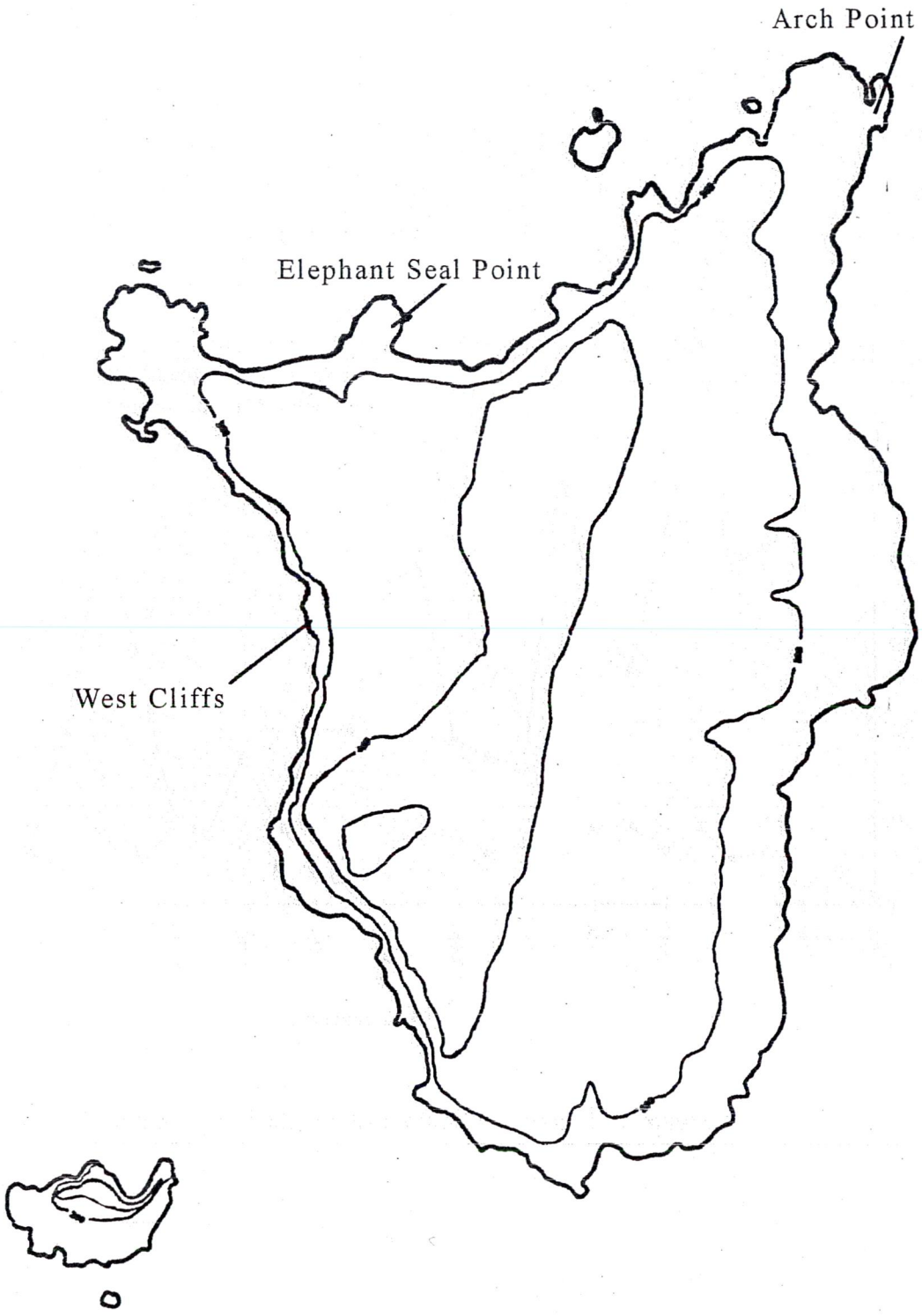


Figure 6. Storm-petrel netting sites on Santa Barbara Island, 1999.

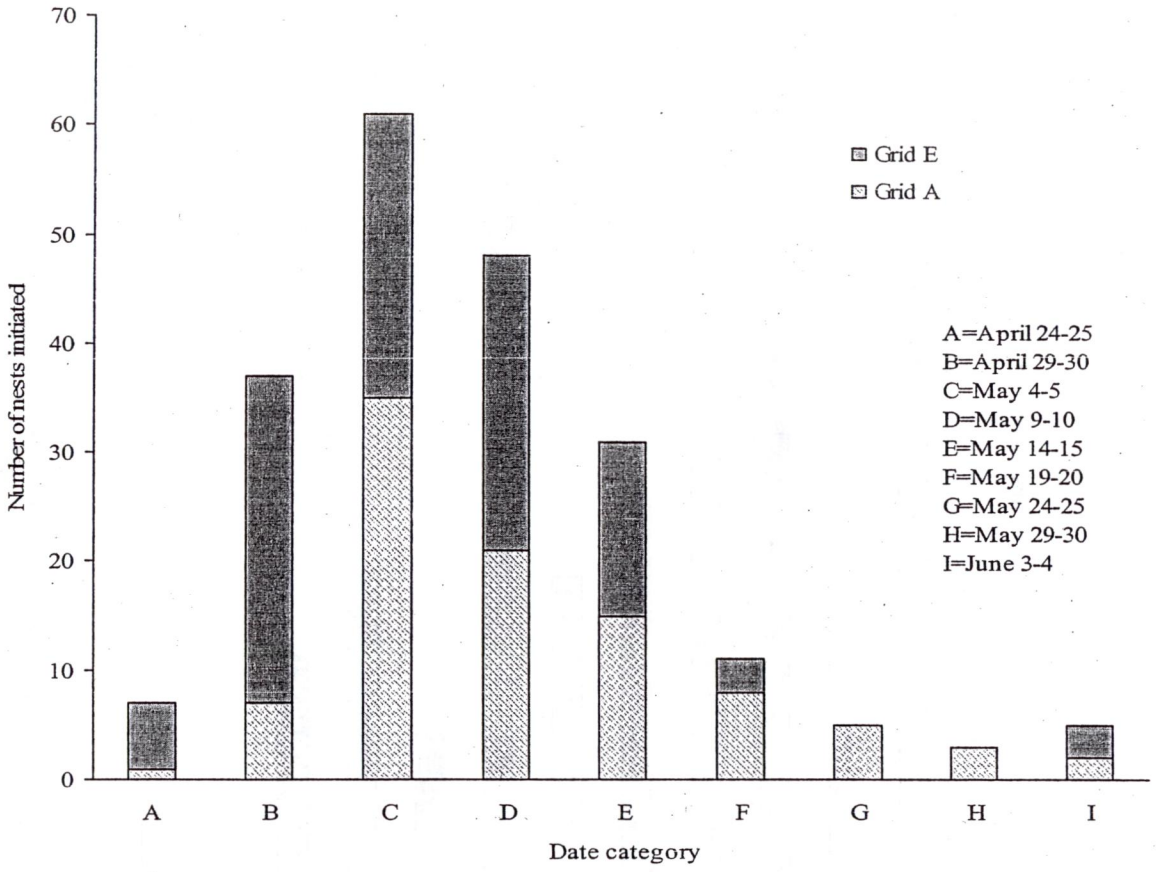


Figure 7. Western Gull clutch initiation dates on Santa Barbara Island, 1999.

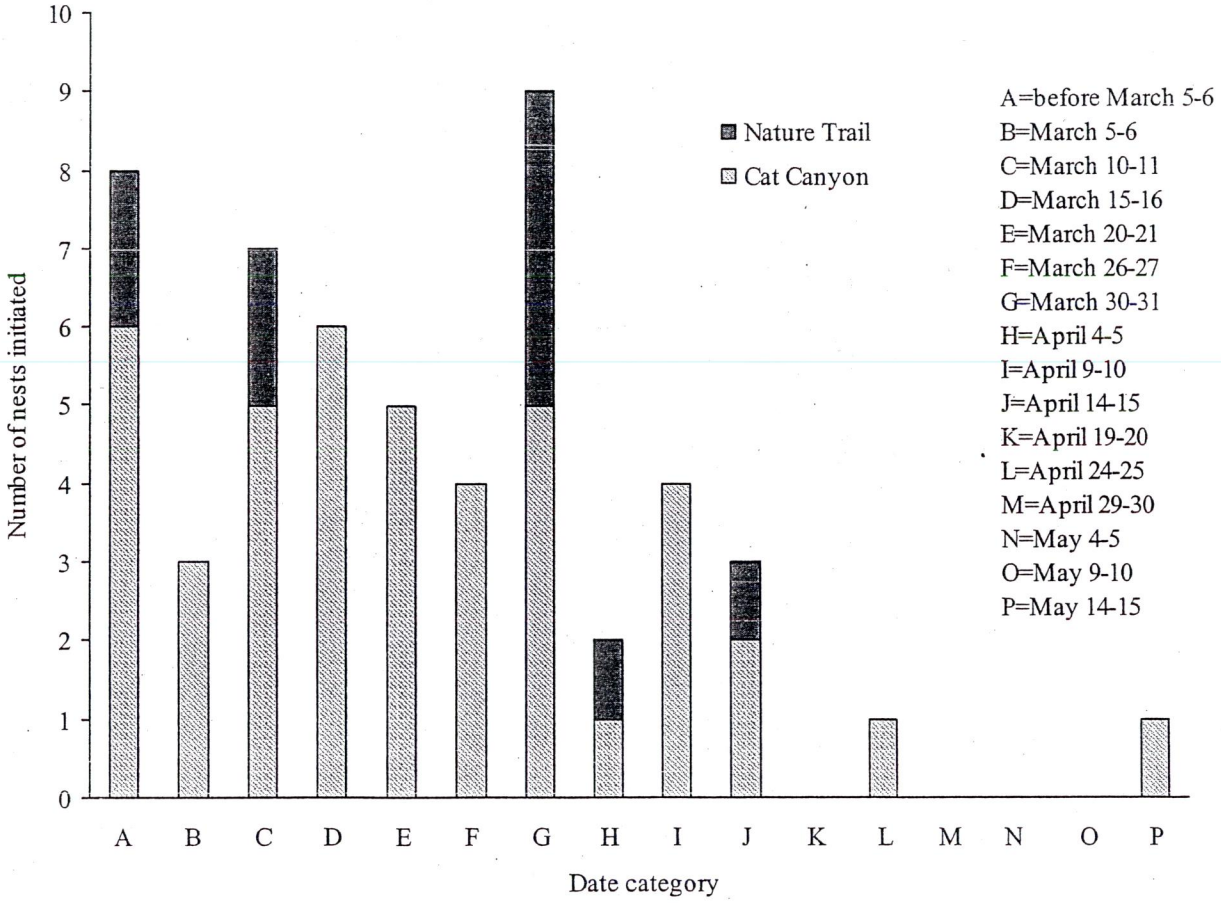


Figure 8. Xantus' Murrelet clutch initiation dates on Santa Barbara Island, 1999.

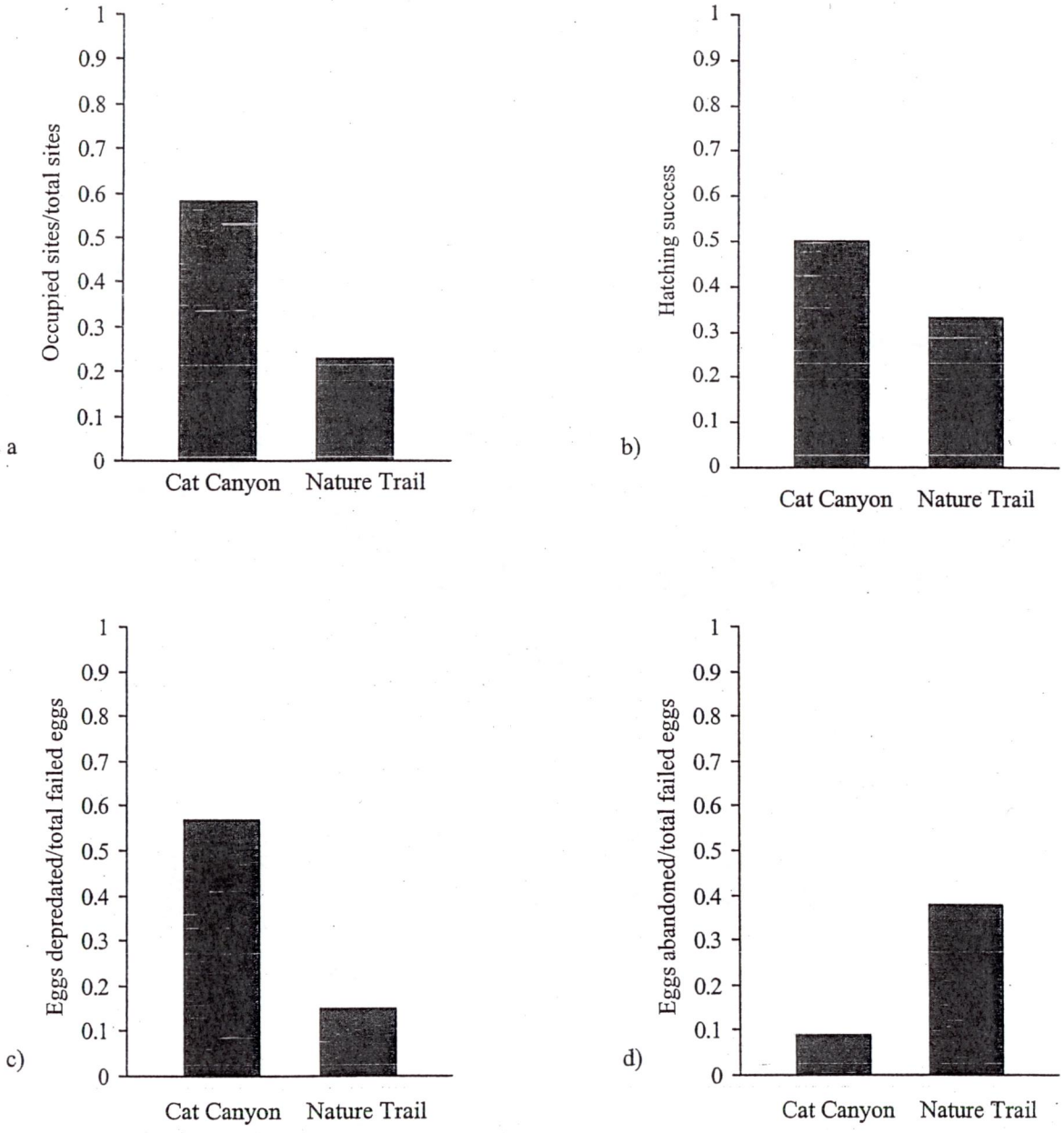


Figure 9. Differences in selected breeding parameters between Cat Canyon and Nature Trail on Santa Barbara Island, 1999 (a) occupied sites/total sites; b) hatching success; c) eggs depredated/total failed eggs; d) eggs abandoned/total failed eggs.

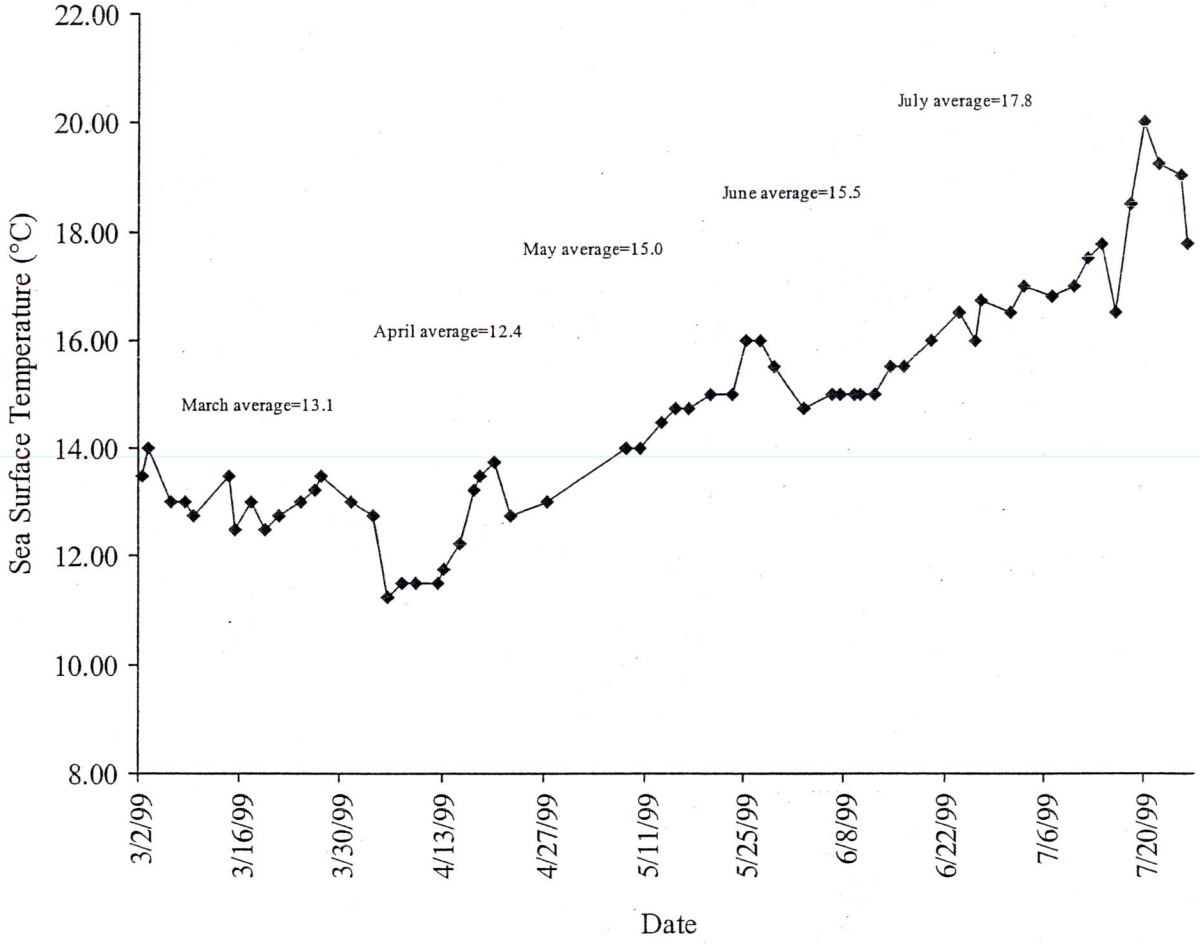


Figure 10. Trends in sea surface temperature (°C) taken at the Landing Cove, Santa Barbara Island,

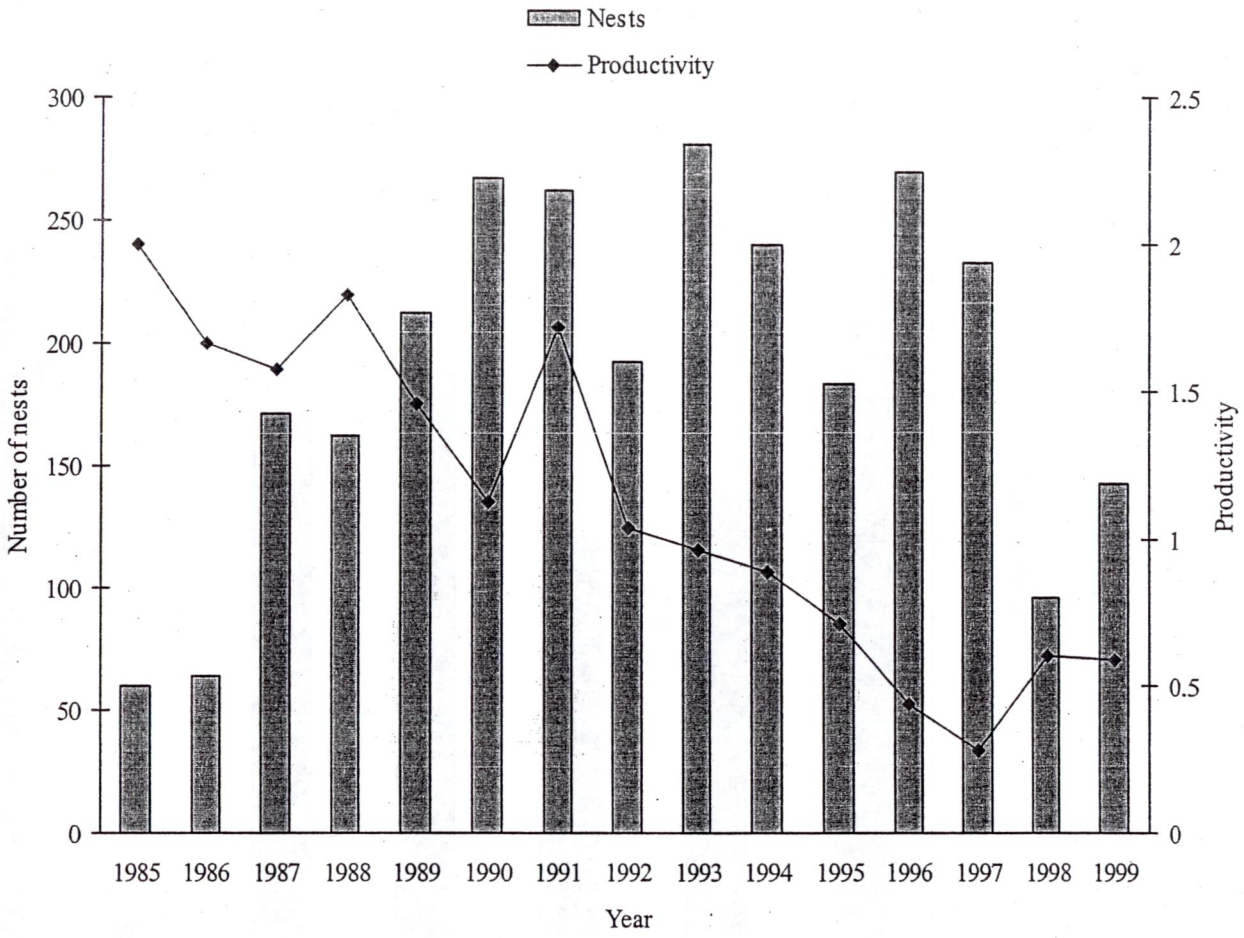


Figure 11. Trends in Double-crested Cormorant productivity and population size on Santa Barbara Island, 1985 to 1999.

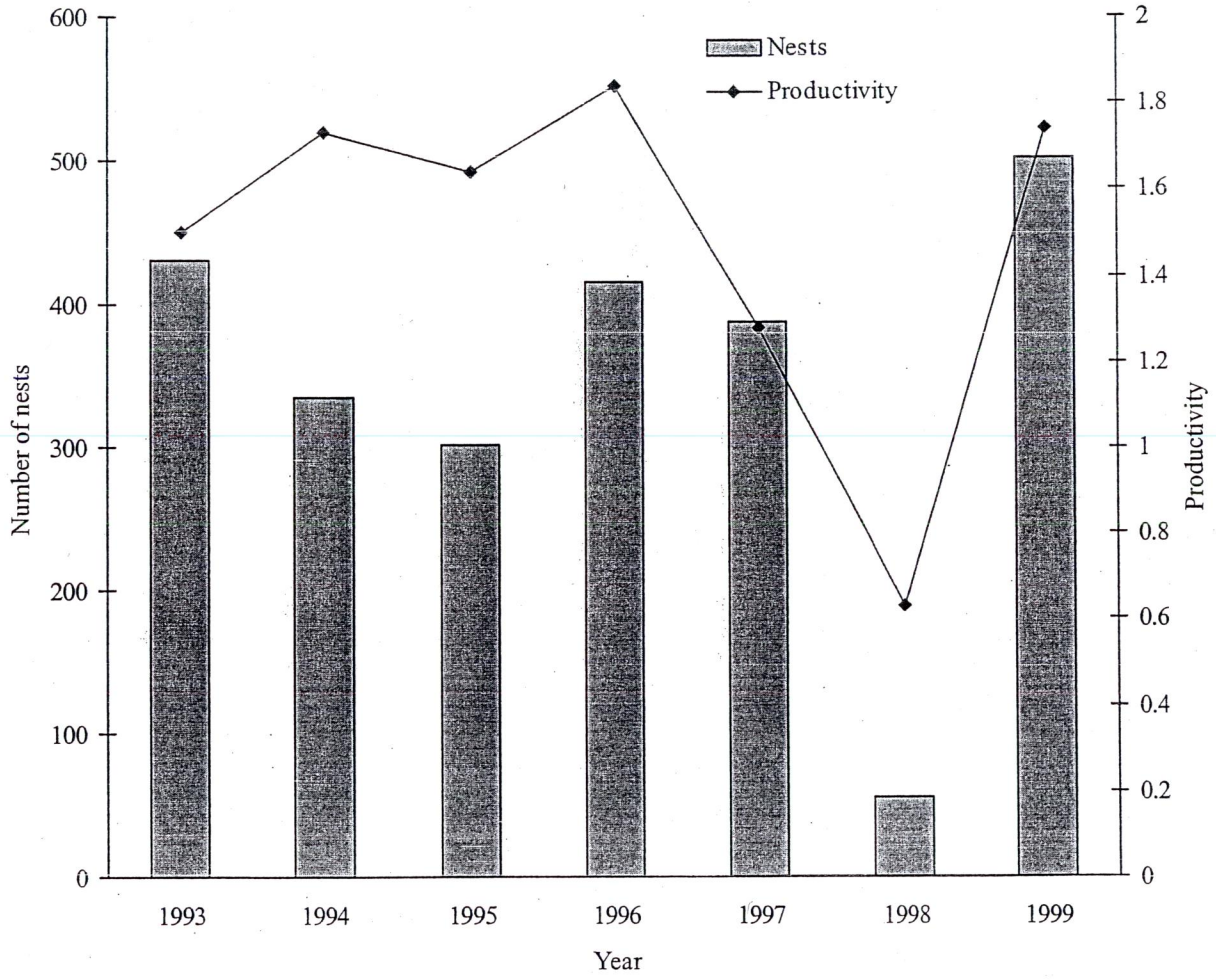


Figure 12. Trends in Brandt's Cormorant productivity and population size on Santa Barbara Island, 1993 to 1999.

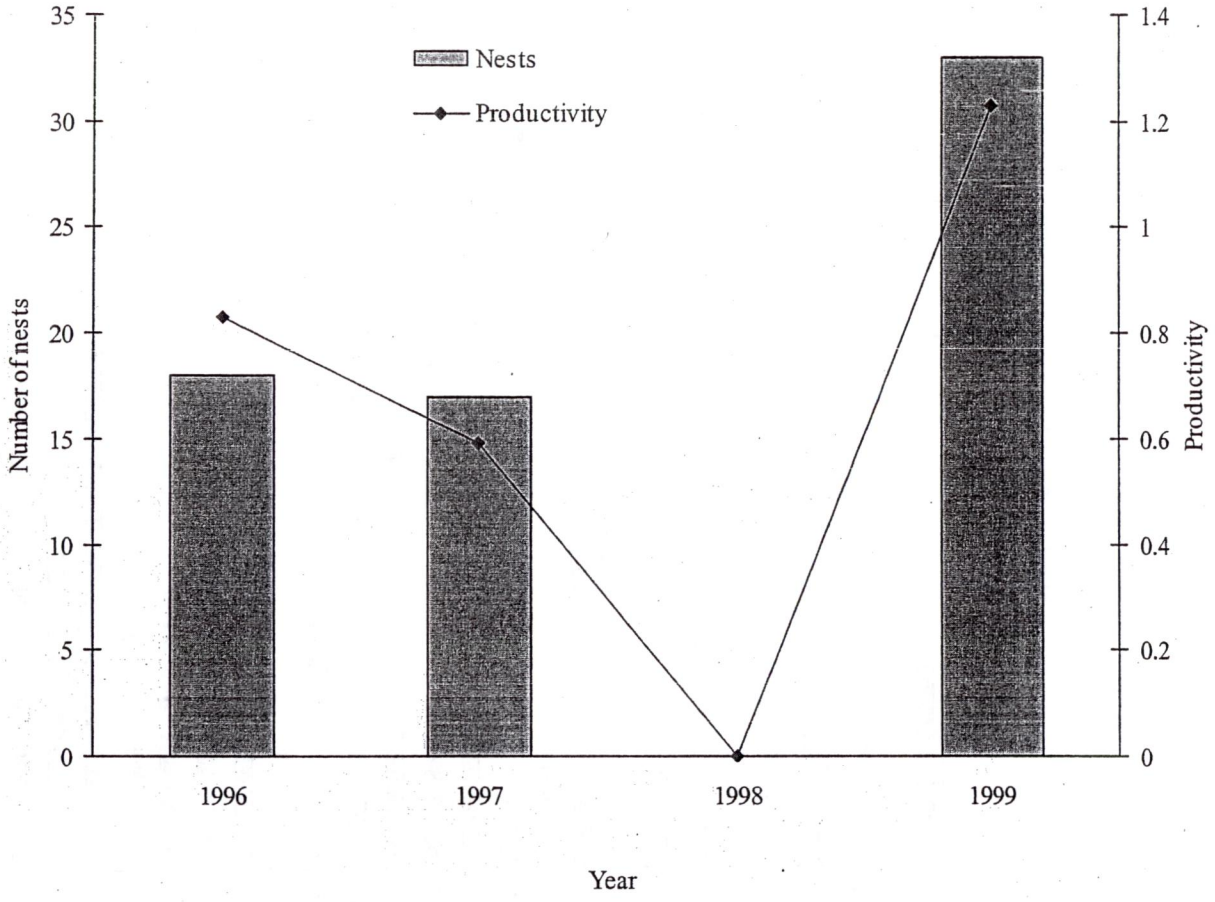


Figure 13. Trends in Pelagic Cormorant productivity and population size on Santa Barbara Island, 1996 to 1999.

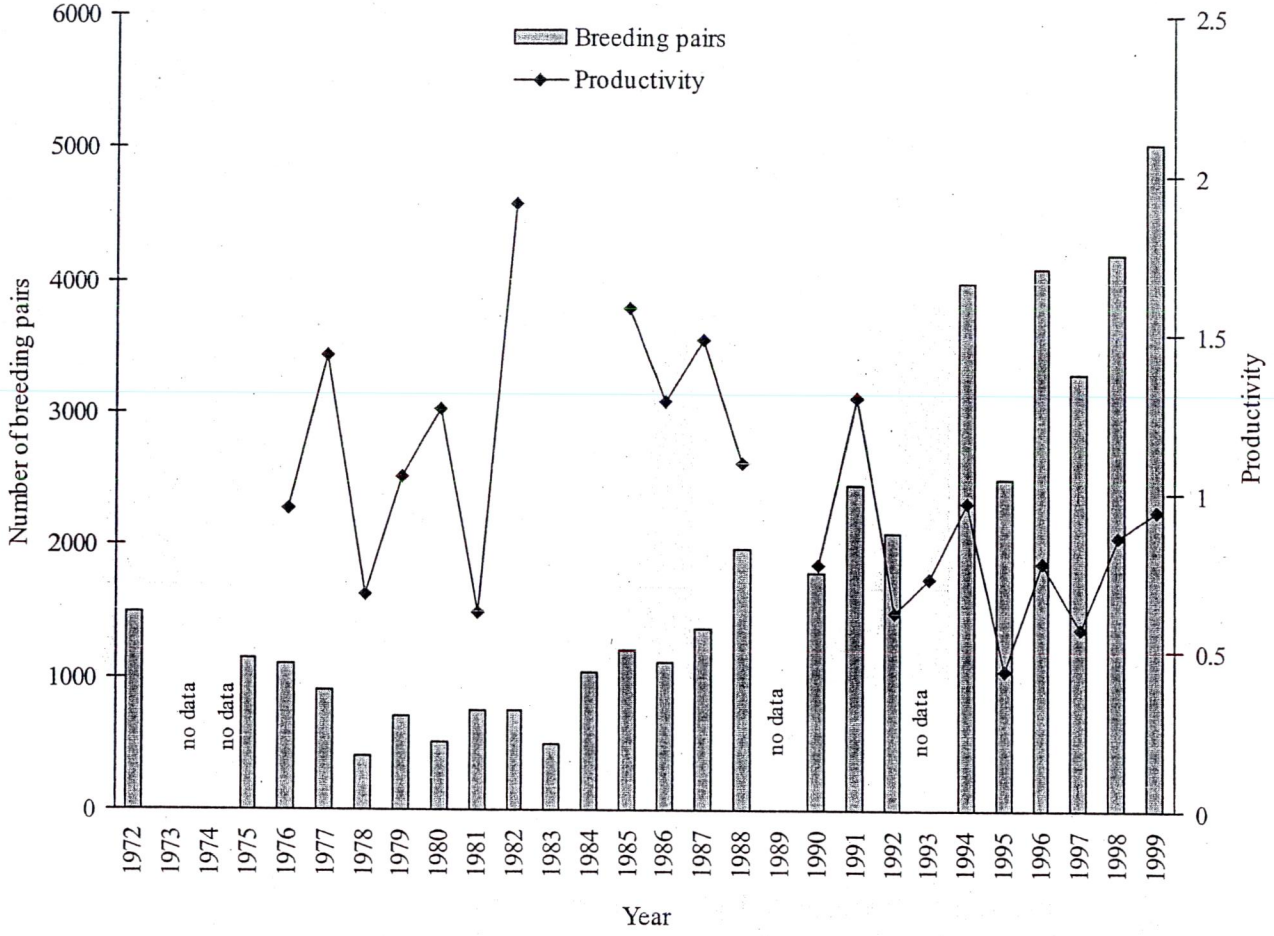


Figure 14. Trends in Western Gull population size and productivity on Santa Barbara Island, 1972 to 1999.

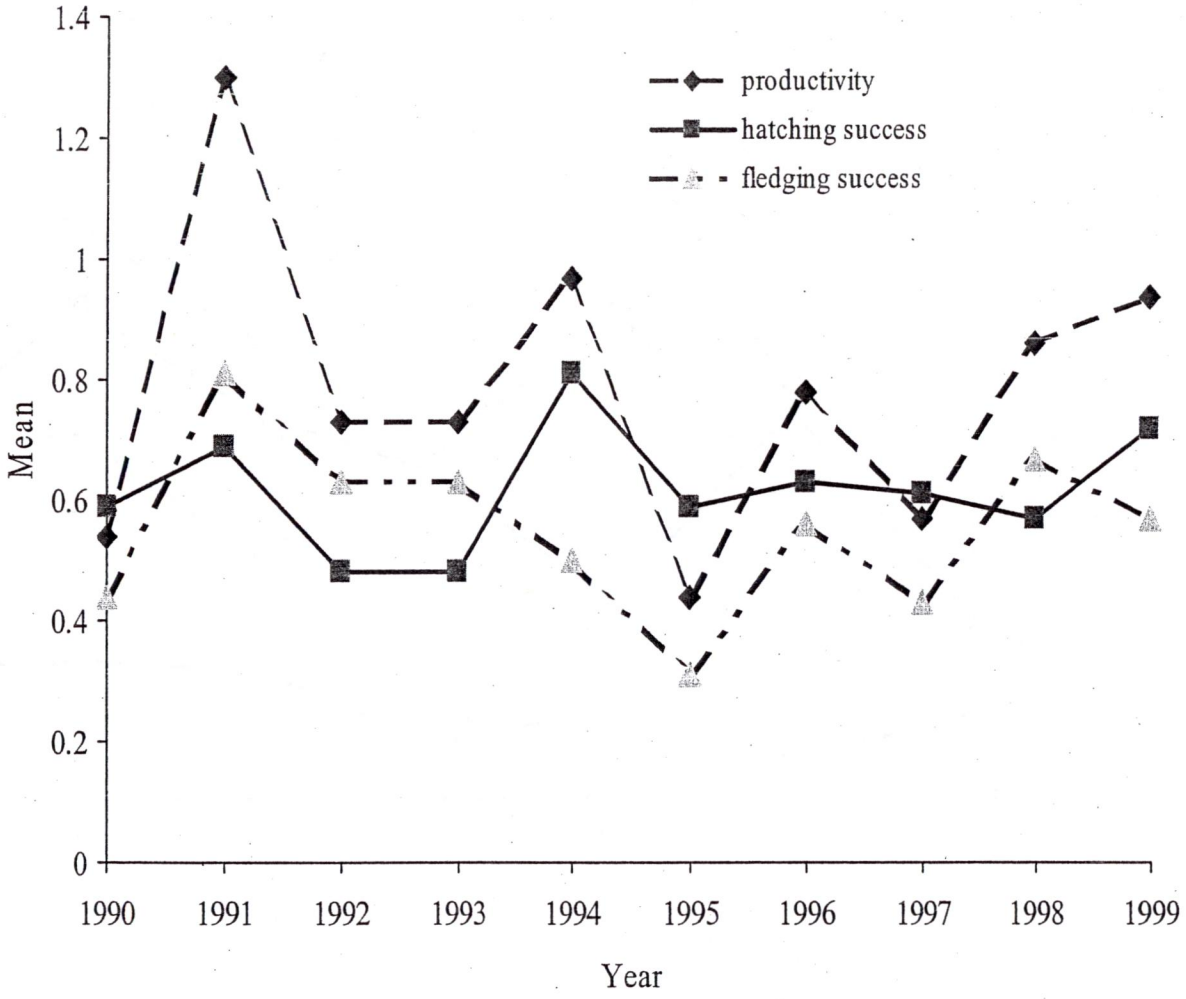


Figure 15. Trends in Western Gull breeding parameters on Santa Barbara Island, 1990 to 1999.

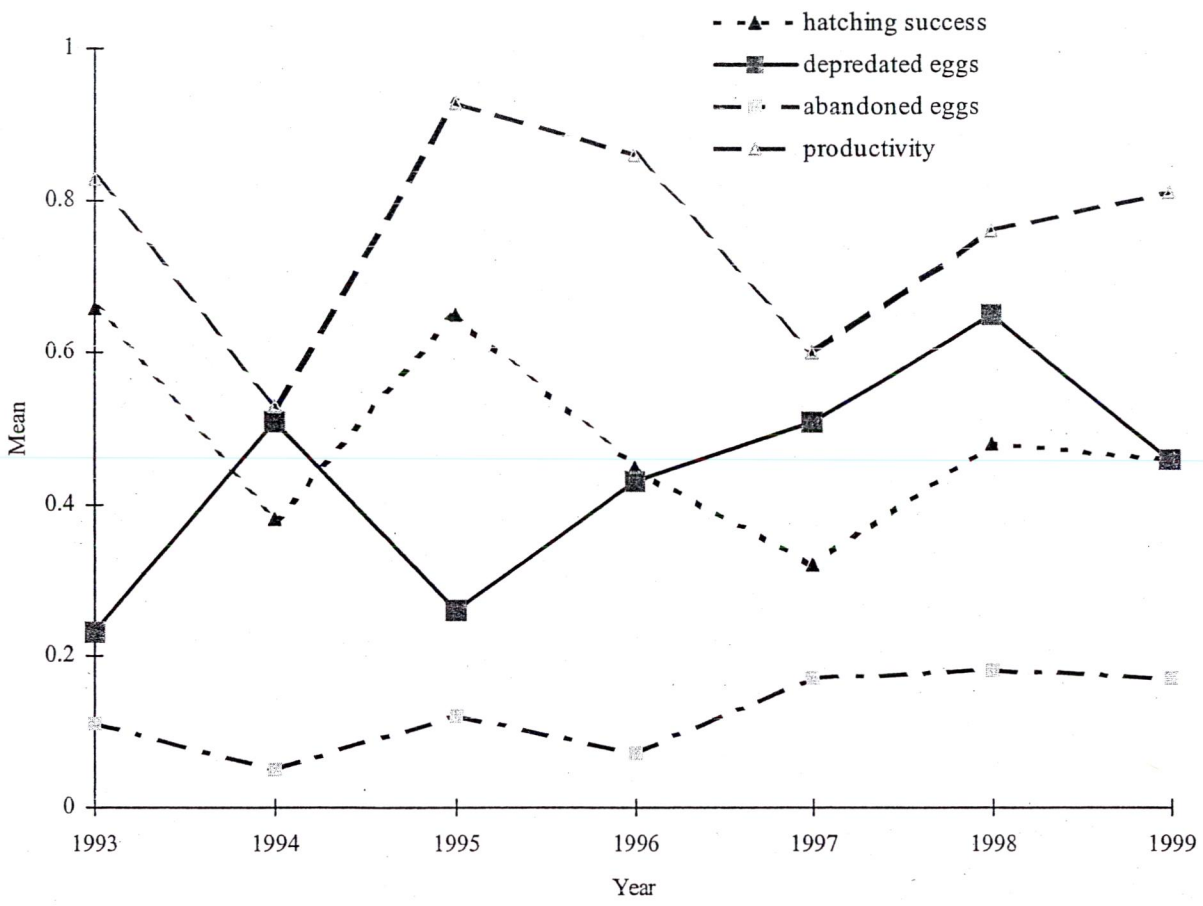


Figure 16. Trends in Xantus' Murrelet breeding parameters on Santa Barbara Island, 1993 to 1999. Depredated eggs refers to the proportion of failed eggs predated by mice. Abandoned eggs refers to the proportion of failed eggs abandoned by pairs.

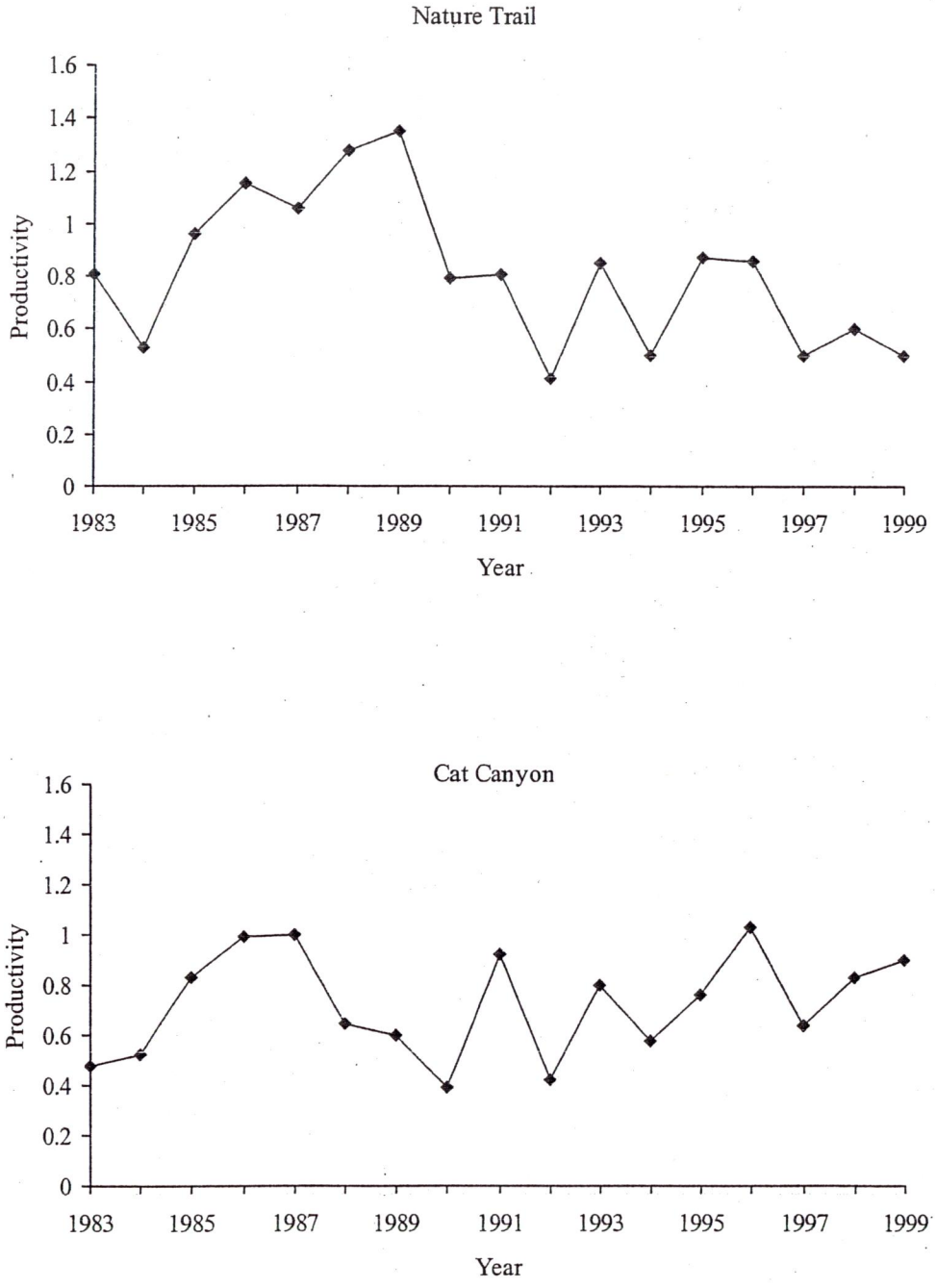


Figure 17. Trends in Xantus' Murrelet productivity in Nature Trail and Cat Canyon, 1983 to 1999.