

Status of the Western Gull at San Nicolas Island, California, 1850-2008



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Executive Summary

The status of Western Gulls (*Larus occidentalis wymani*) at San Nicolas Island, California, from 1850 to 2008 was collated from: (1) a brief historical review of literature and unpublished information on gulls and human activities on the island; (2) unpublished data from ground surveys and nest monitoring for gulls by Humboldt State University and the U.S. Navy (Pacific Missile Test Center or Point Mugu Naval Air Weapons Station) in 1991-1996; and (3) unpublished data from aerial surveys for gulls by the University of California, Santa Cruz, in 2007-2008. This information will help the U.S. Navy and Montrose Settlements Trustee Council assess anthropogenic and natural factors affecting Western Gulls at San Nicolas Island over time and provide baseline data for measuring future changes in this gull population after the successful removal of all feral cats (*Felis catus*) in 2008-2010.

Occurrence of Western Gulls at San Nicolas Island was first noted in the winter of 1850-1851 but breeding was not noted until 1891. Little or no information on population size and nesting distribution was available until 1962-1964, when hundreds of gulls were found nesting on the shorelines of Vizcaino Point at the west end of the island. Due to large populations of Nicoleños around the island for thousands of years and largely foot-accessible coastal habitats, few gulls likely bred on San Nicolas Island until after removal of the few remaining Nicoleños in 1835. Nesting at Vizcaino Point likely first increased after sheep ranching was restricted with a fence to the southern and eastern parts of the island from the 1920s to 1947. Vizcaino Point remained remote and little visited after the U.S. Navy assumed management of the island in the 1930s, until greater access was provided by a round-island coastal road system built in 1951-1957. Subsequent gull population increase at San Nicolas Island prior to 1963 likely resulted from: (1) a recovering California sea lion (*Zalophus californianus*) population providing increased prey for gulls through scavenging of carcasses and after birth; (2) low numbers of feral cats restricted to the Tule Creek-Thousand Springs area; and (3) a very low island fox (*Urocyon littoralis dickeyi*) population (<10 individuals) sometime between 1925 and 1964 (as surmised from genetic analyses).

By 1968, the Vizcaino Point colony had grown to an estimated 860 pairs that nested over most of the upper slopes in an area about 2,400 m long and 200 m wide. Nesting in the upper dune slopes likely was encouraged by growing numbers of sea lions and human disturbance in shoreline areas. Poor hatching success and 16 supernormal clutches in 1968 reflected impacts from organochlorine pollutants and some fox predation. In 1976-1977, estimated population size increased further to 1,494 pairs, hatching success remained low (41-48%), fledging success was high (83-91%), and relatively low nest predation continued. The island fox population crashed in 1974, with much reduced numbers until about 1982-1983; during this period, the feral cat population increased and expanded throughout the island, and fox were not found on Vizcaino Point in 1980. Continued gull colony growth in the late 1970s was likely facilitated by much reduced fox predation in 1974-1983. However, in 1984-1985, extensive fox occurrence and depredation of gull nests was directly observed at Vizcaino Point. Reduced but continuing effects of organochlorine pollutants also were evident in 1977, when only one supernormal clutch was noted.

In 1991, a much larger gull colony (2,443 pairs) was estimated at Vizcaino Point. In 1992, a near lack of egg laying occurred in response to severe El Niño conditions and apparent low prey availability. In 1993, the Vizcaino Point colony reached a peak of 2,483 pairs (189% increase since 1968). Similar gull population levels occurred in 1991-1996, indicating a lack of continued growth in colony size that likely was related to poor reproduction due to predation and possibly reduced immigration. Hatching success in 1993 improved to 53-88%, but 6 supernormal clutches were noted in 1993-1996 indicating some continuing impacts from organochlorine pollutants. Fledging success in 1993 was low (0-23%) due to both poor prey availability and extensive predation. Substantial numbers of gulls also were first documented breeding on the south side of the island (Environmental Gate #2 at Bachelor Beach to Dutch Harbor) in 1991-1996, near coastline areas with extensive marine mammal haul-outs and rookeries.

Between 1996 and 2008, California sea lions occupied most of the upper slopes of the northern portion of Vizcaino Point, resulting in almost complete loss of vegetation and suitable gull nesting habitats in this part of the main gull colony. Sea lions began accessing the upper slopes in 1996, a few years after the road between Environmental Gate #3 at Dos Coves and the north end of Vizcaino Point was closed by the U.S. Navy to most uses in 1993. At this time, entry through this gates was limited to biologists (and more rarely for military purposes) in order to reduce human disturbance of breeding Brandt's Cormorants (*Phalacrocorax penicillatus*), Western Gulls and sea lions. This restriction was originally prompted by unintentional human (non-researcher) disturbance of Brandt's Cormorants at the north end of Vizcaino Point (Bomber Bluff) in 1992 that had resulted in cormorant colony abandonment. The northern half of the Vizcaino Point road was closed to all activities in 1996 and the entire road (i.e., north of Environmental Gate #3 at Dos Coves) was closed in about 1998. Complete road closure was necessary to prevent disturbance to rapidly growing numbers of sea lions on Vizcaino Point which increased by 277% from 1991 (2,174) to 2007 (8,205). The Western Gull colony was reduced to 955 pairs in 2007, a decline of 62% since the peak in 1993. Gulls that previously bred in the north section of the Vizcaino Point colony may have moved to: (1) the south section of Vizcaino Point, or the south or north sides of San Nicolas Island but insufficient surveys were conducted in 2007-2008 to examine potential increased nesting in other areas; or (2) other islands. Remaining gulls in the south section at Vizcaino Point and on the south side likely had moderate to low reproductive success in 1996-2008 because of continuing extensive predation, although small numbers on the north side seemed to have relatively high success in 2007-2008. Reduced levels of organochlorine pollutants likely no longer affected reproduction for most gulls at San Nicolas Island by the 2000s.

Direct evidence of feral cat predation on Western Gulls at San Nicolas Island is limited to one study that recorded gulls as a prey species for feral cats in 1980 when 160-255 cats were estimated on the island. At least 180 cats were removed in 1980-1990, followed by other significant removals in 1994-1999 (97), 2000-2003 (25), and 2005-2007 (18). Only 66 cats were finally removed in 2008-2010, indicating great impact of prior removals for keeping the feral cat population at relatively low levels, especially in the 1980s when the

fox population was reduced. A relatively small population of about 25-100 cats likely occurred on the island between 1990 and 1996. At this time, little evidence of cat presence and no direct evidence of cat predation on gull eggs and chicks were found within the gull colony at Vizcaino Point. In contrast, much evidence of fox presence and apparent fox predation was found, and previous evidence of extensive fox predation on gull nests had been obtained in 1984-1985. Fox likely were primarily responsible for extensive depredation on Western Gull nests in 1991-1996 because the fox population had regrown substantially by 1990 and the cat population was relatively low. However, low predation on gulls in 1968 and 1976-1977 may have involved both fox and cat. After further removal of 96 cats in 1994-1998, the cat population apparently remained suppressed at about 25-66 cats in 1999-2008.

Immediate benefits to the Western Gull population from removal of the remaining 66 cats in 2008-2010 probably have been relatively low because the cat population was relatively low at this time due to extensive removals since 1980 and a large, stable population of fox that had redeveloped by the late 1980s. Future benefits to gulls may be relatively high, through prevention of future depredation of gull eggs and higher reproductive success, especially if: (1) cat removals did not occur in the future or were not effective and cat numbers regrew to high levels; (2) the fox population crashed and the cat population regrew to relatively high levels; and (3) the future gull population occurred mainly in certain areas that were highly accessible to cats. To guarantee potential future benefits from cat removal, efforts are being made by the U.S. Navy and Montrose Settlements Trustee Council to prevent reintroductions and conduct rapid removals if reintroduction is detected to prevent redevelopment of a feral cat population on San Nicolas Island. However, extensive fox depredation and sea lion impacts on nesting gulls continue, and the San Nicolas Island gull population likely will not regrow to 1991-1996 levels. Peak population size and nesting distribution of Western Gulls at San Nicolas Island in the 1990s likely was a temporary condition caused by: (1) increasing sea lion numbers (i.e., recovering from overhunting mainly in the 19th century) that provided carcass and after birth prey for gulls at Vizcaino Point, as well as a large amount of suitable nesting habitat at Vizcaino Point in areas likely previously vacated by sea lions; (2) low fox numbers and relatively low gull nest depredation in 1974-1982; and (3) increasing gull populations and breeding success in the Channel Islands (recovering from impacts mainly from organochlorine pollution and human disturbance) that likely led to immigration of gulls from other colonies to use marine mammal prey resources.

Continued monitoring of breeding Western Gulls at San Nicolas Island with aerial surveys is needed to measure future changes in population size and distribution. Future aerial surveys should cover all west and south coastlines of the island which will entail much greater effort than the portions covered in 2007-2008. Ground surveys at Vizcaino Point and along the south side are no longer feasible due to the presence of large numbers of sea lions and other marine mammals but ground surveys are still feasible and less costly for covering the north side.

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Introduction

In 2008-2010, all 66 remaining feral cats (*Felis catus*) were removed from San Nicolas Island, California, by Island Conservation, with much administrative and financial support from the U.S. Navy, U.S. Fish and Wildlife Service, and Montrose Settlements Trustee Council (Hanson et al. 2010a,b; Hanson and Bonham 2011). Expected benefits of cat removal included an increase in breeding population size and improvement of reproductive success for Western Gulls (*Larus occidentalis wymani*) because this species was recorded as prey of feral cats in 1980 but details of whether eggs, chicks or adults were consumed was not provided (Kovach and Dow 1981b). From 1963 to 1996, numbers of breeding Western Gulls had increased dramatically, with the development of a large colony at Vizcaino Point at the west end of the island; however, low reproductive success, organochlorine pollution, human disturbance, and high levels of nest predation by island fox (*Urocyon littoralis dickeyi*) had been recorded in the 1990s (Schreiber 1970, Hunt et al. 1979, Carter et al. 1992, McChesney 1997; H.R. Carter, unpubl. data). After Environmental Gate #3 was installed near Dos Coves on the Vizcaino Point road in 1993, reduced human disturbance occurred on Vizcaino Point. This action was taken to protect marine mammals and breeding seabirds from human disturbance. Without regular human disturbance along this road, increasing populations of California sea lions (*Zalophus californianus*) began to occupy a portion of the upper dune slopes in 1996 and gradually occupied most of the slopes of the north section of Vizcaino Point with a concomitant loss of much of the gull colony (Capitolo et al. 2008a,b). With many factors affecting the gull population at San Nicolas Island over the past few decades and little documentation of gull status, it has been difficult to estimate the amount and timing of expected benefits to the gull population from cat removal.

In this report, Carter Biological Consulting (CBC), University of California Santa Cruz (UCSC), and the U.S. Navy (USN) collated information on the status of Western Gulls at San Nicolas Island from 1850 to 2008. CBC and USN focused on: (1) a historical review of information on gulls and human activities at San Nicolas Island in 1850-2010; and (2) summarizing unpublished surveys and nest monitoring for reproductive success conducted by Humboldt State University (HSU) and the USN in 1991-1996. UCSC focused on conducting aerial surveys of nesting gulls in 2007-2008 to: (1) provide baseline data for measuring future changes in breeding population size and nesting distribution after cat removal in 2009-2010; and (2) to assess population size and distribution changes since 1996. This collation of information will assist the understanding of anthropogenic and natural factors affecting gulls at San Nicolas Island before cat removal, assist the USN and Montrose Settlements Trustee Council with estimation of amount and timing of expected benefits to the gull population from cat removal, and assist the assessment of long-term trends in the Western Gull population at San Nicolas Island.

Methods

Historical Review

Observations and specimens of Western Gulls at San Nicolas Island were collated from the ornithological literature, unpublished reports, and on-line museum specimen databases (ORNIS — Ornithological Information System). Island history was collated from: (1) key published sources (e.g., Doran 1980); (2) interviews with W. Townsend (June 2008), S. Schwartz (October 2008) and R. Dow (October 2008); and (3) reports and unpublished information on file at USN. Townsend was stationed at San Nicolas Island in 1962-1964 and made many bird observations (Townsend 1968). Dow was a field biologist and director of the environmental program on San Nicolas Island in 1977-1999 and 2003-2009; he retired in 2009. Schwartz was the primary archaeologist and island historian for San Nicolas Island from 1990 to 2013; he retired in 2013.

Surveys

1968: The Smithsonian Institution (SI) conducted a ground nest survey of Western Gulls at Vizcaino Point on 14-15 May (Schreiber 1970). The survey was conducted by R.W. Schreiber, likely assisted by R.L. Brownell or R.L. DeLong.

1975: The University of California Irvine (UCI) conducted a ground nest survey of Western Gulls at Vizcaino Point using a “transect method” (Hunt et al. 1979). A transect method was used that involved counting every nest within n meters of several line transects through the colony. Average nest density was multiplied by the total colony area to derive the approximate numbers of breeding pairs present. Few other details on survey dates, areas covered, or survey personnel are available. The island was visited by boat only on 20 April ($n = 5$ hours), 11 June ($n = 6$ hours), 19 June ($n = 7$ hours), and 17 July ($n = 5$ hours). The survey must have occurred on 11 or 19 June because few if any eggs would have been laid by 20 April and few if any chicks would be left at nests on 17 July.

1976: UCI conducted a ground nest survey of Western Gulls at Vizcaino Point using a “transect method” as in 1975 (Hunt et al. 1979). Few other details on survey dates, areas covered, or survey personnel are available. A researcher was based at the island from 14 May to 8 July and a second researcher was present for periods of time on about 20-24 May, 4-13 June and 2-8 July. Also, two researchers were present on 11-12 May. Since the survey must have occurred during the late egg laying and incubation period and two researchers likely were involved, the survey must have been conducted between 11 May and 13 June. The most likely survey dates were 11-12 May or 20-24 May, similar to probable mid-May survey dates in 1977 (see below).

1977: UCI estimated the number of breeding pairs of Western Gulls at Vizcaino Point (Hunt et al. 1979). The same transect method as used in 1975-1976 did not appear to be used in 1977 but average nest density may have been determined from selected quadrats and then extrapolated for colony area. Few other details on survey dates, areas covered, or survey personnel are available. During the egg laying and incubation period for gulls,

island visits occurred on 13-16 May (n = 58 man hours), 8 June (n = 13 man hours), and 29-30 June (n = 23 man hours). The nest survey most likely occurred on 13-16 May when greater man hours were expended.

1991: HSU conducted ground nest surveys at: (1) Vizcaino Point (from the north end of the point to Dos Coves; north and south sections in Figures 1A and 1B) on 27 May (observers: H.R. Carter, T.W. Keeney, G.J. McChesney, W.D. Shuford, D.L. Whitworth, D. Woodard); (2) south side, including Cormorant Rock Area, Elephant Seal Beach Area and Dutch Harbor Area (observers: H.R. Carter, D.B. Lewis, G.J. McChesney, D.L. Whitworth, W.D. Shuford); and (3) north side, including Thousand Springs and Light Point West (observers: G.J. McChesney, D.B. Lewis). At Vizcaino Point, the survey was conducted by six people walking abreast of each other and spaced out about 10-15 m apart, with people communicating to avoid double-counting or missing nests, as nests were not marked (Carter et al. 1992; see Capitolo et al. 2008a). Nest contents were recorded for each nest. Broken eggs and any unusual observations outside of nests also were recorded.

1992: HSU and USN did not conduct a ground nest survey because most gulls in plots did not lay eggs due to severe El Niño conditions.

1993: HSU and USN conducted ground nest surveys at: (1) Vizcaino Point (from the north end of the point to Environmental Gate #3 at Dos Coves; north and south sections in Figures 1A and 1B) on 1-2 June (observers: H.R. Carter, J.M. Hicks, T.W. Keeney, G.J. McChesney, T.A. Miner [hereafter T.A. Ames], G. Smith); (2) south side on 15 June (observers: T.A. Ames, G.J. McChesney); and (3) Vizcaino Point East on 19 May (G.J. McChesney). In spring 1992, efforts had begun to develop the grid system to facilitate gull surveys. S. Schwartz (USN) used a theodolite to establish straight lines along and across the slope and various gullies and sand dunes at 50 m intervals (see Figures 1A, 1B). One-meter high numbered stakes were pounded into the soil at each intersection and around the periphery of the grid. Each cell of the grid was covered by the survey team of 3-4 personnel working abreast of each other, before proceeding to the next cell. However, the grid was not set up for most of the colony by the time of the 1993 survey. For most of the colony, the same survey method was used as in 1991.

1994: In January 1994, development of the grid system resumed and stakes were set up between cells in most of the colony prior to the June survey. HSU and USN conducted ground nest surveys at: (1) Vizcaino Point (from the point to Environmental Gate #3 at Dos Coves, mostly within the newly-developed grid system and adjacent areas; north and south sections in Figures 1A and 1B) on 11-12 June (observers: H.R. Carter, J.M. Hicks, J. Hosokawa, T. Ingram, G.J. McChesney, L.K. Ochikubo, G. Smith, D.L. Whitworth); (2) south side on 12 June (observers: H.R. Carter, J.M. Hicks, T. Ingram, G.J. McChesney, D.L. Whitworth); and (3) Vizcaino Point East on 8 April (observer: G.J. McChesney). Raw data for Vizcaino Point could not be located for this report but a total nest count was found. After the survey, the grid was expanded and finalized (Figures 1A, 1B).

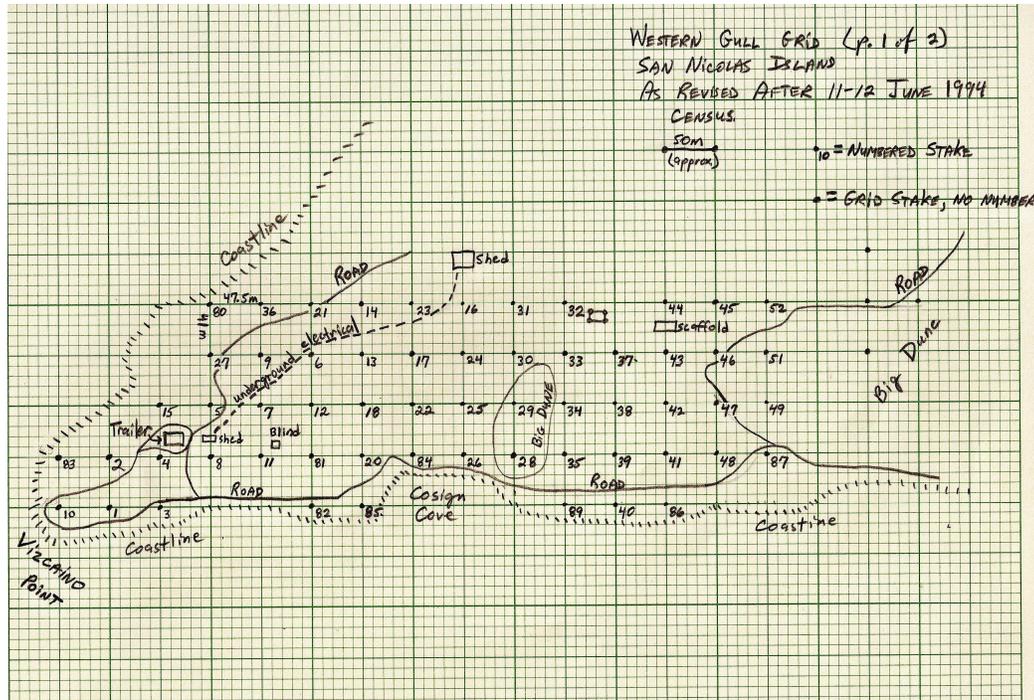


Figure 1A. Grid system (north section) for Western Gull surveys at Vizcaino Point, San Nicolas Island (map prepared by G.J. McChesney in June 1994).

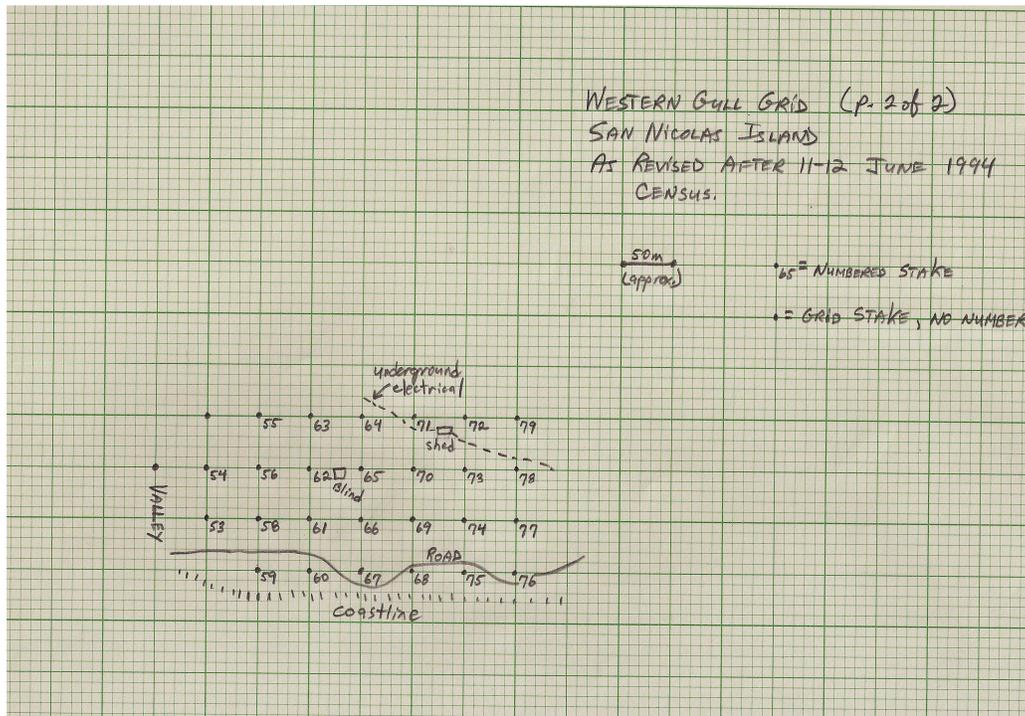


Figure 1B. Grid system (south section) for Western Gull surveys at Vizcaino Point, San Nicolas Island (map prepared by G.J. McChesney in 1994).

1995: HSU and USN conducted ground nest surveys at: (1) Vizcaino Point (from the point to Environmental Gate #3 at Dos Coves, using the grid system and adjacent areas; north and south sections in Figures 1A and 1B) on 10-11 June (observers: H.R. Carter, K. Chess, J.M. Hicks, G.J. McChesney, W.R. McIver, R. Schoenholtz, G. Smith, M. Walgren); (2) south side, including Cormorant Rock Area, Elephant Seal Beach Area and Dutch Harbor Area on 11-12 June (observers: J.M. Hicks, G.J. McChesney, W.R. McIver, R. Schoenholtz, M. Walgren); and (3) Vizcaino Point East on 6 June (observer: G.J. McChesney).

1996: HSU and USN conducted ground nest surveys at: (1) Vizcaino Point (from the point to Environmental Gate #3 at Dos Coves, using the grid system and adjacent areas; north and south sections in Figures 1A and 1B) on 14-15 June (observers: P. Barnes, H.R. Carter, J.M. Hicks, G.J. McChesney, W.R. McIver, R. Schoenholtz, G. Smith, D.L. Whitworth); and (2) south side, including Cormorant Rock Area, Elephant Seal Beach Area and Dutch Harbor Area on 15-16 June (observers: G.J. McChesney, W.R. McIver, G. Smith, D.L. Whitworth).

2007: On 14 May, UCSC conducted aerial photographic surveys from a CDFW Partenavia aircraft at: (1) the Western Gull colony at Vizcaino Point (from the point to about 600 m north of Environmental Gate #3 at Dos Coves); and (2) at Brandt's Cormorant colonies at Dutch Harbor Area and Cormorant Rock Area on the south side and White Bluffs at the far NE end of the island (survey personnel: P.J. Capitolo, J. Davis, L. Henkel) (see Capitolo et al. 2008a,b). The island was circumnavigated to inspect for cormorant colonies, but only at Vizcaino Point was photographic coverage deliberately widened to capture gull nesting on the upper slopes. The north section of the gull colony at Vizcaino Point was completely photographed, but most of the south section was missed (Figures 1A, 1B, 2). All visible nests, sites attended by adults without a nest, and other adults were counted from digital photographs. Nests and sites were added to estimate the number of breeding pairs (see detailed methods in Capitolo et al. 2008a).

A minimum of 2 nests were noted nesting at Coast Guard Beach in 2007 (G. Smith, unpubl. data). To keep the brine discharge from the reverse osmosis processing unit from entering the ocean, public works had created a "berm" between the discharge point on the beach and the shoreline in 2006. This berm caused a pond to form which has remained until a new subterranean discharge system was installed in early 2013. In 2007, two gull nests were noted on this berm. On 1 August, two large chicks and two medium chicks were observed near these nests.

2008: On 20 May, UCSC conducted aerial photographic surveys from a CDFW Partenavia aircraft at: (1) the Western Gull colony at Vizcaino Point (from the point to about 600 m north of Environmental Gate #3 at Dos Coves); and (2) at the Brandt's Cormorant colony at Dutch Harbor Area on the south side (survey personnel: P.J. Capitolo, J. Davis, D. Lipski) (see Capitolo et al. 2010). The Brandt's Cormorant colony at Cormorant Rock Area was surveyed in April, prior to gull egg laying (Appendix 9). The survey was conducted in the same manner as 2007, although aerial photograph

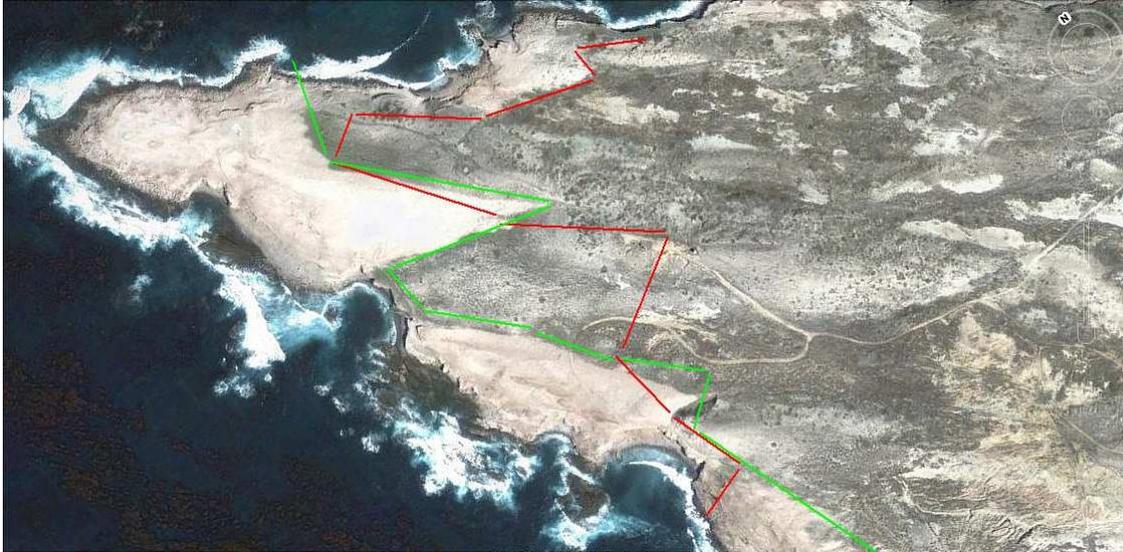


Figure 2. Aerial photography coverage of the Western Gull colony at Vizcaino Point, San Nicolas Island, in 2007 (green) and 2008 (red); coverage was similar in both years (photo by P.J. Capitolo).

coverage of Vizcaino Point was slightly greater, which better ensured that the north section of the gull colony was completely counted (see Figure 2).

At the brine pond near Coast Guard Beach, 13 gull nests were noted in the dunes and on the berm along the shoreline of the brine pond on 13 May 2008 (G. Smith, unpubl. data). Eight nests had three eggs and one nest had two eggs. On 9 July and 8 August, 18 and 17 chicks were observed, respectively.

Reproductive Success

1968: Nest monitoring was conducted weekly between 15 May and 10 June by SI (Schreiber 1970). Four plots were examined that covered about one-third of the Vizcaino Point colony area and about half of the nests ($n = 273$). Nests were marked with spray-paint. Clutch size and hatching success were determined. The primary observer was R.W. Schreiber, assisted at times by R.L. Brownell and R.L. DeLong.

1976: A total of 46 nests in nine 25 m x 25 m quadrats at Vizcaino Point were monitored weekly from 14 May to 8 July by UCI for clutch size, hatching success, fledging success and breeding success (Hunt et al. 1979). Individual nests were marked with stakes. No details on survey personnel are available.

1977: A total of 45 nests were monitored at Vizcaino Point, but less frequently than in 1976, by UCI (Hunt et al. 1979). Clutch size and hatching success were determined. No details on survey dates or survey personnel are available.

1992: Nest monitoring was conducted by HSU and USN at two plots on Vizcaino Point: (1) Point Blind Plot, about 200 m south of the north end of the point, about 100 m south of the old trailer at the end of the main road (see Figure A1-8), and about 50-75 m inland from the shoreline (see Figure 1A; Appendix 1); and (2) Stonehenge Blind Plot, south of the road that bisects the gull colony (about 150-200 m from the south end of the gull colony) and about 100 m inland from the shoreline (see Figure 1B; Appendix 1). Both plots were located in the center of nesting areas. Nests were marked with stakes, mapped, and checked at least once a week from blinds. However, due to shallow slopes, nest contents usually could not be determined from blinds but periodic ground checks were conducted to confirm nest contents. Primary observers were A. Welchel and J. Hosokawa, assisted at times by T.A. Ames, H.R. Carter, T.W. Keeney, and G.J. McChesney.

1993: Nest monitoring was conducted by HSU and USN at the Point Blind Plot and Stonehenge Blind Plot on Vizcaino Point, using the same methods as in 1992. In addition, a Walk-Through Plot was established adjacent to and including the Point Blind Plot; nests were marked with stakes, mapped, and checked every 3-4 days with observers walking through the plot to check nest contents. The primary observer for nest monitoring in all three plots was T.A. Ames, assisted at times by H.R. Carter, J.M. Hicks, J. Hosokawa, T.W. Keeney, G.J. McChesney and L.K. Ochikubo. Clutch size, hatching success, fledging success and breeding success were determined.

Results

Adjusted Population Size Estimates at Vizcaino Point

Comparability of nest counts of Western Gulls at Vizcaino Point in 1968 to 2008 were complicated by several main factors: (1) timing of surveys in relation to timing of egg laying; (2) extensive use of sand scrapes for nest sites; (3) loss of nest contents prior to surveys due to predation; (4) likely exclusion of empty scrapes and empty nests in 1968-1977 surveys; (5) ground nest surveys in 1968-1996 versus aerial surveys in 2007-2008; and (6) incomplete aerial surveys in 2007-2008 (see below). To best describe major gull population changes, we roughly adjusted raw nest counts from 1968-1996 ground surveys prior to making breeding population estimates to increase comparability of estimates within this period and for comparison to unadjusted 2007-2008 estimates from aerial surveys and ground counts which form a baseline for future monitoring. Such adjustments are rough but: (1) allow more reliable description of major population changes than comparing unadjusted estimates; and (2) emphasize the need for standardized surveys in the future.

1991-1996 Adjusted Estimates

In 1991-1996, extensive surveys and monitoring over several years allowed the identification of several factors affecting surveys and comparisons to previous surveys. To increase comparability between population estimates, raw nest counts (Appendixes 2-

6) were adjusted before estimating numbers of breeding pairs (Table 1), as described below. Surveys were conducted between late May and mid June, after almost all or all birds apparently had laid eggs and before almost all chicks were large enough to move far outside of territories (where they might be killed by other gulls) during surveys. In 1993, eggs had been laid at: (1) all sites (100%) in the Point Blind plot; (2) all but one nest (98%) in the Stonehenge Blind plot; and (3) all but two nests in the Walk-Through Plot (97%) by 1-2 June. Relatively large numbers of empty well-formed scrapes and empty nests were recorded during surveys (Appendixes 2-6). However, many eggs also were laid in well-formed scrapes, and we found many broken eggs outside of nest sites indicating extensive predation. In 1993, 34.1% of 48 nest sites with eggs laid at the Stonehenge Blind were sand scrapes. In addition, gulls also are known to periodically build scrapes or build more than one nest within a territory prior to laying eggs. Overall, we considered that most scrapes and empty nests at Vizcaino Point reflected predators removing eggs from nests prior to the survey. When the annual survey was conducted near the end of May, a lower percentage of scrapes and empty nests was recorded (1991 = 37.5%; 1993 = 14.3%); when the survey was closer to mid-June, percentages were higher (1995 = 49.5%; 1996 = 73.8%). In 1993, many eggs laid in the Point Blind and Stonehenge Blind plots also went missing prior to the survey on 1-2 June. In 1996, apparent relaying (i.e., many nearby nests with incomplete clutches, surrounded by many empty nests with broken eggs nearby) appeared to be occurring in certain areas during the survey, indicating egg loss weeks before the survey. Partial clutch loss due to predation also may have occurred at nests with incomplete clutch sizes.

To roughly account for some scrapes and nests probably not having eggs laid in them in the survey year, we subtracted 25% from scrape and empty nest counts in 1991, 1993, 1995, and 1996. In 1996, one team of observers also recorded that 66 (i.e., 7.5%) of 882 empty nests recorded at Vizcaino Point during surveys probably had persisted from the previous year. Prior to removing 25% of empty nests to account for those where eggs were not laid, we subtracted 7.5% of empty nests as possibly being old nests in 1991, 1993, 1995, and 1996. Raw data for the 1994 Vizcaino Point survey were not available to make similar adjustments for scrapes and empty nests, as made in 1991, 1993, 1995 and 1996 (see above). However, a nest count total of 3,137 was recorded in a database for Vizcaino Point South in 1994. Given the later 1994 survey date (11-12 June), we assumed a midpoint proportion of scrapes (24.4%) and empty nests (56.1%) for 1994, based on proportions found in two other years with later surveys (i.e., 1995 — 21.6% scrapes and 59.6% empty nests; and 1996 — 27.2% scrapes and 52.6% empty nests). Using estimated scrapes (765) and estimated empty nests (1,760), we made similar adjustments for 1994 to roughly estimate the number of breeding pairs at Vizcaino Point (Table 1). Due to a near lack of egg laying in 1992, we did not conduct a survey and did not estimate the number of breeding pairs (Table 1). Large numbers of gulls attended the colony and many empty nests were built in the Point Blind Plot and Stonehenge Blind Plot in 1992.

Table 1. Estimated numbers of breeding pairs of Western Gulls at San Nicolas Island, 1968-2008.

Year	Vizcaino Point	South Side	North Side	San Nicolas Island Total
1968	860	0	0	860
1975	860	0	0	860
1976	1,397	0	0	1,397
1977	1,494	1	0	1,495
1991	2,443	180	3 ¹	2,626
1993	2,483	144	0	2,627
1994	2,427	160	NS	2,587
1995	2,348	120	0	2,746
1996	1,994	103	0 ²	2,354
2007	955	192	2	1,149
2008	619	192	13	824

¹ Two isolated nests at “Thousand Springs Area” (i.e., between Thousand Springs and Tule Creek); one nest on bluff top at “Light Point West” (i.e., south of Cissy Cove).

² A few empty old nests were noted near Pirate’s Cove (see text).

In 1991-1995, California sea lions were noted only in rocky intertidal and beach areas below the road and upper slopes at Vizcaino Point. In 1996, the presence of sea lions above the beach area and within the gull colony was first noted. About 100 sea lions were above Cosign Cove, about 40 were on and above the road at the junction of the main road and a spur road (i.e., the “Y”), and over 100 sea lions were noted below the Point Blind. Loss of vegetation due to sea lions also was noted on the coast SW of the trailer (i.e., north of Cosign Cove and south of the point). Several grid sections along and below the main road could not be surveyed, without sea lion disturbance. Gulls previously breeding in these areas likely were prevented from building nests and laying eggs in 1996. We assumed these gulls either did not nest or nested in other areas, and we did not make any adjustment.

In 1991, greater numbers of nesting gulls were first reported on the south side at Cormorant Rock Area (150 nests) and Elephant Seal Beach Area (28 nests) (Appendix 2), likely related to extensive feeding on marine mammal related prey (e.g., placenta, dead pups, etc.). Similar or slightly lower numbers also were noted in these areas in 1993-1996 (Appendixes 3-6). We adjusted south side nest counts in the same manner as for Vizcaino Point but it made little or no difference to these estimates because few scrapes and empty nests were found in these areas. Only 3 nests or sites were noted on the north side in 1991 (Appendix 2). Single standardized nest surveys were conducted in 1993 and 1994 on the north side but nests were not found (G. McChesney, pers. obs.). In 1995 and 1996, specific surveys of the north side were not conducted. In 1996, H. Carter (pers. obs.) recalled finding a few empty old nests (i.e., used before 1995 or earlier) on steep slopes

near Pirate's Cove in 1996 but field notes could not be located. In 1995 and 1996, we assumed no nests for the north side (Table 1; Appendixes 3-6).

Unusual Observations at Vizcaino Point During 1991-1996 Surveys

Broken Eggs: In 1991, six nests only had broken eggs (i.e., number of broken eggs not recorded), 2 nests had one broken egg along with unbroken eggs, and 11 broken eggs were found outside of nests. In 1993, 5 nests only had broken eggs while 6 whole eggs and 71 broken eggs were found outside of nests; 10 (14%) of 71 broken eggs had evidence of fox or cat predation. In 1993-1994, we learned key characteristics of fox-depredated eggs (i.e., two tooth marks and punched in sides of eggs; see below) and subsequently reported many broken eggs with these characteristics as fox-depredated. In 1995, two nests had broken eggs and 156 broken eggs (58 [37%] with evidence of fox predation) were noted outside nests. In 1996, 131 broken eggs were noted outside nests (41 [31%] with evidence of fox depredation). Greater numbers of broken eggs in 1995 and 1996 seemed to at least partly reflect the later timing of the survey. While a substantial proportion of broken eggs were thought to have been depredated by fox, we could not determine if any were broken by cats and did not know how to tell cat-depredated eggs from fox-depredated eggs.

Dead Adults: In 1995, 37 dead adult gulls were recorded at the Vizcaino Point gull colony; in 1996, 12 dead adult gulls were recorded. These adults had died in the survey year. Some bodies were partly eaten and likely were killed by Peregrine Falcons (*Falco peregrinus*) (see below) while others showed no signs of predation. Dead adults were not mentioned in 1991 and 1993 survey notes but may have been present and not recorded. Data were not available for 1994.

Dead-At-Hatch Embryos: In 1993, three nests with dead-at-hatch embryos were noted: (1) 1 egg and 1 dead-at-hatch embryo (n = 2 nests); and (2) 1 egg, 1 broken egg and 1 dead-at-hatch embryo (n = 1 nest). None were noted in 1991, 1995 and 1996. Data were not available for 1994.

Crushed Egg: In 1995, one crushed egg (i.e., crushed on one side likely indicating that it was thin-shelled) was found in a nest. None were found in 1991, 1993 and 1996. Data were not available for 1994.

Runt Eggs: In 1991, one runt egg was found in a three-egg nest. In 1993, three nests with runt eggs were noted: 1 runt egg (n = 1 nest); 2 runt eggs (n = 1 nest); and 1 normal-sized egg and 1 runt egg (n = 1 nest). None were noted in 1995 and 1996. Data were not available for 1994.

Supernormal Clutches: In 1993, four supernormal clutches were recorded: (1) four eggs (n = 2 nests); (2) three eggs and one broken egg in nest (n = 1 nest); and (3) three eggs in the nest and 1 broken egg outside but beside the nest (n = 1 nest). In 1995 and 1996, one four-egg nest was recorded each year. None were noted in 1991. Data were not available for 1994.

Cormorant Eggs: In 1993, one broken Brandt's Cormorant egg was found on the road below the Stonehenge Blind on 24 May and one whole cormorant egg also was found beside a gull nest being monitored at the Stonehenge Blind. In 1995, four cormorant eggshells were found in gull nesting areas during the annual survey. Cormorant eggs found in the gull colony suggested either gull predation of cormorant eggs or mammalian predators carrying cormorant eggs long distances away from cormorant nesting areas on Vizcaino Point.

1968-1977 Adjusted Estimates

Most surveys in 1968-1977 were conducted earlier in the breeding season than 1991-1996 surveys and adjustment was needed to improve comparability to later surveys. Schreiber (1970) counted 491 and estimated about 600 nests of Western Gulls at Vizcaino Point on 14-15 May 1968, likely after mean clutch initiation but before all eggs were laid. We assumed that Schreiber counted small numbers of nests on the beach and a nearshore rock that were associated with California sea lions that had been noted in 1967 by DeLong (1967). Hunt et al. (1979) did not report exact survey dates for 1975-1977 but we suspect surveys were conducted in mid May 1976 (935 nests estimated) and 1977 (1,000 nests estimated), or mid June 1975 (720 pairs estimated) (see earlier). We assumed that about 80% of clutches had been initiated (i.e., most clutches completed) prior to 1968-1977 mid-May surveys. By adding 20% to mid-May nest estimates, we obtained partly adjusted nest estimates of 720, 1,169 and 1,250 for 1968, 1976 and 1977. We did not adjust the mid June 1975 estimate of 720 nests for survey timing in relation to timing of egg laying.

Earlier surveys in 1968-1977 also appeared to treat scrapes and empty nests in a different manner than in 1991-1996 (when scrapes and empty nests accounted for substantial portions of total nests counted) and adjustment was needed to improve comparability. Schreiber (1970) apparently did not count scrapes or empty nests, even though egg loss was reported in 37 nests, apparently due to predation. Hunt et al. (1979) did not mention scrapes and empty nests and we suspect they did not include them. G. Hunt (pers. comm. to H.R. Carter) later asserted in the 1990s that he did not believe that scrapes should be included in nest surveys because a single pair of gulls can make more than one empty scrape in their territory prior to final laying of eggs in a nest, based on his studies at Santa Barbara Island. However, a large proportion of gulls appeared to lay eggs in scrapes at the Vizcaino Point colony in 1991-1996 (see above) where nesting habitats are very different than those on Santa Barbara Island. In 1991 and 1993, surveys were conducted at or near the end of egg laying (i.e., near the end of May); at this time, 14.3% (1993) and 37.5% (1991) of nests were scrapes or empty nests, averaging 25.9%. We considered that: (1) a similar proportion (26%) of empty scrapes and empty nests occurred but were not included in 1968-1977 surveys; and (2) about 25% of scrapes and empty nests did not have eggs laid in them (see above). By adding 19.5% to 1968-1977 partly adjusted nest estimates, we obtained adjusted nest counts (i.e., 860, 860, 1397, and 1494) (Table 1). The great difference between 1975 and 1976 estimates likely reflected sampling error in

1975 when low survey effort also occurred (Hunt et al. 1979). We do not have confidence in the 1975 estimate and relied on 1976-1977 estimates.

In 1968, 16 supernormal clutches (i.e., greater than three eggs) were reported, including four eggs ($n = 12$), five eggs ($n = 3$) and six eggs ($n = 1$) (Schreiber 1970). On 22 May, they accounted for 6% of 273 nests observed. Only one of 74 eggs in these supernormal clutches hatched. In 1977, one supernormal clutch of 5 eggs was noted; none were found in 1976 (Hunt et al. 1979). We did not make any adjustments for supernormal clutches.

2007-2008 Non-Adjusted Estimates

In 2007-2008, aerial surveys were conducted in mid May (likely after mean clutch initiation but before eggs are laid in all nests) but only nests and sites attended by adults were counted in photographs. In 2007, 707 nests and sites were counted in the north section of Vizcaino Point, associated with 1,228 birds; in 2008, 458 nests and sites were counted in the same area, associated with 685 birds. The large difference between 2007 and 2008 was not related to slightly different photographic coverage of this part of the colony and appeared to reflect poor breeding conditions in 2008. Brandt's Cormorants at San Nicolas Island also bred in greatly reduced numbers in 2008 versus 2007 (Appendix 9). The south section of Vizcaino Point was not inspected in 2007-2008 and any nesting gulls could not be seen from the aircraft against the light colored substrate. Also, in 2008, 96 nests and sites were counted at Dutch Harbor, associated with 138 birds, but insufficient photo coverage prevented estimation of numbers at other south side areas. For the north side, we added 2 and 13 nests counted in 2007 and 2008, respectively, at Coast Guard Beach.

We did not make any adjustments to 2007-2008 nest and site totals for likely incomplete counts on the north side and at Dutch Harbor Area. Raw counts were used for estimates of breeding pairs because: (1) many clutches (e.g., 80%) likely had been initiated before mid May surveys; (2) some empty scrapes and empty nests would have been attended by adults in mid May 2007-2008, especially those where eggs would soon be laid; and (3) future monitoring will likely involve aerial surveys and use of adjustments are not desirable for long-term monitoring purposes and trend measurement using regression analyses. Due to incomplete photographic coverage, we could not determine if gulls bred in the southern portion of Vizcaino Point in 2007-2008. To roughly account for other south side areas not surveyed in 2008, we simply doubled the Dutch Harbor Area count to derive a minimum total of 192 nests for the south side which was similar to but slightly larger than 1991-1996 south side counts. A complete survey of the southern portion of Vizcaino Point, and the south and north sides of the island is needed in the near future to better assess nesting in these areas. For this report, we assumed the same value as 2008 for 2007 on the south side.

Reproductive Success

Clutch size: Relatively high (range = 2.3-2.8 eggs per clutch) in 1968, 1976, 1977, and 1993 (Table 2), with 3 eggs being the modal clutch size in all years and many clutches of one or two eggs reflecting partially-laid clutches or partial clutch loss. In 1992, few eggs were laid during severe El Niño conditions; in 1993, egg laying occurred normally during mild El Niño conditions.

Hatching success: Relatively low to moderate (range = 41-55% hatched of eggs recorded) in 1968, 1976 and 1977. Relatively moderate to high in 1993, with 88% at the Point Blind, 53% at the Stonehenge Blind, and 82% at the Walk-Through Plot. Many eggs went missing during nest monitoring in 1993. In 1992, none hatched of the few eggs laid during severe El Niño conditions.

Fledging Success: Relatively high (Range = 83-91% fledged of chicks that hatched) in 1976 and 1977. Relatively low in 1993, with 23% at the Point Blind Plot, 7% at the neighboring Walk-Through Plot, and 0% at the Stonehenge Blind Plot. Many chicks went missing shortly after banding (i.e., probably depredated by foxes or cats) but some larger chicks also went missing and may have wandered outside of territories before dying). Many small and large chicks also died at nest sites (i.e., some chicks clearly starved to death and did not die from depredation) in 1993. Poor food availability likely occurred in 1993 during mild El Niño conditions. Chick growth rates were high in 1968 (31.5 g/day; n = 11 chicks) and 1976 (28.8 grams per day; n = 42 chicks) but were not measured in 1975, 1977, and 1993.

Breeding Success: Relatively low (0.87 chicks per nest) in 1976. Very low in 1993 at blinds, with 0.54 at the Point Blind, 0.15 at the Walk-Through Plot, and 0.00 at the Stonehenge Blind Plot. Breeding success was not measured in 1968, 1975, and 1977.

Human Disturbance (1991-1996)

In 1993, the USN closed Environmental Gate #3 at Dos Coves to entry by regular security patrols and recreational use by off-duty military personnel; in addition, a major sign was erected beside the gate that explained the closure (Figure 3). These actions were taken by the USN in response to a human disturbance event at Bomber Bluff in 1992 which caused colony abandonment by nesting Brandt's Cormorants (McChesney 1997). In 1992 and 1993 at the Point Blind Plot and Stonehenge Blind Plot, low overflights (50-100 m) occurred regularly, usually once but sometimes twice per day during nest monitoring checks between May and August. Usually, only small numbers (<100) of gulls flushed for a few minutes in response to low overflights. On occasion, hundreds of gulls would flush for a few minutes in response to low overflights or for no apparent reason, although undetected predators may have been responsible. In 1992, few nests had eggs laid in them so impacts did not occur. In 1993, we did not notice any major impacts from these disturbances but most nests failed during the chick period apparently due to other factors.

Table 2. Reproductive success of Western Gulls at San Nicolas Island, 1968-1993. Sample sizes in parentheses. Codes: ND, no data.

Year	Clutch Size ¹	Hatching Success ²	Fledging Success ³	Breeding Success ⁴
1968	2.8 (273)	58% (429)	ND	ND
1976	2.3 (46)	41-45% (106)	83% (48)	0.87 (46)
1977	2.6 (45)	48% (120)	91% (58)	ND
1992 (PBP) ⁵	1.3 (3)	0% (4)	- (0)	0.0 (3)
1992 (SHP)	1.0 (1)	0% (1)	- (0)	0.0 (1)
1993 (PBP)	2.7 (48)	88% (130)	23% (114)	0.54 (48)
1993 (WTP)	2.7 (74)	82% (201)	7% (165)	0.15 (74)
1993 (SHP)	2.3 (48)	53% (109)	0% (58)	0.0 (48)

¹ Maximum number of eggs reported per clutch (total number of clutches with eggs recorded).

² Number of eggs hatched of those recorded (total number of eggs in parentheses).

³ Number of chicks fledged of those hatched (total number of chicks hatched in parentheses).

⁴ Number of chicks fledged per clutch recorded (total number of clutches in parentheses).



Figure 3. Sign erected beside Environmental Gate #3 (photo by H.R. Carter; June 1993).

Other forms of human disturbance to nesting gulls that periodically caused flushing included: (1) seabird researchers entering and departing from blinds or conducting surveys; (2) non-seabird researchers and off-duty military personnel walking through the gull colony; and (3) fishing boats close to shore. Gulls flushed during these visitations but we did not note any major impacts.

During most missile launches and other military operations, gull nest monitoring and surveys were not permitted at Vizcaino Point so we often did not witness responses by nesting gulls to these forms of disturbance. However, we did not find any immediate nest abandonments or eggs being kicked out of nests after missile launches, although such eggs would be eaten quickly by gulls and difficult to detect. On several occasions in 1992-1993, gull researchers were asked to monitor certain missile launches and explosive ordinance disposals outside of the gull colony from gull blinds. No disturbances occurred from these military actions or related military personnel. On at least one occasion, a very loud sonic boom occurred which caused gulls to flush but they relanded fairly quickly without apparent impacts (G. McChesney, pers. obs.).

Island Fox at Vizcaino Point (1991-1996)

By 1990, the fox population on San Nicolas Island had recovered to relatively high levels (Smith 1990; G. Smith, unpubl. data; see later). In 1991-1996, much evidence of fox depredation of gull eggs and fox occurrence was obtained at Vizcaino Point. In addition to the many broken gull eggs that appeared to be fox-depredated, many missing gull eggs (likely depredated) and much fox scat occurred in the Vizcaino Point colony. In 1993, extensive fox depredation also led to abandonment of the Brandt's Cormorant colony at Vizcaino Point East (McChesney 1997). Additional evidence of island fox presence and predation on gull nests also was obtained in the Stonehenge Blind area in 1993 and 1996, as described below:

On 3 June 1993, most empty nests were located on the upper perimeter of the colony. Broken eggs (likely depredated by fox), fox tracks and fox trails were observed on several occasions between the blind and the spur access road. On 6 June, foxes were seen on the roads near the blind, with scat, tracks, trails and predated eggs and abandoned nests in areas between the blind and the access road. In retrospect, we have wondered if gull researchers may have attracted fox to blinds through the use of access paths or having human food in blinds. Food was allowed in blinds but all food trash was removed daily from blinds. We did not find any evidence of enhanced fox predation of gull nests or foxes eating human food immediately beside blinds. Predation observations were most consistent with: (1) a gradual progression of fox predation first at nests on the inland peripheries of the colony and later at nests closer to the shoreline; (2) eventual predation in all nests in upper slope areas; and (3) some nests in lower slope areas escaping predation (e.g., Point Blind Plot in 1993 and Walk-Through Plot in 1993).

Abandonment of nests was evident by 17 May 1993, when many eggs had been lost in the plot. On 8 July, no gull chicks remained in the plot or in the entire area near the blind, including the area down to the road and across the road to the water. Fox scat was found

in front of the door to the Stonehenge Blind. Following fox trails behind the north side midden (50-100 m from the blind), a bedding area was found which contained two adult foxes, 3-4 fox bedding sites under bush lupine (*Lupinus albifrons*), and 25-30 broken eggs with punched out centers and tooth marks. This bedding area is the same location as noted for Cache #1 in 1994-1996 (see below). Fox apparently stayed in bedding areas during the day and moved into the gull colony mainly at night. Gull nests closer to bedding areas had a much higher chance of being depredated than those farther away.

In 1996, three caches of fox-depredated eggs were found about 100 m away from gull nests at Vizcaino Point during the survey. Cache #1 was located south of the spur road and between the two portions of the grid (same location as noted in 1993-1995). Two old and two recent gull eggshells depredated by fox were found. More eggshells had been noted in this location in 1995 than in 1996. Cache #2 was located north of the spur road just above the inland boundary of the grid. Eight eggshells depredated by fox were found beside a fox bedding site under goldenbush (*Isocoma menziesii*). Cache #3 was located on the south edge of the colony near but inland from the road near Environmental Gate #3 at Dos Coves. Five eggshells depredated by fox were found, along with fox scat.

Feral cats at Vizcaino Point (1991-1996)

No direct evidence of the presence of cats or depredation of gull eggs or chicks by cats was found on Vizcaino Point during gull surveys or gull nest monitoring in 1991-1996. While we had difficulties assessing fox versus cat depredation of eggs, we suspected that most if not all eggs were depredated by fox, even though this could not be proven. The only observations of cats made by seabird researchers were: (1) an orange tabby cat approached a small group of roosting cormorants and gulls, causing them to flush, at Vizcaino Point East in March 1994 (McChesney 1997); (2) an orange tabby cat walked down a canyon between Cormorant Rock and Grenadier Point on 26 July 1994; and (3) an orange tabby cat ran above the road between Grenadier Point and Elephant Seal Beach on 26 July 1994. In addition, cats were not captured during trapping efforts near Sea Lion Cove in June 1994 (McChesney 1997). During the Vizcaino Point gull survey in 1996, G. Smith (pers. obs.) examined some mammal tracks and thought they might be cat tracks because the print was rounder without nail marks.

Since cats are night hunters and much less active during the day, the few observations of cats alone did not indicate that they did not occur on Vizcaino Point or occurred infrequently. However, in 1980 when cats occurred in relatively high numbers on San Nicolas Island, densities of 1.0-3.9 cats/km² were found on Vizcaino Point; four cats were trapped at Vizcaino Point, with two removed and two left behind (Kovach and Dow 1981b). At this time, no fox occurred on Vizcaino Point (Kovach and Dow 1981a). With lower numbers of cats on the island in 1991-1996 and extensive presence of fox on Vizcaino Point at least by 1984 (Kovach and Dow 1985), numbers of cats on Vizcaino Point probably were lower in 1991-1996 than in 1980. Between June 1994 and June 1995, Archuleta (1996) reported removal of 55 cats from the island; two cats were removed (one shot and one trapped) from the “gull colony” (presumably Vizcaino Point) and one cat removed (trapped) from the “cormorant colony” (presumably Sea Lion Cove;

see McChesney 1997) but dates of removal were not stated, and it is not clear if they were present during the period when gull eggs were available for depredation. Between September 1995 and September 1996, Thomson (1997) reported removal of 21 cats but trap locations were not reported; along with greatly reduced sightings, only a very small cat population appeared to remain. Prior to removals of 76 cats in 1994-1996, we suspect that as many as 100 cats may have occurred on the island in 1991-1993. By 1996, we suspect that as few as about 25-35 cats may have remained on the island (see discussion). With four cats on Vizcaino Point in 1980 when the estimated island cat population was 160-255 cats (Kovach and Dow 1981b), we suspect that between 0 and 2 cats occurred on Vizcaino Point during the gull breeding season in 1991-1996 when the island cat population was about 25-100 cats (see discussion). However, in 2000-2009, several cats were removed from the Vizcaino Red Eye grid area near the Vizcaino Point gull colony (see later), suggesting larger numbers of cats in the 2000s that may have reached similar levels to 1980, even though most gulls no longer bred at Vizcaino Point at this time.

Peregrine Falcons at Vizcaino Point (1991-1996)

Single Peregrine Falcons were noted flying over Vizcaino Point on occasion during nest monitoring and surveys in 1991-1996. While falcon breeding was not known to occur at San Nicolas Island during this period, they were common during the winter and early spring (G. McChesney, pers. obs.). Many dead adult gulls noted during 1995 and 1996 surveys appeared to reflect falcon predation (see above). G. McChesney (pers. obs.) once observed a falcon with a gull carcass in 1993 or 1994. During the 1991 survey, one old dried Cassin's Auklet (*Ptychoramphus aleuticus*) also was noted, likely captured by falcons at sea and brought to the island. During the 1995 survey, four dead Cassin's Auklets also were found in the grid, with three found in the same 50 m x 50 m cell. During the 1996 survey, one decapitated adult gull also suggested falcon predation.

Discussion

Western Gulls at San Nicolas Island (1850-1960)

In winter 1850-1851, T. Jeffries travelled to San Nicolas Island to search for the famous lone Nicoleño woman (later baptized "Juana Marie") unintentionally left behind at the island during heavy seas in 1835 when other remaining Nicoleños were removed from the island and taken to mainland missions; this search was unsuccessful but Jeffries noted "sea-gulls, pelicans and shags" (Hardacre 1880). In April 1852, G. Nidever and Jeffries returned to San Nicolas Island to collect "sea gull" eggs and continue the search for the lone woman (eventually found in 1853); however, the island was visited only briefly and no gull eggs were collected (Hardacre 1880, Ellison 1984). Occurrence or breeding of Western Gulls, with few details, was noted in 1863, 1891, 1897, 1902, 1912-1944, 1945, and 1951 (Appendix 7). Little or no information on the numbers of nesting gulls or nesting locations at San Nicolas Island are available for the 1850-1960 period due to the remote nature of the island with sheep ranching from the 1850s to 1940s and USN management with restricted access since 1933 (Appendix 8). For thousands of years prior

to 1814, substantial numbers of Nicoleños lived on the island and likely hunted gulls and ate their eggs (Appendix 8). We suspect that few gulls were able to breed on San Nicolas Island during this period because almost all coastal areas are accessible to humans on foot. After 1835 when the few remaining Nicoleños were removed from the island, numbers of nesting gulls likely increased. However, sheep ranching began in 1857 and eventually extended over the entire island during the 1860s. The island was divided by a north-south fence about the center of the island in the 1920s, concentrating sheep grazing on the eastern half of the island. Sheep grazing continued until 1943-1947 when USN management of the island was well established and sheep leases expired. Cats may have been introduced to San Nicolas Island during the ranch period, as early as the 1850s, but definite evidence of their occurrence begins in 1952 (Kovach and Dow 1981b). Gulls likely began breeding at Vizcaino Point in the 1920s and 1930s where they could avoid sheep, humans, and most or all cats. In 1952, feral cats were well established and distributed in low numbers from Vizcaino Point to Thousand Springs (Kovach and Dow 1981b). Between 1925 and 1964, the island fox population also reached a very low level of less than 10 foxes, based on genetic analyses (Aguilar et al. 2004).

Early Growth of the Vizcaino Point Colony (1962-1968)

The first evidence of substantial numbers of gulls nesting at San Nicolas Island was obtained in 1962-1964, when nests were found along the shoreline at Vizcaino Point East and Vizcaino Point South and large numbers of nests did not occur above shoreline areas (W. Townsend, pers. comm.). More than 600 downy young were noted in 1963 (Townsend 1968). Feral cats also were noted as more abundant in 1963 than in 1952 (Kovach and Dow 1981b). We suspect that larger numbers of gulls nesting at Vizcaino Point by the early 1960s reflected: (1) the building of a security road network around the entire shoreline of San Nicolas Island, including most of Vizcaino Point, in 1951-1957, leading to few coastal areas without human disturbance; (2) increasing numbers of sea lions on Vizcaino Point in the 1940s and 1950s leading to breeding by gulls in locations with steeper shorelines near marine mammal prey and, for some pairs, to avoid fox and cat predation through close association with sea lions; and (3) a reduced fox population and a small cat population. Nesting areas used in 1962-1964 were the only parts of Vizcaino Point without roads nearby where human access and disturbance did not occur and were located far from the compound area with human food for fox and cats.

The colony of Western Gulls at Vizcaino Point grew substantially between 1963 and 1968, reaching an estimated 860 pairs in 1968. By 1968, the colony had spread over most of Vizcaino Point in an area about 2,400 m long and 200 m wide (Schreiber 1968, 1970). DeLong (1967) had roughly estimated 3,000 pairs in 1967, based on the number of juveniles seen mainly in the water (and a few on the colony) at the west end. We considered that this method had resulted in a great overestimate. However, DeLong also noted "A small number of nests assumed to belong to this species were found on the California sea lion rookery ... The now vacant nests were both on the shore line and on the rock island separated by a Ca. 3 meter-wide channel." W. Townsend (pers. comm.) indicated that gulls did not nest high on the slope at Vizcaino Point in 1963 and were mainly distributed along the shorelines. The inland (and possibly southward) expansion

of nesting areas on the point between 1963 and 1968 and may have been associated mainly with a continued increase in sea lions in shoreline areas and growing human disturbance in coastline areas after the road was built in 1957.

Low hatching success (58%) also was noted in 1968. Of 181 eggs that did not hatch, 39% were “infertile” (i.e., embryos did not develop) and 40% were found within 16 supernormal clutches (11% of clutches). Low hatching success and supernormal clutches mainly reflected serious impacts from organochlorine pollution including eggshell thinning, embryo mortality, embryo feminization, altered sex ratios, and effects on adult behavior but crushed and dead-at-hatch eggs were not recorded (Hunt and Hunt 1973, 1977; Hunt et al. 1980, 1984; Wingfield et al. 1980a,b, 1982; Fry and Toone 1981; Conover and Hunt 1984; Fry et al. 1987; Sayce and Hunt 1987). However, about 20% were broken or missing. Schreiber (1968:4) noted that “Of the 37 eggs which disappeared or were broken, eight were from three clutches at the edge of the colony which an Island Fox (*Urocyon littoralis* Dickey) destroyed in one night. These fox are common on the main portion of the island, but this is the only instance I noted of their predation on gulls.” Small numbers of cats also may have occurred on Vizcaino Point in 1963 and may have been more abundant on the island in 1963 than in 1952 (Kovach and Dow 1981b). No observations of cats or cat depredation were reported in 1968, and most cats apparently occurred in the compound area of the island in 1971 and 1974 (Laughrin 1973, 1978). While cat presence and low predation may have been missed, we suspect that cats did not occur on Vizcaino Point in 1968. In contrast, the fox population in 1971 was widespread on the island (Laughrin 1973, 1978) and fox likely did occur in relatively large numbers on Vizcaino Point in 1963 and 1968. However, extensive gull nest predation was not noted in 1968 (Schreiber 1968, 1970), possibly because fox had not yet discovered how to access this recently increased prey resource. Fledging success was not measured in 1968 and some mortality of chicks from fox predation may not have been recorded.

Gull colony growth in the 1960s (and likely earlier in the 1940s and 1950s) did not appear to be based on relatively poor levels of reproduction in the 1960s. Population growth was more consistent with possibly better reproduction in earlier years or immigration from other colonies to exploit carcass and after birth prey created by recently-expanded marine mammal populations at San Nicolas Island (Schreiber 1970). While extension of nesting from shoreline areas onto the upper slopes probably reflected increased sea lion use and human disturbance in shoreline areas on the west side of the point, the Vizcaino Point East area (where much nesting also was noted in 1962-1964) was less affected by sea lions but a crashed bomber nearby was used in 1962 (and perhaps later years) as a practice aerial bombing target (W. Townsend, pers. comm.) which also may have encouraged these gulls to move over to the other side of the point by 1968. Overall, human disturbance at Vizcaino Point appeared to be relatively low in the 1960s and did not prevent colony increase. However, Schreiber (1968:4) noted that “The gull colony on San Nicolas Island is situated along the favorite Navy recreational fishing area and near a Pacific Missile Range impact site so is daily disturbed by vehicles and men. These disturbances, along with my almost daily survey work, may have

affected egg loss and hatching success, but it was impossible to determine to what extent.”

Continued Growth of the Vizcaino Point Colony (1975-1996)

1970s: The Vizcaino Point colony continued to grow, with 1,494 pairs estimated in 1977. In 1976-1977, hatching success remained low to moderate (41-48%) but fledging success was found to be high (83-91%) (Table 2). Only one supernormal clutch with 5 eggs was reported in 1977, indicating reduced impacts from organochlorine pollutants compared to 1968. Crushed and dead-at-hatch eggs also were not recorded in 1976 or 1977. The marine discharge of organochlorine wastes in southern California was halted in 1970, although bottom sediments remained highly contaminated. Some improvement in Brown Pelican (*Pelecanus occidentalis*) breeding at Anacapa Island had been noted by the mid 1970s (Anderson et al. 1975, Gress 1995). By 1978, most female-female pairs of Western Gulls at Santa Barbara Island also no longer produced supernormal clutches (Hunt et al. 1979). However, gulls at San Nicolas Island continued to feed extensively on marine mammal placenta (Hunt et al. 1979) which had remained highly contaminated. Slightly lower hatching success was noted at San Nicolas Island in 1976 and 1977 than at Santa Barbara Island (Hunt et al. 1979). Most eggs that did not hatch at Santa Barbara Island in 1977 showed no apparent development, clarifying that lack of embryo development was not restricted to supernormal clutches and may have been partly related to contaminants as well as other factors (e.g., overheating). Many eggs that did not hatch at San Nicolas Island also were broken or missing, indicating continued impacts from apparent fox predation, although feral cats likely also were involved but not detected (see later). A heat wave that affected chick survival at Santa Barbara Island in 1976 did not greatly affect gulls at San Nicolas Island which had higher chick survival to fledging and higher chick growth rates (Hunt et al. 1979). Colony growth at Vizcaino Point in the 1970s likely reflected both improved local reproduction and continued immigration of gulls from other nearby colonies. The first nest on the south side nearer to the largest marine mammal areas was noted in 1977, a forerunner for later increases in this area by the 1990s (see below).

Continued colony growth at Vizcaino Point and limited fox predation on gull nests in 1976-1977 also partly reflected low numbers of fox at San Nicolas Island (Hunt et al. 1979). However, relatively low gull reproduction at San Nicolas Island compared with some other colonies in the Channel Islands also suggested that predation still had some impact. In 1974, the fox population crashed and foxes were estimated to be outnumbered by feral cats by a ratio of 2.8:1 (Laughrin 1973, 1978; Kovach and Dow 1981a,b). In 1975, the California Department of Fish and Game (now CDFW) visited the island to assess the status of the fox population (R. Dow, pers. comm.). About 75 fox were found at the back door of the galley feeding on leftover human food waste and CDFW worked closely with the USN to attempt to stop this practice. Many dead fox were found after human food was removed. Low fox numbers were found during limited trapping (3 captured) and vehicle spotlight surveys (2 seen) on San Nicolas Island in December 1977, reflecting a relative decrease of 96% in the monitored Vizcaino Red Eye area near Vizcaino Point between 1971 (7.0/sq. mi. or 18.13/km²) and 1977 (0.25/sq. mi. or

0.65/km²), with 1974 (1.3/sq. mi. or 3.37/km²) intermediate (Laughrin 1973, 1978). Eight cats were trapped (0.7/sq. mi. or 1.81/km²) and two others seen with spotlights in 1977. In 1971, few cats were observed and only in the compound; in 1974, 2 cats were captured but they also were seen only in the compound (Laughrin 1973, 1978). Most fox feeding had stopped in 1977. R. Dow (pers. comm.) did not observe any foxes in 1977, despite extensive spotlighting from roads at night where cats were fairly common. In 1980, further trapping and surveys indicated that no fox occurred on Vizcaino Point (Kovach and Dow 1981a).

Although small numbers of feral cats likely had been present at San Nicolas Island since the 1850s, six additional cats were introduced as pets in 1970 and another pair in 1973 or 1974 (Kovach and Dow 1981b). In 1952-1974, the cat population remained fairly localized on the north side between the compound and Vizcaino Point and apparently were held in check by the established although relatively low fox population. After the fox population crashed in 1974, cats had become widely distributed in relatively large numbers around San Nicolas Island by 1977-1978, including the south side and Vizcaino Point. In April-November 1980, 160-255 cats were estimated based on extensive live trapping, 64 were removed, and gulls were recorded as a prey species for cats (Kovach and Dow 1981b). Island fox were not recorded on Vizcaino Point in 1980 and gulls were not recorded as a prey species for fox in that year (Kovach and Dow 1981a,b). Hunt et al. (1979) did not mention any cats or cat predation at Vizcaino Point in 1976-1977 and assumed some fox predation but it is possible that some cat predation of gulls also occurred without recognition, especially while fox numbers were starting to increase after the crash in 1976-1977. Reduced human disturbance also occurred in the 1970s, after Vizcaino Point was classified as a ground hazard area but human disturbance continued, at least through use of the road to the point by security patrols and likely for recreational fishing. Schreiber and Schreiber (1980) noted that "A certain amount of visual disturbance occurs daily as military vehicles drive along the road on the edge of the [gull] colony. This has been occurring for at least 20 years. Since some gulls nest within 1 m of this road, this vehicular traffic does not appear to adversely affect the birds, and we noticed no particular response by the gulls, with a vehicle serving as a blind to mask the presence of human beings (Schreiber, unpubl. data)." Impacts from military operations were not fully assessed but major impacts were not suspected.

In 1979, heat tolerance in gull embryos and hatchlings was studied by the University of Michigan and the University of California Irvine (Bennett et al. 1981; Dawson and Bennett 1981). Although there was a heat wave on the mainland in June during the study, elevated chick mortality was not observed at San Nicolas Island, even though elevated chick mortality did occur at Santa Barbara Island.

1980s: In 1980, about 1,100 breeding pairs were estimated at Vizcaino Point during disturbance experiments related to assessing potential impacts from sonic booms from space shuttle launches (Schreiber and Schreiber 1980). Seasonal differences in response to visual and auditory stimuli were examined, such as people in the colony, shotguns, and carbide cannon explosions. This population estimate was determined by counting all gulls present in the colony, apparently from a vehicle on the road. The highest total count

(1,532 on 25 April) appeared to have been roughly adjusted for the number of birds per nest (about 1.4 to derive about 1,100 pairs but correction factor data not provided). We considered that this rough estimate likely was an underestimate, given lower numbers than found in the 1970s. Other survey data for Western Gulls gathered by B. Stewart (unpubl. data) during the 1980s (R. Dow, pers. comm.) were not available for this report; we are not aware of any reports that may have been prepared containing such data. In 1983-1984, poor gull reproduction also occurred in association with the severe El Niño conditions and apparent low prey availability (R. Dow, pers. comm.), although a much larger wintering population of Western Gulls and Herring Gulls (*L. argentatus*) had occurred that fed on abundant Pelagic Red Crabs (*Pleuroncodes planipes*) (Stewart et al. 1984). A study of pair-bond formation and behavior of paired gulls also was conducted in 1983 by J. Hand (Froke 1983); we are not aware of any report that may have been prepared. In 1984, the USN began “closures” of many areas to protect sea lions and other marine mammals as well as breeding seabirds but Vizcaino Point was still used extensively by security patrols (R. Dow, pers. comm.). In 1988, high mortality of gull chicks (all ages) occurred at Vizcaino Point during a study of the development of thermoregulation in gull chicks; in some areas 70% of chicks died possibly due to food shortage (Eppley and Bennett 1988). Based on adult gull specimens collected at San Nicolas Island in 1989, a genetics study confirmed the *L. o. wymani* subspecies with no hybridization with the *L. o. occidentalis* subspecies or Glaucous-winged Gulls (*L. glaucescens*) (Bell 1996).

In 1980-1990, at least 180 cats were removed which greatly reduced their numbers, likely to about 50-75 individuals (Table 3). In 1980, 110-130 fox were estimated for the island, reflecting some recovery since 1977-1978, but none were recorded on Vizcaino Point (Kovach and Dow 1981a,b). By 1984-1985, island fox numbers had largely recovered to 475-600 animals (Kovach 1985). In 1984, high fox densities were recorded for the western portion of San Nicolas Island (Grids #11 and #12) when large numbers of fox were first suspected of extensive depredation on Western Gull nests (Kovach and Dow 1985): (1) more than 40 gull eggshells were found at a natal den located slightly more than 1 km from the nearest part of the gull colony; (2) several widely-ranging marked foxes were captured both on the west end of the island (Grid #12) and other areas (Grids #8-11); and (3) fox tracks were noted between the gull colony and Grids #7 and #11. In 1985, 54% higher fox densities than in 1984 were found in Grid #12 and nocturnal fox observations were made on two nights on the edge of the gull colony to verify extensive fox use of this important prey resource (Kovach and Dow 1986:2-3):

“An observation point was established on a high point on the ridge that forms the inland border of the rookery [gull colony]. Using a 200,000 candle power hand held spotlight, a 300 m – 400 m length of the ridge was scanned for island fox activity starting 1 hour after dark and continued for approximately 2 hours. On both occasions, foxes were regularly observed crossing into and out of the rookery; at one time, 6 different foxes were observed along the ridge or in the rookery. Although the observation point allowed for an incomplete view of the rookery itself, our presence most likely had an influence on the foraging behavior of the island foxes observed; however, in each case where the prey item could be identified, observed prey items included eggs and very young gull chicks.”

Table 3. Numbers of cats removed from San Nicolas Island, California, in 1974-2011.

Date	Location	Number of Cats Removed	Source ¹
1974	Compound	2	UCSB (Laughrin 1978; L. Laughrin and W. Clark, unpubl. data)
1975-1976	No capture effort	0	L Laughrin (pers. comm.)
1977 (Dec)	Thousand Springs, NE terrace, theodolite-wells plateau	8	UCSB (Laughrin 1978)
1978-1979	Unknown	a few removed; details not available	R. Dow (pers. comm.)
1980 (Apr-Nov)	Island-wide	64	USN Environmental Division (Kovach and Dow 1981b)
1981 (Jan-Aug)	Island-wide	24	USN Environmental Division (Kovach and Dow 1983)
1982 – 1983 (Sep)	Island-wide	19	USN Environmental Division (Kovach and Dow 1983)
1983 (Oct) – 1984 (Dec)	Island-wide	20	USN Environmental Division (Kovach and Dow 1985)
1985 (Jan) – 1985 (Dec)	Island-wide	13	USN Environmental Division (Kovach and Dow 1986) ²
1986	Island-wide	16	USN Environmental Division (S. Kovach, pers. comm.)
1987	Island-wide	23	USN Environmental Division (S. Kovach, pers. comm.)
1988	No capture effort	0	USN Environmental Division (S. Kovach, pers. comm.)
1989	No capture effort	0	USN Environmental Division (S. Kovach, pers. comm.)
1990	No information available	1	USN Environmental Division (S. Kovach, pers. comm.)
1991-1993	No capture effort	0	T.W. Keeney and G. Smith (unpubl. data)
1994 (Jun) – 1995 (Jun)	Island-wide	55	USDA Animal Damage Control Archuleta (1996)
1995 (Sep) – 1996 (Sep)	Island-wide	21	USDA Animal Damage Control (Thomson 1997a)
1996 (Oct) – 1997 (Oct)	Island-wide	12	USDA Animal Damage Control (Thomson 1997b)
1998 (Jan-Mar)	Island-wide	8	USDA Animal Damage Control (Lyons 1998)
1999 (Dec)	Compound	1	USN Environmental Division
2000 (May-Oct)	Compound, Skyline Grid, Red Eye Grid	12 (8 kittens)	USN Environmental Division
2001 (spring)	Beach Rd at Reverse Osmosis Purification Unit	2 (1 kitten)	USN Environmental Division
2002 (Jan-Jul)	Compound, Red-Eye Grid, Beach Road, Skyline Grid	9	USN Environmental Division
2003 (Jul-Nov)	Skyline, Beach Rd at hairpin	2 (1 kitten)	USN/IWS – fox trapping (Schmidt and Garcelon 2004)
2004	No capture effort	0	G. Smith (unpubl. data)

2005 (Jun-Jul)	Red-Eye Grid	1	USN/IWS – fox trapping (Schmidt et al. 2006)
2006 (Jul-Aug)	Various locations; Surface Water/Tufts	15	USN/IC test study; USN Environmental Division (Hanson et al. 2010b)
2006 (Jul)	Three grids	none captured and removed	USN/IWS – fox trapping (Schmidt et al. 2007)
2007 (Sep-Oct)	Unknown fox grid	2	USN/IWS – fox trapping (Garcelon and Hudgens 2008)
2008 (Nov) – 2009 (Jan)	Various locations	7	USN-HSUS-IWS-IC-USFWS Pilot Program (Hendron 2010)
2009 (Jun-Nov)	Island-wide	57 (10 kittens)	IC/USN Hanson et al. (2010a,b)
2010	Island-wide	2	IC/USN Hanson and Bonham (2011)
2011	Island-wide	0	IC/USN Hanson (2012)
Total 1974-2011	-	396 (minimum)	This Study

¹ Source abbreviations: HSUS – Humane Society of the United States; IC – Island Conservation; IWS – Institute for Wildlife Studies; UCSB – University of California Santa Barbara; USDA – U.S. Dept. of Agriculture; USFWS – U.S. Fish and Wildlife Service; USN – U.S. Navy.

Further fox population recovery had occurred between 1985 and 1990, with 27 captured in Grid #12 in 1990 (Smith 1990; G. Smith, unpubl. data). Similar fox population levels occurred in 2000-2010 (536-801), with 47-80 fox estimated in the Vizcaino Red Eye area near Vizcaino Point (Schmidt et al. 2007; IWS, unpubl data). Fox predation on gull nests likely reached relatively high levels at Vizcaino Point in about 1982-1983, during the period of fox reoccupation of west end habitats, after great reduction or absence of about 5-8 years. By this time, the gull colony at Vizcaino Point had grown further and provided an abundant spring prey resource for fox. Very high fox densities by 1984-1985 also may have partly reflected the development of extensive annual depredation of gull eggs and chicks at the Vizcaino Point gull colony after 1980. Some human disturbance also likely continued in the 1980s, at least through use of the road to the point by security patrols. Impacts from military operations were not fully assessed but major impacts were not suspected.

1990s: The Vizcaino Point colony continued to grow, with a peak of 2,483 pairs estimated in 1993. Similar population sizes were estimated in 1991-1996, ranging from 1,994 to 2,483 pairs (Table 1), indicating a lack of continued increase in population size. Population size had increased 177% from 1968 to 1993. Using only numbers of nests with eggs or chicks, population size increased by 255% from about 600 in 1968 to about 2,131 in 1993. In 1991-1996, the colony had similar dimensions to 1968, about 250-300 m wide and about 2 km long. In 1996, the presence of California sea lions above the beach area was associated with loss of vegetation.

In 1992, a near lack of egg laying occurred in response to severe El Niño conditions and apparent low prey availability. Compared to 1976-1977, hatching success in 1993 had improved (53-88%) but fledging success was low (0-23%) likely related to continued El

Niño conditions and predation. Higher hatching success in 1993 and small numbers of supernormal clutches, crushed eggs, and dead-at-hatch embryos in 1993-1996 probably reflected reduced impacts from organochlorine pollutants compared to 1976-1977. Western Gull eggs averaged 5% thinner in 1992 than pre-1947 although some eggs were 10% or more thinner (Fry 1994, Kiff 1994). Most eggs that did not hatch were missing, suggesting predation. Four runt eggs were noted in three nests in 1993, likely related to environmental stress (e.g., poor prey availability) during El Niño conditions in 1993, although runt eggs also can be related to congenital defect or damaged female reproductive systems (Mulvihill 1987). While crushed, dead-at-hatch, and runt eggs were not recorded in 1968 and 1976-1977, we likely better detected rare occurrences through examining all nests in the colony in 1991-1996 rather than examining relatively small samples of nests in 1968 and 1976-1977.

Small numbers of cats (about 25-100 on the island and possibly 0-2 on Vizcaino Point) in 1991-1996 probably could not account for the rapid predation of 2,000-2,500 gull nests over a period of a few weeks each year at Vizcaino Point whereas the much larger numbers of fox in the Vizcaino Point area were much more consistent with the magnitude and speed of this massive annual predation event. By 1990, fox numbers on the island had largely recovered. In addition, some fox feeding continued by military personnel and contractors at least in 1992-1993 (T. Ames, pers. obs.), but these fox occurred primarily in the living compound area several kilometers from the gull colony. Fox predation apparently was extensive in the 1990s and cat predation likely was greatly reduced. Cat numbers on the island in 1991-1996 likely were low (about 25-100) based on: (1) low cat numbers (66) during final removal in 2008-2010; (2) extensive cat removals in 2005-2007 (18), 2000-2003 (25), and 1994-1999 (97); and (3) extensive cat removals in 1980-1990 (180) (Table 3). Some growth in cat numbers likely occurred between 1987 and 1994 when only one cat was removed because USN management efforts at this time had switched to focus on the concept of fence enclosures to stop island fox depredation on seabirds on major parts of Vizcaino Point which would provide long-term benefits for Western Gulls and Brandt's Cormorants (Carter and Gress 1994; T.W. Keeney, unpubl. data). Cat removals resumed in 1994 when USN management staff changed and Animal Damage Control (U.S. Department of Agriculture) was contracted; 96 cats were removed in 1994-1998 (Table 3). Most removals (76) occurred in 1994-1996 but almost all gull nests still were predated in 1996 (G. Smith, pers. obs.), further suggesting that fox were the primary if not only predator of gull nests. By 1999, the cat population again had been significantly reduced, possibly to about 25-60. The weight of the evidence suggested that fox were primarily responsible for observed mammalian depredation of gull nests and breeding failures at Vizcaino Point in 1991-1996. Peregrine Falcons and human disturbance caused only small impacts to the Point Vizcaino colony in 1991-1996. Maintenance of a large gull colony in the 1990s did not reflect poor local recruitment and likely reflected immigration. Substantial numbers of gulls also bred on the south side above large marine mammal areas.

Another USN activity that might have indirectly affected Western Gull numbers and reproduction on the island was the closure of the San Nicolas Island landfill in 1991-1992. Hundreds of gulls fed daily on refuse at the landfill. The landfill began in 1975 as

refuse disposal in a small narrow ravine and progressed to a trench cell operation covering about 5.7 acres by 1992. Use of refuse by gulls may reduce starvation during periods of prey shortage but also may lead to greater accidents leading to death and reduced survivorship (Spear et al. 1987). Many gulls may have depended on island refuse for food and possibly would have bred successfully during the 1992-1993 El Niño event, if it had been available. Mainland landfills were likely too far away for gulls breeding on San Nicolas Island to use regularly during the breeding season.

Decline of the Vizcaino Point colony (1996-2007)

Occupation of most of Vizcaino Point by California sea lions occurred gradually between 1996 and 2007, resulting in loss of vegetation and loss of suitable Western Gull nesting habitat in the northern section of the gull colony (Figures 1A, 2). Sea lion use of this part of Vizcaino Point increased dramatically after human disturbance was greatly reduced when: (1) Environmental Gate #3 at Dos Coves was installed in 1993 and the Vizcaino Point road closed during the gull nesting season and sea lion pupping season; (2) the northern end of the road was closed in 1996; and (3) the entire road was closed in about 1998. In July 1991, 2,174 California sea lions (live pups and nonpups) were counted between Dos Coves and Vizcaino Point; in July 2007, 8,205 sea lions were counted in the same area, an increase of 277% (Table 4). This major change in sea lion use of Vizcaino Point was a major reason for the reduction in the gull colony to 955 pairs in 2007, a decline of 62% since the peak in 1993. To further verify the general degree of decline, we also compared the numbers of gull nests with eggs and chicks in 1993 (2,131) to the numbers of nests or sites attended by adults in aerial photographs in 2007 (955), which resulted in a 34% decline over this period. However, the lack of data for the south section of the gull colony in 2007 may greatly affect this comparison, especially if gulls moved from the north section to the south section. Data from 2008 were not used for comparison to previous data because nesting numbers were much lower than 2007 and may have reflected poor conditions.

In addition to sea lion impacts, we believe that the Vizcaino Point gull colony likely was beginning to decline by 1996 due to annual high nest depredation, breeding failures, and low local recruitment. These conditions began in the mid 1980s and by the 1991-1995 period had led to a halt to population increase, with little change noted in population size between 1991 and 1995 (range = 2,348-2,483 pairs). However, in 1996, population size dropped by 15% to 1,994 pairs. This drop partly reflected loss of some nesting areas near the shoreline due to initial sea lion use but also appeared to reflect some reduction of nests in other areas. We suspect that immigration of gulls hatched at other increasing colonies in the Channel Islands (Carter et al. 1992, Capitolo et al. 2008a) also had occurred during the 1960s to 1990s to take advantage of abundant marine mammal carcass and after birth prey at Vizcaino Point and at other parts of San Nicolas Island. Immigration probably allowed the gull population to remain at relatively high levels despite high fox impacts until after 1996 when sea lions impacted most of the northern part of Vizcaino Point.

Table 4. Numbers of California sea lions counted in July between Rock Crusher and Vizcaino Point, San Nicolas Island, California, in 1991-2011 (M. Lowry, National Marine Fisheries Service, unpubl data).

Year	Total Live - Pups and NonPups
1991	2174
1992	1935
1993	4115
1994	3711
1995	5063
1996	5475
1997	5557
1998	3520
1999	6363
2000	7124
2001	7607
2002	5541
2003	5759
2004	7655
2005	8599
2006	9461
2007	8205
2008	9967
2011	8843

Extensive fox predation on remaining gull nests likely continued through the 2000s, with a stable and relatively high fox population on San Nicolas Island in 2000-2010; during this period, 536-801 were estimated island-wide and 47-80 were estimated in the Vizcaino Redeye grid near the gull colony (Schmidt et al. 2007; IWS, unpubl. data). Fox feeding seemed to stop completely in the 1990s, after a USN educational program was focused on this issue and many signs were posted in the compound but has resumed in the living compound during recent years. Some cat depredation of gull nests may have occurred because cats were removed from the Vizcaino Red Eye area in 2000, 2002, 2005 and 2009 (Table 3) which indicated cat presence near the dwindling gull colony; however, extensive cat removals, mainly during fox trapping, also had occurred in 2000-2003 (25) and 2005-2007 (18) (Table 3) which likely prevented recovery of the reduced cat population (25-60) in 2000-2007. By the mid 2000s, we suspect that reduced levels of organochlorine pollutants were no longer affecting reproduction for most gulls breeding at San Nicolas Island, although some individuals may still be affected as found in some other seabird species (Carter et al. 2008).

By 2008, gull nesting on the south side was still occurring and numbers may have been larger or the same as in the 1990s but without a complete survey of the south side, we cannot better assess changes since the 1990s. Recent nesting by small numbers of gulls in 2007-2008 at Coast Guard Beach on the north side was associated with artificial nesting

habitat (i.e., the berm and brine pond) but also may reflect gulls displaced from Vizcaino Point or the south side. In 2009, a minimum of six nests, including two large chicks, were noted on the berm on 7 June during cat removals (G. Smith, unpubl. data). In 2010, 10-20 nests were noted on the berm on 10 June and 24 June (G. Smith, unpubl. data). One or two nests also have been seen occasionally on the rock at the mouth of Pirate's Cove in the last decade but notes could not be found (G. Smith, unpubl. data). Recent nesting on the north side indicates an important need to resurvey the entire north side to determine if greater nesting is now occurring in this area than in the 1990s.

Final Thoughts

This summary of information about the breeding population of Western Gulls at San Nicolas Island in 1850-2008 has indicated impacts from human disturbance, organochlorine pollutants, El Niño conditions, island fox predation, feral cat predation, expanding marine mammal populations, and Peregrine Falcon predation. We suspect that cat predation was a significant impact between 1974 and 1980 (when the cat population was relatively high — about 160-255 individuals in 1980) but had a lower impact from 1981 to 2008 (when cat numbers were relatively low — about 25-100 individuals) and few occurred or were suspected to occur on Vizcaino Point. Cat impacts prior to 1974 also likely were low due to a small cat population that did not extend over the entire island but cats did appear to occur at Vizcaino Point by the 1960s. We believe that immediate benefits to the Western Gull population from cat removal in 2008-2010 likely have been relatively low because cat impacts were quite low at this time.

Future benefits for gulls related to cat removal at San Nicolas Island in 2008-2010 may be relatively high, through prevention of future depredation of gull eggs, especially if: (1) cat removals did not occur in the future or removal efforts were not effective and cat numbers regrew to high levels; (2) the fox population crashed and the cat population regrew to relatively high levels; and (3) the future gull population occurred mainly in certain areas that are highly accessible to cats. To guarantee potential future benefits from cat removal, efforts are being made by the USN and Montrose Settlements Trustee Council to prevent reintroductions and conduct rapid removals if reintroduction is detected to prevent redevelopment of a feral cat population on San Nicolas Island.

The San Nicolas Island gull population also is not likely to regrow to 1991-1996 levels because extensive fox depredation and sea lion impacts continue. Peak population size and nesting distribution of Western Gulls at San Nicolas Island in the early 1990s likely was a temporary condition caused by: (1) low but increasing sea lion numbers (i.e., recovering from overhunting mainly in the 19th century) that provided carcass and after birth prey for gulls at Vizcaino Point; (2) low fox numbers and low gull nest depredation in 1974-1982; and (3) increasing gull populations and breeding success in the Channel Islands (recovering from impacts related mainly to organochlorine pollution and human disturbance) may have encouraged immigration.

After the successful removal of all cats in 2008-2010, the chief remaining factors impacting Western Gulls are availability of prey resources, changes in nesting habitats

and displacement by marine mammals on Vizcaino Point and the south side, fox predation, and Peregrine Falcon predation. Two pairs of Peregrine Falcons were recently found breeding at San Nicolas Island in 2013 and may have a greater impact on gulls in the future. Historical breeding was not recorded (Willett 1933; Kiff 1980). If current restoration efforts at Santa Catalina Island and Santa Cruz Island are successful, Bald Eagles (*Haliaeetus leucocephalus*) may eventually breed at San Nicolas Island and also impact gulls; historical breeding at San Nicolas Island was recorded in 1945 (Rett 1947).

Periodic monitoring of Western Gulls is needed to assess future population changes. With much larger populations of marine mammals in most coastal areas on Vizcaino Point and on the south side, complete aerial surveys of both areas are needed to assess future population changes for San Nicolas Island. Future aerial surveys should aim to include all south side shoreline areas and allow for approximately 90 minutes of total San Nicolas Island survey time. The sinuous coastline will require many flight passes and re-approaches. Gull colonies at San Nicolas Island are inconspicuous from the air due to low nest densities and lack of contrast with the sandy substrate. Photographs of the entire shoreline of Vizcaino Point and the south side will be needed for complete coverage. Ground surveys should be conducted along the north side of the island because counts can be conducted in this area with little disturbance to marine mammals and ground surveys would be less costly than aerial surveys.

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Appendix 1. Photographs of Vizcaino Point from Western Gull blinds.

On 6 April 1993, a series of eight overlapping photographs were taken from both the Point Blind and the Stonehenge Blind to document breeding habitats and assist nest monitoring. In Figures A1-1 to A1-8, the westerly view from the Point Blind is presented from the far left in photo #1 (south) to the far right in photo #8 (north). In Figures A1-9 to A1-16, the westerly view from the Stonehenge Blind is presented from the far left in photo #1 (south) to the far right in photo #8 (north).



Figure A1-1. View from the Point Blind (photo #1).



Figure A1-2. View from the Point Blind (photo #2).



Figure A1-3. View from the Point Blind (photo #3).



Figure A1-4. View from the Point Blind (photo #4).



Figure A1-5. View from the Point Blind (photo #5).



Figure A1-6. View from the Point Blind (photo #6).



Figure A1-7. View from the Point Blind (photo #7).



Figure A1-8. View from the Point Blind (photo #8).



Figure A1-9. Stonehenge Blind view (photo #1).



Figure A1-10. Stonehenge Blind view (photo #2).



Figure A1-11. Stonehenge Blind view (photo #3).



Figure A1-12. Stonehenge Blind view (photo #4).



Figure A1-13. Stonehenge Blind view (photo #5).



Figure A1-14. Stonehenge Blind view (photo #6).



Figure A1-15. Stonehenge Blind view (photo #7).



Figure A1-16. Stonehenge Blind view (photo #8).

Appendix 2. Western Gull nest survey (n = 3,003 nests) at San Nicolas Island in 1991.

Nest Category	Vizcaino Point South (Point to Dos Coves)	Vizcaino Point East	Thousand Springs & Light Point West	Cormorant Rock Area	Elephant Seal Beach Area	Dutch Harbor Area
Scrapes & Empty Nests	1,295	0	0	0	7	0
Nests with Eggs/SIN	1,524	0	1	85	20	3
Hatching Nests	0	0	0	0	0	0
Nests with chicks	0	0	0	0	0	0
Unknown Nests/Sites	0	0	2	65	1	0
Total Nests	2,819	0	3	150	28	3

Appendix 3. Western Gull nest survey (n = 2,867 nests) at San Nicolas Island in 1993.

Nest Category	Vizcaino Point South (Point to Dos Coves)	Vizcaino Point East	Cormorant Rock Area	Elephant Seal Beach Area	Dutch Harbor Area
Scrape	141	0	8	2	0
Empty Nests	441	0	27	5	2
Nests with Eggs	1,699	2	21	31	0
Hatching Nests	253	0	1	0	0
Nests with chicks	175	0	9	1	0
Unknown Nests	0	2	45	2	0
Total Nests	2,709	4	111	41	2

Appendix 4. Western Gull nest survey (n = 3,299 nests) at San Nicolas Island in 1994.

Nest Category	Vizcaino Point South (Point to Dos Coves)	Vizcaino Point East	Cormorant Rock Area	Elephant Seal Beach Area	Dutch Harbor Area
Scrapes	ND	0	1	0	NS
Empty Nests	ND	0	7	0	NS
Nests with eggs/SIN	ND	0	91	43	NS
Hatching nests	ND	0	0	0	NS
Nests with Chicks	ND	0	0	0	NS
Unknown Nests/Sites	ND	0	12	8	NS
Total Nests	3,137	0	111	51	NS

Appendix 5. Western Gull nest survey (n = 2,945 nests) at San Nicolas Island in 1995.

Nest Category	Vizcaino Point South (Point to Dos Coves)	Vizcaino Point East	Cormorant Rock Area	Elephant Seal Beach Area	Dutch Harbor Area
Scrapes	436	0	1	0	0
Empty Nests	1,203	0	0	0	0
Nests with eggs/SIN	1,003	0	89	24	0
Hatching nests	118	0	0	0	0
Nests with Chicks	62	0	2	0	0
Unknown Nests/Sites	3	0	1	3	0
Total Nests	2,825	0	93	27	0

Appendix 6. Western Gull nest survey (n = 2,619-2,629 nests) at San Nicolas Island in 1996.

Nest Category	Vizcaino Point South (Point to Dos Coves)	Vizcaino Point East	Cormorant Rock Area	Elephant Seal Beach Area	Dutch Harbor Area
Scrapes	686	ND	0	0	0
Empty Nests	1,326	ND	0	0	0
Nests with eggs/SIN	375	ND	47	48	4
Hatching nests	10	ND	0	0	0
Nests with Chicks	6	ND	0	0	0
Unknown Nests/Sites	113-123	ND	0	4	0
Total Nests	2,516-2,526	ND	47	52	4

Appendix 7. Status of Western Gulls at San Nicolas Island, 1850-2008. Codes: RD, Ron Dow; GS, Grace Smith; and TK, Thomas Keeney.

- 1850-1851:** “Sea-gulls” noted in winter by Jeffries (Hardacre 1880).
- 1852:** Nidever and Jeffries travel to island to harvest sea-gull eggs and search for lone woman; no eggs were collected (Ellison 1984).
- 1863:** Occurrence of Western Gulls noted (Cooper 1870).
- 1886:** Western Gulls noted in fall (Streator 1888).
- 1891:** Western Gull eggs collected on 3 June by T. Shooter (MVZ #2110; Hunt et al. 1979).
- 1897:** Breeding by Western Gulls noted (Grinnell 1897).
- 1902:** Fishermen were stranded and ate gulls (Doran 1980).
- 1909:** Nesting gulls noted on 4 July (Robertson 1910).
- 1912-1944:** Breeding noted on all Channel Islands (Willett 1912; Grinnell 1915; Howell 1917; Willett 1933; Grinnell and Miller 1944).
- 1945:** Nesting reported at Thousand Springs based on old nests found in September (Rett 1947).
- 1951:** Western Gull eggs collected by L.R. Howsley (WFVZ #103,265-103,269).
- 1962-1963:** Western Gulls bred at Vizcaino Point; more than 600 downy young were present in 1963 (Townsend 1968).
- 1960s:** A few gulls were shot at the landfill (RD).
- 1967:** 3,000 pairs of Western Gulls estimated at Vizcaino Point on 20-21 July, based on large numbers of fledglings (DeLong 1967).
- 1968:** Survey and reproductive success were examined by the Smithsonian Institution (Schreiber 1968, 1970). Low hatching success and supernormal clutches noted, indicating organochlorine pollution. Eggs collected by R.W. Schreiber (WVZ #160,721).
- 1974:** Breeding noted at the west end by L. Jones (Hunt et al. 1979).
- 1975-1977:** Surveys, reproductive success and prey examined by the University of California Irvine (Hunt et al. 1979). Moderate hatching success and only one supernormal clutch noted, indicating reduced impacts from organochlorine pollutants.
- 1977-1978:** Landfill closed in 1977-1978; gulls heavily visited the landfill beforehand.
- 1979:** Heat tolerance in gull embryos and hatchlings was studied by the University of Michigan and University of California Irvine (Bennett et al. 1981; Dawson and Bennett 1981).
- 1980:** Eggs collected by R.W. Schreiber (WFVZ #117,686).
- 1980s:** B. Stewart conducted annual gull surveys (RD) but data were not available for this report.
- 1983-1984:** Poor gull reproductive success was noted at Vizcaino Point during a major El Niño event (RD).
- 1984:** Area closures began for marine mammal haul out and seabird breeding areas (RD).
- 1988:** Development of thermoregulation in gull chicks studied by the University of California Irvine (Eppley and Bennett 1988). High mortality of gull chicks (all ages) on the west end; 70% of chicks died possibly due to food shortage.
- 1989:** Ten adult gulls (WFVZ #172,475-172,484) were collected by D.A. Bell (University of California Berkeley) for genetics study (Bell 1996). Gulls bred successfully (RD).
- 1990:** Gulls failed (TK).
- 1991:** Ground surveys conducted by Humboldt State University (Carter et al. 1992; this study). Nest failure occurred after the survey (TWK).
- 1992-1993:** Island landfill capped in 1992-1993; prior to this, hundreds of gulls used the dump regularly (RD). Surveys and reproductive success examined by Humboldt State University and the U.S. Navy (this study). Moderate to high hatching success and few supernormal clutches indicated reduced impacts from organochlorine pollutants. Environmental Gate #3 at Dos Coves was established in 1993 to reduce human disturbance of marine mammals and breeding seabirds at Vizcaino Point.
- 1994-1996:** Surveys conducted by Humboldt State University and USN (this study). Nest failure occurred after surveys (GS). Eggshells collected in 1995 by H.R. Carter (WFVZ #180,773-180,779).
- 1996-1998:** The Vizcaino Point road (between Environmental Gate #3 at Dos Coves and Vizcaino Point) was partly closed in 1996 and fully closed by 1998. California sea lions gradually occupied most of the upper slopes at Vizcaino Point starting in 1996.
- 2007-2008:** Aerial surveys conducted by the University of California Santa Cruz (this study).

Appendix 8: Timelines of human activities on San Nicolas Island, 1602-1970 (sources: Hardacre 1880, Doran 1980, Ellison 1984; S. Schwartz, R. Dow, and W. Townsend, pers. comm.).

- 1602:** Captain Sebastian Vizcaino sighted the island. Large numbers of Nicoleños occupied the island.
- 1811:** A group of 30 Kodiaks lived on the island for a year and killed most male Nicoleños.
- 1815:** A group of Aleuts lived on the island.
- 1835:** 17-18 remaining Nicoleños removed and taken to mainland missions; the lone woman was left behind.
- 1848:** San Nicolas Island became part of the United States of America through the Treaty of Guadalupe Hildago after the U.S.-Mexico War (1846-1848).
- 1850-1853:** Several trips to find the lone woman; she was found (along with feral dogs) in June 1853 and removed from the island.
- 1853-1856:** First sheep and pig ranching at Coral Harbor. Feral dogs noted.
- 1860s:** Ranches occurred at Coral Harbor, Jeheny Beach and NAVFAC on the east side of San Nicolas Island.
- 1864-1866:** Bad drought and island turned into a desert after sheep ate vegetation.
- 1867:** The Lighthouse Bureau reserved 22 acres on the SW point and SE point of the island.
- 1869-1870:** Second bad drought resulted in removal of most sheep from the island but 400 left behind. Sheep interests sold.
- 1875:** Shumacher archaeological expedition (Smithsonian Institution). No birds collected at San Nicolas Island.
- 1877-1878:** deCessac archaeological expedition (French government). No birds collected at San Nicolas Island.
- 1860s to 1900:** Some private homesteading occurred but not formalized.
- 1886:** Parcels of land were for sale (Doran 1980).
- 1890s:** Sheep ranching occurring at the SE end of the island.
- 1900-1901:** Unauthorized sheep ranching was found and entire island was reserved.
- 1901:** Sheep ranching at E end.
- 1902:** Fishermen were stranded and ate gulls.
- 1919:** Vail leased land for sheep ranching.
- 1920s:** A sheep fence was placed across the island and sheep grazed the south end.
- 1924-1926:** Drought years.
- 1920s-1930s:** 1500 sheep. Brooks ranch established NE of NAVFAC.
- 1933:** USN ownership established, used mainly for aircraft carrier operations off southern California coast.
- 1934:** Sheep leases expired. Two navigational lights established at the SE end.
- 1939:** Two more navigational lights established at the SE end.
- 1942-1943:** U.S. Army temporarily occupied island, built another airfield, but then abandoned the island.
- 1944:** USN took over the airfield for training purposes.
- 1947:** Point Mugu Naval Air Station took over control of the island. All sheep were removed.
- 1951:** The road network was expanded.
- 1956:** No roads on Vizcaino Point.
- 1957:** The runway was expanded and paved. A more extensive road system established around the island for security purposes.
- 1962:** Bomber area at Vizcaino Point was temporarily used as a practice aerial bombing target.
- 1962-1964:** The entire coastline of San Nicolas Island was accessible by jeep trails.
- 1964:** The south side road became impossible and the theodolite road was put in.
- Late 1960s:** Targets were set up on the island for missile guidance testing. NW portion of island designated as a ground hazard area due to bomb drops and low-altitude flybys.

Appendix 9. Whole-colony counts of Brandt's Cormorant nests, sites, and birds at San Nicolas Island in 2008 (P.J. Capitolo, unpubl. data).

Colony	USFWSCN	Date	Time (PDT)	Nest Categories ¹						Totals		
				X	C	P	A	E	B	Nests	Sites	Birds
Vizcaino Point	325-048	5/20/08	1206-1242	1,459	5	277	0	0	0	1,741	457	2,554
White Bluffs	524-068	5/20/08	1155	9	19	0	0	0	0	28	18	104
Dutch Harbor Area	524-026	5/20/08	1158	296	0	241	0	0	0	537	152	792
Cormorant Rock Area	524-028	4/21/08	1515	601	0	45	2	21	0	669	58	820
San Nicolas Island Total				2,365	24	563	2	21	0	2,975	685	4,270

¹Nest categories: X=well-built nest; C=nest with chicks evident; P=poorly-built nest; E=empty nest (i.e., egg-laying apparently imminent); A=abandoned nest (i.e., unattended by an adult); B=brood of chicks away from an obvious associated nest structure.

Summary

With funding from the Montrose Settlements Trustee Council, Brandt's Cormorants were counted in 2008 aerial photographs during counting of Western Gulls at Vizcaino Point because of partial overlap of nesting distributions. Other Brandt's Cormorant breeding colonies at San Nicolas Island were counted later through other projects. Using data from 2005-2007 (Capitolo et al. 2008b), we assessed major changes in 2008 as follow. The total number of Brandt's Cormorant nests at San Nicolas Island in 2008 was 23% lower than in 2007. Numbers at Vizcaino Point, the largest colony, were 48% lower in 2008. During the 2005-2007 period, cormorant nest totals were highest in 2006, with more than 5,000 nests counted island-wide, including 3,154 nests at Vizcaino Point. Counts in 2008 were similar to those in 2005. In 2009, breeding by Brandt's Cormorants was first noted at Thousand Springs Area and Elephant Seal Beach Area (Capitolo et al. 2010). These areas were examined during aerial surveys in 2008 but nesting Brandt's Cormorants were not noted.