PEREGRINE FALCON MONITORING ON THE CALIFORNIA CHANNEL ISLANDS, CALIFORNIA, 2019

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INTRODUCTION

American peregrine falcons (*Falco peregrinus anatum*; hereafter peregrines)ally were common residents on all the California Channel Islands (Willett 1912, Howell 1917, Kiff 1980), although the highest number of reported nests in a single year was 15 (Kiff 1980, 2000). Because peregrines and their nests are less conspicuous to casual observers than are other raptors historically found on the Channel Islands, such as bald eagles (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*), historical estimates of the number of peregrines on the islands were almost certainly too low (Kiff 1980) and could have been 30 or more pairs (Hunt 1994).

Peregrine numbers plummeted across much of the northern hemisphere starting in the late 1940s (Hickey and Anderson 1969). Peregrines were at their lowest numbers in the 1960s and early 1970s, at which time they were extirpated from the eastern United States and across the Midwest and reduced to a few hundred pairs in the western United States and Mexico (U.S. Fish and Wildlife Service 2003). Approximately 100 peregrine eyries in California were producing young each year until at least the mid-1940s, with more than a third of the verified or suspected peregrine nest sites occurring within 10 miles of the ocean, including the Channel Islands (Herman et al. 1970). By 1970, the number of breeding peregrines had dropped by at least 95% in California (Herman et al. 1970, Herman 1971). It appears that nests along the southern coast suffered the earliest reductions and the peregrine population on the Channel Islands was drastically reduced or extirpated by 1955 (Herman et al. 1970), with the last reported sighting of a probable Channel Islands breeding adult occurring on Anacapa Island in 1949 (Kiff 1980).

Overwhelming evidence indicated that declines in peregrines and other bird species feeding higher on the food chain were a result of the effects of DDE, a metabolite of DDT, on egg hatchability (Kiff 1980, Mesta 1999, Kiff 2000). The apparent source of the DDT pollution in the Southern California Bight was eventually traced to the Montrose Chemical Corporation's manufacturing plant in Torrance, California. Between 1947 and 1961, an estimated 37 to 53 million liters of DDT-contaminated acid sludge, containing 348-696 metric tons of DDT, was disposed at an ocean dump site 16 km northwest of Catalina Island (Chartrand et al. 1985). In addition, an estimated 1800 metric tons of DDT was discharged from the Joint Water Pollution Control Plant outfall, 3.3 km offshore of Palos Verdes Peninsula (Chartrand et al. 1985).

Peregrines were listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, and later under the Endangered Species Act of 1973 (Mesta 1999). Populations

rebounded following restrictions on the use of organochlorine pesticides in Canada and the United States (banned in 1970 and 1972, respectively) and successful management activities, including the reintroduction of captive-bred and relocated peregrines (Mesta 1999). Between 1983 and 1998, the Santa Cruz Predatory Bird Research Group (SCPBRG) released 37 peregrines on the Channel Islands (12 on San Miguel, 17 on Catalina, 4 on Santa Rosa, and 4 on Santa Cruz; Latta 2012). The first pairs with young were seen on Anacapa and Santa Cruz islands in 1989 and 1990, respectively (Hunt 1994). During a 1992 survey, Hunt (1994) located 9 active eyries on 4 of the Channel Islands. Peregrines were removed from the Endangered Species list in 1999, at which time breeding targets for the Channel Islands (5 pairs) and the Pacific Coast (185 pairs) had been greatly exceeded (Mesta 1999). Ten years later, peregrines were removed from the State of California's list of Endangered and Threatened Animals (California Department of Fish and Game 2011).

After a successful lawsuit against Montrose Chemical et al. for damage caused by the release of DDTs and PCBs into the Southern California Bight, the Montrose Settlements Restoration Program (MSRP) was created to implement restoration projects aimed at restoring natural resources that were directly or indirectly harmed by DDT and PCB contamination. The final consent decree for the Montrose case stated that "the Trustees will use the damages for restoration of injured natural resources, including bald eagles, peregrines and other marine birds, fish and the habitats upon which they depend" (Montrose Settlements Restoration Program 2012). The Montrose Settlements Trustee Council (MSTC) was created to oversee the settlement monies and is composed of representatives of Federal and State agencies that have interests in the Southern California Bight: National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), California Department of Fish and Wildlife (CDFW), California State Lands Commission, and the California Department of Parks and Recreation.

Since the conclusion of peregrine survey efforts in the early 1990s, there were limited surveys conducted on the Channel Islands and the distribution and extent of breeding pairs was not known. Under Phase 1 of MSRP's Restoration Plan, the MSTC contracted with the SCPBRG to conduct a peregrine falcon survey and monitoring project in 2007. The goal of that monitoring effort was to assess the current status of peregrines on the Channel Islands and determine whether their recovery was still being affected by on-going contamination in the local food web

(Montrose Settlements Restoration Program 2005). The 2007 survey located 27 occupied territories on 5 of the 8 islands, but also found that DDE contamination still appeared to be reducing peregrine falcon reproductive success (Latta 2012).

Under Phase 2 of the MSRP Restoration Plan, peregrine surveys were to be conducted at 5-year intervals (Montrose Settlements Restoration Program 2012), although the survey scheduled for 2012 was delayed until 2013. After the Institute for Wildlife Studies (IWS) conducted surveys on all 8 Channel Islands in 2013, the MSTC agreed to our proposal to conduct annual surveys through 2017 to gain more information on population demography and important population parameters, such as survival, immigration and emigration. As part of that effort, IWS located 45 occupied territories in 2013, 48 in 2014, 48 in 2015, 46 in 2016, 51 in 2017, and 38 in 2018 with at least 2 territories on each island (Sharpe 2014, 2015, 2016, 2017, 2018; Sharpe and Melling 2018). During 2019, we conducted surveys and monitoring on a subsample of the islands due to funding and personnel cuts. This report summarizes the results of the 2019 field season.

STUDY AREA

The California Channel Islands are composed of eight islands located off the coast of southern California (Fig. 1). All of the Channel Islands are subject to a Mediterranean climate regime characterized by cool, wet winters and warm, dry summers (Coonan and Schwemm 2009). The northern Channel Islands, which are composed of San Miguel Island, Santa Rosa Island, Santa Cruz Island, and Anacapa Island are located approximately 20 to 44 km off the coast of Ventura and Santa Barbara counties (Junak et al. 1995) and are a tightly clustered group with no more than 9.6 km separating adjacent islands (Moody 2000; Fig. 1). The southern Channel Islands, which are composed of San Nicolas Island, Santa Barbara Island, Santa Catalina Island, and San Clemente Island, are located 32-79 km from the mainland (Junak et al. 1995) and are more remote and scattered than the northern islands, with the closest islands (Santa

Figure 1. California Channel Islands located off the coast of southern California, USA.

Catalina and San Clemente Islands) separated by 34 km (Moody 2000; Fig. 1). We did not survey San Miguel or Santa Barbara islands in 2019.

Santa Rosa Island (hereafter Santa Rosa) is the second largest of the Channel Islands and is owned by the NPS (Fig. 1). The island is approximately 24 x 16 km and encompasses about 217 km^2 with a central mountain range reaching an elevation of approximately 475 m (Junak et al. 1995, Rick 2009). The central highland is dissected by drainages; a relatively gentle marine terrace occurs north of the highland, whereas steep, deeply incised drainages comprise much of the south portion of the island (Coonan and Schwemm 2009).

Santa Cruz Island (hereafter Santa Cruz) is the largest of the 8 Channel Islands and is owned by the NPS (eastern 24% of the island) and The Nature Conservancy (TNC; western 76% of the island). The island measures about 38 km long by 12 km wide at its widest point (Fig. 1), encompassing approximately 249 km^2 with a maximum elevation of 753 m (Junak et al. 1995).

Anacapa Island (hereafter Anacapa), which is composed of 3 islets (East, Middle, and West Anacapa; Fig. 1) is owned by the NPS. The island encompasses approximately 2.8 km^2, spanning about 8 km from end to end and reaching a maximum elevation of 283 m (Junak et al. 1995).

San Nicolas Island (hereafter San Nicolas), owned by the U.S. Navy, is the most remote of the Channel Islands. It is located 98 km from the mainland (Junak et al. 1995) and 45 km from its nearest neighbor, Santa Barbara Island (Moody 2000; Fig. 1). It is approximately 13 x 5 km in size and has an area of about 58 km^2 and a maximum elevation of 277 m (Junak et al. 1995).

Santa Catalina Island (hereafter Catalina), located 34 km south of Long Beach, California, is owned primarily by the Santa Catalina Island Conservancy (~90%). The island is 34 km long, 0.8 to 13.0 km wide, and has an area of 194 km^2, 80 km of coastline, and maximum elevation of 648 m (Junak et al. 1995; Fig. 1).

San Clemente Island (hereafter San Clemente), owned by the U.S. Navy, is the southernmost of the Channel Islands, located approximately 92 km off the coast of California (Fig. 1). The island is 143 km^2, about 34 km long, and has a high point of 610 m (Willey 1997). It is characterized by a series of marine terraces on the west side and a steep escarpment on the east side (Kaiser et al. 2009).

METHODS

Permitting

Our peregrine research activities were covered by multiple state and federal permits. IWS has a Memorandum of Understanding and Scientific Collecting Permits (Permit #s SC-2485 [Peter Sharpe] and SC-0932 [David Garcelon]) with the CDFW to conduct peregrine research on the Channel Islands, a banding permit (# 21564) from the United States Geological Survey's Bird Banding Laboratory (BBL) allowing us to band peregrines with both federal and auxiliary leg bands and draw blood, and a research permit from the Catalina Island Conservancy (Permit 12-014). Our Migratory Bird Treaty Act permit (#MB95076A-0) allowed us to collect feathers, failed eggs, and eggshells at nests.

Survey Method

We used a survey method similar to that used by the National Park Units in the Northern Colorado Plateau Network (NCPN), as described by Daw et al. (2006). The protocol involved monitoring potential nesting areas for up to 4 hours, normally the maximum time between eyrie visits/exchanges at the ledge (Daw et al. 2006), with a minimum of 3 visits to each known

territory between February and June. The NCPN protocol allows for the use of recorded vocalizations to elicit vocal or behavioral responses from territorial birds, which has been found to increase the likelihood of detection and decrease the amount of time required to detect many bird species (Johnson et al. 1981, Anderson 2007, Barnes et al. 2012). Although call-broadcast surveys have typically been used for forest-dwelling raptors (Kimmel and Yahner 1990, Watson et al. 1999), they have also been used for non-forest raptors (Balding and Dibble 1984).

The call-broadcast technique we incorporated into our survey protocol was developed by Barnes et al. (2012) to survey for peregrines in the Lake Mead National Recreation Area. The 10-minute survey protocol begins with a 3-min passive observation period, followed by a 30-sec broadcast period, a 1-min observation period, a second 30-sec broadcast period, and a final 5-min passive observation period. We loaded recorded peregrine vocalizations (Stokes Field Guide to Bird Songs: Western Region; Time Warner Trade Publishing, New York, NY), which were converted to mp3 format to be compatible with a digital game caller, to a FOXPRO NX4 game caller (FOXPRO Inc., Lewiston, PA). The vocalizations consisted of 5 sec of the 'cack' alarm call, immediately followed by 10 sec of the 'eechup' call from an adult female peregrine (described in Linthicum 1996), which were looped to produce 30 sec of continuous calling. During the call-broadcast a surveyor rotated up to 360° (depending on terrain, habitat, and broadcast location) in order to evenly project the sound around the broadcast point and the broadcast was discontinued immediately when a responding peregrine was detected.

We used the 4-hr passive observation and/or the 10-min call-broadcast protocol, depending on where and when we were conducting the survey, as described below. We did not conduct surveys or monitoring during periods of heavy rain, heavy fog, or severe cold. The general protocol called for not conducting surveys or monitoring during periods of sustained high winds greater than 25 km/h (~15 miles/hour). However, the Channel Islands can have long periods of high winds, which would have made it impossible to conduct any surveys for a week or more. Therefore, when there were high winds we attempted to conduct most surveys/monitoring on leeward sides of the islands.

Surveying Historical Nesting Areas

IWS biologists began surveying territories for activity in February 2019. All territory locations on the Channel Islands that had been confirmed during our 2013-2018 surveys (Sharpe

2014, 2015, 2016, 2017, 2018; Sharpe and Melling 2018) were uploaded into Garmin eTrex 20 GPS units (Garmin International Inc., Olathe, KS) to assist in locating the known territories on each island. We added satellite imagery (BirdsEye Satellite Imagery™, available through Garmin Basecamp™) onto each GPS unit for ease of orienting in relation to geographic features.

Initial surveys at each historical territory generally included a 10-min call-broadcast survey, followed by up to 4 hours of passive observations if no peregrines were detected. If any peregrines were detected, we would return at approximately 1-month intervals for further monitoring (see Monitoring Active Territories below). If no pair was detected, we usually returned at least 2 more times at approximately 1-month intervals to verify that the territory was inactive.

Surveying for New/Unknown Territories

We used the 10-min call-broadcast method to conduct ground-based and boat surveys for new or unknown peregrine territories on the islands. Although peregrine habitat typically contains tall cliffs (50+ m) to serve as perching and nesting sites (Johnsgard 1990), we did not assume that those were the only places that peregrines would nest on the islands. In other studies, peregrines have been found nesting on the ground (Hickey and Anderson 1969, Pagel et al. 2010) and in tree nests of other raptors and in tree cavities (Campbell et al. 1977). Because peregrine nests have historically been found far inland in canyons on Santa Rosa (Pemberton 1928), we surveyed for peregrines both along the coastal bluffs and cliffs and in interior portions of the islands. Call-broadcast locations during a single day were generally ~1 km apart, although they could be more closely spaced if required for adequate coverage in areas of high topographic relief that may have minimized the distance at which the broadcast could be heard by peregrines (e.g., opposite sides of a steep ridge, along a coastline with many harbors or prominent points) or where ocean noise impacted our ability to hear responding peregrines. We used GPS units to record our daily survey routes, call-broadcast locations, and sightings of peregrines. While the amount of exploratory surveys for new territories has been reduced due to lack of funding, we were able to locate several previously undocumented peregrine territories this season.

Monitoring Active Territories

We attempted to visit occupied territories at monthly intervals to estimate the chronology of the breeding season. We used photographs and descriptions of chick development in Clum et al. (1996) and Moritsch (1983) to refine estimates of lay and hatch dates using an incubation period of 33 days (Linthicum 1996). We only used the 10-min call-broadcast about 1 time per month at active territories, if needed, to minimize the chance that the birds would become acclimatized to the recorded vocalizations. We observed peregrines and potential or known nest sites from a distance of 150-1500 m using 20-60x spotting scopes and binoculars. Distances to peregrines or nest sites were estimated using a distance measuring function on our GPS units.

On each visit to an active territory we recorded data on weather conditions, time, observer location, peregrines observed, and behavior of any adult and chicks. To standardize behavioral observations made during these visits, we used the definitions and descriptions in Linthicum (1996). For most territories with chicks, we made our last visits when chicks were $\geq$28 days of age to determine success (see Terminology below).

Nest Entry and Banding

We entered active nests when the chicks were approximately 21-28 days of age. The recommended age range for banding nestlings is 21-35 days (Heinrich 1996), but we lowered the upper age limit to minimize the likelihood of chicks jumping from the eyrie. However, due to scheduling constraints and incomplete aging information we sometimes banded nestlings up to 35 days of age. We evaluated each eyrie prior to entry to determine the safest anchoring technique(s) and route of entry. In some cases, we did not band the chicks when a nest entry was not safe for the birds and/or the biologists. For eyries that were only visible from a distant location, a biologist remained at the observation point and used a handheld radio to help direct the climbing team to the eyrie. Chicks were placed in a small duffle bag and carried to the top of the nest cliff for processing when the eyrie was not large enough for two biologists.

Peregrines exhibit reverse sexual size dimorphism and we were able to determine the sex of each chick primarily based on weight, overall size, and the breadth of the tarsi (Burnham et al. 2003, J. Barnes, personal communication). We attempted to band chicks when they were at least 21 days old, at which time they had developed sufficiently so that differences in the size of the tarsus was evident (Craig and Enderson 2004). Males were fit with a USFWS lock-on #6 band

on the left leg and a black anodized aluminum band with silver alphanumerical characters (Acraft Sign & Nameplate Co., Edmonton, Alberta, Canada) on the right leg, and females were banded with a USFWS lock-on #7A band on the right leg and an Acraft band on the left leg. If there was any question as to the sex of the birds, then we used the female bands (Heinrich 1996, Gustafson et al. 1997).

During nest entries, we collected eggshell fragments and addled eggs. Samples were labeled and delivered to the Western Foundation of Vertebrate Zoology (WFVZ; Camarillo, CA) for determination of shell thickness. We enhanced nest ledges, if necessary, by removing sharp stones or adding suitable substrate to reduce the chance of eggs breaking in the nest in the future.

Terminology

There are a variety of definitions used to describe peregrine occupancy and nesting success, but we followed the guidelines in the 2003 Monitoring Plan for the American Peregrine falcon (U.S. Fish and Wildlife Service 2003), as defined below.

Occupied Territory: A territory where either a pair of peregrines is present (2 adults or an adult/subadult mixed pair), or there is evidence of reproduction (e.g., incubation, brooding, eggs or young, food delivery to an eyrie). We considered a territory occupied if there was evidence of occupancy on 2 or more visits to a territory.

Nest Success: The proportion of occupied territories on the Channel Islands in which 1 or more young $\geq$ 28 days old was observed, using the aging guidelines in Clum et al. (1996).

Productivity: The number of young observed at $\geq$ 28 days old per occupied territory, averaged across the Channel Islands.

We further categorized occupied territories based upon the following breeding stages (see Linthicum 1996 for further descriptions).

Courtship: Behavior indicative of pair bonding, such as cooperative hunting, adult prey exchanges, copulation, or ledge courtship displays.

Incubation: Adult observed in incubation posture (low horizontal position) or inferred to be incubating based upon behavior (for eyries that were not visible). The female does most of the incubation, but the male will bring her food several times per day and relieve her at incubation. During incubation, there is generally an adult present at the eyrie, except when disturbed or for short periods on warm days.

Nestling: Chick(s) present. May be able to see chicks, hear begging, or see adults in what appears to be feeding. Generally, only females brood and feed nestlings. An adult brooding young nestlings (< 7 days old) can look a lot like incubation, so we waited for a prey delivery to the eyrie to confirm that chicks were present.

Fledgling: When young reach ≥ 28 days old.

We classified the breeding activity of occupied territories as either successful, unsuccessful, unknown, or none as described below.

Successful: A pair produced 1 or more nestlings that survived until at least 28 days of age.

Unsuccessful: A pair that engaged in prolonged courtship or copulating that either did not produce eggs or failed during the incubation or nestling stage (chicks < 28 days old).

Unknown: There was insufficient survey data to make a determination as to the nesting outcome.

None: Pair present, but no or minimal signs of courtship observed.

Data Management

Data were entered into island-specific Excel files that were shared via the cloud-based file storage program Dropbox. We combined the weekly data into a master database and the field notebooks were kept on each island as backup records. We downloaded data from our GPS units to the free Garmin Basecamp™ program weekly, which allowed us to evaluate which areas needed additional surveys and to share data among our biologists.

RESULTS

Surveying and Nest Monitoring

We surveyed 43 historical peregrine territories on the Channel Islands and located 5 previously unknown territories (Table 1). We confirmed a total of 45 occupied territories, with at least 4 occupied territories on each island surveyed (Figs. 2 and 3, Table 1). Survey summaries for each island and territory are provided below.

Table 1. Status and breeding activity observed at peregrine falcon territories surveyed on the California Channel Islands in 2019.

Island/ Territory Name	State Code[b]	Territory Type	Occupancy Status	Breeding Activity	# Chicks Hatched[c]	# of Fledglings[c]	Notes (see report text for more details)
Santa Rosa							
Carrington Point	MC16	Historical	Occupied	Successful	1	1	Did not band nestlings
Lime Point	MC27	Historical	Occupied	Unknown	3	?	First attempt failed, second unknown
Water Canyon	MC31	Historical	Occupied	Unsuccessful	0	0	No known nesting
Bee Rock Canyon[a]	MC34	Historical	Occupied	Unsuccessful	2	0	Failed during nestling stage
Orr's Camp	MC35	Historical	Unoccupie	None	.	.	No adults present
Trancion	MC50	Historical	Occupied	Unsuccessful	?	0	Failed during incubation/nestling
Krumholtz	MC51	Historical	Occupied	Successful	1	1	Did not band nestlings
Soledad	MC55	Historical	Occupied	Unknown	.	.	No known nesting
Bonn Point	MC65	Historical	Occupied	Unknown	.	.	Unable to monitor regularly
Chickasaw Canyon	MC66	Historical	Unknown	Unknown	.	.	Did not monitor regularly
Sandy Point	MC67	Historical	Occupied	Unknown	1	?	Did not confirm fledge
Gnoma	MC76	Historical	Unknown	Unknown	.	.	Unable to monitor regularly
Santa Cruz							
Gherini Knife Edge[a]	MC18	Historical	Occupied	Successful	2	2	Banded nestlings on 5/9
Laguna	MC19	Historical	Occupied	Unsuccessful	?	0	No known nesting
West End	MC20	Historical	Occupied	Unsuccessful	?	0	No known nesting
Sea Lion[a]	MC30	Historical	Occupied	Successful	2	2	Banded nestlings on 6/9
Black Point[a]	MC38	Historical	Occupied	Unsuccessful	?	0	Failed during incubation/nestling
Arch Rock[a]	MC45	Historical	Occupied	Successful	3	2	Banded 2 nestlings on 6/8
Valley Anchorage[a]	MC46	Historical	Occupied	Unsuccessful	?	0	Failed during incubation/nestling
Cavern Point	MC52	Historical	Occupied	Unsuccessful	0	0	No known nesting
Bowen Point[a]	MC53	Historical	Occupied	Unsuccessful	?	0	Failed during incubation/nestling
Pelican Bay	MC60	Historical	Occupied	Unknown	.	.	No known nesting
Punta Diablo[a]	MC61	Historical	Occupied	Unsuccessful	1	0	Failed during incubation/nestling
Punta Gorda[a]	MC62	Historical	Occupied	Successful	3	3	Banded nestlings on 6/6
San Pedro West[a]	MC63	Historical	Occupied	Successful	2	2	Banded nestlings on 5/27
West Point South	MC64	Historical	Occupied	Successful	1	1	Did not band nestling
East Smuggler's	MC77	Historical	Occupied	Unsuccessful	?	0	Failed during incubation/nestling

Table 1. Continued.

Island/ Territory Name	State Code[b]	Territory Type	Occupancy Status	Breeding Activity	# Chicks Hatched[c]	# of Fledglings[c]	Notes (see report text for more details)
Santa Cruz (continued)							
Del Norte[a]	MC81	Historical	Occupied	Successful	2	2	Did not band nestlings
Red Peak	TBD	New	Occupied	Unknown	.	.	New Territory. Same as Pelican Bay?
Platt's Harbor	TBD	New	Occupied	Unknown	.	.	New territory. No known nesting
Anacapa							
West Anacapa	MC21	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Middle Anacapa	MC43	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Cathedral Cove[a]	MC54	Historical	Occupied	Successful	4	3	Banded chicks on 5/25
Camel Point	MC80	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Lighthouse	MC91	Historical	Occupied	Unknown	2	?	Banded 5/25. Unable to confirm
San Nicolas							
Harrington	MC73	Historical	Occupied	Successful	2	2	Did not band nestlings
Cattail Canyon	MC74	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Midway	MC82	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Arlington Springs	TBD	New	Occupied	Successful	3	3	Did not band nestlings
Santa Catalina							
Bullethead	MC49	Historical	Occupied	Unknown	.	.	Did not monitor regularly
Silver Peak	MC75	Historical	Occupied	Unknown	.	.	Did not monitor regularly
Lone Tree	MC78	Historical	Occupied	Unknown	.	.	Did not monitor regularly
Seal Point	MC88	Historical	Occupied	Unknown	.	.	Did not monitor regularly
San Clemente							
Cave Canyon	MC59	Historical	Occupied	Unknown	.	.	Unable to determine outcome
Seal Cove[a]	MC79	Historical	Occupied	Unknown	1	1	Did not band nestlings
Wilson Cove	MC89	Historical	Occupied	Unknown	.	.	Unable to determine outcome
China Point	TBD	New	Occupied	Unknown	.	.	New territory. No known nesting
Pyramid	TBD	New	Occupied	Unknown	.	.	New territory. Unknown outcome

[a]Territory included in calculations of productivity

[b] Designated by the California Department of Fish and Wildlife (CDFW)

[c]Minimum number

Figure 2. Occupied peregrine falcon territories on the northern Channel Islands in 2019.

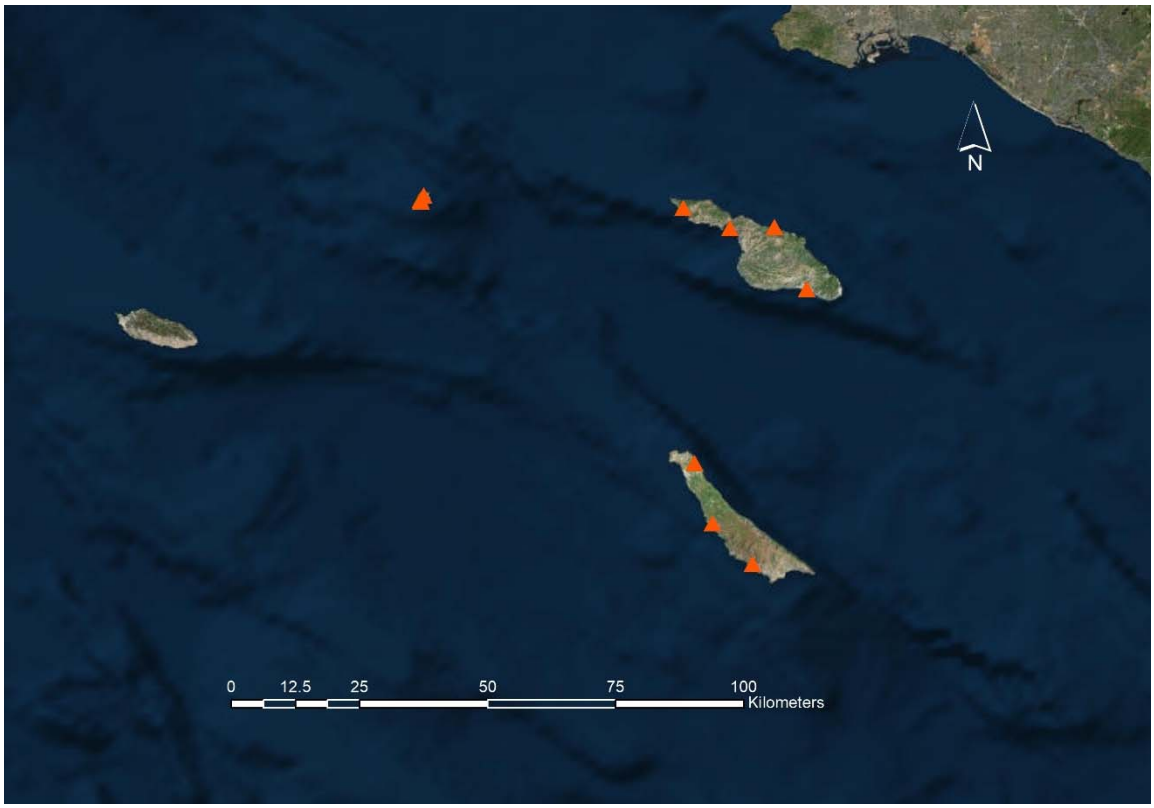

Figure 3. Occupied peregrine falcon territories on the southern Channel Islands in 2019.

Santa Rosa Island

Surveys began on Santa Rosa on 28 February and continued through 25 June. We surveyed 12 previously known territories and confirmed occupancy in 9 (75%) of them (Fig. 4). We did not locate any new territories.

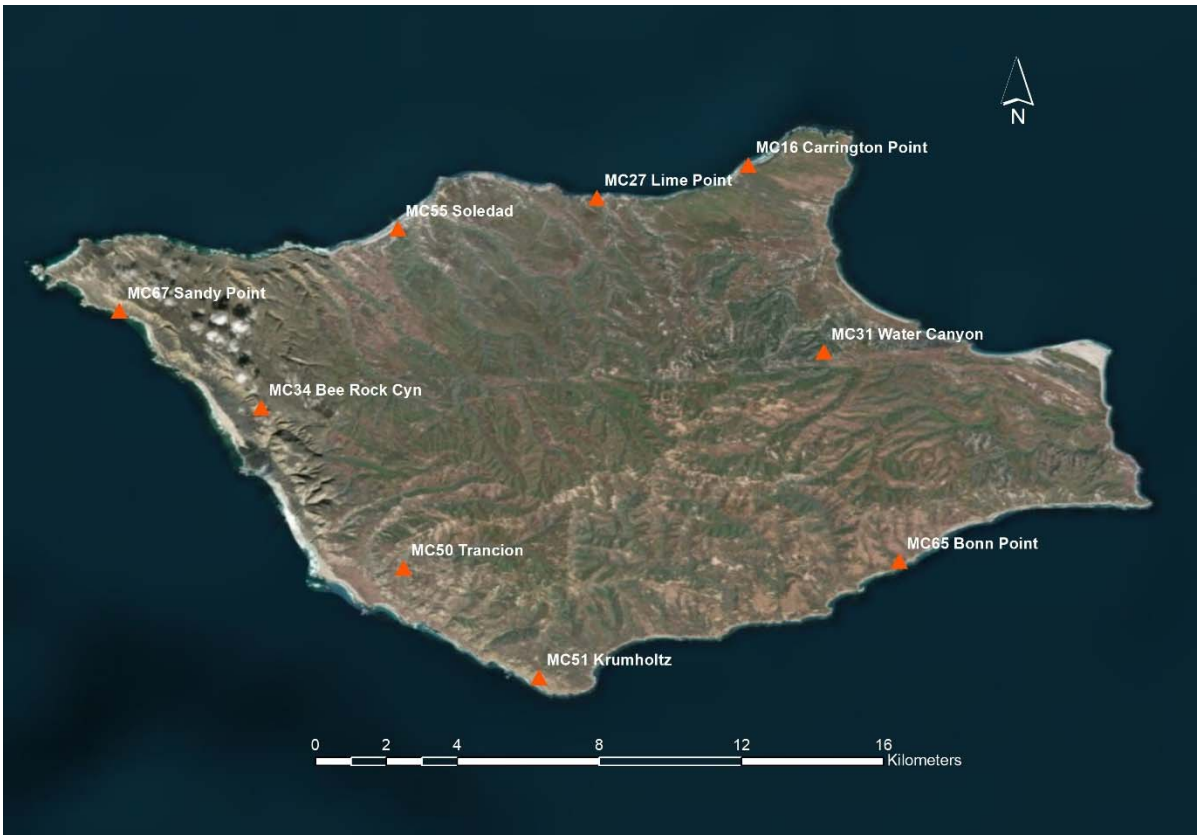

Figure 4. Peregrine falcon territories on Santa Rosa Island, CA, 2019.

MC16 Carrington Point: We confirmed the presence of a pair in the historical Carrington Point territory (Fig. 4) on 3 March. Further surveys failed to confirm active nesting but we documented 1 fledgling in the territory on 9 June.

MC27 Lime Point: We confirmed a pair in the historical Lime Point territory (Fig. 4) on 3 March. The birds were incubating by 11 April near the 2015 eyrie location on a coastal cliff. This cliff was heavily used by nesting Brandt's (*Phalacrocorax penicillatus*) and pelagic (*P. pelagicus*) cormorants, as well as western gulls (*Larus occidentalis*). The nest had failed by 9 May, but we discovered the pair incubating at least 2 eggs in nearby Lobo Canyon on 23 May.

We documented 3 nestlings about 15-18 days old during our last survey on 24 June. We were unable to return to the site to confirm fledge due to logistical constraints.

MC31 Water Canyon: A pair was displaying courtship behavior in the historical Water Canyon territory (Fig. 4) on 27 March. We continued to monitor the territory through 10 June but did not document any evidence of a nesting attempt.

MC34 Bee Rock Canyon: We confirmed a pair in the historical Bee Rock Canyon territory (Fig. 4) on 4 March and confirmed incubation on 24 April. Two nestlings aged 9-11 days were present on 10 May, but subsequent surveys on 27 May and 6 June confirmed the breeding attempt had failed.

MC35 Orr's Camp: We surveyed the historical Orr's Camp territory (Fig. 4) and neighboring areas 3 times between 4 March and 29 April and did not detect any peregrines. It is possible the pair has shifted east or west along the coast, although we have not found a pair in the area since 2017.

MC50 Trancion: We confirmed a pair in the historical Trancion territory (Fig. 4) on 28 March. The birds were incubating on 27 April, but had failed by 7 June.

MC51 Krumholtz: We confirmed a pair in the historical Krumholtz territory (Fig. 4) on 28 March. We never confirmed incubation in subsequent surveys but observed a 3-week-old nestling on 13 May. The nestling was close to fledging during our final check on 7 June.

MC55 Soledad: We confirmed a pair in the historical Soledad territory (Fig. 4) on 31 March. We were unable to locate the pair and found no evidence of nesting during 3 subsequent surveys between 26 April and 25 May.

MC65 Bonn Point: We confirmed a pair in the historical Bonn Point territory (Fig. 4) on 2 March and 30 March. Our final visit on 8 June confirmed the pair still present but with no evidence of

active nesting or recent fledglings. Road closures by the NPS have made surveys at this territory particularly time-consuming and resulted in shorter, more infrequent surveys.

MC66 Chickasaw Canyon: We surveyed the historical Chickasaw Canyon territory (Fig. 4) on 28 March. We were unable to complete 3 separate 4-hour surveys at this historical territory to conclude that it was unoccupied, but a pair has not been seen here since 2015.

MC67 Sandy Point: We confirmed a pair in the historical Sandy Point territory (Fig. 4) on 4 March. The pair was incubating at a new eyrie location on 10 May and we saw 2 eggs on 27 May. We observed a single chick on 6 June and it was still present on our final survey on 25 June (approximately 3 weeks old).

MC76 Gnoma: We detected no peregrines during surveys on 1 March and 1 April. This territory is time-consuming to survey because of recent road closures by the NPS. For this reason we were unable to conduct 3 separate 4-hour surveys to conclude that the territory was unoccupied.

Santa Cruz Island

Surveys began on Santa Cruz on 2 February and continued through 10 July. We surveyed 16 historical territories, which were all occupied (Fig. 5). We also found two previously unknown territories located in the interior of the island.

MC18 Gherini Knife Edge: We confirmed a pair was present in the historical Gherini Knife Edge territory (Fig. 5) on 3 March. They were incubating 1 egg on 14 March and we confirmed 4 eggs on 12 April. Two nestlings were present on 28 April and we entered the eyrie on 9 May to band the chicks and collect eggshell fragments (Table 2, Appendix I). Both nestlings had fledged by our final check on 5 June.

MC19 Laguna: We confirmed a pair was present in the historical Laguna territory (Fig. 5) on our first survey on 13 March. We saw the male during our 27 March and 10 April surveys, and both adults were present during our last survey on 25 April. We found no evidence of a nesting this season.

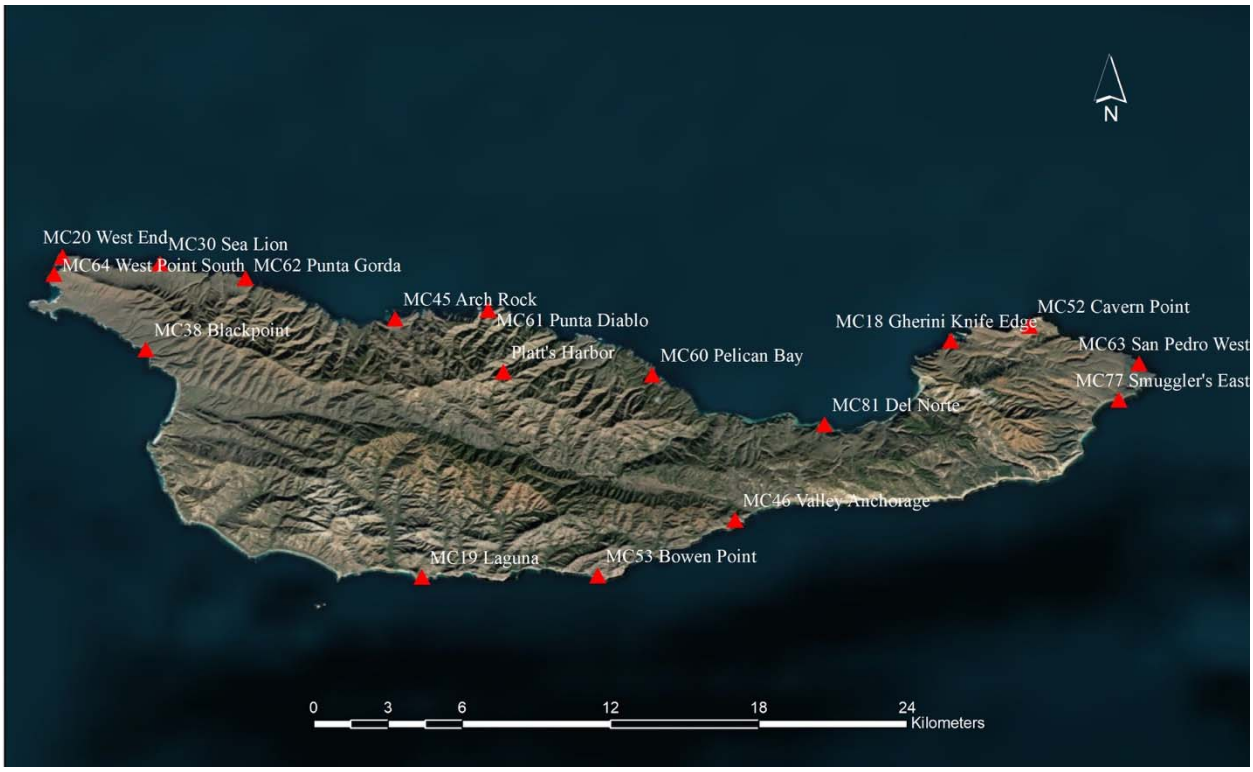

Figure 5. Peregrine falcon territories on Santa Cruz Island, CA, 2019.

MC20 West End: We confirmed a pair in the historical West End territory (Fig. 5) on 16 March. We saw only the female during 3 subsequent surveys through 10 May and were unable to confirm any nesting attempts.

MC30 Sea Lion: We confirmed a pair exhibiting courtship behavior in the historical Sea Lion territory (Fig. 5) on 16 March. Three eggs were present on 5 April and 2 nestlings were present on 24 May. We entered the eyrie on 9 June to band the nestlings and collect eggshell fragments (Table 2, Appendix I).

MC38 Black Point: We confirmed a pair in the historical Black Point territory (Fig. 5) on 31 March. The pair was incubating an unknown number of eggs at a new eyrie location on 26 April. The nest was still active when checked on 10 May, but it had failed by 26 May.

MC45 Arch Rock: We observed courtship behavior from a pair in the historical Arch Rock territory (Fig. 5) on 17 March. We located the pair incubating in a new eyrie approximately 1 km

west of the historical eyrie on 24 April. Three nestlings were present on 5 June, but there were only 2 present when we entered the eyrie on 8 June to band the nestlings and collect eggshell fragments (Table 2, Appendix I).

Table 2. Summary of peregrine falcon banding on the California Channel Islands, CA in 2019.

Island/Territory Name	Sex	Age (days)	USGS Band #	Color Band	Wt. (g)
Santa Cruz					
MC30 Sea Lion	Male	26	1156-16886	08/AE	585
MC30 Sea Lion	Female	26	1947-21696	66/AE	930
MC45 Arch Rock	Male	30	1156-16881	31/AE	370
MC45 Arch Rock	Male	30	1156-16889	28/AE	415
MC62 Punta Gorda	Male	32	1156-16888	34/AE	560
MC62 Punta Gorda	Male	32	1156-16890	23/AE	460
MC62 Punta Gorda	Male	32	1156-16887	44/AE	560
MC63 San Pedro West	Female	20	1947-21695	27/AN	880
MC63 San Pedro West	Male	20	1156-16882	39/AE	640
Anacapa					
MC54 Cathedral Cove	Female	24	1947-21693	69/AE	1000
MC54 Cathedral Cove	Female	24	1947-21694	26/AN	990
MC54 Cathedral Cove	Male	24	1156-16891	47/AE	715
MC91 Lighthouse	Female	21	1947-21692	54/AE	970
MC91 Lighthouse	Male	21	1156-16892	10/AE	645

MC46 Valley Anchorage: We confirmed a pair exhibiting courtship behavior in the historical Valley Anchorage territory (Fig. 5) on 27 February. They were incubating 2 or more eggs by 9 April, but the nest had failed by 11 May.

MC52 Cavern Point: We confirmed a pair in the historical Cavern Point territory (Fig. 5) on 14 March. The pair made visits to a new eyrie location on 28 March and 13 April. We confirmed the pair was present but not incubating on 27 April. We found no sign of active nesting at the suspected eyrie during a brief final survey on 5 June. We believe the pair failed early in the incubation stage or did not lay at all.

MC53 Bowen Point: We confirmed a pair in the historical Bowen Point territory (Fig. 5) on 13 March. The birds were incubating on 10 April and we believe there were nestlings present on 13

May, based upon adult behavior. We observed no activity at the eyrie and no fledglings in the vicinity on 7 June, so we believe the nesting attempt failed.

MC60 Pelican Bay: We confirmed a pair in the historical Pelican Bay territory (Fig. 5) on 12 March. We observed only single birds during 3 more surveys in March and April. We suspect the pair may be moving inland to more suitable cliffs for nesting but we could not locate them. Notably, the newly located Red Peak territory (see below) is directly inland 2.8 km from Pelican Bay. In 2020, we intend to determine whether these are two separate territories.

MC61 Punta Diablo: We confirmed a pair in the historical Punta Diablo territory (Fig. 5) on 17 March. We located the pair incubating at a new eyrie on 14 April. The nest appeared active through 8 May, but the nesting attempt appeared to have failed by 5 June.

MC62 Punta Gorda: We confirmed a pair exhibiting courtship behavior in the historical Punta Gorda territory (Fig. 5) on 17 March. The pair was incubating by 15 April and had nestlings by 24 May. We entered the eyrie on 6 June to band 3 nestlings and collect eggshell fragments (Table 2).

MC63 San Pedro West: We confirmed a pair in the historical San Pedro West territory (Fig. 5) on 28 February. The pair was incubating 3 eggs on 1 April. We entered the nest on 27 May to band 2 nestlings and collect eggshell fragments (Table 2). We confirmed both birds had fledged by 20 June.

MC64 West Point South: We located a new eyrie with nestlings in the historical West Point South territory (Fig. 5) on 15 April. There was 1 nestling about 3 weeks old on 29 April and it had fledged by 9 June.

MC77 East Smuggler's: We confirmed a pair exhibiting courtship behavior in the historical East Smuggler's territory (Fig. 5) on 15 February. We confirmed incubation on 12 April, but the nesting attempt appeared to have failed by 24 May.

MC81 Del Norte: We confirmed a pair in the historical Del Norte territory (Fig. 5) on 28 February. The pair was incubating at a new eyrie on 24 April and 11 May. At our final check on 5 June there were 2 nestlings over 30 days old.

Platt's Harbor (MC# to be determined): We located a pair in courtship up the canyon from Platt's Harbor on 30 March. The pair was located again on 12 May along the ridgeline at the top of the Platt's Harbor canyon, but could not confirm a nesting attempt.

Red Peak (MC# to be determined): We located a previously unknown territory in the interior cliffs west of Red Peak on 12 May, at which time we observed a prey exchange at a possible eyrie location and courtship displays at the same location. There was no indication of a nesting attempt at the eyrie and we were unable to survey the area. This territory may be an extension of the Pelican Bay territory.

Anacapa Island

We conducted surveys of Anacapa from our boat on 18 March, 27 April and 24 May. We located pairs in all 5 of the known historical territories (Fig. 6).

Figure 6. Peregrine falcon territories on Anacapa Island, CA, 2019.

MC21 West Anacapa: We confirmed a pair in the historical West Anacapa territory (Fig. 6) on 27 April. We saw no peregrines on our next survey on 24 May, so we were unable to determine if any nesting attempt occurred.

MC43 Middle Anacapa: We confirmed a pair in the historical Middle Anacapa territory (Fig. 6) on 27 April and 24 May. We were unable to determine whether there were any nesting attempts.

MC54 Cathedral Cove: We monitored the Cathedral Cove nest site (Fig. 6) via a live web cam established in early 2017. They laid eggs on 24 March, 27 March, 29 March, and 2 April. The first egg hatched on 1 May, the second and third eggs hatched on 2 May, and the last egg hatched on 6 May. The youngest nestling died around 11 May, likely because it was unable to compete for food with its larger siblings. We entered the eyrie on 25 May to band the chicks and to collect eggshell fragments (Table 2, Appendix I).

MC80 Camel Point: We were only able to survey this territory twice over the season; once on 18 March, and again on 27 April. We documented the pair in the area on only the first survey, so we were unable to determine if they attempted to breed.

MC91 Lighthouse: We confirmed a pair in the historical Lighthouse territory (Fig. 6) on 18 March. They were incubating eggs by 27 April and we entered the eyrie on 25 May to band 2 nestlings and collect eggshell fragments (Table 2, Appendix I).

San Nicolas Island

We conducted surveys on San Nicolas on 11-14 March, 29-30 May, and 18 June. We located pairs in 3 historical territories on the south side of the island and located a new territory (Fig. 7).

MC73 Harrington: We confirmed a pair in the historical Harrington territory (Fig. 7) on 11 March. There were at least 2 nestlings present on 30 May and we observed 2 fledglings on 18 June.

Figure 7. Peregrine Falcon survey routes and territories on San Nicolas Island, CA, 2019.

MC74 Cattail Canyon: We did not detect a pair in the historical Cattail Canyon territory (Fig. 7) on our first survey on 12 March, but a pair was present on 29 May and 18 June. We were unable to determine whether nesting occurred.

MC82 Midway Territory: We confirmed a pair in the historical Midway territory (Fig. 7) on 14 March, but no birds were observed on 30 May and only 1 adult was seen on 18 June. We do not know whether this pair nested.

Arlington Springs (MC# to be determined): We located a pair in the new Arlington Springs territory (Fig. 7) on 29 May, at which time they had at least 3 nestlings. Three nestlings approximately 4 weeks old were still present on 18 June and M. Ruane observed a fledgling near the nest on 3 July.

Santa Catalina Island

We surveyed 4 previously identified territories on the island and confirmed pairs present in each territory (Fig. 8).

Figure 8. Peregrine falcon territories on Catalina Island, CA, 2019.

MC49 Bullethead: We confirmed a pair in the historical Bullethead territory (Fig. 8) on 19 March. We saw no peregrines when we returned on 13 April, so we were unable to determine if there was a nesting attempt.

MC75 Silver Peak: We confirmed a pair in the historical Silver Peak territory (Fig. 8) on 23 February. The pair were still active in the territory on 15 April, but we did not determine if a breeding attempt was made.

MC78 Lone Tree: We confirmed a pair in the historical Lone Tree territory (Fig. 8) on 22 March and 15 April, but there was no activity on 9 June. We did not determine if there was a nesting attempt.

MC88 Seal Point: We confirmed a pair in the historical Seal Point territory (Fig. 8) on 18 March and 16 April. We documented copulation and courtship displays but did not determine if there was a nesting attempt.

San Clemente Island

We surveyed 3 historical territories on the island and located 2 previously unknown territories (Fig. 9). We confirmed breeding pairs present at each territory.

Figure 9. Peregrine territories on San Clemente Island, CA, 2019.

MC59 Cave Canyon: We confirmed a pair in the historical Cave Canyon territory (Fig. 9) on 14 March. We located a possible eyrie during courtship, but could not determine whether eggs were ever laid.

MC79 Seal Cove: We confirmed a pair in the historical Seal Cove territory (Fig. 9) on 26 February. The pair was incubating on 1 May and there were nestlings on 30 May. We confirmed that at least 1 nestling had fledged on our last visit on 11 July.

MC89 Wilson Cove: We confirmed a pair in the historical Wilson Cove territory (Fig. 9) on 13 March. We documented courtship behavior, but could not confirm whether nesting occurred during 3 subsequent surveys.

China Point (MC# to be determined): We discovered a pair of peregrines exhibiting courtship behavior in the new China Point territory (Fig. 9) on 10 February. We saw a single adult on 14 March and no adults on 20 March or 8 April. Both adults were present on 4 and 31 May, but there were no signs of nesting.

Pyramid (MC# to be determined): We found a pair in the new Pyramid territory (Fig. 9) on 26 February. The female of the pair (Band #1947-21681) fledged from the Cathedral Cove territory on Anacapa Island in 2016. They were incubating by 30 April and continued through at least 1 June. We could not confirm the status of nesting on 17 June or 14 July.

Resightings

In 2019, we received sighting reports on the mainland for 2 peregrines that we had banded as nestlings on the islands.

A female banded in 2016 at the Punta Gorda territory on Santa Cruz (Band #1947-21675) was seen in La Jolla, CA on 20 February.

A female banded in 2014 at the West Point South territory on Santa Cruz Island (Band #1947-21654) was found dead 0.3 miles SW of the Point Dume mobile home park in Los Angeles County on 31 March.

Eggshell Measurements

We collected eggshell fragments from 5 eyries during nest entries. The samples have yet to be analyzed as of the writing of this report.

Productivity

At least 36 chicks are known to have hatched on the Channel Islands in 2019, of which a minimum of 25 (69%) are known to have survived to $\geq$28 days of age. We calculated productivity based upon 13 pairs that were monitored from early in the breeding season (i.e.,

courtship, incubation) and for which we know the outcome of the breeding season (see Table 1). All thirteen pairs laid eggs, 10 pairs hatched at least 1 chick, and 8 pairs (62%) successfully produced at least 1 chick ≥28 days of age. Minimum productivity was 1.31 fledglings per occupied territory and 2.29 fledglings per successful nesting attempt.

DISCUSSION

The once-extirpated peregrine population on the Channel Islands has undergone a strong recovery since initial reintroduction work in the 1980s and 1990s. Our 2013-2018 surveys identified 45-51 occupied territories, which exceeded Hunt's (1994) estimate of approximately 30 territories for historical periods. As a result of the end of regular funding after the 2017 field season, we have been unable to survey as extensively as in previous years, but still located 45 occupied territories in 2019.

The northern Channel Islands continue to be the stronghold for Channel Island peregrines, which is likely due to a higher seabird diversity (Carter et al. 1992, Takekawa et al. 2004) and more cliffs with ledges and potholes for peregrine nesting (Hunt 1994; P. Sharpe, personal observations), as compared to the southern Channel Islands. In other peregrine populations, density of peregrine territories appears to be positively correlated with availability of food resources, with higher densities generally occurring in association with large seabird or shorebird colonies (Ratcliffe 1980). This is likely the case with the peregrines on the Channel Islands.

Nest success (62%) and productivity (1.31 fledglings/occupied territory) in occupied territories with known outcomes was similar to the 2013-2018 average on the Channel Islands of 63% nest success and productivity of 1.32 fledglings/occupied territory. Nest success and productivity on the Channel Islands is similar to that in the Pacific Region in 2003 (65% and 1.45 chicks/occupied territory), but slightly lower than the 2003 national average of 71% and 1.64 chicks/occupied territory (Green et al. 2003). More recent studies reported nest success of 77-78% and 1.8 chicks/occupied territory found in Colorado, Montana, Wyoming, and Idaho (Enderson et al. 2012, Moulton 2012). Nest success and productivity can vary greatly between

years, so continued monitoring will allow us to better estimate long-term reproductive averages and trends in the peregrine population on the Channel Islands.

We continue to locate new breeding territories on both the northern and southern Channel Islands and believe that the peregrine population will continue to expand into currently unoccupied breeding habitat. Although nesting density is high on the northern Channel Islands and the levels of productivity appear sufficient to maintain the population, factors such as juvenile/adult survival and emigration/immigration rates play an important role in population persistence. Annual population monitoring and banding of young could help us gain an understanding of these population parameters for the Channel Islands peregrines and help determine whether contaminants or other issues are negatively impacting the population.

For the 2020 season, we will attempt to survey Anacapa, Santa Cruz, Santa Rosa, San Nicolas, Catalina, and San Clemente islands. Although the peregrine population on the Channel Islands appears stable, we believe it is important to continue regular monitoring to detect any significant decreases in occupancy or productivity that could be caused by contaminants or other environmental conditions. We will rely primarily on the call-broadcast protocol for the rapid assessment of areas with suitable habitat outside of known territories, as has been done in other studies (Klinger and Tomlinson 2010), and we recommend its use in peregrine population monitoring, especially when time and/or personnel are limited.

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Appendix I. Samples collected in 2019.

Sample ID	Island[a]	Territory	Sample Type	Collection Date	Notes
19-MC54-SF-1	Anacapa	Cathedral Cove	Shell Fragments	5/25/19	Collected from eyrie
19-MC91-SF-1	Anacapa	Lighthouse	Shell Fragments	5/25/19	Collected from eyrie
19-MC18-SF-1	Santa Cruz	Gherini	Shell Fragments	5/9/19	Collected from eyrie
19-MC30-SF-1	Santa Cruz	Sea Lion	Shell Fragments	6/9/19	Collected from eyrie
19-MC45-SF-1	Santa Cruz	Arch Rock	Shell Fragments	6/8/19	Collected from eyrie