U.S. Fish & Wildlife Service

Natural History of Band-tailed Pigeons on Eliza Island

Washington, 1952–1953

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Posthumous Author

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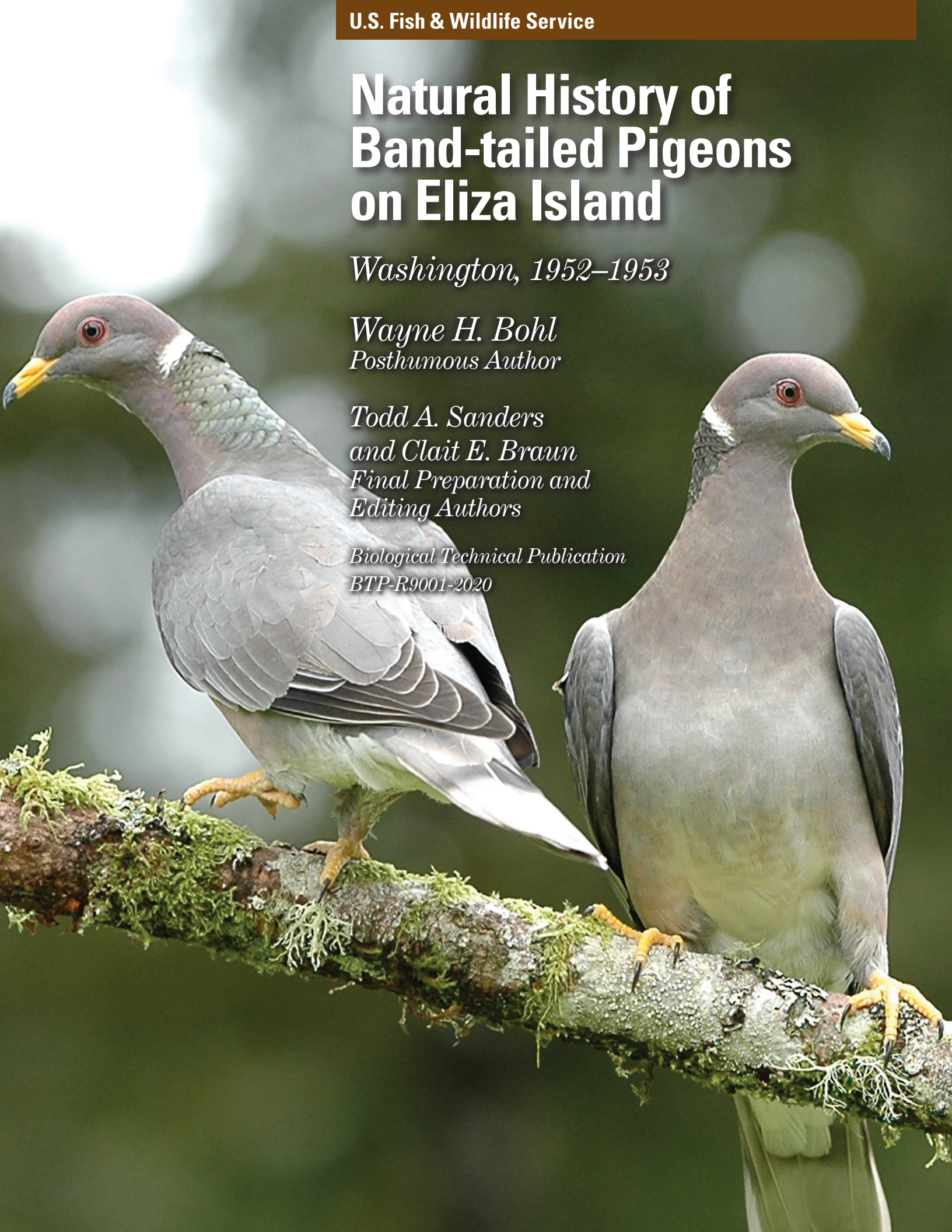

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Band-tailed pigeons
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Preface

Wayne H. Bohl was born on 13 November 1925 and died on 25 August 1995 at 69 years of age at his home on Lummi Island, Whatcom County, Washington. Wayne completed graduate work (Bohl, W. H. 1955. Survival of juvenile ring-necked pheasants on Eliza Island, Washington during 1952. Thesis. Oregon State College, Corvallis, USA) in the Cooperative Wildlife Research Unit at Oregon State University and then studied band-tailed pigeons during 1952–1953. He subsequently worked for the New Mexico Department of Game and Fish, and was a Wildlife Research Biologist in the Foreign Game Bird Investigation Program of the U.S. Department of Interior, Fish and Wildlife Service, with much of his field work outside of the United States. His last duty station was at Logan, Utah. The Foreign Game Bird Investigation Program was discontinued in May 1972 and Wayne eventually transferred to the Endangered Species Program of the U.S. Fish and Wildlife Service in Washington, D.C. Wayne published numerous booklets and reports on a variety of mostly non-native to North America game birds including "A study of the introduction, release, and survival of Asiatic game birds (1957)," "Chukars in New Mexico 1931–1957," "A study and review of the Japanese Green and the Korean ring-necked pheasants (1964)," and "A study of the crested tinamou of Argentina (1970)." He teamed with Gardiner Bump (red junglefowl and Kaliji pheasants [1961]) to study game birds across the globe to identify species with potential for release into the United States for the purpose of increasing sport hunting opportunities.

Wayne Bohl initiated a project to develop a book on band-tailed pigeons based on his field studies on Eliza Island, Washington and review of the literature available at that time. He prepared an outline and developed the text. This was a work in progress over many years and Wayne enlisted many others to help him with his book project. Clait E. Braun (CEB) was contacted by Wayne (letter of 12 February 1970 and subsequent letters) to help with the project. This role expanded as other potential contributors dropped out and Wayne's priorities changed. Bohl provided a copy of his original manuscript, which CEB retained but without the intended photographs. A phone call from Bohl on 13 August 1975 ended with the comment from Wayne that "the book was up to me" (CEB). Many other priorities interfered with bringing Bohl's original work into print.

This manuscript is Bohl's original work provided to CEB in February 1970. Norma Bohl and Laurie Ulrich, Wayne Bohl's wife and daughter, respectively, provided Wayne's original photographs to Todd A. Sanders (TAS) on 19 June 2015. We resurrected the manuscript with only modest changes in wording and style in preparation for publication. Our intent was to present Bohl's work as a reflection of the state of the knowledge about band-tailed pigeons in the 1950s. Those wanting a summation of more current information on the life history of band-tailed pigeons should refer to Keppie and Braun (2000) and Jarvis and Passmore (1992).

Wayne's work is a significant contribution to band-tailed pigeon life history and information. Wayne was among few independent researchers working to understand the life history and management of band-tailed pigeons in the late 1940s and early 1950s in response to increased hunting pressure being exerted on this species and the need for proper management. These early principal researchers included Johnson A. Neff, U.S. Fish and Wildlife Service, working across the western United States (Neff 1947); Fred A. Glover, University professor, working in northwestern California (Glover 1953); Wallace G. MacGregor and Walton M. Smith, California Department of Fish and Wildlife, working in west central California (MacGregor and Smith 1955); and Wayne H. Bohl, Oregon Cooperative Wildlife Research Unit, working in northwestern Washington. Wayne's work is a comprehensive band-tailed pigeon natural history account over two years of extensive observations. Specifically, Wayne provides detailed information about pigeon nest site characteristics from 136 located nests (active and non-active) and nesting chronology and behavior from repeated observations of 57 active nests. To this day, few have been successful in locating nests and observing band-tailed pigeons while nesting. Wayne's observational conclusions are still important in our knowledge of the ecology of band-tailed pigeons, and have largely been confirmed via scientific investigations since the 1950s. Wayne's appreciation and love for band-tailed pigeons is evident in his work and writing. Wayne's review of the literature is generally presented as quoted material, and we have set this quoted material in indented blocks so that readers can easily skip over this information if they so choose.

Interestingly, Wayne's career largely focused on game birds across the globe to identify species with potential for the purpose of increasing sport hunting opportunities, yet Wayne never mentioned the hunting of pigeons in his investigations. Also, despite the now well documented use of sodium water by the Pacific Coast population of band-tailed pigeons, abundant sodium water available at the lagoon and marsh on Eliza Island and surrounding islands, and the spectacle these birds make gathering and descending to drink, Wayne does not mention observations of pigeons using sodium water. However, he did have pictures of the well-known Pigeon Point tidal mineral site (at Rock Point on the Washington mainland) 6.9 miles (11.0 km) southeast of Eliza Island that is used by pigeons to this day. Two other mineral sites (Lake Cavenaugh Road and Sumas natural springs) known to be used by pigeons (for at least 50 years) closest to Eliza Island are both 26 miles (42 km) away on the mainland. Those wanting more information on band-tailed pigeons use of sodium water should refer to Sanders and Jarvis (2000) and Sanders and Koch (2018).

Introduction

There was little scientific information available on band-tailed pigeons (*Columba* [now *Patagioenas] fasciata;* casually referred to as bandtails) in the early 1950s when this study was conceived. At that time, there was increased hunting pressure being exerted on this species and a general lack of knowledge of its life history, which did not allow proper management. Thus, authorization was obtained from the Oregon Cooperative Wildlife Research Unit[1] to conduct a band-tailed pigeon research program on Eliza Island, Washington, during 1952 and 1953. The 1952 bandtail study on the island was sponsored by the Cooperative Unit, and in 1953 the Wildlife Management Institute made available a $375 special grant for the research program allowing it to continue under the direction of the Cooperative Unit.

The primary objective of the life history study was to examine the possibility of the bandtail bringing off more than one brood in one year. During the course of the studies, 57 active nests were located in the forests of Eliza Island and nearby Lummi and Vendovi islands. Of these nests, 50 were found on Eliza Island where the life history observations were centered (Figures 1–3). The entire nesting season was plotted for both years. Specific habits of courtship, nesting, feeding, drinking, roosting, predation, and migration were among the many items recorded.

[1] U.S. Fish and Wildlife Service, Wildlife Management Institute, Oregon and Washington State Game Commissions, Oregon Agricultural Experiment Station and Agricultural Research Foundation, Cooperators.

Study Area

Eliza Island, located eight miles (12.9 km) southwest of Bellingham, Washington (48.650° N, 122.582° W, Figures 1–3), had been used primarily for conducting research on the ring-necked pheasant (*Phasianus colchicus*). The nearest land to Eliza Island is Lummi Island, about 0.75 miles (1.2 km) to the west. Eliza Island is about 141.2 acres (57.1 hectares) in size and is shaped like a crude capital letter "T." The longitudinal landmass, closely paralleling the compass points, stretches one mile (1.6 km) and is a rather steep-sided strip of forested land, rising to a height of 60 feet (18 m) in one section. It contains conifers and deciduous trees, mainly, with Douglas-fir (*Pseudotsuga taxifolia*) and grand fir (*Abies grandis*) the dominant evergreen trees. The east-west axis is about one-half mile (0.8 km) in distance; only the eastern edge and the tip are wooded. Between these two forests is a low area called the central flat, which comprises the principal non-forested area of the island. It is composed of grasses, cultivated fields, and two water areas, a brackish lagoon and a rain-filled marsh. Average yearly rainfall is normally < 25 inches (< 32 cm) for this coastal area. Summer temperatures average 61°F (16 °C) and winters average 45 °F (7 °C).

When a small island, such as Eliza Island, has a sizeable band-tailed pigeon nesting concentration as noted in the two-year study, it readily can be seen how profitably it may serve in obtaining information on such a secretive bird.

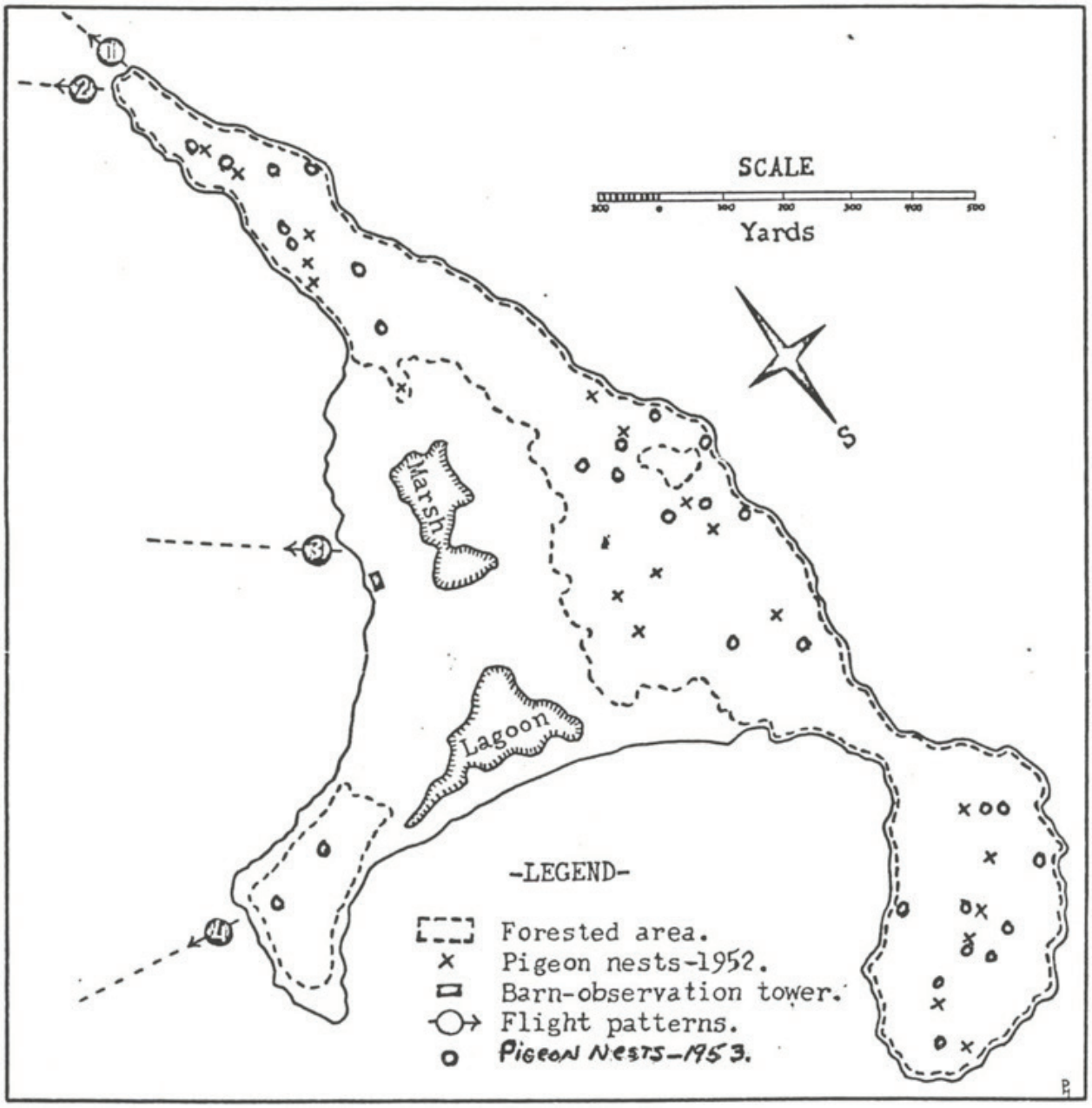

Figure 1. Study area, showing forested areas, band-tailed pigeon nest locations, pigeon flight patterns, and the observation tower, on Eliza Island, Washington, 1952–1953.

Figure 2. Eliza Island, Washington with the mainland in the background as seen from nearby Lummi Island about 1.2 miles (1.9 km) northwest of Eliza Island during the band-tailed pigeon study on Eliza Island, 1952–1953. Eliza Island is about 0.75 miles (1.2 km) due east from Lummi Island and about 4.0 miles (6.4 km) due west of the mainland.

Figure 3. Researcher's house (guest cabin), showing surrounding trees used by pigeons for roosting and nesting, during the band-tailed pigeon study on Eliza Island, Washington, 1952–1953. The cabin was located at the base of the heavily forested ridge on the eastern side of Eliza Island about center from north to south and across the open field from the lagoon (see Figures 1 and 2).

Observation Procedures

The first concerted bandtail research study on Eliza Island was in 1952, and more birds and nests were recorded than in the island's bird-sight files from 1947 through 1951. The possibility existed in 1952 that the pigeon population was larger than usual. However, even greater number of birds and nests were located in 1953 than in 1952. There were more reports in 1953 although it is possible the observer became more acutely aware of pigeon habits and learned to observe their secretive flights and actions that led to discovery of more nests than normally would have been the case.

Initial field observations were made from outside the forest; the major portion being made from an elevated barn tower approximately 25 feet (7.6 m) high from which approximately 90% of the pigeon nesting and feeding areas were visible (Figure 1). This tower was on the central flat about 250 yards (229 m) from the nearest forested area. The elevation proved advantageous in allowing the observer to observe the pigeons' flights to the general area of their nest sites as they darted among the tree tops.

A second observation point was on the central flat where a 30-foot (9.1 m) ladder was elevated as a lookout platform. This station had value in ascertaining whether pigeons were going into the general areas of the north, central, or south woods. Often a rarely observed or devious approach to the island through the forests could delay for a week or more the finding of a suspected nest site. The mile-long (1.6 km) length of forest was separated into thirds in 1953 by cutting two cleared lanes across its width. Since many pigeons coming from nearby Lummi Island or the mainland dropped in among the tree tops or on the far side of the forest from the observer, these open lanes aided in ascertaining if pigeons had landed in a certain forest section. A continued flight would be clearly shown when the bandtails crossed either of these cleared lanes.

Many observations were made from the highest fir tops, some over 100 feet (30.5 m) tall, in or around pigeon nesting areas. The bandtails, in most cases, did not seem to react adversely toward the observer's presence. They were much more antagonistic toward pigeons other than their nesting partner in their own territory.

Other observational procedures included watching trapping operations or nesting intimacies from blinds and lying motionless on the forest floor. Although taxing on nerves, the latter method resulted in interesting observations concerning the wary bandtails. Nesting American robins (*Turdus migratorius*) continually harassed the observer during observations from the forest interior.

Systematic nest searches from the forest floor were made two or three times monthly. This method was a form of "gridding" where the observer scrutinized the tree branches while slowly walking through the forest in prescribed patterns.

Sight Records and Migration

Bandtails arriving at Eliza Island in spring 1952 were first recorded on 9 April. One was seen on 28 March 1953 and four were recorded on 2 April. Previous island records by graduate students list bandtails on nearby Lummi Island on 25 March 1951 (W. Q. Wick, H. D. Hartwell), two on Eliza Island on 27 March 1950 (C. G. Hansen), and one on 1 April 1949 on Eliza Island (R. R. Hoffman). Neff (1947) lists 9 April as the earliest observed appearance in the State of Washington.

Plant phenology records for 1952 and 1953 indicate that besides waste grain from fields, the buds and flowers of Pacific madrone (*Arbutus menziesii*) and manzanita (*Arctostaphylos* spp.) and leaf buds and catkins of Douglas-fir and lowland white fir (*Abies concolor*) were available and eaten by the first bandtails migrating north in late March or early April. Normally it is after 10 April that the first large groups of pigeons start arriving or passing over the island. The early presence of bandtails from the south seems to be governed by the availability of wild foods. Southeast storms are normally present as the first pigeons make their appearance, but apparently they do not restrict the bandtails from moving into the area. The breeding urge undoubtedly is a large factor in bringing some of these adventuresome birds north in early April each year. The Puget Sound birds, and those of southern British Columbia, must leave quite early in the year to travel from California to their northern breeding areas.

Sight records for the two years of the study showed increasing pigeon numbers in April and early May with a tapering off by the end of May (Table 1). Grain used as trapping bait attracted more than the usual pigeon numbers to Eliza Island in late May and June; therefore it was difficult to ascertain that birds were still moving north at these periods.

During June, July, and most of August, the island's bandtail population remained somewhat stable with mainly the nesting birds occupying the area. As soon as baiting stopped in June, this rather fixed population was apparent as nesting birds left the island daily for food and water. The pigeons' main summer food was scarce on Eliza. Consequently birds could be counted rather easily as they left for feeding and returned for nest changes or squab feedings. The water of the bay provided a clear line of demarcation, which facilitated the counting of pigeons.

First signs of the bandtail's southward migration during 1952 were noted on 24 August on Eliza Island. A 'southeaster' storm had started on this day and the first large fall flock, 65 bandtails, was observed flying in a steppingstone fashion from Lummi Island to Eliza Island, and then southward. The following day, with the 'southeaster' continuing, more flocks followed this same pattern southward. Arthur S. Einarsen, arriving at the island on 26 August, reaffirmed the starting of the 1952 southern migration by citing observations made in Cowlitz County, along the Columbia River. He reported seeing several hundred birds funneling together, the normal fall procedure as bandtails move southward.

The 1953 fall migration was not as apparent at Eliza Island as the previous year. Mild summer weather in the Puget Sound area apparently tended to hold the birds longer. Food was plentiful as it is in most years at the start of southern migration. An estimated 2,000 or more pigeons were reported a few miles (km) east of Eliza Island on the mainland (Wickersham Mountain) feeding on red elderberries (*Sambucus racemosa*) on 30 August. The large crop of huckleberries (*Vaccinium* spp.) present was not used to any noticeable extent. A week later, this group was absent from the general area, presumably moving south. On Eliza Island, by 20 August, a build-up of pigeons into larger flocks became noticeable, and from all indications more birds would have been seen moving south at this time had stormy weather occurred. The 1953 study ended on 1 September, and no further observations were made from Eliza Island. However, the author remained in the Puget Sound area until 15 September, and casual observations showed that the pigeons' numbers were decreasing daily. Records indicate the southward migration was primarily completed by 15 September in 1952 and 1953, both on Eliza Island and nearby in the Puget Sound areas. The last birds seen on Eliza Island in 1951 were two on 25 October, both feeding on ripened madrone berries; four were observed in October 1952; there was no report for 1953. Neff (1947) cites 29 October as the latest fall record for the State of Washington.

Neff (1947) further notes more unusual sight records: "An Audubon Society Christmas Bird Count in the Puget Sound area in 1935 tallied 30 pigeons", and W. R. Ransom, in a letter of 15 April 1939, reported that "Small bunches quite regularly winter around Medina and Bellevue, Washington, along the east side of Lake Washington."

W. R. Ransom, in a letter from Glen Carter concerning the coast of Washington, summarized his 1953 pigeon observations during fall migration:

> All through late June and July, pigeons were seen abundantly in groups of two or three, sometimes single birds, all the way from the mouth of the Columbia River northward to the Strait of Juan de Fuca, on the seaward slope of the Coast Range mountains. About the first week in August, the first fall rainstorm swept in from the sea. Almost immediately afterward, pigeons were observed grouping together in various sized groups, usually under 20 birds each, and moving southward. Additional storms dropped over two inches (> 5 cm) of rain throughout August, and by late in the month a definite scarcity of pigeons was noticed on the entire coast where they were so readily seen only one month previous.

Although Glen Carter (letter to W. R. Ransom) indicates the migration started soon after the first storm in early August, the area north and east of the Straits of Juan de Fuca during 1953 had only mild weather during August and early September. Stormy weather along the coast influenced the bandtails to move south almost immediately in early August. Food may be abundant during the time that storms occur; nevertheless, the pigeons migrate. Some hardy individuals hanging on until late October are the exceptions to the storm factor. Pigeons in both 1952 and 1953 nested on Eliza Island into September; these nesting birds may be some of the late migrators. Weather apparently is the strongest factor in starting the birds south. This belief is also evident in other writers' observations.

Summarizing the Eliza Island spring and fall migration records, the bandtails were seen the earliest on 25 March 1951, and normally continued movements northward until late May. In the fall migration, by mid-August birds were moving south and the bulk were usually gone from the Puget Sound area by 20 September each year. Bandtails recorded latest in the fall were two on 25 October 1951 on Eliza Island.

Daily Habits

Bandtails that were not nesting could be seen on perch or could be heard cooing from within the forest approximately 30 to 45 minutes before sunrise. Within 30 minutes after the sun had risen most had flown to feeding areas. This first early morning sporadic feeding on madrone buds or flowers usually lasted an hour. These same birds would then rest in nearby trees and could be found feeding at almost any time during the daylight hours. This particular madrone feeding lasted from mid-April until the latter part of May. Ardent cooing and territorial flights were intermixed with this routine quite often.

Nesting duties comprised the daily routine for bandtails during late May, June, July, and August. Movements south were well underway by late August even though some pairs were nesting even into September.

Roosting often began 45 minutes to an hour or more before sundown in early summer. Bandtails, of all the island bird life, were among the earliest to begin roosting. Those pigeons with nests followed much different patterns. After nesting began, with consequent lessened feeding time, pigeons were often going to roost at sundown or later. Before breakup of flocks in spring for nesting, roosting was often in pairs with perhaps several pairs roosting in the same tree or small area. During nest building, incubation, brooding, and feeding the squab, the pairs usually kept to themselves at roosting time.

The following observations, noted on 3 May 1953, were typical of the pre-nesting bandtail's roosting habits. After pigeon droppings were found on the forest floor of the southern point of Eliza Island, a visit was made at 5:30 PM to this spot to ascertain the time and sequence of roosting. While I was lying on my back some 20 yards (18 m) from the roost, two bandtails dived into the dense forest area at 6:10 PM and landed in a nearby western red cedar (*Thuja plicata*). This red cedar was over-shadowed by taller grand and Douglas-fir trees and was some 150 yards (137 m) inside the forest edge.

One of the bandtails immediately settled down on a limb with its body low to the bough. Its head was pulled down low into its breast feathers. The second pigeon worked its way out to the denser tip of the branch and looked over the area with a cocking head motion. It then settled down and faced toward the north, or closest forest edge. The birds were approximately 25 feet (7.6 m) up in the red cedar, and at no time did they appear to see me lying nearby on the forest floor. At 6:40 PM two more bandtails fluttered noisily into the same red cedar. The two pigeons on roost paid little attention as the newly arrived birds settled down at a higher elevation. The roosting of the two pairs took place one hour and 13 minutes, and 43 minutes before sunset, respectively.

An example of a nesting pair's roosting habits can be shown by an observation on 9 August 1953. At 7:42 PM the female fed her squab on the nest, amid very low cooing of her mate nearby, and left at 7:46 PM. The female flew east about 50 yards (46 m) was joined by the male, and after some fluttering among grand fir branches they settled down six to eight feet (1.8–2.4 m) out on a dense bough about 35 feet (11 m) high.

Another nesting female normally could be found on a high perch about 75 yards (69 m) from her nest each evening prior to roosting. Knowing approximately where she had been roosting by herself, I laid down on the forest floor in this general area. At 7:05 PM a flutter of wings was heard in the fir branches some 60 feet (18 m) above me as the female dropped off her perch into the branches of a nearby Douglas-fir. Another flutter of wings occurred at 7:23 PM as the female dropped down a couple of limbs, then walked out approximately five feet (1.5 m) from the trunk to settle down on a fir bough. Sunset was 7:15 PM. Walking underneath this roost tree, I could see the bandtail facing toward an opening in the boughs about two feet (0.6 m) away. She never moved, as far as I could determine, as I walked around beneath her. The drab coloration of the bandtail in dark roosting tree areas plus its habit of closely hugging the branch and exhibiting little movement would preclude much chance of predation by birds of prey during roosting hours.

Trapping and Marking

Prebaiting

Grain was placed in Eliza Island fields in late April through June to attract bandtails to trapping areas, and pigeons from nearby islands and the mainland soon discovered the baited site (Figure 4). Instead of the 10 to 15 adults using the island daily prior to baiting, the number often increased to 100 to 200 within a few days after grain was put out. Bandtails are quick to note flights of pigeons going to and from new feeding areas. New birds quickly join the flights and are thus able to funnel into new feeding grounds such as the heavy baiting with grain on Eliza Island.

Wild foods and domestic grains in planted fields are limited when the first pigeons arrive in the Puget Sound area in early April. The modern-day farmer has taken more to drilling in his grains rather than hand broadcasting; therefore, pigeons find less waste grains in the fields. They do not dig for food in the ground and are limited to surface grain only.

Prebaiting, that is, liberal spreading of the grain long before the trap is first sprung, was very effective between 15 April and 15 May 1953 (Figure 4). If the same baiting timetable was used simultaneously elsewhere in the state, pigeons might be concentrated enough to obtain a fairly accurate pre-breeding population count in a 3- to 4-day count period. Wherever spring-plowed or fallow fields are found at this time of year, bandtails search diligently for food and quickly move on if none is found. Pigeons appear to indicate by their feeding flights that food is available, and bandtails for miles (kilometers) might be concentrated for a short counting period soon after their main arrival from the south.

In 1953, considerably more pigeons were present daily on Eliza Island due to very early prebaiting. Plentiful use of grain is essential to good trapping results and a sufficient prebaiting period to win the confidence of the birds (Figure 4). Wheat was the preferred grain taken by pigeons, although oats, barley, and corn were taken as second choices. Many songbirds, numbering 50 to 75 per day, ate the bait grain to gluttonous extent over a month's trapping period. On several occasions, a cock pheasant, which had set up the baited area as his territory, would enter the trap for the grain. Occasionally he would frighten the sensitive bandtails from the trap either by a violent crowing demonstration or by dashing at the pigeons. With plenty of grain for all, the situations created by the pheasant were decidedly more comical than serious.

Social Behavior

One of the large trees used by the bandtails for resting near the baited area on Eliza Island was a red cedar. The birds arriving early in the morning hours would perch on its branches from the top to almost the bottom if large numbers of 100 or more were present. As the morning sun in the east hit this tall red cedar it was like a large Christmas tree with its many blue ornaments—the pigeons. Watching this scene re-enacted many times left one with a great appreciation for nature's ability to create stirring pictures.

A late-arriving bird, probably from a nest change, would often try to land on an uppermost branch already full of pigeons and would be struck and pecked at all the way down the tree until it found room for itself. The scene was touched with humor since it appeared the late arrival just couldn't do anything right. Although belligerent at times, bandtails seldom harm one another, and usually bluff for the most part. It was not uncommon for several amorous males to be cooing, displaying in the air and in the tree, and to attempt copulation with any female that appeared receptive.

Figure 4. Prebaiting with mixed grains preparatory to trapping of band-tailed pigeons on Eliza Island, Washington, 1952–1953. The frame-style drop trap was placed in position and ample grain was distributed in order to win the pigeons' confidence prior to trapping when a net is spread across and attached to the frame. The picture is from the western point of Eliza Island, looking west toward Lummi Island.

Trapping

Trapping in the field was accomplished by use of a frame-style drop trap eight feet (2.4 m) deep and 18 feet (5.5 m) wide (Figure 4). The front elevated portion of the frame was six feet (1.8 m) high and was supported by a single brace, which enabled dropping of the trap from a blind at a considerable distance. A rope attached at the base of the single brace ran to the blind approximately 75 feet (22.9 m) away. A board was angled under the brace to allow easy tripping of the trap. A net of 1-inch (2.54 cm) mesh was used, which caused the net to sag in several places due to its overall weight. A lighter cord 1- to 2-inch (2.5 to 5.1 cm) mesh net would have been preferable. A piece of wire was attached to each of the leading corners of the elevated trap and anchored to the ground to steady the trap during windy periods. A second blind for photography was built about 30 feet (9 m) from the trap. It was built in teepee style and the covering was darkened so that pigeons could not see the observer's silhouette.

Whenever possible, a second person accompanied the author to the blind. As the bandtails flushed from nearby trees, one observer dropped into the blind while the second, acting as the decoy, continued away from the trap area. The pigeons would soon return to trees above the trap, apparently unsuspecting of the observer in the blind. Often within a few minutes, or not more than an hour, the birds were again feeding on the bait, allowing the trap to be sprung.

An experiment to examine the reflex actions of pigeons was made in which one observer pulled the trap brace and the second observer noted the first movement of pigeons inside the trap. When the brace was pulled, the front edge of the trap fell six feet (1.8 m) to the ground before any of the 41 bandtails inside made a visible move to escape. They remained motionless until the trap frame hit the ground, and then fluttered around attempting to escape, helpless, once under the net, as indicated by their feeble fluttering.

The observer crawled under one edge of the trap frame after the trap had been sprung, and immediately placed all pigeons in well-ventilated burlap sacks. These sacks restricted movement and the birds quickly became quiet in this semi-dark situation. When all were gathered, the trap frame was raised and the birds were taken from the sacks individually to be banded and released.

It was found advisable to avoid frightening away those pigeons that had not been trapped, to rebait heavily after dropping the trap, and to refrain from trapping at least a day or more. The pigeons usually regained their confidence in this period. Waiting longer periods between trappings is even more desirable.

It is also important after the banding of birds to pick up all the feathers that the birds lost in their movements to escape the trap or observer. Other pigeons will avoid the baited area if these feathers are not removed. Apparently bandtails associate danger with scattered feathers. This conclusion was made, also, in connection with trapping the now extinct passenger pigeon (*Ectopistes migratorius*). On resetting their nets, trappers had to remove every feather before pigeons would again alight (Schorger 1955:21).

The main reason for the many scattered feathers of band-tailed pigeons at the trap is that a certain degree of fright will cause them to be easily detached or loosened from the bird's body. This trait of feather detachment is peculiar to some pigeons and doves and to certain gallinaceous birds.

Windy weather makes trapping difficult since pigeons are then very flighty. Cooper's hawks (*Accipiter cooperii*) in the neighborhood also keep pigeons in a keyed-up state. This species of hawk would repeatedly flush the flock of pigeons waiting in trees near the baited trap. No pigeon was ever observed to be caught by this hawk at the baited area during the studies, and the pigeons would normally return to the rest tree in a short time after having been flushed by the hawk.

An excellent article, "A trapping technique for band-tailed pigeons" by William A. Wooten of the U.S. Fish and Wildlife Service, has been published in the Journal of Wildlife Management (July 1955, Vol. 19, No. 3). Use of the frame-style drop trap, similar to the one used on Eliza Island, is the basis for his article. Wooten's drop trap used in Oregon in 1953 enabled the capture of 212 pigeons in one drop. His trap frame measured 16 feet (4.9 m) square, had one and one-half inch (3.81 cm) mesh net covering with the frame made of two by four-inch (5.1 x 10.2 cm) lumber. A seven-foot (2.1 m) pole was used to elevate the front edge of the trap with a wire run to a sunken pit blind approximately 100 to 150 feet (30–46 m) from the trap.

Wooten (1955) reports 852 birds were trapped and banded during 1953 by the frame-style drop trap method in northern California, Oregon, and Washington. An intensified banding program had been initiated in 1952 by federal and state wildlife agencies in these three states. At this time the migration habits of the pigeons were little known; the limited information available was based on only a few banding returns.

Traps other than the drop trap have been used with varying degrees of success on bandtails. The use of cloverleaf and funnel-entrance traps does not allow too many bandtails to enter the trap as one or more pigeons feeding in the small entrance prevent others from entering. Small numbers only are caught by these types of traps (Neff and Culbreath 1947:22).

One of the most encouraging traps to be used in the past few years is the highly mobile and versatile cannon-net trap. The California Department of Fish and Game was the first to successfully use this trap on wild band-tailed pigeons. Following pre-baiting pigeons into an area, the cannon trap can be set up in 30 to 45 minutes with practice.

Basically, the net used may be 1- or 2-inch (2.5 or 5.1 cm) mesh, nylon or cotton, measuring 50 by 25 or 40 feet (15 x 7.6 or 12 m). The leading edge of the net is attached to ropes which are fastened to two five-pound (2.3 kg) projectiles. The projectiles are shot from cannons, which then carry the net over the baited area and the birds. The cannons can be detonated from a blind by use of a pull lanyard or a "hotshot" battery charge through electrical squibs tied into the shotgun shell charges. Experiments are being made with other methods of detonation.

Marking

Leg bands were attached to 167 field-trapped bandtails, and various wing or tail color marks were applied to aid in identifying adults at a particular nest. In this manner it was hoped a check could be made on the possibility of a second brood being raised by a particular marked pair. The trap days in 1952 were 2, 9, and 13 June when 19 adults were trapped and banded. No pigeons were trapped twice during this year. Of the four trapping dates in 1953, 9 and 29 May and 3 and 5 June, there were six repeats in the second trapping, none in the third, and seven in the fourth. This amounted to 22 repeats of 148 adults banded that year. No pigeon was ever caught more than twice.

Testors yellow model airplane paint, as used successfully by Swank (1952) in his work on trapping and marking mourning doves (*Zenaida macroura*) in Texas, was found to be satisfactory for field-marking band-tailed pigeons. The yellow offered good contrast, and the paint dried rapidly on the feathers as the acetone was exposed to the air. Yellow bars were painted on wings or tails to identify individual birds on the nest.

A nest trap, modified from Swank's design, was used in several cases, but lack of time and early desertions of nests, primarily due to hawk predation of squabs, prevented trapping of many adults to mark them for second brood studies. Only four of the adults banded and marked in the field were observed later during the summer. One of these adults was observed at one of the 30 Eliza nests found in 1953. There was limited marking success, and no pairs of bandtails were found to have nested twice during the year.

Band Returns

Of the 195 bandtails banded on Eliza Island during 1952–1953, 22 returns (return = recapture or recovery) have been made through 1957 (all in Washington, Oregon, and California), an 11% return rate (28 of 167 banded as an adult and 3 of 19 banded as a juvenile) (Table 2). Sixteen of the returns were a result of being shot by a hunter (8% hunter recovery rate over about a 5 year span post banding).

Neff (1947) states that in the United States:

> Up to 1 May 1940, only 185 band-tailed pigeons had been banded, and only 5 return records were in the files of the Fish and Wildlife Service. Three of these were of birds that had been banded by Ferris at Beaver, Oregon late in May 1932. One was shot at China Camp (Calaboose Canyon), Monterey County, California in December 1932; another in the "Monterey Hills" on 10 December 1933; and the third, 15 miles east of Gonzales, Monterey County, on the same date. A pigeon banded at Carmel, California in July 1937 was shot on 14 December 1937, near Atascadero, California, and one banded at the State Game Farm, at Chino, California, in June 1937 was found dead near Cucamonga, California, during the same month.

Two of the most gratifying returns from the Eliza Island studies were two adult bandtails banded on 9 June 1952 (Table 2). These two birds were recaptured on Eliza Island in the same field in 1953, one on 9 May and one on 29 May, almost a full year from the initial trapping date. In all probability, these two adults wintered in California and came back to Eliza Island the following spring in their northward migration. Considering a round trip to the San Francisco area or to the southern California border, these birds would have traveled distances of about 1,500 (2,424 km) to possibly more than 2,200 direct miles (3,540 km). Seven adults banded on Eliza Island have been taken by hunters in California, mainly in Santa Barbara and San Luis Obispo counties. That bandtails will fly from somewhere in central California in the early spring to Puget Sound to breed, and then return in the fall to winter in California, adds more plaudits to their record as hardy game birds. The aesthetic appreciation for this type of migrational habit cannot be underestimated.

One band recovery was from Oregon, and other recoveries were from Washington. The Oregon recovery represented a squab banded on 29 July 1952; it was taken during the September 1955 hunting season. Of the 28 squabs banded, this is the only band to date to be returned as a result of being shot.

Only through banding can the mysteries of migration routes, breeding, and wintering areas be detected. A more intensive banding program has been in place the past few years on the west coast and is bound to turn up much desired migrational and longevity records that will help to better manage bandtails. The bandtails banded through 1 January 1957, as indicated by the U.S. Fish and Wildlife Patuxent Wildlife Research Laboratory, total 3,218 (1950–1956).

Feeding Habits

Annual band-tailed pigeon distribution is influenced by availability of wild foods. The intermittent seasonal productivity of foods preferred by bandtails results in their wandering erratically in their search for available food. Plants may bear abundant crops one year, but may be succeeded by poor production in the following years. Thus, pigeons search out successful crops, which may make their annual movements highly unpredictable.

Bandtails seemingly are quick to locate new feeding areas by following feeding flights of other pigeons. Pigeons on Eliza Island normally rendezvoused with others before leaving for feeding areas, and other birds would join the flights from nearby land areas.

The bandtail's food consists primarily of acorns, pine nuts, various types of wild berries, fruits, buds, flowers, and catkins of shrubs and trees. Domestic fruits, grains, and peas also are taken, particularly when wild foods are scarce. This occurs especially in California where most pigeons of the Pacific Coast winter.

The first small numbers of pigeons involved in migration movements northward each spring for breeding purposes must search for either wild or domestic foods. During March and April of each year, the first birds usually are arriving at the northern end of the migration routes, Washington, British Columbia, Utah, and Colorado. As the birds enter the summer nesting season, wild fruits become increasingly available, and into autumn there are more varieties of fruits and berries plus acorns. They have ample foods from which to choose in their main southern migration, occurring normally in late August and early September.

Although it takes abundant food to attract and hold pigeons in a given area, in some cases the availability of food alone does not control the length of the birds' stay. At the start of the fall migrations in Washington, madrone trees in particular are heavily laden with ripe or ripening fruit.

The predominant foods taken in spring, summer, and fall in pigeon habitats of Washington and Oregon are acorns, dogwood (*Cornus* spp.) fruits, mountain-ash (*Sorbus* spp.) berries, blackberries (*Rubus ursinus)*, raspberries (*Rubus* spp.), thimbleberries (*Rubus* spp.), salmonberries (*Rubus* spp.), along with elderberries (*Sambucus* spp.), currants (*Ribes* spp.), and kinnikinnick (*Arctostaphylos uva-ursi)* berries.

Complaints of crop damage are made against pigeons for feeding to some extent on green prunes, broadcast grain, and field peas. It is noteworthy to report that surface grain is gleaned from the fields by bandtails, but in no instance have they been found scratching out drilled or covered seeds. Observations (Gabrielson and Jewett 1940) of pigeons feeding in pea fields revealed no damage to pea seeds drilled 4 to 6 inches (10–15 cm) deep. As with grain, the pigeons were at no time observed to scratch out well-drilled seed, being apparently content to wander about picking up peas spilled on the surface.

Band-tailed pigeon food habits for September 1946 and 1947 varied (Table 3). These 149 pigeon stomachs and crops were collected by the Oregon Cooperative Wildlife Research Unit and examined by Johnson A. Neff, Biologist, Wildlife Research Laboratory, Denver, Colorado. Listed are percentage by volume and frequency of occurrence of food items eaten. Appearing most frequently as food items were wild dogwood fruits, Oregon white oak (*Quercus garryana*) acorns, elderberry, and cascara (*Rhamnus purshiana*) fruits. Also represented in much lesser percentages were western hawthorn (*Crataegus douglasii*), wild cherry (*Prunus avium*), and western serviceberry (*Amelanchier alnifolia*) fruits, with only a trace of cultivated oats and barley.

J. A. Neff's examination of the crops of these wild pigeons revealed less gravel than any other group of like size he had ever examined. He observed that it is customary for pigeons feeding almost entirely on dogwood, cherry, and other fruits with hard woody pits to take limited amounts of gravel.

Bandtails observed feeding in fall near Mount Hood, Oregon, were apparently feeding in heather patches on the seeds of *Lupinus lyallii* of the legume or pea family (Gabrielson and Jewett 1940). Other wild legume seeds of unidentified species of clover (*Trifolium* spp.), lupine (*Lupinus* spp.), and trefoil (*Lotus* spp.) were eaten in California (Neff 1944).

Huey (1913), working in the Cuyamaca Range of San Diego County, California, observed about 100 bandtails on 3 July 1910 feeding on green manzanita berries. It could well have been the male breeders feeding since Huey reports the birds arrived shortly after sunrise to feed, left between 8:00 and 9:00 AM, then returned in the evening about 4:00 PM and stayed until dark. During the nesting season, feeding periods begin or end at approximately the times when the male replaces

the female in the morning or leaves the nest in the afternoon.

Food preferences on Eliza Island between April and October of the two study years, 1952 and 1953, were first the buds or flowers of numerous madrone trees. Douglas-fir leaf buds and the catkins of grand fir were also taken in early spring. The island grain fields were searched periodically by arriving pigeons in their quest for food. Red elderberries on Eliza Island, nearby islands, and the mainland were used predominately by nesting adults and as supplemental food for the squabs in addition to pigeon 'milk' during June, July, and part of August. Salal (*Gaultheria shallon*) berries followed elderberries, with dogwood appearing in the diet in September. Those pigeons still on the island after the ripening of madrone fruit in September and October avidly ate this food. Wild cherries were eaten by adults from Eliza Island's few trees, but did not appear in the nest droppings as far as could be determined.

Observations on nearby islands and the mainland in August and September showed pigeons eating mainly wild cherries, huckleberries, manzanita berries, coffeeberries (*Rhamnus californica*), blackberries, salal berries, and acorns. The main acorn and pine nut mast crops are found further south in Oregon and California.

The following feeding habits were observed between 11 April and September 1952 on Eliza Island. They show specifically the dates, time of day, and feeding habits for this year. On 11 April, two bandtails were observed in a madrone tree feeding upon the unopened flower buds. There were about 100 madrone trees on the island; this particular tree was in early flower. Daily feeding by pigeons varying from two to five on the above tree continued until 18 April.

On 18 April, one bandtail observed at a distance appeared to be eating something from the branches of a grand fir. The exact nature of this food was determined on 23 April. At 5:20 AM, 19 pigeons landed in a grand fir some 50 yards (46 m) distant and began feeding on the staminate catkins. The birds would feed for 10 to 15 minutes, and then fly to a nearby bigleaf maple (Acer macrophyllum) where they sat 20 to 30 minutes before returning to the fir. They continued this procedure through the morning. At 3:00 PM on the same day, 18 bandtails were flushed from the above fir, and the catkins were closely checked. Many were still rather firm while others had opened and fine pollen was shed. It is not definitely known which type of catkin was taken, firm or pollen-shedding, but since this was one of the few grand firs with any firm staminate catkins left at that time, it might possibly indicate the birds prefer that type. No specimens of birds eating the catkins were taken for crop examination. An interesting point is that although Douglas-fir is at least equally as abundant as grand fir on the island, at no time were pigeons seen eating anything from Douglas-fir.

On 24 April, 12 bandtails were observed feeding in a young grand fir at the southern end of Eliza Island, the last date pigeons were observed feeding in any grand fir. Due to observations being made from outside the forest in the first part of the month, it seems reasonable to assume the pigeons probably were feeding on firs in areas obscured from view earlier than the recorded dates.

During the above-mentioned feeding period in grand firs, madrone trees were being frequented by larger numbers of pigeons. By 28 April, many new budding madrones were being used with 10 to 20 pigeons being flushed almost daily from their branches. Specimens of two bandtails feeding on madrones were collected under a U.S. Fish and Wildlife Service permit. An adult male was collected from a madrone tree on 3 May. This pigeon had a full crop and gizzard, and weighed 17 ounces (482 g). Examination revealed the flowers and unopened buds were being taken as suspected. A second specimen was collected on 11 May. It was an adult male; both specimens had well-developed testes. Weight of the second pigeon was 14 ounces (397 g). Its crop likewise contained madrone buds and flowers.

By 16 May, other madrone trees were being fed upon, since the first flowering trees used in April had begun to fruit. However, at this time the pigeons began to fly to either Lummi Island or the northern mainland for other types of food. The last pigeon observed to feed in a madrone tree on Eliza Island was on 23 May.

It appears that adult nesting birds prefer red elderberries for their early summer diet. One nest showed red elderberry fruit being fed the squab as early as 4 June. Grain was taken in May and June or whenever available either on Eliza Island during the baiting period or in the mainland fields. Normally only exposed grains remaining from the broadcast spring planting would be gleaned by the pigeons from the fields.

Feeding on madrone fruit was first noted in early fall (25 August) on Eliza Island. On this date, one band-tailed pigeon ate a few berries, only a few of which were coloring on the tree. Salal berries were ripening in August and eight pigeons were flushed from these bushes on 27–28 August. On the south point of Eliza Island, six to ten pigeons were often seen feeding in salal patches during September following the end of nesting. Some early-ripening madrone berries were also being used at this time, but most pigeons had migrated south by the time the madrone crop became fully mature. The latest date that pigeons were seen feeding on madrone berries on Eliza Island was on 25 October.

General food habit observations were made on Eliza Island during the intensive 1953 nesting study (Table 4). No live birds were intentionally collected for food habit analyses, nor was a new nest scat analysis made. Food preferences between 12 April and 12

September 1953 were very similar to those apparent from observations in 1952.

Game protector Charlie Long, Washington Department of Game, has observed pigeons feeding on over-ripe madrone fruits in the Puget Sound islands. He reported these birds, after eating a considerable number of fermenting madrone fruit, would flutter around on the ground in an inebriated condition. Approached closely by a human, the pigeons had considerable difficulty eluding the person. Other varieties of over-ripe berries cause similar reactions in pigeons. A heavy diet of madrone fruits results in portions of the pigeon's body flesh becoming discolored; this would apply also to salal and hawthorn berries.

Domestic garden peas (*Pisum sativum*) formed 4.8% of the food of 639 pigeons collected in five western states (Neff 1944). The cultivated peas were all from birds taken in Washington and represent waste or valuable products for the entire year. Use of this food is also described by J. A. Munro (1922) for British Columbia and is reported from certain areas in Oregon and California.

Some foods used to attract and trap wild pigeons in Washington were described by Ransom (1956):

> Popped and unpopped popcorn: Sep, Oct, Jan, Mar, Apr
> Whole yellow field corn: Jan, Mar, Apr
> Dried sweet corn kernels: Jan
> Mountain ash berries: Sep
> *Ailanthus altissima* seeds (Tree of Heaven): Sep
> Sunflower seeds-whole: Jan, Feb, Mar
> Buds of cottonwood (*Populus* spp.) and other poplar trees: Apr, May
> Peanut butter mix: Nov, Dec, Jan
> This food is so foreign to what a band-tailed pigeon in the wild would naturally find that it was extremely amusing to watch them cram their throats with it and then swallow time after time to get it to go on down to their crops. They seemed to relish it however.

Band-tailed pigeons choose to drink salt water at the margin of Puget Sound mud flats even though freshwater streams are available according to Neff (1947). The bandtail is attracted to mineral springs heavy in salt concentration. Salt is also attractive to white-winged (*Zenaida asiatica*) and mourning doves according to Wing (1956).

Molting

Molting information concerning the bandtail that has been published to date is limited. From Bent (1932:357):

> The juvenal plumage is much like that of the adult, but it lacks the white collar and the iridescent metallic colors on the neck; the vinaceous tints are wholly lacking; and the feathers of the breast and wing coverts are narrowly edged with whitish, giving a slightly scaly effect. Molting birds are scarce in collections, but apparently young birds have a complete molt during the first fall, which produces a practically adult plumage. I have been unable to trace the molts of adults, but a complete molt probably occurs, as it does in European pigeons, during summer and fall; this may begin as early as May or June and end as late as October or November.

Aviary studies noted by Neff and Culbreath (1947:20) indicate:

> Male birds in the wild and in the aviary are observed as possessing a distinguishing coloration on the breast; certain writers call it pinkish-brown or vinaceous; the present investigators call it a purplish or raspberry tint. We feel that the extent and intensity of the raspberry tint on the breasts of the male birds is the best physical characteristic of sex; it is least evident during the period from November through March. During this period there is a definite fading of this dominant characteristic until the spring molt; this occurred in March in the aviary birds. Sex determination is impossible from external physical marking from November to late in March. From March to May the raspberry hues on the breasts of the males may be expected to intensify.

Molting by pigeons on Eliza Island became noticeable during June in both 1952 and 1953 with feathers found in fresh nests. Molting increased into July and August, but was beginning to taper off by mid-September. This was a complete molt, judging from the tail, wing, and other body feathers that were found on the island or noted missing on flying pigeons. As many as 15 to 25 molted adult feathers were found in an individual nest during August. A study of Colorado band-tailed pigeons collected in September 1945 showed considerable molt underway (Neff 1947:5).

During observations on 18 August 1953 of a flight route between Orcas Island and the Lummi Indian Reservation on the mainland, the molt was very evident since many birds had wing flight feathers missing. Some 400 pigeons were counted this particular day with a great deal in molt. A check of this same flight route on 26 July had revealed only a minority to be molting wing feathers. An incidental observation of interest was that the majority of the pigeons flew with their bills open.

It was not evident that squabs molted any feathers in their nests, although most of the yellow or whitish down present at hatching was shed or picked off the body by the squab by the time it was ready to leave the nest area. No neck ring was present at this time, but it was acquired before the next spring by a molt, presumably in the fall, which produced the adult plumage.

Ranges and Nesting Season

Pacific Coast

Band-tailed pigeons in their northernmost breeding areas are summer visitors to the Gulf Islands, Puget Sound lowlands, and the Coast Forest Biotic Province of British Columbia. Munroe and Cowan (1947) reported eggs at Victoria, Vancouver Island from 15 April to 30 June; Coquitlam on 30 April 1934; Salt Spring Island in June 1900; and on De Horsey Island on 23 June 1945.

Bent (1932:354) cites E. A. Kitchin as saying the bandtail nesting season in the state of Washington lasted from April through June. Arthur S. Einarsen (letter of 15 December 1939) reported a nest near Triton Cove, Hood's Canal Highway that on 24 August 1939 contained a squab about a week old. Hagenstein (1936) observed a nest containing a squab near Seattle on 17 October 1935.

On Eliza Island in 1952 and 1953, the overall nesting season from eggs to fledged squabs ranged from April into September (Tables 5 and 6). First eggs representing the earliest nesters each year were found between 23 and 30 April. Two squabs did not leave their nests until 3 and 12 September during 1952 and two left their nests on 22 and 23 September 1953. The spread of these dates, plus observations of copulation in early spring and in late July, indicate that at least some bandtail pairs might have time to bring off two broods in one year. Those pigeons arriving late may not be able to nest before May or June, thus elongating the nesting season. Bandtails will renest if their first attempts are hampered by accidents, predation, or other factors. This is another, possibly a primary reason, for some of the widespread nesting dates noted in the Puget Sound, Washington nesting areas.

Nesting seasons in the state of Oregon are reported by Gabrielson and Jewett (1940). They reported that egg-laying in Oregon is at its height late in May and in June, and give 3 May and 12 July as the known extremes of the season. Jewett (1941) later recorded a nest with two eggs in Yamhill County, Oregon on 30 September 1940.

Grinnell et al. (1918), reporting on the nesting season for California, list nests containing eggs or young from 5 March to 23 August. Neff (1947) further reports that:

> A. C. Oberle (letter of 15 April 1935) says that nesting has been observed on the Laurette Ranch north of San Dimas, California, and in Brown's Flat, the first nesting starting about 1 April. Eggs were observed into May. Apparently each nest contained but one egg at a time. Abbott (1927) quoted Bushnell's observation of a nest that contained one egg on 8 March 1925, and later a second egg that hatched in mid-May. Moran (1919) relates finding a nest with one well-incubated egg on 30 March 1895 at the head of Lopez Canyon, San Luis Obispo County. Grinnell (1928) watched a squab being fed in a nest on 29 September 1927. Stillman (1928) describes a young bird that left its nest in San Diego County on 2 October. Kloppenburg (1922) noted a nest in the Plumas National Forest that contained one egg in mid-September. Derby (1920) recorded one containing a naked squab on 1 September 1920 at 6,500 feet (1,981 m) elevation on the headwaters of Deer Creek, Sequoia National Forest.

A literature survey of band-tailed pigeon nesting dates in California was made by Dehnel (1947), which shows nesting as early as February and one young leaving its nest on 1 November. The majority of these observations were made from central California southward, and the spread of these nesting dates through 10 months of the year indicates that it would be possible for some pairs of pigeons to raise more than one brood in a year.

Later studies from California include those of Glover (1953) and MacGregor and Smith (1955); their work adds more light to the nesting season of the secretive band-tailed pigeon. Glover (1953) reported the peak of the nesting season was 15 June to 15 July for his northwestern California, Humboldt County study area. The nesting season in the Humboldt Bay region was earlier reported by Davis (1938) as peaking about 15 June.

MacGregor and Smith (1955) in a west-central California nesting and reproduction study of the bandtail between 1952 and 1955 reported that nesting occurred as early as February and as late as October. Peeters (1962) indicated that nesting activity in his Strawberry Canyon study area did not commence until 28 May in 1961, but had started by April in 1962 as indicated by prenuptial displays.

The northernmost reported nesting location for the band-tailed pigeon in California is Requa, Del Norte County according to J. Mailliard (1923, in Grinnell and Miller 1944). These authors note Stephens (1913) as reporting the southernmost breeding location as Laguna Mountain, San Diego County.

Rocky Mountains

The Rocky Mountains population of band-tailed pigeons in the U.S. includes Utah, Colorado, Arizona, New Mexico, and western Texas. Pigeons in this region are much less numerous than those of the Pacific Coast. Records of nests are less numerous, also, since the birds are scattered widely, but with added interest and research, more nests may be found in coming years.

Neff (1947) noted that only meager records were available for Utah. Lee Griner recorded one active band-tailed pigeon nest in June and Clarence Cottam (1941) observed a juvenile bandtail only recently out of the nest on 24 July. Rawley and Bailey (1964) report nesting in Utah occurs in June and July.

Colorado had no documented band-tailed pigeon nesting records until 1945 when J. A. Neff and R. J. Niedrach found two nests (Neff 1947). The pigeons had been present over a wide area, and it was assumed they were nesting, but no nests were found until that year when one was located on 22 August and the second on 31 August. Neff and Niedrach (1946) believed the nesting season of 1945 was from 1 July to 30 August with possibly some pairs nesting earlier or later.

Interviews with forest rangers in Colorado during 1946 produced the following details in connection with pigeon nests prior to 1945. Neff and Culbreath (1947) reported:

> M. F. Darley, retired, Monte Vista, found his first pigeon nest in Corbett Gulch 5 miles [8 km] northwest of Ouray in what is now the Uncompahgre National Forest, in August 1904. …
>
> M. R. Hickel, District Ranger, now at Salida, reports that in 1940 he found 4 bandtail nests in early September in cottonwood trees along Crystal Creek east of Crawford, on the margin of the Gunnison National Forest. R. K. Gierisch, district ranger, Westcliffe, found a single nest in a yellow pine [*Pinus* spp.] at approximately 9,500 feet [2,896 m] above the South Fork of Hayden Creek, Sangre de Cristo Range, in August, 1944.

Although extensive nest searches were made by Neff and Culbreath (1947) in the Rampart Range, Pike National Forest, no nests were found. "The area where the birds were active in 1945 was almost devoid of activity in 1946, though they fed at the same location on the Perry Park Ranch." This was the same area where Neff and Niedrach (1946) discovered two nests in 1945.

Niedrach and Matteson (1949) reported that four nests were found by Mr. Niedrach in Colorado:

> The first of these was found 5 August and contained an egg which was determined to have been freshly laid. At the time of this writing (October 1949) the squab has become feathered and thence airborne. Two more nests were found, one each on 11 and 12 August, each having a fully feathered squab in the branches of the tree containing the nest. Still another nest was found on 2 September, this one containing an egg. It was noted in this report that all of the nests found during 1949 were in the same vicinity of nests found in the preceding years near the head of Bear Canyon, Colorado.

Neff (1947) noted the following observations on bandtail nesting seasons for Arizona:

> In Arizona, according to Bendire's (1892) correspondents, nesting occurred in nearly every month of the year. Poling, writing to him from Fort Huachuca of various nests, said, "I have taken young two or three months old in February, and since that time young and eggs enough to show that they lay and nest from December to August." Benson reported nesting of bandtails in the Huachuca Mountains from early July to late October; Willard (1913) noted an October nest; and Vorhies (1928) one in September. On Pinal Mountain south of Globe, Arizona, Carlos Stannard reported nests as follows: 18 August 1940, one egg; 19 August 1940, squab ready to fly; 23 August 1940, a squab about 4 days old, which was still in the nest on 30 August; and on 14 August 1941, four nests, one with eggs, three with squabs between 1 and 3 weeks old. Considerable field work by the writer, accompanied by State game wardens, leads to the conclusion that in southern Arizona nesting most commonly begins early in May, though occasionally earlier.

Paul Webb and W. H. Bohl on 17 August 1954 on Mogollon Mesa of central Arizona were awakened at 05:30 AM in the morning to the sounds of male pigeons cooing in the forest. One territorial flight was observed and buzzing calls were heard as males chased others from their nesting areas. At least two males attempted copulation among the females in the group of 25 to 30 birds present. An excellent acorn crop was being used by these pigeons on this date. The forest here was mainly pine (*Pinus* spp.) and oaks (*Quercus* spp.).

There are reports of widespread pigeon nesting in New Mexico over the many scattered mountain ranges. Neff (1947) summarized observations of nesting by bandtails in New Mexico:

> For New Mexico, Mrs. Florence Merriam Bailey (1928) lists a number of interesting records, chief among them being that of a nest containing one well-incubated egg on 23 April 1922, 16 miles [26 km] northeast of Santa Fe, at 10,500 feet [3,200 m] elevation, well above the snow line. There are also records for the Animas Mountains, Guadalupe Mountains, Monument Pass, Black Mountains, and the Pecos, Sacramento, Sandia, Taos, Sangre de Cristo, Jemez, and Mogollon ranges, the dates extending from 3 June to mid-August, and the elevations from 5,800 to 8,000 feet [1,768 to 2,438 m].

A pigeon nest with one egg was located on 1 September 1948 in the Black Range by Alton Ford, a New Mexico Department of Game and Fish trapper. On Hay Mesa in this same range a pigeon squab was located on 17 September 1948 by A. Ford and E. M. Lang, biologist with the New Mexico Department of Game and Fish. Several more active nests were observed in the near vicinity of the above nest in this period (personal communication, A. Ford and E. M. Lang). A pigeon nest with a squab was discovered in the second week of September 1948 on the Fort Bayard Refuge in the Pinos Altos Range by John Shaul, New Mexico Department of Game and Fish trapper (personal communication).

Other nesting records for New Mexico cited in Neff (1952) are:

> State Trapper Dudley Messer, New Mexico, reported under date of 30 July as follows: Three miles (5 km) east of Mimbres post office, on west side of Hedrick's Peak, Black Range. Nest with one egg at this location in a pinon [*Pinus* spp.] tree.

Ranger A. J. Riggs, Silver City District, Gila National Forest, stated in 1954 (USFWS 1955):

> Reports from local residents indicate there were more birds seen this year than in the past four or five. Birds were distributed in the higher mountain areas during June and July but most of them migrated to the woodland type or left the country entirely after continued rains in August. Three nests, two with one bird each and one with one egg, were found in the near vicinity of Signal Peak.

Further consultation with Ranger Riggs revealed these nests were found in June and July 1954.

A report by Mr. Arnold Payne (Neff 1952) indicated:

> … observed band-tailed pigeons in the Animas Mountains periodically throughout July, August, and September. On 16 July, he found one young squab in the nest in Bear Canyon; his report indicates that this bird was about ready to leave the nest on 29 July. On that date he observed 397 birds in Bear and Pine canyons. On 12 August, he located a nest with one egg in a pine tree at Indian Creek Springs. The latter nest was empty on 23 August. On 8 September, he located a nest with one egg at the head of Pine Canyon. On 15 September, he located two nests—one at Indian Creek Springs and one in Indian Creek Canyon. He visited the nest in this canyon on 18 September and a bird was still on the nest.

W. H. Bohl observed bandtail nesting activity on 22 June 1955 at 4,500 feet (1,372 m) in the Animas Mountains of extreme southwestern New Mexico that included several males cooing in the canyons and on the hillsides. Several territorial flutter flights accompanied by buzzing calls were observed and one nest just being constructed was located up the hillside a short distance from a water tank. A squab estimated to be 3 to 4 days old was present in this nest on 18 July. Near the Mayhill Ranger Station, Sacramento Mountains on 9 August 1954, W. H. Bohl observed 100 to 150 pigeons scurrying over freshly-planted grain fields. Some calling was heard from birds perched in juniper (*Juniperus* spp.) trees near the field. One male displayed before a female and in attempting copulation was rejected. Two young of the year, as indicated by their lack of neck-rings, were present at the fields.

W. H. Bohl, while riding horseback up Little Turkey Creek on 19 August 1956 in the Mogollon Range, Gila National Forest, found a bandtail nest with the adult hovering over a squab, approximately 10 days old, during a light rain. When the nest tree was approached, the adult flushed, giving the cripple act, and the squab settled low in the nest.

Two observations of bandtails nesting in Texas were cited by Neff (1947).

> In Texas, Ray Williams, State Game Warden, observed a pair of pigeons building a nest on 22 April 1933 in the Davis Mountains, and saw a nest containing an egg in the Chisos Mountains in July of that year.

Mexico

Information on the breeding areas and season for the band-tailed pigeon in Mexico, Baja California, and other locations to the south has been meager due mainly to a lack of observers. However, several sources were located. Friedmann et al. (1950) differentiated between the subspecies of the bandtail in the United States and those of Mexico and Baja California. They report Columba *[Patagioenas] fasciata monilis* as being present during the breeding season from northern Baja California, Mexico to southwestern British Columbia.

The subspecies Columba [*Patagioenas*] *fasciata vioscae* is found in Mexico and is confined to southern Baja California where it is resident in the oak belt (Upper Sonoran Life-zone) of the Cape District, an area south of latitude 23.75° N. Friedmann et al. (1950) note this race sometimes descends into the foothills. The nesting season of Viosca's pigeon is described as variable or very much prolonged during the year. "Reliable observers have found this pigeon nesting in January, February, March, April, May, June, July, August, September, and December" according to Bent (1932:362).

The subspecies Columba [*Patagioenas*] *fasciata fasciata*, as reported by Bent (1932):

> … breeds in Rocky Mountain States from Colorado south to Pacific Cordillera of Guatemala, wintering from California southward. It breeds in Mexico commonly from northern Sonora east to Coahuila (Diamante Pass), and south, chiefly above 5,000 feet [1,524 m] through both the Sierra Madre Oriental and Sierra Madre Occidental to Guerrero, Chiapas, and Veracruz; winters from at least 6,500 feet [1,981 m] (Babizos, northeast Sinaloa), to somewhat lower altitudes. It has been recorded from Sonora, Sinaloa, Nayarit, Jalisco, Colima, Michoacan, Guerrero, Oaxaca, Chiapas, Chihuahua, Durango, Zacatecas, Guanajuato, Coahuila, San Luis Potosi, Hidalgo, Puebla, Nuevo Leon, Tamaulipas and Veracruz.

Blake (1953) in his book, Birds of Mexico, does not list details for the breeding season for the bandtail in Mexico, but gives the following data:

> Distribution—highlands generally, chiefly above 5,000 feet [1,524 M].
>
> Races—*C. f. monilis* (northern Baja California). *C. f. vioscae* (mountains and foothills of southern Baja California). *C. f. fasciata* (mountain forests, exclusive of Baja California).

Leopold (1959) considered the band-tailed pigeon, which ranges from Baja California to Chiapas, "… nearly as dependable an indicator of pine-oak forest in Mexico as the Montezuma quail [*Cyrtonyx montezumae*]." He reports that pigeons breed over most or all of this range in local colonies but are not uniformly distributed. Of interest are his comments on the seasonal behavior of pigeons in Mexico as he noted them during 12 to 14 years:

> In winter the birds gather into groups of 10 to 100 and shift about widely, following the mast of acorns, manzanita berries, and other winter foods. There is a definite southward influx of birds from the western United States into northern Baja California and probably into Sonora and Chihuahua at that season. But over most of Mexico seasonal movements are local and in no particular direction. In spring the flocks drift back to their breeding areas.

Leopold (1959) reported the band-tailed pigeon nesting season in Mexico as being long, extending from at least May to August. He further noted that on 2 June that he:

> … collected a male bandtail in full breeding condition near Los Reyes, Michoacan, and a few days later on 8 June, I found two nests high in oak trees on the slopes of Mt. Tancitaro. At the same time in this locality we collected well-grown young that had left the nest, indicating that breeding had been in progress for well over a month. The latest nest encountered during the survey was found 18 August near Pacheco, Chihuahua, but on 10 September, I collected two adults on the Cerro San Felipe, Oazaca, whose gonads indicated recent cessation of breeding.

Dr. Leopold surmises from this type of lengthy nesting season and from research data collected in California that each pair of pigeons may complete several nesting cycles during each summer.

On 17 July 1955 a bandtail nest was found by W. H. Bohl along Cajon Bonitc Creek in the State of Chihuahua, Mexico, just south of the New Mexico border. An adult was incubating the egg in the middle of a very warm day. Nesting activity appeared strong here. Over 100 pigeons were seen, occasionally displaying territorial flights and calls, and much cooing was occurring during the day along the sycamore-lined creek with its running stream.

A. F. Skutch (personal letter, 21 July 1956) cited the following data from the mountains above Tecpan, Department of Chimaltenango, Guatemala:

> The nest was found on a bushy hillside about 9,000 feet [2,743 m] above sea level and the

carelessly constructed platform of coarse sticks, measuring about 7 to 8 inches [18–20 cm] in diameter, rested on a large branch against the main trunk 20 feet [6 m] above the ground. On 13 March 1933, it contained one pure white egg, which was about equally blunt on the two ends and measured 0.5 by 1.1 inches [1.3 by 2.8 cm]. It had not hatched by 23 March, and when I next visited the nest on 28 March it had vanished.

Courtship

From the time the first pigeons arrived at Eliza Island from the south, it was apparent that the breeding season was imminent. In both 1952 and 1953, not all of the first arrivals were paired, and fighting and chasing among males was noticeable over the island. Courting desires were exhibited by males pursuing females high in the air or through the treetops. Ardent cooing and showy fluttering flights accompanied by raspy buzzes were other expressions by the males.

The first cooing heard in 1952 was on 11 April, and on 3 April in 1953. Territorial flutter flights were occurring just prior to these dates. These expressions of courtship and defenses of a pair's nesting grounds rapidly increased as more pigeons arrived from the south. Active months of courtship were May, June, and early July with a distinct tapering off by August. The last day cooing was heard in 1953 was on 20 August.

Glover (1953) reported cooing was first heard on 27 April in northwestern California with the peak occurring during the last half of June and early July. The last cooing he heard that year was on 15 August, illustrating a parallel between the two widely separated breeding areas.

Cooing, or owl-like hooting, by the bandtail is as variable as its many other calls, mannerisms, and flights. Florence M. Bailey (in Bent 1932:359) described its wide variety of cooing:

> Sometimes it is a calm whoo'-whoo-hoo, whoo'-whoo-hoo, and others a spirited hoop'-ah-whoo', and again a two syllable Whoo'-ugh, made up of a short hard hoot and a long coo, as if the breath was sharply expelled for the first note and drawn in for the second.

The procedure of the cooing exhibition has been aptly documented by J. H. Wales in Bent (1932:359):

> When the male pigeon starts this performance he usually maneuvers around for a firm footing and perhaps opens his bill slightly once or twice. Next he stretches his neck out in a line parallel with the axis of his body, and bends his head down to a right angle. With his bill open a crack he gives one gasp which fills out the skin of his neck until about three times natural size, and at the same time utters a very faint oo which is not usually audible over 20 feet [6 m]. All of these are preliminary actions, as directly following the first sound comes the whoo-oo. This hoot is made by a quick expelling of the air from the bird's lungs, and is accompanied by a slight downward push, which seems to give abruptness to the first note. The swelled neck skin is not reduced, as the bill is opened and the lungs are refilled for the following coo. There are usually about seven or eight of these hoots in a series, but sometimes as many as eleven. When finished, the male pigeon brings his neck back into its natural position and allows the air to escape from under the neck skin. This performance is repeated at irregular intervals through the early morning and the latter part of the afternoon.

Harry S. Swarth in Bent (1932:354) states:

> During the breeding season the male bird is fond of sitting in some elevated position, usually the top of a tall dead pine, giving utterance, at frequent intervals, to a loud coo, more like the note of an owl than a pigeon, which can be heard at a considerable distance; while occasionally he launches himself into the air with wings and tail stiffly outspread, describes a large circle back to his starting point, uttering meanwhile a peculiar wheezing noise impossible of description. I had supposed that this noise was made by the outspread wings, but a male...in captivity... gave utterance to the same sound whenever angered or excited, evidently by means of his vocal organs, as we had ample opportunity of observing.

Behavior of the Viosca's pigeon (*Columba [Patagioenas] fasciata vioscae*) is similar to the band-tailed pigeon, as evidenced by the comments of Lamb (1926):

> The first bird voices one hears in the early morning in the live-oak region are those of the narrow-fronted woodpeckers [acorn woodpecker, *Melanerpes formicivoris*], closely followed by the Viosca pigeons, whose mellow whoo-whoo (first note short, second long and slightly lower) sounds almost human, as if someone were trying to attract attention. From the specimens taken I learned it was only the males that make this sound. At this time, the birds perch upon some dead or bare limb, usually at some elevation. They are frequently seen fluttering spirally with short wing-beats

> or sailing slowly over some clearing, and then an entirely different note is uttered, at short intervals, hard to describe, but which could be called a sort of hoarse, gutteral croak, sounded for the sustained period.

These observations by Mr. Lamb indicate the males were in the breeding season, and the fluttering flights apparently are the same as the band-tailed pigeon territorial exhibitions displayed in the United States. There is no doubt that this call, this peculiar wheezing noise, like a modified chirping of a cricket, gutteral croak, or buzzing, the word used by this author, are all attempts to describe one and the same call, and it is indeed of vocal origin.

Band-tailed pigeons definitely have a language of their own in their variety of calls. Other than cooing, which is heard only in the breeding season, the buzzes or spitting-like calls may be heard in some variation throughout the year. A warning call is often heard when pigeons are feeding in a tree and the birds are crowded. It may be described as a low, but sharp, guttural-type call and when given appears to mean "move over" or "give me plenty of room." This same type of call was used by one of a group of 12 bandtails resting in a fir, apparently as a warning of my approach. The birds immediately became alert and flushed, although they were not closely approached.

Female bandtails also issue a modification of the buzzing call. This was heard first at one nest, which contained an incubating female. Her mate had just landed nearby in readiness for the morning nest change after having given several territorial flight buzzes. From a distance of 30 yards (27 m) she could be heard to issue a guttural call several times as if expressing impatience to be relieved of her nesting duty. The female used this call, also, for urging the male to bring more twigs to the nest when building was in process. This performance was witnessed by W. H. Bohl on Eliza Island in 1953 and in the Animas Mountains of southwestern New Mexico in 1955. Low buzzing-like calls often were emitted by both adults as they made the exchange in their nest incubating or brooding jobs. These calls are not like those of the female when she exhibits impatience, but more of a pleasant passing exchange coming only at the moment of nest transfer of partners.

The male was observed cooing on the nest infrequently during incubation, brooding, and while feeding the squab after brooding had ceased. In several observations, the male cooed to the squab before coming to the nest and cooed on the nest platform during the quick feeding of the squab. If the female made any similar sounds at the nest they were inaudible to the observer. Schorger (1955) refers to the passenger pigeon also giving a call for requesting nest material:

Ruthven Deane mentions that the female uttered a specific signal for the delivery of nesting material.

Squabs were often heard to utter thin piping notes from the nest platform and fledglings just out of the nest were heard occasionally. This call was their method of pleading for food, as they were dependent upon the adults. The piping sounds often indicated the adult's presence in the vicinity of the nest before it could be seen by the observer from the blind. These notes could be heard up to a distance of 25 yards (23 m).

The adult male flutter flights, which appear only during the pigeon breeding season, are phenomenal sights to see. This peculiar flight has been reported by Pearse (1935) from British Columbia, and others. It is described as short flights in a hesitant quivering manner with the bird appearing at times to be floating. The tail is spread wide with the wings moving in a fluttering motion. Pearse (1935) further reports this type of flight was accompanied by two separate calls, one of which he described as being like the modified chirping of a cricket. This description, in general, corresponds to the many observed bandtail displays on Eliza Island except for the length of these flights and number of calls issued.

At Eliza Island, length of the flights ran from short circling distances to one-quarter of a mile (0.4 km) in a relatively straight line. In most cases, a series of fluttering flights combined with direct flights were involved in the longer distances. In these flights, rather than only two separate calls per flight, there seemed to be no set number. The calls can be described as "buzzes" of short duration. Series of these buzzes were heard with as many as ten separate or grouped ones issued in a single flight. Three to six buzzes perhaps would be more of an average. The number of calls seemed to depend upon the length of flight, desire to display, and territory-defending enthusiasm. The buzzing sounds during territorial flights appeared to be an expression of challenge or irritation against other bandtails rather than wooing calls directed to the female.

Normally the buzzes accompanied the fluttering flights, but they were also heard in rapid direct flight to a much lesser extent. The buzzes were loud enough that on calm days they could be heard at a distance of several hundred yards (m). There are several other bandtail calls that are similar in tone to the buzzes, having a quality of raspiness, only they are much less amplified and can be heard only at closer ranges.

There is no doubt that the described short circling flights with accompanying buzzing are a territorial flight used primarily to delineate the nesting area. The female may or may not be stimulated or attracted by these flights. When this same flight encompasses larger areas, which include the actual or intended nest site, these are classified by the author as "territorial flights." This is a means of notifying other pigeons of his territory. Courtship and territorial flights were also given by unpaired males, seem-

ingly in their desire to attract a female or indicate a territory where nesting could be undertaken.

Some flutter flights were observed at the trap feeding area some distance removed from the actual nest territorial areas. Two nesting males with squabs in the nest were observed to leave their nest areas and enter the feeding area several hundred yards (m) distant in flutter flights on several occasions. These flights usually resulted in other males present at the feeding area also rising in flutter flights.

The first three pigeons, two males and one female, observed on Eliza Island in 1952 serve as representative examples for the numerous flutter displays observed. The fluttering flight, with buzzes, was often exhibited by the unpaired male either in the vicinity of the mated pair or in another forest section. As the sexual urge seemingly grew stronger in the pair, the mated male would often fly to the nearby displaying pigeon and vigorously give chase. The paired male would always enter the air and exhibit the flutter flight when the second male entered his territory. If the second male persisted in remaining in the territory, either on a perch or in the flutter flight, a chase and eviction would usually occur.

While at the resting perches above the trap area, the bandtails exhibited two basic displays, which occurred repeatedly in the male's attempts at conquest of a female during the breeding season. They were the wooing and the threat displays. In the wooing display, the male usually was within a foot (0.3 m) or so of the female and first lowered his body to a near horizontal position to the limb on which he stood. As the body was lowered, inhaling of a large amount of air caused the neck skin to increase much in size and ruffled out the feathers. Deep cooing was then emitted. The call started off sharply, dipped slightly, and ended in a fast ascent. As more calls were issued, they were given a gurgling effect. By the time four to six calls were given in increasingly faster tempo, the sounds were much like the heavy purring of a cat as it is stroked. As each call was given, the head and body were jerked upward, then down, becoming higher from the limb each time, and the male usually kept walking toward the female. By the time several calls had been given, the male had its head very near that of the female. If receptive to this wooing, the female might allow copulation, but usually this did not occur immediately after this type of display. Rather, she either held her perch and somewhat ignored the male, hissed or buzzed at him causing him to stop, or flew to another perch. This wooing display appeared to be the preliminaries of obtaining a mate for the breeding season.

On 27 May 1953, four males at the trap area were cooing ardently to the females present. Two males tried to approach three different females with a wooing display. One male tried to mount two different females by jumping suddenly upon their backs, and one of the females was knocked off her perch by this vigorous approach. In another case, one male was wooing a female on one side and on his other side was a male busily pecking at this competition. That the female ever doubts the male's amorous feelings after seeing his wooing display is questionable.

The second basic exhibition, the threat display, was used by males in warding off or bluffing other males. A male would lower his head and neck in almost a straight line with his body, and then raise his wings, opening them about half way. The body was low and almost horizontal to the limb. In this position he then moved threateningly at an intruder, either bluffing him off the limb or after giving modified buzzing hissing sounds, sometimes attempting to flail the other with his wings. Pecking was also used.

Billing between males and females was first noted on 15 and 19 April 1953 and became increasingly apparent in May as more pigeons formed into pairs. Billing is a display which stimulates both sexes. Normally, a pair would be perched on a limb side-by-side, either resting or doing some feather preening. The more aggressive male would often begin pecking gently at the bill of the female and simulation of feeding a squab would take place if both partners were so inclined. This performance consists of one of the birds opening its bill as the other gently attempts to probe between and around the bills. Also, their heads may be cocked over a shoulder or one bird may lay or move its head over the other's neck or shoulders for short periods. The billing display may be performed near other pigeons, as at the feeding areas, but does not seem to attract a great deal of attention.

The expressive actions of the male both before and during nesting, their ardent cooing, courtship and territorial flights, and loud buzzing calls, were considered typical. The female was never heard to coo, but had other vocal sounds in which she expressed herself.

Due to limited observation time in 1952, only one copulation attempt was observed, this one on 5 June. In 1953, copulation was noted in April, May, June, and July with the first observance on 22 April and the last on 31 July. The occurrence on 22 April was interesting in that it was rather early in the breeding season when few pairs were in evidence. Some 15 pigeons were present in a dead alder (*Alnus* spp.) snag above the trap. One male attempted billing with a female; she immediately moved to another limb. Shortly thereafter, a second male joined this female and followed her down a limb to finally be side-by-side with her. Both were facing the same direction when the male cocked its head back over its shoulder several times. The female then crouched down slightly and raised her wings to form a platform. The male stepped lightly onto her back and wings, and with hardly a flutter of wings stood quietly for a few seconds. The female maneuvered her tail so the male could make contact with her; he then wiggled

and wagged his tail, fluttered his wings and stepped off the female. Soon after, the female dropped to the baited trap without the male. No billing was observed before or after this copulation. The first male, rebuked by the female, apparently sensed she was ready for copulation, but lost out to the second male, supposedly her mate.

A second copulation display was observed at the trap site on 8 May. A pair was sitting close to one another and preening frequently when one turned its body in the opposite direction from the other. The second bird then turned so both birds were again facing the same direction. The female moved closer and, after fluttering her wings rapidly and bobbing her head back over her left wing, she crouched low with raised wings. The male mounted, stood steadily with his tail slightly to one side, wagged his tail several times with accompanying wing flutters, and stepped off the female. He then bobbed his head over his right wing several times. Billing was started by the female and continued for about four minutes until some other pigeons started descending to the trap to feed. Billing ceased immediately and, after looking at the trap areas, the male descended to feed, followed by the female.

Copulation was observed to occur twice with one pair in a half-hour period. This pair was under the forest crown in a bigleaf maple near their nest site. Four other males were in the area, cooing, exhibiting the flutter flight, and emitting buzzes. The male of the pair was irritated, apparently, and would often clap his wings loudly on take-offs, flying above the forest crown to meet any of the other males, some of which were known to have females on nearby nests. This event occurred immediately following afternoon nest changes of partners, and the males, just off the nest, apparently were airing their pent-up emotions and displaying their territorial boundaries.

I noted the following in regard to the time of day copulation occurred: seven times copulation was observed in various pairs between 11:00 AM and 5:30 PM, with many attempts also seen during this same time period. That attempts will be made during any of the daylight hours is very possible considering the actions of four amorous males on 8 May 1953. They were ardently cooing and using flutter flights to display to one female in particular. One male tried to approach her giving a cooing display. A second male landed near her, then two more males approached, and all of the males displayed the threat position toward each other. Shortly thereafter, the female flew away alone, the males not bothering to follow her.

After bandtails had passed through the stages of courtship flights, wooing display, billing, and finally, copulation, the search for the nest site began. Once the male and female were in accord concerning their breeding impulses they separated themselves from the gregarious activities of other pigeons. In the early part of the paired stage some would be found at the rest trees above the baited trap, but their activities were separate from the other birds present. The same was the case at water sites where single and paired birds came to drink. Roosting at night was sometimes with other birds or pairs, but once the nest was formed they almost always roosted apart from others.

Following is an example of a pair which remained apart from other feeding birds. On 12 May 1953 at 7:35 AM, two bandtails from the southern part of the island landed in a flowering madrone tree. One fed on the blossoms a few minutes then flew to a nearby maple where it cooed once. The second bandtail left the madrone at 7:55 AM and, sitting a few minutes in the nearby maple, joined the first pigeon and sat so close that they were touching each other. Both birds preened themselves and rested until 8:20 AM, when there was more feeding in the madrone followed by preening and resting in the maple again. Other pigeons were eating from the same tree, but this pair paid no attention to the others' presence.

Nest Discovery

Eliza Island was a unique research station, being separated from the closest land by about 0.75 miles (1.2 km) of bay. This, in effect, was a line of demarcation over which birds had to cross to leave the island or to return. As preferred food was not present on the island in sufficient quantity for nesting pigeons during June, July, and August, the birds, of necessity, left the island daily for food and water. Their flight patterns were plotted through use of the two observation platforms, which enabled tree-level watchers, and this greatly facilitated the finding of nests (Figures 1, 5, and 6).

Cessation of baiting activities in both years showed that pigeons in large numbers no longer came daily from nearby islands or the mainland, so remaining flights to and from the island were logically those of pigeons nesting there. Although band-tailed pigeon nests have always been difficult to locate, the island's location and the techniques developed definitely helped in the finding of 50 active pigeon nests in 1952 and 1953 (7 additional nests were found on nearby Lummi and Vendovi islands) (Figure 1, Table 5).

Incoming and outgoing pigeon flight patterns were soon correlated with the known nest-shift times. Generally between 8:00 and 10:00 AM the male took the female's place on the nest and remained there until the female replaced him during the afternoon change. This was between 3:30 and 5:30 PM, and the female remained on the nest through the night until the following mornings' exchange with the male.

It is possible the adult male or female may have transposed its time at the nest on certain days. This situation was not known to occur on Eliza Island, but this transposition has been described by Neff (1947) and others. Sexing of adults by external characteristics is difficult even in good light or when the bird is in hand and only by practice can one become fairly proficient in distinguishing between the sexes. When scrutinization was made difficult by foliage obstruction, dark forest interiors, or lack of observed flight patterns on the extremes of the island, the sex of the adult on the nest necessarily remained in question. Which sex was arriving at or leaving the nest was actually immaterial in regard to nest discoveries by means of flight patterns. The important phase at this time was locating the nest, followed by ascertaining at which time each sex was on the nest.

The assumption that a pigeon was a male was based upon its more active and vigorous territorial flights, buzzing, cooing, activity in chasing other bandtails from the nest area, breast coloration, and size of neck ring. Considered as a group, all of these characteristics show a contrast to the opposite sex during the nesting season. Breast coloration and size of neck ring are two identification points that may be considered relative unless the sexes are side by side, at which time the differences are quite noticeable.

Flight patterns followed this general day-long sequence: after the morning feeding period, the male replaced his nest partner. His initial approach to the island usually was made several hundred feet (m) above the water. Upon arriving at Eliza Island he would usually drop to tree level, and if other males were around, he would attempt to chase them away. Cooing from a perch to the female on the nest or making territorial flights encompassing his nest area were other activities. Making the actual nest change occurred after the male sat on a high fir perch, a forest interior perch, or soared overhead apparently until satisfied that no other pigeons or predators required watching. He would then move to the nest tree and take over the nest duties. Depending upon the time the male arrived at Eliza Island from his early morning feeding, the preliminaries leading to the actual nest change ranged from 15 minutes to an hour or more.

After leaving the nest in the morning, the female would usually fly low through the tree tops or along the forest edge for 100 to 200 yards (91–182 m) and then pull up on a high perch. This action was exhibited also by the male in the afternoon change when he might fly as far from the nest as did the female, or as close as 50 yards (45 m). If the nest was in the dense forest interior rather than at an edge, the first flight might have been only a few yards (m); then after a short look, the second flight would have been up to the tree tops. The female generally did not stay long on Eliza after coming off the nest, but flew to mainland or Lummi Island feeding areas. She, of course, sits the longest on the nest during the 24-hour vigil and is undoubtedly very hungry at the end of her night's sitting.

In the evening the female readily indicated the location of her nest area since she was inclined to come directly into the immediate vicinity and make the change, if nothing seemed amiss around the nest area. She did not make territorial flights nor issue cooing, but upon coming in over the island she was heard to give the raspy buzz. Her nest change took less than 20 minutes, as a general rule. After leaving the nest in the afternoon, the male would either defend his territory, coo to the female, or more rarely, leave immediately for feeding areas.

Figure 5. Band-tailed pigeon squab in the nest made of small sticks on the bough of a Douglas-fir tree located during the band-tailed pigeon study on Eliza Island, Washington, 1952–1953.

Figure 6. Band-tailed pigeon squab in the nest made of small sticks on the bough of a Douglas-fir tree located during the band-tailed pigeon study on Eliza Island, Washington, 1952–1953.

Although the pigeons were not gregarious to any extent during nesting, they often joined one another after the nest change to fly to feeding areas. One or more pigeons, upon leaving their nests would fly north until they reached the shoreline. Reaching this point they would make several counter-clockwise circles, gaining altitude in the process. This appeared to be a rendezvous arrangement, for other nesting pigeons would often join them from other parts of the island, and all would then fly obliquely (NW) toward Lummi Island. Infrequently would a single bandtail fly toward Lummi Island, this usually occurred when a nest change was made late and the other pigeons had already left for feeding. Pigeons returned from feeding areas either singly or in small groups. Upon reaching the nesting areas they separated and normally did not tolerate their recent traveling companions in their respective nesting areas.

The bulk of the nests were discovered by use of the flight pattern method, but two other methods were developed to a lesser degree. An imaginary 100-yard (91 m) radius check of a nest area was set up as a result of hearing low cooing of a male within the forest after the evening nest change. Canvassing this area on foot led to the discovery of nests.

A third method was observation of territorial flights. When territorial flights covering large areas were observed the actual pin-pointing of new nests was difficult. However, when smaller flight areas were the rule, the immediate area of the nest was more clearly indicated. Methods of discovering nests, in order of their highest success, were: observing pigeon flight patterns to and from the nest, listening for low cooing of the male after the evening nest exchange, and checking area encompassed by territorial flights.

Although the presence of a nest in a general area was first made obvious by one of these three methods, in all cases the final discovery was made by systematic searches from the forest floor. This involved following standard techniques. Systematic nest searches made two or three times monthly involved a form of "gridding" where the observer walked slowly through the forest in parallel paths over a selected route. Right angle paths were taken as the forest foliage situation demanded closer scrutiny of any particular area. During this "gridding" the observer would sweep his eyes over the trees or bushes in an effort to find a new or suspected nest.

The adult bandtail pigeon normally is a tight-sitting bird whether incubating or brooding the squab. This habit increases the difficulty of locating bandtail nests unless one is "set" to observe certain details, namely an empty and often inconspicuous nest platform, a nest and the low silhouette of a squab (Figures 5 and 6), or the adult sitting motionless on the nest. The adult silhouette is decidedly easier to locate than that of the smaller squab.

Upon first spotting an adult on a nest, the observer's eyes will almost immediately focus next on the basal portion of the pigeon's bill, which is a straw yellow color. If the angle is right the white neck collar will be quickly noted as a second outstanding point, seeming to draw the observer's attention, whereas the general blending of the bluish plumage does not immediately register as an outstanding point. The placement of a nest and the surrounding foliage is such that a pigeon on a nest may be passed by repeatedly no matter how diligent the searchers. The yellow bill and white neck ring were definitely helpful in spotting some adults through rather obscuring foliage. The squab, on the nest, lacks the white neck ring and the strong straw-yellow color of the bill, characteristics usually acquired the year following hatching.

By noting the ends of the twigs in the bandtail pigeon nests (Figures 5 and 6), one can usually tell a current year's twig by its freshly broken tip. The male bandtail normally breaks each nest twig from a nearby tree and does not pick up any material from the ground. Twigs a year old or more can quite easily be distinguished from freshly-broken twigs. This knowledge is profitable when searching large areas for active nests, especially when both old and new nests are located without any eggs. A quick examination of the twig tip enables the observer to determine whether to come back to a particular nest or to classify it as that of a previous year.

Location of a nest containing squab scat remains only can often lead to diagnosis of the approximate date the squab left the nest. Sow bugs (Order Isopoda) usually begin feeding upon the nest remains within one or two weeks. If the nest has been visited by these bugs and they have departed, the scats will be broken down considerably and will shatter upon touch. If the sow bugs have not yet found the nest, the excretory remains will be solidly united and it will require pulling to separate the twigs from the excrement.

Breeding Status

Nesting was in full progress by each May during the Eliza Island studies and it was fortunate that two adult males and one adult female could be examined internally to ascertain the development of testes and egg follicles. Breeding development of one large male collected in late afternoon on 3 May 1952 disclosed right and left testes measuring 0.67 and 0.63 inches (17 and 16 mm) in length. A second but smaller male collected the afternoon of 11 May 1952 had testes measurements of 0.63 and 0.60 inches (16 and 15 mm) for comparison. Peeters (1962) collected an adult male near Berkeley, California on 10 May 1961 and the testes measured 0.60 inches (15 mm) in length while the testes of an immature male had a length of only 0.17 inches (4 mm).

One female bandtail met with an unfortunate trapping accident at Eliza Island on 29 May 1953 when the frame-style drop trap fell upon her, crushing one well-developed egg from her cloaca. Internal examination of this female disclosed three egg follicles measuring 0.16 to 0.20 inches (4 to 5 mm) and 6 others measuring 0.12 inches (3 mm) or less. The accident occurred at 2:15 PM and it appeared that the extruded egg might very well have been laid later the same day or possibly the following day.

Glover (1953) reports that of seven band-tailed pigeons killed illegally in California on 13 June, four were females, two of which showed evidence of recent ovulation. The examining California Department of Fish and Game officer, Captain Leslie Lahr, indicated that none of the other ovarian follicles of these two females were developed larger than a number six shot (0.11 inches, 3 mm). The remaining two females contained at least five ovarian follicles larger than a number six shot and each had one follicle that was larger than a pea.

Neff (1947) reported a total of 280 adult band-tailed pigeons were examined by John C. Knox at Mountain Park, New Mexico, between 25 June and 10 July 1941. Of 235 males in the collection, 151 had testes indicating an active breeding condition. There were 45 females examined, 22 of which contained well-developed eggs. It was not indicated by Neff whether these were egg follicles or a single egg found in the oviduct tract.

Neff and Culbreath (1947) further report on the breeding condition of adult bandtails in Colorado:

> In 1928, R. J. Niedrach collected pigeons on 28 June near Evergreen, and one of the specimens contained an egg with a partially formed shell. Pigeons collected during the cherry season, late June to 15 July over a several year period by Frank Poley and Johnson Neff have all been adults, and none of them contained eggs over one-fourth inch [6 mm] in diameter. Collections made later in August and through September, however, contained active or retrogressive pigeon milk glands.
>
> On 4 June 1946, several pigeons became overheated and died in the trap at Perry Park ranch west of Larkspur. One of these birds was a female containing a soft-shelled egg, probably within three days of laying. If we allow 8 June as the day it would have been laid, and use the data acquired in 1945 on the development of the nestling pigeon, the resulting young from this egg would have left the nest about 18 July.
>
> Of the 12 birds examined on 4 June, 8 were females, 4 were males. The summary [frequency] of breeding development classes was as follows:
>
> Egg follicles less than ¼ inch [<6 mm] 4
>
> Follicles from ¼ to ½ inch [6 to 13 mm] 2
>
> wo follicles in ½ inch [13 mm] class 1
>
> Fully developed egg, 1.6 by 0.9 inches [41 x 23 mm] 1
>
> Males, testes fully developed 4
>
> Attention is called to the one specimen containing two egg follicles of equal development, about one-half inch [13 mm] diameter. This appears to have been an instance where a two-egg clutch might have been laid.

> Egg follicles in live specimens collected in Paonia cherry orchards on 15 June all were under one-fourth inch [<6 mm] in diameter. Of nine specimens collected in the same area on 8 July, two contained follicles one-half inch [13 mm] in diameter, and the oviducts were enlarged as though they might have laid eggs. The testes of a male were in optimum breeding condition.

Nine specimens were collected in late August and September, from LaVeta, Durango, and Norwood. Four were juveniles. The crop walls of three of the adults showed various stages of retrogressive milk cells. Egg follicles were all less than one-eighth inch [<3 mm] in diameter. The testes in the one adult male were less than half the size of the normal breeding conditions.

Nest Construction

On 13 May 1955, while I was walking along our tractor road at 5:30 AM, a bandtail, presumed to be the male, flew low along the same road below the forest crown. One loud buzz was given by this male and shortly another, presumed to be the female, came along the road hopping from tree to tree as if searching for a nesting site. The male took a high perch nearby, looked around intently for a while, then preened and remained alert. About 10 minutes later he clapped his wings together for a short flight down the forest interior and the female, about 30 yards (27 m) from him, flew to another fir. He then gave short low purring calls at three- to eight-second intervals for about ten minutes. He joined the female and all was quiet for 15 minutes. Loud cooing by the male followed; he flew in short hops through the trees and the female followed shortly. Low purring by the male then began again while she preened. Short buzzes were heard later. No nest building actually occurred here this morning, nor did any feeding. This lent support to the supposition that the pair were searching for a nest site.

Between 5:20 and 6:15 PM on 27 May, another pair was observed flying from perch to perch in the forest understory in another section of the island. The male in this case would give short purring calls of the sort heard on 13 May and also appeared to lead the female. The observer presumed this to be an effort to influence her to find a nesting site. There was billing as the pair sat closely on several occasions for short periods when not fluttering through the trees. A nest was built in this immediate area within a week of this observation.

An actual sequence of nest construction was observed starting on 14 May 1953. As I was coming out of the cabin at 5:15 AM, a pair of bandtails flushed from some willow (*Salix* spp.) trees about 20 yards (18 m) away. Examination of one willow tree disclosed a few twigs on a several-pronged crotch of the trunk, apparently the beginning of a pigeon nest. Rather than frighten the pair further this day, I left the area. On 15 May, the female was observed trying the nest platform with her body, then she and the male left for feeding areas. The next day I remained inside the cabin having an excellent view of the nest site about 50 feet (15 m) away. At 5:00 AM the female landed in the willow tree above the nest, which was about 6 feet (2 m) from the ground. She dropped down to the nest at 5:05 AM and with her bill and movement of her body began arranging the twigs. At 5:06 AM the male arrived carrying a twig in his bill. The female raised her wings slightly to form somewhat of a platform and the male stepped onto her back. The twig was then dropped over and in front of the female's head, landing on the nest platform. The male stepped off the female and flew to a Douglas-fir some 40 feet (12 m) away. The female then picked up the twig and worked it into the other nest twigs.

While she was doing this, the male was attempting to break off dead twigs 5 to 15 feet (1.5–4.5 m) from the ground in a nearby Douglas-fir. Some twigs would not break but he would soon find one that would snap off, then he flew quickly back to the nest. Again he mounted the female with half-raised wings and from this point on the twigs were either grasped by her or dropped in front on the forming platform. Twigs were brought by the male to the nest until 5:50 AM. The female continued to arrange the twigs and to turn around in the center of the nest until 6:35 AM, when the male started bringing twigs again. Twigs were brought until 7:00 AM when the male cooed softly from near the nest. The female had not left the nest since first arriving that morning.

At 7:20 AM the male flew to a perch above the nest and peered down at the female, after which he resumed bringing twigs until 7:45 AM. At one point in delivering a twig the male froze on the back of the female as a northwestern crow (*Corvus caurinus*) called nearby. At 7:58 AM the female stepped off the nest and flew from the nest tree; then both left for their morning feeding.

The following morning on 17 May, the female arrived at 4:55 AM and began shaping the nest. The male joined her shortly and mounted on her back. No twigs were brought this first time and he looked down over her shoulder, then stepped off and flew to a nearby tree. Low cooing was heard from him at 5:05 AM and at 5:25 AM, during which time he was bringing twigs to the nest. It was noticed that when the male stepped off the female's back she would each time give short quivers with her wings. Although he mounted the female while at the nest, no copulation was observed here in the several days of nest building. When the male was slow in bringing twigs, the female on the nest pumped her head up and down and emitted short purring buzz calls. Usually the male wasn't long in bringing more twigs following the nest action and the insistent calls of the female.

Cooing by the male on the fourth day of nest building was heard increasingly in the early morning. A total of 23 twigs was delivered to the female up to 7:40 AM and the female continued to work on intertwining the nest twigs. At 8:30 AM the female watched the male fly east overhead, then she walked off the nest and also flew away.

The male brought 21 twigs on the fifth day to the female between 4:45 and 7:42 AM. Twigs were broken off five different Douglas-firs surrounding the nest site. The female left the nest at 7:43 AM, and a check of the nest at 4:30 PM revealed no bird on the nest. At 5:30 PM the female was standing on the nest and one egg was visible. She was not covering the egg at this time; at 6:30 PM she was, and she remained on the nest through the night. The observed construction period amounted to five days in building the nest.

A second chance to observe bandtails building a nest occurred on 22 June 1955, while I was working in New Mexico for the Department of Game and Fish. This is a separate pigeon population distinct from the Pacific Coast areas of California, Oregon, Washington, and British Columbia, but the basic similarities of pigeons' nest construction were substantiated. At 8:15 AM in the Animas Mountains, Indian Creek Canyon, Hidalgo County, a bandtail was seen 150 yards (137 m) up a slope flying away from several oak trees. I climbed the hill slowly to within 75 yards (69 m) of the trees and then began to hear the spitting of buzz-like calls characteristic of the female at the nest. The calls were repeated every few seconds until the male arrived at the nest, mounted her back upon her raised wings, and released a twig. At 8:45 AM the male flew from the nest tree, a netleaf oak (*Quercus rugosa*), and the female soon followed. She flew northwest towards the oak feeding areas about a mile (1.6 km) distant, followed by the male in a semi-flutter flight. Some flutter flights, cooing, and fighting among males had occurred earlier in the morning in this area.

Upon close examination, the nest was noted to be about seven feet (2.1 m) off the ground, nestled among the oak branches. It contained approximately 15 twigs carried to the nest this morning by the male. The twigs were all under one-fourth inch (6 mm) in diameter. A blind for taking photographs was set up immediately about 20 yards (18 m) from the nest.

A return to the nest on the following morning at 7:30 AM showed the male trying to break off a twig from a nearby oak, unsuccessfully. He seemingly was not trying very hard for at 7:35 AM he clapped his wings together, gave one loud buzz and went down the canyon toward the feeding area. The female soon walked off the nest and followed him. An additional 22 twigs had been added to the nest before 7:30 AM. No more observations of the nest were made until 18 July, at which time it was calculated that a squab would be present.

Pictures were taken from inside and outside of the blind between 7:30 and 8:00 PM with the female on the nest. She did not flush even when telephoto equipment was as close as eight yards (7.3 m) of her. During the photograph taking period, the male flew overhead giving a raspy buzz in flutter flight. The female was flushed from the nest and a squab 3 to 4 days old was revealed. The cripple act was given by the female in her effort to decoy the observer from the nest.

One of the earliest references found in literature to the actual building methods of the band-tailed pigeon nest is an article by Michael (1929):

> On 3 August 1928, a pair of band-tailed pigeons (Columba [*Patagioenas*] *fasciat*a) was discovered at work on a nest. The nest was placed on a horizontal branch of an incense cedar [*Calocedrus decurrens*]. It was some 20 feet [6 m] above the ground and but a few inches [>8 cm] from the main stem of the tree. As is the usual case when we find the nest of a pigeon, our attention was first attracted by the sound of snapping twigs. The band-tailed pigeon gathers no nesting material from the ground. The male flies into a tree, usually a living cedar here in the valley, takes a perch, and gazes about in search of a suitable twig. While making up his mind as to just which twig he really wants, he has a strange way of bobbing his head. He draws his head back deliberately and then jabs it forward with a quick, jerky movement. When he decides on the dead twig he wants he flies to the branch, walks slowly out along the limb, leans over, grasps the twig firmly in his mandibles and with a quick twist of his head the twig is snapped off. Now with a great clatter of wings he flies to the nest tree. If the limb containing the nest-site is limber, he does not alight directly upon it but comes to perch above or below and approaches the nest by a series of "flight hops." While the male is out foraging for nesting material, the female waits more or less patiently at the nest site. She received the material from her mate and does the actual work of construction. And between the two, if the truth must be known, the nest is no work of art.
>
> On 9 August the nest was apparently complete, but there was as yet no egg. On 17 August, when the tree was again climbed, the female was incubating. She was reluctant to leave the nest, and it was not until I had approached within 10 feet [3 m] of her that she began to show signs of nervousness. She stood up and craned her neck and finally decided to move. There resting in a cradle of twigs was the one large, white egg. The owner of the egg stood on a limb a few feet [1 m] away and bobbed her head in a strange, nervous manner, but

> she was apparently not particularly frightened and held her ground until I left the tree. Nothing was seen of the male bird. The nest construction period between 3 and 9 August amounted to approximately six days.

Willard (1916) described nest building in the Huachuca Mountains of Arizona, which differed considerably from the nest construction procedure observed on Eliza Island and in the Animas Mountains of southern New Mexico. His description was that nest building was conducted only in the morning hours from sunrise to about 8:00 AM, almost entirely by the female, and that she proceeded in a most lackadaisical manner. It is presumed that the male brought the twigs to the female although this was not mentioned by Willard. The period of building the nest stated by Willard was six days from the placing of the first twig to the laying of the first egg. Seemingly, four to six days would be about average for the nest building sequence of the bandtail pigeons.

Similarities between band-tailed pigeon methods of searching for a nest site and that of the extinct passenger pigeon are interesting. Schorger (1955) states:

> The captive passenger pigeons of C. O. Whitman when ready to select a place for a nest, stretched their heads forward, raised their wings, and moved them slightly. They flew several times against the wire of their cage, and seemed to wish to get out in order to find a new place for a nest. …
>
> Two days later these passenger pigeons were very active, but not yet decided where to place the nest. The male was especially active, taking the lead in the search. He kept alighting on a small tree enclosed in their large pen, and here he would put down his head and call the female. I repeatedly saw this pair flying about in search for a nesting place. I note too, that when the male flew back and forth he called to his mate while on the wing.
>
> A pair in the Zoological Society's Gardens, London, spent three or four days in selecting a building site in a fir tree.

Peeters (1962) presents fairly recent bandtail nest construction data from his California study area near Berkeley:

> The following evidence suggests the male selects the nest tree. The nest building of pair P1 was observed on 30 May 1961. At 4:07 PM, the male drove the female in a semicircle toward a particular tree in the redwood (*Sequoia sempervirens*) grove; then both birds rested, perched close together. Suddenly the male arose and flew off but turned at once and alighted again in the same tree, about 15 feet [4.6 m] beneath the female. He walked back and forth four times on the limb he had alighted on, and then broke off a small dead twig with his bill. The bird then hopped up the tree from limb to limb, spiraling the trunk. After the male had climbed in this fashion about seven feet [2.1 m], the female, which had watched him intently, flew down and perched three feet [0.9 m] from him. The male walked toward her and presented the twig, which she accepted. She then put down the twig awkwardly, simply placing it at the junction of the limb and two smaller side branches. The male broke off another twig, which the female also accepted and placed on the limb. The male now brought a twig from a neighboring tree, then another, both of which the female promptly incorporated into the small platform. The male then stopped and wiped his bill on the limb he was perched on. He cooed twice, and strutted toward the female, which took to the wing. The male followed her at once, and both birds flew out of sight.
>
> No further nest building was observed until 1 June, when the female was seen at 5:17 PM, adding more twigs to the platform. On 2 June, at 6:30 AM, there was one egg in the nest.

Peeters determined the interval between the beginning of nest construction and the appearance of the egg on 2 June was three days. This is the shortest nest-building time reported to my knowledge. It was of further interest to note that no mention was made of the male mounting the female's back to deliver the nest twigs as was observed on Eliza Island, Washington, and in the Animas Mountains of New Mexico. Others who have witnessed the actual bandtail nest-building sequence, including Willard (1916), Michael (1929), and Kitchin as quoted in Bent (1932:354), make no mention of the nest ritual of the male presenting the twigs from the female's back.

Some close similarity in nest construction and the ritual of the bandtails as compared to the male and female passenger pigeons is shown by Schorger (1955):

> The male brought all the nesting material, one piece at a time in his bill, to the female who performed all the labor of construction. The male mounted on the back of the female and placed the stick or straw in front of her, this being apparently the most convenient way to receive it.

Skutch (1956), in reference to nesting of the ruddy ground dove (*Columbina talpacoti*), reported: "The male came twice more with one straw each time and stood on the female's back while he laid it in front of her; when she was present, he always stood upon her

to deposit the material." Doves in the Columbidae normally pick up their nest material from the ground, and the true pigeons break twigs from branches of trees. Skutch (1956) lists the following pigeons found primarily south of the United States which break twigs or inflorescence from high in trees for their nest construction: red-billed pigeon (*Patagioenas flavirostris*), short-billed pigeon (*P. nigrirostris*), and scaled pigeon (*P. speciosa*).

Nest building of the now extinct passenger pigeon is described by Schorger (1955): "In building, according to J. B. Oviatt, they merely flew up and down from the ground." This refers to the passenger pigeon picking up twigs or other nest material from the ground and carrying it to the nest.

Considering that the total body length of the band-tail ranges in adults between 12 to 15 inches (30–38 cm), the nest size, including protruding twigs, often measured in diameter the approximate length of the birds. Grinnell et al. (1918) cite a nest measuring 9 inches by 4 inches (23 x 10 cm), exclusive of protruding twigs. Glover (1953) reports nest measurements as outside diameter 7 to 8 inches (18–20 cm); inside diameter, 5 inches (13 cm); bowl depth, 1.3 inches (3 cm); and thickness under the bowl as 2.1 inches (5 cm).

The nest twigs are intertwined by the female and with the raised nodules or projections on each twig they tend to bind the nest together quite well. Although many small gaps remain, there are rarely those through which the eggs can fall. Neff (1947) stated that nests observed by him near Nogales, Arizona in 1939 and 1940 were so fragile in appearance as to cause one to wonder how eggs and young could remain in them. Eggs can be accidentally knocked from the nest as a parent may be forced to fly hurriedly from the nest. The squab grasps the woven twigs with its toes to keep from falling out.

Glover (1953) states of the five nests he found in northwestern California:

> … all of the nests observed were typically fragile and amounted to little more than a crude, loose collection of twigs and forest litter to form a shallow platform. It was difficult to determine if moss had been added intentionally to some of the nests for probably many of the twigs used already had moss on their surfaces before being utilized as nest material.

No nesting material other than twigs was found in the Eliza Island nests, except for a stray leaf or two.

Normally the bandtail walks on and off the nest rather than alighting from flight when incubating and brooding. Skutch (1956) summarizes the approach and departure for what could represent most of the Columbidae nests:

> When approaching or leaving the nest, ruddy ground doves do not fly directly to or from it in the manner of hummingbirds and other very small birds with well-made nests and minute control of their flight. On the contrary, when coming to the nest they usually alight on a branch a foot [0.3 m] or more away and walk to it. Similarly, when leaving, they carefully step from the nest and walk out along the supporting limb before taking wing. In this fashion they are less likely to knock or shake the egg from the shallow nest. It is only when alarmed that they fly directly from the eggs.

On Eliza Island, pigeon nests were not normally exposed to direct winds, which could dislodge eggs or young. MacGregor and Smith (1955), working in California, received personal reports and surmised during their nesting studies that flimsily-constructed nests caused losses of eggs and squabs when associated with exposure to high winds. It must be accepted that high winds can raise havoc to young and could cut into the pigeons' breeding potential when nesting is in open foliage type trees such as pines and oaks.

The number of twigs in a nest may be small when it is built on a larger dense fir bough. Twigs in the nests found on Eliza Island varied in number from 100 to 143 per nest (Figures 5 and 6). The nest found in New Mexico in 1955, in a netleaf oak, contained 80 twigs. Twigs in most nesting situations are dead or brittle enough to be broken by the male and within a radius of 50 feet (15.2 m) of the nest. One nest on Eliza Island in 1953, built some 55 feet (16.8 m) up in a Douglas-fir, had twigs broken off for distances of 2 to 4 feet (0.6–1.2 m) surrounding the nest. No twigs were ever picked off the ground in the two closely-watched nest building sequences that I watched.

Only one late-nesting pair of pigeons of the 136 active and inactive nests found and plotted in detail at the Eliza Island study area (Table 6) built their nest upon the platform of an old nest. None of twenty active nests located in 1952 was used a second time that year, even though the nests were not removed for scat analyses until late September. The thirty active nests observed in 1953 were left in their original locations and no pigeons nested a second time in any of these. Nesting twice in a nest has occurred, but can be considered the exception to the general rule.

MacGregor and Smith (1955) reported multiple nesting by a pair of band-tail pigeons using the same nest between 1951 and 1955 that brought off three broods in 1954. In an almost domestic situation, this nest is opposite the Carmel, California, police station in an acacia (*Acacia* spp.) tree between the sidewalk and the street.

Tree species and frequency of use by bandtails for 136 active and nonactive nests located on Eliza Island during 1952–1953 were 84 Douglas-fir, 28 grand fir, 15 red cedar, 4 Pacific yew (*Taxus brevifolia*), 3 willow,

1 alder, and 1 dwarf maple (Rocky Mountain maple, *Acer glabrum*) (Table 6). Most (131) nests were placed in conifers, amounting to 96% of the located nests. Conifers were amply scattered throughout the various forest growth on the island. On the nearby islands of Vendovi and Lummi, where five more nests were located, lodgepole pine (*Pinus contorta*) and ocean spray (*Holodiscus discolor*) bushes also were used as nesting sites.

Popular species of trees used by bandtails for nesting in other states include a variety of oaks and various species of pines. Other observers reported nests in mulberry (*Morus* spp.) trees, Sitka spruce (*Picea sitchensis*), and one in a California lilac (*Ceanothus thyrsiflorus*) (Neff 1947). Neff also mentioned yellow pines, Douglas-fir, and lodgepole pines as being used in Colorado. Nesting tree preferences in California include reports by Grinnell et al. (1918) that most of 17 nests were in oaks; by Glover (1953) that of eight nests in northwestern California, three were in conifers; by MacGregor and Smith (1955) that 62 percent or 33 nests near Monterey, California, were in conifers, Monterey pine (*Pinus radiata*), and the others in acacia, coast live oak (*Quercus agrifolia*), and hawthorn. Hansen (1942) discovered a nest in a redwood (*Sequoia gigantea*) in the Sierra Nevada range of California and Peeters (1962) notes that in 9 of 10 nests studied near Berkeley, California, conifers were chosen. Rowley (1934) reports one nest 20 feet (6 m) up in a redwood west of San Andreas Lake in California.

A curious situation was noted in 1953 in the Eliza Island studies upon revisiting each of the previous year's nesting sites. All actively-concluded nests had been removed for scat analysis in 1952 and the trees marked with plastic tags for future identification. Two nests were in the exact trees and precise crotches of limbs in 1953 in which two 1952 nests had been. Hypothetically, one might presume this was the same pair that used the nest tree the previous year, but there was no proof. Two pigeons banded in 1952 on Eliza were recaptured at the same spot in 1953, indicating some pigeons probably have tendencies to return to favorite nesting sites. MacGregor and Smith (1955) described the 1951–1955 nesting of a pair at the same nest each year. Adding further credence to this phenomenon, Neff (1947) reported E. A. Kitchin of Washington stated that bandtails were very fond of their old nesting areas and would come back year after year to the same limb even though the previous nests had been disturbed.

Neff (1947) reported:

> Kitchin records second nests built on the same spot where an earlier nest of the current season had been robbed or destroyed, and cites one instance of a nest from which he collected the egg being followed by a second nest on the same site from which he again took the egg; later in the season he found in the same place a third nest that he left intact.

R. J. Niedrach, Denver Museum of Natural History, observed of Clyde P. Matteson, "that at least three of the active nests found by him this year were within approximately sixty yards (55 m) of nests found in previous years." His suggested correlation of birds returning to favorite nesting sites is obvious when the discussion is considered for Washington, California, and Colorado. Emphasis in a nesting study should be placed upon areas where pigeons have previously nested since the conclusion is that the birds will return the following year unless something drastic occurs to prevent it. Finding bandtail nests, normally difficult to locate, can be simplified by this approach and more needed and interesting life history data recorded in a shorter research period. Generally, bandtail nests are not placed at the tops of trees nor at extreme edges of limbs, consequently nests positioned in the tree interior can withstand high winds and other inclement weather conditions. Placement of 136 nests on Eliza Island in reference to the tree trunks showed 84 nests constructed away from the trunk, many a matter of a few inches (>9 cm), several up to 12 feet (3.7 m) and one 20 feet (6.1 m) out. The remaining nests were on a crotch at the trunk. The diameter of the trunk, five feet (1.5 m) from the ground, in 136 nest trees, ranged from 2 to 38 inches (5–97 cm).

Average height for the 136 nests was 35 feet (11.0 m), with a minimum of 3 feet (0.9 m) and a maximum of 95 feet (29.0 m) (Table 6). A few ground nests or nests on stumps have been reported (Neff 1947) but these are certainly the exception to the norm. The 33 nests reported by MacGregor and Smith (1955) ranged in height from 12 to 95 feet (3.7–29.0 m), with an average of 36 feet (11 m). Glover (1953) in his northwestern California nesting study concerning eight nests, gives heights from six feet (1.8 m) to 150 feet (45.7 m), with the others tallied at 7, 8, 15, 15, 20, and 30 feet (2.1, 2.4, 4.6, 4.6, 6.1, and 9.1 m). Neff (1947), citing Grinnell et al. (1918), reported that most of the nests in California were in oaks at heights of 8 to 30 feet (2.4–9.1 m).

The closely related Vioscae's pigeon is resident in the mountains of the Cape Region of Baja California according to the Check-List of North American Birds (AOU 1957). Similarities in bandtail nesting are reported by Lamb (1926):

> The majority of the numerous nests I examined were in live-oak trees, usually situated on the forks of the larger horizontal limbs, and placed from 10 to 20 feet [3.0–6.1 m] above the ground. Some nests were also found placed among the smaller branches and near their extremities, but this was exceptional. A very few nests were found in a small species of white-oak tree that grows on the hillsides. This oak is peculiar in that in the dry season the leaves turn brown and appear dead, but a few days after the first rain, the leaves gradually grow green again.

> There are a few pine trees, mostly pinyons, scattered among the oaks in some parts, but only in one instance did I find a pigeon's nest in a pine. This was a well-built nest six feet [1.8 m] above the ground, against the trunk where a horizontal limb grew out. One nest was found on a frond of a leaning fan palm (*Washingtonia filifera*) tree. The nest is as a rule carelessly made, of a few coarse twigs, with no nest lining.

Bent (1932) reports:

> A nest collected for me by W. W. Brown, in the Sierra de la Laguna, on 14 June 1913, containing one egg, was described as a frail platform-like structure of sticks, built near the extremity of a branch, in a pine tree about 40 feet [12.2 m] from the ground. An egg in the United States National Museum, taken by Mr. A. Frazar, near Pearce's Ranch, on 18 July 1887, was presented by Mr. Brewster; it was taken from a nest composed of a few sticks, 18 feet [5.5 m] up, on a broken upright branch of a giant cactus.

One egg seems to be the almost invariable rule with Viosca's pigeon. If two eggs are ever laid, it must be very rarely, for in more than 25 nests examined by Mr. Lamb and 8 or 10 by Mr. Brown, only one egg or young was found. The egg is pure white, like that of the band-tailed pigeon. The measurements of 25 eggs average 39.7 by 27.5 mm [1.6 by 1.1 inches]; the eggs showing the four extremes measure 43.2 by 28.5, 41.4 by 29.9, 36.7 by 26.9, and 38.1 by 26.4 mm [1.7 by 1.1, 1.6 by 1.2, 1.4 by 1.1, and 1.5 by 1.0 inches].

Clutch Size

The 60 nests studied by W. H. Bohl on Eliza Island or nearby islands, two in New Mexico and one in Chihuahua, Mexico, all had evidence of either one egg or one squab only. Previous research workers on Eliza Island recorded one nest containing two eggs which was subsequently deserted (Oregon Cooperative Wildlife Research Unit field notes).

A search of the literature reveals that usually the band-tailed pigeon lays only one egg to a nest but that two eggs are sometimes found. Neff (1947:12) cites reports by several competent observers of two-egg nests in California, Oregon, Arizona, New Mexico, Texas, and Mexico. One observer in the Chiricahua Mountains of Arizona noted several nests containing a half-grown squab and one egg. Another observer in the Tumacacori Range northwest of Nogales, Arizona located 56 bandtail nests, 11 of which contained two eggs. During a 1952–1955 band-tailed pigeon nesting study by the California Fish and Game Department, MacGregor and Smith (1955) noted that of twenty-six nests observed, 25 contained one egg or one squab and one nest contained two eggs.

The bandtail egg is pure white, shaped elliptically ovate and slightly pointed. The shell is smooth with a glossy texture. Bendire (1892:124) lists five eggs measuring 40.1 by 27.9, 41.1 by 27.9, 41.1 by 28.7, 42.7 by 26.4, and 42.9 by 27.7 mm (1.6 x 1.1, 1.6 x 1.1, 1.6 x 1.1, 1.7 x 1.0, and 1.7 x 1.0 inches). Bent (1932:356) lists the measurements of 19 eggs, which averaged 39.7 by 27.9 mm (1.6 x 1.1 inches). He further states "the eggs showing the four extremes measure 43.5 by 30.0, 39.3 by 30.2, and 36.8 by 25.9 mm (1.7 x 1.2, 1.5 x 1.2, and 1.4 x 1.0 inches)."

Nesting Chronology

The number of days required to bring bandtail eggs to hatching includes periods of approximately four to six days spent searching for a nest site, four to six days spent building the nest and laying one egg with 18 to 20 days for incubation of the egg. Taking the average number of days for the preparation of the nest to the hatching point amounts to 29 days.

Brooding time and the period after which the adults stop brooding the squab until it can fly from the nest as shown in the Eliza Island studies ranged from 26 to 30 days. On average the squab leaves the nest 28 days after the egg has hatched.

Calculating the approximate number of days for the entire nesting period beginning with searches for the nest site through incubation and brooding until the squab leaves the nest amounts to 57 days. Therefore, if the date a squab leaves the nest is known, the approximate date nesting commenced may be obtained by subtracting 57 days from this known end date.

In two years of study on Eliza Island, the first squab left the nest on 27 June in 1952 and 15 June in 1953. Using the above average 57-day-cycle to fledge a bandtail squab, it is reasoned the first nesting occurred after 20 April and 3 May in 1952 and 1953, respectively.

Considering that the first adult bandtails migrating from the south to Eliza Island in Puget Sound, Washington arrived on 9 April 1952 and 2 April 1953, the number of days between these first arrivals and the estimated nest searching period amounts to approximately 17 to 21 days, respectively. This period or interval is seemingly spent searching for feeding and water locations along with preliminary courting and pairing antics.

Incubation

The crude twig nest of the bandtail causes one at first to wonder how the adults keep the egg warm during incubation. From close observation it has been noted that adults are careful in working the breast feathers around and under the egg, leaving only a small portion exposed on the bottom. Having a body temperature between 108 to 109 °F (42–43 °C) further helps the adults in incubating an egg placed in its airy, twig-frame nest. Periodically the egg is worked under the breast feathers by the birds.

The first documentation on Eliza Island of the exact number of days of incubation was missed when avian harassment caused one particular nest desertion. On the 15th day of observation, this nest contained one egg with a well-formed embryo, obviously within a few days of hatching. A second nest (#17) in 1953 was documented from the time of the adults' search for the nest site, building of the nest, approximate laying date of the egg, and hatching. Due to slight doubt as to whether the egg was laid on 23 or 24 June, the incubation period has been classified in this case as either 18 or 19 days.

Bendire (1892) states that "incubation lasts from 18 to 20 days, both sexes assisting." MacGregor and Smith (1955) reported the bandtail incubation period averaged 19 days.

Eliza Island studies, MacGregor and Smith's (1955) study in California, and records of earlier observers indicate that incubation normally is undertaken by the female at night and the male assumes the duties during the daytime hours. Considerable variation has been observed as to the exact time of day that the male replaces the female in the early morning hours and when the female replaces the male in the afternoon or early evening. Feeding schedules involving availability of food for nesting partners and nesting enthusiasm of both adults are variables that seemingly alter nest partner replacements during the incubation and brooding periods.

Observations during incubation of one pair of bandtails on Eliza Island in May 1953, (nest #6) are mentioned to illustrate the actions of adult pigeons on and off the nest. The one egg of this particular nest was laid in late afternoon of 18 May in a willow tree just outside the island's guest cabin. On 19 May, observations from the cabin started at 4:00 AM. The female was present on the nest, having remained on overnight. At 4:05 AM the male cooed nearby and the female answered him several times with low short purring buzzes. The female had the egg well covered and did some feather preening, but was very watchful. Between 4:20 and 5:07 AM the male cooed five different times, answered each time by purring calls from the female. At 5:01 AM the female purred and at 5:12 AM the male landed on the main limb used to approach the nest. The female then stood up, walked off the nest and flew to a nearby tree. Immediately the male walked onto the nest and took about three minutes arranging himself over the egg. When the egg was satisfactorily tucked under the male, he worked his body down low onto the nest. He faced away from the entrance branch while the female had faced it. At 5:30 AM the female purred from a tree nearby while the male looked alertly around but otherwise remained quiet. At 6:45 AM the male turned around on the nest and half stood for 15 minutes. At 7:00 AM he again turned around this time facing the main entrance branch. The egg was carefully worked under his body. At 7:55 AM he appeared very drowsy and had his head drawn down onto his breast.

Later the same day at 2:30 PM the male was noted facing southwest into a 25 to 35 mile (40–56 km)-an-hour wind, but the surrounding trees helped shield the nest to a certain extent. Some of the wind gusts made the male lean forward and apparently grip the nest twigs. At 4:30 PM with the wind still blowing hard, the female landed in a maple tree over the nest, looked intently down at the nest, and at 4:35 PM dropped down through the willow tree onto a limb supporting the nest platform. The male stood up, walked off the nest and flew into nearby woods after which the female settled immediately on the egg. At 4:45 PM the female was facing into the wind, having tucked the egg under her feathers with her bill, and she remained incubating through the night.

On 23 May, two days later, the following actions were noted for the same female between 4:00 and 4:50 AM: scratched her head with one foot; dug into her breast with bill several times, apparently scratching; got up and turned to a different angle on the nest using her head and bill to work the egg under her body and worked on nest twigs around the egg. At 4:50 AM she stood up and left the nest for almost 45 seconds, defecating nearby. The male cooed nearby at 5:05 AM; the female from 5:15 to 6:00 AM picked at her neck and both underneath and on top of her wing. She then turned in a southwest direction, at a right angle to the north wind. She was drowsing at 6:15 AM when the researcher inside the cabin lit a fire in the wood stove. The female displayed no notice of the

smoke coming out of the chimney. At 7:15 AM the female spent about a minute working diligently on the lattice bottom of the nest below the egg. It appeared that she was trying to lessen the larger gaps in the twigs. Becoming restless, she faced northeast at 7:28 AM and southwest at 7:34 AM; the male began his incubation duty at 8:12 AM.

Incubation actions of the pair continued much the same until the 15th day when a crow attacked the female on the nest evidently causing the egg to be kicked out of the nest. Normally the pair would freeze in their movements when crows were calling nearby, but they were never observed to leave the nest in fright. The nest predation on the 15th was unobserved, but several tail feathers of the bandtail with bill creases indicated that the close-setting female was attacked on the nest by the crow. The crow apparently did not find the egg shell remains and the well-developed embryo on the ground beneath the tree since the contents were untouched.

Peeters (1962), in his California study, reported times of morning nest changes for one particular male replacing the female ranged for 11 days between 10:02 and 10:28 AM. The arrival of the female at the nest for the afternoon changes ranged from 4:17 to 5:30 PM. Peeters recorded the detailed schedule of incubation for this pair and determined that the male over this 11-day observation period spent between 6 hours 8 minutes and 7 hours 12 minutes each day incubating. The female observed for the same number of days spent between 16 hours 36 minutes and 17 hours 38 minutes each day for incubation.

Detailed observations on Eliza Island during incubation and brooding indicated adult bandtails do not defecate on their nests. The male may be on the nest for periods ranging from about seven hours to, rarely, 11 hours, and the female may be on the nest from 15 to 17 hours. Defecation does not occur in the nests during these incubation or brooding hours, but the male or female may leave for a minute or two for this duty, as has been observed, and then return immediately to the nest. The first act of the adult coming off the nest at the nest change time is to defecate nearby. The exiting bird then quietly moves further from the nest area. After watching the area for a short time it then usually leaves for the feeding area. Squabs soil the nest along the outer periphery of the nest twigs but usually the squab's excrement is from the nest.

Efforts were made in the 1952–1953 Eliza Island studies to learn the deposition of the bandtail egg shells after hatching. Few egg shell remains were found inside the nest platform except an occasional piece that apparently slid down and became lodged in the twigs. Shell remains were found on the ground and around the immediate periphery of the nest and up to 30 yards (27 m) from the nest.

It appears the adult bandtail removes the shells by either tossing the remains over the edge or by carrying the shells in their bills for a short distance from the nest, although this action was not witnessed. The shell remains found on the ground indicate by their size that they were tossed out of the nest. Had these large portions remained in the nest it is presumed it would have been only a short time before they would have been crushed and sifted as small pieces through the twigs, quite unlike the larger portions found on the ground.

One deserted bandtail egg, presumed to be infertile, was found and examined on Eliza Island in 1952. This particular egg had been incubated by both adults for at least 13 days, as observed by W. H. Bohl, but the number of days of incubation prior to its discovery was unknown. On the 13th day of observed incubation, the female was missing from the nest early in the morning. The male came to the platform at 08:05 AM, cooed, and then left the nest and its single egg. Examination of the egg revealed the fluid contents of the yolk and albumen had blended, probably because of heat and assumed lack of fertility. Although other nests contained deserted eggs, this was the only one to exhibit the blended yolk-albumen condition.

A personal letter from A. F. Skutch (21 July 1956) gives his detailed observations concerning a pair of pigeons at a nest he found on 13 March 1933 in Guatemala:

> I made observations on this nest on four days. On 17 March the male was on the nest when I arrived at 9:00 AM and he sat continuously until his mate replaced him at 4:00 PM. On 18 March, the male was already on the nest when I came at 8:40 AM. I did not watch continuously that day, but at 3:30 PM, I saw the female replace him and she stayed until dark. On 19 March, I made a continuous all-day watch. The female was sitting at daybreak. At 6:20 AM she left, apparently to avoid soiling the nest, and returned a minute later, staying until her mate replaced her at 8:23 AM. He sat without a break until 3:57 PM when the female replaced him on the egg. She stayed until nightfall. Next morning, 20 March, the female stayed on the egg until her mate relieved her at 8:31 AM, except for an absence of one-minute from 6:13 to 6:14 AM. I left after the male began his long day session. Since the female's absences in the early morning were too brief for foraging, I inferred that she went off to leave her droppings at a distance, and possibly to stretch her wings. There was no ceremony when one pigeon replaced the other on the nest. They sat motionless for long periods, rarely shifting their position and seldom turning the egg. Except when alarmed, they kept their necks contracted, head between the shoulders, and bill turned to the left.

These pigeons were very canny, not taking alarm at some noise or movement in their vicinity, but seeming to make an intelligent appraisal of each possible threat to their security before they acted. Distant noises were mostly disregarded by them, except when very loud and sharp. Sounds from the nearer source caused them to stretch up their necks and survey the situation. If the noise became more alarming, they rose up on the nest and prepared to take flight. If it was only a horse or cow that wandered beneath them, they settled down again, and slowly, very slowly, their necks contracted and their heads turned to its usual orientation, leftward. Thrice while I watched men walk beneath the nest without frightening away the sitting bird, which raised its head, took in the situation, and decided to risk staying, since the trespasser did not look up at it.

It may be of interest that in this pair the irises of both sexes were bright red, their bills yellow with black tips. The crescent on the back of the neck was pure white, bordered below by black. In the member of the pair which occupied the nest by night and evidently the female, this black region appeared more extensive, especially on the sides of the neck, then in the mate. The sides of the male's neck were a beautiful iridescent green when the morning sunshine fell upon him through the needles of the pine tree.

Brooding and Growth of Squab

Caution was taken in the Eliza Island studies to avoid disturbing the adult occupant of any newly-located nest during both incubation and brooding periods except in two special cases. It was desired to have the adults complete as normal a nesting cycle as possible so that a valid nesting season could be plotted in both 1952 and 1953.

A cautious check of the nest twice a day determined when brooding had ceased. These checks, within field-glass range of the nest, were made between 10:00 AM and 2:00 PM and at dusk or, in some cases, as late as 8:00 PM. Cessation of brooding was recorded when the adults were not on the nest at one of the above time checks, but re-checks on the cessation were made to eliminate the possibility that this might not have been the actual termination. It was noted in some cases that after an interval of a day or so that adults might return for more brooding.

Brooding was conducted by both adults with practically the same hours as during incubation; namely, males during the mid-daylight hours and females overnight. In most cases, brooding was concluded between the 10th and 20th day with several extremes of cessation recorded between the sixth and ninth day. If very warm weather occurred during the active brooding period, the male would move from the squab, remaining on the edge of the nest, and would not hover it at all until the weather cooled. However, during this same weather, males would hover the squabs on nests in the forest interior where it was more dark and cool than at the exterior.

Illustrating the sporadic type of brooding exercised by male bandtails, on 3 July 1952, a male came to its nest at 8:45 AM, fed the squab quickly, hovered it until 10:00 AM, then left to fly toward the neighboring island where bandtails fed and watered. The squab was approximately 10 days old at this date.

Another adult male in 1952 exhibited impatience to be relieved of his nest duties at a 3:50 PM nest change. The female had just arrived from Lummi Island and had landed some 50 yards (46 m) from the nest. Shortly afterwards the male stepped off the nest and took to the air, giving the flutter flight and issuing several raspy buzzes. Concluding this short flight, he dropped into the forest crown and proceeded to chase the female to the nest. He then cooed from a nearby tree perch and at 4:25 PM flew toward his feeding and watering areas on Lummi Island or the northern mainland. This was the only observation of a male being so domineering in his action of hazing the female onto the nest. Quite possibly, other males going to their nest duties may have angered this particular male, hence the flights overhead, the flutter flight, and the buzzes seemingly hazing the female to the nest platform.

The female at the nest was much more attentive toward the squab then the male; she would often continue her brooding when nights were cool regardless of when the male stopped his brooding. Brooding by the female continued until some squabs were 10 to 15 days old and, in rarer cases, if not actual brooding, she would remain near the squab until it was approximately 26 to 27 days of age. A check was made every night on several nests to determine continuous or sporadic brooding. If the female was not present by 8:00 PM, it was concluded that she would not be with the squab for that particular night. Sometimes she did not appear one or two nights; occasionally for as many as 10 days or nights before resuming brooding.

In one case the female continued nightly brooding until two days before the squab left the nest. On 15 August 1953, a female was observed on a limb two feet (0.6 m) from a nest and squab at 7:30 PM just before dark. She had not been there at an earlier 5:30 PM check. At 8:00 PM she was found at the nest with the squab which was estimated to be 27 days old.

In another case, a female not at her nest at 7:15 PM was with the squab at 8:00 PM. This squab left its nest platform two days later, its age estimated at 24 days. The females' attachment for the squab appears very close during all portions of the nesting cycle. This was mentioned in another study by Abbott (1927):

> While it was small the mother bird stayed near the nest, some- times sheltering the baby with her wings during the mid-day heat; but when it was about 10 days old she remained away from the nest for hours at a time.

Some nests were found after the squab had hatched but still remained in the nest, making it necessary to develop an aging technique to more accurately ascertain the number of days from hatching to the squab's exodus from the nest. Consequently, the aging of a squab in nest #B-17 (Tables 5 and 7) was documented by photographs and external measurements from its first day of life, 12 July 1953, and every third day through its 19th day (Table 7, Figure 7). On the 22nd day the squab was so wary of the researcher it fluttered off the nest to a nearby limb, precluding further measurements. This squab left the nest tree on 3 August, its 23rd day, for a nearby tree and was fed daily there by the adults. It

could not be located after 11 August by the observer. Had the squab not been handled, it probably would have left the nest between its 26th or 30th day of life, the normal time.

The measurements of the squab (Table 7) indicate no readily visible pinfeathers were noted by the observer on the one-day old squab. Instead, whitish-yellow fuzzy down covered the squab at this age. At 10 days of age, primary feathers, including sheath, measured 1.3 and 1.8 inches (3.2 and 4.5 cm), respectively, for the inner and outermost primaries. These same two primary feathers measured 2.8 and 3.5 inches (7.2 and 9.0 cm) on the squab's 19th day of life. A majority of pin-feathers on the head were open at this age except for some at the base of the bill. Although it was impossible to measure the squab at 22 days of age, it was nevertheless observable that pinfeathers under the base of the bill were as yet unopened; most of the yellow down was gone from the body area and the bill was beginning to exhibit a dull yellow color at the base.

Techniques used in documenting these data involved tree climbing hooks (3 inches [7.6 cm] hook length) and a lineman's belt for tying the researcher into the nest tree. The nest was about 45 feet (13.7 m) up in a tall red cedar, against the trunk where it was supported by two limbs. Cameras were pulled up to the nest by a long cord for taking a sequence of periodic photographs, which began the day following hatching (Figure 7).

The adults from this particular nest, #B-17 (Table 5), had to be flushed from their nest and squab in the early stages of brooding, and each time the cripple act was

Figure 7. Band-tailed pigeon squab (#B-17) at about 1, 4, 10, 16, 19, and 22 days of age in the nest made of small sticks on the bough of a cedar tree located during the band-tailed pigeon study on Eliza Island, Washington, 1952–1953.

given by the male. Photographs and measurements were taken each day between 2:00 and 4:30 PM, the period that the male was on the nest. When the nest tree was climbed on the first day of the squab's life, the male sat closely until I had worked to within about 15 feet (4.6 m) of the nest. He then flushed over the side of the nest, down to within five feet (1.5 m) of the ground, and moved to a low limb about 35 yards (32 m) away. He fluttered his wings and tail in a very convincing cripple act for a short period on the limb and then fled overhead giving raspy buzzing calls. On another day the male let the observer climb to within six feet (1.8 m) of the nest before dropping to within a few feet (1 m) of the ground. The cripple display was given and was again a convincing exhibition with much fluttering and jerkiness of flight.

The observer previously had learned that the male bandtail cooed to the squab on its nest or from a nearby perch. This usually excited the squab, especially if it was about to be fed. Contrarily, it also appeared to calm the squab if feeding was not imminent. Imitating the cooing of the adult male, the observer would begin calling as he started to climb the nest tree. Upon reaching the nest he found the squab was usually calm, thus allowing easier handling of the bird for measurements. Pictures were always taken first with a 3.25 by 4.25 inches (8.3 by 10.8 cm) Super Graflex and, as a precaution against its failure, with a Bolsey 35 mm camera. Measurements (Table 7) were then taken; any other squabs measured at the nest were compared to this information to arrive at their approximate ages. Aging information was to be used ultimately for learning if bandtails raised two broods on Eliza Island during one nesting season.

The following convenient method of measuring the wing, body and tail feathers of the squab was used. The squab was placed on its back in the palm of the observer's left hand with the tail pointing away from the observer. With the index and third finger of this hand, the left wing was spread open enabling measurement of the first and tenth primaries. The thumb, fourth, and fifth fingers retained a firm but gentle grip over a sizable portion of the squab's body. The hand itself was held against a tree branch or the observer's body for steadiness and to give the squab a sense of support. The tail feathers were spread easily by the fingers to obtain their measurements and those body feathers desired. Adequate weighing scales were not available during this particular nest period and no weights were obtained of this squab.

The squab, amid periodic cooing by the researcher, indicated it was ready to eat by its thin peeping calls and fluttering of wings. Many times, although not fed, the squab would search hungrily between the researcher's fingers for an expected meal. Regardless of the cooing, the squab was still suspicious of and belligerent towards the researcher, but it is felt the bird was handled with more ease through the use of the simulated pigeon calls.

Some squabs that have not seen a human being until they are 10 to 20 days old may be excited and so wary of handling that they step backward off the nest and must be retrieved and replaced on the nest platform. Others are very belligerent and emit a sound like spitting, snapping their beaks, and flailing their wings at any hand that attempts to pick them up. Although cooing helps slightly to calm this type of squab, they usually cannot be disturbed more than once or twice without falling from the nest. The head-cocking action typical of adult pigeons is exhibited by the squabs as young as seven days of age in a rather proficient manner.

Measurements of other Eliza Island squabs compared with the age data (Table 7) indicate most left their nest areas between their 24th and 30th day of life. Some squabs left their nest platforms before this period, but careful scrutiny of nearby trees often disclosed the squab sitting immobile on a nearby tree limb. It seems reasonable to conclude that adults in this late nesting stage try to entice the squab to fly and leave the nest. Feeding does cause the squab to pursue the parent into a nearby tree for food when it is not completely ready to fly from the area to procure its own food. This can result in the situation of young bandtails sitting in trees near the nest site each day until they are ready to follow the adult.

On 11 August, I had stationed myself near squab #B-17 where it had been resting since it left the nest tree on 3 August. At 6:55 AM the squab made a short flight to a red cedar branch about 25 yards (23 m) southeast of the nest. An adult bandtail, presumably the male, arrived from Lummi Island at 7:35 AM and made a slow circle over the squab and nest area. Suddenly the adult dived at express speed into the forest, narrowly missing the sitting squab. The squab flushed widely, but I could not follow its hurried flight. The male landed about 15 feet (4.6 m) overhead, sat for five minutes, defecated, and then flew from the forest. This indicated to me the male's way of making the fledgling fly and encouraging it to forage on its own. It certainly appeared this adult was not going to feed the 3l-day-old fledgling. The fledgling was not observed again in the usual nest area.

As the period approached for squabs to leave the nest, males, in particular, would induce the fledglings to chase them through the trees further and further from the nest, an action that increased flying ability. The squab began simulated flight by standing on the nest, hanging onto the nest twigs with its toes, and flailing its wings. Between the 15th and 20th day of its life it is able to fly and glide short distances from the nest.

One squab (#B-17, Tables 5 and 7, Figure 7) left its nest on its 22nd day of life but remained in nearby trees eight more days. It was a fair but erratic flyer. Squabs seemingly preferred to be fed at the nest or in a nearby tree as long as the adults would tolerate the situation. Another squab (#B-24) left its nest when 24 days old and was last seen close to the nest on its 31st day of life, 22 August 1953. At 6:15 AM on this date, the fledgling made a 35-yard (32 m) flight concluded by a very jerky landing on a maple limb. Teetering on the limb for a short time, the bird again flew 35 yards (32 m) to another limb. At 7:00 AM it was still on this limb. It preened its feathers and cocked its head back and forth several

times. At 2:00 PM it was still sitting at this same spot. When the male came to feed the fledgling at 6:11 PM, the fledgling fluttered its wings excitedly about the male in its desire to be fed. After a short one-minute feeding, the squab was left sitting on the limb upon which it had been fed. A check at 7:45 PM revealed it still in that spot, where it roosted for the night. From all observations this bird was fairly capable of flight but at the estimated age of 31 days its flying ability certainly would need much refinement to compare with the adults.

Some squabs remaining in nearby trees left their nests as much as seven days before the normal departure dates above. Often the squab would practice flying, be led by the adult through tree branches, or chase after the adult to be fed. When the researcher accidentally flushed some reasonably-advanced squabs from their nests, they usually had just enough flight mobility to glide and land in a nearby tree.

Once off the nest they seldom returned, but sat in a nearby tree awaiting the adults' return with food. One squab did return the following day to the actual nest platform but this was the exception. On 3 July 1952, a marked squab which had left the nest area on 27 June returned twice to the nest tree. During each visit the squab could be heard peeping. After the adults did not appear the fledgling left, not to be seen again by the observer. This squab had left its nest for an eight-day interval before returning.

How the adults find the squabs that prematurely flush from the nest was interestingly disclosed in 1953. On 23 August 1953, for purposes of photographing and feather measurements, I climbed toward the platform of nest #35, but before I reached the squab it suddenly flushed from the dense grand fir. I was unable to follow the squab's flight and, after an hour's search, decided to wait for the adult feeding period on the following day to see if they could locate the squab. This squab was estimated, based on earlier measurements, to be better than 20 days old on the day it flushed from its nest. At 10:15 AM the following day the adult female landed with a flutter of wings in a fir next to the nest tree, and then proceeded to the empty nest platform. She craned her neck and fluttered around the limbs looking for the squab. She rather frantically moved to a nearby red cedar and there started to give low purring calls. The male, who was now on a high perch nearby, began cooing amid her calls. I moved under the nest tree at this point, but she was so absorbed in her purring calls, now louder, that she did not appear to see my movement below. She flew again to the nest platform and issued even louder purring calls. At this point I heard the squab call weakly from an area to the west of the nest.

The cooing male then moved through the intervening branches toward the calls of the squab, traveling about 50 yards (46 m), until the squab could be seen fluttering its wings on a Douglas-fir limb about 15 feet (4.6 m) from the ground. This tree was in the same direction the squab had flown in a gliding flight the day before. The squab did not fly back to the nest, the female, or move closer to the approaching male. The squab continued to peep midst the cooing of the male, which in addition gave purring calls, the same type as the female's earlier calls. The female fed the squab and left it in the fir, where it was fed for several days before disappearing, apparently to join the adults.

Some squabs in each nesting season can be expected to overstep their nests, especially in their voracious desires to be fed by an approaching adult. A squab fell from its nest just behind our living quarters in July 1953 and, although I searched in the vegetation below the tree, I could not find the squab, which was approximately 10 days old. Remembering how the squabs of other nests answered to the cooing of the males, I proceeded to issue this call, and shortly a very light peeping came from the squab in dense vegetation nearby. It was retrieved and placed in its nest. Without this call to locate it, the squab probably would have perished since it is doubtful the male would have entered the dense vegetation to feed it every day for another 10 to 15 days. Unfortunately, this particular squab died a few days later, apparently from injuries suffered in the fall. The adults began building a second nest within a week in a nearby white fir.

Nesting Success

Nesting successes for studies reported ranged from 27 to 75%. Peeters (1962) reported a high incidence of mortality among nestlings; of 11 nests observed during 1961–1962 near Berkeley, California, only three squabs fledged. MacGregor and Smith (1955) observed 26 nestings, 65% of which were successful in fledging squabs. Glover (1953) estimated a 73% success for 109 breeding pairs in his study area in Humboldt County, California, but this was an estimate only based upon an August census of the adult:immature ratio. Eliza Island studies of 50 nestings showed 75% fledged squabs in 1952 and only 33.3% in 1953. The overall nesting success for 57 observed nestings in 1952 and 1953 on Eliza, Vendovi, and Lummi islands was 50.9% (Table 8).

Of five bandtail nests located at 4,000 feet (1,219 m) near Mesa Grande in San Diego County, California; Abbott (1927) reports that two with eggs were deserted in July and a nest with a one-day-old squab hatched on 19 August 1926 was also deserted. Two other August nests contained eggs but were not reported upon. These nesting mortalities, including two other late September and October nests deserted after cold rain storms indicate a lack of nesting production in this southern California area.

Allen (1941) observed in July 1934, near Altadena, California, a nest where the squab was found dead on the ground. He further reports that in 1936 various pairs of pigeons were seen feeding young on 4 July, incubating eggs on 7 July, and building a nest on 25 August. The latter nest was deserted a few days later.

Another nest located was being constructed on 1 February, 1939, according to Allen (1941) and a dead young bird was found under this nest on 1 April. Other unsuccessful nestings were reported and even with the earliest recorded nesting of 27 February 1939, until the latest, 1 November 1937, when a young pigeon left the nest, Allen reported the proportion of successful nesting was low. Each nest contained but one egg or squab. Willard (1916) missed collecting several bandtail eggs by their being knocked from the nest by the startled adult. It can be envisioned that avian predators could also cause this type of nest loss when the adult, flushed suddenly, knocks the egg or even the squab from the nest platform.

Abbott (1927) stated:

> That successive young pigeons are sometimes raised in one nest the same season was proved by Ralph Bushnell (1925) (in Bent 1932) who found a nest on March 8, containing one egg, from which the squab hatched and grew up. The pigeon then laid an egg in the same nest and started incubating. The second young bird hatched about the middle of May and lived to leave the nest.

MacGregor and Smith (1955) at Carmel, California, reported one nest of 26 observed nestings was used three times in one year. None of the 50 nests found on Eliza Island was used twice nor does Peeters (1962) report second use of the nest platform. Using the same nest platform twice in one year seemingly is not the normal situation for bandtail nesting.

Summary

This study on Eliza Island, Washington, was designed to examine the questions of whether band-tailed pigeons can lay two eggs per clutch and nest twice within the same year. The results indicated that two-egg clutches were very uncommon, but left open the answer as to how many nest attempts can occur in Washington in one breeding season. Review of the literature indicated that two-egg clutches can occur but are uncommon. This review also indicated that at least two nestings per year can occur, especially in southern areas. During the field study on Eliza Island, 20 active nests were located in 1952 and 30 active nests were located in 1953. Nest success (fledging) varied from 1952 to 1953 but averaged 50% for the two years. These results were confounded by an ongoing predator control experiment in conjunction with research on captive-reared and released ring-necked pheasants. Data are presented on characteristics of displays and behaviors of band-tailed pigeons, nesting and incubation behavior, growth of young, and causes of nest failure, food habits, band recaptures and recoveries, and species of trees used for nesting. The life history information in this report were mostly lacking in the scientific literature when this work was completed in 1952–1953. The detail presented is still important in aiding our knowledge of the ecology of band-tailed pigeons.

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Figure 8. Research biologists Hugh Black (left) and Richard Phillips (right) assisted with the band-tailed pigeon study on Eliza Island, Washington, 1952–1953.

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Table 1. Daily band-tailed pigeon counts from 9 April to 1 October 1952 on Eliza Island, Washington.

	Month						
Day	Apr	May	Jun	Jul	Aug	Sep	Oct
1	0	4	15	15	13	21	4
2	0	16	15	20	12	†[1]	0
3	0	5	25	20	12	34	0
4	0	10	25	18	12	2	0
5	0	5	30	15	15	37	0
6	0	6	25	15	14	10	0
7	0	12	20	12	10	2	0
8	0	†	20	12	10	11	0
9	3	5	25	12	10	55	0
10	3	3	15	10	10	20	0
11	3	5	†	12	15	†	0
12	4	9	8	12	12	†	0
13	21	6	12	12	15	4	0
14	14	17	10	12	15	4	0
15	5	5	12	12	12	9	0
16	4	4	12	15	10	4	0
17	6	5	12	12	10	2	0
18	5	3	15	15	10	2	0
19	4	†	12	15	12	1	0
20	4	4	12	15	10	1	0
21	8	4	15	15	10	3	0
22	11	5	15	10	10	2	0
23	21	5	15	12	10	5	0
24	15	4	15	15	65	3	0
25	30	5	15	15	25	3	0
26	7	4	12	12	20	6	0
27	4	8	12	10	18	8	0
28	10	12[2]	10	12	16	0	0
29	11	8	20	10	8	0	0
30	6	9	20	12	†	0	0
31		13		12	31		0

[1] No field observations.

[2] Baiting to attract pigeons for live trapping from 25 May to 13 June resulted in a larger number of birds; the numbers decreased after trapping.

Table 2. Band returns (recoveries and recaptures) through 1 January 1957 of 195 band-tailed pigeons banded on Eliza Island, Whatcom County, Washington, 1952–1953.

Band			Return			
Date	Number[1]	Age class	Date	Days[2]	Location	How
9 Jun 1952	33172	Adult	29 May 1953	354	Eliza Island, Whatcom Co., WA	Trapped
9 Jun 1952	55715	Adult	13 Dec 1953	552	Figureoa Mt., Santa Barbara Co., CA	Shot
9 Jun 1952	55719/505-49145	Adult	9 May 1953	334	Eliza Island, Whatcom Co., WA	Trapped
29 Aug 1952	505-49077	Juvenile	12 Sep 1955	775	Nehalem, Tillamook Co., OR	Shot
9 May 1953	505-49101	Adult	9 Dec 1953	214	Los Padres National Forest near Santa Ynez, Santa Barbara Co., CA	Shot
9 May 1953	505-49103	Adult	2 Sep 1953	116	Near Samish Salmon Rearing Station, Skagit Co., WA	Shot
9 May 1953	505-49115	Adult	8 Jul 1953	60	Eliza Island, Whatcom Co., WA	Trapped
9 May 1953	505-49117	Adult	11 Sep 1953	125	King Co., WA	Shot
9 May 1953	505-49126	Adult	13 Sep 1953	4	Eliza Island, Whatcom Co., WA	Killed by Cooper's hawk
9 May 1953	505-49152	Adult	11 Sep 1955	774	Freeborn Community, East Stanwood, Snohomish Co., WA	Shot
9 May 1953	505-49121	Adult	1 Dec 1957	1667	El Wright Ranch, Cantinas area near Nacimiento River, San Luis Obispo Co., CA	Shot
29 May 1953	505-49062	Adult	1 Sep 1953	95	Lopez Island, San Juan Co., WA	Shot
29 May 1953	505-49063	Adult	15 Sep 1954	474	Near Bellingham, Whatcom Co., WA	Shot
29 May 1953	505-49091	Adult	1 Dec 1954	551	Chews Ridge, Los Padres National Forest, Carmel Valley, Monterey Co., CA	Shot
29 May 1953	505-49306	Adult	4 Sep 1954	463	Tenino, 1 mi (1.6 km) SE Thurston Co., WA	Shot
29 May 1953	505-49315	Adult	5 Sep 1954	464	Head of Eld Inlet, 5 mi (8 km) west of Olympia, Thurston Co., WA	Shot
3 Jun 1953	505-49327	Adult	11 Sep 1955	830	Nagrom, WA	Shot
3 Jun 1953	505-49343	Adult	30 Mar 1955	665	Nevada Co., CA	Shot
5 Jun 1953	515-30723	Adult	1 Dec 1954	544	Los Angeles Co., CA	Shot
5 Jun 1953	515-30745	Adult	5 Dec 1953	183	San Luis Obispo Co., CA	Shot
3 Jul 1953	515-30703	Juvenile	10 Jul 1953	7	Eliza Island, Whatcom Co., WA	Died after falling from nest
9 Jul 1953	515-30707	Juvenile	1 Aug 1953	23	Eliza Island, Whatcom Co., WA	Killed by Cooper's hawk at nest

[1] Bands are U.S. Fish and Wildlife bands except bands with 5 digit-numbers are Oregon State Game Commission bands.
[2] Days between banding and subsequent encounter.

Table 3. Percentage by volume and frequency of occurrence of food items that totaled 0.5% or more of 149 band-tailed pigeons collected by the Oregon Cooperative Wildlife Research Unit, 1-30 September 1946 and 1947.

Food item	Percentage by volume	Percentage by frequency
Cornus nuttallii, dogwood fruits	35.6	65.0
Quercus garrvana, white oak acorns	22.0	32.0
Sambucus glauca, blue elderberry fruits	13.0	25.0
Rhamnus purshiana, cascara fruits	10.0	12.7
Crataegus douglasii, western hawthorn fruits	6.7	8.7
Acorn debris and fragments	6.5	8.7
Prunus emarginata, wild cherry fruits	3.0	9.4
Wheat	1.4	2.7
Amelanchier alnifolia, western serviceberry	0.6	0.7
Oats	trace	0.7
Barley	trace	0.7
Rubus spp.	trace	0.7
Prunus spp.	trace	0.7
Crataegus spp.	trace	0.7

Table 4. Foods observed eaten, found in crop of dead pigeons, or at nest platforms on Eliza Island, Washington from 12 April through 12 September 1953.

Date (1953)	Foods eaten
12 Apr	Feeding on madrone buds, flowers, eating some waste grain from cultivated fields
20 Apr	Feeding on madrone buds, flowers, wheat (being used as trapping bait for pigeons)
22 Apr	One pigeon eating buds from cottonwood tree
2, 3, 4 May	Eating madrone buds, flowers
5 May	Searching for grand fir catkins, eating a few
7 May	Feeding on madrone buds, flowers
29 May	Female pigeon accidentally killed in island trapping operation had cracked corn, several madrone buds, green and red elderberry flowers and fruits in crop
3 Jun	Squab 11 or 12 days old dead in nest; crop contained 50% pigeon's milk, 40% whole wheat kernels (one kernel germinating, 0.43 inch [11 mm] long stem), 10% red elderberries, 3 pieces of grit
14 Jun	Two pigeons feeding on red elderberries
19 Jun	Fruit and seeds of red elderberries found at most nest platforms containing squabs
21 Jun	Ripe red elderberry fruit found on nest platform of squab recently fed
25 Jun	Heavy deposit of red elderberry seeds in nest with squab
30 Jun	Two pigeons feeding on leaf tips of Douglas-fir
21 Jul	Many freshly deposited red elderberry seeds present in nest of 10-day-old squab; pigeons observed eating wild cherries on Vendovi Island nearby, acorns being eaten on Spieden Island
23 Jul	Salal berry on nest platform
29 Jul	Nest contained many salal-stained scats
30 Jul	Wild cherries almost ripe on Eliza Island
2 Aug	Crops of two squabs killed by avian predator contained red elderberry fruit plus pigeon milk
5 Aug	Salal berry seeds numerous in nests
12 Aug	Fresh red elderberry and salal scats in nests
19 Aug	One pair feeding in wild cherry trees; their nest nearby
28 Aug	Many pigeons observed feeding on wild cherries on nearby mainland
12 Sep	Many salal stained scats in nest platforms; madrone fruits and huckleberry beginning to ripen but most pigeons moving south in their migration to California or Baja California

Table 5. Band-tailed pigeon nesting event termination dates (observed and projected) and success for nests located (nest #A = 1952, #B = 1953) on Eliza, Lummi, and Vendovi islands, Washington, 1952 and 1953.

Nest #	Area	Left nest or area	Fate
A-1	Eliza	Projected 29 Jun[1]	Deserted; egg, 10–15 day embryo
A-2	Eliza	25 Jun	Successful
A-3	Eliza	27 Jun	Successful
A-4	Eliza	30 Jun-5 Jul, estimate	Successful
A-5	Eliza	4 Jul	Successful
A-6	Eliza	20 Jul	Successful
A-7	Eliza	15-20 Jul, estimate	Successful
A-8	Eliza	22 Jul	Successful
A-9	Eliza	Projected 22 Aug	Deserted; egg, no development
A-10	Eliza	27 Jul	Successful
A-11	Eliza	Projected 12 Aug	Deserted; egg, no development
A-12	Eliza	Projected 17 Aug[1]	Deserted; squab dead at base of tree
A-13	Eliza	7 Aug	Successful
A-14	Eliza	16 Aug	Successful
A-15	Eliza	28 Aug	Successful
A-16	Eliza	30 Aug	Successful
A-17	Eliza	1 Sep	Successful
A-18	Eliza	4 Sep	Successful
A-19	Eliza	13 Sep	Successful
A-20	Eliza	Unknown	Deserted; egg, no development
B-1	Eliza	Projected 21Jun	Deserted; egg, embryo forming
B-2	Eliza	Projected 22 Jun	Deserted; egg, embryo forming
B-3	Eliza	Projected 20 Jun	Deserted; egg, no development
B-4	Eliza	Projected 28 Jun	Deserted; 11–12 day old squab dead in nest
B-5	Eliza	Projected 28 Jun	Deserted; 3–5 day old squab dead at base of tree
B-6	Eliza	Projected 4 Jul	Deserted; egg, 15-day embryo, crow attacked female on nest
B-7	Eliza	Projected 3 Jul	Deserted; egg broken at base of tree
B-8	Eliza	Projected 9Aug	Deserted; squab missing
B-9	Eliza	Projected 18 Jul[1]	Deserted; egg, no development
B-10	Eliza	Projected 28 Jul	Deserted; squab dead at base of tree
B-11	Eliza	Projected 22 Jul	Deserted; egg, no development
B-12	Eliza	Projected 27 Jul	Deserted; 10-day old squab missing
B-13	Eliza	Projected 24 Jul	Deserted; 8-day old squab missing
B-14	Eliza	27 Jun	Successful
B-15	Eliza	Projected 31 Jul	Deserted; egg missing
B-16	Lummi	Projected 5 Aug	Deserted; egg missing
B-17	Eliza	11 Aug	Successful
B-18	Eliza	Projected 6 Aug	Deserted; egg, slight development
B-19	Eliza	Projected 11Aug	Deserted; egg, slight development
B-20	Eliza	7 Jul	Successful
B-21	Vendovi	Projected 3 Aug	Deserted; 3–5 day old squab missing
B-22	Eliza	Projected 20 Aug	Predation; 14-day old squab killed on nest by Cooper's hawk
B-23	Eliza	Projected 23 Aug	Predation; 18-day old squab killed on nest by Cooper's hawk
B-24	Eliza	24 Aug	Successful
B-25	Eliza	Projected 22 Aug	Deserted; egg missing
B-26	Vendovi	Projected 21 Aug	Successful
B-27	Vendovi	Projected 1 Aug	Deserted; egg, no development
B-28	Vendovi	Projected 4 Aug	Successful
B-29	Vendovi	Projected 20 Jul	Successful
B-30	Vendovi	Projected 5 Aug	Successful
B-31	Eliza	Projected 14 Aug	Predation; 9-day old squab killed on nest by Cooper's hawk
B-32	Eliza	29 Aug	Successful
B-33	Eliza	17 Aug	Successful
B-34	Eliza	25 Aug	Successful
B-35	Eliza	25 Sep	Successful
B-36	Eliza	26 Sep	Successful
B-37	Eliza	30 Aug	Successful

[1] Suspected cause of desertion = human interference A-1, A-12 and B-9.

Table 6. Band-tailed pigeon nest site characteristics for 136 nests located on Eliza Island, Washington, 1952–1953. Nest site characteristics include forest type, distance to forest opening or edge, tree species, tree diameter at breast height, number of nests per tree, nest height from the ground, and distance of the nest from the tree trunk.

Forest type	Dist. to opening (yards [m])	Tree species	DBH (inches [cm])	Nests per tree	Height (feet [m])	Dist. to trunk [m])
Douglas-fir, red cedar	40 [37]	Douglas-fir	11.0 [28]	1	65 [19.8]	5 [1.5]
Douglas-fir, red cedar	35 [32]	Douglas-fir	21.0 [53]	1	47 [14.3]	8 [2.4]
Douglas-fir, red cedar	55 [50]	Red cedar	23.0 [58]	1	60 [18.3]	2 [[0.6]
Douglas-fir, red cedar	100 [91]	Red cedar	6.5 [17]	1	45 [13.7]	0
Douglas-fir, red cedar	100 [91]	Douglas-fir	10.0 [25]	1	75 [22.9]	2 [0.6]
Douglas-fir, red cedar	30 [27]	Red cedar	12.5 [32]	1	60 [18.3]	12 [3.7]
Douglas-fir, grand fir	35 [32]	Douglas-fir	15.0 [38]	1	50 [15.2]	8 [2.4]
Douglas-fir, red cedar	50 [46]	Douglas-fir	10.0 [25]	1	50 [15.2]	4 [1.2]
Douglas-fir	20 [18]	Douglas-fir	9.0 [23]	1	45 [13.7]	4 [1.2]
Douglas-fir, madrone	15 [14]	Douglas-fir	8.0 [20]	1	18 [5.5]	4 [1.2]
Douglas-fir, red cedar	100 [91]	Douglas-fir	11.0 [28]	1	40 [12.2]	2 [0.6]
Douglas-fir, red cedar, ocean spray	0	Douglas-fir	6.5 [17]	1	25 [7.6]	8 [2.4]
Grand fir, Douglas-fir	40 [37]	Grand fir	6.5 [17]	1	22 [6.7]	3 [0.9]
Grand fir, Douglas-fir	75 [69]	Grand fir	6.0 [15]	2	27 [8.2]	2 [0.6]
Grand fir, Douglas-fir	125 [114]	Pacific yew	17.0 [43]	1	25 [7.6]	10 [3.0]
Red cedar, Douglas-fir	130 [119]	Grand fir	21.0 [53]	1	18 [5.5]	0
Red cedar, Douglas-fir	125 [114]	Red cedar	8.0 [20]	1	24 [7.3]	4 [1.2]
Red cedar, Douglas-fir	125 [114]	Red cedar	7.0 [18]	1	15 [4.6]	3 [0.9]
Red cedar, Douglas-fir	100 [91]	Red cedar	6.5 [17]	1	12 [3.7]	1 [0.3]
Red cedar, Douglas-fir	100 [91]	Red cedar	9.0 [23]	2	15 [4.6]	0
Douglas-fir, red cedar	75 [69]	Douglas-fir	24.0 [61]	1	50 [15.2]	8 [2.4]
Red cedar, wild cherry	125 [114]	Pacific yew	7.0 [18]	1	15 [4.6]	5 [1.5]
Red cedar, alder, maple	100 [91]	Red cedar	7.0 [18]	1	20 [6.1]	4 [1.2]
Red cedar, maple	100 [91]	Red alder	19.0 [48]	1	25 [7.6]	0
Grand fir, maple, red cedar	100 [91]	Grand fir	26.0 [66]	1	50 [15.2]	0
Grand fir, maple, red cedar	100 [91]	Grand fir	17.0 [43]	1	30 [9.1]	0
Grand fir, maple, red cedar	100 [91]	Dwarf maple[1]	9.0 [23]	1	15 [4.6]	6 [1.8]
Grand fir, maple, red cedar	100 [91]	Pacific yew	7.5 [19]	1	25 [7.6]	4 [1.2]
Grand fir, alder, Douglas-fir	80 [73]	Pacific yew	5.0 [13]	1	15 [4.6]	4 [1.2]

Forest type	Dist. to opening (yards [m])	Tree species	DBH (inches [cm])	Nests per tree	Height (feet [m])	Dist. to trunk [m])
Red cedar, grand fir, yew	75 [69]	Red cedar	38.0 [97]	1	67 [20.4]	0
Grand fir, Douglas-fir	75 [69]	Grand fir	11.0 [28]	1	50 [15.2]	1 [0.3]
Douglas-fir, red cedar, yew[1]	00 [91]	Douglas-fir	8.0 [20]	1	35 [10.7]	5 [1.5]
Douglas-fir, red cedar	50 [46]	Douglas-fir	7.5 [19]	1	63 [19.2]	2 [0.6]
Grand fir, Douglas-fir, red cedar	60 [55]	Grand fir	13.0 [33]	1	58 [17.7]	0
Grand fir, Douglas-fir, red cedar	75 [69]	Grand fir	15.5 [39]	1	55 [16.8]	0
Grand fir, Douglas-fir, red cedar	35 [32]	Douglas-fir	9.0 [23]	1	50 [15.2]	0
Douglas-fir, grand fir	75 [69]	Douglas-fir	6.0 [15]	1	45 [13.7]	3 [0.9]
Grand fir, dwarf maple	35 [32]	Grand fir	7.0 [18]	1	15 [4.6]	0
Grand fir, dwarf maple	35 [32]	Grand fir	13.0 [33]	1	35 [10.7]	3 [0.9]
Red cedar, grand fir	35 [32]	Red cedar	8.0 [20]	2	40 [12.2]	1 [0.3]
Red cedar, grand fir	30 [27]	Grand fir	13.0 [33]	1	25 [7.6]	0
Red cedar, dwarf maple, grand fir	25 [23]	Red cedar	12.5 [32]	1	15 [4.6]	0
Red cedar, willow, dwarf maple	20 [18]	Grand fir	8.0 [20]	1	14 [4.3]	6 [1.8]
Grand fir, dwarf maple	25 [23]	Grand fir	15.5 [39]	1	25 [7.6]	0
Dwarf maple, Douglas-fir	25 [23]	Grand fir	14.0 [36]	1	30 [9.1]	0
Grand fir, bigleaf maple	30 [27]	Grand fir	7.0 [18]	1	40 [12.2]	0
Grand fir, Douglas-fir, red cedar	45 [41]	Grand fir	18.0 [46]	1	35 [10.7]	0
Bigleaf maple, grand fir	5 [5]	Grand fir	22.0 [56]	1	4 [1.2]	7 [2.1]
Douglas-fir, alder	15 [14]	Douglas-fir	5.0 [13]	1	35 [10.7]	4 [1.2]
Grand fir, dwarf maple	25 [23]	Grand fir	17.0 [43]	1	38 [11.6]	4 [1.2]
Grand fir, Douglas-fir	20 [18]	Douglas-fir	14.0 [36]	1	65 [19.8]	4 [1.2]
Grand fir, red cedar, alder	30 [27]	Grand fir	13.5 [34]	1	55 [16.8]	4 [1.2]
Grand fir, Douglas-fir	30 [27]	Douglas-fir	27.0 [69]	2	18 [5.5]	9 [2.7]
Douglas-fir, alder	25 [23]	Douglas-fir	14.0 [36]	1	15 [4.6]	1 [0.3]
Red cedar, bigleaf maple	0	Grand fir	16.0 [41]	1	50 [15.2]	0
Maple, red cedar	25 [23]	Douglas-fir	17.0 [43]	1	15 [4.6]	12 [3.7]
Douglas-fir, dwarf maple	35 [32]	Douglas-fir	14.5 [37]	1	30 [9.1]	8 [2.4]
Douglas-fir, dwarf maple	15 [14]	Douglas-fir	7.5 [19]	1	42 [12.8]	0
Douglas-fir, red cedar	25 [23]	Douglas-fir	11.0 [28]	1	25 [7.6]	0

Forest type	Dist. to opening (yards [m])	Tree species	DBH (inches [cm])	Nests per tree	Height (feet [m])	Dist. to trunk [m])
Douglas-fir, red cedar	20 [18]	Douglas-fir	11.5 [29]	1	15 [4.6]	0
Red cedar, willow	5 [14]	Willow	9.0 [23]	1	6 [1.8]	8 [2.4]
Douglas-fir, red cedar	15 [14]	Douglas fir	4.5 [11]	1	22 [6.7]	0
Alder, dwarf maple	40 [37]	Grand fir	6.0 [15]	1	23 [7]	0
Douglas-fir, red cedar	75 [69]	Grand fir	20.0 [51]	1	25 [7.6]	3 [0.9]
Douglas-fir, red cedar	100 [91]	Douglas-fir	8.5 [22]	1	45 [13.7]	5 [1.5]
Red cedar, willow	15 [14]	Red cedar	6.0 [15]	1	14 [4.3]	0
Douglas-fir, willow	75 [69]	Douglas-fir	4.0 [10]	1	30 [9.1]	0
Douglas-fir, willow	40 [37]	Douglas-fir	9.0 [23]	1	14 [4.3]	10 [3.0]
Douglas-fir, willow	50 [46]	Douglas-fir	5.0 [13]	1	37 [11.3]	0
Douglas-fir, willow	75 [69]	Douglas-fir	4.0 [10]	1	20 [6.1]	0
Douglas-fir, willow	45 [41]	Grand fir	14.0 [36]	1	35 [10.7]	0
Douglas-fir, willow, dwarf maple	100 [91]	Douglas-fir	8.0 [20]	1	28 [8.5]	5 [1.5]
Douglas-fir, alder	125 [114]	Douglas-fir	13.0 [33]	1	40 [12.2]	8 [2.4]
Douglas-fir, alder, willow	100 [1]	Douglas-fir	19.0 [48]	1	48 [14.6]	5 [1.5]
Grand fir, alder	50 [46]	Grand fir	20.0 [51]	1	35 [10.7]	8 [2.4]
Grand fir, willow	75 [69]	Grand fir	10.0 [25]	1	50 [15.2]	
Douglas fir, red cedar, bigleaf maple	150 [137]	Douglas-fir	8.0 [20]	1	28 [8.5]	10 [3.0]
Douglas-fir, red cedar	125 [114]	Red cedar	32.0 [81]	1	38 [11.6]	6 [1.8]
Douglas-fir, red cedar, dwarf maple	125 [114]	Douglas-fir	6.0 [15]	1	40 [12.2]	0
Douglas-fir, red cedar, willow	125 [114]	Douglas-fir	6.0 [15]	1	45 [13.7]	1 [0.3]
Douglas-fir, red cedar	150 [137]	Douglas-fir	6.0 [15]	1	40 [12.2]	5 [1.5]
Douglas-fir, dwarf maple, red cedar	175 [160]	Douglas-fir	16.5 [42]	1	15 [4.6]	0
Douglas-fir, dwarf maple	175 [160]	Douglas-fir	6.0 [15]	1	22 [6.7]	1 [0.3]
Douglas-fir, bigleaf maple	175 [160]	Douglas-fir	22.0 [56]	1	65 [19.8]	6 [1.8]
Douglas-fir, red cedar	150 [137]	Douglas-fir	16.0 [41]	1	78 [23.8]	6 [1.8]
Douglas-fir, red cedar	100 [91]	Douglas-fir	10.0 [25]	1	95 [29]	0
Red cedar, bigleaf maple	10 [9]	Red cedar	9.0 [23]	1	10 [3.0]	5 [1.5]
Douglas-fir, red cedar	65 [57]	Douglas-fir	19.5 [50]	1	24 [7.3]	0
Douglas-fir, red cedar	75 [69]	Douglas-fir	11.0 [28]	1	58 [17.7]	5 [1.5]
Douglas-fir, red cedar, alder	100 [91]	Douglas-fir	3.5 [9]	1	20 [6.1]	0
Douglas-fir, red cedar	125 [114]	Douglas-fir	6.5 [17]	1	18 [5.5]	0

Forest type	Dist. to opening (yards [m])	Tree species	DBH (inches [cm])	Nests per tree	Height (feet [m])	Dist. to tr unk [m])
Douglas-fir, red cedar	35 [32]	Douglas-fir	18.0 [46]	1	77 [23.5]	5 [1.5]
Douglas-fir	75 [69]	Douglas-fir	18.0 [46]	1	32 [9.7]	0
Douglas-fir, red cedar	100 [91]	Douglas-fir	6.0 [15]	1	45 [13.7]	0
Douglas-fir, red cedar	65 [59]	Douglas-fir	17.0 [43]	1	80 [24.4]	4 [1.2]
Douglas-fir, red cedar	75 [69]	Douglas-fir	13.5 [34]	1	33 [10.1]	1 [0.3]
Douglas-fir	75 [69]	Douglas-fir	4.0 [10]	1	55 [16.8]	0
Douglas-fir, red cedar	100 [91]	Douglas-fir	15.0 [38]	1	15 [4.6]	0
Douglas-fir, dwarf maple	90 [82]	Douglas-fir	7.0 [18]	1	65 [19.8]	0
Douglas-fir, red cedar	125 [114]	Douglas-fir	6.0 [15]	1	20 [6.1]	0
Douglas-fir	125 [114]	Douglas-fir	3.0 [8]	1	28 [8.5]	0
Douglas-fir	75 [69]	Douglas-fir	9.5 [24]	1	22 [6.7]	0
Douglas-fir, willow	2 [2]	Willow	6.0 [15]	1	12 [3.7]	3 [0.9]
Douglas-fir, willow, wild cherry	0	Douglas-fir	7.0 [18]	1	12 [3.7]	3 [0.9]
Bigleaf maple, Douglas-fir	25 [23]	Douglas-fir	31.0 [79]	1	3 [0.9]	20 [6.1]
Douglas-fir, red cedar	30 [27]	Douglas-fir	7.5 [19]	1	34 [10.4]	0
Douglas-fir, alder	10 [9]	Douglas-fir	13.5 34]	1	60 [18.3]	0
Douglas-fir, red cedar	55 [50]	Douglas-fir	14.5 [37]	1	36 [11]	0
Douglas-fir, red cedar	25 [23]	Douglas-fir	15.0 [38]	1	25 [7.6]	8 [2.4]
Douglas-fir, willow, ocean spray	10 [9]	Douglas-fir	6.0 [15]	1	20 [6.1]	10 [3.0]
Douglas-fir, red cedar	40 [37]	Douglas-fir	5.5 [14]	1	35 [10.7]	0
Douglas-fir, bigleaf maple	50 [46]	Willow	11.0 [28]	1	36 [11]	4 [1.2]
Douglas-fir, red cedar	15 [14]	Douglas-fir	9.0 [23]	1	10 [3.0]	8 [2.4]
Douglas-fir, red cedar, madrone	5 [5]	Douglas-fir	10.5 [27]	1	9 [2.7]	8 [2.4]
Douglas-fir, bigleaf maple, red cedar	20 [18]	Douglas-fir	13.0 [33]	1	50 [15.2]	5 [1.5]
Douglas-fir, alder, red cedar	5 [5]	Douglas-fir	3.5 [9]	1	10 [3.0]	4 [1.2]
Ocean spray, willow, Douglas-fir	10 [9]	Douglas-fir	2.0 [5]	1	12 [3.7]	1 [0.3]
Grand fir, dwarf maple	50 [46]	Grand fir	6.5 [17]	1	45 [13.7]	2 [0.6]
Douglas-fir, red cedar, alder, wild cherry	40 [37]	Douglas-fir	7.0 [18]	2	55 [16.8]	2 [0.6]
Douglas-fir, red cedar	45 [41]	Douglas-fir	6.0 [15]	1	45 [13.7]	3 [0.9]
Douglas-fir, ocean spray, dwarf maple	5 [5]	Douglas-fir	9.0 [23]	1	10 [3.0]	0

Forest type	Dist. to opening (yards [m])	Tree species	DBH (inches [cm])	Nests per tree	Height (feet [m])	Dist. to trunk [m])
Ocean spray, Douglas-fir, *Rubus*	1 [1]	Douglas-fir	6.0 [15]	1	12 [3.7]	0
Ocean spray, Douglas-fir, *Rubus*	5 [5]	Red cedar	6.0 [15]	1	4 [1.2]	3 [0.9]
Douglas-fir, red cedar, grand fir	35 [32]	Grand fir	12.0 [30]	1	40 [12.2]	0
Douglas-fir, grand fir, alder	30 [27]	Douglas-fir	8.5 [22]	1	45 [13.7]	0
Douglas-fir, alder, grand fir	40 [37]	Douglas-fir	8.5 [22]	1	50 [15.2]	0
Red cedar, alder, dwarf maple	50 [46]	Douglas-fir	21.0 [53]	1	55 [16.8]	8 [2.4]
Douglas-fir, red cedar, alder	65 [59]	Douglas-fir	9.5 [24]	1	43 [13.1]	5 [1.5]
Douglas-fir, red cedar	45 [41]	Douglas-fir	5.0 [13]	1	38 [11.6]	0
Red cedar, Douglas-fir	35 [32]	Grand fir	6.0 [15]	1	35 [10.7]	0
Douglas-fir, red cedar, wild cherry	30 [27]	Douglas-fir	7.0 [18]	1	50 [15.2]	4 [1.2]
Douglas-fir, red cedar	15 [14]	Douglas-fir	11.0 [28]	1	45 [13.7]	10 [3.0]
Douglas-fir, red cedar	25 [23]	Douglas-fir	6.0 [15]	1	65 [19.8]	2 [0.6]
Douglas-fir, red cedar, alder	75 [69]	Douglas-fir	12.0 [30]	1	60 [18.3]	0
Douglas-fir, red cedar, alder	65 [59]	Douglas-fir	7.0 [18]	1	40 [12.2]	6 [1.8]
Douglas-fir, red cedar	30 [27]	Douglas-fir	6.0 [15]	1	40 [12.2]	2 [0.6]

[1] Dwarf maple = Rocky Mountain maple (*Acer glabrum*), also known as Douglas maple.

Table 7. Development of band-tailed pigeon squab #B-17 on Eliza Island, Washington, 1953.

Date (1953)	Description
12 Jul	Approximately one day old. Nest against trunk, 45 feet (13.7 m) up, supported by large, red cedar branches. No readily visible pinfeathers on body. Covered with whitish-yellow fuzzy down. Started to shiver after being 20 minutes without adult.
15 Jul	Four days old. Primary pinfeathers 0.12–0.16 inches (3–4 mm). Dorsal tract pinfeathers 0.04–0.08 inches (1–2 mm). Flank (over femur, tailward pins) 0.12–0.16 inches (3–4 mm). No other visible pinfeathers. Yellow orange fuzz on head. Yellow white on rest of body. Full crop, no sign of fruit seeds in scats.
18 Jul	Seven days old. Belligerent, half stands. Primary pinfeathers 0.71–0.94 inches (18–24 mm). Dorsal tract pinfeathers 0.28–0.31 inches (7–8 mm). Flank pinfeathers 0.63 inches (16 mm) (feathers out 0.04–0.08 inches [1–2 mm]). Tail pins, 0.16–0.24 inches (4–6 mm). No pins on head. Full crop with few elderberry seeds in nest.
21 Jul	Ten days old. Squab panting when exposed to direct sunlight. Very alert. Primaries1: sheath plus feather 1.26 inches (32 mm) (#1) and 1.77 inches (45 mm) (#2), feather 0.12 inches (3 mm) (#1) and 0.55 inches (14 mm) (#2). Dorsal tract feathers only 0.24–0.31 inches (6–8 mm). Flank (sheath plus feather) 0.79–0.98 inches (20–25 mm). Tail: sheath plus feather 0.59–0.71 inches (15–18 mm), feathers 0.04–0.12 inches (1–3 mm). Head pins only 0.04–0.12 inches (1–3 mm). Shoulder (coverts) feathers only 0.28–0.47 inches (7–12 mm).
24 Jul	Thirteen days old. Very belligerent until heated by sun, then more occupied with panting. Imitating coo of the male makes squab give short low peeps and quiver wings. Primaries: sheath plus feather 1.81 inches (46 mm) (#1) and 2.68 inches (68 mm) (#10), feather 0.87 inches (22 mm) (#1) and 1.57 inches (40 mm) (#10). Dorsal tract, feathers cover well. Flank feathers only 1.18–1.38 inches (30–35 mm). Tail: sheath plus feather 1.38 inches (35 mm) (middle), feather 0.59 inches (15 mm). Head pinfeathers all over, none open. Shoulder (coverts) feathers cover area well. Upper breast feathers 0.28–0.43 inches (7–11 mm).
27 Jul	Sixteen days old. Cooing brings many peeps from squab but it is semi-belligerent and in danger of stepping backward off nest. Primaries: sheath plus feather 2.3 inches (60 mm) (#1) and 3.31 inches (84 mm) (#10), feather 1.46 inches (37 mm) (#1) and 2.68 inches (68 mm) (#10). Tail: sheath plus feather 1.85 inches (47 mm) (middle), feather 1.10 inches (28 mm) (middle). Head (hind) pinfeathers still mainly unopened. Yellowish down attached to most of breast, wing coverts, head and dorsal tract feathers.
30 Jul	Nineteen days old. Still peeps at cooing but suspicious of observer. Last day able to approach for measuring. Primaries: sheath plus feather 2.83 inches (72 mm) (#1) and 3.54 inches (90 mm) (#10). Tail: sheath plus feather 2.76 inches (70 mm) (middle), feather portion 1.93 inches (49 mm) (middle). Exposed head, majority pinfeathers open except base of bill. Most of down picked off outer wing coverts, secondaries, and primaries. Much down in row above each eye, around base of neck and breast.
2 Aug	Twenty-two days old. Flew with a couple of wing beats to nearby limb. Unable to measure squab in hand today. Pinfeathers under base of bill still to open. Most yellow down gone. Bill color dull yellow at base of bill.

Table 8. Band-tailed pigeon nesting success for nests located on Eliza (E), Lummi (L), and Vendovi (V) islands with predator control (PC) and without predator control (NPC), Washington, 1952–1953.

	Year (area)				
	PC			NPC	
Parameter	1952 (E)	1953 (L,V)	Subtotal	1953 (E)	Total
Nests (no.)	20	7	27	30	57
Successful (no.)	15	4	19	10	29
Unsuccessful (no.)	5	3	8	20	28
Success rate (%)	75.0	57.1	70.4	33.3	50.9


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