

DATE: May 30, 1970

SUBJECT: Completion Reports
Contract W54R1-7

TO: Department of Fish and Game
Wildlife Management Branch
Special Wildlife Investigations

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Point Reyes Bird Observatory has completed its 1969-1970 research studies under a \$6,000 contract with the California Department of Fish and Game - Special Wildlife Investigations Project (Pittman-Roberts W54R1-7). The two attached reports, (1) Analysis of aerial and ground censuses in Marin County and (2) Evaluation of shorebird banding and marking in Marin County, plus a report on the shorebird ecology of Limantour Estero submitted earlier complete our obligations under this contract.

Coordination duties involving record keeping on bands will be completed with the Observatory's normal processing of banding records. Recoveries of banded birds will be reported to California Department of Fish and Game whenever such reports are received from the Migratory Bird Populations Station, Patuxent, Maryland. These minor duties will be continued after the closing date of the contract.

Recommendations for future research studies were submitted at an earlier date to the Special Wildlife Investigations Department.

(1) Marin County Aerial Census 1969-1970

Introduction

The present program of aerial censuses originated with exploratory flights in March and April 1968. At that time it was decided that a census flight of the major bays and estuaries of Marin County (Tomaes Bay, Drake's Estero, Limantour Estero, Abbott's Lagoon and Bolinas Lagoon) was a potentially valuable method of obtaining population trends in shorebirds and other birds using this kind of habitat. The pattern established in these early flights has been followed without radical change throughout the 1968-69 and 1969-70 seasons. All flights have been made from Marin County Airport two miles north of Novato, and have covered the five areas mentioned above, weather permitting. On each flight two observers, one on either side of the airplane, recorded their estimates on portable tape recorders - a practice long used by the Department in waterfowl censusing.

The Census Area

Of the areas covered in the census, only Limantour Estero was under study before the program began. One clear positive result of the program is that the importance of each of the areas studied can now be assessed. There follows a general description of each.

Tomaes Bay

Tomaes Bay is a narrow bay about 13 miles long and one mile wide for most of its length, lying in the bottom of the ravine caused by the San Andreas fault; its surface area is about 9290 acres, with 2900 acres of mudflat and 440 acres of marsh. Although this was reported to be numerically the most important shorebird area in the county in the 1969 completion report, further study suggests that it is not quite as important as it first seemed. In terms of shorebirds per acre of mudflat and marsh, Tomaes Bay, with an average of only .9 birds an acre appears to be less rich than any of the other areas. Much of the mudflat included in the 2900-acre figure given in the California Coastal Wetland Inventory produced by the Department of Fish and Game is developed as harbor and supports few shorebirds, if any.

The most important area is the extensive mudflat at the south end of the bay, bordering on some 300 acres of salt marsh. Most of the small sandpipers, plovers, and Willets are seen on this flat. On the east shore two areas support large shorebird numbers: Walker

Creek mouth, which has a large area of salt marsh, is favored by small sandpipers, godwits, and Willets; and Lawson Flat, near the mouth of the bay, is most conspicuous for Marbled Godwits. Tomales Bay is the only area studied that supports a large population of Godwits, sometimes numbering over 800.

Heron and egrets use all the salt marsh areas, including the many isolated patches on the east shore. There are believed to be at least two rookeries in the vicinity of the bay; one near the Point Reyes National Seashore Headquarters three miles from the south end of the bay, and another at the northeast end on the former Brazil Ranch. On results to date, Tomales Bay seems to be more heavily used by Great Blue Herons and Snowy Egrets than Bolinas Lagoon, although the Common Egrets are relatively less numerous.

The west shore is generally unproductive in terms of shorebirds. At the north end of the bay the shore drops steeply to the water with little or no mudflat, while toward the south, around Inverness, there are quite extensive harbors.

Abbott's Lagoon

This area, actually two adjoining lagoons totaling approximately 185 acres, is inaccurately classified as a freshwater pond in the California Coastal Wetland Inventory. The upper portion, partially separated from the main lagoon by a dam, does fit this description, but the lower lagoon, which is cut off from the ocean by less than 100 feet of sand, is highly variable in salinity. It receives salt water by seepage and also by occasional breaching of the sand bar by both natural and artificial means. There is, of course, no tide, and the vegetation surrounding is of freshwater type.

Its importance to shorebirds is variable and difficult to define. In both seasons of the census it has had intermittent large flocks of birds, always in the fall, but on most occasions it has had practically none. On November 13, 1969, over 1600 small sandpipers were observed. During the fall, the lagoon is heavily used by Northern Phalaropes.

Drake's Estero

This estuary complex (about 1480 acres) has a common mouth with Limantour Estero. Each of the four bays adjoining the main part of the estero has mudflats backed by salt marsh. Of these, Schooner Bay at the north end is the most important to shorebirds. One noteworthy development is the expansion of the range of the American Avocet to this area; considered very rare in Marin County west of Richardson Bay as late as 1966, this species has now become established as a wintering bird on the flats by the oyster factory

at the top of Schooner Bay, perhaps as a result of habitat loss around San Francisco Bay. Numbers appear to reach a maximum of 100. On the west side of the estero Barrie's Bay and Creamery Bay, both less than a hundred acres in area, and both undeveloped, support substantial numbers of shorebirds. On the east side toward the north, Home Bay, the top end of which has been dammed, is at least as important as Schooner Bay for herons and egrets.

Limantour Estero

The best known of the areas covered, having been the subject of a Point Reyes Bird Observatory study since 1965, Limantour Estero comprises about 590 acres in all, nearly half of which are intertidal flat and salt marsh. The estero is described in detail in the report submitted to the Department of Fish and Game in November 1969.

Limantour emerged as much the most productive habitat in terms of average birds per acre. It was threatened with harmful development under the 1965 Point Reyes National Seashore master plan. Although the attitude of the 1970 master plan team is more enlightened, the future of this area still gives cause for concern.

Nearly every part of the estero is used by shorebirds, but the most important areas are the flats at the east end (i.e., away from the mouth). The large bay to the north is much used by herons and egrets.

Bolinas Lagoon

Although termed a lagoon, this area is more properly termed an estuary. The most striking feature is that, of a total area of about 1250 acres, over a tenth (150 acres) consists of salt marsh, a much higher proportion than in any of the other study areas.

The most striking phenomenon recorded on the censuses was the occurrence of a vast flock of Western Sandpipers on the flight of April 21, estimated at 16,000 birds. This figure is corroborated by ground observations which showed that between April 10 and the beginning of May, the population of Westerns ranged from 10,000 to over 20,000. Significantly, the April 21 census showed no higher numbers anywhere else in the area; in fact the Bolinas figure was nearly twice that of all the other areas put together. This April migration has been recorded in at least two previous seasons, and is all the more remarkable since Western Sandpipers are not particularly common on the lagoon in fall.

Of course, Bolinas Lagoon is best known for the Audubon Canyon Ranch heronry (55 breeding pairs of Great Blue Herons and 86 pairs

of Common Egrets in 1969). Rather surprisingly therefore, the proportion of Great Blue Herons seen in the lagoon during 1968-70 was only 17.6% of the total, while Tomales Bay showed 45.5%. Intensive ground observations during the 1970 breeding season have shown conclusively that only a small proportion of the adult herons in the Canyon Ranch heronry uses Bolinas Lagoon for feeding; there is strong evidence that the others use wetland areas as far apart as Richardson Bay and Tomales Bay, and of course they feed in fields throughout the entire western part of the county. Common Egrets, on the other hand, rely more heavily on the lagoon for feeding and 59.4% of the total were recorded there (66.8% in 1969-70).

Census Results

Nine complete censuses were made during the 1969-70 season. The results of one of these, made on December 26, 1969, were lost as a result of a malfunctioning tape recorder. A further census on August 21, 1969 was abandoned because high winds made low flight dangerous. Table 1 shows the totals of all shorebirds (sandpipers, plovers and turnstones) recorded on the 1969-70 flights. (Table 1)

The great majority of shorebirds counted were small sandpipers of three species, Least Sandpiper, Dunlin, and Western Sandpiper, which are similar enough in the field to preclude accurate distinction from the air, especially since the three species may often be found within the same flock. The proportion of Willets is usually about three or four per cent of the total, but on February 13 they accounted for 13.3% of the total (765 out of 5736).

Since the censuses in 1969-70 were distributed throughout the season rather differently than those in 1968-69, the most meaningful way to arrive at an estimate of the value of each area is to average the results of the two seasons. Table 2 gives the totals and averages for each area and relates the average to the total acreage.

The high average figure for Bolinas Lagoon is heavily influenced by the one very large total for April 21, 1970. As mentioned previously, this heavy April migration seems to be a regular occurrence, and it is a proper reflection of the use of this area. In fact, the absence of an April census in 1968-69 means that the importance of Bolinas Lagoon is underestimated in the average figures. The figures in birds per acre need some interpretation. It has already been suggested that much of the area of mudflat and marsh in Tomales Bay is useless to birds on account of development, and this would certainly help to explain the low figure of three birds per acre for the bay as a whole, and of .9 birds per acre of mudflat and

TABLE 1. Shorebird totals on 1969-70 census flights.

	<u>1969</u>			<u>1970</u>						
	<u>Sep 10</u>	<u>Oct 17</u>	<u>Nov 13</u>	<u>Jan 26</u>	<u>Feb 13</u>	<u>Mar 12</u>	<u>Apr 2</u>	<u>Apr 21</u>	<u>TOTAL</u>	<u>AVERAGE</u>
Tomales	508	1,205	2,353	2,760	1,834	5,019	4,321	4,881	22,881	2,860
Abbott's	-	117	1,610	-	2	-	-	5	1,734	217
Drake's	351	1,666	3,713	695	1,696	2,892	1,363	1,926	14,382	1,798
Limantour	858	843	3,687	818	1,542	3,200	1,010	1,326	13,284	1,660
Bolinas	750	1,028	857	2,638	662	2,940	3,050	16,027	27,952	3,494
Page	2,467	4,859	12,220	6,911	5,736	14,051	9,744	24,165	80,223	

TABLE 2. 1968-70 Census Totals and Averages (Shorebirds)

	Total(1) Acreage	Mudflat & Marsh	Census Total 1968-70	Average (N=16)	Average Birds/Acre	Birds/Acre Mudflat & Marsh	Percentage of Total Occurrences
Tomales	9290	3340	46,385	2927	.3	.9	32.8
Abbott's	185	-	2,958	185	1.0	-	2.1
Drake's	1480	480	29,682	1855	1.3	3.9	20.8
Limantour	5590	300	26,532	1658	2.8	5.5	18.6
Bolinas	1250	870	36,641	2290	1.8	2.6	25.7

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(1) Acreages from California Coastal Wetland Inventory, (DF&G, 1969)

marsh. It might seem that Bolinas Lagoon, with 70 per cent of its area consisting of mudflat and marsh would have more birds per acre than it actually has. It is certainly true to say that the enormous April flock of sandpipers made use of all the available intertidal flat. On the other hand, the large expanse of salt marsh, while clearly of inestimable value for providing nutriment for the lagoon as a whole, is not itself densely populated by birds. It appears that the highest densities are likely to occur in an area where the ratio of marsh to intertidal flat is much lower than that in Bolinas Lagoon; Limantour Estero is a case in point. Since Abbott's Lagoon has no intertidal flat, only the overall birds per acre figure is given for this area.

Hérons and Egrets

One very useful product of the census flights is an accurate count of herons and egrets. The only identification problem is the distinction between Common and Snowy Egrets, which however can usually be made with complete confidence and a little hesitation.

Rookeries in which one or more of these species nests are scattered throughout Marin County. Apart from the well-known heronry at Audubon Canyon Ranch on Bolinas Lagoon, there is a sizeable colony on Little Marin Island near San Rafael supporting Common and Snowy Egrets and Black-crowned Night Herons, and small colonies of unknown number and composition at Muir Woods, Bear Valley, and the northeast end of Tomales Bay. All three species recorded on the censuses are known to forage far afield and therefore it is quite possible for birds feeding at any given time in Tomales Bay, for instance, to have come from one of three or four different roosts or colonies. Table 3 gives a general idea of occurrences throughout the county.

One would expect Bolinas Lagoon to be used more than any other area since the heronry is so close to it. It is particularly interesting therefore to note that Tomales Bay is the most popular feeding place of Great Blue Herons, even during the breeding season. Drake's Estero (19%) and Limantour Estero (15.7%) are both about as much used by Great Blue Herons as Bolinas Lagoon (17.6%). Observations of headings taken by herons departing from Audubon Canyon Ranch seem to support the theory that birds from the heronry feed in all the locations mentioned above.

Common Egrets from the Canyon Ranch colony rely heavily on Bolinas Lagoon, in fact, the census figures probably underestimate this reliance, since only a small proportion of observations were made during the egret breeding season (March through August) and ground counts during this period frequently show more than double the census high count of 40. A continuing study on the lagoon will provide more accurate data on this problem.

TABLE 3. Herons and Egrets 1968-70

	Great Blue Heron		Common Egret		Snowy Egret	
	<u>High Count</u>	<u>Per Cent of Total</u>	<u>High Count</u>	<u>Per Cent of Total</u>	<u>High Count</u>	<u>Per Cent of Total</u>
Tomales	29	45.5	24	23.1	22	45.8
Abbott's	2	2.1	2	1.1	-	0
Drake's	15	19.0	14	8.1	3	5.8
Limantour	8	15.7	9	8.3	5	9.7
Bolinas	24	17.6	40	59.4	18	38.7

TABLE 4. Comparison of Ground and Aerial Censuses - Limantour Estero

Aerial Census		Ground Census		APPARENT UNDERESTIMATE
Shorebird Count	Date	Shorebird Count	Date	
858	9/10	1290	9/14	33.5
843	10/17	1083	10/19	22.2
3687	11/13	4296	11/11	14.2
1010	11/4/2	1372	3/31	26.4

Snowy Egrets are known to winter on Bolinas Lagoon and census data indicate that they may also winter, perhaps in smaller numbers, in Tomales Bay. The highest counts for Tomales Bay have been recorded in March and April, but it is unlikely that there is a breeding colony in the immediate vicinity since Little Marin Island is reported to be the furthest north coastal breeding colony.

Census Accuracy

The fundamental concern in establishing the Marin County shorebird census was whether the accuracy was sufficient to justify the expenditure. The verdict of the 1968-69 completion report that a reasonable standard of accuracy had been maintained was based on spot checks against ground censuses at Limantour Estero. A similar check for the present season indicates a fairly consistent tendency on the part of censusers to underestimate. The percentages in Table 4 are a little alarming at first sight, but should be somewhat liberally construed. The largest apparent underestimate, on September 10, was made at a time of the year when the population maybbe expected to rise very rapidly, and in the interval of four days could make an enormous difference. While the figures are not conclusive, they do seem to suggest a genuine underestimate by a margin of 10 to 25 per cent.

Just as it is difficult to make an authoritative assessment on the accuracy of the census as a whole, it is hard to assess the accuracy of individual observers. The personal opinion of the writer (Smail) is that he probably tends to underestimate large flocks of sandpipers by over 10 per cent. Other observers, with the possible exception of R. Mallette, underestimate large concentrations by a similar margin, (Footnote 1). The error does not by any means invalidate the census. Although censusers should be made aware that there seems to be a general tendency to underestimate, this should not be allowed to overstimulate their imagination. It is clear that counts bear a quite acceptable relation to the truth, and that useful data are being generated.

Recommendations

The aerial census is proving useful and should be continued. The feasibility of including Bodega Bay in the census should be considered. Since the University of California Marine Laboratory is including shorebirds in its current study of the mudflat community, it would be desirable to have population data for the bay as a whole.

In planning future censuses dates should be chosen to coincide as far as possible with flight dates in 1969-70. This would give

(1) Observers were: J. Smail (7 censuses), Robert D. Mallette (4), Howard R. Leach (3), and Robert Burks (2).

comparative data on month-to-month trends. The flight pattern over Bolinas Lagoon should be more carefully regulated. The triangular shape of the lagoon makes it the most difficult area to census, and the present arbitrariness of approach may result in quite serious omissions.

More stringent tape recorder checks are needed to ensure that accurate results are obtained with the minimum of effort. Apart from the loss of one whole census referred to earlier, several tapes were difficult to transcribe because they were recorded with low batteries. Unfortunately, the Craig 212 model normally used does not have a battery level indicator and there is no indication on a pre-takeoff check that the batteries are too low to take two hours of continuous use. Perhaps a volt meter check would be useful in some cases.

(2) Evaluation of Shorebird Banding and Marking
in Marin County 1969-1970

As part of a much larger state-wide California Fish and Game Department project, Point Reyes Bird Observatory undertook an intensive banding program in west Marin County. This state project was the first large-scale banding and marking project undertaken on shorebirds, and as an experimental program was a tremendous success. It pointed the way for more specific studies, resulted in development of new shorebird trapping techniques, tested some successful color-marking systems, and generated a great interest in and enthusiasm for shorebird studies. The results from the project in terms of answers were good but these will probably be overshadowed by spinoff generated by the project. PRBO can expect to recapture large numbers of banded birds for several years, gaining valuable information on longevity and migration. California banders will probably devote more attention to shorebirds in the coming years by association with this project. The eventual result may be to stimulate numerous studies on, and thereby provide answers for, the many perplexing problems of shorebird migration.

Color Marking

As part of the statewide program of shorebird banding conducted by California Fish and Game the Observatory advised on color marking schemes. Each of the four banding areas was distinguished by dye on the breast (Humboldt Bay - yellow, Sacramento - green, Marin Co. - red, San Diego - blue) and the month of banding was indicated by colored plastic tape over the band. Each color of tape was used twice, on the right leg for one month and on the left for another. Each combination of leg and color indicated one month.

The dyes were not entirely satisfactory, although our experience was only with the red dye (Rhodamine B). Birds banded in August and recaptured in April still had traces of the dye on the body feathers, but it was not useful for field identification a month after application.

The tape over the bands was very conspicuous and in over 100 recaptures we never found a bird that had lost the tape. Even freshly dyed birds could often be located more easily by looking for the tape on the leg.

The color marking was partially successful in our area. It provided negative evidence of movement to Limantour Estero where regular censuses were made. At Bolinas Lagoon the sightings of

color-marked birds did not add to information gained from recapture. In subsequent work we would suggest using only tape, making it an indicator of area rather than month of banding.

Banding

The banding done in 1969-1970 was a continuation of work started in 1965 by Point Reyes Bird Observatory. This was partially supported in 1968-1969 by a grant from the California Department of Fish and Game. The banding totals were relatively small in the initial years but the results were rewarding. Of particular interest was the high rate of recapture (7.7 per cent) found at Limantour Estero in the 1968-1969 banding. Hoping to repeat this high recapture rate we shifted our 1969-1970 banding to Bolinas Lagoon, Marin County where ease of access, better netting conditions, and reduced human interference with netting made the area more desirable. Bolinas Lagoon, like Limantour, is a small self-contained unit with a relatively small shorebird population. The results, 1236 birds banded with 8.3 per cent recaptured, justified our choice of this site. Least Sandpipers and Dunlin were the most frequently caught birds. The Western Sandpipers were caught in smaller numbers and all other species were caught in numbers too small to be significant (Table 5). The banding data for Least Sandpiper, Dunlin, and Western Sandpiper are analysed separately.

Table 5. Shorebirds Banded in Marin County 1969-1970

	Bolinas Lagoon		Elsewhere		
	Banded	Recaptured	Banded	Recaptured	
Least Sandpiper	497	54	14	--	
Western Sandpiper	206	--	80	2	
Dunlin	406	49	67	1	
Miscellaneous*	73	--	24	--	
<hr/>					
Total	1236	103 (8.3%)	185	3 (1.6%)	1527

*Killdeer, Short and Long-billed Dowitcher, Semipalmated Plover, Willet, Pectoral Sandpiper, Red Phalarope, Golden Plover, Marbled Godwit.

Successful trapping of shorebirds is a separate study and we are still plagued by a lack of knowledge in this field. Some of our results have been written up for Western Bird Bander (Sibley, 1970) and the experience of several banders was pooled in a panel discussion at the 1970 annual meeting of the Western Bird Banding Association. More work needs to be done with trapping methods, particularly with the larger species. General conclusions of the panel discussion: 1. A variety of methods is needed to fit the particular combination of weather, location, time of day, and species present. 2. Mist netting is still the cheapest, fastest, and most adaptable system. 3. Under certain conditions a backpack light unit is effective and under special conditions a cannon net can produce spectacular results. In mist netting the bander should concentrate on one species or group of species and adapt his net size and placement to this species.

Least Sandpiper

This small sandpiper is common in Bolinas Lagoon throughout the winter, arriving in August and departing in April. It frequents the small streams on Kent Island more than the Western Sandpiper and therefore was caught in greater numbers because of our net placements.

The population is highest in November and December (approximately 2,000) dropping off in January to 300 and declining further to 150-200 birds in February and March. In April the numbers increase, presumably due to migration from the south.

In 1969-1970 a total of 497 Least Sandpipers were banded on Bolinas Lagoon and 54 (10.9 per cent) were recaptured there. An additional 10 were banded elsewhere in Marin County. No sightings of Bolinas birds were reported from other areas but a bird seen at Limantour in March with a December leg band may have been one banded at Bolinas Lagoon. Despite weekly censuses of Limantour there were no other reports of color-marked birds. Sightings of color-marked birds at Bolinas did not add to the information available from recapture records.

Table 6 gives the number of recaptures by month of banding and month of recapture, and the total number of birds banded in each month. Appendix I lists the recaptures from 1969-1970. The recaptures show that birds caught in August are present in April. This may indicate residence throughout the winter or merely stopping over at the same marsh on migration. The birds caught in September would support the idea of the early birds being migrants as smaller percentages of these were recaptured than October or November banded birds. Both the August and September birds must have spent over a month at Bolinas while regrowing flight feathers.

Table 6. Least Sandpiper Recaptures at Bolinas Lagoon 1969-70

Month of Banding	Number Banded	Month of Recapture										Total
		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.		
Aug.	37	2	-	-	-	-	-	-	-	1	3	
Sept.	115	-	-	1	3	1	-	-	-	-	5	
Oct.	73	-	-	2	11	3	3	-	-	-	19	
Nov.	148	-	-	-	5	11	6	-	-	3	25	
Dec.	68	-	-	-	-	-	-	-	-	-	-	
Jan.	48	-	-	-	-	-	1	-	-	1	2	
Apr.	8	-	-	-	-	-	-	-	-	-	-	
Total		2	-	3	19	15	10	-	-	5	54	

Birds banded in October and November were resident at least into January. It is not known if birds present in February and March are a remnant of the October-January population or new birds from other areas. Four birds recaptured in April indicate some Least Sandpiper stayed in Bolinas Lagoon for the remainder of the winter.

Since 1965 Point Reyes Bird Observatory has banded birds at Limantour Estero, including a small number of Least Sandpipers. We have recaptured 26 banded Least Sandpipers there (10 a year later and 3 two years later). (Appendix II). Birds return to the same wintering area and some birds spend the winter at Limantour. (Table 7)

The information from the two areas indicates Least Sandpipers are resident throughout the winter and return to the same wintering area. The movements of birds comprising the peak October-December populations is not known.

Molt

Body molt was judged on a scale of 0 to 3. In September all birds had light to heavy body molt, in October only 72 per cent were molting, and in November to January none of the birds were molting. With commencement of the pre-nuptial molt in April, 25 per cent were showing light to heavy body molt.

Table 7. Least Sandpipers Recaptured at Limantour

Month of Banding	Month of Recapture									Total
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Aug.	1	2	1	-	-	-	-	-	1	5
Sept.	1	-	-	2	-	1	-	-	-	4
Oct.	-	-	-	1	1	-	-	-	-	2
Nov.	-	-	-	-	2	-	-	-	-	2
Dec.	-	-	1	-	-	1	-	1	-	3
Jan.	-	-	2	-	-	-	-	-	-	2
Feb.	-	-	-	-	1	-	-	-	2	3
Mar.	-	-	-	1	-	-	-	-	-	1
Apr.	1	-	1	1	-	-	-	-	-	3
May	-	-	-	-	-	-	-	-	-	0
June	-	-	-	-	-	-	-	-	-	0
July	-	-	-	-	-	1	-	-	-	1
Totals	3	2	5	5	4	3	-	1	3	26

Wing Molt

In August all birds had one or more primaries growing back. Some birds had as many as seven primaries growing and were barely able to fly. In a sample of 28 birds, five had primaries 1 through 6 growing back, six had primaries 1 and 6 or 7 growing back, 15 had primary 6 or 7 growing, and two had primaries 3 through 6 grow-

ing back. In two cases primary 8 was also growing back with number 7. Evidently primaries 1 through 7 are molted at almost the same time with the molt starting at primary 2 or 3 and working both ways. In September 25 per cent of the birds were regrowing primaries, in 30 cases primary 10, and in three instances primaries 9 and 10.

Data from Sacramento are different. In late August only one bird out of eleven had any molt, and this bird had primaries 1, 6 and 7 growing back. The other ten birds all had new feathers. In September, 33 birds were examined by PRBO personnel and all had new feathers. This striking difference between the coastal and inland populations should be studied more thoroughly. The body molt figures are also different. In August, 50 per cent and in September 72 per cent of the Sacramento birds showed light to heavy body molt versus 100 per cent on the coast.

Secondary Molt

In a sample of 35 birds from August, 11 (30 per cent) were molting. These consisted of birds with secondary 1, 1 through 2, 1 through 3, and 1 through 4 growing. In September only two birds were found with secondaries growing back out of a sample of 100 birds. None of the birds captured at Woodland Sugar Ponds in Sacramento had secondary molt.

The differences between the molt data collected at Bolinas Lagoon and that collected at Woodland Sugar Ponds indicate different migrant populations. This problem should be examined more closely with collection of molt data from several stations.

Fat

Fat was recorded on a five-step scale: 0, trace, "1", "2", and "3". In August, 41 per cent of the birds had fat levels of "1" to "3", in September only 5 per cent had a level this high. (Table 8). The percentage jumped to 52 per cent in October and November, dropping to 41 per cent in December and 33 in January. In April all had fat levels of "1" or higher. Except for April, the changes in fat level, particularly the sharp drop in September, cannot be interpreted. At Sacramento there was a similar drop from August to September. (66 to 12 per cent).

Weight

There is relatively little weight change (Table 8), the birds being slightly heavier in August and considerably heavier in April with a fairly constant weight during the winter months.

The weights at Sacramento parallel those at Bolinas.

Table 8. Fat and Weight of Least Sandpipers at Bolinas

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Apr.
% "1" to "3" fat	41	5	52	53	41	33	100
Weight	22.3	20.9	21.0	21.3	21.1	19.8	24.5
Sample size	20	113	82	110	69	50	11

Dunlin

Dunlin are common in Bolinas Lagoon and are readily caught on both the mudflats and along the stream channels on Kent Island. They arrive in October and depart in April with maximum numbers of 2,000 present in November and December. In January the population drops to around 700 and from February through April remains at about 600.

A total of 460 were banded and 49 (10.7 per cent) recaptured in Bolinas Lagoon. An additional 67 were banded elsewhere in Marin County. Recapture data is presented in Table 9 and Appendix III.

Some Dunlin remain through the winter at Bolinas Lagoon. Both Lincoln index and census figures give a November-December population of 2,000. This means the October and November birds are staying through December. The 17 recaptures from Limantour show that some Dunlin stay through the winter at one location (Appendix IV, Table 10). The one Dunlin recapture of a bird a winter after banding indicates that Dunlin may return to the same wintering area.

None of the fall birds were molting body feathers or wing feathers. In April 90 per cent of the birds were in light to heavy body molt.

Fat levels generally followed the migration time. In October, 57 per cent of the birds had high fat levels and this declined through November to a low of 11 per cent in December. Of the birds caught in March, 30 per cent had high fat levels. The weight (Table 11) followed the fat levels with a high weight of 53.8 grams in October,

a low of 48.9 in December, and back to 53.6 in March.

Table 9. Dunlin Recaptures at Bolinas Lagoon

Month of Banding	Number Banded	Month of Recapture					Total
		Oct.	Nov.	Dec.	Jan.	Mar.	
Oct.	59	1	10	2	-	-	13
Nov.	299	-	22	11	1	1	35
Dec.	89	-	-	-	1	-	1
Jan.	9	-	-	-	-	-	0
Apr.	4	-	-	-	-	-	0
Total	460	1	32	13	2	1	49

Table 10. Recaptures of Dunlin at Limantour

Month of Banding	Month of Recapture							Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Oct.	1	4	-	-	-	4	-	9
Nov.	-	1	1	2	-	-	-	4
Dec.	-	-	1	-	-	-	-	1
Jan.	1	-	-	-	-	-	-	1
Feb.	-	-	-	-	-	-	-	0
Mar.	-	-	-	-	-	1	1	2
Total	2	5	2	2	0	5	1	17

Table 11. Fat and Weight of Dunlin at Bolinas Lagoon

	Oct.	Nov.	Dec.	Jan.	Mar.
% "1" to "3" fat	57	35	11	-	30
Weight	53.8	49.9	48.9	-	53.6
Sample size	51	294	88	-	34

Western Sandpiper

Except during its heavy annual migration in April, this small peep is less common than the Least Sandpiper in Bolinas Lagoon, and during the months of November through mid-February it is virtually absent. It was rarely caught in mist nets set on Kent Island even when present in large numbers. Only when nets were set over the open mudflats did we catch many Western Sandpipers. At Limantour the Western Sandpiper is more common than the Least Sandpiper and caught in greater numbers. During the midwinter months the population in Bolinas Lagoon never exceeded 200. In March there were over 1,000, and in April counts often exceeded 15,000. From observations in the evening it appeared that most of the birds present on any one day in April would depart that evening, and be replaced by a new group in the morning. It was not possible to substantiate this count with banding because of the tremendous numbers of birds involved and the absence of a good opportunity to band (i.e., all the birds departed from Bolinas Lagoon in the evening).

A total of 206 birds were banded in Bolinas Lagoon with no returns, and a total of 80 were banded elsewhere with two returns. This indicates a strictly migrant population in Bolinas Lagoon. Table 12 and Appendix V list the recaptures at Limantour Estero of Western Sandpipers banded between 1965 and 1970. The ten recaptures represent a recapture rate of less than one per cent. The comparison of month of banding and month of recapture shows that birds do not winter at Limantour Estero. The computation of the population by Lincoln index gives a population figure many times higher than that arrived at by censusing, again indicating that the birds banded are moving through the area. The four recaptures one winter after banding, and one recapture two winters after banding show that birds return to the same migration stopover points each year. This raises several questions. Are the birds returning to Limantour each year because there are a limited number of stopping places? Are there several sub-populations of Western Sandpipers, each with a different set of stopover points during migration? Are the coastal migrants a group distinct from the interior migrants? Are most of the spring migrants on the coast birds that migrate south by a different route?

Molt

None of the fall birds showed wing molt. None of the six August birds showed body molt, 22 per cent of the 18 birds caught

in September showed light to heavy body molt. No comparable data are available from Sacramento. In April, 27 per cent showed body molt.

Fat

In August, September and October, 70 to 80 per cent of the birds had high fat levels, presumably indicating migrant birds.

Weight

The average weight of 6 birds in August was 26.0 grams, and of 22 birds in September was 26.7 grams. Comparable figures for Sacramento were 34.8 and 29.5 grams. The Sacramento weights are significantly higher indicating either a different sub-population or better feeding conditions.

In April the average weight of Western Sandpipers in Bolinas Lagoon was 25.8 grams. The percentage of birds with high fat levels is approximately the same in all months (75 per cent).

Table 12. Western Sandpiper Recaptures at Limantour Estero

Month of Recapture										
Month of Banding	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Aug.	-	1	1	-	-	-	-	-	-	2
Sept.	-	-	-	-	-	-	-	1	-	1
Oct.	-	-	-	-	-	-	-	2	-	2
Nov.	-	-	-	-	-	-	-	-	-	0
Dec.	-	-	-	-	-	-	-	-	-	0
Jan.	-	-	-	-	-	-	-	1	-	1
Feb.	-	-	-	-	-	-	-	-	-	0
Mar.	-	-	-	-	-	-	-	2	2	4
Apr.	-	-	-	-	-	-	-	-	-	0
Total	-	1	1	-	-	-	-	6	2	10

Questions raised by the present study:

For the Least Sandpiper and Dunlin, banding indicates that birds stay throughout the winter at one lagoon and return faithfully each year to the same wintering site. At the same time there are consistent seasonal fluctuations in the population. Where do these extra birds come from? Where do they depart to?

Molt differences between Western Sandpipers captured at Bolinas Lagoon and at Sacramento may indicate that they come from separate breeding populations. Are there additional regional differences?

Do the weight differences between Western Sandpipers captured at Bolinas Lagoon and at Sacramento represent sub-populations?

Banding data indicate that some Western Sandpipers return each year to the same lagoon although both band data and census data indicate that the birds do not stay long. Are there several populations of Western Sandpipers each with a specific set of stop-over points on migration?

APPENDIX I

Least Sandpiper Recaptures at Bolinas Lagoon

<u>Band Number</u>	<u>Date Banded</u>	<u>Date Recaptured</u>	<u>Interval in Days</u>
75-88559	08-05-69	08-07-69	2
75-88567	08-05-69	08-07-69, 12-06-69	2, 123
75-88576	08-06-69	04-17-70	253
75-89117	09-13-69	11-01-69	53
75-89124	09-13-69	11-01-69, 11-15-69	49, 112
75-89165	09-13-69	12-06-69	84
75-89190	09-13-69	10-25-69	46
75-90760	10-07-69	10-08-69	1
75-90764	10-07-69	12-20-69	74
75-90765	10-07-69	11-01-69	25
75-90772	10-08-69	01-15-70	99
75-90785	10-08-69	11-01-69	24
75-90786	10-08-69	01-03-70	87
75-90787	10-08-69	11-15-69	38
75-90789	10-08-69	11-22-69	45
75-90791	10-08-69	10-25-69	17
75-90794	10-08-69	01-15-70	99
75-90797	10-08-69	11-15-69	38
74-08701	10-10-69	11-01-69	22
74-08707	10-10-69	12-13-69	64
74-08717	10-25-69	11-09-69	15
74-08719	10-25-69	11-01-69	7
74-08720	10-25-69	12-20-69	56
74-08723	10-25-69	11-10-69, 11-15-69, 11-22-69	16, 21, 28
74-08730	11-01-69	11-22-69	21
74-08733	11-01-69	12-21-69, 04-18-70	50, 168
74-08737	11-01-69	12-18-69	47
74-08744	11-01-69	11-02-69	1
74-08745	11-01-69	11-22-69	21
74-08749	11-01-69	11-09-69	8
74-08750	11-01-69	12-18-69	47
74-08751	11-01-69	12-18-69	47
74-08766	11-02-69	11-09-69	7
74-08788	11-09-69	04-17-70	167
74-08796	11-09-69	01-02-70	62
74-23801	11-15-69	12-18-69	33
74-23807	11-15-69	01-15-70	61
74-23808	11-15-69	01-15-70	61
74-23809	11-15-69	01-15-70	61
74-23815	11-15-69	01-02-70, 01-03-70	48, 49
74-23818	11-22-69	04-17-70	146
74-23821	11-22-69	12-13-69	21

APPENDIX I

Least Sandpiper Recaptures at Bolinas Lagoon - Page 2

<u>Band Number</u>	<u>Date Banded</u>	<u>Date Recaptured</u>	<u>Interval in Days</u>
74-23831	11-24-69	12-13-69	19
74-23833	11-24-69	12-06-69	12
74-23841	11-25-69	12-13-69	18
74-23843	11-25-69	12-06-69	11
74-23862	11-25-69	12-13-69	18
73-90846	01-03-70	01-15-70	14
75-90865	01-15-70	04-18-70	93

APPENDIX II

Least Sandpipers Recaptured at Limantour
1965-1970

<u>Band Number</u>	<u>Date Banded</u>	<u>Date Recaptured</u>	<u>Interval</u>	
			<u>Year</u>	<u>Days</u>
56-79126	09-06-65	11-26-67	2	81
67-26186	02-13-66	04-21-67	1	67
67-26190	02-13-66	12-17-67	1	307
		04-27-68	2	73
72-80905	04-21-67	10-15-67		177
72-80921	04-21-67	11-26-67		219
72-80962	04-22-67	08-11-67		111
72-80561	07-28-67	01-21-68		177
74-23903	08-11-67	04-27-68		259
74-23934	09-15-67	08-25-68		344
74-23945	10-15-67	12-17-67		63
74-23969	11-26-67	12-17-67		21
74-23966	11-26-67	12-17-67		21
74-23989	12-17-67	01-21-68		35
		10-27-68		314
		03-08-69	1	81
74-23997	01-20-68	10-27-68		280
74-07910	01-21-68	10-27-68		279
74-07930	03-17-68	11-24-68		252
74-08216	08-24-68	08-25-68		1
		09-28-68		27
		10-26-68		55
74-08210	08-24-68	09-28-68		27
74-08255	09-29-68	11-23-68		55
		03-08-69		160
74-08273	10-26-68	11-23-68		28

APPENDIX III

Dunlin Recaptures at Bolinas Lagoon

<u>Band Number</u>	<u>Date Banded</u>	<u>Date Recaptured</u>	<u>Interval in Days</u>
72-150195	10-05-69	10-08-69	3
72-150198	10-07-69	11-01-69	25
72-150910	10-08-69	11-01-69	24
72-150929	10-25-69	11-01-69, 11-15-69	7, 21
72-150933	10-25-69	11-01-69, 11-09-69, 11-22-69	7, 15, 28
72-150934	10-25-69	11-09-69	15
72-150940	10-25-69	12-18-69	54
72-150943	10-25-69	12-18-69	54
72-150944	10-25-69	11-01-69	7
72-150953	11-01-69	11-15-69	14
72-150964	11-01-69	11-15-69	14
72-150977	11-01-69	12-18-69	47
72-150984	11-01-69	12-18-69	47
72-150987	11-01-69	11-08-69	7
72-150997	11-01-69	11-15-69	14
72-150999	11-01-69	11-09-69, 12-20-69	8, 49
72-150304	11-01-69	11-09-69	8
72-150307	11-01-69	11-10-69, 11-15-69, 12-18-69	9, 14, 47
72-150308	11-01-69	11-02-69	1
72-150309	11-01-69	11-09-69, 11-15-69, 03-21-70	8, 14, 140
72-150320	11-01-69	11-09-69	8
72-150331	11-02-69	12-06-69	34
72-150340	11-02-69	11-09-69	7
72-150362	11-09-69	11-09-69	0
72-150371	11-09-69	11-15-69	6
72-150379	11-09-69	12-18-69	39
72-150384	11-09-69	11-10-69	1
72-150387	11-09-69	11-15-69	6
72-150388	11-09-69	11-25-69	16
71-120231	11-09-69	11-25-69	16
71-120233	11-09-69	11-15-69	6
71-120234	11-09-69	12-18-69	39
71-120244	11-09-69	12-18-69	39
71-120258	11-10-69	11-15-69	5
71-120266	11-15-69	11-15-69	0
71-120273	11-15-69	12-18-69	33
71-120104	11-15-69	12-18-69	33
71-120116	11-15-69	01-02-70	48
71-120146	11-25-69	12-13-69	18
73-130422	12-18-69	01-02-70	15
73-130466	03-27-70	04-04-70	8

APPENDIX IV

Dunlin Recaptures at Limontour, 1967-1970

<u>Band Number</u>	<u>Date Banded</u>	<u>Date Recaptured</u>	<u>Interval Days</u>
68-146647	11-26-67	12-17-67	21
68-146627	11-26-67	01-21-68	56
68-146615	11-26-67	01-21-68	56
71-120751	12-11-67	01-21-68	41
71-120783	01-21-68	10-27-68	279
71-120994	10-26-68	11-24-68	29
71-120989	10-26-68	11-24-68	29
72-150122	10-26-68	11-24-69	29
71-120985	10-26-68	11-24-68	29
71-120971	10-26-68	10-26-68	0
71-120995	10-26-68	03-30-69	155
71-120974	10-26-68	03-08-69	133
72-150145	10-27-68	03-08-69	132
72-150152	10-27-68	03-08-69	132
72-150156	11-23-68	11-24-68	1
72-150163	03-08-69	03-30-69	22
73-130466	03-27-70	04-04-70	8

APPENDIX V

Western Sandpiper Recaptured at Limantour

<u>Band. Number</u>	<u>Date Banded</u>	<u>Recapture Date</u>	<u>Interval</u>	
			<u>Years</u>	<u>Days</u>
72-79065	01-13-66	03-17-68	2	65
74-23961	10-17-67	03-17-68		150
74-07954	03-17-68	04-27-68		40
74-07943	03-17-68	03-08-69		355
74-08211	08-24-68	09-29-68		35
74-08254	08-29-68	10-26-68		58
74-08251	09-28-68	03-08-69		160
74-08283	10-27-68	03-30-69		153
75-88529	03-29-69	04-04-70	1	6
75-88541	03-29-69	03-27-70		363