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GREAT BAY MIGRATORY SHOREBIRD STUDY

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GREAT BAY MIGRATORY SHOREBIRD STUDY

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for

The Great Bay Estuarine System Conservation Trust

The purpose of this project was to investigate shorebird use of the Great Bay Estuary during fall and spring migratory periods. The estuary has been largely overlooked in relation to information on shorebird use perhaps because of difficult access and long driving distances between observation points with little view of water in between. Bird watchers have traditionally looked for shorebirds near the ocean and this is where most of the records are from. During the New Hampshire Fish and Game Department's Great Bay inventory and survey of flora and fauna 14 shorebird species were identified (New Hampshire Fish and Game Department 1981, 1982) during weekly all-species bird counts of approximately 15 minutes each from 22 sites in 1980-1981 and 13 sites in 1981-1982 and once-a-month boat trips during 8 months on the Squamscott, Lamprey, Bellamy, Cocheco, and Salmon Falls rivers in 1980-1981.

The study area included all portions of the estuary within New Hampshire except the portion of the Piscataqua River south of the entrance to Little Bay and the tidal portion of the Squamscott River upriver from the 108 bridge (Map 1 and 2). Some work was done on the Maine side of the rivers. Several occasionally-inundated salt ponds and a tiny fresh water farm pond located 1 mile east of the Squamscott River in Stratham (Agway Pond) were included. The field work was initiated in July and continued until November 30, 1980 for the fall migratory period and started in March and continued into June 1981 for the spring migratory period.

METHODS

Observations From the Water

Observations were made from a boat, propelled by a 20 horsepower motor, oars or wind/water; canoe, propelled by paddles or wind/water; or a sailboat. Mostly there were two persons on board, occasionally one. With two people, one took major responsibility of scanning the intertidal areas and the other of maintaining location of craft and speed and direction of travel. This second person also

took responsibility for observing flying birds. When one person was in boat, all tasks were done by one person. The number of people aboard was noted for analysis of data.

Shorelines of Great Bay, Little Bay and the rivers were followed. Travel distance from shoreline and/or exposed intertidal areas depended on balancing several factors including:

1. maximizing chance to see the birds without disturbing their behavior,
2. depth of water and rocks,
3. wind parameters and water flow
4. visibility
5. phase of tide

Tidal creeks of all sizes were investigated when possible. On most rivers, observations by the shoreline observer were primarily directed to one side of the river, which side and where were noted. If a particular trip went two directions on a segment of river, the opposite side was thoroughly scanned on the second passage.

When necessary, the craft was halted, anchored, landed or circled to maximize gathering of information. At appropriate areas the craft was anchored and a stretch of shoreline was observed by both people to facilitate observations of use and movement in the area. Standing on land or on craft was employed for better visibility at times.

Scanning was done with binoculars, eyes alone or spotting scope depending on distance, wind, light, and precipitation. Two methods of scanning, steady scanning and segment staring, were used. Steady scanning involves moving eyes along area to be covered while segment staring involves looking at segments in succession. A segment, for example, could consist of the width of the field of a pair of binoculars. If the viewer is moving, as in a boat, segment staring takes advantage of the changing lights and shadows on objects making it easier to pick out sought after objects and, secondly, obstacles such as a plant, rock or subtle topographical change, are less of a barrier when seen from more than one angle. Also, whether or not the viewer is moving, movement of a bird is more likely seen with this latter method.

Generally, the shoreline observer would look ahead of a perpendicular line to the shore. When entering a cove, the secondary observer would check the other side for any birds moving out of the cove.

Observations From Land

Observations were made from land to supplement observations from water. Several different kinds of places and reasons for observations were made.

1. Areas with concentrations of numbers or species
2. Selected areas of observation used in NH Fish and Game Reports (1981,1982.)
3. Areas difficult to view adequately from boat at certain tides
4. Testing areas for use in a monitor program

5. Land observations while doing boat work as listed above
6. To determine when more extensive observations should start in the spring

Note: Some areas were used for more than one of the listed reasons.

Days of Observations

Observations were made from the water on 11 days in July, 14 days in August, 13 days in September, 13 days in October and 10 days in November. Observations were also made from land on most of these days and were also made on four additional days in July, 11 in August, 13 in September, 13 in October and 14 in November. During the spring migration, observations were made from land on seven days in the last half of March, while in April observations were made on 18 days including four boat days the last half of the month. There were 22 observation days in May including 15 boat and canoe days. In the tail end of the season in June observations were made on eight days (Table 1).

Information Collected From Water and Land Observations

Data were collected and recorded during July through June during observations from water and land included:

1. species
2. numbers of individuals
3. activities/behavior
4. substrate
5. date, time, tide
6. temperature, wind, cloud cover
7. specific location
8. areas of intense horseshoe crab egg laying
9. observations of other species of particular concern, such as bald eagles, osprey, harriers, terns, herons, bittern and rails, were noted

Specific locations were recorded on map segments xeroxed from the NOAA Marine Chart #13825 onto 8 1/2 x 11 inch paper. In addition, data on boat traffic, other human use of the estuary, and timing of high and low tides for specific places in the estuary were collected.

To facilitate analysis of data, locations in the estuary were broken down with a four-level hierarchical system. We decided it didn't make sense to divide the shoreline up by distance because of the many coves, inlets etc. Instead we tried to maintain coves and marshes as units and divisions were based on ecological and some practical considerations. The two highest levels are shown on Map 3. Third and fourth levels were added as needed. A specific point on a map completed the record. Nine areas were additionally given a Roman numeral. (Map 4)

We attempted to examine all available types of habitat in the estuary without prejudice from preconceived ideas and to examine these areas at different parts of the tidal cycle and time of day. In recording data, we did not just take tabulated data but more complex information which might give us a better understanding about how the shorebirds and other birds of interest use the estuary. In times and places of great activity, we gave priority to shorebirds and to the perceived greatest gain of information at the time. We tried various approaches to getting information on bird numbers and use in order to evaluate different possibilities for monitoring.

Data collected on all species will be stored in the New Hampshire Fish and Game Department's computerized Fish and Wildlife Information System.

RESULTS AND DISCUSSION

Species Observed

Species Inhabiting This Estuarine System and Their Relative Abundance

Sixteen species of shorebirds were identified during the study period. Relative abundance of these species is shown on Table 2. The most widely distributed shorebirds, spotted sandpiper, greater and lesser yellowlegs and killdeer were found in every major unit (Map 3, Areas 1-8).

Semipalmated Plover

Observed in the estuary 8/17/90 to 9/17/90.

This species was seen in 4 areas north of Little Bay and at one site in Great Bay (Map 5).

The highest numbers of this species seen at one time and place were estimated from counts to be 100 plus on August 17 and more than 200 on August 18. On both dates they were in aggregations of 425 to over 500 shorebirds feeding on a sandy mud flat in 8-A (viii) in the Salmon Falls River. The other principal species seen here were black-bellied plovers and two kinds of peeps (semi-palmated and least sandpipers).

These plovers appeared to use the estuary for only a relatively brief time during the fall migration and were not seen during spring migration. The NH Fish and Game studies (1981, 1982) did not report this species.

Most of our observations were of plovers feeding on flats with variable elevation, which were exposed for a longer period of time than other flats. On the Bellamy River some were feeding in tiny rivulet areas near the edge of low salt marsh. One individual was observed resting on a small island in a panne in 3-B (iv) on 2 separate days, the only observations in the southern portion of the estuary.

In the fall of 1991 this species was again observed on the Salmon Falls and Cocheco sites as well as on flats exposed along Fresh Creek, also located in 6-A.

This species was observed to arrive first at exposed tidal flats, landing as the flat became exposed. They also were the last shorebirds to leave, remaining even when the water was washing over the last remnants of flat.

Killdeer

Observed in the estuary 3/16 to 10/6.

This species was widely distributed over the survey area from north to south and east to west. However the distribution was clumped and appeared to reflect the nearby upland land use such as extensive fields, golf courses, and large mowed areas like at the Cocheco River sewage treatment plant. Areas 8-B, 2-B, 2-C and the upper and lower Cocheco River were some of the areas with greater use.

Killdeer were seen feeding on tidal flats and resting and feeding in high marsh areas.

The largest number of killdeer were observed during the fall migration from mid-September through the first week of October. Flocks of 8, 11, 13, 14 and 20 were observed during this period.

American Golden Plover

One golden plover flew into vii on the lower Cocheco River with a flock of black-bellied plovers on 9/11/90. One individual was seen during the Fish and Game studies in 4-C (1981, 1982).

Black-bellied Plover

Observed in the estuary 5/19-5/30 and 7/31-9/30.

In spring, these plovers were primarily found in the southeastern corner of Great Bay at 2-B and C and the recently cultivated corn field 1/4 mile uphill and east. (Map 6). We had observed the plovers feeding along the tide line near the golf course as the water rose from very low. When the water rose near the low marsh, groups of plovers flew along shore, cut through an opening in the trees and flew up to the field. There they appeared to be capturing earthworms. More than 150 were counted in the corn field area on 5/23 along with 8 short-billed dowagers which had also been hunting on the mudflats. The black-bellied plovers were observed feeding in this corn field on two separate days and were also seen on another recently plowed field 1/4 mile farther east toward the ocean.

In the fall migration, black-bellied plovers were observed in large numbers at the north end of the estuary, where they were also seen in small numbers in the spring. On 8/17 a count of 109 was made at viii, along with 100+ semipalmated plovers and 264 peeps. The plovers fed over the large flat, mostly on the top surface until it was almost covered by water, and then most of them flew west into New Hampshire to the Cocheco River to feed for an additional 30 or more minutes in tidal flat vii. This same general movement pattern continued for several weeks and was repeated again this fall (1991). Almost twice the number of shorebirds recorded on any one day during the study period were seen using these same areas on 9/8/91.

Common Snipe

Observed in the estuary 4/18 to 5/8 and 8/17 to 10/24.

It was found at 5 sites in the estuary, all on Great Bay and the Squamscott River (Map 7).

In the spring at least 29 were seen for several days in the salt marsh in 8-B near Chapman's Landing. They were present near dusk, and the next morning near dawn. The only way we could see them was when they started making very short and low flights across the marsh. They didn't land in panes so generally they disappeared as soon as they landed. Most of our other sightings were of 1 to 3 individuals.

In the Fish and Game report, one snipe was reported. It was seen on the Bellamy River 6-B. An area on the south side of Oyster River was reported to have been used by snipe in the past. Dearborn (1903) reported that they "visit the Newmarket marshes at Great Bay every season,".

Upland Sandpiper

One individual of this endangered species was seen displaying in suitable habitat adjacent to salt marsh on April 30 and was seen again in the same area on May 3.

Spotted Sandpiper

Observed 5/3-10/26.

This species was widely distributed throughout the study area (Map 8). It was particularly found in areas of sand, gravel or undercut banks along rivers. There was a high density of them along the Winnicut River in the salt marshes, along the sandy shore of the northern part of 4-D, and along the upper part of the Cocheco River.

Solitary Sandpiper

Observed in the estuary 4/27 to 5/7 and 8/3 to 11/4

This species was found in places spread over the estuary. It was observed in panne areas of salt marsh, at salt pools which only occasionally get inundated by the tide, on an island, in a tidal creek, on an island and at smaller mud flats (Map 9). It likely was in additional similar sites. It was also observed at Agway Pond. This species was seen in numbers up to 3 at a site. It was observed 6 times in the Fish and Game reports (1981, 1982).

Willet

Four willets were reported seen in ix by volunteers.

Greater Yellowlegs

Observed in the estuary 3/19 to 5/29 and 7/16 to 11/16.

This species and the spotted sandpiper were the most commonly found shorebirds. It was distributed over most of the estuary. It used pannes for resting and feeding at high tide and dispersed over the estuary at lower tides feeding on recently exposed flats and into the water up to breast height. They were seen at the fresh-water Agway Pond and occasionally-inundated ponds. They used a variety of hunting methods and captured a variety of organisms. Main concentrations of 30 or more were seen in spring, and in fall the higher concentrations were seen at the end of October and beginning in November.

Lesser Yellowlegs

Observed in the estuary 4/30 to 5/14 and 7/11 to 10/14.

In fall they arrived earlier and left earlier than the greater yellowlegs. There were high concentrations at i 8/23 and 8/24. On the latter day 62 were counted at one time. There were probably more present. This species was seen at the Agway Pond. They tended to remain together when in the presence of greater yellowlegs. Although distributed over the estuary, they were found in considerably less places than the greater yellowlegs.

Pectoral Sandpiper

Observed in the the estuary 8/19-10/30.

This species was not observed in the spring and was primarily seen during October, mostly in the Great Bay area (Map 10). One or two individuals were seen at a time. Two were seen at the Agway Pond. The Fish and Game study (1981, 1982) reported one observation of 9 birds at Bunker Creek (5-B).

Least Sandpiper and Semipalmated Sandpiper

Observed in the estuary 4/26 to 5/23 and 7/15 to 10/21

Both species were distributed throughout the estuary. They made up the largest flocks of shorebirds seen on the estuary. The largest concentration of semipalmated sandpipers was found in the SFCR complex (Map 4) particularly in 8-A and 8-C. The least sandpipers particularly used this complex also, especially 8-B. They were mostly seen on mudflats in this area. The SEGB complex was particularly used by the least sandpiper especially in the area of the saltmarshes associated with the Winnicut River and tidal brooks. They were seen using the mud banks of the streams, *Salicornia* areas, pannes and among the *Spartina*. During spring most "peeps" seen were least sandpipers.

Dunlin

One dunlin was reported by a volunteer during the study. During the fall 1991 a small group was seen at i on the Squamscott and in 1989 in 8-C.

Short-billed Dowitcher

Observed in the estuary 5/21 and 8/13 to 8/30.

Short-billed dowitchers were seen only once in spring, 8 birds feeding on mud flats together with black-bellied plovers at iii. When the plovers flew up to the corn field, the dowitchers went also. In fall they were seen at i and iv feeding intensively in pannes.

All these sites are in the southern end of the estuary. However, on 8/3/91 they were seen on the tidal flat viii.

Kinds of Habitats and How Used

Tidal Flats

Shorebirds feed and and rest on tidal flats throughout most the estuary. However, some areas are used intensively while others receive only sporadic use and there may be areas that are not used at all. It must be kept in mind that just because we didn't find evidence of use in an area doesn't mean it is not used. If we didn't visit a site at the "right" time in relation to tide, time of season, we wouldn't have observed use. The extensive tidal flats of Great Bay appeared to receive little use in relation to the vast area exposed. Instead, overall, feeding areas at low tide were mostly strung out close to shore, along rivers and in tidal creeks. Some flats have extensive areas that are so flat that the whole area gets exposed and flooded quickly when the water is at a certain height, others have more relief which produces a different pattern of exposure. This difference seems to affect bird usage.

Salt Marshes

High marsh habitats are used mostly during high tide as resting and feeding sites. Some shorebirds like killdeer and common snipe appear to use these habitats irrespective of the tidal phase.

Pannes are key habitats for most shorebirds especially if positioned well among the tidal flats. Pannes with small vegetated islands and a combination of shallow bays, open pools and interconnecting canals seem to be preferred over more continuous, deep pools. The presence of large amounts of wrack and/or surface algae reduces usage as does high water. These conditions vary with season, rainfall, wind and extreme tides.

Areas supporting *Salicornia* are also useful to shorebirds, especially peeps. These sparsely vegetated and slightly depressed sites are used for feeding, resting and hiding.

The tidal flat /low marsh ecotone areas seem to be especially attractive to many of the shorebirds. In the spring we could observe, from an elevated position, birds moving through the short growing stems of *Spartina alterniflora*. We don't know how much of this occurs when the marsh grass is tall and rank. We do see shorebirds drop in behind fringe saltmarsh areas. This behavior serves as an escape from human disturbance. There frequently seems to be open areas near the shoreline.

Ice-rafted salt marsh is utilized by shorebirds. On tidal flats they are used as resting and feeding sites and for protection from wind. Also on marshes, the rafts provide elevation.

Coves and Narrow Inlets

Coves and narrow inlets provide different kinds of situations for shorebirds and other species of birds. Depending on their orientation and width they provide shelter from various weather conditions and human water-related activity, and exposure to sunshine during various parts of the day.

Tidal Creeks and Rivulets

All sizes of waterways down to the tiniest rivulet are selected as feeding sites and mouths of all sizes of waterways appear to be preferred. Unfortunately in some places runoff from new development has been transporting silt to and depositing it on mud flats and in rivers.

Flight Paths Through Trees

When flying from place to place, shorebirds frequently follow waterways flying anywhere from just above water level to above tree level. However, at times, when leaving a site, they rise up and go overland which frequently means flying over trees. In at least 7 different places we saw them fly through a place where there was an opening between the taller trees.

Fresh-water and Occasionally-inundated Salt Ponds

Small salt ponds which rarely get inundated are frequently used during high tide. The Agway Pond is well used and has been for years. It may be an alternate site during high tide for some species.

Human Influence

Boat traffic is much more frequent during high tide when the birds are in the marshes whereas, when the birds are along the flats there tends to be less boat traffic. We have frequently noted that the birds fly to behind the fringe salt marsh for cover when there is disturbance in the area. Furthermore, a number of the well-used pannes are situated back near the uplands. If homes are built near the shoreline, this kind of refuge can be compromised. Dogs and cats were seen travelling along the shoreline. Dogs were observed to cause reactions by the shorebirds. Shorebirds can habituate to a fair amount of activity at times when there is a tradition that people and dogs don't move into the marsh. This situation can be seen at site iv. However, at times even at that site, they flush because of human activity. At many homes along the bay, piles of grass clippings, raked leaves, brush, trees, etc. are dumped on the banks or on salt marshes.

Specific Locations and How They Are Used

Squamscott River Complex SQR (Map 4)

This is a rich site for shorebirds in both spring and fall because of the number of species and also the number of individuals which use it. The panne area behind Chapman's Landing provides a high tide refuge. Birds come into and out of this panne area from both upstream and downstream. There are also additional high tide sites in this area which are used simultaneously with the major site. Many of these panne areas are back from the river and close to the woodlands. During low tide, birds use the extensive upstream areas south of route 108 (out of our study area) in addition to areas downstream. Some flocks have also been observed flying northwest from Chapman's Landing. We haven't been able to determine where they go. Downstream there are low tide feeding areas on the Squamscott and in the spring, particularly at the mouth of the Lamprey on the south shore.

Southeast Great Bay Complex SEGB

This is a rich site in spring and fall with multiple species and some higher numbers. During low tide there is some limited use of the Great Bay tidal flats. Much more feeding occurs near the mouths of the Winnicut River and Pickering Brook including both sides of Pierce Point and up the tidal creeks and river. The shorebirds cross over the Portsmouth Golf Course between these 2 waterway systems. High marsh with pannes are used by resting and feeding birds. Also part of the complex is agricultural fields to the east which were mentioned in species writeups. Three miles to the east is Sagamore Creek near the ocean which is on a tide cycle several hours different from this area. We don't know if the shorebirds take advantage of this difference. We have seen shorebirds flying east from the corn field.

Salmon Falls/Cocheco Complex SFCR

This is a rich site in the fall during the low part of the tidal cycle. The large sandy mud flat (viii) harbors a high number of feeding birds. They move between this tidal flat, tidal flats and fringe marsh up the Salmon Falls River, tidal flats (vii) on the Cocheco River just west of the big flat (viii), and up the Cocheco River to tidal flats and fringe marshes to near the upper tidal limits, and up Fresh Creek. Because these rivers and Fresh Creek are so close, there are a number of alternative feeding sites very close. Furthermore, the Salmon Falls and Cocheco rivers are on a somewhat different tidal schedule. Flocks of shorebirds regularly fly directly between viii and vii over the point of land separating the two river. They generally fly through a gap in the taller trees. The flats at vii stay above the incoming tide for about 30-45 minutes longer than the flats at viii. We have been trying to find out where these birds are coming from. A number of them fly in small flocks up the Piscataqua River. Some stop temporarily at a tidal wetland area south of viii. We have backtracked to below Sturgeon Creek (7-B) and still see flocks. We have been unable to detect birds flying down Sturgeon Creek. At first we considered the possibility that they were coming from North Mill Pond in the Portsmouth area since there is a lag in time of low tide. However, North Mill Pond also has a lag from published Portsmouth tides. In SFCR we have not found high tide sites near these tidal flats. We have seen black-bellied plovers flying from 8-C to 8-A just as the mud flats were beginning to be

exposed. Could they be coming from fields in the area? This complex is a very rich site for not only shorebirds but other birds using the estuary, particularly osprey.

Other Areas

Site ix appears to be a hub for area 3-A. The south shore of the mouth of the Lamprey River is an overlap low tide area for 3-A and for SQR. Site iv and nearby areas appear to act as a high tide hub for 3-B, 3-D, 3-C, and perhaps parts of 4-A, 4-D and 3-E. Shorebirds use 3-F and move all through this area and into at least part of 3-E. There are high and low tide areas. We did not find as many as we would have expected. Area 5 is another area that has high and low tide areas that are used, but not to the degree one might expect. There have been a number of activities in 5 which have put silt into the river in the last few years. We observed lower numbers in Area 6-A than one might expect. Some shorebirds leaving SFCR have been seen flying overland in the direction of 6-B and C.

Species Other Than Shorebirds

Horseshoe Crabs

From our observations, horseshoe crabs appear to start laying eggs in May in this area. This major egg-laying period does coincide with the presence of migrating shorebirds. Egg-laying horseshoe crabs and/or egg-laying sites were found in sand, mud and salt marsh peat. Two areas with the densest individual laying sites that we found were in the north end of 4-D and the west end of 3-F. Both of these sites contained coarse sand. No shorebird activity was noted at a site during egg-laying activity. Area 4-D is an important spotted sandpiper site. At west 3-F we found low shorebird activity overall. The area looked like the kind of place we should have found more activity. Horseshoe crabs still are laying eggs in July when the birds return. We did not detect any obvious relationship between feeding sites and egg-laying sites. Horseshoe crab eggs could be a food item but we did not find evidence that they are a major food source. Spotted sandpipers could be using them as a food source.

In 1990, before the study started, we did some preliminary counts of horseshoe crabs. Counts in 1991 seemed to indicate less horseshoe crabs. In June they stopped appearing in areas where they previously had been coming in to lay eggs. We don't know what happened to them. Lobster fishermen remarked on their absence. Since horseshoe crabs don't mature until after eight year, a loss of immature horseshoe crabs may not be detected for years.

Other Birds

Information was collected on other birds mentioned above. Osprey were seen in all eight areas. The most important areas were 8-A,B,C and 1-A. Area 8-C and Fresh Creek were used as a unit by osprey. The next most important sites were the Bellamy River and the Oyster River. Bald eagles were seen on the Cocheco River, in Little Bay and Great Bay. Marsh hawks were seen in Royalls Cove (6-A), Johnson Creek (5-C) and hunting in all parts of 1-B. We didn't record any rails or bitterns, however, a volunteer reported a bittern. Black-crowned night herons were especially seen in the upper end of the tidal portion of the Cocheco, Bellamy and Lamprey Rivers. Green-backed heron were frequently seen especially on the rivers and tidal creeks. Great-blue herons were seen at

specific sites in every area 1-8. Glossy Ibis were seen in various places in SQR and at iv. Snowy Egrets were particularly seen in 8-A and 1-B. In addition, families of crows visited the mud flats at specific places, hunting.

OVERVIEW DISCUSSION

The estuary is a whole system and all units of habitat no matter how small play a role in the daily rhythm of use by shorebirds. With the exception of existing concentrated human settlements, most of the estuary is available for shorebird use, if only for short periods at some sites. The important point here is that all units of natural habitat serve as primary or alternate sites for use and reduction of even alternate feeding and/or resting sites (or portions of) would have an impact. To illustrate, the closing of a small local grocery store in a small rural community doesn't initiate a mass movement out of the community, but it sure impacts the quality of life for some members of the community. It may discourage newcomers to the community because they would have to travel too far for groceries. Shorebirds, like all wildlife, are keenly aware of their surroundings and are constantly adapting to physical changes in their environment, often forcing them to use alternate, and less desirable habitats. When does the marginal habitat become uninhabitable for an individual, a flock or a population?

It must be remembered that just because we didn't find use in an area doesn't mean that area is not used. This study only covered one year. There can be large variations from year to year.

Management Options for Shorebirds

1. Protection of Habitat

The productivity of the Estuarine system needs to be protected through land use planning, education of shoreland owners and town planning officials, and shoreland protection measures. Several specific points come up. Adjacent and nearby lands also provide needed habitat such as plowed fields, fresh-water ponds and some of the little salt ponds that are only inundated occasionally. Maintenance of these kinds of areas need to be encouraged through education of and agreements with owners, easements or purchase. Secondly, a buffer between normal everyday human and pet activity and the shorebirds' feeding and resting areas would be helpful. Thirdly, although there is some public recognition that the shores of Great Bay, Little Bay and the tidal rivers need protection, there appears to be a general lack of understanding about the tidal creeks and the importance of protecting them. Since the estuary is spread over a wide area it gets very confusing for most people to understand how various little, and for that matter large, waterways are connected to each other and how water and soil misuse even in these areas affect the Bay. Runoff from some recent housing developments and highway construction is carrying silt into some of the tidal rivers. Town master plans frequently don't adequately address tidal areas, particularly tidal creeks.

Two sites (i and iv) would make excellent birdwatching places for education and recreation if handled very carefully. Information about protection of the habitat, etc. could be introduced.

2. Monitoring Guidelines

One of our objectives was to develop ideas on how to monitor these shorebirds in the estuary. This population is the kind that could just "melt away" before most people realize it. They reflect the productivity of the estuary system because they are highly influenced by the ready availability of food.

The most important considerations of a monitoring scheme for the estuary is timing of observations according to the tide cycle, the location and position of observers, duration of the observation and the number of replications during the key periods of the spring and fall migrations.

According to our information, this monitoring period for most shorebirds would be 4/5 to 5/15 and 8/15 to 10/15. In general this would cover the important migration periods. Replication of observation periods at each site should be about 5 days apart during the entire survey period, but at least within one week intervals. Ideally, a combination of observations from land and water would yield the most complete information. Also, the important concentration sites at key pannes and tidal flats should be timed to the tide cycle when each habitat is most attractive. Additionally, timing should be related to the time it is easier to see the birds, for example, when they're flying into the area or when they're concentrated in a part of a flat that is easier to see. Our specific data can be used to help calculate this. Each site should be observed during a continuous 40 to 60 minute period but no less than 30 minutes. In most cases the shorebirds are arriving and departing from key sites, or flushing and landing within the site and therefore observations by at least 2 coordinating individuals at the same site are suggested for a thorough survey. From the water 2 observers are essential as one must constantly be responsible for the boat's position and movements. Perhaps the key success of any survey on land or water is to minimize reactions of the birds to the observers. Accurate complete notes are essential to any monitor effort and a tape recorder would be helpful.

Besides information on numbers and species, data on direction of flight, time, weather, condition of pannes and changes in the area in relation to human development should be collected.

The 3 complexes listed need to be included in the monitoring. These are by no means the only productive sites. Other areas of use, sampling other hubs of activity, should be included. Observers should be constantly aware of shorebird movements and to assess their position or location to make optimum observation, while at the same time keeping in mind it is important to have observation locations and methods which are standard from year to year. Aerial photos of tidal flats in SFCR may be an effective way to count birds using that area. Monitoring spotted sandpipers needs to be done by boat before the adults start losing their spots. Productivity and areas of use can be recorded. Several other non-shorebird species could be monitored at the same time such as green-backed herons, belted kingfisher and osprey. Annual surveys using these species could be a good indicators of changes in the estuary.

There are definite spring/fall differences in shorebird use of northern and southern portions of the estuary. Especially during fall, the two portions should be monitored simultaneously.

In addition to the above, perhaps an "Adopt a Site" system could be established to add another dimension. People who reside on the estuary and are interested in birds could keep records on a particular site. Other areas besides the areas of concentration are important. Because of the nature

of use by the birds of much of this long strung out habitat, this kind of information would round out the monitoring scheme. We found that data kept by our volunteers on this kind of basis could be very useful. Also, by keeping track of shorebird use on or adjacent to their shoreline area they are more likely to detect changes and to observe migrant arrivals and departures. A carefully planned network of resident shorebird observers in the estuary with a few planned observation sites could become the most practical way of monitoring the estuary. Other interested birdwatchers could also be very helpful.

3. Importance of Communication and Cooperation Across Political Boundaries

In the SFCR complex, the large tidal flat where a major concentration of birds occurs is in Maine, however, many of the sites in this complex used by these same birds are in New Hampshire. Four towns and two states border this complex. A decision made by one state or town could affect the whole system. The SQR site includes 4 towns.

4. Management of Habitat

The newly acquired land in 6-B by the state may, or could be, very useful for shorebirds. Decisions on the management of that land could enhance shorebird habitat. Communication about the timing and location of mowing with the owner of the property where the upland sandpiper was displaying would enhance usage by that species and other shorebirds using that area.

Additional Shorebird Research Needs

There are questions that need to be answered to interpret monitoring data. For example:

- Where do the birds come from in SFCR?
- Do the birds in SEGB also use the ocean coastline habitats?
- Why is there low use of the Great Bay mudflats? food availability?
- Why are some areas that look good used very little or are they?
- Location of other important fields, salt and fresh-water ponds?
- Location of other high tide roosts?
- How discrete are the activity areas we proposed?
- Will the patterns show in other years?

There is also a need for additional information on the shorebirds in the parts of the estuary we didn't cover and the rest of the coast in New Hampshire.

The disappearance of horseshoe crabs this past summer is disturbing. More information on this population is needed?

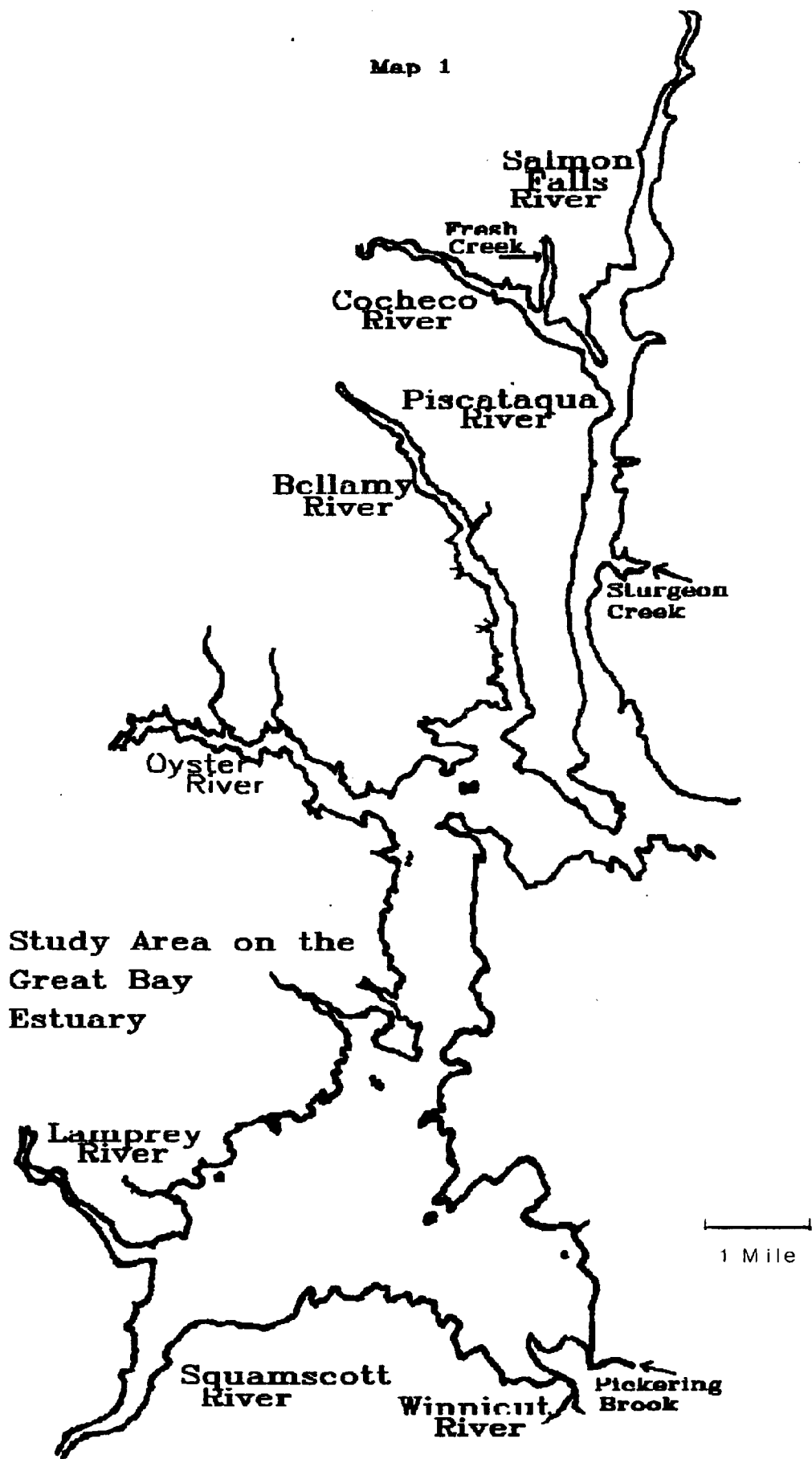
LITERATURE CITED

Dearborn, N., 1903. The birds of Durham and Vicinity. Contrib. Zool. Lab. NH College of Agric. and Arts, Durham

New Hampshire Fish and Game Department. 1981. Inventory of the natural resources of Great Bay Estuarine System. Volume I. NH Fish and Game Dept., Concord. 254 pp.

New Hampshire Fish and Game Department. 1982. Great Bay Estuary monitoring survey, 1981-1982. NH Fish and Game Dept., Concord. 199 pp.

Map 1



Map 2

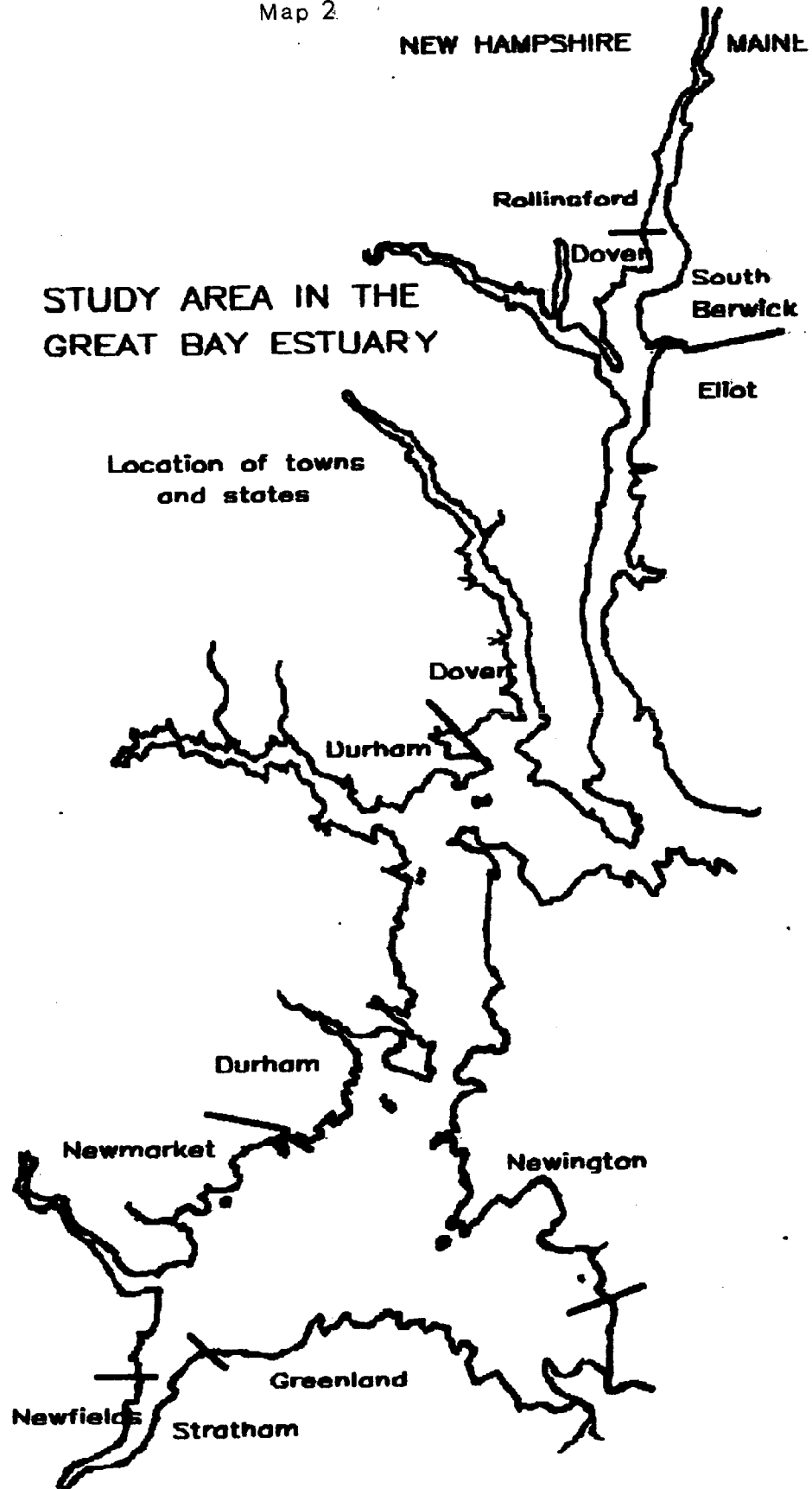


TABLE 1

Field Work for Shorebird Study

Segment of estuary- lists segment(s) of study area in which majority of work done that day

GB Great Bay, Lamprey River, Squamscott River, Winnicut River

LB Little Bay, Oyster River, Bellamy River

PR Upper Piscataqua., Salmon Falls River, Cochecho River

Man hours- Includes all time spent on field work including boat maintenance etc., by Don and Kitty Miller including their volunteer time. Volunteer time of others not included here.

Means- How fieldwork was done that day. If "land" is listed then no work was done from water, only from land, whereas on many days on which work was done from water, there was frequently work also done from land but is not listed as such.

Miles - Car mileage

JULY

DATE	GB	LB	PR	HOURS	MEANS	MILES
July 7	x			5.0	boat	18.4
8	x			6.0	boat	18.4
10	x			1.3	land	22.4
11	x			10.1	boat	44.8
13	x			11.2	canoe	44.4
14		x		8.0	canoe	20.0
15			x	7.2	canoe	22.0
17		x		12.0	boat	18.4
18		x	x	1.0	land	4.6
19	x			12.0	boat	18.4
23		x		14.2	boat	22.4
24	x			2.0	land	22.4
31		x	x	16.0	boat	22.4

Total Monthly Hours - 106

Total Monthly Miles - 299

AUGUST

DATE	GB	LB	PR	HOURS	MEANS	MILES
Aug 1	x			3.5	land	38.4
3	x			3.0	land	18.4
6	x			1.0	land	22.4
7			x	9.0	canoe	44.0
9	x			6.6	sailboat	18.4
10			x	11.0	canoe	44.0
13	x		x	7.0	land	20.0
14		x		14.0	boat	35.0
15	x	x		12.0	boat	22.4
16	x	x		19.0	boat, can	60.0
17	x		x	15.0	canoe	53.0
18			x	6.6	canoe	22.0
19	x		x	3.5	land	52.0
20	x			13.0	boat	56.0
21	x		x	4.0	land	55.0
22	x		x	9.3	canoe	43.2
23	x		x	2.5	land	33.0
24	x	x	x	16.0	canoe	40.0
25	x			0.5	land	18.0
26		x		9.0	canoe	38.4
27	x			12.0	canoe	28.4
28	x	x		3.0	land	60.0
29			x	3.5	canoe	22.0
30	x			2.0	land	30.0
31		x	x	10.0	canoe	25.0

Total Monthly Hours - 196

Total Monthly Miles - 899

SEPTEMBER

DATE	GB	LB	PR	HOURS	MEANS	MILES
Sept 2				2.0	land	18.4
4	x			4.0	land	46.0
5	x			8.5	boat	63.2
6	x			5.6	land	30.0
7	x			9.0	boat, can	22.4
8	x	x		14.2	boat	18.4
9	x			11.5	canoe	30.0
10	x		x	3.0	land	44.4
11			x	11.5	canoe	40.0
12	x			3.5	land	45.0
13		x		6.0	land	36.8
14	x			11.3	canoe	48.0
15	x		x	5.0	canoe	6.0
16		x	x	1.0	land	5.0
17	x		x	10.5	canoe	35.4
18	x		x	0.6	land	35
19	x	x		3.5	canoe	6.0
20	x			4.0	land	20.0
22		x	x	1.8	land	22.0
23		x		2.5	land	18.2
24	x			4.0	land	21.8
25			x	16.0	canoe	27.8
26	x			1.0	land	18.4
27	x	x		12.0	boat	32.8
28		x		14.0	boat	22.0
29	x			7.0	land	33.0
30		x	x	2.0	land	22.0

Total Monthly Hours - 175

Total Monthly Miles - 768

OCTOBER

DATE	GB	LB	PR	HOURS	MEANS	MILES
Oct 1			x	1.5	land	18.0
3	x	x		5.9	boat	36
4	x	x		7.0	land	78
5			x	7.5	canoe	17.5
6	x	x		14.5	boat	28.4
7	x			15.0	boat	18.4
8		x	x	6.5	land	57.0
9	x	x		4.0	land	60.0
10		x		11.2	canoe	24
11	x			1.0	land	18.4
12		x		10.0	canoe	40.0
13	x			2.0	land	18.4
14	x			17.7	canoe	40.0
15	x			2.0	land	18.4
17	x	x		2.5	canoe	18.0
19	x			1.0	land	18.4
20	x			1.5	land	24.0
22		x		1.5	land	24.0
23	x			3.0	land	40.0
24	x			5.5	boat	36.8
26		x		6.5	land	38.0
27			x	9.5	canoe	40.0
29	x			8.0	canoe	40.0
30	x			12.0	boat	18.4
31	x			8.0	boat	18.4

Total Monthly Hours - 164.8

Total Monthly Miles - 788.5

NOVEMBER

DATE	GB	LB	PR	HOURS	MEANS	MILES
Nov 1		x		12.0	boat	18.4
2		x		12.5	boat	18.4
4	x			2.8	land	56.2
5	x			3.2	land	31.7
6	x			1.0	land	18.4
8	x			2.0	land	18.4
9			x	6.0	canoe	24.0
10	x			1.7	land	18.4
11	x			1.5	land	18.4
12	x			2.5	land	45.5
13	x			4.0	land	40.4
14			x	6.0	land	40.0
15			x	13.0	canoe	70.0
16	x			10.0	boat	70.0
18	x			2.5	land	40.0
19	x			2.5	land	36.0
20	x			11.4	boat	38.0
21		x		10.0	boat	18.4
25	x			6.0	boat	18.4
26	x			2.5	land	40.0
27	x			1.0	land	18.4
28		x		8.5	boat	36.0
30			x	3.5	canoe	40.0

Total Monthly Hours - 126.1

Total Monthly Miles - 773.4

MARCH

DATE	GB	LB	PR	HOURS	MEANS	MILES
19	x			2.2	land	38.0
21	x			2.8	land	36.0
25	x			0.8	land	36.0
26	x	x	x	9.4	land	46.5
27	x			1.6	land	41.2
29	x			0.8	land	22.1
30	x	x		1.3	land	21.2

Total monthly hours-18.9

Total monthly miles-241.0

APRIL

DATE	GB	LB	RP	HOURS	MEANS	MILES
1	x			1.1	land	42.0
2	x			1.4	land	23.3
3			x	1.2	land	22.4
5	x			1.6	land	44.8
10		x	x	4.8	land	30.7
12	x			4.8	land	41.8
14	x	x	x	2.3	land	46.0
17	x			2.5	land	17.8
18		x	x	6.4	land	44.1
19	x			2.3	land	25.2
20		x		12.2	boat	10.5
24	x			12.6	boat	22.4
25		x	x	1.7	land	24.0
26	x			5.1	land	17.3
27	x			10.3	boat	22.4
28	x			3.2	boat	38.4
29	x	x		3.7	land	59.7
30	x			2.1	land	29.1

Total Monthly Hours-79.30

Total Monthly Miles-561.90

MAY

DATE	GB	LB	P2	HOURS	MEANS	MILES
May 1			x	6.5	canoe	22.9
2		x		2.0	land	22.0
3	x			6.6	land	22.7
4	x			13.5	canoe	26.6
5	x			2.2	land	41.8
7	x			13.2	boat	27.6
8			x	8.1	boat	21.0
11	x			4.1	land	33.1
14	x			1.8	land	21.0
15		x		8.7	boat	21.0
16	x			9.0	boat	20.4
17		x		6.7	boat	10.4
18		x		7.8	boat	10.4
19	x			11.4	canoe	38.5
20		x		13.7	canoe	50.2
21	x			5.4	land	38.5
22			x	9.2	canoe	46.4
23	x			11.7	land	39.6
25	x			10.1	boat	37.5
27		x		1.4	boat	41.5
29	x			13.5	boat	18.2
30		x		10.0	canoe	22.0

Total monthly hours-176.6

Total monthly miles-633.3

JUNE

DATE	GB	LB	FR	HOURS	MEANS	MILES
June 4	x			2.2	land	21.0
6	x			3.3	land	42.9
7		x	x	2.8	land	21.2
12		x		0.8	land	10.0
14	x			8.3	boat	18.2
16		x		1.3	land	20.0
17		x		3.5	land	27.0
30		x		5.5	land	28.0

Total Monthly Hours-27.7

Total Monthly Miles-183.3

Table 2 Relative abundance of sixteen species of shorebirds observed in the Great Bay Estuary, July 1990 to June 30, 1991.

SPECIES	RELATIVE RATING
Family: Charadriidae	
Semipalmated plover	A
Killdeer	C
American golden plover	D*
Black-bellied plover	A
Family: Scolopacidae	
Common snipe	C
Upland sandpiper	D*
Spotted sandpiper	B
Solitary sandpiper	C
Willet	D
Greater yellowlegs	B
Lesser yellowlegs	B
Pectoral sandpiper	C
Least sandpiper	A
Dowitcher	D*
Short-billed dowitcher	C
Semipalmated sandpiper	A

Relative abundance ratings:

- A Usually locally abundant
- B Widely distributed but rarely in large numbers
- C Small groups and singles, moderate to wide distribution
- D Singles, or pairs and only at one or a few sites

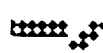
*only one individual observed by us or reported by a volunteer

Map 3

STUDY AREA ON THE GREAT BAY ESTUARY

2 LEVELS OF
BROAD SCALE
SUB-AREAS

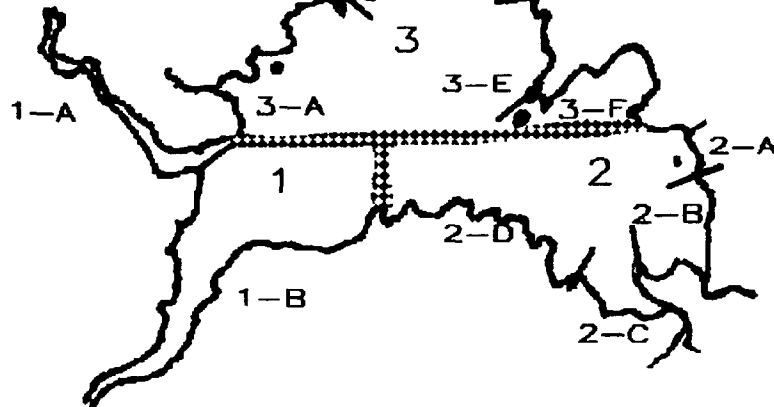
dividing lines
between areas



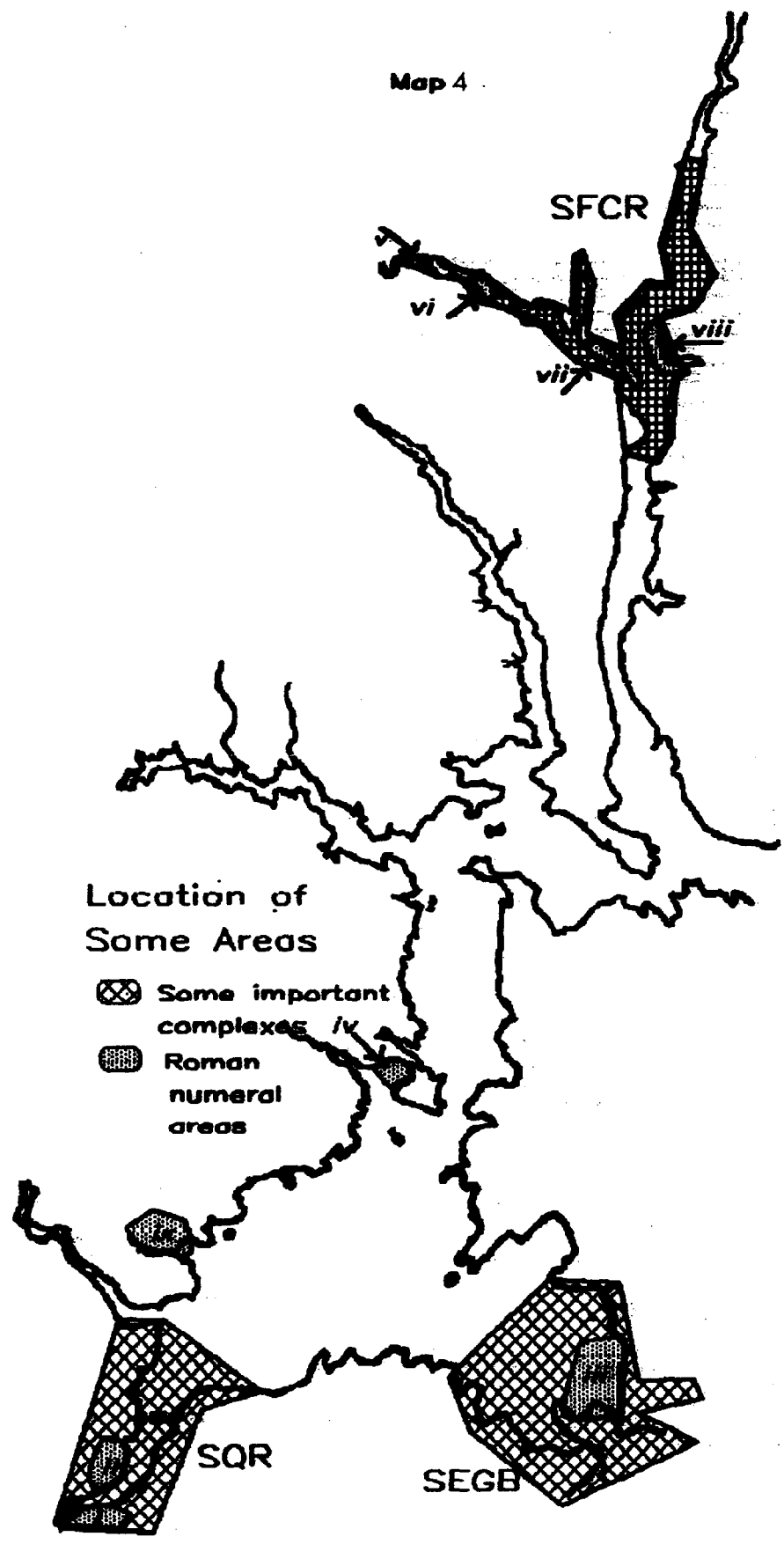
level 1 3-B



level 2



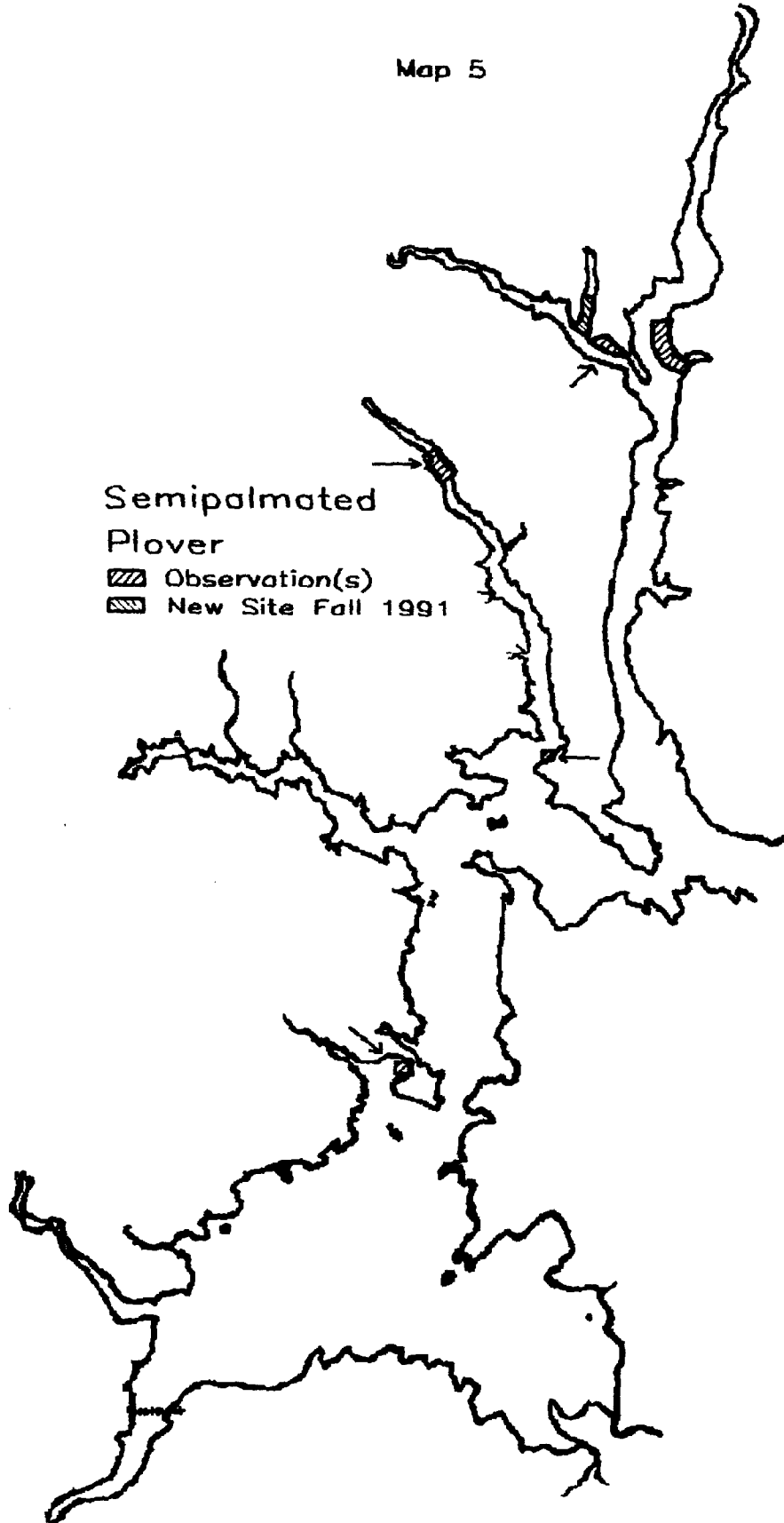
Map 4



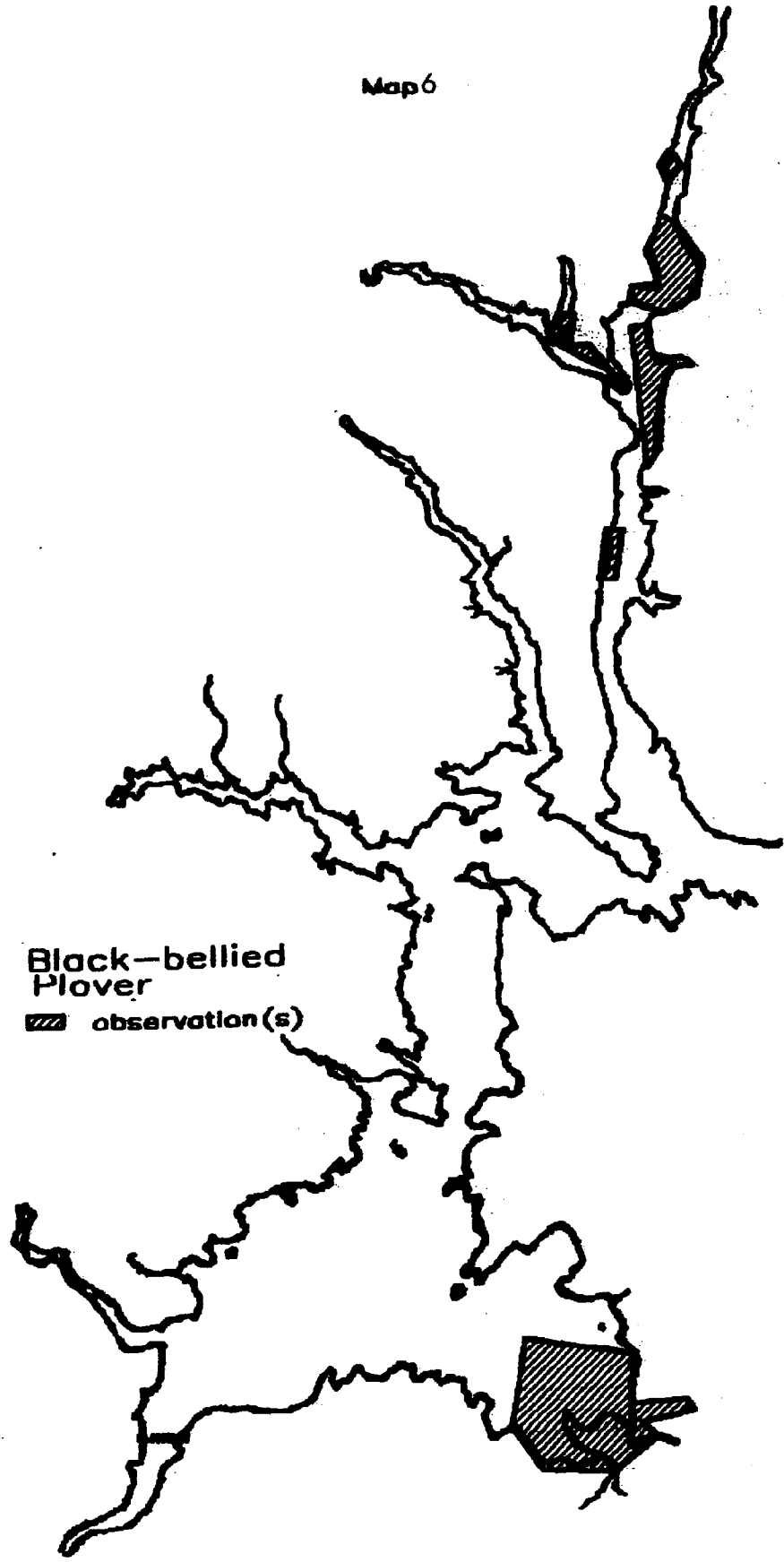
Map 5

Semipalmated
Plover

-  Observation(s)
-  New Site Fall 1991

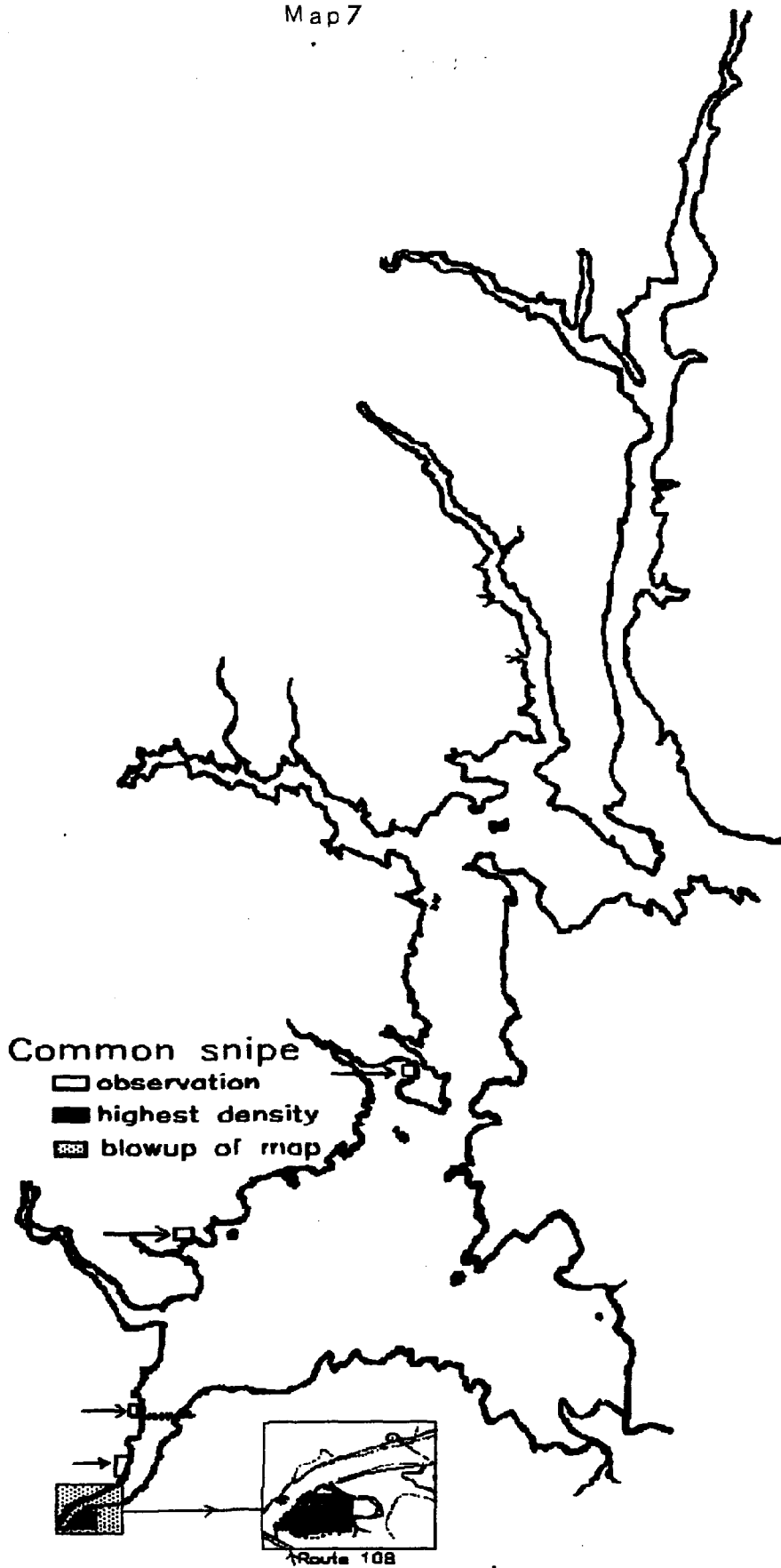


Map 6

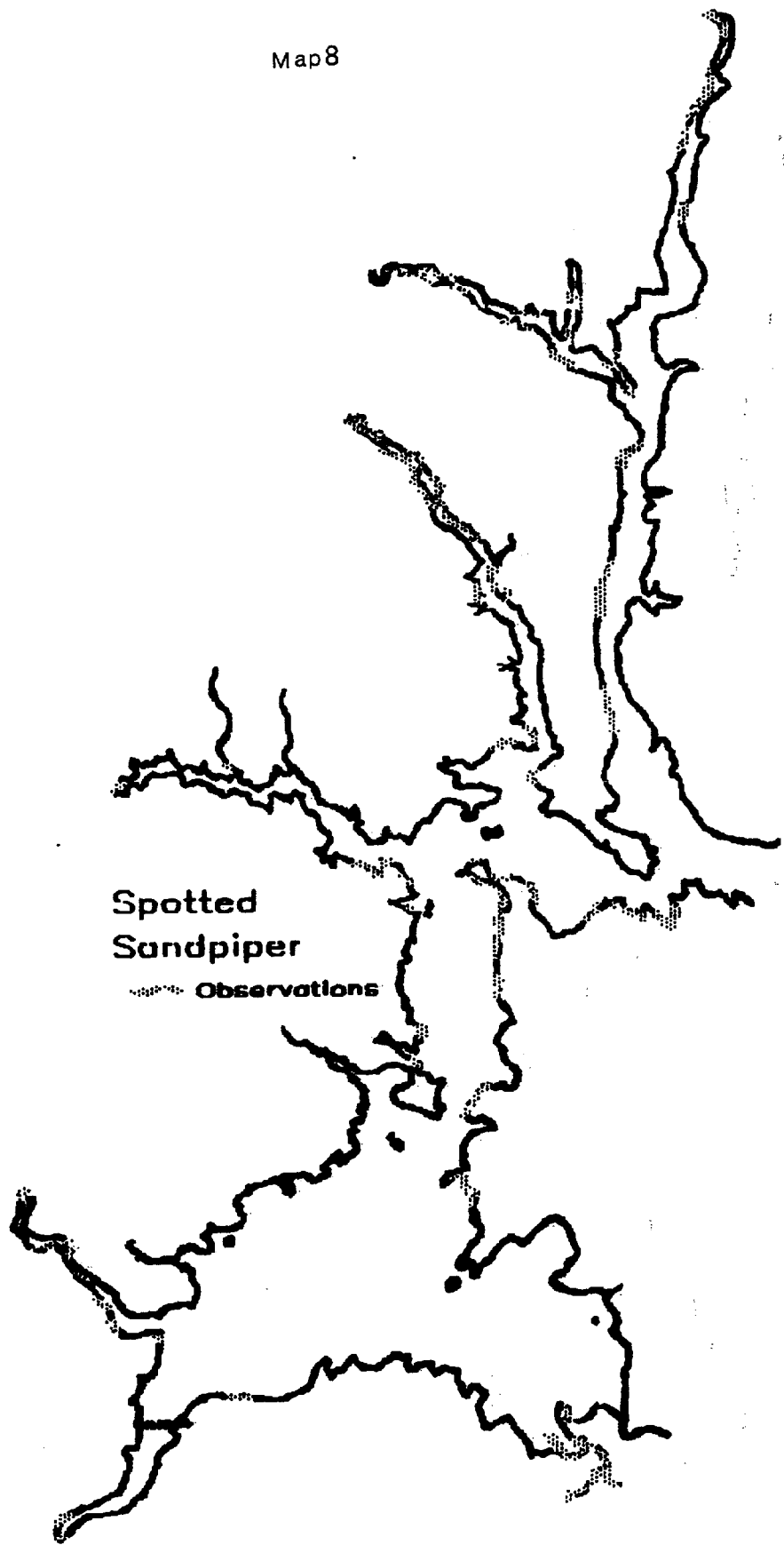


Black-bellied
Plover
▨ observation(s)

Map 7



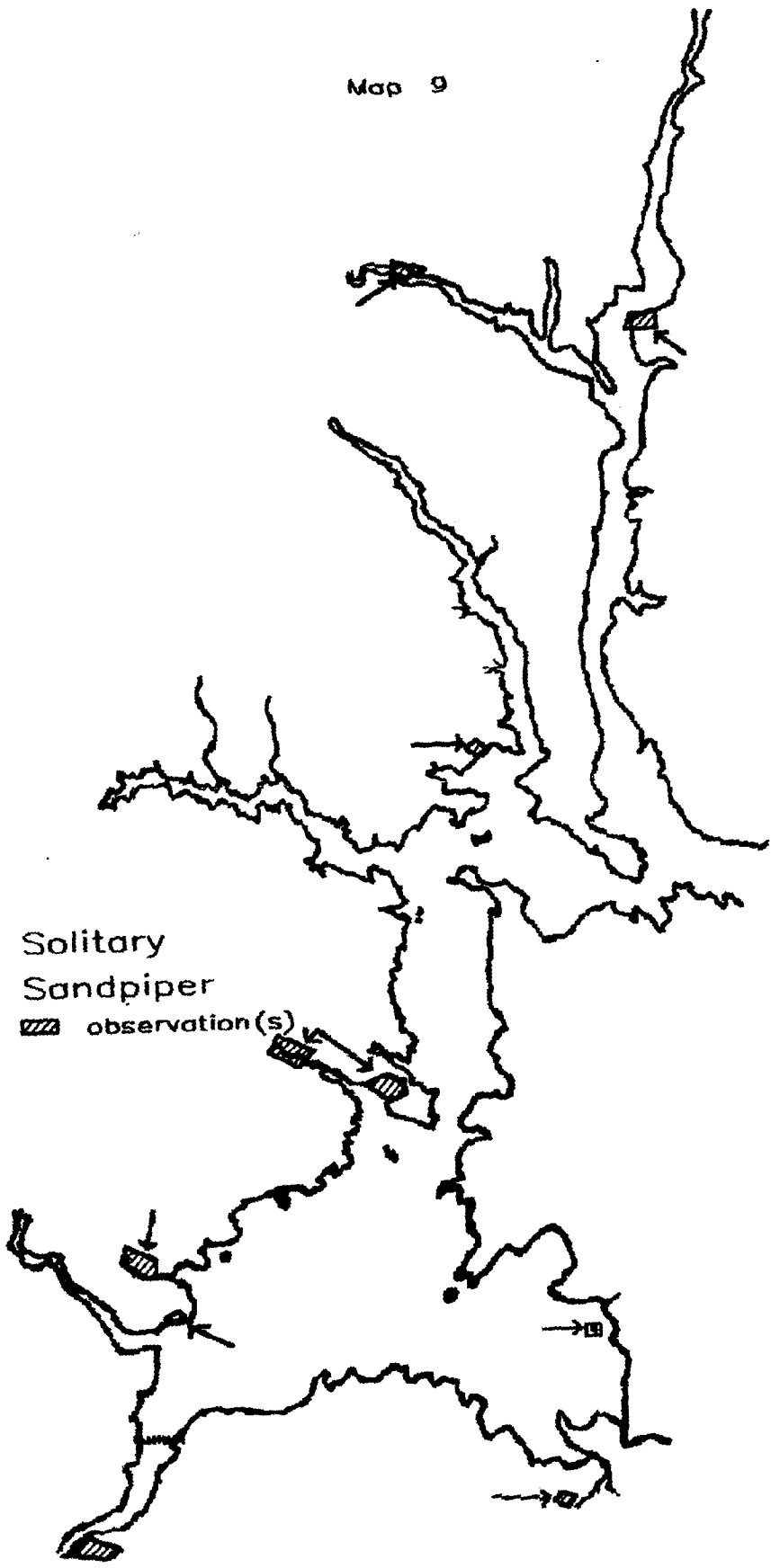
Map 8



**Spotted
Sandpiper**

Observations

Map 9



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