OBSERVATIONS ON WATERBIRD FLIGHT PATTERNS AT SALTON SEA, CALIFORNIA OCTOBER 1976-FEBRUARY 1977

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INTRODUCTION

In order to assist in the environmentally sound development of geothermal resources in Imperial Valley, California, the U. S. Department of Energy has sponsored the Imperial Valley Environmental Project (IVEP). The present investigation was a part of the extensive baseline study of Imperial Valley ecosystems carried out during the IVEP under the direction of the Environmental Sciences Division, Lawrence Livermore Laboratory. It included detailed field observations of wildlife populations and habitat usage at the Salton Sea and other wetland areas in the northern portion of the Imperial Valley.

One of the major tasks of this study was to document the regional flight patterns of bird populations. Vast numbers of shorebirds and waterbirds are known to use this region during migration and many spend the entire winter here (2 , 4, 7). Large flocks are often seen moving along the southern shoreline of Salton Sea or out into adjacent croplands to feed. The high voltage electric transmission lines which will be required in connection with future geothermal power plants could pose a serious hazard to these bird populations (1). Baseline data concerning the locations of heavily travelled flight corridors and the typical range of flight altitudes would provide a valuable input to decisions on transmission line siting.

The impacts of transmission lines on migratory birds are poorly understood, but it is known that they can be a cause of mortality where large concentrations of birds fly at low elevations under conditions of poor visibility (5, 6). The construction of transmission lines through or adjacent to bird habitats may also reduce or eliminate use of resting or feeding areas. Finally, hunting success can be affected where waterfowl are forced to change flight patterns.

This investigation was designed to collect data on the flight patterns of important bird species at Salton Sea and in adjoining parts of the Imperial Valley. Areas of heavily used habitat were identified and bird movements between these areas were quantified as to numbers, direction, and altitude. Observations were carried out from October 1976 through February 1977, when the abundance and diversity of migratory and overwintering birds was at a peak. A prime objective of the study was to evaluate the potential for adverse impacts on wildlife from new transmission lines and to make recommendations for the mitigation of such impacts.

METHODS

Study Areas

Most observations of waterfowl flight patterns were carried out within 3.2 km (2 miles) of the southern shoreline of Salton Sea. Major study areas were at the South Unit of the Salton Sea National Wildlife Refuge (SSNWR), the Headquarters Unit of the SSNWR, Red Hill Marina (Garst Road), and the Wister Unit of the Imperial Wildlife Area. Additional observations were made near the Alamo River at the Finney-Ramer Unit of the Imperial Wildlife Area.

Observational Techniques

Observations on bird movements were usually conducted in early morning and late afternoon, when the greatest amount of activity occurred. Two or more observers stationed themselves at one of the five study areas, often where a major flight corridor passed over a road. The point of origin and the destination of flocks were determined with binoculars; occasionally, groups of birds had to be followed by automobile to establish the starting or ending locations. We also attempted to determine whether the flight was initiated voluntarily or by human disturbance. Data recorded included the type of flight (field-to-field or longer feeding-roosting movement), species and number of individuals in each flock, weather conditions, time of observations, and whether it was a hunt or non-hunt day.

An important objective of the study was the measurement of flight altitudes. Two observers were required for this operation. One person determined the angle (Θ) above the horizontal plane for a flock or an individual bird with a Suunto Optical Reading Clinometer, while the second observer simultaneously measured the distance to the bird or flock with a calibrated Rangematic Mark VI Distance Finder. Flight altitude was calculated by multiplying the distance times $\sin \Theta$. Observer height 1.8 m (2 yds) was added to each altitude calculated in this way. The altitudes of long-distance migratory flights could not be measured, as they generally exceeded the 228.6 m (250 yds) limit of the rangefinder.

RESULTS

During 14 days of observations between 7 October 1976 and 25 February 1977 we recorded movement patterns and measured flight altitudes of 17,388 individual birds of 33 species. The bulk of these data pertain to six species of waterbirds that are particularly abundant at Salton Sea during the fall and winter.

White Pelican (*Pelecanus erythrorhynchos*)

White pelicans in numbers up to a few hundred are nonbreeding residents at Salton Sea. During the fall large numbers of additional birds migrate into the Salton Sea, concentrating near the southern shoreline. As many as 4000 were seen there on 19-20 October 1976 and their daily flight corridor is shown in Figure 1. These birds apparently forage during the early morning at the delta of New River and work their way northeast to a point off the Wister Unit (Imperial Wildlife Area) by afternoon. Late afternoon flights bring them back again to the area near the

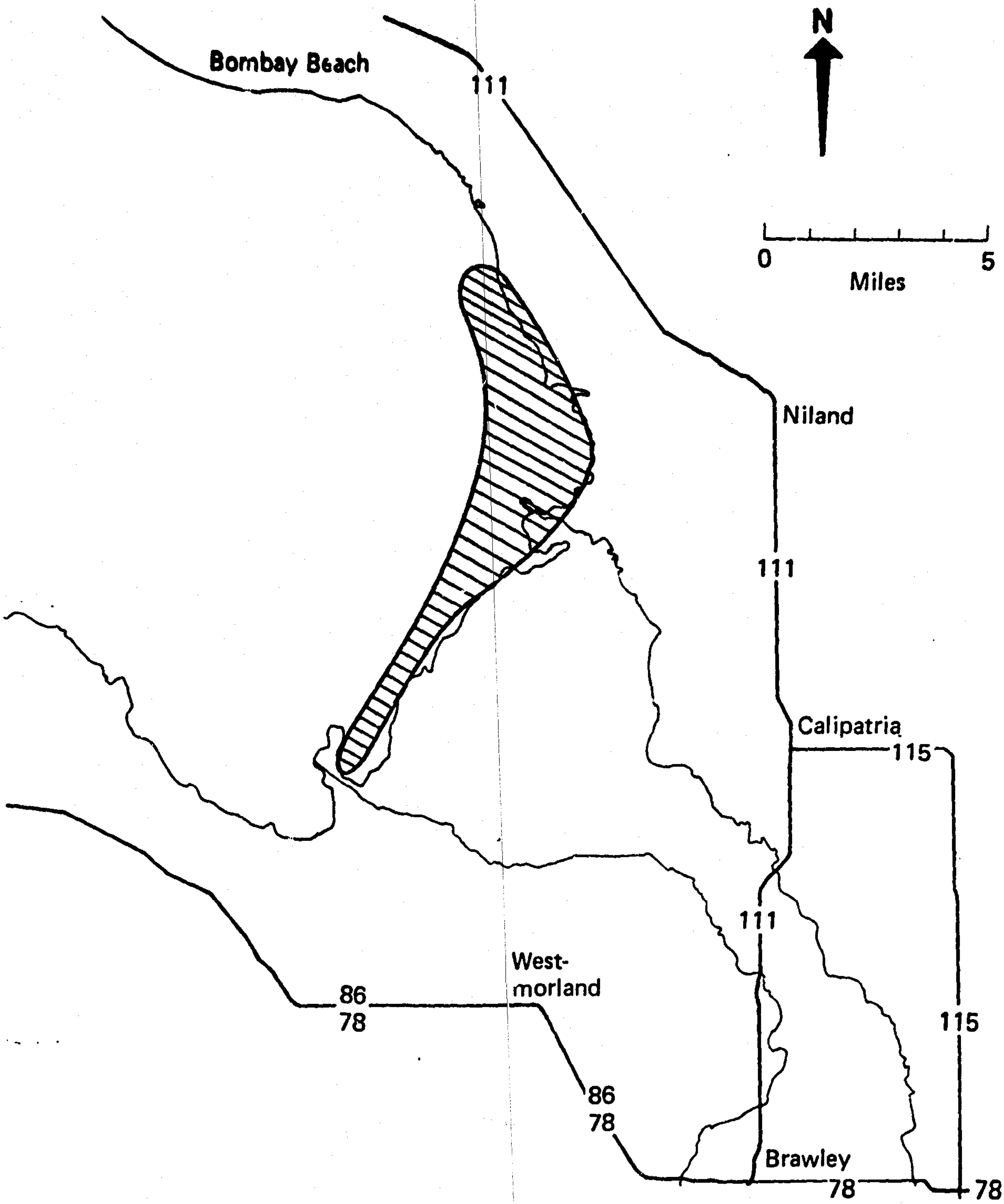


Figure 1. Daily flight corridor of white pelicans during October 1976.

mouth of New River. These movements are typically over water or just over the shoreli at an estimated height of 91.4 m (100 yds).

Cattle Egret (Bubulcus ibis)

Cattle egrets are abundant throughout the year in the Imperial Valley. They often feed during the day in cultivated fields and along canal margins in agricultural lands, returning to large communal roosts to spend the night. Two such roosts were found during this study. A roost near the shoreline of Salton Sea between Red Hill and the Headquarters Unit (SSNWR) contained about 2000 cattle egrets, while the Ramer Lake roost in the Finney-Ramer Unit (Imperial Wildlife Area) sheltered at least 7400 birds. Cattle egrets from Ramer Lake moved south each morning along the Alamo River to their feeding areas, returning to the roost at dusk (Figure 2).

Measurements of flight altitudes were obtained on two different occasions as large numbers of cattle egrets were approaching their Ramer Lake roost from the south along the Alamo River (Figures 3 and 4). In both cases the birds were flying at quite low altitudes. On 1 January 1977 the minimum height was 9.1 m (10 yds) and the mean 19.2 m (21 yds), while comparable values were 17.4 m (19 yds) and 30.2 m (33 yds) on 21 October 1976.

Flocks moving south toward the foraging areas tended to maintain higher altitudes (Figures 5 and 6). In the two samples shown, the mean flight altitude was over 45.7 m (50 yds) and the minimum was 30.2 m (33 yds).

Ring-billed Gull (Larus delawarensis)

This is one of the most abundant gull species in the Imperial Valley. These birds range widely over cultivated fields and into the towns, as well as in mudflat and open water habitats. Flights between roosting and feeding areas were almost always at relatively high altitudes. Measured heights varied from

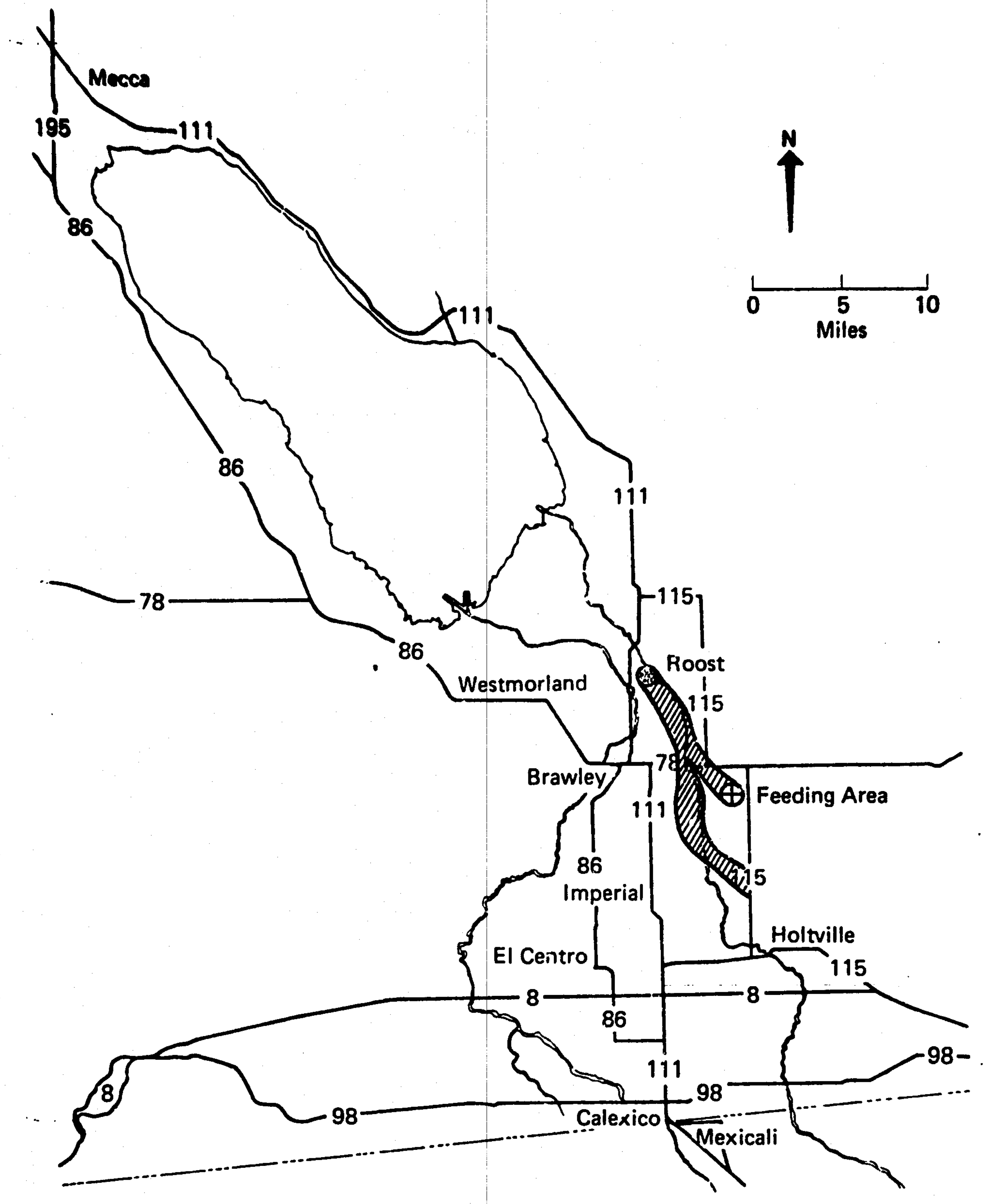


Figure 2. Flight corridor used by cattle egrets during 1976 – 1977.

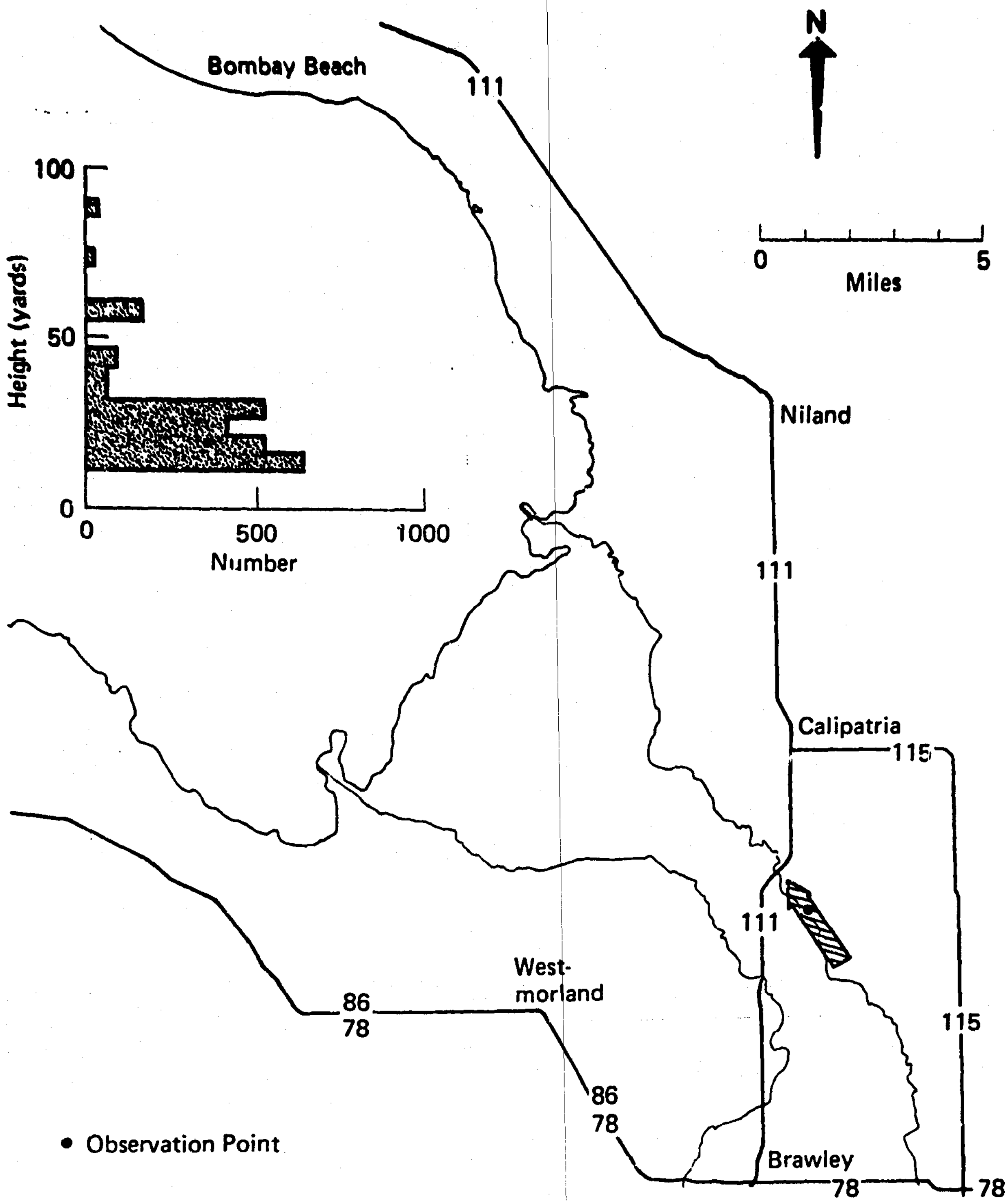


Figure 3. Altitude distribution and flight path of cattle egrets on 1 January 1977.

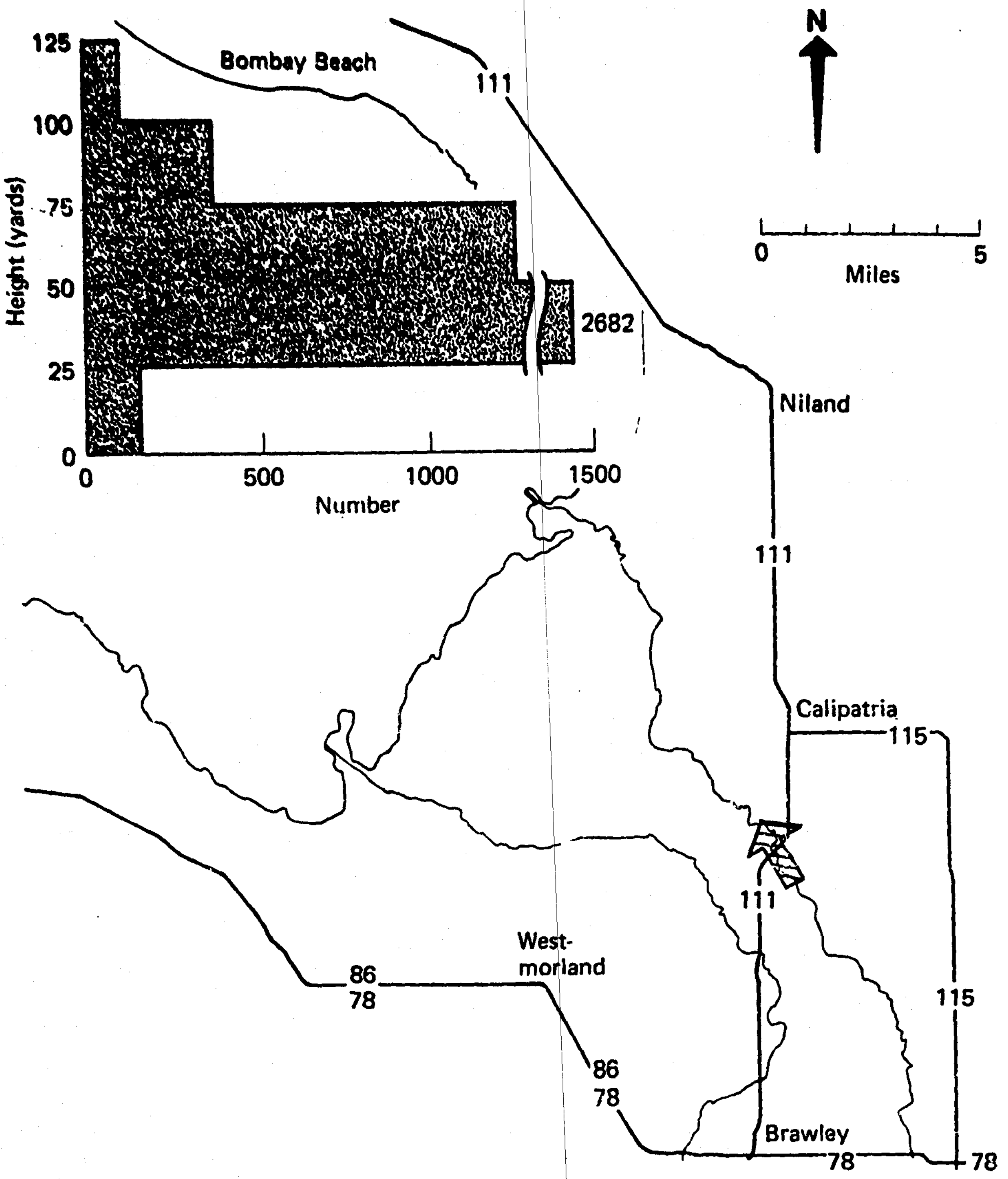


Figure 4. Altitude distribution and flight path of cattle egrets on 21 October 1976.

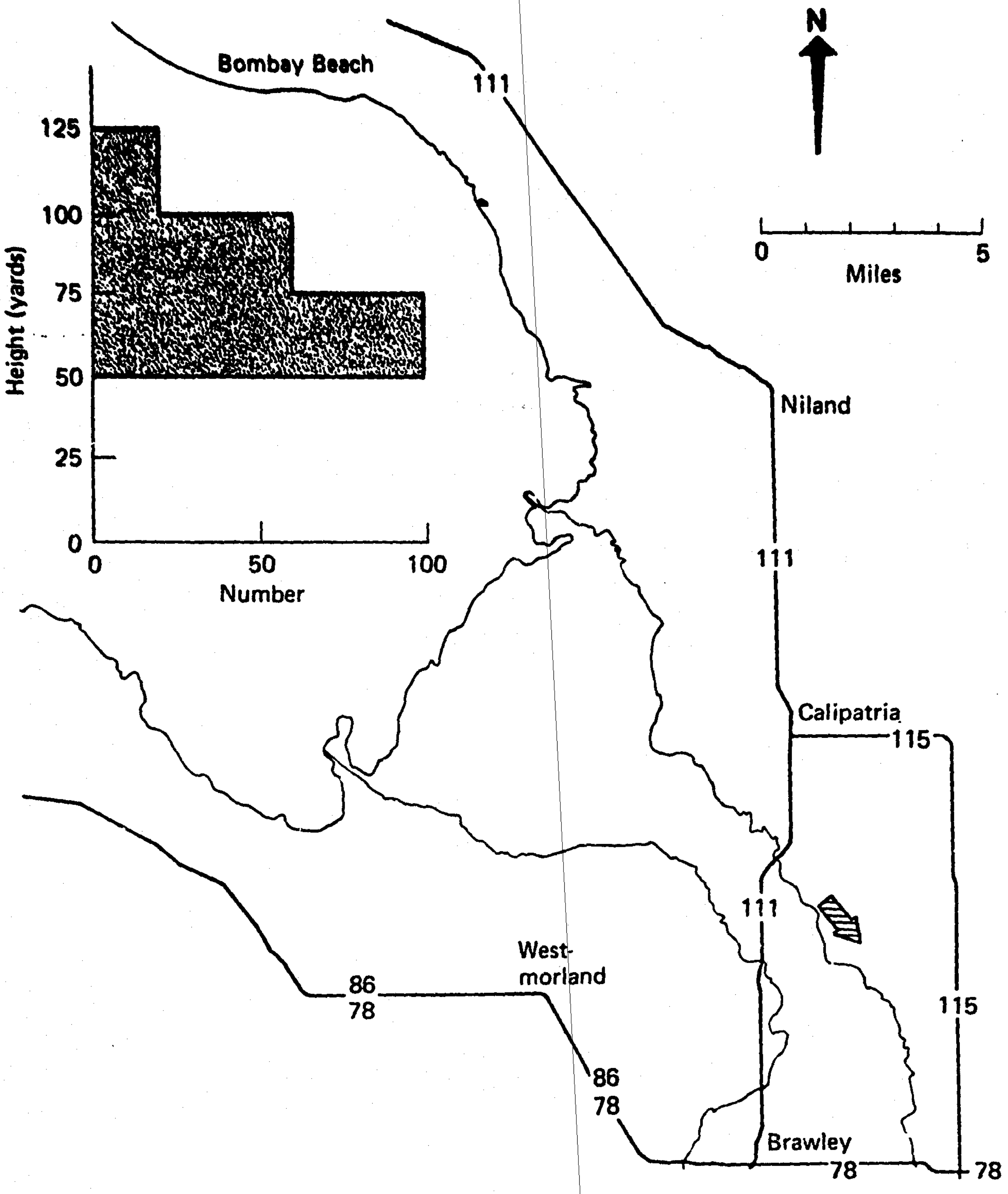


Figure 5. Altitude distribution and flight path of cattle egrets leaving roost on 21 October 1976.

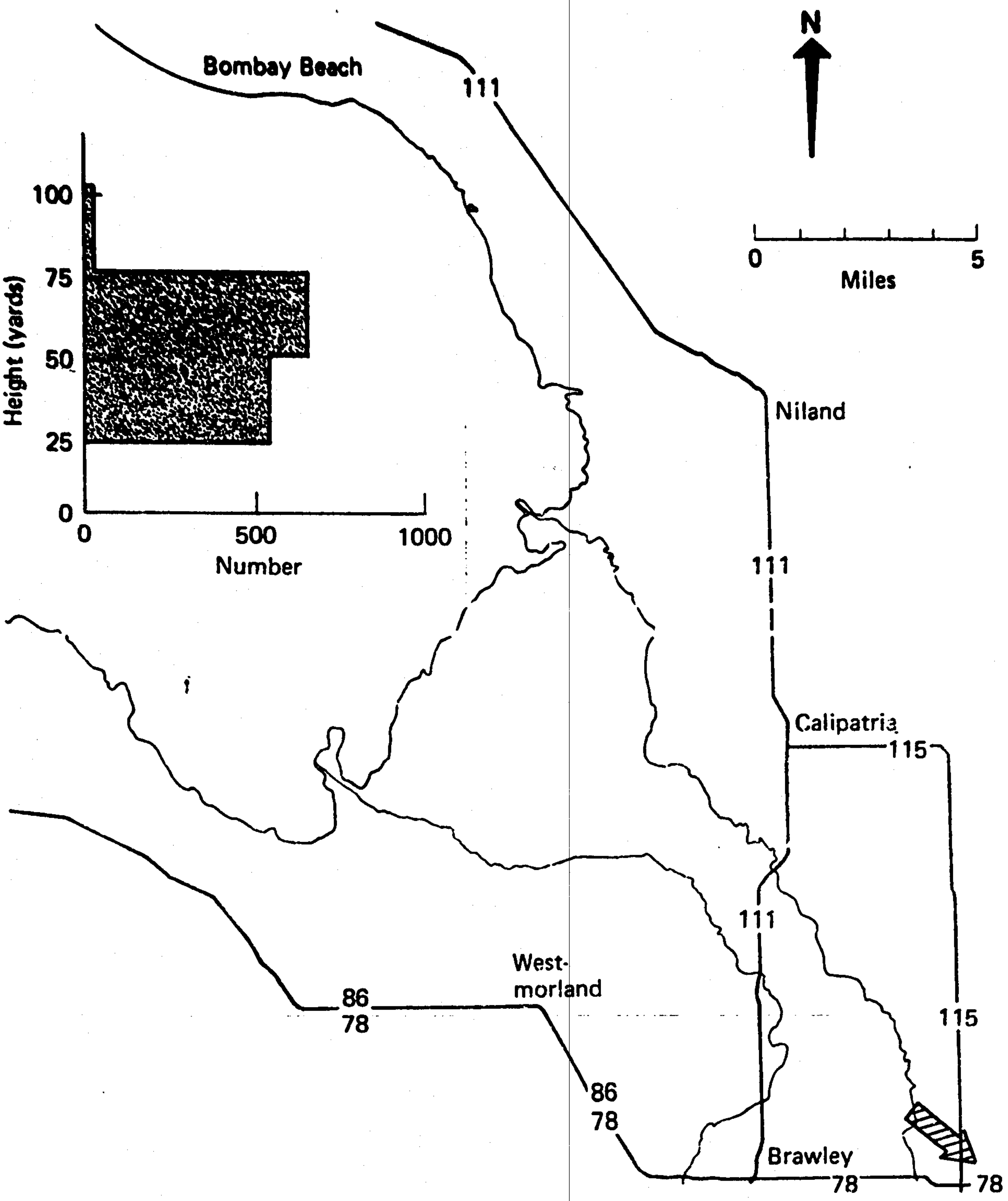


Figure 6. Altitude distribution and flight path of cattle egrets approaching foraging area on 22 October 1976.

45.7 m to 228.6 m (50 to 250 yds) at two locations near the South Unit (SSNWR) (Figures 7 and 8). Ring-billed gulls on roosting flights over the Finney-Ramer Unit (Imperial Wildlife Area) were above the range of our distance-finding equipment (> 228.6 m or 250 yds).

Pintail (Anas acuta)

Up to 200,000 ducks regularly spend the winter at Salton Sea. Pintails are one of the dominant species. Their flights, like those of other waterfowl, generally follow the shoreline of Salton Sea along the corridors indicated in Figure 9. Thousands of pintails often rest during the middle of the day near the Headquarters Unit (SSNWR) and late afternoon flights were frequently observed moving northeast to the Wister Unit (Imperial Wildlife Area).

Figures 10 and 11 show typical flight paths for groups of pintails moving from the Headquarters Unit toward Wister. Flight altitudes measured from Garst Road near the Alamo River were close to or above 91.4 m (100 yds) on both occasions. Pintails were observed to fly below 91.4 m (100 yds) during short-range movements (Figure 12), but in general this species kept to significantly greater altitudes than other common waterfowl of the region.

Canada Goose (Branta canadensis)

Canada geese wintering at Salton Sea usually number 4000-8000 birds, spread over the three wildlife areas along the southern shoreline. They commonly feed in fields within 3.2 or 4.8 km (2 or 3 mi) of the sea. While large numbers of pintails and snow geese regularly undertook fairly long daily flights (> 8 km or 5 mi) between feeding and resting areas, Canada geese rarely displayed this behavior.

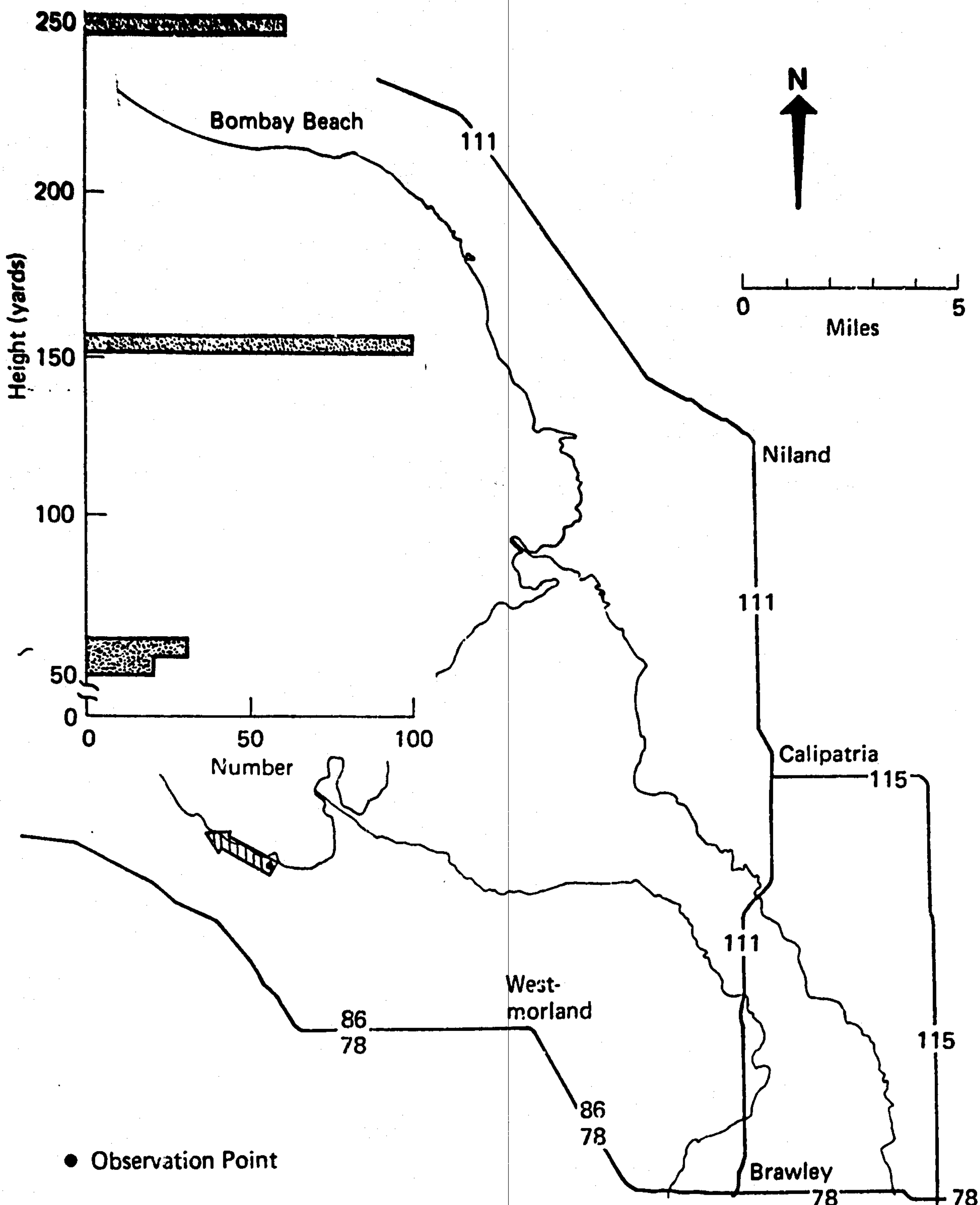


Figure 7. Altitude distribution and flight path of ring-billed gulls on 22 January 1977.

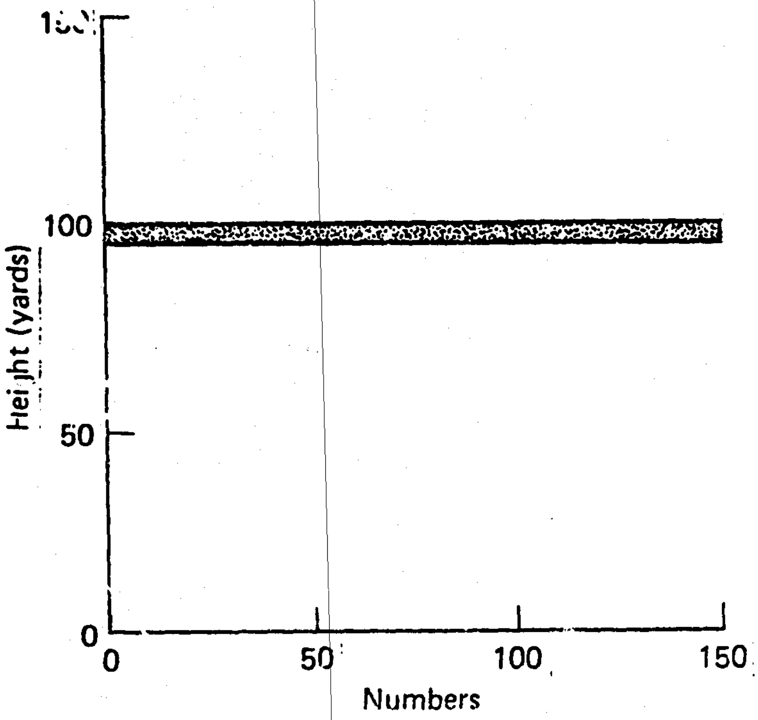


Figure 8. Altitude distribution of ring-billed gulls at Vendel Rd., South Unit, Salton Sea National Wildlife Refuge, 22 January 1977.

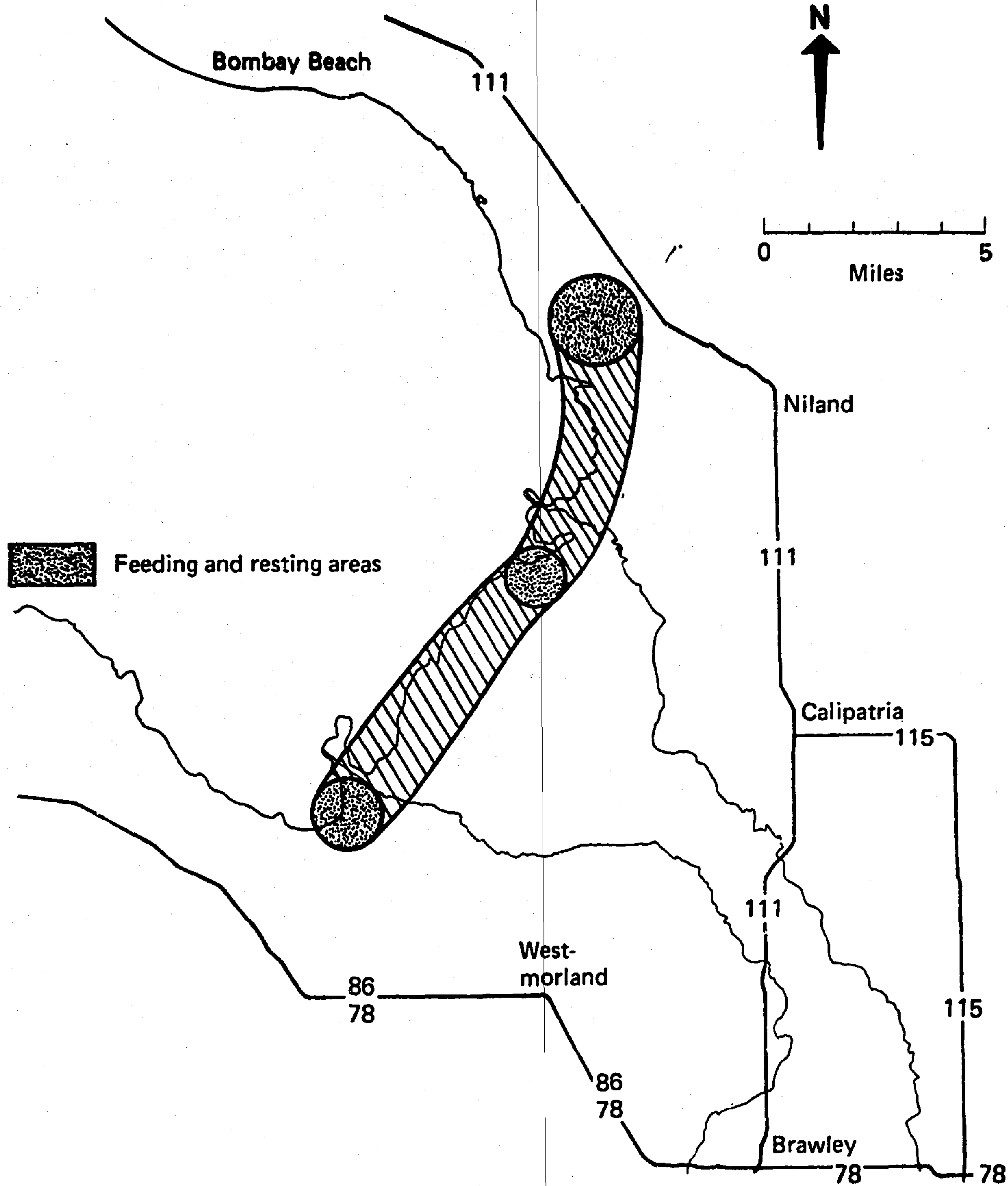


Figure 9. Flight corridor used by Waterfowl between refuge areas.

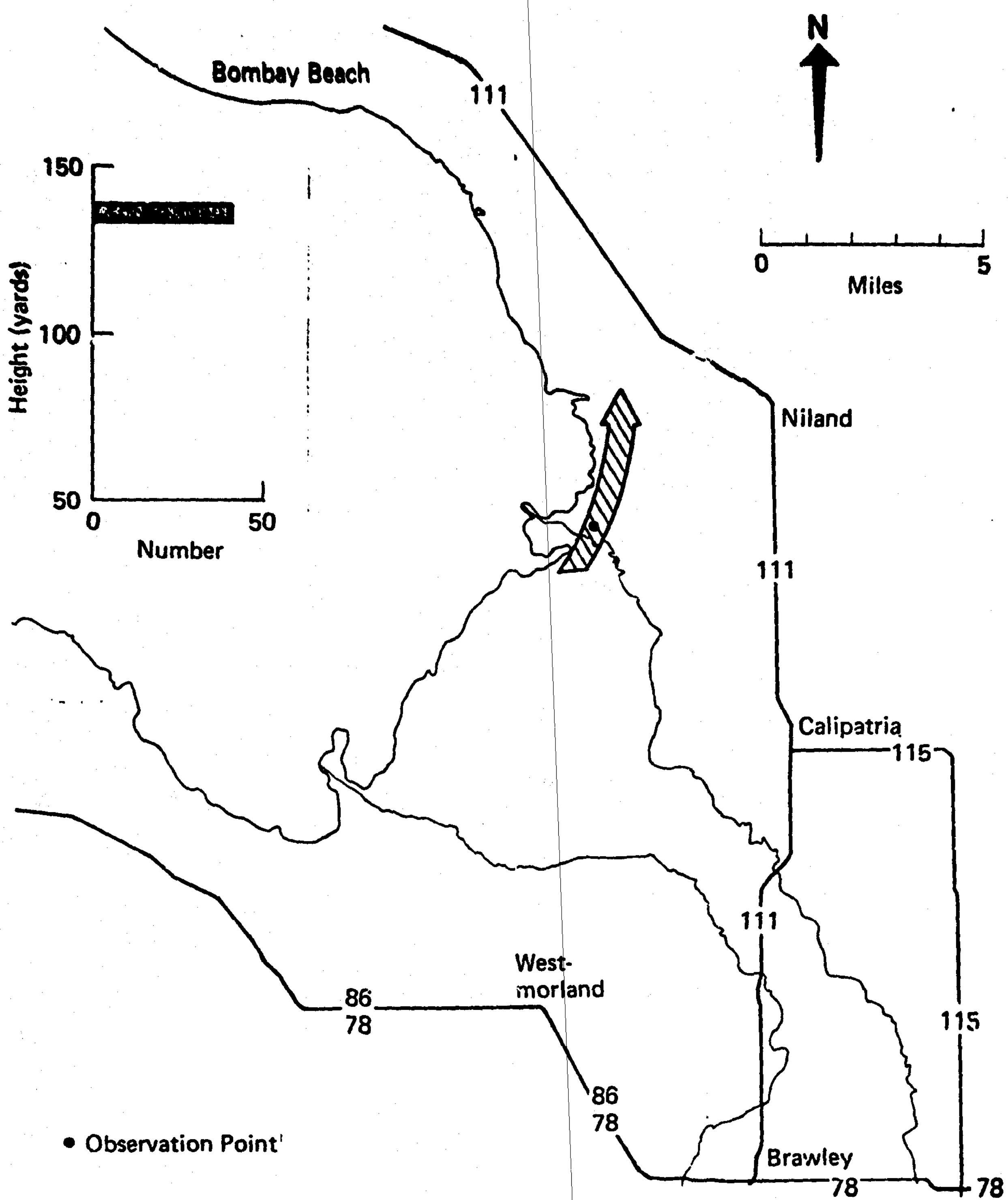


Figure 10. Altitude distribution and flight path of pintails on 18 December 1976.

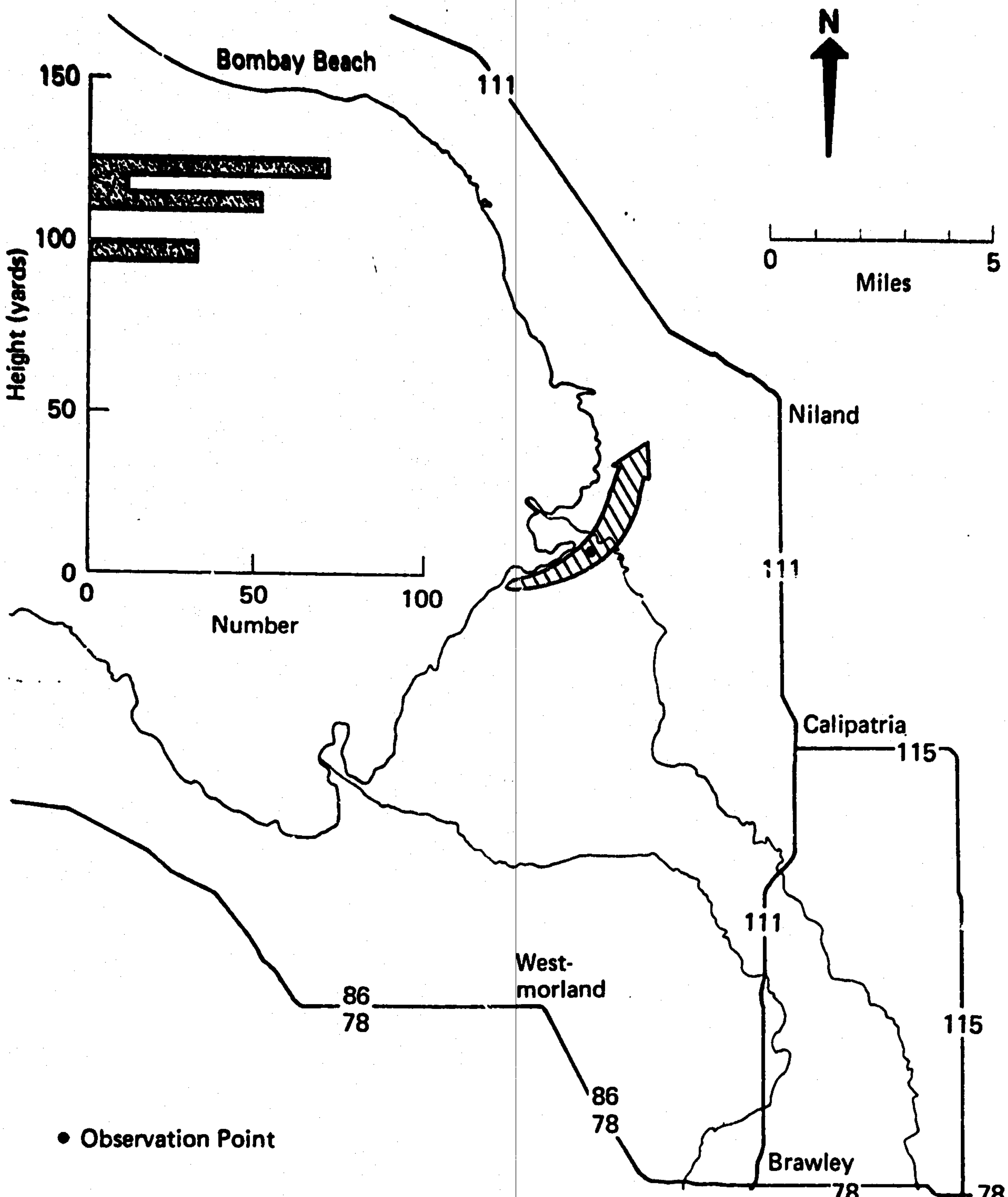
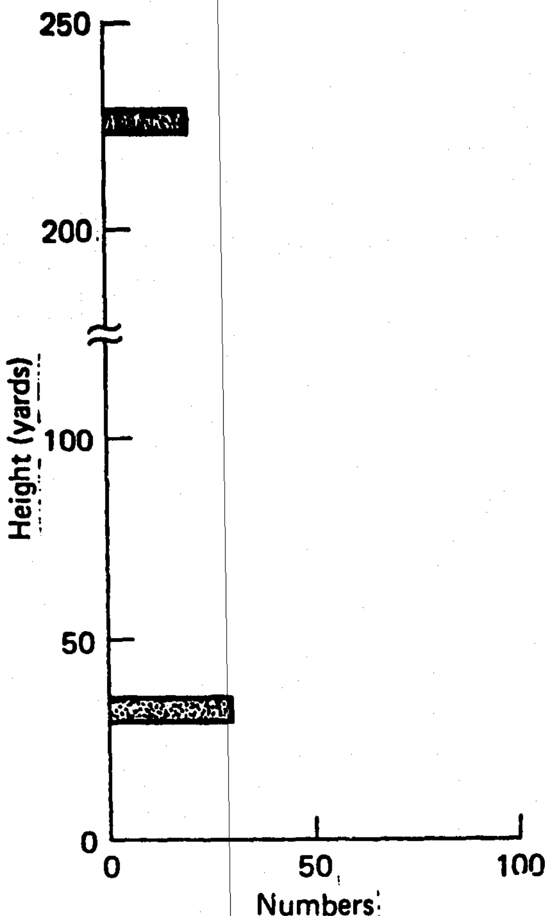
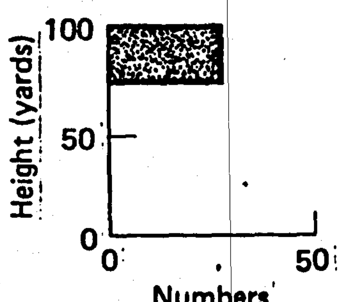


Figure 11. Altitude distribution and path of pintails on 24 February 1977.



A. Vendel Rd., South Unit, Salton Sea National Wildlife Refuge



B. Garst Rd. at Alamo River, 2 January 1977

Figure 12. Altitude distribution of pintails during short flights.

Even the occasional longer flights were often at heights below 45.7 m (50 yds) (Figure 13).

Almost all observations of Canada goose movements involved short flights at low altitudes from one field to another. Figure 14 shows typical altitudinal distributions of flight activity during shifts between adjacent fields; virtually all heights measured were between 22.9 - 45.7 m (25 - 50 yds).

Snow Goose (Chen caerulescens)

This species is present in large numbers (18,000 - 20,000 birds) during fall and winter at several areas along the southern margins of Salton Sea. Snow geese generally rest and feed in the South Unit (SSNWR) in early fall. When most of the available forage there is consumed, the bulk of the wintering birds move to the Headquarters Unit (SSNWR) and finally to the Wister Unit (Imperial Wildlife Area) before returning north in the spring. Almost all snow goose flight and feeding activity occurs within 3.2 km (2 mi) of the Salton Sea shoreline, as shown in Figure 9.

Data on flight altitudes were collected at Garst Road near the Alamo River during late afternoon flights from the Headquarters Unit (SSNWR) to Wister Unit (Imperial Wildlife Area). Figures 15-17 present typical altitude distributions. While there was a wide range of heights represented, no values below 36.6 - 45.7 m (40 - 50 yds) were measured. However, on one occasion a small flock of snow geese moving from fields near the South Unit (SSNWR) toward Salton Sea were observed flying well below 45.7 m (50 yds) (Figure 18).

Flight altitudes were measured for many local movements from field to field. Observers were usually stationed where these local flight paths crossed the roads between fields. In some cases the flocks of snow geese maintained heights well above 45.7 m (50 yds) (Figures 19, 20B, and 21B). Large numbers of birds were observed flying below 45.7 m (50 yds) at several locations (Figures 20A, 20C, 20D, and 21A).

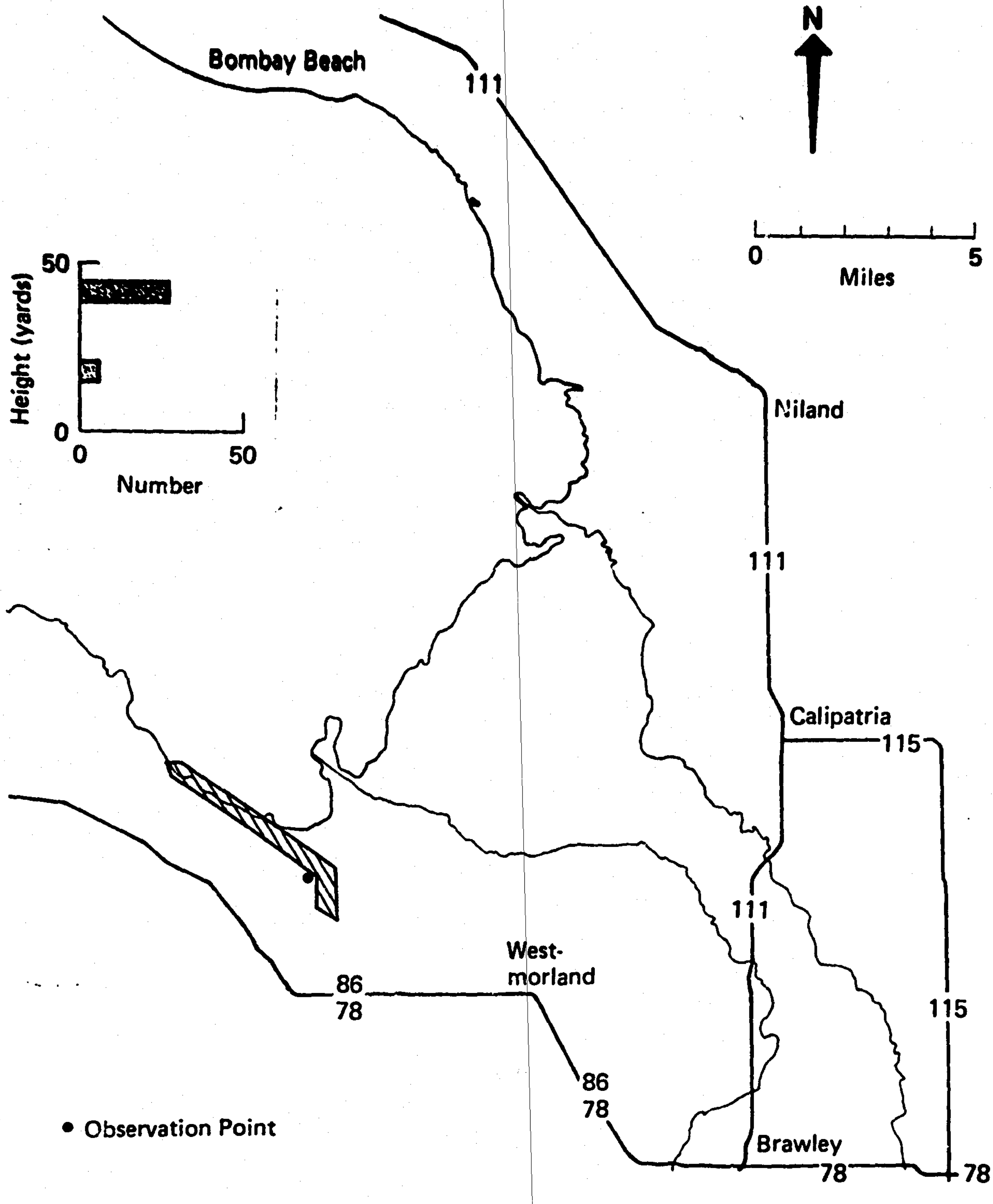


Figure 13. Altitude distribution and path of Canada geese during flight of 23 January 1977.

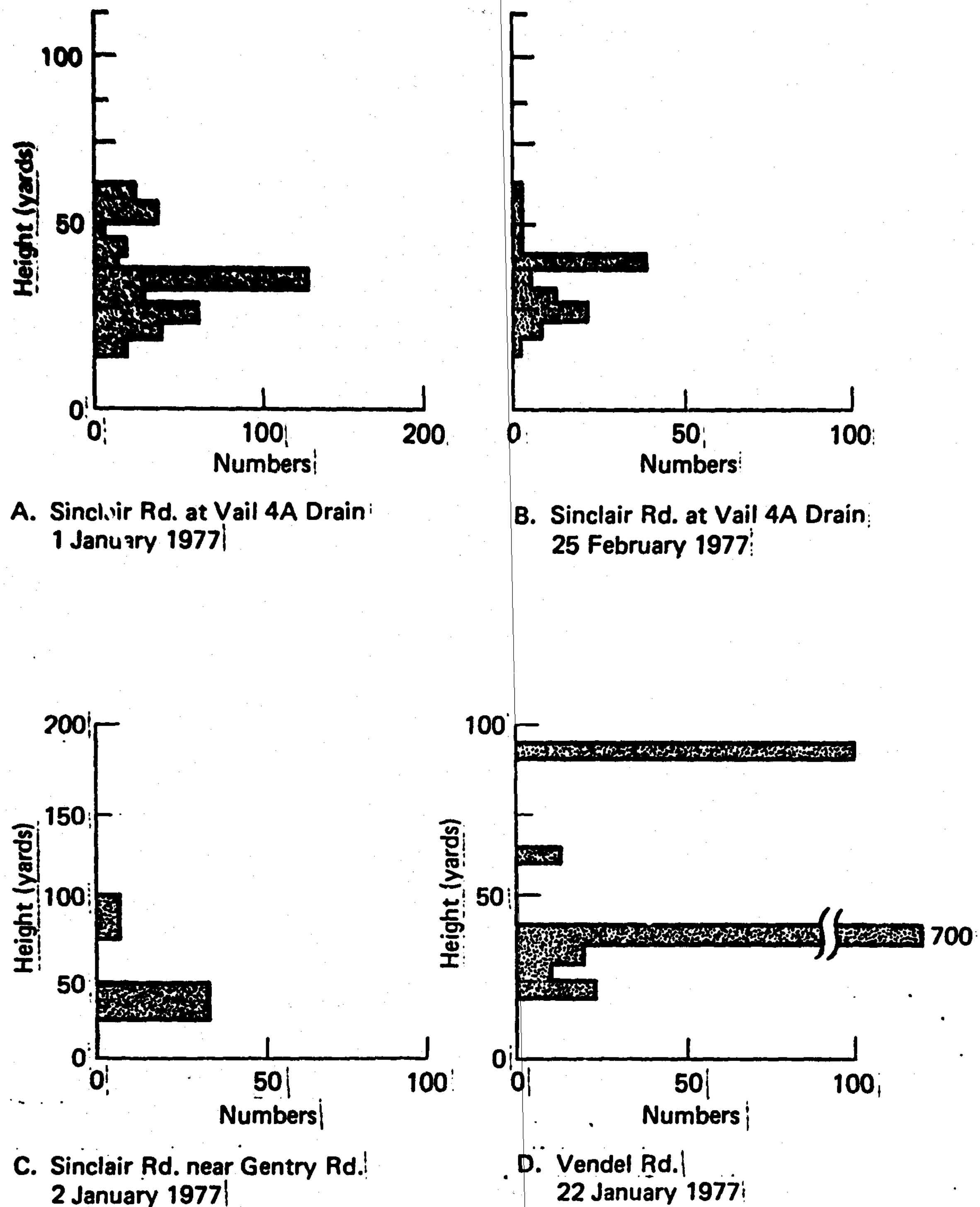


Figure 14. Altitudinal distribution of Canada geese during short flights.

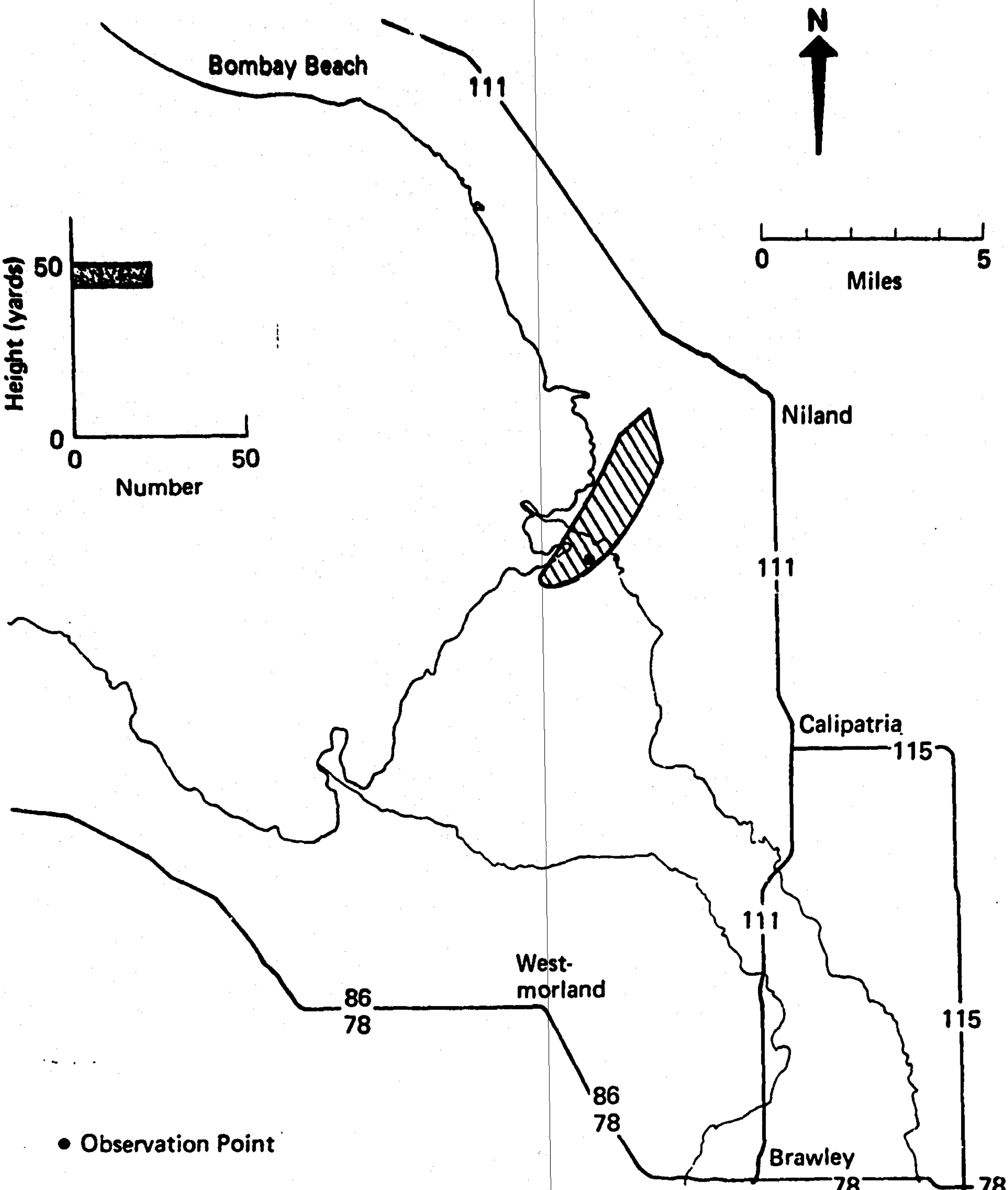


Figure 15. Altitude distribution and flight path of snow geese on 17 December 1976.

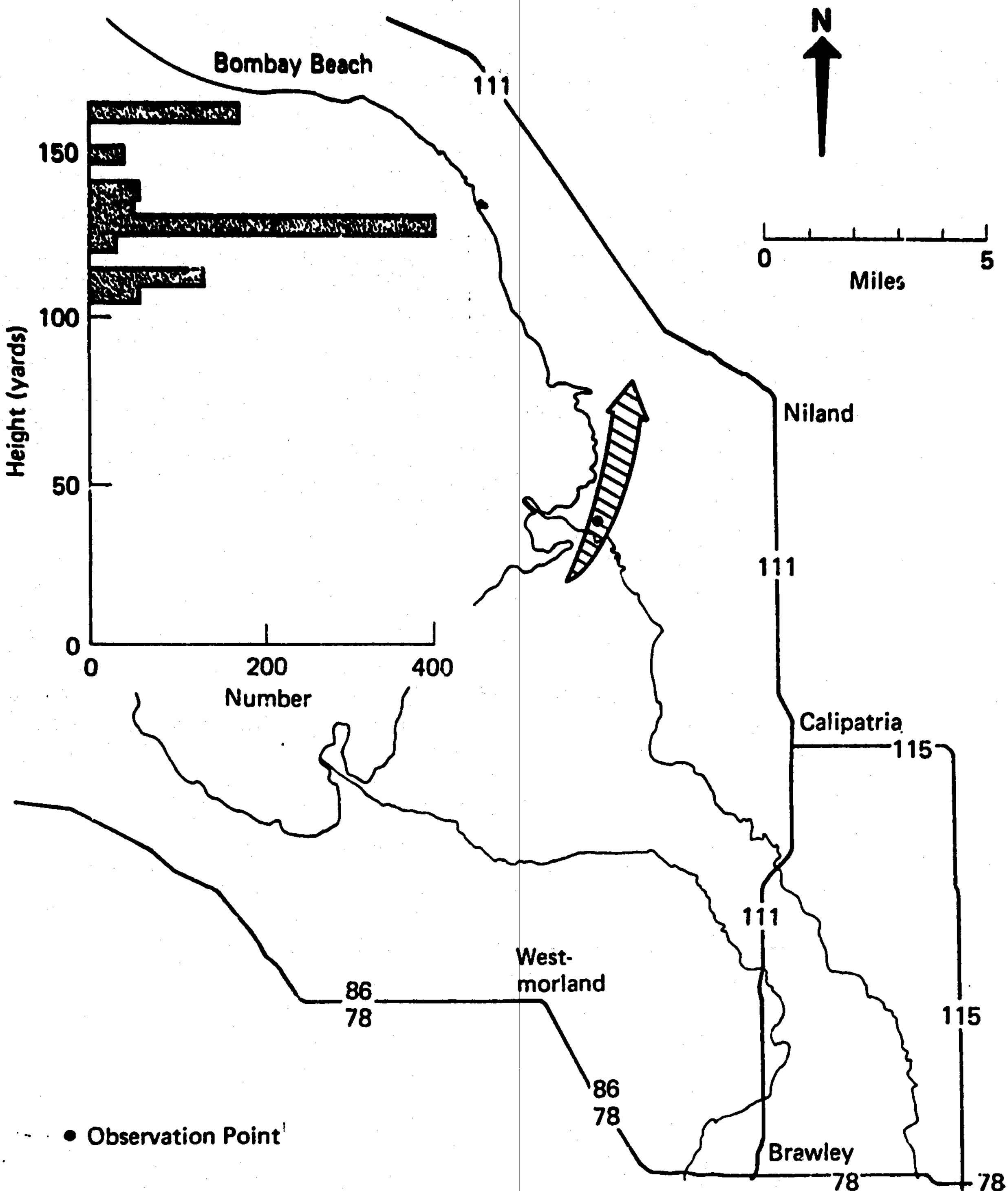


Figure 16. Altitude distribution and flight path of snow geese on 18 December 1976.

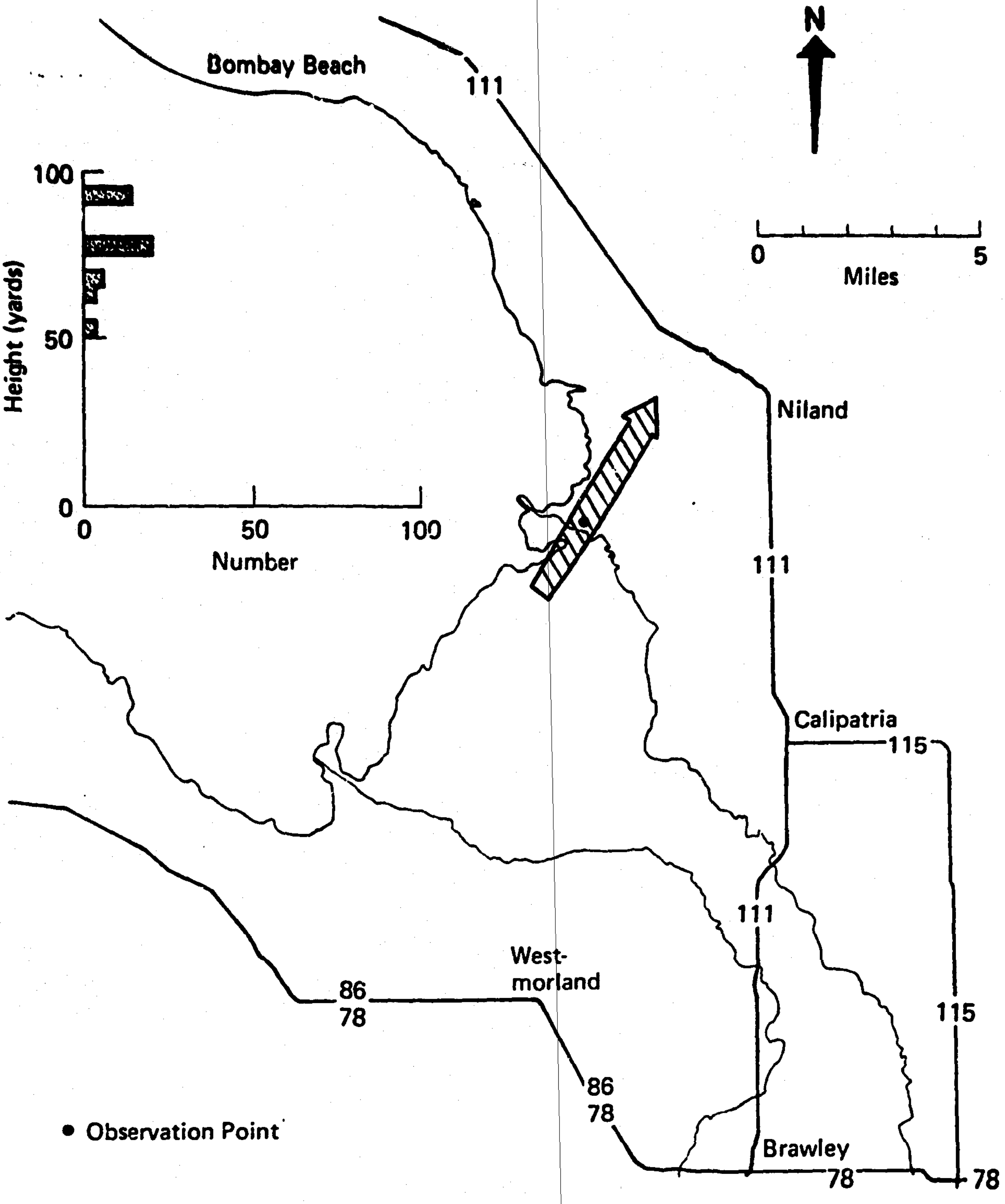


Figure 17. Altitude distribution and flight path of snow geese on 1 January 1977.

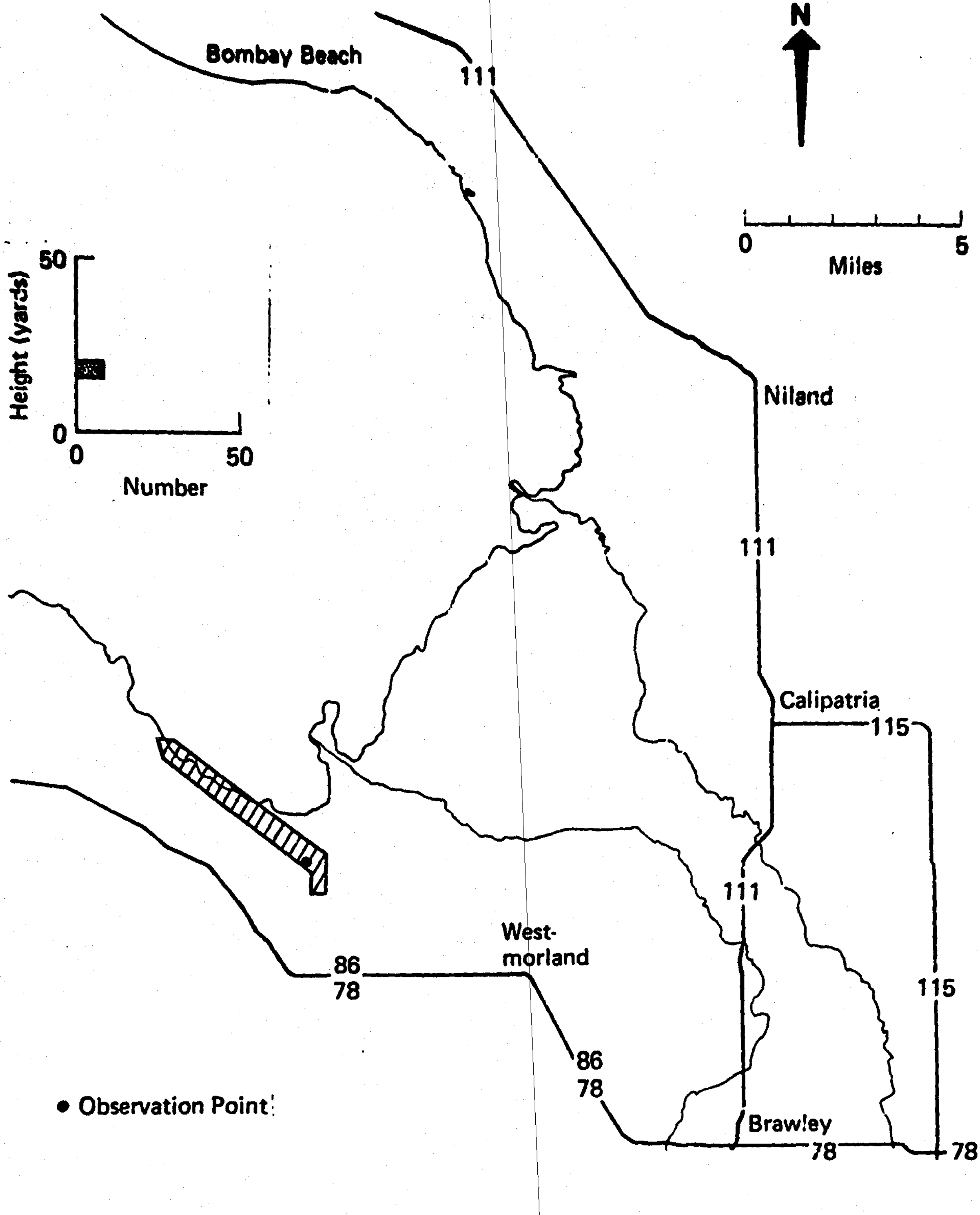


Figure 18. Altitude distribution and flight path of snow geese on 23 January 1977.

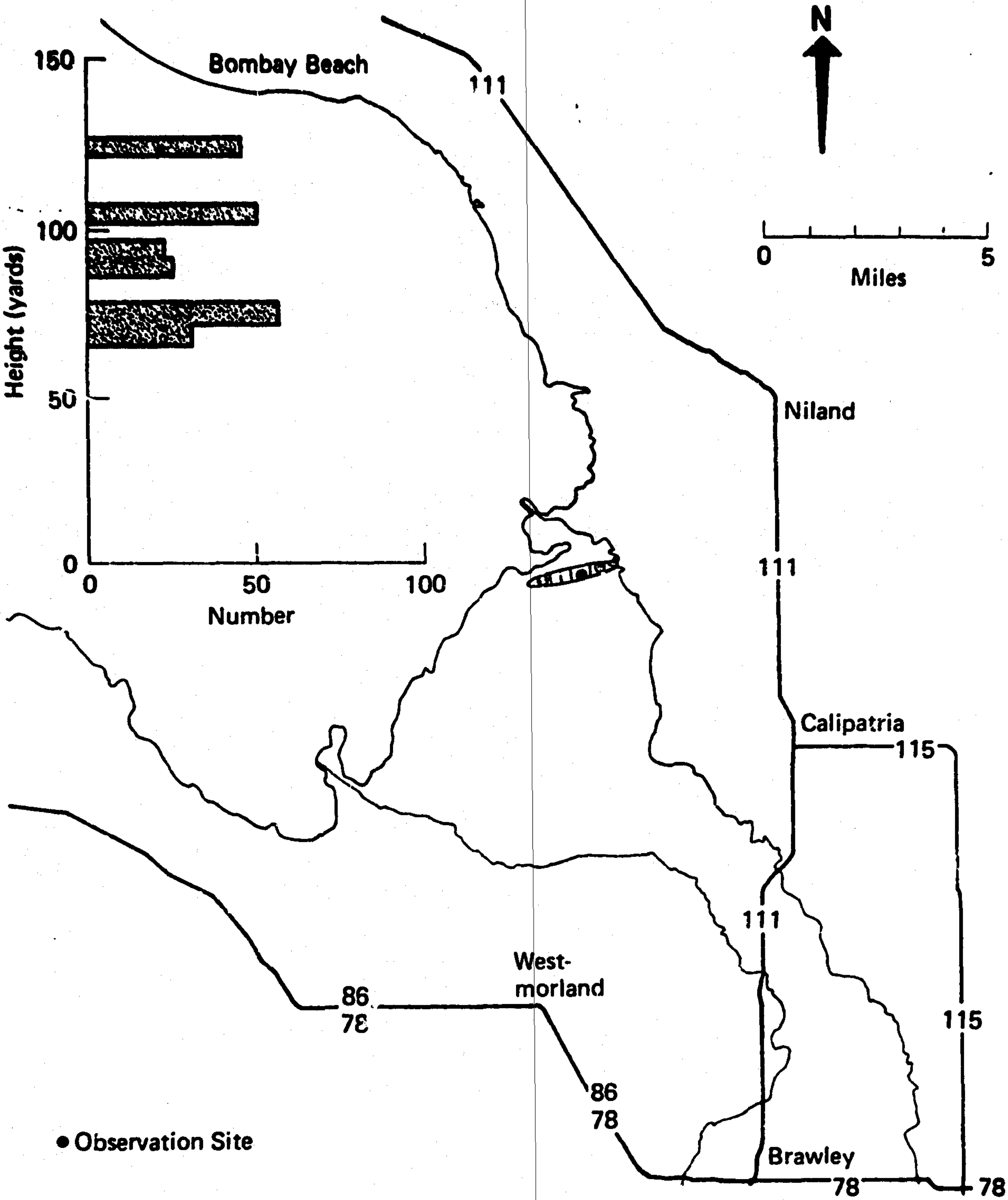
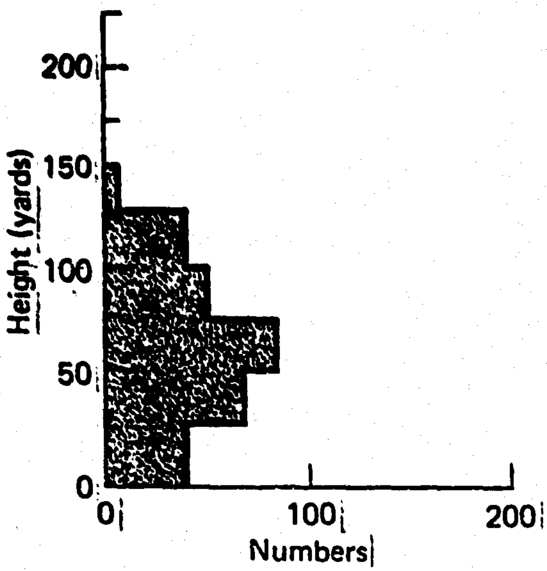
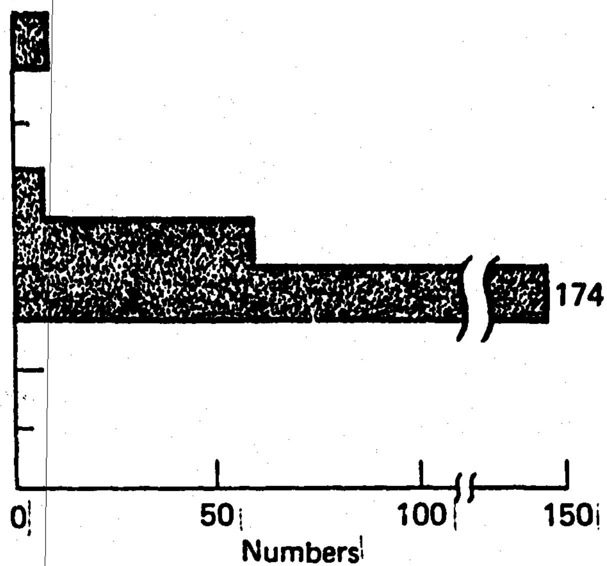


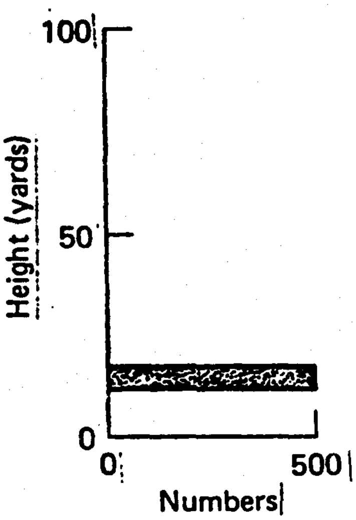
Figure 19. Altitudinal distribution of snow geese during local movement on 24 February 1977.



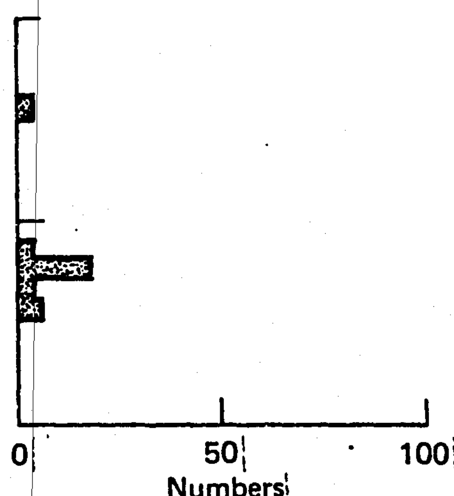
A. Sinclair Rd. near Gentry Rd.
2 January 1977



B. Garst Rd. at Alamo River
2 January 1977

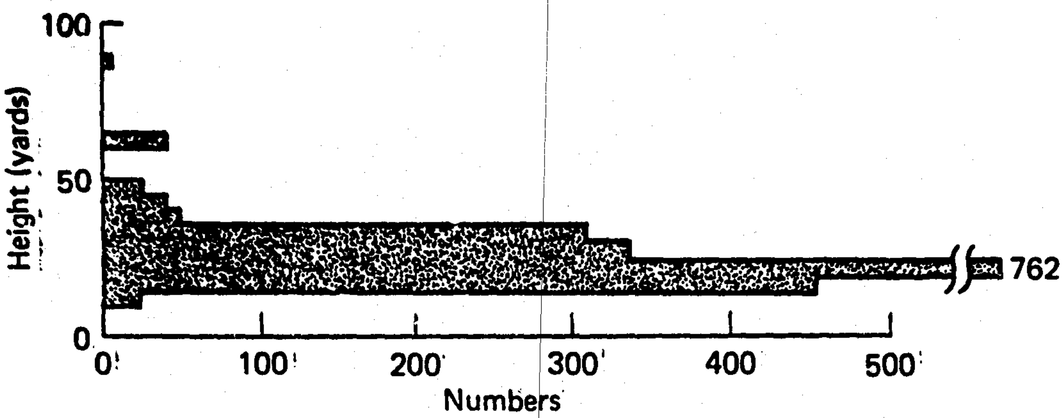


C. Beach Rd. near Davis Rd.
17 December 1976

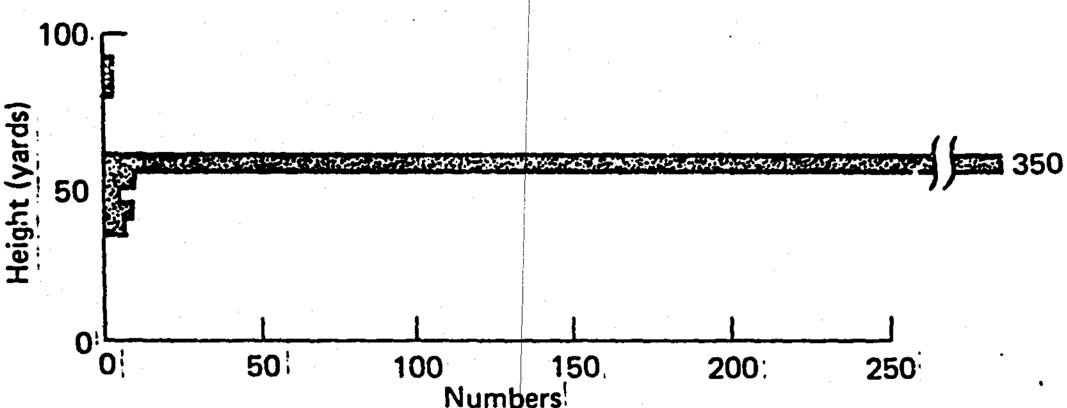


D. Vendel Road
22 January 1977

Figure 20. Altitudinal distribution of snow geese during short flights.



A. Altitudinal distribution of snow geese moving across Sinclair Road as observed from intersection with Vail 4A Drain 1 January 1977



B. Altitudinal distribution of snow geese moving across Sinclair Road, as observed from intersection with Vail 4A Drain 25 February 1977.

Figure 21

DISCUSSION

Geothermal Development in the Study Area

The area in which the present observations on bird flight patterns were carried out is estimated to contain over two-thirds of the total electrical generating potential available from Imperial Valley geothermal resources (3). A number of geothermal wells have been drilled within two miles of Salton Sea in the vicinity of the Headquarters Unit (SSNWR). The very hot, highly saline brines produced from these wells can cause corrosion and scaling, which have thus far discouraged commercial development of this field. However, San Diego Gas & Electric Company and the U.S. Department of Energy have been operating a Geothermal Loop Experimental Facility near Niland for over one year to test the feasibility of electric generation using a binary power cycle. Recent exploratory drilling has also discovered a new geothermal reservoir near the South Unit (SSNWR) in the area where New River enters the Salton Sea. In addition, several geothermal wells with commercial potential have been drilled to the north of the city of Brawley in the vicinity of the Finney-Ramer Unit (Imperial Wildlife Area). In view of this current interest and activity, it is reasonable to assume that several 50-100 MW_e generating facilities will be constructed in the northern Imperial Valley/Salton Sea area during the next decade.

Transmission Lines and Flight Corridors

New high voltage transmission lines will carry electricity from these geothermal power plants to join the regional grid. In order to evaluate the potential for significant effects of these transmission lines on bird populations, it is necessary to consider their probable sizes and configurations as well as the flight patterns of the birds.

Distribution centers located at or near the power plants will step up voltage to 138-kV for long distance transmission. An additional voltage increase to 230-kV will be necessary at some point in the system as well. The general design and dimensions of 138-kV and 230-kV transmission lines are quite similar. Conductors are supported by steel lattice towers with a probable height of 36.6 m (40 yds). Spans between towers average 366 m (400 yds), with about 4.5 towers/1.6 km (mile). The minimum line clearance is 9.2 m (10 yds) and the maximum about 30.5 m (33.3 yds). Thus, birds flying at altitudes of 36.6 m (40 yds) or below would be at risk of collision with towers or conductors.

Major flight corridors as documented in this study generally parallel the southern margins of Salton Sea, extending out over the open water and inland for 0.8 - 1.6 km (0.5 - 1.0 mile). Many flocks of birds also follow the New and Alamo Rivers at relatively low elevations. Finally, feeding flights often originate at the wildlife management areas along the shoreline and move inland for 3.6 - 5.4 km (2-3 miles). It is obvious that the most effective mitigation is the avoidance of these flight paths when siting transmission lines. However, this is not always possible for a variety of reasons, both economic and environmental. A detailed analysis of the probability of serious transmission line effects can be carried out for the various flight corridors by taking account of the behavior and ecology of the bird species which use them.

Shoreline Flight Corridors

The large flocks of white pelicans which follow the shoreline between the South Unit (SSNWR) and Wister Unit (Imperial Wildlife Area) should have little opportunity to encounter transmission lines. Their flight path is usually over the waters of the Salton Sea and typical altitudes are well above the heights of transmission line towers or conductors. Normal foraging flight is at much lower altitudes, but always over open water.

Pintails often follow the shoreline flight path in moving between wildlife management areas, but commonly fly further inland than the pelicans. Nevertheless, there is little chance of collision with transmission lines because flight altitudes are usually above 91.4 m (100 yds). Snow geese typically fly somewhat lower along this corridor, but our observations indicate that they are rarely below 45.7 m (50 yds). Data on Canada geese are insufficient to evaluate the probability of collisions.

Flight Corridors Along Rivers

The cattle egret was the major species using the Alamo River as a flyway during this study. Although cattle egrets undertake their movements during daylight hours when visibility is good, they tend to fly low over the river valley and were often observed at altitudes well under 45.7 m (50 yds). High voltage transmission lines crossing rivers in the northern Imperial Valley might well constitute a hazard to this species. Other heron and egret species are not likely to be at risk because they typically concentrate most of their feeding activity near the Salton Sea and roost in trees along the shoreline.

Flight Corridors from Salton Sea to Feeding Areas

Ring-billed gulls carry out extensive flights to and from their roosting areas near the Salton Sea. Because they may forage at a variety of locations throughout the northern Imperial Valley, flight corridors are not well-defined. Flight altitudes as measured in this study were consistently above 45.7 m (50 yds), so that transmission lines should pose little dificulty for gulls away from the shoreline of the Salton Sea.

The most important species carrying out feeding flights from the Salton Sea into nearby agricultural lands are the snow and Canada geese. Flight corridors were not sharply delineated, since the flat topography allows flocks of geese to move out in almost any direction toward feeding areas. Most flights involved movements up to 0.8 km (0.5 mile) across roads to fields adjacent to wildlife management areas. Very little feeding activity occurred more than 3.2 km (2 miles) from resting areas near the Salton Sea. Flights of this kind are perhaps most susceptible to interaction with transmission lines because altitudes are often well below 45.7 m (50 yds).

Potential Impacts of Transmission Lines

The siting of 138-kV or 230-kV transmission lines within 3.2 - 4.8 km (2-3 miles) of the Salton Sea or in the vicinity of the New or Alamo Rivers should take careful account of possible impacts on certain species of waterbirds. This study suggests that feeding flights of cattle egrets and geese commonly take place at altitudes low enough to encounter transmission line towers or conductors. Flights that we have observed generally occurred when visibility was good and flying birds would have had an opportunity to see and avoid obstacles. Adverse weather conditions such as rain, wind, and fog could make avoidance of transmission lines more difficult and increase the probability of collisions. Bird behavior and flight patterns may also change under such conditions, leading to lower flight altitudes or use of alternate corridors, which could also increase the hazard from transmission lines. Episodes of inclement weather occur rarely in the

Imperial Valley, so that we have had little chance to verify these predictions or to document any alteration of flight patterns.

Direct mortality from collisions is obviously a source of concern, but certain alignments of transmission corridors may have other, more subtle, effects. Particularly where flocks of geese undertake short flights to feed in nearby fields, the construction of a transmission line across a flight path could discourage or greatly reduce usage of that area. Waterfowl hunting is an important recreational activity in the Salton Sea area and hunting success could be significantly impaired by certain transmission line routings. Duck clubs have been long established near most of the wildlife management areas. Construction of transmission lines near duck club properties could reduce the access of geese to their ponds and feeding areas. Public hunting in management areas and along roads could also be affected. Waterfowl might avoid prime hunting locations, fly at higher altitudes to clear transmission lines, or use steeper angles of ascent and descent.

Additional Studies

Additional data on waterbird flight patterns are being collected during the period from October 1977 - March 1978. This effort should provide more reliable and detailed information on flight corridors identified during the present study and should help to clarify the influence of weather conditions and hunting activity on bird flight behavior. A final report incorporating the results of the full investigation will be issued during the second half of 1978.

ACKNOWLEDGEMENTS

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APPENDIX A

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ON

INTERACTIONS BETWEEN BIRDS AND

ELECTRIC TRANSMISSION LINES

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