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PRELIMINARY REPORT

THE STATUS OF THE BROWN PELICAN IN THE U.S.V.I.

1980-1981

TUNDI AGARDY TMA

DIVISION OF FISH AND WILDLIFE

STATUS OF THE BROWN PELICAN IN THE VIRGIN ISLANDS

Although the U.S. Virgin Islands supports a relatively large and stable population of Brown Pelicans (Pelecanus occidentalis occidentalis L. 1766), few data have been recorded on the nominate race. Schreiber (1978) described a colony on the island of Vieques, 18 miles southwest of the Virgin Islands, and at present studies are being conducted on colonies of greater Puerto Rico. In the Virgin Islands incidental information has been collected as to the size and location of breeding colonies. Division of Fish and Wildlife records indicate that nesting sites were once more widespread than at present, and included rookeries on the main islands which are no longer in existence. Within the last decade, however, breeding colonies in the U.S. Virgin Islands have been confined to five well-established sites: Dutchcap and Congo Cays, St. Thomas; Mary Point and Whistling Cay, St. John; and Buck Island, St. Croix. A sixth possible breeding colony was reported in May 1981 on the northwest shore of St. Croix (Hams Bluff), but has not been investigated.

In the Virgin Islands pelicans breed throughout the year, although historical information indicates a peak in breeding occurs in the late fall, generally from October through December (DFW field records). Aerial censuses were conducted throughout the year to confirm these preliminary findings and intensive studies on breeding biology were conducted at specific study sites throughout the peak period.

Study Sites

The five established and currently utilized breeding localities for Brown Pelicans in the Virgin Islands are all relatively inaccessible to normal human disturbance. Four colonies are on remote offshore cays and the fifth is in a remote area of the National Park on St. John. Figure 1 shows a map of the Virgin Islands indicating the five colony sites. The habitats in each colony vary in terms of topography, and predominant vegetation will, therefore, be described separately.

Congo Cay is the site of the largest breeding colony of Brown Pelicans in the Virgin Islands. The cay is approximately 25 acres in size and is located approximately two miles off the east end of St. Thomas. A rocky shoreline gives way to steep cliffs and shrub-covered banks on both the north and south sides of the island, making landing and climbing up to the nest sites difficult. Vegetation on the island is varied, but consists primarily of a dense canopy of Guapina fragrans and Ficus citrifolia trees covering the central plateau with Coccothrinax argentea, especially prominent along the north ridge. (A complete listing of plant species is included in Appendix A.) A trail marked with blaze orange flagging tape was designed to include vantage points on nearly all of the subcolonies and traverses the length of the island (Figure 2).

Dutchcap Cay, located approximately one-half mile northwest of St. Thomas, supports the second largest colony of Brown Pelicans in the Virgin Islands. It is approximately 32 acres in area. Steep rock cliffs make up the periphery of this cay and occasional northerly swells make landing similarly difficult. Scrub brush dominate the island but a stand of isolated Guapira fragrans trees mark the cove and northern slope of the island. The vegetation of the western slope is dense with heavy underbrush and proliferation of Opuntia rubescens.

Whistling Cay and Mary Point, St. John, are in close proximity to one another (Figure 4) and are similar in physical characteristics. The section of shoreline on Mary Point where pelicans breed is approximately one mile in length, and slopes sharply from rocky shoreline to an east-west running ridge. Large trees cover the hillside and include Burcera simarouba, Guapira fragrans, Ficus citrifolia and Coccoltrinx argentea. The northern portion of Whistling Cay, located approximately one-fourth mile to the west of Mary Point, also includes these same tree species. Here the rocky shore gives way to an even more precipitous slope. Censusing of both these colonies is more easily made by boat or airplane than on foot, due to the height above slope of most nests.

Buck Island, St. Croix, situated in the Virgin Islands National Park, has thus far remained undeveloped. The island is 147 acres. Nesting occurs on the eastern portion of the north-facing slope in vine-covered trees and woody shrubs approximately three to seven meters above ground. Figure 5 shows the breeding area on Buck Island.

Methods

Estimates of population numbers of Brown Pelicans were derived from quarterly aerial censuses. A single-engine Cessna was used at an approximate speed of 240 kph and approximate altitude of 180 meters. The aerial transects covering five of the known breeding colonies are plotted in Figure 6. Estimates of colony size were made by visual counts of nest cups and unfledged chicks. The visual cues used to discern nest cups included the ring of nest material and often the presence of the incubating parent. A preliminary field trial using enlarged aerial photographs to count active pelican nests proved to be an ineffective censusing technique and was discontinued.

Monitoring of Colonies

The four major colonies around St. Thomas and St. John were censused approximately once every two weeks: by foot when favorable sea conditions permitted landing on shore or by boat when seas were too rough. Boat censuses allowed the counting of adult birds presumed to be incubating (indicated by lowered sitting position and neck plumage) and either fledgling and prefledgling young. (An 18' boat with 135 hp outboard engine was used for the censuses, and was driven approximately 200 meters from the shoreline.) Surveys made on foot were more intensive and permitted investigation of nest contents (ground truthing). Where nests were not accessible for visual inspection, a telescoping 10m pole with a mirror affixed to the top was used.

On each visit to a colony, whether for purposes of banding or censusing, notes were taken on evidence of food choice, disturbance, and mortality. Although not encouraged to do so, captured or startled chicks sometimes regurgitated their food. In these cases fish species, approximate size, weight and abundance were recorded. Numbers of inviable or cracked eggs, dead or moribund hatchlings, nestlings, and dead adults were recorded, including causes of mortality when obvious. Disturbance by researchers was kept at a minimum by limiting the number of researchers in a colony, restricting access to the colonies during mid-day and during rainy or unusually cool weather, and by limiting noise.

Inter-Island Banding

In addition to regular monitoring of the breeding colonies, prefledgling young were banded and wing-tagged for long-term studies on inter-island movement. (Banding was done under Federal Permit #20218A.) Young approximately ten weeks old were banded with Fish and Wildlife Service aluminum bands on the right leg and green plastic clasp bands with alphanumeric codes on the left leg. A corresponding green plastic wing tag was used to facilitate visual identification from a distance. All "recaptures" were done by visual identification only, and the public was encouraged to report sightings of tagged birds to the Division of Fish and Wildlife.

Results and Discussion

A. Population Dynamics

I. Fluctuations in the Overall Virgin Islands Population

It is difficult to ascertain whether the Virgin Islands breeding population of Brown Pelicans has undergone any major changes since historical information is fragmentary. Division censuses in the last five years (Figure 7) indicate yearly variations in numbers of nesting birds on some offshore cays; however, no attempt was made to census the entire population of Brown Pelicans in the Virgin Islands.

Data is available on individual colonies (DFW field records). Figure 7 shows late spring/early summer censuses of Buck Island conducted by boat during the period of 1975-1981. The fluctuations give only an estimate of population stability since methodological variables may have existed. Furthermore, the surveys were not made during the same month each year.

Boat censuses of Congo Cay during the month of December in 1977, 1978, 1979 and 1980 indicate that total nest numbers may have risen. Again, this is open to speculation since the techniques for censusing were not described.

Division records show that the colony at Mary Point has dwindled since 1977, and incidental records of National Park Service biologists support the claim (DFW and NPS field notes). However, the number of nesting birds on Whistling Cay appears to have risen, suggesting that Whistling Cay is an extension of the Mary Point colony. Since tagging studies have not been attempted in the past this cannot be positively established.

The results of a survey of Dutchcap made in September 1977 by Division biologists is comparable to a survey made during the present study period. Comparing total nests appears to indicate that the number of breeding pairs has increased (137 nests in September 1977 compared to 195 in September 1980); however, field notes indicate that the 1977 census may have been incomplete.

Whether population fluctuations in the form of changes in numbers of breeding birds in any given colony are the result of changes in the entire Virgin Islands population, or are merely a result of inter-colonial movement, cannot be ascertained. It would be premature to derive conclusions from the tagging studies undertaken during 1980-1981 since banded young will not reach maturity for yet another two years. However, sighting reports indicate that dispersion is widespread and occurs almost immediately after fledgling. Band returns and resightings will also yield information as to the return of birds to their birth sites for breeding and renesting.

II. Seasonal Fluctuations in Specific Colonies

Data gathered during this study period indicates that different breeding colonies have seasonal peaks at various times of the year. Some colonies are more seasonal than others. For instance, the Mary Point and Whistling Cay colonies seem to be limited to breeding during the winter months, whereas nesting on Congo Cay occurs throughout the year. Peaks, indicated by number of active nests, are listed by colony.

Congo Cay, St. Thomas	September/October
Dutchcap Cay, St. Thomas	December/January
Mary Point, St. John	November/December
Whistling Cay, St. John	September/October
Buck Island, St. Croix	June/July

An interesting phenomenon occurs on Congo Cay which should be noted. During the fall/winter breeding, subcolonies on Congo are located primarily on the north and central ridges. However, with the spring/summer breeding, nesting is almost entirely abandoned on the north side and occurs predominately on the south side. The reasons for this regular change are not known. It has been suggested (Boulon, personal communication) that the sun's destination and the movement of birds to the shadier side of the island may affect breeding locality. Division records indicate the same alteration of nesting activity in past years.

Synchrony of breeding peaks among cays is not apparent. However, the timing of a small group of nesting birds in a well-defined subcolony is synchronous. Two or more nests in the same tree, for example, are rarely more than a few days apart in life stage, though a group of nests nearby are frequently at different stages.

B. Reproductive Biology

I. Parameters of Reproductive Success

The monitoring of the Congo Island colony has yielded complete history on 108 nests during the period of September 1980 to March 1981. Data indicate an average clutch size of 2.73 eggs per nest, with a reproductive success rate of 1.22 fledglings per breeding pair. Eggs measured from a representative subsample show that the average egg has a length of 71.7mm ($s = 4.28$) and a width of 45.8 ($s = 1.7$). The range of sizes from the subsample is 64.1 x 44.1mm to 77.1 x 47.2mm.

Reproductive success of a given breeding group varies markedly. Pelicans nesting on Congo Cay show variations in clutch size, mortality at different life stages, and realized reproductive potential. A graph of egg laying dates for the Congo colony shows a bimodal distribution of nesting, making the subdivision of early (September 1 - November 30) and late (December 1 - March 30) nesting clear (Figure 8). Early nesting birds had a significantly higher reproductive success compared to late nesting birds (analysis of variance $p < 0.001$) (see Table 1). A review of avian literature as cited by Perrins (1970) indicated that young hatched early in the season had greater survivorship; however, the Congo reproductive success may be more of a function of a higher fecundity during the first breeding period. Clutch size during this initial peak was 2.85 eggs/nest, as compared to 2.65 eggs/nest later in the season. However, reproductive potential for the early and late periods are of similar values at 44% and 46% success to fledgling, respectively.

Mortality at various life stages of the young indicate seasonal variation as well. Egg failure is higher in the later period. This factor together with the smaller clutch size may account for decreased reproductive success in birds nesting later. Table 2 gives a summary of parameters affecting reproductive success as related to season.

Reproductive success varies with each subcolony; that is, between synchronously nesting birds in the same locality. On Congo Cay, 21 distinct breeding aggregations (subcolonies) were identified and monitored (Figure 2). Success levels among groups varied significantly (analysis of variance $p < .05$). However, there appears to be no correlation between subcolony reproductive success and seasonality. Total subgroup reproductive success is plotted according to date of first laying for each of the 21 subgroups in Figure 9.

Although the level of monitoring effort done at the Dutchcap breeding site was minimal, comparisons of reproductive parameters may be made between the pelicans nesting there and those on Congo. Table 3 gives fecundity and success figures of the two colonies.

Table 3:

<u>Colony</u>	<u>N</u>	<u>Av. Clutch Size</u>	<u>Av. Fledged/Nest</u>
Dutchcap	53	2.66	1.62
Congo	109	2.7	1.21

Average clutch sizes are shown to be comparable at the two colonies. However, the higher overall productivity at Dutchcap indicates that nest success is greater on that island. Furthermore, since the values for the average number of chicks/nest are similar for both sites, it can be inferred that nestling mortality is greater on Congo, and thus leads to a lowered reproductive success.

An attempt was made to correlate nest success with certain features of the habitat, specifically the tree species on which the nest was located (see Appendix I) and the height of the nest from the ground. On Congo and Dutchcap Cays, the predominant species in which pelicans nest are Ficus citrofolia, Burcera simarouba, Capparis flexuosa and Stignaphyllon periplocifolius. Nesting occurs in elevations from zero (ground nesting) to 7m above the ground. No relationship can be found between tree species or nest height and reproductive success, however.

C. Mortality Factors

Offspring mortality can be attributed to several factors in the Brown Pelican, although many of these necessarily escape the attention of the field observer. Natural predators on avian eggs and young in the Virgin Islands include seabirds such as the frigate bird and laughing gull; raptors such as the red-tailed hawk and peregrine falcon; snakes including the Alsophis snake; and rats, land crabs, hermit crabs and ants. Of these possible predators, frigate birds and hawks are the most likely to affect pelican nest success, and the incidents of such predation are probably minimal. No instances of predation on Brown Pelican offspring have been witnessed in the research areas.

Starvation is likely to be the single most important mortality factor affecting young pelicans. This is supported by the high percentage of mortality experienced by one- to ten-day-old hatchlings, especially when food is sought by two other siblings. Survivorship increases as a function of age, and the mortality rate sharply decreases after the first three weeks of age (see Figure 10). Starvation has not been proven as a cause of death in any recovered carcasses, but inspection of dead young often yield no other signs of mortality.

The survivorship curve of Brown Pelican young with time agrees closely with curves of most species. When graphed, percent survivorship from egg (day zero) to fledging (day 115 or 87 days posthatching) follows a predictable curve, diminishing sharply with time (see Figure 11). As expected, mortality is highest during egg and hatchling stages, and falls off significantly in later stages.

Egg loss is a major factor in pelican mortality. During the course of this investigation, several instances were observed when a parent knocked or rolled one or more eggs from the nest on takeoff or landing. Chicks were also seen to fall out of the nest, pushed out by larger siblings or inadvertently by the adult. In one case the larger of two mid-downing chicks (approximately 30 days old) was seen snapping its bill at its smaller sibling, until the younger chick was pushed out of the nest and was strangled by the branches it fell through.

Sibling competition for food is a common feature in pelicans as in all avian young, and very often the last chick to hatch in a two or three egg clutch dies within a few days from neglect. Size differences in a family of young birds are often exaggerated due to the imbalanced treatment afforded them by the parents. Within two weeks, one chick is often nearly twice the size of its siblings, and its vivacity will generally guarantee that it will acquire most of the food coming to the nest. Whether parent birds actually deliberately evict weak or undersized young from the nest cannot be determined, but young are commonly seen hanging from branches or vines or on the ground near the nest.

D. Plumage of Adults

Breeding Brown Pelicans assume a plumage pattern during nest building activity which is retained at least until the young fledge. The normal yellow-necked, white-crested color scheme of the nonbreeding adult is replaced by a rust-colored neck. Although some yellow-necked birds have been seen carrying nesting material, none were observed to breed during the course of this study.

Immature birds have a dull brown plumage covering the entire head and body. A few such birds attempted nesting, but only one raised a chick to the late downy stage. All others suffered egg failure. Immature Brown Pelicans have dull brown plumage covering the entire head and back of the body, with white undersides which remain throughout the nesting stage (Schreiber, 1976). The birds become sexually mature at approximately three years of age (Schreiber, 1971), and assume the adult plumage pattern at that time. A few brown-backed pelicans were observed to attempt nesting in the colonies, but only one nursed a chick to late downy stage. All others suffered egg failure. Blus and Keahey (1978) also observed lower reproductive success in breeding birds with immature plumage.

E. Food Choice and Availability

Recovery of food samples regurgitated by adults and young indicate that three major species constitute the diet of the Brown Pelican in the Virgin Islands. These include the blue fry, Anchoa lyolepis; white fry, Venkinsia lamprotaenia; and sprat, Harengula clupei. In one instance a butterflyfish, Cephalpholis fulva, was recovered from an adult pelican.

F. Movement

Analysis of banded pelican observations indicates that dispersion occurs almost immediately after fledging. In several instances, birds banded at 12 weeks of age on Dutchcap Cay were seen within a month's time at Dorado Beach, Puerto Rico, some 50 miles to the west. Movement patterns of banded pelicans in this study are being investigated and will be reported elsewhere. Schreiber and Williams (1973) Schreiber (1976B) also reported that the majority of Brown Pelican young move away from the natal colony during the first months following fledglings.

V. NOTES OF HUMAN DISTURBANCE AND MANAGEMENT RECOMMENDATIONS

As in all field research, one must weigh the cost of possible threats to species under investigation against the benefits derived from understanding its population dynamics. The paradox is especially pronounced in the study of endangered species when the organisms are often particularly sensitive to disturbance, yet when the formulation of effective management, possible only after research has been undertaken, is of necessity. Schreiber (1979) stresses human disturbance factors in his monograph, indicating that egg loss and death of young can occur through adult abandonment of nests, egg breakage, and shaking of eggs induced through disturbance during visits to the colony. The effects of research activities performed in this investigation cannot be accurately ascertained, although several instances of egg loss were observed which may have been caused by an adult's reactions to the biologists. During the course of the study, however, the utmost precaution was taken to avoid any disturbance. Colonies were visited early in the morning to avoid heat stress on unprotected young; nesting birds were approached slowly and given advance warning of approach; and any eggs or chicks found on the ground were replaced in the nest. Since nest success decreased as the investigation continued it may be argued that repetitive disturbance had an impact on the reproductive biology. However, productivity levels were comparable to levels found in other populations studied (Blus and Keahey, 1978; Meandenhall and Prowdy, 1978; Nesbit, et al., 1977; Schreiber and Riseborough, 1977; and Schreiber, 1979).

Although the average reproductive rate of the Brown Pelicans studied is relatively high as compared to data obtained in the Florida (Schreiber, 1979); South Carolina (Blus, et al., 1977); and Mexico (Keith, 1978), nest success for Pelecanus occidentalis occidentalis was found to vary significantly according to season and nest site selection. A theoretical recruitment standard for the maintenance of the Brown Pelican population remains in dispute. For example, Henry's (1972) calculation of 1.51 to 1.87 young per breeding pair was considered too high by Schreiber (1972). Most Brown Pelican populations would be considered subnormal if this standard was applied. Certainly, more important than the search for a theoretical standard is continued investigation of factors affecting reproductive success and mortality of Brown Pelican subspecific stock.

Standard predictions made possible by the mortality and survivorship data sheds light on long-term population trends. The data were fit to the power curve $y = ax^b$ where: y is the number of young surviving to age x , x is the age of young, and a and b are regression coefficients. This extrapolation of the survivorship data shows that the population level of the Brown Pelican in the Virgin Islands is decreasing: in a three-year project only 25% survival of young to breeding age would be expected. However, this prediction does not take into account variability in reproductive success rates according to season, year or locality, and assumes a single reproductive effort per breeding female.

The natural fluctuations in nesting success of the Brown Pelican emphasize the need for a long-term study on the reproductive performance of the species. Seasonal variations in productivity for particular colonies, comparisons of reproductive potential and success of different colonies must be studied over the course of several years. The stability of the local population of Brown Pelicans in the Virgin Islands cannot be determined until long-term trends are investigated.

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Table 1. Seasonal variation in factors affecting reproductive success of Brown Pelicans nesting on Congo Cay

Time Period	Number of Nests	Total # Eggs	Clutch Size (Eggs/Nest)	Total # Fledged	Reproductive Success (Fledglings/Nest)
Sept. 1, 1980 - Nov. 30, 1980	46	131	2.85	73	1.59
Dec. 1, 1980 - Mar. 30, 1981	62	164	2.65	59	0.95
TOTAL Sept. 1, 1980 - Mar. 30, 1981	108	295	2.73	132	1.22

Table 2. Seasonal variation in mortality factors affecting Brown Pelican young on Congo Cay

Time Period	Number of Nests	Egg Failure	Hatchling Failure	Downy Chick Failure	Unknown
Sept. 1, 1980 - Nov. 30, 1980	46	9 (16%)	23 (40%)	20 (34%)	6 (10%)
Dec. 1, 1980 - Mar. 30, 1981	62	23 (22%)	36 (34%)	46 (44%)	
TOTAL Sept. 1, 1980 - Mar. 30, 1981	108	32 (20%)	59 (36%)	66 (40%)	6 (4%)

LIST OF FIGURES

1. The U.S. Virgin Islands showing the five Brown Pelican breeding sites.
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8. Seasonality of Brown Pelican nesting on Congo Cay.
9. Percent successful nests in each subcolony at Congo Cay.
10. Mortality as a function of age in Brown Pelican young.
11. Survivorship of Brown Pelican offspring with age.

APPENDIX I

CONGO CAY

1. Coccotrinax argentea (O.F. Cook) Beccari
2. Hyperbainia laurifolia (Poir) Urban
3. Croton rigidus (Muell. Arg.) Britton
4. Securinega acidoton (L.) Fawcett
5. Pisonnia frigans = Torronbic
6. Guapira fragrans (Dum-Cours) Little*
7. Commicarpus scanding(L) Standley
8. Capparis cynophallophora L.*
9. Capparis flexuosa (L.)*
10. Stigmaphyllon periplocifolius (Desf.) A. Juss.*
11. Bursera simarouba (L) Sarg.*
12. Turnera diffusa Willd
13. Mammillaria nivosa Link
14. Melocactus intortus (Mill) Urban
15. Opuntia rubescens Salm-Dyck
16. Canavalia maritima (Aubl.) Thou.
17. Paspalum laxum Lam.
18. Lantana involucrata L
19. Eragrostis ciliaris (L.) Link
20. Coccoloba unifera (L.) L.
21. Tragia volubilis L.
22. Cassine xylocarpa Vent
23. Schaefferia frutescens Jacq.
24. Serjania polyphylla (L) Radlk*
25. Krugiodendron ferreum (Vahl) Urban
26. Scaveola plumierii (L) Vahl.
27. Solanum persicifolium Dunal
28. Bignonia unguis L.
29. Citharexylum fruticosum L.
30. Pilea microphylla (L.) Liebm.
31. Ficus citrifolia P. Mill*
32. Cyperus planifolius L.C. Rich
33. Cissus trifoliata L.*
34. Plumeria alba L.
35. Sida acuta Burm f.
36. Galactia dubia D.C.
37. Passiflora suberosa L.*
38. Matelea maritima (Jacq.) Woods*
39. Pilosocereus royeri (L.) Byles & Rowley
40. Pappophorum pappiferum (Lam.) Kuntze
41. Eupatorium corymbosum
42. Setaria leiophylla (Nees) Kunth
43. Agave sisalana Perrine
44. Chloris ciliata Sw.
45. Ipomoea pescaprae R. Br.
46. Pethecellobium unguis - cati (L) Benth*

*Pelicans nest here.

DUTCHCAP CAY

1. Acacia macracantha Humb & Bonpl.
2. Commicarpus scandens (L.) Standley
3. Boerhaavea diffusa L.
4. Celtis iguanaea (Jacq.) Sarg.*
5. Erythroxylum rotundifolium Lunan*
6. Opuntia rubescens Salm-Dyck
7. Opuntia dillenii (Ker-Gawl) Haw
8. Melocactus intortus (Mill) Urban
9. Plumeria alba L.
10. Pilosocereus royeri (L.) Boyles & Rowley
11. Agave sisalana Perrine
12. Coccoloba unifera (L.) L.
13. Croton rigidus (Muell. Arg.) Britton
14. Securinega acidoton (L) Fawcett
15. Capparis cynophallophora L.*
16. Capparis flexouosa (L.) L*
17. Stigmaphyllon periplocifolium* (Desf.) A. Juss
18. Bursera simarouba (L) Sarg.*
19. Cyperus planifolius L.C. Rich
20. Guapira fragrans (Dum-Cours) Little*
21. Lantana involucrata L
22. Tragia volubilis L.
23. Solanum persicifolium Dunal
24. Pitcairnia angustifolia (Sw) Redoute
25. Bignoma unguis L.
26. Tillandsia utriculata L.
27. Chloris ciliata
28. Pithecellobium unguis - cati (L.) Benth*
29. Citharexylum fruticosum L.
30. Eragrostis ciliaris (L.) Link
31. Coccotrinax argentea (O.F. Cook) Beccari
32. Ficus citrifolia P. Mill*
33. Setaria leiophylla (Nees) Kunth

*Pelicans nest here.

FIGURE 1. THE U.S. VIRGIN ISLANDS SHOWING THE FIVE BROWN PELICAN BREEDING SITES
(SHOWN IN BLACK)

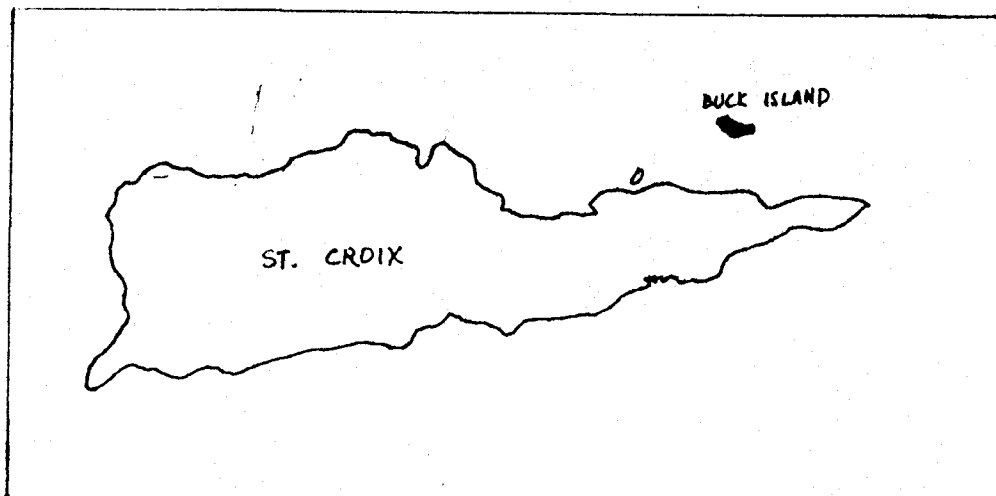
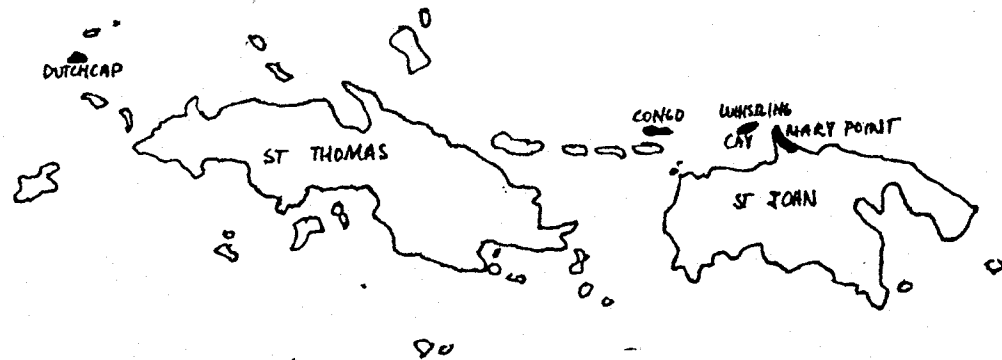
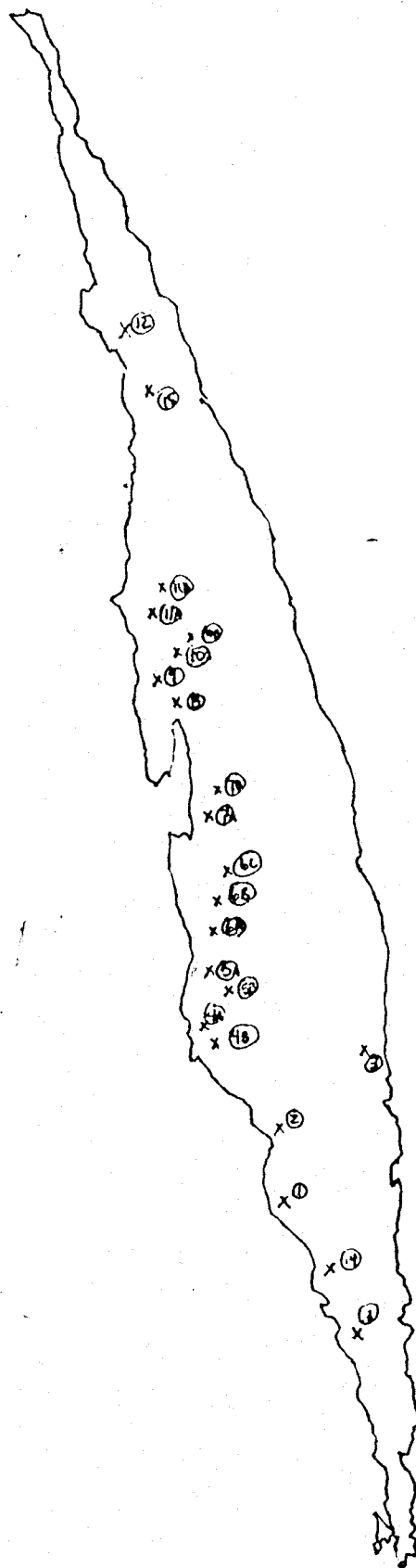


FIGURE 2.

CONGO CAY SHOWING PELICAN NESTING SITES



LEGEND

X MARKS SUBCOLONY SITES

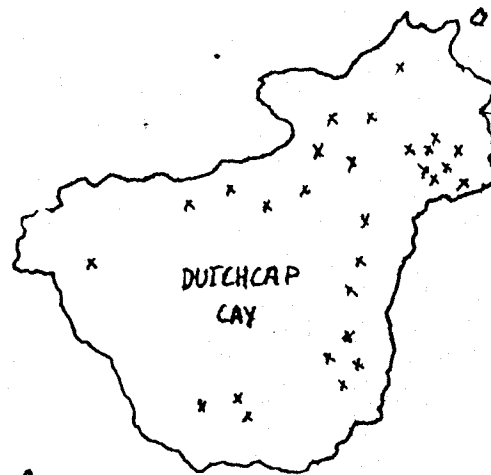
ⓧ REFERS TO SUBCOLONY
NUMBER

0 1
APPROXIMATE
SCALE (KM)

← N

FIGURE 3.

DUTCHCAP CAY SHOWING BROWN PELICAN NESTING SITES



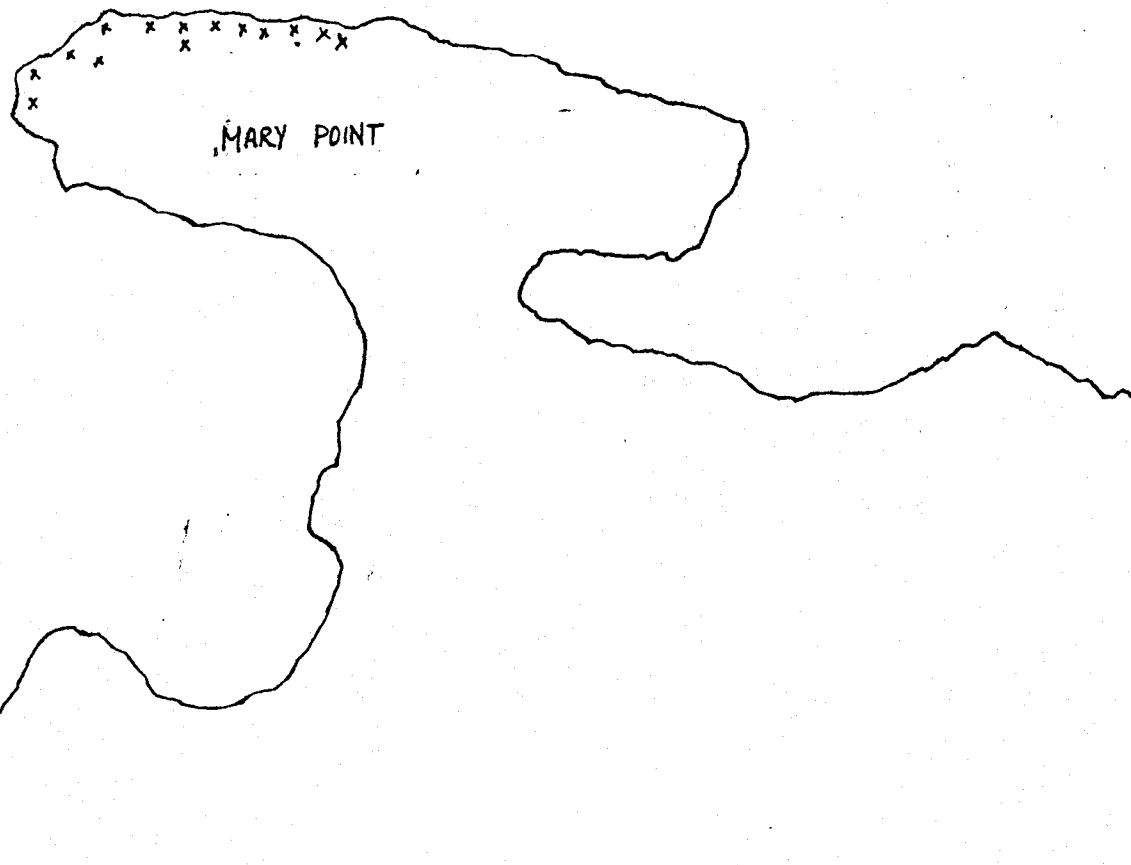
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X MARKS GROUP NESTING AREAS

FIGURE 4.

MARY POINT (ST JOHN) AND WHISTLING CAY SHOWING
BROWN PELICAN NESTING SITES

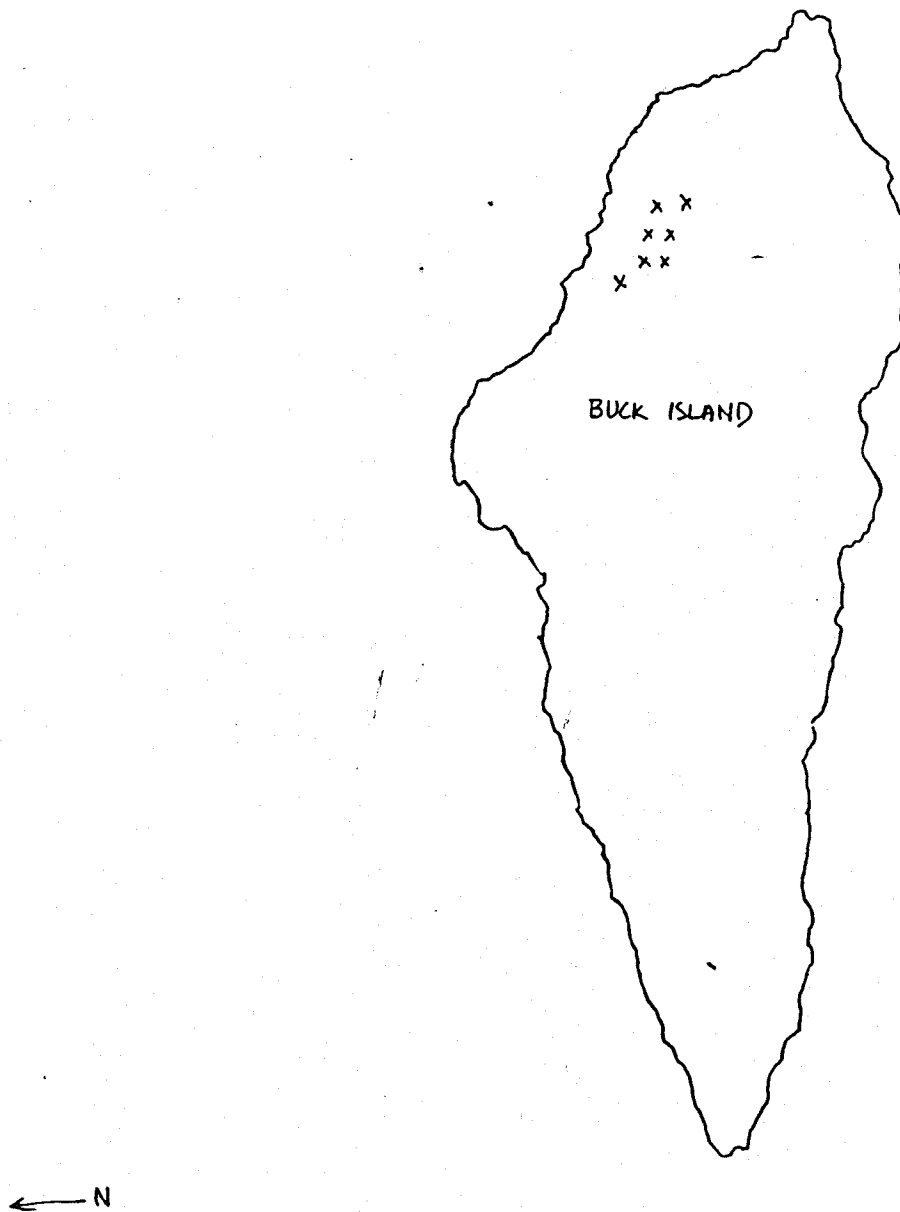
WHISTLING CAY



X MARKS GROUP NESTING AREAS

FIGURE 5.

BUCK ISLAND (ST. CROIX) SHOWING PELICAN NESTING SITES



X MARKS GROUP NESTING AREAS

FIGURE 6. THE U.S. VIRGIN ISLANDS SHOWING PATH OF AERIAL CENSUSES

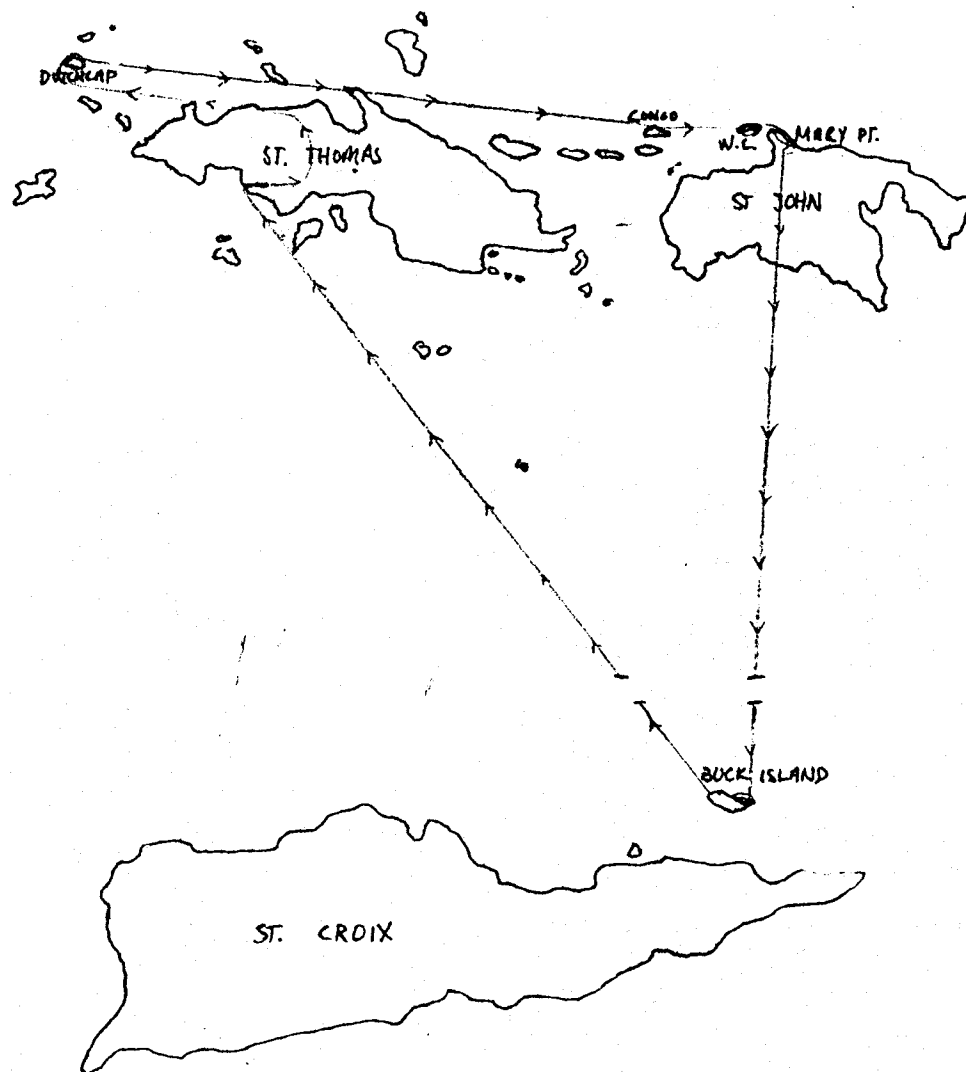


FIGURE 7. FREQUENCY OF BROWN PELICAN ACTIVE NESTS ON BUCK ISLAND 1975-1981
FIGURES GIVE DATE OF CENSUS

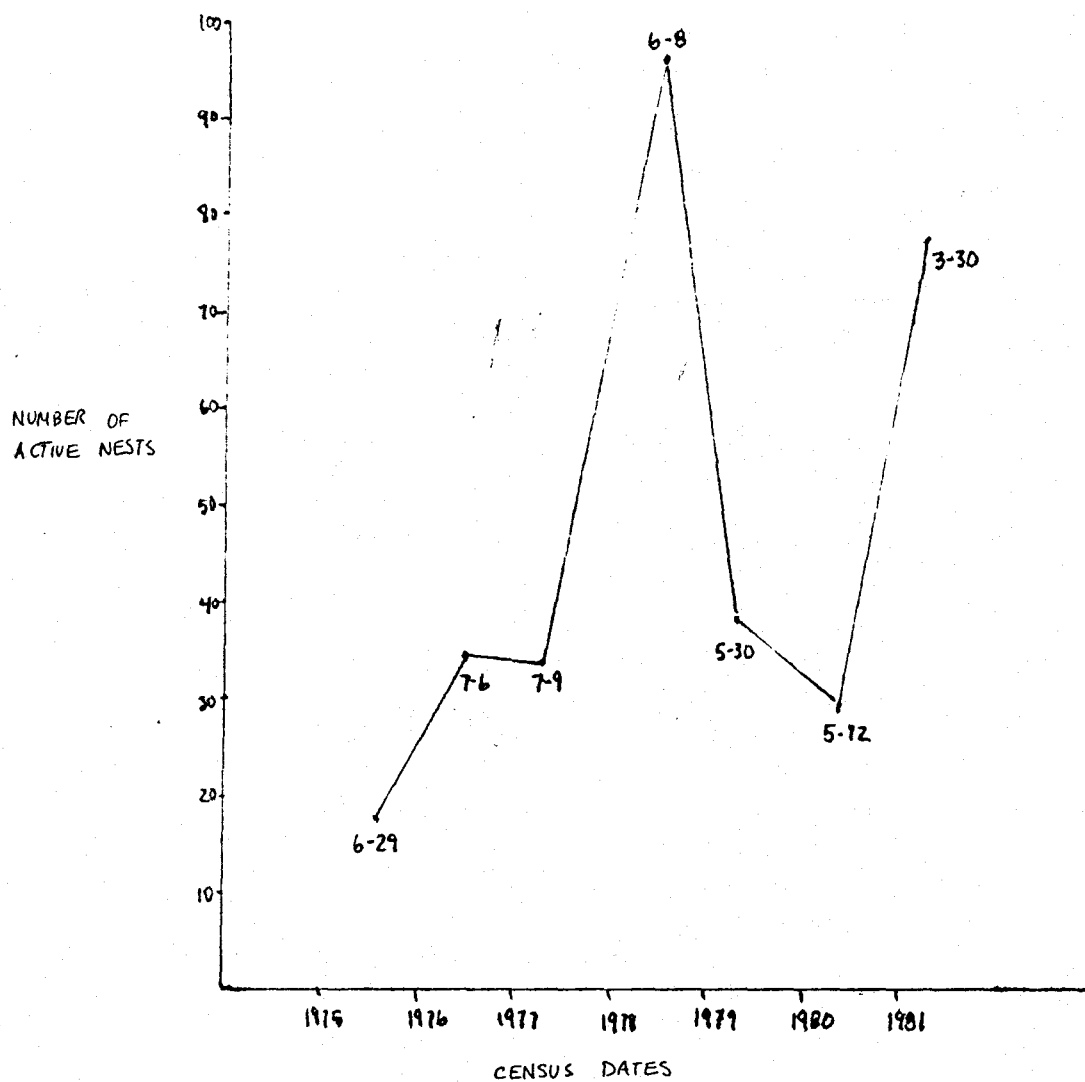


FIGURE 8. SEASONALITY OF BROWN PELICAN NESTING ON CONGO CAY (GRAPHED ACCORDING TO LAYING DATES): 1980-1981

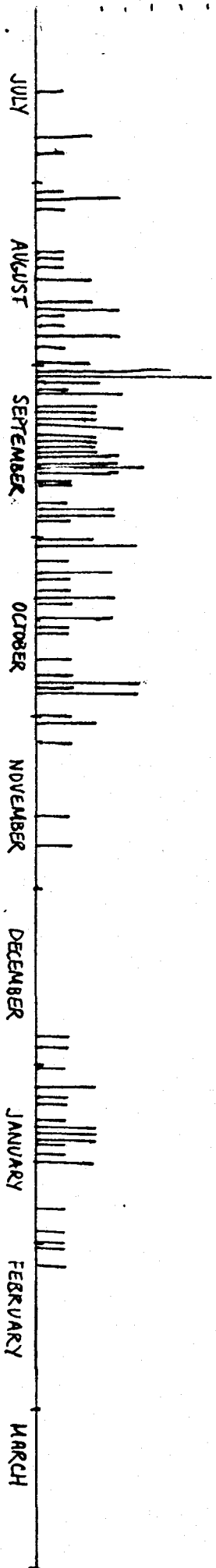


FIGURE 9. PERCENT SUCCESSFUL NESTS IN EACH SUBCOLONY AT CONGO CAY 1980-1981
(GRAPHED ACCORDING TO DATE OF FIRST LAYING)

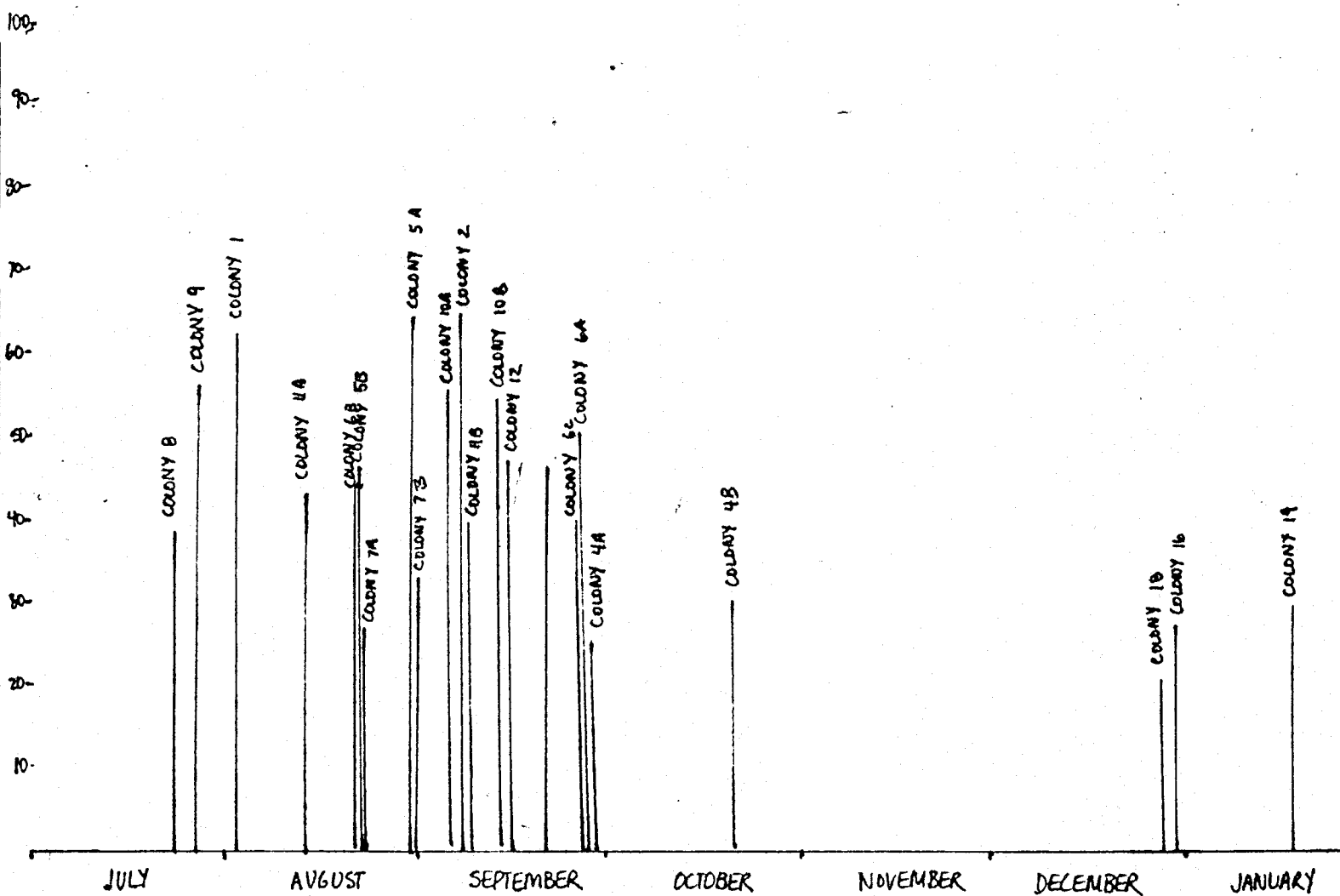


FIGURE 10. MORTALITY AS A FUNCTION OF AGE IN BROWN PELICAN YOUNG

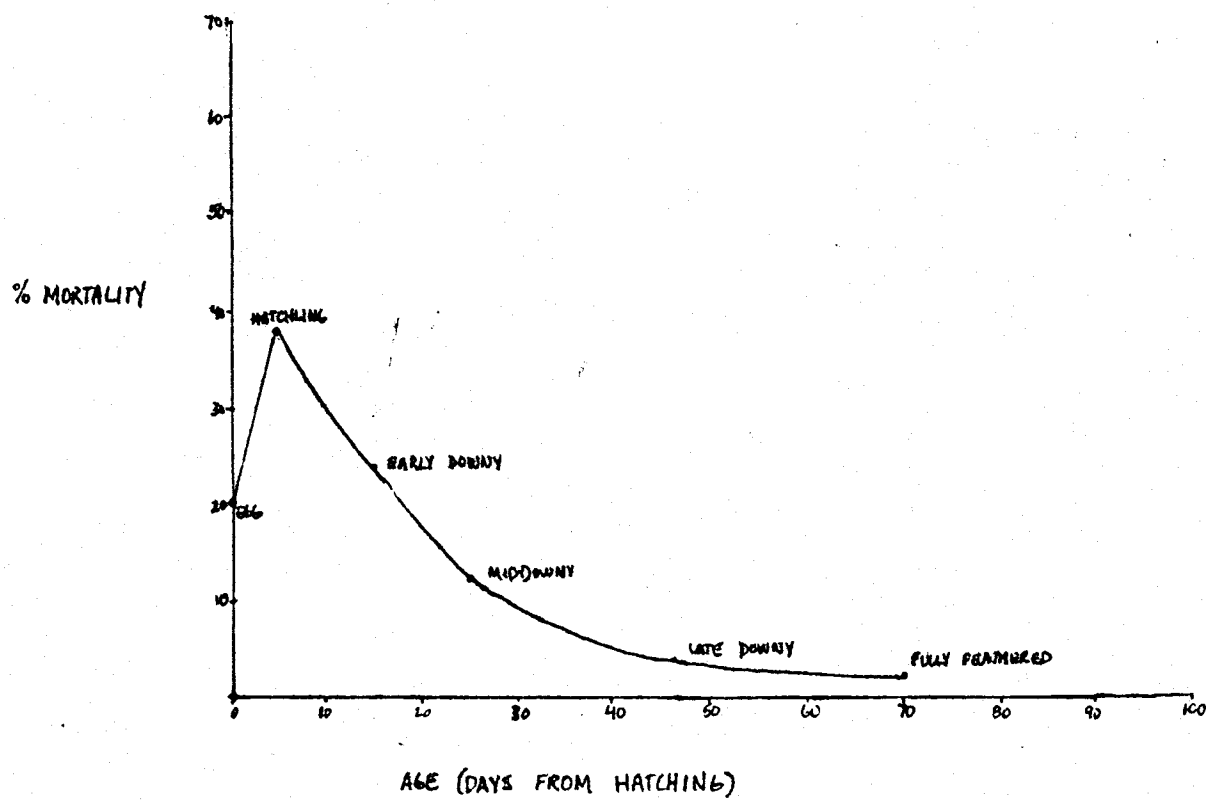


FIGURE 11. SURVIVORSHIP OF BROWN PELICAN OFFSPRING WITH AGE

