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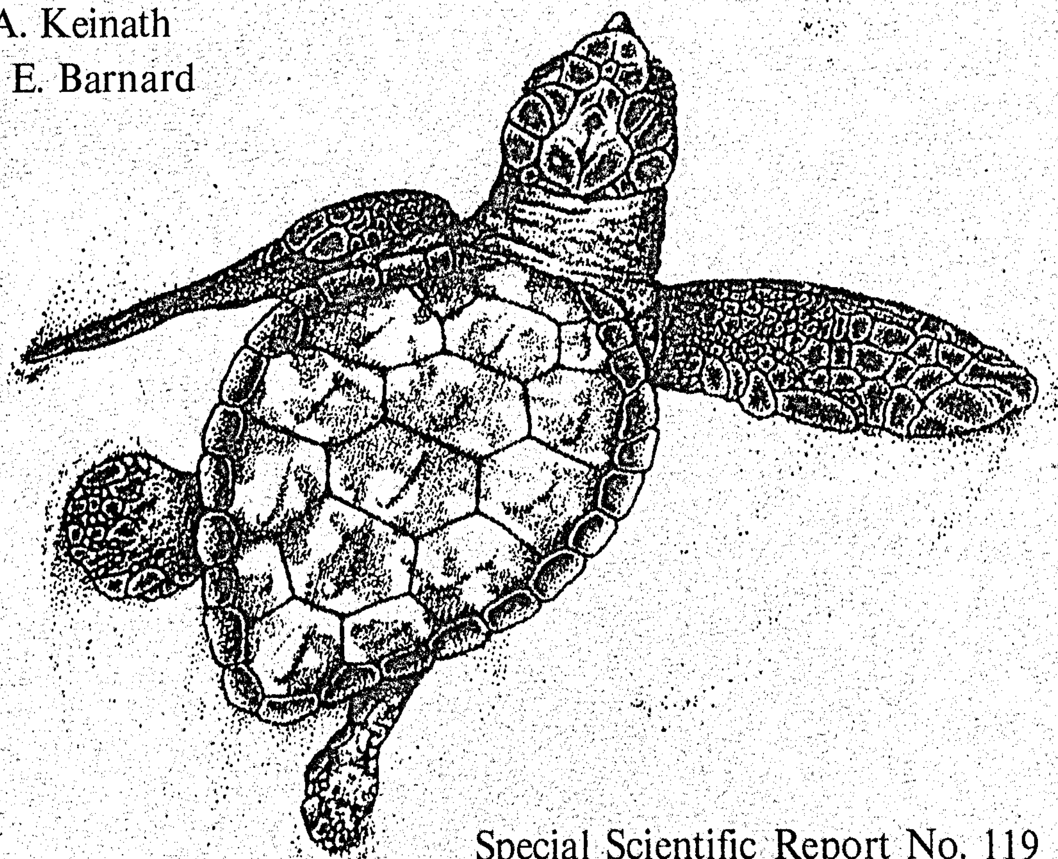

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JULY 1987

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
SCHOOL OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY
GLOUCESTER POINT, VIRGINIA 23062

Final Contract Report
on the
Ecology of Sea Turtles in Virginia

submitted by

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to

National Marine Fisheries Service
Northeast Region
Contract # NA80FAC-00004

14 JULY 1987

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I. INTRODUCTION

The sea turtle program at the Virginia Institute of Marine Science (VIMS) was diversified during 1984 and utilized various methods to address aspects of sea turtle life history, distribution, and mortality and represented a natural progression of studies begun in 1979 (Lutcavage and Musick 1985, Musick *et al.* 1984). Studies continued on stranded dead sea turtles and were expanded on living sea turtles. Effects of the pound net fishery on sea turtle mortality were investigated, clarified, and recommendations concerning pound net turtle mortalities are included in this report.

II. ABUNDANCE AND DISTRIBUTION

A. Strandings

1. Abundance and Distribution

a. Abundance

During 1984 VIMS personnel examined 71 dead loggerhead (*Caretta caretta*), seven Kemp's ridley (*Lepidochelys kempi*), three leatherback (*Dermochelys coriacia*), and two green (*Chelonia mydas*) sea turtles. Stranding data are given in Table 1. In addition to those turtles examined by VIMS, the Virginia stranding network reported 58 stranded dead sea turtles. Mortality in Chesapeake Bay has remained at a relatively constant level since 1979 (Table 2). With the exception of green turtles, species composition and frequency have also remained constant since 1979.

TABLE 1

Sea Turtle Strandings during 1984

Species*	Examined by VIMS Personnel	Examined by Stranding Network	Total	Percent
CC	71	52	123	87.2
LK	7	0	7	5.0
DC	3	0	3	2.1
CM	2	0	2	1.4
UN	0	6	6	4.3
Total	83	58	141	100.0

* CC= Caretta caretta
LK= Lepidochelys kempi
DC= Dermochelys coriacea
CM= Chelonia mydas
UN= Unknown

TABLE 2

Virginia Sea Turtle Mortality
by Year

Species*	1979 VIMS	1979 SN	1980 VIMS	1980 SN	1981 VIMS	1981 SN	1982 VIMS	1982 SN	1983 VIMS	1983 SN	1984 VIMS	1984 SN	Total
CC	62	60	64	125	16	47	63	50	89	42	71	52	741
LK	6	1	5	4	4	3	0	2	5	0	7	0	37
DC	1	0	2	1	0	0	2	0	2	0	3	0	11
CM	0	0	0	0	0	0	0	0	0	0	2	0	2
UN	0	9	0	6	0	6	0	17	0	5	0	6	49
Total	69	70	71	136	20	56	65	69	96	47	83	58	840

* CC= *Caretta caretta*
LK= *Lepidochelys kempi*
DC= *Dermochelys coriacea*
CM= *Chelonia mydas*
UN= unknown

VIMS= Examined by VIMS personnel
SN= Examined by stranding network

Historically, green sea turtles were reportedly occasional visitors to Chesapeake Bay, although relative densities during those times are unknown (Musick 1972, 1979). As with loggerheads and ridleys, green sea turtles are believed to have entered the Bay to forage during summer. A verified siting of a green sea turtle in the Bay has not been reported in over 20 years.

The leatherback sea turtle is an occasional visitor to Chesapeake Bay during summer. It is found offshore and in the Bay mouth. Watermen have reported leatherbacks as far up the Bay as Gywnn's Island off the mouth of the Rappahannock River and have reported up to three per year in the mouth of the York River for the last five years. In addition to the three dead leatherbacks examined by VIMS personnel during 1984, three additional dead and two live leatherbacks were reported by watermen. The live leatherbacks were released from the heads of separate pound nets.

b. Temporal and Spatial Distribution

The temporal distribution of stranded animals during 1984 was similar to years previously studied (Figures 1 and 2) (Musick et al. 1984). In 1984 the first strandings examined by VIMS personnel were during the third week of May. Of the strandings examined, 79% occurred during May (16%) and June (63%). This is comparable with the stranding distribution in previous years.

Spatial distribution of carcasses during 1984 was similar to previous years (Musick et al. 1984). Spatial distribution zones were used to analyze strandings (Figure 3). Mortalities are summarized by zone for animals examined by VIMS personnel and reported by the stranding network during 1984 (Figure 4), and during 1979-1984 (Figure 5). Zones 3, 15, and 7 had the highest densities of all areas examined. Zones 3 and 15 are on the Atlantic

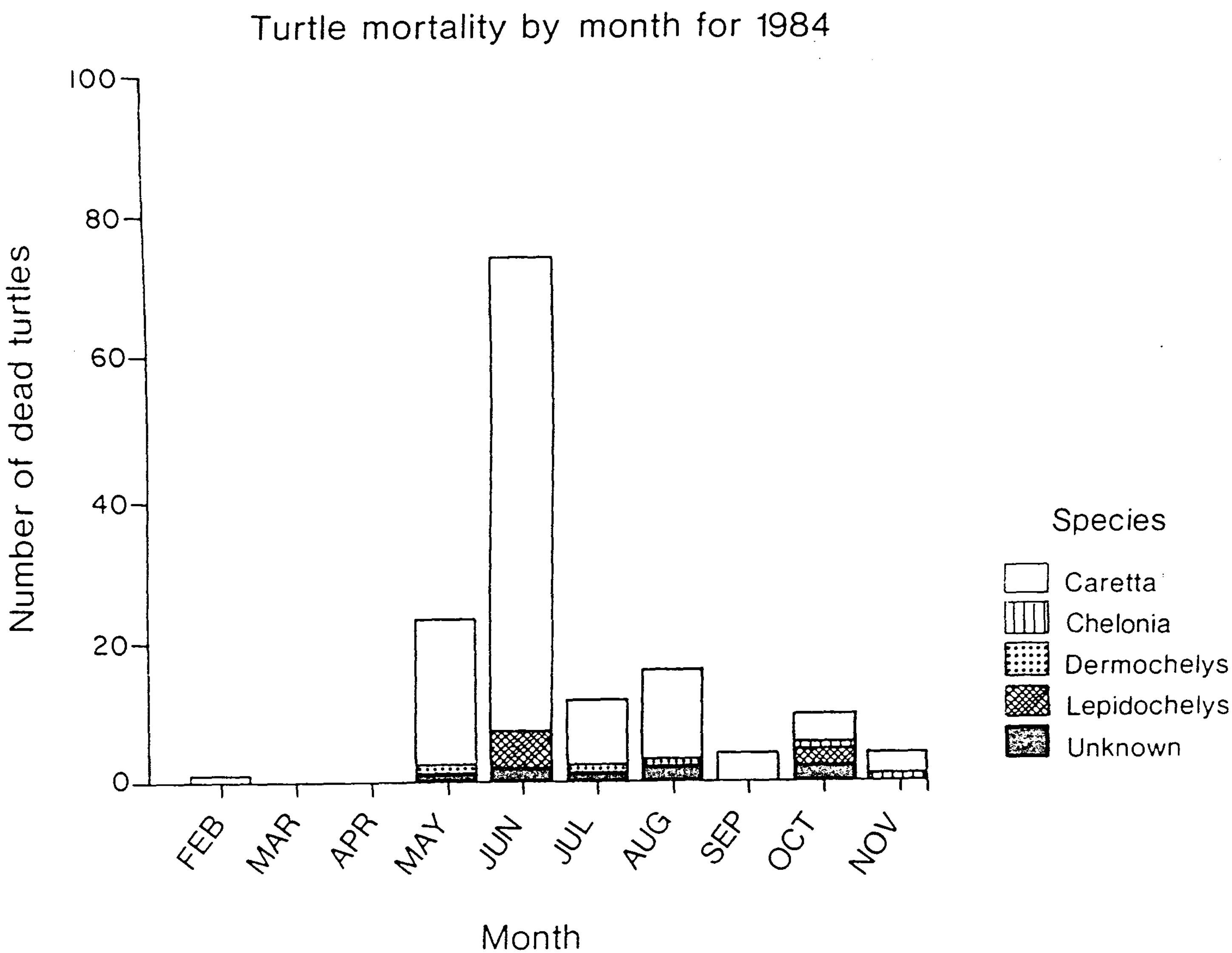

Turtle mortality by month for 1984
100
80
60
40
20
0
Number of dead turtles
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
Month
Species
Caretta
Chelonia
Dermochelys
Lepidochelys
Unknown

Figure 1

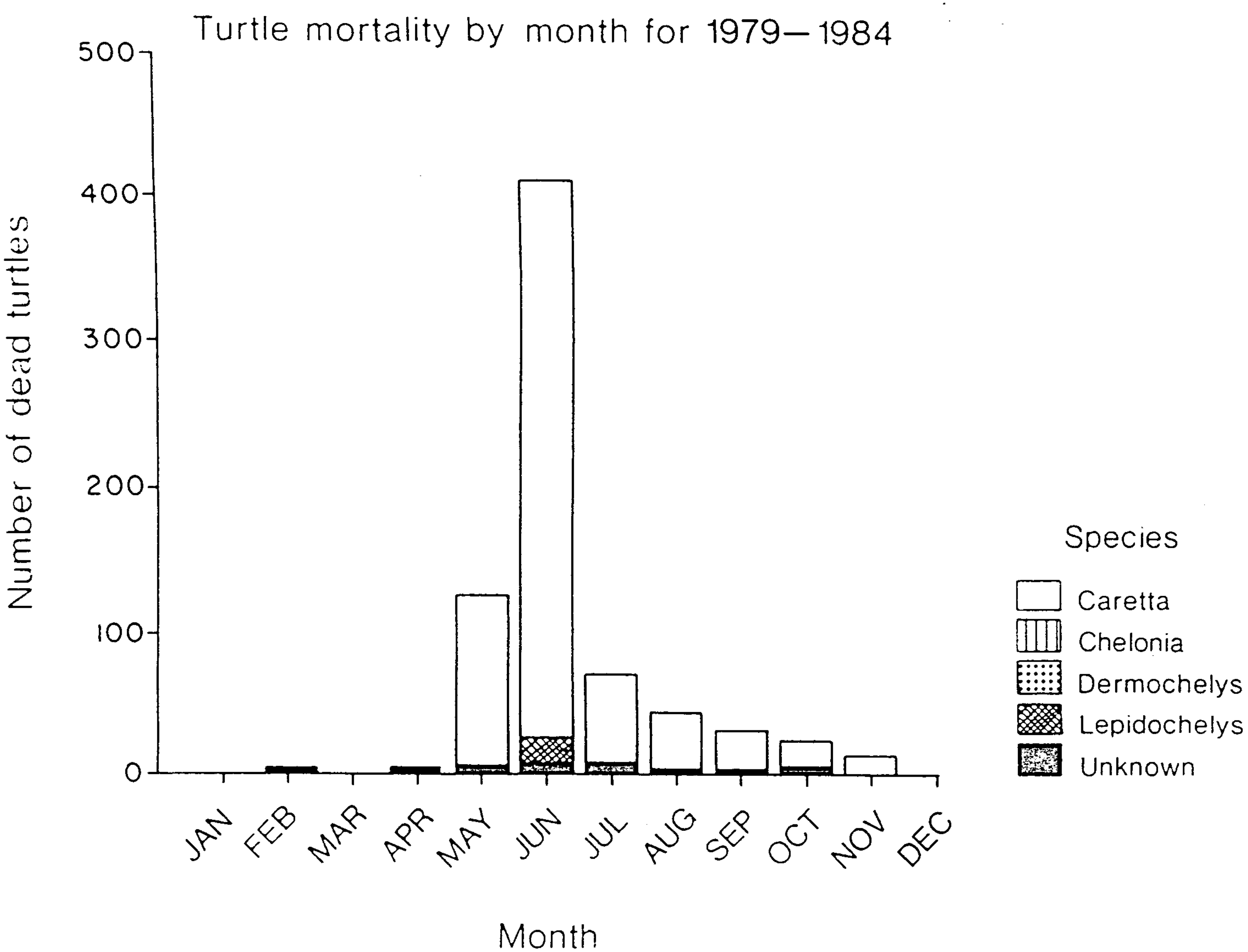
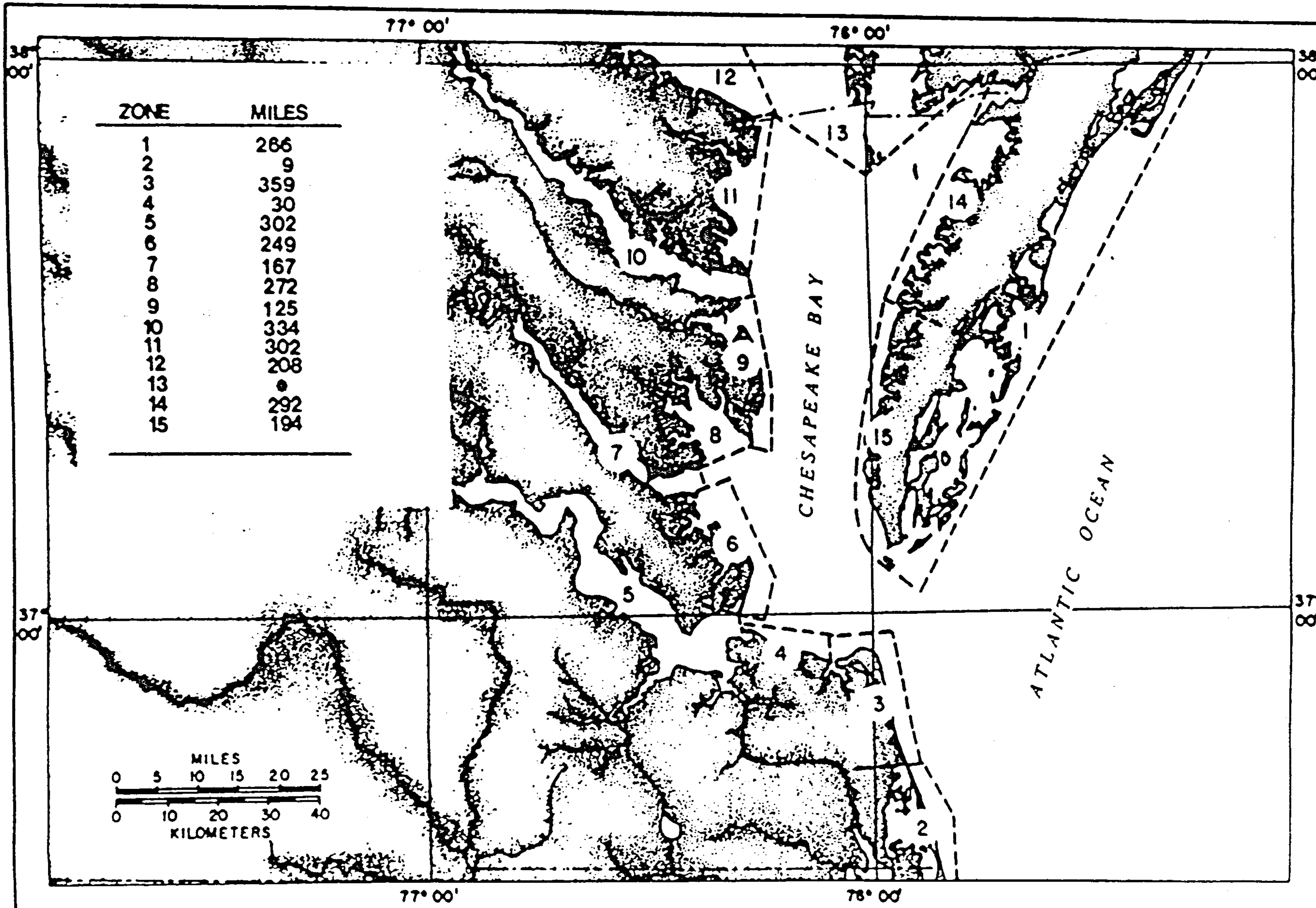

Turtle mortality by month for 1979—1984
Number of dead turtles
500
400
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
Species
Caretta
Chelonia
Dermochelys
Lepidochelys
Unknown

Figure 2



VIRGINIA ZONES

Figure 3

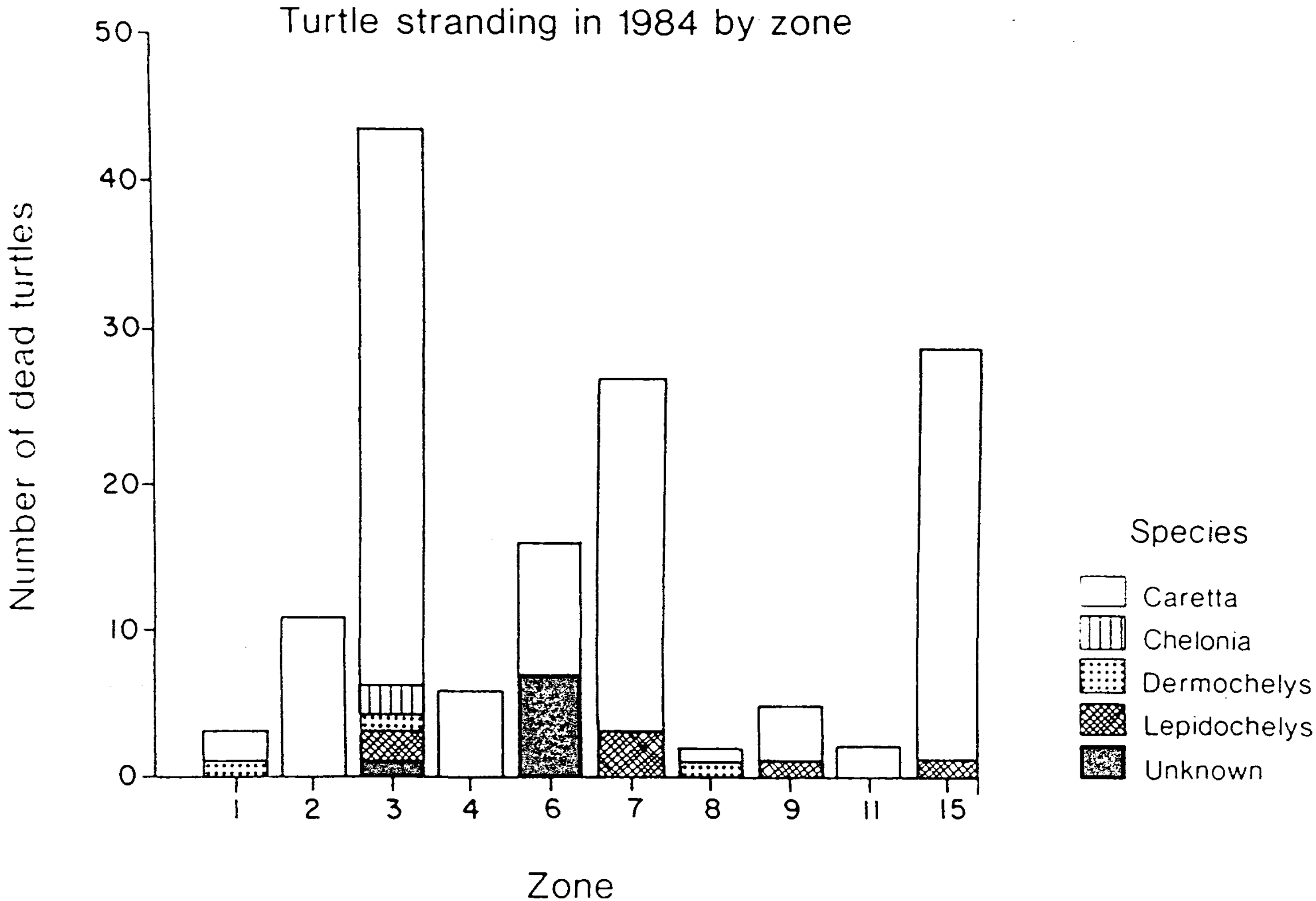

Turtle stranding in 1984 by zone
Number of dead turtles
50
40
30
20
10
0
1
2
3
4
6
7
8
9
11
15
Zone
Species
Caretta
Chelonia
Dermochelys
Lepidochelys
Unknown

Figure 4

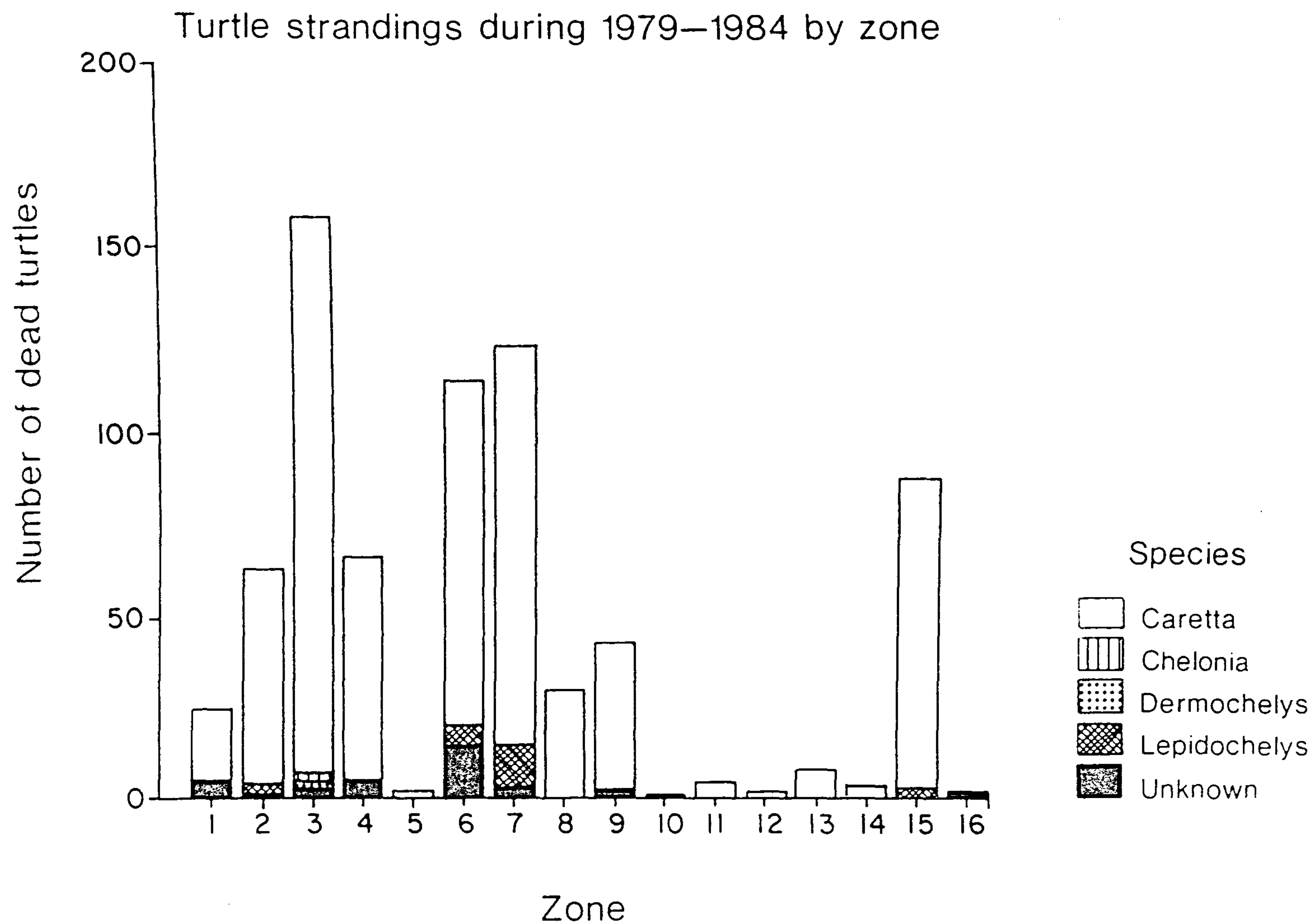

Turtle strandings during 1979—1984 by zone
200
150
100
50
0
Number of dead turtles
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Zone
Species
Caretta
Chelonia
Dermochelys
Lepidochelys
Unknown

Figure 5

coast and the mouth of the Bay, respectively. Zone 7 is opposite the Bay mouth and contains a natural deep channel. Dead animals floating off or just inside the Bay mouth may be entrained in tidal, wind driven, or local currents and strand in these zones. The diversity of species in zone 3 may have resulted from its location on the Atlantic coast. Turtles were reported in zones 8 and 9 by the Coast Guard, but could not be examined due to the marshy nature of the area.

2. Morphometrics

Size classes of dead loggerheads examined during 1984 are shown in Figure 6. The 55.1-60.0 size class predominated in all study years (Figure 7). During 1984, loggerheads utilizing Chesapeake Bay as a summer foraging habitat had a mean carapace straightline length (CLS) of 64.0 cm (SD = 9.9, range = 41.9). Mean weight was 41.9 kg (SD = 19.1). Weight and length means were similar for all study years.

Size classes for Kemp's ridleys for 1979-1984 are shown in Figure 8. Mean CLS for ridleys was 48.5 cm (SD = 11.4, range = 19.8). Mean weight for ridleys was 16.7 kg (SD = 10.3).

3. Cause of Death

a. General Mortality

VIMS examined 83 turtles during 1984 for cause of death (Table 3). Two turtles examined by a reliable source are not included in Table 3. Determinable causes of death were partitioned into: intentional mutilation, boat wounds, constrictions, and net related (pound nets or gill nets). Nets were implicated in 28.9% of the deaths. Evidence which suggested deaths related to pound nets included recovery of carcasses entangled in netting, Size classes of dead Caretta examined by VIMS personnel during 1984

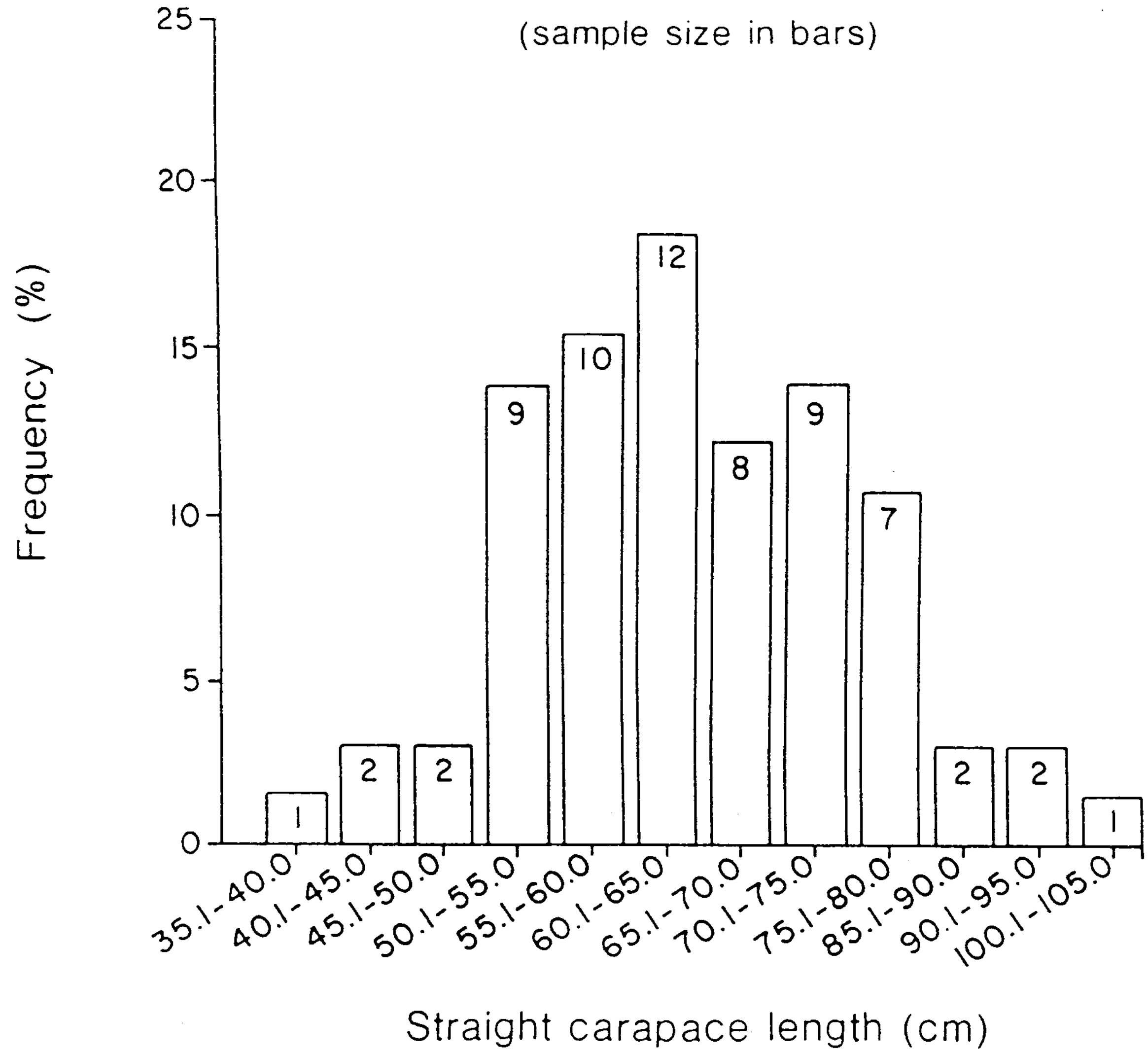


Figure 6

Size classes of dead Caretta examined by VIMS personnel during 1979-1984

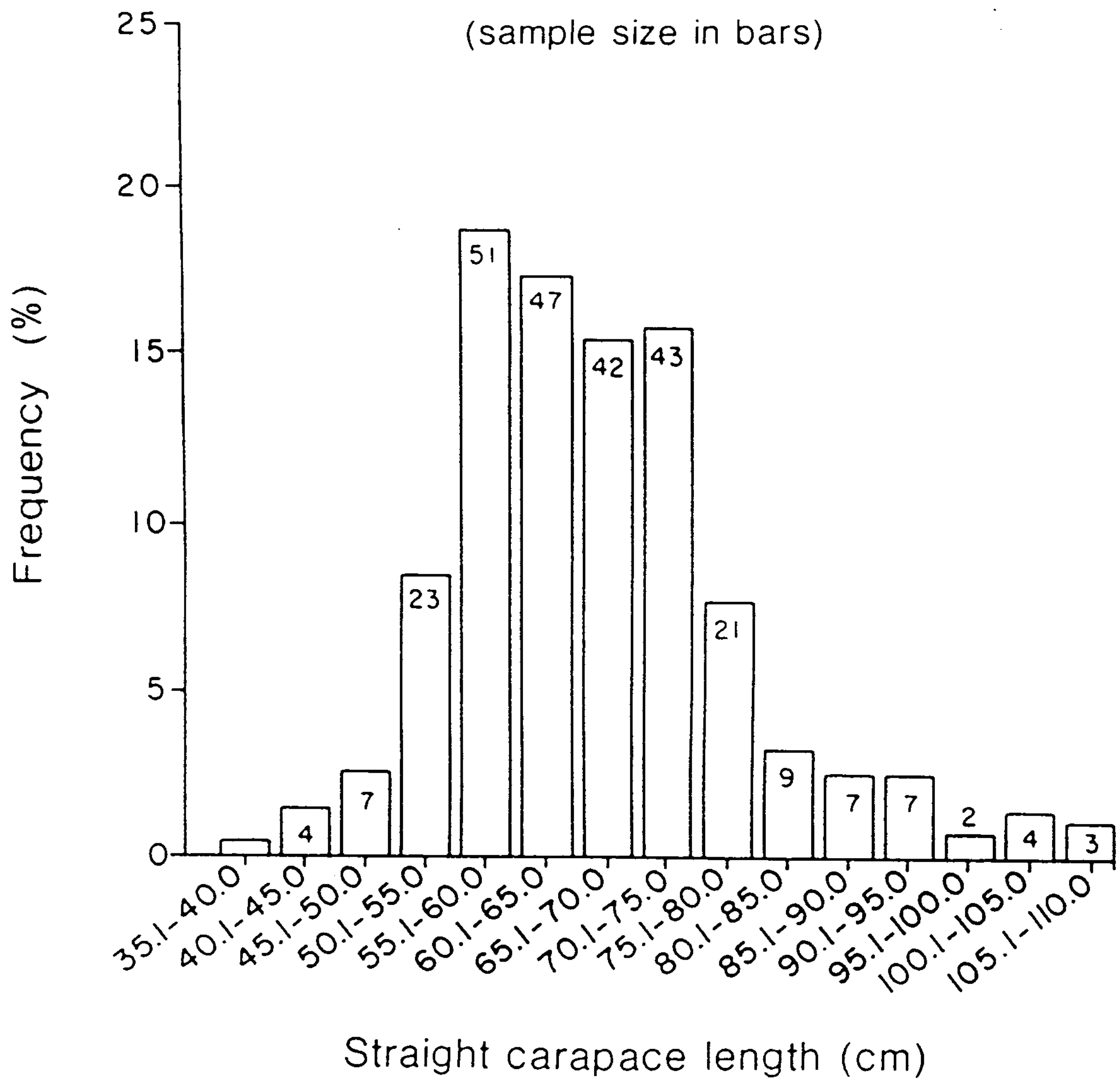


Figure 7

Size classes of dead Lepidochelys examined by VIMS personnel during 1979-1984

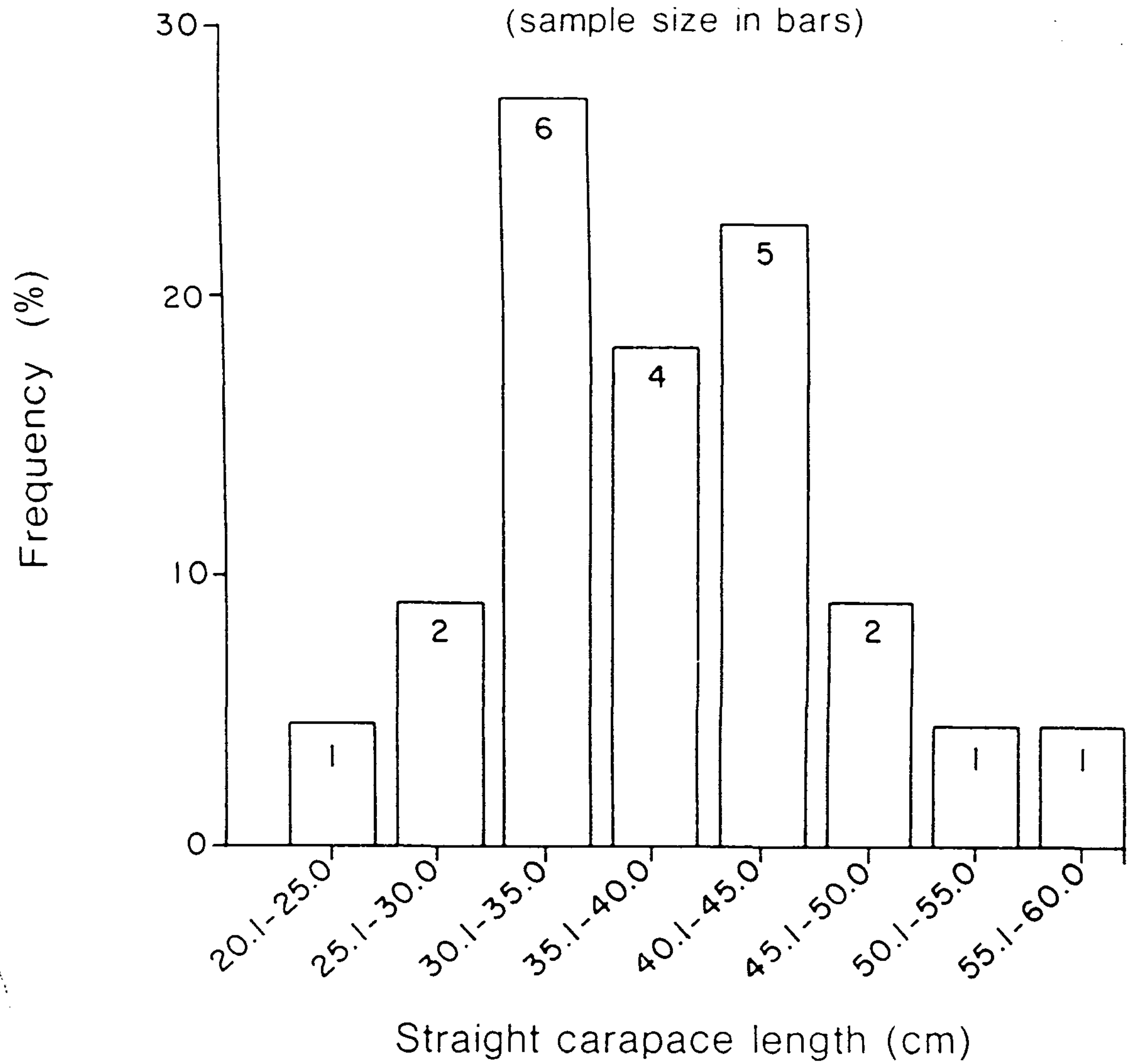


Figure 8

TABLE 3

Apparent Causes of Death
of Sea Turtles Examined by VIMS Personnel
during 1984

Cause of Death	Species*				Number	Percent
	CC	LK	DC	CM		
Undetermined	31	5	2	1	39	47.0
Net Related	23	1	0	0	24	28.9
Constrictions Alone	11	1	0	0	12	14.5
Propeller Damage	7	0	0	1	8	9.6
Total	72	7	2	2	83	100.0

* CC= *Caretta caretta*
LK= *Lepidochelys kempi*
DC= *Dermochelys coriacea*
CM= *Chelonia mydas*

or observation of: traces of anti-fouling paint, fish remains in stomachs, or constrictions around the neck or appendages. Anti-fouling paint is used on pound nets and rubs onto turtles entangled in webbing. Sea turtles are generally not agile enough to capture fish under natural conditions, but may scavenge fish from gill or pound nets. Constrictions around the neck and/or limbs were present on 14.5% of the animals examined. These were possibly due to entanglement in nets, crabpot or other mooring lines, or could occur as a carcass floated into entanglements. Also, constrictions may occur post mortem when the turtle is towed out of nets or shipping channels. Since the cause of constriction marks is variable, marks alone are not used to indicate cause of death. Animals were included in the net related category only if actually observed entangled, or had more than one of the conditions previously listed. Boat wounds were observed in 9.6% of the animals examined. Undetermined death, as in past study years, was the largest group representing 47.0% of deaths. No outward signs of injury were observed or the carcasses were too decomposed to determine a cause of death. Two intentional mutilations, not included in Table 3, resulted from gun shot wounds and were reported by a wildlife officer. Causes of death for turtles during 1979-1983 are in Table 4. Differences in causes of death between 1984 and previous years may be attributable to many reasons. The undetermined category is less for 1983 and 1984 than other years because necropsies were not routinely performed before 1983. During other years, most strandings were not fresh. During 1983 and 1984 necropsies were done on as many animals as possible. The apparent increase in net-related deaths may be due to differences in criteria applied during 1984 versus previous years. During 1984 fish bones from turtle stomachs were used as part of the criteria for implicating net related deaths. Until internal examination of

TABLE 4

Apparent Causes of Death
of Sea Turtles Examined by VIMS Personnel
between 1979-1983

Category	Number	Percent
Undetermined	197	69.1
Net Related	53	18.6
Shark Related	1	0.4
Prop Damage	21	7.4
Intentional (Human Induced)	9	3.2
Other Fishing Gear	4	1.4
Total	285	100.1

many turtles was made this criteria could not be used. During 1984 a new category was added called "constrictions alone" which represents animals exhibiting constriction marks which were due to many sources, including pound nets. Constrictions alone combined with the undetermined cause of death represents 61.5% of the deaths which is close to 69.1% reported in Musick et al. (1984).

The stranding network also reported mutilations in some turtles they examined. Of 55 turtles, 14 had head and/or limbs missing, possibly due to collision with boat propellers, and six had mutilations from unknown causes, possibly sharks, boats, or human induced.

The majority of turtles examined during 1983 were too decomposed to be suitable for histological examination. During 1984 one turtle, which died after rehabilitation attempts failed, was examined histologically. Gross pathology suggested lung infection as the cause of death. This specimen exhibited a systemic infection visible in histological sections of lung, liver, and spleen. The white blood cell count was high in the affected areas which suggested an immune response was triggered in response to a chronic infection. This could also be seen in serum samples taken over the period of time the animal was held at VIMS previous to its death. Turtles may die due to complications resulting from aspiration of water into the lungs. Aquatic turtles are susceptible to lung infections (Fry 1982) and exhibit symptoms similar to those seen in this sea turtle.

b. Pound Net Mortalities

1) Temporal Patterns

Previous research showed that pound net entanglement may account for up to 33% of sea turtle mortality in Chesapeake Bay during some summers (Lutcavage and Musick 1985). Between 1979 and 1984 the percentage of turtles observed entangled in pound nets or implicated in pound net mortality ranged from 3% during 1981 to 33% during 1980 (Lutcavage and Musick 1985; Musick et al. 1984). The percentage of observed mortality during 1984 believed to be net related was within that range and may have varied due to sampling intensity, criteria for describing cause of death, and the type and intensity of examination of the carcass.

During 1983, 113 pound nets were examined by boat for entangled turtles. All were in Virginia's waters or Maryland's Potomac River. During 1984 the scope of net examinations was reduced to 98 nets in an area from Gwynn's Island south to Back River, including Mobjack Bay, York River, York Spit and New Point Comfort. This area was chosen due to accessibility from VIMS and observations from 1983 that entanglements were more likely encountered there. The temporal entanglement patterns followed the patterns found in beach strandings of dead turtles. Beginning in mid-May entanglements increased slowly until early June, then increased sharply and reached a plateau by late June (Figure 9) which was similar to observations during previous years. These surveys and reports from watermen suggest few entanglements occurred after June. In 1984 nets were surveyed through September, but no entanglements were observed after late June. This data suggests pound nets impose mortalities on sea turtles in Chesapeake Bay for

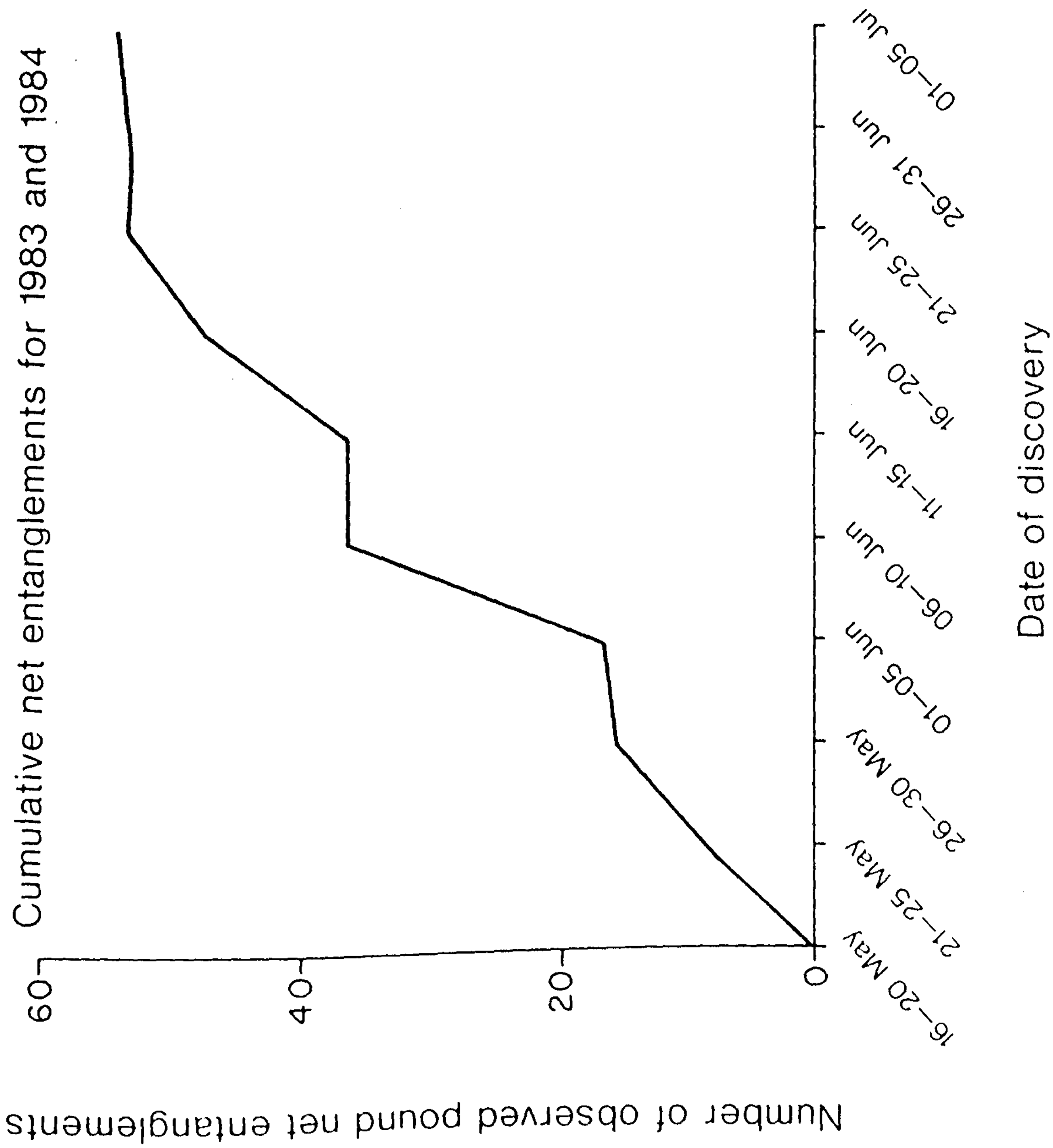

Cumulative net entanglements for 1983 and 1984
Number of observed pound net entanglements
0
20
40
60
16–20 May
21–25 May
26–30 May
01–05 Jun
06–10 Jun
11–15 Jun
16–20 Jun
21–25 Jun
26–31 Jun
01–05 Jul
Date of discovery

Figure 9

a relatively short period of the year (1.5 mo) even though turtles reside in the Bay from May through October.

2) Net Construction and Habitat Type

The construction and size of mesh used on pound net leaders was important to the relative danger of specific nets to sea turtles. Three kinds of mesh were found in pound net leaders used in Chesapeake Bay: small mesh (8-12" stretch) from surface to bottom; large mesh (>12-16" stretch) from surface to bottom; and leaders with stringers 16-18" apart (Figure 10) in their upper part and small mesh in their lower part. Turtle entanglement was insignificant in small mesh nets. During 1983 and 1984 173 large mesh nets were examined and 30 turtles were found entangled (0.2 per net). Thirty eight nets were examined with stringer mesh and 27 turtles were found entangled (0.7 turtles per net); therefore nets with stringer meshing contribute more to turtle mortality.

A fisherman's choice of leader mesh construction depended heavily on the currents where nets were located. Nets in areas with strong tidal currents (deep offshore areas and at large river mouths) were equipped with stringer mesh in their leaders so jellyfish and flotsam did not clog the meshes and cause the net to be swept away. Nets in shallower protected areas (eg. Potomac and Rappahannock Rivers) were usually equipped with small mesh leaders. Nets in intermediate areas usually had large mesh leaders. Since the use of string mesh leaders was correlated to open water pound net stands with strong currents, it is not surprising that the entanglement rate for open water nets was high (0.4 turtles per net) compared to nets in protected areas (0.1 turtles per net). Entanglement of turtles in nets

STRINGER POUND NET LEADER

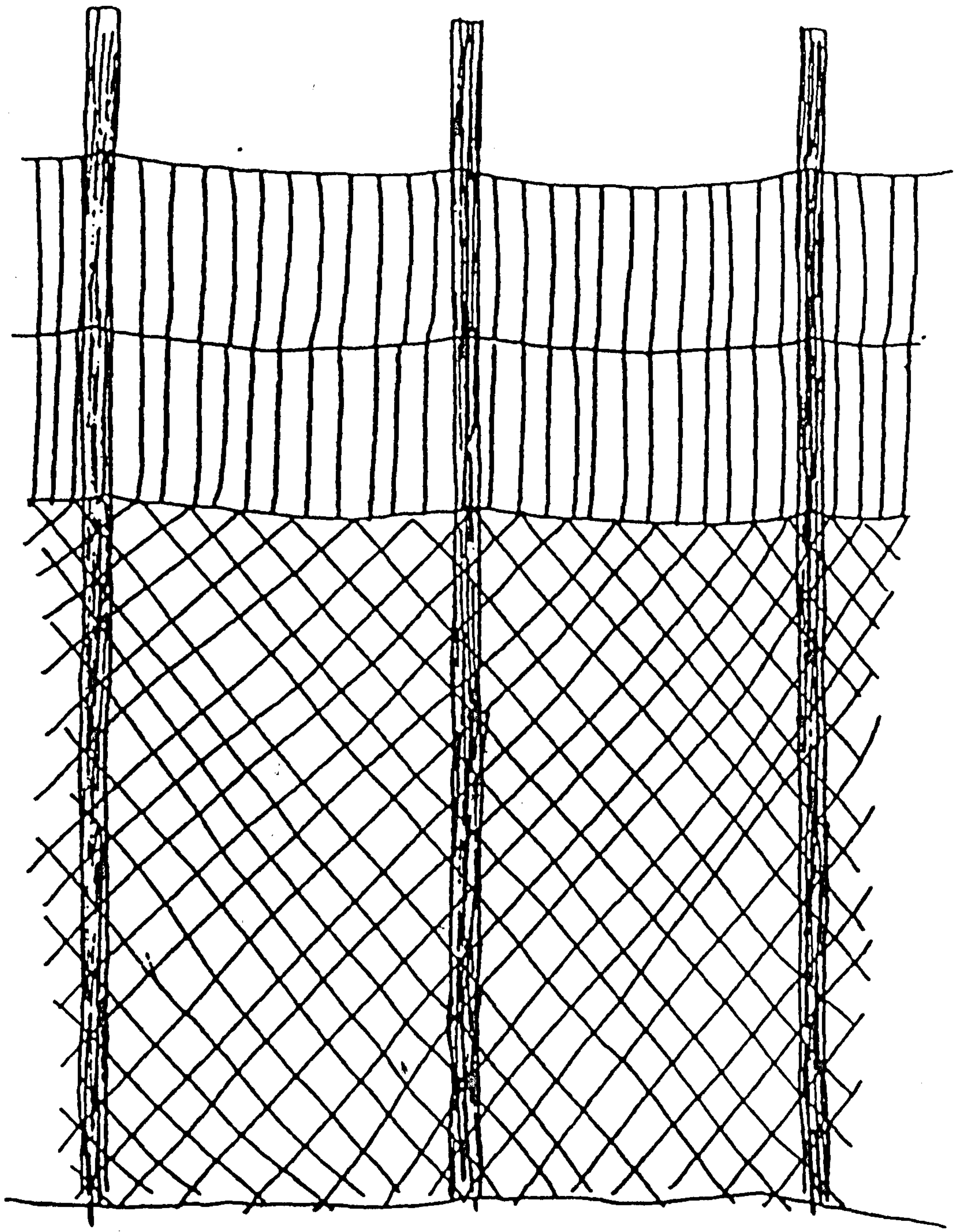


Figure 10

located where strong currents occur may be compounded by the animals' difficulty in "bucking the tide" to avoid such nets.

3) Decomposition Study

During 1984 five turtles were examined intermittently to determine the decomposition rate once a turtle died in a pound net hedge. All the turtles had been entangled less then one week before the first observation.

The turtles exhibited discoloration and some bloating when selected for the study. All were tangled in the top meter of pound net hedges and were floating during low water, which facilitated checking via boat. Three were completely submerged and two were partially submerged at high tide. The weekly stages progressed as follows:

Week 1. Turtles were fresh, but discolored, with slight bloating. Appendage tangled in net (neck or front flipper) were usually severely constricted and discolored more than body.

Week 2. Bloating was pronounced, skin and scutes were beginning to peel. Eyes were usually gone. The portion of the turtle exposed to air was badly discolored and dried.

Week 3. Carapacial bones were separating and falling off. Distal limb bones and heads were usually gone. Specimens were soft and white, and an oily slick was present. Two turtles had internal organs protruding. The others had no internal organs remaining. Species identification would be difficult.

Week 4. Limbs, carapacial, and plastral bones were gone. Some internal bones were still present, but soft parts were reduced to a mass of white fibrous connective tissue. Carcasses were unrecognizable as turtles.

Week 5. Carcasses were reduced to a waving mass of connective tissue.

Decomposition of turtles entangled in pound nets was complete within five weeks. None of the turtles monitored became disentangled by natural causes. Most turtles which become entangled and die, decompose in situ and do not drift free to strand on shore. Therefore, it is not probable that stranded turtles with no visible marks or unknown cause of death (Table 3), were killed by pound nets.

B. Live Captures

1. Abundance and Distribution

Distribution of live animals during 1984, as in previous years, reflected pound net fishing activity and distribution. During 1984 50 live sea turtles were examined by VIMS personnel; 47 loggerhead and three ridley sea turtles. Most turtles were captured at the mouth of the Bay at Lynnhaven and the upper portion of the Bay on the Potomac River at Smith Point. These areas were chosen to maximize the distance between main collection sites. Sea turtles are site specific, returning yearly or weekly to the same net. Potomac River turtles demonstrated this best, returning to the same nets many times within a season (see recaptures). The Chesapeake Bay may be divided into foraging and migrational habitats. The Potomac River is more representative of a summer foraging habitat than Lynnhaven, which represents a migratory route. Animals were present in highest numbers in Lynnhaven pound nets during May and early June, but were present in highest numbers in Potomac River pound nets during late June and July.

Turtles foraging in the Potomac River were generally not visible during upper Bay aerial survey flights although captures indicated large numbers were present. Turtles moving into the Bay during spring and early summer are highly visible, which was readily observed on lower Bay flights during migration. Migrating turtles were more concentrated when coming through the Bay mouth and may spend more time on the surface than foraging turtles.

Foraging habitat could further be divided between loggerheads, which prefer deep channels, and Kemp's ridleys, which prefer shallow grass beds (Musick et al. 1984). Habitat partitioning was also exhibited by the different life stages of the loggerhead sea turtles, described by Carr et al. (1978) as hatchlings, juveniles, sub-adult and adult animals. Data from 1979-1984 indicated that turtles in Virginia partitioned habitat to allow immature stages to forage within Chesapeake Bay, while large sub-adults and adults were found offshore during the summer. Loggerhead turtles within Chesapeake Bay had a mean straightline carapace length (CLS) of 66.7 cm (SD = 10.8, N = 238). Turtles found in coastal waters and on coastal beaches (live and dead) had a mean CLS of 72.3 cm (SD = 17.4, N = 46). Turtles found in coastal waters were significantly larger than turtles found in the Bay (Student's T-test, alpha = 0.05).

2. Morphometrics

During 1984 VIMS personnel examined 47 live loggerhead and three live Kemp's ridley sea turtles. Mean straight line carapace length (CLS), width (CWS), and weight (WT) for live loggerheads in 1984 were: CLS = 64.0 cm (SD = 9.9), CWS = 53.0 cm (SD = 7.2), and WT = 41.9 kg (SD = 19.1). Size classes for 1984 loggerheads and all study years combined are shown in Figures 11 and 12. Morphometrics for the three Kemp's ridleys in 1984 were:

Size classes of live *Caretta* examined by VIMS personnel in 1984

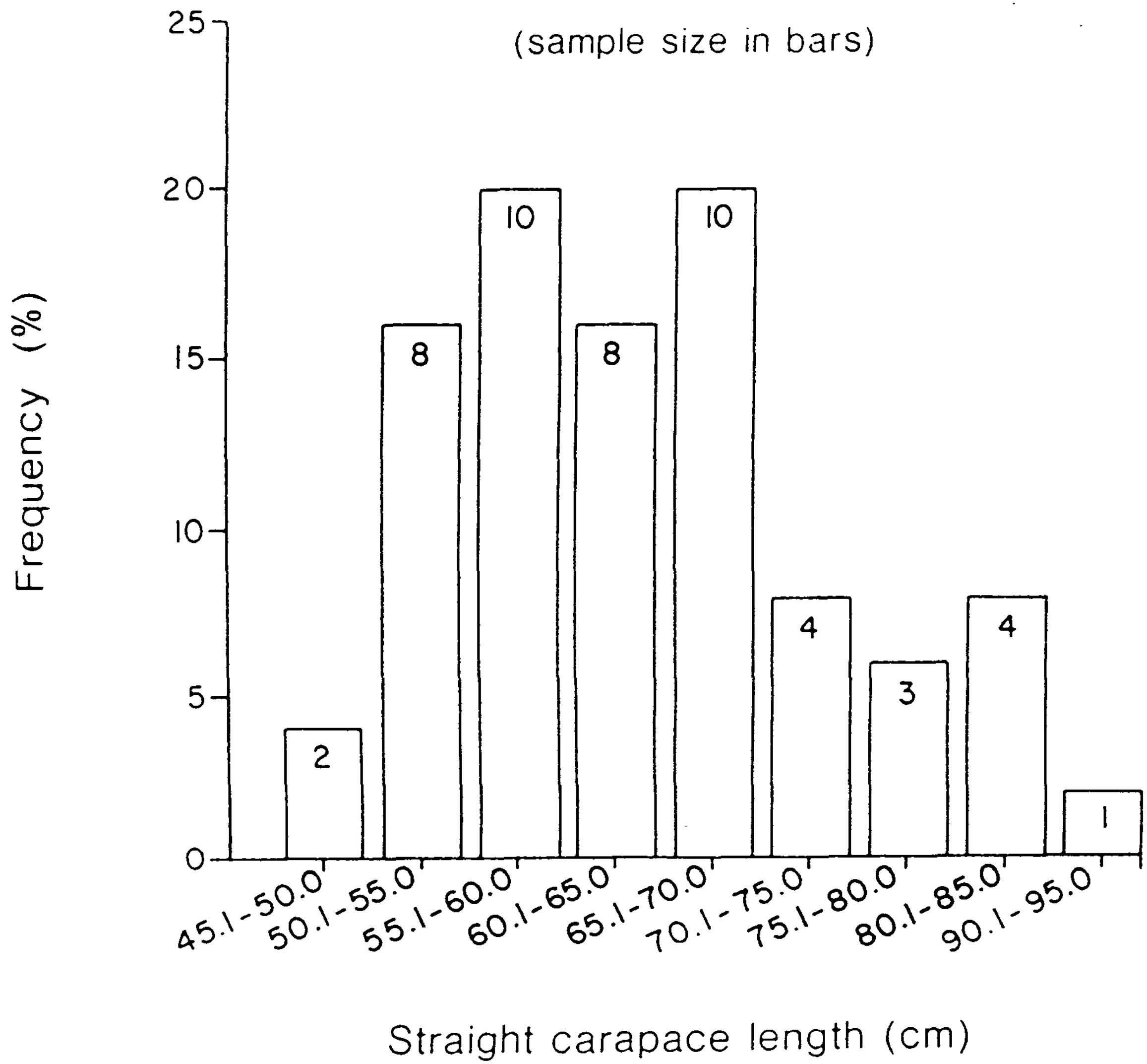


Figure 11

Size classes of live Caretta examined by VIMS personnel during 1979-1984

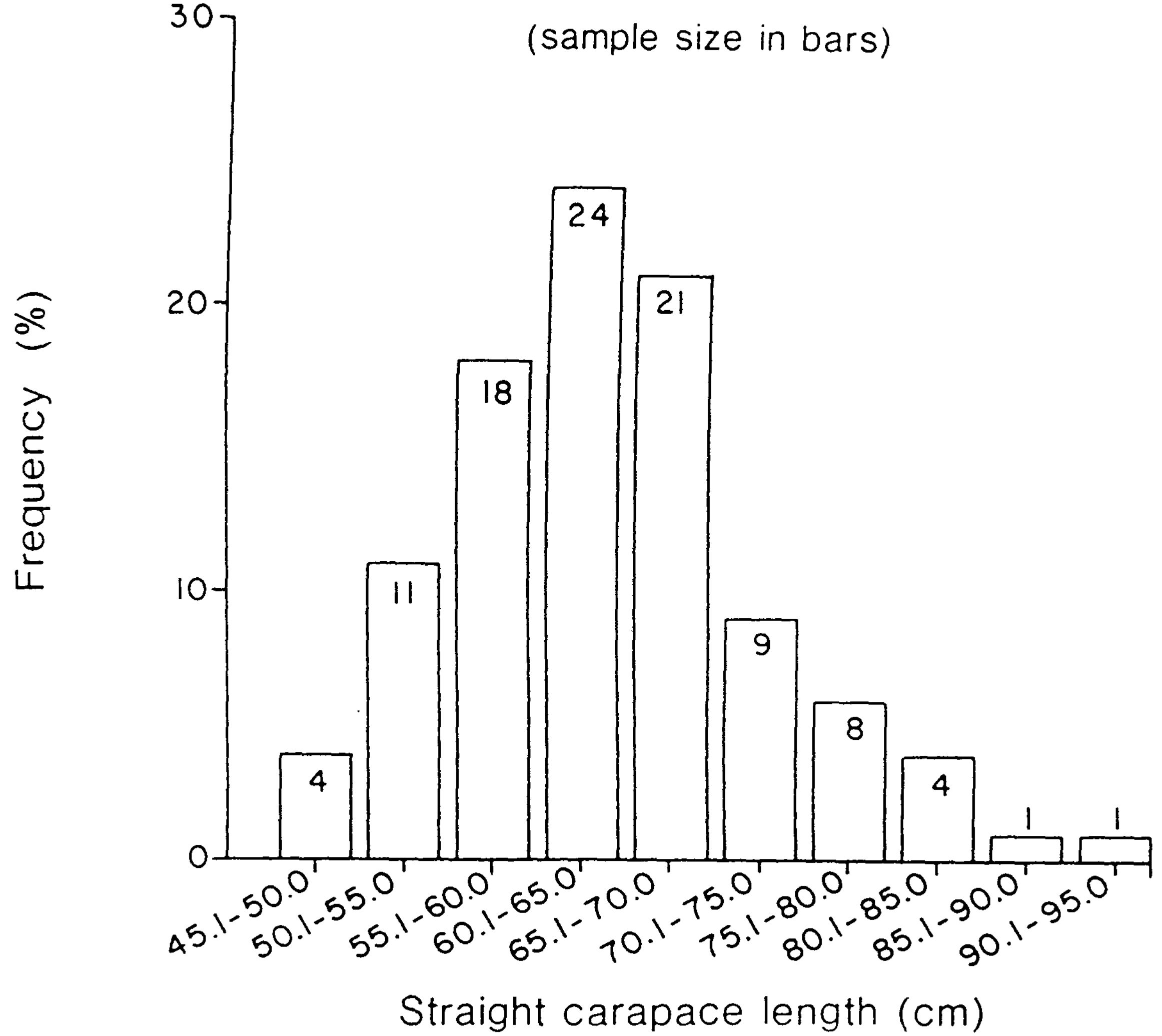


Figure 12

CLS = 48.5 cm (SD = 11.4), CWS = 44.5 cm (SD = 11.39), and WT = 16.7 kg (SD = 10.3). Size classes of live ridleys examined by VIMS for all study years are shown in Figure 13. Size distributions of all turtles were similar to previous years (Musick *et al*. 1984)

3. Tagging

a. Releases

During 1984 48 turtles were tagged by VIMS personnel and 18 were tagged by watermen participating in the VIMS cooperative tagging program. The number of turtles tagged by watermen decreased during 1984 due to the increased effort by VIMS personnel to examine turtles and sample blood. Watermen brought turtles to their dock where they were examined, tagged, and released by VIMS personnel. If VIMS personnel could not be reached turtles were tagged and released by watermen. Standard monel tags were supplied by Dr. Archie Carr of the University of Florida.

b. Recaptures

Seven turtles were recaptured during 1984 (Tables 5 and 6). Six were tagged during the current season, one turtle was originally tagged in 1982 (Table 6). Six turtles were taken in the same set of pound nets or within a few miles of the original capture site. One turtle was captured four times by the same set of pound nets.

Intercapture intervals ranged from 13 days (MT-72-84L) to 112 days (MT-23-84L). Four turtles (MT-72-84L, MT-03-84L, MT-84-84L, and MT-122-84L) were recaptured within a few miles of the original capture site. One turtle (MT-23-84L) tagged on 1 June 1984 in Lynnhaven at the mouth of the

Size classes of live *Lepidochelys* examined by VIMS personnel during 1979-1984

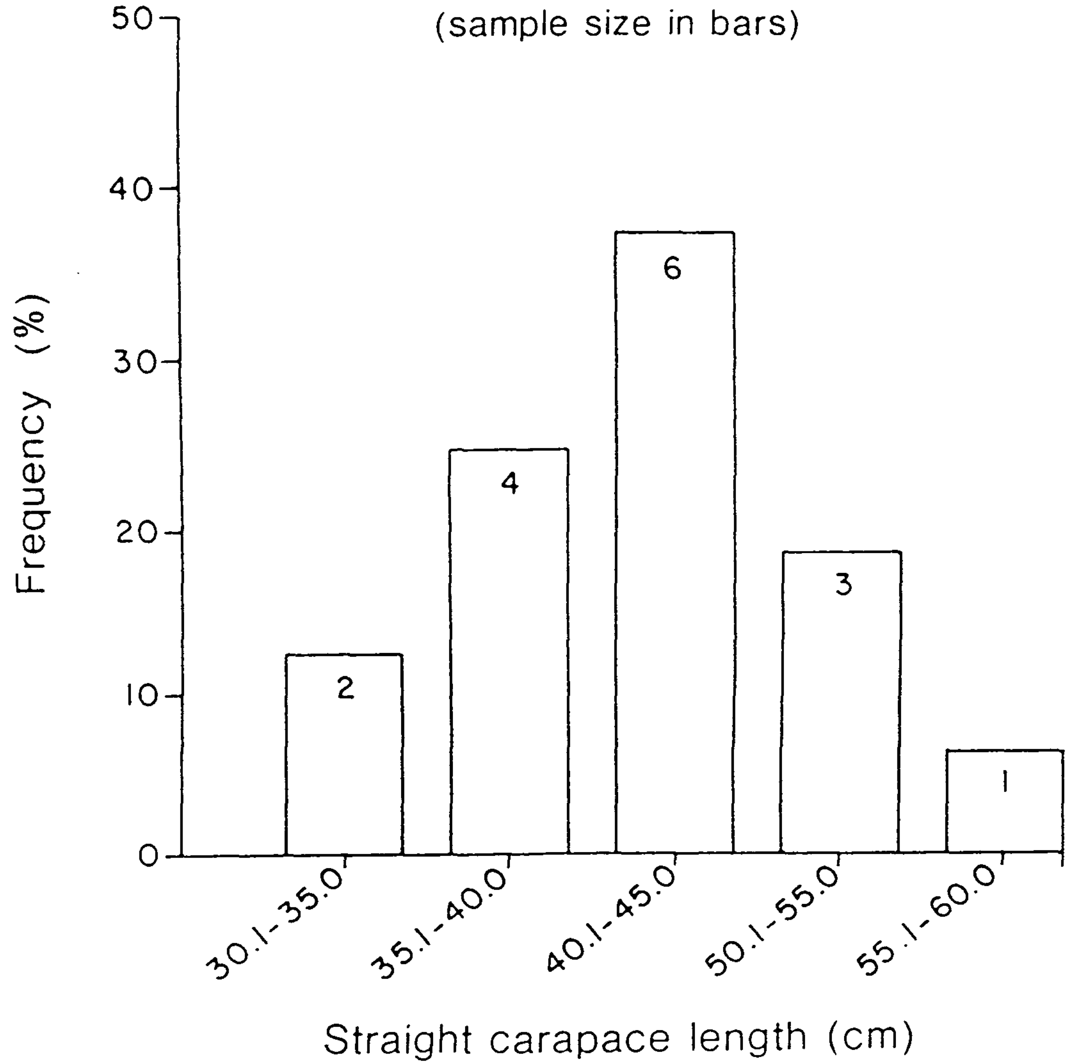


Figure 13

TABLE 5

Loggerhead Turtle
Recaptures During 1984

MT NO. TAG NOS.	CLS* (cm)	DATE TAGGED/ LOCATION	DATE RELEASED/ LOCATION	DATE RECAPTURE/ LOCATION	COMMENTS
MT-72-84L K4661;K4662	70.3	18VI84/Smith Pt., Potomac R., VA	19VI84/New Pt. Comfort, Mobjack Bay, VA	2VII84/Smith Pt., Potomac R., VA	VIMS released first capture; Fishermen released second capture
MT-03-84L K4676;K4677 K4678	64.7	23V84/Gywnn's Island, VA	1VI84/Y-9, York R., VA	6VII84/Cornfield Harbor, Potomac R., MD	One tag removed
MT-23-84L K4685;K4686	67.5	1VI84/Lynnhaven, VA	1VI84/Lynnhaven, VA	20IX84/North side Channel, Delaware Bay Mouth	Tags not removed; Taken in a 40 min. flounder trawl; Apparently healthy
MT-84-84L K4668;K4669	48.4	22VI84/Smith Pt., Potomac R., VA	22VI84/Smith Pt., Potomac R., VA	Unknown date/Cornfield Harbor, Potomac R., MD	Fiesty but skinny
MT-122-84L K2758;K4640; K4641	65.1	VII84/Smith Pt., Potomac R., VA	VII84/Smith Pt., Potomac R., VA	13IX84/Smith Pt., Potomac R., VA	Tagged by fishermen-healthy; Recaptured injured & retagged; Held at VIMS

* CLS= Carapace length straight

TABLE 6

Multiple Recapture of
Loggerhead Turtles
During 1984

MT NO. TAG NOS.	CLS* (cm)	DATE TAGGED/ LOCATION	DATE RELEASED LOCATION	DATE RECAPTURE/ LOCATION	COMMENTS
MT-65-84L K4653;K4654	81.4	15VI84/Smith Pt., Potomac R., VA	15VI84/Smith Pt., Potomac R., VA	(1) 12VII84/Smith Pt.,Potomac R., VA	Healthy; left foreflipper cut-; Anterior portion of humerus-healed;
				(2) 20VII84/Smith Pt., Potomac R., VA	Released by Fishermen on site
				(3) 13IX84/Smith Pt., Potomac R., VA	Released by VIMS-8X84/Bay Mouth, VA
MT-160-82L K2187;K2193	90.0	20IX82/Smith Pt., Potomac R., VA	20IX82/Smith Pt., Potomac R., VA	(1) VII83/Smith, Pt., Potomac R., VA	Released by Fishermen
				(2) 7VII84/Smith Pt., Potomac R., Va	Released by Fishermen
				(3) 23VII84/Smith Pt., Potomac R., VA	Released by Fishermen; tags not removed

* CLS= Carapace length straight

Chesapeake Bay was recaptured by a flounder trawler in the mouth of the Delaware Bay 112 days later.

Two turtles were recaptured more than once during the 1984 season. Turtle MT-65-84L was recaptured three times in the same series of pound nets in the Potomac River where it was originally tagged. The first recapture for MT-65-84L occurred after 28 days, the second after 9 days, and the third 55 days later. Turtle MT-160-82L was originally tagged by VIMS personnel at Smith Point on the Potomac River in 1982 and was recaptured in 1983 in the same set of nets ten months and 20 days later. This turtle was recaptured twice in 1984 in the same set of pound nets. The first recapture in 1984 was 12 months and 16 days after the 1983 capture, and the second recapture was 16 days later. The condition of the animals at each recapture seemed healthy. Turtle MT-65-84L had a partially amputated (but well healed) right fore flipper which caused no apparent disability.

Recaptures confirmed the fishermen's claims that the same turtles are taken in the same nets repeatedly during a season and that individuals return to the same nets year after year. In addition, recaptures support the hypothesis that turtles can move in and around pound nets (in areas with weak currents) without being entangled and drowning.

C. Aerial Surveys

Survey areas are shown in Figure 14. Twelve survey flights were made during 1984 in the southern study area. As reported in previous years (Musick et al. 1984) four east-west transects were flown which averaged 139 linear kilometers. Each flight covered 5% of the study area. This is comparable to surveys flown in 1982 and 1983 (Musick et al. 1984). During 1984 we observed 207 loggerheads, one ridley, one leatherback (dead) and two

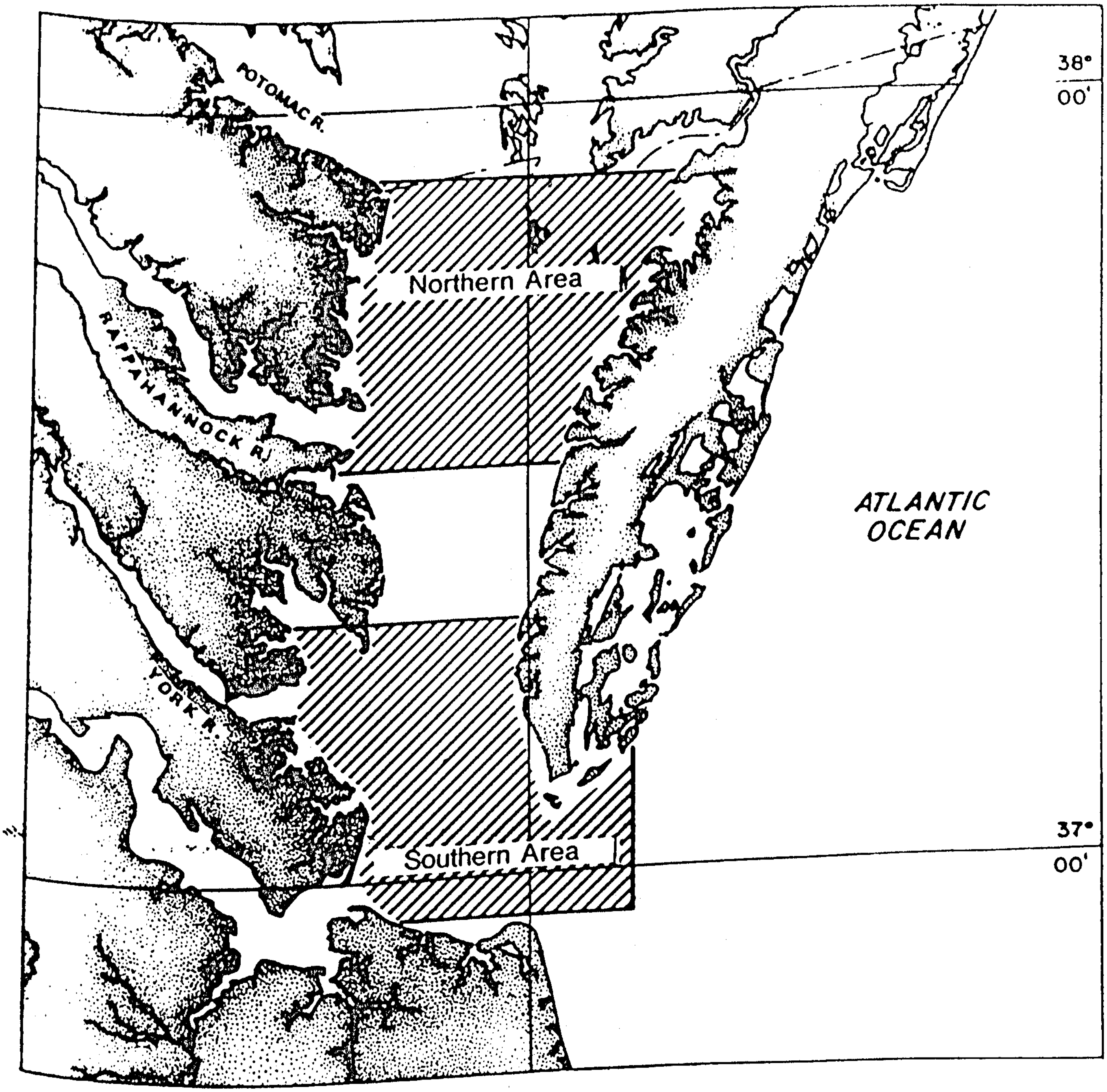


Figure 14. Study Areas For Northern and Southern Aerial Flights.

unknown turtles on southern flights. Species observed by flight are summarized in Table 7. Number of turtles sighted on southern surveys are shown in Figure 15. This is comparable to 1982 and 1983 with the highest density of turtles seen during June. Turtle distance from the flight path (calculated from perpendicular sighting angles) on southern surveys is shown in Figure 16. Eighty six percent of all sightings occurred between 50 meters and 300 meters from the plane's path. Thus, the effective visual strip width is 250 meters on either side of the plane. For two observers the visual path is 0.5 km (2x250 m). Visual path x flight distance = square kilometers observed. The number of turtles observed / km^2 = density. An unadjusted density of 0.22 turtles per km^2 was obtained as an average of all southern surveys during 1984.

Northern Bay flights were flown for the first time in 1984. These were instituted to determine sea turtle distribution within the Bay. Six northern Bay flights were completed. Four east-west transects were flown once a month from May to October. The average length of a survey was 148 linear kilometers and 5% of the study area was covered by each survey. We observed a total of 34 loggerheads. Number of turtles sighted by flight are shown in Figure 17. Number of turtles sighted are believed to drop off after June due to the shift from migrational to feeding behavior. Figure 18 shows turtle distance from the flight path calculated from perpendicular sighting angles. Seventy four percent were sighted between 50 and 300 meters from the flight path of the plane, so we used the above method to determine density. An unadjusted density of 0.06 turtles per km^2 was calculated. Using adjustment factors determined by radiotelemetry we determined densities of 4.1 turtles per km^2 for southern Bay and 1.1 turtles per km^2 for northern Bay. As loggerheads rarely feed in waters less than 4

TABLE 7

Species Summary by Year for Sea Turtles Observed During Southern Aerial Surveys

Species*	1982	1983	1984	Total	Percentages
CC	168	272	207	647	96.8
LK	1	12	1	14	2.1
DC	3	1	1	5	0.8
UN	-	-	2	2	0.3
Total	172	285	211	668	100.0

* CC= *Caretta caretta*
LK= *Lepidochelys kempi*
DC= *Dermochelys coriacea*
UN= Unknown

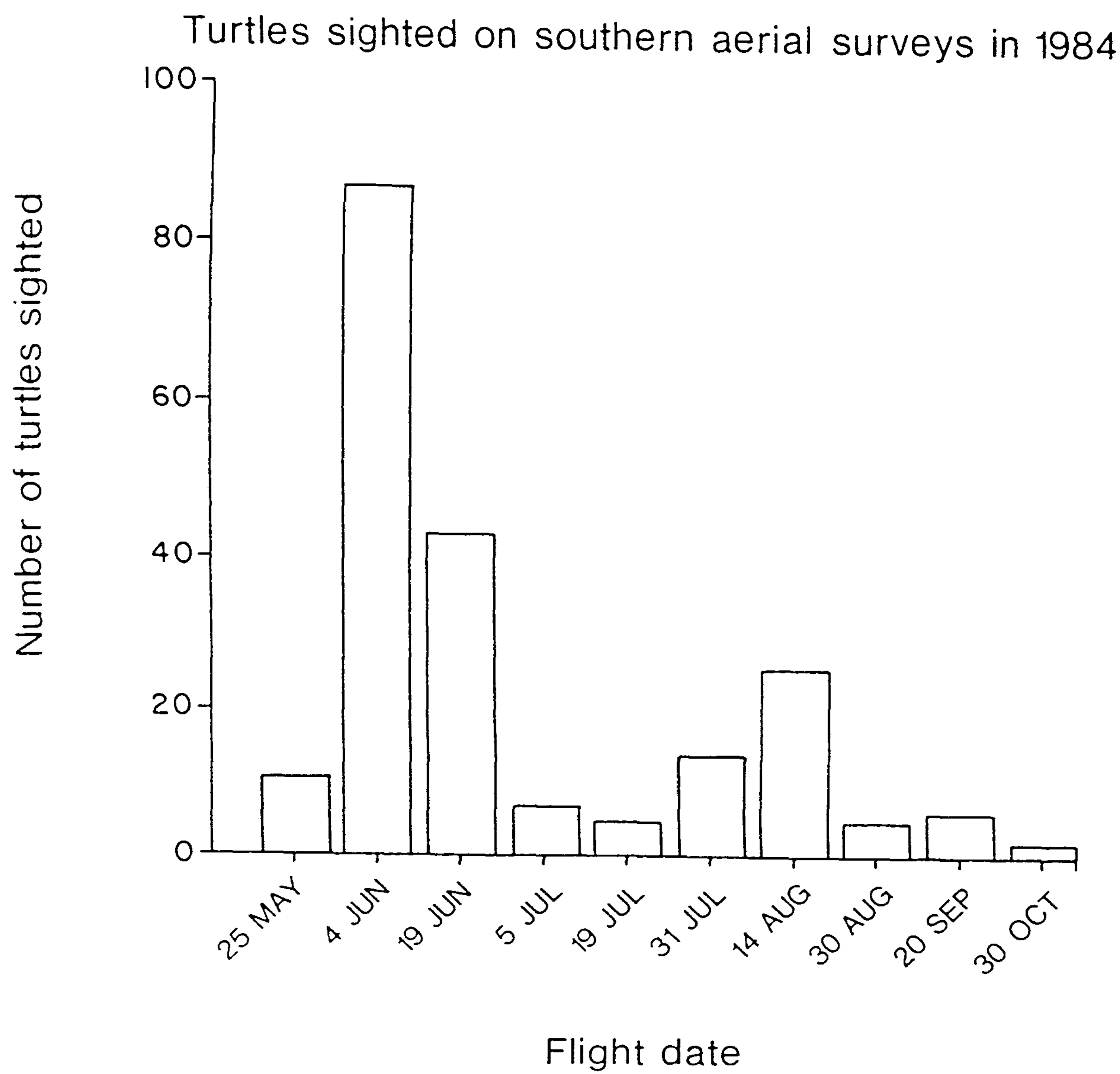

Turtles sighted on southern aerial surveys in 1984
100
80
60
40
20
0
Number of turtles sighted
25 MAY
4 JUN
19 JUN
5 JUL
19 JUL
31 JUL
14 AUG
30 AUG
20 SEP
30 OCT
Flight date

Figure 15

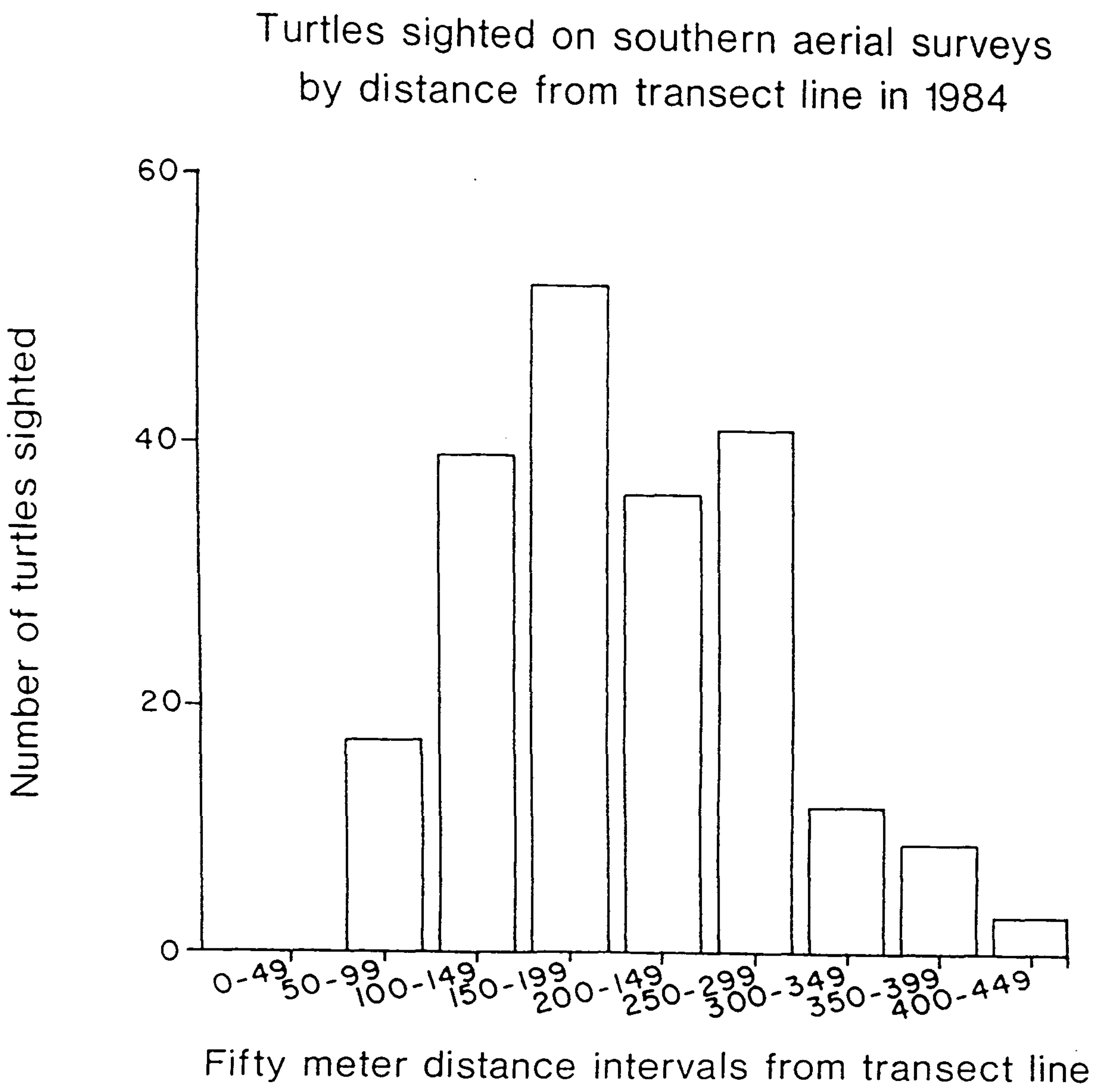

Turtles sighted on southern aerial surveys
by distance from transect line in 1984
Number of turtles sighted
60
40
20
0
0-49
50-99
100-149
150-199
200-149
250-299
300-349
350-399
400-449
Fifty meter distance intervals from transect line

Figure 16

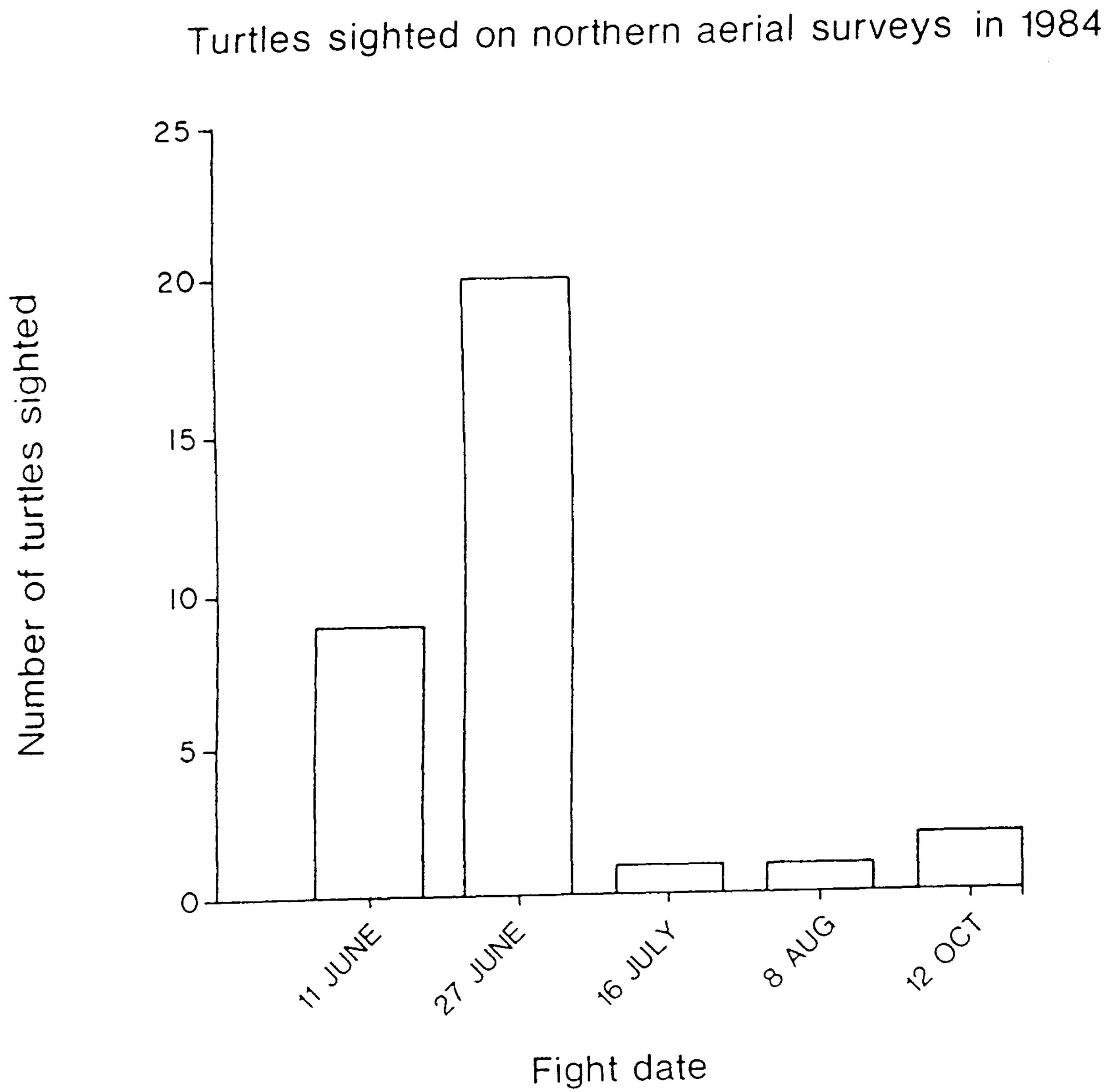

Turtles sighted on northern aerial surveys in 1984
Number of turtles sighted
25
20
15
10
5
0
11 JUNE
27 JUNE
16 JULY
8 AUG
12 OCT
Fight date

Figure 17

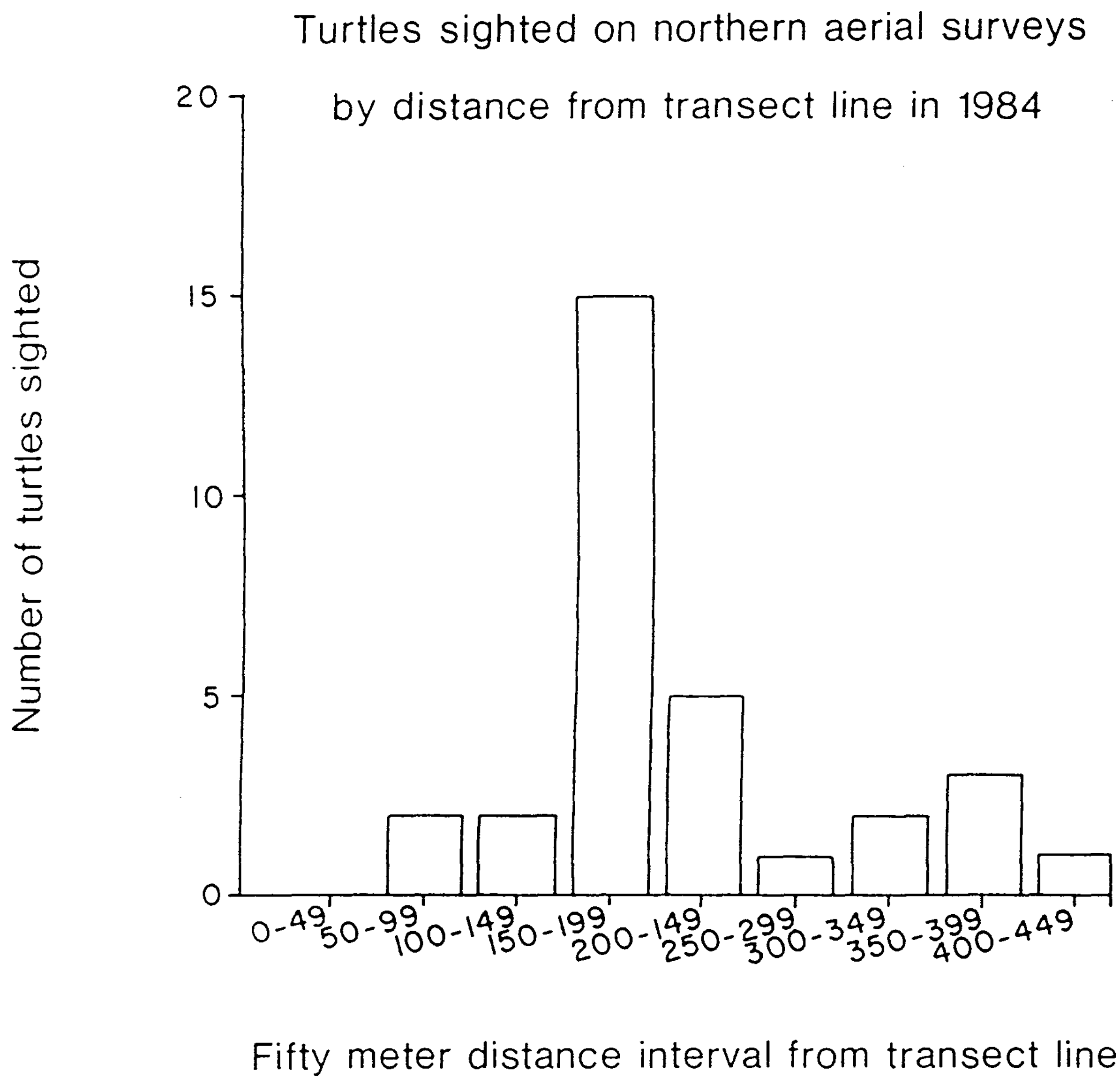

Turtles sighted on northern aerial surveys
by distance from transect line in 1984
Number of turtles sighted
20
15
10
5
0
0-49
50-99
100-149
150-199
200-149
250-299
300-349
350-399
400-449
Fifty meter distance interval from transect line

Figure 18

m deep (Musick *et al.* 1984), calculations for the population estimate were based on a survey area of 1383 km^2; the study area enclosed by the 4 m isobath. This yields an estimate of 5670 loggerheads inhabiting the lower Chesapeake Bay during 1984. This estimate for the lower Bay was consistent with previous estimates shown in Table 8. (Musick *et al.* 1984; Lutcavage and Musick, 1985).

During July a survey was flown over the Delaware Bay to determine the number of sea turtles utilizing that bay as a foraging area. Four east-west transects were flown and only one turtle was seen. As in 1983 we concluded that sea turtles were not present in the lower Delaware Bay during July in numbers detectable by aerial observation.

III. AGE AND GROWTH

Humeri and columnellae bones were removed from dead turtles for age determination. Sixty eight humeri and 56 columnellae were collected as of 1984. Histological preparations of the bone cross sections are being made for examination of growth rings which are evident under the microscope (Zug *et al.* 1986). To determine the number of rings deposited each year we injected 60 loggerheads and four ridleys with oxytetracycline. Oxytetracycline chealates calcium and is incorporated with calcium in the outer layer of growing bone, leaving a mark in the bone that floreses under ultraviolet light. Thus, the florescent ring is a reference point, and the number of rings outside the mark can be correlated with the time elapsed since injection for a determination of the frequency of ring formation. We have collected humeri and columella from three injected turtles. Two died in captivity after rehabilitation attempts failed, 86 and 274 days after

TABLE 8

Yearly Sea Turtle Density in Lower Chesapeake Bay

Density	1982	1983	1984
Unadjusted (turtles per km^2)	0.21	0.37	0.22
Adjusted (turtles per km^2)	3.9	7.0	4.1
Estimated individuals	5,394	9,681	5,670

injection. The third animal stranded 20 days after injection. A tetracycline ring was visible in the 274 day turtle, but subsequent rings were not evident. We anticipate some turtles we injected and released will strand in the future. The length of time for ring formation can then be verified. Analyses are continuing on bones collected to date.

IV. REPRODUCTION

A. Nesting

During 1984 no sea turtle nests were discovered in Virginia. Three non-nesting crawls were examined. One nest was reported on the Virginia/North Carolina border in August: Two bystanders reported a nesting turtle to Back Bay National Wildlife Refuge personnel three weeks after the occurrence. The nest site was examined by VIMS and Fish and Wildlife Service personnel, but no evidence of an egg chamber was found.

B. Sex Ratios

All loggerheads examined were sexually immature. Sex was determined in dead turtles by necropsy. Only three females of those examined had ovarian follicles 3 mm or greater in diameter. One animal examined had follicles between 1-2 cm but was not reproductively active (Owens pers. com.). Two live turtles examined had tails which extended 2-3 cm beyond the edge of the carapace indicating they may have been males. Sex was also determined on live turtles by radioimmune assay of serum for corticosterone (Wibbels et al. 1984). Samples were run by Thane Wibbles and David Owens at Texas A&M University. Sex of all turtles examined are listed in Table 9 by species. Sex ratio (females:males) for all sea turtles assayed at Texas A&M (1.9:1)

TABLE 9

Sex of Sea Turtles Examined by
VIMS Personnel during 1984

Total Number of Turtles Examined

Species*	Male	Female	Unknown	Total
CC	21	45	54	120
LK	1	0	9	10
DC	0	1	2	3
CM	1	1	0	2
Total	23	47	65	135

* CC= *Caretta caretta*
LK= *Lepidochelys kempi*
DC= *Dermochelys coriacea*
CM= *Chelonia mydas*

was similar to the sex ratio for Virginia turtles (2.1:1). Sex ratios for all turtles assayed at Texas were made up of Gulf and Atlantic Coast animals, which are considered the same deme based upon sex ratio (Wibbles *et al.* 1984).

V. FOOD HABITS

The stomach contents of 38 dead turtles were examined. Thirteen were archived for further analysis. The majority of loggerhead stomachs contained horseshoe crab (*Limulus polyphemus*) parts. Eleven contained blue, *Cancer*, or spider crab remains. Fish parts were present in five loggerheads and jellyfish were observed in two loggerhead stomachs. Another loggerhead had only mud in its digestive tract. A few loggerhead stomachs contained small amounts of seaweed, shell fragments, or mud. Eight loggerhead stomachs contained nothing discernible.

Two ridley stomachs were examined. One contained blue crab parts and the other liquid. Nothing was present in the stomach of one leatherback we necropsied. The stomachs of two green turtles contained *Ulva*, *Fucus*, *Zostera*, and hydrozoans. The digestive contents of both green turtles were retained for future examination.

VI. HEALTH AND PHYSICAL CONDITION FACTORS

A. Blood Analysis

Blood sampled from live turtles was used for the development of condition factors for live turtle health determination. Samples run on a

Gilford 3500 serum analyzer possessed excessive variation and the samples are being reanalyzed using other methods.

B. Physical Condition

With the exception of two emaciated and one injured turtle, all turtles examined seemed healthy. A cold stunned loggerhead was recovered on the Eastern Shore of Virginia by VIMS personnel on 12 December, 1984. The body temperature of this animal upon its arrival at VIMS was 8°C, but the turtle was active and apparently unaffected by it's low body temperature. The turtle's body temperature was slowly raised to 20°C and it fed while in captivity. The turtle was flown south and released three weeks after discovery. Two other sick loggerheads were held over the winter at VIMS. One was treated for plastral abscesses, the second suffered from an apparent lung infection. Both were released in 1985.

VII. BEHAVIOR

During 1984 one Kemp's ridley and three loggerhead sea turtles were tracked via telemetry. The Kemp's ridley was tracked for 105 days and exhibited behavior similar to the ridley tracked in 1983 (Musick et al. 1984). The turtle remained in grassbed and shoal areas of Mobjack Bay in areas around crabpots.

The first loggerhead was tracked for 35 days until it's departure from Chesapeake Bay about 26 September. This individual's foraging range was larger than turtles studied in previous years. Movements were mediated by tide (as were turtles previously studied), but it ranged from Thimble Shoals Channel to the York Entrance Channel. The second loggerhead was tracked for

13 days from the Cape Henry release site to the Virginia-North Carolina border where contact was broken. The third turtle was tracked for five days before contact was broken. All turtles were released when we determined (from previous aerial survey data) that the fall emigration had begun. Contact was not re-established with any of the turtles after 30 October due to inclement weather.

VIII. CONCLUSIONS

Four species of sea turtles may be present in the Chesapeake Bay during the warm months of the year. Loggerhead and ridley turtles are the most abundant followed by leatherback and green turtles. Patterns of distribution and abundance of sea turtles in Chesapeake Bay during 1984 were similar to previous years.

Sea turtle strandings recorded by the VIMS program since 1979 have ranged from 76 in 1981 to 203 in 1980; therefore, the 141 strandings recorded in 1984 approximated an average annual mortality. As in other years, most strandings were recorded in June, from zone 3 (Virginia Beach), zone 7 (mouth of the York river), and zone 15 (Eastern shore). Virtually all of the sea turtles stranded in Chesapeake Bay were juveniles. Among those for which cause of death could be determined, pound net entanglement and prop wounds were the two most frequent causes. This pattern agrees with past data.

Decomposition studies showed that turtles caught in pound net leaders do not naturally come free from entanglement and remain until decomposition is complete (although some fishermen untangle and discard dead turtles). The number of turtles that drown in pound net leaders with $\leq$ 30 cm stretch mesh was low in relation to the total killed. Large mesh nets found in strong current areas entangled more turtles than small mesh in areas of weak currents. Nets with stringer type leaders killed more turtles than those with mesh. The use of string leaders in pound nets should be discouraged or outlawed by appropriate management agencies from May through September throughout the Chesapeake Bay.

Patterns of live sea turtle abundance correspond closely with those of the stranded turtles as did species and size composition. Aerial studies of standing stock of sea turtles in lower Chesapeake Bay in summer 1984 averaged 5,670 turtles, a number within the range estimated from other years.

Behavioral studies in 1984 substantiated earlier findings that loggerheads and ridleys are summer residents in Chesapeake Bay with limited foraging ranges and that loggerheads use the channel edges whereas ridleys occupy shallower areas.

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