Preliminary Results of Systematic Sampling for Stranded Sea Turtles in NMFS Statistical Zones 4-5, 17-21, and 28-32

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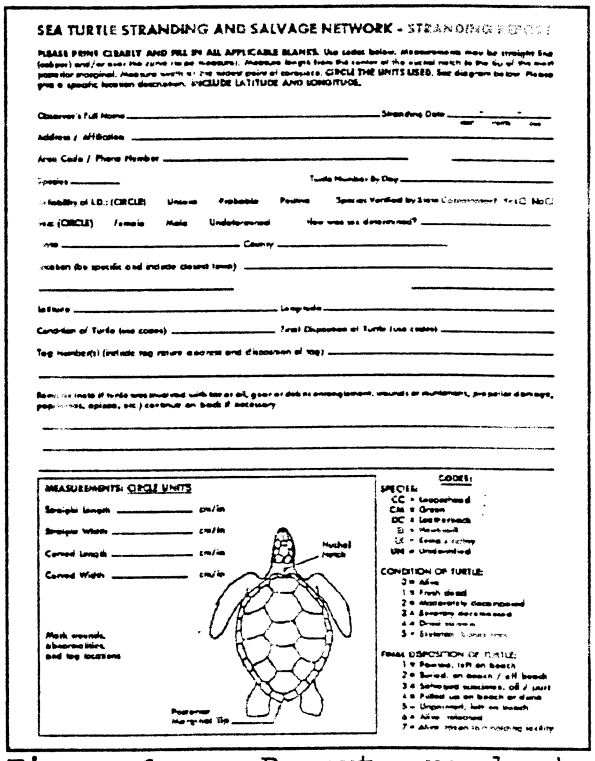
INTRODUCTION AND BACKGROUND

The Sea Turtle Stranding and Salvage Network (STSSN) was established in 1980 to collect data on dead/injured sea turtles that wash up on U.S. Atlantic, Gulf of Mexico, and Caribbean coasts. These wash-ups are referred to as "strandings". The implementation of the network by the Southeast Fisheries Center (SEFC) of the National Marine Fisheries Service (NMFS) followed the recommendation of an ad hoc panel assembled at the First World Conference on Sea Turtle Biology, Conservation, and Management, held in October, 1979 in Washington, D.C. In the ad hoc report, NMFS agreed to organize and implement a network to archive data on sea turtle strandings at the SEFC.
The network was originally organized in the following way in 1980. The SEFC STSSN Coordinator designated a State STSSN Coordinator for each of the eighteen states along the Gulf of Mexico and Atlantic seaboard and one each for Puerto Rico and the U.S. Virgin Islands. Each State STSSN Coordinator established a network of primarily volunteers to collect information on strandings within selected areas of the state coastline. In general, these areas were near homes or workplaces and were therefore easily accessible.

During the nesting season, beaches were sampled daily for nests and any carcasses encountered were reported. In other months, carcasses were reported opportunistically. When beaches were patrolled during the nesting season and no strandings were observed, this information was not reported.

Each time a carcass was encountered, the volunteer completed a standardized form


SEA TURTLE STRANDING AND SALVAGE NETWORK - STRANDING REPORT

PLEASE PRINT CLEARLY AND FILL IN ALL APPLICABLE BLANKS. Use codes below. Measurements may be straight line (caliper) and/or over the curve (tape measure). Measure length from the center of the nuchal notch to the tip of the most posterior marginal. Measure width at the widest point of carapace. CIRCLE THE UNITS USED. See diagram below. Please give a specific location description. INCLUDE LATITUDE AND LONGITUDE.

Observer's Full Name _____ Stranding Date ___ / ___ / ___ (mo / day / yr)

Address / Affiliation _____

Area Code / Phone Number _____

Species _____ Turtle Number By Day _____

Reliability of I.D.: (CIRCLE) Unsure Probable Positive Species Verified by State Coordinator? Yes (C) No (C)

Sex (CIRCLE) Female Male Undetermined How was sex determined? _____

State _____ County _____

Location (be specific and include closest town) _____

Latitude _____ Longitude _____

Condition of Turtle (use codes) _____ Final Disposition of Turtle (use codes) _____

Tag Number(s) (include tag nature, address and disposition of tag) _____

Remarks (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, aplasia, etc.) continue on back if necessary

MEASUREMENTS: CIRCLE UNITS

Straight Length _____ cm/in

Straight Width _____ cm/in

Curved Length _____ cm/in

Curved Width _____ cm/in

Nuchal Notch

Mark wounds, abnormalities, and tag locations

Posterior Marginal Tip _____

CODES:

SPECIES:
CC = Loggerhead
CM = Green
DC = Leatherback
EI = Hawksbill
LK = Kemp's ridley
UN = Undetermined

CONDITION OF TURTLE:
0 = Alive
1 = Fresh dead
2 = Moderately decomposed
3 = Severely decomposed
4 = Dried skeleton
5 = Skeleton, [illegible]

FINAL DISPOSITION OF TURTLE:
1 = Pointed, left on beach
2 = Buried, on beach / off beach
3 = Salvaged [illegible], off / [illegible]
4 = Pulled up on beach or dune
5 = Unpointed, left on beach
6 = Alive, released
7 = Alive, taken to a holding facility

Figure 1 Report used to document stranded sea turtles by the STSSN.

and submitted this to the State STSSN Coordinator for verification (Figure 1). Reports are generally collected for each month by the State Coordinator and submitted to the NMFS STSSN Coordinator at the Miami Laboratory who re-verifies reports and enters them into the centralized data base.

In 1982 we were unsuccessful in attempting to obtain reports indicating that a beach was surveyed and no turtles were observed. Therefore, even in the few areas where sampling of beaches was accomplished in a consistent manner, lack of records of this effort has prohibited estimation of mortality with these data. To provide for the estimation of an index of mortality from strandings requires the consistent sampling of selected areas accompanied with a measure of sampling effort.

In August, 1986 at the Fiscal Year 87 Endangered Species Program planning session held at the SEFC, Miami, it was agreed by the attendees that the most cost efficient approach to develop indices of total mortality was through the systematic sampling of selected sampling zones for stranded turtles. When a measure of sampling effort accompanies the total number of carcasses observed, and it is reasonable to assume that all carcasses are reported or a known proportion of total strandings are reported, then these data can be used to develop comparative indices of total mortality.

This report is the first examination of the data collected via this sampling program which was initiated in March 1987 and phased in through 1987 and 1988 within selected areas of the southeast U.S. coast. The objective of this program is to provide indices of total mortality that can be compared between areas and between years. In particular, the impact of the Turtle Excluder Device (TED) regulations on turtle mortality was to be evaluated from these data. Unfortunately, the on/off cycle of TED implementation (Table I) does not allow for any evaluation of the effect of the TED regulations on turtle mortality at this time. Under a regime of full TED implementation, the index of mortality will be compared to that in this study. Given the lack of TED use within the period 1987 to 1989, the present results are considered to be preliminary baseline indices of total mortality without the inclusion of TEDs

Table I On/off cycle of Ted implementation.

DATE	ZONE(S)	ON/OFF
10/01/87	28	ON
01/01/88	1-4	ON
03/01/88	5-22	ON
04/12/88	ALL	OFF
09/01/88	28	ON
09/18/88	1-21	ON
10/07/88	ALL BUT 28	OFF
01/24/89	29 - 30	ON
02/15/89	29 - 30	ON
03/09/89	29 - 30	ON
05/01/89	ALL	ON
07/10/89	1-21	OFF
07/12/89	ALL	OFF
07/20/89	ALL	ON
07/24/89	ALL	OFF
08/09/89	1-9,28-30	ON
09/08/89	28,1-21	ON
11/30/89	5-9,10-21	OFF

in commercial shrimp trawls.

SAMPLING METHODS

The zones selected for this program include 17-21 in the western Gulf of Mexico (Figure 2); 4 and 5 in the eastern Gulf of Mexico (Figure 2); and 28, 29, 31, and 32 in the Atlantic (Figure 3). These zones were selected because of their accessibility to sampling, the occurrence of shrimping, and the historical occurrence of

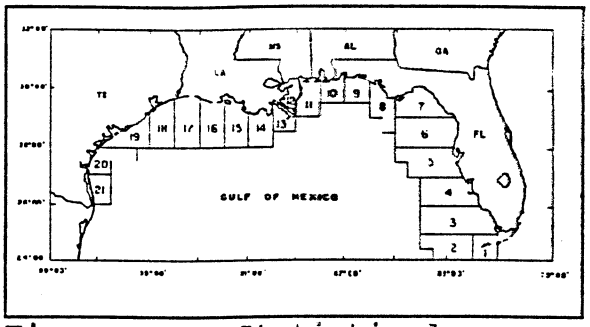


Figure 2 Statistical zones found in the Gulf of Mexico.

significant strandings over the previous three year period 1984-1986 (Schroeder 1987; Schroeder 1986; Anonymous 1985). In December 1988, zone 30 was added to this program as a result of a mass stranding of Kemp's ridleys within zones 29, 30, and 31 from November 1989 through early February 1990 (Figure 3). During this brief period about 100 Kemp's ridleys washed up dead on these beaches. To properly document this event we extended our aerial coverage to include zone 30. This zone was added at essentially no additional cost and has been included in this program since Dec. 1988.
The sampling methods used are consistent within a zone and vary between zones depending on what has been determined to be the optimum survey procedure. Aerial and/or ground surveys are the primary methods used within zones. When aerial surveys are the primary sampling procedure, overflights are accompanied by some level of ground truthing via off road vehicle, foot, or boat. The frequency of sampling, length of coast sampled, and methods of sampling are listed in Table II and summarized below.

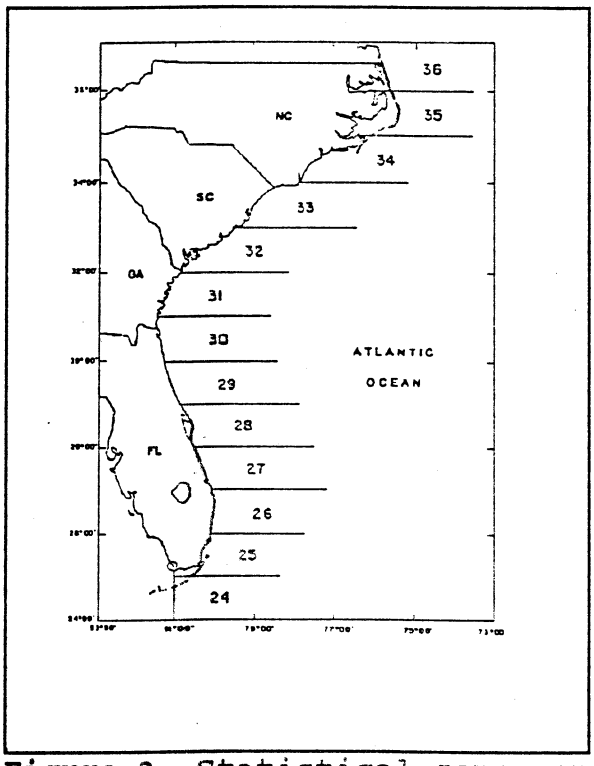


Figure 3 Statistical zones on the Southeast U.S. coast.

Zones 17-21 are surveyed under the supervision of the NMFS/SEFC Galveston Laboratory. Surveys were initiated on March 1, 1987 and are continuing. The length of coast surveyed for each zone is: 57 km in zone

17; 134 km in zone 18; 181 km in zone 19; 117 km in zone 20; and 114 km in zone 21. Surveys are conducted on a weekly basis in zones 17 and 21 and bi-weekly within zones 18, 19, and 20. Aerial surveys are conducted over zones 19 and 20, and beach surveys via off road vehicle and foot are conducted in zones 17,18 and 21. These zones are sampled with the cooperation

Table II Summary of length, sampling methods, and sampling frequency for all Systematic Sampling Zone's.

Zn.	Freq. of Samples	Km of Beach	Sample Methods used[3]
4	Var.[1]	111	A,F
5	Var.[1]	111	A,F
17	4/mo.	57	V,F
18	2/mo.	134	V,F
19	2/mo.	181	A
20	2/mo.	117	A
21	4/mo.	114	V,F
28	4/mo.	135	A,F
29	4/mo.	130	A,F
30	4/mo.	126	A,F
31	Var.[2]	123	A,V,F
32	Var.[2]	170	A,V,F

1 = Zones 4 and 5 are surveyed daily from May through September, and weekly from October through April.

2 = Zone 31 and 32 are surveyed weekly from May through September, and monthly from October through April.

3 = A - aerial survey methods;
V - surveys conducted by vehicles (ie. boat, truck, All Terrain Cycle, etc.)
F - surveys conducted by foot

of: Dr. Frank Judd, Pan American University; Mr. Bill Luken, National Park Service, Dept. of Interior; Dr. Tony Amos, University of Texas; Mr. Brent Giezentaneer, U.S. Fish and Wildlife Service, Dept. of Interior; Dr. Andre Landry, Texas A&M University; and Dr. Gary Gaston, McNeese State University. All stranding forms are sent to the SEFC from the Texas State STSSN Coordinator, Ms. Donna Shaver, National Park Service, Dept. of Interior.

Zones 28 and 29 have been surveyed weekly by fixed wing, single engine aircraft since May 1, 1987. A study to determine the effectiveness of aerial surveys for stranded turtles was conducted within these zones in May through July, 1987. Weekly aerial and beach surveys were conducted and carcass counts compared from ground and aerial surveys. Results from these comparative surveys indicated for these zones, aerial surveys do not miss carcasses. Because overflights require less sampling time than ground surveys and can be completed before there is beach activity that can disturb strandings, aerial surveys were determined to be optimum for censusing dead turtles on open beach. As indicated previously, zone 30 was added when about 100 Kemp's ridleys stranded within zones 29, 30, and 31 in the winter of 1988-1989. The length of beach sampled within each zone is: 135.2 km in zone 28; 129.6 km in zone 29; and 125.9 km in zone 30. These zones are censused under NMFS/SEFC contract to Dr. Llewelyn Ehrhart, of the University of

Central Florida, Orlando, Fl. All forms are sent to the SEFC STSSN Coordinator from the Florida State STSSN Coordinator, Ms. Barbara Schroeder, Florida Dept. of Natural Resources.

Zone 32 is surveyed by airplane, with supporting off-road vehicle, or foot surveys. This is a highly variable coastal area including barrier islands with wide beaches on which carcasses are easily visible to highly vegetated areas where carcasses will only be observed while on foot. However, with this variability in methodology, it is unlikely that many carcasses are not detected and reported throughout the 170.3 km of coastline. Surveys were initiated on October 1, 1987 and are conducted weekly from May 1 to September 30 and monthly from October through April. The expected number of carcasses from the fall through early spring is too low to justify the cost of sampling this difficult coastline. If an unusual stranding event occurs within this zone from October to April, this will justify increased sampling during this period. Ms. Sally Murphy, South Carolina Dept. of Wildlife and Marine Resources, is the State Coordinator who is responsible for all S.C. endangered species data.

Zones 4 and 5 are censused by the Florida Department of Natural Resources (FDNR) through MARFIN funding and sampling began on November 1, 1987. Each zone represents 111 km of coastline which are surveyed daily by beach vehicle from May to September to census turtle nests and turtle carcasses. From October through April, FDNR surveys these zones via single engine, fixed wing aircraft with supportive ground truthing to verify strandings as needed and obtain tissues for histopathological examination as appropriate. Aerial coverage is along the Gulf side of the barrier beaches and does not include inside coastal areas of these beached, where the observation of carcasses is extremely limited and where sampling is logistically difficult. Data are received in Miami via Ms. Barbara Schroeder.

The last zone to implement systematic sampling for strandings was zone 31 which represents over 90% of the Georgia coast, including extensive barrier island coastline. This zone includes 123.2 km of surveyed coastline and was initiated on October 1, 1987. Foot patrols, beach vehicles, and airplane are used along various areas depending on the accessibility of the beach and ease of observing carcasses from aerial platform. All coastal areas, oceanside and bayside are surveyed weekly from May through September. Sampling is conducted monthly from October through April for reasons similar to those for South Carolina. Notably, in the winter 1989, no mass stranding of Kemp's ridleys was reported for zones 29,30, and 31. Mr. Charles Maley, Georgia

Dept. of Natural Resources, is the STSSN Georgia State Coordinator.

ESTIMATION OF MORTALITY

Less than 25% of the strandings are useful for necropsy and tissue examination. Of those that have been examined, cause of death is rarely assigned. Thus, we have not partitioned mortality by possible cause. Based on previous NMFS/SEFC studies, shrimping is probably the most significant cause of non-natural mortality for turtles in the water (Henwood and Stuntz, 1987; Thompson, 1988). Therefore, while estimates are only for total mortality, it is presumed that when TEDs regulations are implemented and enforced, total mortality will measurably decrease. As previously discussed, the lack of continuity in the required use of TEDs prevents a comparison at this time of pre- and post-TED total mortality and all results are considered a baseline for future comparative analysis.

Total turtle mortality per unit of sampling effort (MPUE), where effort is defined as per kilometer surveyed, was estimated for each zone and for each month to examine trends within a year. The consistent measure of sampling effort for all zones is length of coast surveyed. Thus, is it most appropriate to use lineal distance as the measure of effort for this program. For those contiguous zones that are sampled in the same way on the same day, MPUE was estimated for these zones added together. Contiguous zones that allowed for this second estimate were: Zones 28 and 29; and 4 and 5.

Mortality per unit of effort (MPUE) which is defined as the number of strandings reported per kilometer per month, was calculated as follows:

$$MPUE = (TS)/(ETK)$$

TS = total strandings reported within a month

ETK = total kilometers sampled within a month

For ease of interpretation and presentation, each value of MPUE was standardized simply by multiplying by 100, and each resulting standardized estimate represents monthly total mortality per 100 kilometers of coast.

RESULTS AND DISCUSSION

Estimated values of monthly mortality per 100 kilometers of linear sampling were computed for each zone from January 1987 through December 1989 (Figures 4 to 15). These figures include when systematic sampling began (SS) and when TED's were required (IN) and when they were not required (OUT). Only within zone 28 were TEDs required for the majority of time over this three year period (Figure 11). Within the Gulf of Mexico, the cumulative time that TEDs were required was less than when they were not required. In

fact, within most zones during July/August, 1989, TEDs **were required** from July 1-9, **were not required** from July 10-19, **were required** from July 20-23, and **were not required** from July 24 through August 8. Given this regulatory regime, these results can only be interpreted as baseline estimates for mortality without TED usage. Comparisons of estimated mortality cannot be accomplished between periods when TEDs were or were not required because the time periods when TEDs were required were relatively brief compared to when TEDs were not required.

Mortality appeared to be seasonal within most zones. Within zone 32, the peak MPUE occurred from June through August every year. Within zone 31, Georgia, a similar seasonal pattern was demonstrated. The pattern of MPUE for zones 28 through 30 appear to be more uniform and high throughout the year. The only decrease in MPUE appears to have occurred from the period January through March for these zones from 1987 through 1989. Within the Gulf of Mexico zones 4 and 5, peak mpue occurred from about March through May from 1987 through 1989. The magnitude of the index varied with the highest level in 1989 following the elimination of the TED requirement. Within zones 17, 18, 19, and 21 there were no clear seasonal patterns of MPUE and the magnitude of the reported mortality was relatively low compared to all other zones sampled. However, within zone 20, the magnitude of the mortality index was comparable to other zones and there appeared to be a seasonal peak from April through May, a decrease in June and increasing MPUE from July through August.

Because TEDs were largely not required since publication of the regulations in June, 1987, these results cannot be interpreted relative to these regulations. These results represent a baseline index of mortality within these selected sampling areas. Notably, while the magnitude of mortality may be different before the systematic sampling was implemented, the pattern of mortality in the eastern Gulf of Mexico and Atlantic zones are similar before and after systematic sampling. This inconsistency in the seasonality of MPUE before and after the implementation of the systematic samples, indicates that the voluntary stranding network probably provided excellent coverage and that most strandings were reported and recorded. Within these zones, mortality as represented by carcasses washing up on the coast, appears to be highly seasonal. The magnitude of this index of mortality is determined by the causes, the relative abundance of turtles and prevailing seasonal conditions which wash carcasses up on the coast for detection.

When TEDs are fully implemented, a comparison of MPUE between areas, and between years will be completed to detect changes in this index. This will provide one way for

evaluating the effectiveness of TEDs in reducing turtle mortality, given the rate of compliance with the regulations is known.

Figures 4 - 17

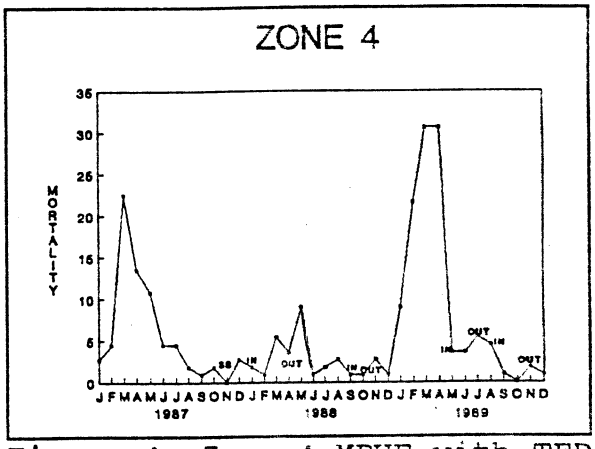


Figure 4 Zone 4 MPUE with TED cycle indicated.

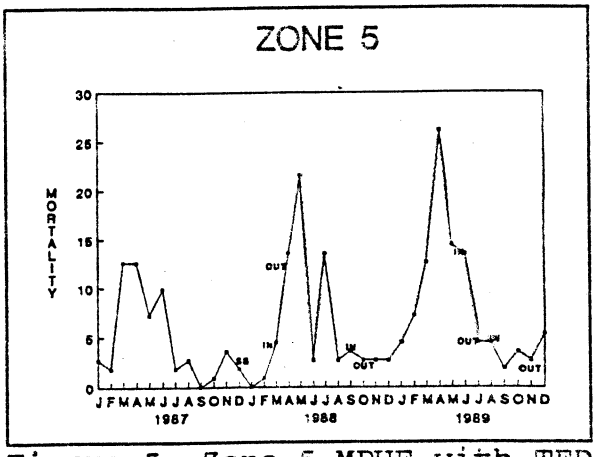


Figure 5 Zone 5 MPUE with TED cycle indicated.

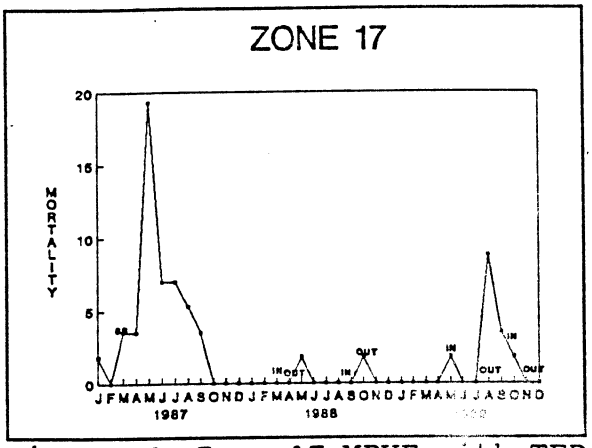


Figure 6 Zone 17 MPUE with TED cycle indicated.

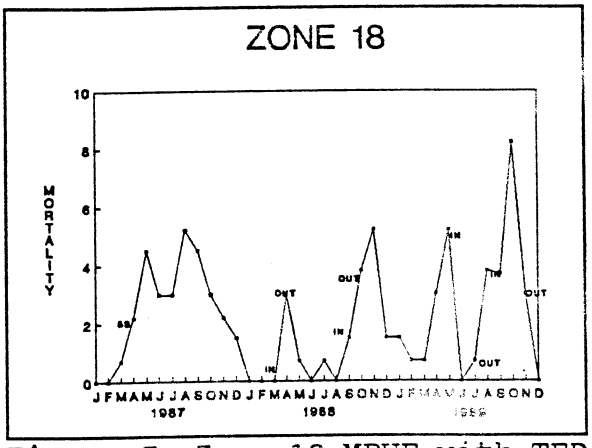


Figure 7 Zone 18 MPUE with TED cycle indicated.

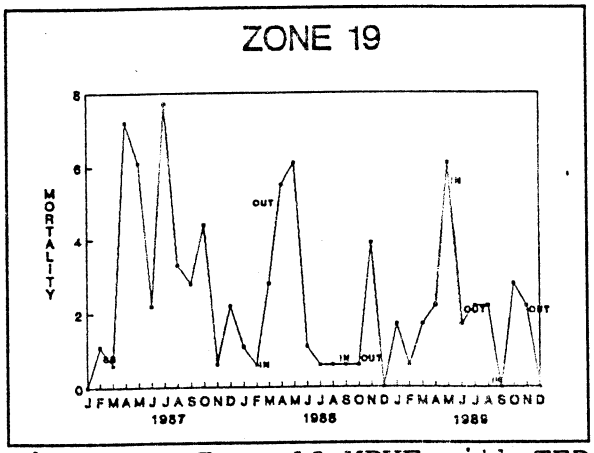


Figure 8 Zone 19 MPUE with TED cycle indicated.

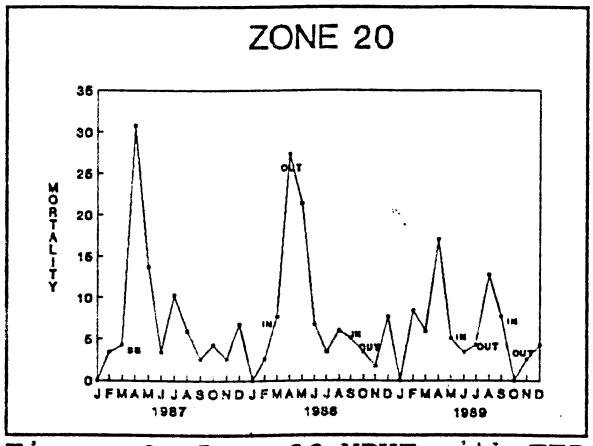


Figure 9 Zone 20 MPUE with TED cycle indicated.

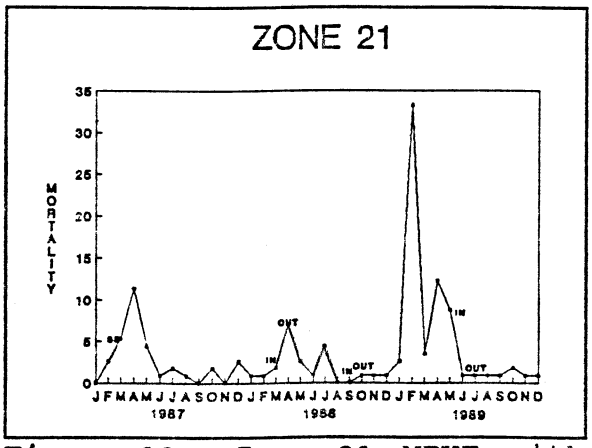


Figure 10 Zone 21 MPUE with TED cycle indicated.

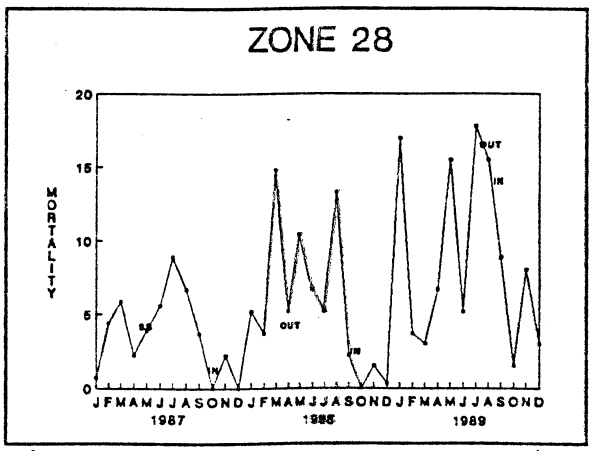


Figure 11 Zone 28 MPUE with TED cycle indicated.

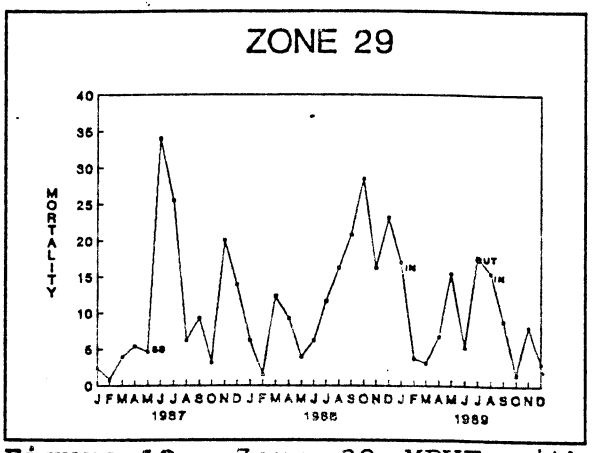


Figure 12 Zone 29 MPUE with TED cycle indicated.

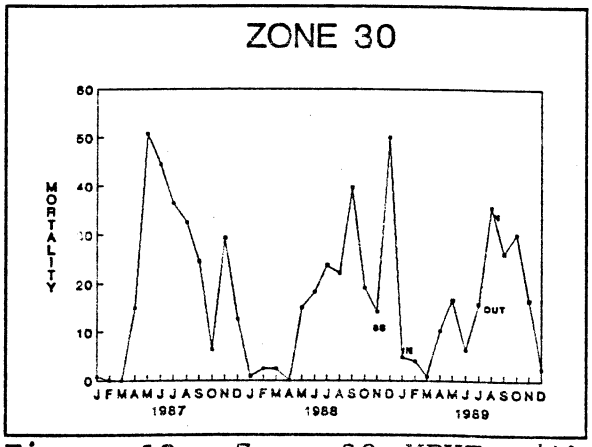


Figure 13 Zone 30 MPUE with TED cycle indicated.

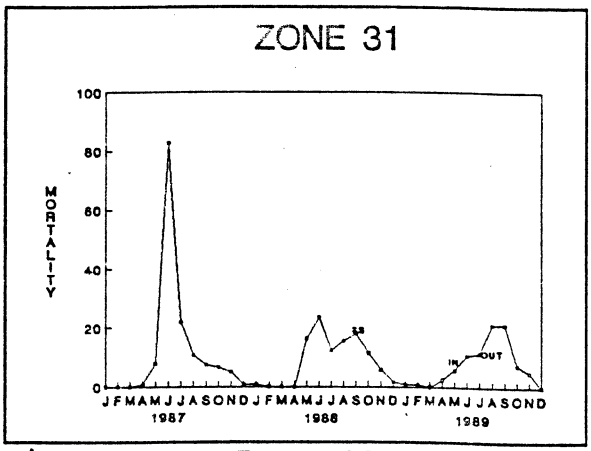


Figure 14 Zone 31 MPUE with TED cycle indicated.

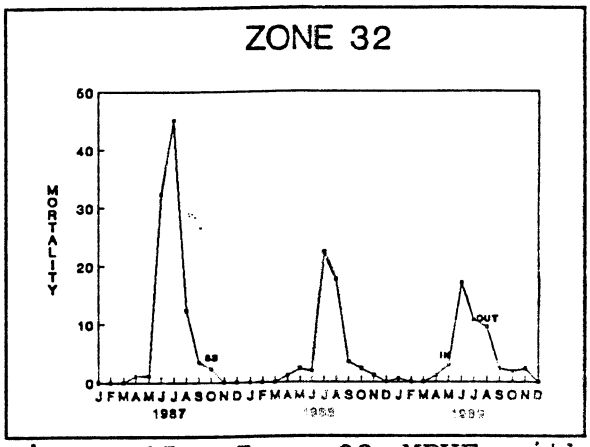


Figure 15 Zone 32 MPUE with TED cycle indicated.

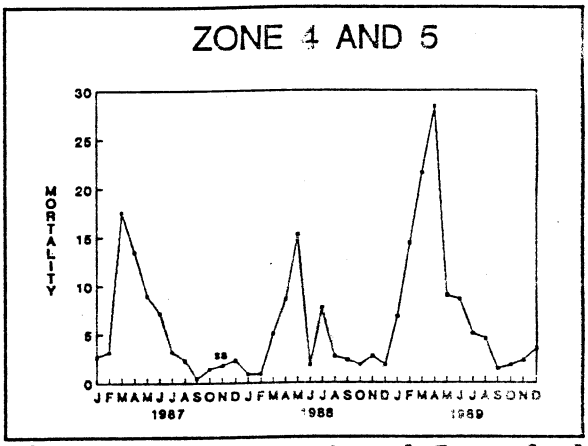


Figure 16 Zones 4 and 5 pooled MPUE.

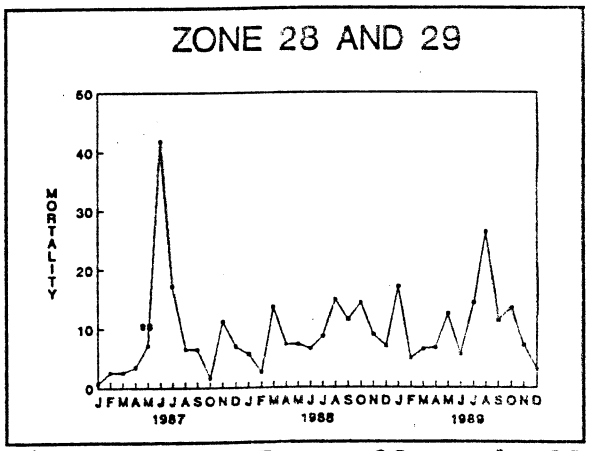


Figure 17 Zone 28 and 29 pooled MPUE.

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