THE EFFECTS OF OPERATIONS OF THE SAN ONOFRE NUCLEAR GENERATING STATION ON FISH

FINAL REPORT
(Vol. 2 of 2)

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APPENDIX A -- Net Gear, Sampling and Analysis Protocols for Midwater and Benthic Fishes

APPENDIX A

PART 1. NET GEAR AND SAMPLING PROTOCOLS FOR MIDWATER FISHES

Introduction

A lampara seining task was initiated in September 1979. Lampara seining is the least biased (Thomas et al. 1979; Allen and DeMartini 1983) netting technique for estimating the relative abundances (CPUE = catch per unit of effort) of coastal, pelagic ("midwater") fishes. These small fishes, principally queenfish and white croaker, together with northern anchovy, dominate the nearshore, midwater habitat in numbers and biomass (Allen and DeMartini 1983). Preoperational (Before) sampling of these fishes was completed at the end of May 1982. Interim monitoring began in June 1982 and continued at reduced effort through March 1984. Operational-phase (After) sampling began in April 1984 and concluded in August 1986.

A same type and size of net and associated gear, and the same team of net-deployment personnel were maintained from the start of pre operational sampling to assure consistency in fishing operations. The shipboard sampling protocols of biological personnel were periodically checked to assure further consistency.

On each cruise, three fixed longshore locations (two Impact, one Control; Appendix A, Fig. 1) were sampled with a single (unreplicated) net-set within each of two fixed depth blocks; particular subblocks were selected randomly on each cruise from within each depth block at each location. The single most important aspect of this design was that <u>all</u> depths at <u>all</u> locations were sampled with <u>equal</u> effort on <u>each</u> cruise. Pilot lampara data demonstrated the necessity of such a design, in order to factor out the strong date effects exhibited by the highly vagile fishes in this assemblage. All lampara samplings were performed at night because catch data are less variable at night. (Many midwater midwater fishes

aggregate in resting schools during the day and disperse to feed at night: Allen and DeMartini 1983. Visual net avoidance is also less at night.)

Gear Specifications and Fishing Protocols

A lampara seine (round semipursing net, Scofield 1951) of standard dimensions was deployed and retrieved in consistent fashion by the crew of the commercial live-bait tender City of Oceanside for the September 1979-May 1982 baseline sampling and for interim-phase sampling through early winter 1983. Accidental loss of this vessel in February 1983 necessitated outfitting a sister ship (Trojan) with identical net and gear during winter-spring 1983. Interim sampling resumed in August 1983 and continued unchanged throughout the operational period. Specifications of the net, associated gear, and fishing techniques used are as follows: wings (2)--each 118 m long x 24 m deep of 15-cm stretch mesh at their free ends and tapering to a bag of 1.25-cm stretch mesh; set time--2 min; retrieval time--7.9 $\pm$ .1 min; net retrieved by three nonbiologists with the aid of a hydraulic winch; catch brailed from bag at shipside (bag not lifted aboard); estimated area (approx. circular) enclosed by net--4,584 $\pm$ 38 (n = 40 sets) m^2; biological sampling crew of three UCSB personnel.

Specific Sampling Design and Rationale

All lampara catches whose data were used for Before/After comparisons of numerical abundances at Impact and Control locations were completed at "night" (1-6 hr after sunset) at twice-weekly to once-monthly intervals during baseline and operational periods (Appendix A, Table 1). On each cruise each of three longshore locations was sampled with one net-set within each of two depth blocks (shallow, S, = 5-10 m; mid-depth, M, = 11-16 m). Each depth block was approximately 1 km onshore/offshore x 1 km longshore (Appendix A, Fig. 1) and was subdivided into twenty-five 200-m x 200-m subblocks from which the one subblock to be sampled on a particular cruise was randomly chosen. The three longshore locations sampled on each cruise were a Near Impact (NI) area ($\pm$ 1/2 km of the SONGS Unit 1 line); a Far Impact (FI) area (2-3 km downcoast of Unit 1); and a Control (C) area (18-19 km downcoast of Unit 1; Appendix A, Fig. 1).

All six combinations of depth blocks and locations were sampled during a single 6-hr period to minimize the effects of both the likely interday and known

diel (Hobson and Chess 1976; DeMartini Allen, Fountain, and Roberts 1985) changes in the distribution and abundance of species such as queenfish. Both daytime and nighttime surveys of coastal pelagics were conducted during the early baseline period from September 1979 through April 1981. These day/night surveys conclusively demonstrated that many of the major species of coastal pelagics make diel onshore and offshore migrations (DeMartini and Larson 1980a; DeMartini et al. 1981a; Allen and DeMartini 1983). The two (S,M) depth blocks were established during the summer of 1979 after analyses of pilot lampara data for May 1978-August 1979 (DeMartini and Larson 1980a) indicated that there was only one major break point (at ~ 10-m bottom depth) in the distribution and composition of coastal, pelagic fishes between 5- and 30-m depths.

Concurrent samples were taken in both S and M blocks at the FI and C locations and in the M block at the NI location on each cruise beginning in September 1979. Because of the presence of buoys and other construction hazards, however, nighttime samples in S block at the NI location were possible only after most of these obstacles were removed when SONGS offshore construction was completed in spring 1981. Hence the baseline data for shallow depths immediately near ($\leq$ 1/2 km of) the SONGS Unit 1 offshore intake structure spans only about one year from April 1981 to May 1982.

Numerical CPUE data collected during fall (October-December) months were found to inflate the variances of baseline deltas (location differences in catches) for major species of coastal, pelagic fishes (DeMartini et al. 1981c). This was due to longshore differences in the timing of the semiannual onshore and offshore migrations made by these fishes during the fall-winter period (DeMartini and Larson 1980a; DeMartini et al. 1981a; Allen and DeMartini 1983). Deletion of these fall data reduces variances of the deltas (DeMartini et al. 1981c). Hence all seine data for October-December periods have been omitted from our impact-test comparisons between baseline and operational periods.

Types of Biological Data

All of the fishes present in each catch of average or lesser magnitude were brailed aboard ship and held in bait receivers. All fishes were counted by species with the exception of the atherinid (silverside) and Anchoa species complexes, for which it was too time-consuming to identify individuals to species.

A maximum of two aliquots of about 50 individuals each of queenfish (and, since March 1982, white croaker) were sacrificed for sex- and length-frequency analyses. All other fishes were returned overboard as they were counted. In the laboratory, sex-specific lengths (± 1 mm, SL) were determined for queenfish and white croaker. The total wet weight (± .1 kg) of the catch of each of these two species of croakers was determined aboard ship.

In cases of rare, very large (> 100 kg) catches of many fish, entire net-hauls were subsampled at shipside using standard live-bait brailers. Evaluation of the precision of subsampling appears in the April 1984 Trimester Report (DeMartini et al. 1984a). The subsampling of seine catches has caused minor (5%) losses of precision in estimating CPUE of queenfish and white croaker; information loss in subsampling for length composition was greater, but acceptable (5% to 20%; DeMartini et al. 1984a). Subsampling accuracy was subsequently evaluated as data became available. For queenfish (the only species for which subsampleable catches occurred once evaluation procedures were established), the effect of subsampling on accurately estimating CPUE was negligible (Appendix A, Table 2).

Data Used in Analyses

CPUE Data. The numerical and biomass catch data provide two types of CPUE (catch-per-unit-of-effort) indices of abundance used in fisheries biology and management estimates. For all species except queenfish, catches were recorded as individuals of all sizes and both sexes pooled. For queenfish, data were evaluated for major maturity and sex categories. The number of immature, adult male, and adult female queenfish present in net-hauls were calculated by applying data on proportions of categories (determined by subsequent examination of subsamples in the laboratory) to the total catch of queenfish. In addition, we evaluated the queenfish catch data for young-of-the-year (YOY), as distinct from "older juvenile and adult" (OJ) age-groupings. The YOY age-grouping was identified from size mode data, assisted by P. Tomlinson's modification of the NORMSEP size-frequency analysis program (Abramson 1971; summarized in Appendix A, part 3).

Only numerical CPUE data were analyzed in our baseline study (DeMartini et al. 1983a). Impact analyses in the present report are also limited to numerical CPUE, because biomass data are generally less precise than numerical data (e.g., DeMartini and Allen 1984).

Size-Composition Data. These data are complementary to CPUE data in that they often allow one to evaluate several meaningful size (age) groupings within catches. The most frequently useful subgroupings are those of YOY (young-of-year, age 0+) and older fish. Abundance of the YOY group is generally used to characterize the recruitment (year-class) success of marine fishes (Pitcher and Hart 1982).

Queenfish and white croaker, queenfish in particular, have been targeted for measurement because of their high levels of entrapment both as juveniles and as adults. Length-frequency as well as abundance data have been divided into size- and sex-categories because ontogenetic changes in behavior (DeMartini, Allen, Fountain, and Roberts 1985) might make different categories differentially susceptible to various sources of SONGS impact. Size-specific entrapment might induce changes in the size- and sex-structure of queenfish near the SONGS intakes. (Immatures may be more vulnerable to entrapment than adults, due to the more onshore nighttime distribution of immatures, as well as the lesser ability of smaller fish to avoid withdrawal.) Queenfish size- and sex-structure was characterized throughout the baseline, interim, and operational monitoring periods. The monitoring of white croaker size- and sex-composition began in March 1982.

For each seine-haul, two samples of approximately 50 fish each of queenfish and white croaker were returned to the laboratory to be measured and sexed. For seine-hauls in which the number of queenfish and white croaker caught was greater than the number measured, the number of fish in each 5-mm length class was multiplied by the number captured divided by the number measured. In this manner, length distributions could be generated for the entire catch.

APPENDIX A -- TABLE 1

LIST OF SAMPLING DATES FOR LAMPARA SEINE CRUISES
(by SONGS Operating Period)

(A) PREOPERATIONAL

Day-Month-Year	Near Impact		Far Impact		Control	
	S	M	S	M	S	M
05 Sep 79	-	X	X	X	X	X
26 Sep 79	-	X	X	X	X	X
10 Oct 79*	-	X	X	X	X	X
02 Nov 79*	-	X	X	X	X	X
05 Nov 79*	-	X	X	X	X	X
15 Nov 79*	-	X	X	X	X	X
26 Nov 79*	-	X	X	X	X	X
11 Dec 79*	-	X	X	X	X	X
19 Dec 79*	-	X	X	X	X	X
19 Mar 80	-	X	X	X	X	X
10 Apr 80	-	X	X	X	X	X
24 Apr 80	-	X	X	X	X	X
08 May 80	-	X	X	X	X	X
20 May 80	-	X	X	X	X	X
05 Jun 80	-	X**	X	X**	X	NQ
19 Jun 80	-	X	X	X	X	X
15 Jul 80	-	X	X	X	X	X
31 Jul 80	-	X**	X	X**	X	NQ
19 Aug 80	-	X	X	X	X	X
28 Aug 80	-	X	X	X	X	X
08 Sep 80	-	X	X	X	X	X
17 Sep 80	-	X	X	X	X	X
23 Sep 80	-	X	X	X	X	X
06 Oct 80*	-	X	X	X	X	X
24 Oct 80*	-	X	X	X	X	X
28 Oct 80*	-	X	X	X	X	X
06 Nov 80*	-	X	X	X	X	X
25 Nov 80*	-	X	X	X	X	X
11 Dec 80*	-	X	X	X	X	X
18 Dec 80*	-	X	X	X	X	X
06 Jan 81	-	X	X	X	X	X
26 Jan 81	-	X	X	X	X	X
02 Feb 81	-	X**	X	X**	X	NQ
11 Feb 81	-	X	X	X	X	X
03 Mar 81	-	X	X	X	X	X
18 Mar 81	-	X	X	X	X	X

*Cruise excluded from baseline/operational-phase comparisons

**Collection excluded because of NQ haul at Control location

APPENDIX A -- TABLE 1(continued)

(A) PREOPERATIONAL

Day-Month-Year	Near Impact S	Near Impact M	Far Impact S	Far Impact M	Control S	Control M
01 Apr 81	X	-	X	-	X	-
04 Apr 81	-	X	-	X	-	X
13 Apr 81	X	-	X	-	X	-
14 Apr 81	-	X	-	X	-	X
20 Apr 81	X	-	X	-	X	-
23 Apr 81	-	X	-	X	-	X
28 Apr 81	X	-	X	-	X	-
29 Apr 81	-	X	-	X	-	X
04 May 81	X	-	X	-	X	-
05 May 81	-	X	-	X	-	X
11 May 81	X	-	X	-	X	-
13 May 81	-	X	-	X	-	X
19 May 81	X	-	X	-	X	-
20 May 81	-	X	-	X	-	X
26 May 81	X	-	X	-	X	-
27 May 81	-	X	-	X	-	X
08 Jun 81	X	X	X	X	X	X
18 Jun 81	X	X	X	X	X	X
22 Jun 81	X	X	X	X	X	X
25 Jun 81	X	X	X	X	X	X
08 Jul 81	X	X	X	X	X	X
14 Jul 81	X	X	X	X	X	X
20 Jul 81	X	X	X	X	X	X
30 Jul 81	X	X	X	X	X	X
05 Aug 81	X	X	X	X	X	X
17 Aug 81	X	X	X	X	X	X
24 Aug 81	X	X	X	X	X	X
03 Sep 81	X	X	X	X	X	X
10 Sep 81	X	X	X	X	X	X
24 Sep 81	X	X	X	X	X	X
08 Oct 81*	X	X	X	X	X	X
20 Oct 81*	X	X	X	X	X	X
17 Nov 81*	X	X	X	X	X	X
24 Nov 81*	X	X	X	X	X	X
04 Dec 81*	X	X	X	X	X	X
14 Dec 81*	X	X	X	X	X	X
11 Jan 82	X	X	X	X	X	X
18 Jan 82	X	X	X	X	X	X
22 Jan 82	X	X	X	X	X	X
18 Feb 82	X	X	X	X	X	X
23 Feb 82	X	X	X	X	X	X
26 Feb 82	X	X	X	X	X	X

*Cruise excluded from baseline/operational-phase comparisons

APPENDIX A -- TABLE 1 (continued)

(A) PREOPERATIONAL

Day-Month-Year	Near Impact S	Near Impact M	Far Impact S	Far Impact M	Control S	Control M
30 Mar 82	X	X	X	X	X	X
05 Apr 82	X	X	X	X	X	X
19 Apr 82	X	X	X	X	X	X
23 Apr 82	X	X	X	X	X	X
26 Apr 82	X	X	X	X	X	X
29 Apr 82	X	X	X	X	X	X
10 May 82	X	X	X	X	X	X
20 May 82	X	X	X	X	X	X
27 May 82	X	X	X	X	X	X
Total No. Quantitative Cruises	43	76	79	76	79	76
No. Cruises (Fall Dates Deleted)	37	56	59	56	59	56

(B) INTERIM

Day-Month-Year	Near Impact S	Near Impact M	Far Impact S	Far Impact M	Control S	Control M
08 Jun 82	X	X	X	X	X	X
30 Jun 82	X	X	X	X	X	X
13 Jul 82	X	X	X	X	X	X
27 Jul 82	X	X	X	X	X	X
24 Aug 82	X	X	X	X	X	X
30 Aug 82	X	X	X	X	X	X
22 Sep 82	X	X	X	X	X	X
30 Sep 82	X	X	X	X	X	X
18 Oct 82*	X	X	X	X	X	X
25 Oct 82*	X	X	X	X	X	X
30 Aug 83	X	X	X	X	X	X
27 Sep 83	X	X	X	X	X	X
11 Oct 83*	X	X	X	X	X	X
08 Feb 84	X	X	X	X	X	X
13 Mar 84	X	X	X	X	X	X
Total No. Quantitative Cruises	15	15	15	15	15	15
No. Cruises (Fall Dates Deleted)	12	12	12	12	12	12

*Cruise excluded from baseline/operational-phase comparisons

APPENDIX A -- TABLE 1 (continued)

(C) OPERATIONAL

Day-Month-Year	Near Impact S	Near Impact M	Far Impact S	Far Impact M	Control S	Control M
30 Apr 84	X	X	X	X	X	X
22 May 84	X	X	X	X	X	X
26 Jun 84	X	X	X	X	X	X
07 Aug 84	X	X	X	X	X	X
18 Sep 84	X	X	X	X	X	X
05 Feb 85	X	X	X	X	X	X
10 Apr 85	X	X	X	X	X	X
23 Apr 85	X	X	X	X	X	X
07 May 85	X	X	X	X	X	X
21 May 85	X	X	X	X	X	X
04 Jun 85	X	X	X	X	X	X
01 Jul 85	X*	X*	X*	X*	NQ	-[1]/
03 Jul 85	X	X	X	X	X	X
10 Jul 85	X	X*	X	X*	X	-[2]/
30 Jul 85	X	X	X	X	X	X
15 Aug 85	X	X	X	X	X	X
11 Sep 85	X	X	X	X	X	X
20 Sep 85	X*	X*	X*	X*	NQ	-[1]/
25 Sep 85	X	X	X	X	X	X
15 Jan 86	X	X	X	X	X	X
28 Jan 86	X	X	X¬	X	X	X
12 Feb 86	X	X	X	X	X	X
19 Mar 86	X	X	X	X	X	X
31 Mar 86	X	X	X	X	X	X
22 Apr 86	X	X	X¬	X	X	X
29 Apr 86	X	X	X	X	X	X
13 May 86	X	X	X	X	X	X
22 May 86	X	X	X	X	X	X
10 Jun 86	X	X	X	X	X	X
17 Jun 86	X	X	X	X	X	X
23 Jul 86	X	X	X¬	X	X	X
13 Aug 86	X	X	X	X	X	X
Total No. Quantitative Cruises	32	32	32	32	30	29
No. Cruises (Fall Dates Deleted)	32	32	32	32	30	29

[1]/ Seine haul at Control, mid-depth not taken because of gear malfunction on the preceding Control, shallow haul.

[2]/ Seine haul at Control, mid-depth mistakenly taken as a second haul in the shallow depth block; this second, shallow set (# 850077) was not analyzed.

*/ Collection deleted from analysis because of inadequate Control data.

¬/ Shallow seine-hauls taken at ~11 m.

APPENDIX A -- TABLE 2

PELAGIC FISHES: SUMMARY RESULTS OF KOLMOLGOROV-SMIRNOV (K-S) TESTS OF DIFFERENCES BETWEEN SUBSAMPLES (ALIQUOTS 1 AND 2) AND THE RESPECTIVE TOTAL CATCH OF **QUEENFISH** FOR EACH OF 3 SUBSAMPLED LAMPARA SEINE COLLECTIONS.

Date	Collection Number	Number of Fish in Subsample	Number of Fish in Sample	Dmax[a]	DCRIT05[b]	P Value
21May85	850044	124	259	.025	.084	>0.2
13May86	860063	104	318	.058	.076	>0.2
22May86	860072	99	162	.094	.107	~0.09

[a]Dmax = maximum observed deviation between expected and observed cumulative percent frequencies.

[b]DCRIT05 = critical value of the K-S statistic for the sample size, using a two-tailed alpha of 0.05.

Appendix A -- Figure 1

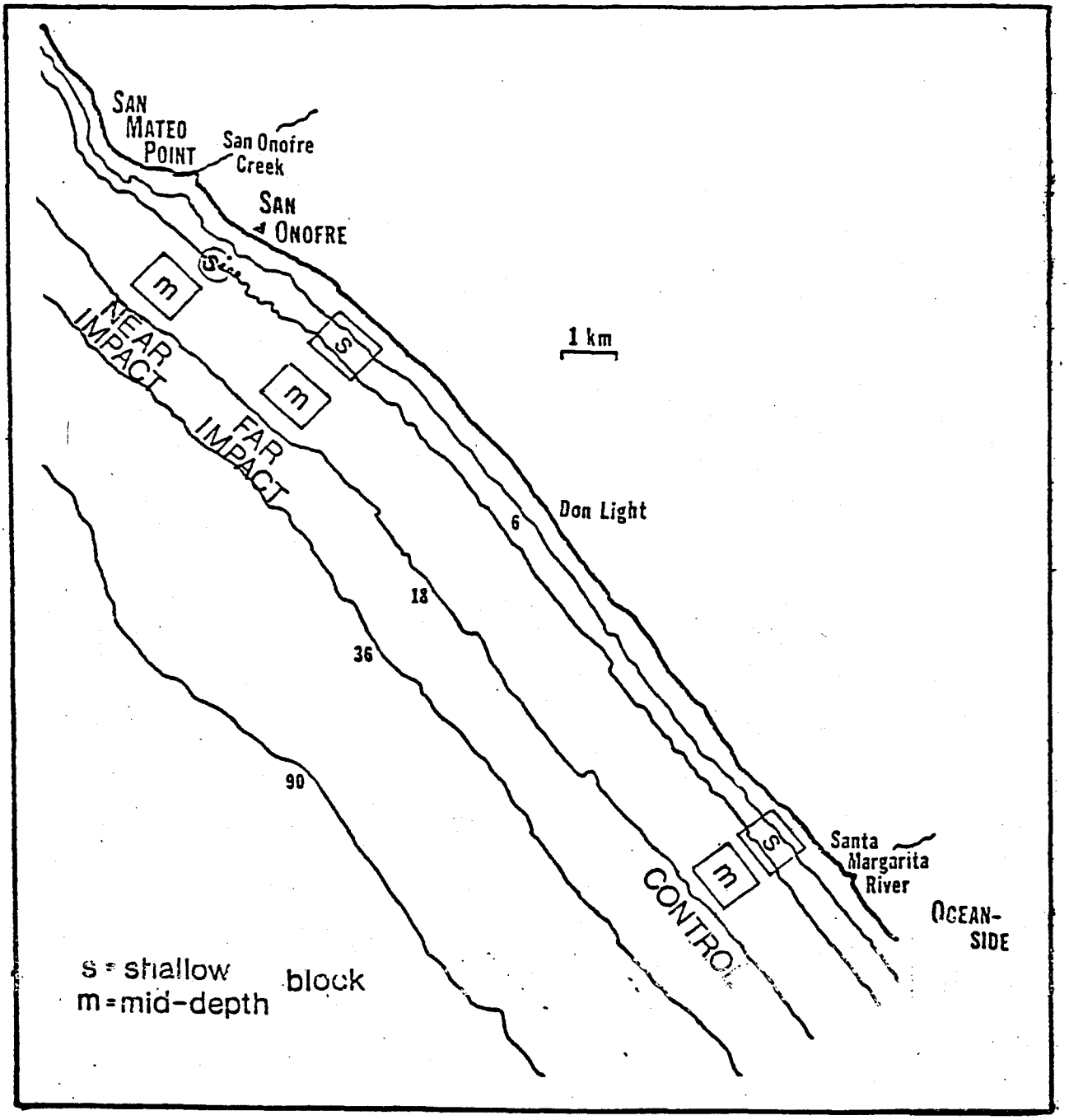


Chart of the general San Onofre area. Noted are the locations of the lampara seine stations. Bottom contours and sampling depth are noted in meters below MLLW.

PART 2. NET GEAR AND SAMPLING PROTOCOLS FOR BENTHIC FISHES

Introduction

An otter trawl task was initiated in January 1980 (quantitative, standard-distance trawling began in May 1980) in order to most accurately sample and determine the relative abundances (CPUE) of select species of fishes that live on or near unconsolidated substrates near San Onofre. Preoperational (Before) sampling of these fishes was completed in June 1982. Interim trawling continued at reduced effort through winter 1984. Operational-phase (After) sampling began in May 1984 and concluded in November 1986.

A single type and size of trawl and associated gear, and the same team of net-deployment personnel were maintained from the beginning of trawl studies, and sampling protocols were checked at intervals to assure consistency of CPUE estimates. The trawl sampling differed from our lampara design in number of locations and level of replication per cruise. On each (approx. monthly) cruise, each of two fixed longshore locations (one Impact, one Control; Appendix A, Fig. 2) were sampled with four replicate, standard-distance trawls along each of two (18-m; 30-m) fixed isobaths. These two isobaths were chosen to represent off-diffuser and off-plume bottom depths, respectively. The single most important aspect of the trawl sample design was that <u>both</u> depths at <u>both</u> locations were sampled with <u>equal</u> (in this case, replicated) effort on <u>each</u> <u>cruise</u>. All trawl cruises made to evaluate numerical impact were completed at night in order to minimize visual net avoidance, capture diurnally unavailable species (e.g., basketweave cusk-eel), and obtain more precise data (DeMartini et al. 1983a; DeMartini and Allen 1984).

Gear Specifications and Protocols

A modified Marinovitch-type otter trawl (bag seine) (manufactured by J. Willis, San Luis Obispo, California) of standard dimensions for coastal trawling in the bight (Mearns and Allen 1978) was used for all trawl operations from their beginning in January 1980. The net used was a 25-ft (7.6-m), single-warp otter trawl with a 50-ft bridle, a 25-ft headrope, a 29-ft footrope, 25 feet of 3/16-in. galvanized chain, body netting of 1-1/2-in. stretch mesh, and 1/2-in. stretch-mesh cod-end liner.

All trawls made throughout baseline and operational sampling were of standard distance, with the start and stop points based on fixed spar buoy stations and/or Motorola Mini-Ranger II positions. The distance travelled by our trawls was an estimated 240 m ± 10%. Before May 1984, distances were determined from transponder signals sent from an auxiliary craft (4.1-m Boston whaler) temporarily moored ~200 m upcoast or downcoast of the trawling station. Beginning in May 1984, trawl distances were based on transponder signals from shore stations at San Mateo Point and Don Light (Appendix A, Fig. 2). (During January, March, and April 1980, trawls were made on a fixed-time {5-min} rather than a fixed-distance basis; these data have been considered qualitative and not appropriate for inclusion in our baseline abundance estimates.) All baseline and operational-phase catches, whose data were used for Before/After comparisons at Impact and Control locations, were completed at night (1 hr after sunset to 1 hr before sunrise) along 18- and 30-m isobaths (approx. parallel to the coastline). Nets were deployed and retrieved in standard manner (scope: five-to-one at 18 m {90-m tow cable} and at 30 m {152-m cable}; mean drag time 3.3 ±.6{SE} min and 3.7 ±.8 min at 18 m and 30 m, respectively; vessel speed an average 2.2 knots using a single vessel {Marine Ecological Consultants' Lo-An} and consistent hauling gear {i.e., A-frame, hydraulic winch}). There were five scientists on the biological sampling crew.

Specifics of Sampling Design

All otter trawling was conducted at two different stations (depths) at each of two longshore locations on repeated cruises (sampling dates). At each station on each cruise a constant four replicate trawls were taken, with two trawls made upcoast and two trawls made downcoast in order to equally sample any possible variation in catch that might result from directional (longshore) currents. (Subsequent analyses have shown that this was an unnecessary precaution {DeMartini and Allen 1984}). Replicate trawls were taken slightly inshore and offshore of the defined isobath to avoid the resampling of trawl tracks.

Preoperational cruises were scheduled, with few exceptions, at monthly intervals from May 1980 to June 1982 (Appendix A, Table 3). One additional cruise was made each month during November-December 1980 (at 18 m and 30 m); two additional cruises were made as part of a pilot "gradient" sampling program (see DeMartini et al. 1981c) during June 1981 (18 m only). Both the additional (November 5-6 and December 3-4) 1980 cruises, and the pilot gradient cruises of

June 8-9 and June 9-10, 1981 were excluded from our baseline-operational comparisons. The June 23-24 and July 16-17, 1980 cruises were not completed until shortly after sunrise. Hence, the data for these two cruises were not used to estimate the abundance of basketweave cusk-eel, a unique species which sequesters itself in burrows (and is thereby unavailable to trawls) after sunrise (Greenfield 1968). Sampling was conducted once every two months during the interim period. Bimonthly sampling was conducted during the first ten months of the operational period. Thereafter, a monthly cruise schedule was followed to complete operational sampling, with the exception of a single cruise in April 1986 for which tows were nonquantitative because pelagic red crabs (Pleuroncodes planipes) continually fouled the trawl.

On each cruise, each of two longshore locations was sampled with the aforementioned four replicate trawls at each of two isobaths (18 m and 30 m), resulting in 16 total trawls per cruise. The two locations, each of ~3-km longshore extent, sampled on each cruise were an Impact (I) area ($\leq$ 1 km upcoast to 2 km downcoast of the SONGS Unit 1 line) and a Control (C) area (17-20 km downcoast of Unit 1; Appendix A, Fig. 2). It is important to reemphasize that all four combinations of depths and locations were sampled on each cruise to minimize the possible effects of date and diel period on the relative distributions and abundances of fishes at the two longshore locations.

Monthly trawling surveys were conducted during the day as well as night from May 1980 through May 1981. These daytime cruises were used to document baseline diel patterns and to evaluate relative catch efficiencies of our otter trawl during day versus night (DeMartini and Allen 1984).

Rationale for Sampling Locations and Depths

The position of the Impact study location was skewed somewhat downcoast of the SONGS outfall lines in order to sample under the average path of the Units 2 and 3 diffuser plume. The average downcoast-setting currents of the area establish an average downcoast-setting plume (Reitzel 1979). The distant Control location was established off Stuart Mesa near Oceanside (Appendix A, Fig. 2) in order to sample a similar environment at a distance from SONGS considered sufficient to preclude influence by Units 2 and 3 operations. This Control location was also used as control station by Marine Ecological Consultants in

their SONGS monitoring studies of mysids, plankton, and ichthyoplankton. The 18- and 30-m isobaths were chosen to represent the off-diffuser and off-plume depths of impact. (At the time that the benthic trawl design was developed, it was thought that the Units 2 and 3 diffuser plume would appreciably alter sediment particle sizes and the relative organic fraction of sediments beneath and offshore of the plune. The plume would thereby affect the kinds and abundances of invertebrate infauna and, indirectly, the abundances of benthic fishes that feed on these invertebrates. At present, several independent types of data on sediment composition and associated benthos strongly suggest that this has been an accurate prediction {Barnett, Watts, and White 1986; Barnett et al. 1986; DeMartini et al. 1986}).

Types of Biological Data

Each trawl catch was brought aboard ship in its entirety, off-loaded into tubs on deck, and wet-sorted by species. The total number of individuals and total wet weight ($\pm$ 10 g for species < 1 kg catch; $\pm$ .1 kg for species $\geq$ 1 kg catch) was determined for each species and for its aggregate within the trawl. Fish were processed as quickly as possible and returned overboard; valuable species like California halibut were given priority, express treatment. Abundance data were tallied separately for each of the four replicate trawls made at a location and depth (station) on a given cruise.

At the beginning of our monitoring of Units 2 and 3 effects in May 1980, we chose 10 (at 18 m) and 12 (30 m) select target species of fishes for rigorous statistical analyses. The species chosen for this analysis were selected for one or more of the following reasons: (1) abundance and frequency of occurrence in trawls; (2) ecological importance; (3) economic importance; (4) suspected susceptibility to impact by SONGS; and (5) sampling distributions amenable to statistical testing according to the BACI model (Stewart-Oaten 1986; Stewart-Oaten et al. 1986).

The California lizardfish was added to this list in our March 1983 quarterly report (DeMartini et al. 1983c) because it greatly increased in abundance during the early interim period. Data for queenfish and white croaker were subsequently emphasized because of the January-July 1983 hiatus in the lampara effort (DeMartini et al. 1983f). The lampara seine remains our primary method of

characterizing the distribution and abundance of these latter two epibenthic and water-column fishes at intake depths, where both species are primarily at risk to entrapment at the SONGS offshore intake structures. The lampara seine also samples from sea surface to sea bed, whereas the otter trawl samples only the larger individuals (primarily adults) of queenfish and white croaker that occur near the sea bed (Johnson 1980) farther offshore (DeMartini, Allen, Fountain, and Roberts 1985). The queenfish and white croaker data included in our evaluation of soft-bottom fishes therefore characterize the distribution and abundance of the fractions of local stocks of both species that may be impacted by benthos (or near-benthos) alteration.

Size-frequency distributions were determined for certain species among those that were abundant and frequently encountered in pilot baseline samples at the particular isobath (white croaker at 18 and 30 m, California halibut at 18 and 30 m, longfin sanddab at 18 and 30 m, Pacific sanddab at 30 m only, speckled sanddab at 18 m, fantail sole at 30 m, and hornyhead turbot at 18 and 30 m). After the trawl-by-trawl enumeration of total catch, the catches of each of these chosen species were pooled by station and mixed; then a random subsample of a maximum of 50 individuals of each species was measured ($\pm$ 1 mm SL) but not sexed. Starting in May 1984, subsample size for white croaker was increased from 50 to 100 individuals as a maximum to assure an adequate characterization of croaker of a broad length range on each cruise. Since a maximum of 50 fish of each species (50 or 100 for white croaker) was measured for each aggregate of four trawls, there were instances when the number of fish measured was less than the number captured. On these occasions the number of fish in each length class was adjusted by a scaling factor equal to the number of fish captured, in the respective series of four trawls, divided by the number of fish measured. These length-frequency data provide a station-by-cruise measure of the general length-frequency distributions of a consistent suite of representative species.

Data Used in Analyses

CPUE Data. The numerical and biomass catch data provide two types of CPUE (catch-per-unit-of-effort) indices of abundance used in fisheries biology and management estimates. Numerical CPUE data were analyzed in our baseline study (DeMartini et al. 1983a) and in the present report because biomass data are generally less precise than numerical data (DeMartini and Allen 1984).

Size-Composition Data. These data are complementary to CPUE data in that they often allow one to evaluate several meaningful size (age) groupings within catches. The most frequently useful subgroupings are those of YOY (young-of-year, age 0+) and older fish. Abundance of the YOY group is generally used to characterize the recruitment (year-class) success of marine fishes (Pitcher and Hart 1982).

APPENDIX A -- TABLE 3

LIST OF SAMPLING DATES FOR OTTER TRAWL CRUISES
(by SONGS Operating Period)

(A) PREOPERATIONAL

Day-Month-Year	Impact 18 m	Impact 30 m	Control 18 m	Control 30 m
30 Apr-01 May 80	X	X	X	X
23-24 Jun 80 **	X	X	X	X
16-17 Jul 80 **	X	X	X	X
13-14 Aug 80	X	X	X	X
12-13 Sep 80	X	X	X	X
21-22 Oct 80	X	X	X	X
05-06 Nov 80*	X	X	X	X
14-15 Nov 80	X	X	X	X
03-04 Dec 80*	X	X	X	X
10-11 Dec 80	X	X	X	X
15-16 Jan 81	X	X	X	X
18-19 Feb 81	X	X	X	X
11-12 Mar 81	X	X	X	X
08-09 Apr 81	X	X	X	X
22-23 May 81	X	X	X	X
04-05 Jun 81	X	X	X	X
08-09 Jun 81*	X	-	X	-
09-10 Jun 81*	X	-	X	-
21-22 Jul 81	X	X	X	X
10-11 Aug 81	X	X	X	X
01-02 Sep 81	X	X	X	X
05-06 Oct 81	X	X	X	X
02-03 Nov 81	X	X	X	X
01-02 Dec 81	X	X	X	X
12-13 Jan 82	X	X	X	X
02-03 Feb 82	X	X	X	X
05-06 Mar 82	X	X	X	X
07-08 Apr 82	X	X	X	X
05-06 May 82	X	X	X	X
03-04 Jun 82	X	X	X	X
Total No. Cruises	30	28	30	28
No. Cruises Used to Construct Baseline	26	26	26	26

*Cruise excluded from baseline/operational-phase comparisons

**Trawls at 30-m depth deleted for BACI tests on cusk-eel

APPENDIX A -- TABLE 3 (continued)

(B) INTERIM

Day-Month-Year	Impact 18 m	Impact 30 m	Control 18 m	Control 30 m
06-07 Jul 82	X	X	X	X
08-09 Sep 82	X	X	X	X
09-10 Nov 82	X	X	X	X
18-19 Jan 83	X	X	X	X
19-20 Mar 83	X	X	X	X
12-13 May 83	X	X	X	X
14-15 Jul 83	X	X	X	X
06-07 Sep 83	X	X	X	X
08-09 Nov 83	X	X	X	X
10-11 Jan 84	X	X	X	X
09-10 Mar 84	X	X	X	X
Total No. Cruises	11	11	11	11
No. Cruises Used to Characterize Interim	11	11	11	11

APPENDIX A -- TABLE 3 (continued)

(C) OPERATIONAL

Day-Month-Year	Impact 18 m	Impact 30 m	Control 18 m	Control 30 m
16-17 May 84	X	X	X	X
02-03 Jul 84	X	X	X	X
20-21 Sep 84	X	X	X	X
14-15 Nov 84	X	X	X	X
05 Jan 85	X	X	X	X
03-04 Mar 85	X	X	X	X
12-13 Apr 85	X	X	X	X
11-12 May 85	X	X	X	X
12-13 Jun 85	X	X	X	X
16-17 Jul 85	X	X	X	X
09-10 Aug 85	X	X	X	X
17-18 Sep 85	X	X	X	X
16-17 Oct 85	X	X	X	X
13-14 Nov 85	X	X	X	X
12-13 Dec 85	X	X	X	X
10-11 Jan 86	X	X	X	X
10-11 Feb 86	X	X	X	X
22-23 Mar 86	X	X	X	X
12-13 May 86	X	X	X	X
09-10 Jun 86	X	X	X	X
07-08 Jul 86	X	X	X	X
22-23 Aug 86	X	X	X	X
30 Sep-01 Oct 86	X	X	X	X
26-27 Oct 86	X	X	X	X
23-24 Nov 86	X	X	X	X
No. Cruises Used to Construct Operational	25	25	25	25

Appendix A -- Figure 2

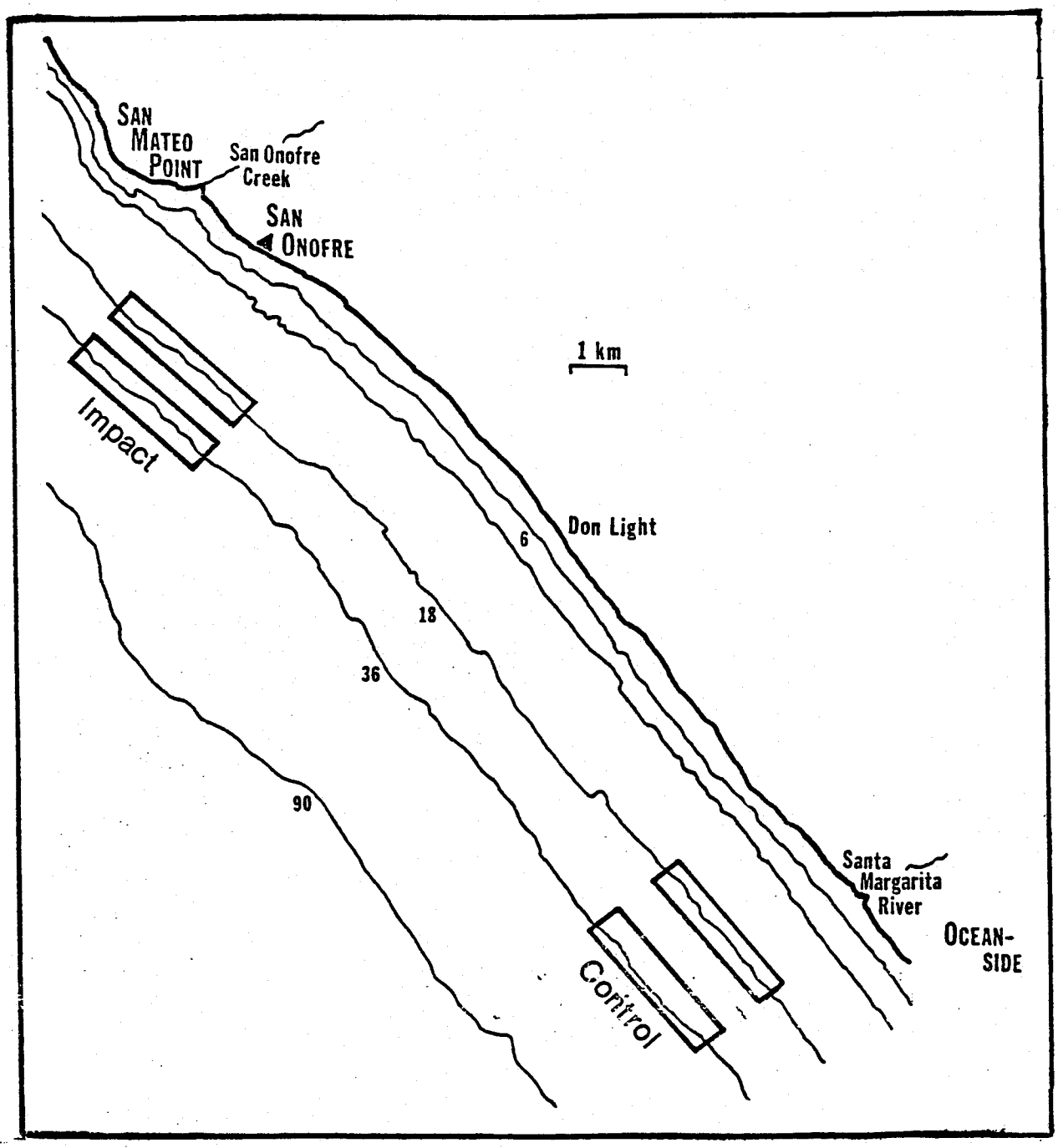


Chart of the general San Onofre area. Noted are the locations of the benthic trawl stations. Bottom contours and sampling depths are noted in meters below MLLW.

APPENDIX A, PART 3 -- Percent Change Calculations for Additive BACI Transformations

by
Janice D. Callahan
April 9, 1986

1. INTRODUCTION

Although BACI testing is frequently performed on a transformed variable, it is desirable to also express a percent change in the units of the untransformed variable. The purpose of this report is to present a method of calculating the percent change in the original units when the BACI test was performed on a transformed variable.

Section 2 discusses how to calculate percent change for the additive model; i.e., when no transformation is required to perform the BACI test. This section defines the additive model, the parameters of the model, and percent change. Section 3 expands the discussion to a multiplicative model. This model is made additive by the log transformation. The last section discusses procedures to be used when a power transformation is necessary.

2. ADDITIVE MODEL

An additive model is one in which an event is accompanied by an increase (or decrease) of a constant amount. For example, the event "spring following winter" shows an increase in abundance of 100 organisms. Thus, a population of 300 would go to 400 organisms, and a population of 3000 would go to 3100 organisms. For the BACI situation, this model can be diagrammed as below:

	I	C
B	Mu	Mu + K1
A	Mu + K2 + S	Mu + K2 + K1

where B stands for the before or preoperational period, A is the after or operational period, I stands for the impact or SONGS area, and C denotes the control area. The true mean under the model for the impact area in the preoperational period is Mu. The true mean under the model for the control area in the preoperational period is Mu + K1. Thus, K1 is the additive difference between the impact and control areas. In the operational period, the model mean for the control area is Mu + K1 + K2, where K2 is the additive difference between the preoperational and the operational periods. The model mean for the impact area in the operational period is Mu + K2 + S, where S is the additive difference due to the power plant. Notice that K1 appears in the model mean for both control means because it represents the control-impact difference; K2 appears in the model means for both operational means because it represent the after-before difference. The SONGS effect, S, only appears in the operational, impact model mean.

Corresponding to the model above, we have the averages of the observations as displayed below:

	I	C
B	YIB	YCB
A	YIA	YCA

YIB is the average of all the impact observations in the preoperational period; YCB is the average of all the control observations in the preoperational period. In the operational period, YIA is the average of all impact observations and YCA

is the average of all control observations. By comparing this table to the model table above, estimates of the model parameters can be obtained as follows:

$$
\begin{aligned}
Mu &= YIB \\
K1 &= YCB - YIB \\
K2 &= YCA - YCB \\
S &= (YIA - YCA) - (YIB - YCB) \\
&= DELTAA - DELTAB \quad .
\end{aligned}
$$

Now consider the operational, impact term. The average YIA estimates the model term Mu + K2 + S. We can consider this as an estimate of what is occurring at SONGS with SONGS present. If SONGS did not exist, then our model would not have the parameter S in it; in this case, the model mean for the operational, impact term would be Mu + K2. We can consider this as the model mean at the SONGS site without SONGS' presence. Furthermore, we can estimate what would have occurred at the SONGS site without SONGS' presence as Mu + K2 = YIB + YCA - YCB.

Percent change in abundance can now be defined as the change due to SONGS' presence divided by what would have been there if SONGS were not present. Mathematically, this yields

$$
\begin{aligned}
\%change &= 100 * (withSONGS - withoutSONGS) / withoutSONGS \\
&= 100 * (YIA - (YIB + YCA - YCB)) / (YIB + YCA - YCB) \\
&= 100 * ((YIA - YCA) - (YIB - YCB)) / ((YIB - YCB) + YCA) \\
&= 100 * (DELTAA - DELTAB) / (DELTAB + YCA) \\
&= 100 * S / (DELTAB + YCA) \quad .
\end{aligned}
$$

3. MULTIPLICATIVE MODEL

A multiplicative model is one in which an event is accompanied by a percent (or multiplier) change. For example, the event "spring following winter" shows an increase of 25% (a multiplier of 1.25). Thus a population of 300 would increase to 375 (a difference of 75), whereas a population of 3000 would increase to 3750 (a difference of 750). The multiplicative model can be diagrammed as below:

	I	C
B	Mu	Mu * K1
A	Mu * K2 * S	Mu * K2 * K1

where B, A, I, C are as defined in Section 2. The true mean under this model for the impact area in the preoperational period is Mu. The model mean in the control area, preoperational period is Mu * K1. Thus, K1 is the multiplier between the impact and control areas. In the operational period, the model mean for the control area is Mu * K1 * K2, where K2 is the multiplier between the preoperational and the operational periods. The model mean for the impact area in the operational period is Mu * K2 * S, where S is the multiplier due to the power plant.

To turn the multiplicative model into an additive model, the log transformation is used. Taking the log of each observation yields the following model:

	I	C
B	LMu	LMu + LK1
A	LMu + LK2 + LS	LMu + LK2 + LK1

In this now additive model, LMu represents Log(Mu), LK1 represents Log(K1), etc. The form of this model in the new parameters is now the same as the additive model discussed above.

Consider the observations. Each observation is log transformed. Then averages are computed for each of the four categories. These averages can be displayed as follows:

	I	C
B	LYIB	LYCB
A	LYIA	LYCA

where LYIB is the average of the log-transformed observations in the impact area, preoperational period, and the other averages are defined similarly. (The important fact is that the logs are taken first, and then averages are computed.) The parameters of this model can now be estimated as for the additive model:

$$
\begin{aligned}
LMu &= LYIB \\
LK1 &= LYCB - LYIB \\
LK2 &= LYCA - LYCB \\
LS &= (LYIA - LYCA) - (LYIB - LYCB) \quad .
\end{aligned}
$$

Applying the same definitions as in Section 1, the estimate for the log transform in the operational period with SONGS present is:

$$LwithSONGS = LYIA \quad .$$

Similarly, the estimate of the log transform in the operational period without SONGS' presence is

$$LwithoutSONGS = LYIB + LYCA - LYCB \quad .$$

These estimates are in the wrong units. To inverse-transform them back to the original units requires exponentiating them (or 10**estimate, if logarithms to the base 10 were used). Thus, inverse-transforming yields:

$$
\begin{aligned}
withSONGS &= \exp(LYIA) \\
withoutSONGS &= \exp(LYIB + LYCA - LYCB) \\
&= \exp(LYIB) * \exp(LYCA) * \exp(-LYCB) \quad .
\end{aligned}
$$

Now, calculating percent change:

```
%change = 100 * (withSONGS - withoutSONGS) / withoutSONGS
        = 100*(exp(LYIA)-exp(LYIB+LYCA-LYCB)) /
          exp(LYIB+LYCA-LYCB)
        = 100 * (exp(LYIA)-(exp(LYIB)*exp(LYCA)*exp(-LYCB)) /
          (exp(LYIB) * exp(LYCA) * exp(-LYCB)
        = 100 * (exp(LYIA)*exp(-LYIB)*exp(-LYCA)*exp(LYCB) - 1)
        = 100 * (exp((LYIA-LYCA) - (LYIB-LYCB)) - 1)
        = 100 * (exp(LS) - 1)
        = 100 * (S - 1)   .
```

where S = exp(LS) is an estimate of the parameter S in the multiplicative model. Note that this result for %change is the usual calculation and interpretation of percent change for a multiplicative model.

4. POWER TRANSFORMATIONS

In a power model, effects are neither additive nor multiplicative. The power model can be diagrammed as below:

	I	C
B	Mu**(1/P)	(Mu + K1)**(1/P)
A	(Mu + K2 + S)**(1/P)	(Mu + K2 + K1)**(1/P)

where B, A, I, and C are as defined in Section 2. The true means under this model are the additive means of Section 2 raised to a power, 1/P. To turn the power model into an additive model, the power transformation is used. Raising each observation to the power P yields the additive model of Section 2, repeated here:

	I	C
B	Mu	Mu + K1
A	Mu + K2 + S	Mu + K2 + K1

The parameters of the transformed model are the same as the parameters in the additive model.

Averages for each of the four categories are computed by first power-transforming the observation and then taking the average. These averages can be displayed as follows:

	I	C
B	PYIB	PYCB
A	PYIA	PYCA

where PYIB is the average of the power-transformed observations in the impact area, preoperational period, and the other averages are defined similarly. The parameters of this model can now be estimated as for the additive model:

$$Mu = PYIB$$
$$K1 = PYCB - PYIB$$
$$K2 = PYCA - PYCB$$
$$S = (PYIA - PYCA) - (PYIB - PYCB) \quad .$$

Applying the definitions of Section 1, the estimate for the power transform in the operational period with SONGS present is:

$$PwithSONGS = PYIA \quad .$$

The estimate of the power transform in the operational period without SONGS' presence is:

$$Pwithout\ SONGS = PYIB + PYCA - PYCB \quad .$$

These estimates are in the wrong units. To inverse-transform them back to the original units requires taking the power 1/P. Thus, inverse-transforming them yields:

$$\begin{aligned} withSONGS &= (PYIA)^{**}(1/P) \\ withoutSONGS &= (PYIB + PYCA - PYCB)^{**}(1/P) \quad . \end{aligned}$$

Lastly, calculating percent change:

$$\begin{aligned} \%change &= 100 * (withSONGS - withoutSONGS) / withoutSONGS \\ &= 100 * ((PYIA)^{**}(1/P) - (PYIB + PYCA - PYCB)^{**}(1/P)) / \\ &\quad (PYIB + PYCA - PYCB)^{**}(1/P) \quad . \end{aligned}$$

APPENDIX A -- PART 4

DESCRIPTION OF UCSB'S APPLICATION OF P. TOMLINSON'S (NMFS) MODIFICATION OF NORMSEP (Abramson 1971)

The TC program is a modification of the National Marine Fisheries Service's TCPA1 program (formerly NORMSEP). This program has been modified by Titan Systems, Inc. to our specifications.

1. PURPOSE

The TC program separates length-frequency distributions of queenfish for each month and year into a variable number of size modes that are normally distributed. The percent composition of each size mode in all 5-mm size classes can then be calculated to separate total queenfish into young-of-the-year (YOY) and older juvenile and adult (OJ and AD) age groupings.

2. PROCEDURE

Size-frequency histograms of total queenfish caught at night are plotted for each month and year combination. Length data are broken into 5-mm size classes. Locations (Near/Far Impact, Control) and depths (5-10 m, 11-16 m) are pooled for each month and year combination in order to provide the most accurate characterization of length distributions by maximizing sample size for a given month and year.

A. For each histogram, parameters are determined for each size mode (K_i). Parameters include:

(1) Size range

(2) Cut-off point between adjacent modes (defined as the point of overlap between two modes, if overlap exists)

(3) Estimated lower (ML) and upper (MU) bounds of each mean, and

(4) Estimated lower (SDL) and upper (SDU) bounds of the standard deviation of each mean, where the lower bound equals the range/10 and the upper bound equals the range/2. (Wide bounds generally yield smaller Chi-squared values in tests between observed and theoretical fits to the data.) Parameters are estimated from the histograms using historical data on the timing and relative rates of monthly growth.

B. The EXEC TCSETUP is next run on the above parameters for each month and year combination. This formats the data for running the primary EXEC (TC).

C. The EXEC TC is run on the output from TCSETUP. It calculates a best fit to the data using the parameters as a guideline. TC produces a permanent data base named DBTC.ALL containing the following data for each month and year combination: frequency and percent frequency for each size mode within each 5-mm size class and total frequency within each 5-mm class. The first size mode represents the YOY age group; the sum of the remaining size modes is equivalent to the OJ & AD age grouping.

D. The DBTC.ALL data base is on the FI contractor (F) disk. The TCSETUP and TC program package is on the FI software (B) disk.

APPENDIX B -- Annotated List of SAS Programs Used in Analyses Related to Net Monitoring and Entrapment

APPENDIX B --
ANNOTATED LIST OF SAS PROGRAMS USED IN ANALYSES RELATED TO NET MONITORING AND ENTRAPMENT

All major statistical analyses were done on the IBM 4341 mainframe computer at the Marine Review Committee (MRC) facility in Encinitas, California. Standard statistical tests utilized canned procedures (PROCs) of the Statistical Analysis System (SAS).

All analysis programs used in this report are listed in the following annotated cross-reference. These programs have been saved on the Report (E) disk. Most analysis programs were developed by UCSB Fish Study project personnel. However, Titan Systems, Inc. and J. Callahan developed the generic BACITEST SAS program, the major program package that we have used in the evaluation of local changes in fish abundance. The parent BACITEST SAS program resides on the X utility disk.

ANNOTATED LIST OF SAS PROGRAMS USED IN ANALYSES
CHAPTER ONE -- NET MONITORING

Program File Name	Program Task	Description	Figure or Table Number (F=Fig., T=Tbl)
		DATA PROCESSING	
OTMEANS4	Otter Trawl	Sparses data for select species; calculates mean CPUE of four trawls at each location-depth.	N/A
OTMW	Otter	Sparses otter trawl biomass data.	N/A
LPMW	Lampara	Sparses lampara seine biomass data.	N/A
PREINTSX	Lampara	Sparses data on queenfish sex classes (preoperational and interim periods).	N/A
PREINTDB	Lampara	Sparses data for select species (preoperational and interim periods).	N/A
UPDINTSX	Lampara	Sparses data on queenfish sex classes (operational period).	N/A
UPDINTDB	Lampara	Sparses data for selected species (operational period).	N/A
YOY	Lampara	Sparses data for young-of-year and older-juvenile queenfish.	N/A
		BACI FIGURES AND TABLES	
MEANABU3/	Otter Trawl	Tabulate mean arithmetic CPUE of selected	T 5;
LPMNABUN	Lampara	species by location, depth, and time period.	T 2.
OTQFWT	Otter	Tabulates mean biomass CPUE of queenfish and	App E, T 15.
LPQFWT	Lampara	white croaker by location, depth & time period.	
OTSUMS10/	Otter Trawl	Tabulate rank CPUE of entire fish assemblage	App C, T 13-16;
LPSUMSP	Lampara	observed at each location, depth, and time period.	App C, T 1-6.
OTFREQ/	Otter Trawl	Tabulate rank frequency of occurrence of	App C, T 17-20;
LPFREQ	Lampara	entire fish assemblage observed at each location, depth, and time period.	App C, T 7-12.
OTPLOT87/	Otter Trawl	Plot time series CPUE and Impact/Control	App E, F 25-46;
LPPLOT87	Lampara	deltas for selected species.	App E, F 1-24.
OTHISTO5/	Otter Trawl	Plot time series of number of all fishes	App C, F 3, 4;
LPHISTO5	Lampara	captured at each location and depth.	App C, F 1, 2.

Program File Name	Program Task	Description	Figure or Table Number (F=Fig., T=Tbl)
		BACI ANALYSES	
BACITES9	Otter Trawl and Lampara	Performs BACI statistical assumption and impact tests (additivity, monotone trends, serial correlation, power, % change, t-test.)	T 1 and App D, T 1, 2, 3; T 4 & App E, T 1-6
BACISMRY	Otter Trawl and Lampara	Produces summary listing from data bases put out by BACITES9 program.	N/A
OTZERO/ LPZERO	Otter Trawl Lampara	Count number and compute % of zero catches.	Text Section 1.3.1.1.
LPBINOM	Lampara	Performs binomial test for impact.	App E, T 3.
OTMNBIOM LPMNBIOM	Otter Trawl Lampara	Tabulates weighted mean weight per fish.	App E, T 13.
OTINFLU	Otter Trawl	Tests for influence points in time-series deltas.	Text Section 1.3.1.3.
OTAUTORG	Otter Trawl	T-tests for species/depths in which deltas were serially correlated.	App D, T 3.
LPAUTINF	Lampara	Tests for influence points in time-series deltas; T-tests for species/depths in which deltas were serially correlated.	App D, T 1, 2.
OTNOWT OTNOWT2	Otter Trawl	Calculates mean number and biomass of total individual fish and performs BACI t-test.	App E, T 14.
OT3WAY/ LP3WAY	Otter Trawl Lampara	Perform 3-factor fixed-effects ANOVA on location, depth, and time period.	T 8; T 7.
		SIZE-FREQUENCY ANALYSES	
OTRLEN	Otter Trawl	Reconfigures DBFOB data base for subsequent analyses.	N/A
SLFREQ	Lampara	Reconfigures DBFLB data base for subsequent analyses.	N/A
FACTRQF	Lampara	Calculates ratio of queenfish subsampled for lengths.	N/A
FACTRWCR	Lampara	Calculates ratio of white croaker subsampled for lengths.	N/A

CHAPTER ONE -- NET MONITORING (continued)

Program File Name	Program Task	Description	Figure or Table Number (F=Fig., T=Tbl)
MONLNFQ/ LPMONFQ2	Otter Trawl Lampara	Divide continuous fish-length data into 5-mm length classes monthly.	N /A
OTMONHIS/ LPMONHIS	Otter Trawl Lampara	Plot size frequencies by month, location, and depth for selected species.	App E, F 65-70; App E, F 53-55.
OTLNFQ8 WCBACIFQ/ QFBACIFQ	Otter Trawl Lampara Lampara	Divide continuous fish length data for selected species into 5-mm length classes for each location, depth, and time period.	N /A
OTOPHIST QFOPHIST WCOPHIST	Otter Trawl Lampara Lampara	Plot histograms of size frequency for selected species at each location, depth, and time period.	App E, F 56-64. App E, F 47-52.
KS87	Otter Trawl and Lampara	Performs BACI K-S test.	T 9, 10 and App E, T 7-11.
SUBSAMPL	Lampara	Outputs cum. % frequencies for K-S tests on differences in distributions betw. samples and subsamples.	App A, T 2.

CHAPTER TWO -- SONGS ENTRAPMENT

Program File Name	Program Task	Description	Figure or Table Number (F=Fig., T=Tbl)
		DATA PROCESSING	
		Sparses impingement data (#s and biomass) for select species and total individuals from quantitative (24-hr, full pump flow) inplant fish collections at SONGS Unit 1 for:	
ALUNIT1		May 1983-December 1984	N/A
INPLU185		January 1985-September 1985	N/A
INPLO1OD		October 1985-December 1985	N/A
INPLO186		January 1986 - August 1986.	N/A

Program File Name	Program Task	Description	Figure or Table Number (F=Fig., T=Tbl)
		Sparses impingement, diversion, and entrapment data (#s and biomass) for select species and total individuals from quantitative collections (24-hr, full pump flow) and paired impingement/diversion samples at SONGS Units 2 and 3 for:	
INPLOSS		May 1983-December 1984	N/A
INPLOS85		January 1985-September 1985	N/A
INPLOSOD		October 1985-December 1985	N/A
INPLOS86		January 1986-August 1986.	N/A
		Sets up impingement and diversion data (#s and biomass) for all species from quantitative inplant fish collections at SONGS Units 2 and 3 for:	
SPMAYDEC		May 1983-December 1984	N/A
SPJS85		January 1985-September 1985.	N/A
		Standardizes variable names and data format for all species in quantitative inplant fish collections at SONGS Units 2 and 3 for:	
SPPABUN84		May 1983-December 1984	N/A
SPPABUN85		January 1985-December 1985	N/A
SPPABUN86		October 1985-August 1986.	N/A
DBFRSPEN		Sets up data for all species from quantitative SONGS fish return survivorship control and experimental pens and calculates by species fraction of fish that died after 96 hr.	N/A
SURV100		Same as DBFRSPEN except sets up data for small queenfish (incorporates length data) from quantitative SONGS fish return survivorship data.	N/A
LAMP161M		Sets up total entrapment data (all queenfish, small queenfish, and large queenfish) for combined SONGS entrapment on dates matched with available offshore abundance data.	N/A
		Sets up offshore (lampara) data for queenfish (large and small) on matching 16 dates with corresponding inplant data for:	N/A

Program File Name	Task	Description	Figure or Table Number (F=Fig., T=Tbl)
LAMP16L9		Near Impact location	N/A
LAMP16L4		Control location	N/A
LAMP16L1		Far Impact location.	N/A
IPLPJOIN		Merges entrapment data with matched off-shore (lampara) data for 16 dates.	N/A
FLOWPAIR		Calculates summed (X-day) SONGS pump volumes to be used in regressions of delta CPUE (as Y) on SONGS entrapment (units pooled) and pump volume.	N/A
FLOWMERG		Merges X-day pump volumes with other regression variables, by date.	N/A
		ENTRAPMENT TABLES	
QTTABL86 QTTABL87		Tallies dates of all quantitative normal flow (NF) collections at SONGS Units 1, 2, 3; by unit.	App F, T 1.
HTTABL86		Tallies dates of all heat treatments at Units 1, 2, 3; by unit.	App F, T 2.
QTTABL86 QTTABL87		Tallies dates of all quantitative matched collections at Unit 1 and at one or both new units.	App F, T 3.
OPDAY785		Calculates/displays # of operational days per mo, yr; by unit.	App F, T 4-6.
CCPTFL86		Tests null hypothesis, slope=1, in regression of entrapment magnitude at one vs. other new unit, adjusted for different # pumps.	App F, T 7.
ANLSU187		Calculates 12-mo entrapment (impingement) during NF operations for SONGS Unit 1; for select species and total fishes (#s, biomass).	T 11; App G, T 1-9.
ANLSMV87		Calculates 12-mo entrapment (impingement, diversion) during NF operations for SONGS Units 2 and 3; for select species and total fishes (#s, biomass).	T 11; App G, T 1-9.
HTABU23 HTLOS86		Tallies heat treatment fish losses; by species and SONGS unit.	T 11; App G, T 10-15.

Program File Name	Task	Description	Figure or Table Number (F=Fig., T=Tbl)
		DIVERSION/SURVIVORSHIP TABLES	
SPPABUN2		Calculates total, % fish impinged and returned at Units 2 and 3 (#s, biomass); by species.	T 12, 13; App H, T 1.
SPPABUN2		Calculates mean body weight of fishes entrapped at Units 2 and 3.	App H, T 2.
TSPPMORT		Tallies #, % fish that lived/died in experimental and control pens; calculates confidence intervals on pen difference in survivorship.	T 12; App H, T 3.
TSPPMORT		Tallies # fish, mortalities, pens; for evaluating survivorship of small and large queenfish; calculates confidence intervals on pen difference in survivorship.	App H, T 4.
		UNIT 1-NEW UNIT COMPARISONS	
CCPTTEST		Performs paired t-tests on matched Unit 1 vs. Units 2 and 3 collections; for select spp. and taxa (#s, biomass)	T 14; App G, T 16.
		ENTRAPMENT AS MECHANISM TABLES	
INPLFLD		Tests regression of new unit entrapment (Y) on FI location, seine CPUE, surge, and turbidity.	App I, T 1, 2.
DCPUINPL		Tests regression of NI-C and NI-FI location deltas of seine CPUE (Y) on concurrent 3-unit entrapment, plus X-day prior SONGS flow volumes.	App I, T 3.
ANL85MVU1 ANLSMV85 ANLSMV86 ANLSU186		Calculates total SONGS NF entrapment (#s, biomass), for 4 select taxa, for specified subperiods.	App I, T 4, 5.
SPORG85C SPORG85X SPORG86A SPORG86C		Calculates total SONGS NF entrapment (#s, biomass), for small and for large queenfish, for specified subperiods.	App I, T 6, 7.
LPIPABUN		Calculates raw seine CPUE for monitoring subperiods; for 4 select taxa and for small and large queenfish.	App I, T 8.

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T=Tbl)
		BALANCE CALCULATIONS	
LQPRDAY	Lampara	Queenfish % recapture -- day	Text 2.4.4.2.
LQPRNITE	Lampara	Queenfish % recapture -- night	App F, 4B.

APPENDIX C -- Summaries of Net Monitoring Data

APPENDIX C -- TABLE 1

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **NEAR IMPACT** LOCATION, **5-10** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
QUEENFISH	9704	1.0	2103	1.0	1708	2
SILVERSIDES spp.	5370	2.0	337	3.0	360	3
ANCHOVY, northern	3629	3.0	1157	2.0	11565	1
MACKEREL, jack	1029	4.0	69	7.0	200	4
BUTTERFISH, Pacific	844	5.0	123	6.0	101	7
CROAKER, white	756	6.0	258	5.0	56	9
BARRACUDA, Pacific	165	7.0	40	8.0	96	8
SURFPERCH, walleye	151	8.0	16	13.0	18	13
MACKEREL, Pacific	148	9.0	261	4.0	148	5
SEAPERCH, white	92	10.0	18	12.0	4	19
ANCHOA spp.	82	11.0	12	15.0	26	12
SALEMA	59	12.0	35	9.0	114	6
PERCH, shiner	57	13.0	33	10.0	1	32
CORBINA, Ca.	41	14.0	13	14.0	8	16
CROAKER, yellowfin	15	15.0	1	25.5	6	18
RAY, bat	14	16.0	8	16.0	7	17
HALIBUT, Ca.	7	17.0	4	17.0	3	21
STINGRAY, round	3	20.0	1	25.5		
FLYINGFISH, Ca.	3	20.0			8	16
SEABASS, white	3	20.0	1	25.5	2	24
SCORPIONFISH, Ca.	3	20.0			3	21
CUSK-EEL, basketweave	3	20.0	2	18.5	1	32
RAY, Ca. butterfly	2	24.0	1	25.5		
BASS, barred sand	2	24.0				
BONITO, Pacific	2	24.0				
THORNBACK	1	29.5			2	24
RAY, Pacific electric	1	29.5				
SANDDAB, Pacific	1	29.5				
SANDDAB, speckled	1	29.5	1	25.5	1	32
TURBOT, diamond	1	29.5				
CROAKER, spotfin	1	29.5	1	25.5		
SEAPERCH, rubberlip	1	29.5				
BLACKSMITH	1	29.5				
FLYINGFISH, sharpchin			21	11.0	9	14
LIZARDFISH, Ca.			2	18.5		
THRESHER, common			1	25.5	1	32
SMOOTHHOUND, brown			1	25.5		
SHARK, leopard			1	25.5		
GUITARFISH, shovelnose			1	25.5	1	32
SARDINE, Pacific			1	25.5	31	11
BASS, spotted sand			1	25.5		
HERRING, round					35	10
SARGO					3	21
PIPEFISH					2	24

APPENDIX C -- TABLE 1 (continued)

Species	PREOPERATIONAL Count	PREOPERATIONAL Rank	INTERIM Count	INTERIM Rank	OPERATIONAL Count	OPERATIONAL Rank
SHARK, horn					1	32
SHAD, American					1	32
NEEDLEFISH, Ca.					1	32
SOLE, bigmouth					1	32
BASS, kelp					1	32
CROAKER, black					1	32
MIDSHIPMAN, plainfin					1	32
KELPFISH, giant					1	32
Total Species	33.0		31.0		38.0	
Total Individuals	22192.0		4524.0		14528.0	
Mean Individuals	516.1		323.1		484.3	

APPENDIX C -- TABLE 2

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **NEAR IMPACT** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
ANCHOVY, northern	44413	1.0	4085	1.0	10497	1
QUEENFISH	6800	2.0	1085	2.0	857	4
MACKEREL, Pacific	5653	3.0	865	3.0	1143	2
MACKEREL, jack	5168	4.0	233	5.0	858	3
BUTTERFISH, Pacific	1400	5.0	135	6.0	47	10
CROAKER, white	720	6.0	39	7.0	39	11
SILVERSIDES spp.	634	7.0	21	10.0	68	9
SALEMA	132	8.0	7	11.0	232	6
SEAPERCH, white	122	9.0	5	13.0	7	15
BONITO, Pacific	102	10.0	1	17.5		
BARRACUDA, Pacific	92	11.0	23	8.0	68	9
ANCHOA spp.	87	12.0			11	14
SEABASS, white	82	13.0	1	17.5	3	18
RAY, bat	64	14.0	22	9.0	32	12
SURFPERCH, walleye	46	15.0			3	18
PERCH, shiner	15	16.0	6	12.0		
SARDINE, Pacific	11	17.0	236	4.0	750	5
SCORPIONFISH, Ca.	7	18.0			1	25
CORBINA, Ca.	6	19.0			1	25
RAY, Pacific electric	4	21.0	1	17.5		
BASS, barred sand	4	21.0			14	13
CROAKER, yellowfin	4	21.0				
BASS, kelp	3	23.0	1	17.5	2	20
FLYINGFISH, Ca.	2	25.0			1	25
HALIBUT, Ca.	2	25.0			1	25
PERCH, kelp	2	25.0				
THORNBACK	1	30.5				
SANDDAB, speckled	1	30.5				
TURBOT, diamond	1	30.5				
TURBOT, hornyhead	1	30.5				
SARGO	1	30.5			1	25
SEAPERCH, rubberlip	1	30.5				
PERCH, pile	1	30.5				
CUSK-EEL, basketweave	1	30.5			1	25
LIZARDFISH, Ca.			3	14.0		
CROAKER, black			1	17.5		
BLACKSMITH			1	17.5		
HERRING, round					81	7
FLYINGFISH, sharpchin					5	16
DOGFISH, spiny					2	20

APPENDIX C -- TABLE 2 (continued)

Species	PREOPERATIONAL Count	PREOPERATIONAL Rank	INTERIM Count	INTERIM Rank	OPERATIONAL Count	OPERATIONAL Rank
TONGUEFISH, Ca.					1	25
MIDSHIPMAN, plainfin					1	25
Total Species	34.0		20.0		28.0	
Total Individuals	65583.0		6771.0		14727.0	
Mean Individuals	862.9		451.4		507.8	

APPENDIX C -- TABLE 3

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **FAR IMPACT** LOCATION, **5-10** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
ANCHOVY, northern	44486	1.0	3857	1.0	3003	1
QUEENFISH	16209	2.0	1765	2.0	2926	2
BUTTERFISH, Pacific	6814	3.0	1084	3.0	420	6
CROAKER, white	6441	4.0	158	5.0	815	5
SILVERSIDES spp.	3703	5.0	452	4.0	1625	3
MACKEREL, jack	720	6.0	10	13.0	49	9
BARRACUDA, Pacific	348	7.0	15	12.0	59	8
SEAPERCH, white	321	8.0	43	7.0	38	10
MACKEREL, Pacific	297	9.0	150	6.0	18	15
SURFPERCH, walleye	153	10.0	4	18.5	23	14
CORBINA, Ca.	92	11.0	17	11.0	15	16
SALEMA	58	12.0	19	9.5	32	12
RAY, bat	49	13.0	5	16.5	28	13
ANCHOA spp.	29	14.0	28	8.0	1013	4
PERCH, shiner	28	15.0	9	14.0	6	18
HALIBUT, Ca.	15	16.0	5	16.5	5	20
DOGFISH, spiny	9	17.5			5	20
CUSK-EEL, basketweave	9	17.5	2	20.0	7	17
SEABASS, white	8	19.0	4	18.5	2	25
BASS, barred sand	6	20.0				
THRESHER, common	4	21.5	1	22.0		
FLYINGFISH, Ca.	4	21.5				
STINGRAY, round	3	23.0			1	32
SMOOTHHOUND, gray	2	27.5			1	32
GUITARFISH, shovelnose	2	27.5	1	22.0		
RAY, Pacific electric	2	27.5				
SKATE, California	2	27.5				
SOLE, fantail	2	27.5				
TURBOT, hornyhead	2	27.5				
CROAKER, yellowfin	2	27.5			1	32
MIDSHIPMAN, specklefin	2	27.5	1	22.0		
SHARK, horn	1	36.0				
THORNBACK	1	36.0			3	22
SARDINE, Pacific	1	36.0	19	9.5	305	7
SANDDAB, speckled	1	36.0			1	32
SEAPERCH, rubberlip	1	36.0				
SEAPERCH, pink	1	36.0				
PIPEFISH	1	36.0			1	32
MIDSHIPMAN, plainfin	1	36.0				
KELPFISH, giant	1	36.0			2	25
LIZARDFISH, Ca.			8	15.0	2	25
HERRING, round					33	11
FLYINGFISH, sharpchin					4	21
TURBOT, spotted					2	25

APPENDIX C -- TABLE 3 (continued)

Species	PREOPERATIONAL Count	PREOPERATIONAL Rank	INTERIM Count	INTERIM Rank	OPERATIONAL Count	OPERATIONAL Rank
SCORPIONFISH, Ca.					2	25
SMOOTHHOUND, sicklefin					1	32
PERCH, black					1	32
SCULPIN, Pacific staghorn					1	32
Total Species	40.0		23.0		35.0	
Total Individuals	79831.0		7657.0		10450.0	
Mean Individuals	1010.5		510.5		360.3	

APPENDIX C -- TABLE 4

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **FAR IMPACT** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
ANCHOVY, northern	63982	1.0	7005	1.0	10679	1
QUEENFISH	9190	2.0	663	3.0	905	2
MACKEREL, Pacific	8260	3.0	1150	2.0	717	3
CROAKER, white	3728	4.0	13	10.0	46	12
MACKEREL, jack	3308	5.0	266	5.0	250	4
BUTTERFISH, Pacific	2690	6.0	133	6.0	84	8
SILVERSIDES spp.	405	7.0	49	7.0	58	9
BARRACUDA, Pacific	302	8.0	34	8.0	118	5
SARDINE, Pacific	264	9.0	351	4.0	109	6
BONITO, Pacific	250	10.0			1	24
SALEMA	123	11.0	17	9.0	96	7
SEAPERCH, white	91	12.0	6	12.5		
RAY, bat	48	13.0	9	11.0	51	11
SURFPERCH, walleye	12	14.0			1	24
CROAKER, yellowfin	10	15.0				
MIDSHIPMAN, plainfin	7	16.0			2	17
CUSK-EEL, basketweave	6	17.0			2	17
DOGFISH, spiny	4	18.5			1	24
PERCH, shiner	4	18.5	1	16.5	5	14
RAY, Pacific electric	3	21.0				
ANCHOA spp.	3	21.0	1	16.5		
CORBINA, Ca.	3	21.0			7	13
FLYINGFISH, Ca.	2	24.0				
HALIBUT, Ca.	2	24.0				
BASS, barred sand	2	24.0			2	17
THRESHER, common	1	30.0				
NEEDLEFISH, Ca.	1	30.0			1	24
TURBOT, hornyhead	1	30.0	1	16.5		
BASS, kelp	1	30.0	3	14.0	1	24
SARGO	1	30.0				
SEABASS, white	1	30.0			1	24
PERCH, kelp	1	30.0				
SCORPIONFISH, Ca.	1	30.0			1	24
TRIGGERFISH, finescale	1	30.0				
FLYINGFISH, sharpchin			6	12.5	4	15
LIZARDFISH, Ca.			1	16.5		
HERRING, round					53	10
GUITARFISH, shovelnose					1	24
SANDDAB, speckled					1	24
PIPEFISH					1	24
Total Species	34.0		18.0		28.0	
Total Individuals	92708.0		9709.0		13198.0	
Mean Individuals	1219.8		647.3		455.1	

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **CONTROL** LOCATION, **5-10** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
ANCHOVY, northern	30595	1.0	595	4.0	6822	1
QUEENFISH	16844	2.0	2186	1.0	4764	2
CROAKER, white	9462	3.0	107	7.0	716	3
SILVERSIDES spp.	7176	4.0	1307	2.0	449	6
BUTTERFISH, Pacific	6992	5.0	909	3.0	320	7
ANCHOA spp.	809	6.0	86	9.0	496	5
CORBINA, Ca.	517	7.0	41	11.0	27	14
MACKEREL, Pacific	230	8.0	183	6.0	109	10
SURFPERCH, walleye	203	9.0	7	13.0	30	11
BARRACUDA, Pacific	121	10.5	2	20.0	272	8
SEAPERCH, white	121	10.5	89	8.0	18	15
CROAKER, yellowfin	98	12.0	1	26.5	1	32
RAY, bat	89	13.0	5	14.0	27	14
MACKEREL, jack	76	14.0	4	15.0	28	12
SARDINE, Pacific	43	15.0	225	5.0	593	4
PERCH, shiner	42	16.0	3	16.5	3	23
HALIBUT, Ca.	38	17.0	2	20.0	7	19
LIZARDFISH, Ca.	34	18.0	44	10.0	1	32
CUSK-EEL, basketweave	28	19.0			5	20
SURFPERCH, barred	26	20.5				
SCORPIONFISH, Ca.	26	20.5	1	26.5	8	18
SALEMA	20	22.0	19	12.0	236	9
SANDDAB, speckled	18	23.0			1	32
DOGFISH, spiny	11	24.0	1	26.5	4	21
STINGRAY, round	10	25.0	2	20.0	3	23
THORNBACK	9	26.5	1	26.5	2	26
RAY, Pacific electric	9	26.5				
GUITARFISH, shovelnose	8	28.0				
FLYINGFISH, Ca.	7	29.0				
TURBOT, hornyhead	6	30.5			1	32
SEABASS, white	6	30.5	2	20.0	1	32
TURBOT, diamond	5	32.0	3	16.5		
BASS, barred sand	3	33.5	1	26.5	8	18
PIPEFISH	3	33.5				
THRESHER, common	2	37.0	1	26.5		
SHARK, leopard	2	37.0	1	26.5		
SOLE, fantail	2	37.0				
TURBOT, spotted	2	37.0			1	32
MIDSHIPMAN, specklefin	2	37.0			1	32
SMOOTHHOUND, gray	1	42.5				
SKATE, California	1	42.5				
FLYINGFISH, sharpchin	1	42.5	2	20.0		
NEEDLEFISH, Cal	1	42.5				
BASS, kelp	1	42.5			1	32

APPENDIX C -- TABLE 5 (continued)

Species	PREOPERATIONAL Count	PREOPERATIONAL Rank	INTERIM Count	INTERIM Rank	OPERATIONAL Count	OPERATIONAL Rank
MIDSHIPMAN, plainfin	1	42.5				
BLACKSMITH			1	26.5		
HERRING, round					13	16
CROAKER, black					3	23
PERCH, black					2	26
HERRING, Pacific					1	32
SCULPIN, Pacific staghorn					1	32
Total Species	45.0		30.0		36.0	
Total Individuals	73701.0		5831.0		14975.0	
Mean Individuals	932.9		388.7		499.2	

APPENDIX C -- TABLE 6

LAMPARA
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **CONTROL** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
ANCHOVY, northern	60558	1.0	2192	1.0	18733	1
QUEENFISH	5886	2.0	763	3.0	1376	3
MACKEREL, Pacific	2042	3.0	1188	2.0	2407	2
CROAKER, white	1490	4.0	74	7.0	47	10
BUTTERFISH, Pacific	1189	5.0	268	5.0	92	7
MACKEREL, jack	1061	6.0	77	6.0	143	6
SILVERSIDES spp.	484	7.0	473	4.0	75	9
ANCHOA spp.	109	8.0	2	14.5	14	12
RAY, bat	108	9.0	17	10.0	42	11
BARRACUDA, Pacific	70	10.0	3	12.0	83	8
LIZARDFISH, Ca.	45	11.0	22	9.0	9	13
BONITO, Pacific	26	12.0	1	16.5	3	16
SEAPERCH, white	21	13.0	3	12.0		
SCORPIONFISH, Ca.	18	14.0			1	20
CORBINA, Ca.	15	15.0			2	18
SALEMA	12	16.5			7	14
SURFPERCH, walleye	12	16.5	2	14.5		
BASS, barred sand	7	18.5			1	20
CUSK-EEL, basketweave	7	18.5			3	16
SARDINE, Pacific	5	21.0	38	8.0	1130	4
HALIBUT, Ca.	5	21.0				
CROAKER, yellowfin	5	21.0				
GUITARFISH, shovelnose	4	24.0				
RAY, Pacific electric	4	24.0				
PERCH, shiner	4	24.0				
THORNBACK	2	27.5				
SANDDAB, speckled	2	27.5				
TURBOT, hornyhead	2	27.5	1	16.5		
MIDSHIPMAN, specklefin	2	27.5			3	16
SMOOTHHOUND, gray	1	31.0				
DOGFISH, spiny	1	31.0				
SKATE, California	1	31.0				
FLYINGFISH, sharpchin			3	12.0	1	20
HERRING, round					345	5
Total Species	32.0		17.0		21.0	
Total Individuals	73198.0		5127.0		24517.0	
Mean Individuals	963.1		341.8		845.4	

APPENDIX C -- TABLE 7

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE **NEAR IMPACT** LOCATION, **5-10** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	100.0	1.0	93.3	1.0	96.7	1
ANCHOVY, northern	95.3	2.0	53.3	8.0	73.3	3
SILVERSIDES spp.	93.0	3.0	80.0	2.0	76.7	2
CROAKER, white	90.7	4.0	73.3	3.0	46.7	8
MACKEREL, jack	74.4	5.0	60.0	6.5	56.7	5
BUTTERFISH, Pacific	69.8	6.0	66.7	4.5	40.0	9
BARRACUDA, Pacific	58.1	7.0	46.7	9.5	50.0	7
SEAPERCH, white	53.5	8.0	46.7	9.5	6.7	23
CORBINA, Ca.	46.5	9.0	26.7	13.5	20.0	14
SALEMA	41.9	10.5	66.7	4.5	50.0	7
SURFPERCH, walleye	41.9	10.5	33.3	11.5	26.7	11
RAY, bat	25.6	12.5	33.3	11.5	20.0	14
MACKEREL, Pacific	25.6	12.5	60.0	6.5	56.7	5
ANCHOA spp.	20.9	14.5	20.0	15.5	10.0	18
PERCH, shiner	20.9	14.5	26.7	13.5	3.3	32
HALIBUT, Ca.	14.0	16.0	20.0	15.5	10.0	18
CROAKER, yellowfin	9.3	17.0	6.7	24.5	10.0	18
SCORPIONFISH, Ca.	7.0	18.0			6.7	23
STINGRAY, round	4.7	21.0	6.7	24.5		
BASS, barred sand	4.7	21.0				
BONITO, Pacific	4.7	21.0				
SEABASS, white	4.7	21.0	6.7	24.5	6.7	23
CUSK-EEL, basketweave	4.7	21.0	13.3	17.0	3.3	32
THORNBACK	2.3	28.5			6.7	23
RAY, Pacific electric	2.3	28.5				
RAY, Ca. butterfly	2.3	28.5	6.7	24.5		
FLYINGFISH, Ca.	2.3	28.5			6.7	23
SANDDAB, Pacific	2.3	28.5				
SANDDAB, speckled	2.3	28.5	6.7	24.5	3.3	32
TURBOT, diamond	2.3	28.5				
CROAKER, spotfin	2.3	28.5	6.7	24.5		
SEAPERCH, rubberlip	2.3	28.5				
BLACKSMITH	2.3	28.5				
THRESHER, common			6.7	24.5	3.3	32
SMOOTHHOUND, brown			6.7	24.5		
SHARK, leopard			6.7	24.5		
GUITARFISH, shovelnose			6.7	24.5	3.3	32
SARDINE, Pacific			6.7	24.5	26.7	11
FLYINGFISH, sharpchin			6.7	24.5	16.7	15
LIZARDFISH, Ca.			6.7	24.5		
BASS, spotted sand			6.7	24.5		
HERRING, round					23.3	12
SARGO					10.0	18
PIPEFISH					6.7	23

APPENDIX C -- TABLE 7 (continued)

Species	PREOPERATIONAL Freq.	PREOPERATIONAL Rank	INTERIM Freq.	INTERIM Rank	OPERATIONAL Freq.	OPERATIONAL Rank
SHARK, horn					3.3	32
SHAD, American					3.3	32
NEEDLEFISH, Ca.					3.3	32
SOLE, bigmouth					3.3	32
BASS, kelp					3.3	32
CROAKER, black					3.3	32
MIDSHIPMAN, plainfin					3.3	32
KELPFISH, giant					3.3	32
NUMBER OF HAULS		43		15		30

APPENDIX C -- TABLE 8

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE **NEAR IMPACT** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	93.4	1.0	80.0	1.5	93.1	1
ANCHOVY, northern	81.6	2.0	80.0	1.5	75.9	2
MACKEREL, jack	69.7	3.0	53.3	4.0	48.3	4
MACKEREL, Pacific	67.1	4.0	73.3	3.0	41.4	7
BUTTERFISH, Pacific	57.9	5.0	33.3	7.5	48.3	4
SILVERSIDES spp.	52.6	6.0	33.3	7.5	48.3	4
CROAKER, white	46.1	7.0	20.0	9.0	24.1	11
RAY, bat	40.8	8.0	46.7	5.0	41.4	7
BARRACUDA, Pacific	30.3	9.0	40.0	6.0	37.9	9
SALEMA	21.1	10.0	13.3	10.5	20.7	12
SURFPERCH, walleye	18.4	11.5			10.3	16
SEAPERCH, white	18.4	11.5	6.7	16.0	3.4	24
PERCH, shiner	9.2	13.0	6.7	16.0		
BONITO, Pacific	7.9	14.5	6.7	16.0		
SCORPIONFISH, Ca.	7.9	14.5			3.4	24
SARDINE, Pacific	5.3	17.0	6.7	16.0	37.9	9
ANCHOA spp.	5.3	17.0			10.3	16
BASS, barred sand	5.3	17.0			17.2	13
RAY, Pacific electric	3.9	20.0	6.7	16.0		
SEABASS, white	3.9	20.0	6.7	16.0	10.3	16
CROAKER, yellowfin	3.9	20.0				
FLYINGFISH, Ca.	2.6	24.0			3.4	24
HALIBUT, Ca.	2.6	24.0			3.4	24
BASS, kelp	2.6	24.0	6.7	16.0	3.4	24
CORBINA, Ca.	2.6	24.0			3.4	24
PERCH, kelp	2.6	24.0				
THORNBACK	1.3	30.5				
SANDDAB, speckled	1.3	30.5				
TURBOT, diamond	1.3	30.5				
TURBOT, hornyhead	1.3	30.5				
SARGO	1.3	30.5			3.4	24
SEAPERCH, rubberlip	1.3	30.5				
PERCH, pile	1.3	30.5				
CUSK-EEL, basketweave	1.3	30.5			3.4	24
LIZARDFISH, Ca.			13.3	10.5		
CROAKER, black			6.7	16.0		
BLACKSMITH			6.7	16.0		
HERRING, round					27.6	10
FLYINGFISH, sharpchin					13.8	14
DOGFISH, spiny					6.9	18
TONGUEFISH, Ca.					3.4	24
MIDSHIPMAN, plainfin					3.4	24
NUMBER OF HAULS	76		15		29	

APPENDIX C -- TABLE 9

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE **FAR IMPACT** LOCATION, **5-10** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	100.0	1.0	93.3	1.5	100.0	1
ANCHOVY, northern	98.7	2.0	93.3	1.5	86.2	3
SILVERSIDES spp.	94.9	3.5	73.3	4.5	89.7	2
CROAKER, white	94.9	3.5	73.3	4.5	82.8	4
BUTTERFISH, Pacific	82.3	5.0	86.7	3.0	65.5	5
BARRACUDA, Pacific	51.9	6.0	46.7	8.0	55.2	6
CORBINA, Ca.	44.3	7.0	53.3	6.5	34.5	8
SEAPERCH, white	40.5	8.0	53.3	6.5	17.2	16
MACKEREL, jack	36.7	9.0	20.0	13.0	27.6	11
RAY, bat	34.2	10.5	20.0	13.0	44.8	7
SURFPERCH, walleye	34.2	10.5	13.3	17.5	24.1	12
MACKEREL, Pacific	26.6	12.0	40.0	9.5	13.8	17
PERCH, shiner	13.9	13.0	20.0	13.0	6.9	24
HALIBUT, Ca.	12.7	14.0	20.0	13.0	17.2	16
ANCHOA spp.	11.4	15.5	6.7	21.5	10.3	19
SALEMA	11.4	15.5	20.0	13.0	31.0	9
CUSK-EEL, basketweave	10.1	17.0	13.3	17.5	20.7	14
BASS, barred sand	6.3	18.5				
SEABASS, white	6.3	18.5	13.3	17.5	6.9	24
DOGFISH, spiny	5.1	20.0			10.3	19
THRESHER, common	3.8	21.0	6.7	21.5		
SMOOTHHOUND, gray	2.5	24.5			3.4	32
GUITARFISH, shovelnose	2.5	24.5	6.7	21.5		
RAY, Pacific electric	2.5	24.5				
FLYINGFISH, Ca.	2.5	24.5				
TURBOT, hornyhead	2.5	24.5				
CROAKER, yellowfin	2.5	24.5			3.4	32
SHARK, horn	1.3	34.0				
THORNBACK	1.3	34.0			10.3	19
SKATE, California	1.3	34.0				
STINGRAY, round	1.3	34.0			3.4	32
SARDINE, Pacific	1.3	34.0	13.3	17.5	20.7	14
SANDDAB, speckled	1.3	34.0			3.4	32
SOLE, fantail	1.3	34.0				
SEAPERCH, rubberlip	1.3	34.0				
SEAPERCH, pink	1.3	34.0				
PIPEFISH	1.3	34.0			3.4	32
MIDSHIPMAN, specklefin	1.3	34.0	6.7	21.5		
MIDSHIPMAN, plainfin	1.3	34.0				
KELPFISH, giant	1.3	34.0			6.9	24
LIZARDFISH, Ca.			40.0	9.5	6.9	24
HERRING, round					27.6	11
FLYINGFISH, sharpchin					6.9	24
TURBOT, spotted					6.9	24

APPENDIX C -- TABLE 9 (continued)

Species	PREOPERATIONAL Freq.	PREOPERATIONAL Rank	INTERIM Freq.	INTERIM Rank	OPERATIONAL Freq.	OPERATIONAL Rank
SCORPIONFISH, Ca.					6.9	24
SMOOTHHOUND, sicklefin					3.4	32
PERCH, black					3.4	32
SCULPIN, Pacific staghorn					3.4	32
NUMBER OF HAULS	79		15		29	

APPENDIX C -- TABLE 10

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE **FAR IMPACT** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	96.1	1.0	66.7	2.5	93.3	1
ANCHOVY, northern	85.5	2.0	66.7	2.5	80.0	2
MACKEREL, Pacific	72.4	3.0	80.0	1.0	60.0	4
BUTTERFISH, Pacific	68.4	4.0	40.0	6.5	46.7	7
MACKEREL, jack	67.1	5.0	60.0	4.0	46.7	7
SILVERSIDES spp.	55.3	6.5	40.0	6.5	43.3	9
CROAKER, white	55.3	6.5	26.7	10.0	26.7	10
BARRACUDA, Pacific	38.2	8.0	40.0	6.5	50.0	5
RAY, bat	34.2	9.0	40.0	6.5	60.0	4
SEAPERCH, white	18.4	10.0	13.3	12.0		
SALEMA	15.8	11.0	33.3	9.0	23.3	11
SARDINE, Pacific	10.5	12.0	13.3	12.0	43.3	9
SURFPERCH, walleye	9.2	13.0			3.3	24
BONITO, Pacific	7.9	14.0			3.3	24
RAY, Pacific electric	3.9	16.5				
CORBINA, Ca.	3.9	16.5			6.7	16
PERCH, shiner	3.9	16.5	6.7	16.0	6.7	16
MIDSHIPMAN, plainfin	3.9	16.5			6.7	16
DOGFISH, spiny	2.6	21.0			3.3	24
ANCHOA spp.	2.6	21.0	6.7	16.0		
HALIBUT, Ca.	2.6	21.0				
BASS, barred sand	2.6	21.0			6.7	16
CUSK-EEL, basketweave	2.6	21.0			6.7	16
THRESHER, common	1.3	29.0				
FLYINGFISH, Ca.	1.3	29.0				
NEEDLEFISH, Ca.	1.3	29.0			3.3	24
TURBOT, hornyhead	1.3	29.0	6.7	16.0		
BASS, kelp	1.3	29.0	6.7	16.0	3.3	24
SARGO	1.3	29.0				
SEABASS, white	1.3	29.0			3.3	24
CROAKER, yellowfin	1.3	29.0				
PERCH, kelp	1.3	29.0				
SCORPIONFISH, Ca.	1.3	29.0			3.3	24
TRIGGERFISH, finescale	1.3	29.0				
FLYINGFISH, sharpchin			13.3	12.0	13.3	13
LIZARDFISH, Ca.			6.7	16.0		
HERRING, round					20.0	12
GUITARFISH, shovelnose					3.3	24
SANDDAB, speckled					3.3	24
PIPEFISH					3.3	24
NUMBER OF HAULS	76		15		30	

APPENDIX C -- TABLE 11

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE CONTROL LOCATION, 5-10 METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	100.0	1.0	93.3	1.5	96.7	1
ANCHOVY, northern	94.9	2.5	73.3	4.0	76.7	3
SILVERSIDES spp.	94.9	2.5	93.3	1.5	73.3	5
CROAKER, white	83.5	4.0	60.0	6.0	76.7	3
BUTTERFISH, Pacific	78.5	5.0	86.7	3.0	76.7	3
CORBINA, Ca.	69.6	6.0	66.7	5.0	30.0	9
ANCHOA spp.	43.0	7.0	33.3	7.5	23.3	13
SURFPERCH, walleye	39.2	8.0	26.7	10.0	36.7	8
RAY, bat	38.0	9.0	26.7	10.0	40.0	7
HALIBUT, Ca.	32.9	10.0	13.3	18.0	20.0	15
BARRACUDA, Pacific	27.8	11.5	13.3	18.0	56.7	6
SEAPERCH, white	27.8	11.5	33.3	7.5	16.7	18
MACKEREL, Pacific	24.1	13.0	26.7	10.0	26.7	11
CUSK-EEL, basketweave	21.5	14.0			13.3	20
CROAKER, yellowfin	15.2	15.5	6.7	26.0	3.3	30
PERCH, shiner	15.2	15.5	20.0	13.0	6.7	23
SALEMA	12.7	17.5	20.0	13.0	26.7	11
SCORPIONFISH, Ca.	12.7	17.5	6.7	26.0	23.3	13
DOGFISH, spiny	10.1	20.0	6.7	26.0	3.3	30
THORNBACK	10.1	20.0	6.7	26.0	3.3	30
SANDDAB, speckled	10.1	20.0			3.3	30
LIZARDFISH, Ca.	8.9	22.0	20.0	13.0	3.3	30
SARDINE, Pacific	7.6	24.0	13.3	18.0	16.7	18
SEABASS, white	7.6	24.0	13.3	18.0	3.3	30
SURFPERCH, barred	7.6	24.0				
RAY, Pacific electric	6.3	27.5				
STINGRAY, round	6.3	27.5	6.7	26.0	10.0	22
TURBOT, hornyhead	6.3	27.5			3.3	30
MACKEREL, jack	6.3	27.5	13.3	18.0	16.7	18
GUITARFISH, shovelnose	3.8	31.0				
TURBOT, diamond	3.8	31.0	13.3	18.0		
BASS, barred sand	3.8	31.0	6.7	26.0	16.7	18
SHARK, leopard	2.5	35.0	6.7	26.0		
FLYINGFISH, Ca.	2.5	35.0				
TURBOT, spotted	2.5	35.0			3.3	30
PIPEFISH	2.5	35.0				
MIDSHIPMAN, specklefin	2.5	35.0			3.3	30
THRESHER, common	1.3	41.5	6.7	26.0		
SMOOTHHOUND, gray	1.3	41.5				
SKATE, California	1.3	41.5				
FLYINGFISH, sharpchin	1.3	41.5	13.3	18.0		
NEEDLEFISH, Ca.	1.3	41.5				
SOLE, fantail	1.3	41.5				
BASS, kelp	1.3	41.5			3.3	30

APPENDIX C -- TABLE 11 (continued)

Species	PREOPERATIONAL Freq.	PREOPERATIONAL Rank	INTERIM Freq.	INTERIM Rank	OPERATIONAL Freq.	OPERATIONAL Rank
MIDSHIPMAN, plainfin	1.3	41.5				
BLACKSMITH			6.7	26.0		
HERRING, round					20.0	15
CROAKER, black					10.0	22
HERRING, Pacific					3.3	30
PERCH, black					3.3	30
SCULPIN, Pacific staghorn					3.3	30
NUMBER OF HAULS	79		15		30	

APPENDIX C -- TABLE 12

LAMPARA
(RANK) PERCENT FREQUENCY OF OCCURRENCE
AT THE **CONTROL** LOCATION, **11-16** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
ANCHOVY, northern	97.4	1.5	93.3	1.0	82.8	2
QUEENFISH	97.4	1.5	86.7	2.0	100.0	1
BUTTERFISH, Pacific	75.0	3.0	73.3	3.0	31.0	9
CROAKER, white	61.8	4.0	33.3	8.5	20.7	11
SILVERSIDES spp.	60.5	5.0	60.0	4.0	51.7	5
RAY, bat	50.0	6.5	46.7	5.5	44.8	7
MACKEREL, Pacific	50.0	6.5	46.7	5.5	51.7	5
BARRACUDA, Pacific	26.3	8.5	13.3	12.0	37.9	8
MACKEREL, jack	26.3	8.5	40.0	7.0	20.7	11
SEAPERCH, white	14.5	10.0	13.3	12.0		
SURFPERCH, walleye	11.8	11.0	6.7	15.5		
ANCHOA spp.	10.5	12.0	13.3	12.0	10.3	14
BASS, barred sand	9.2	14.5			3.4	20
CORBINA, Ca.	9.2	14.5			6.9	17
SCORPIONFISH, Ca.	9.2	14.5			3.4	20
CUSK-EEL, basketweave	9.2	14.5			6.9	17
LIZARDFISH, Ca.	6.6	17.5	26.7	10.0	17.2	12
HALIBUT, Ca.	6.6	17.5				
SALEMA	5.3	19.0			10.3	14
GUITARFISH, shovelnose	3.9	21.0				
RAY, Pacific electric	3.9	21.0				
SARDINE, Pacific	3.9	21.0	33.3	8.5	51.7	5
THORNBACK	2.6	25.5				
SANDDAB, speckled	2.6	25.5				
TURBOT, hornyhead	2.6	25.5	6.7	15.5		
CROAKER, yellowfin	2.6	25.5				
PERCH, shiner	2.6	25.5				
MIDSHIPMAN, specklefin	2.6	25.5			10.3	14
SMOOTHHOUND, gray	1.3	30.5				
DOGFISH, spiny	1.3	30.5				
SKATE, California	1.3	30.5				
BONITO, Pacific	1.3	30.5	6.7	15.5	6.9	17
FLYINGFISH, sharpchin			6.7	15.5	3.4	20
HERRING, round					55.2	3
NUMBER OF HAULS	76		15		29	

APPENDIX C -- TABLE 13

OTTER TRAWL
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **IMPACT** LOCATION, **18**-METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
CROAKER, white	2832	1.0	1111	1.0	2147	2.0
CUSK-EEL, basketweave	1668	2.0	221	3.0	2766	1.0
QUEENFISH	901	3.0	290	2.0	1587	3.0
SANDDAB, speckled	462	4.0	26	4.0	357	4.0
TURBOT, hornyhead	190	5.0	18	7.5	132	6.0
SANDDAB, longfin	152	6.0	3	15.0	141	5.0
HALIBUT, California	106	7.0	19	6.0	19	13.0
SURFPERCH, walleye	90	8.0				
TONGUEFISH, California	54	9.0	22	5.0	75	8.0
GUITARFISH, shovelnose	42	10.5	1	20.0	7	21.0
PERCH, shiner	42	10.5	12	11.0	13	14.0
SOLE, fantail	41	12.0	10	13.0	113	7.0
LIZARDFISH, California	16	13.0	4	14.0	57	9.0
SEAPERCH, white	14	14.5	18	7.5	3	26.0
MIDSHIPMAN, plainfin	14	14.5	1	20.0	25	11.0
SANDDAB, Pacific	13	16.0				
TURBOT, spotted	10	17.5	1	20.0	12	15.0
CORBINA, California	10	17.5	16	9.5	11	16.0
RAY, bat	8	19.5			1	33.0
BASS, barred sand	8	19.5	11	12.0	7	21.0
SKATE, California	7	21.0	1	20.0	8	18.5
RATFISH	6	22.5			2	28.5
SCORPIONFISH, Ca.	6	22.5	2	16.0	10	17.0
STINGRAY, round	5	24.5			4	24.0
SOLE, English	5	24.5			4	24.0
THORNBACK	4	26.0	1	20.0	2	28.5
TURBOT, diamond	3	27.0				
DOGFISH, spiny	2	28.5			4	24.0
MIDSHIPMAN, specklefin	2	28.5	16	9.5	20	12.0
HAKE, Pacific	1	32.0				
SOLE, bigmouth	1	32.0			7	21.0
WHITEFISH, ocean	1	32.0				
PERCH, kelp	1	32.0				
SEAPERCH, pink	1	32.0			52	10.0
BASS, kelp			1	20.0		
SEAPERCH, rubberlip			1	20.0		
SCULPIN, yellowchin					8	18.5
SALEMA					2	28.5
COMBFISH, longspine					2	28.5
FLYINGFISH, sharpchin					1	33.0
CROAKER, yellowfin					1	33.0
BLACKSMITH					1	33.0
KELPFISH, giant					1	33.0
Total Species	34.0		23.0		35.0	
Total Individuals	6718.0		1806.0		7602.0	
Mean Individuals	64.6		41.0		76.8	

APPENDIX C -- TABLE 14

OTTER TRAWL
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **IMPACT** LOCATION, **30**-METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
SEAPERCH, pink	5230	1.0	75	7.0	398	7.0
CROAKER, white	4008	2.0	1174	1.0	1894	1.0
CUSK-EEL, basketweave	1615	3.0	460	2.0	1429	2.0
SANDDAB, Pacific	1161	4.0	9	15.5	208	9.0
SANDDAB, speckled	921	5.0	57	9.0	877	3.0
SANDDAB, longfin	891	6.0	149	5.0	754	4.0
QUEENFISH	725	7.0	418	3.0	659	5.0
TONGUEFISH, California	409	8.0	63	8.0	519	6.0
COMBFISH, longspine	303	9.0	5	19.5	108	15.0
TURBOT, hornyhead	182	10.0	43	10.0	170	10.0
MIDSHIPMAN, plainfin	169	11.0	407	4.0	288	8.0
SOLE, bigmouth	99	12.0	17	12.0	163	11.0
SKATE, California	88	13.0	10	14.0	27	18.0
PERCH, shiner	80	14.0	7	18.0	3	30.0
SOLE, fantail	78	15.0	30	11.0	136	12.0
LIZARDFISH, Ca.	45	16.5	123	6.0	113	13.0
SCULPIN, yellowchin	45	16.5	2	22.5	111	14.0
SCORPIONFISH, Ca.	32	18.0	8	17.0	29	17.0
RATFISH	29	19.0	1	27.5	7	26.0
GUITARFISH, shovelnose	28	20.0	1	27.5	11	23.0
HAKE, Pacific	26	21.0			23	20.0
HALIBUT, California	19	22.0			5	28.0
SEAPERCH, white	13	23.0	11	13.0	1	32.5
MIDSHIPMAN, specklefin	9	24.0	9	15.5	13	21.0
CUSK-EEL, spotted	8	25.0			12	22.0
BASS, barred sand	5	26.0	5	19.5	25	19.0
SOLE, English	4	27.0	2	22.5	9	24.0
HAGFISH, Pacific	3	29.5	1	27.5	8	25.0
RAY, bat	3	29.5	1	27.5		
PERCH, pile	3	29.5				
ROCKFISH, brown	3	29.5				
SMOOTHHOUND, gray	2	32.0			1	32.5
RAY, Pacific electric	1	36.0				
SOLE, Dover	1	36.0				
TURBOT, spotted	1	36.0				
BASS, kelp	1	36.0				
BLACKSMITH	1	36.0	2	22.5	1	32.5
SCULPIN, roughback	1	36.0			1	32.5
SCULPIN, Pacific staghor	1	36.0				
SALEMA			2	22.5	4	29.0
THORNBACK			1	27.5		
POACHER, pigmy			1	27.5		
ARGENTINE, Pacific					46	16.0
DOGFISH, spiny					6	27.0
Total Species	39.0		30.0		34.0	
Total Individuals	16243.0		3094.0		8059.0	
Mean Individuals	156.2		70.3		80.6	

APPENDIX C -- TABLE 15

OTTER TRAWL
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **CONTROL** LOCATION, **18**-METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
CROAKER, white	3803	1.0	761	1.0	1161	3.0
CUSK-EEL, basketweave	2156	2.0	288	2.0	2885	1.0
QUEENFISH	1385	3.0	262	3.0	1338	2.0
SANDDAB, longfin	546	4.0	20	7.5	160	6.0
SANDDAB, speckled	423	5.0	69	4.0	522	4.0
TONGUEFISH, California	178	6.0	15	10.0	112	8.0
HALIBUT, California	141	7.0	6	13.0	38	13.0
TURBOT, hornyhead	132	8.0	18	9.0	155	7.0
PERCH, shiner	82	9.0	2	19.0	4	21.5
LIZARDFISH, California	59	10.0	20	7.5	81	9.0
BASS, barred sand	53	11.0	4	16.0	39	12.0
SOLE, fantail	44	12.0	9	12.0	186	5.0
GUITARFISH, shovelnose	41	13.0	3	17.0	8	18.0
SCORPIONFISH, Ca.	24	14.0	2	19.0	25	15.0
SEAPERCH, white	20	15.5	1	22.5	1	28.0
SEAPERCH, pink	20	15.5				
MIDSHIPMAN, plainfin	13	17.0	23	6.0	26	14.0
SKATE, California	12	18.0	1	22.5	4	21.5
MIDSHIPMAN, specklefin	11	19.0	31	5.0	52	10.0
RAY, bat	10	20.5	5	14.5	4	21.5
TURBOT, spotted	10	20.5			13	17.0
STINGRAY, round	8	23.0	2	19.0	4	21.5
CORBINA, California	8	23.0	10	11.0	42	11.0
SURFPERCH, walleye	8	23.0				
SANDDAB, Pacific	7	25.0	1	22.5		
SOLE, English	5	26.0				
TURBOT, diamond	4	27.5				
BASS, kelp	4	27.5				
THORNBACK	2	30.5	5	14.5	2	25.0
RATFISH	2	30.5				
SOLE, bigmouth	2	30.5			4	21.5
SOLE, curlfin	2	30.5				
SMOOTHHOUND, brown	1	35.5				
RAY, Pacific electric	1	35.5				
SOLE, C-O	1	35.5				
BASS, giant sea	1	35.5				
SEABASS, white	1	35.5				
PIPEFISH	1	35.5				
HAGFISH, Pacific			1	22.5	1	28.0
SCULPIN, yellowchin					18	16.0
COMBFISH, longspine					4	21.5
SMOOTHHOUND, gray					1	28.0
DOGFISH, spiny					1	28.0
KELPFISH, giant					1	28.0
Total Species	38.0		24.0		30.0	
Total Individuals	9221.0		1559.0		6892.0	
Mean Individuals	88.7		35.4		68.9	

APPENDIX C -- TABLE 16

OTTER TRAWL
ABSOLUTE AND RELATIVE SIZES OF CATCHES (NUMBERS)
AT THE **CONTROL** LOCATION, 30-METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Count	Rank	Count	Rank	Count	Rank
CROAKER, white	7016	1.0	1072	1.0	744	4.0
SEAPERCH, pink	2512	2.0	13	15.5	236	8.0
SANDDAB, longfin	1886	3.0	238	4.0	1056	1.0
CUSK-EEL, basketweave	1356	4.0	337	2.0	1014	3.0
QUEENFISH	956	5.0	224	5.0	523	6.0
TONGUEFISH, California	836	6.0	118	7.0	1042	2.0
SANDDAB, Pacific	809	7.0			123	11.0
SANDDAB, speckled	665	8.0	69	8.0	693	5.0
COMBFISH, longspine	218	9.0	16	13.0	109	13.0
TURBOT, hornyhead	203	10.0	41	9.0	110	12.0
MIDSHIPMAN, plainfin	158	11.0	277	3.0	439	7.0
PERCH, shiner	145	12.0	13	15.5		
SKATE, California	106	13.0	9	18.0	24	18.0
SOLE, bigmouth	98	14.0	23	11.0	202	9.0
SOLE, fantail	86	15.0	31	10.0	83	14.0
SCULPIN, yellowchin	74	16.0	5	21.5	193	10.0
LIZARDFISH, California	69	17.0	141	6.0	59	15.0
GUITARFISH, shovelnose	26	18.0				
SCORPIONFISH, Ca.	22	19.0	13	15.5	44	16.0
HALIBUT, California	21	20.5	7	19.0	5	23.5
SOLE, Dover	21	20.5			5	23.5
MIDSHIPMAN, specklefin	19	22.0	22	12.0	33	17.0
SEAPERCH, white	16	23.0	1	26.0		
BASS, barred sand	10	24.0	13	15.5	22	19.5
HAGFISH, Pacific	8	25.0	6	20.0	3	26.5
SOLE, English	6	26.0			2	28.5
HAKE, Pacific	5	27.0			13	21.0
THORNBACK	4	28.5				
SCULPIN, Pacific staghor	4	28.5			1	32.0
GOBY, bay	3	30.0			3	26.5
RAY, bat	2	31.5	5	21.5		
RATFISH	2	31.5	1	26.0		
SEABASS, white	1	33.5				
CUSK-EEL, spotted	1	33.5			22	19.5
BLACKSMITH			2	23.0	2	28.5
SMOOTHHOUND, gray			1	26.0		
SARGO			1	26.0		
SCULPIN, roughback			1	26.0	1	32.0
ARGENTINE, Pacific					11	22.0
SANDDAB, gulf					4	25.0
DOGFISH, spiny					1	32.0
RAY, Pacific electric					1	32.0
ROCKFISH spp.					1	32.0
Total Species	34.0		28.0		34.0	
Total Individuals	17364.0		2700.0		6824.0	
Mean Individuals	167.0		61.4		68.2	

APPENDIX C -- TABLE 17

OTTER TRAWL
(RANK) PERCENT FREQUENCY OF OCCURRENCE IN TRAWLS
AT THE **IMPACT** LOCATION, **18** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
CUSK-EEL, basketweave	96.2	1.0	77.3	2.0	95.0	1
CROAKER, white	92.3	2.0	72.7	3.0	93.0	2
SANDDAB, speckled	91.3	3.0	38.6	4.0	68.0	4
QUEENFISH	86.5	4.0	81.8	1.0	84.0	3
TURBOT, hornyhead	72.1	5.0	29.5	5.0	49.0	5
HALIBUT, Ca.	46.2	6.0	25.0	6.5	13.0	12
SURFPERCH, walleye	33.7	7.0				
TONGUEFISH, Ca.	31.7	8.0	25.0	6.5	37.0	8
SANDDAB, longfin	27.9	9.5	4.5	15.5	45.0	6
SOLE, fantail	27.9	9.5	20.5	8.0	41.0	7
GUITARFISH, shovelnose	23.1	11.0	2.3	20.0	5.0	19
PERCH, shiner	19.2	12.0	18.2	9.0	7.0	17
MIDSHIPMAN, plainfin	10.6	13.0	2.3	20.0	19.0	10
LIZARDFISH, Ca.	9.6	14.0	6.8	14.0	31.0	9
TURBOT, spotted	8.7	15.0	2.3	20.0	10.0	15
RAY, bat	7.7	17.0			1.0	33
BASS, barred sand	7.7	17.0	13.6	12.0	6.0	18
CORBINA, Ca.	7.7	17.0	15.9	10.0	11.0	13
SKATE, Ca.	6.7	19.0	2.3	20.0	7.0	17
RATFISH	5.8	21.0			2.0	27
SEAPERCH, white	5.8	21.0	13.6	12.0	2.0	27
SCORPIONFISH, Ca.	5.8	21.0	4.5	15.5	10.0	15
SANDDAB, Pacific	4.8	23.5				
SOLE, English	4.8	23.5			2.0	27
THORNBACK	3.8	25.5	2.3	20.0	2.0	27
STINGRAY, round	3.8	25.5			4.0	21
TURBOT, diamond	2.9	27.0				
DOGFISH, spiny	1.9	28.5			3.0	24
MIDSHIPMAN, specklefin	1.9	28.5	13.6	12.0	13.0	12
HAKE, Pacific	1.0	32.0				
SOLE, bigmouth	1.0	32.0			4.0	21
WHITEFISH, ocean	1.0	32.0				
PERCH, kelp	1.0	32.0				
SEAPERCH, pink	1.0	32.0			4.0	21
BASS, kelp			2.3	20.0		
SEAPERCH, rubberlip			2.3	20.0		
SCULPIN, yellowchin					3.0	24
SALEMA					2.0	27
FLYINGFISH, sharpchin					1.0	33
CROAKER, yellowfin					1.0	33
BLACKSMITH					1.0	33
COMBFISH, longspine					1.0	33
KELPFISH, giant					1.0	33
NUMBER OF TRAWLS	104		44		100	

APPENDIX C -- TABLE 18

OTTER TRAWL
(RANK) PERCENT FREQUENCY OF OCCURRENCE IN TRAWLS
AT THE **IMPACT** LOCATION, **30** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
CROAKER, white	99.0	1.5	97.7	1.0	99.0	1
CUSK-EEL, basketweave	99.0	1.5	93.2	2.0	93.0	2
SEAPERCH, pink	96.2	3.0	11.4	17.0	29.0	13
SANDDAB, longfin	94.2	4.0	56.8	5.5	92.0	3
SANDDAB, speckled	91.3	5.0	56.8	5.5	90.0	4
QUEENFISH	82.7	6.0	88.6	3.0	70.0	6
SANDDAB, Pacific	77.9	7.0	9.1	20.0	21.0	15
TURBOT, hornyhead	76.0	8.0	52.3	8.0	68.0	7
TONGUEFISH, Ca.	73.1	9.0	54.5	7.0	80.0	5
SKATE, Ca.	48.1	10.0	18.2	12.0	17.0	17
SOLE, bigmouth	46.2	11.0	27.3	11.0	45.0	11
MIDSHIPMAN, plainfin	43.3	12.0	40.9	9.0	64.0	8
SOLE, fantail	42.3	13.0	29.5	10.0	49.0	9
COMBFISH, longspine	38.5	14.0	11.4	17.0	31.0	12
PERCH, shiner	26.0	15.5	13.6	13.5	2.0	30
SCORPIONFISH, Ca.	26.0	15.5	11.4	17.0	20.0	16
RATFISH	23.1	17.5	2.3	27.5	7.0	24
LIZARDFISH, Ca.	23.1	17.5	70.5	4.0	45.0	11
SCULPIN, yellowchin	18.3	19.0	4.5	22.5	26.0	14
GUITARFISH, shovelnose	15.4	20.5	2.3	27.5	5.0	26
HALIBUT, Ca.	15.4	20.5			4.0	27
HAKE, Pacific	9.6	22.5			10.0	20
SEAPERCH, white	9.6	22.5	11.4	17.0	1.0	33
MIDSHIPMAN, specklefin	7.7	24.0	13.6	13.5	10.0	20
CUSK-EEL, spotted	6.7	25.0			10.0	20
BASS, barred sand	4.8	26.0	11.4	17.0	9.0	22
SOLE, English	3.8	27.0	4.5	22.5	6.0	25
HAGFISH, Pacific	2.9	28.5	2.3	27.5	7.0	24
ROCKFISH, brown	2.9	28.5				
SMOOTHHOUND, gray	1.9	30.5			1.0	33
PERCH, pile	1.9	30.5				
RAY, Pacific electric	1.0	35.5				
RAY, bat	1.0	35.5	2.3	27.5		
SOLE, Dover	1.0	35.5				
TURBOT, spotted	1.0	35.5				
BASS, kelp	1.0	35.5				
BLACKSMITH	1.0	35.5	4.5	22.5	1.0	33
SCULPIN, roughback	1.0	35.5			1.0	33
SCULPIN, Pacific staghorn	1.0	35.5				
SALEMA			4.5	22.5	2.0	30
THORNBACK			2.3	27.5		
POACHER, pigmy			2.3	27.5		
ARGENTINE, Pacific					15.0	18
DOGFISH, spiny					3.0	28
NUMBER OF TRAWLS	104		44		100	

APPENDIX C -- TABLE 19

OTTER TRAWL
(RANK) PERCENT FREQUENCY OF OCCURRENCE IN TRAWLS
AT THE **CONTROL** LOCATION, **18** METER DEPTH

	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
QUEENFISH	97.1	1.0	90.9	2.0	89.0	3
CUSK-EEL, basketweave	94.2	2.0	97.7	1.0	96.0	1
CROAKER, white	89.4	3.0	84.1	3.0	93.0	2
SANDDAB, speckled	81.7	4.0	56.8	4.0	87.0	4
SANDDAB, longfin	80.8	5.0	20.5	10.0	49.0	6
TURBOT, hornyhead	63.5	6.0	29.5	7.0	47.0	7
TONGUEFISH, Ca.	54.8	7.0	22.7	8.5	32.0	9
HALIBUT, Ca.	52.9	8.0	11.4	13.5	26.0	10
PERCH, shiner	40.4	9.0	4.5	19.0	3.0	23
LIZARDFISH, Ca.	38.5	10.0	31.8	5.5	42.0	8
SOLE, fantail	32.7	11.0	13.6	12.0	51.0	5
GUITARFISH, shovelnose	29.8	12.0	6.8	16.5	8.0	17
BASS, barred sand	22.1	13.0	9.1	15.0	17.0	13
SCORPIONFISH, Ca.	17.3	14.0	4.5	19.0	18.0	12
SEAPERCH, white	10.6	15.0	2.3	22.5	1.0	28
RAY, bat	9.6	16.5	11.4	13.5	4.0	19
TURBOT, spotted	9.6	16.5			12.0	16
SKATE, Ca.	8.7	19.0	2.3	22.5	4.0	19
MIDSHIPMAN, specklefin	8.7	19.0	31.8	5.5	18.0	12
MIDSHIPMAN, plainfin	8.7	19.0	22.7	8.5	13.0	15
CORBINA, Ca.	5.8	21.0	15.9	11.0	14.0	14
STINGRAY, round	4.8	23.0	4.5	19.0	3.0	23
SOLE, English	4.8	23.0				
SURFPERCH, walleye	4.8	23.0				
SANDDAB, Pacific	3.8	26.0	2.3	22.5		
TURBOT, diamond	3.8	26.0				
BASS, kelp	3.8	26.0				
SEAPERCH, pink	2.9	28.0				
THORNBACK	1.9	30.5	6.8	16.5	2.0	25
RATFISH	1.9	30.5				
SOLE, bigmouth	1.9	30.5			3.0	23
SOLE, curlfin	1.9	30.5				
SMOOTHHOUND, brown	1.0	35.5				
RAY, Pacific electric	1.0	35.5				
SOLE, C-O	1.0	35.5				
BASS, giant sea	1.0	35.5				
SEABASS, white	1.0	35.5				
PIPEFISH	1.0	35.5				
HAGFISH, Pacific			2.3	22.5	1.0	28
SCULPIN, yellowchin					4.0	19
COMBFISH, longspine					3.0	23
SMOOTHHOUND, gray					1.0	28
DOGFISH, spiny					1.0	28
KELPFISH, giant					1.0	28
NUMBER OF TRAWLS	104		44		100	

APPENDIX C -- TABLE 20

OTTER TRAWL
(RANK) PERCENT FREQUENCY OF OCCURRENCE IN TRAWLS
AT THE CONTROL LOCATION, 30 METER DEPTH

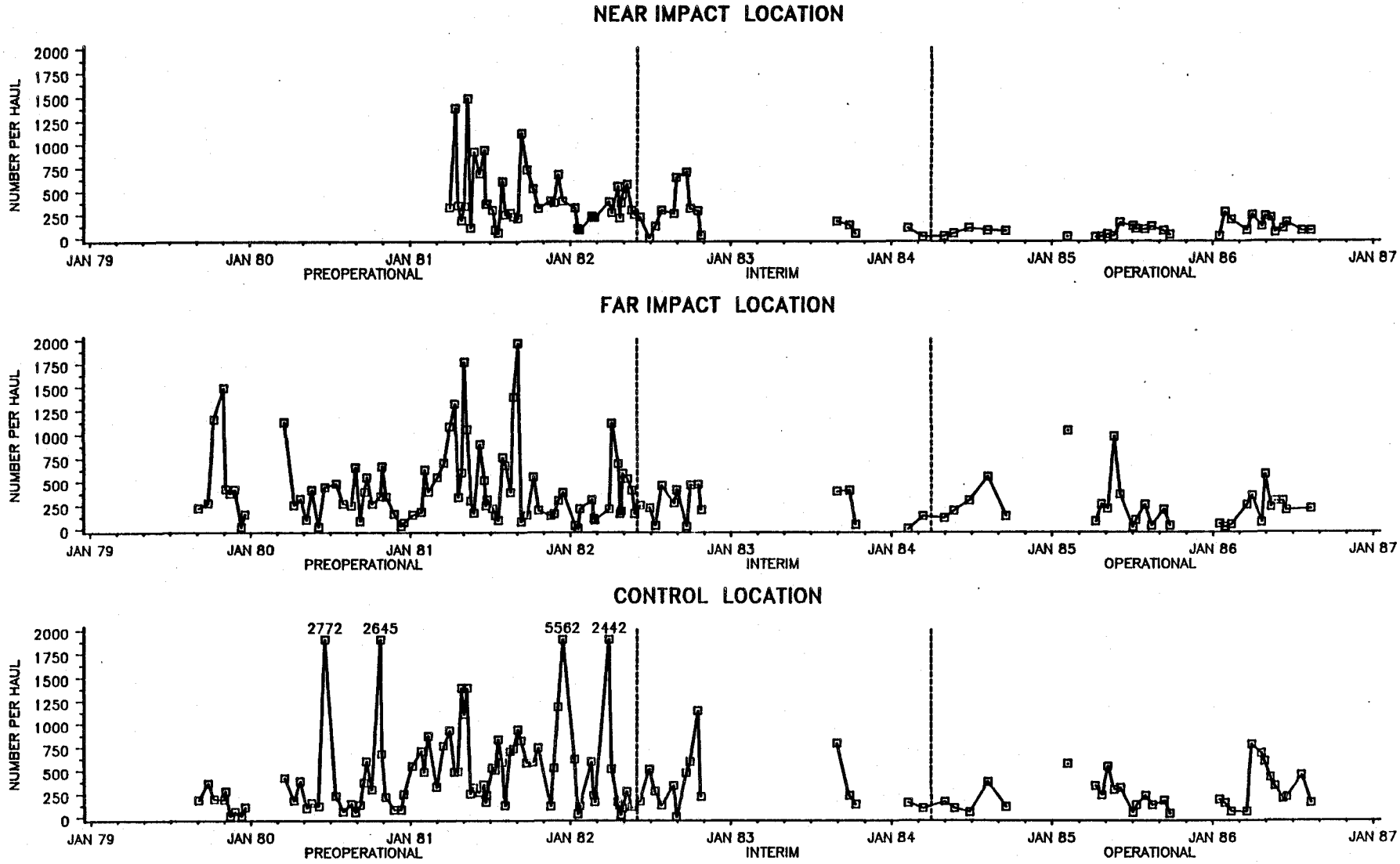
	PREOPERATIONAL		INTERIM		OPERATIONAL	
Species	Freq.	Rank	Freq.	Rank	Freq.	Rank
CROAKER, white	98.1	1.0	90.9	1.0	82.0	4
SANDDAB, longfin	95.2	2.5	63.6	6.0	97.0	1
TONGUEFISH, Ca.	95.2	2.5	81.8	3.0	92.0	2
QUEENFISH	89.4	4.0	65.9	5.0	56.0	8
CUSK-EEL, basketweave	86.5	5.0	88.6	2.0	73.0	5
SEAPERCH, pink	84.6	6.0	4.5	22.5	39.0	9
SANDDAB, speckled	75.0	7.0	61.4	7.0	83.0	3
SANDDAB, Pacific	74.0	8.0			16.0	18
TURBOT, hornyhead	73.1	9.0	56.8	8.0	38.0	10
SKATE, Ca.	57.7	10.0	15.9	14.5	20.0	16
SOLE, bigmouth	48.1	11.0	34.1	11.5	68.0	7
COMBFISH, longspine	43.3	12.5	22.7	13.0	24.0	15
MIDSHIPMAN, plainfin	43.3	12.5	50.0	9.0	71.0	6
SOLE, fantail	42.3	14.0	34.1	11.5	35.0	12
PERCH, shiner	36.5	15.0	11.4	18.0		
SCULPIN, yellowchin	31.7	16.0	9.1	20.5	33.0	13
LIZARDFISH, Ca.	27.9	17.0	75.0	4.0	37.0	11
HALIBUT, Ca.	17.3	18.0	11.4	18.0	5.0	23
GUITARFISH, shovelnose	16.3	19.0				
MIDSHIPMAN, specklefin	15.4	20.0	36.4	10.0	16.0	18
SCORPIONFISH, Ca.	14.4	21.0	15.9	14.5	26.0	14
SOLE, Dover	9.6	22.0			3.0	26
BASS, barred sand	8.7	23.0	13.6	16.0	16.0	18
HAGFISH, Pacific	6.7	24.5	11.4	18.0	3.0	26
SEAPERCH, white	6.7	24.5	2.3	26.0		
HAKE, Pacific	4.8	26.5			11.0	21
SOLE, English	4.8	26.5			2.0	29
SCULPIN, Pacific staghorn	3.8	28.0			1.0	32
GOBY, bay	2.9	29.0			3.0	26
THORNBACK	1.9	31.0				
RAY, bat	1.9	31.0	9.1	20.5		
RATFISH	1.9	31.0	2.3	26.0		
SEABASS, white	1.0	33.5				
CUSK-EEL, spotted	1.0	33.5			14.0	20
BLACKSMITH			4.5	22.5	2.0	29
SMOOTHHOUND, gray			2.3	26.0		
SARGO			2.3	26.0		
SCULPIN, roughback			2.3	26.0	1.0	32
ARGENTINE, Pacific					5.0	23
SANDDAB, gulf					3.0	26
DOGFISH, spiny					1.0	32
RAY, Pacific electric					1.0	32
ROCKFISH spp.					1.0	32
NUMBER OF TRAWLS	104		44		100	

APPENDIX C -- FIGURE 1

LAMPARA SEINE

NUMBER OF INDIVIDUALS CAUGHT PER SEINE HAUL

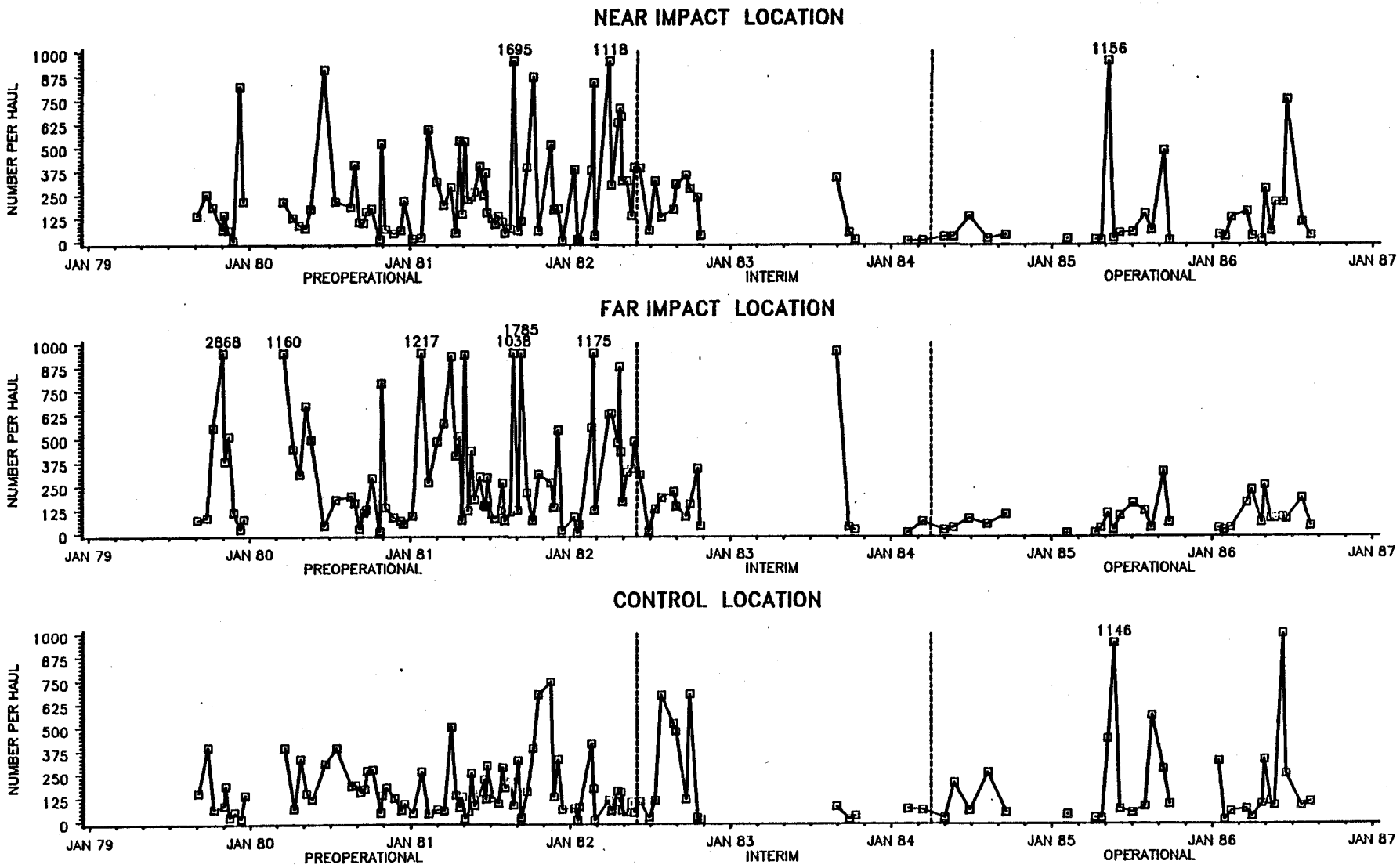
5–11 METER DEPTH



APPENDIX C -- FIGURE 2

LAMPARA SEINE

NUMBER OF INDIVIDUALS CAUGHT PER SEINE HAUL
11–16 METER DEPTH

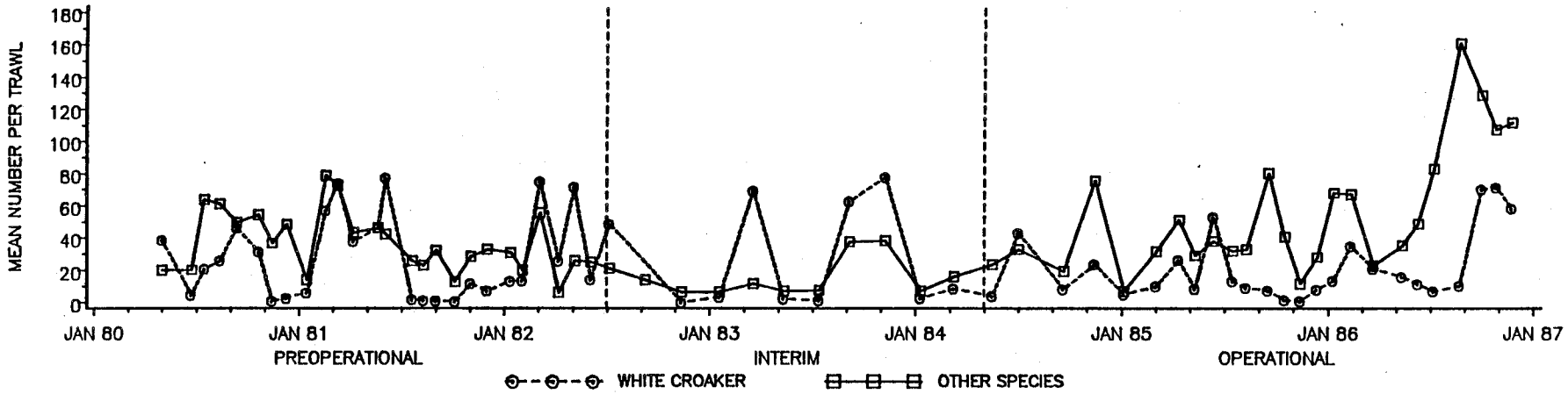


APPENDIX C -- FIGURE 3

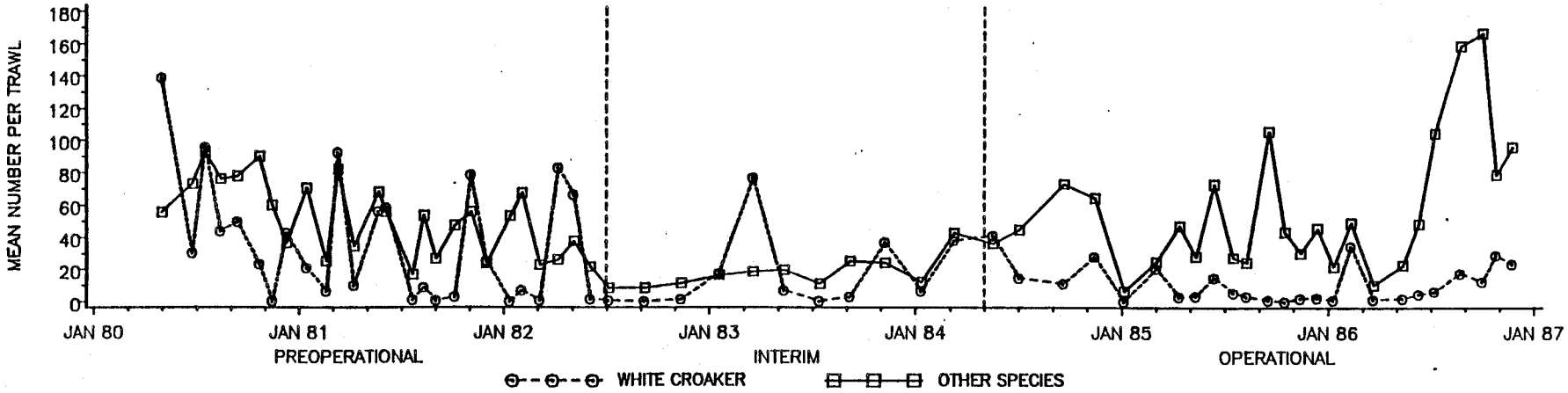
OTTER TRAWL

MEAN NUMBER OF INDIVIDUALS CAUGHT PER TRAWL
18 METER DEPTH

IMPACT LOCATION



CONTROL LOCATION

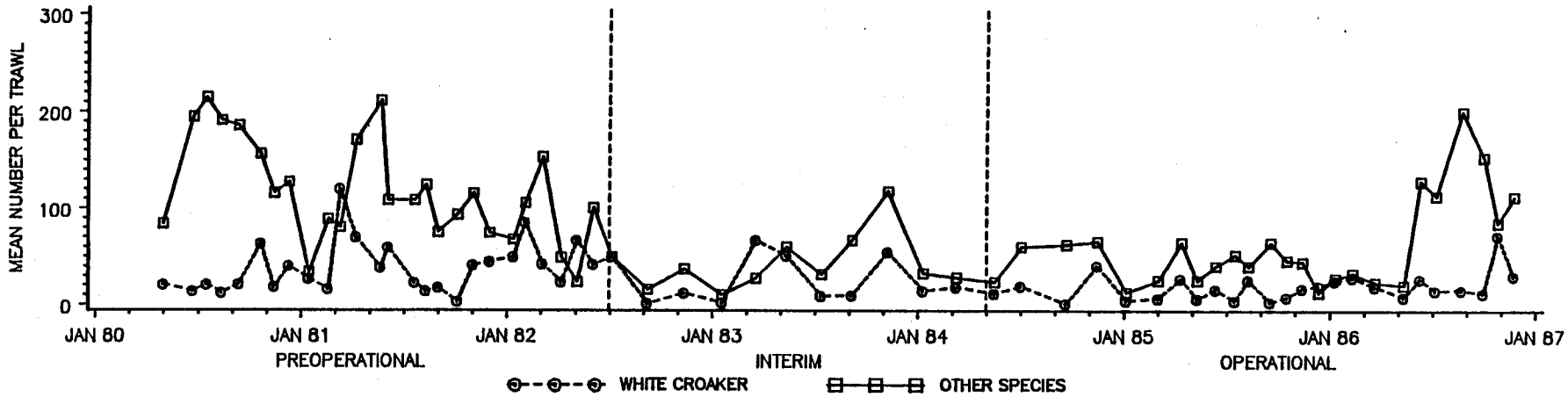


APPENDIX C -- FIGURE 4

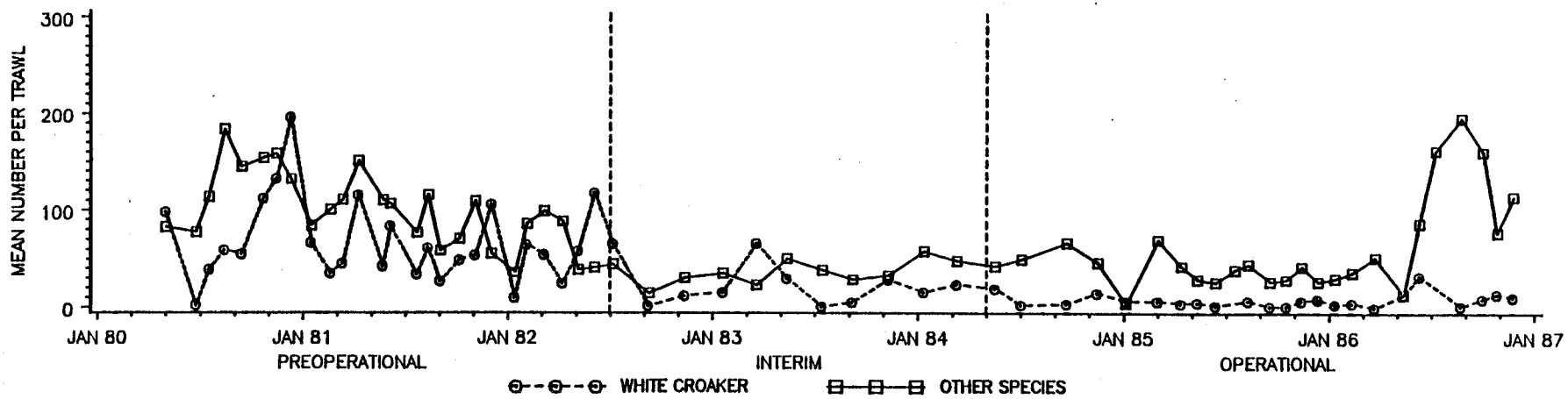
OTTER TRAWL

MEAN NUMBER OF INDIVIDUALS CAUGHT PER TRAWL
30 METER DEPTH

IMPACT LOCATION



CONTROL LOCATION



APPENDIX D -- Summary Results of Screening Tests for Statistical Assumptions

APPENDIX D -- TABLE 1

PELAGIC FISHES, SHALLOW (5-10 M) DEPTH BLOCK: Summary results of screening tests performed prior to BACI t-tests for impact. Preoperational deltas were tested for additivity and monotone trend (by linear regression), and both preoperational and operational deltas were tested for serial correlation (von Neumann's test). Results are based on tests using the data forms listed in Appendix E, Table 1. Dashes indicate that serial correlation problem is moot. A "yes" for resolved serial correlation indicates that including a first-order autoregressive error term removed the serial correlation from the residuals. All screening tests were evaluated at P = 0.05.

(5-10 M DEPTH BLOCK)

		Assumption Met Regarding ?			
Species	Loc. Pair	Additivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR resolved? (if present)
BUTTERFISH, Pacific	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
CROAKER, white	NI,C	no*	yes	yes	--
	FI,C	yes	yes	no	yes
	NI,FI	yes	yes	yes	--
SILVERSIDES	NI,C	yes	yes	no	yes
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	no	yes
QUEENFISH, total	NI,C	yes	yes	no	yes
	FI,C	yes	yes	yes	--
	NI,FI	no	yes	no	--
QUEENFISH, male	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, female	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, immature	NI,C	yes	yes	no	yes
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	no	yes
QUEENFISH, YOY	NI,C	yes	no	yes	--
	FI,C	yes	yes	no	yes
	NI,FI	yes	yes	yes	--

* Additivity test uninterpretable--large % single-zero observations

APPENDIX D -- TABLE 2

PELAGIC FISHES, MIDDLE (11-16 M) DEPTH BLOCK: Summary results of screening tests performed prior to BACI t-tests for impact. Preoperational deltas were tested for additivity and monotone trend (by linear regression), and both preoperational and operational deltas were tested for serial correlation (von Neumann's test). Results are based on tests using the data forms listed in Appendix E, Table 2. Dashes indicate that serial correlation problem is moot. A "yes" for resolved serial correlation indicates that including a first-or second-order autoregressive error term removed the serial correlation from the residuals. All screening tests were evaluated at P = 0.05.

(11-16 M DEPTH BLOCK)

		Assumption Met Regarding ?			
Species	Loc. Pair	Additivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR resolved? (if present)
BUTTERFISH, Pacific	NI,C	yes	yes	yes	--
	FI,C	no	yes	yes	--
	NI,FI	yes	yes	yes	--
CROAKER, white	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
SILVERSIDES	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, total	NI,C	no	no	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, male	NI,C	no	no	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, female	NI,C	yes	yes	yes	--
	FI,C	yes	yes	yes	--
	NI,FI	yes	yes	yes	--
QUEENFISH, immature	NI,C	yes	yes	yes	--
	FI,C	yes	yes	no	yes
	NI,FI	yes	yes	yes	--
QUEENFISH, YOY	NI,C	yes	yes	yes	--
	FI,C	yes	yes	no	yes
	NI,FI	yes	yes	yes	--

APPENDIX D -- TABLE 3

BENTHIC FISHES: Summary results of screening tests performed prior to BACI t-tests for impact. Preoperational deltas were tested for additivity and monotone trend (by linear regression), and both preoperational and operational deltas were tested for serial correlation (von Neumann's test). Results are based on tests using the data forms listed in Appendix E, Table 3. Dashes indicate that serial correlation problem is moot. A "yes" for resolved serial correlation indicates that including a first-order autoregressive error term removed the serial correlation from the residuals. All screening tests were evaluated at P = 0.05.

		Assumption Met Regarding ?			
Species	(M)	Additivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR resolved (if present)
CROAKER, white	18	yes	no	yes	--
	30	yes	yes	yes	--
CUSK-EEL, basketweave	18	yes	yes	yes	--
	30	yes	yes	no	yes
HALIBUT, Ca.	18	yes	no	no	--
LIZARDFISH, Ca.	18	yes	yes	yes	--
	30	yes	yes	yes	--
QUEENFISH	18	yes	yes	yes	--
	30	yes	yes	yes	--
SANDDAB, longfin	18	yes	yes	no	yes
	30	yes	yes	yes	--
SANDDAB, Pacific	30	yes	yes	yes	--
					--
SANDDAB, speckled	18	yes	yes	yes	--
	30	yes	no	no	--
SEAPERCH, pink	30	no	yes	yes	--
SKATE, California	30	yes	yes	yes	--
SOLE, fantail	18	yes	yes	yes	--
	30	yes	yes	yes	--
TONGUEFISH, Ca.	18	yes	no	no	--
	30	yes	yes	no	yes
TURBOT, hornyhead	18	yes	yes	yes	--
	30	no	no	yes	--

APPENDIX E -- Detailed Results of Impact Tests

(BACI T-Tests)

APPENDIX E -- TABLE 1

PELAGIC FISHES: SUMMARY RESULTS OF BACI T-TESTS ON THE DELTAS OF PREOPERATIONAL AND OPERATIONAL PERIOD SEINE DATA AT SHALLOW DEPTHS (5-10 M). Preoperational period: September 1979 (April 1981)-May 1982 (37-59 cruises, depending on location pair -- NI = Near Impact; FI = Far Impact; C = Control); Operational period: April 1984-August 1986 (30-32 cruises, depending on location pair). Data form used was the smallest log-transformation tested that satisfied all screening test assumptions. Dashes signify that t-test results are not valid because data seriously violated statistical assumptions. T-test results are reported either as Student's t (if variances of baseline and operational deltas are indistinguishable) or as Satterthwaite's approximation (t', if the variances of period deltas are unequal at $P \leq 0.05$). Student's t values that had to be corrected for first-order autoregression are flagged with an asterisk. All tests are one-tailed. (* = .10 > P > .05; ** = .05 > P > .01; *** = .01 > P > .001; **** = $P \leq .001$).

Taxon	Location Pair	Data Form	Delta-bars Preop.	Delta-bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I - C) Abundances	t or t'	df	P
BUTTERFISH, Pacific	NI,C	log10(x+.03125)	-.88	-1.14	1.80	1.45	no decline	t = .59	58	.28
	FI,C	log10(x+.03125)	+.02	-.33	1.47	1.32	no decline	t = 1.02	79	.16
	NI,FI	log10(x+.30)	-.67	-.60	.97	.99	no decline	t = .25	54	.40
CROAKER, white	NI,C	log10(x+.03125)	+.61	-1.37	1.39	1.35	-99	t = 5.43	57	<.001****
	FI,C	log10(x+.25)	+.45	+.06	1.07	.85	no decline	t* = 1.29	82	.10
	NI,FI	log10(x+.03125)	-.30	-1.35	.81	1.22	-91	t' = 3.86	43	<.001****
QUEENFISH, total	NI,C	log10(x+12.0)	+.05	-.34	.47	.56	-60	t* = 2.79	64	.003***
	FI,C	log10(x+.03125)	+.03	-.11	.47	.59	no decline	t = 1.22	87	.12
	NI,FI	- - - - - - - -	- - - - - - - - - -	- - - - - - - - - -	statistically	intractable	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - -
QUEENFISH, male	NI,C	log10(x+.5)	+.28	-.22	.75	.77	-68	t = 2.59	61	.006***
	FI,C	log10(x+.5)	+.55	-.11	.64	.86	-78	t = 3.93	83	<.001****
	NI,FI	log10(x+.03125)	-.23	-.10	.68	1.20	no decline	t' = .51	38	.31
QUEENFISH, female	NI,C	log10(x+.03125)	+.18	-.48	.87	1.11	-78	t = 2.64	60	.005***
	FI,C	log10(x+.03125)	+.36	-.07	.71	.94	-63	t = 2.36	84	.01**
	NI,FI	log10(x+.03125)	-.16	-.39	.75	.94	no decline	t = 1.05	61	.15
QUEENFISH, immature	NI,C	log10(x+5.0)	-.02	-.44	.57	.66	-62	t* = 2.50	64	.007***
	FI,C	log10(x+.03125)	-.17	-.08	.76	.77	no decline	t = .50	87	.31
	NI,FI	log10(x+2.0)	+.09	-.44	.09	.14	-71	t* = 2.81	64	.004***
QUEENFISH, YOY	NI,C	- - - - - - - -	- - - -	- - - -	statistically	intractable	- - - - - - - - - -	- - - - - - - - - -	- - -	- - -
	FI,C	log10(x+2.0)	-.26	-.13	.65	.62	no decline	t* = .81	83	.21
	NI,FI	log10(x+.03125)	+.05	-.79	.67	1.13	-86	t' = 3.41	37	.001***
SILVERSIDES	NI,C	log10(x+.03125)	-.02	-.15	1.18	1.50	no decline	t* = .38	61	.36
	FI,C	log10(x+.03125)	-.18	+.66	.98	1.17	no decline	t = 3.47	84	>.99 /a
	NI,FI	log10(x+.10)	+.15	-.75	.83	1.30	-87	t* = 2.86	60	.003***

/a P = (1 - P'/2) for observation opposite in sign to one-tailed prediction; P' .0008

APPENDIX E -- TABLE 2

PELAGIC FISHES: SUMMARY RESULTS OF BACI T-TESTS ON THE DELTAS OF PREOPERATIONAL AND OPERATIONAL PERIOD SEINE DATA AT MID-DEPTHS (11-16 M). Preoperational period: September 1979 (April 1981)-May 1982 (37-59 cruises, depending on location pair -- NI = Near Impact; FI = Far Impact; C = Control); Operational period: April 1984-August 1986 (32 cruises). Data form used was the smallest log-transformation tested that satisfied all screening test assumptions. Dashes signify that t-test results are not valid because data seriously violated statistical assumptions. T-test results are reported either as Student's t (if variances of baseline and operational deltas are indistinguishable) or as Satterthwaite's approximation (t', if period deltas are unequal at P ≤ 0.05). Student's t values that had to be corrected for first-order autoregression are flagged with an asterisk. All tests are one-tailed. (* = .10 > P > .05; ** = .05 > P > .01; *** = .01 > P > .001; **** = P ≤ .001).

Taxon	Location Pair	Data Form	Delta-bars Preop.	Delta-bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I - C) Abundances	t or t'	df	P
BUTTERFISH, Pacific	NI,C	log10(x+.5)	-.21	+.06	.93	.99	no decline	t = 1.1	69	.14
	FI,C	- - - - - - - - - - - - - - - - - - - -	statistically intractable							
	NI,FI	log10(x+.03125)	-.37	-.15	1.46	1.64	no decline	t = .53	65	.30
CROAKER, white	NI,C	log10(x+.03125)	-.39	+.21	1.78	2.14	no decline	t = .98	56	.17
	FI,C	log10(x+.25)	-.25	+.05	1.13	1.32	no decline	t = .79	54	.22
	NI,FI	log10(x+.03125)	-.11	+.11	1.65	1.09	no decline	t = .37	49	.36
QUEENFISH, total	NI,C	- - - - - - - - - - - - - - - - - - - -	statistically intractable							
	FI,C	log10(x+.125)	+.16	-.36	.75	.76	-70	t = 2.99	83	.002***
	NI,FI	log10(x+.03125)	-.20	-.04	.86	1.06	no decline	t = .74	82	.23
QUEENFISH, male	NI,C	- - - - - - - - - - - - - - - - - - - -	statistically intractable							
	FI,C	log10(x+.03125)	+.47	-.39	.94	1.23	-86	t = 3.54	81	<.001****
	NI,FI	log10(x+2.0)	-.19	+.02	.50	.61	no decline	t = 1.67	79	.95 /a
QUEENFISH, female	NI,C	log10(x+.06)	-.40	-.47	.96	1.14	no decline	t = .29	76	.39
	FI,C	log10(x+.03125)	-.16	-.20	1.00	1.09	no decline	t = .16	76	.44
	NI,FI	log10(x+.03125)	-.27	-.35	1.13	1.20	no decline	t = .28	74	.39
QUEENFISH, immature	NI,C	log10(x+.03125)	-.43	-.95	1.32	1.44	-70	t = 1.56	75	.06*
	FI,C	log10(x+.0625)	-.38	-.90	1.22	1.36	-70	t* = 1.83	76	.05**
	NI,FI	log10(x+.03125)	-.00	+.10	1.30	1.65	no decline	t = .29	69	.39
QUEENFISH, YOY	NI,C	log10(x+1.0)	-.17	-.52	.73	.74	-55	t = 1.82	73	.04**
	FI,C	log10(x+1.0)	-.19	-.44	.74	.70	no decline	t* = 1.17	61	.13
	NI,FI	log10(x+.03125)	+.13	-.04	1.23	1.63	no decline	t = .46	66	.33
SILVERSIDES	NI,C	log10(x+.03125)	-.06	-.14	1.58	1.61	no decline	t = .19	61	.43
	FI,C	log10(x+.03125)	-.02	-.19	1.56	1.75	no decline	t = .40	62	.35
	NI,FI	log10(x+.03125)	-.04	+.05	1.40	1.52	no decline	t = .24	60	.42

/a P = (1 - P'/2) for observation opposite in sign to one-tailed prediction; P' = .0495

APPENDIX E -- TABLE 3

COASTAL-PELAGIC FISHES: (A) LIST OF TEST CASES IN WHICH THE FREQUENCY AND PERCENT FREQUENCY OF SINGLE-ZERO OBSERVATIONS EXCEEDED 25% IN BASELINE DATA; AND (B) SUMMARY OF BINOMIAL TEST RESULTS FOR THESE CASES. The white croaker cases listed in (B) might have resulted either in a spuriously rejected additivity test (because of many zeros at one or the other location) or in a spuriously accepted additivity test (because of many single-zeros involving both locations). Probabilities were evaluated at a one-tailed alpha of 0.05. (**** = P < .001.)

(A) FREQUENCY AND PERCENT FREQUENCY OF SINGLE-ZEROS:

Taxon	Depth Block	Location-Pair(s)	Frequency (% Frequency) NI	FI	C
BUTTERFISH, Pacific	11-16[a]	NI,C NI,FI	15(29.4)	10(19.2)	3(5.9)
CROAKER, white	5-10[b]	NI,C	1(2.9)	2(3.4)	9(25.7)
	11-16[c]	NI,C FI,C NI,FI	16(34)	11(25.6)	12(25.5)

(B) SUMMARY OF BINOMIAL TESTS (WHITE CROAKER):

Depth Block	Location Pair(s)	N_B	N_A	P_B	P_A	P_A / P_B	Z	PROB Z
5-10	NI,C	35	24	.48	.07	.15	4.06	<.0001****
11-16	NI,C	47	11	.24	.45	1.86	1.28	.90[d]
	FI,C	44	12	.33	.45	1.35	0.72	.76[d]
	NI,FI	43	8	.39	.51	1.29	0.59	.72[d]

[a]Cases are additive despite a large percentage of single-zero observations at one location.

[b]Case failed additivity test (perhaps) because of a large percentage of single zeros at one or the other location.

[c]Cases passed additivity test despite large percentage of single zeros involving both locations.

[d]If $P_A > P_B$, then $PROB_1 = (1 = PROB_Z/2)$.

APPENDIX E -- TABLE 4

BENTHIC FISHES: SUMMARY RESULTS OF BACI T-TESTS ON THE SONGS MINUS CONTROL DELTAS OF PREOPERATIONAL AND OPERATIONAL PERIOD TRAWL DATA. Preoperational period: May 1980-June 1982 (26 cruises); Operational period: May 1984-November 1986 (25 cruises). Data form used was the smallest log-transformation tested that satisfied all screening test assumptions. Dashes signify that t-test results are not valid because data seriously violated statistical assumptions. T-test results are reported either as Student's t (if variances of baseline and operational deltas are indistinguishable) or as Satterthwaite's approximation (t', if variances of period deltas are unequal at $P \leq 0.05$). Student's t values that had to be corrected for first-order autoregression are flagged with an asterisk. All tests are two-tailed. (* = .10 > P > .05; ** = .05 > P >.01; *** = .01 > P > .001; **** = $P \leq .001$).

Species	Depth	Data Form	Delta-bars Preop.	Delta-bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I - C) Abundances	t or t'	df	P
CROAKER, white	18	statistically intractable								
	30	log (x-bar+.0156)	-.23	+.63	.44	.81	>600% increase	t' = 4.72	37	<. 0001****
CUSK-EEL, basketweave	18	log (x-bar+.0156)	-.07	+.08	.60	.52	no change	t = 0.95	49	.35
	30	log (x-bar+2.0)	+.08	+.26	.30	.28	no change	t* = 1.48	46	.15
HALIBUT, Ca.	18	statistically intractable								
LIZARDFISH, Ca.	18	log (x-bar+.04)	-.86	-.28	.65	1.00	ca. 200% increase	t = 2.30	43	.03**
	30	log (x-bar+.0156)	-.36	+.22	1.13	.73	>250% increase	t = 2.00	40	.05*
QUEENFISH	18	log (x-bar+.0156)	-.24	-.01	.66	.72	no change	t = 1.21	49	.23
	30	log (x-bar+.0156)	-.12	+.40	.88	.96	>200% increase	t = 1.99	48	.05*
SANDDAB, longfin	18	log (x-bar+.07)	-1.04	-.22	.58	.69	ca. 500% increase	t* = 3.56	44	<.001****
	30	log (x-bar+0.0)	-.30	-.15	.44	.45	no change	t = 1.19	49	.24
SANDDAB, Pacific	30	log (x-bar+.0156)	+.21	+.41	.85	.84	no change	t = 0.62	33	.54
SANDDAB, speckled	18	log (x-bar+.25)	+.11	-.23	.37	.35	>50% decline	t = 3.35	44	<.002***
	30	statistically intractable								
SEAPERCH, pink	30	statistically intractable								
SKATE, California	30	log (x-bar+.055)	-.13	-.11	.47	.58	no change	t = 0.16	39	.87
SOLE, fantail	18	log (x-bar+.25)	-.07	-.16	.31	.50	no change	t' = 0.69	31	.50
	30	log (x-bar+.0156)	+.11	+.63	.94	.92	>200% increase	t = 1.92	45	.06*
TONGUEFISH, Ca.	18	statistically intractable								
	30	log (x-bar+.25)	-.44	-.41	.51	.41	no change	t* = 0.32	48	.75
TURBOT, hornyhead	18	log (x-bar+.0625)	+.19	+.03	.39	.45	no change	t = 1.38	48	.17
	30	statistically intractable								

APPENDIX E -- TABLE 5

PELAGIC FISHES, SHALLOW DEPTHS: SUMMARY RESULTS OF POWER ESTIMATES FOR BACI T-TESTS. Power estimates correspond to the log data-form and specific t-test statistic for the particular species and location comparisons listed in Appendix E, Table 1. Power was calculated based on the harmonic mean of baseline and operational sample sizes. Alpha level tested is 0.05 if power is ≥ 80%, but alpha level is 0.10 if power is < 80%. All alpha levels are one-tailed.

Taxon	Location Pair	Data Form	Alpha Level	Power (%)
BUTTERFISH, Pacific	NI,C	log10(x+.03125)	0.10	22
	FI,C	log10(x+.03125)	0.10	31
	NI,FI	log10(x+.30)	0.10	31
CROAKER, white	NI,C	log10(x+.03125)	0.10	32
	FI,C	log10(x+.25)	0.10	46
	NI,FI	log10(x+.03125)	0.10	42
QUEENFISH, total	NI,C	log10(x+12.0)	0.10	81
	FI,C	log10(x+.03125)	0.05	83
	NI,FI	- - - statistically intractable - - - - -		
QUEENFISH, male	NI,C	log10(x+.5)	0.10	57
	FI,C	log10(x+.5)	0.10	65
	NI,FI	log10(x+.03125)	0.10	47
QUEENFISH, female	NI,C	log10(x+.03125)	0.10	45
	FI,C	log10(x+.03125)	0.10	64
	NI,FI	log10(x+.03125)	0.10	53
QUEENFISH, immature	NI,C	log10(x+5.0)	0.10	71
	FI,C	log10(x+.03125)	0.10	66
	NI,FI	log10(x+2.0)	0.10	71
QUEENFISH, YOY	NI,C	- - - statistically intractable - - - - -		
	FI,C	log10(x+2.0)	0.10	65
	NI,FI	log10(x+.03125)	0.10	48
SILVERSIDES	NI,C	log10(x+.03125)	0.10	33
	FI,C	log10(x+.03125)	0.10	47
	NI,FI	log10(x+.10)	0.10	41

PELAGIC FISHES, MID-DEPTHS: SUMMARY RESULTS OF POWER ESTIMATES FOR BACI T-TESTS. Power estimates correspond to the log data-form and specific t-test statistic for the particular species and location comparisons listed in Appendix E, Table 2. Power was calculated based on the harmonic mean of baseline and operational sample sizes. Alpha level tested is 0.05 if power is ≥ 80%, but alpha level is 0.10 if power is < 80%. All alpha levels are one-tailed.

Taxon	Location Pair	Data Form	Alpha Level	Power (%)
BUTTERFISH, Pacific	NI,C	log10(x+.5)	0.10	30
	FI,C	- - - statistically intractable - - - - -		
	NI,FI	log10(x+.03125)	0.10	24
CROAKER, white	NI,C	log10(x+.03125)	0.10	16
	FI,C	log10(x+.25)	0.10	22
	NI,FI	log10(x+.03125)	0.10	17
QUEENFISH, total	NI,C	- - - statistically intractable - - - - -		
	FI,C	log10(x+.125)	0.10	65
	NI,FI	log10(x+.03125)	0.10	53
QUEENFISH, male	NI,C	- - - statistically intractable - - - - -		
	FI,C	log10(x+.03125)	0.10	48
	NI,FI	log10(x+2.0)	0.10	75
QUEENFISH, female	NI,C	log10(x+.06)	0.10	40
	FI,C	log10(x+.03125)	0.10	42
	NI,FI	log10(x+.03125)	0.10	36
QUEENFISH, immature	NI,C	log10(x+.03125)	0.10	30
	FI,C	log10(x+.03125)	0.10	30
	NI,FI	log10(x+.03125)	0.10	29
QUEENFISH, YOY	NI,C	log10(x+1.0)	0.10	37
	FI,C	log10(x+1.0)	0.10	37
	NI,FI	log10(x+.03125)	0.10	30
SILVERSIDES	NI,C	log10(x+.03125)	0.10	23
	FI,C	log10(x+.03125)	0.10	23
	NI,FI	log10(x+.03125)	0.10	24

APPENDIX E -- TABLE 7

BENTHIC FISHES: SUMMARY RESULTS OF POWER ESTIMATES FOR BACI T-TESTS. Power estimates correspond to the log data-form and specific t-test statistic for the particular species and location comparisons listed in Appendix E, Table 4. Power was calculated based on the harmonic mean of baseline and operational sample sizes. Alpha level tested is 0.05 if power is ≥ 80%, but alpha level is 0.10 if power is < 80%. All alpha levels are two-tailed.

Species	Depth	Data Form	Alpha Level	Power (%)
CROAKER, white	18	- - - statistically intractable - - - - - -		
	30	log (x-bar+.0156)	0.10	50
CUSK-EEL, basketweave	18	log (x-bar+.0156)	0.10	60
	30	log (x-bar+2.0)	0.05	80
HALIBUT, Ca.	18	- - - statistically intractable - - - - - -		
LIZARDFISH, Ca.	18	log (x-bar+.04)	0.10	inest.
	30	log (x-bar+.0156)	0.10	16
QUEENFISH	18	log (x-bar+.0156)	0.10	46
	30	log (x-bar+.0156)	0.10	29
SANDDAB, longfin	18	log (x-bar+.07)	0.10	17
	30	log (x-bar+0.0)	0.10	78
SANDDAB, Pacific	30	log (x-bar+.0156)	0.10	23
SANDDAB, speckled	18	log (x-bar+.25)	0.10	84
	30	- - - statistically intractable - - - - - -		
SEAPERCH, pink	30	- - - statistically intractable - - - - - -		
SKATE, California	30	log (x-bar+.055)	0.10	42
SOLE, fantail	18	log (x-bar+.25)	0.10	25
	30	log (x-bar+.0156)	0.10	25
TONGUEFISH, Ca.	18	- - - statistically intractable - - - - - -		
	30	log (x-bar+.25)	0.10	54
TURBOT, hornyhead	18	log (x-bar+.0625)	0.10	75
	30	- - - statistically intractable - - - - - -		

APPENDIX E -- TABLE 8

PELAGIC FISHES: SUMMARY RESULTS OF KOLMOGOROV-SMIRNOV TWO-SAMPLE TESTS OF THE PERCENT LENGTH-FREQUENCY DISTRIBUTIONS OF QUEENFISH AND WHITE CROAKER CAUGHT DURING THE PREOPERATIONAL AND OPERATIONAL PERIODS AT THE THREE STUDY LOCATIONS. Analysis based on catches made in the shallow (5- to 10-meter) depth-block only. DCRIT05 is that value of the test statistic that is significant at $\alpha = .05$.

NEAR IMPACT

Species	NO. CAUGHT Before	NO. CAUGHT After	DMAX	DCRIT05	P Value
CROAKER, white	69	56	0.66	0.24	<.001
QUEENFISH	8247	1708	0.33	0.04	<.001

FAR IMPACT

Species	NO. CAUGHT Before	NO. CAUGHT After	DMAX	DCRIT05	P Value
CROAKER, white	250	815	0.80	0.10	<.001
QUEENFISH	9950	2926	0.10	0.03	<.001

CONTROL

Species	NO. CAUGHT Before	NO. CAUGHT After	DMAX	DCRIT05	P Value
CROAKER, white	45	716	0.53	0.21	<.001
QUEENFISH	8301	4764	0.28	0.02	<.001

APPENDIX E -- TABLE 9

PELAGIC FISHES: SUMMARY RESULTS OF KOLMOGOROV-SMIRNOV TWO-SAMPLE TESTS OF PERCENT LENGTH-FREQUENCY DISTRIBUTIONS OF QUEENFISH AND WHITE CROAKER CAUGHT AT IMPACT AND CONTROL LOCATIONS DURING THE PREOPERATIONAL PERIOD (May 1980-June 1982). Analyses based on catches made in the shallow (5- to 10-meter) depth-block only. DCRIT05 is that value of the test statistic that is significant at $\alpha = .05$.

PREOPERATIONAL PERIOD

NEAR IMPACT VS. CONTROL

Species	NO. CAUGHT NI	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	69	45	0.41	0.26	<.001
QUEENFISH	8247	8301	0.17	0.02	<.001

PREOPERATIONAL PERIOD

FAR IMPACT VS. CONTROL

Species	NO. CAUGHT FI	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	250	45	0.42	0.22	<.001
QUEENFISH	9950	8301	0.18	0.02	<.001

PREOPERATIONAL PERIOD

NEAR IMPACT VS. FAR IMPACT

Species	NO. CAUGHT NI	NO. CAUGHT FI	DMAX	DCRIT05	P Value
CROAKER, white	69	250	0.12	0.18	< .05
QUEENFISH	8247	9950	0.13	0.02	<.001

APPENDIX E -- TABLE 10

PELAGIC FISHES: SUMMARY RESULTS OF KOLMOGOROV-SMIRNOV TWO-SAMPLE TESTS OF THE PERCENT LENGTH-FREQUENCY DISTRIBUTIONS OF QUEENFISH AND WHITE CROAKER CAUGHT AT IMPACT AND CONTROL LOCATIONS DURING THE OPERATIONAL PERIOD (May 1984-November 1986. Analyses based on catches made in the shallow (5- to 10-meter) depth-block only. DCRIT05 is that value of the test statistic that is significant at $\alpha = .05$.

OPERATIONAL PERIOD

NEAR IMPACT VS. CONTROL

Species	NO. CAUGHT NI	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	56	716	0.37	0.19	<.001
QUEENFISH	1708	4764	0.15	0.04	<.001

OPERATIONAL PERIOD

FAR IMPACT VS. CONTROL

Species	NO. CAUGHT FI	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	815	716	0.15	0.07	<.001
QUEENFISH	2926	4764	0.18	0.03	<.001

OPERATIONAL PERIOD

NEAR IMPACT VS. FAR IMPACT

Species	NO. CAUGHT NI	NO. CAUGHT FI	DMAX	DCRIT05	P Value
CROAKER, white	56	815	0.28	0.19	<.001
QUEENFISH	1708	2926	0.30	0.04	<.001

APPENDIX E -- TABLE 11

BENTHIC FISHES: SUMMARY RESULTS OF KOLMOGOROV-SMIRNOV TWO-SAMPLE TESTS OF THE PERCENT LENGTH-FREQUENCY DISTRIBUTIONS OF FISHES TRAWLED AT IMPACT VERSUS CONTROL LOCATIONS. Distributions are tested separately for catches made during the preoperational and operational periods. Species examined are those for which > 50 individuals were measured (at depth) at each longshore location. DCRIT05 is that value of the test statistic that is significant at $\alpha = .05$.

PREOPERATIONAL PERIOD

Species	Depth (M)	NO. CAUGHT Impact	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	18	2832	3800	0.07	0.03	<.001
	30	4008	7016	0.04	0.03	<.001
SANDDAB, longfin	18	153	550	0.16	0.12	.01>P>.001
	30	874	1849	0.24	0.06	<.001
SANDDAB, Pacific	30	1147	802	0.18	0.06	<.001
SANDDAB, speckled	18	465	420	0.07	0.09	>.10
SOLE, fantail	30	78	82	0.15	0.22	>.10
TURBOT, hornyhead	18	193	132	0.13	0.15	>.10
	30	175	203	0.25	0.14	<.001

OPERATIONAL PERIOD

Species	Depth (M)	NO. CAUGHT Impact	NO. CAUGHT Control	DMAX	DCRIT05	P Value
CROAKER, white	18	2147	1157	0.23	0.05	<.001
	30	1894	743	0.13	0.06	<.001
SANDDAB, longfin	18	140	159	0.12	0.16	>.10
	30	754	1050	0.18	0.06	<.001
SANDDAB, Pacific	30	208	123	0.10	0.15	>.10
SANDDAB, speckled	18	354	519	0.03	0.09	>.10
SOLE, fantail	30	133	81	0.22	0.19	.05>P>.01
TURBOT, hornyhead	18	124	155	0.21	0.16	.01>P>.001
	30	170	110	0.17	0.17	.05>P>.01

APPENDIX E -- TABLE 12

BENTHIC FISHES: SUMMARY RESULTS OF KOLMOGOROV-SMIRNOV TWO-SAMPLE TESTS OF THE PERCENT LENGTH-FREQUENCY DISTRIBUTIONS OF FISHES TRAWLED DURING THE PREOPERATIONAL VERSUS OPERATIONAL PERIODS. Distributions are tested separately for catches made at Impact and Control locations. Species examined are those for which > 50 individuals were measured (at depth) at each longshore location. DCRIT05 is that value of the test statistic that is significant at $\alpha = .05$.

IMPACT LOCATION

Species	Depth (M)	NO. CAUGHT Before	NO. CAUGHT After	DMAX	DCRIT05	P Value
CROAKER, white	18	2832	2147	0.21	0.04	<.001
	30	4008	1894	0.35	0.04	<.001
SANDDAB, longfin	18	153	140	0.28	0.16	<.001
	30	874	754	0.19	0.07	<.001
SANDDAB, Pacific	30	1147	208	0.12	0.10	.05>P>.01
SANDDAB, speckled	18	465	354	0.07	0.10	>.10
SOLE, fantail	30	78	133	0.37	0.19	<.001
TURBOT, hornyhead	18	193	124	0.14	0.16	>.10
	30	175	170	0.11	0.15	>.10

CONTROL LOCATION

Species	Depth (M)	NO. CAUGHT Before	NO. CAUGHT After	DMAX	DCRIT05	P Value
CROAKER, white	18	3800	1157	0.17	0.05	<.001
	30	7016	743	0.46	0.05	<.001
SANDDAB, longfin	18	550	159	0.22	0.12	<.001
	30	1849	1050	0.22	0.05	<.001
SANDDAB, Pacific	30	802	123	0.33	0.13	<.001
SANDDAB, speckled	18	420	519	0.09	0.09	.05>P>.01
SOLE, fantail	30	82	81	0.32	0.21	<.001
TURBOT, hornyhead	18	132	155	0.17	0.16	.05>P>.01
	30	203	110	0.35	0.16	<.001

APPENDIX E -- TABLE 13

AVERAGE BODY WEIGHT OF QUEENFISH AND WHITE CROAKER IN (A) LAMPARA SEINE AND (B) OTTER TRAWL CATCHES. Means are estimated by sampling station within depth block (lampara) or depth (trawl), for "Before" (B, baseline) and "After" (A, operational) periods. Weighted means (with standard deviations in parentheses) are noted. Weighted means represent the mean over all cruises in which the species occurred, weighted by its numerical representation in that cruise.

(A) LAMPARA SEINE -- MEAN BODY WEIGHT/FISH (in g):

		DEPTH BLOCK					
		SHALLOW			MID-DEPTH		
Species	Period	NI	FI	C	NI	FI	C
CROAKER, white	B	40(73)	37(171)	44(129)	82(127)	79(200)	42(106)
	A	27(43)	12(125)	18(143)	79(114)	47(169)	57(44)
QUEENFISH	B	17(115)	22(144)	16(95)	31(112)	32(155)	26(80)
	A	28(105)	20(95)	23(143)	40(52)	41(50)	27(100)

(B) OTTER TRAWL -- MEAN BODY WEIGHT/FISH (in g):

		DEPTH			
		18 M		30 M	
Species	Period	Impact	Control	Impact	Control
CROAKER, white	B	80(196)	81(320)	88(288)	90(358)
	A	75(345)	84(200)	125(306)	145(150)
QUEENFISH	B	38(92)	26(127)	53(109)	58(152)
	A	27(170)	18(134)	58(110)	51(80)

APPENDIX E -- TABLE 14

AVERAGE FISH BIOMASS (ALL FISHES IN KG) IN OTTER TRAWL CATCHES. (A) Means are estimated as the grand means of the mean biomass trawled (4-trawl basis) at a station and depth on a cruise. Standard deviations are noted. (B) Also summarized are the results of BACI t-tests performed on the Impact minus Control deltas of LOG 10 (x + 0) biomass, for each of two depths.

(A) OTTER TRAWLS -- MEANS OF TOTAL TRAWL BIOMASS (in kg):

	DEPTH			
	18 M		30 M	
Period	Impact	Control	Impact	Control
B	5.8±4.2	7.7±5.1	8.0±3.4	11.6±4.9
A	4.9±3.6	4.7±4.3	5.6±3.3	3.8±3.1

(B) BACI T-TESTS ON DELTAS OF LOG10 (biomass in kg):

Depth	Before			After					
(m)	Delta-Bar	Std	N	Delta-Bar	Std	N	Pct Change	t	Prob t
18	-.13	.34	26	+.06	.27	25	+57	2.27	0.03
30	-.16	.24	26	+.22	.24	25	+139	5.62	<0.001

APPENDIX E -- TABLE 15

MEAN CPUE (BIOMASS) OF QUEENFISH AND WHITE CROAKER IN (A) LAMPARA SEINES AND (B) OTTER TRAWLS. Estimates are provided for "Before" and "After" operating periods, for near-SONGS and distant control (Stuart Mesa) longshore locations, and for major depths of impact.

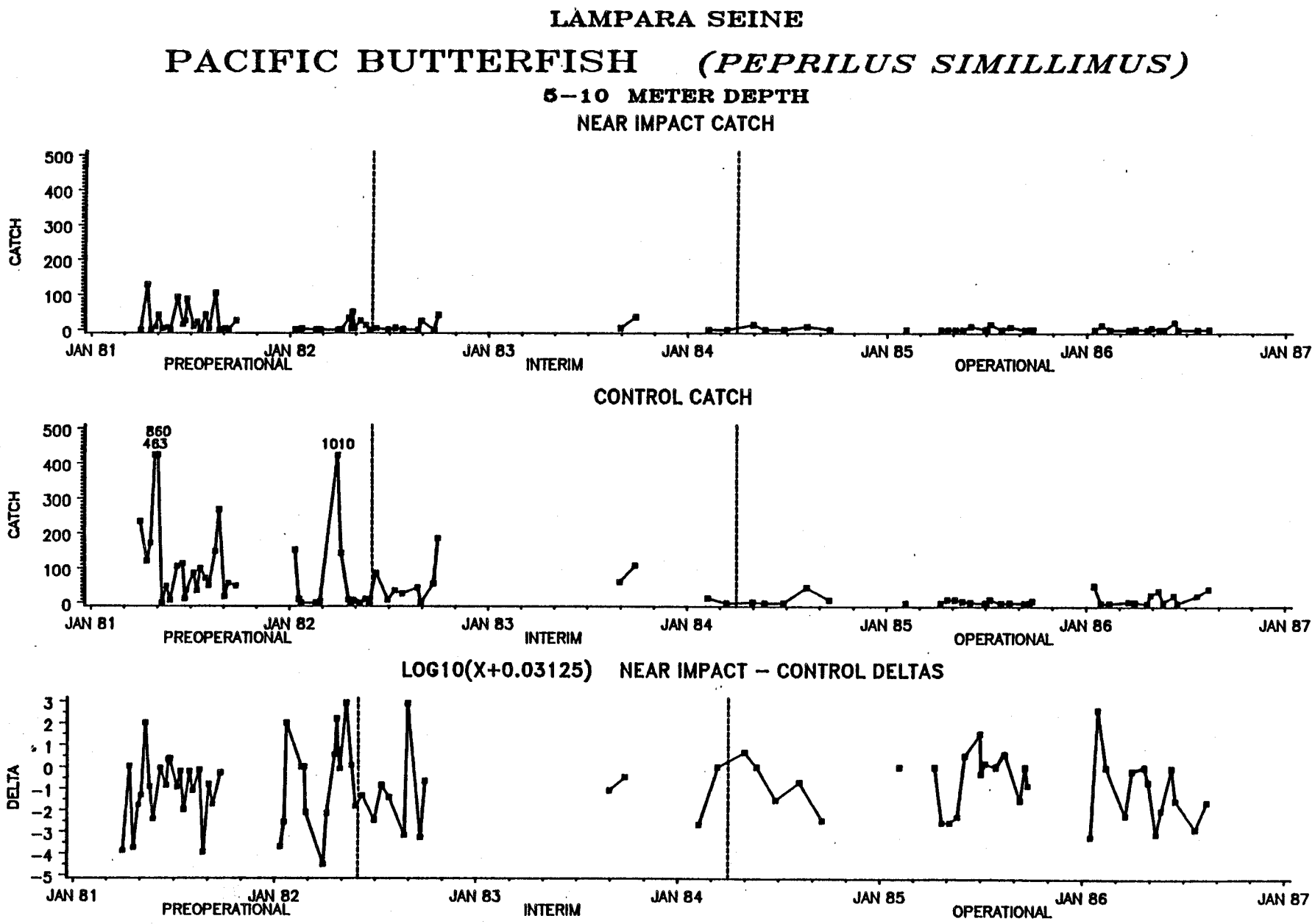
(A) LAMPARA SEINE -- MEAN CPUE BIOMASS (kg)/4,600 M^2:

			SHALLOW DEPTH BLOCK	
Species	Period	N	NI	C
CROAKER, white	B	37,59	.748	2.957
	A	30	.051	.435
QUEENFISH	B	37,59	3.818	2.909
	A	30	1.587	3.724

(B) OTTER TRAWLS -- MEAN CPUE BIOMASS (kg)/950 M^2:

		DEPTH					
		18 M			30 M		
Species	Period	N	Impact	Control	N	Impact	Control
CROAKER, white	B	26	2.166	2.975	26	3.408	6.075
	A	25	1.614	0.977	25	2.362	1.078
QUEENFISH	B	26	.330	.352	26	.371	.537
	A	25	.421	.247	25	.380	.267

APPENDIX E -- FIGURE 1



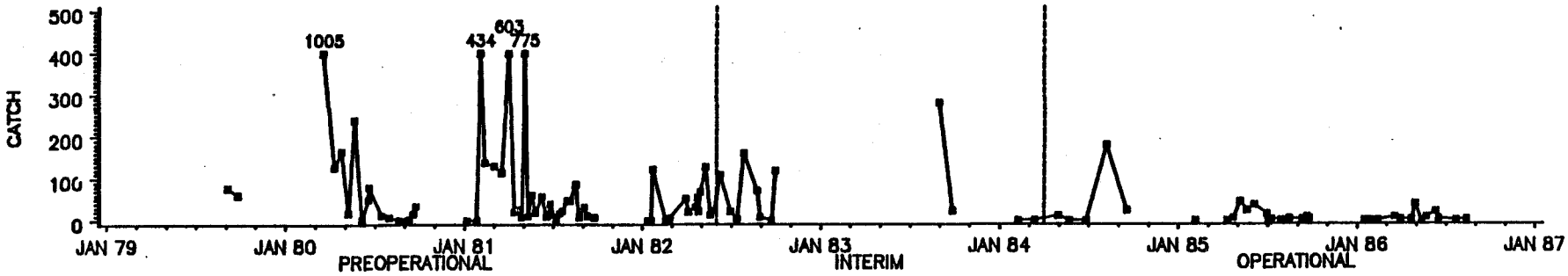
APPENDIX E -- FIGURE 2

LAMPARA SEINE

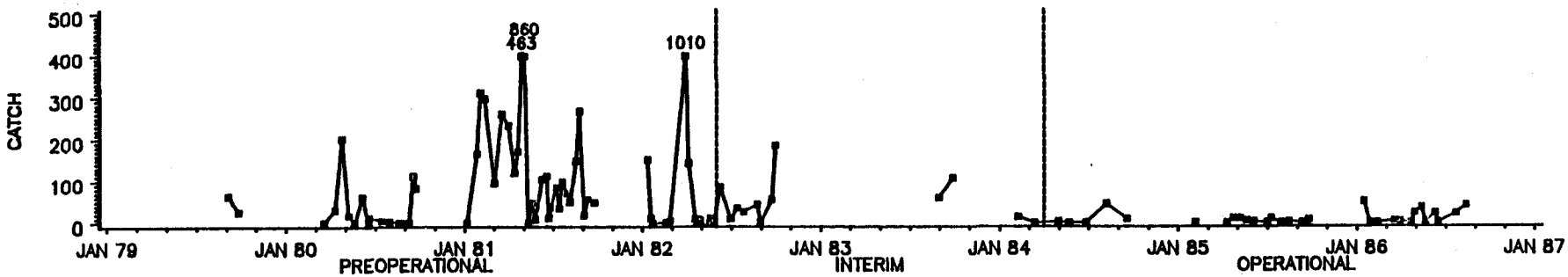
PACIFIC BUTTERFISH *(PEPRILUS SIMILLIMUS)*

5–10 METER DEPTH

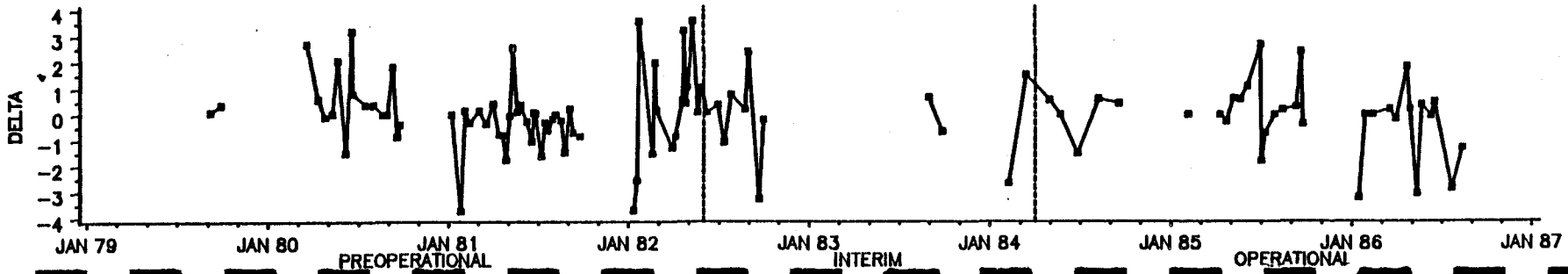
FAR IMPACT CATCH



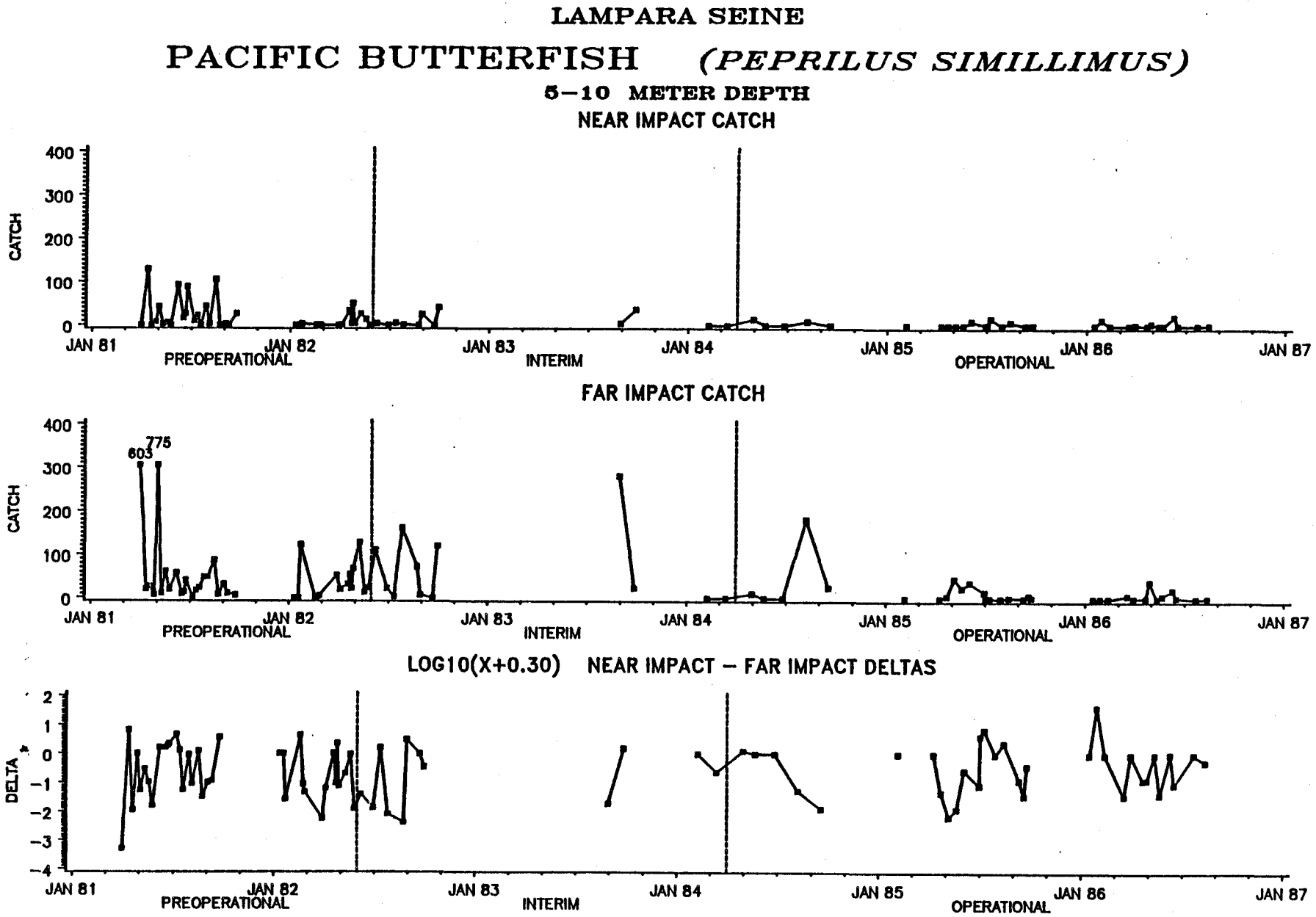
CONTROL CATCH



LOG10(X+0.03125) FAR IMPACT – CONTROL DELTAS



APPENDIX E -- FIGURE 3

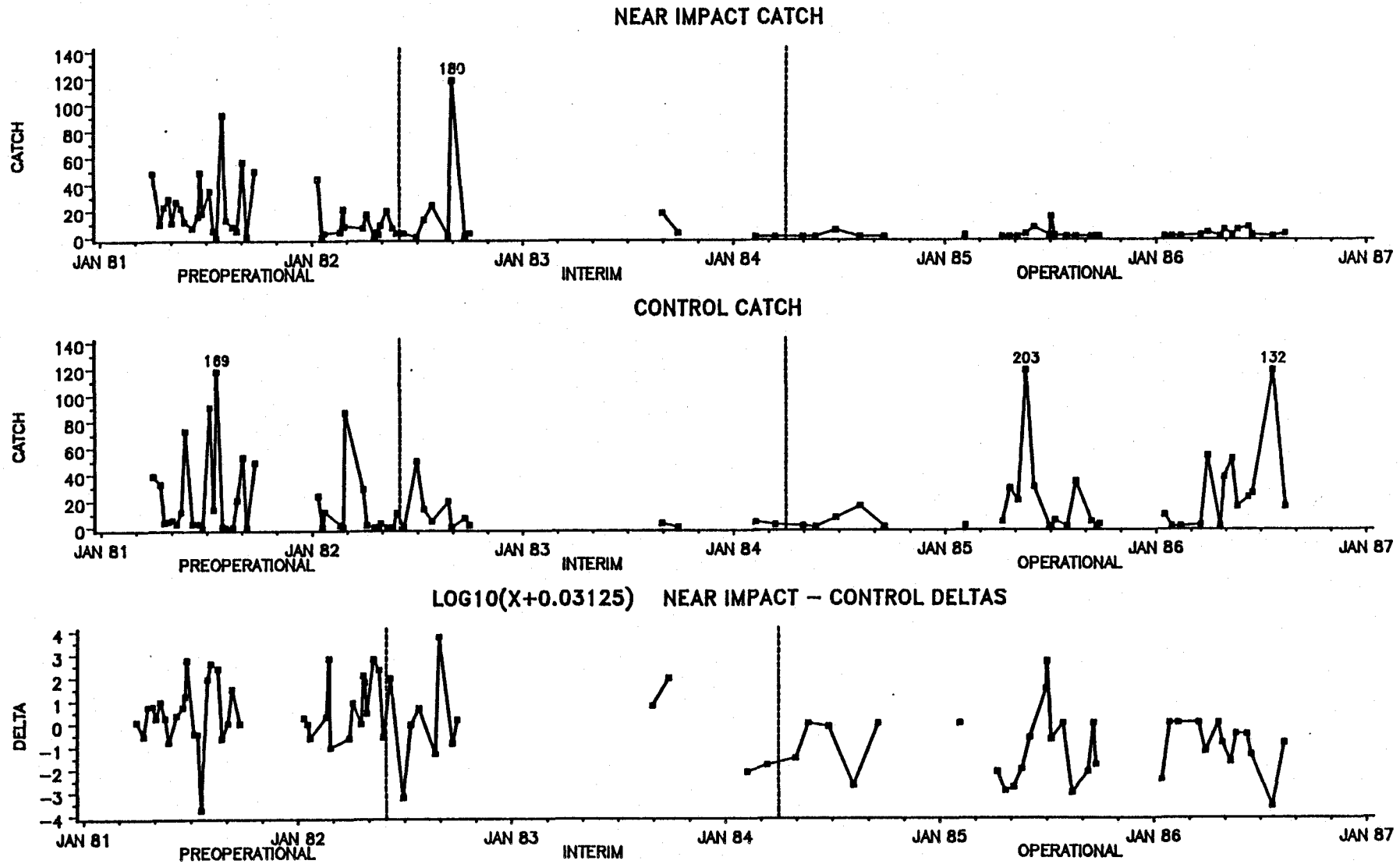


APPENDIX E -- FIGURE 4

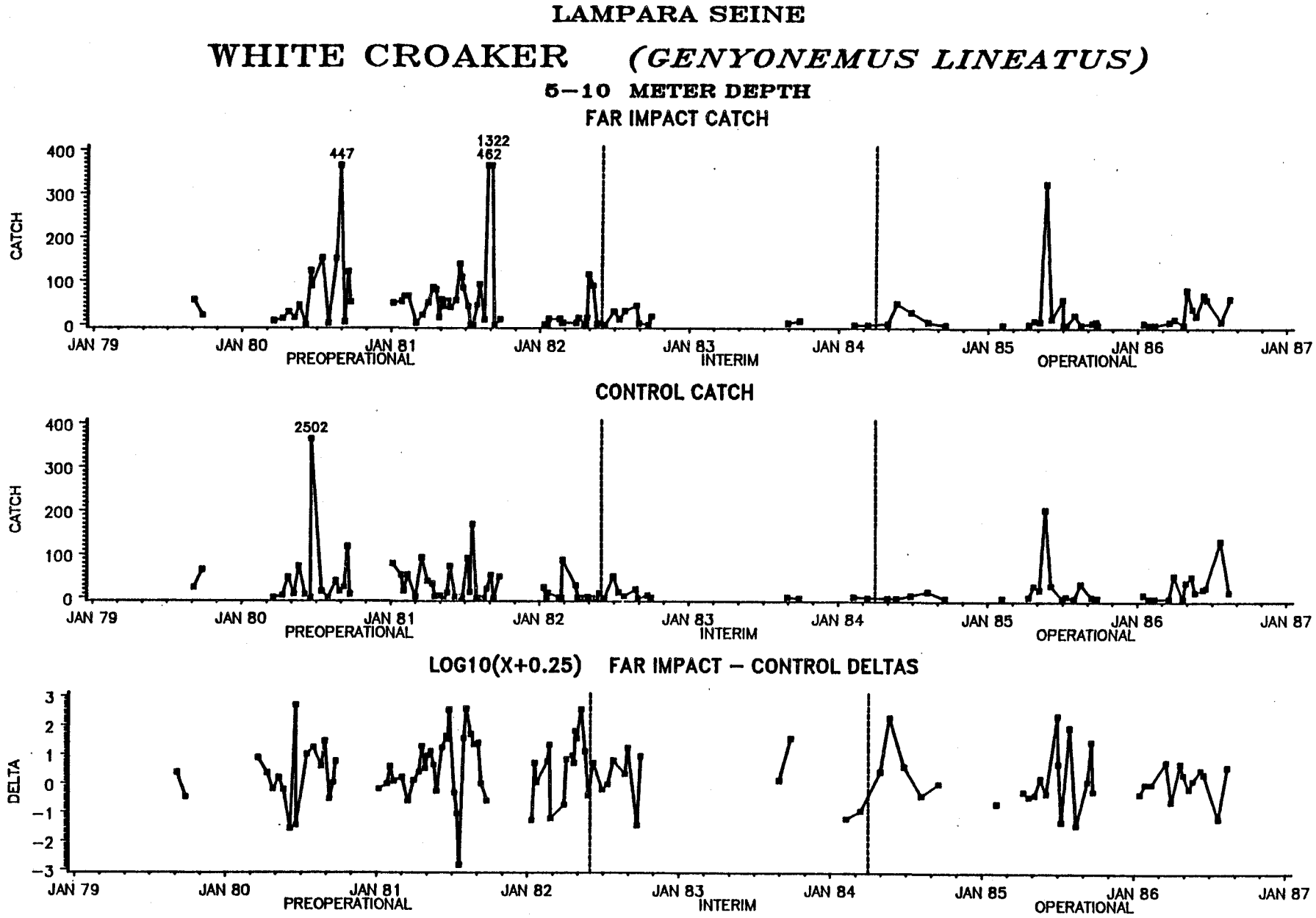
LAMPARA SEINE

WHITE CROAKER *(GENYONEMUS LINEATUS)*

5–10 METER DEPTH



APPENDIX E -- FIGURE 5

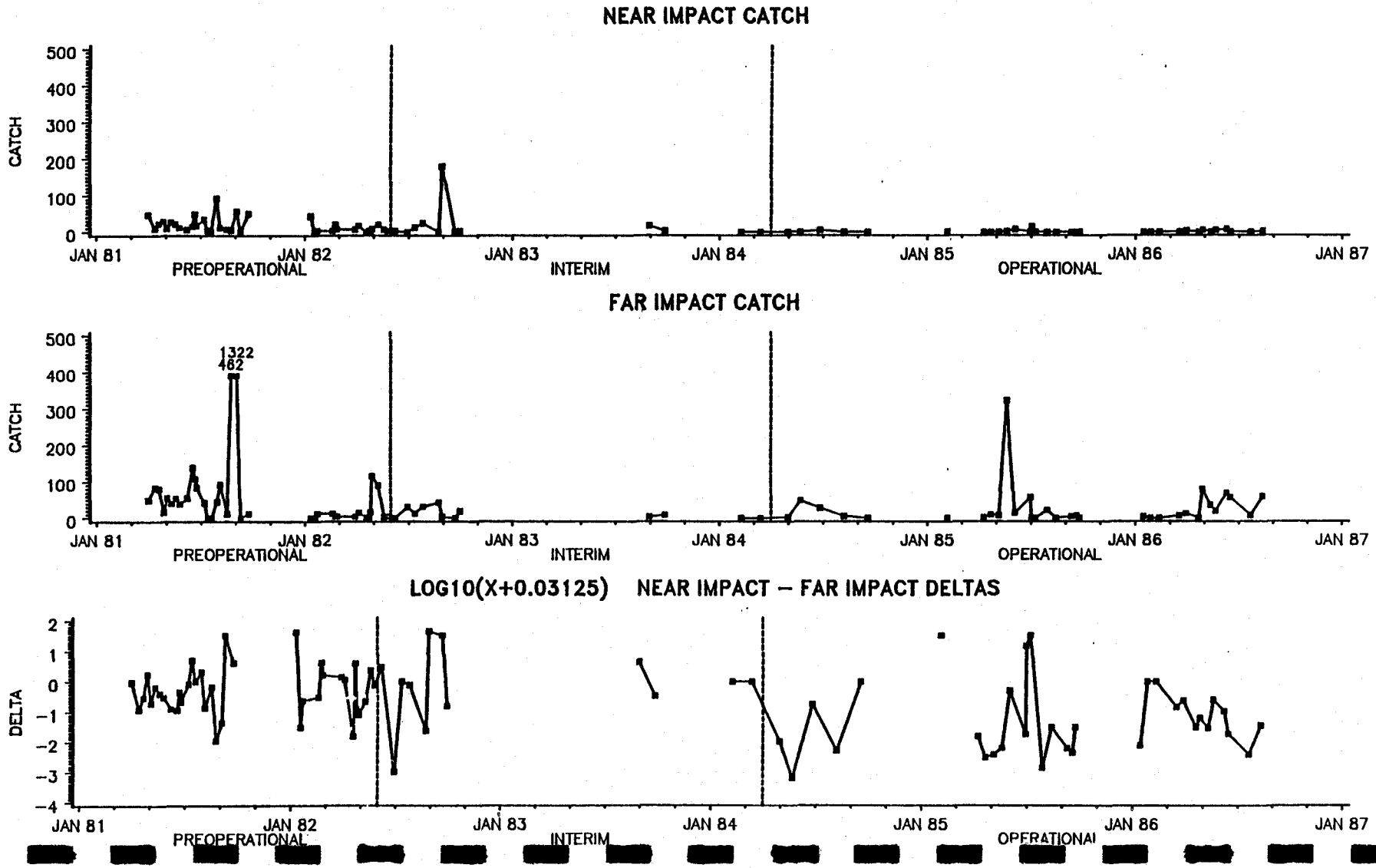


APPENDIX E -- FIGURE 6

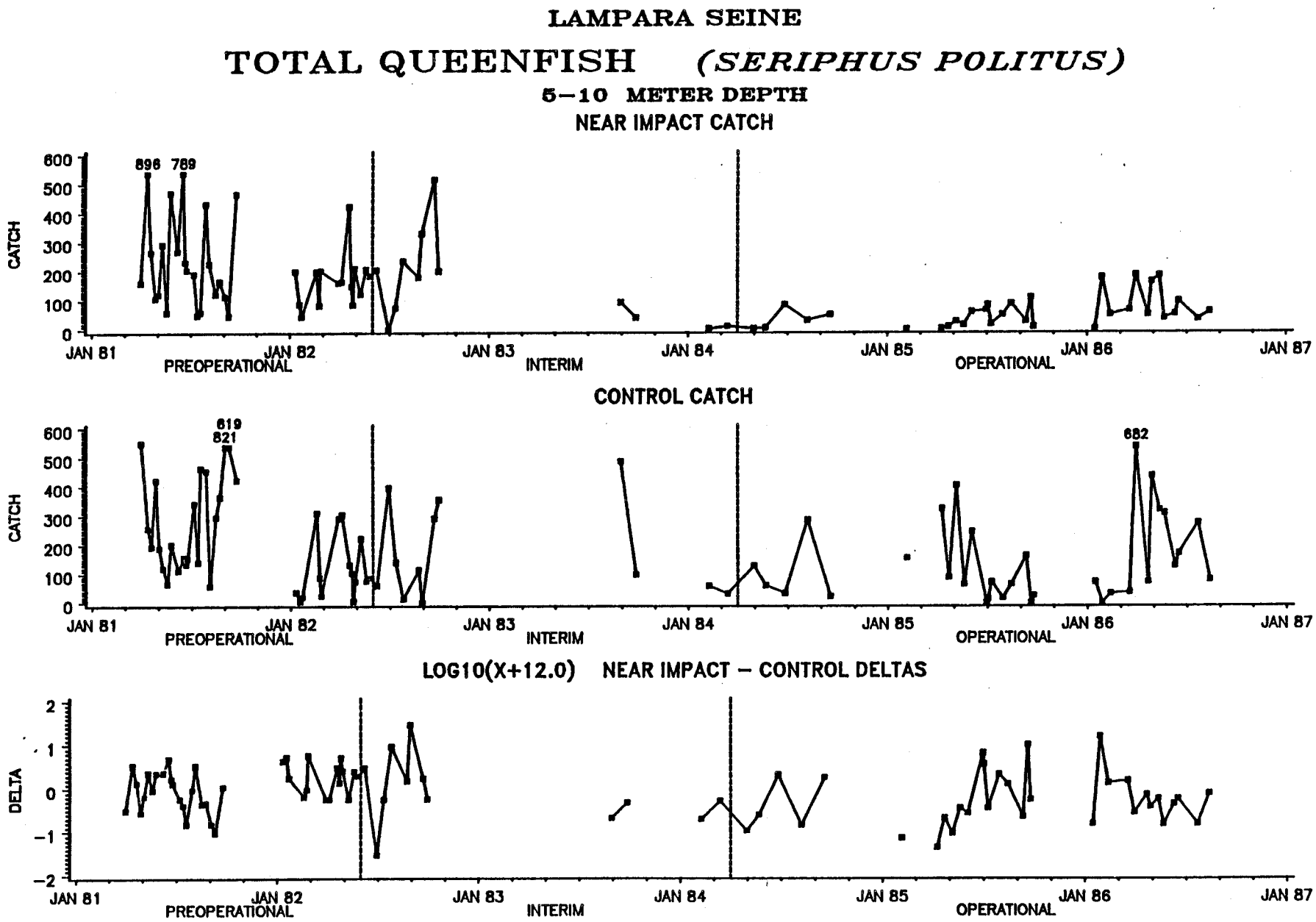
LAMPARA SEINE

WHITE CROAKER *(GENYONEMUS LINEATUS)*

5–10 METER DEPTH



APPENDIX E -- FIGURE 7

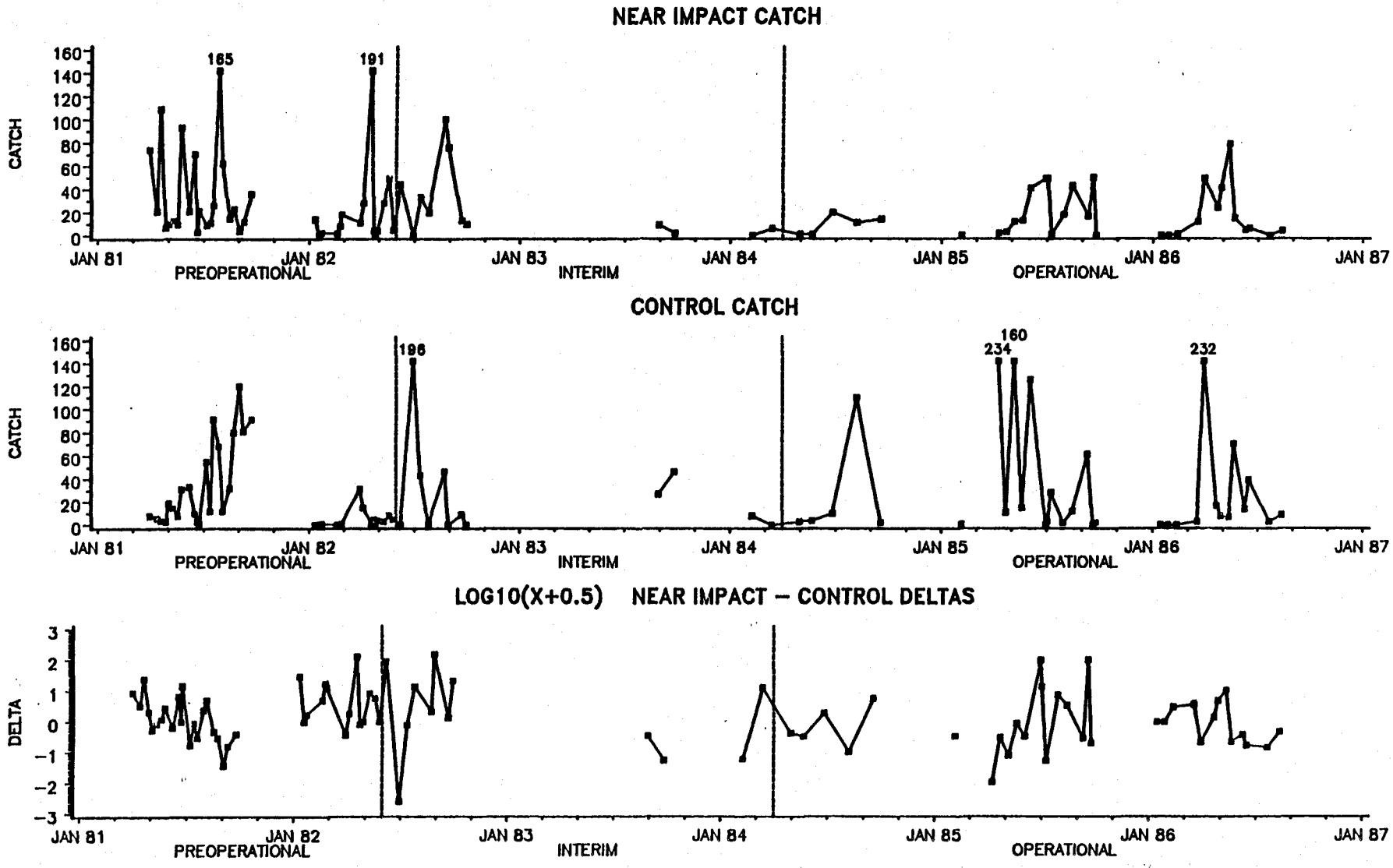


APPENDIX E -- FIGURE 10

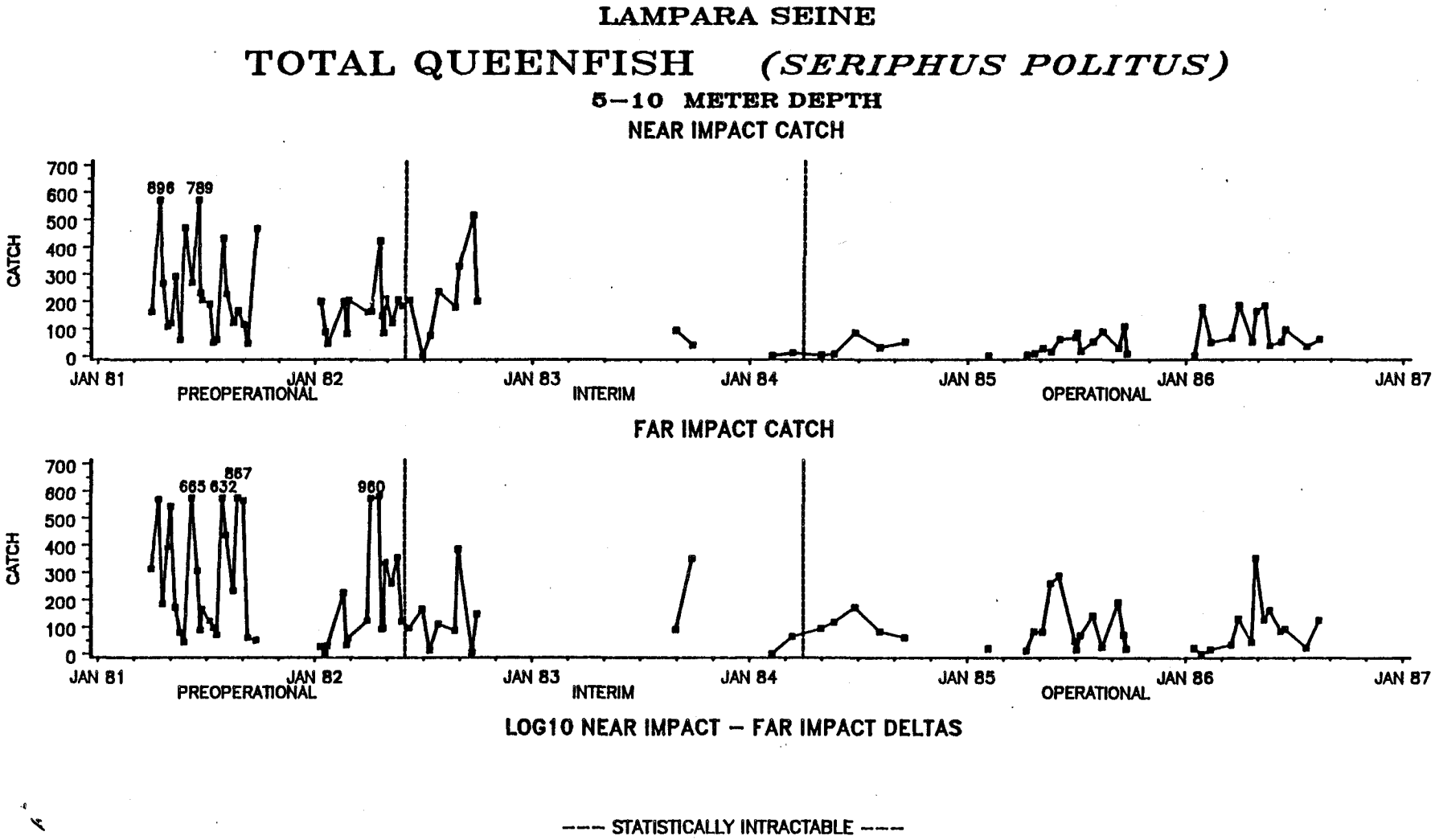
LAMPARA SEINE

MALE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH



APPENDIX E -- FIGURE 9



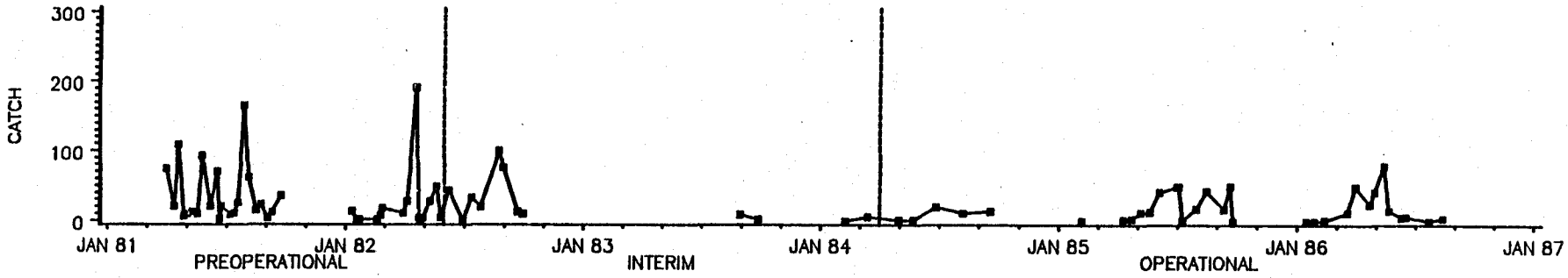
APPENDIX E -- FIGURE 12

LAMPARA SEINE

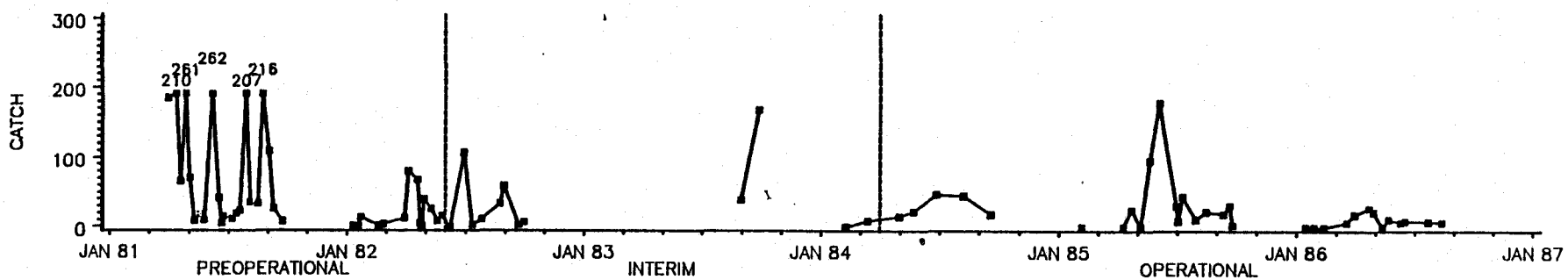
MALE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH

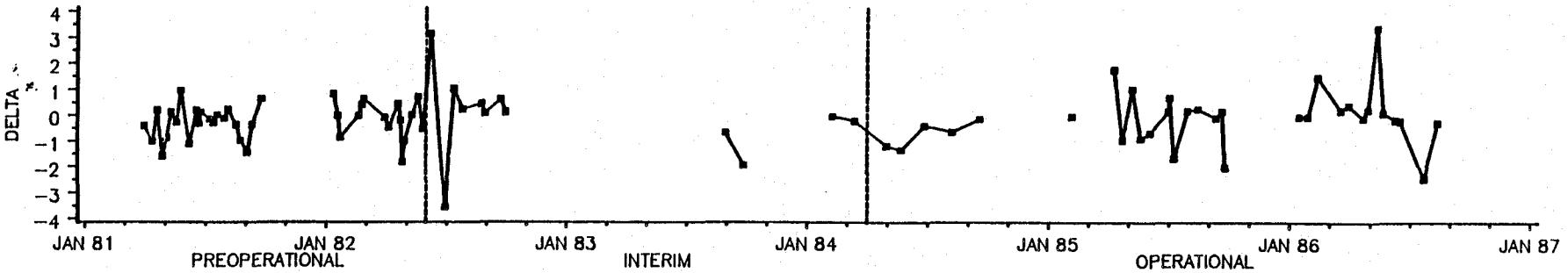
NEAR IMPACT CATCH



FAR IMPACT CATCH



LOG10(X+0.03125) NEAR IMPACT – FAR IMPACT DELTAS

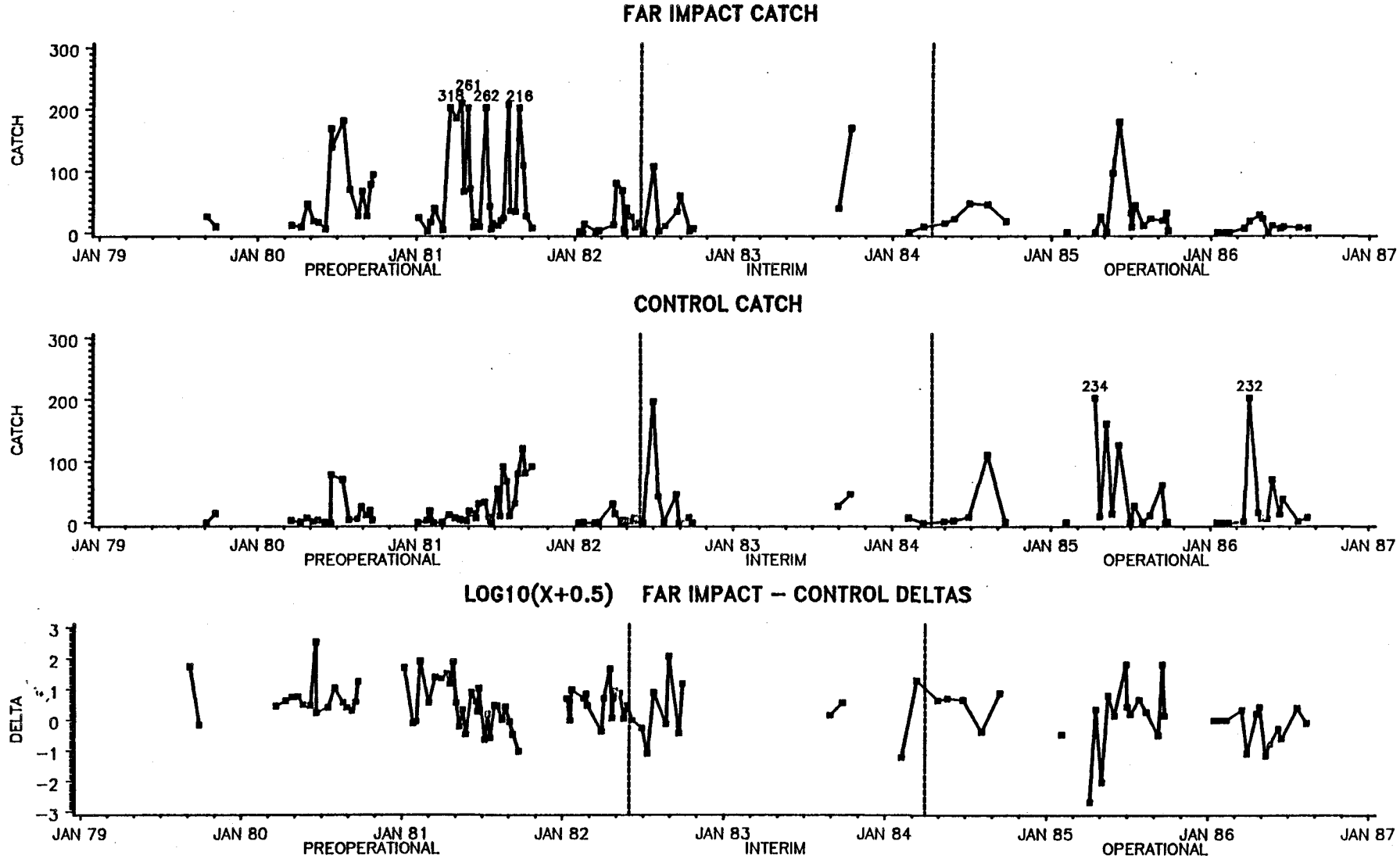


APPENDIX E -- FIGURE 11

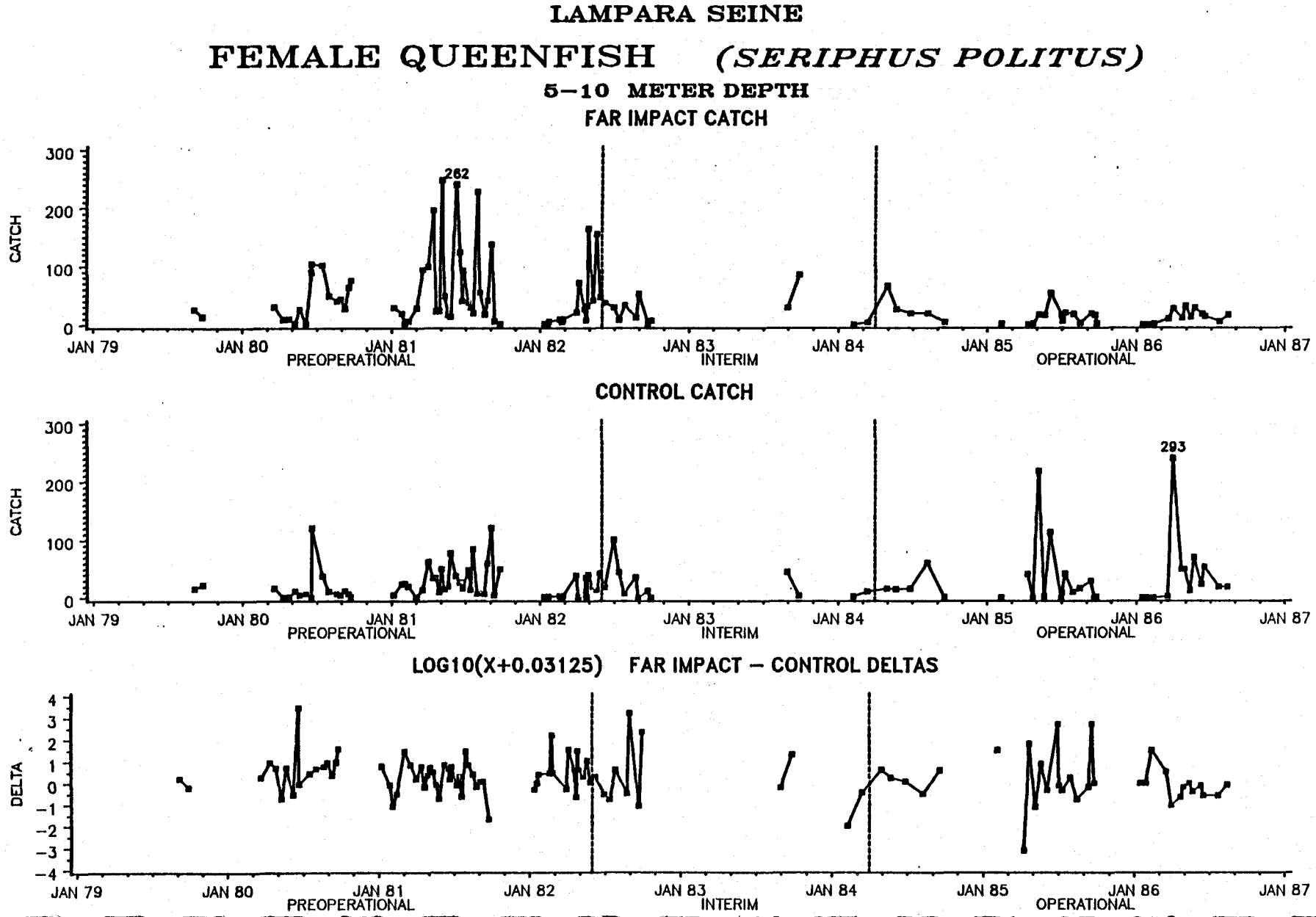
LAMPARA SEINE

MALE QUEENFISH *(SERIPHUS POLITUS)*

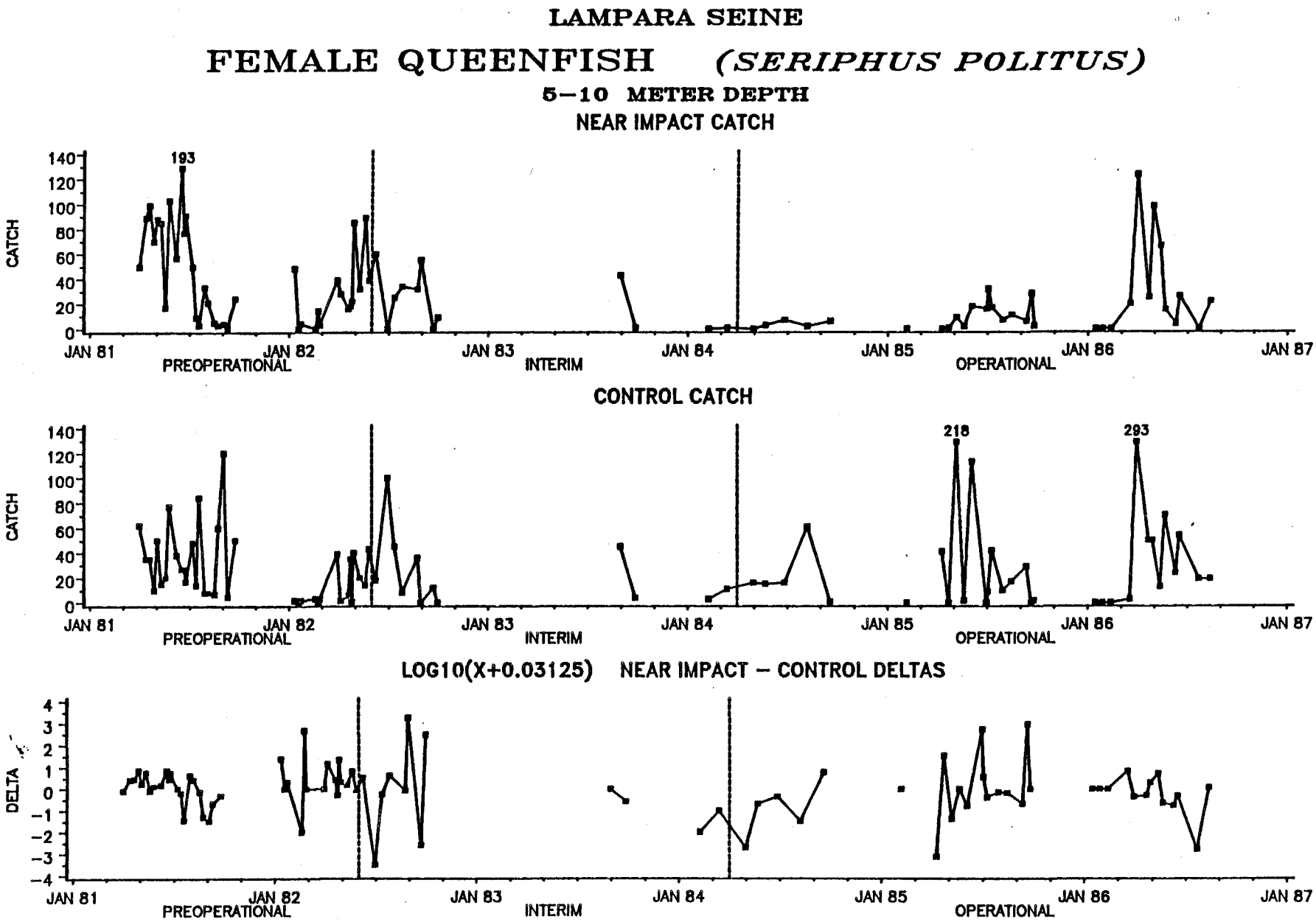
5–10 METER DEPTH



APPENDIX E -- FIGURE 14



APPENDIX E -- FIGURE 13

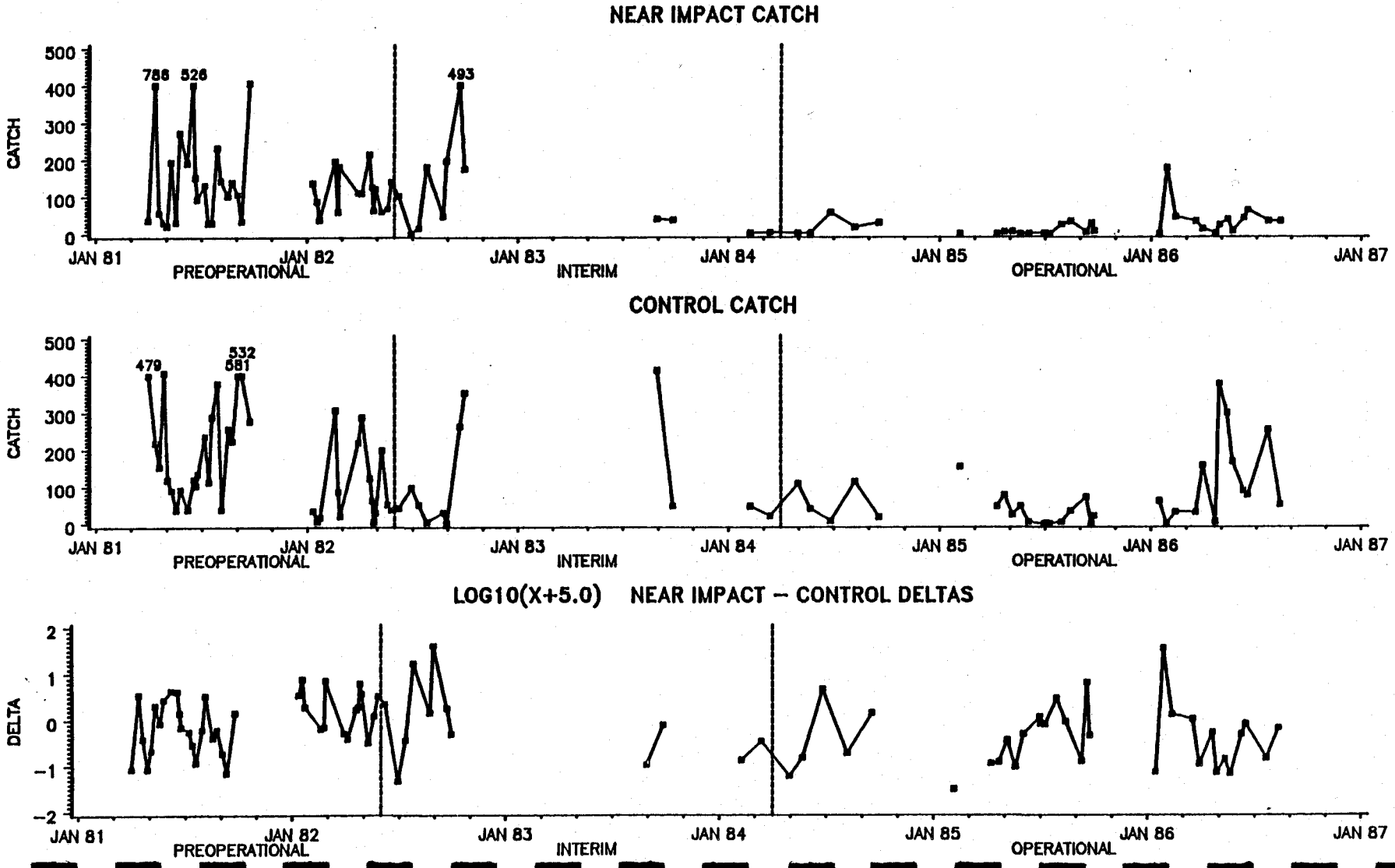


APPENDIX E -- FIGURE 16

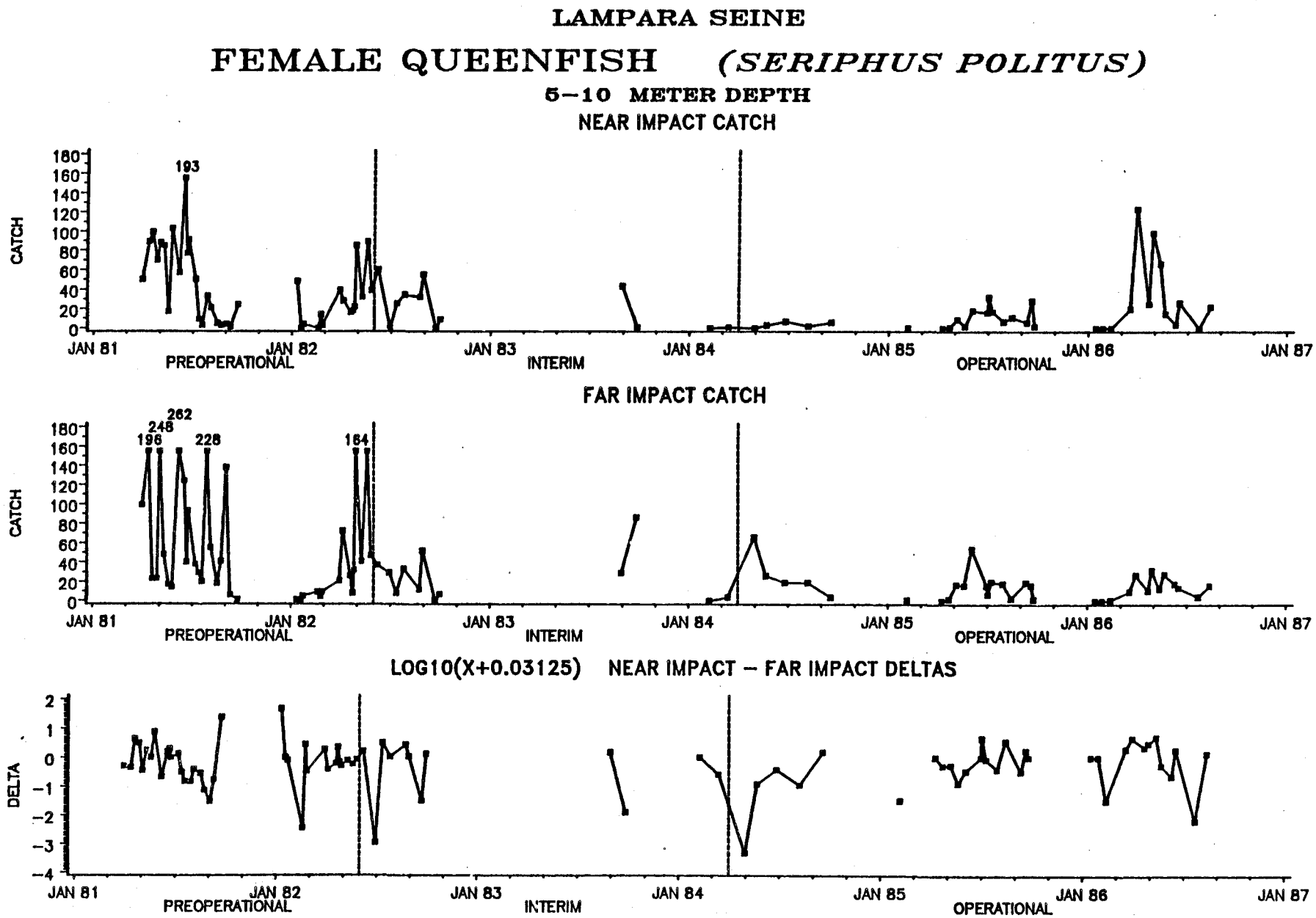
LAMPARA SEINE

IMMATURE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH



APPENDIX E -- FIGURE 15

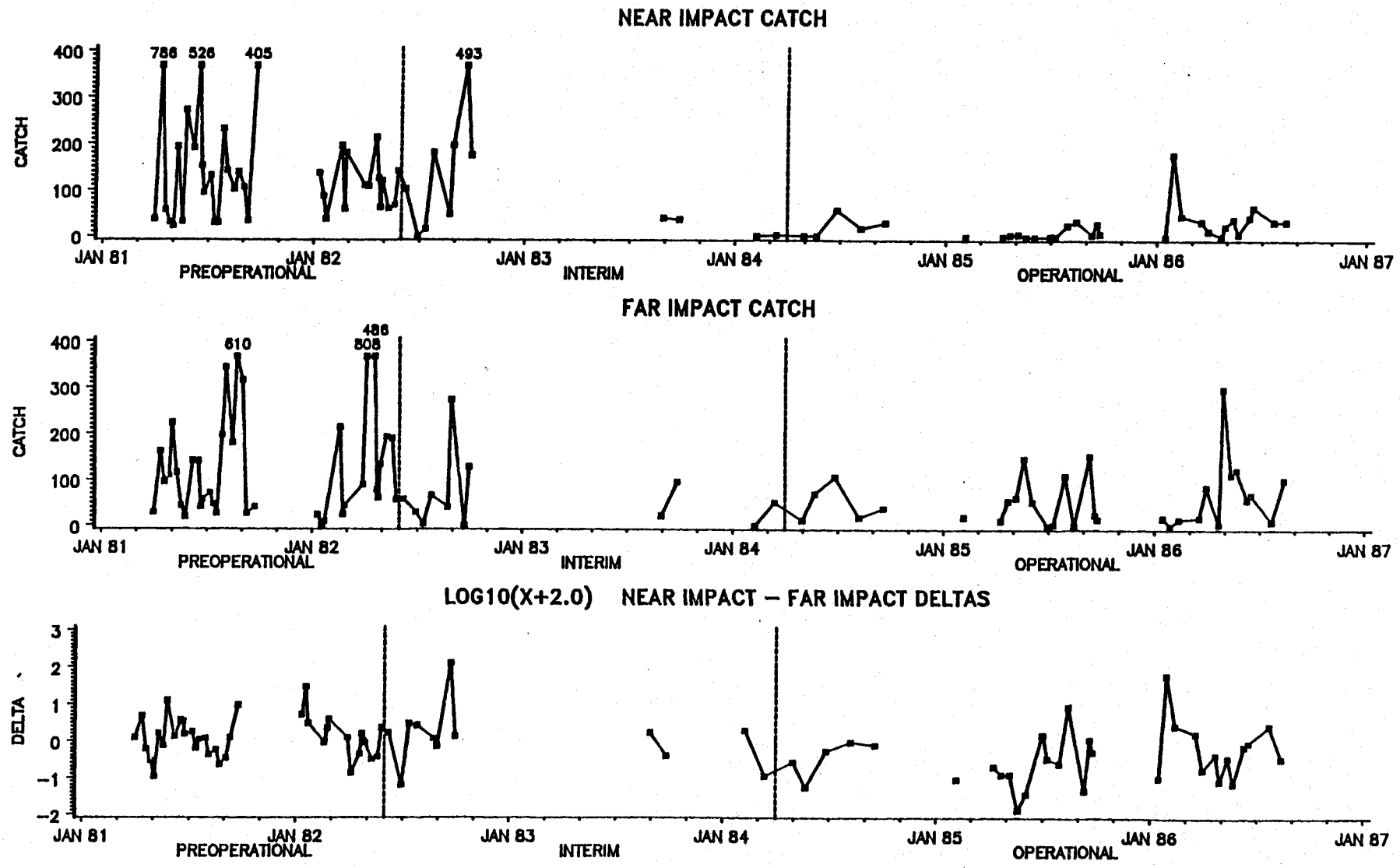


APPENDIX E -- FIGURE 18

LAMPARA SEINE

IMMATURE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH

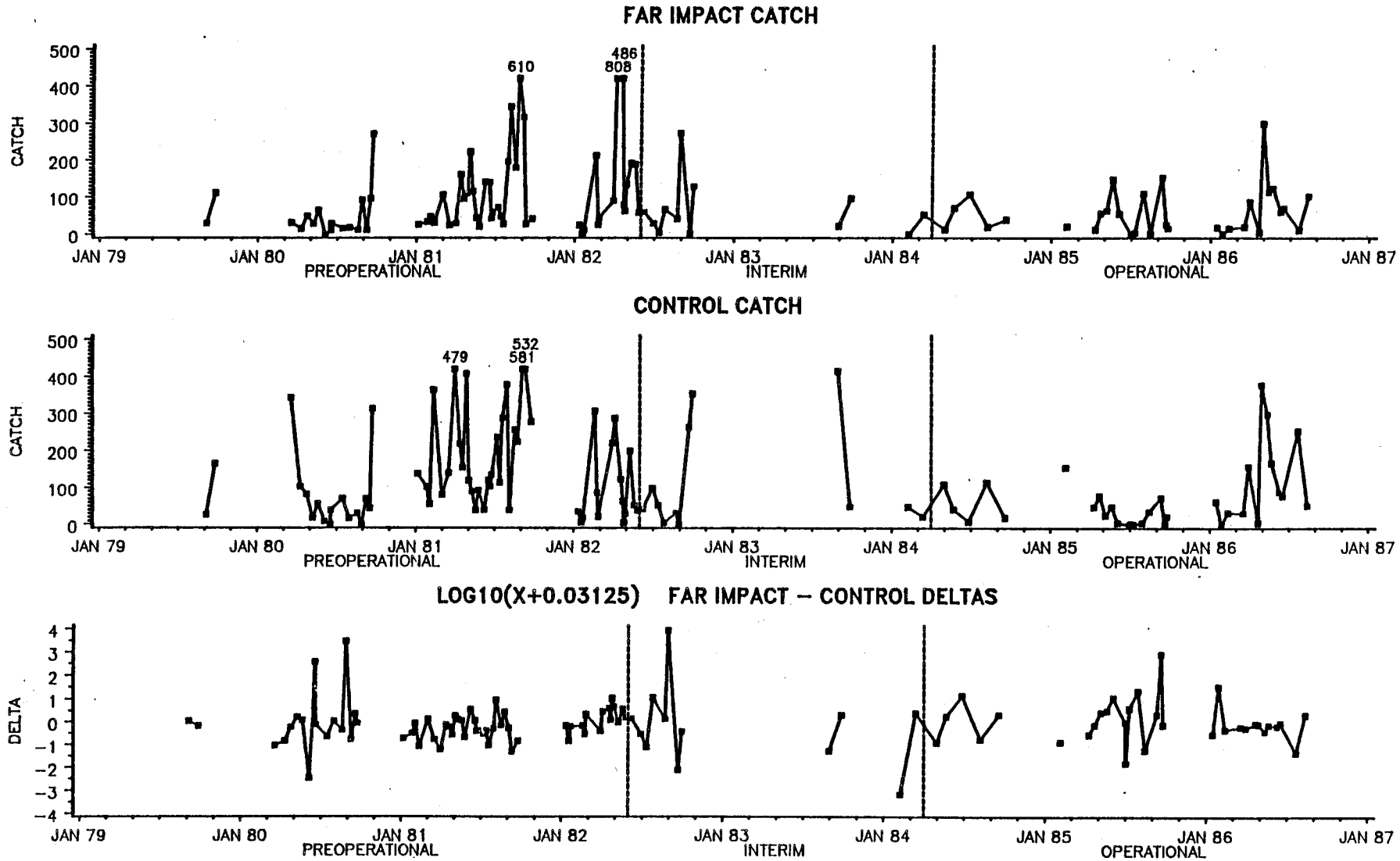


APPENDIX E -- FIGURE 17

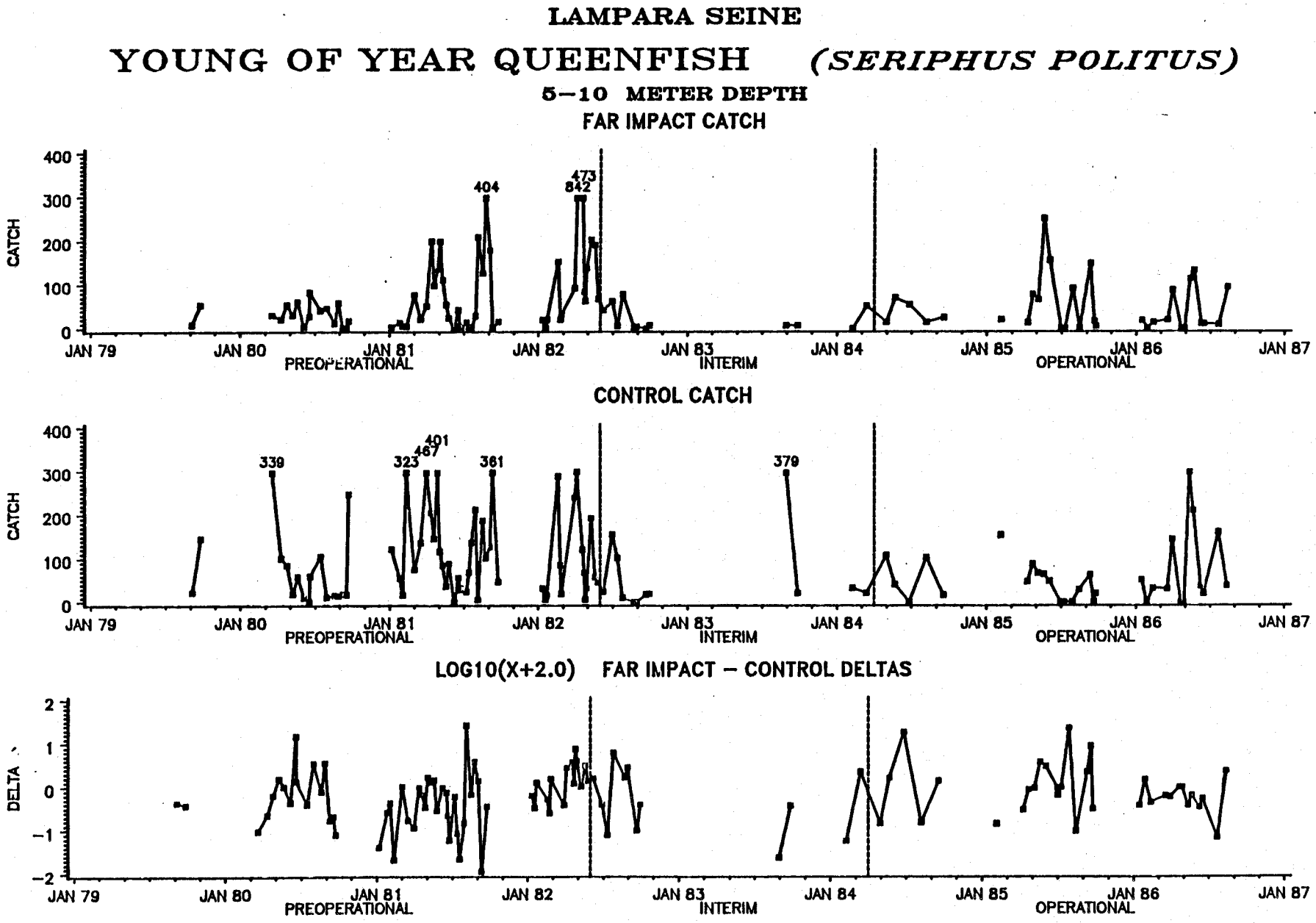
LAMPARA SEINE

IMMATURE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH



APPENDIX E -- FIGURE 20

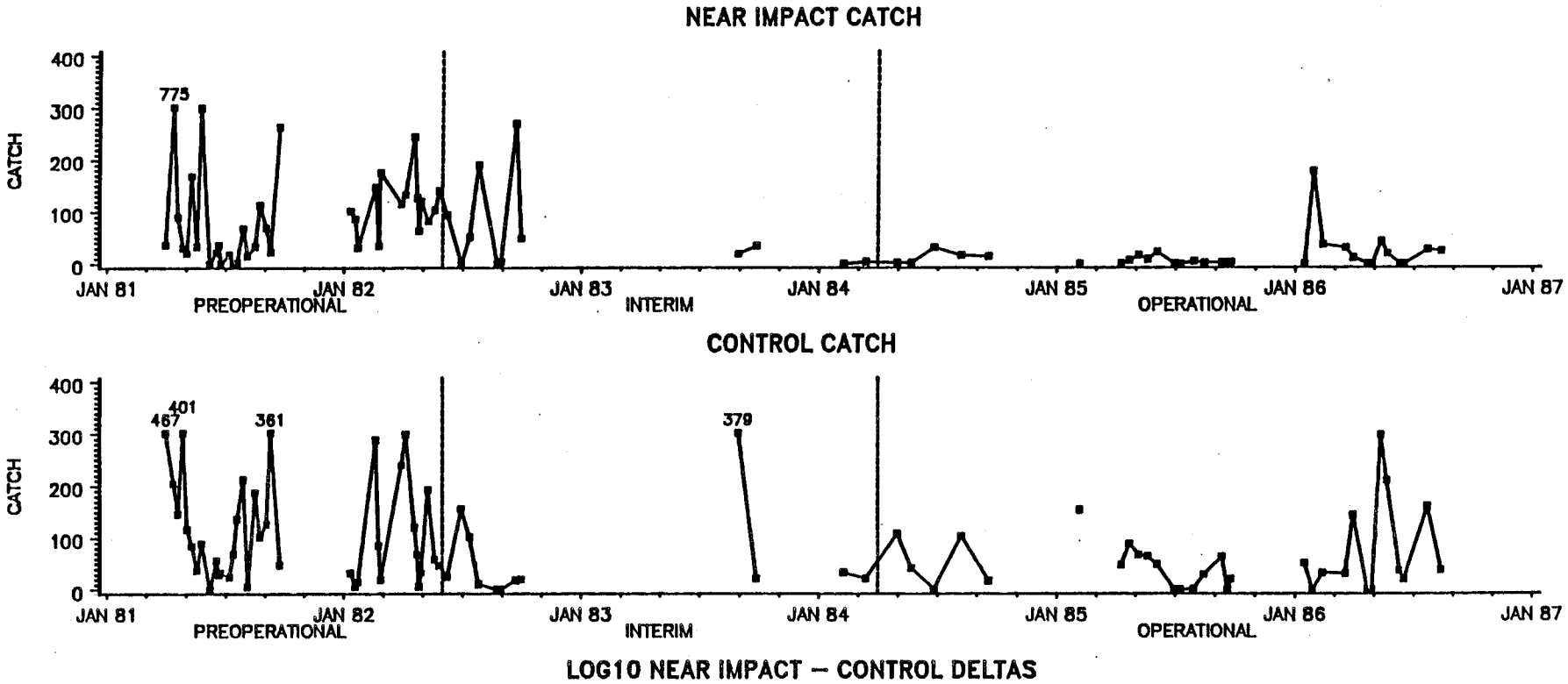


APPENDIX E -- FIGURE 19

LAMPARA SEINE

YOUNG OF YEAR QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH



LOG10 NEAR IMPACT – CONTROL DELTAS

--- STATISTICALLY INTRACTABLE ---

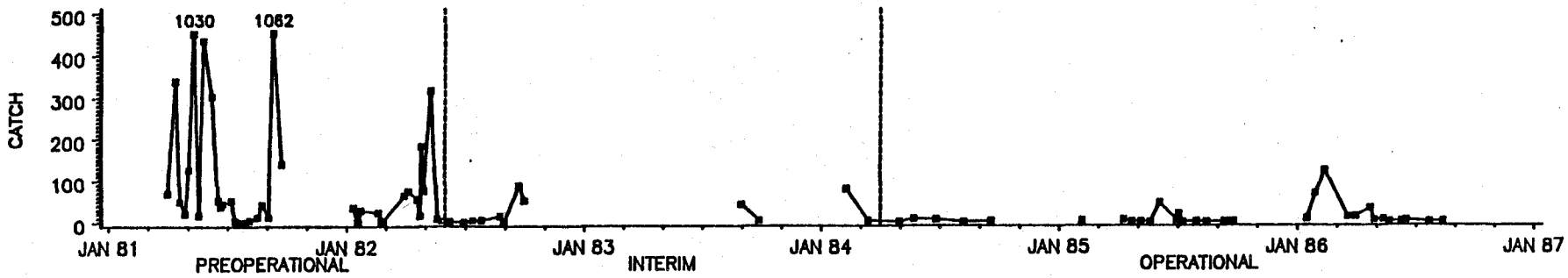
APPENDIX E -- FIGURE 22

LAMPARA SEINE

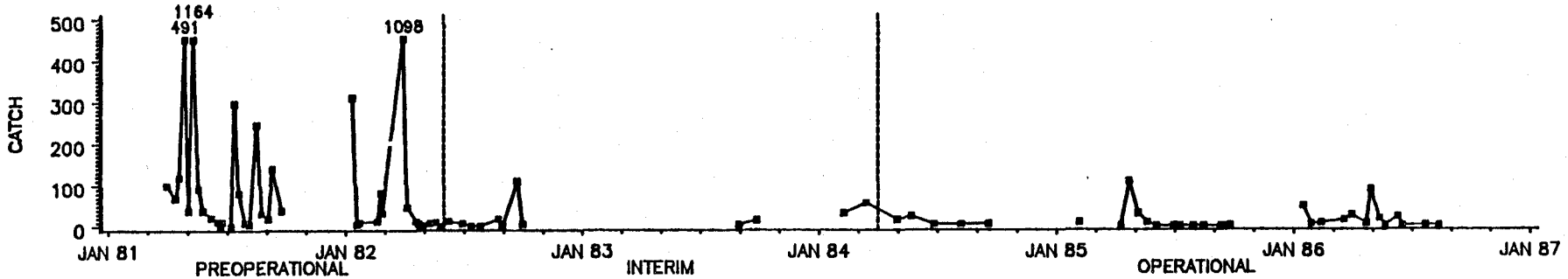
SILVERSIDES *(ATHERINID SPP.)*

5–10 METER DEPTH

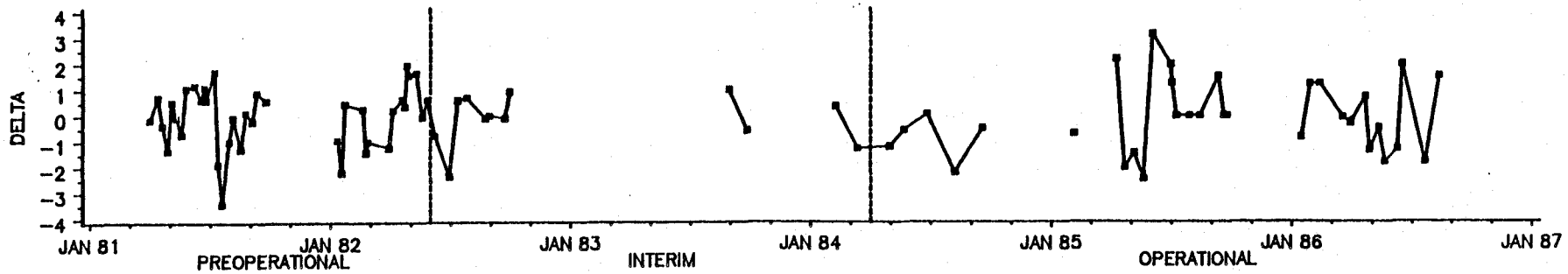
NEAR IMPACT CATCH



CONTROL CATCH



LOG10(X+0.03125) NEAR IMPACT – CONTROL DELTAS

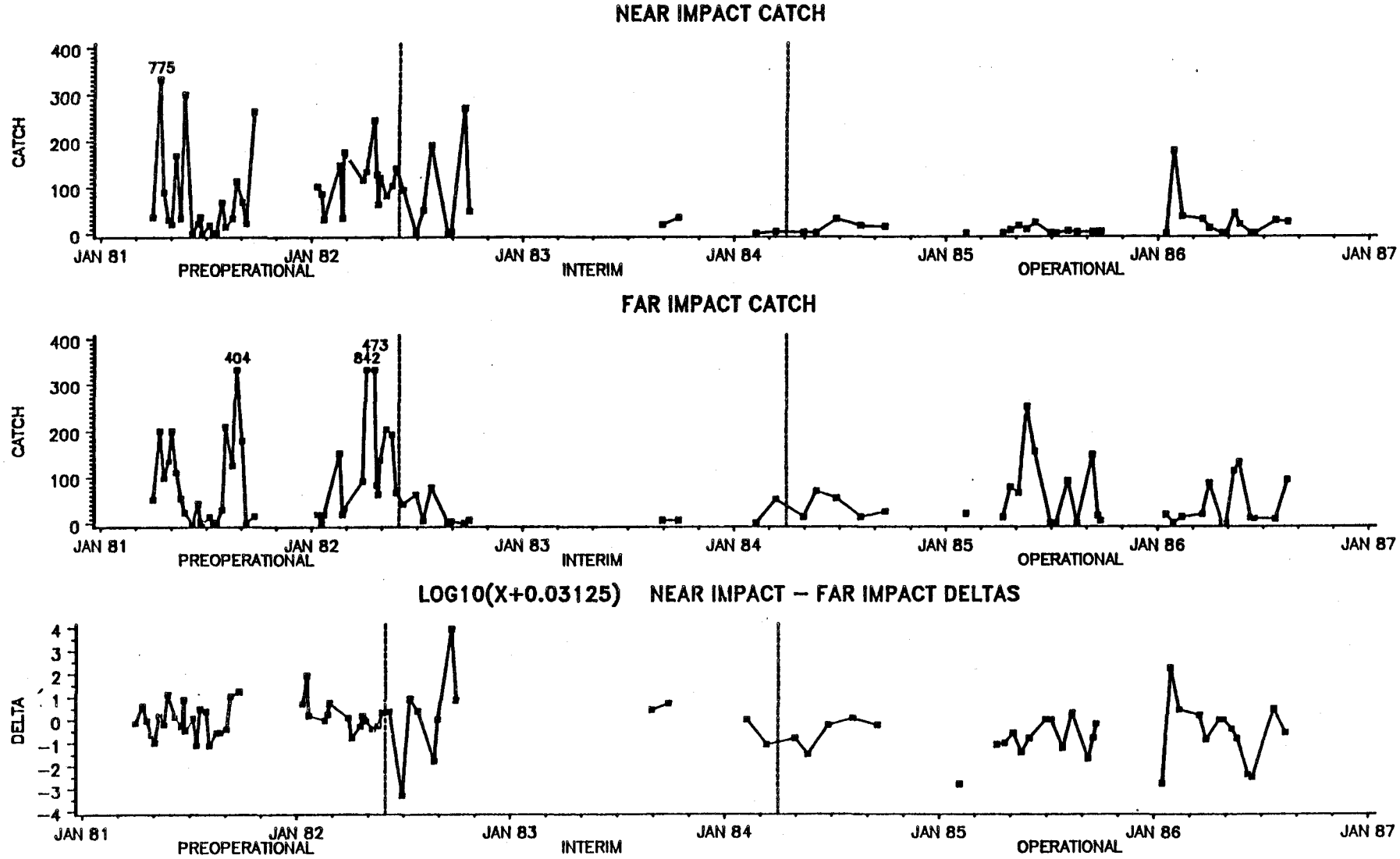


APPENDIX E -- FIGURE 21

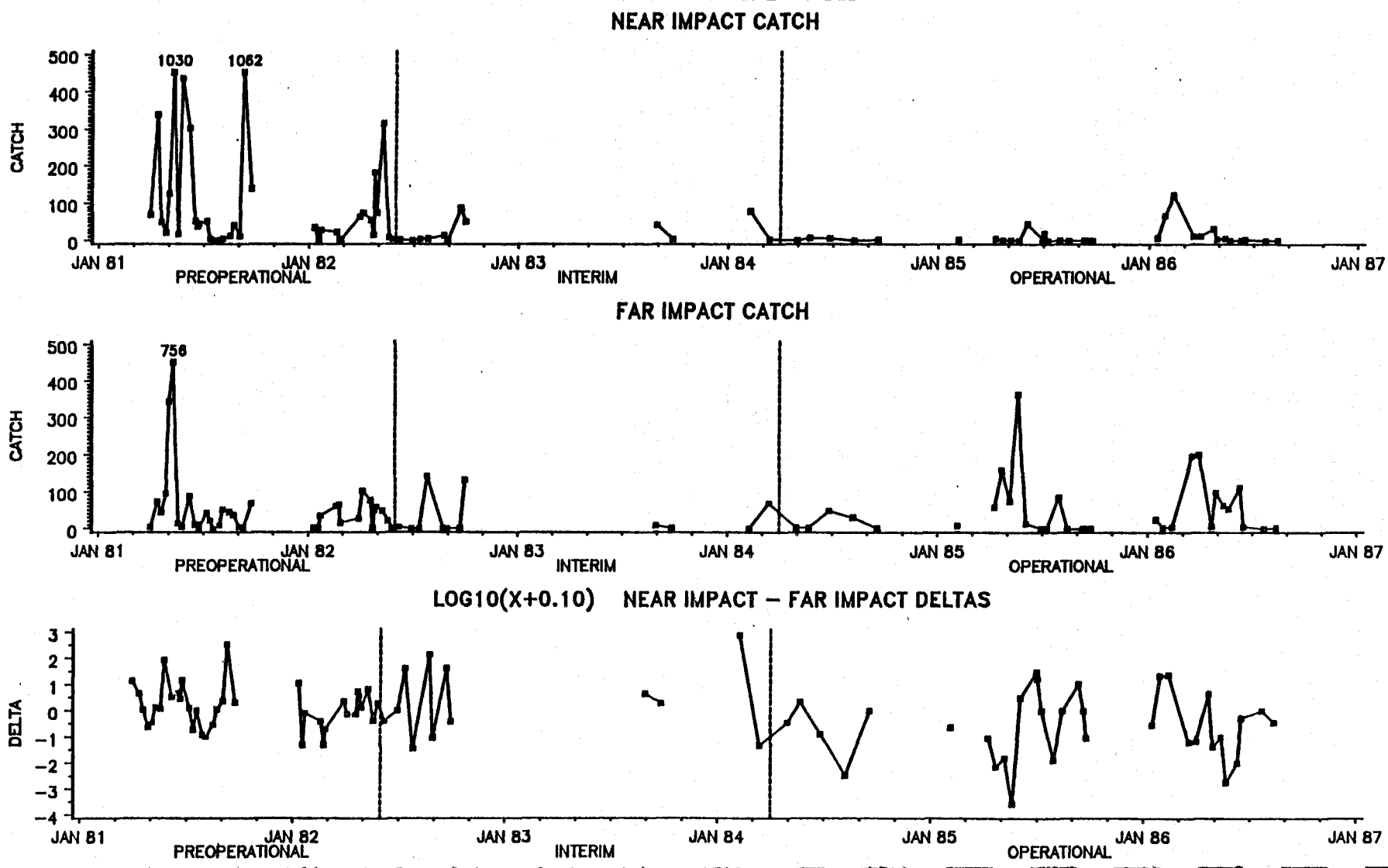
LAMPARA SEINE

YOUNG OF YEAR QUEENFISH *(SERIPHUS POLITUS)*

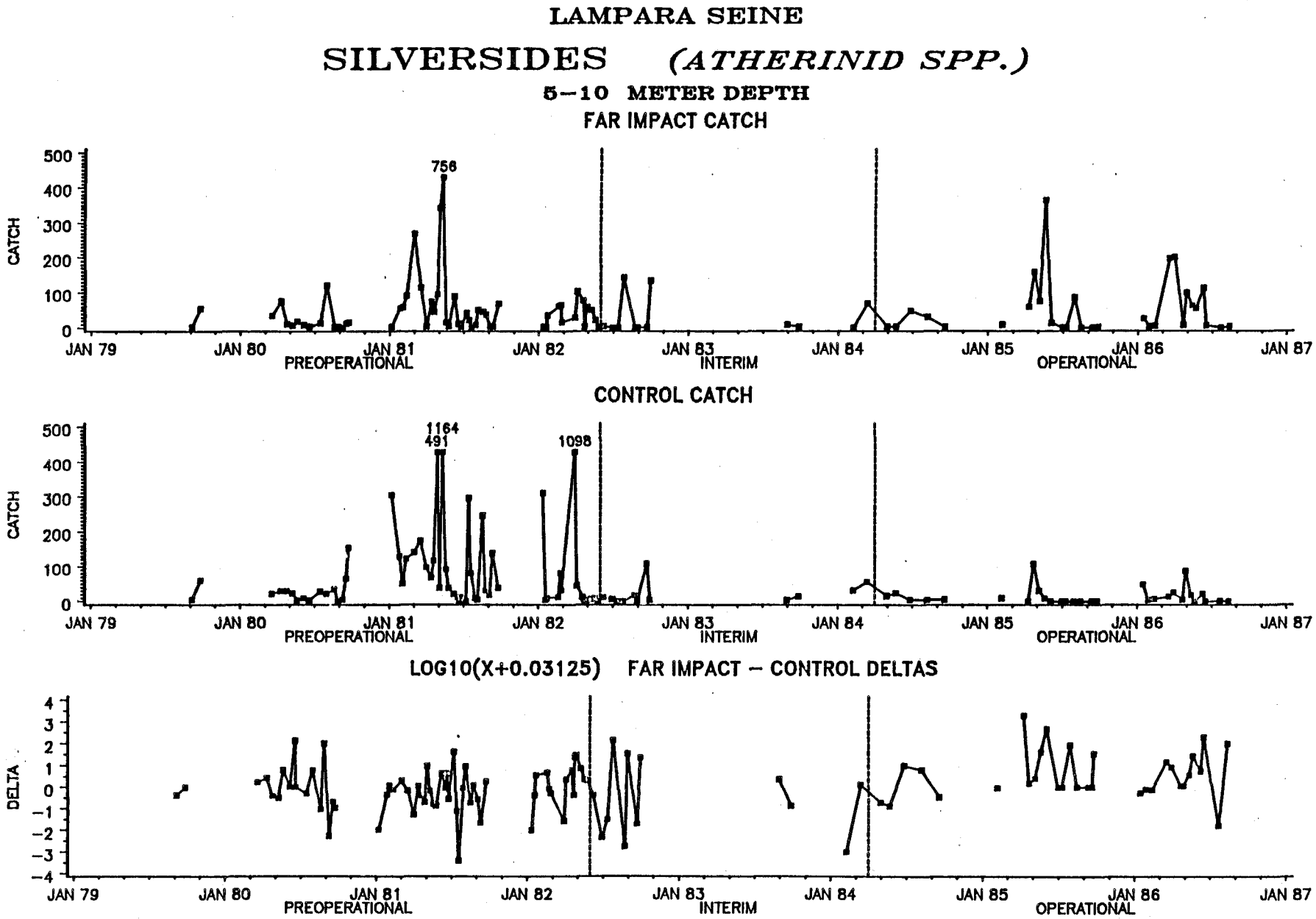
5–10 METER DEPTH



APPENDIX E -- FIGURE 24



APPENDIX E -- FIGURE 23

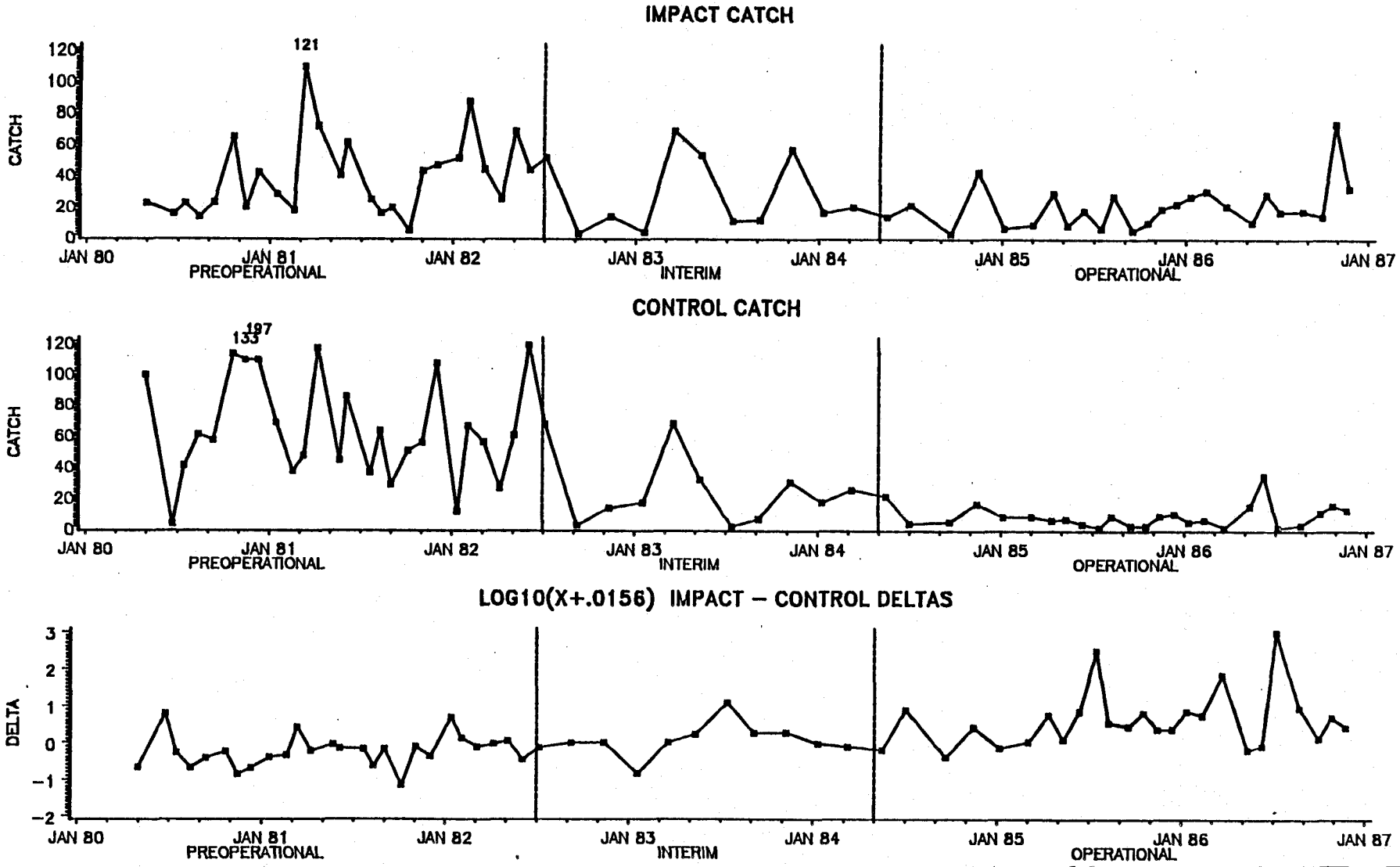


APPENDIX E -- FIGURE 26

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

30 METER DEPTH

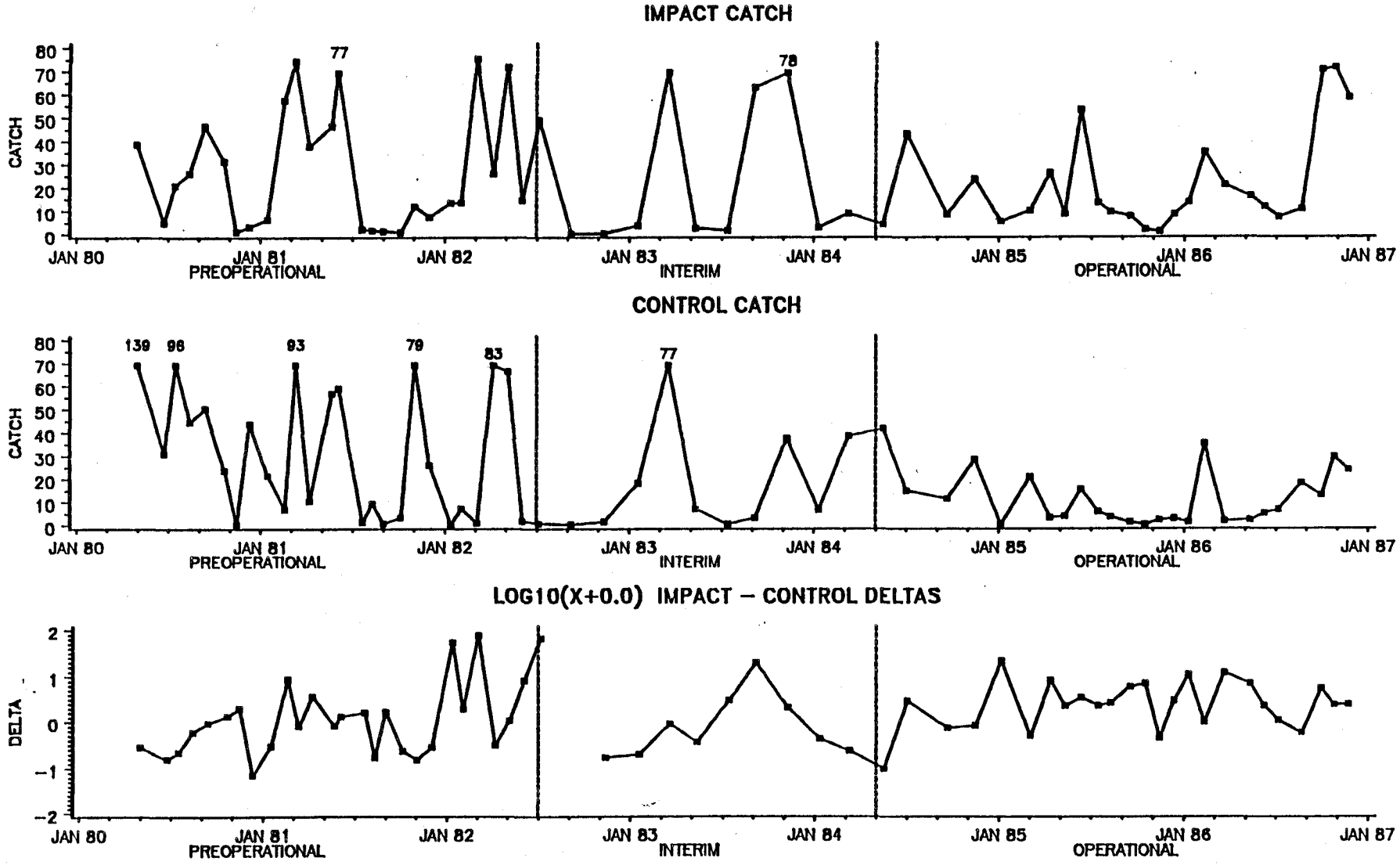


APPENDIX E -- FIGURE 25

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

18 METER DEPTH

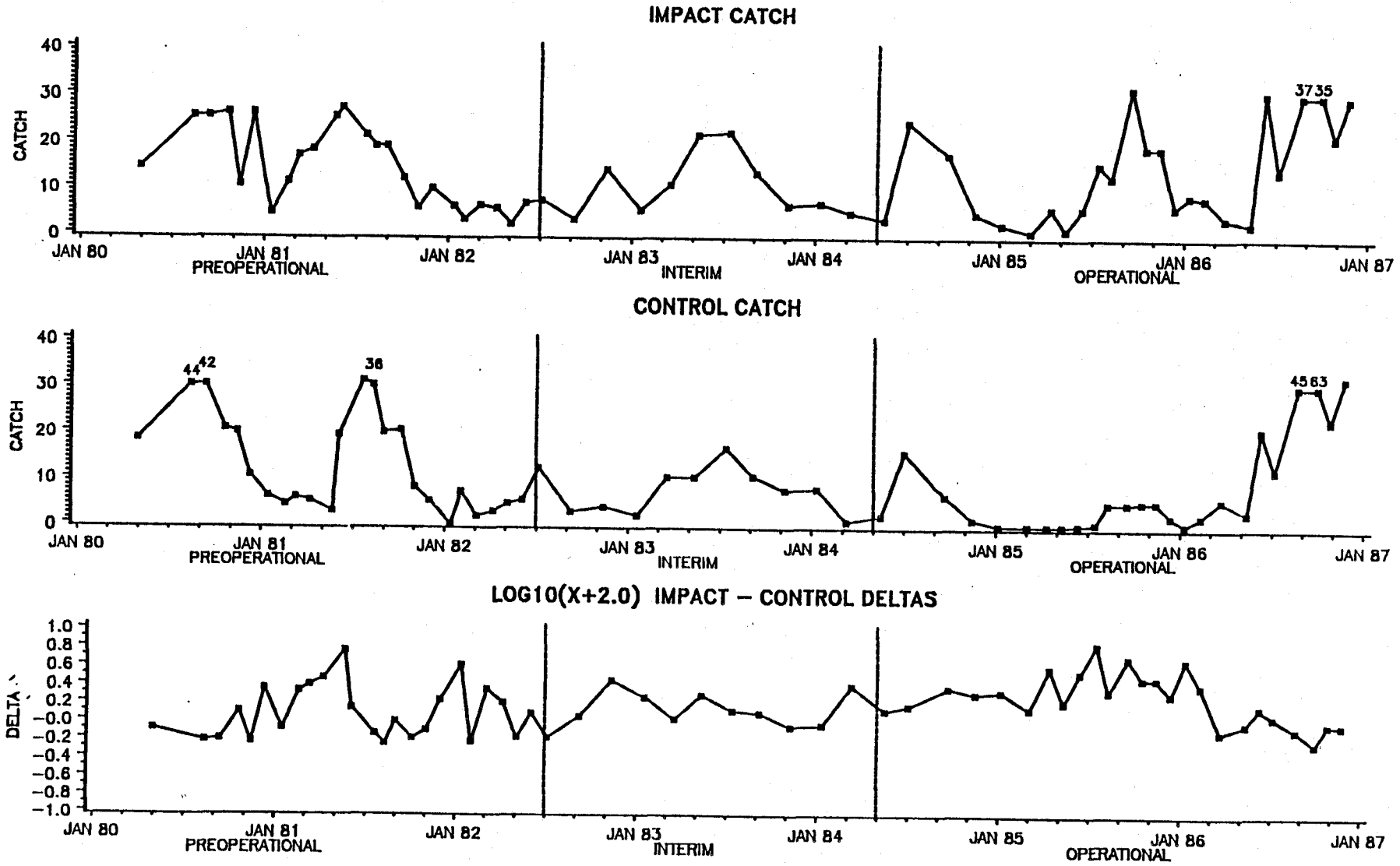


APPENDIX E -- FIGURE 28

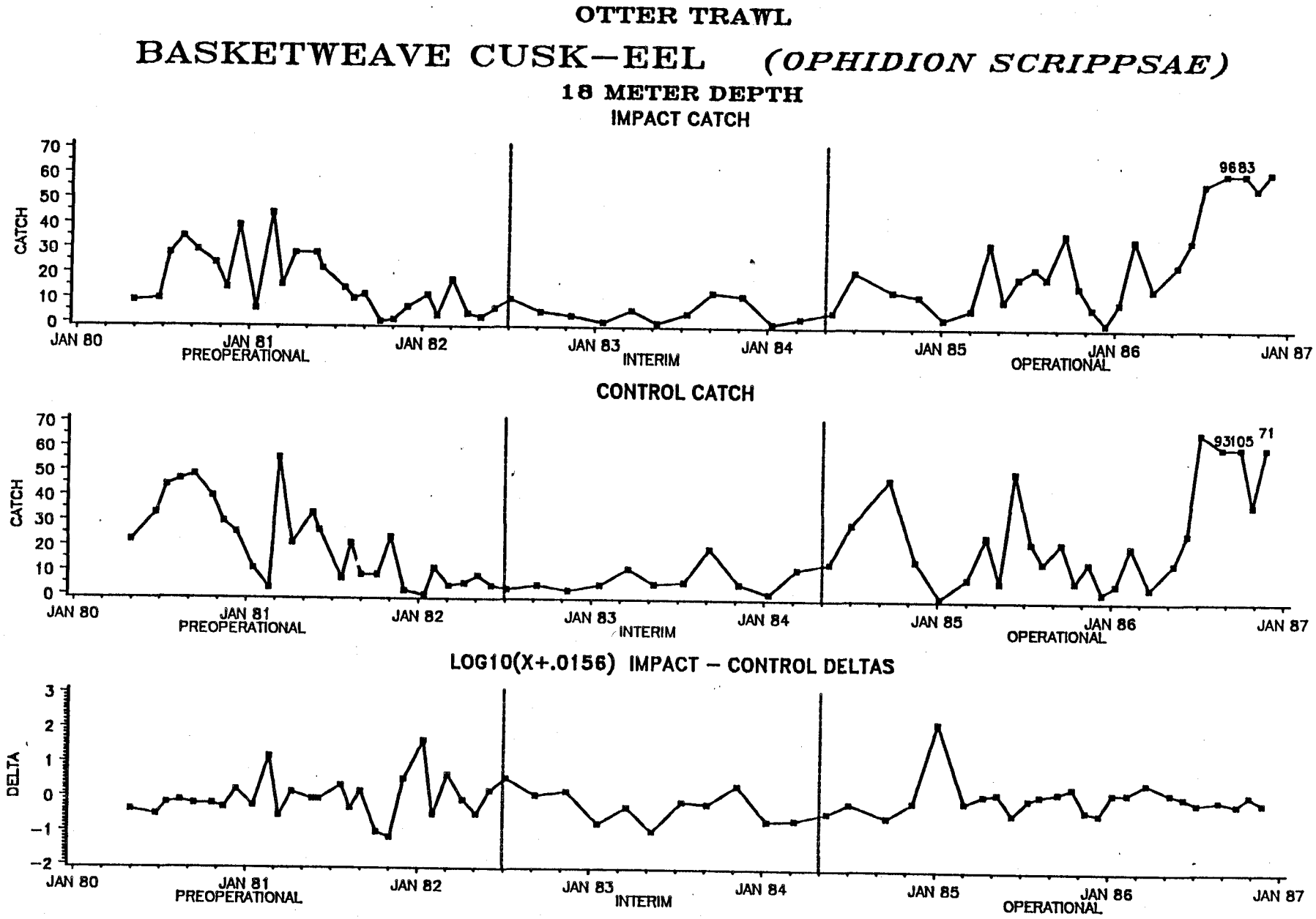
OTTER TRAWL

BASKETWEAVE CUSK–EEL *(OPHIDION SCRIPPSAE)*

30 METER DEPTH



APPENDIX E -- FIGURE 27

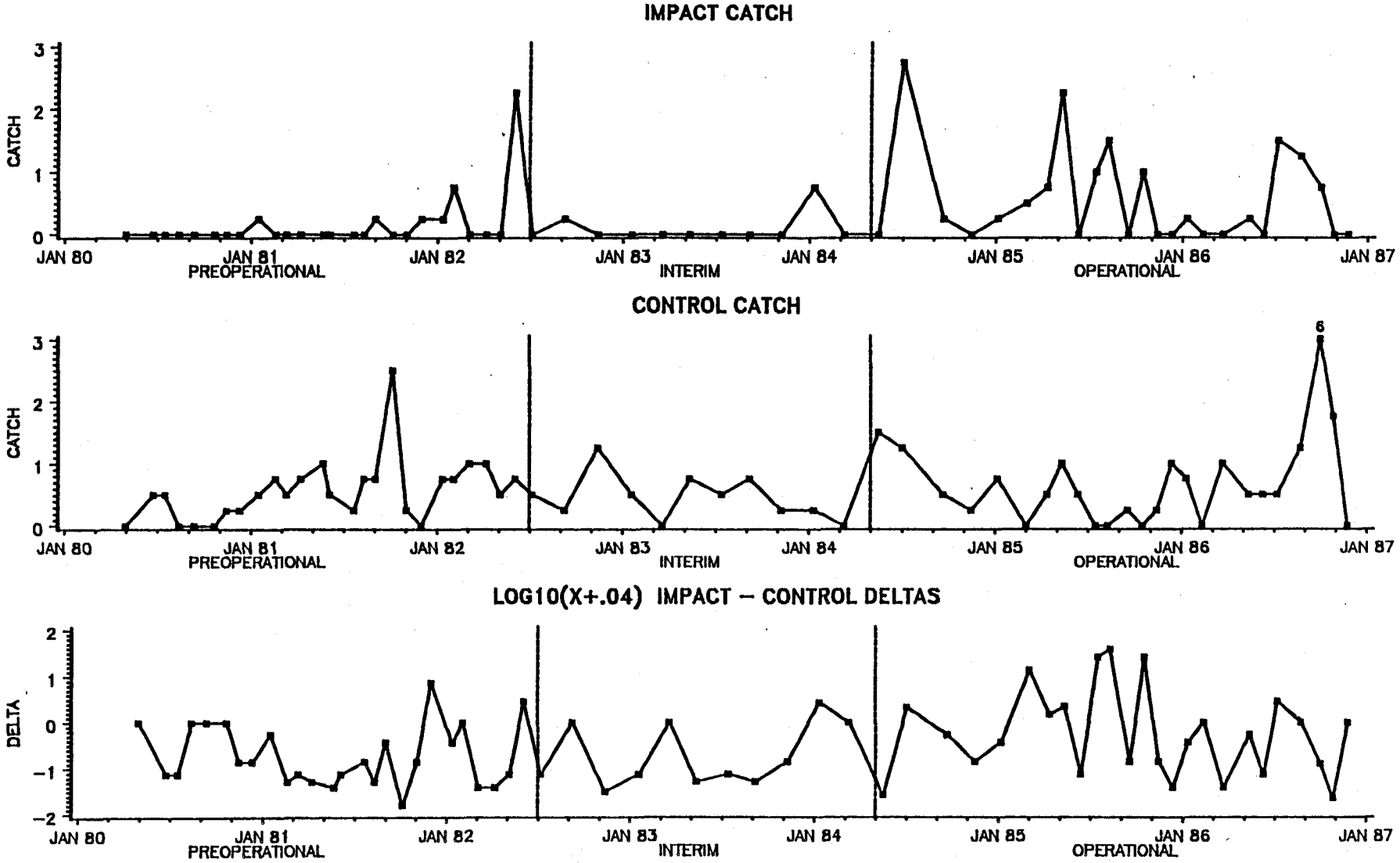


APPENDIX E -- FIGURE 30

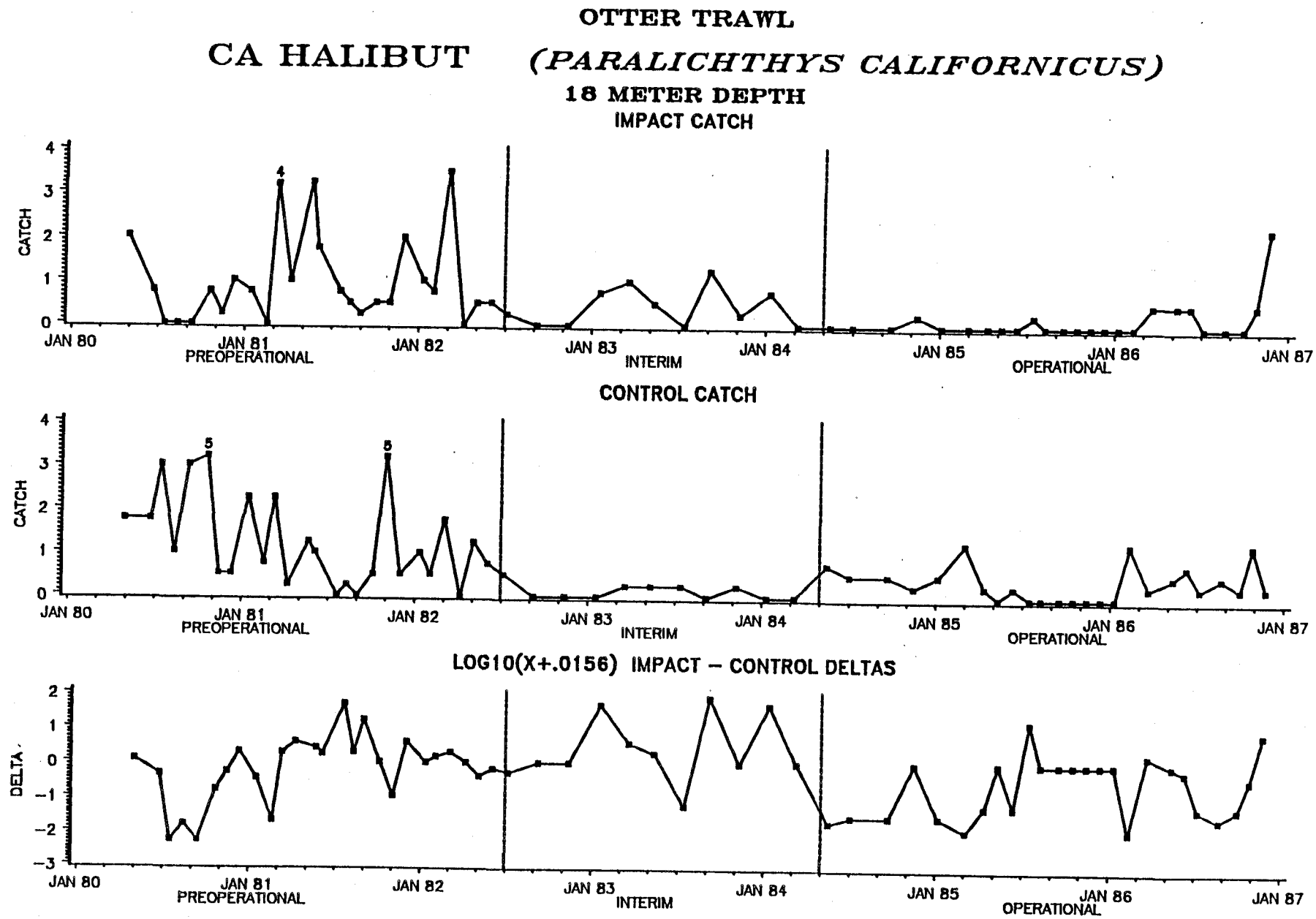
OTTER TRAWL

CA LIZARDFISH *(SYNODUS LUCIOCEPS)*

18 METER DEPTH



APPENDIX E -- FIGURE 29

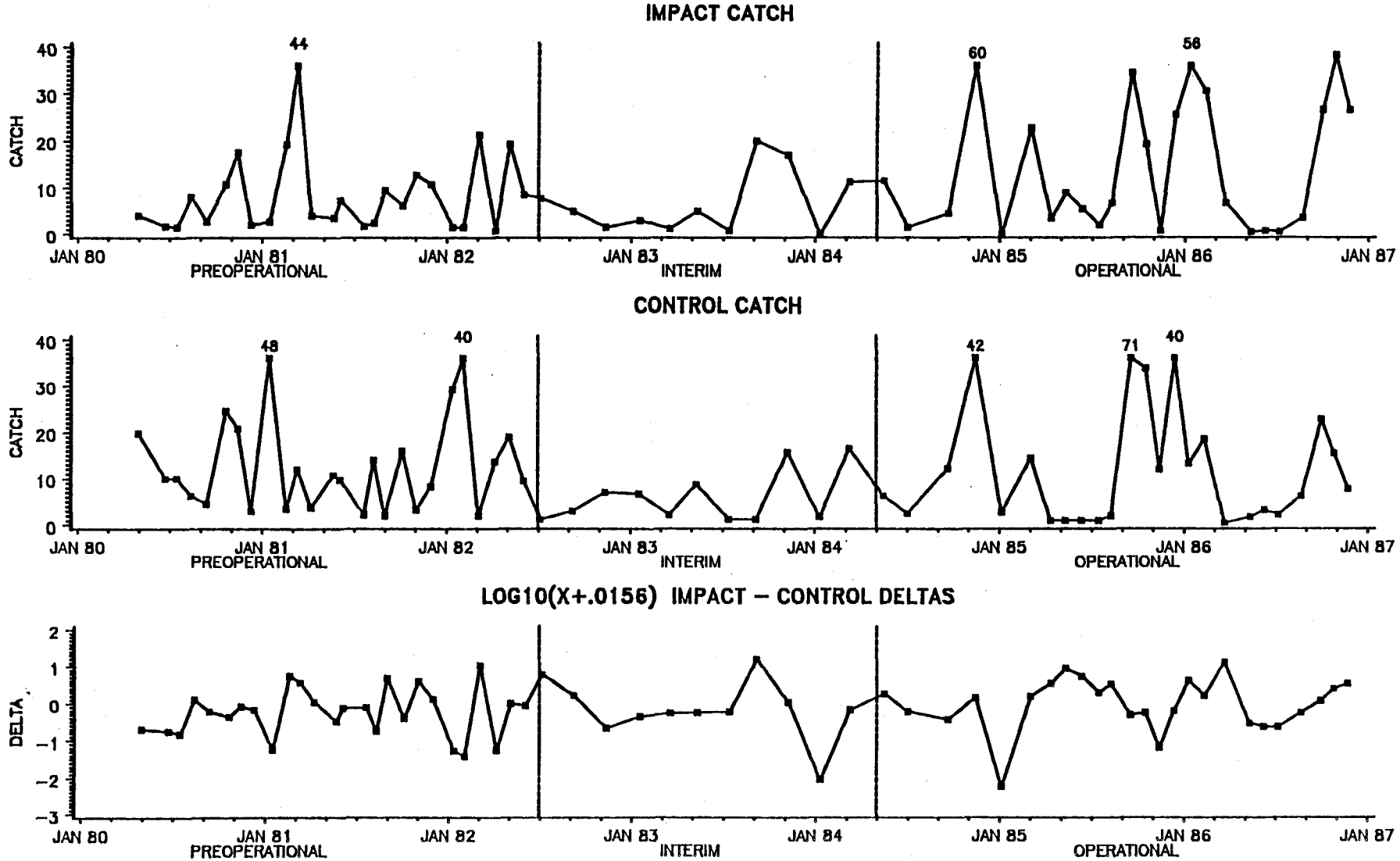


APPENDIX E -- FIGURE 32

OTTER TRAWL

QUEENFISH *(SERIPHUS POLITUS)*

18 METER DEPTH

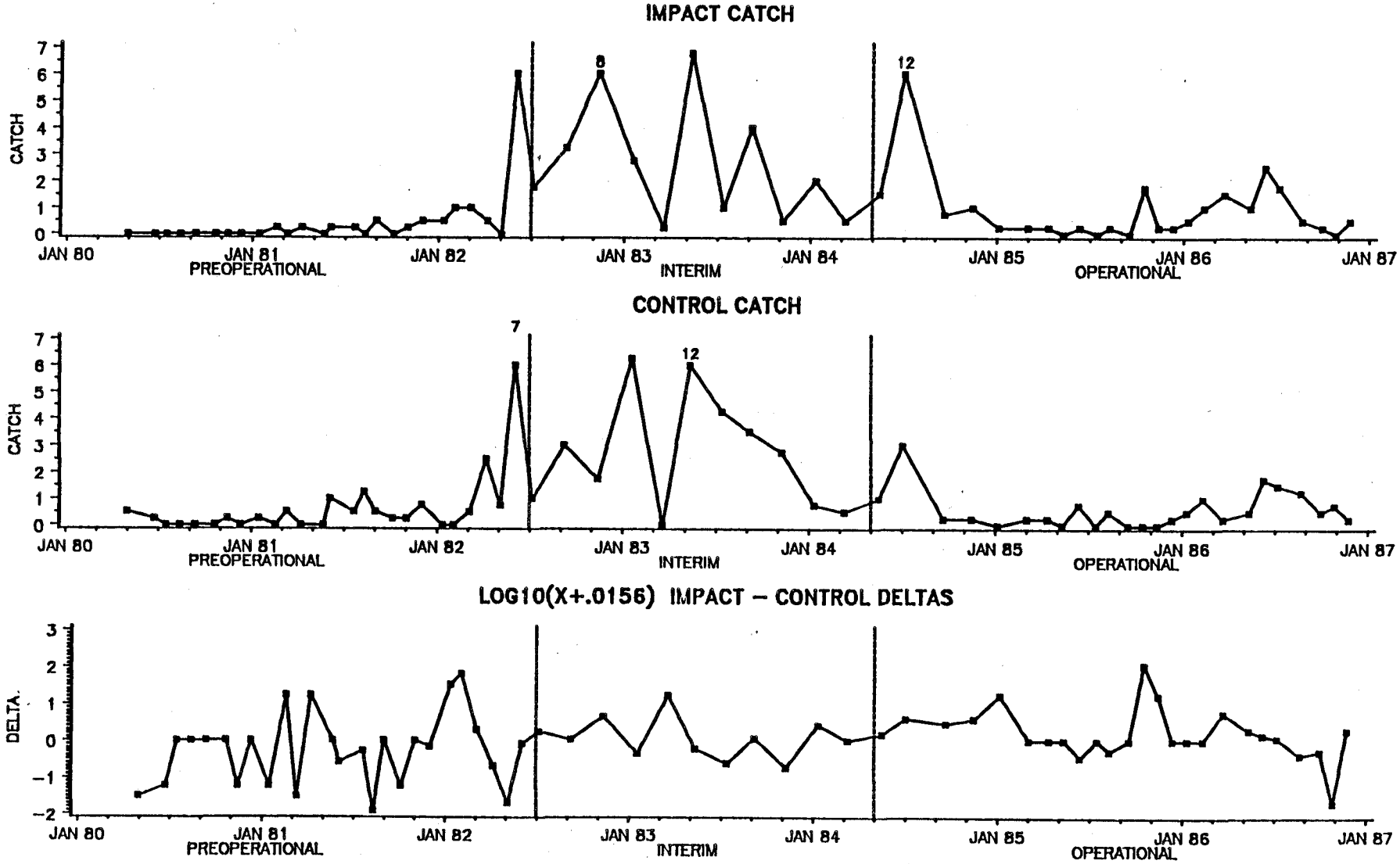


APPENDIX E -- FIGURE 31

OTTER TRAWL

CA LIZARDFISH *(SYNODUS LUCIOCEPS)*

30 METER DEPTH

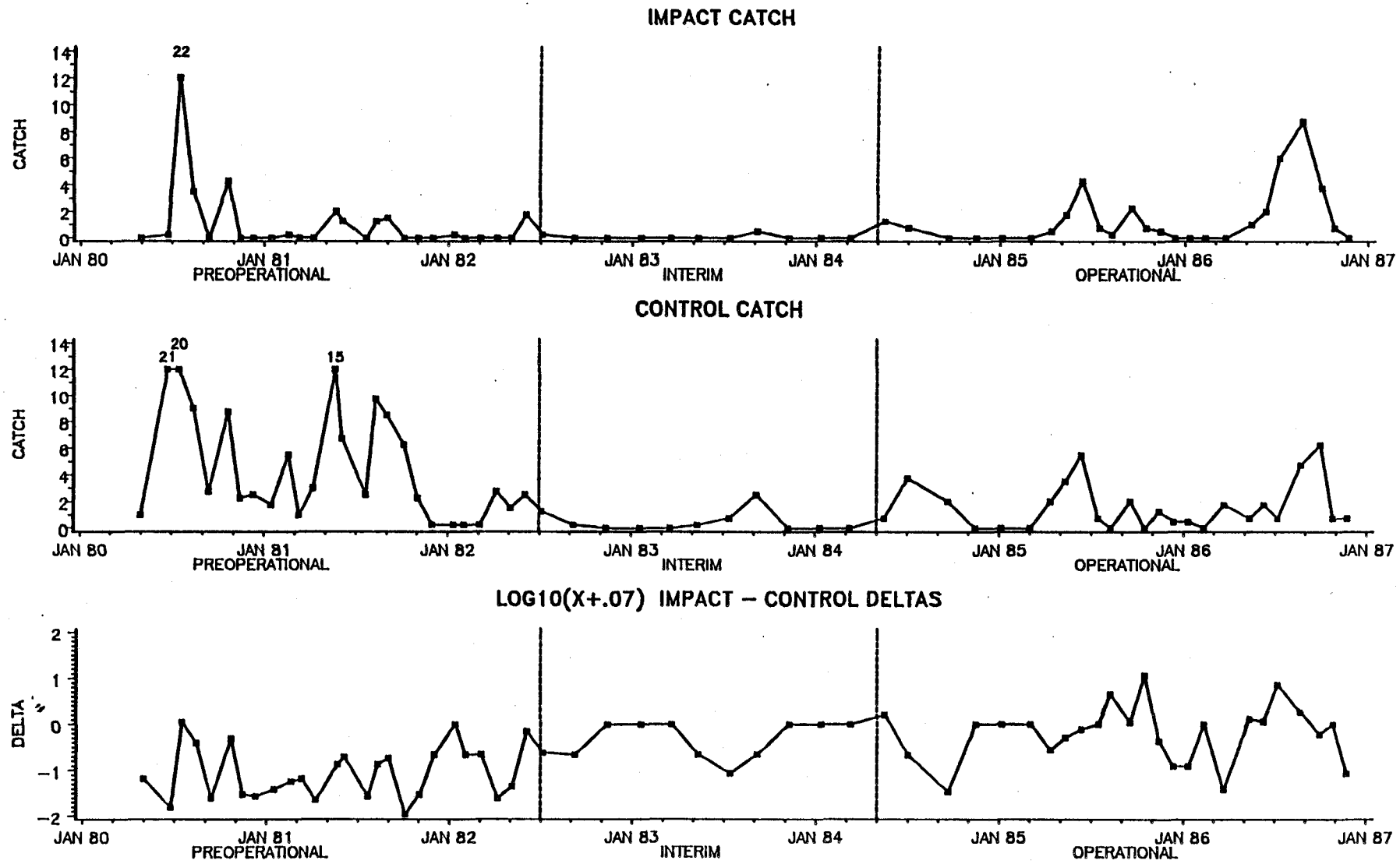


APPENDIX E -- FIGURE 34

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

18 METER DEPTH

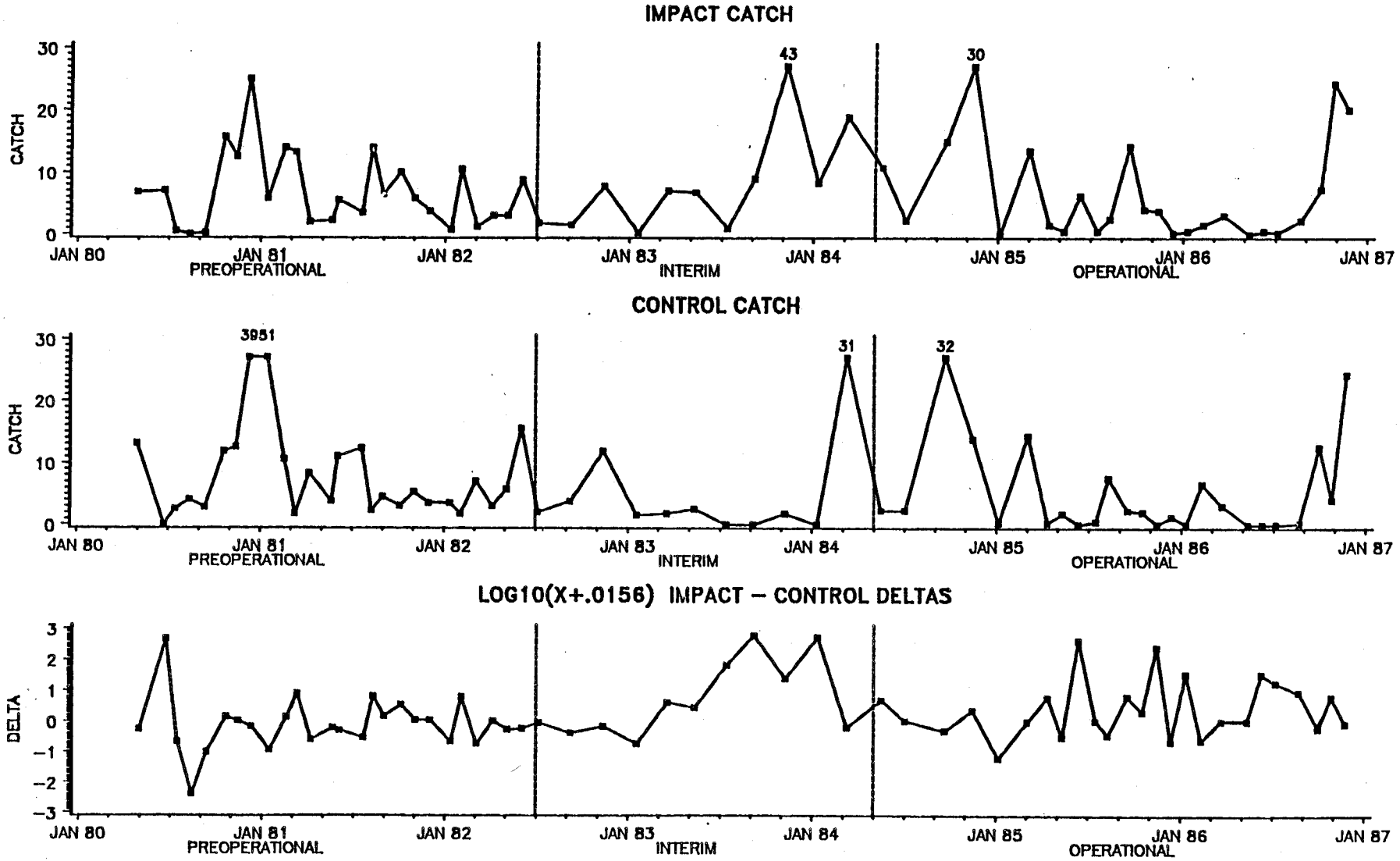


APPENDIX E -- FIGURE 33

OTTER TRAWL

QUEENFISH *(SERIPHUS POLITUS)*

30 METER DEPTH

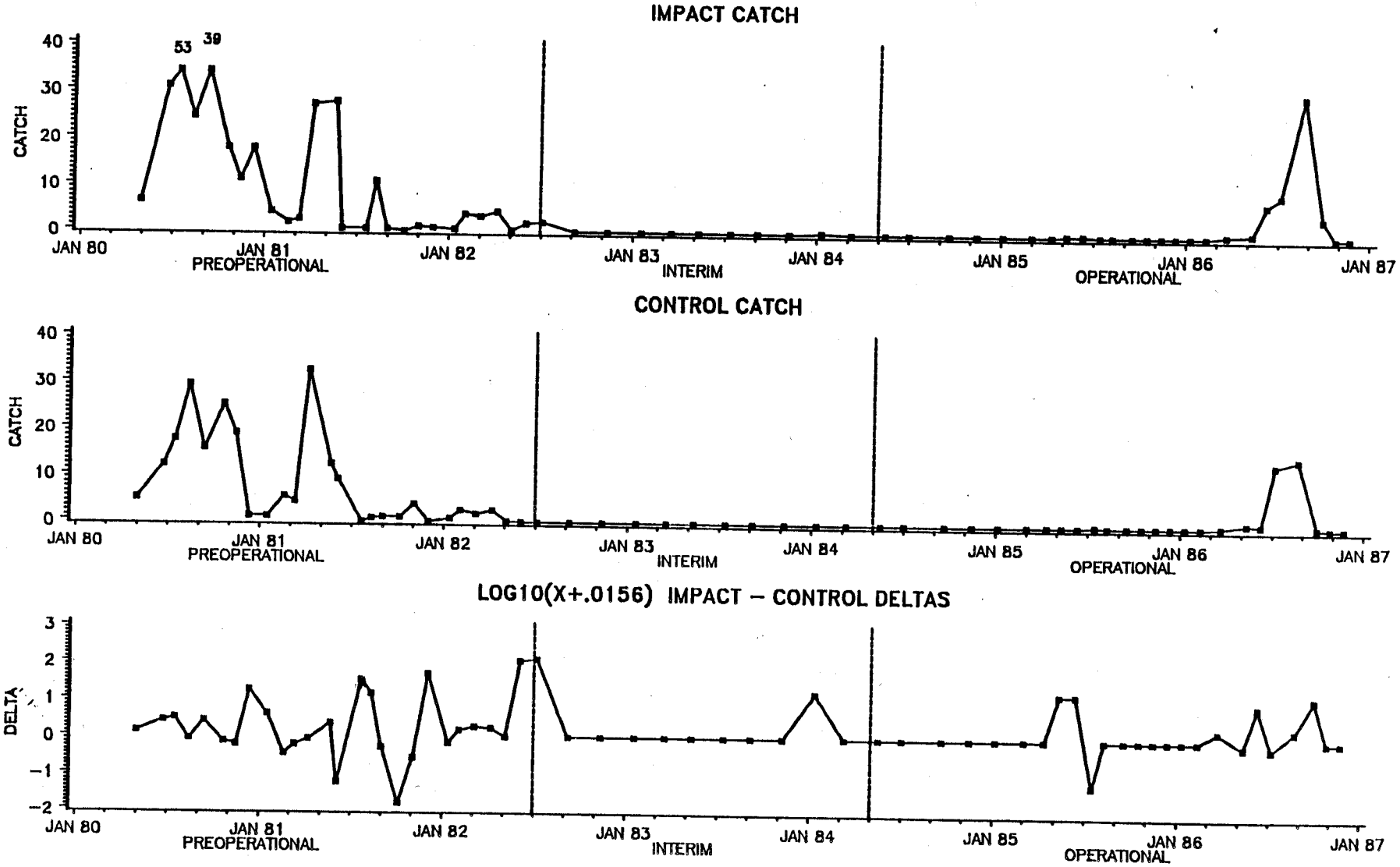


APPENDIX E -- FIGURE 36

OTTER TRAWL

PACIFIC SANDDAB *(CITHARICHTHYS SORDIDUS)*

30 METER DEPTH

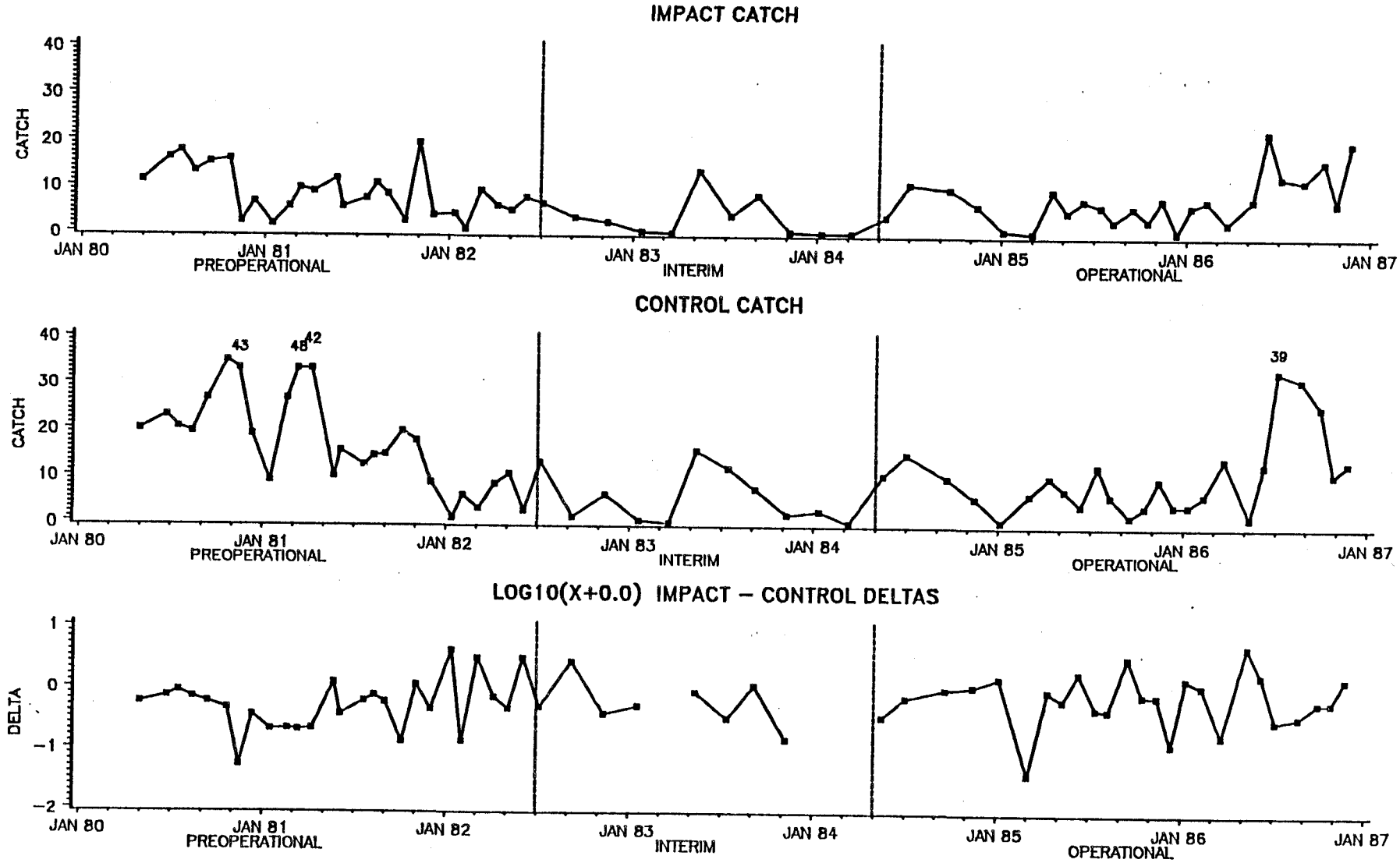


APPENDIX E -- FIGURE 35

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

30 METER DEPTH



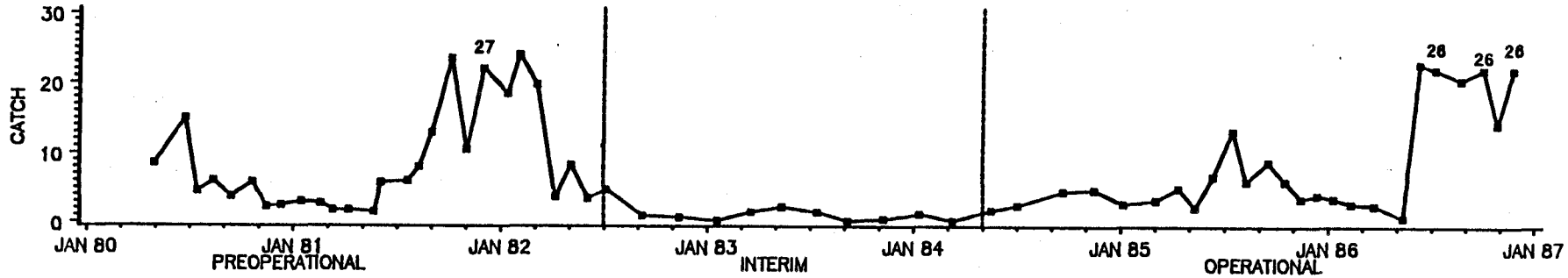
APPENDIX E -- FIGURE 38

OTTER TRAWL

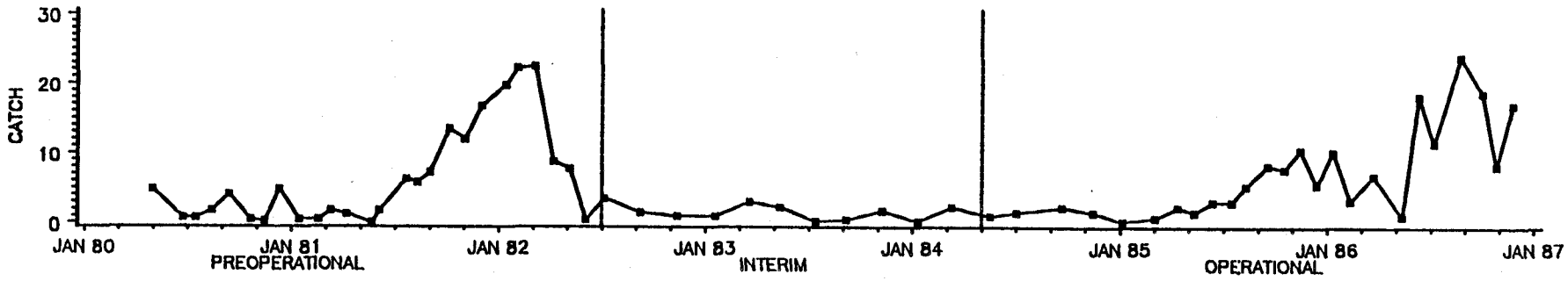
SPECKLED SANDDAB *(CITHARICHTHYS STIGMAEUS)*

30 METER DEPTH

IMPACT CATCH



CONTROL CATCH



LOG10 IMPACT – CONTROL DELTAS

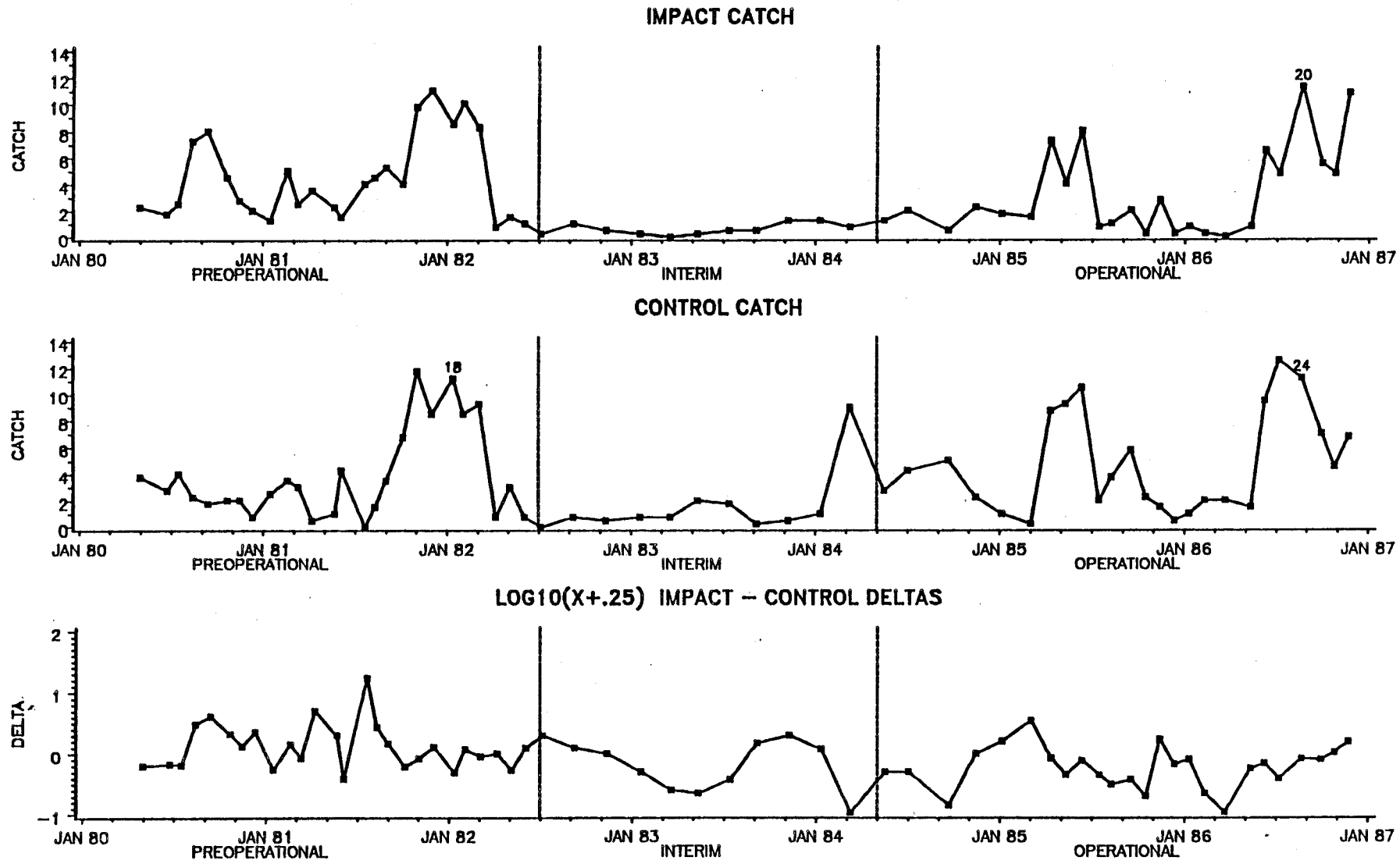
---- STATISTICALLY INTRACTABLE ----

APPENDIX E -- FIGURE 37

OTTER TRAWL

SPECKLED SANDDAB *(CITHARICHTHYS STIGMAEUS)*

18 METER DEPTH

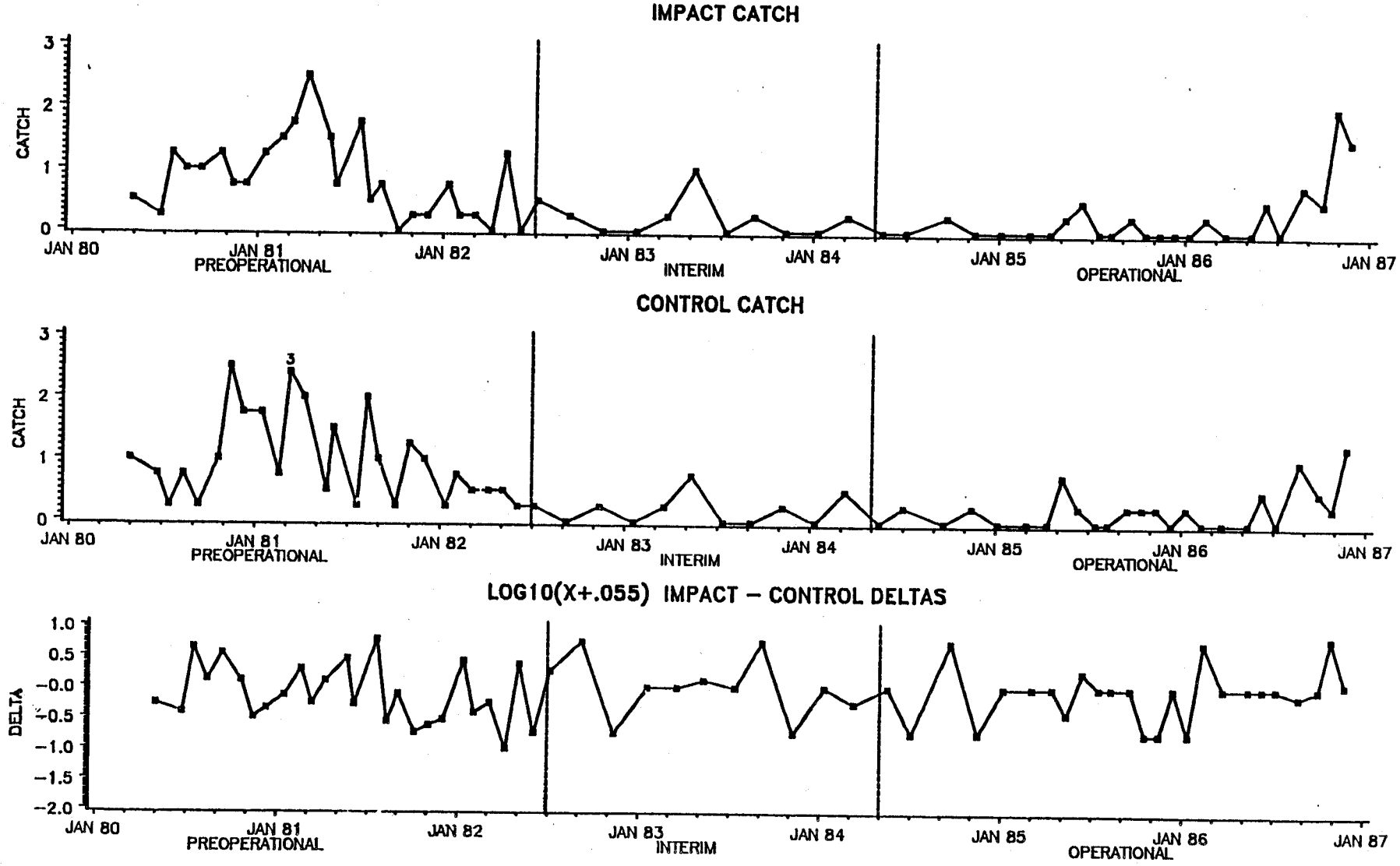


APPENDIX E -- FIGURE 40

OTTER TRAWL

CA SKATE *(RAJA INORNATA)*

30 METER DEPTH

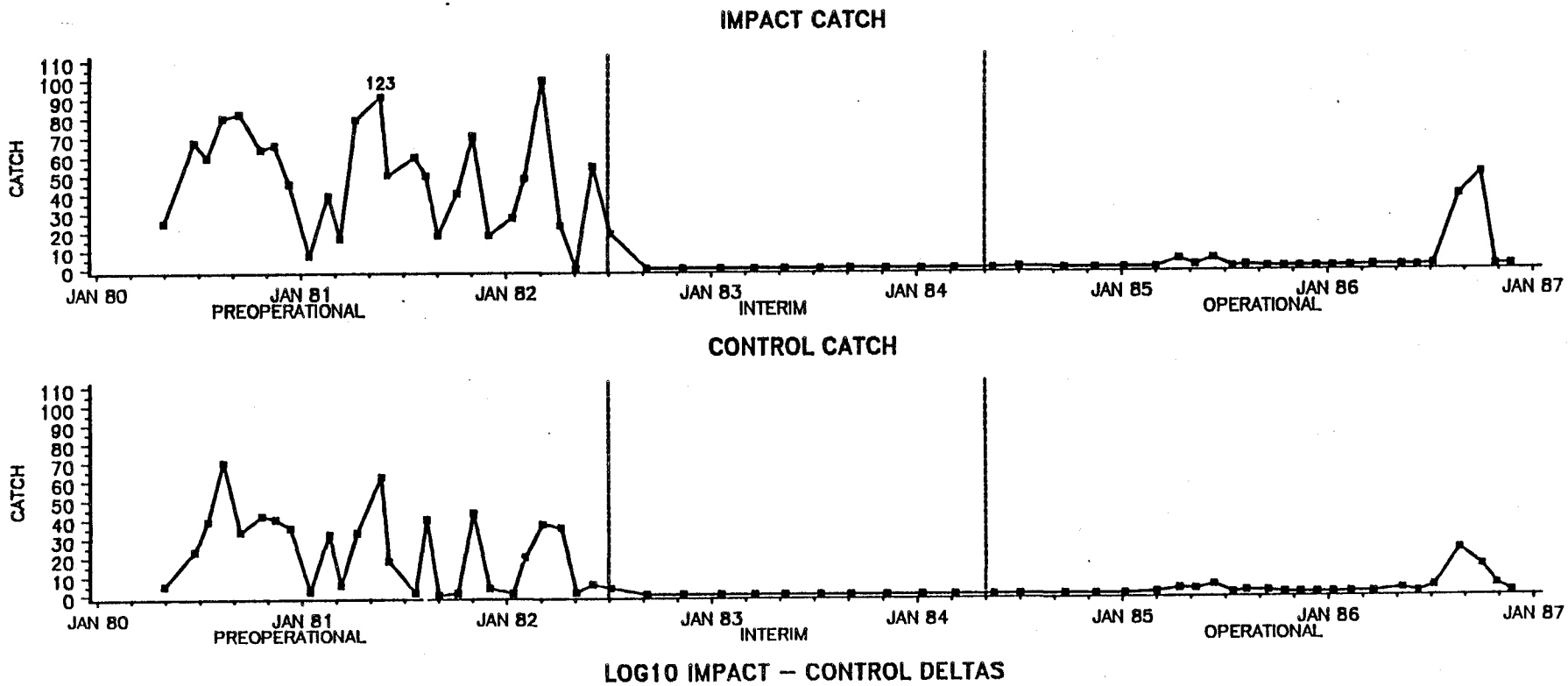


APPENDIX E -- FIGURE 39

OTTER TRAWL

PINK SEAPERCH *(ZALEMBIUS ROSACEUS)*

30 METER DEPTH



LOG10 IMPACT – CONTROL DELTAS

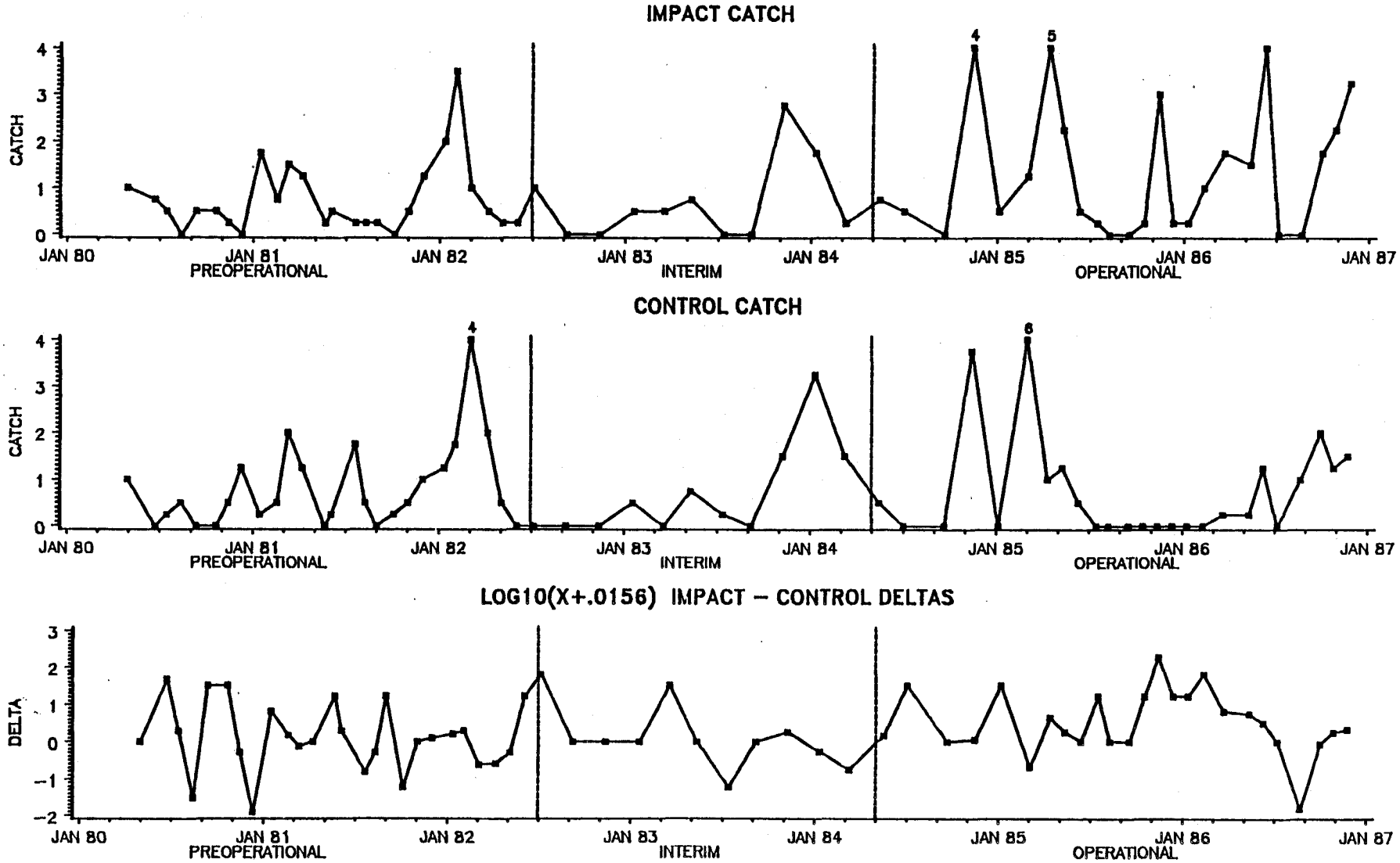
--- STATISTICALLY INTRACTABLE ---

APPENDIX E -- FIGURE 42

OTTER TRAWL

FANTAIL SOLE *(XYSTREURYS LIOLEPIS)*

30 METER DEPTH

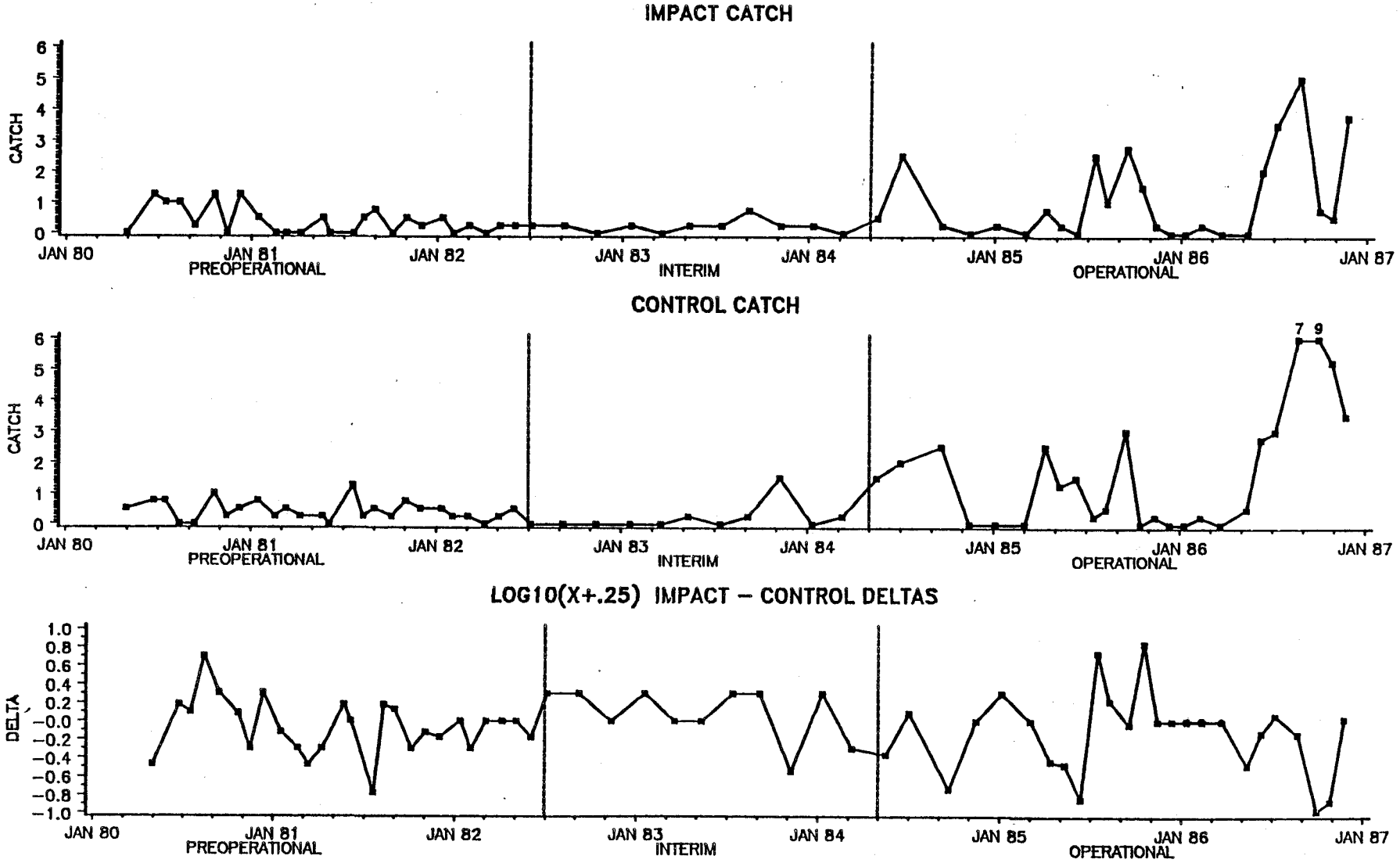


APPENDIX E -- FIGURE 41

OTTER TRAWL

FANTAIL SOLE *(XYSTREURYS LIOLEPIS)*

18 METER DEPTH

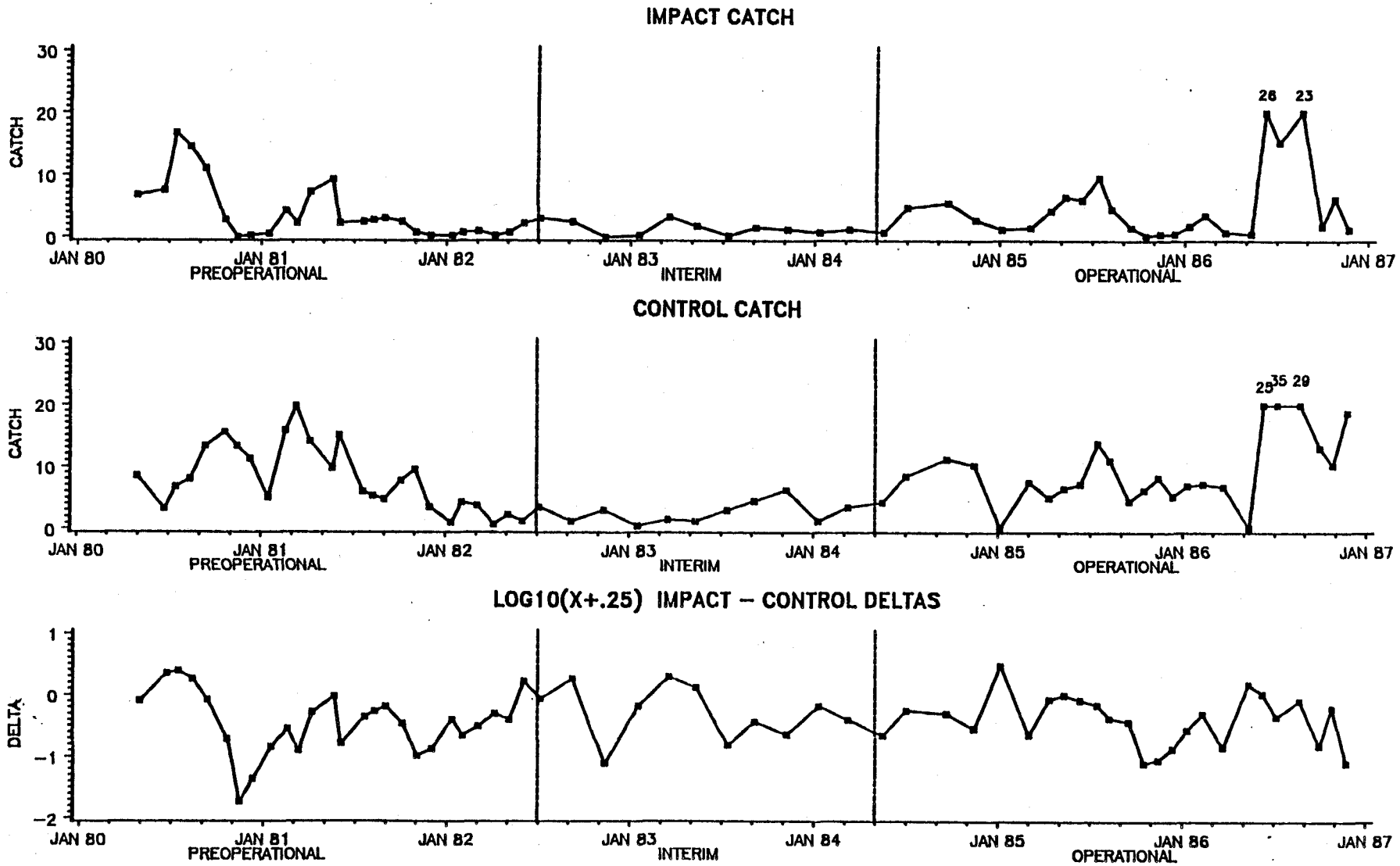


APPENDIX E -- FIGURE 44

OTTER TRAWL

CA TONGUEFISH *(SYMPHURUS ATRICAUDA)*

30 METER DEPTH



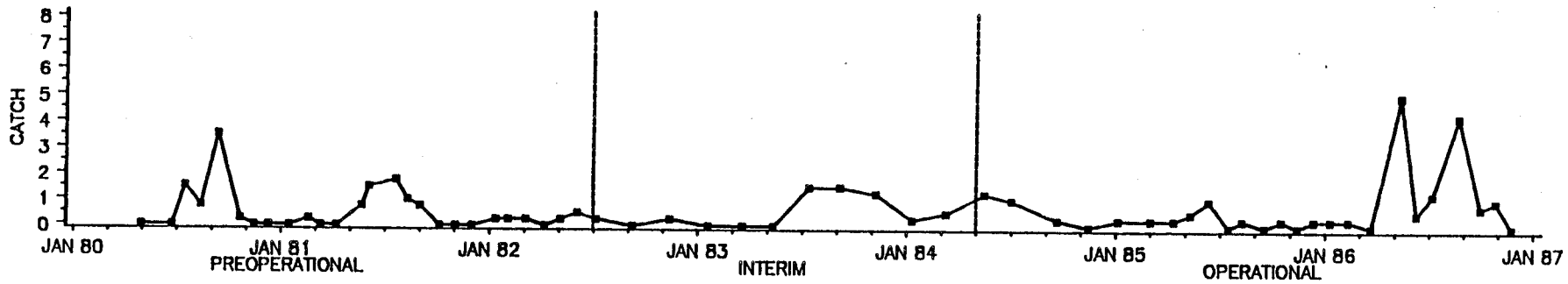
APPENDIX E -- FIGURE 43

OTTER TRAWL

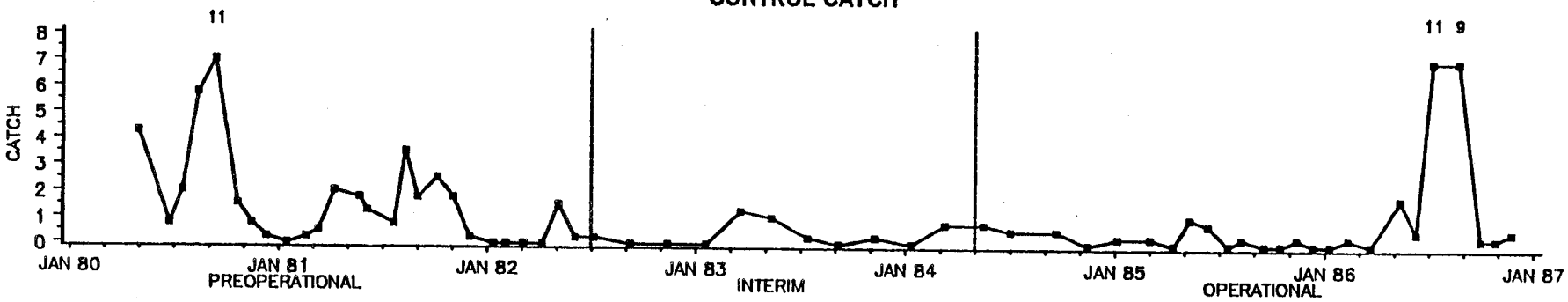
CA TONGUEFISH *(SYMPHURUS ATRICAUDA)*

18 METER DEPTH

IMPACT CATCH



CONTROL CATCH



LOG10 IMPACT – CONTROL DELTAS

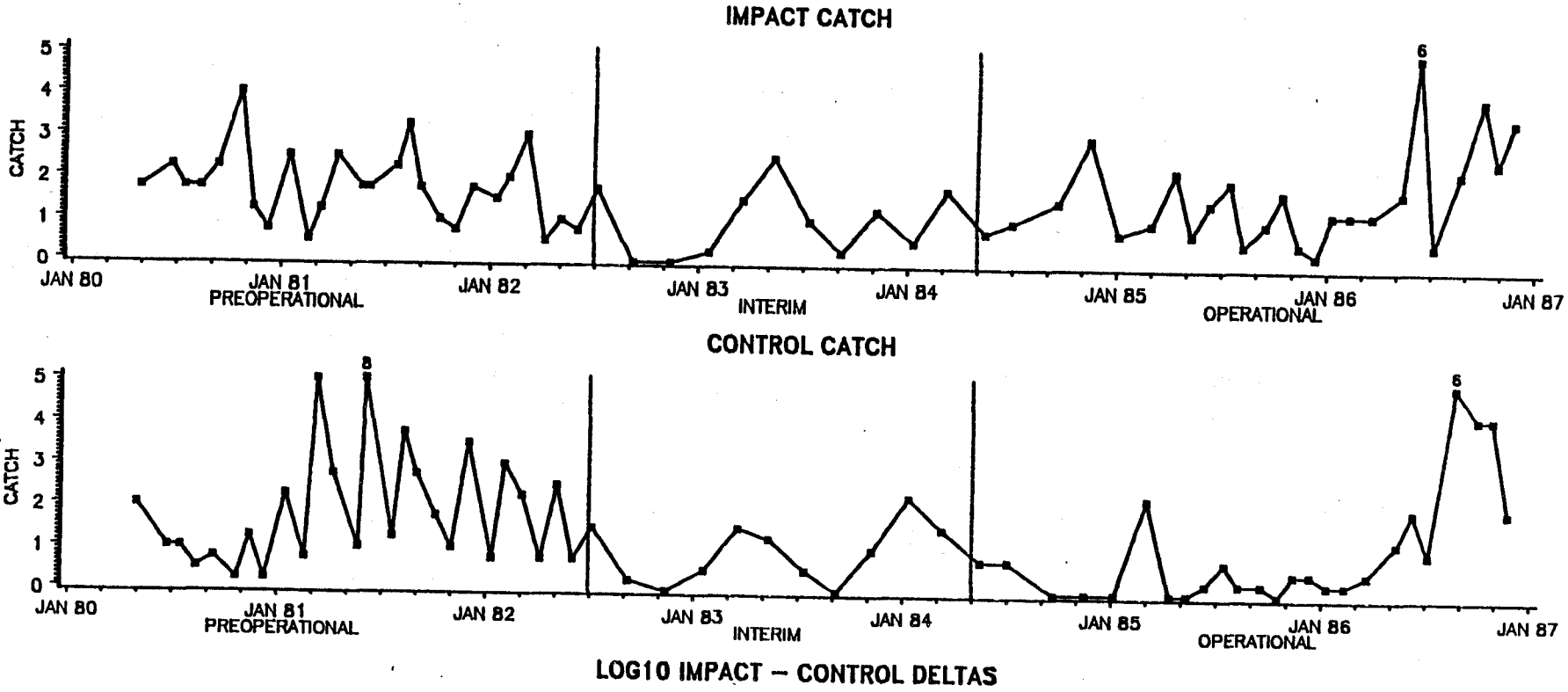
---- STATISTICALLY INTRACTABLE ---

APPENDIX E -- FIGURE 46

OTTER TRAWL

HORNYHEAD TURBOT *(PLEURONICHTHYS VERTICALIS)*

30 METER DEPTH



LOG10 IMPACT – CONTROL DELTAS

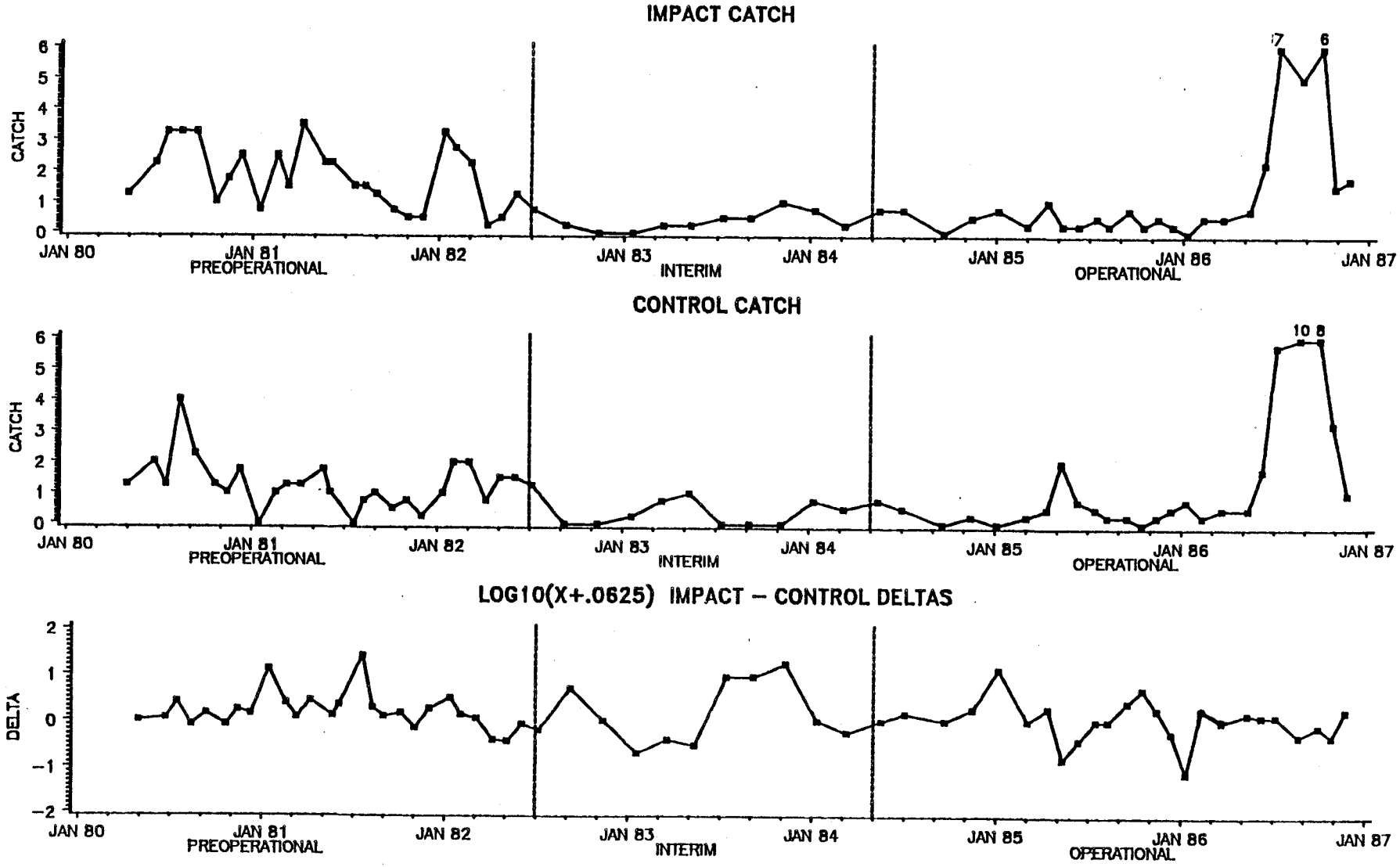
--- STATISTICALLY INTRACTABLE ---

APPENDIX E -- FIGURE 45

OTTER TRAWL

HORNYHEAD TURBOT *(PLEURONICHTHYS VERTICALIS)*

18 METER DEPTH

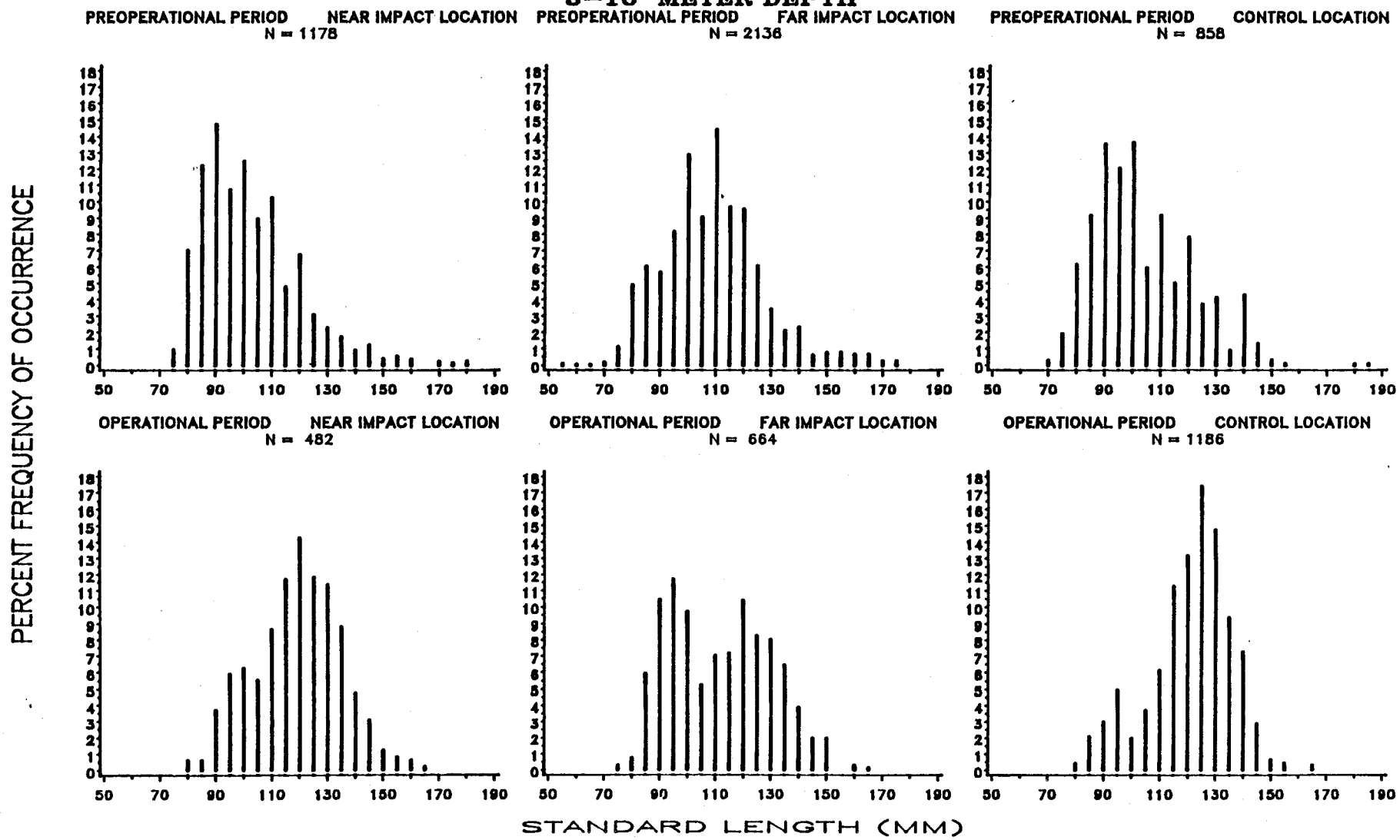


APPENDIX E -- FIGURE 48

LAMPARA SEINE

MALE QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH

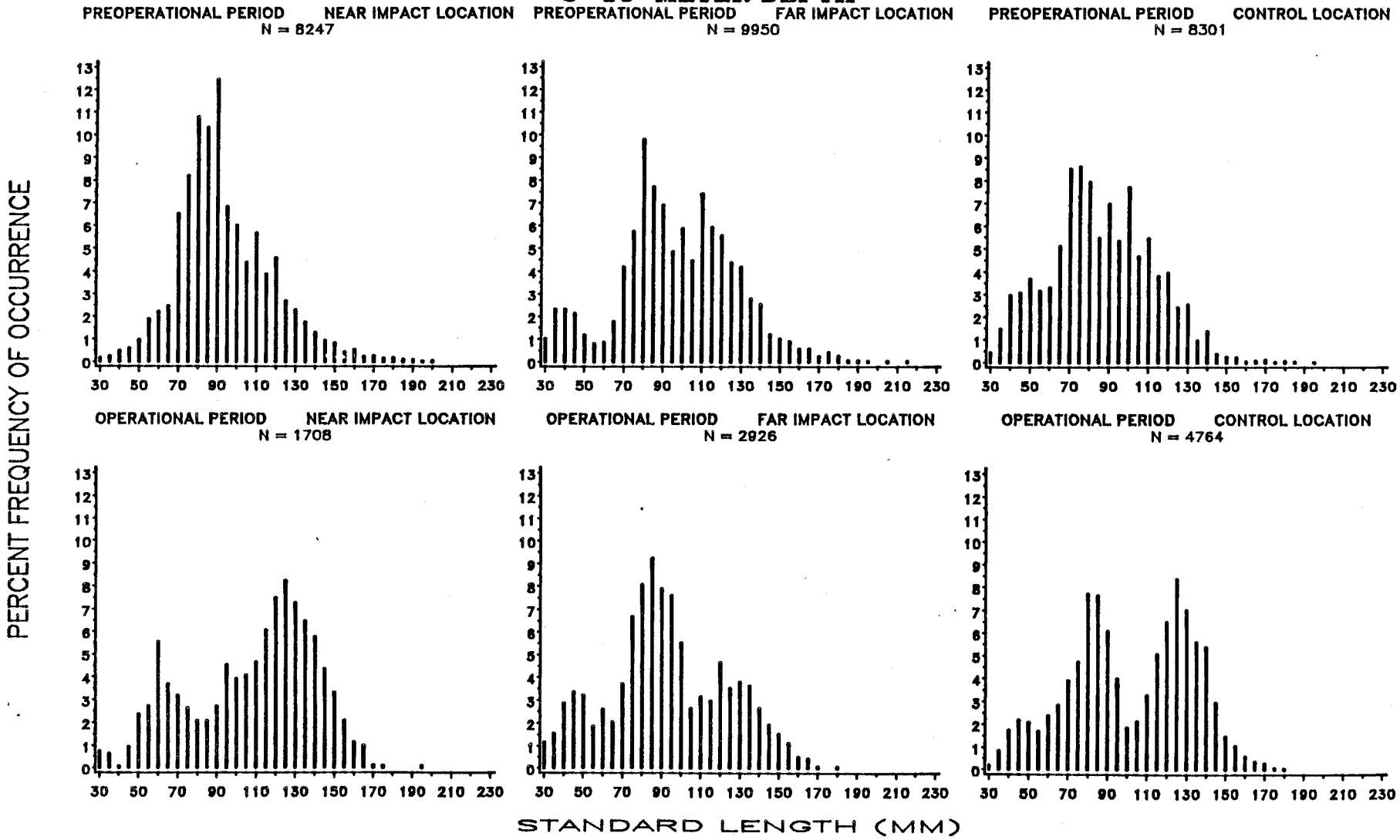


APPENDIX E -- FIGURE 47

LAMPARA SEINE

TOTAL QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH

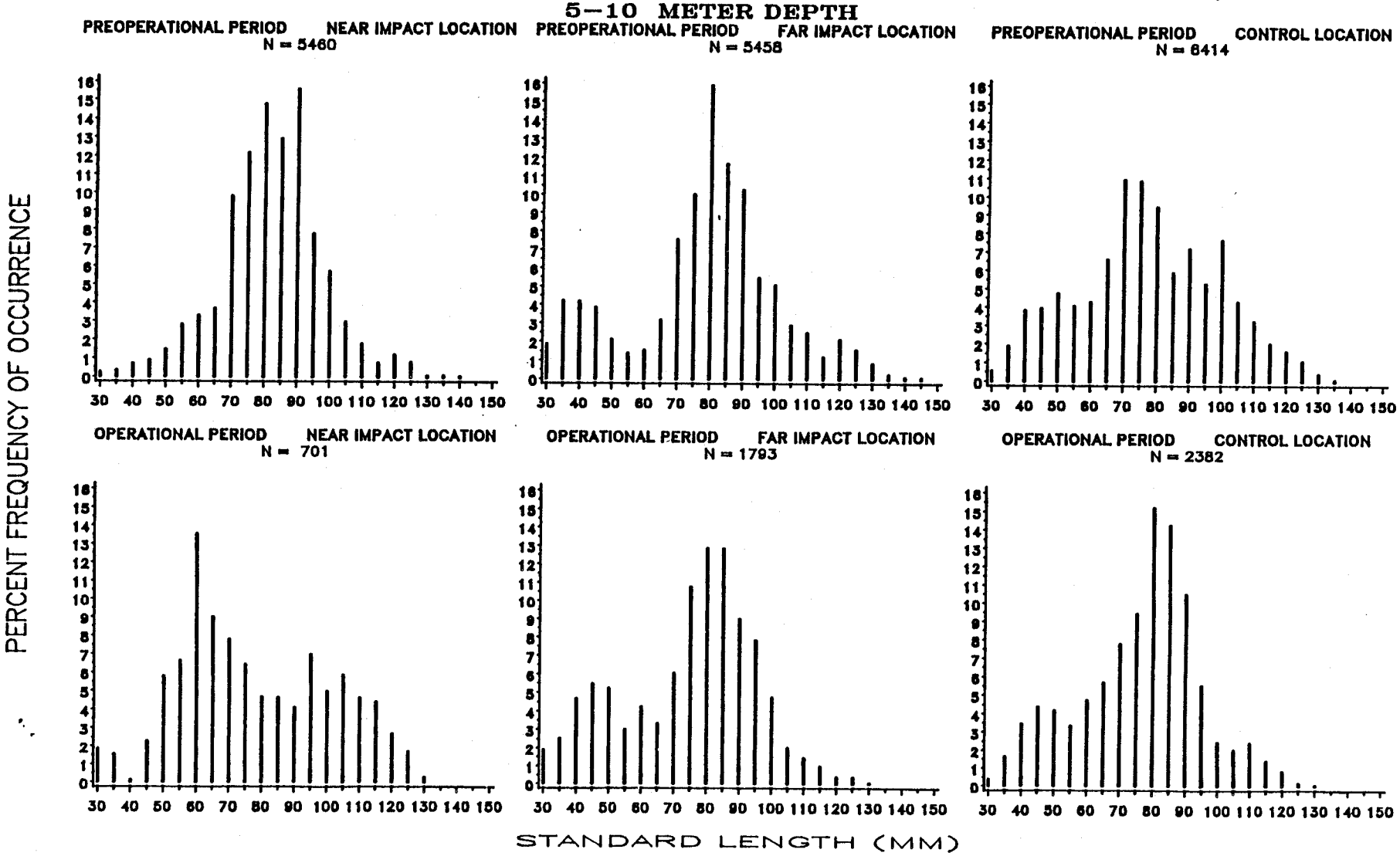


APPENDIX E -- FIGURE 50

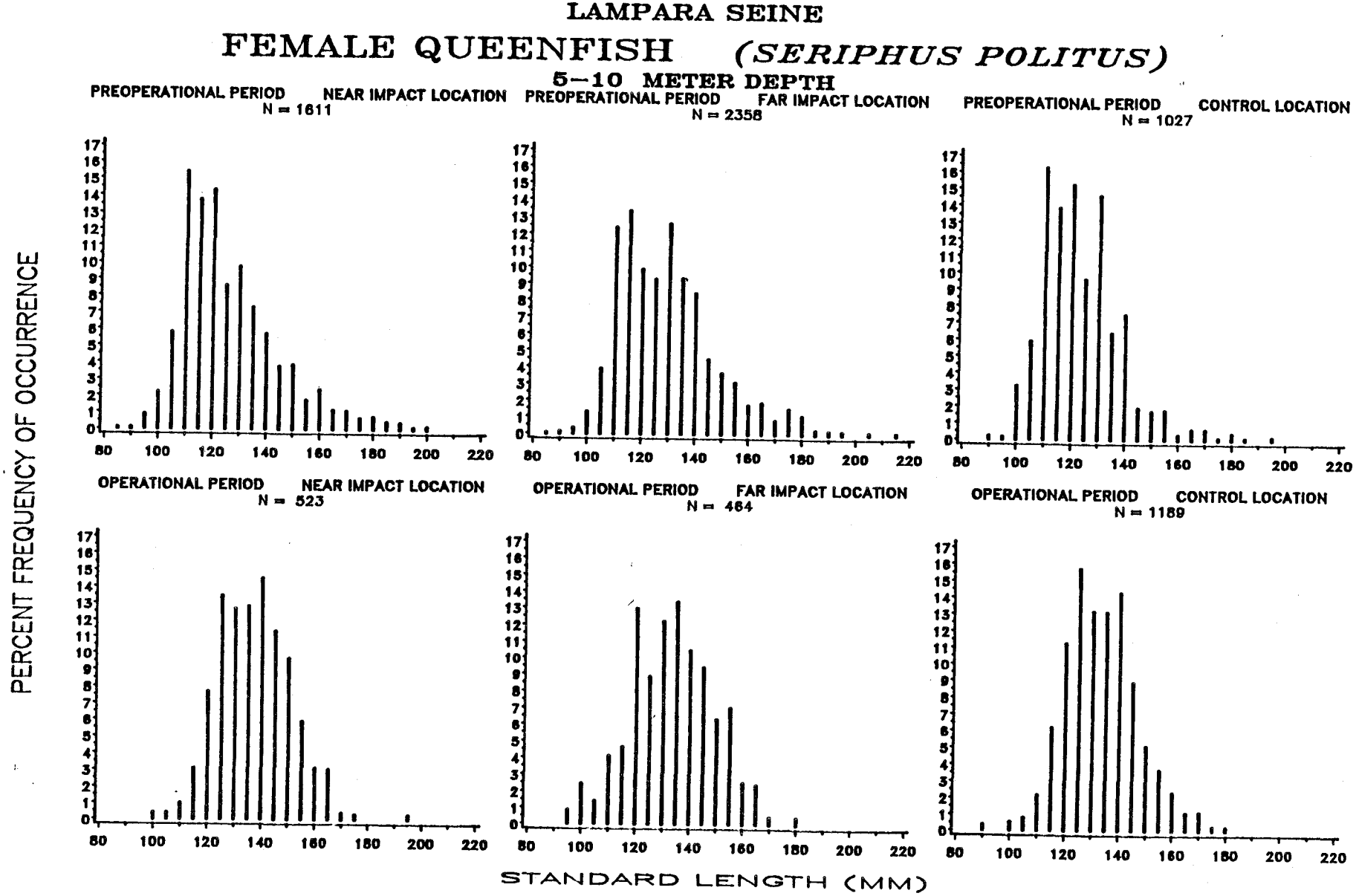
LAMPARA SEINE

IMMATURE QUEENFISH *(SERIPHUS POLITUS)*

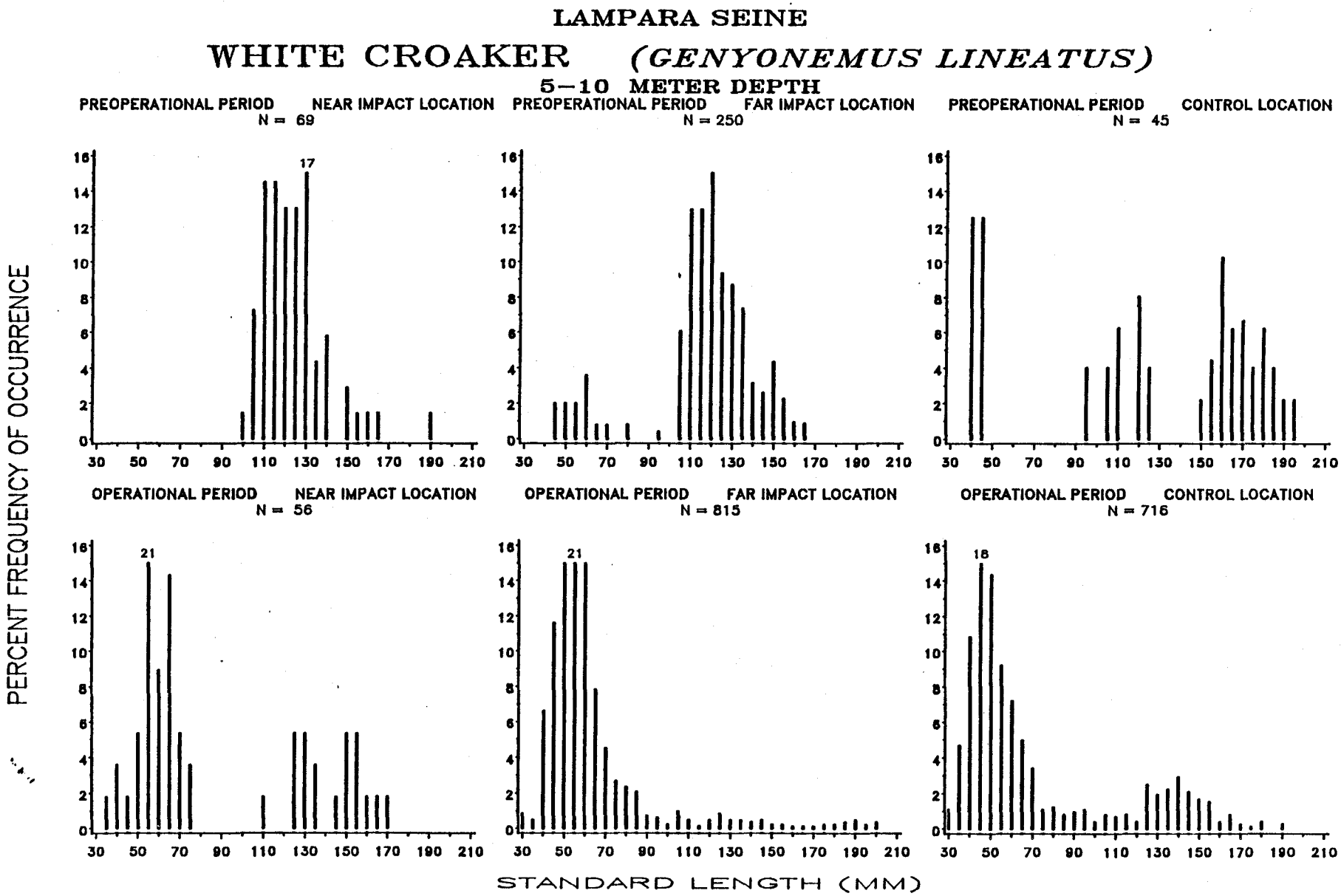
5–10 METER DEPTH



APPENDIX E -- FIGURE 49



APPENDIX E -- FIGURE 52

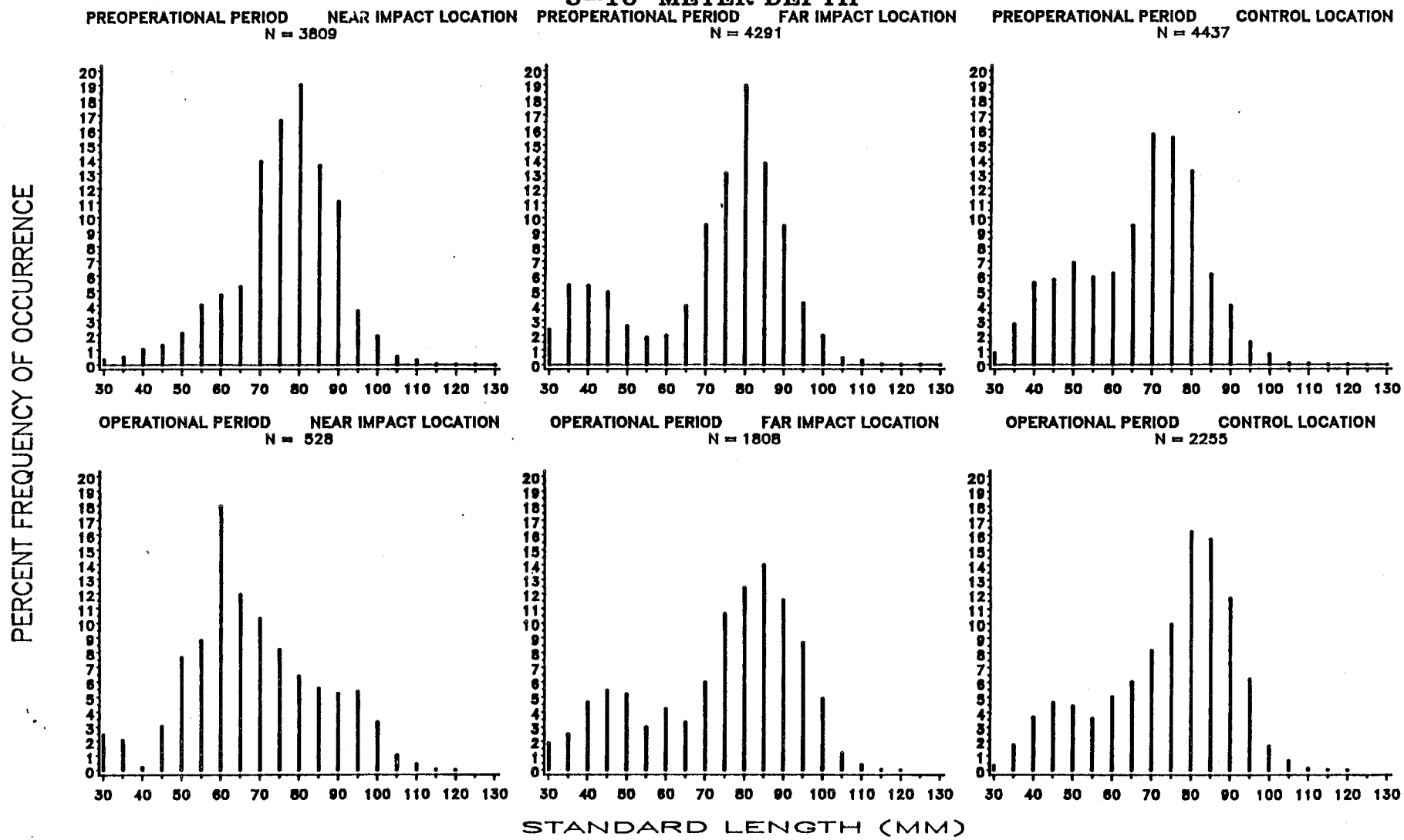


APPENDIX E -- FIGURE 51

LAMPARA SEINE

YOUNG OF YEAR QUEENFISH *(SERIPHUS POLITUS)*

5–10 METER DEPTH

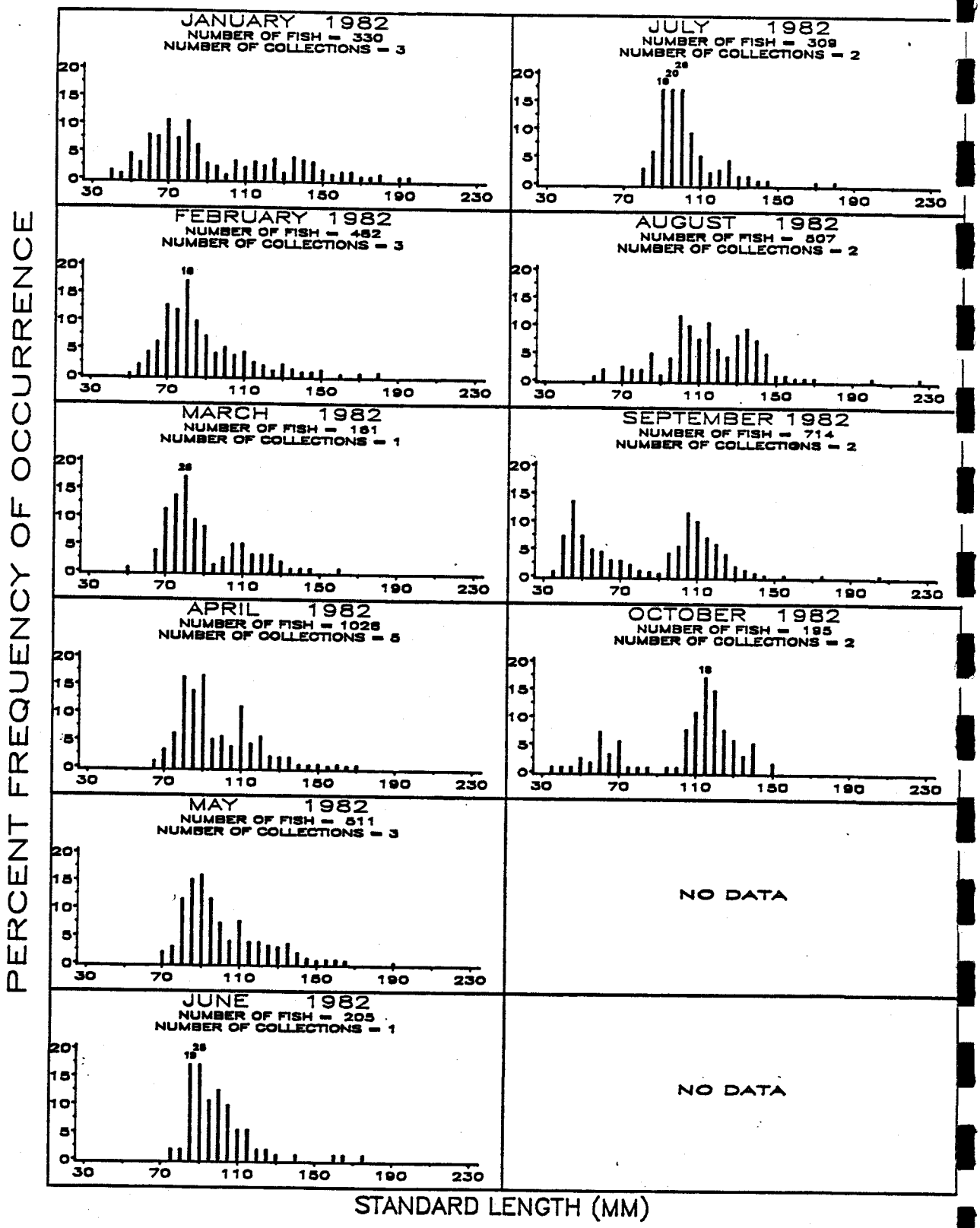


APPENDIX E -- FIGURE 53
(sheet 2 of 5)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

NEAR IMPACT LOCATION 5–10 METER DEPTH

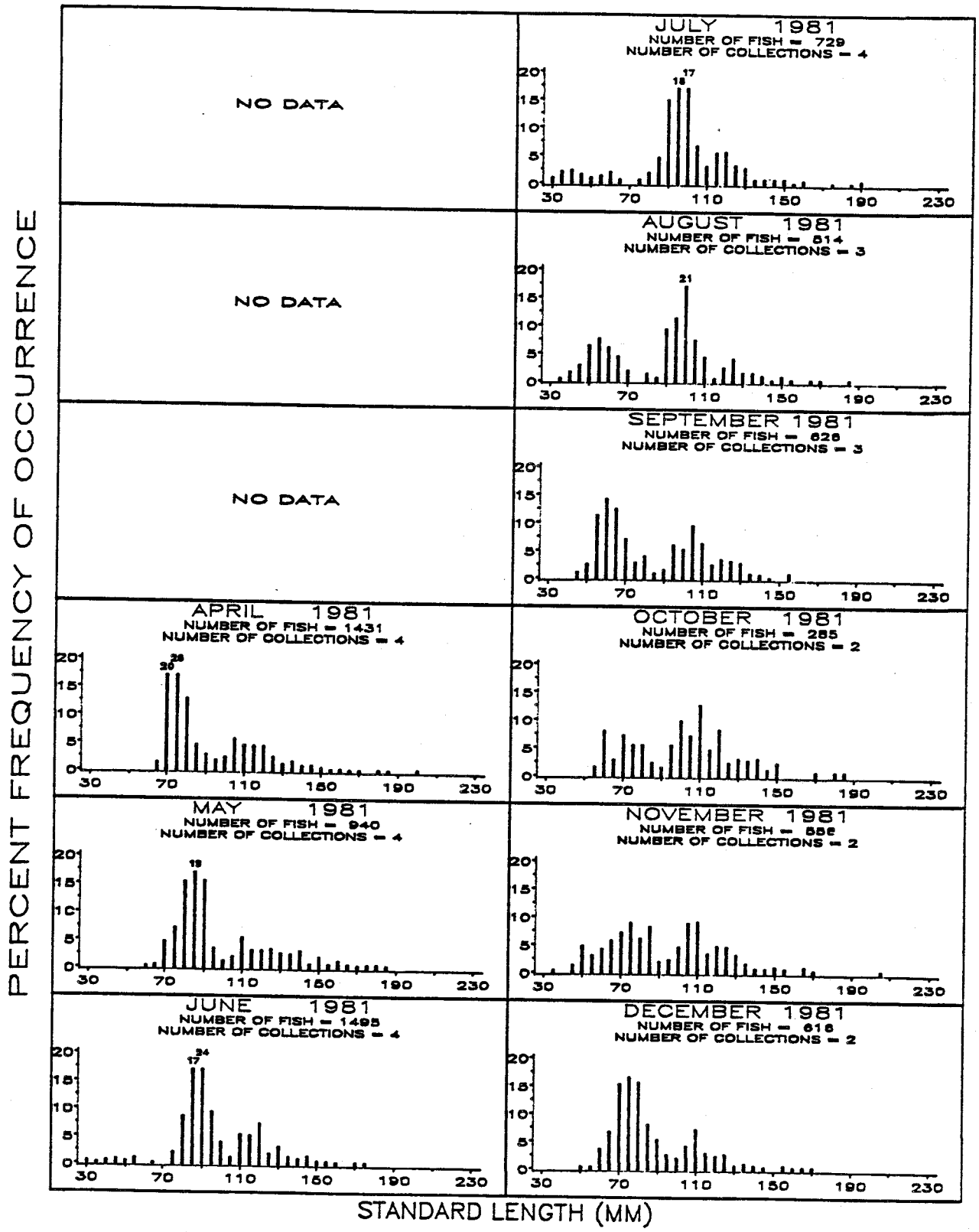


APPENDIX E -- FIGURE 53
(sheet 1 of 5)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

NEAR IMPACT LOCATION 5–10 METER DEPTH

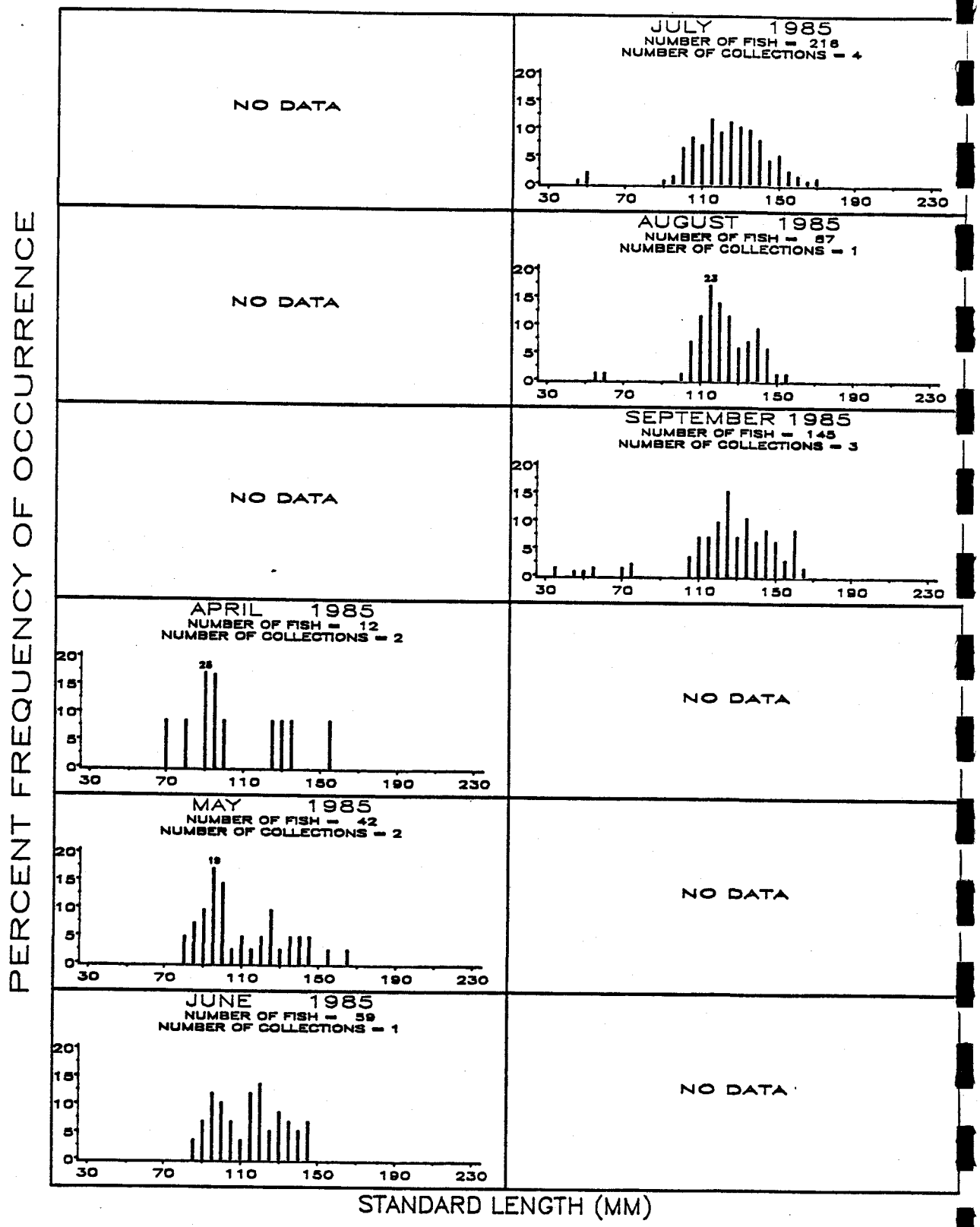


APPENDIX E -- FIGURE 53
(sheet 4 of 5)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

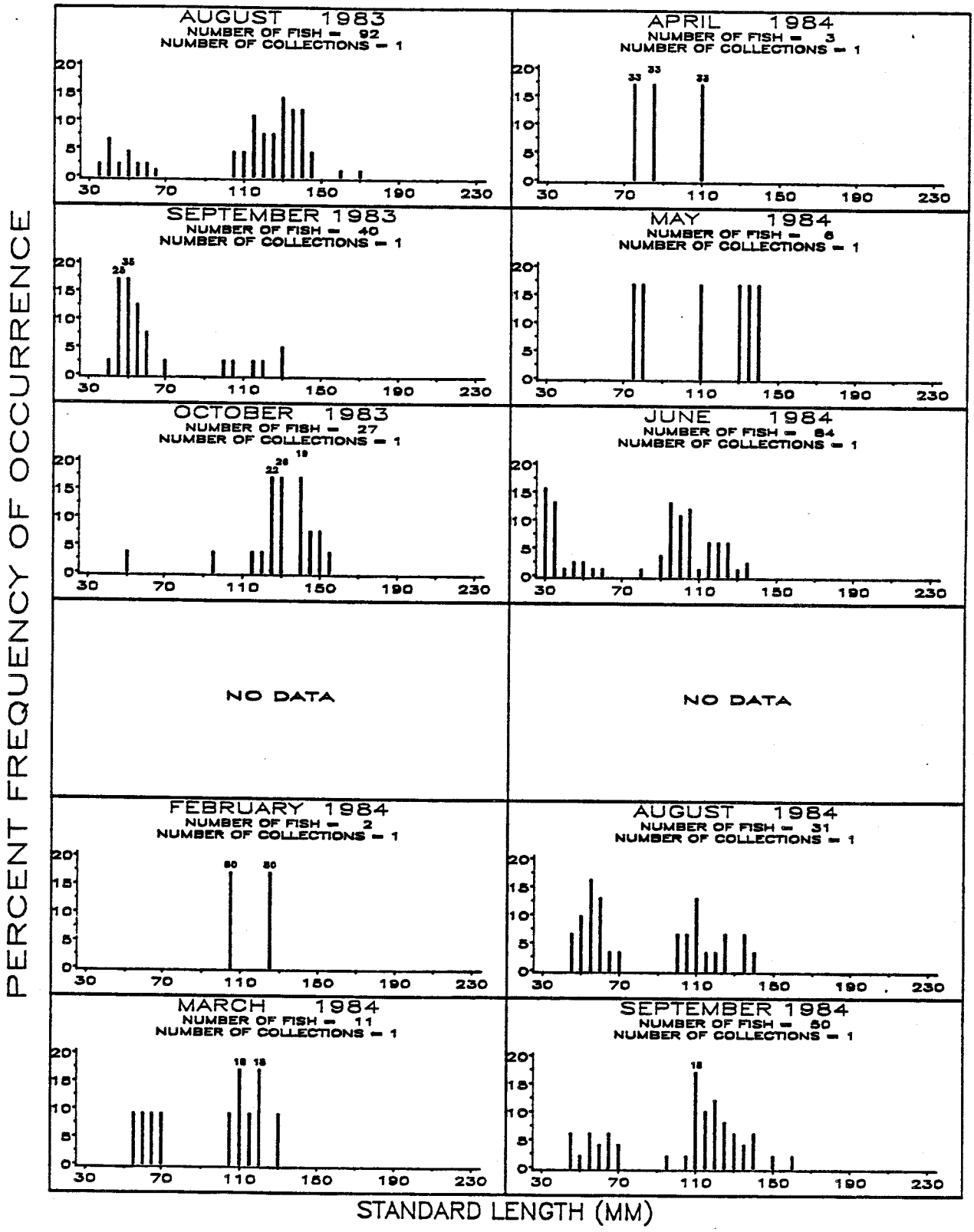
NEAR IMPACT LOCATION 5–10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

NEAR IMPACT LOCATION 5–10 METER DEPTH

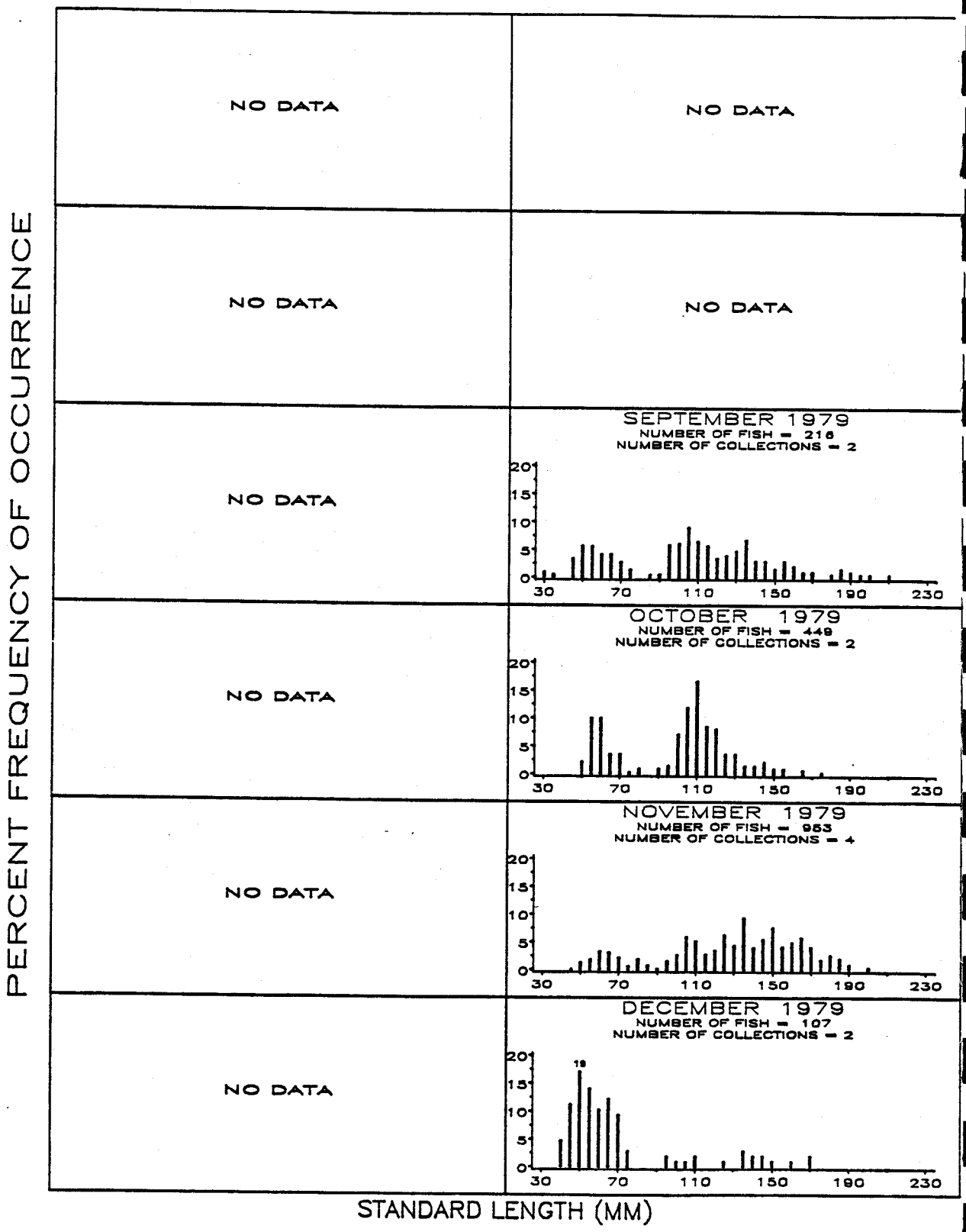


APPENDIX E -- FIGURE 54
(sheet 1 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

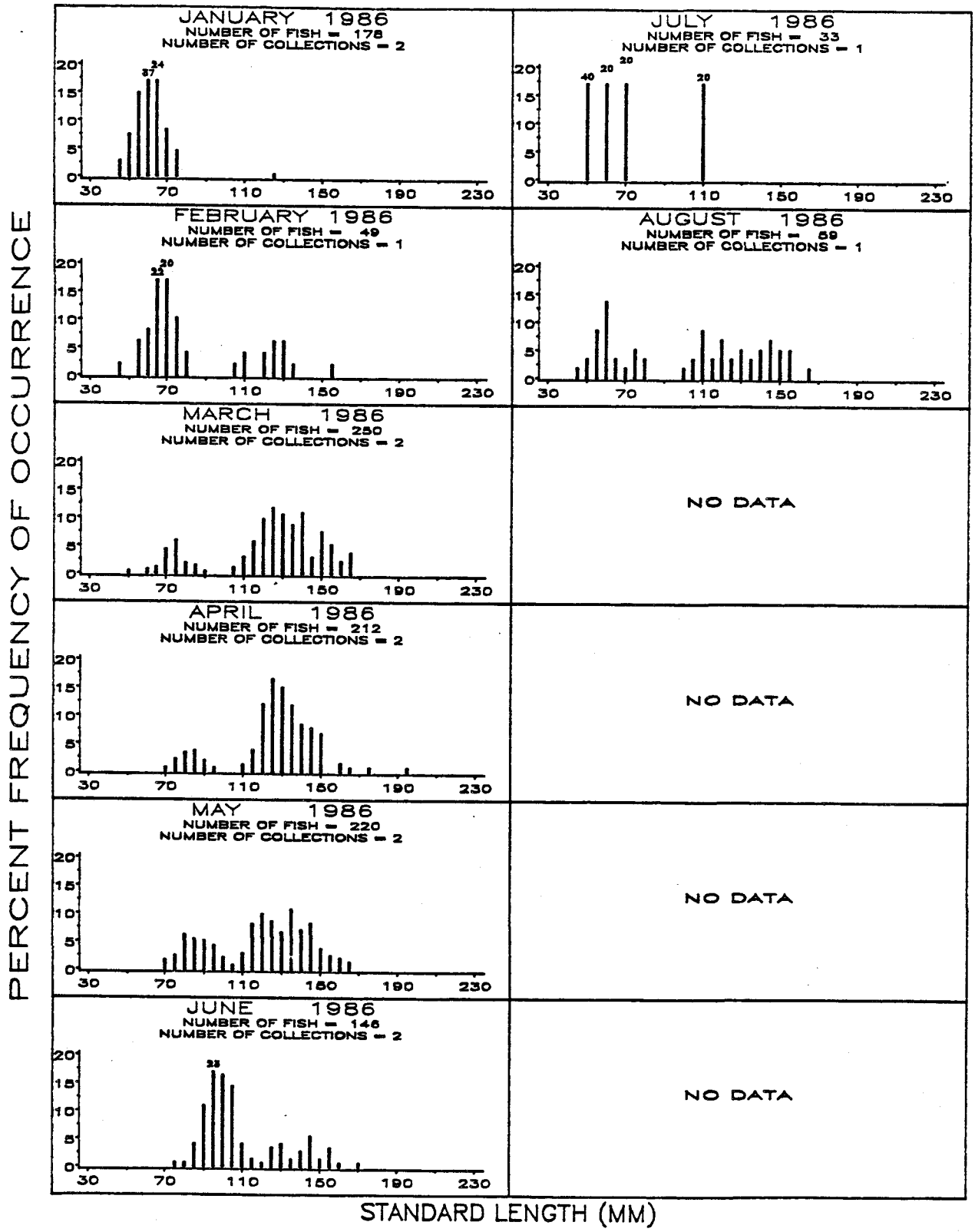
FAR IMPACT LOCATION 5-10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

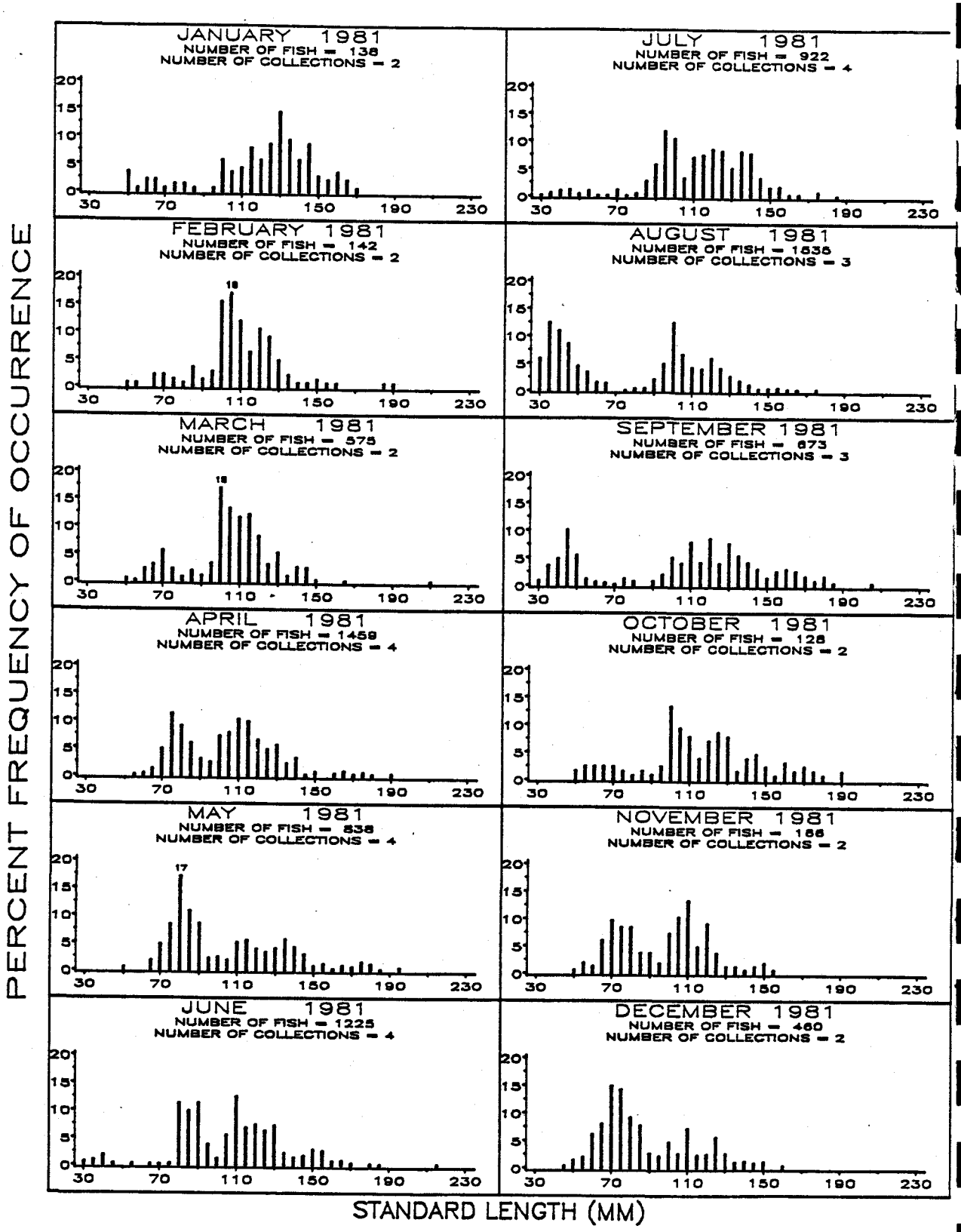
NEAR IMPACT LOCATION 5–10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

FAR IMPACT LOCATION 5–10 METER DEPTH

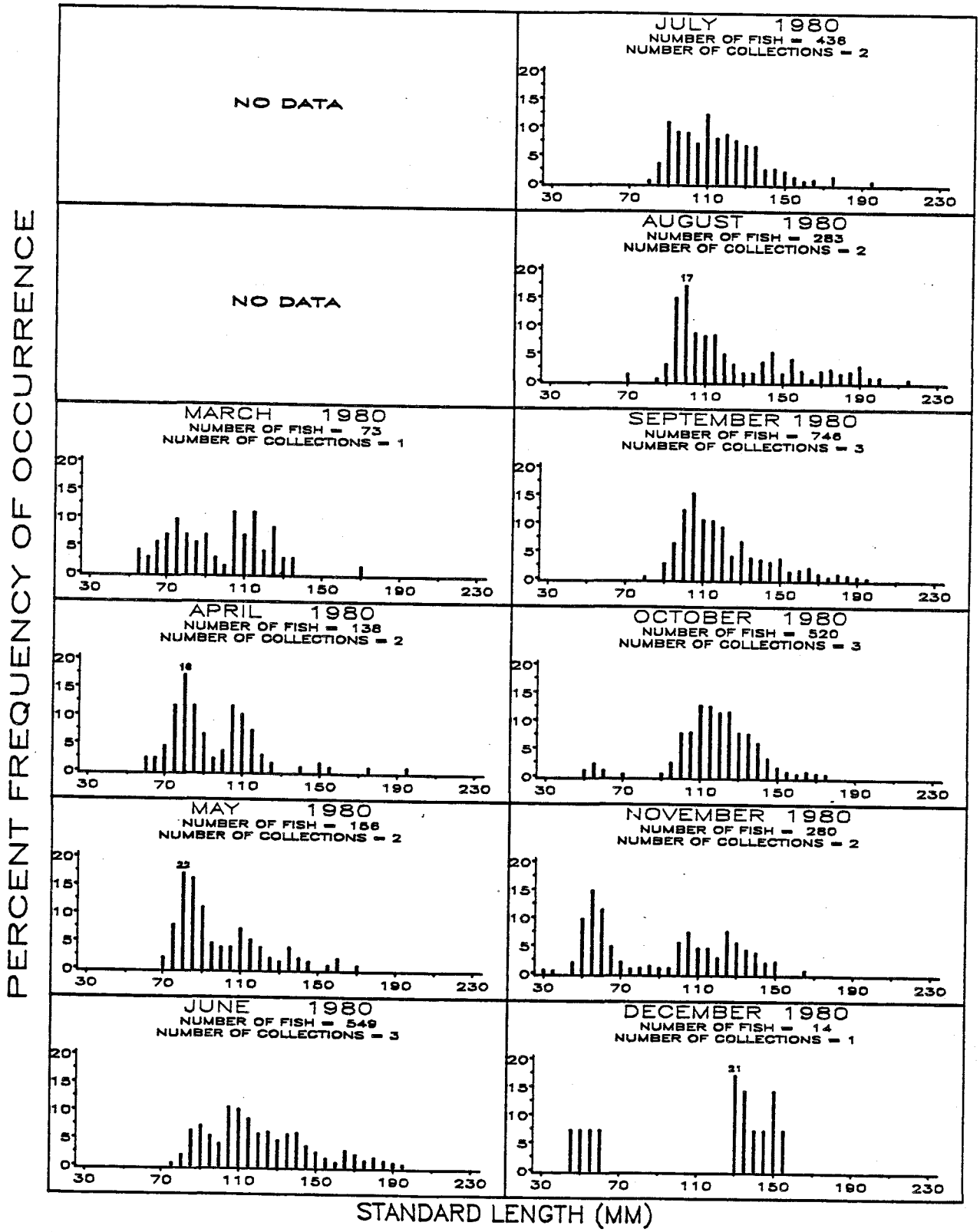


APPENDIX E -- FIGURE 54
(sheet 2 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

FAR IMPACT LOCATION 5–10 METER DEPTH

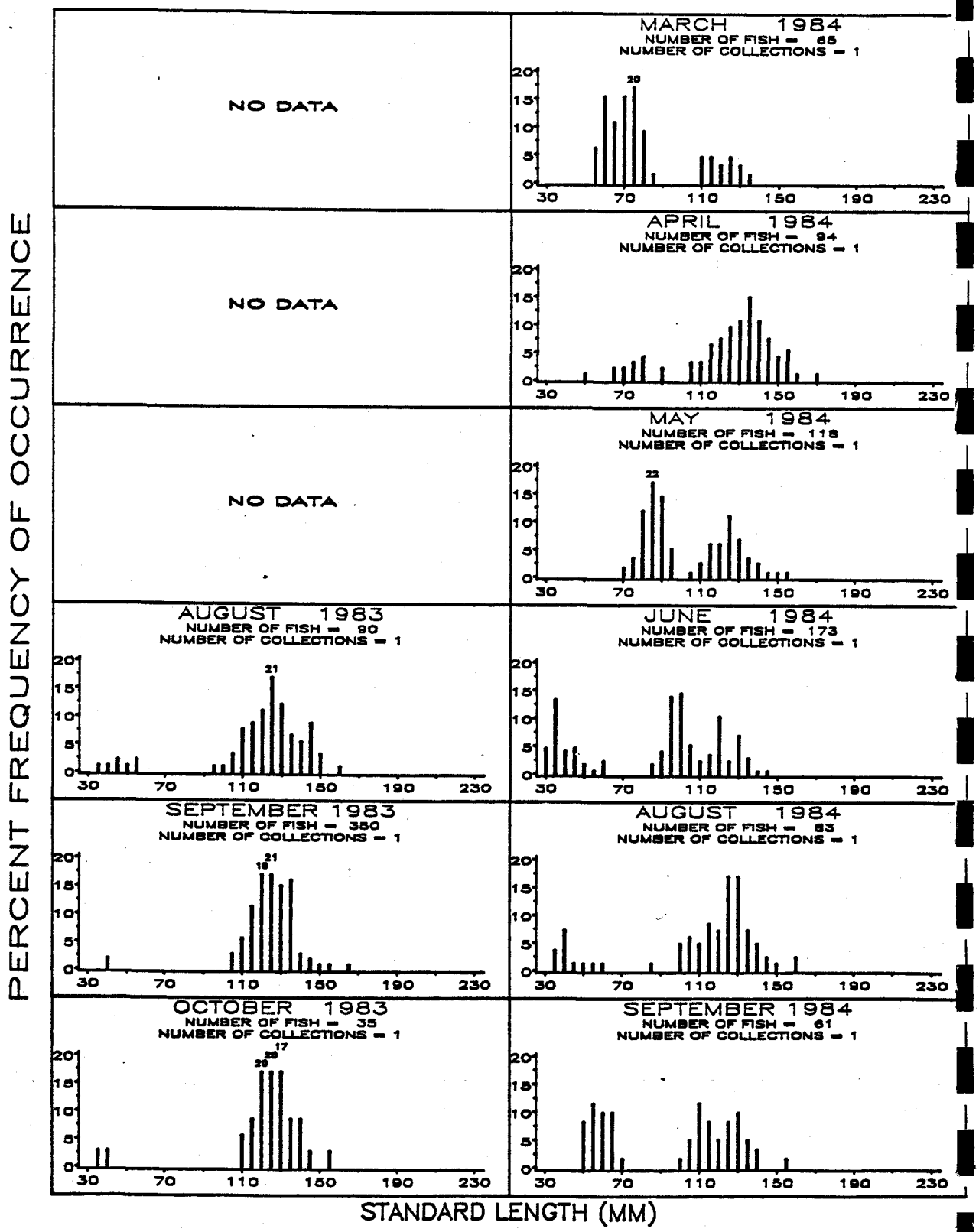


APPENDIX E -- FIGURE 54
(Sheet 5 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

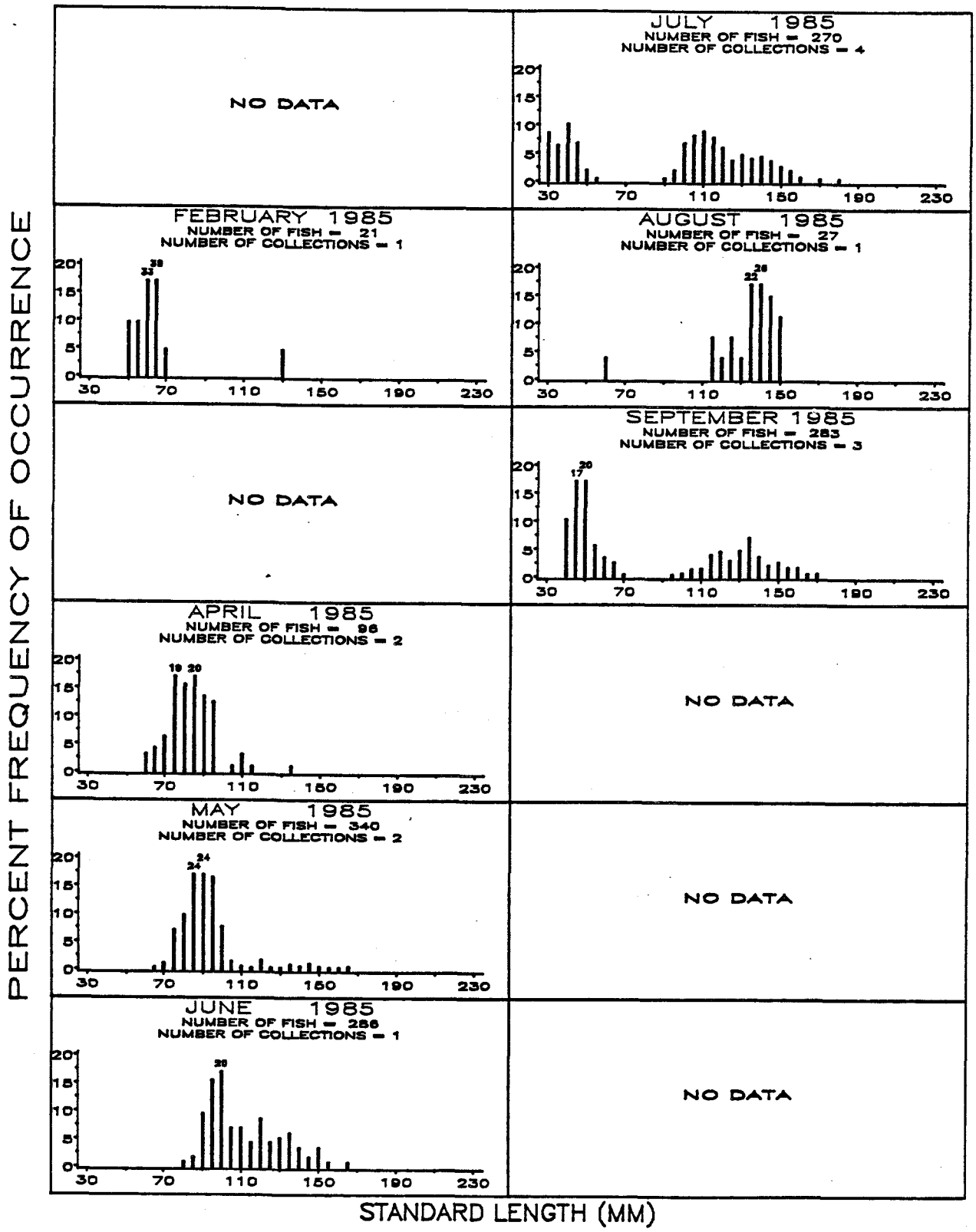
FAR IMPACT LOCATION 5–10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

FAR IMPACT LOCATION 5–10 METER DEPTH

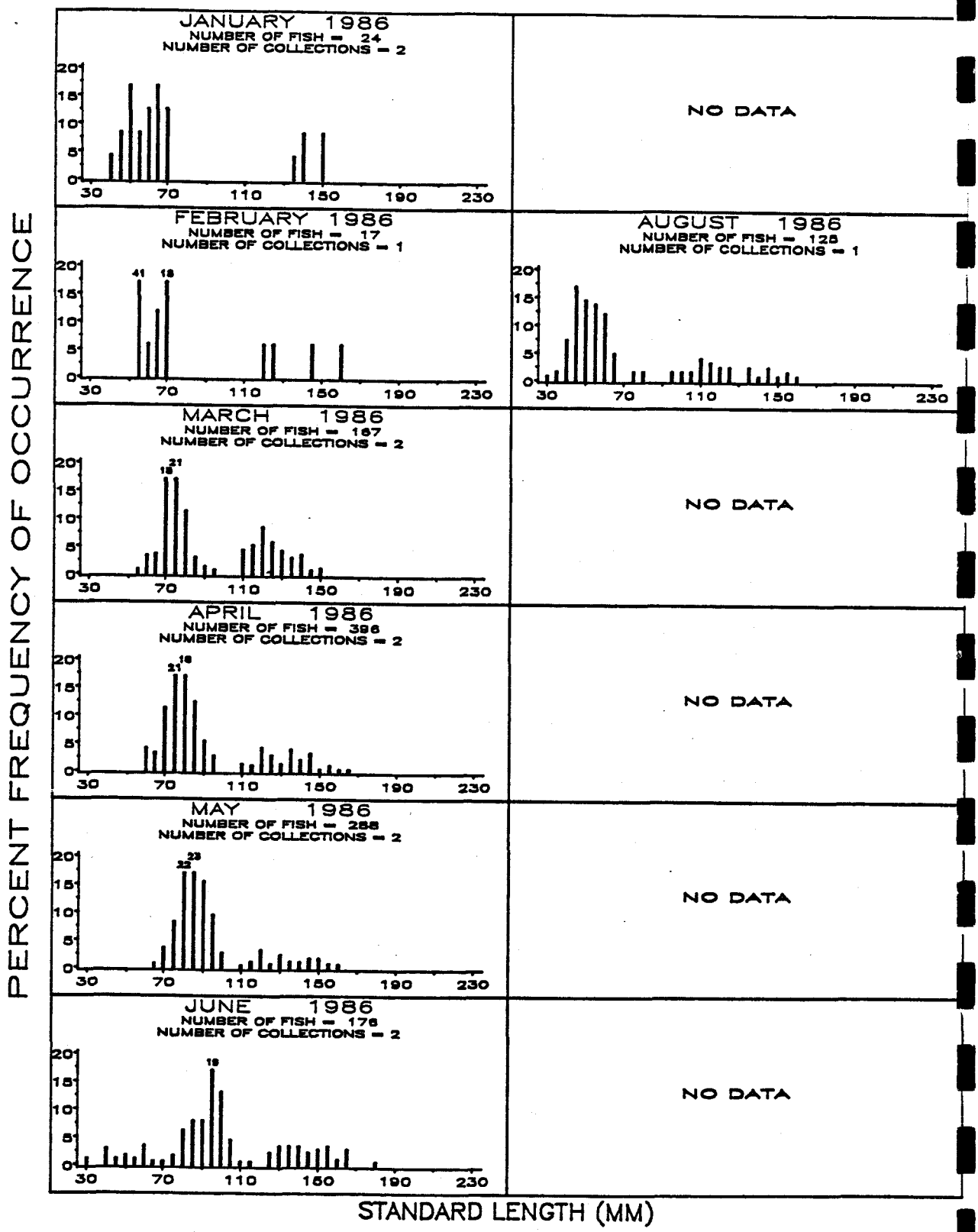


APPENDIX E -- FIGURE 54
(sheet 7 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

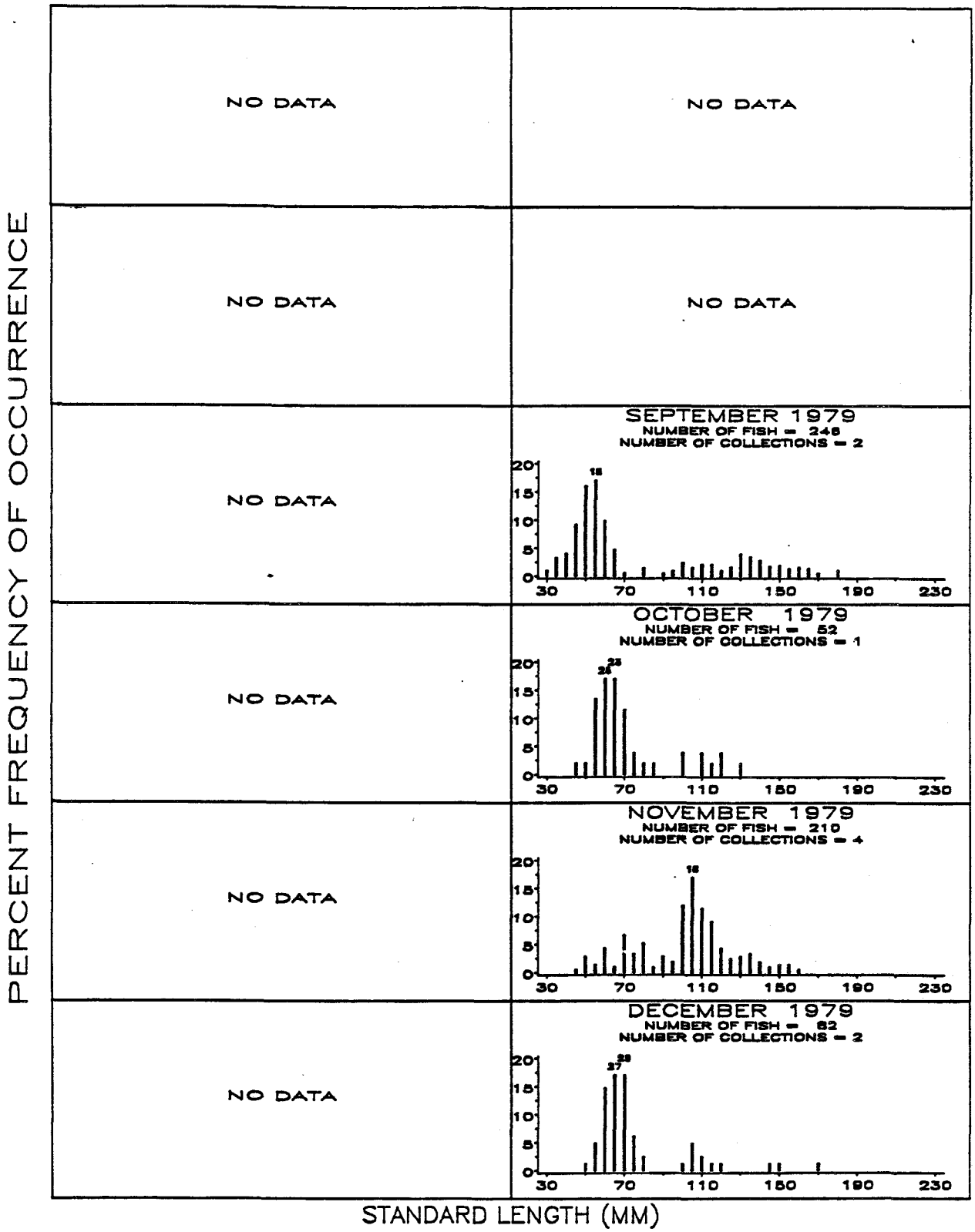
FAR IMPACT LOCATION 5–10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

CONTROL LOCATION 5–10 METER DEPTH

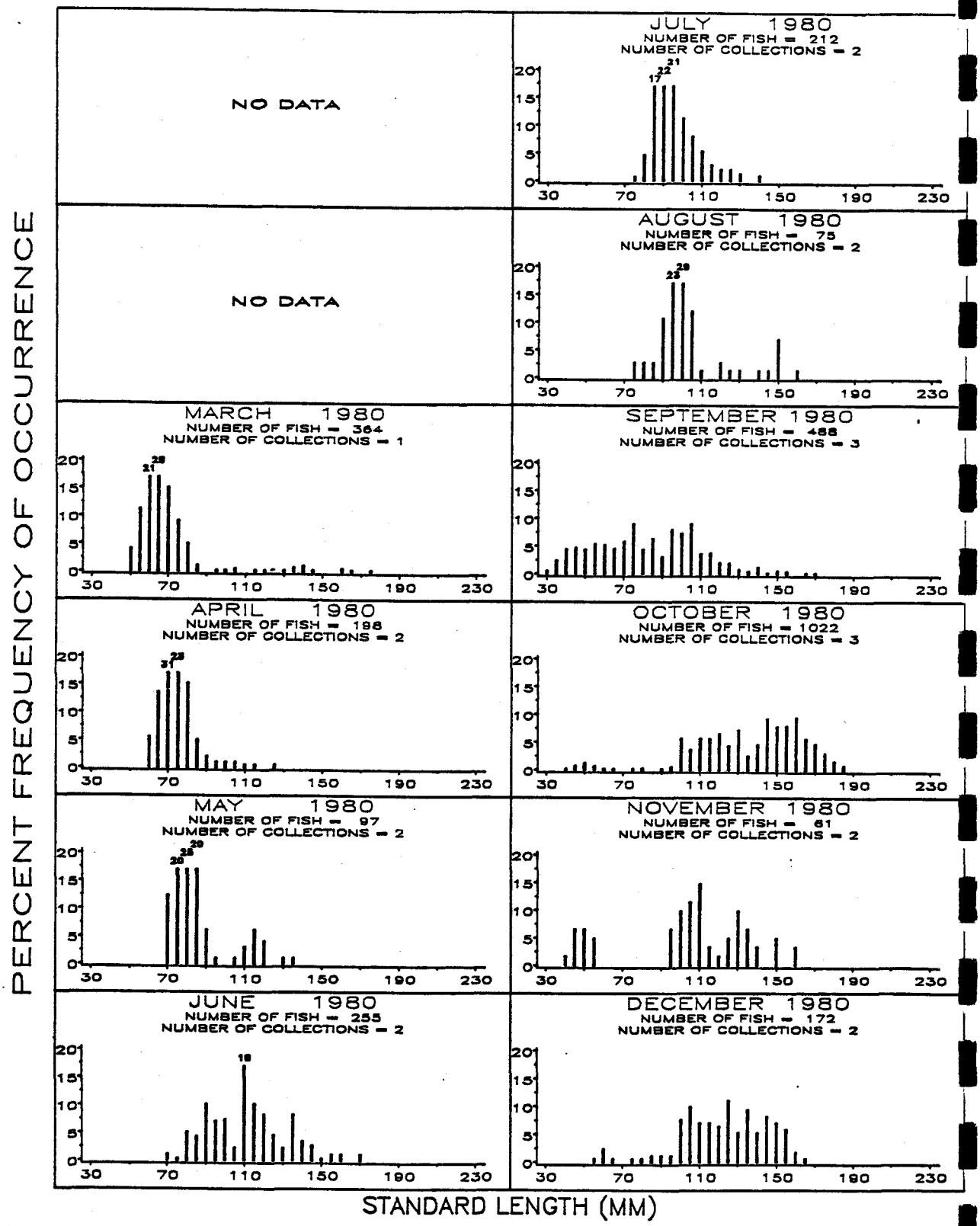


APPENDIX E -- FIGURE 55
(sheet 2 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

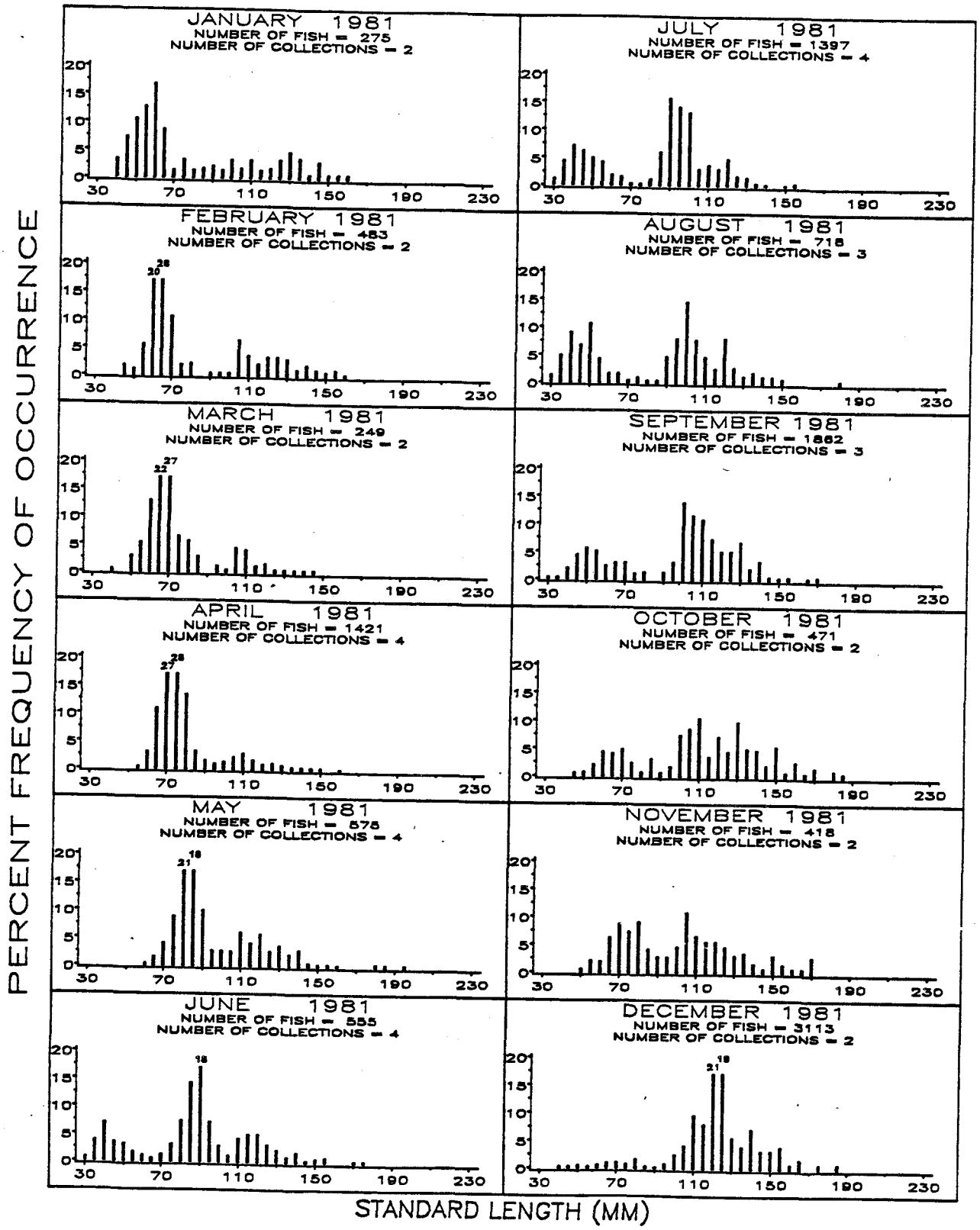
CONTROL LOCATION 5–10 METER DEPTH



LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

CONTROL LOCATION 5–10 METER DEPTH

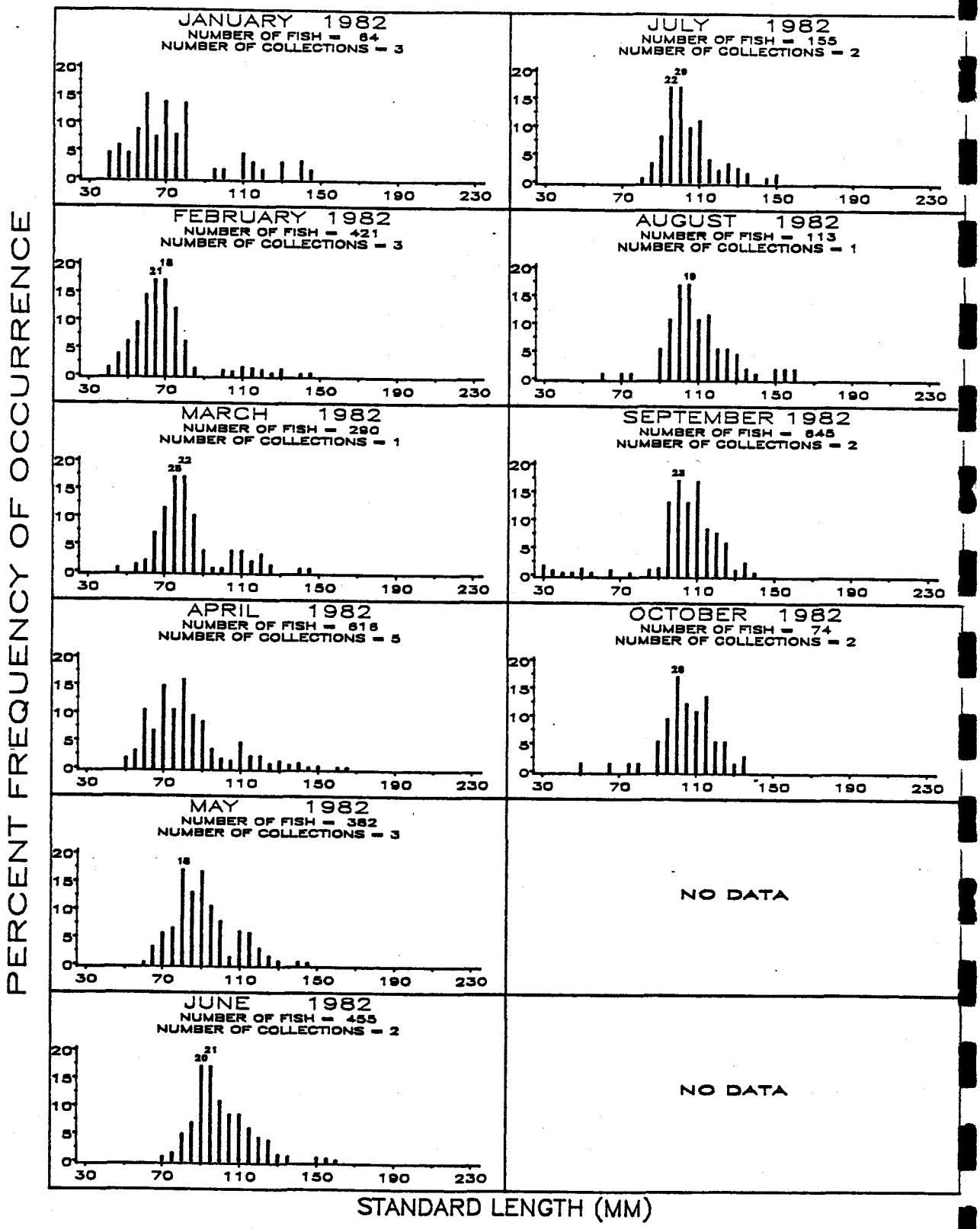


APPENDIX E -- FIGURE 55
(sheet 4 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

CONTROL LOCATION 5–10 METER DEPTH

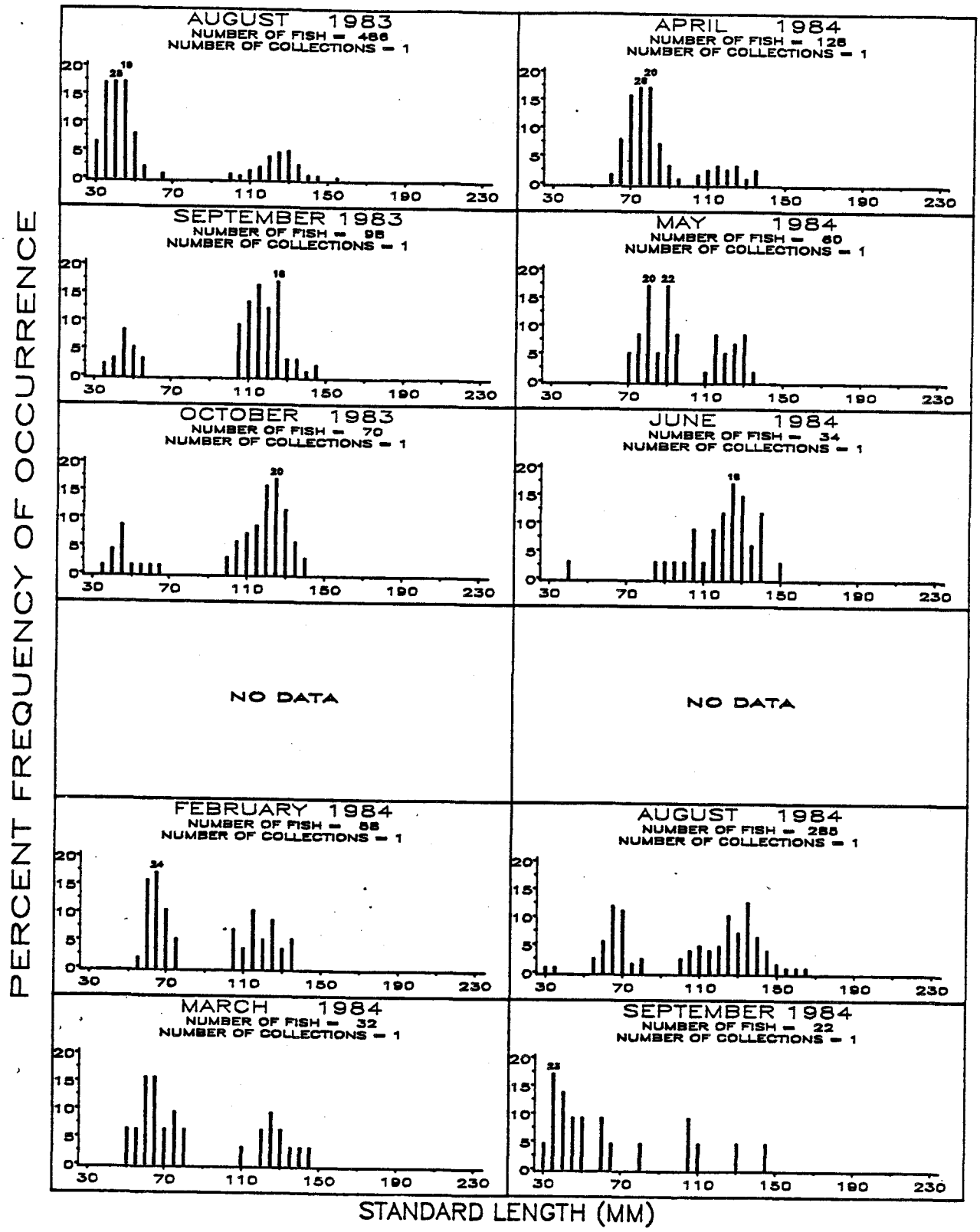


APPENDIX E -- FIGURE 55
(sheet 5 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

CONTROL LOCATION 5–10 METER DEPTH

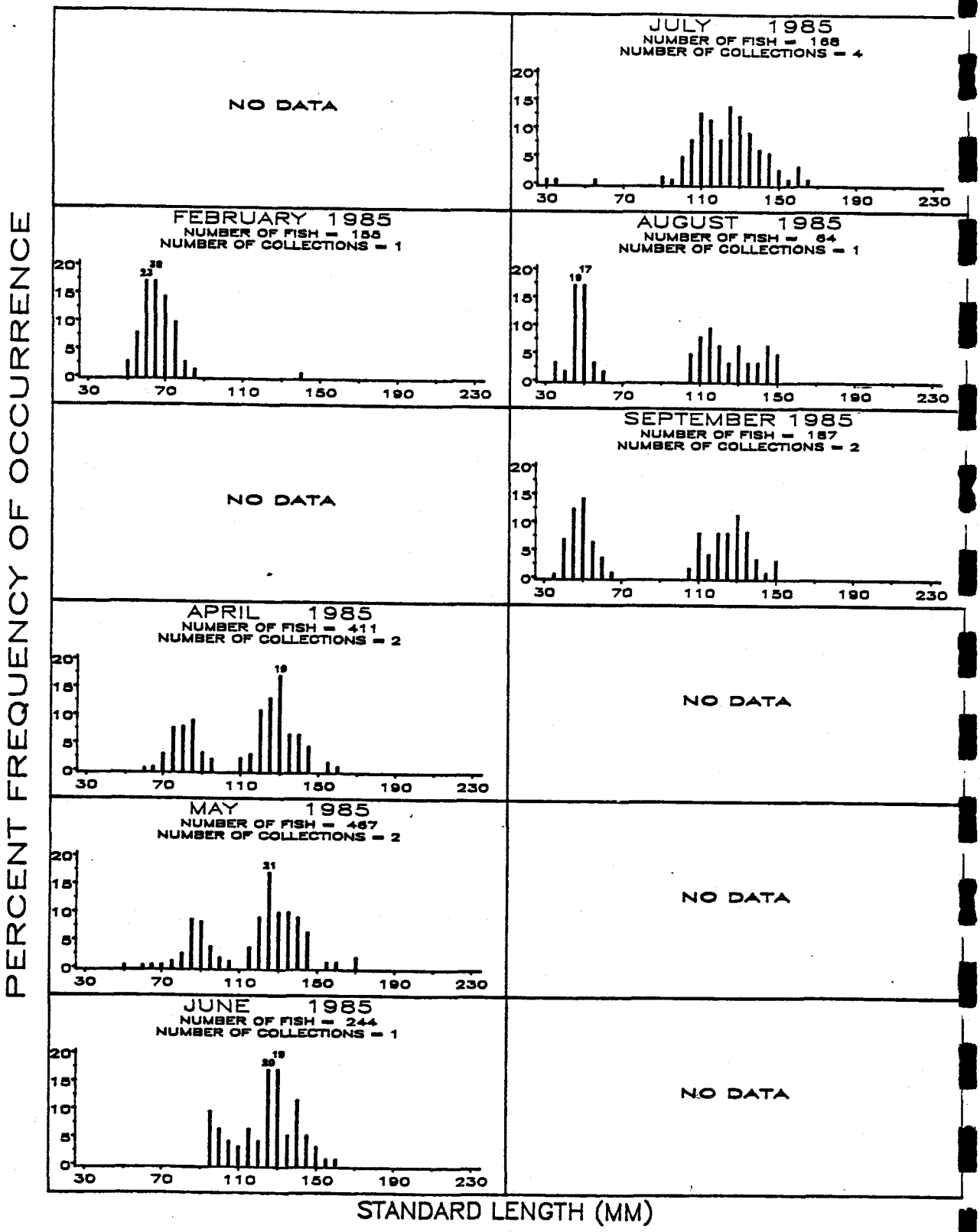


APPENDIX E -- FIGURE 55
(sheet 6 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

CONTROL LOCATION 5–10 METER DEPTH

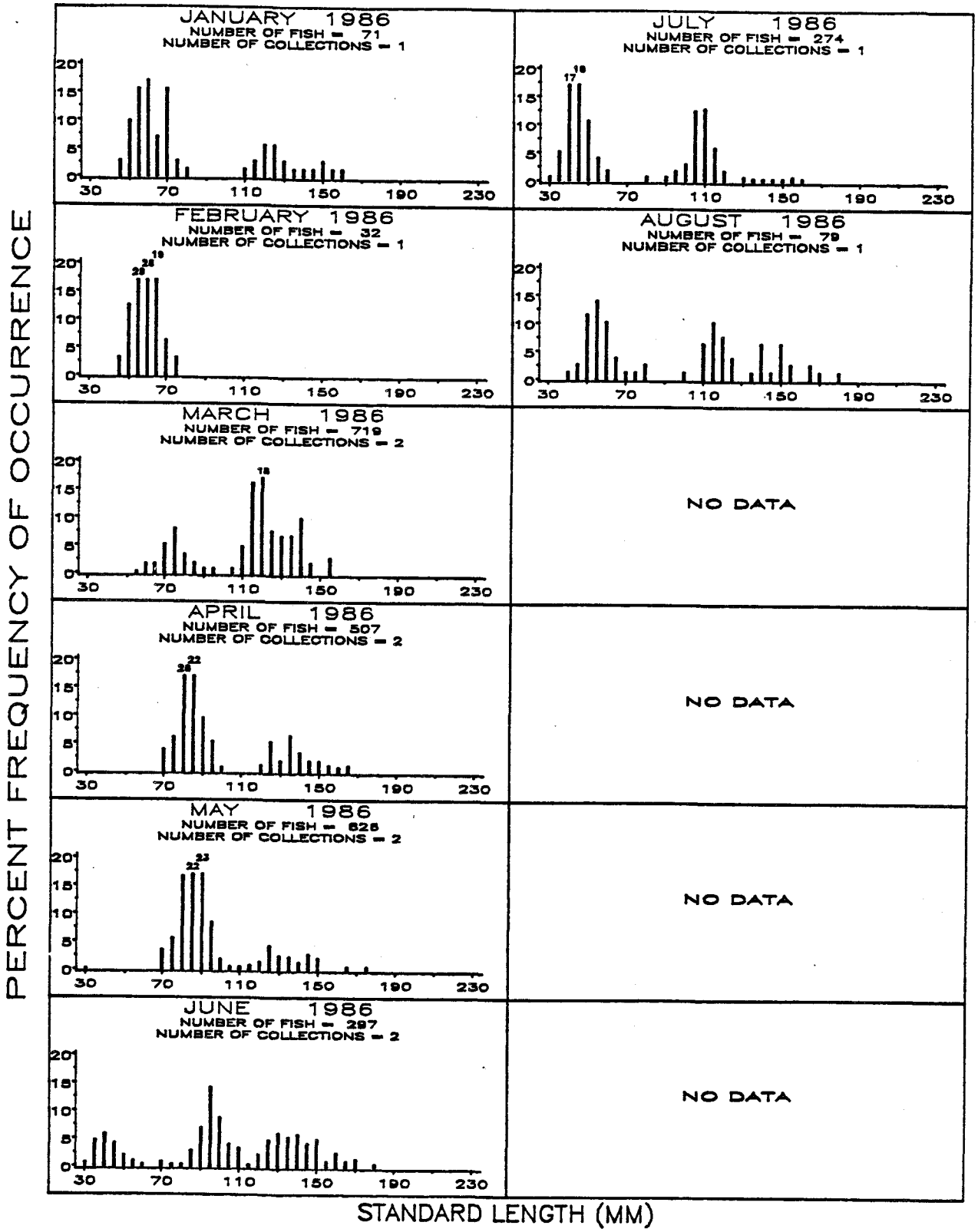


APPENDIX E -- FIGURE 55
(sheet 7 of 7)

LAMPARA SEINE

QUEENFISH *(SERIPHUS POLITUS)*

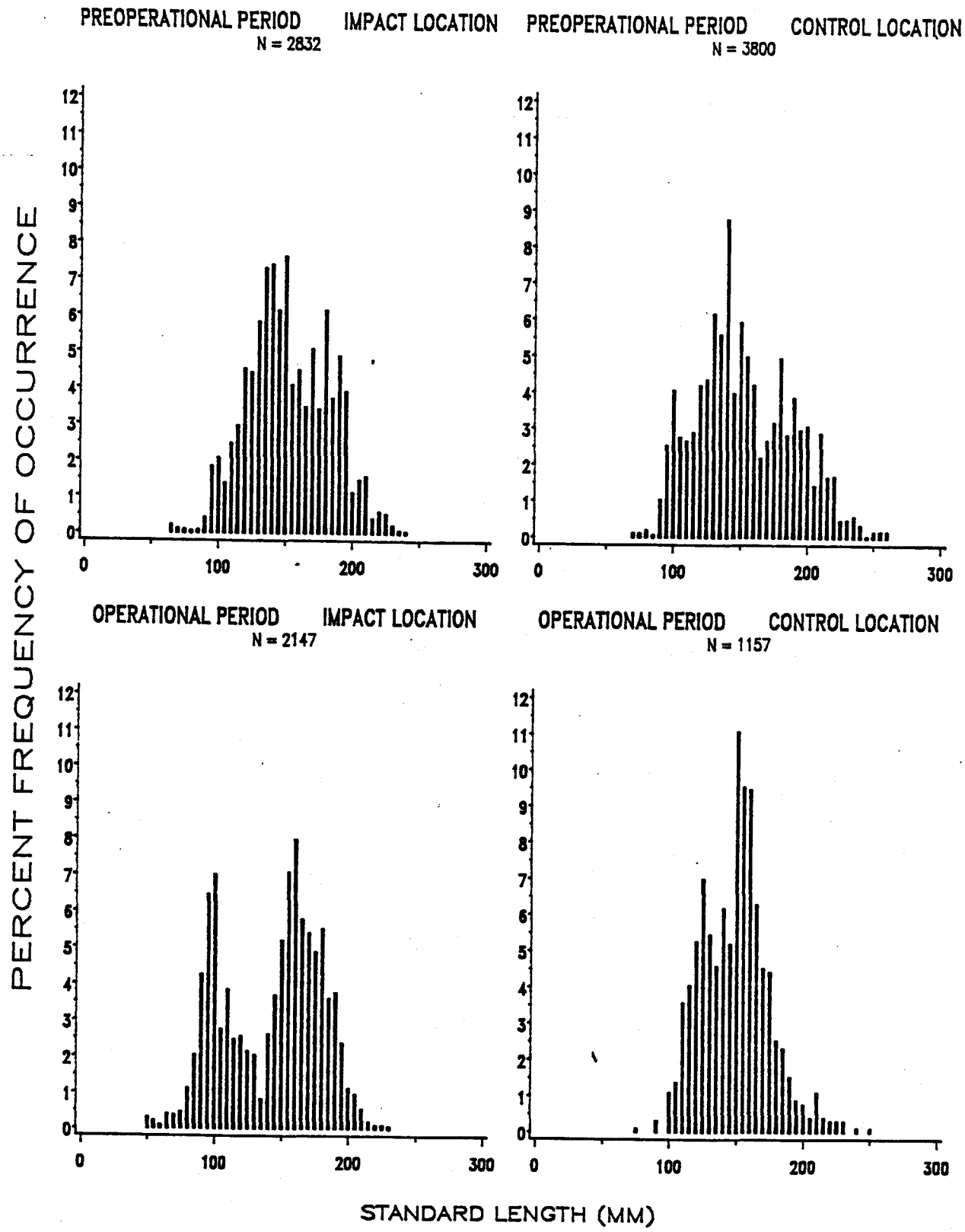
CONTROL LOCATION 5–10 METER DEPTH



OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

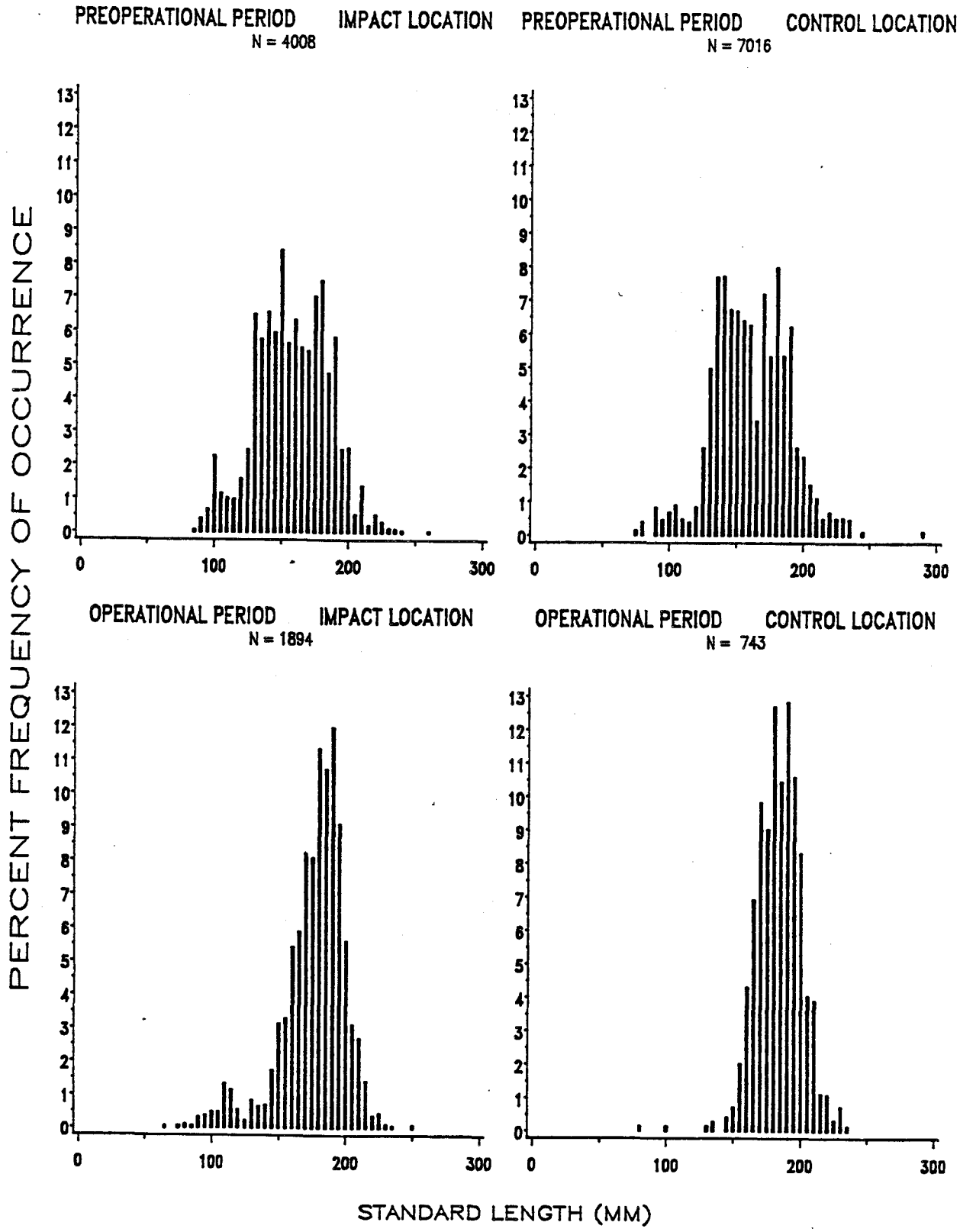
18 METER DEPTH



OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

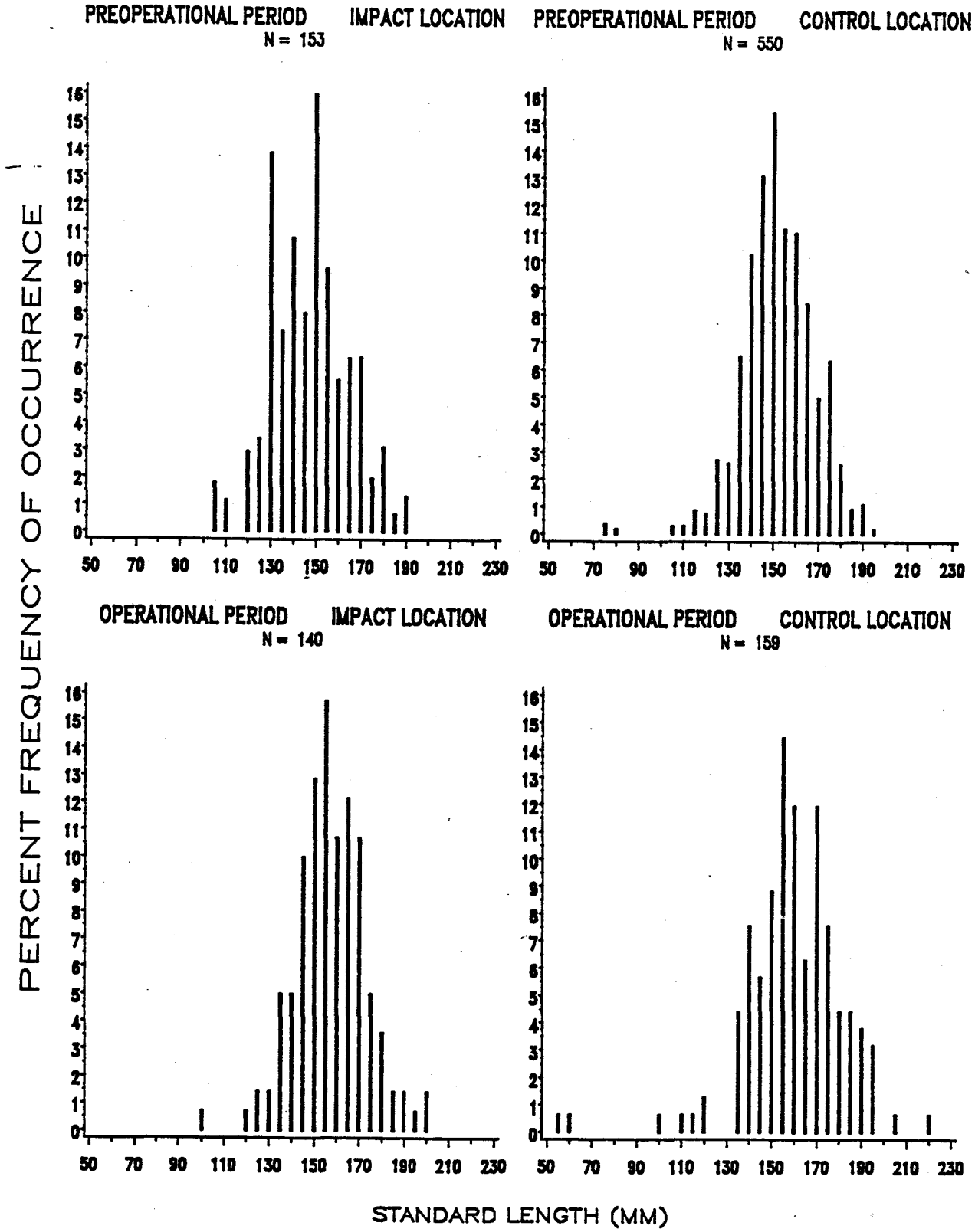
30 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

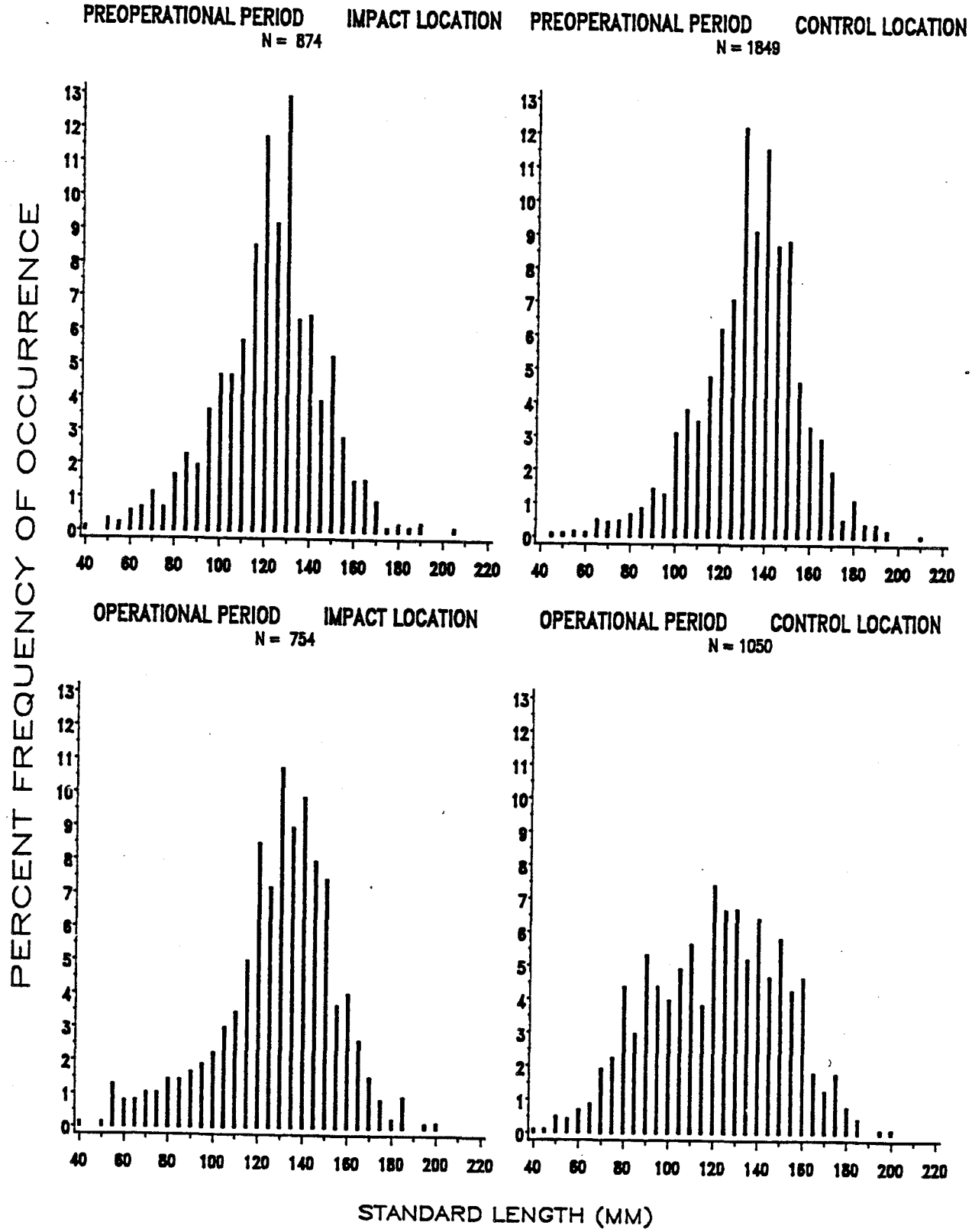
18 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

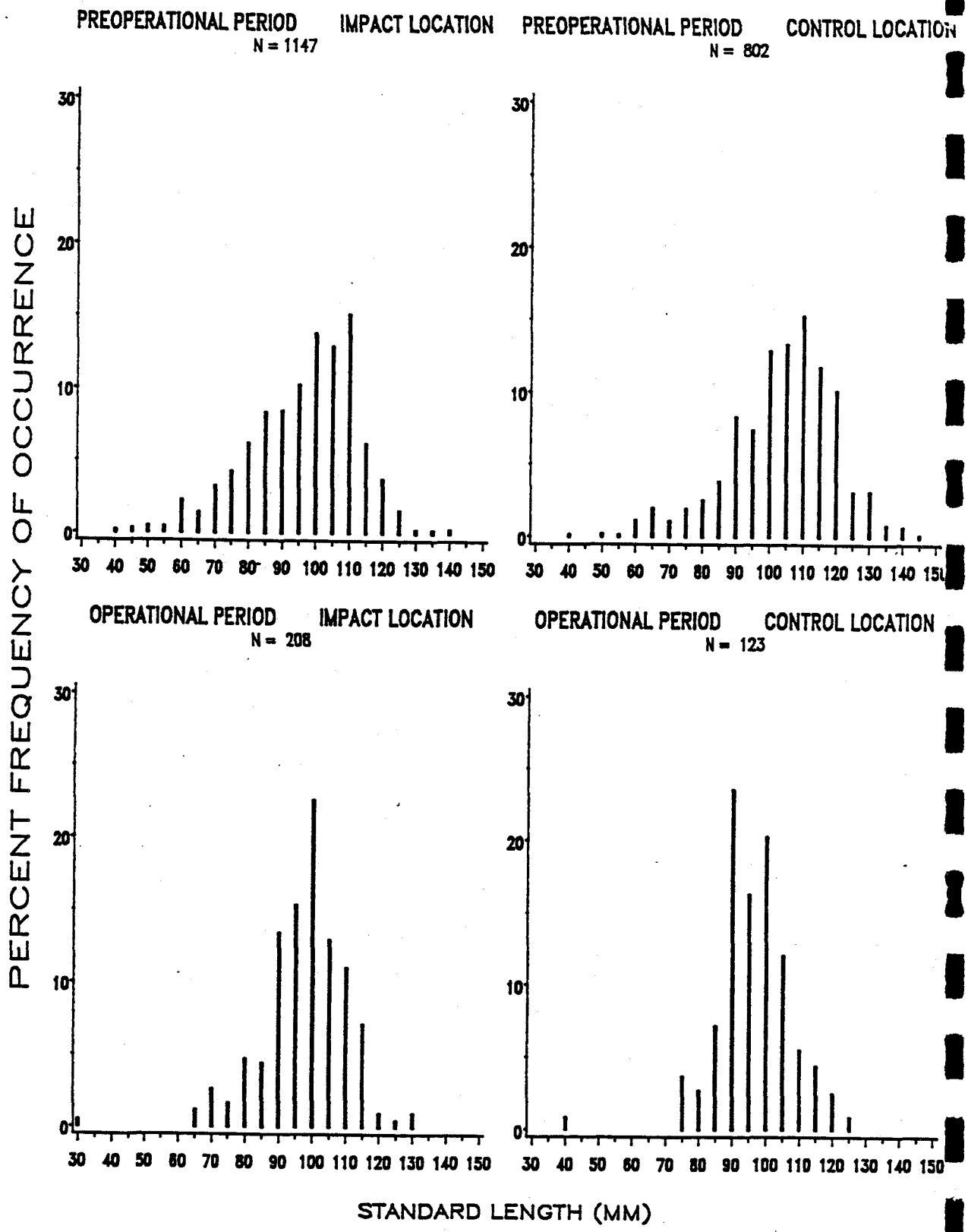
30 METER DEPTH



OTTER TRAWL

PACIFIC SANDDAB *(CITHARICHTHYS SORDIDUS)*

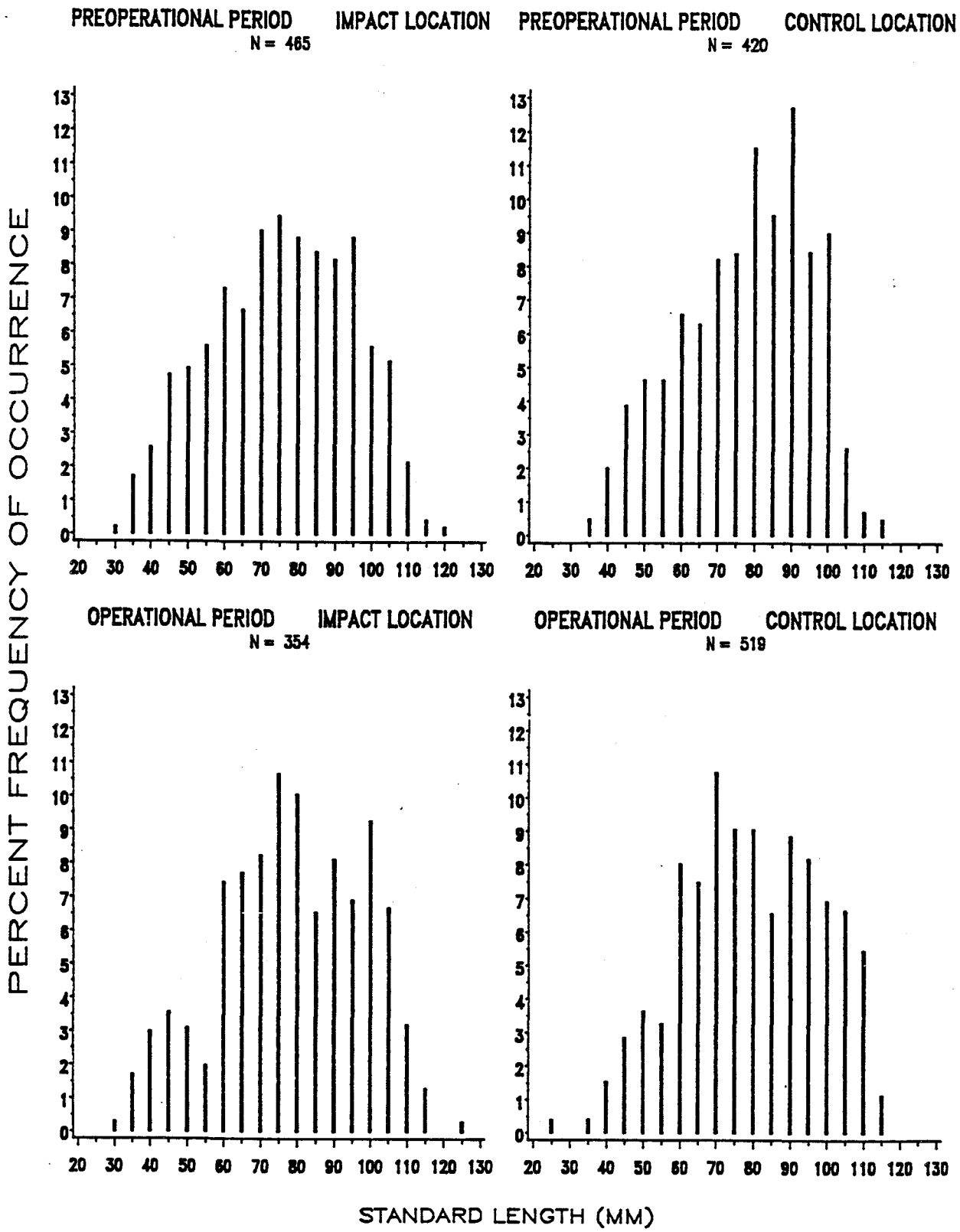
30 METER DEPTH



OTTER TRAWL

SPECKLED SANDDAB *(CITHARICHTHYS STIGMAEUS)*

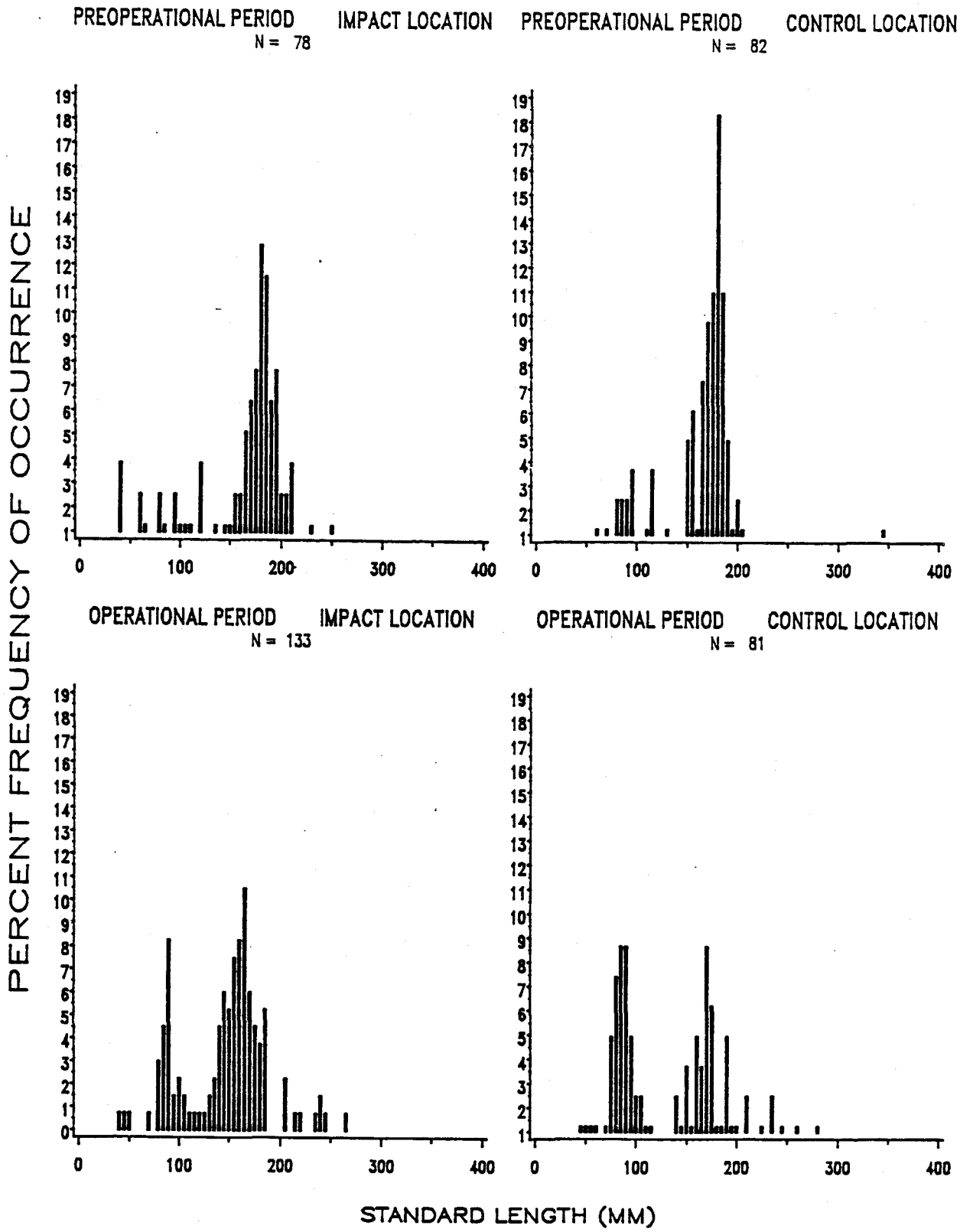
18 METER DEPTH



OTTER TRAWL

FANTAIL SOLE *(XYSTREURYS LIOLEPIS)*

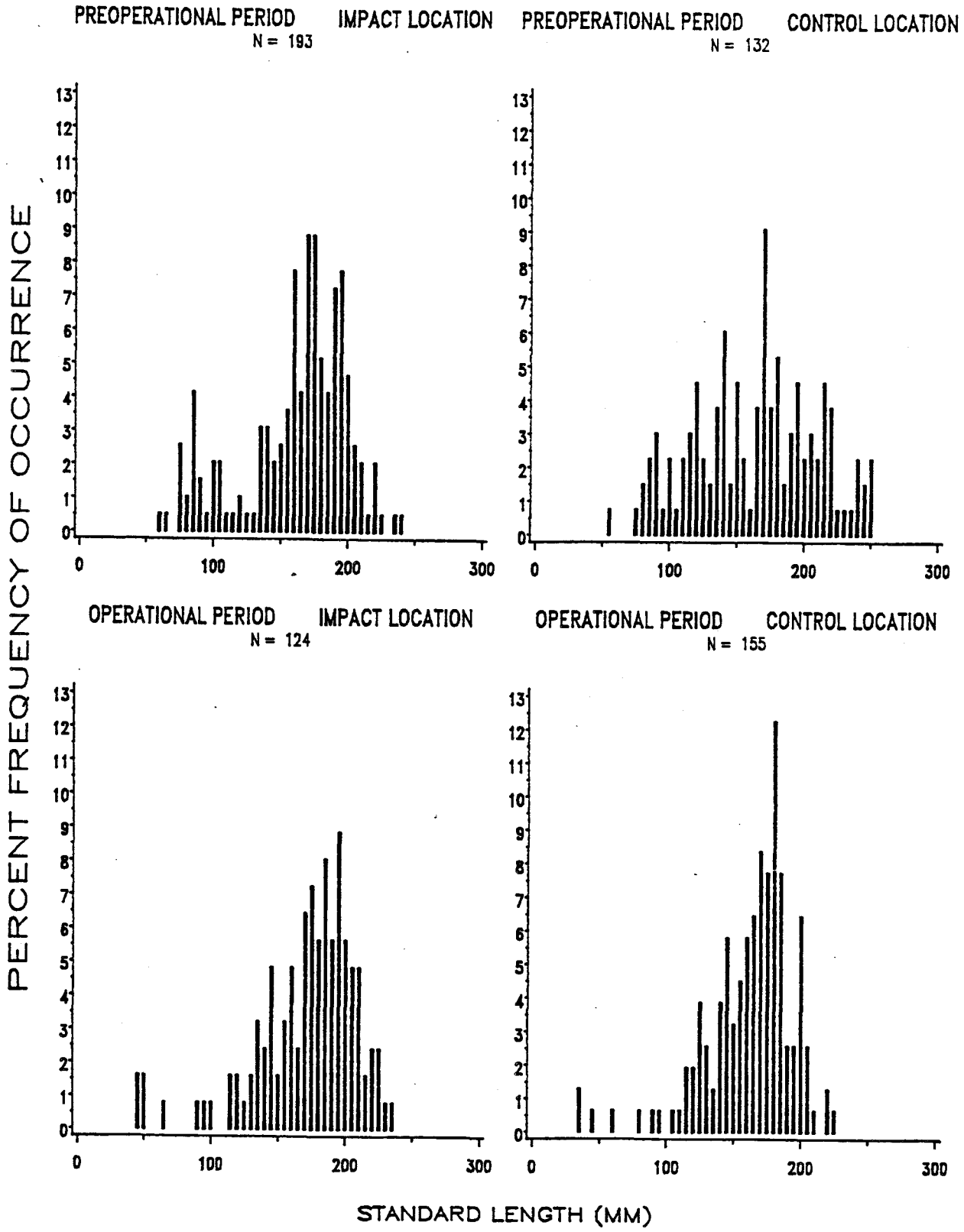
30 METER DEPTH



OTTER TRAWL

HORNYHEAD TURBOT *(PLEURONICHTHYS VERTICALIS)*

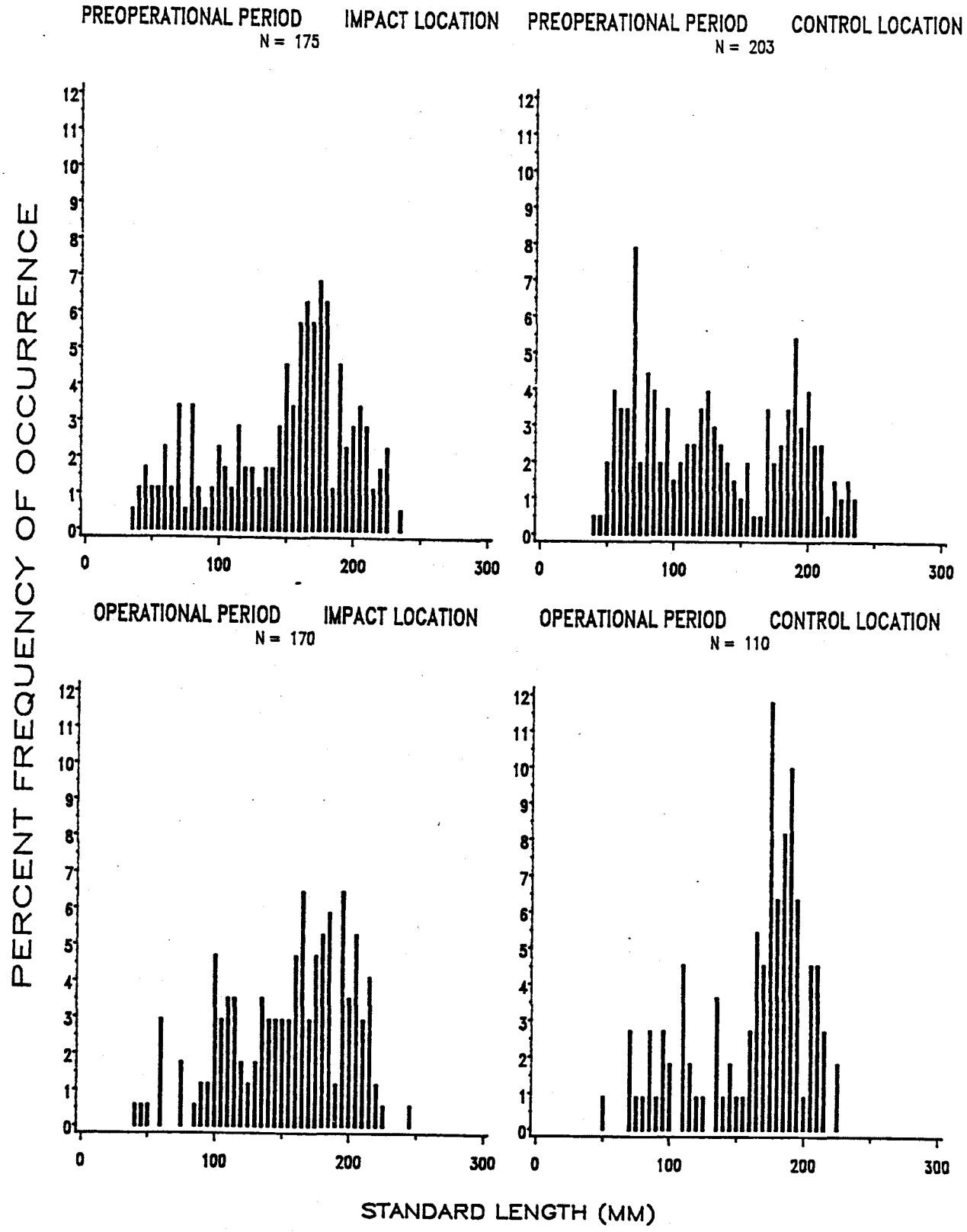
18 METER DEPTH



OTTER TRAWL

HORNYHEAD TURBOT *(PLEURONICHTHYS VERTICALIS)*

30 METER DEPTH

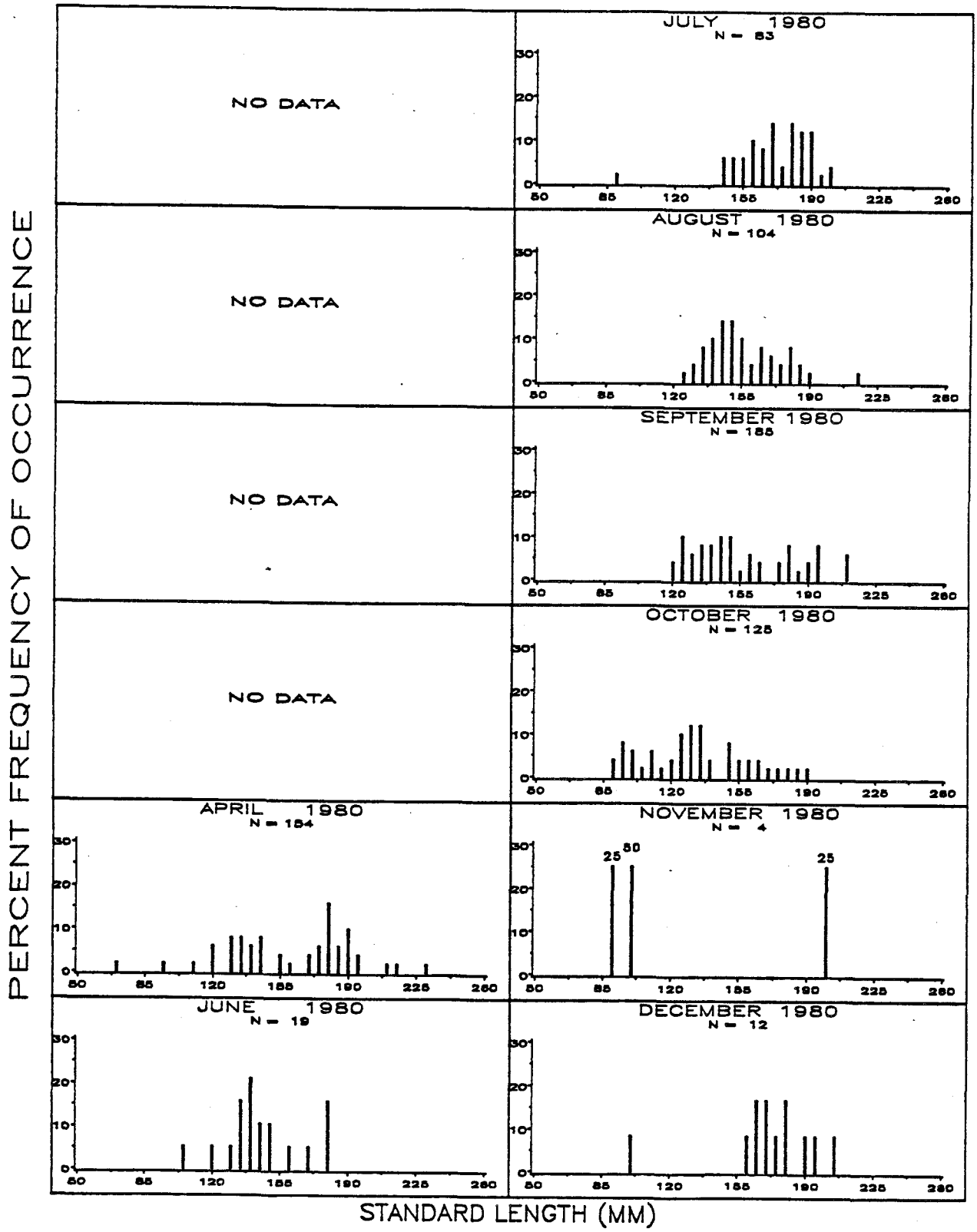


APPENDIX E -- FIGURE 65
(sheet 1 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 18 METER DEPTH

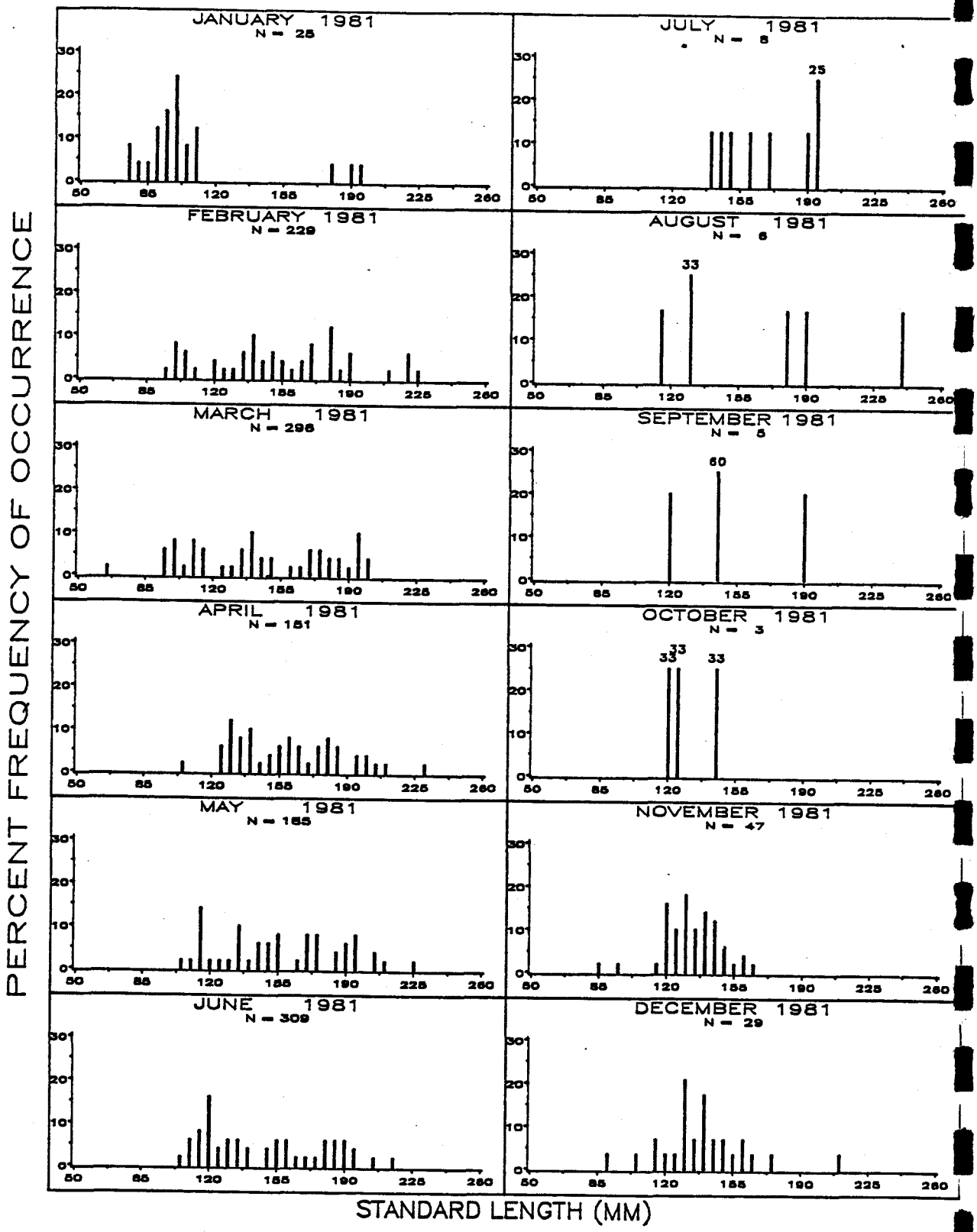


APPENDIX E -- FIGURE 65
(sheet 2 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 18 METER DEPTH

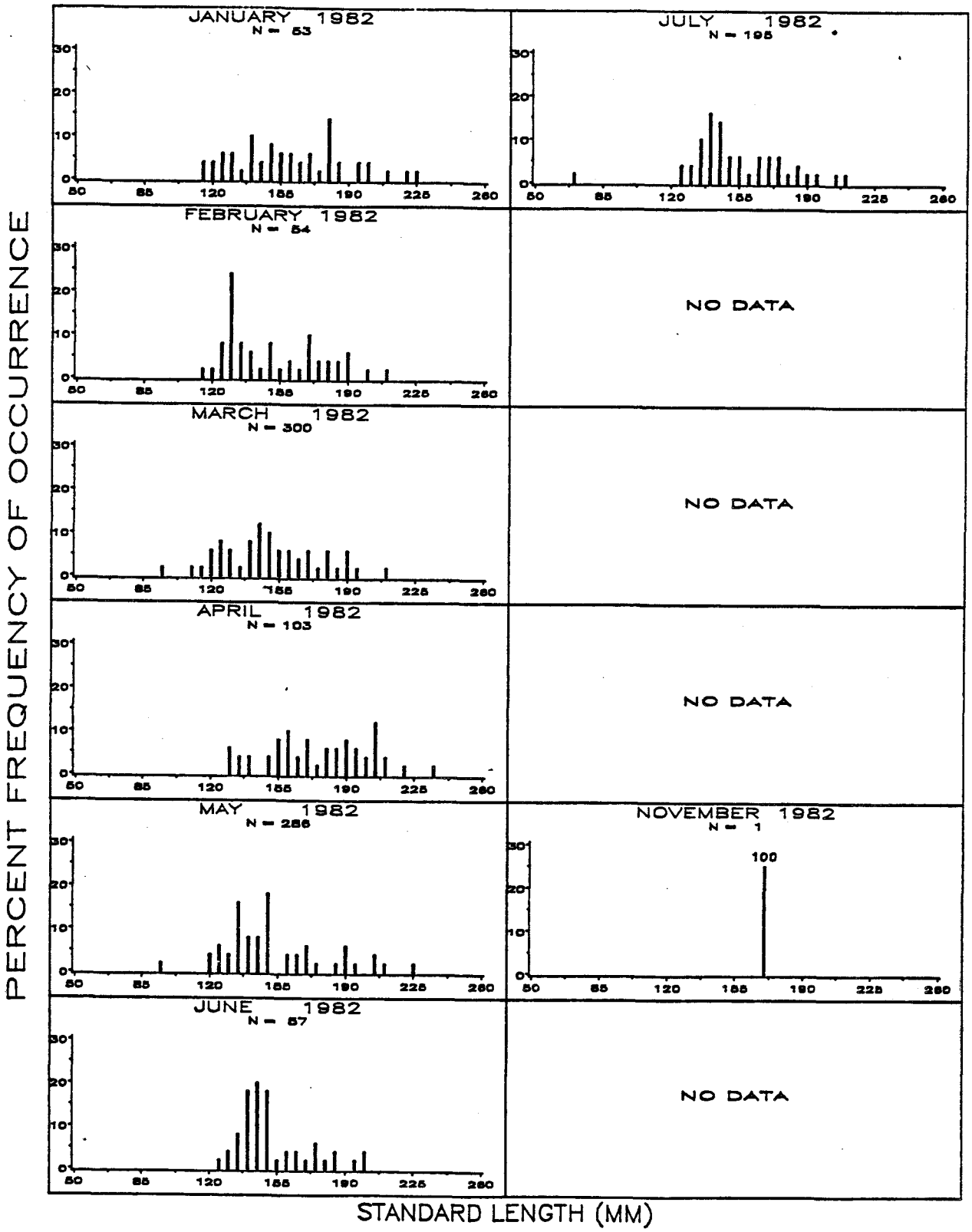


APPENDIX E -- FIGURE 65
(sheet 3 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 18 METER DEPTH

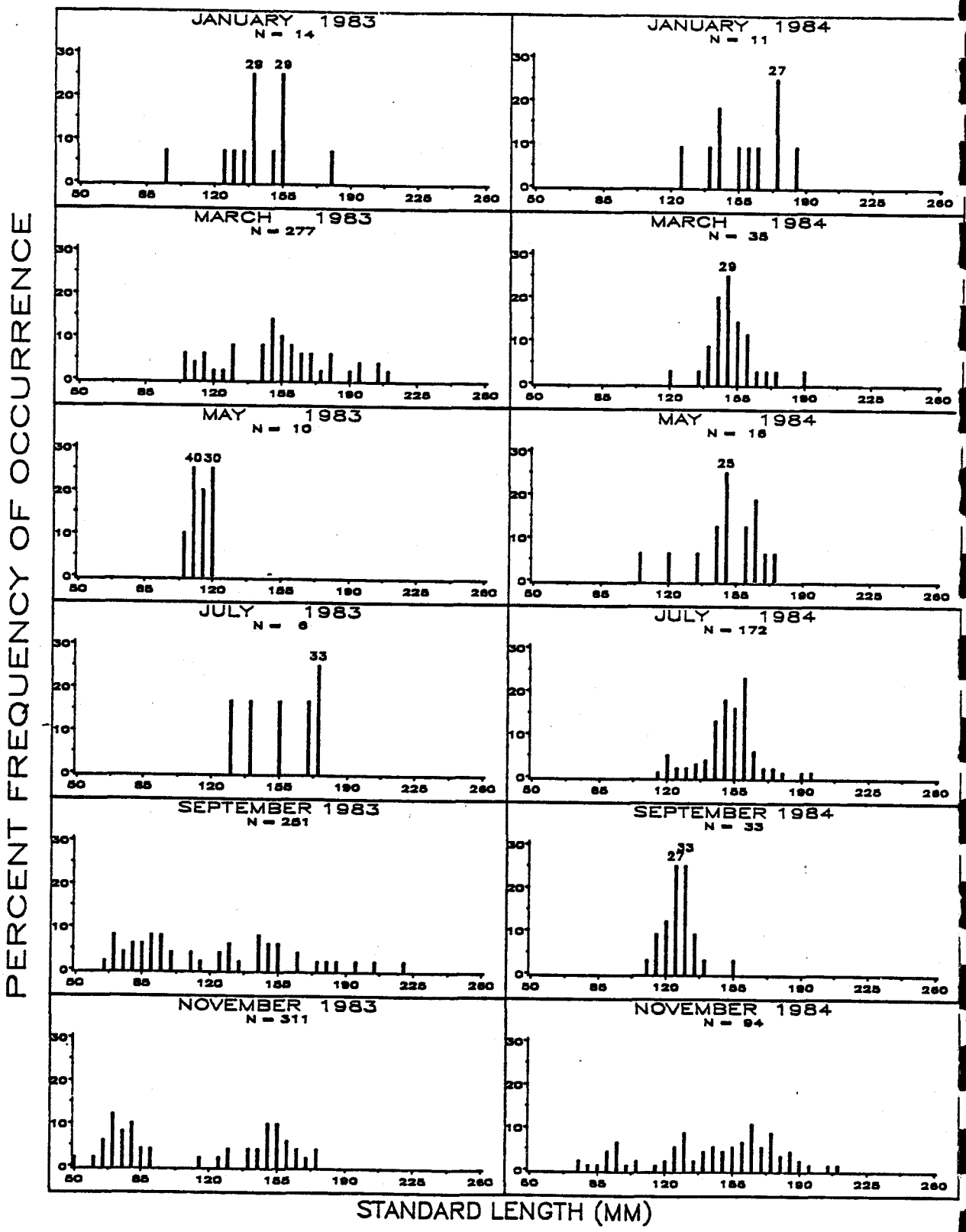


APPENDIX E -- FIGURE 65
(sheet 4 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

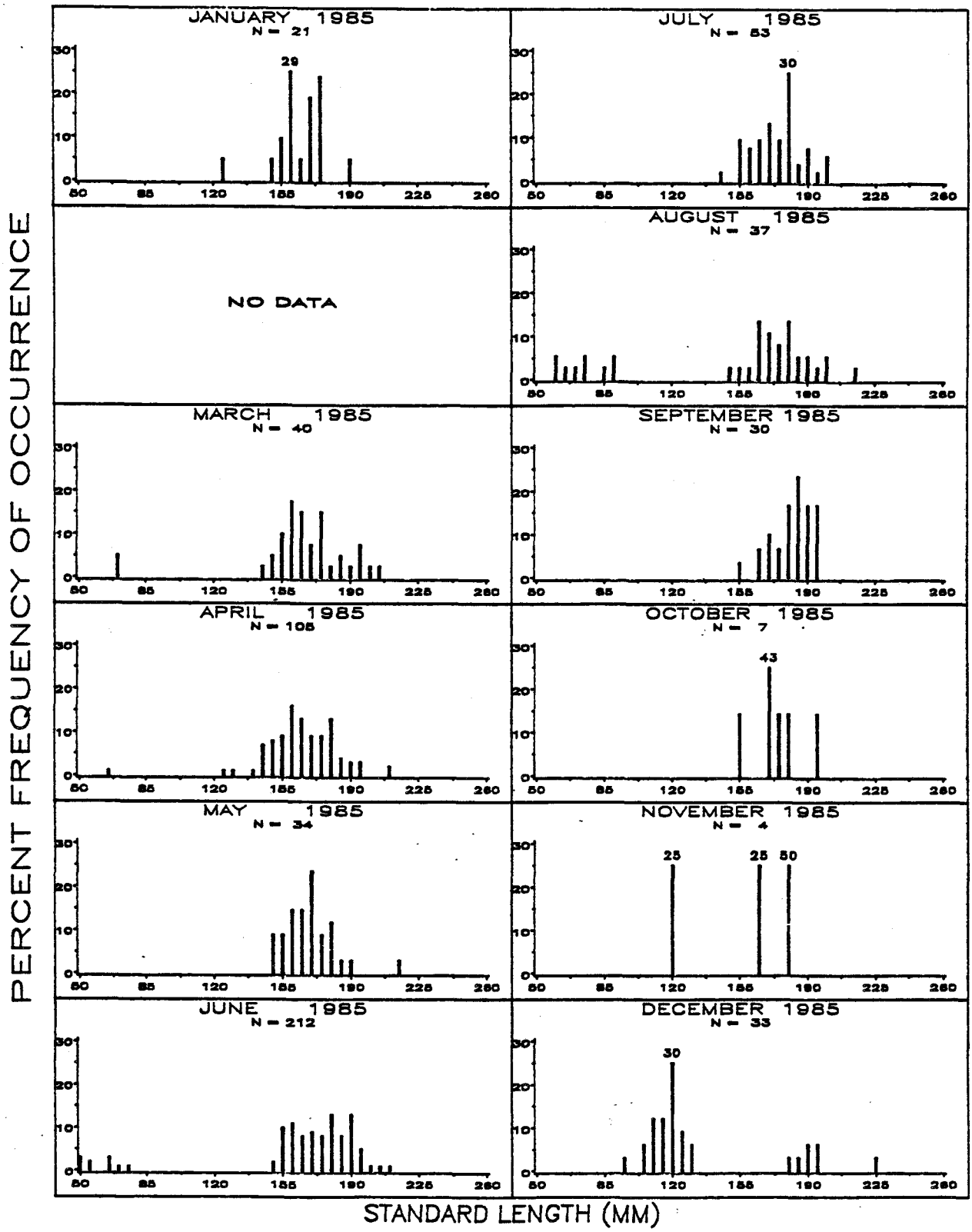
IMPACT LOCATION 18 METER DEPTH



OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 18 METER DEPTH

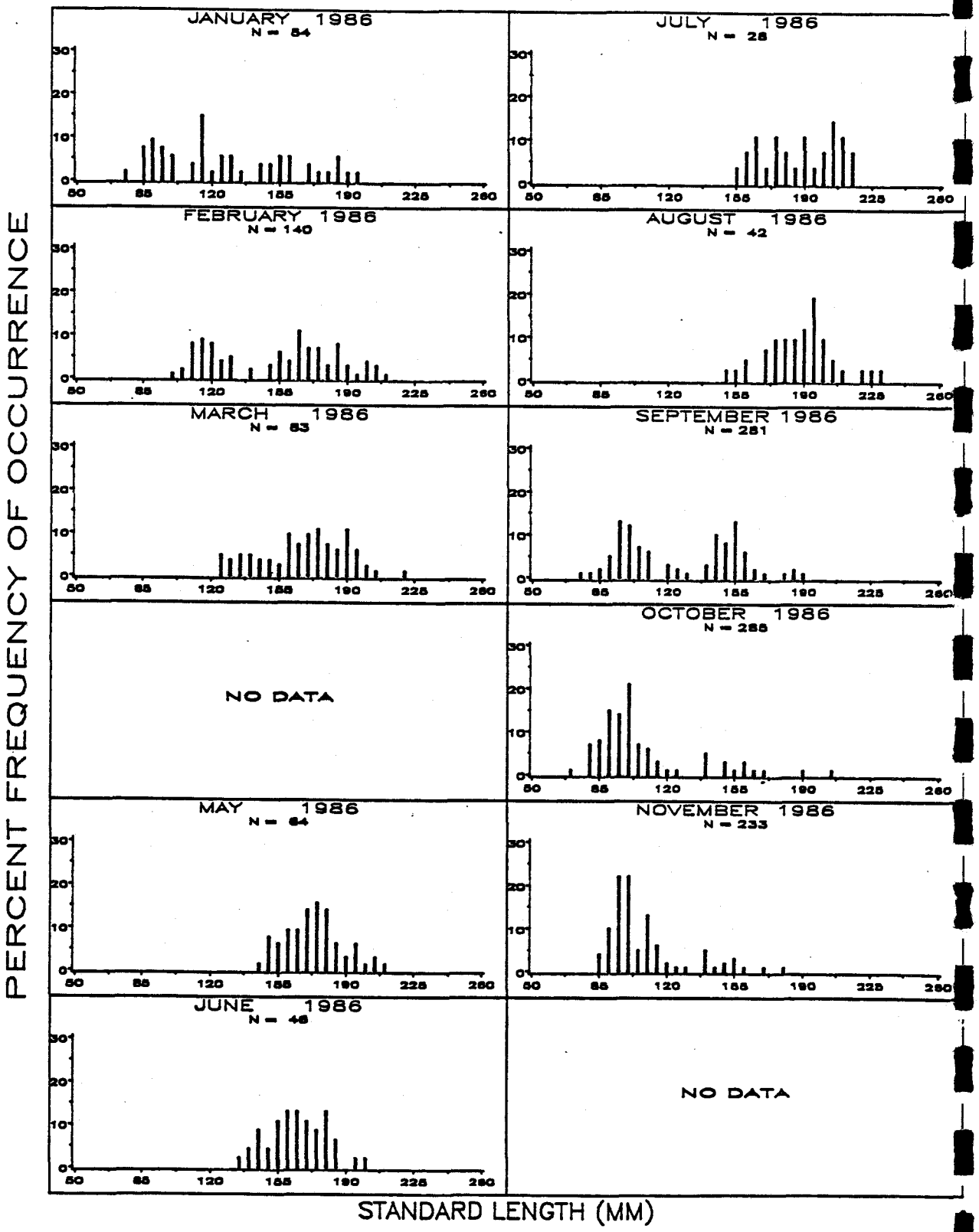


APPENDIX E -- FIGURE 65
(sheet 6 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 18 METER DEPTH

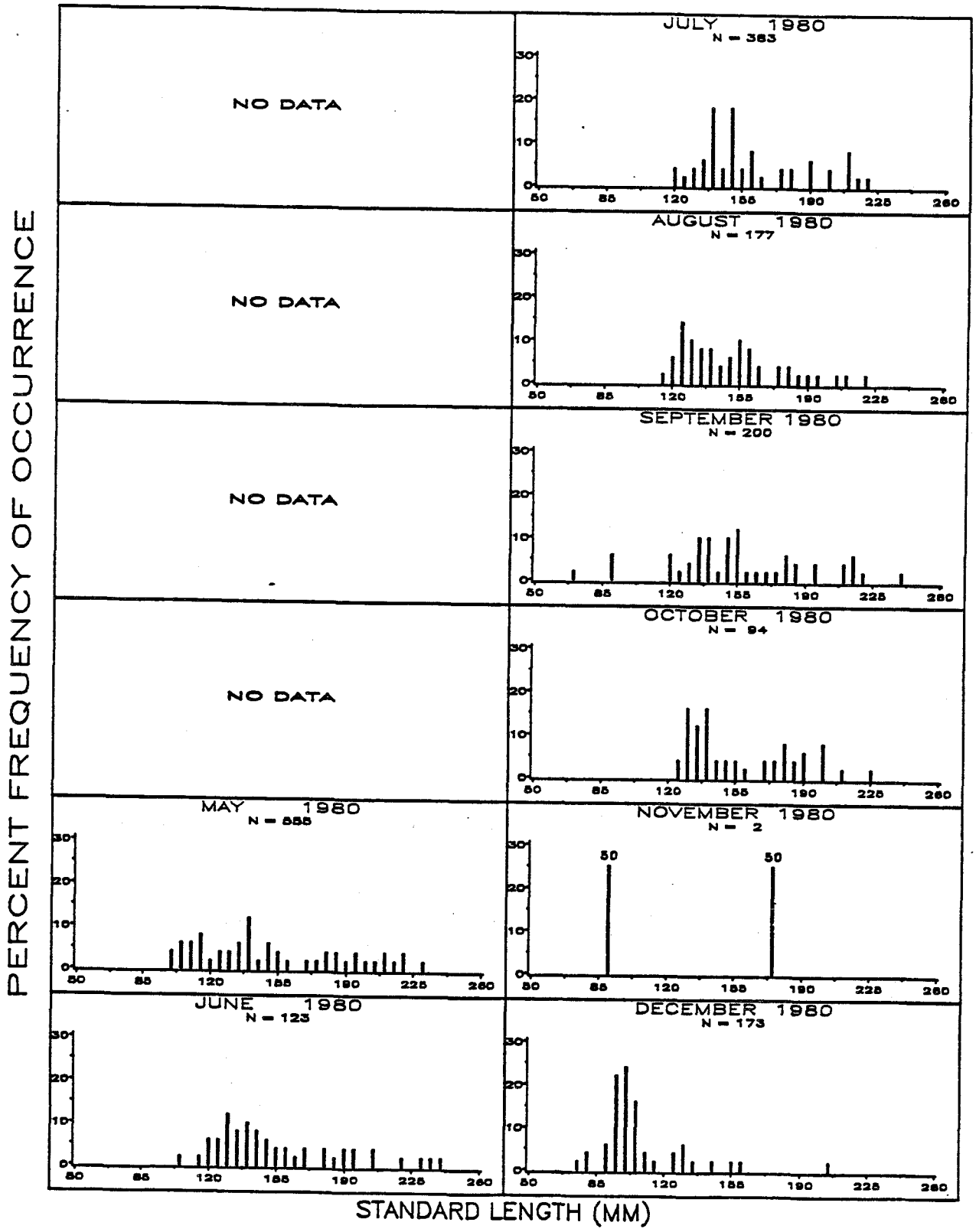


APPENDIX E -- FIGURE 66
(sheet 1 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 18 METER DEPTH

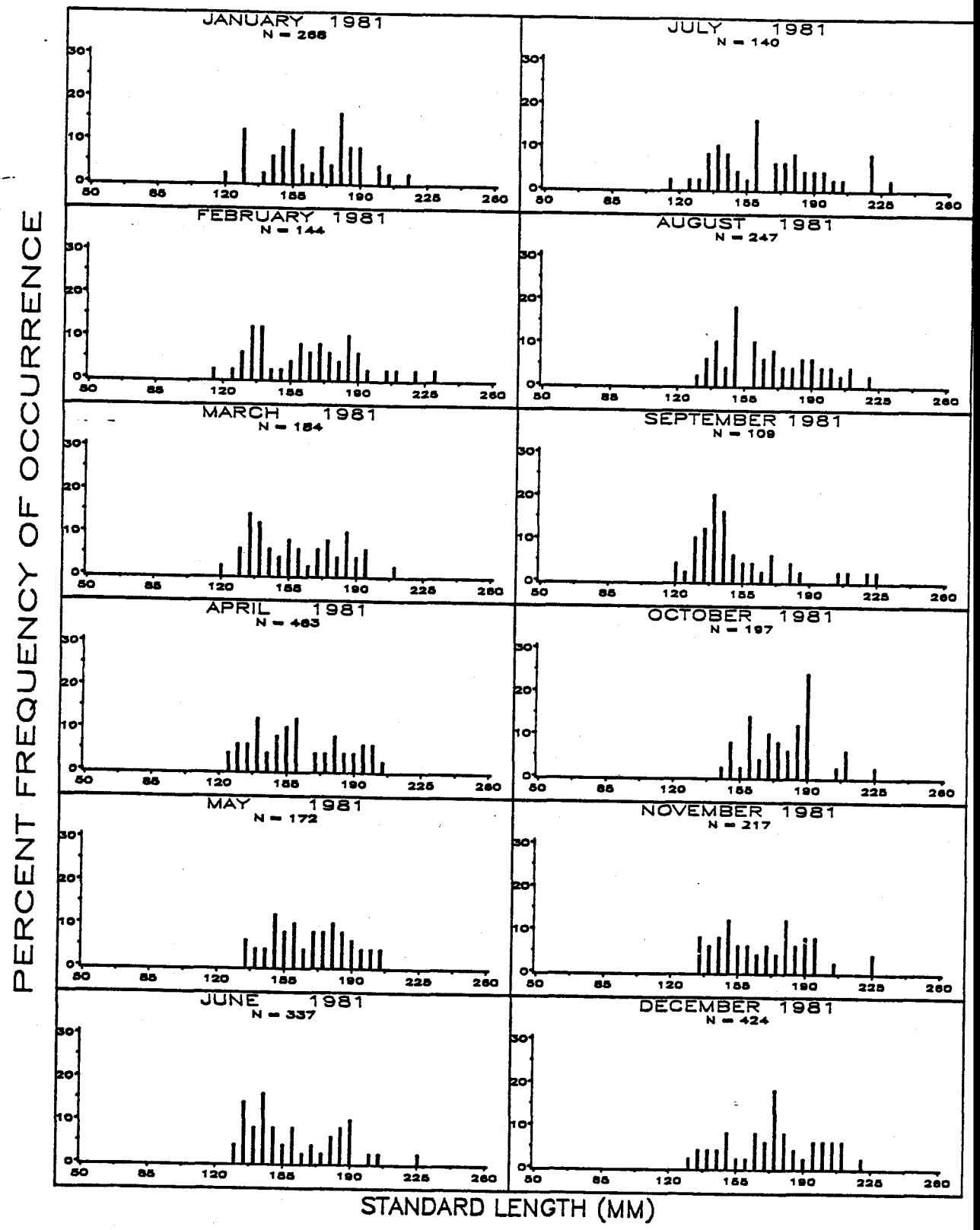


APPENDIX E -- FIGURE 66
(sheet 2 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

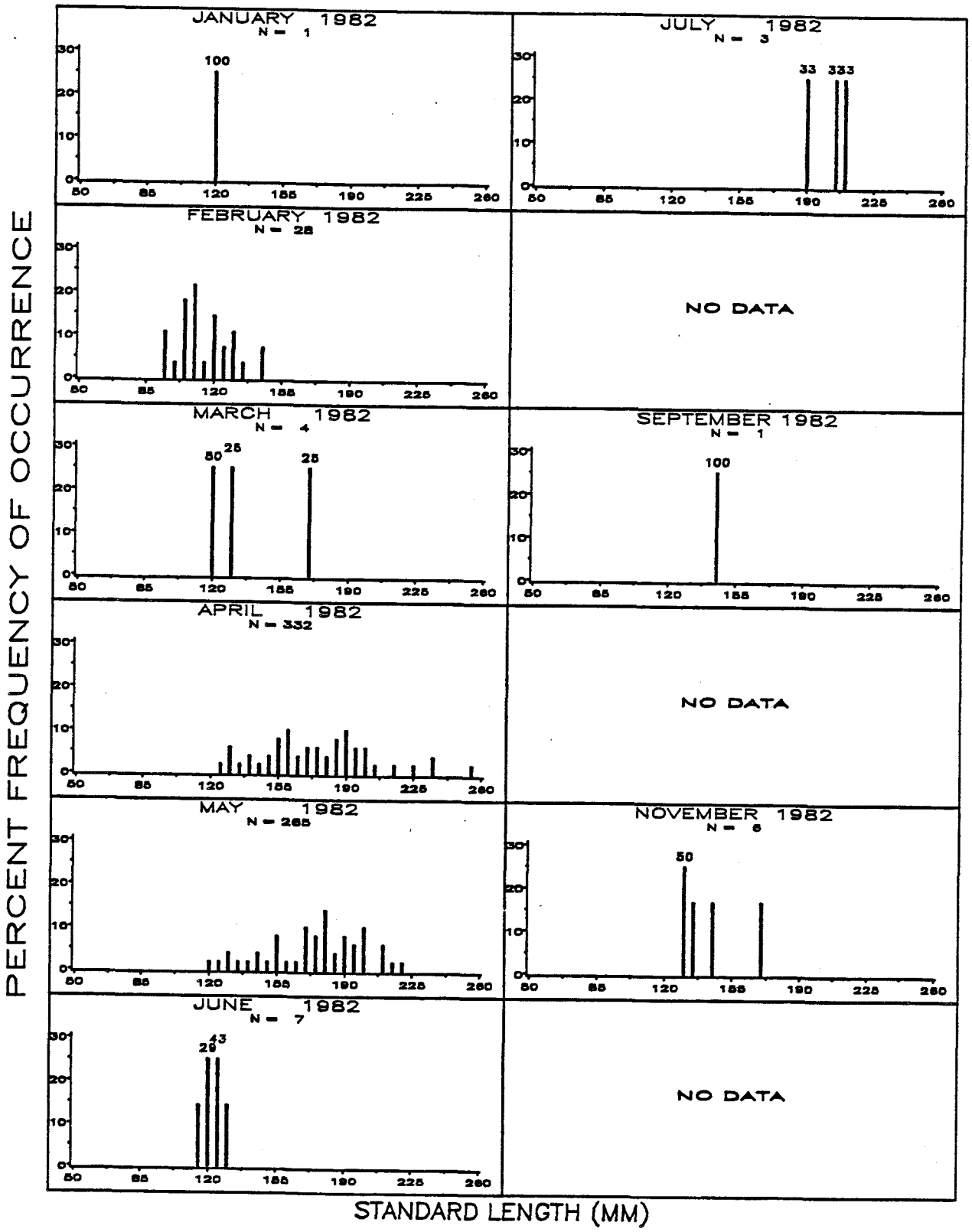


APPENDIX E -- FIGURE 66
(sheet 3 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 18 METER DEPTH

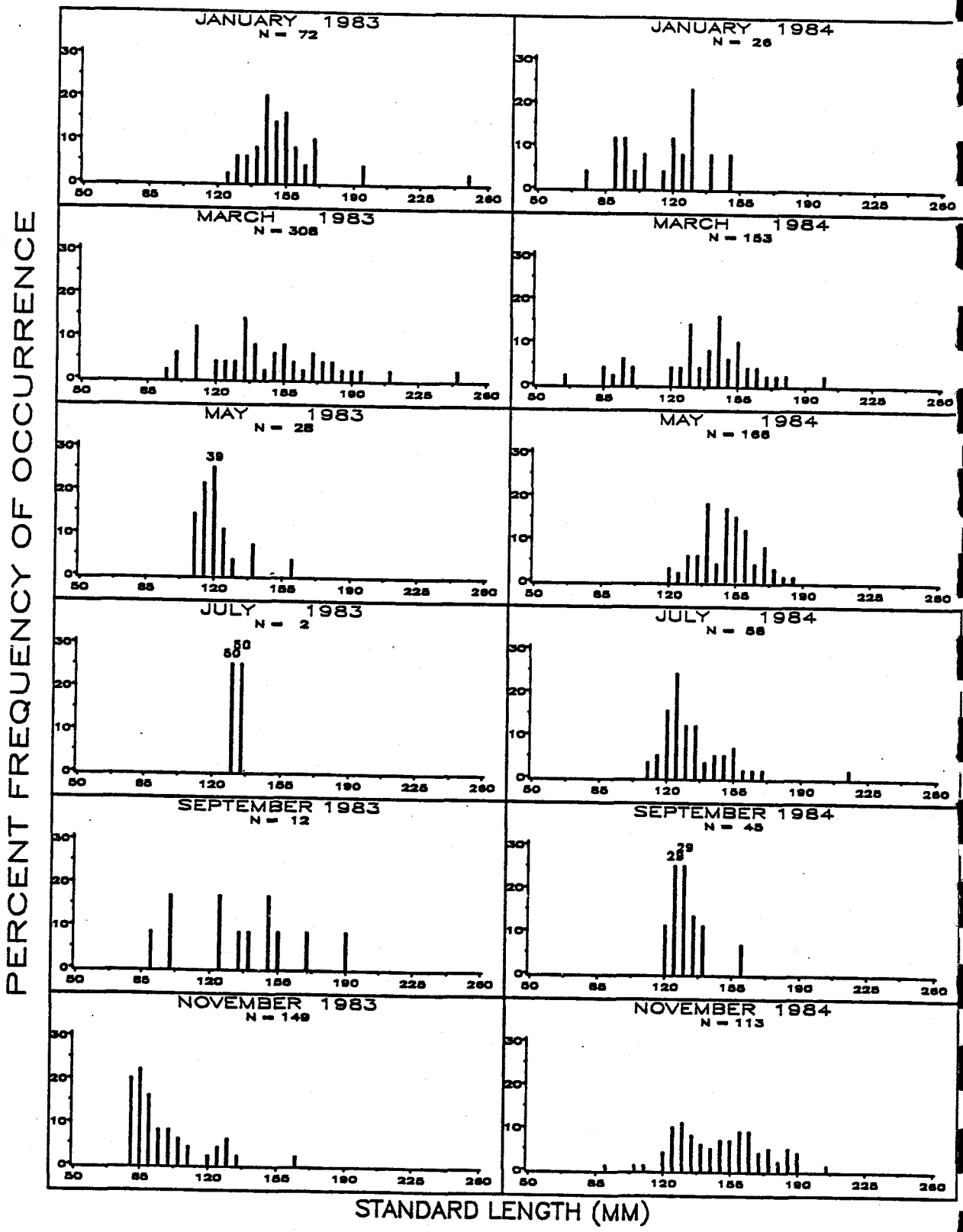


APPENDIX E -- FIGURE 66
(sheet 4 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

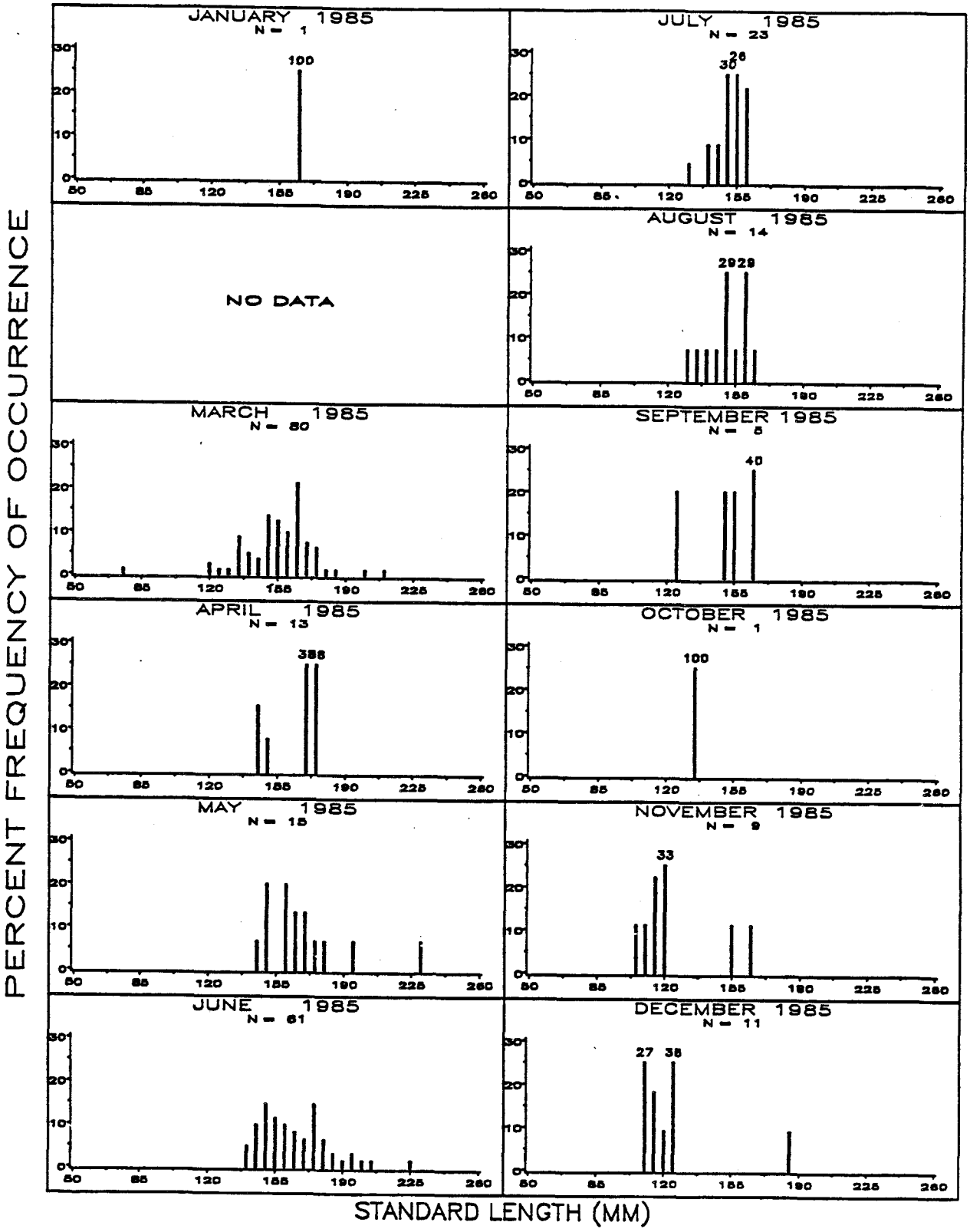
CONTROL LOCATION 18 METER DEPTH



OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 18 METER DEPTH

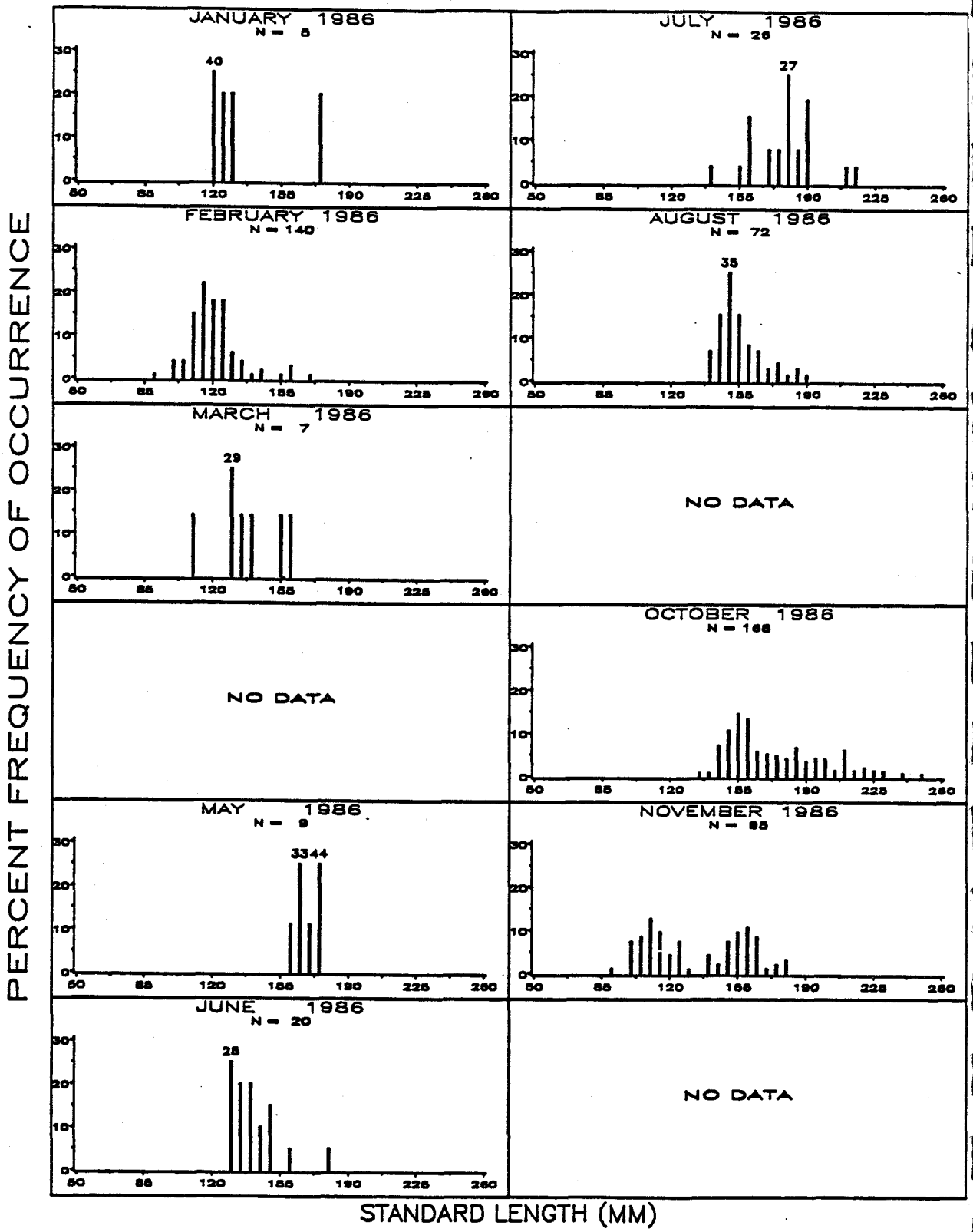


APPENDIX E -- FIGURE 66
(sheet 6 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 18 METER DEPTH

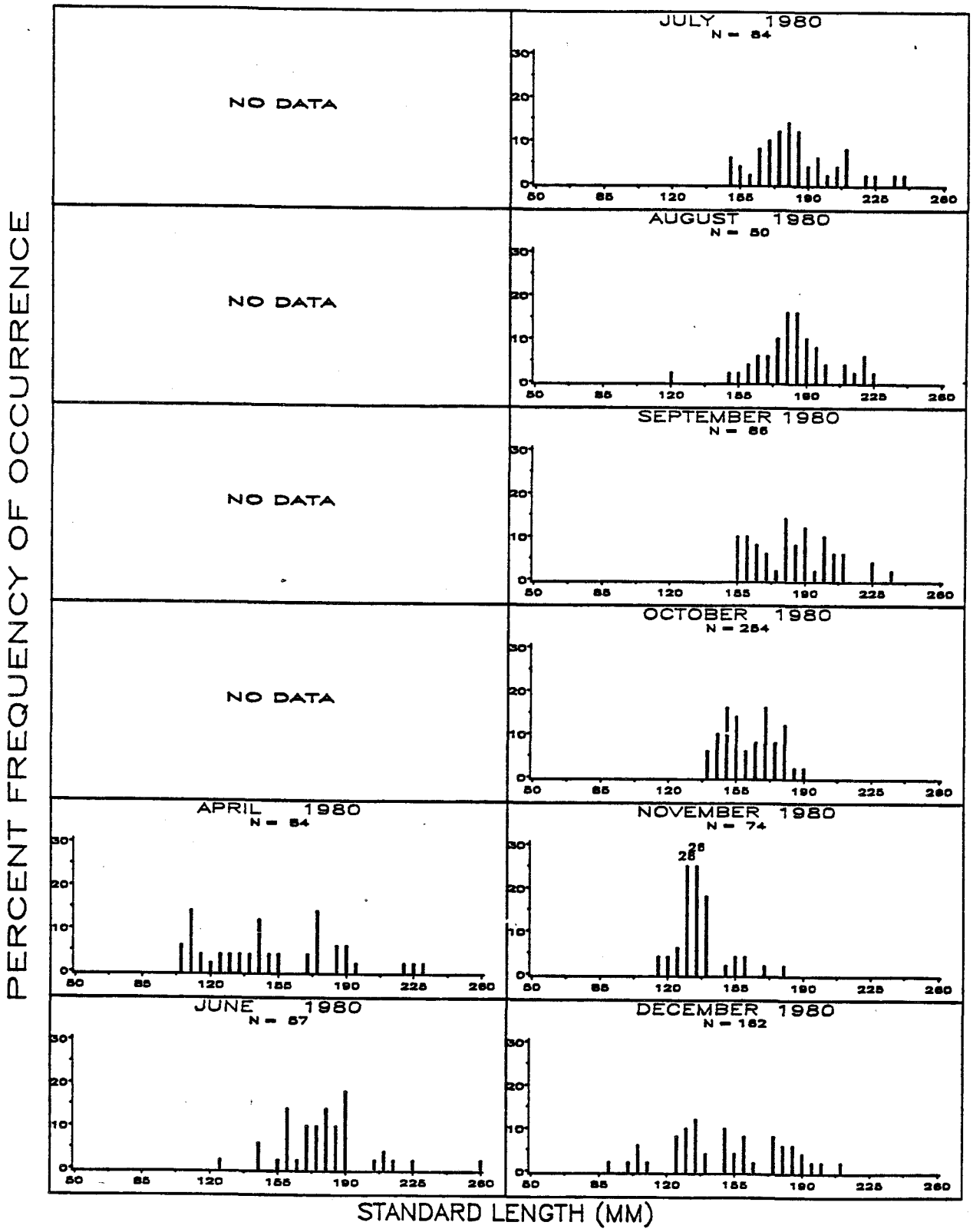


APPENDIX E -- FIGURE 67
(sheet 1 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

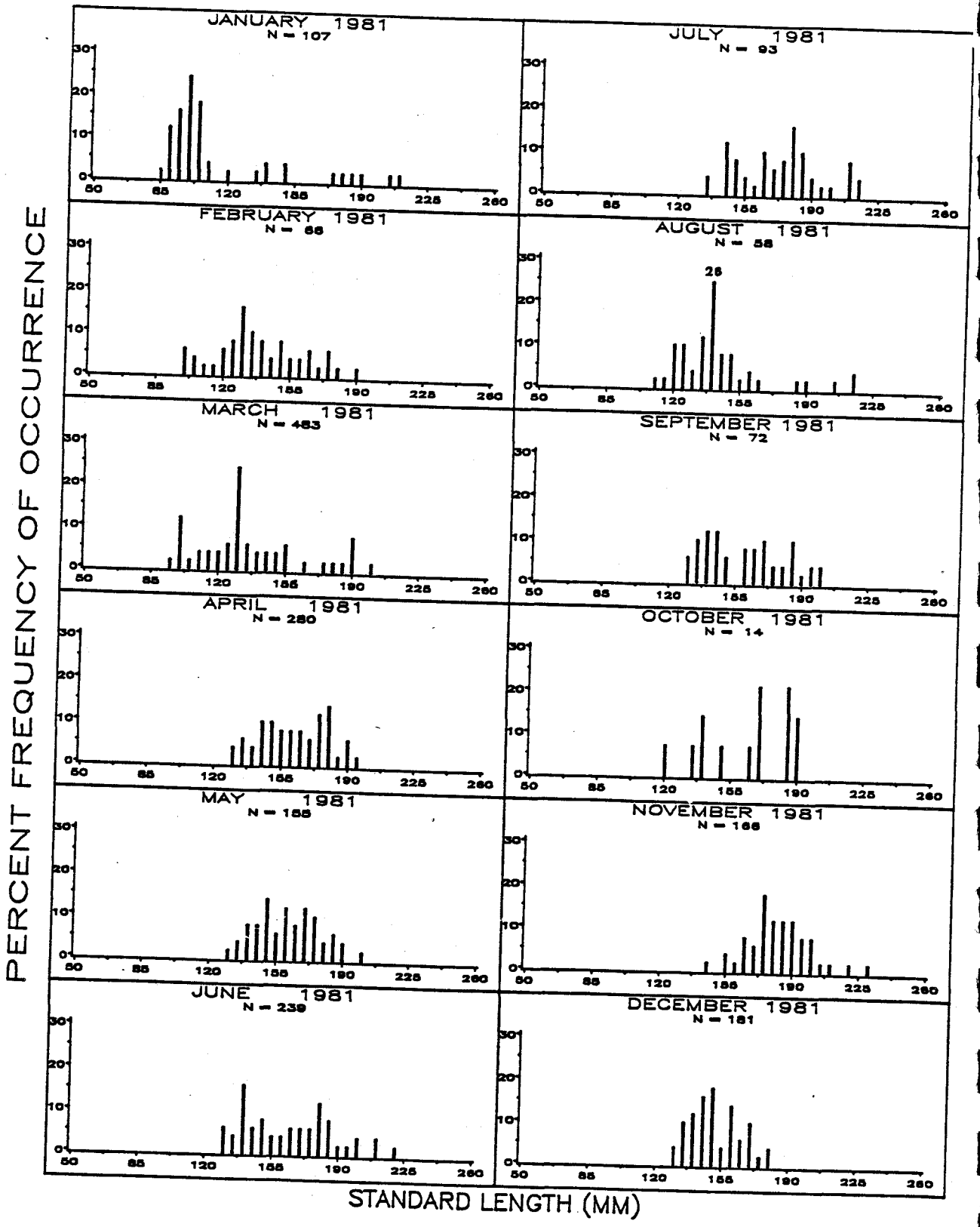


APPENDIX E -- FIGURE 67
(sheet 2 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

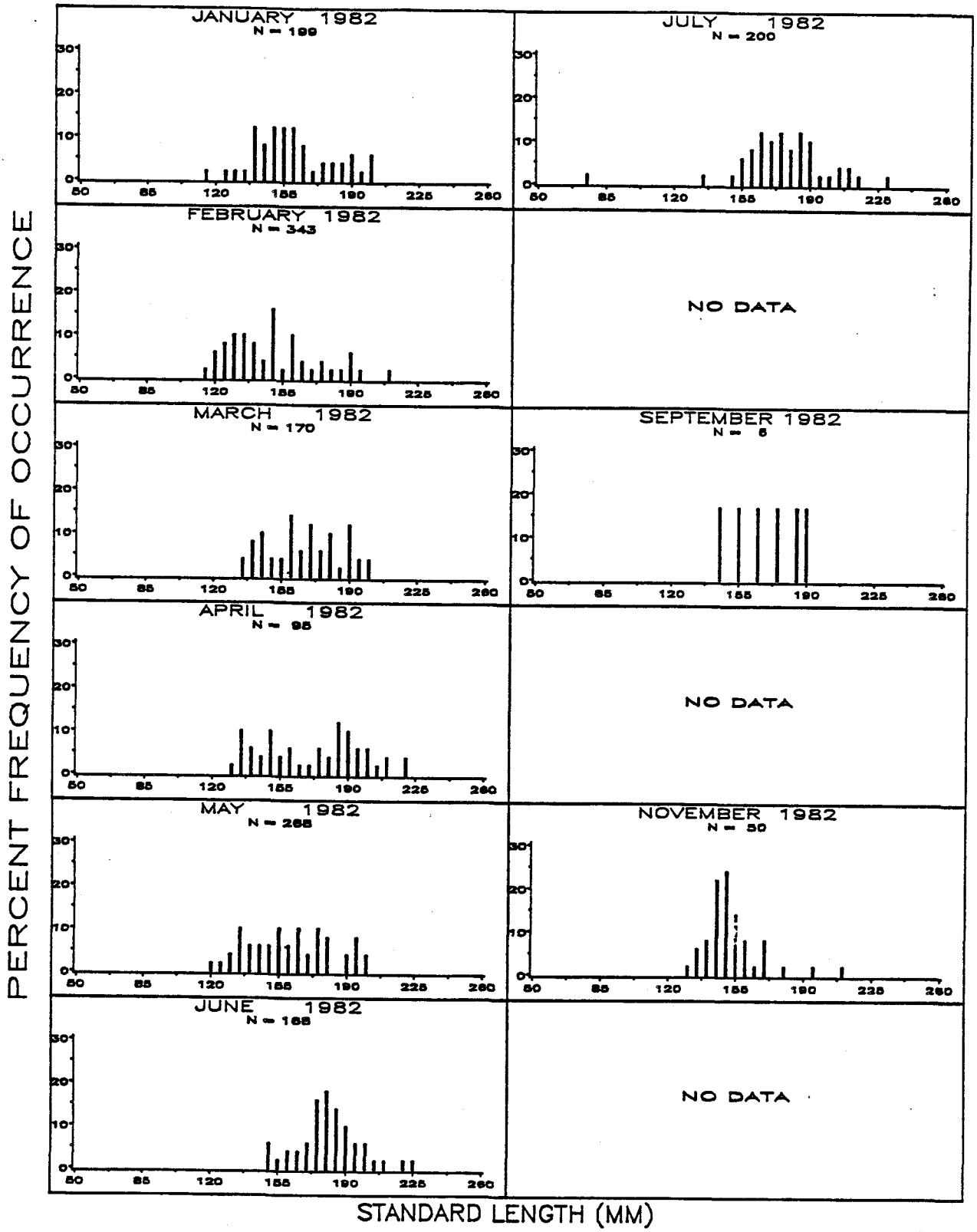


APPENDIX E -- FIGURE 67
(sheet 3 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

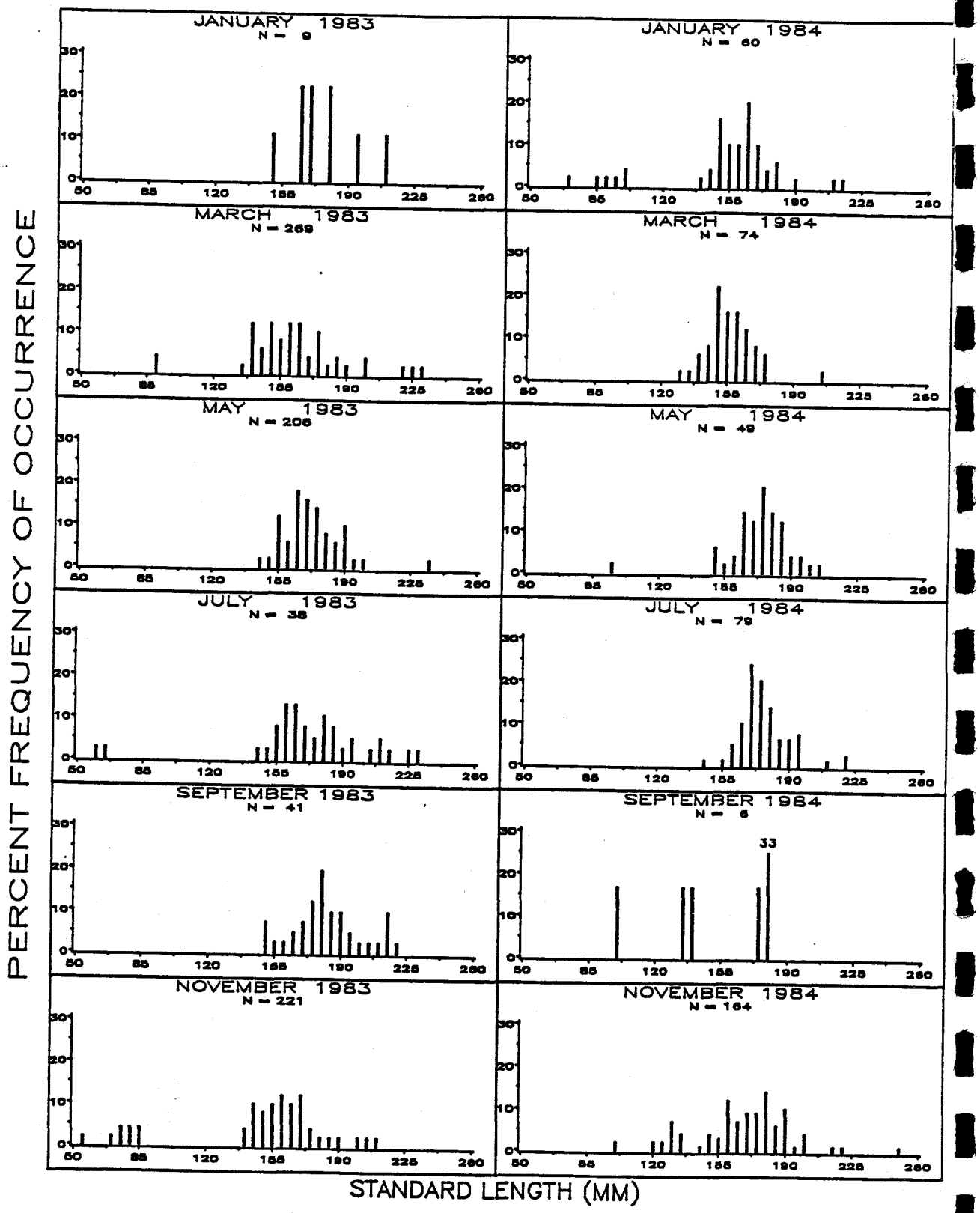


APPENDIX E -- FIGURE 67
(sheet 4 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

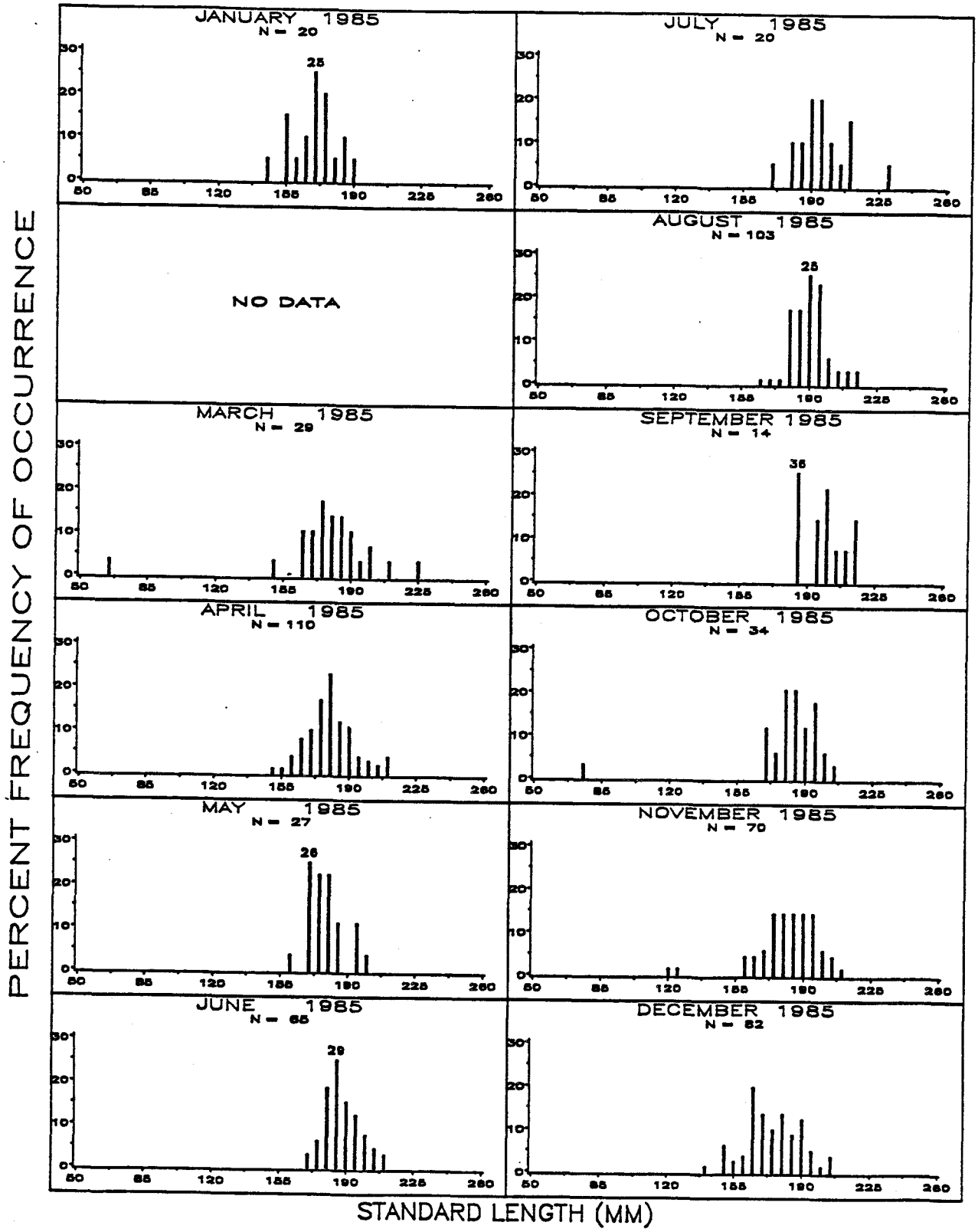


APPENDIX E -- FIGURE 67
(sheet 5 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

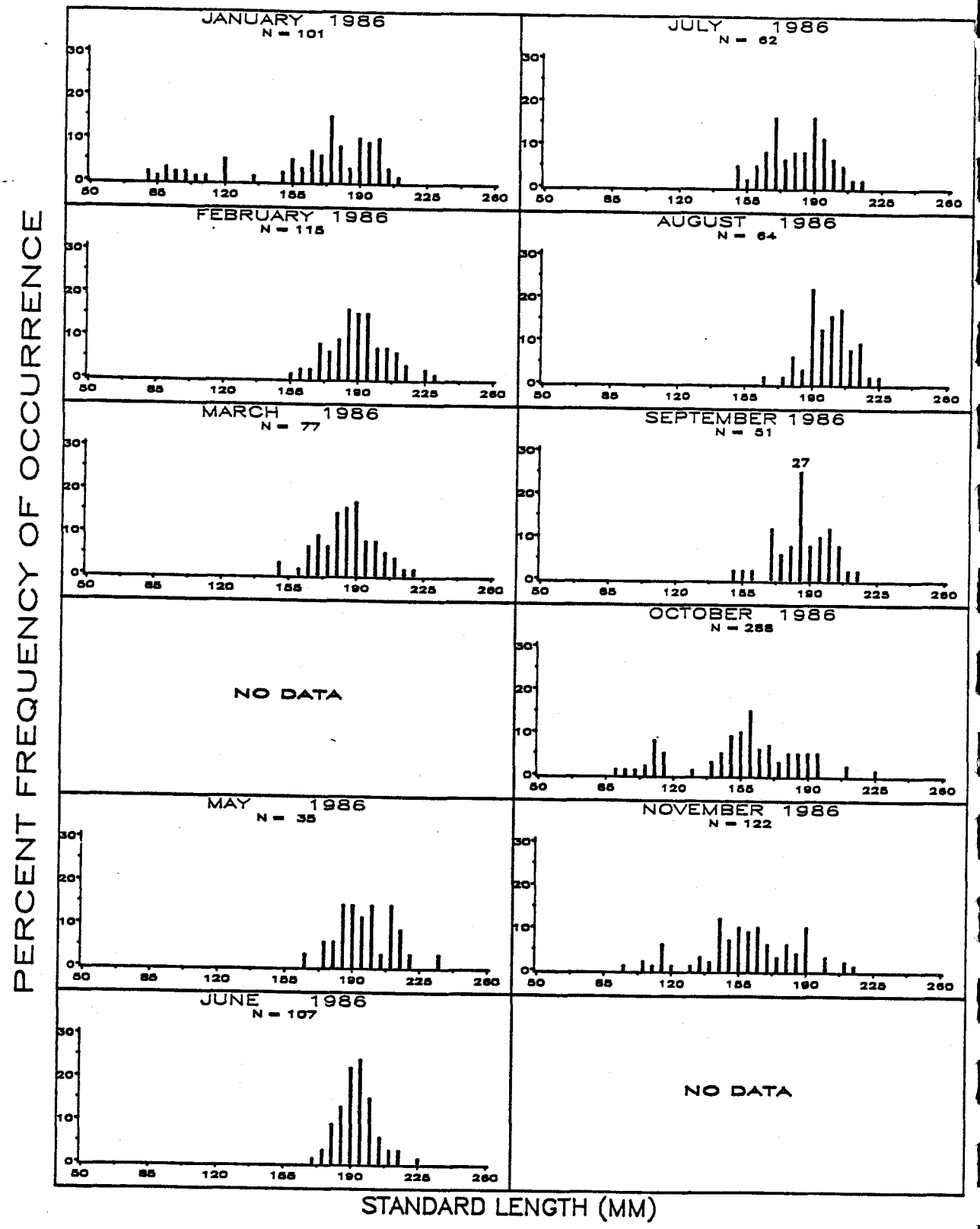


APPENDIX E -- FIGURE 67
(sheet 6 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

IMPACT LOCATION 30 METER DEPTH

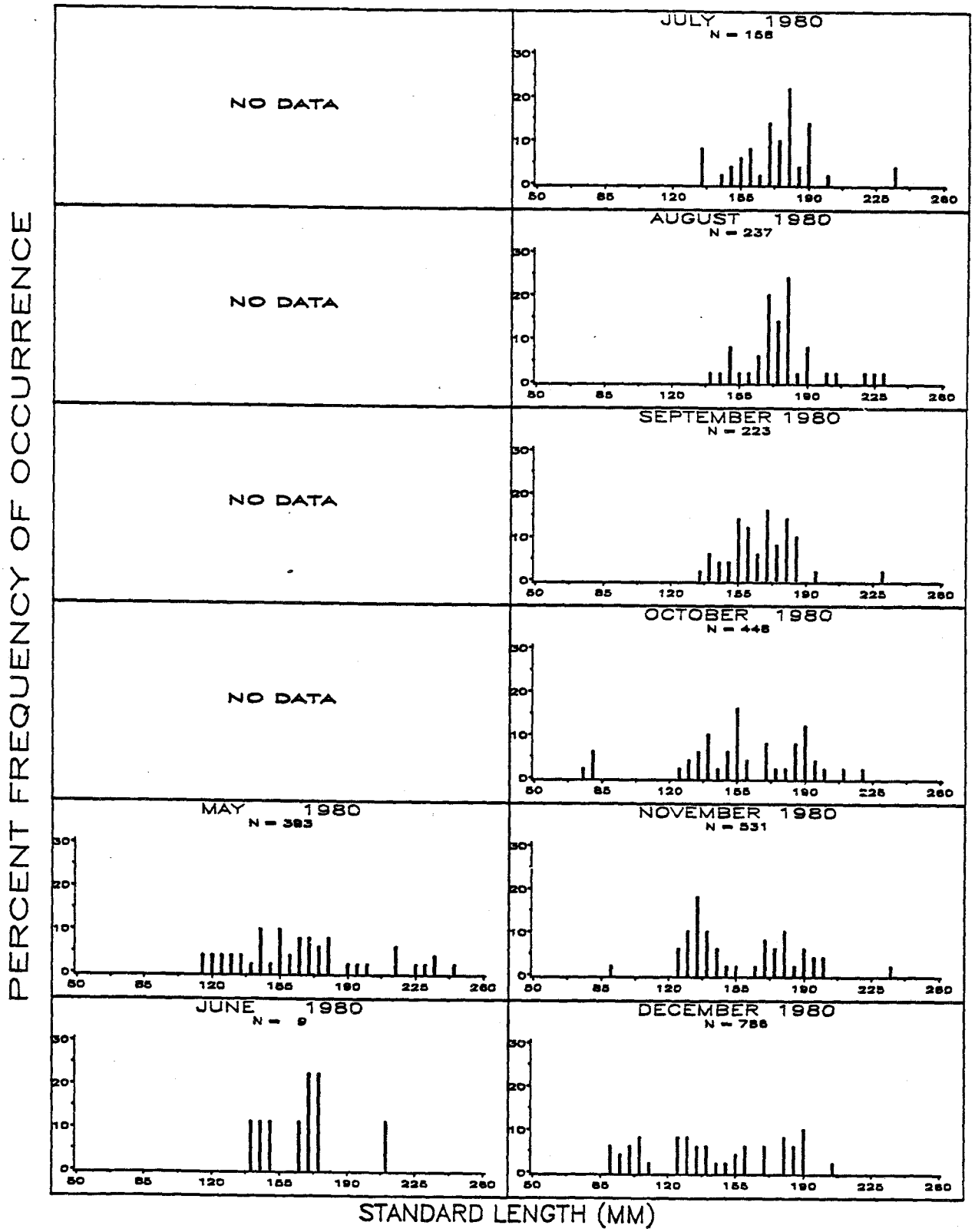


APPENDIX E -- FIGURE 68
(sheet 1 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

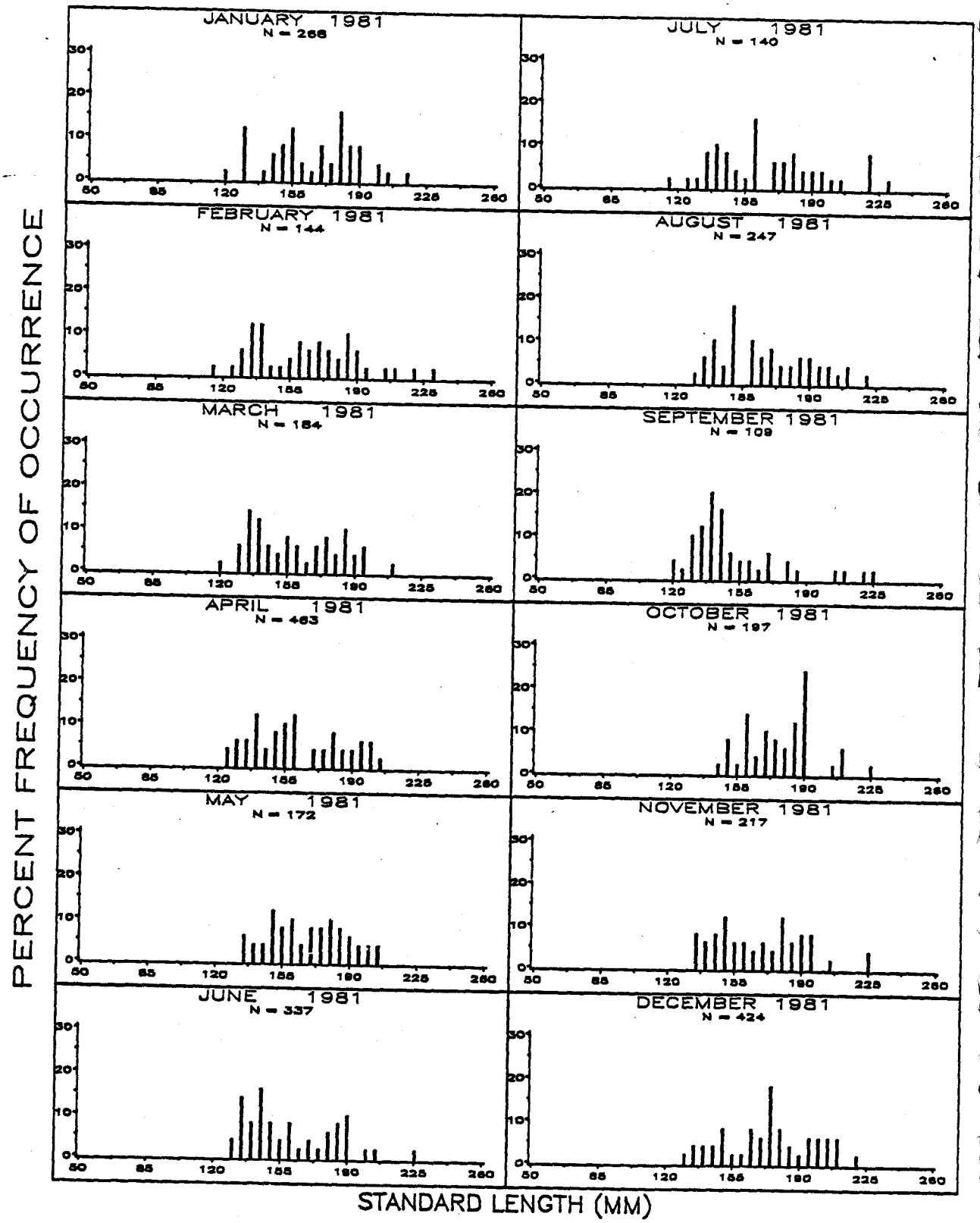


APPENDIX E -- FIGURE 68
(sheet 2 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

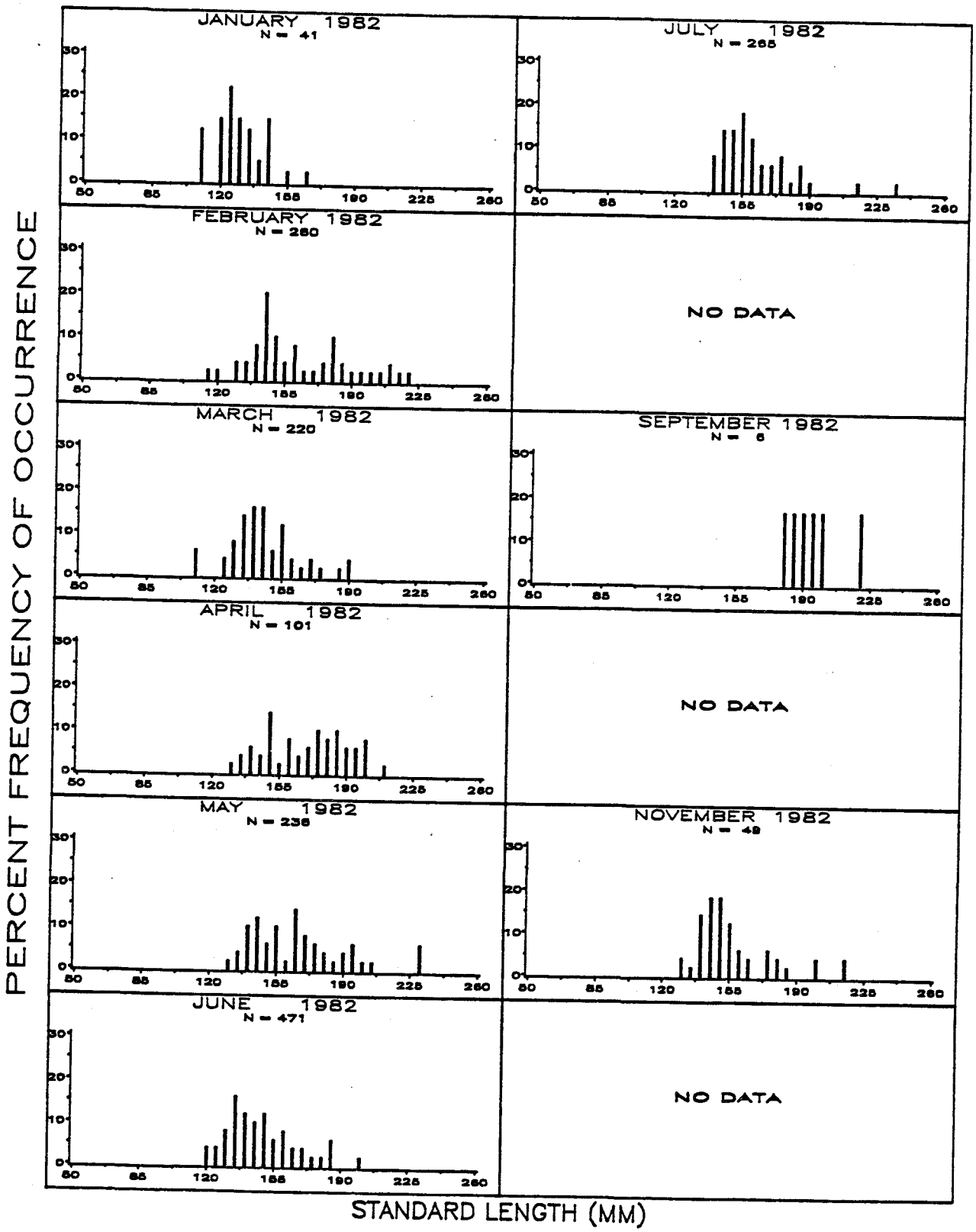
CONTROL LOCATION 30 METER DEPTH



OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

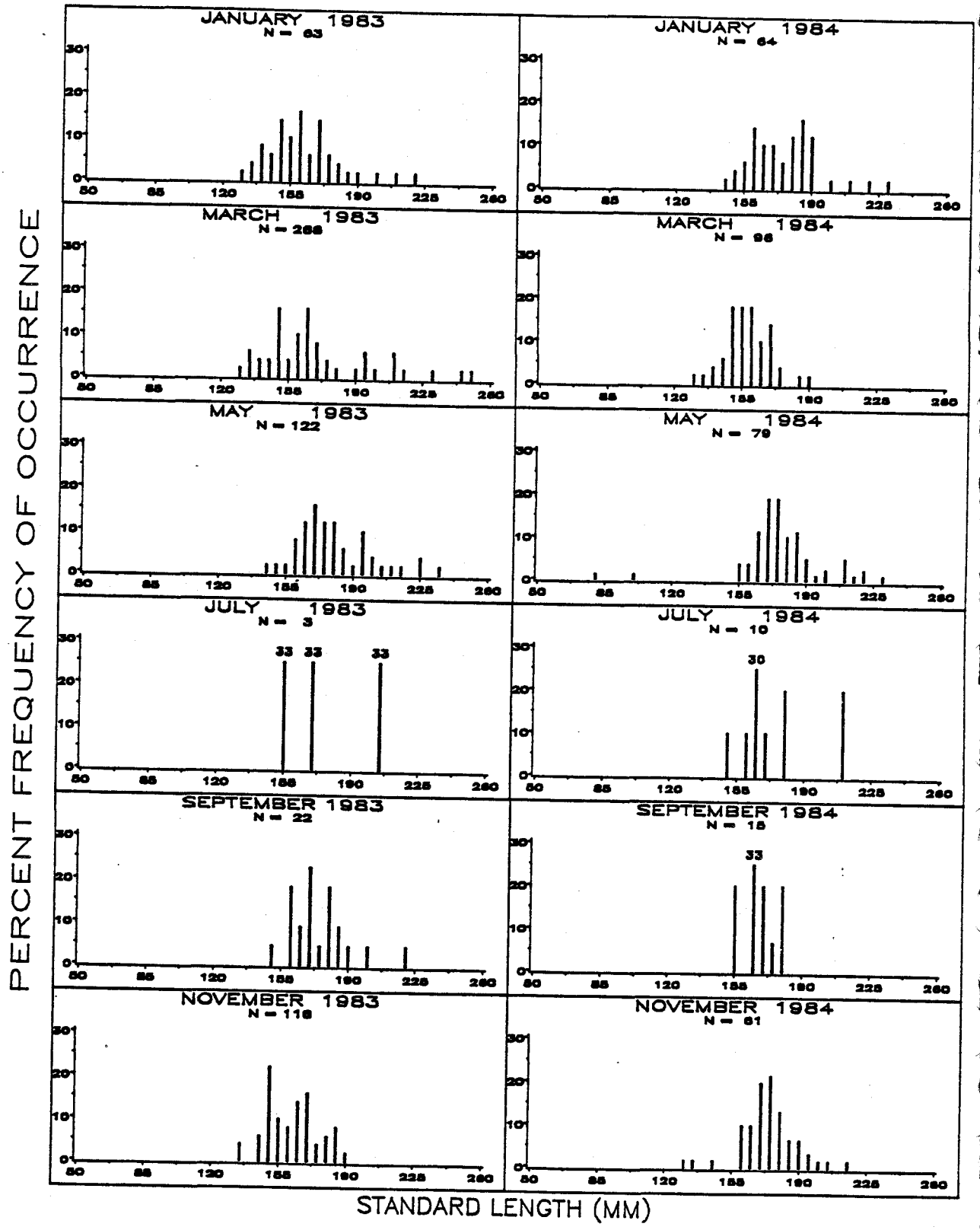


APPENDIX E -- FIGURE 68
(sheet 4 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

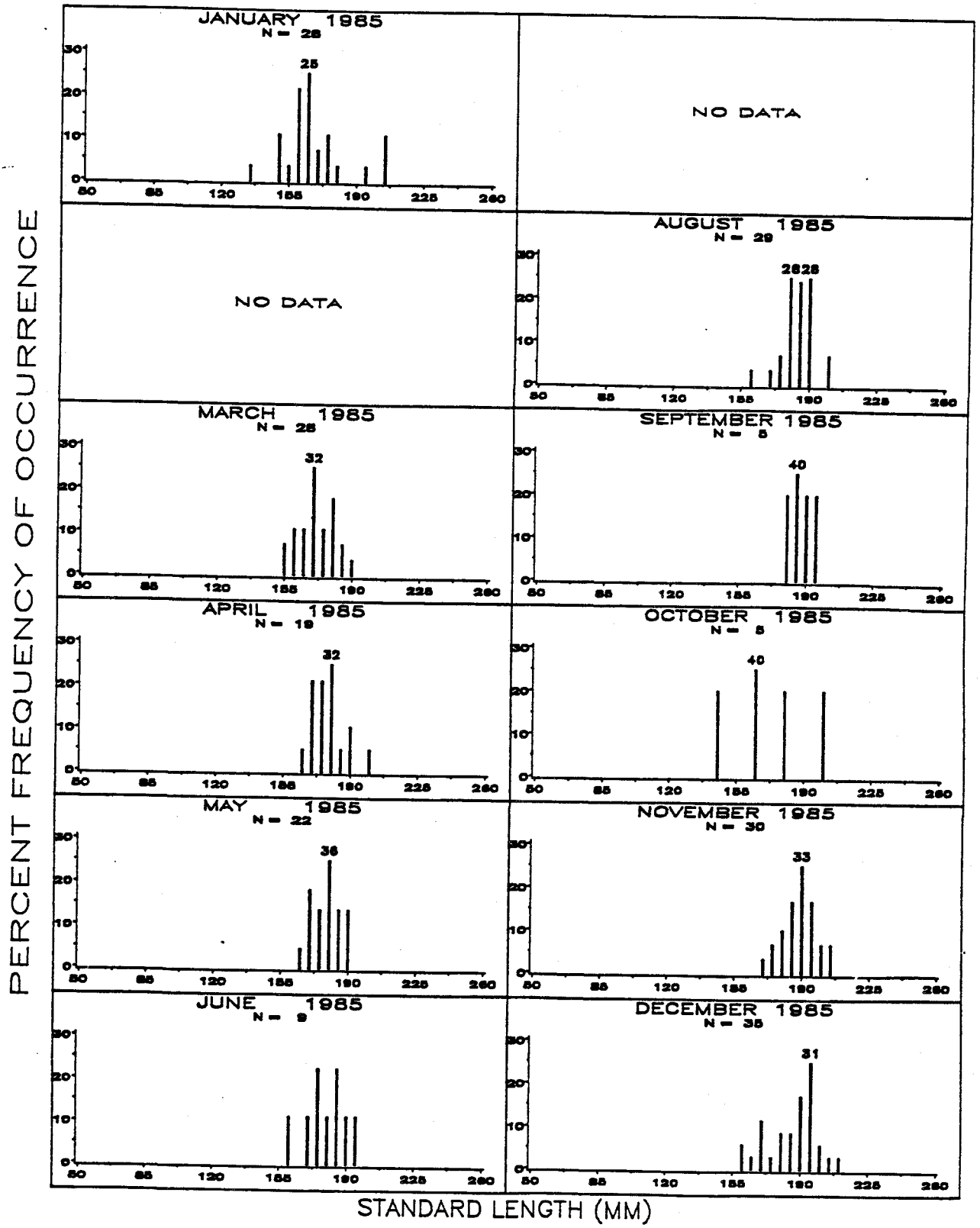


APPENDIX E -- FIGURE 68
(sheet 5 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

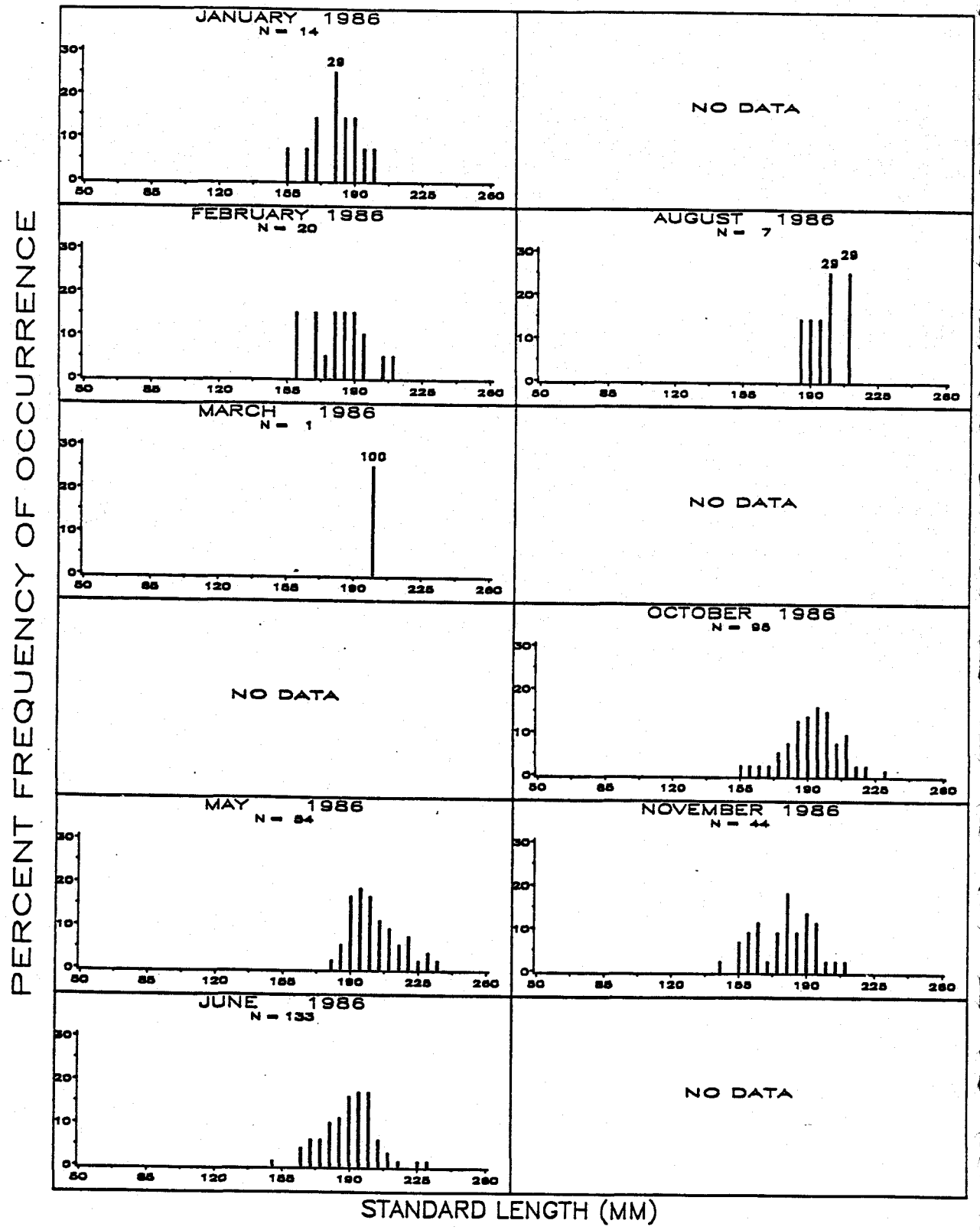


APPENDIX E -- FIGURE 68
(sheet 6 of 6)

OTTER TRAWL

WHITE CROAKER *(GENYONEMUS LINEATUS)*

CONTROL LOCATION 30 METER DEPTH

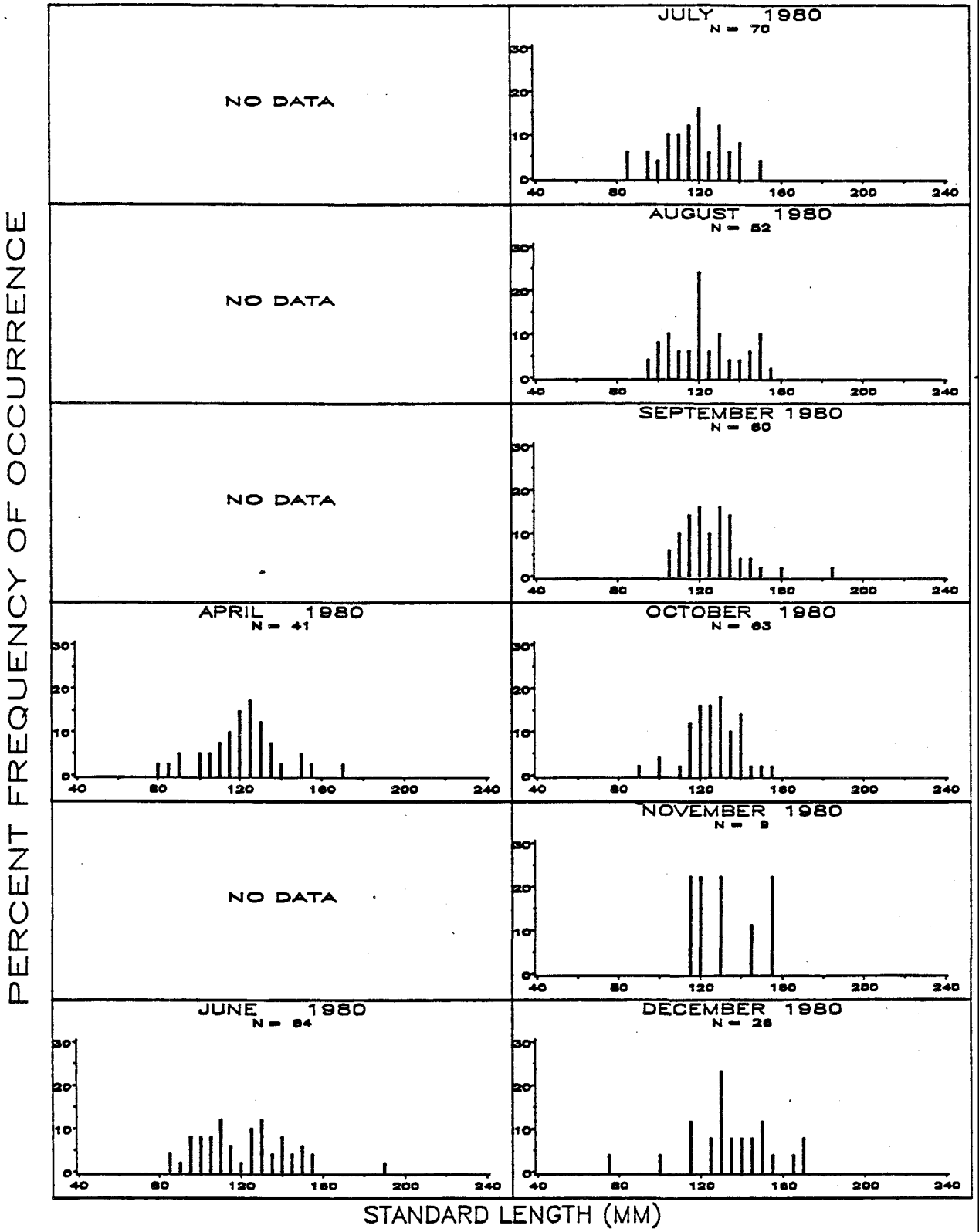


APPENDIX E -- FIGURE 69
(sheet 1 of 6)

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

IMPACT LOCATION 30 METER DEPTH

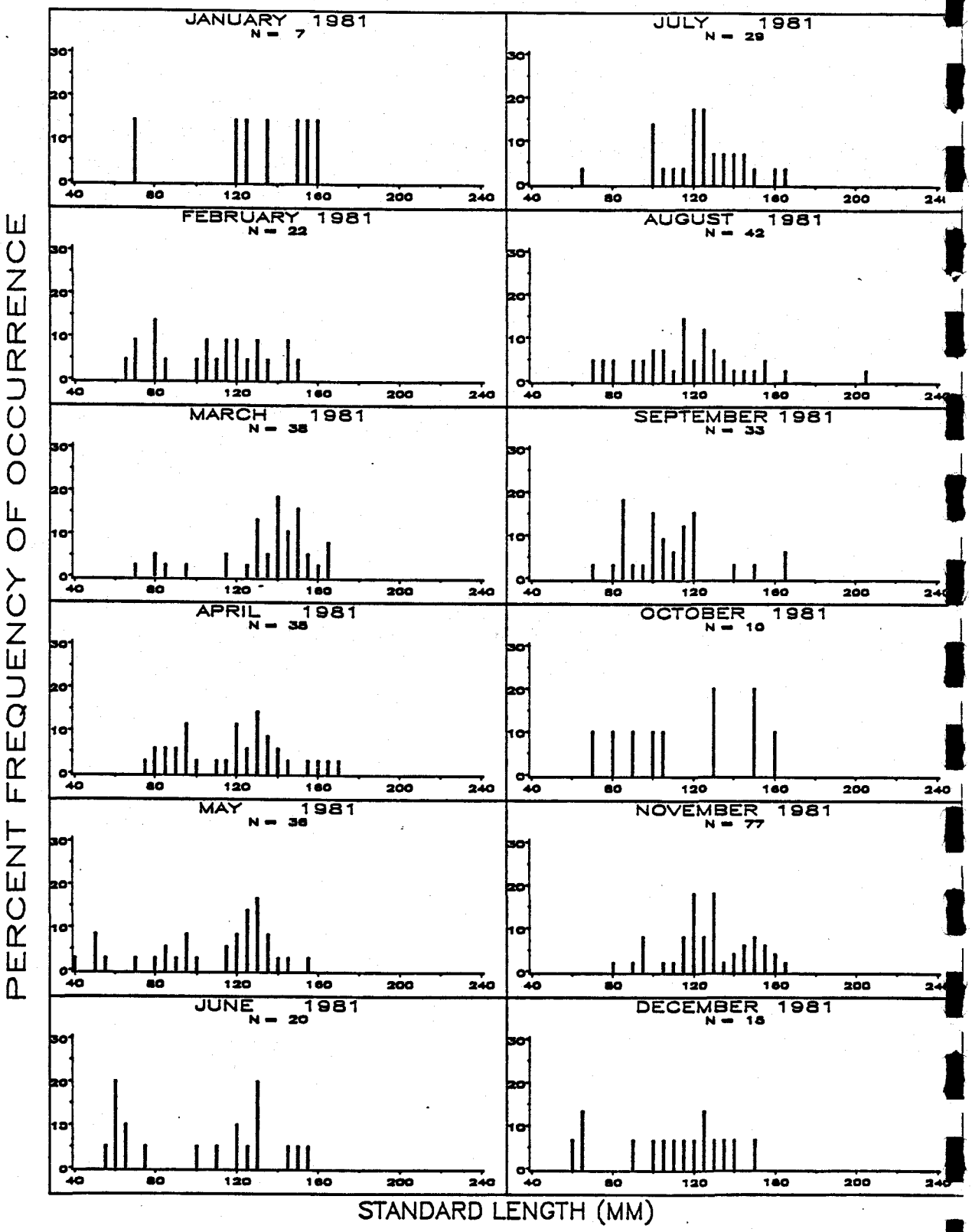


APPENDIX E -- FIGURE 69
(sheet 2 of 6)

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA*

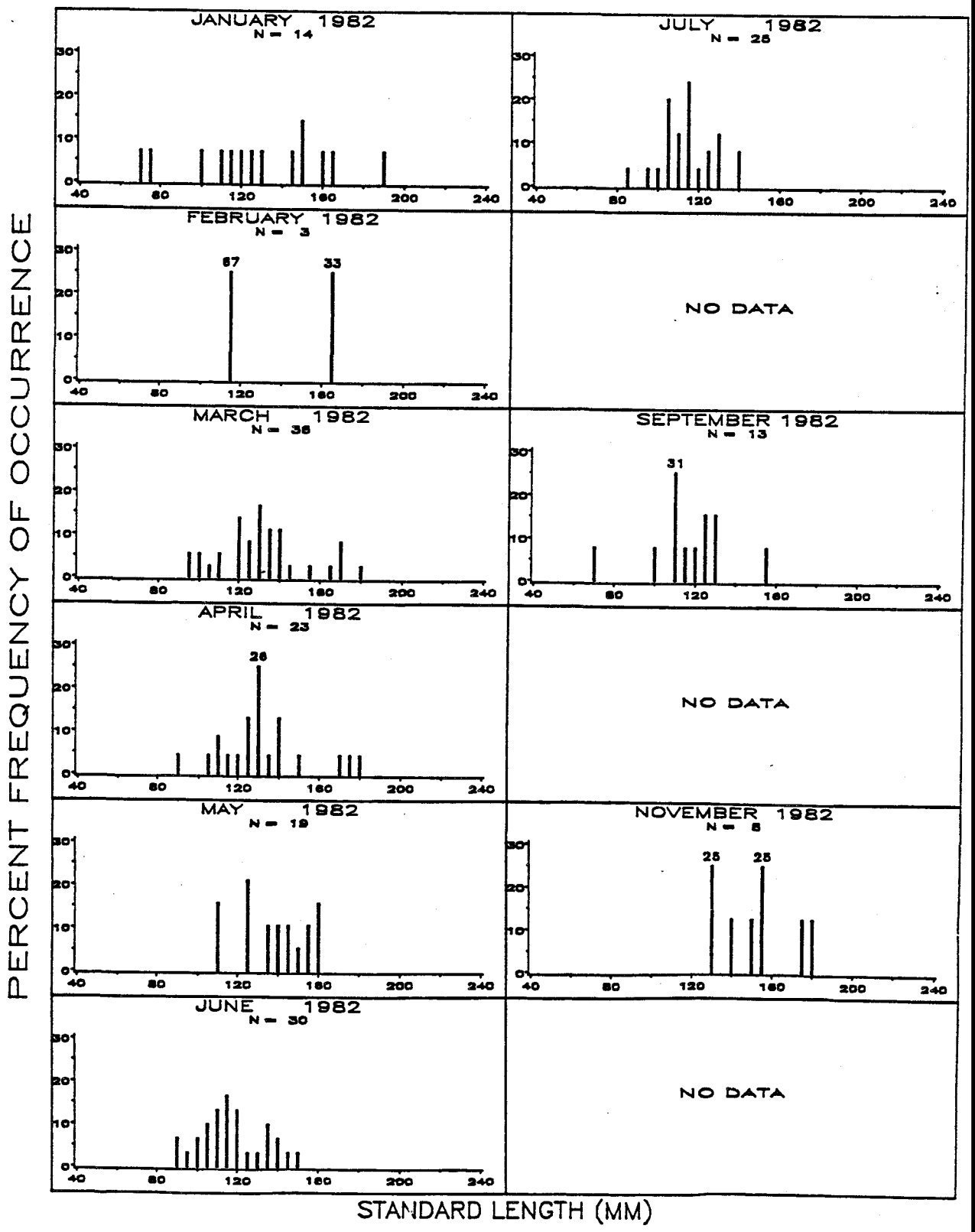
IMPACT LOCATION 30 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

IMPACT LOCATION 30 METER DEPTH

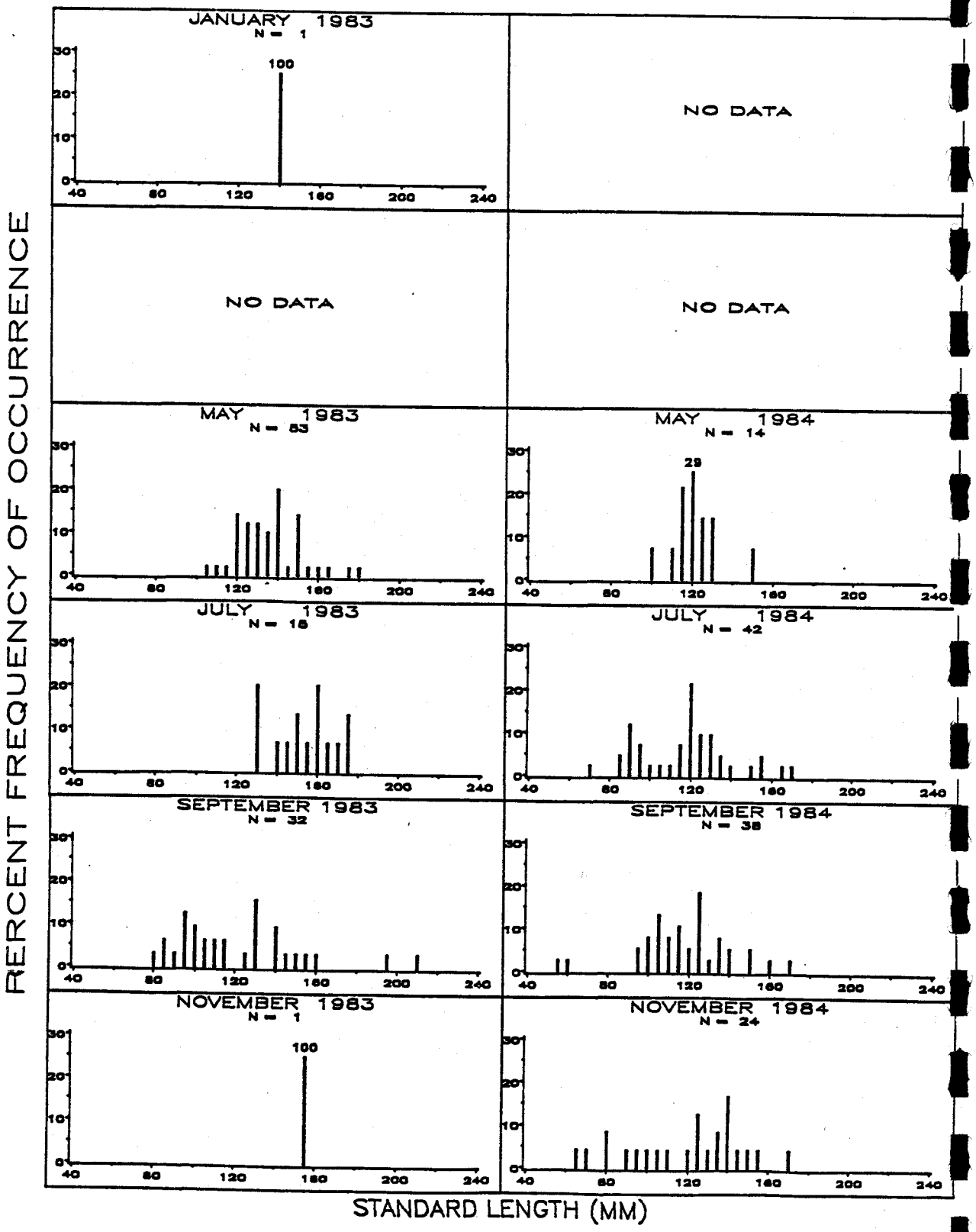


APPENDIX E -- FIGURE 69
(sheet 4 of 6)

OTTER TRAWL

LONGFIN SANDDAB ***(CITHARICHTHYS XANTHOSTIGMA***

IMPACT LOCATION 30 METER DEPTH

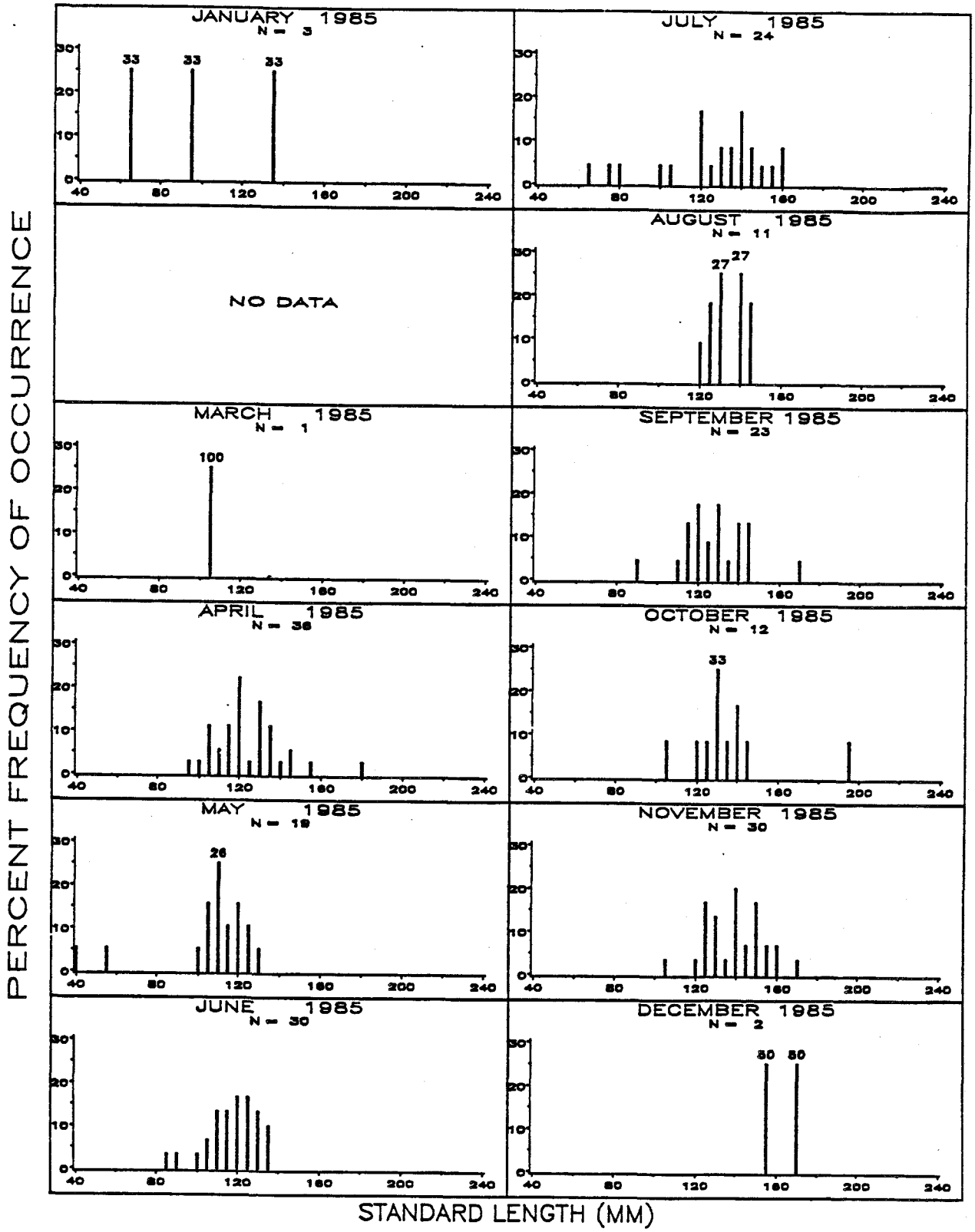


APPENDIX E -- FIGURE 69
(sheet 5 of 6)

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

IMPACT LOCATION 30 METER DEPTH

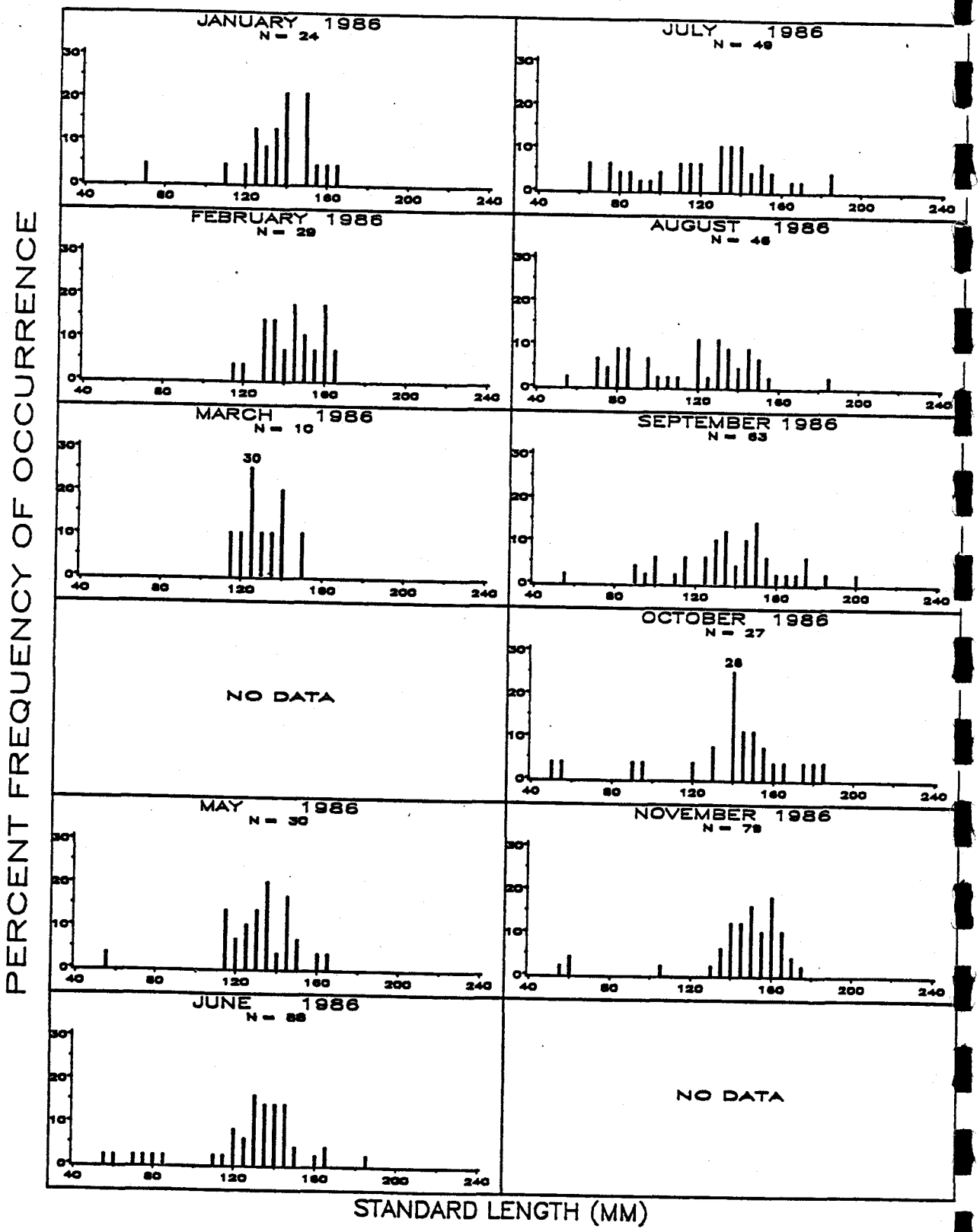


APPENDIX E -- FIGURE 69
(sheet 6 of 6)

OTTER TRAWL

LONGFIN SANDDAB ***(CITHARICHTHYS XANTHOSTIGMA)***

IMPACT LOCATION 30 METER DEPTH

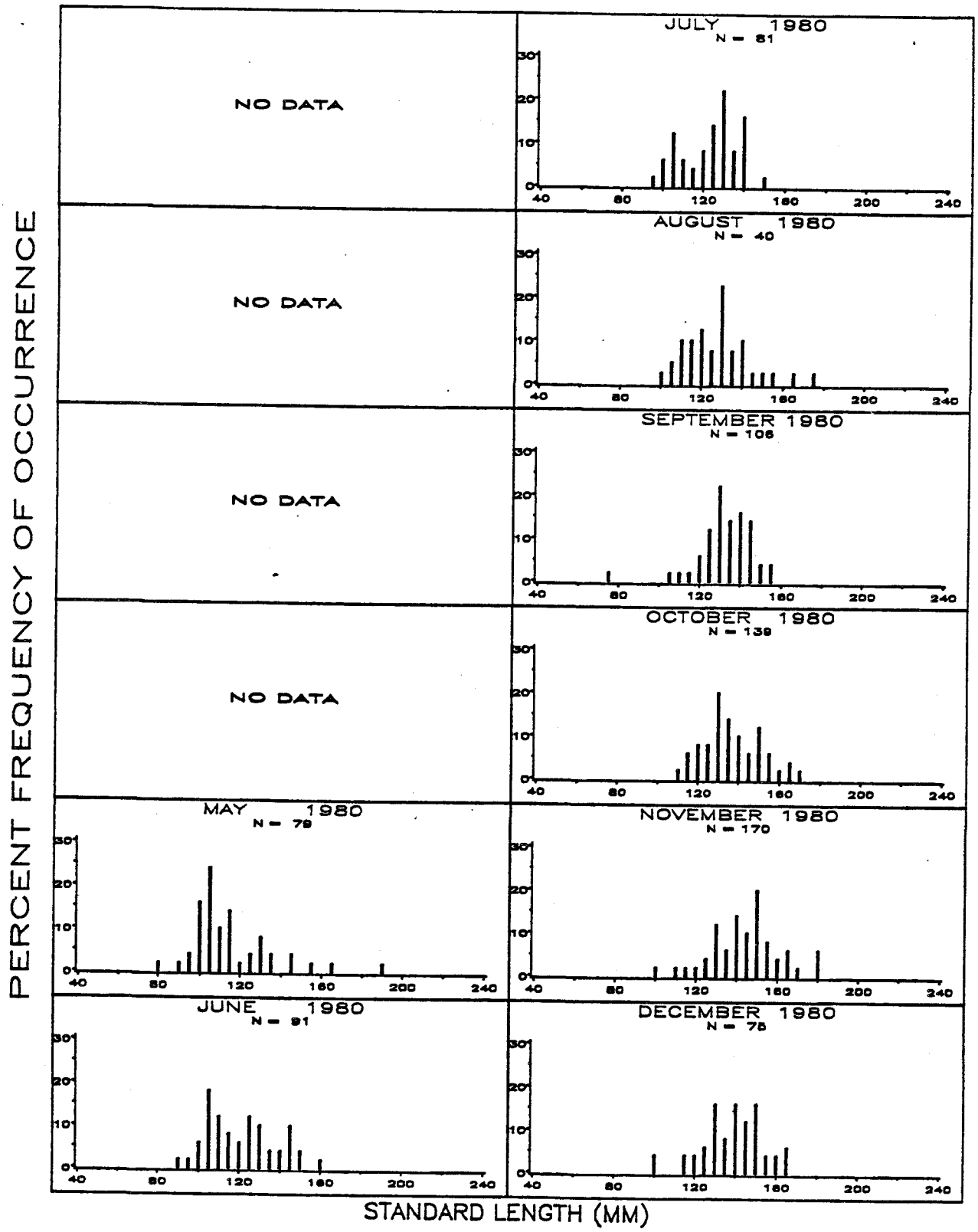


APPENDIX E -- FIGURE 70
(sheet 1 of 6)

OTTER TRAWL

LONGFIN SANDDAB ***(CITHARICHTHYS XANTHOSTIGMA)***

CONTROL LOCATION 30 METER DEPTH

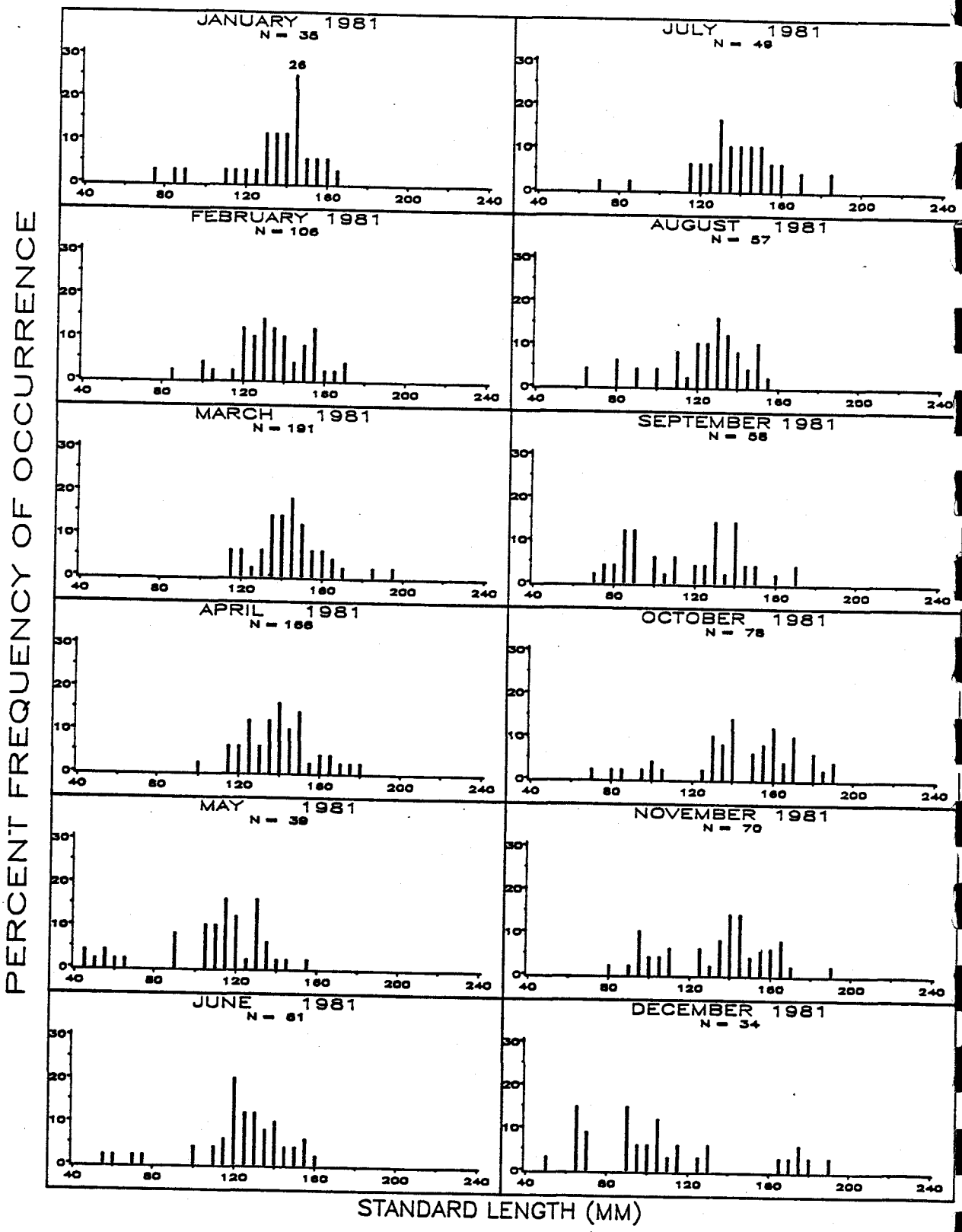


APPENDIX E -- FIGURE 70
(sheet 2 of 6)

OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

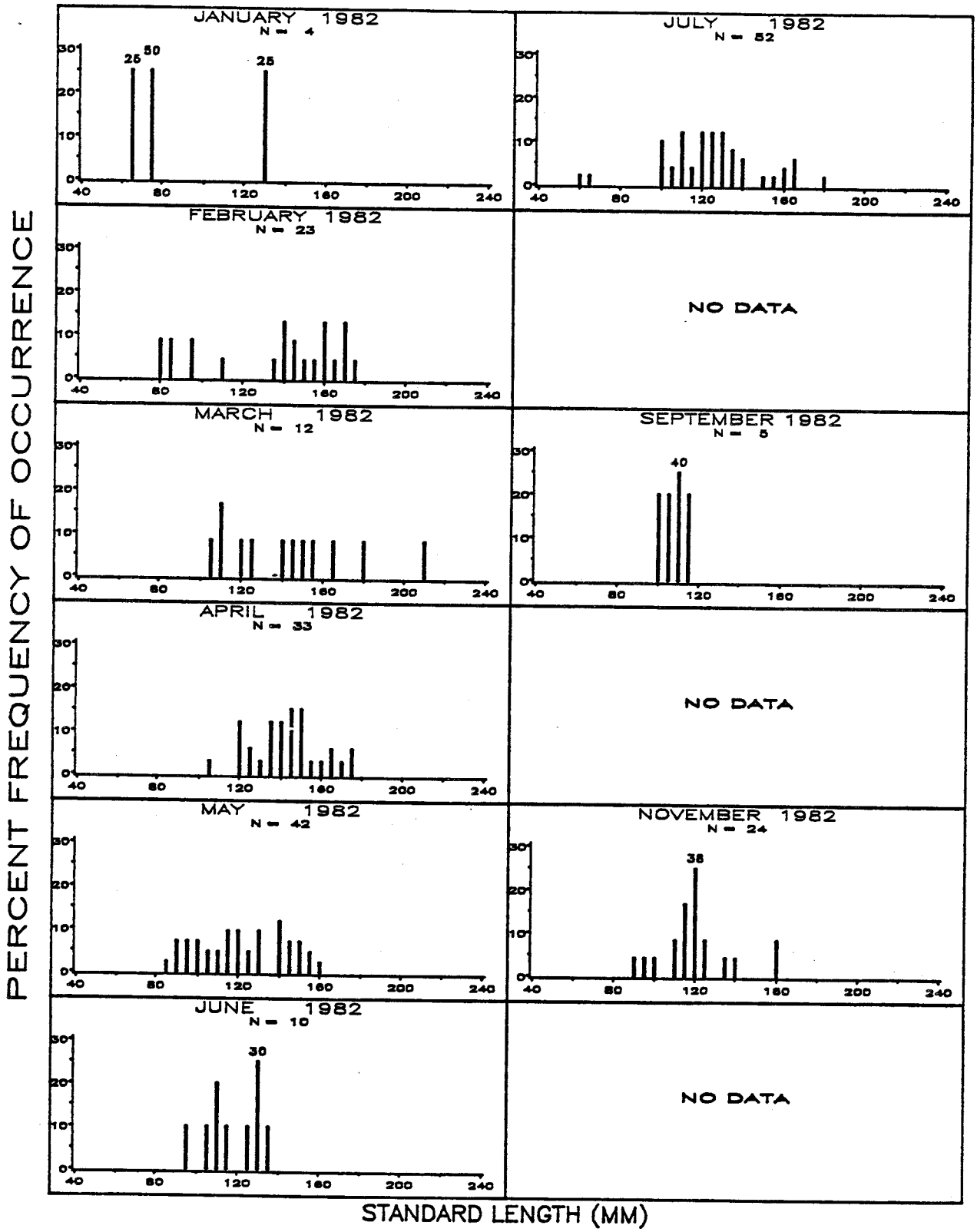
CONTROL LOCATION 30 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB ***(CITHARICHTHYS XANTHOSTIGMA)***

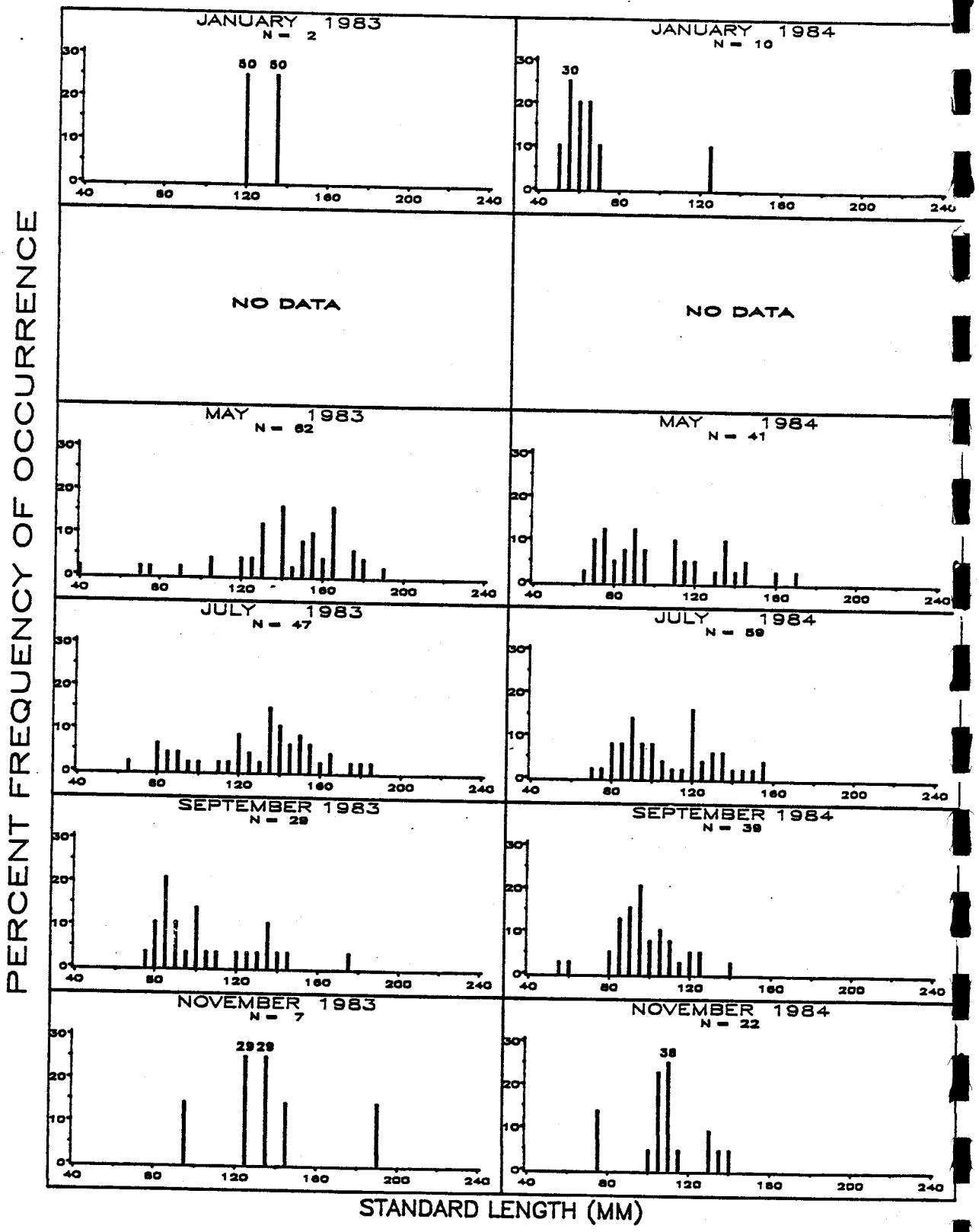
CONTROL LOCATION 30 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA*

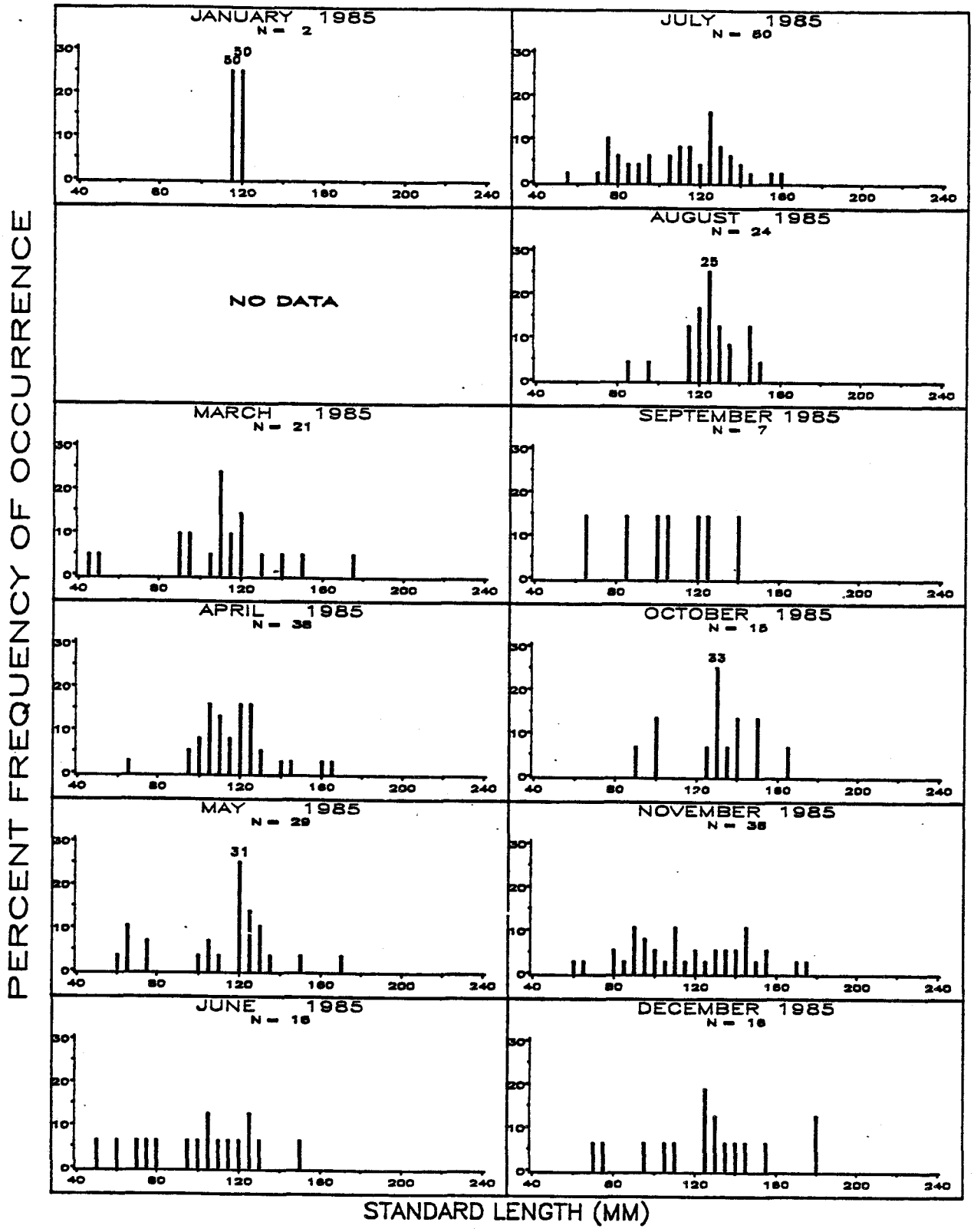
CONTROL LOCATION 30 METER DEPTH



OTTER TRAWL

LONGFIN SANDDAB *(CITHARICHTHYS XANTHOSTIGMA)*

CONTROL LOCATION 30 METER DEPTH

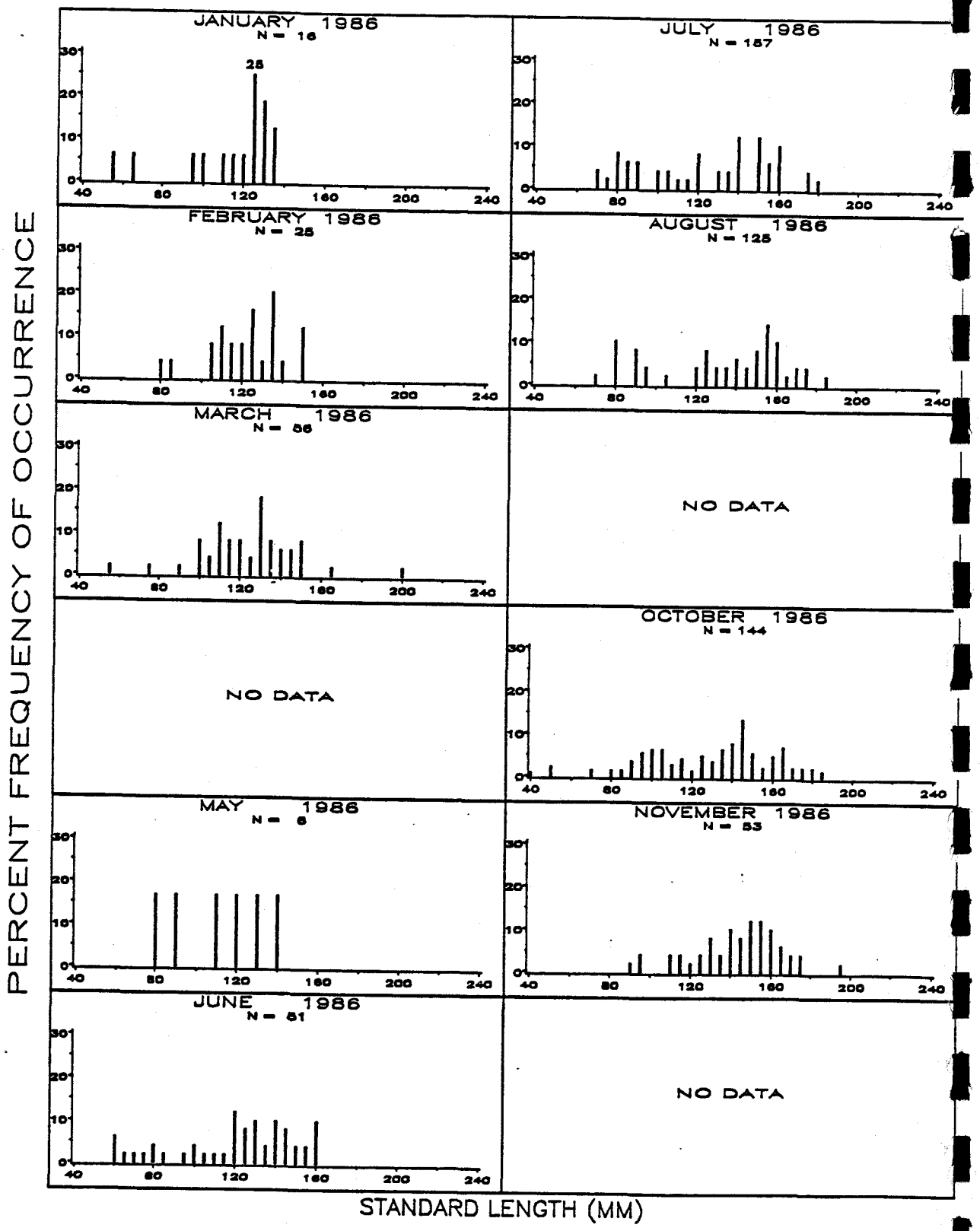


APPENDIX E -- FIGURE 70
(sheet 6 of 6)

OTTER TRAWL

LONGFIN SANDDAB ***(CITHARICHTHYS XANTHOSTIGMA***

CONTROL LOCATION 30 METER DEPTH



APPENDIX F -- Detailed Methods of SONGS Entrapment Studies

APPENDIX F

DETAILED METHODS OF SONGS ENTRAPMENT STUDIES

1. ESTIMATES OF SONGS ENTRAPMENT

A. Impingement and Diversion during Normal Flow

Time Frame of Evaluation. Entrapment estimates were updated for the period from October 1985 to August 1986, the most recent data available on computer. These plus prior data permitted us to make reasonable estimates of annual variations in entrapment magnitude, based on the first 39 months (May 1983-August 1986) of data at the new units, plus concurrent Unit 1 operations. Heat treatments (Section 1.B below) likewise spanned this same 39-mo period.

Sample Definition. Impingement samples at Unit 1 were considered quantitative only if the sample spanned 24 +/- 2-hr operation of both circulator pumps. All analyses for Units 2 and 3 employed paired, quantitative entrapment (impingement plus fish return system) data.

The paired samples at SONGS Units 2 and 3 were considered quantitative only if both of the following criteria were satisfied:

1. Both samples spanned the same 24 +/- 2-hr duration.

2. Four pumps of the same unit were fully operational during the same 24-hr period.

The operating status of each SONGS unit was determined from a record of the volume of water pumped during the period, as indicated on the Marine Review Committee (MRC) SAS data base, DBFLOW (for Units 1, 2, and 3; stored on the MRC's V disk). At full flow, Unit 1 pumps 1.7×10^6 m^3/day (4.5×10^8 gal/day). Units 2 and 3

at full flow each pump 4.5×10^6 m^3/day (1.2×10^9 gal/day). These values were used for the full-flow criteria.

Types of Data. All individuals of every fish species present in each 24-hr impingement sample were enumerated, and aggregate wet weights were determined by species. Catches $\geq$ 1 kg were recorded to the nearest 0.1 kg; catches < 1 kg were estimated to +/- 10 g. Individuals of each of 10 (except for 1) select species (SCE 1982), up to a total of 125 fish, were measured (standard length, SL, in mm) in every 24-hr sample. Prior to November 1983, up to 50 individuals of each select species were also sexed. Beginning in November 1983, up to 250 queenfish were measured and sexed. Length distributions for the total sample were calculated by scaling up the length distributions from the subsamples; these counts provided a more accurate characterization of the parent population (DeMartini et al. 1985a).

Sample and Analysis Designs. Magnitude of impingement and diversion (numbers and biomass) were estimated for the total aggregate of fishes. Analogous estimates of entrapment are also provided for eight previously evaluated (DeMartini et al. 1986) target taxa: white croaker (*Genyonemus lineatus*), queenfish, Pacific electric ray (*Torpedo californica*), white seaperch (*Phanerodon furcatus*), and walleye surfperch (*Hyperprosopon argenteum*), plus Pacific butterfish (*Peprilus simillimus*), silversides (atherinid spp.), and northern anchovy. The numbers and biomass of these fishes that were impinged and diverted at Units 2 and 3 were estimated for normal-flow operations based on all quantitative paired samples that were collected during the 39-mo period from May 1983 to August 1986. Samples from Units 2 and 3 were pooled based on the verified assumption of indistinguishable composition and magnitude of entrapment of the two new units (DeMartini et al. 1986). Samples were used to provide estimates of 24-hr entrapment partitioned into impingement and diversion during normal-flow operations. Quantitative impingement samples at Unit 1 were used to characterize normal-flow entrapment at Unit 1.

The basic data provided by FRS samples were the same, except that we estimated 24-hr samples based on one or two subsamples, each constituting 1/10 of the total sample. The number and weight distributions for each species in the subsamples were scaled up to the total sample. Species composition of each 24-hr sample, estimated from its subsamples, was increased (based on field notes) by the few large organisms that were seen in the total sample but were not included in the subsample because of their size.

Estimates of Entrapment Magnitude. We calculated mean 24-hr values for each calendar month and estimated the total number and biomass impinged or diverted in a month by weighting the mean daily value by the number of "plant-operational days" in that month. Number of plant operational days at Unit 1 was defined as the multiple of its full-flow (two-pump) volume (1.7×10^6 m^3/day) during that month. Number of operational days at Units 2 and 3 was the multiple of their combined full-flow volume (9.1×10^6 m^3/day) contained in the total volume pumped by both units during that month. This method is identical to SCE's method (SCE 1982).

This method is based on the assumption that the magnitude of entrapment (and the ratio of impingement to diversion) is positively and linearly related to volume of water pumped over a range of 25% to 100% pump operation at a unit. A preliminary test of the assumption appears in DeMartini et al. (1986); only 12 samples were then available for the period from May 1983 to August 1985. In the following account, we update this analysis for additional samples collected through August 1986 and evaluate several major species in addition to those (queenfish, anchovy) tested previously (DeMartini et al. 1986). The cumulative number of potential samples is 20 including the update.

With the exception of northern anchovy, the null hypothesis that magnitude of entrapment is a linear function of pumping volume cannot be rejected (Appendix F, Tables 7 and 8). (For anchovy, the data suggest that extrusion through the meshes of the travelling screens is likely greater at higher flow rates.) The relatively small standard errors of the slope estimates indicate that the power of our tests was high (Appendix F, Table 7). We believe that these data strongly support our assumption and justify the method of estimating entrapment magnitude.

Entrapment totals (for an average annual period within May 1983-August 1986) were estimated based on the sum of component monthly losses:

$$\text{Total} = \sum_{j=1}^{12} t_j \quad ,$$

where t_j = monthly loss for month j averaged over different years,

$$= \frac{\text{x-bar}_{j1}n_{j1} + \text{x-bar}_{j2}n_{j2} + \ldots + \text{x-bar}_{jp_j}n_{jp_j}}{p_j} \text{ if } p_j \geq 1 \quad ,$$

where n_{jk} = # of days plant operational in month j and year k,
p_j = # of years for month j, and
x-bar_{jk} = mean 24-hr impingement or entrapment for month j and year k;

$$= \sum_{i=1}^{d_{jk}} x_{ijk}/d_{jk} \quad ,$$

where d_{jk} = # of days observed in month j and year k, and
x_{ijk} = # of fish impinged or entrapped on day i, month j, and year k.

Averaging over years first for each month guarantees that each month is represented equally in the estimated yearly total. This was considered necessary because of the overrepresentation of summer months for the 39-mo period.

Variances of estimated annual normal-flow losses were calculated as the variances of linear combinations (Mood and Graybill 1963:211) using the variances of the 24-hr loss estimates in the component months:

$$\text{var (total)} = \sum_{j=1}^{12} \text{var}(t_j) = \sum_{j=1}^{12} \frac{1}{p_j^2} \sum_{k=1}^{p_j} \frac{n_{jk}^2}{d_{jk}} \text{ var } x_{ijk} \quad .$$

Error bounds thus were slightly underestimated, since losses in adjacent months were somewhat related to one another by seasonal patterns of entrapment.

<u>Currencies of Loss</u>. Entrapment data can be converted to magnitude of fish loss in a number of ways:

Loss estimates are expressed in three ways. First, we estimate numbers and biomass of fishes killed by impingement only. This approach assumes that all fishes diverted and discharged by the FRS survive and is obviously an underestimate. Second, we provide overestimates of loss based on total entrapment (summed impingement and diversion). This set of estimates assumes that all diverted and discharged fishes die within the system or are eaten shortly following discharge. Third, we adjust the diversion component by Occidental College's field survivorship estimates of physiological mortality resulting from entrapment and discharge. Wherever possible, diversion is further adjusted for likely predation shortly following discharge. This third set of estimates is discussed as our best characterization of entrapment loss.

B. Heat Treatments

By mandate of the California Department of Fish and Game, all heat treatments at electric generating stations in southern California must be monitored. Data collected at heat treatments, therefore, represent a "population" not a "sample," because no collections are missed. Thus, all fishes tallied during heat treatments at each of the SONGS units during May 1983-August 1986 were added to entrapment totals for the 39-mo period. Annualized totals were calculated as 12/39ths of 39-mo totals. Not all screenwell resident fishes are killed during heat treatments at the two new units. Robust screenwell residents are herded into the quiet areas of forebays by gradual temperature elevation during the early "fish chase" phase of heat treatment operations. These fishes are collected by lift-bucket and discharged back offshore via the discharge conduit of the FRS. Since these fishes contribute to the diversion component of entrapment, they are not included in the tally of heat treatment mortalities.

Fishes were tallied (numbers, biomass) and body lengths measured (SL, in mm) for select species, as described above for normal-flow operations.

2. EVALUATION OF THE UNITS 2 AND 3 FISH RETURN SYSTEM (FRS)

A. Percent Diversion

All analyses use matched (same-day) "quantitative" impingement and diversion samples only. Because samples were typically collected at about 1000 hr, the diel

period sampled included the late morning, afternoon, and dusk of the calendar day preceding the collection date; the dawn and early morning of the collection date; and the intervening hours of darkness. Samples were considered quantitative only if they represented 24 +/- 2 hr of operation at full flow (all four pumps operative at the unit). A leeway of +/- 2 hr was considered in order to reasonably include all routine variation in sample collection. Only full-flow conditions were analyzed, because the diversion efficiency of the FRS louver system might differ with flow.

B. Percent Survivorship

Offshore Survivorship Tests. The magnitude of FRS-induced mortalities from mechanical damage or physiological stress during discharge was estimated based on 96-hr field experiments. These experiments were contracted directly by Southern California Edison (SCE) and conducted by Occidental College. Preliminary experiments began in May 1983. An appropriately controlled series of experiments began in October 1983 and ended in August 1985. The University of California Santa Barbara (UCSB) Fish Study Project in-plant representative participated in the start and finish of all field tests from April 1984 onward.

FRS-discharged fishes were captured in octagonal (12-ft x 12-ft) pens with frames constructed of PVC pipe. Walls were 1/4-in. (bar), knotless-mesh nylon webbing. Quantitative diversion samples (samples of fishes that had been held approximately 24 hr in screenwells at one or both new SONGS units) were discharged into one or two experimental pens at the start of each 96-hr series. Experimental pens were then moved a short distance upcoast or downcoast of the FRS discharge conduit and anchored. Fishes for control pens were captured in the general SONGS area in pens bearing detachable fyke-net wings that herded fishes through the pen's mouth. Control pens were set up 1 to 2 nights before the start of the experimental pen tests in order to capture crepuscular and nocturnal cross-shelf migrators such as queenfish. Control pens were identical in size and materials with experimental pens.

Control tests were often not concurrent with experimental runs but were frequently alternated over periods of several days to several weeks. However, we believe that date influences (variable surge, seasonal occurrence of fish of particular body sizes, etc.) were randomly distributed among experimental and control tests and thus should not bias the results.

A 96-hr duration was chosen as sufficient to detect death due to bacterial/fungal infection or osmotic stress following mechanical damage. All results were based on fish held in pens for 96 hr. Fishes in experimental and control pens were checked daily by divers, and the data were summed for four days to characterize cumulative mortalities.

The amount of information provided by each experiment varied with (1) the number of experimental and control pens used in each series and (2) the number of individuals of each species and the number of species present in each pen. Factor (1) was not constant because of disruption by storms, etc. Factor (2) also varied between series and between pen types within series because of random fluctuations in the relative abundances of species over time and because the intakes and fyke nets differed in species selectivity. Prior analyses indicate that the number of queenfish mortalities in either experimental or control pens was unrelated to fish densities in the pens (DeMartini et al. 1986).

Because significant effects of stocking densities on queenfish mortality were undetectable, we pooled data over all pens within each type for all experiments conducted off SONGS from October 1983 to August 1985. Total mortality was estimated as (total number dead after 96 hr) divided by (total number of fish tested) for each species represented by more than one individual in each type of pen. Total number of fish tested was the sum of all living and dead fish collected in the experiment. Total number dead after 96 hr included fish that were dead on arrival at the experimental pen immediately after discharge. We used mortality in control pens (p_c) to estimate pen effects per se. Mortality in experimental pens (p_e) was considered an estimate of the sum of both pen-induced and FRS-induced mortality. The difference between p_e and p_c represented FRS-induced mortality (p_{frs}). That is,

$$p_{frs} = p_e - p_c \quad .$$

Standard errors of the mean estimate were based on binomial probabilities:

$$\hat{SE}_{frs} = SQRT\left[\frac{p_e * (1 - p_e)}{N_e} + \frac{p_c * (1 - p_c)}{N_c}\right],$$

where N_e = # individuals tested in all experimental pens, and
N_c = # individuals tested in all control pens.

Ninety-five percent confidence intervals were calculated as the normal approximation, $p_{frs} \pm 1.96\ (SE_{frs})$. If $p_c = 0$ (no fish died in the control pen), this formula still yields the correct confidence intervals for p_{frs}: $p_e \pm 1.96$ SQRT $\{p_e\ (1 - p_e)/N_e\}$.

Analogous survivorship for all fishes falling into several general size classes was estimated in the following manner. The average value of survivorship for "small-bodied" fishes (except northern anchovy) was defined as the weighted mean (0.66) of the observed survivorships of queenfish (0.68) and white croaker (0.48). Queenfish and white croaker together constituted 96% of the numbers and 97% of the biomass of all small fishes (excluding northern anchovy) in comprehensive diversion samples at Units 2 and 3 (Appendix H, Table 1). The survivorship value used for northern anchovy was the observed estimate of 0.97 (Appendix H, Table 3). Survivorship for "medium-sized" fishes was set at 1.0, based on the empirical observations for 122 test salema and the 100% survivorship of 13 individuals of 7 other species in experimental pens (Appendix H, Table 3). Survivorship for "large-bodied" fishes was also set at 1.0, reflecting the observed test results for 405 yellowfin croaker and 21 survivors out of 22 individuals of 9 other species in experimental pens (Appendix H, Table 3).

Predation Upon Discharge. The aforementioned estimates of survivorship based on Occidental College's field tests consider only one of two important aspects of the total survivorship of FRS-discharged fishes. Our evaluation of the overall survivorship of discharged fishes also included a reasoned consideration of the probability of surviving predation shortly following discharge (hereafter referred to as S_2). Values of S_2 were assigned to fishes according to general body sizes. The body size categories were defined as follows. First of all, average body weight was calculated for each fish taxon present in quantitative normal-flow samples at Units 2 and 3 (Appendix H, Table 1). These data fell naturally into three size groups comprising roughly equal numbers of taxa: "small-bodied" fishes

weighing less than 30 g (< ~ 1 oz); "medium-sized" fishes weighing between 30 and 200 g (~ 1/2 lb); and "large-bodied" fishes weighing more than 200 g. The mean body weights of all fishes in these three size categories were 13, 94, and 472 g, respectively (Appendix H, Table 2). With one exception, all small-bodied fishes were assigned a conditional probability of 0.25 of being eaten shortly following discharge (therefore S_2 = .75). Northern anchovy were considered to be at greater risk to predation (S_2 = .5) because of their extremely small size in SONGS entrapment samples (mean = 2 g: Appendix H, Table 1). Medium-sized fishes were given a much higher probability of avoiding predation (e.g., by large predatory fishes and seals: S_2 = .9). Large-bodied fishes were considered almost immune to predation (S_2 = .99).

3. COMPARISONS OF UNIT 1 WITH UNITS 2 AND 3

See Part 1 of this Appendix for a detailed description of the various types of data provided by different classes of SONGS operations and their respective sampling designs.

Analysis methods for Unit 1 versus Units 2 and 3 comparisons are described in Methods Section 2.2.3 of Volume 1.

4. ENTRAPMENT AS MECHANISM FOR OBSERVED NEARFIELD DECLINES

A. Entrapment - Field Abundance Relations

Entrapment versus Near-SONGS Abundance and Susceptibility. This regression analysis used entrapment samples at SONGS Units 2 and/or 3 as the dependent variable. Only quantitative samples (representing full pumping for 24 +/- 2 hr) were used. If quantitative samples were available for both new units on a particular date, values at the two units were averaged. Entrapment data were log-10 transformed before analysis in order to reduce scatter.

Three independent variables were considered.

(1) Near-SONGS abundance was indexed by numerical catch-per-seine-haul (CPUE, see Appendix A) at the sampling station located 2-3 km downcoast of Unit 1. The data used were seine collections made during the night preceding the date of the entrapment sample. CPUE data also were log-10 transformed before analysis.

(2) Wave surge, the first of two environmental measures of susceptibility, was represented by a variable named MAXIMUM SIGNIFICANT WAVE HEIGHT. Data for the first 10 of the 16 sampling dates (Appendix I, Table 1) were collected by ECOsystems Management Associates (ECO-M) at a station located at 11-m depth in 12 m of water, about 1 km offshore of the SONGS Unit 1 outfall. No San Onofre data were available for the last six sampling dates; values for the San Onofre station were estimated using other matched data for the San Onofre, San Clemente Island, and Oceanside stations. These data were collected by the Coastal Data Information System (CDIS) and entered on the MRC's IBM 4341 computer system at Encinitas by ECO-M. These wave-height data are coded as the HEIGHT variable on ECO-M's DBWAVES.YR85 and .YR86 SAS data bases. The mathematical interrelationships of wave-height measurements at the three stations were evaluated for an extensive series of 505 dates spanning the period from January 1985 through November 1986. Because these data were collected at daily intervals within periods separated by missing data (due to meter malfunctions), autocorrelation was evaluated using SAS PROC AUTOREG. A significant ($P < 0.0001$) first-order autoregressive process was detected; regression coefficients, therefore, were adjusted within PROC AUTOREG. The final model used to estimate surge off San Onofre was:

$$\text{San Onofre} = +0.1078 + 0.4183\ \text{San Clemente} + 0.4426\ \text{Oceanside} - 0.0660\ (\text{Oceanside} * \text{San Clemente})$$

$$R^2 = 0.769$$
$$P < 0.0001$$
$$N = 505$$

(3) Turbidity, the second measure of susceptibility, was measured within SONGS screenwells concurrent with the entrapment sample. Southern California Edison (SCE) in-plant contractors took samples of screenwell water and used nephelometry to measure their optical density (in O.D. units) for white light (K. Herbinson, pers. comm.). The average of three readings of each of three screenwell samples was used in our analysis. Data are coded as the TURBID variable on various SCE SAS data bases. These are DBALLIMP.SPARMS (1983-84; stored on the UCSB Fish Project's F disk) and DBSCE.SPPARM85 (1985; on SCE's 404 disk). Both the F and the 404 disks are available on the MRC's IBM 4341 computer system at Encinitas. TURBID data for 1986 were computer-entered by the Fish Project off of the SCE contractor's raw in-plant data sheets. (The 1986 update of SCE's SAS data base had the TURBID variable deleted.)

Nearfield Depression versus Entrapment and Pump History. Our primary regression model used the deltas (differences) between numerical lampara catch per seine haul (CPUE, see Appendix A) at two pairs of longshore locations as the dependent variable. These two pairs of locations were (1) the Near Impact (NI) station, $\leq$ 1/2 km of the SONGS Unit 1 intake, versus the Far Impact (FI) station, 2-3 km downcoast of Unit 1, and (2) the NI station versus the distant Control (C) station, 18-19 km downcoast of SONGS (Appendix A, Fig. 1). CPUE data were log-10 transformed prior to calculation of deltas. Deltas were calculated for each pair of seine samples taken at shallow (5- to 10-m) depths on each sampling date. Deltas were always calculated as Impact minus Control--i.e., either as NI - FI or as NI - C--in keeping with our BACI t-test protocols (Appendix D, E).

Two independent variables were considered.

(1) SONGS entrapment was characterized as the sum of total entrapment at all three SONGS units for any particular 24-hr period. Entrapment at both new units was estimated as twice the entrapment sample at one or other new unit on that date, linearly corrected for less-than-full pump flow as necessary. Entrapment samples at Units 2 and 3 were summed for each of the 8 dates with quantitative samples at both new units. Entrapment was undecremented for FRS survival because a large majority of the test species (small queenfish) are either impinged or die if diverted. On the 3 dates for which a quantitative entrapment sample existed at Unit 1, the Unit 1 collection was added. (Unit 1 was inoperative on 7 other dates.) On the 6 days when Unit 1 was operating but a quantitative sample was not collected, entrapment at Unit 1 was estimated based on average 24-hr entrapment (at full flow) at Unit 1 during that month and year, adjusted for less-than-full pump flow on that day, as necessary.

(2) Recent SONGS pumping history was evaluated for four definitions of "recent" because we lacked data for an a-priori definition of the rate of accrual of nearfield depression. The four periods evaluated were 1 day, 2 days, 3 days, and 7 days before the date of the entrapment estimate. The variable used in the analysis was the total flow volume at all three SONGS units for the period. This variable is coded as FLOWVOL on the SAS data bases DBSONGS. (1983 to 1986 year members) on the MRC's V disk.

B. Balance Calculations

Introduction. One major aspect of the MRC's evaluation of SONGS impact on nearshore fish stocks involves monitoring the abundance of coastal pelagic (midwater) fishes immediately near and at varying distances from the region of SONGS offshore intake structures.

The juvenile-adult life stages of several nocturnally active species of small, schooling, zooplanktivorous fishes are routinely entrapped at these intake structures along with the large volumes of water that are withdrawn to cool SONGS' turbines. Subsequently, these fishes are either impinged on travelling screens in the plant or are diverted within the forebays (at Units 2 and 3 only). The latter are discharged back offshore through a conduit of the fish return system that exits inshore of the new intake structures (DeMartini et al. 1985a, 1986). High numbers and biomass of one species in particular (queenfish, *Seriphus politus*) are entrapped. Even though the majority of these queenfish are diverted and discharged back offshore, it is likely that many or most fish, juveniles in particular, are eaten or otherwise die (DeMartini et al. 1985a). An average of 63% of the small and 73% of the large queenfish survive the physiological rigors of the discharge process. It is likely that survivorship is further reduced by predation upon discharge (see "Percent Survivorship," Chapter 2).

The objective of our field monitoring of juvenile-adult queenfish and allied fishes has been to detect, should it occur, a relative 50% decline in numerical density within the SONGS nearfield (defined as within 1/2-km radius of the SONGS Unit 1 intake). An index of density (catch per unit of effort, CPUE) was estimated using standard-effort hauls of a lampara seine (a type of semipursing, round haul net) in the nearfield and at two other longshore locations (Far Impact = 2-3 km downcoast; Control = 18-19 km downcoast of SONGS off Stuart Mesa). Lampara CPUE was estimated for a baseline period (before sustained operation of Units 2 and 3), an interim period (during partial operations at one or both new units), and an operational period since April 1984, when both new units began pumping at full-flow volumes.

Lampara CPUE data collected during the latter part of the interim period (August-October 1983 and February-March 1984) suggested a relative nearfield decline in postsettlement queenfish at shallow depths, particularly small (3-10 cm

standard length, SL), young-of-the-year (YOY), and age I+ (1- to 2-yr-old) immature fish (DeMartini et al. 1985a, Tables 32 and 33). DeMartini et al. (1985b, Appendix B; 1986, Appendix H) provide several preliminary comparisons between entrapment magnitude and the suggestive nearfield depression that continued through the early operational period.

The purpose of the following account is to provide details supporting our ifinal evaluation of whether the relative declines in queenfish catches near SONGS that have now been substantiated (Chapter 1, this report) are explicable in terms of the predicted mechanism of potential local decline. We herein compare data on the magnitude of entrapment at SONGS Units 1, 2, and 3 with gross estimates of abundance in the SONGS nearfield, the latter based on CPUE estimates and specified assumptions. We base our evaluation on entrapment and abundance data for small queenfish (defined below), because most entrapped queenfish are small and because small queenfish represent those least likely to survive discharge if diverted by the FRS.

Entrapment Data. SONGS entrapment data for small queenfish are provided for two periods. Entrapment was estimated for the period from April to August 1986, which matches our latest series of field abundance estimates. (The most updated inplant data available for SONGS Units 1, 2, and 3 are for the period from October 1985 to August 1986). Entrapment totals were also estimated for the period from April to September 1985. These data match the period of collection of our next-to-last series of lampara field samples. Total numerical entrapment is divided into an entrapment subtotal for small individuals ($\leq$ 10 cm SL) and into an entrapment subtotal for large individuals (> 10 cm SL). Biomass entrapment of small queenfish was estimated from length-frequency distributions by converting length to weight frequencies using the length-weight relation

$$W = (8.7 \times 10^{-6})SL^{3.11} \quad ,$$

where W = weight in grams, and
SL = standard length in mm (DeMartini and Fountain 1981).

Three separate loss estimates were calculated. The first was based on an assumption of 100% mortality of diverted and discharged individuals. The second estimate adjusted mortality of the diversion component of entrapment for the

average survivorship of small queenfish discharged by the FRS (Chapter 2). The third estimate adjusted the diversion component for predation as well as transport factors. Estimated survivorship was 63% (transport only) or 47% (as .63 x .75, for transport plus predation).

Field Abundance. Abundances were estimated using nighttime lampara CPUE (as an index of density), standardized to the area fished by the seine (4,600 m^2) and adjusted for our best estimate of catchability at night (25%: Allen and DeMartini 1983). Abundance-per-area-of-net was then standardized to a presumed circular (500-m radius) area of the nearfield (78.5 ha), based on the multiple (170.6) of the fishing area of the seine contained in the nearfield.

Abundances of small queenfish were estimated for two periods. Baseline abundances were characterized using CPUE data collected on 22 preoperational cruises during the six-month period from April through September 1981. (This portion of the baseline period was chosen because it represents the only continuous series of April-September samples at all locations during that period.) Recent field abundances were estimated based on each of two series of samples. (1) Prior estimates are provided, based on 11 operational cruises completed during the six-month period from April to September 1985. (2) More recent estimates were based on 8 operational cruises completed during the five-month period from April-August 1986. The operational nearfield decline was characterized as the recent versus baseline change in the differences between the average CPUE (raw catch data) at the nearfield and Control locations. Densities at the Far Impact location were also used to provide another basis of comparison with the nearfield data.

Recent-versus-baseline changes in the differences between average catches at these two pairs of locations were calculated as follows. Baseline differences, even if only nominal, were used. If a baseline (natural) deficit existed in nearfield catches, we decremented a deficit observed in operational catches by the proportionate natural deficit. Similarly, a baseline surplus in the nearfield was used to enlarge an observed operational deficit.

Numerical catch data for total queenfish were subdivided into two groups, small-sized and large-sized individuals. Length-frequency distributions from subsamples were scaled up to total numbers of queenfish groups present in the

parent samples. Biomass of small and large queenfish in seine samples was calculated using the average body weights of small and large queenfish groups from entrapment samples during the respective period.

APPENDIX F -- TABLE 1

SONGS ENTRAPMENT: LIST OF DATES (X) OF QUANTITATIVE ENTRAPMENT COLLECTIONS AT SONGS UNIT 1, 2, OR 3 during the 39-mo period from **May 1983 through August 1986**. All collections at Units 2 and/or 3 include both quantitative impingement and diversion samples.

Date	Unit 1	Unit 2	Unit 3
25 MAY 83		X	
01 JUN 83		X	
10 AUG 83	X		
24 AUG 83		X	
21 SEP 83		X	
05 OCT 83		X	
11 OCT 83		X	
12 OCT 83		X	
19 OCT 83		X	
30 NOV 83	X		
04 JAN 84	X	X	
05 JAN 84		X	
11 JAN 84	X		
18 JAN 84	X		
14 FEB 84	X		
15 FEB 84	X		
21 FEB 84	X		
22 FEB 84	X		
29 FEB 84		X	
06 MAR 84		X	
07 MAR 84	X	X	
20 MAR 84		X	X
28 MAR 84			X
17 APR 84			X
18 APR 84		X	X
24 APR 84		X	X
25 APR 84		X	X
22 MAY 84			X
30 MAY 84			X
06 JUN 84		X	X
12 JUN 84		X	
13 JUN 84		X	

APPENDIX F -- TABLE 1 (continued)

Date	Unit 1	Unit 2	Unit 3
18 JUL 84			X
01 AUG 84			X
14 AUG 84		X	X
15 AUG 84			X
22 AUG 84		X	X
05 SEP 84		X	X
19 SEP 84		X	
03 OCT 84			X
09 OCT 84		X	X
10 OCT 84		X	X
16 OCT 84		X	
17 OCT 84		X	X
24 OCT 84			X
30 OCT 84	X		
07 NOV 84	X		
14 NOV 84	X		
20 NOV 84	X		
11 DEC 84	X		X
18 DEC 84	X		
19 DEC 84	X		
26 DEC 84			X
27 DEC 84	X		X
03 JAN 85			x
09 JAN 85	x		x
16 JAN 85	x		x
23 JAN 85	x		x
29 JAN 85	x		
30 JAN 85	x		x
06 MAR 85	x		x
13 MAR 85			x
20 MAR 85	x		x
26 MAR 85	x		
27 MAR 85	x		x
02 APR 85	x		x
03 APR 85	x		x
09 APR 85	x		
10 APR 85	x		x

APPENDIX F -- TABLE 1 (continued)

Date	Unit 1	Unit 2	Unit 3
16 APR 85	x	x	x
17 APR 85	x	x	x
23 APR 85	x	x	x
24 APR 85	x	x	x
30 APR 85	x	x	x
07 MAY 85		x	x
08 MAY 85		x	x
15 MAY 85		x	x
21 MAY 85			x
22 MAY 85			x
29 MAY 85	x		
30 MAY 85		x	
04 JUN 85	x	x	x
05 JUN 85		x	x
11 JUN 85			x
18 JUN 85	x		
25 JUN 85		x	x
26 JUN 85	x	x	x
02 JUL 85	x		x
03 JUL 85			x
09 JUL 85	x		
10 JUL 85			x
16 JUL 85	x	x	x
17 JUL 85		x	x
23 JUL 85		x	x
24 JUL 85		x	x
30 JUL 85		x	x
31 JUL 85	x	x	x
06 AUG 85	x		
14 AUG 85		x	x
15 AUG 85	x		
20 AUG 85	x	x	
21 AUG 85		x	x
27 AUG 85		x	x
28 AUG 85		x	x
04 SEP 85	x	x	x
05 SEP 85			x
10 SEP 85	x		
12 SEP 85		x	x
17 SEP 85	x	x	x
18 SEP 85		x	
24 SEP 85	x		

APPENDIX F -- TABLE 1 (continued)

Date	Unit 1	Unit 2	Unit 3
01 OCT 85	x		
02 OCT 85		x	
08 OCT 85	x		
09 OCT 85		x	
15 OCT 85	x	x	
16 OCT 85		x	
22 OCT 85	x		
29 OCT 85	x		
05 NOV 85	x	x	
13 NOV 85		x	
19 NOV 85	x		
24 DEC 85		x	
31 DEC 85		x	
07 JAN 86		x	
08 JAN 86		x	
21 JAN 86			x
22 JAN 86		x	x
28 JAN 86		x	x
29 JAN 86		x	x
04 FEB 86			x
05 FEB 86			x
19 FEB 86		x	
20 FEB 86		x	
25 FEB 86		x	
26 FEB 86		x	
04 MAR 86		x	
05 MAR 86		x	
11 MAR 86		x	
12 MAR 86		x	
25 MAR 86			x
26 MAR 86			x
01 APR 86			x
02 APR 86			x
08 APR 86			x
09 APR 86			x
15 APR 86			x
16 APR 86			x
22 APR 86			x
23 APR 86			x
29 APR 86			x
30 APR 86			x

APPENDIX F -- TABLE 1 (continued)

Date	Unit 1	Unit 2	Unit 3
07 MAY 86			x
20 MAY 86			x
21 MAY 86			x
28 MAY 86			x
29 MAY 86			x
03 JUN 86			x
04 JUN 86			x
10 JUN 86		x	x
11 JUN 86		x	x
17 JUN 86	x		
18 JUN 86			x
24 JUN 86			x
25 JUN 86			x
01 JUL 86	x	x	x
02 JUL 86		x	x
08 JUL 86	x		
15 JUL 86		x	
16 JUL 86		x	
22 JUL 86		x	x
23 JUL 86		x	x
06 AUG 86	x		
12 AUG 86	x		
19 AUG 86	x	x	
20 AUG 86		x	
26 AUG 86	x	x	x
27 AUG 86			x

APPENDIX F -- TABLE 2

SONGS ENTRAPMENT: LIST OF DATES (x) OF CONCURRENT (SAME DAY) QUANTITATIVE ENTRAPMENT COLLECTIONS AT SONGS UNIT 1 AND AT ONE OR BOTH OF UNITS 2 AND 3 during the 39-mo period from **May 1983 through August 1986**. All collections at Units 2 and/or 3 include both quantitative impingement and diversion samples. No quantitative match-ups occurred during May 1983-December 1984.

Date	Unit 1	Unit 2	Unit 3
04 JAN 84	x	x	
07 MAR 84	x	x	
11 DEC 84	x		x
27 DEC 84	x		x
09 JAN 85	x		x
16 JAN 85	x		x
23 JAN 85	x		x
30 JAN 85	x		x
06 MAR 85	x		x
20 MAR 85	x		x
27 MAR 85	x		x
02 APR 85	x		x
03 APR 85	x		x
10 APR 85	x		x
16 APR 85	x	x	x
17 APR 85	x	x	x
23 APR 85	x	x	x
24 APR 85	x	x	x
30 APR 85	x	x	x
04 JUN 85	x	x	x
26 JUN 85	x	x	x
02 JUL 85	x		x
16 JUL 85	x	x	x
31 JUL 85	x	x	x
20 AUG 85	x	x	
04 SEP 85	x	x	x
17 SEP 85	x	x	x
15 OCT 85	x	x	
05 NOV 85	x	x	
01 JUL 86	x	x	x
19 AUG 86	x	x	
26 AUG 86	x	x	x

APPENDIX F -- TABLE 3

SONGS ENTRAPMENT: LIST OF DATES ON WHICH HEAT TREATMENTS OCCURRED AT SONGS Units 1, 2, or 3 during the periods **May 1983-December 1984**, **January-September 1985**, and **October 1985-August 1986**.

May 1983-December 1984

Date	Unit 1	Unit 2	Unit 3
30 MAY 83		x	
04 JUN 83		x	
20 AUG 83		x	
01 OCT 83		x	
17 OCT 83			x
05 NOV 83			x
14 NOV 83		x	
21 DEC 83		x	
17 MAR 84		x	
05 APR 84			x
28 APR 84		x	
23 MAY 84			x
14 JUL 84			x
29 JUL 84		x	
25 AUG 84			x
15 SEP 84		x	
06 OCT 84			x
20 OCT 84		x	

January-September 1985

Date	Unit 1	Unit 2	Unit 3
25 JAN 85	x		
08 MAR 85	x		
21 MAR 85			x
04 MAY 85		x	
13 MAY 85	x		
26 MAY 85			x
22 JUN 85		x	
30 JUN 85	x		
12 JUL 85			x
03 AUG 85		x	
10 AUG 85	x		
07 SEP 85		x	
14 SEP 85	x		

APPENDIX F -- TABLE 3 (continued)

October 1985-August 1986

Date	Unit 1	Unit 2	Unit 3
03 NOV 85	x		
22 DEC 85		x	
09 FEB 86			x
16 JUN 86		x	
06 JUL 86			x
02 AUG 86			x
24 AUG 86	x		
31 AUG 86		x	

APPENDIX F -- TABLE 4

SONGS ENTRAPMENT: NUMBER OF OPERATIONAL DAYS PER MONTH FOR SONGS UNITS 1, 2, AND 3 for the period **May 1983-December 1984**. Calculations are based on total monthly flow rate (gal)/daily normal-flow rate (gal/dy). The daily flow rate for each unit is:

Unit 1: 4.47×10^8 gal/dy

Unit 2: 1.219×10^9 gal/dy

Unit 3: 1.219×10^9 gal/dy

Date	Unit 1	Unit 2	Unit 3	Units 2 & 3
MAY 83	9.50	25.15	9.65	34.80
JUN 83	11.52	22.39	14.26	36.65
JUL 83	6.77	30.99	15.08	46.08
AUG 83	15.17	29.85	15.49	45.35
SEP 83	9.88	30.00	18.24	48.24
OCT 83	13.62	31.00	29.49	60.49
NOV 83	21.68	30.00	29.99	59.99
DEC 83	21.58	18.25	25.99	44.24
JAN 84	24.88	21.00	12.99	33.99
FEB 84	23.36	19.25	4.89	24.13
MAR 84	21.51	30.75	26.99	57.74
APR 84	11.36	30.00	29.99	59.99
MAY 84	7.41	31.00	24.49	55.49
JUN 84	0.79	21.50	21.49	42.99
JUL 84	0.87	17.50	21.99	39.50
AUG 84	0.00	30.49	30.24	60.74
SEP 84	0.32	30.00	29.99	59.99
OCT 84	23.01	20.00	28.49	48.49
NOV 84	29.96	0.00	14.99	14.99
DEC 84	30.95	0.00	29.00	29.00
Totals	284.14	469.12	433.73	902.88

Total Possible Number of Full-Pumping Days (All Units) = 1,830
(610 per Unit)

Percent of Full Pumping

Unit 1: 284.14 / 610 = **47%**
Unit 2: 469.12 / 610 = **77%**
Unit 3: 433.73 / 610 = **71%**
Units 2 & 3: 902.88 / 1,220 = **74%**

APPENDIX F -- TABLE 5

SONGS ENTRAPMENT: NUMBER OF OPERATIONAL DAYS PER MONTH FOR SONGS UNITS 1, 2, AND 3 for the period **January-September 1985**. Calculations are based on total monthly flow rate (gal)/daily normal-flow rate (gal/dy). The daily flow rate for each unit is:

Unit 1: 4.47×10^8 gal/dy

Unit 2: 1.219×10^9 gal/dy

Unit 3: 1.219×10^9 gal/dy

Date	Unit 1	Unit 2	Unit 3	Units 2 & 3
JAN 85	29.68	3.25	28.00	31.25
FEB 85	16.51	12.00	14.00	26.00
MAR 85	27.97	21.00	30.50	51.50
APR 85	29.86	23.50	29.75	53.25
MAY 85	26.00	31.00	30.92	61.92
JUN 85	29.78	30.00	30.00	60.00
JUL 85	29.51	31.00	31.00	62.00
AUG 85	24.86	31.00	31.00	62.00
SEP 85	27.69	30.00	17.00	47.00
Totals	241.86	212.75	242.17	454.92

Total Possible Number of Full-Pumping Days (All Units) = 819
(273 per Unit)

Percent of Full Pumping

Unit 1: 241.86 / 273 = **89%**
Unit 2: 212.75 / 273 = **78%**
Unit 3: 242.17 / 273 = **89%**
Units 2 & 3: 454.92 / 546 = **83%**

APPENDIX F -- TABLE 6

SONGS ENTRAPMENT: NUMBER OF OPERATIONAL DAYS PER MONTH FOR SONGS UNITS 1, 2, AND 3 for the period **October 1985-August 1986**. Calculations are based on total monthly flow rate (gal)/daily normal-flow rate (gal/dy). The daily flow rate for each unit is:

Unit 1: 4.47×10^8 gal/dy

Unit 2: 1.219×10^9 gal/dy

Unit 3: 1.219×10^9 gal/dy

Date	Unit 1	Unit 2	Unit 3	Units 2 & 3
OCT 85	30.67	31.00	0.00	31.00
NOV 85	23.91	19.77	0.42	20.20
DEC 85	15.50	29.57	15.67	45.25
JAN 86	4.86	30.82	26.22	57.05
FEB 86	0.00	28.00	25.30	53.30
MAR 86	0.00	18.92	22.07	40.99
APR 86	0.00	0.34	30.00	30.34
MAY 86	7.20	2.68	31.00	33.68
JUN 86	17.72	27.32	30.00	57.32
JUL 86	23.83	30.74	29.46	60.20
AUG 86	28.23	30.65	28.68	59.33
Totals	151.92	249.83	238.84	488.67

Total Possible Number of Full-Pumping Days (All Units) = 1,005
(335 per Unit)

Percent of Full Pumping

Unit 1: 151.92 / 335 = **45%**
Unit 2: 249.83 / 335 = **75%**
Unit 3: 238.84 / 335 = **71%**
Units 2 & 3: 488.67 / 670 = **73%**

APPENDIX F -- TABLE 7

SONGS INPLANT: SUMMARY RESULTS OF T-TESTS OF THE SLOPE OF THE RELATION WHERE ENTRAPMENT MAGNITUDE AT ONE NEW SONGS UNIT IS REGRESSED ON CONCURRENT ENTRAPMENT AT THE OTHER NEW SONGS UNIT, WITH ONE OR BOTH VALUES ADJUSTED TO (EQUIVALENT) FULL FLOW. The null hypothesis tested was that level of entrapment at the two units is indistinguishable on a unit flow volume basis (Ho: slope = 1; no intercept model: Y = mx). Fishes tested included representative, heavily entrapped species, plus interpretable compound taxa. Both numbers and biomass are tested.

Species/taxon	Number of Paired Samples	Slope (#s)			Slope (Bio.)		
		Est.	SE	Prob.	Est.	SE	Prob.
ANCHOVY, northern	19	+.06	.02	<.0001	+.07	.02	<.0001
CROAKER, white	19	+.83	.15	.25	+.82	.16	.27
QUEENFISH	20	+.99	.06	.85	+1.00	.06	.96
SURFPERCH, walleye	11	+1.00	.17	>.99	+1.09	.28	.75
TOTAL FISHES	20	+.98	.05	.62	+.99	.04	.81
TOTAL FISHES (minus no. anchovy)	20	+1.00	.05	.92	+1.00	.04	.91

APPENDIX F -- TABLE 8

SONGS INPLANT: PUMP HISTORY AT EACH NEW SONGS UNIT AND THE FACTOR USED TO SCALE THE LESSER OF THE TWO PUMP VOLUMES UP TO THE GREATER VOLUME OF THE OTHER UNIT ON THAT DATE. Twenty-four-hour (± 2 hr) entrapment data for the dates listed were used for the analysis presented in Appendix F, Table 6.

	Unit 2		Unit 3	
Date	# Pumps	Factor	# Pumps	Factor
18 JUL 84	2	2.0	4	--
01 AUG 84	4	--	2	2.0
08 AUG 84	4	--	3	1.3333
06 FEB 85	1	4.0	2	2.0
27 FEB 85	2	--	2	--
06 MAR 85	3	1.3333	4	--
13 MAR 85	3	1.3333	4	--
20 MAR 85	3	1.3333	4	--
27 MAR 85	2	2.0	4	--
02 APR 85	2	2.0	4	--
03 APR 85	2	2.0	4	--
10 APR 85	2	2.0	4	--
07 JAN 86	4	--	3	1.3333
08 JAN 86	4	--	3	1.3333
26 FEB 86	4	--	2	2.0
04 MAR 86	4	--	2	2.0
05 MAR 86	4	--	2	2.0
11 MAR 86	4	--	2	2.0
03 JUN 86	3	1.3333	4	--
04 JUN 86	3	1.3333	4	--

APPENDIX G -- Summaries of SONGS Units 1, 2, and 3 Entrapment Data

APPENDIX G -- TABLE 1

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **QUEENFISH** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	34,367	1,101,166	577.7	14,011.0
Standard deviation	4,677	91,419	98.8	1,351.9

APPENDIX G -- TABLE 2

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **WHITE CROAKER** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	797	123,916	7.9	882.3
Standard deviation	199	39,430	1.6	227.4

APPENDIX G -- TABLE 3

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **WALLEYE SURFPERCH** Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	1,852	12,428	43.8	160.8
Standard deviation	491	4,893	12.6	56.1

APPENDIX G -- TABLE 4

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **PACIFIC ELECTRIC RAY** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	116	135	1,230.9	1,330.6
Standard deviation	21	19	215.8	224.2

APPENDIX G -- TABLE 5

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **WHITE SEAPERCH** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	360	5,310	3.6	74.5
Standard deviation	98	441	1.0	13.8

APPENDIX G -- TABLE 6

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **PACIFIC BUTTERFISH** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	202	12,896	4.4	212.8
Standard deviation	47	4,213	0.5	50.5

APPENDIX G -- TABLE 7

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **SILVERSIDES spp.** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	341	33,689	39.4	4,261.4
Standard deviation	113	9,524	15.2	1,228.9

APPENDIX G -- TABLE 8

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF **NORTHERN ANCHOVY** at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	288*	4,148,604	1.6*	4,706.3
Standard deviation	52	223,711	0.3	499.7

*Unit 1 traveling screens are 5/8-in. mesh; only a small fraction of the juvenile anchovies entrapped at Unit 1 get impinged.

APPENDIX G -- TABLE 9

SONGS INPLANT: SUMMARY OF 24-HR (NORMAL FLOW) ENTRAPMENT TOTALS OF TOTAL FISHES at Unit 1 and at Units 2 & 3 during the 39-mo period from May 1983 through August 1986. Average annual (12-mo) totals are estimated based on entrapment during various normal flow operations (Unit 1: impingement samples only; Units 2 and 3: impingement and diversion). See Appendix F, part 1A for description of how totals and their standard deviations were calculated.

	Numbers		Biomass (kg)	
12-mo Entrapment	Unit 1	Units 2 & 3	Unit 1	Units 2 & 3
Estimate	45,169	5,533,401	3,429.4	33,852.3
Standard deviation	5,834	269,610	349.3	3,310.6

APPENDIX G -- TABLE 10

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS, WEIGHTS, AND MEAN FISH WEIGHTS of heat-treatment fish at **SONGS Unit 1** for the 20-mo period **May 1983-December 1984**. No heat treatments occurred at Unit 1 during this period (dates = 0).

No heat treatments occurred at SONGS Unit 1 during May83-Dec84.

APPENDIX G -- TABLE 11

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS, WEIGHTS, AND MEAN FISH WEIGHTS of heat-treatment fish at **SONGS Units 2 and 3** for the 20-mo period **May 1983-December 1984** (dates = 18). Species are ranked by total heat-treatment weight.

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
SARGO	5,634	1,475.610	262
PERCH, zebra	1,590	912.712	574
CROAKER, yellowfin	1,956	577.130	295
CROAKER, spotfin	584	356.825	611
BASS, barred sand	842	211.555	251
BASS, kelp	546	111.588	204
QUEENFISH	3,807	88.956	23
SALEMA	1,924	81.994	43
OPALEYE	84	47.940	571
GUITARFISH, shovelnose	11	33.600	3055
ANCHOVY, northern	13,510	32.405	2
CROAKER, black	139	27.368	197
ANCHOVY, deepbody	1,519	20.555	14
STINGRAY, round	40	17.500	437
RAY, Pacific electric	2	17.300	8650
MACKEREL, jack	152	16.063	106
GARIBALDI	27	12.485	462
PERCH, black	64	11.147	174
SHEEPHEAD, California	14	9.720	694
MORAY, California	4	9.200	2300
JACKSMELT	83	8.535	103
SCORPIONFISH, California	43	7.521	175
BLACKSMITH	80	6.704	84
BLENNY spp.	2,596	5.727	2
TRIGGERFISH, finescale	3	5.600	1867
TOPSMELT	105	5.523	53
SEABASS, white	23	5.378	234
HALFMOON	15	4.834	322
PERCH, pile	12	4.580	382
HALIBUT, California	36	3.663	102
WRASSE, rock	13	3.433	264
SHARK, horn	2	3.050	1525
SEAPERCH, rubberlip	10	2.933	293
MIDSHIPMAN, plainfin	42	2.480	59
SURFPERCH, walleye	48	2.242	47
YELLOWTAIL	2	2.000	1000
CROAKER, white	63	1.790	28
SMOOTHHOUND, gray	2	1.750	875
BUTTERFISH, Pacific	57	1.677	29
CORBINA, California	10	1.544	154
KELPFISH, giant	42	1.179	28
CABEZON	26	1.149	44

APPENDIX G -- TABLE 11 (continued)

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
BASS, spotted sand	8	1.110	139
ANCHOVY, slough	197	0.978	5
SEAPERCH, white	21	0.862	41
ROCKFISH, rock	3	0.730	243
BARRACUDA, Pacific	24	0.723	30
MACKEREL, Pacific	7	0.665	95
THORNBACK	2	0.480	240
PERCH, kelp	12	0.317	26
PERCH, shiner	19	0.272	14
ROCKFISH, brown	8	0.240	30
TURBOT, diamond	2	0.222	111
KELPFISH, striped	120	0.192	2
TURBOT, spotted	9	0.141	16
CUSK-EEL, spotted	3	0.124	41
KELPFISH, spotted	51	0.102	2
GRUNION	12	0.076	6
BOCACCIO	2	0.060	30
CUSK-EEL, basketweave	6	0.034	6
SARDINE, Pacific	4	0.025	6
PIPEFISH spp.	11	0.023	2
SURFPERCH, barred	1	0.016	16
KELPFISH spp.	2	0.013	6
BLENNY, rockpool	2	0.010	5
TURBOT, hornyhead	1	0.006	6
FRINGEHEAD, sarcastic	1	0.005	5
KELPFISH, crevice	1	0.002	2
ROCKFISH spp.	2	0.002	1
GOBY spp.	1	<0.001	<1
Total Fishes	36,294	4,162.375	
Total No. Taxa	70		
Mean Wt. Fish	4,162.375 kg/36,294 fish = 115 g/fish		

APPENDIX G -- TABLE 12

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS AND WEIGHTS, at SONGS Unit 1 for the 9-mo period January 1985-September 1985 (dates = 6). Species are ranked by total heat treatment weight.

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
SARGO	1,854	259.660	140
CROAKER, yellowfin	1,129	153.524	136
CROAKER, spotfin	200	102.812	514
PERCH, zebra	506	84.640	167
JACKSMELT	485	54.050	111
QUEENFISH	1,400	38.110	27
SURFPERCH, walleye	915	35.150	38
BASS, barred sand	141	28.180	200
CROAKER, black	233	25.979	111
OPALEYE	48	21.947	457
PERCH, black	136	20.430	150
SALEMA	469	16.007	34
THRESHER, common	1	9.500	9,500
SHARK, Pacific angel	1	9.500	9,500
GUITARFISH, shovelnose	3	9.200	3,067
PERCH, pile	24	8.580	357
BASS, kelp	43	8.260	192
CORBINA, California	37	8.220	222
GARIBALDI	17	6.470	381
SHEEPHEAD, California	6	6.040	1,007
BLACKSMITH	87	5.533	64
STINGRAY, round	9	5.000	556
SEABASS, white	18	3.767	209
HALFMOON	20	3.546	177
TOPSMELT	50	2.605	52
SHARK, horn	1	2.030	2,030
SEAPERCH, white	25	1.733	69
ROCKFISH, brown	10	1.588	159
BARRACUDA, Pacific	7	1.531	219
ROCKFISH, grass	4	1.310	327
SCORPIONFISH, California	10	1.275	127
KELPFISH, giant	18	1.130	63
WRASSE, rock	14	0.982	70
THORNBACK	2	0.640	320
CABEZON	6	0.490	82
MACKEREL, Pacific	2	0.330	165
ANCHOVY, deepbody	25	0.293	12
MIDSHIPMAN, specklefin	1	0.290	290
BUTTERFISH, Pacific	5	0.224	45
BASS, spotted sand	3	0.210	70
HALIBUT, California	1	0.140	140

APPENDIX G -- TABLE 12 (continued)

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
CROAKER, white	3	0.102	34
TURBOT, spotted	3	0.081	27
PERCH, shiner	3	0.076	25
MIDSHIPMAN, plainfin	1	0.041	41
BLENNY spp.	9	0.040	4
ANCHOVY, northern	2	0.034	17
GRUNION	1	0.016	16
SOLE, fantail	1	0.009	9
KELPFISH, spotted	2	0.006	3
Total Fishes	7,991	941.311	
Total No. Taxa	50		
Mean Wt. Fish	941.311 kg/7,991 fish = 118 g/fish		

APPENDIX G -- TABLE 13

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS AND WEIGHTS, at SONGS Units 2 and 3 for the 9-mo period January 1985-September 1985 (dates = 7). Species are ranked by total heat treatment weight.

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
CROAKER, yellowfin	5,154	1873.200	363
SARGO	1,485	353.233	238
PERCH, zebra	319	168.170	527
QUEENFISH	7,441	153.090	21
GUITARFISH, shovelnose	26	75.580	2,907
SALEMA	786	24.453	31
BASS, barred sand	130	23.793	183
BASS, kelp	70	15.300	219
CROAKER, spotfin	28	11.670	417
RAY, bat	3	10.140	3,380
MACKEREL, jack	69	6.123	89
BLENNY spp.	2,220	4.686	2
STINGRAY, round	7	3.540	506
BLACKSMITH	45	3.505	78
ROCKFISH, brown	8	3.450	431
WRASSE, rock	28	3.067	110
SCORPIONFISH, California	19	3.013	159
ANCHOVY, deepbody	178	2.568	14
JACKSMELT	23	2.202	96
CORBINA, California	7	2.020	289
HALIBUT, California	18	1.887	105
OPALEYE	5	1.700	340
CROAKER, black	12	1.660	138
SURFPERCH, walleye	39	1.590	41
SMOOTHHOUND, grey	4	1.515	379
MIDSHIPMAN, plainfin	30	1.488	50
MIDSHIPMAN, specklefin	5	1.439	288
CROAKER, white	191	1.271	7
ANCHOVY, northern	327	1.239	4
BARRACUDA, Pacific	11	1.067	97
BUTTERFISH, Pacific	26	0.669	26
SEABASS, white	6	0.554	92
THORNBACK	1	0.530	530
RAY, California butterfly	1	0.510	510
MACKEREL, Pacific	4	0.414	103
GARIBALDI	1	0.350	350
PERCH, black	5	0.309	62
BASS, spotted sand	2	0.300	150

APPENDIX G -- TABLE 13 (continued)

Species	Total Fish Number	Total Fish Weight (kg)	Mean Wt. per Fish (g)
TURBOT, spotted	14	0.270	19
SEAPERCH, white	13	0.251	19
KELPFISH, giant	10	0.245	24
CABEZON	10	0.204	20
GRUNION	14	0.192	14
PERCH, shiner	11	0.103	9
ROCKFISH, grass	2	0.084	42
SENORITA	1	0.070	70
TOPSMELT	1	0.062	62
BOCACCIO	2	0.011	5
GIBBONSIA	3	0.008	3
CUSK-EEL, basketweave	2	0.004	2
KELPFISH, spotted	2	0.004	2
PIPEFISH	1	0.002	2
Total Fishes	18,820	2,762.805	
Total No. Taxa	52		
Mean Wt. Fish	2,762.805 kg/18,820 fish = 147 g/fish		

APPENDIX G -- TABLE 14

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS AND WEIGHTS, at SONGS Unit 1 for the 11-mo period October 1985-August 1986 (dates = 2). Species are ranked by total heat treatment weight.

Species	Heat Treatment (No.)	Heat Treatment (kg)
SARGO	1031	164.180
BASS, kelp	103	29.580
HALFMOON	86	21.680
PERCH, black	135	19.200
SALEMA	389	17.520
CROAKER, yellowfin	112	16.520
CROAKER, black	97	12.900
OPALEYE	31	12.680
SURFPERCH, walleye	278	11.320
QUEENFISH	376	9.560
PERCH, zebra	15	7.440
SEABASS, white	57	7.270
CROAKER, spotfin	21	6.710
GUITARFISH, shovelnose	1	6.500
CORBINA, California	32	6.160
GARIBALDI	14	5.350
BASS, barred sand	50	5.110
PERCH, pile	26	4.685
SHEEPHEAD, California	5	3.030
SCORPIONFISH, Ca.	9	1.680
SEAPERCH, white	11	0.820
KELPFISH, giant	5	0.560
BLACKSMITH	8	0.480
CABEZON	2	0.440
SURFPERCH, barred	1	0.390
STINGRAY, round	1	0.330
TOPSMELT	13	0.300
MACKEREL, Pacific	2	0.300
WRASSE, rock	2	0.240
SEAPERCH, rubberlip	1	0.190
MIDSHIPMAN, specklefin	1	0.160
ROCKFISH, brown	1	0.150
BASS, spotted sand	1	0.140
MACKEREL, jack	2	0.076
ANCHOVY, deepbody	8	0.073
PERCH, shiner	1	0.015
BLENNY spp.	2	0.013
TURBOT, spotted	1	0.003
Total Fishes	2,931	373.755
Total No. Taxa	38	
Mean Wt. Fish	373.755 kg/2,931 fish = 128 g/fish	

APPENDIX G -- TABLE 15

SONGS INPLANT: SUMMARY OF HEAT TREATMENT COLLECTIONS, BY TOTAL NUMBERS AND WEIGHTS, at SONGS **Units 2 and 3** for the 11-mo period **October 1985-August 1986** (dates = 6). Species are ranked by total heat treatment weight.

Species	Heat Treatment (No.)	Heat Treatment (kg)
PERCH, zebra	1,452	800.780
CROAKER, yellowfin	1,675	634.320
QUEENFISH	67,864	456.020
SARGO	1,028	310.422
ANCHOVY, northern	84,488	267.034
BASS, barred sand	423	119.100
BASS, kelp	309	60.770
SALEMA	905	52.760
JACKSMELT	356	50.800
GUITARFISH, shovelnose	8	27.850
HALIBUT, California	11	11.810
SHEEPHEAD, California	12	8.910
STINGRAY, round	14	7.622
CROAKER, white	252	7.075
CROAKER, spotfin	14	6.890
WRASSE, rock	46	6.690
CORBINA, California	19	4.730
CROAKER, black	46	4.630
SHARK, horn	1	4.580
PERCH, pile	17	4.440
MACKEREL, Pacific	21	3.354
SCORPIONFISH, Ca.	27	2.710
BUTTERFISH, Pacific	157	2.463
BARRACUDA, Pacific	29	1.999
SURFPERCH, walleye	53	1.930
GARIBALDI	4	1.820
HALFMOON	10	1.780
SEABASS, white	7	1.420
BLENNY spp.	551	1.330
THORNBACK	4	1.070
CABEZON	3	1.030
MACKEREL, jack	63	0.998
ANCHOVY, deepbody	49	0.978
MIDSHIPMAN, specklefin	3	0.970
PERCH, black	7	0.883
SMOOTHHOUND, gray	1	0.780
BLACKSMITH	10	0.698
PERCH, shiner	68	0.666
KELPFISH, giant	11	0.586
TOPSMELT	9	0.460
BASS, spotted sand	2	0.445
SEAPERCH, white	11	0.430

APPENDIX G -- TABLE 15 (continued)

Species	Heat Treatment (No.)	Heat Treatment (kg)
SMOOTHHOUND, brown	2	0.340
TURBOT, spotted	5	0.171
ANCHOVY, slough	15	0.036
SANDDAB, speckled	2	0.020
KELPFISH, spotted	2	0.017
FRINGEHEAD, onespot	1	0.008
GIBBONSIA sp.	1	0.007
SCULPIN, Pacific staghorn	1	0.003
Total Fishes	160,069	2,876.635
Total No. Taxa	50	
Mean Wt. Fish	2,876.635 kg/160,069 fish = 18 g/fish	

APPENDIX G -- TABLE 16

SONGS INPLANT: SUMMARY STATISTICS AND RESULTS OF PAIRED T-TEST COMPARISONS BETWEEN MAGNITUDE OF ENTRAPMENT AT **SONGS UNIT 1** AND AT ONE OR OTHER OF THE TWO **NEW UNITS**. Four major species (including two size-classes of queenfish) plus three compound taxa were analyzed. Analyses were based on 45 quantitative samples collected at Unit 1 and at Unit 2 and/or Unit 3 during **May 1983-August 1986**. Sample sizes used in tests exclude all co-absences at Unit 1 and at a new unit.

	NUMBERS				BIOMASS			
Species/Taxon	Mean ± SE	N	t	P	Mean ± SE	N	t	P
CROAKER, white	.73 ± .13	35	5.81	<.0001	1.04 ± .18	35	5.93	<.0001
QUEENFISH								
Total	.70 ± .09	45	7.92	<.0001	.71 ± .10	45	7.20	<.0001
Small	.67 ± .09	45	7.41	<.0001	.67 ± .09	45	7.03	<.0001
Large	.53 ± .11	45	4.75	<.0001	.67 ± .15	45	4.53	<.0001
SALEMA	.50 ± .16	25	3.22	<.004	1.18 ± .33	25	3.56	.002
SURFPERCH, walleye	-.42 ± .11	36	-3.87	<.001	-.77 ± .23	36	-3.30	.002
TOTAL FISH, minus NO. ANCHOVY	.74 ± .08	45	8.78	<.0001	.51 ± .10	45	4.96	<.0001
TOTAL FISH, minus all ANCHOVY SPP	.69 ± .09	45	7.83	<.0001	.49 ± .10	45	4.73	<.0001
TOTAL FISHES	.95 ± .10	45	9.55	<.0001	.54 ± .10	45	5.34	<.0001

APPENDIX H -- SONGS Fish Return System

Data Summaries Used in Evaluation of Percent Diversion

and

Percent Survivorship of Fishes

APPENDIX H -- TABLE 1

SUMMARY: TALLY OF FISH IMPINGED VERSUS FISH RETURNED AT SONGS UNITS 2 AND 3. Total numbers and total weights of impingement samples were tallied for the period May 25, 1983-August 27, 1986 (collections = 191). Fish species are ranked by total weight entrapped.

Species	Total Number Impinged	Total Number Returned	Total Weight Impinged (kg)	Total Weight Returned (kg)	Percent Number Returned	Percent Weight Returned
QUEENFISH	127,730	329,792	1,384.685	5,245.597	72.1	79.1
ANCHOVY, northern	86,081	872,874	311.275	1,191.997	91.0	79.3
JACKSMELT	3,095	4,440	374.094	649.958	58.9	63.5
CROAKER, yellowfin	11	2,602	0.834	639.949	99.6	99.9
RAY, bat	26	52	100.810	398.250	66.7	79.8
RAY, Pacific electric	30	21	237.748	244.850	41.2	50.7
ZEBRAPERCH	0	720	0.000	402.055	100.0	100.0
CROAKER, white	34,995	33,996	156.913	233.376	49.3	59.8
GUITARFISH, shovelnose	7	76	3.601	269.440	91.6	98.7
SALEMA	91	5,063	1.300	200.660	98.2	99.4
CORBINA, California	83	495	10.555	123.574	85.6	92.1
BASS, kelp	11	505	0.573	124.977	97.9	99.5
SARGO	41	586	0.938	124.389	93.5	99.3
STINGRAY, round	47	197	18.489	82.845	80.7	81.8
HALIBUT, California	65	204	13.286	82.812	75.8	86.2
SEABASS, white	58	359	2.573	88.703	86.1	97.2
TOPSMELT	31	951	0.894	82.316	96.8	98.9
SMOOTHHOUND, gray	8	61	3.061	72.015	88.4	95.9
BUTTERFISH, Pacific	2,701	2,110	28.727	40.598	43.9	58.6
MACKEREL, Pacific	88	308	12.409	54.440	77.9	81.4
THORNBACK	122	46	41.082	23.960	27.4	36.8
BASS, barred sand	51	198	14.443	45.564	79.5	75.9
CROAKER, spotfin	6	170	1.100	48.578	96.6	97.8
ANCHOVY, slough	12,412	4,663	35.125	11.565	27.3	24.8
ANCHOVY, deepbody	2,158	2,812	21.762	24.605	56.6	53.1
SURFPERCH, walleye	226	3,504	3.562	41.891	93.9	92.2
MIDSHIPMAN, specklefin	128	24	28.634	7.304	15.8	20.3
SEAPERCH, white	683	1,115	5.264	25.005	62.0	82.6
RAY, California butterfly	4	12	5.550	23.480	75.0	80.9
SHARK, leopard	2	7	1.700	23.290	77.8	93.2
DOGFISH, spiny	29	15	15.504	7.600	34.1	32.9
MIDSHIPMAN, plainfin	576	25	21.755	1.272	4.2	5.5
OPALEYE	2	29	0.656	19.540	93.5	96.8
PERCH, pile	2	43	0.004	18.413	95.6	100.0
SCORPIONFISH, California	119	31	10.049	4.300	20.7	30.0
CROAKER, black	1	77	0.005	12.076	98.7	100.0
SMOOTHHOUND, brown	4	12	1.927	9.750	75.0	83.5
PERCH, black	19	94	0.280	11.069	83.2	97.5
BARRACUDA, Pacific	101	53	3.568	7.566	34.4	68.0
SHARK, horn	2	7	1.700	8.640	77.8	83.6
MACKEREL, jack	345	175	3.008	6.926	33.7	69.7
KELPFISH, giant	219	60	6.396	3.043	21.5	32.2
SHARK, Pacific angel	0	1	0.000	8.500	100.0	100.0
TURBOT, spotted	64	45	5.141	2.778	41.3	35.1
BLACKSMITH	2	81	0.100	6.697	97.6	98.5

APPENDIX H -- TABLE 1 (continued)

Species	Total Number Impinged	Total Number Returned	Total Weight Impinged (kg)	Total Weight Returned (kg)	Percent Number Returned	Percent Weight Returned
HALFMOON	0	27	0.000	6.624	100.0	100.0
GRUNION	82	105	2.357	3.005	56.1	56.0
PERCH, shiner	339	272	2.391	2.712	44.5	53.1
TURBOT, diamond	12	8	3.460	1.377	40.0	28.5
GARIBALDI	0	11	0.000	4.800	100.0	100.0
SARDINE, Pacific	38	112	1.484	2.855	74.7	65.8
PIPEFISH	139	0	3.815	0.000	0.0	0.0
CUSK-EEL, spotted	35	17	2.122	0.793	32.7	27.2
WRASSE, rock	15	13	0.811	1.400	46.4	63.3
TRIGGERFISH, finescale	0	1	0.000	2.150	100.0	100.0
CABEZON	5	3	0.545	1.559	37.5	74.1
SOLE, fantail	19	14	0.563	0.920	42.4	62.0
ROCKFISH, brown	2	0	1.408	0.000	0.0	0.0
LIZARDFISH, California	6	1	1.099	0.220	14.3	16.7
SEAPERCH, rubberlip	0	14	0.000	1.114	100.0	100.0
SEAPERCH, rainbow	0	5	0.000	1.000	100.0	100.0
SCULPIN, Pacific staghorn	19	1	0.726	0.100	5.0	12.1
PERCH, kelp	10	11	0.162	0.566	52.4	77.7
BONITO, Pacific	0	1	0.000	0.700	100.0	100.0
EEL, yellow snake	1	0	0.620	0.000	0.0	0.0
SANDDAB, speckled	35	8	0.519	0.031	18.6	5.6
CUSK-EEL, basketweave	28	4	0.417	0.068	12.5	14.0
TURBOT, hornyhead	3	1	0.286	0.040	25.0	12.3
SURFPERCH, barred	1	1	0.265	0.048	50.0	15.3
MIDSHIPMAN sp.	0	2	0.000	0.300	100.0	100.0
BASS, spotted sand	0	1	0.000	0.170	100.0	100.0
BOCACCIO	12	11	0.079	0.064	47.8	44.8
BLENNY spp.	41	0	0.129	0.000	0.0	0.0
KELPFISH, spotted	6	1	0.074	0.012	14.3	14.0
GIBBONSIA	6	1	0.069	0.008	14.3	10.4
SENORITA	1	1	0.008	0.065	50.0	89.0
TONGUEFISH, California	3	0	0.068	0.000	0.0	0.0
BOXFISH, spiny	1	0	0.043	0.000	0.0	0.0
HERRING, round	2	11	0.003	0.021	84.6	87.5
GOBY, yellowfin	1	0	0.022	0.000	0.0	0.0
BLENNY, rockpool	4	0	0.018	0.000	0.0	0.0
TREEFISH	2	0	0.011	0.000	0.0	0.0
KELPFISH, striped	1	0	0.003	0.000	0.0	0.0
SOLE, Dover	1	0	0.002	0.000	0.0	0.0
HERRING, Pacific	0	1	0.000	0.002	100.0	100.0
SANDDAB, Pacific	1	0	0.001	0.000	0.0	0.0
Total Fishes	273,347	1,269,370	2,914.662	10,788.9		

Total No. of Taxa Entrapped = 86

% No. Returned = 1,269,370/1,542,717 = 82.3%

% Weight Returned = 10,788.9/13,703.6 = 78.7%

APPENDIX H -- TABLE 2

SONGS ENTRAPMENT: AVERAGE BODY WEIGHT AND SIZE CLASSIFICATION FOR FISHES ENTRAPPED AT SONGS UNITS 2 AND 3. Estimates and classification are based on all quantitative samples (n = 191) at either new unit during the period May 25, 1983-August 27, 1986. Fishes are classified either as small (S, < 30 g), medium (M, 30-200 g), or large (L, ≥ 200 g). Species are ranked by total weight entrapped. Also noted are percent total entrapment and percent diversion (numbers, biomass) for northern anchovy and the three general size classes of fishes.

Species	Average Body Weight (g)	Body Size Classification
QUEENFISH	14	S
ANCHOVY, northern	2	S
JACKSMELT	136	M
CROAKER, yellowfin	245	L
RAY, bat	6,398	L
RAY, Pacific electric	9,463	L
ZEBRAPERCH	558	L
CROAKER, white	6	S
GUITARFISH, shovelnose	3,289	L
SALEMA	39	M
CORBINA, California	232	L
BASS, kelp	243	L
SARGO	200	L
STINGRAY, round	415	L
HALIBUT, California	357	L
SEABASS, white	219	L
TOPSMELT	85	M
SMOOTHHOUND, gray	1,088	L
BUTTERFISH, Pacific	14	S
MACKEREL, Pacific	169	M
THORNBACK	387	L
BASS, barred sand	241	L
CROAKER, spotfin	282	L
ANCHOVY, slough	3	S
ANCHOVY, deepbody	9	S
SURFPERCH, walleye	12	S
MIDSHIPMAN, specklefin	236	L
SEAPERCH, white	17	S
RAY, California butterfly	1,814	L
SHARK, leopard	2,777	L
DOGFISH, spiny	525	L
MIDSHIPMAN, plainfin	38	M
OPALEYE	651	L
PERCH, pile	409	L
SCORPIONFISH, California	96	M

APPENDIX H -- TABLE 2 (continued)

Species	Average Body Weight (g)	Body Size Classification
CROAKER, black	154	M
SMOOTHHOUND, brown	730	L
PERCH, black	100	M
BARRACUDA, Pacific	72	M
SHARK, horn	1,149	L
MACKEREL, jack	19	S
KELPFISH, giant	34	M
SHARK, Pacific angel	8,500	L
TURBOT, spotted	73	M
BLACKSMITH	82	M
HALFMOON	245	L
GRUNION	29	S
PERCH, shiner	8	S
TURBOT, diamond	242	L
GARIBALDI	436	L
SARDINE, Pacific	29	S
PIPEFISH	27	S
CUSK-EEL, spotted	56	M
WRASSE, rock	79	M
TRIGGERFISH, finescale	2,150	L
CABEZON	263	L
SOLE, fantail	45	M
ROCKFISH, brown	704	L
LIZARDFISH, California	188	M
SEAPERCH, rubberlip	80	M
SEAPERCH, rainbow	200	L
SCULPIN, Pacific staghorn	41	M
PERCH, kelp	35	M
BONITO, Pacific	700	L
EEL, yellow snake	620	L
SANDDAB, speckled	13	S
CUSK-EEL, basketweave	15	S
TURBOT, hornyhead	82	M
SURFPERCH, barred	156	M
MIDSHIPMAN sp.	150	M
BASS, spotted sand	170	M
BOCACCIO	6	S
BLENNY spp.	3	S
KELPFISH, spotted	12	S
GIBBONSIA	11	S
SENORITA	36	M
TONGUEFISH, California	23	S
BOXFISH, spiny	43	M
HERRING, round	2	S
GOBY, yellowfin	22	S

APPENDIX H -- TABLE 2 (continued)

Species	Average Body Weight (g)	Body Size Classification
BLENNY, rockpool	4	S
TREEFISH	6	S
KELPFISH, striped	3	S
SOLE, Dover	2	S
HERRING, Pacific	2	S
SANDDAB, Pacific	1	S

Anchovy/Size-class Subtotal	Average Body Weight (g)	% Total Entrapment	
		#s	Biomass
Northern anchovy	2	62.2	11.0
Other small-bodied fishes (27 taxa)	13	36.3	53.2
All medium-sized fishes (25 taxa)	94	1.0	10.8
All large-bodied fishes (33 taxa)	472	0.5	25.0
Total fishes (86 taxa)	9	100.0	100.0

Anchovy/Size-class Subtotal	% Total Diversion	
	#s	Biomass
Northern anchovy	68.8	11.0
Other small-bodied fishes (27 taxa)	29.8	52.3
All medium-sized fishes (25 taxa)	0.9	9.7
All large-bodied fishes (33 taxa)	0.5	27.0

APPENDIX H -- TABLE 3

OFFSHORE SURVIVORSHIP TESTS: Summary results of 1983-1985 field experiments to estimate percent physiological mortality of fishes entrapped at SONGS Units 2 and 3 and subsequently discharged by the Fish Return System (FRS).

	OBSERVED MORTALITY							
	Experimental Pens			Control Pens			Difference (Experimental - Control)	
SPECIES	%	N pens	N fish	%	N pens	N fish	%	Half-width of 95% C.I
ANCHOVY, deepbody	13	4	175	--	--	--	--	--
ANCHOVY, northern	3	10	5,564	85	1	108	(3)[a]	--
ANCHOVY, slough	100	3	100	--	--	--	--	--
BARRACUDA, California	0	1	1	0	1	1	0	--
BASS, barred sand	0	1	1	0	2	4	0	--
BASS, kelp	0	1	1	0	3	3	0	--
BLACKSMITH	0	2	2	--	--	--	--	--
BUTTERFISH, Pacific	7	2	14	--	--	--	--	--
CORBINA, California	0	2	2	0	1	2	0	--
CROAKER, black	0	1	1	0	2	6	0	--
CROAKER, spotfin	--	--	--	0	1	3	--	--
CROAKER, white	52	10	155	0	3	12	52	8
CROAKER, yellowfin	<1	9	405	0	3	15	<1	<1
GARIBALDI	--	--	--	0	1	1	--	--
HALFMOON	0	1	1	--	--	--	--	--

[a] Control data insufficient; results disregarded -- total (Experimental + Contol) mortality estimated to be 3% based on Experimental data alone.

APPENDIX H -- TABLE 3 (continued)

OBSERVED MORTALITY

SPECIES	Experimental Pens %	Experimental Pens N pens	Experimental Pens N fish	Control Pens %	Control Pens N pens	Control Pens N fish	Difference (Experimental - Control) %	Difference (Experimental - Control) Half-width of 95% C.I
HALIBUT, California	100	1	1	--	--	--	--	--
KELPFISH, giant	0	2	2	--	--	--	--	--
JACKSMELT	0	2	3	--	--	--	--	--
MACKEREL, jack	0	2	5	--	--	--	--	--
MACKEREL, Pacific	0	3	3	--	--	--	--	--
PERCH, black	0	1	1	--	--	--	--	--
PERCH, pile	0	2	4	--	--	--	--	--
PERCH, shiner	0	1	1	0	2	5	0	--
PERCH, walleye	2	9	40	0	5	20	2	5
PERCH. white	7	7	30	0	3	8	7	9
QUEENFISH	52	18	2,753	20	9	185	32	6
SALEMA	0	12	122	--	--	--	--	--
SARGO	0	2	6	0	1	3	0	--
SEABASS, white	0	3	3	--	--	--	--	--
TOPSMELT	30	2	466	--	--	--	--	--
ZEBRAPERCH	0	1	3	--	--	--	--	--

APPENDIX H --TABLE 4

OFFSHORE SURVIVORSHIP TEST: ESTIMATED PERCENT PHYSIOLOGICAL MORTALITY OF SMALL (≤ 10 CM SL) AND LARGE (> 10 CM) queenfish in 1983-1985 field experiments (Offshore Survivorship Tests).

	Experimental Pens			Control Pens			Percent Mortality Difference (Experimental - Control)	
Queenfish Size-Class	# Fish Tested	Percent Mortality	# Pens	# Fish Tested	Percent Mortality	# Pens	M	Half-width of 95% C.I.
≤ 10 cm SL	1,625	57	17	46	20	8	37	12
> 10 cm SL	1,126	46	17	130	19	8	27	7

APPENDIX I --. SONGS Entrapment as Mechanism for the Observed Near-SONGS Declines in Queenfish

APPENDIX I -- TABLE 1

PHYSICAL DATA: DATE LISTING OF PHYSICAL DATA USED IN CALCULATING THE MATHEMATICAL INTERRELATIONSHIPS OF **SONGS UNITS 2 AND 3** ENTRAPMENT, FIELD ABUNDANCE, AND THREE PHYSICAL VARIABLES. Dates listed are those of entrapment samples when the TURBID variable was measured inplant. The value of the WAVHT variable listed is either a field measure or an estimate, depending on date (see Methods, Appendix F). The 3DAYVOL variable represents the total volume (gal) pumped by all three SONGS units on the calendar date plus the preceding two calendar days.

	VARIABLE		
Date (N = 16)	WAVHT	TURBID	3DAYVOL
12 OCT 83	0.6	2.380	30,249,720
08 AUG 84	0.8	0.720	27,470,016
19 SEP 84	0.7	1.270	27,470,016
24 APR 85	0.9	1.050	33,029,424
08 MAY 85	0.7	1.390	31,003,843
22 MAY 85	0.7	0.240	33,029,424
05 JUN 85	0.8	0.445	32,626,624
02 JUL 85	1.4	0.450	33,028,781
31 JUL 85	1.0	1.590	33,029,424
12 SEP 85	0.7	1.720	33,029,424
29 JAN 86	0.5	0.840	24,470,016
01 APR 86	0.6	0.970	17,168,760
23 APR 86	0.4	1.520	13,735,008
30 APR 86	0.8	1.210	13,735,008
11 JUN 86	0.7	1.440	27,470,016
18 JUN 86	0.8	0.700	31,614,591

APPENDIX I -- TABLE 2

BIOLOGICAL DATA: DATE LISTING OF BIOLOGICAL DATA USED IN CALCULATING THE INTERRELATIONSHIPS OF **SONGS UNITS 2 AND/OR 3** ENTRAPMENT, FIELD ABUNDANCE, AND TWO PHYSICAL VARIABLES (SURGE, TURBIDITY) for **SMALL** (≤ 10 CM SL) **QUEENFISH**. Each date estimate of entrapment was based on quantitative sample(s) at one or both new units, as indicated. Field abundance was indexed by lampara seine CPUE (catch per seine haul). Dates listed are those of entrapment samples; corresponding dates of collection of seine samples are date - 1 (taken the preceding night). All entrapment and seine data were log-10 transformed prior to analyses. A description of the model tested is provided at the bottom, along with its summary regression statistics.

Date (N = 16)	Identity New Unit(s) Sample(s)	(Average) Entrapment (#s) at New Unit(s)	Lampara CPUE (#s) at Loc. FI
12 OCT 83	Unit 2	1,553	2
08 AUG 84	Unit 2	1,314	14
19 SEP 84	Unit 2	3,207	25
24 APR 85	Units 2,3	558	77
08 MAY 85	Units 2,3	444	64
22 MAY 85	Unit 3	129	229
05 JUN 85	Units 2,3	183	86
02 JUL 85	Unit 3	67	2
31 JUL 85	Units 2,3	513	94
12 SEP 85	Units 2,3	2,228	148
29 JAN 86	Units 2,3	5,284	1
01 APR 86	Unit 3	3,545	86
23 APR 86	Unit 3	622	6
30 APR 86	Unit 3	10,831	304
11 JUN 86	Units 2,3	1,599	53
18 JUN 86	Units 2,3	416	54

ENTRAPMENT = 3.30 + 0.85 FI CPUE - 1.13 SURGE + 0.35 TURBIDITY

$R^2 = 0.37$
$P = 0.13$
$N = 16$

APPENDIX I -- TABLE 3

BIOLOGICAL DATA: DATE LISTING OF BIOLOGICAL DATA USED IN CALCULATING THE INTERRELATIONSHIPS OF THE SONGS NEARFIELD DEPRESSION, **SONGS UNITS 1, 2 AND 3** ENTRAPMENT, AND A THIRD PHYSICAL VARIABLE (3-DAY PUMPING VOLUME) FOR **SMALL** (≤ 10 CM SL) **QUEENFISH**. Each date estimate of entrapment was based on quantitative samples at one or more SONGS units, if available; or, if a collection was unavailable for that date, an estimate based on the product of (1) that unit's average daily entrapment for that month at full flow and (2) the fraction of full flow during its last 24 hr of pumping. A description of the models tested is provided at the bottom, along with their summary regression statistics.

Date (N = 16)	Identity New Unit(s) Sample(s)	Estimated Total Entrapment (All Units, #s)	Lampara CPUE (#s, by location)		
			NI	FI	Control
12 OCT 83	Unit 2	3,108	27	2	14
08 AUG 84	Unit 2	2,628	31	14	105
19 SEP 84	Unit 2	6,414	50	25	17
24 APR 85	Units 2,3	1,133	9	77	88
08 MAY 85	Units 2,3	1,021	27	64	63
22 MAY 85	Unit 3	391	15	229	60
05 JUN 85	Units 2,3	428	59	86	31
02 JUL 85	Unit 3	160	66	2	-
31 JUL 85	Units 2,3	1,045	50	94	2
12 SEP 85	Units 2,3	4,617	28	148	63
29 JAN 86	Units 2,3	10,568	177	1	0
01 APR 86	Unit 3	4,431	185	86	143
23 APR 86	Unit 3	622	50	6	6
30 APR 86	Unit 3	10,831	162	304	373
11 JUN 86	Units 2,3	3,198	51	53	75
18 JUN 86	Units 2,3	860	95	54	69

DELTA-CPUE (NI-FI) = -2.25 + 0.48 ENTRAPMENT + 7E-09 3dayvol

$R^2 = 0.09$
$P = 0.55$
$N = 16$

DELTA-CPUE (NI-C) = -2.88 + 0.52 ENTRAPMENT + 3E-08 3dayvol

$R^2 = 0.08$
$P = 0.60$
$N = 16$

APPENDIX I -- TABLE 4

SONGS ENTRAPMENT: ESTIMATED ENTRAPMENT IN (A) NUMBERS AND (B) BIOMASS FOR EACH OF 4 TAXA AT SONGS **UNITS 1, 2, AND 3** FROM **APRIL-SEPTEMBER 1985**. Total entrapment during normal flow at all units includes impingement (IMP) and heat treatments (HT). Total entrapment at Units 2 and 3 includes diversion (DIV).

(A) NUMERICAL ENTRAPMENT (# of fish)

	UNIT 1		NEW UNITS		ALL UNITS
Taxon	Impingement	HT	IMP + DIV	HT	Total Entrapment
QUEENFISH	18,950	1,225	404,376	7,117	431,668
BUTTERFISH, Pac.	7	5	2,156	26	2,194
CROAKER, white	959	2	313,889	119	314,969
SILVERSIDES	114	535	413	36	1,098

(B) BIOMASS ENTRAPMENT (in kg)

	UNIT 1		NEW UNITS		ALL UNITS
Taxon	Impingement	HT	IMP + DIV	HT	Total Entrapment
QUEENFISH	342.4	35.4	6,251.1	149.8	6,779
BUTTERFISH, Pac.	0.07	0.2	44.7	0.7	46
CROAKER, white	4.7	0.1	1,376.9	1.3	1,383
SILVERSIDES	11.1	56.6	43.3	2.3	113

APPENDIX I -- TABLE 5

SONGS ENTRAPMENT: ESTIMATED ENTRAPMENT IN (A) NUMBERS AND (B) BIOMASS FOR EACH OF 4 TAXA AT SONGS **UNITS 1, 2, AND 3** FROM **APRIL-AUGUST 1986**. Total entrapment during normal flow at all units includes impingement (IMP) and heat treatments (HT). Total entrapment at Units 2 and 3 includes diversion (DIV).

(A) NUMERICAL ENTRAPMENT (# of fish)

	UNIT 1		NEW UNITS		ALL UNITS
Taxon	Impingement	HT	IMP + DIV	HT	Total Entrapment
QUEENFISH	11,753	228.4	1,414,315	65,027	1,491,415
BUTTERFISH, Pac.	33	0	28,079	153	28,265
CROAKER, white	115	0	89,321	216	89,652
SILVERSIDES	7	13	2,216	70	2,306

(B) BIOMASS ENTRAPMENT (in kg)

	UNIT 1		NEW UNITS		ALL UNITS
Taxon	Impingement	HT	IMP + DIV	HT	Total Entrapment
QUEENFISH	228.4	8.2	21,122.2	421.2	21,780.0
BUTTERFISH, Pac.	0.2	0.0	305.2	2.4	307.8
CROAKER, white	1.5	0.0	770.0	6.6	778.1
SILVERSIDES	1.1	0.3	273.3	6.2	280.9

APPENDIX I -- TABLE 6

SONGS ENTRAPMENT DATA: ESTIMATED (A) NUMBERS AND (B) BIOMASS OF **SMALL** (≤ 10 cm SL) AND **LARGE** (> 10 cm SL) **QUEENFISH** ENTRAPPED AT SONGS **UNIT 1, UNITS 2 AND 3**, AND **ALL UNITS** POOLED DURING **APRIL-SEPTEMBER 1985**. Values in parentheses () represent diversion subtotals adjusted for survivorship (the complement of mortality)* due to physiological deaths resulting from FRS transport. The second number in parentheses is the diversion subtotal further adjusted for the probability of predation following discharge (assumed to be 0.25).

(A) NUMERICAL LOSS (thousands of fish)

QUEENFISH SIZE/CLASS	UNIT 1		NEW UNITS			ALL UNITS
	Impingement	HT	IMP	DIV	HT	Total Entrapment
≤ 10 cm SL	9.0	0.6	87.0	149.5 (55, 79)	4.3	250 (156, 180)
> 10 cm SL	10.0	0.6	38.4	129.4 (35, 58)	2.8	181 (87, 110)
ALL QUEENFISH	19.0	1.2	125.4	278.9 (90, 137)	7.1	432 (243, 290)

(B) BIOMASS LOSS (in metric tons, MT)

QUEENFISH SIZE/CLASS	UNIT 1		NEW UNITS			ALL UNITS
	Impingement	HT	IMP	DIV	HT	Total Entrapment
≤ 10 cm SL	.073	.008	.322	.962 (.4, .5)	.030	1.4 (.8, .9)
> 10 cm SL	.269	.028	1.020	3.947 (1.1, 1.8)	.120	5.4 (2.5, 3.2)
ALL QUEENFISH	.342	.036	1.342	4.909 (1.6, 2.4)	.150	6.8 (3.4, 4.3)

*% physiological mortality for small queenfish = 37 ± 12%; for large queenfish = 27 ± 7%; for all queenfish 32 ± 6%

APPENDIX I -- TABLE 7

SONGS ENTRAPMENT DATA: ESTIMATED (A) NUMBERS AND (B) BIOMASS OF **SMALL** (≤ 10 cm SL) AND **LARGE** (> 10 cm SL) **QUEENFISH** ENTRAPPED AT SONGS **UNIT 1, UNITS 2 AND 3**, AND **ALL UNITS** POOLED DURING **APRIL-AUGUST 1986**. Values in parentheses () represent diversion subtotals adjusted for survivorship (the complement of mortality)* due to physiological deaths resulting from FRS transport. The second number in parentheses is the diversion subtotal further adjusted for the probability of predation following discharge (assumed to be 0.25).

(A) NUMERICAL LOSS (thousands of fish)

QUEENFISH SIZE/CLASS	UNIT 1		NEW UNITS			ALL UNITS
	Impingement	HT	IMP	DIV	HT	Total Entrapment
≤ 10 cm SL	6.0	0.2	352.8	529.4 (196, 280)	41.6	930 (597, 681)
> 10 cm SL	5.8	0.2	104.2	427.9 (116, 193)	23.4	561 (250, 327)
ALL QUEENFISH	11.8	0.3	457.0	957.3 (306, 469)	65.0	1,491 (840, 1003)

(B) BIOMASS LOSS (in metric tons, MT)

QUEENFISH SIZE/CLASS	UNIT 1		NEW UNITS			ALL UNITS
	Impingement	HT	IMP	DIV	HT	Total Entrapment
≤ 10 cm SL	.042	.001	1.509	3.879 (1.4, 2.1)	.105	5.5 (3.1, 3.7)
> 10 cm SL	.186	.007	3.036	12.698 (3.4, 5.7)	.316	16.2 (7.0, 9.3)
ALL QUEENFISH	.228	.008	4.545	16.577 (5.3, 8.1)	.421	21.780 (10.5, 13.3)

*% physiological mortality for small queenfish = 37 ± 12%; for large queenfish = 27 ± 7%; for all queenfish 32 ± 6%.

APPENDIX I -- TABLE 8

FIELD ABUNDANCE DATA: ESTIMATED MEAN LAMPARA SEINE CPUE (catch-per-standard-net-haul) AT SONGS OFFSHORE INTAKE STRUCTURE DEPTHS (5-10 M) FOR 4 SELECT TAXA OF COASTAL PELAGIC FISHES AND 2 SIZE-CLASSES OF **QUEENFISH** DURING (A) **APRIL-SEPTEMBER 1981**, (B) **APRIL-SEPTEMBER 1985**, AND (C) **APRIL-AUGUST 1986**. Seine CPUE estimates are listed separately for the three longshore sampling locations (NI = Near Impact; FI = Far Impact; C = Control), together with the differences (deltas) in mean CPUE for all three pairwise contrasts. Based on N = 22 sampling dates in 1981, N = 11 dates in 1985, and N = 8 dates in 1986. All estimates include zero catches.

(A) APRIL-SEPTEMBER 1981

	Average Seine CPUE (#s)			Deltas of Mean CPUE (#s)		
Taxon	NI	FI	C	NI-C	FI-C	NI-FI
QUEENFISH:						
Total	261	302	297	-36	+5	-41
Small only	166	128	182	-16	-54	+38
Large only	95	174	115	-20	+59	-79
BUTTERFISH, Pac.	28	88	139	-111	-51	-60
CROAKER, white	24	127	26	-2	+101	-103
SILVERSIDES	175	79	137	+38	-58	+96

(B) APRIL-SEPTEMBER 1985

	Average Seine CPUE (#s)			Deltas of Mean CPUE (#s)		
Taxon	NI	FI	C	NI-C	FI-C	NI-FI
QUEENFISH:						
Total	35	108	134	-99	-26.	-73
Small only	5	64	36	-31	+28	-59
Large only	30	44	98	-68	-54	-14
BUTTERFISH, Pac.	3	11	5	-2	+6	-8
CROAKER, white	2	35	30	-28	+5	-33
SILVERSIDES	7	69	13	-6	+56	-62

APPENDIX I -- TABLE 8 (continued)

(C) APRIL-AUGUST 1986

Taxon	Average Seine CPUE (#s)			Deltas of Mean CPUE (#s)		
	NI	FI	C	NI-C	FI-C	NI-FI
QUEENFISH:						
Total	84	126	223	-139	-97	-42
Small only	17	85	143	-126	-68	-68
Large only	66	41	80	-14	-39	+25
BUTTERFISH, Pac.	3	9	19	-16	-10	-6
CROAKER, white	3	41	37	-34	+4	-38
SILVERSIDES	6	43	17	-11	+26	-37

APPENDIX J -- Detailed Description of Methods Used for Kelp-Bed Fish Studies

APPENDIX J

DETAILED DESCRIPTION OF METHODS USED FOR KELP-BED FISH STUDIES

1. MEASURING DISTRIBUTION AND DENSITY

1.1 Scuba Gear

All fish surveys were performed using conventional scuba and exposure suits. Single 72-cu-ft tanks provided more than enough air for water-column surveys. Single 105-cu-ft tanks were often necessary for bottom transects, depending on tide stage (depth) and individual rate of air consumption. (Double 72-cu-ft tanks were not used, because the yokes connecting double tanks proved unwieldly when divers swam through giant kelp.)

1.2 Dive Effort

Individual dives lasted about 45-60 min for water-column surveys. The latter figure applies to the combined canopy/midwater-column surveys that were done in fall 1985-86. Bottom dives lasted 35-40 min. Because the bottom surveys took place at 15 m, individual divers could alternate a maximum of two bottom dives and one water-column dive during a single 7-8 hr interval without exceeding the no-decompression limits.

1.3 Transect Boards

On bottom transects, divers recorded fish tallies directly on a slate mounted on a take-up spool. A submersible compass was mounted on the top of the slate. The take-up spool housed > 75 m of 1/8-in. nylon line, marked at 1-m intervals. Quast (1968b; Fig. 21) illustrates a prototype of such a device.

1.4 Photographic Equipment

In the surface canopy (3.1-m depth) and in the midwater column (7.7-m depth), fish counts were recorded using underwater motion picture equipment. Fishes were filmed on Kodak EG 464 (Type G) Super-8 film (15-m, 3-min cassettes; 160 ASA; developed at the rated film speed). All baseline and operational sampling used autofocus Kodak XL 330 cameras, fast (9 mm, f/1.2) Ektar lenses, and Ikelite 5733 housings. A submersible compass was attached to the top front of the housing for diver navigation. A five-pound weight was used to make the unit close to neutrally buoyant underwater.

1.5 Transect Dimensions

Bottom transects were a constant area (225 m^2) and volume (337.5 m^3). The width (hence volume) of canopy and midwater-column cinetransects were visibility dependent, however (Larson and DeMartini 1984). Width of cinetransects (i.e., distance from the diver that the eye of the camera could see) was a positive but decelerating function of water visibility, best modeled by the following equation of Larson and DeMartini (1984):

$$CR = 1 / (P_1 + P_2(P_3)^x),$$

where CR = camera range; the P_i's are empirically derived parameters for the particular camera system used; and x is horizontal visibility (as estimated by divers; see below). Thus the volume searched by the diver, while panning the camera over a 120° arc (60° on each side of the major transect axis) and over a minor (vertical) axis of 1.5 m above and below, was the volume of a solid elliptical cylinder with the following dimensions:

$$V = 1.5 \text{ pi } L (\cos 30^\circ \times CR),$$

where V was cinetransect volume in cubic meters; 1.5 m was the minor axis of the ellipse; L was cinetransect length; and CR was camera range, as estimated above (Larson and DeMartini 1984).

Estimated visibilities ranged to > 20 m, but averaged from < 5 to about 10 m (Appendix J, Table 2). Because of the poor resolution of distant objects

(relative to the human eye) using high-speed film taken at 18 frames per second, the camera was able to record fishes to a maximum distance of < 4 m, regardless of apparent visibility (see Fig. 3 of Larson and DeMartini 1984). Consequently, the volume sampled on cinetransects usually averaged between about 750 m^3 and 1000+ m^3, and the scaling factor used to convert volume sampled to #s/1000 m^3 varied only from about 1 to 1.3. The conversion factor averaged about 1.01 at a mean apparent visibility of 8.5 m (Appendix J, Tables 3, 4).

Several additional sampling protocols related to cinetransect volume should be noted. Divers panned cameras to view all fish sighted within a distance of about 4 m. When a group or school of traveling fish was encountered, divers panned once from leading to trailing edge of the school.

1.6 Station Layout

During both baseline seasons (fall 1980, 1981) there were two stations at each sampling location. The two stations typically were about 75 to 100 m apart. The location and station designations were

SMK (= location 1) -- stations 1 and 2
SOKU (= location 3) -- stations 5 and 9
SOKD (= location 4) -- stations 11 and 12

On each date that a location was sampled, each member of a pair of divers sampled one of two stations on bottom, and each of a second pair of divers sampled one of the two stations in the surface canopy. Divers were rotated among locations, stations, and depths on different days in order to randomize potential diver biases. The two stations at a location did not overlap. During 1980-81 and 1985, divers sampled a minimum 250° arc (75-m radius) at each station. Sampling arcs varied in area in 1986 because of limited size of the kelp stands. Arcs then ranged from 120° (at SOKUin) to 250° (at SOKUout). Arcs were subdivided into quadrants, and transect bearings were established randomly within the quadrants before the survey. Sampling always excluded the first 5-m radius at a station in order to avoid resampling the area immediately near the station hub on successive transects.

In fall 1985, the sampling protocol at kelp-bed locations was changed slightly to improve diver safety. Sampling was conducted at a single station at each location. The location designations were

SMK (= location 1)
CobbleUp (= location 2)
SOKUout (= location 3)
SOKDin (= location 4)
SOKUin (= location 5)
SOKDout (= location 6)

On each sampling date, a pair of divers sampled on bottom at a station-location. The second pair of divers did likewise in the surface canopy and the midwater column at that station. Most other characteristics of stations and sampling protocols were identical to baseline designs. The same stations were sampled in fall 1986 as in 1985, plus two new locations (for a total of 8 kelp-bed stations, including 7 at SOK). The new location designations were

SOKinbetween (= location 7)
CobbleD (= location 9)

1.7 Visibility Measurements

Divers estimated horizontal underwater visibility at all sampling depths for each station-date. Similar techniques were employed on the bottom and for canopy/midwater-column regions. Visibility estimates were based on sightings of a yellowish-brown float ~15 cm in length. (This distance was considered that at which a diver could routinely distinguish fish species encountered on transect swims.)

On bottom, sightings were made at the end of each transect and at the station hub. Visibility was estimated to the nearest 0.1 m using the transect line, which was marked in 1-m increments. Mean visibility was calculated as the sum of the (3 transect end values plus 3 hub values) divided by 6.

Visibility in canopy and midwater-column regions at the station was measured by the second pair of divers. Visibility was estimated in the following manner:

the pair of divers first descended to 7-8 m at a randomly selected site near the station hub. One diver remained stationary at depth, holding the visibility float and end of a waterproof tape measure. (The float was held at arm's length away from, and to the side of, the diver's body.) The second diver swam out the tape measure to beyond the limit of visibility, turned, and then retrieved the tape, noting the distance at which the float became distinguishable. The divers then ascended to 3-4 m and repeated the process. After completing all transects, the divers again assessed visibilty only if a noticeable change in visibility occurred during the sampling period. The average of all measurements (at depth) was used to estimate the mean visibility at that depth for that station-date.

1.8 Supplementary Diver Observations on Cinetransects

After completing each cinetransect swim, divers returned to the vessel to exchange spent for unexposed film cassettes. At this time, the divers informed the shipboard assistant of the species encountered on the transect, emphasizing the presence of any unusual (e.g., white seabass) or cryptic species (pipefish, giant kelpfish). (These field notes were later used by film viewers as an aid when scoring films.)

2. ANALYSIS METHODS

2.1 Data Management

All quantitative survey data were reviewed aboard ship immediately following collection, and reviewed and checked twice in the laboratory before being keypunched. Once the data tape was loaded on computer, standard error-check programs were run to flag out-of-field data entries and other outliers (e.g., inadmissably small or large values).

2.2 Quantitative Density Estimates

Each of two criteria had to be met for data to be considered "quantitative": (1) the average horizontal visibility for that stratum (canopy/midwater or bottom) at the station on that date had to meet or exceed 2.5 m, and (2) the subjectively estimated current speed then had to allow at least half of the surface kelp present to reach the surface (code 3 or greater). If either criterion was

lacking, the data for that stratum-station on that date were not considered adequate for statistical analysis. (Quantitative samples, therefore, sometimes existed for some, but not all, sampling strata at a station on a given date. This fact variously influenced the analyses of different species, depending on which strata the species inhabited.) The important consideration for tests of densities was that quantitative samples of a species were available on a given date for both of the locations being compared. Appendix J, Table 1 lists all quantitative sampling dates by location and fall period.

2.3 YOY Kelp Bass: Density Estimates and BACI Tests

The density estimates for juvenile kelp bass were subdivided into YOY and older juvenile (OJ) substages. Density estimates for all other species were made for a pooled juvenile (JUV) stage. (This is important only if, for that species, juveniles included fish older than YOY). For all species, two later life stages were recognized: subadults (SAD) and adults (AD). The YOY and OJ substages of juvenile kelp bass were evaluated only for the second fall of the baseline period (1981), however, because YOY data were not consistently recognized and recorded by divers on bottom transects in fall 1980. Baseline estimates for the pooled juvenile stage of kelp bass used comprehensive (1980 + 1981) data.

2.4 Data Used in Abundance Estimates

The suite of quantitative data that was appropriate for estimating fish abundances in fall 1985-86 differed slightly from the data used for BACI tests of densities. This was because the BACI tests required a complete set of data for both pairs of stations tested on a given date, whereas abundance estimates required only that the data were quantitative at a particular station. As for BACI tests, the admissable samples for abundance estimation required matched canopy and bottom samples at a station, on a given date.

2.5 Input of Weight Data to Abundance Estimates

In order to convert numerical abundance estimates to biomass, it was necessary to estimate the average body weight of the various life stages and species that were sampled. Estimates of average body weight required empirical data on length distributions and a mathematical expression of the length-weight

relationship. Many of the published length-weight relations of bony fishes are expressed in terms of standard length (SL), the distance between the tip of the snout and the base of the caudal fin. This is a conventional measurement used in fisheries work in which the specimen can be measured in-hand. Because visual estimates of length underwater required use of total length (TL), we frequently had to convert our TL estimates to SL. This conversion obviously required data on the mathematical relation between SL and TL. In some cases this relation was undocumented, and we were unable to determine it ourselves. In these cases, we determined the SL/TL relation from published photographs of the species. Care was taken to use only photos in which the major body axis of the specimen was perpendicular to the camera lens, in order to minimize distortion due to parallax. Length-weight relations and SL/TL conversion factors are listed in Appendix T; references for photographs are listed therein, along with mathematical formulae.

2.6 Details of PROC STEPWISE Analysis

SAS PROC STEPWISE was used in a preliminary step of our evaluation of fish-kelp relations. Specifically, when we performed stepwise multiple regressions (SAS, Inc. 1985) we elected to use the default ("stepwise") option and the default probability level (P = 0.15) for the identification and inclusion of variables in our models. The stepwise option includes aspects of both "forward" and "backward" options; namely, the variable that alone explains most variation in the dependent variable is entered first, and successive variables are entered one at a time in a forward fashion. As each new variable is entered, however, all prior variables are reevaluated -- if the P value of any variable increases above the defined level (in this case, P = 0.15), that variable is dropped from the model. We felt that this approach was most reasonable for relating fish and kelp densities for the following reasons: (1) the backwards option assumes prior knowledge of all relevant variables and that all of these variables were measured (which was not true in our case); (2) The forward option locks in variables entered early in the analysis, even if some subsequent combination of variables has greater explanatory power. This latter aspect was unacceptable, because prior analyses indicated that there had to be frequent interaction effects between year and many of the seabed variables. A conservative P value of 0.15 seemed reasonable because of the large variances in our estimates of the dependent variable -- fish density.

APPENDIX J -- TABLE 1

KELP BED FISHES: DATE TALLY OF QUANTITATIVE SAMPLES OF FISHES IN SONGS-AREA KELP BEDS. Dates are listed by fall sampling period (1980, 1981, 1985, 1986). Samples are further categorized by position within the water column (canopy and bottom strata). (Dates of canopy samples also include midwater--7.7-m depth--samples in 1985 and 1986 only.) Location acronyms are defined as follows: SMK = San Mateo Kelp bed; SOK = San Onofre Kelp bed; U = upcoast region of SOK; D = downcoast; out = offshore region of SOK; in = inshore; inbetw = region of SOK between its upcoast and downcoast regions; cobble = region of sparse kelp to kelpless cobble adjacent to upcoast or downcoast SOK. The MRC (X,Y) coordinates of each sampling location are listed in Appendix J, Table 2.

APPENDIX J -- TABLE 1

KELP BED SUMMARY OF COLLECTIONS
(1980)

Date	Stratum	SMK	SOKU	SOKD
07 OCT 80	CANOPY		X	X
10 OCT 80	CANOPY	X	X	X
20 OCT 80	CANOPY	X	X	X
22 OCT 80	CANOPY	X	X	X
24 OCT 80	CANOPY	X	X	X
24 OCT 80	BOTTOM	X	X	X
27 OCT 80	CANOPY		X	X
27 OCT 80	BOTTOM		X	X
29 OCT 80	BOTTOM	X	X	X
31 OCT 80	CANOPY	X	X	X
31 OCT 80	BOTTOM	X	X	X
03 NOV 80	CANOPY	X	X	X
10 NOV 80	CANOPY	X	X	X
14 NOV 80	BOTTOM		X	X
17 NOV 80	BOTTOM	X	X	X
19 NOV 80	CANOPY	X	X	X
20 NOV 80	CANOPY	X	X	X
20 NOV 80	BOTTOM	X	X	X
21 NOV 80	CANOPY	X	X	X
21 NOV 80	BOTTOM	X	X	X
24 NOV 80	CANOPY	X	X	X
24 NOV 80	BOTTOM	X	X	X
25 NOV 80	CANOPY	X	X	X
25 NOV 80	BOTTOM	X	X	X
26 NOV 80	CANOPY	X	X	
26 NOV 80	BOTTOM	X	X	X
02 DEC 80	CANOPY	X	X	X
02 DEC 80	BOTTOM	X	X	X
03 DEC 80	CANOPY	X	X	X
03 DEC 80	BOTTOM	X	X	X
08 DEC 80	CANOPY		X	X
08 DEC 80	BOTTOM		X	X
10 DEC 80	CANOPY	X	X	X
10 DEC 80	BOTTOM	X	X	X
11 DEC 80	CANOPY	X	X	X
11 DEC 80	BOTTOM	X	X	X
12 DEC 80	CANOPY	X	X	X
12 DEC 80	BOTTOM	X	X	X
15 DEC 80	CANOPY	X	X	X
15 DEC 80	BOTTOM	X	X	X
17 DEC 80	CANOPY	X	X	X
17 DEC 80	BOTTOM	X	X	X
18 DEC 80	CANOPY	X	X	X
18 DEC 80	BOTTOM	X	X	X

APPENDIX J -- TABLE 1 (continued)

KELP BED SUMMARY OF COLLECTIONS
(1981)

Date	Stratum	SMK	SOKU	SOKD
07 OCT 81	CANOPY	X	X	X
07 OCT 81	BOTTOM	X	X	X
09 OCT 81	CANOPY	X	X	X
09 OCT 81	BOTTOM	X	X	X
12 OCT 81	CANOPY	X	X	X
14 OCT 81	CANOPY	X	X	X
16 OCT 81	CANOPY		X	X
19 OCT 81	CANOPY	X	X	X
19 OCT 81	BOTTOM	X	X	X
21 OCT 81	CANOPY	X	X	X
21 OCT 81	BOTTOM	X	X	X
23 OCT 81	CANOPY	X	X	X
23 OCT 81	BOTTOM	X	X	X
28 OCT 81	CANOPY		X	X
02 NOV 81	BOTTOM	X	X	X
04 NOV 81	CANOPY	X	X	X
06 NOV 81	CANOPY	X	X	X
09 NOV 81	CANOPY	X	X	X
09 NOV 81	BOTTOM	X	X	X
11 NOV 81	BOTTOM	X	X	X
23 NOV 81	CANOPY	X	X	X
30 NOV 81	CANOPY		X	X
30 NOV 81	BOTTOM		X	X
01 DEC 81	CANOPY		X	X
02 DEC 81	CANOPY	X	X	X
07 DEC 81	CANOPY	X	X	X
09 DEC 81	CANOPY		X	X
11 DEC 81	CANOPY	X	X	X
14 DEC 81	CANOPY	X	X	X
14 DEC 81	BOTTOM	X	X	X
15 DEC 81	CANOPY	X	X	X
15 DEC 81	BOTTOM	X	X	X
16 DEC 81	CANOPY		X	X
16 DEC 81	BOTTOM	X	X	X
17 DEC 81	CANOPY	X	X	X
17 DEC 81	BOTTOM	X	X	X
18 DEC 81	CANOPY	X	X	X
18 DEC 81	BOTTOM	X	X	X

APPENDIX J -- TABLE 1 (continued)

KELP BED SUMMARY OF COLLECTIONS
(1985)

Date	Stratum	SMK	SOKUout	SOKDin	SOKUin	SOKDout	CobbleU
09 OCT 85	CANOPY	X	X				
11 OCT 85	CANOPY	X	X	X			
11 OCT 85	BOTTOM	X	X	X			
17 OCT 85	CANOPY	X	X	X			
17 OCT 85	BOTTOM	X	X	X			
18 OCT 85	CANOPY				X	X	
18 OCT 85	BOTTOM				X	X	X
22 OCT 85	CANOPY				X	X	
25 OCT 85	CANOPY	X	X	X			
25 OCT 85	BOTTOM	X	X	X			
28 OCT 85	CANOPY			X	X	X	
04 NOV 85	CANOPY	X	X	X			
06 NOV 85	CANOPY				X	X	
14 NOV 85	BOTTOM				X	X	X
19 NOV 85	CANOPY	X	X	X			
19 NOV 85	BOTTOM	X	X	X			
20 NOV 85	CANOPY				X	X	
20 NOV 85	BOTTOM				X	X	X
22 NOV 85	CANOPY	X	X	X			
22 NOV 85	BOTTOM	X	X	X			
27 NOV 85	CANOPY				X	X	
27 NOV 85	BOTTOM				X	X	X
02 DEC 85	BOTTOM				X	X	X
12 DEC 85	CANOPY				X	X	
12 DEC 85	BOTTOM				X	X	X
16 DEC 85	CANOPY	X	X	X			
16 DEC 85	BOTTOM	X	X	X			
17 DEC 85	CANOPY				X	X	
17 DEC 85	BOTTOM				X	X	X
18 DEC 85	CANOPY	X	X	X			
18 DEC 85	BOTTOM	X	X	X			
19 DEC 85	CANOPY				X	X	
19 DEC 85	BOTTOM				X	X	X
20 DEC 85	CANOPY	X	X	X			
20 DEC 85	BOTTOM	X	X	X			

APPENDIX J -- TABLE 1 (continued)

KELP BED SUMMARY OF COLLECTIONS
(1986)

Date	Stratum	SMK	SOKUout	SOKDin	SOKUin	SOKDout	SOKinbetw	CobU	CobD
03 OCT 86	CANOPY	X	X						
03 OCT 86	BOTTOM	X	X						
14 OCT 86	CANOPY	X	X	X					
16 OCT 86	BOTTOM								X
07 NOV 86	CANOPY				X	X			
07 NOV 86	BOTTOM				X	X		X	
11 NOV 86	CANOPY	X	X	X					
11 NOV 86	BOTTOM	X	X	X					
12 NOV 86	CANOPY				X	X	X		
12 NOV 86	BOTTOM				X	X	X		
13 NOV 86	CANOPY	X	X						
13 NOV 86	BOTTOM	X	X						
14 NOV 86	CANOPY				X	X			
14 NOV 86	BOTTOM				X	X			X
19 NOV 86	CANOPY				X	X			
19 NOV 86	BOTTOM				X	X		X	
26 NOV 86	CANOPY	X	X	X					
26 NOV 86	BOTTOM	X	X	X					
02 DEC 86	CANOPY				X	X	X		
02 DEC 86	BOTTOM				X	X	X		
03 DEC 86	CANOPY	X	X	X					
03 DEC 86	BOTTOM	X	X	X					
04 DEC 86	CANOPY				X	X			
04 DEC 86	BOTTOM				X	X			X
05 DEC 86	CANOPY	X	X	X					
05 DEC 86	BOTTOM	X	X	X					
09 DEC 86	CANOPY				X	X			
09 DEC 86	BOTTOM				X	X		X	
10 DEC 86	CANOPY	X	X	X					
10 DEC 86	BOTTOM	X	X	X					
11 DEC 86	CANOPY						X		
11 DEC 86	BOTTOM						X	X	X
12 DEC 86	CANOPY			X	X	X			
12 DEC 86	BOTTOM			X	X	X			

APPENDIX J -- TABLE 2

KELP BED FISHES: MRC COORDINATES OF ALL LOCATIONS AT SAN MATEO KELP BED (SMK), SAN ONOFRE KELP BED (SOK), AND AT COBBLE STATIONS (MBS) ADJACENT TO SOK THAT WERE SAMPLED FOR FISHES DURING ONE OR MORE FALL PERIODS INCLUDING 1980, 1981, 1985, AND 1986. Coordinates during 1980 and 1981 are the average of the component stations.

Station Name	Fall Period	MRC Coordinates
SMKpreop	1980, 1981	X = -4550; Y = - 850
SMK1985	1985	X = -4554; Y = - 955
SMK1986	1986	X = -4400; Y = - 974
SOKUpreop	1980, 1981	X = + 780; Y = -1830
SOKUout	1985, 1986	X = + 773; Y = -1926
SOKUin	1985, 1986	X = + 891; Y = -1803
SOKDpreop	1980, 1981	X = +1635; Y = -1700
SOKDout	1985, 1986	X = +1424; Y = -1603
SOKDin	1985, 1986	X = +1763; Y = -1618
SOKinbetween	1986	X = +1145; Y = -1680
CobbleUp	1985, 1986	X = + 752; Y = -1784
CobbleDown	1986	X = +1689; Y = -1704

APPENDIX J -- TABLE 3

KELP BED FISHES: MEANS OF UNDERWATER VISIBILITY MEASURED IN (A) CANOPY AND (B) BOTTOM ZONES. Summary statistics are provided for each location sampled in each of the 4 years of study (see Appendix J, Table 2 for MRC coordinates of the stations). Underwater visibilities were estimated (to 0.1 m) by divers (Section 1.7, this appendix). Canopy sampled at 3.1 m beneath sea surface; bottom zone averaged 14.5 m in depth. Dashes indicate that the station was not sampled during a particular fall period.

(A) CANOPY

	FALL SEASON			
STATION	1980	1981	1985	1986
SMK	6.8	8.0	6.7	5.1
SOKUpreop	8.1	10.5	--	--
SOKUin	--	--	8.5	8.8
SOKUout	--	--	8.5	7.8
SOKDpreop	9.3	9.8	--	--
SOKDin	--	--	10.6	9.2
SOKDout	--	--	7.7	9.0
SOKinbetween	--	--	--	7.8

(B) BOTTOM

	FALL SEASON			
STATION	1980	1981	1985	1986
SMK	4.8	5.8	4.3	3.7
SOKUpreop	4.1	4.6	--	--
SOKUin	--	--	4.8	5.8
SOKUout	--	--	4.8	5.9
SOKDpreop	4.4	4.9	--	--
SOKDin	--	--	4.9	5.3
SOKDout	--	--	5.1	5.2
SOKinbetween	--	--	--	5.9
MBSU	--	--	4.5	5.8
MBSD	--	--	--	4.5

APPENDIX J -- TABLE 4

KELP BED FISHES: MEANS OF VISIBILITY-DEPENDENT CORRECTION FACTORS USED TO STANDARDIZE CINETRANSECT VOLUMES. Summary statistics are provided for each location sampled in each of the 4 years of study (see Appendix J, Table 2 for MRC coordinates of the stations). Canopy sampled at 3.1 m beneath sea surface; midwater sampled at 7.7-m depth. Dashes indicate that the station was not sampled during a particular fall period.

(A) CANOPY

	FALL SEASON			
STATION	1980	1981	1985	1986
SMK	1.27	1.22	1.25	1.44
SOKUpreop	1.20	1.00	--	--
SOKUin	--	--	1.03	1.04
SOKUout	--	--	1.20	1.32
SOKDpreop	1.07	1.02	--	--
SOKDin	--	--	1.00	0.99
SOKDout	--	--	1.07	1.00
SOKinbetween	--	--	--	1.07

(B) MIDWATER

	FALL SEASON			
STATION	1980	1981	1985	1986
SMK	--	--	1.29	1.60
SOKUpreop	--	--	--	--
SOKUin	--	--	1.08	1.05
SOKUout	--	--	1.28	1.34
SOKDpreop	--	--	--	--
SOKDin	--	--	1.02	1.06
SOKDout	--	--	1.11	1.02
SOKinbetween	--	--	--	1.08

APPENDIX K -- Annotated List of SAS Programs Used in Analyses of Fishes in SONGS-Area Kelp Beds and at PAR

APPENDIX K --
ANNOTATED LIST OF SAS PROGRAMS USED IN ANALYSES

All major statistical analyses were done on the IBM 4341 mainframe computer at the Marine Review Committee (MRC) facility in Encinitas, California. Standard statistical tests utilized canned procedures (PROCs) of the Statistical Analysis System (SAS).

All analysis programs used in this report are listed in the following annotated cross-reference. These programs have been saved on the Report (E) disk. Most analysis programs were developed by UCSB Fish Study project personnel. However, Titan Systems, Inc. and J. Callahan developed the generic BACITEST SAS program, the major program package that we have used in the evaluation of local changes in fish density. A slightly modified version of this program (BACITES9) was used to analyze kelp-bed data.

ANNOTATED LIST OF SAS PROGRAMS USED IN ANALYSES

CHAPTER THREE -- SONGS IMPACT ON SAN ONOFRE KELP BED FISHES

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T=Tbl)
		DATA PROCESSING	
KBSPARS	Kelp Bed	Sparses data one year at a time: no. of fish per 1000 m**3 calculated, all species included, all locations included, all depths included.	N/A
KBSPARS4	Kelp Bed	Sparses data for preoperational and operational period simultaneously: no. of fish per 1000 m**3 calculated; only BACI species included; only BACI depths included; only BACI locations included; only BACI collections included.	N/A
KBADDY02	Kelp Bed	Adds YOY and OJ kelp bass to KBSPARS4 data bases.	N/A
		BACI FIGURES AND TABLES	
BACITES9	Kelp Bed	Performs BACI statistical assumption and impact tests (additivity, monotone trends, serial correlation, power, percent change, t-test).	T 15, 16; App M, T 2, 4; App N, T 1.
KBACISMR	Kelp Bed	Produces summary listing from data bases output by BACITES9 program.	T 15, 16; App M, T 2, 4; App N, T 1.
KBACITBL	Kelp Bed	Produces summary listing of t-test and assumption test results. List contains "best" constants.	T 15, 16; App M, T 2, 4; App N, T 1.
KBAUTINF	Kelp Bed	Performs BACI t-test on species which have serial correlation.	T 15, 16; App M, T 2, 3; App N, T 1.
KBZERO	Kelp Bed	Tabulates number and percent frequency of single-zero observations.	App N, T 2.
KBINOMAL	Kelp Bed	Performs binomial test for SONGS effects.	T 15, 16; App N, T 3.

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T=Tbl)
		FISH/KELP RELATIONSHIP	
KBMACRO	Kelp Bed	ANOVA tests for location differences in Macrocystis density by year.	T 20; App O, T 1.
KBSTEP	Kelp Bed	Runs SAS stepwise procedure to ascertain relative influence of substrate variables on fish density.	T 21; App O, T 7.
KBCOBST	Kelp Bed	ANCOVA determines if changes in fish density can be explained by any of five substrate variables plus location.	T 21; App O, T 8, 9.
KBC48586	Kelp Bed	ANCOVA tests relationship between fish density and Macrocystis density.	T 21; App O, T 6.
KBSUBANV	Kelp Bed	ANOVA tests for location differences in substrate variables for 1985 and 1986.	App O, T 2, 3.
KBSUB87	Kelp Bed	Tests for correlations between Macrocystis and five substrate variables in 1985 and 1986.	App O, T 4, 5.
		NUMERICAL AND BIOMASS ABUNDANCE	
KBPRXWT	Kelp Bed; PAR	Estimates weight of all species and maturities observed based on fish lengths and length/weight regressions.	App T, T 6, 7.
ABUNDAN5	Kelp Bed	Estimates numerical fish abundance based on sidescan sonar.	App P, T 8.
ABUNDAN6	Kelp Bed	Estimates numerical fish abundance based on downlooking sonar.	T 22, 23.
KBIOM87	Kelp Bed	Estimates fish biomass based on either downlooking or sidescan sonar.	T 24, 25.
KBUNSM87	Kelp Bed	Summarizes results of ABUNDAN5, ABUNDAN6, and KBIOM87 into report-ready tables.	T 22, 23, 24, 25.
KBPOOLD2	Kelp Bed	Tabulates weighted densities per 1000 m**2 of all fishes by location.	App P, T 1-4.

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T=Tbl)
		SUPPORTING TABLES AND FIGURES	
KBMNABUN	Kelp Bed	Tabulates mean arithmetic density for select species and life stages.	T 17-19.
KBDATES3	Kelp Bed	Tabulates sampling dates.	App J, T 1.
KBVIS	Kelp Bed	Tabulates mean underwater visibility and underwater visibility factors by location and year.	App J, T 3, 4.
KBPCMT87	Kelp Bed	Tabulates numerical density and percent composition by maturity and location for select species.	App L, T 1-3.
KBPCKB87	Kelp Bed	Tabulates numerical density and percent composition by maturity and location for kelp bass.	App L, T 1-3.
KBPLOT	Kelp Bed	Plots time series fish densities and impact/control deltas for select species.	App N, Figs 1-83.
FKLSUMSP	Kelp Bed	Tabulates total number of fishes observed on fish length surveys in 1985.	App T, T 4A.
FKLSUM87	Kelp Bed	Tabulates total number of fishes observed on fish length surveys in 1986.	App T, T 4B.

CHAPTER FOUR -- FISHES AT PENDLETON ARTIFICIAL REEF

DATA PROCESSING

FMONSP87	PAR	JUV/AD fishes: Sparses crest, slope, and ecotone data; calculates density per 1000 m**3.	N/A
RADLSP87	PAR	JUV/AD fishes: Sparses radial transects; calculates density per 1000 m**3.	N/A

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T-Tbl)
FMONxTRA	PAR	JUV/AD fishes: Creates data base which contains extralimital counts of sargo, black croaker, and blacksmith.	N/A
YOYSPARS	PAR	YOY/OJ fishes: Sparses data; calculates density per 1000 m**3.	N/A
		A N O V A S	
FMONAN85	PAR	JUV/AD fishes: Two-way ANOVA on 1985 data testing for effects of stratum and maturity.	T 26.
FMONAN86	PAR	JUV/AD fishes: Two-way ANOVA on 1986 data testing for effects of stratum and maturity.	T 27.
FMONA286	PAR	JUV/AD fishes: Three-way ANOVA testing for effects of stratum, maturity, and year.	T 28.
YOY3WY86	PAR	YOY/OJ fishes: Three-way ANOVA testing for effects of stratum, maturity, and year.	T 29.
YOY2WY86	PAR	YOY/OJ fishes: Two-way ANOVA testing for effects of stratum and year on select spp.	T 29.
GBY2WY86	PAR	YOY/OJ fishes: Two-way ANOVA testing for effects of maturity and year on blackeye goby.	T 29.
PARSTRAT	PAR	YOY/OJ fishes: One-way ANOVA tests effect of stratum on biomass density during 1986.	App S, T 1.
RADINOUT	PAR	YOY/OJ fishes: One-way ANOVA compares biomass density of fishes censused on "Internal" versus "External" radial transects during 1986.	App S, T 2.
		D E N S I T Y , A B U N D A N C E , A N D B I O M A S S	
FMONAB85	PAR	JUV/AD fishes: Tabulates numerical density, numerical abundance, and biomass abundance for 1985.	T 30, 32, 33.

Program			Figure or Table Number
File Name	Task	Description	(F=Fig., T-Tbl)
FMONAB87	PAR	JUV/AD fishes: Tabulates numerical density, numerical abundance, and biomass abundance for 1986.	T 31, 34, 35; App S, T 9-14.
YOYABUN	PAR	YOY/OJ fishes: Tabulates numerical density and numerical abundance for 1985 and 1986.	T 36-39.
RADLPLOT	PAR	JUV/AD fishes: Plots fish density versus distance from module for 1985 data.	F 4.
RADLBIOM	PAR	JUV/AD fishes: Plots mean body weight per individual versus microhabitat for 1985 data.	F 5.
RADLPL87	PAR	JUV/AD fishes: Plots fish density versus distance from module for 1986 data.	F 6.
RADLBI87	PAR	JUV/AD fishes: Plots mean body weight per individual versus microhabitat for 1986 data.	F 7.
FMONMT87	PAR	JUV/AD fishes: Tabulates mean and rank densities of all fishes by stratum and life stage during 1985 and 1986.	App R, T 1-3 and 5-9.
RADLMEAN	PAR	JUV/AD fishes: Tabulates mean and rank densities of all fishes observed on radial transects in 1985.	App R, T 4.
YOYMAT	PAR	YOY/OJ fishes: Tabulates mean and rank densities of all fishes by stratum and life stage during 1985 and 1986.	App R, T 10, 11.
FMONST85	PAR	JUV/AD fishes: Tabulates numerical abundance and biomass by maturity, stratum, and species for 1985.	App S, T 3, 5.
FMONST87	PAR	JUV/AD fishes: Tabulates numerical abundance and biomass by maturity, stratum, and species for 1986.	App S, T 4, 6.
YOYST87	PAR	YOY/OJ fishes: Tabulates numerical abundance by maturity, stratum, and species for 1985 and 1986.	App S, T 7, 8.
FKLSUMPR	PAR	JUV/AD fishes: Tabulates total number of fishes observed on fish-length surveys in 1985 and 1986.	App T, T 5A, 5B.

APPENDIX L -- Summary Data: Kelp Bed Fish Monitoring

APPENDIX L -- TABLES 1-3

KELP BED FISHES: NUMERICAL DENSITIES AND PERCENT COMPOSITION OF JUVENILE (JUV), SUBADULT (SAD), AND ADULT (AD) LIFE STAGES OF FISHES THAT WERE COMMON AND ABUNDANT IN BASELINE (FALL 1980, FALL 1981) SAMPLES AND IN OPERATIONAL (FALL 1985, FALL 1986) SAMPLES AT SMK, SOKD, AND SOKU. Densities are numbers of individuals per 1000 m**3. The species characterized are those used in our BACI t-tests. Also noted is the number of sampling dates used in the characterization. All quantitative samples are used in the characterization, including "double zero" observations excluded from BACI tests (Appendix J, Table 1). The number of dates used varied among fishes, depending on whether they were considered canopy, bottom, or canopy-bottom ("cosmopolite") species (see Appendix M, Table 1 for classification).

APPENDIX L -- TABLE 1

PERCENT COMPOSITION BY NUMERICAL DENSITY (#/1000 m^3) AND BY LIFE STAGE AT SAN MATEO KELP BED (SMK)

	PREOPERATIONAL (1980 and 1981)						OPERATIONAL (1985 and 1986)					
	Juvenile		Subadult		Adult		Juvenile		Subadult		Adult	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
BASS, barred sand	0.1	11.1	0.8	79.4	0.1	9.5	1.1	24.6	2.3	53.1	1.0	22.3
BASS, kelp	2.3[a]	33.0[a]	4.6	64.9	0.1	2.1	2.8[a]	59.3[a]	1.7	34.9	0.3	5.9
BLACKSMITH	0.9	100.0	0.0	0.0	0.0	0.0	0.8	99.1	0.0	0.9	0.0	0.0
HALFMOON	0.0	0.0	0.2	3.8	3.9	96.2	0.0	0.0	0.0	3.6	1.1	96.4
KELPFISH, giant	0.0	35.7	0.0	47.5	0.0	16.9	0.1	29.7	0.2	68.3	0.0	2.1
PERCH, black	0.0	0.0	1.0	32.0	2.0	68.0	0.4	7.6	4.1	72.7	1.1	19.8
PERCH, kelp	0.0	0.0	0.0	0.0	32.9	100.0	0.0	0.0	0.0	0.0	3.7	100.0
PERCH, pile	0.0	0.5	1.5	49.2	1.6	50.3	0.2	13.0	1.1	73.9	0.2	13.0
SEAPERCH, rainbow	0.0	1.9	0.6	71.7	0.2	26.4	0.0	5.6	0.5	77.8	0.1	16.7
SEAPERCH, white	0.1	1.5	0.7	17.8	3.2	80.6	0.0	0.0	0.2	69.2	0.1	30.8
SENORITA	3.4	14.1	1.5	6.0	19.4	79.9	1.6	8.0	3.7	19.1	14.3	72.9
SHEEPHEAD, Calif.	2.6	31.9	5.1	62.1	0.5	6.0	1.7	66.2	0.7	28.6	0.1	5.2
SILVERSIDES spp.	0.0	0.0	0.0	0.0	7.8	100.0	0.0	0.0	0.0	0.0	3.2	100.0
WRASSE, rock	0.0	0.4	0.4	10.5	3.8	89.1	1.1	3.1	22.6	62.6	12.4	34.3
Number of Sampling Dates	CANOPY 39 BOTTOM 30 CANOPY and BOTTOM 25						CANOPY 18 BOTTOM 15 CANOPY and BOTTOM 15					

[a] Juvenile kelp bass only, includes YOY (Preop, 1981 only: N = 0.6/1000 m^3, 7.0%; Op: N = 0.6/1000 m^3, 12.7%).

APPENDIX L -- TABLE 2

PERCENT COMPOSITION BY NUMERICAL DENSITY (#/1000 m^3) AND BY LIFE STAGE
AT SAN ONFRE KELP BED - DOWNCOAST (SOKD)

	PREOPERATIONAL (1980 and 1981)						OPERATIONAL (1985 and 1986)											
							SOKDout						SOKDin					
	Juvenile		Subadult		Adult		Juvenile		Subadult		Adult		Juvenile		Subadult		Adult	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
BASS, barred sand	0.3	9.3	2.4	64.6	1.0	26.1	5.0	45.8	4.8	43.5	1.2	10.7	0.7	25.7	1.3	50.0	0.6	24.3
BASS, kelp	2.8[a]	24.3[a]	8.3	72.4	0.4	3.3	5.2[a]	50.1[a]	4.9	47.2	0.3	2.7	1.0[a]	46.9[a]	1.0	50.7	0.1	2.5
BLACKSMITH	0.1	91.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	100.0	0.2	100.0	0.0	0.0	0.0	0.0
HALFMOON	0.0	0.0	0.0	1.6	2.9	98.4	0.0	0.0	0.0	0.8	3.4	99.2	0.0	0.0	0.0	0.0	0.4	100.0
KELPFISH, giant	0.0	45.8	0.0	18.5	0.0	35.6	0.1	23.8	0.2	73.7	0.0	2.6	0.0	0.0	0.0	100.0	0.0	0.0
PERCH, black	0.2	0.7	5.4	22.9	18.0	76.3	0.2	1.5	7.9	64.1	4.3	34.4	0.0	0.0	0.3	50.0	0.3	50.0
PERCH, kelp	0.0	0.0	0.0	0.0	7.7	100.0	0.0	0.0	0.0	0.0	1.9	100.0	0.0	0.0	0.0	0.0	0.1	100.0
PERCH, pile	0.0	1.1	1.6	38.2	2.5	60.7	0.2	2.6	6.0	82.8	1.0	14.6	0.0	0.0	0.2	60.0	0.1	40.0
SEAPERCH, rainbow	0.0	0.9	1.8	38.2	2.8	60.8	0.0	0.0	0.9	66.7	0.4	33.3	0.0	0.0	0.0	50.0	0.0	50.0
SEAPERCH, white	0.0	0.0	3.1	44.5	3.8	55.5	0.0	0.0	0.4	47.4	0.4	52.6	0.0	0.0	0.3	75.3	0.1	24.7
SENORITA	1.3	10.9	0.2	1.3	10.3	87.8	2.4	6.8	2.6	7.1	31.0	86.1	2.6	9.4	4.0	14.2	21.6	76.4
SHEEPHEAD, Calif.	5.2	29.3	11.0	61.5	1.7	9.3	1.9	81.1	0.4	16.2	0.1	2.7	0.8	79.3	0.2	20.7	0.0	0.0
SILVERSIDES spp.	0.0	0.0	0.0	0.0	4.1	100.0	0.0	0.0	0.0	0.0	0.1	100.0	0.0	0.0	0.0	0.0	1.1	100.0
WRASSE, rock	0.0	0.7	0.3	14.1	1.8	85.2	2.0	6.4	18.2	58.1	11.1	35.5	1.0	4.5	15.7	68.8	6.1	26.7
Number of Sampling Dates	CANOPY and	CANOPY 47 BOTTOM 34 BOTTOM 28					CANOPY and	CANOPY 17 BOTTOM 16 BOTTOM 14					CANOPY and	CANOPY 17 BOTTOM 16 BOTTOM 14				

[a] Juvenile kelp bass only, includes YOY (Preop, 1981 only: N = 2.6/1000 m^3, 39.4%; Op: SOKDout--N = 0.6/1000 m^3, 6.0%; SOKDin--N = 0.1/1000 m^3, 5.3%).

APPENDIX L -- TABLE 3

PERCENT COMPOSITION BY NUMERICAL DENSITY (#/1000 m^3) AND BY LIFE STAGE
AT SAN ONOFRE KELP BED - UPCOAST (SOKU)

	PREOPERATIONAL (1980 and 1981)						OPERATIONAL (1985 and 1986)											
							SOKUout						SOKUin					
	Juvenile		Subadult		Adult		Juvenile		Subadult		Adult		Juvenile		Subadult		Adult	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
BASS, barred sand	0.7	11.3	4.0	60.7	1.8	28.0	1.1	18.6	4.5	74.3	0.4	7.1	0.2	11.1	1.2	61.9	0.5	27.0
BASS, kelp	3.5[a]	27.9[a]	8.8	70.3	0.2	1.8	2.3[a]	50.8[a]	2.1	45.0	0.2	4.2	1.8[a]	63.9[a]	0.9	32.8	0.1	3.3
BLACKSMITH	0.2	100.0	0.0	0.0	0.0	0.0	0.4	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
HALFMOON	0.0	0.0	0.0	0.9	2.9	99.1	0.0	0.0	0.1	1.7	5.2	98.3	0.0	0.0	0.0	1.0	5.0	99.0
KELPFISH, giant	0.0	51.0	0.0	19.2	0.0	29.8	0.1	49.4	0.1	50.6	0.0	0.0	0.1	100.0	0.0	0.0	0.0	0.0
PERCH, black	0.0	0.1	1.0	8.4	10.6	91.5	0.0	0.0	0.5	19.2	1.9	80.8	0.0	0.0	0.2	53.8	0.2	46.2
PERCH, kelp	0.0	0.0	0.0	0.0	10.7	100.0	0.0	0.0	0.0	0.0	0.9	100.0	0.0	0.0	0.0	0.0	0.0	100.0
PERCH, pile	0.0	0.5	1.5	53.1	1.3	46.4	0.0	0.0	0.1	10.0	0.6	90.0	0.0	0.0	0.1	50.0	0.1	50.0
SEAPERCH, rainbow	0.0	0.0	0.2	25.0	0.6	75.0	0.0	0.0	0.1	60.0	0.1	40.0	0.0	0.0	0.0	0.0	0.0	0.0
SEAPERCH, white	0.1	0.6	5.8	47.4	6.4	52.0	0.0	0.5	0.6	43.7	0.7	55.8	0.0	0.0	0.1	80.9	0.0	19.1
SENORITA	0.6	4.5	0.3	2.8	11.4	92.7	2.4	5.9	4.4	10.9	33.3	83.2	1.1	8.2	0.5	3.3	12.0	88.5
SHEEPHEAD, Calif.	6.2	28.3	12.9	59.4	2.7	12.3	3.3	85.5	0.5	12.0	0.1	2.6	1.5	85.5	0.2	10.9	0.1	3.6
SILVERSIDES spp.	0.0	0.0	0.0	0.0	3.4	100.0	0.0	0.0	0.0	0.0	0.9	100.0	0.0	0.0	0.0	0.0	6.5	100.0
WRASSE, rock	0.0	2.7	0.1	5.4	1.0	91.9	0.5	2.2	12.3	55.1	9.5	42.7	0.3	1.4	17.1	77.2	4.8	21.4
Number of Sampling Dates	CANOPY 48 BOTTOM 34 CANOPY and BOTTOM 29						CANOPY 18 BOTTOM 15 CANOPY and BOTTOM 15						CANOPY 17 BOTTOM 16 CANOPY and BOTTOM 14					

[a] Juvenile kelp bass only, includes YOY (Preop, 1981 only: N = 0.4/1000 m^3, 2.6%; Op: SOKUout--N = 0.6/1000 m^3, 12.2%; SOKUin--N = 0.6/1000 m^3, 19.8%).

APPENDIX M: Summary of Pre-BACI Screening Tests for Kelp Bed Fishes

APPENDIX M -- TABLE 1

KELP BED FISHES: CATEGORIZATION OF 14 SPECIES AND ONE TAXON USED IN BACI T-TESTS ACCORDING TO WATER-COLUMN HABITAT OCCUPIED. "Canopy" fishes are those that primarily (>>90% of numbers) inhabit the upper several meters of the water column in SONGS-area kelp beds. "Bottom" fishes are those that primarily inhabit the near-seabed stratum. "Canopy-Bottom" fishes ("cosmopolites:" Larson and DeMartini 1984) are those that are frequently encountered and abundant throughout the water column from canopy to seabed. All life-stages within species/taxon were evaluated using the parent classification.

Species/Taxon	Water Column Habitat
BASS, barred sand	Bottom
BASS, kelp	Canopy-Bottom
BLACKSMITH	Canopy-Bottom
HALFMOON	Canopy*
KELPFISH, giant	Canopy-Bottom
PERCH, black	Bottom
PERCH, kelp	Canopy
PERCH, pile	Bottom
SEAPERCH, rainbow	Bottom
SEAPERCH, rubberlip	Bottom
SEAPERCH, white	Canopy-Bottom
SENORITA	Canopy-Bottom
SHEEPHEAD, California	Bottom
SILVERSIDES	Canopy
WRASSE, rock	Bottom

* In other (ANCOVA) analyses of fish-kelp relations, halfmoon are considered as a "canopy-midwater" species. (Note that the midwater stratum is N/A for BACI impact tests.)

APPENDIX M -- TABLE 2

KELP BED FISHES: SUMMARY RESULTS OF SCREENING TESTS PERFORMED PRIOR TO BACI T-TESTS FOR IMPACT. Preoperational deltas only were tested for additivity. Both preoperational and operational deltas were tested for monotone trends (linear regression) and serial correlation (von Neumann's test). If serial correlation was detected, the entire baseline plus operational data series was re-evaluated for first- and second-order autoregressive processes, based on the Durbin-Watson test statistic, using SAS PROC AUTOREG. The comment "N/A" indicates either that (1) the data were insufficient for evaluation or (2) the pooled life-stage category "TOTAL" was inappropriate because of heterogeneous components. The comment "?" indicates that the results of the additivity test were possibly spurious because of too many (> 25%) single-zero observations during the baseline period at the Impact location, Control location, or both locations. Resolution of serial correlation was "moot" if other assumptions were violated.

APPENDIX M -- TABLE 2

Taxon	Life Stage	Control Location	Assumption Met Regarding ? Addi-tivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR Resolved? (if present)
BASS, barred sand	AD	SMK	YES	YES	YES	-
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	YES	YES	YES	-
	JUV	SOKD	YES	YES	YES	-
	SAD	SMK	YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	YES	YES	YES	-
BASS, kelp	AD	SMK	YES	NO	NO	MOOT
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	YES	YES	NO	YES
	JUV	SOKD	YES	YES	YES	-
	OJ	SMK	YES	YES	YES	-
	OJ	SOKD	YES	NO	NO	MOOT
	SAD	SMK	YES	YES	YES	-
	SAD	SOKD	NO	NO	NO	MOOT
	TOTAL	SMK	-- N/A : heterogeneous taxon --			
	TOTAL	SOKD	-- N/A : heterogeneous taxon --			
	YOY	SMK	YES	YES	YES	-
	YOY	SOKD	YES	YES	YES	-
BLACKSMITH	AD	SMK	-- N/A : too few data --			
	AD	SOKD	-- N/A : too few data --			
	JUV	SMK	YES	YES	YES	-
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	-- N/A : too few data --			
	SAD	SOKD	-- N/A : too few data --			
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	?YES	YES	YES	-
HALFMOON	AD	SMK	YES	YES	YES	-
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	?YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	-- N/A : heterogeneous taxon --			

APPENDIX M -- TABLE 2 (continued)

Taxon	Life Stage	Control Location	Assumption Met Regarding ? Addi-tivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR Resolved? (if present)
KELPFISH, giant	AD	SMK	-- N/A : too few data --			
	AD	SOKD	-- N/A : too few data --			
	JUV	SMK	?YES	YES	YES	-
	JUV	SOKD	?YES	YES	YES	-
	SAD	SMK	?YES	YES	YES	-
	SAD	SOKD	-- N/A : too few data --			
	TOTAL	SMK	?YES	YES	YES	-
	TOTAL	SOKD	?YES	YES	YES	-
PERCH, black	AD	SMK	NO	NO	NO	MOOT
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	?YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	NO	NO	NO	MOOT
	TOTAL	SOKD	YES	YES	YES	-
PERCH, kelp	TOTAL	SMK	NO	NO	NO	MOOT
	TOTAL	SOKD	YES	YES	NO	YES
PERCH, pile	AD	SMK	YES	YES	YES	-
	AD	SOKD	NO	NO	NO	MOOT
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	YES	NO	YES	-
	SAD	SOKD	YES	NO	YES	-
	TOTAL	SMK	YES	NO	YES	-
	TOTAL	SOKD	YES	NO	YES	-
SEAPERCH, rainbow	AD	SMK	-- N/A : too few data --			
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	?YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	YES	YES	YES	-
SEAPERCH, rubberlip	AD	SMK	-- N/A : too few data --			
	AD	SOKD	-- N/A : too few data --			
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	-- N/A : too few data --			
	SAD	SOKD	-- N/A : too few data --			
	TOTAL	SMK	?YES	YES	YES	-
	TOTAL	SOKD	?YES	YES	YES	-

APPENDIX M -- TABLE 2 (continued)

Taxon	Life Stage	Control Location	Assumption Met Regarding ? Addi-tivity	Monotone Trend	Serial Correlation (SERCORR)	SERCORR Resolved? (if present)
SEAPERCH, white	AD	SMK	YES	NO	NO	MOOT
	AD	SOKD	NO	NO	NO	MOOT
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	-- N/A : heterogeneous taxon --			
	TOTAL	SOKD	YES	NO	NO	MOOT
SENORITA	AD	SMK	YES	YES	YES	-
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	YES	YES	YES	-
	JUV	SOKD	?YES	YES	YES	-
	SAD	SMK	YES	YES	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	YES	YES	YES	-
SHEEPHEAD, California	AD	SMK	-- N/A : too few data --			
	AD	SOKD	-- N/A : too few data --			
	JUV	SMK	YES	YES	YES	-
	JUV	SOKD	YES	YES	YES	-
	SAD	SMK	NO	NO	YES	-
	SAD	SOKD	YES	YES	YES	-
	TOTAL	SMK	-- N/A : heterogeneous taxon --			
	TOTAL	SOKD	YES	NO	YES	-
SILVERSIDES	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	?YES	YES	YES	-
WRASSE, rock	AD	SMK	YES	YES	YES	-
	AD	SOKD	YES	YES	YES	-
	JUV	SMK	-- N/A : too few data --			
	JUV	SOKD	-- N/A : too few data --			
	SAD	SMK	?NO	YES	YES	-
	SAD	SOKD	NO	NO	NO	MOOT
	TOTAL	SMK	YES	YES	YES	-
	TOTAL	SOKD	YES	YES	YES	-

APPENDIX M - TABLE 3

KELP BED FISHES: SUMMARY RESULTS FOR SELECT LIFE STAGE - LOCATION PAIRS HAVING SIGNIFICANT SERIAL CORRELATION AMONG RESIDUALS OF THE DELTAS ACCORDING TO VON NEUMANN'S TEST. Tests are based on preoperational and operational data through Fall 1986; preoperational and operational period deltas were first evaluated separately using von Neumann's test. In all cases, the additive form chosen for the impact test was further evaluated for first- and second-order autocorrelation based on the Durbin-Watson test statistic (using SAS PROC AUTOREG). Significant ($P < .05$) first- or second-order autoregressive processes are indicated by bold-typed probability values.

APPENDIX M -- TABLE 3

Taxon	Life Stage	Control Location	Von Neumann's Test for Serially Correlated Deltas (Within Period) Preop.	Op.	SAS PROC AUTOREG Test Statistics for Pooled Deltas (Preop. + Op.) PROB (1st order)	PROB (2nd order)
BASS, kelp	JUV	SMK	SIG	SIG	**.03**	.67
	YOY	SMK	NS	SIG	.18	.76
BLACKSMITH	JUV	SMK	NS	SIG	.28	.82
	TOTAL	SMK	NS	SIG	.30	.83
HALFMOON	AD	SMK	SIG	NS	.10	<.001
	TOTAL	SMK	SIG	NS	**.03**	<.01
KELPFISH, giant	JUV	SMK	NS	SIG	.55	.76
	SAD	SMK	NS	SIG	.31	.46
	TOTAL	SMK	NS	SIG	.53	.10
PERCH, black	SAD	SMK	NS	SIG	.84	**.03**
PERCH, kelp	TOTAL	SOKD	SIG	NS	**.0001**	.26
PERCH, pile	AD	SMK	NS	SIG	.68	.45
SEAPERCH, rubberlip	TOTAL	SMK	SIG	NS	.60	.86
SEAPERCH, white	SAD	SOKD	NS	SIG	.23	.10
SENORITA	SAD	SMK	NS	SIG	.15	.82
SILVERSIDES	TOTAL	SMK	NS	SIG	.23	.45
	TOTAL	SOKD	SIG	NS	**.002**	.84
WRASSE, rock	AD	SMK	SIG	NS	.07	.51
	AD	SOKD	NS	SIG	.46	.42
	SAD	SMK	NS	SIG	.10	.38
	TOTAL	SMK	SIG	SIG	**.04**	.64
	TOTAL	SOKD	NS	SIG	.87	.68

APPENDIX M -- TABLE 4

KELP BED FISHES: DETAILED PROC T-TEST RESULTS FOR A TOTAL OF 61 TAXON/LIFE STAGES AT SPECIFIED LOCATION PAIRS (SOKU, SOKD, SMK) for preoperational (Fall 1980 and 1981) versus operational (Fall 1985 and 1986) monitoring periods. Results are based on the most appropriate transformation (as shown) for each tractable combination of taxon/life-stage and locations. "T-corrected" signifies that t-test statistics had to be adjusted for unequal (UNEQ) variances based on Satterthwaite's approximation . Cases of equal (EQ) variances did not require this adjustment. Autocorrelated and statistically intractable combinations are noted; these are not included in the tally of t-test results.

APPENDIX M -- TABLE 4

Taxon/ Species	Life Stage	Control Location	Log-10 Transformation	Variances	T Corrected?
BASS, barred sand	AD	SMK	(x-bar + .04)	UNEQ	YES
	AD	SOKD	(x-bar + .005)	EQ	NO
	JUV	SMK	(x-bar + .005)	EQ	NO
	JUV	SOKD	(x-bar + .005)	EQ	NO
	SAD	SMK	(x-bar + .08)	EQ	NO
	SAD	SOKD	(x-bar + .005)	EQ	NO
	TOTAL	SMK	(x-bar + .25)	EQ	NO
	TOTAL	SOKD	(x-bar + .75)	EQ	NO
BASS, kelp	AD	SMK	moot	-- intractable --	
	AD	SOKD	(x-bar + .0025)	EQ	NO
	JUV	SMK	(x-bar + .0025)	-- autocorrelated --	
	JUV	SOKD	(x-bar + .02)	UNEQ	YES
	OJ	SMK	(x-bar + 0.0)	EQ	NO
	OJ	SOKD	moot	-- intractable --	
	SAD	SMK	(x-bar + .0025)	UNEQ	YES
	SAD	SOKD	moot	-- intractable --	
	YOY	SMK	(x-bar + .0025)	EQ	NO
	YOY	SOKD	(x-bar + .0025)	EQ	NO
	TOTAL	SMK	moot	-- intractable --	
	TOTAL	SOKD	moot	-- intractable --	
BLACKSMITH	JUV	SMK	(x-bar + .0025)	EQ	NO
	JUV	SOKD	moot	-- too few data --	
	TOTAL	SMK	(x-bar + .0025)	EQ	NO
	TOTAL	SOKD	N/A	-- Binomial test --	
HALFMOON	AD	SMK	(x-bar + .25)	-- autocorrelated --	
	AD	SOKD	(x-bar + .0025)	UNEQ	YES
	SAD	SMK	N/A	-- Binomial test --	
	SAD	SOKD	(x-bar + .0025)	EQ	NO
	TOTAL	SMK	(x-bar + .35)	-- autocorrelated --	
	TOTAL	SOKD	moot	-- intractable --	
KELPFISH, giant	JUV	SMK	N/A	-- Binomial test --	
	JUV	SOKD	N/A	-- Binomial test --	
	SAD	SMK	N/A	-- Binomial test --	
	SAD	SOKD	moot	-- too few data --	
	TOTAL	SMK	N/A	-- Binomial test --	
	TOTAL	SOKD	N/A	-- Binomial test --	

APPENDIX M -- TABLE 4 (continued)

Taxon/ Species	Life Stage	Control Location	Log-10 Transformation	Variances	T Corrected?
PERCH, black	AD	SMK	moot	-- intractable --	
	AD	SOKD	(x-bar + .08)	EQ	NO
	SAD	SMK	N/A	-- Binomial test --	
	SAD	SOKD	(x-bar + .005)	UNEQ	YES
	TOTAL	SMK	moot	-- intractable --	
	TOTAL	SOKD	(x-bar + .15)	EQ	NO
PERCH, kelp	TOTAL	SMK	moot	-- intractable --	
	TOTAL	SOKD	(x-bar + .50)	-- autocorrelated --	
PERCH, pile	TOTAL	SMK	(x-bar + .005)	EQ	NO
	TOTAL	SOKD	moot	-- intractable --	
SEAPERCH, rainbow	AD	SMK	moot	-- intractable --	
	AD	SOKD	(x-bar + .08)	UNEQ	YES
	SAD	SMK	N/A	-- Binomial test --	
	SAD	SOKD	(x-bar + .005)	UNEQ	YES
	TOTAL	SMK	(x-bar + .005)	EQ	NO
	TOTAL	SOKD	(x-bar + .08)	EQ	NO
SEAPERCH, rubberlip	TOTAL	SMK	N/A	-- Binomial test --	
	TOTAL	SOKD	N/A	-- Binomial test --	
SEAPERCH, white	SAD	SMK	(x-bar + .0025)	EQ	NO
	SAD	SOKD	(x-bar + .0025)	EQ	NO
	TOTAL	SMK	moot	-- heterogeneous taxon --	
	TOTAL	SOKD	moot	-- intractable --	
SENORITA	AD	SMK	(x-bar + 0.0)	EQ	NO
	AD	SOKD	(x-bar + 0.0)	EQ	NO
	JUV	SMK	(x-bar + .04)	EQ	NO
	JUV	SOKD	N/A	-- Binomial test --	
	SAD	SMK	(x-bar + .0025)	EQ	NO
	SAD	SOKD	(x-bar + .0025)	EQ	NO
	TOTAL	SMK	(x-bar + .25)	EQ	NO
	TOTAL	SOKD	(x-bar + 0.0)	EQ	NO
SHEEPHEAD, California	JUV	SMK	(x-bar + .005)	EQ	NO
	JUV	SOKD	(x-bar + .005)	EQ	NO
	SAD	SMK	moot	-- intractable --	
	SAD	SOKD	(x-bar + .005)	UNEQ	YES
	TOTAL	SMK	moot	-- heterogeneous taxon --	
	TOTAL	SOKD	moot	-- intractable --	

APPENDIX M -- TABLE 4 (continued)

Taxon/ Species	Life Stage	Control Location	Log-10 Transformation	Variances	T Corrected?
SILVERSIDES	TOTAL	SMK	(x-bar + .0025)	EQ	NO
	TOTAL	SOKD	N/A	-- Binomial test --	
WRASSE, rock	AD	SMK	(x-bar + .005)	UNEQ	YES
	AD	SOKD	(x-bar + .25)	EQ	NO
	SAD	SMK	N/A	-- Binomial test --	
	SAD	SOKD	moot	-- intractable --	
	TOTAL	SMK	(x-bar + .04)	-- autocorrelated --	
	TOTAL	SOKD	(x-bar + .50)	EQ	NO

APPENDIX N -- FIGURES 1 - 83

KELP BED FISHES: (DIFFERENCES IN) OBSERVED DENSITIES OF SELECT SPECIES AT THE IMPACT (SOKU) AND EITHER OF THE TWO CONTROL LOCATIONS (SMK, SOKD) DURING THE FALL 1980-81 PREOPERATIONAL AND FALL 1985-86 OPERATIONAL MONITORING PERIODS. Stations used for BACI analyses varied with sampling period (see text Section 3.2.2). Densities are estimated mean numbers per 1,000 m**3. Densities are illustrated in the top two panels of each figure and deltas (differences) in densities in the bottom panel. Sampling dates are listed in Appendix J, Table 1. In cases where data are analyzed by t-test, density data are plotted as the most appropriate of the additive, log-10 transformations and as the deltas of this transformation (see Appendix M). For cases analyzed by binomial test, the raw density data are plotted in the top two panels. Figures include each of the 61 cases that were statistically tractable, plus 22 others for which statistical tests were inappropriate (Appendix M). For the latter 22 cases, raw density data are plotted for impact and control locations in the top two panels, but the bottom panel is left blank.

APPENDIX N -- TABLE 1

KELP BED FISHES: Summary results of BACI t-tests for baseline (Fall 1980, Fall 1981) versus operational period (Fall 1985, Fall 1986) samples. Analyses performed for total individuals and all component life stages (AD = adult, JUV = juvenile, SAD = subadult) that were common and abundant in baseline and operational samples. Impact location is SOKU. (* = 0.1 > P > .05; ** = .05 > P > .01; *** = .01 > P > .001; **** = P < .001). (Juvenile kelp bass evaluated as YOY = young of year and OJ = older juveniles). A particular life stage was flagged as "intractable" or as a "heterogeneous taxon" for a location-pair if it was analyzable at the other pair of locations; otherwise, the life stage was deleted from analysis. "Intractable" signifies that the case was inappropriate for analysis because of violations of one or more major statistical assumptions. "Heterogeneous taxon" signifies that component life stages exhibited contradictory patterns of change. Some cases whose additivity test results may have been spurious were also evaluated using a more conservative (binomial) test (Appendix N,Table 3); these cases are flagged by a "?" opposite the life stage.

Taxon	Life Stage	Log-10 Transformation	Control Location	Delta-Bars Preop.	Delta-Bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I Minus C) Abundances	t or t'	df	P
BASS, barred sand	AD	(x-bar + .04)	SMK	1.43	- .57	.60	1.09	- 99	t' = 5.27	10	<.001****
	AD	(x-bar + .005)	SOKD	.47	- .60	1.38	1.78	- 92	t = 2.13	43	.04**
	JUV	(x-bar + .005)	SMK	1.54	- .06	1.47	1.92	- 98	t = 2.83	34	.008***
	JUV	(x-bar + .005)	SOKD	.71	-2.14	1.78	1.07	- 99	t = 5.47	38	<.0001****
	SAD	(x-bar + .08)	SMK	.90	.22	.77	.65	- 79	t = 2.89	42	.006***
	SAD	(x-bar + .005)	SOKD	.35	-1.15	.95	1.16	- 97	t = 4.82	47	<.0001****
	TOTAL	(x-bar + .25)	SMK	.86	.09	.51	.49	- 83	t = 4.84	43	<.0001****
	TOTAL	(x-bar + .75)	SOKD	.25	- .63	.40	.42	- 87	t = 7.09	48	<.0001****
BASS, kelp	AD	moot	SMK	-- intractable --							
	AD	(x-bar + .0025)	SOKD	- .04	- .73	1.49	1.25	- 80	t = 1.29	32	.21
	JUV	(x-bar + .0025)	SMK	+ .16	- .10	.88	.60	- 45	t* = .64	38	.53
	JUV	(x-bar + .02)	SOKD	+ .22	- .53	.70	.34	- 82	t' = 4.66	40	<.0001****
	OJ	(x-bar + 0.0)	SMK	.03	- .07	.42	.60	- 21	t = .46	23	.65
	OJ	moot	SOKD	-- intractable --							
	SAD	(x-bar + .0025)	SMK	.30	- .18	.50	1.30	- 67	t' = 1.37	16	.19
	SAD	moot	SOKD	-- intractable --							
	YOY	(x-bar + .0025)	SMK	- .33	- .58	.99	1.13	- 44	t = .57	22	.57
	YOY	(x-bar + .0025)	SOKD	- .60	- .45	1.28	1.24	+ 41	t = .29	22	.77
	TOTAL	moot	SMK	-- heterogeneous taxon --							
	TOTAL	moot	SOKD	-- heterogeneous taxon --							
BLACKSMITH	JUV	(x-bar + .0025)	SMK	- .64	.30	1.64	2.29	+778	t = .92	14	.37
	JUV	(x-bar + .0025)	SOKD	-- too few data --							
	TOTAL	(x-bar + .0025)	SMK	- .64	.27	1.64	2.33	+714	t = .88	14	.40
	?TOTAL	(x-bar + .0025)	SOKD	.29	.16	2.71	2.12	- 26	t = .08	9	.94
HALFMOON	AD	(x-bar + .25)	SMK	- .31	.19	.72	.81	+218	t* = .02	47	.98
	AD	(x-bar + .0025)	SOKD	< .01	.06	.86	1.76	+ 15	t' = .11	11	.91
	?SAD	(x-bar + .0025)	SMK	- .21	.57	1.77	1.92	+506	t = .82	13	.42
	SAD	(x-bar + .0025)	SOKD	.44	- .25	1.69	2.13	- 80	t = .60	9	.56
	TOTAL	(x-bar + .35)	SMK	- .30	.20	.67	.60	+215	t* = 2.52	52	.015**
	TOTAL	moot	SOKD	-- heterogenous taxon --							

APPENDIX N -- TABLE 1 (continued)

Taxon	Life Stage	Log-10 Transformation	Control Location	Delta-Bars Preop.	Delta-Bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I Minus C) Abundances	t or t'	df	P
KELPFISH, giant	?JUV	(x-bar + .0025)	SMK	- .03	.12	1.64	2.03	+ 40	t = .16	14	.88
	?JUV	(x-bar + .0025)	SOKD	.36	- .10	1.64	1.67	- 66	t = .62	18	.54
	?SAD	(x-bar + .0025)	SMK	- .63	- .69	1.85	1.54	- 13	t = .08	17	.94
	SAD	moot	SOKD	-- too few data --							
	?TOTAL	(x-bar + .0025)	SMK	- .07	- .84	1.59	1.29	- 83	t = 1.40	27	.17
	?TOTAL	(x-bar + .0025)	SOKD	.22	- .79	1.58	1.64	- 90	t = 1.59	24	.125
PERCH, black	AD	moot	SMK	-- intractable --							
	AD	(x-bar + .08)	SOKD	- .79	- 1.15	1.24	.85	- 57	t = .97	44	.34
	?SAD	(x-bar + .005)	SMK	.11	- 2.07	2.50	1.29	- 99	t* = 2.53	30	.017**
	SAD	(x-bar + .005)	SOKD	-1.15	- 2.43	2.07	1.04	- 95	t' = 2.48	34	.018**
	TOTAL	moot	SMK	-- intractable --							
	TOTAL	(x-bar + .15)	SOKD	- .70	- 1.33	1.03	.66	- 77	t = 2.25	47	.029**
PERCH, kelp	TOTAL	moot	SMK	-- intractable --							
	TOTAL	(x-bar + .50)	SOKD	.23	- .86	.58	.31	- 92	t* = 3.29	52	.002***
PERCH, pile	AD	(x-bar + .005)	SMK	- .06	.82	1.68	1.98	+ 656	t = 1.28	32	.21
	AD	moot	SOKD	-- intractable --							
	SAD	moot	SMK	-- intractable --							
	SAD	moot	SOKD	-- intractable --							
	TOTAL	moot	SMK	-- intractable --							
	TOTAL	moot	SOKD	-- intractable --							
SEAPERCH, rainbow	AD	moot	SMK	-- too few data --							
	AD	(x-bar + .08)	SOKD	- .97	-1.22	.72	.23	- 44	t' = 1.45	20	.16
	?SAD	(x-bar + .005)	SMK	< .01	- .66	2.47	2.58	- 78	t = .50	16	.62
	SAD	(x-bar + .005)	SOKD	-1.32	-2.58	1.56	.40	- 95*	t' = 3.16	22	.005***
	TOTAL	(x-bar + .005)	SMK	.74	.03	2.18	2.56	- 80	t = .69	23	.50
	TOTAL	(x-bar + .08)	SOKD	- .95	-1.32	.65	.37	- 57	t = 1.62	37	.11
SEAPERCH, rubberlip	?TOTAL	(x-bar + .005)	SMK	- .04	.47	2.21	2.90	+ 219	t = .41	18	.69
	?TOTAL	(x-bar + .005)	SOKD	- .92	-2.06	2.21	2.74	- 93	t = .93	25	.36
SEAPERCH, white	AD	moot	SMK	-- intractable --							
	AD	moot	SOKD	-- intractable --							
	SAD	(x-bar + .0025)	SMK	.94	.87	1.77	1.58	- 16	t = .13	30	.90
	SAD	(x-bar + .0025)	SOKD	.63	- .79	1.27	1.45	- 96	t = 2.67	25	.013**
	TOTAL	moot	SMK	-- heterogeneous taxon --							
	TOTAL	moot	SOKD	-- intractable --							

APPENDIX N -- TABLE 1 (continued)

Taxon	Life Stage	Log-10 Transformation	Control Location	Delta-Bars Preop.	Delta-Bars Op.	STD of Deltas Preop.	STD of Deltas Op.	% Change in (I Minus C) Abundances	t or t'	df	P
SENORITA	AD	(x-bar + 0.0)	SMK	- .26	.40	.54	.58	+ 362	t = 3.67	38	<.001****
	AD	(x-bar + 0.0)	SOKD	.13	- .52	.54	.64	- 77	t = 3.41	40	.001***
	JUV	(x-bar + .04)	SMK	-1.28	- .09	.68	1.12	+1425	t = 3.85	32	<.001****
	?JUV	(x-bar + .0025)	SOKD	- .60	-1.33	2.21	2.04	- 81	t = .91	27	.37
	SAD	(x-bar + .0025)	SMK	-1.19	.58	1.60	1.38	+5686	t = 3.55	38	.001***
	SAD	(x-bar + .0025)	SOKD	.15	- .56	1.53	1.07	- 81	t = 1.47	31	.15
	TOTAL	(x-bar + .25)	SMK	- .34	.38	.45	.55	+ 420	t = 4.46	38	<.0001****
	TOTAL	(x-bar + 0.0)	SOKD	.09	- .53	.51	.56	- 76	t = 3.59	40	<.001****
SHEEPHEAD, California	JUV	(x-bar + .005)	SMK	.46	.58	1.36	1.24	+ 34	t = .29	42	.77
	JUV	(x-bar + .005)	SOKD	- .01	- .21	1.19	1.32	- 38	t = .55	48	.59
	SAD	moot	SMK	-- intractable --							
	SAD	(x-bar + .005)	SOKD	.08	- .92	.45	1.87	- 90	t' = 1.92	13	.078*
	TOTAL	moot	SMK	-- heterogeneous taxon --							
	TOTAL	moot	SOKD	-- intractable --							
SILVERSIDES	TOTAL	(x-bar + .0025)	SMK	- .37	-1.56	2.02	2.96	- 94	t = 1.44	35	.16
	?TOTAL	(x-bar + .0025)	SOKD	.08	2.59	2.53	2.09	+31,800	t* = 2.22	42	.032**
WRASSE, rock	AD	(x-bar + .005)	SMK	- .98	- .14	1.65	.38	+ 590	t' = 2.61	33	.014**
	AD	(x-bar + .25)	SOKD	- .30	- .52	.52	.42	- 40	t = 1.48	46	.15
	?SAD	(x-bar + .04)	SMK	- .98	- .39	.63	.36	+ 290	t' = 3.10	20	.006***
	SAD	moot	SOKD	-- intractable --							
	TOTAL	(x-bar + .04)	SMK	- .83	- .30	.98	.29	+ 239	t* = 1.53	42	.13
	TOTAL	(x-bar + .50)	SOKD	- .28	- .36	.36	.44	- 16	t = .66	46	.51

APPENDIX N -- TABLE 2

KELP BED FISHES: LIST OF FREQUENCY AND PERCENT FREQUENCY OF SINGLE-ZERO OBSERVATIONS OF KELP BED FISHES IN BASELINE DATA, BY TAXON AND LIFE STAGE, FOR THE 15 SELECT TAXA USED IN THE BACI IMPACT TEST EVALUATION. Only taxa/life stages that are statistically tractable for BACI impact evaluation are listed. All percentages of 25% or larger are flagged in **BOLD**.

Taxon/Life Stage	Control Location	N Dates	SONGS #	SONGS %	CONTROL #	CONTROL %
BASS, barred sand/AD	SMK	28	0	0.0	23	**82.1***
BASS, barred sand/AD	SOKD	33	3	9.1	7	21.2
BASS, barred sand/JUV	SMK	21	2	9.5	16	**76.2***
BASS, barred sand/JUV	SOKD	26	5	19.2	13	**50.0***
BASS, barred sand/SAD	SMK	29	1	3.4	13	**44.8***
BASS, barred sand/SAD	SOKD	33	1	3.0	2	6.1
BASS, barred sand/TOTAL	SMK	30	0	0.0	12	**40.0***
BASS, barred sand/TOTAL	SOKD	34	0	0.0	2	5.9
BASS, kelp/AD	SOKD	24	5	20.8	7	**29.2***
BASS, kelp/JUV	SOKD	28	0	0.0	2	7.1
BASS, kelp/OJ	SMK	10	0	0.0	0	0.0
BASS, kelp/SAD	SMK	25	0	0.0	0	0.0
BASS, kelp/YOY	SMK	10	1	10.0	0	0.0
BASS, kelp/YOY	SOKD	12	1	8.3	1	8.3
BLACKSMITH/JUV	SMK	7	3	**42.9***	1	14.3
BLACKSMITH/TOTAL	SMK	7	3	**42.9***	1	14.3
BLACKSMITH/TOTAL	SOKD	7	3	**42.9**	4	**57.1**
HALFMOON/AD	SMK	39	13	**33.3***	1	2.6
HALFMOON/SAD	SMK	8	3	**37.5**	3	**37.5**
HALFMOON/SAD	SOKD	6	1	16.7	3	**50.0***
HALFMOON/TOTAL	SMK	39	12	**30.8***	1	2.6
KELPFISH, giant/JUV	SMK	8	3	**37.5**	3	**37.5**
KELPFISH, giant/JUV	SOKD	9	3	**33.3**	5	**55.6**
KELPFISH, giant/SAD	SMK	6	4	**66.7**	2	**33.3**
KELPFISH, giant/TOTAL	SMK	16	6	**37.5**	6	**37.5**
KELPFISH, giant/TOTAL	SOKD	15	5	**33.3**	7	**46.7**

APPENDIX N -- TABLE 2 (continued)

Taxon/Life Stage	Control Location	N Dates	SONGS #	SONGS %	CONTROL #	CONTROL %
PERCH, black/AD	SOKD	33	13	**39.4***	1	3.0
PERCH, black/SAD	SMK	17	7	**41.2**	8	**47.1**
PERCH, black/SAD	SOKD	23	11	**47.8***	4	17.4
PERCH, black/TOTAL	SOKD	33	9	**27.3***	0	0.0
PERCH, kelp/TOTAL	SOKD	46	0	0.0	7	15.2
PERCH, pile/AD	SMK	25	7	**28.0***	6	24.0
SEAPERCH, rainbow/AD	SOKD	28	17	**60.7***	0	0.0
SEAPERCH, rainbow/SAD	SMK	13	6	**46.2**	7	**53.8**
SEAPERCH, rainbow/SAD	SOKD	19	11	**57.9***	2	10.5
SEAPERCH, rainbow/TOTAL	SMK	18	4	22.2	11	**61.1***
SEAPERCH, rainbow/TOTAL	SOKD	30	14	**46.7***	0	0.0
SEAPERCH, rubberlip/TOTAL	SMK	15	5	**33.3**	5	**33.3**
SEAPERCH, rubberlip/TOTAL	SOKD	23	12	**52.2**	6	**26.1**
SEAPERCH, white/SAD	SMK	19	4	21.1	8	**42.1***
SEAPERCH, white/SAD	SOKD	17	0	0.0	3	17.6
SENORITA/AD	SMK	25	0	0.0	0	0.0
SENORITA/AD	SOKD	28	0	0.0	0	0.0
SENORITA/JUV	SMK	21	13	**61.9***	0	0.0
SENORITA/JUV	SOKD	16	7	**43.8**	4	**25.0**
SENORITA/SAD	SMK	25	11	**44.0***	2	8.0
SENORITA/SAD	SOKD	20	4	20.0	5	**25.0***
SENORITA/TOTAL	SMK	25	0	0.0	0	0.0
SENORITA/TOTAL	SOKD	28	0	0.0	0	0.0
SHEEPHEAD, Calif./JUV	SMK	30	2	6.7	4	13.3
SHEEPHEAD, Calif./JUV	SOKD	34	2	5.9	2	5.9
SHEEPHEAD, Calif./SAD	SMK	30	0	0.0	2	6.7
SHEEPHEAD, Calif./SAD	SOKD	34	0	0.0	0	0.0

APPENDIX N -- TABLE 2 (continued)

Taxon/Life Stage	Control Location	N Dates	SONGS #	SONGS %	CONTROL #	CONTROL %
SILVERSIDES/TOTAL	SMK	25	8	32.0*	5	20.0
SILVERSIDES/TOTAL	SOKD	34	10	29.4	11	32.4
WRASSE, rock/AD	SMK	29	10	34.5*	3	10.3
WRASSE, rock/AD	SOKD	32	10	31.3*	2	6.3
WRASSE, rock/SAD	SMK	14	10	71.4**	0	0.0
WRASSE, rock/TOTAL	SMK	29	9	31.0*	1	3.4
WRASSE, rock/TOTAL	SOKD	32	9	28.1*	0	0.0

*Indicates case that passed additivity test despite large percentage of single-zero observations at one or the other location

**Indicates case that failed additivity test (perhaps) because of a large percentage of single-zero observations at one or the other location.

APPENDIX N -- TABLE 3

KELP BED FISHES: SUMMARY OF BINOMIAL TEST RESULTS FOR TAXA AND LIFE STAGES OF FISHES FOR WHICH THIS TEST WAS USED TO EVALUATE BACI CHANGES IN LIEU OF THE T-TEST. (The binomial test alternative was used only if a large percentage of single-zero observations in the baseline data was likely to have resulted in either an (A) spuriously rejected additivity test (many zeros at one or the other location) or a (B) spuriously accepted additivity test (many zeros at both locations). See Appendix N, Table 2 for a tally of the frequency of zero observations and Section 3.2.2.3 for further explanation (** = .05 > P > .01; *** = .01 > P > .001; **** = P < .001.)

Taxon/Life Stage	Control Location	N_B	N_A	P_B	P_A	P_A/P_B	Z	$PROB_Z$
(A) MANY ZEROS AT ONE OR OTHER LOCATION:								
WRASSE, rock/SAD	SMK	14	15	.13	.35	2.73	1.46	.14
(B) MANY ZEROS AT BOTH LOCATIONS:								
BLACKSMITH/TOTAL	SOKD	7	4	.59	.25	.42	1.19	.23
HALFMOON/SAD	SMK	8	7	.17	.68	4.05	2.31	.02**
KELPFISH, giant/JUV	SMK	8	8	.48	.37	.76	.47	.64
KELPFISH, giant/JUV	SOKD	9	11	.59	.53	.89	.29	.77
KELPFISH, giant/SAD	SMK	6	13	.23	.21	.89	.12	.90
KELPFISH, giant/TOTAL	SMK	16	13	.41	.26	.63	.88	.38
KELPFISH, giant/TOTAL	SOKD	15	11	.55	.21	.38	1.92	.06
PERCH, black/SAD	SMK	17	15	.52	.10	.19	2.92	.004***
SEAPERCH, rainbow/SAD	SMK	13	5	.25	.18	.69	.38	.71
SEAPERCH, rubberlip/TOTAL	SMK	15	5	.47	.55	1.15	.28	.78
SEAPERCH, rubberlip/TOTAL	SOKD	23	4	.14	<.01	.06	1.54	.12
SENORITA, JUV	SOKD	16	13	.31	.31	1.01	.03	.98
SILVERSIDES/TOTAL	SOKD	34	10	.45	.99	2.21	5.83	<.0001****

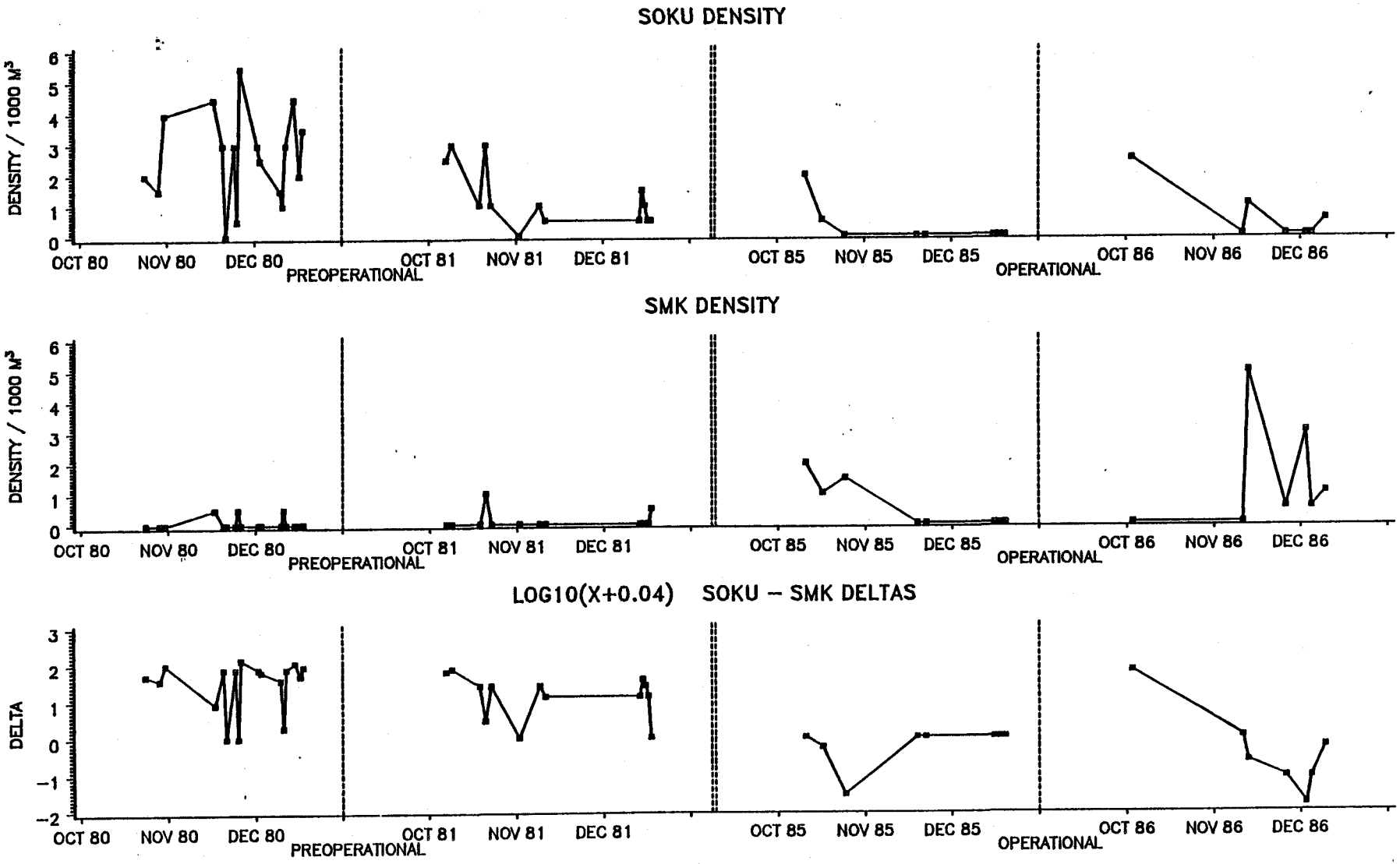
APPENDIX N -- FIGURES 1 - 83

KELP BED FISHES: (DIFFERENCES IN) OBSERVED DENSITIES OF SELECT SPECIES AT THE IMPACT (SOKU) AND EITHER OF THE TWO CONTROL LOCATIONS (SMK, SOKD) DURING THE FALL 1980-81 PREOPERATIONAL AND FALL 1985-86 OPERATIONAL MONITORING PERIODS. Densities are estimated mean numbers per 1,000 m**3. Densities are illustrated in the top two panels of each figure and deltas (differences) in densities in the bottom panel. Sampling dates are listed in Appendix J, Table 1. In cases where data are analyzed by t-test, density data are plotted as the most appropriate of the additive, log-10 transformations and as the deltas of this transformation (see Appendix M). For cases analyzed by binomial test, the raw density data are plotted in the top two panels. Figures include each of the 61 cases that were statistically tractable, plus 22 others for which statistical tests were inappropriate (Appendix M). For the latter 22 cases, raw density data are plotted for impact and control locations in the top two panels, but the bottom panel is left blank.

APPENDIX N FIGURE 1

ADULT BARRED SAND BASS

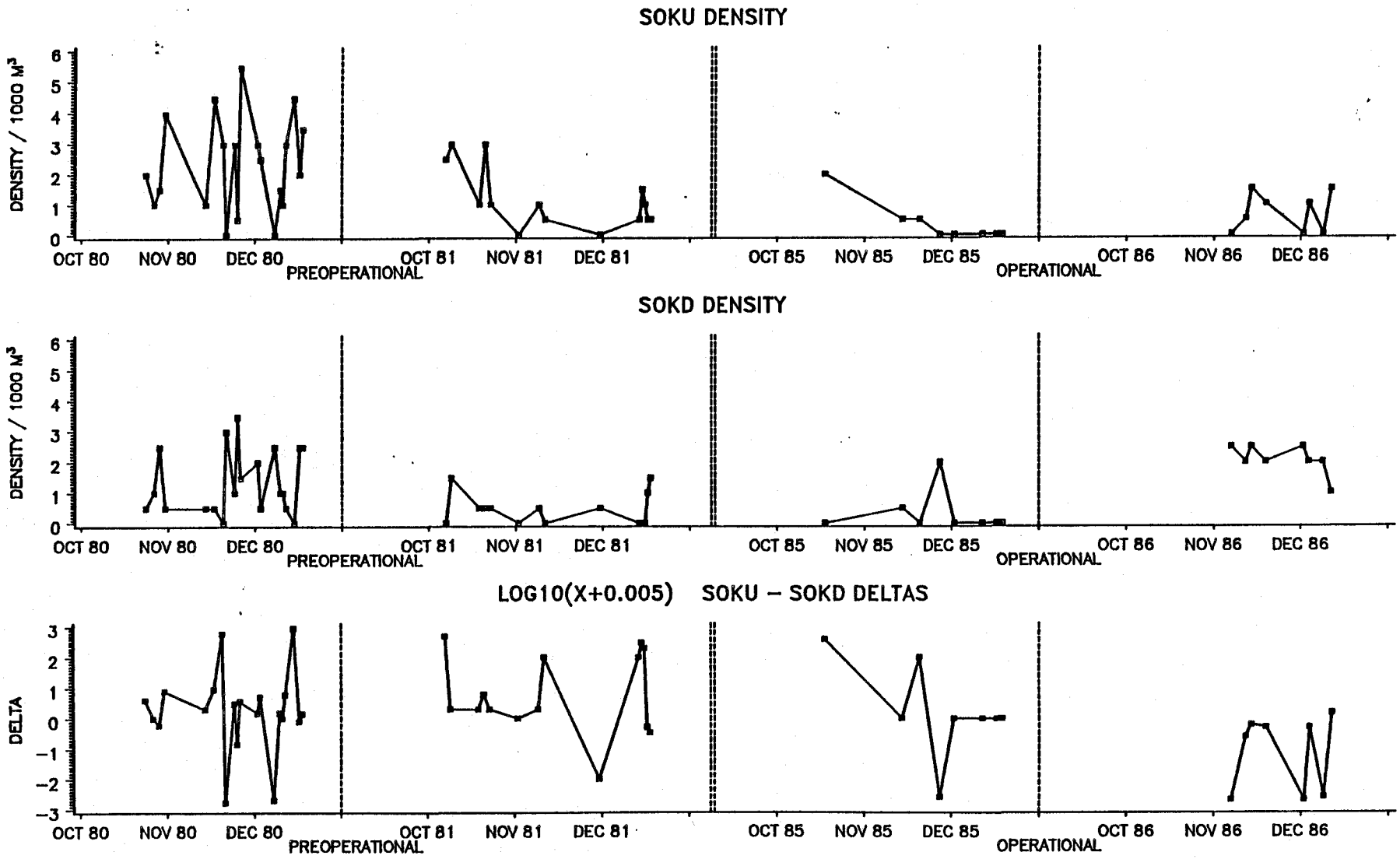
PARALABRAX NEBULIFER



APPENDIX N FIGURE 2

ADULT BARRED SAND BASS

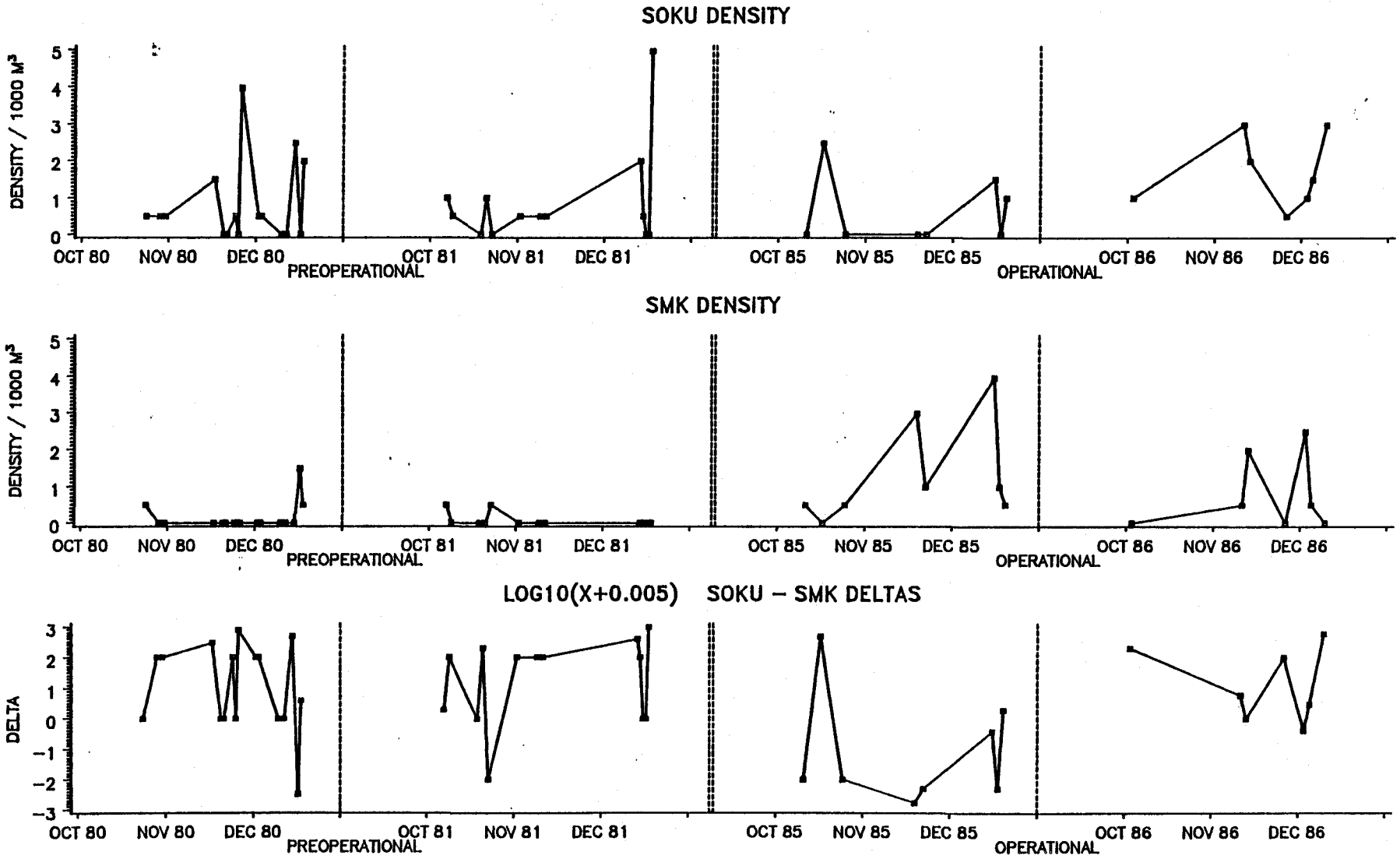
PARALABRAX NEBULIFER



APPENDIX N FIGURE 3

YOY & OLDER JUVENILE BARRED SAND BASS

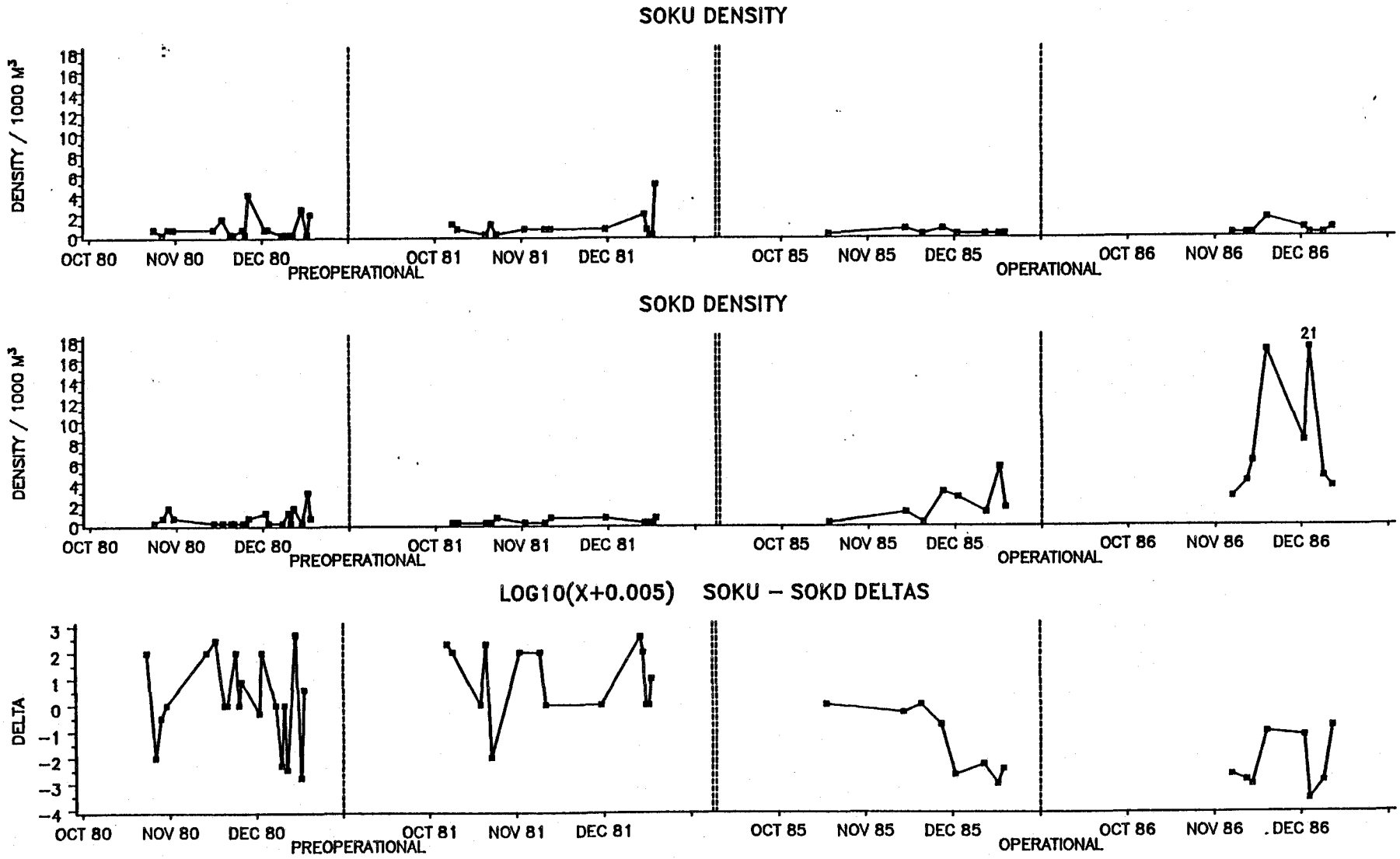
PARALABRAX NEBULIFER



APPENDIX N FIGURE 4

YOY & OLDER JUVENILE BARRED SAND BASS

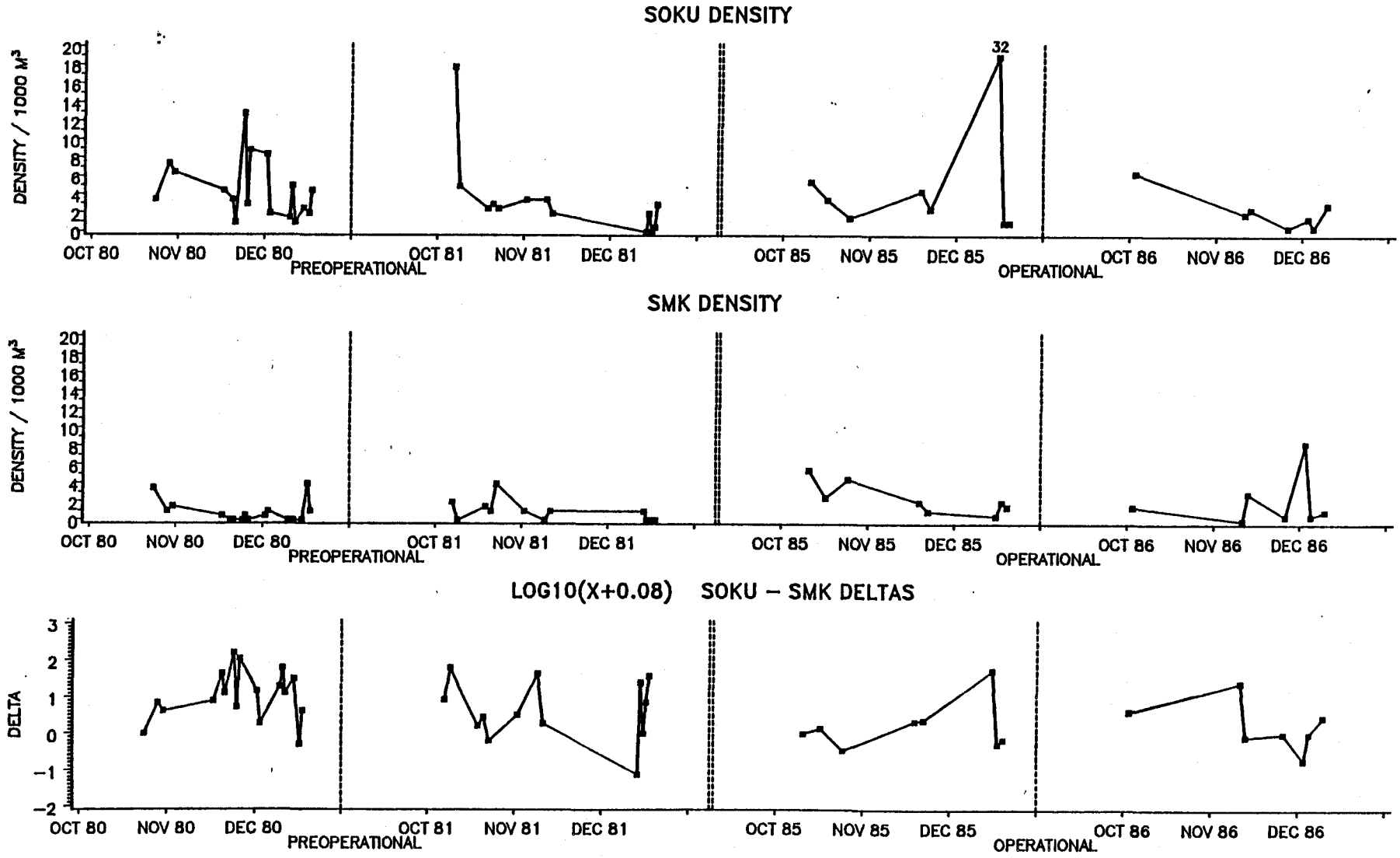
PARALABRAX NEBULIFER



APPENDIX N FIGURE 5

SUB–ADULT BARRED SAND BASS

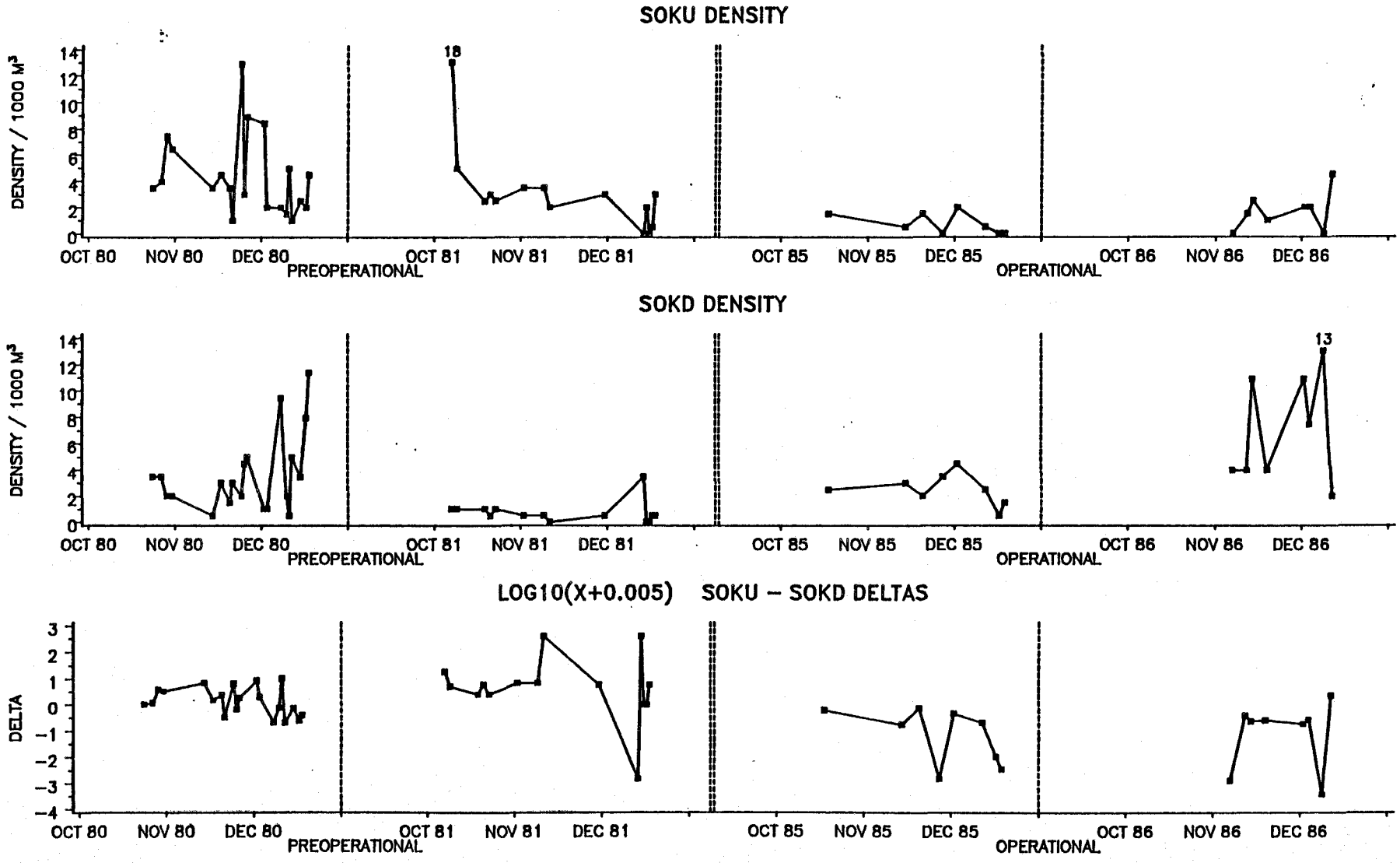
PARALABRAX NEBULIFER



APPENDIX N FIGURE 6

SUB–ADULT BARRED SAND BASS

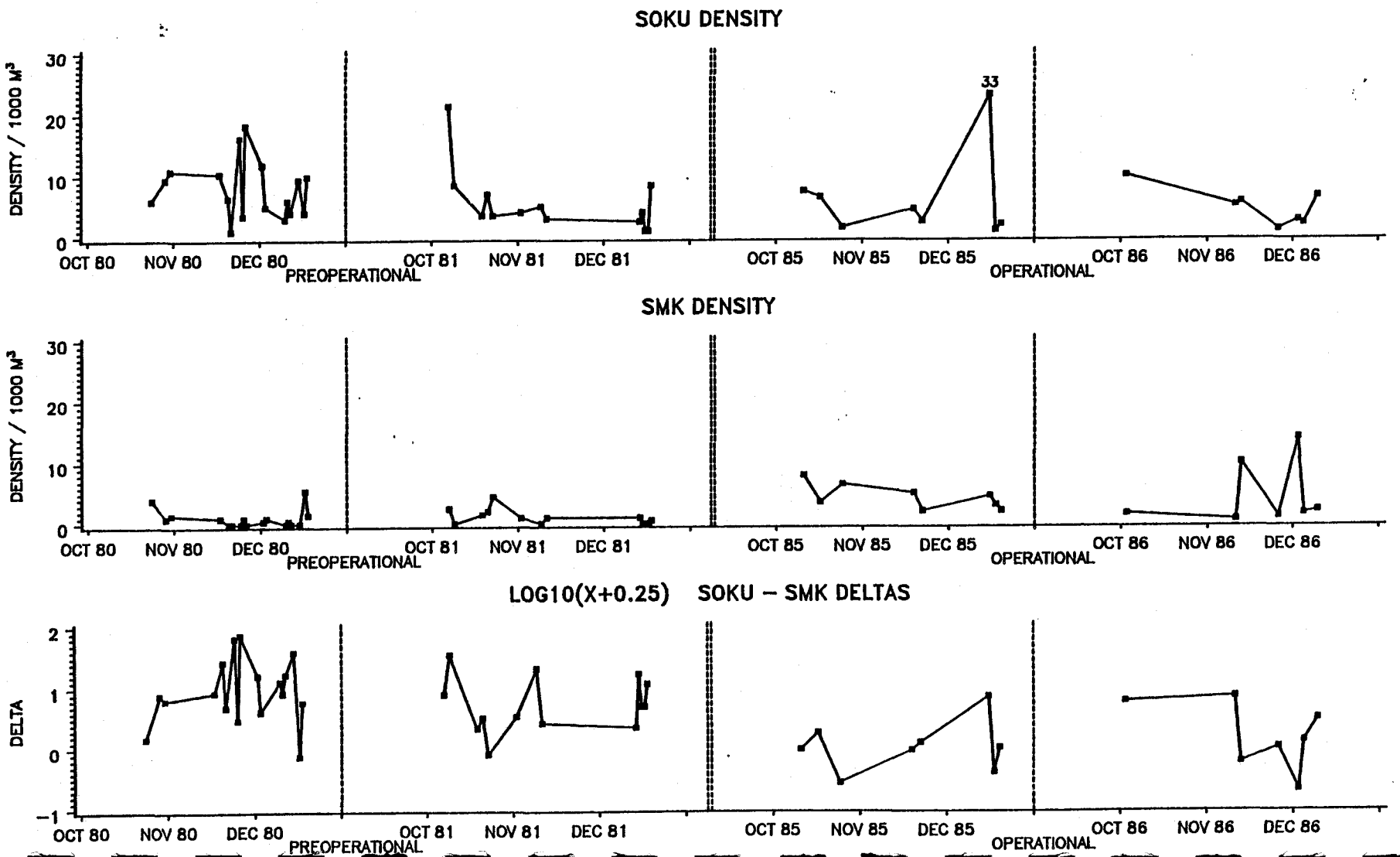
PARALABRAX NEBULIFER



APPENDIX N FIGURE 7

TOTAL BARRED SAND BASS

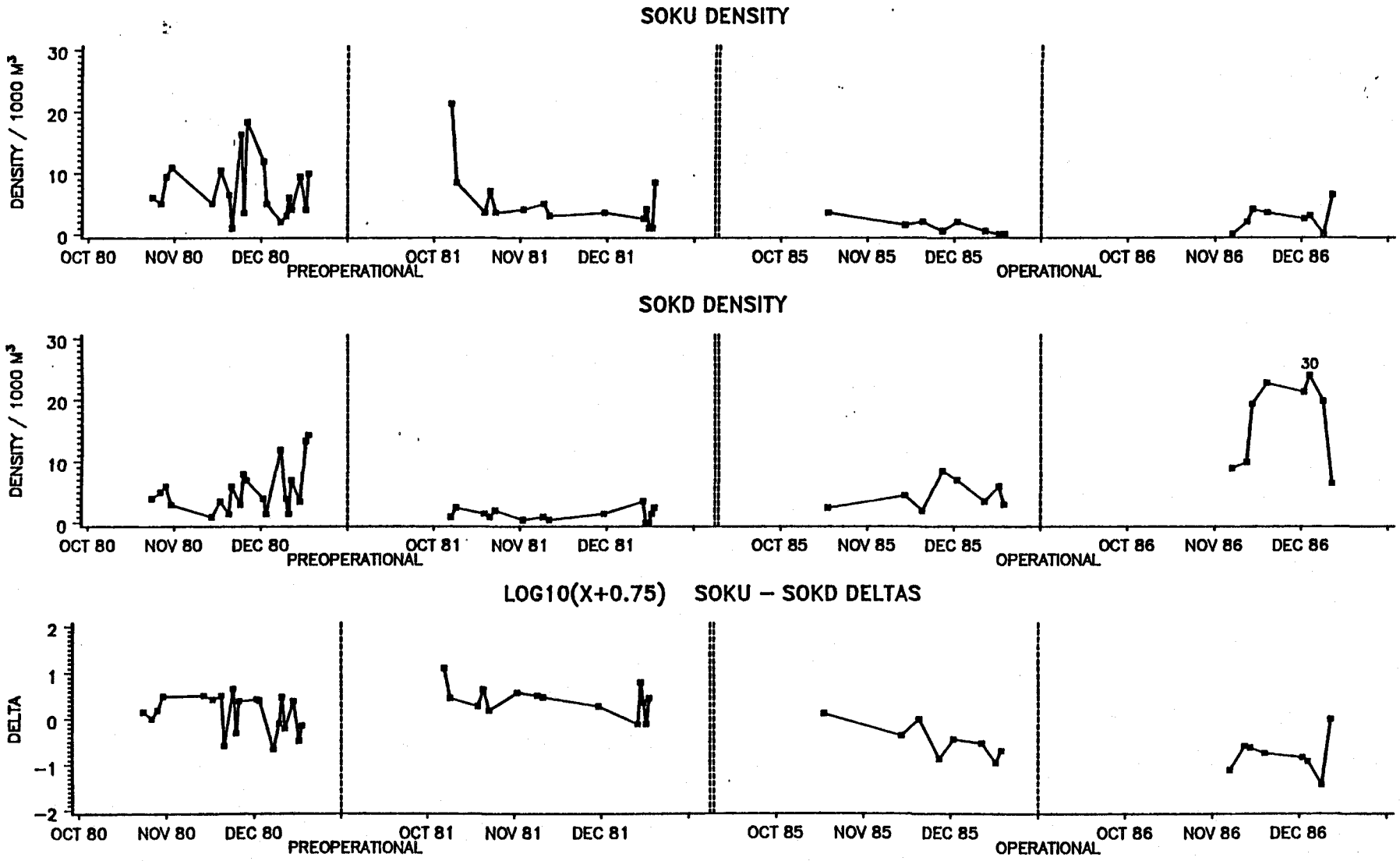
PARALABRAX NEBULIFER



APPENDIX N FIGURE 8

TOTAL BARRED SAND BASS

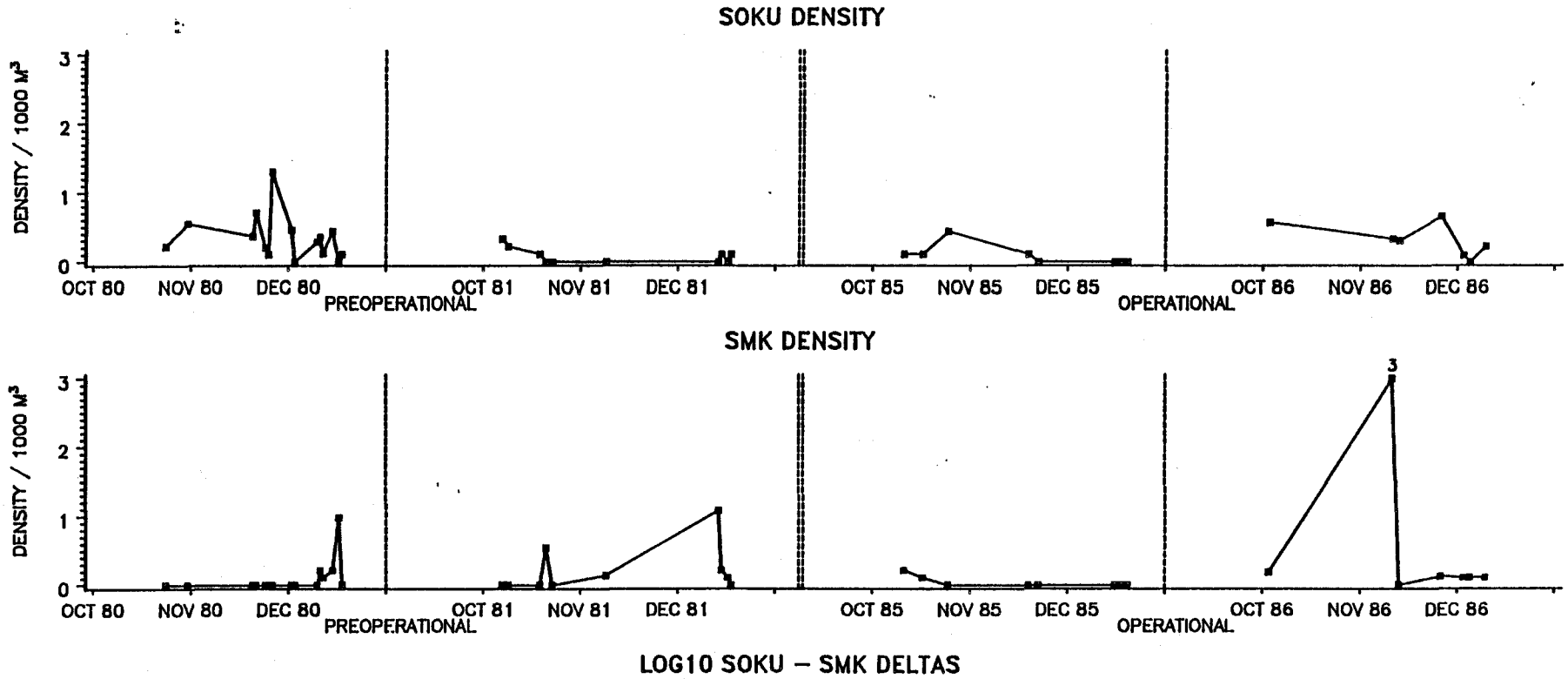
PARALABRAX NEBULIFER



APPENDIX N FIGURE 9

ADULT KELP BASS

PARALABRAX CLATHRATUS



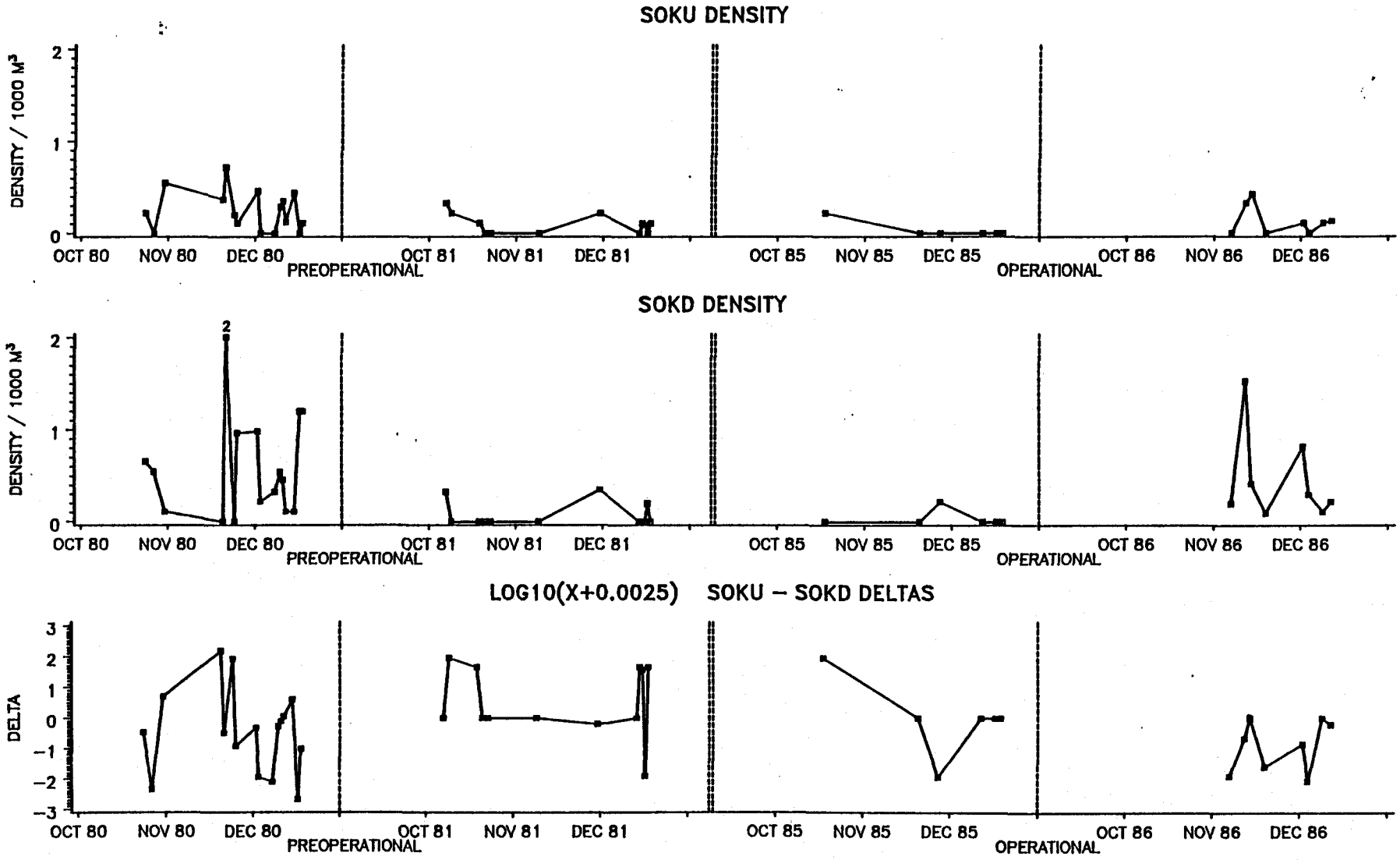
LOG10 SOKU – SMK DELTAS

---- STATISTICALLY INTRACTABLE ----

APPENDIX N FIGURE 10

ADULT KELP BASS

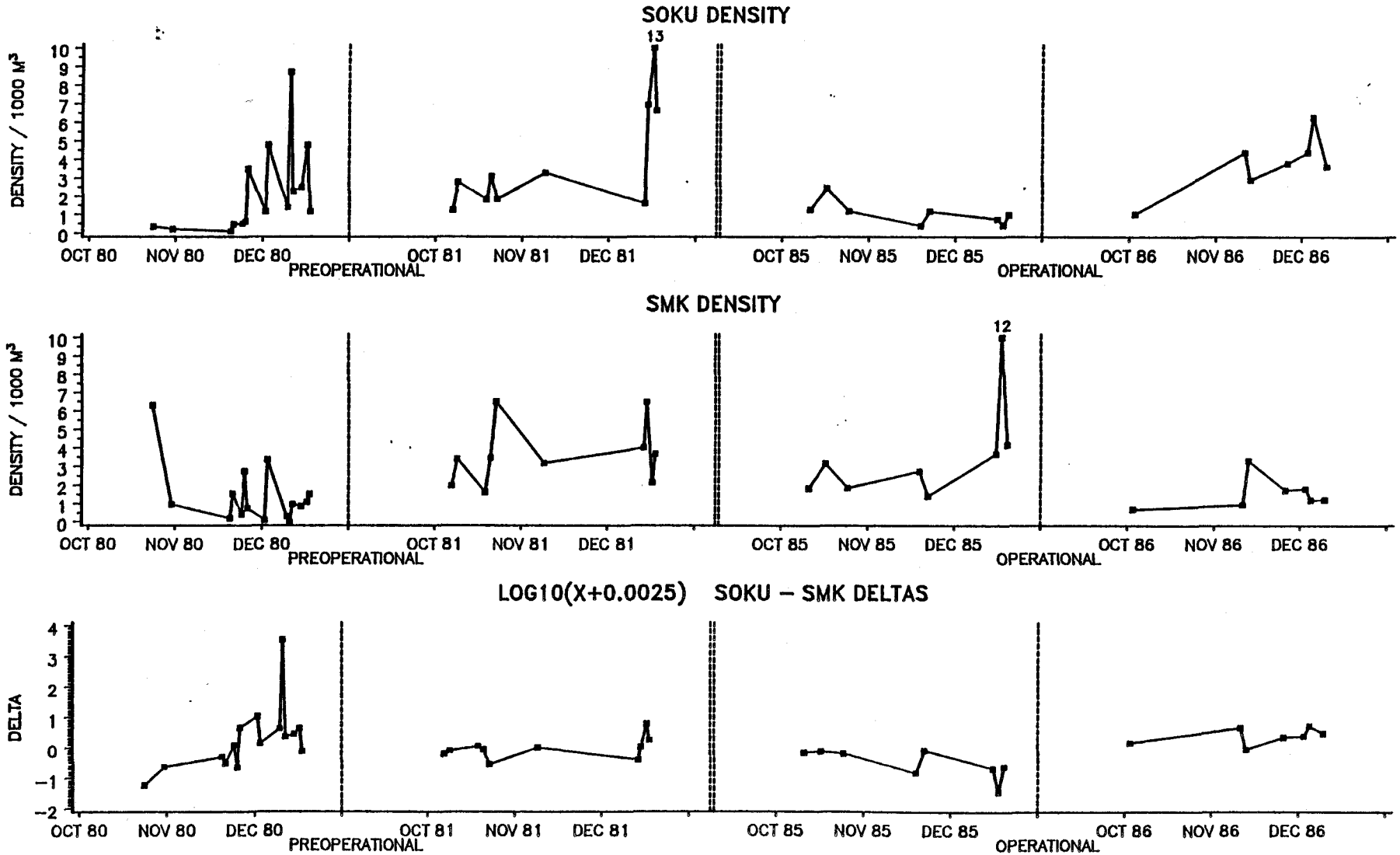
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 11

YOY & OLDER JUVENILE KELP BASS

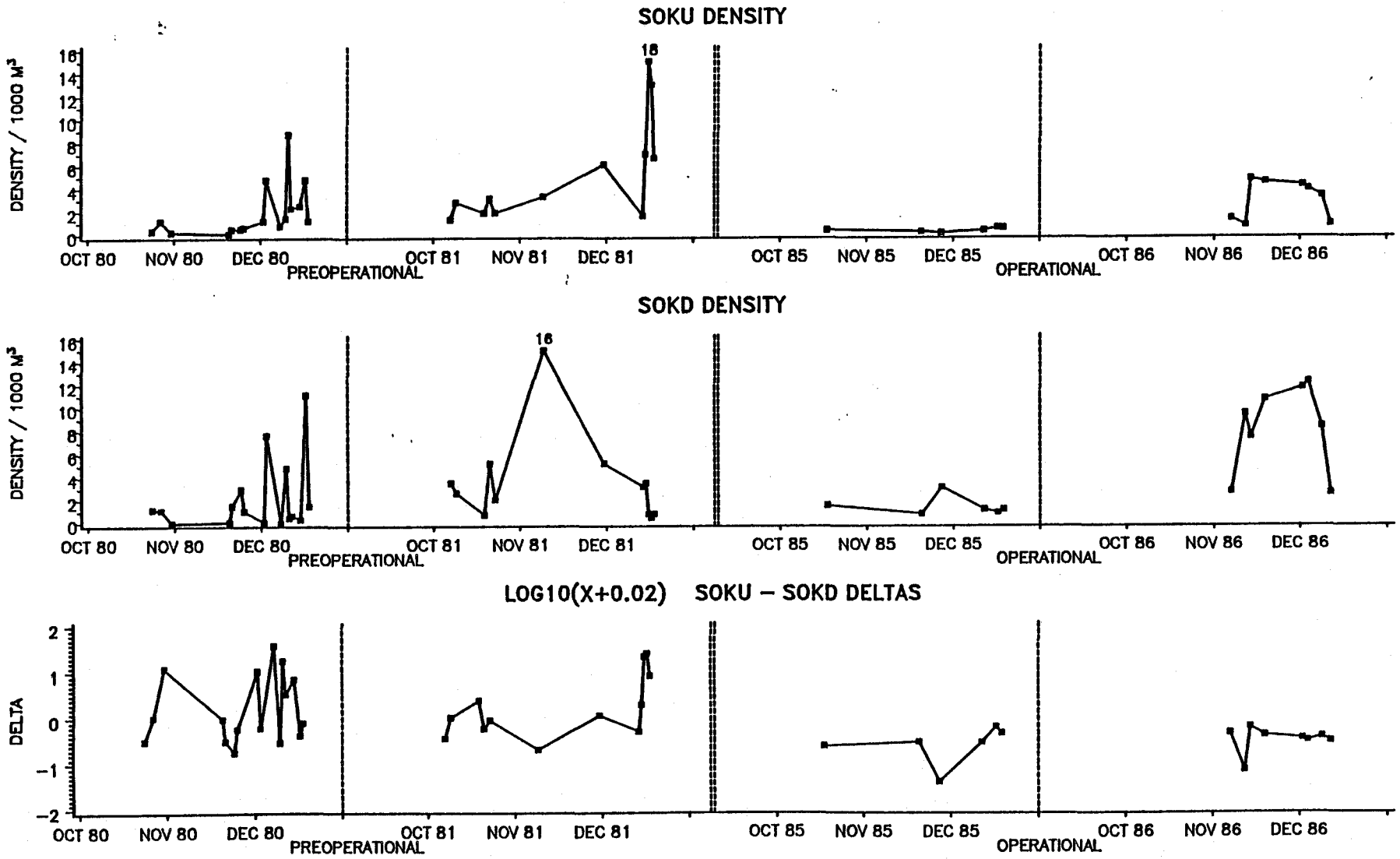
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 12

YOY & OLDER JUVENILE KELP BASS

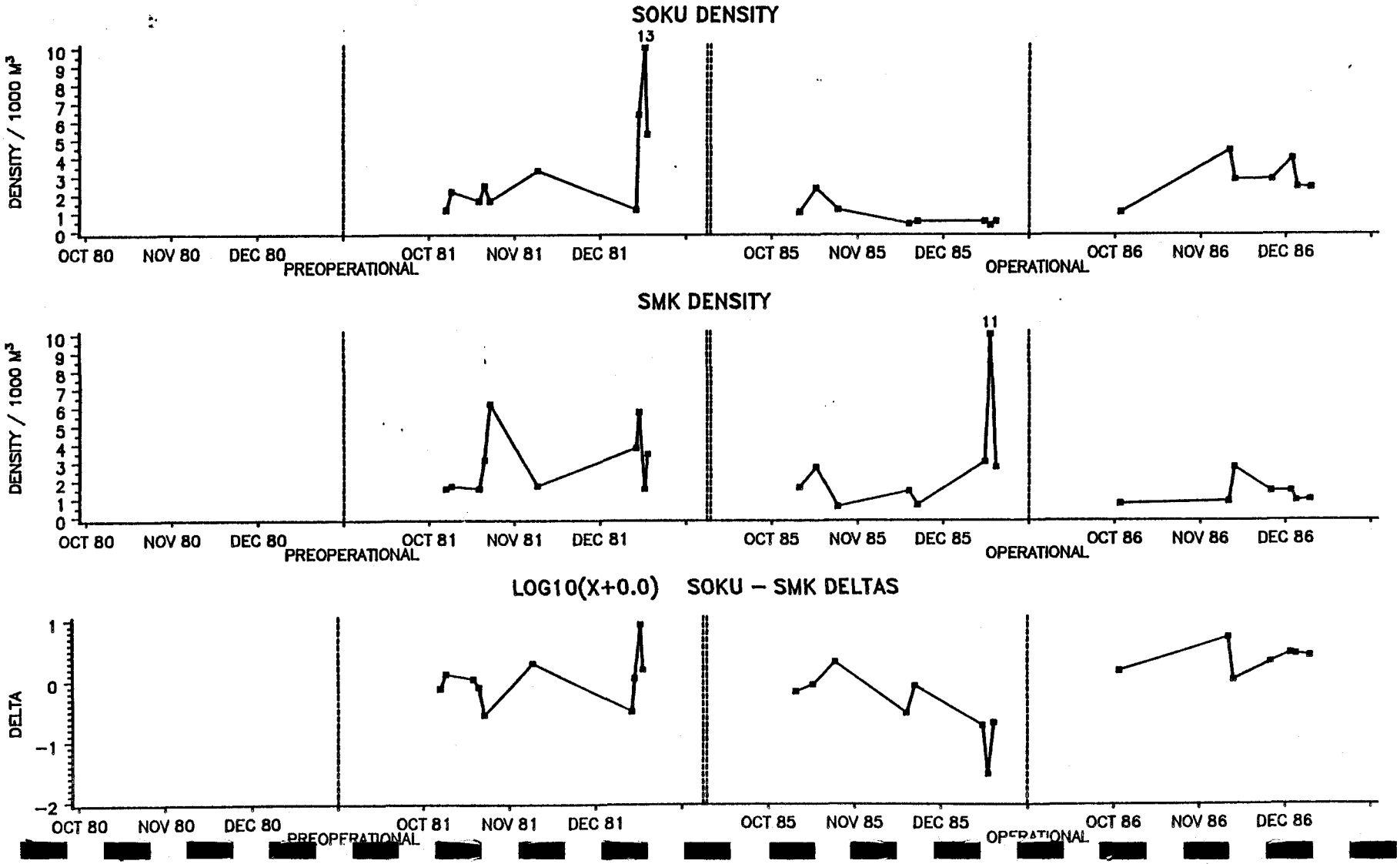
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 13

OLDER JUVENILE KELP BASS

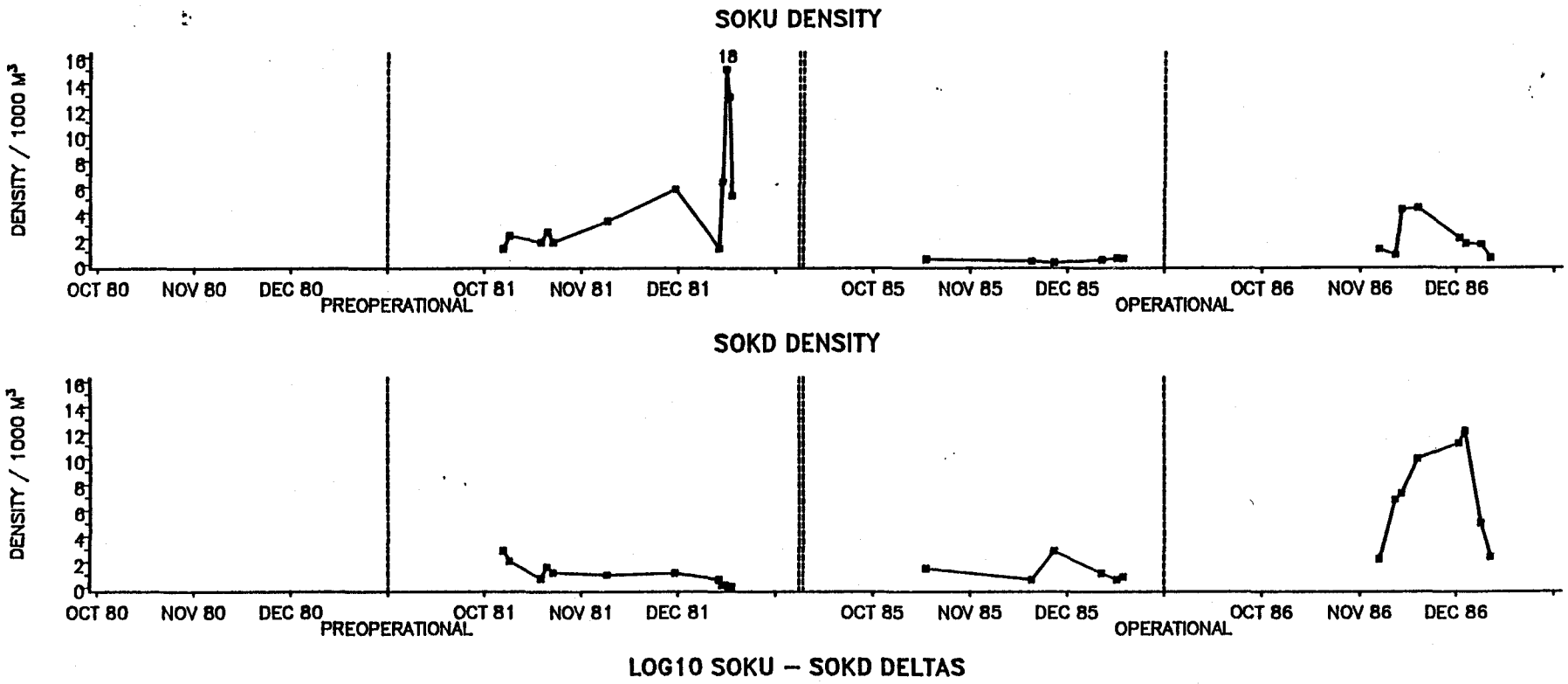
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 14

OLDER JUVENILE KELP BASS

PARALABRAX CLATHRATUS



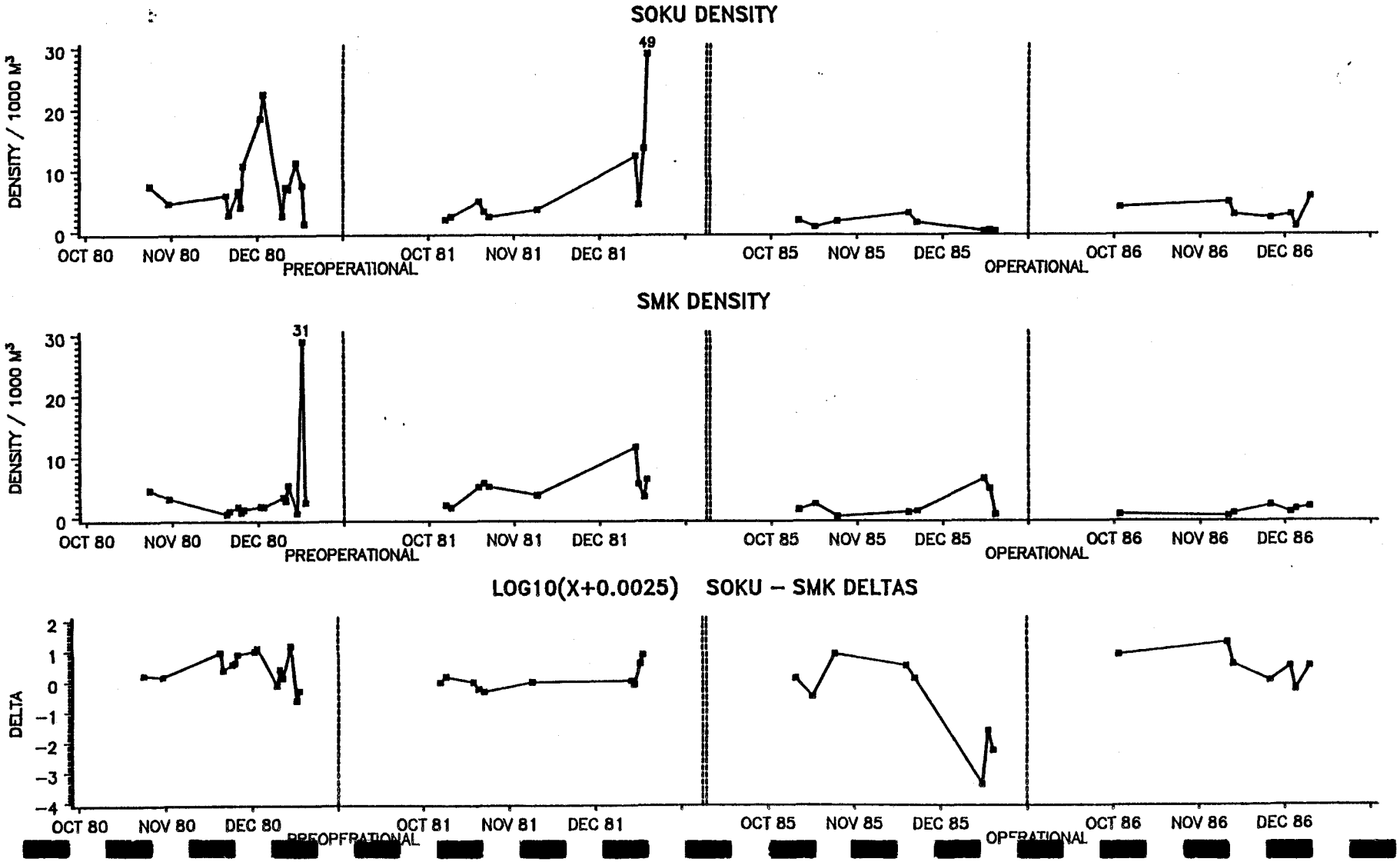
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 15

SUB–ADULT KELP BASS

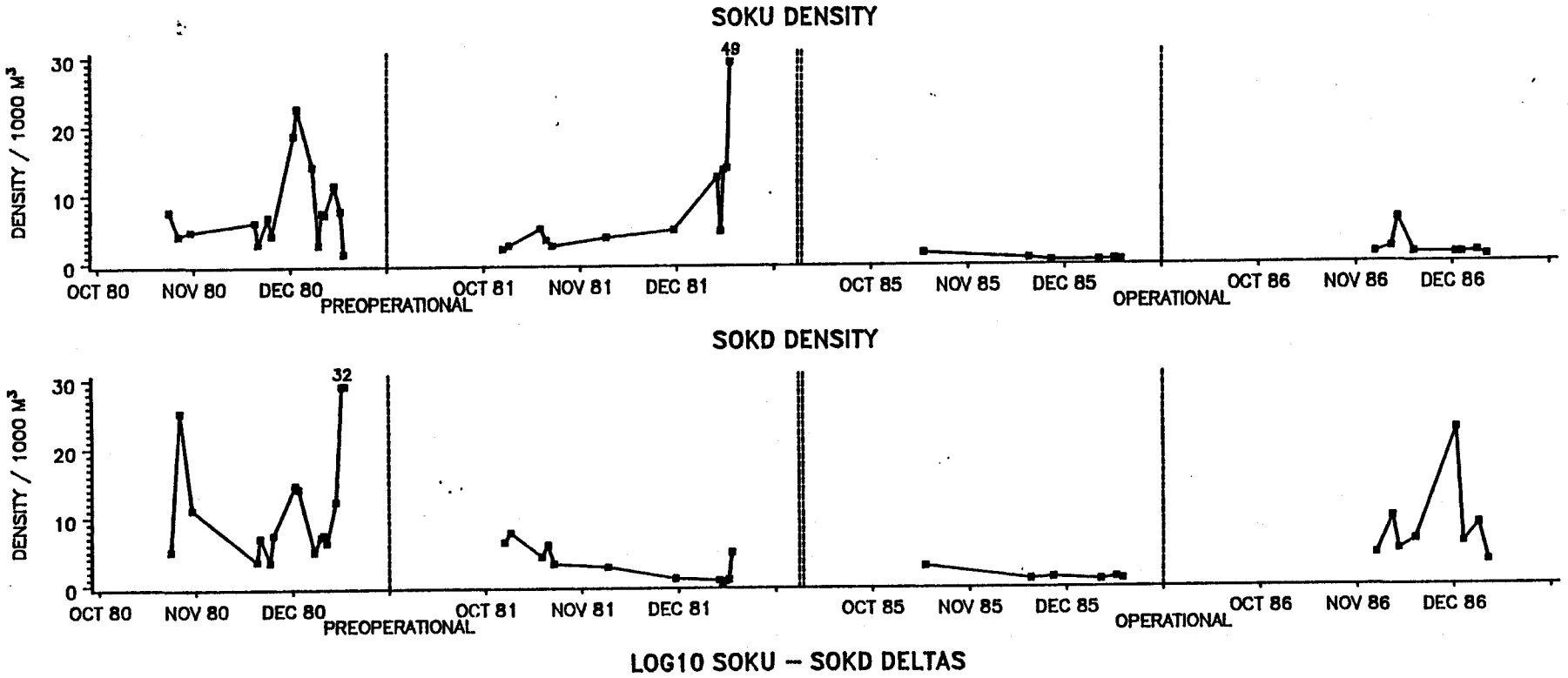
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 16

SUB–ADULT KELP BASS

PARALABRAX CLATHRATUS



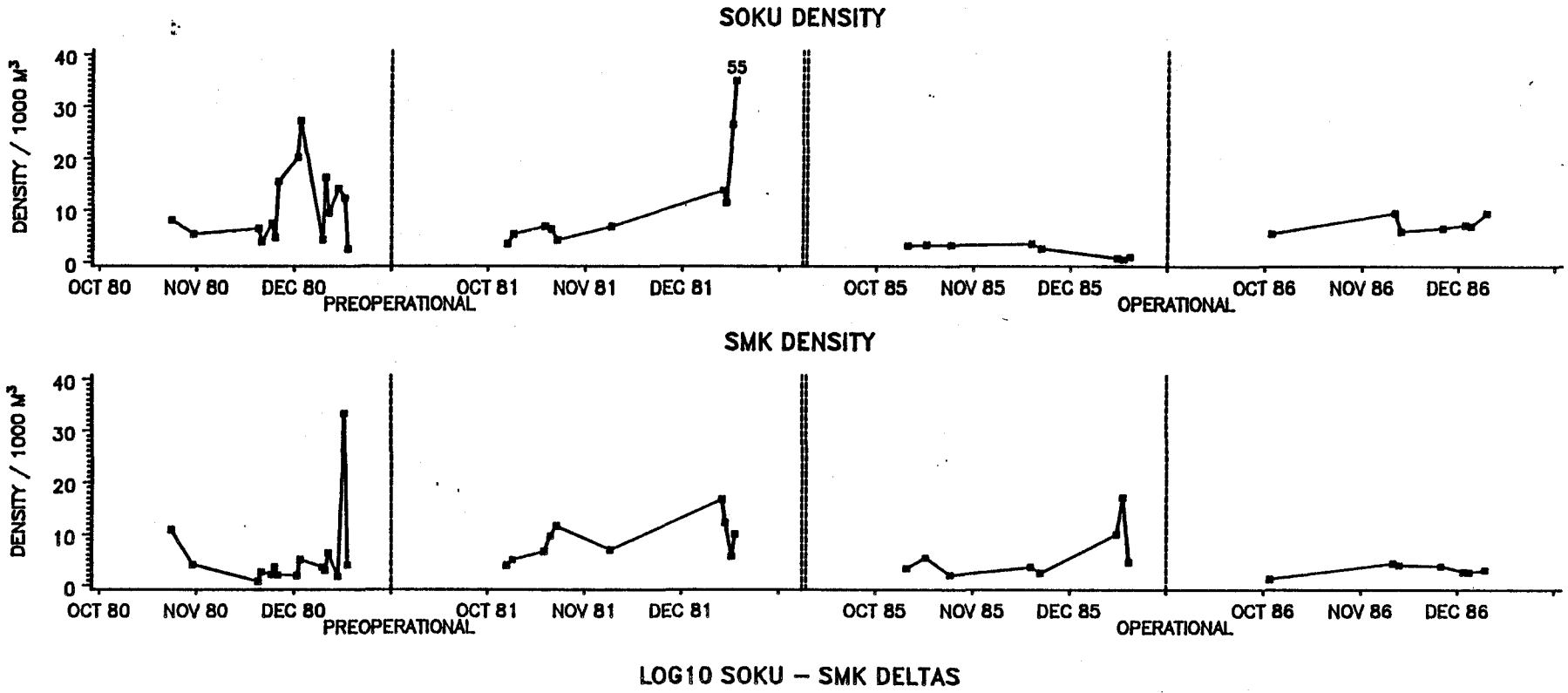
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 17

TOTAL KELP BASS

PARALABRAX CLATHRATUS



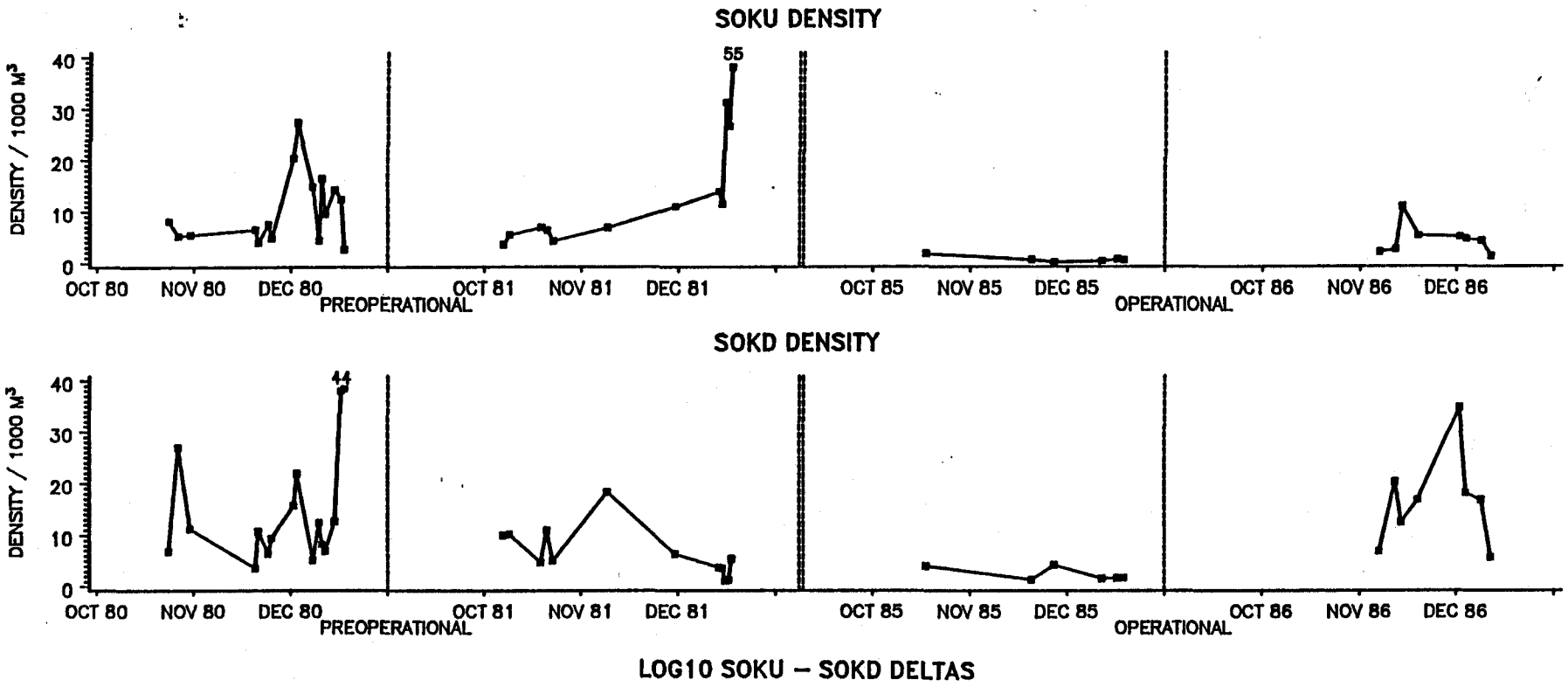
LOG10 SOKU – SMK DELTAS

--- HETEROGENEOUS TAXON ---

APPENDIX N FIGURE 18

TOTAL KELP BASS

PARALABRAX CLATHRATUS



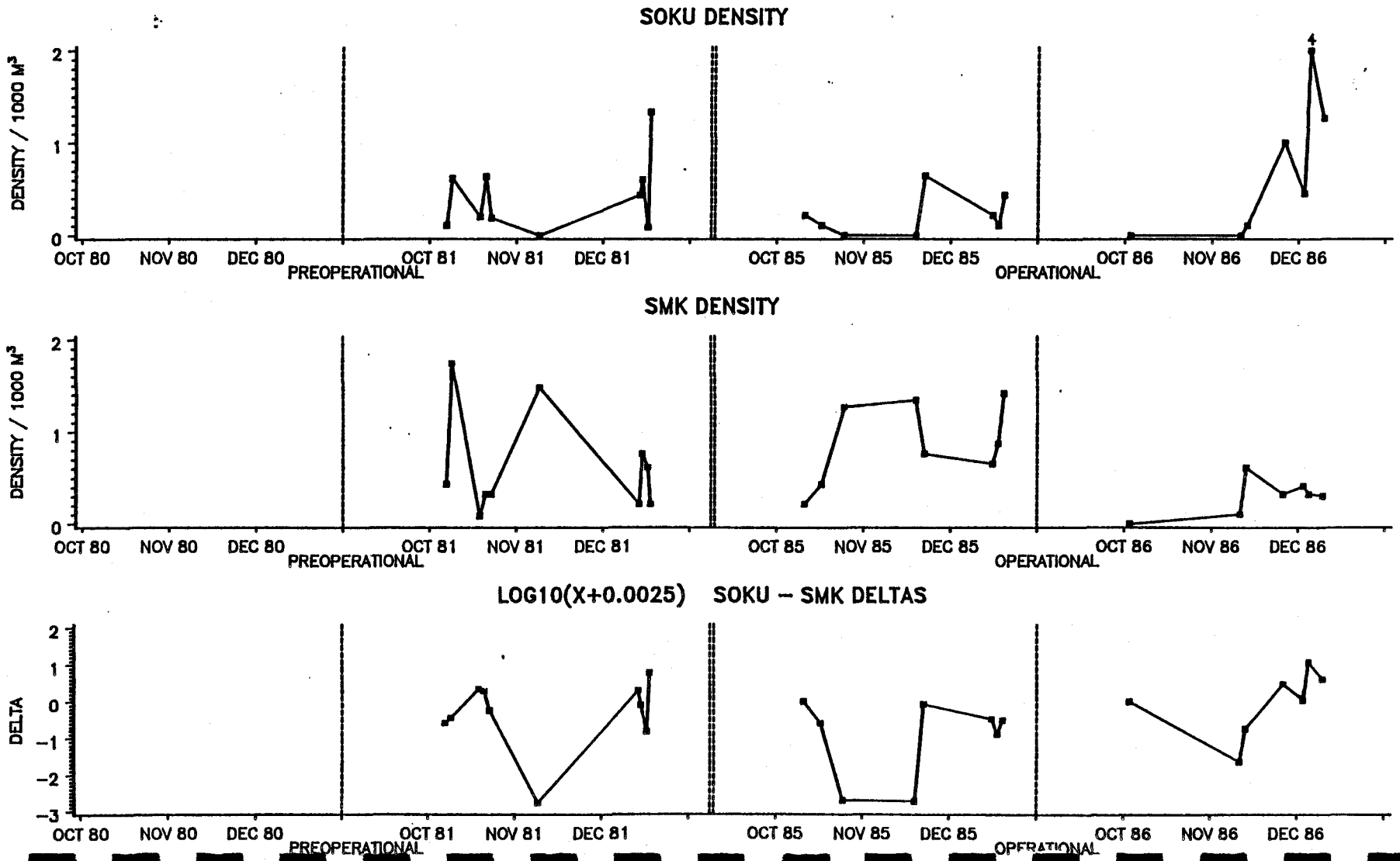
LOG10 SOKU – SOKD DELTAS

--- HETEROGENEOUS TAXON ---

APPENDIX N FIGURE 19

YOUNG OF YEAR KELP BASS

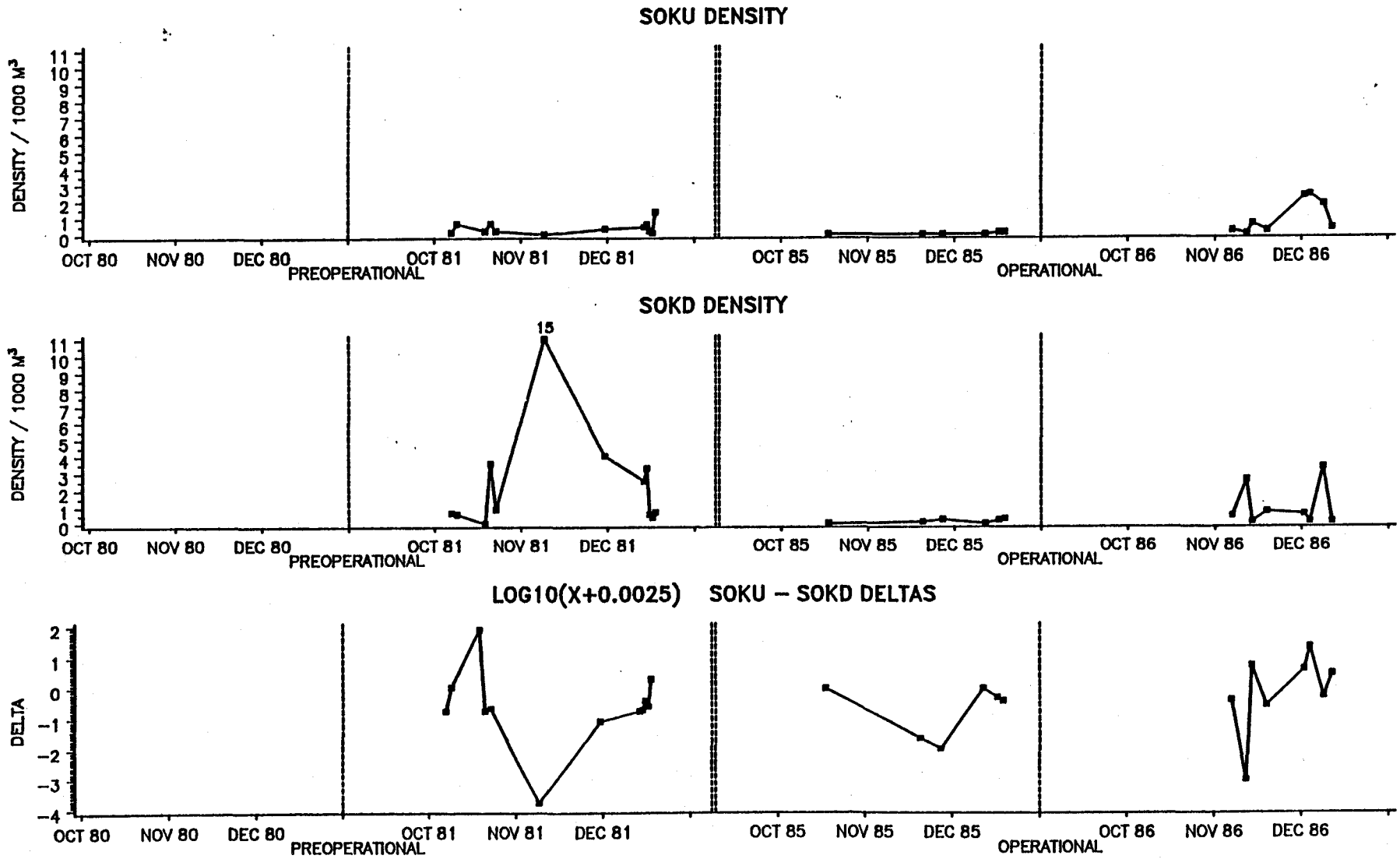
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 20

YOUNG OF YEAR KELP BASS

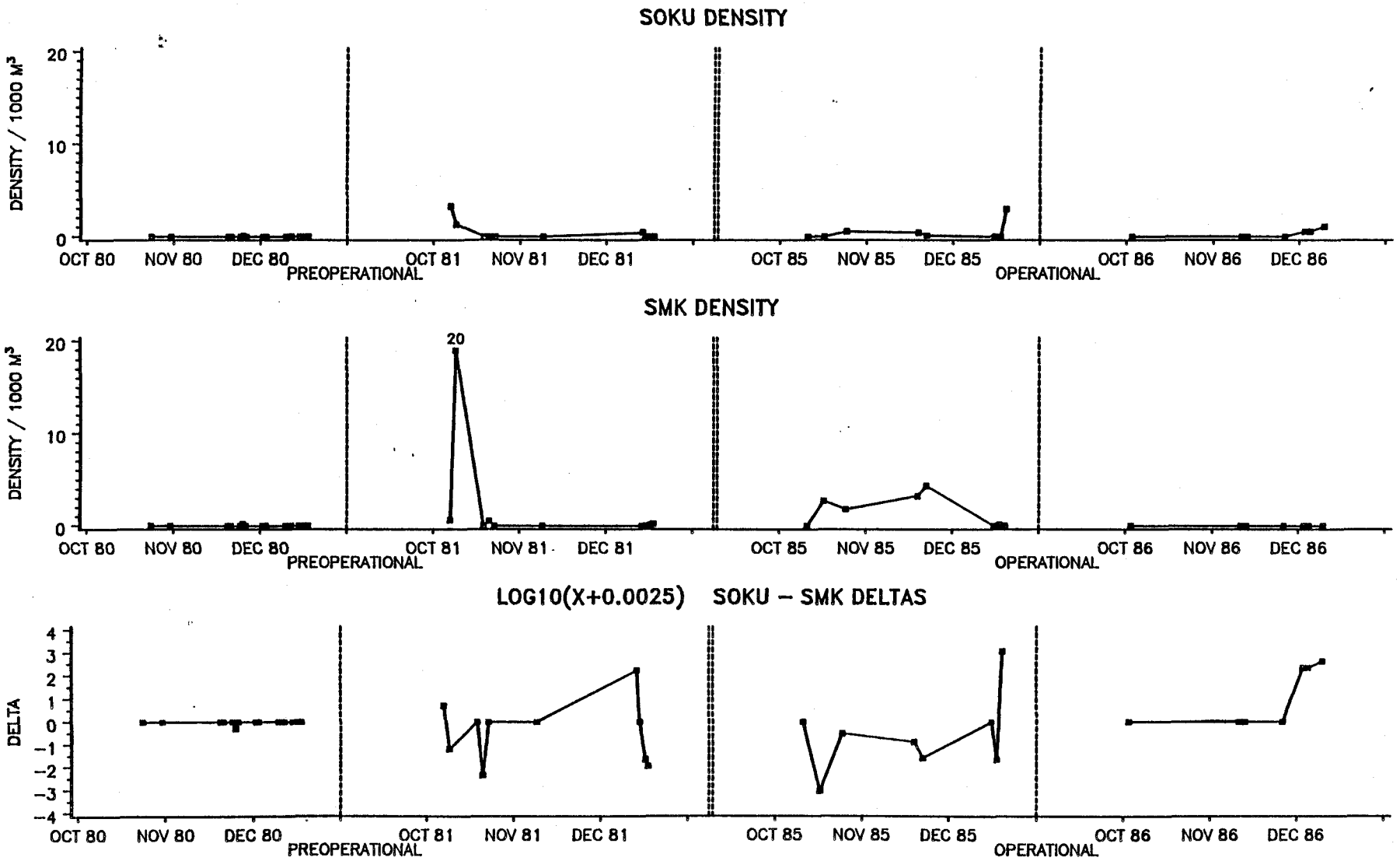
PARALABRAX CLATHRATUS



APPENDIX N FIGURE 21

YOY & OLDER JUVENILE BLACKSMITH

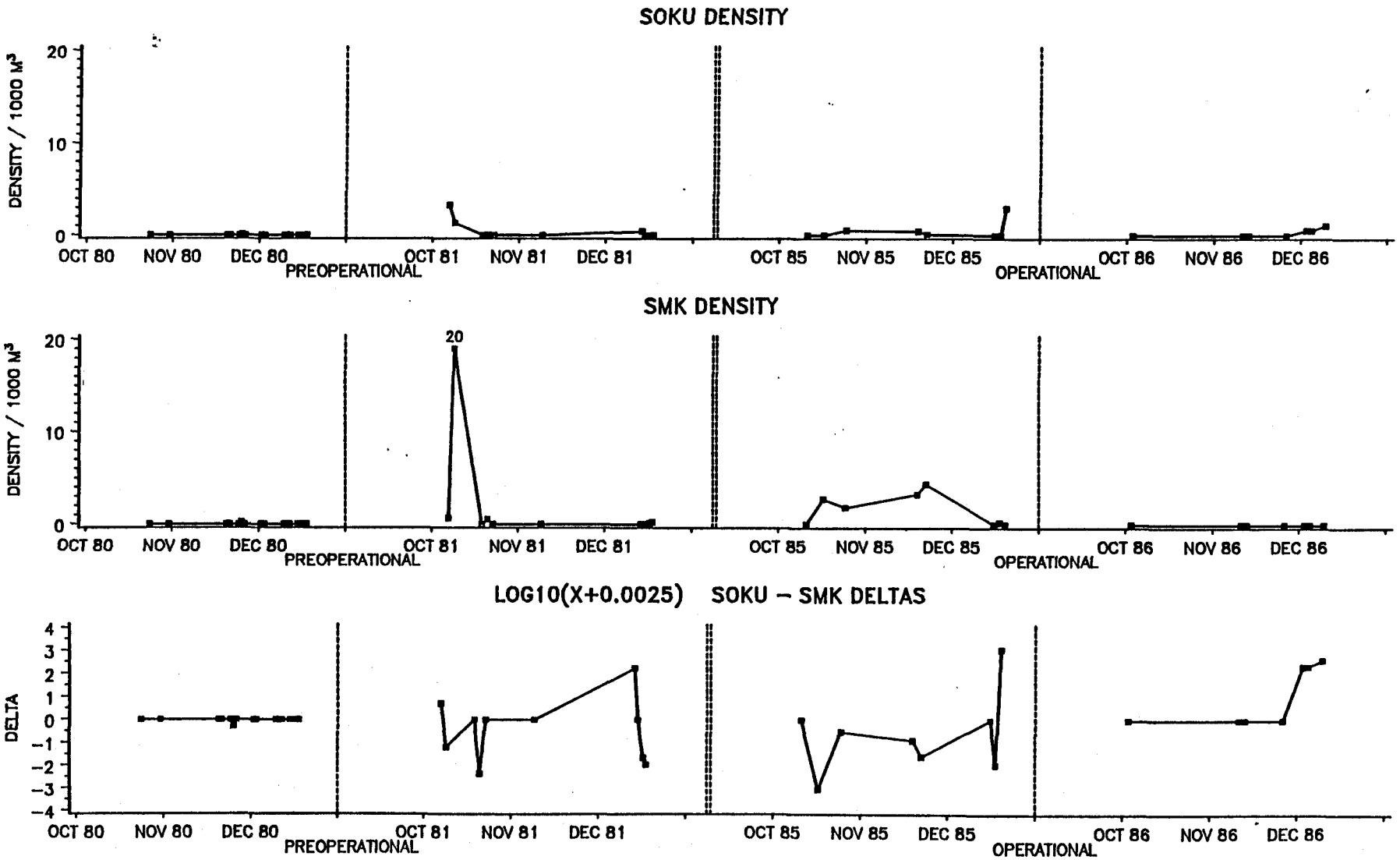
CHROMIS PUNCTIPINNIS



APPENDIX N FIGURE 22

TOTAL BLACKSMITH

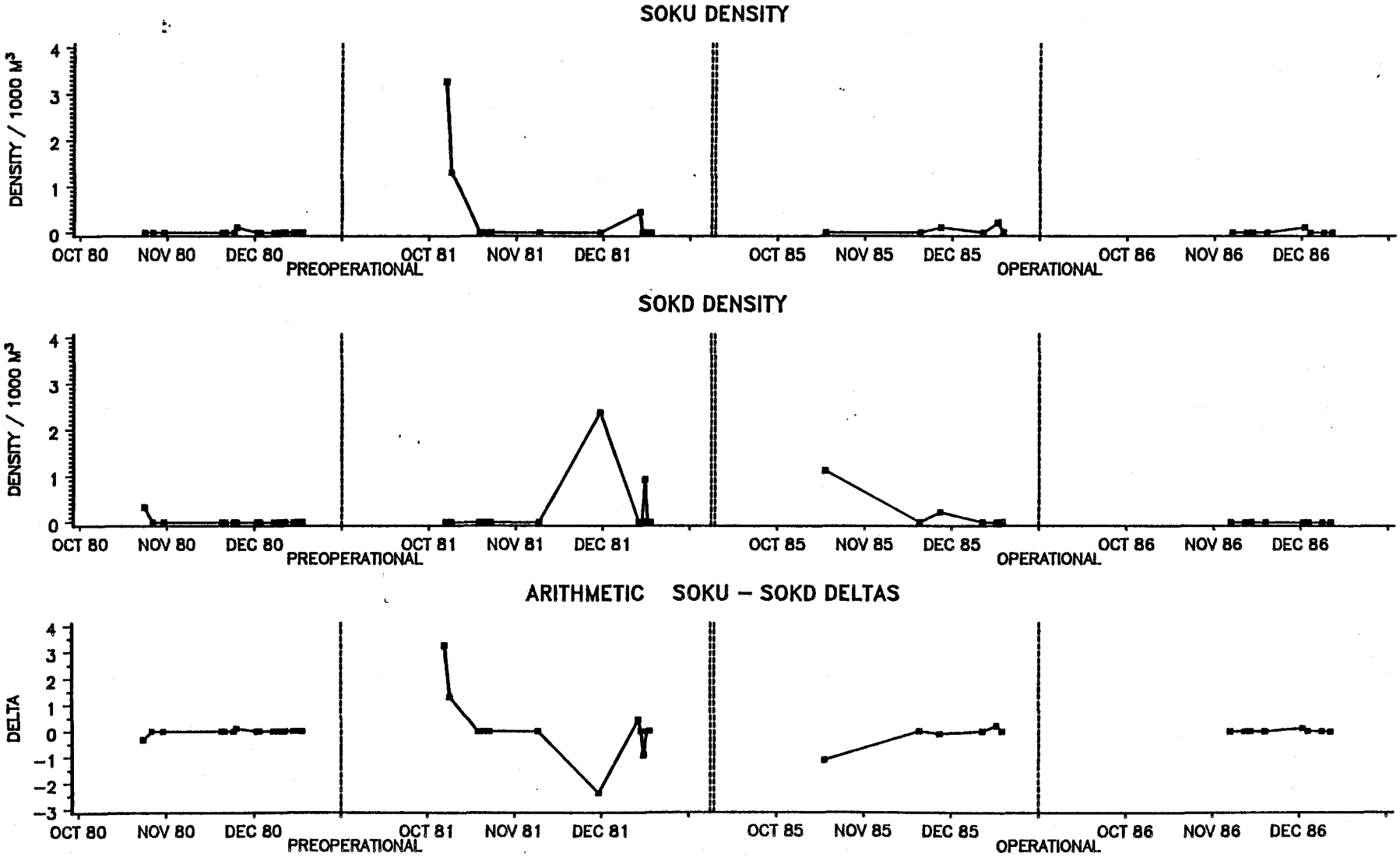
CHROMIS PUNCTIPINNIS



APPENDIX N FIGURE 23

TOTAL BLACKSMITH

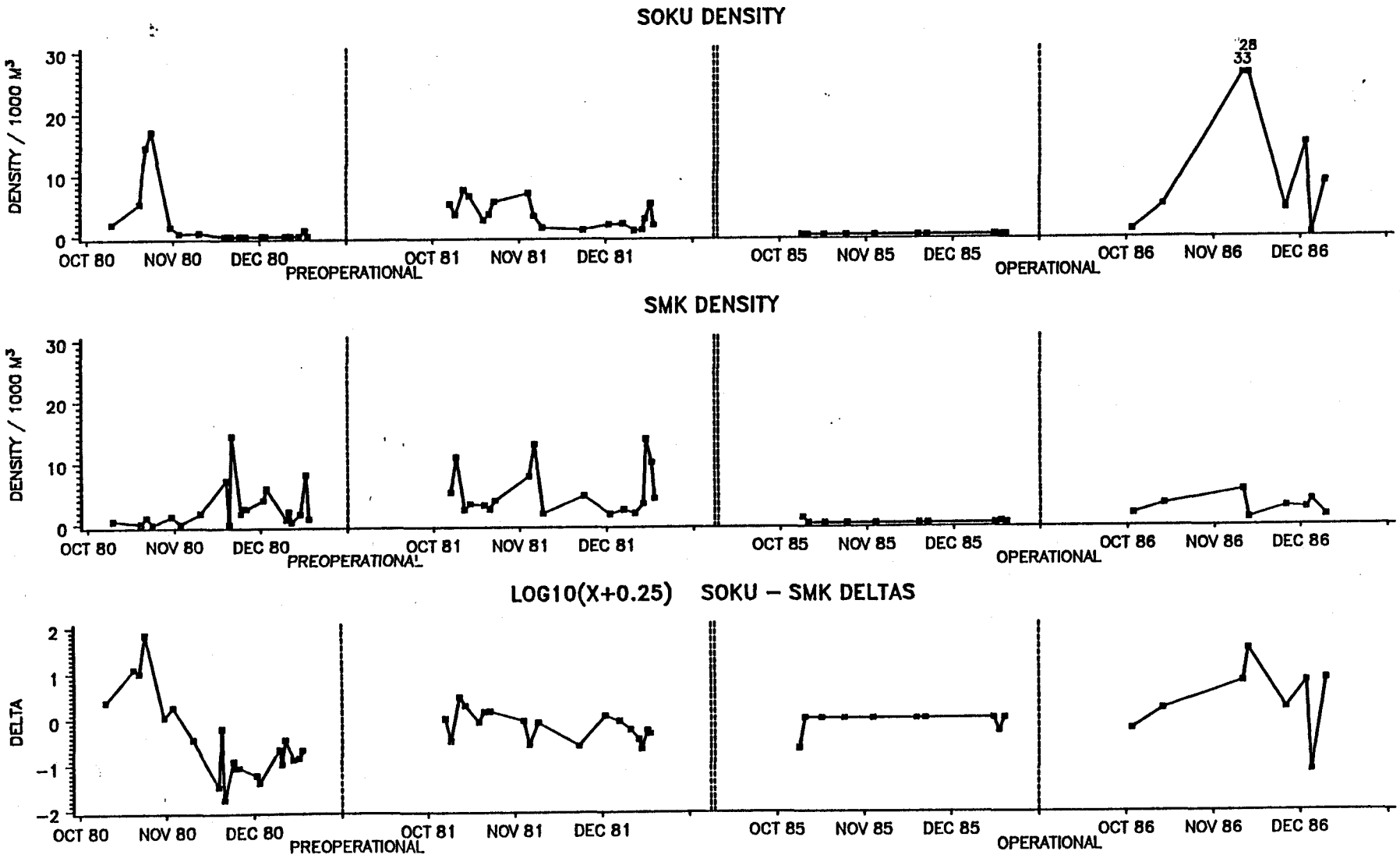
CHROMIS PUNCTIPINNIS



APPENDIX N FIGURE 24

ADULT HALFMOON

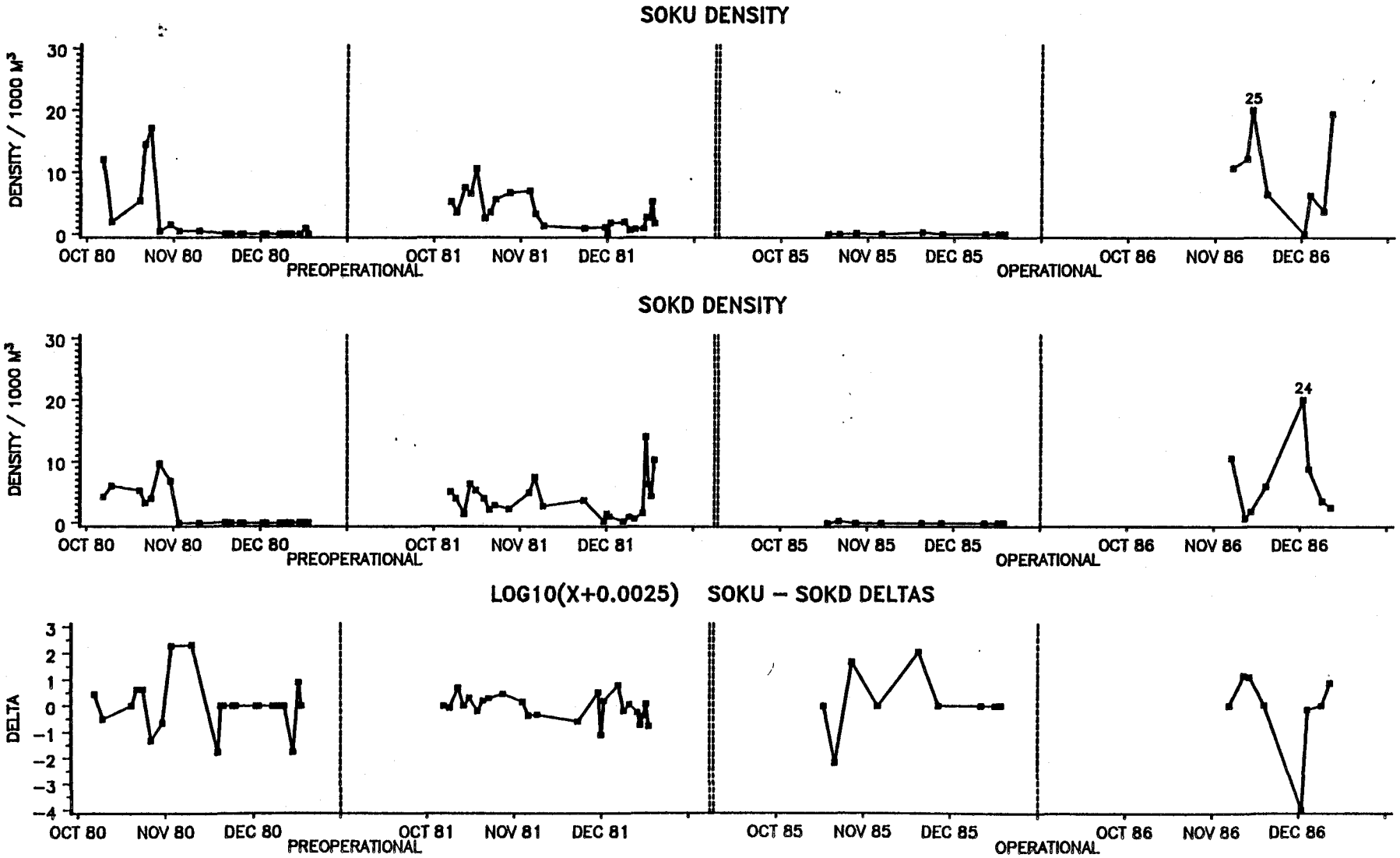
MEDIALUNA CALIFORNIENSIS



APPENDIX N FIGURE 25

ADULT HALFMOON

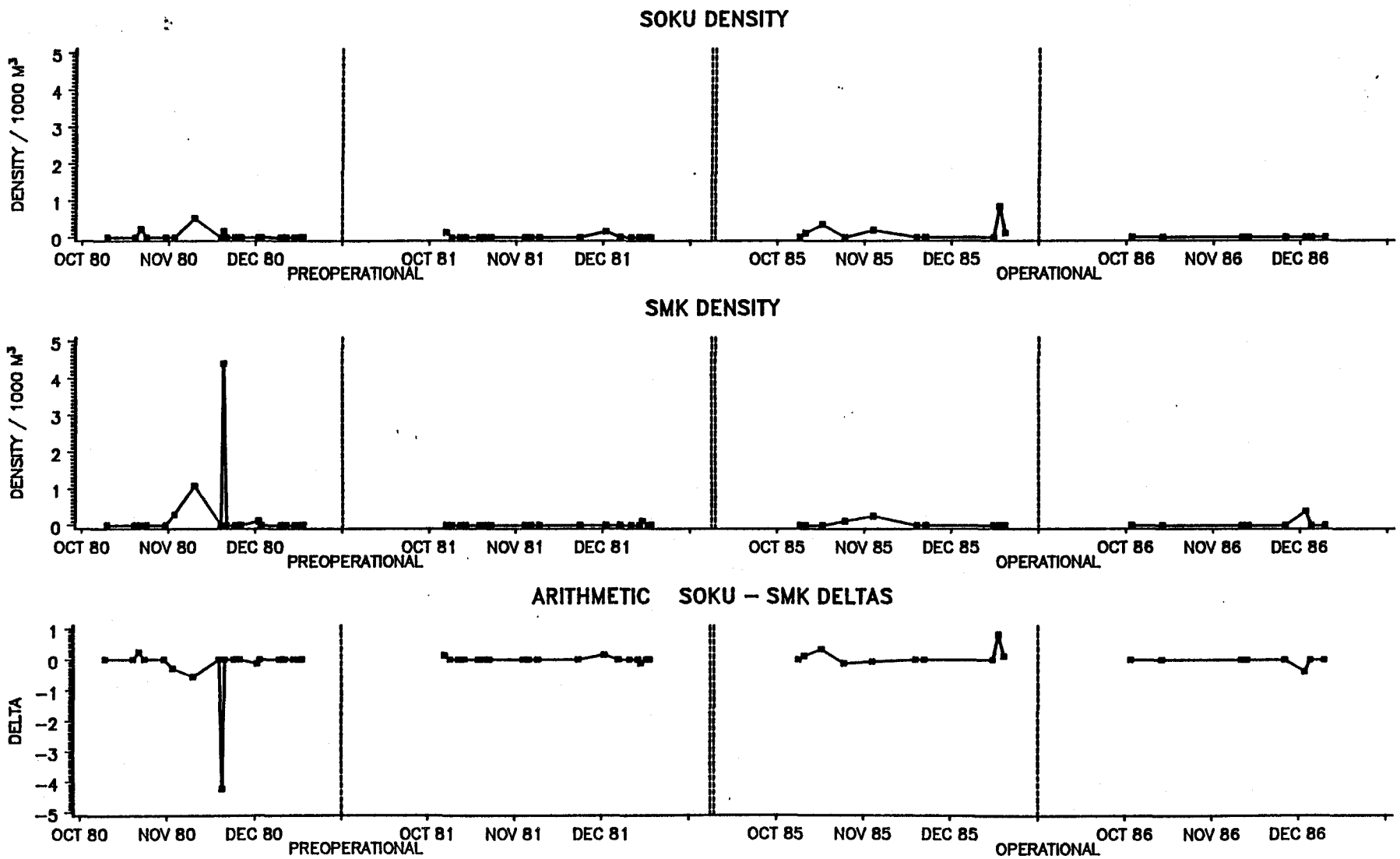
MEDIALUNA CALIFORNIENSIS



APPENDIX N FIGURE 26

SUB–ADULT HALFMOON

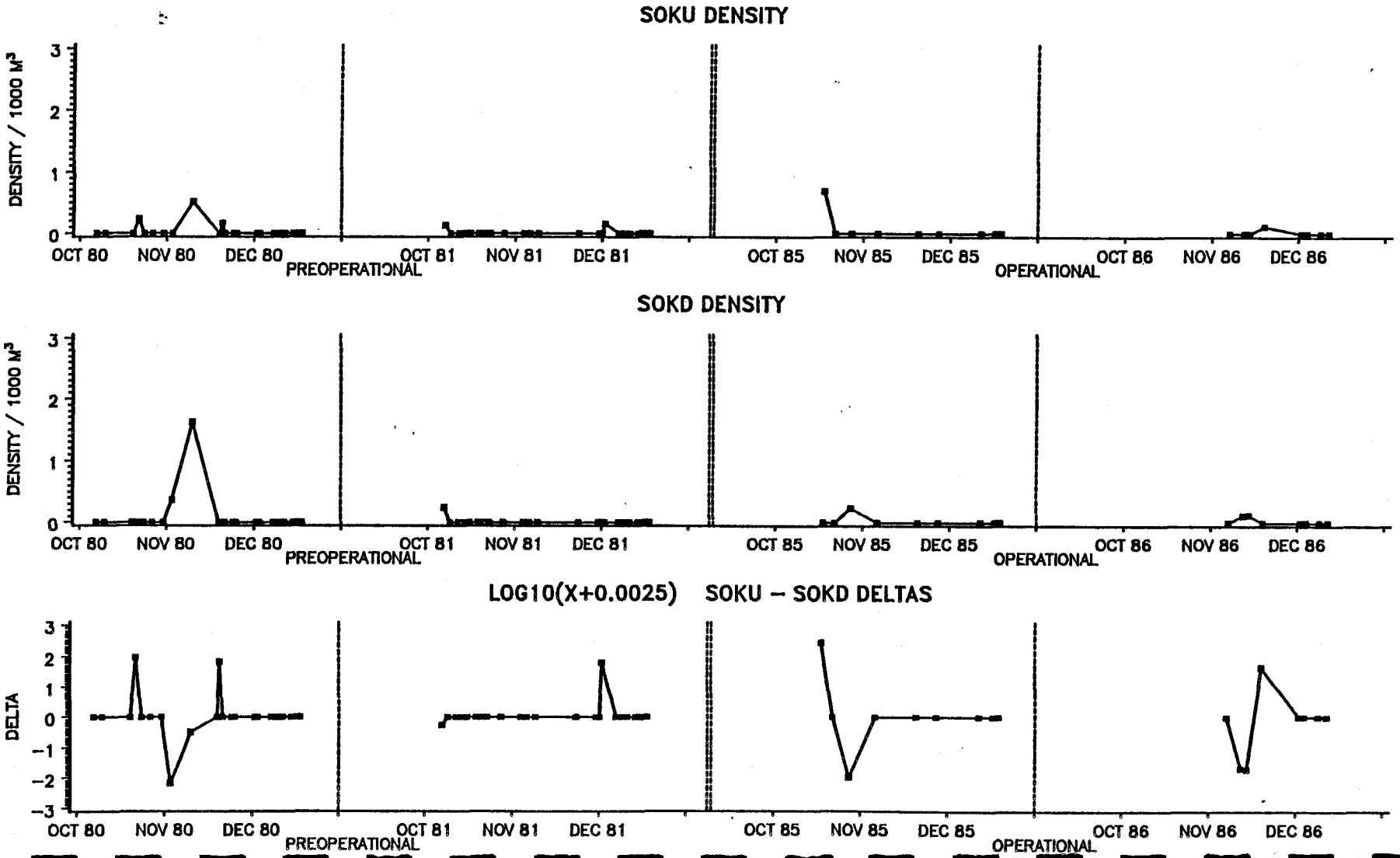
MEDIALUNA CALIFORNIENSIS



APPENDIX N FIGURE 27

SUB–ADULT HALFMOON

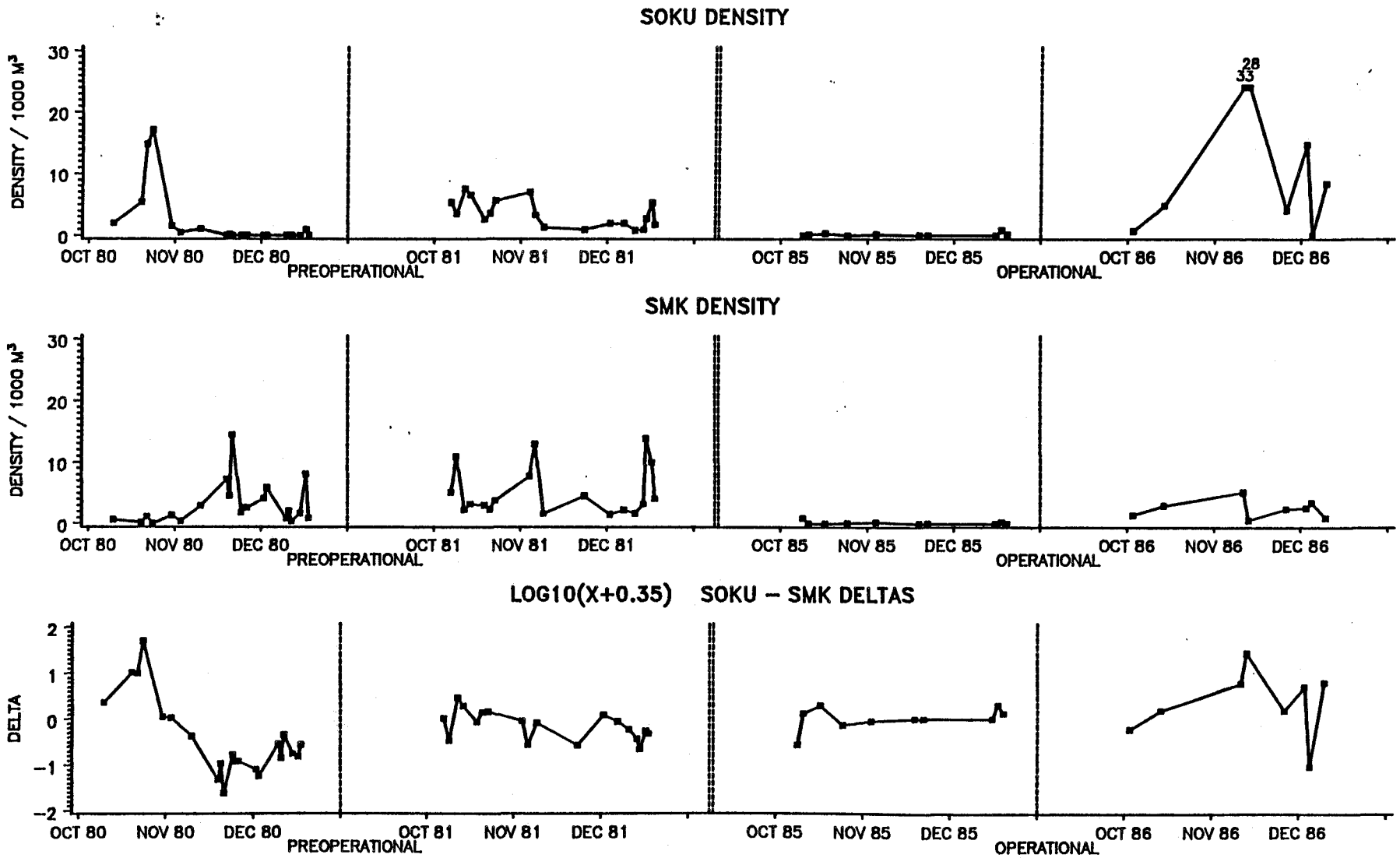
MEDIALUNA CALIFORNIENSIS



APPENDIX N FIGURE 28

TOTAL HALFMOON

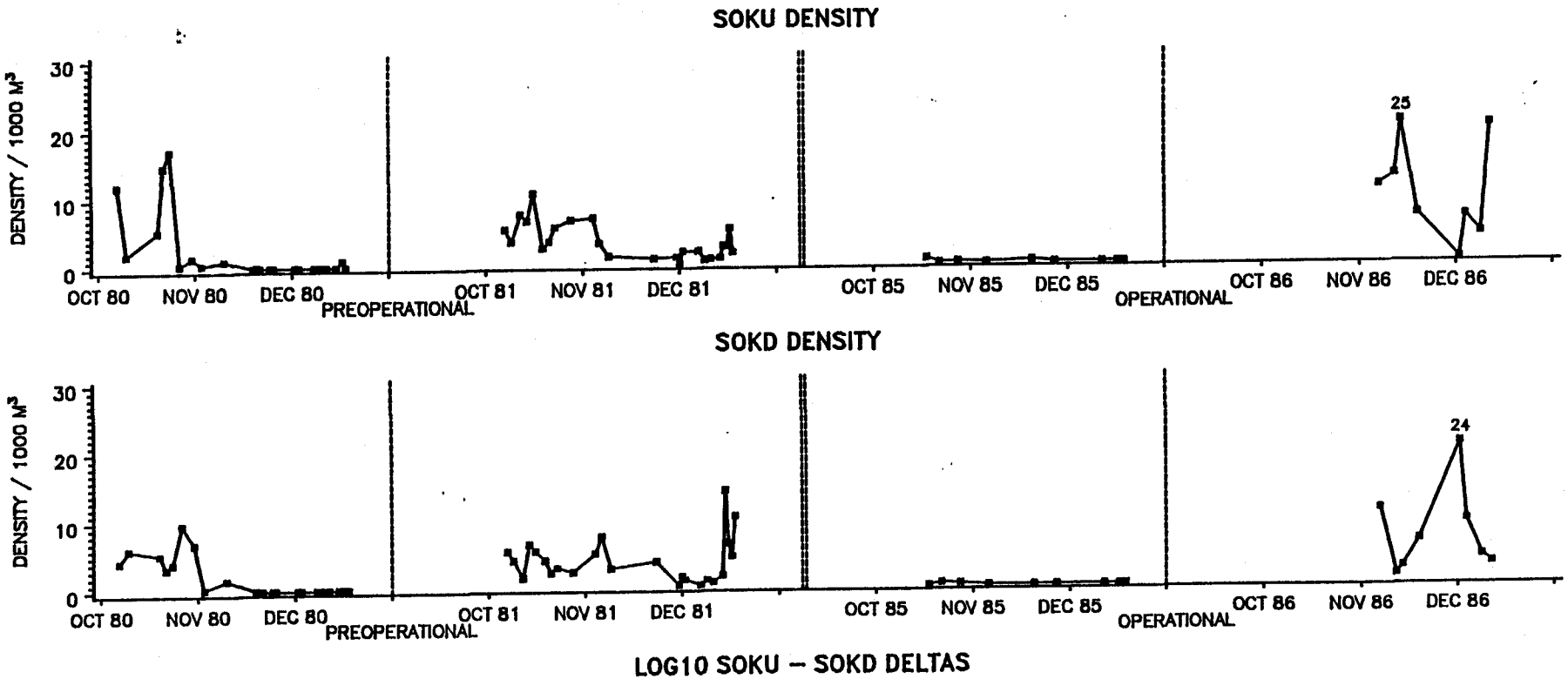
MEDIALUNA CALIFORNIENSIS



APPENDIX N FIGURE 29

TOTAL HALFMOON

MEDIALUNA CALIFORNIENSIS



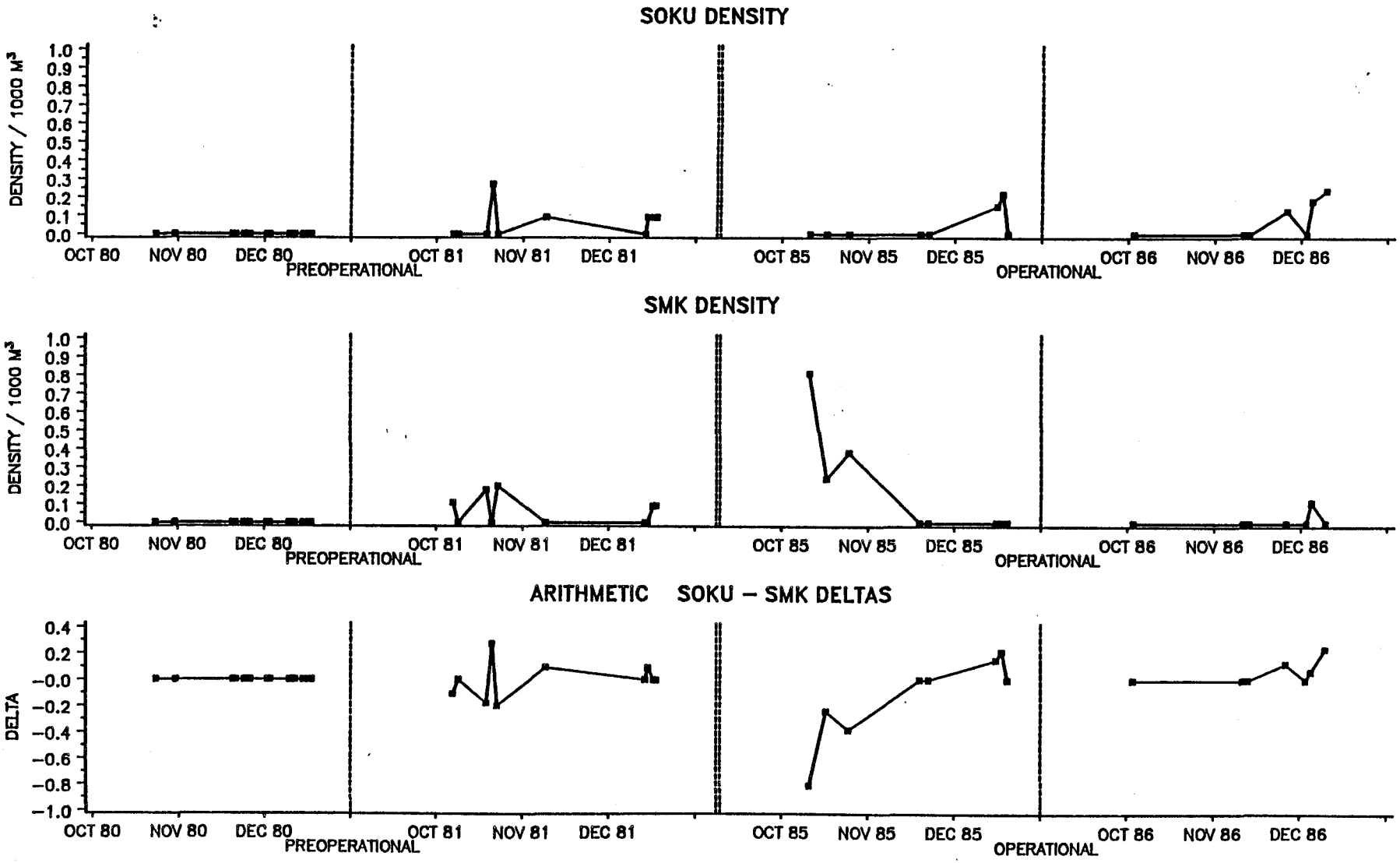
LOG10 SOKU – SOKD DELTAS

--- HETEROGENEOUS TAXON ---

APPENDIX N FIGURE 30

YOY & OLDER JUVENILE GIANT KELPFISH

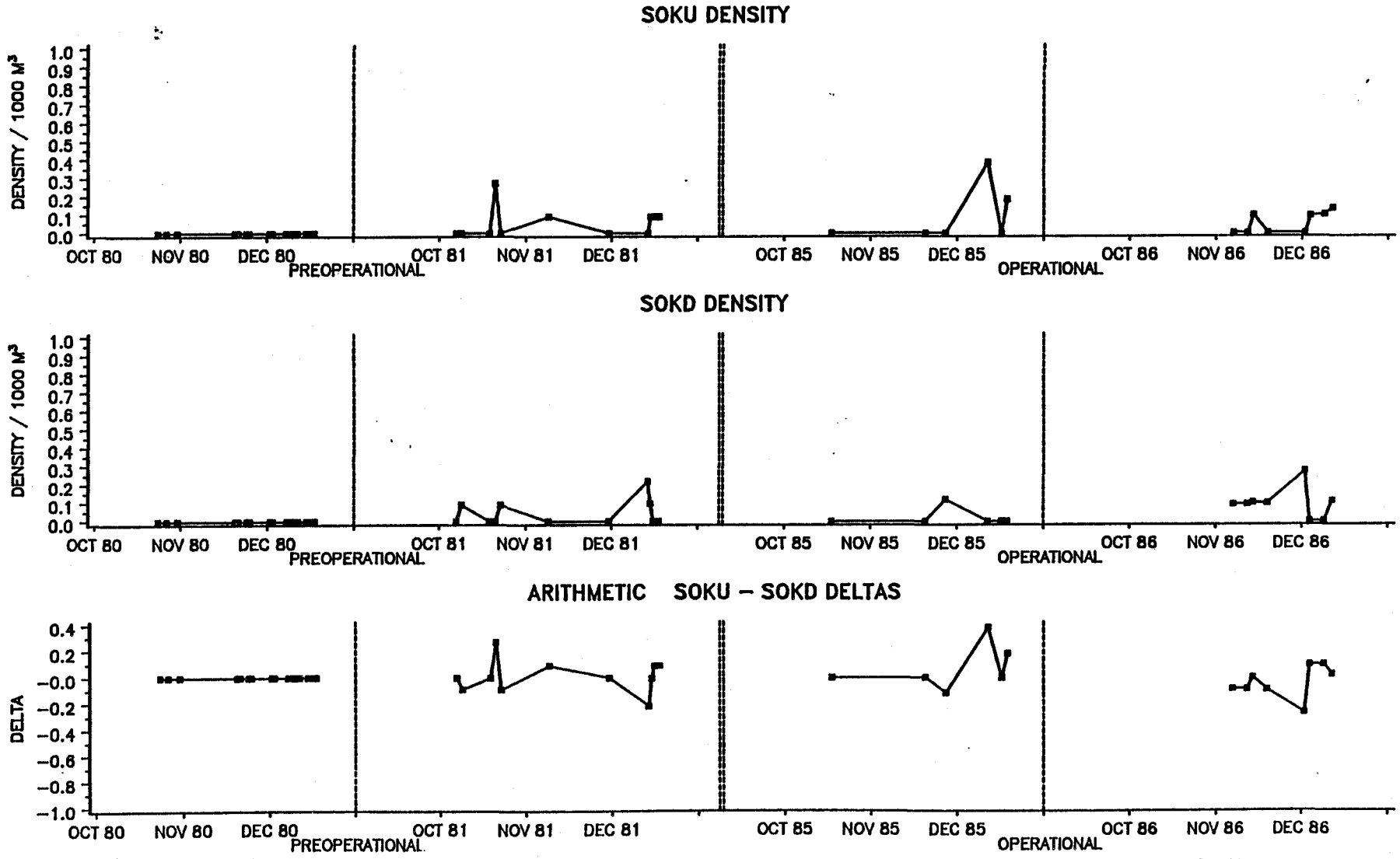
HETEROSTICHUS ROSTRATUS



APPENDIX N FIGURE 31

YOY & OLDER JUVENILE GIANT KELPFISH

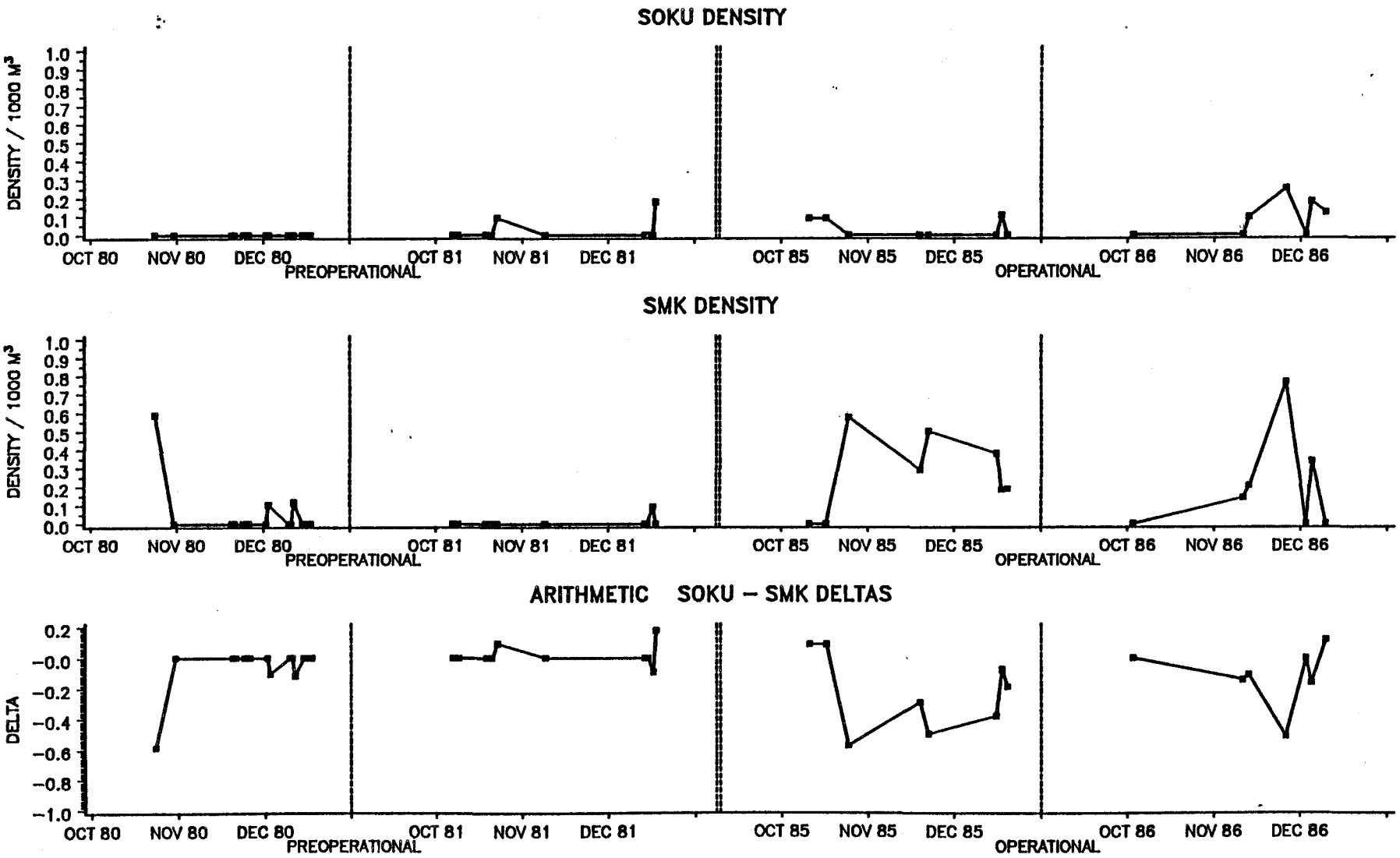
HETEROSTICHUS ROSTRATUS



APPENDIX N FIGURE 32

SUB–ADULT GIANT KELPFISH

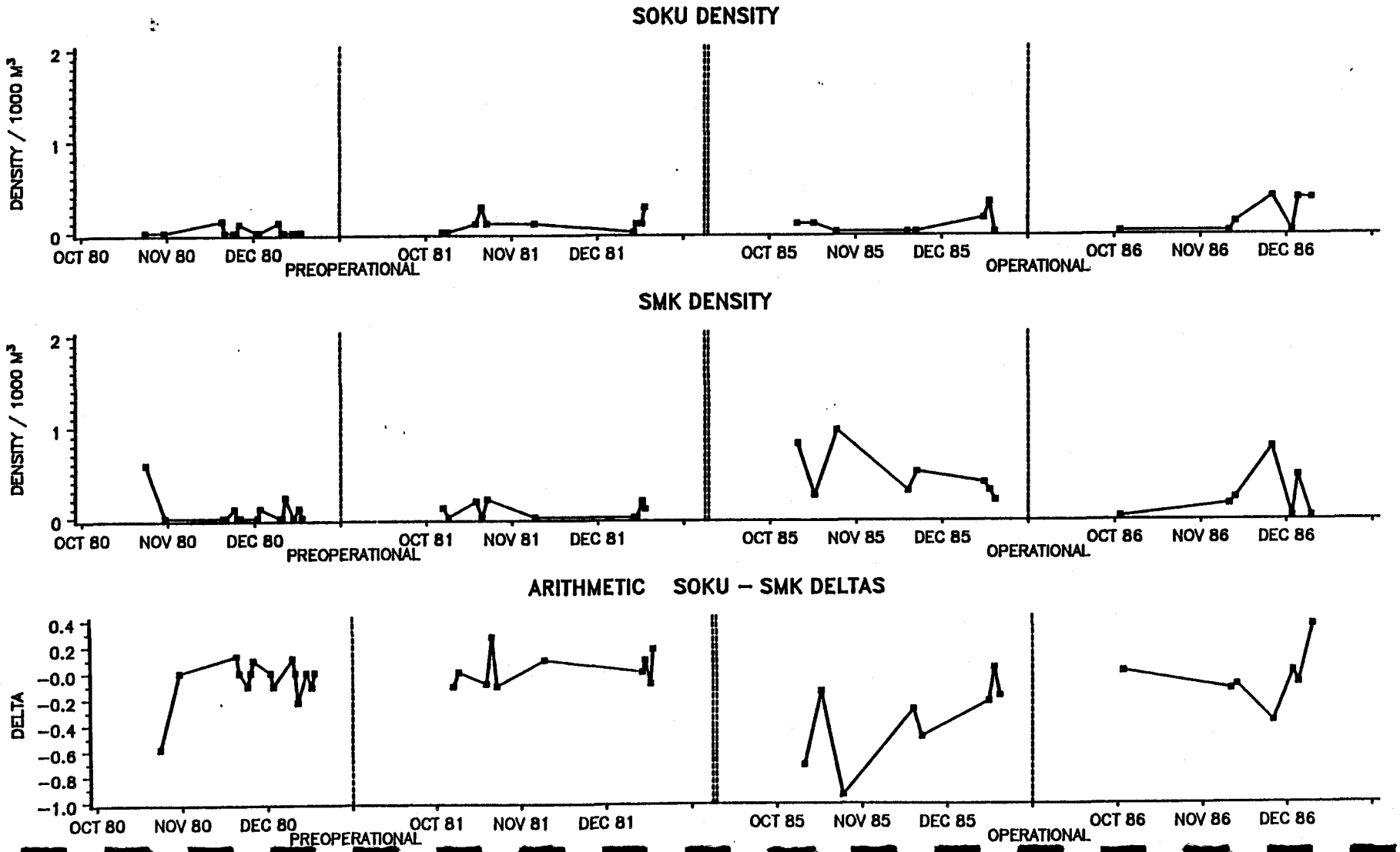
HETEROSTICHUS ROSTRATUS



APPENDIX N FIGURE 33

TOTAL GIANT KELPFISH

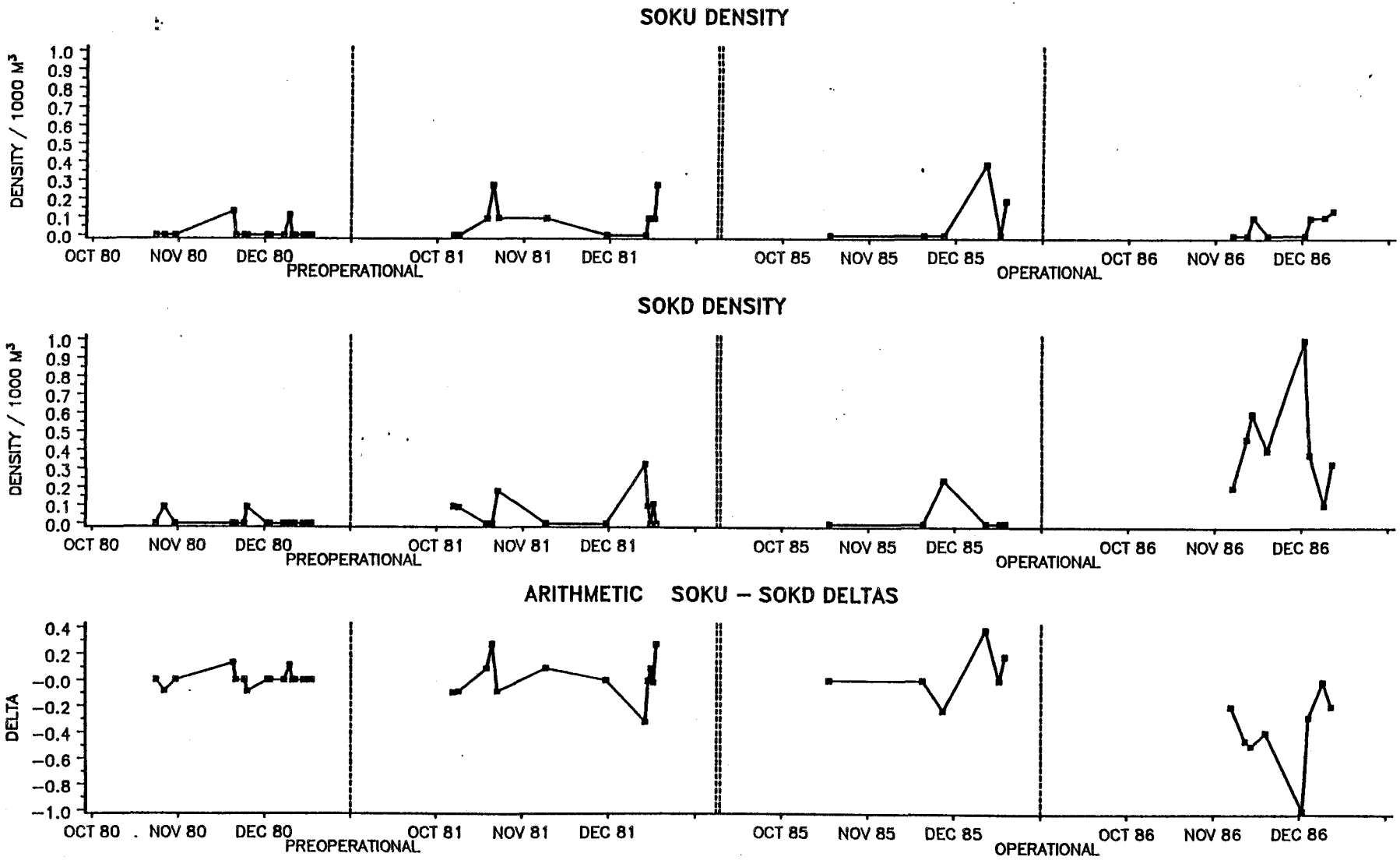
HETEROSTICHUS ROSTRATUS



APPENDIX N FIGURE 34

TOTAL GIANT KELPFISH

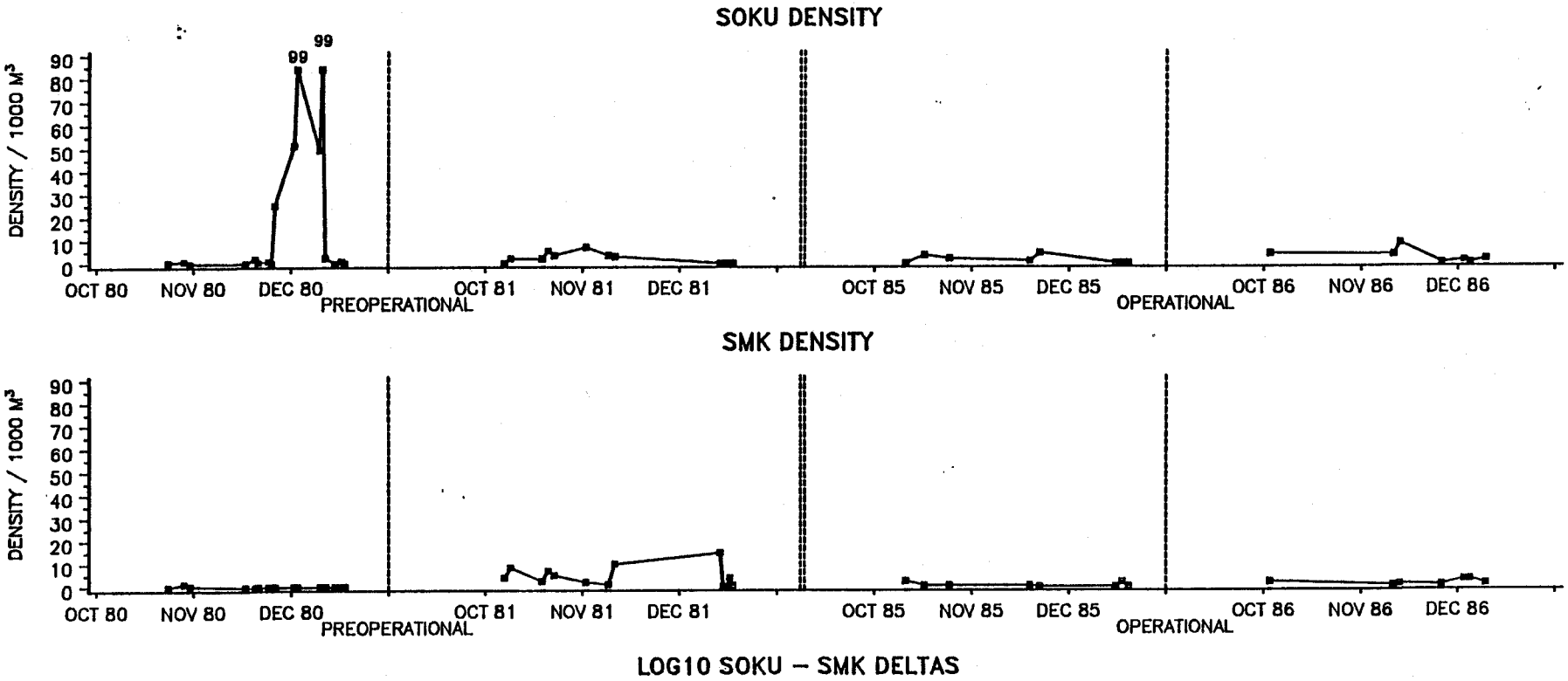
HETEROSTICHUS ROSTRATUS



APPENDIX N FIGURE 35

ADULT BLACK PERCH

EMBIOTOCA JACKSONI



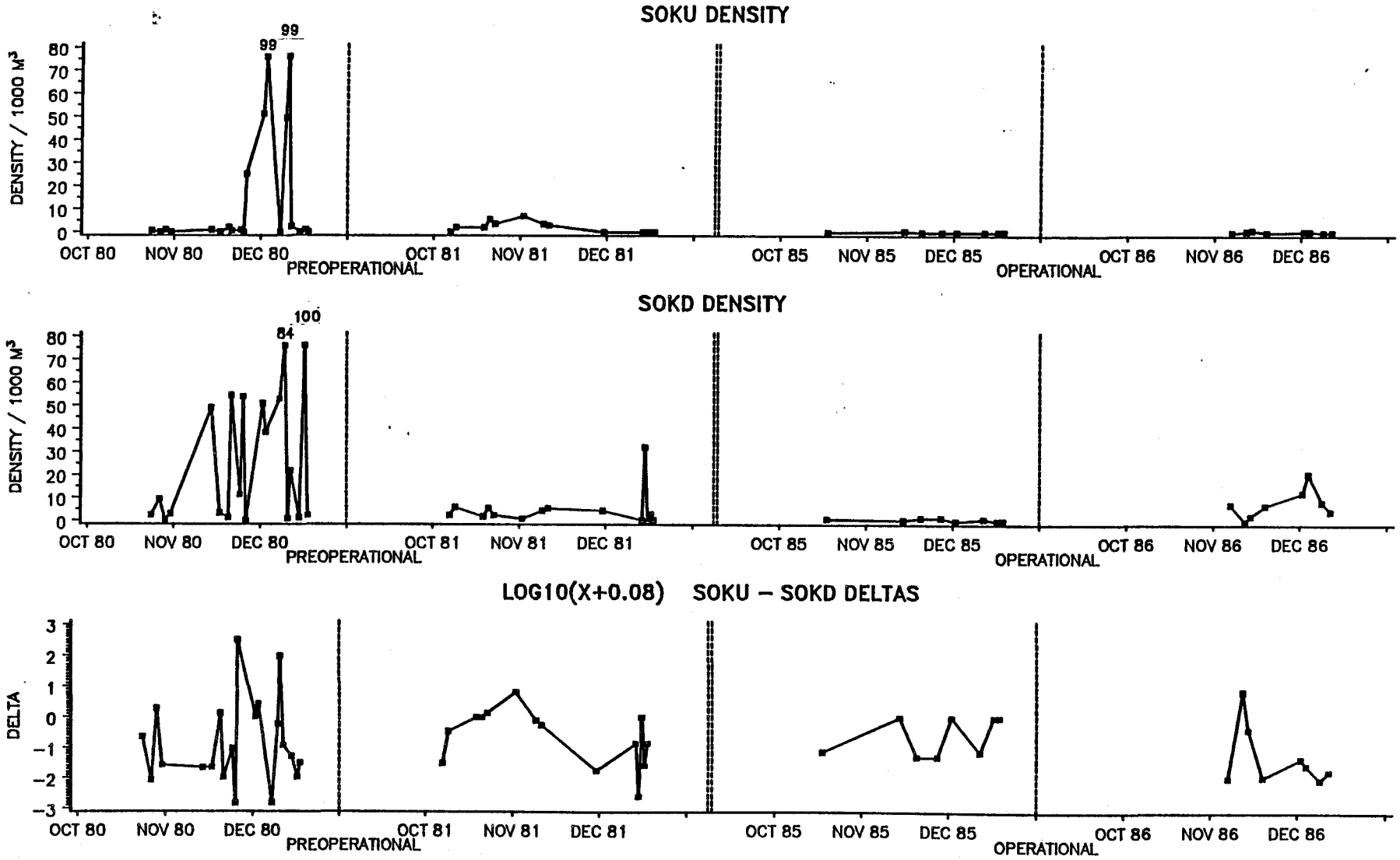
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 36

ADULT BLACK PERCH

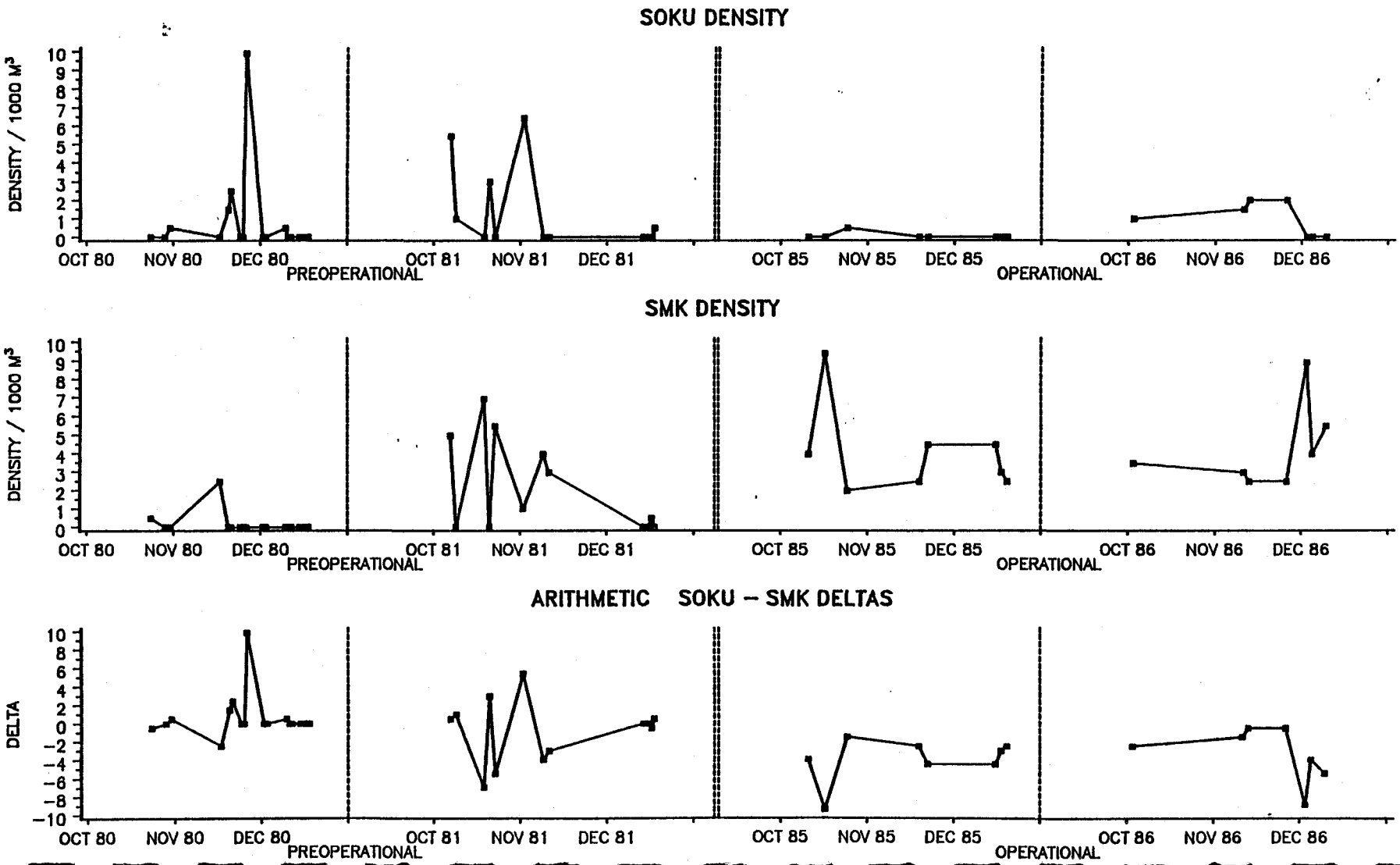
EMBIOTOCA JACKSONI



APPENDIX N FIGURE 37

SUB–ADULT BLACK PERCH

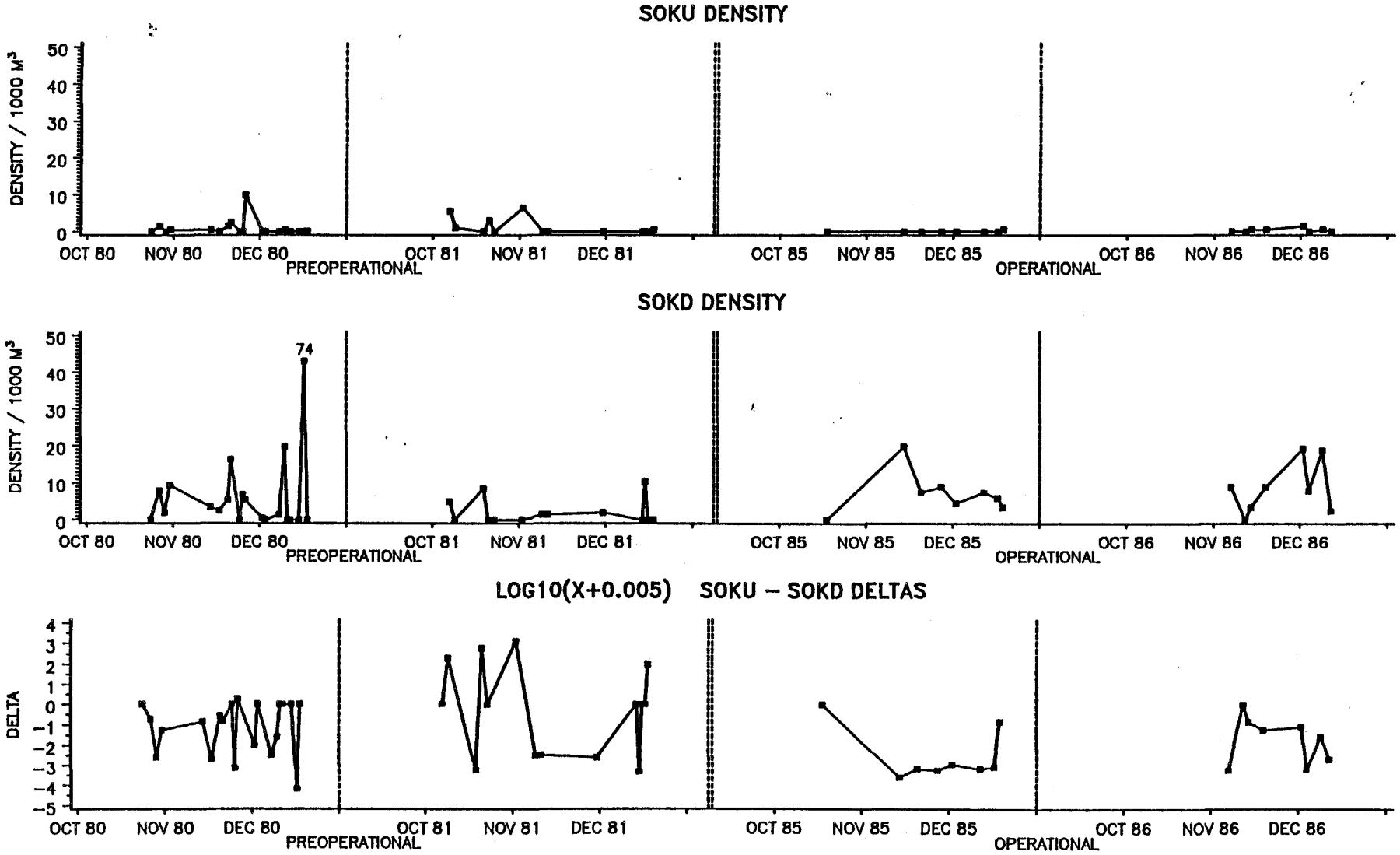
EMBIOTOCA JACKSONI



APPENDIX N FIGURE 38

SUB–ADULT BLACK PERCH

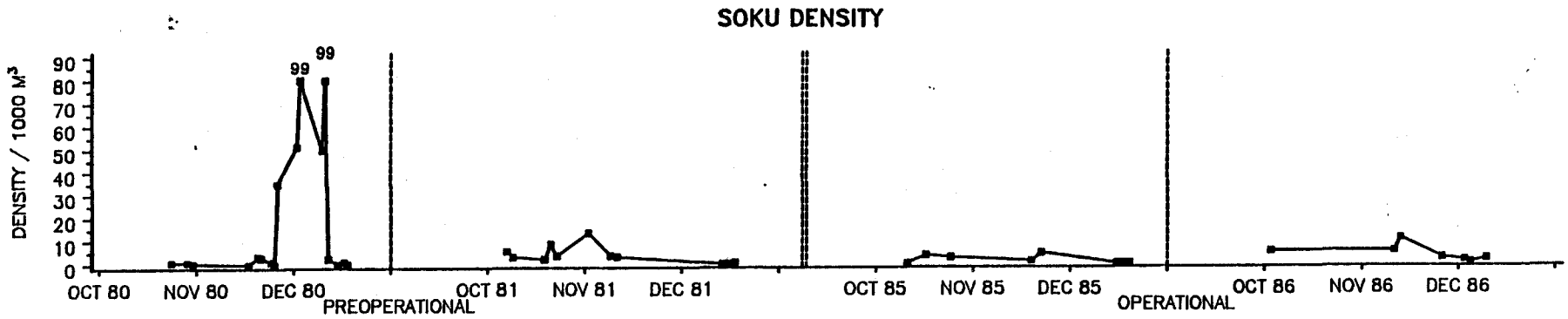
EMBIOTOCA JACKSONI

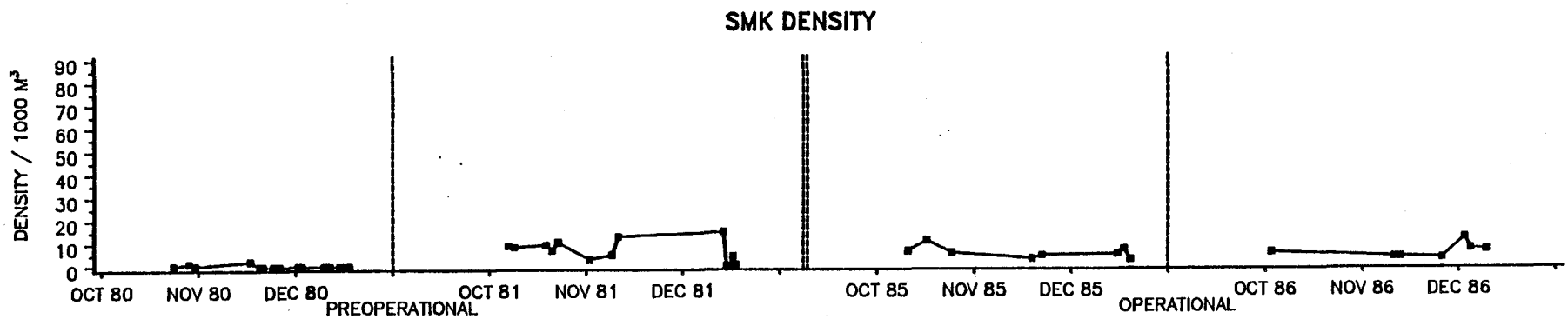


APPENDIX N FIGURE 39

TOTAL BLACK PERCH

EMBIOTOCA JACKSONI





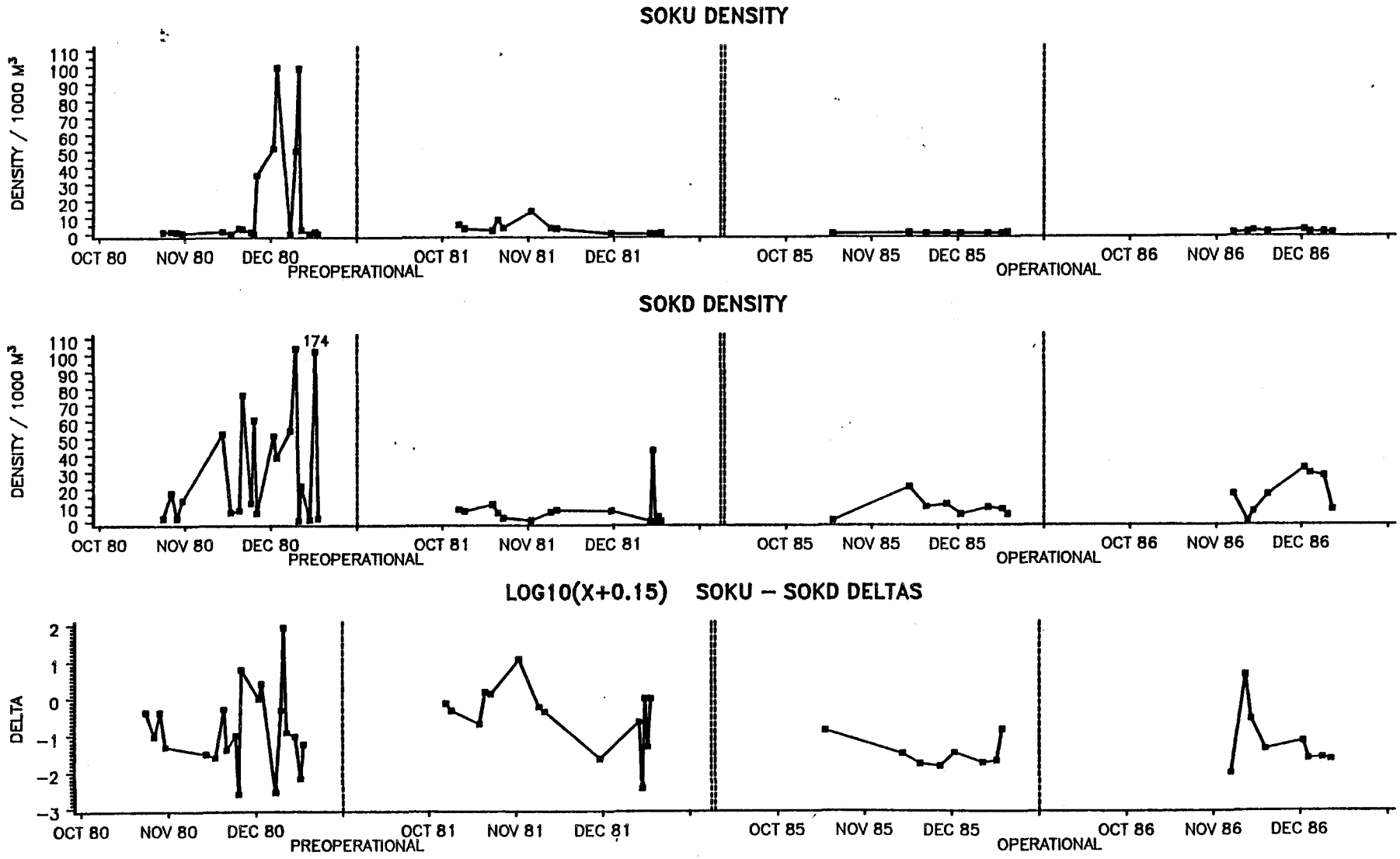
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 40

TOTAL BLACK PERCH

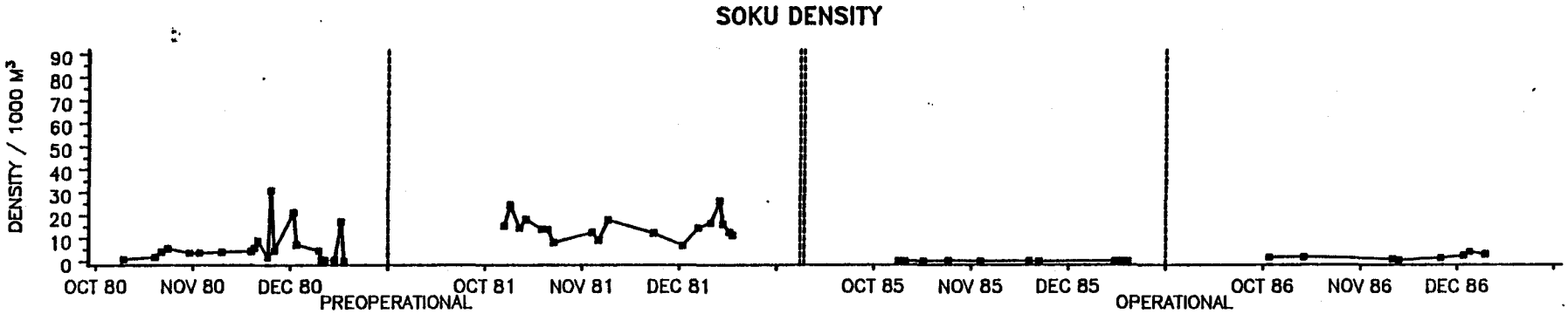
EMBIOTOCA JACKSONI

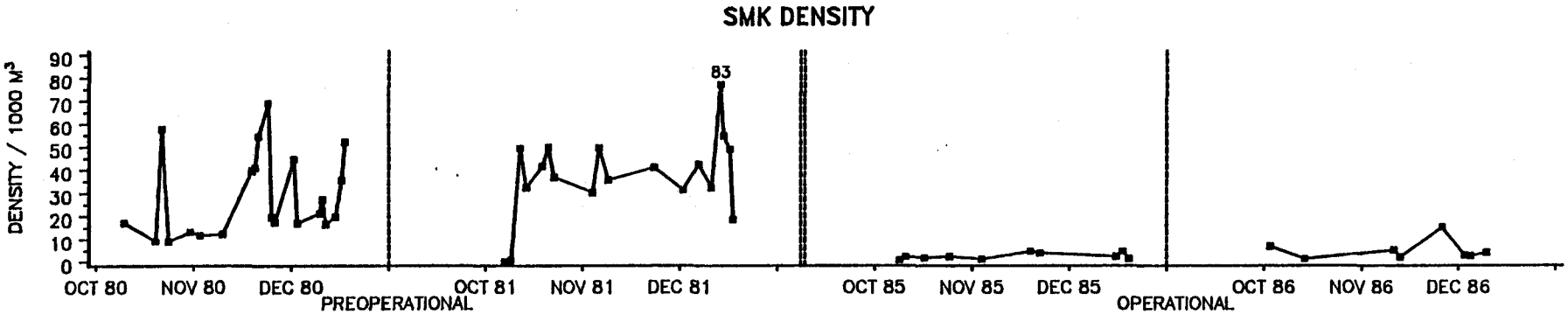


APPENDIX N FIGURE 41

TOTAL KELP PERCH

BRACHYISTIUS FRENATUS





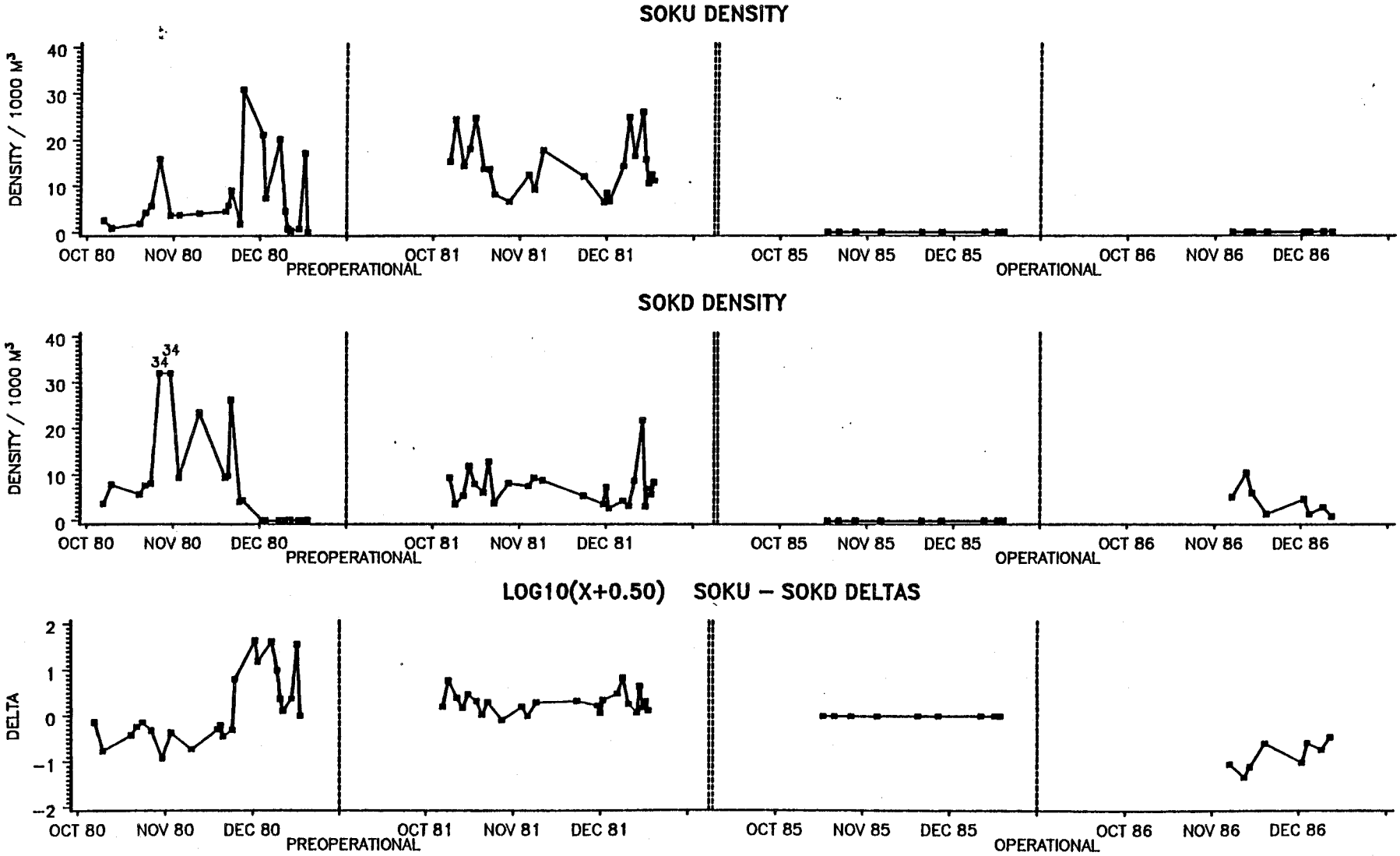
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 42

TOTAL KELP PERCH

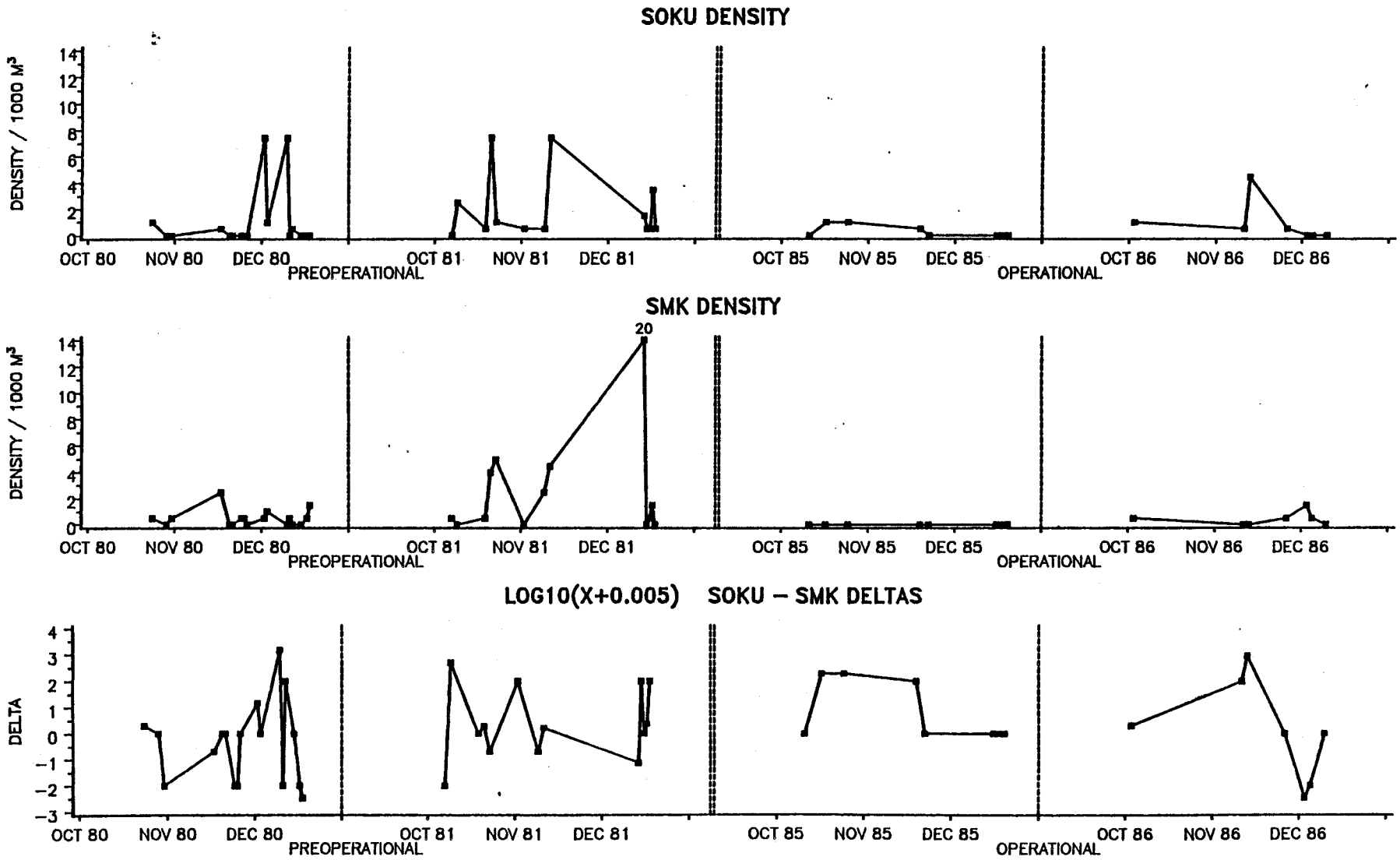
BRACHYISTIUS FRENATUS



APPENDIX N FIGURE 43

ADULT PILE PERCH

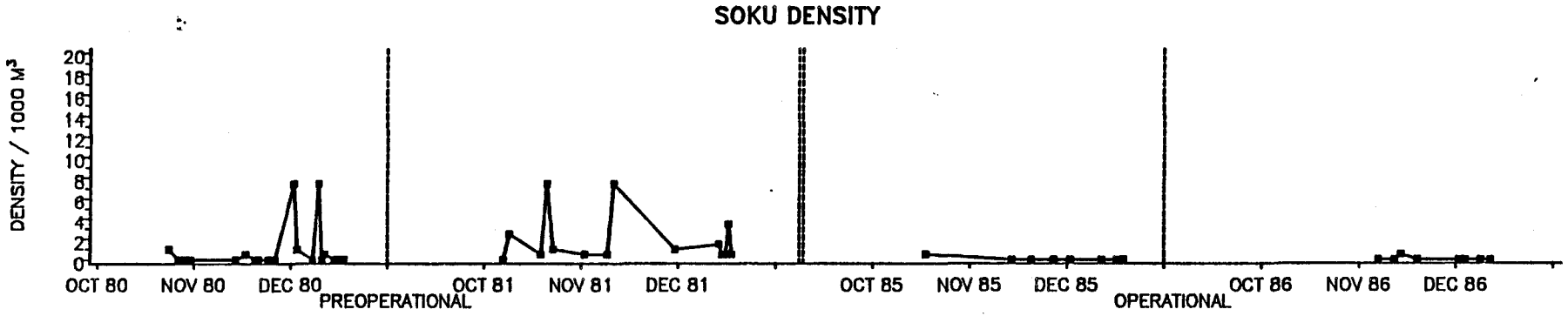
DAMALICHTHYS VACCA

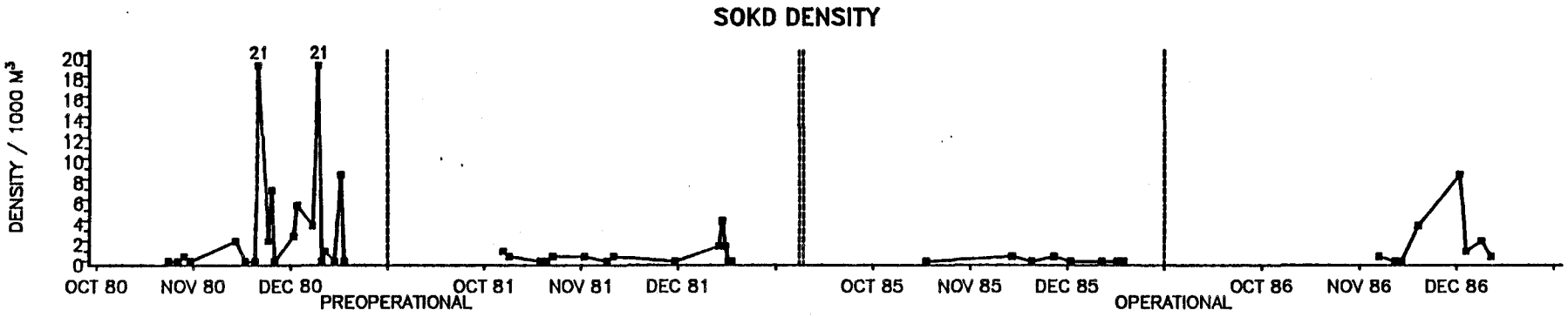


APPENDIX N FIGURE 44

ADULT PILE PERCH

DAMALICHTHYS VACCA





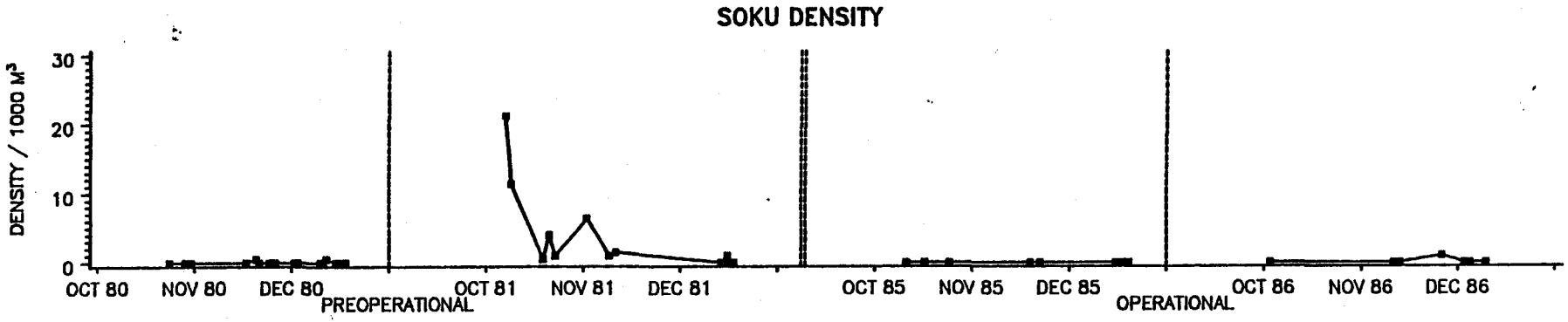
LOG10 SOKU – SOKD DELTAS

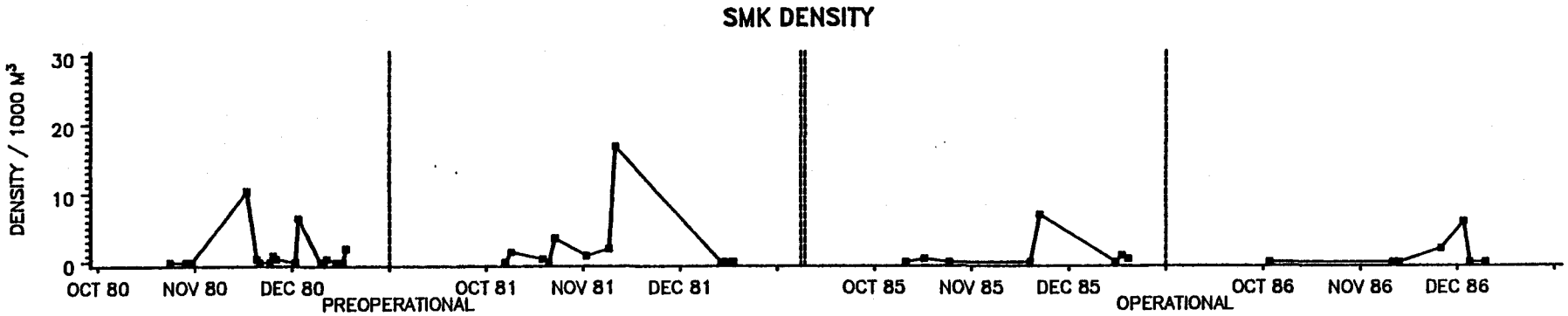
--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 45

SUB–ADULT PILE PERCH

DAMALICHTHYS VACCA





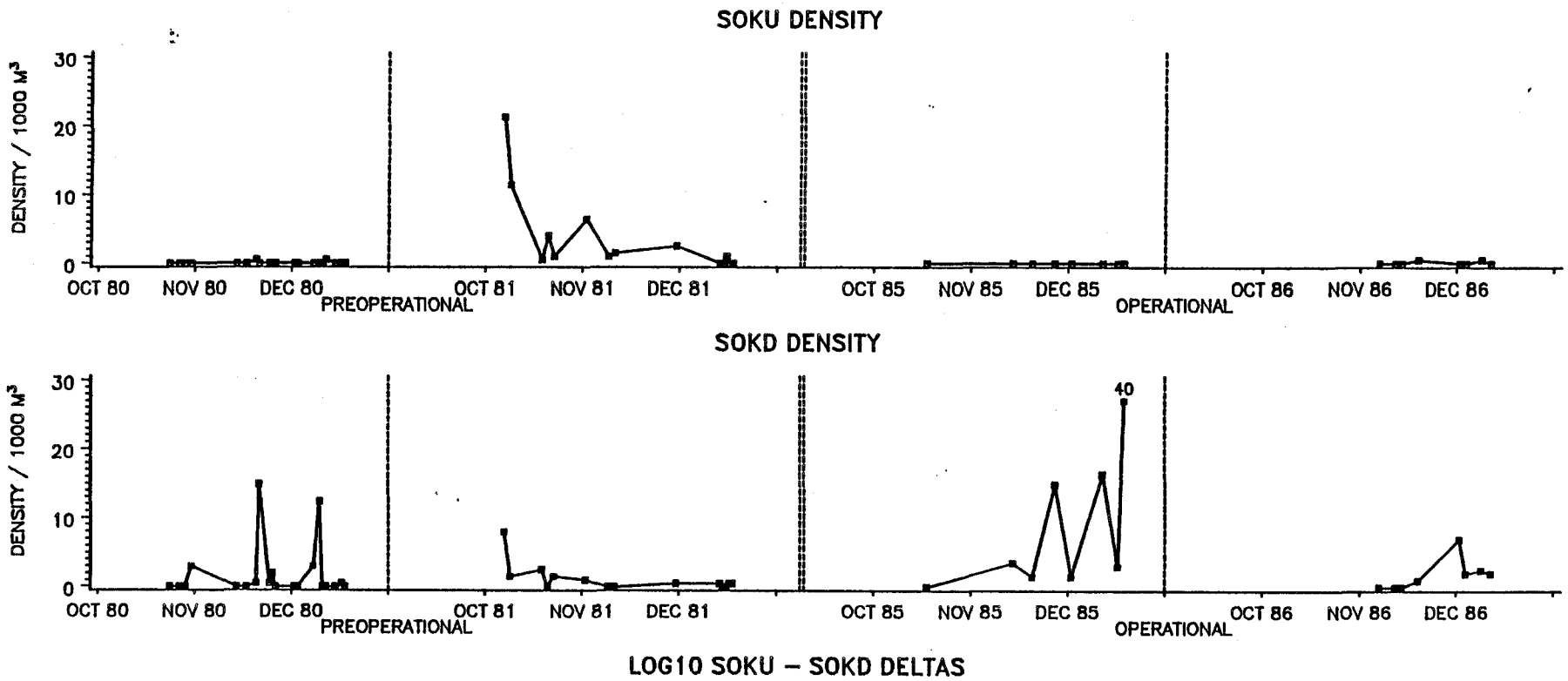
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 46

SUB–ADULT PILE PERCH

DAMALICHTHYS VACCA



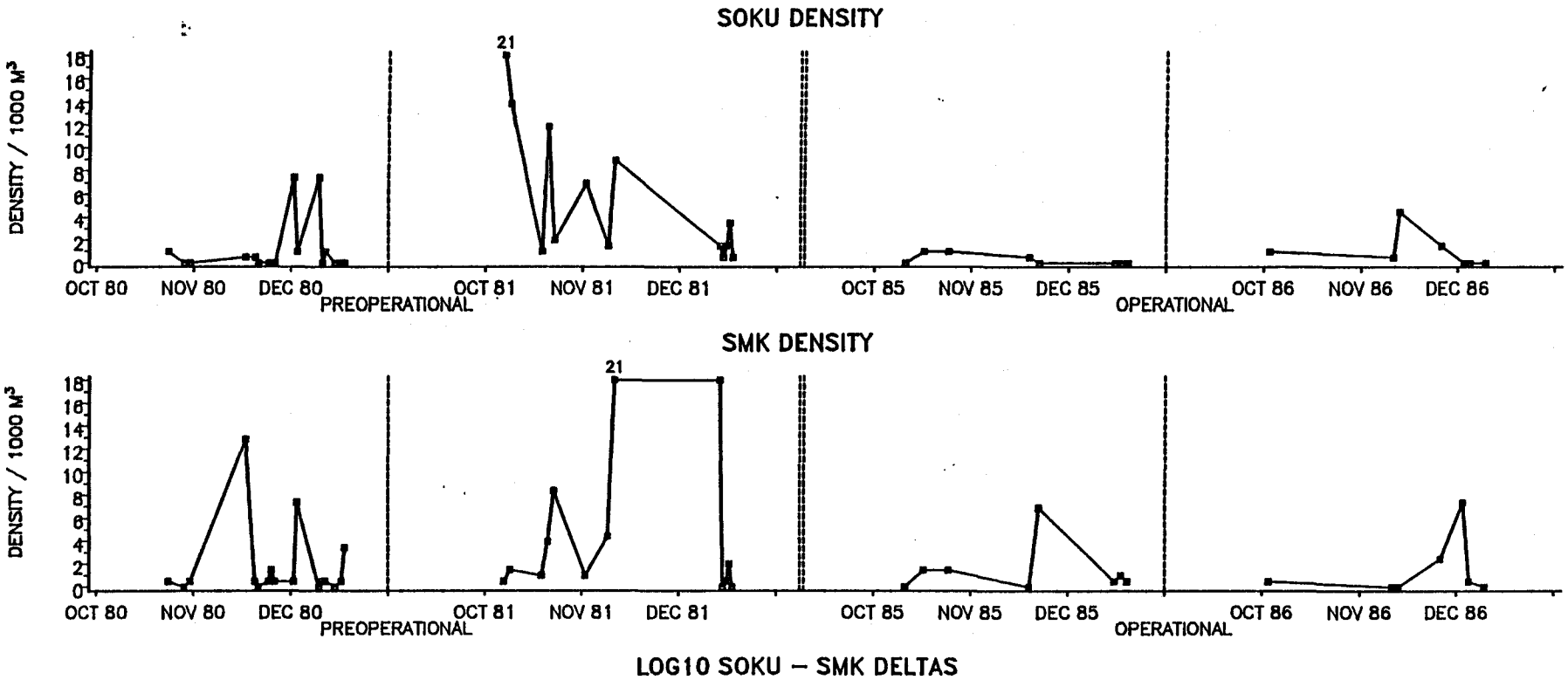
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 47

TOTAL PILE PERCH

DAMALICHTHYS VACCA



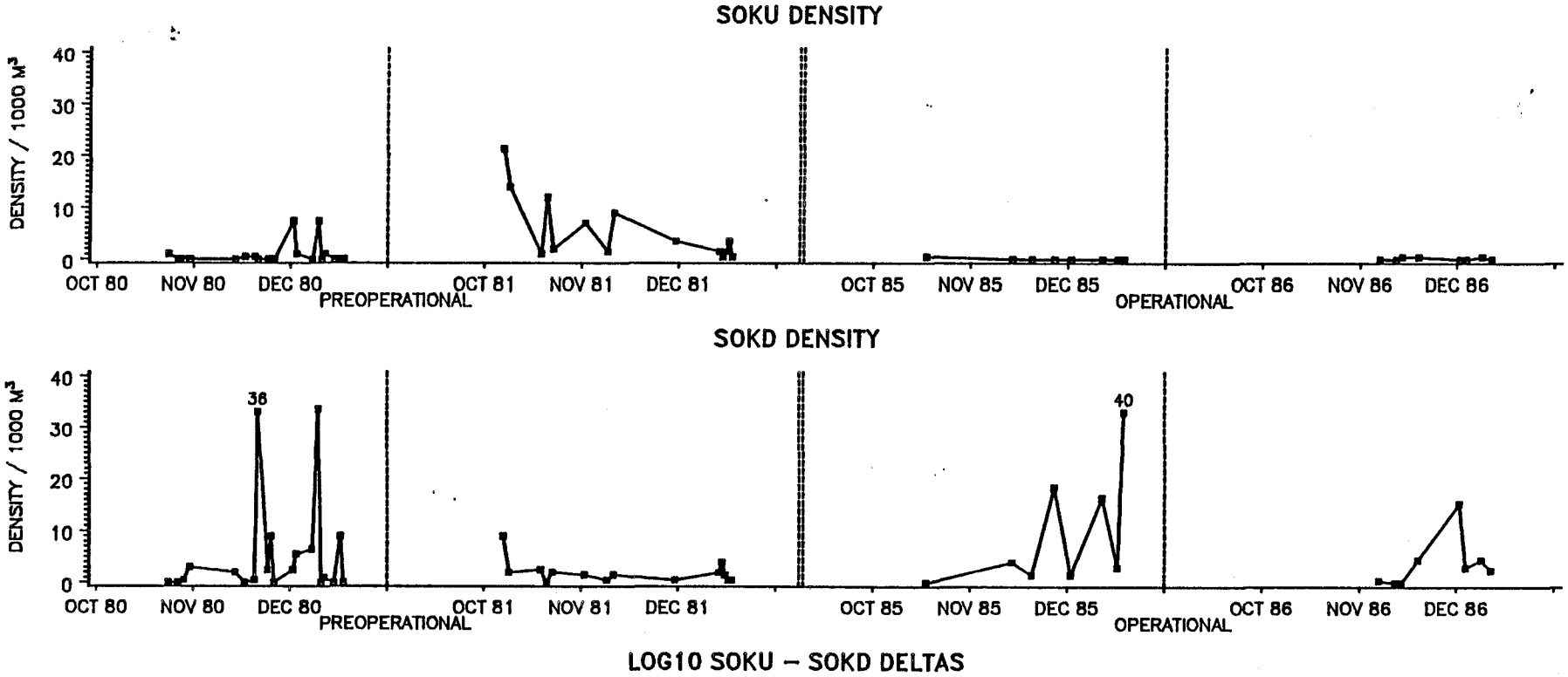
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 48

TOTAL PILE PERCH

DAMALICHTHYS VACCA



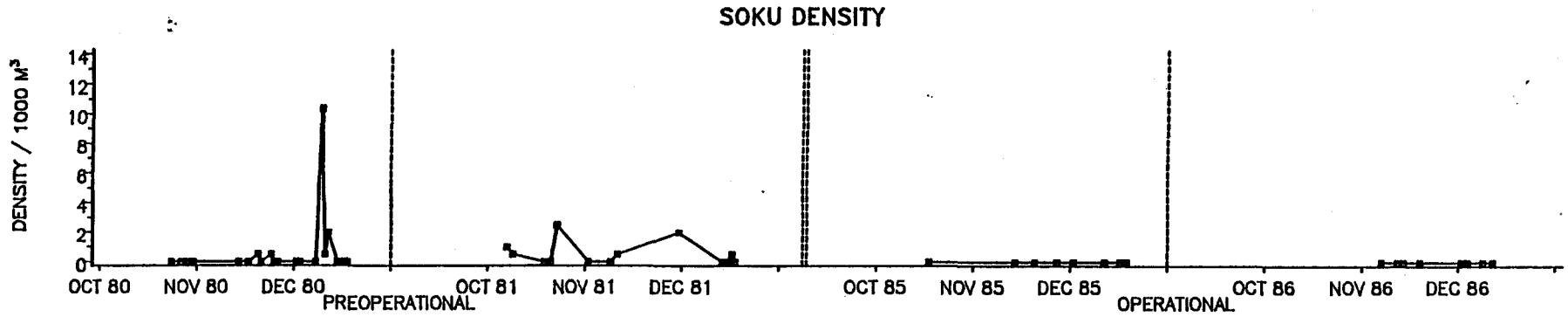
LOG10 SOKU – SOKD DELTAS

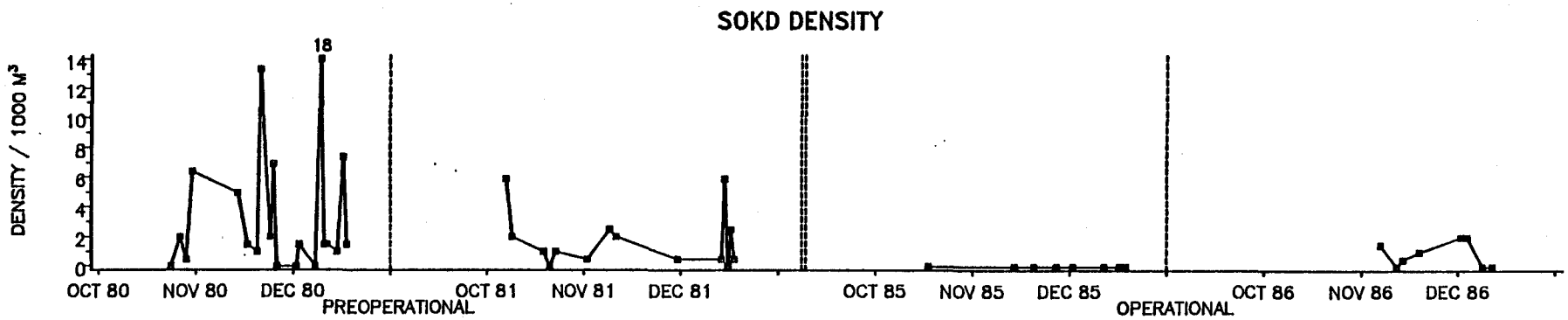
--- STATISTICALLY INTRACTABLE ---

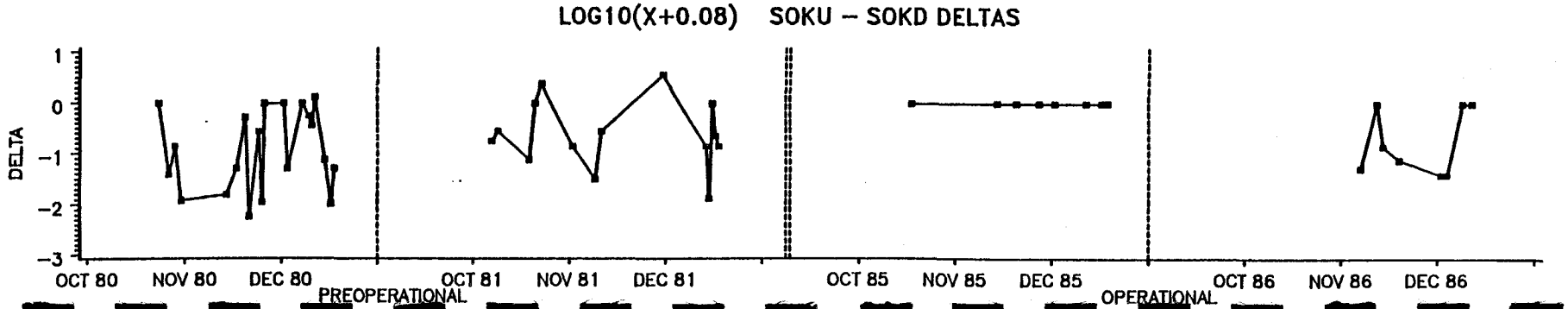
APPENDIX N FIGURE 49

ADULT RAINBOW SEAPERCH

HYPSURUS CARYI



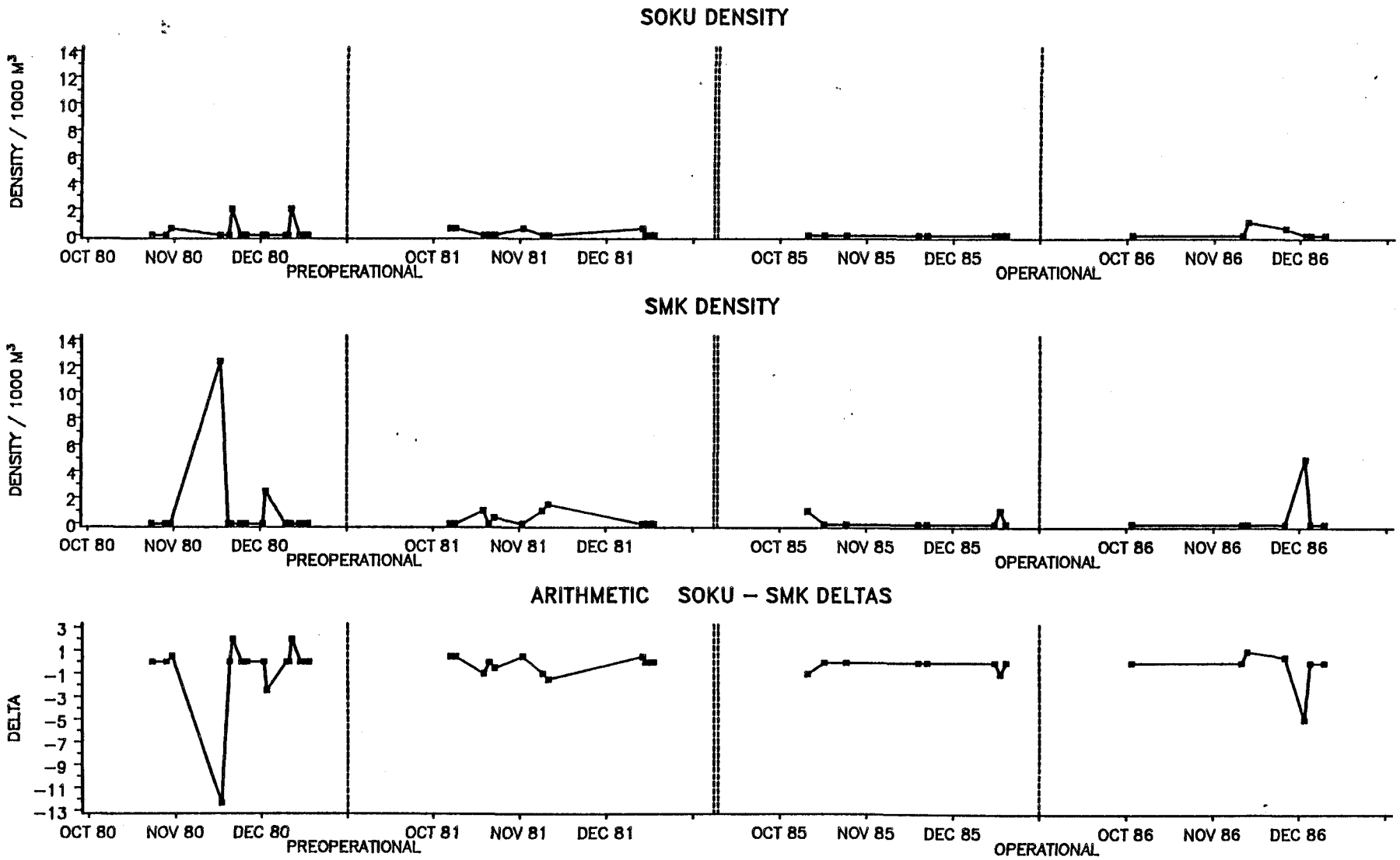




APPENDIX N FIGURE 50

SUB–ADULT RAINBOW SEAPERCH

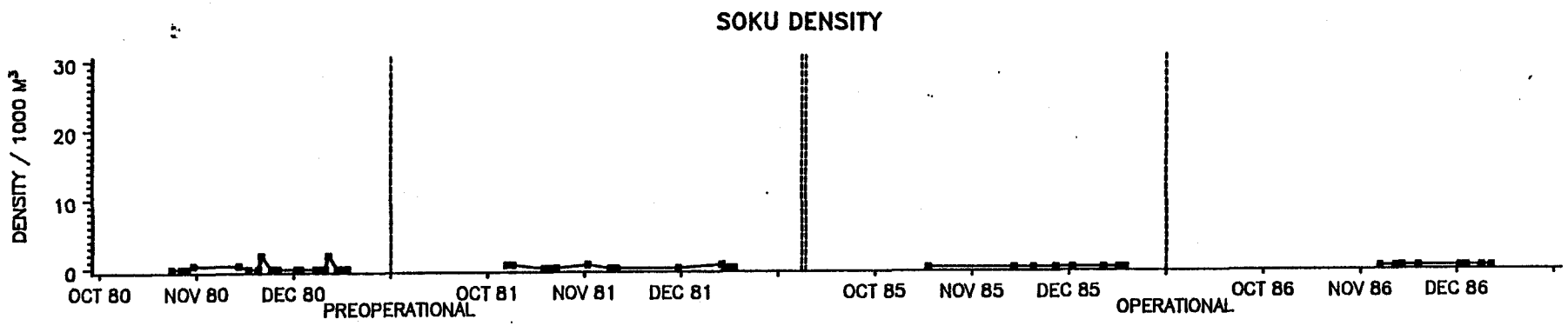
HYPSURUS CARYI

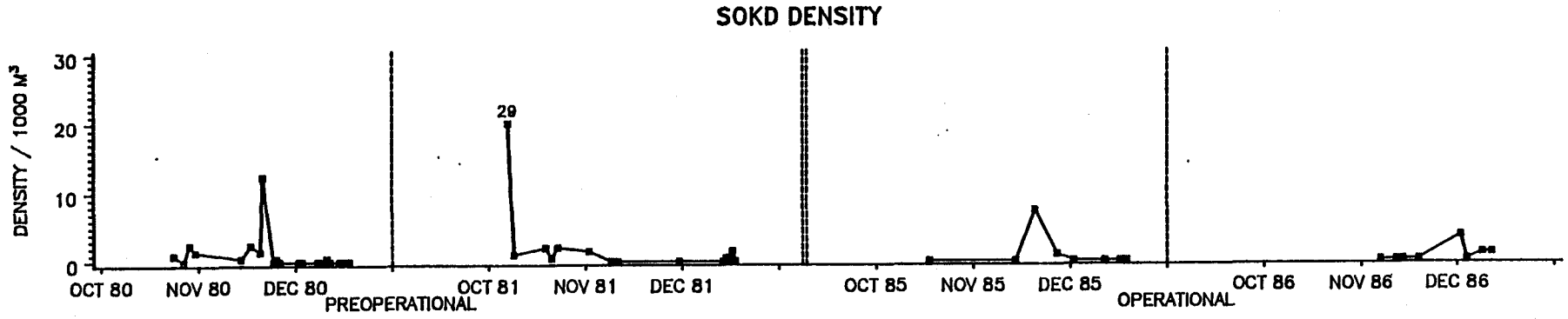


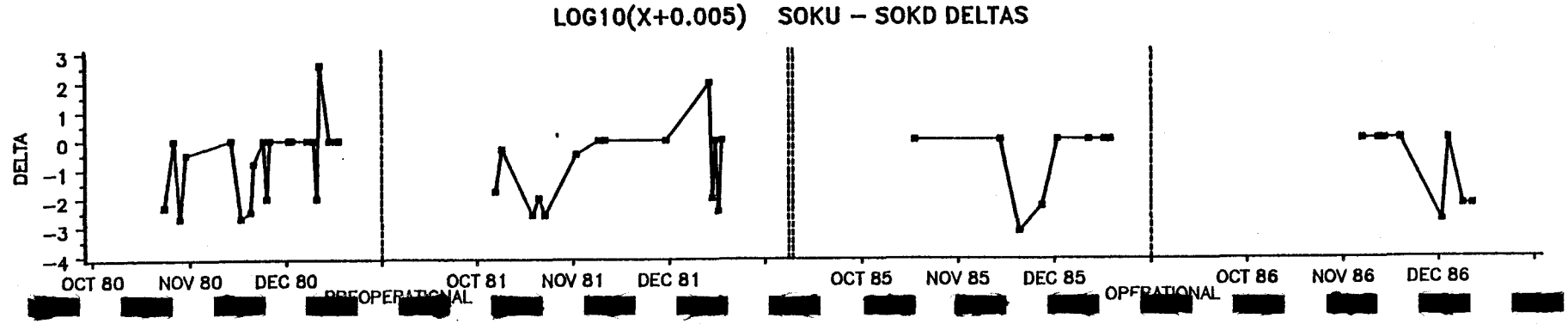
APPENDIX N FIGURE 51

SUB–ADULT RAINBOW SEAPERCH

HYPSURUS CARYI



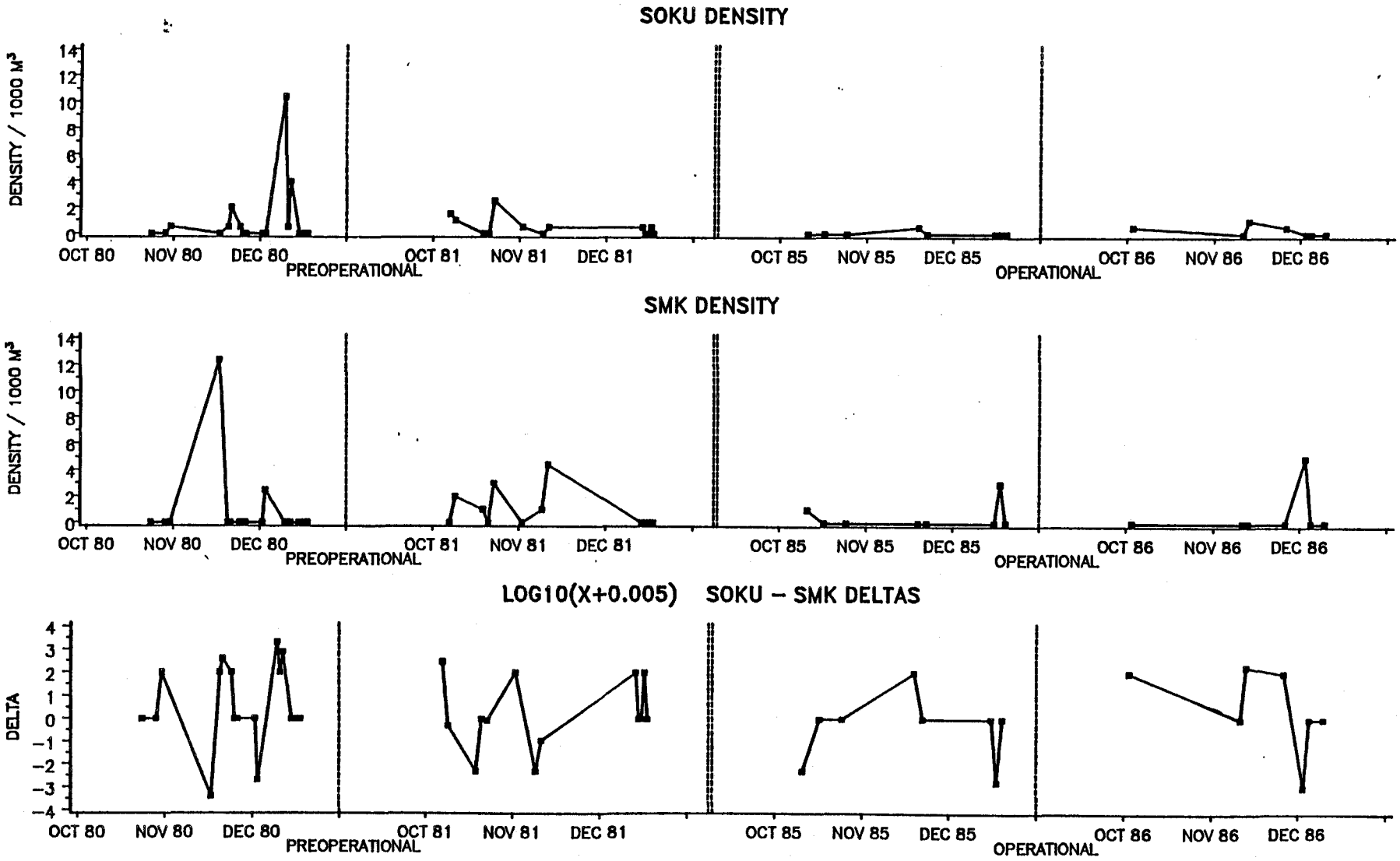




APPENDIX N FIGURE 52

TOTAL RAINBOW SEAPERCH

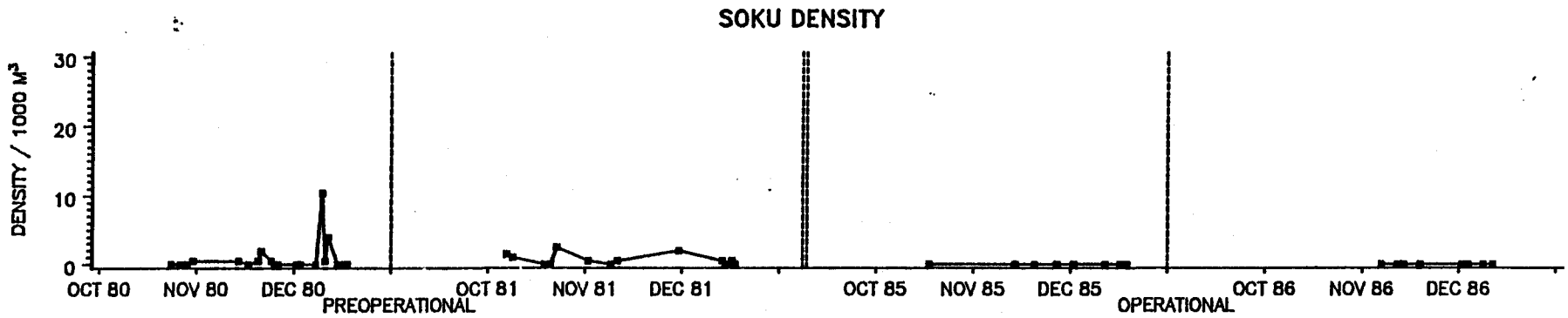
HYPSURUS CARYI

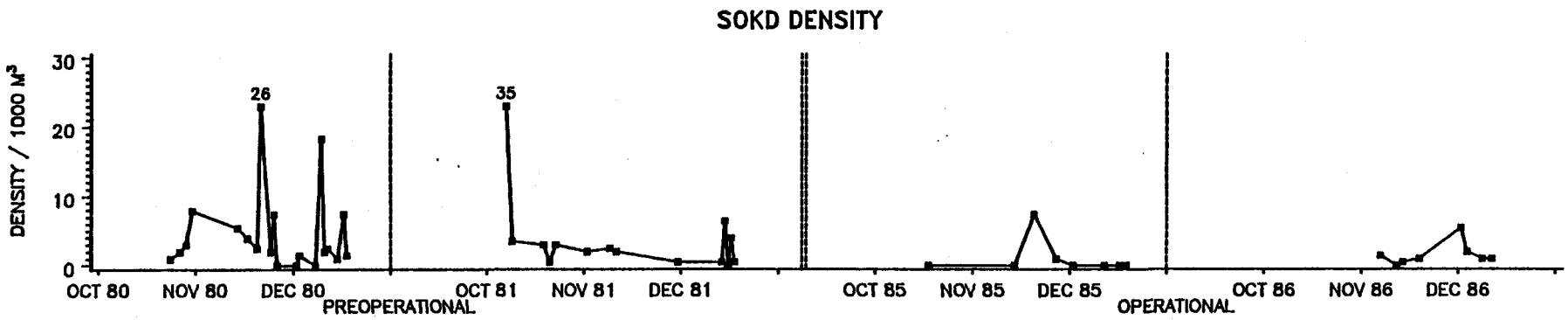


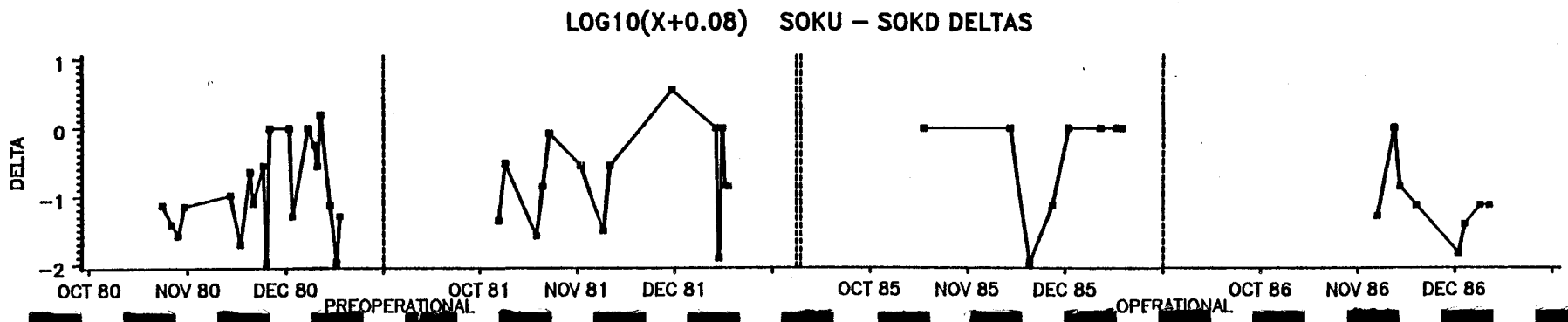
APPENDIX N FIGURE 53

TOTAL RAINBOW SEAPERCH

HYPSURUS CARYI



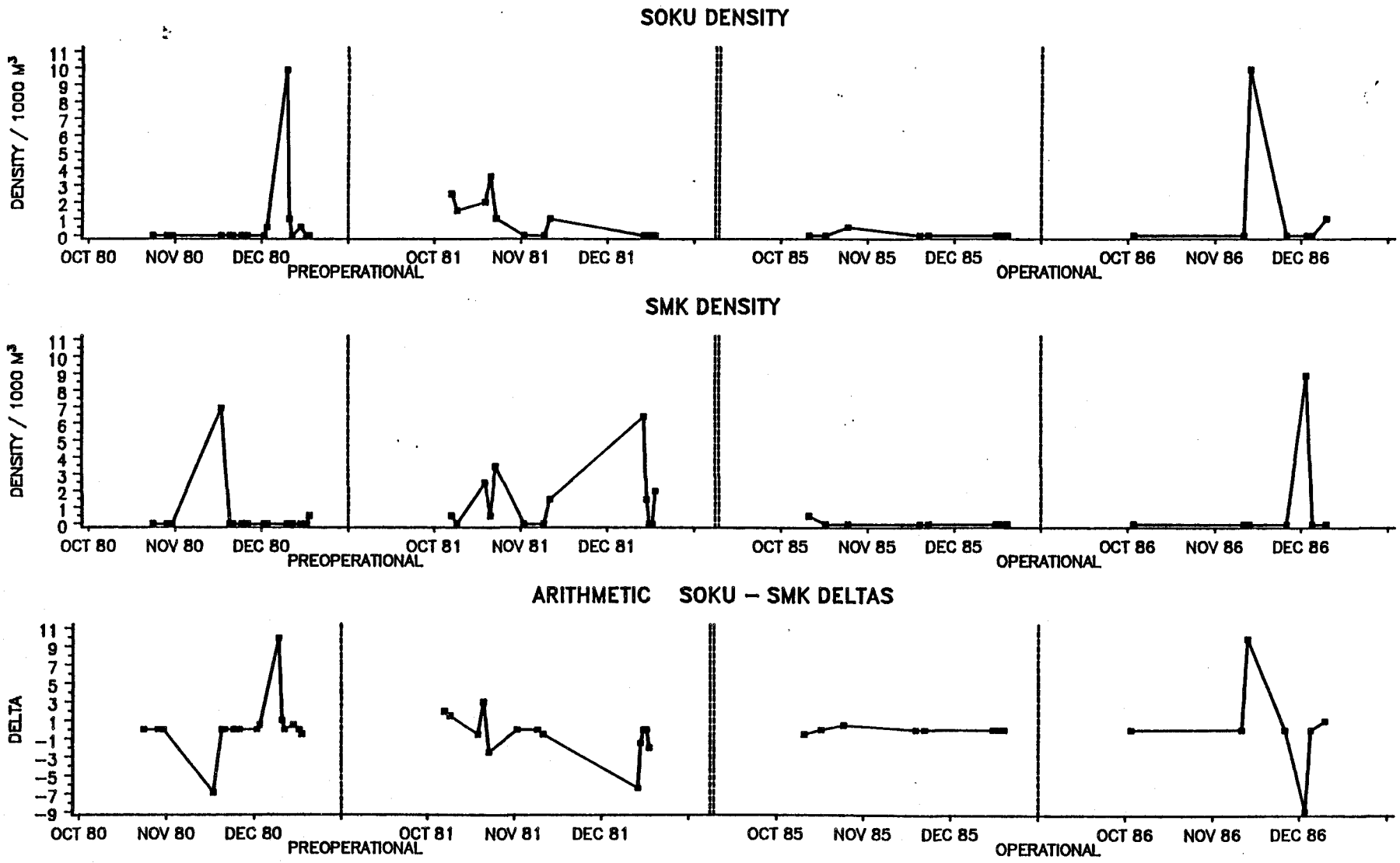




APPENDIX N FIGURE 54

TOTAL RUBBERLIP SEAPERCH

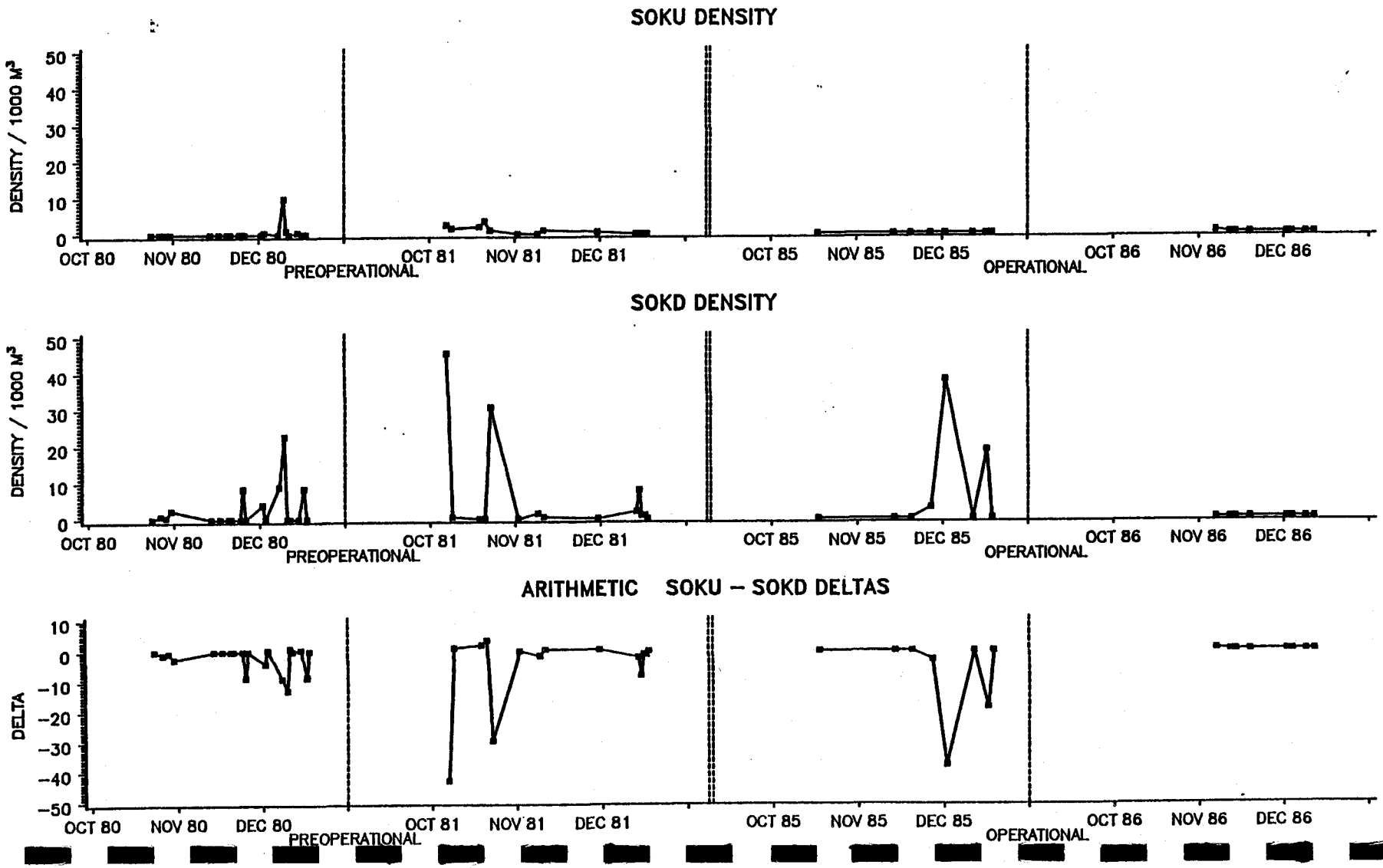
RHACOCHILUS TOXOTES



APPENDIX N FIGURE 55

TOTAL RUBBERLIP SEAPERCH

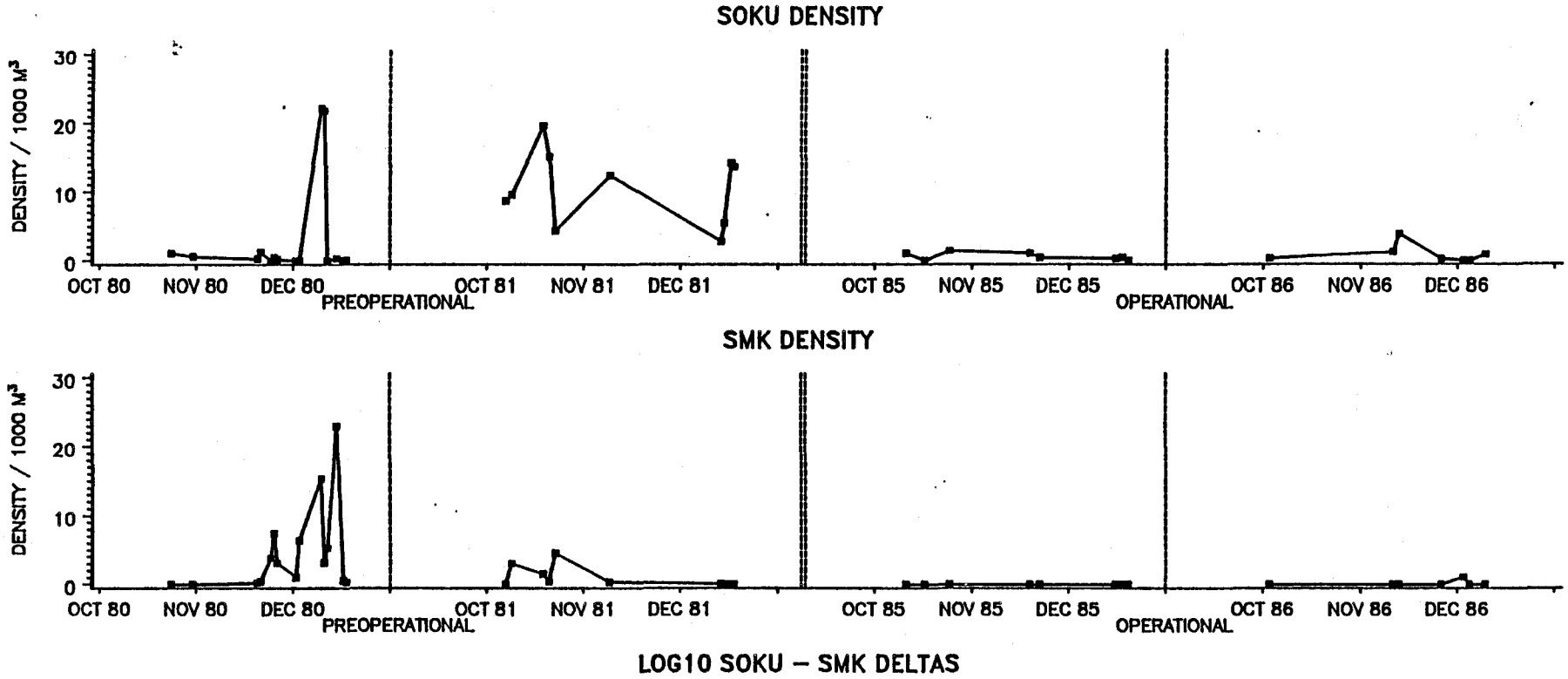
RHACOCHILUS TOXOTES



APPENDIX N FIGURE 56

ADULT WHITE SEAPERCH

PHANERODON FURCATUS



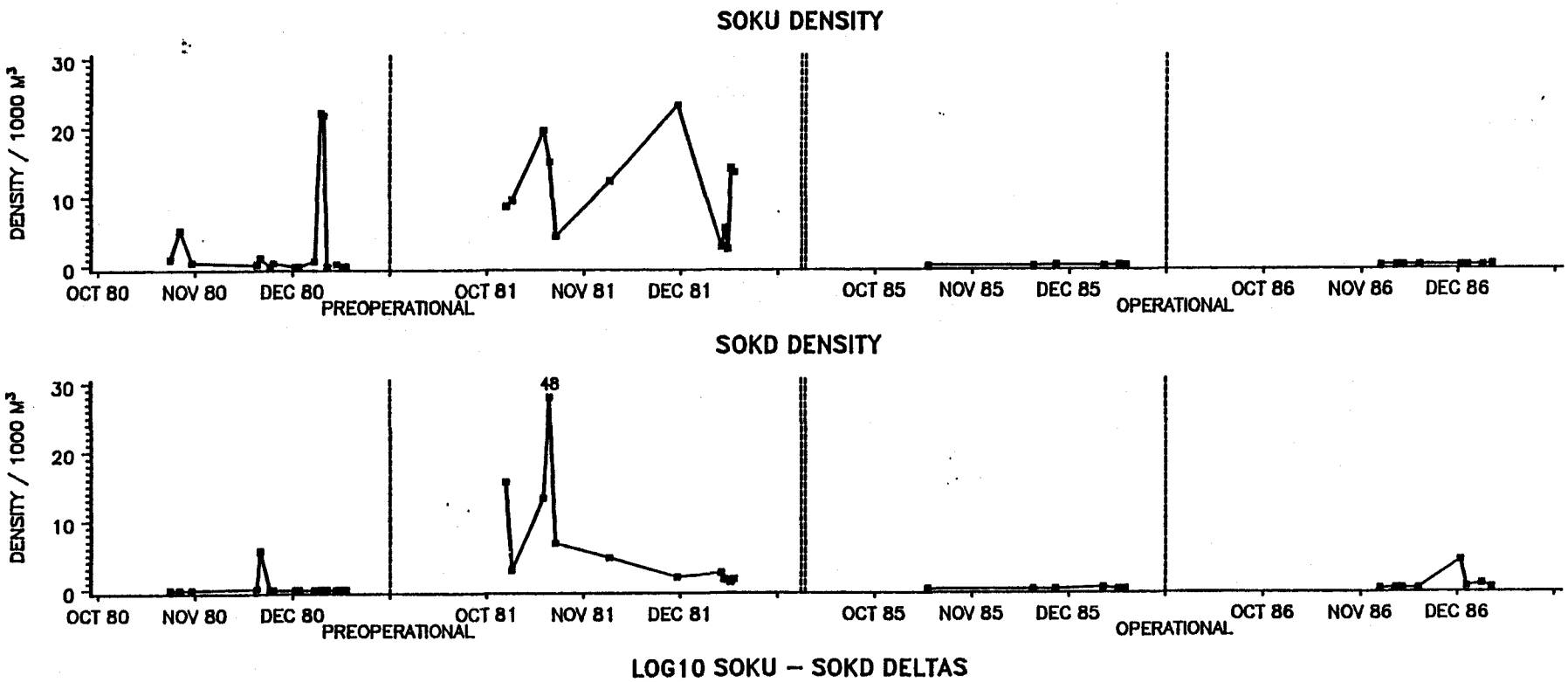
LOG10 SOKU – SMK DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 57

ADULT WHITE SEAPERCH

PHANERODON FURCATUS



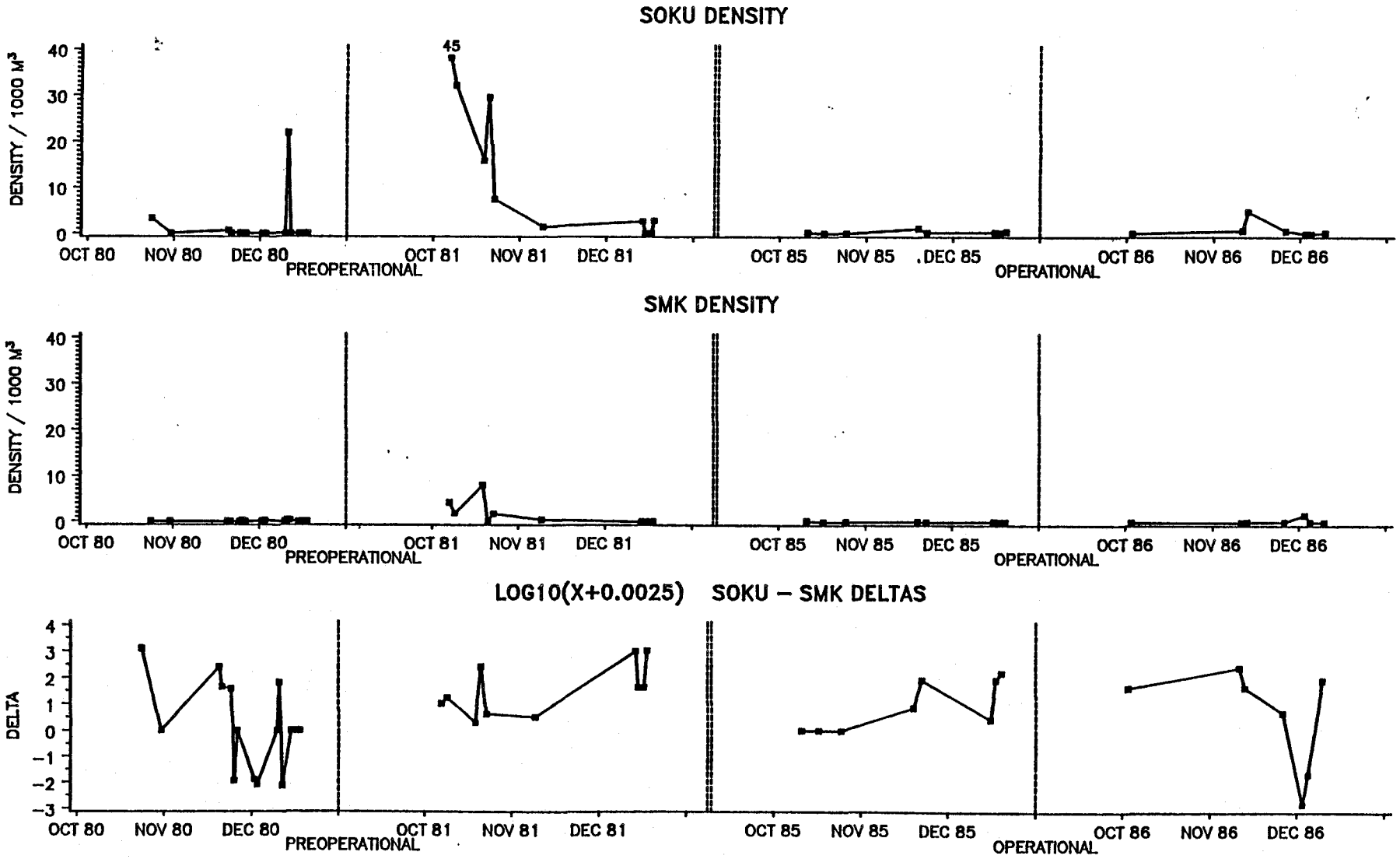
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 58

SUB–ADULT WHITE SEAPERCH

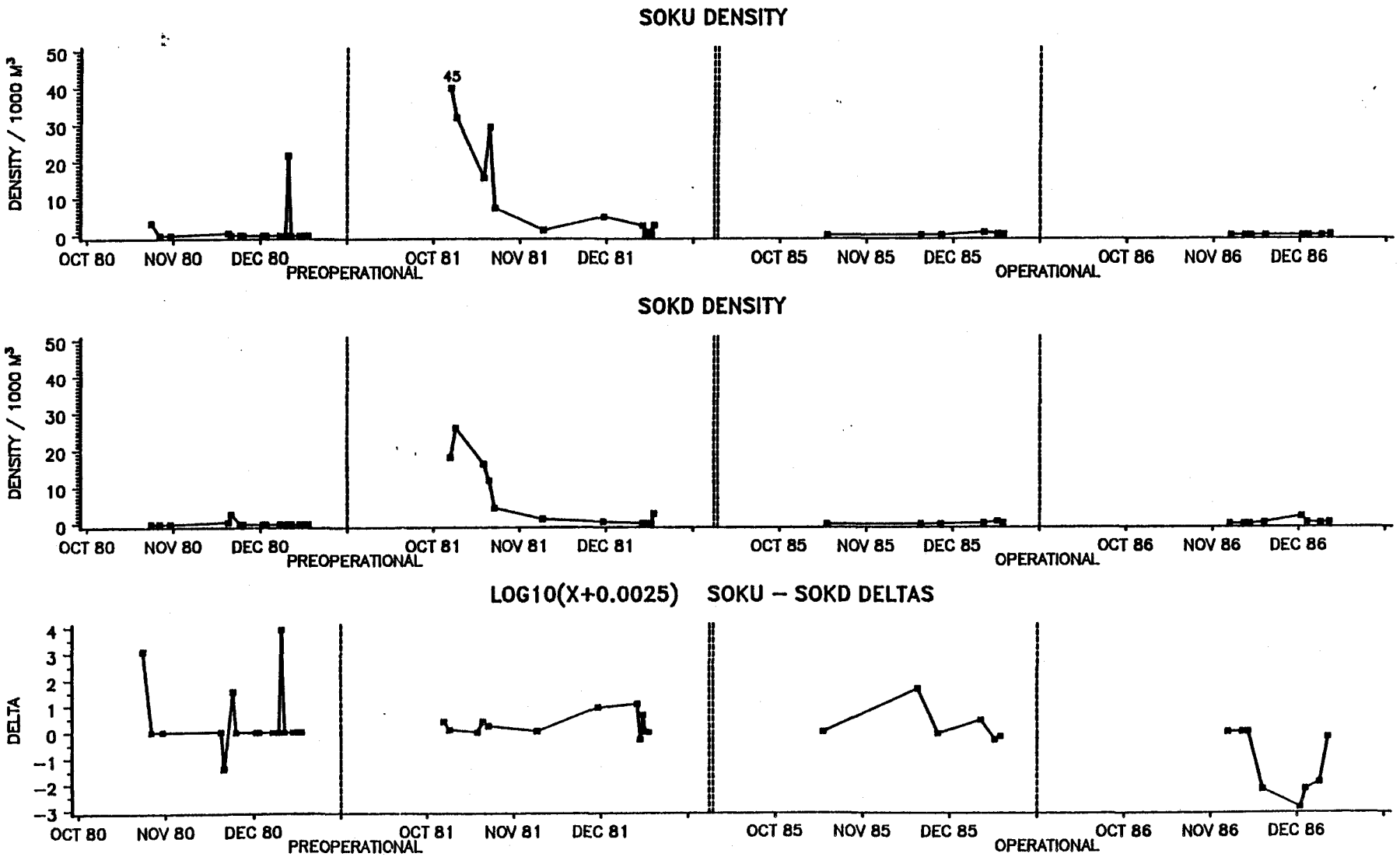
PHANERODON FURCATUS



APPENDIX N FIGURE 59

SUB–ADULT WHITE SEAPERCH

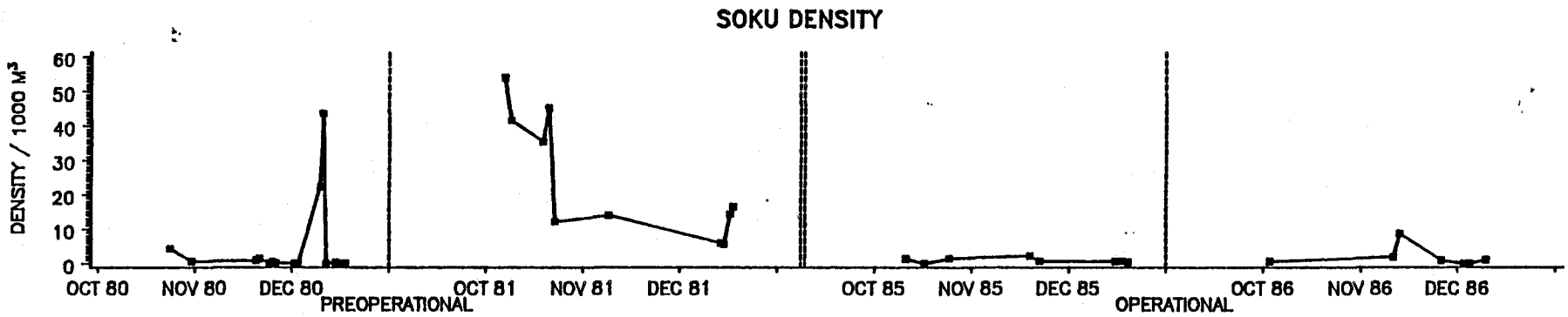
PHANERODON FURCATUS

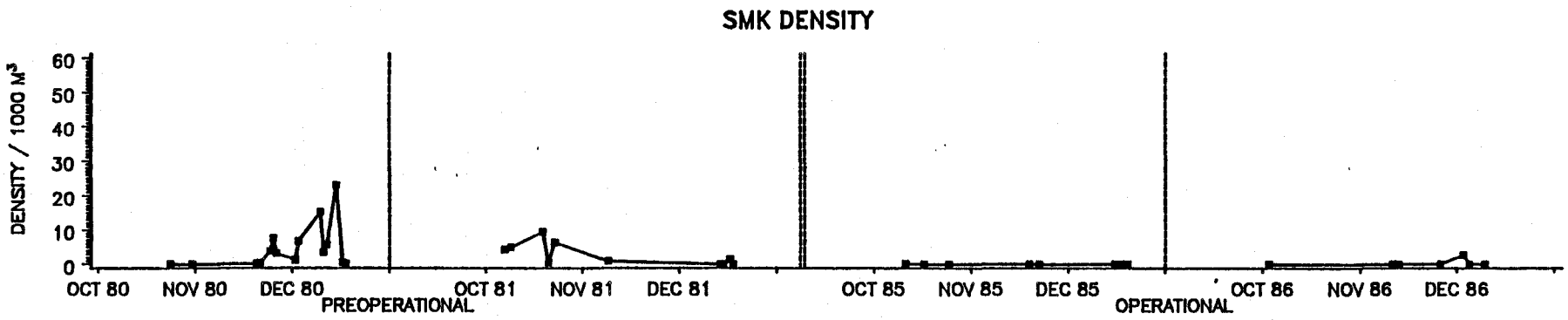


APPENDIX N FIGURE 60

TOTAL WHITE SEAPERCH

PHANERODON FURCATUS





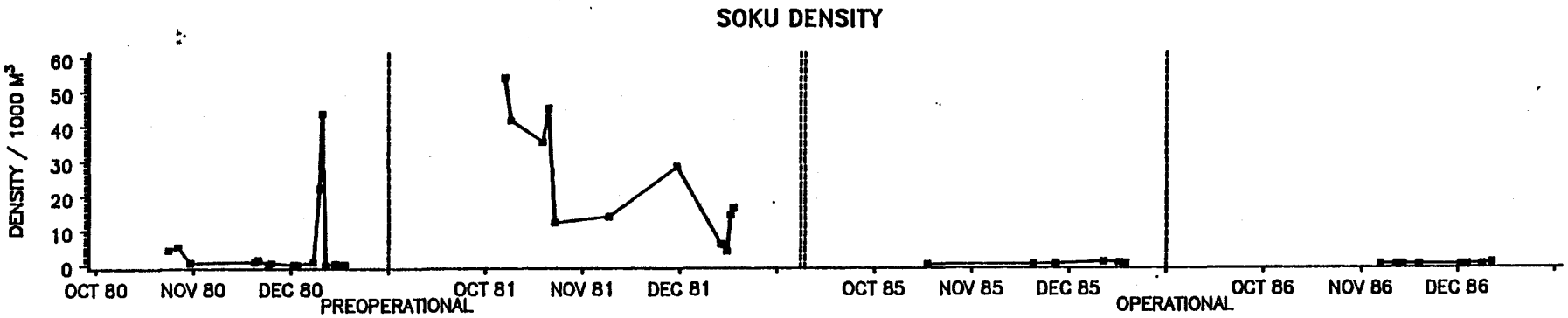
LOG10 SOKU – SMK DELTAS

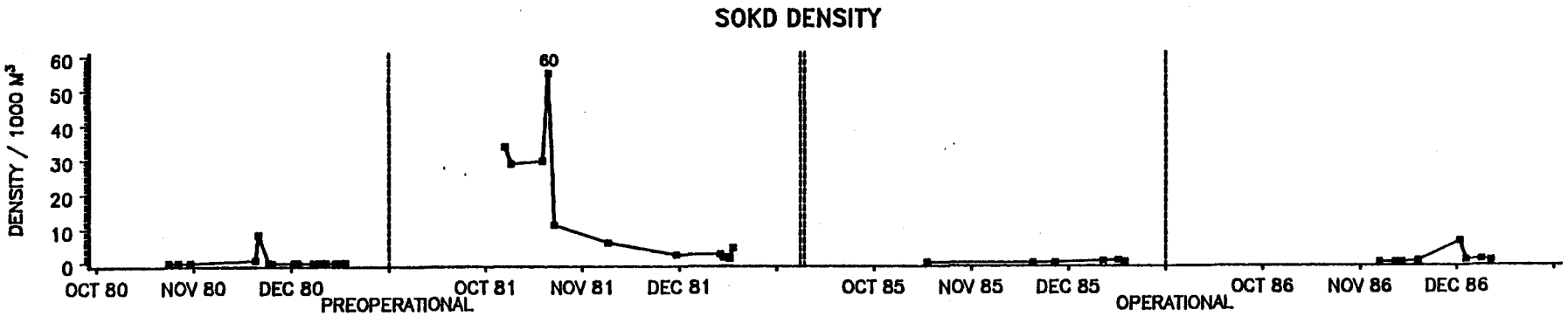
--- HETEROGENEOUS TAXON ---

APPENDIX N FIGURE 61

TOTAL WHITE SEAPERCH

PHANERODON FURCATUS





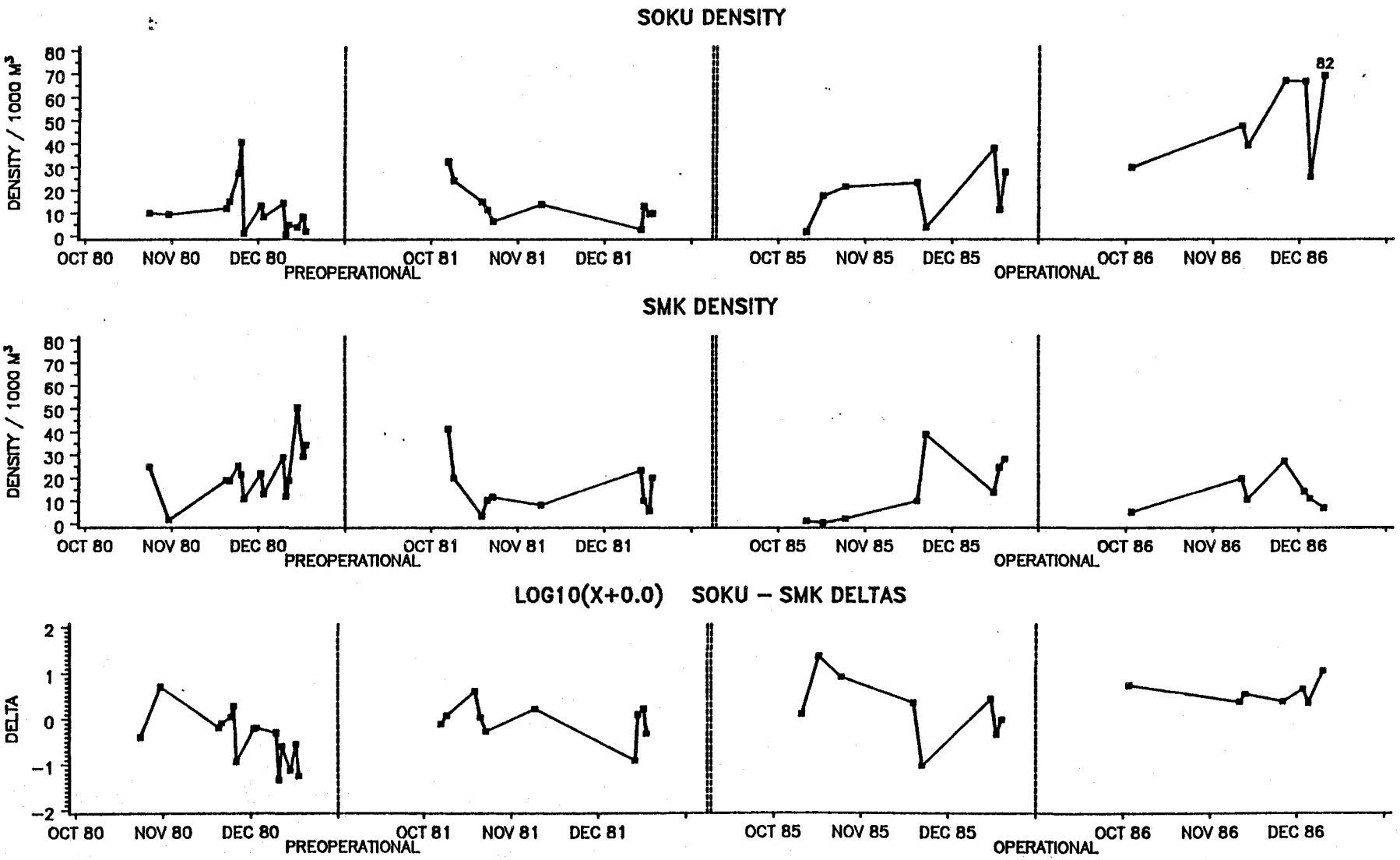
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 62

ADULT SENORITA

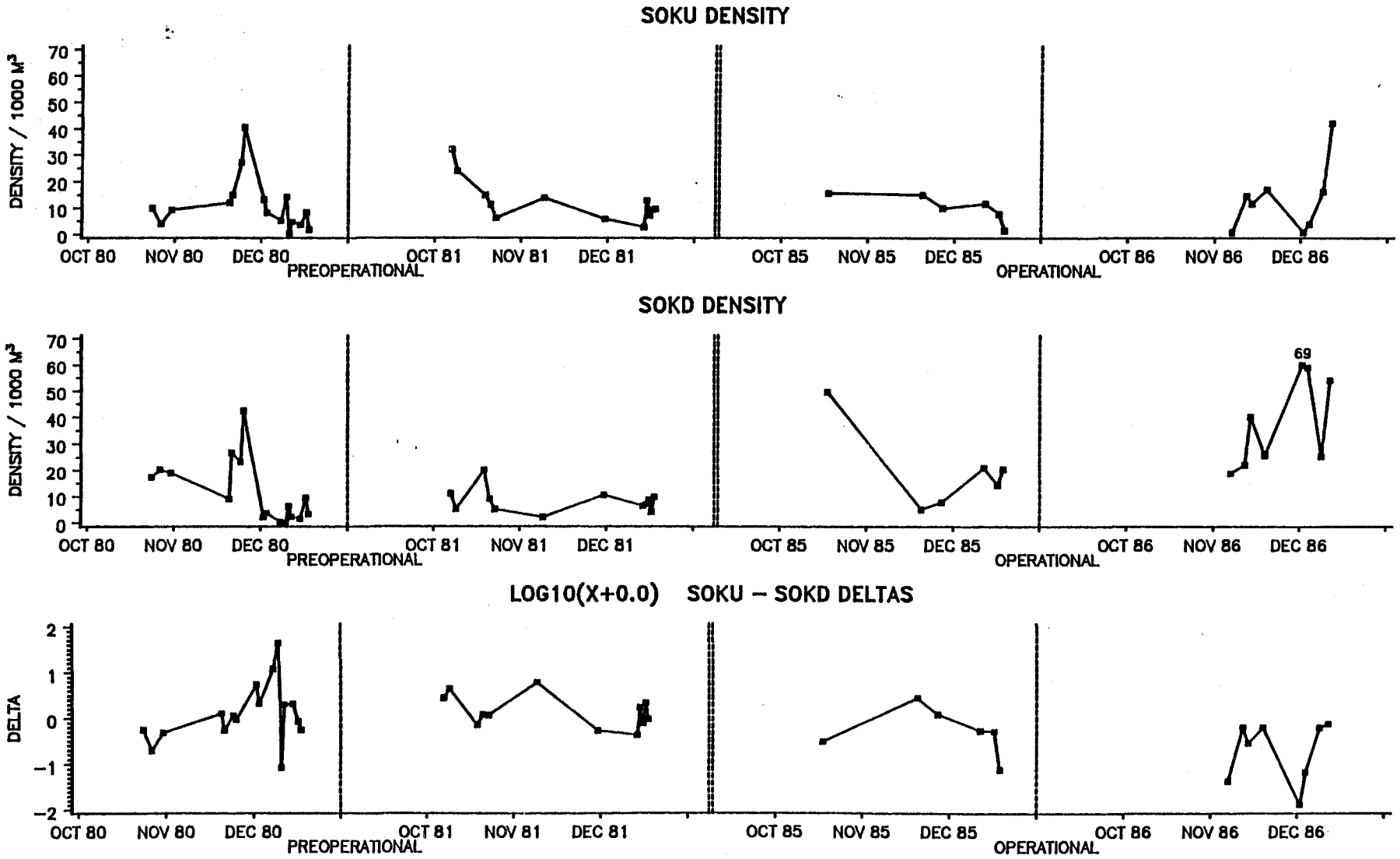
OXYJULIS CALIFORNICA



APPENDIX N FIGURE 63

ADULT SENORITA

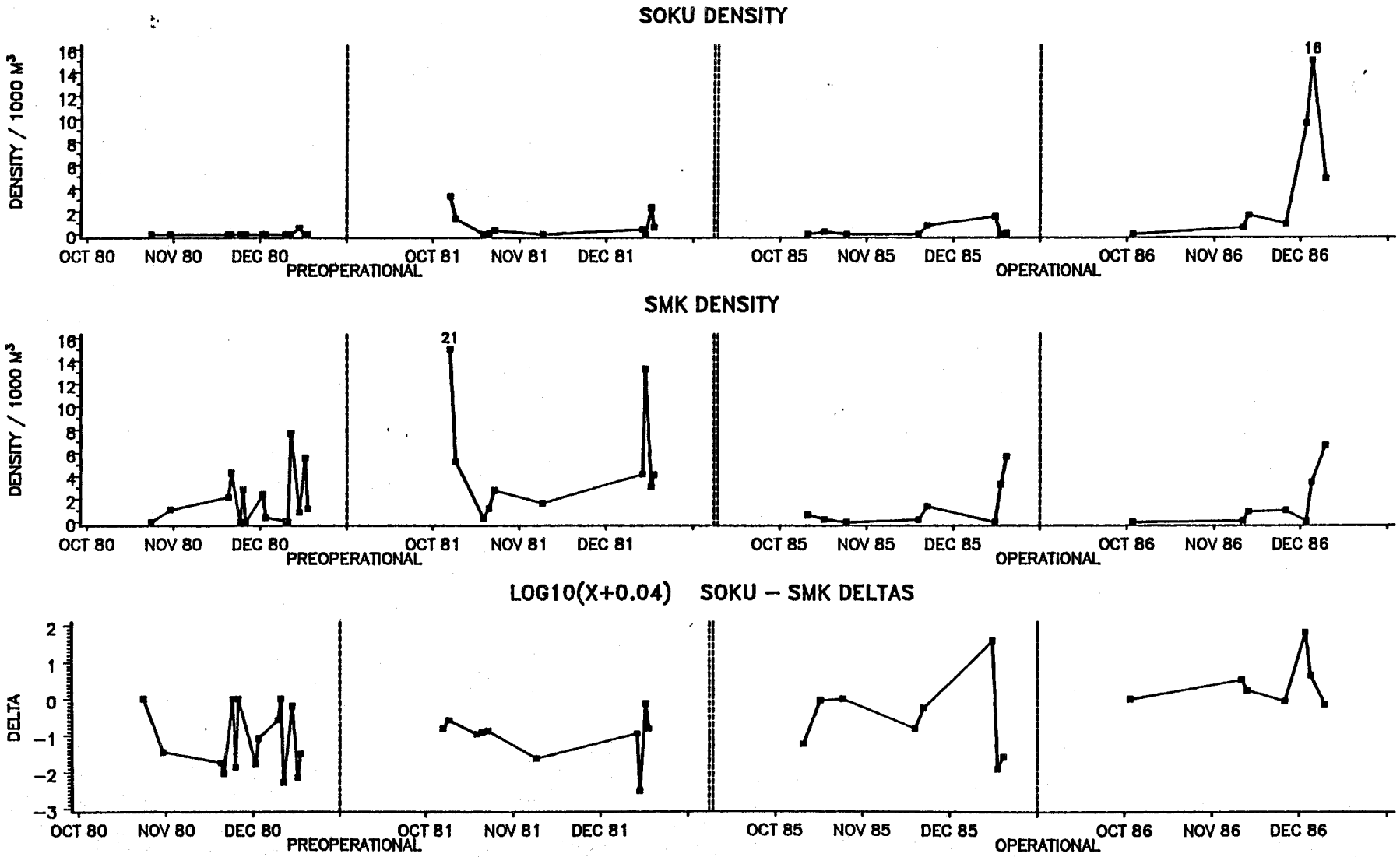
OXYJULIS CALIFORNICA



APPENDIX N FIGURE 64

YOY & OLDER JUVENILE SENORITA

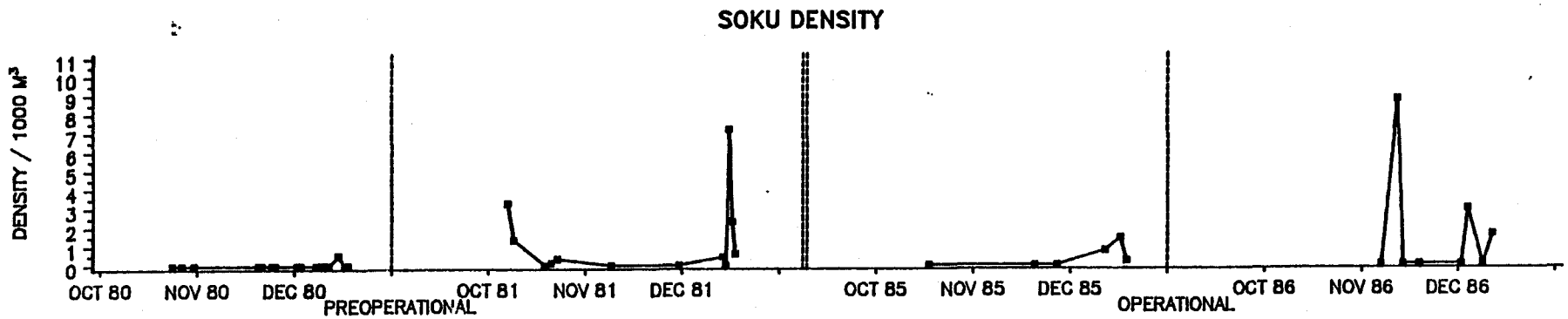
OXYJULIS CALIFORNICA

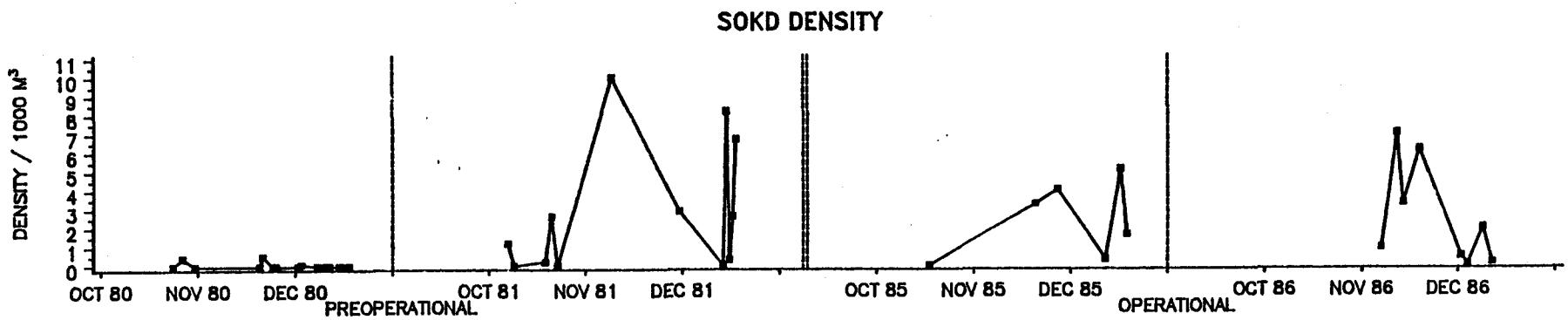


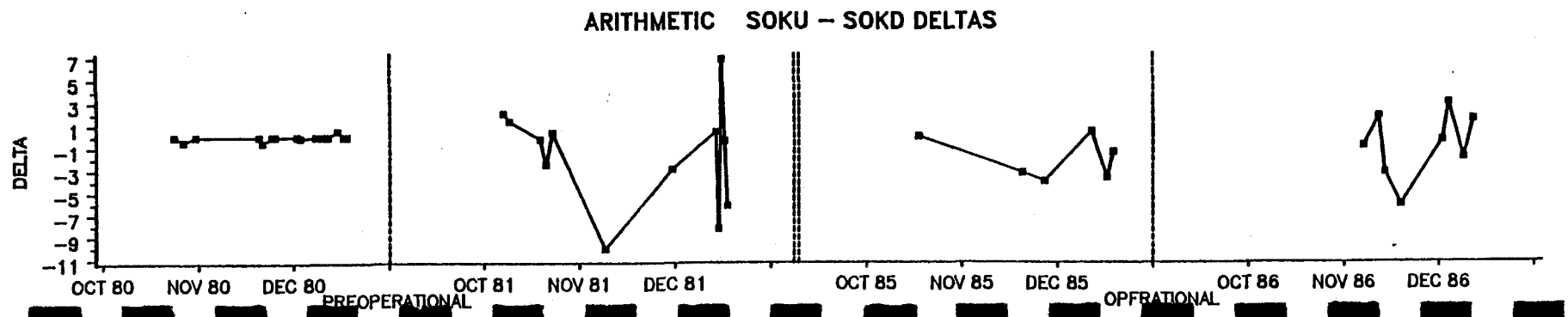
APPENDIX N FIGURE 65

YOY & OLDER JUVENILE SENORITA

OXYJULIS CALIFORNICA



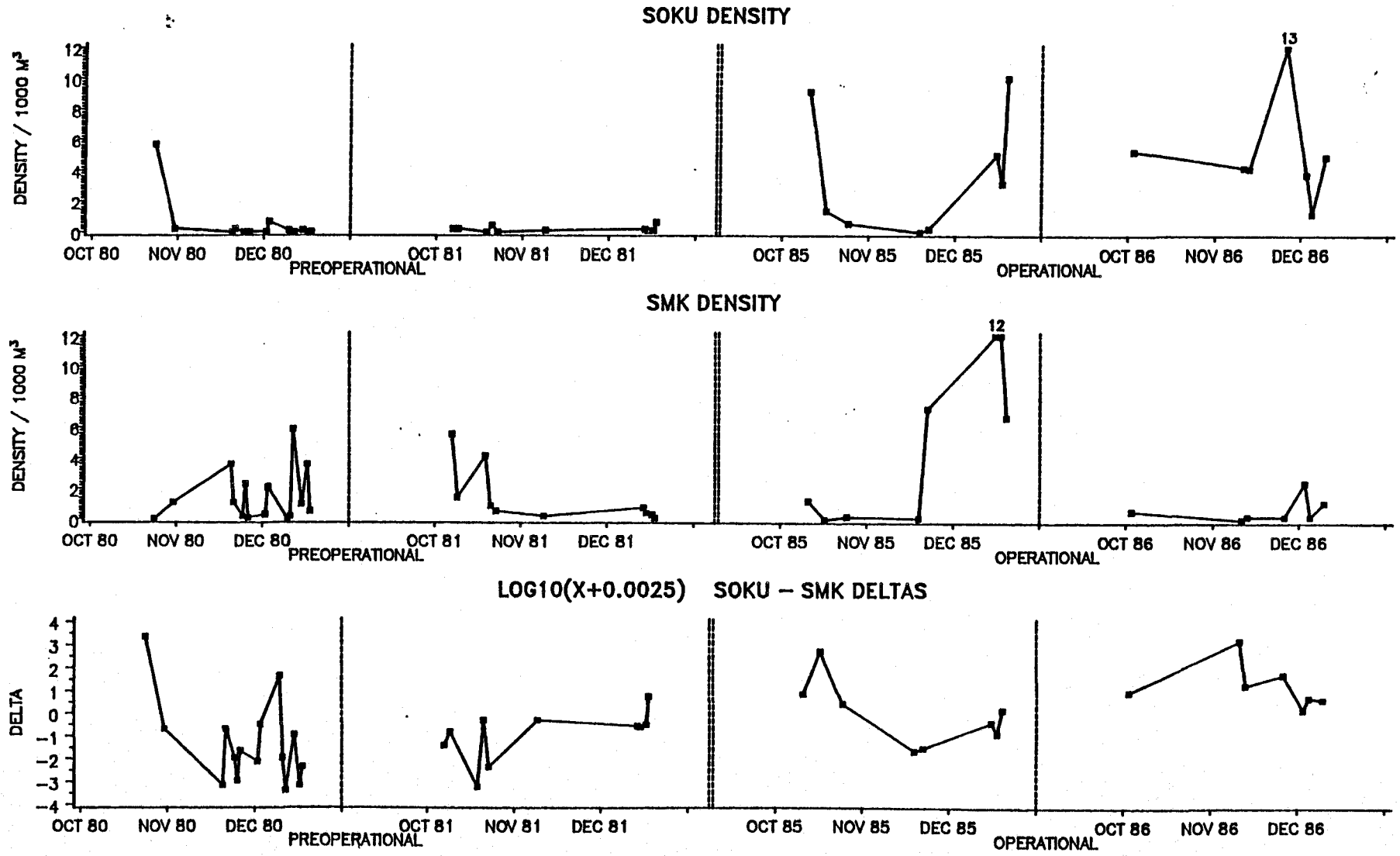




APPENDIX N FIGURE 66

SUB–ADULT SENORITA

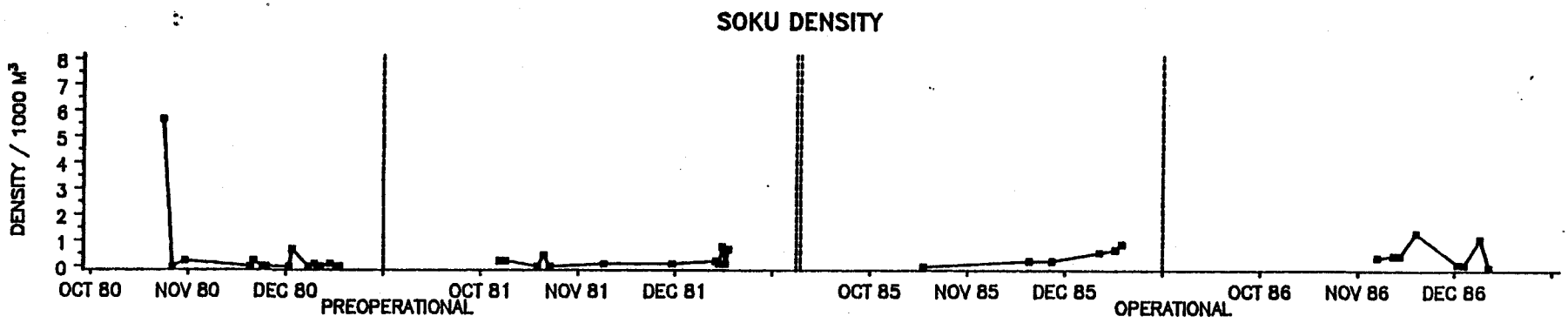
OXYJULIS CALIFORNICA

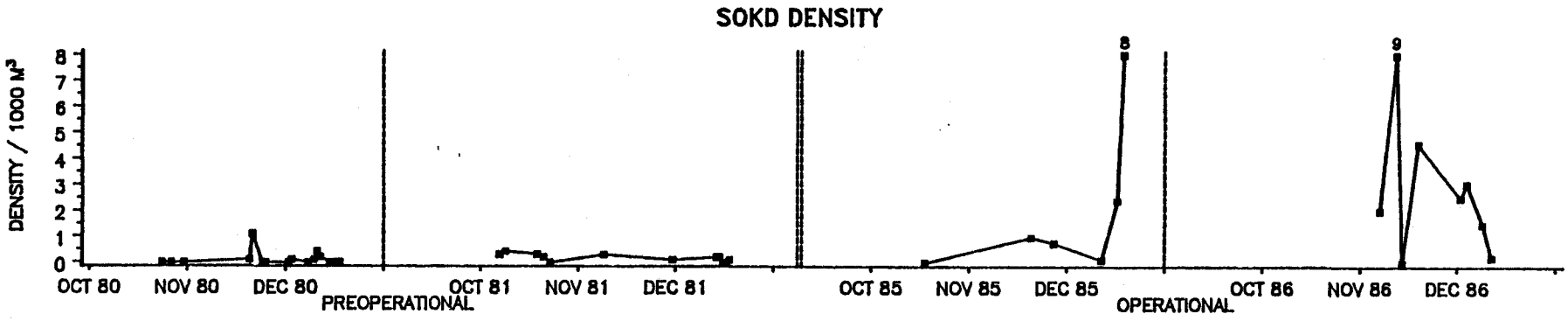


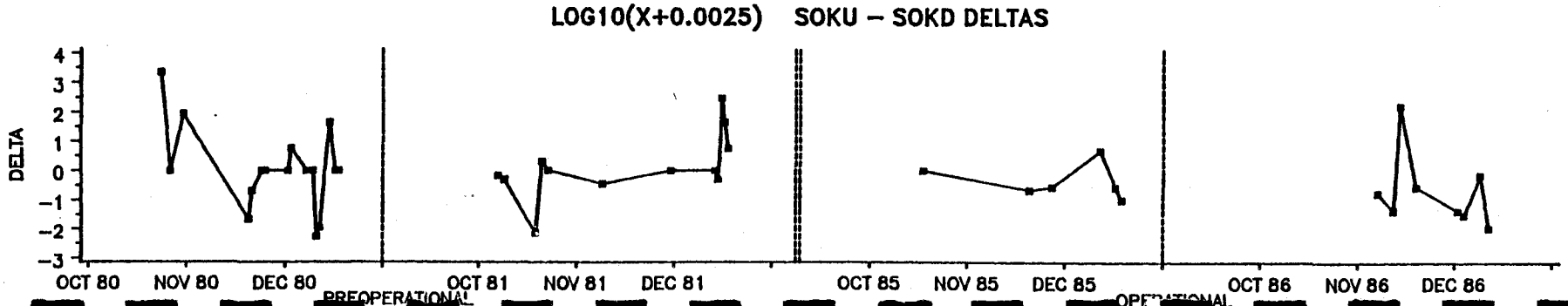
APPENDIX N FIGURE 67

SUB–ADULT SENORITA

OXYJULIS CALIFORNICA



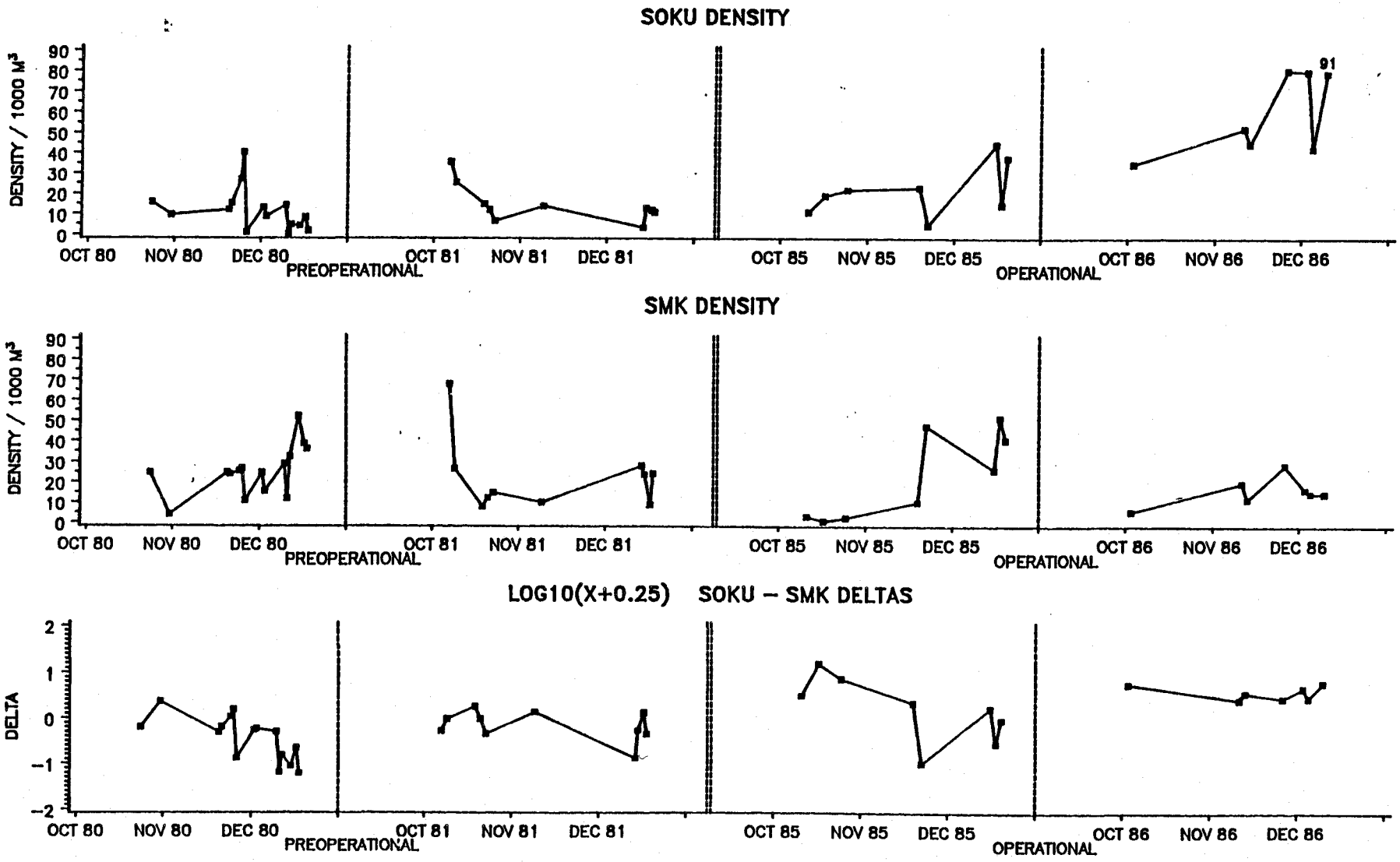




APPENDIX N FIGURE 68

TOTAL SENORITA

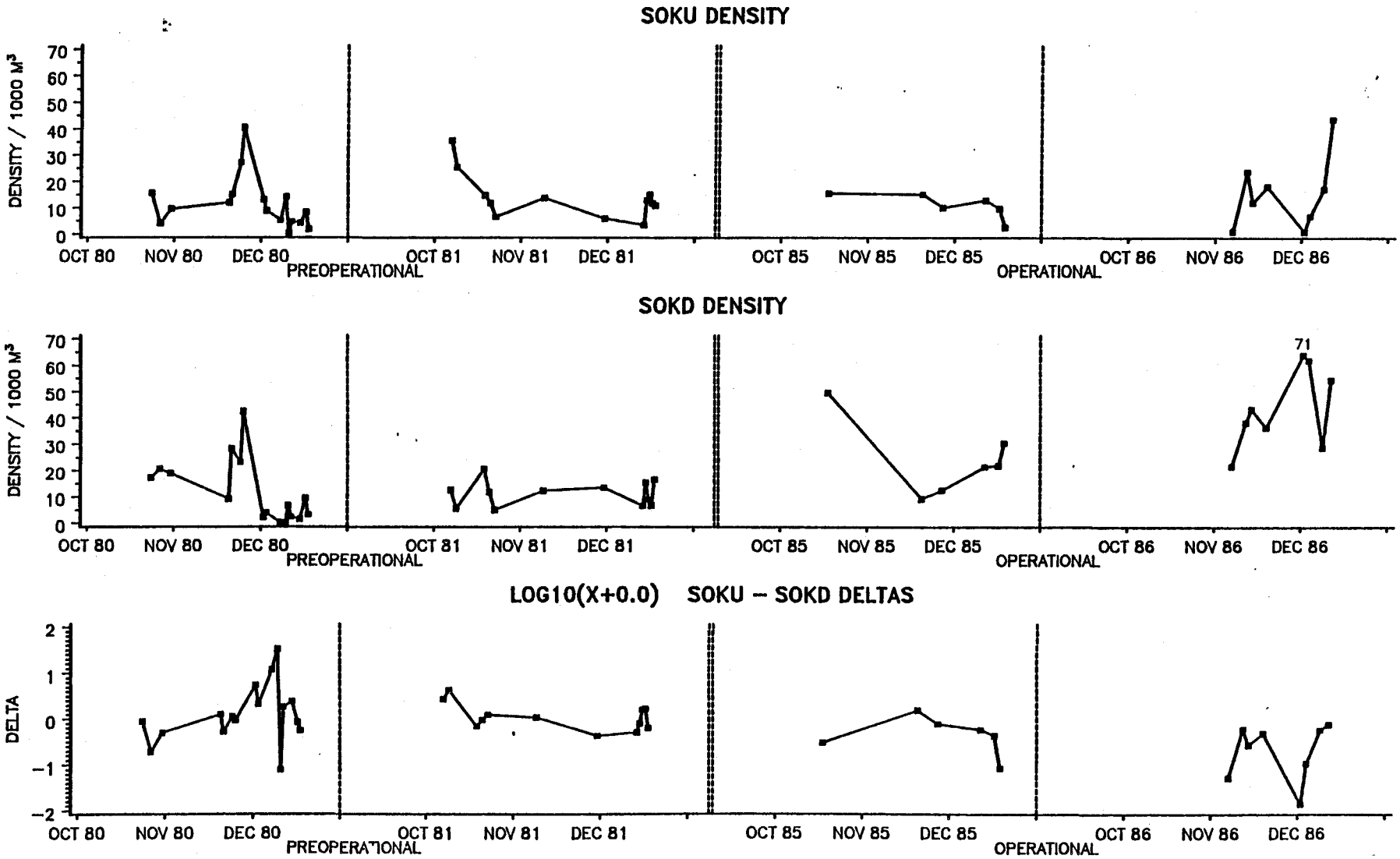
OXYJULIS CALIFORNICA



APPENDIX N FIGURE 69

TOTAL SENORITA

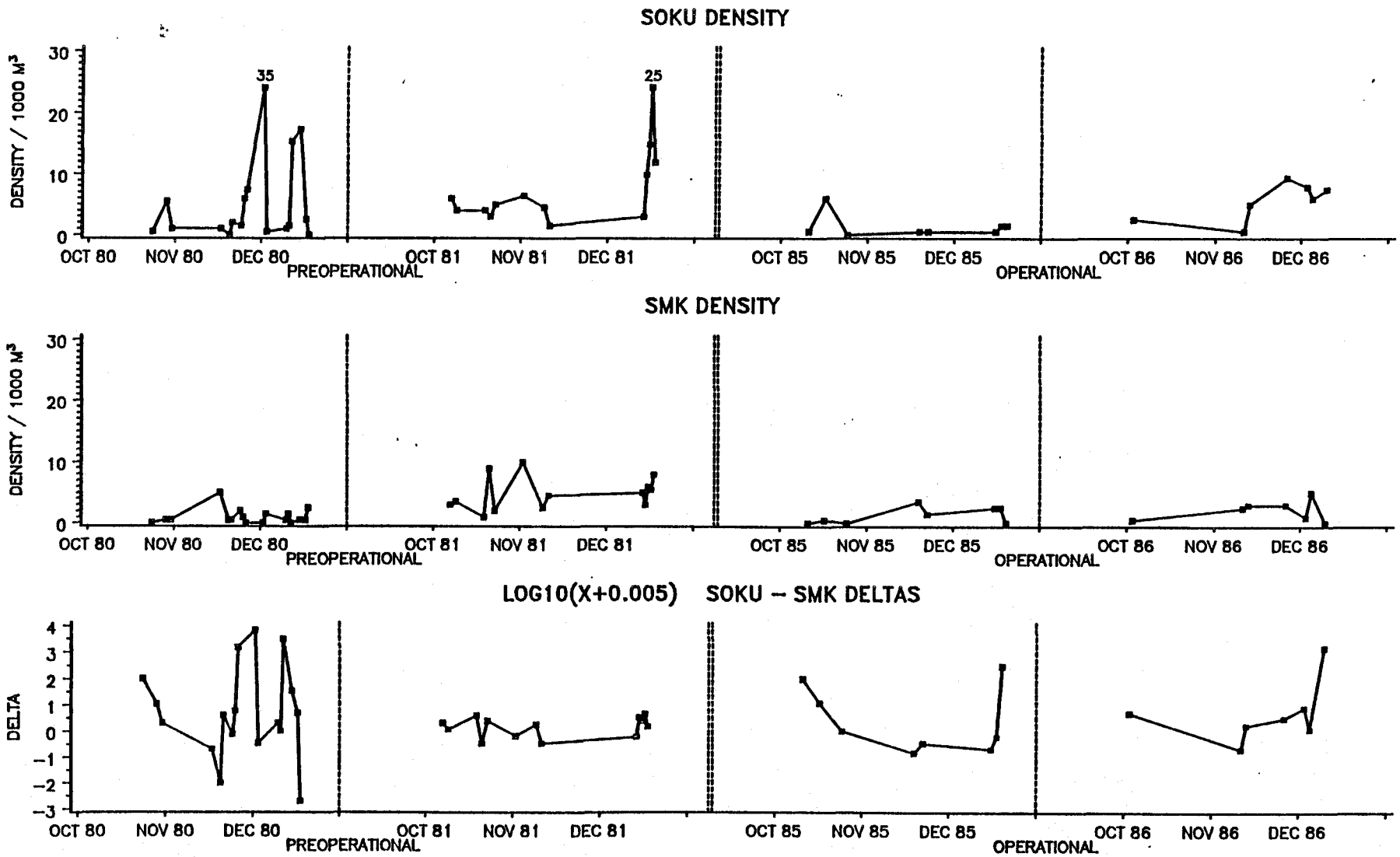
OXYJULIS CALIFORNICA



APPENDIX N FIGURE 70

YOY & OLDER JUVENILE CA SHEEPHEAD

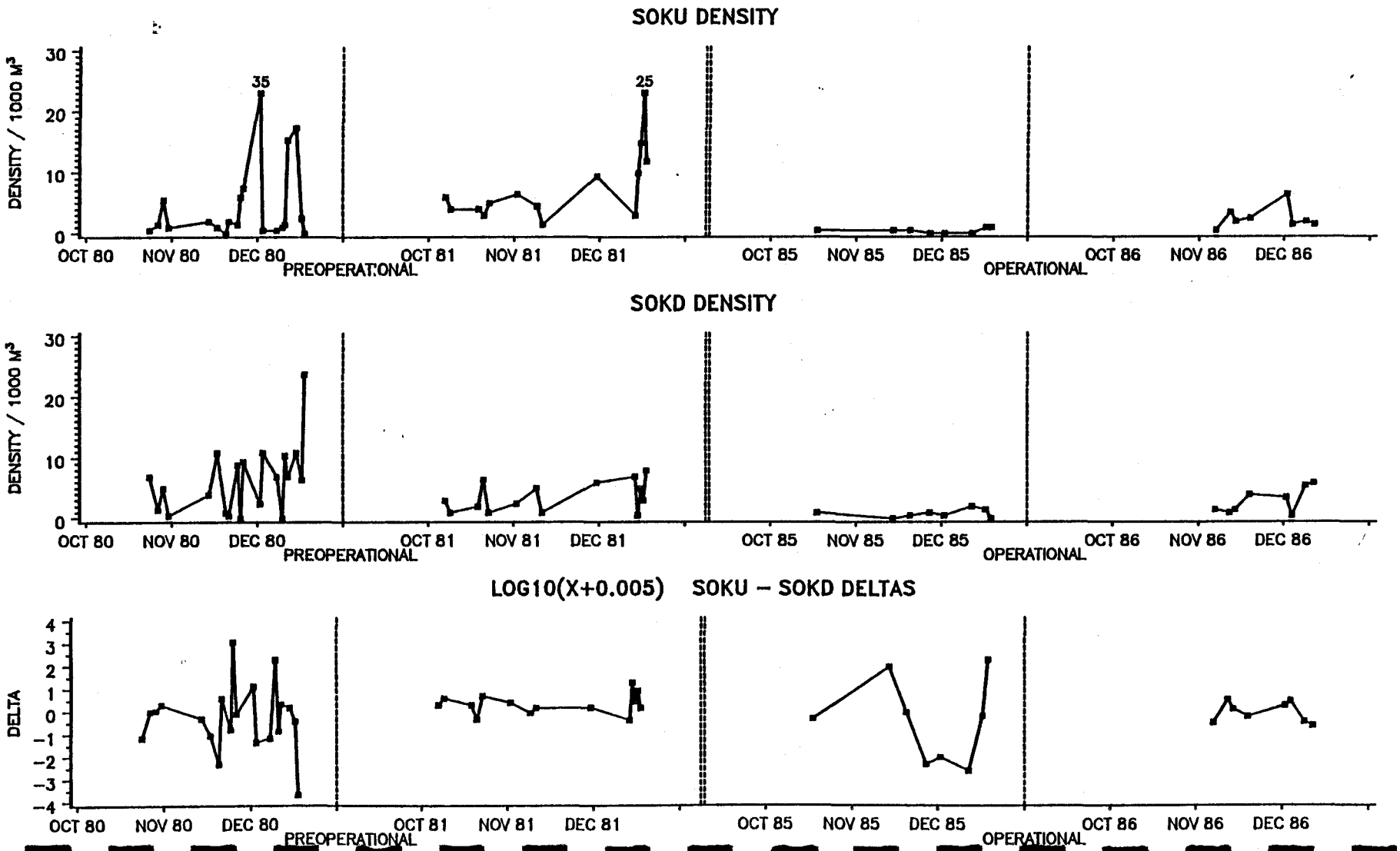
SEMICOSSYPHUS PULCHER



APPENDIX N FIGURE 71

YOY & OLDER JUVENILE CA SHEEPHEAD

SEMICOSSYPHUS PULCHER

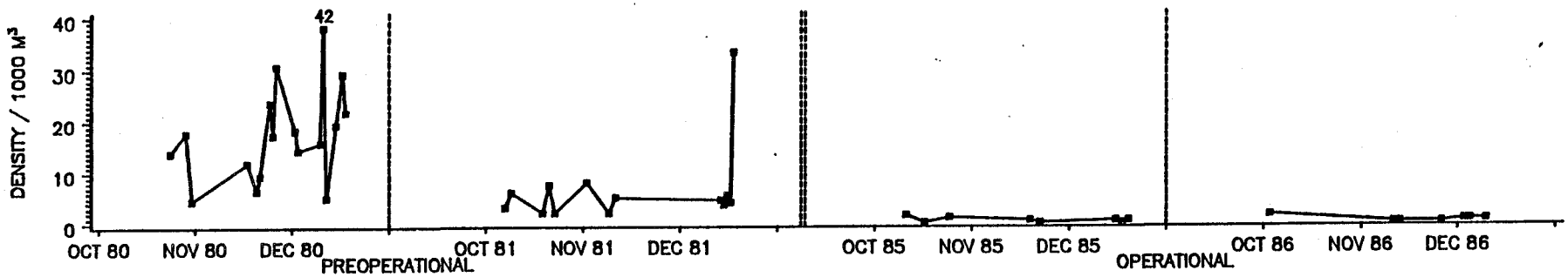


APPENDIX N FIGURE 72

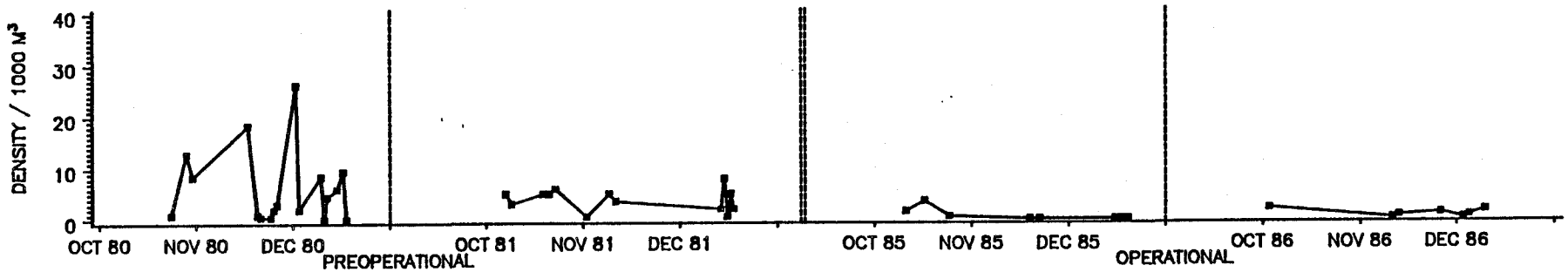
SUB–ADULT CA SHEEPHEAD

SEMICOSSYPHUS PULCHER

SOKU DENSITY



SMK DENSITY



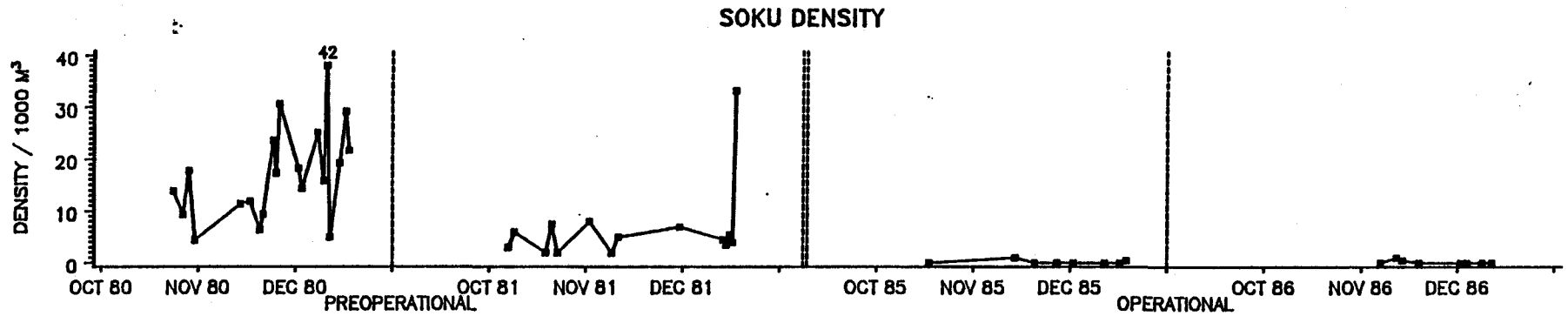
LOG10 SOKU – SMK DELTAS

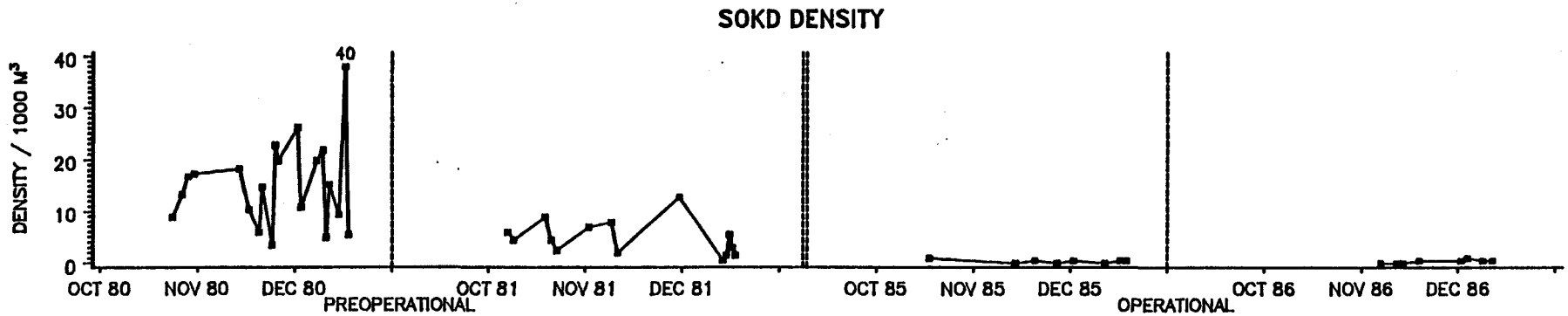
--- STATISTICALLY INTRACTABLE ---

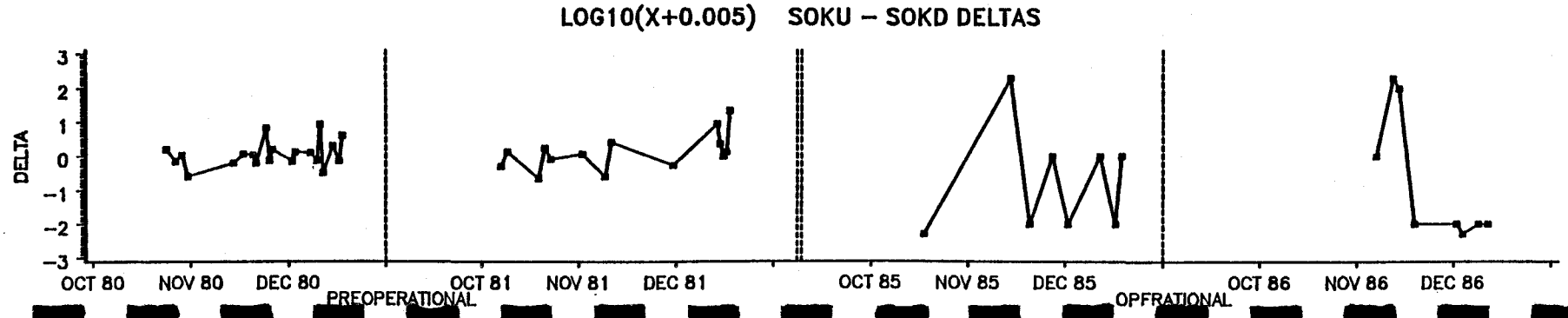
APPENDIX N FIGURE 73

SUB–ADULT CA SHEEPHEAD

SEMICOSSYPHUS PULCHER



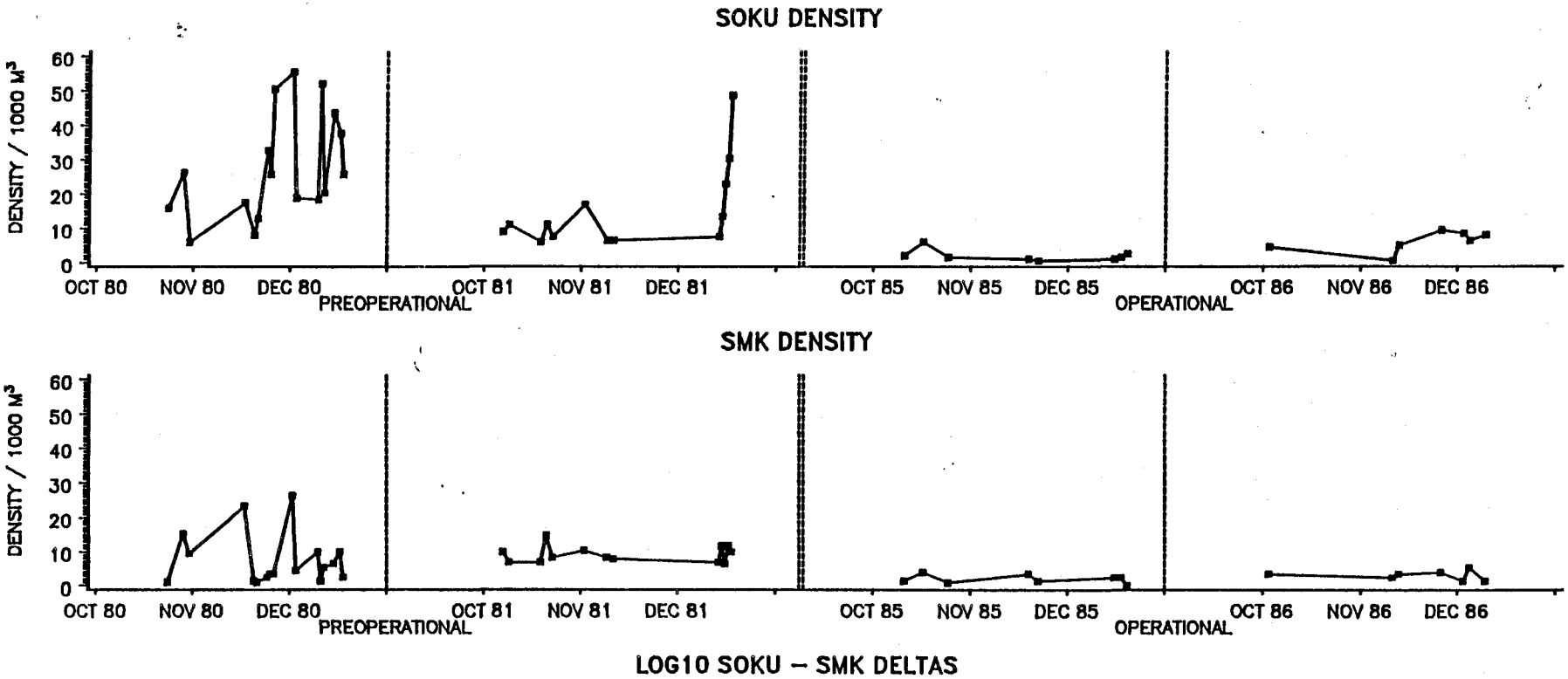




APPENDIX N FIGURE 74

TOTAL CA SHEEPHEAD

SEMICOSSYPHUS PULCHER



LOG10 SOKU – SMK DELTAS

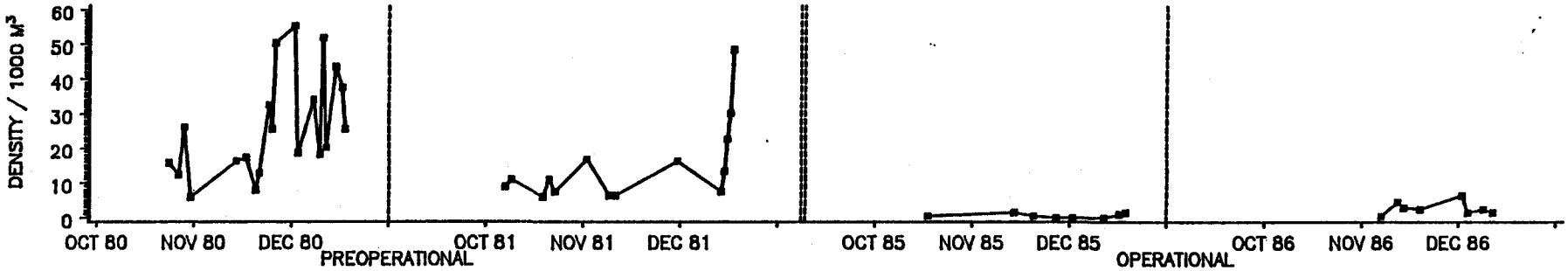
---- HETEROGENEOUS TAXON ----

APPENDIX N FIGURE 75

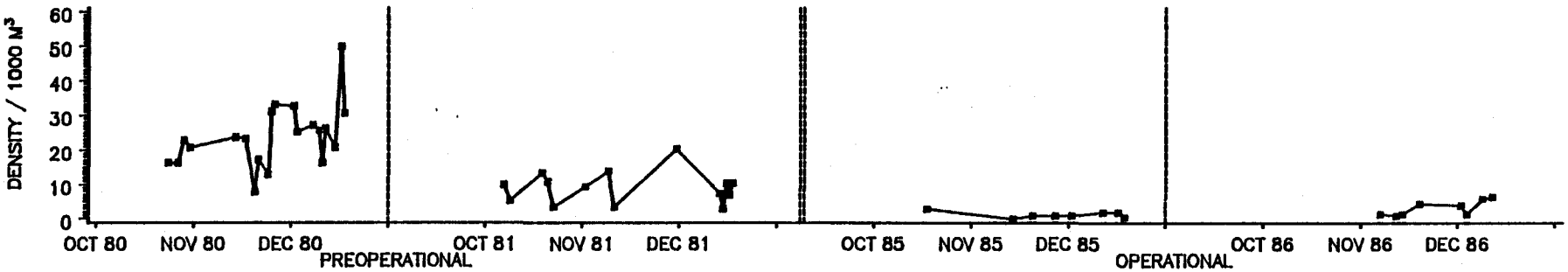
TOTAL CA SHEEPHEAD

SEMICOSSYPHUS PULCHER

SOKU DENSITY



SOKD DENSITY



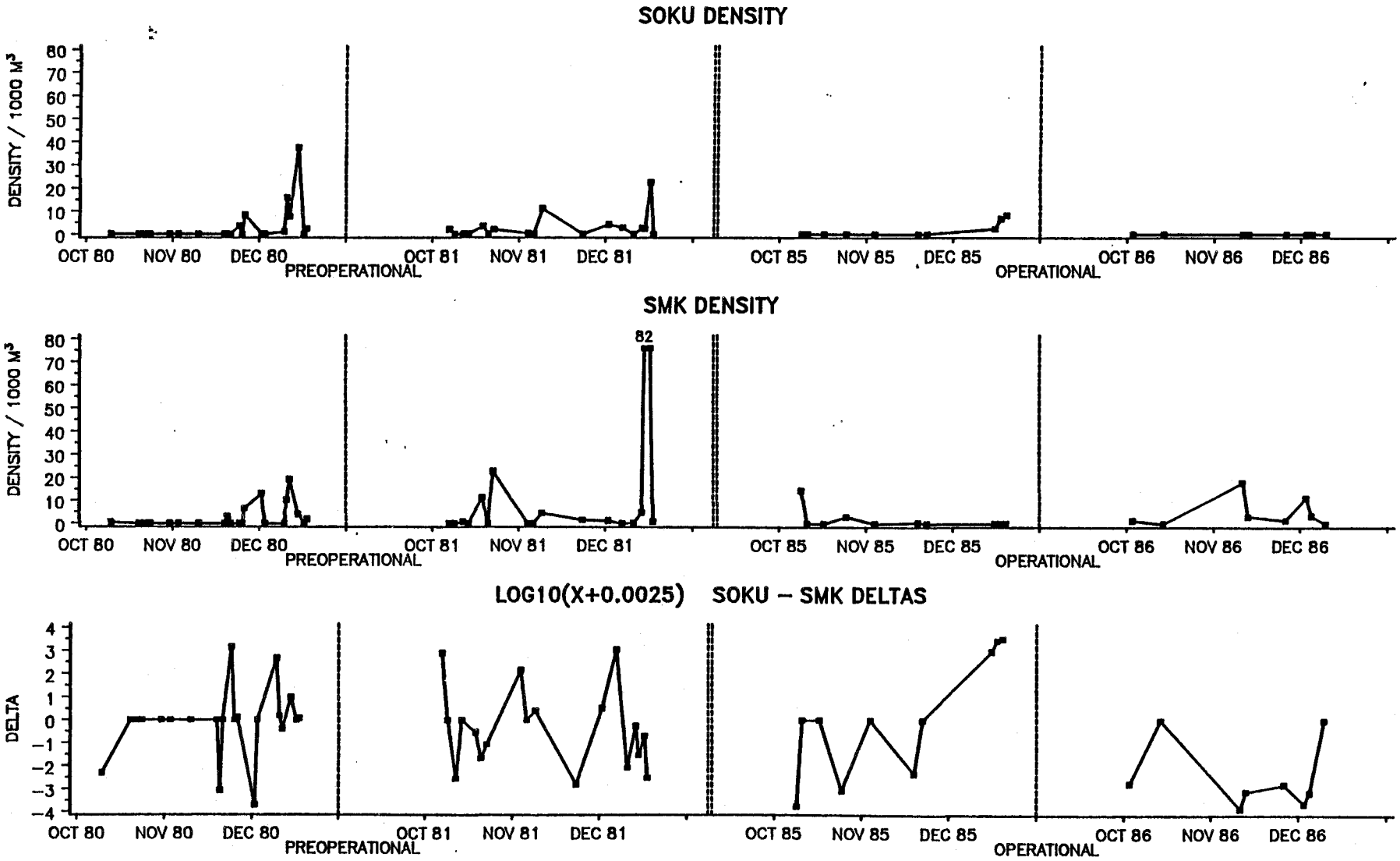
LOG10 SOKU – SOKD DELTAS

--- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 76

TOTAL SILVERSIDES SPP.

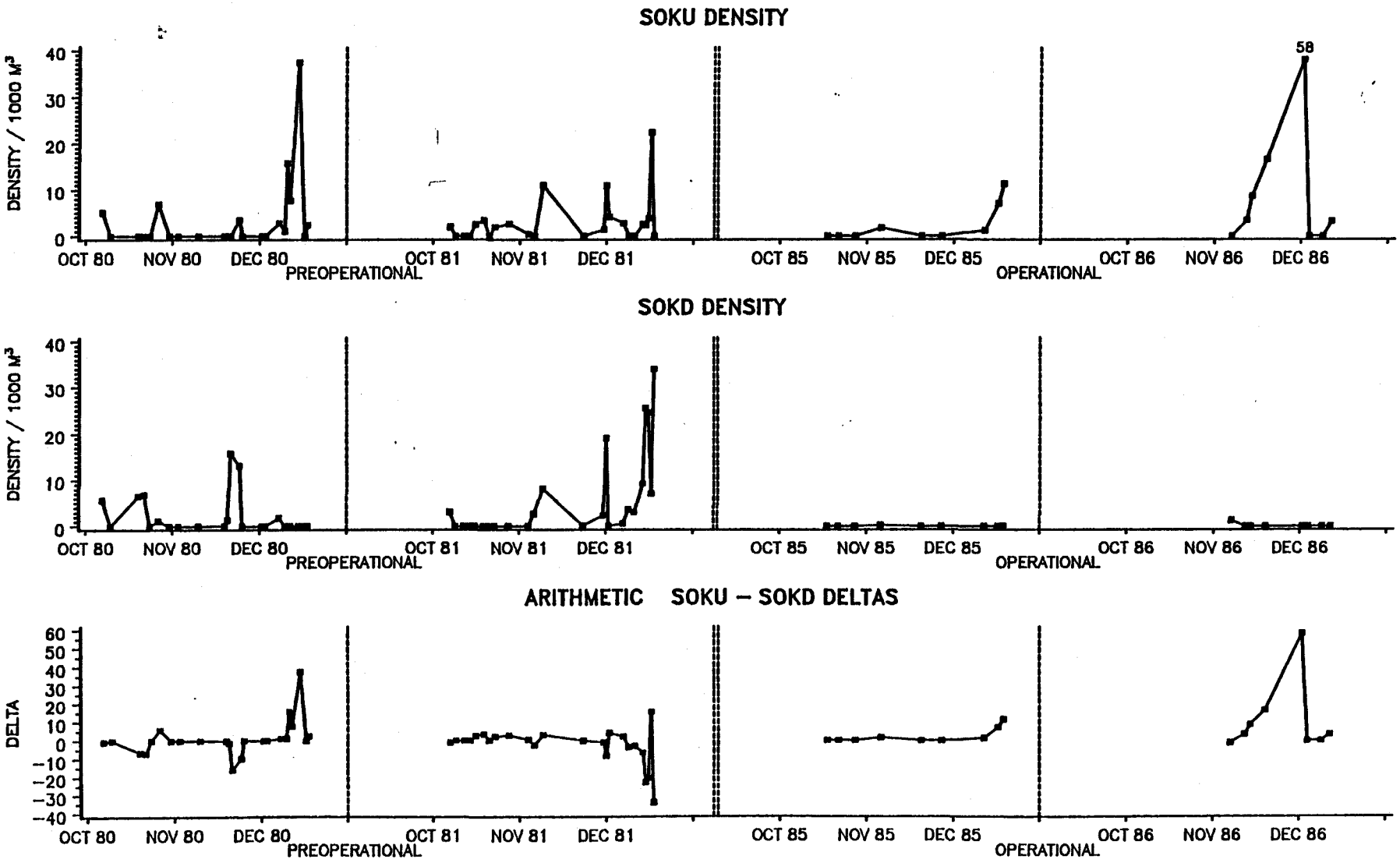
ATHERINID SPP.



APPENDIX N FIGURE 77

TOTAL SILVERSIDES SPP.

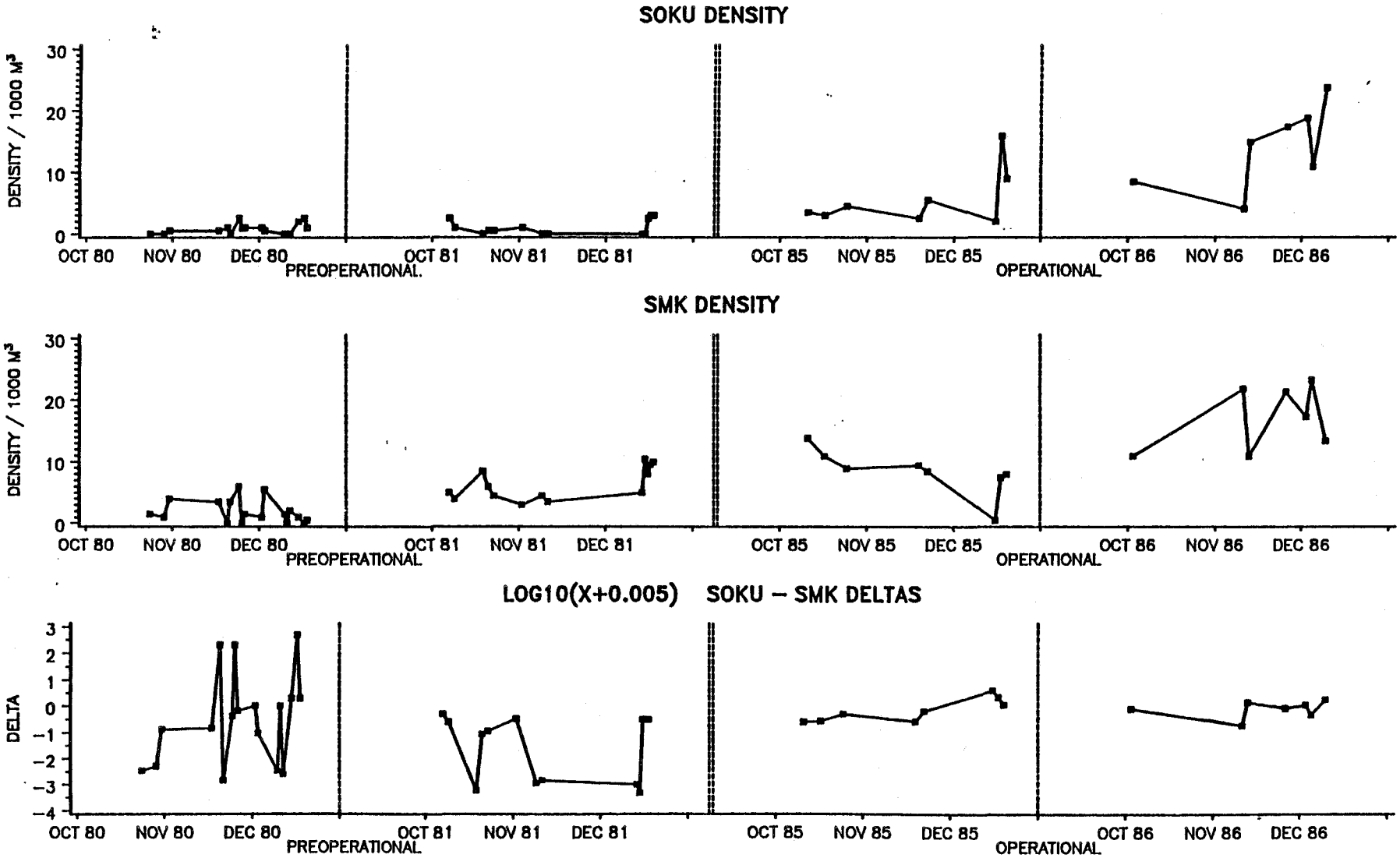
ATHERINID SPP.



APPENDIX N FIGURE 78

ADULT ROCK WRASSE

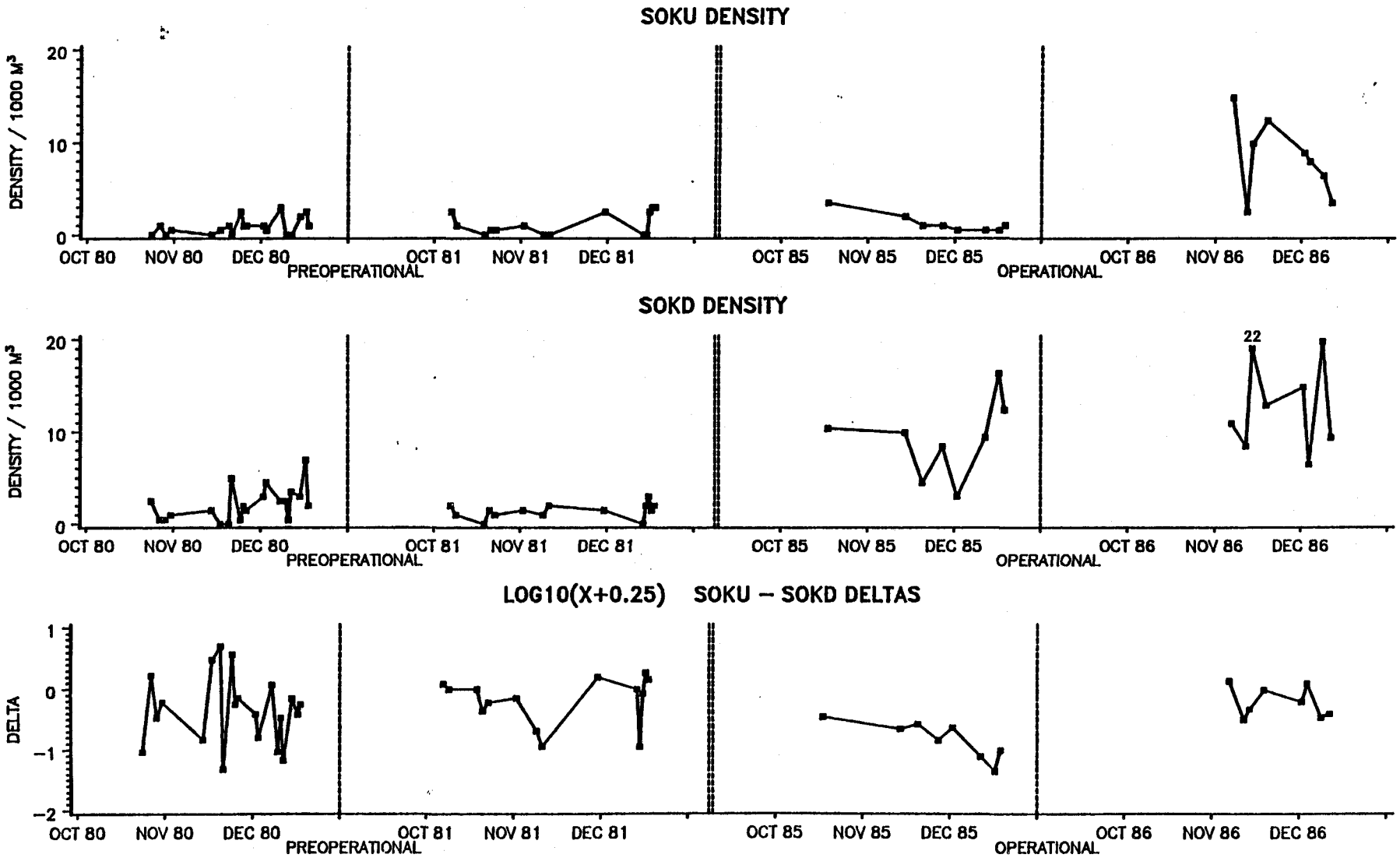
HALICHOERES SEMICINCTUS



APPENDIX N FIGURE 79

ADULT ROCK WRASSE

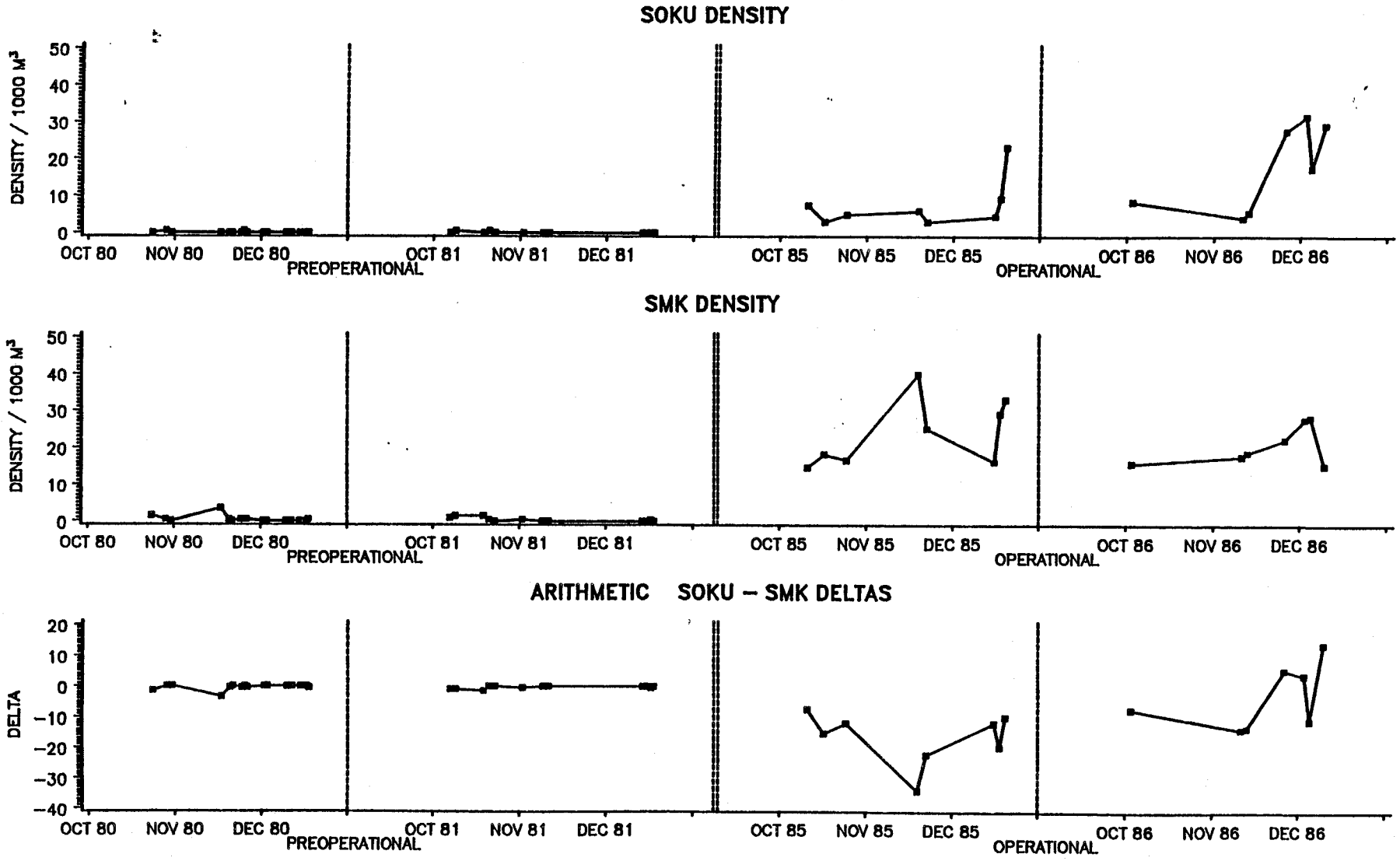
HALICHOERES SEMICINCTUS



APPENDIX N FIGURE 80

SUB–ADULT ROCK WRASSE

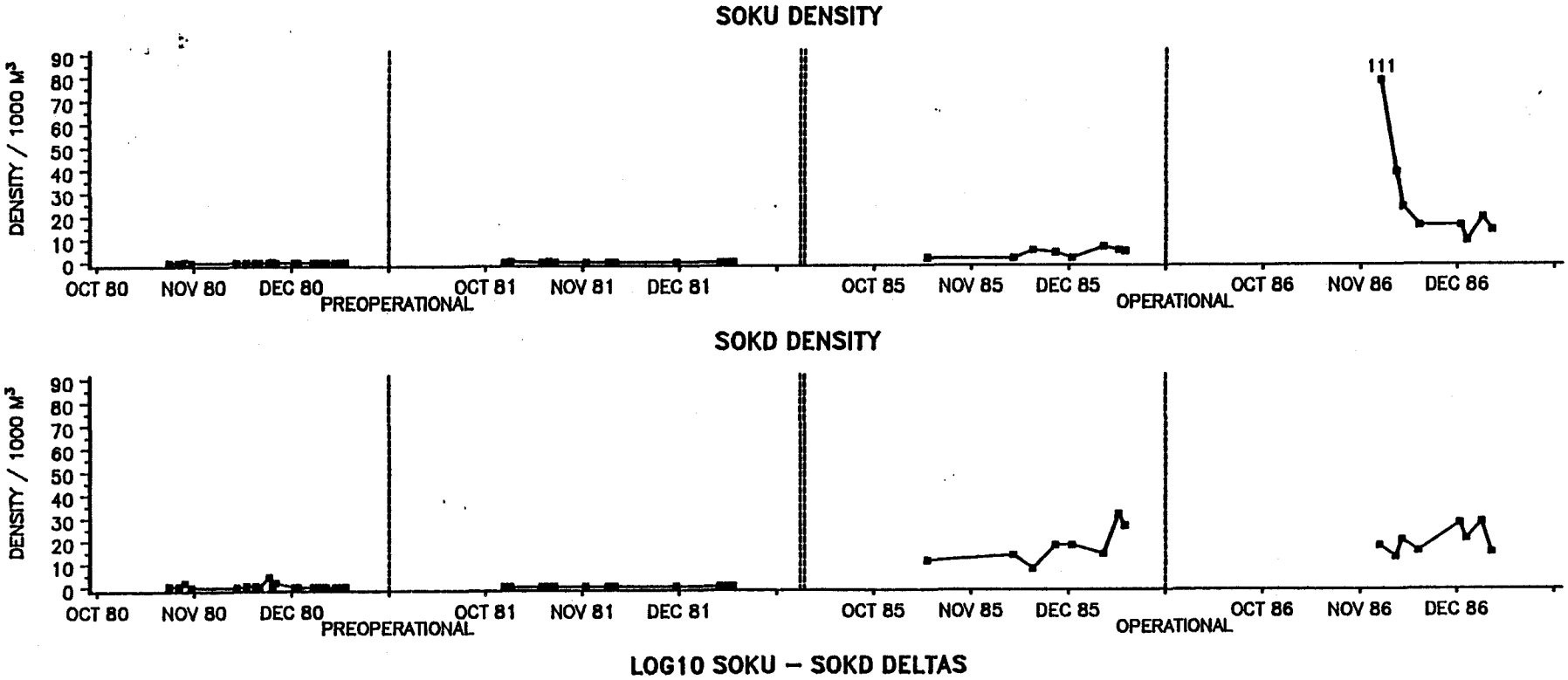
HALICHOERES SEMICINCTUS



APPENDIX N FIGURE 81

SUB–ADULT ROCK WRASSE

HALICHOERES SEMICINCTUS



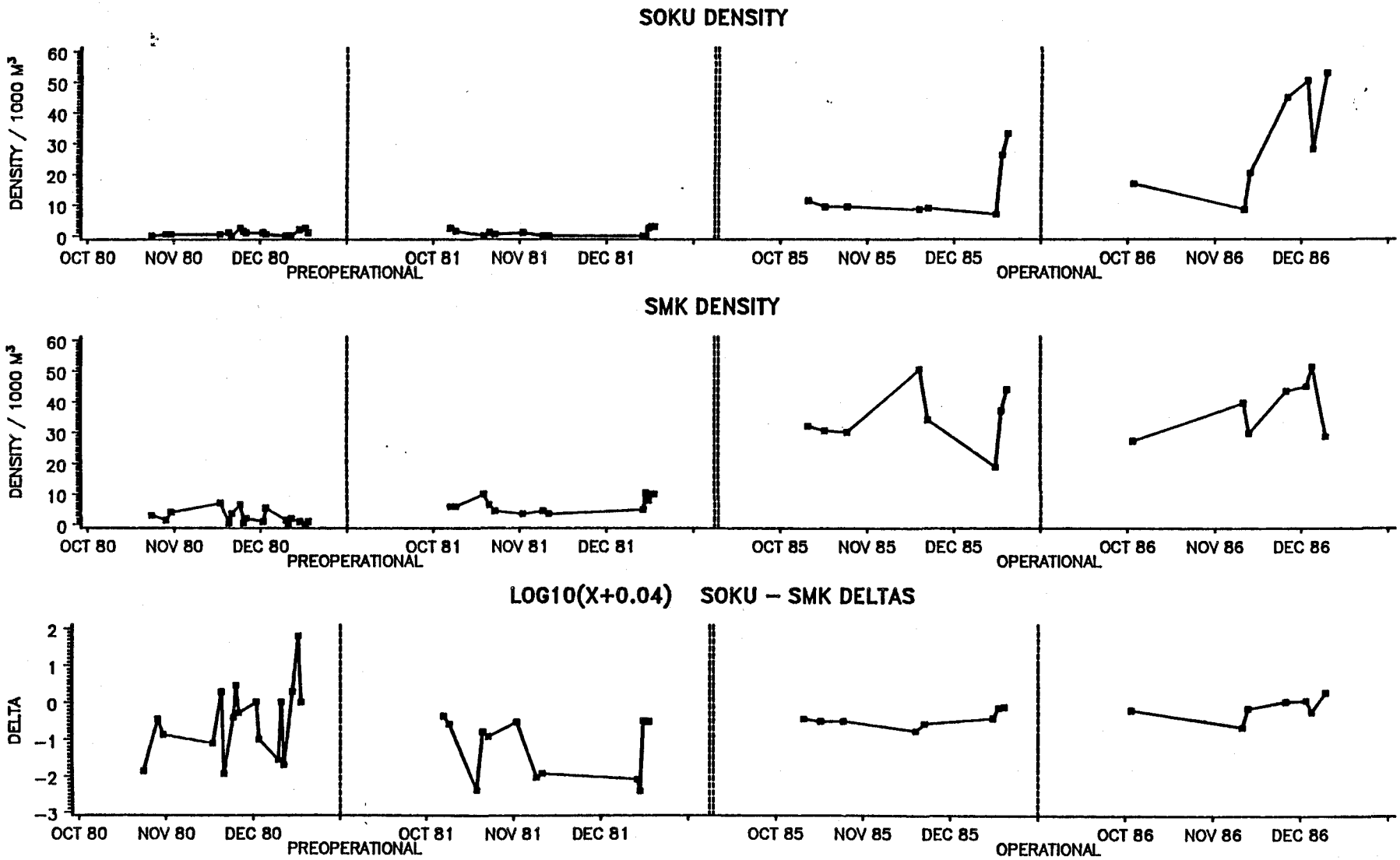
LOG10 SOKU – SOKD DELTAS

---- STATISTICALLY INTRACTABLE ---

APPENDIX N FIGURE 82

TOTAL ROCK WRASSE

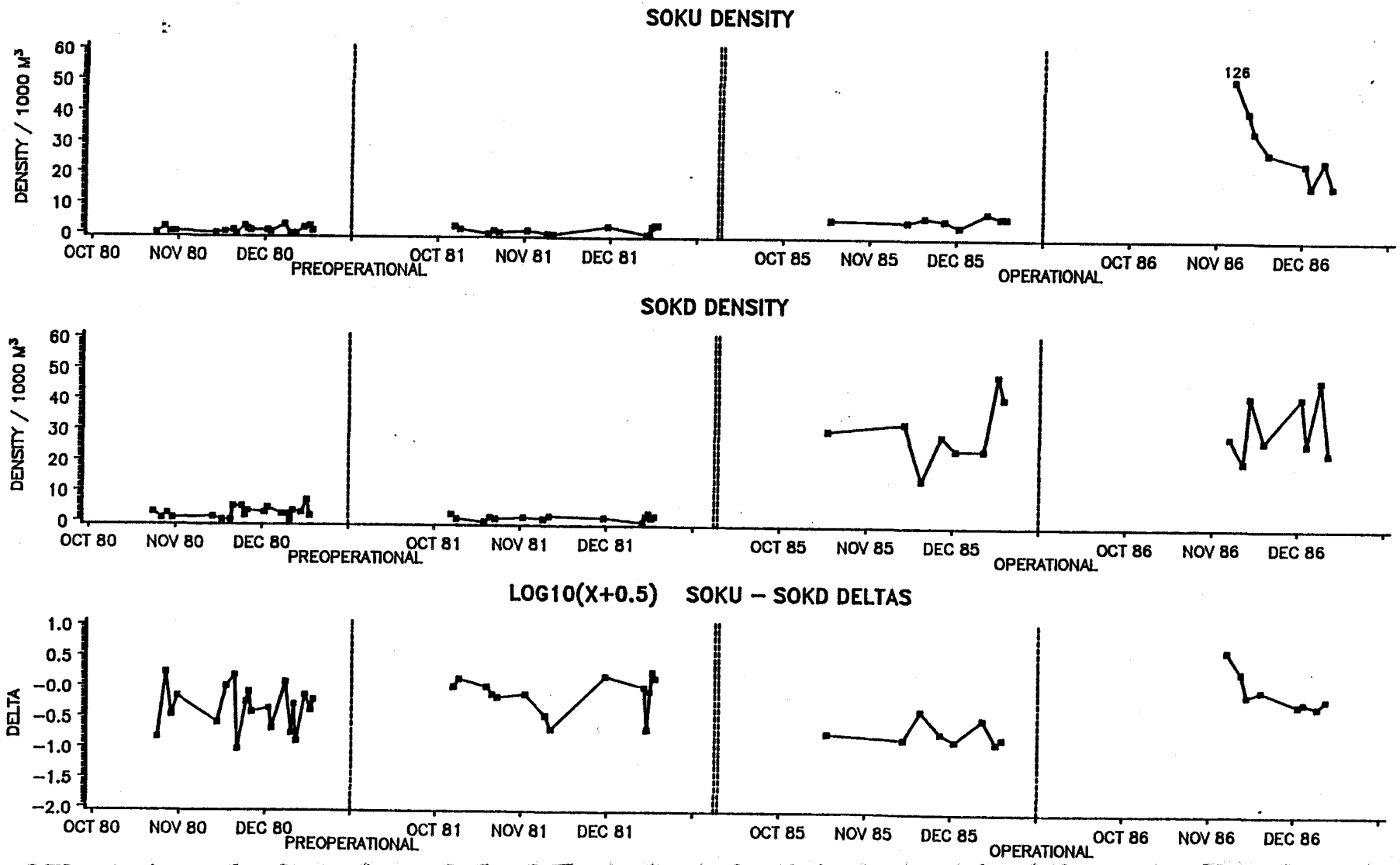
HALICHOERES SEMICINCTUS



APPENDIX N FIGURE 83

TOTAL ROCK WRASSE

HALICHOERES SEMICINCTUS



APPENDIX O -- Detailed Analyses of Fish--Kelp Relations

CURVE FITTING FOR FISH - KELP RELATIONS

Prior to performing regression and ANCOVA analyses for our evaluation of the interrelationships of fish density, kelp density, indices of abundance for benthic habitat formers and bottom type, we explored the nature (shape) of the functional relation between fish and kelp. Fits to log fish data were generated for two nonlinear, biologically intuitive, models and one linear model:

$$\text{log fish density} = A + B * \{(1 + \text{kelp density})^{**} (-P)\}. \qquad (1)$$

$$\text{log fish density} = A + B * \text{EXP}\{(-P) * \text{kelp density}\}. \qquad (2)$$

$$\text{log fish density} = A + B * \text{kelp density}. \qquad (3)$$

The nonlinear models (1) and (2) were evaluated using nonlinear regression (SAS PROC NLIN: SAS, Inc. 1985). Linear regression was used for model (3). Model (3) fits a straight line between log fish density and kelp density where the sign of B (+ or -) indicates if the relationship is positive (increasing fish with increasing kelp) or negative (decreasing fish with increasing kelp); A estimates log fish abundance when no kelp is present. Models (1) and (2) fit S-shaped curves with a threshold in fish density for zero or low kelp density and another threshold in fish density for very high kelp density. The parameters A and B characterize these thresholds whereas P fits the steepness of the S-curve. For negative values of B, the curve begins at A + B and rises to A (remember B is negative) in an S-shape (i.e., a positive relation between fish and kelp density). For positive values of B, the curve begins at A + B and falls to A in an "inverse" S-shape (a negative relation). All 3 models were applied to the data of each major species and component life-stage of fish encountered at SOK in 1985-86. Exponent values for models (1) and (2) were derived independently and evaluated separately for each species and life-stage. The most appropriate model (i.e., inverse, exponential, or raw) was chosen on the basis of the best fit (highest R^2) among the various regression

relationships. Both positive and negative relations between fish and kelp densities were considered for each species and life stage of fish.

APPENDIX O -- TABLE 1

KELP BED FISHES: DIVER ESTIMATES OF DENSITIES OF GIANT KELP PLANTS PRESENT ON BOTTOM TRANSECTS AT SAN MATEO KELP BED (SMK) AND AT SAN ONOFRE KELP BED (SOK) DURING EACH OF 4 FALL PERIODS (1980, 1981, 1985, AND 1986. Densities are the number of "juvenile-or-older" plants (i.e., 1 m or taller: Dean 1980) present on random belt-transects of 225 m^2, standardized to number per 100 m^2. N signifies number of transects.

KELP PLANT DENSITY PER 100 M^2

	Fall 1980			Fall 1981			Fall 1985			Fall 1986		
Location	Mean	Std	N	Mean	Std	N	Mean	Std	N	Mean	Std	N
SMK	18.4	6.52	101	68.2	37.40	78	33.1	7.25	48	58.1	36.3	42
SOKUout	13.5	5.18	102	12.2	4.95	78	21.4	6.83	48	10.5	3.6	42
SOKUin	N/A			N/A			8.5	4.42	48	2.5	2.4	48
SOKDout	N/A			N/A			22.0	6.98	48	10.4	3.9	48
SOKDin	11.5	4.96	102	41.7	25.0	78	10.5	3.70	48	4.0	2.3	36
SOKinbetween	N/A			N/A			--no data--			13.5	5.8	18
Cobbleup	N/A			N/A			0.5	0.71	48	0.0	0.0	24
Cobbledn	N/A			N/A			--no data--			0.4	1.2	24

APPENDIX O -- TABLE 2

KELP BED FISHES: LOCATION MEANS AND RESULTS OF A POSTERIORI CONTRASTS AMONG LOCATIONS FOR EACH OF FIVE SEABED-ASSOCIATED BIOLOGICAL VARIABLES SAMPLED AT SIX STATIONS IN SAN MATEO KELP BED (SMK) AND AT SAN ONOFRE KELP BED (SOK) DURING **FALL 1985**. All values are subjective indices (range: 1 - 4; where 1 = nil to sparse, 2 = sparse to moderate, 3 = moderate to dense, 4 = dense to very dense) of % cover (algal taxa) other relative abundance (*Lytechinus* urchins), or % sand versus % cobble for bottom type (range: 1 - 4; where 1 = mostly sand, 2 = sand with some cobble, 3 = cobble with some sand, and 4 = mostly cobble with larger rocks. All location effects are significant (at $P \leq 0.0001$; 1-way ANOVA) for each of the five factors. Locations that are underlined are indistinguishable by a posteriori contrast.

Variable	Location Contrast Among Means					
Acrosorium	3.41	3.06	2.88	2.47	1.74	1.03
	SOKDin	CobbleU	SOKUin	SOKDout	SOKUout	SMK
Pterygophora	1.85	1.46	1.42	1.35	1.33	1.12
	SOKUin	SOKDin	SOKDout	CobbleU	SOKUout	SMK
Cystoseira	2.98	2.09	2.02	1.37	1.20	1.10
	SOKDout	CobbleU	SOKUin	SOKDin	SMK	SOKUout
Lytechinus	2.35	2.27	1.77	1.76	1.51	1.17
	SOKUin	CobbleU	SOKDin	SOKDout	SOKUout	SMK
Bottom type	3.81 >	2.60 >	2.33 =	2.31 =	2.10 >	1.85
	SMK	SOKUout	SOKDout	SOKUin	CobbleU	SOKDin

APPENDIX O -- TABLE 3

KELP BED FISHES: LOCATION MEANS AND RESULTS OF A POSTERIORI CONTRASTS AMONG LOCATIONS FOR EACH OF FIVE SEABED-ASSOCIATED BIOLOGICAL VARIABLES SAMPLED AT SIX STATIONS IN SAN MATEO KELP BED (SMK) AND AT SAN ONOFRE KELP BED (SOK) DURING **FALL 1986**. All values are subjective indices (range: 1 - 4; where 1 = nil to sparse, 2 = sparse to moderate, 3 = moderate to dense, 4 = dense to very dense) of % cover (algal taxa) other relative abundance (*Lytechinus* urchins), or % sand versus % cobble for bottom type (range: 1 - 4; where 1 = mostly sand, 2 = sand with some cobble, 3 = cobble with some sand, and 4 = mostly cobble with larger rocks. All locations effects are significant (at $P \leq 0.0001$; 1-way ANOVA) for each of the five factors. Locations that are underlined are indistinguishable by *a posteriori* contrast.

Variable	Location Contrast Among Means
Acrosorium	1.71 > 1.25 = 1.08 = 1.05 = 1.04 ≥ 1.02
	SMK > SOKDin = SOKDout = SOKUout = CobbleU ≥ SOKUin
Pterygophora	2.17 > 1.90 > 1.33 = 1.24 = 1.17 = 1.06
	SOKDin > SOKUin > CobbleU = SOKUout = SMK = SOKDout
Cystoseira	2.27 = 2.17 = 2.04 = 1.86 > 1.52 = 1.31
	SOKDout = SOKUin = CobbleU = SOKDin > SMK = SOKUout
Lytechinus	2.48 = 2.40 = 2.29 > 1.78 > 1.23 = 1.07
	SOKUout = SOKUin = CobbleU > SOKDin > SOKDout = SMK
Bottom type	3.64 > 2.76 = 2.50 ≥ 2.23 = 2.12 = 2.00
	SMK > SOKUout = SOKUin ≥ SOKDout = CobbleU = SOKDin

APPENDIX O -- TABLE 4

KELP BED FISHES: QUALITATIVE SUMMARY OF CORRELATION MATRIX FOR GIANT KELP DENSITY ("Macro" = Macrocystis) and indices of relative abundance for five other seabed-associated biological variables. The latter include three algal taxa (where "Acro" = Acrosorium, "Ptery" = Pterygophora, "Cysto" = Cystoseira), Lytechinus urchins ("Lyt"), and "Bottyp" = type of bottom substrate. Summary reflects predominant 1985-86 patterns of interrelations at stations (within SOK and at SMK) having greater-than-sparse Macrocystis densities.

Variable	Macro	Acro*	Ptery	Cysto	Lyt	Bottyp
Macrocystis	--	*	Neg	Neg	Neg	Pos
Acrosorium*		--	*	*	*	*
Pterygophora			--	Pos	Pos	Neg
Cystoseira				--	Pos	Neg
Lytechinus					--	Neg
Bottom type						--

*The interrelationships of Acrosorium, giant kelp, and bottom type differed during Fall 1985 and Fall 1986. In Fall 1985, Acrosorium was negatively related to giant kelp and bottom type, but positively related to the other two algae and urchins. In Fall 1986, Acrosorium was positively related to giant kelp and bottom type, but negatively related to the two algae and urchins. All other interrrelationships were consistent between the two time periods.

APPENDIX O -- TABLE 5

KELP BED FISHES: LOCATION MEANS OF DIVER SCORES OF SUBCANOPY (PTERYGOPHORA) ABUNDANCE DURING THE FALL PERIODS OF 1980, 1981, 1985, AND 1986. Values are subjective indices of percent cover (range: 1 - 4; where 1 = nil to sparse, 2 = sparse to moderate, 3 = moderate to dense, 4 = dense to very dense). Also noted are standard deviations of transect scores.

	Preoperational		Operational	
Location	Fall 1980	Fall 1981	Fall 1985	Fall 1986
SMK	1.01 ± .01	1.05 ± .22	1.12 ± .39	1.17 ± .44
SOKU(Preop.); SOKUout (Op.)	2.20 ± .72	1.64 ± .76	1.33 ± .56	1.24 ± .48
SOKD(Preop.); SOKDout (Op.)	2.10 ± .57	2.20 ± .86	1.42 ± .24	1.06 ± .24
N transects	102	78	48	42

APPENDIX O -- TABLE 6

KELP BED FISHES: SUMMARY OF SIGNIFICANT INTERRELATIONSHIPS OF FISH DENSITY, KELP DENSITY, AND YEAR FOR COMPONENT LIFE-STAGES OF 14 SELECT TAXA. Results are based on general linear model fits of log fish density ("logdens": #s/1000 m**3) and kelp density ("klp": #s/100 m**2) for the two Fall sampling periods ("yr": 1985, 1986). All evaluations are restricted to the five stations sampled within San Onofre Kelp bed (SOK) during each of the two years. The kelp-by year interaction term (klp*yr) is included in the model only if significant ($P < 0.05$). An "ns" signifies that a main effect is insignificant. All models include an intercept term. Sample sizes range from 57 (canopy and canopy-midwater taxa) to 69 (cosmopolites) to 73 (bottom taxa). (See Appendix M, Table 1 for classification of taxa). Also noted is the model R**2 and the probability that the observed R**2 value is equal to zero.

APPENDIX O -- TABLE 6

Taxon	Life Stage	Model	R^2	PROB
BASS, barred sand	AD	Logdens = klp(ns) yr	.184	.0008
	JUV	Logdens = klp(ns) yr(ns) klp*yr	.391	.0001
	SAD	Logdens = klp yr	.176	.0011
	TOTAL	Logdens = klp yr	.238	.0001
BASS, kelp	AD	Logdens = klp(ns) yr(ns) klp*yr	.329	.0001
	JUV	Logdens = klp yr klp*yr	.534	.0001
	OJ	Logdens = klp yr klp*yr	.486	.0001
	SAD	Logdens = klp yr klp*yr	.445	.0001
	TOTAL	Logdens = klp yr klp*yr	.512	.0001
	YOY	Logdens = klp yr(ns) klp*yr	.366	.0001
BLACKSMITH	JUV	Logdens = klp yr(ns)	.084	.055
	TOTAL	Logdens = klp yr(ns)	.185	.0012
HALFMOON	AD	Logdens = klp(ns) yr	.649	.0001
	SAD	Logdens = klp(ns) yr(ns)	.059	.194
	TOTAL	Logdens = klp(ns) yr	.582	.0001
KELPFISH, giant	JUV	Logdens = klp yr	.108	.023
	SAD	Logdens = klp(ns) yr(ns) klp*yr	.447	.0001
	TOTAL	Logdens = klp(ns) yr(ns) klp*yr	.399	.0001
PERCH, black	AD	Logdens = klp yr(ns) klp*yr	.436	.0001
	SAD	Logdens = klp yr(ns) klp*yr	.345	.0001
	TOTAL	Logdens = klp yr(ns) klp*yr	.205	.0012

APPENDIX O -- TABLE 6 (continued)

Taxon	Life Stage	Model	R^2	PROB
PERCH, kelp	TOTAL	Logdens = klp(ns) yr(ns) klp*yr	.735	.0001
PERCH, pile	AD	Logdens = klp(ns) yr(ns) klp*yr	.353	.0001
	SAD	Logdens = klp yr(ns)	.171	.0014
	TOTAL	Logdens = klp yr	.232	.0001
SEAPERCH, rainbow	AD	Logdens = klp(ns) yr(ns) klp*yr	.205	.0012
	SAD	Logdens = klp yr	.094	.032
	TOTAL	Logdens = klp(ns) yr(ns) klp*yr	.255	.0001
SEAPERCH, white	AD	Logdens = klp yr(ns)	.101	.030
	SAD	Logdens = klp yr(ns)	.119	.0152
	TOTAL	Logdens = klp yr(ns)	.209	.0003
SENORITA	AD	Logdens = klp yr	.439	.0001
	JUV	Logdens = klp yr	.122	.014
	SAD	Logdens = klp yr(ns) klp*yr	.280	.0001
	TOTAL	Logdens = klp yr	.428	.0001
SHEEPHEAD, California	JUV	Logdens = klp(ns) yr klp*yr	.383	.0001
	SAD	Logdens = klp(ns) yr(ns)	.004	.86
	TOTAL	Logdens = klp(ns) yr	.257	.0001

APPENDIX O -- TABLE 6 (continued)

Taxon	Life Stage	Model	R^2	PROB
SILVERSIDES	TOTAL	Logdens = klp(ns) yr klp*yr	.175	.016
WRASSE, rock	AD	Logdens = klp yr	.385	.0001
	JUV	Logdens = klp yr(ns) klp*yr	.497	.0001
	SAD	Logdens = klp yr	.277	.0001
	TOTAL	Logdens = klp yr	.346	.0001

APPENDIX O -- TABLE 7

KELP BED FISHES: LIST OF PARSIMONIOUS MODELS RELATING FISH DENSITY WITH FIVE SEABED VARIABLES, PLUS GIANT KELP, AND THEIR YEAR CROSS-PRODUCTS. Results are based on general linear model fits of log fish density ("logdens": #s/1000 m**3), kelp density ("klp": #s/100 m**2), abundance indices of Acrosorium (acr), subcanopy Pterygophora (sc), Cystoseira (cys), Lytechinus urchins (lyt), and an index of bottom substrate type (bt) during the two (Fall 1985, Fall 1986) sampling periods. All evaluations are restricted to the five stations sampled within San Onofre Kelp bed (SOK) during each of the two years. Main effects and interaction terms are included in the model statement only if P < .15 using the "stepwise" method of SAS PROC STEPWISE. All models include an intercept term. Sample sizes range from 57 (for canopy and canopy-midwater taxa) to 61-69 (cosmopolites) to 65-73 (bottom taxa). (See Appendix M, Table 1 for classification of taxa.) Also noted is the model R**2 and the probability that the observed R**2 value is equal to zero.

APPENDIX O -- TABLE 7

Taxon	Life Stage	Model	R^2	PROB
BASS, barred sand	AD	Logdens = klp cys*yr lyt sc	.540	.0001
	JUV	Logdens = klp*yr cys lyt sc bt*yr	.579	.0001
	SAD	Logdens = acr lyt sc	.395	.0001
	TOTAL	Logdens = acr lyt sc	.475	.0001
BASS, kelp	AD	Logdens = klp klp*yr lyt	.468	.0001
	JUV	Logdens = klp klp*yr cys sc*yr	.698	.0001
	OJ	Logdens = klp klp*yr cys sc*yr	.692	.0001
	SAD	Logdens = klp*yr cys cys*yr lyt sc*yr	.713	.0001
	TOTAL	Logdens = klp klp*yr cys lyt sc*yr	.700	.0001
	YOY	Logdens = klp klp*yr lyt*yr	.369	.0001
BLACKSMITH	JUV	Logdens = klp cys lyt	.288	.0003
	TOTAL	Logdens = klp	.194	.0004
HALFMOON	AD	Logdens = yr	.649	.0001
	SAD	Logdens = yr	.057	.075
	TOTAL	Logdens = yr	.582	.0001
KELPFISH, giant	JUV	Logdens = klp*yr bt	.144	.01
	SAD	Logdens = klp*yr lyt*yr sc*yr bt*yr	.600	.0001
	TOTAL	Logdens = yr klp*yr acr lyt*yr sc*yr bt	.547	.0001

APPENDIX O -- TABLE 7 (continued)

Taxon	Life Stage	Model	R^2	PROB
PERCH, black	AD	Logdens = klp*yr cys lyt	.550	.0001
	SAD	Logdens = klp klp*yr cys bt	.675	.0001
	TOTAL	Logdens = klp klp*yr cys lyt	.662	.0001
PERCH, kelp	TOTAL	Logdens = klp klp*yr	.734	.0001
PERCH, pile	AD	Logdens = klp*yr lyt	.408	.0001
	SAD	Logdens = klp acr acr*yr cys cys*yr lyt lyt*yr	.686	.0001
	TOTAL	Logdens = klp klp*yr cys lyt	.550	.0001
SEAPERCH, rainbow	AD	Logdens = klp*yr cys lyt	.360	.0001
	SAD	Logdens = yr klp acr*yr cys sc	.220	.01
	TOTAL	Logdens = klp*yr cys lyt bt*yr	.432	.0001
SEAPERCH, white	AD	Logdens = klp klp*yr	.127	.02
	SAD	Logdens = klp klp*yr	.190	.002
	TOTAL	Logdens = klp klp*yr	.186	.003
SENORITA	AD	Logdens = klp klp*yr cys sc*yr bt*yr	.656	.0001
	JUV	Logdens = klp klp*yr sc bt	.297	.0005
	SAD	Logdens = klp klp*yr sc	.389	.0001
	TOTAL	Logdens = klp klp*yr cys sc sc*yr bt	.674	.0001
SHEEPHEAD, California	JUV	Logdens = cys*yr sc bt*yr	.470	.0001
	SAD	No significant model found	--	--
	TOTAL	Logdens = sc bt*yr	.400	.0001

APPENDIX O -- TABLE 7 (continued)

Taxon	Life Stage	Model	R^2	PROB
SILVERSIDES	TOTAL	No significant model found	--	--
WRASSE, rock	AD	Logdens = klp*yr acr lyt	.383	.0001
	JUV	Logdens = klp klp*yr cys	.634	.0001
	SAD	Logdens = klp cys*yr	.334	.0001
	TOTAL	Logdens = klp cys*yr sc*yr	.394	.0001

APPENDIX O -- TABLE 8

KELP BED FISHES: SUMMARY OF SIGNIFICANT RELATIONSHIPS BETWEEN FISH DENSITY AND THE MOST PARSIMONIOUS SUITE OF SIGNIFICANT CO-VARIATES IDENTIFIED BY STEPWISE MULTIPLE REGRESSION. Results are based on general linear model ANCOVA fits of log fish density ("logdens": #s/1000 m**3) to potentially significant model terms including kelp density ("klp": #s/100 m**2), abundance indices of Acrosorium (acr), Cystoseira (cys), subcanopy Pterygophora (sc), Lytechinus urchins (lyt), and an index of bottom substrate type (bt), plus location (loc) as the remainder of all nonrandom variation. All covariates (including year cross-products, but excluding location) were included only if probabilities in the preceding stepwise multiple regression were 0.15 or less (the latter results are summarized in Appendix O, Table 7). The data used were collected during two (Fall 1985, Fall 1986) sampling periods. All evaluations are restricted to the five stations sampled within San Onofre Kelp bed (SOK) during each of the two years. All models include an intercept term. Sample sizes range from 57 (for canopy and canopy-midwater taxa) to 60 (cosmopolites) to 64 (bottom taxa). (See Appendix M, Table 1 for classification of taxa.) Also noted is the model R**2 and the probability that the observed R**2 value is equal to zero.

APPENDIX O -- TABLE 8

Taxon	Life Stage	Model	R^2	PROB
BASS, barred sand	AD	Logdens = klp cys*yr lyt sc	.540	.0001
	JUV	Logdens = klp*yr cys lyt sc bt*yr	.579	.0001
	SAD	Logdens = acr lyt sc	.395	.0001
	TOTAL	Logdens = acr lyt sc	.475	.0001
BASS, kelp	AD	Logdens = klp klp*yr lyt loc	.504	.0001
	JUV	Logdens = klp klp*yr cys sc*yr	.698	.0001
	OJ	Logdens = klp klp*yr cys sc*yr	.692	.0001
	SAD	Logdens = klp*yr cys cys*yr lyt sc*yr	.713	.0001
	TOTAL	Logdens = klp klp*yr cys lyt sc*yr	.700	.0001
	YOY	Logdens = klp klp*yr lyt*yr	.369	.0001
BLACKSMITH	JUV	Logdens = klp cys lyt	.288	.0003
	TOTAL	Logdens = klp	.194	.0004
HALFMOON	AD	Logdens = yr	.649	.0001
	SAD	No significant model found	--	--
	TOTAL	Logdens = yr	.582	.0001
KELPFISH, giant	JUV	Logdens = klp*yr bt	.144	.011
	SAD	Logdens = klp*yr lyt*yr sc*yr bt*yr	.600	.0001
	TOTAL	Logdens = yr klp*r acr lyt*yr sc*yr bt	.547	.0001

APPENDIX O -- TABLE 8 (continued)

Taxon	Life Stage	Model	R^2	PROB
PERCH, black	AD	Logdens = klp*yr cys lyt	.550	.0001
	SAD	Logdens = klp klp*yr cys bt loc	.754	.0001
	TOTAL	Logdens = klp klp*yr cys lyt	.662	.0001
PERCH, kelp	TOTAL	Logdens = klp klp*yr loc	.818	.0001
PERCH, pile	AD	Logdens = klp*yr lyt	.408	.0001
	SAD	Logdens = klp acr acr*yr cys cys*yr lyt lyt*yr	.686	.0001
	TOTAL	Logdens = klp klp*yr cys lyt	.550	.0001
SEAPERCH, rainbow	AD	Logdens = klp*yr cys lyt	.360	.0001
	SAD	Logdens = yr klp acr*yr cys sc	.220	.01
	TOTAL	Logdens = klp*yr cys lyt bt*yr	.432	.0001
SEAPERCH, white	AD	Logdens = klp klp*yr loc	.280	.002
	SAD	Logdens = klp klp*yr	.190	.002
	TOTAL	Logdens = klp klp*yr	.186	.002
SENORITA	AD	Logdens = klp klp*yr cys sc*yr bt*yr loc	.770	.0001
	JUV	Logdens = klp klp*yr sc bt	.297	.0005
	SAD	Logdens = klp klp*yr sc loc	.444	.0001
	TOTAL	Logdens = klp klp*yr cys sc sc*yr bt loc	.760	.0001
SHEEPHEAD, California	JUV	Logdens = cys*yr sc bt*yr	.470	.0001
	SAD	No significant model found	--	--
	TOTAL	Logdens = sc bt*yr loc	.452	.0001

APPENDIX O -- TABLE 8 (continued)

Taxon	Life Stage	Model	R^2	PROB
SILVERSIDES	TOTAL	Logdens = loc	.213	.005
WRASSE, rock	AD	Logdens = klp*yr acr lyt	.383	.0001
	JUV	Logdens = klp klp*yr cys	.634	.0001
	SAD	Logdens = klp cys*yr	.334	.0001
	TOTAL	Logdens = klp cys*yr sc*yr	.394	.0001

APPENDIX O -- TABLE 9

KELP BED FISHES: SUMMARY OF PARTIAL R-SQUARED VALUES FOR EACH COVARIATE (PLUS LOCATION EFFECT AS THE REMAINDER OF ALL NON-RANDOM VARIATION) INCLUDED IN THE FINAL MODEL DESCRIBING THE INTERRELATIONSHIPS OF FISH DENSITY AND OTHER MEASURED (A)BIOTIC VARIABLES. Results are based on general linear model ANCOVA fits (Appendix O, Table 8) of log fish density ("logdens": #s/1000 m**3) to potentially significant model terms including kelp density ("klp": #s/100 m**2), abundance indices of Acrosorium (acr), Cystoseira (cys), subcanopy Pterygophora (sc), Lytechinus urchins (lyt), and an index of bottom substrate type (bt), plus location (loc) as the remainder of all nonrandom variation. All covariates (including year cross-products --flagged by asterisks --but excluding location) were included only if probabilities in the preceding stepwise multiple regression were 0.15 or less (the latter results are summarized in Appendix O, Table 7). The data used were collected during two (Fall 1985, Fall 1986) sampling periods. All evaluations are restricted to the five stations sampled within San Onofre Kelp bed (SOK) during each of the two years. All models include an intercept term. Sample sizes range from 57 (for canopy and canopy-midwater taxa) to 61-69 (cosmopolites) to 65-73 (bottom taxa). (See Appendix M, Table 1 for classification of taxa.)

APPENDIX O -- TABLE 9

Partial R^2

		YR	KLP(*)	ACR(*)	SC(*)	CYS(*)	LYT(*)	BT(*)	LOC
BASS,	AD	--	.04	--	.04	--	.16	--	--
			--	--	--	.31(*)	--	--	
sand	JUV	--	--	--	.02	.10	.01	--	--
			.37(*)	--	--	--	--	.01	
	SAD	--	--	.09	.05	--	.25	--	--
			--	--	--	--	--	--	
	TOTAL	--	--	.16	.06	--	.26	--	--
			--	--	--	--	--	--	
BASS,	AD	--	.02	--	--	--	.03	--	.06
kelp			.42(*)	--	--	--	--	--	
	JUV	--	.06	--	--	.06	--	--	--
			.50(*)	--	.08(*)	--	--	--	
	OJ	--	.04	--	--	.08	--	--	--
			.49(*)	--	.08(*)	--	--	--	
	SAD	--	--	--	--	.02	.10	--	--
			.46(*)	--	.11(*)	.02(*)	--	--	
	TOTAL	--	.05	--	--	.02	.06	--	--
			.49(*)	--	.07(*)	--	--	--	
	YOY	--	.05	--	--	--	--	--	--
			.27(*)	--	--	--	.05(*)	--	
BLKSMTH	JUV	--	.08	--	--	.18	.03	--	--
			--	--	--	--	--	--	
	TOTAL	--	.19	--	--	--	--	--	--
			--	--	--	--	--	--	
HALFMOON	AD	.65	--	--	--	--	--	--	--
			--	--	--	--	--	--	
	SAD	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	
	TOTAL	.58	--	--	--	--	--	--	--
			--	--	--	--	--	--	
KELPFISH,	JUV	--	--	--	--	--	--	.04	--
giant			.10(*)	--	--	--	--	--	
	SAD	--	--	--	--	--	--	--	--
			.42(*)	--	.04(*)	--	.07(*)	.07(*)	
	TOTAL	.05	--	.02	--	--	--	.04	--
			.36(*)	--	.03(*)	--	.05(*)	--	

APPENDIX O -- TABLE 9 (continued)

Partial R^2

		YR	KLP(*)	ACR(*)	SC(*)	CYS(*)	LYT(*)	BT(*)	LOC
PERCH, black	AD	--	--	--	--	.03	.10	--	--
			.42(*)	--	--	--	--	--	
	SAD	--	.18	--	--	.21	--	.03	.08
			.25(*)	--	--	--	--	--	
	TOTAL	--	.16	--	--	.19	.03	--	--
			.28(*)	--	--	--	--	--	
PERCH, kelp	TOTAL	--	.01	--	--	--	--	--	.09
			.72(*)	--	--	--	--	--	
PERCH, pile	AD	--	--	--	--	--	.03	--	--
			.37(*)	--	--	--	--	--	
	SAD	--	.21	.06	--	.32	.05	--	--
			--	.02(*)	--	.01(*)	.01(*)	--	
	TOTAL	--	.20	--	--	.21	.03	--	--
			.11(*)	--	--	--	--	--	
SEAPERCH, rainbow	AD	--	--	--	--	.05	.13	--	--
			.18(*)	--	--	--	--	--	
	SAD	.03	.06	--	.03	.04	--	--	--
			--	.06(*)	--	--	--	--	
	TOTAL	--	--	--	--	.08	.13	--	--
			.20(*)	--	--	--	--	.02(*)	
SEAPERCH, white	AD	--	.07	--	--	--	--	--	.15
			.06(*)	--	--	--	--	--	
	SAD	--	.15	--	--	--	--	--	--
			.04(*)	--	--	--	--	--	
	TOTAL	--	.15	--	--	--	--	--	--
			.04(*)	--	--	--	--	--	

APPENDIX O -- TABLE 9 (continued)

Partial R^2

		YR	KLP(*)	ACR(*)	SC(*)	CYS(*)	LYT(*)	BT(*)	LOC
SENORITA	AD	--	.24	--	--	.04	--	--	.11
			.02(*)	--	.32(*)	--	--	.04	
	JUV	--	.10	--	.06	--	--	.06	--
			.08(*)	--	--	--	--	--	
	SAD	--	.14	--	.08	--	--	--	.05
			.17(*)	--	--	--	--	--	
	TOTAL	--	.26	--	.03	.05	--	.02	.09
			.03(*)	--	.28(*)	--	--	--	
SHEEPHD, Calif.	JUV	--	--	--	.05	--	--	--	--
			--	--	--	.03(*)	--	.39(*)	
	SAD	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	
	TOTAL	--	--	--	.07	--	--	--	.05
			--	--	--	--	--	.33(*)	
SLVRSIDES	TOTAL	--	--	--	--	--	--	--	.213
WRASSE, rock	AD	--	--	.05	--	--	.04	--	--
			.29(*)	--	--	--	--	--	
	JUV	--	.45	--	--	.06	--	--	--
			.12(*)	--	--	--	--	--	
	SAD	--	.12	--	--	--	--	--	--
			--	--	--	.21(*)	--	--	
	TOTAL	--	.05	.22	--	--	--	--	--
			--	--	.02(*)	.10(*)	--	--	

	YR	KLP(*)	ACR(*)	SC(*)	CYS(*)	LYT(*)	BT(*)	LOC
PCT VARIANCE EXPLAINED (ALL TAXA & STAGES)	7	52	3	8	12	8	5	5

APPENDIX P -- Back-Up Data for Abundance Calculations of Kelp Bed Fishes

APPENDIX P -- TABLES 1 - 4

KELP BED FISHES: ESTIMATES OF THE WEIGHTED MEAN DENSITIES OF EACH SPECIES/TAXON OF FISHES ENCOUNTERED ON QUANTITATIVE TRANSECTS IN SAN ONOFRE KELP BED DURING FALL 1985 and 1986. Table 1 (1985) and Table 3 (1986) provide estimates for each location at SOK (San Onofre Kelp bed); Table 2 (1985) and Table 4 (1986) summarize data for stations of like kelp-density (based on diver counts of plants 1 m or taller) at SOK. Fish density estimates are weighted according to the contribution of all water-column strata relevant to a particular species/taxon. Estimates of mean density at SOK (Tables 2, 4) are further weighted for the areal contributions of regions of various kelp density. (See Methods section and Appendix M, Table 1.)

APPENDIX P -- TABLE 1

SAN ONOFRE KELP BEDS -- FALL 1985
MEAN DENSITY OF FISHES PER 1000 M^2
(BY INDIVIDUAL LOCATION)

Species	CobbleU	SOKUout	SOKDin	SOKUin	SOKDout
SENORITA	14.1	545.0	278.9	263.8	286.4
SALEMA	0.0	361.0	0.0	31.1	100.7
WRASSE, rock	16.8	21.8	31.1	8.8	47.7
BASS, kelp	9.0	25.8	7.5	6.2	62.2
BARRACUDA, Pacific	0.0	63.0	0.0	0.0	15.8
MACKEREL, jack	0.0	6.9	40.7	1.0	12.5
SILVERSIDES spp.	0.0	11.2	0.0	17.3	0.0
BASS, barred sand	8.1	10.9	3.2	1.6	7.6
SEAPERCH, white	10.1	8.3	0.0	2.7	7.1
PERCH, pile	0.5	0.5	0.0	0.1	17.9
PERCH, black	0.5	2.1	0.0	0.1	13.1
SHEEPHEAD, Calif.	4.1	3.0	0.7	0.9	2.0
BLACKSMITH	0.0	3.4	1.9	0.4	4.3
HALFMOON	0.0	0.9	0.5	2.4	0.0
SEAPERCH, rubberlip	0.0	<.1	0.0	0.0	4.7
SEAPERCH, rainbow	0.2	<.1	0.0	0.0	1.8
KELPFISH, giant	0.1	0.6	0.2	0.6	0.3
PERCH, kelp	0.0	0.5	0.0	0.0	0.0
SHARK, leopard	0.0	0.0	<.1	0.0	0.3
SHARK, horn	0.0	0.0	<.1	0.0	0.2
RAY, bat	0.0	<.1	0.2	0.0	0.0
GIBBONSIA, spp.	0.0	0.0	0.0	0.2	0.0
HALIBUT, Calif.	0.0	0.0	0.0	0.1	0.1
STINGRAY, round	0.0	0.0	<.1	0.0	0.1
THORNBACK	0.0	0.0	0.2	0.0	0.0
SCORPIONFISH, Calif.	0.0	<.1	<.1	0.0	0.0
GUITARFISH, shovelnose	0.0	0.0	0.0	0.1	0.0
PIPEFISH	0.0	0.0	0.0	0.0	0.1
GREENLING, painted	0.0	0.0	<.1	0.0	0.0
All Species	63.6	1065	365.6	337.6	585.0

APPENDIX P -- TABLE 2

SAN ONOFRE KELP BED -- FALL 1985

MEAN DENSITY OF FISHES PER 1000 M^2

(LOCATIONS OF LIKE KELP-DENSITY POOLED)

Estimates of mean density (all SOK) are based on the weighted means of the three density regions. Each component mean is weighted by its contribution to the total area at SOK.

Species	Moderate-Density Kelp Stations[a]	Low-Density Kelp Stations[b]	Sparse-Density Kelp Station[c]	Mean (All SOK)
SENORITA	415.7	271.4	14.1	125.8
WRASSE, rock	34.8	19.9	16.8	18.6
SALEMA	230.8	15.5	0.0	14.0
BASS, kelp	44.0	6.8	9.0	9.4
MACKEREL, jack	9.7	20.9	0.0	8.3
SEAPERCH, white	7.7	1.4	10.1	6.7
BASS, barred sand	9.3	2.4	8.1	6.0
SILVERSIDES spp.	5.6	8.7	0.0	3.5
SHEEPHEAD, Ca.	2.5	0.8	4.1	2.8
BARRACUDA, Pacific	39.4	0.0	0.0	1.4
PERCH, pile	9.2	<.1	0.5	0.7
PERCH, black	7.6	<.1	0.5	0.6
HALFMOON	0.5	1.5	0.0	0.6
BLACKSMITH	3.9	1.1	0.0	0.6
KELPFISH, giant	0.4	0.4	0.1	0.2
SEAPERCH, rainbow	0.9	0.0	0.2	0.2
SEAPERCH, rubberlip	2.4	0.0	0.0	<.1
GIBBONSIA, spp.	0.0	0.1	0.0	<.1
RAY, bat	<.1	<.1	0.0	<.1
THORNBACK	0.0	<.1	0.0	<.1
HALIBUT, Ca.	<.1	<.1	0.0	<.1
GUITARFISH, shovelnose	0.0	<.1	0.0	<.1
SHARK, leopard	0.2	<.1	0.0	<.1
SHARK, horn	0.1	<.1	0.0	<.1
STINGRAY, round	<.1	<.1	0.0	<.1
SCORPIONFISH, Ca.	<.1	<.1	0.0	<.1
GREENLING, painted	0.0	<.1	0.0	<.1
PERCH, kelp	0.2	0.0	0.0	<.01
PIPEFISH	<.1	0.0	0.0	<.01
All Species	825.1	351.6	63.6	199.6

[a]SOKUout, SOKDout; [b]SOKUin, SOKDin; [c]CobbleU

APPENDIX P -- TABLE 3

SAN ONOFRE KELP BED -- FALL 1986
MEAN DENSITY OF FISHES PER 1000 M^2
(BY INDIVIDUAL LOCATION)

Species	CobbleU	SOKUout	SOKDin	SOKUin	SOKDout	SOK inbetw	CobbleD
SENORITA	18.8	746.7	979.4	280.8	536.0	302.2	1.1
BASS, kelp	2.2	60.8	79.1	44.9	178.0	223.9	0.4
BARRACUDA, Pacific	0.0	195.7	2.9	206.6	71.5	0.0	0.0
MACKEREL, jack	0.0	52.7	98.8	96.2	111.9	5.6	0.0
HALFMOON	0.5	84.1	19.0	83.0	46.4	54.3	0.0
WRASSE, rock	29.1	47.6	38.9	59.7	50.1	49.2	5.9
SILVERSIDES spp.	0.0	0.0	16.5	78.0	0.8	0.0	0.0
BONITO, Pacific	0.0	11.1	0.0	77.7	4.6	0.0	0.0
SEAPERCH, white	0.0	17.2	6.2	0.8	10.8	84.0	0.0
PERCH, kelp	0.0	10.5	1.6	<.1	24.9	42.4	0.0
PERCH, black	0.2	5.3	2.2	1.0	24.8	53.0	1.1
BASS, barred sand	5.9	6.9	4.8	4.0	49.0	8.5	2.2
PERCH, pile	0.0	1.8	1.2	0.3	6.4	29.9	0.0
SHEEPHEAD, Ca.	3.5	9.0	2.6	4.2	4.9	11.9	0.7
SEAPERCH, rainbow	0.0	0.4	0.2	0.0	2.3	9.3	0.0
KELPFISH, giant	0.0	2.3	0.1	0.4	2.9	3.2	0.0
MACKEREL, Pacific	0.2	0.0	0.2	5.0	0.0	0.0	0.0
SALEMA	0.0	4.0	0.0	0.0	0.0	0.0	0.0
ROCKFISH, kelp	0.0	0.0	0.0	0.0	0.2	2.6	0.0
SEAPERCH, rubberlip	0.0	2.3	0.1	<.1	0.0	0.0	0.0
BLACKSMITH	0.0	2.1	0.0	<.1	0.0	0.0	0.0
ROCKFISH, olive	0.0	0.0	0.0	0.0	0.0	0.7	0.0
STINGRAY, round	0.0	0.1	0.4	0.0	0.0	0.0	0.0
OPALEYE	0.0	0.2	0.0	0.0	0.2	0.0	0.0
RAY, Pacific electric	0.0	0.2	0.0	0.0	0.0	0.0	0.0
SHARK, leopard	0.0	0.1	0.1	0.0	0.0	0.0	0.0
GIBBONSIA, spp.	0.0	0.0	0.0	0.2	0.0	0.0	0.0
SCORPIONFISH, Ca.	0.0	0.0	0.1	0.0	0.0	0.0	0.0
SARGO	0.0	0.1	0.0	0.0	0.0	0.0	0.0
GUITARFISH, shovelnose	0.0	0.0	0.0	0.0	<.1	0.0	0.0
All Species	60.5	1261.3	1254.5	943.2	1125.9	880.7	11.5

APPENDIX P -- TABLE 4

SAN ONOFRE KELP BED -- FALL 1986

MEAN DENSITY OF FISHES PER 1000 M^2

(LOCATIONS OF LIKE KELP-DENSITY POOLED)

Estimates of mean density (all SOK) are based on the weighted means of the three density regions. Each component mean is weighted by its contribution to the total area at SOK.

Species	Low-Density Kelp Stations[a]	Very Low-Density Kelp Stations[b]	Sparse-Density Kelp Stations[c]	Mean (All SOK)
SENORITA	528.3	630.1	9.9	246.5
BARRACUDA, Pacific	89.1	104.8	0.0	40.0
MACKEREL, jack	56.7	97.5	0.0	35.7
BASS, kelp	154.2	62.0	1.3	30.5
WRASSE, rock	49.0	49.3	17.5	29.9
HALFMOON	61.6	51.0	0.2	20.7
SILVERSIDES spp.	0.3	47.3	0.0	15.7
BONITO, Pacific	5.2	38.8	0.0	13.2
BASS, barred sand	21.5	4.4	4.1	5.2
SEAPERCH, white	37.3	3.5	0.0	3.4
SHEEPHEAD, Ca.	8.6	3.4	2.1	2.9
PERCH, black	27.7	1.6	0.7	2.6
PERCH, kelp	25.9	0.8	0.0	1.8
PERCH, pile	12.7	0.8	0.0	1.0
MACKEREL, Pacific	0.0	2.6	0.1	0.9
SEAPERCH, rainbow	4.0	0.1	0.0	0.3
KELPFISH, giant	2.8	0.2	0.0	0.2
SEAPERCH, rubberlip	0.8	0.1	0.0	<.1
SALEMA	1.3	0.0	0.0	<.1
STINGRAY, round	<.1	0.2	0.0	<.1
BLACKSMITH	0.7	<.1	0.0	<.1
ROCKFISH, kelp	0.9	0.0	0.0	<.1
GIBBONSIA, spp.	0.0	<.1	0.0	<.1
SHARK, leopard	<.1	<.1	0.0	<.1
SCORPIONFISH, Ca.	0.0	<.1	0.0	<.1
ROCKFISH, olive	0.2	0.0	0.0	<.1
OPALEYE	0.1	0.0	0.0	<.01
RAY, Pacific electric	<.1	0.0	0.0	<.01
SARGO	<.1	0.0	0.0	<.01
GUITARFISH, shovelnose	<.1	0.0	0.0	<.01
All Species	1089.3	1098.8	36.0	451.1

[a]SOKUout, SOKDout, SOKinbetween; [b]SOKUin, SOKDin; [c]CobbleU, CobbleD

APPENDIX P -- TABLE 5

KELP BED FISHES: ESTIMATED AREAL EXTENTS FOR REGIONS OF VARIOUS KELP DENSITIES AT SAN ONOFRE KELP BED (SOK) DURING FALL 1985, BASED ON SIDESCAN AND DOWNLOOKING SONAR. Sonar data used were those of ECOsystems Management Associates' Sidescan Sonar Survey No. 22 and Downlooking Sonar Survey No. 7. Areas estimated by electronic planimetry using ECO-M's Apple II Graphics Tablet.

Kelp Density Region	Estimated Surface Area (Ha) Based on				Ratio of Sidescan : Downlooking Estimate
	Sidescan Sonar		Downlooking Sonar		
	Area	%	Area	%	
High[a]	25.8	30	29.3	26	0.88
Medium[b]	14.7	17	17.5	15	0.84
Low[c]	45.4	53	66.0	59	0.69
All regions	85.9	100	112.8	100	0.76

[a]Sidescan: density of > 8 plants per 100 m^2; downlooking: > 16 plants per 100 m^2

[b]Sidescan: density of 4-8 plants per 100 m^2; downlooking: 4-16 plants per 100 m^2

[c]Sidescan: density of < 4 plants per 100 m^2; downlooking: < 4 plants per 100 m^2

APPENDIX P -- TABLE 6

KELP BED FISHES: ESTIMATED AREAL EXTENTS FOR REGIONS OF VARIOUS KELP DENSITIES AT SAN ONOFRE KELP BED (SOK) DURING FALL 1986, BASED ON SIDESCAN AND DOWNLOOKING SONAR. Sonar data used were those of ECOsystems Management Associates' Sidescan Sonar Survey No. 24 and Downlooking Sonar Survey No. 9. Areas estimated by electronic planimetry using ECO-M's Apple II Graphics Tablet.

Kelp Density Region	Estimated Surface Area (Ha) Based on				Ratio of Sidescan : Downlooking Estimate
	Sidescan Sonar		Downlooking Sonar		
	Area	%	Area	%	
High[a]	6.8	8.7	5.2	5.9	1.31
Medium[b]	15.9	20.4	29.2	33.2	0.54
Low[c]	55.3	70.9	53.5	60.9	1.03
All regions	78.0	100	87.9	100	0.89

[a]Sidescan: density of > 8 plants per 100 m^2; downlooking: > 8 plants per 100 m^2

[b]Sidescan: density of 4-8 plants per 100 m^2; downlooking: 2-8 plants per 100 m^2

[c]Sidescan: density of < 4 plants per 100 m^2; downlooking: < 2 plants per 100 m^2

APPENDIX P -- TABLE 7

KELP BED FISHES: ESTIMATED AREAL EXTENTS FOR REGIONS OF VARIOUS KELP DENSITIES AT SAN ONOFRE KELP BED (SOK) DURING THE FALL PERIODS OF 1980, 1981, 1985, AND 1986, BASED ON SIDESCAN SONAR. Sonar data used were those of ECOsystems Management Associates' Sidescan Sonar Surveys 12, 14, 22, and 24. Areas estimated by electronic planimetry using ECOM's Apple II Graphics Tablet.

Kelp Density Region	Sidescan Sonar-Based Estimate of Areal Extent (Ha)							
	Fall 1980		Fall 1981		Fall 1985		Fall 1986	
	Area	%	Area	%	Area	%	Area	%
Dense surface canopy[a]	25.2	--	49.9	--	11.6	--	15.1	--
High density[b]	44.0	37	48.4	40	25.8	30	6.8	9
Medium-to-high density[c]	50.5	43	32.6	27	14.7	17	15.9	20
Low-to-medium density[d]	23.3	20	39.5	33	45.4	53	55.3	71
All Regions[e]	117.8	100	120.5	100	85.9	100	78.0	100

[a]Based on vessel's circumnavigation of floating (surface) canopy

[b]"High density of plants GE 1-m tall" defined as GT 8 plants per 100 m^2.

[c]"Medium-to-high density" defined as 4-8 plants per 100 m^2.

[d]"Low density" defined as ~ 0-4 plants per 100 m^2.

[e]As the sum of "high," "medium-to-high," and "low-to-medium" density regions only. ("Dense surface canopy" enclosed within the "high" density region.)

APPENDIX P -- TABLE 8

KELP BED FISHES: ESTIMATED NUMERICAL ABUNDANCES OF EACH OF 14 MAJOR SPECIES AND TOTAL FISHES (ALL SPECIES) WITHIN "MEDIUM-TO-HIGH" PLUS "HIGH"-DENSITY KELP AT SAN ONOFRE KELP BED (SOK) DURING THE FALL PERIODS OF 1980, 1981, 1985, AND 1986. Fish abundances (all life stages pooled) are estimated as the cross-products of fish-density data and the areal extents of kelp during the respective fall period. Fish densities are estimated using surface canopy and bottom data only at SOKU and SOKD during fall 1980 and fall 1981, and using analogous data for four stations (SOKUout, SOKUin, SOKDout, SOKDin) in fall 1985 and fall 1986. Areas were estimated by electronic planimetry (see Methods section) of ECOSystems sidescan sonar charts (Sidescan Surveys 12, 14, 22, and 24). All areas within the "high-density kelp > 1 m tall" and "medium-to-high-density kelp > 1 m tall" isopleths were included. Half-widths of the 95% confidence intervals of the abundance estimate are expressed as a percentage of the estimate.

Species	YEAR VARIATIONS IN ESTIMATED FISH ABUNDANCES AT SOK IN SIDESCAN SONAR REGIONS OF Medium-To-High Plus High-Density Kelp[a]							
	Fall 1980		Fall 1981		Fall 1985		Fall 1986	
	Numbers	CI/2 (%)	Numbers	CI/2 (%)	Numbers	CI/2 (%)	Numbers	CI/2 (%)
BASS, barred sand	8,830	25	4,372	45	2,240	54	1,639	19
BASS, kelp	78,492	26	60,394	43	4,148	25	9,830	24
BLACKSMITH	103	130	1,905	101	703	82	55	94
HALFMOON	6,859	89	17,478	29	190	88	8,567	37
KELPFISH, giant	95	86	454	48	172	68	162	29
PERCH, black	41,357	48	5,944	69	1,557	47	1,973	42
PERCH, kelp	40,619	43	48,566	20	49	83	1,600	30
PERCH, pile	5,109	72	4,634	53	1,871	89	980	137
SEAPERCH, rainbow	4,300	59	3,373	100	192	166	290	122
SEAPERCH, white	16,892	106	105,301	38	1,118	39	2,565	64
SENORITA	71,513	33	70,235	23	47,978	23	51,841	26
SHEEPHEAD, Calif.	34,845	19	15,364	31	666	35	1,118	33
SILVERSIDES spp.	18,173	70	29,371	57	2,896	85	6,056	102
WRASSE, rock	2,654	27	1,674	32	10,962	20	10,939	29
TOTAL FISHES	392,029	27%	462,956	23%	99,733	22%	121,007	20%

[a] Using sidescan sonar charts to delineate kelp density regions within SOK.

APPENDIX Q

PAR FISHES: DETAILED METHODS OF SAMPLING AND ANALYSIS

1. SAMPLING METHODS

1.1 Measuring Distribution and Density

Fishes in rock and sand microhabitats were surveyed by stratified sampling in which seven strata were recognized: A Crest stratum atop the apex (major axis) of each module; a Slope stratum midway between the Crest and the module Perimeter (sand-rock interface); an Ecotone stratum extending 0-3 m off the sand-rock interface; and four strata on sand bottom peripheral to the modules. The latter included Adjacent Sand (at 3-8 m from the perimeter); and three incremental bands in Outlying Sand (8-13 m, 13-23 m, and 23-33 m; Appendix Q, Fig. 2).

All transects made in Crest, Slope, and Ecotone strata were free-swims that the individual diver conformed to the defined microhabitat. On the Crest, divers purposely swam on the apex of the major axis (LOSL 1983a; Jessee et al. 1985b) of the module. On Slope transects, mid-distance between Crest and Perimeter habitats was gauged by eye. Divers bisected the discrete (< 1-m wide) sand-rock interface on the Perimeter transects of the JUVENILE surveys. Paths of Ecotone transects (on JUV-AD surveys) were centered an estimated 1.5 m peripheral to the sand-rock interface. The entire sand-rock interface was traced by the diver on each Perimeter and Ecotone transect for 6/8 modules. On modules 4 and 5 only, minor sections of Perimeter and Ecotone habitat were omitted from the actual areas sampled (Appendix Q, Fig.1).

All transects made in Adjacent and Outlying Sand regions ("radial transects") utilized metered lines, payed out (and retrieved) with the same reel/slate assembly used for surveying and recording fishes on

bottom transects at SOK (Appendix J). At each module on each survey, a single line (transect) was payed out along a pre-determined compass bearing within each of four quadrants. Radial transects started 3 m peripheral to module Perimeters, and bearings ran perpendicular to the fringing rocks of the module. Fishes were noted and recorded as the line was payed out, and data were recorded by segment of the transect ("SEGTRANS"). SEGTRANS 1 was the first 5-m section (3- to 8-m distance off-module); SEGTRANS 2 was the second 5 m (at 8 to 13 m); SEGTRANS 3 was the second 10 m (at 13 to 23 m); and SEGTRANS 4 was the third 10 m (at 23 to 33 m; Appendix Q, Fig. 2). Radial transects were a maximum of 30 m long; however, 10/32 were only 5-m long because of interference by adjacent modules (Appendix Q, Fig. 1). Of the 22 others that were 30 m long, 10 were classified as "internal" and 12 were "external," based on a subjective impression of their position relative to the general PAR complex. Each of the four transects on each module was identified by number (1,2,3,4; Appendix Q, Fig. 1).

2. ANALYSIS METHODS

2.1 Distribution and Density

The module factor had eight levels (i.e., the eight PAR modules) because all modules were surveyed in each fall season. We considered it necessary to sample all eight modules in order to adequately consider possible differences among modules when estimating average fish densities and total fish abundances.

We considered the module factor as a blocking variable; i.e., we included this term in the model to keep module differences from inflating the error variances. Interactions between module and other factors were not included, because we were interested in module effects only insofar as failure to acknowledge any significant effects weakened tests for other variables by inflating error terms.

We considered surveys (three in each fall season) as temporal replicates, because we were interested in estimating the average density and abundance of fishes during each of the two fall seasons.

The JUV-AD fish data were evaluated for comprehensive stratum effects in fall 1986 using two-way (in addition to three-way) ANOVA. We performed this

complementary analysis because our sampling design changed in fall 1986: two additional microhabitats were sampled on all 1986 surveys. In this series of analyses, the stratum factor had seven levels (the original two: Crest and Slope), plus Ecotone (sampled previouly only on the December 1985 survey), plus the four, newly added sand strata at incremental distances peripheral to module ecotones.

2.2 Calculating Fish Abundances

2.2.1 Numerical Abundances

Densities of fishes (standardized to #s/1000 m^3 for prior statistical tests) were reexpressed as their corresponding values per 1000 m^2 of reef surface area. For each life stage of each species, the density estimate for each stratum at each module was then converted to numerical abundance within one of several subregions of the module, defined by isobaths. Isobaths were identified using bathymetry sonar chart No. 3068, determined November 12, 1980, by ECOSystems Mangement Associates, Inc. (This chart was the basis for Lockheed's prior bathymetric characterization of the PAR rock modules: LOSL 1983a; Carter et al. 1985a).

Subregions were defined somewhat differently when estimating the abundances of JUV-AD fishes and JUVENILE fishes. For the JUV-AD estimates, crest habitat included all regions at 9-m depth (mean lowest low water, MLLW) or shallower. Slope habitat encompassed all regions between 9 m and the sand-rock interface (Perimeter) at 11-m depth. In 1985, the area of the Ecotone (surveyed on the December survey only) was defined as a 3-m-wide strip whose midline was 1.5 m peripheral to the 11-m isobath. The limits of ecotone regions were slightly redefined in fall 1986: the Ecotone stratum in 1986 was described as a 3-m-wide strip contiguous with the 11-m isobath, but excluding the small fraction of this area that overlapped on adjacent modules. (Hence the total estimated area of Ecotone in 1986 was about 9% smaller than in 1985 {Appendix Q, Table 3}).

In both years, total area of habitat present atop and outlining the PAR modules included the sections of modules 4 and 5 that were not actually sampled by divers (Appendix Q, Fig. 1).

In fall 1986, we also estimated the abundances of three select species of JUV-AD fishes present in "extralimital" regions atop the crests and slopes of the

modules. These estimates were made in the following manner: the numbers of blacksmith, sargo, and black croaker present in the water column above Crest and Slope habitat were estimated during free-swims over the module immediately following the transect swims. These estimates were then averaged among modules on each survey. Extralimital data were for the TOTAL category only (life stages pooled), because observations could not be made for particular life stages. Proportions of juveniles, subadults, and adults were instead estimated from proportions of the respective species recorded on formal transects (all sampling strata). Last, extralimital abundance estimates were added to the Rock (Crest plus Slope) abundance subtotal for the respective species and survey.

For the YOY-OJ abundance estimates based on JUVENILE surveys, crest habitat included all regions as deep as, or shallower than, the 10-m isobath, plus one-half of the 11-m isobath. Perimeter habitat was the remaining half of the 11-m isobath.

2.2.2 Biomass Abundances

Numerical abundances were converted to biomass abundances by multiplying stage-specific numerical data by the average body weight of the corresponding species and stage. Average body weight was estimated from the length-frequency distribution (inch-class distribution) of the stage, with each class's midpoint multiplied by its weight as estimated from a published or derived length-weight relationship (Appendix T, Table 2).

The length-frequency distributions of fishes were characterized, by species, based on length tallies generated during timed free-swims that complemented formal transect observations. During fall 1985, one diver tallied fish lengths (total length, to the nearest inch) during a single 20-min period spent at Crest-Perimeter depths at each module on each survey. Divers were rotated among modules (to randomize potential biases) on the various surveys. An additional 10-min Ecotone search (for barred sand bass) was conducted at each module during the December 1985 survey only. A total observation time of 560 minutes was spent at PAR tallying fish lengths in fall 1985.

In fall 1986, one diver tallied fish lengths during one 20-min dive in Crest-Slope-Ecotone regions at each module during each of the three surveys. A total of 480 minutes was spent tallying fish lengths at PAR in fall 1986.

During 1-2 weeks before each fall season, the divers conducted field exercises to (1) develop skills at accurately estimating fish lengths underwater and (2) evaluate the consistency among team members in estimating lengths. The method used was an improvement on that of Bell et al. (1985).

Exercises were conducted in a protected shallow habitat (Mission Bay channel entrance; DeMartini and Roberts 1982). Approximately 100 (Formalin-fixed) fish were placed at 3-m intervals along a 300-m transect line. Fish were staked out, in upright (swimming) position, on tenpenny nails epoxied to sheet metal bases used to anchor the specimens in the sand. The fishes that were used represented most common and abundant rocky inshore species, with a range of body sizes from 3 to 20 inches total length. Individual fish were identified by numbered tag. Fish were positioned along the transect line in random sequence. Fish positions were re-randomized on replicate trials. Later, individual fish were measured in the laboratory, and the field data was compared among divers and with the actual fish lengths.

APPENDIX Q -- TABLE 1

PENDLETON ARTIFICIAL REEF FISH STUDIES: SAMPLING DATES DURING THE (A) FALL 1984, (B) FALL 1985 AND (C) FALL 1986 SAMPLING PERIODS OF THE UCSB FISH PROJECT. All samples samples were collected during daylight (0800-1600) hours. YOY-OJ fishes only were sampled on 4/8 PAR modules as a pilot study in Fall 1984. Eight transects (i.e., one per module) were completed for YOY-OJ fishes in crest and in perimeter strata and for JUV-AD fishes in crest and in slope strata during each of the 3 Fall 1985 surveys. During 1985, the ecotone stratum (all eight modules) was sampled on the December survey only. Also on the December 1985 survey, four radial transects (three 30 m long; one 75 m long) were sampled on module 3 and on module 6 only as a pilot study. On each of the three November 1986-January 1987 surveys, all eight modules were sampled for YOY-OJ fishes as in Fall 1985. In Fall 1986, JUV-AD fishes were evaluated on 3 surveys; on each survey, fishes were enumerated in crest, slope, ecotone, and adjacent and outlying sandy areas on and near all 8 modules.

	TYPE OF STUDY			
Month-Year	YOY-OJ (Crest/Perimeter)	JUV-AD (Crest/Slope)	JUV-AD (Ecotone)	JUV-AD (Radial)
FALL 1984				
October	X	--	--	--
FALL 1985				
October	X	X	--	--
November	X	X	--	--
December	X	X	X	X
FALL 1986				
November[1]	X	X	X	X
November[2]	X	X	X	X
January 1987	X	X	X	X

APPENDIX Q -- TABLE 2

SUMMARY OF TRANSECT DIMENSIONS USED AT PAR, FALL 1985 AND FALL 1986

(A) YOY - OJ Study[a]

Module Number	Crest Transects Length (m)	Crest Transects Area (m^2)	Crest Transects Volume (m^3)	Perimeter Transects Length (m)	Perimeter Transects Area (m^2)	Perimeter Transects Volume (m^3)
1	17	17	34	141	141	141
2	27	27	54	147	147	147
3	35	35	70	116	116	116
4	16	16	32	90	90	90
5	30	30	60	146	146	146
6	19	19	38	131	131	131
7	14	14	28	184	184	184
8	31	31	62	195	195	195
Sum	189	189	378	1,150	1,150	1,150

(B) JUVENILE - ADULT Study[b]

Module Number	Crest Transects Length (m)	Crest Transects Area (m^2)	Crest Transects Volume (m^3)	Slope Transects Length (m)	Slope Transects Area (m^2)	Slope Transects Volume (m^3)	Ecotone Transects Length (m)	Ecotone Transects Area (m^2)	Ecotone Transects Volume (m^3)
1	17	51	76.5	91	273	409.5	146	438	657
2	27	81	121.5	110	330	495.0	153	459	689
3	35	105	157.5	112	336	504.0	123	369	554
4	16	48	72.0	76	228	342.0	97	291	437
5	30	90	135.0	87	261	391.5	156	468	702
6	19	57	85.0	112	336	504.0	142	426	639
7	14	42	63.0	138	414	621.0	189	567	851
8	31	93	139.5	150	450	675.0	207	621	932
Sum	189	567	850.5	876	2,628	3,942	1,213	3,639	5,461

[a]YOY - OJ Study. Crest transects: X m long by 1 m wide by 2 m high; perimeter transects: X m long by 1 m wide by 1 m high.

[b]JUVENILE - ADULT Study. Crest, Slope, and Ecotone transects: X m long by 3 m wide by 1.5 m high; radial transects (1986 only): either 5 m or 30 m long by 3 m wide by 1.5 m high (15 or 90 m**2 area; 22.5 or 135 m**3 volume). Fish in these adjacent and outlying sand areas were surveyed on transects that extended radially from the peripheral edge of ecotones (3 m out from the sand-rock interface). Out of a total 32 transects sampled among the 8 PAR modules, 22 were 30 m long and 10 were 5 m long (as illustrated in Appendix Q, Fig.2).

APPENDIX Q -- TABLE 3

FISHES AT PAR: ESTIMATED STRATUM-SPECIFIC AREAS AT THE PAR MODULES. Strata[a] that were used varied with group of fish (YOY - OJ versus JUVENILE - ADULT) surveyed, as noted. Thresholds between strata were defined by isobath. Areal extents of strata were estimated by planimetry; ECOsystem's Apple II Graphics Tablet was used on 4:1 enlargements of their chart of PAR (Drawing 3068, updated 12 Nov 80). See text for definitions of stratum boundaries.

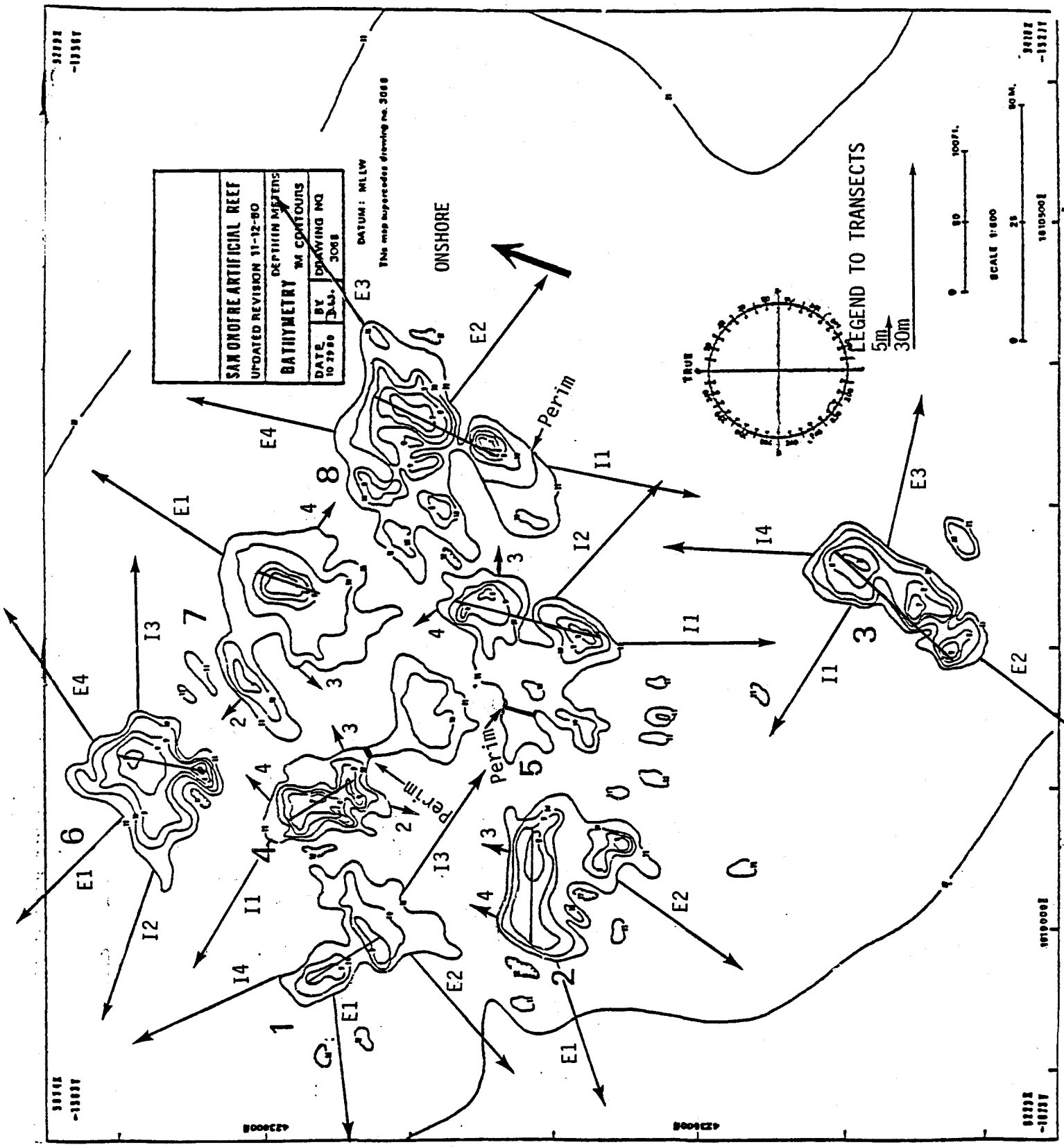
	AREA (M^2) ENCLOSED WITHIN STRATUM					
	YOY - OJ Study		JUVENILE - ADULT Study			
Module					Ecotone	
Number	Crest	Perimeter	Crest	Slope	1985	1986
1	310	434	95	649	438	389
2	622	441	330	733	459	368
3	680	254	446	488	369	344
4	502	491	245	748	522	489
5	505	689	195	999	519	558
6	616	296	371	541	426	412
7	626	622	206	1,042	567	424
8	1,048	888	513	1,423	705	681
Stratum Total	4,909	4,115	2,401	6,623	4,005	3,654
GRAND TOTAL	9,024		13,029 ('85) & 12,678 ('86)			

[a]Areal extent of the "adjacent sand" habitat, sampled by the first 5-m segment of radial transects, was an estimated 4,056 m**2. Areal extent of the "outlying sand" habitat, sampled by the peripheral 25 m of radial transects, was an estimated 17,536 m**2.

APPENDIX Q -- FIGURE 1

Bathymetry map (1-m contours; Datum: MLLW) showing spatial positions of PAR Modules 1 through 8. Mapped by ECOsystems Management (updated version 12 November 1980; Drawing No. 3068). This map has a reported accuracy of ± 3 m horizontal extent and ± 0.9 m vertical relief. Large arabic numbers refer to module designations. Lines atop module crests indicate major axes. Also illustrated are approximate locations of all radial transects made in Adjacent and Outlying Sand regions. (Transect lengths are not to scale of chart.) Small numerals refer to transect designations on the module; letters indicate whether transect was considered "Internal" or "External" to the module complex.

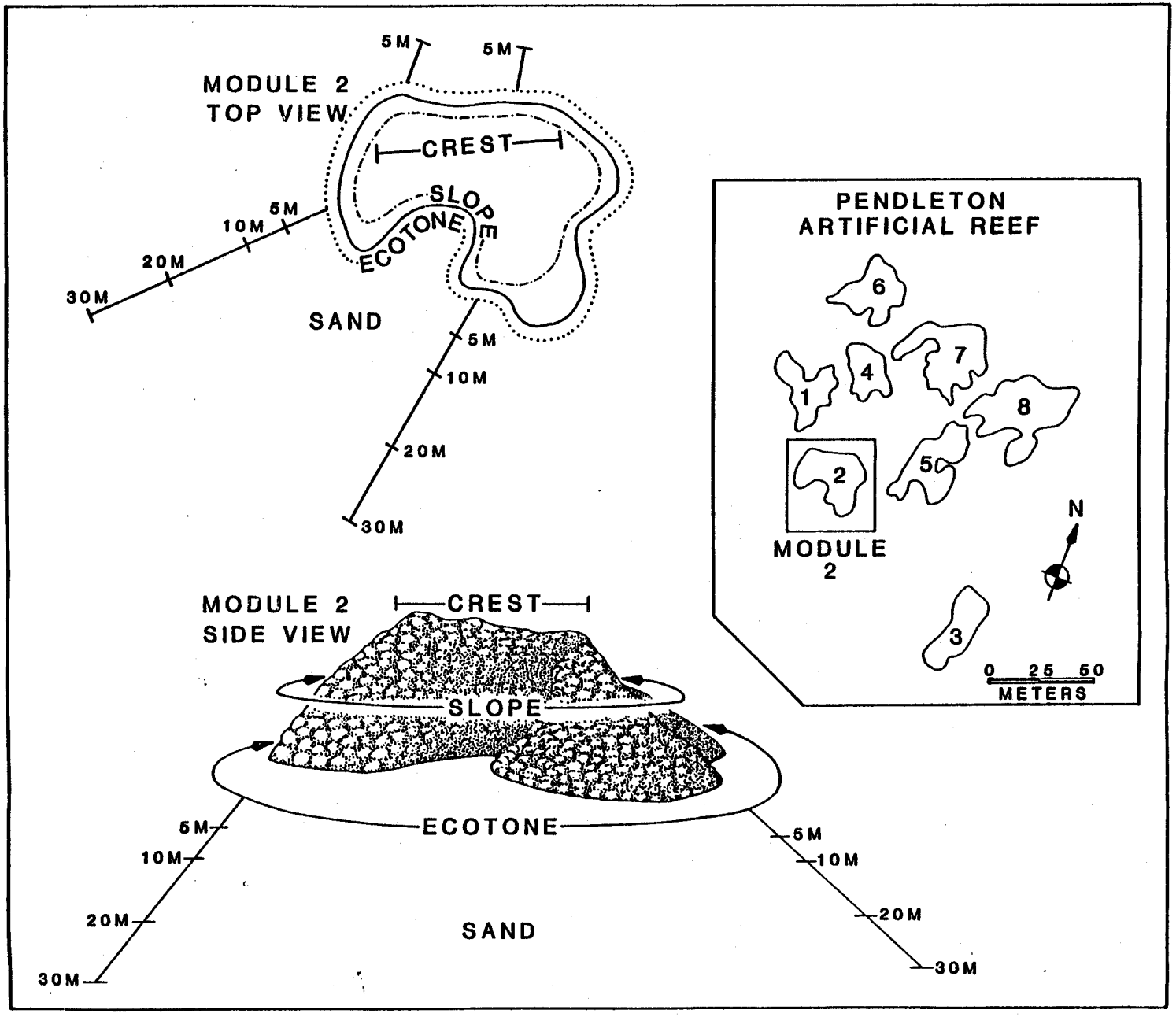
APPENDIX Q -- FIGURE 1



APPENDIX Q -- FIGURE 2

Schematic diagram of a representative station layout (Module 2) used to sample JUV-AD fishes in Crest, Slope, and Ecotone strata, plus sandy regions at distances of 3 to 33 m peripheral to the rock-sand interface.

APPENDIX Q -- FIGURE 2



APPENDIX R -- TABLES 1-4

JUVENILE-ADULT FISHES AT PAR: Estimated mean (rank) densities of juvenile (JUV), subadult (SAD), and adult (AD) life stages, plus totals (pooled stages) of each fish species encountered on quantitative transects at PAR, in Crest and Slope strata (Oct, Nov, Dec), in the Ecotone stratum (Dec only), and in outlying sand regions (Dec only), during fall 1985.

APPENDIX R TABLE 1

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1985 SURVEYS

CREST TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	1853.4	1.0	24.7	3.0	143.4	1.0	2021.5	1.0
WRASSE, rock	2.4	6.0	36.6	1.0	15.0	4.0	54.0	2.0
SHEEPHEAD, Ca	15.6	2.0	24.7	2.0	11.0	6.0	51.4	3.0
GARIBALDI	1.5	7.0	17.6	5.0	23.3	2.0	42.5	4.0
PERCH, black	6.0	5.0	12.0	6.0	22.1	3.0	40.2	5.0
HALFMOON			7.6	9.0	13.4	5.0	21.0	6.0
CROAKER, black			20.9	4.0			20.9	7.0
SENORITA	9.7	3.0	2.4	10.0	8.1	7.0	20.2	8.0
SARGO	1.0	9.0	12.0	7.0	6.1	9.0	19.1	9.0
BASS, kelp	7.1	4.0	8.2	8.0	1.2	12.0	16.5	10.0
OPALEYE			1.9	11.0	6.3	8.0	8.2	11.0
SCORPIONFISH, Ca			1.1	12.0	2.5	10.0	3.6	12.0
PERCH, pile			0.9	13.0	1.8	11.0	2.7	13.0
BASS, barred sand	1.1	8.0	0.8	14.0	0.3	15.0	2.2	14.0
SEAPERCH, rubberlip			0.3	16.0	0.6	13.5	0.8	15.0
ROCKFISH, brown					0.6	13.5	0.6	16.0
GREENLING, painted			0.3	15.0			0.3	17.0
TOTAL SPECIES	9.0		16.0		15.0		17.0	
TOTAL FISHES	1897.9		171.9		255.8		2325.7	

APPENDIX R TABLE 2

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1985 SURVEYS

SLOPE TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	203.6	1.0	14.7	1.0	7.2	2.0	225.5	1.0
PERCH, black	4.2	4.0	6.3	5.0	9.0	1.0	19.6	2.0
SHEEPHEAD, Ca	9.8	2.0	6.7	4.0	2.5	5.0	19.0	3.0
WRASSE, rock	1.4	7.0	11.8	2.0	3.3	3.0	16.5	4.0
SENORITA	8.9	3.0	0.9	10.0	1.3	8.0	11.1	5.0
CROAKER, black	0.4	8.0	8.1	3.0	1.0	9.0	9.5	6.0
GARIBALDI	0.1	10.0	3.6	6.0	2.8	4.0	6.5	7.0
BASS, kelp	2.5	5.0	1.8	7.0	0.2	13.0	4.5	8.0
HALFMOON			1.5	8.0	2.1	6.0	3.6	9.0
BASS, barred sand	1.5	6.0	0.7	11.0	0.1	15.0	2.3	10.0
OPALEYE			0.5	12.0	1.3	7.0	1.9	11.0
SARGO			0.9	9.0	0.2	14.0	1.1	12.0
PERCH, pile	0.1	11.0	0.4	14.0	0.6	10.0	1.0	13.0
SCORPIONFISH, Ca			0.4	13.0	0.3	12.0	0.7	14.0
SEAPERCH, rubberlip					0.6	11.0	0.6	15.0
GOBY, bluebanded	0.3	9.0					0.3	16.0
SEAPERCH, rainbow					0.1	16.0	0.1	17.0
SEAPERCH, white					0.1	17.0	0.1	18.0
TRIGGERFISH, finescale					0.1	18.0	0.1	19.0
TOTAL SPECIES	11.0		14.0		18.0		19.0	
TOTAL FISHES	232.7		58.1		33.0		323.8	

APPENDIX R TABLE 3

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1985 SURVEYS

ECOTONE TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	16.7	1.0	16.3	1.0	6.9	3.0	39.9	1.0
BASS, barred sand	4.1	2.0	8.5	2.0	3.5	5.0	16.0	2.0
PERCH, black	0.8	6.0	3.5	4.0	9.6	2.0	14.0	3.0
OPALEYE			0.2	7.0	11.0	1.0	11.2	4.0
WRASSE, rock	2.0	5.0	5.5	3.0	2.7	6.0	10.2	5.0
SHEEPHEAD, Ca	2.1	4.0	3.3	5.0	1.9	8.0	7.3	6.0
BASS, kelp	2.2	3.0	2.1	6.0	0.7	12.0	5.0	7.0
SARGO					3.7	4.0	3.7	8.0
SEAPERCH, rubberlip					2.3	7.0	2.3	9.0
HALFMOON					1.5	9.0	1.5	10.0
PERCH, pile					1.1	10.0	1.1	11.0
SEAPERCH, rainbow					1.0	11.0	1.0	12.0
GARIBALDI					0.4	13.0	0.4	13.0
CROAKER, black					0.1	14.0	0.1	14.0
TOTAL SPECIES	6.0		7.0		14.0		14.0	
TOTAL FISHES	28.0		39.5		46.3		113.7	

APPENDIX R -- TABLE 4

PAR RADIAL TRANSECTS, DECEMBER 1985
MEAN NUMBER OF JUVENILE-ADULT FISH
ALL MATURITY CATEGORIES COMBINED
(NO. PER 1000 CUBIC METERS)

Species	SEGMENT 1[a]		SEGMENT 2[b]		SEGMENT 3[c]		SEGMENT 4[d]	
	MEAN	STD	MEAN	STD	MEAN	STD	MEAN	STD
BASS, barred sand	19.4	14.2	13.9	31.3	2.8	7.9	0.0	0.0
BASS, kelp	2.8	7.9	2.8	7.9	8.3	16.5	0.0	0.0
HALFMOON	2.8	7.9	0.0	0.0	0.0	0.0	0.0	0.0
PERCH, black	22.2	23.8	0.0	0.0	0.0	0.0	0.0	0.0
SEAPERCH, rubberlip	2.8	7.9	0.0	0.0	0.0	0.0	0.0	0.0
SENORITA	0.0	0.0	0.0	0.0	2.8	7.9	0.0	0.0
SHEEPHEAD, California	5.6	10.3	11.1	23.8	0.0	0.0	0.0	0.0
WRASSE, rock	5.6	10.3	0.0	0.0	0.0	0.0	0.0	0.0
No. different species	7		3		3		0	
No. total individuals	61.1	35.1	27.8	56.7	13.9	16.5	0.0	0.0
No. transects	8		8		8		2	
Area searched	240 m^2		240 m^2		240 m^2		270 m^2	

[a] First 10 m of transect at distance of 3 to 13 m peripheral to Ecotone.

[b] Second 10-m segment at distance of 13-23 m.

[c] Third 10-m segment at distance of 23-33 m.

[d] Last 45-m segment at distance of 33-78 m.

JUVENILE-ADULT FISHES AT PAR: Estimated mean (rank) densities of juvenile (JUV), subadult (SAD), and adult (AD) life stages, plus totals (pooled stages) of each fish species encountered on quantitative transects at PAR, in Crest, Slope, Ecotone, Adjacent Sand (RAD1), and Outlying Sand (RADS2-4) strata, during fall 1986 (November 1986, January 1987).

APPENDIX R TABLE 5

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

CREST TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	1220.0	1.0	136.5	1.0	8.1	4.0	1364.6	1.0
WRASSE, rock			65.7	2.0	21.5	1.0	87.3	2.0
SHEEPHEAD, Ca	46.9	2.0	19.1	6.0	4.1	7.0	70.2	3.0
PERCH, black	14.1	3.0	33.9	3.0	10.2	3.0	58.2	4.0
HALFMOON			19.7	5.0	15.6	2.0	35.3	5.0
GARIBALDI	1.5	6.0	21.7	4.0	4.7	6.0	27.9	6.0
MACKEREL, jack			16.3	7.0			16.3	7.0
SENORITA	7.7	4.0	4.0	9.0	2.1	9.0	13.8	8.0
SARGO			3.3	10.0	7.2	5.0	10.5	9.0
BASS, kelp	5.5	5.0	2.0	12.0	1.6	10.0	9.1	10.0
CROAKER, black			5.7	8.0			5.7	11.0
OPALEYE			0.9	15.0	2.2	8.0	3.1	12.0
PERCH, pile			2.6	11.0	0.3	13.0	2.9	13.0
BASS, barred sand			1.6	13.0			1.6	14.0
GREENLING, painted			1.0	14.0			1.0	15.0
SCORPIONFISH, Ca			0.3	16.0	0.7	11.0	1.0	16.0
TRIGGERFISH, finescale					0.3	12.0	0.3	17.0
TOTAL SPECIES	6.0		16.0		13.0		17.0	
TOTAL FISHES	1295.6		334.3		78.6		1708.6	

APPENDIX R TABLE 6

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

SLOPE TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	137.8	1.0	58.2	1.0	4.6	2.0	200.7	1.0
WRASSE, rock	0.4	6.0	18.1	2.0	7.0	1.0	25.5	2.0
SENORITA	20.2	2.0	2.8	8.0	0.6	9.0	23.5	3.0
SHEEPHEAD, Ca	13.0	3.0	6.3	5.0	1.4	6.0	20.7	4.0
MACKEREL, jack			17.5	3.0			17.5	5.0
PERCH, black	2.5	4.0	8.2	4.0	4.2	3.0	14.9	6.0
GARIBALDI			2.9	7.0	1.8	5.0	4.7	7.0
HALFMOON			1.7	10.0	2.7	4.0	4.4	8.0
CROAKER, black			3.7	6.0			3.7	9.0
SARGO			2.3	9.0	0.5	10.0	2.8	10.0
BASS, kelp	1.3	5.0	0.5	12.0	0.3	11.0	2.1	11.0
BASS, barred sand	0.4	7.0	0.6	11.0	0.3	12.0	1.2	12.0
OPALEYE			0.4	13.0	0.7	7.0	1.1	13.0
PERCH, pile			0.2	15.0	0.7	8.0	0.9	14.0
SEAPERCH, rubberlip			0.3	14.0			0.3	15.0
SCORPIONFISH, Ca			0.1	16.0	0.1	13.0	0.1	16.0
TOTAL SPECIES	7.0		16.0		13.0		16.0	
TOTAL FISHES	175.6		123.6		24.8		324.0	

APPENDIX R TABLE 7

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

ECOTONE TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	26.3	1.0	6.6	2.0	2.0	3.0	34.9	1.0
WRASSE, rock	0.3	9.0	11.4	1.0	5.3	1.0	16.9	2.0
SENORITA	14.2	2.0	0.5	10.0	0.3	11.0	15.0	3.0
SHEEPHEAD, Ca	6.0	3.0	1.9	6.0	0.6	7.0	8.5	4.0
PERCH, black	2.0	4.0	3.5	4.0	2.1	2.0	7.7	5.0
MACKEREL, jack			5.4	3.0			5.4	6.0
BASS, barred sand	1.9	5.0	2.2	5.0	0.8	6.0	4.9	7.0
SARGO			0.6	8.0	1.1	5.0	1.7	8.0
PERCH, pile			0.5	9.0	1.1	4.0	1.6	9.0
BASS, kelp	0.6	6.0	0.4	11.0	0.1	13.0	1.1	10.0
CARIBALDI			0.9	7.0			0.9	11.0
SEAPERCH, rubberlip			0.2	13.0	0.5	9.0	0.7	12.0
OPALEYE			0.1	15.0	0.5	8.0	0.6	13.0
SCORPIONFISH, Ca	0.3	8.0	0.2	12.0	0.1	12.0	0.6	14.0
BONITO, Pacific	0.6	7.0					0.6	15.0
HALFMOON			0.1	14.0	0.4	10.0	0.5	16.0
ROCKFISH, olive			0.1	16.0			0.1	17.0
CROAKER, black			0.1	17.0			0.1	18.0
TOTAL SPECIES	9.0		17.0		13.0		18.0	
TOTAL FISHES	52.3		34.8		14.7		101.8	

APPENDIX R TABLE 8

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

RAD 1 TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH			60.2	1.0	23.1	1.0	83.3	1.0
MACKEREL, jack			58.8	2.0			58.8	2.0
SARGO			2.8	8.0	13.4	2.0	16.2	3.0
WRASSE, rock			7.9	3.0	6.0	4.0	13.9	4.0
PERCH, black			6.5	4.0	6.5	3.0	13.0	5.0
BASS, barred sand	5.1	1.0	4.2	6.5	1.9	5.5	11.1	6.0
SHEEPHEAD, Ca	3.7	2.0	5.1	5.0	1.4	7.0	10.2	7.0
CROAKER, black			4.2	6.5			4.2	8.0
BASS, kelp	0.9	3.0	1.4	9.0			2.3	9.0
PERCH, pile					1.9	5.5	1.9	10.0
SENORITA			0.9	10.0	0.5	9.5	1.4	11.0
HALFMOON					0.5	9.5	0.5	13.0
SEAPERCH, rubberlip					0.5	9.5	0.5	13.0
GARIBALDI					0.5	9.5	0.5	13.0
TOTAL SPECIES	3.0		10.0		11.0		14.0	
TOTAL FISHES	9.7		151.9		56.0		217.6	

APPENDIX R TABLE 9

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

RAD 2-4 TRANSECTS

	JUVENILE		SUB-ADULT		ADULT		TOTAL	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK	DENS.	RANK
MACKEREL, jack			69.4	1.0			69.4	1.0
BLACKSMITH	0.5	4.0	36.1	2.0	7.6	2.0	44.2	2.0
BASS, barred sand	3.1	1.0	7.6	3.0	3.0	3.0	13.6	3.0
SARGO			0.2	9.0	11.1	1.0	11.3	4.0
SHEEPHEAD, Ca	0.5	3.0	2.4	4.5	0.3	7.0	3.1	5.0
WRASSE, rock			2.4	4.5	0.6	5.5	3.0	6.0
SENORITA			0.9	7.0	1.7	4.0	2.6	7.0
BASS, kelp	0.8	2.0	1.5	6.0	0.2	9.0	2.5	8.0
PERCH, black			0.8	8.0	0.6	5.5	1.4	9.0
HALFMOON					0.2	9.0	0.2	10.5
SEAPERCH, rubberlip					0.2	9.0	0.2	10.5
SCORPIONFISH, Ca					0.1	11.0	0.1	12.5
HALIBUT, Ca			0.1	10.0			0.1	12.5
TOTAL SPECIES	4.0		10.0		11.0		13.0	
TOTAL FISHES	4.8		121.5		25.4		151.7	

APPENDIX R -- TABLE 10

YOY-OJ FISHES AT PAR: Estimated mean (rank) densities of young-of-the-year (YOY) and older juvenile (OJ) life-stages of each fish species encountered on quantitative transects, in Crest and Perimeter strata, on all (Oct, Nov, Dec) surveys at PAR in fall 1985.

APPENDIX R TABLE 10

PENDLETON ARTIFICIAL REEF
YOUNG-OF-YEAR FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS
FALL 1985 SURVEYS

CREST TRANSECTS

	YOUNG-OF-YEAR		OLDER JUV.		TOTAL JUV.	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	5316.5	1.0	117.9	1.0	5434.3	1.0
SHEEPHEAD, Ca	21.8	4.0	70.9	3.0	92.6	2.0
WRASSE, rock			74.8	2.0	74.8	3.0
BASS, kelp			45.9	4.0	45.9	4.0
GARIBALDI	9.1	5.0	29.1	5.0	38.2	5.0
PERCH, black	37.5	2.0			37.5	6.0
SENORITA	33.1	3.0	2.1	12.0	35.2	7.0
HALFMOON			13.6	6.0	13.6	8.0
SCORPIONFISH, Ca			8.4	7.0	8.4	9.0
SARGO	0.7	7.0	5.0	9.0	5.7	10.0
BASS, barred sand			5.6	8.0	5.6	11.0
PERCH, pile			4.5	10.0	4.5	12.0
GOBY, bluebanded	3.1	6.0			3.1	13.0
CROAKER, black			2.6	11.0	2.6	14.0
GREENLING, painted			2.0	13.0	2.0	15.0
TOTAL SPECIES	7.0		13.0		15.0	
TOTAL FISHES	5421.7		382.3		5804.0	

PERIMETER TRANSECTS

	YOUNG-OF-YEAR		OLDER JUV.		TOTAL JUV.	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK
SENORITA	71.7	1.0	4.4	6.0	76.1	1.0
WRASSE, rock	0.5	9.0	60.7	1.0	61.1	2.0
SHEEPHEAD, Ca	6.4	6.0	45.1	2.0	51.5	3.0
GOBY, blackeye	9.1	5.0	42.3	3.0	51.4	4.0
BLACKSMITH	17.5	2.0	19.0	4.0	36.4	5.0
BASS, barred sand			18.1	5.0	18.1	6.0
GOBY, bluebanded	13.6	3.0			13.6	7.0
PERCH, black	10.3	4.0			10.3	8.0
BASS, kelp			2.4	7.0	2.4	9.0
PERCH, pile	1.1	7.0	0.5	9.0	1.6	10.0
GARIBALDI			1.4	8.0	1.4	11.0
GOBY, zebra	0.9	8.0			0.9	12.0
HALIBUT, Ca			0.3	10.0	0.3	13.0
SCORPIONFISH, Ca	0.3	10.0			0.3	14.0
HALFMOON			0.2	11.0	0.2	15.0
TOTAL SPECIES	10.0		11.0		15.0	
TOTAL FISHES	131.3		194.4		325.7	

APPENDIX R -- TABLE 11

YOY-OJ FISHES AT PAR: Estimated mean (rank) densities of young-of-the-year (YOY), older juvenile (OJ), and total juvenile (TJUV) life stages of each fish species encountered on quantitative transects, in Crest and Perimeter strata, on all (Nov 1986, Jan 1987) surveys at PAR in fall 1986.

APPENDIX R TABLE 11

PENDLETON ARTIFICIAL REEF
YOUNG-OF-YEAR FISH SURVEY
MEAN (AND RANK) DENSITY PER 1000 CUBIC METERS

FALL 1986 SURVEYS

CREST TRANSECTS

	YOUNG-OF-YEAR		OLDER JUV.		TOTAL JUV.	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK
BLACKSMITH	2221.4	1.0	154.4	2.0	2375.8	1.0
SHEEPHEAD, Ca	2.1	4.0	174.5	1.0	176.6	2.0
PERCH, black	67.8	2.0			67.8	3.0
WRASSE, rock			49.6	3.0	49.6	4.0
GARIBALDI	1.2	5.0	19.4	4.0	20.6	5.0
SENORITA	6.6	3.0	8.7	7.0	15.3	6.0
HALFMOON			13.9	5.0	13.9	7.0
BASS, kelp	0.8	6.0	11.0	6.0	11.8	8.0
CROAKER, black			8.7	8.0	8.7	9.0
GREENLING, painted			1.3	9.0	1.3	10.0
SARGO			1.2	10.5	1.2	11.5
PERCH, pile			1.2	10.5	1.2	11.5
GOBY, bluebanded	0.7	7.0			0.7	13.0
TOTAL SPECIES	7.0		11.0		13.0	
TOTAL FISHES	2300.4		443.9		2744.4	

PERIMETER TRANSECTS

	YOUNG-OF-YEAR		OLDER JUV.		TOTAL JUV.	
SPECIES	DENS.	RANK	DENS.	RANK	DENS.	RANK
SENORITA	184.8	1.0	1.5	6.0	186.4	1.0
GOBY, blackeye	38.3	2.0	65.0	2.0	103.3	2.0
SHEEPHEAD, Ca	2.5	6.0	87.2	1.0	89.7	3.0
BLACKSMITH	13.3	3.0	19.4	4.0	32.7	4.0
WRASSE, rock			25.8	3.0	25.8	5.0
BASS, barred sand			10.5	5.0	10.5	6.0
PERCH, black	4.4	4.0			4.4	7.0
GOBY, bluebanded	4.1	5.0			4.1	8.0
BASS, kelp			0.5	7.0	0.5	9.5
SCORPIONFISH, Ca	0.2	7.0	0.3	8.0	0.5	9.5
HALIBUT, Ca			0.2	9.0	0.2	11.0
GARIBALDI			0.2	10.0	0.2	12.0
TOTAL SPECIES	7.0		10.0		12.0	
TOTAL FISHES	247.6		210.7		458.3	

APPENDIX S -- Complementary Analyses and Summary Data Used for Abundance Calculations of PAR Fishes

APPENDIX S -- TABLE 1

JUV-AD FISHES AT PAR: SUMMARY OF A POSTERIORI CONTRASTS FOR 1-WAY ANOVAS OF THE EFFECTS OF STRATUM ON BIOMASS DENSITY AT PAR IN FALL 1986. Strata evaluated were Crest (C), Slope (S), Ecotone (ECO), Adjacent Sand (RAD1), and 3 more distal segments of radial transects in Outlying Sand (RADS2,3,4). Data were pooled over all component life stages (juvenile, subadult, adult); module was used as a blocking variable. We evaluated five species that were biomass-dominant in Sand regions, along with the total of all nontransient fishes[a]. Analyses used log-transformed densities (grams per 1000 m^3). Values reported are the original raw data in kg/1000 m^3.

Species	Stratum Contrast
BASS, barred sand	6.1 ≥ 7.3 = 1.3 = 2.1 = 3.1 = 0.4 ≥ 0.3 RAD4 ≥ RAD2 = ECO = RAD3 = RAD1 = S ≥ C
BASS, kelp	1.9 > 0.4 = 0.2 = 0.3 = 1.1 = 0.4 = 0.2 C > all others
PERCH, black	4.7 = 1.5 ≥ 0.7 > 1.8 = 0.5 ≥ 0.2 = .02 C = S ≥ ECO > RAD1 = RAD2 ≥ RAD4 = RAD3
SHEEPHEAD, Calif.	19.0 ≥ 6.1 = 2.2 > 4.6 > 3.4 = 1.3 = 0.9 C ≥ S = ECO > RAD1 > RAD2 = RAD3 = RAD4
WRASSE, rock	8.0 = 2.4 = 1.7 > 1.6 > 0.7 = 0.2 = 0.1 C = S = ECO > RAD1 > RAD2 = RAD3 = RAD4
TOTAL (RESIDENT) FISHES[a]	59.9 ≥ 17.2 = 8.4 = 19.8 = 30.0 > 8.4 = 5.8 C > S = ECO = RAD1 = RAD2 > RAD4 = RAD3

[a]Excluding two transient species (*Trachurus*, *Sarda*)

APPENDIX S -- TABLE 2

JUV-AD FISHES AT PAR: SUMMARY OF 1-WAY ANOVA OF THE BIOMASS DENSITIES OF FISHES ON THE OUTLYING SAND SEGMENTS OF "INTERNAL" VERSUS "EXTERNAL" RADIAL TRANSECTS. Surveys (fall 1986) were used as a blocking variable with 3 levels. Transects were identified based on their location relative to the entire rock module complex at PAR; Outlying Sand regions were sampled by transect segments (SEGTRANS) 2, 3, and 4 (Appendix Q, Fig. 2). The five fishes evaluated (and their total) were species that dominated resident fish biomass in sandy regions. Analyses used log-transformed densities (grams per 1000 m^3). Values reported are the original raw data. Significance was adjusted for the Bonferroni t and evaluated at $\alpha_1 = 0.05/5 = 0.01$ for each of the five component species. Key: ** -- .01 > P > .001.

	Mean Density		
Species	Internal	External	Prob Int > Ext
BASS, barred sand	4,668	3,481	.24
BASS, kelp	788	306	.016
PERCH, black	243	240	.40
SHEEPHEAD, Calif.	2,308	632	.012
WRASSE, rock	446	118	.023
TOTAL (five spp)	8,453	4,779	.002**

APPENDIX S -- TABLES 3-4

JUV-AD FISHES AT PAR: ESTIMATED NUMERICAL ABUNDANCE, BY RELEVANT STRATUM AND YEAR, FOR EACH STRATUM WITHIN A TAXON, ENCOUNTERED ON SURVEYS DURING FALL 1985-86. Also noted is the percentage contribution of each stratum to total density. Taxa include each species encountered, plus total fishes (all species).

APPENDIX S TABLE 3 A

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=JUVENILE

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	2	5.5	16	37.6	24	56.9	42
BASS, kelp	24	41.4	21	36.3	13	22.3	57
BLACKSMITH	6,199	75.0	1,952	23.6	111	1.3	8,261
CROAKER, black	.	.	3	100.0	.	.	3
GARIBALDI	5	74.2	2	25.8	.	.	7
GOBY, bluebanded	.	.	2	100.0	.	.	2
PERCH, black	22	33.1	39	59.6	5	7.3	65
PERCH, pile	.	.	1	100.0	.	.	1
SARGO	5	100.0	.	.	.	.	5
SENORITA	46	36.1	82	63.9	.	.	128
SHEEPHEAD, Ca	47	30.2	96	62.0	12	7.9	155
WRASSE, rock	6	19.1	13	42.7	11	38.2	29
TOTAL	6,355	72.6	2,226	25.4	176	2.0	8,756

APPENDIX S TABLE 3 B

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=SUB-ADULT

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		ABUNDANCE
	ABUNDANCE		ABUNDANCE		ABUNDANCE		
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	3	4.9	9	14.4	48	80.8	59
BASS, kelp	24	43.9	18	34.1	12	22.1	54
BLACKSMITH	60	21.2	128	45.0	96	33.8	283
CROAKER, black	84	49.8	85	50.2	.	.	169
GARIBALDI	68	66.4	34	33.6	.	.	102
GREENLING, painted	2	100.0	.	.	.	.	2
HALFMOON	29	64.4	16	35.6	.	.	45
OPALEYE	10	57.0	6	37.2	1	5.7	17
PERCH, black	43	32.3	67	51.1	22	16.5	132
PERCH, pile	3	40.4	5	59.6	.	.	8
SARGO	36	77.8	10	22.2	.	.	46
SCORPIONFISH, Ca	6	60.4	4	39.6	.	.	10
SEAPERCH, rubberlip	1	100.0	.	.	.	.	1
SENORITA	8	56.5	6	43.5	.	.	14
SHEEPHEAD, Ca	82	49.6	63	38.3	20	12.2	165
WRASSE, rock	140	47.7	120	41.0	33	11.2	292
TOTAL	597	42.7	571	40.8	231	16.5	1,400

APPENDI, TABLE 3 C

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=ADULT

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	1	3.1	2	8.2	21	88.7	23
BASS, kelp	3	34.8	3	26.5	4	38.8	10
BLACKSMITH	189	65.6	61	21.1	39	13.3	289
CROAKER, black	.	.	7	86.1	1	13.9	8
GARIBALDI	78	71.9	28	26.1	2	2.0	108
HALFMOON	52	63.2	22	26.3	9	10.5	83
OPALEYE	29	28.4	13	12.6	61	59.1	103
PERCH, black	70	32.7	87	40.5	57	26.9	214
PERCH, pile	6	34.0	6	31.8	6	34.2	18
ROCKFISH, brown	2	100.0	.	.	.	.	2
SARGO	27	53.3	2	4.2	22	42.5	51
SCORPIONFISH, Ca	12	82.6	3	17.4	.	.	15
SEAPERCH, rainbow	.	.	1	17.9	5	82.1	6
SEAPERCH, rubberlip	2	8.7	4	18.5	14	72.8	19
SEAPERCH, white	.	.	1	100.0	.	.	1
SENORITA	21	66.2	11	33.8	.	.	32
SHEEPHEAD, Ca	37	50.0	26	34.9	11	15.1	74
TRIGGERFISH, finescale	.	.	1	100.0	.	.	1
WRASSE, rock	52	51.1	33	32.3	17	16.6	102
TOTAL	581	50.2	308	26.6	268	23.1	1,157

APPENDIX TABLE 3 D

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE
FALL 1985 SURVEYS
MATURITY=TOTAL

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
SPECIES	NO.	%	NO.	%	NO.	%	NO.
BASS, barred sand	6	4.7	26	21.1	93	74.2	125
BASS, kelp	51	42.0	42	34.5	28	23.5	121
BLACKSMITH	6,448	73.0	2,140	24.2	245	2.8	8,833
CROAKER, black	84	46.6	95	52.7	1	0.6	180
GARIBALDI	150	69.4	64	29.6	2	1.0	217
GOBY, bluebanded	.	.	2	100.0	.	.	2
GREENLING, painted	2	100.0	.	.	.	.	2
HALFMOON	81	63.6	38	29.6	9	6.8	128
OPALEYE	39	32.5	19	16.1	62	51.4	120
PERCH, black	134	32.6	193	46.9	84	20.4	411
PERCH, pile	9	34.6	11	43.0	6	22.5	27
ROCKFISH, brown	2	100.0	.	.	.	.	2
SARGO	67	66.5	12	12.2	22	21.3	101
SCORPIONFISH, Ca	18	73.8	6	26.2	.	.	24
SEAPERCH, rainbow	.	.	1	17.9	5	82.1	6
SEAPERCH, rubberlip	3	14.9	4	17.2	14	67.8	21
SEAPERCH, white	.	.	1	100.0	.	.	1
SENORITA	76	43.3	99	56.7	.	.	175
SHEEPHEAD, Ca	165	42.0	185	46.9	43	11.0	394
TRIGGERFISH, finescale	.	.	1	100.0	.	.	1
WRASSE, rock	197	46.6	165	39.1	61	14.4	424
TOTAL	7,533	66.6	3,105	27.4	675	6.0	11,313

APPENDIX S TABLE 4 A

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=JUVENILE

	STRATUM										TOTAL
	SLOPE		ECOTONE		RAD 1		RAD 2-4		CREST		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	3	2.6	10	7.7	31	24.0	85	65.8	.	.	129
BASS, kelp	10	16.8	4	6.8	6	9.3	21	35.2	19	31.9	60
BLACKSMITH	1,660	24.1	131	1.9	.	.	18	0.3	5,067	73.7	6,876
BONITO, Pacific	.	.	3	100.0	.	.	.	.	.	.	3
GARIBALDI	.	.	.	.	.	.	.	.	5	100.0	5
PERCH, black	31	34.7	9	10.1	.	.	.	.	49	55.3	89
SCORPIONFISH, Ca	.	.	1	100.0	.	.	.	.	.	.	1
SENORITA	223	68.0	74	22.5	.	.	.	.	31	9.4	328
SHEEPHEAD, Ca	123	34.4	31	8.8	23	6.3	14	4.0	167	46.6	359
WRASSE, rock	3	66.2	2	33.8	.	.	.	.	.	.	5
TOTAL	2,054	26.1	265	3.4	59	0.8	138	1.8	5,339	68.0	7,855

APPENDIX S TABLE 4 B

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=SUB-ADULT

	STRATUM										TOTAL
	CREST		SLOPE		ECOTONE		RAD 1		RAD 2-4		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	6	2.6	6	2.6	12	5.1	25	10.7	188	79.1	238
BASS, kelp	8	13.2	5	8.6	2	4.0	8	14.3	35	59.9	59
BLACKSMITH	528	21.5	553	22.5	37	1.5	366	14.9	974	39.6	2,459
CROAKER, black	26	25.1	51	49.5	1	0.6	25	24.8	.	.	102
GARIBALDI	70	66.5	31	28.9	5	4.6	.	.	.	.	106
GREENLING, painted	4	100.0	.	.	.	.	.	.	.	.	4
HALFMOON	58	75.4	18	23.7	1	0.8	.	.	.	.	77
HALIBUT, Ca	.	.	.	.	.	.	.	.	4	100.0	4
MACKEREL, jack	19	0.6	123	4.0	24	0.8	358	11.6	2,551	83.0	3,074
OPALEYE	4	50.6	3	41.6	1	7.8	.	.	.	.	8
PERCH, black	95	34.8	87	32.1	22	8.2	39	14.5	28	10.4	273
PERCH, pile	12	72.4	2	9.6	3	18.0	.	.	.	.	17
ROCKFISH, olive	.	.	.	.	1	100.0	.	.	.	.	1
SARGO	13	21.1	21	34.2	3	4.9	17	28.1	7	11.8	60
SCORPIONFISH, Ca	1	27.6	1	32.1	1	40.3	.	.	.	.	3
SEAPERCH, rubberlip	.	.	3	71.2	1	28.8	.	.	.	.	4
SENORITA	15	25.5	22	37.6	2	3.7	6	9.5	14	23.8	60
SHEEPHEAD, Ca	62	28.5	62	28.4	10	4.5	31	14.2	53	24.4	218
WRASSE, rock	225	38.9	183	31.6	63	10.9	48	8.3	60	10.4	579
TOTAL	1,146	15.6	1,170	15.9	189	2.6	924	12.6	3,915	53.3	7,344

APPENDIX S TABLE 4 C

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=ADULT

	STRATUM										TOTAL
	SLOPE		ECOTONE		RAD 1		RAD 2-4		CREST		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	2	2.4	4	5.1	11	14.6	60	77.9	.	.	77
BASS, kelp	3	18.1	0	2.4	.	.	7	43.0	6	36.6	16
BLACKSMITH	39	7.6	9	1.7	141	27.5	290	56.7	33	6.5	512
GARIBALDI	16	44.9	.	.	3	7.9	.	.	17	47.1	36
HALFMOON	24	28.0	2	2.2	3	3.3	7	8.4	49	58.1	84
OPALEYE	6	32.9	3	15.1	.	.	.	.	10	52.0	19
PERCH, black	43	28.7	11	7.1	39	26.5	21	14.3	35	23.5	149
PERCH, pile	6	25.2	5	22.4	11	46.5	.	.	1	5.8	24
SARGO	4	0.7	5	0.9	82	14.7	425	76.8	38	6.9	554
SCORPIONFISH, Ca	0	8.2	0	4.3	.	.	4	59.9	2	27.6	6
SEAPERCH, rubberlip	.	.	2	17.8	3	23.4	7	58.8	.	.	12
SENORITA	4	5.4	1	1.6	3	3.5	64	79.8	8	9.7	80
SHEEPHEAD, Ca	15	33.2	3	7.1	8	18.4	7	15.5	12	25.8	46
TRIGGERFISH, finescale	.	.	.	.	.	.	.	.	1	100.0	1
WRASSE, rock	67	30.1	28	12.5	37	16.4	18	7.9	74	33.1	224
TOTAL	230	12.5	73	4.0	341	18.5	910	49.5	286	15.5	1,841

APPENDIX S TABLE 4 D
PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE
FALL 1986 SURVEYS
MATURITY=TOTAL

	STRATUM										TOTAL
	CREST		SLOPE		ECOTONE		RAD 1		RAD 2-4		
	ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	6	1.4	11	2.5	26	5.9	68	15.2	333	75.0	444
BASS, kelp	33	24.3	18	13.4	7	5.1	14	10.3	64	46.9	136
BLACKSMITH	5,628	57.2	2,253	22.9	177	1.8	507	5.1	1,282	13.0	9,847
BONITO, Pacific	.	.	.	.	3	100.0	.	.	.	.	3
CROAKER, black	26	25.1	51	49.5	1	0.6	25	24.8	.	.	102
GARIBALDI	92	63.0	47	31.7	5	3.3	3	1.9	.	.	147
GREENLING, painted	4	100.0	.	.	.	.	.	.	.	.	4
HALFMOON	107	66.3	42	26.0	3	1.6	3	1.7	7	4.4	161
HALIBUT, Ca	.	.	.	.	.	.	.	.	4	100.0	4
MACKEREL, jack	19	0.6	123	4.0	24	0.8	358	11.6	2,551	83.0	3,074
OPALEYE	14	51.6	10	35.5	4	12.9	.	.	.	.	27
PERCH, black	179	35.1	161	31.5	42	8.2	79	15.4	50	9.7	511
PERCH, pile	14	33.3	8	18.8	8	20.6	11	27.3	.	.	41
ROCKFISH, olive	.	.	.	.	1	100.0	.	.	.	.	1
SARGO	51	8.3	25	4.0	8	1.3	99	16.1	432	70.4	614
SCORPIONFISH, Ca	2	24.1	1	13.5	3	26.2	.	.	4	36.2	10
SEAPERCH, rubberlip	.	.	3	17.4	3	20.5	3	17.7	7	44.5	16
SENORITA	54	11.5	250	53.4	77	16.5	8	1.8	78	16.7	467
SHEEPHEAD, Ca	241	38.7	200	32.2	44	7.1	62	10.0	74	12.0	622
TRIGGERFISH, finescale	1	100.0	.	.	.	.	.	.	.	.	1
WRASSE, rock	299	37.1	253	31.4	93	11.5	84	10.5	78	9.7	808
TOTAL	6,771	39.7	3,454	20.3	527	3.1	1,323	7.8	4,963	29.1	17,039

APPENDIX S -- TABLES 5-6

JUV-AD FISHES AT PAR: ESTIMATED **BIOMASS ABUNDANCE**, BY RELEVANT STRATUM AND YEAR, FOR EACH STAGE WITHIN A TAXON, ENCOUNTERED ON SURVEYS DURING **FALL 1985-86**. Also noted is the percentage contribution of each stratum to total deinsity. Taxa include each species encountered, plus total fishes (all species).

APPENDIX S TABLE 5 A

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=JUVENILE

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		
	BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	0.16	5.5	1.10	37.6	1.66	56.9	2.93
BASS, kelp	1.05	41.4	0.92	36.3	0.57	22.3	2.54
BLACKSMITH	7.70	75.0	2.43	23.6	0.14	1.3	10.27
CROAKER, black	.	.	0.12	100.0	.	.	0.12
GARIBALDI	0.09	74.2	0.03	25.8	.	.	0.13
PERCH, black	0.15	33.1	0.26	59.6	0.03	7.3	0.44
SARGO	0.06	100.0	.	.	.	.	0.06
SENORITA	0.03	36.1	0.05	63.9	.	.	0.09
SHEEPHEAD, Ca	3.81	30.2	7.84	62.0	0.99	7.9	12.64
WRASSE, rock	0.06	19.1	0.13	42.7	0.12	38.2	0.31
TOTAL	13.12	44.4	12.89	43.7	3.51	11.9	29.52

APPENDIX S TABLE 5 B

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=SUB-ADULT

	STRATUM						TOTAL
	CREST		SLOPE		ECOTONE		
	BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	0.70	4.9	2.06	14.4	11.59	80.8	14.35
BASS, kelp	4.71	43.9	3.66	34.1	2.37	22.1	10.73
BLACKSMITH	1.88	21.2	4.00	45.0	3.00	33.8	8.88
CROAKER, black	10.00	49.8	10.08	50.2	.	.	20.09
GARIBALDI	18.47	66.4	9.33	33.6	.	.	27.80
GREENLING, painted	0.11	100.0	.	.	.	.	0.11
HALFMOON	3.66	64.4	2.03	35.6	.	.	5.68
OPALEYE	2.65	57.0	1.73	37.2	0.27	5.7	4.65
PERCH, black	3.00	32.3	4.75	51.1	1.53	16.5	9.28
PERCH, pile	0.48	40.4	0.71	59.6	.	.	1.19
SARGO	4.25	77.8	1.21	22.2	.	.	5.45
SCORPIONFISH, Ca	2.24	60.4	1.47	39.6	.	.	3.72
SEAPERCH, rubberlip	0.43	100.0	.	.	.	.	0.43
SENORITA	0.21	56.5	0.16	43.5	.	.	0.37
SHEEPHEAD, Ca	42.22	49.6	32.58	38.3	10.37	12.2	85.17
WRASSE, rock	7.20	47.7	6.19	41.0	1.69	11.2	15.07
TOTAL	102.20	48.0	79.96	37.5	30.82	14.5	212.98

APPENDIX S TABLE 5 C

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=ADULT

	STRATUM						
	CREST		SLOPE		ECOTONE		TOTAL
	BIOMASS		BIOMASS		BIOMASS		BIOMASS
SPECIES	NO.	%	NO.	%	NO.	%	NO.
BASS, barred sand	0.60	3.1	1.57	8.2	17.04	88.7	19.21
BASS, kelp	2.39	34.8	1.82	26.5	2.67	38.8	6.88
BLACKSMITH	17.06	65.6	5.49	21.1	3.47	13.3	26.02
CROAKER, black	.	.	1.94	86.1	0.31	13.9	2.25
GARIBALDI	49.53	71.9	18.01	26.1	1.35	2.0	68.89
HALFMOON	14.26	63.2	5.94	26.3	2.37	10.5	22.57
OPALEYE	14.75	28.4	6.54	12.6	30.71	59.1	52.01
PERCH, black	14.95	32.7	18.53	40.5	12.30	26.9	45.78
PERCH, pile	2.21	34.0	2.07	31.8	2.22	34.2	6.50
SARGO	8.50	53.3	0.68	4.2	6.79	42.5	15.97
SCORPIONFISH, Ca	10.59	82.6	2.23	17.4	.	.	12.81
SEAPERCH, rainbow	.	.	0.18	17.9	0.81	82.1	0.99
SEAPERCH, rubberlip	1.21	8.7	2.56	18.5	10.08	72.8	13.86
SENORITA	1.42	66.2	0.73	33.8	.	.	2.15
SHEEPHEAD, Ca	52.05	50.0	36.31	34.9	15.77	15.1	104.12
TRIGGERFISH, finescale	.	.	0.12	100.0	.	.	0.12
WRASSE, rock	9.29	51.1	5.87	32.3	3.01	16.6	18.16
TOTAL	198.81	47.5	110.57	26.4	108.90	26.0	418.28

APPENDIX . TABLE 5 D

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=TOTAL

	STRATUM						
	CREST		SLOPE		ECOTONE		TOTAL
	BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.
SPECIES							
BASS, barred sand	1.45	4.0	4.73	13.0	30.30	83.1	36.48
BASS, kelp	8.15	40.4	6.40	31.7	5.61	27.8	20.15
BLACKSMITH	26.64	59.0	11.91	26.4	6.60	14.6	45.16
CROAKER, black	10.00	44.5	12.14	54.1	0.31	1.4	22.46
GARIBALDI	68.10	70.3	27.37	28.3	1.35	1.4	96.82
GREENLING, painted	0.11	100.0	.	.	.	.	0.11
HALFMOON	17.92	63.4	7.96	28.2	2.37	8.4	28.25
OPALEYE	17.40	30.7	8.28	14.6	30.98	54.7	56.66
PERCH, black	18.10	32.6	23.54	42.4	13.87	25.0	55.50
PERCH, pile	2.69	35.0	2.78	36.1	2.22	28.9	7.69
SARGO	12.81	59.6	1.89	8.8	6.79	31.6	21.48
SCORPIONFISH, Ca	12.83	77.6	3.70	22.4	.	.	16.53
SEAPERCH, rainbow	.	.	0.18	17.9	0.81	82.1	0.99
SEAPERCH, rubberlip	1.64	11.5	2.56	17.9	10.08	70.6	14.28
SENORITA	1.66	63.8	0.94	36.2	.	.	2.61
SHEEPHEAD, Ca	98.08	48.6	76.73	38.0	27.13	13.4	201.94
TRIGGERFISH, finescale	.	.	0.12	100.0	.	.	0.12
WRASSE, rock	16.54	49.3	12.19	36.3	4.81	14.3	33.54
TOTAL	314.12	47.5	203.42	30.8	143.24	21.7	660.78

APPENDIX S TABLE 6 A

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=JUVENILE

	STRATUM										
	SLOPE		ECOTONE		RAD 1		RAD 2-4		CREST		TOTAL
	BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	0.21	2.6	0.63	7.7	1.97	24.0	5.42	65.8	.	.	8.24
BASS, kelp	0.49	16.8	0.20	6.8	0.27	9.3	1.03	35.2	0.94	31.9	2.94
BLACKSMITH	1.67	24.1	0.13	1.9	.	.	0.02	0.3	5.09	73.7	6.90
BONITO, Pacific	.	.	0.68	100.0	.	.	.	.	.	.	0.68
GARIBALDI	.	.	.	.	.	.	.	.	0.12	100.0	0.12
PERCH, black	0.21	34.7	0.06	10.1	.	.	.	.	0.33	55.3	0.60
SENORITA	0.11	68.0	0.04	22.5	.	.	.	.	0.02	9.4	0.16
SHEEPHEAD, Ca	11.17	34.4	2.85	8.8	2.04	6.3	1.28	4.0	15.16	46.6	32.51
WRASSE, rock	0.03	66.2	0.02	33.8	.	.	.	.	.	.	0.05
TOTAL	13.90	26.6	4.61	8.8	4.29	8.2	7.75	14.9	21.65	41.5	52.20

APPENDIX S TABLE 6 B

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=SUB-ADULT

	STRATUM										TOTAL
	CREST		SLOPE		ECOTONE		RAD 1		RAD 2-4		
	BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	1.32	2.6	1.28	2.6	2.55	5.1	5.35	10.7	39.64	79.1	50.15
BASS, kelp	1.59	13.2	1.03	8.6	0.48	4.0	1.72	14.3	7.20	59.9	12.02
BLACKSMITH	10.92	21.5	11.45	22.5	0.77	1.5	7.57	14.9	20.16	39.6	50.87
CROAKER, black	2.61	25.1	5.13	49.5	0.06	0.6	2.57	24.8	.	.	10.37
GARIBALDI	19.68	66.5	8.54	28.9	1.36	4.6	.	.	.	.	29.58
GREENLING, painted	0.21	100.0	.	.	.	.	.	.	.	.	0.21
HALFMOON	7.52	75.4	2.37	23.7	0.08	0.8	.	.	.	.	9.97
HALIBUT, Ca	.	.	.	.	.	.	.	.	1.50	100.0	1.50
MACKEREL, jack	1.24	0.6	8.11	4.0	1.59	0.8	23.65	11.6	168.72	83.0	203.30
OPALEYE	1.08	50.6	0.89	41.6	0.17	7.8	.	.	.	.	2.14
PERCH, black	7.31	34.8	6.73	32.1	1.73	8.2	3.04	14.5	2.18	10.4	20.98
PERCH, pile	1.37	72.4	0.18	9.6	0.34	18.0	.	.	.	.	1.89
ROCKFISH, olive	.	.	.	.	0.04	100.0	.	.	.	.	0.04
SARGO	1.39	21.1	2.25	34.2	0.32	4.9	1.85	28.1	0.78	11.8	6.59
SCORPIONFISH, Ca	0.33	27.6	0.38	32.1	0.48	40.3	.	.	.	.	1.18
SEAPERCH, rubberlip	.	.	0.60	71.2	0.24	28.8	.	.	.	.	0.85
SENORITA	0.34	25.5	0.50	37.6	0.05	3.7	0.13	9.5	0.32	23.8	1.33
SHEEPHEAD, Ca	30.60	28.5	30.54	28.4	4.83	4.5	15.29	14.2	26.23	24.4	107.49
WRASSE, rock	14.75	38.9	11.97	31.6	4.13	10.9	3.13	8.3	3.94	10.4	37.92
TOTAL	102.25	18.6	91.95	16.8	19.23	3.5	64.30	11.7	270.66	49.4	548.39

APPENDIX S TABLE 6 C

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=ADULT

	STRATUM										
	SLOPE		ECOTONE		RAD 1		RAD 2-4		CREST		TOTAL
	BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	1.88	2.4	3.99	5.1	11.35	14.6	60.70	77.9	.	.	77.92
BASS, kelp	2.35	18.1	0.31	2.4	.	.	5.60	43.0	4.77	36.6	13.04
BLACKSMITH	3.24	7.6	0.72	1.7	11.67	27.5	24.08	56.7	2.76	6.5	42.47
GARIBALDI	10.21	44.9	.	.	1.80	7.9	.	.	10.70	47.1	22.71
HALFMOON	5.83	28.0	0.47	2.2	0.69	3.3	1.75	8.4	12.08	58.1	20.82
OPALEYE	3.53	32.9	1.62	15.1	.	.	.	.	5.57	52.0	10.72
PERCH, black	8.39	28.7	2.07	7.1	7.73	26.5	4.17	14.3	6.87	23.5	29.22
PERCH, pile	2.19	25.2	1.95	22.4	4.04	46.5	.	.	0.51	5.8	8.68
SARGO	0.93	0.7	1.13	0.9	19.16	14.7	99.75	76.8	8.96	6.9	129.92
SCORPIONFISH, Ca	0.45	8.2	0.24	4.3	.	.	3.30	59.9	1.52	27.6	5.51
SEAPERCH, rubberlip	.	.	1.23	17.8	1.61	23.4	4.05	58.8	.	.	6.89
SENORITA	0.25	5.4	0.07	1.6	0.17	3.5	3.74	79.8	0.45	9.7	4.69
SHEEPHEAD, Ca	19.65	33.2	4.19	7.1	10.90	18.4	9.14	15.5	15.29	25.8	59.17
TRIGGERFISH, finescale	.	.	.	.	.	.	.	.	0.65	100.0	0.65
WRASSE, rock	11.73	30.1	4.86	12.5	6.38	16.4	3.08	7.9	12.89	33.1	38.94
TOTAL	70.63	15.0	22.83	4.8	75.50	16.0	219.36	46.5	83.02	17.6	471.35

APPENDIX S TABLE 6 D
PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE
FALL 1986 SURVEYS
MATURITY=TOTAL

	STRATUM										
	CREST		SLOPE		ECOTONE		RAD 1		RAD 2-4		TOTAL
	BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS		BIOMASS
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.
SPECIES											
BASS, barred sand	1.32	1.0	3.38	2.5	7.18	5.3	18.68	13.7	105.76	77.6	136.31
BASS, kelp	7.30	26.1	3.88	13.9	1.00	3.6	1.99	7.1	13.83	49.4	28.00
BLACKSMITH	18.76	18.7	16.36	16.3	1.62	1.6	19.24	19.2	44.26	44.1	100.25
BONITO, Pacific	.	.	.	.	0.68	100.0	.	.	.	.	0.68
CROAKER, black	2.61	25.1	5.13	49.5	0.06	0.6	2.57	24.8	.	.	10.37
GARIBALDI	30.51	58.2	18.75	35.8	1.36	2.6	1.80	3.4	.	.	52.41
GREENLING, painted	0.21	100.0	.	.	.	.	.	.	.	.	0.21
HALFMOON	19.61	63.7	8.19	26.6	0.55	1.8	0.69	2.3	1.75	5.7	30.79
HALIBUT, Ca	.	.	.	.	.	.	.	.	1.50	100.0	1.50
MACKEREL, jack	1.24	0.6	8.11	4.0	1.59	0.8	23.65	11.6	168.72	83.0	203.30
OPALEYE	6.66	51.8	4.42	34.4	1.78	13.9	.	.	.	.	12.86
PERCH, black	14.50	28.5	15.33	30.2	3.85	7.6	10.77	21.2	6.35	12.5	50.80
PERCH, pile	1.88	17.7	2.37	22.4	2.29	21.6	4.04	38.2	.	.	10.57
ROCKFISH, olive	.	.	.	.	0.04	100.0	.	.	.	.	0.04
SARGO	10.35	7.6	3.18	2.3	1.45	1.1	21.01	15.4	100.52	73.6	136.52
SCORPIONFISH, Ca	1.85	27.6	0.83	12.4	0.71	10.6	.	.	3.30	49.3	6.69
SEAPERCH, rubberlip	.	.	0.60	7.8	1.47	19.0	1.61	20.8	4.05	52.4	7.74
SENORITA	0.81	13.1	0.86	14.0	0.16	2.6	0.29	4.7	4.06	65.7	6.17
SHEEPHEAD, Ca	61.04	30.6	61.36	30.8	11.87	6.0	28.23	14.2	36.66	18.4	199.17
TRIGGERFISH, finescale	0.65	100.0	.	.	.	.	.	.	.	.	0.65
WRASSE, rock	27.64	35.9	23.73	30.9	9.00	11.7	9.51	12.4	7.03	9.1	76.90
TOTAL	206.92	19.3	176.48	16.5	46.67	4.4	144.09	13.4	497.78	46.4	1071.94

APPENDIX S -- TABLES 7-8

YOY-OJ FISHES AT PAR: ESTIMATED NUMERICAL ABUNDANCE, BY RELEVANT STRATUM AND YEAR, FOR EACH STRATUM WITHIN A TAXON, ENCOUNTERED ON SURVEYS DURING FALL 1985-86. Also noted is the percentage contribution of each stratum to total density. Taxa include each species encountered, plus total fishes (all species).

APPENDIX S TABLE 7 A

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=YOY

	STRATUM				TOTAL
	CREST		PERIMETER		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.
SPECIES					
BLACKSMITH	72,873	99.9	39	0.1	72,912
GARIBALDI	146	100.0	.	.	146
GOBY, blackeye	.	.	17	100.0	17
GOBY, bluebanded	62	70.0	26	30.0	88
GOBY, zebra	.	.	2	100.0	2
PERCH, black	545	96.2	21	3.8	566
PERCH, pile	.	.	3	100.0	3
SARGO	16	100.0	.	.	16
SCORPIONFISH, Ca	.	.	1	100.0	1
SENORITA	596	80.1	148	19.9	744
SHEEPHEAD, Ca	273	95.9	12	4.1	285
WRASSE, rock	.	.	1	100.0	1
TOTAL	74,511	99.6	270	0.4	74,780

APPENDIX S TABLE 7 B

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=JUVENILE

	STRATUM				TOTAL
	CREST		PERIMETER		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.
SPECIES					
BASS, barred sand	64	63.9	36	36.1	101
BASS, kelp	643	99.3	5	0.7	647
BLACKSMITH	1,517	98.0	31	2.0	1,548
CROAKER, black	31	100.0	.	.	31
GARIBALDI	386	99.3	3	0.7	388
GOBY, blackeye	.	.	84	100.0	84
GREENLING, painted	48	100.0	.	.	48
HALFMOON	220	99.7	1	0.3	220
HALIBUT, Ca	.	.	0	100.0	0
PERCH, pile	67	98.7	1	1.3	68
SARGO	72	100.0	.	.	72
SCORPIONFISH, Ca	109	100.0	.	.	109
SENORITA	26	77.1	8	22.9	34
SHEEPHEAD, Ca	1,044	92.8	81	7.2	1,124
WRASSE, rock	982	89.1	120	10.9	1,102
TOTAL	5,209	93.4	368	6.6	5,577

APPENDIX S TABLE 7 C

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1985 SURVEYS

MATURITY=TOTAL

	STRATUM				TOTAL
	CREST		PERIMETER		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.
SPECIES					
BASS, barred sand	64	63.9	36	36.1	101
BASS, kelp	643	99.3	5	0.7	647
BLACKSMITH	74,390	99.9	71	0.1	74,461
CROAKER, black	31	100.0	.	.	31
GARIBALDI	532	99.5	3	0.5	535
GOBY, blackeye	.	.	101	100.0	101
GOBY, bluebanded	62	70.0	26	30.0	88
GOBY, zebra	.	.	2	100.0	2
GREENLING, painted	48	100.0	.	.	48
HALFMOON	220	99.7	1	0.3	220
HALIBUT, Ca	.	.	0	100.0	0
PERCH, black	545	96.2	21	3.8	566
PERCH, pile	67	94.7	4	5.3	71
SARGO	88	100.0	.	.	88
SCORPIONFISH, Ca	109	99.5	1	0.5	109
SENORITA	622	80.0	156	20.0	777
SHEEPHEAD, Ca	1,317	93.5	92	6.5	1,409
WRASSE, rock	982	89.1	121	10.9	1,103
TOTAL	79,720	99.2	638	0.8	80,358

APPENDIX S TABLE 8 A

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=YOY

	STRATUM				TOTAL
	CREST		PERIMETER		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
SPECIES	NO.	%	NO.	%	NO.
BASS, kelp	10	100.0	.	.	10
BLACKSMITH	30,301	99.9	25	0.1	30,327
GARIBALDI	15	100.0	.	.	15
GOBY, blackeye	.	.	72	100.0	72
GOBY, bluebanded	9	47.8	10	52.2	20
PERCH, black	906	98.9	10	1.1	916
SCORPIONFISH, Ca	.	.	1	100.0	1
SENORITA	80	17.9	368	82.1	449
SHEEPHEAD, Ca	28	86.3	5	13.7	33
TOTAL	31,351	98.5	491	1.5	31,842

APPENDIX S TABLE 8 B

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=JUVENILE

	STRATUM				TOTAL
	PERIMETER		CREST		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.
SPECIES					
BASS, barred sand	23	100.0	.	.	23
BASS, kelp	1	0.9	143	99.1	144
BLACKSMITH	34	1.7	1,968	98.3	2,002
CROAKER, black	.	.	108	100.0	108
GARIBALDI	1	0.3	251	99.7	252
GOBY, blackeye	121	100.0	.	.	121
GREENLING, painted	.	.	16	100.0	16
HALFMOON	.	.	183	100.0	183
HALIBUT, Ca	1	100.0	.	.	1
PERCH, pile	.	.	10	100.0	10
SARGO	.	.	10	100.0	10
SCORPIONFISH, Ca	1	100.0	.	.	1
SENORITA	4	2.8	124	97.2	128
SHEEPHEAD, Ca	159	6.2	2,416	93.8	2,575
WRASSE, rock	57	7.2	731	92.8	788
TOTAL	400	6.3	5,961	93.7	6,361

APPENDIX S TABLE 8 C

PENDLETON ARTIFICIAL REEF
YOUNG OF YEAR -- OLDER JUVENILE FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE

FALL 1986 SURVEYS

MATURITY=TOTAL

	STRATUM				TOTAL
	PERIMETER		CREST		
	ABUNDANCE		ABUNDANCE		ABUNDANCE
	NO.	%	NO.	%	NO.
SPECIES					
BASS, barred sand	23	100.0	.	.	23
BASS, kelp	1	0.8	153	99.2	155
BLACKSMITH	59	0.2	32,270	99.8	32,329
CROAKER, black	.	.	108	100.0	108
GARIBALDI	1	0.3	266	99.7	267
GOBY, blackeye	193	100.0	.	.	193
GOBY, bluebanded	10	52.2	9	47.8	20
GREENLING, painted	.	.	16	100.0	16
HALFMOON	.	.	183	100.0	183
HALIBUT, Ca	1	100.0	.	.	1
PERCH, black	10	1.1	906	98.9	916
PERCH, pile	.	.	10	100.0	10
SARGO	.	.	10	100.0	10
SCORPIONFISH, Ca	1	100.0	.	.	1
SENORITA	372	64.5	205	35.5	577
SHEEPHEAD, Ca	163	6.3	2,444	93.7	2,607
WRASSE, rock	57	7.2	731	92.8	788
TOTAL	891	2.3	37,312	97.7	38,203

JUVENILE-ADULT FISHES AT PAR: ESTIMATED ABUNDANCE (NUMBERS AND BIOMASS), FOR EACH LIFE STAGE (AND POOLED LIFE STAGES) WITHIN A TAXON, ENCOUNTERED ON SURVEYS DURING FALL 1986. Taxa include each species encountered, plus total fishes (all species). Abundance estimates are the sum of stratum subtotals weighted by the areal contribution of the respective stratum. This alternate 1986 estimate is based on Rock (Crest, Slope) plus Ecotone strata.

APPENDIX S -- TABLE 9

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE FOR ROCK PLUS ECOTONE HABITATS
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	ABUN.	RANK	ABUN.	RANK	ABUN.	RANK	ABUN.	2*SE	RANK
BLACKSMITH	9832	1	2080	1	309	1	12221	7102	1
WRASSE, rock	5	8	471	2	169	2	645	214	2
SHEEPHEAD, Ca	322	3	134	6	30	7	486	44	3
PERCH, black	89	4	205	3	88	4	382	132	4
SENORITA	328	2	40	10	13	9	381	74	5
CROAKER, black			191	4			191	187	6
SARGO	1	11	48	9	130	3	178	185	7
MACKEREL, jack			165	5			165	331	8
HALFMOON			77	8	75	5	151	126	9
GARIBALDI	5	7	106	7	33	6	144	35	10
BASS, kelp	34	5	15	13	9	11	58	19	11
BASS, barred sand	13	6	24	11	6	12	44	61	12
PERCH, pile			17	12	13	10	30	24	13
OPALEYE			8	14	19	8	27	8	14
SCORPIONFISH, Ca	1	10	3	17	2	13	6	4	15
SEAPERCH, rubberlip			4	16	2	14	6	4	16
GREENLING, painted			4	15			4	9	17
BONITO, Pacific	3	9					3	5	18
TRIGGERFISH, finescale					1	15	1	3	19
ROCKFISH, olive			1	18			1	1	20
Total Individuals	10632	.	3592	.	900	.	15124	6737	.

APPENDIX S -- TABLE 10

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BICMASS ABUNDANCE ESTIMATE (KG) FOR ROCK PLUS ECOTONE HABITATS
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	BIOM.	RANK	BIOM.	RANK	BIOM.	RANK	BIOM.	2*SE	RANK
SHEEPHEAD, Ca	29.18	1	65.97	1	39.13	1	134.27	18.60	1
BLACKSMITH	9.87	2	43.03	2	25.61	4	78.51	14.61	2
WRASSE, rock	0.05	9	30.84	3	29.48	3	60.37	19.85	3
GARIBALDI	0.12	8	29.58	4	20.91	5	50.61	18.41	4
SARGO			5.21	9	30.43	2	35.65	42.82	5
PERCH, black	0.60	6	15.76	6	17.32	7	33.69	6.07	6
HALFMOON			9.97	8	18.38	6	28.35	24.95	7
CROAKER, black			19.34	5			19.34	19.03	8
OPALEYE			2.14	12	10.72	8	12.86	5.36	9
BASS, kelp	1.63	3	3.10	11	7.44	9	12.17	12.74	10
BASS, barred sand	0.85	4	5.16	10	5.87	10	11.88	19.25	11
MACKEREL, jack			10.93	7			10.93	21.87	12
PERCH, pile			1.89	13	4.64	11	6.53	4.89	13
SCORPIONFISH, Ca			1.18	14	2.21	12	3.39	1.30	14
SEAPERCH, rubberlip			0.85	16	1.23	13	2.07	1.57	15
SENORITA	0.16	7	0.88	15	0.78	14	1.83	1.06	16
BONITO, Pacific	0.68	5					0.68	1.37	17
TRIGGERFISH, finescale					0.65	15	0.65	1.29	18
GREENLING, painted			0.21	17			0.21	0.43	19
ROCKFISH, olive			0.04	18			0.04	0.09	20
Total individuals	43.15	.	246.10	.	214.80	.	504.05	82.26	.

JUVENILE-ADULT FISHES AT PAR: ESTIMATED ABUNDANCE (NUMBERS AND BIOMASS), FOR EACH LIFE STAGE (AND POOLED LIFE STAGES) WITHIN A TAXON, ENCOUNTERED ON SURVEYS DURING FALL 1986. Taxa include each species encountered, plus total fishes (all species). Abundance estimates are the sum of stratum subtotals weighted by the areal contribution of the respective stratum. One alternate 1986 estimate is based on Sand (Adjacent and Outlying Sand: Tables 11, 12); the other alternate 1986 estimate is based on all strata sampled (Rock = Crest + Slope, Ecotone, and Sand: Tables 13, 14).

APPENDIX S -- TABLE 11

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE FOR THE SAND HABITAT
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	ABUN.	RANK	ABUN.	RANK	ABUN.	RANK	ABUN.	2*SE	RANK
MACKEREL, jack	957	1	1952	1			2908	5817	1
BLACKSMITH	18	5	1340	2	431	2	1789	3143	2
SARGO	3	6	21	9	507	1	531	767	3
BASS, barred sand	116	2	213	3	71	3	401	447	4
WRASSE, rock			108	4	54	6	162	33	5
SHEEPHEAD, Ca	37	3	84	5	16	7	136	48	6
PERCH, black			68	6	61	5	128	58	7
SENORITA			20	10	67	4	86	134	8
BASS, kelp	27	4	44	7	7	11	78	62	9
CROAKER, black			25	8			25	51	10
PERCH, pile					11	8	11	15	11
HALFMOON					10	9	10	11	12
SEAPERCH, rubberlip					10	10	10	20	13
SCORPIONFISH, Ca					4	12	4	7	15
HALIBUT, Ca			4	11			4	7	15
GARIBALDI					3	13	3	6	16
Total Individuals	1157	.	3879	.	1251	.	6287	9378	.

APPENDIX S -- TABLE 12

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE (KG) FOR THE SAND HABITAT
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	BIOM.	RANK	BIOM.	RANK	BIOM.	RANK	BIOM.	2*SE	RANK
MACKEREL, jack			129.10	1			129.10	258.20	1
BASS, barred sand	7.39	1	45.00	2	72.05	2	124.43	178.98	2
SARGO			2.32	9	118.91	1	121.22	181.86	3
SHEEPHEAD, Ca	3.33	2	41.52	3	20.05	4	64.89	37.30	4
BLACKSMITH	0.02	4	27.73	4	35.75	3	63.50	92.50	5
PERCH, black			5.22	7	11.90	5	17.12	10.84	6
WRASSE, rock			7.07	6	9.46	6	16.53	1.61	7
BASS, kelp	1.31	3	8.91	5	5.60	8	15.82	10.73	8
SEAPERCH, rubberlip					5.66	7	5.66	11.32	9
SENORITA			0.44	11	3.91	10	4.35	7.52	10
PERCH, pile					4.04	9	4.04	5.34	11
SCORPIONFISH, Ca					3.30	11	3.30	6.60	12
CROAKER, black			2.57	8			2.57	5.15	13
HALFMOON					2.44	12	2.44	2.72	14
GARIBALDI					1.80	13	1.80	3.60	15
HALIBUT, Ca			1.50	10			1.50	3.00	16
Total Individuals	12.04	.	271.39	.	294.86	.	578.29	508.37	.

APPENDIX S -- TABLE 13

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
NUMERICAL ABUNDANCE ESTIMATE FOR THE ENTIRE PAR COMPLEX OF SAND & ROCK
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	ABUN.	RANK	ABUN.	RANK	ABUN.	RANK	ABUN.	2*SE	RANK
BLACKSMITH	9850	1	3420	1	740	1	14010	5982	1
MACKEREL, jack	957	2	2117	2			3074	6147	2
WRASSE, rock	5	9	579	3	224	3	808	237	3
SARGO	3	10	69	10	636	2	709	941	4
SHEEPHEAD, Ca	359	3	218	6	46	8	622	57	5
PERCH, black	89	6	273	4	149	4	511	181	6
SENORITA	328	4	60	11	80	6	467	143	7
BASS, barred sand	129	5	238	5	77	7	444	508	8
CROAKER, black			216	7			216	147	9
HALFMOON			77	9	84	5	161	134	10
GARIBALDI	5	8	106	8	36	9	147	37	11
BASS, kelp	60	7	59	12	16	12	136	76	12
PERCH, pile			17	13	24	10	41	38	13
OPALEYE			8	14	19	11	27	8	14
SEAPERCH, rubberlip			4	16	12	13	16	22	15
SCORPIONFISH, Ca	1	12	3	18	6	14	10	7	16
GREENLING, painted			4	15			4	9	17
HALIBUT, Ca			4	17			4	7	18
BONITO, Pacific	3	11					3	5	19
TRIGGERFISH, finescale					1	15	1	3	20
ROCKFISH, olive			1	19			1	1	21
Total Individuals	11788	.	7471	.	2152	.	21411	7842	.

APPENDIX S -- TABLE 14

PENDLETON ARTIFICIAL REEF
JUVENILE -- ADULT FISH SURVEY
BIOMASS ABUNDANCE ESTIMATE (KG) FOR ENTIRE PAR COMPLEX OF SAND & ROCK
FALL 1986 SURVEYS

	JUVENILE		SUB-ADULT		ADULT		TOTAL		
SPECIES	BIOM.	RANK	BIOM.	RANK	BIOM.	RANK	BIOM.	2*SE	RANK
SHEEPHEAD, Ca	32.51	1	107.49	2	59.17	4	199.17	55.46	1
SARGO			7.53	11	149.34	1	156.87	223.94	2
BLACKSMITH	9.89	2	70.76	3	61.37	3	142.01	97.43	3
MACKEREL, jack			140.04	1			140.04	280.07	4
BASS, barred sand	8.24	3	50.15	4	77.92	2	136.31	198.22	5
WRASSE, rock	0.05	9	37.92	5	38.94	5	76.90	20.83	6
GARIBALDI	0.12	8	29.58	6	22.71	7	52.41	18.09	7
PERCH, black	0.60	6	20.98	8	29.22	6	50.80	15.27	8
HALFMOON			9.97	10	20.82	8	30.79	27.02	9
BASS, kelp	2.94	4	12.02	9	13.04	9	28.00	22.59	10
CROAKER, black			21.91	7			21.91	14.97	11
OPALEYE			2.14	12	10.72	10	12.86	5.36	12
PERCH, pile			1.89	13	8.68	11	10.57	10.19	13
SEAPERCH, rubberlip			0.85	17	6.89	12	7.74	11.86	14
SCORPIONFISH, Ca			1.18	16	5.51	13	6.69	7.80	15
SENORITA	0.16	7	1.33	15	4.69	14	6.17	6.88	16
HALIBUT, Ca			1.50	14			1.50	3.00	17
BONITO, Pacific	0.68	5					0.68	1.37	18
TRIGGERFISH, finescale					0.65	15	0.65	1.29	19
GREENLING, painted			0.21	18			0.21	0.43	20
ROCKFISH, olive			0.04	19			0.04	0.09	21
Total Individuals	55.19	.	517.49	.	509.66	.	1082.34	590.40	.

APPENDIX T -- TABLE 1A

JUVENILE - ADULT FISH LENGTH CLASSES

Taxon/Species	LENGTH CLASSES[a] (TL inclusive, in in./ft)		
	Juvenile	Subadult	Adult
ANCHOVY, northern	<3 in.	3 - 4 in.	>4 in.
BARRACUDA, California	<1 ft	12 - 20 in.	>2 ft.
BASS, barred sand	<9 in.	9 - 12 in.	>1 ft.
BASS, kelp	<9 in.	9 - 12 in.	>1 ft.
BLACKSMITH	<4 in.[b]	4 - 6 in.	>6 in.
BONITO, Pacific	<23 in.	23 - 25 in.	>25 in.
CABEZON	<10 in.	10 - 15 in.	>15 in.
CROAKER, black	<7 in.	7 - 10 in.	>10 in.
GARIBALDI	<5 in.	5 - 10 in.	>10 in.
GIBBONSIA spp	<4 in.	4 - 6 in.	>6 in.
GREENLING, painted	<6 in.	6 - 7 in.	>7 in.
HALFMOON	<5 in.	5 - 8 in.	>8 in.
KELPFISH, giant	<6 in.	6 - 10 in.	>10 in.
MACKEREL, jack	<6 in.	6 - 10 in.	>10 in.
MACKEREL, Pacific	<11 in.	11 - 13 in.	>13 in.
OPALEYE	<7 in.	7 - 10 in.	>10 in.
PIPEFISH sp.	<6 in.	6 - 10 in.	>10 in.
QUEENFISH	<4 in.	4 - 5 in.	>5 in.
RAY, bat[c]	<1 ft.	1 - 2 ft.	>2 ft.
RAY, Pacific electric[c]	<1 ft.	1 - 2 ft.	>2 ft.
RAY, round sting[c]	<5 in.	5 - 7 in.	>7 in.
ROCKFISH, grass	<8 in.	8 - 12 in.	>12 in.
ROCKFISH, olive	<8 in.	8 - 12 in.	>12 in.
ROCKFISH, juv. sp.	<4 in.	--	--
ROCKFISH, kelp	<5 in.	5 - 8 in.	>8 in.
SALEMA	<4 in.	4 - 6 in.	>6 in.
SARGO	<5 in.	5 - 9 in.	>9 in.

APPENDIX T -- Supplements Used to Estimate the Numerical and Biomass Abundances of Fishes in SONGS-Area Kelp Beds and at PAR in Fall 1985 and Fall 1986

APPENDIX T -- TABLE 1B

YOY AND JUVENILE FISH LENGTH CLASSES
(PAR YOY - OJ Study)

Taxon/Species	LENGTH CLASSES[a] (TL inclusive, in inches) YOY[b]	Older Juvenile	Comments
BASS, barred sand	<3	3 - 10	
BASS, kelp	<3	3 - 10	
BLACKSMITH	<3	3 - 6	
CABEZON	<5	5 - 16	
CROAKER, black	<4	4 - 9	
GARIBALDI	<2	2 - 8	
GOBY, blackeye	<1	1 - 2	
GOBY, bluebanded	All YOY	N/A	
GREENLING, painted	<4	4 - 5	
HALFMOON	<5	5 - 8	
HALIBUT, California	N/A	9(M) - 18(F)	
KELPFISH, giant	<5	5 - 8	
PERCH, black	<5	N/A	All juveniles are YOY.
PERCH, pile	<5	5 - 9	
SEAPERCH, rainbow	<5	5 - 7	
SEAPERCH, rubberlip	<6	6 - 10	
SEAPERCH, white	<5	5 - 8	
SARGO	<4	4 - 7	
SCORPIONFISH, spotted	<4	4 - 10	
SENORITA	<3	3 - 5	3 to 5 in. TL are yearling adults.
SHEEPHEAD, California	<3	3 - 12	
WRASSE, rock	<4	4 - 6	

[a]Actual size. Remember that water magnifies one-third. So, for example, a fish that looks 16 in. long is actually 12 in. long, and a fish that looks 12 in. long is actually 9 in. long.

[b]Estimated average maximum total length of YOY during September-October 1985, based on literature and/or direct observations by E. DeMartini at PAR.

APPENDIX T -- TABLE 1A (continued)

Taxon/Species	LENGTH CLASSES[a] (TL inclusive, in in./ft)		
	Juvenile	Subadult	Adult
SCORPIONFISH (= sculpin)	<8 in.	8 - 12 in.	>1 ft.
SEABASS, white	<20 in.	20 - 24 in.	>24 in.
SENORITA	yoy: <2 in. juv: 2-4 in.	4 - 6 in.	>6 in.
SHARK, horn	<15 in.	15 - 24 in.	>24 in.
SHARK, leopard	<2 ft.	2 - 3 ft.	>3 ft.
SHEEPHEAD, California	<10 in.	10 - 14[d] in.	>14 in.
SILVERSIDES	<3 in.	3 - 5 in.	>5 in.
PERCH, black	<4 in.	4 - 7 in.	>7 in.
PERCH, kelp	<3 in.	3 - 4 in.	>4 in.
PERCH, pile	<5 in.	5 - 9 in.	>9 in.
SEAPERCH, rainbow	<4 in.	4 - 7 in.	>7 in.
SEAPERCH, rubberlip	<6 in.	6 - 10 in.	>10 in.
SEAPERCH, white	<4 in.	4 - 7 in.	>7 in.
SURFPERCH, walleye	<3 in.	3 - 5 in.	>5 in.
THORNBACK[c]	<5 in.	5 - 7 in.	>7 in.
TURBOT spp.	<5 in.	5 - 8 in.	>8 in.
WRASSE, rock	<5 in.	5 - 8 in.	>8 in.

[a]Actual size. Remember that water magnifies one-third. So, for example, a fish that looks 16 in. long is actually 12 in. long, and a fish that looks 12 in. long is actually 9 in. long.

[b]Orange below and posteriorly.

[c]Disk width.

[d]Includes transforming males.

APPENDIX T -- TABLE 2

LENGTH - WEIGHT RELATIONSHIP FOR EACH FISH TAXON ENCOUNTERED ON "JUVENILE-ADULT" FISH SURVEYS AT SONGS-AREA KELP BEDS AND AT PAR DURING FALL 1985 AND FALL 1986. All lengths are mm and all weights are total body in g, unless otherwise noted. Lengths are total length (TL), standard length (SL), and fork length (FL) for teleosts; disk width (DW) for raylike elasmobranchs.

APPENDIX T -- TABLE 2

Taxon	Relationship	Source(s)
SHARK, horn (Models = Horn shark & Port Jackson shark)	W = 3.0E-07 (TL)**3.54	Tetratech (unpub. data); McLaughlin & O'Gower (1971); Taylor (1972)
SMOOTHHOUND spp. (Model = Grey smoothhound)	W = 8.0E-08 (TL)**3.56	Tetratech (unpub. data); Herald et al. (1960)
SHARK, Leopard	W = 3.0E-07 (TL)**3.41	Tetratech (unpub. data)
THORNBACK	W = 1.2E-04 (DW)**2.83	Tetratech (unpub. data)
GUITARFISH, shovelnose	W = 6.9E-06 (TL)**2.91	Tetratech (unpub. data)
RAY, Pacific electric	W = 2.3E-04 (DW)**2.79	DeMartini (unpub. data)
STINGRAY, round	W = 4.5E-03 (DW)**2.19	Tetratech (unpub.data)
RAY, bat	W = 1.4E-05 (DW)**3.04	Tetratech (unpub. data)
ANCHOVY, northern	W = 2.0E-07 (SL)**3.86	Quast (1968b)
HALIBUT, California	W = 8.5E-06 (TL)**3.03	J. Schott (unpub. data)
PLEURONICHTHYS spp. (Model = P. coenosus)	W = 9.6E-06 (SL)**3.20	Quast (1968b)
TURBOT, diamond	W = 2.2E-05 (SL)**3.04	Lane (1975)
BASS, kelp	W = 1.8E-06 (TL)**3.34	Young (1963)
BASS, barred sand	W = 5.4E-06 (TL)**3.15	DeMartini (unpub. data)
SILVERSIDES spp. (Model = Topsmelt)	W = 8.9E-06 (SL)**3.04	Quast (1968b)
BARRACUDA, Pacific	W = 4.0E-03 $(TL)_{cm}$**2.98	Walford (1932)
YELLOWTAIL	W_{lb}= 7.4E-08 (FL)**2.85	Baxter et al. (1960)
MACKEREL,jack	W = 3.3E-06 (FL)**3.22	Wine & Knaggs (1975)
BONITO, Pacific	W = 9.0E-07 (TL)**3.34	Collins et al. (1980)
MACKEREL, Pacific	W = 1.4E-06 (FL)**3.39	Knaggs & Parrish (1973)
SARGO	W = 5.0E-06 (TL)**3.19	DeMartini (unpub. data)

Table 2 (continued)

Taxon	Relationship	Source(s)
SALEMA	W = 3.6E-05 (SL)**2.90	Quast (1968b)
CROAKER, black	W = 2.8E-06 (TL)**3.26	DeMartini (unpub. data)
SEABASS, white	W = 1.6E-05 (TL)**2.92	Thomas (1968)
PERCH, kelp (>65 mm SL)	W = 1.2E-05 (SL)**3.17	Quast (1968b)
PERCH, pile (>80 mm SL)	W = 2.7E-05 (SL)**3.03	Quast (1968b)
PERCH, black	W = 8.3E-06 (SL)**3.31	Quast (1968b)
SEAPERCH, rainbow	W = 2.0E-06 (SL)**3.56	Quast (1968b)
SEAPERCH, white	W = 1.4E-05 (SL)**3.12	Quast (1968b)
SEAPERCH, rubberlip	W = 4.5E-06 (SL)**3.36	Quast (1968b)
BLACKSMITH	W = 1.8E-05 (SL)**3.09	Quast (1968b)
GARIBALDI	W = 3.6E-05 (SL)**3.10	Quast (1968b)
WRASSE, rock	W = 3.3E-06 (TL)**3.24	DeMartini (unpub. data)
SENORITA	W = 1.3E-06 (SL)**3.50	Quast (1968b)
SHEEPHEAD, Calif.	W = 1.3E-05 (SL)**3.16	Quast (1968b)
OPALEYE	W = 5.3E-05 (SL)**2.93	Quast (1968b)
HALFMOON	W = 8.3E-06 (SL)**3.26	Quast (1968b)
SCORPIONFISH, Calif.	W = 2.0E-02 $(TL)_{cm}$**3.01	M. Love (unpub. data)
GREENLING, painted	W = 3.2E-05 (SL)**2.93	Quast (1968b)
CABEZON	W = 5.4E-04 (TL)**2.98	O'Connell (1953)
PIPEFISH	W = 1.6E-09 (SL)**3.96	Quast (1968b)
ROCKFISH, brown (Model = Grass rockfish)	W = 1.1E-05 (SL)**3.21	Quast (1968b)

APPENDIX T -- TABLE 3

LIST OF FACTORS USED TO CONVERT TOTAL LENGTH (TL) TO EITHER DISK WIDTH (DW-RAYS), STANDARD LENGTH (SL), OR FORK LENGTH (FL) AS INPUT TO LENGTH-WEIGHT FORMULAS (TABLE 2) FOR FISHES ENCOUNTERED BY DIVERS ON TRANSECTS AT PAR AND AT SONGS-AREA KELP BEDS DURING FALL 1985 AND FALL 1986. N/A indicates that a conversion was not necessary.)

Table 2 (continued)

Taxon	Relationship	Source(s)
ROCKFISH, kelp	W = 4.2E-05 (SL)**2.92	Quast (1968b)
ROCKFISH, olive	W = 7.8E-06 (SL)**3.18	Quast (1968b)
GOBY, blackeye (Model = Bay goby)	W = 8.3E-06 (SL)**3.10	Grossman (1979)
GOBY, bluebanded (Model = Bay goby)	W = 8.3E-06 (SL)**3.10	Grossman (1979)
GIBBONSIA spp. (Model = *G. metzi*)	W = 4.6E-06 (SL)**3.21	Quast (1968b)
KELPFISH, giant	W = 1.8E-06 (SL)**3.33	Quast (1968b)
TRIGGERFISH, finescale (Model = Grey triggerfish)	W = 2.2E-05 (FL)**2.99	Johnson & Salomon (1984)

APPENDIX T -- TABLE 3

Taxon	Conversion Factor	Source(s)
SHARK, horn	N/A	
SMOOTHHOUND SPP.	N/A	
SHARK, leopard	N/A	
THORNBACK	DW = 0.48TL	Tetratech (unpub. data)
GUITARFISH, shovelnose	N/A	
RAY, Pacific electric	DW = 0.66TL	DeMartini (unpub. data)
STINGRAY, round	DW = 0.57TL	Babel (1967)
RAY, bat	DW = 1.35TL	L. Martin (1982)
ANCHOVY, northern	SL = 0.85TL	Clark & Phillips (1952)
HALIBUT, California	N/A	
PLEURONICHTHYS SPP (Model = P. verticalis)	SL = 0.81TL	Roedel (1953); Burgess & Axelrod (1984)
TURBOT, diamond	SL = 0.83TL	Lane (1975)
BASS, kelp	N/A	
BASS, barred sand	SL = 0.82TL	DeMartini (unpub. data)
SILVERSIDES SPP (Model = Topsmelt)	SL = 0.87TL	Roedel (1953)
BARRACUDA, Pacific	N/A	
YELLOWTAIL	FL = 0.87TL	Baxter et al. (1960)
MACKEREL, jack	FL = 0.93TL	Roedel (1953); Gotshall (1977, 1981); Walford (1974)
BONITO, Pacific	N/A	
MACKEREL, Pacific	FL = 0.93TL	Walford (1974)
SARGO	N/A	
SALEMA	SL = 0.84TL	Roedel (1953); Feder et al. (1974); Gotshall (1977, 1981)
CROAKER, black	N/A	
SEABASS, white	N/A	
PERCH, kelp	SL = 0.79TL	DeMartini (unpub. data)

Table 3 (continued)

Taxon	Conversion Factor	Source(s)
PERCH, pile	SL = 0.80TL	Eckmayer (1979)
PERCH, black	SL = 0.80TL	Eckmayer (1979)
SEAPERCH, rainbow	SL = 0.82TL	Roedel (1953); Gotshall (1981); Burgess & Axelrod (1984)
SEAPERCH, white	SL = 0.77TL	Eckmayer (1979)
SEAPERCH, rubberlip	SL = 0.84TL	Roedel (1953); Burgess & Axelrod (1984)
BLACKSMITH	SL = 0.80TL	Feder et al. (1974); Gotshall (1977); Burgess & Axelrod (1984)
GARIBALDI	SL = 0.78TL	Clarke (1970)
WRASSE, rock	N/A	
SENORITA	SL = 0.84TL	Gotshall (1977); Burgess & Axelrod (1984)
SHEEPHEAD, California	SL = 0.84TL	Walford (1974); Burgess & Axelrod (1984)
OPALEYE	SL = 0.82TL	Roedel (1953); Burgess & Axelrod (1984)
HALFMOON	SL = 0.83TL	Walford (1974); Feder et al. (1974)
SCORPIONFISH, California	N/A	
GREENLING, painted	SL = 0.85TL	DeMartini (unpub. data)
CABEZON	N/A	
PIPEFISH	SL = 0.98TL	DeMartini (unpub. data)
ROCKFISH, brown	SL = 0.83TL	Burgess & Axelrod (1984)
ROCKFISH, kelp	SL = 0.83TL	Burgess & Axelrod (1984)
ROCKFISH, olive	SL = 0.81TL	Burgess & Axelrod (1984)
GOBY, blackeye	SL = 0.84TL	Wiley (1973)
GOBY, bluebanded	SL = 0.84TL	Wiley (1973)
GIBBONSIA SPP	SL = 0.90TL	Feder et al. (1974)
KELPFISH, giant	SL = 0.90TL	Roedel (1953)
TRIGGERFISH, finescale (Model = Grey triggerfish)	FL = 0.86TL	Johnson & Salomon (1984)

APPENDIX T -- TABLE 4A

KELP BED -- FALL 1985
TOTAL NUMBER OF FISHES OBSERVED ON FISH LENGTH SURVEYS

Data represent the sum of the tallies made on 5 - 40-min searches (200 min) at 3-5 m depths (100 min) and at 7-8 m depths (100 min), plus 5 - 40-min dives (200 min) on bottom, at each station except CobbleU. At the latter station, 5 - 40-min searches (200 min) were completed on bottom only.

Species	SMK	Cobble Upcoast	SOKUout	SOKDin	SOKUin	SOKDout	All Locations
SENORITA	1,958	789	5,265	2,987	1,811	3,195	16,005
SALEMA	0	0	2,190	0	1,071	105	3,366
BASS, kelp	675	115	286	262	451	670	2,459
WRASSE, rock	570	275	396	606	177	277	2,301
BARRACUDA, Pacific	0	0	152	719	132	934	1,937
MACKEREL, jack	39	0	643	354	174	320	1,530
SEAPERCH, white	325	0	963	15	31	74	1,408
BASS, barred sand	52	198	667	16	77	159	1,169
SILVERSIDES spp.	274	0	324	0	50	0	648
SEAPERCH, rubberlip	172	4	1	0	0	451	628
PERCH, black	318	1	14	0	14	129	476
BLACKSMITH	92	14	105	17	92	23	343
PERCH, pile	149	1	2	4	3	173	332
SHEEPHEAD, California	37	64	69	8	39	66	283
HALFMOON	22	0	22	25	17	8	94
PERCH, kelp	84	0	5	0	0	0	89
KELPFISH, giant	26	1	3	1	3	4	38
SEAPERCH, rainbow	28	0	0	0	2	1	31
SHARK, leopard	0	0	0	2	1	1	4
RAY, bat	0	0	0	2	0	2	4
BONITO, Pacific	0	0	0	0	2	0	2
GARIBALDI	2	0	0	0	0	0	2
SHARK, horn	0	0	0	1	0	0	1
RAY, Pacific electric	0	0	0	0	0	1	1
SEABASS, white	0	0	0	0	0	1	1
OPALEYE	1	0	0	0	0	0	1
SCORPIONFISH, Ca.	0	0	0	0	1	0	1
	4,824	1,462	11,107	5,019	4,148	6,594	33,154

APPENDIX T -- TABLE 4B

KELP BED -- FALL 1986
TOTAL NUMBER OF FISHES OBSERVED ON FISH LENGTH SURVEYS

Data represent the sum of the tallies made on 4 - 40-min searches (160 min) at 3-5 m depths (80 min) and at 7-8 m depths (80 min), plus 4 - 40-min dives (160 min) on bottom, at each station except SOKUin and CobbleU. At SOKUin there were 3 - 40-min searches in canopy/midwater and 3 - 40-min bottom searches; at CobbleU diving conditions allowed only 2 - 40-min bottom searches.

SPECIES	COBBLE U	COBBLE D	SOKU OUT	SOKD IN	SOKU IN	SOKD OUT	SOK INBET	ALL LOCS
SENORITA	5	188	3,536	2,048	980	706	1,294	8,757
BASS, kelp	14	16	339	403	379	382	433	1,966
HALFMOON	0	31	113	120	821	132	138	1,355
WRASSE, rock	96	143	265	230	172	218	203	1,327
MACKEREL, jack	0	60	146	471	170	202	209	1,258
BASS, barred sand	158	21	91	59	77	109	67	582
PERCH, black	3	24	88	42	47	89	235	528
PERCH, kelp	0	0	70	38	33	172	183	496
BARRACUDA, Pacific	0	100	15	0	328	15	0	458
BONITO, Pacific	0	0	75	51	300	0	0	426
SHEEPHEAD, Ca.	36	48	66	39	49	51	67	356
SALEMA	0	0	0	211	0	13	34	258
SILVERSIDES spp.	0	0	1	23	170	0	0	194
SEAPERCH, white	0	0	123	29	6	7	29	194
SEAPERCH, rubberlip	0	0	5	0	9	44	109	167
PERCH, pile	0	0	22	23	6	15	41	107
MACKEREL, Pacific	0	0	0	0	100	0	0	100
SEAPERCH, rainbow	0	0	9	1	3	3	52	68
KELPFISH, giant	0	0	4	6	10	23	8	51
BLACKSMITH	0	0	21	0	0	0	11	32
ROCKFISH, kelp	0	0	7	0	1	1	0	9
SURFPERCH, walleye	0	0	0	0	0	0	3	3
SHARK, leopard	0	0	0	1	0	0	1	2
HALIBUT, Ca.	0	0	0	0	2	0	0	2
ROCKFISH, olive	0	0	0	0	0	1	1	2
GIBBONSIA, spp.	1	0	0	0	0	1	0	2
THORNBACK	0	1	0	0	0	0	0	1
STINGRAY, round	0	0	0	0	0	0	1	1
RAY, bat	0	1	0	0	0	0	0	1
GARIBALDI	0	0	0	0	0	1	0	1
SCORPIONFISH, Ca.	0	0	0	0	1	0	0	1
	313	633	4,996	3,795	3,664	2,185	3,119	18,705

APPENDIX T -- TABLE 5A

PENDLETON ARTIFICIAL REEF -- FALL 1985
TOTAL NUMBER OF FISHES OBSERVED ON FISH LENGTH SURVEYS

Species	October	November	December	All Surveys
BLACKSMITH	23,793	14,978	10,037	48,808
SARGO	462	338	965	1,765
CROAKER, black	417	192	201	810
PERCH, black	101	125	162	388
WRASSE, rock	127	107	138	372
SHEEPHEAD, California	102	125	143	370
SENORITA	85	136	41	262
GARIBALDI	57	62	60	179
BASS, kelp	73	30	62	165
HALFMOON	31	45	86	162
OPALEYE	14	56	46	116
BASS, barred sand	15	10	31	56
PERCH, pile	2	4	19	25
SCORPIONFISH, California	4	6	7	17
SEAPERCH, rubberlip	0	1	5	6
GREENLING, painted	0	2	2	4
GOBY, blackeye	0	0	3	3
ROCKFISH, brown	1	0	1	2
SEAPERCH, rainbow	1	0	0	1
GOBY, bluebanded	0	0	1	1
TRIGGERFISH, finescale	0	1	0	1
	25,285	16,218	12,010	53,513

APPENDIX T -- TABLE 5B

PENDLETON ARTIFICIAL REEF -- FALL 1986
TOTAL NUMBER OF FISHES OBSERVED ON FISH LENGTH SURVEYS

Species	November$_1$	November$_2$	January '87	All Surveys
BLACKSMITH	3,303	6,521	3,498	13,322
SHEEPHEAD, California	184	179	171	534
PERCH, black	80	99	353	532
WRASSE, rock	181	187	154	522
CROAKER, black	162	136	221	519
SENORITA	174	97	169	440
GARIBALDI	55	57	59	171
HALFMOON	39	50	55	144
SARGO	95	5	30	130
BASS, kelp	42	23	52	117
OPALEYE	13	13	31	57
GOBY, blackeye	12	22	18	52
PERCH, pile	8	6	19	33
SEAPERCH, rubberlip	1	4	27	32
BASS, barred sand	7	6	17	30
SEAPERCH, rainbow	0	0	7	7
GREENLING, painted	1	1	1	3
SCORPIONFISH, California	1	0	0	1
GOBY, bluebanded	1	0	0	1
TRIGGERFISH, finescale	0	0	1	1
	4,359	7,406	4,883	16,648

APPENDIX T -- TABLES 6 AND 7

ESTIMATED AVERAGE WET-BODY WEIGHTS for major life-stages of fishes observed at the SONGS-area kelp beds (Tables 6A, 6B) and at PAR (Tables 7A, 7B) during fall 1985 and fall 1986. Weights of major stages (AD = adult, JUV = juvenile, SAD = subadult) are characterized by using length-specific weights (Appendix T, Table 2), weighted by the frequency of observed lengths.

APPENDIX T -- TABLE 6A

KELP BED -- FALL 1985
STAGE-SPECIFIC FISH WEIGHTS
FORMATTED CONTENTS OF KBMEANWT.YR85 DATA BASE

Species	Stage	No. of Fish	Mean Weight (g)
ANCHOVY, northern	SAD	2256	4.0
BARRACUDA, Pacific	JUV	12	31.6
	SAD	1925	268.2
BASS, barred sand	JUV	254	80.5
	SAD	885	207.7
	AD	66	648.1
BASS, kelp	JUV	1738	52.4
	SAD	646	191.4
	AD	88	746.0
BLACKSMITH	JUV	306	2.0
	SAD	37	23.6
BONITO, Pacific	AD	2	465.7
GARIBALDI	JUV	1	27.7
	SAD	1	55.4
GREENLING, painted	JUV	1	29.0
GUITARFISH, shovelnose	JUV	1	269.7
HALFMOON	SAD	90	119.7
	AD	4	221.7
HALIBUT, California	AD	2	2266.0
KELPFISH, giant	JUV	9	1.9
	SAD	27	50.1
	AD	2	207.2
KELPFISH, spp.	SAD	1	9.1
	AD	1	122.6
MACKEREL, jack	JUV	167	15.5
	SAD	1363	32.9

APPENDIX T -- TABLE 6A (continued)

Species	Stage	No. of Fish	Mean Weight (g)
OPALEYE	AD	1	883.2
PERCH, black	SAD	422	70.6
	AD	54	180.4
PERCH, kelp	AD	89	17.4
PERCH, pile	SAD	324	77.4
	AD	8	352.7
PIPEFISH	AD	1	18.7
RAY, bat	SAD	3	2721.0
	AD	3	15149.5
RAY, Pacific electric	SAD	1	4372.3
SALEMA	SAD	3346	32.8
	AD	20	72.7
SCORPIONFISH, California	SAD	2	451.0
	AD	1	745.7
SEABASS, white	AD	1	936.8
SEAPERCH, rainbow	SAD	21	75.0
	AD	10	179.2
SEAPERCH, rubberlip	JUV	3	29.3
	SAD	619	105.2
	AD	6	566.2
SEAPERCH, white	SAD	1228	51.1
	AD	180	108.8
SENORITA	JUV	912	1.7
	SAD	7865	24.5
	AD	7228	66.3

APPENDIX T --TABLE 6A (continued)

Species	Stage	No. of Fish	Mean Weight (g)
SHARK, horn	JUV	3	235.4
	SAD	1	783.2
SHARK, leopard	JUV	1	189.7
	SAD	4	2200.9
	AD	2	7264.9
SHEEPHEAD, California	JUV	197	96.3
	SAD	89	452.9
	AD	9	1453.7
SILVERSIDES spp.	AD	648	26.4
STINGRAY, round	SAD	1	271.6
	AD	1	510.0
THORNBACK	SAD	2	230.2
WRASSE, rock	JUV	41	10.3
	SAD	1851	61.2
	AD	409	174.4

APPENDIX T -- TABLE 6B

KELP BED -- FALL 1986
STAGE-SPECIFIC FISH WEIGHTS
FORMATTED CONTENTS OF KBMEANWT.YR86 DATA BASE

Species	Stage	No. of Fish	Mean Weight (g)
SHARK, leopard	JUV	1	700.3
	AD	2	18199.3
THORNBACK	AD	1	2416.6
GUITARFISH, shovelnose	JUV	1	380.0
RAY, Pacific electric	SAD	1	13552.0
STINGRAY, round	AD	5	664.3
RAY, bat	AD	1	8077.4
HALIBUT, California	SAD	1	364.2
	AD	1	10972.5
BASS, kelp	JUV	1594	43.6
	SAD	459	212.8
	AD	175	594.7
BASS, barred, sand	JUV	185	78.4
	SAD	354	232.1
	AD	199	641.7
SILVERSIDES	AD	437	48.1
BARRACUDA, Pacific	JUV	105	81.6
	SAD	443	223.6
MACKEREL, jack	JUV	813	15.1
	SAD	895	28.2
BONITO, Pacific	JUV	426	244.5
MACKEREL, Pacific	JUV	103	28.7

APPENDIX T -- TABLE 6B (continued)

Species	Stage	No. of Fish	Mean Weight (g)
SARGO	AD	1	419.7
SALEMA	SAD	172	41.2
	AD	86	73.5
PERCH, kelp	JUV	2	1.4
	SAD	325	11.6
	AD	312	31.1
PERCH, black	SAD	364	100.6
	AD	328	197.6
SEAPERCH, rainbow	SAD	62	89.9
	AD	31	176.0
SEAPERCH,white	SAD	144	46.8
	AD	61	111.2
SEAPERCH, rubberlip	SAD	145	221.2
	AD	26	458.4
PERCH, pile	SAD	75	142.8
	AD	41	292.4
BLACKSMITH	JUV	47	1.0
	SAD	12	47.3
GARIBALDI	SAD	1	97.5
WRASSE, rock	JUV	2	10.5
	SAD	1314	69.0
	AD	533	177.7
SENORITA	JUV	560	1.1
	SAD	2811	28.7
	AD	6438	68.4
SHEEPHEAD, California	JUV	276	119.0
	SAD	120	451.1
	AD	31	1127.3

APPENDIX T -- TABLE 6B (continued)

Species	Stage	No. of Fish	Mean Weight (g)
OPALEYE	SAD	3	300.4
	AD	7	646.1
HALFMOON	SAD	1200	135.5
	AD	308	232.6
SCORPIONFISH, California	SAD	2	586.0
ROCKFISH, kelp	JUV	3	5.9
	SAD	1	133.7
	AD	6	222.5
ROCKFISH, olive	JUV	3	42.3
	SAD	1	126.7
PIPEFISH	AD	1	40.3
KELPFISH spp.	AD	2	122.6
KELPFISH, giant	JUV	30	6.8
	SAD	50	62.8
	AD	2	207.2

APPENDIX T -- TABLE 7A

PENDLETON ARTIFICIAL REEF -- FALL 1985
STAGE-SPECIFIC FISH WEIGHTS
FORMATTED CONTENTS OF PRMEANWT.YR85 DATA BASE

Species	Stage	No. of Fish	Mean Weight (g)
BASS, barred sand	JUV	78	69.09
	SAD	50	241.60
	AD	34	827.32
BASS, kelp	JUV	136	44.36
	SAD	28	199.29
	AD	7	703.59
BLACKSMITH	JUV	48395	1.24
	SAD	336	31.34
	AD	77	90.06
CROAKER, black	JUV	2	36.62
	SAD	754	118.97
	AD	54	276.99
GARIBALDI	JUV	13	18.31
	SAD	163	273.37
	AD	3	638.41
GOBY, blackeye	AD	3	4.88
GOBY, bluebanded	AD	1	3.30
GREENLING, painted	JUV	1	6.49
	SAD	3	58.91
HALFMOON	SAD	103	126.22
	AD	59	272.40
OPALEYE	JUV	1	73.77
	SAD	67	267.63
	AD	48	505.16
PERCH, black	JUV	8	6.72
	SAD	229	70.46
	AD	151	214.20
PERCH, pile	SAD	18	146.63
	AD	7	370.58
ROCKFISH, brown	SAD	2	317.07

APPENDIX T -- TABLE 7A (continued)

Species	Stage	No. of Fish	Mean Weight (g)
SARGO	JUV	1	12.62
	SAD	1268	119.25
	AD	496	315.14
SCORPIONFISH, California	JUV	2	47.11
	SAD	12	384.05
	AD	3	869.90
SEAPERCH, rainbow	AD	1	162.34
SEAPERCH, rubberlip	SAD	2	301.32
	AD	4	711.97
SENORITA	JUV	220	0.67
	SAD	25	26.20
	AD	17	66.59
SHEEPHEAD, California	JUV	224	81.80
	SAD	148	515.72
	AD	25	1408.32
TRIGGERFISH, finescale	AD	1	217.28
WRASSE, rock	JUV	8	10.49
	SAD	284	51.55
	AD	80	178.42

APPENDIX T -- TABLE 7B

PENDLETON ARTIFICIAL REEF -- FALL 1986
STAGE-SPECIFIC FISH WEIGHTS
FORMATTED CONTENTS OF PRMEANWT.YR86 DATA BASE

Species	Stage	No. of Fish	Mean Weight (g)
HALIBUT, California	SAD	2	423.8
BASS, kelp	JUV	75	48.6
	SAD	26	203.2
	AD	24	790.5
BASS, barred sand	JUV	21	63.7
	SAD	7	211.1
	AD	34	1007.9
MACKEREL, jack	SAD	517	66.2
BONITO, Pacific	JUV	79	256.8
SARGO	SAD	125	109.6
	AD	5	234.6
CROAKER, black	JUV	2	36.6
	SAD	517	101.5
PERCH, black	JUV	1	6.7
	SAD	367	77.0
	AD	164	196.1
SEAPERCH, rainbow	SAD	6	100.9
	AD	1	162.3
SEAPERCH, rubberlip	SAD	26	217.9
	AD	6	571.9
PERCH, pile	SAD	23	111.0
	AD	10	358.7
BLACKSMITH	JUV	11611	1.0
	SAD	1690	20.7
	AD	21	82.9
GARIBALDI	JUV	4	23.6
	SAD	167	279.4
	AD	1	638.4

APPENDIX T -- TABLE 7B (continued)

Species	Stage	No. of Fish	Mean Weight (g)
WRASSE, rock	JUV	3	10.5
	SAD	418	65.4
	AD	101	174.2
SENORITA	JUV	296	0.5
	SAD	122	22.3
	AD	22	58.7
SHEEPHEAD, California	JUV	396	90.6
	SAD	129	493.6
	AD	47	1290.6
OPALEYE	SAD	37	258.7
	AD	23	562.5
HALFMOON	SAD	85	129.8
	AD	59	246.4
SCORPIONFISH, California	SAD	1	451.0
	AD	3	932.0
ROCKFISH, olive	SAD	2	87.2
GREENLING, painted	JUV	1	29.0
	SAD	4	49.5
GOBY, blackeye	AD	52	4.8
GOBY, bluebanded	JUV	1	0.1
TRIGGERFISH, finescale	AD	1	476.1

APPENDIX T --

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APPENDIX U -- Supplementary Data for Fish Production Estimates

APPENDIX U -- TABLE 1

KELP BED/PAR FISHES: Mean weight ($\bar{W}$) of fish of different age groups and maximum life spans for representative southern Californian species. Data are reproduced from Table S-12 of DeMartini and Larson (1980b).

Species:	T[a] (in yr)	$\bar{W}$ (g) at midpoint of age group t													Sources
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	
BASS, kelp	9	23	100	274	455	626	793	998	1,219	1,743					Young (1963) Quast (1968c)
BARRACUDA, California	9	160	492	923	1,211	1,553	1,814	-- no data --							Walford (1932) Pinkas (1966)
SHEEPHEAD, California	13	27	106	234	424	489	661	825	1,233	1,673	2,333	2,517	3,021	3,590	Warner (1975) Quast (1968b)

[a] T = average maximum life span = age beyond which the fish becomes extremely rare.

APPENDIX U -- TABLE 2

KELP BED/PAR FISHES: Instantaneous rates of total mortality, Z (annual basis), for the juvenile-adult stages of representative southern Californian species. Data (other than Cowen, 1985) are reproduced from Table S-11 of DeMartini and Larson (1980b).

Species	Z (Fished)	Z (Unfished)	Source(s)
BARRACUDA, Calif.	0.62-0.73	--	Pinkas (1966)
BASS, kelp	0.54	0.29	Young (1963) Quast (1968c)
SHEEPHEAD, Calif.	0.29; 0.29-0.55 (mean = .43)	--	Warner (1975) Cowen (1985)