Department of Water Resources
Division of Planning
Modeling Support Branch

Comparison of Alternative Isohaline Standards and Associated Water Supply Impacts

Memorandum Report

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SUMMARY AND FINDINGS

The two parts per thousand bottom isohaline (X2) is a key parameter used in crafting the EPA proposed estuarine standard. X2 is thought to provide a simple scalar index of entrapment zone position, salinity field characteristics, and species abundance. It is relatively easy to measure and it is considered a robust integrator of several physical and biological processes [Shubel, SFEP Workshop Report, 1992].

X2 is a reasonable but arbitrary index of the physical and biological phenomena to which it correlates. DWR has found that other isohaline positions near X2 provide equally useful indices of estuarine habitat health. Specifically, this report focuses on the three parts per thousand isohaline (X3) and shows that it is equally indicative of salinity field characteristics and turbidity and abundance patterns.

Water costs associated with EPA proposed rules would be significantly reduced by posing the standard in terms of X3. Water supply impacts are examined using three independent water cost simulation methods. Method one predicts present isohaline position as a function of outflow and antecedent isohaline position, method two predicts salinity as a function of antecedent outflow, and method three is the state–wide water supply simulations model, DWRSIM. All three methods indicate that the water cost of the proposed EPA standard could be reduced by 20 to 40 percent if implemented in terms of X3.

Balancing environmental benefits with water costs is now open for wider discussion. Conceptually, isohaline position near X2 could be a decision variable that trades off biological benefits and water costs in a continuous way. It may now be possible to choose a level of water supply capacity that will be dedicated to environmental uses and then back–calculate the isohaline position and associated level of protection provided.

I. BACKGROUND

Recent initiatives by the EPA to craft habitat standards for the Bay–Delta estuary based on X2 arise from the following premises that represent conclusions of the San Francisco Estuary Project (SFEP) Workshop [Schubel, 1992]:

> Freshwater outflow determines salinity distribution, geographic location of entrapment phenomena, and estuarine turbidity maximum.
>
> The salinity field contains information about habitat conditions for estuarine species at all trophic levels.
>
> X2 responds clearly and unambiguously to freshwater inflow. It integrates a number of important estuarine properties and processes; measurement is relatively easy, inexpensive, and robust.
>
> Near bottom X2 is a diagnostic index to the leading edge of the entrapment zone and

the seaward limit of very low salinity habitat.

Well behaved statistical relationships exist between X2 and some physical processes and species abundance.

There is some understanding of the causal mechanisms underlying the correlations. X2 is either a direct causal factor or it is highly correlated with direct causal factors.

Estuarine standards should be crafted to maintain near bottom X2 in biologically appropriate areas of the estuary for biologically relevant time periods.

X2 is an arbitrary index of the physical and biological phenomena to which it correlates. The purpose of this report is not to dispute the SFEP Workshop conclusions. Instead we suggest that other isohaline positions near X2 could provide equally useful indices of estuarine habitat health. This report does not argue for an "optimal" index isohaline position. Rather, it focuses on the three ppt isohaline (X3), and shows that it provides an index of equal power for indicating habitat conditions in the estuary.

This report ultimaltely examines the water costs to State and Federal water projects that would result from the proposed standards. By crafting the standards on the basis of X3 rather that X2, water costs of the proposed standards are expected to decline significantly despite concomitant increases in the number of days the standard must be met.

The analysis of X3 is given in four sections. In each section, previous work by researchers on X2 is repeated and expanded to include similar analysis on X3. The following four areas are covered:

1. Monismith [1992] showed that X2 is a useful length scale for defining the spatial structure of the salinity field in the northern estuary. The analysis is repeated on the same data set using X3 as the length scale parameter.

2. Jassby et al. [1994] provided a correlative analysis between average X2 and various biological resources and physical phenomena to determine if X2 explains abundance response across trophic levels. Identical statistical proceedures are followed to develop correlations between species abundance and X3.

3. Kimmerer [1992] argued that a fixed salinity value should be used as an operational definition of the position of the entrapment zone. He also showed good correlations between maximums in turbidity and inter–trophic level abundances and the salinity range near X2. We reproduce graphical representations of the salinity class–abundance data which show that X3 is equally well associated with abundance peaks for phytoplankton, some key zooplankton species, and turbidity maximum.

4. Several groups have investigated the water costs of implementing the EPA estuarine habitat standard in terms of geographic maintenance of 2 ppt salinity. An impact analysis algorithm was developed by DWR to simulate the timing and magnitude of additional water requirements imposed by X2 standards above historical (DAYFLOW) outflow. The results of this analysis, along with impacts based on an antecedent outflow routine

developed by Denton [1993], and DWR's DWRSIM, are used to show significant reductions in water cost if the standard is based on X3 rather than X2.

II. DESCRIPTION OF LONGITUDINAL VARIATION IN SALINITY USING DISCRETE ISOHALINES

In this section, we reproduce the analysis done by Monismith [1992] on the physical significance of X2 using 1990–92 USGS CTD (conductivity,temperature, depth) data. The same analysis is repeated and extended to examine the properties of X3 for comparison with X2. The purpose is to show that X3 provides a scalar length scale which describes the salinity field as well as X2.

X2 Analysis

The 1990–92 USGS CTD data, provided by Dr. Stephen Monismith of Stanford University, was used. We repeat his analysis here. First, the depth–average salinity as a function of distance from Golden Gate, for 21 transect boat cruises during 1990–92 were reproduced graphically (Figure 1A). Then for each transect, the distance of 2 ppt bottom salinity from Golden Gate was determined by linear interpolation between two adjacent stations for which the bottom salinities bracketed 2 ppt. A dimensionless distance was computed for each station as the ratio of X/X2 where X is river distance from Golden Gate. Figure 1B shows depth–average salinity as a function of X/X2. The salinity scatter in Figure 1A is collapsed around X/X2 = 1.0.

Figure 1C shows the top–bottom salinity difference as a function of the X/X2 ratio. The figure shows that upstream of X2 (X/X2>1.0), there is little stratification. However, downstream of X2 the stratification increases and reaches its peak at a region between 0.4 and 0.7 of X/X2. This means that at locations between 40 percent and 70 percent of X2 from Golden Gate, salt field is at its peak stratification. As X2 moves closer to the ocean, the increased logitudinal salinity gradient results in a higher baroclinic pressure gradient, which, in turn, intensifies the stratification phenomenon through gravitational circulation. By knowing only the position of X2, significant additional information can be inferred about the salinity field.

X3 Analysis

The same analysis was performed for the position of X3. The results are shown in Figures 2A, 2B and 2C. Figure 2A is the same as Figure 1A showing the depth–average salinity as a function of distance X from Golden Gate. Figure 2B, is similar to Figure 1B, except X3 is the normalizing length scale. X3 has essentially the same normalizing effect on measured salinity along the estuary as X2, as data collapses around X/X3 =1.0. The maximum scatter, as in X2, is also at about 50 percent of X3 distance position from Golden Gate. Figure 2C, shows the top–bottom salinity difference as a function of X/X3. Although the peak salinity difference occurs at distance ratios slightly higher than that of X2 (Figure 2C), the actual location is the same since X3 is a shorter distance (closer to the Golden Gate). In general, longitudinal variation in salinity is characterized equally well using X2 or X3.

The above comparison shows that X2 and X3 provide comparable scalar length–scales for describing physical characteristics of the estuary. The spatial structure of the salinity field, baroclinic pressure gradient, and location of the entrapment zone can also be inferred adequately from either X2 or X3 since the distance between them is 5 km or less (Figure 3).

III. ISOHALINE POSITION AS HABITAT INDICATORS

Jassby et al. [1994] suggested that the salinity distribution is indicative of habitat conditions for estuarine species. Further, they suggest that temporal variability in the salinity field reflects changing habitat conditions. Their main hypothesis is that the position of near–bottom X2 can be used to index the response of estuarine species to freshwater flow and that therefore X2 is an effective policy variable to manage population abundances.

A focus of the work of Jassby et al. was to determine the pervasiveness of the relationship between average X2 position and inter–trophic level species abundance. Our analysis uses the same response variables reported in Jassby [1994] (Table 1). The base of the food chain is represented by particulate organic carbon (POC) supply; the benthos is represented by total mollusc abundance in Grizzly Bay; zooplankton is represented by *Neomysis mercedis* abundance in Suisun Bay and the western Delta; downstream higher trophic levels are represented by *Crangon franciscorum* and starry flounder, which are thought to utilize upstream moving bottom currents; upstream higher trophic levels are represented by striped bass and longfin smelt, which spend early life stages in the western Delta and Suisun Bay.

We reproduced the statistical methodology used by Jassby et al. This involved modeling the correlation between estuarine species and X2/X3 with generalized linear models which are flexible extensions of classical linear models. Generalized linear models are somewhat more complex but allow greater flexibility for exploratory data analysis and model fitting. See Jassby et al. [1994] for details.

It was also necessary to generate a historical data set of the daily X2 and X3 for the period of the species record. In general, the methodology described by Kimmerer and Monismith [1993] was used with some generalizing modifications. The actual approach for developing isohaline position data sets is described in Section V.

Jassby et al. assigned an averaging period relevant to each species on the basis of when the flow and salinity field most affect the abundance of the population. The hydrological relevance of these averaging periods may need further investigation, however, for this study, we generated X3 averages per Jassby et al. We also deferred to the best fitting models determined by Jassby et al. No exploratory analysis or alternative model fitting was attempted.

Our X2 data set is somewhat different from that of Jassby et al. since it was derived in a slightly different way (discussed in Section V). Therefore, all fitted models generate somewhat different residual statistics due to the small number of data points. However, all species exhibit significant responses to X2 and X3 and are consistent with the authors' results in every way. Model fits, as measured by the multiple correlation coefficient R, improved in four cases and declined in three cases. Only the fit for molluscs was very different, although with only 10 data points, we can expect model statistics to be sensitive to small changes in X2 and X3.

All significant relations show a decline as period averages of X2 and X3 move upstream. Phytoplankton and *Neomysis* are best fit by linear models, while the others are nonlinear in X2/X3. The abundance data for *Eurytemora* and Delta smelt were not available for this analysis, but Jassby et al. report that they could not be described with generalized linear models in X2.

Table 2 presents summary results and Figures 4 through 11 show the X2 and X3 versus abundance scatterplots with fitted models. In all cases, the correlation between the response variable and fitted values (R) is the same for X2 and X3 to two significant figures. The correlation between average for the period X2 and species response is translated almost directly downstream for X3. Clearly, the relationship between X3 and species response is as pervasive and descriptive as X2.

IV. ABUNDANCE VERSUS SALINITY CLASS

Correlations between period average X2 and X3 position and abundance show that when the upstream end of the mixing zone is downstream, abundance of several species tend to be higher. It does not suggest anything special about X2 or X3 as preferred salinity habitat for individual species. However, salinity is the critical physical variable affecting species composition at any location in the estuary (e.g., Miller 1983). Species have physiological preferences for certain salinity ranges and tend not to survive outside that range.

To investigate the salinity range preferences of phytoplankton and zooplankton, Kimmerer [1992] divided the DFG monitoring program salinity data into 20 classes containing nearly equal numbers of observations to equalize confidence intervals. He used the mean salinity in each class to eliminate distortions caused by unequal numbers of salinity data in each class. Viewing abundance data versus salinity class removes the effect of position, and indicates species salinity class preferences. See Kimmerer [1992] for further details.

Kimmerer showed that broad peaks in abundance and turbidity maximum occur around the 2 ppt salinity class for some species. Further, the peaks are usually contained within an operational definition of the upstream and downstream ends of the entrapment zone, a salinity range of about 1.2 to 6 mmhos/cm [Arthur and Ball, 1978]. We have reproduced the plots with salinity class as the independent variable and included vertical lines at approximately 2 and 3 ppt bottom salinity. To the extent that X2 is thought to be an indicator of peak abundance and habitat preference, we believe that X3 exhibits equal indicative power.

Figures 12A and 12B relate salinity class with chlorophyll *a*. Figure 12A shows that DFG and DWR data exibit similar patterns with abundance peaks around salinity class 17 (about 5.6 ppt). Figure 12B shows four categories of entrapment zone position. Abundance peaks appear to occur when the entrapment zone is between Honker Bay and the western Delta. In both plots, it appears that X3 is a somewhat better index location than X2 for predicting the upstream end of phytoplankton abundance peaks.

Figures 13A and 13B relate salinity class with *Eurytemora affinis.* Figure 13A shows a broad peak in abundance with a maximum directly between our estimate of 2 and 3 ppt bottom salinity. For reference, the plot also shows the operational extent of the entrapment zone as suggested by Arthur and Ball [1979]. Figure 13B shows *E. affinis* abundance with respect to four categories of entrapment zone position. Similar peak abundances occur regardless of entrapment zone position, although the peaks shift downstream relative to the entrapment zone when the entrapment zone moves upstream. While Kimmerer suggests that there are some confounding artifacts associated with using salinity classes for identifying salinty–abundance peaks, both plots show that X2 and X3 are equally useful scalar indexes of salinity preference for *E. affinis.*

Figures 14A and 14B relate salinity class with *Neomysis mercedis*. Again, the data show a broad peak in abundance with a maximum directly between our estimate of 2 and 3 ppt bottom salinity. Abundance peaks are similar for different ranges of operationally defined entrapment zone position except when it is upstream of 92 km. As the entrapment zone shifts upstream, the peak abundance occurs at a higher salinity classes possibly indicating a geographic preference component to *N. mercedis* distribution. Again, X2 and X3 appear to contain equivalent information about abundance peaks and salinity preferences of *N. mercedis*.

The entrapment zone is thought to be the site of highest concentrations of certain species of phytoplankton and zooplankton in the estuary. Sediments and phytoplankton are entrapped by the interaction of their settling and the current shear. Some fish and zooplankton may also use favorable currents in the entrapment zone water column to maintain position. Our derivation of daily X2 and X3 time series data is based on interpolations of X2 and X3 position between fixed electric conductivity stations, and a constant conversion of surface salinity to bottom salinity (Section V). Since this process does not account for changing stratification conditions, it is of interest to determine how well X2 and X3 coincide with actual entrapment zone position.

We verified the plots of turbidity versus salinity class from Kimmerer [1992]. Figure 15A shows the long–term average position of the turbidity maximum. The broad peak is within and upstream of the operational entrapment zone, and X2 and X3 are near the peak. Figure 15B shows four ranges of operationally defined entrapment zone positions. Peak turbidity tends to occur in lower salinity classes when the entrapment zone is downstream. X2 is closer to turbidity peaks when the entrapment zone is downstream of 82 km, and X3 is closer to the peaks when the entrapment zone is upstream of 82 km.

V. WATER SUPPLY IMPACT ANALYSIS: X2 VERSUS X3

This report is motivated by the observation that the water supply impacts of EPA proposed estuarine standards are significantly reduced if the habitat index is shifted from X2 to X3. Prior to this discovery many people assumed that water supply impacts would not change significantly because reduced Delta outflow requirements with X3 would be balanced by an expanded standard period requirement. In this section, we present the procedure for generating daily X2 and X3 time series, the procedure for determining water supply impacts, and offer specific examples to explain the difference in water supply impacts between X2 and X3.

X2 and X3 Time Series Development

Previous water supply impact analysis based on X2 were conducted using the Kimmerer–Monismith X2 equation which relates present day X2 to present day Delta outflow and previous day X2. Using that equation, a 63–year time series of daily X2 was generated using Delta outflow from DAYFLOW. For comparison, an X3 time series was required that used the same development procedure. However, after we interpolated the fixed ec data into an X3 time series, we found that there were many gaps in the 1975–77 sequence Kimmerer–Monismith used to derive the autoregressive model for X2 (see Kimmerer, Monismith, [1992] for details). Wishing to maintain development consistancy between isohaline time–series, another approach was needed.

A general method for determining the time series of positions for any isohaline was developed. The approach is as follows:

1. Top ec to Bottom Salinity Conversion The conversion of daily average surface ec to bottom salinity was performed according to the procedure described in DWR [1994]. Others argue for other approaches to top–bottom ec to salinity conversion. However, for purposes of determining the relative difference in impacts from an an X2 versus X3 estuarine standard, the conversion procedure is inconsequential.

We assumed that 2.0 bottom psu is equivalent to 2.9 mmhos/cm ec at the surface, and 3.0 bottom psu is equivalent to 4.3 mmhos/cm surface ec. We also recognize that applying the same constant top ec to bottom salinity conversion to downstream isohalines where stratification is greater could be problematic. The X3 time series is likely to be biased downstream by a small but unknown amount.

2. Interpolation to X2–X3 To determine the position of X2 and X3 from the fixed monitoring data, it is necessary to linearize the salinity profile near X2–X3 as well as possible. Kimmerer–Monismith determined the daily location of X2 by interpolating log salinity versus X/V_X for the period of record (October 1, 1967, to November 30, 1991), where X is the distance from the Golden Gate in kilometers, and V_X is the volume between X and 100 kilometers upstream. While there is some theoretical basis for this method, our analysis shows that the best linearization results simply from interpolating log salinity versus X. By graphically animating the daily salinity profile for both schemes from Martinez to Rio Vista for several different years, we found the log salinity versus X profiles were more consistently linear, especially for the February through June standard period. Interpolations to X2 and X3 were calculated for stations that bracketed X2 and X3, and extrapolation up to 5 kilometers upstream and downstream were calculated when X2 or X3 was downstream of Martinez, or upstream of RioVista.

3. Regression to Predict Daily X2 and X3 and Fill Gaps As stated above, Kimmerer and Monismith used a 1,000–day sequence of X2 data between 1975 and 1977 to generate a regression model for predicting X2 from log outflow and 1–day lagged X2. Our X3 data set did not offer the same contiguous sequence. We therefore chose to generalize the determination of regression coefficients with an iterative approach. With an initial guess of the coefficients, we forecasted in both directions to fill in the gaps for the entire daily record from 1967 to 1992. We then regressed the entire record again to fit a new model. With the new model, we refilled the gaps. In six to eight iterations, the procedure converged to coefficients that did not change to four significant figures.

DWR [1994] showed that a regression developed with an alternative contiguous sequence of data between 1986 and 1989 resulted in substantially different coefficients than those fit with the 1975–1977 data used by Kimmerer–Monismith. Subsequent simulations of EPA standard water requirements using both equations resulted in significantly different water costs. The iterative approach presented here removes this inconsistency by using the entire data set for isohaline prediction model development. It also allows a general and consistent way to construct other isohaline prediction equations.

New X2 and X3 equations were developed using the above procedure. The equations are:

$$X2(t) = 14.53 + 0.926 * X2(t-1) - 2.192 * \mathrm{LOG}\, Q_{out}(t) \qquad (1)$$

s.e. = 1.33 km
$R^2 = 0.989$.

and

$$X3(t) = 13.941 + 0.926 * X2(t-1) - 2.117 * \mathrm{LOG}\, Q_{out}(t) \qquad (2)$$

s.e. = 1.34 km
$R^2 = 0.988$.

Figure 16A shows the February through June average X2 and X3 position along with the difference. The average X2 is about 65.2 kilometers while the average X3 is about 62.3 kilometers for an average difference of 2.9 kilometers. Figure 16b compares the original Kimmerer–Monismith X2 equation with the whole data set iterated X2 equation. The difference is also shown. The average X2 for the two methods is equal (65.2 km). The Kimmerer–Monismith equation predicts up to 2 km higher X2 during low flows and up to 2 km lower X2 during high flows.

For use with the state–wide reservoir planning model DWRSIM, the daily X2 and X3 time series were averaged by month. Linear regressions were were fit to this data to generate predictions of monthly average X2 and X3 as a function of previous month X2/X3, and present month average log10 outflow. The monthly equations are:

$$X2(t) = 122.519 + 0.372 * X2(t-1) - 18.397 * \mathrm{LOG}\, Q_{out}(t) \qquad (3)$$

s.e. = 2.14 km
$R^2 = 0.976$.

and

$$X3(t) = 118.235 + 0.374 * X2(t-1) - 17.867 * \mathrm{LOG}\, Q_{out}(t) \quad (4)$$
s.e. = 2.08 km
R^2 = 0.978.

Water Supply Impact (Method 1)

In this section, we discuss an impact analysis routine used to simulate the water supply impacts that result from applying the standard in terms of X2 and X3. Specific examples are presented to show why impacts are reduced when X3 is the index criteria. Finally, independent checks of the analysis are made with an antecedent outflow algorithm and DWRSIM.

A FORTRAN program was developed to simulate the relative impacts of EPA standard proposals on a daily basis. It was developed to test alternative approaches and identify operational caveats. The routine reads daily outflows from the 1930 through 1992 DAYFLOW record and uses an autoregressive model of the form $X2(t) = f(X2(t-1), Q_{out}(t))$ to predict daily X2. Regression equation coefficients are input by the user. EPA standards in the form of the number of days between February and June that isohalines must be maintained downstream of Port Chicago, Chipps Island, and Collinsville are also input to the model. These rules have been predetermined by calculating the average number of days X2 or X3 is downstream of the three locations in each 40–30–30 year–class. The impact analysis routine includes the "cocked trigger" concept in which the Port Chicago standard is activated only when the index isohaline moves upstream Port Chicago after February 1. All standards are triggered and applied on the basis of 14–day running average X2 and index isohalines upstream of Collinsville prior to February 1 are "ramped" incrementally dowstream to Chipps Island. The routine does not account for reservoir storage or other criteria such as Delta smelt or salmon survival requirements. Results are considered relative indices of actual impacts of the proposed standard.

The X2 and X3 number of days standards based on the 1930–1992 DAYFLOW record and equations 1 and 2 are as follows:

X2:

	Port Chicago	Chipps Island	Confluence	Total
WET	124	142	149	150
AN	103	135	147	150
BN	89	119	134	150
DRY	35	93	124	150
CRT	3	40	57	150

X3:

	Port Chicago	Chipps Island	Confluence	Total
WET	135	146	150	150
AN	114	144	149	150
BN	102	128	139	150
DRY	53	102	136	150
CRT	12	45	73	150

Using these standards and the corresponding regression equations 1 and 2, simulations of

Delta outflow requirements above DAYFLOW outflow were made. Month, year, and average yearly impacts are shown in Table 3 (for X2) and Table 4 (for X3). The frequency with which the standards are actually met along with the years that the Port Chicago standard is triggered are shown in Table 5 (for X2) and Table 6 (for X3).

On average, posing the standard in terms of X3 reduces impacts by about 40 percent. While we acknowledge several caveats to moving the standard to bottom isohalines further downstream, we completed similar simulations of the proposed standard in terms of X4 and X5 for comparison purposes. Figure 17 shows the exponential decline in water costs as the standard is applied to downstream isohalines.

The impact analysis routine outputs the current standard, the current day X2 or X3, the current 14–day average X2 or X3, and, if necessary, the new X2 or X3 and 14–day average X2 or X3 if additional outflow is required. Several reasons can be identified for the reduction of outflow requirements for an X3 standard:

– The number of days requirement, based on the historical average number of days downstream of each standard location is only 4 to 9 days more for Chipps Island, and eleven to twenty days more for Port Chicago.

– The steady–state flow required to maintain X2 and X3 at the standards stations are:

	Port Chicago	Chipps Island	Confluence
X2	28,500	13,000	7,500
X3	22,600	10,100	5,800

– In some years, the Port Chicago standard is triggered by X2 but not X3 when the 14–day average X2 enters February upstream of Port Chicago and 14–day average X3 is downstream of Port Chicago. An example from our simulations occured in 1986 when outflow continuously declined from high February levels. Essentially, X2 moved downstream of Port Chicago for only a few days while X3 remains below 64 km. In these cases, the Port Chicago standard is triggered for X2, but not X3. In wet years like 1953,1965, and 1986, large water costs are then incurred in May and June when outflow declines significantly but X2 must be maintained at Port Chicago. Since X3 never triggers Port Chicago, no impacts occur.

– In general, the impacts of the additional number of days the X3 standard must be met does not equalize the reduced outflow required to meet X3. More important are the long sequences of standard maintaining steady–state flows that must be released in many years, and the fact that the X2 standard is always binding sooner. Careful comparison of Tables 7 and 8 show how this happens. The tables show how the X2 standard (Table 7) and the X3 standard (Table 8) were met on a daily basis in 1972, a below normal water year. Columns from right to left are year–type, date, DAYFLOW outflow, required outflow (by the standard), 14–day average X2 before flow augmentation, 14–day average X2 after flow augmentation, daily X2 before flow augmentation, daily X2 after flow augmentation, standard status, and number of days since February 1.

Tables 7 and 8 show that outflows continuously decline after about March 7 1972. The X2 standard is violated on April 1 at Chipps Island when additional outflow is required to maintain a 74 km position. Outflow continues at a low level so X3 also becomes binding at Chipps Island on April 5 although the additional outflow requirement is almost 3000 cfs less. As outflow increases after about April 9, the X3 standard becomes non–binding on April 11, while the X2 standard requires additional outflow through April 12. Later, the X3 standard requires additional outflow for 9 more days between May 29 and June 7, but the Collinsville standard again binds X2 earlier, and stays in effect longer with greater outflow requirement than X3.

This is a typical pattern that is repeated many times in the 63–year DAYFLOW record. For our example year 1972, the X2 standard would require 906 TAF of additional outflow while the X3 standard would require 557 TAF.

Antecedent Outflow (Method 2)

An antecedent outflow scheme developed by Denton [1993] was also implemented to determine the relative difference in impacts between an X2 and X3 standard. Using this approach with the same assumptions applied by Sullivan et al. [1993], X3 water requirements were 33 percent less than X2 requirements.

It should be noted that methods one and two use DAYFLOW to estimate water supply impacts. DAYFLOW does not account for the impact of upstream conditions or the level of development on flow into the Delta. We also recognize that there are a number of sliding scale concepts now under consideration. However, regardless of how the standard is ultimately crafted, the water supply impacts of meeting X3 rather than X2 would generally be significantly less.

DWRSIM Analysis (Method 3)

The state–wide reservoir planning model, DWRSIM, was used with the monthly X2 and X3 equations developed above. Simulations were based on D1485 requirements and EPA isohaline standards. Preliminary results show that with EPA standards based on X3, critical period impacts are reduced by about 33 percent, and the overall 70–year average impacts are reduced by about 20 percent.

VI. CONCLUSIONS

Other isohaline positions besides X2 can provide esturine habitat indexes of equal descriptive power. Specifically, we have shown that X3 is closely correlated with inter–trophic level species abundance and turbidity maximum. Further, we have shown that EPA standards impose significantly less impact on water supply capacity if implemented in terms of X3. We acknowledge that the location of isohalines downstream of X2 becomes increasingly uncertain due to greater stratification. However, in light of the findings, further consideration should be given to other index isohaline positions near X2 for balancing the continuous trade–offs between biological benefits and water costs.

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TABLE 1

Data Used for Testing Relationships Between Various Biological Resources and X2 Adapted from Jassby et al. [1994]

SPECIES	MEASURE	LOCATION	X2 PERIOD	HISTORICAL OBSERVATIONS
POC supply	annual primary production plus river load of algal-derived POC (Gg/yr^{-1})	Suisun Bay	Jan–Dec	1975–89
Neomysis mercedis	March–November abundance index	Suisun Bay, Delta	Mar–Nov	1972–82, 1984–90
Crangon franciscorum	Annual abundance index	South Bay through Suisun Bay	Mar–May	1980–90
Longfin smelt	Annual abundance index	San Pablo through Delta	Jan–Jun	1968–73, 1975–78, 1980–82, 1984–91
Striped bass survival	38–mm Index: Peterson egg Eastern production	Apr–Jul San Pablo Bay– Delta	1969–82,	1984–91
Striped bass	Fall mid–water trawl index San Pablo	Jul–Nov Bay through Delta	1968–73,	1975–78, 1980–91
Molluscs	Annual abundance (no.m^{-2}) Grizzly Bay	3–year mean Jan–Dec	1981–90	
Starry founder	Annual abundance index	South Bay through Suisun Bay	previous yr Mar–Jun	1980–91

TABLE 2

Summary of Relationships Between Species Response and X2/X3

SPECIES	n	R (X2)	R (X3)
POC supply	15	0.86	0.86
Neomysis	18	0.79	0.79
Crangon	11	0.94	0.94
Longfin smelt	21	0.73	0.73
Molluscs	10	0.49	0.49
Starry flounder	12	0.73	0.73
Striped bass survival	22	0.68	0.68
Striped bass fall MWT	22	0.86	0.86

TABLE 3

MONTH, YEAR, AND YEAR AVERAGE IMPACTS OF X2 STANDARD (TAF)

YEAR	FEB	MAR	APR	MAY	JUN	TOTAL
1930	0.	0.	0.	0.	12.	12.
1931	0.	0.	278.	190.	374.	842.
1932	0.	0.	0.	0.	0.	0.
1933	0.	0.	377.	55.	0.	433.
1934	0.	0.	0.	76.	328.	404.
1935	0.	0.	0.	0.	0.	0.
1936	0.	0.	0.	0.	0.	0.
1937	0.	0.	0.	0.	0.	0.
1938	0.	0.	0.	0.	0.	0.
1939	0.	0.	431.	0.	325.	756.
1940	0.	0.	0.	0.	0.	0.
1941	0.	0.	0.	0.	0.	0.
1942	0.	0.	0.	0.	0.	0.
1943	0.	0.	0.	0.	0.	0.
1944	0.	17.	0.	0.	22.	40.
1945	0.	0.	0.	0.	0.	0.
1946	0.	0.	0.	0.	0.	0.
1947	0.	0.	0.	0.	133.	133.
1948	19.	63.	0.	0.	0.	82.
1949	0.	0.	0.	0.	16.	16.
1950	0.	0.	0.	0.	0.	0.
1951	0.	0.	0.	0.	0.	0.
1952	0.	0.	0.	0.	0.	0.
1953	0.	0.	205.	0.	0.	205.
1954	0.	0.	0.	0.	71.	71.
1955	0.	48.	236.	0.	94.	378.
1956	0.	0.	0.	0.	0.	0.
1957	140.	0.	353.	439.	0.	932.
1958	0.	0.	0.	0.	0.	0.
1959	0.	0.	118.	321.	313.	752.
1960	10.	154.	0.	0.	196.	360.
1961	0.	84.	57.	50.	227.	418.
1962	40.	0.	62.	131.	0.	234.
1963	0.	0.	0.	0.	449.	449.
1964	0.	5.	239.	31.	137.	412.
1965	0.	0.	0.	0.	684.	684.
1966	0.	0.	0.	172.	254.	425.
1967	0.	0.	0.	0.	0.	0.
1968	0.	0.	182.	346.	194.	721.
1969	0.	0.	0.	0.	0.	0.
1970	0.	0.	64.	141.	291.	495.
1971	0.	0.	0.	124.	434.	558.
1972	0.	0.	326.	444.	136.	906.
1973	0.	0.	0.	74.	113.	187.
1974	0.	0.	0.	0.	0.	0.
1975	0.	0.	0.	10.	27.	37.
1976	805.	92.	50.	214.	216.	1377.
1977	1139.	357.	265.	226.	299.	2286.
1978	0.	0.	0.	0.	10.	10.
1979	0.	0.	817.	419.	80.	1316.
1980	0.	0.	0.	0.	0.	0.
1981	29.	0.	152.	85.	140.	406.
1982	0.	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.	0.
1984	0.	0.	45.	121.	202.	368.
1985	4.	215.	337.	53.	149.	758.
1986	0.	0.	0.	649.	231.	880.
1987	354.	63.	329.	146.	241.	1133.
1988	766.	261.	0.	147.	258.	1432.
1989	1190.	15.	366.	38.	86.	1694.
1990	881.	302.	97.	134.	172.	1586.
1991	1052.	1.	168.	218.	201.	1639.
1992	711.	0.	67.	251.	233.	1261.

average taf impact per year for X2 equation = 430.

TABLE 4

MONTH, YEAR, AND YEAR AVERAGE IMPACTS OF X3 STANDARD (TAF)

YEAR	FEB	MAR	APR	MAY	JUN	TOTAL
1930	0.	0.	0.	0.	0.	0.
1931	0.	0.	114.	169.	269.	552.
1932	0.	0.	0.	0.	0.	0.
1933	0.	0.	88.	49.	0.	137.
1934	0.	0.	0.	13.	223.	235.
1935	0.	0.	0.	0.	0.	0.
1936	0.	0.	0.	0.	0.	0.
1937	0.	0.	0.	0.	0.	0.
1938	0.	0.	0.	0.	0.	0.
1939	0.	0.	191.	70.	210.	470.
1940	0.	0.	0.	0.	0.	0.
1941	0.	0.	0.	0.	0.	0.
1942	0.	0.	0.	0.	0.	0.
1943	0.	0.	0.	0.	0.	0.
1944	0.	0.	0.	0.	253.	253.
1945	0.	0.	0.	0.	0.	0.
1946	0.	0.	0.	0.	0.	0.
1947	0.	18.	0.	0.	70.	88.
1948	0.	0.	0.	0.	0.	0.
1949	0.	0.	0.	0.	0.	0.
1950	0.	0.	0.	0.	0.	0.
1951	0.	0.	0.	0.	0.	0.
1952	0.	0.	0.	0.	0.	0.
1953	0.	0.	0.	0.	0.	0.
1954	0.	0.	0.	0.	49.	49.
1955	0.	0.	113.	0.	44.	157.
1956	0.	0.	0.	0.	0.	0.
1957	0.	0.	50.	229.	0.	280.
1958	0.	0.	0.	0.	0.	0.
1959	0.	0.	34.	153.	284.	471.
1960	0.	0.	0.	0.	108.	108.
1961	0.	0.	0.	60.	136.	197.
1962	0.	0.	0.	26.	0.	26.
1963	0.	0.	0.	0.	0.	0.
1964	0.	0.	90.	15.	67.	172.
1965	0.	0.	0.	0.	0.	0.
1966	0.	0.	0.	54.	225.	279.
1967	0.	0.	0.	0.	0.	0.
1968	0.	0.	73.	209.	151.	433.
1969	0.	0.	0.	0.	0.	0.
1970	0.	0.	0.	26.	200.	226.
1971	0.	0.	0.	0.	120.	120.
1972	0.	0.	133.	307.	117.	557.
1973	0.	0.	0.	0.	101.	101.
1974	0.	0.	0.	0.	0.	0.
1975	0.	0.	0.	0.	0.	0.
1976	470.	47.	0.	101.	111.	729.
1977	814.	282.	160.	128.	194.	1578.
1978	0.	0.	0.	0.	12.	12.
1979	0.	0.	476.	455.	7.	939.
1980	0.	0.	0.	0.	0.	0.
1981	0.	0.	624.	329.	44.	997.
1982	0.	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.	0.
1984	0.	0.	0.	23.	93.	116.
1985	0.	49.	168.	71.	56.	344.
1986	0.	0.	0.	0.	37.	37.
1987	0.	24.	152.	125.	136.	437.
1988	442.	216.	0.	45.	153.	857.
1989	806.	9.	562.	32.	12.	1420.
1990	608.	224.	34.	53.	81.	999.
1991	692.	0.	91.	111.	97.	991.
1992	461.	0.	0.	139.	128.	728.

average taf impact per year for X3 equation = 240.

TABLE 5

NUMBER OF DAYS X2 IS ACTUALLY DOWNSTREAM UNDER THE CURRENT SCENARIO
(X2 Number of Days Standard in Parenthesis)

		PortChicago	Chipps Is	Confluence
1930	DRY	107 (35)	145 (93)	150 (150)
1931	DRY	0 (35)	93 (93)	150 (150)
1932	DRY	151 (35)	151 (93)	151 (150)
1933	DRY	35 (35)	150 (93)	150 (150)
1934	CRT	33 (3)	100 (40)	150 (150)
1935	BN	150 (89)	150 (119)	150 (150)
1936	BN	151 (89)	151 (119)	151 (150)
1937	BN	148 (89)	150 (119)	150 (150)
1938	WET	150 (124)	150 (142)	150 (150)
1939	DRY	35 (35)	108 (93)	150 (150)
1940	AN	145 (103)	151 (135)	151 (150)
1941	WET	150 (124)	150 (142)	150 (150)
1942	WET	150 (124)	150 (142)	150 (150)
1943	WET	146 (124)	150 (142)	150 (150)
1944	DRY	40 (35)	145 (93)	151 (150)
1945	BN	143 (89)	150 (119)	150 (150)
1946	BN	137 (89)	150 (119)	150 (150)
1947	DRY	49 (35)	111 (93)	150 (150)
1948	BN	93 (89)	151 (119)	151 (150)
1949	DRY	89 (35)	143 (93)	150 (150)
1950	BN	129 (89)	150 (119)	150 (150)
1951	AN	128 (103)	148 (135)	150 (150)
1952	WET	151 (124)	151 (142)	151 (150)
1953	WET	129 (124)	150 (142)	150 (150)
1954	AN	122 (103)	139 (135)	150 (150)
1955	DRY	0 (35)	138 (93)	150 (150)
1956	WET	151 (124)	151 (142)	151 (150)
1957	AN	116 (103)	150 (135)	150 (150)
1958	WET	150 (124)	150 (142)	150 (150)
1959	BN	58 (89)	119 (119)	150 (150)
1960	DRY	68 (35)	113 (93)	151 (150)
1961	DRY	56 (35)	94 (93)	150 (150)
1962	BN	89 (89)	144 (119)	150 (150)
1963	WET	139 (124)	150 (142)	150 (150)
1964	DRY	14 (35)	93 (93)	151 (150)
1965	WET	141 (124)	150 (142)	150 (150)
1966	BN	37 (89)	120 (119)	150 (150)
1967	WET	150 (124)	150 (142)	150 (150)
1968	BN	69 (89)	119 (119)	151 (150)
1969	WET	150 (124)	150 (142)	150 (150)
1970	WET	71 (124)	142 (142)	150 (150)
1971	WET	127 (124)	150 (142)	150 (150)
1972	BN	0 (89)	119 (119)	151 (150)
1973	AN	85 (103)	137 (135)	150 (150)
1974	WET	121 (124)	150 (142)	150 (150)
1975	WET	137 (124)	150 (142)	150 (150)
1976	CRT	0 (3)	44 (40)	151 (150)
1977	CRT	0 (3)	40 (40)	150 (150)
1978	AN	129 (103)	144 (135)	150 (150)
1979	BN	89 (89)	130 (119)	150 (150)
1980	AN	95 (103)	151 (135)	151 (150)
1981	DRY	0 (35)	94 (93)	150 (150)
1982	WET	150 (124)	150 (142)	150 (150)
1983	WET	150 (124)	150 (142)	150 (150)
1984	WET	74 (124)	142 (142)	151 (150)
1985	DRY	0 (35)	93 (93)	150 (150)
1986	WET	124 (124)	147 (142)	150 (150)
1987	DRY	0 (35)	93 (93)	150 (150)
1988	CRT	0 (3)	40 (40)	151 (150)
1989	DRY	36 (35)	95 (93)	150 (150)
1990	CRT	0 (3)	40 (40)	150 (150)
1991	CRT	0 (3)	73 (40)	150 (150)
1992	CRT	0 (3)	62 (40)	151 (150)

YEAR TYPE AVERAGES

	PortChicago	Chipps Is	Confluence
WET	135 (124)	149 (142)	150 (150)
AN	117 (103)	145 (135)	150 (150)
BN	99 (89)	138 (119)	150 (150)
DRY	42 (35)	116 (93)	150 (150)
CRT	4 (3)	57 (40)	150 (150)

TABLE 6

NUMBER OF DAYS X3 IS ACTUALLY DOWNSTREAM UNDER THE CURRENT SCENARIO
(X3 Number of Days Standard in Parenthesis)

		PortChicago	Chipps Is	Confluence
1930	DRY	125 (53)	150 (102)	150 (150)
1931	DRY	0 (53)	102 (102)	150 (150)
1932	DRY	151 (53)	151 (102)	151 (150)
1933	DRY	71 (53)	150 (102)	150 (150)
1934	CRT	67 (12)	109 (45)	150 (150)
1935	BN	150 (102)	150 (128)	150 (150)
1936	BN	151 (102)	151 (128)	151 (150)
1937	BN	150 (102)	150 (128)	150 (150)
1938	WET	150 (135)	150 (146)	150 (150)
1939	DRY	53 (53)	118 (102)	150 (150)
1940	AN	150 (114)	151 (144)	151 (150)
1941	WET	150 (135)	150 (146)	150 (150)
1942	WET	150 (135)	150 (146)	150 (150)
1943	WET	150 (135)	150 (146)	150 (150)
1944	DRY	113 (53)	151 (102)	151 (150)
1945	BN	150 (102)	150 (128)	150 (150)
1946	BN	142 (102)	150 (128)	150 (150)
1947	DRY	78 (53)	121 (102)	150 (150)
1948	BN	99 (102)	151 (128)	151 (150)
1949	DRY	103 (53)	148 (102)	150 (150)
1950	BN	145 (102)	150 (128)	150 (150)
1951	AN	134 (114)	150 (144)	150 (150)
1952	WET	151 (135)	151 (146)	151 (150)
1953	WET	150 (135)	150 (146)	150 (150)
1954	AN	126 (114)	147 (144)	150 (150)
1955	DRY	14 (53)	143 (102)	150 (150)
1956	WET	151 (135)	151 (146)	151 (150)
1957	AN	122 (114)	150 (144)	150 (150)
1958	WET	150 (135)	150 (146)	150 (150)
1959	BN	69 (102)	128 (128)	150 (150)
1960	DRY	80 (53)	133 (102)	151 (150)
1961	DRY	77 (53)	114 (102)	150 (150)
1962	BN	105 (102)	150 (128)	150 (150)
1963	WET	148 (135)	150 (146)	150 (150)
1964	DRY	27 (53)	121 (102)	151 (150)
1965	WET	141 (135)	150 (146)	150 (150)
1966	BN	83 (102)	128 (128)	150 (150)
1967	WET	150 (135)	150 (146)	150 (150)
1968	BN	75 (102)	128 (128)	151 (150)
1969	WET	150 (135)	150 (146)	150 (150)
1970	WET	75 (135)	146 (146)	150 (150)
1971	WET	146 (135)	150 (146)	150 (150)
1972	BN	22 (102)	128 (128)	151 (150)
1973	AN	91 (114)	145 (144)	150 (150)
1974	WET	139 (135)	150 (146)	150 (150)
1975	WET	150 (135)	150 (146)	150 (150)
1976	CRT	0 (12)	49 (45)	151 (150)
1977	CRT	0 (12)	45 (45)	150 (150)
1978	AN	134 (114)	149 (144)	150 (150)
1979	BN	102 (102)	136 (128)	150 (150)
1980	AN	120 (114)	151 (144)	151 (150)
1981	DRY	53 (53)	130 (102)	150 (150)
1982	WET	150 (135)	150 (146)	150 (150)
1983	WET	150 (135)	150 (146)	150 (150)
1984	WET	81 (135)	146 (146)	151 (150)
1985	DRY	0 (53)	102 (102)	150 (150)
1986	WET	109 (135)	149 (146)	150 (150)
1987	DRY	0 (53)	102 (102)	150 (150)
1988	CRT	0 (12)	52 (45)	151 (150)
1989	DRY	53 (53)	114 (102)	150 (150)
1990	CRT	0 (12)	45 (45)	150 (150)
1991	CRT	0 (12)	75 (45)	150 (150)
1992	CRT	21 (12)	66 (45)	151 (150)

YEAR TYPE AVERAGES

	PortChicago	Chipps Is	Confluence
WET	139 (135)	149 (146)	150 (150)
AN	125 (114)	149 (144)	150 (150)
BN	111 (102)	142 (128)	150 (150)
DRY	62 (53)	128 (102)	150 (150)
CRT	12 (12)	63 (45)	150 (150)

TABLE 7

EXAMPLE OUTPUT FOR FEBRUARY THROUGH JUNE 1972: X2 STANDARD

YT	DATE	OUTFLOW	REQ.Q	Old14X2	New14X2	Old X2	New X2	Stnd.	Status	Day
BN	14FEB1972	17274.	0.	66.38	66.38	66.29	66.29	NT	NI	14
BN	15FEB1972	17929.	0.	66.33	66.33	66.56	66.56	NT	NI	15
BN	16FEB1972	18109.	0.	66.31	66.31	66.80	66.80	NT	NI	16
BN	17FEB1972	17741.	0.	66.31	66.31	67.04	67.04	NT	NI	17
BN	18FEB1972	16795.	0.	66.34	66.34	67.32	67.32	NT	NI	18
BN	19FEB1972	15965.	0.	66.40	66.40	67.62	67.62	NT	NI	19
BN	20FEB1972	14950.	0.	66.50	66.50	67.97	67.97	NT	NI	20
BN	21FEB1972	13631.	0.	66.65	66.65	68.37	68.37	NT	NI	21
BN	22FEB1972	14270.	0.	66.83	66.83	68.70	68.70	NT	NI	22
BN	23FEB1972	14173.	0.	67.05	67.05	69.02	69.02	NT	NI	23
BN	24FEB1972	15111.	0.	67.30	67.30	69.25	69.25	NT	NI	24
BN	25FEB1972	18065.	0.	67.56	67.56	69.29	69.29	NT	NI	25
BN	26FEB1972	24065.	0.	67.81	67.81	69.06	69.06	NT	NI	26
BN	27FEB1972	26217.	0.	68.00	68.00	68.76	68.76	NT	NI	27
BN	28FEB1972	26539.	0.	68.16	68.16	68.47	68.47	NT	NI	28
BN	29FEB1972	23751.	0.	68.29	68.29	68.31	68.31	NT	NI	29
BN	01MAR1972	24231.	0.	68.38	68.38	68.14	68.14	NT	NI	30
BN	02MAR1972	27368.	0.	68.44	68.44	67.87	67.87	NT	NI	31
BN	03MAR1972	25816.	0.	68.47	68.47	67.68	67.68	NT	NI	32
BN	04MAR1972	22651.	0.	68.47	68.47	67.62	67.62	NT	NI	33
BN	05MAR1972	23855.	0.	68.43	68.43	67.52	67.52	NT	NI	34
BN	06MAR1972	26990.	0.	68.36	68.36	67.31	67.31	NT	NI	35
BN	07MAR1972	26779.	0.	68.24	68.24	67.12	67.12	NT	NI	36
BN	08MAR1972	25054.	0.	68.10	68.10	67.01	67.01	NT	NI	37
BN	09MAR1972	24945.	0.	67.93	67.93	66.91	66.91	NT	NI	38
BN	10MAR1972	23859.	0.	67.76	67.76	66.86	66.86	NT	NI	39
BN	11MAR1972	22528.	0.	67.60	67.60	66.87	66.87	NT	NI	40
BN	12MAR1972	20985.	0.	67.48	67.48	66.95	66.95	NT	NI	41
BN	13MAR1972	21083.	0.	67.37	67.37	67.02	67.02	NT	NI	42
BN	14MAR1972	21987.	0.	67.28	67.28	67.04	67.04	NT	NI	43
BN	15MAR1972	21132.	0.	67.21	67.21	67.09	67.09	NT	NI	44
BN	16MAR1972	19481.	0.	67.16	67.16	67.23	67.23	NT	NI	45
BN	17MAR1972	18751.	0.	67.14	67.14	67.38	67.38	NT	NI	46
BN	18MAR1972	16997.	0.	67.14	67.14	67.62	67.62	NT	NI	47
BN	19MAR1972	15478.	0.	67.17	67.17	67.93	67.93	NT	NI	48
BN	20MAR1972	16500.	0.	67.23	67.23	68.16	68.16	NT	NI	49
BN	21MAR1972	16845.	0.	67.32	67.32	68.35	68.35	NT	NI	50
BN	22MAR1972	14350.	0.	67.44	67.44	68.68	68.68	NT	NI	51
BN	23MAR1972	12329.	0.	67.59	67.59	69.13	69.13	NT	NI	52
BN	24MAR1972	10254.	0.	67.80	67.80	69.72	69.72	NT	NI	53
BN	25MAR1972	10029.	0.	68.04	68.04	70.28	70.28	NT	NI	54
BN	26MAR1972	7839.	0.	68.33	68.33	71.04	71.04	NT	NI	55
BN	27MAR1972	8429.	0.	68.67	68.67	71.68	71.68	NT	NI	56
BN	28MAR1972	9390.	0.	69.03	69.03	72.16	72.16	NT	NI	57
BN	29MAR1972	8758.	0.	69.43	69.43	72.68	72.68	NT	NI	58
BN	30MAR1972	8410.	0.	69.86	69.86	73.19	73.19	NT	NI	59
BN	31MAR1972	7317.	0.	70.32	70.32	73.80	73.80	NT	NI	60
BN	01APR1972	5496.	10756.	70.82	70.77	74.64	74.00	NT	NI	61
BN	02APR1972	2830.	13029.	71.31	71.21	75.45	74.00	NT	NI	62
BN	03APR1972	6482.	13029.	71.67	71.62	74.66	74.00	NT	NI	63
BN	04APR1972	6725.	13029.	72.07	72.03	74.63	74.00	NT	NI	64
BN	05APR1972	6963.	13029.	72.45	72.41	74.60	74.00	NT	NI	65
BN	06APR1972	8173.	13029.	72.79	72.75	74.44	74.00	NT	NI	66
BN	07APR1972	9384.	13029.	73.08	73.06	74.31	74.00	NT	NI	67
BN	08APR1972	9270.	13029.	73.35	73.33	74.32	74.00	NT	NI	68
BN	09APR1972	9306.	13029.	73.56	73.54	74.32	74.00	NT	NI	69
BN	10APR1972	8820.	13029.	73.73	73.70	74.37	74.00	NT	NI	70
BN	11APR1972	9755.	13029.	73.85	73.83	74.28	74.00	NT	NI	71
BN	12APR1972	12180.	13029.	73.93	73.93	74.06	74.00	NT	NI	72
BN	13APR1972	13898.	0.	73.98	73.98	73.94	73.94	NT	NI	73
BN	14APR1972	15434.	0.	73.98	73.98	73.78	73.78	NT	NI	74
BN	15APR1972	15957.	0.	73.95	73.95	73.61	73.61	NT	NI	75
BN	16APR1972	12836.	0.	73.93	73.93	73.65	73.65	NT	NI	76
BN	17APR1972	11128.	0.	73.91	73.91	73.82	73.82	NT	NI	77
BN	18APR1972	7488.	10989.	73.94	73.91	74.37	74.00	NT	NI	78
BN	19APR1972	6316.	13029.	73.96	73.91	74.69	74.00	NT	NI	79
BN	20APR1972	5069.	13029.	73.98	73.91	74.90	74.00	NT	NI	80
BN	21APR1972	4864.	13029.	73.98	73.91	74.94	74.00	NT	NI	81
BN	22APR1972	3396.	13029.	74.01	73.91	75.28	74.00	NT	NI	82
BN	23APR1972	3686.	13029.	74.00	73.91	75.20	74.00	NT	NI	83
BN	24APR1972	5197.	13029.	73.98	73.91	74.88	74.00	NT	NI	84
BN	25APR1972	5041.	13029.	73.98	73.91	74.90	74.00	NT	NI	85
BN	26APR1972	5307.	13029.	73.98	73.91	74.86	74.00	NT	NI	86
BN	27APR1972	4907.	13029.	73.99	73.92	74.93	74.00	NT	NI	87
BN	28APR1972	3793.	13029.	74.02	73.93	75.17	74.00	NT	NI	88
BN	29APR1972	2639.	13029.	74.07	73.96	75.52	74.00	NT	NI	89
BN	30APR1972	3911.	13029.	74.07	73.99	75.15	74.00	NT	NI	90
BN	01MAY1972	3870.	13029.	74.08	74.00	75.16	74.00	NT	NI	91
BN	02MAY1972	4039.	13029.	74.08	74.00	75.12	74.00	NT	NI	92
BN	03MAY1972	3253.	13029.	74.09	74.00	75.32	74.00	NT	NI	93
BN	04MAY1972	2983.	13029.	74.10	74.00	75.40	74.00	NT	NI	94
BN	05MAY1972	3408.	13029.	74.09	74.00	75.28	74.00	NT	NI	95
BN	06MAY1972	4350.	13029.	74.07	74.00	75.04	74.00	NT	NI	96
BN	07MAY1972	5419.	13029.	74.06	74.00	74.84	74.00	NT	NI	97
BN	08MAY1972	5905.	13029.	74.05	74.00	74.75	74.00	NT	NI	98

BN	09MAY1972	6583.	13029.	74.05	74.00	74.65	74.00	NT	NI	99
BN	10MAY1972	6304.	13029.	74.05	74.00	74.69	74.00	NT	NI	100
BN	11MAY1972	6202.	13029.	74.05	74.00	74.71	74.00	NT	NI	101
BN	12MAY1972	6165.	13029.	74.05	74.00	74.71	74.00	NT	NI	102
BN	13MAY1972	5074.	13029.	74.06	74.00	74.90	74.00	NT	NI	103
BN	14MAY1972	4601.	13029.	74.07	74.00	74.99	74.00	NT	NI	104
BN	15MAY1972	4798.	13029.	74.07	74.00	74.95	74.00	NT	NI	105
BN	16MAY1972	4985.	13029.	74.07	74.00	74.91	74.00	NT	NI	106
BN	17MAY1972	5161.	13029.	74.06	74.00	74.88	74.00	NT	NI	107
BN	18MAY1972	5102.	13029.	74.06	74.00	74.89	74.00	NT	NI	108
BN	19MAY1972	4217.	13029.	74.08	74.00	75.07	74.00	NT	NI	109
BN	20MAY1972	4316.	13029.	74.08	74.00	75.05	74.00	NT	NI	110
BN	21MAY1972	5897.	13029.	74.05	74.00	74.75	74.00	NT	NI	111
BN	22MAY1972	6468.	13029.	74.05	74.00	74.67	74.00	NT	NI	112
BN	23MAY1972	8984.	13029.	74.03	74.00	74.35	74.00	NT	NI	113
BN	24MAY1972	9300.	13029.	74.02	74.00	74.32	74.00	NT	NI	114
BN	25MAY1972	8593.	13029.	74.03	74.00	74.40	74.00	NT	NI	115
BN	26MAY1972	5741.	13029.	74.06	74.00	74.78	74.00	NT	NI	116
BN	27MAY1972	4785.	13029.	74.07	74.00	74.95	74.00	NT	NI	117
BN	28MAY1972	3817.	13029.	74.08	74.00	75.17	74.00	NT	NI	118
BN	29MAY1972	3529.	13029.	74.09	74.00	75.24	74.00	NT	NI	119
BN	30MAY1972	2780.	0.	74.11	74.11	75.47	75.47	NT	NI	120
BN	31MAY1972	2704.	0.	74.31	74.31	76.86	76.86	NT	NI	121
BN	01JUN1972	2229.	0.	74.62	74.62	78.33	78.33	NT	NI	122
BN	02JUN1972	2974.	0.	75.00	75.00	79.41	79.41	NT	NI	123
BN	03JUN1972	3437.	0.	75.45	75.45	80.28	80.28	NT	NI	124
BN	04JUN1972	4285.	0.	75.94	75.94	80.87	80.87	NT	NI	125
BN	05JUN1972	4124.	6638.	76.48	76.44	81.45	81.00	NT	NI	126
BN	06JUN1972	3578.	7539.	76.99	76.94	81.71	81.00	NT	NI	127
BN	07JUN1972	3001.	7539.	77.51	77.44	81.88	81.00	NT	NI	128
BN	08JUN1972	3741.	7539.	77.99	77.94	81.67	81.00	NT	NI	129
BN	09JUN1972	3496.	7539.	78.50	78.44	81.73	81.00	NT	NI	130
BN	10JUN1972	4780.	7539.	78.97	78.94	81.43	81.00	NT	NI	131
BN	11JUN1972	5006.	7539.	79.47	79.44	81.39	81.00	NT	NI	132
BN	12JUN1972	5458.	7539.	79.97	79.94	81.31	81.00	NT	NI	133
BN	13JUN1972	5340.	7539.	80.36	80.34	81.33	81.00	NT	NI	134
BN	14JUN1972	5218.	7539.	80.66	80.63	81.35	81.00	NT	NI	135
BN	15JUN1972	3725.	7539.	80.87	80.83	81.67	81.00	NT	NI	136
BN	16JUN1972	3465.	7539.	80.99	80.94	81.74	81.00	NT	NI	137
BN	17JUN1972	3219.	7539.	81.05	80.99	81.81	81.00	NT	NI	138
BN	18JUN1972	3104.	7539.	81.06	81.00	81.84	81.00	NT	NI	139
BN	19JUN1972	3600.	7539.	81.05	81.00	81.70	81.00	NT	NI	140
BN	20JUN1972	3621.	7539.	81.05	81.00	81.70	81.00	NT	NI	141
BN	21JUN1972	1000.	7539.	81.14	81.00	82.92	81.00	NT	NI	142
BN	22JUN1972	1000.	7539.	81.14	81.00	82.92	81.00	NT	NI	143
BN	23JUN1972	8997.	0.	80.99	80.99	80.83	80.83	NT	NI	144
BN	24JUN1972	9502.	0.	80.96	80.96	80.62	80.62	NT	NI	145
BN	25JUN1972	9940.	0.	80.92	80.92	80.39	80.39	NT	NI	146
BN	26JUN1972	9867.	0.	80.86	80.86	80.18	80.18	NT	NI	147
BN	27JUN1972	10048.	0.	80.78	80.78	79.97	79.97	NT	NI	148
BN	28JUN1972	11097.	0.	80.69	80.69	79.67	79.67	NT	NI	149
BN	29JUN1972	10901.	0.	80.58	80.58	79.42	79.42	NT	NI	150
BN	30JUN1972	10668.	0.	80.45	80.45	79.21	79.21	NT	NI	151

TABLE 8

EXAMPLE OUTPUT FOR FEBRUARY THROUGH JUNE 1972: X3 STANDARD

YT	DATE	OUTFLOW	REQ.Q	Old14X2	New14X2	Old X2	New X2	Stnd.Status	Day
BN	14FEB1972	17274.	0.	63.46	63.46	63.37	63.37	NC lt 64.0	14
BN	15FEB1972	17929.	0.	63.41	63.41	63.63	63.63	NC lt 64.0	15
BN	16FEB1972	18109.	0.	63.39	63.39	63.86	63.86	NC lt 64.0	16
BN	17FEB1972	17741.	0.	63.39	63.39	64.09	64.09	NC lt 64.0	17
BN	18FEB1972	16795.	0.	63.41	63.41	64.36	64.36	NC lt 64.0	18
BN	19FEB1972	15965.	0.	63.47	63.47	64.65	64.65	NC lt 64.0	19
BN	20FEB1972	14950.	0.	63.57	63.57	64.98	64.98	NC lt 64.0	20
BN	21FEB1972	13631.	0.	63.71	63.71	65.38	65.38	NC lt 64.0	21
BN	22FEB1972	14270.	0.	63.89	63.89	65.70	65.70	NC lt 64.0	22
BN	23FEB1972	14173.	0.	64.10	64.10	66.00	66.00	NT NI	23
BN	24FEB1972	15111.	0.	64.34	64.34	66.22	66.22	NT NI	24
BN	25FEB1972	18065.	0.	64.59	64.59	66.27	66.27	NT NI	25
BN	26FEB1972	24065.	0.	64.83	64.83	66.04	66.04	NT NI	26
BN	27FEB1972	26217.	0.	65.02	65.02	65.75	65.75	NT NI	27
BN	28FEB1972	26539.	0.	65.17	65.17	65.48	65.48	NT NI	28
BN	29FEB1972	23751.	0.	65.29	65.29	65.32	65.32	NT NI	29
BN	01MAR1972	24231.	0.	65.39	65.39	65.16	65.16	NT NI	30
BN	02MAR1972	27368.	0.	65.44	65.44	64.90	64.90	NT NI	31
BN	03MAR1972	25816.	0.	65.47	65.47	64.71	64.71	NT NI	32
BN	04MAR1972	22651.	0.	65.47	65.47	64.66	64.66	NT NI	33
BN	05MAR1972	23855.	0.	65.44	65.44	64.56	64.56	NT NI	34
BN	06MAR1972	26990.	0.	65.37	65.37	64.36	64.36	NT NI	35
BN	07MAR1972	26779.	0.	65.26	65.26	64.17	64.17	NT NI	36
BN	08MAR1972	25054.	0.	65.12	65.12	64.07	64.07	NT NI	37
BN	09MAR1972	24945.	0.	64.96	64.96	63.97	63.97	NT NI	38
BN	10MAR1972	23859.	0.	64.79	64.79	63.92	63.92	NT NI	39
BN	11MAR1972	22528.	0.	64.64	64.64	63.93	63.93	NT NI	40
BN	12MAR1972	20985.	0.	64.52	64.52	64.01	64.01	NT NI	41
BN	13MAR1972	21083.	0.	64.41	64.41	64.07	64.07	NT NI	42
BN	14MAR1972	21987.	0.	64.33	64.33	64.09	64.09	NT NI	43
BN	15MAR1972	21132.	0.	64.25	64.25	64.14	64.14	NT NI	44
BN	16MAR1972	19481.	0.	64.21	64.21	64.27	64.27	NT NI	45
BN	17MAR1972	18751.	0.	64.19	64.19	64.42	64.42	NT NI	46
BN	18MAR1972	16997.	0.	64.19	64.19	64.65	64.65	NT NI	47
BN	19MAR1972	15478.	0.	64.22	64.22	64.95	64.95	NT NI	48
BN	20MAR1972	16500.	0.	64.27	64.27	65.17	65.17	NT NI	49
BN	21MAR1972	16845.	0.	64.36	64.36	65.36	65.36	NT NI	50
BN	22MAR1972	14350.	0.	64.47	64.47	65.67	65.67	NT NI	51
BN	23MAR1972	12329.	0.	64.63	64.63	66.11	66.11	NT NI	52
BN	24MAR1972	10254.	0.	64.82	64.82	66.68	66.68	NT NI	53
BN	25MAR1972	10029.	0.	65.06	65.06	67.23	67.23	NT NI	54
BN	26MAR1972	7839.	0.	65.34	65.34	67.96	67.96	NT NI	55
BN	27MAR1972	8429.	0.	65.66	65.66	68.58	68.58	NT NI	56
BN	28MAR1972	9390.	0.	66.02	66.02	69.05	69.05	NT NI	57
BN	29MAR1972	8758.	0.	66.40	66.40	69.55	69.55	NT NI	58
BN	30MAR1972	8410.	0.	66.82	66.82	70.05	70.05	NT NI	59
BN	31MAR1972	7317.	0.	67.26	67.26	70.64	70.64	NT NI	60
BN	01APR1972	5496.	0.	67.75	67.75	71.45	71.45	NT NI	61
BN	02APR1972	2830.	0.	68.31	68.31	72.81	72.81	NT NI	62
BN	03APR1972	6482.	0.	68.89	68.89	73.31	73.31	NT NI	63
BN	04APR1972	6725.	0.	69.49	69.49	73.74	73.74	NT NI	64
BN	05APR1972	6963.	7762.	70.09	70.08	74.10	74.00	NT NI	65
BN	06APR1972	8173.	10130.	70.66	70.65	74.20	74.00	NT NI	66
BN	07APR1972	9384.	10130.	71.17	71.17	74.07	74.00	NT NI	67
BN	08APR1972	9270.	10130.	71.66	71.65	74.08	74.00	NT NI	68
BN	09APR1972	9306.	10130.	72.09	72.08	74.08	74.00	NT NI	69
BN	10APR1972	8820.	10130.	72.48	72.47	74.13	74.00	NT NI	70
BN	11APR1972	9755.	10130.	72.83	72.82	74.03	74.00	NT NI	71
BN	12APR1972	12180.	0.	73.13	73.13	73.83	73.83	NT NI	72
BN	13APR1972	13898.	0.	73.38	73.38	73.55	73.55	NT NI	73
BN	14APR1972	15434.	0.	73.56	73.56	73.20	73.20	NT NI	74
BN	15APR1972	15957.	0.	73.66	73.66	72.84	72.84	NT NI	75
BN	16APR1972	12836.	0.	73.66	73.66	72.71	72.71	NT NI	76
BN	17APR1972	11128.	0.	73.61	73.61	72.72	72.72	NT NI	77
BN	18APR1972	7488.	0.	73.57	73.57	73.09	73.09	NT NI	78
BN	19APR1972	6316.	0.	73.54	73.54	73.59	73.59	NT NI	79
BN	20APR1972	5069.	6708.	73.56	73.54	74.26	74.00	NT NI	80
BN	21APR1972	4864.	10130.	73.59	73.54	74.67	74.00	NT NI	81
BN	22APR1972	3396.	10130.	73.61	73.54	75.00	74.00	NT NI	82
BN	23APR1972	3686.	10130.	73.60	73.54	74.93	74.00	NT NI	83
BN	24APR1972	5197.	10130.	73.58	73.54	74.61	74.00	NT NI	84
BN	25APR1972	5041.	10130.	73.58	73.54	74.64	74.00	NT NI	85
BN	26APR1972	5307.	10130.	73.59	73.55	74.59	74.00	NT NI	86
BN	27APR1972	4907.	10130.	73.63	73.58	74.67	74.00	NT NI	87
BN	28APR1972	3793.	10130.	73.70	73.64	74.90	74.00	NT NI	88
BN	29APR1972	2639.	10130.	73.81	73.72	75.24	74.00	NT NI	89
BN	30APR1972	3911.	10130.	73.88	73.81	74.88	74.00	NT NI	90
BN	01MAY1972	3870.	10130.	73.97	73.91	74.88	74.00	NT NI	91
BN	02MAY1972	4039.	10130.	74.03	73.97	74.85	74.00	NT NI	92
BN	03MAY1972	3253.	10130.	74.07	74.00	75.04	74.00	NT NI	93
BN	04MAY1972	2983.	10130.	74.08	74.00	75.12	74.00	NT NI	94
BN	05MAY1972	3408.	10130.	74.07	74.00	75.00	74.00	NT NI	95
BN	06MAY1972	4350.	10130.	74.06	74.00	74.78	74.00	NT NI	96
BN	07MAY1972	5419.	10130.	74.04	74.00	74.58	74.00	NT NI	97
BN	08MAY1972	5905.	10130.	74.04	74.00	74.50	74.00	NT NI	98

BN	09MAY1972	6583.	10130.	74.03	74.00	74.40	74.00	NT	NI	99
BN	10MAY1972	6304.	10130.	74.03	74.00	74.44	74.00	NT	NI	100
BN	11MAY1972	6202.	10130.	74.03	74.00	74.45	74.00	NT	NI	101
BN	12MAY1972	6165.	10130.	74.03	74.00	74.46	74.00	NT	NI	102
BN	13MAY1972	5074.	10130.	74.05	74.00	74.64	74.00	NT	NI	103
BN	14MAY1972	4601.	10130.	74.05	74.00	74.73	74.00	NT	NI	104
BN	15MAY1972	4798.	10130.	74.05	74.00	74.69	74.00	NT	NI	105
BN	16MAY1972	4985.	10130.	74.05	74.00	74.65	74.00	NT	NI	106
BN	17MAY1972	5161.	10130.	74.04	74.00	74.62	74.00	NT	NI	107
BN	18MAY1972	5102.	10130.	74.05	74.00	74.63	74.00	NT	NI	108
BN	19MAY1972	4217.	10130.	74.06	74.00	74.81	74.00	NT	NI	109
BN	20MAY1972	4316.	10130.	74.06	74.00	74.78	74.00	NT	NI	110
BN	21MAY1972	5897.	10130.	74.04	74.00	74.50	74.00	NT	NI	111
BN	22MAY1972	6468.	10130.	74.03	74.00	74.41	74.00	NT	NI	112
BN	23MAY1972	8984.	10130.	74.01	74.00	74.11	74.00	NT	NI	113
BN	24MAY1972	9300.	10130.	74.01	74.00	74.08	74.00	NT	NI	114
BN	25MAY1972	8593.	10130.	74.01	74.00	74.15	74.00	NT	NI	115
BN	26MAY1972	5741.	10130.	74.04	74.00	74.52	74.00	NT	NI	116
BN	27MAY1972	4785.	10130.	74.05	74.00	74.69	74.00	NT	NI	117
BN	28MAY1972	3817.	10130.	74.06	74.00	74.90	74.00	NT	NI	118
BN	29MAY1972	3529.	10130.	74.07	74.00	74.97	74.00	NT	NI	119
BN	30MAY1972	2780.	10130.	74.08	74.00	75.19	74.00	NT	NI	120
BN	31MAY1972	2704.	10130.	74.09	74.00	75.21	74.00	NT	NI	121
BN	01JUN1972	2229.	10130.	74.10	74.00	75.39	74.00	NT	NI	122
BN	02JUN1972	2974.	10130.	74.08	74.00	75.13	74.00	NT	NI	123
BN	03JUN1972	3437.	10130.	74.07	74.00	74.99	74.00	NT	NI	124
BN	04JUN1972	4285.	10130.	74.06	74.00	74.79	74.00	NT	NI	125
BN	05JUN1972	4124.	10130.	74.06	74.00	74.83	74.00	NT	NI	126
BN	06JUN1972	3578.	10130.	74.07	74.00	74.96	74.00	NT	NI	127
BN	07JUN1972	3001.	10130.	74.08	74.00	75.12	74.00	NT	NI	128
BN	08JUN1972	3741.	0.	74.07	74.07	74.92	74.92	NT	NI	129
BN	09JUN1972	3496.	0.	74.20	74.20	75.83	75.83	NT	NI	130
BN	10JUN1972	4780.	0.	74.37	74.37	76.38	76.38	NT	NI	131
BN	11JUN1972	5006.	0.	74.57	74.57	76.85	76.85	NT	NI	132
BN	12JUN1972	5458.	0.	74.80	74.80	77.21	77.21	NT	NI	133
BN	13JUN1972	5340.	0.	75.05	75.05	77.56	77.56	NT	NI	134
BN	14JUN1972	5218.	0.	75.33	75.33	77.91	77.91	NT	NI	135
BN	15JUN1972	3725.	0.	75.66	75.66	78.54	78.54	NT	NI	136
BN	16JUN1972	3465.	0.	76.03	76.03	79.19	79.19	NT	NI	137
BN	17JUN1972	3219.	0.	76.45	76.45	79.86	79.86	NT	NI	138
BN	18JUN1972	3104.	0.	76.91	76.91	80.52	80.52	NT	NI	139
BN	19JUN1972	3600.	0.	77.41	77.41	80.99	80.99	NT	NI	140
BN	20JUN1972	3621.	5711.	77.94	77.91	81.42	81.00	NT	NI	141
BN	21JUN1972	1000.	5776.	78.53	78.41	82.61	81.00	NT	NI	142
BN	22JUN1972	1000.	5776.	78.96	78.85	82.61	81.00	NT	NI	143
BN	23JUN1972	8997.	0.	79.19	79.19	80.59	80.59	NT	NI	144
BN	24JUN1972	9502.	0.	79.46	79.46	80.16	80.16	NT	NI	145
BN	25JUN1972	9940.	0.	79.66	79.66	79.73	79.73	NT	NI	146
BN	26JUN1972	9867.	0.	79.81	79.81	79.33	79.33	NT	NI	147
BN	27JUN1972	10048.	0.	79.91	79.91	78.94	78.94	NT	NI	148
BN	28JUN1972	11097.	0.	79.95	79.95	78.49	78.49	NT	NI	149
BN	29JUN1972	10901.	0.	79.92	79.92	78.10	78.10	NT	NI	150
BN	30JUN1972	10668.	0.	79.82	79.82	77.75	77.75	NT	NI	151

FIGURE 1 1990-1992 USGS CTD DATA

X2 LENGTH-SCALE

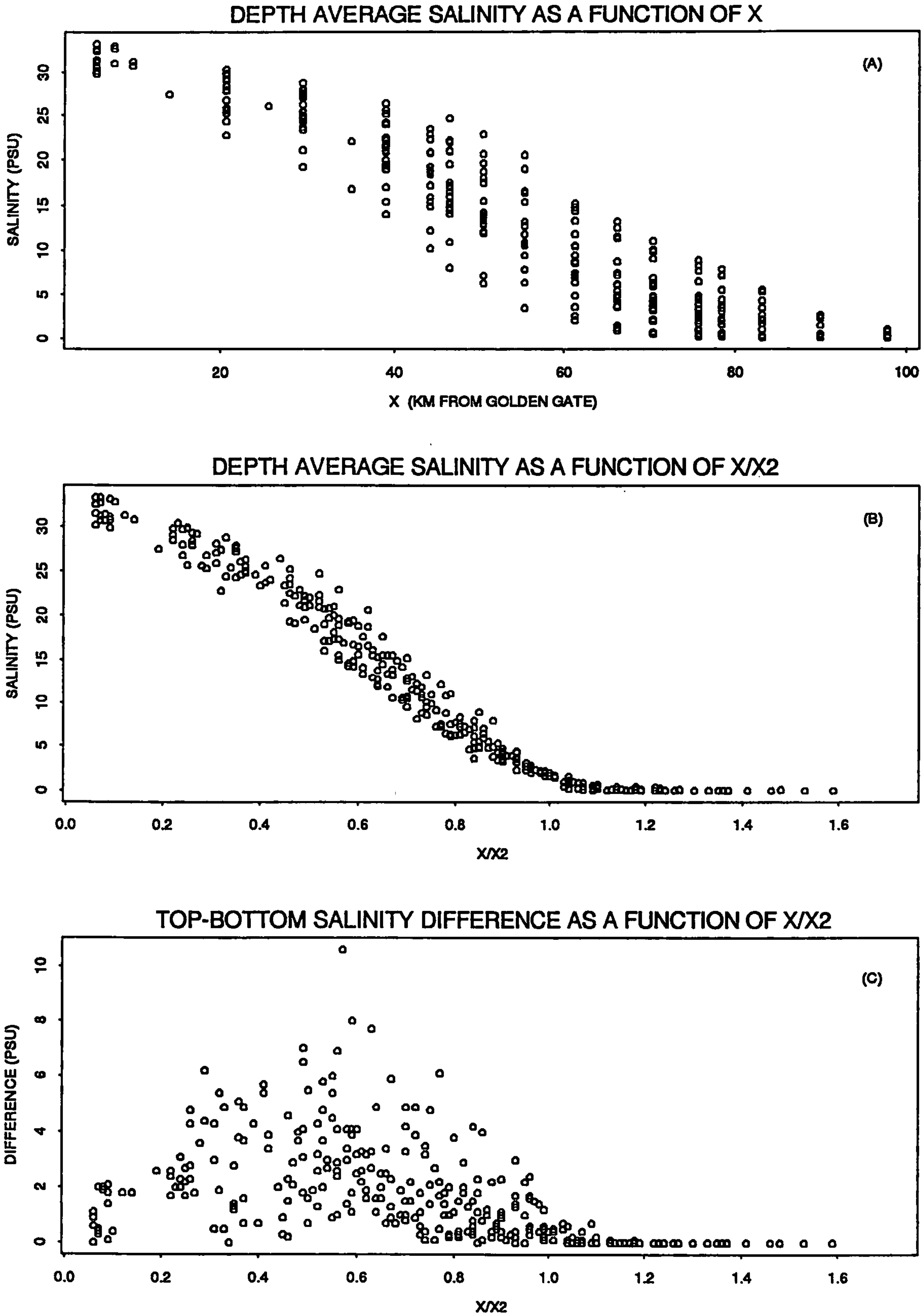
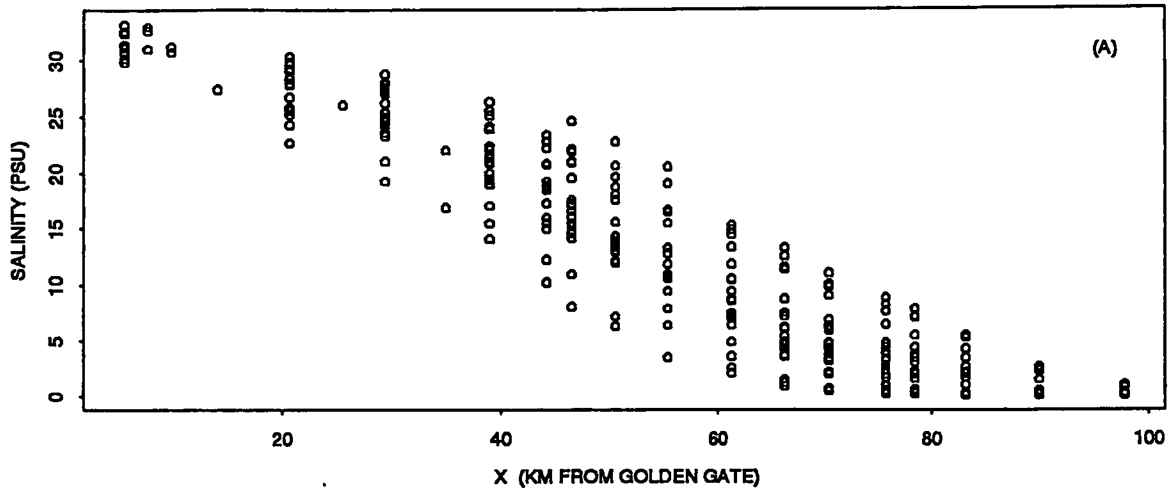


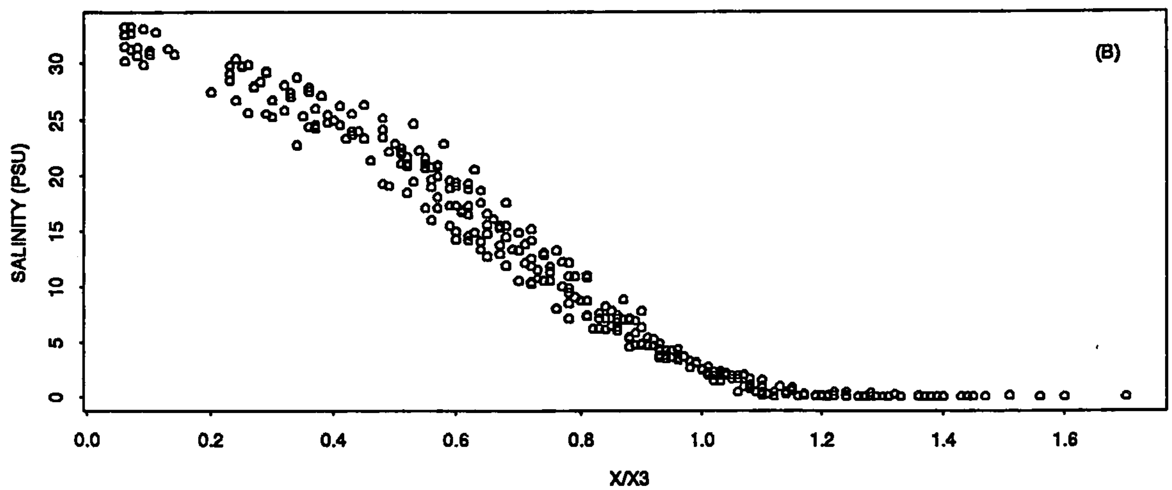
FIGURE 2 1990-1992 USGS CTD DATA

X3 LENGTH-SCALE

DEPTH AVERAGE SALINITY AS A FUNCTION OF X



DEPTH AVERAGE SALINITY AS A FUNCTION OF X/X3



TOP-BOTTOM SALINITY DIFFERENCE AS A FUNCTION OF X/X3

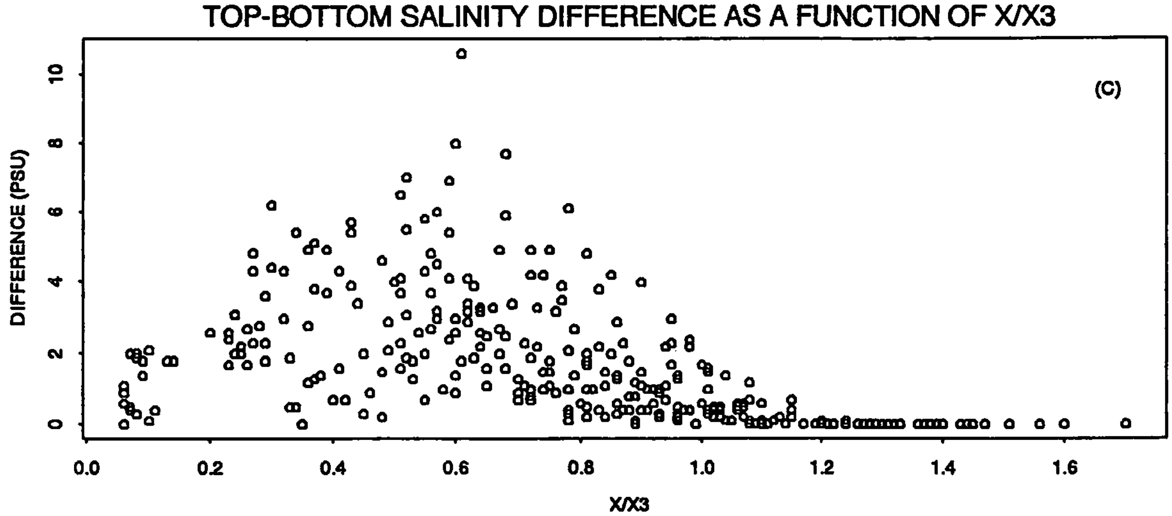


FIGURE 3
X2 AND X3 LOCATIONS; 1990-1992 USGS CTD DATA

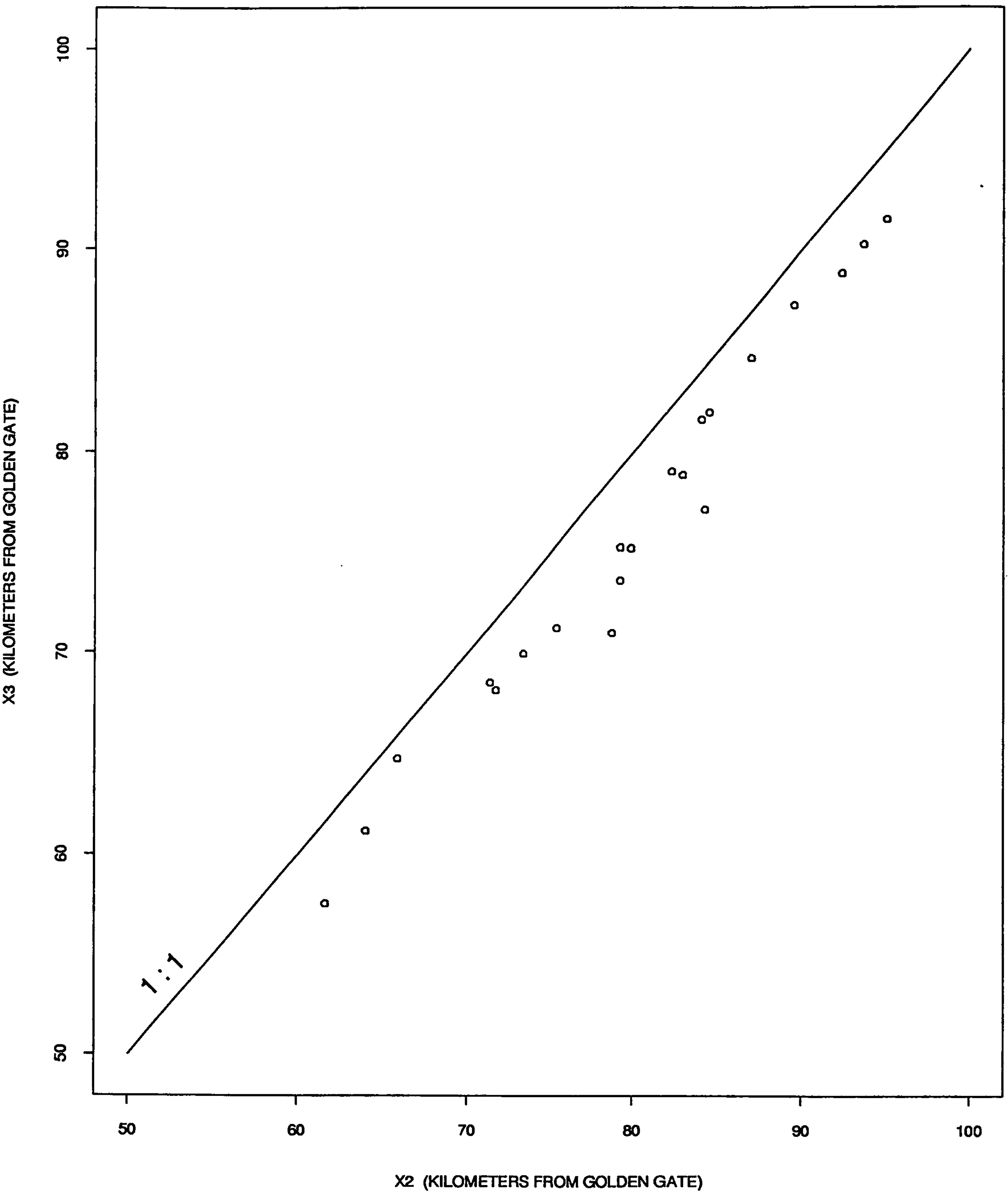
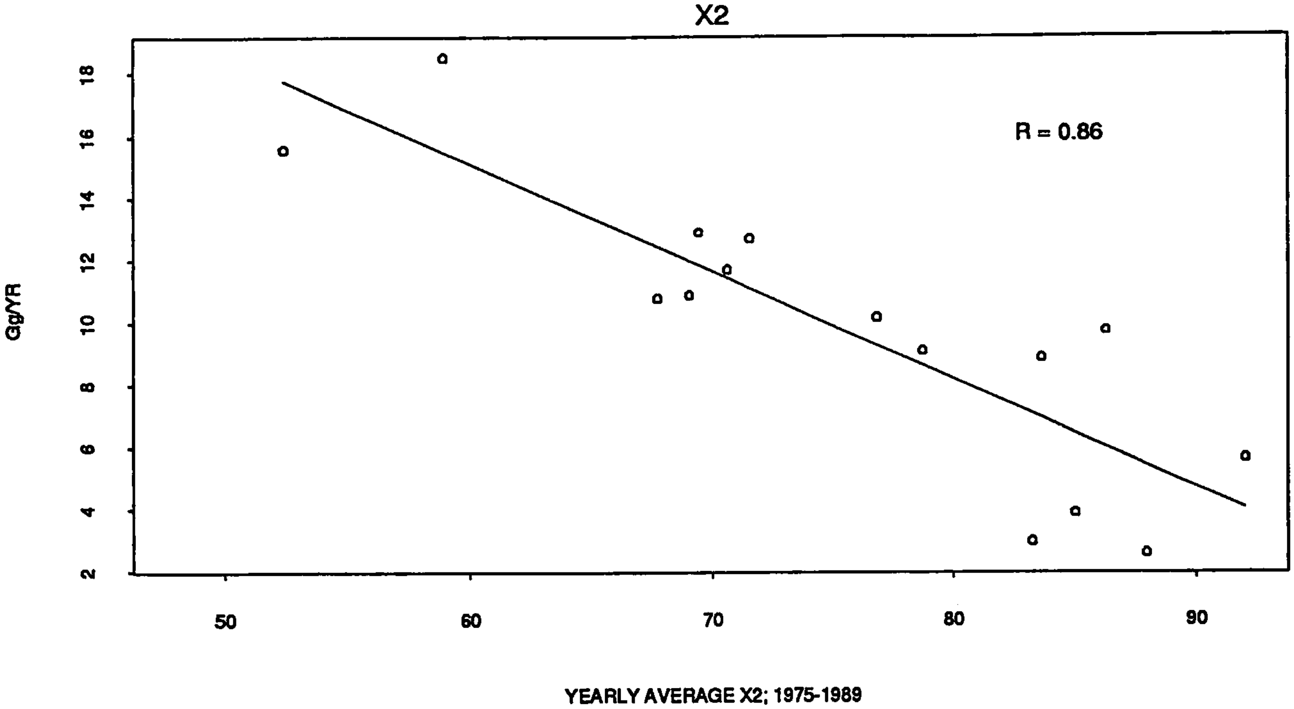


FIGURE 4

PRIMARY PRODUCTION AND ISOHALINE POSITION



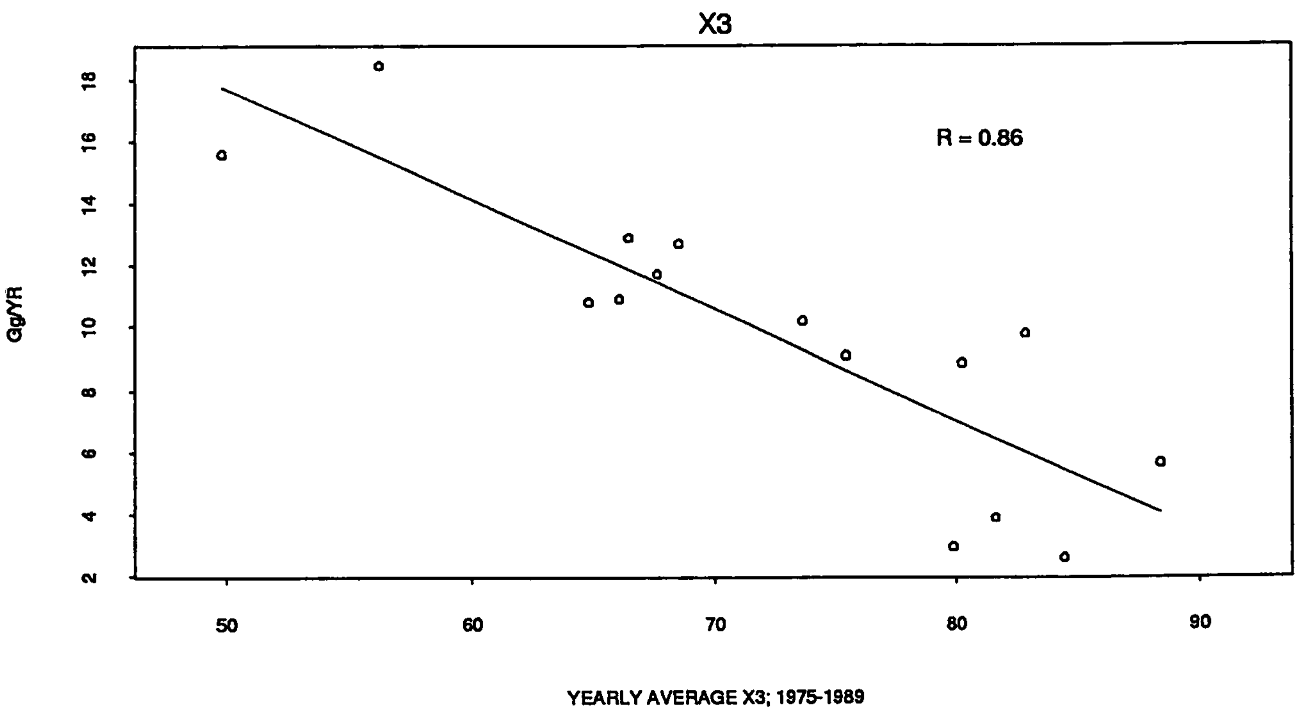
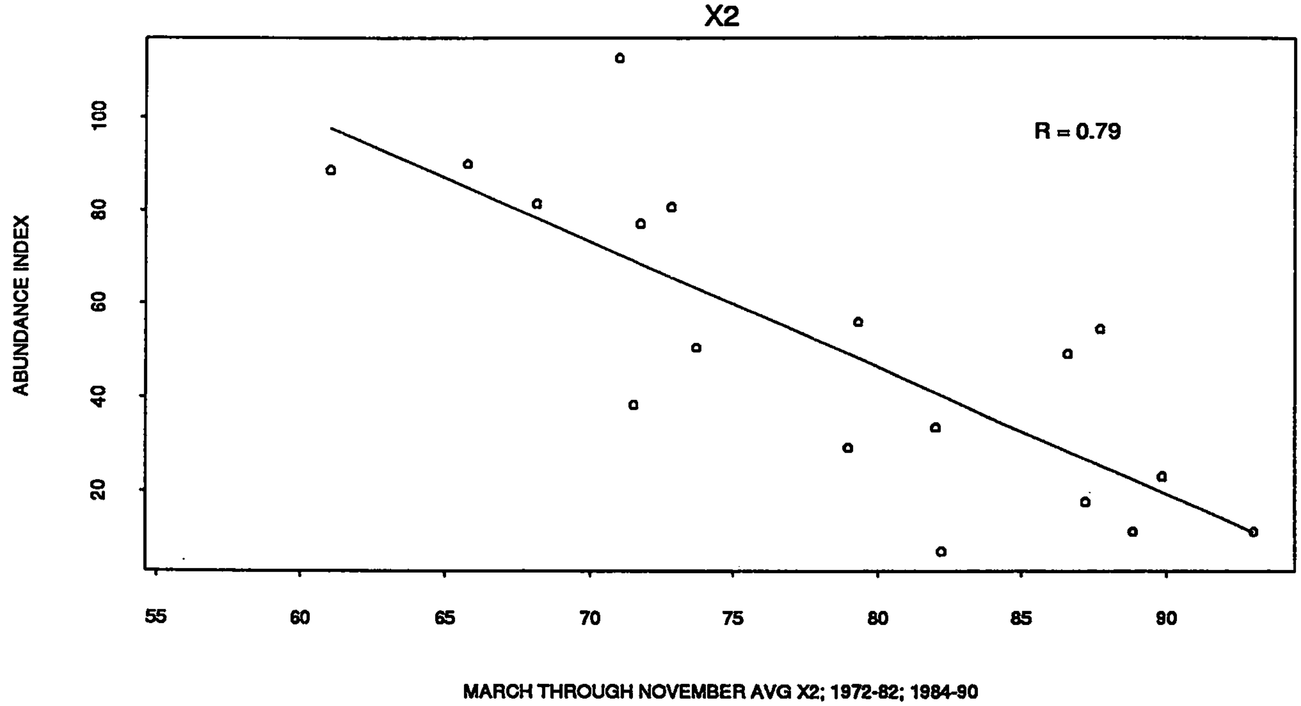


FIGURE 5

NEOMYSIS MERCEDIS AND ISOHALINE POSITION



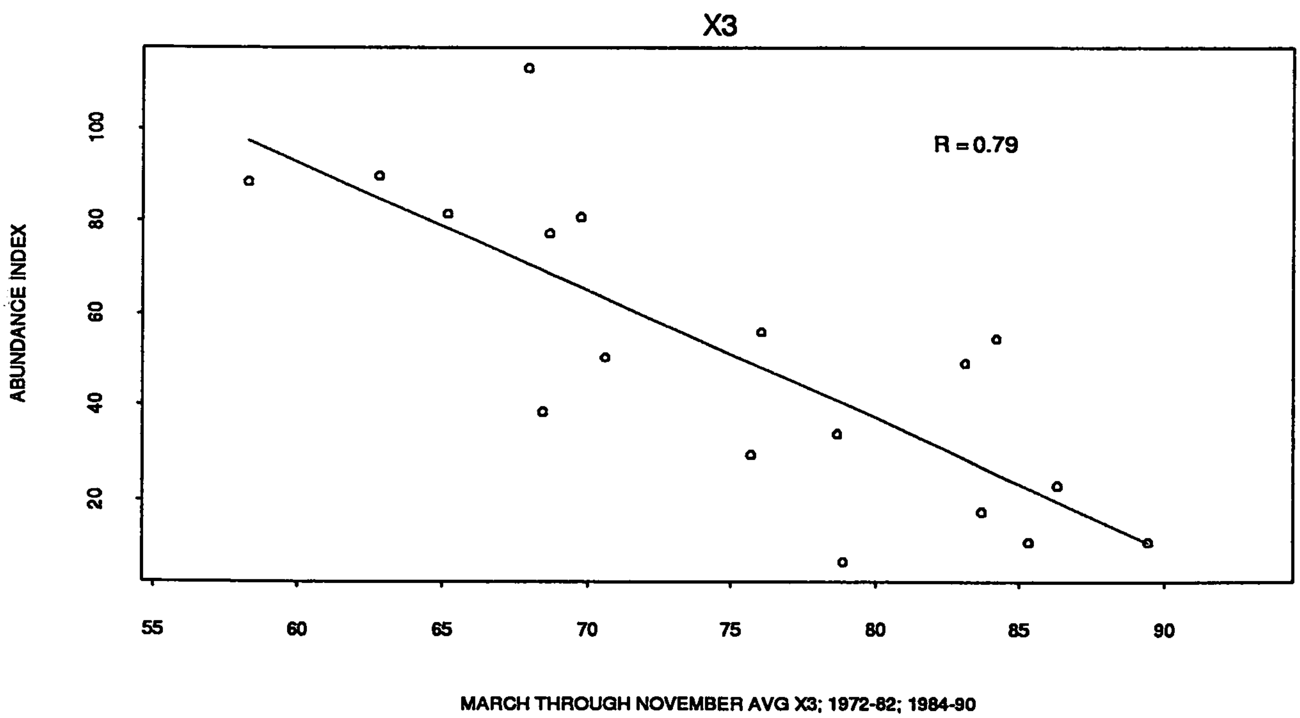
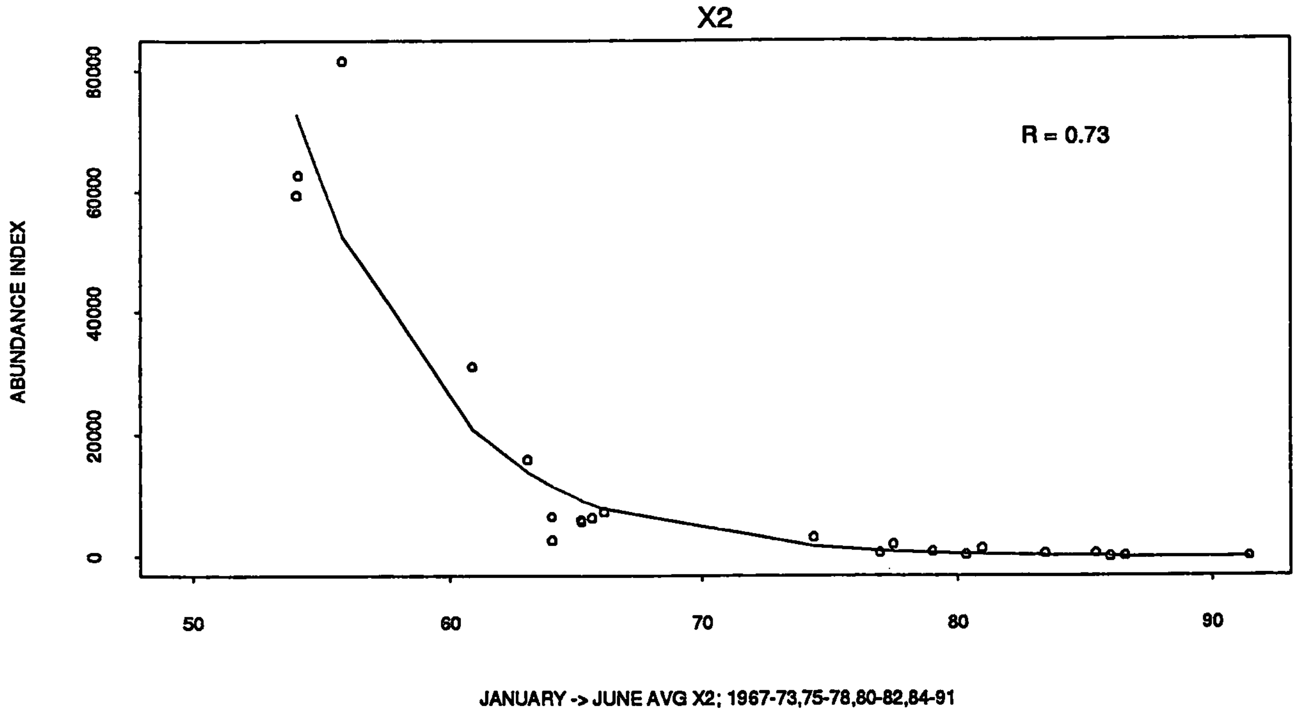


FIGURE 6

LONGFIN SMELT AND ISOHALINE POSITION



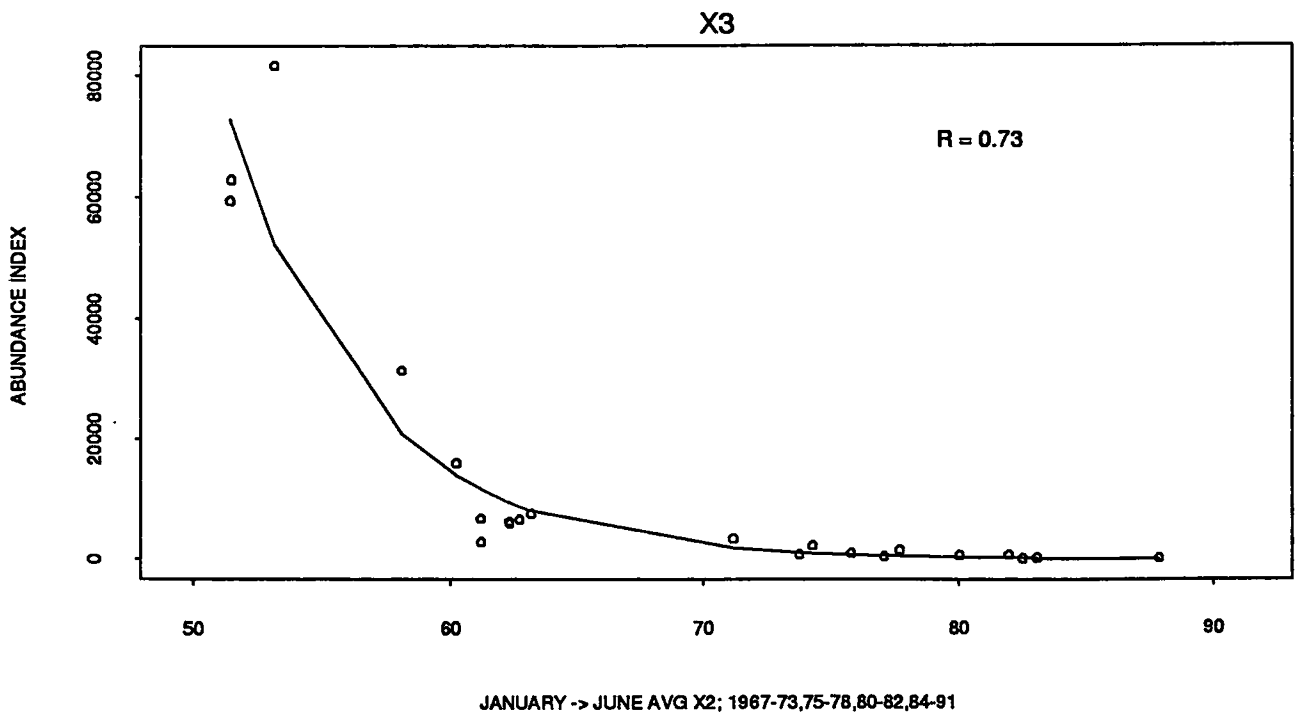


FIGURE 7

STRIPED BASS SURVIVAL AND ISOHALINE POSITION

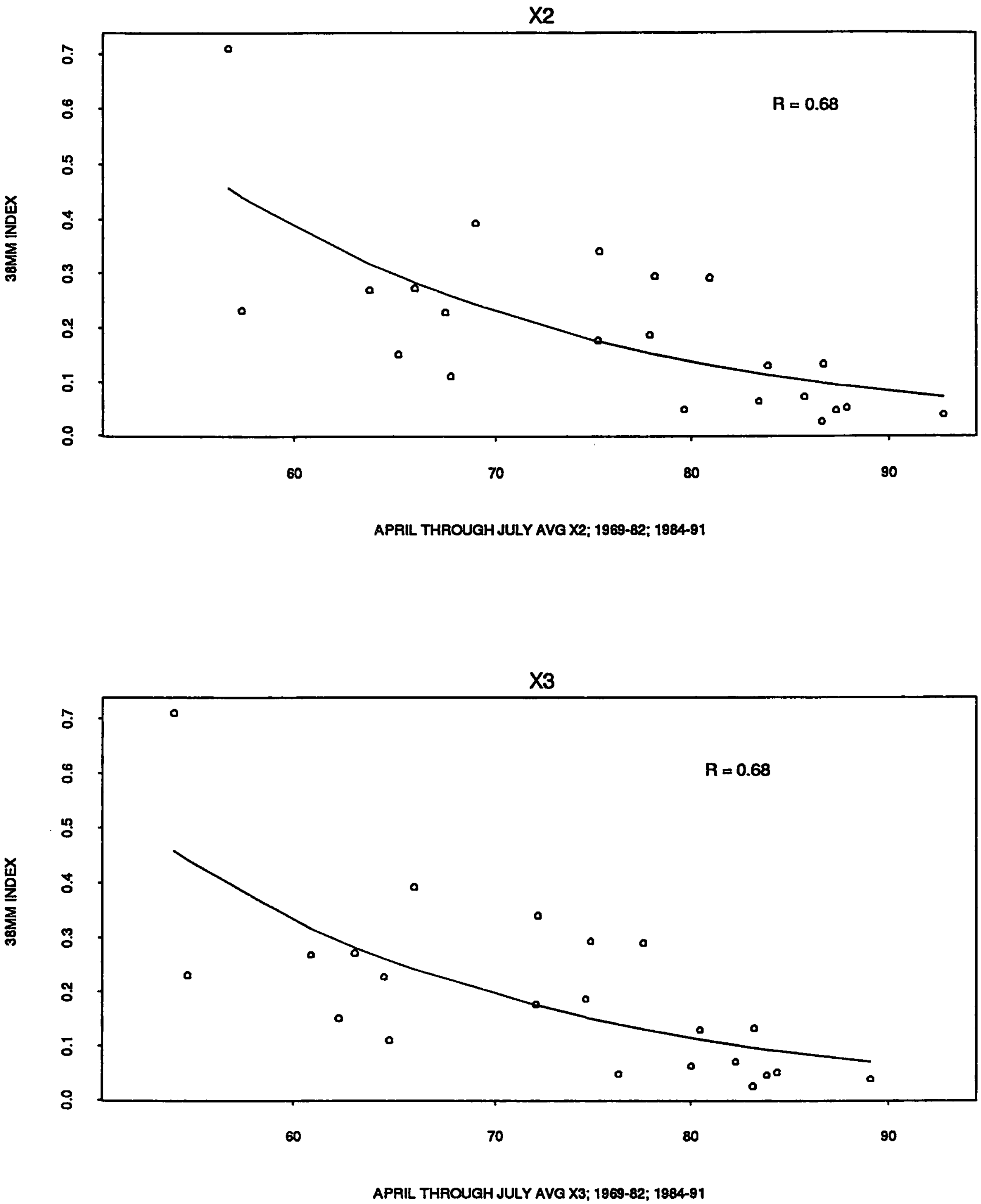
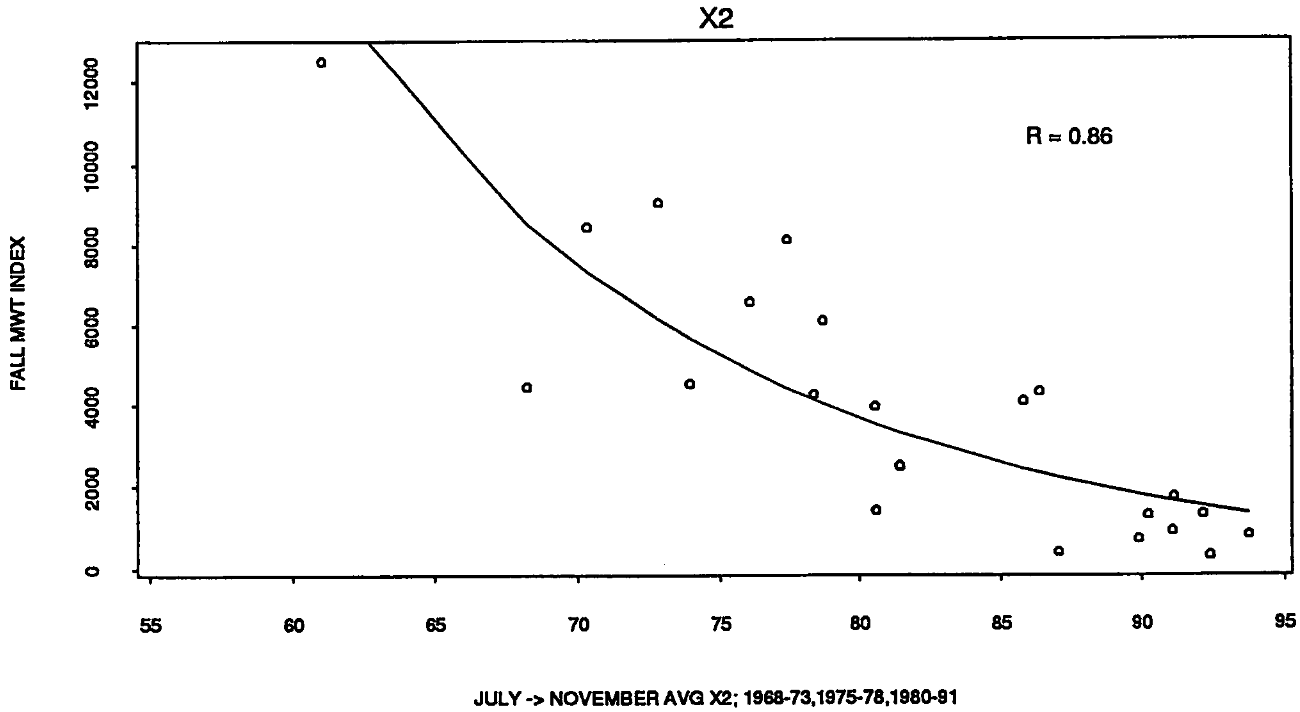


FIGURE 8

STRIPED BASS FALL MWT AND ISOHALINE POSITION



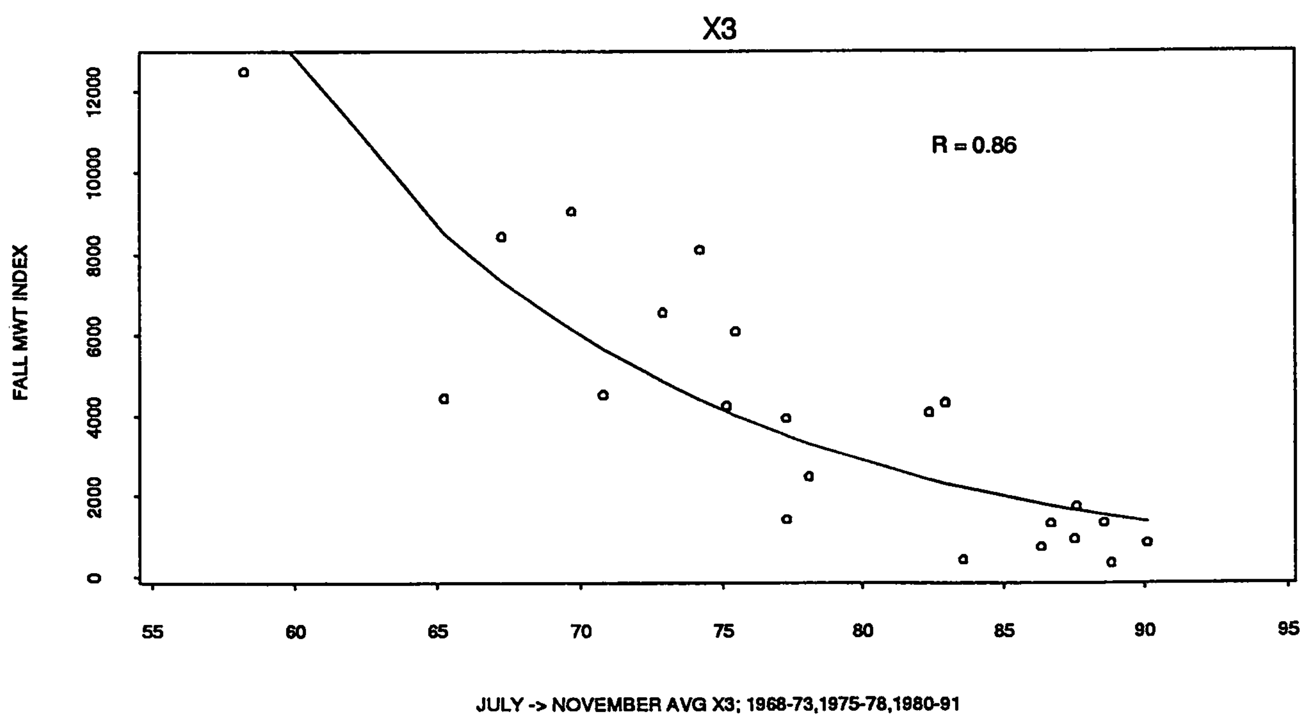
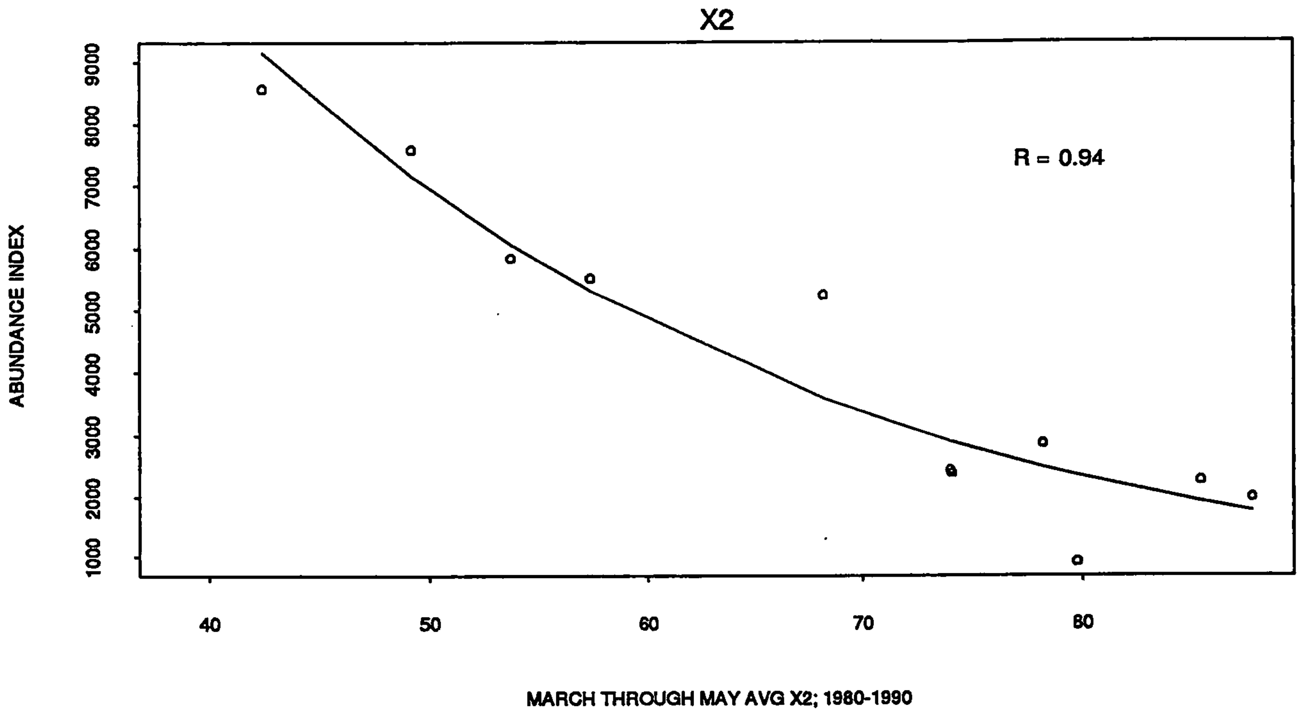


FIGURE 9

CRANGON FRANCISCORUM AND ISOHALINE POSITION



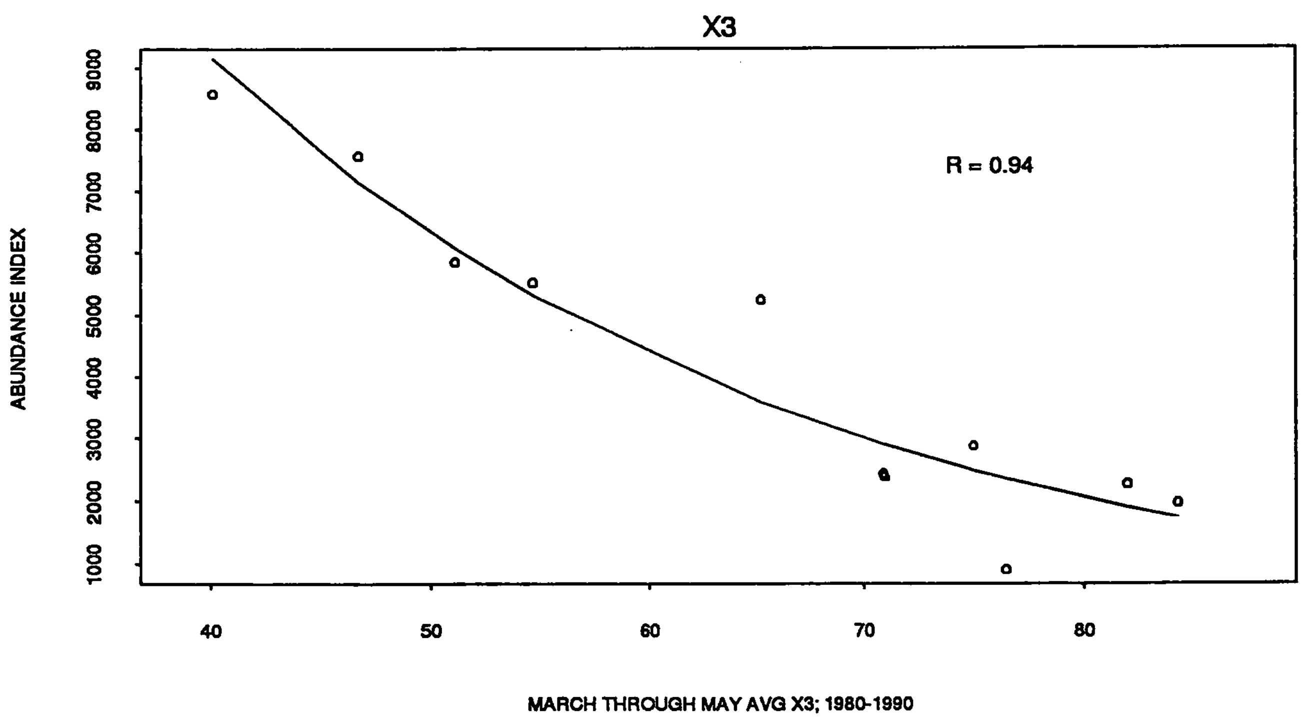
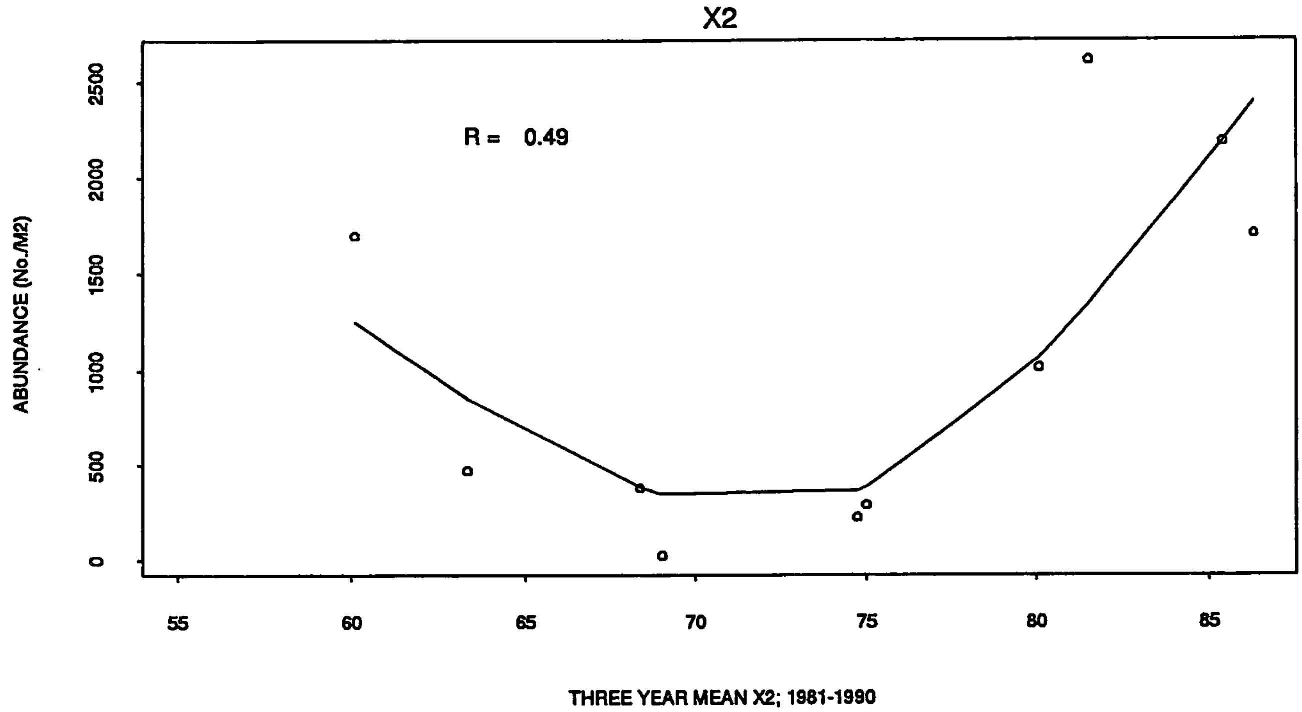


FIGURE 10

MOLLUSCS AND ISOHALINE POSITION



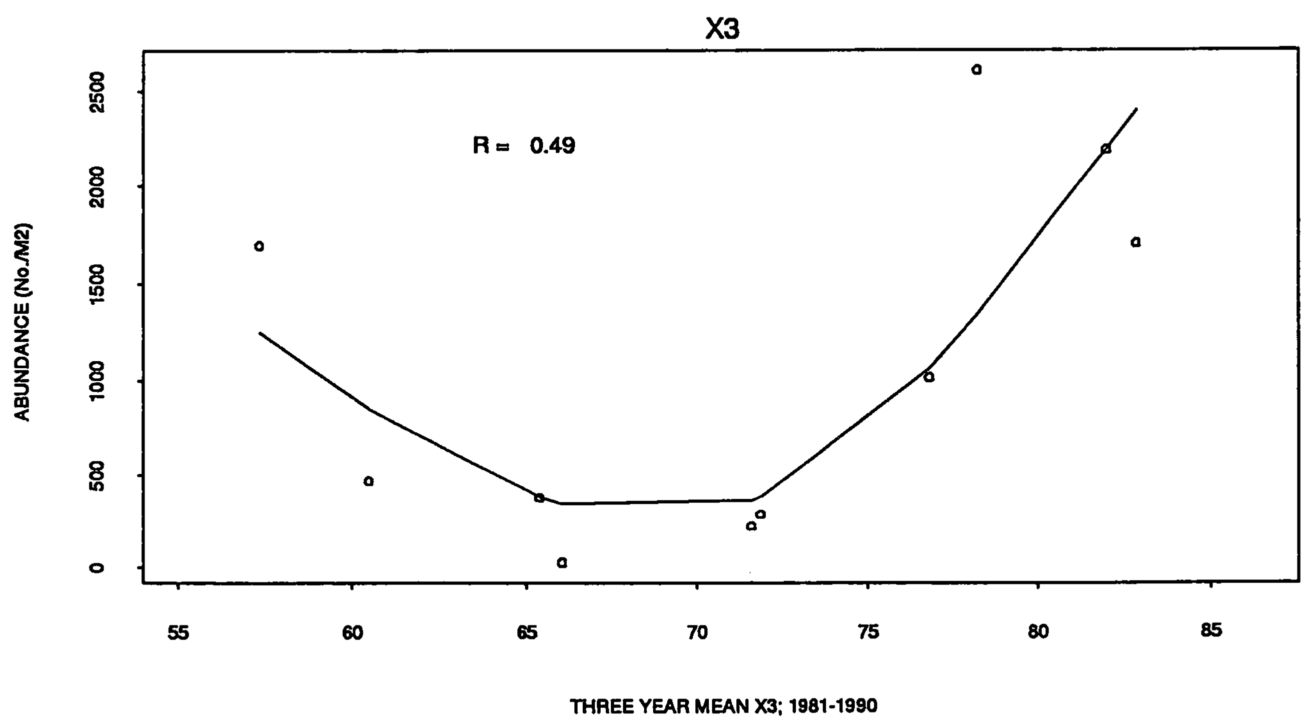
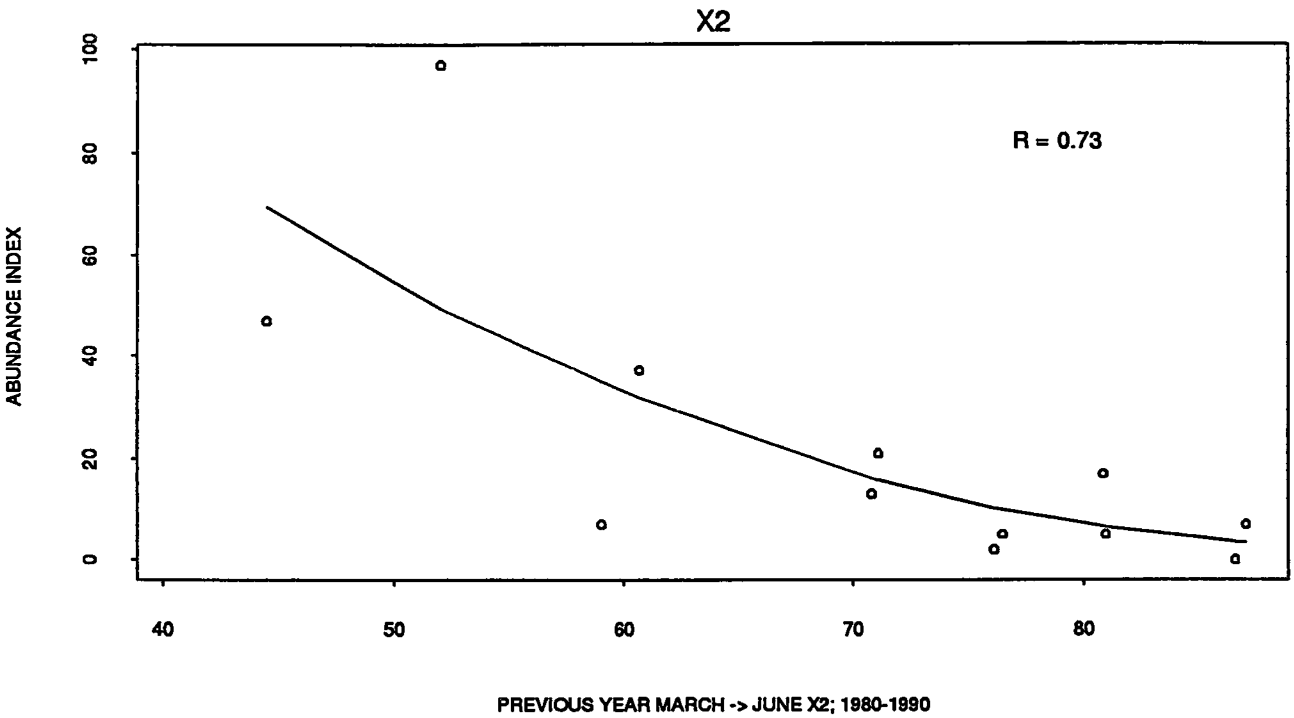


FIGURE II

STARRY FLOUNDER AND ISOHALINE POSITION



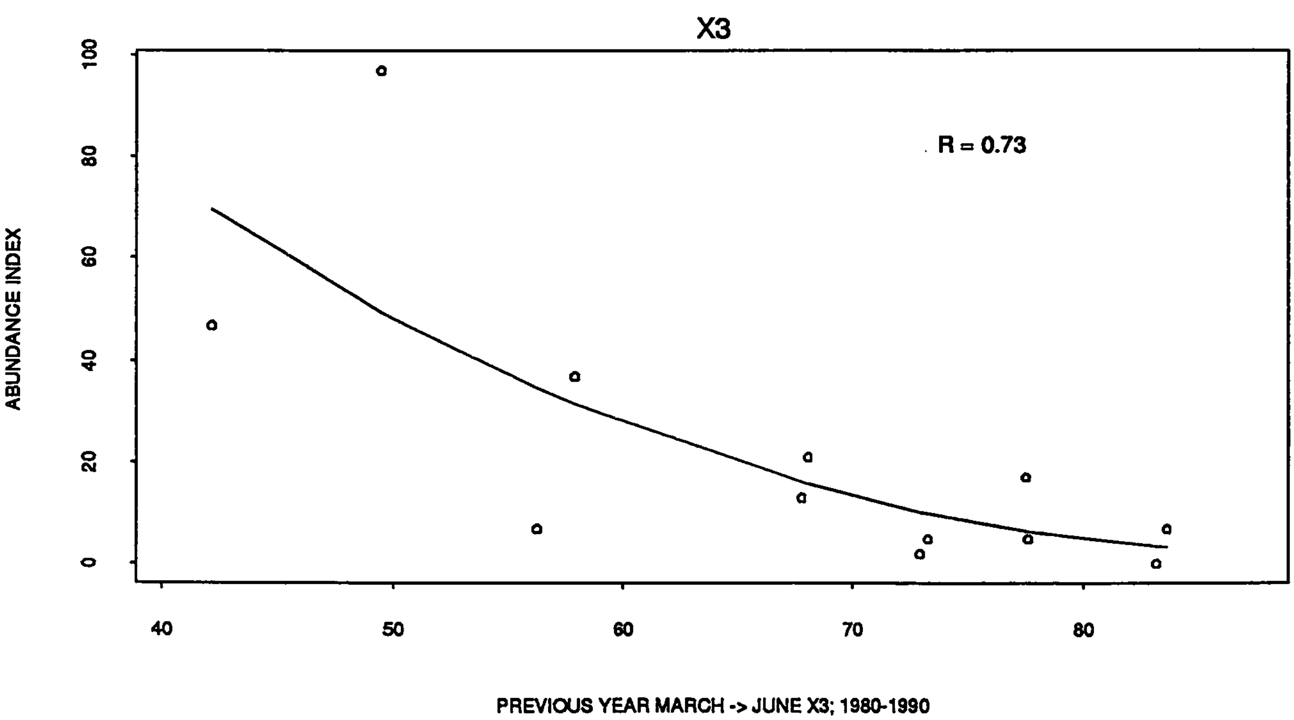


FIGURE 12A
CHLOROPHYLL VS. SALINITY CLASS FROM DWR AND CDFG DATA*

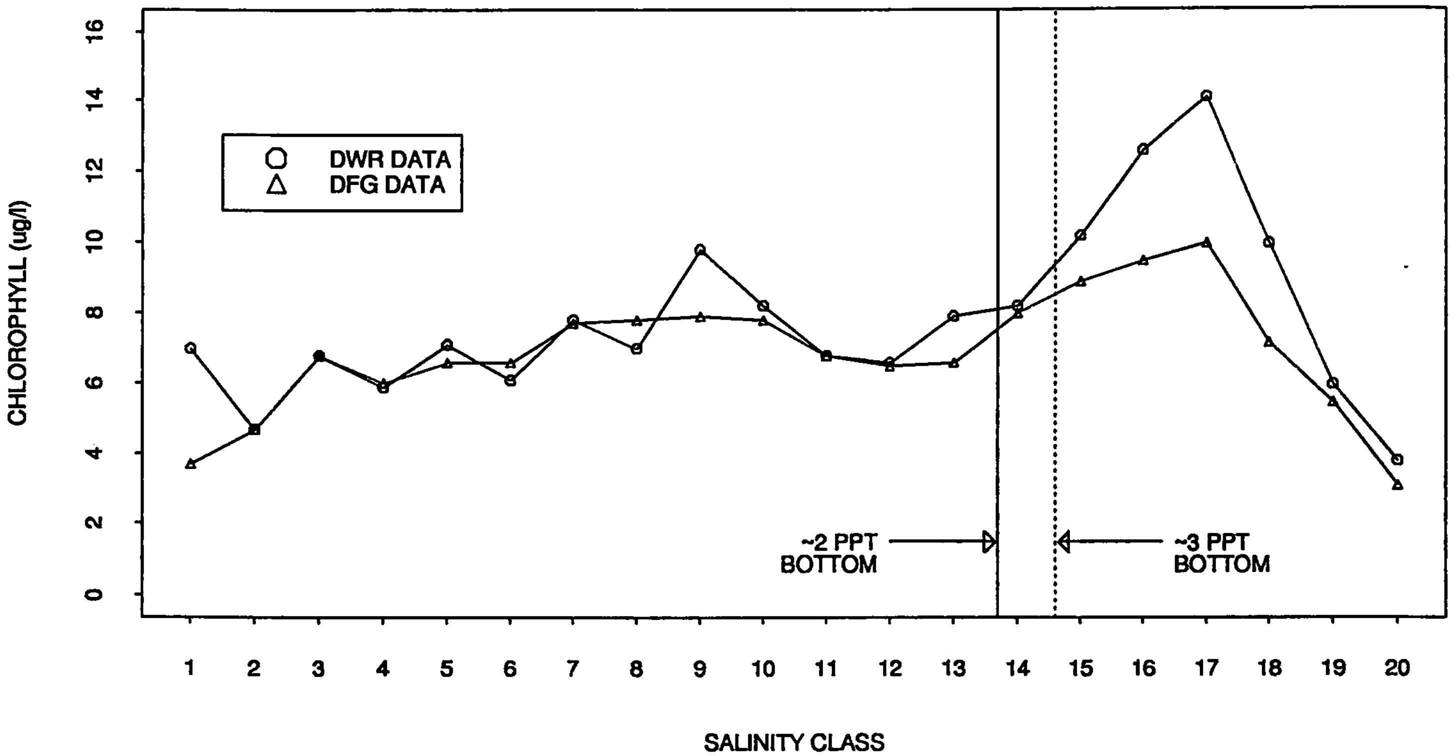
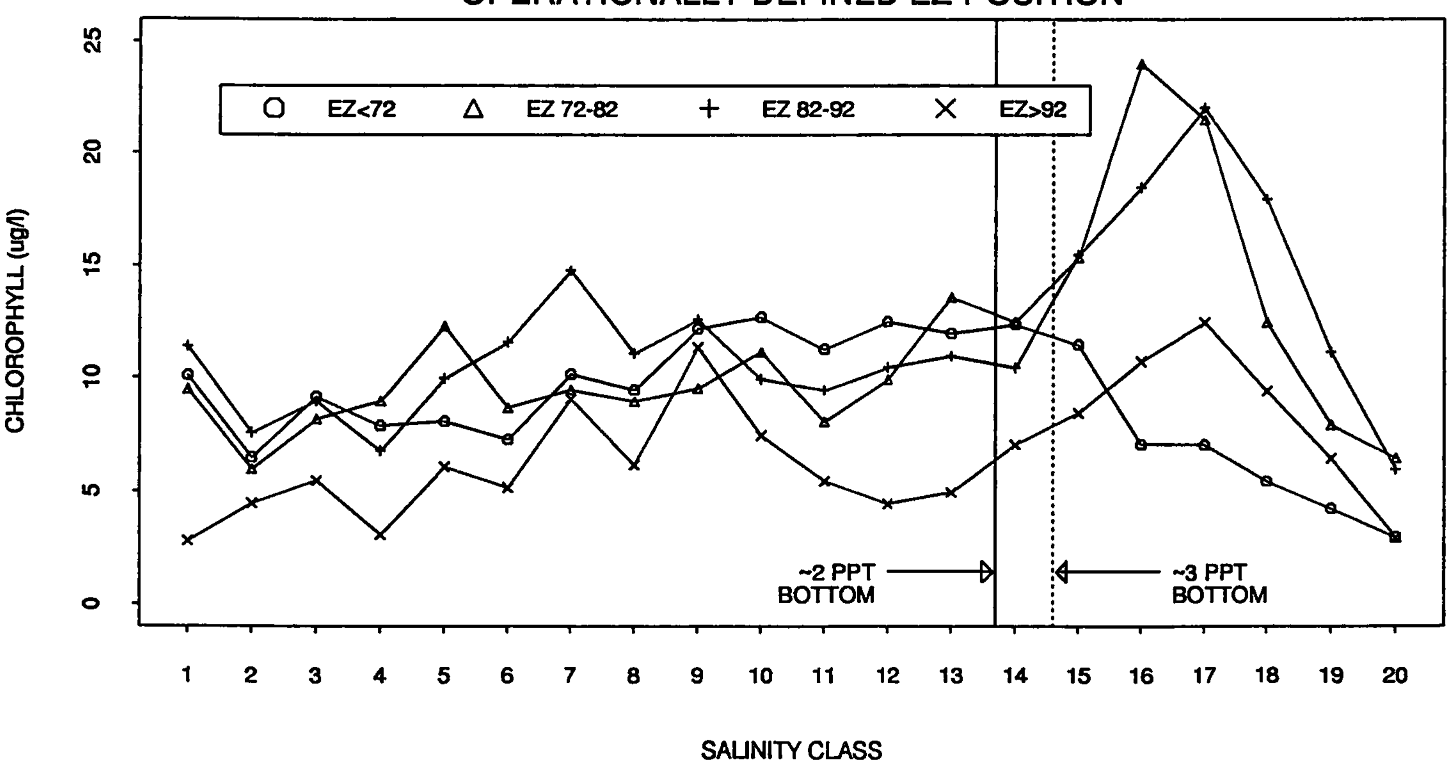


FIGURE 12B CHLOROPHYLL VS. SALINITY CLASS FOR FOUR RANGES OF OPERATIONALLY DEFINED EZ POSITION*



* ADAPTED FROM KIMMERER (1992)

FIGURE 13A
LOG ABUNDANCE OF EURYTEMORA AFFINIS VS. SALINITY CLASS*

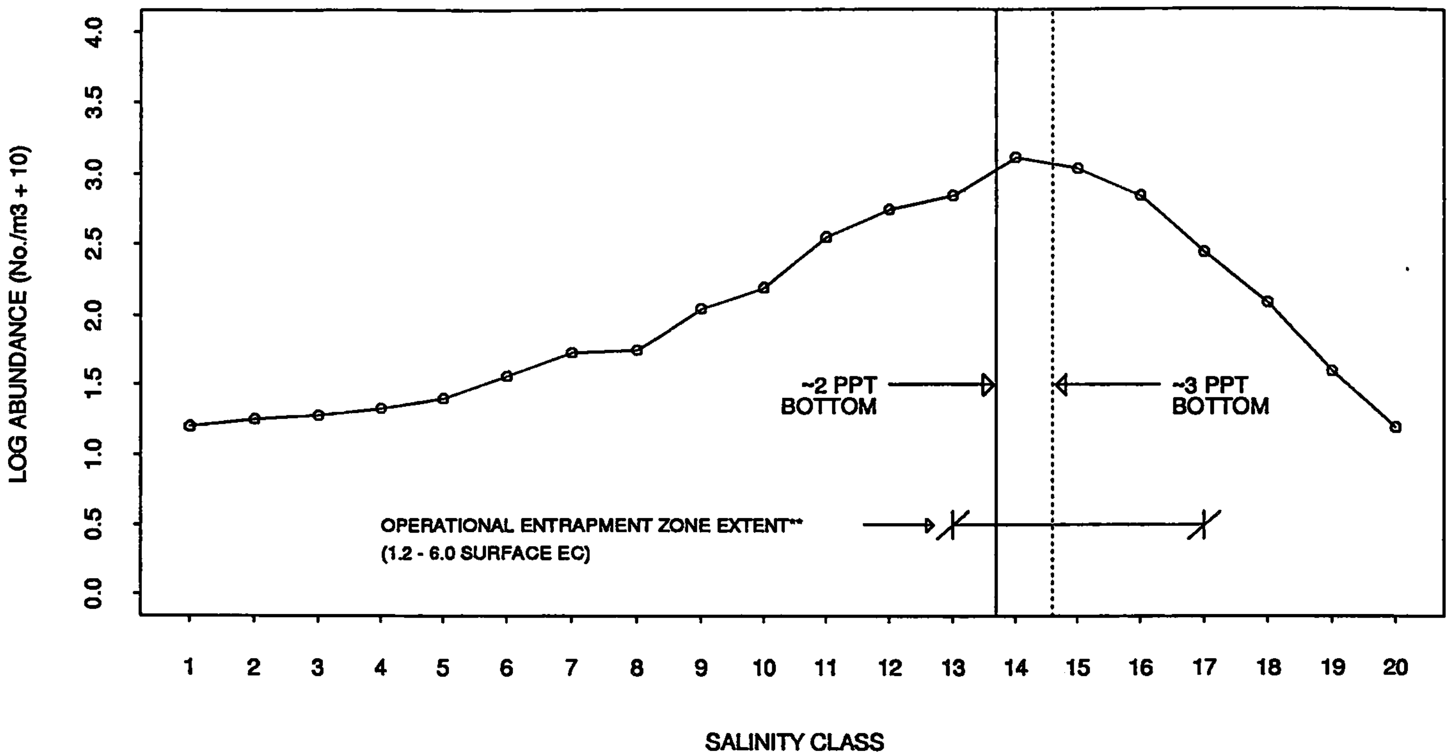


FIGURE 13B LOG ABUNDANCE OF EURYTEMORA AFFINIS VS. SALINITY CLASS FOR FOUR RANGES OF OPERTIONALLY DEFINED ENTRAPMENT ZONE POSITION*

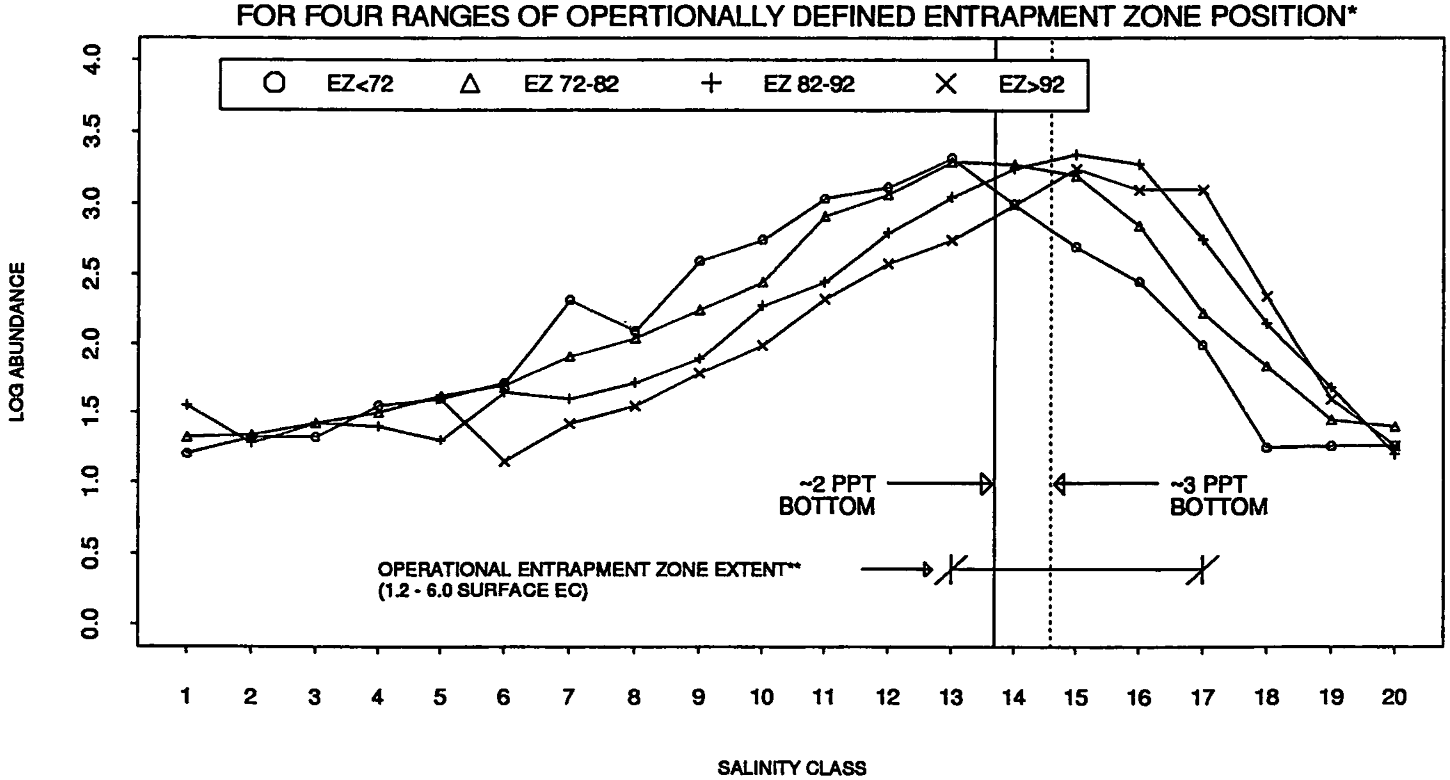


FIGURE 14A
LOG ABUNDANCE OF NEOMYSIS MERCEDIS VS. SALINITY CLASS*

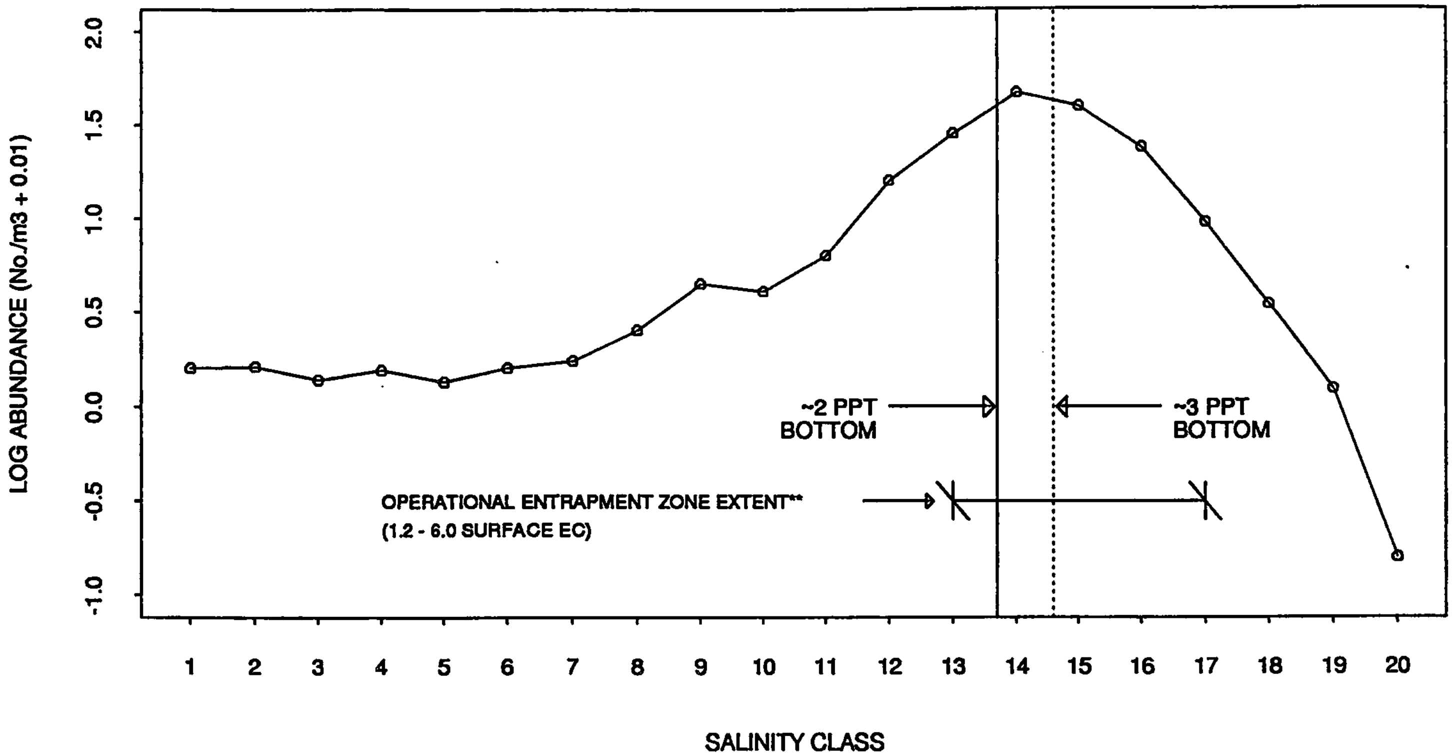
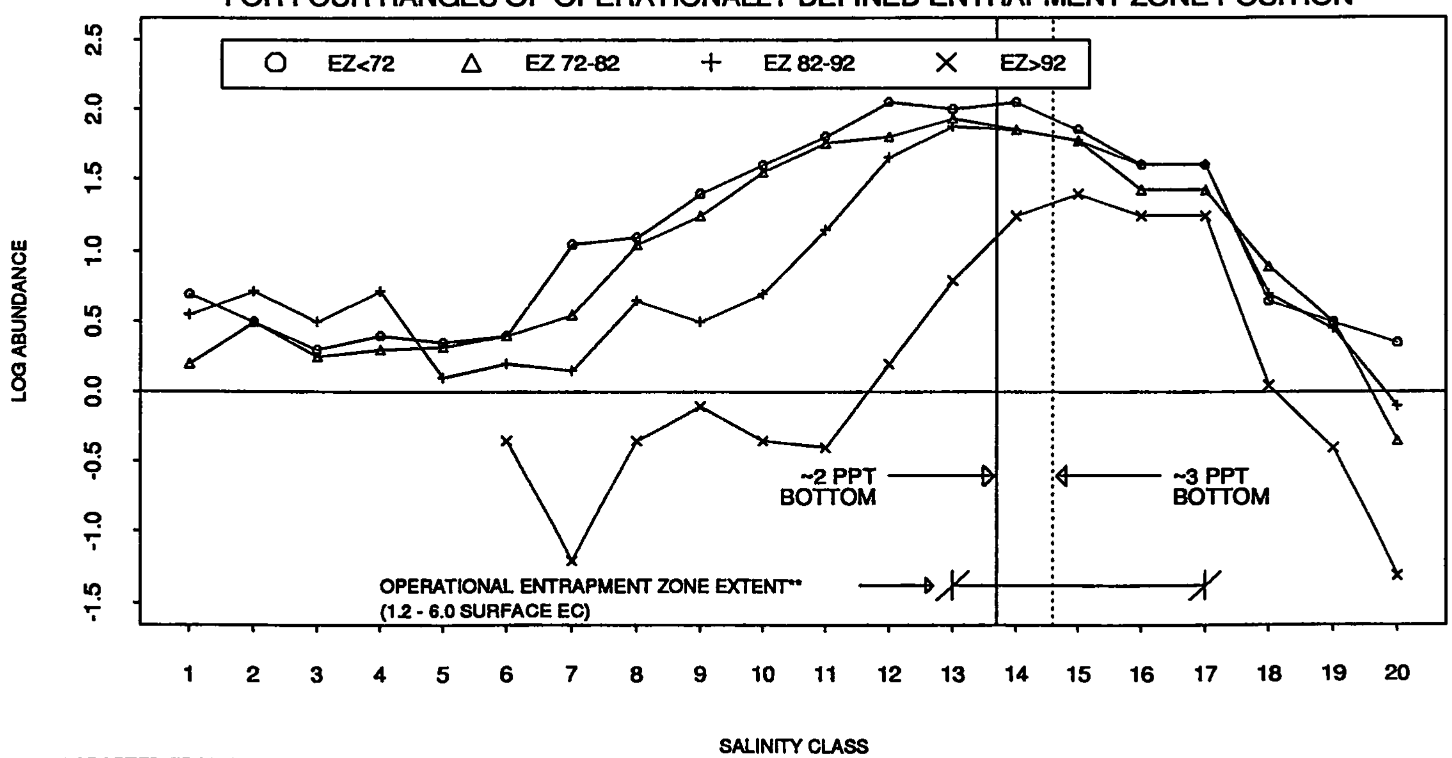


FIGURE 14B LOG ABUNDANCE OF NEOMYSIS MERCEDIS VS. SALINITY CLASS
FOR FOUR RANGES OF OPERATIONALLY DEFINED ENTRAPMENT ZONE POSITION*



* ADAPTED FROM KIMMERER (1992)

** ARTHUR AND BALL (1978)

FIGURE 15A
TURBIDITY MEASURED AS 1/SECCHI DISK DEPTH VS. SALINITY CLASS*

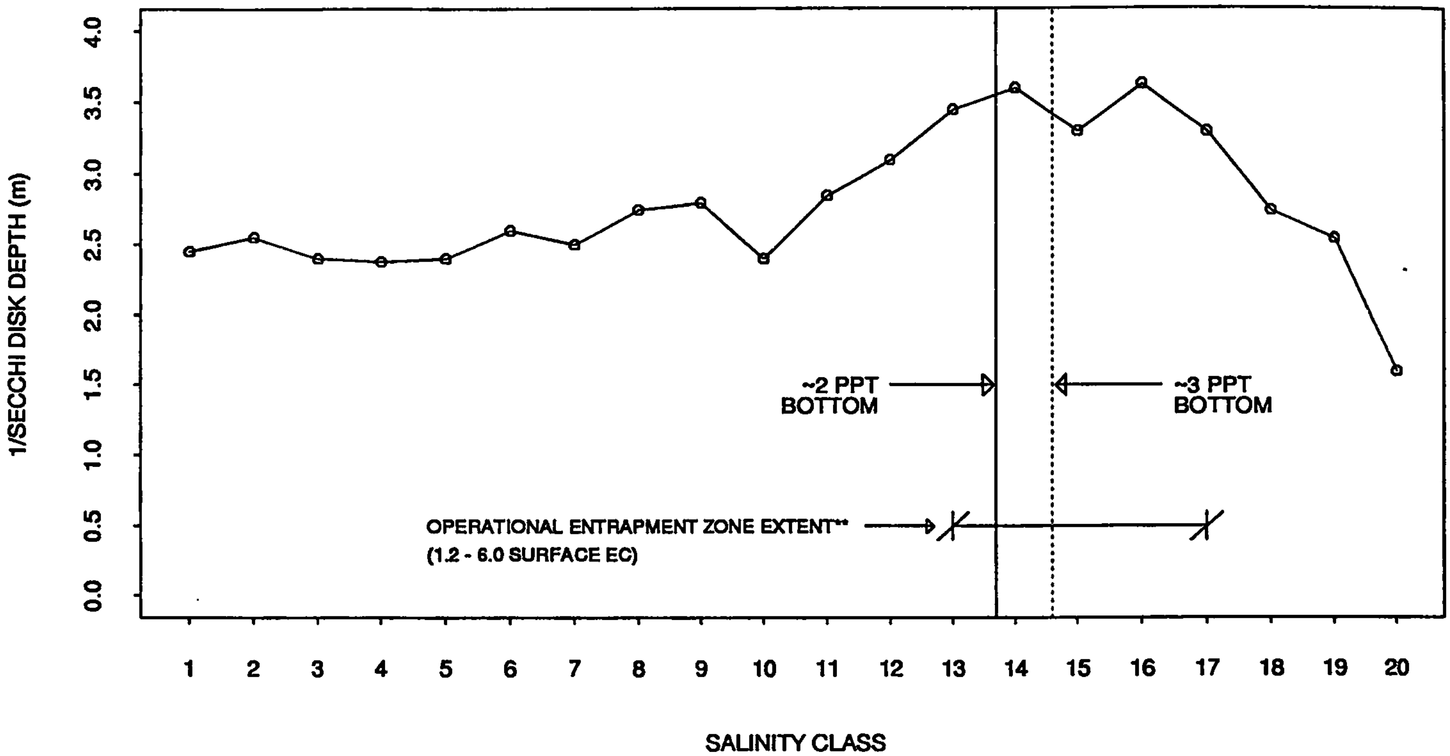
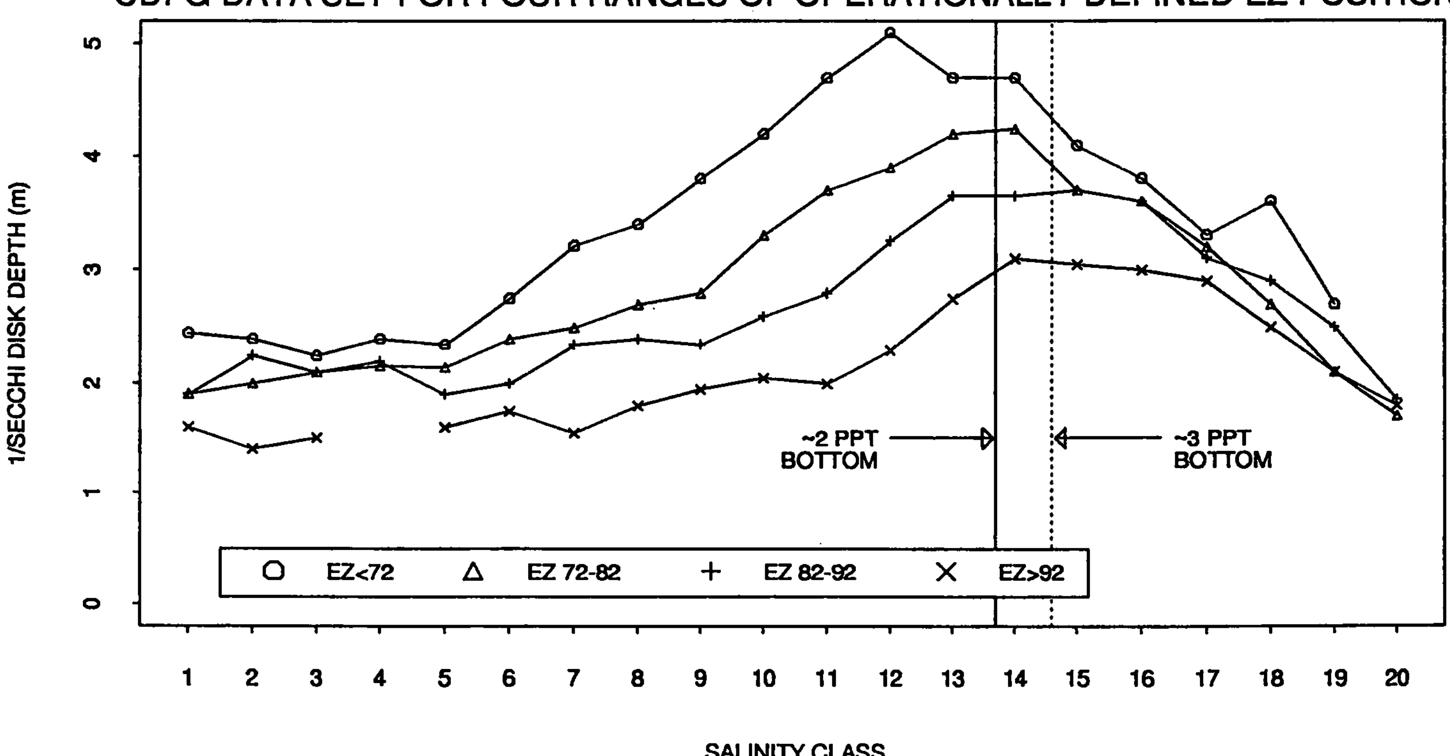


FIGURE 15B TURBIDITY AS 1/SECCHI DISK DEPTH VS. SALINITY CLASS FROM CDFG DATA SET FOR FOUR RANGES OF OPERATIONALLY DEFINED EZ POSITION*



* ADAPTED FROM KIMMERER (1992)

** ARTHUR AND BALL (1978)

FIGURE 16A
AVERAGE FEBRUARY THROUGH JUNE X2 AND X3 POSITION, 1930-1992

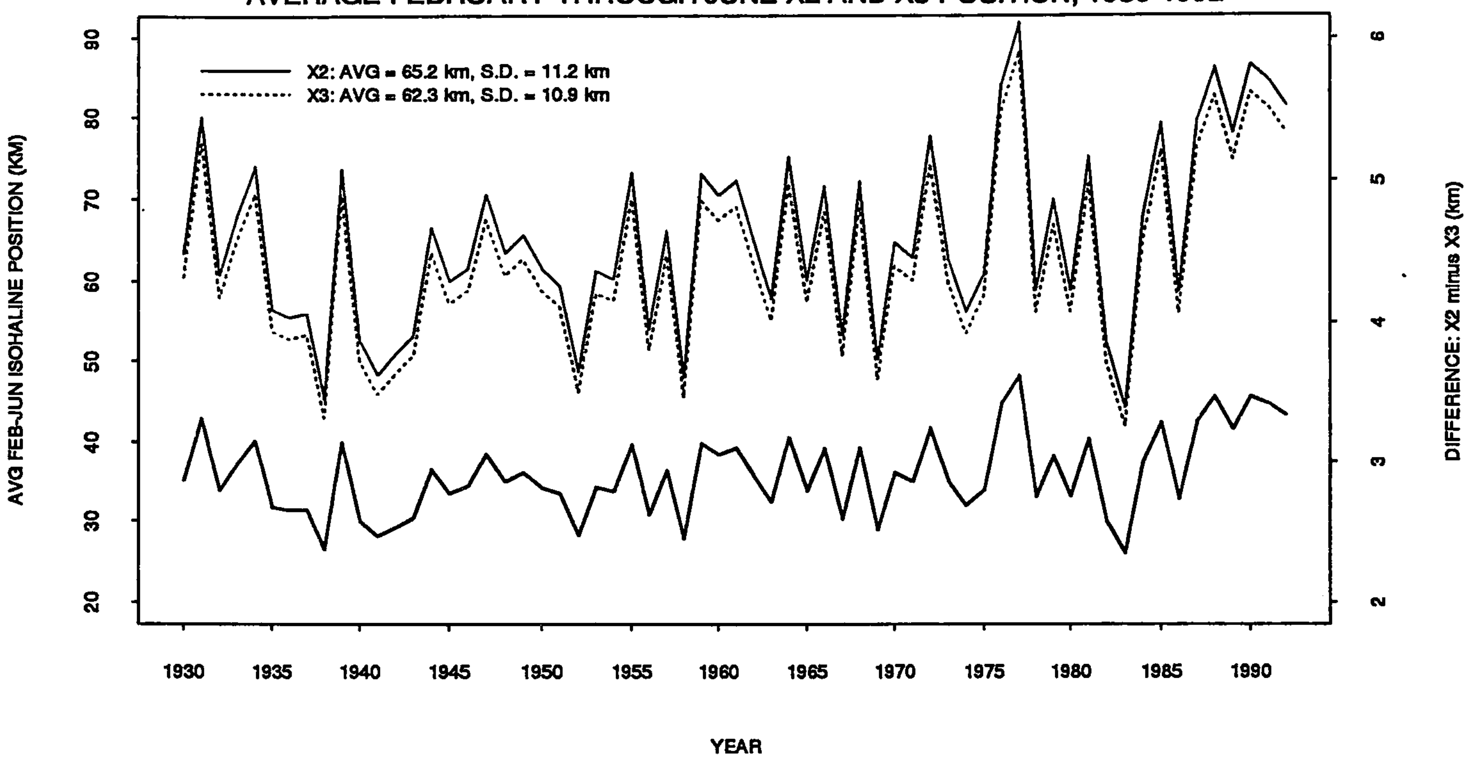


FIGURE 16B
KIMMERER-MONISMITH X2 VERSUS ITERATION X2; FEB-JUN AVG; 1930-1992

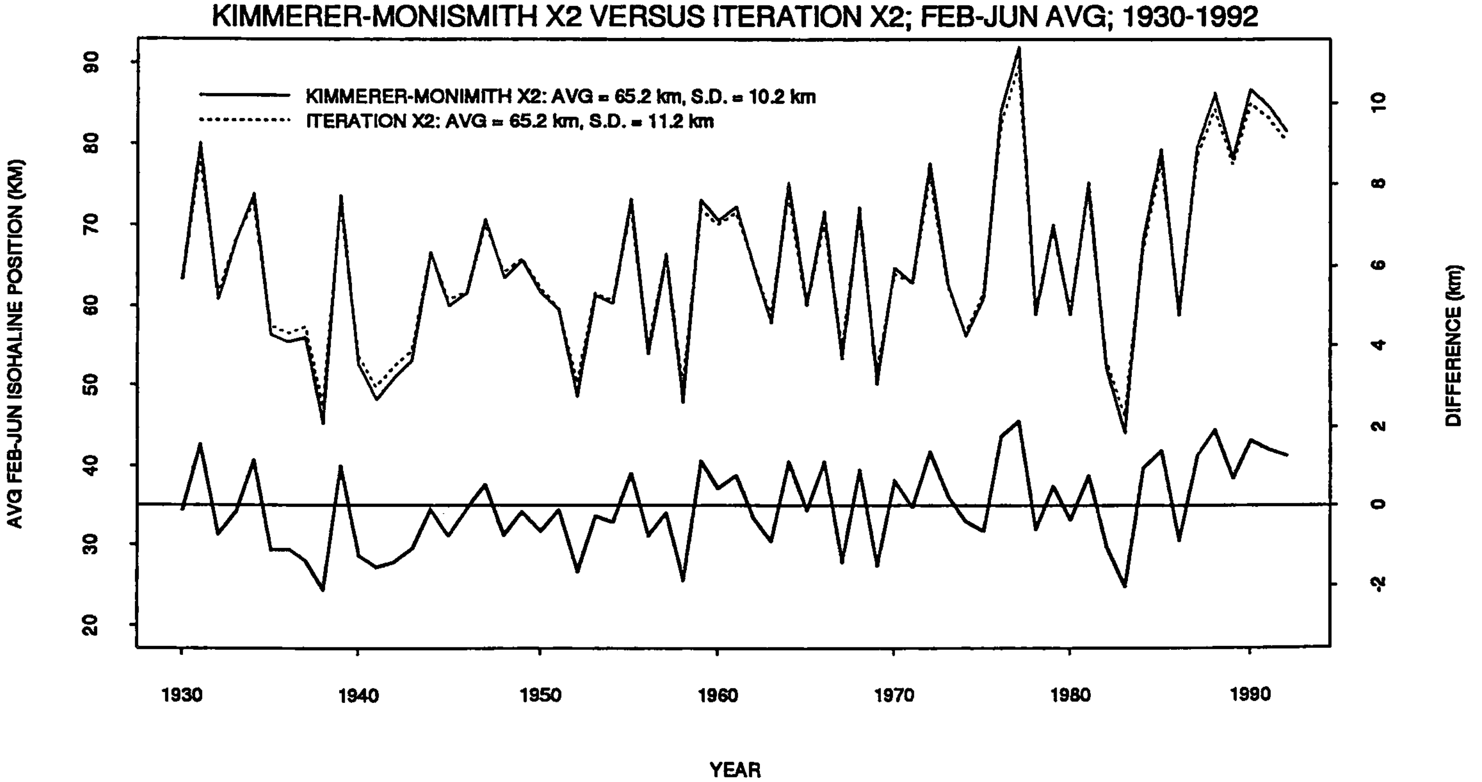


FIGURE 17
IMPACT OF ALTERNATIVE ISOHALINE STANDARDS FOLLOWING EPA X2 APPROACH