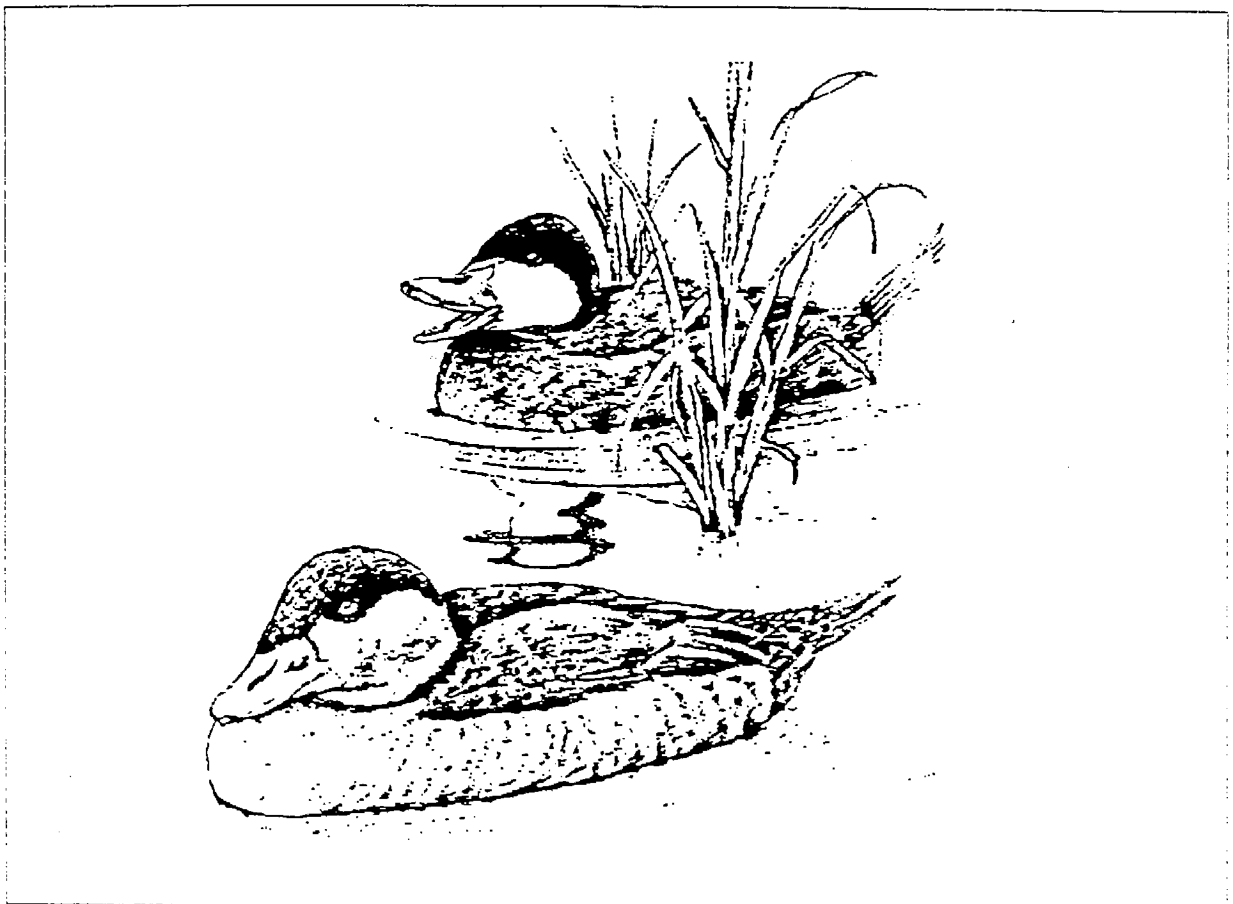

SELENIUM VERIFICATION STUDY 1988 - 1990

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May 1991

WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

SELENIUM VERIFICATION STUDY
1988-1990

91 - 2 WQWR

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Selenium Verification Study 1988-1990

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FOREWORD

This report was prepared using data collected by the California Department of Fish and Game's (DFG) Selenium Verification Study (SVS) from August 1988 through May 1989, and July 1989 through September 1990. Some of the shorebird and migratory waterfowl samples from the south San Joaquin Valley were from collections made by the U.S. Fish and Wildlife Service (D. Barnum and J. Skorupa). All selenium analyses were performed by DFG's Water Pollution Control Laboratory (WPCL). These data were collected from the Sacramento-San Joaquin Estuary south through portions of the San Joaquin River and valley floor to selected agricultural evaporation ponds in Kern, Kings, and Tulare counties. This report fulfills a contractual commitment to the California State Water Resources Control Board (State Board) to provide additional information and selenium (Se) concentrations in various biotic and abiotic media. This effort represents a continuation of a statewide investigation of Se in fish and wildlife which began in January of 1986.

EXECUTIVE SUMMARY

The 1988-89/1989-90 Selenium Verification Study (SVS) provided an assessment of levels of selenium (Se) contamination in fish and wildlife from the San Francisco Bay and Delta, the lower San Joaquin River and selected Grasslands tributaries, and agricultural drainage evaporation ponds of the Tulare Lake Basin.

The purpose of this program is to measure levels of Se in biota from areas of concern to determine if concentrations are high enough to be harmful.

Four species of birds, six species of fish, and nine species of invertebrates were collected from 1988 through 1990 from 15 locations statewide. Filtered water, microscopic filtrates, plankton, and sediments were collected in 1988-90 at San Joaquin River sites during fish collections, and whole water from evaporation ponds, in order to investigate food chain relationships. Principal findings were as follows:

- Late winter collection of surf scoters from the San Francisco Bay complex showed extremely high levels of Se (more than 30 ppm wet weight in liver and more than 6 ppm in flesh). The trend towards increasing Se concentrations seems to have leveled off in 1990 (Figure 1.A). These levels are generally much higher than Se levels for coots and puddle ducks measured by the U.S. Fish and Wildlife Service (USFWS) which resulted in Se toxicosis and reproductive impairment (10 ppm wet weight in liver).

- Se levels in adult striped bass from the Delta (0.39 ppm wet weight in flesh) remain unchanged and are similar to the national average for freshwater fish (0.42 ppm wet weight on a whole body basis).

- Se levels in muscle tissue of adult white sturgeon collected from Suisun Bay were higher in 1989-90 (average of 4.1 ppm wet weight) than when first measured in 1986 (1.8 ppm); (Figure 1.B). In recent years, more than 50 percent of the white sturgeon muscle samples have exceeded 2 ppm wet weight, the State Department of Health Services (DHS) interim level used to screen data for potential hazard to human consumers. DHS is currently evaluating the data to determine if a health warning should be issued. Food habitat studies show that white sturgeon feed predominantly on Potamocorbula Spp., the recently introduced asiatic clam. On a whole body basis, this new predominant food species has higher levels of Se than other clam species in the diet of white sturgeon.

  The new species may be contributing to recent increases in Se levels in these fish. Se levels in juvenile white sturgeon were measured for the first time in the 1989-90 study. Se levels in juvenile sturgeon were approximately half the levels found in adult fish.

- No consistent seasonal patterns were found in Se levels measured in filtered water, suspended particulate, plankton, sediment, resident Corbicula, catfish, bass, bluegill, and transplanted Corbicula in the San Joaquin River and its west side tributaries. While there are some significant seasonal variations in some media, levels in all media were lowest in the San Joaquin River at the Lander Avenue sampling station above the influence of Grasslands. The Se levels observed in filtered water and plankton from Grasslands streams or canals (Camp 13 ditch, Agatha Canal, Mud and Salt Sloughs) were occasionally highly elevated (>20 ppb for water and >2 ppm dry weight for plankton). The highest levels observed could result in toxic impacts to aquatic fauna. The highest Se levels in filtered water were found in the Camp 13 ditch, while the highest levels in plankton and sediments were found in Mud and Salt Sloughs. The concentration of Se in the muscle tissue of catfish ranged from 0.1 to 2.0 ppm (wet weight) with the highest value observed in Agatha Canal. The values of selenium in large mouth bass and bluegill ranged from 0.2 to 1.5 ppm (wet weight) with the highest value found in Salt Slough. Sportfish and freshwater species tissue that could be consumed by local subsistence anglers from the Grasslands area should be monitored periodically to ensure that they do not exceed the DHS advisory level (Figure 1.C).

- Levels of Se in fish in the Delta are not approaching levels which DHS would consider to be of concern for human consumption (2 ppm wet weight), nor are they approaching levels of concern for fish health. Largemouth bass and bluegill tended to have lower concentrations in flesh than catfish species. No freshwater resident species of fish contain Se in flesh at levels of concern for human health (2 ppm wet weight). Species of fish sampled in dead-end sloughs of the Delta did not appear to be accumulating higher levels of Se than the rest of the Delta.

- Sampling of aquatic invertebrates in evaporation ponds indicated significant differences in Se levels between species, among cells in a pond complex, and within a single cell of the same pond complex. Additional analysis of results are needed to discriminate significant differences between sample means. An evaluation is underway to develop improved monitoring schemes to assure adequate sampling and to account for the variability in evaporation pond invertebrate Se levels.

- Waterfowl (ruddy ducks, northern shovelers [diving ducks]; northern pintail, mallards, and green-wing teal [dabbling ducks]) collected from evaporation pond complexes showed accumulation of Se in liver and muscle tissues significantly above background levels. Birds from the most contaminated sites, such as Westfarmers ponds had Se levels significantly higher than birds from Kern National Wildlife Refuge. The levels of Se measured in the livers of some dabbling ducks (pintail, teal, and mallards) are elevated above background in ponds studied; however, they have not reached chronic or acute impact levels (>10 ppm wet weight--as determined by USFWS research). On the other hand, Se levels in ruddy ducks and northern shovelers are high enough to be of concern for the potential to cause chronic impacts (Figure 1.D). Adult black-necked stilts (shorebirds) accumulate Se while using evaporation ponds during winter (3--15 ppm wet weight in liver). Juvenile stilts often accumulate Se from ponds at higher levels than adults collected from the same site a month or two earlier (8--23 ppm wet weight in liver). Chicks that do hatch and appear normal may still be chronically impacted by high body burdens of Se at some evaporation pond complexes.

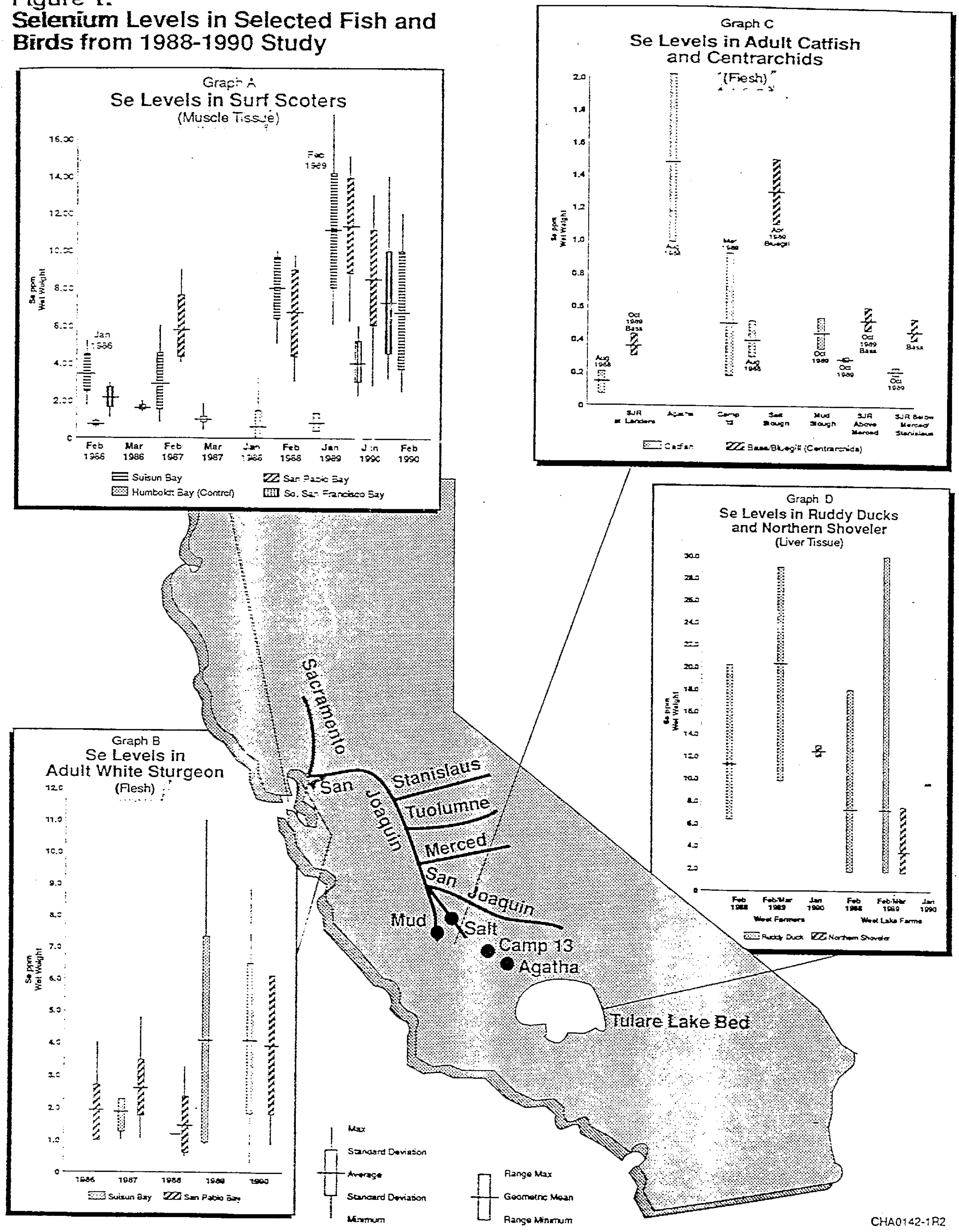
USFWS researchers have demonstrated teratogenesis (mutations) and reduced hatching success of shorebirds on some evaporation ponds. The concentrations of Se in pond water varies greatly and the wildlife impacts vary with concentrations of Se in pond waters.

- Comparison of this program's past and present study results have verified problem areas regarding potential harm to fish and wildlife. Problems most in need of correction are occuring in the San Francisco Bay complex and at evaporation ponds.

- Risks associated with the current mode of operation of existing evaporation ponds have largely been established. Present management actions, primarily hazing, are not effective for protecting certain species of waterfowl and essentially all shorebirds. More stringent management actions are needed, such as the recommendations outlined in the San Joaquin Valley Drainage Program Management Plan, September 1990 (smaller sized ponds, steeper sides, etc.) It may be necessary to place nets over evaporation ponds (thus the need for the smaller size). New ponds should be designed in this manner as well.

- A long-term monitoring program is needed to determine Se level trends in certain "at risk" species of fish and wildlife (surf scoters, white sturgeon, and fishes in the lower San Joaquin River and west side tributaries). The data collected in the 1988-90 study reflects the conditions during two dry years. More data needs to be collected for wet years as well. In addition to monitoring trend information, further research is needed to determine if high levels of Se in certain species of fish and wildlife pose an actual serious threat to the organism or a potential risk for human consumption.

Figure 1.
Selenium Levels in Selected Fish and Birds from 1988-1990 Study



CHAPTER I

INTRODUCTION

The Selenium Verification Study (SVS), begun in 1985, is one of eight original elements of the State Water Resources Control Board's (State Board) Subsurface Agricultural Drainage Program. The study plan of the State Board program called for: 1) problem identification, 2) problem verification, and 3) regulatory efforts to protect beneficial uses of water from potentially toxic trace elements found in subsurface agricultural drainage waters in California. The purpose of the SVS is to provide rigorous assessments of selenium (Se) and other trace elements in biota from previously identified areas of concern to determine if trace elements occur at levels known to be harmful to fish and wildlife.

The Department of Fish and Game conducts the SVS work under an interagency agreement with the State Board. Sample collection and data analyses and interpretation are performed by the Bay-Delta Project in Stockton. Sample preparation and chemical analyses are performed by the analytical chemistry unit of the Water Pollution Control Laboratory (WPCL) in Rancho Cordova.

This report covers results from biota collected from August 1988 through May 1989, and from July 1989 through September 1990.

Findings are interpreted in relation to the continuously growing body of knowledge pertaining to Se and its effects on biological systems. The tissue burden of Se measured in an organism depends on its exposure history in terms of concentration and duration; species specific rates of uptake and depuration; and the age, sex, and reproductive condition of individuals. Relating tissue burdens to local environmental conditions requires an understanding of factors affecting speciation and bioavailability of Se in natural systems; trophic pathways through which uptake of Se occurs; process of biological accumulation in individuals and biomagnification through food chains which produce high tissue concentrations of Se from low ambient levels; the behavioral ecology of each species; and particularly for migratory species, knowledge of Se exposure at different locations in other seasons. Determining the implications of tissue burdens for the health of individual organisms and populations requires documenting adverse effects associated with above-normal tissue burdens; though normal levels for most species except marine aquatic birds are now well defined (Birkner 1978, Eisler 1985, Hothem and Ohlendorf 1989, Saiki, et al., in press, and Skorupa and Ohlendorf in press) precise toxic effect criteria for tissue Se levels are not always available. Selenium may impact individual organisms through impairment of various physiological functions and, even without mortality of individual adults, may eliminate populations by making individuals functionally sterile (Lemly 1987).

Protection of fish and wildlife from the toxic effects of Se will involve establishing criteria for concentrations in water, a difficult task given the tendency for biological accumulation and magnification in food chains from low levels in water and the often small differences between essential levels and toxic levels of Se in some animals. Recent laboratory experiments conducted by the U.S. Fish and Wildlife Service (USFWS) have provided some data on "effect levels" of Se in fish and wildlife diets and tissues. However, only a few species have been included in experimental investigations. Other trace elements may react synergistically or antagonistically with Se. These interactions are poorly understood and complementary data for other elements are not always available. This study has measured tissue burdens of biota, with no intent to evaluate reproductive success or effects on target species at the population level. Measured levels of Se in biota are compared with data from other sources; conclusions are drawn, appropriately qualified in the context of the uncertainties described above. In the absence of complete information, hypotheses are stated to stimulate thought and to identify needs for additional information.

The presence of Se in biota was determined by analyzing specific tissues. In fish and birds, Se was measured in liver tissue, primarily because Se concentrations are higher in liver than in flesh and it is a satisfactory indicator of an animal's exposure (Lemly 1982), and also to be consistent with previous studies and other on-going investigations. Because of a potential public health threat, Se was measured in the breast muscle of game bird species and in the skeletal muscle of fish. In clams and mussels, Se was measured in the soft tissue or, when dissection was not possible in whole body composite samples.

The 1988-89 program included investigations in the San Francisco Bay and Estuary, the Sacramento-San Joaquin Delta, the lower San Joaquin River and selected tributaries and canals in the Grasslands area of western Merced County, and evaporation ponds in the Tulare Lake Basin currently used for the disposal of subsurface agricultural drainage water (Figure I-1). Appendix A contains the location and description codes. Specific aspects of the studies in San Francisco Bay and Estuary were designed to: 1) determine if there are detectable trends in Se levels in adult striped bass, 2) determine if there are detectable trends in Se levels in adult white sturgeon and compare these Se levels to the Department of Health Services interim internal guidance level used for screening sample data for potential health risks, and 3) determine if Se is increasing in San Francisco Bay waterfowl. Investigations in the lower San Joaquin River were designed to: 1) determine if there are detectable increases in biotic Se levels caused by agricultural drainwater that was discharged into downstream reaches of the San Joaquin River, and 2) determine if Se accumulates to greater and potentially harmful levels in the slower moving environment of the southern Delta than in the more rapid flowing environment of the San Joaquin River.

Studies in evaporation ponds in the Tulare Basin were designed to: 1) determine if waterfowl collected from wildlife areas near evaporation ponds contain concentrations of Se similar to waterfowl collected from evaporation ponds, 2) determine if shorebirds nesting on

FIGURE I -1

1. HUMBOLDT BAY
2. SACRAMENTO RIVER, CLARKSBURG
3. SAN PABLO BAY
4. SUISUN BAY
5. ANTIOCH
6. SOUTH SAN FRANCISCO BAY
7. SAN JOAQUIN RIVER, DOS REIS
8. MIDDLE RIVER
9. OLD RIVER
10. SAN JOAQUIN RIVER, AT PARADISE CUT
11. SAN JOAQUIN RIVER, BELOW THE STANISLAUS RIVER
12. SAN JOAQUIN RIVER, BELOW THE MERCED RIVER
13. SAN JOAQUIN RIVER, LANDER AVENUE
14. SALT SLOUGH
15. MUD SLOUGH
16. CAMP 13 DITCH
17. AGATHA CANAL
18. TULARE LAKE DRAINAGE DISTRICT, NORTH
19. WESTLAKE 3 EVAP. PONDS
20. TULARE LAKE DRAINAGE DISTRICT, SOUTH
21. KERN NATIONAL WILDLIFE REFUGE
22. WESTFARMERS EVAP. PONDS

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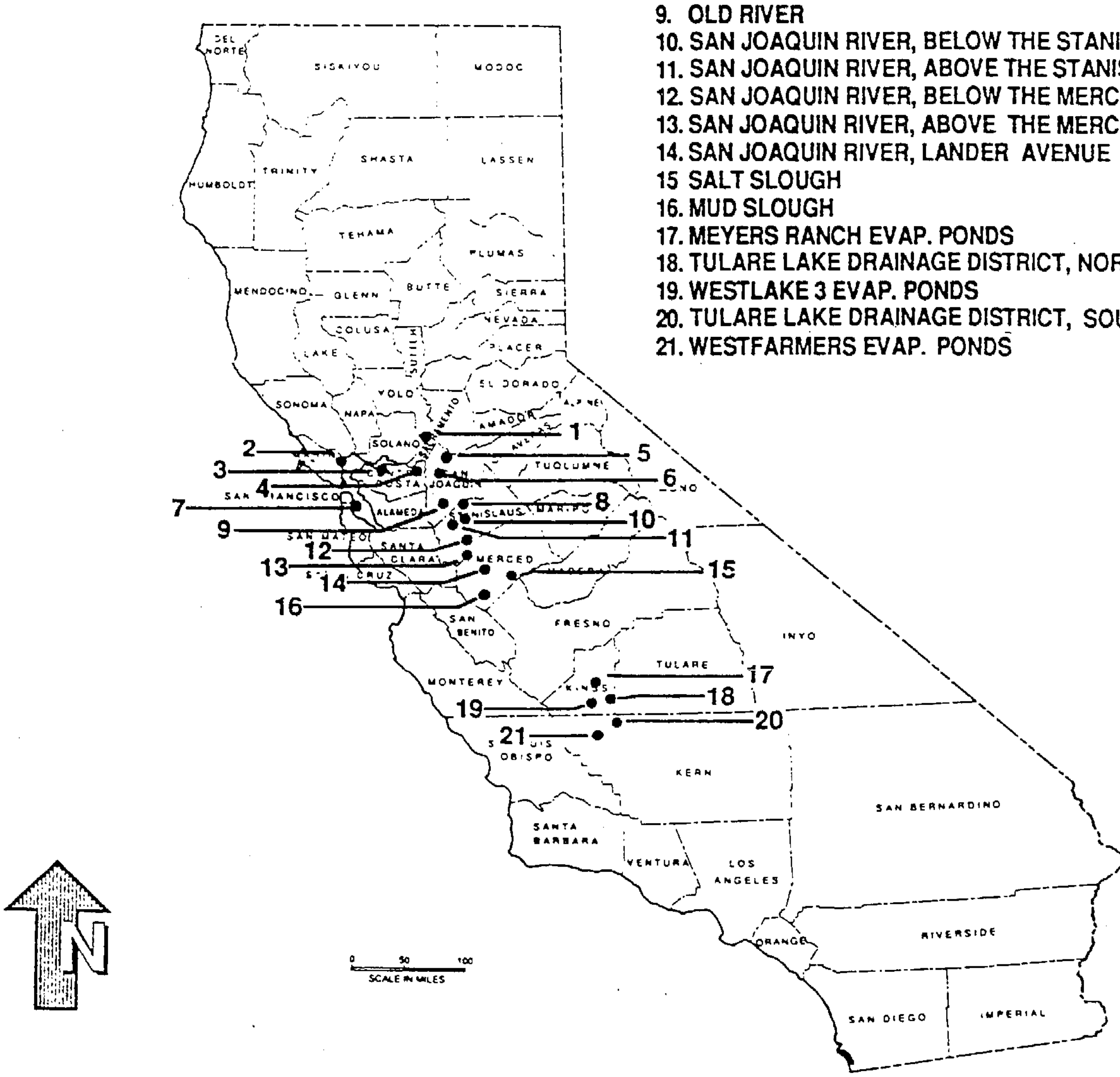
evaporation ponds accumulate significant amounts of Se from the time they arrive until the time they leave, 3) determine if a single invertebrate species can serve as an "indicator" species to assess compliance with monitoring requirements, 4) determine whether more than one cell of a pond complex needs to be sampled to characterize Se levels in each pond complex system, and 5) determine how many samples of invertebrates are required to assure that accurate monitoring results are obtained.

The 1989-90 program included investigations in the San Francisco Bay and Estuary, the Sacramento-San Joaquin Delta, the lower San Joaquin River and selected tributaries, and evaporation ponds in the Tulare Lake Basin (Figure I-2). Specific aspects of the San Francisco Bay/Estuary studies were also designed to determine if there are detectable trends in adult striped bass. In addition, several new elements were added to studies on adult white sturgeon including determining: 1) if the diet has changed, 2) the current preferred species of bivalves, 3) which dietary species have high levels of Se, 4) if Se levels in the 1989-90 diet are different from the 1987-88 diet, and 5) if there are differences in Se levels in dietary species between bays. Studies on waterfowl in the Bay were designed to determine if Se levels in diving ducks are increasing.

Investigations in the San Joaquin River were designed to determine trends in Se levels occurring in biota from waters with varying proportions of subsurface agricultural drainage (source channels vs. receiving waters vs. mixed drainage resulting from dilution by east side tributaries, and to determine if Se was accumulated to a greater degree in the fauna of dead-end sloughs in the Delta). In addition, San Joaquin River investigations included an element to determine if Corbicula fluminea can be used as a site-specific monitor of short-to intermediate-term accumulation of Se by aquatic biota. This study is designed to help evaluate annual or seasonal impacts of future levels of agricultural drainage.

Investigations on evaporation ponds were designed to determine: 1) if there are intra-cellular differences in the Se levels of invertebrates occupying evaporation ponds, 2) if waterfowl and shorebirds collected from wildlife areas contain concentrations of Se similar to waterfowl and shorebirds collected from evaporation ponds (this was follow up to work initiated during the 1988-89 study), and 3) if juvenile shorebirds reared on evaporation ponds were accumulating toxic levels of Se. A list of all species collected during sample year 1988-89 and 1989-90 is included in Appendix B-1. Their scientific names and name codes are included in Appendix B-2.

1. STEAMBOAT SLOUGH
2. SAN PABLO BAY
3. SUISUN BAY
4. ANTIOCH
5. BEAVER SLOUGH
6. SANDMOUND SLOUGH
7. SOUTH SAN FRANCISCO BAY
8. MIDDLE RIVER
9. OLD RIVER
10. SAN JOAQUIN RIVER, BELOW THE STANISLAUS RIVER
11. SAN JOAQUIN RIVER, ABOVE THE STANISLAUS RIVER
12. SAN JOAQUIN RIVER, BELOW THE MERCED RIVER
13. SAN JOAQUIN RIVER, ABOVE THE MERCED RIVER
14. SAN JOAQUIN RIVER, LANDER AVENUE
15. SALT SLOUGH
16. MUD SLOUGH
17. MEYERS RANCH EVAP. PONDS
18. TULARE LAKE DRAINAGE DISTRICT, NORTH
19. WESTLAKE 3 EVAP. PONDS
20. TULARE LAKE DRAINAGE DISTRICT, SOUTH
21. WESTFARMERS EVAP. PONDS



SELENIUM VERIFICATION STUDY: STATE WIDE DISTRIBUTION OF PRIMARY SAMPLING SITES - 1989 - 1990

CHAPTER II
SELENIUM IN WINTERING SURF SCOTERS FROM THE SAN FRANCISCO BAY AREA

INTRODUCTION

Although waterborne Se levels have been found to be relatively low, Se levels in tissues of diving ducks wintering in Suisun and San Pablo bays are high (White, et al., 1989) and Se levels in birds in late winter appear to be increasing from year to year from 1986 through 1988. The SVS objective for collection and analysis of surf scoters (Melanitta perspicillata) was to determine if Se levels in diving ducks in San Francisco Bay are increasing and whether regulation of Se sources by the State Board and the Regional Water Quality Control Board (Regional Board) could potentially effect changes in body burden.

FIELD METHODS

Surf scoters were collected using 12 gauge shotguns and steel shot. To reduce the intraspecific variation among individuals, we attempted to collect only adult males. Female and immature birds collected inadvertently or when necessary to obtain minimum sample quantities were analyzed and included in our results. Ten adult female surf scoters were collected in Suisun Bay in February 1988 for comparison with male scoters collected at the same time and females were found to have lower muscle Se levels but equivalent liver levels.

Birds were weighed using spring scales. Age was determined based on plumage; sex was determined from plumage or examination of gonads. The liver was removed from all birds; a breast muscle sample was obtained in accordance with the study plan.

Disposable polyethylene gloves were worn during field dissections to prevent sample contamination through contact with human skin. After the skin was peeled from the breast muscle, the furcula and ribs were cut with stainless steel shears, the whole breast with sternum attached was removed and placed in a sealable 4 mil plastic bag. The liver was removed with Tefzel forceps and a scalpel and placed in a separate bag. The two sample bags were placed in a third bag with a sample label. Samples were put on dry ice immediately and frozen; they were subsequently stored in a chest freezer at -12°C, usually for a few weeks but at most one month, until they were delivered to the DFG Fish and Wildlife Water Pollution Control Laboratory (WPCL) in Rancho Cordova. Sample storage conditions at WPCL are described in the section on laboratory operations.

In order to investigate possible pathways of selenium into the avifauna, the food habits of collected birds were examined. Data was collected in 1988-89 but not in 1989-90, and have not yet been analyzed. The esophagus, proventriculus, and gizzard of each bird were removed, their contents emptied into a small jar, and preserved in ethyl alcohol for later identification. Food items were quantified by frequency of occurrence. Volumetric measurements were not made because digestion of soft parts had already occurred in many samples.

LABORATORY METHODS

Tissue Sample Preparation

All whole body samples and field dissected birds were received frozen at the WPCL. Samples remained frozen at -15°C until dissected (within three months).

All samples were prepared for analysis in a "clean room" to minimize airborne contamination. All glassware, tools, and work surfaces were cleaned and samples were dissected and homogenized as described in White, et al., 1989 Appendix B.

After homogenization, the samples were refrozen until they were subsampled for analysis. When the samples were weighed for analysis, a portion of each sample was transferred to a clean 30 mL linear polyethylene wide-mouth bottle (see Sample Container Preparation, White, et al., 1989 Appendix B). These samples were then archived at -15°C.

WPCL Analytical Techniques and Quality Control for Selenium in Tissues

All tissue samples received by WPCL were analyzed for Se by hydride generation atomic absorption spectrophotometry (HGAA). In addition to Se, samples were also analyzed for moisture content. Analytical procedures used for tissue samples are described in detail in White, et al., 1989, Appendix C.

Approximately 10 percent of the samples analyzed for Se and moisture content were done in duplicate to determine intra-laboratory precision. The relative standard deviation (RSD = {standard deviation/mean} X 100), also called the coefficient of variation (Zar 1984), was calculated from the results of each duplicate pair. The individual values as well as the average percent RSD for duplicate samples analyzed for Se and moisture content are listed in Appendix C for sample year 1988-89 and Appendix D for sample year 1989-90. Based on duplicate analyses, we conclude that the Se and moisture determinations demonstrate acceptable levels of precision.

National Institute of Standards and Technology (NIST) reference materials were analyzed with each set of samples to verify accuracy (Appendix E). Results of Se analyses of NIST reference materials indicated accuracy within the 95 percent statistical tolerance limits of the certified selenium concentration. Results in Appendix E indicate that HGAA provides acceptable accuracy for the analysis of selenium in tissue.

Neutron Activation Analysis for Selenium Concentration

In 1989, as part of our quality control program, a total of 102 samples were sent to the University of Missouri for neutron activation analysis (NAA) following the method of McKown and Morris (1978). These samples included bird flesh and liver tissue samples. These samples had been analyzed by WPCL prior to sending them for neutron activation analysis.

The average percent RSD for bird flesh samples was 7.0 while the average percent RSD for bird liver samples was 4.4. Appendix F contains the results of NAA analysis, HGAA analysis, and the percent RSD.

STATISTICAL METHODS

Statistical analyses were performed on wet weight data only. This was done because dry weights are calculated using two numbers (wet weight/1-decimal % moisture) and thus the computed sample variance of dry weight numbers does not adequately represent, and may underestimate, the actual variance in these numbers, which are actually a product of the variance of both the wet weight and percent moisture values. Selenium concentrations were transformed to natural logarithms ($\log_e$) prior to statistical analysis because distributions were non-normal and variances tended to be proportional to sample means (coefficients of variation relatively similar). Where possible, two-way analysis of variance (ANOVA) was used to test the effects of time period and collection location on Se concentrations. Because sample sizes varied, a regression approach was used to partition sums of squares in testing hypotheses. This approach tested the significance of individual model components after adjusting for all other effects in the ANOVA model. When a main effect was significant, Tukey's studentized range test (HSD) was used to compare main-effect means and identify nonsignificant subsets. One-way ANOVA was used to test the effect of time period or location when data were not available for all time period-location combinations. The one-way ANOVA's and Tukey tests often had to be run more than once using the same subset of data. When this situation occurred, we ran our analytical tests at $\alpha=0.01$ to keep the cumulative significance of all tests less than $\alpha=0.05$. Simple correlation was used to test for a relationship between size and Se concentration. These analyses were performed on a micro-computer with SPSS/PC+ or BMDPPC statistical packages (SPSS Inc., 1986 and BMDP Inc., 1988).

Geometric means represent the values used to test for significant differences between groups and, therefore, are presented in the text and in tables illustrating the results of statistical analyses. Arithmetic means of untransformed data are plotted in figures used to illustrate the range and variability of the raw data. Differences between geometric and arithmetic means were usually small.

Statistical significance was determined at p=0.05; references in the text to "significant" differences unaccompanied by a probability value imply statistical significance at less than, or equal to, the 0.05 probability level.

RESULTS AND DISCUSSION

Surf Scoters

The SVS has, since 1986, measured Se in tissues of several species of diving ducks that use the San Francisco Bay and other California coastal bays during the winter (White, et al., 1987, 1988, and 1989). Initial findings revealed that surf scoters, greater scaup and lesser scaup (Aythya marila and A. affinis) found in San Francisco Bay contained Se concentrations higher than background levels measured in the same species wintering at Humboldt Bay or Morro Bay. Subsequent sampling confirmed these results. Findings in 1987-88 showed that Se had accumulated in diving ducks 12,000 to 30,000 times higher than Se levels in the water. Clams, a primary food source for these ducks, had accumulated Se between 4,000 and 5,500 times higher than the levels in the water. In addition, results from 1986-87 sampling indicated that Se concentrations in diving ducks increased as winter progressed. Sampling in 1986-87 indicated that, although San Francisco Bay water contained less than 1 ppb, Se was concentrated by organisms and accumulated to high concentrations in bird tissues. Limited histological examination of diving duck tissues sampled in 1986-87 produced no evidence of Se induced pathology associated with these elevated concentrations, however.

Forty surf scoters were collected during the 1988 through 1990 study period (Table II-1). Sampling in later winter 1989 confirmed that Se concentrations in surf scoters captured in the San Francisco Bay Estuary continued to be higher than background levels measured in the same species wintering at Humboldt Bay (Table II-2). There was no significant difference in Se levels measured in flesh or liver from scoters taken from Humboldt Bay from 1987 through 1989. No sample was taken from Humboldt Bay in the 1989-90 period.

In 1989, concentrations of Se were higher in birds from Suisun and San Pablo bays than concentrations from birds sampled in South San Francisco Bay. In 1990, however, there was no significant difference among Suisun, San Pablo, and South San Francisco bays (Table II-2). Trends were the same for both flesh and liver samples for both years. Levels measured in surf scoters in recent years are much higher than those measured by USFWS researchers in 1982 and 1985. Surf scoters from South San Francisco Bay had liver levels of 10.5 ppm wet weight in 1982 (Ohlendorf, et al., 1986C) and approximately 16 ppm wet weight in 1985 (Ohlendorf, et al., 1989). Wet weight values were approximated using % moisture values from Ohlendorf, et al., (1986C). Combined levels in surf scoters from South San Pablo Bay and Richmond Harbor were approximately 21.4 ppm wet weight in 1985 (Ohlendorf, et al., 1989), much lower than levels from this study in 1989 and 1990. Trends over the several years of sampling at each location showed the following:

Table II-1 Selenium Verification Study Waterfowl Collections in the San Francisco Bay-Estuary and Humboldt Bay During Late Winter 1988-1990.

Location	Species	Date Collected
Suisun Bay	Surf Scoter	2-17-89 2-21-90
San Pablo Bay	Surf Scoter	1-26-89 1-18-90
South San Francisco Bay	Surf Scoter	1-24-89 1-24-90
Humboldt Bay	Surf Scoter	1-18-89

Table II-2. Selenium Concentrations in muscle and liver tissues of Surf Scoters collected at the end of the migratory waterfowl season from Humboldt Bay, Morro Bay and the San Francisco Bay-Estuary. Geometric means and ranges (ppm, wet wt.), followed by sample sizes in parenthesis.

Location	1986 Jan-Mar	1987 Jan-Mar	1988 Jan-Feb	1989 Jan-Feb	1990 Jan-Feb
LIVER					
Morro Bay		7.2, 4.1-10.0(6)			
Humboldt Bay	3.1, 2.4-5.6(10)	4.2, 2.1-8.4(8)	2.5, 1.2-15.9(10)	3.8, 1.7-6.3(10)	
Suisun Bay	21.2, 10.0-34.9(10)	16.6, 3.2-41.1(15)	55.3, 41.1-83.8(20)	63.4, 37.1-91.8(10)	34.1, 24.0-53.1(9)
San Pablo Bay	15.9, 11.9-17.9(10)	38.2, 26.9-55.3(7)	35.9, 15.9-50.9(10)	42.1, 20.0-63.1(10)	35.6, 24.0-58.1(10)
South San Francisco Bay	9.9, 6.9-17.0(11)	23.0(1)		16.9, 9.2-28.1(10)	30.6, 19.9-53.1(10)
MUSCLE					
Morro Bay		1.2, 0.9-1.8(7)			
Humboldt Bay	0.8, 0.5-1.0(10)	1.0, 0.4-1.8(8)	0.6, 0.3-3.2(10)	0.8, 0.4-1.3(10)	
Suisun Bay	3.4, 1.6-5.3(10)	2.8, 1.0-7.1(15)	7.9, 4.9-10.0(20)	10.7, 6.0-17.0(10)	6.2, 3.5-11.9(9)
San Pablo Bay	1.6, 1.4-2.0(10)	5.7, 4.0-9.2(7)	7.2, 4.0-9.9(10)	10.0, 6.2-15.0(10)	8.1, 2.8-13.0(10)
South San Francisco Bay	1.9, 1.0-2.8(11)	3.3(1)		3.9, 2.4-6.0(10)	6.7, 3.5-14.0(10)

Suisun Bay - Concentrations of Se in both liver and flesh were higher in 1989 than in 1986, 1987 and 1990. Concentrations of Se in liver and in flesh were higher in 1988 than in 1986 and 1987. Concentrations of Se in liver and in flesh were higher in 1990 than in 1987, Figures II-1 and II-2.

San Pablo Bay - Concentrations of Se were higher in liver and flesh in 1987, 1988, 1989 and 1990 than in 1986. Concentrations of Se were higher in flesh in 1989 than in 1987 and 1988, Figures II-3 and II-4.

South San Francisco Bay - Concentrations of Se were higher in liver and flesh in 1989 and 1990 than in 1986. Concentrations of Se in liver and flesh were higher in 1990 than in 1989, Figures II-5 and II-6.

In spite of occasional variability among bays and within bays, the overall trend appears to be that Se levels have increased through 1989 and then leveled off in 1990 in wintering diving ducks from the San Francisco Bay Estuary. Though limited histopathological studies of surf scoters in 1986-87 (White, et al., 1988) failed to detect any effects of Se, the levels observed in these birds in 1989 and 1990 are in excess of the levels measured in American coots from Kesterson which were diagnosed to have died from Se toxicosis, and higher than levels which caused reproductive impairment in puddle ducks (Ohlendorf, et al., 1986a and 1986b). Waterfowl with liver Se levels greater than 30 ppm dry weight (approximately 8 ppm wet weight assuming 75% moisture) during the egg-laying period have a very high risk of embryonic deformities (USFWS 1990a).

We do not know exactly how the Se levels observed in this study might affect the overall health and reproductive capacity of surf scoters, but these levels are above background levels (normally less than 10 ppm dry weight [approximately < 2.5 ppm wet weight]) for migratory waterfowl from 86 inland, freshwater, uncontaminated reference sites (J.P. Skorupa, unpublished data). Studies by USFWS researchers using mallards (USFWS 1990a) indicate that this species could breed successfully two to three weeks after cessation of a Se supplemented diet which would have prevented reproduction had birds been fed that level of Se continuously. This suggests that waterfowl leaving San Francisco Bay and feeding on a low Se diet on the way to their breeding grounds may still breed successfully even though they accumulated high levels of Se in recent years (Table II-2). However, laboratory feeding studies are still needed to measure the Se depuration rates of surf scoters and lesser and greater scaup, whose Se levels are also elevated (White, et al., 1989). This information combined with data on the length of time it takes these birds to migrate to their breeding grounds would allow us to evaluate the probability of their reproductive efforts being impacted by the levels of Se they have accumulated wintering on San Francisco Bay. Because of the variability, and the need to determine if regulatory changes will have an effect on the birds and their environment, continued sampling should be conducted yearly or at least every other year on a long-term basis.

FIGURE II-1 Selenium concentrations (arithmetic $\bar{X}$ I s. d., & range; ppm, wet weight) in liver tissue of surf scoters Sulsun Bay vs. control sites during selected late winter periods of 1986 to 1990.

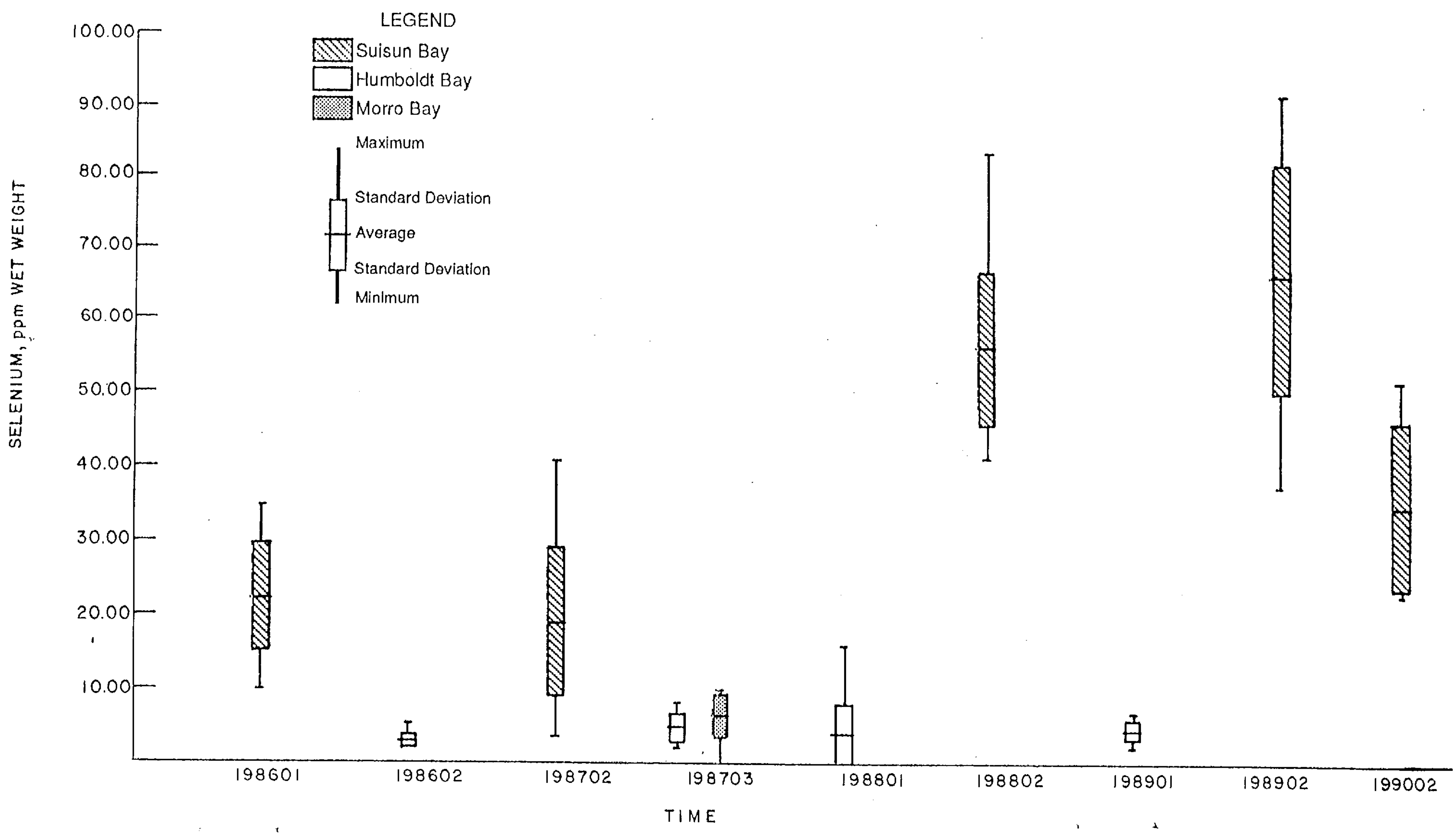


FIGURE II-2 Selenium concentrations (arithmetic $\overline{x}$ I s. d., & range; ppm, wet weight) in muscle tissue of surf scoters Suisun Bay vs. control sites during selected late winter periods of 1986 to 1990.

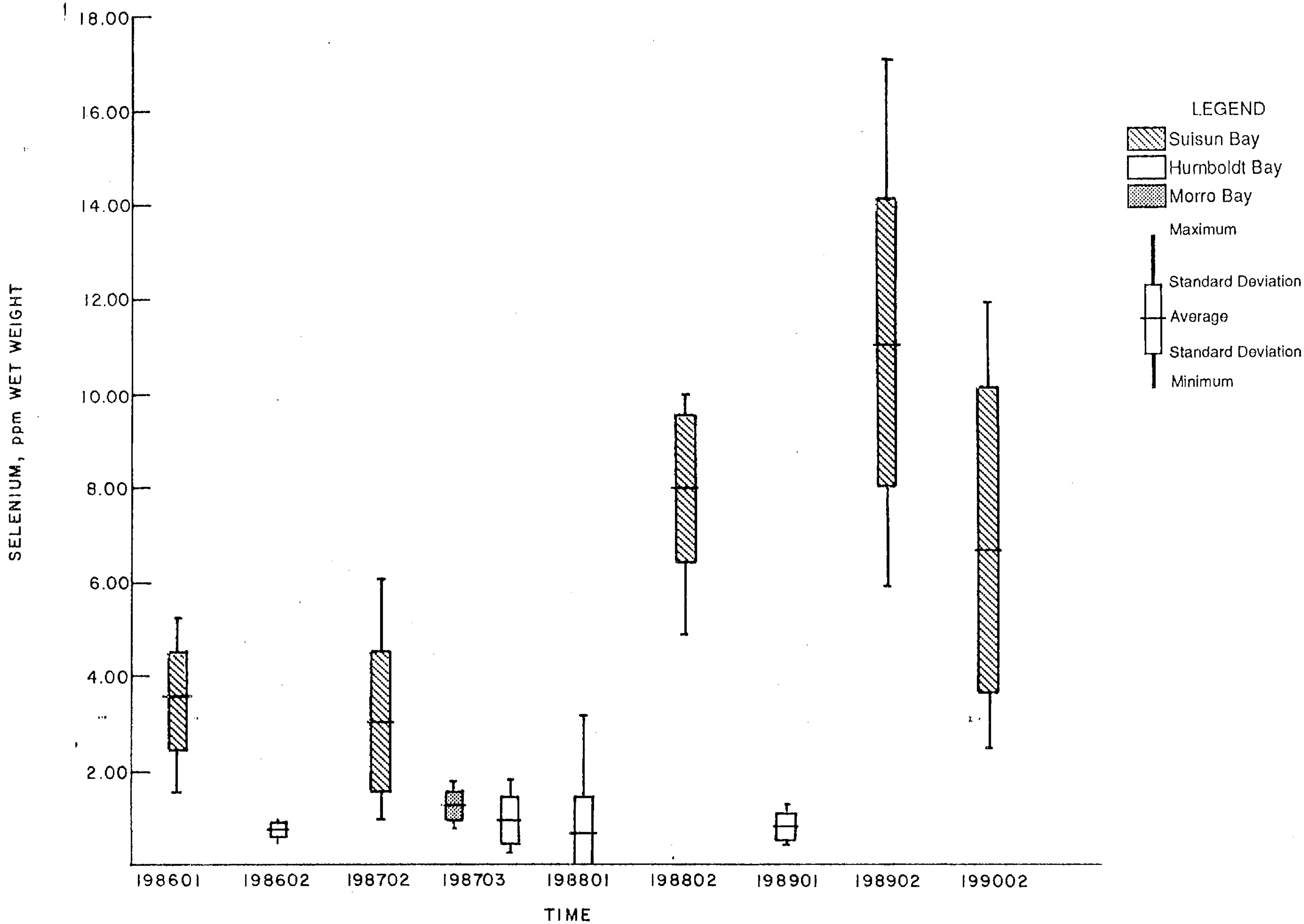


FIGURE II-3 Selenium concentrations (arithmetic $\bar{x}$ I s. d., & range; ppm, wet weight) in liver tissue of surf scoters from San Pablo Bay vs. control sites during selected late winter periods of 1986 to 1990.

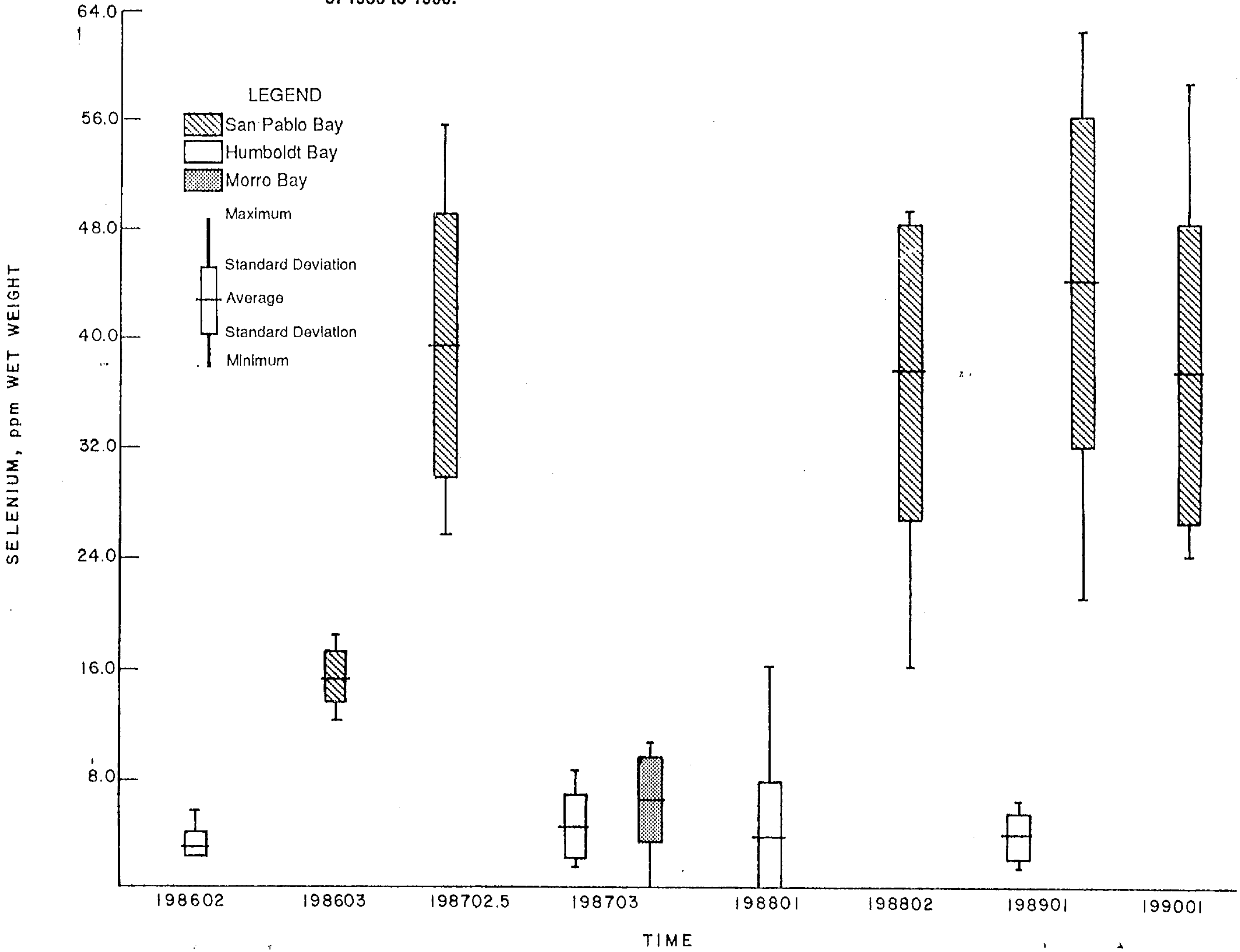


FIGURE II-4 Selenium concentrations (arithmetic $\bar{x}$ 1 s. d., & range; ppm, wet weight) in muscle tissue of surf scoters from San Pablo Bay vs. control sites during selected late winter periods of 1986 to 1990.

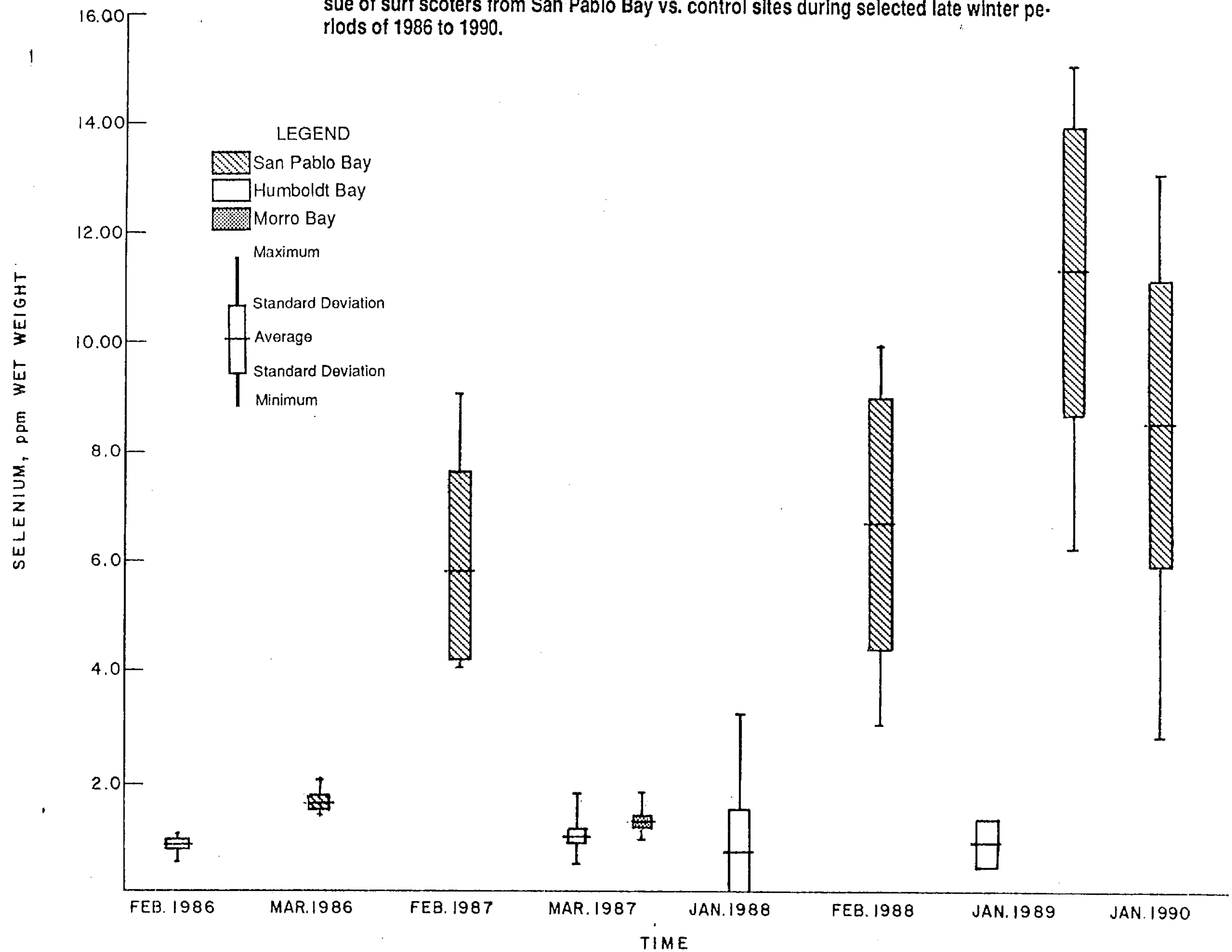


FIGURE II-5 Selenium concentrations (arithmetic $\bar{x}$ I s. d., & range; ppm, wet weight) in liver tissue of surf scoters from South San Francisco vs. control sites during selected late winter periods of 1986 to 1990.

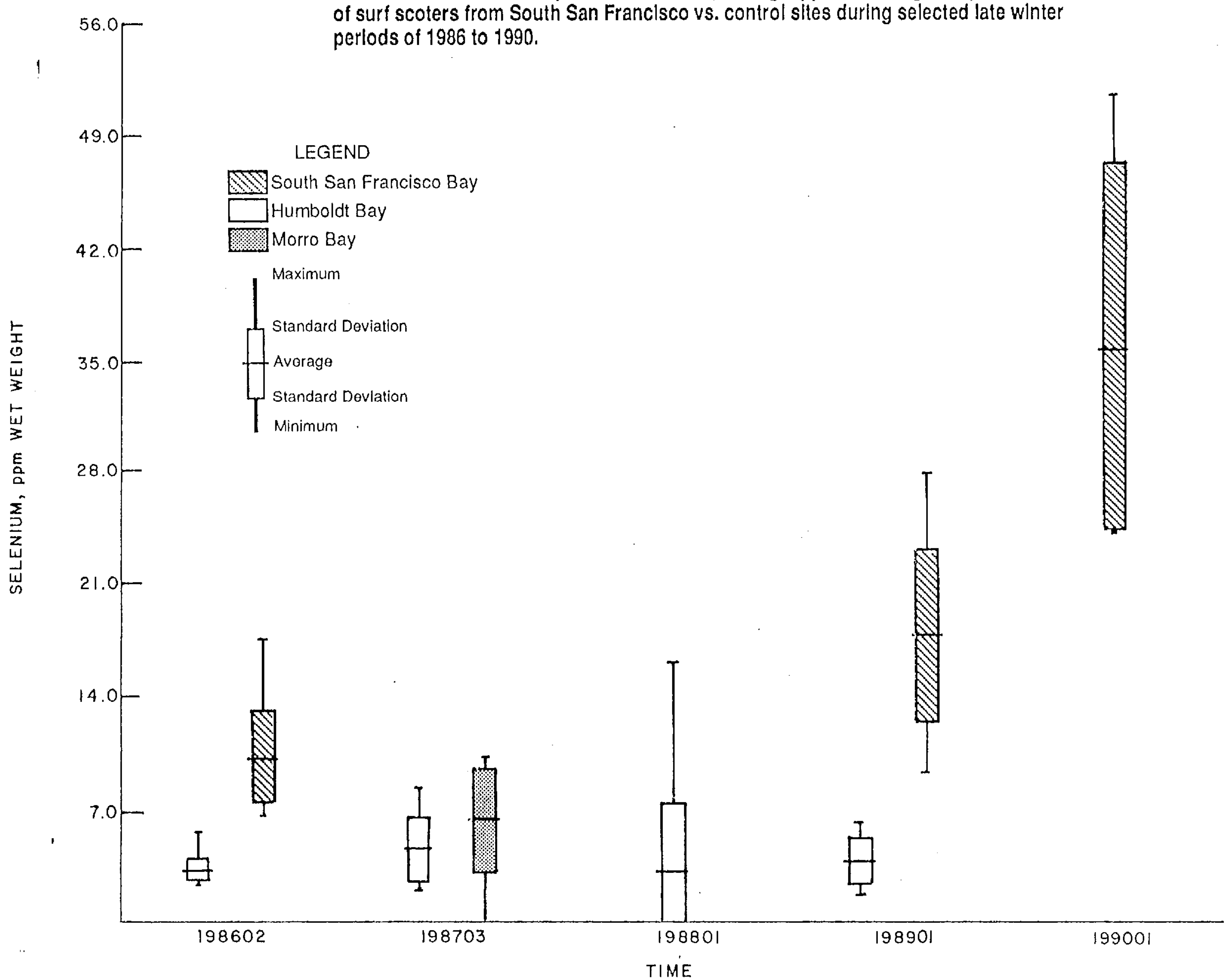
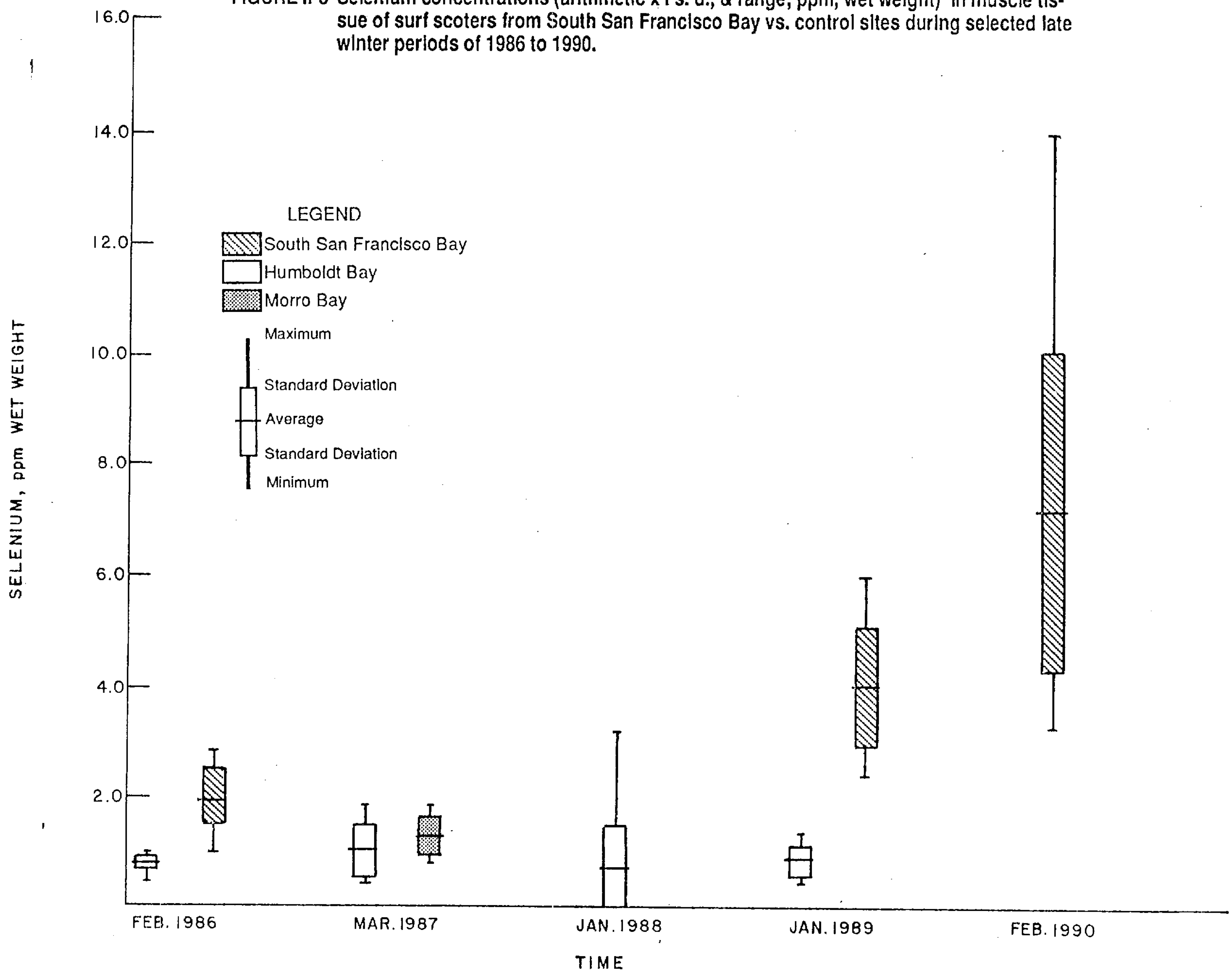


FIGURE II-6 Selenium concentrations (arithmetic $\bar{X}$ I s. d., & range; ppm, wet weight) in muscle tissue of surf scoters from South San Francisco Bay vs. control sites during selected late winter periods of 1986 to 1990.



SUMMARY

SVS data added additional information to ongoing efforts to evaluate the extent to which Se levels may be increasing in diving ducks in San Francisco Bay. The overall trend has been for increasing Se levels in both surf scoter liver and flesh through 1989. Although this increasing trend has leveled off in 1990, measured Se levels remain much higher than those measured by USFWS researchers for American coots and puddle ducks. Those levels resulted in Se toxicosis and reproductive impairment.

Additional data are needed to evaluate whether these Se concentrations actually result in reproductive impairment. Likewise, ongoing sampling in the San Francisco Bay should continue.

CHAPTER III

SELENIUM IN ADULT ANADROMOUS FISH IN THE ESTUARY

INTRODUCTION

Two species of anadromous fish, striped bass (Morone saxatilis) and white sturgeon (Acipenser transmontanus) are important sportfish in the Sacramento-San Joaquin Estuary. The abundance of adult striped bass has declined since the 1960's. The reasons for the decline are not well understood, however, pollutants may be partly responsible. Measurements of Se in striped bass muscle tissue from 1986 through 1989 under the SVS have not shown consistent trends even though Se levels increased from 1986 to 1987.

Previous SVS findings indicated that Se levels in white sturgeon muscle increased from 1986 to 1987, but decreased in 1988 (White, et al., 1989). Since white sturgeon feed mostly on the bottom and are exposed to Se bioaccumulated by bottom dwelling organisms such as molluscs and crustaceans, they have great potential to accumulate high levels of Se. The risk to public health of further increases in Se concentrations in white sturgeon may be substantial. Levels measured in the last three years are just below the State Department of Health Services "interim internal guidance and screening level" of 2 ppm wet weight, beyond which they begin monitoring tissue levels and evaluating the available data for potential impacts to human health.

To further evaluate these issues, striped bass and white sturgeon were collected in the Sacramento-San Joaquin Estuary in 1989 and 1990. Se concentrations in the muscle tissue of these species were measured to determine trends in Se levels and to compare these levels to Department of Health Services guidelines for minimizing health risks. In addition, food habits data and the Se concentration of the principal dietary components of white sturgeon were evaluated.

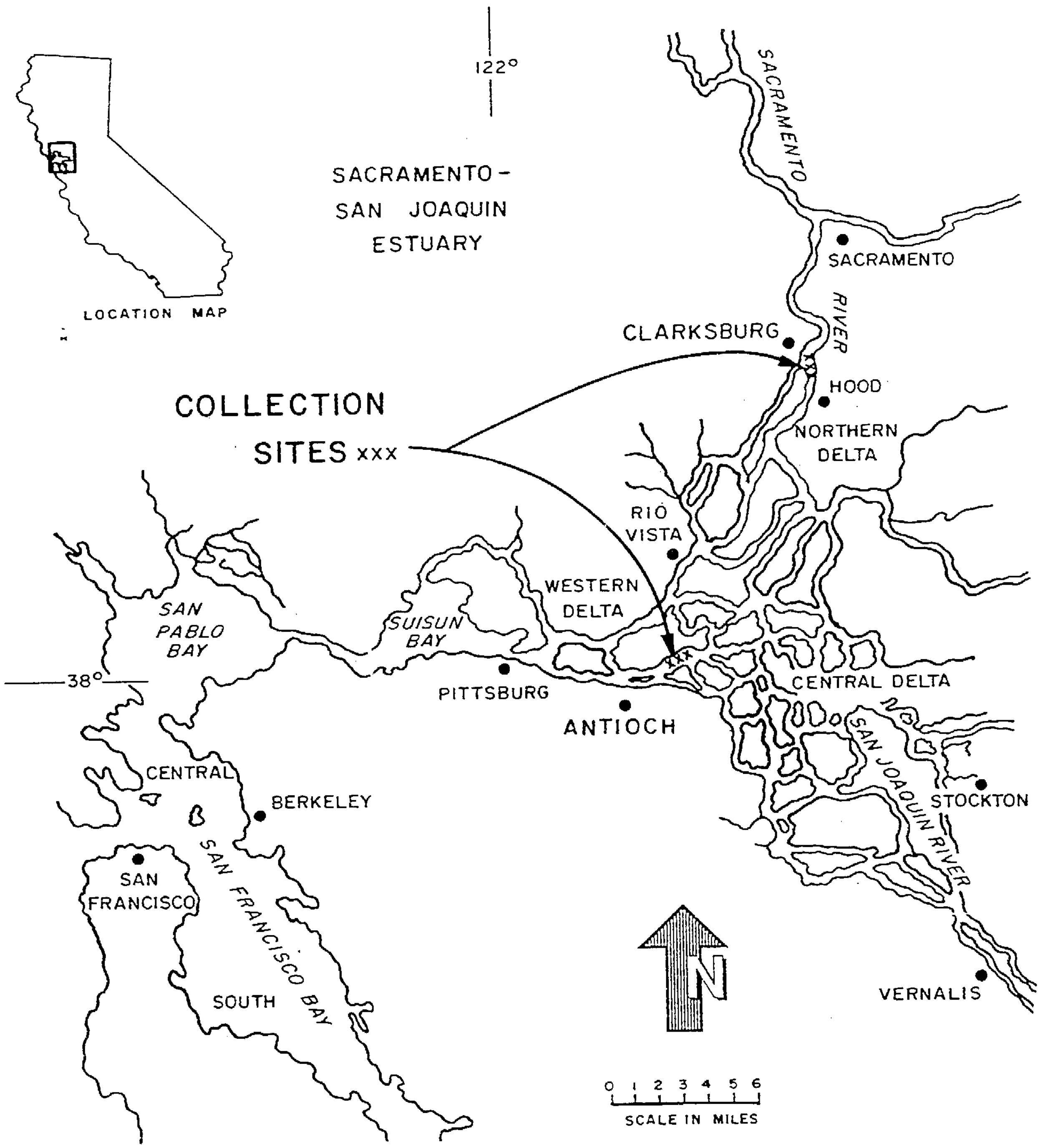
FIELD METHODS

Adult striped bass and adult and juvenile white sturgeon were collected from February 26, 1989 through May 16, 1990 principally from 4 locations in the Sacramento-San Joaquin Estuary (Figure III-1 and III-2).

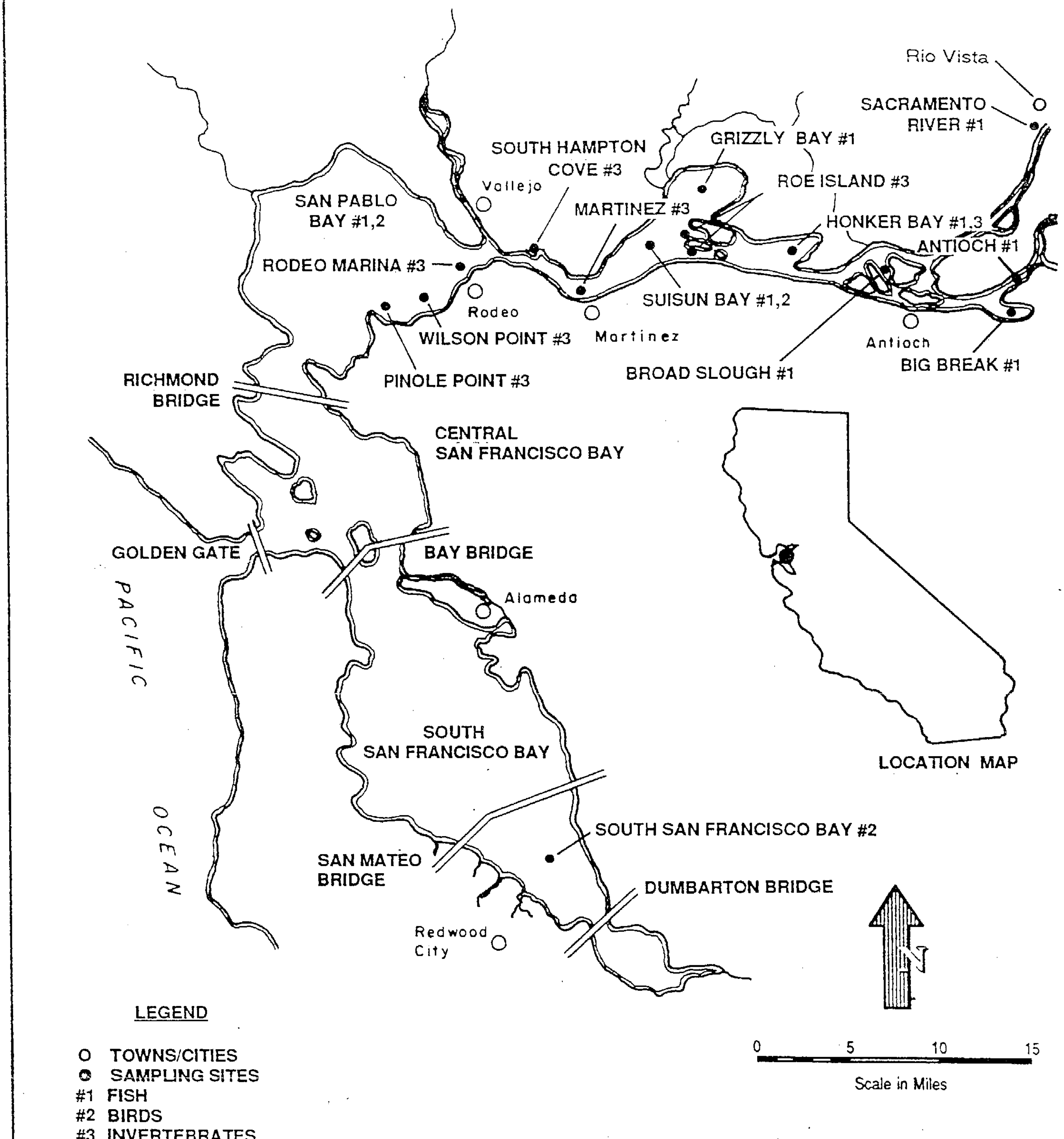
Sturgeon tissue samples were collected from sport-caught fish landed at the San Rafael, Crockette, and Antioch harbor. Striped bass samples were from fish caught in gillnets or caught in fyke traps for the DFG's Adult Striped Bass Tagging Program.

As soon as possible after collection, fish samples were placed in sealable plastic bags, frozen with dry ice, and subsequently stored in a chest freezer at -12°C until delivered to WPCL for dissection, sample preparation, and analysis.

FIGURE III -1



1988-89 & 1989-90
SELENIUM VERIFICATION STUDY: STRIPED BASS COLLECTION SITES



SELENIUM VERIFICATION STUDY: SAN FRANCISCO, BAY - ESTUARY
SAMPLING SITES - 1989 - 1990

Tissues of striped bass and white sturgeon were analyzed individually because data from individual organisms provide more information on variability within populations than that from several organisms in a composite sample.

Clams collected during the white sturgeon food habits investigation were obtained with a sled-mounted rake or a Petersen-type grab.

LABORATORY METHODS

Laboratory methods for tissue preparation were the same as those described for surf scoters in Chapter II. Also, Se analysis methodology followed that described by White, et al., (1989, Appendix C). Appendix C and D of this report contain the results of the duplicate analyses for both 1988-89 and 1989-90 and Appendix F contains the results of the accuracy verifications which determined that the hydride generation atomic absorption spectrophotometry (HGAA) method provided acceptable accuracy for Se analysis in tissue. Appendix F contains the results of the neutron activation analysis and HGAA. The percent RSD is also shown. The average percent RSD for fish flesh and fish liver were 6.8 and 5.7, respectively.

STATISTICAL METHODS

Statistical methods used to analyze Se concentration data for anadromous fish samples were the same as used for analyzing Se concentrations in wintering diving ducks (Chapter II).

RESULTS AND DISCUSSION

Striped Bass

The location and dates of striped bass and sturgeon samples are indicated in Table III-1. The geometric mean Se concentration in the muscle tissue of ten adult striped bass collected from the Sacramento-San Joaquin Estuary in 1989 was 0.48 ppm wet weight (1.9 ppm dry weight) and 0.39 ppm wet weight (1.7 ppm dry weight) in 1990 (Table III-2). There were no significant differences between the muscle Se levels of fish collected from Antioch or Clarksburg in 1987, 1988 and 1989. Lumping samples from both locations for between year comparisons, showed that in 1989 striped bass muscle Se levels (0.48 ppm wet weight) were higher than 1988 levels (0.38 ppm wet weight), but not significantly different from 1987 (0.43 ppm wet weight) or 1990 levels (0.39 ppm wet weight). Thus there has been no upward or downward trend in Se levels over this four year time period. There is no significant correlation between muscle Se levels and length of striped bass. However, in 1986 when Se levels were measured in liver there was a significant negative correlation between length and liver Se levels ($r=-0.73$). The levels measured are low and can be considered background levels. They are similar to the median whole body levels (0.42 ppm, wet weight (1.7 ppm dry weight)) measured in freshwater fish on a nationwide basis by the National Contaminant Biomonitoring Program (Lowe, et al., 1985).

Table III-1. Selenium Verification Study Collection Program - Anadromous Fish 1988-1990.

LOCATION	SPP COLLECTED	DATE COLLECTED
Antioch, San Joaquin River	Striped Bass	5-08-89, 5-16-90
Clarksburg, Sacramento River	Striped Bass	5-03-89
Suisun Bay	Adult White Sturgeon	
San Pablo Bay	Adult White Sturgeon	
Various Locations	Juvenile White Sturgeon	

Table III-2. Selenium concentrations in muscle tissue of adult striped bass (*Morone saxatilis*) from the Sacramento-San Joaquin Estuary. Concentrations in ppm wet weight.

Site	Year	N	Geometric $\bar{x}$	Arithmetic $\bar{x}$ & s.d	Range
Antioch,	1987	11	0.44	0.44 ± 0.08	0.30 - 0.62
San Joaquin	1988	5	0.37	0.37 ± 0.07	0.28 - 0.48
River	1989	5	0.49	0.49 ± 0.03	0.43 - 0.54
	1990	10	0.39	0.39 ± 0.06	0.28 - 0.49
Clarksburg,	1987	11	0.42	0.42 ± 0.09	0.28 - 0.62
Sacramento	1988	5	0.40	0.40 ± 0.05	0.34 - 0.48
River	1989	5	0.46	0.46 ± 0.04	0.38 - 0.49

White Sturgeon

The geometric mean Se concentration in muscle tissue of adult white sturgeon collected in 1990 was 3.48 ppm wet weight (15.0 ppm dry weight), and 3.36 ppm wet weight (14.6 ppm dry weight) in 1989 (Table III-3). The average Se concentration in adult livers in 1990 was 8.17 ppm, wet weight (30.8 ppm dry weight). There were no significant differences in the Se levels of fish from Suisun or San Pablo bays in either muscle or liver tissue. Analyzing both locations together, muscle Se levels were significantly higher in 1989 and 1990 than in 1988. The 1990 levels were higher than those measured in 1986, but neither year differed significantly from 1987. Liver Se levels were three times higher in 1990 (8.17 ppm wet weight (30.8 ppm dry weight)) than when they were last measured in 1986 (2.70 ppm wet weight (8.7 ppm dry weight)). Muscle Se levels in the last two years have more than doubled from their low in 1988 and increased 52 to 97% since they were first measured in 1986 and 1987. A greater percentage of the fish sampled were equal to or greater than the Department of Health Services "interim internal guidance and screening level" of 2 ppm wet weight (1990-79%, 1989-57%, 1988-21%, 1987-77%, 1986-40%) and in the last two years the proportion of fish in samples greater than 4 ppm increased drastically (1990-45%, 1989-50%, 1988-0%, 1987-8%, 1986-10%). The Department of Health Services is currently conducting human health risk evaluations of these data.

There were no differences between male and female sturgeon in Se accumulation of either liver (n=11) or muscle tissue (n=25), but this is based on an evaluation of very few fish. In 1990 the Se levels in muscle and liver of sub-legal sturgeon (age 0 to age 4, average age 2) were found to be one-third to one-fourth the levels observed in adults (Table III-3). Se levels in juvenile sturgeon are within the range of background levels measured for a variety of saltwater fish (Eisler 1985) and so are adult liver levels. Adult muscle levels are higher than those seen in most saltwater fish other than tuna or marlin (Eisler 1985). Both adults and juveniles have muscle Se levels about two to ten times that measured in English sole, speckled sanddab, and starry flounder sampled from the Bay in 1986 (White, et al., 1987). It appears that Se levels in adult sturgeon may be increasing. It is not clear whether they exceed what might be considered normal/background levels, or whether Se levels are reaching a point where the fish might be vulnerable to chronic long term effects. However, recent toxicological data developed by the USFWS (USFWS 1990b) for other freshwater and anadromous fish species suggest that the levels measured in adult and juvenile sturgeon in 1989 and 1990 are closely approaching levels which may have chronic and acute effects. Chinook salmon fry began to experience mortalities when whole body Se levels reached 5-8 ppm dry weight and fingerling bluegill experienced mortality at 5-10 ppm dry weight on a whole body basis. Flesh levels (most comparable to whole body data) in juvenile sturgeon are 4.5 ppm dry weight (0.89 ppm wet weight). Whole body residues in adult bluegill, whose fry experienced partial to complete mortality during the yolk sack stage, were 16-18 ppm dry weight. According to Lemly and Smith (1987) biological suppositions of contamination in sensitive freshwater fish occur at $\geq$ 12 ppm dry weight on a whole body

Table III-3. Selenium concentrations in muscle and liver tissue of adult and juvenile white sturgeon (Acipenser transmontanus) from the Sacramento-San Joaquin Estuary. Concentrations in ppm wet weight.

Age/Site	Tissue	Year	N	Geometric $\bar{x}$	Arithmetic $\bar{x}$ & s.d	Range
Adult/						
Suisun Bay						
	F	1987	5	1.78	1.82 ± 0.49	1.00 - 2.30
		1989	14	3.35	4.14 ± 3.19	1.20 - 11.00
		1990	28	3.48	4.10 ± 2.41	0.28 - 8.80
	L	1990	23	8.39	9.78 ± 5.53	2.20 - 22.00
San Pablo Bay	F	1986	10	1.77	1.86 ± 0.84	1.10 - 4.00
		1987	8	2.52	2.63 ± 0.91	1.11 - 4.30
		1988	14	1.37	1.48 ± 0.84	0.51 - 3.30
		1990	5	3.57	3.89 ± 2.17	0.80 - 4.75
	L	1986	10	2.70	2.79 ± 0.83	1.20 - 3.90
		1990	3	6.46	7.27 ± 3.98	2.70 - 10.00
Juvenile/						
Various Locations	F	1990	21	0.89	0.97 ± 0.68	0.33 - 3.00
	L	1990	22	2.36	2.73 ± 2.46	0.80 - 13.00

F = Flesh or muscle tissue
L = Liver tissue

basis. Adult sturgeon have flesh levels in 1990 of 15.0 ppm dry weight (3.48 ppm wet weight). No definitive decisions can currently be made as to whether the levels of Se observed in sturgeon are chronically harmful, because these fish are taxonomically dissimilar to the species for which we do have data (salmon, striped bass and bluegill). Therefore, it is important that chronic toxicity studies evaluating growth, histological and biochemical responses to Se contamination be conducted with juvenile and adult sturgeon. Otherwise, we may risk this fish population's decline due to possible reductions in reproductive success induced by Se contamination.

The association between fish length and selenium levels in liver and muscle tissue of adult or juvenile sturgeon is not consistent. There is a significant positive correlation between size and liver Se concentrations ($r=0.51$) for juveniles, but the correlation between muscle Se concentration and size is not significant. In adults using all five years data combined, there is no significant correlation between fish size and Se in muscle. Using 1990 data only, however, there is a significant negative correlation between fish size and muscle ($r=-0.47$) and liver ($r=-0.62$) Se concentrations. This was also true for 1988 muscle Se levels (see White, et al., 1989).

White Sturgeon Food Habits

An examination of the stomach contents of adult white sturgeon collected in 1988-89 and 1989-90 (Tables III-4 & III-5) indicates that the recently introduced clam Potamocorbula spp. was the predominant item in sturgeon gut. It is the most commonly consumed item ("% of stomachs", Tables III-4 & III-5) as well as the predominant item consumed in numbers or mass by sturgeon. Various other crustaceans, gobies and polychaete worms comprise the rest of the diet but appear to be consumed much less frequently than Potamocorbula. This cursory diet analysis does not indicate that Potamocorbula is the most important food item in the diet of white sturgeon, however. If the caloric value of the food items were known, the nutritional value of less commonly consumed food items, which may occur at lower densities in the estuarine environment or be harder for sturgeon to capture, can be evaluated. This would indicate wether they are equally or possibly more important in fulfilling the growth and energy needs of sturgeon than Potamocorbula spp., especially if they are a more preferred food item. Dietary preference would be indicated by a higher proportion of a food item in the diet than is commonly available in the estuarine environment. It is possible that Potamocorbula spp. has less nutritional value to sturgeon than the other food items given that a large proportion of each clam's body mass is composed of indigestible shell. Qualitative observations indicate that Potamocorbula can be passed live and intact through the entire gut of a sturgeon and that many shells are not crushed in the sturgeon's stomach. Small mollusks (clams) were consistently the predominant food item in the diet of the sturgeon collected in 1965-67 (McKechnie & Fenner 1971), comprising approximately one third of the diet on a volume basis. In recent years, anecdotal information from sport fishermen, charter boat crews, and Fish and Game field personnel suggest that Corbicula

Table III-4. Percent occurrence of food items in adult white sturgeon stomachs from Suisun Bay in spring 1989 (N=14, 2 fish had empty stomachs)

Food Items	% of Stomachs Containing Food Items N=14	Mean % Occurrence [1/] all Stomachs N=14	Mean % Occurrence [1/] full Stomachs N=12
Mollusca			
Potomocorbula spp.	71	59	69
Crustacea			
Decapoda			
Crangon spp.	29	9	10
Rhithropanopeus harrisii	7	1	1
Hemigrapsus oregonensis	7	1	1
Cancer magister	36	11	12
Isopoda	14	4	5

1/ The arithmetic average of the percent occurrence of a food item in each fish's stomach, therefore, valves in a column do not necessarily sum 100%. Percent occurrence in each fish was computed as the % of total food items in a gut that were composed of that specific prey species.

Table III-5. Percent occurrence of food items in adult white sturgeon stomachs from Suisun Bay and San Pablo Bay, in Spring 1990.

	SUISB[1/]				SNPBB[2/]	
	ALL FISH		FULL STOMACHS ONLY			
FOOD ITEMS	% of [3/] Stomachs	Mean % [4/] Wt.	% of [3/] Stomachs	Mean % [4/] Wt.	% of [3/] Stomachs	Mean % [4/] Wt.
Polychaete, Tube Worms					33	33
Mollusca						
Bivalvia						
Potomocorbula spp.	64	56	82	73	67	67
Corbicula fluminea	4	1	6	1		
Crustacea						
Decapoda						
Crangon nigricauda	4	1	6	2		
Crangon franciscorum	4	Trace	6	Trace		
Callinassa californiensis	4	2	6	3		
Rithropanopeus harrisii	14	10	18	13		
Isopoda	4	1	6	1		
Fish						
Acanthogobius flavimanus	9	5	12	7		

1/ n=22, 5 empty stomachs.
2/ n=3, all full stomachs.
3/ % of all stomachs collected that contained this food item.
4/ The arithmetic average of the percent weight of a food item in each fish's stomach.

fluminea was a major portion of the sturgeon's diet until the introduction and establishment of Potamocorbula.

A variety of bivalve molluscs that represent a range of primary food items currently and historically consumed by sturgeon were collected from locations in Suisun and San Pablo bays to compare their differences in Se levels (Table III-6). The wet weight Se levels are all low and do not vary a great deal among species. The apparently high dry weight Se levels presented for Corbicula fluminea are misleading since only flesh was analyzed, not the whole body. Corbicula has a hard shell that cannot be ground for chemical analysis, so its tissues were dissected and used for analysis. The rest of the clam species are too small to dissect and have softer shells which can be homogenized for analysis. If the Corbicula wet weight values are adjusted to account for the weight of the shell the 2/89 value is decreased to 0.08 ppm wet weight (0.32 ppm dry weight) and the 5/90 value is 0.06 ppm wet weight (0.24 ppm dry weight) and they become the lowest values measured. It was difficult to gather enough biomass of any species besides Potamocorbula to enable us to do multiple Se assays of each species at each site, since this species is now the dominant member of the shallow water clam community in both Suisun and San Pablo bays. Where comparisons were possible, it was found that Potamocorbula had more Se wet weight, whole body basis at Pt. Pinole (Figure III-2) than at Rodeo or Roe Island, and that clams from Roe Island had more than those from Rodeo. The only inter-specific comparison made was at Pt. Pinole where Potamocorbula contained significantly more Se than did Tapes japonica. Potamocorbula, the dominant food item consumed by sturgeon, has higher selenium levels on a whole body basis than the other clams collected with the possible exception of Musculus senhousia whose dry wet Se levels appear to be higher. Since anecdotal information would suggest that Corbicula was the dominant clam in the diet of sturgeon from Suisun Bay in recent years before Potamocorbula became established, a shift by sturgeon to increased consumption of the new introduced species could have contributed to the observed increases in Se in their tissue over the last two years. Because Potamocorbula appears to have little food value for sturgeon, digestive studies are needed to define the degree to which these clams are digested and the proportion of the total calories in the average sturgeon's diet due to consumption of Potomocorbula. Other food items may contribute to bioaccumulation of Se by these fish. In both Suisun and San Pablo bays a variety of other clams were traditionally consumed by sturgeon (McKechnie & Fenner 1971), including Tapes japonica, Macoma sp and Gemma gemma. Only live specimens of Tapes, were found and it generally had lower levels of Se than Potamocorbula which would also suggest that a shift from Tapes to Potamocorbula could contribute to increased Se levels in sturgeon. In most years, we were not able to collect enough clams to do multiple Se assays so sample sizes are insufficient for interannual comparisons of Se in clams with the exception of Potamocorbula from Roe Island in February of 1988 and 1990, and Corbicula fluminea from the same area in 1988 and 1989. For both species, wet weight Se values were significantly lower in the second and later collection year. With the exception of Musculus senhousia collected from Pt. Wilson in November 1987, the levels in Tapes japonica and Musculus appear to be similar in both

Table III-6. Geometric mean selenium concentrations in bivalve molluscs from Suisun and San Pablo Bays (ppm dry weight with wet weight in parenthesis).

Date	Species [1/]	Bay	Subsite	Selenium Concentration		N
1/87	Corbicula fluminea	Suisun	Middle Ground	3.6	(0.61)	1
"	" "	"	Mouth of Suisun Slough	4.9	(0.78)	1
2/87	" "	"	Roe Island	4.4	(0.84)	1
4/87	" "	"	Middle Ground	4.5	(0.86)	1
"	" "	"	Roe Island	4.8	(0.82)	1
10/87	" "	"	" "	6.4	(0.85)	2
"	Potamocorbula	"	" "	1.0	(0.48)	1
11/87	Musculus senhousia	San Pablo	Pt. Wilson	0.64	(0.18)	3
"	"	"	Castro Cove	1.40	(0.43)	2
"	"	"	China Camp	2.00	(0.38)	3
"	Potamocorbula	"	Petaluma R. Approach	1.20	(0.53)	2
"	Tapes japonica	"	Castro Cove	0.54	(0.29)	1
12/87	Corbicula fluminea	Suisun	Roe Island	5.60	(0.81)	2
"	Potamocorbula	"	" "	0.90	(0.44)	2
2/88	"	"	" "	1.15	(0.50)	3
"	Corbicula fluminea	"	" "	5.7	(0.78)	3
2/17/89	Corbicula fluminea	Suisun	Roe Island	6.84	(0.48)	3
"	Potamocorbula	"	" "	0.63	(0.41)	1
2/27/90	Potamocorbula	"	" "	0.54	(0.28)	10
2/28/90	"	San Pablo	Pt. Pinole	0.91	(0.41)	4
"	"	"	Rodeo	0.36	(0.15)	4
"	Tapes japonica	"	"	0.48	(0.20)	1
"	Musculus senhousia	"	"	1.21	(0.39)	1
"	" "	"	Pt. Pinole	1.32	(0 30)	1
"	Tapes joponica	"	" "	0.36	(0.20)	5
4/19/90	Potamocorbula	Suisun	Southhampton Bay	1.01	(0.46)	1
"	"	"	Martinez	1.24	(0.55)	1
5/2/90	Corbicula fluminea	"	Honker Bay	7.90	(0.42)	3

1/ Corbicula values are based on tissue only, all other species are whole body analyses, including the shell.

1987 and 1990. The SVS data is insufficient to demonstrate any clear trends in the Se levels of clams, but where we have enough data, there appear to be interannual differences in the Se levels of some species. Bioaccumulation factors vary from 1 to 105 for sturgeon muscle tissue vs. clams and 3 to 147 for liver (Figure III-3). These levels are similar to those measured for diving ducks in 1987-88 (White, et al., 1987). No data was collected for other fish food items.

SUMMARY

Findings failed to substantiate any upward or downward trend in Se levels in striped bass from 1987 through early 1990. Results for white sturgeon, however, were noteworthy. For instance, measured Se levels in white sturgeon liver samples were three times higher than samples measured in 1986. A greater percentage of white sturgeon sampled were equal to or greater than Department of Health Services "interim internal guidance and screening levels" of 2 ppm wet weight. In addition while it is not now possible to determine whether sturgeon might be vulnerable to chronic long term effects, measured levels are approaching those levels where USFWS researchers suspect chronic and acute effects.

Se concentrations were determined for bivalve molluscs obtained from the stomachs of white sturgeon. While Se concentrations in the introduced clam, Potomocorbula were among the highest of this group, food habitat studies did not quantify the contribution Potomocorbula make to the sturgeon's diet.

Additional data should be collected on Se levels in white sturgeon. Follow-up studies to determine the actual food values for Potomocorbula should also be conducted.

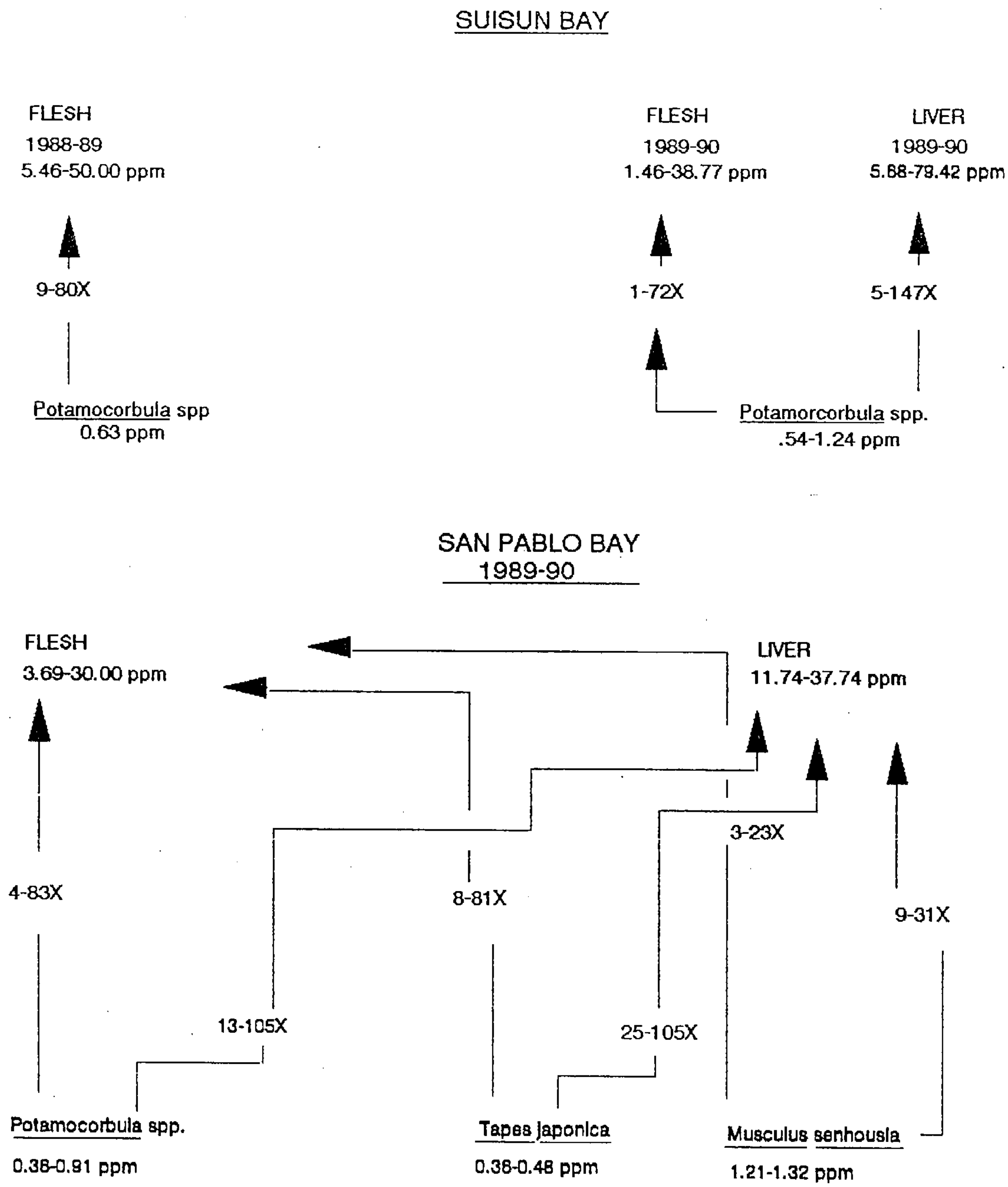


Figure III-3. Bioaccumulation factors between trophic levels in the food chain of white sturgeon from the San Francisco Bay/Estuary Factors were derived from geometric means of the dry weight concentrations of selenium in fish tissues and whole bodies of clams.

CHAPTER IV

SELENIUM IN BIOTIC AND ABIOTIC COMPONENTS OF THE LOWER SAN JOAQUIN RIVER AND SELECTED VALLEY FLOOR TRIBUTARIES

INTRODUCTION

Previous studies have demonstrated that Se levels are reduced in the water column, probably as a result of both dilution and biofixation/bioaccumulation, as the San Joaquin River flows downstream from the Grasslands (White, et al., 1989). SVS data from 1987-88 indicated higher levels of selenium in fish sampled from tributaries to the San Joaquin River in the Grasslands than fish sampled in the lower river. Se levels in fish taken from the lower San Joaquin river were not significantly different from levels in fish from the Sacramento River (Rio Vista) and the western Delta (Mayberry Slough). Selenium in fish taken from the San Joaquin River upstream from the influence of Grasslands tributaries were the lowest levels measured in the system. In order to (1) evaluate trends in biota of Se contamination derived from irrigated agriculture and (2) to determine the rates of Se accumulation in lower velocity south Delta channels compared to the main stem of the San Joaquin River, samples of fish, bivalves, sediment, water, plankton, and suspended particulates were collected from sites in the lower San Joaquin River drainage and the Sacramento-San Joaquin Delta. The use of transplanted Corbicula as a site-specific indicator of short to intermediate term accumulation of Se by aquatic biota was also evaluated.

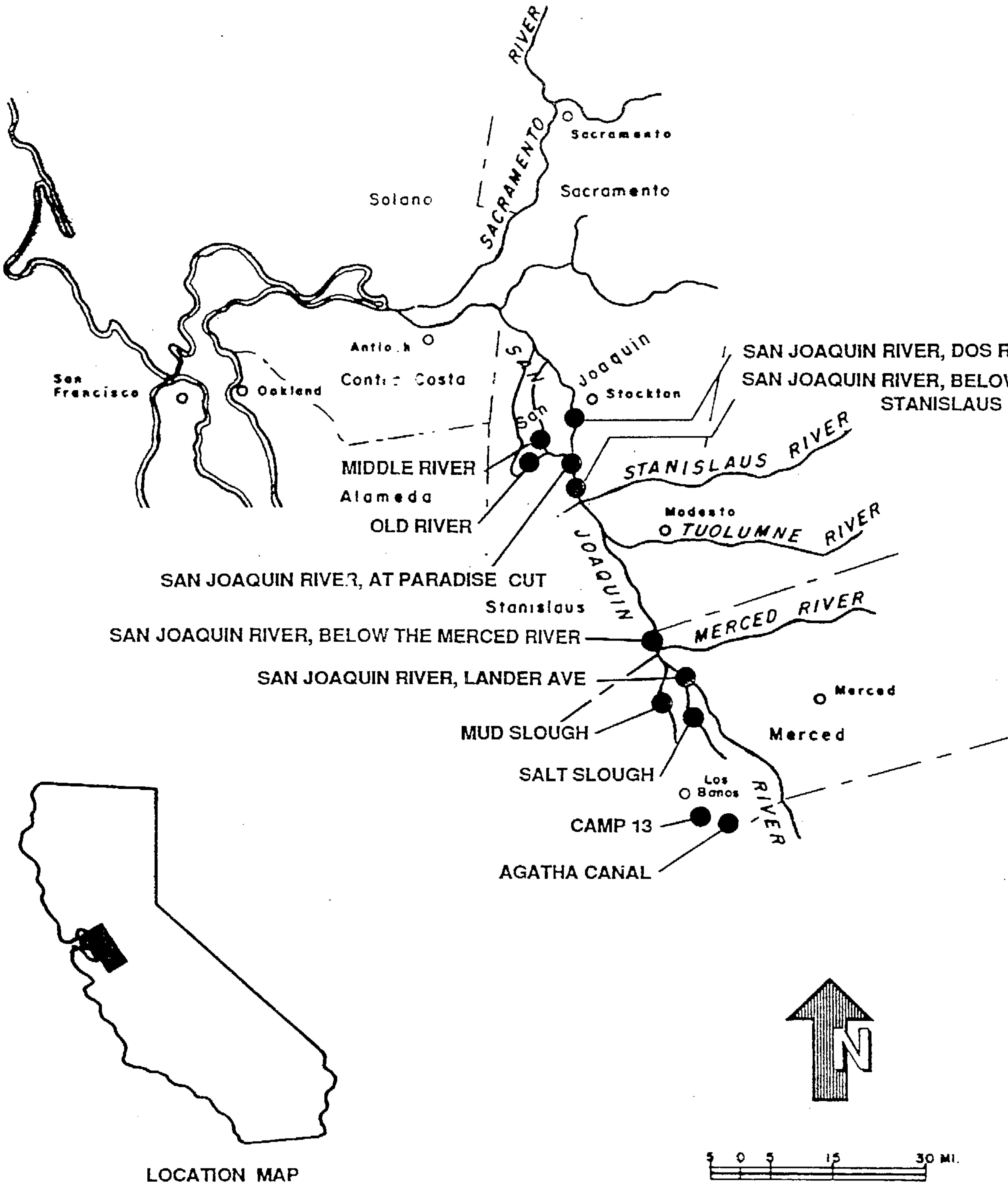
FIELD METHODS

Fish and Clam Collection and Processing

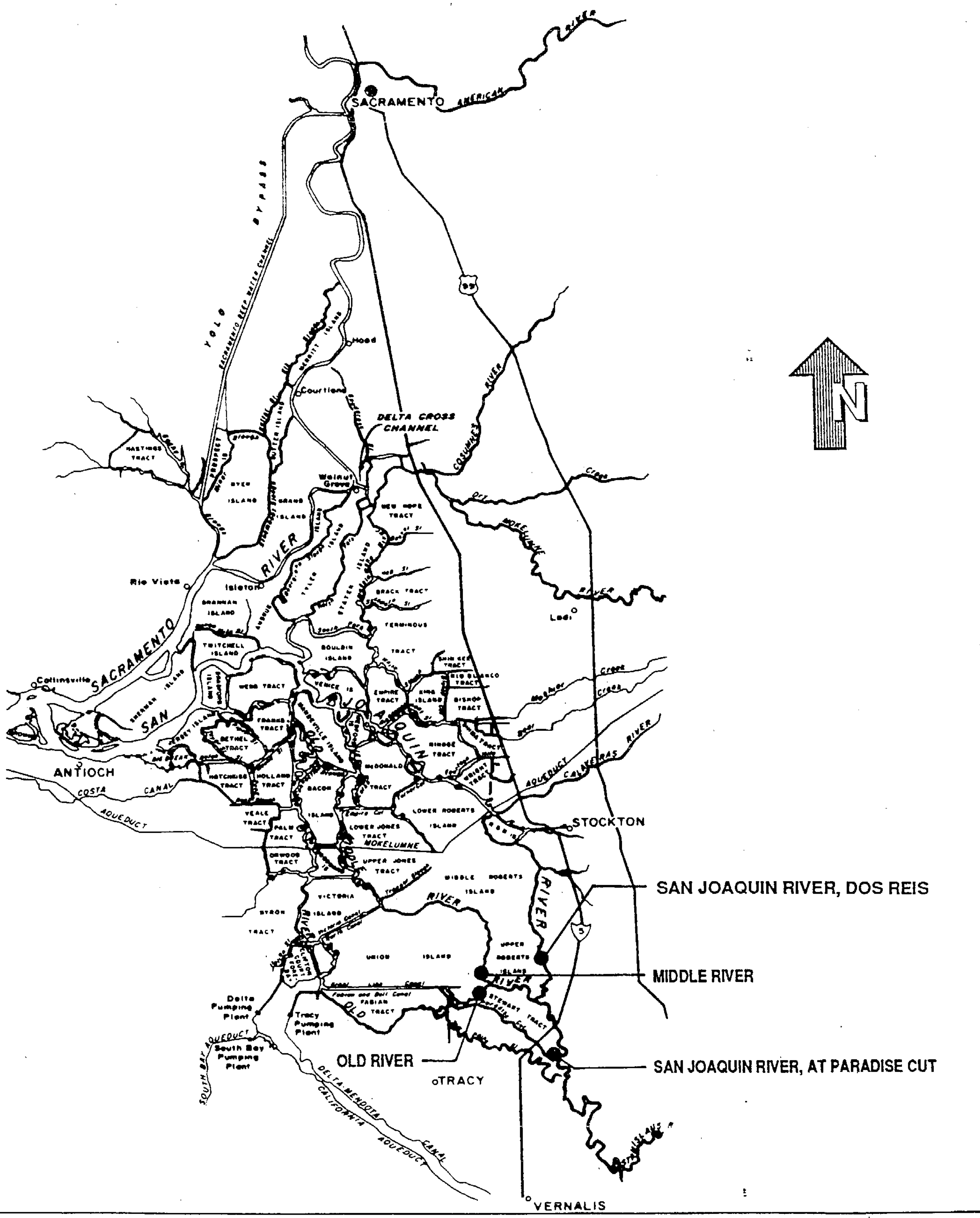
Fish sampling gear included hoop nets. gillnets, minnow seines, and hook and line and electrofishing. Clams were collected with clam dredges towed behind a boat or by hand. Fish and clam samples were placed in sealable plastic bags, frozen with dry ice and subsequently stored in a chest freezer at -12°C until delivered to the WPCL for dissection, sample preparation, and analysis as soon as possible after collection,.

Fish were analyzed in composite samples of six individuals to accommodate the constraint on total samples. Channel catfish and white catfish were not mixed in composite samples. Fish and clams were collected at selected locations in the delta and lower San Joaquin River in 1988-1989 (Figure IV-1 and IV-2) and 1989-1990 (Figure IV-3 and IV-4).

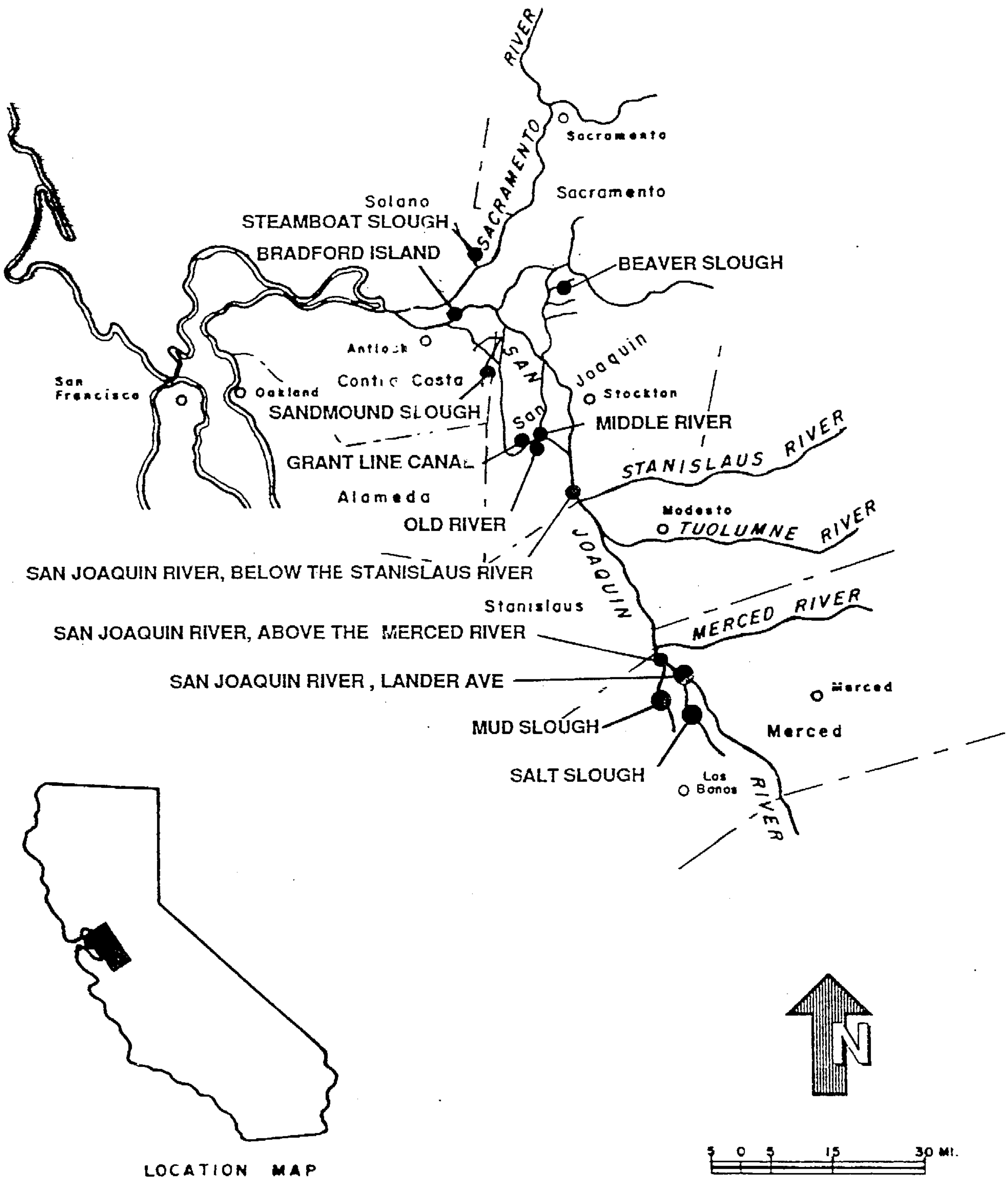
FIGURE IV -1



SELENIUM VERIFICATION STUDY: FRESHWATER FISH SAMPLING SITES - 1988 - 1989

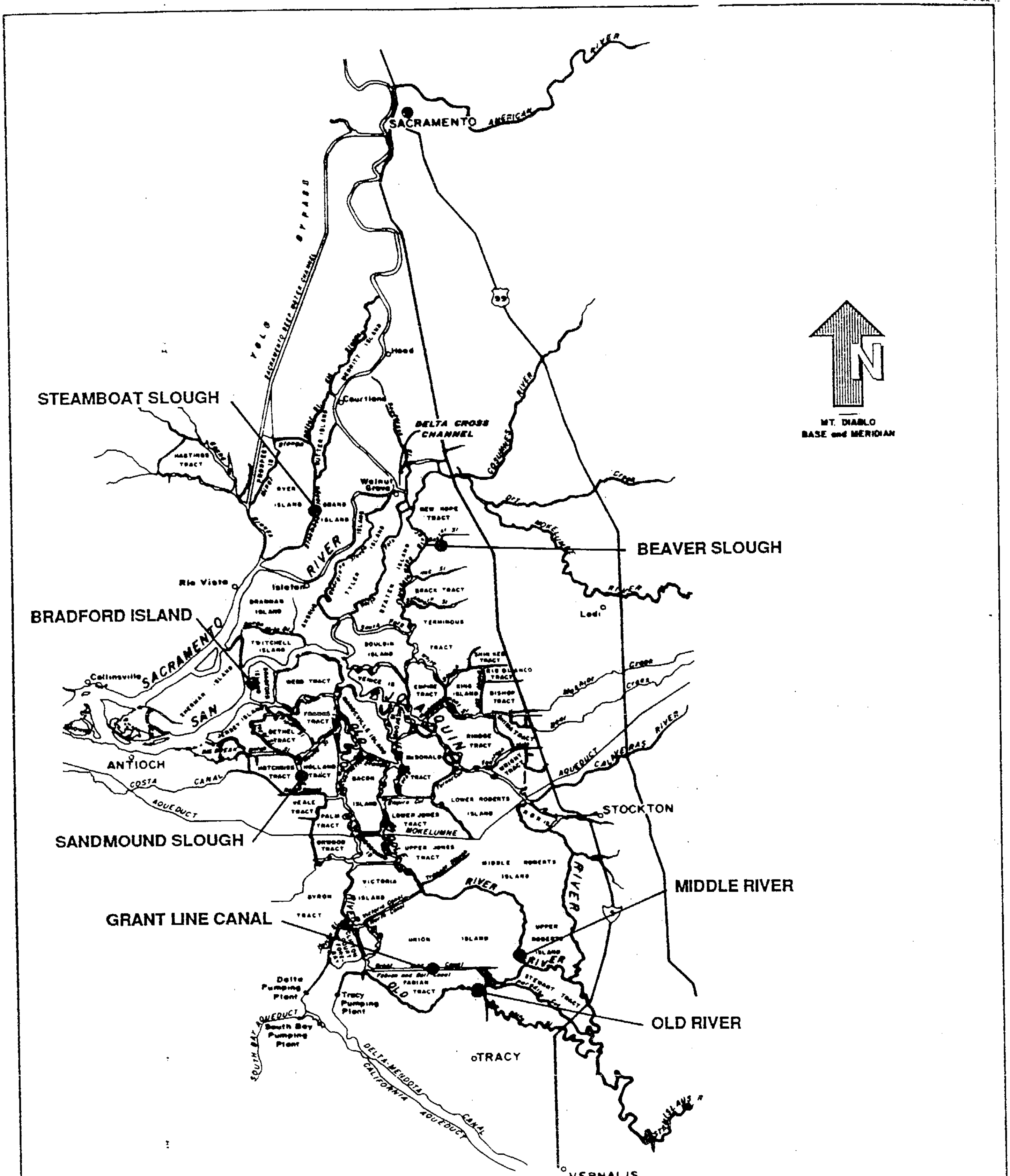


SELENIUM VERIFICATION STUDY: SOUTH DELTA FRESHWATER FISH SAMPLING SITES - 1988 - 1989



SELENIUM VERIFICATION STUDY: FRESHWATER FISH SAMPLING SITES - 1989 - 1990

FIGURE IV -4



SELENIUM VERIFICATION STUDY: DELTA FRESHWATER FISH SAMPLING SITES - 1989 - 1990

Water, Particulates, Plankton, and Sediment Collection and Processing

To assess the magnitude of bioaccumulation between trophic levels, samples of filtered water, filterable suspended particulates, plankton, and sediment were collected at each freshwater fish sampling site, during fall (September), mid-winter (November/December), and spring (March/April) collection periods.

Both whole and filtered water samples were collected in polyethylene bottles which had been previously cleaned with 1.0M nitric acid (analytical reagent grade) and rinsed with Type I water. The unfiltered (whole) water samples were preserved at the time of collection with hydrochloric acid to a final concentration of 0.08 Molar. The samples were frozen and remained frozen until the time of analysis.

Filtered field water samples were strained through a 75 um nylon plankton net in the field before being filtered through a 0.45 um polycarbonate nuclepore filter in a Geotech 142 mm filter holder. Filtration was completed at the end of each day of sampling and whole water was stored on ice until filtration. The filtered water was acidified with nitric acid. Water samples were stored in 0.5 L or 1.0 L nalgene polyethylene bottles and were either frozen or refrigerated until laboratory analysis.

After the filtered water samples were collected, additional sample site water was pumped through the Neclepore filter until the filter membrane began to clog. The filter was then folded inward to retain the particulates, placed in a polyethylene vial, and frozen on dry ice for later determination of Se in suspended particulates.

Plankton samples were collected with a #20 (75 um) nylon plankton net. The contents were then transferred to a polyethylene vial, and frozen until analysis at WPCL. These samples are composites of phytoplankton, zooplankton, and detritus greater than 75 um in size. Macroinvertebrates and larger pieces of detritus are removed, if necessary, before the samples are transferred to the sample bottles.

Sediment samples were initially collected with a shovel or Petersen-type grab sampler, and then subsampled with a clean plastic spoon to obtain a sample that had not been in contact with the sampling device. The dredged samples were put into polyethylene bottles and frozen immediately on dry ice. Samples were subsequently stored in a chest freezer at -12°C until delivered to WPCL. Later in the study, sediment samples were collected using clean, freshly manufactured 1 gallon plastic milk jugs which had their bases cut off to modify them into a scoop.

Selenium Accumulation by Transplanted Corbicula

Corbicula were collected from the Sacramento River immediately north of Sherman Island (Figure IV-5) using a sled-mounted rake or a Petersen-type grab sampler. A representative sample was sacrificed to determine initial Se levels in clam tissues using laboratory and statistical methods described in Chapter III. Corbicula were kept alive in ice chests with wet burlap and transported to selected sites in the San Joaquin River (Figure IV-5). Corbicula were placed in cages constructed with 3/4 inch PVC pipe and one inch ABS plastic mesh, with external cage dimensions of 30 by 14 by 15 inches. These cages were each filled with 500 Corbicula and anchored in pairs at the selected sites. Sample cages were to be visited at 1, 2, 4, 8 and 16 week intervals, samples of Corbicula collected from the cages, and Se levels assayed. Clams were not depurated prior to transplantation as we lacked the facilities to do so. Staff also felt depuration was not necessary because our study goal was to measure changes in Se from a starting value when clams were collected for transplantation, rather than to make interpretations based upon the absolute levels of Se in clam tissue. Depuration is usually undertaken to minimize the amount of organic/inorganic material ingested by each clam which might contribute to variations in contaminant levels. However, even considering possible variations that may have been due to gut contents, significant changes were still observed (See Results section). Gut contents are also a very minor proportion of the dissected tissue mass in Corbicula fluminea.

LABORATORY METHODS

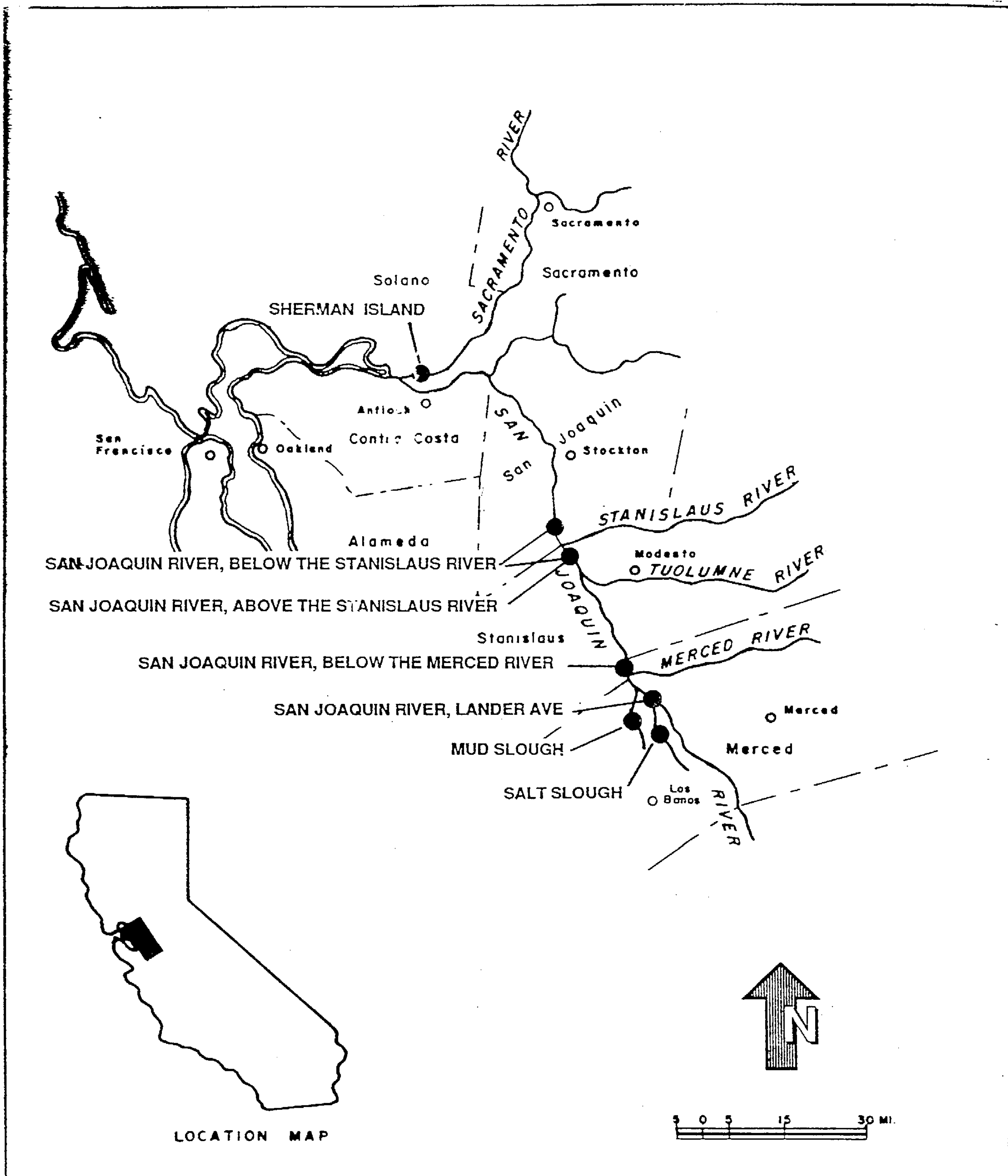
Fish and Clam Collection and Processing

Laboratory methods and quality control efforts for fish and aquatic invertebrate tissue samples were as described in Chapters III and IV.

Analytical Techniques for Water, Particulates, Plankton, and Sediments and Quality Control for Selenium in Water

A magnesium nitrate dry ash digestion followed by HGAA (White, et al. 1989, Appendix C) was used to analyze for Se in water. This dry ash technique had a detection limit (1.0 ug/kg) with little background interference and produced consistent results.

All sediment, filter residue, and plankton samples were collected in clean plastic bottles and frozen at the time of collection. The samples remained frozen until analyzed.



SELENIUM VERIFICATION STUDY: CORBICULA TRANSPLANTATION SITES - 1989 - 1990

Because no standard method was available, a method of analysis for Se in sediment was developed at the WPCL based on methods developed by May (1982) and used for all sediment samples as described in White, et al., (1989, Appendix C). EPA-approved methods have been developed to analyze for Se in sediment but WPCL continues to use their own method which they are in the process of validating. The results of the sediment analyses performed at WPCL are reported as acid hydrolyzable Se and on a dry weight basis.

The preweighed filters were dried at 80°C and reweighed to determine the weight of the residue retained on the filter. Filters with their residue were then analyzed using the sediment procedure.

Plankton samples were thawed and strained with a clean plankton net to separate solids from excess water. The moist solid sample retained on the net was subsampled for Se and moisture. The plankton samples were digested and analyzed using the sediment procedure.

Selenium in Resident Corbicula and Selenium Accumulation by Transplanted Corbicula

Laboratory methods for determining Se concentrations in Corbicula were those described in Chapter III.

Interlaboratory Quality Control SJVDP Round Robin

During 1988 and 1989 WPCL participated in an interlaboratory round robin study sponsored by the San Joaquin Valley Drainage Program (SJVDP). The results of WPCL analyses as well as the mean of all participating laboratories are reported in Table IV-1.

STATISTICAL METHODS

Statistical methods were the same as used in Chapter III.

RESULTS AND DISCUSSION

Ten sites were selected in 1988-89 to represent influence from Se in agricultural drainwater on westside and lower San Joaquin River waterways (Figure IV-1 and IV-2). In 1989-90, twelve sites were selected in order to include a site in the Sacramento River drainage and two dead-end sloughs (Figure IV-3 and IV-4). Camp 13 Ditch and Agatha Canal are used to transport irrigation water and to remove agricultural drainage in the south Grasslands area. The San Joaquin River at Lander Avenue (State Highway 165) is upstream from Mud and Salt sloughs which are the primary San Joaquin River tributaries used in recent years as conduits for Se enriched subsurface agricultural drainage water from irrigated agriculture in portions of the western San Joaquin Valley. At sites downstream from the Merced River and the Stanislaus River, the effects of agricultural drainage on water quality and the biota are

Table IV-1. Results of WPCL and Participating Laboratories in the San Joaquin Valley Drainage Program Round Robin.

Sample	Mean Value Participating Laboratories	WPCL Value
SJVDP 2891 (Vegetation)	2.23 ug/g	2.4 ug/g
SJVDP 2892 (Vegetation)	18.89 ug/g	23.0 ug/g
SJVDP 2895 (Water)	5.61 ug/liter	5.4 ug/liter
SJVDP 2896 (Water)	98.68 ug/liter	100.0 ug/liter
SJVDP 7891 (Water)	0.14 ug/liter	<1.0 ug/liter
SJVDP 7892 (Water)	97[illegible]92 ug/liter	100.0 ug/liter
SJVDP 7893 (Vegetation)	2.639 ug/g	2.7 ug/kg
SJVDP 7894 (Vegetation)	20.204 ug/g	22.0 ug/g

influenced by dilution from first one, and then three east-side tributaries, and Se cycling among components of the riverine environment. In 1989-90, the site below the Merced River was moved upstream to measure the impacts of drainage water in the mainstem San Joaquin River prior to dilution from east-side tributaries. The station below the Stanislaus River was retained to measure the impacts of cumulative dilutionary flows from all three east-side tributaries (Merced, Toulumne, and Stanislaus rivers). During some sampling periods, fish sampling could not be completed at the station below the Stanislaus River so samples were collected from a downstream site adjacent to the upper end of Paradise Cut. It was assumed that this site was comparable to the site just below the Stanislaus River because of its close proximity and because there were no new major drainage or riverine influences in the reach between the two sites. Therefore, both sites were treated as equivalent locations for statistical analyses. The San Joaquin River at Dos Reis, Middle River, and Old River stations represent areas in the three main channels of the south Delta. Grant Line Canal collections were substituted for nearby Old River collections when no catfish were available at the latter site. Sandmound Slough was a central Delta dead-end slough, and Beaver Slough was a northeast Delta dead-end slough. When catfish were not available at Sandmound Slough they were substituted by collections from Bradford Island. Steamboat Slough is a side channel off the Sacramento River which carries water from that drainage. It begins and ends in the Sacramento River and was selected to represent Se levels in fauna from the Sacramento River which, in theory, would have Se levels lower than the San Joaquin River drainage.

Selenium Dissolved in Water

Se levels in filtered water from various locations in the lower San Joaquin River and selected tributaries in 1988-89 (Figure IV-6) decreased as sampling proceeded from agricultural drainage channels such as Camp 13 Ditch, to grasslands tributaries (Mud and Salt sloughs), to the mainstem San Joaquin River, and downstream below the influence of the three east-side tributary rivers. This was the same pattern observed in 1987-88 (White, et al., 1989) and Se levels were similar at most sites in both years. USFWS studies have also documented similar Se levels in water from the same general areas (USFWS 1990b). Continuous exposure to dissolved Se averaging 10 ppb or greater (similar values were observed at various times at Mud and Salt sloughs or Camp 13 Ditch) could be harmful to fish and cause serious contamination of the aquatic food chain (Eisler 1985, Lemly and Smith 1987). However, the levels accumulated in fish tissue, discussed later, do not appear to reflect the full influence of these high levels of dissolved Se. This could have occurred for a number of reasons: (1) the high Se levels observed in these tributaries to the upper San Joaquin River may occur intermittently and may not remain at these levels for any great length of time, (2) the ionic species or biochemical form of Se in these areas may not be readily bioavailable to food chain organisms, or (3) Se may interact with other compounds or water quality constituents so that it is less toxic or bioavailable to the fauna. For further comparison, Figure IV-7 displays the log of the Se concentrations in filtered water at the sampling sites.

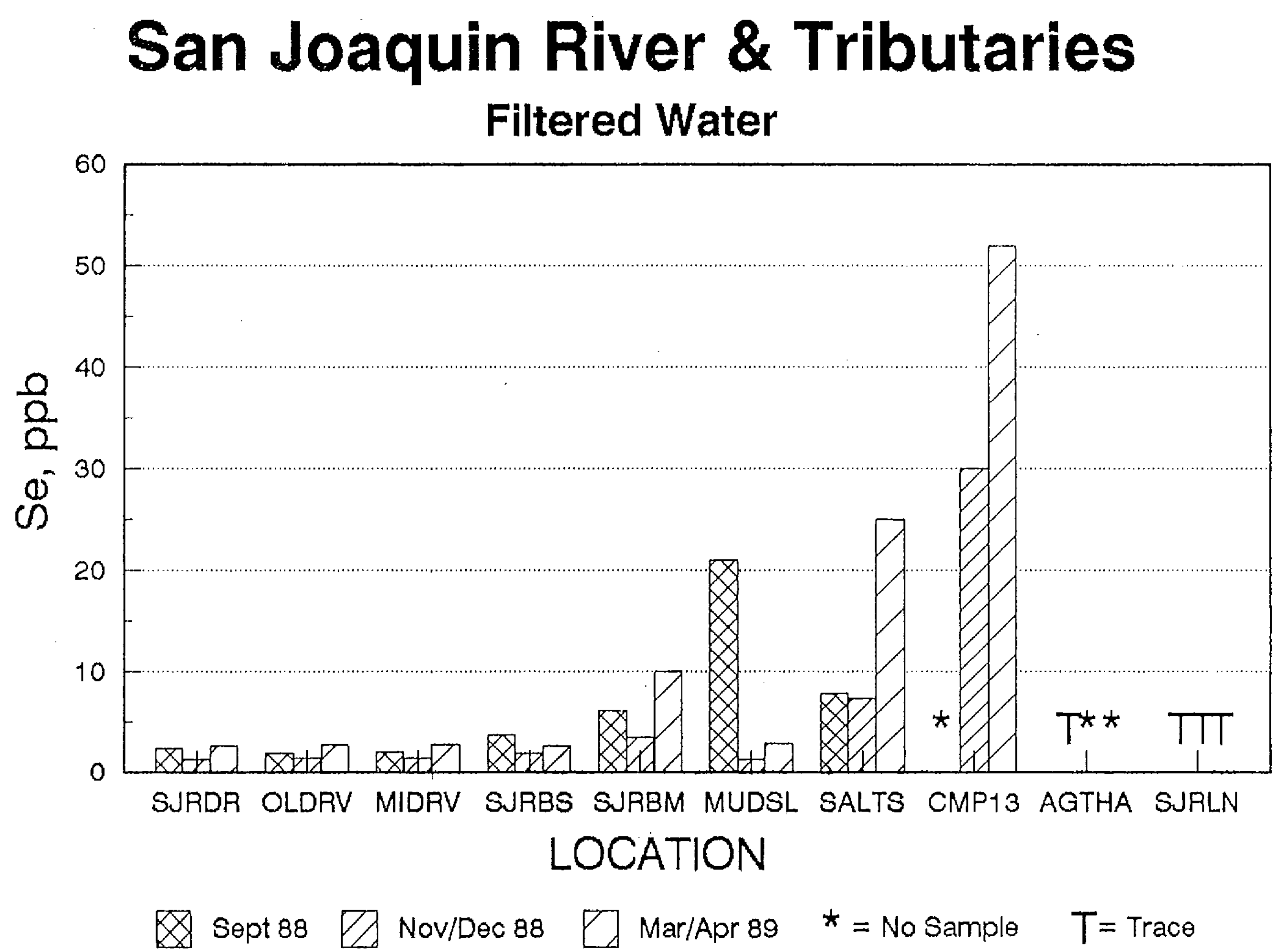


Figure IV-6. Levels of selenium in filtered water (ppb) collected from various sites in the lower San Joaquin River drainage.

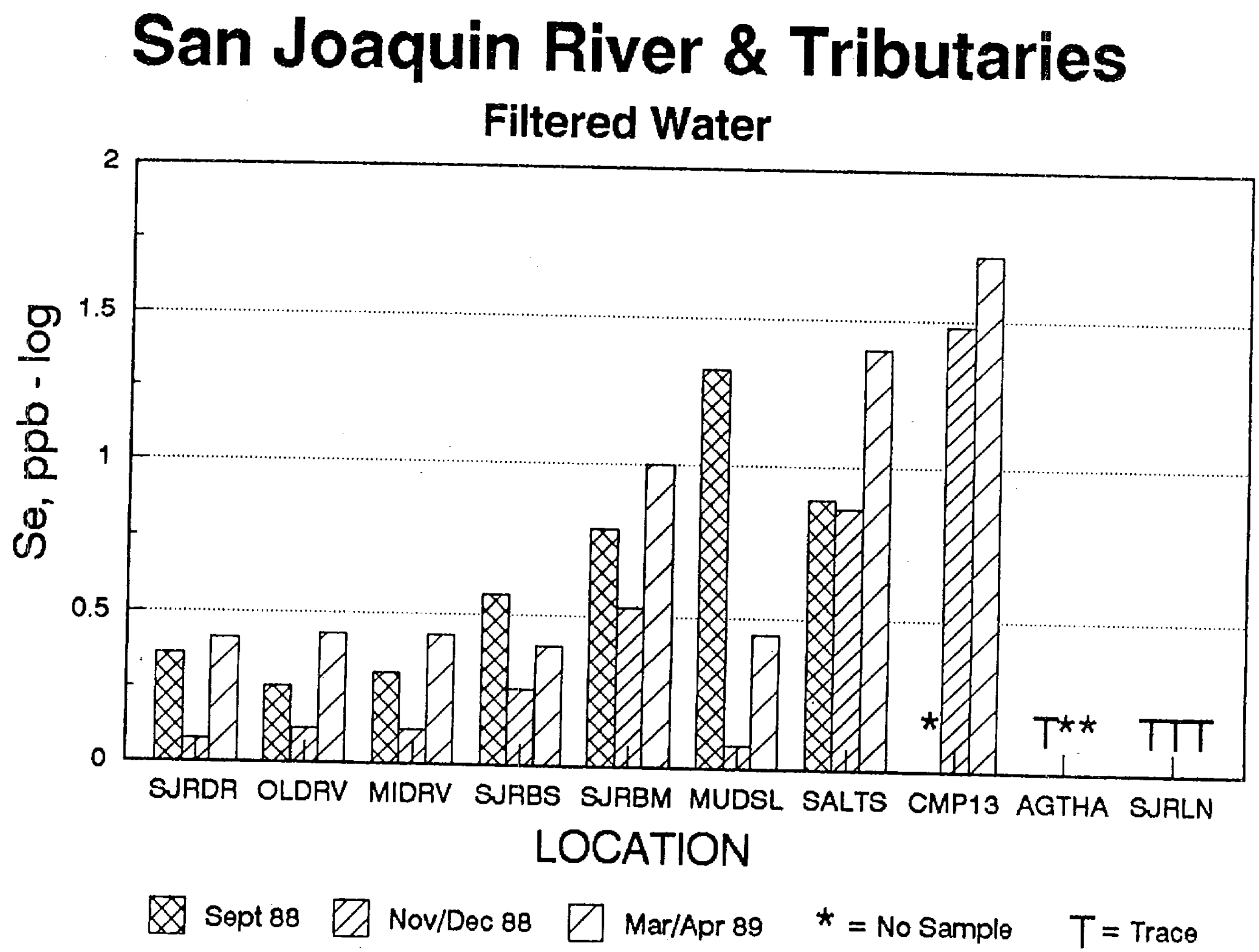


Figure IV-7. Levels of selenium in filtered water (ppb) collected from various sites in the lower San Joaquin River drainage, plotted on a $\log_{10}$ scale.

Suspended Particulate Selenium

Se levels in suspended particulate matter >45 um filtered from water samples showed a very weak trend of Se levels progressively decreasing downstream from Mud and Salt sloughs and Camp 13 Ditch (Figure IV-8). This trend was much weaker than that observed in 1987-88 (White, et al., 1989). Levels were similar to those measured in 1987-88 except for the peak value at Mud Slough in September 1988 which was more than twice as high as the highest value measured in 1987-88 and more than 3 times that measured at that site in November 1987.

Selenium in Plankton

Se levels in crude homogenates of plankton (particles >75 um) showed a distinct downstream decrease in concentrations, with the exception of the San Joaquin River at Dos Reis where levels were even slightly higher than those at the San Joaquin River below the Merced River Figure (IV-9). Concentrations of Se in plankton were higher (2 to 7 fold) in 1988-89 than were measured in 1987-88. Se levels at Camp 13 Ditch, Agatha Canal, Salt Slough, and Mud Slough were all high enough to be of concern for bioaccumulation and contamination of the food chain for the following reasons. Waterfowl can be negatively impacted when their food contains ≥3ppm dry weight Se; fish can be negatively impacted when values exceed 5 ppm dry weight (Lemly and Smith 1987). Plankton values at the aforementioned sites ranged from 1.4 to 5 ppm dry weight. These levels imply that secondary consumers, like aquatic insects, which are potential prey items for fish and waterfowl, may be accumulating toxic levels of Se from plankton during this time period. Plankton are also one of the primary sources for biofixation of Se in aquatic environments (USFWS 1990b) and responsible for the greatest degree of bioaccumulation in the food chain (White, et al., 1989). If plankton are fixing Se into an organic form such as selenomethionine, the levels oserved could already be toxic to fish since selenomethionine can be toxic in the range of 3-16 ppb dry weight (USFWS 1990b). Future studies should evaluate the proportions of selenate, selenite, and organic selenium compounds found in plankton and filtered water due to the widely differing toxicities of these forms of Se. If a major proportion of the total Se measured is organicallly fixed Se, such as selenomethionine, then the toxicity of water and plankton to aquatic resources will be on the order of ppb not ppm (USFWS 1990b).

Selenium in Sediment

Se levels in sediment (Figure IV-10) clearly show a decreasing trend as you move downstream in the San Joaquin River from the drainage ditches and tributaries of the Grasslands area. Levels in 1988-89 are similar to those observed in 1987-88.

Selenium levels in sediment, suspended particulates, plankton, and filtered water have all varied over time at each collection location, in some cases quite drastically. Based on Figure IV-8

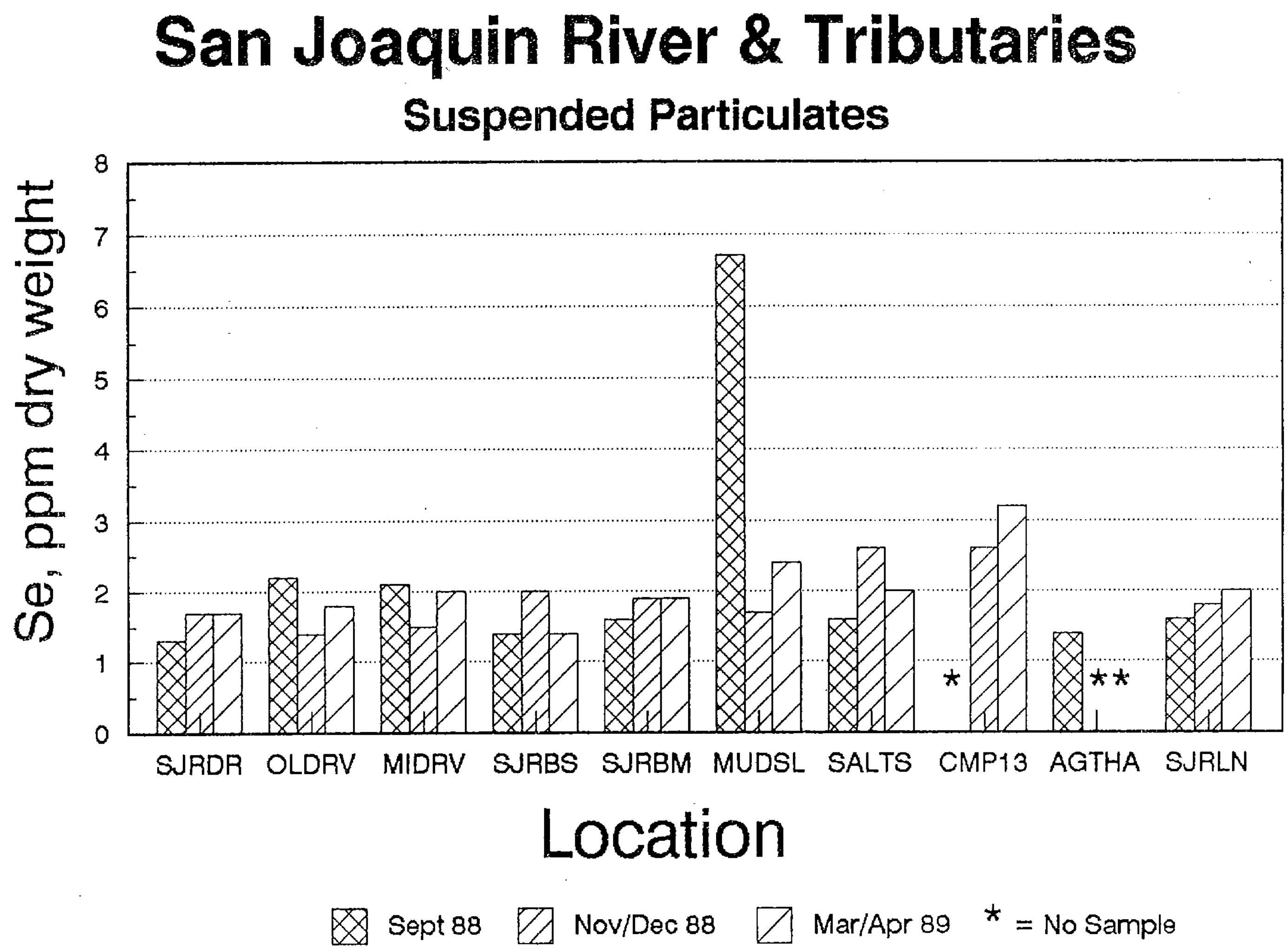


Figure IV-8. Levels of selenium in suspended particulate material (ppm dry wt.) collected from various sites in the lower San Joaquin River drainage.

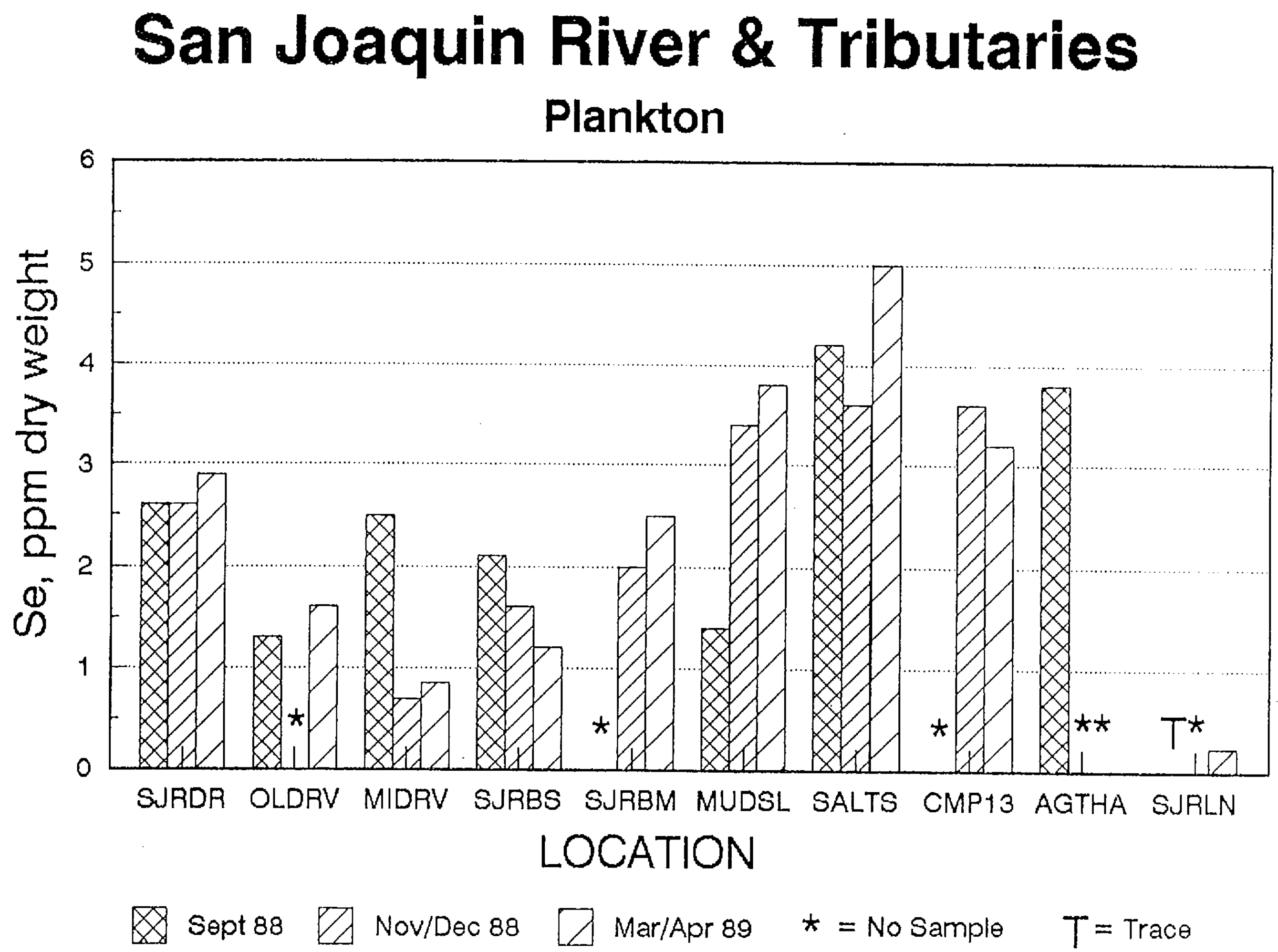


Figure IV-9. Levels of selenium in plankton (ppm dry wt.) collected from various sites in the lower San Joaquin River drainage.

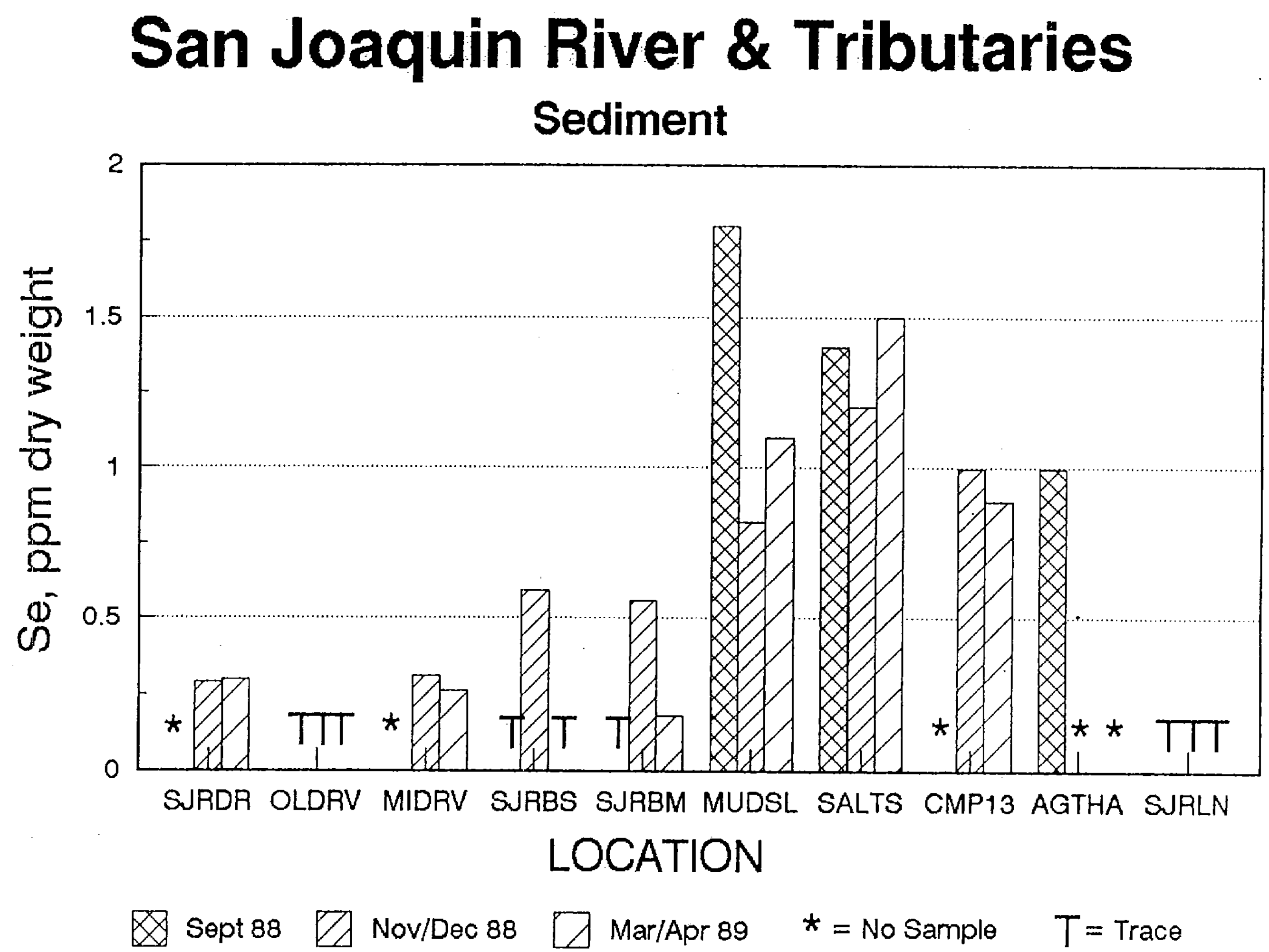


Figure IV-10. Levels of selenium in sediment (ppm dry wt.) collected from various sites in the lower San Joaquin River drainage.

1987-88 (White, et. al., 1989) and 1988-89 data there do not appear to be consistent seasonal trends, although spacial similarities are obvious. Se levels in all media with possible exception of sediments varied both spatially and temporally.

Selenium in Resident Corbicula

In both 1988-89 and 1989-90, Corbicula were collected, when available, from sampling sites in the San Joaquin River and Delta. However, in the winter of 1988-89 and the fall of 1989 clam dredge was marginally successful collecting Corbicula. Although dredges were very effective for collecting clams from the southern and western Delta, areas where Corbicula can be found in large beds, they were not effective in the San Joaquin River and its tributaries where clams were distributed more sparsely. Corbicula distribution in the river, was spotty and they occurred in very small beds in sandbars, along the base of and intermixed with rip-rap, or in association with irrigation water pumps or return pipes. In the spring of 1990 we ceased our clam dredges. Instead, field crews searched the shoreline in likely areas and collected Corbicula at most sites.

Where seasonal or inter-annual comparisons were possible (Table IV-2) no significant differences were detected. Significant differences between sites were observed in March and April 1990. Corbicula from Salt Slough had higher wet weight levels of Se than those from other sites. We were only able to collect one sample in August 1988 and one sample again in April 1990 at Mud Slough. However, the Se levels were quite similar to those from Salt Slough. Clams from the San Joaquin River below the Stanislaus River and from Old River had higher Se levels than those collected from Sandmound Slough in the Central Delta and the San Joaquin River at Lander Ave, the latter of which was above the input of Mud and Salt sloughs. Old River also had higher Se levels than Beaver Slough in the northeast Delta. The patterns of Se accumulation in resident clams from the San Joaquin River and Delta parallel those observed in water, suspended particulates, plankton and sediments as measured in both 1988-89 and 1987-88 (White, et. al., 1989). Curiously, clams from Steamboat Slough near the Sacramento River had higher levels of Se than clams from the San Joaquin River at Lander Ave. No data was collected to verify the source of Se at Steamboat Slough. It is highly unlikely, however, that Se from the San Joaquin River influences clams collected at the former site, because most of the annual flow into the Delta comes from the Sacramento River and water tends to flow from north to south across the Delta due to pumping at the large State and Federal water diversion projects in the southwest Delta. These circumstances make it difficult to decide on whether background levels of Se should be characterized as those found at San Joaquin River at Lander Ave. site or central and north Delta sites (SNDSL, BVRSL, STBSL). In any case, significant Se enrichment from grasslands drains extends at least as far downstream as Old River in the south Delta.
When evaluating Corbicula as a potential contaminated food source for catfish it is best to look at the dry weight Se values for digestible tissue, because the tissue is consumed by fish and is the source of Se, not the shell. Also, data on harmful dietary levels of Se are usually reported on a dry weight basis. With the exception of the San Joaquin River at Lander Ave.

Table IV-2 Selenium Concentrations in the Flesh of Freshwater Asiatic Clams (<u>Corbicula fluminea</u>) Collected from the San Joaquin River (SJR), the Delta and Selected Tributaries. Geometric Means and Ranges (ppm, wet wt.) Followed by Sample Sizes in Parenthesis.

SITE	DATE				
	August 19 88	Nov 1988	March 1989	Oct-Nov 1989	Mar-Apr 1990
SJRLN					0.23, 0.22-0.23 (2)
SALTS				0.69, 0.49-0.91 (2)	0.88, 0.77-1.1 (3)
Mud Slough	0.88 (1)				0.76 1/
SJR Below Stanislaus River				0.46, 0.42-0.49 (3)	
SJR at Dos Reis		0.50, (1)	0.68, 0.63-0.75 (3)		
Middle River		0.52, 0.48-0.56 (3)	0.59, 0.58-0.60 (2)		
Old River		0.53, 0.51-0.58 (3)	0.58, 0.58 (3)		0.56, 0.0.55-0.58 (3)
Sandmound Slough					0.29, 0.26-0.32 (3)
Beaver Slough					0.34, 0.34-0.35 (3)
Steamboat Slough				0.20. (1)	0.40, 0.40-0.41 (3)

1/ Values for freshwater muscles collected from Mud slough but not found elsewhere.

where dry weight Se values were 1.3 ppm, most sites had averaged around 3 ppm to 4 ppm. However, Salt Slough clams had an average dry weight Se level of 6.6 ppm. These last values approach levels which might be harmful to fish (5-15 ppm, USFWS 1990b), especially if they represent the levels in other invertebrate fauna such as aquatic insects. Few field or laboratory studies exist which clearly indicate the levels of Se in the food chain that are harmful to fish, but those that do exist indicate that levels $\geq$ 5 ppm dry weight are probably harmful (Lemly and Smith 1987).

Selenium in Catfish

White catfish and channel catfish were collected by electrofishing and with hoopnets from various locations in the San Joaquin River selected tributaries (Figures IV-1, IV-2, IV-3, and IV-4), and the Delta during Fall (August and September 1988), winter (November and December 1988) and spring (March and April 1989) of 1988-89 and an extended period representing late fall and winter of 1989-90 (October 1989 through January 1990). Both species were analyzed separately for Se but their individual values were averaged to get the mean value for each location and time point. Catfish were not a primary target species in 1989-90 and were only collected in the first half of 1989-90 because an adequate number of centrarchids could not be found.

Analysis of Se in liver tissue on a wet weight basis indicated that there were no significant differences between time periods (Table IV-3) in the Se concentrations found in catfish in the San Joaquin River at Lander Ave., Mud Slough, the San Joaquin River below the Merced River, and at Dos Reis. Se levels in catfish from Salt Slough and Middle River varied significantly (ANOVA, $p < 0.05$) but aposteriori tests could not discern specific group differences at $P < 0.01$. The same was true of the San Joaquin River below the Stanislaus River and at Paradise Cut. These two sites were lumped to evaluate differences over time since they represented conditions in geographically adjacent and presumably equivalent stretches of the San Joaquin River. At Old River, fall 1988 Se levels were greater than those of winter 1988 or spring 1989, however, winter 1988 values were not different from late fall and winter levels in 1989-90 of catfish collected from nearby Grant Line Canal.

Trends in muscle tissue showed even less variability over time (Table IV-4). The only significant differences were measured at Middle River where fall 1988 values were greater than either winter 1988 or spring 1989 collections at the same site.

In August and September of 1988 Se levels in catfish livers were greater at Agatha Canal than at all other sites except Middle River and Salt Slough. Se levels in catfish from Salt Slough were greater than levels from the San Joaquin River at Lander Ave and below the Merced River. They were not significantly different from the three south Delta sites.

Table IV-3. Selenium concentrations in the liver tissue of white and channel catfish from the San Joaquin River (SJR), the Delta, and selected tributaries. (geometric mean, sample size, and range; ppm wet weight)

Site:	Date			
	Aug-Sept, 1988	Nov-Dec, 1988	Mar-Apr, 1989	Oct,89/Jan,90
SJR[1/] at Lander Ave	1.41,3,1.41	1.02,2,0.97-1.2	1.31,3,0.99-1.8	0.70
Agatha Canal	3.59,51,3.1-3.9	-	-	-
Camp 13 Ditch	-	-	3.90,2,3.90	-
Salt Slough	2.94,3,2.4-3.5	1.65,3,1.3-2.1	2.06,3,2.0-2.1	2.66,3,2.1-
2.6 Mud Slough	2.29	2.19	1.70,2,1.6-1.8	1.99,2,1.4-2.7
SJR above the Merced R.	-	-	-	2.41,3,2.1-2.6
SJR " " "	1.69,3,1.5-1.9	.23,3,0.20-0.26	0.23,3,0.13-0.30	-
SJR " " Stanis.R.	2.35,3,2.3-2.4	1.43,4,0.99-2.0	-	1.73,3,1.2-2.1
SJR at Paradise Cut	-	-	1.77,3,1.6-2.0	-
SJR at Dos Reis	2.42,3,2.3-2.6	1.83,4,1.3-2.1	1.90,3,1.8-2.0	-
Middle R.	2.74,3,2.6-2.8	1.60,2,1.4-1.8	1.68,2,1.6-1.7	-
Old R.	2.63,3,2.5-2.8	1.86,4,1.5-2.1	1.67,4,1.4-1.9	1.51
Grant Line Canal	-	-	-	1.40,2,1.2-1.6
Bradford Island	-	-	-	1.37,3,1.3-1.4
Beaver Slough	-	-	-	0.76,5,0.68-0.97

1/ SJR = San Joaquin River

Table IV-4. Selenium concentrations in the muscle tissue of white and channel catfish from the San Joaquin River (SJR), the Delta, and selected tributaries. (geometric mean, sample size, and range; ppm wet weight)

Site:	Date			
	Aug-Sept, 1988	Nov-Dec, 1988	Mar-Apr, 1989	Oct,89/Jan,90
SJR at Lander Ave	0.16,3,0.08-0.21	0.13,2,0.11-0.16	0.19,3,0.14-0.30	0.16
Agatha Canal	1.43,24,0.99-2.1	-	-	-
Camp 13 Ditch	-	-	0.50,2,0.17-0.92	-
Salt Slough	0.40,3,0.30-0.52	0.32,3,0.25-0.40	0.35,3,0.28-0.42	0.38,3,0.36-0.40
Mud Slough	0.30	0.43	0.25,2,0.09-0.42	0.45,2,0.36-0.54
SJR above the Merced R.	-	-	-	0.29,2,0.28-0.30
SJR below " "	0.25,3,0.16-0.30	0.23,3,0.20-0.26	0.23,3,0.13-0.30	-
SJR " " Stanis.R.	0.21,3,0.21	0.20,5,0.16-0.26	-	0.21,2,0.19-0.23
SJR at Paradise Cut	-	-	0.26,3,0.25-0.27	-
SJR at Dos Reis	0.20,3,0.19-0.21	0.20,4,0.17-0.21	0.18,3,0.17-0.19	-
Middle R.	0.30,3,0.28-0.31	0.20,2,0.19-0.21	0.19,2,0.19-0.20	-
Old R.	0.21,3,0.20-0.21	0.19,4,0.15-0.22	0.19,4,0.15-0.25	0.14
Grant Line Canal	-	-	-	0.21,2,0.19-0.23
Bradford Island	-	-	-	0.14,3,0.13-0.15
Beaver Slough	-	-	-	0.10,5,0.07-0.12

Catfish from the San Joaquin River at Lander Ave and below the Merced River had the lowest Se levels of all sites during this period, with the exception that the site below the Merced River was not different from the site below the Stanislaus River. No significant differences were measured in liver levels between sites in November and December 1988. In March and April 1989, catfish from Camp 13 Ditch had higher levels of Se than all other locations, the rest of which were not significantly different from each other. In October 1989 through January 1990 collections, catfish from both Salt and Mud Sloughs and the San Joaquin River sites above the Delta (SJRAM, SJRBS) had greater Se levels than catfish collected from Beaver Slough. There were no other significant between-site differences during late fall and winter of 1989-90.

Trends in muscle tissue Se levels showed similar, but not identical, trends between locations during each time period. In August and September 1988, muscle tissue levels of Se were highest in catfish from Agatha Canal, but not significantly different at the rest of the sites. In November and December 1988, catfish from Salt Slough had higher muscle Se levels than those collected from the San Joaquin River at Lander Ave. and Old River. All other sites were not significantly different from each other in winter 1988. Although there were significant differences among locations in liver selenium levels during the spring of 1989, no such differences were detectable in muscle tissue. In late fall/winter 1989-90, catfish from Mud Slough had significantly higher muscle selenium levels than those at any other station downstream from them. Catfish from Salt Slough had higher levels than those from any site beginning with the San Joaquin River below the Stanislaus and continuing downstream. Muscle Se levels in catfish from the San Joaquin River above the Merced River were greater than those from Bradford Island or Beaver Slough. Lastly, levels in catfish from the San Joaquin River below the Stanislaus River were higher than those from Beaver Slough in the northeast Delta. All other comparisons between sites during each time period, and between time periods at each site which were not mentioned above, were not significantly different.

Selenium in Bass

Largemouth and smallmouth bass were collected incidentally at some sites in 1988-89. They were one of the two target centrarchid species in 1989-90. Bass were collected using electrofishing. There were no significant differences between collection periods at any location, in either muscle or liver tissue Se levels (Tables IV-5 and IV-6). There was no difference in liver values between locations. Muscle selenium levels in Bass during this period were greater at the San Joaquin River above the Merced River and at Old River than at any of the three central or north Delta sites (SNDSL, BVRSL, STMSL). Bass collected from the San Joaquin River below the Stanislaus River had higher muscle Se levels than bass from Beaver or Sandmound Sloughs. During March and April of 1990, liver Se levels of bass were greater at the San Joaquin River below the Stanislaus and Old River than they were at Beaver Slough. Muscle Se levels in bass, for the same period, were higher at the same two sites than at any other location. Any comparisons between time periods at each

Table IV-5 Selenium concentrations in the tissue of largemouth and smallmouth bass collected from the San Joaquin River (SJR), the Delta, and selected tributaries. Geometric means and ranges; (ppm wt wt), followed by sample sizes in parenthesis.

SITE	DATE Sept-Oct 1988	Nov-Dec 1988	Mar-May 1989	Oct-Dec 1989	Mar-Apr 1990
SJRLN				0.36-0.30-0.43 (2)	0.22, 0.20-0.25 (2)
SALTS		0.93 (1)	0.51, 0.45-0.55 (2)	1.60 (1)	
SJR above Merced River				0.51, 0.46-0.60 (3)	0.40, (1)
SJR below Stanislaus River				0.45, 0.40-0.54 (3)	0.55, 0.54-0.57 (3)
SJR at Paradise Cut		0.38, 0.28-0.63 (4)	0.72, 0.54-0.92 (2)		
SJR at Dos Reis	0.60 (1)	0.48, 0.35-0.62 (3)	0.49, 0.43-0.54 (3)		
Middle River	0.59 (1)		0.54, 0.43-0.67 (2)		
Old River	0.60 (1)	0.41, 0.35-0.48 (2)	0.47, 0.42-0.51 (3)	0.60, 0.15-0.68 (3)	0.50, 0.46-0.54(2)
Sandmound Slough				0.21, 0.19-0.26 (3)	0.23, 0.20-0.28 (3)
Beaver Slough				0.16, 0.14-0.20 (3)	0.19, 0.19-2.0 (3)
Steamboat Slough				0.25, 0.25-0.27 (3)	0.23, 0.21-0.25 (3)

Table IV-6 Selenium concentrations in the liver tissue of largemouth and smallmouth bass collected from the San Joaquin River (SJR), the Delta, and selected tributaries. Geometric means and ranges; (ppm wt wt), followed by sample sizes in parenthesis.

SITE	DATE				
	Sept-Oct 1988	Nov-Dec 1988	Mar-May 1989	Oct-Dec 1989	Mar-Apr 1990
SJRLN				0.72, 0.77-0.80 (2)	0.64 0.55-0.73 (2)
SALTS		2.1 (1)	0.93, 1.6-2.3	2.8 (1)	
SJR above Merced River				1.4, 1.1-1.20 (3)	1.6 (1)
SJR below Stanislaus River				1.2, 0.92-1.5 (3)	1.4, 1.1-1.6 (3)
SJR at Paradise Cut	1.2, 0.55-1.9 (4)		1.5, 1.2-1.8 (2)		
SJR at Dos Reis	1.60 (1)	1.1. 0.77-1.3 (3)	1.5 (3)		
Middle River	2.0 (1)		1.6, 1.4-1.8 (2)		
Old River	1.3 (1)	1.2, 0.99-1.4 (2)	1.1, 0.99-1.2 (3)	1.1, 0.99-1.2 (3)	1.4, 1.1-1.8 (2)
Sandmound Slough				0.68 0.58-0.77 (3)	0.73 0.63-0.84 (3)
Baver Slough				0.69, 0.48-0.86 (3)	0.65, 0.62-0.67 (3)
Steamboat Slough				0.63, 0.48-0.86 (3)	0.78, 0.73-0.82 (3)

site or between sites at each time period not previously mentioned, were not significantly different. Thus, while there do not appear to be seasonal changes in Se levels of largemouth and smallmouth bass tissues, there are consistent differences between locations which parallel differences in catfish. In short, bass from upstream sites tend to have greater Se levels than those downstream. Significant elevations in Se levels of bass tissues occur as far downstream as Old River. Se levels in livers of largemouth and smallmouth bass tended to be lower than those of white and channel catfish collected from the same site, during the same time period (Table IV-6 vs. IV-3). However, the muscle Se levels found in bass tended to be greater than those of catfish (Table IV-5 vs. IV-4).

Selenium in Bluegill

Bluegill were collected incidentally at some sites in 1988-89. They also were one of two target centrachid species in 1989-90. Bluegill were collected using electrofishing in Fall 1988 (Sept-Oct), winter 1988 (Nov-Dec), spring 1989 (Mar-May), late fall/winter 1989 (Oct-Dec), and Spring 1990 (Mar-Apr).

There were few differences between collection periods at most sites (Tables IV-7 and IV-8). Se levels in muscle tissue of bluegill collected at Beaver Slough were greater in Spring 1990 than in late fall/winter 1989, but liver Se levels did not differ significantly. Liver Se levels were greater in Spring 1989 bluegill from the San Joaquin River at Paradise Cut than in Winter 1988 bluegill from the same location, however, muscle Se levels were not significantly different between these two time periods at this site. Both muscle and liver Se levels were greater in bluegill collected during the late fall/winter period of 1989 in the San Joaquin River below the Stanislaus River than at the nearby Paradise Cut site in winter of 1988.

No significant differences between locations was detected for fall 1988. Winter 1988 muscle Se levels were higher in the San Joaquin River at Paradise Cut and Dos Reis than they were upstream from ag-drainage input at Lander Ave. Not enough liver samples were collected to make similar comparisons and the two consecutive San Joaquin River sites at Paradise Cut and Dos Reis weren't significantly different. In Spring 1989, muscle Se levels were higher in bluegill muscle from Salt Slough than those from the San Joaquin River at Paradise Cut. During the late fall/winter of 1989, muscle and liver Se levels of bluegill collected at the San Joaquin River above the Merced and below the Stanislaus were greater than those collected from Sandmound or Beaver Sloughs. Muscle levels at the two former sites were also greater than levels observed at Steamboat Slough. Se levels in bluegill muscle from the San Joaquin River above the Merced during this time period were also greater than levels at Old River. Old River levels were greater than those measured at Sandmound or Beaver Sloughs, but liver levels didn't differ significantly. Both muscle and liver Se levels were greater in bluegill from Old River and the San Joaquin River below the Stanislaus River in spring 1990 than at the San Joaquin River at Lander Ave. and Beaver or Sandmound Sloughs during the same period. All other comparisons between time periods at each site and between sites during each time period were not significantly different.

Table IV-7. Selenium concentrations in the liver tissue of bluegill sunfish collected from the San Joaquin River (SJR), the Delta, and selected tributaries (geometric mean, and range; (ppm wet wt.) followed by sample size in parenthesis.

SITE	DATE				
	Sep-Oct 1988	Nov-Dec 1988	Apr-May 1989	Oct-Dec 1989	Mar-Apr 1990
SJRLN		0.88 (1)		0.53 (1)	0.67, 0.58-0.77 (3)
SALTS			2.7 (1)		
Mud Slough					
SJR above Merced River				2.3, 1.8-2.8 (2)	2.2 (1)
SJR Below Stanislaus River				1.9, 1.6-2.2 (4)	1.7, 1.4-1.9 (3)
SJR at Paradise Cut		1.4, 1.3-1.6 (6)	1.8, 1.6-1.9 (3)		
SJR at Dos Reis	1.8, 1.5-2.2 (3)	1.5, 1.2-1.9 (2)	1.9 (1)		
Middle River	1.8, 1.6-1.9 (2)		2.1 (1)		
Old River	1.9, 1.5-2.4 (3)	2.0 (1)	2.3, 1.9-2.6 (3)	1.4, 1.3-1.6 (2)	2.0, 1.9-2.0 (3)
Sandmound Slough				0.83, 0.72-0.90 (3)	0.71, 0.63-0.77 (3)
Beaver Slough				0.65, 0.49-0.73 (3)	0.88, 0.82-0.92 (3)
Steamboat Slough				1.1, 0.99-1.3 (3)	0.97 (1)

1/ See Appendix A for sample locations and code definitions as appropriate

Table IV-8 Selenium concentrations in the muscle tissue of bluegill sunfish collected from the San Joaquin River (SJR), the Delta, and selected tributaries. Geometric means and range; (ppm, wet wt.) followed by sample sizes in parenthesis.

SITE	DATE Sep-Oct 1988	Nov-Dec 1988	Mar-May 1989	Oct-Dec 1989	Mar-Apr 1990
SJRLN		0.31, 0.26-0.35 (3)		0.18 (1)	0.21,0.20-0.23 (3)
SALTS			1.29, 1.1-1.5 (2)		
SJR above Merced River				1.0, 0.86-1.2 (2)	0.93 (1)
SJR Below Stanislaus River				0.72, 0.68-0.75 (4)	0.67, 0.58-0.72 (3)
SJR at Paradise Cut		0.56, 0.52-0.60 (6)	0.59, 0.54-0.67 (3)		
SJR at Dos Reis	0.57, 0.54-0.60 (3)	0.60, 0.55-0.65 (2)	0.50(1)		
Middle River	0.68, 0.63-0.73 (2)		0.69 (1)		
Old River	0.60, 0.55-0.67 (3)	0.67 (1)	0.77, 0.67-0.86 (3)	0.60, 0.54-0.72 (3)	0.69, 0.65-0.77 (3)
Sandmound Slough				0.21, 0.17-0.25 (3)	0.20, 0.19-0.22 (3)
Beaver Slough				0.17, 0.15-0.17 (3)	0.21, 0.20-0.22 (3)
Steamboat Slough				0.39, 0.31-0.48 (2)	0.34 (1)

Selenium levels in bluegill livers (Table IV-7) tended to be slightly higher than those of largemouth bass collected from the same sites at the same time (Table IV-6) but were generally still less than catfish liver levels (Table IV-3). However, as was true for the largemouth and smallmouth bass, bluegill muscle tissue Se levels tended to be higher than those seen in catfish (Table IV-8 vs. IV-4). Bluegill also often had slightly higher levels than bass from the same location and collection period (Table IV-8 vs. IV-5).

Selenium Accumulation by Transplanted Corbicula

Corbicula were collected near the northern shore of Sherman Island in the Sacramento River (Figure IV-5). These organisms, which had a mean of 0.54 ppm Se in their tissues, were transplanted to six locations in the San Joaquin River, where they accumulated Se up to a mean of 1.15 ppm (Figure IV-11). Significant differences between sites occurred the first week after transplantation, although most sites were not significantly different from their starting Se values until the eight-week sampling period (Figure IV-11).

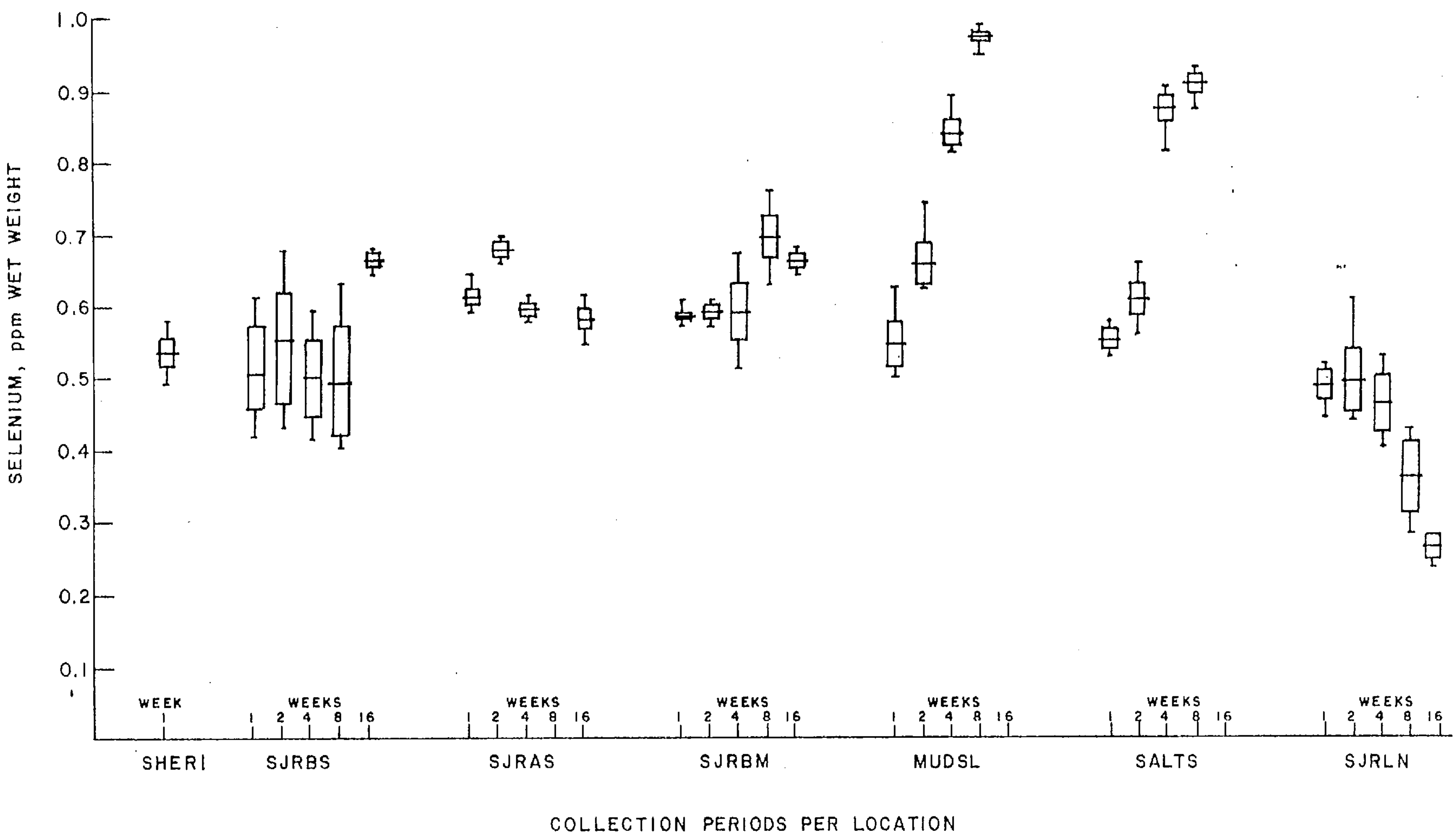
By the end of the first week after transplantation, Corbicula planted in the San Joaquin River above the Stanislaus River (SJRAS) had levels higher than those from the San Joaquin River below the Stanislaus River (SJRBS) (Figure IV-11, 0.62 vs 0.52 ppm respectively). The differences in the Se levels between the two sites were probably influenced by dilution from the Stanislaus River. Corbicula from the San Joaquin River at Lander Avenue (SJRLN) had Se levels (0.49 ppm) significantly lower than clams at SJRAS or the San Joaquin River below the Merced River (SJRBM) (0.59 ppm). However, none of these sites yet had values significantly different from the levels measured at Sherman Island, prior to transplantation.

By the two week collection period SJRAS had Se levels (0.68 ppm) significantly higher than the starting values two weeks earlier at Sherman Island (0.54 ppm). Clams in Mud Slough had levels (0.66 ppm) greater than those measured at SJRBS (0.54 ppm) or SJRLN (0.50 ppm) and Salt Slough also had levels (0.62 ppm) higher than those at SJRLN, but neither location had levels significantly greater than when they were transplanted.

At four weeks, clams from both Mud and Salt sloughs had Se levels (0.85 and 0.88 ppm, respectively) that were higher than the initial levels measured at Sherman Island. Those levels were also higher than at any of the other stations, although they were not significantly different from each other, however. The Se level in clams from SJRLN dropped to 0.47 ppm, which was significantly less than levels from all other sites except SJRBS, although this was not a significant difference from the starting value. Levels in clams from SJRAS dropped from 0.68 ppm to 0.60 ppm within a two week intervening period and were no longer significantly different from levels at SJRBS or from initial collections at Sherman Island.

By the eight-week collection, clams from SJRLN had depurated enough Se that their levels (0.37 ppm) were now less than clams from any other station and significantly lower than

FIGURE IV-11 Trends in the selenium levels of the tissue of <u>Corbicula Fluminea</u> collected from Sherman Island and transplanted to various San Joaquin River and tributary sites over a one to sixteen week period in 1990.



their starting levels. The clams from SJRBM accumulated enough Se (0.70 ppm) to have significantly more in their tissues than clams form SJRAS or SJRBS, and than when they were collected from Sherman Island. The other significant differences described for the four-week collection period remained in effect for the eight-week collection.

By the final sixteen-week collection, both the SJRBM (0.67 ppm) and Mud Slough (1.15 ppm) stations had Se levels higher than their starting values or any site downstream from them. Clams from the SJRLN site had undergone significant depuration of Se levels to half of what they had been when they were transplanted four months earlier. Their levels were now also significantly less than clams from any other transplantation site. Clams from SJRBS and SJRAS also appear to have accumulated levels of Se greater than when they were first transplanted ($0.05 < p < 0.10$). Transplantation cages in Salt Slough were buried under a foot of sediment before 16 week sample collections and were not recovered until flows receded a month later. Thus we have no 16 week collections from this site.

Levels of Se observed in transplanted clams at Mud and Salt sloughs from the first through eighth week of collection were similar to levels in bivalves collected locally (Table IV-2). However, levels in transplanted clams collected in the sixteenth week exceeded levels in locally collected clams (Figure IV-11 vs. Table IV-2). Levels in transplanted clams from SJRBS were similar to clams collected locally (Figure IV-11 vs Table IV-2). Clams transplanted to SJRLN depurated Se until, by the sixteenth week, they had levels similar to clams collected locally (Fig IV-11 vs Table IV-2).

Clams in Mud and Salt sloughs had accumulated significantly higher levels of Se by the four week collection and this accumulation did not appear to be levelling off during the sixteen-week period. The less contaminated sites at SJRBM and SJRLN took eight weeks to show differences from starting values. The last two stations (SJRAS and SJRBS) appeared to be on the verge of showing differences by the sixteenth week. The significant reductions over time in the Se levels of Corbicula at SJRLN are noteworthy and imply that perhaps Corbicula at SJRLN was losing Se due to reduced health or Se enrichment from an unidentified source is occurring at the Sherman Island site. We expected that the clams from Sherman Island would represent background levels and did not expect that Se levels in transplanted clams would decrease at any site. The mortality rates in the transplantation cages were higher than expected based on preliminary test transplants in the San Joaquin River near Airport Way (between SJRAS and SJRBM) where we had less than 3% total mortality three weeks after transplantation. At SJRLN, SJRAS, and SJRBS mortality rates were consistent throughout most of the sampling period (Table IV-9). At upstream sites (SJRBM and Salt Slough) mortalities were drastically higher in the fourth or eighth week, however, Mud Slough had the greatest mortalities in the first two weeks. It is not known whether the clams grew and gained weight during the study, or lost weight over the same period. However, when they were dissected for Se assays the clams did not appear emaciated in comparison to clams collected from the field. Growth data is needed to verify the effect of Se on clam health. The levels of Se in clam may have been affected by the clams health.

Table IV-9. Mortality of transplanted Corbicula fluminea at various transplantation sites in the lower San Joaquin River drainage during experiments conducted between May 15th and September 4th, 1990. Value listed is the average absolute % mortality for the two cages at each location over the intervening period between sampling, which varied from one to eight weeks. The value in parenthesis is the % mortality divided by the intervening time period to produce a mortality rate in %/week.

Site:	Week[1/]: 1	2	4	8	16
SJR[2/] at Lander Ave.	6% (6)	7% (7)	5% (2.5)	13% (6.5)	58%[4/] (7.3)
Salt Slough	3% (3)	8% (8)	9% (4.5)	57%[3/](14.3)	--
Mud Slough	13% (13)	30% (30)	9% (4.5)	15% (7.5)	35%[5/] (4.4)
SJR below the Merced R.	6% (6)	2% (2)	30% (15)	36% (9)	12%[5/] (1.5)
SJR above the Stanislaus R.	2% (2)	3% (3)	10% (5)	21% (5.3)	18% (2.3)
SJR below the Stanislaus R.	1% (1)	1% (1)	5% (2.5)	16% (4)	14%[3/] (1.8)

1/ Weeks since initial transplantation, at which time live clams were removed for Se analysis and dead clams were counted and removed.

2/ SJR = San Joaquin River

3/ Value is for one cage only the other was buried and not recovered for a few months, no further samples were taken from this location.

4/ The first of two cages was removed four weeks after the 8 week sampling period and had 47.2% mortality at that time. The value shown is for the remaining cage at 16 weeks, and represents mortality over the intervening eight week period.

5/ Value is for one remaining cage the other was removed at week 8.

Summary

Trends in the Se levels of water, plankton, sediment, resident and transplanted Corbicula, largemouth and smallmouth bass, white and channel catfish, and bluegill from San Joaquin River sampling sites parallelled each other to a great degree. In any of the three sampling periods, Se levels, regardless of which media they were measured in, tended to decrease as you progress downstream in the San Joaquin River. Dilution by the three east-side tributaries (Merced, Tuolumne, and Stanislaus Rivers), settling out of particulate matter containing Se, and biofixation of Se into various components of the riverine ecosystem and biota contributed to the trend. Se is found as far downstream as Old River, Middle River, and the San Joaquin River at Dos Reis, and levels in the Delta often exceed those measured in the San Joaquin River at Lander Ave which is upstream from the input of agricultural drainage water from the grasslands. Interestingly, fauna from Steamboat Slough off of the Sacramento River did not have the lowest Se levels as expected, rather fauna from two deadend sloughs, Sandmound Slough and Beaver Slough, tended to have the lowest Se levels of any collection site. This suggests that Se is not being selectively concentrated in these backwater areas of the Delta. However, in Beaver Slough most of the fish collected came from the lower half of the slough, closest to the influence of the South Fork of the Mokelumne River. The upper reaches of Beaver Slough contained a sparse fish fauna probably due to periodic high temperatures and anoxia that can occur in the uppermost reaches of the eastern Delta's dead-end sloughs. Hence, it is still possible that the uppermost reaches of dead-end sloughs could be accumulating Se, however, sampling did not adequately cover these areas. Data from the lower reaches of the slough do not imply that we should be concerned about Se levels further up the slough. Considering the four sites with the lowest Se levels in all fauna (SJRLN, SNDSL, BVRSL, STMSL), background levels of Se in fish muscle tend to be less than 0.3 ppm wet weight and levels in liver tend to be less than 1 ppm wet weight. Levels of Se in the flesh of the five gamefish species collected do not appear to be approaching levels which would be of concern for human consumption ($\sim$2 ppm wet weight, State Department of Health Services "interim internal guidance level") at any location.

Some quantitative studies exist (USFWS 1990b) to help evaluate whether tissue Se levels observed in fish tissue from the upper reaches of the San Joaquin River and various Grasslands tributaries are high enough to have a chronic effect on these species. Based on comparisons to the available tissue residue data (see Lemly and Smith 1987 and Eisler 1985), these levels do not appear to be high enough to cause chronic or acute impacts. However, other studies by USFWS researchers (USFWS 1990b and Saiki, et al., 1990) have measured higher levels in fish from Grasslands tributaries and suggest that sensitive centrarchid species may be excluded from these areas due to the effects of elevated Se levels on their reproduction. The levels observed in filtered water starting with the San Joaquin River below the Merced River and upstream through Mud and Salt Slough in 1988-89 and 1987-88 are high enough to be of concern ($\geq$ 2-5 ppb, Lemly and Smith 1987), as well as levels observed in crude homogenates of plankton collected from Mud and Salt Sloughs in 1988-89

($\geq$ 5-15 ppm dry weight, USFWS 1990b). Perhaps these high levels of Se at the base of the food chain are not reflected in the tissues of the local fish species because the fish collected are not year-round residents of these areas. If levels like those observed in filtered water from Mud and Salt sloughs occurred for long periods of time there could be chronic and acute impacts to the fish fauna (Lemly and Smith 1987). These data might be different in normal or wet years. SVS measurements reflect a sustained drought condition; hence, sampling over a longer period of time is recommended.

CHAPTER V
SUBSURFACE AGRICULTURAL DRAINAGE WATER EVAPORATION PONDS

INTRODUCTION

Subsurface agricultural drainage water ponded for storage and evaporation at sites in the San Joaquin Valley continues to provide some of the only vestiges of wetland habitat in an otherwise arid region. As such, these evaporation basins continue to attract numerous species of waterfowl and shorebirds.

SVS efforts in 1988 through 1990 focused on collecting the additional data required to develop strategies for regulating evaporation basins and protecting waterfowl and shorebirds from contaminant exposure.

Diving ducks and dabbling ducks were collected at selected evaporation ponds in the Tulare Basin to determine if Se concentrations were comparable to those of birds collected by other researchers in wildlife areas near evaporation ponds (D. Barnum, USFWS).

Initial sampling for Se in biota from evaporation ponds has been followed by various investigations of water quality, community structure and contaminant levels of aquatic invertebrates, bird use patterns and food habits, bird condition, and reproductive success of birds breeding at these sites (Saiki and Lowe 1987, Ohlendorf, et al., 1987, Westcot, et al., 1988, Hothem and Ohlendorf 1989). Studies of a more general nature have been conducted at a large number of pond systems. More intensive studies such as an assessment of reproductive success have been conducted at 17 systems (J. Skorupa, unpublished data). Participants have included research units of the U.S. Fish and Wildlife Service (USFWS); the Department of Water Resources; the Central Valley Regional Board; University of California Davis, Riverside, and Los Angeles; and California State University, Fresno.

Initial results of studies by the USFWS disclosed embryo toxicity and adverse impacts on wildlife populations at several pond systems in the Tulare Lake Basin. For instance, at ten of 17 sites evaluated by the USFWS, significant adverse effects were noted including reduced egg hatchability, reproductive failure and deformities (J. Skorupa, unpublished data). SVS studies in 1988-89 and 1989-90 were designed to complement information collected by the USFWS by posing the following questions:

1988-89 Study - Do adult shorebirds nesting on evaporation pond systems accumulate significant concentrations of Se between the time they arrive and the time they leave?

1989-90 Study - Do juvenile shorebirds reared on evaporation ponds accumulate high levels of Se? Earlier studies by the USFWS showed that although embryotoxicity and teratogenesis were noted in shorebirds at several pond systems, some eggs hatched.

Substantial invertebrate sampling was also conducted in order to assess the value of a single invertebrate "indicator" species and determine suitable sample sizes for accurate Se monitoring, particularly as that monitoring related to potential intra-cell differences. Data collected during this study component will enhance the knowledge of fish and wildlife managers so that effective supportable management decisions regarding evaporation ponds may be made and the results of these decisions monitored effectively.

FIELD METHODS

Aquatic Invertebrates

Evaporation pond invertebrates were collected with bottom aquatic kick nets (Wildco Model No. 425-A50, Turtox design 73-422) with .8 x .9 mm mesh size polyester netting. The collected invertebrates were transferred to sealable polyethylene bags using either disposable polyethylene gloves or clean plastic (Tefzel) forceps. The sealed sample was then inserted into a second sealable polyethylene bag along with a field data label. The sample was recorded on a field data sheet showing the sample number, date, specific location, species, and collector(s). Immediately after being bagged, the sample was frozen on dry ice and kept frozen at -12°C until it was delivered to the WPCL.

Special care was excercised to insure all collecting equipment and sample handling gear was kept clean. To prevent contamination, petroleum products (gas, oil, grease) were never allowed to contact the sampling equipment and invertebrates were not touched with bare hands. Metal forceps and metal pans could be possible sources of selenium contamination and, therefore, were not used.

Diving and Dabbling Ducks

Field collection techniques for ducks followed those described for diving ducks in Chapter II. SVS crews focused on sampling ruddy ducks (Oxyura jamaicensis), northern shovelers (Anas clypeata), northern pintail (Anas acuta), green-winged teal (Anas crecca), mallard (Anas platyrhynchos), and American wigeon (Anas americana) during this study phase. Samples were obtained from four pond sampling sites (Figure V-1) (Meyer's Ranch, Tulare Lake Drainage District North (TLDDN), Tulare Lake Drainage District South (TLDDS), Westfarmers) and Kern National Wildlife Refuge (KNWR). Many of the samples were from collections made by D. Barnum of the USFWS which DFG analyzed on a cooperative basis.

Shorebirds

Field collection techniques also followed those described for diving ducks in Chapter II. Collection sites were the same as for waterfowl. SVS field crews focused on collecting black-necked stilts (Himantopus mexicanus).

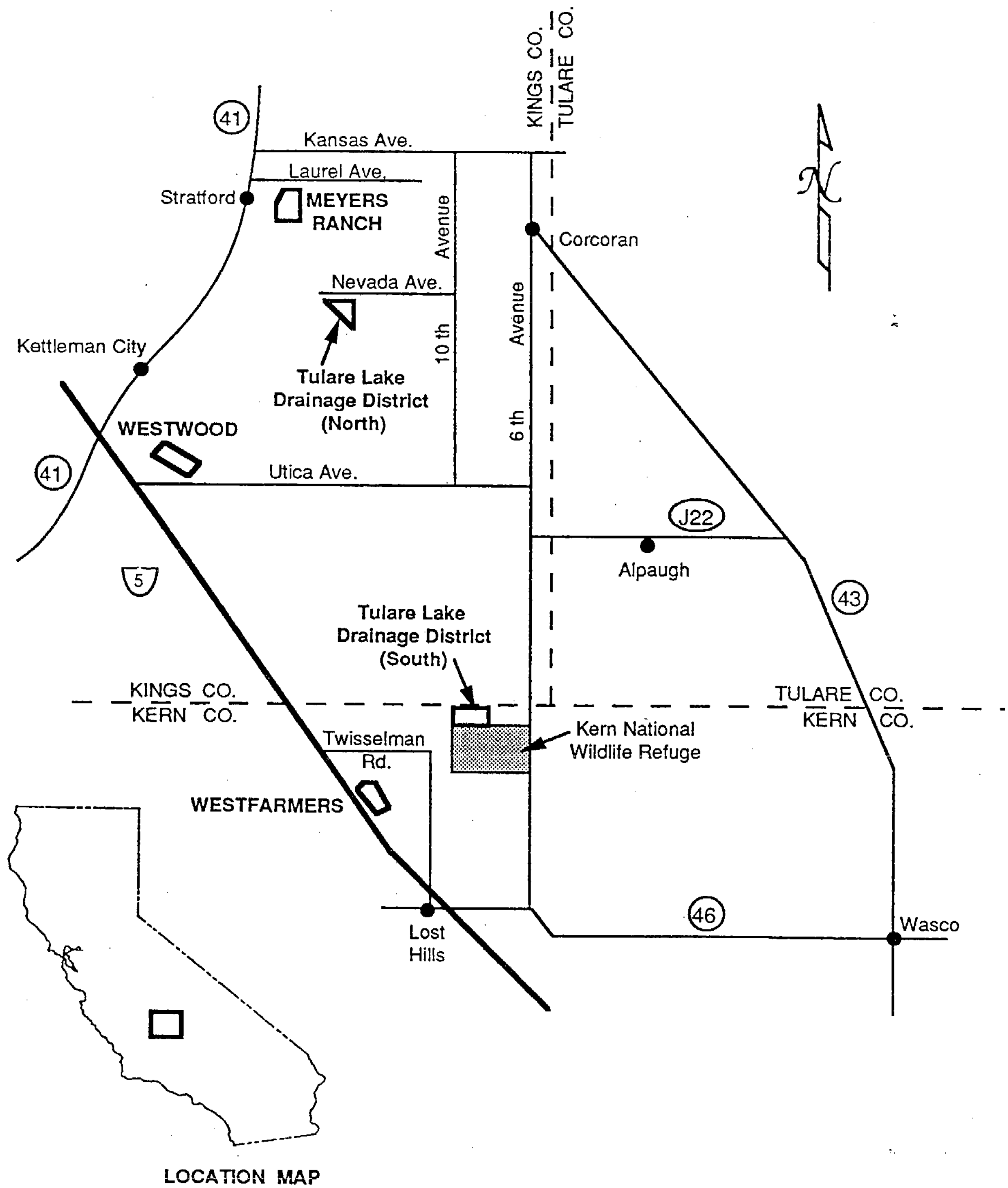


FIGURE V-1 Selenium Verification Study- Agricultural Drainwater Evaporation Pond Sampling Sites, 1988-89 and 1989-90

LABORATORY METHODS

Laboratory methods were the same as described previously in Chapters II, III and IV.

STATISTICAL METHODS

Statistical methods were the same as those described in Chapter II. Methods used to conduct the power analysis in this chapter followed Zar (1984) Chapter 8.6, Equations 8.8 and 8.9. The tests were performed to estimate: (1) the minimum detectable difference which could be measured at a significance level of 0.05 with a 90% probability of detecting a difference if one exists and (2) the sample size needed to detect a difference of 0.5 ppm or 1.0 ppm dry weight if one were to take a new sample from a population with the same variance as the sample. Unlike other computations and statistical analyses in this report, dry weights were used for this analyses since regulatory standards promulgated by the DFG and the USFWS to evaluate contaminant hazards to migratory birds are based on the dry weight concentration of Se in aquatic invertebrates. Analyses were also performed in this specific case, on untransformed data, since the samples we collected did not contain any major outliers and sample distributions were not skewed. Results using $\log_e$ transformed data should not, therefore, have been appreciably different.

RESULTS AND DISCUSSION

Aquatic Invertebrates

In 1988-89, differences in the Se levels measured in different species from the same site, and in the same species between cells in an individual pond complex were evaluated. The sample size necessary to accurately measure the Se levels in various aquatic invertebrate species was also evaluated in the spring of 1989. In 1989-90, the intra-cell variability in aquatic invertebrates from Westfarmers evaporation ponds was evaluated. This was a site where Joe Skorupa (USFWS researcher) found significant variability in the teratogenesis and hatching rates of black-necked stilts among adjacent sampling areas. Differences even occurred between two sides of the same levee or between two segments of the same stretch of shoreline.

During the 1988-89 studies at various sites (Table V-1), significant differences between species collected from the same evaporation pond cell and the same species from different cells of the same pond complexes were observed. At Westfarmers adult brineflies along the shoreline had higher Se levels than pupae in an adjacent pond. Adult brineflies also had higher Se levels than waterboatmen from the same site. At Tulare Lake Drainage District - North (TLDDN) waterboatmen from Cells 3B and 5B contained more Se than those from Cell 7. At Westlake Farms waterboatmen from Cells 1 and 2 had higher levels of Se than those from Cell 5. At Tulare Lake Drainage District - South (TLDDS) in May 1989 Table

Table V-1 Selenium trends in aquatic invertebrates collected from evaporation pond complexes in the southern San Joaquin Valley in February through May 1989. Values are geometric mean and range (ppm wet weight), with sample size in parenthesis.

Site	Cell #	Brinefly Adults	Brinefly Pupae	Water Boatman	Daphnia
TLDDS	5			4.4, 1.4-11 (2)	
3/89	6			1.7, 1.7-1.8 (2)	
TLDDS	2			1.2, 1.1-1.3 (3)	
5/89	6			2.9, 2.8-3.2 (3)	
	9			1.7, 1.5-2.0 (30)	
TLDDN	2B				0.13, 0.10-0.15 (10)
5/89	3A			0.37, 0.36-0.38 (2)	
	5B			0.36, 0.35-0.36 (2)	0.18, 0.17-0.19 (3)
	7			0.16, 1.13-0.17 (13)	
WLAKE	1			1.5, 1.4-1.7 (3)	
5/89	2			1.7, 1.6-1.8 (2)	
	5			0.75, 0.62-0.88 (13)	
WFRMR 3/89	3C	8.4, 6.3-10.0 (9)	3.8, 3.3-4.3 (26)		
4/89	3C	7.9, 5.9-9.1 (4)			
5/89	2	6.8, 4.9-7.8 (20)	3.6, 3.4-3.8 (3)		

waterboatmen from Cell 6 had more Se than Cells 2 or 9, and samples from Cell 9 had more than those in Cell 2. In March 1989, sample sizes of waterboatmen were too small to detect significant differences at TLDDS ponds but the two mean values appear to be different.

Table V-2 presents the results of power tests (Zar 1984) for differences from the mean which was computed for all of the larger samples ($N \geq 9$). Table V-2 shows that the samples collected could be used to detect significant differences between means as fine as 0.08 ppm dry weight to as crudely as 7.19 ppm dry weight. If the goal of regulation is to be able to detect a difference of 0.5 ppm dry weight from a regulatory criterion expressed in ppm dry weight then, depending on sample variability, the number of samples needed vary between 3 to as many as 1,842. If detecting a difference of 1 ppm dry weight is enough, it will take between 2 to 471 samples. Notice that the coefficients of variation are relatively similar among samples (Table V-2), and that larger sample sizes were necessary to detect the same absolute difference between means for samples with larger mean values. Given these observations, the average coefficient of variation for all the "mega-samples" (0.0856) was calculated and the size of the sample needed to detect a difference of 0.5 or 1.0 ppm dry weight in a sample with a mean of 5 ppm dry weight and an average level of variation around the mean was estimated. Since DFG requires that ponds be hazed when the Se levels in aquatic invertebrates exceed 4 ppm dry weight adequate sample sizes should be known. Determining significant differences at these concentration levels near 4 ppm would probably take a sample size of ten or more to detect a 0.5 ppm difference, and to detect a 1.0 ppm difference would take a sample of five or more (see Table V-2). A sampling protocol could be considered to reduce analysis costs. For instance, five to ten samples would be collected and properly stored. Initially three of the samples would be randomly selected and analyzed for Se. If necessary, the remaining samples would be analyzed either together or one at a time until sample variance was low enough to determine a significant difference from the 4 ppm regulatory standard.

In 1989-90 the intracell variations in Se levels of adult waterboatmen, brineflies, brineshrimp, and damselflies were evaluated at Westfarmers Evaporation Pond Basin owned by the Lost Hills Water District. Significant variation in all species was observed in excess of the ± 0.1 ppm accuracy of our analytical methodology. Waterboatmen had higher levels of Se at sites 1 and 6 than at sites 3, 4, and 5 (Figure V-2). Site 7 had levels greater than site 3 or 4, and sites 8 and 2 were greater than site 4. In cell 2 (Figure V-2), Se levels in waterboatmen were greater at site 10 than at 4, 9, 5, or 7. Sites 2 and 11 had higher levels than sites 4, 9, or 5, and sites 3, 1, 6 and 7 were greater than at site 4. Two comparisons were possible for waterboatmen between adjacent sites in adjacent cells. There was no significant difference between Cell 1 - Site 1 and Cell 2 - Site 1, but Se levels at Cell 1 - Site 2 were less than those at Cell 2 - Site 11.

When Se levels were measured in brineshrimp, Cell 3B - Site 1 was less than Cell 3A - Site 4, adjacent to it in the next pond (Figure V-3). In Cell 3A brineshrimp at Site 1 had higher levels of Se than those from Sites 3 or 4.

Table V-2 Power Analyses of large replicate samples of aquatic invertebrates collected from evaporation pond complexes in the southern San Joaquin Valley.

Species	Date	Site	Cell #	N	$\bar{x}$[1]	CV[2]	Detectable[3] Difference	N for Δ 0.5[4]	N for Δ 1.0[5]
Waterboatmen	5/89	TLDDS	9	30	11.9	0.06	0.44	24	8
		TLDDN	7	13	1.12	0.07	0.08	3	2
		WLAKE	5	13	5.9	0.09	0.53	15	6
Daphnia	5/89	TLDDN	2B	10	2.17	0.14	0.03	6	4
Brinefly Adults	3/89	WFRMR	3C	9	45.2	0.08	4.35	525	133
	4/89	WFRMR	3C	17	36.2	0.04	1.16	82	23
	5/89	WFRMR	2	20	53.3	0.07	2.69	700	471
Brinefly Pupae	3/89	WFRMR	3C	26	24.7	0.06	0.94	86	23
Brineshrimp	3/89	WFRMR	2	11	42.6	0.16	7.19	1842	462

1/ Arithmetic mean ppm dry weight

2/ Coefficient of variation = standard deviation/x (Based on untransformed data)

3/ The minimum difference between means detectable with this sample given its variance

4/ Minimum sample size needed to detect a difference of 0.5 ppm dry weight.

5/ Minimum sample size needed to detect a difference of 1.0 ppm dry weight.

FIGURE V-2 WESTFARMERS EVAPORATION POND BASIN [1], AVERAGE SELENIUM LEVELS IN WATERBOATMEN IN ppm WET WEIGHT

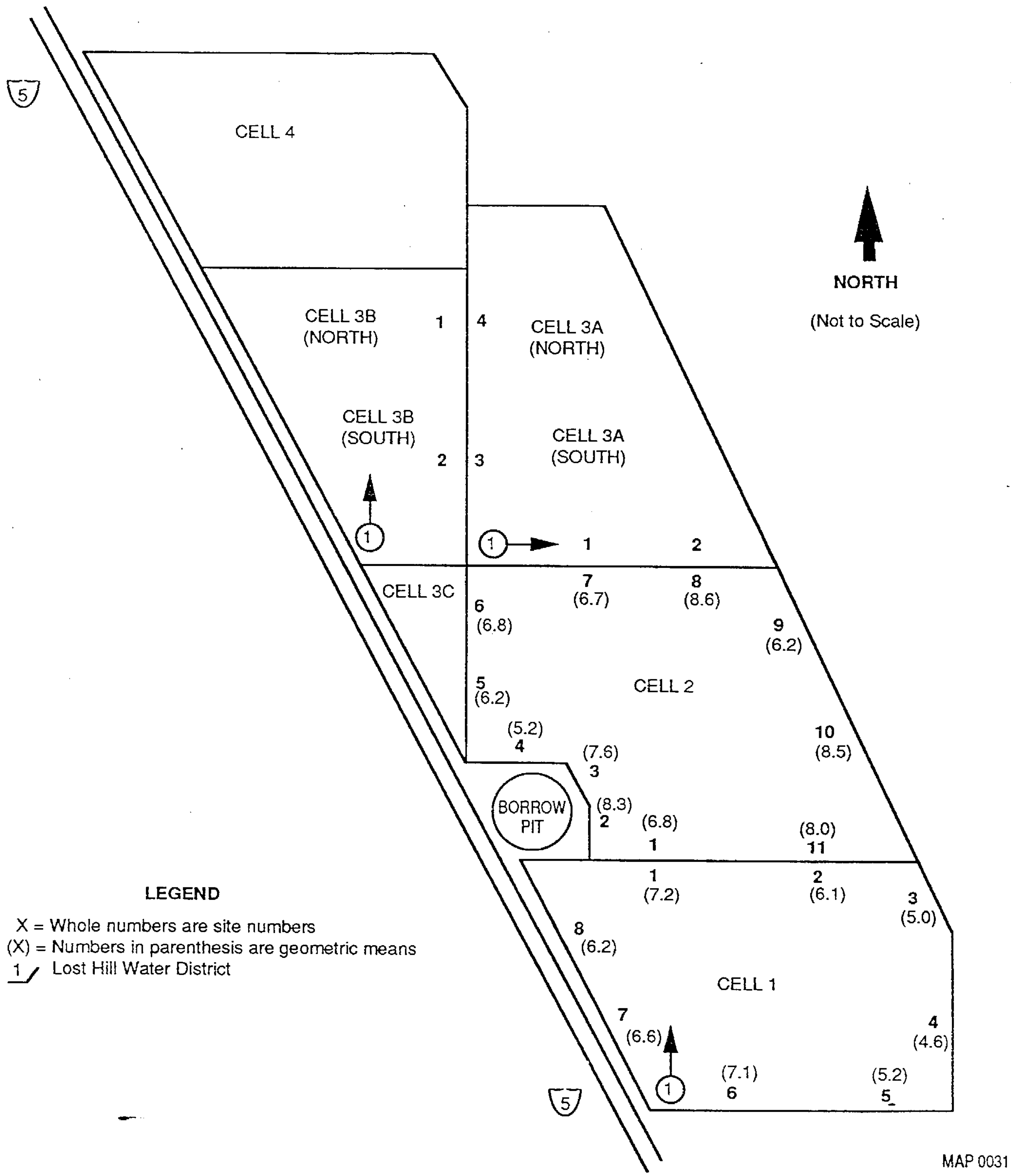
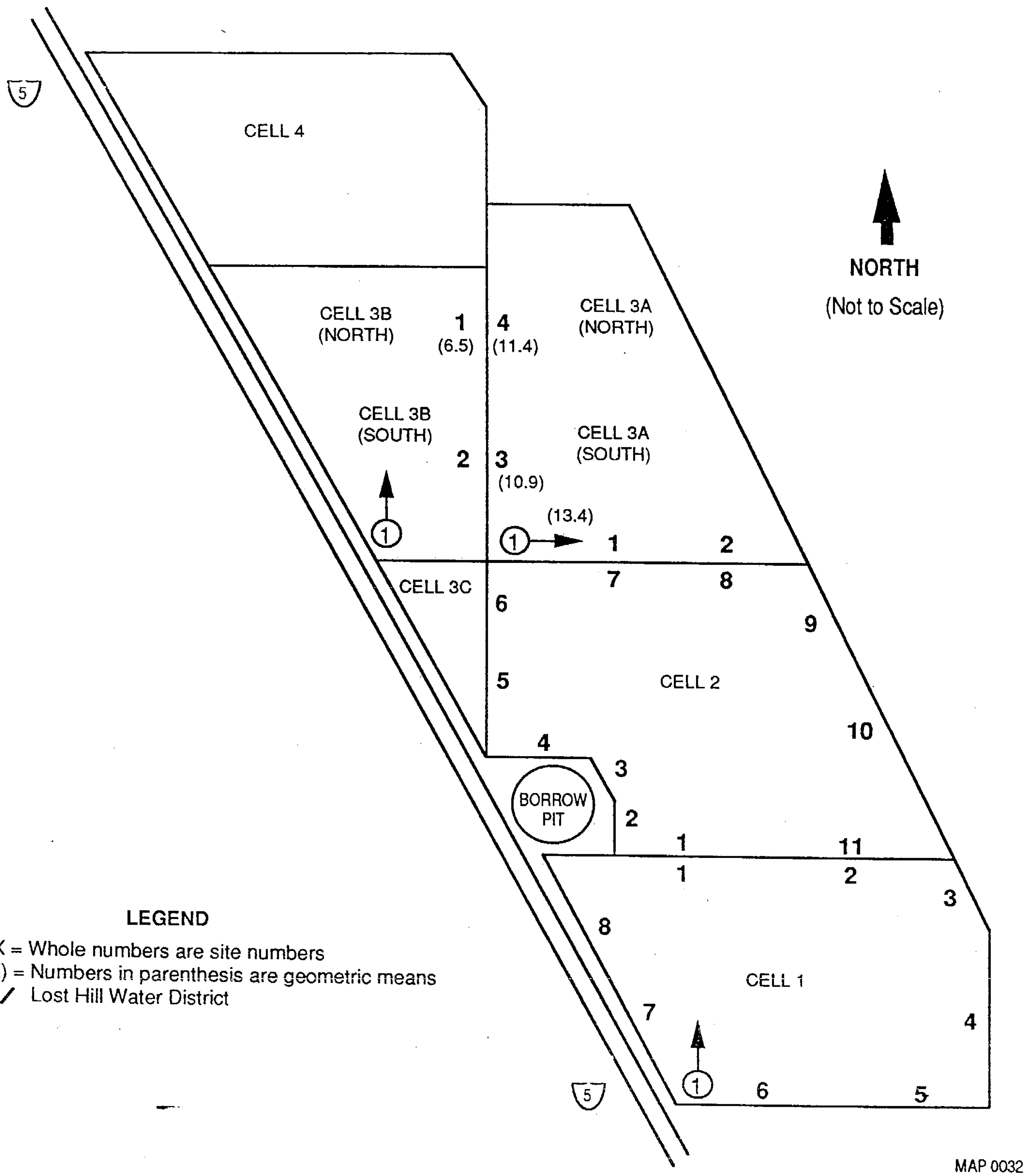


FIGURE V-3 WESTFARMERS EVAPORATION POND BASIN 1/, AVERAGE SELENIUM LEVELS IN BRINESHRIMP IN ppm WET WEIGHT



LEGEND

X = Whole numbers are site numbers
(X) = Numbers in parenthesis are geometric means
1/ Lost Hill Water District

Brineflies collected from Cell 1 had higher levels of Se at Sites 4, 6, and 7 than at Site 3 (Figure V-4). In Cell 2, brineflies from Sites 9, 10, and 11 had higher Se levels than those from 1, 3, 4, or 6 and Sites 3, 4, and 6 had levels greater than at Site 1. In Cell 3A, sites 1 and 2 were not significantly different.

Damselflies collected from Cell 1 (Figure V-5) had higher levels at Sites 3 and 4 than at Sites 5 and 6.

The results of the two years of aquatic invertebrate sampling lead to the following recommendations for improvements to the sampling procedures commonly used by regulatory agencies to evaluate the degree of contamination in the aquatic invertebrate fauna of evaporation pond complexes. Based on sampling results, the minimum sample size at any one location should be 5, with a sample size of 10 preferable to increase the likelihood that if significant differences from regularity standards exist they can be detected. Several additional recommendations were made to address observed differences. Sampling programs should either collect a composite sample of all aquatic species present at a site to represent the cumulative level of contamination in the fauna of that site or make separate collections of each available species. This needs to be done to ensure that single species collections don't lead to results which are unrepresentative of the range of contamination at a site, since there is significant variation between species. Collections should be made from at least two of the pond complex with preferably one collection from the first cell receiving initial concentrations of drainwater and one from a cell further on in the evaporative process which represents higher concentrations of agricultural-drainage water. Should available water quality data from a pond complex indicate that down-gradient cells do not contain the highest Se concentrations, those cells that are the most contaminated should be sampled. The higher of these values would be used for regulatory decision making. In addition, collections of aquatic insects should be made from the water column along at least four separate stretches of shoreline around a cell to adequately represent the range of intracell variability observed. Studies to date, do not yet indicate a recommended sampling frequency. All of the above recommendations will require an increase in sampling beyond that currently undertaken by any agency. The recommendations and any alternative strategies which result in an efficient and comprehensive accounting of potential Se contamination levels should be implemented. No estimate of the cost of this increased sampling effort has been made.

Diving Ducks

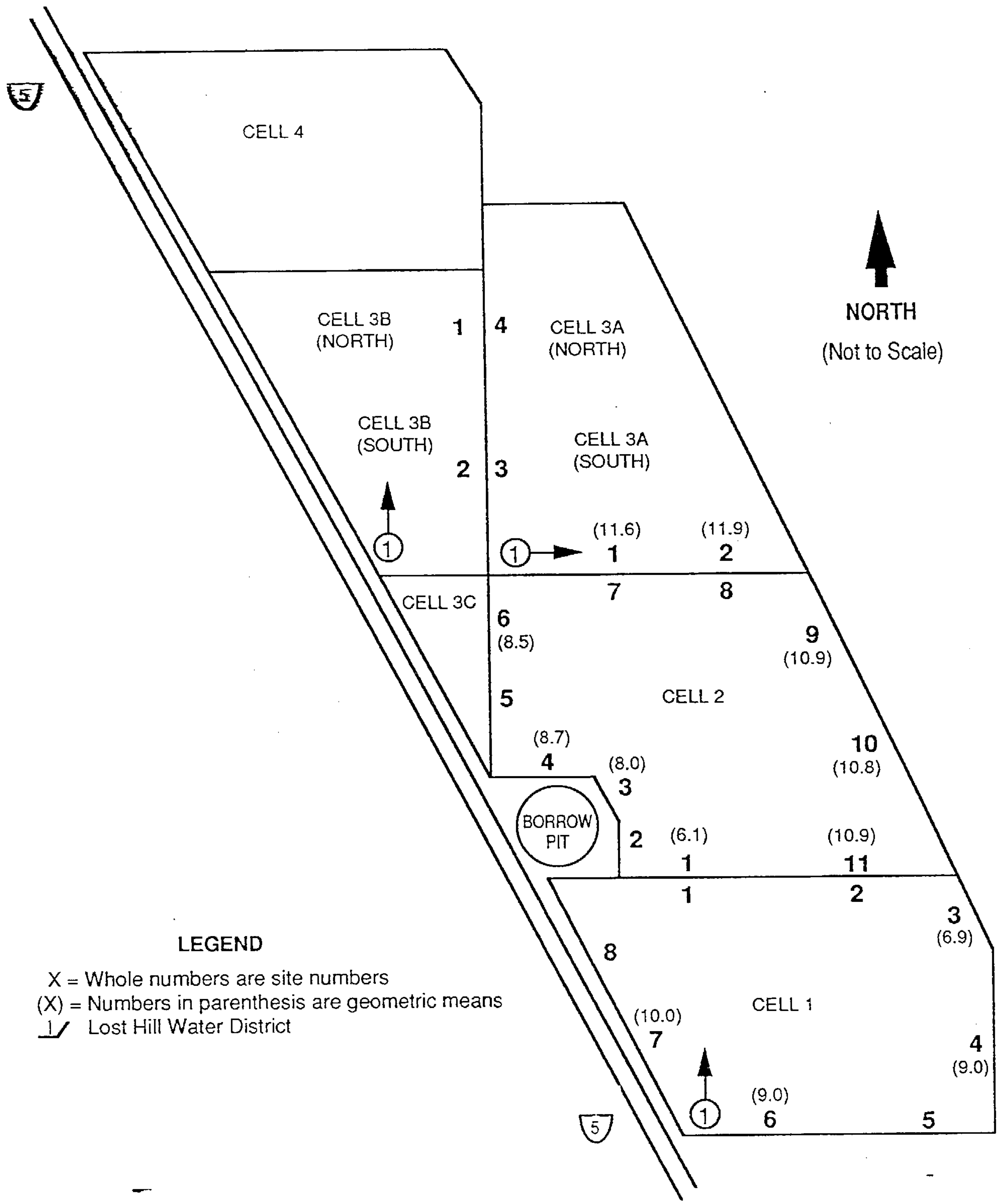
Ruddy Ducks

Twenty liver and 20 muscle samples were collected during the late winter of 1987-88 at the Westfarmers and Westlake Farms evaporation basins (Table V-3). Liver and muscle samples were obtained from nine ruddy ducks collected in the early winter of 1988-89 and from 40 ruddy ducks collected later during that same winter (Table V-3) These collections were made at the KNWR and TLDDN as well as the Westfarmers and Westlake Farms basins.

Table V-3. Ruddy ducks: Selenium concentrations in the tissues of birds collected from southern San Joaquin Valley agricultural drainage water evaporation pond basins and Kern National Wildlife Refuge. Geometric mean, and range (ppm, wet weight), followed by sample size in parenthesis.

Site	Feb. 1988 Mean Range	Nov/Dec 1988 Mean Range	Feb/Mar 1989 Mean Range
		Liver	
KNWR		2.65, 0.9-9.5(9)	
Westfarmers	11.30, 6.4-21.0(10)		20.33,9.8-29.0(10)
Westlake Farms	7.18, 1.8-18.0(10)		7.15,1.8-30.0(10)
TLDDS			9.69,2.9-22.0(10)
TLDDN			4.39,1.2-12.0(10)
		Muscle	
KNWR		1.19,0.41-2.8(9)	
Westfarmers	5.25, 1.6-10.0(10)		5.38,2.1-11.0(10)
Westlake Farms	2.19, 0.45-4.4(10)		2.66,0.61-6.6(10)
TLDDS			3.01,0.96-6.5(10)
TLDDN			1.53,0.64-5.3(10)

FIGURE V-4 WESTFARMERS EVAPORATION POND BASIN [1], AVERAGE SELENIUM LEVELS IN ADULT BRINEFLIES IN ppm WET WEIGHT



LEGEND

X = Whole numbers are site numbers

(X) = Numbers in parenthesis are geometric means

1/ Lost Hill Water District

MAP 0033

Se levels in the livers of ruddy ducks collected at Westfarmers showed a significant increase between 1988 and 1989 [11.3 vs. 20.3 ppm wet weight (18.7 vs 78.8 ppm dry weight)]. No significant change was noted in livers collected between 1988 and 1989 at the Westlake Farms pond basin (Table V-3). Se levels in muscle tissue samples showed elevated levels in 1989 at both Westfarmers [x = 5.25 ppm wet weight in 1988 vs. x = 5.38 ppm wet weight in 1989 (18.7 ppm dry weight vs. 19.1 ppm dry weight)] and Westlake Farms [x = 2.16 ppm wet weight in 1988 vs. x = 2.66 ppm wet weight in 1989 (7.7 ppm dry weight vs. 9.0 ppm dry weight)]. However, these increases were not statistically significant.

Differences were also observed among sample areas with respect to Se concentrations in ruddy duck liver samples (Table V-3). Samples collected at the KNWR were significantly lower (2.6 ppm wet weight and 9.2 ppm dry weight) than samples obtained at Westfarmers (20.3 ppm wet weight and 78.8 ppm dry weight) and TLDDS complexes (9.7 ppm wet weight and 34.9 ppm dry weight). Westfarmers was also significantly higher than the TLDDN complex. Although the KNWR had the lowest levels in relation to any other pond complexes, except for those comparisons described above, no significant difference was observed when comparing KNWR with the TLDDN and Westlake Farms. Demonstrated differences in muscle tissue Se levels were less pronounced. Westfarmers continued to be significantly higher [x = 5.38 ppm wet weight (19.1 ppm dry weight)] than either KNWR [x = 1.19 ppm wet weight (3.8 ppm dry weight)] or TLDDN [x = 1.53 ppm wet weight (5.3 ppm dry weight)].

Puddle Ducks

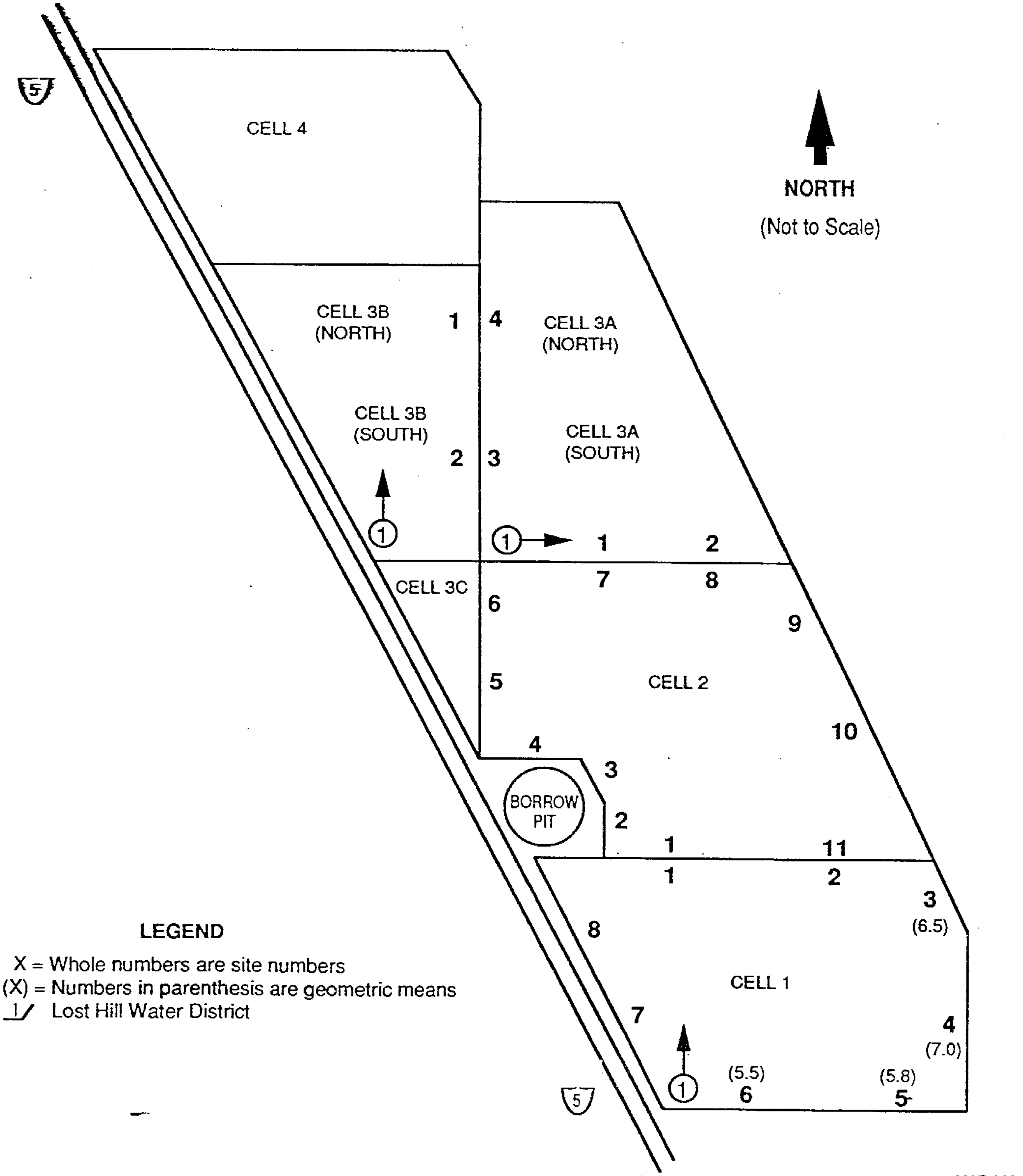
Northern Shovelers

Thirty three liver and 50 muscle samples from northern shovelers were collected at the KNWR, TLDDN, TLDDS, Westlake Farms, Meyers Farms, and Westfarmers (Table V-4). Collections were made during the winter of 1988-89 (Sept. 1988, and Jan, Feb, and March 1989) and the winter of 1989-90 (November 1989 and January 1990). Most of the five species of dabbling ducks discussed in this chapter were collected by Doug Barnum (USFWS) and analyzed by the WPCL.

During the winter of 1988-89, Se levels in northern shoveler livers were significantly higher at the TLDDS basin (6.3 ppm wet weight and 21.4 ppm dry weight) when compared to the KNWR (2.8 ppm wet weight and 9.6 ppm dry weight) and Westlake Farms (3.5 ppm wet weight and 12.5 ppm dry weight). No other comparisons of concentrations in liver tissue were found to be significant. Se levels in muscle samples obtained in the winter of 1988-89 at the TLDDS complex (2.3 ppm wet weight and 7.8 ppm dry weight) were found to be significantly higher than the KNWR (0.98 ppm wet weight and 3.5 ppm dry weight).

No significant trends could be determined between the winters of 1988-89 and 1989-90 when all sites were combined for both liver and muscle samples.

FIGURE V-5 WESTFARMERS EVAPORATION POND BASIN 1/, AVERAGE SELENIUM LEVELS IN ADULT DAMSELFLIES IN ppm WET WEIGHT



LEGEND

X = Whole numbers are site numbers
(X) = Numbers in parenthesis are geometric means
1/ Lost Hill Water District

MAP 0034

Table V-4. Selenium Concentrations in the tissues of Northern Shovelers collected from southern San Joaquin Valley agricultural drainage water evaporation pond basins and Kern National Wildlife Refuge. Geometric mean and range (ppm, wet wt.), followed by sample sizes in parenthesis.

Liver

Site:	Sept. 1988	Jan 1989	Feb/Mar 1989	Nov. 1989	Jan 1990
Kern NWR		2.79, 1.6-2.4(9)			
TLDD South	7.78,6.5-8.7(5)		6.26, 4.6-7.6(5)	6.92, 6.5-7.4(2)	
Westlake Farms			3.49, 2.1-7.5(7)		9.6(1)
Meyers Farms				1.7(1)	
TLDD North				1.2(1)	
Westfarmers					12.46,12.0-13.0 (2)

Muscle

	Sept, 1988	Nov 88/Jan 1989	Feb/Mar 1989	Nov. 1989	Jan 1990
KNWR		0.98,0.34-2.0(26)			
TLDDS	3.01, 1.9-4.2(5)		2.27,5,1.8-2.9(5)	1.66,1.3-2.1(2)	
Westlake Farms			0.79,0.36-2.7(7)		2.8(1)
Meyers Farms				0.46(1)	
TLDDN				0.30(1)	
Westfarmers					1.61,1.4-1.8(2)

Northern Pintail

Four liver samples and 39 muscle samples were obtained from northern pintail collected at Westfarmers, KNWR, and Westlake Farms during the winters of 1988-89 and 1989-90 (Table V-5).

Se levels in livers obtained from Westlake Farms were not significantly higher than birds collected at the Tule Lake National Wildlife Refuge in October 1986 (White, et al., 1987). Westlake Farms samples collected in January 1990 had a geometric mean of 3.12 ppm wet weight (11.3 ppm dry weight) while Se levels in livers collected at Tule Lake had a geometric mean of 1.53 ppm wet weight (5.6 ppm dry weight).

Se levels in muscle tissue samples during winter 1988-89 were significantly higher at Westfarmers (1.55 ppm wet weight and 4.51 ppm dry weight) and Westlake Farms (1.2 ppm wet weight and 4.0 ppm dry weight) when compared to samples obtained at the KNWR (0.52 ppm wet weight and 1.9 ppm dry weight).

Greenwing Teal

Seven liver samples and 41 muscle samples were obtained from the KNWR, Westfarmers and Westlake Farms in the winter of 1988-89 and 1989-90 (Table V-6). Although Se levels measured in liver tissue collected at Westlake Farms were higher than Westfarmers, 1.94 ppm wet weight compared to 0.96 ppm wet weight, (6.2 ppm dry weight vs. 3.8 ppm dry weight) there was no statistically significant difference.

Se levels measured in muscle tissue at Westfarmers were significantly higher in winter 1989 than observed at the KNWR (1.29 ppm, wet weight compared to 0.43 ppm wet weight (4.7 ppm dry weight vs. 1.5 ppm dry weight)).

Westfarmers did show decreased Se levels in muscle from the winter of 1989 to the winter of 1990 ($x = 1.29$ ppm wet weight in 1989 compared to 0.40 ppm wet weight in 1990 (4.7 ppm dry weight vs. 1.4 ppm dry weight). This change was determined to be statistically significant. None of the other observed changes between ponds and between study years were found to be significant.

Other Dabbling Ducks

Three liver and 3 muscle samples from mallards were collected at the Westfarmers pond complex in January 1990. The geometric mean of the Se levels measured in liver samples was 3.71 ppm wet weight (14.8 ppm dry weight) with a range of 3.6-3.9 (14.1-15.7 ppm dry weight). Se levels in muscle samples had a geometric mean of 0.90 ppm wet weight (3.1 ppm dry weight) with a range of 0.77-1.0 (2.8-3.5 ppm dry weight). Only one wigeon was

Table V-5. Selenium concentrations in the tissues of Northern Pintail collected from southern San Joaquin Valley agricultural drainage water evaporation pond basins and Kern National Wildlife Refuge. Geometric mean, and range (ppm, wet wt.), followed by sample size in parenthesis.

Site:	Oct 88- Jan 1989	Feb 1989	March 1989	Nov 1989	Jan 1990
			Liver		
Westlake Farms				2.2(1)	3.12,1.7-4.4(3)
			Muscle		
KNWR	0.52,0.22-1.6(28)				
Westfarmers			1.55,0.75-2.1(4)		
Westlake Farms		1.20,0.84-2.1(3)		0.81(1)	1.24,0.67-1.8(3)

Table V-6. Selenium Concentrations in the tissues of Green-wing Teal collected from southern San Joaquin Valley agricultural drainage water evaporation pond basins and Kern National Wildlife Refuge. Geometric mean and range (ppm, wet wt.), followed by sample sizes in parenthesis.

Site:	Nov 88-Jan 1989	Mar 1989	Nov-Dec 1989	Jan 1990
			Liver	
Westfarmers				0.96,0.60-1.45(4)
Westlake Farms			1.94,0.98-5.2(3)	
			Muscle	
KNWR	0.43,0.27-0.97(30)			
Westfarmers		1.29,1.0-1.9(4)		0.40,0.35-0.46(4)
Westlake Farms			0.52,0.25-1.1(3)	

collected at Westlake Farms in January 1990. It's liver measured 3.30 ppm wet weight (13.2 ppm dry weight) while Se levels in muscle measured 1.20 ppm, wet weight (6.4 ppm dry weight).

Se values measured for mallard liver and muscle samples were both higher than data from collections previously made by the SVS (White, et al., 1987). Table V-7 provides a comparison of these data.

Individual dabbling ducks may range throughout the Tulare Lake Basin to feed, given their normal foraging habits (Bellrose 1978). Therefore, our analyses of duck Se levels on a site by site basis could be criticized as overly detailed. However, it is important to note that our intra-site differences are significant. In addition, the pattern of inter-site variability is consistent among the various species of ducks analyzed and contamination levels in duck tissues parallel the pattern of Se levels in whole water collected during similar time periods.

Shorebirds

<u>Black necked Stilts</u>

Sampling in 1989 showed that concentrations of Se in liver tissue of adult black-necked stilts captured at TLDDS, Westfarmers, and Westlake Farms were higher than background levels of Se in birds captured during spring 1986 at Gray Lodge SWA, Sacramento NWR, Suisun Marsh, and San Pablo Bay, and during 1989 at TLDDN and KNWR (Table V-8). Concentrations of Se in liver tissues were significantly higher in adult stilts from Westfarmers than in stilts from TLDDS, and Westlake Farms during 1989. Concentrations of Se in Stilts from TLDDS, and Westlake Farms increased as the sampling period progressed. There was no significant difference in Se concentrations in birds from Westfarmers and TLDDN, during successive sampling. Although sampling was limited, there appears to be a trend toward an increasing accumulation of Se by shorebirds during the time they used the ponds (as evidenced by samples from TLDDS and Westlake Farms). Results of sampling at Westfarmers indicate that food chain items may be very high in Se and, in response, birds may accumulate Se to elevated concentrations soon after arrival and maintain these concentrations during the course of their stay.

Sampling in 1989 indicates that concentrations of Se in liver tissue of juvenile black-necked stilts collected at TLDDS and Westfarmers were significantly higher than background levels of Se in stilts captured in June 1986 at Suisun Marsh (Table V-9). At Westfarmers, concentrations of Se in liver tissue of juvenile stilts were lower in 1989 than in juvenile stilts sampled in 1987; however, juveniles sampled in July 1989 were higher than adult stilts sampled in May 1989. In addition, the data showed that juvenile stilts captured at Westfarmers in May and June 1987 and July 1989 had higher Se levels in liver tissue than juveniles from all other sites. Concentrations of Se in the liver of stilts captured at TLDDS

Table V-7. Comparisons of geometric means, Se levels (ppm, wet weight) in mallard tissues collected from Westfarmers Evaporation Pond Basins in Jan. 1990 with Se levels in mallard tissues collected at Gray Lodge, Suisun Marsh and Tule Lake National Wildlife Refuge in 1986.

Site	Liver	Muscle
Westfarmers	3.71	0.90
Gray Lodge	1.02	0.33
Suisun Marsh	1.2	0.30
Tule Lake National Wildlife Refuge	0.99	0.24

Table V-8. Adult black-necked stilts: geometric mean liver selenium concentration (ppm wet weight) followed by sample size in parenthesis.

Location	1986			1989		
	Feb.	March	June	March	April	May
Salton Sea	5.89 (6)					
Gray Lodge SWR		3.01 (10)				
San Pablo Bay		1.48 (3)				
Sacramento NWR			2.46 (10)			
Suisun Marsh			1.86 (7)			
Tulare Lake Drainage District North				2.50 (1)	2.59 (9)	3.27 (10)
Tulare Lake Drainage District South				3.11 (3)	6.18 (7)	6.77 (9)
Westfarmers				14.80 (10)		12.22 (10)
Westlake				2.80 (1)	5.64 (9)	8.99 (10)
Kern NWR				3.32 (10)		

Table V-9. Juvenile black-necked stilt livers: geometric mean liver selenium concentratio (ppm wet weight), followed by sample size in parenthesis.

Location	1986		1987	1989
	Feb.	June	May/June	July
Salton Sea	6.39 (6)			
Suisun Marsh		1.20 (3)		
Tulare Lake Drainage District South			7.90 (1)	8.88 (10)
Westfarmers			23.05 (7)	18.49 (10)
Westlake			4.21 (7)	3.53 (10)
Tulare Lake Drainage District North				4.21 (3)

in 1989 were higher than concentrations in stilt liver samples from Westlake Farms; however, there was no significant difference in Se concentrations in stilts from other locations. Although the data are limited and trends are subtle at best, there is evidence that juvenile stilts reared on evaporation ponds do accumulate high levels of Se.

Because of the potential for long-term adverse impacts, sampling of shorebirds should be included in a long-term monitoring program, both to bring any trends into focus and to determine if hazing or other specific management efforts are effective.

The recent data on black-necked stilts were collected during an extended period of drought, the effect of drought conditions on these results were not evaluated. Rainfall in the Southern San Joaquin Valley is normally low, and even during a very wet year there is probably very little alternative habitat in the Tulare Lake basin for shorebirds to feed in, thus the evaporation ponds are probably still their primary feeding areas.

SUMMARY

SVS data added new information to ongoing efforts to further refine strategies for regulating evaporation basins. Significant differences observed between aquatic invertebrate species collected from the same pond cell and the same species from different cells of the same pond complex combined with a power analysis helped guide recommendations for sample sizes. Several additional recommendations for a sampling protocol were also made to account for these observed differences.

Based on samples collected during this study period, a minimum of five samples would be required to detect differences of 1.0 ppm dry weight. A minimum of ten samples would be required to detect differences of 0.5 ppm dry weight. A sampling strategy was described which would allow incremental sampling of less than these recommended sample sizes until sample variance was low enough to determine a significant difference from the 4 ppm regulatory standard.

Analyses of Se concentrations in the liver tissue of ruddy ducks showed significant increases at the Westfarmers basin during the study period. Data collected for five dabbling ducks collected at various pond complexes also indicated concentrations of Se significantly higher than at the KNWR. No significant trend could be determined for northern shorebirds between the winter of 1988-89 and 1989-90 when all sites were combined for both liver and muscle samples. Se levels in muscle tissue for northern pintail were significantly higher at Westfarmers and Westlake Farms compared to KNWR. Se levels in green-wing teal muscle tissue samples were significantly higher at Westfarmers than KNWR in the winter of 1989. However, significantly lower Se levels were recorded from the winter of 1989 to the winter of 1990 at Westfarmers.

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APPENDICES

APPENDIX A

SAMPLING LOCATION AND CODES 1988-1990

ANTCH - Antioch - 38°03'N, 121°42'W. The San Joaquin River near Schad Landing, approximately 7 km upstream of the Antioch Bridge, Contra Costa County.

CMP13 - Camp 13 - 38°56'N, 120°42W'. The Camp 13 Ditch, just downstream from its intersection with the CCID Main Canal, approximately 17 km south of Los Banos, Merced County.

CLKBG - Clarksburg - 38°26'N, 121°31'W. Sacramento River adjacent to Clarksburg, Yolo County.

HMBLT - Humboldt Bay - 40°43'N, 124°14'W. Humboldt Bay, Humboldt County.

MEYER - Meyers Ranch Evaporation Ponds - 36°19'N, 119°51°W. Evaporation ponds located south of Laurel Ave, approximately 2 km east of Stratford, Kings County.

MUDSL - Mud Slough - 37°16'N, 12°55'W. Mud Slough on Kesterson National Wildlife Refuge, approximately 200 m. north of the end of the San Luis Drain, Merced County.

PRYSE - Pryse Evaporation Ponds - 35°51'N, 119°32°W. Evaporation ponds east of county road J33, approximately 3 km north of Alpaugh, Tulare County.

SALTS - Salt Slough - 37°15'N, 120°51'W. Salt Slough upstream from the Lander Avenue (Highway 165) crossing, Merced County.

SJRLN - San Joaquin River at Lander Road - 37°18'N, 120°50'W. San Joaquin River downstream from the Lander Avenue (Highway 165) crossing, Merced County.

SJRMR - San Joaquin River at Merced River - 37°21'N, 120°58'W. San Joaquin River just downstream from its confluence with the Merced River, Merced County.

SNPBB - San Pablo Bay - 38°03'N, 122°23'W. San Pablo Bay north of the Richmond-San Rafael Bridge and west of the Carquinez Bridge.

SUISB - Suisun Bay - 38°04'N, 122°03'W. Suisun Bay between the Carquinez Bridge and Antioch, including Grizzly Bay.

MAZEB - San Joaquin River at Maze Blvd. - 37°36'N, 121°10'W. San Joaquin River south of the Highway 132 (Maze Blvd.) crossing, 10 km east of Vernalis, Stanislaus County.

WFRMR - Westfarmers Evaporation Ponds - 35°44'N, 119°44'W. Evaporation ponds located southeast of the intersection of Twisselman Road and Interstate 5, Kern County. Currently managed by Lost Hills Water District.

WLAKE - Westlake 3 Evaporation Ponds - 35°56'N, 119°50'W. Evaporation ponds north of Utica Avenue, approximately 7 km southeast of Kettleman City, Kings County.

KNWR - Kern National Wildlife Refuge

TLDDS - Tulare Lake Drainage District South

TLDDN - Tulare Lake Drainage District North

APPENDIX B-1

SELENIUM VERIFICATION STUDY COLLECTION PROGRAM, SAMPLES COLLECTED IN 1988-89 AND 1989-90

1988-1990 BIRD TISSUE SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES AVOCET									
* LOCATION WLAKE									
03/22/89	WLAKE	AVOCET	M	A	370	L	72	2.20	7.86
03/22/89	WLAKE	AVOCET	M	A	335	L	71	7.10	24.48
03/22/89	WLAKE	AVOCET	M	A	380	L	71	3.90	13.45
** SPECIES BNSTLT									
* LOCATION KERNR									
03/23/89	KERNR	BNSTLT	F	A	195	L	74	3.60	13.85
03/23/89	KERNR	BNSTLT	F	A	185	L	70	7.60	25.33
03/23/89	KERNR	BNSTLT	F	A	170	L	73	2.30	8.52
03/23/89	KERNR	BNSTLT	F	A	200	L	70	1.30	4.33
03/23/89	KERNR	BNSTLT	F	A	205	L	72	4.70	16.79
03/23/89	KERNR	BNSTLT	M	A	170	L	72	2.50	8.93
03/23/89	KERNR	BNSTLT	M	A	180	L	71	2.80	9.66
03/23/89	KERNR	BNSTLT	M	A	200	L	72	1.80	6.43
03/23/89	KERNR	BNSTLT	M	A	185	L	74	6.00	23.08
03/23/89	KERNR	BNSTLT	M	A	190	L	72	4.00	14.29
* LOCATION TLDDN									
03/24/89	TLDDN	BNSTLT	M	A	180	L	72	2.50	8.93
04/05/89	TLDDN	BNSTLT	M	A	165	L	72	4.70	16.79
04/05/89	TLDDN	BNSTLT	M	A	160	L	72	2.00	7.14
04/05/89	TLDDN	BNSTLT	M	A	160	L	71	4.10	14.14
04/05/89	TLDDN	BNSTLT	M	A	185	L	72	3.60	12.86
04/05/89	TLDDN	BNSTLT	F	A	145	L	73	1.80	6.67
04/05/89	TLDDN	BNSTLT	F	A	185	L	70	2.60	8.67
04/05/89	TLDDN	BNSTLT	F	A	180	L	71	2.70	9.31
04/05/89	TLDDN	BNSTLT	F	A	155	L	73	1.90	7.04
04/05/89	TLDDN	BNSTLT	F	A	160	L	74	1.30	5.00
05/17/89	TLDDN	BNSTLT	M	A	180	L	72	2.80	10.00
05/17/89	TLDDN	BNSTLT	M	A	175	L	72	3.00	10.71
05/17/89	TLDDN	BNSTLT	F	A	220	L	75	1.70	6.80
05/17/89	TLDDN	BNSTLT	M	A	185	L	72	2.70	9.64
05/17/89	TLDDN	BNSTLT	F	A	215	L	74	2.20	8.46
05/17/89	TLDDN	BNSTLT	F	A	190	L	73	3.50	12.96
05/17/89	TLDDN	BNSTLT	M	A	195	L	72	3.60	12.86
05/17/89	TLDDN	BNSTLT	M	A	200	L	72	8.20	29.29
05/17/89	TLDDN	BNSTLT	F	A	200	L	73	4.80	17.78
05/17/89	TLDDN	BNSTLT	M	A	195	L	72	2.70	9.64
07/20/89	TLDDN	BNSTLT	U	J	195	L	74	4.40	16.79
07/20/89	TLDDN	BNSTLT	U	J	210	L	72	4.20	15.16
07/20/89	TLDDN	BNSTLT	U	J	215	L	73	4.00	14.87

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION TLDDS									
03/22/89	TLDDS	BNSTLT	F	A	170	L	73	3.00	11.11
03/22/89	TLDDS	BNSTLT	M	A	200	L	72	3.00	10.71
03/22/89	TLDDS	BNSTLT	M	A	180	L	72	3.30	11.79
04/06/89	TLDDS	BNSTLT	M	A	160	L	72	5.80	20.71
04/06/89	TLDDS	BNSTLT	M	A	185	L	72	4.80	17.14
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.90	24.64
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.00	21.43
04/06/89	TLDDS	BNSTLT	F	A	185	L	73	5.10	18.89
04/06/89	TLDDS	BNSTLT	F	A	195	L	73	5.60	20.74
04/06/89	TLDDS	BNSTLT	F	A	170	L	73	10.00	37.04
05/16/89	TLDDS	BNSTLT	M	A	190	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	F	A	210	L	72	4.50	16.07
05/16/89	TLDDS	BNSTLT	F	A	195	L	73	8.10	30.00
05/16/89	TLDDS	BNSTLT	F	A	165	L	75	6.80	27.20
05/16/89	TLDDS	BNSTLT	F	A	190	L	74	4.10	15.77
05/16/89	TLDDS	BNSTLT	F	A	205	L	72	8.10	28.93
05/16/89	TLDDS	BNSTLT	M	A	195	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	M	A	190	L	69	5.40	17.42
05/16/89	TLDDS	BNSTLT	F	A	185	L	75	9.10	36.40
07/19/89	TLDDS	BNSTLT	F	J	160	L	74	12.00	46.15
07/19/89	TLDDS	BNSTLT	U	J	185	L	72	8.00	28.17
07/19/89	TLDDS	BNSTLT	F	J	190	L	70	9.65	32.60
07/19/89	TLDDS	BNSTLT	F	J	185	L	71	12.00	40.96
07/19/89	TLDDS	BNSTLT	M	J	185	L	71	9.10	31.60
07/19/89	TLDDS	BNSTLT	U	J	160	L	73	7.10	26.59
07/19/89	TLDDS	BNSTLT	F	J	145	L	74	7.00	26.62
07/19/89	TLDDS	BNSTLT	M	J	180	L	69	7.00	22.73
07/19/89	TLDDS	BNSTLT	M	J	165	L	74	6.80	26.36
07/19/89	TLDDS	BNSTLT	F	J	180	L	73	13.00	47.45
* LOCATION WFRMR									
03/20/89	WFRMR	BNSTLT	M	A	205	L	74	11.00	42.31
03/20/89	WFRMR	BNSTLT	M	A	180	L	71	18.00	62.07
03/20/89	WFRMR	BNSTLT	F	A	230	L	71	12.00	41.38
03/20/89	WFRMR	BNSTLT	M	A	215	L	75	21.00	84.00
03/20/89	WFRMR	BNSTLT	F	A	155	L	74	20.00	76.92
03/20/89	WFRMR	BNSTLT	F	A	205	L	72	14.00	50.00
03/20/89	WFRMR	BNSTLT	F	A	210	L	74	19.00	73.08
03/20/89	WFRMR	BNSTLT	F	A	185	L	75	13.00	52.00
03/20/89	WFRMR	BNSTLT	F	A	200	L	76	9.70	40.42
03/20/89	WFRMR	BNSTLT	F	A	165	L	73	15.00	55.56
05/15/89	WFRMR	BNSTLT	F	A	180	L	73	14.00	51.85
05/15/89	WFRMR	BNSTLT	F	A	175	L	73	23.00	85.19
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	8.00	26.67
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	14.00	46.67

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
05/15/89	WFRMR	BNSTLT	F	A	170	L	73	14.00	51.85
05/15/89	WFRMR	BNSTLT	F	A	185	L	73	14.00	51.85
05/15/89	WFRMR	BNSTLT	F	A	175	L	73	15.00	55.56
05/15/89	WFRMR	BNSTLT	F	A	165	L	73	18.10	67.04
05/15/89	WFRMR	BNSTLT	M	A	180	L	72	17.00	60.71
05/15/89	WFRMR	BNSTLT	M	A	185	L	72	2.50	8.93
05/15/89	WFRMR	BNSTLT	M	A	200	L	72	9.20	32.86
07/19/89	WFRMR	BNSTLT	F	J	170	L	75	18.50	72.83
07/19/89	WFRMR	BNSTLT	M	J	160	L	70	23.00	77.44
07/19/89	WFRMR	BNSTLT	F	J	150	L	73	18.00	66.67
07/19/89	WFRMR	BNSTLT	M	J	175	L	74	20.00	77.82
07/19/89	WFRMR	BNSTLT	M	J	180	L	70	10.00	33.56
07/19/89	WFRMR	BNSTLT	U	J	210	L	71	17.00	59.03
07/19/89	WFRMR	BNSTLT	F	J	190	L	72	20.00	70.92
07/19/89	WFRMR	BNSTLT	U	J	185	L	74	20.50	77.95
07/19/89	WFRMR	BNSTLT	U	J	170	L	73	18.00	65.45
07/19/89	WFRMR	BNSTLT	M	J	190	L	74	24.00	91.25
* LOCATION WLAKE									
03/22/89	WLAKE	BNSTLT	F	A	185	L	69	2.80	9.03
04/05/89	WLAKE	BNSTLT	M	A	185	L	72	16.00	57.14
04/05/89	WLAKE	BNSTLT	M	A	190	L	71	11.00	37.93
04/05/89	WLAKE	BNSTLT	F	A	175	L	73	7.10	26.30
04/05/89	WLAKE	BNSTLT	F	A	160	L	73	3.00	11.11
04/05/89	WLAKE	BNSTLT	F	A	165	L	73	3.90	14.44
04/05/89	WLAKE	BNSTLT	M	A	180	L	72	3.30	11.79
04/05/89	WLAKE	BNSTLT	M	A	170	L	72	5.90	21.07
04/06/89	WLAKE	BNSTLT	U	A	170	L	72	3.70	13.21
04/06/89	WLAKE	BNSTLT	U	A	165	L	72	4.60	16.43
05/16/89	WLAKE	BNSTLT	M	A	200	L	72	12.00	42.86
05/16/89	WLAKE	BNSTLT	M	A	185	L	72	11.00	39.29
05/16/89	WLAKE	BNSTLT	M	A	185	L	73	17.00	62.96
05/16/89	WLAKE	BNSTLT	F	A	165	L	73	8.60	31.85
05/16/89	WLAKE	BNSTLT	M	A	195	L	72	15.00	53.57
05/16/89	WLAKE	BNSTLT	F	A	260	L	72	6.40	22.86
05/16/89	WLAKE	BNSTLT	F	A	245	L	72	6.00	21.43
05/16/89	WLAKE	BNSTLT	M	A	165	L	74	7.70	29.62
05/16/89	WLAKE	BNSTLT	M	A	180	L	74	3.70	14.23
05/16/89	WLAKE	BNSTLT	F	A	180	L	73	10.00	37.04
07/19/89	WLAKE	BNSTLT	U	J	180	L	72	3.80	13.43
07/19/89	WLAKE	BNSTLT	U	J	155	L	73	1.50	5.64
07/19/89	WLAKE	BNSTLT	U	J	160	L	73	1.90	6.93
07/19/89	WLAKE	BNSTLT	U	J	150	L	74	7.50	28.96
07/19/89	WLAKE	BNSTLT	U	J	185	L	74	4.30	16.48
07/20/89	WLAKE	BNSTLT	U	J	155	L	70	3.70	12.37
07/20/89	WLAKE	BNSTLT	U	J	130	L	75	7.30	29.67

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
07/20/89	WLAKE	BNSTLT	U	J	160	L	71	2.20	7.64
07/20/89	WLAKE	BNSTLT	U	J	145	L	73	3.40	12.59
07/20/89	WLAKE	BNSTLT	U	J	165	L	72	3.10	10.95
** SPECIES GWTEAL									
* LOCATION KERNR									
10/22/88	KERNR	GWTEAL	F	U	0	F	72	0.33	1.18
10/22/88	KERNR	GWTEAL	F	U	0	F	72	0.43	1.54
10/22/88	KERNR	GWTEAL	M	U	0	F	76	0.72	3.00
10/29/88	KERNR	GWTEAL	F	U	0	F	71	0.57	1.97
10/29/88	KERNR	GWTEAL	M	U	0	F	74	0.67	2.58
10/29/88	KERNR	GWTEAL	M	U	0	F	75	0.46	1.84
10/29/88	KERNR	GWTEAL	F	U	0	F	75	0.64	2.56
10/29/88	KERNR	GWTEAL	M	U	0	F	73	0.67	2.48
10/29/88	KERNR	GWTEAL	M	U	0	F	71	0.61	2.10
10/29/88	KERNR	GWTEAL	M	U	0	F	70	0.78	2.60
11/02/88	KERNR	GWTEAL	F	U	0	F	73	0.47	1.74
11/02/88	KERNR	GWTEAL	F	U	0	F	71	0.40	1.38
11/02/88	KERNR	GWTEAL	M	U	0	F	71	0.62	2.14
11/05/88	KERNR	GWTEAL	F	U	0	F	73	0.38	1.41
11/05/88	KERNR	GWTEAL	M	U	0	F	73	0.42	1.56
11/05/88	KERNR	GWTEAL	F	U	0	F	72	0.61	2.18
11/12/88	KERNR	GWTEAL	M	U	0	F	71	0.52	1.79
11/12/88	KERNR	GWTEAL	F	U	0	F	72	0.33	1.18
11/12/88	KERNR	GWTEAL	M	U	0	F	70	0.53	1.77
11/12/88	KERNR	GWTEAL	F	U	0	F	74	0.42	1.62
12/07/88	KERNR	GWTEAL	M	U	0	F	70	0.49	1.63
12/07/88	KERNR	GWTEAL	M	U	0	F	76	0.28	1.17
12/10/88	KERNR	GWTEAL	M	U	0	F	72	0.54	1.93
12/10/88	KERNR	GWTEAL	M	U	0	F	72	0.42	1.50
12/10/88	KERNR	GWTEAL	F	U	0	F	72	0.27	0.96
12/14/88	KERNR	GWTEAL	F	U	0	F	72	0.33	1.18
12/14/88	KERNR	GWTEAL	M	U	0	F	69	0.30	0.97
12/17/88	KERNR	GWTEAL	M	U	0	F	72	0.32	1.14
12/17/88	KERNR	GWTEAL	F	U	0	F	71	0.35	1.21
12/17/88	KERNR	GWTEAL	F	U	0	F	71	0.30	1.03
12/17/88	KERNR	GWTEAL	F	U	0	F	70	0.37	1.23
12/28/88	KERNR	GWTEAL	M	U	0	F	73	0.54	2.00
12/28/88	KERNR	GWTEAL	F	U	0	F	69	0.97	3.13
12/28/88	KERNR	GWTEAL	M	U	0	F	72	0.40	1.43
12/28/88	KERNR	GWTEAL	F	U	0	F	73	0.30	1.11
12/28/88	KERNR	GWTEAL	M	U	0	F	71	0.27	0.93
01/04/89	KERNR	GWTEAL	F	U	0	F	72	0.88	3.14
01/04/89	KERNR	GWTEAL	M	U	0	F	72	0.31	1.11
01/07/89	KERNR	GWTEAL	F	U	0	F	73	0.37	1.37

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
01/07/89	KERNR	GWTEAL	F	U	0	F	72	0.42	1.50
* LOCATION WFRMR									
03/01/89	WFRMR	GWTEAL	M	U	0	F	79	1.40	6.67
03/01/89	WFRMR	GWTEAL	F	U	0	F	72	1.00	3.57
03/01/89	WFRMR	GWTEAL	M	U	0	F	67	1.90	5.76
03/01/89	WFRMR	GWTEAL	M	U	0	F	71	1.00	3.45
01/05/90	WFRMR	GWTEAL	M	A	370	F	72	0.40	1.41
01/05/90	WFRMR	GWTEAL	M	A	380	F	72	0.41	1.49
01/05/90	WFRMR	GWTEAL	M	A	360	F	72	0.35	1.23
01/05/90	WFRMR	GWTEAL	M	A	400	F	72	0.46	1.62
01/05/90	WFRMR	GWTEAL	M	A	360	L	75	0.60	2.43
01/05/90	WFRMR	GWTEAL	M	A	400	L	73	1.45	5.35
01/05/90	WFRMR	GWTEAL	M	A	380	L	76	1.00	4.15
01/05/90	WFRMR	GWTEAL	M	A	370	L	76	0.88	3.70
* LOCATION WLAKE									
11/29/89	WLAKE	GWTEAL	M	A	370	F	70	0.34	1.15
11/29/89	WLAKE	GWTEAL	M	A	300	F	71	0.24	0.82
12/01/89	WLAKE	GWTEAL	M	A	360	F	71	1.10	3.82
11/29/89	WLAKE	GWTEAL	M	A	300	L	72	0.98	3.54
11/29/89	WLAKE	GWTEAL	M	A	370	L	71	1.10	3.78
12/01/89	WLAKE	GWTEAL	M	A	360	L	69	5.20	16.56
** SPECIES MALLRD									
* LOCATION TLDDS									
11/29/89	TLDDS	MALLRD	M	A	1060	F	72	2.80	10.00
11/29/89	TLDDS	MALLRD	M	A	1060	L	76	5.20	21.49
* LOCATION WFRMR									
01/05/90	WFRMR	MALLRD	F	A	1060	F	66	1.00	2.92
01/05/90	WFRMR	MALLRD	M	A	1280	F	73	0.96	3.50
01/05/90	WFRMR	MALLRD	M	A	1230	F	73	0.76	2.80
01/05/90	WFRMR	MALLRD	F	A	1060	L	77	3.60	15.72
01/05/90	WFRMR	MALLRD	M	A	1280	L	75	3.60	14.46
01/05/90	WFRMR	MALLRD	M	A	1230	L	72	3.90	14.13
** SPECIES NOSHOV									
* LOCATION KERNR									
10/22/88	KERNR	NOSHOV	F	U	0	F	71	2.45	8.45
10/22/88	KERNR	NOSHOV	M	U	0	F	72	4.40	15.71
10/22/88	KERNR	NOSHOV	F	U	0	F	73	3.70	13.70
10/22/88	KERNR	NOSHOV	F	U	0	F	72	2.80	10.00
10/26/88	KERNR	NOSHOV	M	U	0	F	79	1.80	8.57

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
10/29/88	KERNR	NOSHOV	M	U	0	F	69	3.20	10.32
10/29/88	KERNR	NOSHOV	F	U	0	F	70	0.55	1.83
11/02/88	KERNR	NOSHOV	M	U	0	F	70	0.90	3.00
11/02/88	KERNR	NOSHOV	F	U	0	F	70	0.41	1.37
11/02/88	KERNR	NOSHOV	F	U	0	F	71	1.40	4.83
11/12/88	KERNR	NOSHOV	F	U	0	F	74	4.20	16.15
11/12/88	KERNR	NOSHOV	M	U	0	F	68	4.40	13.75
11/12/88	KERNR	NOSHOV	M	U	0	F	70	0.76	2.53
11/30/88	KERNR	NOSHOV	M	U	0	F	69	0.72	2.32
12/07/88	KERNR	NOSHOV	F	U	0	F	68	1.00	3.13
12/07/88	KERNR	NOSHOV	F	U	0	F	70	1.90	6.33
12/07/88	KERNR	NOSHOV	F	U	0	F	72	2.00	7.14
12/10/88	KERNR	NOSHOV	F	U	0	F	70	0.66	2.20
12/10/88	KERNR	NOSHOV	F	U	0	F	70	0.40	1.33
12/10/88	KERNR	NOSHOV	F	U	0	F	68	1.40	4.38
12/14/88	KERNR	NOSHOV	F	U	0	F	72	0.35	1.25
12/14/88	KERNR	NOSHOV	F	U	0	F	71	1.90	6.55
12/17/88	KERNR	NOSHOV	M	U	0	F	71	0.54	1.86
12/17/88	KERNR	NOSHOV	M	U	0	F	67	0.33	1.00
12/17/88	KERNR	NOSHOV	M	U	0	F	70	0.40	1.33
12/17/88	KERNR	NOSHOV	M	U	0	F	68	0.54	1.69
12/21/88	KERNR	NOSHOV	M	U	0	F	70	1.40	4.67
12/24/88	KERNR	NOSHOV	M	U	0	F	71	0.95	3.28
12/24/88	KERNR	NOSHOV	M	U	0	F	70	0.98	3.27
12/28/88	KERNR	NOSHOV	F	U	0	F	74	1.90	7.31
12/28/88	KERNR	NOSHOV	M	U	0	F	72	0.79	2.82
01/10/89	KERNR	NOSHOV	F	U	0	F	71	1.20	4.14
01/10/89	KERNR	NOSHOV	M	U	0	F	72	0.95	3.39
01/10/89	KERNR	NOSHOV	M	U	0	F	70	0.94	3.13
01/10/89	KERNR	NOSHOV	F	U	0	F	71	1.20	4.14
01/11/89	KERNR	NOSHOV	M	U	0	F	71	1.80	6.21
01/11/89	KERNR	NOSHOV	M	U	0	F	72	1.40	5.00
01/13/89	KERNR	NOSHOV	F	U	0	F	71	0.37	1.28
01/13/89	KERNR	NOSHOV	F	U	0	F	71	0.86	2.97
01/13/89	KERNR	NOSHOV	M	U	0	F	72	0.96	3.43
01/10/89	KERNR	NOSHOV	M	U	0	L	73	2.00	7.41
01/10/89	KERNR	NOSHOV	F	U	0	L	72	4.20	15.00
01/10/89	KERNR	NOSHOV	M	U	0	L	70	3.60	12.00
01/10/89	KERNR	NOSHOV	F	U	0	L	71	3.40	11.72
01/11/89	KERNR	NOSHOV	M	U	0	L	69	2.00	6.45
01/11/89	KERNR	NOSHOV	M	U	0	L	70	3.10	10.33
01/13/89	KERNR	NOSHOV	F	U	0	L	71	1.60	5.52
01/13/89	KERNR	NOSHOV	M	U	0	L	72	3.40	12.14
01/13/89	KERNR	NOSHOV	F	U	0	L	72	2.60	9.29

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION MEYER									
11/02/89	MEYER	NOSHOV	F	A	575	F	71	0.46	1.59
11/02/89	MEYER	NOSHOV	F	A	575	L	72	1.70	6.12
* LOCATION TLDDN									
11/01/89	TLDDN	NOSHOV	M	A	600	F	72	0.30	1.08
11/01/89	TLDDN	NOSHOV	M	A	600	L	74	1.20	4.58
* LOCATION TLDDS									
09/22/88	TLDDS	NOSHOV	M	U	0	F	71	4.20	14.48
09/22/88	TLDDS	NOSHOV	M	U	0	F	70	4.20	14.00
09/22/88	TLDDS	NOSHOV	M	U	0	F	73	2.60	9.63
09/22/88	TLDDS	NOSHOV	M	U	0	F	71	1.90	6.55
09/22/88	TLDDS	NOSHOV	M	U	0	F	71	2.70	9.31
02/02/89	TLDDS	NOSHOV	M	U	0	F	72	1.80	6.43
02/02/89	TLDDS	NOSHOV	M	U	0	F	71	2.00	6.90
02/02/89	TLDDS	NOSHOV	F	U	0	F	71	2.90	10.00
02/02/89	TLDDS	NOSHOV	M	U	0	F	71	2.10	7.24
02/23/89	TLDDS	NOSHOV	F	U	0	F	71	2.70	9.31
11/28/89	TLDDS	NOSHOV	M	J	640	F	70	1.30	4.38
11/28/89	TLDDS	NOSHOV	M	A	700	F	71	2.10	7.34
09/22/88	TLDDS	NOSHOV	M	U	0	L	74	6.50	25.00
09/22/88	TLDDS	NOSHOV	M	U	0	L	71	8.60	29.66
09/22/88	TLDDS	NOSHOV	M	U	0	L	71	7.60	26.21
09/22/88	TLDDS	NOSHOV	M	U	0	L	72	8.70	31.07
09/22/88	TLDDS	NOSHOV	M	U	0	L	72	7.80	27.86
02/02/89	TLDDS	NOSHOV	F	U	0	L	69	6.60	21.29
02/02/89	TLDDS	NOSHOV	M	U	0	L	72	7.60	27.14
02/02/89	TLDDS	NOSHOV	M	U	0	L	69	6.50	20.97
02/02/89	TLDDS	NOSHOV	M	U	0	L	71	6.40	22.07
02/23/89	TLDDS	NOSHOV	F	U	0	L	72	4.60	16.43
11/28/89	TLDDS	NOSHOV	M	J	640	L	70	7.40	24.34
11/28/89	TLDDS	NOSHOV	M	A	700	L	77	6.50	28.38
* LOCATION WFRMR									
01/04/90	WFRMR	NOSHOV	M	A	690	F	71	1.40	4.81
01/04/90	WFRMR	NOSHOV	M	J	540	F	71	1.80	6.25
01/04/90	WFRMR	NOSHOV	M	A	690	L	73	13.00	47.79
01/04/90	WFRMR	NOSHOV	M	J	540	L	73	12.00	43.64
* LOCATION WLAKE									
02/21/89	WLAKE	NOSHOV	F	U	0	F	72	0.43	-1.54
02/21/89	WLAKE	NOSHOV	U	U	0	F	71	0.44	1.52
02/22/89	WLAKE	NOSHOV	F	U	0	F	72	0.95	3.39
03/22/89	WLAKE	NOSHOV	M	A	615	F	70	0.36	1.20
03/22/89	WLAKE	NOSHOV	F	A	480	F	71	0.67	2.31

1988-1990 BIRD TISSUE
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SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/22/89	WLAKE	NOSHOV	M	A	710	F	70	2.70	9.00
03/22/89	WLAKE	NOSHOV	M	A	540	F	71	0.73	2.52
01/02/90	WLAKE	NOSHOV	F	A	570	F	73	2.80	10.26
02/21/89	WLAKE	NOSHOV	U	U	0	L	71	2.60	8.97
02/21/89	WLAKE	NOSHOV	F	U	0	L	73	2.60	9.63
02/22/89	WLAKE	NOSHOV	F	U	0	L	75	3.20	12.80
03/22/89	WLAKE	NOSHOV	M	A	615	L	72	7.50	26.79
03/22/89	WLAKE	NOSHOV	M	A	540	L	73	6.20	22.96
03/22/89	WLAKE	NOSHOV	M	A	710	L	71	2.10	7.24
03/22/89	WLAKE	NOSHOV	F	A	480	L	72	2.60	9.29
01/02/90	WLAKE	NOSHOV	F	A	570	L	74	9.60	36.23
** SPECIES NPINTL									
* LOCATION KERNR									
10/22/88	KERNR	NPINTL	M	U	0	F	73	0.63	2.33
10/22/88	KERNR	NPINTL	M	U	0	F	71	0.42	1.45
10/22/88	KERNR	NPINTL	M	U	0	F	70	1.60	5.33
10/22/88	KERNR	NPINTL	F	U	0	F	71	0.59	2.03
10/26/88	KERNR	NPINTL	F	U	0	F	73	0.32	1.19
10/26/88	KERNR	NPINTL	M	U	0	F	74	0.32	1.23
11/02/88	KERNR	NPINTL	F	U	0	F	71	0.31	1.07
11/09/88	KERNR	NPINTL	M	U	0	F	72	0.58	2.07
11/12/88	KERNR	NPINTL	M	U	0	F	75	0.63	2.52
11/12/88	KERNR	NPINTL	F	U	0	F	72	0.41	1.46
11/12/88	KERNR	NPINTL	M	U	0	F	72	0.64	2.29
12/07/88	KERNR	NPINTL	M	U	0	F	70	0.66	2.20
12/07/88	KERNR	NPINTL	M	U	0	F	71	0.54	1.86
12/07/88	KERNR	NPINTL	M	U	0	F	71	0.36	1.24
12/10/88	KERNR	NPINTL	M	U	0	F	74	0.59	2.27
12/10/88	KERNR	NPINTL	F	U	0	F	74	0.99	3.81
12/17/88	KERNR	NPINTL	M	U	0	F	75	0.58	2.32
12/17/88	KERNR	NPINTL	M	U	0	F	72	0.56	2.00
12/17/88	KERNR	NPINTL	F	U	0	F	76	0.22	0.92
12/21/88	KERNR	NPINTL	F	U	0	F	76	0.34	1.42
12/24/88	KERNR	NPINTL	M	U	0	F	76	0.56	2.33
12/24/88	KERNR	NPINTL	M	U	0	F	75	0.54	2.16
12/28/88	KERNR	NPINTL	M	U	0	F	76	0.36	1.50
01/07/89	KERNR	NPINTL	M	U	0	F	73	0.49	1.81
01/07/89	KERNR	NPINTL	M	U	0	F	75	0.38	1.52
01/07/89	KERNR	NPINTL	M	U	0	F	71	0.48	1.66
01/07/89	KERNR	NPINTL	M	U	0	F	75	0.52	2.08
01/10/89	KERNR	NPINTL	F	U	0	F	74	0.42	1.62
* LOCATION WFRMR									
03/01/89	WFRMR	NPINTL	M	U	0	F	69	0.75	2.42

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/01/89	WFRMR	NPINTL	M	U	0	F	73	1.70	6.30
03/01/89	WFRMR	NPINTL	M	U	0	F	68	1.90	5.94
03/01/89	WFRMR	NPINTL	F	U	0	F	70	2.10	7.00
* LOCATION WLAKE									
02/22/89	WLAKE	NPINTL	M	U	0	F	72	2.10	7.50
02/22/89	WLAKE	NPINTL	M	U	0	F	69	0.85	2.74
02/22/89	WLAKE	NPINTL	F	U	0	F	70	0.84	2.80
11/29/89	WLAKE	NPINTL	M	A	990	F	72	0.81	2.91
01/02/90	WLAKE	NPINTL	M	A	920	F	72	0.66	2.39
01/02/90	WLAKE	NPINTL	M	A	1000	F	72	1.80	6.47
01/03/90	WLAKE	NPINTL	M	A	940	F	72	1.40	5.02
11/29/89	WLAKE	NPINTL	M	A	990	L	70	2.20	7.26
01/02/90	WLAKE	NPINTL	M	A	920	L	72	1.70	5.99
01/02/90	WLAKE	NPINTL	M	A	1000	L	75	3.80	15.26
01/03/90	WLAKE	NPINTL	M	A	940	L	71	4.40	15.22
** SPECIES RUDDYD									
* LOCATION KERNR									
11/30/88	KERNR	RUDDYD	F	U	0	F	69	2.80	9.03
11/30/88	KERNR	RUDDYD	M	U	0	F	70	0.41	1.37
11/30/88	KERNR	RUDDYD	F	U	0	F	70	1.60	5.33
11/30/88	KERNR	RUDDYD	M	U	0	F	68	0.41	1.28
11/30/88	KERNR	RUDDYD	M	U	0	F	72	0.77	2.75
12/15/88	KERNR	RUDDYD	M	U	0	F	70	1.10	3.67
12/17/88	KERNR	RUDDYD	M	U	0	F	71	2.40	8.28
12/30/88	KERNR	RUDDYD	M	U	0	F	71	1.70	5.86
12/30/88	KERNR	RUDDYD	F	U	0	F	70	0.73	2.43
11/30/88	KERNR	RUDDYD	F	U	0	L	70	3.00	10.00
11/30/88	KERNR	RUDDYD	M	U	0	L	72	1.10	3.93
11/30/88	KERNR	RUDDYD	M	U	0	L	72	0.90	3.21
11/30/88	KERNR	RUDDYD	M	U	0	L	77	1.40	6.09
11/30/88	KERNR	RUDDYD	F	U	0	L	71	5.10	17.59
12/15/88	KERNR	RUDDYD	M	U	0	L	73	4.20	15.56
12/17/88	KERNR	RUDDYD	M	U	0	L	70	2.90	9.67
12/30/88	KERNR	RUDDYD	M	U	0	L	73	9.50	35.19
12/30/88	KERNR	RUDDYD	F	U	0	L	75	1.30	5.20
* LOCATION TLDDN									
03/22/89	TLDDN	RUDDYD	F	U	560	F	71	0.64	2.21
03/22/89	TLDDN	RUDDYD	M	U	630	F	74	1.10	4.23
03/22/89	TLDDN	RUDDYD	F	U	520	F	74	0.69	2.65
03/22/89	TLDDN	RUDDYD	M	U	640	F	71	1.50	5.17
03/22/89	TLDDN	RUDDYD	F	U	580	F	73	1.80	6.67
03/22/89	TLDDN	RUDDYD	F	U	470	F	73	5.30	19.63

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/22/89	TLDDN	RUDDYD	F	U	560	F	71	1.50	5.17
03/22/89	TLDDN	RUDDYD	M	U	650	F	70	2.80	9.33
03/22/89	TLDDN	RUDDYD	F	U	550	F	74	1.00	3.85
03/22/89	TLDDN	RUDDYD	M	U	620	F	72	1.20	4.29
03/22/89	TLDDN	RUDDYD	M	U	650	L	72	6.80	24.29
03/22/89	TLDDN	RUDDYD	F	U	470	L	74	7.90	30.38
03/22/89	TLDDN	RUDDYD	M	U	620	L	72	4.60	16.43
03/22/89	TLDDN	RUDDYD	F	U	580	L	73	3.80	14.07
03/22/89	TLDDN	RUDDYD	F	U	550	L	71	4.30	14.83
03/22/89	TLDDN	RUDDYD	F	U	560	L	71	1.60	5.52
03/22/89	TLDDN	RUDDYD	M	U	630	L	73	3.10	11.48
03/22/89	TLDDN	RUDDYD	F	U	520	L	76	1.20	5.00
03/22/89	TLDDN	RUDDYD	M	U	640	L	71	12.00	41.38
03/22/89	TLDDN	RUDDYD	F	U	560	L	73	5.90	21.85
* LOCATION TLDDS									
02/02/89	TLDDS	RUDDYD	F	U	0	F	74	5.50	21.15
02/02/89	TLDDS	RUDDYD	F	U	0	F	76	2.20	9.17
02/02/89	TLDDS	RUDDYD	F	U	0	F	72	5.80	20.71
02/02/89	TLDDS	RUDDYD	F	U	0	F	71	6.50	22.41
02/02/89	TLDDS	RUDDYD	F	U	0	F	74	2.20	8.46
02/02/89	TLDDS	RUDDYD	M	U	0	F	71	3.30	11.38
02/02/89	TLDDS	RUDDYD	F	U	0	F	72	4.90	17.50
02/17/89	TLDDS	RUDDYD	F	U	0	F	71	0.96	3.31
02/17/89	TLDDS	RUDDYD	F	U	0	F	71	2.10	7.24
02/23/89	TLDDS	RUDDYD	U	U	0	F	69	1.10	3.55
02/02/89	TLDDS	RUDDYD	F	U	0	L	72	6.30	22.50
02/02/89	TLDDS	RUDDYD	F	U	0	L	74	22.00	84.62
02/02/89	TLDDS	RUDDYD	M	U	0	L	71	9.20	31.72
02/02/89	TLDDS	RUDDYD	F	U	0	L	74	18.00	69.23
02/02/89	TLDDS	RUDDYD	F	U	0	L	73	11.00	40.74
02/02/89	TLDDS	RUDDYD	F	U	0	L	72	19.00	67.86
02/02/89	TLDDS	RUDDYD	F	U	0	L	75	9.00	36.00
02/17/89	TLDDS	RUDDYD	F	U	0	L	72	2.90	10.36
02/17/89	TLDDS	RUDDYD	F	U	0	L	72	10.00	35.71
02/23/89	TLDDS	RUDDYD	U	U	0	L	72	4.80	17.14
* LOCATION WFRMR									
03/20/89	WFRMR	RUDDYD	F	U	540	F	71	7.20	24.83
03/20/89	WFRMR	RUDDYD	F	U	500	F	74	4.90	18.85
03/20/89	WFRMR	RUDDYD	F	U	550	F	74	2.10	8.08
03/20/89	WFRMR	RUDDYD	M	U	540	F	72	5.10	18.21
03/20/89	WFRMR	RUDDYD	M	U	480	F	72	6.50	23.21
03/20/89	WFRMR	RUDDYD	M	U	640	F	71	11.00	37.93
03/20/89	WFRMR	RUDDYD	M	U	550	F	71	6.80	23.45
03/20/89	WFRMR	RUDDYD	M	U	640	F	71	6.60	22.76

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/20/89	WFRMR	RUDDYD	F	U	580	F	72	5.30	18.93
03/20/89	WFRMR	RUDDYD	F	U	510	F	73	2.70	10.00
03/20/89	WFRMR	RUDDYD	F	U	540	L	74	29.00	111.54
03/20/89	WFRMR	RUDDYD	F	U	510	L	74	23.00	88.46
03/20/89	WFRMR	RUDDYD	F	U	500	L	74	22.00	84.62
03/20/89	WFRMR	RUDDYD	F	U	580	L	76	19.00	79.17
03/20/89	WFRMR	RUDDYD	M	U	640	L	75	22.00	88.00
03/20/89	WFRMR	RUDDYD	M	U	640	L	74	22.00	84.62
03/20/89	WFRMR	RUDDYD	F	U	550	L	74	9.80	37.69
03/20/89	WFRMR	RUDDYD	M	U	550	L	74	22.00	84.62
03/20/89	WFRMR	RUDDYD	M	U	480	L	74	22.00	84.62
03/20/89	WFRMR	RUDDYD	M	U	540	L	74	18.00	69.23
* LOCATION WLAKE									
02/21/89	WLAKE	RUDDYD	F	U	0	F	75	6.60	26.40
02/21/89	WLAKE	RUDDYD	U	U	0	F	73	4.40	16.30
02/22/89	WLAKE	RUDDYD	U	U	0	F	73	5.70	21.11
02/22/89	WLAKE	RUDDYD	U	U	0	F	72	0.63	2.25
02/22/89	WLAKE	RUDDYD	U	U	0	F	72	5.70	20.36
02/22/89	WLAKE	RUDDYD	M	U	0	F	72	2.00	7.14
02/22/89	WLAKE	RUDDYD	U	U	0	F	70	0.77	2.57
02/22/89	WLAKE	RUDDYD	U	U	0	F	71	0.61	2.10
03/22/89	WLAKE	RUDDYD	M	A	620	F	72	2.30	8.21
03/22/89	WLAKE	RUDDYD	M	A	650	F	73	4.10	15.19
02/21/89	WLAKE	RUDDYD	F	U	0	L	72	30.00	107.14
02/21/89	WLAKE	RUDDYD	U	U	0	L	75	10.00	40.00
02/22/89	WLAKE	RUDDYD	U	U	0	L	73	3.80	14.07
02/22/89	WLAKE	RUDDYD	M	U	0	L	73	6.90	25.56
02/22/89	WLAKE	RUDDYD	U	U	0	L	71	1.80	6.21
02/22/89	WLAKE	RUDDYD	U	U	0	L	73	1.90	7.04
02/22/89	WLAKE	RUDDYD	U	U	0	L	71	11.00	37.93
02/22/89	WLAKE	RUDDYD	U	U	0	L	73	12.00	44.44
03/22/89	WLAKE	RUDDYD	M	A	650	L	73	11.00	40.74
03/22/89	WLAKE	RUDDYD	M	A	620	L	73	5.70	21.11
** SPECIES SCOTER									
* LOCATION HMBLT									
01/18/89	HMBLT	SCOTER	M	A	1100	F	72	1.10	3.93
01/18/89	HMBLT	SCOTER	M	A	1160	F	72	1.30	4.64
01/18/89	HMBLT	SCOTER	M	A	1070	F	71	0.43	1.48
01/18/89	HMBLT	SCOTER	M	A	1080	F	72	0.59	2.11
01/18/89	HMBLT	SCOTER	M	A	1100	F	71	0.66	2.28
01/18/89	HMBLT	SCOTER	M	A	1200	F	70	0.57	1.90
01/18/89	HMBLT	SCOTER	M	A	1310	F	71	1.00	3.45
01/18/89	HMBLT	SCOTER	M	A	980	F	73	1.20	4.44

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
01/18/89	HMBLT	SCOTER	M	A	1190	F	72	0.97	3.46
01/18/89	HMBLT	SCOTER	M	A	1050	F	70	0.70	2.33
01/18/89	HMBLT	SCOTER	M	A	1050	L	73	3.80	14.07
01/18/89	HMBLT	SCOTER	M	A	1190	L	75	3.80	15.20
01/18/89	HMBLT	SCOTER	M	A	980	L	71	5.70	19.66
01/18/89	HMBLT	SCOTER	M	A	1080	L	76	3.10	12.92
01/18/89	HMBLT	SCOTER	M	A	1100	L	72	4.10	14.64
01/18/89	HMBLT	SCOTER	M	A	1310	L	74	4.60	17.69
01/18/89	HMBLT	SCOTER	M	A	1160	L	71	6.30	21.72
01/18/89	HMBLT	SCOTER	M	A	1200	L	72	2.60	9.29
01/18/89	HMBLT	SCOTER	M	A	1100	L	72	3.60	12.86
01/18/89	HMBLT	SCOTER	M	A	1070	L	76	1.70	7.08
* LOCATION SNPBB									
01/26/89	SNPBB	SCOTER	M	A	1370	F	73	12.00	44.44
01/26/89	SNPBB	SCOTER	M	A	1110	F	71	14.00	48.28
01/26/89	SNPBB	SCOTER	M	A	1150	F	71	6.20	21.38
01/26/89	SNPBB	SCOTER	M	A	1100	F	72	11.00	39.29
01/26/89	SNPBB	SCOTER	M	A	1170	F	72	10.00	35.71
01/26/89	SNPBB	SCOTER	M	A	1300	F	70	15.00	50.00
01/26/89	SNPBB	SCOTER	M	A	1120	F	72	12.00	42.86
01/26/89	SNPBB	SCOTER	M	A	1310	F	72	14.00	50.00
01/26/89	SNPBB	SCOTER	M	A	1070	F	72	8.80	31.43
01/26/89	SNPBB	SCOTER	M	A	1200	F	71	9.90	34.14
01/18/90	SNPBB	SCOTER	M	A	1300	F	71	8.30	28.42
01/18/90	SNPBB	SCOTER	M	A	1140	F	71	6.40	21.99
01/18/90	SNPBB	SCOTER	M	A	1220	F	72	10.00	35.97
01/18/90	SNPBB	SCOTER	M	A	1180	F	71	9.70	33.45
01/18/90	SNPBB	SCOTER	M	A	1200	F	70	7.15	23.60
01/18/90	SNPBB	SCOTER	M	A	1280	F	72	10.00	35.09
01/18/90	SNPBB	SCOTER	M	A	1280	F	72	9.50	33.33
01/18/90	SNPBB	SCOTER	M	A	1160	F	72	2.80	9.86
01/18/90	SNPBB	SCOTER	M	A	1120	F	72	13.00	46.59
01/18/90	SNPBB	SCOTER	M	A	1120	F	70	8.60	29.05
01/26/89	SNPBB	SCOTER	M	A	1310	L	75	44.00	176.00
01/26/89	SNPBB	SCOTER	M	A	1120	L	72	51.00	182.14
01/26/89	SNPBB	SCOTER	M	A	1300	L	73	52.00	192.59
01/26/89	SNPBB	SCOTER	M	A	1100	L	73	54.00	200.00
01/26/89	SNPBB	SCOTER	M	A	1150	L	74	21.00	80.77
01/26/89	SNPBB	SCOTER	M	A	1170	L	71	63.00	217.24
01/26/89	SNPBB	SCOTER	M	A	1200	L	72	40.00	142.86
01/26/89	SNPBB	SCOTER	M	A	1070	L	74	26.00	100.00
01/26/89	SNPBB	SCOTER	M	A	1370	L	73	46.00	170.37
01/26/89	SNPBB	SCOTER	M	A	1110	L	72	43.00	153.57
01/18/90	SNPBB	SCOTER	M	A	1220	L	72	35.00	124.56
01/18/90	SNPBB	SCOTER	M	A	1300	L	69	34.00	110.75

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
01/18/90	SNPBB	SCOTER	M	A	1280	L	73	25.00	91.24
01/18/90	SNPBB	SCOTER	M	A	1160	L	71	24.00	83.62
01/18/90	SNPBB	SCOTER	M	A	1280	L	72	35.00	125.00
01/18/90	SNPBB	SCOTER	M	A	1200	L	74	43.00	167.97
01/18/90	SNPBB	SCOTER	M	A	1180	L	69	54.00	176.47
01/18/90	SNPBB	SCOTER	M	A	1140	L	72	27.00	96.09
01/18/90	SNPBB	SCOTER	M	A	1120	L	70	58.00	192.05
01/18/90	SNPBB	SCOTER	M	A	1120	L	74	36.00	137.40
* LOCATION SOSFB									
01/24/89	SOSFB	SCOTER	M	A	1040	F	74	4.40	16.92
01/24/89	SOSFB	SCOTER	M	A	1090	F	73	5.10	18.89
01/24/89	SOSFB	SCOTER	M	A	1130	F	73	2.40	8.89
01/24/89	SOSFB	SCOTER	M	A	1010	F	72	6.00	21.43
01/24/89	SOSFB	SCOTER	M	A	1110	F	72	4.90	17.50
01/24/89	SOSFB	SCOTER	M	A	1140	F	73	3.20	11.85
01/24/89	SOSFB	SCOTER	M	A	960	F	71	4.80	16.55
01/24/89	SOSFB	SCOTER	M	A	1010	F	73	2.70	10.00
01/24/89	SOSFB	SCOTER	M	A	1010	F	72	3.60	12.86
01/24/89	SOSFB	SCOTER	M	A	1060	F	74	3.40	13.08
01/24/90	SOSFB	SCOTER	M	A	1160	F	71	5.10	17.71
01/24/90	SOSFB	SCOTER	M	A	1180	F	71	6.10	21.03
01/24/90	SOSFB	SCOTER	M	A	1220	F	72	3.50	12.64
01/24/90	SOSFB	SCOTER	M	A	1220	F	72	6.20	22.14
01/24/90	SOSFB	SCOTER	M	A	1340	F	72	14.00	49.30
01/24/90	SOSFB	SCOTER	M	A	1300	F	73	7.90	28.83
01/24/90	SOSFB	SCOTER	M	A	1380	F	71	6.20	21.38
01/24/90	SOSFB	SCOTER	M	A	1220	F	70	10.00	33.22
01/24/90	SOSFB	SCOTER	M	A	1360	F	71	8.50	29.31
01/24/90	SOSFB	SCOTER	M	A	1140	F	71	4.30	15.03
01/24/89	SOSFB	SCOTER	M	A	1060	L	71	15.00	51.72
01/24/89	SOSFB	SCOTER	M	A	1010	L	71	14.00	48.28
01/24/89	SOSFB	SCOTER	M	A	1010	L	72	28.00	100.00
01/24/89	SOSFB	SCOTER	M	A	1130	L	71	11.00	37.93
01/24/89	SOSFB	SCOTER	M	A	960	L	71	22.00	75.86
01/24/89	SOSFB	SCOTER	M	A	1010	L	71	9.20	31.72
01/24/89	SOSFB	SCOTER	M	A	1140	L	72	20.00	71.43
01/24/89	SOSFB	SCOTER	M	A	1090	L	72	23.00	82.14
01/24/89	SOSFB	SCOTER	M	A	1040	L	71	20.00	68.97
01/24/89	SOSFB	SCOTER	M	A	1110	L	74	15.00	57.69
01/24/90	SOSFB	SCOTER	M	A	1300	L	73	38.00	142.86
01/24/90	SOSFB	SCOTER	M	A	1220	L	73	26.00	97.01
01/24/90	SOSFB	SCOTER	M	A	1160	L	71	34.00	118.47
01/24/90	SOSFB	SCOTER	M	A	1140	L	72	28.00	98.25
01/24/90	SOSFB	SCOTER	M	A	1220	L	70	37.00	124.58
01/24/90	SOSFB	SCOTER	M	A	1180	L	72	28.00	98.59

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
01/24/90	SOSFB	SCOTER	M	A	1340	L	71	53.00	184.67
01/24/90	SOSFB	SCOTER	M	A	1360	L	69	32.00	101.91
01/24/90	SOSFB	SCOTER	M	A	1220	L	74	21.50	82.69
01/24/90	SOSFB	SCOTER	M	A	1380	L	72	20.00	71.17
* LOCATION SUISB									
02/17/89	SUISB	SCOTER	M	A	1080	F	74	9.80	37.69
02/17/89	SUISB	SCOTER	M	A	1160	F	72	11.00	39.29
02/17/89	SUISB	SCOTER	M	A	1120	F	72	6.00	21.43
02/17/89	SUISB	SCOTER	M	A	1240	F	71	7.90	27.24
02/17/89	SUISB	SCOTER	M	A	1260	F	72	11.00	39.29
02/17/89	SUISB	SCOTER	M	A	1000	F	72	15.00	53.57
02/17/89	SUISB	SCOTER	M	A	1130	F	70	11.00	36.67
02/17/89	SUISB	SCOTER	M	A	1130	F	71	17.00	58.62
02/17/89	SUISB	SCOTER	M	A	1280	F	71	9.50	32.76
02/21/90	SUISB	SCOTER	M	A	1200	F	71	13.00	44.83
02/21/90	SUISB	SCOTER	M	A	1120	F	72	4.00	14.23
02/21/90	SUISB	SCOTER	M	A	1220	F	72	3.10	11.07
02/21/90	SUISB	SCOTER	M	A	1360	F	70	7.50	25.00
02/21/90	SUISB	SCOTER	F	A	1060	F	74	11.00	42.47
02/21/90	SUISB	SCOTER	F	A	1020	F	74	5.10	19.32
02/21/90	SUISB	SCOTER	F	A	1020	F	73	7.50	27.37
02/21/90	SUISB	SCOTER	M	A	1200	F	69	9.50	30.84
02/21/90	SUISB	SCOTER	F	A	1000	F	73	2.50	9.16
02/21/90	SUISB	SCOTER	F	A	900	F	73	12.00	44.12
02/17/89	SUISB	SCOTER	M	A	1260	L	70	70.00	233.33
02/17/89	SUISB	SCOTER	M	A	1120	L	73	37.00	137.04
02/17/89	SUISB	SCOTER	M	A	1130	L	70	56.00	186.67
02/17/89	SUISB	SCOTER	M	A	1240	L	74	62.00	238.46
02/17/89	SUISB	SCOTER	M	A	1160	L	70	81.00	270.00
02/17/89	SUISB	SCOTER	M	A	1000	L	75	92.00	368.00
02/17/89	SUISB	SCOTER	M	A	1280	L	74	40.00	153.85
02/17/89	SUISB	SCOTER	M	A	1130	L	73	80.00	296.30
02/17/89	SUISB	SCOTER	M	A	1200	L	71	75.00	258.62
02/17/89	SUISB	SCOTER	M	A	1080	L	72	66.00	235.71
02/21/90	SUISB	SCOTER	M	A	1200	L	69	50.00	160.77
02/21/90	SUISB	SCOTER	F	A	1020	L	74	31.50	120.23
02/21/90	SUISB	SCOTER	M	A	1360	L	75	26.00	103.17
02/21/90	SUISB	SCOTER	F	A	900	L	73	52.00	189.78
02/21/90	SUISB	SCOTER	F	A	1020	L	73	25.00	93.28
02/21/90	SUISB	SCOTER	M	A	1120	L	72	30.00	107.91
02/21/90	SUISB	SCOTER	F	A	1000	L	70	30.00	99.01
02/21/90	SUISB	SCOTER	M	A	1220	L	69	24.00	78.43
02/21/90	SUISB	SCOTER	F	A	1060	L	72	53.00	188.61

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES WIGEON									
* LCCATION WLAKE									
01/03/90	WLAKE	WIGEON	F	A	800	F	81	1.20	6.38
01/03/90	WLAKE	WIGEON	F	A	800	L	75	3.30	13.25

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES BLGILL							
* LOCATION BVRSL							
11/30/89	BVRSL	BLGILL	99	F	78	0.15	0.68
11/30/89	BVRSL	BLGILL	124	F	78	0.17	0.79
11/30/89	BVRSL	BLGILL	165	F	78	0.17	0.77
04/10/90	BVRSL	BLGILL	139	F	80	0.22	1.10
04/10/90	BVRSL	BLGILL	150	F	79	0.21	1.00
04/10/90	BVRSL	BLGILL	141	F	79	0.20	0.95
11/30/89	BVRSL	BLGILL	99	L	82	0.49	2.77
11/30/89	BVRSL	BLGILL	124	L	82	0.74	4.18
11/30/89	BVRSL	BLGILL	165	L	84	0.74	4.65
04/10/90	BVRSL	BLGILL	150	L	82	0.92	4.97
04/10/90	BVRSL	BLGILL	141	L	84	0.92	5.82
04/10/90	BVRSL	BLGILL	139	L	82	0.82	4.43
* LOCATION EMPRW							
10/04/88	EMPRW	BLGILL	140	F	81	0.15	0.79
10/04/88	EMPRW	BLGILL	91	F	81	0.15	0.79
10/04/88	EMPRW	BLGILL	113	F	81	0.18	0.95
05/23/89	EMPRW	BLGILL	113	F	80	0.21	1.05
05/23/89	EMPRW	BLGILL	126	F	80	0.22	1.10
05/23/89	EMPRW	BLGILL	138	F	80	0.20	1.00
10/04/88	EMPRW	BLGILL	140	L	84	0.66	4.13
10/04/88	EMPRW	BLGILL	113	L	86	0.56	4.00
05/23/89	EMPRW	BLGILL	113	L	83	0.81	4.76
05/23/89	EMPRW	BLGILL	138	L	83	0.74	4.35
05/23/89	EMPRW	BLGILL	126	L	83	0.79	4.65
* LOCATION MIDRV							
09/07/88	MIDRV	BLGILL	159	F	80	0.63	3.15
09/07/88	MIDRV	BLGILL	108	F	79	0.73	3.48
04/21/89	MIDRV	BLGILL	160	F	79	0.69	3.29
09/07/88	MIDRV	BLGILL	159	L	84	1.90	11.88
09/07/88	MIDRV	BLGILL	108	L	85	1.60	10.67
04/21/89	MIDRV	BLGILL	160	L	80	2.10	10.50
04/21/89	MIDRV	BLGILL	54	W	78	0.68	3.09
* LOCATION OLDRV							
09/07/88	OLDRV	BLGILL	165	F	82	0.58	3.22
09/07/88	OLDRV	BLGILL	139	F	79	0.66	3.14
09/07/88	OLDRV	BLGILL	176	F	80	0.55	2.75
11/17/88	OLDRV	BLGILL	157	F	80	0.67	3.35
04/21/89	OLDRV	BLGILL	131	F	79	0.85	4.05
04/21/89	OLDRV	BLGILL	150	F	80	0.66	3.30
04/21/89	OLDRV	BLGILL	121	F	79	0.80	3.81
11/29/89	OLDRV	BLGILL	157	F	79	0.56	2.68
11/29/89	OLDRV	BLGILL	127	F	76	0.54	2.27

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
11/29/89	OLDRV	BLGILL	100	F	80	0.72	3.53
03/29/90	OLDRV	BLGILL	142	F	80	0.77	3.76
03/29/90	OLDRV	BLGILL	154	F	80	0.65	3.22
03/29/90	OLDRV	BLGILL	140	F	79	0.67	3.16
09/07/88	OLDRV	BLGILL	176	L	83	2.40	14.12
09/07/88	OLDRV	BLGILL	139	L	84	1.50	9.38
09/07/88	OLDRV	BLGILL	165	L	84	1.80	11.25
11/17/88	OLDRV	BLGILL	157	L	82	2.00	11.11
04/21/89	OLDRV	BLGILL	121	L	83	1.90	11.18
04/21/89	OLDRV	BLGILL	131	L	83	2.60	15.29
04/21/89	OLDRV	BLGILL	150	L	83	2.60	15.29
11/29/89	OLDRV	BLGILL	157	L	83	1.30	7.78
11/29/89	OLDRV	BLGILL	127	L	82	1.60	9.04
03/29/90	OLDRV	BLGILL	140	L	82	2.00	10.99
03/29/90	OLDRV	BLGILL	154	L	83	1.90	11.11
03/29/90	OLDRV	BLGILL	142	L	84	2.00	12.35
* LOCATION	PEOPW						
10/05/88	PEOPW	BLGILL	88	F	75	0.24	0.96
05/23/89	PEOPW	BLGILL	110	F	79	0.16	0.76
05/23/89	PEOPW	BLGILL	133	F	80	0.18	0.90
05/23/89	PEOPW	BLGILL	110	L	82	0.56	3.11
05/23/89	PEOPW	BLGILL	133	L	83	0.66	3.88
* LOCATION	SALTS						
03/30/89	SALTS	BLGILL	36	F	79	1.10	5.24
03/30/89	SALTS	BLGILL	120	F	78	1.50	6.82
03/30/89	SALTS	BLGILL	120	L	83	2.70	15.88
12/13/88	SALTS	BLGILL	39	W	84	0.90	5.63
12/13/88	SALTS	BLGILL	43	W	83	0.98	5.76
03/14/90	SALTS	BLGILL	110	W	77	1.50	6.38
* LOCATION	SJRAM						
10/19/89	SJRAM	BLGILL	174	F	79	0.86	4.02
11/28/89	SJRAM	BLGILL	122	F	79	1.20	5.66
03/28/90	SJRAM	BLGILL	122	F	80	0.93	4.56
10/19/89	SJRAM	BLGILL	174	L	82	1.80	10.17
11/28/89	SJRAM	BLGILL	122	L	82	2.80	15.82
03/28/90	SJRAM	BLGILL	122	L	82	2.20	12.43
* LOCATION	SJRDR						
09/07/88	SJRDR	BLGILL	170	F	80	0.58	2.90
09/07/88	SJRDR	BLGILL	185	F	79	0.54	2.57
09/07/88	SJRDR	BLGILL	149	F	79	0.60	2.86
11/21/88	SJRDR	BLGILL	175	F	80	0.55	2.75
11/21/88	SJRDR	BLGILL	141	F	79	0.65	3.10
04/21/89	SJRDR	BLGILL	179	F	79	0.50	2.38

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
09/07/88	SJRDR	BLGILL	170	L	85	1.50	10.00
09/07/88	SJRDR	BLGILL	185	L	83	2.20	12.94
09/07/88	SJRDR	BLGILL	149	L	86	1.60	11.43
11/21/88	SJRDR	BLGILL	175	L	84	1.90	11.88
11/21/88	SJRDR	BLGILL	141	L	87	1.20	9.23
04/21/89	SJRDR	BLGILL	179	L	81	1.90	10.00
* LOCATION SJRLN							
12/01/88	SJRLN	BLGILL	120	F	79	0.26	1.24
12/01/88	SJRLN	BLGILL	101	F	80	0.31	1.55
12/01/88	SJRLN	BLGILL	87	F	80	0.35	1.75
11/16/89	SJRLN	BLGILL	126	F	77	0.18	0.79
03/15/90	SJRLN	BLGILL	115	F	79	0.20	0.94
03/15/90	SJRLN	BLGILL	124	F	79	0.20	0.97
03/15/90	SJRLN	BLGILL	152	F	80	0.23	1.13
12/01/88	SJRLN	BLGILL	120	L	83	0.88	5.18
11/16/89	SJRLN	BLGILL	126	L	82	0.53	2.99
03/15/90	SJRLN	BLGILL	152	L	82	0.77	4.35
03/15/90	SJRLN	BLGILL	115	L	83	0.59	3.49
03/15/90	SJRLN	BLGILL	124	L	82	0.66	3.73
11/16/89	SJRLN	BLGILL	91	W	77	0.20	0.85
11/16/89	SJRLN	BLGILL	78	W	77	0.20	0.88
* LOCATION SJRMR							
12/16/88	SJRMR	BLGILL	53	W	81	0.84	4.42
12/16/88	SJRMR	BLGILL	38	W	84	0.84	5.25
03/31/89	SJRMR	BLGILL	61	W	78	0.80	3.64
03/31/89	SJRMR	BLGILL	54	W	78	0.77	3.50
* LOCATION SJRPC							
12/12/88	SJRPC	BLGILL	172	F	79	0.59	2.81
12/12/88	SJRPC	BLGILL	122	F	79	0.60	2.86
12/12/88	SJRPC	BLGILL	148	F	79	0.55	2.62
12/12/88	SJRPC	BLGILL	137	F	79	0.58	2.76
12/12/88	SJRPC	BLGILL	162	F	79	0.52	2.48
12/12/88	SJRPC	BLGILL	153	F	78	0.54	2.45
04/28/89	SJRPC	BLGILL	176	F	79	0.57	2.71
04/28/89	SJRPC	BLGILL	167	F	79	0.66	3.14
04/28/89	SJRPC	BLGILL	153	F	79	0.54	2.57
12/12/88	SJRPC	BLGILL	122	L	83	1.30	7.65
12/12/88	SJRPC	BLGILL	172	L	81	1.60	8.42
12/12/88	SJRPC	BLGILL	162	L	81	1.30	6.84
12/12/88	SJRPC	BLGILL	137	L	79	1.40	6.67
12/12/88	SJRPC	BLGILL	153	L	81	1.40	7.37
12/12/88	SJRPC	BLGILL	148	L	83	1.30	7.65
04/28/89	SJRPC	BLGILL	167	L	80	1.80	9.00
04/28/89	SJRPC	BLGILL	153	L	82	1.60	8.89

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
04/28/89	SJRPC	BLGILL	176	L	81	1.90	10.00
* LOCATION	SNDSL						
12/01/89	SNDSL	BLGILL	103	F	79	0.21	1.01
12/01/89	SNDSL	BLGILL	160	F	78	0.25	1.16
12/01/89	SNDSL	BLGILL	143	F	79	0.17	0.79
04/05/90	SNDSL	BLGILL	132	F	80	0.18	0.90
04/05/90	SNDSL	BLGILL	155	F	79	0.19	0.92
04/05/90	SNDSL	BLGILL	145	F	79	0.22	1.05
12/01/89	SNDSL	BLGILL	160	L	82	0.90	5.08
12/01/89	SNDSL	BLGILL	143	L	83	0.72	4.31
12/01/89	SNDSL	BLGILL	103	L	82	0.89	5.03
04/05/90	SNDSL	BLGILL	155	L	83	0.74	4.33
04/05/90	SNDSL	BLGILL	132	L	83	0.76	4.37
04/05/90	SNDSL	BLGILL	145	L	82	0.64	3.50
* LOCATION	STINW						
10/05/88	STINW	BLGILL	40	W	82	0.19	1.06
* LOCATION	STMSL						
11/07/89	STMSL	BLGILL	141	F	79	0.47	2.21
11/07/89	STMSL	BLGILL	168	F	79	0.31	1.46
04/11/90	STMSL	BLGILL	138	F	79	0.34	1.60
11/07/89	STMSL	BLGILL	168	L	83	1.00	5.71
11/07/89	STMSL	BLGILL	141	L	82	1.30	7.34
04/11/90	STMSL	BLGILL	138	L	82	0.97	5.30
11/07/89	STMSL	BLGILL	83	W	73	0.24	0.88
04/11/90	STMSL	BLGILL	89	W	77	0.31	1.37
* LOCATION	VRNLS						
10/24/89	VRNLS	BLGILL	164	F	78	0.71	3.27
10/24/89	VRNLS	BLGILL	154	F	78	0.74	3.39
10/24/89	VRNLS	BLGILL	186	F	76	0.75	3.10
10/24/89	VRNLS	BLGILL	178	F	78	0.68	3.06
04/02/90	VRNLS	BLGILL	129	F	80	0.58	2.94
04/02/90	VRNLS	BLGILL	146	F	79	0.72	3.50
04/02/90	VRNLS	BLGILL	133	F	80	0.72	3.55
10/24/89	VRNLS	BLGILL	154	L	82	1.60	9.04
10/24/89	VRNLS	BLGILL	178	L	80	1.90	9.69
10/24/89	VRNLS	BLGILL	164	L	79	1.80	8.53
10/24/89	VRNLS	BLGILL	186	L	81	2.20	11.34
04/02/90	VRNLS	BLGILL	146	L	81	1.90	10.11
04/02/90	VRNLS	BLGILL	129	L	84	1.40	8.97
04/02/90	VRNLS	BLGILL	133	L	82	1.80	9.73

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES BLKBHD							
* LOCATION MUDSL							
11/15/89	MUDSL	BLKBHD	150	W	78	0.62	2.86
** SPECIES BRNBHD							
* LOCATION MUDSL							
04/13/89	MUDSL	BRNBHD	119	F	83	0.44	2.59
04/13/89	MUDSL	BRNBHD	148	F	82	0.48	2.67
04/13/89	MUDSL	BRNBHD	148	L	86	1.80	12.86
04/13/89	MUDSL	BRNBHD	119	L	86	1.60	11.43
* LOCATION SNDSL							
12/11/89	SNDSL	BRNBHD	300	F	78	0.10	0.44
12/11/89	SNDSL	BRNBHD	300	L	83	1.35	7.94
** SPECIES BULFRG							
* LOCATION BVRSL							
11/30/89	BVRSL	BULFRG	125	F	80	0.06	0.30
11/30/89	BVRSL	BULFRG	125	L	78	0.66	3.04
* LOCATION SALTS							
03/14/90	SALTS	BULFRG	195	F	81	0.78	4.11
03/14/90	SALTS	BULFRG	195	L	81	7.30	38.83
* LOCATION SJRAM							
11/28/89	SJRAM	BULFRG	110	F	80	0.45	2.27
11/28/89	SJRAM	BULFRG	110	L	80	3.00	14.85
** SPECIES CARPPP							
* LOCATION BVRSL							
11/30/89	BVRSL	CARPPP	236	F	79	0.07	0.34
11/30/89	BVRSL	CARPPP	345	F	77	0.11	0.48
* LOCATION CRSNT							
05/22/89	CRSNT	CARPPP	321	F	78	0.14	0.64
05/22/89	CRSNT	CARPPP	362	F	77	0.19	0.83
05/22/89	CRSNT	CARPPP	384	F	78	0.20	0.91
* LOCATION EMPRW							
05/23/89	EMPRW	CARPPP	299	F	76	0.22	0.92
05/23/89	EMPRW	CARPPP	315	F	77	0.20	0.87
05/23/89	EMPRW	CARPPP	334	F	77	0.22	0.96

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION	MUDSL						
11/15/89	MUDSL	CARPPP	439	F	77	0.74	3.27
11/15/89	MUDSL	CARPPP	450	F	73	0.52	1.94
11/15/89	MUDSL	CARPPP	408	F	79	0.73	3.41
03/13/90	MUDSL	CARPPP	505	F	78	0.87	4.03
03/15/90	MUDSL	CARPPP	175	F	80	0.56	2.73
* LOCATION	OLDRV						
11/29/89	OLDRV	CARPPP	396	F	78	0.56	2.57
11/29/89	OLDRV	CARPPP	385	F	75	0.59	2.35
* LOCATION	PEOPW						
05/23/89	PEOPW	CARPPP	445	F	77	0.19	0.83
05/23/89	PEOPW	CARPPP	395	F	78	0.25	1.14
05/23/89	PEOPW	CARPPP	425	F	77	0.22	0.96
* LOCATION	SALTS						
11/17/89	SALTS	CARPPP	316	F	80	1.30	6.63
03/14/90	SALTS	CARPPP	320	F	78	2.10	9.72
03/14/90	SALTS	CARPPP	299	F	79	1.40	6.76
03/14/90	SALTS	CARPPP	328	F	79	2.00	9.39
* LOCATION	SJRAM						
11/28/89	SJRAM	CARPPP	320	F	78	0.95	4.36
11/28/89	SJRAM	CARPPP	254	F	78	0.90	4.07
11/28/89	SJRAM	CARPPP	199	F	79	0.94	4.56
03/28/90	SJRAM	CARPPP	294	F	81	0.71	3.66
03/28/90	SJRAM	CARPPP	292	F	79	0.95	4.55
* LOCATION	SJRLN						
11/16/89	SJRLN	CARPPP	394	F	79	0.33	1.59
03/15/90	SJRLN	CARPPP	305	F	80	0.38	1.86
03/15/90	SJRLN	CARPPP	318	F	80	0.31	1.52
* LOCATION	VRNLS						
04/02/90	VRNLS	CARPPP	368	F	78	0.55	2.47
04/02/90	VRNLS	CARPPP	356	F	80	0.48	2.34
** SPECIES	CHNCAT						
* LOCATION	AGTHA						
08/24/88	AGTHA	CHNCAT	175	F	81	1.20	6.32
08/24/88	AGTHA	CHNCAT	157	F	80	1.80	9.00
08/24/88	AGTHA	CHNCAT	294	F	80	1.40	7.00
08/24/88	AGTHA	CHNCAT	140	F	81	1.00	5.26
08/24/88	AGTHA	CHNCAT	256	F	81	1.50	7.89
08/24/88	AGTHA	CHNCAT	168	F	80	1.40	7.00

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
08/24/88	AGTHA	CHNCAT	296	F	77	1.70	7.39
08/24/88	AGTHA	CHNCAT	305	F	79	1.40	6.67
08/24/88	AGTHA	CHNCAT	294	F	80	1.50	7.50
08/24/88	AGTHA	CHNCAT	246	F	79	1.60	7.62
08/24/88	AGTHA	CHNCAT	270	F	78	1.90	8.64
08/24/88	AGTHA	CHNCAT	350	F	81	1.10	5.79
08/24/88	AGTHA	CHNCAT	345	F	81	1.90	10.00
08/24/88	AGTHA	CHNCAT	360	F	79	1.20	5.71
08/24/88	AGTHA	CHNCAT	206	F	81	1.40	7.37
08/25/88	AGTHA	CHNCAT	385	F	79	1.10	5.24
08/25/88	AGTHA	CHNCAT	265	F	75	2.10	8.40
08/25/88	AGTHA	CHNCAT	195	F	81	1.20	6.32
08/25/88	AGTHA	CHNCAT	180	F	80	2.00	10.00
08/25/88	AGTHA	CHNCAT	197	F	81	1.30	6.84
08/25/88	AGTHA	CHNCAT	350	F	79	0.99	4.71
08/25/88	AGTHA	CHNCAT	190	F	80	1.60	8.00
08/25/88	AGTHA	CHNCAT	160	F	82	1.30	7.22
08/25/88	AGTHA	CHNCAT	278	F	77	1.10	4.78
08/24/88	AGTHA	CHNCAT	331	L	81	3.90	20.53
08/24/88	AGTHA	CHNCAT	272	L	80	3.70	18.50
08/24/88	AGTHA	CHNCAT	169	L	82	3.50	19.44
08/25/88	AGTHA	CHNCAT	320	L	81	3.80	20.00
08/25/88	AGTHA	CHNCAT	184	L	82	3.10	17.22
* LOCATION	BVRSL						
11/30/89	BVRSL	CHNCAT	520	F	75	0.08	0.33
11/30/89	BVRSL	CHNCAT	400	F	76	0.07	0.29
11/30/89	BVRSL	CHNCAT	450	F	77	0.11	0.47
11/30/89	BVRSL	CHNCAT	450	L	82	0.74	4.04
11/30/89	BVRSL	CHNCAT	520	L	81	0.71	3.78
11/30/89	BVRSL	CHNCAT	400	L	78	0.73	3.32
* LOCATION	CMP13						
04/12/89	CMP13	CHNCAT	338	F	83	0.91	5.35
04/12/89	CMP13	CHNCAT	62	F	79	0.17	0.81
04/12/89	CMP13	CHNCAT	62	L	81	3.90	20.53
04/12/89	CMP13	CHNCAT	338	L	80	3.90	19.50
* LOCATION	MIDRV						
12/08/88	MIDRV	CHNCAT	220	F	81	0.21	1.11
12/08/88	MIDRV	CHNCAT	220	L	79	1.40	6.67
* LOCATION	MUDSL						
11/30/88	MUDSL	CHNCAT	483	F	79	0.43	2.05
03/30/89	MUDSL	CHNCAT	595	F	81	0.09	0.47
03/30/89	MUDSL	CHNCAT	229	F	80	0.42	2.10
11/15/89	MUDSL	CHNCAT	462	F	77	0.37	1.59

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
11/30/88	MUDSL	CHNCAT	483	L	79	2.20	10.48
03/30/89	MUDSL	CHNCAT	595	L	81	1.60	8.42
03/30/89	MUDSL	CHNCAT	229	L	84	1.80	11.25
11/15/89	MUDSL	CHNCAT	462	L	83	1.40	8.28
* LOCATION OLDRV							
11/17/88	OLDRV	CHNCAT	360	F	78	0.22	1.00
03/09/89	OLDRV	CHNCAT	247	F	78	0.24	1.09
11/17/88	OLDRV	CHNCAT	360	L	79	1.50	7.14
03/09/89	OLDRV	CHNCAT	247	L	81	1.60	8.42
* LOCATION SALTS							
08/26/88	SALTS	CHNCAT	257	F	80	0.52	2.60
11/29/88	SALTS	CHNCAT	258	F	80	0.40	2.00
11/29/88	SALTS	CHNCAT	225	F	82	0.32	1.78
03/30/89	SALTS	CHNCAT	341	F	76	0.28	1.17
03/30/89	SALTS	CHNCAT	240	F	82	0.36	2.00
03/30/89	SALTS	CHNCAT	314	F	80	0.42	2.10
08/26/88	SALTS	CHNCAT	257	L	81	2.40	12.63
11/29/88	SALTS	CHNCAT	258	L	79	1.30	6.19
11/29/88	SALTS	CHNCAT	225	L	79	1.60	7.62
03/30/89	SALTS	CHNCAT	314	L	82	2.10	11.67
03/30/89	SALTS	CHNCAT	240	L	82	2.10	11.67
03/30/89	SALTS	CHNCAT	341	L	82	2.00	11.11
* LOCATION SJRDR							
11/21/88	SJRDR	CHNCAT	395	F	78	0.17	0.77
11/21/88	SJRDR	CHNCAT	395	L	77	1.30	5.65
* LOCATION SJRLN							
08/25/88	SJRLN	CHNCAT	296	F	80	0.21	1.05
08/25/88	SJRLN	CHNCAT	233	F	80	0.20	1.00
04/12/89	SJRLN	CHNCAT	204	F	81	0.30	1.58
04/12/89	SJRLN	CHNCAT	310	F	79	0.14	0.67
11/21/89	SJRLN	CHNCAT	195	F	79	0.16	0.77
08/25/88	SJRLN	CHNCAT	233	L	81	1.40	7.37
08/25/88	SJRLN	CHNCAT	296	L	81	1.40	7.37
04/12/89	SJRLN	CHNCAT	310	L	81	1.20	6.32
04/12/89	SJRLN	CHNCAT	204	L	82	1.80	10.00
11/21/89	SJRLN	CHNCAT	195	L	81	0.70	3.66
* LOCATION SJRMR							
08/25/88	SJRMR	CHNCAT	307	F	79	0.30	1.43
08/25/88	SJRMR	CHNCAT	261	F	79	0.29	1.38
11/29/88	SJRMR	CHNCAT	258	F	80	0.25	1.25
11/29/88	SJRMR	CHNCAT	217	F	81	0.26	1.37
03/31/89	SJRMR	CHNCAT	204	F	80	0.30	1.50

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/31/89	SJRMR	CHNCAT	279	F	77	0.13	0.57
03/31/89	SJRMR	CHNCAT	262	F	80	0.27	1.35
08/25/88	SJRMR	CHNCAT	307	L	81	1.70	8.95
08/25/88	SJRMR	CHNCAT	261	L	80	1.50	7.50
11/29/88	SJRMR	CHNCAT	258	L	79	1.20	5.71
11/29/88	SJRMR	CHNCAT	217	L	79	0.88	4.19
03/31/89	SJRMR	CHNCAT	204	L	83	1.80	10.59
03/31/89	SJRMR	CHNCAT	279	L	82	1.50	8.33
03/31/89	SJRMR	CHNCAT	262	L	80	2.00	10.00
* LOCATION SJRPC							
04/28/89	SJRPC	CHNCAT	337	F	76	0.27	1.13
04/28/89	SJRPC	CHNCAT	337	L	79	1.65	7.86
* LOCATION VRNLS							
12/15/88	VRNLS	CHNCAT	218	F	81	0.26	1.37
12/15/88	VRNLS	CHNCAT	291	F	78	0.19	0.86
12/15/88	VRNLS	CHNCAT	260	F	79	0.16	0.76
10/24/89	VRNLS	CHNCAT	392	F	77	0.24	1.02
12/15/88	VRNLS	CHNCAT	260	L	79	1.00	4.76
12/15/88	VRNLS	CHNCAT	291	L	78	1.30	5.91
12/15/88	VRNLS	CHNCAT	218	L	77	1.30	5.65
10/24/89	VRNLS	CHNCAT	392	L	80	1.20	6.09
** SPECIES CRPPIE							
* LOCATION EMPRW							
10/04/88	EMPRW	CRPPIE	173	F	80	0.15	0.75
05/23/89	EMPRW	CRPPIE	200	F	81	0.14	0.74
10/04/88	EMPRW	CRPPIE	173	L	84	0.86	5.38
05/23/89	EMPRW	CRPPIE	200	L	80	0.45	2.25
* LOCATION PEOPW							
05/23/89	PEOPW	CRPPIE	145	F	81	0.16	0.84
05/23/89	PEOPW	CRPPIE	145	L	80	0.64	3.20
* LOCATION SJRDR							
11/21/88	SJRDR	CRPPIE	162	F	81	0.52	2.74
11/21/88	SJRDR	CRPPIE	162	L	80	3.00	15.00
* LOCATION SJRLN							
11/16/89	SJRLN	CRPPIE	196	F	77	0.10	0.44
11/16/89	SJRLN	CRPPIE	196	L	0	0.42	0.00
* LOCATION SJRPC							
12/12/88	SJRPC	CRPPIE	279	F	79	0.44	2.10
04/28/89	SJRPC	CRPPIE	260	F	79	0.33	1.57

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
12/12/88	SJRPC	CRPPIE	279	L	76	1.70	7.08
04/28/89	SJRPC	CRPPIE	260	L	80	2.00	10.00
** SPECIES FATHED							
* LOCATION MUDSL							
12/16/88	MUDSL	FATHED	59	W	79	1.40	6.67
* LOCATION SALTS							
12/13/88	SALTS	FATHED	57	W	79	1.30	6.19
12/13/88	SALTS	FATHED	43	W	87	0.80	6.15
12/13/88	SALTS	FATHED	48	W	80	1.20	6.00
03/30/89	SALTS	FATHED	52	W	78	1.60	7.27
* LOCATION SJRLN							
04/12/89	SJRLN	FATHED	56	W	78	0.70	3.18
* LOCATION SJRMR							
12/16/88	SJRMR	FATHED	46	W	83	0.70	4.12
03/31/89	SJRMR	FATHED	52	W	77	0.78	3.39
** SPECIES GAMBSA							
* LOCATION MUDSL							
08/25/88	MUDSL	GAMBSA	36	W	80	1.10	5.50
03/30/89	MUDSL	GAMBSA	0	W	79	1.10	5.24
03/30/89	MUDSL	GAMBSA	0	W	78	1.20	5.45
* LOCATION SALTS							
08/26/88	SALTS	GAMBSA	33	W	83	0.93	5.47
* LOCATION SJRLN							
08/25/88	SJRLN	GAMBSA	39	W	79	0.30	1.43
12/01/88	SJRLN	GAMBSA	33	W	81	0.27	1.42
* LOCATION SJRMR							
08/25/88	SJRMR	GAMBSA	38	W	81	0.67	3.53
03/31/89	SJRMR	GAMBSA	0	W	83	0.37	2.18
* LOCATION STINW							
10/05/88	STINW	GAMBSA	43	W	80	0.20	1.00
10/05/88	STINW	GAMBSA	43	W	81	0.18	0.95
10/05/88	STINW	GAMBSA	45	W	80	0.18	0.90

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES GRNSNF							
* LOCATION EMPRW							
05/23/89	EMPRW	GRNSNF	130	F	80	0.13	0.65
05/23/89	EMPRW	GRNSNF	164	F	81	0.11	0.58
05/23/89	EMPRW	GRNSNF	164	L	86	0.50	3.57
05/23/89	EMPRW	GRNSNF	130	L	86	0.53	3.79
* LOCATION MUDSL							
03/30/89	MUDSL	GRNSNF	98	F	79	0.95	4.52
03/30/89	MUDSL	GRNSNF	98	L	86	1.50	10.71
08/25/88	MUDSL	GRNSNF	41	W	77	1.20	5.22
04/13/89	MUDSL	GRNSNF	58	W	79	1.20	5.71
11/15/89	MUDSL	GRNSNF	96	W	76	0.94	3.95
* LOCATION OLDRV							
11/17/88	OLDRV	GRNSNF	146	F	79	0.62	2.95
11/17/88	OLDRV	GRNSNF	146	L	86	1.20	8.57
* LOCATION PEOPW							
05/23/89	PEOPW	GRNSNF	165	F	81	0.12	0.63
05/23/89	PEOPW	GRNSNF	165	L	86	0.86	6.14
* LOCATION SALTS							
08/26/88	SALTS	GRNSNF	33	W	82	1.10	6.11
* LOCATION SJRDR							
09/07/88	SJRDR	GRNSNF	138	F	79	0.60	2.86
11/21/88	SJRDR	GRNSNF	132	F	79	0.64	3.05
04/21/89	SJRDR	GRNSNF	119	F	78	0.71	3.23
09/07/88	SJRDR	GRNSNF	138	L	85	1.30	8.67
11/21/88	SJRDR	GRNSNF	132	L	86	2.20	15.71
04/21/89	SJRDR	GRNSNF	119	L	86	2.10	15.00
* LOCATION SJRLN							
11/30/88	SJRLN	GRNSNF	134	F	79	0.17	0.81
11/30/88	SJRLN	GRNSNF	134	L	86	0.79	5.64
04/12/89	SJRLN	GRNSNF	57	W	79	0.29	1.38
04/12/89	SJRLN	GRNSNF	61	W	79	0.31	1.48
* LOCATION SJRMR							
08/25/88	SJRMR	GRNSNF	39	W	80	0.76	3.80
03/31/89	SJRMR	GRNSNF	112	W	76	0.53	2.21
03/31/89	SJRMR	GRNSNF	56	W	78	0.77	3.50

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES GSTRGN							
* LOCATION SACRV							
10/23/89	SACRV	GSTRGN	280	F	82	0.33	1.80
10/23/89	SACRV	GSTRGN	280	L	81	0.80	4.23
** SPECIES INDLSS							
* LOCATION BVRSL							
11/30/89	BVRSL	INDLSS	72	W	77	0.20	0.86
** SPECIES INLDSS							
* LOCATION CRSNT							
05/22/89	CRSNT	INLDSS	0	W	79	0.24	1.14
05/22/89	CRSNT	INLDSS	0	W	78	0.24	1.09
* LOCATION MUDSL							
08/25/88	MUDSL	INLDSS	56	W	78	1.30	5.91
12/16/88	MUDSL	INLDSS	450	W	83	1.10	6.47
12/16/88	MUDSL	INLDSS	51	W	83	1.10	6.47
12/16/88	MUDSL	INLDSS	71	W	80	1.50	7.50
03/30/89	MUDSL	INLDSS	0	W	77	1.20	5.22
03/30/89	MUDSL	INLDSS	0	W	77	1.30	5.65
03/30/89	MUDSL	INLDSS	0	W	78	1.10	5.00
10/20/89	MUDSL	INLDSS	73	W	77	1.10	4.70
10/20/89	MUDSL	INLDSS	79	W	77	1.10	4.68
10/20/89	MUDSL	INLDSS	68	W	78	0.86	3.87
* LOCATION SALTS							
08/25/88	SALTS	INLDSS	52	W	79	0.99	4.71
12/13/88	SALTS	INLDSS	45	W	80	1.20	6.00
12/13/88	SALTS	INLDSS	71	W	78	1.00	4.55
12/13/88	SALTS	INLDSS	51	W	80	1.10	5.50
10/23/89	SALTS	INLDSS	50	W	80	0.87	4.35
* LOCATION SJRAM							
11/28/89	SJRAM	INLDSS	72	W	78	0.78	3.48
* LOCATION SJRLN							
08/25/88	SJRLN	INLDSS	48	W	77	0.36	1.57
12/01/88	SJRLN	INLDSS	64	W	79	0.29	1.38
12/01/88	SJRLN	INLDSS	59	W	79	0.27	1.29
04/12/89	SJRLN	INLDSS	0	W	77	0.37	1.61
04/12/89	SJRLN	INLDSS	0	W	79	0.31	1.48
04/12/89	SJRLN	INLDSS	0	W	78	0.34	1.55

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION SJRMR							
12/16/88	SJRMR	INLDSS	60	W	79	0.81	3.86
12/16/88	SJRMR	INLDSS	64	W	78	0.84	3.82
* LOCATION SNDSL							
12/01/89	SNDSL	INLDSS	56	W	75	0.26	1.03
* LOCATION VRNLS							
10/24/89	VRNLS	INLDSS	68	W	80	0.50	2.46
** SPECIES LMBASS							
* LOCATION BVRSL							
11/30/89	BVRSL	LMBASS	375	F	77	0.15	0.66
11/30/89	BVRSL	LMBASS	360	F	77	0.20	0.88
11/30/89	BVRSL	LMBASS	196	F	79	0.14	0.66
04/10/90	BVRSL	LMBASS	275	F	79	0.18	0.84
04/10/90	BVRSL	LMBASS	205	F	79	0.19	0.92
04/10/90	BVRSL	LMBASS	316	F	80	0.20	0.98
11/30/89	BVRSL	LMBASS	375	L	81	0.86	4.55
11/30/89	BVRSL	LMBASS	360	L	80	0.77	3.87
11/30/89	BVRSL	LMBASS	196	L	84	0.47	2.87
04/10/90	BVRSL	LMBASS	316	L	81	0.66	3.53
04/10/90	BVRSL	LMBASS	205	L	80	0.62	3.07
04/10/90	BVRSL	LMBASS	275	L	81	0.66	3.38
* LOCATION EMPRW							
10/04/88	EMPRW	LMBASS	248	F	79	0.14	0.67
10/04/88	EMPRW	LMBASS	106	F	81	0.14	0.74
10/04/88	EMPRW	LMBASS	138	F	81	0.12	0.63
05/23/89	EMPRW	LMBASS	316	F	79	0.14	0.67
05/23/89	EMPRW	LMBASS	283	F	79	0.15	0.71
05/23/89	EMPRW	LMBASS	219	F	79	0.18	0.86
10/04/88	EMPRW	LMBASS	138	L	82	0.44	2.44
10/04/88	EMPRW	LMBASS	248	L	80	0.59	2.95
10/04/88	EMPRW	LMBASS	106	L	85	0.35	2.33
05/23/89	EMPRW	LMBASS	316	L	78	0.67	3.05
05/23/89	EMPRW	LMBASS	219	L	79	0.69	3.29
05/23/89	EMPRW	LMBASS	283	L	78	0.74	3.36
* LOCATION MIDRV							
09/07/88	MIDRV	LMBASS	320	F	79	0.59	2.81
04/21/89	MIDRV	LMBASS	224	F	79	0.67	3.19
04/21/89	MIDRV	LMBASS	285	F	80	0.44	2.20
09/07/88	MIDRV	LMBASS	320	L	78	2.00	9.09
04/21/89	MIDRV	LMBASS	224	L	78	1.80	8.18
04/21/89	MIDRV	LMBASS	285	L	77	1.40	6.09

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION	OLDRV						
09/07/88	OLDRV	LMBASS	172	F	79	0.60	2.86
11/17/88	OLDRV	LMBASS	249	F	79	0.48	2.29
04/21/89	OLDRV	LMBASS	330	F	79	0.50	2.38
11/29/89	OLDRV	LMBASS	342	F	77	0.69	3.05
11/29/89	OLDRV	LMBASS	268	F	78	0.51	2.35
11/29/89	OLDRV	LMBASS	270	F	78	0.60	2.73
03/29/90	OLDRV	LMBASS	290	F	79	0.46	2.16
03/29/90	OLDRV	LMBASS	415	F	77	0.53	2.28
09/07/88	OLDRV	LMBASS	172	L	81	1.30	6.84
11/17/88	OLDRV	LMBASS	249	L	77	1.40	6.09
04/21/89	OLDRV	LMBASS	330	L	80	1.20	6.00
11/29/89	OLDRV	LMBASS	268	L	82	0.99	5.56
11/29/89	OLDRV	LMBASS	342	L	80	1.20	6.06
11/29/89	OLDRV	LMBASS	270	L	81	1.20	6.35
03/29/90	OLDRV	LMBASS	290	L	82	1.10	6.18
03/29/90	OLDRV	LMBASS	415	L	79	1.80	8.49
* LOCATION	PEOPW						
10/05/88	PEOPW	LMBASS	156	F	80	0.17	0.85
10/05/88	PEOPW	LMBASS	79	F	76	0.24	1.00
10/05/88	PEOPW	LMBASS	75	F	77	0.25	1.09
05/23/89	PEOPW	LMBASS	283	F	79	0.18	0.86
05/23/89	PEOPW	LMBASS	243	F	79	0.20	0.95
10/05/88	PEOPW	LMBASS	156	L	77	0.60	2.61
05/23/89	PEOPW	LMBASS	243	L	78	0.92	4.18
05/23/89	PEOPW	LMBASS	283	L	79	0.89	4.24
* LOCATION	SALTS						
12/13/88	SALTS	LMBASS	352	F	79	0.94	4.48
03/30/89	SALTS	LMBASS	240	F	79	0.48	2.29
03/30/89	SALTS	LMBASS	450	F	79	0.56	2.67
11/17/89	SALTS	LMBASS	440	F	77	1.60	7.05
12/13/88	SALTS	LMBASS	352	L	78	2.10	9.55
03/30/89	SALTS	LMBASS	240	L	78	2.30	10.45
03/30/89	SALTS	LMBASS	450	L	82	1.60	8.89
11/17/89	SALTS	LMBASS	440	L	78	2.75	12.50
03/14/90	SALTS	LMBASS	113	W	77	2.00	8.73
* LOCATION	SJRAM						
10/19/89	SJRAM	LMBASS	363	F	78	0.60	2.70
10/19/89	SJRAM	LMBASS	298	F	77	0.48	2.08
10/19/89	SJRAM	LMBASS	300	F	77	0.46	2.03
03/28/90	SJRAM	LMBASS	354	F	80	0.40	1.97
10/19/89	SJRAM	LMBASS	298	L	79	1.10	5.19
10/19/89	SJRAM	LMBASS	363	L	80	2.00	10.20

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
10/19/89	SJRAM	LMBASS	300	L	79	1.10	5.16
03/28/90	SJRAM	LMBASS	354	L	80	1.60	8.12
* LOCATION	SJRDR						
09/07/88	SJRDR	LMBASS	189	F	80	0.60	3.00
11/21/88	SJRDR	LMBASS	245	F	80	0.62	3.10
04/21/89	SJRDR	LMBASS	196	F	79	0.54	2.57
04/21/89	SJRDR	LMBASS	225	F	79	0.44	2.10
04/21/89	SJRDR	LMBASS	230	F	80	0.49	2.45
09/07/88	SJRDR	LMBASS	189	L	81	1.60	8.42
11/21/88	SJRDR	LMBASS	245	L	82	1.30	7.22
04/21/89	SJRDR	LMBASS	196	L	81	1.50	7.89
04/21/89	SJRDR	LMBASS	230	L	77	1.50	6.52
04/21/89	SJRDR	LMBASS	225	L	77	1.50	6.52
* LOCATION	SJRLN						
11/16/89	SJRLN	LMBASS	424	F	78	0.44	1.96
11/16/89	SJRLN	LMBASS	307	F	77	0.30	1.31
03/15/90	SJRLN	LMBASS	375	F	78	0.20	0.92
03/15/90	SJRLN	LMBASS	460	F	79	0.25	1.16
11/16/89	SJRLN	LMBASS	307	L	76	0.80	3.39
11/16/89	SJRLN	LMBASS	424	L	79	0.77	3.62
03/15/90	SJRLN	LMBASS	375	L	80	0.55	2.74
03/15/90	SJRLN	LMBASS	460	L	80	0.74	3.76
* LOCATION	SJRMR						
12/16/88	SJRMR	LMBASS	123	W	78	0.75	3.41
* LOCATION	SJRPC						
12/12/88	SJRPC	LMBASS	350	F	79	0.28	1.33
12/12/88	SJRPC	LMBASS	234	F	77	0.62	2.70
04/28/89	SJRPC	LMBASS	250	F	78	0.93	4.23
04/28/89	SJRPC	LMBASS	182	F	76	0.53	2.21
12/12/88	SJRPC	LMBASS	350	L	78	0.96	4.36
12/12/88	SJRPC	LMBASS	234	L	77	1.10	4.78
04/28/89	SJRPC	LMBASS	182	L	81	1.20	6.32
04/28/89	SJRPC	LMBASS	250	L	80	1.80	9.00
* LOCATION	SNDSL						
12/01/89	SNDSL	LMBASS	349	F	76	0.20	0.84
12/01/89	SNDSL	LMBASS	287	F	77	0.26	1.11
12/01/89	SNDSL	LMBASS	193	F	77	0.18	0.79
04/05/90	SNDSL	LMBASS	126	F	80	0.28	1.42
04/05/90	SNDSL	LMBASS	318	F	78	0.20	0.93
04/05/90	SNDSL	LMBASS	316	F	78	0.22	0.99
12/01/89	SNDSL	LMBASS	349	L	82	0.76	4.15
12/01/89	SNDSL	LMBASS	193	L	80	0.59	2.99

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
12/01/89	SNDSL	LMBASS	287	L	80	0.70	3.50
04/05/90	SNDSL	LMBASS	126	L	80	0.84	4.29
04/05/90	SNDSL	LMBASS	316	L	81	0.64	3.30
04/05/90	SNDSL	LMBASS	318	L	80	0.74	3.78
* LOCATION	STMSL						
11/07/89	STMSL	LMBASS	195	F	79	0.24	1.13
11/07/89	STMSL	LMBASS	373	F	76	0.25	1.06
11/07/89	STMSL	LMBASS	225	F	78	0.27	1.22
04/11/90	STMSL	LMBASS	340	F	79	0.21	0.98
04/11/90	STMSL	LMBASS	355	F	79	0.24	1.14
04/11/90	STMSL	LMBASS	304	F	79	0.22	1.03
11/07/89	STMSL	LMBASS	373	L	79	0.48	2.25
11/07/89	STMSL	LMBASS	195	L	82	0.57	3.22
11/07/89	STMSL	LMBASS	225	L	81	0.85	4.43
04/11/90	STMSL	LMBASS	340	L	81	0.74	3.89
04/11/90	STMSL	LMBASS	304	L	82	0.83	4.59
04/11/90	STMSL	LMBASS	355	L	82	0.78	4.29
* LOCATION	VRNLS						
10/24/89	VRNLS	LMBASS	345	F	78	0.53	2.38
04/02/90	VRNLS	LMBASS	432	F	79	0.57	2.74
04/02/90	VRNLS	LMBASS	321	F	79	0.54	2.57
10/24/89	VRNLS	LMBASS	345	L	82	1.50	8.29
04/02/90	VRNLS	LMBASS	432	L	80	1.40	7.11
04/02/90	VRNLS	LMBASS	321	L	81	1.10	5.70
** SPECIES	RDSHNR						
* LOCATION	MUDSL						
03/30/89	MUDSL	RDSHNR	39	W	80	0.85	4.25
* LOCATION	SALTS						
12/13/88	SALTS	RDSHNR	43	W	78	0.96	4.36
12/13/88	SALTS	RDSHNR	44	W	79	1.10	5.24
03/30/89	SALTS	RDSHNR	0	W	77	1.00	4.35
03/30/89	SALTS	RDSHNR	0	W	75	1.10	4.40
03/30/89	SALTS	RDSHNR	0	W	73	1.10	4.07
* LOCATION	SJRLN						
12/01/88	SJRLN	RDSHNR	46	W	77	0.41	1.78
04/12/89	SJRLN	RDSHNR	52	W	74	0.45	1.73
04/12/89	SJRLN	RDSHNR	45	W	76	0.45	1.88
04/12/89	SJRLN	RDSHNR	58	W	74	0.46	1.77
* LOCATION	SJRMR						
12/16/88	SJRMR	RDSHNR	38	W	79	0.70	3.33

1988-1990 FISH TISSUE
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SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
12/16/88	SJRMR	RDSHNR	41	W	80	0.63	3.15
12/16/88	SJRMR	RDSHNR	39	W	83	0.52	3.06
03/31/89	SJRMR	RDSHNR	0	W	79	0.66	3.14
03/31/89	SJRMR	RDSHNR	0	W	77	0.64	2.78
03/31/89	SJRMR	RDSHNR	0	W	79	0.59	2.81
** SPECIES REDEAR							
* LOCATION EMPRW							
10/04/88	EMPRW	REDEAR	103	F	80	0.21	1.05
10/04/88	EMPRW	REDEAR	141	F	80	0.15	0.75
10/04/88	EMPRW	REDEAR	126	F	80	0.21	1.05
10/04/88	EMPRW	REDEAR	141	L	87	0.77	5.92
10/04/88	EMPRW	REDEAR	126	L	85	0.72	4.80
* LOCATION MIDRV							
09/07/88	MIDRV	REDEAR	180	F	79	0.68	3.24
04/21/89	MIDRV	REDEAR	154	F	78	0.88	4.00
09/07/88	MIDRV	REDEAR	180	L	85	2.30	15.33
04/21/89	MIDRV	REDEAR	154	L	80	1.80	9.00
04/21/89	MIDRV	REDEAR	67	W	76	0.87	3.63
* LOCATION OLDRV							
11/17/88	OLDRV	REDEAR	206	F	79	0.86	4.10
04/21/89	OLDRV	REDEAR	225	F	76	1.30	5.42
11/17/88	OLDRV	REDEAR	206	L	83	2.10	12.35
04/21/89	OLDRV	REDEAR	225	L	82	3.00	16.67
04/21/89	OLDRV	REDEAR	79	W	76	1.10	4.58
* LOCATION SALTS							
12/13/88	SALTS	REDEAR	69	W	80	1.00	5.00
11/17/89	SALTS	REDEAR	95	W	76	2.10	8.86
* LOCATION SJRDR							
09/07/88	SJRDR	REDEAR	148	F	78	0.99	4.50
09/07/88	SJRDR	REDEAR	215	F	78	0.76	3.45
11/21/88	SJRDR	REDEAR	224	F	80	0.71	3.55
11/21/88	SJRDR	REDEAR	173	F	79	0.89	4.24
04/21/89	SJRDR	REDEAR	126	F	80	0.80	4.00
09/07/88	SJRDR	REDEAR	148	L	81	1.70	8.95
09/07/88	SJRDR	REDEAR	215	L	82	2.40	13.33
11/21/88	SJRDR	REDEAR	173	L	82	1.90	10.56
11/21/88	SJRDR	REDEAR	224	L	82	3.50	19.44
04/21/89	SJRDR	REDEAR	126	L	80	2.20	11.00
* LOCATION SJRLN							
12/01/88	SJRLN	REDEAR	145	F	79	0.26	1.24

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
12/01/88	SJRLN	REDEAR	145	L	78	0.74	3.36
* LOCATION SJRMR							
12/16/88	SJRMR	REDEAR	93	W	74	1.30	5.00
* LOCATION SJRPC							
12/12/88	SJRPC	REDEAR	192	F	79	1.00	4.76
04/28/89	SJRPC	REDEAR	196	F	76	1.10	4.58
04/28/89	SJRPC	REDEAR	214	F	77	0.94	4.09
12/12/88	SJRPC	REDEAR	192	L	82	1.70	9.44
04/28/89	SJRPC	REDEAR	196	L	80	2.70	13.50
04/28/89	SJRPC	REDEAR	214	L	79	2.40	11.43
** SPECIES SMBASS							
* LOCATION OLDRV							
11/17/88	OLDRV	SMBASS	193	F	79	0.35	1.67
04/21/89	OLDRV	SMBASS	200	F	76	0.47	1.96
04/21/89	OLDRV	SMBASS	188	F	79	0.42	2.00
11/17/88	OLDRV	SMBASS	193	L	77	1.00	4.35
04/21/89	OLDRV	SMBASS	200	L	79	1.20	5.71
04/21/89	OLDRV	SMBASS	188	L	79	1.00	4.76
* LOCATION PEOPW							
05/23/89	PEOPW	SMBASS	163	F	79	0.24	1.14
05/23/89	PEOPW	SMBASS	163	L	82	0.81	4.50
* LOCATION SJRDR							
11/21/88	SJRDR	SMBASS	176	F	79	0.48	2.29
11/21/88	SJRDR	SMBASS	221	F	78	0.35	1.59
11/21/88	SJRDR	SMBASS	176	L	80	0.97	4.85
11/21/88	SJRDR	SMBASS	221	L	79	0.99	4.71
* LOCATION SJRPC							
12/12/88	SJRPC	SMBASS	352	F	78	0.29	1.32
12/12/88	SJRPC	SMBASS	185	F	78	0.37	1.68
12/12/88	SJRPC	SMBASS	185	L	78	0.93	4.23
12/12/88	SJRPC	SMBASS	352	L	76	1.90	7.92
* LOCATION VRNLS							
10/24/89	VRNLS	SMBASS	292	F	76	0.42	1.74
10/24/89	VRNLS	SMBASS	183	F	81	0.41	2.14
04/02/90	VRNLS	SMBASS	231	F	79	0.56	2.68
10/24/89	VRNLS	SMBASS	183	L	78	0.92	4.18
10/24/89	VRNLS	SMBASS	292	L	78	1.20	5.36
04/02/90	VRNLS	SMBASS	231	L	78	1.60	7.41

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES SPLITL							
* LOCATION HONKB							
01/24/90	HONKB	SPLITL	194	F	77	0.56	2.38
01/24/90	HONKB	SPLITL	271	F	78	0.40	1.80
01/24/90	HONKB	SPLITL	296	F	77	0.44	1.93
01/24/90	HONKB	SPLITL	296	L	78	2.50	11.21
01/24/90	HONKB	SPLITL	271	L	77	2.20	9.57
** SPECIES STBASS							
* LOCATION ANTCH							
05/04/89	ANTCH	STBASS	640	F	76	0.44	1.83
05/04/89	ANTCH	STBASS	580	F	76	0.49	2.04
05/04/89	ANTCH	STBASS	560	F	77	0.54	2.35
05/04/89	ANTCH	STBASS	640	F	74	0.50	1.92
05/04/89	ANTCH	STBASS	690	F	76	0.48	2.00
05/16/90	ANTCH	STBASS	580	F	78	0.31	1.38
05/16/90	ANTCH	STBASS	570	F	80	0.39	1.93
05/16/90	ANTCH	STBASS	640	F	76	0.28	1.16
05/16/90	ANTCH	STBASS	540	F	79	0.38	1.78
05/16/90	ANTCH	STBASS	510	F	78	0.43	1.94
05/16/90	ANTCH	STBASS	490	F	78	0.41	1.84
05/16/90	ANTCH	STBASS	450	F	79	0.49	2.31
05/16/90	ANTCH	STBASS	630	F	76	0.37	1.54
05/16/90	ANTCH	STBASS	660	F	75	0.41	1.62
05/16/90	ANTCH	STBASS	620	F	74	0.47	1.83
05/16/90	ANTCH	STBASS	450	L	0	3.20	0.00
05/16/90	ANTCH	STBASS	540	L	0	2.40	0.00
05/16/90	ANTCH	STBASS	510	L	0	1.90	0.00
05/16/90	ANTCH	STBASS	580	L	0	2.30	0.00
05/16/90	ANTCH	STBASS	620	L	0	1.40	0.00
05/16/90	ANTCH	STBASS	570	L	0	2.60	0.00
05/16/90	ANTCH	STBASS	640	L	0	1.20	0.00
05/16/90	ANTCH	STBASS	490	L	0	8.90	0.00
05/16/90	ANTCH	STBASS	630	L	0	1.40	0.00
05/16/90	ANTCH	STBASS	660	L	0	1.30	0.00
* LOCATION CLKBG							
05/03/89	CLKBG	STBASS	685	F	75	0.38	1.52
05/03/89	CLKBG	STBASS	625	F	73	0.47	1.74
05/08/89	CLKBG	STBASS	690	F	76	0.49	2.04
05/08/89	CLKBG	STBASS	600	F	76	0.49	2.04
05/08/89	CLKBG	STBASS	660	F	73	0.48	1.78
* LOCATION MUDSL							
11/30/88	MUDSL	STBASS	165	F	78	2.00	9.09

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
11/30/88	MUDSL	STBASS	370	F	76	1.20	5.00
11/30/88	MUDSL	STBASS	165	L	72	5.20	18.57
11/30/88	MUDSL	STBASS	370	L	70	2.90	9.67
* LOCATION SJRMR							
12/16/88	SJRMR	STBASS	90	W	74	1.00	3.85
* LOCATION SJRPC							
12/12/88	SJRPC	STBASS	185	F	79	0.58	2.76
12/12/88	SJRPC	STBASS	185	L	75	2.00	8.00
12/12/88	SJRPC	STBASS	125	W	74	0.69	2.65
** SPECIES TFSHAD							
* LOCATION CRSNT							
05/22/89	CRSNT	TFSHAD	0	W	85	0.22	1.47
* LOCATION EMPRW							
05/23/89	EMPRW	TFSHAD	89	W	73	0.19	0.70
* LOCATION MUDSL							
08/25/88	MUDSL	TFSHAD	66	W	73	1.20	4.44
12/16/88	MUDSL	TFSHAD	95	W	72	0.65	2.32
* LOCATION SJRLN							
08/25/88	SJRLN	TFSHAD	46	W	70	0.37	1.23
* LOCATION SJRMR							
12/16/88	SJRMR	TFSHAD	78	W	71	0.59	2.03
** SPECIES WHTCAT							
* LOCATION BRADI							
01/23/90	BRADI	WHTCAT	258	F	76	0.13	0.55
01/23/90	BRADI	WHTCAT	247	F	76	0.14	0.59
01/23/90	BRADI	WHTCAT	282	F	76	0.15	0.63
01/23/90	BRADI	WHTCAT	282	L	79	1.40	6.51
01/23/90	BRADI	WHTCAT	258	L	77	1.30	5.73
01/23/90	BRADI	WHTCAT	247	L	80	1.40	6.90
* LOCATION BVRSL							
12/11/89	BVRSL	WHTCAT	327	F	80	0.12	0.59
12/11/89	BVRSL	WHTCAT	316	F	78	0.11	0.50
12/11/89	BVRSL	WHTCAT	327	L	82	0.69	3.88
12/11/89	BVRSL	WHTCAT	316	L	79	0.98	4.56

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION GLCAN							
12/08/89	GLCAN	WHTCAT	188	F	77	0.23	1.00
12/11/89	GLCAN	WHTCAT	212	F	76	0.19	0.79
12/08/89	GLCAN	WHTCAT	188	L	81	1.20	6.45
12/11/89	GLCAN	WHTCAT	212	L	81	1.60	8.21
* LOCATION MIDRV							
09/07/88	MIDRV	WHTCAT	199	F	79	0.31	1.48
09/07/88	MIDRV	WHTCAT	245	F	80	0.30	1.50
09/07/88	MIDRV	WHTCAT	228	F	79	0.29	1.38
12/08/88	MIDRV	WHTCAT	254	F	81	0.18	0.95
04/21/89	MIDRV	WHTCAT	315	F	79	0.18	0.86
04/21/89	MIDRV	WHTCAT	242	F	80	0.20	1.00
09/07/88	MIDRV	WHTCAT	228	L	81	2.80	14.74
09/07/88	MIDRV	WHTCAT	199	L	81	2.60	13.68
09/07/88	MIDRV	WHTCAT	245	L	81	2.80	14.74
12/08/88	MIDRV	WHTCAT	254	L	81	1.80	9.47
04/21/89	MIDRV	WHTCAT	242	L	81	1.75	9.21
04/21/89	MIDRV	WHTCAT	315	L	77	1.60	6.96
* LOCATION MUDSL							
08/25/88	MUDSL	WHTCAT	228	F	80	0.30	1.50
11/21/89	MUDSL	WHTCAT	230	F	78	0.53	2.44
08/25/88	MUDSL	WHTCAT	228	L	81	2.30	12.11
11/21/89	MUDSL	WHTCAT	230	L	78	2.70	12.16
* LOCATION OLDRV							
09/07/88	OLDRV	WHTCAT	205	F	79	0.21	1.00
09/07/88	OLDRV	WHTCAT	221	F	80	0.21	1.05
09/07/88	OLDRV	WHTCAT	240	F	80	0.20	1.00
12/08/88	OLDRV	WHTCAT	246	F	79	0.15	0.71
12/08/88	OLDRV	WHTCAT	224	F	80	0.18	0.90
12/08/88	OLDRV	WHTCAT	216	F	79	0.18	0.86
03/09/89	OLDRV	WHTCAT	227	F	77	0.17	0.74
03/09/89	OLDRV	WHTCAT	250	F	78	0.15	0.68
03/09/89	OLDRV	WHTCAT	218	F	78	0.20	0.91
11/29/89	OLDRV	WHTCAT	273	F	78	0.14	0.63
09/07/88	OLDRV	WHTCAT	205	L	81	2.80	14.74
09/07/88	OLDRV	WHTCAT	240	L	81	2.50	13.16
09/07/88	OLDRV	WHTCAT	221	L	81	2.60	13.68
12/08/88	OLDRV	WHTCAT	216	L	78	2.10	9.55
12/08/88	OLDRV	WHTCAT	246	L	79	1.80	8.57
12/08/88	OLDRV	WHTCAT	224	L	79	2.10	10.00
03/09/89	OLDRV	WHTCAT	227	L	81	1.80	9.47
03/09/89	OLDRV	WHTCAT	218	L	81	1.90	10.00
03/09/89	OLDRV	WHTCAT	250	L	82	1.40	7.78
11/29/89	OLDRV	WHTCAT	273	L	81	1.50	7.98

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION SALTS							
08/26/88	SALTS	WHTCAT	200	F	81	0.30	1.58
08/26/88	SALTS	WHTCAT	185	F	80	0.39	1.95
11/29/88	SALTS	WHTCAT	189	F	81	0.24	1.26
11/17/89	SALTS	WHTCAT	198	F	80	0.38	1.90
11/21/89	SALTS	WHTCAT	173	F	79	0.36	1.73
11/21/89	SALTS	WHTCAT	166	F	79	0.40	1.89
08/26/88	SALTS	WHTCAT	185	L	82	3.50	19.44
08/26/88	SALTS	WHTCAT	200	L	82	3.00	16.67
11/29/88	SALTS	WHTCAT	189	L	80	2.10	10.50
11/17/89	SALTS	WHTCAT	198	L	83	2.70	15.88
11/21/89	SALTS	WHTCAT	173	L	81	2.30	12.23
11/21/89	SALTS	WHTCAT	166	L	83	3.00	17.65
* LOCATION SJRAM							
10/19/89	SJRAM	WHTCAT	196	F	80	0.30	1.49
10/19/89	SJRAM	WHTCAT	178	F	79	0.29	1.41
10/19/89	SJRAM	WHTCAT	166	F	81	0.29	1.49
10/19/89	SJRAM	WHTCAT	196	L	84	2.20	13.92
10/19/89	SJRAM	WHTCAT	178	L	83	2.50	14.71
10/19/89	SJRAM	WHTCAT	166	L	81	2.55	13.64
* LOCATION SJRDR							
09/07/88	SJRDR	WHTCAT	238	F	80	0.21	1.05
09/07/88	SJRDR	WHTCAT	223	F	79	0.20	0.95
09/07/88	SJRDR	WHTCAT	203	F	79	0.19	0.90
11/21/88	SJRDR	WHTCAT	266	F	81	0.20	1.05
11/21/88	SJRDR	WHTCAT	243	F	80	0.21	1.05
11/21/88	SJRDR	WHTCAT	253	F	81	0.21	1.11
03/09/89	SJRDR	WHTCAT	202	F	79	0.18	0.86
03/09/89	SJRDR	WHTCAT	235	F	78	0.18	0.82
03/09/89	SJRDR	WHTCAT	217	F	81	0.17	0.89
09/07/88	SJRDR	WHTCAT	203	L	82	2.30	12.78
09/07/88	SJRDR	WHTCAT	223	L	81	2.60	13.68
09/07/88	SJRDR	WHTCAT	238	L	81	2.40	12.63
11/21/88	SJRDR	WHTCAT	243	L	81	2.10	11.05
11/21/88	SJRDR	WHTCAT	266	L	81	2.00	10.53
11/21/88	SJRDR	WHTCAT	253	L	81	2.00	10.53
03/09/89	SJRDR	WHTCAT	202	L	81	1.90	10.00
03/09/89	SJRDR	WHTCAT	235	L	81	1.80	9.47
03/09/89	SJRDR	WHTCAT	217	L	81	2.00	10.53
* LOCATION SJRLN							
08/25/88	SJRLN	WHTCAT	222	F	80	0.08	0.40
12/01/88	SJRLN	WHTCAT	163	F	81	0.11	0.58
12/01/88	SJRLN	WHTCAT	183	F	80	0.16	0.80

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
04/12/89	SJRLN	WHTCAT	190	F	82	0.14	0.78
08/25/88	SJRLN	WHTCAT	222	L	82	1.40	7.78
12/01/88	SJRLN	WHTCAT	163	L	80	0.97	4.85
12/01/88	SJRLN	WHTCAT	183	L	80	1.20	6.00
04/12/89	SJRLN	WHTCAT	190	L	83	1.00	5.88
* LOCATION	SJRMR						
08/25/88	SJRMR	WHTCAT	257	F	80	0.16	0.80
11/29/88	SJRMR	WHTCAT	218	F	80	0.20	1.00
08/25/88	SJRMR	WHTCAT	257	L	82	1.90	10.56
11/29/88	SJRMR	WHTCAT	218	L	80	1.50	7.50
* LOCATION	SJRPC						
04/28/89	SJRPC	WHTCAT	241	F	77	0.24	1.04
04/28/89	SJRPC	WHTCAT	205	F	77	0.24	1.04
04/28/89	SJRPC	WHTCAT	241	L	81	2.00	10.53
04/28/89	SJRPC	WHTCAT	205	L	81	1.70	8.95
* LOCATION	VRNLS						
09/07/88	VRNLS	WHTCAT	209	F	81	0.21	1.11
09/07/88	VRNLS	WHTCAT	187	F	80	0.21	1.05
09/07/88	VRNLS	WHTCAT	176	F	80	0.21	1.05
12/15/88	VRNLS	WHTCAT	186	F	79	0.19	0.90
12/15/88	VRNLS	WHTCAT	209	F	80	0.22	1.10
10/24/89	VRNLS	WHTCAT	240	F	79	0.19	0.92
10/24/89	VRNLS	WHTCAT	237	F	79	0.18	0.87
09/07/88	VRNLS	WHTCAT	176	L	81	2.30	12.11
09/07/88	VRNLS	WHTCAT	187	L	81	2.40	12.63
09/07/88	VRNLS	WHTCAT	209	L	83	2.40	14.12
12/15/88	VRNLS	WHTCAT	186	L	78	2.00	9.09
12/15/88	VRNLS	WHTCAT	209	L	79	1.70	8.10
10/24/89	VRNLS	WHTCAT	240	L	81	2.05	11.02
10/24/89	VRNLS	WHTCAT	237	L	83	2.00	11.49
** SPECIES	WSTRGN						
* LOCATION	BIGBK						
01/23/90	BIGBK	WSTRGN	600	F	87	0.38	2.81
01/23/90	BIGBK	WSTRGN	600	L	83	1.70	10.00
* LOCATION	BRDSL						
10/24/89	BRDSL	WSTRGN	463	F	74	0.57	2.16
10/24/89	BRDSL	WSTRGN	463	L	76	1.50	6.20
* LOCATION	HONKB						
01/24/90	HONKB	WSTRGN	440	F	78	0.89	3.99
01/24/90	HONKB	WSTRGN	550	F	81	0.74	3.92

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
01/24/90	HONKB	WSTRGN	440	L	79	1.60	7.77
01/24/90	HONKB	WSTRGN	619	L	82	2.90	16.20
01/24/90	HONKB	WSTRGN	550	L	84	2.60	15.76
* LOCATION	SACRV						
10/23/89	SACRV	WSTRGN	583	F	81	0.74	3.87
10/24/89	SACRV	WSTRGN	588	F	78	3.00	13.76
01/24/90	SACRV	WSTRGN	509	F	77	0.63	2.79
10/23/89	SACRV	WSTRGN	583	L	81	1.20	6.32
10/24/89	SACRV	WSTRGN	588	L	78	2.50	11.26
01/24/90	SACRV	WSTRGN	509	L	80	1.40	6.97
* LOCATION	SNPBB						
02/10/90	SNPBB	WSTRGN	0	F	75	4.60	18.47
02/10/90	SNPBB	WSTRGN	0	F	76	7.20	30.00
03/05/90	SNPBB	WSTRGN	1780	F	78	0.80	3.69
03/11/90	SNPBB	WSTRGN	1080	F	79	3.30	15.79
03/11/90	SNPBB	WSTRGN	1270	F	77	4.75	20.83
03/05/90	SNPBB	WSTRGN	1780	L	77	2.70	11.74
03/11/90	SNPBB	WSTRGN	1080	L	74	10.00	37.74
03/11/90	SNPBB	WSTRGN	1270	L	73	9.10	34.21
* LOCATION	SUISB						
02/26/89	SUISB	WSTRGN	1520	F	76	5.10	21.25
02/26/89	SUISB	WSTRGN	1320	F	79	2.10	10.00
02/26/89	SUISB	WSTRGN	1200	F	78	5.40	24.55
02/26/89	SUISB	WSTRGN	1270	F	81	1.20	6.32
02/26/89	SUISB	WSTRGN	1170	F	81	1.80	9.47
02/26/89	SUISB	WSTRGN	1430	F	79	5.40	25.71
02/26/89	SUISB	WSTRGN	1070	F	79	1.90	9.05
03/11/89	SUISB	WSTRGN	1330	F	77	9.90	43.04
03/11/89	SUISB	WSTRGN	1130	F	78	11.00	50.00
03/11/89	SUISB	WSTRGN	1080	F	78	5.40	24.55
03/11/89	SUISB	WSTRGN	1230	F	78	1.30	5.91
03/11/89	SUISB	WSTRGN	1460	F	78	1.20	5.45
03/11/89	SUISB	WSTRGN	1520	F	72	4.60	16.43
03/11/89	SUISB	WSTRGN	1020	F	78	1.70	7.73
10/24/89	SUISB	WSTRGN	611	F	80	0.54	2.67
10/27/89	SUISB	WSTRGN	390	F	80	1.10	5.37
10/27/89	SUISB	WSTRGN	600	F	78	1.40	6.42
10/27/89	SUISB	WSTRGN	595	F	83	0.59	3.39
12/14/89	SUISB	WSTRGN	642	F	82	0.86	4.78
12/14/89	SUISB	WSTRGN	536	F	79	1.80	8.53
12/14/89	SUISB	WSTRGN	640	F	80	0.88	4.36
12/15/89	SUISB	WSTRGN	502	F	76	0.90	3.75
12/15/89	SUISB	WSTRGN	629	F	82	0.66	3.73
12/15/89	SUISB	WSTRGN	603	F	83	0.45	2.60

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
12/15/89	SUISB	WSTRGN	610	F	82	0.81	4.48
01/26/90	SUISB	WSTRGN	670	F	82	0.65	3.65
01/26/90	SUISB	WSTRGN	660	F	83	2.50	14.29
02/24/90	SUISB	WSTRGN	0	F	77	1.10	4.87
02/24/90	SUISB	WSTRGN	0	F	75	7.70	31.30
02/24/90	SUISB	WSTRGN	0	F	75	4.50	17.72
02/24/90	SUISB	WSTRGN	0	F	80	0.63	3.15
02/24/90	SUISB	WSTRGN	0	F	77	3.40	14.91
02/25/90	SUISB	WSTRGN	1350	F	76	7.20	30.51
02/25/90	SUISB	WSTRGN	1580	F	70	8.00	27.03
03/06/90	SUISB	WSTRGN	1550	F	78	2.70	12.00
03/13/90	SUISB	WSTRGN	1170	F	78	5.40	25.00
03/13/90	SUISB	WSTRGN	1320	F	78	2.20	9.91
03/17/90	SUISB	WSTRGN	1320	F	78	7.85	36.34
03/17/90	SUISB	WSTRGN	1450	F	79	3.80	17.67
03/17/90	SUISB	WSTRGN	1470	F	81	0.28	1.46
03/23/90	SUISB	WSTRGN	1170	F	79	4.90	23.56
03/23/90	SUISB	WSTRGN	1690	F	78	1.20	5.41
03/24/90	SUISB	WSTRGN	1450	F	77	6.00	26.43
03/25/90	SUISB	WSTRGN	1490	F	79	4.80	22.33
03/25/90	SUISB	WSTRGN	1520	F	81	3.50	18.23
03/25/90	SUISB	WSTRGN	1240	F	78	5.90	26.46
03/25/90	SUISB	WSTRGN	1290	F	87	1.80	13.64
03/25/90	SUISB	WSTRGN	1420	F	80	3.90	19.12
03/25/90	SUISB	WSTRGN	1310	F	79	3.60	16.98
03/25/90	SUISB	WSTRGN	1610	F	74	2.60	10.16
03/25/90	SUISB	WSTRGN	1090	F	82	3.00	16.76
03/25/90	SUISB	WSTRGN	1400	F	77	3.40	14.47
03/29/90	SUISB	WSTRGN	1550	F	81	1.10	5.73
03/30/90	SUISB	WSTRGN	1040	F	77	8.80	38.77
03/30/90	SUISB	WSTRGN	1240	F	76	4.20	17.57
10/24/89	SUISB	WSTRGN	611	L	86	1.40	10.00
10/27/89	SUISB	WSTRGN	390	L	81	2.20	11.52
10/27/89	SUISB	WSTRGN	595	L	86	1.70	11.72
10/27/89	SUISB	WSTRGN	600	L	84	2.40	14.81
12/14/89	SUISB	WSTRGN	536	L	71	2.80	9.66
12/14/89	SUISB	WSTRGN	640	L	77	2.00	8.81
12/14/89	SUISB	WSTRGN	642	L	81	3.40	17.71
12/15/89	SUISB	WSTRGN	629	L	82	4.50	24.59
12/15/89	SUISB	WSTRGN	603	L	88	1.50	12.50
12/15/89	SUISB	WSTRGN	610	L	85	2.90	19.86
12/15/89	SUISB	WSTRGN	502	L	81	2.80	14.89
01/26/90	SUISB	WSTRGN	660	L	83	13.00	75.58
01/26/90	SUISB	WSTRGN	670	L	77	3.40	14.59
02/24/90	SUISB	WSTRGN	0	L	72	22.00	79.42
02/24/90	SUISB	WSTRGN	0	L	61	2.20	5.68
03/06/90	SUISB	WSTRGN	1550	L	78	5.90	27.19

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION TLDDS									
03/22/89	TLDDS	BNSTLT	F	A	170	L	73	3.00	11.11
03/22/89	TLDDS	BNSTLT	M	A	200	L	72	3.00	10.71
03/22/89	TLDDS	BNSTLT	M	A	180	L	72	3.30	11.79
04/06/89	TLDDS	BNSTLT	M	A	160	L	72	5.80	20.71
04/06/89	TLDDS	BNSTLT	M	A	185	L	72	4.80	17.14
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.90	24.64
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.00	21.43
04/06/89	TLDDS	BNSTLT	F	A	185	L	73	5.10	18.89
04/06/89	TLDDS	BNSTLT	F	A	195	L	73	5.60	20.74
04/06/89	TLDDS	BNSTLT	F	A	170	L	73	10.00	37.04
05/16/89	TLDDS	BNSTLT	M	A	190	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	F	A	210	L	72	4.50	16.07
05/16/89	TLDDS	BNSTLT	F	A	195	L	73	8.10	30.00
05/16/89	TLDDS	BNSTLT	F	A	165	L	75	6.80	27.20
05/16/89	TLDDS	BNSTLT	F	A	190	L	74	4.10	15.77
05/16/89	TLDDS	BNSTLT	F	A	205	L	72	8.10	28.93
05/16/89	TLDDS	BNSTLT	M	A	195	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	M	A	190	L	69	5.40	17.42
05/16/89	TLDDS	BNSTLT	F	A	185	L	75	9.10	36.40
07/19/89	TLDDS	BNSTLT	F	J	160	L	74	12.00	46.15
07/19/89	TLDDS	BNSTLT	U	J	185	L	72	8.00	28.17
07/19/89	TLDDS	BNSTLT	F	J	190	L	70	9.65	32.60
07/19/89	TLDDS	BNSTLT	F	J	185	L	71	12.00	40.96
07/19/89	TLDDS	BNSTLT	M	J	185	L	71	9.10	31.60
07/19/89	TLDDS	BNSTLT	U	J	160	L	73	7.10	26.59
07/19/89	TLDDS	BNSTLT	F	J	145	L	74	7.00	26.62
07/19/89	TLDDS	BNSTLT	M	J	180	L	69	7.00	22.73
07/19/89	TLDDS	BNSTLT	M	J	165	L	74	6.80	26.36
07/19/89	TLDDS	BNSTLT	F	J	180	L	73	13.00	47.45
* LOCATION WFRMR									
03/20/89	WFRMR	BNSTLT	M	A	205	L	74	11.00	42.31
03/20/89	WFRMR	BNSTLT	M	A	180	L	71	18.00	62.07
03/20/89	WFRMR	BNSTLT	F	A	230	L	71	12.00	41.38
03/20/89	WFRMR	BNSTLT	M	A	215	L	75	21.00	84.00
03/20/89	WFRMR	BNSTLT	F	A	155	L	74	20.00	76.92
03/20/89	WFRMR	BNSTLT	F	A	205	L	72	14.00	50.00
03/20/89	WFRMR	BNSTLT	F	A	210	L	74	19.00	73.08
03/20/89	WFRMR	BNSTLT	F	A	185	L	75	13.00	52.00
03/20/89	WFRMR	BNSTLT	F	A	200	L	76	9.70	40.42
03/20/89	WFRMR	BNSTLT	F	A	165	L	73	15.00	55.56
05/15/89	WFRMR	BNSTLT	F	A	180	L	73	14.00	51.85
05/15/89	WFRMR	BNSTLT	F	A	175	L	73	23.00	85.19
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	8.00	26.67
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	14.00	46.67

1988-1990 BIRD TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	SEX	AGE	WGHT (gm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
* LOCATION TLDDS									
03/22/89	TLDDS	BNSTLT	F	A	170	L	73	3.00	11.11
03/22/89	TLDDS	BNSTLT	M	A	200	L	72	3.00	10.71
03/22/89	TLDDS	BNSTLT	M	A	180	L	72	3.30	11.79
04/06/89	TLDDS	BNSTLT	M	A	160	L	72	5.80	20.71
04/06/89	TLDDS	BNSTLT	M	A	185	L	72	4.80	17.14
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.90	24.64
04/06/89	TLDDS	BNSTLT	M	A	190	L	72	6.00	21.43
04/06/89	TLDDS	BNSTLT	F	A	185	L	73	5.10	18.89
04/06/89	TLDDS	BNSTLT	F	A	195	L	73	5.60	20.74
04/06/89	TLDDS	BNSTLT	F	A	170	L	73	10.00	37.04
05/16/89	TLDDS	BNSTLT	M	A	190	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	F	A	210	L	72	4.50	16.07
05/16/89	TLDDS	BNSTLT	F	A	195	L	73	8.10	30.00
05/16/89	TLDDS	BNSTLT	F	A	165	L	75	6.80	27.20
05/16/89	TLDDS	BNSTLT	F	A	190	L	74	4.10	15.77
05/16/89	TLDDS	BNSTLT	F	A	205	L	72	8.10	28.93
05/16/89	TLDDS	BNSTLT	M	A	195	L	72	8.40	30.00
05/16/89	TLDDS	BNSTLT	M	A	190	L	69	5.40	17.42
05/16/89	TLDDS	BNSTLT	F	A	185	L	75	9.10	36.40
07/19/89	TLDDS	BNSTLT	F	J	160	L	74	12.00	46.15
07/19/89	TLDDS	BNSTLT	U	J	185	L	72	8.00	28.17
07/19/89	TLDDS	BNSTLT	F	J	190	L	70	9.65	32.60
07/19/89	TLDDS	BNSTLT	F	J	185	L	71	12.00	40.96
07/19/89	TLDDS	BNSTLT	M	J	185	L	71	9.10	31.60
07/19/89	TLDDS	BNSTLT	U	J	160	L	73	7.10	26.59
07/19/89	TLDDS	BNSTLT	F	J	145	L	74	7.00	26.62
07/19/89	TLDDS	BNSTLT	M	J	180	L	69	7.00	22.73
07/19/89	TLDDS	BNSTLT	M	J	165	L	74	6.80	26.36
07/19/89	TLDDS	BNSTLT	F	J	180	L	73	13.00	47.45
* LOCATION WFRMR									
03/20/89	WFRMR	BNSTLT	M	A	205	L	74	11.00	42.31
03/20/89	WFRMR	BNSTLT	M	A	180	L	71	18.00	62.07
03/20/89	WFRMR	BNSTLT	F	A	230	L	71	12.00	41.38
03/20/89	WFRMR	BNSTLT	M	A	215	L	75	21.00	84.00
03/20/89	WFRMR	BNSTLT	F	A	155	L	74	20.00	76.92
03/20/89	WFRMR	BNSTLT	F	A	205	L	72	14.00	50.00
03/20/89	WFRMR	BNSTLT	F	A	210	L	74	19.00	73.08
03/20/89	WFRMR	BNSTLT	F	A	185	L	75	13.00	52.00
03/20/89	WFRMR	BNSTLT	F	A	200	L	76	9.70	40.42
03/20/89	WFRMR	BNSTLT	F	A	165	L	73	15.00	55.56
05/15/89	WFRMR	BNSTLT	F	A	180	L	73	14.00	51.85
05/15/89	WFRMR	BNSTLT	F	A	175	L	73	23.00	85.19
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	8.00	26.67
05/15/89	WFRMR	BNSTLT	F	A	160	L	70	14.00	46.67

1988-1990 FISH TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SPECIES	MEAN LENGTH (mm)	TISSUE TYPE	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/13/90	SUISB	WSTRGN	1170	L	73	8.20	29.93
03/13/90	SUISB	WSTRGN	1320	L	72	18.00	65.22
03/17/90	SUISB	WSTRGN	1320	L	79	9.70	46.19
03/17/90	SUISB	WSTRGN	1450	L	80	7.20	35.64
03/17/90	SUISB	WSTRGN	1470	L	73	3.90	14.44
03/23/90	SUISB	WSTRGN	1690	L	54	2.70	5.82
03/23/90	SUISB	WSTRGN	1170	L	72	8.50	29.82
03/24/90	SUISB	WSTRGN	1450	L	64	15.00	41.21
03/25/90	SUISB	WSTRGN	1420	L	67	7.60	23.24
03/25/90	SUISB	WSTRGN	1090	L	81	14.00	72.92
03/25/90	SUISB	WSTRGN	1400	L	80	6.45	31.93
03/25/90	SUISB	WSTRGN	1520	L	78	8.30	37.05
03/25/90	SUISB	WSTRGN	1240	L	80	9.40	46.53
03/25/90	SUISB	WSTRGN	1310	L	74	6.70	25.48
03/25/90	SUISB	WSTRGN	1290	L	81	7.50	40.32
03/25/90	SUISB	WSTRGN	1490	L	75	18.00	71.71
03/25/90	SUISB	WSTRGN	1610	L	69	2.60	8.50
03/29/90	SUISB	WSTRGN	1550	L	67	12.00	36.81
03/30/90	SUISB	WSTRGN	1040	L	72	19.00	66.67
03/30/90	SUISB	WSTRGN	1240	L	78	10.00	45.05
** SPECIES YFGOBY							
* LOCATION GRIZB							
01/26/90	GRIZB	YFGOBY	109	W	80	0.60	3.06
* LOCATION SUISB							
01/26/90	SUISB	YFGOBY	140	F	81	0.38	2.03
01/26/90	SUISB	YFGOBY	140	L	0	0.95	0.00

1988-1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES BOATMN						
* LOCATION TLDDN						
05/17/89	TLDDN	3A	BOATMN	82	0.38	2.11
05/17/89	TLDDN	3A	BOATMN	85	0.36	2.40
05/17/89	TLDDN	5B	BOATMN	86	0.37	2.64
05/17/89	TLDDN	5B	BOATMN	84	0.35	2.19
05/17/89	TLDDN	7	BOATMN	86	0.17	1.21
05/17/89	TLDDN	7	BOATMN	86	0.17	1.21
05/17/89	TLDDN	7	BOATMN	86	0.16	1.14
05/17/89	TLDDN	7	BOATMN	86	0.13	0.93
05/17/89	TLDDN	7	BOATMN	86	0.16	1.14
05/17/89	TLDDN	7	BOATMN	87	0.15	1.15
05/17/89	TLDDN	7	BOATMN	86	0.16	1.14
05/17/89	TLDDN	7	BOATMN	86	0.16	1.14
05/17/89	TLDDN	7	BOATMN	86	0.15	1.07
05/17/89	TLDDN	7	BOATMN	86	0.15	1.07
05/17/89	TLDDN	7	BOATMN	86	0.16	1.14
05/17/89	TLDDN	7	BOATMN	86	0.14	1.00
05/17/89	TLDDN	7	BOATMN	86	0.17	1.21
* LOCATION TLDDS						
03/22/89	TLDDS	10	BOATMN	79	1.60	7.62
05/16/89	TLDDS	2	BOATMN	82	1.10	6.11
05/16/89	TLDDS	2	BOATMN	81	1.30	6.84
05/16/89	TLDDS	2	BOATMN	83	1.10	6.47
05/16/89	TLDDS	4	BOATMN	85	1.60	10.67
03/22/89	TLDDS	5	BOATMN	77	11.00	47.83
03/22/89	TLDDS	5	BOATMN	61	1.40	3.59
03/22/89	TLDDS	6	BOATMN	74	1.80	6.92
03/22/89	TLDDS	6	BOATMN	66	1.70	5.00
05/16/89	TLDDS	6	BOATMN	82	2.80	15.56
05/16/89	TLDDS	6	BOATMN	82	3.20	17.78
05/16/89	TLDDS	6	BOATMN	84	2.80	17.50
05/16/89	TLDDS	9	BOATMN	85	1.50	10.00
05/16/89	TLDDS	9	BOATMN	86	1.60	11.43
05/16/89	TLDDS	9	BOATMN	85	1.70	11.33
05/16/89	TLDDS	9	BOATMN	86	1.70	12.14
05/16/89	TLDDS	9	BOATMN	85	1.70	11.33
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.70	11.33
05/16/89	TLDDS	9	BOATMN	85	1.60	10.67
05/16/89	TLDDS	9	BOATMN	85	1.70	11.33
05/16/89	TLDDS	9	BOATMN	86	1.60	11.43
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	86	1.70	12.14
05/16/89	TLDDS	9	BOATMN	85	2.00	13.33

1988-1990 INVERTEBRATE TISSUE SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
05/16/89	TLDDS	9	BOATMN	85	1.90	12.67
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.90	12.67
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.90	12.67
05/16/89	TLDDS	9	BOATMN	86	1.60	11.43
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	86	1.50	10.71
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.90	12.67
05/16/89	TLDDS	9	BOATMN	86	1.60	11.43
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	86	1.80	12.86
05/16/89	TLDDS	9	BOATMN	86	1.80	12.86
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
05/16/89	TLDDS	9	BOATMN	85	1.80	12.00
* LOCATION WFRMR						
05/15/89	WFRMR	2	BOATMN	83	3.80	22.35
05/15/89	WFRMR	2	BOATMN	85	3.50	23.33
05/15/89	WFRMR	2	BOATMN	85	3.40	22.67
06/05/90	WFRMR	C1S	BOATMN	72	7.90	28.42
06/05/90	WFRMR	C1S	BOATMN	71	7.00	24.14
06/05/90	WFRMR	C1S	BOATMN	71	7.20	25.17
06/05/90	WFRMR	C1S	BOATMN	71	7.10	24.40
06/05/90	WFRMR	C1S	BOATMN	70	7.00	23.41
06/05/90	WFRMR	C1S	BOATMN	75	6.20	25.20
06/05/90	WFRMR	C1S	BOATMN	73	6.70	24.81
06/05/90	WFRMR	C1S	BOATMN	76	5.60	23.33
06/05/90	WFRMR	C1S	BOATMN	75	6.20	24.31
06/05/90	WFRMR	C1S	BOATMN	76	5.90	25.00
06/05/90	WFRMR	C1S	BOATMN	80	6.00	29.70
06/05/90	WFRMR	C1S	BOATMN	80	4.70	22.93
06/05/90	WFRMR	C1S	BOATMN	84	5.40	33.96
06/05/90	WFRMR	C1S	BOATMN	83	4.60	26.74
06/05/90	WFRMR	C1S	BOATMN	81	4.50	23.94
06/05/90	WFRMR	C1S	BOATMN	82	4.60	25.41
06/05/90	WFRMR	C1S	BOATMN	84	3.80	24.36
06/05/90	WFRMR	C1S	BOATMN	75	4.90	19.37
06/05/90	WFRMR	C1S	BOATMN	68	4.60	14.51
06/05/90	WFRMR	C1S	BOATMN	73	5.10	18.96
06/06/90	WFRMR	C1S	BOATMN	83	5.90	34.10
06/06/90	WFRMR	C1S	BOATMN	85	4.45	28.90
06/06/90	WFRMR	C1S	BOATMN	86	4.20	29.17
06/06/90	WFRMR	C1S	BOATMN	80	6.30	31.50
06/06/90	WFRMR	C1S	BOATMN	81	7.50	39.06
06/06/90	WFRMR	C1S	BOATMN	80	7.40	37.76

1988–1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
06/06/90	WFRMR	C1S	BOATMN	81	6.40	33.51
06/06/90	WFRMR	C1S	BOATMN	79	7.10	33.81
06/06/90	WFRMR	C1S	BOATMN	79	6.60	31.13
06/06/90	WFRMR	C1S	BOATMN	82	6.10	33.15
06/06/90	WFRMR	C1S	BOATMN	81	5.90	30.41
06/06/90	WFRMR	C1S	BOATMN	83	5.80	34.73
06/06/90	WFRMR	C1S	BOATMN	80	6.20	30.54
06/06/90	WFRMR	C1S	BOATMN	77	6.80	29.31
06/06/90	WFRMR	C2S	BOATMN	84	6.60	41.77
06/06/90	WFRMR	C2S	BOATMN	85	6.90	44.52
06/06/90	WFRMR	C2S	BOATMN	84	7.50	48.08
06/06/90	WFRMR	C2S	BOATMN	86	6.40	45.71
06/13/90	WFRMR	C2S	BOATMN	80	8.40	42.21
06/13/90	WFRMR	C2S	BOATMN	80	8.80	43.35
06/13/90	WFRMR	C2S	BOATMN	80	8.10	40.91
06/13/90	WFRMR	C2S	BOATMN	80	8.60	42.36
06/13/90	WFRMR	C2S	BOATMN	80	8.30	42.13
06/13/90	WFRMR	C2S	BOATMN	80	8.40	42.86
06/13/90	WFRMR	C2S	BOATMN	81	7.80	40.63
06/13/90	WFRMR	C2S	BOATMN	81	7.40	39.78
06/06/90	WFRMR	C2S	BOATMN	81	8.20	43.85
06/06/90	WFRMR	C2S	BOATMN	82	7.60	43.18
06/06/90	WFRMR	C2S	BOATMN	82	9.40	51.37
06/06/90	WFRMR	C2S	BOATMN	83	8.00	45.71
06/06/90	WFRMR	C2S	BOATMN	84	7.30	46.20
06/06/90	WFRMR	C2S	BOATMN	82	7.80	42.16
06/06/90	WFRMR	C2S	BOATMN	83	7.20	43.37
06/06/90	WFRMR	C2S	BOATMN	83	8.30	49.40
06/07/90	WFRMR	C2S	BOATMN	87	4.60	35.94
06/07/90	WFRMR	C2S	BOATMN	88	4.70	39.17
06/07/90	WFRMR	C2S	BOATMN	87	5.20	41.27
06/07/90	WFRMR	C2S	BOATMN	83	6.40	37.87
06/07/90	WFRMR	C2S	BOATMN	86	5.20	35.86
06/07/90	WFRMR	C2S	BOATMN	82	6.65	37.57
06/07/90	WFRMR	C2S	BOATMN	84	6.40	39.02
06/07/90	WFRMR	C2S	BOATMN	81	6.80	35.42
06/07/90	WFRMR	C2S	BOATMN	81	7.40	38.74
06/07/90	WFRMR	C2S	BOATMN	82	6.50	36.72
06/07/90	WFRMR	C2S	BOATMN	82	7.20	39.34
06/07/90	WFRMR	C2S	BOATMN	83	6.40	36.78
06/07/90	WFRMR	C2S	BOATMN	83	6.60	37.93
06/07/90	WFRMR	C2S	BOATMN	82	6.80	38.20
06/07/90	WFRMR	C2S	BOATMN	86	6.30	44.06
06/07/90	WFRMR	C2S	BOATMN	81	7.30	38.42
06/07/90	WFRMR	C2S	BOATMN	80	8.70	43.94
06/07/90	WFRMR	C2S	BOATMN	81	8.30	44.62
06/07/90	WFRMR	C2S	BOATMN	80	8.40	42.21

1988-1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
06/07/90	WFRMR	C2S	BOATMN	80	9.10	45.27
06/13/90	WFRMR	C2S	BOATMN	83	6.00	34.88
06/13/90	WFRMR	C2S	BOATMN	82	5.30	29.28
06/13/90	WFRMR	C2S	BOATMN	82	7.60	42.22
06/13/90	WFRMR	C2S	BOATMN	83	6.00	34.68
* LOCATION WLAKE						
05/16/89	WLAKE	1	BOATMN	89	1.40	12.73
05/16/89	WLAKE	1	BOATMN	90	1.40	14.00
05/16/89	WLAKE	1	BOATMN	90	1.70	17.00
05/16/89	WLAKE	2	BOATMN	88	1.80	15.00
05/16/89	WLAKE	2	BOATMN	88	1.60	13.33
03/22/89	WLAKE	3	BOATMN	84	0.89	5.56
05/16/89	WLAKE	4	BOATMN	90	0.74	7.40
05/16/89	WLAKE	5	BOATMN	88	0.66	5.50
05/16/89	WLAKE	5	BOATMN	87	0.88	6.77
05/16/89	WLAKE	5	BOATMN	88	0.67	5.58
05/16/89	WLAKE	5	BOATMN	87	0.68	5.23
05/16/89	WLAKE	5	BOATMN	88	0.71	5.92
05/16/89	WLAKE	5	BOATMN	88	0.62	5.17
05/16/89	WLAKE	5	BOATMN	87	0.72	5.54
05/16/89	WLAKE	5	BOATMN	87	0.67	5.15
05/16/89	WLAKE	5	BOATMN	86	0.87	6.21
05/16/89	WLAKE	5	BOATMN	87	0.86	6.62
05/16/89	WLAKE	5	BOATMN	87	0.81	6.23
05/16/89	WLAKE	5	BOATMN	87	0.77	5.92
05/16/89	WLAKE	5	BOATMN	87	0.81	6.23
** SPECIES BRNESH						
* LOCATION WFRMR						
06/13/90	WFRMR	C3A	BRNESH	88	14.00	112.90
06/13/90	WFRMR	C3A	BRNESH	88	13.00	107.44
06/13/90	WFRMR	C3A	BRNESH	88	12.00	97.56
06/13/90	WFRMR	C3A	BRNESH	87	15.00	111.11
06/13/90	WFRMR	C3A	BRNESH	88	11.00	91.67
06/13/90	WFRMR	C3A	BRNESH	88	11.00	88.71
06/13/90	WFRMR	C3A	BRNESH	88	11.00	89.43
06/12/90	WFRMR	C3A	BRNESH	88	12.00	103.45
06/12/90	WFRMR	C3A	BRNESH	88	12.00	97.56
06/12/90	WFRMR	C3A	BRNESH	88	12.00	98.36
06/12/90	WFRMR	C3A	BRNESH	89	10.00	91.74
06/12/90	WFRMR	C3B	BRNESH	88	6.10	50.83
06/12/90	WFRMR	C3B	BRNESH	88	6.60	53.23
06/12/90	WFRMR	C3B	BRNESH	88	6.60	53.66
06/12/90	WFRMR	C3B	BRNESH	88	6.80	55.74

1988-1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES BRNFLY						
* LOCATION WFRMR						
05/15/89	WFRMR	2	BRNFLY	86	7.30	52.14
05/15/89	WFRMR	2	BRNFLY	86	7.60	54.29
05/15/89	WFRMR	2	BRNFLY	88	6.40	53.33
05/15/89	WFRMR	2	BRNFLY	87	7.30	56.15
05/15/89	WFRMR	2	BRNFLY	88	6.80	56.67
05/15/89	WFRMR	2	BRNFLY	87	6.80	52.31
05/15/89	WFRMR	2	BRNFLY	87	7.20	55.38
05/15/89	WFRMR	2	BRNFLY	86	7.30	52.14
05/15/89	WFRMR	2	BRNFLY	87	7.80	60.00
05/15/89	WFRMR	2	BRNFLY	87	6.60	50.77
05/15/89	WFRMR	2	BRNFLY	88	7.40	61.67
05/15/89	WFRMR	2	BRNFLY	86	7.00	50.00
05/15/89	WFRMR	2	BRNFLY	88	6.40	53.33
05/15/89	WFRMR	2	BRNFLY	88	6.30	52.50
05/15/89	WFRMR	2	BRNFLY	87	6.10	46.92
05/15/89	WFRMR	2	BRNFLY	87	6.60	50.77
05/15/89	WFRMR	2	BRNFLY	88	6.70	55.83
05/15/89	WFRMR	2	BRNFLY	86	7.20	51.43
05/15/89	WFRMR	2	BRNFLY	87	7.20	55.38
05/15/89	WFRMR	2	BRNFLY	89	4.90	44.55
03/20/89	WFRMR	3C	BRNFLY	81	9.40	49.47
03/20/89	WFRMR	3C	BRNFLY	81	9.20	48.42
03/20/89	WFRMR	3C	BRNFLY	85	6.30	42.00
03/20/89	WFRMR	3C	BRNFLY	84	6.80	42.50
03/20/89	WFRMR	3C	BRNFLY	81	8.80	46.32
03/20/89	WFRMR	3C	BRNFLY	78	9.40	42.73
03/20/89	WFRMR	3C	BRNFLY	78	10.00	45.45
03/20/89	WFRMR	3C	BRNFLY	80	9.80	49.00
03/20/89	WFRMR	3C	BRNFLY	83	6.80	40.00
04/05/89	WFRMR	3C	BRNFLY	77	8.70	37.83
04/05/89	WFRMR	3C	BRNFLY	78	8.60	39.09
04/05/89	WFRMR	3C	BRNFLY	78	7.90	35.91
04/05/89	WFRMR	3C	BRNFLY	77	8.20	35.65
04/05/89	WFRMR	3C	BRNFLY	77	8.10	35.22
04/05/89	WFRMR	3C	BRNFLY	77	8.20	35.65
04/05/89	WFRMR	3C	BRNFLY	77	8.50	36.96
04/05/89	WFRMR	3C	BRNFLY	79	7.40	35.24
04/05/89	WFRMR	3C	BRNFLY	79	7.40	35.24
04/05/89	WFRMR	3C	BRNFLY	78	8.20	37.27
04/05/89	WFRMR	3C	BRNFLY	80	7.20	36.00
04/05/89	WFRMR	3C	BRNFLY	81	7.00	36.84
04/05/89	WFRMR	3C	BRNFLY	82	5.90	32.78
04/05/89	WFRMR	3C	BRNFLY	78	8.20	37.27
04/05/89	WFRMR	3C	BRNFLY	77	8.30	36.09

1988-1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
04/05/89	WFRMR	3C	BRNFLY	75	9.10	36.40
04/05/89	WFRMR	3C	BRNFLY	77	8.10	35.22
06/05/90	WFRMR	C1S	BRNFLY	53	8.70	18.63
06/05/90	WFRMR	C1S	BRNFLY	75	7.20	29.27
06/05/90	WFRMR	C1S	BRNFLY	72	6.70	24.10
06/05/90	WFRMR	C1S	BRNFLY	67	8.50	25.37
06/05/90	WFRMR	C1S	BRNFLY	67	9.60	29.45
06/06/90	WFRMR	C1S	BRNFLY	65	8.80	24.86
06/06/90	WFRMR	C1S	BRNFLY	63	8.90	23.86
06/06/90	WFRMR	C1S	BRNFLY	62	9.30	24.28
06/06/90	WFRMR	C1S	BRNFLY	73	10.00	36.90
06/06/90	WFRMR	C1S	BRNFLY	71	10.00	34.25
06/06/90	WFRMR	C1S	BRNFLY	72	10.00	35.97
06/06/90	WFRMR	C1S	BRNFLY	48	8.30	16.09
06/05/90	WFRMR	C2S	BRNFLY	82	6.40	34.59
06/05/90	WFRMR	C2S	BRNFLY	81	6.00	31.58
06/05/90	WFRMR	C2S	BRNFLY	80	5.80	28.86
06/13/90	WFRMR	C2S	BRNFLY	74	11.00	41.51
06/13/90	WFRMR	C2S	BRNFLY	73	11.00	41.35
06/13/90	WFRMR	C2S	BRNFLY	71	10.50	35.96
06/13/90	WFRMR	C2S	BRNFLY	74	11.00	41.67
06/13/90	WFRMR	C2S	BRNFLY	74	11.00	42.15
06/13/90	WFRMR	C2S	BRNFLY	74	11.00	42.31
06/06/90	WFRMR	C2S	BRNFLY	64	9.70	27.02
06/06/90	WFRMR	C2S	BRNFLY	75	8.00	31.75
06/06/90	WFRMR	C2S	BRNFLY	74	8.30	31.80
06/06/90	WFRMR	C2S	BRNFLY	74	7.80	30.47
06/07/90	WFRMR	C2S	BRNFLY	56	8.70	19.86
06/07/90	WFRMR	C2S	BRNFLY	73	8.70	32.71
06/07/90	WFRMR	C2S	BRNFLY	65	7.30	20.62
06/07/90	WFRMR	C2S	BRNFLY	74	9.00	35.16
06/07/90	WFRMR	C2S	BRNFLY	69	9.40	30.72
06/13/90	WFRMR	C2S	BRNFLY	52	11.00	22.82
06/13/90	WFRMR	C2S	BRNFLY	62	11.00	29.26
06/13/90	WFRMR	C2S	BRNFLY	55	11.00	24.50
06/07/90	WFRMR	C3A	BRNFLY	70	12.00	40.54
06/07/90	WFRMR	C3A	BRNFLY	73	11.00	40.74
06/07/90	WFRMR	C3A	BRNFLY	72	12.00	42.11
06/13/90	WFRMR	C3A	BRNFLY	72	12.00	42.25
06/13/90	WFRMR	C3A	BRNFLY	72	12.00	42.11
06/13/90	WFRMR	C3A	BRNFLY	67	12.00	35.82
06/13/90	WFRMR	C3B	BRNFLY	72	9.00	31.69
06/13/90	WFRMR	C3B	BRNFLY	70	9.10	30.64
06/13/90	WFRMR	C3B	BRNFLY	70	8.90	29.37
* LOCATION WLAKE						
05/16/89	WLAKE	5	BRNFLY	86	1.10	7.86

1988–1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES BRNPUP						
* LOCATION WFRMR						
03/20/89	WFRMR	3C	BRNPUP	85	3.70	24.67
03/20/89	WFRMR	3C	BRNPUP	84	4.00	25.00
03/20/89	WFRMR	3C	BRNPUP	84	4.00	25.00
03/20/89	WFRMR	3C	BRNPUP	84	4.10	25.63
03/20/89	WFRMR	3C	BRNPUP	85	3.60	24.00
03/20/89	WFRMR	3C	BRNPUP	86	3.40	24.29
03/20/89	WFRMR	3C	BRNPUP	84	3.80	23.75
03/20/89	WFRMR	3C	BRNPUP	86	3.50	25.00
03/20/89	WFRMR	3C	BRNPUP	84	4.10	25.63
03/20/89	WFRMR	3C	BRNPUP	86	3.50	25.00
03/20/89	WFRMR	3C	BRNPUP	84	4.10	25.63
03/20/89	WFRMR	3C	BRNPUP	84	3.70	23.13
03/20/89	WFRMR	3C	BRNPUP	85	3.60	24.00
03/20/89	WFRMR	3C	BRNPUP	84	3.90	24.38
03/20/89	WFRMR	3C	BRNPUP	85	3.90	26.00
03/20/89	WFRMR	3C	BRNPUP	83	3.90	22.94
03/20/89	WFRMR	3C	BRNPUP	85	3.30	22.00
03/20/89	WFRMR	3C	BRNPUP	85	3.70	24.67
03/20/89	WFRMR	3C	BRNPUP	87	3.40	26.15
03/20/89	WFRMR	3C	BRNPUP	84	3.90	24.38
03/20/89	WFRMR	3C	BRNPUP	84	3.70	23.13
03/20/89	WFRMR	3C	BRNPUP	81	4.10	21.58
03/20/89	WFRMR	3C	BRNPUP	84	4.20	26.25
03/20/89	WFRMR	3C	BRNPUP	84	4.30	26.88
03/20/89	WFRMR	3C	BRNPUP	88	3.30	27.50
03/20/89	WFRMR	3C	BRNPUP	84	4.10	25.63
** SPECIES BRNSHP						
* LOCATION TLDDS						
05/16/89	TLDDS	10	BRNSHP	89	1.10	10.00
05/16/89	TLDDS	10	BRNSHP	88	1.20	10.00
05/16/89	TLDDS	10	BRNSHP	88	1.30	10.83
* LOCATION WFRMR						
03/20/89	WFRMR	2	BRNSHP	93	1.70	24.29
03/20/89	WFRMR	2	BRNSHP	88	5.50	45.83
03/20/89	WFRMR	2	BRNSHP	88	5.30	44.17
03/20/89	WFRMR	2	BRNSHP	88	5.00	41.67
03/20/89	WFRMR	2	BRNSHP	87	5.60	43.08
03/20/89	WFRMR	2	BRNSHP	88	4.90	40.83
03/20/89	WFRMR	2	BRNSHP	88	5.10	42.50
03/20/89	WFRMR	2	BRNSHP	88	5.30	44.17

1988-1990 INVERTEBRATE TISSUE
SELENIUM LEVELS

SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
03/20/89	WFRMR	2	BRNSHP	87	5.90	45.38
03/20/89	WFRMR	2	BRNSHP	88	6.10	50.83
03/20/89	WFRMR	2	BRNSHP	89	5.00	45.45
** SPECIES	CRBCLA					
* LOCATION	BVRSL					
04/10/90	BVRSL	N/A	CRBCLA	91	0.33	3.67
04/10/90	BVRSL	N/A	CRBCLA	89	0.35	3.07
04/10/90	BVRSL	N/A	CRBCLA	89	0.34	3.09
* LOCATION	CCIDM					
11/30/88	CCIDM	N/A	CRBCLA	84	0.56	3.50
11/30/88	CCIDM	N/A	CRBCLA	81	0.61	3.21
11/30/88	CCIDM	N/A	CRBCLA	88	0.47	3.92
* LOCATION	HONKB					
05/02/90	HONKB	N/A	CRBCLA	95	0.41	7.74
05/02/90	HONKB	N/A	CRBCLA	95	0.43	7.82
05/02/90	HONKB	N/A	CRBCLA	95	0.44	8.15
* LOCATION	MIDRV					
11/17/88	MIDRV	N/A	CRBCLA	86	0.48	3.43
11/17/88	MIDRV	N/A	CRBCLA	81	0.56	2.95
11/17/88	MIDRV	N/A	CRBCLA	80	0.54	2.70
03/09/89	MIDRV	N/A	CRBCLA	82	0.58	3.22
03/09/89	MIDRV	N/A	CRBCLA	82	0.60	3.33
* LOCATION	MUDSL					
08/25/88	MUDSL	N/A	CRBCLA	83	0.88	5.18
04/17/90	MUDSL	N/A	CRBCLA	81	0.76	4.09
05/22/90	MUDSL	N\A	CRBCLA	88	0.55	4.51
05/22/90	MUDSL	N\A	CRBCLA	87	0.64	4.78
05/22/90	MUDSL	N\A	CRBCLA	89	0.52	4.77
05/22/90	MUDSL	N\A	CRBCLA	89	0.54	4.74
05/22/90	MUDSL	N\A	CRBCLA	90	0.50	4.76
05/29/90	MUDSL	N\A	CRBCLA	88	0.65	5.33
05/29/90	MUDSL	N\A	CRBCLA	88	0.65	5.33
05/29/90	MUDSL	N\A	CRBCLA	88	0.64	5.47
05/29/90	MUDSL	N\A	CRBCLA	88	0.63	5.34
05/29/90	MUDSL	N\A	CRBCLA	86	0.75	5.36
06/12/90	MUDSL	N\A	CRBCLA	83	0.82	4.69
06/12/90	MUDSL	N\A	CRBCLA	83	0.86	5.15
06/12/90	MUDSL	N\A	CRBCLA	83	0.83	4.91
06/12/90	MUDSL	N\A	CRBCLA	83	0.84	4.91
06/12/90	MUDSL	N\A	CRBCLA	82	0.90	4.95
07/10/90	MUDSL	N\A	CRBCLA	78	1.00	4.63

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
07/10/90	MUDSL	N\A	CRBCLA	78	1.00	4.44
07/10/90	MUDSL	N\A	CRBCLA	78	0.96	4.44
07/10/90	MUDSL	N\A	CRBCLA	78	1.00	4.59
07/10/90	MUDSL	N\A	CRBCLA	77	1.00	4.39
08/21/90	MUDSL	N\A	CRBCLA	78	1.20	5.33
08/21/90	MUDSL	N\A	CRBCLA	79	1.10	5.14
* LOCATION OLDRV						
11/17/88	OLDRV	N/A	CRBCLA	82	0.58	3.22
11/17/88	OLDRV	N/A	CRBCLA	84	0.51	3.19
11/17/88	OLDRV	N/A	CRBCLA	84	0.51	3.19
03/09/89	OLDRV	N/A	CRBCLA	85	0.58	3.87
03/09/89	OLDRV	N/A	CRBCLA	84	0.58	3.63
03/09/89	OLDRV	N/A	CRBCLA	83	0.58	3.41
03/29/90	OLDRV	N/A	CRBCLA	85	0.56	3.64
03/29/90	OLDRV	N/A	CRBCLA	85	0.58	3.77
03/29/90	OLDRV	N/A	CRBCLA	83	0.55	3.14
* LOCATION SALTS						
10/23/89	SALTS	N/A	CRBCLA	91	0.49	5.63
11/17/89	SALTS	N/A	CRBCLA	87	0.91	7.22
03/22/90	SALTS	N/A	CRBCLA	88	0.80	6.67
03/22/90	SALTS	N/A	CRBCLA	84	1.10	6.83
03/22/90	SALTS	N/A	CRBCLA	88	0.77	6.53
05/22/90	SALTS	N\A	CRBCLA	90	0.59	5.96
05/22/90	SALTS	N\A	CRBCLA	91	0.54	6.00
05/22/90	SALTS	N\A	CRBCLA	91	0.55	5.98
05/22/90	SALTS	N\A	CRBCLA	91	0.54	5.87
05/22/90	SALTS	N\A	CRBCLA	90	0.59	5.96
05/29/90	SALTS	N\A	CRBCLA	91	0.57	6.55
05/29/90	SALTS	N\A	CRBCLA	90	0.61	6.35
05/29/90	SALTS	N\A	CRBCLA	90	0.60	6.19
05/29/90	SALTS	N\A	CRBCLA	89	0.66	5.84
05/29/90	SALTS	N\A	CRBCLA	90	0.64	6.34
06/12/90	SALTS	N\A	CRBCLA	86	0.89	6.14
06/12/90	SALTS	N\A	CRBCLA	84	0.90	5.73
06/12/90	SALTS	N\A	CRBCLA	87	0.82	6.26
06/12/90	SALTS	N\A	CRBCLA	84	0.92	5.64
06/12/90	SALTS	N\A	CRBCLA	86	0.88	6.11
07/12/90	SALTS	N\A	CRBCLA	82	0.87	4.83
07/12/90	SALTS	N\A	CRBCLA	80	0.92	4.69
07/12/90	SALTS	N\A	CRBCLA	81	0.93	4.89
07/12/90	SALTS	N\A	CRBCLA	81	0.93	4.84
* LOCATION SHERI						
02/08/90	SHERI	N/A	CRBCLA	89	0.40	3.70
05/15/90	SHERI	N\A	CRBCLA	88	0.58	4.96

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
05/15/90	SHERI	N\A	CRBCLA	89	0.49	4.62
05/15/90	SHERI	N\A	CRBCLA	90	0.52	5.31
05/15/90	SHERI	N\A	CRBCLA	90	0.52	5.25
05/15/90	SHERI	N\A	CRBCLA	88	0.55	4.44
05/15/90	SHERI	N\A	CRBCLA	88	0.55	4.51
* LOCATION SJRAS						
05/25/90	SJRAS	N\A	CRBCLA	88	0.65	5.24
05/25/90	SJRAS	N\A	CRBCLA	89	0.60	5.26
05/25/90	SJRAS	N\A	CRBCLA	89	0.60	5.41
05/25/90	SJRAS	N\A	CRBCLA	88	0.61	5.21
05/25/90	SJRAS	N\A	CRBCLA	89	0.62	5.59
06/01/90	SJRAS	N\A	CRBCLA	86	0.66	4.82
06/01/90	SJRAS	N\A	CRBCLA	86	0.70	4.96
06/01/90	SJRAS	N\A	CRBCLA	86	0.70	5.00
06/01/90	SJRAS	N\A	CRBCLA	87	0.67	5.00
06/01/90	SJRAS	N\A	CRBCLA	86	0.68	4.76
06/14/90	SJRAS	N\A	CRBCLA	82	0.60	3.26
06/14/90	SJRAS	N\A	CRBCLA	83	0.62	3.67
06/14/90	SJRAS	N\A	CRBCLA	83	0.59	3.55
06/14/90	SJRAS	N\A	CRBCLA	83	0.62	3.58
06/14/90	SJRAS	N\A	CRBCLA	84	0.58	3.52
07/12/90	SJRAS	N\A	CRBCLA	81	0.54	2.90
07/12/90	SJRAS	N\A	CRBCLA	82	0.53	2.86
07/12/90	SJRAS	N\A	CRBCLA	81	0.54	2.84
07/12/90	SJRAS	N\A	CRBCLA	81	0.54	2.87
07/12/90	SJRAS	N\A	CRBCLA	81	0.54	2.78
09/05/90	SJRAS	N\A	CRBCLA	80	0.56	2.76
09/05/90	SJRAS	N\A	CRBCLA	79	0.59	2.82
09/05/90	SJRAS	N\A	CRBCLA	78	0.61	2.80
09/05/90	SJRAS	N\A	CRBCLA	77	0.60	2.58
09/05/90	SJRAS	N\A	CRBCLA	78	0.59	2.73
* LOCATION SJRAW						
03/01/90	SJRAW	N/A	CRBCLA	90	0.48	4.57
03/01/90	SJRAW	N/A	CRBCLA	90	0.44	4.40
03/01/90	SJRAW	N/A	CRBCLA	89	0.52	4.52
03/01/90	SJRAW	N/A	CRBCLA	91	0.44	4.63
03/01/90	SJRAW	N/A	CRBCLA	90	0.44	4.31
03/01/90	SJRAW	N/A	CRBCLA	90	0.45	4.50
03/01/90	SJRAW	N/A	CRBCLA	90	0.49	4.85
03/01/90	SJRAW	N/A	CRBCLA	89	0.46	4.30
03/01/90	SJRAW	N/A	CRBCLA	90	0.46	4.42
* LOCATION SJRBM						
05/25/90	SJRBM	N\A	CRBCLA	90	0.60	6.12
05/25/90	SJRBM	N\A	CRBCLA	90	0.58	5.74

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
05/25/90	SJRBM	N\A	CRBCLA	90	0.58	5.63
05/25/90	SJRBM	N\A	CRBCLA	89	0.61	5.35
05/25/90	SJRBM	N\A	CRBCLA	89	0.59	5.46
06/01/90	SJRBM	N\A	CRBCLA	88	0.59	5.00
06/01/90	SJRBM	N\A	CRBCLA	89	0.58	5.23
06/01/90	SJRBM	N\A	CRBCLA	89	0.58	5.37
06/01/90	SJRBM	N\A	CRBCLA	88	0.62	5.00
06/01/90	SJRBM	N\A	CRBCLA	89	0.62	5.69
06/14/90	SJRBM	N\A	CRBCLA	84	0.62	3.92
06/14/90	SJRBM	N\A	CRBCLA	82	0.69	3.73
06/14/90	SJRBM	N\A	CRBCLA	87	0.52	3.94
06/14/90	SJRBM	N\A	CRBCLA	87	0.55	4.17
06/14/90	SJRBM	N\A	CRBCLA	84	0.61	3.89
07/12/90	SJRBM	N\A	CRBCLA	84	0.64	3.93
07/12/90	SJRBM	N\A	CRBCLA	80	0.74	3.76
07/12/90	SJRBM	N\A	CRBCLA	80	0.76	3.88
07/12/90	SJRBM	N\A	CRBCLA	81	0.69	3.67
07/12/90	SJRBM	N\A	CRBCLA	81	0.70	3.68
09/04/90	SJRBM	N\A	CRBCLA	80	0.65	3.25
09/04/90	SJRBM	N\A	CRBCLA	80	0.66	3.27
09/04/90	SJRBM	N\A	CRBCLA	80	0.68	3.33
09/04/90	SJRBM	N\A	CRBCLA	78	0.68	3.12
* LOCATION SJRBS						
04/02/90	SJRBS	N/A	CRBCLA	89	0.48	4.21
04/02/90	SJRBS	N/A	CRBCLA	87	0.42	3.16
04/02/90	SJRBS	N/A	CRBCLA	86	0.49	3.58
05/25/90	SJRBS	N\A	CRBCLA	92	0.42	5.19
05/25/90	SJRBS	N\A	CRBCLA	91	0.46	5.00
05/25/90	SJRBS	N\A	CRBCLA	89	0.62	5.79
05/25/90	SJRBS	N\A	CRBCLA	90	0.49	4.71
05/25/90	SJRBS	N\A	CRBCLA	89	0.60	5.31
06/01/90	SJRBS	N\A	CRBCLA	86	0.69	5.00
06/01/90	SJRBS	N\A	CRBCLA	86	0.65	4.61
06/01/90	SJRBS	N\A	CRBCLA	89	0.53	4.91
06/01/90	SJRBS	N\A	CRBCLA	91	0.43	4.83
06/01/90	SJRBS	N\A	CRBCLA	90	0.44	4.49
06/14/90	SJRBS	N\A	CRBCLA	83	0.60	3.45
06/14/90	SJRBS	N\A	CRBCLA	89	0.47	4.23
06/14/90	SJRBS	N\A	CRBCLA	90	0.45	4.55
06/14/90	SJRBS	N\A	CRBCLA	89	0.42	3.93
06/14/90	SJRBS	N\A	CRBCLA	83	0.58	3.37
07/12/90	SJRBS	N\A	CRBCLA	88	0.42	3.50
07/12/90	SJRBS	N\A	CRBCLA	88	0.41	3.39
07/12/90	SJRBS	N\A	CRBCLA	87	0.43	3.36
07/12/90	SJRBS	N\A	CRBCLA	80	0.64	3.15
07/12/90	SJRBS	N\A	CRBCLA	80	0.61	3.08

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
09/04/90	SJRBS	N\A	CRBCLA	80	0.58	2.84
09/04/90	SJRBS	N\A	CRBCLA	80	0.60	3.00
09/04/90	SJRBS	N\A	CRBCLA	80	0.56	2.75
09/04/90	SJRBS	N\A	CRBCLA	79	0.60	2.83
09/04/90	SJRBS	N\A	CRBCLA	80	0.59	2.89
* LOCATION	SJRDR					
11/21/88	SJRDR	N/A	CRBCLA	83	0.50	2.94
03/09/89	SJRDR	N/A	CRBCLA	82	0.67	3.72
03/09/89	SJRDR	N/A	CRBCLA	82	0.63	3.50
03/09/89	SJRDR	N/A	CRBCLA	81	0.75	3.95
* LOCATION	SJRLN					
03/22/90	SJRLN	N/A	CRBCLA	83	0.23	1.32
03/22/90	SJRLN	N/A	CRBCLA	84	0.22	1.34
05/22/90	SJRLN	N\A	CRBCLA	89	0.52	4.52
05/22/90	SJRLN	N\A	CRBCLA	91	0.45	4.89
05/22/90	SJRLN	N\A	CRBCLA	90	0.48	5.00
05/22/90	SJRLN	N\A	CRBCLA	91	0.51	5.43
05/22/90	SJRLN	N\A	CRBCLA	90	0.51	5.20
05/29/90	SJRLN	N\A	CRBCLA	90	0.45	4.29
05/29/90	SJRLN	N\A	CRBCLA	90	0.46	4.47
05/29/90	SJRLN	N\A	CRBCLA	89	0.48	4.49
05/30/90	SJRLN	N\A	CRBCLA	88	0.62	5.21
05/30/90	SJRLN	N\A	CRBCLA	90	0.51	5.26
06/12/90	SJRLN	N\A	CRBCLA	89	0.53	4.86
06/12/90	SJRLN	N\A	CRBCLA	88	0.42	3.56
06/12/90	SJRLN	N\A	CRBCLA	89	0.51	4.47
06/12/90	SJRLN	N\A	CRBCLA	88	0.40	3.39
06/12/90	SJRLN	N\A	CRBCLA	89	0.48	4.44
07/10/90	SJRLN	N\A	CRBCLA	91	0.40	4.55
07/10/90	SJRLN	N\A	CRBCLA	89	0.30	2.83
07/10/90	SJRLN	N\A	CRBCLA	90	0.44	4.44
07/10/90	SJRLN	N\A	CRBCLA	91	0.41	4.51
07/10/90	SJRLN	N\A	CRBCLA	90	0.30	2.94
09/05/90	SJRLN	N\A	CRBCLA	91	0.29	3.09
09/05/90	SJRLN	N\A	CRBCLA	91	0.28	3.11
09/05/90	SJRLN	N\A	CRBCLA	92	0.25	3.01
* LOCATION	SNDSL					
04/05/90	SNDSL	N/A	CRBCLA	94	0.28	4.38
04/05/90	SNDSL	N/A	CRBCLA	94	0.26	4.41
04/05/90	SNDSL	N/A	CRBCLA	92	0.32	4.05
* LOCATION	STBSL					
11/07/89	STBSL	N/A	CRBCLA	94	0.20	3.57
04/11/90	STBSL	N/A	CRBCLA	88	0.40	3.39

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
04/11/90	STBSL	N/A	CRBCLA	89	0.41	3.81
04/11/90	STBSL	N/A	CRBCLA	90	0.40	3.92
* LOCATION SUISB						
02/17/89	SUISB	N/A	CRBCLA	94	0.43	7.17
02/17/89	SUISB	N/A	CRBCLA	92	0.48	6.00
02/17/89	SUISB	N/A	CRBCLA	93	0.52	7.43
** SPECIES DAPHNA						
* LOCATION TLDDN						
03/23/89	TLDDN	2B	DAPHNA	94	0.11	1.83
03/23/89	TLDDN	2B	DAPHNA	94	0.10	1.67
03/23/89	TLDDN	2B	DAPHNA	94	0.14	2.33
03/23/89	TLDDN	2B	DAPHNA	94	0.13	2.17
03/23/89	TLDDN	2B	DAPHNA	94	0.15	2.50
03/23/89	TLDDN	2B	DAPHNA	95	0.12	2.40
03/23/89	TLDDN	2B	DAPHNA	94	0.13	2.17
03/23/89	TLDDN	2B	DAPHNA	94	0.11	1.83
03/23/89	TLDDN	2B	DAPHNA	94	0.14	2.33
03/23/89	TLDDN	2B	DAPHNA	94	0.15	2.50
05/17/89	TLDDN	3B	DAPHNA	92	0.27	3.38
05/17/89	TLDDN	3B	DAPHNA	93	0.22	3.14
05/17/89	TLDDN	3B	DAPHNA	93	0.24	3.43
03/23/89	TLDDN	5B	DAPHNA	94	0.17	2.83
03/23/89	TLDDN	5B	DAPHNA	94	0.19	3.17
03/23/89	TLDDN	5B	DAPHNA	94	0.18	3.00
** SPECIES DSFLYA						
* LOCATION WFRMR						
06/13/90	WFRMR	C1S	DSFLYA	71	6.60	23.08
06/13/90	WFRMR	C1S	DSFLYA	70	6.20	20.67
06/13/90	WFRMR	C1S	DSFLYA	68	6.70	20.74
06/07/90	WFRMR	C1S	DSFLYA	68	6.70	20.81
06/07/90	WFRMR	C1S	DSFLYA	63	7.20	19.51
06/07/90	WFRMR	C1S	DSFLYA	64	7.10	19.45
06/13/90	WFRMR	C1S	DSFLYA	73	5.90	22.18
06/13/90	WFRMR	C1S	DSFLYA	73	5.70	21.43
06/13/90	WFRMR	C1S	DSFLYA	73	5.80	21.72
06/13/90	WFRMR	C1S	DSFLYA	71	5.40	18.49
06/13/90	WFRMR	C1S	DSFLYA	71	5.70	19.66
06/13/90	WFRMR	C1S	DSFLYA	70	5.30	17.61

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
** SPECIES DSFLYL						
* LOCATION WFRMR						
06/05/90	WFRMR	C1S	DSFLYL	76	5.00	21.01
06/06/90	WFRMR	C1S	DSFLYL	84	3.20	19.51
06/06/90	WFRMR	C1S	DSFLYL	88	3.30	27.50
06/06/90	WFRMR	C1S	DSFLYL	79	4.80	22.33
06/06/90	WFRMR	C1S	DSFLYL	83	3.80	21.84
** SPECIES FWMUSS						
* LOCATION MUDSL						
04/17/90	MUDSL	N/A	FWMUSS	88	0.31	2.63
04/17/90	MUDSL	N/A	FWMUSS	89	0.34	3.18
04/17/90	MUDSL	N/A	FWMUSS	91	0.28	3.15
** SPECIES MIDGEL						
* LOCATION WFRMR						
05/15/89	WFRMR	3A	MIDGEL	83	2.00	11.76
05/15/89	WFRMR	3A	MIDGEL	83	2.00	11.76
05/15/89	WFRMR	3A	MIDGEL	83	1.90	11.18
** SPECIES MUSSEN						
* LOCATION SNPBB						
02/28/90	SNPBB	PTP	MUSSEN	77	0.30	1.32
02/28/90	SNPBB	ROD	MUSSEN	68	0.39	1.21
** SPECIES POTAMC						
* LOCATION SNPBB						
02/28/90	SNPBB	PTP	POTAMC	50	0.38	0.76
02/28/90	SNPBB	PTP	POTAMC	60	0.40	1.00
02/28/90	SNPBB	PTP	POTAMC	58	0.43	1.03
02/28/90	SNPBB	PTP	POTAMC	52	0.42	0.88
02/28/90	SNPBB	ROD	POTAMC	57	0.14	0.33
02/28/90	SNPBB	ROD	POTAMC	63	0.14	0.38
02/28/90	SNPBB	ROD	POTAMC	55	0.18	0.40
02/28/90	SNPBB	ROD	POTAMC	53	0.15	0.32
* LOCATION SUISB						
04/19/90	SUISB	MAR	POTAMC	56	0.55	1.24
02/17/89	SUISB	N/A	POTAMC	35	0.41	0.63
02/27/90	SUISB	ROE	POTAMC	50	0.34	0.68
02/27/90	SUISB	ROE	POTAMC	46	0.23	0.43
02/27/90	SUISB	ROE	POTAMC	45	0.29	0.53
02/27/90	SUISB	ROE	POTAMC	48	0.23	0.44

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SAMPLE DATE	SAMPLE LOCATION	SUBSITE	SPECIES	PERCENT MOISTURE	Se (ppm) wet wt.	Se (ppm) dry wt.
02/27/90	SUISB	ROE	POTAMC	50	0.32	0.65
02/27/90	SUISB	ROE	POTAMC	50	0.35	0.70
02/27/90	SUISB	ROE	POTAMC	54	0.29	0.62
02/27/90	SUISB	ROE	POTAMC	45	0.25	0.45
02/27/90	SUISB	ROE	POTAMC	50	0.24	0.48
02/27/90	SUISB	ROE	POTAMC	48	0.22	0.42
04/19/90	SUISB	SOH	POTAMC	54	0.46	1.01

** SPECIES TAPESJ
* LOCATION SNPBB

02/28/90	SNPBB	PTP	TAPESJ	41	0.19	0.32
02/28/90	SNPBB	PTP	TAPESJ	37	0.17	0.27
02/28/90	SNPBB	PTP	TAPESJ	40	0.19	0.32
02/28/90	SNPBB	PTP	TAPESJ	47	0.28	0.53
02/28/90	SNPBB	PTP	TAPESJ	51	0.19	0.39
02/28/90	SNPBB	ROD	TAPESJ	58	0.20	0.48

APPENDIX B-2

COMMON NAME, SCIENTIFIC NAME, FAMILY AND SPECIES NAME CODE OF BIRDS, FISHES AND INVERTEBRATES COLLECTED IN 1988-89 AND 1989-90

BIRDS

Common Name	Species	Family	Code
lesser scaup	*Aythya affinis*	Anatidae	LSCAUP
greater scaup	*Aythya marila*	"	GSCAUP
surf scoter	*Melanitta perspicillata*	"	SCOTER
ruddy duck	*Oxyura jamaicensis*	"	RUDDYD
northern shoveler	*Anas clypeata*	"	NSHVLR
northern pintail	*Anas acuta*	"	NPNTL
green-winged teal	*Anas crecca*	"	GWTEAL
mallard	*Anas platyrhynchos*	"	MALLRD
American wigeon	*Anas americana*	"	AWIGON
black-necked stilt	*Himantopus mexicanus*	Recurvirostidae	BNSTLT

FISHES

white sturgeon	*Acipenser transmontanus*	Acipenseridae	WSTRGN
white catfish	*Ictalurus catus*	Ictaluridae	WHTCAT
channel catfish	*Ictalurus punctatus*	"	CHNCAT
striped bass	*Morone saxatilis*	Percichthyidae	STBASS
brown bullhead	*Ictalurus nebulosus*	Ictaluridae	BRNBHD
green sunfish	*Lepomis cyanellus*	Centrarchidae	GRNSNF

INVERTEBRATES

Asiatic freshwater clam	*Corbicula fluminea*	Corbiculidae	CRBCLA
Potamacorbula clams	*Potamacorbula spp*	Corbulidae	POTAMC

fingernail mussels	Musculus senhousia	Mytilidae	MUSSEN
bent-nosed clam	Macoma nasuta	Tellinidae	MACNAS
littleneck clam	Protothaca staminga	Veneridae	LTNECK
Japanese littleneck	Tapes japonica	"	TAPESI
Baltic clam	Macoma balthica	Tellinidae	MACBAL
brine shrimp	Artemia salina	Artemiidae	BRNESH
water boatmen	undetermined		BOATMN

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Bird Flesh			
B3010F	5.8	6.1	3.6
B3020F	14.	13.	5.2
B3033F	9.4	9.6	1.5
B3040F	5.9	6.0	1.2
B3059F	11.	10.	6.7
B3068F	0.36	0.37	1.9
B3081F	5.3	5.2	1.3
B3124F	1.1	1.1	0.0
B3127F	2.8	2.9	2.5
B3133F	5.8	5.7	1.2
B3145F	0.61	0.60	1.2
B3152F	1.9	2.0	3.6
B3159F	1.4	1.4	0.0
B3167F	2.1	2.2	3.3
B3230F	0.79	0.77	1.8
B3245F	0.52	0.54	2.7
B3248F	0.27	0.28	2.6
B3257F	0.38	0.36	3.8
B3274F	2.5	2.4	2.9
B3278F	0.91	0.90	0.7
B3284F	0.74	0.70	3.9
B3293F	0.55	0.54	1.3
B3327F	0.58	0.58	0.0
B3345F	0.43	0.41	3.4
Bird Liver			
B3022L	52.	52.	0.0
B3023L	52.	50.	2.8
B3029L	46.	46.	0.0
B3038L	66.	66.	0.0
B3053L	23.	23.	0.0
B3059L	22.	22.	0.0
B3064L	11.	11.	0.0
B3073L	4.6	4.7	1.5
B3084L	2.2	2.1	3.3
B3094L	6.0	6.0	0.0
B3122L	1.4	1.5	4.9
B3123L	0.90	0.89	0.79
B3124L	3.3	3.3	0.0
B3125L	1.1	1.1	0.0
B3132L	22.	23.	3.1
B3136L	6.4	6.2	2.2

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Bird Liver-Continued			
B3138L	9.1	9.2	0.77
B3160L	3.1	3.1	0.0
B3167L	6.4	6.4	0.0
B3171L	4.6	4.5	1.6
B3188L	9.1	9.1	0.0
B3190L	4.1	4.1	0.0
B3208L	1.6	1.7	4.3
B3219L	2.9	2.9	0.0
Fish Flesh			
F3012F	0.40	0.38	3.6
F3016	0.37	0.37	0.0
F3031F	0.68	0.68	0.0
F3043F	0.20	0.19	3.6
F3048F	0.21	0.20	3.4
F3053F	0.18	0.18	0.0
F3065	0.19	0.20	3.6
F3067	0.24	0.24	0.0
F3075F	0.62	0.62	0.0
F3089F	0.20	0.19	3.6
F3094F	0.40	0.39	1.8
F3109F	1.4	1.5	4.9
F3114F	1.2	1.2	0.0
F3127	0.27	0.26	2.7
F3144F	0.50	0.54	5.4
F3151	0.69	0.70	1.0
F3162	1.2	1.3	5.7
F3172	0.81	0.81	0.0
F3174	0.58	0.60	2.4
F3195F	0.15	0.15	0.0
F3205F	9.8	10.	1.4
F3209F	0.12	0.14	11.
F3216	0.67	0.64	3.2
F3233	1.1	1.1	0.0
F3235F	0.28	0.27	2.6
F3244	0.36	0.37	1.9
F3257F	0.80	0.80	0.0
F3258	1.1	1.0	6.7
F3264F	0.19	0.20	3.6
F3282F	0.52	0.54	2.7
F3288F	0.27	0.27	0.0
F3295F	0.49	0.49	0.0

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Fish Liver			
F3018L	1.4	1.5	4.9
F3024L	1.9	1.6	12.
F3025L	2.3	2.4	3.0
F3035L	1.6	1.6	0.0
F3042L	2.4	2.3	3.0
F3043L	2.6	2.7	2.7
F3059L	0.59	0.58	1.2
F3072L	1.4	1.4	0.0
F3081L	1.3	1.3	0.0
F3089L	1.5	1.5	0.0
F3097L	2.1	2.2	3.3
F3115-8L	3.7	3.8	1.9
F3134L	1.8	1.7	4.0
F3138L	0.98	0.94	2.9
F3148L	1.7	1.7	0.0
F3167L	2.1	2.0	3.4
F3199L	1.9	1.9	0.0
F3209L	1.5	1.5	0.0
F3226.1L	1.6	1.6	0.0
F3227L	1.6	1.6	0.0
F3263L	1.6	1.6	0.0
F3264L	1.8	1.7	4.0
F3288L	1.6	1.7	4.3
Invertebrates			
I3001F	0.88	0.89	0.80
I3007F	0.50	0.52	2.8
I3011F	0.56	0.56	0.0
I3013F	0.48	0.53	7.0
I3039	1.6	1.6	0.0
I3042	0.17	0.18	4.0
I3047	2.0	2.0	0.0
I3051	0.98	1.1	8.2
I3067	0.71	0.76	4.8
I3103	5.6	5.6	0.0
I3134	8.9	8.6	2.4
I3161	4.2	4.4	3.3
I3173	3.2	3.4	4.3
I3185	3.4	3.4	o.o
I3198	0.11	0.10	6.7
I3227	8.4	8.2	1.7
I3230	8.1	8.0	0.88

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Invertebrates-Continued			
I3255	7.7	7.9	1.8
I3265	6.6	7.0	4.2
I3280	1.9	1.9	0.0
I3289	1.8	1.7	4.0
I3303	1.6	1.7	4.3
I3315	0.80	0.82	1.7
I3344	0.16	0.17	4.3
I3350	0.17	0.17	0.0
Plankton			
P3003	0.44	0.43	1.6
P3013	0.47	0.49	2.9
P3016	0.57	0.60	3.6
P3018	0.43	0.46	4.8
P3023	1.2	1.4	11.
P3024	0.32	0.31	2.2
Sediment			
S3006	0.71	0.69	2.0
S3011	0.13	0.15	10.

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.		Selenium Fresh Weight ug/g (ppb)			%RSD[1/]
Filtered Water					
L3001		2.1	1.8		11.
L3002		1.7	1.9		7.9
L3003		2.2	2.3		3.1
L3005		7.6	7.8		1.8
L3008		6.2	5.9	6.3	3.4
L3009		3.6	4.0	3.6	6.2
L3010	1.3	1.3	1.4	1.3	3.8
L3011	1.4	1.2	1.4	1.0	15.
L3013		3.3	3.4		2.1
L3017		<1.0	<1.		
L3021		2.6	2.6		0.0
L3023		53.	52.		1.3
Unfiltered Water					
W3001, W3002		8.6	8.8		1.6
W3003, W3004		11.	11.		0.0
W3005, W3006		9.0	8.8		1.6
W3007, W3008		160.	170.		4.3
W3009, W3010		180.	170.		4.0
W3011, W3012		1.2	1.4		11.
W3013, W3014		1.0	1.0		0.0
W3015, W3016		280.	280.		0.0
W3017, W3018		240.	220.		6.1
W3019, W3020		15.	14.		4.9
W3021, W3022		9.3	8.4		7.2
W3023, W3024		8.8	8.8		0.0
W3025, W3026		5.8	5.8		0.0
W3027, W3028		2.1	2.3		6.4
W3029, W3030		<1.0	<1.0		

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Percent Moisture		%RSD[1/]
Bird Flesh			
B3010F	72	73	0.98
B3020F	71	71	0.0
B3033F	71	71	0.0
B3040F	72	71	0.99
B3059F	71	71	0.0
B3068F	70	70	0.0
B3081F	73	73	0.0
B3124F	73	73	0.0
B3127F	69	70	1.0
B3133F	72	72	0.0
B3145F	71	71	0.0
B3152F	71	70	1.0
B3159F	72	72	0.0
B3167F	71	71	0.0
B3230F	70	70	0.0
B3245F	70	70	0.0
B3248F	76	76	0.0
B3257F	70	71	1.0
B3274F	71	71	0.0
B3278F	70	70	0.0
B3284F	69	69	0.0
B3293F	69	67	2.1
B3327F	75	75	0.0
B3345F	74	74	0.0
Bird Liver			
B3022L	73	73	0.0
B3023L	72	72	0.0
B3029L	73	73	0.0
B3038L	72	72	0.0
B3053L	74	74	0.0
B3059L	75	75	0.0
B3064L	73	73	0.0
B3073L	72	72	0.0
B3122L	77	76	0.92
B3123L	72	72	0.0
B3124L	71	71	0.0
B3125L	72	73	0.98
B3132L	74	73	0.96
B3136L	72	72	0.0
B3138L	71	71	0.0
B3160L	70	71	1.0
B3167L	71	71	0.0

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Percent Moisture		%RSD[1/]
Bird Liver-Continued			
B3171L	72	72	0.0
B3188L	75	75	0.0
B3190L	74	73	0.96
B3208L	75	75	0.0
B3219L	73	73	0.0
Fish Flesh			
F3012F	81	80	0.88
F3031F	79	79	0.0
F3043F	79	79	0.0
F3048F	79	80	0.89
F3053F	81	81	0.0
F3065	82	81	0.87
F3067	76	76	0.0
F3075F	79	79	0.0
F3089F	81	79	1.8
F3094F	81	79	1.8
F3109F	80	79	0.89
F3114F	79	79	0.0
F3127	79	79	0.0
F3144F	79	79	0.0
F3151	74	74	0.0
F3162	79	81	1.8
F3172	79	79	0.0
F3174	72	70	2.0
F3195F	78	79	0.90
F3209F	77	78	0.91
F3216	78	79	0.90
F3233	75	75	0.0
F3235F	76	76	0.0
F3244	76	77	0.92
F3257F	79	79	0.0
F3258	76	76	0.0
F3264F	80	80	0.0
F3282F	76	76	0.0
F3288F	76	76	0.0
F3295F	76	76	0.0

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Sample No.	Percent Moisture		%RSD[1/]
Liver			
F3018L	81	81	0.0
F3025L	83	82	0.86
F3035L	86	86	0.0
F3042L	81	81	0.0
F3043L	81	81	0.0
F3059L	80	79	0.89
F3072L	77	77	0.0
F3081L	77	77	0.0
F3089L	80	79	0.89
F3097L	79	79	0.0
F3115-8L	81	81	0.0
F3134L	81	80	0.88
F3138L	78	78	0.0
F3148L	76	76	0.0
F3167L	78	78	0.0
F3199L	81	81	0.0
F3209L	82	82	0.0
F3226.1L	81	81	0.0
F3227L	82	81	0.87
F3263L	77	78	0.91
F3264L	81	81	0.0
F3288L	79	79	0.0
Invertebrates			
I3001F	83	83	0.0
I3007F	84	84	0.0
I3011F	84	84	0.0
I3013F	92	93	0.76
I3039	93	93	0.0
I3042	94	94	0.0
I3047	84	82	1.7
I3051	81	83	1.7
I3067	90	89	0.79
I3103	87	87	0.0
I3134	81	81	0.0
I3173	85	84	0.84
I3185	87	87	0.0
I3198	94	95	0.75
I3227	77	77	0.0
I3230	77	77	0.0
I3280	85	85	0.0
I3303	85	85	0.0
I3315	87	87	0.0

APPENDIX C (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content Analysis 1988-89.

Percent

Sample	No.	Moisture	%RSD[1/]
Invertebrates-Continued			
I3344	86	86	0.0
I3350	86	86	0.0
Plankton			
P3003	84	83	0.85
P3013	77	77	0.0
P3016	84	81	2.6
P3018	77	62	15.
P3023	56	61	6.0
P3024	74	76	1.9
Sediment			
S3006	61	60	1.2
S3011	52	55	4.0

APPENDIX D. Average Percent Relative Standard Deviation (%RSD) for Duplicate Samples Analyzed for Selenium and Moisture Content 1989-90.

Sample Type	Selenium Concentration Average % RSD and Range	Number of Duplicate Selenium Analyses	Percent Moisture Average % RSD and Range	Number of Duplicate Moisture Analyses
All samples	2.1 (0 to 11.)	127	0.72 (0 to 13.)	125
Bird Flesh	0.93 (0 to 3.0)	6	0.25 (0 to 0.98)	6
Bird Liver	2.1 (0 to 5.1)	11	0.67 (0 to 4.4)	11
Fish Flesh	2.0 (0 to 11.)	30	0.45 (0 to 2.5)	30
Fish Liver	1.8 (0 to 10.)	31	0.21 (0 to 1.3)	23
Invertebrates-Insects	3.4 (0 to 11.)	22	0.60 (0 to 1.6)	22
Invertebrates-Mussels	1.9 (0 to 11.)	33	1.5 (0 to 13.)	33

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Bird Flesh			
B4040	0.81	0.80	0.88
B4053	1.2	1.2	0.0
B4067	7.3	7.0	3.0
B4081	8.4	8.6	1.7
B4089	14.	14.	0.0
B4096	12.	12.	0.0
Bird Liver			
B4005	10.	9.3	5.1
B4017	19.	18.	3.8
B4018	21.	20.	3.4
B4027	3.1	3.1	0.0
B4044	1.7	1.7	0.0
B4062	1.5	1.4	4.9
B4067	43.	43.	0.0
B4069	25.	25.	0.0
B4081	32.	32.	0.0
B4088	21.	22.	3.3
B4097	32.	31.	2.2
Fish Flesh			
F4003	0.60	0.60	0.0
F4008	0.84	0.88	3.3
F4034	0.27	0.26	2.7
F4057W	0.96	0.92	3.0
F4061	0.73	0.73	0.0
F4068W	0.21	0.18	11.
F4076	1.3	1.3	0.0
F4093W	0.77	0.78	0.91
F4110	0.56	0.57	1.2
F4122W	0.20	0.19	3.6
F4150W	0.25	0.27	5.4
F4159	0.84	0.89	4.1
F4168	1.4	1.4	0.0
F4170	0.56	0.58	2.5
F4179	0.13	0.13	0.0
F4187W	0.62	0.57	5.9
F4199	2.7	2.7	0.0
F4215	0.77	0.79	1.8
F4218	2.0	2.0	0.0

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Fish Flesh-Continued			
F4240	0.20	0.19	3.6
F4250	7.8	7.9	0.90
F4254	4.8	4.7	1.5
F4266	2.6	2.6	0.0
F4284	0.65	0.64	1.1
F4306	0.57	0.55	2.5
F4307	0.54	0.55	1.3
F4327	0.18	0.18	0.0
F4336	0.22	0.22	0.0
F4340W	0.31	0.31	0.0
F4348	8.8	8.8	0.0
F4356	0.42	0.40	3.4
Fish Liver			
F4000	2.6	2.5	2.8
F4001	2.4	2.6	5.7
F4018	2.1	2.0	3.4
F4019	1.2	1.2	0.0
F4052	1.4	1.4	0.0
F4064	0.81	0.78	2.7
F4073	2.8	2.7	2.6
F4083	2.2	2.4	6.1
F4135	0.73	0.73	0.0
F4154	1.4	1.3	5.2
F4166	1.2	1.2	0.0
F4174	2.6	3.0	10.
F4174L-R	2.9	2.9	0.0
F4186	13.	13.	0.0
F4215	7.1	7.5	3.9
F4251	8.2	8.2	0.0
F4261	6.5	6.4	1.1
F4266	2.6	2.6	0.0
F4267	3.9	3.9	0.0
F4276	1.6	1.6	0.0
F4318	0.74	0.74	0.0
F4337	0.79	0.78	0.90
F4349	10.	10.	0.0
F4355	1.4	1.4	0.0

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Invertebrates			
I4001F	0.20	0.21	3.4
I4004	0.23	0.26	8.7
I4005	0.21	0.24	9.4
I4006	0.24	0.24	0.0
I4007	0.24	0.22	6.1
I4008	0.22	0.22	0.0
I4018	0.14	0.14	0.0
I4019	0.14	0.14	0.0
I4020	0.15	0.14	4.9
I4021	0.20	0.17	11.
I4044F	0.49	0.48	1.5
I4048F	0.46	0.46	0.0
I4058F	0.48	0.48	0.0
I4065F	0.35	0.35	0.0
I4073F	0.75	0.77	1.9
I4082F	0.54	0.54	0.0
I4091F	0.52	0.52	0.0
I4103F	0.47	0.45	3.1
I4104F	0.62	0.62	0.0
I4117F	0.45	0.45	0.0
I4127F	0.62	0.62	0.0
I4130F	0.61	0.62	1.1
I4137F	0.69	0.71	2.0
I4142	9.3	9.7	3.0
I4155	6.5	7.0	5.2
I4161	5.8	5.4	5.1
I4163	5.3	6.2	11.
I4164	5.9	6.1	2.4
I4165	6.2	6.6	4.4
I4169	6.7	7.4	7.0
I4172	5.7	5.9	2.4
I4188F	0.40	0.40	0.0
I4189F	0.88	0.88	0.0
I4198	10.	10.	0.0
I4216F	0.46	0.44	3.1
I4224F	0.60	0.60	0.0
I4226	4.7	4.2	7.9
I4230	7.4	7.6	1.9
I4240	10.	9.4	4.4
I4250	7.2	7.2	0.0
I4259	6.6	6.7	4.2
I4277	6.7	6.5	2.1
I4288	6.2	6.2	0.0
I4292	5.6	6.1	6.0
I4296	11.	11.	0.0
I4304	11.	10.	6.7

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Selenium Fresh Weight ug/g (ppm)		%RSD[1/]
Invertebrates-Continued			
I4313	11.	11.	0.0
I4317	7.6	7.6	0.0
I4327	15.	15.	0.0
I4367	1.0	1.0	0.0
I4376F	0.62	0.65	3.3
I4385F	0.62	0.60	2.3
I4387F	0.54	0.54	0.0
I4398F	0.61	0.59	2.4
I4409F	0.59	0.59	0.0

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Percent Moisture		%RSD[1/]
Bird Flesh			
B4040	72.7	71.7	0.98
B4053	81.2	81.2	0.0
B4067	69.8	69.6	0.20
B4081	71.0	71.0	0.0
B4089	71.5	71.8	0.30
B4096	72.8	72.8	0.0
Bird Liver			
B4005	70.6	70.3	0.30
B4017	74.6	74.6	0.0
B4018	73.1	74.3	1.2
B4027	72.0	71.4	0.59
B4044	71.5	71.6	0.10
B4062	72.7	73.1	0.39
B4067	74.4	74.3	0.10
B4069	72.6	72.7	0.10
B4081	70.8	66.5	4.4
B4088	74.0	74.0	0.0
B4097	73.7	73.9	0.19
Fish Flesh			
F4003	77.3	78.4	1.0
F4008	78.4	78.9	0.45
F4034	77.8	77.7	0.09
F4057W	76.5	75.9	0.56
F4061	79.0	78.3	0.63
F4068W	76.9	76.4	0.46
F4076	80.5	80.4	0.09
F4093W	78.0	77.1	0.82
F4110	78.3	78.2	0.09
F4122W	76.8	76.9	0.09
F4150W	74.7	74.8	0.09
F4159	82.0	82.0	0.0
F4168	79.6	76.8	2.5
F4170	73.1	74.2	1.1
F4179	76.0	76.8	0.74
F4187W	80.0	80.8	0.70
F4199	77.7	77.3	0.36
F4218	78.5	78.8	0.27
F4240	79.4	79.4	0.0
F4250	77.9	78.8	0.81
F4254	77.1	77.3	0.18

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Percent Moisture		%RSD[1/]
Fish Flesh-Continued			
F4266	74.5	74.3	0.19
F4284	79.7	79.9	0.18
F4306	79.3	78.9	0.36
F4307	78.6	79.5	0.80
F4327	78.6	78.6	0.0
F4336	78.6	78.7	0.09
F4340W	77.4	77.4	0.0
F4348	77.3	77.3	0.0
F4356	74.2	75.1	0.85
Fish Liver			
F4000	81.7	80.9	0.70
F4001	82.9	83.0	0.09
F4018	81.3	81.4	0.09
F4019	80.5	80.1	0.35
F4052	83.1	83.1	0.0
F4064	76.5	76.4	0.09
F4073	78.1	77.9	0.18
F4083	82.4	81.9	0.43
F4135	78.1	77.8	0.27
F4154	82.8	83.2	0.34
F4166	81.0	80.9	0.09
F4174	81.4	81.4	0.0
F4186	82.7	82.8	0.09
F4215	81.6	80.9	0.61
F4251	72.6	72.6	0.0
F4261	79.7	79.8	0.09
F4266	69.4	69.4	0.0
F4267	73.6	72.3	1.3
F4276	80.3	80.3	0.0
F4318	80.6	80.7	0.09
F4337	81.8	81.8	0.0
F4349	77.7	77.9	0.18
F4355	68.3	68.3	0.0

Appendix D (cont). WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Percent Moisture		%RSD[1/]
Invertebrates			
I4001F	94.4	94.4	0.0
I4004	45.2	44.6	0.94
I4005	46.5	45.8	1.1
I4006	47.9	51.7	5.4
I4007	47.3	43.7	5.6
I4008	43.8	52.6	13.
I4018	58.3	56.4	2.3
I4019	60.1	65.3	5.9
I4020	51.2	55.4	5.6
I4021	51.3	57.9	8.5
I4044F	89.9	89.8	0.08
I4048F	89.6	89.5	0.08
I4058F	88.6	88.6	0.0
I4065F	88.5	88.7	0.16
I4073F	81.5	81.3	0.17
I4082F	91.0	91.0	0.0
I4091F	88.5	88.5	0.0
I4103F	90.8	90.9	0.08
I4104F	89.3	89.3	0.0
I4117F	89.5	89.5	0.0
I4127F	89.1	89.1	0.0
I4130F	87.6	87.7	0.08
I4137F	86.0	86.0	0.0
I4142	67.4	67.1	0.32
I4155	71.3	72.1	0.79
I4161	76.1	76.1	0.0
I4163	80.6	79.2	1.2
I4164	81.4	80.6	0.70
I4165	81.9	81.0	0.78
I4169	71.3	70.8	0.50
I4172	83.0	83.5	0.42
I4188F	88.1	88.2	0.08
I4189F	85.6	85.5	0.08
I4198	73.0	72.7	0.29
I4216F	90.1	90.1	0.0
I4224F	81.6	81.6	0.0
I4226	84.4	84.8	0.33
I4230	84.3	84.5	0.17
I4240	64.2	64.0	0.22
I4250	62.5	63.6	1.2
I4259	81.7	83.0	1.1
I4277	81.9	83.4	1.3
I4288	71.0	71.0	0.0
I4292	73.3	73.3	0.0
I4296	73.7	74.2	0.48
I4304	70.0	71.6	1.6
I4313	62.7	62.1	0.68

Appendix D (cont) WPCL Results of Duplicate Samples Analysed for Selenium and Moisture Content, 1989-90.

Sample No.	Percent Moisture		%RSD[1/]
Invertebrates-Continued			
I4317	81.4	82.7	1.1
I4327	86.6	86.5	0.08
I4367F	77.1	77.2	0.09
I4376F	83.7	83.7	0.0
I4385F	80.2	80.2	0.0
I4387F	81.0	81.0	0.0
I4398F	78.7	78.8	0.09
I4409F	79.0	79.2	0.18

APPENDIX E. WPCL results of analyses of freeze dried standard reference materials reported in ug/g (ppm).

Reference Material	Mean	n[4]	Standard Error[5]	%RSD[6]	Bias[7]
NBS 50[1/2] (Tuna) 3.6±0.4 ug/g	3.8	31	0.003	2.6	5.6
NBS 1577a (Bovine liver) 0.71±0.07 ug/g	0.69	35	0.001	5.2	-2.8
Nies 6[2/3] (Mussel) 1.5 ug/g	1.4	3	0.02	4.2	-6.7
NBS 1566a (Oyster tissue) 2.21±0.24 ug/g	2.0	5	0.01	2.8	-9.5
NBS 1646[2] (Esturine sediment) 0.6 ug/g	0.55	7	0.004	5.6	-8.3
NBS 2704[2] (River sediment) 1.1 ug/g	0.99	7	0.007	5.2	-10.
NBS 1643b (Water) 9.7±0.5 ng/g	9.7	7	0.05	3.7	0.0
Kale (Vegetation) 0.131±0.044 ug/g	0.13	3	0.002	4.6	-0.008

1/ National Bureau of Standards, Washington, D.C. 20234
2/ Noncertified, but accepted value of constituent element
3/ National Institue of Environmental Studies, Japan Environmental Agency
4/ Number of analyses
5/ Standard error = standard deviation/number of values
6/ Relative standard deviation = (standard deviation/mean x 100
7/ Bias (% difference) = {(experimental value - reference value)/reference value} x 100

APPENDIX F. Results of Selenium Analyses by Neutron Activation Analysis (University of Missouri) and Hydride Generation Atomic Absorption (WPCL).

Sample Number	ug/g (ppm) Dry Weight	NAA Selenium ug/g (ppm) Dry Weight	WPCL Selenium %RSD
B3001F	3.1	3.5	8.6
B3002F	3.8	4.4	10.
B3008F	3.8	3.9	1.8
B3010F	19.	22.	10.
B3015F	15.	17.	8.8
B3018F	8.8	8.9	0.80
B3019F	16.	19.	12.
B3020F	45.	46.	1.6
B3024F	44.	50.	9.0
B3028F	19.	21.	
B3033F	29.	32.	7.0
B3034F	51.	59.	10.
B3039F	48.	54.	8.0
B3040F	20.	21.	
B3042F	34.	37.	6.0
B3002L	18.	20.	7.4
B3006L	6.5	7.1	6.2
B3007L	19.	22.	10.
B3010L	96.	100.	2.9
B3013L	36.	32.	8.3
B3014L	72.	76.	4.2
B3019L	84.	82.	5.0

APPENDIX F. (cont) Results of Selenium Analyses by Neutron Activation Analysis (University of Missouri) and Hydride Generation Atomic Absorption (WPCL).

Sample Number	NAA Selenium ug/g (ppm) Dry Weight	WPCL Selenium ug/g (ppm) Dry Weight	%RSD
B3022L	180.	190.	3.8
B3023L	170.	180.	4.0
B3026L	200.	220.	6.7
B3029L	160.	170.	4.3
B3033L	150.	150.	0.0
B3037L	260.	270.	2.7
B3038L	220.	240.	6.1
B3039L	340.	370.	6.0
F3004F	2.0	2.0	0.0
F3005F	1.5	1.5	0.0
F3010F	2.8	2.6	5.2
F3016	1.8	1.8	0.0
F3018F	1.1	1.0	6.7
F3028F	2.4	2.8	11.
F3067	0.9	1.0	5.9
F3127	1.1	1.2	6.1
F3151	2.6	2.6	0.0
F3169	3.3	3.3	0.0
F3180	4.0	3.8	3.6
F3181	7.2	6.7	5.1
F3012F	1.9	2.0	3.6
F3024F	0.87	0.80	0.9
F3031F	3.2	3.2	0.0
F3061F	0.80	0.63	17.
F3066F	0.94	0.85	7.1
F3094F	1.9	2.0	3.6
F3095F	12.	9.0	20.
F3096F	5.3	5.0	4.1
F3109F	7.2	7.0	2.0
F3114F	7.0	5.7	14.
F3150F	2.7	2.8	2.6
F3179F	4.4	5.0	9.0
F3188F	26.	26.	0.0
F3192F	24.	24.	0.0
F3200F	20.	16.	16.
F3203F	21.	24.	9.4
F3205F	43.	43.	0.0
F3206F	39.	50.	17.
F3024L	8.0	9.4	11.
F3059L	2.8	2.9	2.5
F3110-F3113L	16.	20.	16.
F3115-F3118L	16.	20.	16.
F3138L	4.2	4.4	1.6
F3150L	8.8	8.0	6.7

APPENDIX F. (cont)

Results of Selenium Analyses by Neutron Activation Analysis (University of Missouri) and Hydride Generation Atomic Absorption (WPCL).

Sample Number	NAA Selenium ug/g (ppm) Dry Weight	WPCL Selenium ug/g (ppm) Dry Weight	%RSD
F3029F	3.7	3.5	3.9
F3030F	3.1	3.2	2.2
F3032F	0.89	1.5	36.
F3035F	2.9	2.8	2.5
F3039F	4.8	4.5	4.6
F3040F	3.5	3.4	2.0
F3041F	2.3	3.0	19 .
F3043F	1.0	0.98	1.4
F3071F	4.2	4.1	1.7
F3075F	2.9	3.0	2.4
F3 107F	9.7	8.6	8.5
F3112F	11.	10.	6.7
F3122F	15.	10.	28.
F3131F	0.59	0.58	1.2
F3132F	0.82	0.80	1.7
F3136F	0.86	0.90	3.2
F3139F	3.0	2.7	7.4
F3144F	2.8	2.5	8.0
F3186F	5.6	6.3	8.3
F3187F	9.0	9.0	0.0
F3190F	10.	10.	0.0
F3191F	23.	21.	6.4
F3195F	0.76	0.68	7.9
I3001F	5.0	5.2	2.8
I3025F	50.	40.	16.
I3034F	7.2	6.9	3.0
I3103F	51.	43.	12.
I3132F	58.	45.	18.
I3135F	55.	48.	9.6
I3176F	27.	25.	5.4
I3185F	28.	26.	5.2
I3198F	1.7	1.9	7.8
I3001F	5.0	5.2	2.8

Appendix G. Selenium concentrations in water (ug/kg, ppb), suspended particulates (ppm), plankton (ppm) and sediments (ppm) collected in 1988-89 and 1989-90.

Sample Date	Sample Location	Sample Number	Nucleopore Filter Residue Dry Weight (ppm) (ug/l)	Filtered Water (ppb) (ug/g)	Sediment Dry Weight (ppm) (ug/g)	Plankton Dry Weight (ppm) (ug/g)
9/88	MIDRV	3001	2.1	2.0		2.5
	OLDRV	3002	2.2	1.8		1.3
	SJRDR	3003	1.3	2.3		2.6
	AGTHA	3004	1.4	<1.0	1.0	3.8
	SALTS	3005	1.6	7.8	1.4	4.2
	MUDSL	3006	6.7	21.0	1.8	1.4
	SJRLN	3007	1.6	<1.0	<0.18	<0.10
	SJRBM	3008	1.6	6.1	<0.18	
	SJRBS	3009	1.4	3.7	<0.18	2.1
11/88 & 12/88	OLDRV	3010	1.4	1.3	<0.18	I.S.*
	MFDRV	3011	1.5	1.3	0.31	0.69
	SJRDR	3012	1.7	1.2	0.29	2.6
	SJRBM	3013	1.9	3.4	0.56	2.0
	SALTS	3014	2.6	7.3	1.2	3.6
	CAMP13	3015	2.6	30.0	1.0	3.6
	MUDSL	3016	1.7	1.2	0.82	3.4
	SJRLN	3017	1.8	<1.0	<0.18	I.S.*
	SJRBS	3018A	1.5			
			MEAN= 2.0	1.8	0.59	1.6
	SJRBS	3018B	2.4			
3/89 & 4/89	OLDRV	3019	1.8	2.7	<0.18	1.6
	MIDRV	3020	2.0	2.7	0.26	0.85
	SJRDR	3021	1.7	2.6	0.30	2.9
	SJRLN	3022	2.0	<1.0	<0.18	0.23
	CMP13	3023	3.2	52.0	0.89	3.2
	SJRBS	3024	1.4	2.5	<0.18	1.2
	SJRBM	3028	1.9	10.0	0.18	2.5
	MUDSL	3029	2.4	2.8	1.1	3.8
	SALTS	3030	2.0	25.0	1.5	5.0

* I.S. = insufficient sample

Appendix G. (cont.)

SELENIUM VERIFICATION PROGRAM 1988-89
UNFILTERED WATER

SAMPLE DATE	SAMPLE LOCATION	SAMPLE NUMBER	(ppb) (ug/l)
3/89	WLAKE 3	W3001	8.6
		W3002	8.8
	TLDDS 5	W3003	11.0
		W3004	11.0
	10	W3005	9.0
		W3006	8.8
	WFRMR 3C	W3007	160.0
		W3008	170.0
	2	W3009	180.0
		W3010	170.0
	TLDDN 5B	W3011	1.2
		W3012	1.4
	5A	W3013	1.0
		W3014	1.0
5/89	WFRMR 2	W3015	280.0
		W3016	280.0
	3A	W3017	240.0
		W3018	220.0
	TLDDS 4	W3019	15.0
		W3020	14.0
	9	W3021	9.3
		W3022	8.4
	WLAKE 5	W3023	8.8
		W3024	8.8
	2	W3025	5.8
		W3026	5.8
	TLDDN 3A	W3027	2.1
		W3028	2.3
	7	W3029	<1.0
		W3030	<1.0

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