MFO Induction and Histopathology in Pink Salmon Fry from Oiled Streams in Prince William Sound, Alaska 1990-1991

by
Mark J. Fink

Technical Report No. 92-1

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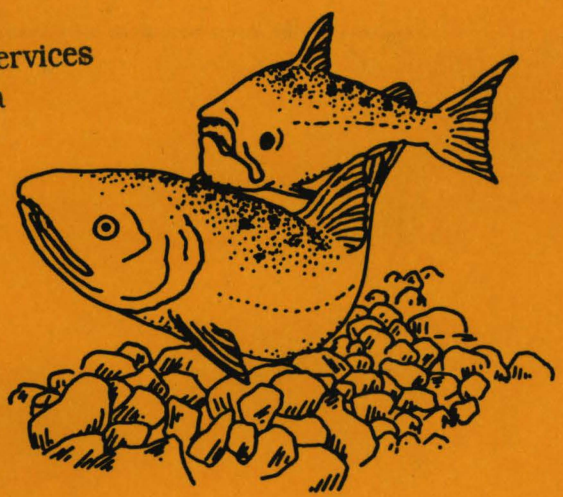

Alaska Department of Fish and Game
Habitat Division

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Abstract

The effects of oil exposure on pink salmon (*Oncorhynchus gorbuscha*) eggs and fry in Prince William Sound, Alaska were examined from December, 1989 through May, 1991 using mixed-function oxidase (MFO) induction and histopathological analyses. Comparisons were made between four oiled and five unoiled sites in anadromous streams. Observed MFO induction was greater in pre-emergent fry from oiled streams and appeared independent of developmental stage. MFO induction was not observed in eggs. The frequency of histopathological lesions was greater in fry from oiled streams, and the occurrence appeared to correlate with the absorption of the yolk sac. Lesion occurrence and severity appeared greatest in fry collected during 1990.

Introduction

On March 24, 1989, the M/V Exxon Valdez grounded on Bligh Reef outside of Valdez and released nearly 11 million gallons of oil into Prince William Sound. Over 120 streams supporting anadromous fish in Prince William Sound (PWS), the outer Kenai Peninsula, the Kodiak Archipelago, and the Alaska Peninsula were oiled to some degree. Up to 75% of all wild pink salmon spawn intertidally in PWS (Bue 1992, pers. comm.). The Alaska Department of Fish and Game (ADFG), in conjunction with the Alaska Department of Environmental Conservation (ADEC) and the Alaska Department of Natural Resources (ADNR), assumed responsibility for monitoring the clean-up of anadromous streams impacted by the oil, in addition to monitoring other special or critical areas important to fish and wildlife. After the initial clean-up, ADFG questioned the adequacy of treatment of many of the oiled anadromous streams. There was a concern that remaining oil might negatively impact developing pink salmon fry and eggs found within the stream sediments.

Many studies have suggested possible negative impacts from environmental hydrocarbon contamination. McCain et al. (1977) demonstrated the uptake and bioaccumulation of aromatic hydrocarbons from Alaskan crude oil in flatfish. Exposed flat fish exhibited a significantly greater weight loss and more severe hepatocellular lipid vacuolization (HLV) in the liver tissues than the control group. A high incidence of liver lesions was found in bullheads (*Ictalurus nebulosus*) exposed to sediments with elevated levels of polynuclear aromatic hydrocarbons (PAHs) (Baumann and Harshbarger 1985). Bowser et al. (1990) found a higher prevalence of liver lesions in bullheads from a contaminated site than fish from an uncontaminated site. Laboratory studies have shown increased gill and liver histopathology in fishes exposed to hydrocarbons (Stoker et al. 1985, Wolfe et al. 1977). Studies testing survival and fry development have found increased sensitivity and toxicity in pink salmon subjected to varying concentrations of the water soluble fraction (WSF) of crude oil (Korn et al. 1985, Moles et al. 1979, Moles et al. 1987). Moles et

al. (1987) found that alevins exposed to 0.7-2.4 mg/liter of WSF in a simulated tidal cycle were more sensitive to oil, had reduced yolk stores, and accumulated more hydrocarbons than did alevins exposed to the same concentrations in fresh water.

The Natural Resource Damage Assessment (NRDA) group within ADFG began a study in 1989 of mortality/survival of pink salmon fry and eggs to assess damage from oil exposure. While acknowledging the potential for acute effects from initial oil exposure, the Habitat Division, in its response role, was concerned with possible long term sublethal effects; especially the question of how much oil needed to be removed to preclude further damage to intertidal pink salmon populations. Therefore, a relatively quick test was needed to determine if pink salmon eggs and fry were still being exposed to residual oil after the initial clean-up. If the Habitat Division could produce evidence indicating continued exposure to oil, additional appropriate treatment measures could be recommended for anadromous streams. The Habitat Division has maintained that anadromous streams are of special concern, and therefore, should have a high standard for clean-up.

There are several biological indicators of exposure to toxic contaminants in the environment (Jimenez and Stegeman 1990, Hinton and Lauren 1990). Jimenez and Stegeman (1990) described the advantage of using monooxygenase activity, also known as mixed-function oxidase (MFO), as indicators of environmental stress. The monooxygenase system works to facilitate the excretion of pollutants. Cytochrome P-450E is a particular group of enzymes that are induced in the presence of hydrocarbons (Stegeman and Kloepper-Sams 1987). Cytochrome P-450E activity may also produce potential carcinogens while reducing the acute toxicity of some organic compounds. Using cytochrome P-450E induction in pink salmon as an indicator of exposure to hydrocarbons will not necessarily suggest a negative impact from oil.

During the initial collection of pre-emergent pink salmon fry for analysis of cytochrome P-450E induction, a significant number of

fry from three streams were found to have some degree of fin erosion (Figures 1 and 2, Wiedmer 1991, pers. comm.). The Habitat study was then broadened to include histopathological analyses of pink salmon fry.

Histopathological changes in animal tissues can be used as biological indicators of environmental stress while also identifying specific target tissues or organs that may have been affected (Hinton and Lauren 1990). However, histopathology alone cannot generally distinguish toxic actions of particular environmental contaminants from the actions of natural products, diseases, and normal physiological changes.

In order to determine if pink salmon fry and eggs were negatively impacted from oil remaining after treatment, an overall study was begun in the winter of 1989/90 to determine if:

1) Pink salmon fry and eggs were exposed to hydrocarbons (Cytochrome P-450E induction), and

2) Histopathological changes occurred in pink salmon fry and eggs from oiled streams.

Methodology

Sample sites

Pre-emergent pink salmon eggs and fry were collected from sites at four oiled streams and five control streams in Prince William Sound (Figure 3). Oiled sample sites were selected for geographical representation, high degree of oiling, and high probability of successful egg/fry sampling, based on salmon counts in streams during late summer and early fall. Four streams, one each in Shelter Bay (T3), Marsha Bay (T2), Sleepy Bay (T4), and at a location just south of Herring Point (T1) were selected from the 20 or more streams considered heavily oiled in 1989 (ADF&G 1991).

These streams are identified by anadromous stream catalog numbers (ASC#) 2264016613, 2263016840, 2264016780, and 2261016996, respectively (ADF&G 1990). Oil in these streams was characteristically distributed over a large portion of the mid to upper intertidal zone. Oil penetrated to a depth of four feet in areas at Sleepy Bay and to a lesser depth in the other streams. These streams were still considered heavily oiled in 1990 with both surface oil, in the form of asphalt and tar, and subsurface oil present.

Control sites were selected based upon an absence of oil, physical similarity and proximity to oiled sites, and high probability of successful fry/egg sampling. Due, in part, to the large number of anadromous streams (over 70) that were initially oiled in western Prince William Sound, some of the control samples had to be collected in oiled streams above the zones of contamination. The five control sites included Loomis Creek (C1), and unnamed streams in Herring Bay, Knight Island (C2); east Chenega Island (C3); Kake Cove, south Chenega Island (C4); and Shelter Bay, Latouche Island (C5). These streams are identified by ASC#'s 2253015060, 2261016982, 2262016280, 2262016262, and 2264016610, respectively (ADF&G 1990). ADFG maintains a catalog of streams, rivers, and lakes documented as used by anadromous fish for spawning, rearing, or migration. Anadromous waterways are protected by ADFG through Alaska Statute 16.05.870.

Field collections

Eggs and fry from oiled sites were collected from the mid to upper intertidal zones, within the area of oil contamination. Samples from control sites were collected from the upper intertidal zone, above any possible oiling impact area. It was originally planned to make collections in September, December, March, and May of each year to include a range of developmental stages within the pink salmon samples. However, due to logistical problems associated with inclement weather and transportation, samples were only collected in December, 1989; May, June, and September, 1990; and

March and May, 1991. Because of small sample sizes, four egg samples collected during stream surveys in September, 1990, at oiled and unoiled sites at Point Countess (ASC# 2262016397) and an unoiled site in Thumb Bay (ASC# 2264016809) were included in the MFO analysis.

Pink salmon eggs and fry collected from the 1989 brood year (samples from December, 1989 through June, 1990) will, be referred to as 1990 samples. Eggs and fry collected from the 1990 brood year (samples from September, 1990 through May, 1991) will be referred to as 1991 samples.

Samples were collected from spawning gravels at low tide using a shovel and a small, 0.7 X 1.0 meter fyke net. An egg pump was considered, but freezing air temperatures inhibited proper operation of the pump. Specimens were preserved in 10% buffered formalin in the field, and later examined macroscopically for obvious physical abnormalities such as caudal fin erosion.

MFO Induction Analysis

Samples consisting of six fry each were analyzed for cytochrome P-450E induction at Woods Hole Oceanographic Institution (WHOI), in Massachusetts. Fry and eggs were sectioned using standard histologic techniques and stained with monoclonal antibody 1-12-3 and a peroxidase-labeled second antibody (Smolowitz et al. 1991). Staining intensity and occurrence was determined for tissues in each egg or fry, and an overall, relative level of induction was determined for each sample. The levels of induction were classified as strong, moderate, mild, very mild, and negative. To avoid possible bias, background information on samples and collection sites was not provided to WHOI. After MFO induction analysis, duplicate slides and embedded fry were sent to the University of California at Davis (UC Davis) for histopathology analyses.

Histopathology Analysis

At UC Davis, additional slides were prepared where the liver was missing from duplicate slides received from WHOI. Individual slides (two fry per slide) contained two or three serial or near-serial longitudinal sections. A sample consisted of three slides or six fry. In addition, sections from twelve pink salmon eggs (on four slides) were examined. Because each sample consisted of six fry mounted on three slides (two each slide), slides were not randomized for "blind" examination.

Each larval section was initially examined to determine the extent of autolysis and sectioning artifact. Sections were ranked in the following manner:

Autolysis:
1) minimum (min), all cell membranes were intact;
2) mild, a few cells on the tips of the intestinal villi were affected;
3) moderate (mod), at least one section of intestine had transmural autolysis (extending through the intestinal wall);
4) severe (sev), for greater than focal transmural autolysis.

Sectioning artifact was ranked as none, mild, mod, or sev. Rankings were based on the difficulty of tissue reading due to the extent of artifact. At least mild sectioning artifact was found in all sections, which would be expected from paraffin embedding (Hinton and Marty 1991 unpublished).

Each larva was scanned at low power (4X) for the presence of major organs and the relative abundance of liver glycogen. Major organs included brain, heart, kidney, retina, liver, spleen, gill, gastrointestinal tract, skin, yolk, skeletal muscle, and gonad. The gonad was further classified, when present, as male(testes), female(ovary), or undifferentiated.

The relative abundance of liver glycogen was ranked and scored as follows:

1) min, no obvious hepatocellular vacuoles;
2) mod, volume of hepatocellular vacuoles less than nuclear volume;
3) abundant (ab), volume of hepatocellular vacuoles greater than nuclear volume.

Larvae were then scanned a second time at medium power (10X objective) for lesions. Frequently occurring lesions were ranked and scored relative to other similar lesions as none (0), mild (1), mod (2), or sev (3).

Statistical Analysis

The experimental unit for this study was the stream. Therefore, fry samples were pooled for each stream, stratified by time, and the level of impact for each stream was estimated by the median of stream specific MFO, lesion, or yolk store scores.

The Mann/Whitney (Wilcoxon) two-sample test (Conover 1980) was used to test for statistical differences between oiled and control streams. Statistical tests were one-tailed and performed at the α =0.10 level. The null hypothesis for all tests was that oiled and control streams were affected equally. Alternative hypotheses were; 1) MFO response was greater for oiled streams, 2) more lesions were observed for oiled streams, and 3) yolk stores were less for oiled streams. The statistical comparisons were not expected to be powerful due to the small number of streams in the study.

Median values of MFO, lesion, and yolk store scores for each stream were plotted to provide visual comparisons (Figures 4,5,6, and 7). Scores for each parameter were as follows: MFO induction 1 = negative, 2 = very mild, 3 = mild, 4 = moderate, and 5 = severe; lesions 1 = negative, 2 = mild, 3 = moderate, 4 = severe; and yolk stores 1 = none, 2 = minimal, 3 = abundant. Lesion scores included epidermal atrophy (EA) and myofiber degeneration and/or

necrosis (MDN). Scores for individual hepatocellular necrosis (IHN) and vacuolar degeneration of gastric glands (VDGG) were not used because of several missing values.

Results

MFO Induction

MFO induction was found in 13 of 16 pink salmon fry samples collected from oiled streams in 1990-91 (Table 1). All seven fry samples from control streams were negative for induction. The ten egg samples, from both oiled and control streams, were negative for MFO induction. Organs exhibiting positive immunochemical staining included the kidney (tubules, sinusoidal and vascular endothelium, collecting duct), gill (epithelium, buds), liver (central veins, hepatocytes, sinusoidal endothelium), intestine (enterocytes, midgut and cecal epithelium), heart (atrial and ventricular endothelium), yolk sac (endothelium), brain (vessel endothelium), along with vertebral cord cartilage, skin, peritoneal connective tissue, and pharyngeal epithelium. Staining intensity and occurrence for cytochrome P-450E induction in each sample are found in Appendix 1.

MFO induction was observed in pink salmon fry collected from December, 1989 through May, 1991. In 1990 (1989 brood year), induction in December fry from Marsha Bay was moderate/mild, while induction ranged from very mild to severe in fry collected in May/June from Sleepy Bay, Marsha Bay, Herring Pt, and Shelter Bay (Figure 4). In 1991 (1990 brood year), MFO induction appeared to decrease, somewhat, over time. Induction ranged from mild to moderate in March samples, and negative to moderate in May samples (Figure 5).

While no statistical test was performed on the December pink salmon fry samples of the 1989 brood year due to small sample size, visual examination suggests a difference in MFO induction between oiled

and control streams (Figure 4). A statistical difference was detected for MFO induction between oiled and control streams in May/June, 1990 samples ($P<0.067$). In 1991, induction differed statistically between oiled and control streams in March samples ($P<0.10$), while no statistical difference was detected in May samples ($P<0.20$). However, visual examination suggests a difference in May, 1991 (Figure 5). There was no apparent difference in MFO induction between years.

Histopathology

Twenty-three samples totalling 135 pink salmon fry from nine locations in 1990-91 were analyzed for histopathology. Scores for lesions and the relative abundance of yolk stores and hepatocellular glycogen for each fish are listed in Appendices 2A and 2B. The lesion scores were based on the four observed lesions: myofiber degeneration and necrosis (MDN), vacuolar degeneration of gastric glands (VDGG), individual hepatocellular degeneration and necrosis (IHN), and epidermal atrophy (EA). Additional, infrequently observed histopathology in individual fry is also described in Appendices 2A and 2B.

Lesions were found in fry from six of the sixteen samples (35 of 93 fry) collected within the oiled zone of impacted streams in 1990-91 (Table 2). Lesions were found in fry from three of the seven control samples (7 of 42 fry). Epidermal atrophy was the most frequently observed lesion. Both MDN and IHN were absent in 1991 samples. Vacuolar degeneration of gastric glands (VDGG) was not observed in 1990 samples but was observed in 1991 samples.

The occurrence of lesions appeared time-dependent (i.e. fry developmental stage). Lesions were not found in samples collected from oiled streams in December of 1989 or in March of 1991 (early life stages). However, lesions were found in samples collected May/June of 1990 and May of 1991 (near the time of emergence).

Overall, lesions were less severe and occurred less frequently in 1991 samples as compared to 1990 samples. In 1990 oiled samples, EA, MDN, and IHN lesions were observed, including 12 of 21 fry with multiple lesions. Lesions were characterized as moderate or severe in 17 of 21 fry. In 1991 oiled samples, EA and VDGG lesions were observed, including 4 of 14 fry with multiple lesions. Lesions were characterized as moderate or severe in 7 of 14 fry.

No statistical difference was detected in the occurrence of lesions between oiled and control streams in May/June, 1990 samples ($P<0.27$), although visual examination of median lesion scores suggests there may be a difference (Figure 6). The occurrence of lesions between oiled and control streams in May, 1991, was not statistically different ($P<0.40$, Figure 7).

Yolk stores were not significantly different between oiled and control streams in both 1990 and 1991 ($P<0.40$ and $P<0.60$, respectively). Yolk stores were characterized as abundant in samples collected early in the 1989 (December) and 1990 (March) brood years, while yolk stores in samples collected just prior to fry emergence from the 1989 (May/June, 1990) and 1990 (May, 1991) brood years varied from none to abundant. However, yolk stores were absent or pale (minimal) in 23 of 24 fry observed with lesions in 1990. In 1991, yolk stores were characterized as absent or pale in 13 of 18 fry with lesions.

Representative fry from three oiled streams which exhibited physical abnormalities including caudal fin erosion in 1990 (Figures 1 and 2) were found to have mild to moderate lesions, including epidermal atrophy, myofiber degeneration and/or necrosis, and individual hepatocellular necrosis. No analyses were performed to correlate the occurrence of lesions with caudal fin erosion.

Representative lesion types are shown in Figures 8 through 17. Following are descriptions of the lesions or other observations found in specific organs of the pink salmon fry:

Liver - Glycogen stores were abundant in smaller fish. Decreased glycogen stores are associated with decreased yolk stores (i.e. absorption of the yolk sac).

Individual hepatocellular necrosis, found only in sample # 90MW106V (Marsha Bay), was characterized by a vacuolated appearance. Spaces previously occupied by hepatocytes were filled with a single macrophage or with fluid.

Skin - Epidermal atrophy, the most frequently observed lesion, was characterized by a thinning of the epidermis and an absence of mucous cells.

Skeletal muscle - Myofiber degeneration and necrosis was found in a few fish collected in 1990. This subtle lesion was characterized by swelling of affected myofibers, along with hypersegmentation and coagulation of the cytoplasm. Nuclei were pyknotic to karyorrhectic (shrinking of the cell nucleus to disintegration of the nucleus), with occasional central nuclei that indicated attempts at regeneration.

Vacuolar myopathy (vacuoles in the muscle tissue), found in all fry from sample # 91MF010V (Shelter Bay, control), was characterized by clear, irregular to oval vacuoles, which ranged up to 200 μm in diameter. The vacuoles were not associated with inflammation, cellular degeneration or necrosis. Most probably, the changes represent handling or fixation artifacts.

Gastrointestinal tract - Vacuolar degeneration of gastric glands, found in only a few fish collected in 1991, was characterized by epithelial cell cytoplasm with large, clear, irregular vacuoles characteristic of hydropic degeneration. Nuclei of affected cells generally had no histologic lesions.

Coagulated eosinophilic cytoplasm was found in gastric epithelial cells of three fish from sample # 90MW106V (Marsha Bay).

The cytoplasm was not vacuolated and nuclei were pyknotic to karyorrhectic.

Brain - Vacuolar encephalopathy (vacuoles in the brain tissue) was found in all six fry from sample # 91MF010V (Shelter Bay, control), and vacuoles were similarly characterized as those described in vacuolar myopathy, above. No other histologic lesions were observed.

Retina - Vacuolar retinopathy (vacuoles in the eye tissues) was found in two of the fry from sample # 91MF010V (Shelter Bay, control), and vacuoles were characterized as those described above for vacuolar myopathy.

Kidney, Gill, Heart, Yolk, and Spleen - No histologic lesions were observed in any of these organs. Gill section in whole-fish sections were not analyzed for mucous cell hyperplasia due to the variety of angles of sectioning and volume of tissue in the sections (Hinton and Marty 1991, unpublished).

MFO and Histopathology

Lesions were found in 6 of 13 samples from oiled streams exhibiting positive MFO induction from 1990-1991 (Table 2). In 1990, 4 of 6 samples contained fry with lesions (21 of 36 fry), and in 1991, 2 of 7 samples (3 of 40 fry) were found with both positive MFO induction and lesions.
In two 1991 samples from Marsha Bay, EA and VDGG lesions were found in 11 of 12 fry although MFO induction was negative, while one 1990 sample (Sleepy Bay) was both negative for MFO induction and lesions.

Lesions were found in three of seven samples from control streams exhibiting a negative MFO induction from 1990-1991 (Table 2). In 1990, lesions were observed in one of three samples (3 of 18 fry), while in 1991, lesions were observed in two of four samples (4 of

24 fry). Figures 6 and 7 suggest a correlation between MFO induction, the occurrence of lesions, and yolk stores.

Discussion

MFO results suggest that pre-emergent pink salmon fry from collection sites in Prince William Sound were responding to environmental stresses by activation of the monooxygenase system. Induction did not appear to be dependent on larval stage (based on yolk stores).

While the activation of the monooxgenase system is not specific to a particular contaminant, evidence suggests that hydrocarbons may have been the source. Oiled sediment samples from the four oiled sites were positively correlated to Prudhoe Bay crude oil (GERG 1991). Cytochrome P-450E is induced by polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) (Stegeman and Kloepper-Sams 1987).

Histopathological results suggest possible sublethal effects including skin, muscle, and liver tissue damage from oil exposure. Vacuolar degeneration of gastric glands, found in both oiled and control streams (only 7 of 135 fry), did not appear significant and was possibly due to poor fixation at the time of collection (Sullivan 1991, pers. comm.).

Previous studies have found histopathology concentrated in the liver in fish exposed to hydrocarbons (Stoker et al. 1985, Baumann and Harshbarger 1985, McCain et al. 1977, Freeman et al. 1983, and Peters et al. 1987). The gills of coho salmon (*Oncorhynchus kitsutch*) and starry flounder (*Platichthys stellatus*) exposed to the water-soluble fraction (WSF) of crude oil for five days developed lesions which indicated the loss of the surface cells (Hawkes 1977). These studies involved adult fish. Ernst et al. (1977) demonstrated that in embryos of the marine fish (*Fundulus grandis* Baird and Girard), continuous exposure to the WSF of No. 2

fuel oil in concentrations of 2.2 and 4.4 ppm produced pathological liver, kidney, epithelial, and lens tissues.

In general, lesions appeared to be more severe and of greater frequency in 1990 samples as compared to 1991 samples. This might be expected as a result of natural cleaning by winter storms, along with stream treatments in the summer of 1990 at the four oiled streams. Treatment included manual removal and tilling of oiled sediments, with mechanical tilling at two of the four oiled streams (ADF&G 1990).

Several studies have been conducted to determine effects of hydrocarbons on the development of salmon, but results have not included histopathology. In sensitivity studies with the WSF of Prudhoe Bay crude oil, sensitivity to aromatic hydrocarbons in pink salmon (*Oncorhynchus gorbuscha*) increased from egg to fry (Korn and Rice 1981, Rice et al. 1975, Moles et al. 1979). Emergent fry were the most sensitive.

In this study, while MFO induction was found in fry collected from oiled streams in December through early June, the occurrence of lesions in fry appeared to be time-dependent (life stage). Sac fry with abundant yolk did not exhibit lesions, while fry with a minimal amount of yolk were more likely to be found with lesions (Figures 6 and 7). Few lesions were found in samples from Sleepy Bay in 1990-91 and Shelter Bay in 1991, although MFO induction ranged from very mild to moderate. However at the time of sampling, yolk stores were abundant in fry from both of these streams. The prevalence of lesions may have increased had samples been collected after the fry had absorbed most of their yolk sacs.

Korn and Rice (1981) found that fry with abundant yolk were most tolerant to aromatic hydrocarbons. The amount of yolk influenced sensitivity because the lipophilic, aromatic hydrocarbons were partitioned into the yolk, reducing the availability of the hydrocarbons to the developing embryos.

The samples in this study were all collected from within the intertidal zone. Developing pink salmon embryos were found to be more sensitive to aromatic hydrocarbons in a simulated tidal environment than in freshwater (Moles et al. 1979, Moles et al. 1987). In addition, alevins exposed to the WSF of Cook Inlet crude oil in the tidal simulation had reduced yolk reserves and accumulated more hydrocarbons than alevins exposed in freshwater (Moles et al. 1987).

MFO induction was negative in samples from Marsha Bay (heavily oiled) in 1991, although lesions were found in 11 of the 12 fry. These particular fry were very thin and appeared to be in poor condition. Monooxygenase activity has been found to be reduced in starved fish as compared to well-nourished fish (Jimenez and Stegeman 1990). Perhaps these fry had depleted yolk reserves in an effort to metabolize hydrocarbons so that MFO induction was inhibited. Also, certain pollutants at high concentrations become hepatotoxic, which could reduce or prevent induction of monooxygenases (Jimenez et al. in press, cited in Jimenez and Stegeman 1990).

In conclusion, evidence suggests that pre-emergent pink salmon fry in Prince William Sound have responded to residual hydrocarbons in intertidal spawning gravels by increasing cytochrome P-450E induction. With the absorption of the yolk sac, sublethal effects of exposure to hydrocarbons may have included the development of lesions, particularly epidermal atrophy in these fry. The skin is the first line of defense against pathogens and is also important in osmoregulation. Fry undergo physiological changes upon emergence, and subsequent acclimation into saltwater. Additional physiological stresses may affect an individual fry's ability to avoid predation, thereby affecting survival.

Additional treatment was performed on selected contaminated streams in the summer of 1991. MFO Induction and histopathological analyses on fry in the spring and early summer of 1992 may be necessary to assess treatment success. Data on emergent fry

cytochrome P-450 induction and histopathology, as well as histopathology on returning adults is needed to determine the severity of possible sublethal effects of hydrocarbon exposure. Combined results from these studies should assist in developing appropriate standards for the treatment of anadromous streams following major oil contamination.

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Tables and Figures

Table 1. Cytochrome P-450E induction analysis of pink salmon fry and eggs collected from streams in Prince William Sound, 1989-1991.

Sample No.	Date Collected	Location (Segment)	Stage	Oiled?	Induction	Tissue[1]
T89MW002V	12/8/89	Marsha Bay KN701B	egg	yes	negative	
T89MW003V	12/8/89	Marsha Bay KN701B	fry	yes	mild/mod	K_t
T89MW004V	12/9/89	Chenega Is. CH001A	egg	no[2]	negative	
T89MW005V	12/9/89	Chenega Is. CH001A	fry	no[2]	negative	
T90MW104V	5/25/90	Sleepy Bay LA018A	fry	yes	negative	
T90MW104VB	5/25/90	Sleepy Bay LA018A	fry	yes	very mild	VCC
T90MW105V	5/25/90	Sleepy Bay LA018A	fry	yes	very mild	VCC
T90MW106V	5/30/90	Marsha Bay KN701B	fry	yes	mild	VCC, $I_{m,c}$
T90MW108V	5/30/90	Herring Bay KN132B	fry	no[2]	negative	
T90MW110V	6/2/90	Loomis Ck. EB001A	fry	no[2]	negative	

Table 1. **Continued.**

Sample No.	Date Collected	Location (Segment)	Stage	Oiled?	Induction	Tissue[1]
T90MW112V	6/8/90	Herring Pt. KN500B	fry	yes	moderate	G_c, Sk, VCC
T90MW115V	6/8/90	Shelter Bay EV025A	fry	yes	strong	G_c, $K_{t,c}$, H_c, B, PC, L, VCC, $I_{m,c}$, I_c
T90MW903V	9/7/90	Pt. Countess BP004A	eggs	yes	negative	
T90MW904V	9/7/90	Pt. Countess BP004A	eggs	yes	negative	
T90MW905V	9/7/90	Pt. Countess BP004A	eggs	no[2]	negative	
T90MW907V	9/25/90	Shelter Bay EV027A	eggs	no[2]	negative	
T90MW909V	9/25/90	Shelter Bay EV025A	eggs	yes	negative	
T90MW910V	9/25/90	Shelter Bay EV025A	eggs	yes	negative	
T90MW911	9/25/90	Shelter Bay EV025A	eggs	yes	negative	
T90MW914	9/25/90	Thumb Bay KN604A	eggs	no[2]	negative	

Table 1. **Continued.**

Sample No.	Date Collected	Location (Segment)	Stage	Oiled?	Induction	Tissue[1]
N3000-91	3/13/91	Sleepy Bay LA018A	fry	yes	moderate	$G_{e,b}$, Y, K_c, $K_{s,v}$, $H_{a,v}$,
T91MF001V	3/21/91	Marsha Bay KN701B	fry	yes	moderate	L_s, P, G_e, I_e, $K_{s,v}$
T91MF002V	3/21/91	Marsha Bay KN701B	fry	yes	mild	I_e, K_c
T91MF006V	3/21/91	Shelter Bay EV025A	fry	yes	mod/mild	Y, I_e, L_s, $K_{s,v}$
T91MF008V	3/21/91	Shelter Bay EV025A	fry	yes	moderate	I_e, $K_{s,v}$, G_b, $H_{a,v}$, L_h, Y
T91MF010V	3/21/91	Shelter Bay EV027A	fry	no[2]	negative	
T91MF012V	3/22/91	Kake Cove CH017A	fry	no[2]	negative	
T91MF014V	5/4/91	Sleepy Bay LA018A	fry	yes	moderate	G_e, P, $H_{a,v}$, $K_{s,v}$, K_c, Y, $L_{h,c}$
T91MF015V	5/4/91	Shelter Bay EV025A	fry	yes	mild	L_h, $K_{s,v}$
T91MF017V	5/4/91	Shelter Bay EV027A	fry	no[2]	negative	

Table 1. **Continued.**

Sample No.	Date Collected	Location (Segment)	Stage	Oiled?	Induction	Tissue[1]
T91MF019V	5/5/91	Kake Cove CH017A	fry	no[2]	negative	
T91MF021V	5/14/91	Marsha Bay KN701B	fry	yes	negative	
T91MF023V	5/14/91	Marsha Bay KN701B	fry	yes	negative	

[1] Tissue types that immunochemically stained for cytochrome P-450E: B - brain vessel endothelium; $K_{t,e}$ - tubules of anterior kidney and endothelium; $K_{s,v}$ - kidney sinusoidal and vascular endothelium; K_c - kidney collecting duct; $I_{m,c}$ - midgut and cecal epithelium; I_e - anterior or posterior intestine enterocytes; $G_{b,e}$ - gill buds and epithelium; $H_{a,v}$ - heart atrial or ventricular endothelium; H_e - heart endothelium; L_c - liver central veins; $L_{h,s}$ - liver hepatocytes and sinusoidal endothelium; P - pharyngeal epithelium; PC - peritoneal connective tissue; Sk - skin; VCC - vertebral cord cartilage; Y - yolk sac endothelium.

[2] While portions of the general stream area may have been initially oiled, the source of samples was upstream of the zone of contamination.

Table 2. Comparison of MFO induction and histopathology in pre-emergent pink salmon fry collected from streams in Prince William Sound, 1989-91.

Sample No.	Date Collected	Location Segment	Oiled?	MFO Induction	Histopathology[1]
T89MW005V	12/9/89	Chenega Is. CH001A	no[2]	negative	none
T89MW003V	12/8/89	Marsha Bay KN701B	yes	mild-mod	none
T90MW108V	5/30/90	Herring Bay KN132B	no[2]	negative	none
T90MW110V	6/2/90	Loomis Ck EB001A	no[2]	negative	EA
T90MW104V	5/25/90	Sleepy Bay LA018A	yes	negative	none
T90MW104VB	5/25/90	Sleepy Bay LA018A	yes	very mild	none
T90MW105V	5/25/90	Sleepy Bay LA018A	yes	very mild	EA
T90MW106V	5/30/90	Marsha Bay KN701B	yes	mild	EA, MDN, IHN
T90MW112V	6/8/90	Herring Pt KN500B	yes	moderate	EA, MDN
T90MW115V	6/8/90	Shelter Bay EV025A	yes	strong	EA, MDN
T91MF010V	3/21/91	Shelter Bay EV027A	no[2]	negative	none
T91MF012V	3/22/91	Kake Cove CH017A	no[2]	negative	VDGG
N3000-91	3/13/91	Sleepy Bay LA018A	yes	moderate	none
T91MF001V	3/21/91	Marsha Bay KN701B	yes	moderate	none

Table 2. **Continued.**

Sample No.	Date Collected	Location Segment	Oiled?	MFO Induction	Histopathology[1]
T91MF002V	3/21/91	Marsha Bay KN701B	yes	mild	none
T91MF006V	3/21/91	Shelter Bay EV025A	yes	mod-mild	none
T91MF008V	3/21/91	Shelter Bay EV025A	yes	moderate	none
T91MF017V	5/4/91	Shelter Bay EV027A	no[2]	negative	EA, VDGG
T91MF019V	5/4/91	Kake Cove CH017A	no[2]	negative	none
T91MF014V	5/4/91	Sleepy Bay LA018A	yes	moderate	EA
T91MF015V	5/4/91	Shelter Bay EV025A	yes	mild	EA
T91MF021V	5/14/91	Marsha Bay KN701B	yes	negative	EA, VDGG
T91MF023V	5/14/91	Marsha Bay KN701B	yes	negative	EA, VDGG

[1] Indicates the presence of any of four major lesions in one or more of the fry in a sample. EA - epidermal atrophy; MDN - myofier degeneration and/or necrosis; IHN - individual heptocellular necrosis.

[2] While portions ofthe general stream area may have been initially oiled, the source of the sample was upstream of the zone of contamination.

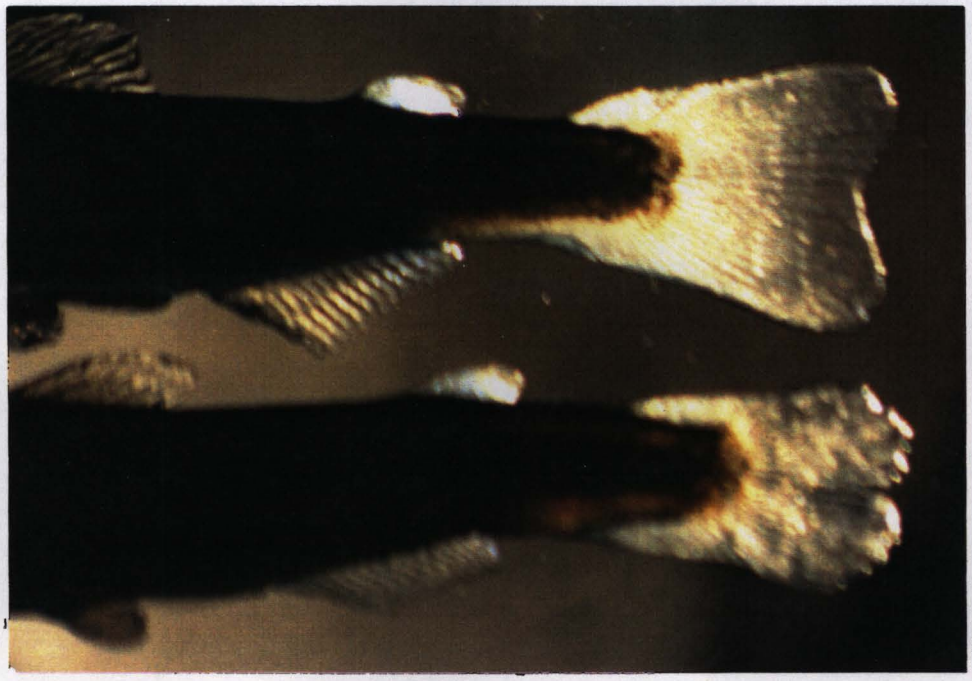

Figure 1. Fin erosion in a pink salmon alevin collected within the oiled zone of an anadromous stream in Prince William Sound, Alaska (May 1990). The top alevin was collected above the oiled zone. Photograph by M. Wiedmer

Figure 2. Caudal fin erosion in a pink salmon alevin collected within the oiled zone of an anadromous stream in Prince William Sound, Alaska (May 1990). Photograph by M. Wiedmer

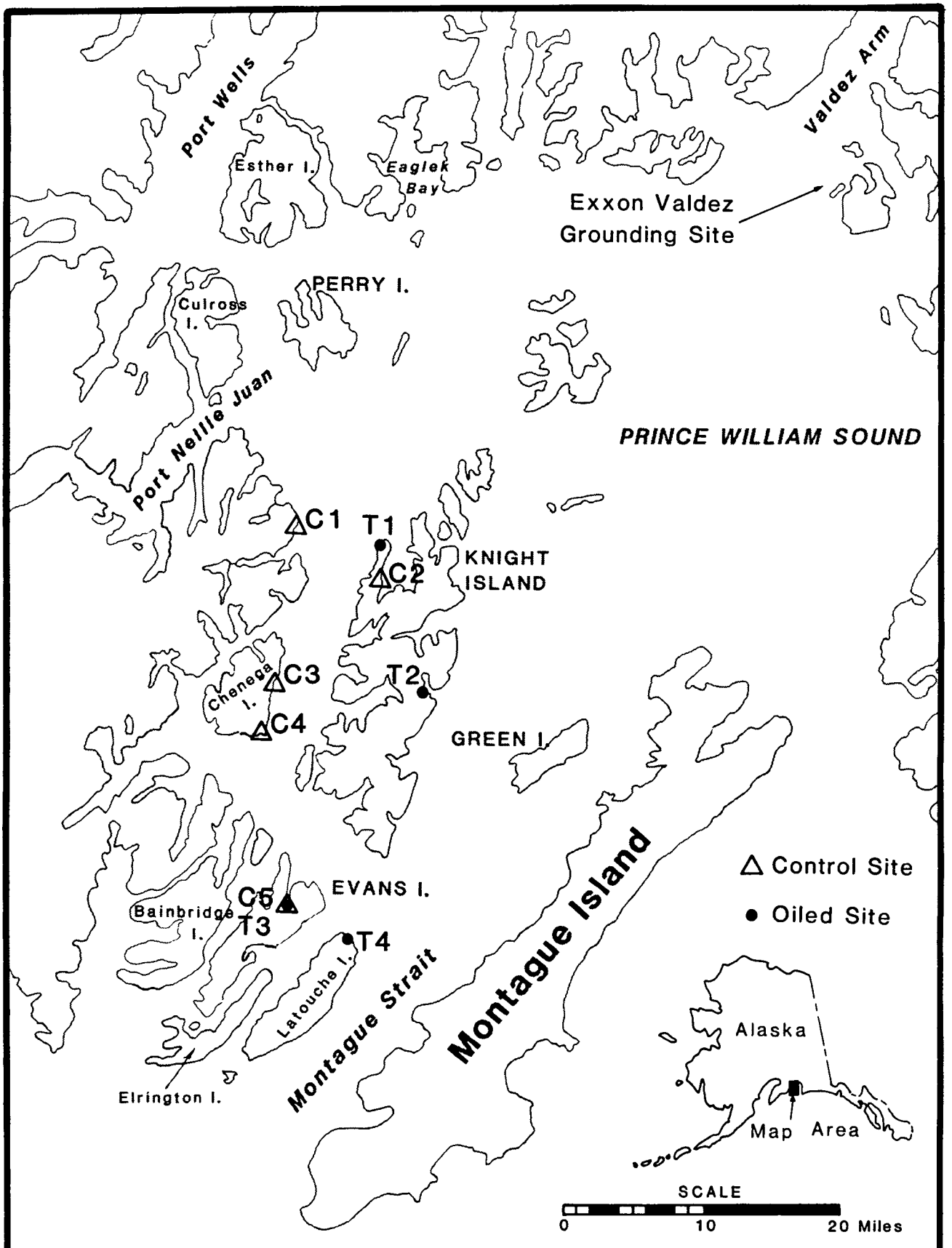

Figure 3. Pink salmon egg/fry collection site locations for the MFO/Histopathology study, 1989-1991. (ADF&G, Habitat)

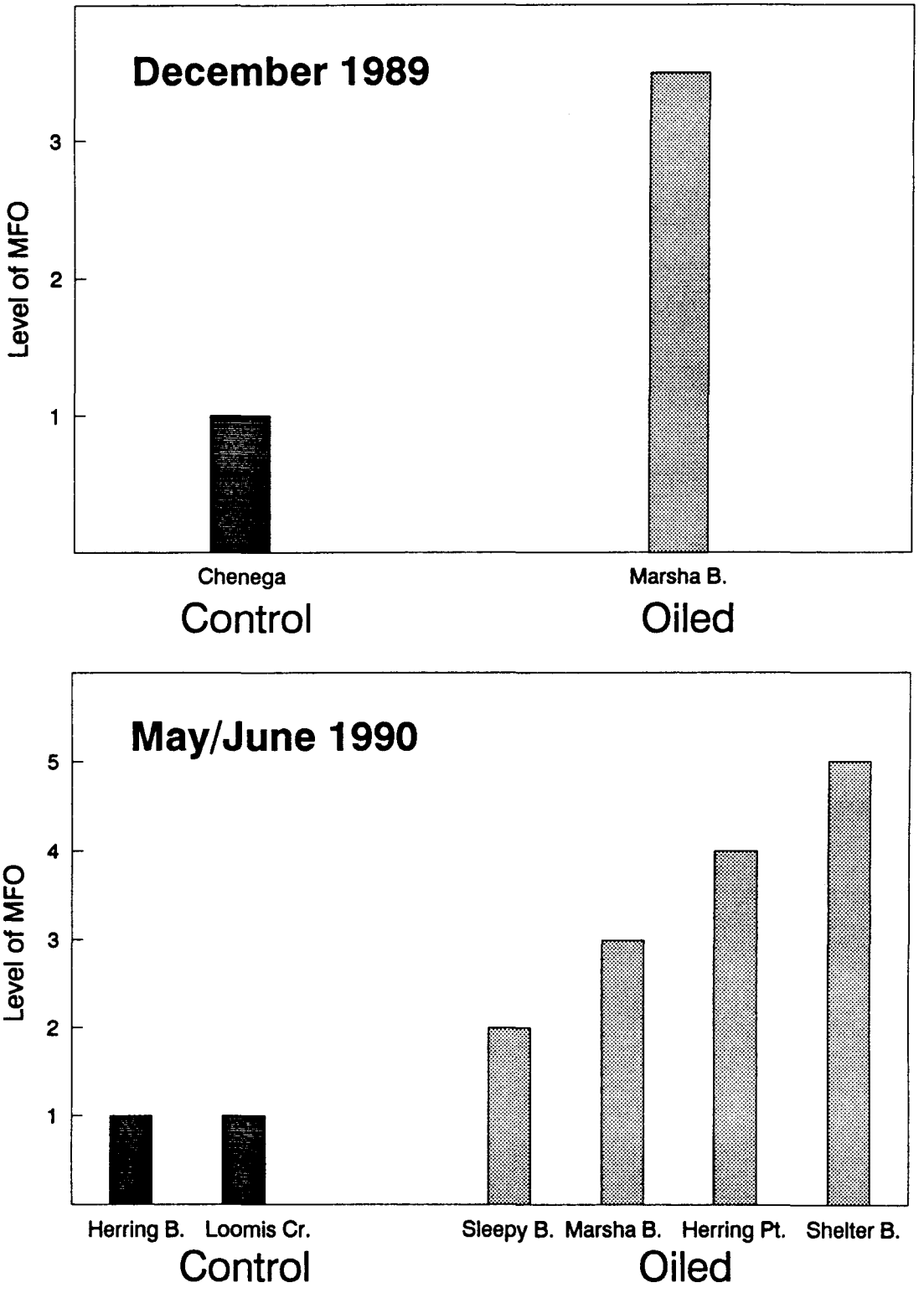

Figure 4. Mixed-function oxidase (MFO) induction results for pink salmon fry samples collected in December, 1989, and May/June, 1990, from oiled and control streams in Prince William Sound, Alaska.

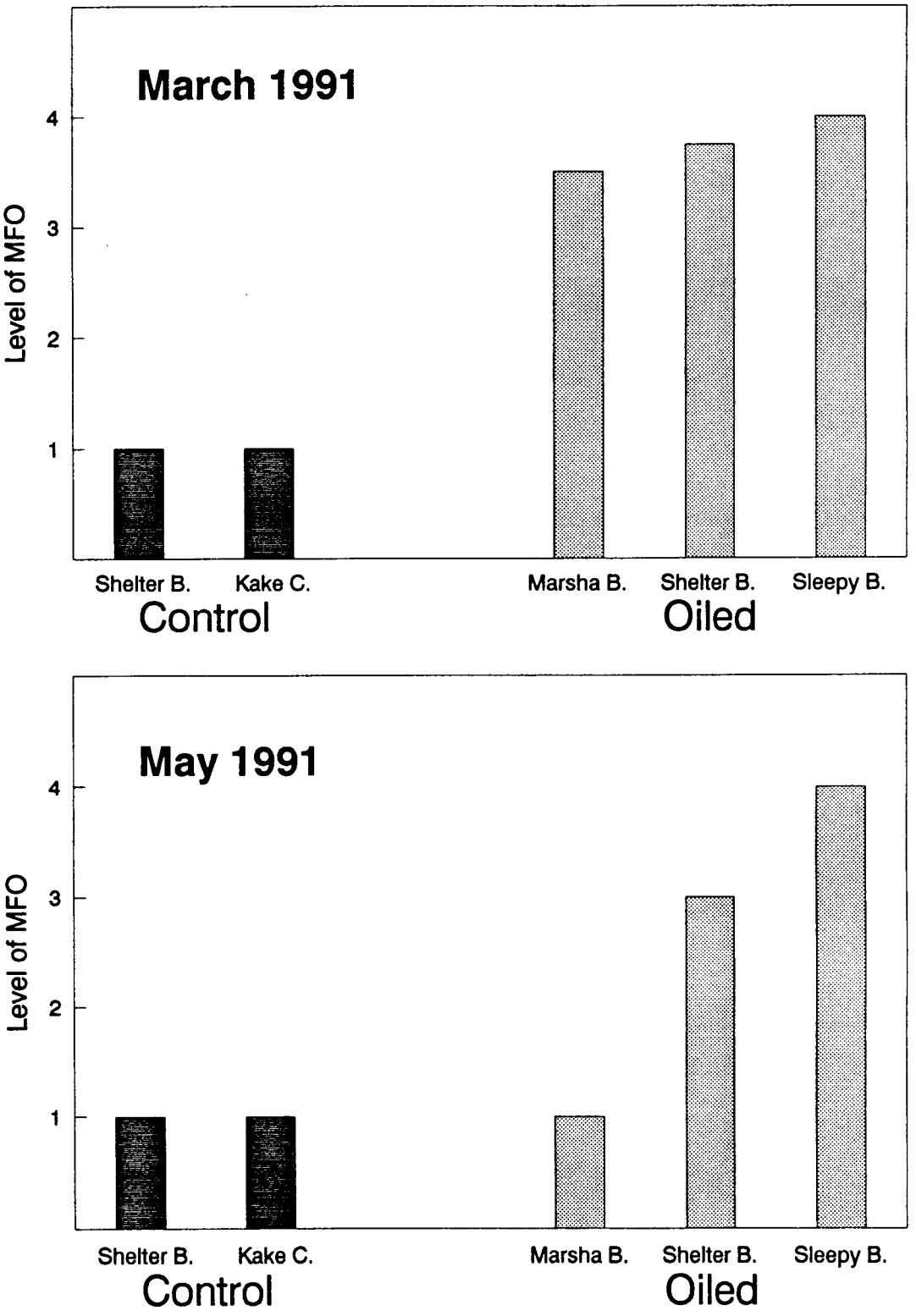

Figure 5. Mixed-function oxidase (MFO) induction results for pink salmon fry samples collected in March and May, 1991, from oiled and control streams in Prince William Sound, Alaska.

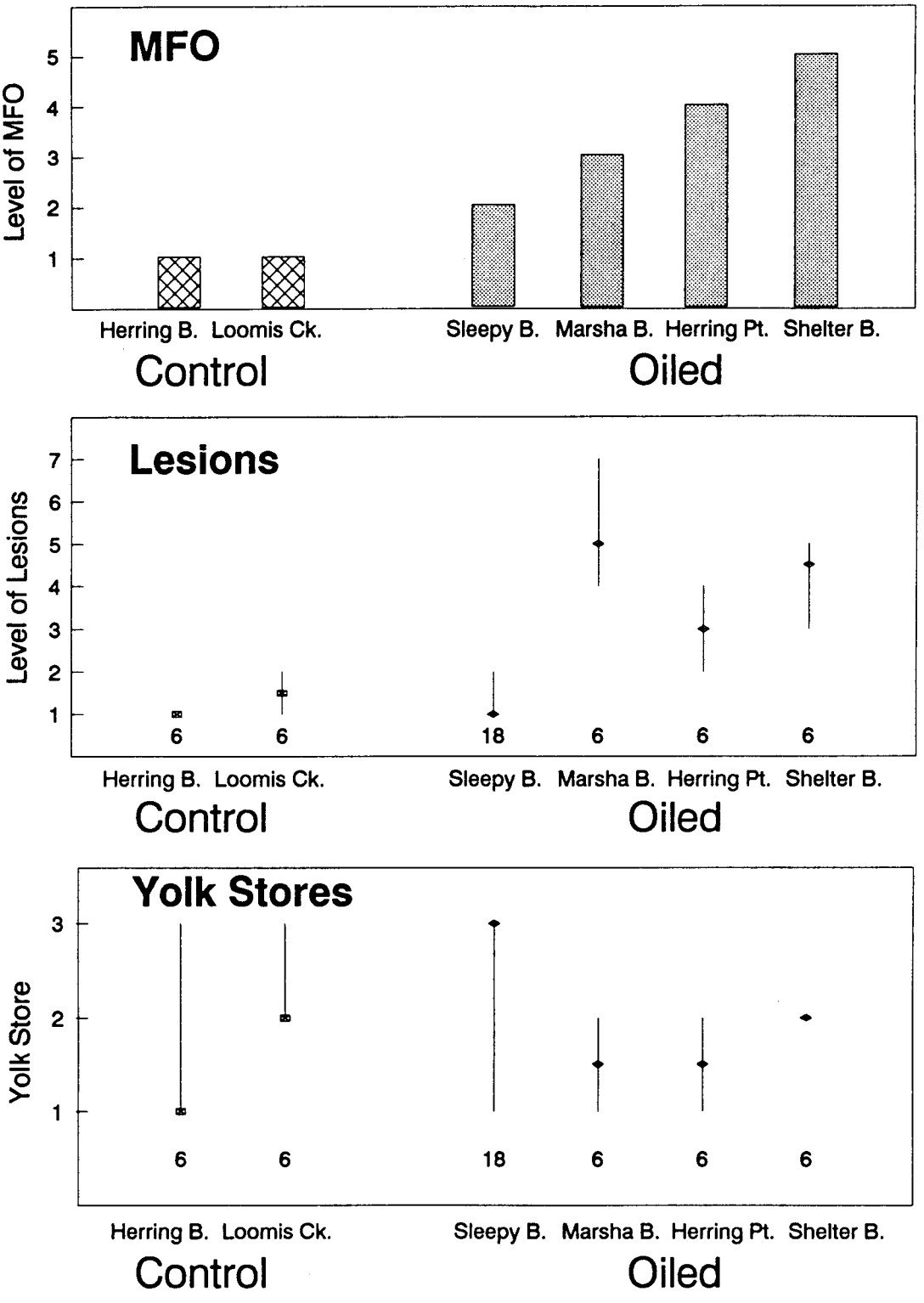

Figure 6. Median scores for MFO induction, lesions, and yolk stores in pink salmon fry collected in May/June, 1990, from oiled and control streams in Prince William Sound, Alaska. Ranges indicate the middle two-thirds of the data. Numbers above site locations represent total fry per site.

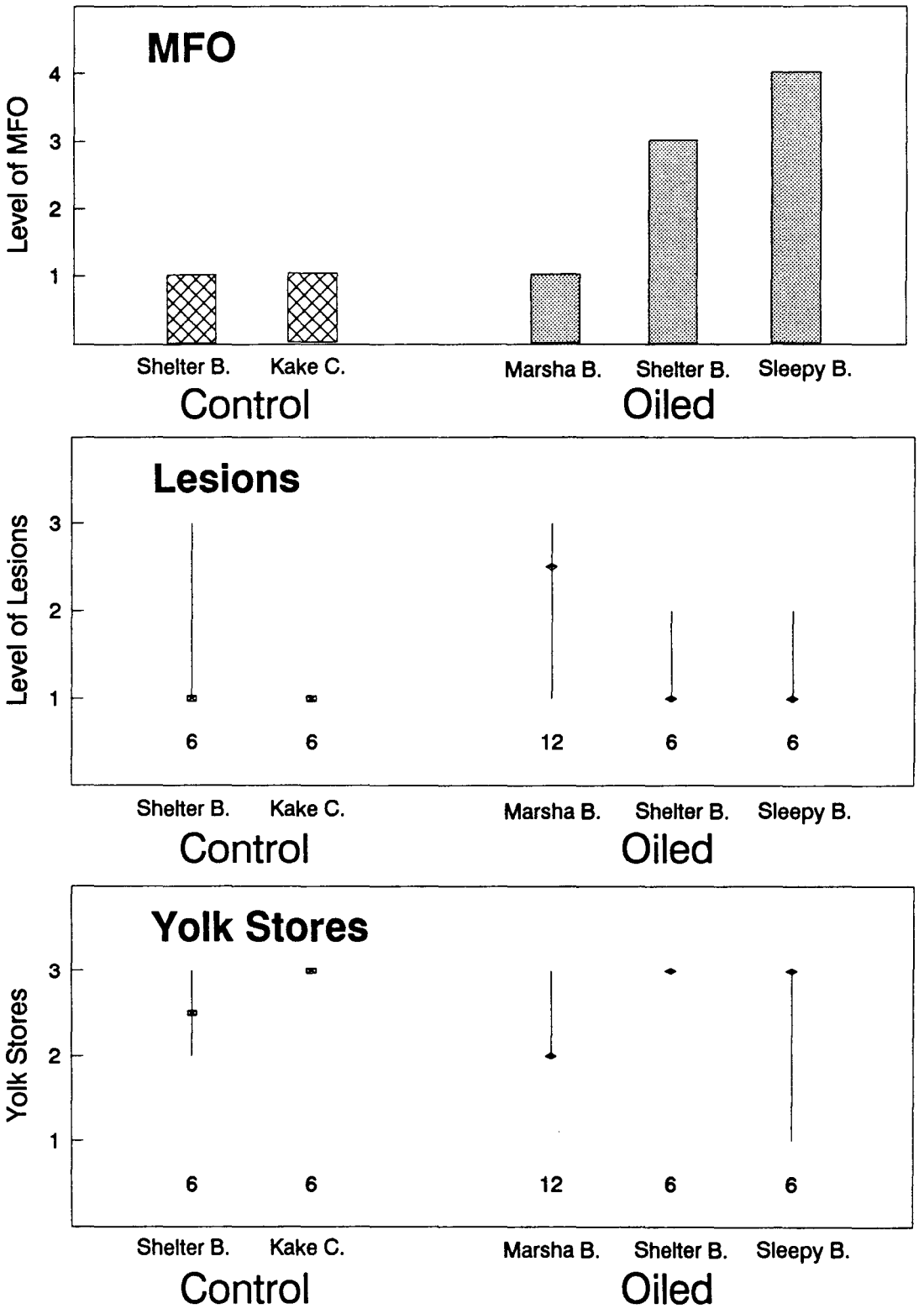

Figure 7. Median scores for MFO induction, lesions, and yolk stores in pink salmon fry collected in May, 1991, from oiled and control streams in Prince William Sound, Alaska. Ranges indicate the middle two-thirds of the data. Numbers above site locations represent total fry per site.

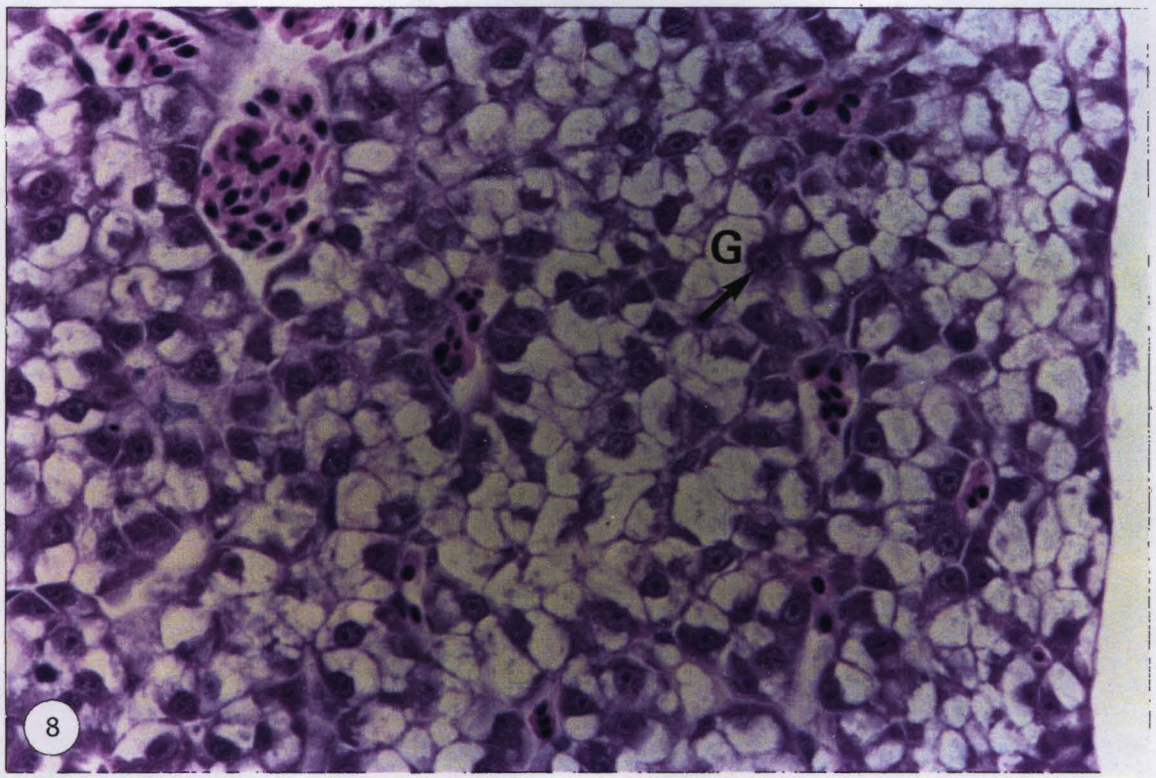

Figure 8. Liver of pink salmon larva 90.665.A2 fish #1 (oiled site, 90MW104VB) with abundant glycogen (G) stores [GLY = 3] in hepatocytes. Note that hepatocyte nuclei (arrow) have finely dispersed chromatin and prominent nucleoli. 425x

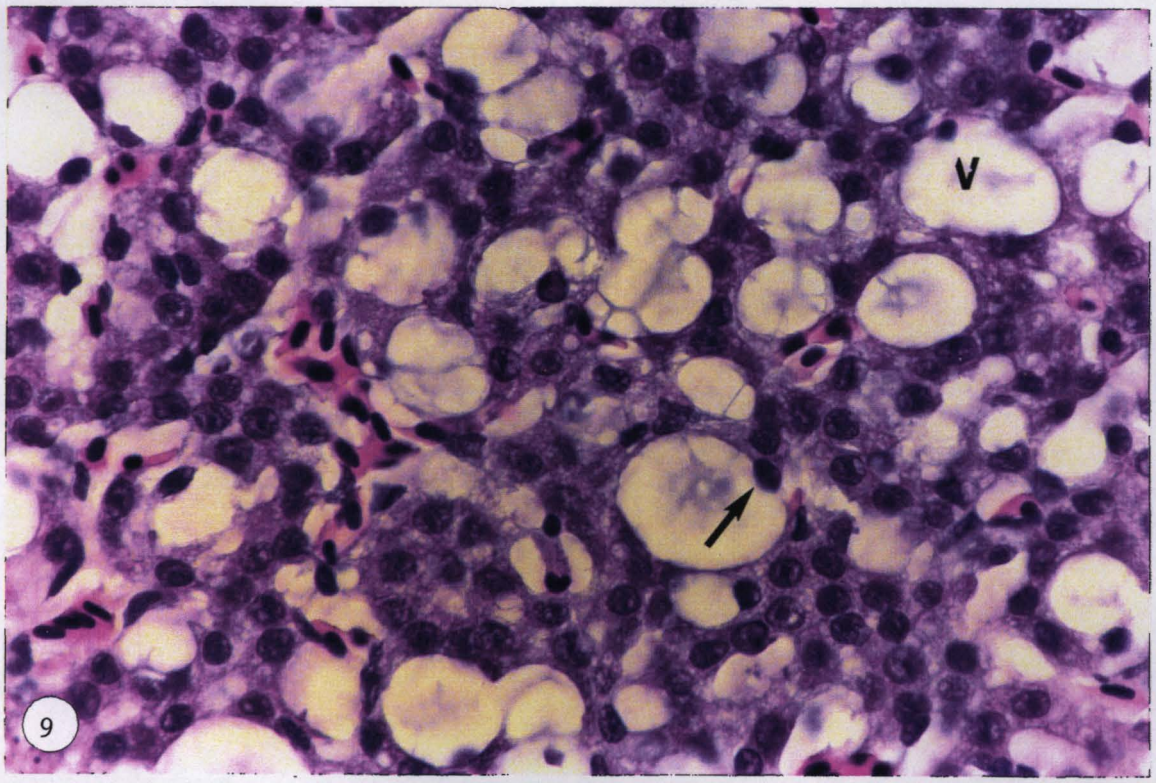

Figure 9. Liver of pink salmon larva 90.667.A3 fish #1 (oiled site, 90MW106V) with vacuolar change and necrosis [IHN = 2] of individual hepatocytes. Note that nuclei (arrow) of affected cells are pyknotic, and degenerative cytoplasmic vacuoles (V) are larger than the glycogen-filled spaces in Figure 8. 650x

Micrographs by G. Marty

Figure 10. Liver and yolk sac of pink salmon larva 90.671.A1 fish #2 (oiled site, 90MW115V). The liver (L) has minimal hepatocellular glycogen [GLY = 1]; although nuclei are normal, the clear, pale, glycogen-filled, cytoplasmic spaces common in Figure 8 [same magnification] are lacking in these depleted hepatocytes. The yolk sac (Y) contains only pale remnants of eosinophilic protein [YOLK = 1] surrounded by scattered, giant, yolk epithelial cell nuclei. 425x

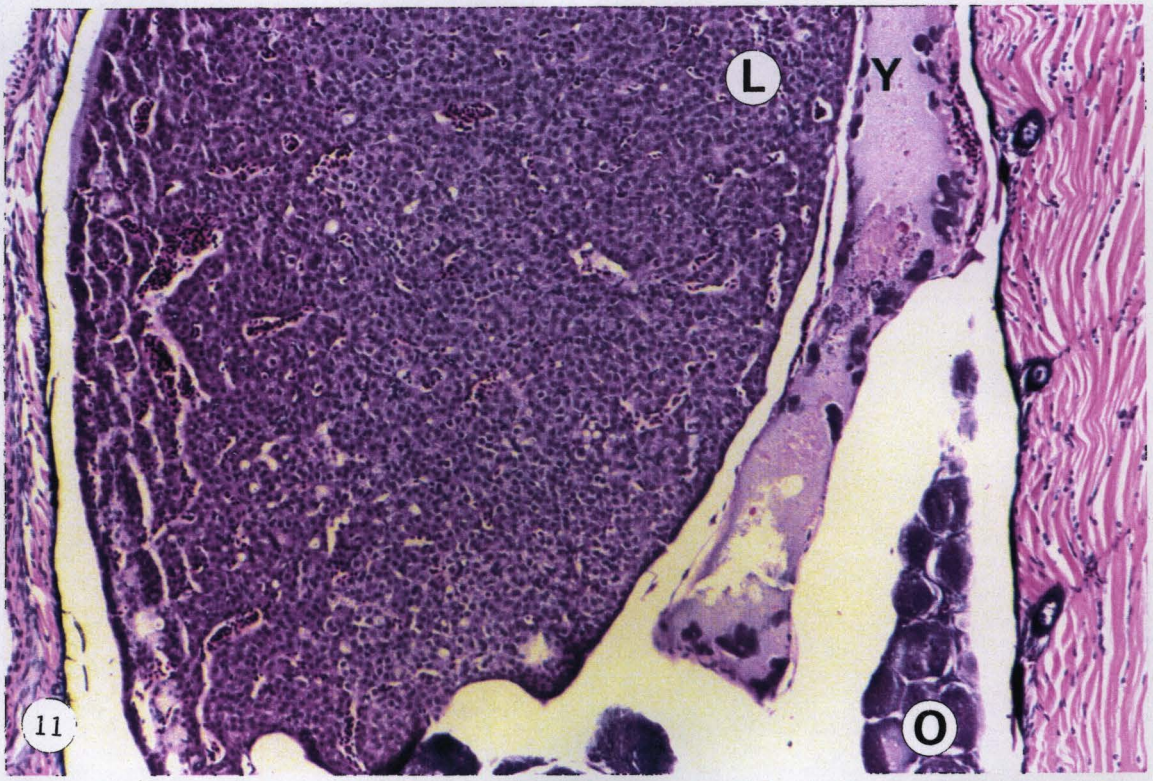

Figure 11. Yolk sac of pink salmon larva 90.671.A1 fish #2 (oiled site, 90MW115V). Overview of Figure 10 demonstrates the relatively small amount yolk (Y) compared to the size of the liver (L). The ovary (O) of this female is labelled. Compare the size of the yolk sac and intensity of staining here with the yolk in Figure 12 [same magnification]. 110x

Micrographs by G. Marty

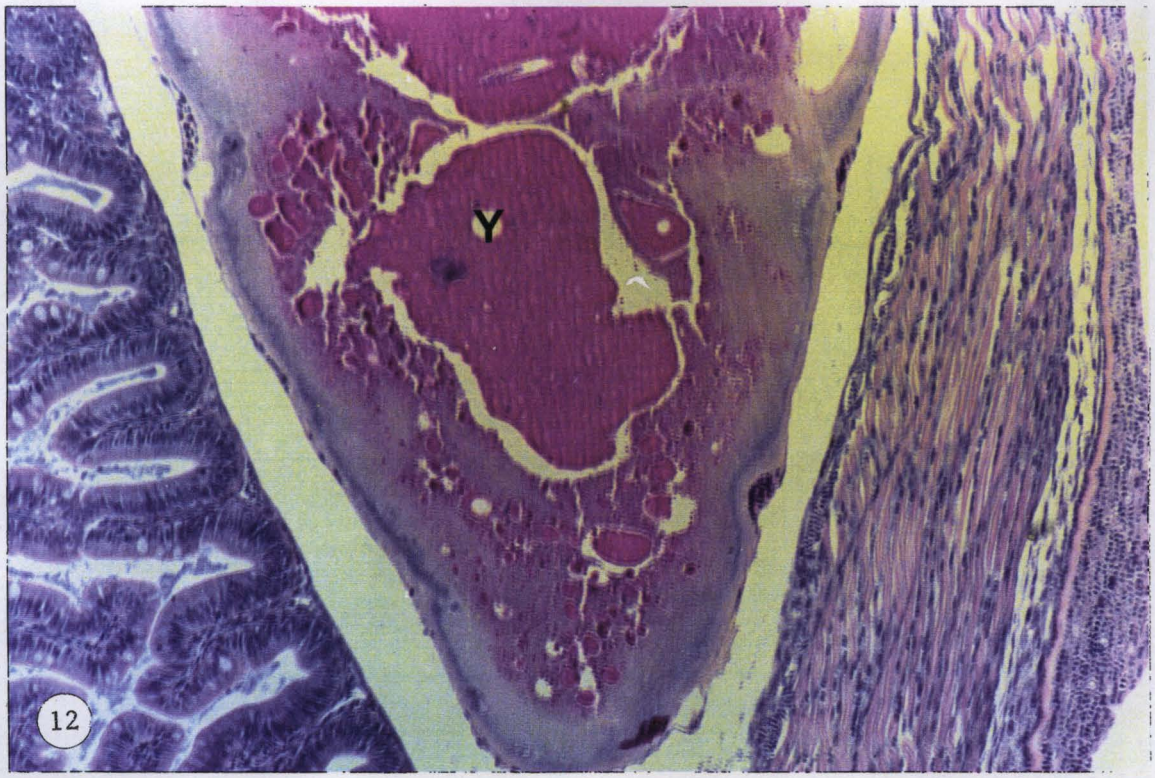

Figure 12. Yolk sac of pink salmon larva 90.665.A2 fish #1 (oiled site, 90MW104VB) with abundant, intensely eosinophilic, yolk stores (Y) [YOLK = 3]. Normal intestine and skeletal musculature are on opposite margins of the micrograph. Compare the size of the yolk and intensity of staining here with the yolk in Figure 11 [same magnification]. **110x**

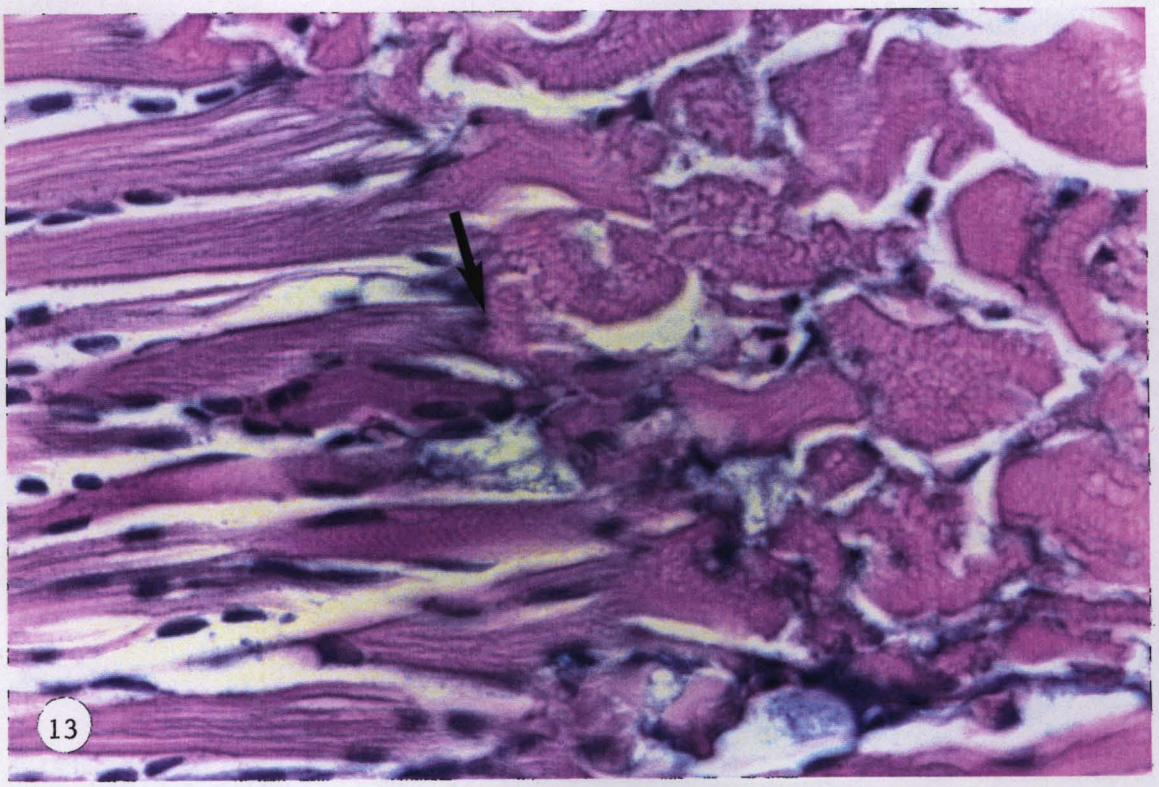

Figure 13. Skeletal muscle of pink salmon larva 90.671.A3 fish #2 (oiled site, 90MW115V) with focal coagulative myonecrosis [MDN = 2]. Note the abrupt change (arrow) from normal striated fibers (left) to vacuolated and coagulated fibers that have lost their striations and nuclei (right). **570x**

Micrographs by G. Marty

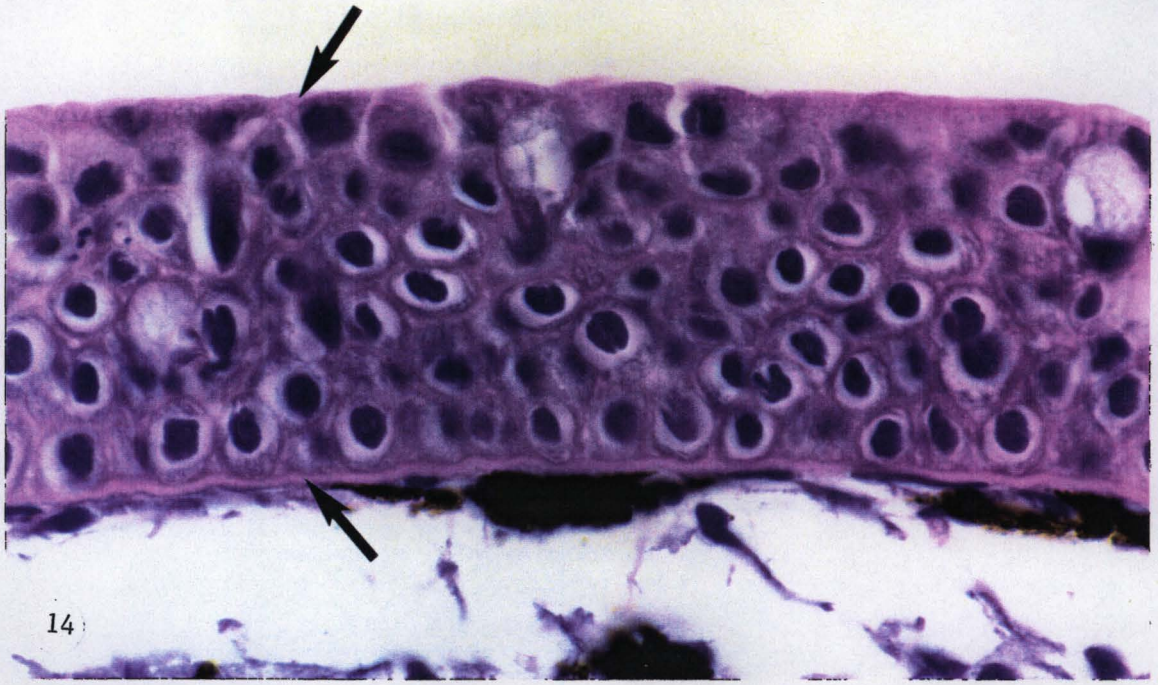

Figure 14. Normal rostral cranial epidermis (between arrows) of pink salmon larva 90.665.A2 fish #1 (oiled site, 90MW104VB) with normal numbers of large, clear, mucous cells [EA = 0]. 850x

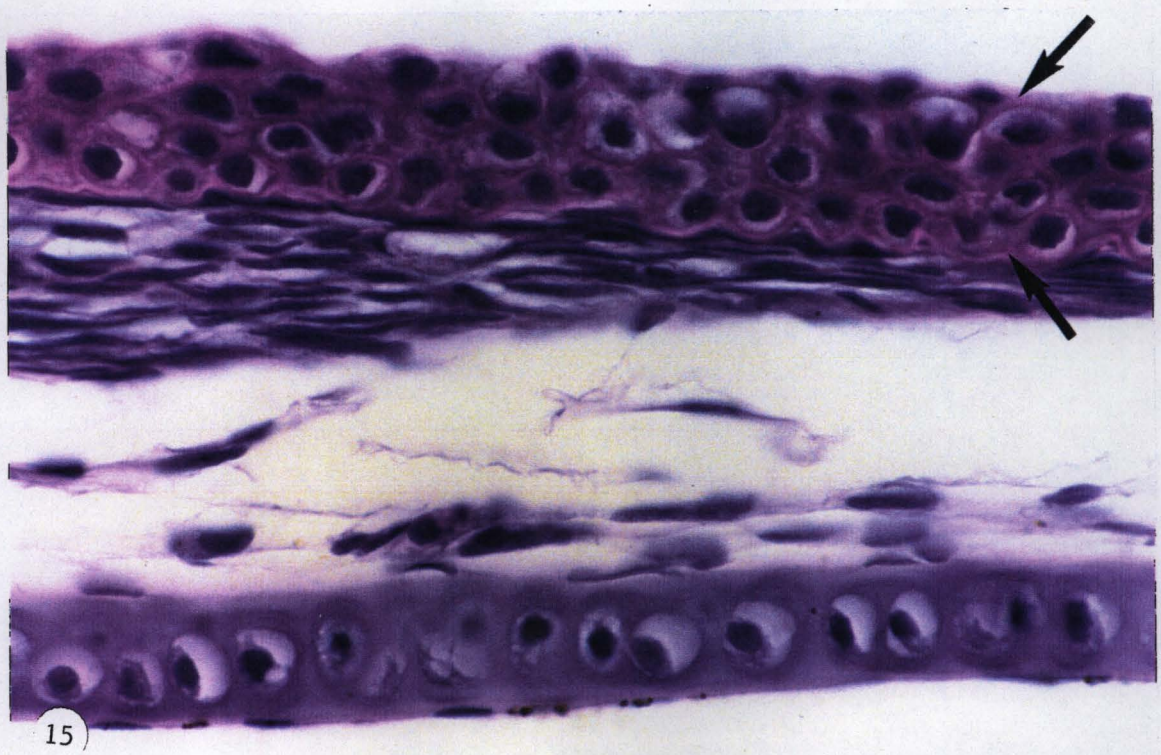

Figure 15. Rostral cranial epidermis of pink salmon larva 90.671.A1 fish #2 (oiled site, 90MW115V) with only a few, small, clear, mucous cells [EA = 2] and decreased distance between the basement membrane and the surface (arrows) compared with Figure 14 [same magnification]. Subepidermal connective tissue and rostral cartilage are evident. 850x

Micrographs by G. Marty

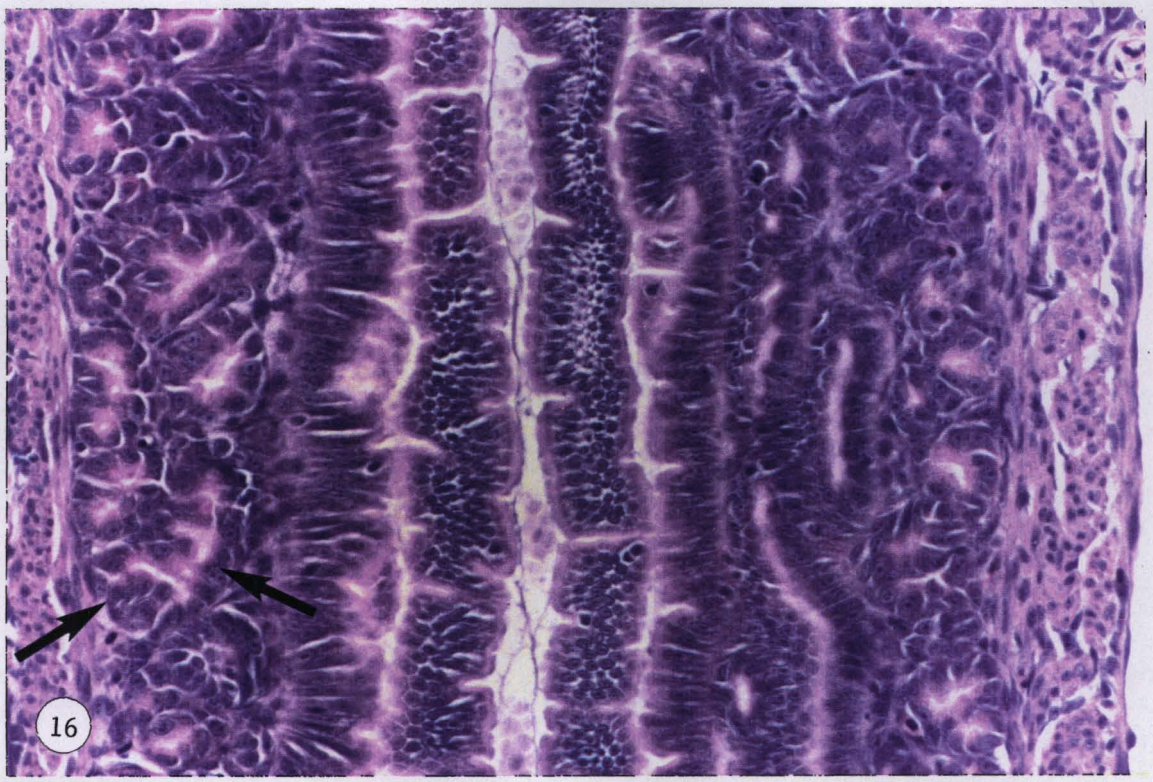

Figure 16. Longitudinal section of normal stomach from pink salmon larva 90.665.A2 fish #1 (oiled site, 90MW104VB). Note that the gastric gland epithelium (arrows) is homogeneous and amphophilic [VDGG = 0]. The intestinal lumen is in the center of the micrograph. 285x

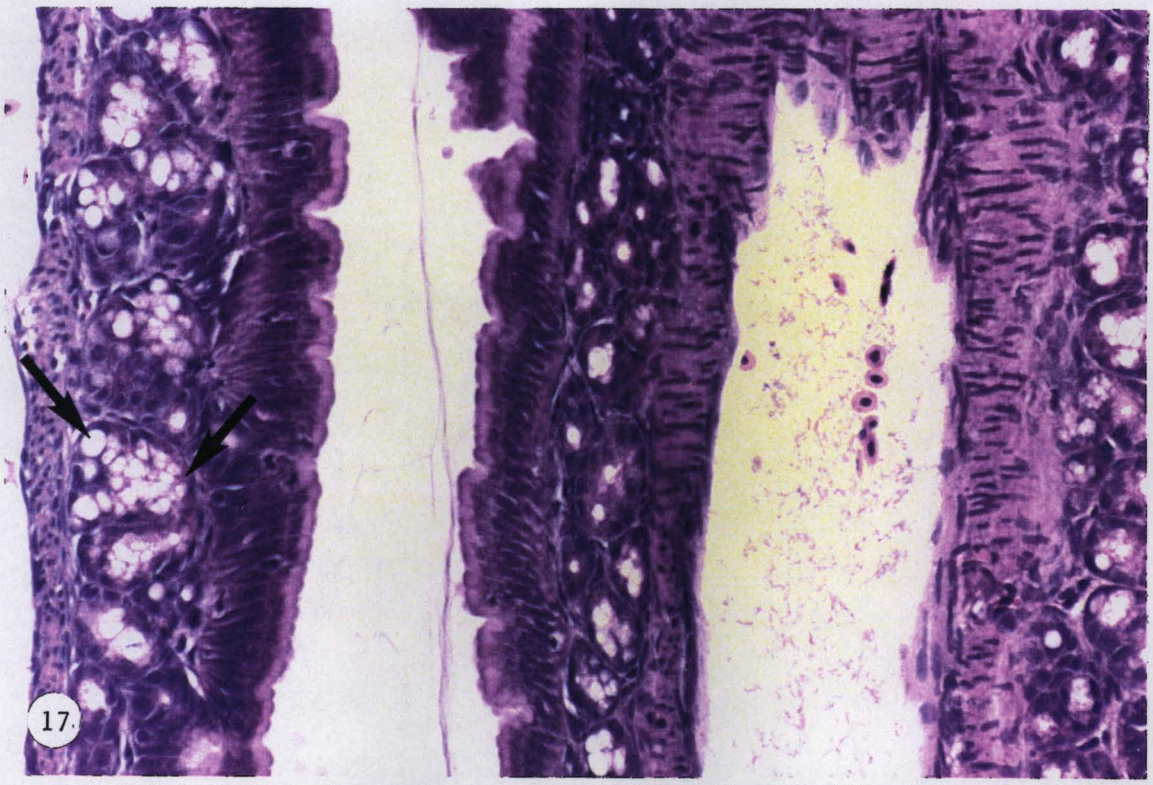

Figure 17. Longitudinal section of stomach from pink salmon larve 91.751.A1 fish #2 (control site, 91MF012V). Note that the gastric gland epithelium (arrows) contains multiple, clear, well-demarcated, irregular vacuoles [VDGG = 2]. The intestinal lumen is slightly to the left of center in this micrograph. Compare the vacuolated gastric glands here with normal glands in Figure 16 [same magnification]. 285x

Micrographs by G. Marty

Appendices

Appendix 1. Summary of mixed-function oxidase (MFO) induction in pink salmon fry and eggs collected from Prince William Sound, Alaska, 1989-1991.

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	GILL	EPITHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	GILL	BUDS	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	HEART	ATRIAL ENDOTHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	COLLECTING DUCT	VERY MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	YOLK SAC	ENDOTHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	GILL	EPITHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	GILL	BUDS	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	GILL	EPITHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	GILL	BUDS	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	GILL	EPITHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	GILL	BUDS	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	HEART	ATRIAL ENDOTHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	GILL	EPITHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	GILL	BUDS	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	YOLK SAC	ENDOTHELIUM	MILD	MULTIFOCAL	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	GILL	EPITHELIUM	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	GILL	BUDS	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	HEART	ATRIAL ENDOTHELIUM	NEGATIVE		
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	MILD	RARE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
N3000-91 03/17/91	LA018 A 2264016780	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	DIFFUSE	
T89MW002V 12/08/89	KN701 B 2263016840	EGGS	YES	NEGATIVE		/			NEGATIVE		NO SPECIFIC STAINING DETECTED.
T89MW003V 12/08/89	KN701 B 2263016840	SAC FRY	YES	MILD/ MODERATE	A1	2/2			NEGATIVE		NO KIDNEY PRESENT IN SECTIONS.
T89MW003V 12/08/89	KN701 B 2263016840	SAC FRY	YES	MILD/ MODERATE	A2	1/2	ANTERIOR KIDNEY	TUBULES	MILD		OTHER FISH, NO TUBULES SEEN IN ANTERIOR KIDNEY, BUT TUBULES WERE SEEN IN POSTERIOR KIDNEY.

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T89MW003V 12/08/89	KN701 B 2263016840	SAC FRY	YES	MILD/ MODERATE	A3	1/2	ANTERIOR KIDNEY	TUBULES	MODERATE		MODERATE STAINING OF 2 CROSS SECTIONS. OTHER FISH, NO KIDNEY PRESENT.
T89MW004V 12/09/89	CH001 A 2262016280	EGGS	NO^	NEGATIVE		/			NEGATIVE		NO SPECIFIC STAINING DETECTED.
T89MW005V 12/09/89	CH001 A 2262016280	SAC FRY	NO^	NEGATIVE	A1	2/2			NEGATIVE		NO SPECIFIC STAINING SEEN IN ANY ORGANS. NO HEAD KIDNEY TUBULES PRESENT IN SECTIONS.
T89MW005V 12/09/89	CH001 A 2262016280	SAC FRY	NO^	NEGATIVE	A2	2/2	HEAD KIDNEY	TUBULES	NEGATIVE		NO SPECIFIC STAINING SEEN ON ANY ORGANS. HEAD KIDNEY TUBULES PRESENT IN BOTH FISH.
T89MW005V 12/09/89	CH001 A 2262016280	SAC FRY	NO^	NEGATIVE	A3	2/2			NEGATIVE		NO STAINING OF ANY TISSUES. NO KIDNEY PRESENT IN SECTIONS.
T90MW104V 05/25/90	LA018 A 2264016780	BUTTONED UP FRY	YES	NEGATIVE		6/6			NEGATIVE		NO SPECIFIC STAINING DETECTED.
T90MW104VB 05/25/90	LA018 A 2264016780	BUTTONED UP FRY	YES	VERY MILD		5/6	VERTEBRAL CORD	CARTILAGE	MODERATE		36 FOCI.
T90MW105V 05/25/90	LA018 A 2264016780	BUTTONED UP FRY	YES	VERY MILD		3/6	VERTEBRAL CORD	CARTILAGE	MODERATE		13 FOCI.
T90MW106V 05/30/90	KN701 B 2263016840	BUTTONED UP FRY	YES	MILD		5/6	VERTEBRAL CORD	CARTILAGE	MODERATE		38 FOCI.
T90MW106V 05/30/90	KN701 B 2263016840	BUTTONED UP FRY	YES	MILD		1/6	MIDGUT & CAECA	EPITHELIUM	MODERATE	MULTIFOCAL	
T90MW108V 05/30/90	KN132 B 2261016982	BUTTONED UP FRY	NO^	NEGATIVE		6/6			NEGATIVE		NO SPECIFIC STAINING DETECTED.
T90MW110V 06/02/90	EB001 A 2253015060	BUTTONED UP FRY	NO^	NEGATIVE		6/6			NEGATIVE		NO SPECIFIC STAINING DETECTED.
T90MW112V 06/08/90	KN500B B 2261016996	BUTTONED UP FRY	YES	MODERATE		1/6		SKIN	POSITIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T90MW112V 06/08/90	KN500 B 2261016996	BUTTONED UP	YES	MODERATE		5/5	PHARYNX	PHARYNGEAL EPITHELIUM	MILD/ MODE	MULTIFOCAL	
T90MW112V 06/08/90	KN500 B 2261016996	BUTTONED UP	YES	MODERATE		6/6	GILL	EPITHELIAL CELLS	MILD/ MODE	MULTIFOCAL	
T90MW112V 06/08/90	KN500B B 2261016996	BUTTONED UP FRY	YES	MODERATE		4/6	VERTEBRAL CORD	CARTILAGE	MODERATE		15 FOCI.
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		1/6	BRAIN	VESSEL ENDOTHELIUM	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		1/6		PERITONEAL CONNECTIVE TISSUE	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		6/6	GILL	EPITHELIUM	MODERATE	MULTIFOCAL TO DIFFUSE	
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		5/5	KIDNEY	TUBULES	MILD		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		1/6	GUT	VESSEL ENDOTHELIUM	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		4/4	HEART	ENDOTHELIUM	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		5/6	VERTEBRAL CORD	CARTILAGE	POSITIVE		17 FOCI TOTAL.
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		1/4	LIVER	VESSEL ENDOTHELIUM	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		3/6	KIDNEY	ENDOTHELIUM	MILD/MODER		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		4/4	LIVER	HEPATOCYTES	VERY MILD		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		2/6	MIDGUT & CAECA	EPITHELIUM	MODERATE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		3/6	MIDGUT & CAECA	EPITHELIUM	MILD		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP FRY	YES	STRONG		1/6	MIDGUT & CAECA	EPITHELIUM	NEGATIVE		
T90MW115V 06/08/90	EV025 A 2264016613	BUTTONED UP	YES	STRONG		6/6	PHARYNX	PHARYNGEAL EPITHELIUM	MODERATE	MULTIFOCAL TO DIFFUSE	
T90MW903V 09/07/90	BP004 A 2262016397	EGGS	YES	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC IMMUNOCHEMICAL STAINING. NO EMBRYOS SEEN.
T90MW904V 09/07/90	BP004 A 2262016397	EGGS	YES	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. NO EMBRYOS SEEN.
T90MW905V 09/07/90	BP004 A 2262016397	EGGS	NO	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. NO EMBRYOS SEEN.
T90MW907V 09/25/90	EV027 A 2264016610	EGGS	NO	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. SEVERAL EGGS DID NOT CONTAIN VIABLE (BEFORE FIXED) EMBRYOS.
T90MW909V 09/25/90	EV025 A 2264016613	EGGS	YES	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. SEVERAL EGGS DID NOT CONTAIN VIABLE (BEFORE FIXED) EMBRYOS.
T90MW910V 09/25/90	EV025 A 2264016613	EGGS	YES	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. SEVERAL EGGS DID NOT CONTAIN VIABLE (BEFORE FIXED) EMBRYOS.
T90MW911V 09/25/90	EV025 A 2264016613	EGGS	YES	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. SEVERAL EGGS DID NOT CONTAIN VIABLE (BEFORE FIXED) EGGS.
T90MW914V 09/25/90	KN604 A 2264016809	EGGS	NO	NEGATIVE	ALL	/		ALL TISSUES	NEGATIVE		NEGATIVE FOR ANY SPECIFIC STAINING. SEVERAL EGGS DID NOT CONTAIN VIABLE (BEFORE FIXED) EMBRYOS.
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	VERY MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	GILL	EPITHELIAL CELLS	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	GILL	EPITHELIAL CELLS	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	GILL	EPITHELIAL CELLS	MILD	MULTIFOCAL	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	GILL	EPITHELIAL CELLS	MILD	MULTIFOCAL	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MILD	MILD	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	VERY MILD	MULTIFOCAL	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	VERY MILD	RARE	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	GILL	EPITHELIAL CELLS	VERY MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	VERY MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	GILL	EPITHELIAL CELLS	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	RARE	
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	NEGATIVE		
T91MF001V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	MILD	MULTIFOCAL	
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	MILD	DIFFUSE	
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A2	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	1A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	2A2	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A1	1/1	KIDNEY	COLLECTING DUCT	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A2	1/1	KIDNEY	COLLECTING DUCT	VERY MILD	MULTIFOCAL	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF002V 03/21/91	KN701 B 2263016840	SAC FRY	YES	MILD	3A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	RARE	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	RARE	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A1	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	MILD	RARE	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A2	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A1	1/1	YOLK SAC	ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A2	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	2A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	VERY MILD	RARE	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A1	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A1	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A2	1/1	LIVER	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A2	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	VERY MILD	MULTIFOCAL	
T91MF006V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE/ MILD	3A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	VERY MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	YOLK SAC	ENDOTHELIUM	VERY MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	GILL	BUDS	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	LIVER	HEPATOCYTES	VERY MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	VERY MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	VERY MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	GILL	BUDS	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	LIVER	HEPATOCYTES	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	HEART	ATRIAL ENDOTHELIUM	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	GILL	BUDS	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A1	1/1	LIVER	HEPATOCYTES	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	LIVER	HEPATOCYTES	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	GILL	BUDS	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	HEART	ATRIAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	2A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	VERY MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	LIVER	HEPATOCYTES	VERY MILD	DIFFUSE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	YOLK SAC	ENDOTHELIUM	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	VERY MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	POSTERIOR INTESTINE	ENTEROCYTES	VERY MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	GILL	BUDS	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	LIVER	HEPATOCYTES	VERY MILD	DIFFUSE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	ANTERIOR INTESTINE	ENTEROCYTES	NE		CELLS NOT SEEN
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	POSTERIOR INTESTINE	ENTEROCYTES	NEGATIVE		
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	GILL	BUDS	MILD	RARE	
T91MF008V 03/21/91	EV025 A 2264016613	SAC FRY	YES	MODERATE	3A2	1/1	YOLK SAC	ENDOTHELIUM	VERY MILD	MULTIFOCAL	
T91MF010V 03/21/91	EV027 A 2264016610	SAC FRY	NO	NEGATIVE	ALL	6/6			NEGATIVE		ALL TISSUES NEGATIVE FOR ANY SPECIFIC STAIN.
T91MF012V 03/22/91	CH017 A 2262016262	SAC FRY	NO	NEGATIVE	ALL	6/6			NEGATIVE		ALL TISSUES NEGATIVE FOR ANY SPECIFIC STAIN.
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	GILL	EPITHELIAL CELLS	MODERATE	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	LIVER	HEPATOCYTES	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	KIDNEY	COLLECTING DUCTS	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	LIVER	CENTRAL VEINS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A1	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MODERATE	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	GILL	EPITHELIAL CELLS	MODERATE	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	YOLK SAC	ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	LIVER	HEPATOCYTES	MILD	RARE	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	LIVER	CENTRAL VEINS	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	1A2	1/1	KIDNEY	COLLECTING DUCTS	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	KIDNEY	COLLECTING DUCTS	VERY MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	LIVER	HEPATOCYTES	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	LIVER	CENTRAL VEINS	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	GILL	EPITHELIAL CELLS	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A1	1/1	YOLK SAC	ENDOTHELIUM	NE		CELLS NOT SEEN

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	LIVER	HEPATOCYTES	MODERATE	MULTIFOCAL	FOCALLY AT THE HILUS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	LIVER	HEPATOCYTES	VERY MILD	MULTIFOCAL	AT THE EDGES
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	KIDNEY	COLLECTING DUCTS	VERY MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	YOLK SAC	ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	HEART	ATRIAL ENDOTHELIUM	NE		CELLS NOT SEEN
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	GILL	EPITHELIAL CELLS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MODERATE	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	2A2	1/1	LIVER	CENTRAL VEINS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	KIDNEY	COLLECTING DUCTS	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	YOLK SAC	ENDOTHELIUM	MODERATE	MULTIFOCAL	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	LIVER	CENTRAL VEINS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	HEART	VENTRICULAR ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	LIVER	HEPATOCYTES	VERY MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	DIFFUSE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	GILL	EPITHELIAL CELLS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A1	1/1	HEART	ATRIAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	GILL	EPITHELIAL CELLS	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MODERATE	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	LIVER	HEPATOCYTES	VERY MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	LIVER	CENTRAL VEINS	NEGATIVE		
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	MULTIFOCAL	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	KIDNEY	COLLECTING DUCTS	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	YOLK SAC	ENDOTHELIUM	VERY MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	PHARYNX	PHARYNGEAL EPITHELIUM	MILD	MULTIFOCAL	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	HEART	ATRIAL ENDOTHELIUM	MILD	RARE	
T91MF014V 05/04/91	LA018 A 2264016780	BUTTONED UP	YES	MODERATE	3A2	1/1	HEART	VENTRICULAR ENDOTHELIUM	MILD	RARE	
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A1	1/1	LIVER	HEPATOCYTES	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A2	1/1	LIVER	HEPATOCYTES	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	1A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A1	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A1	1/1	LIVER	HEPATOCYTES	VERY MILD	MULTIFOCAL	

Appendix 1. Continued.

SAMPLE ID DATE	SEGMENT STREAM#	LIFESTAGE	OILING	GENERAL RESULTS	SLIDE	C/T	ORGAN	TISSUE	STAIN	OCCURRENCE	COMMENTS
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A1	1/1	KIDNEY	VASCULAR ENDOTHELIUM	MILD	MULTIFOCAL	
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A2	1/1	KIDNEY	VASCULAR ENDOTHELIUM	VERY MILD	RARE	
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A2	1/1	LIVER	HEPATOCYTES	NEGATIVE		
T91MF015V 05/04/91	EV025 A 2264016613	BUTTONED UP	YES	MILD	2A2	1/1	KIDNEY	SINUSOIDAL ENDOTHELIUM	VERY MILD	RARE	
T91MF017V 05/04/91	EV027 A 2264016610	BUTTONED UP	NO^	NEGATIVE	ALL	6/6		ALL TISSUES	NEGATIVE		ALL TISSUES WERE NEGATIVE FOR ANY SPECIFIC STAINING.
T91MF019V 05/05/91	CH017 A 2262016262	BUTTONED UP	NO^	NEGATIVE	ALL	6/6		ALL TISSUES	NEGATIVE		ALL TISSUES WERE NEGATIVE FOR ANY SPECIFIC STAINING.
T91MF021V 05/14/91	KN701 B 2263016840	BUTTONED UP	YES	NEGATIVE	ALL	6/6		ALL TISSUES	NEGATIVE		ALL TISSUES NEGATIVE FOR ANY SPECIFIC STAINING.
T91MF023V 05/14/91	KN701 B 2263016840	BUTTONED UP	YES	NEGATIVE	ALL	6/6		ALL TISSUES	NEGATIVE		ALL TISSUES NEGATIVE FOR ANY SPECIFIC STAINING.

^ WHILE PORTIONS OF THE GENERAL STREAM AREA MAY HAVE BEEN INITIALLY OILED, THE SOURCE OF THE SAMPLE WAS UPSTREAM OF THE ZONE OF CONTAMINATION.

^^ SAMPLE COLLECTED FROM KITOI BAY FISH HATCHERY.

Appendix 2A. Summary of major histopathologic lesions in pink salmon fry collected from Prince William Sound, 1989-1990.[1]

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	COMMENTS
1	90.181.A1 #2	89MW005V	1	2	U	NE	3	0	0	NE	0	
2	90.181.A1 #1	89MW005V	1	1	A	2	3	0	0	0	0	
3	90.181.A2 #2	89MW005V	1	2	U	NE	3	0	0	NE	0	
4	90.181.A2 #1	89MW005V	1	3	U	NE	3	0	0	NE	0	
5	90.181.A3 #2	89MW005V	1	1	U	NE	3	0	0	NE	0	
6	90.181.A3 #1	89MW005V	1	2	U	3	3	0	0	0	0	
13	90.183.A1 #2	89MW003V	1	1	U	2	3	0	0	0	0	
14	90.183.A1 #1	89MW003V	1	1	U	NE	3	0	0	NE	0	
15	90.183.A2 #2	89MW003V	1	1	U	NE	3	0	0	NE	0	
16	90.183.A2 #1	89MW003V	1	1	U	NE	3	0	0	NE	0	
17	90.183.A3 #2	89MW003V	1	2	U	NE	3	0	0	NE	0	
18	90.183.A3 #1	89MW003V	1	2	U	NE	3	0	0	NE	0	
73	90.664.A1 #2	90MW104V	1	1	F	3	3	0	0	0	0	
74	90.664.A1 #1	90MW104V	2	1	U	3	3	0	0	0	0	See below #74
75	90.664.A2 #2	90MW104V	2	1	U	3	3	0	0	0	0	
76	90.664.A2 #1	90MW104V	1	1	U	3	3	0	0	0	0	
77	90.664.A3 #2	90MW104V	2	1	U	2	3	0	0	0	0	
78	90.664.A3 #1	90MW104V	2	1	U	3	3	0	0	0	0	
79	90.665.A1 #2	90MW104VB	2	1	A	3	0	0	0	0	0	
80	90.665.A1 #1	90MW104VB	2	1	A	3	1	0	0	0	0	
81	90.665.A2 #2	90MW104VB	1	1	F	3	3	0	0	0	0	
82	90.665.A2 #1	90MW104VB	2	1	F	3	3	0	0	0	0	
83	90.665.A3 #2	90MW104VB	2	1	A	3	3	0	0	0	0	
84	90.665.A3 #1	90MW104VB	2	1	F	3	3	0	0	0	0	

[1]From the October 28, 1991, Quarterly Report - Histopathology Contract IHP-91-033, University of California at Davis.

Appendix 2A. **Continued.**

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	COMMENTS
85	90.666.A1 #2	90MW105V	1	1	M	2	3	0	0	0	0	
86	90.666.A1 #1	90MW105V	1	1	U	1	3	1	0	0	0	
87	90.666.A2 #2	90MW105V	1	1	M	1	3	0	0	0	0	See below #87
88	90.666.A2 #1	90MW105V	2	1	M	3	3	0	0	0	0	
89	90.666.A3 #2	90MW105V	2	2	U	1	1	1	0	0	0	See below #89
90	90.666.A3 #1	90MW105V	2	2	F	1	1	1	0	0	0	
91	90.667.A1 #2	90MW106V	2	1	F	1	1	2	0	2	0	See below #91
92	90.667.A1 #1	90MW106V	2	2	U	1	0	2	2	2	0	
93	90.667.A2 #2	90MW106V	2	2	M	1	1	3	0	1	0	See below #93
94	90.667.A2 #1	90MW106V	2	1	M	1	1	2	2	1	0	
95	90.667.A3 #2	90MW106V	2	1	F	1	0	2	0	1	0	
96	90.667.A3 #1	90MW106V	2	1	M	1	0	2	0	2	0	See below #96
97	90.668.A1 #2	90MW108V	1	1	A	3	0	0	0	0	0	
98	90.668.A1 #1	90MW108V	2	1	U	3	3	0	0	0	0	
99	90.668.A2 #2	90MW108V	2	1	A	3	0	0	0	0	0	
100	90.668.A2 #1	90MW108V	2	1	A	3	0	0	0	0	NE	
101	90.668.A3 #1	90MW108V	2	1	A	2	0	0	0	0	0	
102	90.668.A3 #2	90MW108V	2	1	A	3	3	0	0	0	0	
103	90.669.A1 #2	90MW110V	2	1	F	1	1	1	0	0	0	
104	90.669.A1 #1	90MW110V	2	2	M	1	1	1	0	0	0	
105	90.669.A2 #2	90MW110V	2	1	A	2	3	0	0	0	0	See below #105
106	90.669.A2 #1	90MW110V	2	1	A	3	3	0	0	0	0	
107	90.669.A3 #2	90MW110V	2	1	M	2	1	0	0	0	0	
108	90.669.A3 #1	90MW110V	2	1	M	2	1	1	0	0	0	
109	90.670.A1 #2	90MW112V	2	1	U	1	1	2	0	0	0	See below #109
110	90.670.A1 #1	90MW112V	2	1	A	1	1	2	0	0	0	
111	90.670.A2 #2	90MW112V	2	1	F	1	0	2	1	0	0	
112	90.670.A2 #1	90MW112V	2	1	M	1	0	2	0	0	0	
113	90.670.A3 #2	90MW112V	1	1	A	1	1	2	0	0	NG	
114	90.670.A3 #1	90MW112V	2	1	F	1	0	1	0	0	0	See below #114

Appendix 2A. **Continued.**

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	COMMENTS
115	90.671.A1 #2	90MW115V	1	1	F	1	1	2	2	0	NG	
116	90.671.A1 #1	90MW115V	2	1	A	1	1	2	0	0	0	
117	90.671.A2 #2	90MW115V	2	2	A	1	1	2	1	0	0	
118	90.671.A2 #1	90MW115V	2	1	A	1	1	2	1	0	0	
119	90.671.A3 #2	90MW115V	3	2	F	1	1	2	2	0	0	See below #119
120	90.671.A3 #1	90MW115V	2	2	M	2	1	2	2	0	0	See below #120

Abbreviations used:

min = minimal; mod = moderate; sev = severe; NE or . = not examined/not present

Atly = autolysis; ranked as min (1), mild (2), mod (3), or sev (4)
art = sectioning artifact; ranked as none (0), mild (1), mod (2), or sev (3)
sex = gonad; listed as male (M), female (F), unknown/undifferentiated (U), absent (A
GLY = hepatic glycogen; ranked as min (1), mod (2), sev (3), or NE
YOLK = status of yolk stores; ranked as none (0), pale (1), or eosinophilic (3)
EA = epidermal atrophy; ranked as mild (1), mod (2), or sev (3)
MDN = myofiber degeneration and/or necrosis; ranked as EA
IHN = individual hepatocellular necrosis; ranked as EA, plus NE
VDGG = vacuolar degeneration of gastric gland epithelial cells; ranked as IHN, plus:
NG (no good) - the GI tract is present, but cannot be evaluated for VDGG due to autolysis or "wrong part of GI tract."

(Comment notes follow on next page)

Appendix 2A. **Continued.**

Hinton #	Comments
74	Liver has a syncytial cell and two cells with large nuclei.
87	Unknown eosinophilic material in peritoneal cavity (artifact?)
89	A Bowman's capsule is dilated, but has no glomerulus.
91	Individual necrotic cells in stomach, mod
93	Individual necrotic cells in stomach, mod
96	Individual necrotic cells in stomach, mild
105	Hepatocellular karyomegaly, mild
109	Renal tubular necrosis, mild (slide #2)
114	Thrombosis of branchial vessel, focal, mild
119	Fat in ventricle?
120	Fat in ventricle?; mod. necrosis/autolysis of exocrine pancreas?

Appendix 2B. Summary of major histopathologic lesions in pink salmon fry collected from Prince William Sound, 1991.[1]

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	Comments
1	91.746.A1 #1	91-MFO01V	1	1	F	3	3	0	0	0	0	
2	91.746.A1 #2	91-MFO01V	1	1	F	3	3	0	0	0	NE	
3	91.746.A2 #1	91-MFO01V	3	1	M	3	3	0	0	0	0	
4	91.746.A2 #2	91-MFO01V	1	1	A	3	3	0	0	0	0	
5	91.746.A3 #1	91-MFO01V	1	1	F	3	3	0	0	0	0	
6	91.746.A3 #2	91-MFO01V	1	1	F	NE	3	0	0	NE	0	
7	91.747.A1 #1	91-MFO02V	1	1	M	3	3	0	0	0	0	
8	91.747.A1 #2	91-MFO02V	1	1	M	3	3	0	0	0	0	
9	91.747.A2 #1	91-MFO02V	1	1	M	3	3	0	0	0	0	
10	91.747.A2 #2	91-MFO02V	1	1	M	3	3	0	0	0	0	
11	91.747.A3 #1	91-MFO02V	1	2	U	3	3	0	0	0	0	
12	91.747.A3 #2	91-MFO02V	1	1	F	3	3	0	0	0	0	
13	91.748.A1 #1	91-MFO06V	1	1	M	3	3	0	0	0	0	
14	91.748.A1 #2	91-MFO06V	1	1	M	NE	3	0	0	NE	0	
15	91.748.A2 #1	91-MFO06V	1	1	M	3	3	0	0	0	0	
16	91.748.A2 #2	91-MFO06V	1	2	A	3	3	0	0	0	0	
17	91.748.A3 #1	91-MFO06V	1	1	U	NE	3	0	0	NE	0	
18	91.748.A3 #2	91-MFO06V	1	1	M	NE	3	0	0	NE	0	
19	91.749.A1 #1	91-MFO08V	1	1	M	NE	3	0	0	NE	0	
20	91.749.A1 #2	91-MFO08V	1	1	M	NE	3	0	0	NE	0	
21	91.749.A2 #1	91-MFO08V	1	1	M	NE	3	0	0	NE	0	
22	91.749.A2 #2	91-MFO08V	1	1	A	NE	3	0	0	NE	0	
23	91.749.A3 #1	91-MFO08V	1	1	M	NE	3	0	0	NE	0	
24	91.749.A3 #2	91-MFO08V	1	1	M	3	3	0	0	0	0	

[1]From the October 28, 1991, Quarterly Report - Histopathology Contract IHP-91-033, University of California at Davis.

Appendix 2B. **Continued.**

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	Comments
25	91.750.A1 #1	91-MFO10V	1	1	M	3	3	0	0	0	0	See below #25
26	91.750.A1 #2	91-MFO10V	1	1	M	NE	3	0	0	NE	0	See below #26
27	91.750.A2 #1	91-MFO10V	1	1	A	3	3	0	0	0	0	See below #27
28	91.750.A2 #2	91-MFO10V	1	1	A	NE	3	0	0	NE	0	See below #28
29	91.750.A3 #1	91-MFO10V	1	1	F	3	3	0	0	0	0	See below #29
30	91.750.A3 #2	91-MFO10V	1	1	M	NE	3	0	0	NE	0	See below #30
31	91.751.A1 #1	91-MFO12V	1	1	M	3	3	0	0	0	0	
32	91.751.A1 #2	91-MFO12V	1	1	M	3	3	0	0	0	2	
33	91.751.A2 #1	91-MFO12V	1	1	M	3	3	0	0	0	0	See below #33
34	91.751.A2 #2	91-MFO12V	1	1	F	3	3	0	0	0	1	
35	91.751.A3 #1	91-MFO12V	1	1	F	3	3	0	0	0	0	
36	91.751.A3 #2	91-MFO12V	1	1	F	3	3	0	0	0	0	
37	91.752.A1 #1	3000(91)	1	1	F	NE	3	0	0	NE	0	
38	91.752.A1 #2	3000(91)	1	1	F	2	3	0	0	0	NG	
39	91.752.A2 #1	3000(91)	1	1	A	2	3	0	0	0	NG	
40	91.752.A2 #2	3000(91)	1	1	M	3	3	0	0	0	NG	
41	91.752.A3 #1	3000(91)	1	1	M	NE	3	0	0	NE	0	
42	91.752.A3 #1	3000(91)	1	1	A	NE	3	0	0	NE	0	
43	91.801.A1 #1	T91MFO14V	1	1	F	3	3	0	0	0	0	See below #43
44	91.801.A1 #2	T91MFO14V	1	1	A	3	3	1	0	0	0	
45	91.801.A2 #1	T91MFO14V	2	1	U	3	3	0	0	0	0	
46	91.801.A2 #2	T91MFO14V	1	1	F	3	0	1	0	0	0	
47	91.801.A3 #1	T91MFO14V	1	1	F	3	3	0	0	0	0	
48	91.801.A3 #2	T91MFO14V	1	1	U	3	3	0	0	0	0	
49	91.802.A1 #1	T91MFO21V	1	1	M	1	1	1	0	0	1	
50	91.802.A1 #2	T91MFO21V	1	1	U	1	1	2	0	0	1	
51	91.802.A2 #1	T91MFO21V	1	1	A	NE	1	2	0	NE	0	
52	91.802.A2 #2	T91MFO21V	1	1	F	1	1	2	0	0	1	
53	91.802.A3 #1	T91MFO21V	1	2	F	1	1	2	0	0	NG	
54	91.802.A3 #2	T91MFO21V	1	2	A	NE	1	2	0	NE	NE	

Appendix 2B. **Continued.**

Hinton Number	Woodshole Number	Alaska Number	Atly	art	sex	GLY	YOLK	EA	MDN	IHN	VDIG	Comments
55	91.803.A1 #1	T91MFO23V	1	1	M	1	1	2	0	0	0	
56	91.803.A1 #2	T91MFO23V	1	1	F	1	1	1	0	0	0	
57	91.803.A2 #1	T91MFO23V	1	2	F	2	1	1	0	0	0	
58	91.803.A2 #2	T91MFO23V	1	2	A	3	3	0	0	0	NE	
59	91.803.A3 #1	T91MFO23V	1	2	F	1	1	2	0	0	0	
60	91.803.A3 #2	T91MFO23V	1	2	A	2	1	1	0	0	1	
61	91.804.A1 #1	T91MFO15V	1	2	M	3	3	0	0	0	0	
62	91.804.A1 #2	T91MFO15V	1	1	U	3	3	1	0	0	0	See below #62
63	91.804.A2 #1	T91MFO15V	1	1	U	3	3	0	0	0	0	
64	91.804.A2 #2	T91MFO15V	1	1	F	3	3	0	0	0	0	
65	91.805.A1 #1	T91MFO17V	1	2	F	3	3	0	0	0	1	
66	91.805.A1 #2	T91MFO17V	1	2	M	NE	1	0	0	NE	NE	
67	91.805.A2 #1	T91MFO17V	2	2	F	1	1	2	0	0	0	
68	91.805.A2 #2	T91MFO17V	1	1	F	3	3	0	0	0	0	
69	91.805.A3 #1	T91MFO17V	1	2	F	3	3	0	0	0	0	
70	91.805.A3 #2	T91MFO17V	2	1	F	2	1	0	0	0	0	
71	91.806.A1 #1	T91MFO19V	2	2	M	3	3	0	0	0	0	
72	91.806.A1 #2	T91MFO19V	1	2	F	3	3	0	0	0	0	
73	91.806.A2 #1	T91MFO19V	1	1	F	3	3	0	0	0	NG	
74	91.806.A2 #2	T91MFO19V	2	1	M	3	3	0	0	0	NG	
75	91.806.A3 #1	T91MFO19V	1	1	M	3	3	0	0	0	0	
76	91.806.A3 #2	T91MFO19V	1	1	M	3	3	0	0	0	0	

(Abbreviations used on the next page)

Appendix 2B. **Continued.**

Abbreviations used:

min = minimal; mod = moderate; sev = severe; NE or "." = not examined
Atly = autolysis; ranked as min (1), mild (2), mod (3), or sev (4)
art = sectioning artifact; ranked as none (0), mild (1), mod (2), or sev (3)
sex = gonad; listed as male (M), female (F), unknown/undifferentiated (U), absent (A)
GLY = hepatic glycogen; ranked as min (1), mod (2), sev (3), or NE
YOLK = status of yolk stores; ranked as none (0), pale (1), or eosinophilic (3)
EA = epidermal atrophy; ranked as mild (1), mod (2), or sev (3)
MDN = myofiber degeneration and/or necrosis; ranked as EA
IHN = individual hepatocellular necrosis; ranked as EA, plus NE
VDIG = vacuolar degeneration of intestinal gland epithelial cells; ranked as IHN, plus:
NG (no good) - the GI tract is present, but cannot be evaluated for VDIG due to autolysis or "wrong part of GI tract"

Hinton #	Comments
25	(artifact?) vacuolar encephalopathy, retinopathy, and myopathy; moderate
26	(artifact?) vacuolar encephalopathy, retinopathy, and myopathy; moderate
27	(artifact?) vacuolar encephalopathy and myopathy; moderate
28	(artifact?) vacuolar encephalopathy and myopathy; moderate
29	(artifact?) vacuolar encephalopathy and myopathy; moderate
30	(artifact?) vacuolar encephalopathy and myopathy; moderate
33	proteinaceousblebsontips of intestinal villi, microvescicles in ventral epidermis, moderate
43	gill telangiectasia, mild
44	liver has a 200-um-diameter focuswith sections of 15 bile ductules.