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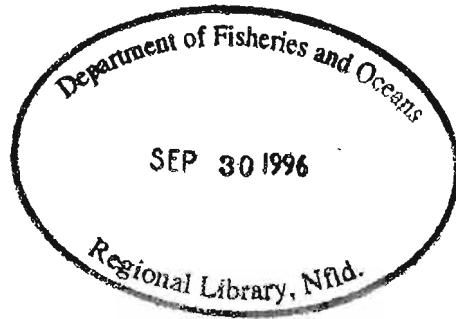
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Sublethal Toxicological Stress in Adult Sockeye Salmon (*Oncorhynchus nerka*) Exposed to a Combination of Resin Acid and Salt Water Hypoxia

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SUBLETHAL TOXICOLOGICAL STRESS IN ADULT SOCKEYE SALMON
(ONCORHYNCHUS NERKA) EXPOSED TO A COMBINATION OF RESIN ACID AND
SALT WATER HYPOXIA

by

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TABLE OF CONTENTS

ABSTRACT	iv
RÉSUMÉ	v
LIST OF TABLES	vi
LIST OF FIGURES	vii
INTRODUCTION	1
MATERIALS AND METHODS	2
FISH CAPTURE AND MAINTENANCE	2
HYPOXIC WATER	3
SWIM CHAMBERS	4
TEST CHEMICAL	4
EXPERIMENTAL PROTOCOL	5
SWIMMING PERFORMANCE TESTS	6
RESPIRATORY VARIABLES	6
ACKNOWLEDGEMENTS	7
REFERENCES	8
FIGURES & TABLES	10

ABSTRACT

Korstrom, J.S., R. Fink, S. Spohn and I.K. Birtwell. 1996. Sublethal toxicological stress in adult sockeye salmon (*Oncorhynchus nerka*) exposed to a combination of resin acid and salt water hypoxia. Can. Data Rep. Fish. Aquat. Sci. 985: 83 p.

This study examined the combined sublethal effects of hypoxic salt water and dehydroabietic acid, on adult sockeye salmon (*Oncorhynchus nerka*) from Alberni Inlet, British Columbia.

Changes in sustained swimming performance and respiratory frequency were used as indicators of sublethal effects. Assessment of swimming stamina consisted of exposing control and treatment groups of 4 fish (3 replicates) for 24 h to sublethal concentrations of dehydroabietic acid ($0.57 \text{ mg}\cdot\text{L}^{-1}$) in an annular swim chamber, under normoxic (90% air saturation) or hypoxic (30 - 40% air saturation) conditions, in salt water ($12\text{-}14^\circ\text{C}$, 26-28‰ salinity). Fish were then challenged to swim in 20.0°C fresh water, for 8 h against a water velocity of $42 \text{ cm}\cdot\text{s}^{-1}$ ($0.67 \text{ body lengths}\cdot\text{s}^{-1}$). These temperature, salinity, and dissolved oxygen conditions simulated those which may be encountered by adult sockeye salmon during their spawning migration through Alberni Inlet into the Somass River.

The ventilatory and cough frequency of the fish were also monitored in relation to normoxic and hypoxic conditions under two temperature regimes. Quantification of the respiration rate was determined to ascertain whether an increased energetic demand was placed on the fish due to the imposition of experimental conditions. Fish behavior (relative activity level) was documented during observation periods. Post - experimental survival of the fish was monitored in fresh water. Physical parameters such as length, weight, sex, age, and gonadal somatic index were recorded for each fish at the conclusion of the experiment.

Key words: adult sockeye salmon, swimming performance, respiratory frequency, hypoxic salt water, dehydroabietic acid

RÉSUMÉ

Korstrom, J.S., R. Fink, I.K. Birtwell and S. Spohn. 1996. Sublethal toxicological stress in adult sockeye salmon (*Oncorhynchus nerka*) exposed to a combination of resin acid and salt water hypoxia. Can. Data Rep. Fish. Aquat. Sci. 985: 83 p.

Dans cette étude, on a examiné les effets toxiques sublétaux de l'eau salée faiblement oxygénée et de l'acide déshydroabiétique chez le saumon rouge (*Oncorhynchus nerka*) adulte de l'inlet Alberni, en Colombie-Britannique.

Les changements de la performance en nage prolongée et de la fréquence respiratoire ont servi d'indicateurs des effets sublétaux. Pour l'évaluation de la vigueur de la nage, on a exposé pendant 24 h des groupes de 4 poissons témoins et de 4 poissons traités (3 groupes dans chaque cas) à des concentrations sublétale d'acide déshydroabiétique ($0,57 \text{ mg.L}^{-1}$) dans un bassin annulaire en conditions d'oxygenation normale (saturation en air de 90 %) ou faible (saturation en air de 30-40 %) en eau salée (12-14 °C ; salinité de 26-28 U). Les poissons ont ensuite été placés 8 h dans un bassin d'eau douce à 20,0 °C où ils devaient nager contre un courant de 42 cm.s^{-1} ($0,67 \text{ longueur des poissons.s}^{-1}$). Ces conditions de température, de salinité et d'oxygenation reproduisaient celles que peut retrouver le saumon rouge adulte durant la migration de la fraye, lorsqu'il passe dans l'inlet Alberni pour remonter la rivière Somass.

On a également observé la fréquence ventilatoire et la fréquence de la toux en conditions d'oxygenation normale et faible, à deux régimes de température, et l'on a quantifié la vitesse respiratoire afin de déterminer si les conditions expérimentales exigeaient des poissons une dépense énergétique accrue. On a surveillé le comportement (degré relatif d'activité) des poissons durant les périodes d'observation et noté la survie post-expérimentale en eau douce. À la fin de l'expérience, on a mesuré certains paramètres physiques chez chaque poisson : longueur, poids, sexe, âge et indices somatiques gonadiques.

Mots-clés: saumon rouge adulte, performance en nage, fréquence respiratoire, eau salée faiblement oxygénée, acide déshydroabiétique

LIST OF TABLES

Swim Chamber Water Quality

Table 1.	Swim chamber water quality conditions - Expt. #1.....	12
Table 2.	Swim chamber water quality conditions - Expt. #2.....	14
Table 3.	Swim chamber water quality conditions - Expt. #3.....	16
Table 4.	Swim chamber water quality conditions - Expt. #4.....	18
Table 5.	Swim chamber water quality conditions - Expt. #5.....	20
Table 6.	Swim chamber water quality conditions - Expt. #6.....	22
Table 7.	Summary of physical parameters of adult sockeye salmon 1995	37

Swim Tests

Table 8.	Summary of percentage time per activity in an 8 h swim test.....	41
Table 9.	Summary of swim test results Expt. #1 - Normoxic Control Group.....	42
Table 10.	Summary of swim test results Expt. #1 - Normoxic DHA Group.....	43
Table 11.	Summary of swim test results Expt. #2 - Hypoxic Control Group	44
Table 12.	Summary of swim test results Expt. #2 - Hypoxic DHA Group	45
Table 13.	Summary of swim test results Expt. #3 - Normoxic Control Group.....	46
Table 14.	Summary of swim test results Expt. #3 - Normoxic DHA Group.....	47
Table 15.	Summary of swim test results Expt. #4 - Hypoxic Control Group	48
Table 16.	Summary of swim test results Expt. #4 - Hypoxic DHA Group	49
Table 17.	Summary of swim test results Expt. #5 - Normoxic Control Group.....	50
Table 18.	Summary of swim test results Expt. #5 - Normoxic DHA Group.....	51
Table 19.	Summary of swim test results Expt. #6 - Hypoxic Control Group	52
Table 20.	Summary of swim test results Expt. #6 - Hypoxic DHA Group	53

Breathing Frequencies

Table 21.	Respirometry and activity levels of adult sockeye salmon Expt. #1	60
Table 22.	Respirometry and activity levels of adult sockeye salmon Expt. #2.....	64
Table 23.	Respirometry and activity levels of adult sockeye salmon Expt. #3.....	68
Table 24.	Respirometry and activity levels of adult sockeye salmon Expt. #4.....	72
Table 25.	Respirometry and activity levels of adult sockeye salmon Expt. #5.....	76
Table 26.	Respirometry and activity levels of adult sockeye salmon Expt. #6.....	80

LIST OF FIGURES

Figure 1. Alberni Inlet, British Columbia..... 10

Figure 2. Schematic diagram of swim chamber apparatus 11

Water Quality Conditions

Figure 3. Dissolved oxygen concentrations Expt. #1 24

Figure 4. Dissolved oxygen concentrations Expt. #2 25

Figure 5. Dissolved oxygen concentrations Expt. #3 26

Figure 6. Dissolved oxygen concentrations Expt. #4 27

Figure 7. Dissolved oxygen concentrations Expt. #5 28

Figure 8. Dissolved oxygen concentrations Expt. #6 29

Figure 9. Salinity and temperature conditions Expt. #1 30

Figure 10. Salinity and temperature conditions Expt. #2 31

Figure 11. Salinity and temperature conditions Expt. #3 32

Figure 12. Salinity and temperature conditions Expt. #4 33

Figure 13. Salinity and temperature conditions Expt. #5 34

Figure 14. Salinity and temperature conditions Expt. #6 35

Figure 15. Experimental protocol for 1995 sockeye salmon experiments 36

Figure 16. Post - experimental survival in fresh water 39

Figure 17. Sex differences in post experimental survival 40

Breathing Frequencies

Figure 18. Breathing frequency of adult sockeye in Expt. #1 54

Figure 19. Breathing frequency of adult sockeye in Expt. #2 55

Figure 20. Breathing frequency of adult sockeye in Expt. #3 56

Figure 21. Breathing frequency of adult sockeye in Expt. #4 57

Figure 22. Breathing frequency of adult sockeye in Expt. #5 58

Figure 23. Breathing frequency of adult sockeye in Expt. #6 59

INTRODUCTION

Persistent hypoxic conditions exist in the sub-halocline waters of the Somass River estuary at the head of 45 km long Alberni Inlet, British Columbia. These conditions are related to a naturally slow flushing rate and the biological oxygen demand of organic material in effluent from a pulp and paper mill at its' head. Over the last forty years the discharge of effluent into the freshwater lens of the highly stratified estuary, has contributed in a decline in the dissolved oxygen concentrations of these surface waters by an average of $1\text{mg}\cdot\text{L}^{-1}$ from pre-discharge conditions. Over the same period the corresponding decline in the deeper sub-halocline waters has been about $4\text{mg}\cdot\text{L}^{-1}$, a reduction of almost 60% (Stucchi et al. 1990, unpubl. data).

The ecological success of salmonids in estuarine environments with reduced water quality and industrial pollutants depends in part on their ability to sense variations in physico-chemical factors and to employ the appropriate compensatory mechanisms in a timely manner. If migrating salmon encounter suboptimal habitats, e.g., hypoxic waters, toxic effluents, and thermal layers, the accrued compensatory energetic costs may have consequences in terms of both survival and successful reproduction because of their reliance on finite energy reserves. Reduced reproductive potential is possible as a portion of the energy allocated for gamete production and spawning activities may be used during migration (Gilhousen 1980) resulting in the gradual decline of the fish population.

The progressive deterioration in the aquatic habitat of Alberni Inlet, and especially the concern about valuable salmon resources, prompted reviews by federal and provincial government agencies and the forest products industry. This report examines one aspect of a multi-disciplinary study which investigates the physiology and behavior of adult sockeye to simulated aquatic conditions in the laboratory. As there are few studies which investigate the effects of pulp mill effluent on adult sockeye salmon, the impetus of the present study was to examine the interaction of hypoxic waters and contaminants (such as resin acids), on the ability of sockeye salmon to migrate through warm (20.0°C) fresh water. Resin acids are commonly found in wood processing wastes and dehydroabietic acid is considered one of the most abundant and persistent (Oikari et al. 1983).

It was recognized that measured indicators of environmental stress may be categorized on different levels of biological integration which range from the biochemical level to the ecosystem level. Therefore, the objective of the present study was to investigate aspects of swimming performance and respiration in relation to conditions which adult sockeye salmon may confront during their migration to natal lakes. Ventilation frequency is a physiological variable and swimming stamina is considered a performance capacity variable (Heath 1990) and both responses segregate along gradients of toxicological and ecological relevance and response time (Adams 1990). In agreement, Walden (1976) reported that sublethal concentrations of pulp mill effluent affected fish respiration and fish stamina, which is an important sublethal parameter measured most frequently by swimming performance.

Respirometry has been used to assess toxicological stress and the energetic cost of breathing and oxygen uptake, as the difference between resting and active metabolism is easily quantifiable by counting opercular beats per minute (Schreck 1990). An increase in respiration rate is also considered to be the first or initial response to hypoxia and this elevation in gill ventilation is mediated through increases in ventilatory frequency and ventilatory stroke volume (Holeton and Randall 1967; Tetens and Lykkeboe 1985; Claireaux et al. 1988; Aota et al. 1990; Jensen et al. 1993) and reflects the ability of salmonids to compensate for decreased oxygen carrying capacity and oxygen affinity through adjustments of the respiratory system. In sustained long-term hypoxia, increases in ventilation, which require a considerable amount of energy (Marvin and Heath 1968), may lead to a serious depletion of the finite energy stores of the fish which are otherwise reserved for reproductive activities.

Performance tests are experiments in which the endpoint measures the capacity of fish to carry out essential life processes (Schreck 1990) such as swimming ability which is especially important to salmon on a spawning migration (Sprague 1971). If the fish is suffering from the consequences of toxicological stress, its performance could be impaired (Schreck 1990) and therefore, measurement of swimming ability is one of the "best" means of evaluating sublethal effects (Cairns 1966). One such performance capacity measure is a fixed velocity swim challenge which tests stamina by encouraging fish to swim against a current for a pre-determined length of time.

MATERIALS AND METHODS

FISH CAPTURE AND MAINTENANCE

Adult sockeye salmon (predominantly aged 5⁺ and 6⁺ years) were captured by the commercial seiner *Viking Spirit* in Alberni Inlet and individually transferred into and out of the ship's holds using a low abrasion dipnet. On June 20, 1995, 140 fish were caught near Chup Point (Figure 1) and transported via the seiner, within 20 h, to sea water holding facilities at the West Vancouver Laboratory. Sea water in the hold was exchanged continuously during transit by an onboard pump of 150 L·min⁻¹ capacity. At the laboratory, the fish were anaesthetized with 0.5 mg·L⁻¹ metomidate hydrochloride (Syndel Laboratories, Vancouver, BC) to reduce stress due to handling and thereby facilitate transfer into outdoor holding tanks. On July 11, 1995, 44 fish were caught near Pocohontas Point (Figure 1) and during transit were mildly anaesthetized with 0.25 mg·L⁻¹ metomidate hydrochloride in an approximately isosmotic mixture of fresh and sea water (2:1). Transport to the laboratory was accomplished using a truck fitted with an insulated fibreglass tank supplied with compressed oxygen and containing 500 g Ammomex, (Argent Chemical Laboratories, Redmond, WA) a natural clay that rapidly binds to, and eliminates, ammonia.

Fish (mean weight 2130 g ± 377 g; fork length 60.4 cm, ± 3.5 cm) were maintained outdoors in 3500 L tanks continuously supplied with air-equilibrated salt water (salinity

16 - 29 ‰, temperature 11.2 - 18.5 °C, and dissolved oxygen 7.5 - 10.3 mg·L⁻¹). Water flow was delivered to the tanks at approximately 46 L·min⁻¹ which ensured a 90% replacement within 3 h, and fish density was maintained at ≤ 2 kg·m⁻³ (Sprague 1969). The salmon were held under a natural photoperiod and were not fed throughout the 5 - 10 wk acclimation period prior to experiments.

The spawning season is a period of increased susceptibility to disease (Pickering and Christie 1980) and the stress induced from encountering oxygen depleted habitats during the spawning migration may predispose the animals to infection (Jensen et al. 1993). Accordingly, the antibiotic chloramine-T (N-sodium-N-chloro-para-toluenesulphonamide) was used for the therapeutic treatment of suspected salt water vibriosis (*Vibrio sp.*) as well as a prophylactic treatment against bacterial gill disease and associated fin rot (*Sporocytophaga sp.*). All experimental fish were exposed to chloramine-T (Syndel Laboratories, Vancouver, BC) in an aerated static bath of concentration 8.5 mg·L⁻¹ for 1 h followed by a second treatment 24 h later. Subsequently, the fish were allowed a recovery period of at least 4 wks: no mortality was observed in the 2 wks prior to starting experiments.

HYPOXIC WATER

The apparatus used to generate hypoxic sea water was a vacuum degasser (Point Four Systems, Coquitlam, BC). Degassing was accomplished by exposing incoming water to a partial vacuum within a 25 x 350 cm PVC column. The magnitude of the vacuum regulated the degree of degassing that occurred. The control of sea water level in the degasser column was maintained by a dynamic equilibrium. Sea water supplied through an input Griswold valve (38 L·min⁻¹) entered the top of, and was dispersed down, the packed degasser column (1" Koch flexi rings). Effluent water passed via a 3/4 HP Grundfos single stage impeller pump (Grundfos Pumps Corp., Clovis, CA) through the output Griswold valve (37 L·min⁻¹) to a 40L polyethylene header tank and from there was distributed to the two swim chambers. The difference in water flow between input and output valves was discharged to waste using a stainless steel bypass solenoid valve controlled by a float-activated switch located in the degasser column at the air - water interface.

Measurement and control of dissolved oxygen concentration in the effluent water from the degasser column was achieved through a feedback control loop using a temperature compensated galvanic cell oxygen probe with a multichannel oxygen monitoring unit (Oxyguard Model 1W; Point Four Systems Inc., Coquitlam, BC, accuracy ± 2.0% saturation). The oxygen controller, in combination with a solenoid valve located on the vacuum line to an aspirator, regulated the absolute pressure within the degasser column. An aspirator was used to evacuate accumulated gas from the column and maintain the desired vacuum. In performance tests conducted on the degasser, a 14.5% (1.9 mg·L⁻¹) dissolved oxygen saturation level in column effluent was maintained with a water input of 38 L·min⁻¹ (salinity 0 ‰, temperature 1 °C) and a column pressure of 50 mmHg absolute.

SWIM CHAMBERS

The test apparatus (Figure 2) consisted of two 1600 L annular fibreglass raceway tanks (outside length 343 cm, depth 41 cm, width 46 cm) each equipped with a variable output stainless steel trolling motor to provide a controlled flow. Clear plexiglass (10 mm thick) overlain with black polyethylene screens minimized external disturbances and algal growth. Within each straight section of a tank an enclosed (knotless nylon net; 1.5 cm mesh diameter) two-chambered PVC trough (length 122 cm, width 20 cm, depth 30 cm) was arranged to accomodate two fish in tandem. At the downstream end of each trough an electrified horizontal grid was charged during the swim test with a 0 - 9 V pulsed DC current at 0.5 A.

Light entered the chambers through aluminum cylinders (25cm diameter x 40cm deep) positioned at each end of the test troughs. Water was continuously delivered to the chambers at a rate of 10 L·min⁻¹ which corresponded to a 90% replacement time of approximately 6 h (Sprague 1969) (Tables 1 - 6). As per Bell and Terhune (1970) straightener vanes and contraction cones, located upstream of the test troughs, corrected rotational disturbances introduced by the propellers and smoothed the velocity profile within test sections. The correction calculation for flow interference effects such as solid blocking, was ignored, as only 10% of the test trough cross sectional area was occupied by the fish and therefore velocity increases would be minimal (Bell and Terhune 1970). Dissolved oxygen and temperature (Oxyguard PT4 Multichannel Oxygen and Temperature Monitoring System; Point Four Systems Inc. Coquitlam, BC) in the swim chambers was recorded continuously (Figures 3 - 14).

TEST CHEMICAL

A stock solution of dehydroabietic acid (DHA) of 99% purity (Helix Biotech Corp., Richmond, BC) was prepared weekly by dissolving 16.6 g of DHA in 2000 mL 100% ethanol, 130 mL 5 N NaOH and 2200 mL distilled water. This mixture was then diluted with distilled water to 26 L and kept in opaque glass carboys with a final concentration of 638 mg·L⁻¹ DHA. The final concentration of DHA in the swim chambers was 0.57 mg·L⁻¹ ± 0.23 mg·L⁻¹ which is similar to the value of a flow through freshwater 96 h LC₅₀ bioassay which exposed yearling sockeye salmon to dehydroabietic acid (Rogers et al. 1975). The resin acid solution was metered to the swim chamber using a positive displacement diaphragm pump (Model 4-MD; Little Giant Pump Co., Okla. City, Okla.) and the carrier solution (NaOH and ethanol) was metered to the control chamber using a gravity fed drip system. Although both systems were pre-calibrated prior to the initiation of exposure periods and adjusted as required, the gravity fed system was less accurate than the diaphragm pump and resulted in variable carrier solution delivery rates. Quality assurance was based on water samples collected to confirm concentrations at the end of exposure, and quality control was based on the submission of samples spiked with known concentrations of DHA. All samples were preserved and analyses for dehydroabietic acid (Resin Acids Method, Version 3.0,

1995 21p.) were performed by Environment Canada, Pacific Environmental Science Centre, North Vancouver B.C. A recovery of 86% DHA was obtained through these analyses and the results presented in this report have therefore been corrected.

EXPERIMENTAL PROTOCOL

From August 14, to September 22, 1995, 6 consecutive experiments were conducted on a weekly basis (Figure 15). This experimental period coincided with adult sockeye encountering hypoxic conditions in the sub-halocline waters of some coastal inlets of British Columbia during their spawning migration to natal lakes. Hypoxic or normoxic experimental conditions were alternated weekly during the toxicant exposure phase of each experiment, yielding 3 replicate experiments (12 fish total) per treatment protocol. Eight fish per experiment were anaesthetized with $100 \text{ mg}\cdot\text{L}^{-1}$ MS-222 (tricaine methanesulfonate; Argent Chemical Laboratories, Redmond, WA) and transferred to the swim chambers. Four fish per chamber were allowed to acclimate in seawater (temperature $11\text{-}13.5^\circ\text{C}$; salinity $20\text{-}28\text{‰}$) under continuous flow conditions ($17 \text{ cm}\cdot\text{s}^{-1}$) for a 24 h period.

Each trial consisted of a 24 h DHA exposure, while the control chamber was supplied with carrier solution, under alternately normoxic (90% oxygen saturation) or hypoxic (30 - 40% oxygen saturation) conditions. Subsequently the salt water was replaced by fresh water ($10 \text{ L}\cdot\text{min}^{-1}$) and the temperature was progressively increased over 6 h to 20.0°C . Promptly following an 18 h acclimation period under the new water quality conditions, fish were challenged with an 8 h fixed velocity swim test. Thereafter, the thermal regime in the chambers was progressively decreased over a 6 h period from 20.0°C to 12.0°C . Fish were allowed a 10 h recovery period followed by anaesthetization with $100 \text{ mg}\cdot\text{L}^{-1}$ MS222 to reduce handling stress during removal from the swim chambers. The fork length ($\pm 0.5 \text{ cm}$), and weight ($\pm 1 \text{ g}$), of all fish were recorded, scales were taken for age determination and the salmon were tagged at the base of the dorsal fin (Anchor Tag FD-68BC; Floy Tag and Manufacturing Inc., Seattle, WA) for future identification (Table 7).

The fish were then returned to the holding tanks and maintained in natural creek water (1.1°C - 15.1°C) to determine post-experimental survival time (Figure 16 - 17). The sex of mortalities was noted and the stage of maturation was determined by a comparison of ovarian or testicular weight to total body weight and expressed as gonadal somatic index. Experiments were terminated on December 20, 1995, at which point all surviving fish were sacrificed with a lethal dose of anaesthetic (MS-222).

SWIMMING PERFORMANCE TESTS

Fixed velocity swim tests have been developed as a quantitative technique to measure sustained swimming performance in salmonids. Ellis (1967) found that sockeye salmon while on spawning migration through a river where opposing river velocities had dropped to a mean of $42 \text{ cm}\cdot\text{sec}^{-1}$ changed their mode of swimming from nonsustained

steady swimming to sustained steady swimming. In addition, Brett (1965) reported that the optimum efficiency in terms of energy cost per km in relation to swimming speed for a 2.3 kg sockeye of 61cm total length during ocean migration was $50 \text{ cm}\cdot\text{s}^{-1}$. Therefore, in this study, the initial velocity prior to commencing the test was set at $17 \text{ cm}\cdot\text{s}^{-1}$, following which, the velocity was increased to $42 \text{ cm}\cdot\text{s}^{-1}$ ($0.67 \text{ body lengths}\cdot\text{s}^{-1}$) and maintained at this velocity for 8 h (Table 8). To encourage swimming an electrified horizontal grid was charged with a 6 - 9 V pulsed DC current at 0.5 A. During the swimming challenge the black polyethylene covers were removed from the swim chambers to permit unobstructed viewing. Routine observations were recorded at 10 min intervals to determine whether fish were swimming, resting, or in contact with the grid (Tables 9 - 20). Throughout observations special care was exercised to avoid casting shadows on or otherwise disturbing the fish.

RESPIRATORY VARIABLES

Observations of breathing frequency (measured as opercular openings $\cdot\text{min}^{-1}$) and cough frequency (number $\cdot\text{min}^{-1}$) of fish in the swim chambers was recorded daily throughout the acclimation and experimental periods at 07:30 h and again at 14:30 h (Figures 18 - 23). Determinations of these respiratory variables were conducted for each fish consecutively, through a series of five sequential 1 min periods, which were averaged for comparative purposes (Tables 21 - 26). In addition, the relative activity levels of each fish during the observation periods were recorded and related to a 4 point scale. Inactive fish were given a 1 point rating, and very active fish were given a 4 point rating. Fish exhibiting intermediate levels of activity, such as steady, slow swimming , or variable but "non frantic" searching behavior, were given ratings of 2 and 3 respectively.

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Figure 1. Alberni Inlet, British Columbia.

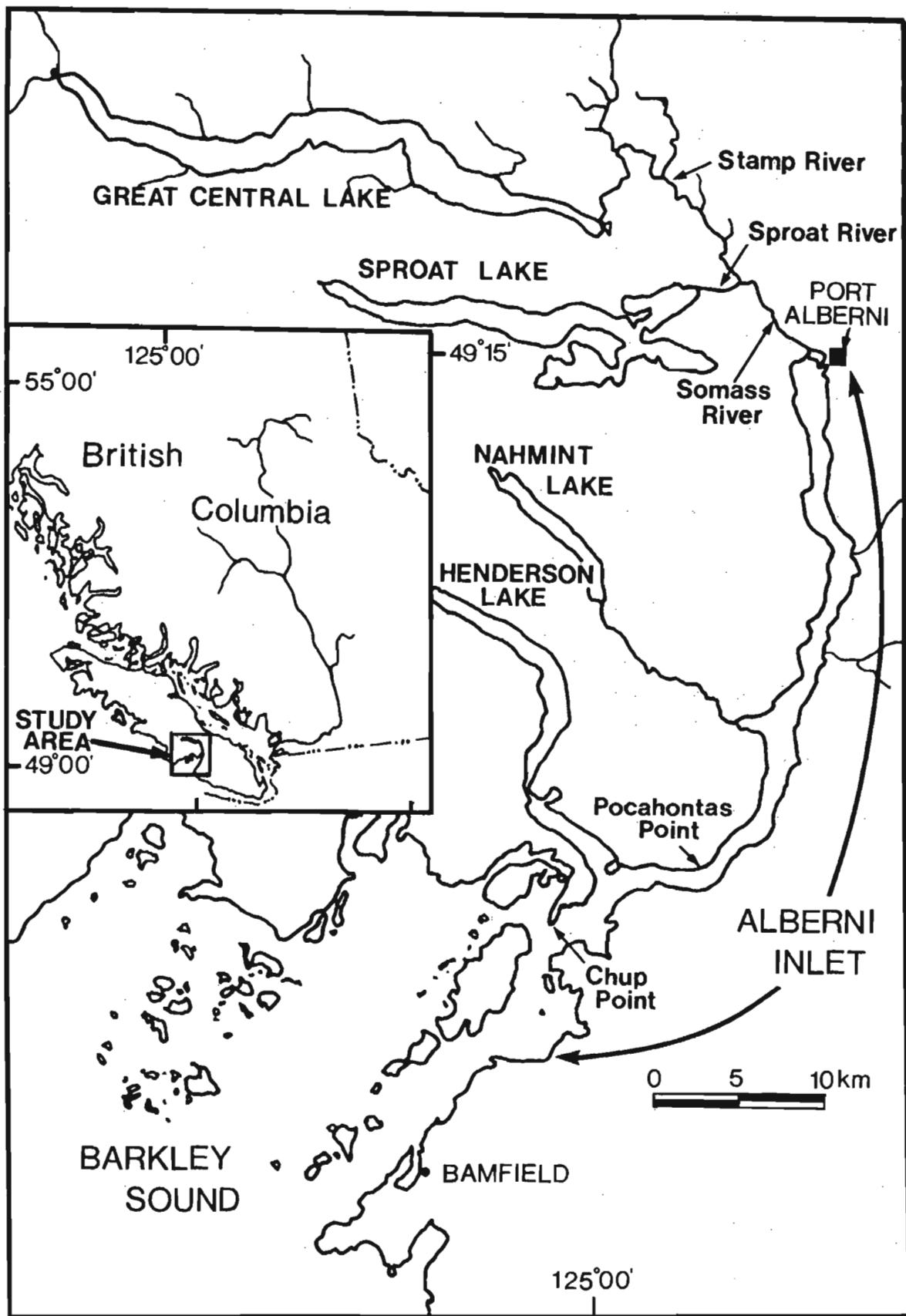
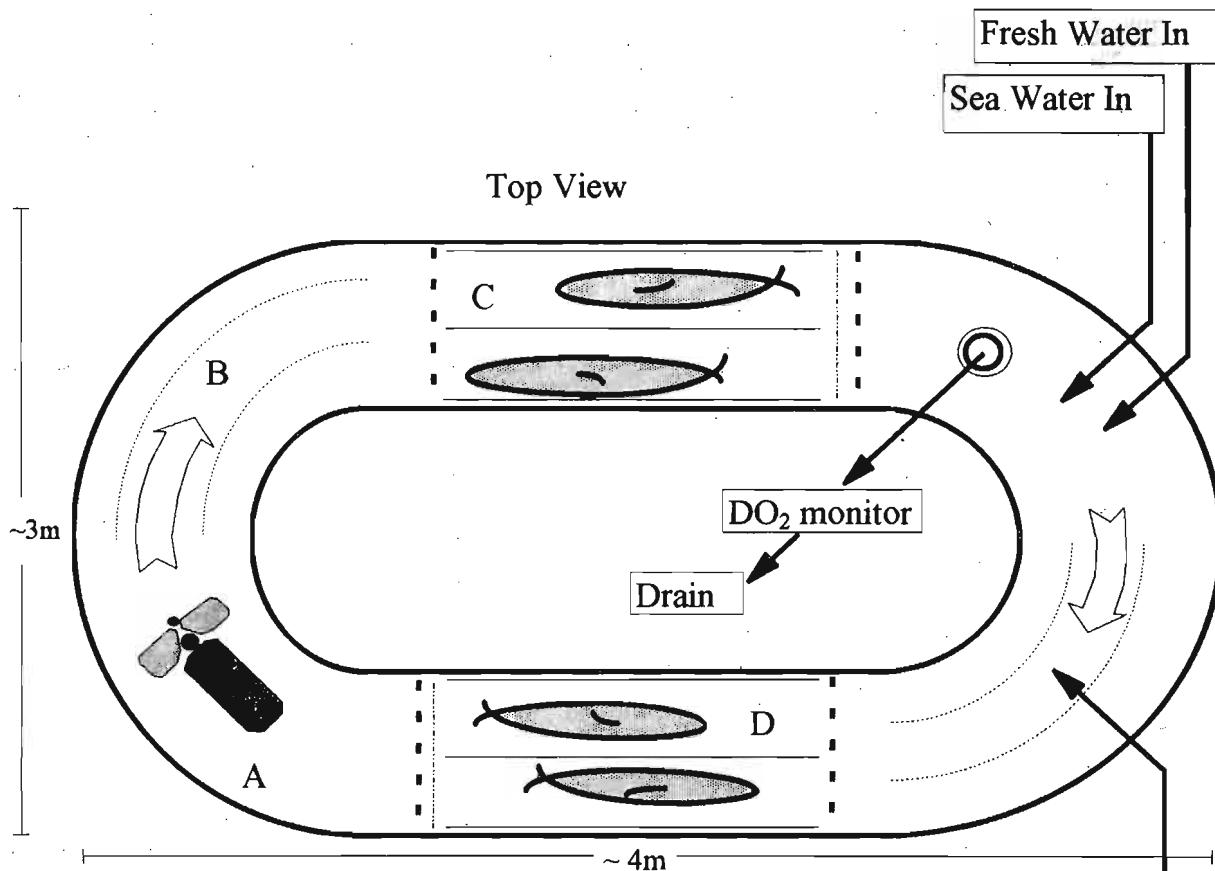


Figure 2. Schematic diagram of swim chamber apparatus



A - 24 Volt stainless motor

B - Flow control vanes

C - Fish trough

D - Fish trough

DHA/Carrier
Solution In

----- Fish retaining screen

----- 6-9 Volt electrified grid

Capacity

Flow rate 10 L / minute

Water velocity 0 - 50 cm / second

Water Quality

Sea Water	27-29 PPT	at	12 - 15 ° C
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Fresh Water	25 - 75 micro Siemens	at	10 - 20 ° C
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Dissolved Oxygen	25 - 100% Saturation	at	10 L / minute
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Table 1. Swim chamber water quality conditions - Expt. #1

Experiment 1: 14 - 18 Aug, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	10:45	0					
	11:00	1	83	97	28.0	11.3	Acclimation in seawater
	12:00	2	81	92		11.4	
	13:00	3	81	88		11.5	
	14:00	4	81	90		11.5	
	15:00	5	80	90		11.8	
	16:00	6	81	87		12.0	
	17:00	7	79	85		12.2	
	18:00	8	79	82		12.0	
	19:00	9	80	81		11.8	
	20:00	10	80	81		11.5	
	21:00	11	81	81		11.3	
	22:00	12	83	84		11.2	
	23:00	13	85	87		11.0	
	0:00	14	86	88		11.0	
	1:00	15	87	90		11.0	
	2:00	16	86	91		11.3	
	3:00	17	84	91		11.5	
	4:00	18	85	91		11.7	
	5:00	19	83	90		11.8	
	6:00	20	83	88		11.8	
	7:00	21	87	88		11.7	
2	8:00	22	91	90		11.6	08:30 - DHA /carrier drip started
	9:00	23	93	91		11.4	
	10:00	24	94	92		11.4	
	11:00	25	95	93		11.5	
	12:00	26	95	94		12.0	
	13:00	27	95	93		12.4	
	14:00	28	95	95		12.5	14:30 - 90% replacement time
	15:00	29	95	95		13.0	
	16:00	30	95	95	28.0	13.2	
	17:00	31	94	92		12.8	
	18:00	32	93	92		12.6	18:30 - 100% replacement
	19:00	33	92	90		12.3	
	20:00	34	92	92		11.8	
	21:00	35	90	92		11.3	
	22:00	36	90	92		11.0	
	23:00	37	92	93		10.8	
	0:00	38	93	93		10.6	
	1:00	39	94	93		10.5	
	2:00	40	94	93		10.6	
	3:00	41	93	93		10.8	
	4:00	42	94	93		11.0	
	5:00	43	91	92		11.2	
	6:00	44	92	92		11.3	
	7:00	45	93	92		11.4	
3	8:00	46	95	93	25.5	11.3	08:45 - DHA / carrier drips stopped
	9:00	47	96	94	24.0	11.7	
							08:45 - start conversion to 20° C FW

Table 1. (cont.)

Experiment 1: 14 - 18 Aug, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	10:00	48	98	97	18.0	14.2	
	11:00	49	96	95	12.0	16.2	
	12:00	50	92	91	7.5	17.3	
	13:00	51	89	88	5.5	18.0	
	14:00	52	89	87	4.0	18.5	14:45 - 90% replacement of SW with FW
	15:00	53	88	87	2.5	19.2	
	16:00	54	89	86	2.0	19.5	
	17:00	55	90	85	2.0	19.9	
	18:00	56	90	85	1.0	20.0	18:30 - 100 % replacement
	19:00	57	88	84	1.0	20.0	
	20:00	58	87	83	1.0	19.9	
	21:00	59	83	80	1.0	19.7	
	22:00	60	82	77	0.0	19.7	
	23:00	61	82	79		19.5	
	0:00	62	83	80		19.5	
	1:00	63	84	81		19.3	
	2:00	64	84	82		19.3	
	3:00	65	80	82		19.3	
	4:00	66	82	83		19.1	
	5:00	67	84	84		19.1	
	6:00	68	83	80		19.1	
	7:00	69	85	82		19.1	
	8:00	70	85	84		19.1	
4	9:00	71	86	84		19.2	09:20 - start swim test @ 40 cm/s
	10:00	72	81	80		19.4	
	11:00	73	80	81		19.5	
	12:00	74	82	80		19.9	
	13:00	75	82	83		20.5	
	14:00	76	83	85		20.9	
	15:00	77	83	86		21.0	
	16:00	78	84	84		21.3	
	17:00	79	86	85		21.2	17:30 - swim test stopped
	18:00	80	86	83		20.8	17:30 - start conversion to 12°C FW
	19:00	81	86	82		19.2	
	20:00	82	86	84		17.4	
	21:00	83	85	87		16.0	
	22:00	84	85	88		14.9	
	23:00	85	87	91		14.0	
	0:00	86	89	92		13.5	
	1:00	87	90	94		13.1	
	2:00	88	92	95		12.8	
	3:00	89	93	95		12.5	
	4:00	90	94	96		12.3	
	5:00	91	94	96		12.2	
	6:00	92	94	96		12.0	
	7:00	93	95	97		12.0	
	8:00	94	95	97		12.0	
	9:00	95	95	98		11.8	
	10:00	96	92	97		12.1	End Experiment - fish to holding tanks

Table 2. Swim chamber water quality conditions - Expt. #2

Experiment 2: 21 - 25 Aug, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	11:00	0	94	96	28.5	11.8	Acclimation in Seawater
	12:00	1	94	96		12.8	
	13:00	2	93	95		12.5	
	14:00	3	93	95		12.7	
	15:00	4	92	91		12.7	
	16:00	5	91	87		12.7	
	17:00	6	87	85		13.0	
	18:00	7	88	84		12.8	
	19:00	8	90	84		12.6	
	20:00	9	91	84		12.5	
	21:00	10	90	84		12.1	
	22:00	11	87	83		12.0	
	23:00	12	87	83		11.8	
	0:00	13	86	82		11.8	
	1:00	14	86	82	30.0	11.6	
	2:00	15	83	83		11.5	
	3:00	16	82	84		11.5	
	4:00	17	80	86		11.5	
	5:00	18	79	88		11.5	
	6:00	19	79	90		11.5	07:30 - clean oxygen probes
	7:00	20	78	90		11.4	07:30 - chamber #1 increased 4%
	8:00	21	86	92		11.5	
2	9:00	22	83	92	11.7	08:50 - DHA / carrier drip started	
	10:00	23	69	71		12.2	08:50 - hypoxia started
	11:00	24	57	57		12.7	
	12:00	25	51	52		13.2	
	13:00	26	45	48		13.4	
	14:00	27	41	43		13.5	
	15:00	28	39	39		13.5	14:50 - 90% replacement time
	16:00	29	38	37		13.4	
	17:00	30	36	40		13.3	
	18:00	31	35	41		13.1	
	19:00	32	34	42		12.9	18:50 - 100% replacement time
	20:00	33	33	41		12.6	
	21:00	34	32	40		12.4	
	22:00	35	30	40		12.2	
	23:00	36	30	40		12.0	
	0:00	37	30	41		11.8	
	1:00	38	30	41		11.7	
	2:00	39	30	42		11.7	
	3:00	40	30	42		11.5	
	4:00	41	30	41		11.5	
	5:00	42	30	42		11.3	
	6:00	43	30	41		11.2	
	7:00	44	30	41		11.2	08:50 - hypoxia stopped
	8:00	45	35	42	29.0	11.2	08:50 - DHA / carrier drip stopped
	9:00	46	43	46		11.3	08:50 - start conversion to 20 °C FW
	10:00	47	63	69		14.1	
3	11:00	48	72	80	13.5	16.5	

Table 2. (cont.)

Experiment 2: 21 - 25 Aug, 1995

Day	Time	Hour	Dissolved Oxygen*		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	12:00	49	78	81	9.0	17.9	
	13:00	50	78	80	7.0	19.0	
	16:00	53	76	81	2.5	20.0	
	17:00	54	77	81	2.0	20.3	
	18:00	55	77	82	2.0	20.8	
	19:00	56	76	82	1.0	20.8	18:50 - 100% replacement time
	20:00	57	74	78	1.0	20.7	
	21:00	58	69	73	1.0	20.6	
	22:00	59	67	75	1.0	20.6	
	23:00	60	66	78	1.0	20.6	
	0:00	61	67	80	0.0	20.5	
	1:00	62	67	81		20.5	
	2:00	63	66	82		20.3	
	3:00	64	67	83		20.2	
	4:00	65	69	85		20.0	
	5:00	66	72	84		20.0	
	6:00	67	72	82		19.8	
	7:00	68	72	78		19.7	
	8:00	69	73	77		19.3	
4	9:00	70	75	80		19.4	08:55 - start swim test @ 40 cm/s
	10:00	71	73	90		19.2	
	11:00	72	73	92		19.5	
	12:00	73	77	90		19.6	
	13:00	74	78	86		19.9	
	14:00	75	79	83		19.9	
	15:00	76	80	79		19.9	
	16:00	77	80	76		20.0	
	17:00	78	80	76		20.0	
	18:00	79	76	80		19.6	17:55 - swim test stopped
	19:00	80	75	75		18.4	17:55 - start conversion to 12 °C
	20:00	81	76	75		17.1	
	21:00	82	77	74		16.1	
	22:00	83	81	76		15.1	
	23:00	84	84	78		14.3	
	0:00	85	88	81		13.8	
	1:00	86	90	84		13.3	
	2:00	87	92	86		13.0	
	3:00	88	93	89		12.6	
	4:00	89	93	91		12.4	
	5:00	90	94	93		12.1	
	6:00	91	93	94		12.0	
	7:00	92	93	94		11.8	
	8:00	93	93	96		11.6	
	9:00	94	95	99		12.0	
	10:00	95	94	100		12.3	End experiment - fish to holding tanks

Table 3. Swim chamber water quality conditions - Expt. #3

Experiment 3: 28 Aug - 01 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	11:00	0	85	93	28.0	11.5	Acclimation in seawater
	12:00	1	83	88		12.0	
	13:00	2	79	83		12.5	
	14:00	3	78	82	28.0	13.0	
	15:00	4	77	80		13.3	
	16:00	5	77	77		13.4	
	17:00	6	76	75	27.0	13.3	
	18:00	7	79	75		12.8	
	19:00	8	81	77		12.5	
	20:00	9	82	78		12.1	
	21:00	10	80	78		11.8	
	22:00	11	80	79		11.7	
	23:00	12	83	81		11.5	
	0:00	13	85	84		11.5	
	1:00	14	86	85		11.5	
	2:00	15	85	84		11.7	
	3:00	16	85	85		12.0	
	4:00	17	86	86		12.2	
	5:00	18	86	85		12.1	
	6:00	19	84	86		11.8	
	7:00	20	85	87		11.6	
2	8:00	21	88	89	28.0	11.5	08:50 - start DHA / carrier drip
	9:00	22	91	90	27.0	11.4	
	10:00	23	90	90		11.5	
	11:00	24	90	90		11.4	
	12:00	25	90	89		11.5	
	13:00	26	90	88	28.0	11.6	
	14:00	27	89	90		11.9	
	15:00	28	88	91	28.0	12.5	14:50 - 90% replacement time
	16:00	29	88	91		13.0	
	17:00	30	87	90		13.3	
	18:00	31	85	91		13.3	
	19:00	32	85	90		13.1	19:50 - 100% replacement time
	20:00	33	85	90		12.8	
	21:00	34	84	89		12.5	
	22:00	35	85	88		12.3	
	23:00	36	85	89		12.0	
	0:00	37	85	90		11.9	
	1:00	38	86	90		11.8	
	2:00	39	86	91		11.7	
	3:00	40	85	90		11.8	
	4:00	41	85	90		11.8	
	5:00	42	85	89		11.9	
	6:00	43	85	88		11.8	
	7:00	44	84	88		11.6	
3	8:00	45	85	89	28.5	11.5	08:50 - DHA / carrier drip stopped
	9:00	46	89	91		11.7	08:50 - start conversion to 20 °C FW
	10:00	47	91	92	19.0	14.5	
	11:00	48	91	89	16.0	16.0	

Table 3. (cont.)

Experiment 3: 28 Aug - 01 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	12:00	49	90	85	10.0	17.3	
	13:00	50	89	82	7.0	18.0	
	16:00	53	85	83	3.0	19.3	
	17:00	54	83	81	2.0	19.5	
	18:00	55	82	81	1.5	19.5	
	19:00	56	80	81	1.0	19.4	18:50 - 100% replacement time
	20:00	57	80	80	1.0	19.4	
	21:00	58	75	76	0.5	19.2	
	22:00	59	74	76	0.0	19.0	
	23:00	60	75	78		19.0	
	0:00	61	74	79		19.0	
	1:00	62	73	79		19.0	
	2:00	63	75	81		19.0	
	3:00	64	77	82		19.0	
	4:00	65	78	80		19.0	
	5:00	66	79	80		19.0	
	6:00	67	78	77		18.8	
	7:00	68	80	78		18.7	
	8:00	69	82	80		18.7	
4	9:00	70	83	82		18.8	09:00 - start swim test @ 40 cm/s
	10:00	71	75	81		19.0	
	11:00	72	73	80		19.3	
	12:00	73	73	81		19.5	
	13:00	74	73	81		19.7	
	14:00	75	73	81		19.7	
	15:00	76	73	82		20.0	
	16:00	77	74	82		20.2	17:00 - swim test stopped
	17:00	78	74	82		20.4	17:00 - start conversion to 12 °C
	18:00	79	73	80		20.0	17:20 - clean oxygen probes
	19:00	80	73	78		18.7	17:20 - chamber #2 increased 4%
	20:00	81	71	78		17.5	
	21:00	82	70	79		16.3	
	22:00	83	71	82		15.5	
	23:00	84	73	84		14.7	
	0:00	85	75	86		14.2	
	1:00	86	77	89		13.6	
	2:00	87	79	89		13.3	
	3:00	88	81	86		13.1	
	4:00	89	82	85		12.8	
	5:00	90	83	87		12.6	
	6:00	91	83	87		12.5	
	7:00	92	83	87		12.4	
	8:00	93	85	89		12.3	
	9:00	94	88	91		12.3	End Experiment - fish to holding tanks

Table 4. Swim chamber water quality conditions - Expt. #4

Experiment 4: 05 - 09 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	11:00	0	86	91	27.0	12.5	Acclimation in seawater
	12:00	1	85	90		12.6	
	13:00	2	84	88		12.8	
	14:00	3	85	86	30.0	12.8	
	15:00	4	86	86		12.5	
	16:00	5	86	86	28.0	12.5	
	17:00	6	87	86		12.3	
	18:00	7	88	86		12.0	
	19:00	8	89	86		12.0	
	20:00	9	89	86		12.0	
	21:00	10	84	86		12.0	
	22:00	11	81	82		12.0	
	23:00	12	81	79		12.0	
	0:00	13	85	78		12.0	
	1:00	14	86	77		12.0	
	2:00	15	86	76		11.8	
	3:00	16	86	75		11.5	
	4:00	17	89	77		11.3	
	5:00	18	88	77		11.0	
	6:00	19	88	78		11.2	
	7:00	20	89	76		11.3	07:35 - clean oxygen probes
2	8:00	21	91	81	28.0	11.4	07:35 - chamber #2 increased 4%
	9:00	22	86	82		11.5	08:55 - start DHA / carrier drips
	10:00	23	71	67	28.0	12.3	08:55 - start hypoxia
	11:00	24	61	57		12.6	
	12:00	25	54	47		13.0	
	13:00	26	54	46		13.1	
	14:00	27	56	47		13.2	
	15:00	28	53	46	28.0	13.3	14:55 - 90 % replacement time
	16:00	29	52	44		13.0	
	17:00	30	52	43		12.8	
	18:00	31	51	42		12.6	
	19:00	32	51	42		12.5	18:55 - 100 % replacement time
	20:00	33	51	41		12.5	
	21:00	34	50	40		12.5	
	22:00	35	50	38		12.4	
	23:00	36	50	38		12.2	
	0:00	37	50	38		12.3	
	1:00	38	50	38		12.2	
	2:00	39	50	37		12.0	
	3:00	40	50	37		12.0	
	4:00	41	50	38		11.7	
	5:00	42	50	38		11.5	
	6:00	43	50	37		11.4	
	7:00	44	50	37		11.5	
	8:00	45	50	38		11.5	09:00 - hypoxia stopped
3	9:00	46	52	40	27.5	11.9	09:00 - DHA / carrier drip stopped
	10:00	47	73	61	18.0	14.0	09:00 - start conversion to 20 °C FW
	11:00	48	81	72	13.0	15.8	

Table 4. (cont.)

Experiment 4: 05 - 09 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	12:00	49	85	76	13.0	17.2	
	13:00	50	86	75	9.0	18.0	
	16:00	53	83	72	3.0	19.0	
	17:00	54	84	69	3.0	20.0	
	18:00	55	84	69	1.5	20.0	
	19:00	56	85	67	0.5	20.1	19:00 - 100% replacement time
	20:00	57	85	68	0.0	20.1	
	21:00	58	83	69		20.0	
	22:00	59	84	70		20.1	
	23:00	60	84	72		20.1	
	0:00	61	85	75		20.0	
	1:00	62	84	78		20.1	
	2:00	63	85	80		20.1	
	3:00	64	85	80		20.2	
	4:00	65	85	79		20.2	
	5:00	66	83	81		20.2	
	6:00	67	86	82		20.1	
	7:00	68	80	78		20.0	
	8:00	69	83	77		20.0	
	9:00	70	85	77		20.0	09:05 - start swim test @ 40 cm/s
	10:00	71	82	78		20.2	
	11:00	72	80	77		20.4	
	12:00	73	83	77		20.7	
	13:00	74	82	79		21.0	
	14:00	75	83	76		21.0	
	15:00	76	81	77		21.0	
	16:00	77	82	77		21.2	17:05 - swim test stopped
	17:00	78	82	75		21.1	17:05 - start conversion to 12 °C
	18:00	79	82	70		20.4	
	19:00	80	82	70		19.0	
	20:00	81	82	70		17.7	
	21:00	82	80	70		16.6	
	22:00	83	81	72		15.8	
	23:00	84	82	74		15.2	
	0:00	85	82	76		14.6	
	1:00	86	83	76		14.4	
	2:00	87	84	76		14.0	
	3:00	88	84	76		13.8	
	4:00	89	85	76		13.6	
	5:00	90	86	77		13.5	
	6:00	91	87	77		13.5	
	7:00	92	88	77		13.3	
	8:00	93	89	78		13.3	08:50 - clean oxygen probes
	9:00	94	93	87		13.4	08:50 - chamber #2 increased 7%
	10:00	95	93	88		13.4	End Experiment - fish to holding tanks

Table 5. Swim chamber water quality conditions - Expt. #5

Experiment 5: 11 - 15 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	11:00	0	81	75	30.0	11.0	Acclimation in seawater
	12:00	1	76	72		11.6	
	13:00	2	74	70		12.0	
	14:00	3	76	70		12.5	
	15:00	4	77	69		12.8	
	16:00	5	79	68		13.2	
	17:00	6	78	67		13.0	
	18:00	7	77	66		12.6	
	19:00	8	77	67		12.2	
	20:00	9	79	67		11.8	
	21:00	10	78	67		11.5	
	22:00	11	78	66		11.2	
	23:00	12	80	68		11.0	
	0:00	13	81	68		11.0	
	1:00	14	81	70		11.2	
	2:00	15	80	70		11.5	
	3:00	16	77	70		11.6	
	4:00	17	77	71		11.6	
	5:00	18	79	71		11.6	
	6:00	19	80	71		11.5	07:35 - clean oxygen probes
	7:00	20	78	68		11.7	07:35 - chamber #1 increased 6%
	8:00	21	86	89	27.0	11.0	07:35 - chamber #2 increased 18%
	9:00	22	88	90		11.0	08:45 - start DHA / carrier drips
	10:00	23	88	90		11.0	
	11:00	24	88	89		11.0	
	12:00	25	89	89		11.2	
	13:00	26	88	88		11.5	
	14:00	27	89	88		12.2	
	15:00	28	87	87		12.8	14:45 - 90% replacement time
	16:00	29	87	86		13.0	
	17:00	30	86	86		13.2	
	18:00	31	86	85		12.9	
	19:00	32	87	85		12.5	18:45 - 100% replacement time
	20:00	33	87	85		12.0	
	21:00	34	86	85		11.7	
	22:00	35	86	85		11.5	
	23:00	36	87	84		11.2	
	0:00	37	88	84		11.2	
	1:00	38	88	85		11.0	
	2:00	39	87	85		11.1	
	3:00	40	87	84		11.5	
	4:00	41	86	83		11.8	
	5:00	42	86	83		11.9	
	6:00	43	85	83		12.0	
	7:00	44	84	82		11.6	
	8:00	45	85	84	28.0	11.5	08:55 - DHA / carrier drips stopped
	9:00	46	86	85		11.3	08:55 - start conversion to 20 °C FW
	10:00	47	88	85		14.3	
	11:00	48	83	82		16.5	

Table 5. (cont.)

Experiment 5: 11 - 15 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	12:00	49	77	78	8.5	17.8	
	13:00	50	73	71	6.0	19.0	
	16:00	53	73	69	1.0	20.2	
	17:00	54	75	69	1.0	20.4	
	18:00	55	74	71	1.0	20.4	
	19:00	56	77	75	0.0	20.4	18:55 - 100% replacement time
	20:00	57	77	73		20.4	
	21:00	58	76	72		20.3	
	22:00	59	76	74		20.1	
	23:00	60	78	75		20.0	
	0:00	61	80	78		20.0	
	1:00	62	82	79		20.0	
	2:00	63	84	80		20.0	
	3:00	64	84	81		20.0	
	4:00	65	85	81		20.0	
	5:00	66	86	82		20.0	
	6:00	67	85	82		20.0	
	7:00	68	81	76		19.7	
	8:00	69	80	75		19.9	
	9:00	70	77	77		19.9	08:45 - start swim test @ 40 cm/s
	10:00	71	72	81		19.9	
	11:00	72	70	79		20.0	
	12:00	73	71	79		20.4	
	13:00	74	73	76		20.6	13:45 - clean oxygen probes
	14:00	75	79	82		20.8	13:45 - chamber #1 increased 3%
	15:00	76	79	79		21.0	13:45 - chamber #2 increased 6%
	16:00	77	79	77		21.0	
	17:00	78	80	77		20.8	16:45 - swim test stopped
	18:00	79	81	75		19.8	16:45 - start conversion to 12 °C
	19:00	80	83	74		18.6	
	20:00	81	83	74		17.6	
	21:00	82	86	73		16.7	
	22:00	83	88	73		16.2	
	23:00	84	89	75		15.6	
	0:00	85	90	77		15.4	
	1:00	86	91	77		15.0	
	2:00	87	91	80		14.8	
	3:00	88	92	82		14.6	
	4:00	89	92	83		14.5	
	5:00	90	92	84		14.4	
	6:00	91	91	85		14.3	
	7:00	92	90	86		14.2	
	8:00	93	91	89		14.2	
	9:00	94	92	89		14.0	
	10:00	95	92	89		14.0	End Experiment - fish to holding tank

Table 6. Swim chamber water quality conditions - Expt. #6

Experiment 6: 18 - 22 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
1	11:00	0	82	82	27.0	12.1	Acclimation to sea water
	12:00	1	77	80		12.1	
	13:00	2	72	76		12.1	
	14:00	3	73	73	27.0	12.1	
	15:00	4	70	72		12.1	
	16:00	5	70	72		12.0	
	17:00	6	69	74		12.0	
	18:00	7	71	76		11.8	
	19:00	8	71	78		11.5	
	20:00	9	72	80		11.4	
	21:00	10	74	79		11.3	
	22:00	11	76	78		11.1	
	23:00	12	78	79		11.0	
	0:00	13	79	80		11.0	
	1:00	14	80	81		11.0	
	2:00	15	77	83		11.0	
	3:00	16	78	83		11.0	
	4:00	17	81	85		10.9	
	5:00	18	85	86		10.9	
	6:00	19	86	88		10.9	
	7:00	20	86	86	28.0	10.9	
	8:00	21	85	83		11.1	
	9:00	22	83	85		11.6	09:00 - start DHA / carrier drips
	10:00	23	59	64		12.2	09:00 - start hypoxia
	11:00	24	44	50		12.5	
	12:00	25	39	44		12.6	
	13:00	26	37	39		12.4	
	14:00	27	38	37		12.3	
	15:00	28	40	36		12.2	15:00 - 90% replacement time
	16:00	29	41	35		12.2	
	17:00	30	41	34		12.1	
	18:00	31	40	32		12.0	
	19:00	32	39	31		11.8	19:00 - 100% replacement time
	20:00	33	39	31		11.5	
	21:00	34	40	30		11.5	
	22:00	35	40	29		11.5	
	23:00	36	41	30		11.5	
	0:00	37	41	31		11.5	
	1:00	38	41	31		11.3	
	2:00	39	41	31		11.2	
	3:00	40	42	31		11.0	
	4:00	41	42	31		11.0	
	5:00	42	42	31		11.0	
	6:00	43	42	31		10.9	
	7:00	44	39	29		10.9	
	8:00	45	39	30		10.8	09:00 - stop hypoxia
	9:00	46	39	30	28.0	11.5	09:00 - DHA / carrier drips stopped
	10:00	47	64	51	20.0	14.0	09:00 - start conversion to 20 °C FW
	11:00	48	72	61	14.0	16.4	

Table 6. (cont.)

Experiment 6: 18 - 22 Sept, 1995

Day	Time	Hour	Dissolved Oxygen		Salinity (ppt)	Temperature (°C)	Conditions
			Chamber 1	Chamber 2			
	12:00	49	70	64	10.0	18.0	
	13:00	50	69	66	6.0	19.0	
	16:00	53	65	66	1.0	20.5	
	17:00	54	67	68	1.0	20.7	
	18:00	55	71	71	0.0	20.8	
	19:00	56	75	72		20.8	19:00 - 100% replacement time
	20:00	57	74	70		20.6	
	21:00	58	76	73		20.5	
	22:00	59	79	75		20.5	
	23:00	60	80	76		20.5	
	0:00	61	83	76		20.3	
	1:00	62	84	76		20.2	
	2:00	63	86	75		20.2	
	3:00	64	88	76		20.0	
	4:00	65	88	78		20.0	
	5:00	66	87	79		20.2	
	6:00	67	87	81		20.2	
	7:00	68	79	78		20.2	
	8:00	69	78	79		20.1	
	9:00	70	75	78		20.1	09:05 - start swim test @ 40 cm/s
	10:00	71	78	71		20.2	
	11:00	72	76	70		20.4	
	12:00	73	73	69		20.8	
	13:00	74	74	69		21.2	
	14:00	75	79	70		21.2	
	15:00	76	79	71		21.1	
	16:00	77	83	70		21.0	
	17:00	78	84	69		20.9	17:05 - swim test stopped
	18:00	79	84	77		20.5	17:05 - clean oxygen probes
	19:00	80	80	76		19.3	17:05 - chamber #2 increased 10%
	20:00	81	79	78		17.8	
	21:00	82	81	80		16.5	
	22:00	83	84	81		15.5	
	23:00	84	88	83		14.6	
	0:00	85	90	85		14.0	
	1:00	86	91	86		13.5	
	2:00	87	92	86		13.3	
	3:00	88	93	86		13.0	
	4:00	89	94	87		12.8	
	5:00	90	94	87		12.5	
	6:00	91	95	88		12.5	
	7:00	92	93	87		12.2	
	8:00	93	91	89		12.5	
	9:00	94	92	89		12.4	
	10:00	95	93	89		12.4	End Experiment - fish to holding tank

Figure 3. Dissolved oxygen concentrations Expt. #1

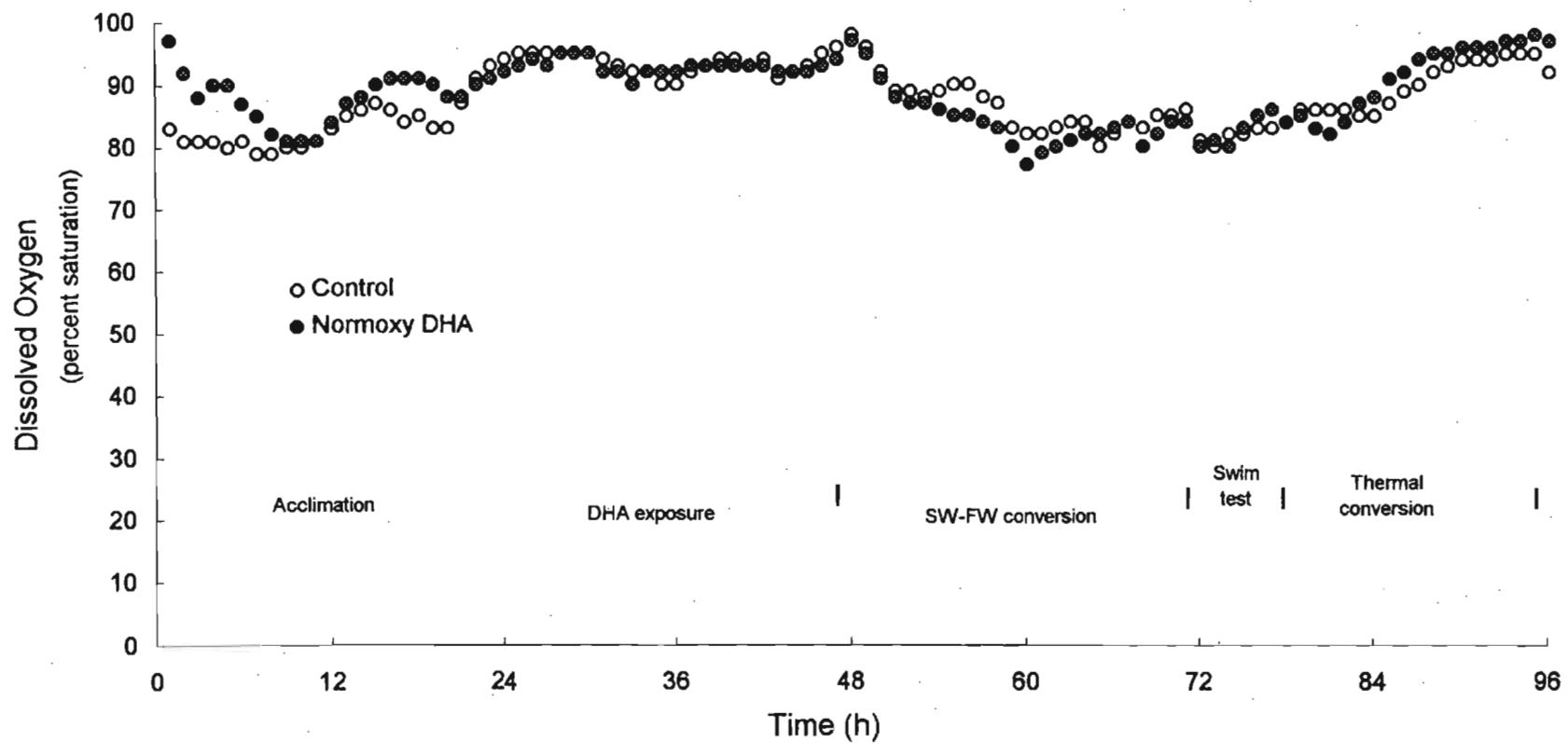


Figure 4. Dissolved oxygen concentrations Expt. #2

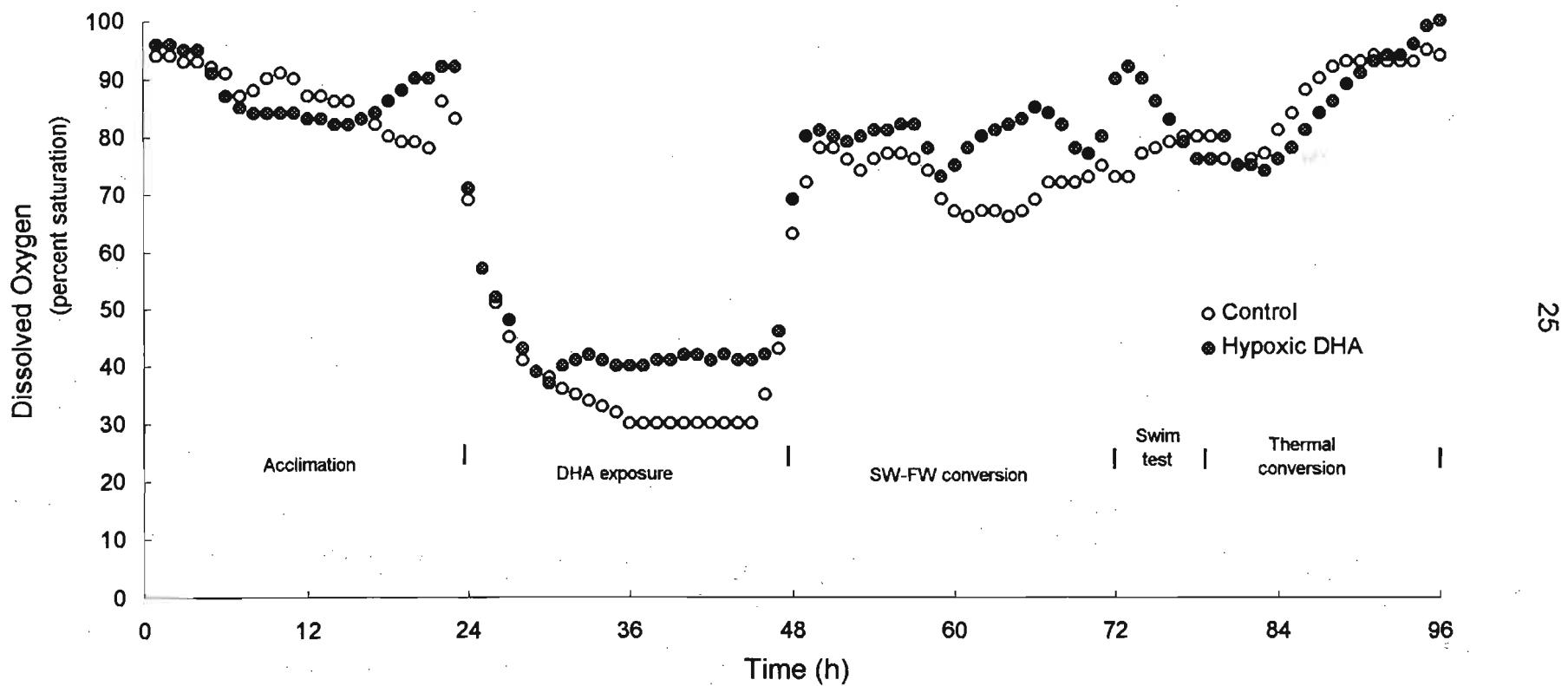


Figure 5. Dissolved oxygen concentrations Expt. #3

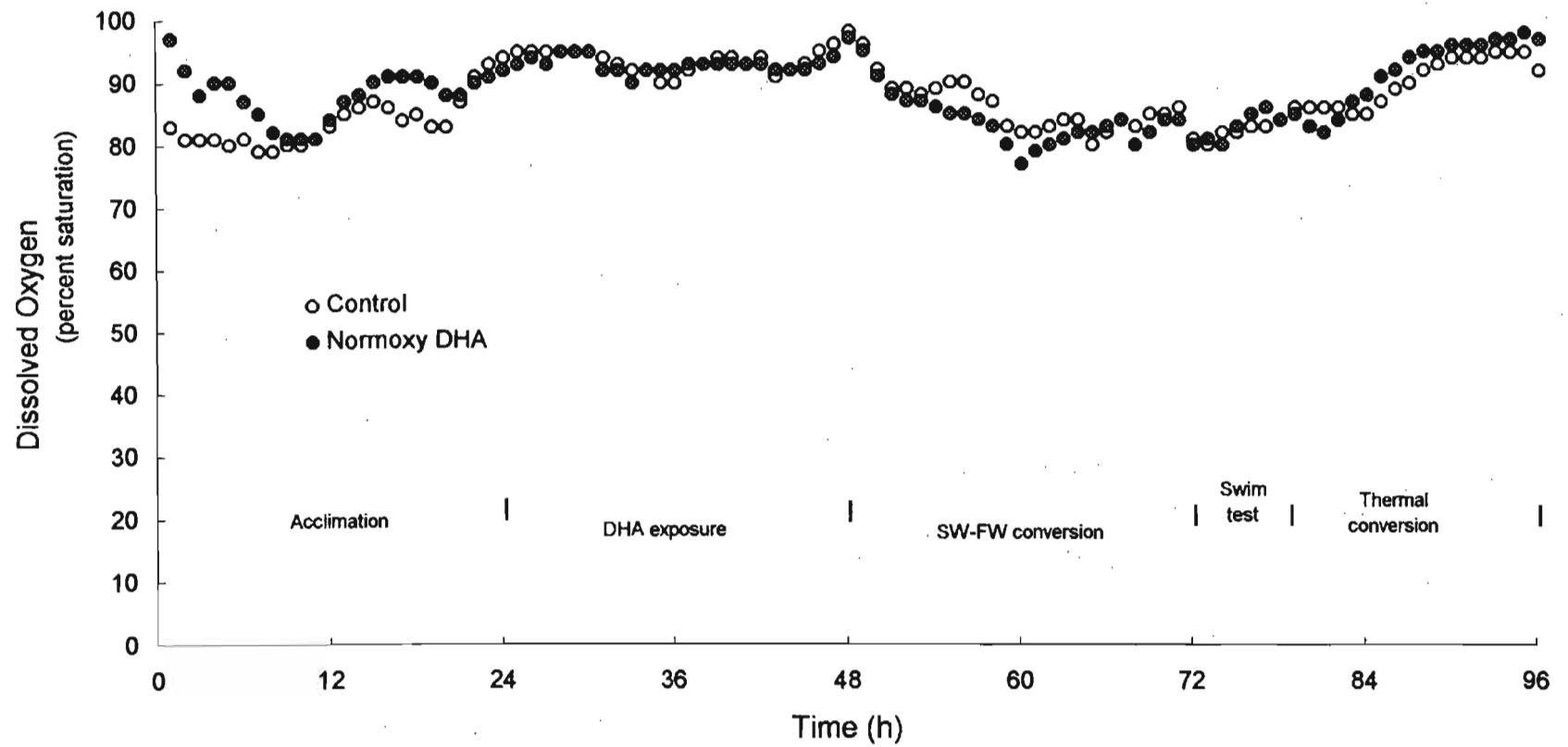


Figure 6. Dissolved oxygen concentrations Expt. #4

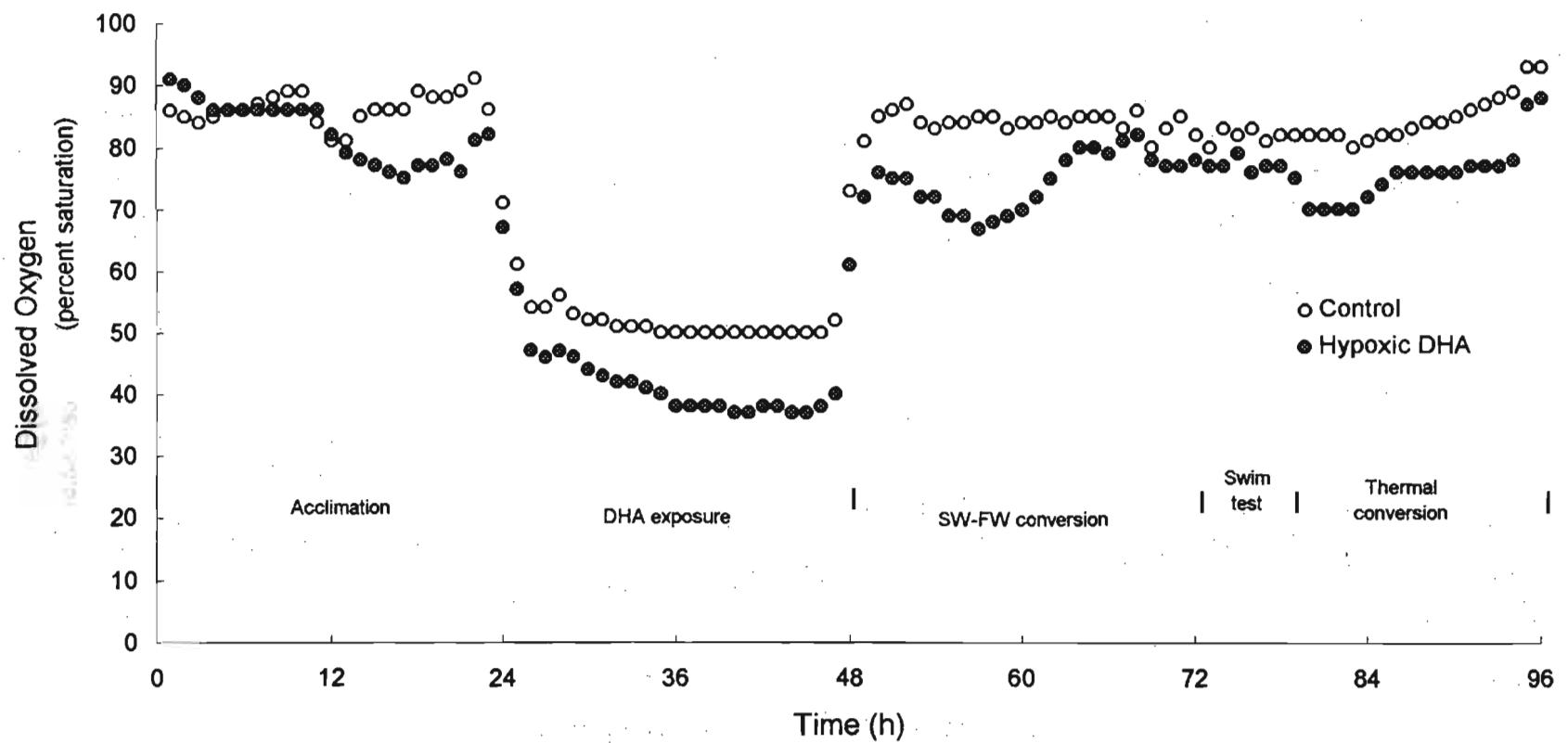


Figure 7. Dissolved oxygen concentrations Expt. #5

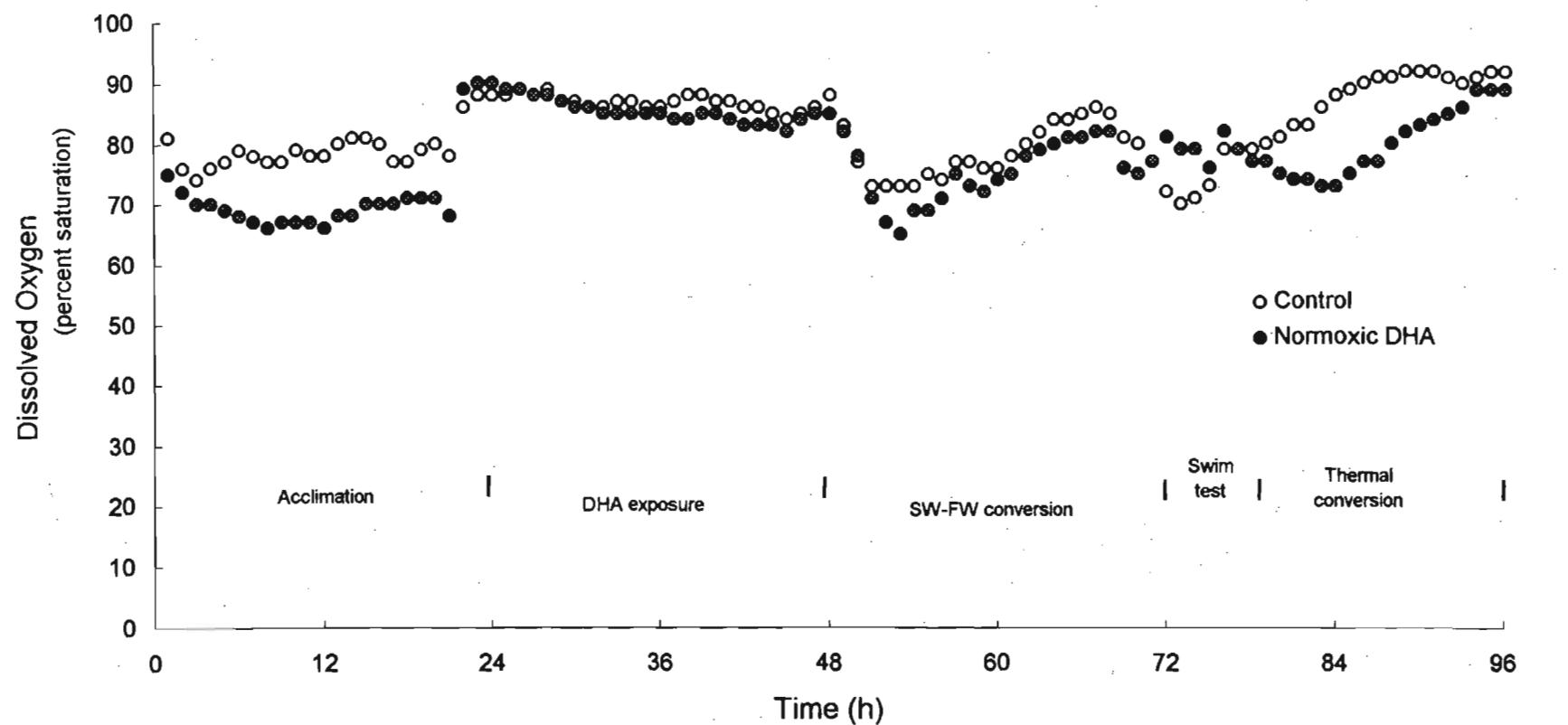


Figure 8. Dissolved oxygen concentrations Expt. #6

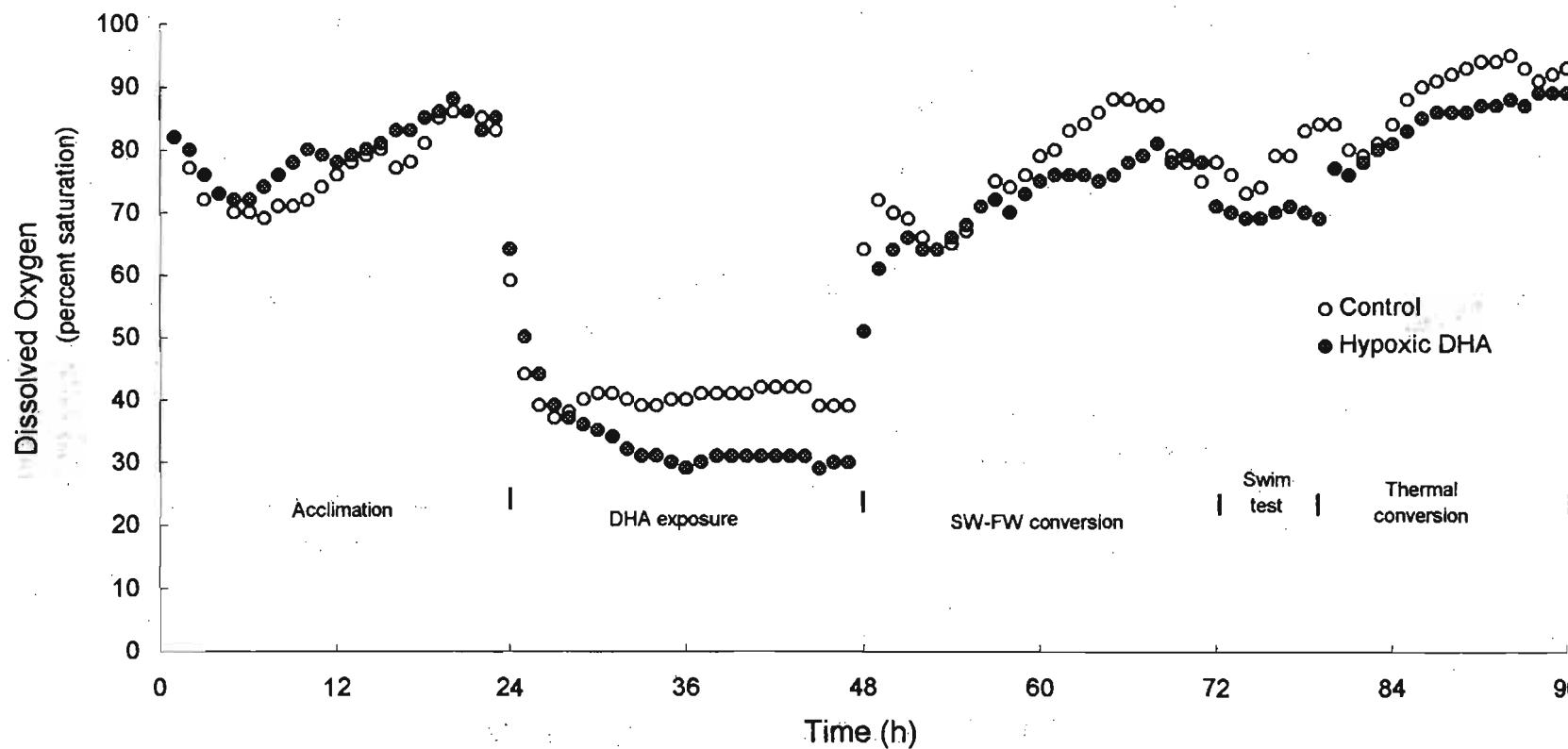


Figure 9. Salinity and temperature conditions Expt. #1

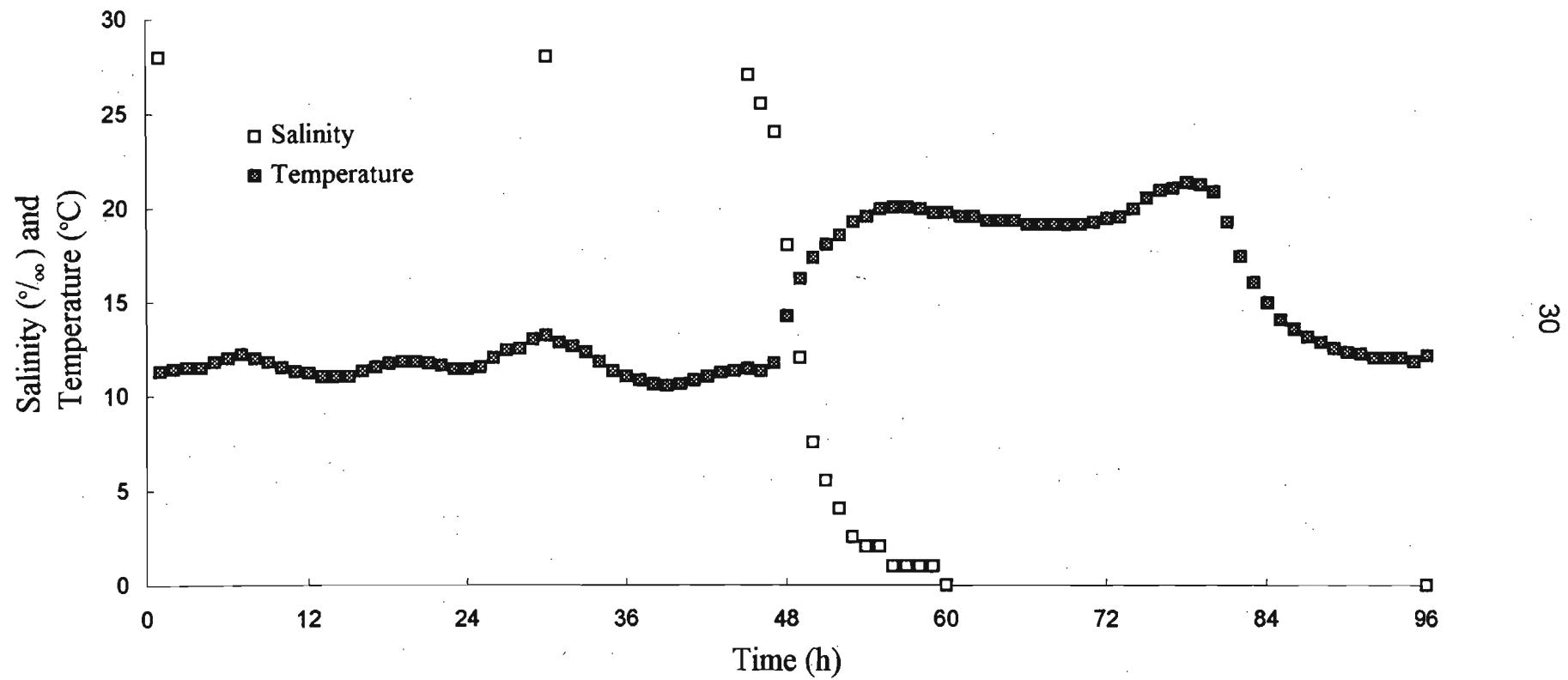


Figure 10. Salinity and temperature conditions Expt. #2

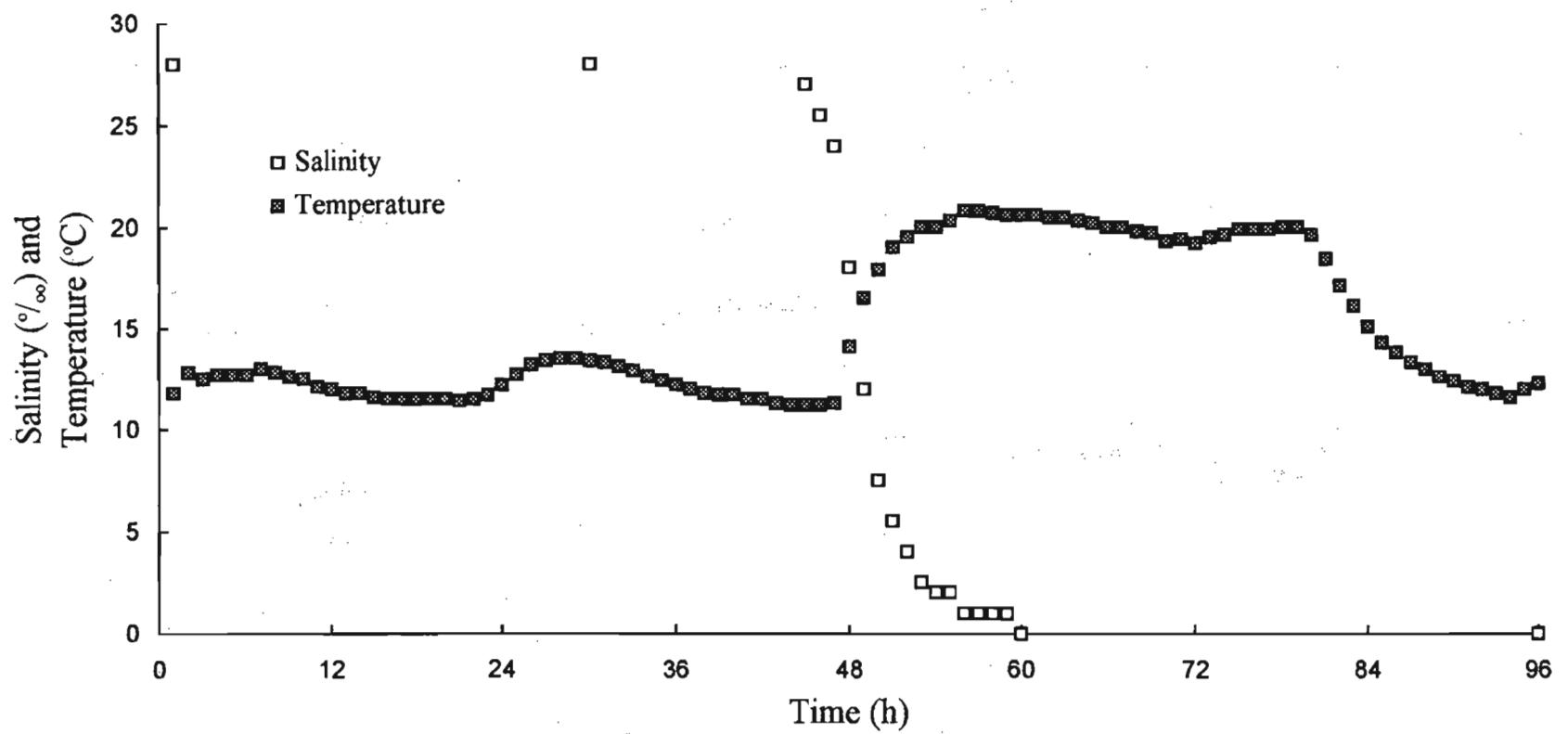


Figure 11. Salinity and temperature conditions Expt. #3

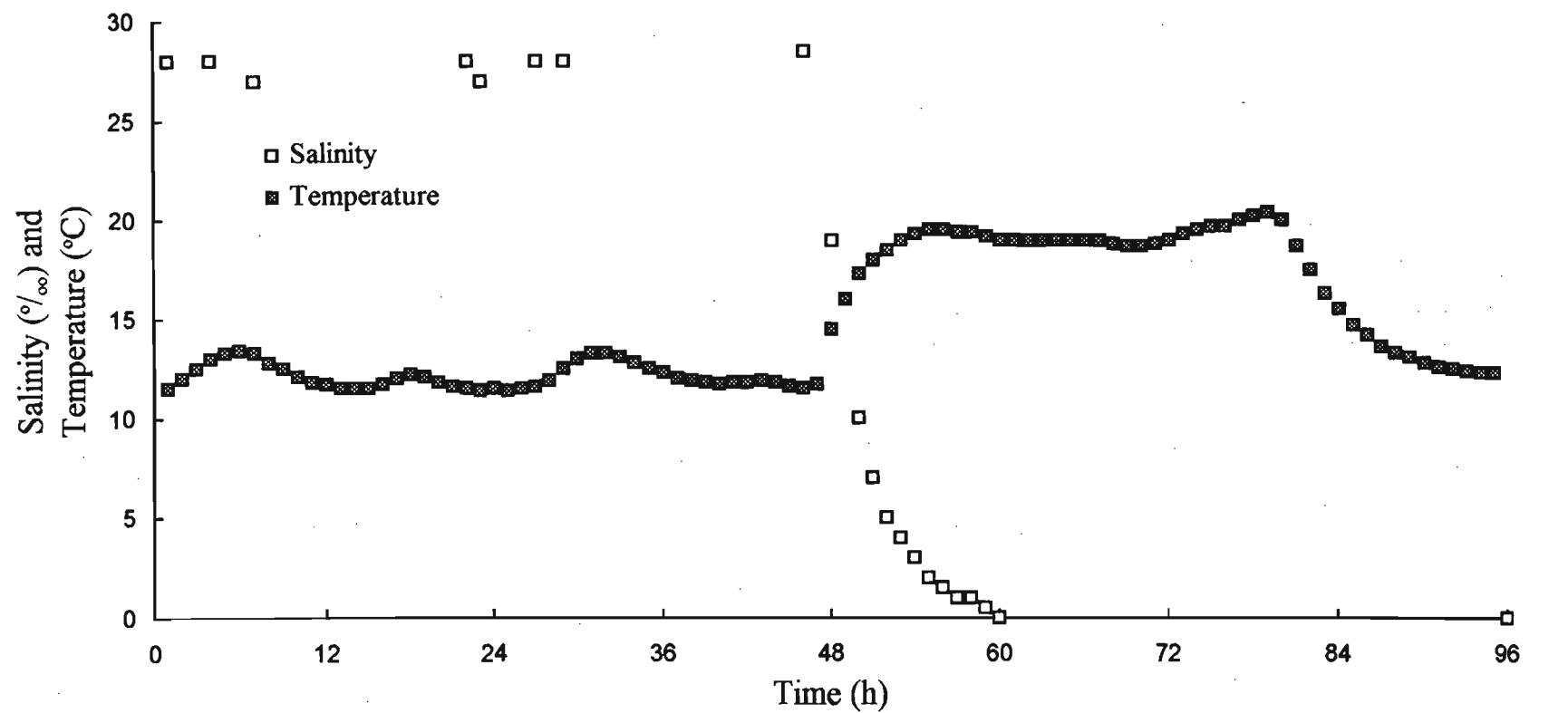


Figure 12. Salinity and temperature conditions Expt. #4

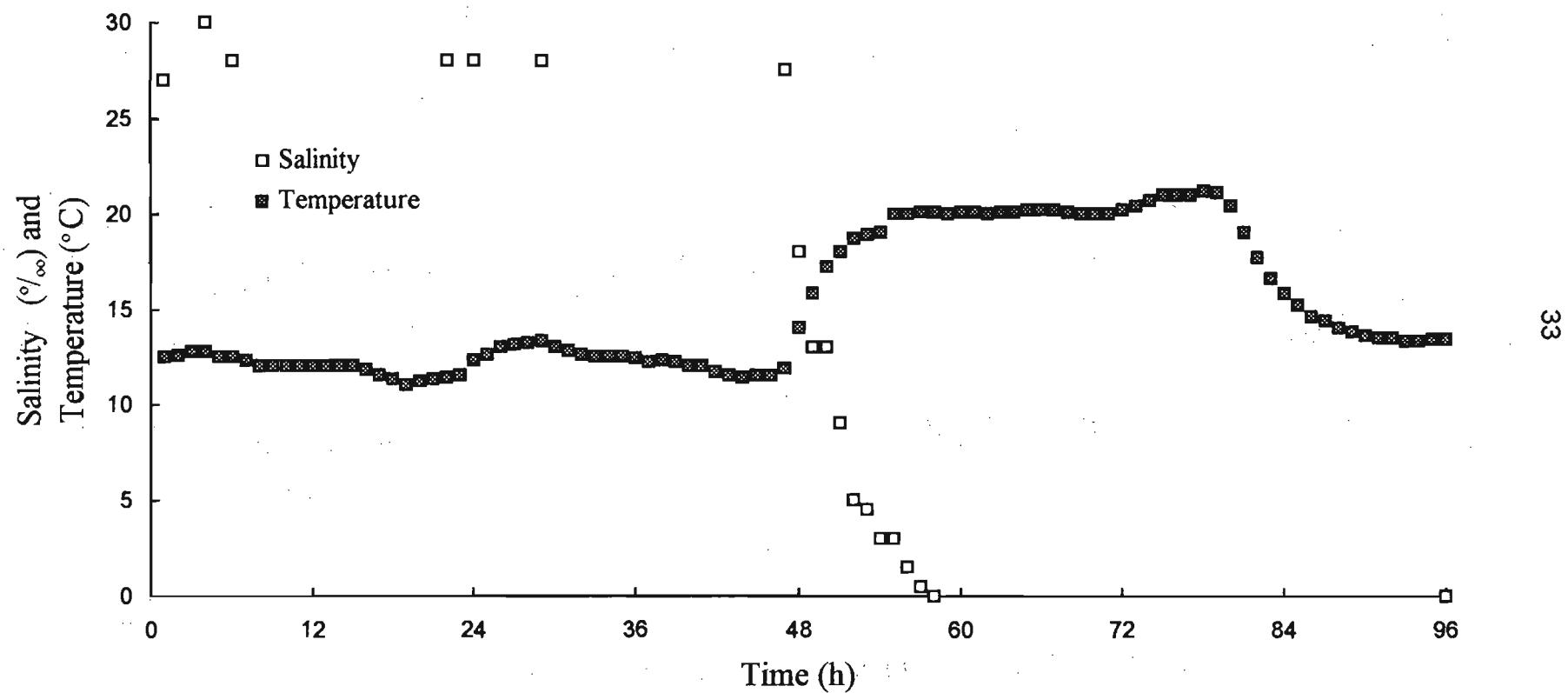


Figure 13. Salinity and temperature conditions Expt. #5

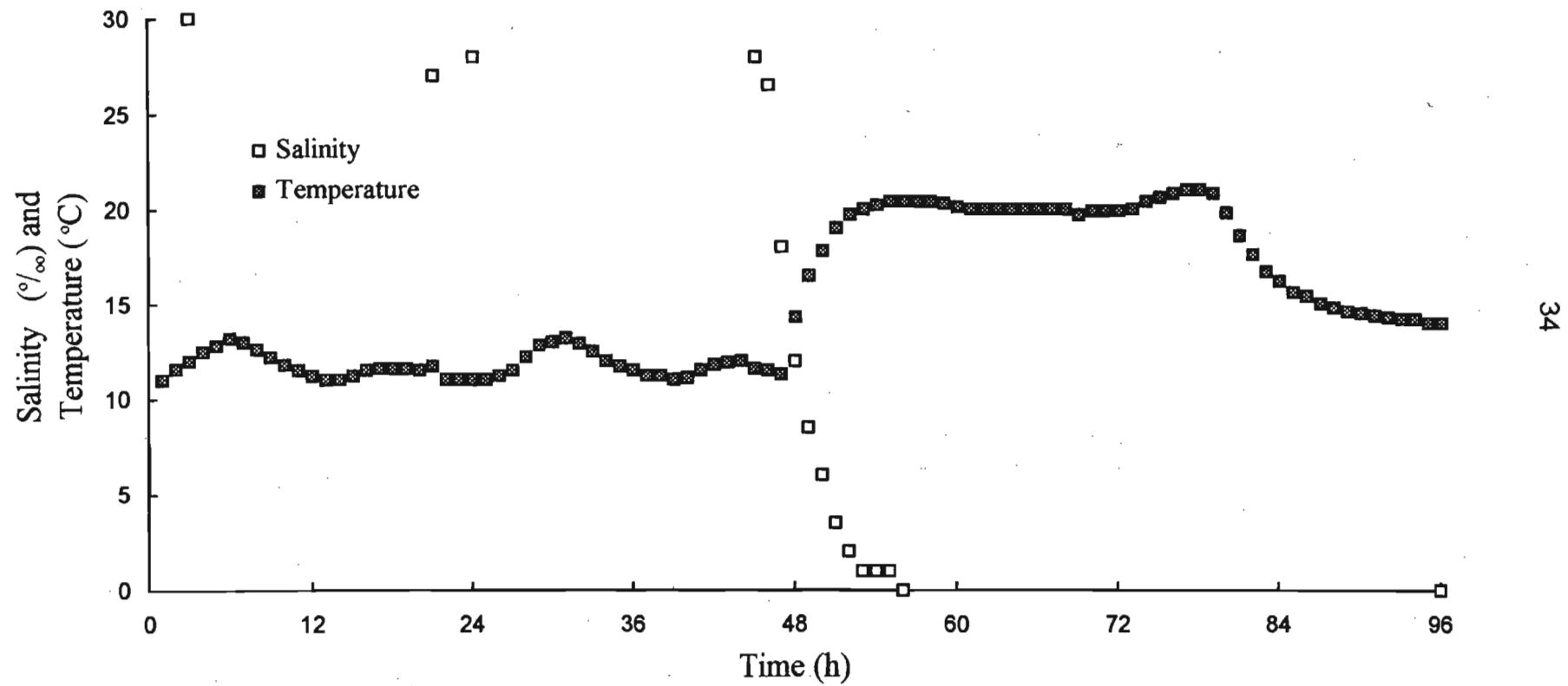


Figure 14. Salinity and temperature conditions Expt. #6

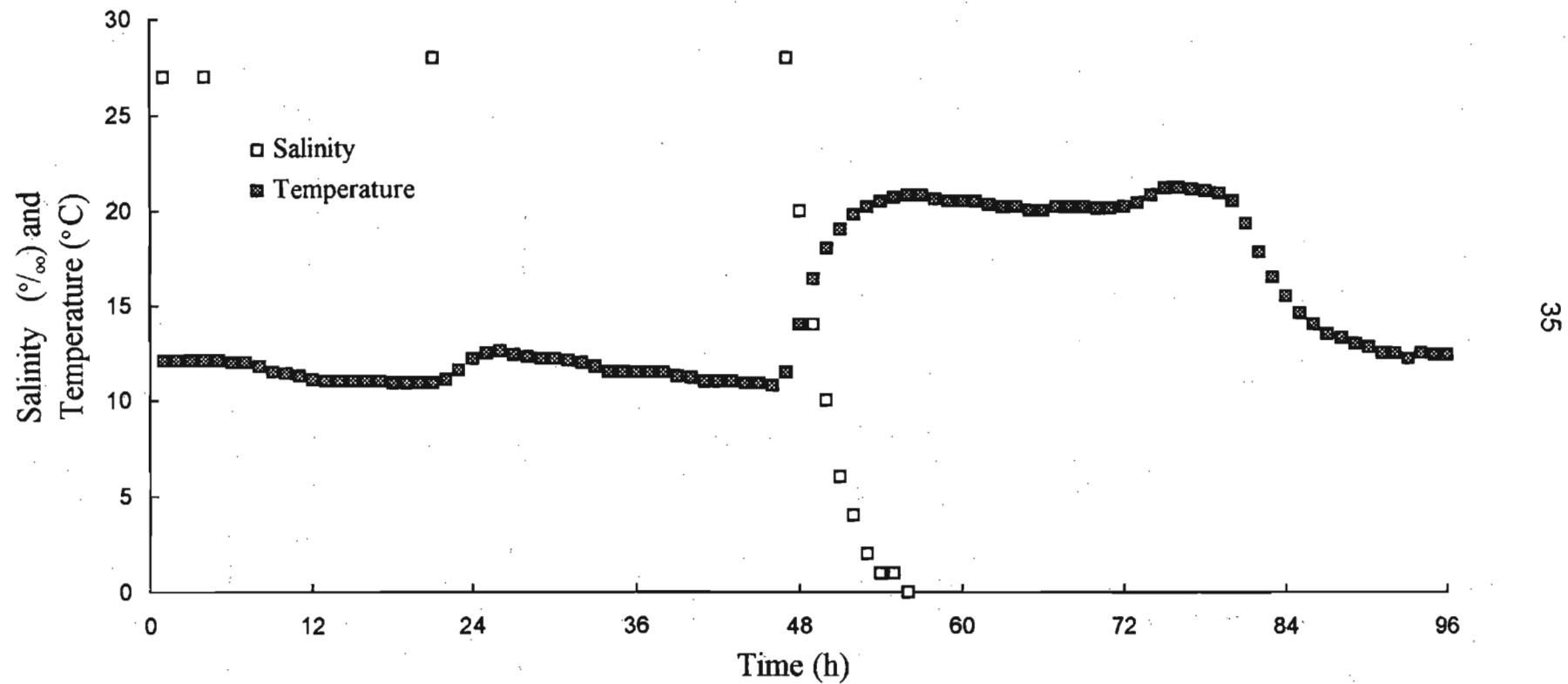


Figure 15. Experimental protocol for 1995 sockeye salmon experiments

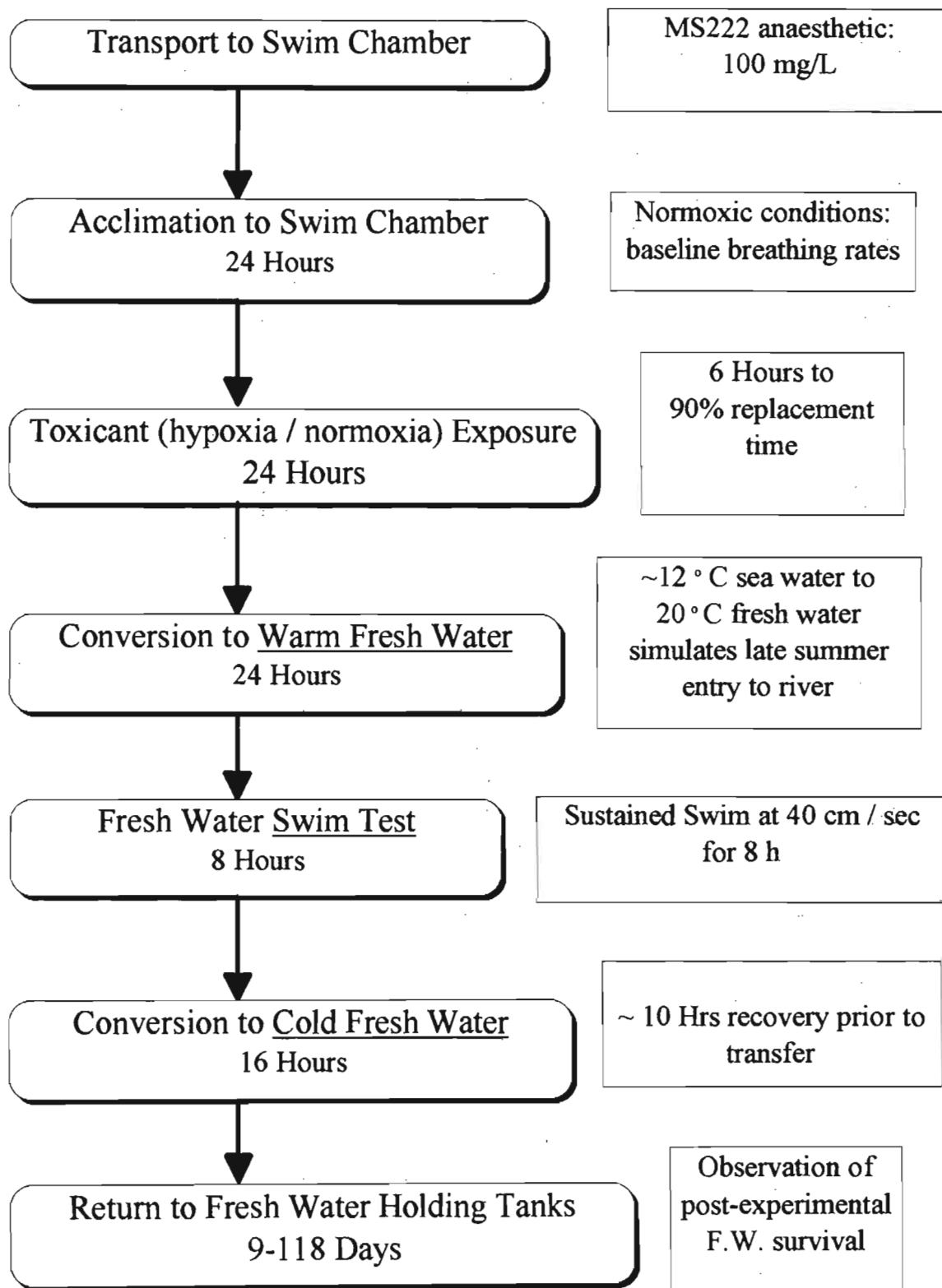


Table 7. Summary of Physical Parameters of Adult Sockeye Salmon 1995

Exp No.	Fish No.	Tank No.	Tag No.	Treatment Group	Sex	Length (mm) initial	Weight (g) initial	Length (mm) final	Weight (g) final	Gonad Weight (g)	Post Expt. Days in F.W.	Date Died
1	1	5	754	Norm Control	M	61.0	2262	-	2194	54.0	36	22-Sep
	2		756		F	59.0	1986	-	1957	168.0	47	3-Oct
	3		757		M	59.0	2250	-	2104	75.0	83	9-Nov
	4		758		F	54.0	1452	52.7	1524	256.0	95	24-Nov
	5		759	Norm DHA	F	61.5	2104	-	2108	186.0	34	20-Sep
	6		760		F	56.0	1594	-	1532	210.0	63	19-Oct
	7		761		M	67.0	2942	68.0	2984	52.0	95	20-Nov
	8		762		M	54.5	1712	-	1861	57.0	85	10-Nov
2	1	2	763	Hypox Control	F	59.0	2050	57.1	1722	369.4	118	20-Dec
	2		764		M	64.0	2112	62.6	2544		118	20-Dec
	3		765		M	56.0	1560	57.5	1853		118	20-Dec
	4		766		M	66.0	2916	65.2	3374		118	20-Dec
	5		767	Hypox DHA	M	60.5	2244	61.0	2493	-	118	20-Dec
	6		768		M	58.5	1916	58.7	2191		118	20-Dec
	7		769		F	60.5	2454	59.5	2385	445.0+	112	14-Dec
	8		770		F	55.0	1622	55.0	1544	295.0	118	20-Dec
3	1	1	771	Norm Control	F	57.5	1792	55.3	1630	322.2	111	20-Dec
	2		772		F	60.0	2106	58.8	2034	397.0	> 84 *	23-Nov
	3		773		M	63.0	2418	61.0	2093	24.0+	102	11-Dec
	4		774		M	59.5	2364	60.0	1840	48.3+	97	30-Nov
	5		775	Norm DHA	M	63.0	2522	-	2250	14.0	55	25-Oct
	6		776		M	59.0	1934	57.0	1725	14.2+	97	6-Dec
	7		777		M	62.0	2248	61.9	2500		111	20-Dec
	8		778		F	60.0	2120	58.0	1745	307.0+	98	7-Dec

Notes: Experiment terminated on Dec 20, 1995, all fish sacrificed. Bold tag numbers signify uncertainty, ie fish had lost tag and were assigned tags by process of elimination.

* - denotes fish which escaped from the holding tanks

Table 7. (Cont.)

Exp No.	Fish No.	Tank No.	Tag No.	Treatment Group	Sex	Length (mm) initial	Weight (g) initial	Length (mm) final	Weight (g) final	Gonad Weight (g)	Post Expt. Days in F.W.	Date Died
4	1	6	779	Hypox Control	F	57.0	1782	-	1732	312.0	38	16-Oct
	2		780		F	58.0	1886	54.5	2011		103	20-Dec
	3		781		M	64.0	2386	61.9	2745		103	20-Dec
	4		782		M	56.0	1350	54.0	1361	21.0+	91	8-Dec
5			783	Hypox DHA	M	58.0	1778	57.6	2039		103	20-Dec
	6		784		F	61.0	1966	-	1898	270.0	9	18-Sep
	7		785		F	61.0	2302	62.5	2222	342.0	> 70 *	17-Nov
	8		786		M	63.5	2398	-	2493	67.9	80	27-Nov
5	1	10	787	Norm Control	F	59.0	1886	58.3	1971	303.9	97	20-Dec
	2		788		M	61.5	2182	59.5	2039		97	20-Dec
	3		789		M	59.0	1976	58.7	2153		97	20-Dec
	4		790		M	55.0	1717	55.0	1626		97	20-Dec
5			791	Norm DHA	M	58.0	1912	56.7	1780		97	20-Dec
	6		792		F	59.0	2154	59.0	2094	367.3	97	20-Dec
	7		DEAD		M	65.0	2462	-	2388	46.0	0	15-Sep
	8		793		F	60.0	2072	58.3	1867	442.0	97	20-Dec
6	1	7	794	Hypox Control	F	58.0	1778	-	1902	202.0	27	18-Oct
	2		795		F	61.0	2044	58.6	1988	461.1	90	20-Dec
	3		796		M	67.5	2772	68.3	2823	29.1+	70	30-Nov
	4		797		M	61.5	2456	59.7	2278		90	20-Dec
5			798	Hypox DHA	M	68.0	2712	67.0	2938	32.3+	> 55 *	15-Nov
	6		799		M	64.0	2196	-	1861	23.1	67	27-Nov
	7		800		M	65.0	2864	-	2712	58.0+	89	19-Dec
	8		726		F	64.0	2548	-	2668	398.0	> 48 *	8-Nov

Notes: Experiment terminated on Dec 20, 1995, all fish sacrificed. Bold tag numbers signify uncertainty, ie fish had lost tag and were assigned tags by process of elimination.

* - denotes fish which escaped from the holding tanks

Figure 16. Post-experimental survival in fresh water

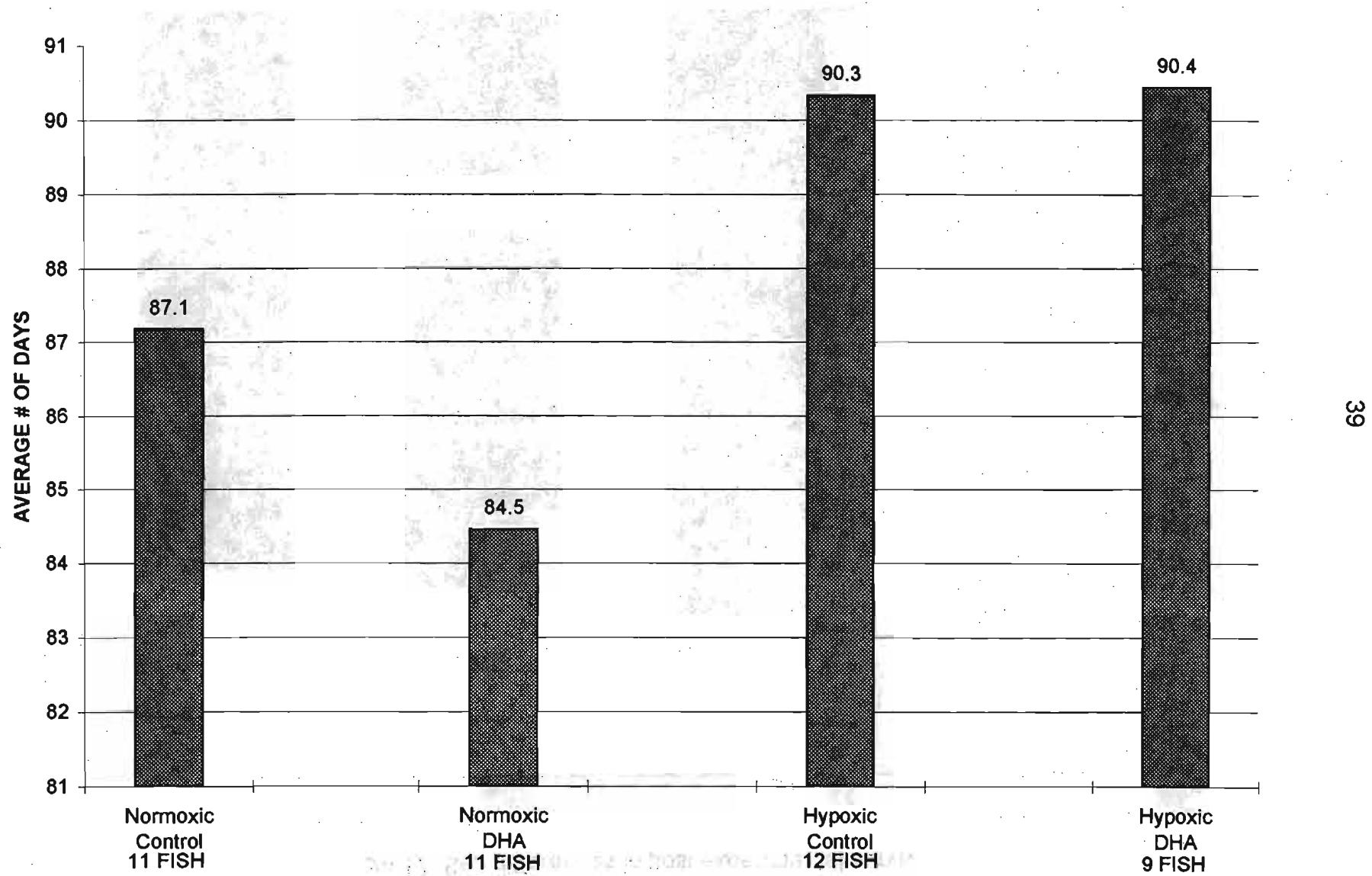


Figure 17. Sex differences in post experimental survival

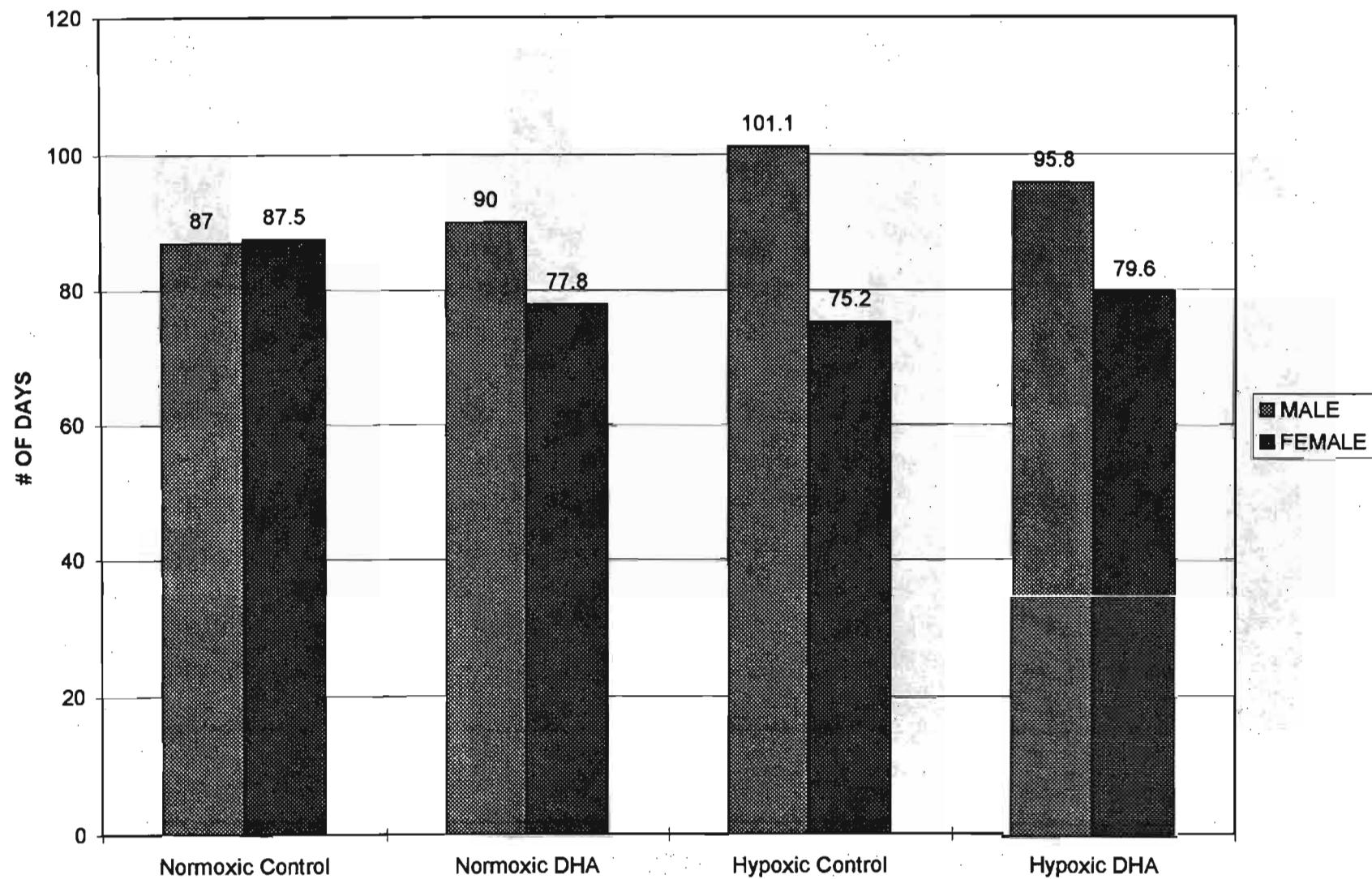


Table 8. Summary of percentage time per activity in an 8 h swim test.

EXPT #	TOTAL NUMBER OF OBSERVATIONS PER ACTIVITY					
	NORMOXIC CONTROL			NORMOXIC DHA		
	SWIM	REST	GRID	SWIM	REST	GRID
1	93	31	0	83	39	2
3	120	64	0	159	23	2
5	185	6	1	148	36	8
TOTAL	398	101	1	390	98	12
PERCENT	79.6%	20.2%	0.2%	78.0%	19.6%	2.4%

EXPT #	TOTAL NUMBER OF OBSERVATIONS PER ACTIVITY					
	HYPOXIC CONTROL			HYPOXIC DHA		
	SWIM	REST	GRID	SWIM	REST	GRID
2	158	18	4	136	36	8
4	184	7	1	186	6	0
6	168	23	1	181	11	0
TOTAL	510	48	6	503	53	8
PERCENT	90.4%	8.5%	1.1%	89.2%	9.4%	1.4%

SWIM = SWIMMING IN WATER COLUMN

REST = RESTING ON BOTTOM OF SWIM CHAMBER

GRID = TOUCHING ELECTRIFIED GRID AT DOWNSTREAM END OF SWIM CHAMBER

Table 9. Summary of swim test results Expt. #1 - Normoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
1000		1			1			1			1	
1020		1			1			1			1	
1040		1			1			1			1	
1043		1			1			1				1
1047		1			1			1			1	
1100		1			1			1			1	
1120		1				1			1		1	
1140		1			1				1		1	
1145		1			1			1			1	
1200		1			1			1				1
1205	1				1			1			1	
1215		1			1			1			1	
1220		1			1			1			1	
1240	1				1			1			1	
1300		1				1		1			1	
1310		1				1		1			1	
1320		1				1		1			1	
1340		1				1		1			1	
1400		1				1		1			1	
1420		1				1		1			1	
1430		1				1		1			1	
1440		1				1		1			1	
1500		1				1		1			1	
1520	1					1		1			1	
1530		1				1		1			1	
1540	1					1		1			1	
1600	1					1		1			1	
1620	1					1		1			1	
1640	1					1		1			1	
1700	1					1		1			1	
1720	1					1		1			1	

Table 10. Summary of swim test results Expt. #1 - Normoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
1000	1			1				1		1		
1020	1			1				1		1		
1040	1			1				1		1		
1043	1				1		1				1	
1047	1			1				1		1		
1100	1			1				1		1		
1120	1				1			1		1		
1140		1			1				1		1	
1145	1			1				1		1		
1200	1			1				1		1		
1205	1			1				1		1		
1215	1			1				1		1		
1220	1			1					1		1	
1240	1			1				1		1		
1300		1		1				1		1		
1310	1			1				1		1		
1320	1				1			1		1		
1340	1			1				1		1		
1400	1			1				1			1	
1420	1			1				1		1		
1430	1				1			1		1		
1440	1				1			1		1		
1500	1			1				1		1		
1520	1			1				1		1		
1530	1			1				1		1		
1540	1			1				1		1		
1600	1			1				1		1		
1620	1			1				1		1		
1640	1			1				1		1		
1700	1				1			1		1		
1720	1			1				1		1		

Table 11. Summary of swim test results Expt. #2 - Hypoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
910	1				1		1					1
920	1					1	1					1
940	1				1			1			1	
950	1				1			1			1	
1000	1				1			1			1	
1020	1				1			1			1	
1040	1					1		1				1
1050	1					1		1			1	
1100	1				1			1			1	
1110	1				1			1			1	
1120	1					1			1		1	
1130	1				1			1			1	
1140	1					1			1		1	
1200	1				1			1			1	
1210	1				1				1		1	
1220	1					1					1	
1230	1				1			1			1	
1240	1				1			1			1	
1250	1					1					1	
1300	1				1				1		1	
1310	1				1			1			1	
1320	1				1			1			1	
1325	1				1				1		1	
1330	1					1					1	
1340	1				1			1			1	
1350	1				1			1			1	
1400	1					1					1	
1410	1				1			1			1	
1420	1				1			1			1	
1430	1					1		1			1	
1440	1				1			1			1	
1450	1				1				1		1	
1500	1					1					1	
1510	1				1			1				1
1520	1				1			1			1	
1530	1				1			1			1	
1540	1				1			1			1	
1550	1					1		1			1	
1600	1				1			1			1	
1610	1				1			1			1	
1620	1					1		1			1	
1630	1				1			1			1	
1640	1				1			1			1	
1650	1					1		1			1	
1700	1				1			1			1	

Table 12. Summary of swim test results Expt. #2 - Hypoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
910		1			1		1				1	
920	1				1			1		1		
940	1				1			1		1		
950	1				1			1		1		
1000	1				1			1		1		
1020	1				1		1			1		
1040	1				1			1		1		
1050	1				1			1		1		
1100	1				1			1		1		
1110	1				1			1		1		
1120	1				1			1		1		
1130	1				1			1		1		
1140		1			1			1			1	
1200	1				1			1			1	
1210		1			1				1		1	
1220		1			1			1			1	
1230	1				1			1			1	
1240	1				1			1			1	
1250	1				1				1		1	
1300		1			1			1			1	
1310	1				1				1		1	
1320	1				1			1			1	
1325		1			1			1			1	
1330	1				1			1			1	
1340	1				1			1			1	
1350		1			1			1			1	
1400	1				1			1			1	
1410	1				1			1			1	
1420		1			1			1			1	
1430	1				1			1			1	
1440	1				1				1		1	
1450	1				1			1			1	
1500	1				1				1		1	
1510	1				1			1			1	
1520	1				1			1			1	
1530	1				1			1			1	
1540	1				1				1		1	
1550	1				1			1			1	
1600	1				1			1			1	
1610	1				1			1			1	
1620	1				1			1			1	
1630	1				1			1			1	
1640	1				1				1		1	
1650	1				1			1			1	
1700	1				1				1		1	

Table 13. Summary of swim test results Expt. #3 - Normoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
910	1				1				1		1	
920	1				1				1		1	
940		1		1				1			1	
950	1			1				1			1	
1000		1			1			1			1	
1015	1				1				1		1	
1020	1				1				1		1	
1030		1			1				1		1	
1040	1				1				1		1	
1050		1			1				1		1	
1100		1			1				1		1	
1115		1			1				1		1	
1120	1				1				1		1	
1130	1				1				1		1	
1140	1				1				1		1	
1150		1			1				1		1	
1200		1			1				1		1	
1210		1			1				1		1	
1220	1				1				1		1	
1230	1				1				1		1	
1240	1				1				1		1	
1250	1				1				1		1	
1300	1				1				1		1	
1315	1				1				1		1	
1320	1				1				1		1	
1330		1			1				1		1	
1340	1				1				1		1	
1350	1				1				1		1	
1400	1				1				1		1	
1410	1				1				1		1	
1420	1				1				1		1	
1430	1				1				1		1	
1440	1				1				1		1	
1450	1				1				1		1	
1500	1				1				1		1	
1515	1				1				1		1	
1520	1				1				1		1	
1540	1				1				1		1	
1555		1			1				1		1	
1600	1				1				1		1	
1610	1				1				1		1	
1620	1				1				1		1	
1635	1				1				1		1	
1640		1			1				1		1	
1650	1				1				1		1	
1700	1				1				1		1	

Table 14. Summary of swim test results Expt. #3 - Normoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
910		1			1			1			1	
920		1			1			1			1	
940		1			1			1			1	
950	1				1			1			1	
1000	1				1			1			1	
1015		1			1			1			1	
1020		1			1			1			1	
1030		1			1			1			1	
1040		1			1			1			1	
1050			1		1			1			1	
1100		1			1				1		1	
1115		1			1			1			1	
1120	1				1			1			1	
1130	1				1			1			1	
1140	1				1			1			1	
1150	1				1			1			1	
1200	1				1			1			1	
1210	1				1			1			1	
1220	1				1			1			1	
1230	1				1			1			1	
1240	1				1			1			1	
1250	1				1			1			1	
1300	1				1			1			1	
1315	1				1			1			1	
1320	1				1			1			1	
1330		1			1			1			1	
1340	1				1			1			1	
1350	1				1			1			1	
1400	1				1			1			1	
1410	1				1			1			1	
1420		1			1			1			1	
1430	1				1			1			1	
1440		1			1			1			1	
1450	1				1			1			1	
1500		1			1			1			1	
1515	1				1			1			1	
1520	1				1			1			1	
1540	1				1			1			1	
1555	1				1			1			1	
1600	1				1			1			1	
1610	1				1			1			1	
1620	1				1			1			1	
1635	1				1			1			1	
1640	1				1			1			1	
1650	1				1			1			1	
1700		1			1			1			1	

Table 15. Summary of swim test results Expt. #4 - Hypoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
910	1			1			1			1		
920	1			1			1			1		
930	1			1			1			1		
940	1					1	1			1		
950	1			1			1			1		
1000	1			1			1			1		
1010	1			1			1			1		
1020	1			1			1			1		
1030	1			1			1			1		
1040	1			1			1			1		
1050	1			1			1			1		
1100	1			1			1			1		
1110	1			1			1			1		
1120	1			1			1			1		
1130		1		1			1			1		
1140	1			1			1			1		
1150	1			1			1			1		
1200	1			1			1			1		
1210	1			1			1			1		
1220	1			1			1			1		
1230	1			1			1			1		
1240		1		1			1			1		
1250	1			1			1			1		
1300	1			1			1			1		
1310	1			1			1			1		
1320	1			1			1			1		
1330	1			1			1			1		
1340	1			1			1			1		
1350	1			1			1			1		
1400	1				1		1			1		
1410	1			1			1			1		
1420	1			1			1			1		
1430	1			1			1			1		
1440	1			1			1			1		
1450	1			1			1			1		
1500	1			1			1			1		
1510	1			1			1			1		
1520	1			1			1			1		
1530	1			1			1			1		
1540	1			1			1			1		
1550	1			1			1			1		
1600	1			1			1			1		
1610	1			1			1			1		
1620		1		1				1		1		
1630	1			1			1			1		
1640	1			1			1			1		
1650	1			1			1			1		
1700	1			1			1			1		

Table 16. Summary of swim test results Expt. #4 - Hypoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
910	1			1			1			1		
920	1			1			1			1		
930	1			1			1			1		
940	1			1			1			1		
950	1			1			1			1		
1000	1			1			1			1		
1010	1			1			1			1		
1020	1			1			1			1		
1030	1			1			1			1		
1040	1			1			1			1		
1050	1			1			1			1		
1100	1			1			1			1		
1110	1			1			1			1		
1120	1			1			1			1		
1130	1			1			1			1		
1140	1			1			1			1		
1150	1			1			1			1		
1200	1			1			1			1		
1210	1			1			1			1		
1220	1			1			1			1		
1230	1			1			1			1		
1240	1			1			1			1		
1250	1			1			1			1		
1300	1			1			1			1		
1310	1			1			1			1		
1320	1			1			1			1		
1330	1			1			1			1		
1340	1			1			1			1		
1350	1			1			1			1		
1400	1			1			1			1		
1410	1			1			1			1		
1420	1			1			1			1		
1430	1			1			1			1		
1440	1			1			1			1		
1450	1			1			1			1		
1500	1			1			1			1		
1510	1			1			1			1		
1520	1			1			1			1		
1530	1			1			1			1		
1540	1			1			1			1		
1550	1			1			1			1		
1600	1			1			1			1		
1610	1			1			1			1		
1620	1			1			1			1		
1630	1			1			1			1		
1640	1			1			1			1		
1650	1			1			1			1		
1700	1			1			1			1		

Table 17. Summary of swim test results Expt. #5 - Normoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
850	1			1			1				1	
900	1			1			1			1		
910	1			1			1			1		
920	1			1			1			1		
930	1			1			1			1		
940	1			1			1			1		
950	1			1			1			1		
1000	1			1			1				1	
1010	1			1			1			1		
1020	1			1			1				1	
1030	1			1			1			1		
1040	1			1			1			1		
1050	1			1			1				1	
1100	1			1			1				1	
1110	1			1			1				1	
1120	1			1			1				1	
1130	1			1			1				1	
1140	1			1			1				1	
1150	1			1			1				1	
1200	1			1			1				1	
1210	1			1			1				1	
1220	1			1			1				1	
1230	1			1			1				1	
1240	1			1			1					1
1250	1			1			1				1	
1300	1			1			1				1	
1310	1			1			1				1	
1320	1			1			1				1	
1330	1			1			1				1	
1340	1			1			1				1	
1350	1			1			1				1	
1400	1			1			1				1	
1410	1			1			1				1	
1420	1			1			1				1	
1430	1			1			1					1
1440	1			1			1				1	
1450	1			1			1				1	
1500	1			1			1				1	
1510	1			1			1				1	
1520	1			1			1				1	
1530	1			1			1				1	
1540	1			1			1				1	
1550	1			1			1					1
1600	1			1			1				1	
1610	1			1			1				1	
1620	1			1			1				1	
1630	1			1			1				1	
1640	1			1			1				1	

Table 18. Summary of swim test results Expt. #5 - Normoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
850	1				1			1				1
900		1			1			1			1	
910		1			1			1		1		
920	1			1			1			1		
930	1			1			1					1
940	1			1			1			1		
950	1			1			1			1		
1000	1			1			1			1		
1010	1			1			1			1		
1020	1			1			1			1		
1030	1			1			1			1		
1040	1			1			1			1		
1050	1			1			1			1		
1100		1		1			1			1		
1110	1			1			1			1		
1120	1			1			1					1
1130	1				1		1				1	
1140	1				1		1				1	
1150	1				1		1				1	
1200	1				1		1				1	
1210	1				1		1				1	
1220	1				1		1				1	
1230	1				1		1				1	
1240	1				1		1			1		
1250	1					1	1			1		
1300	1				1		1			1		
1310	1				1		1					1
1320	1				1		1					1
1330	1				1		1			1		
1340	1				1		1			1		
1350	1				1		1					1
1400	1				1		1			1		
1410	1				1		1				1	
1420	1				1		1			1		
1430	1				1		1			1		
1440	1				1		1			1		
1450	1				1		1			1		
1500	1				1		1				1	
1510	1				1		1			1		
1520	1				1		1				1	
1530	1				1		1				1	
1540	1				1		1				1	
1550	1				1		1				1	
1600	1				1		1				1	
1610	1				1		1				1	
1620	1				1		1				1	
1630	1				1		1				1	
1640	1				1		1			1		

Table 19. Summary of swim test results Expt. #6 - Hypoxic Control Group

Time	Fish No.1			Fish No.2			Fish No.3			Fish No.4		
	Swim	Rest	Grid									
910	1				1		1			1		
920	1				1			1		1		
930	1				1		1			1		
940	1				1		1			1		
950	1				1		1			1		
1000	1				1		1			1		
1010	1				1		1			1		
1020		1			1		1			1		
1030	1				1			1		1		
1040	1				1			1		1		
1050	1				1		1			1		
1100	1				1		1			1		
1110	1				1			1		1		
1120	1				1			1		1		
1130	1				1		1			1		
1140	1				1		1			1		
1150	1				1		1			1		
1200	1				1		1			1		
1210	1				1		1			1		
1220	1				1		1			1		
1230	1				1		1			1		
1240	1				1		1			1		
1250	1				1		1			1		
1300	1				1		1			1		
1310	1				1			1		1		
1320	1				1			1		1		
1330	1				1		1			1		
1340	1				1		1			1		
1350	1				1		1			1		
1400	1				1		1			1		
1410	1				1			1		1		
1420	1				1		1			1		
1430	1				1		1			1		
1440	1				1		1			1		
1450	1				1		1			1		
1500	1				1			1		1		
1510	1				1		1			1		
1520	1				1			1		1		
1530	1				1		1			1		
1540	1				1			1		1		
1550	1				1		1			1		
1600	1				1			1			1	
1610	1				1			1		1		
1620	1				1			1		1		
1630	1				1			1		1		
1640	1				1			1		1		
1650	1				1			1		1		
1700	1				1		1			1		

Table 20. Summary of swim test results Expt. #6 - Hypoxic DHA Group

Time	Fish No.5			Fish No.6			Fish No.7			Fish No.8		
	Swim	Rest	Grid									
910	1			1			1			1		
920	1			1			1			1		
930	1			1			1			1		
940	1			1			1			1		
950	1			1			1			1		
1000	1			1			1			1		
1010	1			1			1			1		
1020	1			1			1			1		
1030	1			1			1			1		
1040	1			1			1			1		
1050	1			1			1			1		
1100	1			1			1			1		
1110	1			1			1			1		
1120	1			1			1			1		
1130	1			1			1			1		
1140	1			1			1			1		
1150	1			1			1			1		
1200	1			1			1			1		
1210	1			1			1			1		
1220	1			1			1			1		
1230	1			1			1			1		
1240	1			1			1			1		
1250	1			1			1			1		
1300	1			1			1			1		
1310	1			1			1			1		
1320	1			1			1			1	*	
1330	1			1			1			1		
1340	1			1			1			1		
1350	1			1			1			1		
1400	1			1			1			1		
1410	1			1			1			1		
1420	1			1			1			1		
1430	1			1			1			1		
1440	1			1			1			1		
1450	1			1			1			1		
1500	1			1			1			1		
1510	1			1			1			1		
1520	1			1			1			1		
1530	1			1			1			1		
1540	1			1			1			1		
1550	1			1			1			1		
1600	1			1			1			1		
1610	1			1			1			1		
1620	1			1			1			1		
1630	1			1			1			1		
1640	1			1			1			1		
1650	1			1			1			1		
1700	1			1			1			1		

* indicates electric grid reconnected at this time

Figure 18. Breathing frequency of adult sockeye in Expt. #1

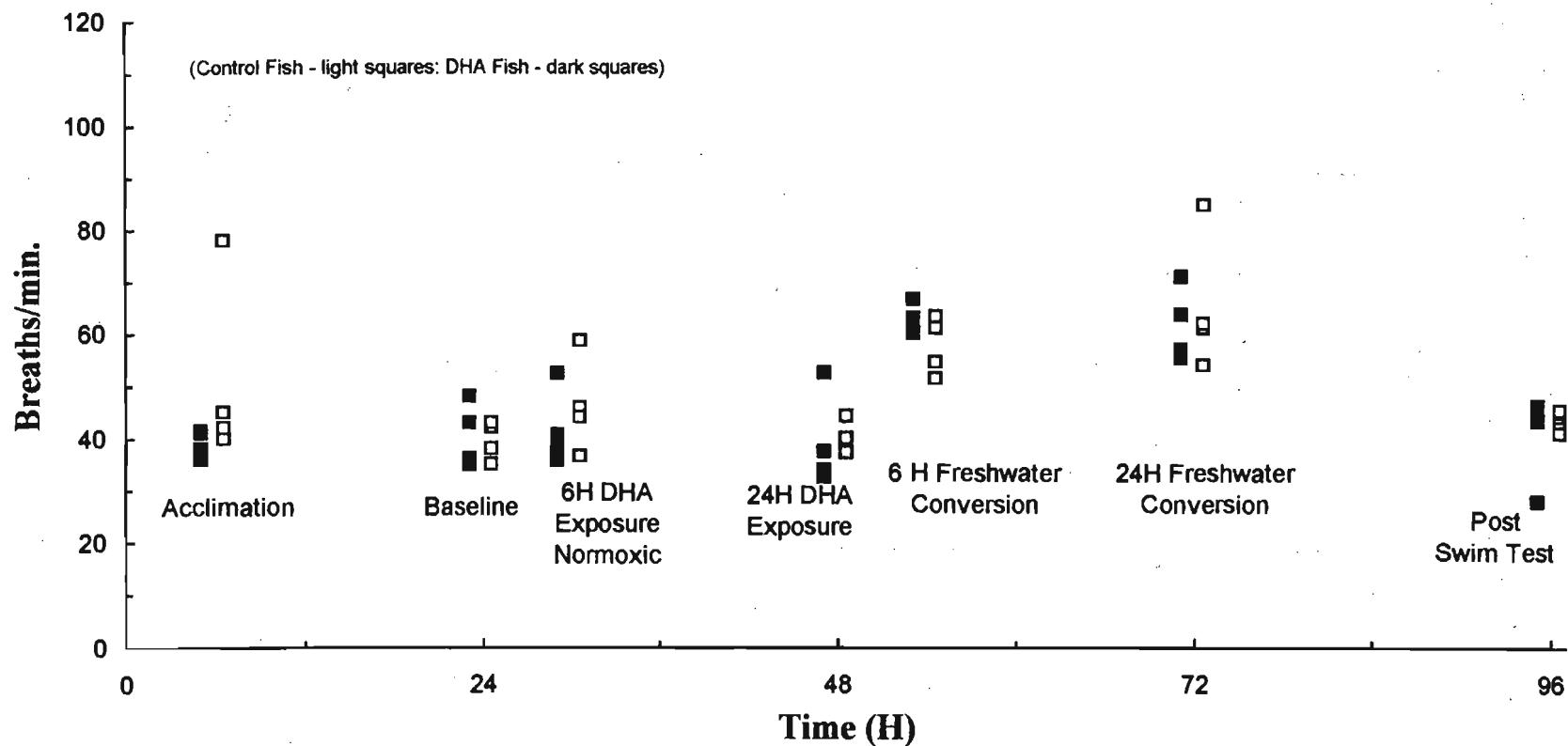


Figure 19. Breathing frequency of adult sockeye Expt.#2

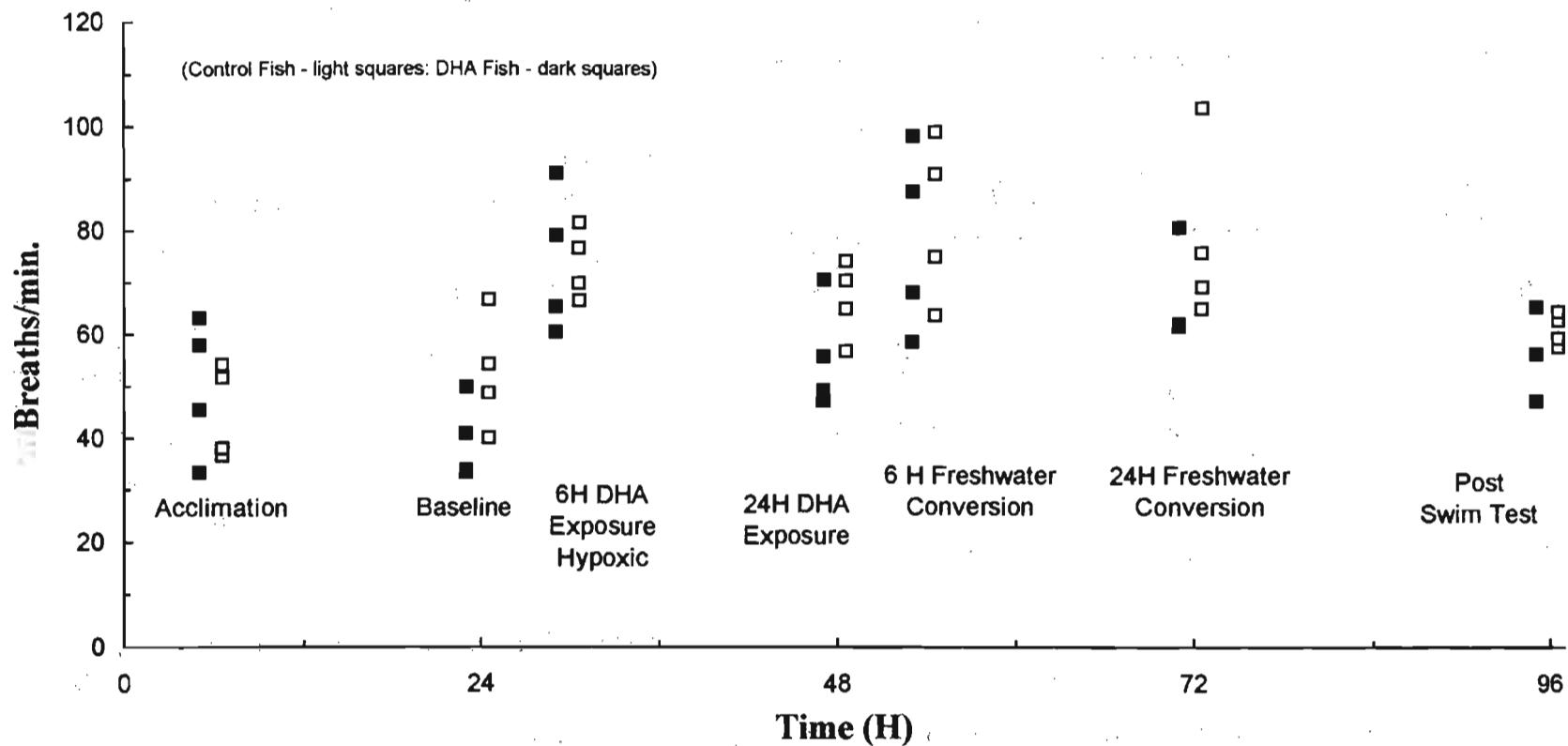


Figure 20. Breathing frequency of adult sockeye Expt. #3

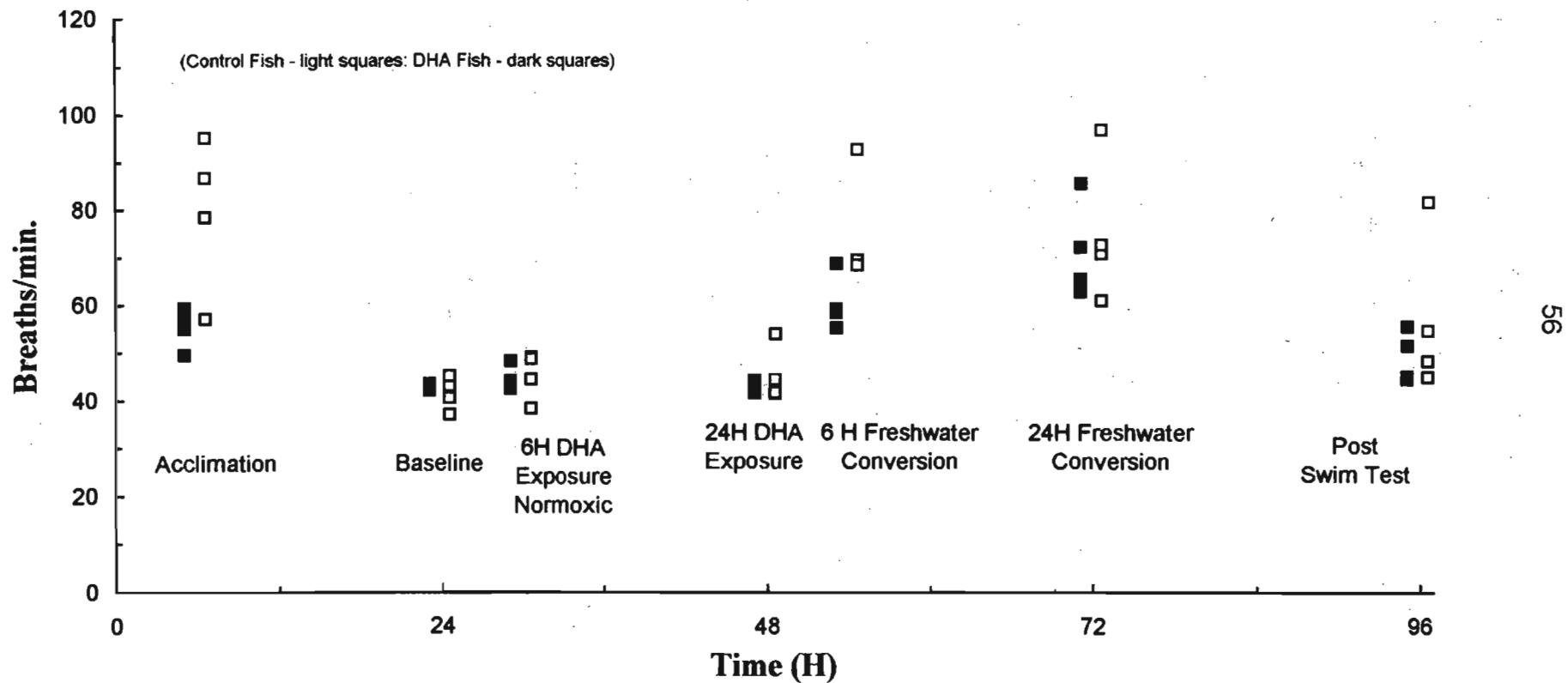


Figure 21. Breathing frequency of adult sockeye Expt. #4

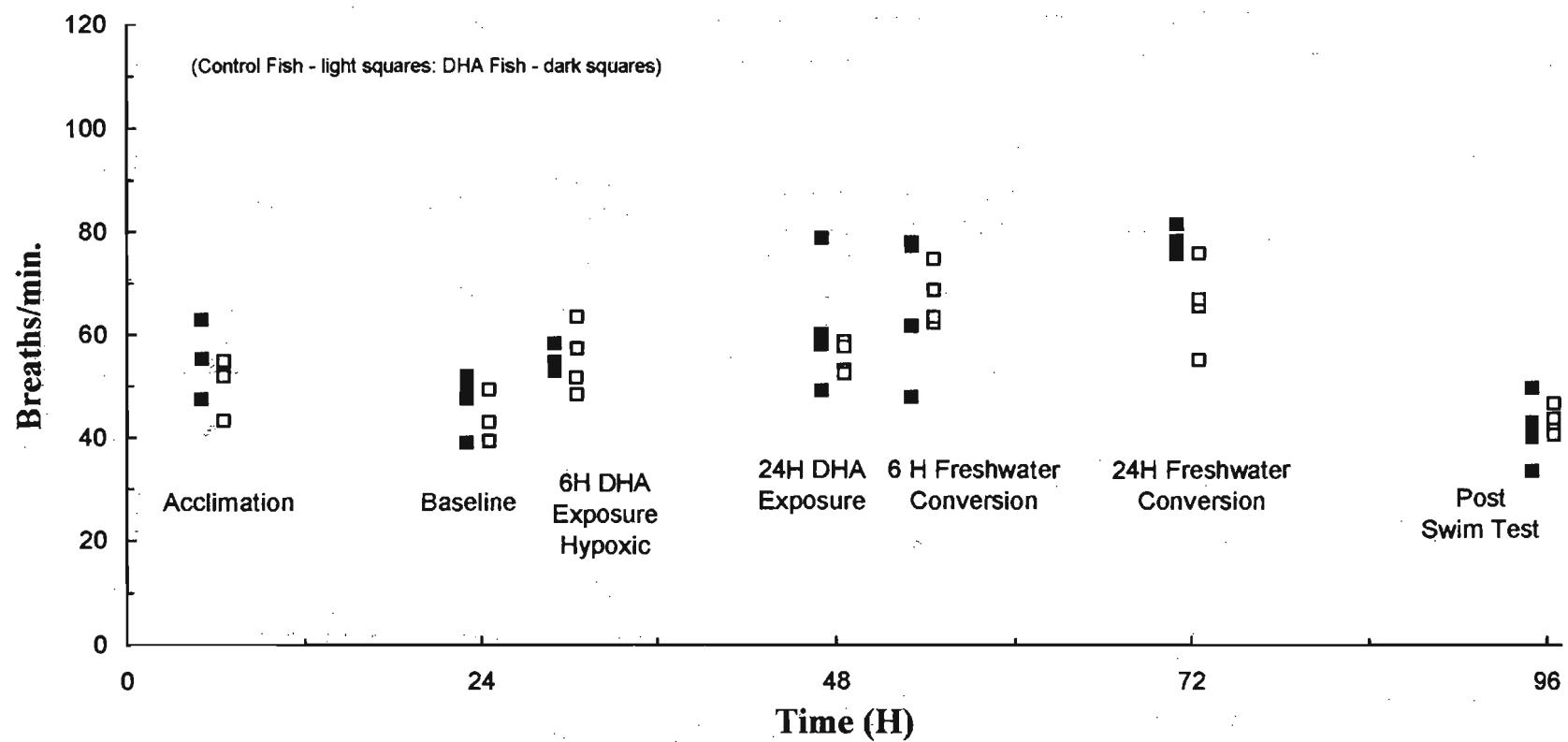


Figure 22. Breathing frequency of adult sockeye Expt. #5

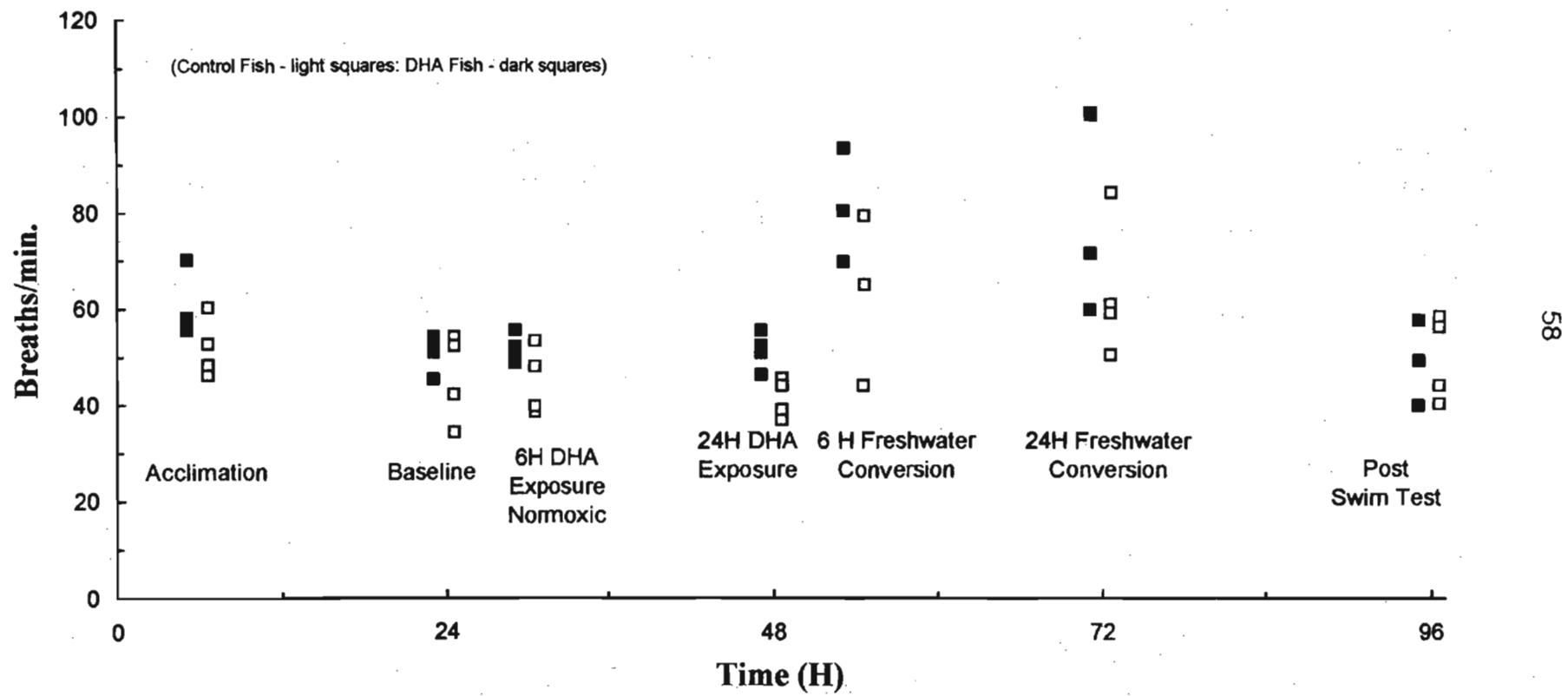


Figure 23. Breathing frequencies of adult sockeye Expt. #6

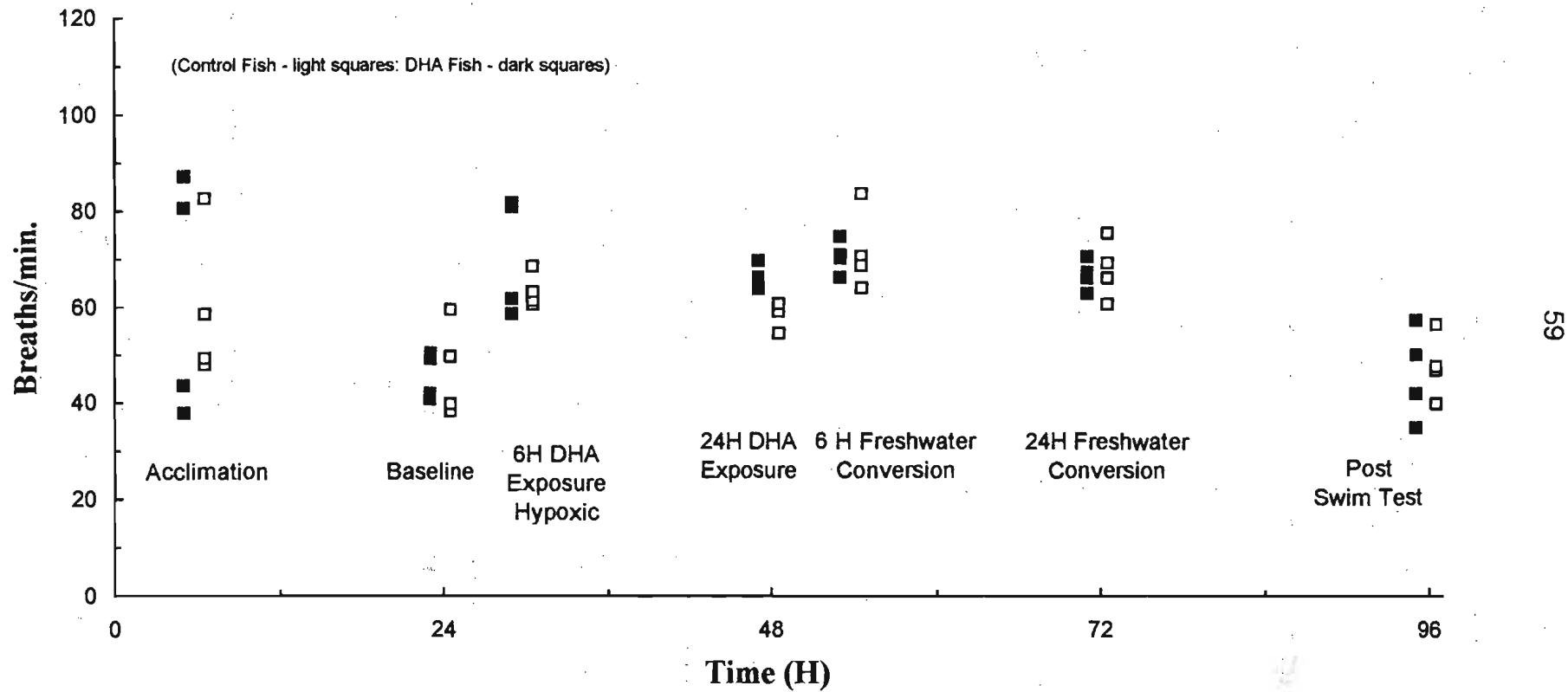


Table 21. Respirometry and activity levels of adult sockeye salmon - Expt. #1**Experiment #1: 14 - 18 Aug, 1995**

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)								
Breaths/min.	79 77 39	42 39 46	44 40 39	47	41	38	36	39 44
mean	78	40	45	42	41	38	36	42
Coughs/min.	0 1 0	1.3 2 0	2 0 0	1.5	0	1	1	1 0
mean	0	0.7667	2	0.5	0	1	1	0.5
Activity Level *	3	1	2	1	1	1	2	1
Baseline (AM)								
Breaths/min.	42	43	35	38	43	36	35	48
mean	42	43	35	38	43	36	35	48
Coughs/min.	1	1	0	1	1	0	1	1
mean	1	1	0	1	1	0	1	1
Activity Level *	1	1	1	1-2	1	1	1	2

Table 21. (cont.)

Experiment 1: 14 - 18 Aug, 1995

Table 21. (cont.)

Experiment 1: 14 - 18 Aug, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	61	55	61	48	64	51	65	62
	61	52	65	50	65	51	57	53
	62	56	64	51	66	64	60	68
	59	56	65	54	67	68	64	61
	63	54	62	54	72	82	55	58
mean	61	55	63	51	67	63	60	60
Coughs/min.	2	3	3	3	1	0	1	0
	2	3	3	2	1	2	1	1
	2	2	2	2	2	2	1	2
	2	2	3	2	2	1	0	0
	2	2	3	1	2	1	1	0
mean	2	2.4	2.8	2	1.6	1.2	0.8	0.6
Activity Level *	1-2	1	2	1	1-2	3	1-2	4
Freshwater Conversion (AM)								
Breaths/min.	59	65	88	54	71	52	53	62
	62	65	84	56	69	56	48	59
	65	61	85	50	72	58	54	64
	58	61	85	54	75	60	59	64
	62	58	82	56	68	59	63	70
mean	61	62	85	54	71	57	55	64
Coughs/min.	3	3	4	1	0	2	2	1
	2	2	2	1	1	2	1	1
	1	2	2	1	1	2	2	2
	1	2	2	1	2	2	2	1
	2	1	2	1	2	1	2	0
mean	1.8	2	2.4	1	1.2	1.8	1.8	1
Activity Level *	1	1	1	1	1-2	2	1	3

Table 21. (cont.)

Experiment 1: 14 - 18 Aug, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	43	40	48	40	48	45	28	44
	40	42	48	38	45	42	27	46
	46	45	44	42	48	43	26	45
	42	42	42	40	45	45	31	42
	43	41	45	45	45	42	28	46
mean	43	42	45	41	46	43	28	45
Coughs/min.	1	2	1	0	1	0	1	1
	1	1	2	1	0	0	0	1
	2	1	2	1	1	1	2	0
	1	1	1	1	1	2	1	1
	1	1	1	0	1	1	2	1
mean	1.2	1.2	1.4	0.6	0.8	0.8	1.2	0.8
Activity Level *	1	1	1	2	1	1	1	2

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber

Table 22. Respirometry and activity levels of adult sockeye salmon - Expt. #2**Experiment #2: 21 - 25 Aug, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)								
Breaths/min.	34	48	58	39	58	50	60	34
	34	49	48	36	58	42	53	34
	37	52	51	39	56	47	70	33
	40	56	54	38	56	42	67	32
	38	53	60	38	62	46	66	34
mean	37	51	54	38	58	45	63	33
Coughs/min.	2	0	1	0	0	2	2	1
	0	2	0	0	0	0	2	0
	3	1	1	0	0	1	0	1
	2	0	2	0	2	0	1	0
	2	1	2	2	1	0	0	0
mean	1.8	0.8	1.2	0.4	0.6	0.6	1	0.4
Activity Level *	1	2	2	1	2	1	2	1
Baseline (AM)								
Breaths/min.	38	63	54	48	36	33	50	35
	41	66	50	50	42	30	46	33
	40	68	56	46	40	36	51	30
	38	67	54	49	44	35	47	37
	43	69	57	50	42	33	55	34
mean	40	67	54	49	41	33	50	34
Coughs/min.	0	0	0	0	1	0	3	1
	1	2	1	1	1	0	2	1
	2	1	1	0	1	0	2	0
	1	1	0	1	1	0	1	0
	2	1	0	1	1	0	1	0
mean	1.2	1	0.4	0.6	1	0	1.8	0.4
Activity Level *	2	1	2	2	1	1	2	1

Table 22. (cont.)**Experiment 2: 21 - 25 Aug, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Exposure (PM)								
Breaths/min.	61	83	76	67	77	68	89	63
	65	81	76	70	82	66	92	60
	71	82	73	72	82	63	90	60
	63	81	80	72	77	63	90	59
	72	80	78	68	77	66	94	60
mean	66	81	77	70	79	65	91	60
Coughs/min.	0	1	0	1	1	0	2	1
	1	0	0	1	1	0	2	1
	1	1	1	1	0	0	2	0
	2	1	1	1	1	0	1	1
	1	1	0	0	1	1	1	1
mean	1	0.8	0.4	0.8	0.8	0.2	1.6	0.8
Activity Level *	2	1	2	1	2	2	2	2
Exposure (AM)								
Breaths/min.	70	79	60	66	55	48	70	50
	68	75	59	64	58	47	70	45
	71	76	60	64	57	53	70	46
	73	71	53	65	53	48	70	45
	70	70	52	66	56	50	73	50
mean	70	74	57	65	56	49	71	47
Coughs/min.	0	0	0	0	0	0	0	0
	0	0	1	1	1	0	2	0
	0	0	1	1	0	0	2	0
	0	0	1	0	0	1	2	1
	1	0	1	1	1	0	1	0
mean	0.2	0	0.8	0.6	0.4	0.2	1.4	0.2
Activity Level *	2	1	1	1	1	1	1	1

Table 22. (cont.)

Experiment 2: 21 - 25 Aug, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	102	75	60	104	64	96	81	58
	87	75	66	97	68	97	88	64
	80	76	64	98	69	99	95	59
	96	73	63	101	69	99	83	55
	90	76	65	95	71	100	91	57
mean	91	75	64	99	68	98	88	59
Coughs/min.	2	3	3	4	0	1	3	1
	2	2	2	4	2	0	2	0
	2	1	3	3	1	0	3	2
	1	3	3	4	1	0	3	2
	2	2	3	3	3	0	3	1
mean	1.8	2.2	2.8	3.6	1.4	0.2	2.8	1.2
Activity Level *	3	1	1	1	2	4	3	2
Freshwater Conversion (AM)								
Breaths/min.	67	103	76	65	58	56	78	58
	64	107	77	66	60	59	80	60
	65	100	76	66	62	60	82	65
	62	102	71	62	64	67	81	64
	88	106	79	66	64	68	82	62
mean	69	104	76	65	62	62	81	62
Coughs/min.	2	3	3	2	1	1	10	1
	2	2	2	1	1	2	10	1
	0	2	2	0	1	1	11	0
	1	1	2	2	1	0	12	2
	0	2	1	2	2	1	12	2
mean	1	2	2	1.4	1.2	1	11	1.2
Activity Level *	4	1	2	2	4	1	3	2

Table 22. (cont.)**Experiment 2: 21 - 25 Aug, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	55	67	67	58	49	50	66	60
	57	63	65	65	44	44	65	57
	58	61	60	52	50	50	64	50
	60	61	65	58	45	46	65	60
	58	62	65	64	48	46	67	54
mean	58	63	64	59	47	47	65	56
Coughs/min.	0	0	1	1	1	1	7	0
	0	0	1	0	1	2	6	0
	0	0	0	2	2	1	6	0
	0	0	1	0	2	0	7	0
	1	1	0	2	2	0	7	0
mean	0.2	0.2	0.6	1	1.6	0.8	6.6	0
Activity Level *	2	1	2	2	1	2	1	2

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber

Table 23. Respirometry and activity levels of adult sockeye salmon - Expt. #3

Experiment #3: 28 Aug - 01 Sept, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)	Control Fish No.				DHA Fish No.			
Breaths/min.	79	94	77	58	56	59	44	55
	86	95	81	56	56	60	46	57
	84	110	78	56	55	58	55	57
	90	88	80	58	60	60	52	52
	94	88	76	57	61	60	50	54
mean	87	95	78	57	58	59	49	55
Coughs/min.	0	0	3	2	1	1	2	2
	0	0	3	2	0	0	0	1
	2	1	3	2	1	0	2	1
	0	1	2	2	0	0	2	0
	0	0	4	2	1	1	2	0
mean	0.4	0.4	3	2	0.6	0.4	1.6	0.8
Activity Level *	4	3	2	2	2	3	2	2
Baseline (AM)								
Breaths/min.	40	35	40	47	42	42	45	41
	44	38	43	42	44	40	40	43
	44	34	40	44	46	44	44	39
	45	38	38	47	42	42	47	45
	42	40	41	45	42	42	41	45
mean	43	37	40	45	43	42	43	43
Coughs/min.	0	1	0	1	1	0	1	0
	0	0	0	0	1	0	0	1
	0	1	1	0	0	0	1	1
	1	1	1	1	0	1	1	2
	0	0	0	1	0	0	0	1
mean	0.2	0.6	0.4	0.6	0.4	0.2	0.6	1
Activity Level *	1	2	1	1	1	1	1	1

Table 23. (cont.)

Experiment 3: 28 Aug - 01 Sept, 1995

Table 23. (cont.)

Experiment 3: 28 Aug - 01 Sept, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	66	68	66	88	55	58	58	68
	71	74	65	80	57	58	60	67
	67	68	66	102	55	59	58	69
	70	68	71	98	54	61	58	68
	70	69	74	95	55	60	57	71
mean	69	69	68	93	55	59	58	69
Coughs/min.	2	3	3	4	0	1	0	0
	2	2	2	2	1	2	0	1
	2	2	3	0	2	1	0	1
	1	1	4	1	2	2	1	1
	2	1	2	1	1	1	0	2
mean	1.8	1.8	2.8	1.6	1.2	1.4	0.2	1
Activity Level *	1	3	2	2	1	2	2	2
Freshwater Conversion (AM)								
Breaths/min.	95	62	70	70	85	61	65	69
	98	60	75	75	92	64	68	67
	97	60	69	74	82	63	63	74
	95	64	68	71	85	64	66	78
	99	59	72	73	84	62		73
mean	97	61	71	73	86	63	66	72
Coughs/min.	0	1	3	4	1	2	1	0
	0	1	3	3	2	0	1	0
	0	0	4	2	0	1	0	0
	0	1	4	2	3	1	0	0
	0	1	2	1	2	1		2
mean	0	0.8	3.2	2.4	1.6	1	0.5	0.4
Activity Level *	4	3	1	1	2	1	2	2

Table 23. (cont.)

Experiment 3: 28 Aug - 01 Sept, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	86	42	46	52	50	42	49	59
	79	47	47	58	50	45	46	52
	86	44	50	54	57	45	42	
	84	46	51	54	52	44	44	
	74	46	48	56	49	47	45	
mean	82	45	48	55	52	45	45	56
Coughs/min.	0	1	1	1	2	1	0	2
	0	1	2	2	1	2	1	2
	0	1	2	1	1	2	2	
	1	0	1	2	2	1	2	
	0	1	1	2	1	1	1	
mean	0.2	0.8	1.4	1.6	1.4	1.4	1.2	2
Activity Level *	4	2	2	2	1	1	1	1

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber

Table 24. Respirometry and activity levels of adult sockeye salmon - Expt. #4

Experiment #4: 05 - 09 Sept, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)	Control Fish No.				DHA Fish No.			
Breaths/min.	51	42	55	54	48	56	60	54
	52	41	54	60	47	50	62	53
	50	46	53	56	50	60	65	54
	52	43	55	52	46	54	63	57
	54	44	56	52	46	56	64	58
mean	52	43	55	55	47	55	63	55
Coughs/min.	1	1	1	1	0	0	0	1
	0	0	0	0	0	0	0	2
	0	2	1	1	0	0	0	2
	2	1	0	1	1	0	0	0
	0	0	0	0	2	0	0	0
mean	0.6	0.8	0.4	0.6	0.6	0	0	1
Activity Level *	2	1	2	2	2	3	2	1
Baseline (AM)								
Breaths/min.	47	48	38	48	48	38	46	53
	43	47	40	51	49	40	51	51
	41	52	37	50	50	38	47	52
	41	48	41	48	47	38	53	50
	42	51	40	49	43	40	48	53
mean	43	49	39	49	47	39	49	52
Coughs/min.	1	0	0	0	0	1	1	0
	1	0	0	0	1	1	0	1
	0	0	1	1	1	1	1	2
	1	1	1	1	1	1	2	1
	0	1	0	1	1	1	1	2
mean	0.6	0.4	0.4	0.6	0.8	1	1	1.2
Activity Level *	1	1	2	1	2	1	2	2

Table 24. (cont.)

Experiment 4: 05 - 09 Sept, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Exposure (PM)								
Breaths/min.	47	60	53	61	55	55	61	54
	48	59	50	64	55	53	58	52
	47	58	52	66	54	52	54	52
	51	55	53	61	54	53	56	53
	48	54	50	65	55	52	62	53
mean	48	57	52	63	55	53	58	53
Coughs/min.	0	1	0	2	0	1	0	3
	1	1	1	1	0	1	1	2
	1	0	1	0	1	0	1	0
	1	1	1	1	1	0	0	2
	0	1	0	1	1	1	2	2
mean	0.6	0.8	0.6	1	0.6	0.6	0.8	1.8
Activity Level *	2	2	1	2	2	1	2	2
Exposure (AM)								
Breaths/min.	52	60	54	58	74	50	58	60
	51	56	54	59	78	50	56	61
	54	59	49	56	81	49	58	59
	56	62	53	58	81	47	57	58
	52	56	52	57	79	49	61	62
mean	53	59	52	58	79	49	58	60
Coughs/min.	0	1	1	1	0	1	0	0
	1	1	1	0	0	1	0	0
	0	1	1	1	1	0	1	0
	1	0	1	1	1	1	0	1
	0	1	0	1	0	1	1	1
mean	0.4	0.8	0.8	0.8	0.4	0.8	0.4	0.4
Activity Level *	2	1	2	1	2	1	2	1

Table 24. (cont.)**Experiment 4: 05 - 09 Sept, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	67	70	60	74	82	59	62	78
	64	72	66	75	75	42	60	80
	60	69	66	76	78	46	62	75
	58	66	61	73	76	50	60	75
	62	66	64	75	78	42	64	78
mean	62	69	63	75	78	48	62	77
Coughs/min.	1	0	2	2	0	2	1	2
	1	0	2	2	0	1	1	1
	1	0	1	1	0	1	1	1
	1	1	2	2	0	2	2	0
	0	1	3	2	0	1	1	0
mean	0.8	0.4	2	1.8	0	1.4	1.2	0.8
Activity Level *	2	2	1	2	3	4	2	3
Freshwater Conversion (AM)								
Breaths/min.	66	54	67	75	88	84	76	75
	65	49	68	74	83	68	79	85
	67	58	66	79	73	63	76	82
	64	54	67	78	69	80	72	81
	65	60	66	73	72	96	75	84
mean	65	55	67	76	77	78	76	81
Coughs/min.	1	0	1	0	0	0	1	2
	1	1	1	0	0	0	1	3
	1	1	1	3	0	1	1	2
	1	0	2	2	0	0	2	1
	0	1	1	4	1	0	1	2
mean	0.8	0.6	1.2	1.8	0.2	0.2	1.2	2
Activity Level *	2	1	1	2	3	4	2	3

Table 24. (cont.)**Experiment 4: 05 - 09 Sept, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	39	45	39	49	43	34	40	45
	42	44	40	48	44	34	38	53
	44	43	40	44	42	33	42	52
	44	44	41	46	43	34	38	50
	42	42	42	46	42	32	42	48
mean	42	44	40	47	43	33	40	50
Coughs/min.	0	0	0	1	1	1	1	2
	0	0	0	0	1	0	1	3
	1	1	0	2	0	0	1	2
	0	1	0	0	1	0	2	2
	0	0	0	0	0	1	0	2
mean	0.2	0.4	0	0.6	0.6	0.4	1	2.2
Activity Level *	1	1	1	1	1	1	2	2

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber
 ram - indicates ram ventilation was observed during the measurement period

Table 25. Respirometry and activity levels of adult sockeye salmon - Expt. #5

Experiment #5: 11 - 15 Sept, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)	Control Fish No.				DHA Fish No.			
Breaths/min.	49	45	49	58	69	56	56	50
	44	50	50	60	68	60	56	52
	44	52	54	58	72	56	56	59
	48	44	54	63	72	58	54	60
	46	50	56	62	70	61	55	62
mean	46	48	53	60	70	58	55	57
Coughs/min.	1	1	0	0	2	0	1	1
	1	1	0	0	0	0	0	0
	1	1	0	0	2	1	1	1
	0	2	0	2	1	0	2	2
	0	1	0	1	2	1	1	1
mean	0.6	1.2	0	0.6	1.4	0.4	1	1
Activity Level *	1	1	1	1	3	1	2	1
Baseline (AM)								
Breaths/min.	34	45	53	56	42	55	51	50
	35	42	56	49	44	52	49	53
	33	40	54	52	48	54	54	54
	32	40	51	50	43	58	52	48
	37	43	56	54	49	51	56	49
mean	34	42	54	52	45	54	52	51
Coughs/min.	1	1	0	1	0	0	1	1
	0	1	1	0	0	0	1	1
	0	0	1	0	1	1	0	2
	1	0	1	1	1	1	0	1
	0	1	2	0	0	1	1	0
mean	0.4	0.6	1	0.4	0.4	0.6	0.6	1
Activity Level *	1	1	2	2	2	2	2	2

Table 25. (cont.)

Experiment 5: 11 - 15 Sept, 1995

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Exposure (PM)								
Breaths/min.	38	42	49	45	53	56	49	47
	35	40	50	46	50	58	54	48
	39	38	57	51	45	53	53	48
	40	40	58	47	48	50	52	52
	40	38	52	50	51	60	52	48
mean	38	40	53	48	49	55	52	49
Coughs/min.	0	0	1	0	0	0	0	0
	0	0	1	1	0	0	1	1
	0	0	2	1	1	0	1	2
	0	0	1	2	0	1	1	0
	0	1	0	1	0	0	2	1
mean	0	0.2	1	1	0.2	0.2	1	0.8
Activity Level *	1	1	2	1	1	1	2	2
Exposure (AM)								
Breaths/min.	36	39	45	48	56	48	48	51
	36	40	46	41	58	52	46	48
	38	37	46	43	51	52	45	53
	38	38	47	42	53	56	46	50
	36	40	43	45	59	53	46	51
mean	37	39	45	44	55	52	46	51
Coughs/min.	0	1	1	1	0	0	1	1
	0	1	1	2	1	1	1	1
	1	1	1	2	1	0	0	0
	0	2	1	1	1	0	1	1
	1	1	0	2	0	1	1	0
mean	0.4	1.2	0.8	1.6	0.6	0.4	0.8	0.6
Activity Level *	1	1	1	2	1	1	2	2

Table 25. (cont.)**Experiment 5: 11 - 15 Sept, 1995**

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	40	64	66	79	85	69	66	86
	49	65	68	80	81	70	70	88
	40	66	66	80	76	68	72	98
	48	65	62	81	79	70	69	92
	42	64	62	76	80	71	71	102
mean	44	65	65	79	80	70	70	93
ram								
Coughs/min.	2	0	3	3	1	1	1	0
	3	0	2	2	1	1	0	0
	2	0	2	3	0	1	0	0
	2	1	2	2	3	1	0	0
	2	1	3	1	1	1	1	0
mean	2.2	0.4	2.4	2.2	1.2	1	0.4	0
Activity Level *	1	2	2	2	3	3	3	4
Freshwater Conversion (AM)								
Breaths/min.	45	84	65	56	96	87	60	72
	55	81	60	58	103	96	62	70
	51	75	64	60	91	97	59	72
	51	91	59	64	105	106	57	74
	49	89	56	57	108	115	60	69
mean	50	84	61	59	101	100	60	71
ram								
Coughs/min.	1	0	0	1	1	0	1	1
	1	0	0	2	1	0	1	0
	2	0	1	2	0	1	0	1
	1	1	1	1	1	0	1	0
	2	1	0	1	0	0	0	0
mean	1.4	0.4	0.4	1.4	0.6	0.2	0.6	0.4
Activity Level *	2	4	2	3	4	4	2	2

Table 25. (cont.)**Experiment 5: 11 - 15 Sept, 1995**

	Normoxic Control Fish No.				Normoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	41	40	60	60	48	38	0	60
	46	36	58	59	52	36	0	56
	45	38	53	60	48	44	0	58
	46	42	54	58	48	42	0	60
	42	45	56	55	50	39	0	54
mean	44	40	56	58	49	40	dead	58
Coughs/min.	0	0	1	1	1	0	0	1
	0	0	1	0	0	0	0	1
	0	0	1	2	2	0	0	1
	0	1	2	1	1	1	0	0
	1	1	1	1	0	1	0	0
mean	0.2	0.4	1.2	1	0.8	0.4	dead	0.6
Activity Level *	1	1	2	2	2	1	dead	2

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber
 ram - indicates ram ventilation was observed during the measurement period

Table 26. Respirometry and activity levels of adult sockeye salmon - Expt. #6

Experiment #6: 18 - 22 Sept, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Acclimation (PM)	Control Fish No.				DHA Fish No.			
Breaths/min.	46	56	61	82	45	34	78	89
	47	46	60	72	46	32	80	90
	48	51	56	74	42	41	81	87
	48	45	56	91	44	40	82	84
	50	48	59	94	41	42	82	86
mean	48	49	58	83	44	38	81	87
Coughs/min.	0	0	1	1	2	0	0	0
	0	0	0	1	0	0	0	0
	2	1	0	0	2	1	1	0
	2	1	0	0	2	0	2	0
	0	0	1	0	0	1	1	0
mean	0.8	0.4	0.4	0.4	1.2	0.4	0.8	0
Activity Level *	2	2	3	4	1	2	4	4
Baseline (AM)								
Breaths/min.	36	38	60	52	48	48	40	43
	38	40	55	51	51	47	42	40
	37	37	60	48	50	51	40	41
	40	41	62	47	51	50	42	42
	40	42	60	50	52	49	39	44
mean	38	40	59	50	50	49	41	42
Coughs/min.	0	0	0	0	0	1	0	0
	0	0	0	0	1	0	0	0
	1	0	1	1	1	1	0	1
	0	0	0	1	0	2	0	2
	0	1	0	0	1	1	0	0
mean	0.2	0.2	0.2	0.4	0.6	1	0	0.6
Activity Level *	1	1	3	3	1	1	1	1

Table 26. (cont.)

Experiment 6: 18 - 22 Sept, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Exposure (PM)								
Breaths/min.	65	61	62	69	82	85	60	60
	58	60	64	70	81	86	61	57
	59	63	60	69	81	75	65	60
	60	61	62	68	84	81	60	58
	60	61	67	66	80	77	62	57
mean	60	61	63	68	82	81	62	58
Coughs/min.	1	0	0	1	0	0	0	1
	1	0	1	2	2	0	0	0
	1	0	1	1	1	0	2	0
	1	0	1	2	0	0	1	0
	1	1	0	1	1	1	0	1
mean	1	0.2	0.6	1.4	0.8	0.2	0.6	0.4
Activity Level *	2	1	2	2	3	3	1	1
Exposure (AM)								
Breaths/min.	60	58	53	60	70	68	64	70
	59	60	55	62	68	65	64	66
	59	59	54	61	70	63	63	65
	60	60	54	60	71	60	64	64
	58	58	56	60	69	64	63	66
mean	59	59	54	61	70	64	64	66
Coughs/min.	1	0	0	1	0	0	0	1
	1	0	0	2	0	0	0	1
	0	0	0	2	0	0	1	1
	0	1	0	1	1	0	1	1
	0	0	0	1	0	0	0	0
mean	0.4	0.2	0	1.4	0.2	0	0.4	0.8
Activity Level *	1	1	1	2	1	1	3	2

Table 26. (cont.)**Experiment 6: 18 - 22 Sept, 1995**

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Freshwater Conversion (PM)								
Breaths/min.	80	62	72	71	75	68	68	70
	83	62	66	69	70	71	65	70
	85	65	71	66	76	70	63	69
	86	63	75	72	76	73	68	72
	84	68	69	65	76	72	67	70
mean	84	64	71	69	75	71	66	70
Coughs/min.	0	0	0	2	3	2	0	2
	0	0	1	1	1	1	0	1
	1	1	1	2	2	2	0	1
	1	1	1	1	3	1	0	0
	0	2	1	1	1	0	0	1
mean	0.4	0.8	0.8	1.4	2	1.2	0	1
Activity Level *	3	2	1	2	2	3	2	2
Freshwater Conversion (AM)								
Breaths/min.	70	62	74	60	74	60	68	67
	68	68	76	59	72	61	67	68
	69	65	78	63	68	63	64	70
	72	68	73	60	71	63	67	65
	67	67	76	61	67	67	64	66
mean	69	66	75	61	70	63	66	67
Coughs/min.	1	1	1	1	1	0	0	0
	1	1	0	0	1	0	0	1
	1	1	1	0	0	0	0	1
	0	0	0	0	0	1	0	2
	1	1	1	1	0	0	0	1
mean	0.8	0.8	0.6	0.4	0.4	0.2	0	1
Activity Level *	2	2	2	3	2	3	3	2

Table 26. (cont.)

Experiment 6: 18 - 22 Sept, 1995

	Hypoxic Control Fish No.				Hypoxic DHA Fish No.			
	1	2	3	4	5	6	7	8
Post Swim Test (AM)								
Breaths/min.	45	38	45	56	57	50	32	41
	47	40	48	54	59	51	38	43
	46	42	52	59	60	48	36	44
	50	39	49	55	56	49	33	42
	46	40	44	58	54	52	35	40
mean	47	40	48	56	57	50	35	42
Coughs/min.	0	1	0	0	1	1	0	1
	0	1	2	1	1	0	1	0
	0	1	1	2	1	0	1	0
	0	0	1	1	1	1	1	0
	0	0	0	1	1	1	1	1
mean	0	0.6	0.8	1	1	0.6	0.8	0.4
Activity Level *	1	2	3	2	2	2	1	2

* Activity level : 1- Stationary on bottom; 2 - slowly swimming; 3 - rapid swimming 4 - agitated/turning in chamber

