



UNIVERSITAS AIRLANGGA

FAKULTAS PERIKANAN DAN KELAUTAN

Kampus C Mulyorejo Surabaya 60115 Telp. (031) 5911451 Fax (031) 5965741

Laman : <https://fpk.unair.ac.id>, e-mail : info@fpk.unair.ac.id

SURAT KETERANGAN

Nomor: 1441/UN3.FPK/KP/2023

Yang bertanda tangan di bawah ini:

Nama : **Dr. Eng. Sapto Andriyono, S.Pi., MT.**
NIP : 197909252008121002
Pangkat/Golongan : Penata/III - C
Jabatan : Wakil Dekan III

Dengan ini menerangkan bahwa:

Nama : **Dr. Endang Dewi Masithah, Ir., MP.**
NIP : 196909121997022001
Pangkat/Golongan : Pembina/IV - A
Jabatan : Lektor Kepala

Telah melakukan penelitian yang dipublikasi pada bulan November tahun 2022 dengan judul sebagai berikut:

The Effect of Temperature Differences on The Gonad Maturity Levels and Embryogenesis of Vaname Shrimp Broodstock (Litopenaeus vannamei)

Adapun penelitian ini sudah mengacu pada prosedur pertimbangan etik dari:

1. *American Fisheries Society* (AFS, 2014) yang berjudul *Guideline for the Use of Fishes in Research* yang menyebutkan bahwa: penelitian dalam kondisi laboratorium baru mengatur tentang hewan percobaan berupa ikan hidup, untuk hewan percobaan berupa udang (crustacean) tidak termasuk (hal 43 ; terlampir), dan
2. *Canadian Council on Animal Care* (CCAC, 2005) yang berjudul *Guideline on the Care and Use of Fish in Research, Teaching and Testing* yang menyebutkan bahwa: pedoman tersebut hanya digunakan untuk hewan uji berupa ikan (Kelas: Chondrichthyes, Agnatha, dan Osteichthyes) dan Avertebrata (Kelas: Cephalopoda) (hal 13,14 ; terlampir).

Sedangkan dalam penelitian tersebut menggunakan indukan udang vaname sebagai hewan percobaan. Sehingga penelitian tersebut tidak perlu dilakukan ***Uji Ethical Clearance***.

Demikian Surat Keterangan ini kami buat untuk dapat dipergunakan sebagai persyaratan pengusulan Jabatan Fungsional **Guru Besar** atas nama Dr. Endang Dewi Masithah, Ir., MP.

Surabaya, 27 April 2023

Wakil Dekan III FPK Unair

Dr. Eng. Sapto Andriyono, S.Pi., MT.
NIP. 197909252008121002

Mengetahui,
Dekan FPK Unair



Priat Moch Amin Alamsjah, Ir., M.Si., Ph.D.
NIP. 197001161995031002

Guidelines for the Use of Fishes in Research

Use of Fishes in Research Committee members:

J. A. Jenkins, Chair, H. L. Bart, Jr., J. D. Bowker, P. R. Bowser, J. R. MacMillan, J. G. Nickum, J. D. Rose, P. W. Sorensen, and G. W. Whitley on behalf of the American Fisheries Society; J. W. Rachlin and B. E. Warkentine on behalf of the American Institute of Fishery Research Biologists; and H. L. Bart on behalf of the American Society of Ichthyologists and Herpetologists

American Fisheries Society
Bethesda, Maryland
2014

A suggested citation format for this book follows.

Use of Fishes in Research Committee (joint committee of the American Fisheries Society, the American Institute of Fishery Research Biologists, and the American Society of Ichthyologists and Herpetologists). 2014. Guidelines for the use of fishes in research. American Fisheries Society, Bethesda, Maryland.

Cover art: Close-up photograph of Brown Trout, *Salmo trutta*, from the South Fork of the Cache la Poudre River, Colorado, taken by James Rose in 2010.

© Copyright 2014 by the American Fisheries Society

All rights reserved. Photocopying for internal or personal use, or for the internal or personal use of specific clients, is permitted by AFS provided that the appropriate fee is paid directly to Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, Massachusetts 01923, USA; phone 978-750-8400. Request authorization to make multiple copies for classroom use from CCC. These permissions do not extend to electronic distribution or long-term storage of articles or to copying for resale, promotion, advertising, general distribution, or creation of new collective works. For such uses, permission or license must be obtained from AFS.

Printed in the United States of America on acid-free paper.

Library of Congress Control Number 2014943876
ISBN 978-1-934874-39-4

American Fisheries Society Web site address: www.fisheries.org

American Fisheries Society
5410 Grosvenor Lane, Suite 100
Bethesda, Maryland 20814
USA

Table of Contents

Use of Fishes in Research Committee, 2014	vii
Preface.....	ix
Acknowledgments.....	xi
Statement of Purpose	xiii
1. Introduction.....	1
2. General Considerations.....	3
2.1 Approval of Research Plans by IACUCs	3
2.2 Project Quality Assurance Plans and Standard Operating Procedures	4
2.3 Statistical Design.....	5
2.4 Mortality as an Experimental Endpoint	6
2.5 Fish Health Management: Control of Pathogens and Parasites	6
3. Statutory Requirements and Regulatory Bodies.....	9
3.1 International Regulations and Guidelines	9
3.2 Biosecurity	11
3.3 Federal, State, and Local Regulations.....	12
3.4 Permits and Certificates	14
4. Animal Welfare Considerations.....	17
4.1 General Considerations	17
4.2 Stress	17
4.2.1 Stages of Stress.....	18
4.2.2 Measuring and Avoiding Stress.....	18
4.3 Nociception and Pain	20
5. Field Activities.....	23
5.1 Habitat and Population Considerations.....	23
5.2 Field Collections	23
5.2.1 Permits.....	23
5.2.2 Natural History Collections.....	24

5.2.3 Representative Samples	24
5.2.4 Collection of Imperiled Species	25
5.2.5 Museum Specimens and Other Preserved Specimens	26
5.3 Live Capture Techniques and Equipment	28
5.4 Field Restraint of Fishes: Sedatives	28
5.4.1 Drugs Approved for Use on Fish	29
5.4.2 Low Regulatory Priority (LRP) Drugs	29
5.4.3 Investigational New Animal Drugs (INAD)	30
5.5 Dangerous Species and Specimens	30
5.6 Handling and Transport	31
5.7 Facilities for Temporary Holding and Maintenance	32
5.8 Field Acclimation	33
5.9 Collection of Blood and Other Tissues	34
6. Marking and Tagging	37
6.1 General Principles	37
6.2 External Tags and Marks	37
6.3 Internal Tags and Marks, and Biotelemetry	38
6.4 Genetic Markers	40
6.5 Stable Isotopes	41
6.6 Fatty Acids	42
7. Laboratory Activities	43
7.1 General Principles	43
7.2 Confinement, Isolation, and Quarantine	43
7.3 Acclimation to Laboratory Conditions	45
7.4 Facilities for Long-Term Housing of Fishes	45
7.5 Density of Animals	47
7.6 Feeds and Feeding	47
7.7 Water Quality	49
7.8 Water Recirculation Units	50
7.9 Effluents and Permits	51

7.10 Dangerous Species and Specimens in Captivity	51
7.11 Restraint of Fishes: Sedatives and Related Chemicals.....	52
7.12 Surgical Procedures.....	53
7.13 Administration of Drugs, Biologics, and Other Chemicals	55
7.13.1 Drugs	55
7.13.2 Biologics and Other Chemicals	56
7.13.3 Chemical Facility Anti-Terrorism Standards (CFATS)	56
8. Final Disposition of Experimental Animals	59
8.1 Euthanasia	59
8.2 Storage or Return to Aquatic Habitat.....	60
9. Future Revisions	61
10. Literature Cited	63
Appendix.....	85
Brief Checklist for IACUC Readiness	85
List of Low Regulatory Priority Drugs and Consideration for Their Use	86
Appendix Table 1. Low regulatory priority aquaculture drugs, indications, and doses.	87
Appendix Table 2. OIE-notifiable causative disease agents for fish and amphibians.	88
Index of Terms and Acronyms.....	89
Note on Additional Readings	90

Studies of early life stages may require very large numbers of individuals. In all cases, studies should be designed to use the fewest animals necessary to reliably answer the questions posed. The use of adequate numbers to establish variance and to ensure reliability is essential so as to prevent needless repetition of the study (ASIH et al. 1987, 1988). A true “replicate” is the smallest experimental unit to which a treatment can be applied independently. Pseudoreplication can result from wrongly treating multiple samples from one experimental unit as multiple experimental units or from using experimental units that are not statistically independent (Heffner et al. 1996). Statistical power analysis can improve designs of experiments (Peterman 1990). Conducting statistical power analyses ensures the development of study designs that have the appropriate statistical power to accomplish research objectives.

2.4 Mortality as an Experimental Endpoint

In laboratory studies, experimental endpoints, other than death of the experimental subjects, should be developed unless mortality is required by the study protocol. The use of mortality as an endpoint is appropriate when one or both of the following criteria are met: (1) Little or no information pertaining to research objectives is available on the species of interest or the experimental variable being imposed (e.g., short-term, limited mortality studies may be used to develop experimental limits for subsequent sublethal studies), and (2) mortality data are required, or at least preferred, by a sponsoring agency to provide a basis for criteria development as part of a regulatory process. Studies that require mortality endpoints include, but are not limited to, those concerning the effects of pathogens and parasites, toxicological research, and physiological tolerance.

2.5 Fish Health Management: Control of Pathogens and Parasites

In laboratory studies involving fishes, healthy subjects are prerequisites for reliable data (Jenkins 2011a), unless an infectious disease is part of the experimental protocol. Fish used in research must be free of any notable microbial presence that could indicate a diseased condition. Fish free from infectious fish pathogens generally will be satisfactory; however, an unrecognized disease condition, even at chronic or nonlethal levels, can seriously confound research results (Lawrence et al. 2012). The source of fish used in research will, in general, influence their health status. Fish raised in captivity have a level of health oversight that will not occur in wild-caught fish. When inquiring about the health status of fish at a culture facility, the researcher can request specific information including any available fish health inspection reports. When fish are brought into a laboratory setting from the wild, the researcher should expect that microorganisms are present. If no disease symptoms are apparent, this is no guarantee that these wild-caught fish are free from problematic disease organisms. Once those fish are in a laboratory setting, the culture conditions and associated stressors will be very different from those in the natural environment, whereby an active disease event can develop. Many laboratories will administer formalin baths to newly arrived fish during an acclimation period (see section [7.3 Acclimation to Laboratory Conditions](#)). The goal is to eliminate external protozoa and monogeneans from the

4. Animal Welfare Considerations

4.1 General Considerations

Research involving living animals, including fishes, must be based on experimental designs and animal care practices that can lead to scientifically valid results. Fishes are acutely sensitive to stress (e.g., Barton and Iwama 1991), and responses may include changes in behavior (e.g., Martins et al. 2012), reduced growth, changes in osmotic status, suppressed immune systems (with consequent disease onset), and altered reproductive capacity (Iwama et al. 2006; Schreck et al. 2001; Schreck 2010). Accordingly, unless the experimental objectives require actions or conditions designed to test responses to stress, fishes should be maintained, handled, and tested under conditions that will not create such responses. The Guidelines addresses the conduct of scientific research and focuses on established facts and the processes through which knowledge is developed. Research plans submitted to IACUCs should address animal care considerations, in addition to the details of research goals, objectives, and procedures. The extent to which IACUCs incorporate personal values concerning animal welfare into their institutional guidelines is determined within each institution.

4.2 Stress

The study of stress has focused on how animals have evolved physiological and behavioral mechanisms to address the challenges of changing environmental conditions and then to permit them to maintain homeostasis, or self-sustaining balance. The set of environmental variables (conditions) best suited for the well-being of each species typically encompasses a specific range for each factor and species (see section 5.7 Facilities for Temporary Holding and Maintenance), as stress responses are species-specific (Schreck 2010). Accordingly, when fishes are maintained within these ranges, a state of homeostatic balance is expected. Deviations from homeostasis characterize a stress response. While many definitions for stress have been proposed, we employ the definition of Schreck (2000) and Schreck et al. (2001): “a physiological cascade of events that occurs when the organism is attempting to resist death or reestablish homeostatic norms in the face of insult.” When stressed, fish generally attempt to reestablish homeostasis via a process known as “allostasis regulation in which they adjust their physiological function to re-establish a dynamic balance” (Sterling and Eyer 1988). While allostasis is generally adaptive because it helps keep animals alive in the face of a short-term stressor(s), it can be maladaptive over the long term and have negative consequences on growth, reproduction, and immunological health (Schreck 2010). Accordingly, investigators need to understand those factors that might cause stress in their experimental animal(s), the potential consequences, and how stress might be avoided by optimizing experimental conditions.

7. Laboratory Activities

7.1 General Principles

Working with live fishes under laboratory conditions requires attention to many details concerning the requirements for, and limits of tolerance of, the particular species under study. Acceptable physical facilities and an adequate supply of water with good quality must be provided, even if the fishes are to be held for only short periods of time. Although fish may tolerate marginal facilities and conditions for a few hours or even several days, holding them under less than optimal conditions will affect the results of the research. Standards for humane treatment of animals must also be maintained, regardless of the length of time that the fishes are held.

The reader should note that some content of section 7 is not restricted to laboratory activities, but may be applicable to field situations, as well.

7.2 Confinement, Isolation, and Quarantine

Prior to bringing fishes into a laboratory, facilities and plans should be in place to ensure that the fish cannot escape, especially species not native to the watershed, and that the introduced fishes can be isolated physically from fishes already present. Each holding unit should have its own set of nets and other equipment. Facilities and equipment used for previous studies should be disinfected prior to use in new studies, typically with a chlorinated disinfectant or another disinfectant such as Virkon[®] Aquatic (www.wchemical.com/). If the introduced fishes may carry disease agents, especially pathogens or parasites that are not endemic to the area, quarantine-level facilities should be used. The level of quarantine required will vary with the seriousness of the known or suspected disease agent (see section 2.5 Fish Health Management: Control of Pathogens and Parasites).

Individual fish with suspected ill health should be quarantined from the others so as to negate the potential for spread of potential disease agents. Such fish should be evaluated by an individual with expertise in fish diseases (fish pathologist or veterinarian), and the proper therapeutant should be applied as directed. Providing guidance for the treatment of specific diseases is beyond the scope of this document. The investigator is strongly urged to establish a working relationship with individuals with expertise in fish health with whom they may consult.

Experimentation with nonindigenous fishes, transgenic fishes, or other genetically modified fishes is a special situation that requires additional precautions to preclude their escape. Permitting with site visits by state wildlife agencies may be required for holding nonindigenous species (see section 3.4 Permits and Certificates). The specific barriers may be similar to those used to prevent the escape of disease agents but must be developed to fit the physical characteristics of the laboratory or experimental facility. The USDA has developed

Canadian Council on Animal Care



guidelines on:

***the care and use of
fish in research,
teaching and
testing***

This document, the CCAC *guidelines on: the care and use of fish in research, teaching and testing*, has been developed by the *ad hoc* subcommittee on fish of the Canadian Council on Animal Care (CCAC) Guidelines Committee.

Mr John Batt, Dalhousie University
Dr Kristina Bennett-Steward, Bioniche
Mr Cyr Couturier, Memorial University
Dr Larry Hammell, University of Prince Edward Island
Dr Chris Harvey-Clark, University of British Columbia (Chair)
Mr Henrik Kreiberg, Fisheries and Oceans Canada
Dr George Iwama, Acadia University
Dr Santosh Lall, National Research Council
Dr Matt Litvak, University of New Brunswick at St John
Dr Don Rainnie, University of Prince Edward Island
Dr Don Stevens, University of Guelph
Dr Jim Wright, University of Calgary
Dr Gilly Griffin, Canadian Council on Animal Care

In addition, the CCAC is grateful to former members of CCAC Council: Ms Susan Waddy, Fisheries and Oceans Canada; Dr Jack Miller, University of Western Ontario; and Dr Choong Foong, Dalhousie University; and to Dr David Noakes, University of Guelph who provided considerable assistance in preliminary phases of this project. CCAC thanks the many individuals, organizations and associations that provided comments on earlier drafts of this guidelines document. In particular, thanks are extended to representatives of Fisheries and Oceans Canada, Environment Canada, the Canadian Aquaculture Institute, the Canadian Food Inspection Agency and the Canadian Society of Zoologists.

© Canadian Council on Animal Care, 2005

ISBN: 0-919087-43-4

Canadian Council on Animal Care
1510-130 Albert Street
Ottawa ON CANADA
K1P 5G4

<http://www.ccac.ca>

TABLE OF CONTENTS

A. PREFACE	1		
SUMMARY OF THE GUIDELINES LISTED IN THIS DOCUMENT	3		
B. INTRODUCTION	13		
1. Definition of Fish	13		
2. Rationale for Guidelines on the Care and Use of Fish	13		
3. Ethical Overview	14		
3.1 Principles of the Three Rs	14		
4. Responsibilities	15		
4.1 Responsibilities of investigators ..	15		
4.2 Responsibilities of the animal care committee	16		
4.3 Role of the veterinarian	17		
5. Government Regulations and Policies on the Use of Fish	17		
5.1 International	17		
5.2 Federal	18		
5.3 First Nations	20		
5.4 Provincial/territorial	20		
5.5 Municipal	20		
C. AQUATIC FACILITIES	21		
1. Water Supply	21		
2. Water Quality	21		
3. Engineering and Design	22		
3.1 Structural materials	23		
3.2 Room ventilation and airflow in aquatic areas	24		
3.3 Mechanical and electrical requirements	25		
3.4 Lighting	25		
3.5 Redundancy in aquatic life support systems	26		
4. Types of Systems	26		
4.1 Flow-through systems	27		
4.2 Recirculation systems	27		
4.3 Static systems	27		
4.4 Mesocosms	28		
5. Fish Housing	28		
5.1 Fish well-being	28		
5.2 Tank/enclosure design	28		
D. FACILITY MANAGEMENT, OPERATION AND MAINTENANCE	31		
1. Security and Access	31		
2. General Maintenance of the Facility ..	31		
3. Environmental Monitoring and Control	32		
3.1 Management of water quality ..	33		
3.2 Temperature	33		
3.3 Oxygen	34		
3.4 Supersaturation	34		
3.5 pH	35		
3.6 Nitrogen compounds	35		
3.7 Carbon dioxide	36		
3.8 Salinity	36		
3.9 Toxic agents	37		
E. CAPTURE, ACQUISITION, TRANSPORTATION AND QUARANTINE	38		
1. Capture of Wild Stock	38		
2. Killed Specimens	38		
3. Piscicidal Compounds	38		

4. Acquisition of Hatchery Fish	39	3.3 Anesthesia	53
5. Transportation	39	3.4 Surgical equipment	54
6. Quarantine and Acclimation	40	3.5 Incisions	54
6.1 Quarantine	40	3.6 Suture materials and techniques . .	54
6.2 Acclimation	41	3.7 Pathophysiology of surgery and wound healing in fishes	55
F. HUSBANDRY	42	3.8 Postoperative care	55
1. Record-keeping and Documentation . .	42	4. Administration of Compounds and Devices by Various Routes	56
1.1 Standard Operating Procedures .	42	4.1 Branchial diffusion ("inhalation")	56
1.2 General checklists	42	4.2 Oral	56
1.3 Assessment of fish well-being . .	42	4.3 Injection	57
2. Density and Carrying Capacity	42	4.4 Implants, windows and bioreactors	57
3. Food, Feeding and Nutrition	43	5. Tagging and Marking	57
3.1 Nutrition	43	5.1 Tissue marking	58
3.2 Food and feeding	43	5.2 Tagging	58
3.3 Feed quality and storage	43	6. Collection of Body Fluids	58
3.4 Larval weaning	45	7. Use of Infectious Disease Agents, Tumorigenic or Mutagenic Agents, and Toxic and Noxious Compounds . .	59
3.5 Use of medicated feeds	45	8. Endpoints and Criteria for Early Euthanasia	59
4. Broodstock and Breeding	46	8.1 Recognition of "pain", "distress" and "stress"	59
4.1 Induction of spawning	46	8.2 Choosing an appropriate endpoint	60
G. HEALTH AND DISEASE CONTROL	47	9. Monitoring	62
1. Fish Health Program	47	10. Negative Reinforcement Modalities . .	62
1.1 Disease prevention	47	11. Exercise to Exhaustion	62
1.2 Disease diagnosis and identification of pathogens	47	12. Environmental Extremes	62
1.3 Injuries and other disorders	48	13. Genetically Modified Fish	62
H. EXPERIMENTAL PROCEDURES . .	50	I. EUTHANASIA	64
1. Handling and Restraint	50	J. DISPOSITION OF FISH AFTER STUDY	65
1.1 Restraint of dangerous species . .	51		
2. Restricted Environments	51		
3. Surgery	51		
3.1 Surgical preparation and skin disinfection	52		
3.2 Water quality during surgery . . .	53		

1. Consumption of Fish65
2. Release of Fish to Wild65
3. Fish as Pets65
4. Transfer of Fish Between Facilities65
5. Disposal of Dead Fish65
K. REFERENCES66
L. GLOSSARY73
M. ABBREVIATIONS75
APPENDIX A RELEVANT GUIDELINES AND ORGANIZATIONS76

APPENDIX B ZOOBOTIC DISEASE- TRANSMISSION OF FISH DISEASES TO MAN77
--	------------

APPENDIX C GUIDELINES FOR CONTAINMENT FACILITIES (FOR PATHOGEN STUDIES)79
--	------------

APPENDIX D WATER QUALITY CRITERIA FOR OPTIMUM FISH HEALTH – FOR COLDWATER, WARMWATER AND MARINE SPECIES OF FISH84
--	------------

the care and use of fish in research, teaching and testing



A. PREFACE

The Canadian Council on Animal Care (CCAC) is the national peer review agency responsible for setting and maintaining standards for the care and use of animals used in research, teaching and testing throughout Canada. In addition to the *Guide to the Care and Use of Experimental Animals*, vol. 1, 2nd ed., 1993 and vol. 2, 1984, which provide the general principles for the care and use of animals, the CCAC also publishes detailed guidelines on issues of current and emerging concerns. The CCAC *guidelines on: the care and use of fish in research, teaching and testing* is the seventh of this series. This document supersedes Chapter I - Fish, *Guide to the Care and Use of Experimental Animals*, vol. 2 (CCAC, 1984).

These guidelines aim to provide information for investigators, animal care committees, facility managers and animal care staff that will assist in improving both the care given to fishes and the manner in which experimental procedures are carried out.

The present document has drawn substantially from the work of organizations listed in Appendix A. Their contributions to the development of these guidelines are gratefully acknowledged.

The guidelines have been developed by the CCAC subcommittee on fish and were reviewed by a total of 69 experts. A preliminary first draft was agreed on by the subcommittee and circulated to experts in June 2002 (including representatives of the organizations listed in Appendix A), and a second draft was circulated for widespread comment in June 2003. A final review was carried out in August 2004 involving all individuals who had previously provided significant input to the development process. The development of these guidelines also involved consultation with the Canadian Association for Laboratory Animal Science (CALAS) and the Canadian Society of Zoologists (CSZ) through workshops held at annual meetings in Québec City (June 2003), Acadia University (May 2004), and Hamilton (June 2004). Consultations were also held at the Aquaculture Association of Canada and AquaNet annual meetings in Québec City (October 2004), and at the CCAC Workshop on the Fish Guidelines in Vancouver (April 2005).

The guidelines have been organized in a format that should facilitate easy access to relevant sections. Early sections provide an ethical overview relevant to the use of fishes in research, teaching and testing. This is followed

by a brief overview of regulations and responsibilities relevant to the care and use of fishes in science in Canada. The remainder of the document provides guidelines to assist in caring for fishes in laboratory facilities, followed by guidelines to help in the development and review of experimental protocols. An overview of the CCAC *guidelines on: the care and use of fish in research, teaching and testing* is provided through a summary of the guidelines listed in

this document prior to the beginning of the main text.

The refinement of animal care and use guidelines is a continuous process. These guidelines are intended to provide assistance in the implementation of best practices, and should not be viewed as regulations. Where regulatory requirements are involved or where it is absolutely imperative to adhere to a particular guideline, the term *must* has been used.

B. INTRODUCTION

The greatest challenge in providing *guidelines on: the care and use of fish* is the wide variety of fishes used in Canada and the diversity of their habits, behavior, life history, and environmental and husbandry requirements. In addition, the scientific information required to define the preferred conditions for fish well-being is limited. While considerable research has been conducted on culture strategies and environmental and water quality requirements, such studies have generally been aimed at determining conditions that optimize production in aquaculture systems, rather than improving the welfare of fishes, and have not usually addressed the difference between *tolerance* and *preference* (Fisher, 2000).

An important consideration in these guidelines is the naturally high mortality rates of juveniles in species whose ecological strategies include the generation of large numbers of progeny to ensure adequate survival in the wild. In addition, many experimental populations of species with usually high survival contain individuals that will not thrive to adulthood even under the best environmental conditions. In some situations, a population-based (or a group of study fish) approach to well-being may be appropriate, but individuals that are not likely to thrive should be euthanized as soon as they are identified.

Another consideration for these guidelines is the general acceptance by the public of the current killing methods used in harvesting wild fishes or in recreational angling. In general, the public appears to be willing to accept these killing methods for food production but not when fishes are used for research. These guidelines accept that for research, teaching, and testing use of any animal, including fishes, more emphasis will be placed on individual well-being than is generally accepted for the commercial harvesting or production of animals for food. It is recognized, however, that in some instances investigators may obtain fishes from people involved in commercial or recreational harvesting and have little influence over the capture methods.

These guidelines apply to fishes held in facilities for research, teaching and testing, as well as to fishes that are studied in their natural habitats.

1. Definition of Fish

For the purpose of these guidelines, fishes are defined as all bony and cartilaginous fish genera (classes Chondrichthyes [cartilaginous fishes], Agnatha, and Osteichthyes [bony fishes]). Fish eggs, embryos or larvae that have not developed beyond exclusive reliance on their own yolk nutrients are not covered by these guidelines. Similarly, invertebrates (except cephalopods) are not covered under the CCAC system of surveillance, but institutions are encouraged to foster respect for these animals by ensuring that holding facilities and levels of husbandry meet standards equivalent to those used for fishes.

2. Rationale for Guidelines on the Care and Use of Fish

The use of fishes as experimental subjects has increased substantially over the past two decades. This increase in use is a result of the rapid development of the aquaculture industry, requirements for testing involving fishes as indicators of environmental change, and the use of fishes as a replacement for mammals in biomedical, pharmacological and genetic research (DeTolla *et al.*, 1995; Fabacher & Little, 2000). The trend toward the use of fishes as a replacement for studies that would previously have used mammals as experimental subjects is not discouraged. However, it must also be recognized that fishes have the capacity to perceive noxious stimuli. Noxious stimuli are those stimuli that are damaging or potentially damaging to normal tissue (e.g., mechanical pressure, extremes of temperature and corrosive chemicals). Whether or not fishes have the capacity to experience any of the adverse states usually associated with pain in mammals is subject to a great deal of debate in the scientific literature (FAWC, 1996; FSBI, 2002; Rose, 2002; Braithwaite & Huntingford, 2004). Nonetheless, fishes are capable of behavioral,

physiological and hormonal responses to stressors (including noxious stimuli) which can be detrimental to their well-being. These CCAC guidelines both support the leadership role that Canadians play in fish research, and ensure that the welfare of fishes is carefully considered during the use of fishes for research, teaching and testing, recognizing that better welfare will result in better science.

3. Ethical Overview

Guideline 1:

Fishes used in research, teaching and testing must be treated with the respect accorded to other vertebrate species.

The CCAC's surveillance system for animals used in research, teaching and testing is based on the principles of humane science, i.e. the Three Rs of Russell and Burch (Russell & Burch, 1959) - Reduction, Replacement and Refinement. For the CCAC, these principles are laid out in its *policy statement on: ethics of animal investigation* (CCAC, 1989). The *ethics of animal investigation* applies to all species covered by the CCAC system, i.e. all vertebrates and cephalopods.

In addition, the CCAC system takes a "moral stewardship" approach to the use of animals in science as explained in the CCAC Experimental Animal User Training Core Topics - Module 2, Ethics in Animal Experimentation (http://www.ccac.ca/en/CCAC_Programs/ETCC/Module02/toc.html).

The first guideline statement in the CCAC *guidelines on: institutional animal user training* (CCAC, 1999a) states, "Institutions must strive through their training programs to sustain an institutional culture of respect for animal life".

3.1 Principles of the Three Rs

According to the CCAC *policy statement on: ethics of animal investigation* (CCAC, 1989), it is the responsibility of the local animal care committee (ACC) to ensure that fishes are used only if the investigator's best efforts to find a non-animal model have failed.

As for any other species covered by the CCAC system, investigators using fishes are required to use the most humane methods on the smallest

number of animals necessary to obtain valid information. This requires the use of a sound research strategy, including: identification of key experiments that determine whether a particular line of enquiry is worth pursuing; use of pilot studies; staging of *in vitro* to *in vivo* experiments where possible; and implementation of staged increase in test stimuli where possible (Balls *et al.*, 1995). The numbers and species of animals required depend on the questions to be explored. Field studies, aquaculture studies and laboratory studies require different statistical designs; field studies and aquaculture production typically require the use of larger numbers of animals. The life stage of the fishes used in each study will also affect the numbers of animals needed. Studies of early life stages typically require large numbers of individuals. In all cases, studies should be designed to use the fewest animals necessary. Heffner *et al.* (1996) and Festing *et al.* (2002) provide discussions on the appropriate treatment of samples and experimental units. Investigators are encouraged to consult with a statistician to develop study designs that have the appropriate statistical power to accomplish the research objectives (Nickum *et al.*, 2004).

The CCAC *policy statement on: ethics of animal investigation* (CCAC, 1989) also requires adherence to the following principles:

- animals must be maintained in a manner that provides for their optimal health and well-being, consistent with the demands imposed by the experimental protocol;
- animals must not be subjected to pain and/or distress that is avoidable and that is not required by the nature of the relevant protocol;
- expert opinion must attest to the potential value of studies with all animals, including fishes (e.g., scientific merit for research, see CCAC *policy statement on: the importance of independent scientific merit of animal based research projects* [CCAC, 2000a]; pedagogical value for teaching; and the appropriateness of the method to provide data for testing according to current regulatory requirements);
- if pain or distress is a justified component of