CURRICULUM VITAE

NICHOLAS F. HUGHES

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PERSONAL

Date of Birth: January 17, 1962
Citizenship: Dual U.S.A./United Kingdom

DEGREES

- 1991. Ph.D. in biology, University of Alaska Fairbanks, Fairbanks, Alaska, USA
- 1990. M.A. in zoology, Oxford University, Oxford, England
- 1984. B.A. (Hons) in zoology, Oxford University, Oxford, England

EMPLOYMENT HISTORY

- 1998 - present. Assistant Professor, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, Alaska, 99775. Dean: Dr. Al Tyler.
- 1995 - 1998. Research Associate, Behavioral Ecology Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C., Canada, V5A 1 S6. Director: Dr. Lawrence Dill.
- 1992 - present. Research Associate, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7220. Director: Dr. Robert White.
- 1993-1995. N.S.E.R.C. International Post-Doctoral Fellow, Behavioral Ecology Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C., Canada V5A 1 S6. Supervisor: Dr. Lawrence Dill.
- Fall 1991-Spring 1992. Instructor (fall '91) and visiting assistant professor (spring '92), School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7020. Dean: Dr. Al Tyler.
- 1990 and 1991. Student Intern, Sportfish Division, Alaska Department of Fish and Game, 1300 College Road, Fairbanks Alaska. Supervisor: Dr. John Clark.
- 1984 -1991. Research Assistant and doctoral student, Alaska Cooperative Fish and Wildlife Research Unit, Biological Resources Division, United States Geological Survey, 209 Irving I, P.O. Box 757020, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7020. Supervisor: Dr. James Reynolds.

AWARDS AND FELLOWSHIPS

- 1993-1995 N.S.E.R.C. International Post-Doctoral Fellowship to study with Dr. Lawrence Dill at the Behavioral Ecology Research Group, Simon Fraser University.
- 1984. Awarded a Gibbs prize by Oxford University.
- 1983. Awarded a Benefactors prize by The Queen's College, Oxford University.

RESEARCH GRANTS

- 1998-2000. PI's: Dr. John Hayes, Dr. Nicholas Hughes, and Ian Jowett. Title: Salmonid Foraging and Energetics Models 2.. Source: New Zealand Foundation for Research Science and Technology. Amount: $600,000 NZ.
- 1999-2001. PI: Dr. Nicholas Hughes. Title: Effects of Suburbanization on Juvenile Salmonids in South Central Alaska. Source: United States Geological Survey, Water Resources Division. Amount: $39,747.
- 1993. PI's: Dr. Nicholas Hughes, Dr. Jacqueline LaPerriere, and Dr. Jock Irons. Title: Testing Models Explaining Multi-Stream Distribution Patterns of Arctic Grayling Populations II. Source: Natural Resource Fund, University of Alaska. Amount: $9,845
- 1992. PI's: Dr. Nicholas Hughes, Dr. Jacqueline LaPerriere, and Dr. Jock Irons. Title: Testing Models Explaining Multi-Stream Distribution Patterns of Arctic Grayling Populations I. Source: Natural Resource Fund, University of Alaska. Amount: $4,983

REFEREED PUBLICATIONS

Stream Salmonid Behavior and Ecology

- Hughes, N.F. Testing the ability of habitat selection theory to predict interannual movement patterns of a drift-feeding salmonid. ***Ecology of Freshwater Fish*** *(in press).*
- Hughes, N.F., and T.C. Grand. Physiological ecology meets the ideal free distribution: predicting the distribution of size-structured fish populations across temperature gradients. ***Environmental Biology of Fishes*** *(in press).*
- Hughes, N.F. Population processes responsible for larger-fish-upstream distribution patterns of Arctic grayling (*Thymallus arcticus*) in interior Alaskan runoff rivers. ***Canadian Journal of Fisheries and Aquatic Sciences*** *(in press).*
- Hughes, N.F. 1998. A model of habitat selection by drift-feeding stream salmonids at different scales. ***Ecology*** 79: 281-294.
- Hughes, N.F. 1998. Use of whole-stream patterns of age segregation to infer the interannual movements of stream salmonids: A demonstration with arctic grayling in an interior Alaskan stream. ***Transactions of the American Fisheries Society*** 127: 1067-1071.

- Hughes, N.F. 1998. Reduction in growth due to electrofishing and tagging may change interannual movement behavior of stream salmonids: Evidence from Arctic grayling in an interior Alaskan stream. ***Transactions of the American Fisheries Society*** 127: 1072-1077.

- Hughes, N. F., and L. H. Kelly. 1996. A Hydrodynamic model for estimating the energetic cost of swimming maneuvers from a description of their geometry and dynamics. ***Canadian Journal of Fisheries and Aquatic Sciences***, 53: 2484-2493.

- Hughes, N. F., and L. H. Kelly. 1996. New techniques for 3-D video tracking of fish swimming movements in still or flowing water. ***Canadian Journal of Fisheries and Aquatic Sciences***, 53: 2473-2483.

- Hughes, N. F., and J. B. Reynolds 1994. Why do Arctic grayling *Thymallus arcticus* get bigger as you go upstream? ***Canadian Journal of Fisheries and Aquatic Sciences***, 51: 2154-2163.

- Hughes, N. F. 1992. Ranking of feeding positions by drift-feeding Arctic grayling *Thymallus arcticus* in dominance hierarchies. ***Canadian Journal of Fisheries and Aquatic Sciences***, 49: 1994-1998.

- Hughes, N. F. 1992. Selection of positions by drift-feeding salmonids in dominance hierarchies: model and test for Arctic grayling *Thymallus arcticus* in subarctic mountain streams, interior Alaska. ***Canadian Journal of Fisheries and Aquatic Sciences***, 49: 1999-2008.

- Hughes, N. F., and L. M. Dill. 1990. Position choice by drift-feeding salmonids: a model and test for Arctic grayling *(Thymallus arcticus)* in subarctic mountain streams, Interior Alaska. ***Canadian Journal of Fisheries and Aquatic Sciences***, 47: 2039-2048.

Ecology of Nile Perch in African Lakes

- Hughes, N. F. 1992. Growth and reproduction of the Nile perch, *Lates niloticus*, an introduced predator, in the Nyanza Gulf, Lake Victoria, East Africa. ***Environmental Biology of Fishes***, 33: 299-305.

- Hughes, N. F. 1992. Nile perch, *Lates niloticus*, predation on the freshwater prawn, *Caridina nilotica*, in the Nyanza Gulf, Lake Victoria, East Africa. ***Environmental Biology of Fishes***, 33: 307-309.

- Hughes, N. F. 1986. Changes in the feeding biology of the Nile perch *Lates niloticus* (L.) (Pisces: Centropomidae), in Lake Victoria, since its introduction in 1960, and its impact on the native fish community of the Nyanza Gulf. ***Journal of Fish Biology***, 29: 541-548.

- Barel, C. D. N., R. Dorit, P. H. Greenwood, G. Fryer, N. Hughes, P. B. N. Jackson, H. Kanwanabe, R .H. Lowe-McConnel, M. Nagoshi, A. J. Ribbink, E. Trewavas, F. Witte, and K. Yamaoka. 1985. Destruction of fisheries in Africa's lakes. ***Nature***, 315: 19-20.

Manuscripts in Preparation

- Hughes, N.F., and L.M. Dill. Drift-feeding fish maneuver into mainstream foraging ecology: development and test of a model predicting the geometry, dynamics, and time and energy costs of prey capture in flowing water. In preparation for submission to ***Ecology***.

- Hughes, N.F., and R. Dukas. Modeling the influences of cognitive capacity, search rate, and prey conspicuousness on the prey detection field of drift-feeding fish. In preparation for submission to *Ecology*.

CONFERENCE PRESENTATIONS

- Hughes, N.F. Dynamic habitat selection theory: linking stream morphology to salmonid population dynamics. 3rd International Symposium on Ecohydraulics, 1999, Salt Lake City, Utah.
- Hughes, N.F. New approaches to understanding the velocity preferences of drift-feeding stream salmonids. American Fisheries Society, Western Division Meeting 1999, Anchorage, Alaska.
- Hughes, N.F. Invited Plenary Speaker. Drift-feeding fish maneuver into mainstream foraging ecology: linking models of prey interception maneuvers and the spatial allocation of information processing capacity to predict the energy intake rate of a central place forager. FORAGING/98, an International Conference on Foraging Behavior, 1998, Santa Cruz, California.
- Hughes, N.F. A model of habitat selection by stream salmonids at the whole-stream scale. International Stream Fish Ecology Symposium, 1998, Luarca, Spain.
- Hughes, N.F. Why we still don't understand velocity choice by drift-feeding stream salmonids: a short review and prospectus. American Fisheries Society, National Meeting 1997, Monterey, California.
- Hughes, N.F. A model of habitat selection by drift-feeding salmonids at different scales. American Fisheries Society, Western Division Meeting 1996, Eugene, Oregon.
- Hughes, N.F. Influence of invertebrate drift abundance on position choice by drift-feeding salmonids: test of a foraging model using Arctic grayling *Thymallus arcticus*. American Fisheries Society, National Meeting 1991, San Antonio, Texas.
- Hughes, N.F. Why do Arctic grayling get bigger as you go upstream? American Fisheries Society, Western Division Meeting 1990, Sun Valley, Idaho.
- Hughes, N.F. A foraging model of position choice by drift-feeding salmonids makes accurate predictions for solitary Arctic grayling feeding in pools of a subarctic mountain stream. American Fisheries Society, National Meeting 1989, Anchorage, Alaska.
- Hughes, N.F. The behavioural ecology of Arctic grayling distribution. Pacific Ecology Conference January 1988, Brackendale, British Columbia.
- Hughes, N.F. Why do Arctic grayling get bigger as you go upstream? American Fisheries Society, Alaska Chapter Meeting 1987, Fairbanks, Alaska.

INVITED DEPARTMENTAL SEMINARS

- Spring 1999. Utah State, Biology, Fisheries, and Wildlife Seminar. New approaches to understanding velocity choice by drift-feeding stream salmonids.
- Spring 1997. University of Alaska Fairbanks, Life Sciences Seminar. Modeling habitat selection by drift-feeding stream salmonids at different scales: a unified theory of distribution patterns and behavioral mechanisms.
- Fall 1996. University of Washington, Seattle, Vertebrate Biology Seminar. Distribution patterns of drift-feeding salmonids.
- Spring 1996. University of British Columbia, Vancouver, B.C., Ecology Seminar. Behavioral ecology of stream-salmonid distribution patterns.
- Spring 1995. University of Montana, Missoula, Biology Seminar. Behavioral ecology of stream-salmonid distribution patterns.
- Fall 1988. University of Alaska Juneau, Fisheries Seminar. Behavioral ecology of Arctic grayling distribution patterns.

EDITING, REVIEWING, AND SESSION CHAIRS

- 1997-present. Associate Editor for the American Fisheries Society, handling manuscripts on stream salmonids for the North American Journal of Fisheries Management.
- Invited Chair, Behavioral Ecology Session of the International Stream Fish Ecology Symposium, 1998, Luarca, Spain.
- Referee for the Canadian Journal of Fisheries and Aquatic Sciences, Environmental Biology of Fishes, Journal of Fish Biology, Ecology, Functional Ecology, Oecologia, Hydrobiologia, Transactions of the American Fisheries Society, North American Journal of Fisheries Managment, and Water Resources Research.
- Solicited to evaluate research proposals by Canada's National Science and Engineering Council (N.S.E.R.C.) and the Israeli Academy of Sciences.

MEMBERSHIP IN PROFESSIONAL SOCIETIES

- American Fisheries Society.
- Ecological Society of America.

TEACHING EXPERIENCE

- Fall 1998-Current. Teach the following courses at the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, Alaska, USA, 99775-7020. Dean: Dr. Al Tyler.

  FISH/BIOL 650 Fish Ecology

  FISH/BIOL 692 Seminar. Topics in Fisheries and Aquatic Sciences

  FISH 401 Fisheries Management

  FISH/BIOL 384 Freshwater Fishes of Alaska

- Fall 1991-Spring 1992. Developed and taught the following courses while instructor (fall '91) and visiting assistant professor (spring '92) at the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, Alaska, USA, 99775-7020. Dean: Dr. Al Tyler.

  BIOL 650 Fish Ecology

  FISH 400 Fisheries Science

  FISH 401 Fisheries Management

  BIOL 384 Freshwater Fishes of Alaska

- 1995-present. Invited lecturer in a wide variety of courses at the University of Alaska and Simon Fraser University, including courses in fish ecology, fisheries science, advanced animal behavior, animal ecology, ethology and statistical aspects of habitat selection.

- Fall 1985. Teaching Assistant and Lab Coordinator for Limnology 473 at University of Alaska Fairbanks, Fairbanks, Alaska 99775-7020. Professor: Dr. Mark Oswood.

TEACHING INTERESTS

My area of teaching interest ranges across the fields of fish and fisheries biology, including foraging ecology, behavior, habitat selection theory, life-history theory, community ecology, population dynamics, physiology, functional morphology, and the biological, historical, and cultural foundations of fisheries science and fishery management.

I enjoy the challenges of teaching, particularly developing the students' interest in fish and fisheries biology, encouraging the development of their analytical and creative thinking skills, and equipping them with knowledge that will be useful to them in their careers. To develop students' enthusiasm for the subject I usually try to develop the topic of the day around some inherently interesting question, such as - why do salmon go to sea? and get them to volunteer opinions, before presenting the range of explanations. I believe that the simple process of expressing an opinion makes the student more open to learning, and that the more interested and involved the students are the more easily they learn, and the harder they are inclined to work. To develop analytical thinking skills I encourage the students to develop the habitat of hypothesis testing, matching new information with predictions based on their current knowledge. This can help them critique incoming information, and also revise their own world view. To develop creative thinking skills I try to pose the students with an interesting problem that forces them to rearrange standard information in a non-standard way, such as constructing a dichotomous key for identification of Pacific salmon using life-history traits, rather than morphology. The mastery of the information that this demands also helps to load the course material into long-term memory. Fisheries science is a practical discipline and to develop the skills

to solve practical problems I like to provide students with real world problems, and real data, such as how to manage a salmon fishery with a Ricker stock recruitment curve. These kinds of exercises really help students to understand *why* it is useful to learn how to estimate fish abundance, or age fish from scales, and this in turn makes the course more interesting and enjoyable.

TEACHING PERFORMANCE

The following are a (nonrandom) selection of student comments from two of the courses I taught at the School of Fisheries and Ocean Sciences in 1991/1992 (Fish Ecology and Freshwater Fishes of Alaska).

"Good teaching techniques, learned a whole bunch about fish! Enjoyed listening."

"Excellent readings, very interesting topics, generally good discussions."

"Very informative teacher."

"Excellent overhead presentations, excellent speakers, class overall was a lot of fun."

"I really like the way the class was taught. I liked the use of journal articles. Liked the take home exams. I espec. like the comments written on the exam + the fact that you cared enough to call us into your office when we were 'struggling + not enlightened.' Over all a <u>good</u> course!"

"The best aspect was being exposed to all the research on fish. Most undergraduate classes are just a bunch of memorization. This class raised so many questions I had never been exposed to and I really appreciate it, and all the research necessary to put a class like this together."

"I felt that the course was taught in a thought-provoking way, where the student must ponder the questions and answers on his own. It seem like a good way to get a feel for concepts."

"Nick's knowledge of fishes + ecological approach to the class were really interesting. His teaching style was very interactive with the students + he tried to get the students to come up with their own answers to questions + input + was fun to listen to. Overall a very different but very good class."

PAST AND CURRENT RESEARCH TOPICS

- **Prey Interception Maneuvers by Drift-Feeding Salmonids:** One of the most significant obstacles to understanding stream salmonid ecology is our inability to apply mainstream foraging theory to drift-feeding fish. This is a result of the fact that we cannot assign handling times or energy costs to prey encountered and captured in moving water. For the last several years Dr. Lawrence Dill and I have attacked this problem by developing and testing a model that predicts the design of maneuvers used to capture prey in running water. This work has demanded theoretical work in energetics, hydrodynamics, and behavioral ecology. It has also entailed development of computer programs to simulate time and energy costs of maneuvers, search for optimal maneuver designs using genetic algorithms and local optimization techniques, and visualize the results of simulations. Field experiments to test the model have demanded the development and application of a novel 3-D video tracking system, in collaboration with Lon Kelly, Bureau of Land Management.

- **Large-Scale Distribution Patterns of Drift-Feeding Salmonids:** Whole-stream studies of stream salmonids have been neglected, and yet a whole-stream approach is almost always necessary to

understand fish-habitat interactions and population ecology. For several years I have been working to extend models of habitat selection by individuals at small scales to explain population level processes at these larger whole-stream scales. During my doctoral research Dr. James Reynolds and I developed a habitat selection model that explained larger-fish-upstream distribution patterns of Arctic grayling, and tested it successfully with a large scale field experiment. Recently I have extended this model to account for the effects of whole-stream variation in temperature and food abundance, and completed a large scale multi-stream field study to test the model using Arctic grayling, in collaboration with Dr. Jackie LaPerriere, Alaska Cooperative Fish and Wildlife Research Unit, Dr. Jock Irons Institute of Northern Forestry, and Bill Ridder, Alaska Department of Fish and Game. I have also used the habitat selection logic of these models to predict whole-stream patterns of movement and growth, and tested these predictions with Arctic grayling.

- **Local Scale Habitat Selection Models for Drift-Feeding Salmonids:** One of the greatest challenges in explaining habitat selection by stream salmonids is understanding how a variety of different habitat characteristics combine to influence the quality of a position in the habitat. This is a problem that I began to address during my doctoral work, developing foraging models that predict the potential for net energy intake rate across the habitat, by integrating information on water depth, velocity, temperature, invertebrate drift abundance and size-composition. Initially I tested the ability of these models to predict the position of solitary fish, later I extended them to predict the distribution pattern of fish in dominance hierarchies. I continue to develop these models and other researchers are applying them successfully to a variety of stream salmonid species in North America and New Zealand.

- **Ecology of the Nile Perch:** In the early 1960's the Nile perch *(Lates niloticus)* was introduced to Lake Victoria, Africa's largest lake, and during the late 1970's there was a population explosion in the Nyanza Gulf, Kenya, resulting in radical changes in the Lakes ecology. I became aware of this situation when visiting inland and marine fisheries in Kenya during 1982, and in 1983 I organized the Oxford University Nile Perch Project to document changes in the Nile perch's feeding habits, analyse its impact on the native fish community, and investigate the relationship between Nile perch and the small freshwater prawn *(Caridina nilotica)*, which now provides much of its food. I also did comparative work on growth rates and reproduction, coordinating these studies with the Kenyan Fisheries Department, the Kenya Marine and Fisheries Research Institute, Kenya National Museums, and commercial fishermen.

DEVELOPING RESEARCH INTERESTS

My long term research goal is to develop and test general theories that explain interactions between stream salmonids and their habitats. The logic for this research program is that the stream habitat acts as a template, guiding the way natural selection shapes the ecology and behavior of individual fish, and that larger scale properties such as distribution patterns, population dynamics, and community structure can be explained in terms of the ecology and behavior of individuals. So far this approach has been successful in explaining many features of distribution patterns, but I believe it can be extended much further in the fields of population dynamics, life-history theory, and community ecology. This program has both basic and applied aspects, especially as more emphasis is placed on the management and restoration of riparian habitats. A sampling of projects that I have in the pipeline illustrates where I hope to see this program go in the medium term:

- **Dynamic Habitat Selection Models:** Although we know that competition for space can regulate abundance of stream salmonids, no one has yet accounted for the fact that habitat preferences changes as fish grow, particularly during the first summer of life. This means that we can't yet explain how stream habitat interacts with fish behavior to produce the observed timing and extent of density dependent mortality, and consequent population dynamics. In my current research at Simon Fraser University I am working to close this knowledge gap by developing models that explain how growth, distribution, and abundance of salmonids change during the first growing season, and how these changes are influenced by habitat structure. I am developing these models for coho salmon, steelhead, and Atlantic salmon.

- **Hybrid Habitat Selection Models:** More work needs to be done to make habitat selection theory realistic enough to apply to stream salmonids. For example, although my models of contest competition for space have worked well for larger drift-feeding salmonids there is plenty of evidence that both scramble and contest competition commonly coexists in juvenile salmonid rearing areas. To bridge this realism gap Tamara Grand (Simon Fraser University) and I are developing "hybrid" models that allow fish to scramble for competition in pools (Ideal Free Theory) and compete for territories in nearby riffles and runs (extension of contest competition models). This kind of model is ideally suited to coho salmon and steelhead.

- **Linking Marine and Freshwater Life-History Models:** The use juvenile anadromous salmonids make of stream habitats and the marine environment are interdependent. For example, the migration from fresh to salt water can be seen as an optimized trade-off between size-dependent growth and mortality rates in the two habitats. This means we can expect life-history characteristics in freshwater to be responsive to changes in marine conditions, and vice versa. The consequences of this might be profound. For example, deteriorating conditions in the nearshore marine environment might favor longer freshwater residency, greater inter-cohort competition, and lower system productivity. This means that high quality freshwater habitat may be particularly important in times when marine environments are relatively inhospitable. Dr. Lawrence Dill and I are pursuing support for work on "whole life-history habitat selection models," which will entail work in both freshwater and the marine environment. Likely collaborators include Dr. Mike Healy, and Dr. Carl Walters, University of British Columbia.

- **Habitat Segregation at Different Scales:** As a continuation of my work on prey interception maneuvers I am planning to test models that explain habitat segregation between species with different body morphologies. In particular I intend to test the hypothesis that the relatively slender square-tailed steelhead juveniles are better adapted to forage in fast moving riffles, while deeper bodied fork-tailed coho are better adapted to forage in slower moving pools. The goal of this work is to explain local habitat segregation, and also get insight into why some streams appear to produce predominantly coho while others produce predominantly steelhead. On a larger scale, I plan to develop and test models that explain the longitudinal zonation of salmonids. For example, where brown trout and rainbow trout live in the same stream, browns are typically distributed upstream of rainbows. There are no realistic theories that explain this longitudinal zonation. This work will likely involve collaboration with Dr. John Hayes, perhaps New Zealand's leading trout ecologist.

REFERENCES

Dr. Lawrence M. Dill
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