

Six Decades of Fishery Genetics: Taking Stock

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At the Six Decades of Fishery Genetics Conference held in Seattle, Washington, Fred Utter (second from left) is honored with an award for his recognition as a NOAA History Maker and he receives congratulations from Usha Varanasi, director of the NOAA Fisheries Northwest Fisheries Science Center; Nancy Utter; Robin Waples, NWFSC; and Nils Ryman, Stockholm University.

The field of fishery genetics has definitely come of age. That was the overwhelming consensus at a recent meeting held in Seattle entitled, "Six Decades of Fishery Genetics: A Retrospective View and a Vision for the Future." This symposium, jointly sponsored by NOAA Fisheries' Northwest Fisheries Science Center and the University of Washington's School of Aquatic and Fishery Sciences, drew 150 participants from 8 countries and 4 continents. The symposium had three major objectives. First, as part of its retrospective view, the meeting honored Fred Utter's long record of scientific contributions to the field. It was suggested that his legacy can be attributed largely to four factors.

Vision: Utter was one of the earliest to see the relevance of genetic information to fishery management and he has never wavered in his efforts to promote that connection.

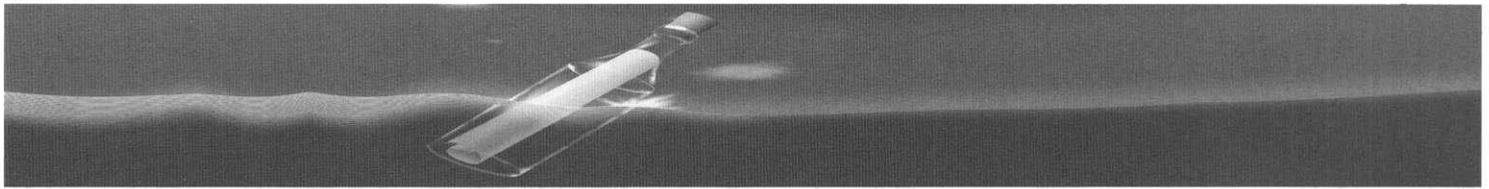
Mentoring: Many of his early students and colleagues have gone on to play major roles in the field, and Utter continues as a mentor through his activities at the University of Washington and the American Fisheries Society.

Humanity: Never one to bother with artifice, Utter treats everyone with generosity and respect—to the pleasant surprise of many fledgling students who have sought his counsel.

Stamina: Utter's scientific career already spans the terms of nine U.S. presidents (and counting). He took a summer job at the Montlake Laboratory in 1953 (shortly after Harry Truman vacated the Oval Office), and he remains actively engaged in scientific activities well into his eighth decade. More information about Utter's career and his recent recognition as a NOAA History Maker can be found at

http://celebrating200years.noaa.gov/historymakers/side_hon_mentions.html.

The ride through these six decades has not always been easy; many bumps have occurred along the way, and areas of tension between fishery genetics and fishery management persist today. Indeed, Phil Pister, who sent his regrets at not being able to attend, suggested (perhaps only partly tongue in cheek) that a better title for the meeting might have been, "How to Survive Six Decades of Fish Geneticists." According to Pister, an eminent trout biologist (who shall remain anonymous but whose initials are RB) keeps a (large) bottle of whiskey in his desk drawer, ready for the next call from a fish geneticist. And one commenter noted that managers of some pelagic fish stocks, discouraged with the type of information provided by geneticists, have recently turned back to more traditional types of data for evaluating stock structure. Nevertheless, the



meeting provided abundant evidence for application of genetic methods to practical problems in fishery management. This was aptly demonstrated by Michael Hansen from Denmark, who described results of a series of detailed investigations of hatchery-wild interactions that have led to a revolution in the local management of salmonid fishes.

Reflecting on development of the field of fishery genetics, two major phases can be identified. Phase 1 is getting the attention of fishery managers. This phase was often very protracted, and for some species in some geographic areas it is still difficult to get managers to take genetic information seriously. In Phase 2, having attracted the attention of managers, geneticists must deliver information that is timely and relevant for the problems that managers must deal with. This has not always been easy, and this challenge has not always been dealt with effectively by geneticists. Some of us recall

a comment made by Ellen Marsden at an AFS Annual Meeting nearly two decades ago to the effect that:

If significant differences are found [between samples from different areas], geneticists say the populations should be managed as separate stocks; if no differences are found, they still say they should be managed separately because there might be differences they couldn't detect.

As Marsden noted, if this is the only type of guidance geneticists can provide, it would not be surprising if managers stopped asking for our advice. This example might be apocryphal, but it contains enough truth to serve as a persistent warning to geneticists. Furthermore, if geneticists lose the faith of managers because of the inability to deliver useful information, it might be a long time before we get their attention again. Central to this difficulty is the

reality that genetic measures of population differentiation tend to become saturated at relatively low levels of gene flow, well below the levels of migration that define the transition between demographic independence and demographic coupling. Because defining this transition region is often the primary concern of fishery managers, geneticists face an ongoing challenge to deliver in Phase 2. Strongly diverged populations that require separate management are easy to identify, but based on genetic markers alone it is very difficult to demonstrate that flux of individuals is sufficiently large to make two systems demographically coupled.

The second major objective of the meeting was to provide a brief overview of the broad array of current applications of genetic and molecular methods to all aspects of modern fishery biology. This was a challenging task, as rapid advances in DNA technology have opened up a vast

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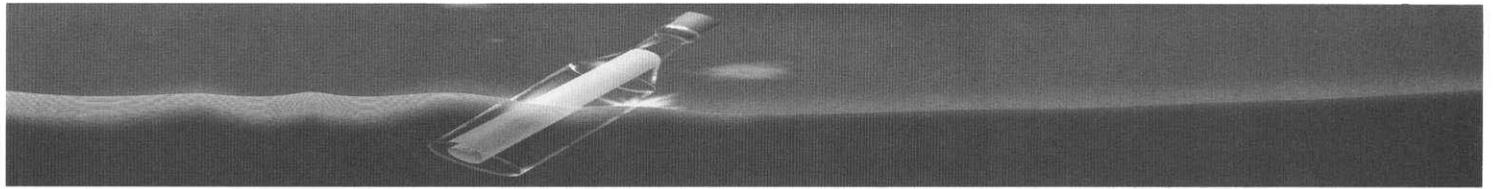
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array of applications to questions of management relevance. In a two-day meeting it was not possible to include all leading figures in the field, or even to include on the program all laboratories making important contributions. Nevertheless, a considerable range of topics was covered, as evidenced by this short list of reports by a fraction of the speakers:

- Bayesian analysis of demographic and environmental factors responsible for stock structure in Atlantic herring (Oscar Gaggiotti, Grenoble, France);
- A global effort to DNA-barcode all species of fish (Bob Ward, Australian Commonwealth Scientific and Industrial Research Organisation [CSIRO], Tasmania);
- Fishery-induced selection in Chinook salmon (Willy Eldridge, University of Washington);
- Three-decades of parentage analysis of Columbia River steelhead (Hitoshi Araki, Oregon State University);
- Use of high throughput techniques for real-time management of mixed-stock fisheries in Alaska (Jim Seeb, Alaska Department of Fish and Game and University of Washington);
- Gene expression analyses to assess reproductive status (Julien Bobe, French National Institute for Agricultural Research [INRA], Rennes, France);
- Evolutionary relationships between IHNV virus and salmonid fishes (Maureen Purcell, U.S. Geological Survey, Seattle); and
- Molecular tools for remote biosensing (Kelly Goodwin, Atlantic Oceanographic and Meteorological Laboratory [AOML], Miami).

See www.nwfsc.noaa.gov/events/workshops/index.cfm for the complete meeting agenda. These and other presentations illustrated that, although the more traditional fishery

management questions such as "How many stocks are there?" are still vitally important, recent analytical and technological innovations allow researchers to ask all sorts of questions and address many problems that weren't possible only a few years ago. It is apparent that molecular genetic methods have become central to many aspects of sound fishery management in the twenty-first century.

At a general discussion session, the audience was challenged to consider a series of questions that inspired reflection about the current state of the science in the context of past accomplishments. The questions, which were motivated by genetics issues but are more broadly relevant to conservation and management, included the following:

- To what extent are the questions being asked by geneticists and managers the same as they were in the past? If they differ, how?
- How are the early results being used today? Are they still valid?
- Do we do a better job today than, say, 20 years ago? If so, how and why? (This question might be asked both of geneticists and managers.)
- Scientists today have a much wider variety of genetic markers, as well as refined analytical tools. How have these factors helped?
- Do current workers in applied population genetics have a better understanding of the theoretical aspects than in the old days?

As might be expected, few definitive answers to these questions were offered, and it was recognized that it would be productive to periodically revisit them to ensure that the overall trajectory of the field remains on track. A topic that generated considerable discussion was evaluating the net effects of the widespread availability of sophisticated computer software to analyze genetic data. These programs not only automate many routine and tedious analyses, they also introduce bold new types of analysis that have only recently become

available. Collectively, these programs considerably expand the capabilities of fishery geneticists. On the other hand, several potential drawbacks were noted, including the often-heavy dependence on (sometimes) poorly documented assumptions, a general lack of rigorous sensitivity analysis, and requirements that the user pick many esoteric parameter values, any one of which might have profound effects on the results. A major concern expressed was that students today (and even experienced researchers) are tempted to substitute a slick computer program for a sound understanding of population genetic principles. Furthermore, a focus on software risks losing sight of the underlying biological questions that should be driving our investigations. A subtext of the questions posed to the audience was the old maxim that those who don't understand history are condemned to repeat it. Researchers in the field today have unprecedented opportunities owing to technological, analytical, and computational advances. An ongoing challenge will be how, in the race to take advantage of these new opportunities, to avoid losing sight of the fundamental principles that have built a solid foundation for fisheries genetics.

Finally, speakers and participants were asked to think about the future and how best to capitalize on rapid technological advances to provide new types of information for managing aquatic resources. Molecular data now can be acquired faster, easier, and more cheaply than ever before, thus increasing the size of the average data set by orders of magnitude. Moreover, if efforts to reduce genome-sequencing costs are successful, the entire genome of a new species could be sequenced relatively easily, thus eliminating problems associated with lack of sequence information in non-model species that have plagued fishery genetics from the outset. Presentations at the symposium showed that both technologies and analytical methods are further developed than broadly assumed. In the near future, we can expect to see a maturation of the fields of func-

tional genomics and gene expression, with potentially widespread and novel applications designed to improve our understanding of how aquatic ecosystems function. The molecular revolution in biology promises to continue to transform fishery genetics and open research opportunities that were unthinkable before; as a consequence, we expect that developments over the next decade will rival, and perhaps even surpass, the remarkable advances in fishery genetics of the last six decades.

In part inspired by the themes of this meeting, Lorenz Hauser, Robin Waples, and Gary Carvalho will edit a special issue of *Fish and Fisheries* devoted to fishery genetics. Major papers planned for the special issue, targeted to appear in December 2008, will cover (1) paradigm shifts, (2) functional genomics, (3) insights into connectivity in marine systems from genetic and non-genetic data, (4) bridging the gap between molecular genetics and adaptive variation, and (5) more effective integration of genetics into fishery management. ☺

THE MOVING BOX

AFS has received a purchase offer for most of its office space from Nations Academy, contingent on the school obtaining a zoning exemption. However, application for the exemption has been held up due to a county commission declaring part of the Grosvenor property as "Legacy Open Space," forcing the academy to rework its site plans. It is now thought that the purchase may not be finalized until May 2009. Meanwhile, the ad hoc AFS Transition Committee made its final report to the Governing Board, who will discuss possible transition issues at its retreat at the mid-term meeting in March. The report addresses relocation considerations such as partnerships, ownership options, pros and cons of various locations, staff preferences, and minimum physical specifications. The Governing Board is also expected to discuss possibly creating a foundation to handle any proceeds from the sale. We will keep you posted.

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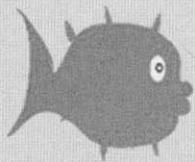
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