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Science in an UNCERTAIN MILLENNIUM

2000 AAAS ANNUAL MEETING AND SCIENCE INNOVATION EXPOSITION

FEBRUARY 17–22, 2000 • WASHINGTON, DC

166th National Meeting of the American Association for the Advancement of Science

Rebecca Paulson, Editor

Michael S. Strauss, Ph.D.,
Annual Meeting Program Director

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

particular, the interplay between bacteria and plants is vital for plant growth. Studies of this interaction have had important implications for biotechnology. Other aspects to be covered include the mechanisms of mutation in bacteria, which have significance for indicating ways that disease such as cancer develop. Bacterial mutation also affects antibiotic resistance, in which infectious disease treatment is returning to the pre-antibiotic era. Finally, the key role of microbial evolution in the evolution of more complex forms will be discussed.

SPEAKERS

Rita R. Colwell, National Science Foundation
Microbial Ecology and Systematics: Subdisciplines Whose Time Has Come
Julian E. Davies, University of British Columbia
Superbugs and Superdrugs
Jeffrey H. Miller, University of California-Los Angeles
What Controls Mutation in Bacteria?
Eugene W. Nester, University of Washington
Macromolecule Transfer from Prokaryotes to Eukaryotes: The Agrobacterium Paradigm
W. Ford Doolittle, Dalhousie University
Microbial Evolution and Phylogeny: Is There a New Synthesis?
Richard Roberts, New England Biolabs
Restriction and Modification of Genomes

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Back to the Future: Restoring Ecosystems Impacted by Fisheries

Monday, February 21 **8:00am–11:00am**
Marriott, Lobby Level **Virginia Suite C**

Organized by Tony J. Pitcher and Daniel Pauly, University of British Columbia

Sponsored by AAAS Section on Biological Sciences

This symposium reviews the history and nature of the impacts of fisheries on aquatic ecosystems, examines how those impacts have prejudiced the future wealth—generating capacity and sustainability, and introduces a new policy agenda that aims to mitigate and inform the reconstruction of our fisheries. We review state-of-the-art innovative ecosystem simulation techniques that can address questions previously thought unaskable. The role of mitigation measures, such as protected areas, in restoring aquatic ecosystems is explored. 'Back to the Future' envisions the restoration of aquatic ecosystems to a degree that maximizes their benefits to society. Ecoval, grounded in the new discipline of ecological economics, implements an interdisciplinary policy evaluation required for a restoration agenda that is both equitable and receives wide public support. Constructing marine ecosystems as they might have been prior to industrial fishing combines scientific information with the traditional environmental knowledge (TEK) of indigenous peoples and coastal communities, with archeological data and with historical archives. The interdisciplinary 'Back to the Future' process is poised to harness broad support for management from the public and from stakeholders that has been eroded by recent and widespread failures. By acting as sentinels, the public may encourage compliance, while reconstruction will bring substantive gains in value and product diversity to the seafood industry. Embedded in the 'Back to the Future' approach is an assurance that aquatic ecosystems are managed to optimize the trade-off between exploitation for human food and the conservation of aquatic biodiversity.

SPEAKERS

Tony J. Pitcher, University of British Columbia
How Fisheries Impact Aquatic Ecosystems
Daniel Pauly, University of British Columbia
Simulating Fisheries Impacts on Aquatic Ecosystems
Russ Jones, Council of the Haida Nation and Nigel Haggan, University of British Columbia
Aboriginal Fisheries: TEK and Back to the Future
Andrew Trites, North Pacific Universities Marine Mammal Research Consortium
Ecosystem Change: Unraveling the Effects of Fisheries from Natural Oceanographic Changes
Christofer H. Boggs, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Turning Back the Clock for Pacific Tuna Fisheries Using Ecosim
Rashid Sumaila, Michelson Institute of Economics
Ecoval: Evaluating the Benefits from Alternative Ecosystems Using Ecological Economics

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Scientific Advice for Endangered Species Recovery

Monday, February 21 **3:00pm–6:00**
Marriott, Lobby Level **Virginia Suite**

Organized by Andrew A. Rosenberg, National Marine Fisheries Service, Usha Varanasi, NOAA Northwest Fisheries Science Center

Sponsored by AAAS Section on Biological Sciences

The National Research Council recently recommended that implementation of the Endangered Species Act should be made more scientific, but this is much more difficult than most realize—a point well illustrated by the challenge of recovering salmonids on the West Coast of North America. Salmon have suffered hundred-fold declines in the twentieth century as a result of poor harvest management, water withdrawals for irrigation, construction of dams, forest practices that increase stream sediments, and many other environmental abuses associated with expanding human populations. The blame is widespread, but unlike many battles involving "less charismatic" species, the public desire to save salmon is enormous. Failure to recover salmon will be a failure of science and of government, not of public will. There are several competing scientific visions for how to best recover salmon. One champions a "return to the natural river," and the ecological processes embodied in this idea. Other solutions involve an ambitious combination of fish transportation, habitat improvements, and hatcheries. Sorting through this complexity requires a cumulative risk analysis that can weigh the benefits of different management actions against one another. But the risk analysis approach does not deal easily with the longer-term goals of evolutionary sustainability, the preservation of local adaptations, or the potential for future local adaptation. Even if the science could deliver clear and unambiguous risk analyses, there are formidable problems in making sure that it works effectively in the treacherous arena of natural resource politics and land-use planning.

SPEAKERS

William Rodgers Jr., University of Washington
A Common Property, Cultural Legacy and Regional Icon
Jack Stanford, The University of Montana
The Normative River: Recipe for Salmon Recovery
Peter M. Kareiva, Northwest Fisheries Science Center
Escaping Past Legacies to Promote Recovery of Salmon: A Cumulative Risk Analysis
Brian Riddell, Pacific Biological Station
Salmon Recovery in the Columbia Basin: Science Reviews and Changing Perspectives
Mike Lynch, University of Oregon
The Genetic Risks of Extinction
Usha Varanasi, NOAA Northwest Fisheries Science Center
Making Science Useful in a Complex Political and Legal Arena

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among resource users and increased management cost at the very time when returns are low or negative, e.g. Canada?s $3.5 billion cost after the cod closure. BTF brings Aboriginal peoples, fishers, fisheries scientists, historians, archaeologists, managers and policy makers together to reconstruct the past. UBC provides a neutral forum. Reconstructing past abundance provides an alternative and positive focus as opposed to fighting over allocation. A ?reflective? or ceremonial element acknowledges our changed relationshlp with the sea and recognizes that all sectors have valuable management information. An example is given from Hecate Strait in Northern BC where a preliminary model of the system as it might have been prior to modern industrial fishing (100 years ago) was constructed based largely on workshop input from Aboriginal people and retired fishers.

Aboriginal fisheries, TEK and back to the future. RUSS JONES (Haida Nation, Haida Gwaii, B.C. (Queen Charlotte Islands) and Sitka, Ak. email: rjones@island.net)

This paper will examine how aboriginal peoples such as those in Haida Gwaii (the Queen Charlotte Islands in B.C., Canada) can collaborate in the Back to the Future policy agenda, and how traditional environmental knowledge (TEK) can be used in the model reconstruction of past ecosystems.

Simulating fisheries impacts on aquatic ecosystems: what we can and cannot do. DANIEL PAULY (Fisheries Centre, 2204 Main Mall, University of British Columbia, Vancouver B.C., Canada V6T 1Z4. Tel: (604) 822 1201; email: pauly@fisheries.com)

Since its initial development in the early 1980s, the mass-balance approach incorporated in the Ecopath software has been widely used for constructing food web models of marine and other ecosystems. This has led to a number of generalizations on the structure and functioning of such ecosystems, relevant to the issue of fisheries impacts on ecosystems. Some of these generalizations have revisited older themes, while others were new. Both sets of generalizations have impacted on the development of the Ecopath approach itself. Herein, the description of some reference states of an ecosystem, using Ecopath proper, also serves to parameterize systems of coupled difference and differential equations, used to depict changes in biomasses and trophic interactions in time (Ecosim) and space (Ecospace). The results of these simulations can then be used to modify the initial Ecopath parameterization, and the simulations rerun until external validation is achieved. This reconceptualization of the Ecopath approach as an iterative process, which helps address issues of structural uncertainty, does not, however, markedly increase its input requirements. Rather, it has become possible, through a Bayesian resampling routine, to explicitly consider the numerical uncertainty associated with these inputs. In the course of presenting key features of this reconceptualized Ecopath approach, this contribution presents a number of generalizations on the ecosystem impacts of fisheries. We conclude with a brief discussion of the limitations of the Ecopath approach, both present and intrinsic, the latter leading to a discussion of the limitation of trophic dynamic approaches for the investigations of the ecosystem impact of fisheries, and propose a new approach ('mediation') for considering non-trophic impacts within trophic models. We conclude that the main limitations to the approach that remains at present are (1) the inability of Ecospace to represent migratory flows, and (2) the limited capability of the Ecopath approach as a whole to represent complex trophic ontogenies in species that move from planktivory as larvae to being top predators.

How fisheries impact aquatic ecosystems. TONY. J. PITCHER (Fisheries Centre, 2204 Main Mall, University of British Columbia, Vancouver, BC, Canada V6T 1Z4. email: tpitcher@fisheries.com)

First, I examine the ecological effects of fishing on aquatic ecosystems, with historical and archaeological examples. Overexploitation causes loss of diversity by removing fish with life history characters and spatial behaviour inimical to harvesting, both within and among species. The loss of keystone species can shift the nature of ecosystems. Long-lived, high-value, demersal resources are replaced by pelagic, rapid-turnover, low-value species. Driven by a progression of clever human harvest technologies, I identify three ratchet-like processes that have brought about episodes of depletion. Secondly, the present policy goal of sustainability will successively foreclose future options for the generation of food, wealth and services from ocean resources. Only a policy of rebuilding of ecosystems can reverse this trend. Rebuilding can reduce conflict among resource stakeholders and encourage the public to act as sentinels. Moreover, the maximum economic value in tomorrow's markets, where supply will vastly outstrip demand, will come from rebuilt ecosystems. Finally, I introduce a novel methodology, termed 'BACK TO THE FUTURE', that may be employed to implement a goal of rebuilding. Models of past ecosystems are reconstructed using information about the presence and abundance of species derived from historical documents, archaeology, local and traditional environmental knowledge (LEK and TEK). Economic evaluation of past systems can then be compared with present and alternative ecosystems. Moreover, for almost the first time, the 'BACK TO THE FUTURE' methodology provides the TEK of aboriginal and indigenous peoples with a valuable, direct role in resource management.

Ecoval: evaluating the benefits from alternative ecosystems using ... economics. USSIF RASHID SUMAILA. (Chr. Michelsen ... Norway. email: sumaila@fisheries.com)

This paper will look at the trade-offs between exploitation and ... analyze ways in which the benefit to society of alternative ... may be evaluated.

Ecosystem Change: Unraveling the Effects of Fisheries from Natural Oc... Changes. ANDREW W. TRITES (North Pacific Universities Marine M... Consortium, 604-822-8181, trites@zoology.ubc.ca)

We employed an integrated software package (Ecopath with Ecosim) to ... describe the eastern Bering Sea ecosystem as it was in the 1950s (before ... exploitation) and in the 1980s (following commercial whaling and the ... fisheries). The ecosystem modelling software enabled us to reconstruct the ... with relatively limited data and to test the frequently posed explanations ... exploitation and/or a shift in the physical oceanography altered the ... Sea ecosystem. Among the best-documented changes between the two ... the declines of Steller sea lions and northern fur seals, and the possible ... dominance of groundfish – pollock and large flatfish. Our models indicated ... eastern Bering Sea was more mature in the 1950s than in the 1980s, and ... relatively resilient and resistant to perturbations. Our models suggest ... Sea populations of Steller sea lions would be larger if adult pollock and ... lower in abundance due to competitive release of important prey. Large ... pollock are significant competitors of seals, and there are large overlaps in ... pollock and baleen whales. Our simulations showed that removing whales ... ecosystem would have had a positive effect on pollock by reducing ... However, whaling alone cannot explain the 400% increase in Pollock ... the 1950s and the 1980s. Nor can commercial fisheries account for these ... model suggests that the magnitude of changes that occurred in the eastern ... cannot be explained solely through trophic interactions, and that fisheries ... heavily impacted this ecosystem. Rather, it appears that the observed ... can be explained by factors comprising a regime shift, such as changes in ... temperature or ocean currents. As such it may not be possible for fisheries ... to restore the Bering Sea to its former state.

Scientific Advice for Endangered Species Recov...

Monday, February 21 3:00PM-6:...
Marriott, Lobby Level Virginia ...

Escaping Past Legacies to Promote the Recovery of Salmon: A Cumulative Risk Analysis: PETER KAREIVA. (Fish Ecology Division, Northwest Fisheries Science Center, 2725 Montlake Blvd. East, Seattle, WA 98112-2097, 206-860-3404, peter.kareiva@noaa.gov

Wild salmon in the Columbia Basin have suffered ten-to-hundred-fold declines ... the twentieth century. The blame for these declines can be spread widely: poor ... policy, habitat degradation, dams, unwanted impacts of hatchery fish, exotic ... and so forth. Debates about how to recover salmon have foundered on endless ... arguments about "who or what is the most to blame," rather than carefully describing ... current conditions and identifying where are the greatest future opportunities for ... recovery. Using a cumulative risk analysis the NWFSC has first quantified risks of ... extinction for threatened populations and in turn estimated how much improvement in ... annual rates of population growth would be needed to mitigate these extinction risks. ... Second, using classical tools from demography, sensitivity analyses highlight what ... improvements in the life cycles of different salmon populations will be most effective. ... The next question then is whether these potentially high-yield improvements are ... actually biological feasible, given on-the-ground management actions. Lastly, this ... combination of risk analyses and feasibility studies is used to array a range of different ... management options - some simple, and others involving a mix of many different ... activities.

Salmon Recovery in the Columbia Basin: Science Reviews and Changing Perspectives ... BRIAN RIDDELL. (Department of Fisheries and Oceans, Science Branch, Pacific ... Biological Station, Nanaimo, B.C. V9R 5K6, 250-756-7145, Riddellb@dfo-mpo.gc.ca

The recovery of salmon production in the Columbia Basin is an enormous challenge to ... science and societies. Over 150 years of exploitation and regional development has ... taken a well-known toll on this resource. At present 55% of the watershed area or 31% ... of the stream miles are inaccessible to salmon due to dam construction, and the net ... effect of all impacts has resulted recently in the listing of several "population segments" ... under the Endangered Species Act. Why has this situation developed? Hatcheries have ... been built to mitigate for habitat loss, extraordinary investments have been made in dam ... passage modifications and research generally, and institutional processes were ... established. Recently, a few major scientific reports have addressed this concern. The ... reviews comment on past activities but more importantly reflect significant changes in