**CNH-Style Snippet**

**Amalgamated Fisheries Modeling: A cross-scale approach to environmental dilemmas**

This project aims to better understand systemic environmental problems, focused on fisheries management, by developing new cross-scale perspectives. Researchers will investigate how social and ecological systems at diverse scales interact, and how these insights can be integrated into a general modeling framework for coupled multi-scale dynamics.

**Longer Statement**

The Open World project aims to better understand systemic problems in fisheries management by developing new cross-scale perspectives. Fisheries collapse is a global concern, affecting world food supply and economic prospects for fishing communities, and impacting ecosystem services and endangered species. Management structures have struggled with perverse economic incentives, multiple scales of uncertainty, and unintended policy consequences. Policies and dynamics at regional scales, including climate, trade, and migration networks, have a complicated relationship with local choices and behaviors. By improving our understanding of how scales and systems interact, we
hope to reveal opportunities for more sustainable management.

This analysis starts with a spatially complex and institutionally specific model. For fish ecosystems, we hope to build models at both ecosystem and regional levels, allowing these to interact and each to inform possible scenarios. To model fisheries management, we will consider decision-making at the fishing community level, regional policy-making level, and the influences of various institutions and their decision-making procedures. To build these models, we plan to engage with fishing groups, scientists, policy-makers, and other stakeholders.

One goal of this research is to identify and understand potential policy leverage points. By unraveling the systemic forces that make fisheries management so intractable, we hope to also find opportunities for policy approaches that avoid opposition or counterproductive side effects. The work will start with a particular region and fishery, but the framework we build will allow models representing different fish species and policy mechanisms to be easily "plugged-in" to explore different contexts.

To study these interactions, the Open World project explores a powerful intersection between new theoretical foundations and modeling technology. Using theories of complex systems and statistical dynamics, we seek a stronger basis for multi-scale systems and new forms of coupling. This foundation supports the development of new frameworks for "amalgamated" modeling, which allows models at diverse scales and contexts to interact. Such a composite model also needs new theoretical and technological work to elucidate the driving principles behind the resulting dynamics.

The interactions between natural and human systems at different scales are central to many environmental and resource management issues. For example, global and regional policies place constraints on local behaviors, but the collective impact of these local decisions enters the large-scale systems that define those policies. A combination of coupling across scales using downscaling and aggregation, and the interplay between large-scale networks, constituent small-scale networks, and diffusion offers a way to understand these connections.

Models of economics and natural science are most effective at a given scale and context, but the boundaries between social institutions, between ecosystems, and between scales are rarely clear. Moreover, direct coupling of these models can both distort their accuracy and obfuscate the drivers behind their results. This project investigates how we can move beyond coupling, by looking at how systems and their component elements can overlap and mutually inform each other.

To support this research, the project will build a general framework for integrating an unlimited collection of models of social-ecological systems. This framework would provide an interface between models operating at different scales and contexts and according to different techniques and assumptions. The amalgamated approach allows different policy scenarios and ecological models to be easily substituted and compared. The composite system aims to be transparent in its operation, available as a rich foundation for other researchers, and open to new contributions.

Computational tools for validating and communicating the results become central in this framework. The Open World project will study new cross-scale metrics and statistical approaches to connect the amalgamated models and real world data. Equally important are tools that support more insightful communication, including ways to identify critical feedback loops and the most salient internal connections, helping to construct higher-level conceptual models. Finally, a key need for environmental problems is the ability to evaluate management leverage points, such as parameters or structures where small changes can result in pervasive differences in dynamics.

Our first goal is to compose an application for the Dynamics of Coupled Natural and Human Systems grant as a Large CNH Interdisciplinary project, due November 20. More information on the grant is available at [http://www.nsf.gov/funding/pgm\_summ.jsp?pims\_id=13681](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13681" \t "_blank).