

bubble or any empirical result will be potentially flawed and backed on assumptions that might be wrong. Short term management has to be based on data collection and on short term information.

Carl Walters

A wise stock market analyst won't ever predict the market, he will develop a portfolio of investments that will make the client feel as safe as they want to be, without having to predict what will happen.

What do you see the prospects are for the ecomodels that you have been working on for the last few years? Will it solve the prediction problem for us at all?

James Scandol

In-season estimates are easier to manage. If something goes drastically wrong and there are no fish when we thought there were going to be a whole lot, then at least you have some fallback mechanism with in-season management. Any model - even a fancy mechanistic model with some weird geometry or a strictly good correlation - needs to be ready to be knocked out of the system if it looks as if there is incompatible information coming in from the short term data collection.

I think models need to be slaughtered as soon as the need occurs.

Laser Ablation ICP-MS - A New Method to Identify Individual Natal Stream Sources of Salmonids and Migration Patterns of Fish

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Poster

Laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) has been applied as a method to determine elemental distribution in biological tissue specimens, providing high spatial resolution and sensitivity. It has been determined that certain elements are assimilated into growing biota from the food source and fresh water in

natal streams, hatcheries, and fish farms. The elements are deposited into the skeletal structure of growing fish and remain throughout the life span in scales, otoliths and vertebrae. Variation in chemistry of the environment produces a pattern of discrete bands in the biota corresponding to the changes in chemistry and the duration of exposure. A micro-analysis of these regions allows the establishment of data to provide specific information on the unique elemental signatures (finger prints) in fish from a particular source, and subsequent exposure to environmental changes during migration. A classification accuracy of up to 100% is achieved when fish scales are examined.

Using mass-balance (ECOPATH) food web models to structure dynamic (ECOSIM) simulation models

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Demonstration

The linear equations which describe trophic fluxes in mass-balance, food web models of ecosystems (such as in the ECOPATH approach and software) can be re-expressed as differential equations defining trophic interactions as dynamic relationships varying with biomasses and fishing regimes. The trajectories of biomass predicted by these differential equations, and equilibrium system responses under different exploitation regimes are found by setting the differential equations equal to zero, and solving for biomasses at different levels of fishing mortality. This approach, incorporated as a routine (called "ECOSIM") into the well-documented ECOPATH software (see also Pauly and Christensen, this vol., page 23) will enable a wide range of potential users to conduct fisheries policy analyses that explicitly account for ecosystem trophic interactions, without requiring the users to engage in detailed information gathering (beyond that

those looking at oceans were looking more at ecosystem-based management. Marine protected areas might be perhaps a tool for that latter form of management.

I am on a fisheries resource conservation council on the Atlantic coast of Canada that tries to deal with recommending conservation measures to the government. We have been struggling with issue like this and we face questions like does it make sense to harvest capelin when the cod stocks are depressed, and does it make sense to trawl on the bottom of the ocean when that disturbs the bottom habitat?

Those kind of issues are ones raised by the fishers that we listen to. To me those are the fundamental questions that are out there, and I would be interested in any comments as to how to address them, apart from saying we need more research.

Tony Pitcher

I wonder how many of us feel about incorporating the ecosystem perspective in a management plan. How many people here feel that we have enough knowledge and the right tools to confidently include the ecosystem aspect in conventional fisheries management? I am talking about more than just the single species management. - the fish population dynamics that traditionally have been used by fisheries managers. Do we know enough after sessions like today, to include that in our management?

Jake Rice

There is not a yes or no answer. In some areas we have some knowledge that we could use to do ecosystem based management. For example, we have excellent experience with tuna-dolphins and with other species of bycatch, I wouldn't go further on other examples. That is the approach that we are trying to pursue but I wouldn't be bigheaded enough to assume we can do it.

John Schnute

It does seem as if there are two schools of thought. I belong to a school where a great deal of my professional energy is directed towards looking at the data we actually have and trying to decide what is actually happening out there. This is very Sherlock Holmes-like - here are the fingerprints and the footprints and all the clues, and now what

can we say about what has transpired?

A person of my school of thought looks at this sort of ecosystem stuff and says it doesn't really help because it is so unpredictable and so it doesn't help solve the problem. On the other hand, the other school looks at me and says, well you idiot, of course these fish eat this and eat that and how can you possibly ignore these facts about the process.

It seems to me a theme of this meeting is try to see each other as Sherlock Holmes. How do we bridge between the two schools? Your question Tony was in some sense unanswerable. You would have to be an idiot to disagree that the food web matters somehow. But is the ecosystem perspective germane to the analysis? This is important because of the expense of ecosystem research. Where do we focus our attention for data? What is useful for the taxpayer?

I might say Jim that I thought that your talk was one of the most convincing that I have ever heard on how things can really happen.

I guess it was expensive and you had the privilege of being able to manipulate things a bit. The question I have for you is that some of the manipulations in your system were handed to you, either by nature or by virtue of the fact that publicity brought in the sports fishermen. Other times you went and moved fish. It seems to me that most of us have to depend a lot on naturally induced contrasts.

Jake Rice

On that theme, and prompted by Tony's question, studies of marine ecosystems, whether they are pelagic, open ocean or whatever, have taught us a great deal over the last three decades.

But if you look at the assessment tools being used for fish stocks, and try to build analytical linkages between the research on ecosystems and actually doing the stock assessment to provide forecasts in the short and medium term - I raise my hand to Tony Pitcher's question and say yes- we do know a lot, we know a great deal, but we are not using these analytical paths to give advice to managers. And I don't know a jurisdiction in the world that is providing funding to build those links. We are

funding lots of ecosystem based research and lots of modelling on fish stocks, but we are not linking those two things. It seems very unglamorous work but it is where we are going to get the pay off.

Rashid Sumaila

We have several systems, from the fjords to the Barents Sea to the North Sea, where we can see that the production of phytoplankton can be modelled from the local conditions, but the biomass of zooplankton cannot be modelled from the local phytoplankton concentrations, only from the advection from the open ocean.

For instance, the Norwegian Sea supplies the whole Barents Sea (which is three times the size of the North Sea). It is driven by advection. Fish production is not driven by local conditions but by input from the Atlantic. This is not similar to a lake.

Kevern Cochrane

Can I respond to that, and put forward a gross oversimplification, but then that is what modelling is all about! I suggest that we could take one of Jim's half hectare models and with minimal change apply it to the Black Sea, but in doing so we would have to split it up into 4-5 little areas, and we would have to model interactions between those areas. We could apply it to the Mediterranean, but we would have to split it up into 20 -30 different areas, and look at the interactions between areas. And we could go on to do the same for the Pacific Ocean, with many little coupled areas.

What would be happening is that the interaction terms would be becoming more and more dominant. So what was happening in the box (for example what Jim was telling us) would become less and less important, and what is happening between the boxes would become more and more important. This leads to the uncertainty that we talked about earlier.

Tony Pitcher

The naturalistic fallacy in philosophy is to try to get an *is* from an *ought*. As scientists we are adept at avoiding this pitfall - we know we ought to use ecosystem management, but this discussion shows that we are very eager not to use it because we like to claim we don't know what it is. The papers in this session

suggest that this claim not really true, but the discussion is symptomatic of our reluctance to get involved.

The freshwater people know more about their systems because they more bounded or coupled than marine ones, and so maybe they are more confident to use knowledge of the ecosystem in resource management. But our profession is very unhappy at the notion of trying to use such knowledge in the oceans.

There is an instructive paradox here: the public may be surprised at our professional coyness. We say that we do not have the knowledge to manage aquatic resources using information about their roles in ecosystems. Yet as several speakers have pointed out, we humans have already documented massive impacts on marine systems. So we may have the basis for more understanding more than we care to admit.

Several speakers pointed to massive uncertainties and unpredictability in aquatic systems. But similar massive uncertainties are incorporated as a matter of routine into everyday stock assessments. We baulk at the uncertainties of including prey, predator and trophic web effects, but often these trophic interactions turn out to be supported by food consumption data dating back many years. I suggest that we try to have the courage to develop and use ecosystem -based management tools.
