

Management Panel

Tools and Strategies for Assessment and Management of Data-Limited Fish Stocks

30th Wakefield Fisheries Symposium, May 2015, Anchorage, Alaska

Alaska Sea Grant

Natalie Dowling, CSIRO, Australia; Doug Butterworth, University of Cape Town, South Africa; Cathy Dichmont, CSIRO, Australia; and Steven Cadrin, University of Massachusetts, USA.

Moderated by Olav Ormseth, NOAA Alaska Fisheries Science Center

Olav Ormseth: We want to get input from the audience as well as panel members. My starting question—and this morning made that question even more relevant—where do we go from here? We've talked about problems with the Magnuson Stevens Act, in terms of how we approach things. We've seen some great new technology. We've seen big inroads like in the Galapagos. In the next 10-20 years across the world, where do you see this heading in terms of management advancements in data-limited situations?

Natalie Dowling: There are a number of points. I think that first off your question pertains to existing policies where we have “square peg–round hole” kind of issues of data-poor. We have had this issue when developing management strategies for Australian Commonwealth data-limited fisheries. We really need a T-shirt that says we are consistent with the intent of the policy. Ideally we should be aiming for a defensible target reference point. What needs to be built into these policies is the flexibility that acknowledges that you can't make a silk purse out of a sow's ear. It's not just about data availability—it's also about capacity and economics. You need to be looking at not only the available information but also the socioeconomic and the governance aspects of the situation. If you don't have these things there are pragmatic things that are still available to you. Whether or not they are consistent with what the policy is demanding is another question. I think we can do two things: we can advocate for more flexibility in those policies. Whatever we do needs to be adaptive in terms of data collection and the kind of assessment that we need. Whatever we put in place it obviously has to be better than nothing. We put in background monitoring that's affordable, so as we proceed we are putting in a framework, whereby as we reach indicators or trigger points that suggest things are expanding or changing, then we are in a position to respond to those accordingly and therefore we move adaptively forward.

Doug Butterworth: The first thing I took particularly from this morning's discussion is effort limitation on catch as a basis for control. I think we need to give more attention to that. The second point I'd make is simplicity. With these data-poor approaches, I'd argue very strongly for an empirical approach for many reasons, particularly stakeholder understanding. I'm not saying that there is no room for complex assessments—my comment does not concern the way you test your approaches mathematically, but rather the way you apply them. If you have indices of abundance, you work off trends or levels of those indices. You don't put them through complicated models to obtain your management recommendations. And the third point I'd make at this stage is I think we need to give attention to developing countries and how we apply these approaches there. Most of the people here are from developed countries, and even

in developed countries there are data-poor fisheries. We've talked about how we've developed methods that can be used in developed countries in these circumstances. But the real need in the world fisheries is in developing countries where most of the unregulated fisheries are to be found, as generally these fisheries are not doing very well. In the developing world we have to look toward a product that is readily sold and applied. There is much more that could be said about this. I hope we can come back to that at some stage. Thanks

Cathy Dichmont: I was going to say two things, some of which Doug has already said. The first thing is I don't think we should try NOT to repeat history in the data-rich world in the data-limited world. And one thing that we're tending to do is to have paradigms that we are trying to sell. ITQs or TACs are the way to go, and that's the default and really nothing else goes. I think that's a dangerous one and similarly I think you need to be data-rich no matter how much you can afford or actually do it. So that's the first thing: I'd like us to see a little bit of open-mindedness about how people can approach a data-limited fishery as long as they follow the spirit of the policy. I really do agree with Natalie in that regard. The second thing is I think the world is becoming very innovative and there is a lot of technology happening. There is also another thing that is happening to us on the fisheries side—at least some of us—which is that we are actually starting to see that other user groups beyond fisheries are impacting us. I think in the next 20 years we are going to start seeing the more multiple use aspect of our world impinging on us and we are going to have to start working with ports and mines like I do. And then third and lastly I think the developing world is very, very different and it's almost good for us to work in both worlds. If we have a foot in both doors, we learn things from both and the more you do that as a community and share that knowledge we would actually come up with a great product that will be useful in both developed and developing countries.

Steve Cadrin: In answer to the question where do we go from here, I think the first step would be to do something—to not use the uncertainty to avoid having any management. And I think in the US we have largely done that—perhaps from a command and control system without the controls—but we are doing something. The ICES community is doing something for all of their stocks. We've gone away in those two systems from just an unknown status and no management. The way we do that is we take an inventory of what information is available, both the time series and the quality. We use Tom Carruthers' decision tree about what assessment methods are appropriate for that data availability. We have some assessment and some approximation of sustainable yield or the status of the stock and we have some management. Now when John Hoenig suggested this yesterday that is essentially reverse engineering. It's taking what you have and what can you do with it as opposed to where do you want to go, which is strategic. So I think the next step is identifying how is this current data availability and our capability lacking for our aspirational goals? And what investments do we need with the next step? It's a different thing in every area. In the Marianas it's probably monitoring CPUE of each species within that complex. In the Caribbean it's probably changing the culture to try to start monitoring the fisheries. In the South Atlantic it's probably better recreational statistics. In New England it's probably as Doug said some form of effort control, bycatch avoidance, and catch optimization. So I think it really is adaptive and incremental from a very pragmatic approach of what we have, to where do we want to go.

Ross Tallman, DFO Canada: I was really excited when the symposium was set up. Unfortunately I missed a few days. I have not been disappointed with what I've heard. We should have effort control; that makes sense for me. I'm working in essentially a third world situation in the Canadian Arctic. I'll use the example of Canada Department of Fisheries and Oceans. You have the policies and the way to deal with things driven by the dominant industrial fisheries, the big fisheries. And you have the people who advise on the policy, they tend to be your top experts who deal with the most sophisticated modelers, who deal with data-rich fisheries, and then that becomes across the board policy so that fisheries management objectives become quota. So we're applying I think quite inappropriately. I saw some really good talks about this—of course that makes sense. We're applying commercial quotas to things that are mixed subsistence and commercial fisheries in some cases—if you make the commercial quota small enough that the subsistence catch goes up. But you don't really see that, you know, you have all of these things you can't handle. The people on the panel deal with other jurisdictions. I have the impression that in Australia and elsewhere, because there are so many data-poor stocks, maybe the policies have been more oriented that way. I wonder if the panel could comment on how do you move the inertia in large agencies. How do you lead to those stocks in one paradigm policies?

Cathy Dichmont: I have real sympathy for that because I actually have gone through this process. In Australia I was involved in a data-rich fishery that did not want to use an ITQ system. It's in an individual transferable effort unit system, and it's extremely well managed. It's Marine Steward Council—certified and yet as I was saying this paradigm—this idea that ITQs are the way to go—was almost forced onto this fishery. It cost them a fortune to get the scientific backing to explain that the way they were managing at the moment is perfectly good and that has actually remained. What was interesting for me, in the 2.5 years that we went through that process of convincing the government that it is a good management system to manage through effort controls, is how many scientists were getting up and telling them that ITQs are the way to go. So in a way I don't think we can just blame them. They are actually getting advice from scientists and scientists are standing up and saying "this is the rule." We have to ask ourselves how much are we contributors to this view, that the top down management system is the way to go and ITQs are the way to go. I think if we start writing articles that are more broad and more expose those kinds of questions and experiences, maybe we would be able to influence policy as well.

Natalie Dowling: I'd like to add my thought that a lot of policy is driven as we all are aware from the data-rich context. I think a lot of general kind of guidance has been developed for the data-poor kind of thing, and there has been a lot of specific implementation where people have worked one-on-one with fisheries in detail like what were seeing with the Galapagos case this morning. What I think is lacking—this is something like the work I am doing with the Science for Nature and People project that I will be talking about tomorrow—where it's difficult for policy makers is that they can't see a how to reconcile information, biology, life history, fishery operational characteristics, socioeconomics, and governance to say "look, given this combination of circumstances across those five categories these are things that are realistic

options and these are things that are not.” If we can say we’ve got some demonstrable case studies where it’s been shown that ITQs fail and that they fail because of life history or because of implementation, from a socioeconomic perspective of miss-reporting of them, the governance perspective, if we can provide a framework that isn’t arms-length guidance, it shows that for combinations of circumstances this is what’s likely to work and we do that in a very pragmatic way. I completely agree with Doug—we do that in a very simple manner and we re-educate on what an assessment comprises because people immediately equate assessment with model based. We have 38 empirical assessments that underpin this process that we are doing with SNAP. People have to get sold on the idea that it’s still going to give you some understanding of data that’s some Bmsy reference point. As Cathy is saying we have a responsibility to get the common sense approach happening but to map that out in a very clear and understandable way for lay people. They get bogged down in very technical questions from a data-rich top-down perspective or we try and provide very general guidance to fisheries where those specific circumstances across all five categories are going to make the circumstances unique. It is going to be hard to move from general guidance to implementation.

Doug Butterworth: I find this interesting coming from a country with a developed scientific system (Australia) in contrast to a developing country management (or policy) system where there is actually very little by way of policy or associated debate in our (South African) circumstances. I think what is needed is firm, well-structured scientific advice. In South Africa, we have a system where we have the flexibility to do that because we don’t have an Act that has (in practical reality) the sort of constraints you might have with the Magnuson Stevens Act. The other point I would offer, which will connect it with something Steve said, is that what we have found (even though I have reservations about this in some contexts) that the MSC has been a great ally of science, indirectly because it’s a wolf with which scientists can threaten some of the other players in the system. And that is what one has with the MSC, if you get competent people on their review panels and a common understanding. Steve, I was interested that you showed one MSC-related slide talking about catch (output) controls. Do they really mean that literally? I would have confidence in most of the people on the MSC panels with which I’ve worked: given a sensible argument they’ll support it, so that if it is sensible to use a control based on other than catch they’ll support it? And the fact that these MSC reviews provide a bit of a stick as well has been useful for us as scientists. So it’s a rather different perspective that I’m giving you here from what Cathy and Natalie have said. They’ve come from a developed country policy environment, whereas I’m coming from a policy environment that is rather more like you’d find in developing countries. I think there is an opportunity there for scientists in developing countries provided that they act responsibly and coherently. There can be the problem, as Cathy said, of in specific cases saying something contrary to what’s being said generally for other cases. You obviously have to try to avoid that, as you can’t risk the divide-and-rule option being used against scientists. You must try to get a single voice from the scientists. But I think that there is now hope given that we’re getting a strong scientific input.

Steve Cadrin: Within the MSC system you’re down-scored for not having output controls. It is required for a perfect score but certainly they are certifiable and I think that’s Cathy’s example as well, that you can have effort controls that you get certified but you are down-scored for it.

Even the labels are very telling. We are considered developed countries and anything that does not conform to our value system and governance control is “developing.” Some of these societies are thousands of years old and they are still developing because they are not conforming to us. When it comes to certification there is inequity in many of the countries. We are stamping eco-labels on things just because they don’t conform to our value system.

Unknown: I hear a lot about effort control. And ITQs being top down. Any of these systems that are top down are doomed to failure. Remember we are using the word developing nation. If they are truly developing they are going to help with your effort controls. As a fisherman I spent a lot of time trying to figure out ways around effort controls. They are very smart people and they are able to get around them. So without getting buy-in from the stakeholders in the management system it’s not going to work no matter what you put in place. The first step may be just sitting down and talking to people about what they think would work and what they think needs to happen in the system. And maybe convincing them that they need a solution because a lot of them are not convinced that a solution is needed. They are perfectly happy under the current system they are working in.

Natalie Dowling: I couldn’t agree more. I think that is the absolute necessity that needs to happen. We’ve got two families of context here. One is where you have policy and another is where you have developing nation context fisheries where they’ve never been managed. In both of those instances—I’ve worked heavily in the former and somewhat in the latter—you cannot do better than starting at the bottom and talking to the stakeholders. They are your best source of information if treated with respect. The fishery and its operational characteristics are going to affect heavily the kind of decisions you make about what kind of assessment and control rule is going to be effective. They are the ones whose buy-in you need to make this thing non-farcical. It’s not only about ITQs or effort control. There are certain families that we have identified—harvest control, spatial restrictions, gear restrictions, sex regulations—and under each of those families we’ve got things like move-on provisions, permanent closures, seasonal closures, TRPs, rotational systems. All of those options should be considered in the context of what’s going to work given what you know about the fishes, socioeconomics, level of cooperation, governance issues. If you’ve got buy-in from the start you’re going to, by orders of magnitude, improve your chance of success. We should not be advocating anything but a bottom up approach with stakeholders involved from the get-go. That is paramount.

Steve Cadrin: I completely agree. One of the surprises of this conference has been that many of the lessons in data-limited assessment and management apply to data-rich. This is one of them. When you go to best management practices of small-scale data-limited-fisheries—whether that’s FAO or New Zealand—everything is exactly as Natalie said. You need to engage the community. The reason you have to do that is because we don’t have enforced monitoring. I think we fool ourselves that when we do have enforcement and monitoring we can have top down, that we can micromanage. It’s a false belief. As much enforcement and monitoring as we have, unless the fishermen buy in they’ll always be able to out-clever us when it comes to these things. Again, there is another lesson on bottom up that micromanaging simply does not work. The National Marine Fisheries Service offers a ridiculous proportion of federal regulations every

year across all of our industries. We are obviously micromanaging our fisheries and we are fooling ourselves that it is actually effective.

Steve Barbeaux, NOAA Alaska Fisheries Science Center: I don't necessarily agree with that. In Alaska we've had successful fisheries that are managed very strictly with in-season management—maybe because there's more money up here to manage things—really strong observer programs and successful fisheries. To make the statement that it hasn't worked—maybe it hasn't worked in certain regions because of the political climate, maybe no buy-in from the fishermen, but in some places in the world it has worked. I'm not saying that's the solution for every place.

Steve Cadrin: But you have trust here. You've done both. You have bottom-up collaboration between science and industry and management. You can contrast New England and the North Pacific with the data availability. We lack the trust. This region is actually an example of what we are talking about.

Unknown: Yes, it is bottom up that enables the top down at the same time.

Cathy Dichmont: People who are not aware of the Australian system should see Natalie and me. We inherently have a co-management system. We almost forget that others don't have it. We are so used to having meetings with industry and managers that we forget others don't do that. It's really a great system. A lot of people criticize it. But I've lived the system with and without industry in the room and I'd rather have that any day. One of the fisheries I'm involved with is actually self-managed. They do all their own management and they are audited by the management authority. One of the things I've learned about that kind of system is it's really a long gradient between top-down and bottom-up. It has to fit the fishery that you've got. There's no one size fits all. Fisheries go in and out of phases as well. When the industry is very cohesive and they have a high trust factor like this case, self-management makes perfect sense. But there are cases in Australia where in some fisheries the industry has become less cohesive over time and they've had to go back into a more top-down approach. We should be open minded in the systems that we are trying to bring whether its co-management, self-management, net gradient, ITQs or TRPS, whether it's data-limited or data-rich—we should be flexible. As long as we are flexible and adaptive we'll make a lot of progress. That applies both in the developing and developed world.

Doug Butterworth: I might get into trouble here, in pointing to another developing country aspect. In principle I very much agree with the buy-in aspect. You have to get stakeholders buying in. But one must be realistic about the context, depending on the circumstances from which one is coming. Here is an example (I am not to be quoted on this!): we have a problem with our rock lobster fishery in South Africa. It is heavily depleted but greatly sought after and is heavily poached because of its value. The fact that the scientists are saying it's heavily depleted is contested at a very superficial level. From a number of those who utilize it, here is an example of a comment. This comment is not just coming from fishermen; it was also made at a very high level and mentioned quietly to me. We have occasional "walk outs" of lobsters when

there's a phytoplankton bloom that removes the oxygen from the water. This traps some of the lobsters inshore and they walk out onto the beach and die. The comment was: "This is a sign from God that there are so many lobsters that there is not room for all of them in the sea." This is with what one has deal. If I put you in that situation, would you go for bottom-up or top-down control? I'll make a second point, also off the record. In some of our scientific meetings industry requests: can't we have overruns and under-runs of TACs each year to allow flexibility to maximize economic benefits with prices varying over time, provided we balance out in the medium term. And scientists say we thoroughly agree, but we have a management system that isn't capable of handling that level of complexity. So you've got to tailor what you do to what your system is capable of implementing. Here I'll get into trouble again when I say I have a maxim that the best government is the least government, up to a point. That point of view is what's behind the KISS in my introductory talk—you have to stay simple on many of these issues, particularly in certain environments. The last point I'd make is we have a wonderful habit of hopping between advocating input and output controls. When we have output controls we say the problem is that we should have input controls, and *vice versa*. At the moment though I am pretty positively inclined toward some of the arguments that I've heard here today about more input than output controls in certain circumstances. Let's not lose sight of why we do have reservations about input controls. We've heard about all of the problems related to output controls. What are the fundamental reservations about input controls? There are two—one is the efficiency creep, and the other is a different form of efficiency creep, to which a previous speaker referred just a moment ago. But surely we have considerable experience now in the way those tricks can be played. And with that experience can't we do a better job? Admittedly the business of business is, given regulations, to find how to work within those regulations to the best and most efficient effect in terms of financial returns, and administrators are always going to have to be chasing that. But it's an asymptotic game. The benefits one can get from trying to get around the system are not unlimited. I haven't seen any articles on this, but surely it would be a valuable study to pick out what have we learned about the ways people can get round the simple effort controls, and set down how can we advise people on ways to stop them.

Natalie Dowling: I'd like to add my thought that a lot of policy is driven - as we all are aware - from the data-rich context. I think a lot of general kind of guidance has been developed for the data-poor kind of thing, and there has been a lot of specific implementation where people have worked one-on-one with fisheries in detail like what we were seeing with the Galapagos case this morning. What I think is lacking—this is something like the work I am doing with the Science for Nature and People project that I will be talking about tomorrow—where it's difficult for policy makers is that they can't see a how to reconcile information, biology, life history, fishery operational characteristics, socioeconomics, and governance to say "look, given this combination of circumstances across those five categories, these are things that are realistic options and these are things that are not." If we can say we've got some demonstrable case studies where it's been shown that ITQs fail and that they fail because of life history or because of implementation, from a socioeconomic perspective, or of misreporting, or the governance perspective, if we can provide a framework that isn't arms-length guidance, it shows that for combinations of circumstances "this is what's likely to work" and we do that in a very pragmatic

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Doug Butterworth: I find this interesting coming from a country with a developed scientific system and a developing country management system or policy system where there is very little by way of policy in our circumstances. I think what is needed is firm, well-structured scientific advice. We have a system where we have the flexibility to do that because we don't have an act that has in reality the sort of constraints you might have with the Magnuson Stevens Act. The other point I would offer, and I will connect it with something Steve said, what we have found even though I have reservations about this in some contexts is the MSC has been a great ally of science, indirectly because it's a wolf we can threaten some of the other people with. And what one has quite honestly with the MSC, if you get decent people on your review panels or a common understanding. Steve, I was interested you brought up the one MSC slide talking about catch. Do they really mean it literally in the sense that I would have confidence in most of the MSC type people, panels I've worked with, given the sensible argument they'll support it and if it is sensible rather than catch they'll support it? And the fact that it carries a bit of a stick as well has been useful for us as scientists. So it's a rather different perspective that I'm giving you here from what Cathy and Natalie have said. They've come from a developed country policy environment where I'm coming from a policy environment that is rather more like you'd find in developing countries. I think there is an opportunity there for scientists provided they act responsibly and coherently. It's not like, as Cathy said, the problem more in specific cases saying one thing contrary to what's been said generally in other cases. You obviously have to avoid that you can't risk scientifically the divide-and-rule option. You must try to get a single voice from the scientists. But I think there is hope that we're getting a strong scientific input.

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Doug Butterworth: I might get into trouble here, giving another developing country aspect. In principle I very much agree with the buy-in aspect. You have to get stakeholders buying in. But one must be realistic about the context, depending on the circumstances from which one is coming. Here is an example (I am not to be quoted on this): we have a problem with our rock lobster fishery in South Africa. It is heavily depleted but greatly sought after and is greatly poached because of its value. The fact that the scientists are saying it's heavily depleted is contested at a very superficial level. Of a number of those who utilize it here is an example of a comment. This comment is not just coming from fishermen, it was made at a very high level and reported to me. We have occasional "walk out" of lobsters when there's a phytoplankton bloom that removes the oxygen from the water. This traps some of the lobsters inshore and they walk out. The comment was, "This is a sign from God that there are so many lobsters that there is not room for them." This is what you've got to deal with. If I put you in that situation do you go bottom-up or top-down? I'll make a second point, off the record. In some of our scientific meetings with complicated regulations we hear—yes we would do better if the industry comes to us and says can't we have overruns and under-runs of TACs. And we say we

thoroughly agree with you, but we've got a management system that isn't capable of handling that. So you've got to tailor what you can do, to what your managers are capable of implementing. Here I'll get into trouble again when I say I have a maxim that the best government is the least government up to a point. From that point of view what's behind the KISS in my introductory talk—you've got to be simple with many of these things, particularly in certain environments. The last point I'd make is we have a wonderful habit of hopping between input and output controls. When you've got output controls you say the problem is you should have input controls, and vice versa. At the moment though I am pretty positively inclined toward some of the arguments that I've heard here today about more input than output controls in certain circumstances. Let's not lose sight of why do we have reservations about input controls. We've heard all there is of them based about output controls. What are the fundamental reservations about input controls? There are two—one is the efficiency creep, and the other form of efficiency creep, which the other gentlemen just referred to a moment ago, that surely we have considerable experience now in the way these tricks can be played. And with that experience can't we do a better job? Admittedly yes, business of business has given regulations to find how to work within those regulations to the best and most efficient effect and you're always as administrators going to be chasing that. But it's an asymptotic game. It's not infinite, the benefits you can get from trying to get around the system. I haven't see the articles on this but surely this is a valuable study, to pick out what have we learned about the way people can get round the simple effort controls and how can we advise people on ways to stop there.

Natalie Dowling: I'll build on what Doug said in a noncontroversial way. I don't think we should be thinking in terms of limiting ourselves to one form of control rule, either. When we went through this exercise with these Australian Commonwealth fisheries, what we were really trying to get in the absence of information was a broader understanding of how the fishery operated. We were looking at closing loopholes. Things like—if we see something happening with effort that's also accompanied by some kind of spatial issues and there's a shift in catch on certain species, etc., you're looking and saying you've got some kind of decision tree where certain combinations of indicators might be suggesting something, then you're covering your butt there. By the same token when you have something like arrow squid, which has a boom and bust life history, and suddenly they appear, if the fishermen don't take them they'll just die anyway due to natural attrition. I believe you have to have that flexibility built in in the form of a controlled override, where again you say how do we define a boom. You need to a priori define the criteria. You have this many boats at these catch rates for this sustained period of time. We then lift catch regulations for a certain period of time and re-evaluate it. You just have to think like a game of Twister where you are trying to cover your bases. Regarding your Huxley-esque loving act of God industry person, my answer to that would be yes, in the first instance you might have to be top down but you should also be a bit evangelical when working with these people. In a positive context I am trying to sell what management control can do, rather than being a big stick. It's about the social perception. Empowering people and selling the benefits of management strategies is a really big thing where we can't make promises that we can't keep. I'm not comfortable with this whole risk catch trade-off that with better assessment we are to take more. That's really scary territory. But we can sell other benefits and

help empower industry to manage their fisheries. That's an important consideration.

John Hoenig, Virginia Institute of Marine Science: I think buy-in is very important but it's not always clear who you need to have buy-in. I have my own God story, with the crab fisherman who told me that God determines the recruitment, not managers. So there's no need for cutting back the effort. Even though it's way overcapitalized it's an act of God what recruitment you'll get. I don't know that there is any hope of convincing him of the utility of managing the fishery, but in the Caribbean the problem seems to be with not just the scientists but with the whole system of government—the ministers. I was surprised when I started going down in the Caribbean and meeting with people from different countries—almost all the fisheries officers and scientists who came were women. When I started in the fisheries in the US it was heavily dominated by men. Now there are lots of women. I sort of thought the Caribbean would be behind us and it would be mostly men. No. Doing the scientific work—that's women's work because the men go out fishing and make money. That was a cultural thing that I had to adjust to. Most of the scientists had high school educations. So plotting y vs. x for some of them was difficult. And the agencies tended to think going to the meeting was a perk so they rotated among the scientists so that everybody got a reward. This meant that somebody would come and start to get the sense of what's going on, and they would really benefit from coming back a couple more times and seeing it through. But then they would send in somebody else who was completely clueless their first time. It was extraordinarily frustrating. The organization that was bringing me there to help was trying to deal with the fisheries ministers, and they did not see the importance of collecting data. They were not data-poor fisheries—in some case they were data-nonexistent fisheries. I would come to the meeting and say—OK I will help you analyze your data. What have you got? They didn't bring anything. Zero. So that makes it rather hard to analyze the data. You could get all the buy-in you want from the fishers, but there was no infrastructure, no understanding of what exactly does science offer and what can management do and how it would be implemented. It was: "Let me get this straight. You want me to spend funds to develop management and the next 3-5 years we'll get how many dollars of benefit? It will take some time to develop this. Well I'm going to retire in three years so if it's not going to benefit me before then, what is the point? It's only going to cost me. I'm going to have to justify the funds." In some cases the buy-in is really not with the industry. It's with the managers and that is part of the problem. That's part of why they'll go with what they heard. "I heard in the men's room that you should do ITQs." Or "we should have ecosystem management." And I said, do you want to do ecosystem management? You don't have any management, so you're going to start with that? You don't know the catches. Well that's what they heard.

Willow Battista, Environmental Defense Fund: This question relates to a lot of what's been said. Originally I thought of it during Doug's very first comment. Sorry it's a little bit of a throwback. We spend a lot of time at EDF talking about how to make these data-limited assessment methods more accessible to the managers of fisheries in developing and developed countries around the world. We grapple a lot with the question of what is the best way, the best happy medium between making these methods understandable and accessible, and the other side being making them so accessible that there is danger that someone might just take the method without fully understanding what is going on, and sort of press go and then build

their management based on that. I would love feedback from the panel as well as the rest of the attendees of this conference. What do you think is the best way to walk that fine line? Thank you.

Steve Cadrin: I think EDF should fund highly technical people to go to the tropics and teach these things. I think outreach and training is part of the solution. And welcome the funding.

Doug Butterworth: First can I request that you turn off the recorder again? This gets to a number of points that I was going to raise. Perhaps picking up on what John said, I'd raise the question here because I do have considerable sympathy for the MSC approach, and the stick that it effectively carries. I don't think it's operating effectively now because the MSC have put their bar so high that it is hardly an effective stick or incentive or anything. I would welcome some comments on whether you consider a lower MSC bar would be better because many of these countries do depend on the export markets for their product. And now from the developed countries to which they are exporting there is the line being taken: no, we're not going to buy from you unless you are certified to some extent. If you can set a realistic bar, would that not provide the incentive to get something done here and to move away from the situation John related? I can certainly relate to John's experience; I've seen exactly that sort of situation. I want to pick up here on a comment made earlier when we started—Tom Carruthers has developed this library of methods and all we've got to do is give it to these groups, and they'll pull one off the shelf and Bob's your uncle and it's all done. I don't believe that will happen, because the reality is that however well you document those packages, my view—and I hope we can get a group together at this meeting outside the formal procedures to talk about this a little bit further—is that there has to be at least someone to initiate the process as Steve was saying—and that requires some engagement from people from the outside who are experts and can be told what exactly the situation is. Do it across the table so there are not going to be misunderstandings, and advise from there on where you suggest to go. But with this comes a political problem. Here again I'm not to be quoted, but I've heard this said: the MSC is a MAFIA trying to place trade restrictions on developing countries. That is part of the reality that many of these countries do not like, and understandably so — outsiders coming in and telling them what to do. It's a very sensitive issue about how best this can be approached. If you are going to do anything you have to develop confidences, contacts, trust and collaboration with a certain people to get that across, and these are the routes we have to take. It's multi-faceted, it's not a simple maxim or single bullet. We have to have more engagement with these people, but in a way that they feel comfortable in accommodating. It can't be top-down in our sense, just arriving and saying this is what you've got to do. But equally well I think there is room for a form of an effective stick, but it can't be the stick we've got at the moment. I've criticized the MSC for pressuring for yet higher standards. They are losing the plot. What we need improved in the world's fisheries is not the top 10% best managed fisheries. It's not even the lower 90%, but it is the worst 50%—that's what we need to get improved. Most of those, I hope people don't mind me saying so, will be found in the developing countries. We need to find a way to influence that.

Cathy Dichmont: To add to that, I've worked extensively in the developing part of Southeast

Asia. We have collaborative projects there and I agree with Doug the way to go is collaboratively. You form long-term relationships with people in countries where it is not easy to just walk in as the expert. The truth is that they're already using these packages. We are denying the fact that now a toolbox exists. The people overseas are downloading those packages right now and I've seen them do it. Some don't know how to run them and some do. Some are experts and some are not. They are desperate, and we've run these courses where we've taught them some of these methods and it is very much appreciated. We should not desist from giving freely available packages because we are worried people are going to misuse it. There is always that risk—no matter whether you make it freely available. What you should do is make it available at a very good price. That's the thing. What the first world countries are creating is expensive for developing countries. So at a very good price provide that service and develop in-country capacity. The other thing that we should not forget is that the in-country capacity shouldn't just be stock assessment methods. It is hard to manage. It amazes me how often those courses do best. It's just a simple—what's the best way to go about managing a system? People really appreciate that.

Natalie Dowling: Your question tracked exactly where I was going to go. I think there is a balance to be had between providing packages and tool kits and the need to go in and develop collaborations. The irony of what Cathy just alluded to is the expense. When you are data-poor and you are a developing nation you need to be able to afford to do that and in an ongoing manner. Programs like ACIAR in Australia or nongovernment agencies like The Nature Conservancy are very valuable, but the key is that these packages can accelerate and can make this whole process more efficient if they are applied appropriately. There is a definite place for them but caution is needed. I agree with Cathy—it will happen anywhere. The onus is that as Doug said you start by engaging with people. You do that by either having a workshop or—what we're advocating in the SNAP project—a questionnaire. The two phase approach can be one-on-one with managers and fishers during a workshop. It's a broad-brush thing to get a fisheries context and digging into the relevant things that come up, and you can form a management strategy choice process.

Ross Tallman, DFO Canada: This is a dilemma—the balance between putting out something that people can use cheaply but have some kind of structure and then whether they have enough knowledge to do it. I was originally trained by Carl Walters and Ray Hilborn, on the side of “you don't want to go out there and use models inappropriately.” The other contrast in my mind might be Daniel Pauly—of course nothing will get Ray Hilborn more excitable than to mention Daniel Pauly—whose philosophy was to just run the model. So I started out on the one side and have gradually over many years of dealing with fishing groups—and I am dealing with a little bit different situation within Canada—I've gradually come toward a more poly point of view. Because everybody builds models. The fishermen build models, we have traditional ecological knowledge models, we have the fishery manager-built models. Everybody has something they want to try to make a decision with. If you avoid it, and say we can't put anything formal down because “I'm not Ray Hilborn or I'm not Carl Walters, I don't feel I'm capable,” then those models actually come into play in the decisions and they may have nothing explicit. As someone said, in the washroom you talk about this or that and it becomes

the new paradigm. It's kind of funny in business how much that word is used. Thomas Kuhn put it forward and now it's used everywhere—"paradigm shift." The value of these things, like a toolbox and other things, is to make them as accessible as possible. I agree with all the points about getting together but those are expensive and they take a lot of time. It is expensive to go to communities and deal with people. At least it's something explicit as long as it's written down—how did I do this.

Unknown: Something I think is important is that over my career here working in Alaska we went from free access fisheries to essentially owned by various IFQs and things like that. As the older fishermen retired and the newer fishermen got used to that system there's a real change in the way people looked at it. It became more and more that if I and all of us follow the rules then I personally will have more fish in the future. I know many of us can say we have lots of interaction now with fishermen, go out on their boats. Fishermen want to participate in our science so it will be better for them and it's not so suspicious of us as it was 20 years ago. I think ownership by the fishermen of the resource can really change things in management in how it works and getting the data you otherwise couldn't get.

Steve Cadrin: That is a generality that is true, that the sense of stewardship is promoted with allocation and especially some form of permanent allocation. Unfortunately that also has to come from the bottom up. If that is forced from above all of those positive incentives at least for the transition period are not there. And that's what I've seen in New England. I think your generality is true and if the stakeholders are the ones promoting it then you get all of those positive incentives. If it comes down from above you don't always get them.

Doug Butterworth: A different point going back to this issue. I'll characterize it as trying to assist developing countries. Let me make a comment but I'm happy to have it shot down. In my mind what's important when you go in is to deal with their specific fisheries, not to go in with "this is a formal course on stock assessment." I've seen utter wastes of money with general courses where people attend them, and in a couple days they've forgotten it all since none of it was of any relevance to the fishery with which they are dealing. You have to base it on being prepared to go in and consider the specific cases rather than pontificate in the abstract. Take a specific hometown problem and build your education around that. This is the same as the gentleman said about the local knowledge that you'll get out of the stakeholders through effective interactions. What I think you have to do is establish a conversation, to draw down within that, and establish whether some of those impressions are valid while some others are not. Once you take people through the arguments they'll realize that—my emphasis is always in this context—bring in the outsiders in an appropriate way, a partnership way, a way that's non-threatening, but don't get them in to deal with their favorite academic topic. Get them addressing the problem on the ground. And people will relate to that much better.

Robert Campbell, CSIRO Australia: I have a question now, since David was leaning in the direction. A paradigm driving resource management over the last 50 years was Garrett Hardin's publication of Tragedy of the Commons. You have a free resource that unmanaged would be overexploited, especially in an overpopulated world that we have today, and that led

economists to convince managers that maybe the best way to go is to make the society choose; whereas David pointed out the fishers actually have buy-in because they own the resource now and if they own the resource then it's more likely they'll manage it, look after it, because they'll benefit in the future. I'm wondering what the panel thinks of the sense of ownership of the resource—ITQ type management in the future basically, as we move to the alternative types of management based on effort controls and other types of controls. I think we saw the examples in the Galapagos even with the TRP system. There was still the sense of trying to get ownership of the resource in that area. How important do you think the ownership of the resource by the fishers themselves is important as you move to future management?

Cathy Dichmont: I think it's good that you brought up the Tragedy of the Commons. One of the things that we as a community haven't been greeting widely enough is the large literature about the Tragedy of the Commons beyond the original paper. There is quite a lot of work done on natural resource management, not just fisheries management. The classic one is Odum of course who has done a lot of work on water resource management and other kinds of management. One of the things that has been shown is that ownership is only one aspect of why management is succeeding. For example, Van Vugt wrote a paper that looked at successful management systems in natural resource management, more than just fisheries. I don't think they did any fisheries work. They basically came up with the four I's that all had to be in place for there to be successful management: (1) Good sense of identity—ownership is one of them but it's not the only one. (2) Good information base. (3) Good institutional structures. (4) Good incentives. I got all 4! I think that makes a lot of sense—you almost need all four of those to have success for management. We should be careful not to just think ownership is THE answer, because it isn't. It is true that in experience we have found that ownership has mattered. In Indonesia I worked in a crab fishery where they were bringing in a minimum size. It was an extremely overfished fishery. They wanted to lower the effort because there was no other way of doing it. We got complete agreement from the local industry people but there was an open access fishery. They could not control what people were going to do from outside coming in. It really was impossible to advance management systems at all. In that sense some kind of ownership where they took a TRP system would have been a kind of a leap forward. There is very interesting literature out there saying what constitutes successful management that is not just fisheries literature; it comes from interesting sources. Van Vugt was a psychologist for example.

Steve Cadrin: I think I'll build on that. It depends on the success of ITQs or some kind of catch share system. Also it depends on the utilities and the objective that you are trying to achieve. When it comes to economic efficiency there is a lot of logic that allocation system does work. But one aspect of most catch share systems is consolidation of effort, so when you layer on some of the social aspects like jobs and communities a lot of those are negatively impacted by this ownership. That is not a damning criticism, because you can have consolidation caps and things like that but as long as you are keeping all of your social, economic, ecological indicators as your target, and you are monitoring them and you design them to achieve them then it can be a way forward.

Natalie Dowling: Going back to Robert's comment and building on Cathy's reply, ownership does not necessarily equate the management measure used as being a system of TURFs where you are in control of your spatial unit. I think ownership equates to empowerment and trust in whatever is decided. So we get back to this business about building relationships and building trust from the get-go. Even if it is an ITQ the fishers are empowered to see that the things they are most likely to achieve is a trade-off between objectives, then that's going to be your best chance for success. It's about the sense of ownership; it's not just about a system that equates to an ownership system. It's about what they are empowered to believe or give them the best chance for success in the long run. If I can ask the indulgence of going back to the tool kits—I think part of this process is helped by having tool kits that aren't just about quantitative approaches but tool kits that can help guide choices, not just choices for assessment but also choices for monitoring and choices for harvest control rules. We can get too quantitative about it—we have a whole bunch of quantitative models that we can run. What about the tool kits that tell us what is the most appropriate choice of models to run? What is the most appropriate choice of control rules given your situation, governance, and operational characteristics, and your data? That's the sort of stuff I'm going to talk about tomorrow. It is really important that if we're going to talk tool kits, we don't just talk about levers that you pull to assess but levers that you pull given the process you've gone through to understand the fishery to inform what's realistic in terms of management strategies as a whole.

Doug Butterworth: Rob, you came in with ITQs, and I think that the main point to take out of that is—please don't equate the need to avoid the Tragedy of the Commons with the need therefore to put ITQs in place. Whatever way we cut it, I don't think one can get away from some form of ownership. Both from the point of view of the resource being limited, and particularly from the point of view that it's not only ownership, it's some guarantee of the continuation of that ownership. Because without that there is no incentive to conserve. Don't just say ITQs, please. I would argue very strongly that you have to have those two concepts (ownership and some continuation of ownership) in any system that is going to conserve for the future.

Andrea Jara, Oregon State University: I'd like to talk from the developing country side of the room. I think that the perspective here is really important. I am living here in the States. I have the impression that you developed the model. In the developed countries you have this reality, this cultural perspective of how the things work. Then you translate this in a tool kit or in a model or something in a developing country. In South America each country has their own reality. Even if Colombia is next to Ecuador or Peru. Peru has a huge fishery. We, in Colombia, have just small fisheries. So I don't know if the solution is to try to help us with the tool kit or to try to create these partnerships. I think that it's more important to get this input from the developed countries, not on how to use the tool or how to use the model, but to build something different in each space because the realities are really, really different. We can't copy it like it's happening there—everything, the social part, the economic part. The developing countries always try to copy what developed countries do in everything. That's why we are jumping the steps to take the complete path to that place. We are just trying to copy and to jump the important steps that we need. If we start to jump all the really small steps we need,

we are just going to be jumping from one tool to the other one to another one trying to fit one in our reality. But I think we need to build our own methodologies, our own assessments, not following just some kind of rules.

Natalie Dowling: I don't think we've any contradiction to what's being said. No one is against what you're purporting. I think everybody's in agreement that tool kits have to be underpinned by collaboration in the first instance and by, as Doug keeps saying, a very simple, very one-on-one kind of—I call it the darts down the pub—approach where in the first instance you talk to people in very simple terms like—tell me about your fishery, what are your main issues, what are your objectives, what kind of information do you have, what would you like to see, how would you like this fishery to be managed, what are your problems for your family—getting in very broad terms, being able to put some ticks in your mind as an expert against available information, biology, life history, fishery operation, socioeconomics, governance. You start that by having a very open-minded, very open-ended conversation on very simple terms. And then you start to delve a little deeper. You don't come at it with an “I'm in a data-rich top-down mindset and I'm going to impose something.” That said, I don't see any point in reinventing the wheel either. Building your own assessments, yes absolutely, but firmly grounded in this whole collaborative approach where previous lessons have shown that this will or won't work in these circumstances. That's where these tool kits can then come into their own by saying, OK now that we understand the attributes of your fishery then these are the kinds of things that are going to be realistic for monitoring, these are options. And you don't just sell one magic bullet. These are possible options, these are possible assessments—and to me it's about knocking out what's not feasible—and these are possible forms of control rules. Then you revisit that in the context of what are the objectives for the fishery. If those objectives aren't clearly elucidated then it's back to the drawing board. Because what might get thrown out is people may say, “well, we don't want to try this” or “we don't want those control rules.” It's, “aha, good. So now we've actually gotten somewhere, and we can go back to the start. What is it you want?” So I think we want to be very, very bottom-up. We want to be learning from the lessons in which we've had experience.

Andrea Jara, Oregon State University: I completely agree with that. But sometimes in our reality is that the problem is not in the model or the tool per se. You have to fight against the bureaucracy, against the agency, management, against the politics. We don't have a great law management like here, we have to fight from the ministry all the way down to the owner of the small boats. It's probably not all the tool. It's the cultural and the socioeconomic aspects.

Cathy Dichmont: I just want to emphasize that I feel very strongly that socioeconomics and governance should not be considered an option. They mainly are parts of this information gathering, and options are going to be considered explicitly with those things in mind. So that's my personal belief. I'll talk more to that tomorrow.

Steve Barbeaux, NOAA Alaska Fisheries Science Center: I think the best part of what you said is that the best management approach may be a process rather than a final result. It is the iterative adaptive approach. Dave Somerton described some of the history about how the

North Pacific arrived at where they are. And part of it was good science. Part of it was good management, good administration. Honestly I think the NOAA Science Center or the Council and the Regional Office all work together with the industry. And so they built that trust. They built great data, have good resources, and ITQ was part of it. And unfortunately from my view of things our most recent national standard guidelines are a way of saying if everybody would just do things the way they do in the North Pacific then everything would be fine. But that is taking the result, the product, and turning into square pegs in round holes. Whereas if we took the process of HOW the North Pacific arrived at where they are that would be more transportable and more applicable to New England, to Colombia, to many different places. The best practices are the approach rather than the product.

Cathy Dichmont: I actually have experienced some of what you described and it's really tough. At times I've been stumped by it and I don't know myself how to help the in-country person at all because they seem at times quite insurmountable problems, and it's not a scientific problem. One of the things that I did with the group of people was to take the "Four I's." There are things that you need to have, the kind of indicators in those Four I's. We ended with a priority list of what was missing and in the end it was all on the governance end, and we ended up having an international lawyer come in on the project. He engaged with the agency involved and he opened doors that none of us could open. He went right into ministers' offices. In fact I saw more impact with this one person in my ten years working there. Sometimes you have to think about it in a completely different way. It depends on where the sticking point is. If it's data then that is where we should look. But even if it's in the governance system then that is where the energy should go. Sometimes we are too quick to jump into the science. We think the science can solve every problem. I don't think it can.

Unknown: I am trying to think something through in my head. When you come into a system that has been in place for any amount of time, the people that you are working with are the winners in that system. So you have to get over that inertia somehow for them to see some benefit at the government level, or even the fisherman level or the scientific level. All three of those levels you have this amount of inertia that you have to get over if you want to change it. All three of those levels have to see some benefit in changing the system. And I think that's particularly true in the developing world—you come into a system where you may not see a management system in place, but there is something in place. And those are the winners that you are dealing with. How do you get over that inertia—is what we are dealing with.

Doug Butterworth: I'm very interested in what Cathy says about her magic lawyer. What I don't like however is the thought that it's lawyers we need above all else. [audience laughing]. What is needed is exactly what our Colombian colleagues are saying—it is influence at a high level. Typically scientists, no disrespect, are not the ones to have that influence at that high level, probably even more so in developing countries. I am interested in thoughts on this, and perhaps Cathy can be clearer about whether this guy succeeded because he was a lawyer or whether he succeeded because of a particular contact structure. To my mind what you need is the right information to get through to people at the top of the food chain, who can then influence events in a way which is not going to happen from the bottom up.

Cathy Dichmont: He was from Ghana, a developing country, and I think that was one very important aspect. The other thing is that he was a constitutional/international law of the sea lawyer, so he was used to working at an extremely high level. He was not a cut-throat, go-to-the-courts-and-fight-it-out kind of lawyer—he was used to going into parliaments and talking to ministers. Also he had extremely good contacts within that country. And he was hugely respected, which is the third aspect. He just walked the walk that none of us ever dreamed you could and made a lot of very good changes that honestly we would not have been able to do without him. I'm not saying lawyers are the answer. All I'm saying is when you try to work out where the stumbling blocks are, it's humbling to find out how often it isn't us that can make the difference. I think we should maybe be less sure that we can solve all the problems.

Liz Connors, NOAA: This is kind of an aside from the discussion but I think it's important to bring it up. What I'm hearing is a message for those of us who are creating new models—new approaches—for data-poor situations, that says we need to put in more effort than modelers are ordinarily inclined to. The message is to be very up-front about what assumptions are going in, what are the conditions that make this an appropriate approach, what are the conditions that would make this an inappropriate approach, and that part of building the tool kit is putting all that information up-front where it is very visible to somebody who may not have the technical background but who might be interested in using this approach. Most people who write code very much don't like writing comments, but what I'm hearing is that we definitely need to be putting effort into that because there will be people from developing countries who want to use these approaches, who need to be able to judge up front where is this approach going to work, where is it not going to work, what do I need to have to make it work?

Anne Cooper, ICES: I work with stock assessment to take care of over 50% of the stocks in European waters and I'd say from all those interactions 50-75% of the people don't know what they are doing with their models. It's a black box. This is not a problem of the global south. Definitely I see it as a human capacity problem, throughout fishery science. It is not a growing field. I don't see new programs opening for fishery stock assessment. If you know of them please let me know where they are, because I will recruit those people to help. More work needs to be done on training people to really understand what they are working with throughout all marine stock assessment. The people in this room, yes. It is really amazing to be with all of you because you are so well versed in what you do and you are really leading this field, but most people working with these stocks, with regular old stocks, they aren't. Their model is really a black box. They have a list of instructions and they follow those. Thankfully there are still people around who know what the answers are and how to fix them but most of the ranks don't. It is a broader issue.

Doug Butterworth: I'll try to pick up on both those points because I think they go together: a sort of positive and then a negative aspect. I think you are right that there needs to be, in the description of the model, concentration also given to where it is appropriate and where it's not appropriate to apply it. But that also rapidly gets into diminishing returns territory. Each problem is different. If you try to cover all eventualities, you will end up with such a large tome

it will never be read. So you come back to the position where you need that one-on-one interaction with the local people to understand what their problem is. I tend not to be a fan of the black box. Most of our assessment modeling in South Africa is done from scratch for each specific resource. We are lucky we are able to do that. But unfortunately that is also the difficulty for this approach. As was just said, there are not enough people around who have that ability *ab initio* to translate the problem they perceive into whatever quantitative model structure is needed to deal with it. Very often the particular approach from the shelf does not fit. You need people who understand that approach well enough to know how to change it. Sometimes the way to deal with it is an extremely simple approach, but what is necessary to get that point across is not a knowledge of all the packages that are around; rather it's knowledge of exactly what is driving the underlying models to understand whether it is sensible to try to apply them (perhaps with slight modifications). But the real problem is the multi-disciplinarity aspect. (Turn off the recorder again.) The difficulty in this field is that you need a combination of skills. The modeling skill for which you are asking is a combination of two aspects: people who understand the biological reality—too often the scientists who study biology are the ones who don't understand the mathematics because if they did they'd have studied engineering instead (it pays better!)—and equally well, coming from the mathematical side, the sort of problems we have to confront are not of the type that mathematicians like—we have to deal with “messy” problems. Mathematicians tend to like very intricate problems that have nice neat solutions, but that's not what we have to deal with in fisheries. We have to have a particular skill at saying how many corners are we going to cut to get, not the perfect solution, but an appropriate and reasonable solution. The sort of skill set that you need has to cover that. There are actually rather a limited number of people who have that particular skill set and interest. We have nevertheless to find some way to develop them further. This is absolutely a major worldwide problem: shortage of the sorts of people with the skill sets and interest to undertake stock assessment. I don't mean the “push the button” type scientists who report assessments. I mean the type who actually understand what's going on inside the models. To be blunt again, it's only in the US where I see some commitment toward investing properly in advancing the development of such scientists.

Unknown: That's definitely the situation but that puts the onus on the quantitative scientist to do the translation. The biologist who's not good at math is not going to have the ability to evaluate the models, if the people who create the models don't translate the models into verbal context.

Unknown: Absolutely. It's easy to say that recruitment coming from God is something that is very antithetical to how and why we would approach assessment, but there's no difference between that statement and allowing for a high steepness. So you do need to translate things. Having stakeholders say recruitment comes from God is just saying you don't have much of a stock-recruit relationship. So we are not really cross talking as much as we think we are. And we need the translation.

Unknown: That's right!

Cathy Dichmont: Some of you in the room would know that I've got an Australian funded project, looking at the Australian dilemma. It is a first world country dilemma, which is that we have not got enough funding to do all our assessments that we need to do as home grown assessments. We do not have the people capacity or the funding capacity. Some of that is because we have a cost recovery system. Every assessment we do is funded by the industry, and there is a real resistance for them to cover every single species that we need to do an assessment on. In my project I am looking at exactly that trade-off of when do you do a package off the shelf and just apply it. I'm looking quite a lot at the packages that are available in the US and I will be going to ICES and talking to lenders. There is a surprising amount of packages around. And from early results we are getting, there is a surprising amount of home grown software that is exactly the same as stuff that is already being produced. In fact, we really need to be careful that we are not continually reproducing something that already exists, number one, and number two we also don't want to go the other way and say everyone needs to use packages with no homegrown software, because I have a homegrown software that I don't think a package exists for at all. No one is crazy enough to write that as a package intended for other people to use to be honest. It's incredibly fun as a stock assessment person to build your own. At the same time we must be careful that we don't continually build our own if there is already in existence a perfectly good example of it somewhere else. My point is, what I am finding in the early stages of this work is there is a real risk and also the support for those packages is dependent on individuals and they don't necessarily have funding for it. They are doing it because they really care. There is always this feeling that if a person either loses interest or they no longer get support the whole program will fall over. We should be thinking about this issue. It is not possible both from a human resource perspective and from a funding perspective to cover all the data-limited fisheries in the world and all the data-rich fisheries in the world and not actually pick up a package at some stage.

Natalie Dowling: Final comment about what Anne was saying and Cathy as well. I think this comes down to an age-old problem in science that we are not good PR people. I really believe that we strongly need the technicians, whether or not in developing customized tools or historically where the packages have been built. But I don't think we can get around the fact that we need a translator or somebody to walk the walk with these people in case studies so that we avoid this black box mentality. I don't think that's a one-person-fits-all problem. We need to stop thinking about ourselves as separate. I heard somebody this morning, and I'm not going to point fingers, but they made the comment quite reasonably that yesterday's session was a very information-dense math geek session. I thought—we've got to stop putting this divide where that is their domain, this is ours. We've got to look at how we can link. And say—there's somebody here who understands the technical aspects but can actually explain these in grass roots terms to people. When I talk about packages I am talking about packages that can help walk people through options for them, but I still believe that requires somebody to sit alongside people and develop collaborations from the grass roots up. It is a theme we are seeing over and over again in this hour and also throughout the symposium, that we need to market this stuff better in how we take it to people.

Doug Butterworth: The panel has been agreeing too much, so I'm going to disagree. I want to

challenge Cathy on a comment about the package here. What occurs to me is that if you have a data-poor situation, you are going to need to deal with it with a simple model. The point is though that even if it's simple, it still may not be available in a package. But if it is simple, number one, it should not require that much time and trouble to build and code the model from scratch. The problems really are understanding the situation, and working out what you need to put into the model. And to the comment about the black box mentality, about people who press the buttons on the model package but don't understand what's going on inside, the response is simple: the people who understand what's going on are the people who put it together from scratch. My argument would be, and I'm not saying this is a black or white situation, that there is still a meeting point between me and what Cathy says because ultimately we are still short of people to undertake this. But I am still inclined to say that there is more space in data-poor situations to ask people to develop case-specific but not very complicated models from scratch. Write the code themselves and apply it, because that way one makes sure that there is a better understanding. So Cathy can now kick me.

Elvar Hallfredsson, Institute of Marine Research, Norway: I'm trying to sort things out. I'm a little bit confused here. In Norway and Iceland the situation is similar to Alaska—fairly high acceptance from fishermen for what we are doing. It is not one size fits all. I tend to look at our trade. We try to assess how much fish is there and how much to fish and so on. I tend to look at me as a small player in the big picture of monitoring the fisheries. I find my trade hard enough just to find out how many fish are there, and how much to take out. I would love to be a statistician, mathematician, oceanographer, geotechnologist, all in one person. Should I, or do I, want to try to add also social scientist, economist, to that list? Maybe it is just very different systems but I cannot save the whole world. I know my trade, and talking about black boxes and so on that are problems here and not there. I guess this is really more opposite to what you are saying.

Natalie Dowling: Instead of bringing in expert after expert shouldn't we just be reverting back to some semblance of common sense in how we are handling these problems? In an acknowledgment of the various aspects that we have to factor in, I don't necessarily think we need an expert social scientist, an expert economist, whatever else, I just think we need more of an awareness from the get-go of all those aspects, and like Cathy said, an identification of where the sticking points are and then digging further against those. I go back to Doug's keynote that we have to start with these things very simply and build in complexity and experts as they are required. It is a mistake to think that you need to start saving the world. From the get-go you need to be talking about things from the context of data availability from the nature of the fishery operations, the socioeconomics, the governance. But you need to have that broad common sense awareness of what the issues are. I don't think you need to be doing all those things at an expert level simultaneously. I don't know what the others think.

Steve Cadrin: I'd like to build on that. We do need common sense in the decision on how much we invest in this. In this whole thrust to assess and manage data-limited and data-poor resources we've exacerbated the problem. We've gone from having, and the statistics varied this week, 90% of our world fisheries being unassessed and unmanaged. We are trying to

confront that. Other people who have countered it have said, well that 10% of the stocks that we're assessing and managing, they account for the majority of our biomass and landing and our economic yield. We need to have common sense as to how much do we invest into the fisheries that are producing the most for society and how much do we need to invest in the rest of them. And I think common sense would say it would make sense to invest less. To invest more in the fisheries that are producing the most for food security for us, for recreational opportunities for us. We don't want to have the uncertainty paradox where the least certain are not being managed at all, but should we invest all the top tier methods into these? I think "keep it simple" is justifiable. We want to manage them, but we want to manage them in a simple way, where you don't need a biogeographic, economic, social model, all the disciplines you talked about. What we need to have are simple assessment and management procedures, that are commensurate with what these fisheries are for society.

Jim Berkson, National Sea Grant Office: I want to talk about the shortage of stock assessment scientists, one of my favorite topics. I think there's this sort of myth that people have that everyone in this field has to be a student of Andre Punt, has to have a PhD or postdoc, has to be capable of using stock synthesis and developing tool kits. And that's not true. Obviously there are people who, especially with data-limited stocks, can use things like the tool kits, who can understand the assumptions that go into these methods, who can interpret the results and yet would not be necessarily capable of writing the code, or developing the methods themselves. Yet they could be very valuable in the process. We overlook people at that stage and don't give them credit. In fact, we're not training people to be at that stage. Here in the US we are putting lots of money into turning out more PhDs at places like the University of Washington, but we are decreasing dramatically the amount of money we are putting into the master's students. Those are exactly the kinds of students that can be helping out with the dissemination of the use of these data-poor methods. There needs to be a change in the thinking about how we go about training and what's acceptable for our training, if we are going to make these methods more accessible.

Doug Butterworth: I think you certainly have a very good point. One of the problems is the academic reward system, which wants fancy PhDs and fancy articles in journals that aren't interested in something the articles say if they consider it old hat. They want something that is a development, a yet a more complex version of something that's been done already. I again would come back to this: in most data-poor situations the models you want to use are simple. And the coding should not be a problem. What's necessary is developing the understanding that says, for example: "this is not a situation where I should use a linear regression; I should include some power in the relationship." A recognition of those basic aspects of data interpretation is what we need—I don't know whether it's better conveyed through a course or a textbook—but it's something that can come from some case studies which are simple. Not the complex ones—the simple case studies to try to train people in the sort of decisions they have to make to be able to be effective. I think they can be effective without being stars in highly complex mathematics and coding. I think there is certainly a way to go there. But we are running up against an academic culture, which is pushing in other directions. One has to find a way to solve that puzzle.

Cathy Dichmont: I completely agree with you as well. I would add that the non-academic, institutional incentives also go against that. It's both in the university and in organizations for a person on this road get good career progression. It is not easy for them to remain on the technical side of things. They have to be innovative. And they have to remain on that innovation wheel. If they are not there, then they have to be prepared to stay where they are. In actuality a person might be willing to start in an organization like ours as someone who's a model user but at some point they would want to transition into a model developer. That transition is not a bad thing. But it's often very hard to do. Somehow we need to be able to address the incentives that are happening in both the employment end and in the training end at the university to make sure it's OK to be a model user in some circumstances. And it's also OK to be a model developer. To be honest I think the way forward is perhaps for people to be both. So that in fact we almost let go some of our data-rich fisheries and put them into a more package-like world. And take our innovation into the data-limited fisheries, so the people who know the methods actually almost walk away from our data-rich fisheries that are so much fun. I've just done that two years ago and it is an incredibly interesting journey to take. One other option is perhaps to de-emphasize our data-rich fisheries. We've put 20-30 years of work, sometimes 50 years of work, in them and they are quite mature. If they are, maybe we don't need to be there every day looking over the shoulders. I agree with you. I think there is a place for both.

Natalie Dowling: I agree with everything that has been said by Jim and Cathy but I repeat what I said before. It is almost a tyranny of personality type of people who generally enjoy those highly technical problems—they often aren't good communicators or enjoy doing the communication-outreach side of things. I don't see this just in fisheries. It's a science personality type that is very common. Equal weight and importance needs to be placed on people-people in science. I agree with Cathy—you can and probably should be both technical and able to communicate. But if I survey the people in CSIRO I know that a lot of the highly technical people who I work with are very reluctant to take on those kind of roles. It is a psychological issue across the field of science that we just have to be a little bit aware of. I don't know that I even want to do this; I might be controversial. It's something that Doug just said, that a lot of the simpler models don't require the coding expertise. I agree with that. What I have found with my own experience in developing management strategy evaluation models is that for the supposedly simple assessments—I'm talking about catch trigger systems—the coding is easy. The decisions on how you set up and establish those systems involve—how big should we set the triggers, do we do it by region, what do we do in response, how do we code that in? These things get a lot more woolly the simpler you go. But then interpreting the results—you can end up with some unusual stuff happening with off the tree behavior or knocking up against boundaries you weren't expecting. And your inherent judgment of how a simple system might work can often play out quite differently in an MSE context. I would caution a little bit about dismissing with simplicity of coding up simple assessments

Doug Butterworth: What you've done, Natalie, is turn my simple problem into a complex one. When I made that comment I was thinking at the level of a simpler, basic assessment. I don't

think I would even have included simple MSEs in that. I'm looking at a very basic level, but nevertheless a level that goes beyond the complete non-quantitative. I think we've got to take this one step at a time.

Natalie Dowling: Let me just clarify that the context in which you made the comment that "coding would be simple, I'm not sure I even put that into an MSE context." I'm not quite sure what you meant with coding such an assessment.

Doug Butterworth: What I'm thinking of is—let's take an almost trivial case - something like a Schaefer-type model that anyone should be able to handle with a relatively simple level of instruction. For an assessment one could even consider a simpler model still—a replacement yield model, which effectively takes out the density-dependence or fixes some of the parameters. That can be done simply. That can also be taught simply, and the most important associated aspect that people have to be taught is the interpretation of the most straightforward diagnostics, realizing when the model does not fit the data, realizing what a variance means, realizing what model mis-specification means, and realizing that there may be something very simple that you have to do, such as just assume that CPUE is not proportional to biomass but the square root of biomass. And that takes away the model mis-specification at that level. I think we can train people quite straightforwardly and at that level. I'd like to see them doing the coding themselves, because frankly for this example that can be done inside one page. But the moment you get more complex, and even the simplest management strategy evaluations are relatively complex because you have to go into stochastic generation of future data and so forth, that is a further step. So let's crawl before we try to walk here.

Natalie Dowling: I'll finish that dialogue with apologies to the room at large. I'm just trying to throw this one out. I think that even a Schaefer model is a reasonably data-rich assessment. I'm in cowboy land here with what I do. I'm talking about things where we really don't have that much data and I'm talking about an assessment being something like changes in length or a system of catch triggers. We don't have any reference points here so we know nothing apart from catch. It's a multispecies fishery, for example, for 5 key species we're putting in 3 levels of catch trigger against which we have increasingly strong management responses. When you talk about how do you actually evaluate the potential success, that was my domain in terms of what you might run into. It's a conversation we can carry on elsewhere. I just want to put a cautionary tale to the room at large: You are still in a model domain with a Schaefer model and that can be coded in a spreadsheet I will agree. When you get down to the really, really data-bankrupt fisheries (to coin a new one) how do you then say, this is a fairly simple approach, easy to implement? What if it performs in a different way from what we expect? When you get into that kind of domain you do need a lot of technical expertise. I guess we are making slightly different points.

Cathy Dichmont: One of the things that's really interesting is that about 15 years ago I got involved with a fishery that we managed through simple linear regression of a catch rate series. It is a very successfully managed fishery today. So I'll start there. It was quite a confronting journey for me as a scientist. First, doing a linear regression of a catch rate series itself was

confronting because I come from the data-rich world. The second thing is that it was very easy for the industry to just do the same thing—right? So they very soon had the same thing on a spreadsheet and they were working on what the management measure was going to be, as soon as the new data came in. They almost knew the answer before I knew the answer. I thought I had control but I lost control in a way. It was very interesting that they picked up some of the problems with the system and they actually came back with the solution. By the time we started realizing that, there was an environmental signal that meant we were going to get into trouble in the transition period and they understood that. We changed it very simply—with the advice. It is interesting that when you get involved in very, very data-limited methods—I know catch rate is rich in some places but you have to admit just putting a straight line through the last 5-7 years isn't very high tech. (1) It is interesting that it is still a very successful management system, (2) they started hating it and funded a survey. Today this fishery is managed with a survey that they fund, and (3) the industry probably had a far better idea of what the bells and whistles were and also the bad things of the method. They spent a lot more energy there than any of us could, trying to solve it. It is an interesting journey. Not necessarily a bad one.

Amy Then, University of Malaya: I was going to propose something that I think might be a very useful tool for data-limited, data-bankrupt, data-terrible fisheries. I work with John Hoenig on data-limited ways to estimate mortality rates. Now that I am back in Malaysia I was introducing myself to the fisheries department and trying to engage them and say, "Hey, can I be of help in some way?" I think that's going to be one difficulty I'm going to have. I recently went to the Bay of Bengal workshop engaging with fisheries scientists from the region, to get Ecopath modeling training. Anyone who is familiar with Ecopath knows it is very data-hungry. It seemed not that practical but it was interesting because fishery scientists in the region—data-poor, lots of poverty, small scale fisheries—they are interested in doing something. We don't necessarily know how to go forward. When I look at what people are using for reference, a lot of them still go back to Pauly, because Pauly has made a tool that is so easy to use and so easy to replicate. Everybody goes back to using Pauly's method and his way of assessing length-based, whether for better or for worse. We seem to have made a lot of advances, I feel, in this workshop in terms of coming up with methods. Liz, I was intrigued with your catch rate and simple method as a successful case study. I haven't looked at Carruthers' toolbox. I know there are reservations about scientists or users who are naive and possibly abusing the methods, but there are checks in place to prevent abuse from happening in the first place. People don't want to pick up those methods just to do them unless of course there are scientists who because of key performance index have to publish papers. They are trying to do everything they can to generate publications so everyone is still going back to Pauly and trying to do anything they can. Why not come up with some easy tools that fisheries scientists can use even though there might be a risk of people abusing it? A good trade-off could be that more simple assessments can be done, and basic information can be made available. Scientists can assess the data-poor stocks based on whatever data are there. I was thinking of Murray Logan's biostatistical book— if anyone has looked at that book, it is something as simple as—do you have this life history parameter? Then go to step 2. And from step 2 go to step 3. I know it sounds like it's a really simple tool kit but that tool kit could be useful and we could possibly include specific case studies where certain

things that have worked are not in there. We could use it as a very simple textbook that people who have a little background and fisheries training could use. That is one thought that came to my mind of making things relatively simple to use.

Natalie Dowling: Tomorrow at 8:20 Amy. The SNAP working group is trying to do exactly that. I'm vaguely alluding to it, but we have developed a bottom-up process-oriented tool via a two-part questionnaire cross database to elicit the information about the fisheries, across five categories, including socioeconomic and governance. I gave this presentation at NOAA last week. I used the analogy of the slot machine. Basically it then says, OK do you have this—tick tick tick—it's exclusive to the user on what criteria the subset of options that it spits out are being included or rejected. It spits out options for monitoring, for assessments, and for harvest control rules and then it presents the caveats against all of those that haven't been included in the process. I'm hoping very much that that sort of thing is in the hole with what you are suggesting. Unfortunately my talk will be a very broad overview orientation, but we are putting in a manuscript. If you want to talk data I am happy to do that.

Olav Ormseth: Can each of you make a closing remark to wrap up what we've talked about?

Doug Butterworth: Can I go first with a sound bite? This is more about process than methods.

Steve Cadrin: I think the one thing we probably didn't touch on but which may address some of the expanded throughput and need for expertise, is that one part of a management procedure will have to be quality control and peer review. But the reason I mention it is that for these simple data-limited processes we don't need a full blown peer review, a full blown SEDAR, or a full blown SARC. They can be a fairly streamlined peer review to make sure that the people are applying the data to the methods appropriately. So some form of peer review quality control I think will address much of this.

Cathy Dichmont: I think I'm going to steal Doug's starting one which is the keep it simple rule. The other one I'd really like to add is that we should be flexible and open minded, as long as we make things that are practical and make sense. You know when we start a process, it very much is a process. We should be open minded as to where we want to end, and I think we'll get to a good place.

Natalie Dowling: Bottom up, pragmatic, early engagement, cost effective. I also think that we need to, from the get go, acknowledge all of the categories of information that we have, and they must include socioeconomic and governance from the start. We need to not be aspiring to gold standards as highly quantitative models. I think we need to acknowledge that we can go a long way on simple approaches. We need to not focus on assessments. We need to focus on management strategies as a whole including monitoring and control rules. We need to have confidence in local knowledge and judgment, and we need to be empowering stakeholders from the point of inception. I have nothing else to add because the other three have been so succinct. Thank you very much for the opportunity to be on the panel by the way. I am honored to be on such a thing. Thank you for the invitation. It has been really valuable for me personally.

Olav Ormseth: On behalf of all of us thanks to you guys for a really interesting discussion. Join me. (Applause)