Seeking Convergence:

Proceedings of the MPAs and Fisheries Science Forum

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Contents

Welcome & introductions

Presenters: *Sabine Jessen, Canadian Parks and Wilderness Society (CPAWS), and* James McIsaac, *BC Commercial Fishing Caucus*

Jessen and McIsaac welcomed participants, acknowledging that they were gathered on the traditional territories of the Musqueam, Sto:lo and Tseil Waututh First Nations and noting that this forum was a joint effort between the conservation and commercial fishing sectors resulting from two years of planning.

Reviewing the background, Jessen noted joint efforts over the previous two years to identify potential avenues for collaboration as governments look to establish a coast-wide network of Marine Protected Areas for Canada's Pacific coast. The focus of discussions between the commercial fishing and conservation sectors is on how to design MPAs to meet the goals of both biodiversity conservation and healthy fisheries, by drawing on expertise from around the world.

McIsaac noted that this initiative originated from bilateral discussions between the conservation and commercial fisheries sectors during integrated marine planning. This was one of several areas* identified by the sectors that could be worked on together. Discussions to date involving the conservation and commercial fisheries sectors have identified agreement that MPAs may provide significant benefits for both biodiversity and fishing; that MPA design should reflect social and economic goals as well as ecological ones; and that there is a need to evaluate costs and benefits over relevant timeframes. How to support collaboration and pursue collective interests in MPA design were therefore key themes underlying the planning for this forum.

Jessen recognized other members of the Steering Committee: Hussein Alidina, World Wildlife Fund Canada; Karin Bodtker, Living Oceans Society; Christina Burridge, BC Seafood Alliance; and Dan Edwards, BC Commercial Fishing Caucus. McIsaac introduced facilitator Craig Darling, a central figure in this ongoing work for several years, along with the CPAWS coordinators, Alexandra Barron and Rhona Govender who were responsible for planning and logistics. Jessen also recognized the many expert participants from Australia, the United States and Canada, thanking them for their enthusiasm, interest and support.

A key result of the collective work done to date is a better understanding of different perspectives, with McIsaac noting agreement between the commercial fishery and conservation sectors that:

* Other areas of joint interest included: infrastructure, pollution prevention, conflict resolution, Rockfish Conservation Areas, conservation finance, enabling conditions, climate change and ocean acidification.

1. MPAs may provide significant benefits for ecosystem health that are good for both biodiversity and fishing.
2. The social, economic, and ecological effects of MPAs need to be recognized and addressed in the MPA network design within an ecosystem-based management framework.
3. MPA network design should address both the long-term and short-term implications of MPAs on communities that are dependent on healthy fisheries

Jessen noted the forum's goal was to help inform the design of an MPA network on Canada's Pacific Coast that supports both biodiversity conservation and healthy fisheries. To address this, four broad topics were formulated to frame the forum's roundtable discussions:

1. The biological and ecological effects of MPAs on fisheries
2. The social and economic effects (the human dimensions) of MPAs on fisheries
3. Integrating MPA networks with fisheries management.
4. Tools available, or to be developed, to plan an MPA network that considers both biodiversity conservation and healthy fisheries.

McIsaac added that the steering committee had undertaken an extensive literature review and expert interviews to develop the questions assigned to the roundtables, namely:

1. Do spillover and larval export from MPAs provide a benefit to fisheries, and under what circumstances?
2. What factors determine social and economic effects of MPAs on fisheries resources?
3. How can MPA networks and fisheries management be integrated and coordinated?
4. What tools (e.g. bio-economic tools, models, and/or techniques) can be used to integrate biodiversity conservation and fisheries management and how were they employed in two case studies?

The forum objectives are:

1. To advance our collective understanding of the science of MPAs and fisheries, consolidating knowledge and experience.
2. To begin the process of reconciling scientific perspectives, and exploring and narrowing differences on selected science issues.
3. To assess the applicability of key findings and lessons learned elsewhere to guide MPA network design in British Columbia.

In reviewing all the background material available, the Steering Committee acknowledged limits to how much this forum could cover in the time available. Give the number and complexity of the issues and the unique Canadian context, some key topics, such as integrated planning and governance, are not on this agenda.

Jessen noted Craig Darling's key role in designing the unusual roundtable discussion format, with an expert panel dialogue focused on problem solving and highlighting areas of agreement and disagreement.

She closed by introducing the keynote presenters, noting they had modeled the collaborative approach by jointly developing their presentation.

Keynote Presentation

Food Security & Biodiversity: Can Marine Protected Areas Deliver Both?

Presenters: *Dr. Ray Hilborn, University of Washington, and Dr. Anne Salomon, Simon Fraser University*

Salomon opened by noting that the development of solutions to the many challenges facing the oceans is one of the major challenges of this century. Growing use of the world's oceans by a growing human population has led to increased demand for dietary protein from the sea. Moreover, we are increasingly relying on our oceans and coastlines for transportation, flood control, clean energy, and even atmospheric carbon sequestration…

As a result strong trade-offs exist.

MPAs are increasingly advocated as a tool to help achieve multiple objectives and considerable scientific efforts have been geared towards inform Marine reserve design & assess their effectiveness. Yet wildly diverging opinions among the scientific community have ignited controversy.

This controversy has challenged us all to examine our own assumptions, learn from the strengths and weaknesses of different analyses and approaches, and ask ourselves: are we asking the right questions? While this controversy has already triggered advances in marine conservation and fisheries science, it has made it tricky for practitioners (government agencies, NGOs, & fishing industry, fishing communities) to navigate a clear path forward.

The objectives for this talk are to synthesize key areas of scientific agreement and disagreement; to identify when MPAs improve fishery yields; to learn from successes and failures at reconciling fishery and conservation objectives; and to recommend ways forward for Canada's Pacific Coast.

There is general agreement on what needs to be achieved in the ocean. We share common goals such as preventing overfishing, recovering depleted fish stocks, reducing bycatch and habitat impacts, maintaining livelihoods and coastal communities and sustaining food production and food security.

However, controversy exists on how to achieve the dual objectives of conserving biodiversity and sustaining productive fisheries. There is general agreement that the magnitude, direction of effect and rate of recovery attributable to MPAs can vary among species and locations. MPA effectiveness is

related to the magnitude of fishing pressure before protection, as well as ongoing pressures outside of MPAs; reduction of fishing pressure inside the MPA (enforcement is key); mobility and intrinsic rate of population increase of target species; size and age of the reserve; species interactions; and oceanographic context. It is also agreed that there are ecological and socioeconomic costs and benefits to MPAs, which can change over time.

Hilborn summarized key points of disagreement, including whether MPAs always improve or are neutral to fisheries yields; whether they always increase fisheries abundance; whether MPAs are equivalent to catch regulation; and whether or not they differentially impact dependent communities.

He explained the theory of a simple yield curve, whereby expected benefits to fisheries are maximized if up to 40% of a region is closed to fishing, with benefits declining as more of the area is closed. But this simple theory is wrong, he argued. For one, it assumes there are no fish outside the reserve. The broader context of fisheries management also significantly affects fishery results. The benefits of protected areas also depend on their size and the species involved. In order to augment harvest, reserves need to be large enough to allow populations to build up inside and small enough to allow them to spill outside where fisheries can access them. The same dimensions won't work for all species, because they have different needs, so choices will be necessary.

MPAs also come with environmental costs because they don't reduce fishing effort they simply move it. So there will be negative impacts elsewhere. Lower CPUE means you have to fish more to get the same catch, so that also leads to more impacts. And when you reduce fisheries yield, that foregone harvest has to come from somewhere else (e.g. importing fish from countries with poorly-managed fisheries or more agricultural production, which can have greater environmental impacts than well-managed fisheries).

These issues are outlined in a new book: *"The Controversy over Marine Protected Areas – Science meets Policy,"* by Alex Caveen and others.*

Salomon continued, offering some of the reasons for these areas of disagreement. Marine conservation and fisheries science differ in their specific objectives. They have conflicting mandates, which require, at least in the short- and medium-term, different policies and management actions that seek to achieve one objective at the expense of the other. For example, traditional fisheries science attempts to design policies that maximize fishable production in terms of biomass, sustain catches and maintain economic stability. Conservation scientists design policies that attempt to maintain high fish abundances, high biodiversity, population size structure, ecosystem functions, and protect habitats. Scientists from the two disciplines also differ in terms of their experiences. They measure different things at different time

* Caveen, A., N. Polunin, T. Gray, S.M. Stead. 2015. The Controversy over Marine Protected Areas: Science meets Policy. London: Springer. 162 pp.

and spatial scales. These differences also relate to their academic training and the values that shape that. The disciplinary divide between fisheries scientists and marine ecologists stems from their focus on single species vs. species interactions, large scale/long term vs. small scale/short term, observational vs. experimental, continental shelf vs. nearshore, humans as predators vs. external disruptors and *in silico* vs. *in situ* study.

But despite all these differences, I think we're coming together, Salomon continued. Marine conservation science is drawing increasingly on economics and the social sciences, and conservation practitioners are recognizing the need to achieve conservation goals in working seascapes that are a source of livelihood and food security. While fisheries science is recognizing the need to move from conventional single-species assessments of yield towards multi-species approaches, including assessing the larger ecosystem consequences of fishing.

Hilborn presented a series of animated graphs illustrating different model scenarios for the recovery of a local fish population and harvest levels after establishment of an MPA to address over-exploited fish populations. The scenarios demonstrated different outcomes, depending on harvest rates, broader fishery management, and mobility and life history of the target species.

Salomon presented a simulation model example for Gwaii Haanas, where a marine planning process is currently underway. The model looked at the expected response for a range of species after 10 years under three scenarios: MPA alone, MPA plus reduced fishing pressure outside, and reduced fishing pressure alone (no MPA). For low-dispersing species like rockfish and lingcod, the combined policy causes the greatest increase in biomass. A large reduction in fishing pressure was the only simulation that showed an increase for widely dispersing species. There were also indirect effects in reserves due to an increase in predation from a growing population of predatory fish within the reserve.

Salomon continued by summarizing that MPAs improve fisheries yield: when target species are overfished outside the MPA; when target species have specific life history traits (broadcast spawners with low mobility); when spawning aggregations and juvenile rearing grounds are protected; and when there are well-understood source-sink dynamics (which unfortunately are rarely understood and worse, can change over time).

Hilborn turned to examples of what has and has not worked elsewhere.

California's Marine Life Protected Area (MLPA) system was implemented in three phases: In phase 1, an approach based on top-down implementation failed, with extensive pushback from stakeholders. The second approach called for extensive stakeholder consultation but proved too costly for State budgets at the time. With the third attempt, there was significant funding available from foundations to pay for stakeholder consultation and extensive stakeholder input in design (within tight constraints set by science guidelines). Key groups involved included the state Fish and Game Commission, a Blue Ribbon Task Force, regional stakeholder groups and a Science Advisory Team.

The first step was the development of design criteria by the science team. Stakeholders were then invited to draft proposals, which the science team evaluated against the science criteria. The Blue Ribbon Panel compared alternatives and recommended a plan, for modification and/or approval by the Fish and Game Commission.

For BC, a key question is how much can you decentralize the process? California's plan was developed in stages for the five coastal regions but within a rigid structure that all regions had to follow. This proved to be a challenge in the north, with pushback from First Nations who expected more control. Could different regions of BC have different objectives and/or process to address regional differences?

Salomon described an example from Chile, where a complete transformation in governance of its coastal benthic marine resources occurred in the 1980s and has led to of successes at achieving both fisheries & conservation objectives. Former open-access fisheries were converted to a system of marine tenures allocating rights and responsibilities to fishing collectives.

The process started with science recognition of a problem, with depletion of target species (locally known as 'Loco' – a marine predatory whelk *Concopleas concolepas*) due to harvest by humans. Experimental management areas were established, building on smaller scientific pilots. An important lesson was that a joint approach involving local fishermen and science was key to building the trust and collaboration that led to success. Scientific knowledge of the ecology & resilience of loco and its role in ecosystem dynamics was also key.

Salomon described a similar experience in Baja, involving a federation of fishing cooperatives that have rights to access different species. This initiative included experimental closures (MPAs), with monitoring of biological results and socioeconomic costs given foregone harvest in MPAs. Investing in better knowledge of the system was a key factor in the initiative's success. Cooperation, clear boundaries, MPAs, enforcement, and transparent local decision-making were also important.

The big question is: If these are indeed sucessful examples of obtaining fishereis and biodviersity objectives, to what extent can these types of governance structures be scaled-up? How might this influence their performance?

Key attributes of successful fisheries were identified in a meta-analysis* of 130 examples of co-management globally. These included strong community leadership and social cohesion; incentives via catch shares and conservation benefits from MPAs; and redundancy in management regulations.

Hilborn and Salomon summarized their key recommendations for moving forward in British Columbia:

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* Gutierrez, N., R. Hilborn, and O. Defeo. 2011. Leadership, social capital and incentives promote successful fisheries. Nature 470:386-389.

1. Use dynamic models to evaluate MPA design and evaluate trade-offs. Best results are along the efficiency (Pareto) frontier; attaining the most optimal economic and conservation value. Your models have to be right and they are probably not, so when you first start drawing areas on a map, they are unlikely to be anywhere near the best solutions.
2. It is important to recognize the dynamic interaction between social systems, management systems and ecosystems, to consider a portfolio of management and conservation strategies that acknowledge these interactions and to consider strategies with multiple objectives in mind.
3. Evaluation (of biological, social and economic outcomes post MPA establishment) is important because you can't predict what will happen when you first set it up and you need to evaluate if your policy is meeting your objectives. The evaluation framework must be at the seascape level (simply looking at the ratio of fish inside vs. outside is not an optimal evaluation method because it does not evaluate MPAs at the spatial scale at which they are designed to effect fisheries and biodiversity. A big question is what is an adequate control for an MPA?).
4. Adaptive design is important and you need to be able to change the structure after the evaluation instead of assuming when it goes in that it will be there forever. Hilborn cited an example where after spending millions on establishing MPAs, it was concluded that the money would have been better spent instead on improving fisheries management. This highlights that you can't do it in isolation.
5. The scales of management must match the scales of socioeconomic and ecological processes and variability. Decentralized management systems can help avoid the "tragedy of scale" where regional management fails to control over-exploitation of local stocks. Decision-making at local scales may more effectively acquire and incorporate biological information into management plans. Community-based spatial management nested within larger-scale management systems may ensure efficient use of local knowledge and allow fishers to adapt to changing conditions and markets. Decentralized approaches are also likely to support better compliance, power distribution and equity.

Q&A Session

- David Boyes: Multiple levels of management regulations with redundancy sounds like a recipe for chaos.
    - Salomon: One study (*meta-analysis by Gutierrez et al.)* found co-management regimes that had multiple ways to regulate fisheries and that used multiple management strategies were among the most successful, in terms of economic and biological performance.
- Q: What are examples of where MPAs may or may not work, e.g. in relation to the life history of target species?
    - Hilborn: If older individuals have more fecundity, then the fishery exploitation rate should be lower. But you may be able to get just as good a result with effective catch regulation as with an MPA. The key is to get the fisheries regulation right, and then you can do some fine-tuning with MPAs if necessary. MPAs or no-take areas are just another

tool like protecting spawning areas, although it's trickier because "no take" applies to everything.

Jessen closed the evening by thanking the co-presenters for providing lots of food for thought for the next few days.

April 9: Welcome

Sabine Jessen welcomed participants, referencing the April 8 keynote presentation, which set the stage for discussion, and reminding attendees of the forum's objectives:

1. To advance our collective understanding of the science of MPAs and fisheries, consolidating knowledge and experience.
2. To begin the process of reconciling scientific perspectives, and exploring and narrowing differences on selected science issues.
3. To assess the applicability of key findings and lessons learned elsewhere to guide MPA network design in British Columbia.

Craig Darling reviewed the agenda and roundtable discussion format. Audience members were invited to submit any questions in writing for the Q&A session to follow each roundtable. Darling acknowledged the limited time available for questions, noting the Steering Committee would consider them all, even if there was not enough time to present them to the roundtables.

The forum's discussion format was designed to elicit expert advice, with roundtable members invited to identify the issues they wished to address, while recognizing limits to what could be covered in the time available. The format uses the model of a problem solving science forum, with key elements including a series of roundtable problem-solving sessions to address the questions in each of the roundtable sessions. The experts will work together in a facilitated, non-adversarial forum, using a joint problem-solving approach to explore the issues and identify areas of agreement and disagreement. The experts will be encouraged to represent their area of expertise.

The Steering Committee was particularly interested in guidance about:

- What are the key findings from research around the world?
- How applicable are these findings to the Pacific coast of Canada?
- What additional research/action is necessary to determine the extent to which these findings apply in the context of the Pacific coast of Canada?
- What are the relevant lessons that could help inform design of a network of MPAs in the context of the Pacific coast of Canada?

He acknowledged that this is an ongoing process and that the Steering Committee does not expect this forum to reconcile everything. The intent is to look for convergence and move towards union.

Roundtable 1: The Biological and Ecological Effects of MPAs on Fisheries

Question: Do spillover and larval export from MPAs provide a benefit to fisheries, and under what circumstances?

Roundtable members:
Dr. Sean Cox, Simon Fraser University
Dr. Graham Edgar, University of Tasmania
Dr. Selina Heppell, Oregon State University
Dr. George Rose, Memorial University Newfoundland
Dr. Wilson White, University of North Carolina Wilmington

Roundtable members briefly introduced themselves, noting their respective fields of study.

Presentation: Do spillover and larval export from MPAs provide a benefit for fisheries?

Presenter: *Will White*

The general direct benefits that MPAs can provide to fisheries include spillover effects and benefits from having older, large fish in the reserves.

Spillover can benefit fisheries in two ways: they can sustain harvests if poor management leads to over-harvesting outside; spillover can also improve harvests relative to conventional management under a narrow set of circumstances.

Benefits from having populations protected inside reserves include more resilience to changes imposed by fishing and the environment. There is some evidence that larger fish can produce fitter, larger larvae, and they may also counteract fishery-induced evolution.

It is important to keep in mind the goals that MPAs are intended to achieve, which do not necessarily include optimizing fishery benefits. Often the goal is to achieve biodiversity conservation benefits while minimizing harm to fisheries. This is not the same as trying to maximize benefits to biodiversity *and* fisheries; there are likely to be trade-offs.

This presentation will discuss theoretical modeling examples, empirical results, additional points for discussion and a summary. In general, the term MPA will refer to no-take reserves.

Theoretical modeling results for a homogenous system with no special habitats or connectivity features are similar to those outlined in the opening keynote, with the effects of MPAs on fisheries largely dependent on fishery management outside reserves. Adding reserves to a conservatively managed fishery will simply reduce harvest yields for that species or species group. At higher levels of harvest and

over-fishing, reserves can improve and sustain fisheries yield – up to a point. However, as MPAs expand to cover a greater proportion of the fishing area, the harvest benefits level off and decline. The shape of these yield curves depends on the level of management (conservative harvest restrictions to "scorched earth" scenarios with no fishing control) and whether the species has a smaller or larger home range.

Next, results were presented for a specific model for Southern California (included a realistic coastline, habitat heterogeneity, larval connectivity, etc.) with scenarios run for different reserve network designs, with and without taking into account different fishery management regimes. The model found that the effects of different management scenarios vastly outweighed those of network design. Plans with the most/largest reserves provided either the best or worst impacts on fisheries, depending on whether the fisheries were either poorly- or well-managed. This suggests that no single reserve design provides the maximum benefits for both fisheries and conservation.

MPAs can be part of a plan to optimize fishery yield if they are strategically placed (i.e. you need information on sources and sinks to optimize larval connectivity and habitat), if there is a low cost to the resulting additional fishing effort in open patches and if there is relatively weak density dependence. It is easier to optimize all this for some species than others.

Where spillover benefits will occur depends on fishermen's behaviour. If the response to MPA establishment is to "fish the line" at reserve boundaries, then you would not expect to see spillover benefits just outside reserves due to adult movements (this is most important to consider in follow-up monitoring).

Larval dispersal beyond reserve boundaries depends on the species (long- or short-dispersing) and other factors such as spawning seasons, so the best reserve design for one species may be sub-optimal for others.

When spillover occurs will depend on factors such as filling in of age distributions in populations with a truncated age structure, the time scale of new reproduction and recruitment variability. These factors, along with the extent of fishing pressure before the MPA was established and overall abundance, can result in different patterns, with varying time lags and even oscillating population density during the recovery.

Empirical results were presented for the Great Barrier Reef (GBR) reserves after the 2004 rezoning. Initially, biomass increased but not fish numbers, possibly due to filling in of older age classes before spillover benefits were seen, with increases in both biomass and numbers subsequently seen in 2012.

The GBR system was primarily designed for conservation, not fishery enhancement. Commercial harvests of coral trout, which was already a fairly well-managed fishery, declined after the 2004 expansion of the GBR reserve network. However, it is unclear that this is a direct consequence of the 2004 expansion. Concomitantly at the commencement of the 2004 expanded marine reserve expansion, other important factors affected coral trout harvest. These included fishery management interventions

reducing numbers of fishers permitted to access the fishery coinciding with the introduction of total allowable commercial catch limit significantly reducing available harvest from historically high levels.

California implemented marine reserves in 2007 to protect slow-growing rockfish species. No increases have been seen yet – either it's too early or they were previously fished lightly, so there was no benefit. In one instance, there was actually a higher biomass before the new reserve was established (as an expansion of a former small reserve). Biomass trends show the strong influence of poor/variable recruitment and highlight the long time scales (over 20 years) required for recovery with some species.

Other points to consider include ancillary benefits to fisheries of having filled-in age structures inside reserves. For some fish species, big old fat females produce offspring with higher growth and survival rates. Populations with broader age distributions may have additional resilience to some threats (e.g. hypoxia and cyclones). MPAs can also be designed to minimize or maximize spillover due to adult fish movement (location of MPA relative to habitat patches). Other points to discuss include species with ontogenetic migration and species with spawning aggregations.

White presented a table summarizing factors that positively and negatively affect reserve profits and relevant design attributes (based on Gaines et al. 2010)* and concluded with the five topics identified to guide the roundtable's discussion:

1. Objectives: biodiversity conservation or fishery management tool?
2. Social and management context.
3. Species life history: fast vs. slow species, ontogenetic movement, age-fecundity relationships.
4. Species behaviour: temporal and spatial scale of movement; spawning aggregations.
5. Population structure and connectivity.

Discussion

1. Objectives: biodiversity conservation or fish management?

Heppell: The first question to ask is what we are trying to solve, whether it's creating parks in the oceans, minimizing fisheries impacts, etc. The evidence from other countries is quite relevant to BC. Sometimes the species are different or there are different fishery needs but there are lots of examples that we can use, so we need to be clear about the objectives in order to evaluate what's the best strategy for BC. Defining the objectives also helps identify research needs, so we need discussion of the objectives first in order to give the best advice.

Edgar: In Tasmania we have been monitoring reserves for over two decades and there are clear spillover benefits, but they are very variable between species. One species, the trumpeter, was extremely over-

* Gaines, S.D., C.White, M.H. Carr, and S.R. Palumbi. 2010. Designing marine reserve networks for both conservation and fisheries management. PNAS 107(43):18286-18293.

fished outside MPAs, but a long-term population crash had been attributed to changing climate. We found significant increases in the reserve and followed individuals as they grew and then left the reserve. So there were very clear spillover benefits in this case, as the reserve protected individuals from fishing pressure until they matured. Abalone, which has very limited movement, did not disperse outside the MPA. The population actually declined due to trophic interactions in the reserve (lobster predation), so the MPA clearly provided no benefit for that species. The overall benefits for different species can range from extremely high to low.

Cox: Biodiversity conservation is not just affected by fisheries and fishery management. There is a lot of uncertainty about what will happen when you implement an MPA, as the effects will play out in a dynamic ecosystem. Recent work on preserving corals and sponges showed there was larval dispersion although the adults are not mobile. We don't know what the benefits of those communities are for fish production, although research elsewhere shows benefits of similar habitats. Some species in BC are in more trouble than others. BC also has a pretty high level of species diversity to start with, so there is a lot that could be done in terms of maintaining that. Benefits of MPAs to fisheries will depend on fish productivity and mobility. Species like halibut have been studied to death, yet we still make gross assumptions about their productivity and we still don't understand their mobility despite tagging studies. So determining the productivity and mobility effects of MPAs would take a long time to do.

Rose: My first experience of closures was in Kenya in the late 1960s when it was basically a last resort management action in a completely unregulated fishery. We have evolved significantly in our thinking since then. On whether the objective is conservation or fisheries, BC implemented RCAs to protect rockfish and lingcod as close to a last resort. Both species were highly depleted and there were no other management options. The lesson is that in a well-managed fishery, the objectives and design might be better based on biodiversity, as the benefits to fisheries are very difficult to measure or determine. Where complete closures are very valuable is in completely unregulated fisheries. Even in BC, where fisheries are well-run, we still have many species where strict fisheries management can't apply, so closed reserves can have a major effect. I believe in biodiversity protection – I buy that it's not just about increasing productivity – but the benefits of protecting spawning areas, migrations, etc. is also just old-school fisheries science. The difference is when you have a complete closure, as the pluses and minuses are not always very clear. Ray's models highlighted that. It depends on many things. To understand this in the BC context, you have to understand that the species and the location really make a difference, so we can't generalize without knowing which species and locations. Where are the spawning/larval production areas and do we know that sufficiently for the species that we're trying to protect? Fish productivity is very complex. But in a well-managed situation, none of this really matters all that much.

White: Given all the uncertainties and species variability, there is no way to optimize benefits across the board. There are also costs in gaining more information, so go with the solution that meets minimum requirements and attributes rather than searching for magic bullets. Look for the best solution possible – the idea of "satisficing" as a way to handle tradeoffs. There is also a need for research on the

economic side: on where the valuable fishing groups are, what are the costs of moving fisheries, etc. One benefit of MPAs is as a source of information: i.e. what an un-fished population looks like.

Darling invited participants to add further thoughts or summarize areas of agreement.

Rose: We can have some consensus on what benefits both conservation and fisheries, since clearly some things don't benefit both. Closures really provide benefits in terms of learning about population dynamics, etc., even if there are no spillover benefits.

Heppell: There are indirect benefits such as food web dynamics and resilience, or from differences in the population and habitat structure of un-fished areas. There are also different costs for different fishing groups, so it creates difficulties if you set specific thresholds – e.g. that it can't cost more than this amount or must provide certain minimum benefits. It's valuable for yield when there is a poorly-managed fishery but also consider the value of having a buffer for uncertainty, as there may be indirect benefits like that.

Edgar: Fishery management models are based on existing data, but in a context of trying to cope with unprecedented climate change and changing fishing technology and pressure, the uncertainties even in a well-managed fishery can result in a population crashes. Spillover benefits from MPAs can provide some insurance.

Cox: Research is an important issue. Should we create MPAs for the benefit of learning about population dynamics? You have to look at whether the costs are worth it – probably not. For example, sablefish closures in BC resulted in a massive increase in abundance. Then they went back down and up and down again. So you can see the natural variability, with peaks corresponding to the 2004 and 2007 year classes. But we already knew these year classes were there, so we did not learn all that much from the closure. It provides some comfort level having it there. But in terms of doing it for research benefits, we need to ensure those are actually there.

Heppell: And we can't assume that the reserve is a totally un-fished population because they are moving in and out.

Rose: Historically, fisheries management and biodiversity goals came from two separate worlds, but that is no longer really the case. Fishery scientists are trying to get away from the narrow single-species focus, embedding that in a larger ecosystem model and also including people and social factors as important considerations. So fishery science is moving towards hard-core protection. Establishing MPAs without close cooperation with existing fisheries management is probably going to fail. To move forward in BC, it will be important to ensure the goals for these two sides are brought together under the umbrella of ecosystem-based management.

Darling invited members to summarize what would benefit both fisheries and conservation:

Heppell: An area protected from fishing offers potential benefits to the ecosystem that can translate into benefits for fisheries, even if those are not as direct and measurable as we would like them to be.

Edgar: Larval dispersal is a win-win for both conservation and fisheries. Even if spillover doesn't contribute to fisheries outside, it won't be a negative. With adult spillover, in a global analysis we found that the factor that contributed most to building biomass in MPAs was having barriers around the reserve. Benefits to fisheries from adult spillover are possibly overstated given that the most effective MPAs have relatively little spillover.

Cox: I like the "satisficing" criteria – so what is good enough for biodiversity conservation but with the least intrusion for fisheries. Minimizing costs is simpler than maximizing benefits. In terms of research needs, it's important to have the right monitoring design to assess responses in fish and communities that fish.

Rose: Benefits to both include potential resilience of systems in the face of threats like climate change. The research needs to be looked at carefully. There are also benefits from increasing production in unmanaged or lightly managed fisheries. From a fisheries standpoint, being part of an MPA system is good PR for industry, even if it doesn't actually benefit production, in an MSC-certification world.

White: I agree on the importance of monitoring after you take action, using an adaptive framework. Sablefish is a great example and that's a potential gap with BC's RCAs. The lesson from California is that everything works better and it's simpler if MPA design and fishery management work together.

Additional comments:

Heppell: Where we will see the biggest change in fish biomass and abundance, habitat quality or biodiversity is where fishing is having the greatest impact, because fishing effects are what you are changing in the system. What are we monitoring and what do we expect or want to see?

Cox: MPA design is a map and a map is not a certain thing. For example, after drawing the boundaries, you may find no corals there. So don't put MPAs in forever. We are still trying to figure out how to do it.

White: It requires a lot of salesmanship to implement MPAs. What do you expect to see? If you stop fishing you may not always see more fish, so it's important to monitor.

Edgar: If there is no population change, it doesn't mean it's not useful. It depends on what is happening outside. Even if populations are stable inside an MPA, then that MPA may be doing a great job if populations outside are collapsing.

Rose: It's important to make predictions in the plan and then assess whether it's happening or not.

Break

2. Applicability to BC and research needs.

Cox: BC fisheries cover a wide range of finfish to invertebrates. It's not clear that protecting an area would provide overall fishery benefits, as closures affect the whole spectrum of species.

Edgar: Regarding research needs and relevance to BC, for a better understanding of species life history, it is important that fishery information is gathered on a fine-resolution spatial scale. Fishery management is based on regional units, so you need to collect information at that scale. An assumption is that biomass increases inside the MPA and once there is crowding, individuals will move out and become available for capture elsewhere. But there is negligible empirical evidence of such behaviour so it is also a critical research need, for BC and elsewhere. Research is also needed on genetic tools and the level of connectivity over different distances. There is very little information on that in BC and it is relatively cost-effective information to gather.

Heppell: The movement issue is key and there are nice tools available to study that. For a reserve in southern Oregon, a hydroacoustic array and tagging were used to monitor what fish were doing in the reserve, and how often they were leaving and returning. Tracking the movement of adults is hard to do at a large scale but there are ways to track local movements.

White: There are guidelines on larval movements for simple scenarios but they don't necessarily apply to BC's more complicated geography, in terms of how they aggregate and move along migratory corridors, fjord geography, etc.

Cox: That's true. We've already done quite a few tagging studies, e.g. on winter/ summer ranges for flatfishes. There are major gullies that link to the continental shelf and we have existing tagging data. For the last nine years we have detailed spatial catch information and we can use that to tease out patterns of distribution and how it changes over time. There are good possibilities for telemetry in BC, especially if we can link it to fishing activity (e.g. receivers on fishing vessels). Also on the point regarding age and fecundity, we have extensive data on this for many species. Some are stable and some change quite a bit over time.

Rose: Many of my points have been covered. The more we know about distribution and abundance and life history the better, although the reality is we won't always know everything. Telemetry is being used extensively on the East Coast, on cod, for example, and some of the findings are very surprising, although you wouldn't expect that after 400 years of fishing and 100 years of research. Recent technological advances are incredible. But it's not cheap and you also need to consider that. The other point is unintended consequences. For example, very large 50 x 50-miles closures off Labrador resulted in many unintended consequences, so you should be conscious of that. In another example, BC's RCAs have resulted in such large increases in the Yelloweye rockfish population; now fishermen don't want to go near the RCAs, because they have to be mindful of their quotas. There is a lot of literature on much of this that can be brought to bear – you should just do it.

Edgar: In response to the point about Yelloweye rockfish, the result can only be good for the fishery at a larger scale. I agree on the value of telemetry. You find some individuals will sit around, then move great

distances, then return to the initial location. These multi-residence locations were largely overlooked historically because they could not be detected with traditional tagging methods that involve capture and death of tagged fish.

Cox: Regarding telemetry costs, the benefits are not just about MPAs. You can learn other useful things such as ontogenetic corridors, and change management to try to avoid those fish.

Heppell: The term "unintended consequences" sounds very dire. We should say unpredicted changes because they can be positive or negative. There is a lot we don't understand about species and interactions but we can assume there will be some winners and losers so monitoring is important. Despite an easy coastline in Oregon, we don't know a lot about where our fisheries occur and the actual impact they are having. We need basic research on what are the fishing impacts.

Cox: In addition to research, there are also training needs. Fishery managers are not experts on MPAs, so prior to establishing an MPA process, ensure that managers are aware of their role. Monitoring impacts of fisheries is very expensive and it's not guaranteed to play out. I'm most familiar with groundfish and we have long-running trawl surveys that cover maybe 20 species. But they may be precise enough to detect changes over 10 years for only two or three species. That's the reality of a multi-species environment. Surveys of other fisheries (trap, hook & line, etc.) are not very precise and don't cover much area. So monitoring impacts is a big challenge. Maybe the research need is new ways of capturing that information in a useful way.

Rose: Unintended consequences are usually bad. Fish are easier to predict than people and consequences are usually due to the interaction of fish and people. With research, cost is always an issue so we need to take better advantage of the people out on the water. It's not perfect but it is more cost effective. As we move to a system where fishermen are part of management, it will help solve some of these riddles.

White: You can't treat movement patterns, etc. as static properties. In BC, species move in and out as conditions shift, so this poses the risk of decisions based on an anomalous year or situations where the time scale of variability is not in synch with the time scale of the MPA. This is another research need.

Rose: There is some literature that you should just put in MPAs and you don't need to do anything else. But that overlooks that there are many other things happening in the ocean – pollution, climate change, other changes due to industrialization – all of which have nothing to do with fisheries but which have major environmental impacts. So this is one piece, not a total solution.

Edgar: I don't know of any literature suggesting that MPAs are the only solution. I also disagree that RCAs had negative unintended consequence. It's a win-win situation where you have that outcome with considerable spillover for a seriously depleted species like rockfish. It's an ideal situation.

Rose: It's ideal for the species, but not for the fishermen – that is the concern. There are similar situations in the western Atlantic. You need to be clear about where the negative impacts are.

Edgar: That is a failure of fisheries regulation in allowing rockfish to deplete to the point that they are largely restricted to RCAs. If populations weren't so depleted then RCAs would be unnecessary. Regulations should be changed to accommodate this reality.

Cox: It's a research need. There is evidence of fishing effort piling up on the edge of MPAs to capture the benefit. So for Yelloweye rockfish it would be useful to do some modeling work.

Heppell: This highlights a critical thing about the social and management context. Species response models are not capturing that these are mixed-stock fisheries – so the benefits will depend on what's happening with other fish as well. The recovery of that species is a good thing, but will it provide additional constraints for the short term due to the need to avoid it? So you need to consider the management context throughout.

Darling: So where do we stand?

Edgar: It's a broader management problem rather than an MPA issue. It's a scenario where the MPA is doing a good job.

Rose: Yelloweye is not a highly over-fished species so it's not really a conservation issue. We always have to be aware that there are consequences to management actions that we can't foresee ahead of time. It requires a close meshing of the biodiversity and fishery management sides, so we need to try to make them compatible.

Heppell: There are lots of research needs in biology, and on fishing impacts. Precise predictions will be impossible, as there is too much cost and uncertainty. So focus on avoiding things that could be big mistakes – i.e. a big impact on the fishery, species or environment. Focus on the tradeoffs that are robust to these uncertainties and to the unknowns.

Cox: The conversation is going towards integrating biology with the management context.

Rose: The more we get the fishing industry involved, the better. We won't get anywhere with the old-school way of excluding industry, and it's not just their involvement but also their support because without that it won't be successful.

Darling: Any conclusions or other topics?

Heppell: It's not clear what is meant by "well managed" fisheries in BC. Clearly they were not well managed in the past if you needed RCAs. If they are well-managed, MPAs will only be a cost and we need to minimize that cost. So is that true or are there benefits?

Rose: Some fisheries are well managed, with surveys, stocks assessments, measures of biological parameters, etc. Others don't have any of that. The reason for rockfish/lingcod protection areas was that there was no management. RCAs were a last resort. I don't think management has changed much – RCAs are the management, although it's a blunt instrument.

Cox: The reason for RCAs was that the species were not assessable. You couldn't monitor one Yelloweye rockfish population and conclude anything about all the others. They had been subjected to serial depletion, and the only way to address that was to set aside a percentage of the habitat for inshore rockfish species. Survey data has been accumulated – the problem is that it's a quota fishery and to do that, we need estimates of biomass. So science and biomass don't meet very well and the MPA is the only solution.

Edgar: Management of the system is key to benefits of MPAs and how useful they are in those situations. Fishery management is not directed at individual species and the great majority of species are not managed, they are incidental, regardless of how many resources are in the fisheries basket. In Tasmania, MPAs were very effective because of the lack of stock assessment. MPAs enhanced the maturation of species. It was not effective from a spillover but from a spawning aggregation perspective.

White: There are different ways to address poorly managed fisheries. Some are data poor (so MPAs can serve as an insurance factor). In some cases we have data but they are over-fished and the MPA is addressing a different problem.

Heppell: We see from modeling and empirical data that MPAs are useful for unmanaged and data-poor fisheries. The question is if all fisheries are well-managed and not data-poor, do we not need MPAs, or are there other benefits?

Cox: There are other things there that MPAs can protect that we don't understand, for example, nursery habitat. Also, our fisheries involve multiple sectors and species, and costs are not evenly distributed across the different fisheries, so we should try to assess who will be impacted. Some fisheries won't be impacted at all.

Rose: On Selina's point, I don't see all BC fisheries being well managed. There are many species out there, some not fished, which are not amenable to other forms of management. This is a form of management and there is evidence that it's working and I don't see that changing, in terms of how we manage many things, including things whose function we don't understand and where it's not possible to do stock assessment. So it's a management tool. I'd like to see more data but it appears to be working and I don't think it will ever be perfectly managed.

White: The distribution of costs across fishery sectors is an important point. It's also important to consider distribution of costs and benefits over time – e.g. costs to today's fishermen and benefits to future ones.

Conclusions:

White: Key issues include biological and management uncertainty and the need to grapple with those. There are also good ideas on research needs, including on movement of fish and larva and connectivity, where fisheries are occurring and where they would move and how fishermen respond when you put in MPAs.

Rose: There is a grand opportunity to build on what's already been done. I would like to know more about what's been achieved, but the smart move is to build on what's been done. It started with collaboration between management and industry. Fill in the knowledge gaps by encouraging further involvement and bringing people together. We clearly need more research on outcomes, but it's hard to say what would provide the best payoffs. It needs more thought, but there are opportunities for telemetry that cry out for application.

Cox: The points we started with are well ordered. It starts with the importance of setting objectives for conservation and fisheries. Then it becomes scientifically tractable. When there are specific objectives, things happen quickly and you can get the feedback process started. Also you're not starting something that will be set in stone, it's something that will have to adapt, especially in the early stages.

Edgar: Many areas of consensus exist, including: 1) agreement that MPAs have a useful purpose for both of those objectives; 2) the larval dispersal side is especially important if there is over-fishing outside; and 3) MPAs are useful in managing for uncertainty. Monitoring scenarios may assume constant effort, which is not realistic. It is also useful to distinguish commercial and recreational effort. Commercial effort is well tracked while recreational effort is increasing but there is much less information on it. If there is increasing effort outside MPAs or a displacement of fishing effort to new areas through time, then traditional management scenarios become less predictable and more risky. Population trends in marine species are intrinsically unstable, often with large fluctuations between generations. If you have 20 percent reduction in an area where fishers can legally fish through declaration of a MPA network, this seems a substantial amount, but compared to long-term changes in populations of fishery species, removal of 20 percent is only a minor change.

Heppell: We've taken a fairly broad sweep, so coming back to our original question, there are more points of agreement than otherwise. There are species and fishery-specific (benefits) and also the management context is key. Benefits also depend on natural environmental variability, so concentrate research on unknowns to understand those aspects. There is more agreement than disagreement.

White: On larval dispersal being an unmitigated good, it's not always clear that this will compensate for fishery losses.

Edgar: It may generally be neutral but I haven't heard of any situations where spillover has negative impact.

Rose: Assessing spillover benefits can't be done in a general sense; it has to be done at the specific level. So the objectives need to be clear. Then look at the details, species, biology, etc. We can't answer that generally – it depends on the situation. With RCAs, you would assume there are benefits before even looking – there is likely spillover of adults, though larval dispersal is more complex and dependent on drift patterns, etc.

Darling sought and received agreement that it was okay to characterize this last round as the group's collective advice.

Q&A Session

- Comment: Unintended consequences of MPA networks are not always negative. Today we know that the GBR no-take network includes habitats and species that were unknown at the time of rezoning. The systematic and comprehensive representational approach to zoning included areas that we now know include these previously-unknown features.
- Jenna Stoner, Living Oceans Society: Is "good enough" good enough? Do basic minimum criteria set us up for "lose-lose" rather than letting one side win here and another win over there?
    - Cox: Some areas are good for some things, so it is possible to use spatial diversity that way.
    - Rose: I don't think that separating these things is a productive way to go – i.e. it should be a "one ocean" approach. There may be situations where biodiversity outweighs fishery benefits, but generally they intermingle.
    - Edgar: It would be nearly impossible to set up MPA networks that don't result in losses to fisheries. Even trying to have MPAs in minimally-fished areas is not a good approach because the threats are highest in the highest-fished areas.
- Q: Research, fishery management and protection usually focus on commercially-valuable species. Is it worth focusing on forage species of high ecological value?
    - Cox: One such example in the works is the Scott Islands proposal to protect sand lance, which is an important forage species for seabirds.
    - Rose: Conservation of forage species is a key issue around the world. As fisheries science moves more to ecosystem-based thinking, there is a growing focus on forage fish. It doesn't matter if they're fished or not, they're important in the whole fish production system.
    - Heppell: There are examples of MPAs designed to protect forage species.
- Rashid Sumaila, UBC Fisheries Centre: I agree that industry should be engaged in fisheries management. One problem is that future fishers can't be engaged, so can MPAs be used to protect their interests?
    - White: This is an important point and it's a societal decision to establish an appropriate discount rate – in other words, how much do you discount the value of current benefits in order to protect future fisheries.
    - Heppell: As younger people get more involved in fisheries, they have a different attitude – a stronger sense of stewardship – and this is seen as just part of doing business. Self-enforcement is a way to bring in these kinds of approaches.
    - Cox: Answering the question of whether the costs of research are worth it depends on the discount rate you choose. Short-term costs can disappear if you take into account that the discount rate is different when you consider the interests of future fishermen.
- Q: If stock status for a particular fishery is good, can you shift the focus of MPAs to protecting different marine values/species and have the fishery adjust its spatial footprint while still having the opportunity to catch their quota?

    - Cox: Models show that you could remove up to 70 percent of the best habitat for sponges and corals and have almost no impact on trawl fisheries. So you could have additional protection with little cost to fisheries.
- Mark Carr, UCSC: Be careful about conflating biological and ecological effects of MPAs on fisheries with biodiversity conservation or fishery management tool. These are very different concepts. To consider both ecological effects and management tools, you need to ask what your expectations of fishery management are. Single-species, MSY-focused fisheries do not consider ecosystem consequences as ecosystem-based fishery management does. Which of these is your goal?
    - Rose: Fisheries science is moving towards a more ecosystem-based management approach. It doesn't mean abandoning the single-species approach, but the results of that are looked at in the context of the ecosystem approach. We're definitely moving in that direction.
    - Cox: My goal doesn't matter. The evaluation is from the perspective of what are the objectives.
    - Heppell: There are other ways to reduce ecosystem effects of fishing beside MPAs so it comes back to where MPAs fit within the broader management context.
- Q: How do we take into account the wider ecosystem implications of fish decline and where does this fall as a priority in the MPA/fisheries tradeoffs?
    - Edgar: A key benefit of MPAs is their role in helping to understand the wider ecosystem and to separate the impacts of fishing from all the other changes happening to the system.
- Alejandro Frid: By exploiting top predators, fisheries can potentially have cascading effects to lower trophic levels and alter community structure, with unpredicted consequences for people. What is the role of MPAs in understanding these indirect species interactions and can they provide a control for understanding changes at the community level?
    - White: Yes, with the caveat that like Atlantic cod, it won't necessarily go back to the same state as before.
    - Edgar: In Tasmania, we found abalone numbers in the MPA were going down due to lobster predation – this was useful information for both species.

Roundtable 2: Social and economic effects (human dimensions) of MPAs on fisheries

Question: What factors determine social and economic effects of MPAs on healthy fisheries?

Roundtable members:

Dr. Edward Allison, University of Washington

Dr. Ratana Chuenpagdee, Memorial University Newfoundland
Mr. Gordon Gislason, G.S. Gislason & Associates
Dr. Nadine Marshall, Commonwealth Science and Industry Research Org.
Dr. Kerrie O'Donnell, Ecotrust
Dr. Evelyn Pinkerton, Simon Fraser University
Dr. Rashid Sumaila, University of BC

Roundtable members briefly introduced themselves, and outlined their backgrounds/interests.

Presentation: What factors determine social and economic effects of MPAs on healthy fisheries?

Presenter: *Edward Allison*

The presentation covered key definitions, context, global experience and applicability to the BC context.

The terms "MPA" and "No-take reserve" are often used interchangeably, but most Canadian MPAs are not complete no-take or no-go areas.

Healthy fisheries require a productive ecosystem with fish stocks harvested at sustainable levels. They must also be financially viable, with benefits distributed in ways that meet societal goals and aspirations (and this is a political question that needs to be negotiated and argued). Healthy fisheries must also be governable, with reasonable and fairly-distributed governance costs.

Studies provide growing evidence that fisheries governance reform is working for resource sustainability, in terms of conserving and rebuilding fish stocks. But there is much less explicit analysis of economic impacts, or else economic impacts are addressed in aggregate, without looking at distribution (who is benefitting) and at community level (social/cultural) impacts.

One global study found the impacts of MPAs are different for different fisher subgroups, in terms of effects on food security, resource control, employment, community organization and income. So the benefits are very mixed and there is no clear analysis that shows that MPAs are always good for everyone. The evidence is very mixed, with winners and losers, and a very thin basis for analysis.

The question for this group is what factors determine the socioeconomic benefits of MPAs. The simple assumption is that more fish means more food security, etc., without looking at the "black box" in the middle for an explanation of how one outcome leads to the other. Putting more fish in the sea won't necessarily solve hunger, so we need to analyze the links through social science.

One study showed more consumption of fish for women living near well-managed MPAs. But there are gaps in the study, such as what was happening before the MPAs? Part of the problem is that we're good at counting fish, but not at "counting" social status before and after to assess the effects.

Another study on conservation of manta rays in Indonesia found they had significantly higher economic value for supporting tourism than fisheries. But how much of the $15 million derived from tourism goes to outside tour operators vs. local people? We haven't been very good at analyzing the distribution of such impacts.

MPAs may have a role in securing space for both conservation and fisheries in increasingly crowded marine waters. Traditional approaches located reserves in the most remote areas, but there are benefits in locating them to closer to communities, where the benefits of MPAs to food production can help withstand pressure from competing claims for other marine industrial uses (oil and gas, aquaculture, shipping, etc). For example, the existence of an oyster industry provides important incentives to protect water quality in Puget Sound.

The following key questions were framed to guide the roundtable discussion:

1. What kind of MPA network supports healthy fisheries? (Governance principles and procedural justice)
2. What influences the perceived or experienced costs and benefits of MPAs? (Distributional justice, dependence and scale)
3. How can MPAs help protect fisheries from future shocks and unexpected events? (Adaptation and resilience – of economies, communities and management systems).

The group was asked to examine the scientific evidence, applicability to the BC context, to consider research needs and offer conclusions.

Discussion

Opening comments:

Sumaila: To consider the benefits of MPAs, you need to evaluate them in the context of the problems that you're facing. These are complex issues, which are very hard to understand – for example managing complex fisheries like halibut and salmon, plus added challenges like climate change. It's getting more difficult, so how do you still try to manage everything? When things get too complicated, you can solve them by trying to simplify the solutions. Portfolio solutions are an example, whereby you diversify your holdings as a way to manage risk and uncertainty.

Gislason: Few studies have documented the socioeconomic impacts of MPAs. They are one of many available fishery management levers and should not be dealt with in isolation. The benefits of MPAs will depend on the nature of the resource, the footprint of the fishery, and the MPA design. With good fisheries management, the benefits of MPAs may be modest. It may be short-term pain for long-term gain. Fisheries management outside the MPA may drive the results and the impacts on communities that depend on the resource. No manager will ever say his fishery is poorly managed. Management has to adapt to the MPA. MPAs may or may not affect TACs. For example, with the restrictions on Bowie Seamount to fish sablefish, the coast wide sablefish TAC did not change. The socioeconomic impacts will

also depend on whether the MPA is aimed at a target or bycatch species. There is a proposal to list Boccaccio rockfish, a bycatch species, under SARA (Species at Risk Act). They seemed to be on the upswing, so this is a potential nightmare for fishermen unless the bycatch TAC increases with increasing Boccaccio biomass. We need adaptive management for these things and we need to take into account whether it's a target species or bycatch. Process, dialogue and leadership are important. It should not be top-down; an inclusive approach is better, although it takes time and money. But the last thing you want is an MPA in which you spend a lot of money on compliance. If it ends up being a game of cops and robbers, the fishermen will win.

Chuenpagdee: There is a lot of complexity and the human dimensions add more complexity. On the idea in the presentation of five different socioeconomic impacts, like food security, it would be interesting to see if there is an argument there for First Nations in the BC context. It also highlights the importance of community organization and the fact that such initiatives can bring people together, which is an important unintended consequence. Complexity is one thing but understanding context is also very important, as is understanding whether an MPA will do what you want it to do. That's the importance of this forum: we don't spend enough time thinking about whose idea it is and whether we have agreement on having MPAs.

O'Donnell: I'm encouraged that the organizers have brought us together for this conversation. My work with communities on BC's north coast highlights the importance of considering community values and the social, economic and cultural effects of MPAs on fisheries.

Marshall: In Canada and Australia, we don't have to think about food security as much but we do think about empowerment, opportunities for income and employment. It's also important to consider security not just of income but other benefits, such as community and identity. Another point is the importance of legitimacy and how fishers respond. They need to feel empowered in the decision-making process and valued by society. It also has to be manageable. Strengthening a sense of community in industry is important, in terms of supporting a united front and cohesion. As individuals, fishers' strength is their independence. But that also is a weakness, because without unity it's hard to move ahead in a way that is manageable. Healthy fisheries support healthy ecosystems. The two go hand in hand to such an extent that if you are serious about conserving biodiversity, invest in the ability of people with strong links to the environment to recognize change within their own environment. The majority of the industry is disconnected from the environment and that direct feedback. And lastly, it has to be a full ecosystem approach, so considering other things like dredging, etc.

Pinkerton: We need to think about MPAs in a context of growing income inequality in Canada. Coastal communities are rapidly losing access to fisheries and experiencing growing inequality. When they lose access, they are going to experience it as injustice and perceive MPAs as illegitimate, unless they have some form of access rights and control. That is overwhelmingly an important part of the situation that we face. How do coastal communities respond to issues like oil and gas, aquaculture, cruise ship dumping? For example in the response to Northern Gateway, they have come out swinging to protect the resources. Will that continue in the future if they have no stake? We face huge pressures to allocate

ocean resources to others, so we have to think very seriously about that and consider a lot of models. What does the research tell us? Consider examples where local municipalities manage marine resources in the Philippines, Mexico and Haida Gwaii. We can't forget the importance of the adjacency principle. Canada's Ocean's Act says adjacent communities matter, so we need to pay attention to them and I hope our remarks will reflect that awareness. In BC, we're probably talking about MPAs with some fisheries access, so if those people could collect more data, it would be a huge benefit in terms of addressing data gaps, especially if we could have finer-scale data collection. Under BC's fishery management approach, there has been a loss of access and infrastructure, but I think of MPAs as a way to balance that a bit.

Allison: The way we think about fishers contributing to food security is more about the quality of nutrition. That nutritional contribution is an important counter to arguments about the economic value of sport fishing.

Question 1. What kind of MPA network supports healthy fisheries?

Marshall: It depends on the design, development and implementation of MPAs. Studies have looked at how they affect capacity to cope with ecosystem changes and threats like cyclones. Involvement and collaboration are also important. Individuals who were involved in the process tend to do better, and those with higher capacity had higher support.

Sumaila: The MPA must be reasonably large in size and cover different habitats, in order to provide healthy oceans into the future.

Gislason: The MPA network should have clear objectives, consistency with the fishery management regime, and good process (engaging stakeholders). The Canadian Species at Risk Act (SARA) provides very specific instructions on listing species but not on de-listing. So we also need to ask whether MPAs are here forever and if not, under what circumstances they would be reviewed.

Chuenpagdee: We also need to identify who will be involved in setting the objectives. Development of MPAs must take into account existing institutions (so assess the compatibility, scale and implications of different governing bodies at different levels).

Marshall: Engaging the fishing industry is key, and broader engagement of others as well is ideal. Consider the people issues and the importance of equity and transparency. You may be OK with an outcome until you see that someone else is getting more than you are.

Darling summarized some of the key ideas heard, including the importance of inclusivity, and principles relating to compatibility, appropriate scale, equity and transparency.

Chuenpagdee: There are also power issues to consider when you involve stakeholders – just getting them to the table is not inclusive.

O'Donnell: An important aspect of power is the evidence you are able to provide to support your position. Many of the values derived from fisheries are less tangible, so you need to ensure you acknowledge and include the less tangible values that drive participation and benefits. For example, in BC, the value of food fish caught for personal consumption and trading. We need to consider that value in addition to the economic value of commercial fisheries.

Marshall: In seeking to engage with commercial fishers, understand that this is a field that draws an extreme personality type, which makes it very difficult to engage them. Understand that often they feel very isolated and misunderstood by society.

Questions 2 & 3: What influences the perceived or experienced costs and benefits of MPAs? How can MPAs help protect fisheries from future shocks and unexpected events?

Allison: A key influence on perceived or experienced costs and benefits of MPAs is the degree to which people feel consulted in the process of MPA creation and management. This will influence whether people buy into the key argument for creating and maintaining MPAs: that the short-term, localized costs of their establishment will, in the long run, be outweighed by the benefits they bring as a means of protecting marine and coastal habitat. Functional marine habitats can generate recurrent benefits – for example from fishing or from recreation and tourism – and some form of environmental protection can guard against uses incompatible with these functions. This only works if there is broad political support for the MPAs – both locally and at national and even international scale. If this political support is missing, no amount of research quantifying MPA benefits is going to help in maintaining them in the face of larger global forces. In Australia recently, all the research about the value of the GBR could not counter high-level political pressure to expand a new coal-exporting terminal at Abbott point, with dredging that threatened critical areas of the GBR MPA. This highlights the importance of legislative teeth to address such issues.

Pinkerton: Is there agreement that coastal communities need to be involved in design and management of MPAs because of their importance as adjacent communities?

Marshall: I agree. On questions 2 and 3, I want to address social variability and the difficulty of understanding distribution of benefits. People fish for different reasons, not just for economic and financial reasons. There are also reasons relating to identity and attachment to place. So there are differential impacts. The impacts also depend on how employable they are, the alternatives available, and whether they share values, such as the importance of biodiversity. There is also investment in local knowledge, etc. – so there are many factors before you even get to the economic impacts.

O'Donnell: On Question 2, I'd like to share these words from a fisherman on BC's north coast: "*When I bought a house…I didn't have any collateral. Based just on knowing the bank manager, sheer knowing each other, I got a loan. He gave it to me based on who I was, on the value of my word."* Question 3 is about resilience of human communities. Fishermen in the study discussed many non-economic values attached to fishing, including attachment to their communities, so consider how those can lead to

tangible economic outcomes. In one example, an individual bought a house, and had no collateral but the bank manager knew him and respected the value of his word, so he got the loan he needed as a result. This speaks to how fishing affects communities and how that in turn affects economies.

Chuenpagdee: Consider how an MPA is embedded in the community and find synergies between sectors. It makes a difference whether humans are seen as predators or disruptors. There are a lot of examples where communities play the role of stewards.

Sumaila: Perceived effects are very important relative to what is actually experienced. In one example, NGOs pushed through the establishments of an MPA and the community did not feel part of it. Even after it resulted in them catching bigger fish, they still didn't like it. On including the fishing community or industry, recognize that we're not all here and that we need to manage for all Canadians, including future generations. The value of conservation groups is that they focus on future benefits. So that is the perceived side of things. On experienced benefits, a key question to ask is, "Why do you fish?" The pressure of "now" is very important to people who fish, when it is their livelihood and they have debts to pay, etc. However, MPAs are mostly about the future. So are you managing for 5 years, 10 years…? We want resilience for the industry, but that is very strongly linked to the resilience of the ecosystem. We need the fish to have a fishery, so I hope we can agree on that.

Research needs:

Gislason: What is an impact? An MPA is like any other management measure, so you need to look at what is the difference between the two trajectories i.e., with vs. without the measure. A major challenge is knowing what the world looks like without the MPA. We have huge data gaps and errors of omission and commission. With the GBR structural adjustment package, the Australian Government paid out significantly more funds than the quantum of economic loss of fisheries access was initially estimated. Much of that went to land-based businesses that were not directly involved in fishing. Improved fisheries data, including socio-economic data could have improved the design, delivery and evaluation of the GBR structural adjustment package and such lessons need to be considered in the BC context. Another challenge is that the world outside changes after the MPA is created, so how do you take that into account, especially if the benefits take 10 years or longer to play out. We have a tendency to research the issue of the day rather than investing in ongoing research to better understand the year-to-year fishery and I'm not confident that will change in BC.

Chuenpagdee: We need research on the arrangements needed to support implementation of MPAs and on those that work and those that don't.

O'Donnell: We've been talking about a pretty broad range of data, including data on the economic and other values of the fish that are landed. We have catch data but we need higher-level economic and multiplier factors, understanding which businesses are affected, etc. We also need more research on the community level role that fisheries play, including the economic and less tangible contributions, and we are especially data-poor on the less tangible benefits.

Marshall: You need to start now to develop good baseline data before you establish MPAs.

Pinkerton: We need studies of community-managed MPAs elsewhere around the world and how that affects the benefits. Also how MPAs can integrate local knowledge.

Allison: It's not just about academic research; the role of NGOs and community action can provide added benefits. One approach is using impact pathway analysis. Identify where you want to get to and then work back along the steps needed to get there, the things that can potentially derail you, etc. The private sector and defense industry use "possible scenarios". A third approach is action research: you try to influence change and then study what happens and see what you can learn in that process and how to do it better next time.

Sumaila: Look at the significant global costs to manage fisheries. Study the cost effectiveness of different fishery management approaches and the costs of simple approaches like MPAs. Also look at the portfolio approach and how much of the total portfolio should be conservatively managed when you factor in the different risks. Study is also needed on how to address the interests of future generations in current management, and how to apply discounting.

Conclusions

Pinkerton: Do people support the idea of MPAs involving people in adjacent communities, both in managing and sharing benefits? This relates to issues of legitimacy and compliance.

Allison: It's a good principle for some communities but it's different when you have a mobile fishing fleet that's not always adjacent. Another issue to consider is gentrification of coastal communities where fishers are replaced with others whose connection with the local environment is not so strong and whose values and interests in the environment may be very different to those who traditionally utilize the local environment in some way to support their livelihoods.

Sumaila: Definitely communities need to be involved, but with caveats. This relates to the question of who is calling the shots: government, community or is it co-management? One study found that having the community in charge could crash the fishery, and the same happened with government in charge. The best result was with co-management.

Marshall: A key concern relates to community engagement and gaps because a lot of people who should be involved are not well informed.

Gislason: Existing users need to be involved. Should adjacent communities have more say? The resources are owned by the people of Canada so I don't have an answer for that. But there are examples where involvement in planning included interests beyond the existing users (e.g. eco-tourism).

O'Donnell: People who have vested interests – stakeholders – should be involved. There is also a spectrum in terms of how commercial fisheries are organized, from owner-operator to others, so it's important to recognize that spectrum and how they all contribute to use.

Chuenpagdee: I agree with the adjacency principle but I have some concern about how it is used. Examples from the East Coast (shrimp trawlers) highlight the importance of criteria on legitimacy. People whose livelihoods depend on fishing and who are affected by the MPA should have more say.

Darling: The notion of inclusivity is generally supported, so the response is yes, and there are additional considerations.

Final comments:

Marshall: On accommodating conservation goals while minimizing impacts on fisheries, it's still early days in terms of understanding how to do this. Science must be considered along with the context – fish are easier to predict than people. I would love to see social scientists integrating human behaviour into the models, working with ecologists and fisheries scientists.

Sumaila: Understanding fisher behaviour is very important.

Gislason: Fisheries management is more about managing people than fish. Good work has been done in Australia on social indicators and socioeconomic impacts of MPAs. It's important to have a list of indicators for assessing performance on the objectives that you were interested in before the MPAs are put in place. It's important to evaluate MPAs and to have flexibility to adjust things like zoning or exploitation rates based on that evaluation, given uncertainties in the socioeconomic and biological responses.

Chuenpagdee: There is a lot of uncertainty in the fisheries, so there is a tendency to manage the people because that's easier. But if you decide on managing MPAs for people, it would be different than managing MPAs for the fish.

O'Donnell: Work has been done based on asking people rather than biologists where to put MPAs and the results showed a lot of overlap.[*]

Pinkerton: Lots of important work has been done – I hope people will start to listen.

Allison: There is lots of overlap here. These are soluble problems, and we have common interests in the room.

Q&A Session

- Comment: Natural scientists are more predictable than social scientists.
- Rob Morley: In asking how to design MPAs to meet multiple objectives, the assumption seems to be that fishing is the problem, when in fact fishing is only one of many impacts and MPAs are

[*] Ban, N.C., C.R. Picard and A.C.J. Vincent. 2009. Comparing and integrating community-based and science-based approaches to prioritizing marine areas for protection. Conservation Biology 23(4): 899-910.

one of many tools. Shouldn't you choose a strategy based on a comprehensive cost/benefit analysis? The answers are possibly outside the realm of fisheries.
    - Marshall: You should involve social scientists and explain what are the costs as well as the benefits.
    - Allison: Key questions include where to put MPAs and how to manage fisheries, and the answer to one is more expensive than the other. But I would hope that MPAs are established after you've asked the question of what's the best approach.
    - Sumaila: It's important to have a comprehensive analysis done on a case-by-case basis.
- Caroline Butler: On the adjacency principle, resource use and adjacency are not always linked for communities. How should engagement and governance processes reflect the complexity of interests, including both residents and non-residents?
    - Pinkerton: One way is to establish a board that brings together the interests, including local residents. Questions include determining appropriate weighting of representation. You need to have local representatives but you can also have interests represented from outside.
- Alejandro Frid: How can MPA design and management help resolve conflicts between the needs of Aboriginal communities, for whom reliance on local marine resources has important cultural, mental and physical health aspects, and competition from commercial and recreational harvesters.
    - Sumaila: There is an important role for MPAs in making management of resources more sustainable for all.
    - Marshall: This is a political question and the process to address it needs to be transparent.
- Dave Boyes: Many speakers assume that more MPAs would be beneficial for BC. What is the evidence for that and what problems are we trying to fix?
    - Sumaila: The total number of MPAs is not as important as their size – MPAs need to cover a sufficiently large area to be effective.
    - Pinkerton: We've seen MPAs used in some cases to compensate for other management problems – e.g. impacts related to implementation of ITQs.
    - Gislason: This highlights the need for evaluation. We have not evaluated the existing ones in BC, so we don't know.
- Jon Day: In evaluation, how much emphasis should there be on non-monetary values and how to do it?
    - Pinkerton: These other issues are very important.
    - Allison: You can measure them, albeit imperfectly and you then weight them as the values indicate you should.
    - Sumaila: It is very difficult to manage intangibles, but a lot of work is being done to improve that. Because of these challenges, people usually just address the tangibles and mention the others on the side.

- Chuenpagdee: There are ways to elicit the values that are important without putting a dollar value on them – for example asking people to rank things based on their relative importance.
- O'Donnell: We can't yet answer that, but it's excellent that the question is being raised. We do tend to put less weight on things we can't quantify, so we need to be creative.
- Marshall: You have to keep in mind that there are two answers to such questions: 1) what is their importance within the commercial fishing industry and 2) within society more broadly. There is a need to develop a new currency to discuss these things more broadly.
- Gislason: It's important to develop indicators for this. It's also important to understand that we're not going to address the extinction of an iconic species via an MPA. It's more about local impacts.

Darling thanked the roundtable and the audience members for their questions, commenting that the group had set an ambitious agenda and risen to the challenge.

April 10: Welcome and Introductions

Jim McIsaac welcomed everyone back and reviewed the three objectives for the forum. Next steps will include a two-day weekend workshop, work on summarizing the key findings from Day 1 and Day 2, and a move to cross-pollinate the advice received, along with members of the Steering Committee.

Darling reviewed the Day 2 agenda, noting the third roundtable would take a slightly different approach to presenting and discussing their topic.

Roundtable 3: Integrating MPA Networks with Fisheries Management

Question: How can MPA networks and fisheries management be integrated and coordinated?

Roundtable members:
Dr. Jim Boutillier, Fisheries and Oceans Canada (Emeritus)
Dr. Ellen Pikitch, Stone Brook University
Dr. Jake Rice, Fisheries and Oceans Canada (Emeritus)
Dr. Trevor Ward, University of Technology, Sydney

Roundtable members introduced themselves and briefly reviewed their backgrounds.

Presentation: BC MPAs and Fishing

Presenter: *Trevor Ward*

This roundtable will address the question of what characteristics of MPA networks can help integrate the objectives of healthy fisheries and biodiversity conservation. Roundtable members will offer four perspectives covering a strategic framework to facilitate integration; the setting of objectives in a systematic planning and performance assessment framework; types and scales of MPA networks; and existing constraints and opportunities in BC.

We define integrated MPAs as a system of MPAs for the Pacific coast that meets both biodiversity conservation and fishing objectives.

Why integrate? Institutional silos have created a system of sector-specific MPA objectives competing with each other. Different values and standards lead to failure in terms of efficiency and effectiveness.

Common outcome objectives for specific assets and values can provide a basis for achieving integration, for workable governance models and for supporting institutional structures (which are 90 percent of the problem, but we're not addressing that here).

Framing common outcomes requires agreement on standards, which is most efficiently achieved using a common currency. If not, it will require tradeoffs, at a cost to both sectors.

The core of a systematic approach is a framework into which all the issues are inserted. It involves a hierarchical system of developing principles, which inform the setting of goals, then objectives, surrogates (or proxies – e.g. biomass by age class), standards (MPA benchmarks), spatial expression (i.e. translate objectives and standards into a spatial expression), and efficient packing (i.e. to minimize the area occupied), leading to MPA size, placement and zoning, and finally verification and adaptation.

Systematic planning science is a tried and true method that has been used in many countries, and while there are some "barnacles on the hull," it's been largely successful. To work, this approach has to be adopted right from the start (in setting the objectives) otherwise you get an inferior approach of treating the attributes of fishing as a cost to be minimized to preserve biodiversity.

Presentation: Integration of Objectives

Presenter: *Jake Rice*

Originally this was going to be a commercial on why we need objectives and why they need to be integrated. But everyone already believes that, so why is it so hard to achieve it?

Message 1: Integration of objectives is a great ideal but very hard in reality.

The 2014 publication *Governance of Marine Fisheries and Biodiversity Conservation: Interaction and Coevolution*, by Serge M Garcia et al, outlined how these two streams diverged after WWI and then began converging in the 1970s, with the growing focus on sustainable development. As a co-author, Rice and colleagues invited experts to write about the challenges they faced in trying to integrate these two objectives in their work. An important message was the need to face uncomfortable truths if we are to make any progress and achieve positive real-world outcomes. In writing the book, we expected to have examples in all areas. But we found few examples of successes and many examples where it was largely about one side or the other strengthening control over their turf. Neither side trusts the other to match risk profiles enough to concede core competencies and jurisdictions.

This plays out both ways in BC. Fishery managers need to learn to trust those who are developing spatial tools to conserve biodiversity and vice versa. Until we get that trust and a willingness to give the other side control over things that we used to control, we will have a challenge achieving integration.

Message 2: Where might MPAs be needed?

We heard repeatedly on Day 1 that when fishery management works well, the gains from establishing MPA are modest at best. We should build on that message, not resist it.

In BC, offshore (beyond the continental shelf) fisheries management is working. Those who challenge that are relying on preconceptions, not reality. Inshore (on the continental shelf), that's not true; the commercial recreational fishery is very hard to manage with traditional fishery management tools.

So efforts should focus on strengthening existing networks, like RCAs, in the nearshore areas, where there are also important benefits of community engagement and social license. For offshore, the focus should be on biodiversity and protecting vulnerable habitats, and analysis of commercial fishery data for signs of consistent spatial hotspots for MPAs, although rolling "hotspot" closures are likely a better option.

Message 3: Insurance and benchmarking (ecosystem function)

Earlier speakers addressed important messages about the insurance and benchmarking roles for MPAs. In order to provide these benefits, you need to work at a minimum spatial scale equal to the scale of trophodynamic functions (e.g. all of one of the large gullies, one-third to half of Hecate Strait, or the same fraction of offshore west coast of Vancouver Island), as a smaller mosaic of MPAs will not provide those benefits.

Presentation: Characteristics of MPA networks that integrate conservation and healthy fisheries

Presenter: *Ellen Pikitch*

This presentation covers characteristics relating to objectives; size, number and location; and level of protection/zoning; with examples of zoned reserves in Belize.

As noted earlier, when fishery management is effective, the benefits of MPAs are marginal at best, at least when the sole objective is good management of the target species. But there are many other important species, and valued uses besides fishing. These include maintaining ecosystem integrity, tourism, having wild oceans and marine parks and control sites that enhance scientific knowledge. Yesterday's discussion was still focused on single-species fishery management but we need to think more broadly.

About 99 percent of the ocean is open to fishing. But we need to recognize the importance of non-fishing objectives and we will need a shift in the amount of ocean area open to fishing. Consider the manta ray example from yesterday or the economic value of forage fish. In a 2014 paper, Pikitch et al [*] showed that the indirect commercial value of forage fish globally was double that of directed commercial harvests.[+]

It's not just about keeping fish in the water, but also about keeping a lot of fish in the water. Another study found that one-third of forage fish populations needed to remain in the water to keep sea bird

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[*] E. Pikitch et al. (and 19 co-authors). The global contribution of forage fish to marine fisheries and ecosystems. Fish and Fisheries 15:43-64.

populations healthy. On the question of where to locate MPAs, a study of Magellanic penguins in southern Argentina was able to identify the most important areas where adult penguins feed in order to raise their young. Small chicks require food sources close by because they will starve if they are not fed every day.

A meta-analysis covering over 100 studies showed the mean, median and modal amounts of ocean protection needed to meet objectives is 30 to 35 percent of the ocean.* Current global agreements include the Convention on Biological Diversity target and Sustainable Development Goal that every country should put aside at least 10 percent of their waters by 2020. The World Parks Congress recommended a goal of 30 percent by 2030.

MPAs established in the Belize Barrier Reef provide an example where biodiversity conservation and sustainable fisheries were both important objectives. The area is a World Heritage Site, because of its very high biodiversity. Every MPA had to include a yes-fishing zone to benefit adjacent communities. MPAs were established as a "first resort" tool offering a simple and cost-effective way to integrate both objectives.

Pikitch described the geographic context and the no-take zone established at Glover's Reef, adjacent to a series of small, inhabited islands, which could provide "eyes on the water." The remaining 75 percent is a "general use" zone with some fishing restrictions. This was a very successful example that helped to maintain populations of groupers and spiny lobsters, with quicker ecosystem recovery from bleaching events than other unprotected reefs in the region. Reef shark populations have also been very stable here, compared to declines in other Belize reef areas.

In conclusion, zoned MPAs can be an important tool for ecosystem-based fishery management with benefits for both the ecosystem and fisheries. This is an under-utilized tool that can help to maintain biodiversity, ecological roles and support services. It can also sustain fisheries and increase resilience. In spatial zoning design, look for increased convergence in areas that are critical to meeting human, fisheries and predator needs.

Presentation: Existing constraints and opportunities in BC

Presenter: *Jim Boutillier*

This presentation provided an overview of work to establish MPAs and an MPA network in BC by the provincial government, Environment Canada, Parks Canada, DFO and First Nations.

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* Roberts et al, in preparation, (slide showing this result is in presentation was provided by Callum Roberts with permission)

Canada's Pacific MPA network is in the developmental stages and will build on a number of enhanced protected area initiatives ongoing in the region including sites such as: Environment Canada's proposed Scott Islands marine National Wildlife Area (mNWA) to protect and conserve sea bird populations and the ecosystem components that they rely upon; the DFO proposed Areas of Interest to protect glass sponge reefs in Hecate Strait; Parks Canada's National Marine Conservation Area (NMCA) for Gwaii Haanas ; DFO's designated MPA offshore sites at Bowie Seamount and Endeavour Hydrothermal Vents; marine areas adjacent to a number of provincial park and ecological reserve sites; and potentially other contributory sites such as DFO's Rockfish Conservation Areas. One of the main objectives (but certainly not the only objective) for the federal government's family of marine protected area initiatives (mNWA, NMCA, and AOI/MPAs) is strongly linked with the conservation of biodiversity within the marine protected area boundaries. Within these federal marine protected areas in BC, fishing is allowed with some restrictions consistent with the objectives for the area.

Within the Endeavour MPA, concerns about the levels of impact by research activities on the hydrothermal vents and their communities, prompted designation of some areas as off-limits to research, with only restricted monitoring. Some commercial fishing is allowed in designated areas of the Bowie Seamount MPA, although recreational and First Nations harvests are permitted everywhere. Industry continues to contribute to research to understand the extent and nature of the impacts of longline sablefish trapping on benthic communities. For the Gwaii Haanas NMCA, planners are still working to identify objectives and areas for additional protection.

The proposed establishment of an MPA to protect glass sponge reefs in Hecate Straits includes adaptive management fishing zones around core protection areas. One of the concerns associated with the adaptive management zone are the potential effects of re-suspended sediment on the sponge reef from fishing activities. Fisheries management, science, industry, NGOs and First Nations are working to address this concern. There have been two CSAS (Canadian Science Advisory Secretariat) papers presented on the potential consequences and potential mitigation measures to address this issue.

The proposed Scott Islands mNWA objectives take into account broader ecosystem considerations including protection of the habitats of prey species like sand lance that are important to sea bird populations. A recent review of the interactions between fisheries and marine birds in the proposed mNWA found some major inconsistencies in the approaches to management of different fisheries to address these broader ecosystem concerns. Some fisheries have developed a very proactive approach to address these issues, e.g. groundfish management with support from the industry has implemented integrated, comprehensive observer and electronic monitoring programs, and fishing mitigation methods within the management framework to address issues such as marine bird by-catch issues. Other fisheries are dealing with the issues on a voluntary reporting and compliance basis, which is known to only capture a fraction of the impacts. The review did however find one consistent problem with all the programs, which was the lack of species details in terms of bird impacts. It noted the need to improve management and reporting of sea bird encounters and for more work on identifying bird

populations. The boundaries of the MPA do not match the foraging habitat of the birds. Protocols and methods that can be implemented more broadly are being developed for the area.

Discussion

Darling invited members to discuss the importance of all this to BC.

Ward: Responding to the points that Jake and Ellen made, in my experience there is more to it than risk profiles. Some differences relate as much to different standards and different management inputs being applied. It's not surprising that people don't trust each other because they're doing different things. That's why there is a need for a common currency. When this is happening in practice, the outcome (at least for the Australian Commonwealth MPAs) is that the fishermen had no opportunity to participate fully from the start and then they didn't like the outcomes. So it comes back to the issue of common standards and having different management inputs. The difference in BC is the sectors here are talking in a language that is constructive and it's also still early in the process, so you can have a different outcome than Australia.

Jake also made an important point about global areas protected, as the research is often confused on this. It's important to distinguish between a design process that delivers an outcome regarding how much area should be covered, and using a square-kilometer target as an input to the process (the latter approach is not the way to do it). In the Australian example for areas outside the GBR, the green no-take areas chosen were mostly far offshore, with few competing uses. The objective was to be seen as achieving international targets. It's true that you are protecting important offshore biodiversity, but this approach fails to protect nearshore areas.

Pikitch: I see your point. But the problem in Australia did not result from having a 10 percent target; it resulted from the lack of other criteria to ensure there was good coverage for other habitats.

Rice: Regarding the 10 percent target, the important part is having 10 percent of the water mass in MPAs or other areas managed by spatial tools. On whether the issue is risk profiles or other language, different disciplines have different vocabulary for talking about the same things. I use risk profile intentionally because the differences were not about the outcome in terms of whether everything works, as the perspectives are very similar in terms of where they want to go. In one example, an international group with balanced perspectives found that both sides could agree on two-thirds of the possible outcomes. But the one-third where they differed was about those that reflected their core values, such as maximizing economic values. So those core values influence the discussions, and pretending otherwise is naive. The issue is not about risks when it goes right, it is about the risks when things don't go right. You can fail to achieve the objective due to a miss or a false alarm. The risks attached to those two are fundamentally different and that's part of the dialogue that's needed. So it's

about how to find the sweet spot of convergence, given the difference in core values. It's not a debate about the outcome that's the problem in moving forward; it's debate about the path to get to that outcome.

Boutillier: Some things discussed and implemented in other parts of the world are being tried in BC, for example the Pacific marine ecological classification system, might address what percentage of area coverage is needed. There is also the Ecologically and Biologically Significant Areas (EBSA) process, which has done well in the short time frame, but it failed to include local knowledge and industry and community experts to help identify critical habitat. So it's an excellent point and we need to do more of that kind of research.

Ward: Australia used a very systematic process but they did not do it properly. They failed to engage fishing and other communities. The experts developed a map to consult with and then altered it a bit based on feedback to minimize the costs of compensation. They did not engage initially to develop common objectives, using a common currency. This two-stage approach of doing all the science and then doing community engagement has let us down quite badly. (Boutillier nodded agreement)

Break

Pikitch: Jake discussed the BC nearshore area and noted that management information for many species is lacking. MPAs could be very useful in addressing that. Are there any thoughts on site location and features?

Rice: My understanding is there is lots of habitat diversity in the nearshore areas. I can't say which places have the key habitat profiles but some of that information exists and could be used to identify areas – for example, reef structures have been proven globally to provide important habitat and give the species that live there a high degree of protection. We also need to increase our ability to collect information, so that's a good place to start. We have spatial data on fishing patterns and that is useful, although the more data, the more disruptive it is to close the area. But at least it's a basis to start.

Pikitch: Those are great points that Jake made. I'm wondering about locations relative to the communities that rely on the resources. BC and Belize are not very similar but the principle of adjacency in terms of benefits spreading to nearshore areas is pretty important. Should locations be spread out based on adjacency of communities, and not just habitat?

Boutillier: I agree. One of the major problems now is clarifying what the objectives are. All the commercial fisheries are well managed. But some other intensive fisheries, e.g. sport fisheries, are not well managed. There may be room for things like RCAs in addressing this problem, but a big issue is enforcement and that's where adjacent communities come in and can play a critical role. So we have to work with industry. They have a lot of knowledge and can help identify areas. But they're not the problem; the problem is other uncontrolled fisheries. A different point is that in looking at these things, we have to be adaptive.

Ward: This raises a question about assets and values. There will be immediately identifiable high-value areas. From a biodiversity perspective, there was an approach in Australia that could apply to BC, based on using an eco-classification approach and sampling places from each classification for inclusion in a protected area network. Often you don't know what you're getting, as the results may be unknown for some time. Just because we don't yet know what's happening is not a reason to not protect things. They all have value; maybe not to fishing but in an ecological sense, they all have value and deserve to be sampled. Australia has resorted to geomorphic classifications (e.g. canyons in the continental shelf). We don't know very much about them but it's good to have samples. Representation of whole ecosystem features for 'insurance' purposes is complementary but a different approach and relies on surrogates and proxies.

Rice: That's been part of the plan for MPA networks since the early days of discussion. You start with the three coasts in Canada, and at each scale you then move down to the next scale. You don't have a part of 100 canyons; you have a whole subset of the canyons.

Ward: The points about adjacency are well made. There is no reason that can't be an objective, same as having canyons and important fisheries.

Pikitch: Good point, Trevor, it makes a lot of sense. I would like to discuss the level of protection as I sense reluctance among many speakers for permanent no-take reserves. I feel strongly that a significant fraction of reserves should be strongly protected. One, it maximizes benefits to biodiversity protection. If you have a rotating system or on/off fishing, you miss an opportunity to see what happens to the full spectrum of benefits when you fully protect an area for a long time, say 30 to 50 years. The adjacency principle makes sense and another reason not to move around is consistency in management. People get used to rules and changes are difficult. Also many sea birds populations use the same colony areas year after year.

Rice: I only disagree that there is a reluctance to bring it up. A lot has been said about the level of protection. If we are going to get the insurance policy portfolio benefits, there is no other way to get those benefits except via a high level of exclusionary protection of large enough areas. Without that, you don't get those benefits. It also requires putting the biological objective as higher than the fishery objective. We haven't been prepared to be that blunt, but trying to paper it over just raises unrealistic expectations.

Boutillier: One problem when we do no-take zones is often it will reach a new equilibrium, although maybe not the one you expect. For example, the sea urchin population grows and has confounding effects on kelp beds. So depending on what your objective is (e.g. if you want to rebuild kelp beds), you may have to be adaptive in your approach.

Ward: How will Canada report this BC network under international conventions? If MPAs don't fully comply with their standards, it will be a tough call and non-permanence is a tough call under those standards. Don't ignore the importance of your national government being able to claim credit and

permanence is important to that. No matter what you're trying to achieve, don't start by identifying it as a biodiversity targeted process. Start by saying you're trying to make it for the fishery and biodiversity. Some objectives may not be joint, but don't start that way. List all the objectives and don't necessarily categorize them as one or the other. It's about a commitment to significant engagement in a fairly well structured framework.

Rice: There's been a lot of discussion about the international commitments. Permanence is not an issue but if you're saying it can't be changed without a major legal intervention, is a commitment to do it for 30 years permanent, as opposed to saying you could take it out next year? That hasn't been an easy discussion. Is an area closed primarily for biodiversity or is demonstrable biological co-benefits sufficient? Can you be saved through good works alone or does it require faith? You must have explicit biodiversity goals to be counted.

Pikitch: There may be more opportunity for convergence in this group than previously thought. We all want the insurance value of biodiversity conservation as one of the things to achieve, with scientific knowledge from MPAs as control sites, and no-take reserves are the most important way to achieve some of those goals. There is also the concept of zoning and that not every part of an MPA must have the same rules. Biodiversity may not have to always come first; maybe it's just on an unequal footing with fishing.

Darling: This comes back to our objective of how to combine the two goals.

Boutillier: On biodiversity conservation, if we can have no-take zones with minimal impact on the fishery, it's important to have them, especially in deeper areas where we're finding new species all the time. We don't know what's there, so we can't set specific objectives, but we understand there is a lot we don't know and that there are real benefits to protecting it. A better understanding of how we model fishery production is one of them, so that we can manage fisheries for future generations.

Rice: It's not that no one liked that benefit. The way the workshop worked, getting 100 people to brainstorm MPA objectives led to a long list of possibilities and then both sides could support two-thirds of those. It was the one-third that addressed core values for both interests that was the problem. And we need to acknowledge and confront those or else we will just keep the discussion on the areas where you already agree.

Ward: It's counter-productive to say you will achieve one or the other. In BC you will also have to deal with ports, shipping, etc., all of which will also want to be at the table. There is a framework where everyone can add their objectives, but it doesn't mean you will achieve every one. That approach will remove a lot of the win/lose aspect from the equation, although there will be a small amount of give and take required. The Australia example protected 50 percent of the area in the region and cost industry 8 to 10 percent of harvest. There ended up being additional benefits in terms of new knowledge. So MPAs provide a good opportunity for win-win solutions with minimal cost. The GBR initiative could even have scaled back a bit and still had a fantastic outcome for biodiversity.

Darling cited examples of some of the many sectors involved in the BC context.

Research needs:

Pikitch: In terms of research needs, how much information do we need to move forward on MPAs? We may not agree on this. More information leads to better decisions, but I'm nervous about arguments about waiting for information before we can design a system, as it can be an excuse for inaction. We need to move ahead with the information we have and incorporate new information as we get it. The more we know, the more aggressively we can fish. So start really big and then reduce the areas as you learn more. Rough enough is good enough. In Belize, they took a practical approach to locate MPAs where they can manage them.

Rice: I don't disagree with most of that. But I am disturbed. I know many data sources exist that have not been looked at and I'm concerned about the momentum to go ahead without looking at existing data that could inform decision-making, just because no one has the resources to do the analysis of that data. Fifteen years of spatial analysis of the BC trawl fishery is an example of such forgotten data, and there are many other information sources like that. We should focus proposed resources for new studies on analysis of existing data. I don't disagree that it's a precautionary strategy to start big and reduce it as knowledge grows. This is very consistent with the precautionary approach. But it requires explicitly recognizing that we are prone to potential false alarms, with resulting costs to industry, and that we're willing to take that risk to avoid misses (failing to protect key areas). I'm not saying one risk profile is the same as the other. They're not the same and they won't come together through dialogue. It's about imposing costs due to false alarms vs. increasing risks through misses. That is the dialogue we need to have.

Pikitch: These things need to be acknowledged and transparent. It makes sense, I agree. But Trevor would disagree about optimizing instead of "rough is good enough."

Ward: I don't think we disagree. It's possibly a different approach or different interpretation. Doing more research and having better information for good design is central to where we're heading. But a lack of information should not prevent you setting the objective. Instead, your objective will have a lower level of resolution. So agree that you set the objective and then you run the MPA selection process anyway and do sensitivity analysis. If it's very sensitive to where the rocky promontories are located, then you do need to do extra research on that, including data-mining everything that's already there that you can find, and then go back and decide where to locate the MPA. It's a good progressive approach as it forces you to prioritize. You can do it at any resolution. Decide how critically sensitive the outcome is and that points to where you need to do more research.

Boutillier: BC had a major effort to bring together the data, and much of it is available on the Web. I'm very impressed with how this forum has brought together two very divergent groups. We have a phenomenal world-leading industry here. Initiatives have been brought forward, despite industry experiencing rough times, like shutting the sea cucumber harvest and adopting a fishing strategy that

provided the information needed to insure the fishery proceeded in a sustainable manner. We need to work together on monitoring and data collection because none of us has the resources. A lot of data that is collected gets lost. Many interest groups collect data but often it's very difficult to get the data from them. So it's very important that we get access to baseline data, get it reviewed and get a system in place to make informed decisions. We need to mine it better, and not just the fisheries data, it needs to include environmental baseline and impact data from all marine industries.

Conclusions

Ward: There has been a lot of discussion on rolling fishing grounds. There's no problem bringing that into the prioritization process, providing there is a reasonable time series of data to work from. I don't think this discussion has been very disagreeable. Integration could be achieved, but it requires positive action from two communities to actively move "holding hands" to do this.

Pikitch: On research needs, spatial information is important and there may be more available that can be analyzed, including information on migration patterns and trophic interactions. There is definitely more agreement than I expected. Biodiversity and fishery objectives can be integrated. We need to be explicit about the risk profiles of the individuals who come to the table and it needs to be transparent. Don't let a lack of information stop you moving forward and BC should target the establishment of 10 percent in highly-protected areas by 2020.

Rice: BC should give priority to an inshore network. The BC coast is one of the most data-rich places in the world. This highlights the importance of analysis of the data streams that Jim mentioned. The current work being done offshore needs support. We also need to discuss achieving some of the offshore objectives and whether BC and Canada are willing to pay the costs to get some of the benefits. We will have a more constructive dialogue when we have done a year or two of data analysis. There will be difficult tradeoffs, so do them under the most informed circumstances.

Boutillier: DFO previously conducted research programs directed at understanding trophic interactions in the region. This stopped a number of years ago, which is a major loss in the continuity of a data set that could have provided invaluable information on ecosystem changes that might expect as a result of climate change. BC is a transition area – it is the southern limit of distribution for a number of northern marine species and vice versa. We are seeing a lot of changes in distribution of species correlated with changes in oceanographic conditions. If we are going to properly plan for the benefits of MPA networks we need to make sure we are collecting the right kinds of information that will allow us to understand and adapt to the impacts of factors such as climate change.

Q&A Session

- Dave Boyes: Examples of MPAs in developing countries with artisanal fisheries are not relevant to the BC context. The management system also imposes de facto MPAs for 50 percent of the marine area.
    - Ward: The 50 percent area that is currently not fished may not be the 50 percent that needs to be protected. Without knowing the biodiversity objectives, we can't say what contribution those areas make.
    - Rice: I can't say what portion of the 50 percent is not fished every year but there is ongoing avoidance of hot spots. We have all the observer data but it needs analysis. I expect we will find that some of that 50 percent consists of high biodiversity areas.
    - Pikitch: If the areas not fished have high biodiversity, they would be good candidates for MPAs.
    - Boutillier: The groundfish industry has taken this very seriously but we may need to talk to others. I agree with the other comments. But some of these areas have been fished for 100 years and have been heavily impacted.
- Kim Sander Wright: What does governance mean - is effective governance possible in the BC context?
    - Darling: Governance is not a focus of this forum.
    - Rice: We were instructed to steer clear of it. It's hard to discuss our part of the overall mandate without mentioning the G word. We won't have effective ocean governance until we see the ocean and fishery management sectors sit down and find ground where they can move forward together, not just in terms of the overlapping mandate but the other part. But we have not seen that happen at the national or regional scale and rarely at local scales. People work very well in the area that's within their comfort zone but are still very possessive.
    - Boutillier: There are excellent examples of fisheries and oceans managers who work very well together. There are also some new, younger managers who understand the context and who want to manage fisheries in the wider ecosystem context. So it's also a question of how we can train managers.
    - Ward: If the fishing and conservation sectors can get together and agree on MPAs, it is the precursor and it is very difficult to see how governments would not be convinced to come to the party. But without agreement between the sectors, it would be very difficult for governments.
- Dan Edwards: In order to achieve transparency, etc. we need to come together in a process that sets objectives for an MPA strategy, with a process design that addresses imbalances in the power dynamics. Are the governments you deal with willing to take the leadership role needed to set this stage?
    - Rice: That is the stated government policy. Would they say something they don't believe?
    - Ward: Bottom-up processes are remarkably effective where leadership is lacking.

- Evelyn Pinkerton: How would ocean acidification affect the location/target species in MPA design?
    - Ward: Some species will be affected, but GBR studies show that well-preserved areas are more resilient in general. I'm not sure how acidification will affect species but MPAs could provide important information on impacts.
    - Rice: This was discussed at the Brazil conference, and they said reserves can buy a little time but that no management intervention can counter the growing threat of acidification. The only way is a major reduction in carbon emissions.
    - Pikitch: A recent paper showed that healthy ecosystems are more resilient to ocean acidification. True it's just buying time but there will be winner and loser species. Should we plan ahead for the winners and write off the losers? It's a question we will have to grapple with.
    - Boutillier: The biggest losers may be some of the pelagic species that are most important as food fish. We're already seeing impacts along the Pacific Coast. I'm not sure how MPAs will help but this issue shows the importance of understanding the ocean and for us all to be responsible for our footprints.

The Roundtable closed with the following invitation from the audience observers:

> *On behalf of the MPA Network development team for Canada, BC and First Nations, we'd like to invite the roundtable members to spend some time over the weekend considering how we might draft* ***integrated objectives,*** *as Trevor Ward has described them.*

Roundtable 4: Tools to plan an MPA network that considers both biodiversity conservation and healthy fisheries

Question: What tools (e.g. bio-economic tools, models, and/or techniques) can be used to integrate biodiversity conservation and healthy fisheries for designing MPA networks, and how were they employed in two case studies?

Roundtable members:
Dr. Natalie Ban, University of Victoria
Darren Cameron, Great Barrier Reef Marine Park Authority
Dr. Mark Carr, University of California, Santa Cruz
Jon Day, James Cook University
Charles Steinback, Point 97

Roundtable members briefly introduced themselves and outlined their backgrounds.

Case Study: How useful were different tools and techniques in rezoning of the Great Barrier Reef (GBR)

***Presenters**: Jon Day and Darren Cameron*

Day began with an outline of the presentation, which provided an overview of the GBR, the Representative Areas Program (RAP), operating principles, fisheries input, and a review of the potential benefits and limitations of decision support/analytical tools used.

Day described the GBR, including the overlapping federal and state (Queensland) marine park boundaries. Coral reefs only represent about 10 percent of the entire area covered by the GBR multiple-use MPA. The experience gained there over the past 40 years is useful for informing ecosystem-based management elsewhere, particularly with regard to MPA planning and implementation, fisheries management challenges, threatened species management and integrated coastal management.

Ocean zoning, which has been in place in the GBR since the 1980s, is a key spatial planning and management tool, with seven marine zones ranging from least to most restrictive, allowing different activities. Concerns about inadequate protection of biodiversity in the late 1990s led to a re-zoning initiative, which took five years (1999-2004), with the overall objective to protect the full range of biodiversity while minimizing impacts to fisheries and other users.

Day provided an overview of the re-zoning process, noting science was an important underpinning for the zoning plan. The early steps included developing a map of 70 different habitat types, or bioregions, and operating principles. The GBR legislation required two formal phases of public engagement, with the first occurring before development of a draft plan. The draft plan was then put out for a second round of comments before development of the final plan. The planning process included demonstrating to the minister how all the 31,000 public comments were considered.

The process relied on using the best available science – we didn't go out and collect any more, Day noted, as there was a lot of good science available. Independent scientific experts helped to evaluate the available information and to develop the map of bioregions. Some of the bioregion boundaries were subsequently adjusted based on public feedback, including from fishers, and additional information. A map of bioregions was a key component for planning the new zoning network.

The planning process included the development of 11 biophysical operational principles. These were not targets or hard rules, but more like guidelines to be followed "as far as possible." The approach was to consider the whole package of principles in their totality, so collectively these principles were fundamental. Some were hard for the public to understand (such as connectivity), so graphics and other communications tools were used to illustrate key principles during the consultation.

There were also four economic, social, cultural and management operational principles. These included maximizing complementarity of candidate areas with human values/activities and opportunities; ensuring that final selection of no-take areas consider social costs and benefits; maximizing placement

of no-take areas in locations that complement and include present and future management and tenure programs; and maximizing public understanding and acceptance/facilitating enforcement of no-take areas.

It was important to convince people to get involved, and the planning process provided numerous opportunities for that; consequently there were many changes to the draft plan based on the public input.

Lessons learned included not waiting for "perfect science," but using the best information available to start and then incorporating new information as you go. The robust bioregionlization was a fundamental underpinning, as was having a clear and transparent set of operating principles. It was also helpful that the operating principles were not presented as targets or ideals, and that they were designed to be considered as a complete package.

Cameron continued the presentation, with an overview of fisheries that occur within the multiple-use zones of the GBRMP.

Total commercial harvest is around 8,000 metric tonnes annually, and fisheries include commercial trawl, gillnet, crab, and hook and line fleets, along with traditional use fisheries by Aboriginal and Torres Strait Islander Peoples, plus a large recreational fishery.

He reviewed how existing data was used to develop the bioregions. For the trawl fishery, they started by looking at fishery management closure areas and logbook data to identify non-fishing areas and important fishing areas. These data were incorporated into the new MPA network design. Spatial VMS data was later overlaid with the proposed no-take zones to identify areas of overlap. This allowed the planners to adjust the boundaries of no-take zones in most cases to minimize fishery impacts.

Turning to lessons learned, Cameron advised that during the rezoning process, Australia did not have a fisheries adjustment policy in place to address the loss of fisheries access caused by increases in no-take marine reserves. The absence of any policy in this regard made for a difficult negotiating environment for both fishers and marine park managers. A policy was released not long after the zoning was completed, along with a structural adjustment package. The GBR structural adjustment program, however, did not have a robust framework in place to minimize opportunities for political interference or fishing industry influence. So the lesson is that government assistance or structural adjustment programs need to be treated as an integral part of any MPA planning process.

In terms of the public response, there were some very disparaging headlines about the impacts of the rezoning during the consultation processes, but eventually there was fairly good buy-in by the wider community, both nationally and internationally.

Cameron also briefly described fisheries monitoring/auditing through the AIMS long-term monitoring program and spillover research, which has found that no-take zones are punching 'well above their

weight' in terms of larval spillover. The next step is to look at whether these recruits are maturing and entering into the fishery. Other work includes comprehensive ecological risk assessments of fisheries.

There are continuing challenges, such as those created by an in-press *Ecological Applications* paper by Fletcher et al. (2015) arguing that large-scale expansion of no-take closures within the GBR has not enhanced fishery production. A critique of this paper by 15 Australian coral reef scientists and managers has been submitted to *Ecological Applications* concluding that the Fletcher et al. paper is flawed. At the time of preparation of these proceedings, the critique has been peer reviewed and will be published after addressing some reviewer's comments.

Cameron stressed in conclusion that zoning and MPAs won't address all marine ecosystem pressures and challenges including fisheries management challenges – for example water quality issues occurring in adjacent agriculture areas and caused by external sources can only be dealt with by improved catchment management.

Day resumed the presentation, discussing the role of decision-support and analytical tools in the GBR rezoning.

Zoning is one of several spatial tools available. Marxan was one tool used in the planning process, although others were also used. The bioregions had a major influence on the initial network of green (protected) zones generated by Marxan. Socio-economic information was added to further refine the network. As additional information was brought in, there were significant changes to the network of green zones, which led to the draft plan. There were, however, significant further changes made to produce the final plan, which was very different from the original network generated by Marxan.

Tools can help in developing spatial outcomes but they cannot produce the final pragmatic, politically acceptable solution, Day noted. They can, however, help stakeholders to understand the planning process in a logical and transparent way. Post-hoc accounting (or auditing) of the final network was an invaluable part of the analytical approach and this proved to be the most useful role for analytical tools, assessing the extent to which the planning principles had been met.

Analytical tools won't compensate for missing or incomplete data, and poor data will lead to poor results. Outcomes are of little practical value if social and economic information is not included – although such data often are not readily available, and some information can't be effectively included in analytical tools (e.g. the inevitable political tradeoffs required). Tools have their limitations and can't provide quick answers. They sometimes produce simplistic results or unintended side effects and cannot solve the complexity of real-world planning problems on their own. This highlights the value of the more traditional planning approach including dedicated consultation and engagement with stakeholders.

The success of the GBR rezoning outcome relied heavily on using the best available scientific knowledge, a high level of public participation, effective leadership and consequent socio-political support. All four were essential, but the importance of the latter three cannot be emphasized enough.

Summarizing the overall result of the re-zoning process, one-third of the total GBR now consists of no-take zones (that maximize the protection of biodiversity), one-third protects the benthos (allows most forms of fishing while still protecting benthos) and one-third allows all reasonable uses including trawling and other types of fishing.

Case Study: Tools to integrate biodiversity conservation and healthy fisheries for designing MPA networks: California case study

Presenter: *Mark Carr*

The California initiative was mandated in 1999, when passage of the *California Marine Life Protection Act* established a legislative mandate for a state-wide network of MPAs. The seven-year coast-wide planning process concluded in 2011. The six goals for establishing the California MPA network were solely focused on protecting and maintaining biodiversity, so consideration of fisheries was secondary. The six goals were further elaborated in a series of guidelines addressing the protection of habitat and populations.

It is fundamental to start with an understanding of the process design, as this affects the tools you choose and how you use them. A key point in this example was interaction between the science advisory team (which developed the ecological MPA design guidelines) and stakeholder groups, which used those guidelines to generate an MPA network design. The results went back to the science team, which evaluated how well the proposals met the guidelines and then sent them back for modification as necessary in an iterative approach.

The tools developed to facilitate this process were based on the best readily available science at the time. The first tool was the set of guidelines for evaluating MPA design proposals, which were formalized in an official document.

MarineMap was an online, user-friendly decision-support mapping tool that was developed for the process. It allowed participants to access a geo-referenced database and related analytical tools, and to draw or modify their proposals and receive real-time information in response. This allowed stakeholders to work on their own or with constituents and take their time to prepare for meetings, then come together and share their proposals with others and exchange ideas or work on changes. Staff support was provided to run the mapping exercises during these meetings. The data layers available to work with included habitat, biological, physical, cultural, socioeconomic and reference data. A key function of this tool was to provide visualization of proposed individual MPAs or networks, along with feedback on how well they met the design guidelines.

Benefits of an online tool include support for participation, collaboration and communication; science-based decision making for all participants; transparency, speed, efficiency and real-time feedback. Benefits of this “adaptive development” approach included having an embedded team of experts, a

flexible, open-source technology and having staff on hand at meetings to support the consultation process. The approach was strongly endorsed by participants.

Another important tool was the bioeconomic model used to evaluate results of different design proposals by providing predictions of the impacts to conservation and fisheries. Elements of this tool included habitat mapping, information on key fishery species, larval dispersal, biogeographic patterns, and fishing fleet models. The latter predicted fleet response to establishment of MPAs, with model runs under three different future levels of fishing pressure (conservative, medium and over-fishing). Model outputs included conservation metrics (biomass relative to un-fished), fishery metrics (yield relative to MSY) and overall score. The best-case scenario was a win-win for both and this was a useful tool for evaluating tradeoffs. Although this tool was used in the MLPA process to evaluate the relative trade-offs between fishery yield and conservation for a suite of MPA networks that were proposed using the ecological guidelines, it could also be used to actually generate draft networks in future processes as long as the information required to develop the models is available.

The process resulted in a coastal network of MPAs established in stages for California's five coastal regions. This included 63 no-take reserves covering 9.4 percent of state waters, plus additional MPAs allowing limited take that together covered a total of 16 percent of state waters.

Discussion

How successful were these technical tools in integrating biodiversity conservation and healthy fisheries?

Carr: These tools are all applicable to BC. The decision on whether you might use them depends on the process and objectives. For example, California didn't use Marxan because Marxan is designed for planning when you have a predetermined target for the amount to set aside. That's what influences which tool to use.

Steinback: Agreed. The choice of tools is tied to process. MarineMap was customized to support the California process.

Day: Tools may be custom-made but they are driven by the goals.

Ban: Both Australia and California are fairly similar to the Canadian context. Commercial fishermen in Australia and California would also call themselves well managed. But what drove the need for an MPA process in both cases was the deeper historical context. Many species are affected by past over-fishing. There is so much that we don't know yet, so that's my plug for the need.

Carr: When the process was launched, there was not a consensus that California fisheries were well managed (e.g. abalone, and huge rockfish closures required after significant mismanagement of one of the most important fisheries).

Cameron: Prior to the GBR rezoning, there were major interventions and restructuring of fisheries to address ecological and fisheries sustainability issues. But there were plenty of things that still needed to

be improved. The GBR re-zoning coincided with other changes, such as a change to ITQs and major reductions in harvest for some fisheries.

Day: We didn't have perfect information when we did the rezoning. But a systematic and representative process can protect things you don't even know about at the time, e.g. the subsequent discovery of cold-water corals that were unknown at the time in the deep waters offshore. So you do need to take a representative and precautionary approach. You try to minimize the impact to users but don't draw back from the objectives. Another issue is federal and state integration. In our case these were totally complementary, despite some difficult spots.

Carr: The original motivation in California was the quality of fisheries management but another reason was about embracing the idea of ecosystem-based fisheries management – so managing not just to achieve MSY but with the recognition that removing species from the system affects that system. Stephen Ling et al. published an example of how reserves can enhance ecosystem-based management focusing on the consequences of fishing lobster.* The fishery itself was well-managed and sustainable but it resulted in a population of smaller-size lobsters that could not control sea urchin abundance, leading to an influx of urchins. Where the urchin population was controlled, kelp forests were maintained, supporting the abalone fishery. So this is a good example of how to apply no-take reserves, even in a well-managed fishery. When you understand the ecosystem, you ensure the fishery is not just sustainable but is also maintaining the ecosystem function of that species.

Ban: Several studies have examined impacts of climate change on the Great Barrier Reef. One finding was that the representative no-take areas have also captured areas of different risk to changing temperatures, cyclones, etc., even though the design didn't include spatially explicit information on climate change. Thus one of the benefits of the no-take network in the GBR – protecting areas exposed to different risks of climate change – was not considered at the time. Another issue is Aboriginal fisheries, given their rights to fish and their great interest in what happens with marine planning, and how to include them in planning.

Cameron: We had dedicated teams, who engaged extensively with commercial and recreational fishers and with Indigenous communities. The Native Title Act in Australia overrides the GBR Marine Park Act. We consulted with Traditional Owners on their needs and uses and the final plan allows such access to resources within the green (no-take) zones for traditional and customary purposes.

Day: We entered into formal agreements with different indigenous groups. Some were more organized than others and some are restricting their own activities to support conservation, recognizing that some of the species are under pressure.

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* Ling, S.D., C.R. Johnson, S.D. Frusher, and K.R. Ridgway. 2009. Overfishing reduces resilience of kelp beds to climate-driven catastrophic phase shift. PNAS. www.pnas.org_cgi_doi_10.1073_pnas.0907529106

Carr: There were three key issues relating to how we interacted with First Nations. First, there were big differences in different regions as we went along the coastline, with tribal issues and participation becoming much more important as we moved north. An important lesson is that embarking on these policies can have bigger ramifications than you anticipate. Second, we had never really discussed First Nations participating in managing marine resources, so it became very contentious and California had to really re-think their understanding of the relationships and recognition of the First Nations role. Third, this resulted in a huge effort to try to engage that sector, especially in the north. The Blue Ribbon task force, a group of very politically savvy individuals that included a First Nations representative who was added as we got to the north coast, played a key role.

Steinback: There was another aspect that was difficult, as it was a heavily data-driven process and there were cultural sensitivities around that which presented challenges, in terms of how to protect that information. It was somewhat like playing Battleship at first. But the tribes are now playing a leading role in monitoring MPAs and developing resources to generate information, including information to inform their own management.

Break

Cameron: On the question of gathering and organizing existing data that was raised earlier, there is a lot of spatial/temporal variability in Queensland fisheries. There were a lot of discussions and questions about what time period best represented the respective fisheries and different perspectives on how far back utilized data should go. This highlights the importance of starting to use the data that is available and doing that in consultation with the fishery, including fishers and managers.

Carr: I should add one note of caution on how to evaluate the success of the tool used. MarineMap gave participants an excellent way to achieve the guidelines. But they didn't meet the guidelines in many cases and partly that was because the process said you didn't really need to do so. With the bioeconomic model, unlike the theme for this forum, it was not about how to balance the two sides. It was all about biodiversity conservation and fisheries were a very secondary consideration. In California, it was used to evaluate the performance of the proposals generated by the guidelines. But for BC, you might start using the bioeconomic model from the start, not just to evaluate proposals.

Steinback: An important consideration is getting politically acceptable outcomes and you can't build that into decision-support tools. So the reality is that at the end, there will still be some political decisions that have to happen.

Darling asked for comments on how training needs were addressed.

Steinback: In California, training was a fulltime job. There was a lot of upfront training, but providing incentives to use the tools was also important.

Day: In Australia, the process was most important, not the tool. It was about having operating principles and a clear hierarchy of objectives. In Australia, it wasn't primarily about fishery management either.

Cameron: A zoning approach with strong community engagement offering a spectrum of access was important. We also used Marxan for post hoc accounting and auditing. Some communities comprising a range of community sectors and views came together to develop joint proposals. That collaboration helped them get close to what they asked for in terms of the placement of the network of no-take reserves and other zones in their adjacent waters. Another issue that is continually raised even now is the question of rotational closures. Short-term closures to fishing won't optimize the benefits to biodiversity conservation and reduces potential ecosystem resilience. In one 1990s experiment in the Great Barrier Reef, a reef was closed for nearly four years to rebuild fish populations and then re-opened to fishing. It resulted in a gold rush fishing mentality, with the estimated population of 20,000 adult coral trout reduced to 8,000 in less than six weeks by commercial and recreational hook and line fishing. In the GBR, rotational closures are used in other zones, outside the network of no-take areas where fishing can occur, for fisheries management purposes.

Ban: My sense in BC is that the reluctance to establish MPAs relates to how stock assessment is generally done here (species-specific rather than spatial). Has fisheries management changed since rezoning?

Carr: With the protected areas in place in California, managers are thinking about their use for stock assessment. We're looking at the data we generate from monitoring MPAs, adapting our models and looking at ratios of species abundance inside/outside. This relates to questions about the role of MPAs, whether in a poor, medium or well-managed fishery. Depending on your needs for accuracy and precision, this could be a very cost-effective way to do it.

Cameron: I work for the GBR Marine Park Authority but I also work closely with Fisheries Queensland, which is the State Government agency responsible for fisheries management. Unfortunately, many nearshore species have no or poor stock assessments undertaken on them. For coral trout, we now have estimates for the biomass inside and outside the no-take zones. The Total Allowable Commercial Catch quota for coral trout has recently been reduced because catch rates were less than what the commercial fishery wants. The objective of this TACC reduction is to increase available fished stock leading to increased catch rates.

Ban: The choice of tools relates to process and goals. But it is useful to learn from the lessons of others to avoid repeating mistakes. What about questions around the public process and the animosity that later subsides and the issue of compensation.

Day: We made some mistakes at the start. For example, public meetings are not a good way to engage, so we moved to community information sessions. It was more labour-intensive and required a lot of resources but it's a better way to share information. We invited people to walk in and talk one-on-one or in small groups with expert staff. We also had to learn how to deal with 31,000 submissions and show how all were considered in the final plan. We also learned how to frame questions in the questionnaire – i.e. not open-ended.

Darling: In BC, there has been a tendency to invite reps from stakeholder groups.

Day: We also had people engaging with expert stakeholder groups representing tourism, fishing and water quality. There is no one tool or one-size-fits-all solution.

Cameron: We had to prepare our own internal structure for engagement. We developed a specialized database for the submissions, many of which included GPS/spatial data. So it required 50 to 60 people working for very intensive periods. I would have liked to have some commercial fishermen working on staff to share their expertise during this process. We also used community champions, such as Australian Aboriginal Olympic Gold Medalist, Cathy Freeman and other local community leaders.

Carr: Ray Hilborn made the point that during the first round for the MLPA process, we got the scientists to design the first draft, and they literally got run out of town. So next we went to the opposite end of the continuum and tried to get everyone involved, which was logistically very difficult. So the stakeholder engagement process that worked best was the third round, which worked well. It was an unprecedented engagement process for California.

Steinback: Public engagement was a high priority. It opened a conversation and having MarineMap changed the dynamics of that conversation. It showed right away when proposals were not meeting the guidelines and what they needed to do to resolve that instead of having the scientists take it away for a month and then reject it. In the first few regions we worked very closely with the fishing community but they got steamrolled by the well-resourced conservation community. We learned that the needs changed from region to region. In one part, the commercial and recreational sectors worked it out together port by port. It was very rewarding. All the engagement is critical to creating trust – and it's all about trust. The tools provided transparency to start building trust, and then when it showed how we were including their data, they began to trust the process.

Conclusions

Cameron: In the development of the 2004 GBR rezoning there was no structural adjustment policy in place for the whole process, and trying to engage in an environment where you couldn't talk such matters about it made it very difficult for stakeholders and staff. The advice is to start talking about it early as part of the MPA process, as it will ultimately save government money, facilitate the process and make it more likely to achieve the MPA objectives. As concluded by Macintosh et al. (2010)[*], the financial quantum spent of the GBR Structural Adjustment Package (about $250 million) was an enormous and disproportionate sum to provide to mitigate the impacts of an MPA program that had

[*] Macintosh, A., T. Bonyhady, and D. Wilkinson. 2010. Dealing with interests displaced by marine protected areas: A case study on the Great Barrier Reef Marine Park Structural Adjustment Package. Ocean & Coastal Management 53(9): 581-588.

only relatively minor impacts on the financial interests of the commercial and recreational fishing sectors.

Day: To put the costs of planning and compensation in context, the GBR generates in excess of $5 billion a year for the Australian economy. The MPA network is not intended to be set in stone forever, but it is intended to be long term. Things are changing as we speak, e.g. external pressures and climate change, so we will have to review it again at some point. Others have adapted our planning process and used it elsewhere and improved it – e.g. using online feedback forms.

Cameron: Key aspects were the bioregionalization map and the operational principles – you can call them tools as well. But the map was a pivotal start to get everyone to agree that we wanted to cover all of the habitats in the GBR. Long-term monitoring of socioeconomic effects are also important. Anything you can do in developing that kind of information in the early stages, such as socioeconomic data for local communities, would be very valuable.

Carr: Essentially it's a three-step process. You have to decide how to structure the planning process. That determines what tools you need. The third step is to ensure you have the data, expert support and resources to run those tools.

Ban: Tools are just that and others exist that haven't been discussed. Much of the emphasis has been on commercial fisheries but some of the non-use values are also very important, including cultural values. Sometimes those get forgotten and they are very important to integrate.

Steinback: You need to be able to quantify objectives or else you may start building tools that are solutions looking for problems. The choice of tools is also shaped by how people are going to interact and how you are going to evaluate and measure proposals.

Q&A Session

- Hilborn: In the GBR, only 3 percent difference was found between benthos in trawled and un-trawled areas, so was the $200 million worth it?
    - Cameron: I don't think the $250 million payout was well spent.
- Heppell: How do you ensure all participants have adequate access and address training to ensure equal access?
    - Steinback: It takes time and money. California provided additional resources to ensure the fishing community was on a level playing field with others. You need to think carefully about process design and about going to where people are.
- Gislalon: BC does not have a VMS requirement. How important was that information to the design and assessment of impacts?
    - Cameron: VMS has been mandatory in several commercial fisheries since the early 2000s. Efforts are now underway to engage with industry about expanding that to all other commercial fisheries. There are the usual concerns regarding costs and privacy. However, without that finer-scale VMS data, the GBR zoning would not have been able

to avoid impacting on key fishing grounds to the extent that was achieved. The data was also very important for demonstrating to fishers and decision makers how the no-take network proposed, while satisfy biological operational principles, was also having the least impact on fisheries as possible.

- Linda Nowlan: How important were the laws requiring MPA network formation in each case study, and what advice do you have for BC about laws with mandates, timelines, objectives, public participation requirements, etc? (Law is a tool)
    - Carr: The MPLA Act was passed in 1999 and that gave the state a mandate so people knew that something was going to happen. Some stakeholders initially spent a lot of time trying to derail it rather than participating in the process and they paid for that. So once it moved to the next region, they knew it was important to get involved. It happened under Governor Schwarzenegger and was a key part of his legacy, so it was understood that it had to be completed under his term in office and it was a big rush towards the end. Political context is important to participation.
    - Day: For the GBR, every zone has a clear legal objective. So we had the higher-level objectives for zoning and an overarching objective of public participation. But you can't put everything in the law, for example, things like local-level guidelines and timelines.
    - Steinback: Timelines weren't in the California legislation, but once it started, there was a timeline set and it was important to stay on track. It was like a business, with clear objectives and timelines and resources – and that helped to get it accomplished.
- Geoff Krause: Considering the non-geographical components of an idealized MPA network and referencing the data collection, monitoring, coordination, assessment and synthesis of knowledge, etc. comment please on appropriate contributions and responsibilities of fishing and industry stakeholders, First Nations, governments, etc. Please give some attention to resourcing levels and sources.
    - Carr: You should engage all those groups collaboratively to do the evaluation. Everyone has something to contribute to high-quality monitoring and evaluation, and to the collective design of a monitoring and evaluation program.
    - Steinback: You should be doing that even as part of the initial design phase. California has been asking industry about monitoring now and they're burned out. It's not clear what's going to be done about monitoring, how that informs management, and what will happen in the future, so that has caused some confusion.
    - Day: We went out of our way to engage every possible group, some better than others, and so there are lessons learned. We learned there was a huge amount of data in people's heads, so bring that in as much as you can. Now we have citizen science programs to engage people to help monitor. Everyone contributed, although it was mainly government-collated data.
    - Cameron: There is a Government deregulation agenda currently in Australia. In the GBR we are working with stakeholders on improving stewardship (volunteers and reef guardians) so that's something that is evolving.

- Q: Could you have the opposite of compensation, with sectors paying for lost ecosystem services?
    - Cameron: I haven't thought much about it.
    - Day: There is some user pays, such as fees collected by tourist operators, and I think there will be other applications of user pays in future.
- Q: When you assigned different experts to deal with different groups, how did you avoid creating different expectations or other inconsistencies?
    - Day: The experts worked as part of a team, so there was a common mission and message, although it was recognized that you may have to convey it differently for different groups. But it was critically important to have different experts who were knowledgeable working with each group.
    - Cameron: Though I was primarily involved in consultations with the commercial fishing sector, I also joined colleagues at the broader community information sessions and meetings to understand what was being said and communicated by the community and my work colleagues. There was also a communications team, which provided strategies and templates and kept us all up to date.
    - Day: One useful tool was a fact sheet to address common misconceptions.
    - Steinback: It was also important to understand who you were talking to and to understand who were the group leaders, networks and hubs.

Roundtable members were thanked for their contributions.

Closing remarks: Final thoughts

Presenters: *Ray Hilborn and Anne Salomon*.

Hilborn: Threats to marine ecosystems include ocean warming, exotic species, illegal fishing, acidification, pollutants, and over-fishing. MPAs will only solve the last one; they won't solve the major threats to oceans.

Salomon: MPAs are one of many tools. They should be considered in the context of total ocean protection, the Canadian constitution and portfolio strategies. We also can't discuss it without considering First Nations rights, and costs.

Hilborn: It will cost four times as much as the Cohen Commission.

Salomon: But how much will it cost if current management fails?

Hilborn: So for BC, an important question is what is the best allocation of scarce resources?

Salomon: We need to learn from Buzz Holling, be more humble and admit our ignorance. We can learn from models but we need to admit when we don't know (e.g. complex food webs). Given that uncertainty exists and surprises are certain, MPAs can provide learning opportunities, for example on

the indirect effects of fishing, as we are now in a "no analogue" situation. With the changes happening around us, we are going to have to change too. We need to experiment and we don't know if the benefits will outweigh the costs but we have to try.

We've also discussed that the objectives need to reflect use and non-use values. It's not just about protein and profit; for example, predators also have needs. BC has large invertebrate and algal diversity. There are different perceptions of what constitutes good management. It's uncomfortable but we need to also recognize the other perspectives. Marine spatial planning can help meet diverse and sometimes conflicting objectives, sometimes in different spaces. But it's not the only approach.

Hilborn: Advice on next steps in MPA design includes not trying to do the whole coast as one unit. So decentralize and define the relevant objectives for each region. Assemble the existing data, start at the front with a modeling team, generate dynamic models to sharpen the hypotheses and start working on designs to explore tradeoffs between competing objectives. You don't need size and spacing guidelines up front; the model helps to determine that. Use models to find starting points near the frontier that reflects the best balance of tradeoffs between conservation and economic values.

Salomon: In terms of next steps, there is utility in nearshore protected areas and experimenting with MPAs in conjunction with fisheries management policies like Territorial User Rights for Fishing where access rights to fish are designated in space.

Hilborn: While doing that, look at recreational-only reserves at the same time.

A big question is who makes the big decision. Regionally, you might need a board that represents all the stakeholders. Politicians probably don't want to do that, so there is no easy answer.

Research needs include spatial information on fish populations, trophic interactions and fisheries, but that should not stall you moving forward

In evaluating performance, consider biological effects, economic losses and benefits and social issues, including perceptions of fairness.

Next steps

McIsaac summed up the next steps, noting the weekend workshop would allow cross-pollination between the participants and development of a draft summary that captures key themes, including the science issues to address. We're hoping to develop advice for both sectors that captures the spirit and outcomes of this forum and to explore other opportunities for future collaboration, he added.

The workshop objectives were as follows:

1. To review and assess Forum outcomes with the Steering Committee – examining the need for, clarification, refinement or further development

2. To identify and explore key science issues drawing on Steering Committee knowledge of the BC context, and discuss approaches to meeting the forum goal
3. To consolidate collective guidance on international research and applicability to Canada's Pacific coast
4. To explore opportunities for future collaboration.

Acknowledgements

Noting that it had been a very interesting few days, Jessen thanked the keynote presenters for their thoughts and collaborative approach. She also thanked the roundtable members for their provocative and interesting discussions. Although it was impossible to touch on every issue in a couple days, it has been inspiring, with lots of food for thought. This venue is a special place and it has been great to work with the support staff, including the volunteers who helped with registration and greeting. Jessen thanked Darling for guiding this process over the past few years and for designing the great discussion format. She also thanked the Steering Committee members, noting it had been a team effort, an amazing journey and one that would continue. She also thanked volunteer notetakers, Eric Angel and Jenn Burt, and the CPAWS BC team, Rhona Govender and Alexandra Barron, for their invaluable help and logistical support. Finally, she also thanked all participants.

Appendix 1: Presentations

Appendix 2: Bios for Keynote Speakers, Roundtable Experts and Steering Committee Members

Keynote Speaker Bios

Ray Hilborn, University of Washington, School of Aquatic and Fishery Sciences

Ray Hilborn is a Professor in the School of Aquatic and Fishery Sciences, University of Washington specializing in natural resource management and conservation. He teaches graduate and undergraduate courses in conservation, quantitative population dynamics and risk analysis. He co-authored "Quantitative Fisheries Stock Assessment" with Carl Walters in 1992, and "The Ecological Detective: Confronting Models with Data" with Marc Mangel, in 1997 and has published over 200 peer reviewed articles. He serves on the Editorial Boards of 7 journals including the Board of Reviewing Editors of Science Magazine. He has been a member of the Ocean Studies Board of the National Research Council, and the Scientific Advisory Panel for the Presidents Commission on Ocean Policy and the Independent Science Advisory Panel for the Commission for the Conservation of Southern Bluefin Tuna. He has received the Volvo Environmental Prize, the American Fisheries Societies Award of Excellence, and the American Institute of Fisheries Research Biologists Outstanding Achievement Award. He is a Fellow of the Washington Academy of Sciences, the Royal Society of Canada and the American Academy of Arts and Sciences.

http://fish.washington.edu/people/rayh/

Anne Salomon, Simon Fraser University, School of Resource and Environmental Management

Anne Salomon seeks to advance our understanding of how human disturbances alter the productivity, biodiversity and resilience of coastal marine ecosystems to inform ecosystem approaches to marine conservation. Broadly, Anne is interested in the cascading effects of predator depletion on marine food webs, marine reserve design and evaluation, climate change impacts on coastal ocean ecosystems, alternative state dynamics, and the resilience of social-ecological systems. Ultimately, Anne strives to engage coastal communities and government agencies in collaborative research and encourage constructive dialogue among stakeholders to navigate the tradeoffs between coastal conservation and resource use.

Understanding the dynamics of coastal ecosystems at the temporal and spatial scales germane to conservation and management necessitates a combination of approaches. Consequently, Dr. Salomon and her students complement their field-based research with stable isotope analyses, ecosystem modeling, historical ecology, archaeology, traditional knowledge, satellite remote sensing, and the quantitative techniques required to draw these multiple lines of evidence together.

http://www.rem.sfu.ca/people/faculty/salomon/

Roundtable Member Bios

Eddie Allison, University of Washington, School of Marine and Environmental Affairs

Eddie Allison's research centers on the human connection to natural resources. He focuses on the contribution of fisheries and aquaculture to food and nutrition security and to coastal livelihoods, on governance of small-scale fisheries and aquaculture production and the human rights of fisherfolk, and on the vulnerability and adaptation to climate change of people dependent on marine and freshwater resources. His work spans the globe, holding past positions in the field of fisheries and aquaculture management and development in sub-Saharan Africa, Asia, Oceania, Latin America and Europe, as researcher or technical and policy advisor for various international organizations. He has held faculty appointments at the University of East Anglia, and was recently the director of Policy, Economics, and Social Science at the WorldFish Center in Malaysia prior to coming to the School of Marine and Environmental Affairs.

http://coenv.washington.edu/faculty/edward-allison/

Natalie Ban, University of Victoria, Environmental Studies

Dr Natalie Ban and her students pursue applied research that merges the needs of human communities with those of marine ecosystems. She joined the University of Victoria's School of Environmental Studies as an assistant professor in January 2013. Prior to joining UVic, Natalie spent four years in tropical north Queensland as a research fellow at James Cook University, Australia, researching marine conservation planning approaches in Australia, Melanesia, the high seas, while remaining engaged in her home country of Canada. She obtained her undergraduate and master's degrees in geography and environmental studies from McGill University, worked for several years in marine conservation in BC, and then completed her PhD in resource management and environmental studies at the UBC Fisheries Centre. Her PhD research explored marine conservation issues on British Columbia's coast, including combining traditional ecological knowledge and biodiversity hotspot assessments to identify priorities for marine conservation. In general, Dr Ban's research investigates the needs of biodiversity and human communities – and potential trade-offs or win-win scenarios – in conservation of marine ecosystems, especially marine protected areas, through an ethno ecological lens.

http://www.uvic.ca/socialsciences/environmental/people/faculty/bannatalie.php

Jim Boutillier, Fisheries and Oceans Canada (Emeritus)

Jim Boutillier is retired from DFO where he held a number of positions including Marine Ecosystem Research Coordinator, Section Head Invertebrate and Marine Mammal Stock Assessments, Division Head of Aquaculture, Research coordinator and research assessment biologist during his 38+ years at the Pacific Biological Station. Specific emphasis in his career has been on the development of the assessment and management frameworks that insure the conservation of exploited resources. This can vary from geo-spatial analysis of fishery independent trawl and trap surveys and fishery dependent fishing logbook records to set fixed exploitation levels in the shrimp trawl fisheries to development of at-sea assessment protocols to insure fixed escapement levels for females shrimp in the Prawn trap

fisheries. . Recent research has been focused on the development and application of an ecosystem risk assessments framework for the Pacific region of Canada region and a framework for Pacific Marine Ecosystem Classification System.

http://www.researchgate.net/profile/James_Boutillier

Darren Cameron, Great Barrier Reef Marine Park Authority

Darren Cameron is currently the Manager of Sustainable Fishing with the Great Barrier Reef Marine Park Authority (GBRMPA). Darren has 30 years' experience in fisheries and marine protected area (MPA) science and management, mainly in Australia, but has also worked extensively throughout the Western and Central Pacific region. His skills and experience relating to multiple-use MPA management and fisheries is mostly associated with the 2004 re-zoning of the Great Barrier Reef (GBR) Marine Park. Darren has extensive experience utilizing MPA zoning tools in the GBR including acquiring and responsibly using fisheries data to achieve a balance between conservation and fisheries objectives. In the GBR rezoning process over a four-year period, Darren worked directly with commercial and recreational fishers and their peak body representatives, conducting many informal and formal meetings. He was actively involved in all internal agency decisions on no-take area zoning placement, actively briefed Federal Members of Parliament and Ministers and negotiated key compromises with fishing industry leaders. A decade later he is actively involved in the continued implementation of the GBR Zoning Plan and proactive fisheries management in the GBR. In the last two years Darren has also worked with both the Brazilian and Ecuadorian Governments assessing and providing advice on MPA design and implementation, incorporating fisheries management considerations.

http://www.researchgate.net/profile/Darren_Cameron

Mark Carr, University of California Santa Cruz, Ecology & Evolutionary Biology

Dr. Mark Carr is a professor of marine ecology in the Department of Ecology and Evolutionary Biology at the University of California, Santa Cruz. His research focuses on the ecology of coastal marine fishes and coastal marine ecosystems and informs a variety of topics in marine conservation and fisheries management, including the design and evaluation of marine protected areas (MPAs). For eight years, Mark served as Co-chair of the Science Advisory Team to California's Marine Life Protection Act, which culminated in the establishment of a network of marine protected areas the length of the coast of California. Mark is now the Co-chair of the Science Advisory Team to California's Ocean Protection Council and a member of the U.S. Marine Protected Areas Federal Advisory Committee. He is a founding principal investigator with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), a consortium of West Coast universities that conducts research on the nearshore marine ecosystems, funded by the David and Lucile Packard Foundation. Learn more about Mark and his graduate student's research at:

http://www.research.pbsci.ucsc.edu/eeb/rclab/

Ratana Chuenpagdee, Memorial University, Department of Geography

Ratana Chuenpagdee is Canada Research Chair in Natural Resource Sustainability and Community Development and Professor of Geography at Memorial University of Newfoundland, St. John's, Canada. She conducts interdisciplinary research on topics related to small-scale fisheries, coastal and ocean governance, coastal sustainability, and science-policy integration. Ratana is currently leading a major global research partnership initiative, Too Big To Ignore, which aims at elevating the profile of small-scale fisheries and rectifying their marginalization in national and international policies through the development of global information system, comparative case studies, and building of transdisciplinary research and governance capacity at all levels.

http://www.mun.ca/geog/people/faculty/rchuenpagdee.php

Sean Cox, Simon Fraser University, Fisheries Science and Management

Sean Cox is a fisheries scientist focusing on stock assessment and management strategies for large-scale commercial fisheries. His research develops quantitative fisheries stock assessment methods and simulation approaches to addressing issues in fisheries management such as (i) design and evaluation of management procedures for commercial groundfish, herring, and salmon fisheries; (ii) evaluating impacts of bottom-fishing gear on benthic marine ecosystems; and (iii) the role of spatial processes in fish population dynamics, fisheries, and monitoring programs.

http://www.rem.sfu.ca/people/faculty/seancox/

Jon Day, James Cook University

Jon Day has 39 years of professional experience as a protected area planner and manager, 28 years of which were in the Great Barrier Reef (GBR) Marine Park. Prior to joining GBRMPA, Jon worked eleven years in terrestrial protected areas. As one of the GBRMPA Directors from 1998-2014, Jon had responsibility for a range of GBR matters including conservation and biodiversity, planning, World Heritage, other heritage matters, Indigenous Partnerships, and the Outlook Report; his last position before retiring was Director for Heritage Conservation. Between 1998-2003, Jon was responsible for commencing and coordinating the Representative Areas Program (RAP), the major rezoning program undertaken for the entire GBR. The systematic marine planning approach developed during RAP is widely considered as 'best practice' and received 14 international and national awards. For his efforts with RAP, Jon received an Australian Public Service Medal and a Smithsonian-Queensland Fellowship. Jon has had a long association with World Heritage matters and was part of Australia's delegation on the WH Committee between 2008-11. Jon has over 40 peer-reviewed publications, including primary author of 10 chapters or books, and is currently a PhD student at ARC Centre of Excellence for Coral Reef Studies at James Cook University in Townsville.

https://scholar.google.com.au/citations?user=cu3rw-wAAAAJ&hl=en

Graham Edgar, University of Tasmania, Institute for Marine and Antarctic Studies

Professor Graham Edgar is a marine ecologist at the University of Tasmania. He is one of only three scientists to receive the most prestigious Australian awards for both environmental science (Eureka Prize 2014) and marine science (AMSA Silver Jubilee Award 2011). He was also the recipient of a Fulbright Tasmania Scholarship in 2010. This scholarship is awarded to an applicant to undertake research in the United States on a topic or issue of importance to the Tasmanian state. Through his Fulbright, Graham researched the effectiveness of marine protected areas as a tool for biodiversity conservation at the Centre for Applied Biodiversity Science, Conservation International in Arlington, Virginia. Graham has a PhD and an honours degree in marine biology from the University of Tasmania, and a BSc from the University of Sydney. He is President of Reef Life Survey Foundation, a charitable NGO that aims to improve biodiversity conservation and the sustainable management of marine resources by coordinating surveys of rocky and coral reefs using scientific methods, with the ultimate goal to improve coastal stewardship.

https://theconversation.com/profiles/graham-edgar-115704

Gordon Gislason, GSGislason & Associates Ltd. Vancouver Canada

Gordon Gislason is an economist and statistician with 40 years experience in analyzing fisheries and resource issues - he has analyzed fisheries in every province and every territory of Canada. His socio-economic impact work includes: 1) the socio-economic impacts of an MPA in the Arctic to protect beluga whales, 2) socio-economic impacts of alternative Fraser River sockeye management scenarios, 3) socio-economic impacts of catch shares management for commercial fisheries, 4) socio-economic impacts of the SARA listing of several fish species, and 5) socio-economic impacts of bycatch management in fisheries. He also has conducted several environmental economics projects including the human health benefits from reducing air pollution, the compliance costs for more stringent water quality guidelines for placer mining in Yukon, and fisheries benefits from reduced phosphorus loading in lake systems. Gordon is an invited speaker to fisheries conferences around the world having delivered papers to events in Australia, Japan, France, Germany, Iceland as well as the US and Canada.

Selina Heppell, Oregon State University, Fisheries and Wildlife

Selina Heppell is a marine fisheries ecologist and Interim Head of the Department of Fisheries and Wildlife at Oregon State University. Her research is focused on the population dynamics of long-lived marine vertebrates and how they respond to perturbations. Dr. Heppell has worked with fishermen, agency scientists, and policy makers on a variety of issues related to MPAs and alternative methods for stock assessment and management. She led a review of MPA design criteria for the state of Oregon and was head of the Ecosystem-based Management Subcommittee for the Science and Statistical Committee of the Pacific Fisheries Management Council. Dr. Heppell helps diverse working groups communicate and identify pragmatic approaches to marine conservation and fisheries management, focusing on what works as much as what's "best".

http://oregonstate.edu/heppell/heppell.html

Nadine Marshall, Commonwealth Scientific and Industrial Research Organisation

Nadine Marshall's research interests centre on understanding how social and ecological systems are resilient to change and how strategies might be developed for sustainability. These interests are addressed through understanding "resource dependency", the linkages between people and the environment as well as through operationalizing concepts such as adaptive capacity and vulnerability. She works with primary industries and communities within Australia and the Middle East. These include: commercial fishing, marine-based tourism, traditional owners, cattle grazing, farming, shipping, ports, and coastal communities. Dr. Marshall spent eight years in research at the Reef Cooperative Research Centre (CRC) based at James Cook University, Townsville, Queensland, Australia. She worked mostly with the trawl industry, line fishery, net fishery, crab fishery, marine tourism industry, charter fisheries and harvest fisheries. She has also recently worked as a consultant for the International Union for Conservation of Nature (IUCN) through the provision of social data for the establishment of marine protected areas in the Mediterranean.

https://scholar.google.ca/citations?user=obK6DLAAAAAJ&hl=en

Kerrie O'Donnell, Ecotrust Canada

Dr. Kerrie O'Donnell is interested in incorporating local knowledge into fisheries and conservation solutions. Since 2011, Kerrie has been the Fisheries Research Coordinator for Ecotrust Canada, though she is currently on leave. She has provided scientific and technical advice on many fisheries projects while with Ecotrust and collaborated with TBuck Suzuki to understand the full suite of values that fisheries on the North Coast of British Columbia bring to their communities http://ecotrust.ca/report/understanding-values-canadas-north-pacific/. Prior to working with Ecotrust, Kerrie completed her PhD in Zoology at the University of British Columbia Fisheries Centre. Her PhD research explored pragmatic approaches to understanding small-scale, data-poor fisheries in the Philippines, including combining fisher knowledge and spatial behaviour with fish population dynamics modelling to identify areas needing protection. Before beginning her PhD, she worked for several years on different collaborative research projects with commercial cod and lobster fishermen back home on the East Coast of the United States. Kerrie earned her BA in Environmental Studies from Brown University in 2002.

Ellen Pikitch, Stony Brook University, School of Marine and Atmospheric Sciences

Professor Ellen Pikitch's research focuses on fish conservation and fisheries sustainability, with emphases on ecosystem-based fishery management and endangered fishes. Her contributions to advancing ocean conservation range from basic science innovations to achieving domestic and international policy change. Ecosystem-based fishery management is a holistic approach that emphasizes the integrity of marine ecosystems and the interconnectedness of species and habitats. She spearheaded the first scientific consensus on ecosystem-based fishery management, which was published in the journal Science in 2004. More recently, Dr. Pikitch chaired the Lenfest Forage Fish Task Force, an international team of 13 preeminent scientists whose mission was to develop consensus recommendations for forage fish management that recognized the critical role these species play in marine ecosystems. The task force conducted the most comprehensive global analysis of forage fish

management to date, and successfully achieved its charge, releasing its report in April 2012. In less than a year's time, the report, "Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs," began influencing policy decisions, both nationally and internationally, about forage fish management, including California's ecosystem-based forage fishery policy adopted in November 2012. She has led several major oceanic field expeditions and served on many high-level scientific panels, including President Clinton's Panel on Ocean Exploration, the Task Force on Environmental Sustainability commissioned by U.N. Secretary-General Kofi Annan, and several committees of the National Academy of Sciences. Currently she is serving on the Ecological Society of America's rapid response team, on the Seafood Watch Science Advisory Board, as well as the International Advisory Board of WildAid.

http://somas.stonybrook.edu/people/pikitch.html

Evelyn Pinkerton, Simon Fraser University, School of Resource and Environmental management

Dr. Pinkerton is a maritime anthropologist who has integrated common property theory and cultural/political ecology in considering the role communities play in the management of adjacent renewable natural resources. She has played a key role in developing the theory and practice of power-sharing and stewardship through co-management agreements. Beginning with the introduction to her 1989 edited volume Cooperative Management of Local Fisheries (UBC Press), she has been generating middle-range theoretical propositions about the conditions under which co-management is likely to arise and to endure. She has published over 40 peer-reviewed articles on fisheries and forestry co-management arrangements, and in Fisheries that Work (1995, co-authored with Martin Weinstein), began to develop a more comprehensive framework for analyzing and comparing co-management arrangements. This work has since evolved into analysis of the developmental sequence of types of co-management rights and activities.

http://www.rem.sfu.ca/people/faculty/pinkerton/

Jake Rice, Fisheries and Oceans Canada (Emeritus)

Over the years Jake Rice has participated in research on marine and terrestrial community structure and function, analytical methods for addressing uncertainty in ecological data, objective methods for selecting indicators and reference points for use in management, size- and species- based approaches to modeling community and ecosystem dynamics, species habitat relationships, and population based vs. place-based approaches to management. Recently his work has focused on practical aspects of implementing an ecosystem approach to management, methods for integrated ecosystem assessments, and particularly the interfaces between science and policy and between natural and social sciences

http://www.meds-sdmm.dfo-mpo.gc.ca/sdb-bds/profileprofil.do?id=260&lang=eng

George Rose, Memorial University and Marine Institute

Dr. George Rose has worked in the Newfoundland and Labrador fisheries for over 30 years. Dr. Rose was the Natural Sciences and Engineering Research Council of Canada chair of Fisheries Conservation at the Marine Institute prior to becoming director of the Centre for Fisheries Ecosystems Research (CFER). He

obtained a PhD from McGill University focusing on the Labrador fisheries, an MSc from Laurentian University and BSc in fisheries management from the University of Guelph. He has worked for provincial, federal and international fisheries organizations and extensively in East Africa. Dr. Rose has published more than 125 scientific papers primarily on the North Atlantic fisheries, many popular articles and an award-winning book on the Newfoundland and Labrador fisheries ecosystems. He was a contributor to the Nobel Prize winning International Panel on Climate Change report in 2007 and is currently Editor-in-Chief of the international journal Fisheries Research.

http://fishcons.mi.mun.ca/people.html

Rashid Sumaila, University of British Columbia, Fisheries Centre

Dr. Rashid Sumaila is Professor and Director of the Fisheries Economics and Management, UBC Fisheries Centre. He specializes in bioeconomics, marine ecosystem valuation and the analysis of global issues such as fisheries subsidies, illegal fishing, climate change and oil spills. Sumaila has experience working in fisheries and natural resource projects in Norway, Canada and the North Atlantic region, Namibia and the Southern African region, Ghana and the West African region and Hong Kong and the South China Sea. He is widely published, with over 160 articles in peer-reviewed journals, including Science, Nature and the Journal of Environmental Economics and Management. Sumaila has won a number of awards such as the American Fisheries Society's 2013 Excellence in Public Outreach Award, the Leopold Leadership Fellowship (Stanford), and the Pew Fellowship for Marine Conservation. Sumaila's work has generated a great deal of interest, and has been appeared in, among others, the Economist, the Boston Globe, the International Herald Tribune and the Vancouver Sun.

http://www.fisheries.ubc.ca/faculty-staff/rashid-sumaila

Charles Steinback, Point 97

Over more than a decade, Charles Steinback has been pushing the frontier for ocean planning. With his help, community fisheries are shifting the power dynamics of industrialized fishing monopolies, influencing the designation of Marine Protected Areas (MPA), and safeguarding inshore fisheries through the use of mobile technology. His leadership has further contributed to the development of advance technology platforms that are uniting, informing, and inspiring decision-makers on a wide variety of coastal issues through the use of data and maps. As Co-Founder and Managing Director of Point 97 ("nine-seven") Charles has been been leading the transition from Ecotrust nonprofit, Marine Consulting Initiative, to for-purpose tech company with a mission of delivering technology solutions that drive marine resource dependent communities towards food and economic security. Charles was raised in the fishing community of Astoria, Oregon, is a graduate of the University of Massachusetts at Amherst and currently lives in Portland, Oregon.

http://pointnineseven.com/people/team

Trevor Ward, UTS, School of the Environment

Dr. Ward is a widely recognized and published marine systems ecologist—more than 140 technical publications in international journals, books and reports, including two university texts on ecolabelling in marine fisheries. His career includes more than 20 years with CSIRO, Australia's premier science organisation, and in 1996 he was jointly awarded the CSIRO Chairman's Medal for Excellence in Science. Dr. Ward specializes in the development and implementation of monitoring, evaluation and reporting (MER) systems for the natural resources and biodiversity of ocean and coastal ecosystems. He was lead marine author for Australia's national State of the Environment Report in 2011. His system designs focus on the vertical integration of global policies and best practices of ecological sustainability into local-level conservation, wealth generation and community development, as well as strategies for efficient and effective implementation. Recent areas of activity include strategic policy support and evaluation in ocean biodiversity and marine natural resources management; MER for management systems in fisheries, aquaculture, and coastal habitats and pollution; and design and delivery of vertically integrated assessment and certification systems. He has held many government advisory and board positions, including most recently as independent expert member of the Assessment Panel for the Australia's National Environmental Science Program.

https://www.uts.edu.au/staff/trevor.ward
https://scholar.google.com.au/citations?user=sevgECkAAAAJ&hl=en

J. Wilson White, University of North Carolina Wilmington

Dr. Will White is an Assistant Professor of Marine Biology at the University of North Carolina Wilmington. His research addresses the population dynamics of fish and invertebrates, including metapopulation dynamics within reserve networks and short-term population dynamics following reserve implementation, and he has published more than 45 articles on these topics in scientific journals. Dr. White served on the Science Advisory Team for the recent MPA network design process in California (under the Marine Life Protection Act), and he built population models that were used to guide that effort. He earned his PhD from the University of California Santa Barbara in 2007, and completed postdoctoral research at UC Davis before taking his current position.

http://uncw.edu/bio/faculty_white.html

Steering Committee Bios

Sabine Jessen, Canadian Parks and Wilderness Society (CPAWS)

Sabine has been involved with CPAWS since 1991 when she began four years of volunteer work, prior to becoming the first Executive Director of the BC chapter. In addition to her role as the National Director of the Oceans Program, she is also the Marine Conservation Director for the CPAWS British Columbia Chapter. Sabine brings a deep passion for protecting Canada's coastal and ocean ecosystems to these roles. Sabine holds a Masters Degree in Geography from the University of Waterloo, specializing in coastal zone management and environmental regulation. She has served as an Advisor to Fisheries and Oceans Canada, BC Parks, the British Columbia Commission on Resources and Environment, and the Economic Council of Canada. Sabine was an Adjunct Professor in the Resource and Environmental Management Program at Simon Fraser University (SFU) and in 2009, she began her PhD studies in the Department of Geography at SFU focused on 'political will' in the establishment of MPAs in Australia, Canada and New Zealand. Her contribution to coastal zone management in Canada was recognized in 2008 with the H.B. Nicholls award from the Coastal Zone Canada Association. She was awarded the Stan Rowe Home Place Graduate Award by the Canadian Council on Ecological Areas (CCEA) 2010, a Pacific Institute for Climate Solutions PhD fellowship in 2011, and an Australian Endeavour Research Fellowship in 2012. In addition to her love of the ocean, Sabine is an avid photographer and bird watcher, which she combines with her pursuit of outdoor activities including hiking and kayaking in wild places around the world.

Jim McIsaac, BC Commercial Fishing Caucus

Jim McIsaac is coordinator of the BC Commercial Fishing Caucus, a group from the BC fishing industry organizations including the Fishermen's Union, the Native Brotherhood, Area A Crab, the BC Longline Fishermen's Association, and 8 other fishing organizations, engaged in marine planning and MPA processes. Jim is involved in various marine planning and MPA processes including Pacific North Coast Integrated Management Area, the Marine Planning Partnership of the North Pacific, West Coast Aquatic Management Board, Gwaii Haanas National Marine Conservation Area, Sgaan Kinghlas Bowie Seamount MPA, Scott Island Marine National Wildlife Area proposal, and Hecate Strait Glass Sponge Reef Area of Interest. He is also the executive director of the T Buck Suzuki Foundation, a fisheries foundation created by fishermen to protect habitat, prevent pollution and promote sustainable fisheries.

Hussein Alidina, World Wildlife Fund Canada

Hussein has worked for WWF in various settings on projects spanning all three of Canada's Oceans - the Atlantic, Pacific and Arctic. He has provided conservation assessments and applied conservation science support for identifying priority marine conservation areas, assessing cumulative impacts of human activity and developing approaches for incorporating climate change in conservation planning. In his current role based out of Vancouver, Hussein supports the Pacific Region Program to advance marine conservation through tools such as Marine Protected Areas (MPAs), Marine Spatial Planning, Ecosystem Based Management, Fisheries Certification and Climate Adaptation. As a native of East Africa, Hussein has taken up periodic assignments there that have included running a community-based fisheries

program, engaging coastal fisheries management and policy and providing analysis for watershed planning. He is an Associate at CORDIO East Africa. Hussein holds a B.Sc. in Environmental & Resource Science, a Graduate Certificate in GIS Applications and an Interdisciplinary Master's degree in Marine Management.

Karin Bodtker, Living Oceans Society

Karin Bodtker, Director of Mapping and Analysis at Living Oceans Society, is on the steering committee for the forum and will liase with Roundtable 3 members. Karin, whose work currently focuses on marine spatial planning, has been using mapping (GIS) technology to analyze and illustrate marine conservation issues since 2007. Karin earned a Master's in Resource and Environmental Management from Simon Fraser University, specializing in ecological modeling, fisheries stock assessment, and developing conservation reference points for data-poor salmon stocks. Through her work at Living Oceans, Karin has been engaged in multiple initiatives linked to coastal zoning, MPA planning, and has served on several science advisory boards and committees. She also co-led a six-year collaborative project, the British Columbia Marine Conservation Analysis (BCMCA).

Christina Burridge, BC Seafood Alliance

Christina Burridge is the executive director of the BC Seafood Alliance and the steering committee liaison for round table two on the social and economic effects of MPAs on fisheries. If you have any questions about the roundtable, Christina will do her best to answer them. Christina has worked for various BC fishery associations since 1988, originally in marketing and now in policy. Most of her current work is with the BC Seafood Alliance, an umbrella organization whose members include almost all of the fisheries in BC and is committed to a sustainable, profitable sector. Christina has also had a long engagement with the Marine Stewardship Council and sits on one of its governance bodies, the Stakeholder Council, as well as chairing the international Association of Sustainable Fisheries, which represents fisheries in the MSC process. In between, Christina is a contributor to the food and drink pages of Vancouver Magazine—and hopes you all have the chance to try some of the wonderful seafood and wine (and maybe a craft beer or two) from BC over the course of our event.

Dan Edwards, BC Commercial Fishing Caucus

Dan Edwards is a third generation fishermen living in Ucluelet B.C. He fishes in partnership with his son on an integrated longline groundfish vessel. He is the executive director of the Area A Crab Association based in Prince Rupert B.C., and at 64 years old has been fishing for the last fifty years on small boats, troll, and longline vessels. Dan helped to negotiate the regional management board for the West Coast of Vancouver Island as the community representative. This involved four levels of government and 8 stakeholder groups working in a consensus to help manage aquatic resources under the enabling legislation of Canada's Oceans Act. Dan has also represented the dogfish hook and line association in negotiating the integrated ground fish fishery in B.C., which relies on transferable quotas between fleets, as well as full camera coverage for the hook and line fleet and 100% dockside monitoring. He is a member of the Commercial Fishing Caucus, originally formed to help include the fishing industry in the B.C. Marine Planning process through PNCIMA, and later on in the MaPP process. Dan has participated

in the process for designing RCAs (Rockfish Conservation Areas) in British Columbia, a strategy set up to help stabilize populations of inshore rockfish aggregates found in B.C. waters. The outcomes of this include dramatic decreases in TACs and inclusion of these species in the integrated rockfish process previously mentioned. The concern for rockfish in B.C. was the main driver for developing ground fish integration. He is on the board of the CFRN (Commercial Fishing Research Network), which is training several PhD and Masters students from across Canada in a variety of capture fisheries related projects through NSERC (Natural Science and Engineering Research Committee).

Appendix 3: Agenda

MPAs and Fisheries Science Forum

Agenda

April 8 4:30 pm – 9:00 pm
April 9 8:30 am – 4:30 pm
April 10 9:00 am – 4:30 pm

Forum Goal: To help inform the design of a Marine Protected Area (MPA) Network on Canada's Pacific coast that achieves both biodiversity conservation and healthy fisheries.

Objectives:

1. To advance our collective understanding of the science of MPAs and fisheries, consolidating knowledge and experience
2. To begin the process of reconciling scientific perspectives, exploring and narrowing differences on selected science issues
3. To assess the applicability of key findings and lessons learned elsewhere to guide MPA Network design in British Columbia

April 8

Time	Agenda Item	Location
4:30 – 6:00 pm	Meeting of ALL Roundtable members with Facilitator and Steering Committee (light dinner will be provided)	Room 420
6:30 pm	Registration	Atrium
7:00 pm	Welcome & Introductions	Asia Pacific Hall
	Keynote Presentation: Dr. Ray Hilborn, University of Washington and Dr. Anne Salomon, Simon Fraser University	Asia Pacific Hall
8:00 – 9.00 pm	Reception	Atrium

April 9 – Day 1

Time	Agenda Item	Location
8:30 am	Registration	Atrium
9:00 am	Welcome Review meeting format and agenda **Asia Pacific Hall**	Asia Pacific Hall
9:15 am	**Roundtable 1 – The Biological and Ecological Effects of MPAs on Fisheries** *Do spillover and larval export from MPAs provide a benefit to fisheries, and under what circumstances?* **Roundtable Members**: Dr. Sean Cox — Simon Fraser University Dr. Graham Edgar — University of Tasmania Dr. Selina Heppel — Oregon State University Dr. George Rose — Marine Institute & Memorial University Newfoundland Dr. Wilson White — University of North Carolina Wilmington	Asia Pacific Hall *Break in atrium
12:00 pm	Questions from Audience	Asia Pacific Hall
12:15 pm	Lunch	ICBC Concourse
1:30 pm	**Roundtable 2 – The Social and Economic Effects (the human dimensions) of MPAs on Fisheries** *What factors determine social and economic effects of MPAs on healthy fisheries?* **Roundtable Members**: Dr. Edward Allison — University of Washington Dr. Ratana Chuenpagdee — Memorial University Mr. Gordon Gislason — G.S. Gislason & Associates Dr. Nadine Marshall — Commonwealth Science & Industrial Research Org. Dr. Kerrie O'Donnell — Ecotrust Dr. Evelyn Pinkerton — Simon Fraser University Dr. Rashid Sumaila — University of British Columbia	Asia Pacific Hall *Break in atrium
4:15pm	Questions from Audience	Asia Pacific Hall
4:30 pm	Adjourn Day 1	Asia Pacific Hall

April 10 – Day 2

Time	Agenda Item	Location
9:00 am	Convene Day 2	Asia Pacific Hall
9:05 am	**Roundtable 3 – Integrating MPA Networks into Fisheries Management** *How can MPA networks and fisheries management be integrated and coordinated?* **Roundtable Members**: Dr. Jim Boutillier — Fisheries and Oceans Canada (Emeritus) Dr. Ellen Pikitch — Stony Brook University Dr. Jake Rice — Fisheries and Oceans Canada (Emeritus) Dr. Trevor Ward — University of Technology, Sidney	Asia Pacific Hall *Break in atrium
11:45 am	Questions from Audience	Asia Pacific Hall
12:00 pm	Lunch - **ICBC Concourse (downstairs from Asia Pacific Hall)**	ICBC Concourse
1:00 pm	**Roundtable 4 – Integration Tools** *What tools (e.g. bio---economic tools, models, and/or techniques) can be used to integrate biodiversity conservation and healthy fisheries for designing MPA networks, and how were they employed in two case studies – California and Australia?* **Roundtable Members:** Dr. Natalie Ban — University of Victoria Darren Cameron — Great Barrier Reef Marine Park Authority Dr. Mark Carr — University of Southern California, Santa Cruz Jon Day — James Cook University Charles Steinback — Point 97	Asia Pacific Hall *Break in Atrium
3:45 pm	Questions from Audience	Asia Pacific Hall
4:00 pm	**Closing Remarks** Keynote Speakers: Dr. Ray Hilborn and Dr. Anne Salomon Steering Committee Co-Leads: Sabine Jessen and Jim McIsaac	Asia Pacific Hall
4:30 pm	Adjourn Forum	Asia Pacific Hall