Australian Science Media Centre

BACKGROUND BRIEFING -
THE GREAT BARRIER REEF IN 2050

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TRANSCRIPT

Chair: Sheriden Morris
Welcome everybody here today. My name is Sheriden Morris from the Reef and Rainforest Research Centre. We are here today and we have an opportunity to actually look at some of the most up to date and contemporary issues with the Great Barrier Reef and look forward to the future of the Great Barrier Reef. We have speakers here today; world renowned speakers, some of the best reef researchers in Australian and around the world. I would like to thank FASTS for actually organising this opportunity for us to actually speak in Parliament House, to come and meet many of the ministers and the parliamentarians and this is a wonderful opportunity because it is being webcast around Australia, so it is a wonderful opportunity to actually raise these issues and look at some of the solutions for the Great Barrier Reef. I would also right now like to recognise the traditional owners to this area and I would like to welcome the Honourable Jan McLucas, Senator for Queensland and from Cairns, my home town, to come and actually open the forum – thanks Jan.

Hon. Jan McLucas
Thank you very much Sheriden and can I actually also acknowledge the traditional land owners of this country that we are meeting here today. Can I say that it is wonderful that we do this now, given what has occurred in the Parliament in the last couple of weeks. Welcome to this very important forum in charge of the Great Barrier Reef 2050 and I think beautifully named because as a person who lives in Far North Queensland, I need your Reef, I need the Reef to be there in 2050 and I think we all do. I welcome colleagues from the Parliament. We have been able to get some colleagues and staff from members and senators offices. The scientists who are here, welcome and I hope that this afternoon will be of benefit to us all.

It is an honour to represent Peter Garrett who is the Federal Minister for the Environment, who has unfortunately been called to a cabinet meeting, but I am somewhat pleased that he has, because it gives me an opportunity to play a role. Ken, thank you from FASTS for facilitating this important forum here today and whoever did the web casting, well done and that means that a lot of people around Australia have the opportunity to share some of this information that we will be presented with this afternoon.

It is an understatement to say that we in Far North Queensland and North Queensland value The Great Barrier Reef. The Reef is worth six billion dollars to our economy. It employs 63,000 people directly and who knows how many indirectly. It has enormous economic benefit to our region, but along with that it has enormous environmental benefit to our region and often the benefit that is understated or under said is the social value; the importance of the Reef to our way of life. I acknowledge the member for Herbert, Peter Lindsay, I'm glad you could get here.

We have a sense of ownership over The Great Barrier Reef in North Queensland, but can I say that I think that sense of ownership is shared by all Australians and increasingly, by people around the world. What will happen this afternoon, will progress the solution finding because our Reef is under threat. It is under threat from climate change. You all know that two degrees of warming in the water will devastate our Reef so we are looking at the FASTS community to participate in the solution finding, that we have to achieve. We know our Reef is under threat, particularly the inner Reef, from declining water quality and that is why I was so pleased when our Government announced $200 million to work with the farming communities, but in particular to ensure that the best quality water is going to the inner Reef lagoon. We also know that the Reef is under threat from increasing coastal population growth. There is work to do there to ensure that that growth in population does not impact on

the environmental values of The Great Barrier Reef. And can I commend The Great Barrier Reef Marine Park Authority, Russell Reichelt's here and that's great today for the work that they have done in terms of managing, particularly the uses of the Reef and in particular the fishing; the use of the Reef for fishing.

Today we are talking about solutions and that is another opportunity to share information that scientists have found about what we need to do to ensure the health and quality of our Great Barrier Reef and that is important for us in North Queensland. But can I also say that it is also important for all of the world, because reefs around the world are also under threat and a lot of what we are doing here in Australia is really leading the world in managing reef quality and vibrancy of the reef. So what you are doing as a science community for us in North Queensland are for Australia and can also be shared internationally, so I thank you for doing that and it is with great pleasure then that I declare this important forum open. Thank you.

Chair: Sheriden Morris
To actually kick the forum off; the presentation off, I would like to introduce Professor Ove Hoegh-Guldberg from Queensland University to talk about climate change and its impact on the future of The Great Barrier Reef.

Professor Ove Hoegh-Guldberg – The Queensland University
Thanks very much Sheridan. Well as the Honourable Senator has actually outlined, one of the biggest challenges of getting the Reef to 2050 is the issue of climate change and I am going to talk about that and my colleagues will follow up with a series of issues that relate to it. It is as important to consider the local factors because those are the ones that we can change while we try and get the mitigation issue under control. So let me do a bit of technological things here.

So really I think this graph is one of the most important graphs in our understanding of climate change and what it shows is the CO2 and temperature of the earth over the last 420,000 years, derived from ice core data. This is where you drill into the ice and you get signatures of that past atmosphere. And what it tells us immediately is that the earth has been rattling back and forth between two states. There has been cool periods, ice ages, with inter glacial periods. And of course you might then ask, "Well alright if it has been rattling around so much over the past probably couple of million years, what is the problem with today?" And of course it comes down to two issues and that is that we have this massive change in the rate of change and we are also into novel territory. We are now above where we were for the last several million years and CO2 levels have never been this high and we are heading up for extraordinary levels. And of course if you go and calculate these rates, they are extraordinary. You can do this yourself and you can download the data from the Bostock Ice Core; do a Google of course. You could calculate a rate of changed based on really over estimating the rate as it bounced around over that time and then compare it to what happened over the past 136 years. And what you see here is that the rates of change are several orders of magnitude higher than the fastest rate of change in the past. And of course you can see this visually and this is actually; I have had to fatten up the rate over the last several million years, but that is the rate that we are progressing at and that is the fastest rate over the last half a million years.

Now of course when you look at that and you ask what happened to the Woolly Mammoths and a whole bunch of other flora and fauna of the planet, it changed dramatically. So you have to ask the question, you have to ask the question, "Will biology keep up?"... And of course we now know from the inter governmental panel on climate change, the report that was put out last year, the fourth in a series of reports going back to the late eighties, that nature is changing. We have got huge migrations of animals; butterflies, birds, moving; we have got the problems of sea ice and polar bears and so on. We have got a change in the climate, the timing of all sorts of biology and of course in our areas of the world, one of the most striking and early signatures was the fact that our beautiful Great Barrier Reef bleached. And when you consider bleaching, it is a rather stark change. It is when the Reef literally goes from being brown and healthy to being a stark white and this happens with very small changes in temperature and what we see here is the bleaching event in 2002, southern Great Barrier Reef reefs around Great Keppel Island. As far as the eye can see in this particular

case, after a two degree rise in temperature above that summer maximum that these reefs would normally see, you see this enormously disturbed reef. And of course this comes down to thermal anomalies which probably were quite natural and didn't cause this in the past, but because sea temperatures are now a lot higher, they are now reaching the thresholds at which coral get into distress and of course it is really large scale impacts. And this is a map that was produced by scientists at AIMS and the CRC, which shows essentially anything that is not blue is bleached – you have over 50% of the Reef undergoing this stress and about five to 10% dying.

Now when you look at this, it is due to the fact that corals when they are healthy have a symbiosis with a tiny plant like organism called the zooxanthellae. And that when they stress out, falls apart and they go white and they go from being highly productive, calcifying at high rates to essentially being very vulnerable to disease and death and not growing and not putting down that limestone and of course that is the heart of the eco system that supports possibly over a million species and we actually only know a small fraction of those. And of course when you have a look at this on a global scale, it is really is a fundamental change to way these eco systems work, which the Senator pointed out. This is not just a problem for Australia, it is a problem for most reefs around the world and this is just a snapshot of what happened in 1998, almost every area of the world experienced enormously high water temperatures, you had bleaching and by the end of it, 48% of coral that was surveyed in the western Indian Ocean for example in 1997, it disappeared by the end of this event and those reefs, many of them have not come back.

When we look at Australia, we are relatively, we got away with it scot free in a way and some of the speakers will talk about why this might have been. We only lost about five to 10% at the most, but worldwide, 16% of the coral disappeared in that year. And of course when you look at the progression of these changes, they truly extraordinary. This is work also done by Scientists at AIMS and the CRC and what you are seeing is two models. You have got an A1 scenario or a very high intense scenario under low and high predictions and what you are seeing is that the colour of the water temperature, the temperature is indicated by the colour and you see that it is migrating down the Reef at a shockingly fast rate. And so you are actually seeing waters that might be typical of Papua New Guinea at the southern end of The Great Barrier Reef, as early as 2050. Those sort of changes that have driven the biology of this system are extremely important. And of course this is the modelling done some years ago now, for the three regions on the Barrier Reef. It shows projections with the doubling of CO2; the lines in each graph is what we know as sort of the thermal threshold of these corals and you can see that in all cases, by about 2030-2050, we are above that line that we know causes temperatures that cause bleaching.

And course if that weren't bad enough and I feel sometimes that I am the doomsday sayer, we also have the problem of ocean acidification. This is something that has been one of the sleeper issue and it is caused by the fact that CO2 going into the atmosphere, goes into the ocean and creates a very dilute acid and that acid then drives down something called the carbonate iron concentration. That is the building block that corals make calcium carbonate out of. And of course what we are seeing here is a massive change in the fundamental chemistry of the ocean and what we know about coral is that if you drop that calcium carbonate concentration, they don't make limestone as much or these limestone type materials as much as they use too and of course that has implications to the very structure of reefs.

This is really a snapshot of where we are today, at 320 parts per million carbon dioxide and what we have plotted here in this Science paper is essential the concentration of the two iron species that allows corals to calcify. And what we see is that the blue areas encompass the pink dots which are the locations of coral reefs today. And you will notice that if you go outside of those waters, you don't find those pink dots. This is what happens as we increase the carbon dioxide concentration in the atmosphere, going from the pre industrial times to today, to 450 and notice the blue water, that is what you need as far as we know, to form carbonate reef systems, it is practically gone by 500 parts per million. This is a lot lower than a lot of has had first thought and actually brings the pressure of the issue at a much more

compelling level. And so if we get to any of these high scenarios, we just don't have the conditions that we know that coral reefs need to survive.

So what is the future of The Great Barrier Reef? Well if we are unrestrained and we continue to increase the concentration of CO2 in the atmosphere at the current rate of near two parts per million per year, we will be at those concentrations before 2050 comes up. If that's the case, we go from I think having reefs that are, still if we were to stop today, we would still be able to maintain high biodiversity systems that support tourism and fisheries. But if we start to go to these other levels of CO2, we start to see that they become much more brittle systems. They get knocked over by those local factors much more easily and of course that is where the action is, as we will hear from the other speakers.

So what are the actions that we have to do? Well it is very clear that the world has to mitigate the emissions of CO2 with an urgency like never before. We can't afford to go near 450 parts per million for reasons to do with water supply. But for the Reef, we will have a fundamentally different system. One that is less productive, has less eco system services and is of less value and of course it would be sad for us as Australians for us to lose that icon. And of course the second most important thing that we have to do, because these systems are going to be brittle in the future while we try to struggle with this issue of emissions. We are going to have to step up the management of those local factors, otherwise we won't have a reef that we can call our own any more. Thank you very much.

Chair: Sheriden Morris
Thank you Ove. Now to talk about some of those local factors is Professor Iain Gordon from CSIRO in Townsville and he is here to talk about water quality and its impacts on the impact of the Great Barrier Reef.

Professor Iain Gordon – CSIRO Townsville
Thank you very much indeed. Thanks Ove, thanks for setting that up for me. Ove obviously comes across as a doomsayer, but one of the most important things that he said at the end, is that there are local things that we can manage in order to protect the Reef of increase the resilience of the Reef to the climate change impact. And the thing that I am going to be talking about now is the water quality impact, because it is our belief that by managing the land and the catchments that feed into the lagoon of the Reef, you can increase the resilience of the Reef to those climate change effects.

I will just give you a little bit of the background of those catchments. There are the catchments that are on the eastern seaboard of Queensland, there is about 400,000 kilometres of, square kilometres of catchments that feed into the lagoon of the Reef and there is about one million people that are there. The population increase is about 1.5%, so it is rapidly expanding population and it has major industries in there; mining is one of them, but the other one is primarily agriculture dominated by extensive cattle grazing and also by sugar cane. That industry is worth about $3 billion to the economy, so it is a very important part of that region.

The relationship between the land and Reef is primarily from the fresh water that flows off the land into the lagoon of the Reef and then bathes the Reef itself. And that water takes with it pollutants and those pollutants I will talk about in a minute. They feed in when you get these big flushes of water out of the system and they affect the Reef. The water quality has a negative impact on coral biodiversity and coral cover through a range of different effects and the others will be more detailed about this, through things like smothering the coral and also by blocking light that is happening through silt and mud. Tipping the balance towards micro algae away from the hard corals, a lot of the stuff that Ove talked about was hard coral that you are tipping towards. Algal dominated coral reefs and also by disrupting reproduction and recovery and Ove mentioned that there is going to be a lot of effects whereby climate changes means that the Reef is in a recovery stage for a lot of the period and if you have poor water quality that means that it is difficult for the Reef to recover from those events because of limits in reproduction and recovery.

What's the scale of the problem? Since European settlement of the eastern seaboard of Queensland, there has been an increase in the amount of sediment and nutrient run off that there is into the system, primarily because of the change in the landscapes, due to changes in the agricultural practise. You have got a freak nine fold increase in the sediment loss, increases in nutrients that feed into the system, nitrates and phosphates and also new kinds of chemicals in that water that is around the Reef; pesticide and herbicides, they haven't been there before.

The map on the left hand side shows some of the concentrations of these. For example, this is the herbicide and you now get concentrations of herbicide in the Reefs close to the shore, which are the main areas where that $6 billion tourist industry is now, around the Cairns, down to Mission Beach and Hinchinbrook Island and around the Whitsundays. So there is a major impact now of these pollutants on things like the tourist industry, which is based on the Reef.

Where are these things coming from? They are coming from primarily, whilst they are local hot spots, the primary deliverer of these pollutants to the system is through sediments, nutrients and pesticides and the concentration – most of those are coming out of the grazing land areas. So grazing is an important thing that we have to manage, in order to more effectively manage the Reef. The thing is that there is already a policy in place; a join agreement between Queensland and the Federal Government, to try and protect the Reef through improvements in water quality. That's the Reef Water Quality Protection Plan and it runs for ten years from 2003. There is two main areas that it is concentrating on and one is to reduce the pollutants that enter into the Reef, primarily from diffused pollution; that is the agricultural component of the system and also to rehabilitate and conserve the area; the habitats that act as a sort of filter that mop up the pollutants before they feed into the lagoon or the Reef. That is the wetlands and stream bank areas where revegetation would happen.

The money that is being used at the moment for achieving these outcomes is directed primarily towards the natural resource management boards and the catchments that are along the coast and those natural resource management boards are developing what is called water quality improvement plans. And the important thing is that those plans are part of what is called and adapted management cycle, because we are not sure about the consequences of the improvements in management and whether that is going to be enough to achieve the outcomes that we are after in terms of protection of the Reef. So the adapted management cycle is primarily where you have a planning phase, and implementation or doing phase, you then look at the response of the system to that through monitoring and then you use that information to feed back and to increase the predicted capacity of your future planning and implementation.

So the past five years have really been about the planning phase in terms of what should we be doing and these have been done through these water quality improvement plans and now the announcement of Reef rescue will be primarily about effecting change on the ground; that is the doing phase and that will be directed towards changes in management practise, particularly in the agricultural community.

How has science helped to inform this process? This was an example for Tully which is just south of Cairns, where scientists have been using set targets and actions and the targets are set through information that is provided from AIMS and from The Great Barrier Reef Marine Park Authority that sets the targets for the water quality that should be flowing into the lagoon of the Reef. The Scientists from various organisations including my own, will provide information in terms of what the best management practise is for cultural production on these landscapes and whereabouts it should be place on the landscape in order to achieve those targets and then various other organisations including Natural Resources and Mines, a State Government Department, is helping to monitor the response of the system to those implementations in management practise.

Science is also informing the changes in practice directly. For example, improvement in fertiliser application, in for example cane, to try and provide fertiliser in a way that the crop more efficiently uses it and less of it leeches into the water system. Better grazing

management practices through producing increases in cover of vegetation and reduces the loss of sediments and nutrients into the water course and restoring those filtering habitats such as wetlands and stream banks.

It is also core in relation to the kinds of things that we do, to provide advice to the planning process; we have developed environmental economic models that allow us to make predictions about the consequences of changes of land management and land use at the catchment scale in terms of the environmental and economic outcomes. So on the left hand side here we have the current base state. In the middle we have one where you have the optimal implementation of best management practice and on the right hand side, you have the implementation of management practise to achieve a 40% reduction in the amount of nitrogen that flows out into the lagoon or the Reef.

You can look at the consequences of that in terms of economics. So for example, where you have implementation of optimal best management practise in an optimal way, you can actually increase the local economy because you have got a reduction in the use of fertiliser for example and you can achieve a reduction in the amount of dissolved inorganic (?) nitrogen that flows out, so that is a win, win situation. If you want to look at reduction of the amount of nutrients that are dissolved inorganic nitrogen that flows into the system, then that would be at a cost say, in this case, our predictions would be around $15 million to the local economy. So to achieve the environmental outcome here, we are predicting that there would be a reduction in the local economy and we have to talk about how that might affect social and economic returns for the farmers in that region.

So the conclusions that I have got in relation to this are really that land base run off effects the health of the Reef and that this is likely to become more important as the climate changes, that the Federal and Queensland Governments are putting the Reef plan, which is effective in their policy, to initiate change in the land management to protect the Reef against water quality impact. And that already we have started strong Science management through the development of natural resource management bodies, water quality improvement plan.

So that is what is happening at the moment. What do we need in terms of science? And I think we come back to that adapted management cycle. We have done the planning and we are into the implementation, then we have got to evaluate and learn that is really about monitoring the response of the system, more feeding that information back into our model and sort of improving the models predicted capacity. The questions that we have though are things like, will management actions achieve the targets that are being set? At the moment, we are not sure. We are doing the best as far as science advice is concerned, but we are not sure that they will achieve the targets that have been set. Have we got the right targets? Will the targets that are set for the end of the river system, really benefit the Reef in terms of its resilience, particular in the face of climate change? And the other thing at the moment is that each of the individual catchments that are developing their own water quality improvement plans. If we pull all those together, will those in the long run benefit the health of the Reef? And that is a major question that we have. Thank you very much.

Chair: Sheriden Morris
Actually now to build on that about water quality and to actually talk about other local impacts that can be managed, I have Dr Peter Doherty from the Australian Institute of Marine Science, to talk about zoning in the marine park and the consequences of that zoning and the influences that that zoning is having on the Reef.

Dr Peter Doherty – Australian Institute of Marine Science
Thank you very much Sheridan. Just while the talk is going up, Sheridan has asked me to speak about the role that marine protected may have in the future of the Reef. MPA as they are commonly called mean ‘no take zones’. We are not just talking about a simple fishing fan here, but no taking of crayfish, no taking of valuable sea cucumbers, no taking of pretty molluscs or specimen shells; no taking of biodiversity. I put this slide up to remind you that The Great Barrier Reef, although a World Heritage area, is not a pristine wilderness. It is in fact a multiple use marine park, with significant economic values from tourism, fishing and shipping. We have heard something about the stresses and the natural values of this system

from water quality inshore, from changing conditions in the global ocean which had particular significance for the iconic coral reefs offshore. But throw into the mix the other human uses of this area and you do have a significant management, in an area which is three times the size of Tasmania.

Now The Great Barrier Reef Marine Park Authority has long used area management as its principle tool for separating conflicting uses and follows a strategy of trying to minimise the cumulative impact in any particular area. Notice that the original plan created with The Act, which set the Authority up in 1975 was focussed very much on coral reefs, so although MPA no take zones were present in the original plan, they were very much focussed on coral reefs, they occurred in small patches, they largely were scattered through the off shore reef matrix. Up to 30 years of working with a model like that, the Authority recommended to the Federal Parliament, that the amount of protection for the system should be increased substantially and furthermore that the opportunity should be taken to increase that protection to all of the habitats present within the Marine Park. The Federal Parliament agreed and so The Act was passed in 2003 to be implemented in the middle of 2004 and we can see the very dramatic amount of the increase in the highly protected areas within the Park.

Now for those of you who are interested in the architecture of those odds shapes where the green is, it did actually come about following a structured and well organised process in the years leading up to the proposed rezoning. The Authority conducted what is called the 'Represented of Areas Program' in which they collected all of the available knowledge at the time about The Great Barrier Reef Eco Systems and recognised a total of 70 bio regions which are these patterns indicted here. They take, if you like advantage from natural gradients on shore to off shore from north to south, but they are essentially recognised as distinctive places within The Great Barrier Reef Eco System. To get to the zoning from that, there were a number of principles. So an important one was that at least 20% of every bio region should be put into a highly protected stated. There were perhaps another dozen caveats as well that included having a certain minimum size, to chose the main alternatives and so on, but that is how we arrived at that plan.

Now in the last three years in the Cooperative Research for The Great Barrier Reef, Scientists from four organisations conducted their own campaign and made a major survey of inter reefal habitats throughout the length and breadth of The Great Barrier Reef, using cameras and sampling the biodiversity where we could and came up at the end of that process with a map based on, if you like, going there and observing the non reef eco systems. And when I compare that to the bio regions that we used to create the zoning plan, we can both on the one had see some significant similarities and we can also see probably some significant differences. What is important however, is that we were able to take the zoning map which was approved to come into effect in the middle of 2004, overlay it over the map we had produced and ask, "Does this zoning plan delivery the principles that were encoded in the represented areas programs? And yes the answer was, it has met or exceeded its targets to conserve biodiversity and habitat diversity."

This then lead to other questions. Having imposed a comprehensive, adequate and representative system of protection over The Great Barrier Reef, what evidence do we have that it is actually making a different or if I make that more operational, do not take areas have a measurable impact on biodiversity? Well we know the answer to that question even before we start the research, courtesy of a group at James Cook University, lead by Professor Gary Russ, who for some years had been studying differences that can be found between green zones that were created in the original plan in 1975 and adjacent areas and we know that there are differences in the number, size and abundance for example of line caught fish species inside and outside of highly protected areas.

What we don't know is anything about the dynamic of that, how quickly these differences may accumulate and so this team took advantage of the once in a lifetime opportunity with the rezoning to actually survey sites in 2004 and then resurvey them after the new zoning plan had been in place for less than two years and this lead to the somewhat surprising results, that even with such a short period, iconic species like the Coral Trout which are ate and important apex predators in this system, were already becoming more important in the new

green areas, compared to the adjacent controls that reminded open to fishing. So the more the team was able to find some of the evidence of trophic cascades. So in other words, these species which are the foods of Coral Trouts and other big predators, were in fact becoming less abundant inside the green areas, than the areas that remained open to fishing.

Now some people have seen this results and said, "Well this means that this zoning actually has a negative impact on species," but his was not a bad thing. This presents a rebalancing of species at different levels in the food web, to their more natural state. I could perhaps illustrate that with an example from North America more obviously than here, where an icon study showed that the removal of sharks along the Atlantic Coast has lead to a large increase in the number of Skates and Rays, which has lead to declining harvest of commercial shell fish. So what we have in that example, is shark fishermen hurting shell fishermen, indirectly through the impacts of the first group upon the food web.

Now the first sets of results that I have shown you there came from in shore coral reefs where their habitat is limited and the recreational fishing pressure is quite intense. AIMS was able to use its vessels to translate the same question to the more complex reef matrix off shore, by comparing closely matched reefs that had previously all been open to fishing, where half of them had been closed to fishing within their zoning plan and found a consistent and nearly identical result to that observed on inshore reefs. So in each of these five regions, again Coral Trout being measure here, but there are plenty of other elements of biodiversity being measured in the study, the Coral Trout were becoming more abundant, given less than two years worth of protection and the net effect of the MPA is summarised in that graph.

Now one final study here and then a conclusion. A student study based on those long term closures had demonstrated from Tropical Snapper for example in this case, that not only are there more fish in MPA's, but they more importantly, more eggs are being produced out of those areas and this is a result of having more fish, fish live for longer, they reach larger size and in this example, the eggs per unit area coming out of the MPA were nearly three times the number of eggs per unit area, produced in the surrounding territory.

The significance of that is that sporn from most marine organisms is broadcast into the ocean, where currents and winds disperse these propigills quite widely and so that material that originally came from protected stock in an area like this, here is the final distribution of that, far beyond the boundaries of the MPA.

So to summarise. The zoning plan has removed the extraction from at least 20% of the unique habitats and communities within the Marine Park. To put that a different way, it has moved one third of The Great Barrier Reef into highly protected areas, designed to rebuilt ecological resilience. The no take zones have been shown to start recovering towards their undisturbed state within two years, reflected by more apex predictive and those trophic cascades at those lower levels in the food chain. I have just shown you a simulation that suggest that there is good grounds for believing that these no take zones will explore their benefits beyond the boundaries of the MPA and collectively we believe the rebuilding the ecological resilience to the most natural state is one of the best ways that we can make The Great Barrier Reef more resilient to other challenges expected between now and 2050. Thank you very much.

Chair: Sheriden Morris
Thank you Peter, now to pull some of those components together, we will have Professor Terry Hughes talks about resilience and from there we will have Dr Russell Reichelt to actually sum it up and take some questions from the floor, Terry.

Professor Terry Hughes – James Cook University, Qld
Oh hi everyone. Well we have just heard three eminent talks about the major issues for The Great Barrier Reef family; climate change, run off from land and fishing and you are probably wondering what is this guy going to talk about? I am going to try and integrate all three of those issues and in particular, I am going to try and shift the focus away from just the gloom and doom and look at some solutions to some of issue, which are highly integrated and highly inter related.

I would like to start just with the observation that the three talks that we just heard, you couldn't have heard ten years ago and that is because the way we do science today, particularly coral reef science has changed fundamentally. So marine science is a very exciting place right now. We are seeing major shifts and in particular we are seeing a scaling up, both a time scale and a spatial scale in the way we do science and that is largely driven by issues such as climate change, catchment scale issues and over fishing along The Great Barrier Reef system.

We are also seeing a big shift in fisheries science, where it has become less fashionable to manage species by species, as if they were separate entities in an eco system. Instead now we are looking at something called eco system based management. We are seeing no take areas or green zones emerging worldwide as adaptive tools for managing the resilience of eco systems and I will explain this issue of resilience in a moment and there is a new focus on people and eco systems and how they relate to each other. How things like the market can drive damage for a fishing stock and how that in turn effects the dynamics of an eco system. We are also looking at adaptive governors and ways to better manage eco systems; the links between society, economies and the natural world.

Part of this scaling up is a growing realisation among Scientists and also now the general public, that the system that we are dealing with are already highly altered and that is important, because in many cases, the resilience of an eco system to fix things like climate change to which are now emerging problems, can be compromised by their recent and not so recent history. So the picture on the left there shows a food web for a typical coral reef and there aren't any people in that food web. Well of course that is not the case any longer for the vast majority of reefs worldwide, so we are already dealing with highly altered eco systems and those arrows on the right show a top down effect of people, by removing especially top predators and globally we are now seeing a phenomenon called 'fishing down the food chain', where top predators have long since been depleted and there is a greater focus now on fisheries that are target carnivorous fish; fish that eat seaweed. We are also seeing bottom up effects by people from nutrient addition, which can also propagate from the bottom up, through a food web and make it very different.

The term resilience refers to the capacity of a system to absorb insults or disturbances without fundamentally changing or without slipping, going over a tipping point or a threshold into a very different configuration or state. And that system can be an ecological one; an eco system or it can be a social economic one or it can be both. And increasingly Marine Scientists are collaborating with Social Scientists and Economists to look at the linkages between those different systems which show complex dynamics that have threshold behaviour and here is an example of threshold behaviour from coral reefs. The picture on the left shows a coral dominated, healthy eco system. The picture on the right shows a much degraded system. The coral reef has lost its resilience and its capacity to absorb insults like coral bleaching due to global warming and instead of recovering like it has done for millenniums, it can quite suddenly and quite unexpectedly, slip into this alternate, degraded state.

So let me give you a little bit of gloom and doom before I move onto talk about some potential solutions. We have heard about the recipe for killing the coral reef from our last three speakers. The first thing we can do is distort the food web by removing herbivorous fish; take away the lawn mowers. The next bad thing you can do is add nutrients, fertilise the reef; both of those produce algal blooms. So the next inherent thing that you have to do is wait for something bad to kill the coral and increasingly that something bad is likely to be a bleaching event from global warming. And when those three things coincide, we get an algal bloom that can replace the coral.

So how do we deal with these issues? So I want to focus now on building coral reef resilience. The first thing we can do is rebuild food webs and Peter talked about the ethnicity of new green zones, following the rezoning of The Great Barrier Reef and there are other fishing regulations that are important too. We can improve land uses practises which Ian talked about a moment ago, dealing with things like sewage treatment and costal planning

and thirdly we need to prevent dangerous climate change by reducing carbon dioxide emissions. Now an important point is that we have to do all three simultaneously. We can't just establish green zones and improve run off into The Great Barrier Reef, without tackling number three. We can't climate proof The Great Barrier Reef, without dealing with greenhouse gases and so this integrated approach is really important. Now we have seen vast improvements in dealing with over fishing on The Great Barrier Reef and improvement are underway with run off, but unless we also deal with climate change, all we have really done is bought ourselves some time. We have a narrow window of opportunity to protect The Great Barrier Reef into the future and we need to act on all three fronts.

I want to finish my talk by showing you some results from what I think was an interesting experiment that we undertook on The Great Barrier Reef over the last two years. This picture shows a fairly typical picture of an in shore coral reef today. There is a lot of dead coral here which was killed in the 1998 bleaching event which Ove described and those four or five corals there are teenage corals which have settled onto that bare space which was created by that bleaching event. So The Great Barrier Reef is still a resilient system which is recovering rapidly from recent impacts like the 1998 bleaching event and herbivorous fish play a critical role in that regenerative capacity, by keeping that dead coral space clear of algae, so that new juvenile corals can re-establish themselves. So we set up a fish exclusion experiment at Orpheus Island and the question we were interested in, was whether the loss of fish would increase the Reef's vulnerability to climate change? So we set up these enormous chook cages and they are about the size of a squash court and that there is a two metre high door and at high tide we could jump into the cages over the top, but if you stayed there too long you needed the door to escape at low tide. And we ran this experiment for three years.

Prior to the experiment, the fish could come and go; that was our control treatment. Another part of the experiment was fully meshed cages, where we excluded the fish for three years. So I am going to show you three little movie clips. This is inside the part of the experiment where the fish could come and go. Those are mainly Parrot fish and mainly and school of Sergeant fish just there and you can see that they are busily feeding on the substrate and they are keeping that substrate clear of seaweed. If you look closely at the Reef, you will see lots of scrape marks like this. Those are the feeding marks from Parrot fish and they control algal blooms and here is the front end of a very big Parrot fish and you can see that they don't use dental floss. These are the main lawn mower of the Reef. I am going to show you a second movie clip and this starts just outside one of those doors to a cage and I am going to push the cage open with the camera and show you what the Reef looked like after three years with no herbivorous fish. So we experimentally created the equivalent of a kelp bed. We experimentally initiated a slit in this eco system, thereby demonstrating the important of herbivorous fish in this system.

The corals are on the bottom there and they are now in deep shade. Those corals are recovering from the 1998 bleaching event and so this is just my insurance policy in case the movies didn't work. That is a picture of the inside of the cage after three years and this is the only data slide that I will show you. It shows that number of coral recruits in different parts of our experiment, inside the cages where we experimentally excluded fish and in the other parts of the experiment, where grazing continued. And this experiment demonstrates the importance of herbivorous fish in maintaining the ability of the Reef to bounce back after a bleaching event, which occurred in 1998.

So the take home message from this study is that loss of fish biodiversity is critically important for the resilience of the Reef, because different fish have important ecological roles. Fish control their prey species; in this case seaweed, but other fish control sea urchins, crowned althorn starfish, snails and so on. So when we deplete the stocks of the species that we are targeting, we are not only effecting those targeted stocks, we are effecting the entire eco system dynamics.

So managing fisheries can help to prevent these regime shifts or phase shift, help to maintain the Reefs resilience for future climate change and I think that is an important message, because it says that there are local proactive management options specifically managing fish stocks, because of their ecological roles and managing run off onto the reefs, in anticipation

of future bleaching events, that we can do locally as well as dealing with global greenhouse gas emissions.

So in summary, climate change, run off and over fishing are not separate issues, even though you heard three separate talks beforehand, they are actually highly inter reacting issues. Climate change is already happening, it is not a distant threat that may or may not happen in 20 years; it is here now. Local proactive interventions can help to build resilience to future further climate change. I don't believe that reefs will disappear, if we can avoid extreme climate change and manage food webs and nutrients more locally. Thank you very much.

Chair: Sheriden Morris
Thank you Terry and just too now sum up these components and take a few questions from the floor, Russel Reichelt, he is chairman and CEO of The Great Barrier Reef Marine Park Authority.

Dr Russell Reichelt – Great Barrier Reef Marine Park Authority
Thank you very much and thanks to all the tremendous science talks we have just heard. The question is in 2050, will we have a Great Barrier Reef and if you look at the downsides, the doom and gloom scenarios that have been painted in the worse case, you would have to have your doubts. These are very serious messages from the science community, but there is also some excellent solution ideas that are imbedded in those talks. High quality scientific research is vital to secure the future of the Reef; it is not too late to look after The Great Barrier Reef.

I will give you a quote from a book that has just been released by Harvard. It is by Charlie Verin at the Institute of Marine Sciences, former Chief Scientist. It has got the disturbing title of 'A Reef in Time – The Great Barrier Reef from beginning to End.' And he analyses all the effects on the Reef, its evolution and its possible futures and I would like to read to you, at the end of that book and he is looking ahead some centuries and he is talking about what can happen if there is strong, urgent action taken now.

Charlie says, "With immediate global action now, it will drastically reduce CO2 emissions and there will come a time when the crisis has passed. The Great Barrier Reef although scared, will come through what lies ahead and once again be the place it is now." What Charlie is telling us in this book is that urgent action is needed, strong management is needed and the analogy I draw is that we need to secure the resilience of the Reef from a local management point of view. Others have talked about mitigation on global scales; the resilience of the Reef is my day job and it is vitally important to secure the Reef's future.

I will just say a couple of things about the management of The Great Barrier Reef. It is a large region and it is not only The Great Barrier Reef Marine Park Authorities responsibility, there are a large number of people involved in looking after the Barrier Reef. Numerous Commonwealth and Queensland Government agencies, natural resource management catchment bodies, philanthropic organisations, the industries that use the reef – we have Reef Guardian Local Councils. We have a thing called the Reef Guardian Schools and there are 130 schools with 60,000 school children who are proud to be a member of the Reef Guardian Schools Program, so we are looking after the attitudes of the future as well.

However, thing are going to be very different in 2050. The population is likely to double to something like two million along the coast. Industrial expansion just witnessed the recent mining boom and the infrastructure that is needed along the coast for expanding economies. Tourism is vitally important, coastal infrastructure, ports and marine; the number of boat licenses, you will not believe and the bigger ones have to be parked somewhere. I have got a pet project I am working on, The Reef Guardian Marina, but I haven't announced that yet, but they are part of our – it is a marine managed area and it is not a pristine exclusive area and people are very important to looking after it. The more people that enjoy the Reef, the more strongly they will feel about, the more strongly they will enable our political leaders to take action, like we saw with the rezoning of the Reef.

So what have we got to do? We have heard these messages. Building resilience is a key strategy. I would like to dwell on a couple of things that I think and I am addressing this to the science community and perhaps those that might want to be scientists as well. What kind of skills will be needed in the future, by 2050 will the science world be different and I think it will be. I think the importance of scaling up of ecology as Terry Hughes mentioned is rising rapidly. Large scale, integrated, scientific studies that inform and build a knowledge base, are vitally important. The flow of information is phenomenal. The technology is in place now to know where every vessel on The Great Barrier Reef larger than a rowing boat is, every five seconds and built into that software I think we have collision avoidance, safety mechanisms and the volumes of information flowing are huge and we need scientists with synthetic, analytical tools to represent that information so that it is useful to take action and protect the sustainability of the Reef – that would be one thing. Dealing with high volume information, in an information world, Reef management is different.

One of the side products of that is a large scale integrated program, the Reef and Rainforest Research Centre, is managing a program with the Federal Government called the Marine and Tropical Science Research Facility and all of the speakers here are partners in that program and they are creating a risk, resilience and response atlas for The Great Barrier Reef and I think people in my role with increasingly rely on that sort of information for regional and localised adaptive responses. It is becoming critical that we deal with issues, that the Reef is so large, that issues at one end are different from the other.

The other, I have talked about synthesis, the other thing that is different with that large population, we talk about on the land and high population growth. We have already seen that Noosa use to be as far north as things went and then we have Bundaberg, Agnes Waters, it is beautiful sub tropical coast going up to The Great Barrier Reef. That will expand and people will be using that area and agricultural uses will conflict with urban expansion, tourism – they call it is a contested landscape. We are going to see the same thing in the water, the contested seascape.

What will be valuable is scientific solutions to help society resolve those resource conflicts. So brokering ability, facilitation skills will need to be a standard part of the tool kit of Scientists in 2050. So just a couple of examples where I think the world will go. If we are going to make sure that The Great Barrier Reef gets across what is coming down the road with climate change. We have heard a graphic description of that from Ove Hoegh-Guldberg. Mitigate the problem of declining water and deal with the resilience issues which better and Terry talked about – we need urgent action now and the Science community is a vital part of it.

I thank you all for coming and what I would like to do is pause now and see if there is questions from you, more importantly questions for the speakers. Can I have questions from the floor. Yeah.

Question from the Floor
[inaudible]

Dr Russell Reichelt
How do you help people change their practise?

Iain Gordon
A lot of it actually is going to come through the Reef Rescue package and it is getting people to believe that the practises will improve their own situation and as I showed, a lot of the practises will actually reduce the cost of farming in the long run and so you need to give people the incentive to take up those new practises and see the change that happens. And in effect what you need also is people in the farming community, be it sugarcane, bananas, grazing, who are the leaders, take this on and demonstrate the benefit and then the others will follow. So that is a lot of what that rescue package is about; it is getting people to see the benefits and in effect, providing them with an incentive to take on the change.

Dr Russell Reichelt
Thank you, another question.

Question from the Floor
[inaudible]

Dr Russell Reichelt
I will look for volunteers, perhaps Terry to begin with, to introduce various I would like to hear it from the Reef's perspective, from the point of view from people living around the Reef – you just want to know about the biology? We have some low lying islands in the Torres Strait and whom the people are very interested in sea level rise, I can tell you. Terry, about the Reef.

Professor Terry Hughes
If I could answer that question from the Reef's perspective by looking at the recent history of The Great Barrier Reef. At the end of the last Ice Age, the sea level was such that The Great Barrier Reef didn't exist. So between about 14,000 and 6,000 years ago, the sea level rose 140 metres, I think these are the figures. John and Ove can correct me on that but those are roughly the numbers and so The Great Barrier Reef has dealt with that sort of shift in sea level over a relatively short period. So another 50 centimetres or so from a corals perspective is not a big deal. Certainly a minor issue compared to global warming and thermal stress and in the longer term to acidification (?).

The effect on coastal real estate and low lying islands in the Pacific is going to be obviously quite profound, but biologically it is not a major issue.

Dr Russell Reichelt
Time for a couple more. Maria here and then one right over the back too.

Question from the Floor
[inaudible]

Dr Russell Reichelt
[1:01:44] Sheridan, do you want to talk about Cyclone Larry? We have had our own Katrina here on the coast not so long ago. [Inaudible]. It is to do with the impacts of increasing extreme weather events such as tropical storms.

Ove Hoegh-Guldberg
Yeah I think the issues is out there and I think that most people would say that storm impacts can be isolated events and of course if you increase the storminess to a certain point and the some of the modellers are correct, you might get to a point where they are visiting the Reef at a greater rate than they can recover. So it is another of the interactive factors if you like, when you add in the storm, plus the bleaching event, plus impacts from local factors, you eventually cede the ability to probably sustain itself in time.

At this point, I think Larry was interesting because it came in at high tide and so swept very quickly across the Reef and there was minimal damage. Some of the storm damage that has been registered in the Caribbean actually came from the furniture that was sort of taken out of the hotel system in the Yucatan for example and ended up rolling around on the Reef and of course we are not in that type of situation because we have got fairly small amounts of infrastructure. So really it is an important point, but I don't think we have an answer for it.

Dr Russell Reichelt
Now there is one here and then one from right up the back.

Question from the Floor
[Inaudible]

Dr Russell Reichelt
Thank you. If I could invite Ove Hoegh-Guldberg to comment on the sensitivity of the climate and the relative changes we're seeing.

Ove Hoegh-Guldberg

That is a really good question because it highlights the fact that the deliberations of the IPCC by nature are highly conservative because to get a consensus on any issue, you are going to have to take the middle ground. And if you take Jim Hanson from NASA, you take Rumstelf ?[inaudible] on sea level, you see that actually world experts and predicting much great impact – five to six metre sea level rise over 150 years. So of course the middle ground – if I was to try and get everyone in this room to agree on a particular issue, I would actually end up taking and cutting off the edges of those predictions. So I think we have got to be very mindful of that and the IPCC Fourth Assessment Report is a highly conservative document and is likely to be way behind where the science actually is. Now that is not to say that the report hasn't been an important tool, because it had to get a consensus to settle down the politics and get the science right in terms of the wider theories. But we have got to remember that these things might happen a lot faster than we think and it was a very good question.

Dr Russell Reichelt
Thank you Ove and we have got the last questions now from the back; our time is nearly up.

Question from the Floor
[Inaudible]

Dr Russell Reichelt
Thanks very much. In terms of the schools program which I mentioned, clearly we have been doing that with firmly of the view that the earth is in the hands of the young and most people would agree with that. Changing attitudes of people of my generation, often comes from what their children say around the dinner table. So the outreach to youth in education I think is critically important; it is a very important part of our society.

How we do that is to reach into schools and reach into curriculum. I could see a need – what we are doing now, better integrated with programs that are running, that raise the value of science to our community, the flow through from kindergarten to Year 12 into undergraduate and graduate studies. I am a firm believer that if we could build some of the training needed to produce these world class scientists delivering into the problems of 2050, we need to start now essentially. So I can't say a lot more than that. We have some eminent academics here who run large programs in wonderful institutions and low employment rates, I think we need to work on the skills shortage of future scientists now; starting young.

Question from the Floor
[Inaudible]

Dr Russell Reichelt
Sorry, I didn't see you. Ian Pointer.

Question from the Floor
[Inaudible]

Dr Russell Reichelt
Thanks Ian. Our time is short, but I would like to ask the speakers to come to the front and remain at the front and each give their very short answer to Ian's question. What are the big science issues that they would like to see addressed to get us through to 2050 and make sure the Reef does survive. Short answers please gentlemen.

Professor Terry Hughes
The biggest challenge I see is dealing with the issue of ecological surprises. I mentioned that ecosystems are complex, they have threshold behaviour, tipping points and we need to radically improve our capacity to detect those tipping points before we go over them, that to me is the biggest challenge.

Peter Doherty
I would have to say that the most obstinent problem facing us at the moment would have to be ocean acidification and the impact that that will have, not only coral reefs, but all calcifying

organisms. So there are many examples, including the plankton of the high seas on which a lot of life's productivity depends. And at the moment, that is really the big challenge for us.

Dr Russell Reichelt
Iain.

Iain Gordon
I think the big challenge is to actually build the capacity of the community from the farmers, through the planners, to the managers to the society to deal with the challenges that we face with the reef.

Ove Hoegh-Guldberg
Coming last of course, I would have to say that I endorse all of those, but particularly I would like to echo Peter Doherty's point about ocean acidification and as we picked up, the rate of change is a lot higher than we thought it was and you can now detect it in all oceans and we really don't have a clue what to do and we really have to get there very quickly.

Dr Russell Reichelt
Thank you very much and I will invite Sheriden Morris to have the last word.

Chair: Sheriden Morris
As usual, get a female in to have the last word, it is always an important thing to do. I would like to thank everyone here today. I would like to thank the speakers for their commitment in coming here today and talking and I would like to thank all of you for coming here today and the webcast opportunities that we have had. Again, thank you to FASTS and this opportunity and we look forward to having some activity and greater activity in the Reef in the future and getting the outcomes that we all require. Thank you very much.

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