



# Episode 174: Peak fish: Rising human consumption of seafood, and its implications

## VOICEOVER

Welcome to Up Close, the research talk show from the University of Melbourne, Australia.

## DYANI LEWIS

I'm Dyani Lewis. Thanks for joining us. Industrialisation has brought drastic changes to the way in which we grow and source our food. Agriculture occupies vast swathes of land for the production of domesticated livestock and plant crops. And now, the only food that we still obtain, largely, from the wild is fish. Even fishing is starting to change. The romantic notion of local businesses catching and selling fish is being replaced with industrial scale fishing fleets that scour the oceans to bring seafood to our plates. Aquaculture too has emerged as an increasingly important source of captive fish to supplement wild catches. These changes have not been without consequence. To discuss the impact of modern fishing practices on wild fish stocks and to debate the role of aquaculture in feeding an increasingly populist world, we are joined today on Up Close by Fisheries' scientists Dr Tim Dempster and Dr Reg Watson. Tim is Senior Lecturer in marine ecology from the Sustainable Aquaculture Laboratory at the Department of Zoology, here at the University of Melbourne. Tim's work focuses on aquaculture and its ecological impacts. Welcome to Up Close, Tim.

## TIM DEMPSTER

Pleased to be here, Dyani.

## DYANI LEWIS

Reg, on the other hand, is concerned, primarily, with wild fisheries and marine ecosystems. He's a senior Research Fellow on The Sea Around Us Project in the Fisheries Centre at the University of British Columbia in Canada. Reg is joining us today via Skype from Hobart, Tasmania. Welcome to Up Close, Reg.

## REG WATSON

Hi. Thanks for the invitation.

DYANI LEWIS

Reg, could I start by asking you to give us an idea of how fishing and, in particular, ocean fishing has changed over the last century or so? REG WATSON Well, ocean fishing still happens in the coastal waters, but more and more it's done by multinational fleets. It's done at greater and greater distances away from fishing ports to feed a huge market which is very global in context. The fish that you eat in your neighbourhood supermarket would necessarily not have come from the waters where you live. They could have come from almost anywhere in the world. And the fishing practices have changed accordingly as well. Different types of gear are used more, that go across the bottom or encircle large areas of the sea. The image of somebody going out in a small boat from the coast and dropping a hook and waiting a couple of hours to catch a few fish in return back to port, that's largely gone, and has done for decades in some cases.

DYANI LEWIS

What types of impact has this had on the ocean ecosystems?

REG WATSON

Well, it's had a range of impacts because we've extended not just the intensity of our fishing practices - that is how much of the bottom we disturb and how much of different sorts of fish are killed incidentally to the ones that we actually want to catch. We've really wrapped it up. The numbers of vessels involved and the distances that they go have increased enormously, so that now the mid-ocean, far away from any ports, are being fished. Fishing fleets, basically, roam almost all places within the world's oceans. Increasingly, even those places that we think about as very remote - those down, say, approaching the South Pole - are places where fishing fleets are looking for opportunities.

DYANI LEWIS

So are there particular types of fish or, perhaps, regions in the world that are more susceptible than others to overfishing?

REG WATSON

Well, the fisheries that are more susceptible where, obviously, there isn't a balance between the production of the fish; the ecosystem isn't robust enough to support the level of fishing. So this tends to happen in two sorts of areas. It happens where there is very intense fishing; as there would be outside of China; in many areas of Asia, where there is intense fishing pressure. It also happens in some of those newer areas that we're fishing in now. That is those that are in deep water or in colder water, where the system isn't as productive. Therefore, whatever we take is a larger proportion of what's down there. So if we fish those areas intensely, then they just can't support that level of exploitation.

DYANI LEWIS

When you talk about productivity how do you go about determining how productive the fisheries are?

REG WATSON

There are some types of fish which only live to be one or two years of age. They have, typically, many eggs and so many young. The numbers of those fish in the environment tend to fluctuate wildly. Generally speaking, there is a huge biomass and there are many, many individuals. There are other types of fishes - like tunas and sharks et cetera - that are long lived. Some have reproductive strategies that mean that they don't have very many young at all. Those ones are particularly susceptible to overfishing.

DYANI LEWIS

Current practice has been described as fishing down the food web. Could you explain to us what that means?

REG WATSON

Well, if you picture a food web or pyramid with the bottom of the pyramid - the big, broad base of the pyramid - being the input into the ecosystems of the world; the energy coming from the sun; which, as we know - generally speaking, we can't do much about that part of the equation. This energy comes into the ecosystem. Things that eat plants are the first level above the plants in this pyramid, going toward the top. Those that eat those fishes, in turn, are further up this pyramid. It's a pyramid because it's getting narrower as we go up, because each time an animal eats another animal there's a loss. Not all of the energy and matter in the prey is being transferred to the predator. Therefore, what's being described by fishing down is that, in some places, effectively, we've targeted the top of the food web: those animals at the very top: the sharks, the tunas et cetera. We target them because we prefer to or because they're more vulnerable. We've tended to remove those large predators. It has many effects on the food web. It changes the way that animals have to live, what prey that they can seek. Other animals, it's a welcome relief because all of a sudden we've removed the predators that have been hunting them, so they can expand in numbers. All sorts of shifts in the marine ecosystems can happen as a result.

DYANI LEWIS

So how do we actually know that the fish stocks are declining? Is it simply a matter of going out into the oceans and sampling the various species? Or adding up catch reports, for example?

REG WATSON

Well, that operates on different levels, depending on whether you're talking about stocks that are well monitored and researched by developing countries with big budgets that allow them to go out and have log book programs with fishing people. They have satellite monitoring of fishing vessels. They have sophisticated mathematical models that involve having to go out and do the same kind of surveys, year in, year out - or whether you're talking about more developing countries, where a lot of the interesting changes that are happening around the world - in the tropics et cetera - where they don't have these kinds of resources. So sometimes we can't get this information also because fishing fleets consider it confidential. There are a variety of ways of looking at it. One of the things that we noted, back in 2000, was

that the reported global landings, once you corrected for some distortions, was actually going down since the last couple of decades. So this is an indication, perhaps, that, overall, we are having a detrimental effect on the global fisheries stocks.

DYANI LEWIS

What are some of those distortions that you talk about?

REG WATSON

Well, there is the kind of random noise that you get from species that are low down the food web, that tend to be in boom/bust situations. They go through big fluctuations in their numbers, which we can make worse, we can induce. Generally speaking, they would happen anyway. I'm thinking about the reporting problems that we noted with Chinese statistics. As we reported in nature then we were asked by the United Nations - the Food and Agriculture Organisation - to look at the Chinese statistics because their catches were increasing enormously every single year. The United Nations couldn't believe the statistics anymore and they asked us to investigate it. It turned out that, yes, they were tending to exaggerate their statistics to meet management targets. It didn't seem to strike anybody as odd that the proportion of the world's catch by China was increasing every year. In fact, there were people even bragging that by the 2050 65 per cent of the world's catch would be caught by Chinese fleets. So we looked into this. We found that there was this over-reporting and that once you corrected for that you saw, actually, a decline in the global stocks.

DYANI LEWIS

I'm Dyani Lewis. I'm joined today on Up Close by Tim Dempster and Reg Watson. We're exploring marine fisheries, from wild fish to aquaculture. Now, Tim, Reg has painted a fairly bleak picture of decline in the world's oceans. There are some who consider aquaculture to being the solution to food fish production. Before we get to that could you describe aquaculture for us? For example, what does a typical modern fish farm look like?

TIM DEMPSTER

Well, there are lots of different types of aquaculture from aquaculture in algae, aquaculture in shellfish and then aquaculture in fish. I guess, today, we're mainly talking about the fish perspective of it. If you look at the global statistics for aquaculture then a lot of aquaculture is actually algae and shellfish; so you have to take those out of the picture. We'll just come to the fish. Most of the fish production thus far is in fresh water. Again, China is very important. It produces a lot of fish in freshwater ponds inland. Then we come to the marine side. Essentially, marine fish farming is relatively new to the world. It's only, at the moment, responsible for about three or four million tonnes of fish, itself; again, because most of the fish that is produced comes from that freshwater production elsewhere. It's rapidly expanding. It's something that's thought of as something that can, essentially, bolster seafood supplies because of this dwindling catch from wild fisheries that we heard about.

DYANI LEWIS

Can any fish be grown in fish farms? Or are there some species that are more suited to this type of cultivation than others?

TIM DEMPSTER

I think there are probably 50 different species that are being trialled seriously around the world; to begin to grow them on an industrial scale. At the moment there are probably only five or six species that you could say were really seriously grown in large quantities in the ocean. The biggest of those are salmon and trout. They're very easy to aquaculture for number of reasons. Certainly, there are other fish - sea bream and sea bass - that are grown in the Mediterranean, and others around the world. Most of the innovation and the research and development, I guess, goes along with that salmon and trout production. That's sort of the global driver for fish farming in the sea. All of the other industries look to what's happening in the salmon and trout industry because that's 20 or 30 years ahead of anybody else.

DYANI LEWIS

So if you take a salmon farm then in the sea what would the operation look like for that?

TIM DEMPSTER

It started about 30 years ago. It was, essentially, at that point, very small cages, made out of trawl net; floating wooden structures on the surface to hold the net up; maybe 1000 or 5000 fish in a single cage. You might have had four or five or six of those cages. With development and industrialisation over the past two or three decades we now see very large structures. They can be 50 metres in diameter. They can go down to 50 metres deep. A single cage can have up to half a million four-kilo salmon in it; so we're talking about 1000 tonnes of salmon in a single sea cage. Then you may have, again, multiple sea cages at a site. The site may only be a couple of hectares, so it doesn't take up a lot of coastal space; even though you have the potential to produce 5000 or 6000 tonnes of fish per year in a hectare or two of coastal space.

DYANI LEWIS

With that kind of density of fish how can you ensure the welfare of the fish in those farms?

TIM DEMPSTER

It's an interesting one. That's certainly something that, again, has been part of the research and development. They're kept at about the maximum of 25 kilograms per cubic metre. That's, essentially, four or five kilo salmon per cubic metre of water space; to give you an image. Salmon are a schooling fish. At that level of density - as long as the water conditions are good in terms of the amount of oxygen coming into the cage, mainly - then you can hold fish at that density in the ocean without major impacts on their welfare. If you hold them in conditions where the oxygen drops, for example, then you can have consequences for their welfare. They'll develop sores and get cataracts, for example, is a common one.

DYANI LEWIS

In terrestrial agriculture there's often a large ecological footprint left by commercial sized farming operations. What sort of impact to aquaculture farms have on the environment in which they are established?TIM DEMPSTERThey have, I guess, near field effects on the environment, and far field effects. The near field effects really come about through the food that you have to feed them that goes into the cages. The fish eat the food and then it goes out as waste. So a large proportion of the food you put in goes as waste, nitrogenous waste to the environment. Essentially, that has to be dissolved, diluted, into the environment and assimilated by the environment. If you put those farms in places where the environment doesn't have the capacity to do that you'll have problems with the sea floor, you'll change the sea floor environment; it will become anoxic and you'll completely change the biodiversity of that surrounding area, on a scale of a couple of hundred metres, essentially.

DYANI LEWIS

So it just takes out all the oxygen from the sea floor?

TIM DEMPSTER

Yes, it takes out the oxygen from the sea floor because you have too much nutrient loading on the sea floor. If you put those in areas where the flow dilutes the nutrients going to the environment - and the environment is also one that typically tolerates high nutrient loads - then you can't curriculum measure the impact.Certainly, in a lot of places now, that have put there farms in good sites, it's very difficult to measure the impact of the outflow of nutrients, even though the farms are very big. That, in a sense, is a problem that existed 20 or 30 years ago. Through research and development it is largely believed, in many cases, to be solved. Certainly, on a site by site basis, it's problematic in a few places. So that's not the major problem with fish farming now, I think.

DYANI LEWIS

So what does determine what a good site would be?

TIM DEMPSTER

Well, early on they had them close to the coast. Now they're shifting them further out into more exposed environments where current flows are stronger, for example, and the nutrients disperse over larger areas.

DYANI LEWIS

How do fish farms alter the local wild fish populations?

TIM DEMPSTER

This is, perhaps, where they're beginning to have some impacts that are concerning. That is mainly through the fact that when you put so many fish in the sea and you have an accident, then fish can escape. Then you can have farm fish which may have been selectively bred over many generations so that their genetic material is different from wild fish. They then enter wild populations and have the chance to compete with them; have the chance to interbreed with them and then change the

genetics of the wild population. In a farm environment, essentially, you're selecting for what does well in a farm environment. Those genes might not do well in a wild environment. So when you mix them you might actually make wild fish less capable of surviving in a wild environment. The other way which is also very important is, again, when you have so many fish in one location you create the circumstances where parasites or diseases can amplify. That's certainly the case in salmon farming. There are a number of diseases and parasites that they are affected by. On the farm they're controlled through vaccination, through medication and through various treatments. More or less, that's under control. It fluctuates. Sometimes it's problematic; sometimes it's under control. The main problem there for wild stocks is the diseases or the parasites can then flow back to wild fish. Then wild fish might become infected or have higher loads of specific parasites. Of course, you can't treat the wild fish; they're out in the environment. It's believed to be something that leads to depression of wild fish stocks in certain areas, particularly for wild salmon that are swimming out from their little rivers. They go through the coastal area, where there's a lot of salmon farms, and out into the ocean. They pick up a load of parasites on their way out to the ocean. It's believed to be one of the drivers of decline of wild salmon stocks in northern Europe and North America.

DYANI LEWIS

Those are some very direct impacts that they have on wild fish. What about if we get back to whether aquaculture actually eases the pressure for wild catches?

TIM DEMPSTER

This is an interesting one because aquaculture and wild fisheries are intrinsically linked because the food that you have to feed these kinds of fish is made from wild fish; so you're relying on a wild fish catch of small pelagic fish, usually. These fish are then boiled down. You take the oil. You take the fish meal. Then you reconstitute that in a fish feed which you feed to your wild fish. There are lots of estimates of how many kilos of wild fish you need to make a kilo of farm fish. It varies, depending on what the farm fish is. For salmon it's believed to be roughly between two to three kilos of wild fish that you need to feed to make one kilo of salmon. On that basic calculation you can say well, in that case, aquaculture is, in fact, not contributing to the overall amount of seafood that we eat. It's a little more complicated than that because a lot of those fish that are being used to make feeds we never ate, and we have never eaten. They were always used as a feed for something. Before salmon aquaculture came along - and, to a lesser extent, prawn aquaculture, which also uses this kind of feed - that feed was going to chicken and pigs. Chicken and pigs used it far more ineffectively than salmon. Salmon have, in a sense, driven a more sustainable use of that resource. You can argue that it's still not as sustainable as it should be, but it's certainly gone in that direction with aquaculture. With research and development it may get to the point where there's a one to one conversion, or even less. That will be the breakeven point for that kind of aquaculture; where we can say well, it's no longer detracting from the amount of seafood we can gain from the environment.

DYANI LEWIS

Is there any reason that we can't use other sources of protein to feed the fish?

TIM DEMPSTER

Yes. There are lots of other sources of protein that can be used. To reduce the amount of wild fish we are using, we substitute lots of different kinds of meals and oils into the feed. A lot of them come from terrestrial agriculture: soy beans and canola oil, for example. A lot of the terrestrial products lack the long-chain Omega-3 fatty acids. These are the ones that we talk about when we talk about health benefits from eating sea foods. These are only found in the marine food chain. They are made by marine phytoplankton, the little plankton that live in the ocean. That's, essentially, concentrated up the food web into fish. That's why, if you want long-chain Omega-3s, you have to eat fish. That's, essentially, the key problem. So you can transfer in other types of feed stuffs into fish feed, but you can't get the long-chain Omega-3s unless you use wild fish. There are a number of ways that people are trying to address that problem at the moment. People are trying to culture yeasts and things like that that make long-chain Omega-3 fatty acids. Also this is where GM modification comes in as well. There is a research group here in Australia, at CSIRO, who are trying to take the genes, essentially, out of those marine phytoplankton and put them into canola so that canola - a land based plant - can then produce long-chain Omega-3 fatty acids in its seeds; which we could then use for human food or put into aquaculture feeds.

DYANI LEWIS

I'm Dyani Lewis. My guests today are fisheries scientists Reg Watson and Tim Dempster. We're talking about the ecological impact of the seafood industry here on Up Close; coming to you from the University of Melbourne, Australia. Now, Reg, as someone who monitors wild marine ecosystems, how do you see the role of aquaculture in the global fishing industry?

REG WATSON

Now, let me start by saying that I work with a group of people who are very negative about any kind of aquaculture. I tend to see that, with our increasing populations and need to feed them, that it's inevitable there will be more interest and more pressure to get food sourced from aquaculture. I guess some of the things that Tim mentioned - he's probably a little more optimistic about them than I am. Perhaps some of the disasters might be understated. But I guess the first thing that Tim said that has to be amplified is that it's not disconnected from wild stocks or the health of wild stocks. So it's not as if we can let our wild stocks diminish or forget about them because they're not relevant anymore. They're very relevant to all these fish rearing places, where we have to incorporate that into the feed. It is still an essential ingredient. We also know that most of the fisheries around the world use the coastal areas - the shallow coastal areas - because that's where the conditions are the best. You get the light to run the ecosystem properly. You get the right amount of nutrients coming off the land et cetera. Those are the areas which, of course, are of prime interest for putting aquaculture facilities; places where they're not going to be exposed to storms et cetera, et cetera. So we have to be careful when we're siting these things - not that the system can deal with the nutrients that are going to come

out and that disease could interfere with wild stocks, but that we are, in fact, blocking out, for aquaculture, some of the most important habitats; be they for adult or juveniles because, of course, many species of marine fishes have essential needs to live in inshore environments as juveniles. That may be where they breed. That's certainly where they survive, in sea grass areas et cetera, close to the coast. So those very habitats that we think aren't being used properly because we're not using them, are being used to support many other animals and many of the animals that we've come to rely on. If you look in some places, such as Indonesia, there are many areas of the coastline where these cages go back to back to back for kilometres and kilometres. Under those circumstances there really isn't a natural coastal marine habitat there anymore. The amount of nutrients that are coming from that large scale production can't be absorbed in any natural way by the rest of the marine system. So it's a question of siting them. It's a question of scale. It's a question of knowing how it's going to impact the wild environment. When I tried to find out something to make an ecological model for one of the embayments in western part of Tasmania, here in Australia, I tried to find out something about the marine systems. I knew that there was a lot of salmon farms there - a lot of big round areas where salmon were being reared - but I wanted to know something about the wild stocks in that area. I found precious little. So I think one of the things that has to happen is to find out more about what's happening in the marine environment; how the ecosystem works et cetera, before we make a decision to change it in what could be quite a significant way.

DYANI LEWIS

So, Tim, what is the contribution of aquaculture catch in the global catch each year?

TIM DEMPSTER

The current figures from the Fisheries and Agriculture Organisation of the United Nations say that of the fish that we actually eat - and that's not all of the fish that we catch necessarily - but of the fish that we eat half of it now comes from wild fisheries and half of it comes from aquaculture sources. So aquaculture, essentially, has, over the past three or four decades, starting from a very low point, caught up in terms of production. It now roughly matches fisheries production.

DYANI LEWIS

Reg, is that the same picture that you are getting?

REG WATSON

I just think that there are two things that the listeners have to consider. One is that there has been a decline in wild captures, landings, over the years, which, of course, is going to make the ratio towards aquaculture look better. The other one is that the Chinese reporting system - the incentive was to meet production targets that couldn't be met; so, in fact, the reporting was inflated year after year. This is the wild catch. We're still interested to know whether that, possibly, can be happening with aquaculture statistics as well because I think Tim will tell you that the biggest growth element in the aquaculture production globally is Chinese. There is at least one paper that I'm aware of that reported that - at least with some shrimp production - that what

was actually being reported to the United Nations was way inflated over what was actually happening. So I'm hoping that those production figures are accurate and that we are being able to source food by production systems like aquaculture to make up for what might be the deficits that we're facing. I'm a little bit suspicious that some of the statistics need a bit of work there as well.

DYANI LEWIS

Reg, in order to understand what is really going on in the oceans and to determine how to address some of the problems, monitoring, obviously, becomes quite important. This is partly the role of The Sea Around Us Project. Could you explain to us what The Sea Around Us Project is about?

REG WATSON

Well, we wanted to allow a study of what the impacts of fisheries around the world - what they were, particularly globally, because we're all very aware that in developed countries there are research organisations that study in fine detail what happens with particular fisheries. But globally, we wanted to see what was happening. We found that the only information that was on a global scale was that produced by the United Nations through the Food and Agriculture Organisation. It was wanting for several reasons; one of which is didn't actually tell you with any precision at all - other than maybe the South Pacific - where the fishing was happening; where these fishes were being taken. So how could you look at that and see what impact it might be having on a sea mount or sea grass or a marine birds' nesting environments et cetera. You needed to be able to put that into a spatial context where you knew where the fishing was happening; so how it was interacting with marine habitats - which there are some good maps now for many of them - and other species like birds and marine mammals et cetera. So that's what we've been trying to do, is compile better information on the fishing that's going on around the world.

DYANI LEWIS

So it sounds like we have a clear case of the tragedy of the commons: everyone's acting with their self-interest in mind to plunder these shared resources. Is that how you see things continuing over the next 50 years? Or is there a glimmer of hope in all of this, Reg?

REG WATSON

Well, I think that if we continue to have population growth we're going to continue to have to feed those populations. So with all the best of intentions we'll probably put greater and greater pressure on all our food resources, including the wild fisheries of the world. There is greater co-operation in management. There is a recognition of the difficulties of managing in these more remote areas because countries claim jurisdiction over approximately 200 nautical miles surrounding them. They try and stop foreign fishing fleets from coming in unless there's an arrangement. So they're trying to manage those for their own purposes, but for the future. So those areas outside of those areas on the high seas have been problematic, particularly those few places around the world where the bottom comes close up to the surface in a sea mount situation, where fishing on those areas tends to be quite destructive; but

they're outside of the jurisdiction of particular countries. So I am optimistic there will be more co-operation; that there will be more monitoring of what's happening and, perhaps, better informed choices. I don't think that the pressures to exploit these will lessen, although the costs, in the form of fuel prices et cetera, will definitely increase.

DYANI LEWIS

Tim, what about the regulation of the aquaculture industry? What measures could help to minimise the impact on the environment?

TIM DEMPSTER

There are lots of different ways that we should be looking at to increase regulation. Regulation really varies dramatically from country to country and region to region; so we have some countries where, essentially, our governance systems and our environmental monitoring and management systems are very good, at least in those countries - when new information becomes available - with some time lag that's taken on board. Then it becomes part of the regulations which govern where aquaculture can happen and how much should be in a certain area. In the area where aquaculture is growing the most - and that, essentially, is the Asia Pacific region. In a lot of those countries we don't see, necessarily, good governance structures and good systems for management and monitoring. It's really in those places where aquaculture, as it expands - and it will do so over the next century - essentially, has the greatest potential to have these coastal impacts. So that's, essentially, where our focus should be. Again, a lot of the information for doing this properly already exists. It's held by scientists like ourselves. It's held by international agencies. But it's making the links between that and on the ground management and practice in these areas; which is where, essentially, the real innovation needs to take place.

DYANI LEWIS

What about the consumers? Is there anything that we, as consumers, can do to make sustainable choices when purchasing seafood?

TIM DEMPSTER

I find this a very interesting question because there's a big push to get consumers to understand more about seafood and drive their choices based on sustainability criteria. I think, generally, that's a very good idea. For me it's something that is often mired in complexity. There are really so many types of fish that we eat. It comes from so many different places. For a simple consumer to really have the capacity to understand what might be sustainable and what might not be sustainable is very difficult. I guess simple systems that are put out by a range of agencies that say this kind of fish, not this kind of fish - they're very positive and can have some benefit. For me, I think the real innovation is coming back to governments and getting them to drive regulation at that level. That's where it really has teeth, in my view.

DYANI LEWIS

Reg, did you have anything to add to that?

REG WATSON

Yes. I think that there is some real hope that consumers can make some wiser choices. Anybody who has been in the position of wanting to try and select seafood wisely and following any kind of little car door pamphlet that they've been given to say eat this and don't eat that has probably run into the same problem that I have; that, often, the restaurant has no idea. If they know what it is, they don't know where it came from or which fishery. The fisheries around the world - and even within individual countries - some of them can be in real trouble in one place and not at all in danger in another place. So we need to know more about where our seafood is coming from and whether it's being managed properly. This has to translate through the whole system. The restaurant has to know what it is that they're serving and we have to be able to make sense of that. So we need some help. We're not all fishery scientists.

DYANI LEWIS

Well, Reg and Tim, thank you for being our guests today on Up Close.

TIM DEMPSTER

Thank you very much.

REG WATSON

Thank you very much.

DYANI LEWIS

Dr Reg Watson is Senior Research Fellow with the Fisheries Centre at the University of British Columbia in Vancouver, Canada. He joined us via Skype from Hobart, Tasmania. Dr Tim Dempster is Senior Lecturer in marine ecology from the Sustainable Aquaculture Laboratory at the Department of Zoology, here at the University of Melbourne. Relevant links, a full transcript and more information on this episode can be found at our website at [upclose.unimelb.edu.au](http://upclose.unimelb.edu.au). Up Close is a production of the University of Melbourne, Australia. This episode was recorded on 8 December 2011. Our producers for this episode were Kelvin Param and Eric van Bommel; audio engineering by Gavin Nebauer. Up Close is created by Eric van Bommel and Kelvin Param. I'm Dyani Lewis. Until next time, goodbye.

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