

Discussion of Session I

Chaired by John Gunn

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Chair John Gunn invited discussion after each presentation. These are recorded in sequence here. This concluded the morning session. Further discussion relevant to this session occurred during the closing "General Discussion" at the end of day 2.

The first comment after *John Koehn's* presentation was that it is vital, in studies of movement patterns, to have very specific questions in mind and then to determine what was the best method and hardware (including type and number of tags) to use. Sometimes a combination of conventional tags and radio tracking tags could be useful as the two techniques provide very different but often complementary information. However, without specific questions, using radio tags can waste a lot of time and money. John Koehn agreed that radio tags were just another tool and that the most important thing to consider was what question was being asked.

Tony Fowler (SARDI) asked what type of metabolic or physiological data could be collected with radio tags. John Koehn answered that heart rate had been monitored in a number of studies (internationally) and that the technology to monitor other metabolic parameters was expanding rapidly. There were several medical developments that were currently being applied to terrestrial studies (e.g. measuring hibernation) and these offered considerable promise for technology transfer to aquatic studies.

Malcolm Haddon (TAFI University of Tasmania) pointed out that differentiating between electronic tag types was becoming increasingly arbitrary with the appearance of hybrid tags (e.g. combination of radio and acoustic technologies) and that there was not yet a good nomenclature for these advanced tags. However, the primary issue was not so much how tags were labelled but what researchers did with them – how they defined specific questions and then applied resources to solving them. John Koehn again restated his agreement regarding the importance of clearly specifying the objectives of any tracking study. He also noted that hybrid electronic tags were getting over some of the limitations of the mono-tag type, e.g. radio waves do not penetrate seawater so a fish must come to the surface before such a tag in the marine environment will transmit, but combining this with acoustics – which allow free transmission through seawater – allows tracking for and transmission of data. Some hybrid tags still suffered from limited battery duration. However, advances in power-saving measures (e.g. programmable tags that cycled on and off, or that could switch to a low power mode) were extending the life of such tags and thus reducing the need for extra batteries – the heaviest components of such tags. This was particularly useful for the study of small fish where tag size and weight were critical.

John Gunn, from the chair, commented that there was a wealth of expertise in the electronics engineering

field and that it was really up to researchers to identify a specific question or identify the type of technological requirement rather than necessarily wait for something to be developed. Electronics engineers (particularly within universities) are relatively untapped resources by fish biologists in Australia. There is a growing tendency in the US and Europe for biologists to liaise more and more with electronics engineers to develop new technology.

Following *Ivor Stuart's* presentation, Richard Tilzey (BRS) asked if the extent of downstream movement through fishways was known. Ivor Stuart replied that such studies primarily concentrated on upstream movement. He noted that while some studies had attempted to look at downstream movement by trapping (largely with sea mullet and yellowfin bream), this area still needs a great deal more research in Australia.

Mark Kennard (CCISR) asked if there were any attempts to link fish movement or the use of fishways with environmental parameters such as river discharge. Ivor Stuart replied that their studies had addressed movements associated with discharge, noting that some species turned up in samples on high flows that were completely absent on low flows (and vice-versa), but that it is far more difficult to establish relationships with other parameters such as water temperature, salinity or conductivity. This is because it is hard to isolate these particular components in the field and design manipulative experiments to test them.

Andrew Sanger (NSW Fisheries) asked if Ivor Stuart could elaborate on the downstream migration problems associated with catadromous species. Ivor Stuart replied that this had been largely ignored in many studies and that several catadromous fish are now locally extinct above many barriers, so getting them back upstream is probably the first issue. Fish returning downstream will be a large problem in the future in Australia. He went on to report that researchers in North America are currently grappling with how to keep adult and juvenile fish from going

back downstream through turbines and over spillways by developing bypass technology and screens. Australia has not progressed to that stage yet. It is unknown what are the effects on survival for juvenile and adult Australian fishes of going over weirs or going through turbines or even the extent to which species can successfully find fishway entrances so they can get back downstream. This is an enormous problem that should receive research attention. NRE is starting programmes to look at this issue.

Martin Mallen-Cooper (Fishway Consulting Services) emphasised that fishways can also be incredibly useful tools for looking at the movements of particularly small fish that would otherwise be hard to monitor. Paul Close (NRE) asked if there were studies that identified what proportion of fish were moving upstream and how selective were the fishways? Is sampling a fishway going to give a representative sample? Ivor Stuart replied that fishway assessments first had to establish the success of the facility by making an accurate count of how many fish made it to the top. Second, was to establish how many fish were out in the river and whether they were actively migrating, resident or doing their own thing. Ivor Stuart referred to work conducted by Martin Mallen-Cooper which had attempted to quantify these parameters by netting a river before and after a fishway was constructed. By examining changes in abundance, this study had concluded that a large proportion of fish was actively migrating upstream. These types of studies would benefit from using both PIT-tag and radio tracking technology.

Following *Julian Pepperell's* presentation, Malcolm Haddon commented that while game-fish tag-release was useful because fish were released rather than killed, he believed that data derived from such studies would only be useful for looking at gross movement patterns. Estimates of size were too inaccurate to look at growth. Julian Pepperell did not agree. He pointed to a number of scientific publications that had come from such data sets and noted that utilising game and sports fishers as "unpaid field assistants" had many

benefits. He did, however, note that to maximise the benefits of such studies, it is important to co-ordinate game and sports fishing groups to collect specific data or target specific species.

André Punt (CSIRO Marine Research) asked if anyone had looked quantitatively at whether there were greater reporting errors in estimates of movement rates and if there was a greater incidence of tag shedding in "non-scientifically" tagged fish compared to those tagged in conventional research programmes. Julian Pepperell replied that there had been a fair amount of double tagging of billfish in the Atlantic using two different tag types and that results were comparable to scientifically-tagged fish. He believed that estimates of movement rates should not differ between the two types of programmes. Yellowfin tuna tagging was a good example. This species had been extensively tagged by both researchers and game/sports fishers in the same areas and estimates of movement rates were not significantly different.

A further point was made from the floor that although there were at times, limitations to the data, one should not overlook the cooperative value of sports-fish tagging, particularly when the species concerned was targeted by both commercial and recreational fishing operations. Julian Pepperell agreed that involving recreational fishers often had benefits far in excess of the data collected.

John Gunn commented that CSIRO tag many of the species used in Julian Pepperell's cooperative tagging programmes and that he regarded the recreational data as semi-quantitative or qualitative, depending on the species. Nevertheless, recreational fishers are often able to tag fish in areas where the commercial fishers do not operate or which research programmes are unable to cover. One benefit of involving recreational fishers in tagging is thus the combined ability to tag over far broader areas.

Following Geoff Arnold's presentation, John Gunn asked whether the advances in "off the shelf" tracking

technology had now approached the capabilities of the system that Lowestoft had been using. Geoff Arnold commented that the hydraulic stabilisation package that Lowestoft was using cost £250 000 in 1970. Nowadays there are much more affordable units available that can generate very good data as evidenced by the increasing number of publications dealing with such work.

Malcolm Haddon commented on the expense of both the systems used by Lowestoft and the ship-time required for the study of movements of a relatively small number of fish. He then asked if there were any problems with the ship influencing the behaviour of the fish during tracking. Geoff Arnold noted that work in the open sea is an expensive exercise at the best of times. He noted that there were also some things like obtaining concurrent ADCP data for the measurement of current patterns and orientation that you cannot get without using large vessels in these areas. What is needed are good, robust measures of the average speed and orientation of moving fish to put into models. With respect to the ship influencing the behaviour of the tracked fish, Geoff Arnold replied that they had looked at that by steaming around fish during tracking to see if they changed direction or behaviour. In all cases they had been unsuccessful in eliciting any activity that could be construed as influencing the fish. Tracking usually occurred at a very slow speed (1-2 knots) and the current ship was extremely quiet at that speed. Even in other vessels that were much noisier, there was no apparent influence on the fish during tracking. The behaviour of acoustically-tracked and archival-tagged fish was similar.

John Gunn commented that one of the interesting data series to come from his group's archival tag work with tuna was that the fish behaved very differently for the first 2-4 days compared to the rest of the time at liberty. With so much work put into tagging and tracking, this raised the question of whether much of the short-term data collected reflects abnormal (capture stress) or normal swimming behaviour. Because his group surgically implant their tags rather than attaching them

externally, as was the case in many studies, this procedure may create more handling stress. Geoff Arnold replied that they do see a recovery period in their archival tag data of up to 1-2 days. With acoustic tagging, they have always inserted the attachment wire through the fish well ahead of time and then only attached the acoustic tag just before release. They had not seen evidence of a recovery period using this technique. On the other hand, monitoring a recovery period can be turned to your advantage. For example, their work with cod allowed them to look at swim bladder inflation over the first 2-4 days as the released fish adjusted their depth to neutral buoyancy. They were able to measure rates of increase of depth and deduce that the fish was not neutrally buoyant all through its depth range (which was the classical idea). The fish were neutrally buoyant at some specific depths.

John Gunn asked Geoff Arnold if they generally kept their fish in a tank for a while before releasing them. Geoff Arnold replied that they did so to be able to select the fish that were not heavily bruised during collection *via* trawling. It would be better if they did not have to hold them but this procedure had produced the best results.

Following *John Gunn's* presentation, *André Punt* commented that the extent to which tagging information was used seemed inversely proportional to the cost of the technology. He asked if we are yet ready to take the output from archival tags and use it to form management advice. How close are we realistically, to using such data to change the way we manage a resource? John Gunn replied that there is a very real and large potential for interactions between tuna fisheries that needs to be factored into management decisions. Using conventional tagging has given us a very biased perspective on the interactions between, say, the domestic southern bluefin tuna (SBT) surface fishery and the fishery in the central Indian Ocean. We have never had a conventional tag back from the central Indian Ocean and have previously assumed that there was little

interaction between the domestic and this Taiwanese-based fishery. Archival tags have indicated that this assumption was flawed and this instigated a new research initiative that identified an enormous amount of SBT being taken in the Taiwanese fishery that was not being recorded. These catches are now being included in the stock assessments. Although this is not a direct use of archival tag data, it did provide the initial step towards including this catch component in assessments.

Will Zacharin (PIRSA) asked what level of under-reporting there was with archival tags and whether the information gained from the tags has been used by fishers to alter their fishing behaviour. John Gunn believed that there was a considerable level of under-reporting by the Japanese fishery. He also noted that Japanese researchers had concurrently been buying archival tag readers so that they could down-load the data themselves. He suspected that the fishers had benefited from this. John Gunn further indicated that the archival tag data were now encrypted so that this was becoming less of an issue.

Malcolm Haddon noted that there was a distinction between what populations do and what individuals do. Archival tags may be useful to help interpret what populations might do but this needs to be married with other information to make it more useful to managers. John Gunn suggested that this aspect would be covered in *André Punt's* session about spatial dynamics models. The integration of conventional tagging, catch data and archival tag data *via* spatial models was an active area within John Gunn's group.

Following *David Mills'* presentation, Rob Day (University of Melbourne) said that he had done something similar in California with seeding reared abalone onto reefs. They were able to show that doing so resulted in a decrease in the total number of wild juvenile abalone. This was not only a competition effect, but seeding apparently attracted predators into the area, which consequently reduced the natural abundance. David Mills replied that he was very