RSNZ Biodiversity Committee Response to the Environmental Research Roadmap draft document.

This response is an official response of the Royal Society of New Zealand, under the delegations bestowed upon its Committees of experts by the Council of the Royal Society of New Zealand.

The members of the Biodiversity Committee are named on the RSNZ website http://www.rsnz.org/advisory/biodiversity/ and those with direct input to this response are listed below. In addition, we have solicited further input from the biodiversity research constituency of the committee (including research managers and colleagues).

Chair – Dr Dennis Gordon; Executive Officer (RSNZ) – Dr Kathleen Logan
Members – Dr Murray Parsons (consultant botanist), Dr Murray Potter (Massey University), Dr Peter Lockhart (Allan Wilson Centre of Molecular Biosciences), Mr John Charles (HortResearch), Ms Melanie Newfield (Biosecurity New Zealand).

Preamble

The Biodiversity Committee was set up by the Royal Society of New Zealand originally to advise the government in support of its ratification of the Convention on Biological Diversity (CBD). The government has endorsed the Global Taxonomy Initiative of the CBD, which has a work plan devised to overcome the 'taxonomic impediment' to achieving the goals of the CBD, i.e. to ensure the nation has a core of trained taxonomy professionals equipped to handle all taxonomic needs and questions pertaining to biodiversity inventory and monitoring in the context of achieving the CBD goals for New Zealand. The Biodiversity Committee includes representatives from university, CRI and public sectors. The latter are often users of the kinds of environmental research undertaken by the areas represented on the Committee (for example the Biosecurity New Zealand). The committee is concerned with actions that implement the Convention of Biological Diversity including conservation, research, and management of environmental resources to mitigate losses of biodiversity, and promote conservation.

The Biodiversity Committee discussed the Draft Environment Research Roadmap at a scheduled meeting in Wellington on Friday 6th of October, and this response is a summary of that discussion, including comments from our constituency.

It is laudable that the MoRST should have a plan for its environmental research, and that it should go out 20 years. This is the minimum necessary time frame to consider the importance of quality environmental research to help society adapt to the impacts of the recent human population explosion.

1. ROADMAP DIRECTIONS

The main goals of the Roadmap are acceptable, but how we get there, or how we travel along this road will impact on the outcomes at the end of the journey. Focusing only on high-tech research per se, for no other reason than it being a 'trend', may result in deletion of whole areas of perfectly good discipline-based research that is performing well and achieving desired goals. We warn against such a journey.

We note that human capability issues are not directly addressed in this roadmap; however, capability issues are effectively solved by maintaining and increasing activity. Therefore

before considering the HOW of this roadmap (i.e. how will it be implemented) you must consider the sentence in section 1.4.4: "this should not occur through the loss of small-scale, disciplinary science because this is still needed to underpin larger scale studies…". We strongly endorse this idea.

Yet, this sentence is at odds with the sentence under "Delivering the Benefits" where it "may require reprioritisation of existing funding." Moving money to more expensive, high tech areas will not achieve the desired goals. Only new money to enable high-tech, more expensive research, in addition to that which underpins it, will move us toward achieving the goals of this roadmap. We think MoRST needs to strongly lobby Treasury for a greater priority for environmental research. It underpins our society and economic structure. The proposed new high-tech areas of research will be relatively expensive and may draw inordinate amounts of funds from the "small-scale disciplinary science" resulting in erosion of the latter. This will effectively result in a total erosion of the total science done, even if new kinds of things will be possible that we couldn't do before. We reiterate below why this is a problem.

We note that the roadmap was informed by reports based on other countries' strategies, and New Zealand reports. But, from a biodiversity point of view, there was a skew toward integrated modelling, and complex systems science. We appreciate that these trends are in line with overseas policies, and the language used in this roadmap is consistent with that overseas. We also recognise the value of complex, systems analysis and holistic views of ecosystems in producing environmental outcomes. However, we want to reiterate the need for simple information to fill in the data in (complex systems) databases. That is, do not move money *away* from the research that is actually obtaining the necessary observations and classifications to achieve our needs under the Convention of Biological Diversity, the Biodiversity Strategy and the Biosecurity Strategy. These require actual taxonomic descriptions of individual species, as well as habitat information. The raw information, placed into large scale databases will subsequently inform the complex systems analyses. The latter cannot proceed without the former, and the former is in serious decline, and noted to be under threat by the Conference of the Parties to the Convention of Biological Diversity.

MoRST should recognise that we are already doing integrated research. Therefore, some of the underlying premises for this roadmap are wrong – ecosystem scale research (that which deals with energy flow-through) depends on an underlying understanding of organisms in an environment: evolution scale, individual, species. There is a problem with the notion of collating existing information to a database without attention to **ongoing population** of that database (from what the paper describes as "small scale, discipline-based research").

The philosophy of science means that even when concentrating on systems-wide approaches, it is still hard to design experiments that are not 'reductionist' in nature. This is due to the methods of observation, testing, verification (repeatability) and other notions that are fundamental to scientific practise.

Having reductionist experimentation with statistically verifiable results, combined with good communication across disciplines THEN enables larger scale modelling. (This integration already occurs to a larger extent than the roadmap recognises, maybe for reasons that are explained below about scientist motivation). In any case, shifting funding from the former to the latter without consideration of how short we currently are of basic environmental information-gathering scientists will defeat a holistic strategy.

MISSING DIRECTIONS

An additional or different generic direction is: the way things are currently done!

There seems to be a notion that, to have a direction, it must be away from the existing place where one is at. Well, we say that if part of a system is working well, why move away from it? The broad directions of enhancing long-term data, ecosystem scale research and demonstration and innovation all fail to consider that **long term data also includes human-intensive data collection like taxonomy, behaviour, and ecosystem relationships**.

Biodiversity data must have a focus on the organism. Both terrestrial and marine data need to include the tri-trophic interactions – what something eats, what eats it and its habitat (where it lives and in what conditions). These require good quality human researchers to gather the data. It is not ecosystem-scale at the point of collection and analysis, yet it is information that underpins, and then contributes to, higher level ecosystem understanding. So the directions that move away from the need for skilled humans to gather and interpret information, and focus instead on automated data collection and super-scale analysis are not valid methods for all areas of science.

Apart from this very important point, - to **ensure that this current discipline-based research is supported and expanded where necessary** - we agree with the goals.

The Approach to High Level Priority Setting (section 1.5)

The broad priority setting that just 'maintains' biodiversity conservation systems and the short and long-term research to support it does not marry with the current needs. There is currently a severe shortage of certain skill sets, (such as taxonomy, systematists and bioinformatists) since in the recent past there has been a continual erosion of full-time equivalents or a lack of funding to train staff in new areas. Therefore we suggest this priority should be changed to '**increase**' or 'recovery to required levels' based on the needs of the CRIs, Universities and various agencies and businesses such as Biosecurity New Zealand, or fisheries etc.

Under the government's goals (and, thus, the priorities these bestow on MoRST's priority framework), there is a problem with the lack of recognition that: the science behind a lot of ecosystems research is the *same* for environmental research *and* industry research. However, the current funding systems separate, artificially, these pots of money. It should be made possible for good environmental science to be carried out in either (or both) natural or modified environments without bureaucratic 'cross-portfolio' constraints on funding.

Boxes 1 and 2 on page 22 appear somewhat mischievous – although talking about biocomplexity, there is little 'bio' in there! While we accept that physical data are likely to be obtained by automated sensors and machines, and no humans, (and in some cases this may include physical data relating to organisms), the biological aspects will always require human expertise. Observations of ecosystems including taxonomy, behaviour and other raw data require the eyes of people to observe and analyse, especially when talking about new organisms. The census of biological information is what goes into complex systems storage databases and modelling systems. One needs both. And one can't just rely on a description – names become important for classification.

3. SCOPE AND FUNDING OF RESEARCH

We acknowledge problems of balance, between needs-driven and curiosity driven research. This is sometimes a problem of scale, in that respect, we commend MoRST for having a 20 year plan. The representative from Biosecurity NZ noted that previous long term investment in taxonomic descriptions has enabled quick responses to biosecurity incursions recently. Maintaining, and increasing capabilities where they can be shown to be low, is fundamental, and taxonomy is one such area. The species that actually invade NZ often make a mockery of our predictive abilities. When one lists expected or potential threats that may arrive, prioritising the likelihood of each threat, the reality is that often a completely different species arrives, or one low on the list. Therefore prioritising by perceived needs is not helpful in this area, and having a broad base is what is required.

Currently, we are losing small clusters of expertise just because they don't fit into a funding structure that is set up without an understanding of the backbone of current science. The gaps in expertise in the science system appear more and more, as single experts or small groups lose funding when it is shifted to larger collaborative and coordinated programmes. This may occur even when the latter provide a lower quality of expertise in individual areas (whilst maintaining a strong generalist approach to their science programme and, hopefully, better uptake of the research outputs to achieve consolidated outcomes, i.e. the OBI). However, we also understand that with a budget of only 0.58% of GDP, necessarily the 'marmite is spread thinly on the toast and holes appear'. One question that is not dealt with is how to incorporate small groups or single experts in a policy that trends toward funding existing, large groups with major integrated programmes?

This needs to be addressed.

New recruits in some areas of research take a long time to build up expertise. There are good reasons for trying to keep those individual experts or teams that operate separately from larger groups. Those who say that scientists do all their best work before they are 35 years of age fail to appreciate that knowledge, built up over a lifetime of research, becomes more valuable when a scientist is at the peak of his or her career, namely in the later stages of the career. In fact, many scientists are now known to retire from administrative duties, but keep a research office so that they can continue to study and continue to add to the body of scientific knowledge. These retired workers are an exploited group in many professions, subsidising the work of an organisation with free intellectual endeavour, and in NZ are being used as the 'corporate memory' of accumulated expertise. With reduced resources and little attention to human capabilities, it is of concern to us: who will fulfil this role when they are dead?

The comment that "competition drives the pursuit of excellence" has been debunked in many circles. Competition also drives exploitation of resources for short-term gain, including using post-docs for cheap labour without consideration to their long-term training or career path. In addition, as mentioned, retired scientists are used and abused for their accumulated knowledge and memory. The lack of long-term consideration in these cost-effective methods of doing research will put us in a dire situation in a short few years.

We appreciate that the human resources for science and technology are being dealt with in another policy stream; yet, one cannot separate this issue from any area of science. What kind of career does the government want for New Zealand's scientists? Attracting people will ultimately depend on the HOW of the funding and investment pathways. The Scope and Funding of Research may be *delivered* primarily by FRST and HRC, however, we believe

there is a strong leadership role for MoRST to guide investment in order to maintain and increase our environmental research capabilities, including people, and outcomes.

4. EXPLANATION OF BROAD DIRECTIONS

This section detailing the directions has a number of points made that concern us.

4.3.1. Description versus Prediction

The title of this paragraph is predicated upon a completely misleading notion. Description **leads to** prediction: it is not something separate from, competing with, or opposite to. It is true that *users* of research may need more of the latter, but it is necessary first to undertake the former (descriptive research) on which prediction depends.

Throughout the roadmap there seems to be a flavour to move away from actual discovery and observation, and instead to find new ways to analyse the information that we have now. While this may be admirable with new technologies and modelling systems to be developed, we think it is very short-sighted, as we will need new data to input into these models for the future. Big pictures are indeed useful but they need the underpinning work – one cannot continue long term on work that has been done historically; we need a continual pipeline of information. Therefore the human-based science capabilities are still required no matter how 'automated' and high tech the analyses get. Also, physical data are much more amenable to automatic collection and analysis than biological data. In particular, areas of poor current understanding, such as marine biodiversity and invertebrate biosecurity threats, require a solid backbone of observation, classification, taxonomy and habitat /life cycle analysis before relevant holistic ecosystem studies can be undertaken.

4.3.3 and 4.3.4 High Technology

Research is technology-led. If a scientist proposes a project using new technology, it is more likely to get funding than when proposing a traditional project, using traditional methods, no matter how important to New Zealand.

Technologies often enable research to be done faster and on a bigger scale, and so research expands to use that, making new discoveries, which iteratively produce new technologies. Science begets technology, begets science. The notion that scientists should always be using the latest, most expensive technology is not necessary, as some science does not require it. Some science continues using well-established, traditional methods with people using a wealth of knowledge about biological systems built up over time – their tools are their memories and executive logic functions (brains), microscopes and computers for data storage. There may be peripheral improvements to image analyses for data storage (of pictures) but fundamentally the human eye is required to, e.g., look down the microscope and make judgements about a biological specimen. This type of research can be very cost-effective, due to comparatively low asset investment; but most importantly, it is the only way this research can be done.

The Roadmap directions reveal an emphasis on scientists using high technology and we like this if it is *in addition to basic work.* However, it is expensive, and sometimes does not fit well with the current funding model. That is, depreciating large assets (necessary for high technology research) is problematic and said to be less cost-effective than off-shore sourcing of research services. The latter is all very well, but reduces local capacity to do research in the long term. Scientists should use the technology and methods that they **need** to undertake their work, rather than implying that we should somehow be forced to use high technology

when it is not warranted. Please remember that in some cases it requires experienced scientists (humans, not machines) to provide information, observation or analysis.

We are also concerned with the sentence on p31, (Opportunities for innovation) stating that "New Zealand has limited research capacity in the natural resource socio-economic systems area"! What does this mean? Does this mean we are not good at science in general at all? The conjunction of all these areas (natural resources, human needs, economics), is surely a political arena, and subject to policy, rather than research findings. To suggest that with enough systematics we can 'discover' the optimal econo-social use of natural resources is a bit far-fetched. Responsibility for our environmental footprint is a policy question, not something that can be discovered. It can definitely be informed by environmental and social research, but to expect a systematic understanding of these (when economics is hardly yet a science) suggests a poor understanding of systematics.

4.4 Achieving integration

Considering the contestable funding model that is not expected to change, we are concerned with the statement at the bottom of page 32 – it is an insult as it is not true. This should be better worded. Researchers are already motivated to work collectively, and they do so now (often despite the system, not because of it). There are some barriers to collaborative efforts between CRI and University staff at an official level, due to the need for CRI staff to allocate funds to overheads (that the University collaborators don't need to do). This requires complex management of contracts etc. However, collaborations are still happening according to anecdotal evidence, sometimes under the radar, at unofficial levels.

The CoREs have enabled a new level of collaboration and integration. The ability in CoREs to work together using strong interactions between university, CRI and other parts of the science system illustrates scientists' natural inclination to collaborate to achieve large-scale goals.

'Full cost recovery' has problems in other ways too, including depreciating large assets, as if a machine had to be replaced at the end of its lifetime, and the inclusion of overheads (sometimes) on such depreciation calculations. Such accounting can limit the ability of official collaborations with CRI staff, but despite this they are happening anyway.

How can integration work better?

Remove contestability for overhead funding, and keep a contest for ideas funding.

Overall integration is already working. Scientists highly value working in teams or on multidisciplinary projects. In addition, scientists highly value the usefulness and utility of their findings, e.g. the applications to Biosecurity New Zealand, Dept of Conservation, Ministry of Fisheries and the Biodiversity Strategy.

One of the incredible strengths of NZ science is that, because we are a small nation, all of our research campuses comprise several different organisations where people gather and discuss work across disciplines, structures (private, CRI, University), and programmes. We should take advantage of this by thinking about how to remove barriers to official collaborations. Existing scientists already are quite close in the way they work, in spite of the Foundation's funding mechanisms. These and the current science management philosophy are considered by many at the grassroots as being altogether wrong.

At grassroots level, scientists are asking: "what kind of scientists do you want?" Omni-competent generalists? Or specialists with gaps in research fields covered nationwide? What sort of career path does MoRST see as important? It is now very hard to be a specialist. If integration (working together) is seen as important, then it is equally important to sort out the career path problems that exist in CRIs, and to some extent, universities (particularly with post-doctoral trainees). Therefore we suggest that the Environment Research Roadmap be closely aligned with the Human Resources in S&T policy stream to maximise integration in New Zealand's science system.

The only other comments we would like to make about 'integrative programmes and research capabilities in NZ' is that sometimes there is no need for it. So don't force it upon all areas of science, as there are some areas that work well in a discipline-based mode, with information sharing at the output end; rather than having to make an artificial joining just to get funding.

[Criticism of box on p37 regarding Marine Biotoxin Research Workshops: the 1993 organism found at Orewa was new to science, and without identification of the organism, we wouldn't have developed the new technologies relating to identification of biotoxins. This box does not even acknowledge that what we know (i.e. what the organism is and how it fits into the global system) is because of taxonomic expertise at NIWA. The latter used to be supported by 0.9 FTE funding from FRST per taxonomist in 1992, but is now only supported at a rate of 0.46 FTE or less today. This is a situation of current under-funding, and if only 'maintenance' of this sector of environmental research is the ultimate goal, then such "examples of small and large scale integrative science programmes" will, in future, stop at the first hurdle.]

5. SPECIFIC DIRECTIONS FOR EACH ECOSYSTEM

The following points relate mainly to biodiversity and biosecurity, as these are the expertise areas of this Committee.

Regarding the threat to taxonomy – we agree with the sentiments at the bottom of page 56, on recognition that taxonomy is a threatened capability, but the suggestion that 'a more strategic oversight… and prioritising biosystematics research according to actual needs' is another cheap-shot that implies it is not already being done. Research organisations do, indeed, prioritise according to needs - they have to in the competition for funding, but the shortage of investment is what causes the ultimate threat.

The Biosecurity NZ says that it cannot predict, in advance, needs and thus 'strategise' on an area. A focus on perceived needs would ultimately reduce expertise across the spectrum of taxonomists. Having a breadth of expertise enables us (NZ) to respond to unexpected threats of biosecurity and other unexpected incursions.

Biodiversity is not just taxonomy. "Functional biodiversity" is critical too. How many, and which species can an ecosystem lose/gain before it collapses? Questions such as these require considerable applied ecological skills as well.

5.5.1 Throughout the roadmap we wondered about the 'futures analysis' input. Appreciating the long-term time scale, and the unknown technologies that may be developed from new discoveries in the interim, we were still concerned at the level of 'science fiction' rather than science fact going in to the roadmap. On page 55 the policy context mentions evolution to 'a higher state' – it is a strange terminology, do you really want to say that? Perhaps MoRST

could include the science (fiction) references that informed the futures concept of this Evolved Higher State?

5.5.3 Under research directions of biodiversity the roadmap recognises that "Halting the decline depends on maintaining the persistence of biodiversity… and the protection of … the processes that sustain it." We suggest that a key challenge is also to understand *biodiversity processes*. For example the relation between diversification of species and climate instability, historically, could inform impacts of climate change in future, but only if we understand the underlying processes.

6. PUTTING THE ROADMAP IN PLACE

MoRST should show leadership in ensuring the policies of this roadmap are faithfully supported by FRST and HRC, and not just the spirit since it's the detail that counts.

It is important to consider careers as part of the roadmap; they cannot be separated from achieving environmental goals.

Science is not a business: It has been noted for many years, at least since the CRIs were established, that New Zealand is very good at doing science, but not very good at turning it into business. Yet, we go into science for a career in science, not business. Certainly, scientists should work on science that is of benefit to New Zealand, but it should not be solely scientists' responsibility to implement it – the onus is on business to take up opportunities revealed by science. It's fair to say that communications between science and businesspeople could be improved, but, ultimately, scientists should not be penalised for lack of uptake.

This concept is repeated in the Roadmap with opportunities to take environmental science and make it work for the benefit of New Zealand. The roadmap implies that it's the scientists' job to take it to the outcomes, when this is a job for an environmental business. We must have good science in order to deliver good outcomes. Focussing on outcome delivery at the expense of good science is fatal. MoRST should ensure that the additional costs of implementing science outcomes do not come out of Vote RS&T, hence diluting the actual science effort required to make outcome-delivery feasible in the first place.

Implementation of the Roadmap

Lobbying to get an increase in environmental research funding is of paramount importance if there is a policy move towards more expensive, high-tech research. Otherwise the total quantum of research achieved will be substantially reduced, potentially involving permanent loss of human capabilities, and stranding of large assets.

CRIs will support the call to Treasury for an increase in the total quantum of Vote R,S&T funding, as long as the mechanisms for investment are fair and inclusive, and do not further jeopardise the breadth of scientific expertise in NZ.

Basically, more dollars are needed; moving money around within the pot does not enable further goals to be reached. Prioritisation does not help, since there is simply a lack of overall research to support the existing activities of the Ministry for the Environment (environmental standards) and the Biodiversity and Biosecurity Strategies. A cross-government discussion needs to be held to appreciate just how severe is the shortfall of environmental research. Funding has been declining in relative terms over the past 12 years, and, as research gets more expensive per project, necessarily, capabilities are permanently lost. Environmental research needs a greater priority.

SUMMARY

Integrated systems-based research using high levels of technology may be useful in some areas of science, but this should not occur through the loss of small-scale, disciplinary science because the latter is still needed to underpin larger scale studies

Scientists are already doing integrated research, as the natural way in which they work. Such collaborative tendencies should be better supported by funding structures and policy.

High quality research is essential to deliver good environmental outcomes. Outcome delivery should not be at the expense of quality research, as the latter is fundamental to achieving the former.

Career structure issues need to be addressed in the process of implementing this Roadmap. We strongly encourage MoRST to align this policy with that of the Human Resources in Science and Technology, and take care not to allow further erosion of capabilities.