

PLANNING STRATEGIC RESEARCH FOR WILD FISHERIES, AQUATIC ECOSYSTEMS AND AQUACULTURE IN NSW

– Tables of Research Priorities –

– Last updated 16 May 2011 –



NOTES:

These tables are “living documents” available online at (<http://www.dpi.nsw.gov.au/research/fishing-aquaculture>). As priorities change in the light of new research being completed and as new questions are formulated, stakeholders are given the opportunity to update their priorities and these updates are presented here. Stakeholders wishing to provide updates to this document should e-mail: tracey.mcvea@industry.nsw.gov.au

* indicates that research is currently underway

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INTRODUCTION

Decision-makers who manage fisheries, aquatic ecosystems and aquaculture receive advice from many stakeholders, interest groups and experts. Whilst such advice and opinions come from industry, recreational, Indigenous, environmental and political groups, the most influential information upon which decisions are made usually comes from rigorous, objective science. That is, decision-makers require answers to complex, difficult questions about fisheries, aquatic ecosystems and aquaculture that require the “best available scientific information”. Because scientific research ultimately provides this scientific information, its direction is one of the most important factors in framing future management policies and laws.

The questions that are asked of fisheries science are usually far greater in number and scope than can be readily answered – particularly in a state like New South Wales with relatively small commercial fishing and aquaculture industries and, therefore, relatively few resources available for their scientific study. Deciding which are the most important questions to answer, and how to answer them, are key processes in shaping future fisheries research and, ultimately, future fisheries management. The latter process (how to answer high priority questions) is usually accepted as being best done by professional scientists because they are trained to be objective, impartial and to base their interpretations on rigorous analyses of available evidence. It is also well-accepted, however, that the best group(s) to lead the former process (the prioritisation of which questions should be answered) should be the end-users of the research results and potential beneficiaries, i.e., the decision-makers and stakeholders themselves. This is because these groups are in the best position to decide which areas of inquiry would contribute to decisions that would lead to the greatest improvement in the particular “stakes” in which they have a “holding”.

This rationale is used in the development of the following research priorities for NSW by continually consulting with as many stakeholder groups as possible regarding the research questions they have for their particular stakeholding. These priorities are then combined and re-circulated so that these stakeholder groups have an opportunity to prioritise each others’ research areas in addition to their own.

Most of NSW’s various advisory councils and committees for commercial and recreational fisheries, aquaculture industries, catchment management groups, Indigenous groups, the marketing sector and other stakeholder groups are involved in this process as well as relevant Government agencies (see below table).

List of stakeholder groups consulted

| | |
|--------------|---------------------------------------------------|
| AbMAC | Abalone Management Advisory Committee |
| AC (TOG) | Aboriginal Communities (Traditional Owner Groups) |
| ACoRF | Advisory Council on Recreational Fishing |
| AM | Australian Museum |
| ARAC | Aquaculture Research Advisory Committee |
| ARG | Aboriginal Reference Group |
| CMAs | Catchment Management Authorities |
| Coastal CMAs | Coastal Catchment Management Authorities |
| Co-ops | Association of NSW Fishermen's Cooperatives |
| DECCW | Department of Environment, Climate Change & Water |
| EGMAC | Estuary General Management Advisory Committee |
| EPTMAC | Estuary Prawn Trawl Management Advisory Committee |
| FSC | Fisheries Scientific Committee |

| | |
|----------|-------------------------------------------------|
| AbMAC | Abalone Management Advisory Committee |
| LCMA | Lachlan Catchment Management Authority |
| LobMAC | Lobster Management Advisory Committee |
| Maritime | NSW Maritime |
| MCMA | Murray Catchment Management Authority |
| MDBA | Murray Darling Basin Authority |
| MFMA | Master Fish Merchants' Association |
| MPAC | Marine Park Advisory Council |
| NCC | Nature Conservation Council |
| NOW | NSW Office of Water |
| NRC | Natural Resources Commission of New South Wales |
| NRCMA | Northern Rivers Catchment Management Authority |
| NSWALC | NSW Aboriginal Lands Council |
| NSWSIC | NSW Seafood Industry Council |
| NSWDPI | NSW Department of Primary Industries |
| OHAULMAC | Ocean Haul Management Advisory Committee |
| OPTMAC | Ocean Prawn Trawl Management Advisory Committee |
| OT&LMAC | Ocean Trap & Line Management Advisory Committee |
| SFM | Sydney Fish Markets |
| SIAC | Seafood Industry Advisory Council |

The net result is hundreds of different research areas being identified as requiring attention. These tables of priorities are 'living tables' that are regularly updated as priorities change as new questions are formulated, as new research is completed, as new feedback is received from stakeholders and, most importantly, as new directions and requirements come from decision-makers. To this end, regular updates of the priorities in these tables are available on the NSW DPI website (<http://www.dpi.nsw.gov.au/research/fishing-aquaculture>).

The tables identify the various priority areas identified during the consultative process, grouped into appropriate categories and sub-categories, and which stakeholder group(s) held particular areas as high priorities. For those research areas where work is currently underway, an asterisk (*) is appended. We also provide a brief description of most of the general areas of inquiry and the sorts of scientific work that are required to do them.

These tables should be viewed as a resource for those interested in aquatic research in NSW and those wanting to do research or seek funding for research from granting bodies. It will also prove a useful tool for such funding bodies as they decide which particular research projects should be supported and, in so doing, which particular stakeholder group(s) will be satisfied.

These tables do not prioritise the many research areas and questions because particular priorities for research depend on the point-of-view held by any particular stakeholder group. For one group (e.g., NSW DPI) to provide such a prioritisation would be simply placing its priorities above all others. Instead, we present the whole list, identifying which stakeholders hold particular priorities as important at the present time so that researchers, decision-makers and granting agencies can weigh the costs and benefits associated with answering particular questions (rather than others) in the light of knowing which stakeholders will be satisfied and which ones may not be.

Resourcing

Whilst there are several sources of funds available for research into fisheries, aquatic ecosystems and aquaculture in NSW, the majority of resources are provided by the NSW Government. The NSW Government has the overriding responsibility to manage and monitor the aquatic resources of the state on behalf of its owners (the public of NSW) and, unfortunately, at the present time, there exists little capacity outside NSW DPI for aquacultural science or for wild harvest fisheries research such as resource assessment, recreational creel surveys, etc.

However, research into fisheries, aquatic ecosystems and aquaculture in NSW does not happen in a vacuum. NSW is Australia's most populous state, is located centrally on the eastern seaboard and contains a large proportion of the country's freshwater habitats. These attributes position NSW's research issues into aquatic resources as highly significant at a national level, ensuring that NSW remains a major player in national research efforts. Such a prominent national position provides significant and on-going opportunities for the focussing of interstate and Australian Government research expertise and resources towards NSW-centric issues and a proportionate attraction of investment into their resolution.

Whilst such national foci (and their many consequent collaborations) are important to NSW, it is nevertheless true that, in an ideal world, the overall funding of research into fisheries, aquaculture and aquatic conservation in NSW would be enhanced. However, in a state with relatively few fisheries resources, a relatively small aquaculture industry and a very finite amount of funding available for a massive number of research questions, opportunities to increase funding for aquatic research remain limited.

In the foreseeable future, therefore, the majority of resources for aquatic research (which, as noted above, are provided by the NSW Government) have to be assigned to the most pressing and core issues facing our wild harvest fisheries, aquatic ecosystems and aquaculture industries. For wild harvest fisheries and aquatic conservation issues, this must involve monitoring wild stocks, aquatic biodiversity and habitats to: (i) identify if and when changes to management are warranted; and (ii) determine the success (or otherwise) of such management changes. For aquaculture, enhancing the existing and developing aquaculture industries of NSW is the priority and therefore the technological work needed to improve production for existing and new aquaculture species will continue to attract the greatest attention.

WILD FISHERIES RESOURCES

This category of priorities refers to issues concerning NSW's many commercial and recreational fisheries. These two sectors differ in the way fish are caught and what happens to them after capture (sold, released or consumed) but are similar in many of the actual species and stocks exploited.

It is well-recognised that fisheries science concerning wild harvest resources is a particularly difficult field of science because many of the questions that require answering involve dealing with things that are invisible to normal methods of observation. For its entire history, the field of fisheries science has suffered by not having at its disposal non-destructive techniques for sampling and monitoring aquatic resources. This has meant that most avenues of inquiry involve indirect measures of stocks based on catch-per-unit-effort information and increasingly sophisticated predictive models to estimate fluctuations in nature. This reliance on information about animals that are already caught, dead and removed from systems, for use in analyses that try to predict what will happen to those systems, establishes significant problems that fisheries scientists have tried to deal with for decades.

Resource Assessment

Questions about the status of stocks are fundamental to the management of all fisheries and therefore formed a consistently requested item for research across many stakeholders involved in the fishing industry or concerned about the long-term sustainability of fishing. Stock assessments of all species exploited in most of NSW's commercial fisheries are listed which, because recreational fisheries often target the same stocks, means that such assessments would also be applicable to recreational fishing interests. Another consistent feature was the identification of priorities to develop new ways to do stock assessments that are appropriate for the relatively low value fisheries that characterise NSW.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Assess the stock status of all important species in all commercial, recreational and indigenous fisheries in NSW * | NSW DPI, AbMAC, ACoRF, DECCW, EGMAC, LobMAC, MDBA, MPAC, NCC, OFTMAC, OHAULMAC, OPTMAC, OT&LMAC, SIAC |
| Develop and test fishery-independent surveys to assess the biodiversity and status of wild fisheries resources in NSW * | NSW DPI, AM, MDBA, NCC |
| Develop non-destructive fishery-independent technologies to monitor fish populations in the wild | NSW DPI, AM, MDBA, NCC |
| Develop and test optimal strategies for assessing the status of populations of wild fisheries resources in NSW | NSW DPI |
| Develop cost-effective methodologies to assess recreational fisheries in NSW | NSW DPI, MDBA, NCC |
| Develop and test the effects of recovery plans for all overfished species | NSW DPI, MDBA, NCC |
| Assess the levels of catches from all sectors and determine the allocation of fisheries resources between and within fishery sectors, e.g., commercial versus recreational, estuary general versus ocean hauling etc. | NSW DPI, NCC |
| Develop robust time-series estimates of recreational catch and effort | NSW DPI, MDBA, NCC |
| Estimate recreational catches of abalone and eastern rock lobster to enhance the TACC setting process for these species | NSW DPI |
| Developing and applying methodologies to estimate the relative abundances and size-structures of pipis at appropriate spatial and temporal scales in NSW | NSW DPI |

Biology and Ecology

Information that is closely related to that required for resource assessments and many other management-related enquiries is information on the basic biology and ecology of exploited species. This information is a high priority for many commercial and recreational stakeholders and includes studies on characteristics such as a species' growth, reproductive biology, mortality, distributions, abundances, movements, interactions with other species, and how all these vary spatially and temporally.

Often the most efficient way to answer such questions involves species-specific studies (which usually make excellent post-graduate theses) but, because of the nature of the methodologies used, it is often possible to obtain data and samples on relevant characteristics of several species simultaneously using common, standardised sampling regimes.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Determine the reproductive biology, abundance and spawning biomass of sea mullet | NSW DPI, OHAULMAC |
| Examine abundance, size-distributions, growth, movements and puerulus recruitment of lobsters * | NSW DPI, LobMAC |
| Examine and report on the biology and recreational fishery of rock blackfish * | NSW DPI, ACoRF |
| Examine age, growth and reproductive biology of recreationally important fish species * | NSW DPI, ACoRF, MDBA |
| Assess the biology of freshwater yabbies and their harvest potential * | NSW DPI, Inland MAC |
| Determine the distribution abundance and habitats of spiny crayfish especially in relation to stocked salmonids | NSW DPI |
| Determine the growth, movements and biomass of bream via a tagging program * | NSW DPI, ACoRF |
| Identify the distribution and abundance of larval stages of fish and shellfish of commercial and recreational importance * | AM, DECCW |
| Monitor the migration, movement and breeding behaviour of Australian Bass and Estuary Perch * | NSW DPI, DECCW |
| Address information gaps with respect to biological and fishery data for species with an 'overfished' exploitation status | NSW DPI, NCC |
| Provide accurate stock identification and up-to-date taxonomy of exploited species, particularly demersal fish, sharks, rays and harvested invertebrates such as pipis, crayfish, nippers, beach worms, etc. * | NSW DPI, AM, NCC |
| Population structure and distribution of carp | NSW DPI, MDBA |
| Examine the reproductive biology of school prawns * | NSW DPI |
| Determine the impacts of climate change on the wild fisheries resources and fisheries of NSW | NSW DPI, AM, MDBA |
| Examine the biology, linkages and diet of Australian salmon * | NSW DPI, ACoRF |
| Determine movements of key recreational fish species and environment and habitat relationships * | NSW DPI, AM, MDBA |
| Determine the connectivity of key fish and invertebrate species among estuaries and coastal waters * | NSW DPI, AM |
| Examine the effects of rainfall and environmental flows on wild fisheries resources and fisheries * | NSW DPI, MDBA |
| Examine the biology and movements of sharks in estuaries and coastal waters of NSW * | NSW DPI, NCC |
| Review the trophic level of catch by the Ocean Haul Fishery and trophic | NSW DPI, DECCW, NCC, |

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------|
| interactions with other fisheries | OHAULMAC |
| Determine the impacts of a possible sea urchin fishery on enhancing abalone populations and effects on other species | NSW DPI, AbMAC |
| Examine predatory impacts of Australian salmon on other commercially important fish species * | OHAULMAC |
| Examine biotic and abiotic factors affecting the recruitment of prawns and fish to estuaries | NSW DPI, DECCW, EPTMAC, OPTMAC |

Influence of Habitats and Other External Impacts

The mapping of reefs and other aquatic habitats is a key element of conservation-orientated research (see later tables) but the issues identified here for wild harvest fisheries (location of key fishing grounds, influence of physical and biological factors on production) have significant relevance for the management, production and sustainable exploitation of stocks. This sort of work can be achieved via the collection of information on the areas fished, and the distribution and abundance of organisms and physical variables that may be correlated with them. Once identified, mensurative and manipulative field experiments would be needed to show cause-and-effect relationships among such factors.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| Map and describe all fishing grounds and coastal reefs to assist in management strategies involving spatial and temporal allocations of fishing effort | NSW DPI, AM, DECCW, EPTMAC, NCC, OPTMAC, OT&LMAC, SIAC |
| Investigate the impacts of nutrient enrichments and other stressors such as sewerage treatment outfalls / discharge points and regional development on wild fisheries | NSW DPI, AbMAC, MDBA, NCC, SIAC |
| Determine sources of primary productivity that support NSW estuarine fisheries * | DECCW |
| Identify key water quality parameters necessary for sustainable fisheries to establish a mechanism to maintain and improve the environmental conditions required for sustainable fisheries production | EGMAC, EPTMAC |
| Examine the effects on wild fisheries populations from aquaculture fish, pond run-off or artificial feeds escaping or being released | NSW DPI, DECCW, MDBA, OT&LMAC |

Impacts of Management and Manipulation

There are often changes in the management of fisheries in NSW such as closures of commercial and recreational fishing in various areas and times, changes in size limits, gear restrictions, etc. It is not surprising, therefore, that significant priority has been assigned by many stakeholders to identifying the impacts of such changes on commercial and recreational fisheries and the species involved. Ideally, all changes in fisheries management should include a research program that examines them, so that the cost-effectiveness of the manipulation can be assessed in an adaptive management context. Research such as this is, however, by its nature, long-term and large-scale because it should involve adequate surveys and monitoring of the particular fishery/stocks being managed well before, during and after changes occur, in addition to mirrored examinations of “control”, unchanged fisheries and stocks. Such studies are all-too-rare throughout the world and it is unfortunate that changes to management are frequently made first and then research programs are subsequently established to monitor their effects – without prior information (nor controls) to compare against. To avoid the situation of trying to establish monitoring surveys for long periods before every individual change to management is made, large-scale, long-term, generic surveys (which are ideally fishery-independent) should be established to provide the required before and control datasets against which any subsequent management changes to a subset of fisheries and stocks can be made.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Examine the effects of recreational fishing havens on fish populations and fishing * | NSW DPI, ACoRF, DECCW, EGMAC, FSC, MDBA, NCC, SIAC |
| Assess the utility of spatial and temporal closure strategies in managing a range of issues including marine pests, biodiversity, stock sustainability and sharing the resources * | NSW DPI, AM, DECCW, MDBA, NCC, OPTMAC, SIAC |
| Use fishery independent surveys to assess populations of fish in estuaries open and closed to different fishing regimes * | NSW DPI, AM, DECCW, EGMAC, NCC |
| Determine the utility of alternative size limits and fish downs for abalone | NSW DPI, AbMAC |
| Examine the utility of legal slot sizes and relationship between the release of larger fish by recreational fishers and population fecundity * | NSW DPI, ACoRF, DECCW, MDBA, NCC |
| Investigate the viability of stocking fish into the marine environment (e.g., suitable species, methods, environmental impacts) * | NSW DPI |
| Determine the effectiveness of marine reserves on marine biodiversity, wild fisheries resources and fisheries | NSW DPI AM, |
| Determine the effectiveness of recreational bag limits and legal lengths on wild fisheries resources * | NSW DPI, MDBA, NCC |
| Examine effectiveness of changes in management rules on wild fisheries resources * | NSW DPI, MDBA |
| Determine methods to restore depleted reefs of abalone through techniques such as transplants, habitat rehabilitation and reseedling | AbMAC |
| Assess the benefits of fishing restrictions at Grey Nurse Shark critical habitat sites * | NSW DPI, NCC |
| Investigate techniques to reduce the by-catch of threatened species in NSW's commercial and recreational fisheries * | FSC, MDBA, NCC |

Reporting, Managerial and Policy Methodologies

Many research priorities were identified by stakeholders concerning ways to improve the data and information available for scientists and managers in NSW. Key priorities involve estimating wild harvests (both legal and illegal) by commercial, recreational and Indigenous fishers, using logbook systems, fishery-dependant and fishery independent surveys and creel surveys. Several important areas involve the development of ways to assess and evaluate the performance of Fishery Management Strategies and the utility of their trigger points and performance indicators.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Develop and evaluate indicators and performance measures for the impacts of commercial and recreational fishing activities on biodiversity | NSW DPI, AM, DECCW, MDBA, NCC |
| Develop and evaluate robust performance indicators and trigger points in all Fishery Management Strategies * | DECCW, EGMAC, MDBA, NCC |
| Estimate unreported and illegal catches of species for the commercial and recreational sectors | NSW DPI, AbMAC, DECCW, LobMAC, MPAC, MDBA, NCC |
| Initiate a commercial fishery logbook program for lobsters * | NSW DPI, LobMAC |
| Coordinate underwater harvesting programs to provide: (i) a comprehensive picture of competition and non club-based spearfishing activity; and (ii) estimates of recreational harvest by spear fishers | NSW DPI, ACoRF, DECCW, NCC |
| Assess recreational baitfish usage * | NSW DPI, DECCW |
| Monitor recreational fishing effort in coastal waters using sea rescue bases | NSW DPI |

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Develop indicators of recreational fishing quality * | NSW DPI |
| Develop a framework for the evaluation of recreational fishing survey design | NSW DPI |
| Develop protocols for analysis of charter boat logbook information * | NSW DPI |
| Use the recreational license data to provide the basis or frame for future survey and assessments of recreational fishing | NSW DPI |
| Collect historical/anecdotal information from older fishers regarding the biology and fishery of yellowtail scad | OHAULMAC |
| Determine the appropriate geographical size of fishery management units * | AM, DECCW |
| Develop a strategic research and development plan for the abalone fishery and industry in NSW | AbMAC |
| Develop finer scale co-management of the abalone fishery, particularly through the use of industry knowledge and experience, to provide a more cost-efficient and effective assessment of stocks * | AbMAC |
| Develop policies and procedures for the effective monitoring and management of abalone farms | AbMAC |
| Estimate monetary value of species landed in the Estuary General and Estuary Prawn Trawl fisheries when sold in markets alternative to the Sydney Fish Market | EGMAC, EPTMAC |
| Develop ecosystem-based fisheries management and performance indicators | NSW DPI, DECCW, MDBA, NCC |

Concomitant Effects of Wild Harvest – Impacts of Fishing Methods and Technology

This category of priorities involves the impacts of wild harvest fisheries on other, interacting fisheries and on ecosystems and biodiversity. Many of the priorities identified in this category were identified as important by a large number of stakeholder groups, placing these issues as among the most important throughout all the tables.

These priorities include those concerned with identifying and quantifying concomitant effects of fishing (through observer programs of by-catches and issue-specific experiments to identify impacts) and those that seek solutions to those problems via technological changes to fishing practices. NSW has developed an excellent record in identifying and then finding solutions to such issues such that the methods for answering such questions are becoming routine.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Use observer programmes to monitor by-catches and retained catches for all commercial fisheries * | NSW DPI, DECCW, EPTMAC, LobMAC, MPAC, NCC, OHAULMAC, OPTMAC, OT&LMAC, |
| Quantify and investigate the fate of discards across all gears in all fisheries and develop strategies to maximise discard survival * | NSW DPI, NCC |
| Determine the selectivity of current fishing gear (including effective BRDs) for key target and bycatch species * | NSW DPI, NCC |
| Examine the impact of trawling, hauling and other mobile fishing methods on other fisheries, biodiversity of ecosystems and habitats * | NSW DPI, AM, DECCW, OFTMAC, OHAULMAC, OPTMAC, OT&LMAC, NCC |
| Examine the effects of nipper pumping in estuaries | NSW DPI, SIAC |
| Investigate changes in biomass and species composition of affected species after reducing by-catch | NSW DPI, ACoRF, DECCW |
| Determine hook mortality rate of released fish (species survival; best handling | ACoRF, MDBA, NCC |

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| methods; hook patterns and sizes) and develop ways to maximise survival of released fish * | |
| Assess impacts of pollution from fishing activities (e.g., lost gear, bait wrappers etc.) on the environment and the development of strategies to minimise the impacts of pollution from fishing activities | DECCW, MDBA, NCC |
| Examine potential impacts and interactions of various fishing sectors and methods with seabirds and marine mammals | DECCW, MPA |
| Monitor habitat loss / modification as a result of commercial fishing | AM, NCC |
| Develop fishing operations and gear designs to minimise the impact of fishing on incidentally caught species and undersize conspecifics of target species * | NSW DPI, DECCW, EPTMAC, NCC |
| Study lobster trap selectivity rates of ingress and egress and consequences for trap efficiency and ghost-fishing mortality and develop a system for the remote release of submerged lobster head-gear * | NSW DPI, DECCW, LobMAC |
| Study the effects of lobster trapping on the benthos including physical disturbance and potential effects on the ecosystem | DECCW |
| Assess industry-initiated gear modifications in all fisheries | NSW DPI |
| Determine the effectiveness of approved BRDs following the implementation of square-mesh codends in the Estuary Prawn Trawl and Ocean Trawl fisheries | NSW DPI, NCC |
| Determine whether FAD's and artificial reefs provide nursery areas for fish and their other effects on biodiversity * | NSW DPI, AM, ACoRF, NCC |

AQUATIC ECOSYSTEMS

This category of priorities concerns the many ecological and environmental issues that arise when managing anthropogenic impacts on aquatic resources and habitats to ensure that such influences are sustainable. Many of these issues involve the importance of aquatic habitats to living aquatic resources, but issues concerning threatened species, the maintenance of biodiversity, alien species and the use of marine protected areas as management tools also provide major challenges for science because of the complex questions involved.

Biology

This table of priorities identifies basic biological studies that relate to the study, maintenance and enhancement of aquatic biodiversity in NSW. Many projects have been identified as necessary to answer questions concerning species that are listed as vulnerable, threatened or endangered in NSW. These sorts of detailed biological studies are usually best done on a species-specific level and may make interesting post-graduate projects. An unfortunate characteristic of working on threatened species, however, is the fact that they are rare and often require sophisticated, non-destructive sampling techniques.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Population genetics, distribution, abundance, movements and biology of threatened marine and freshwater species to assess species conservation status and response to recovery actions * <i>(current emphasis is on grey nurse sharks, black cod, eastern freshwater cod, Macquarie perch, southern pygmy perch and purple-spotted gudgeon)</i> | NSW DPI, ACoRF, AM, DECCW, FSC, MCMA, MDBA, NCC |
| Protecting the genetic integrity of wild stocks of Australian native freshwater fish * | NSW DPI, ACoA, AM, DECCW, MDBA, NCC |
| Modeling the Grey Nurse Shark population | NSW DPI, NCC |
| Distribution, abundance and genetic studies of <i>Notopala sublineata</i> (snail) and <i>Archaeophya adamsi</i> (dragonfly) | AM, FSC |
| Active research on the distribution of remaining populations of the river snail, <i>Notopala sublineata</i> , and techniques for a captive breeding and conservation stocking program | FSC |
| Monitor the distribution and abundance of threatened species * | NSW DPI, AM, DECCW, FSC, MDBA, NCC |
| Determine the historical genetics and existing genetic variability of threatened species | FSC, AM, MDBA |
| Investigate recruitment biology, fine scale distribution patterns and rehabilitation techniques for <i>Posidonia</i> along the coast of NSW * | NSW DPI, FSC |
| Monitor and assess eastern freshwater cod populations in the Clarence and Richmond River catchment * | NSW DPI, FSC, NOW, NRCMA |
| Actively search for populations and determine the distribution of <i>Nereia lophocladia</i> at Coffs Harbour | FSC |
| Monitor the status of caprellids along NSW coastal waters | FSC |
| Determine the habitat requirements, environmental tolerances, population dynamics and other aspects of the life history and ecology of threatened species | FSC |
| Assess the status of trout cod populations | FSC |
| Undertake a genetic study of black cod populations on east coast and offshore islands and reefs | FSC |
| Undertake genetic study to verify the origin of river blackfish in the Snowy River catchment | FSC |

Ecological Processes

The priorities listed in this table involve studies of ecological interactions among aquatic species. Many of the listed priorities require ongoing, large research programs requiring decades of study and millions of dollars. While such a “wish list” of grand-scale initiatives is difficult to achieve, such work is being addressed by co-ordinating large-scale, long-term surveys of habitats and biodiversity in aquatic systems under an overarching ecosystem-based fisheries management framework.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Examine estuarine ecosystem relationships and functions, including potential effects of climate variability * | NSW DPI, DECCW, NCC |
| Determine genetic and ecological effects of stocking in freshwater habitats * | NSW DPI, DECCW, MDBA, NCC |
| Compile biodiversity inventories for marine and freshwater bioregions * | NSW DPI, AM, DECCW, NCC |
| Contribute to sustainable rivers audit and other freshwater biodiversity surveys * | NSW DPI, AM, DECCW, MDBA, NCC, NOW |
| Develop survey methods for marine biodiversity * (<i>current focus is on rocky reef biota</i>) | NSW DPI, AM, DECCW, NCC |
| Develop genetic biodiversity procedures | NSW DPI, AM, DECCW, MDBA, NCC |
| Develop ecosystem models for aquatic habitats * | NSW DPI, DECCW, MDBA, NCC |
| Examine ecological investigations of key habitats in Marine Parks | NSW DPI, DECCW, NCC |
| Develop tools for the assessment of the ecological health of estuarine, freshwater and marine ecosystems as part of the NSW State priority MER (Monitoring, Evaluation & Reporting) * | AM, DECCW, NCC, NRC |
| Undertake ongoing monitoring of key indicators of aquatic health in estuarine, freshwater and marine ecosystems as part of the NSW State priority MER (Monitoring, Evaluation & Reporting) * | NSW DPI |
| Examine species connectivity at multiple scales, particularly in relation to local and regional scale oceanography | AM, DECCW, MPA |
| Comprehensive regional assessments of biodiversity, with a particular emphasis on the distribution of rare and threatened aquatic species | AM, FSC, MDBA |

Influence of Habitats and Other External Impacts

The quality and quantity of the aquatic habitats in which each life-history stage of aquatic species live affect the number, growth and reproductive potential of those species and the overall diversity of the aquatic community. That is, healthy aquatic habitats usually lead to healthy fish, more productive fish populations and a greater diversity of assemblages of aquatic organisms. The factors that affect the health of aquatic habitats are characterised by being: (i) many in number; (ii) varied; (iii) mostly terrestrial in origin; and (iv) managed by a variety of authorities (e.g., urban and rural runoff, sewage and other sources of pollution, clearing of habitats for construction, etc.).

Studying, understanding and then communicating the role of these influences on aquatic species to relevant decisions-makers can lead to very effective, positive results for living aquatic resources. The methods for achieving such results, whilst large-scale and expensive, usually involve correlative survey work of habitats and biota, mensurative and manipulative field experimentation to establish causes-and-effects and, most importantly, the communication of results to the public and those who can influence the external impacts that affect aquatic habitats. A necessary first step in getting this information for many aquatic habitats in NSW is implementing large-scale habitat-mapping projects,

augmented with information on various physical factors and water quality measures and coupled with targeted surveys of biodiversity.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Determine and reduce the impacts of water extraction, flood mitigation, invasive species, blue green algae, flood events and land management practices on water quality, fish habitats, ecosystems and associated fisheries | NSW DPI, ACoRF, DECCW, EGMAC, MDBA, NCC, OT&LMAC |
| Integrated monitoring of environmental flows and their impacts on different life stages of freshwater fish * | NSW DPI, AM, DECCW, MDBA, NCC |
| Determine effects of thermal pollution, altered water chemistry and boundary layer processes on key freshwater species | NSW DPI, DECCW, MDBA, NCC |
| Identify rivers with current/potential salinity issues and fish likely to be affected | NSW DPI, DECCW, MDBA, NCC |
| Relate river discharge to estuarine production of fish and invertebrates | NSW DPI, DECCW, NCC |
| Determine flow requirements for threatened freshwater fish | NSW DPI, DECCW, MDBA, NCC |
| Investigate fish use of snags and develop 'resnagging' methodologies * | NSW DPI, DECCW, MDBA, NCC |
| Investigate recruitment and migration of fish into floodplains * | NSW DPI, DECCW, MDBA, NCC |
| Develop methods to assess and monitor existing and potential marine, estuarine and freshwater habitats as aquatic reserves * | NSW DPI, AM, DECCW, MDBA, NCC |
| Improve standard techniques for bioregional assessments | NSW DPI, AM, DECCW, NCC |
| Determine the habitat requirements of fishes and invertebrates throughout their life cycle | AM, DECCW, MDBA |
| Determine the habitat requirements, environmental tolerances, population dynamics and other aspects of the life history and ecology of threatened species | AM, FSC, MDBA |
| Clearly identify the precise impacts of known and potential threats to threatened species | FSC, MDBA |
| Investigate potential impacts of sea level rise on coastal fish habitats, in particular saltmarsh, mangroves, seagrass and rocky shores * | NSW DPI, DECCW, NCC |
| Examine the effects on fish stocks of the management of Intermittently Closed and Open Lagoons | NSW DPI, DECCW, NCC |
| Assist Catchment Management Authorities to assess the status of river health and aquatic biodiversity associated with regional natural resource management reforms * | NSW DPI, CMAs, DECCW |
| Assess the effects of seawalls on saltmarsh and seagrass | NCC |
| Examine the potential impacts of stock access on saltmarsh and mangrove communities | NSW DPI |
| Investigate low flow fish passage in unregulated coastal rivers | NSW DPI |
| Investigate restoration methods for blowout holes in <i>Posidonia</i> meadows caused by boat swing moorings * | NSW DPI, FSC |
| Assess the effectiveness of Seagrass Friendly Moorings and anchoring restrictions in protecting seagrasses and promoting their recovery * | NSW DPI, Maritime |
| Examine the effects of boating activity on the spread of <i>Caulerpa taxifolia</i> | Maritime |
| Examine the environmental effects of boating-related pollution (i.e., sewage, grey water, etc.) in the context of other point and diffuse sources | Maritime |
| Investigate the effect of vessel wash on intertidal and shallow water habitats and communities | Maritime |

Impacts of Management, Manipulation and Technology

There is a need to develop the databases required to assess the impacts of any management strategy on those aquatic species and/or habitats that they are designed to enhance. Whilst this is common-sense in any sort of adaptive management framework, it is all-too-common that measurement of the effectiveness of management strategies takes second place to the drive to implement the strategies in the first place. The methodologies for achieving such ends are not new but usually require the establishment of scientific monitoring protocols well before management changes occur, the inclusion of control places where no changes are expected, and they need to continue well after the implementation of any given strategy. It is also apparent that stakeholders and an ever-increasingly informed public expect such programs to be in place so that management initiatives that are shown to work through rigorous science can be encouraged, and ones that do not work, can be replaced. This group of priorities also includes the work needed to enhance fish passage in our vital freshwater rivers and streams, including the techniques to census these fish populations.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Baseline and ongoing habitat/species monitoring programs to assess performance of each marine park and the zones within them * | NSW DPI, DECCW, MPAC, NCC |
| Evaluate marine protected areas' contribution to sustaining fisheries ecosystems and the conservation of threatened species | NSW DPI, AM, DECCW, MPAC, NCC |
| Monitor improvement of fish abundances after the water reform process * | NSW DPI, DECCW, NCC |
| Investigate effects of barrier removal on improving fish passage * | NSW DPI, DECCW, MDBA, NCC |
| Assess the effectiveness of aquatic habitat and fish passage rehabilitation techniques * | NSW DPI, CMAs, DECCW, MDBA, NCC |
| Determine effectiveness of rehabilitation in acid sulphate soil areas and floodplains | NSW DPI, DECCW, MDBA, NCC |
| Use existing and new data to determine optimum size and arrangement of MPA's | NSW DPI, AM, DECCW, NCC |
| Determine the effects of reclamation, jetties and other structures on benthic habitats and biodiversity | NSW DPI, DECCW, NCC |
| Determine the effectiveness of existing aquatic habitat protection and management policies | NSW DPI, DECCW, MDBA, NCC |
| Develop techniques for captive breeding and conservation stocking of Macquarie perch and southern pygmy perch * | NSW DPI, FSC, HNCMA, LCMA, MDBA |
| Examine the environmental impacts of aquaculture on water quality and coastal environments * | ARAC, DECCW, NCC |
| Assess the potential benefits of aquaculture to decrease pollution and improve aquatic ecosystems (i.e., seagrasses) * | NSW DPI, ARAC, DECCW |
| Develop and assess new designs for fishways and the effectiveness of existing fishway designs * | NSW DPI, DECCW, MDBA, NCC |
| Evaluate effectiveness of by-pass channels | NCC |
| Assess modified lock operations and weir design in ameliorating fish passage * | NSW DPI, CMAs, MDBA, NCC |
| Assess the effectiveness of new fish passage remediation options such as active floodgate management and new designs for waterway crossings | NSW DPI, CMAs, MDBA, NCC |
| Continually improve efficiency of electrofishing and other fish sampling techniques to minimise mortality or harm | NSW DPI, FSC, MDBA, NCC |
| Investigate the efficacy of screens on water pump inlets in preventing fish / larvae / egg entrainment * | NSW DPI, MDBA |

Alien Species

This group of priorities deals with those challenges facing managers in NSW as they try to develop ways to ameliorate the effects of harmful, invasive species like *Caulerpa taxifolia*, carp, *Gambusia*, etc. Introduced pests such as these have usually evolved elsewhere but, when introduced into NSW's unique aquatic systems, are free to live and reproduce without the natural checks and balances of their native locations. Removing these species, or at least ameliorating their impacts, is a major ongoing challenge for aquatic managers that will probably never be fully realised. Nevertheless, there are a variety of techniques available to deal with such issues (including targeted removals in well-defined areas) and it is sometimes possible to develop innovative methods. The issues involved in dealing with these problems are so large, complex and difficult that the programmes required are usually characterised by being long-term, expensive and often involve substantial laboratory work followed by long periods of field testing before solutions can be safely implemented into natural systems.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| Determine the spread, impacts and control mechanisms for <i>Caulerpa taxifolia</i> * | NSW DPI, ACoRF, DECCW, EGMAC, NCC, SIAC |
| Develop integrated carp management tools * | NSW DPI, CMAs, DECCW, MDBA |
| Investigate the population structure and distribution of carp * | CMAs, DECCW, Inland MAC, MDBA |
| Responses of carp populations to reduction (e.g., can carp compensate for reduction in adult density by increasing recruitment) | NSW DPI, CMAs, DECCW, MDBA |
| Identification of habitats where carp do not occur to prevent invasion or to eradicate new invasions before they are established | NSW DPI, CMAs, DECCW, MDBA |
| Determine distribution patterns and impacts of introduced freshwater alien fish species on habitats and biodiversity | NSW DPI, AM, CMAs, DECCW, MDBA |
| Targeted biodiversity surveys in ports to detect presence of introduced marine species * | NSW DPI, AM, Coastal CMAs, DECCW |
| Develop control techniques for <i>Gambusia</i> | DECCW, MDBA |
| Develop control techniques for redbfin, goldfish, weatherloach, banded grunter, tilapia and other freshwater pests * (current focus is on redbfin perch) | NSW DPI, CMAs, DECCW, MDBA |
| Determine impacts and develop management and control techniques for all alien species as and when they become an issue (e.g., <i>Didemnum sp</i> in 2010) | NSW DPI, CMAs, DECCW, MDBA, NCC |

AQUACULTURE

As in many places in the world, production from wild harvest fisheries in NSW will probably not be able to increase to meet expanding demand for seafood. Already some of NSW's most important aquatic resource industries are based on aquaculture (in particular, its largest – the oyster industry) and it is recognised that aquaculture has significant potential for growth as a provider of seafood. Farming fish in ponds, tanks and sea-cages is a very different discipline to the harvesting of wild stocks by commercial and recreational fishers because it requires animal husbandry to raise, in captivity, large numbers of a few species to market-size. As a consequence, the priorities for aquaculture research are mostly technologically based (see below), involving the development of methods to: (i) close the life-cycle (in laboratory aquaria) of candidate species (i.e., species that can grow quickly and easily in dense populations in captivity and that have high market appeal); and (ii) grow these species to a size and in numbers that are profitable. This involves the development of cost-effective feeds and feeding strategies and managing fish health to minimise losses.

There is a strong link between aquaculture science and more traditional fisheries biology. Aquaculture science, at least during the initial stages of domesticating a species, usually relies on information about reproduction, feeding patterns, migration and growth potential that has been established via research on animals in the wild. In turn, aquaculture research informs wild harvest fisheries science, particularly by identifying larval stages, environmental cues for spawning, growth characteristics and nutritional requirements.

Overall priorities for aquaculture research are largely driven by the need to overcome constraints to profitable culture. This involves a close interaction between scientists and existing and potential aquaculture farmers. Prioritising research topics involves identifying the key species that should be studied and those aspects of hatchery, growout technology or post-harvest issues that are most important. In a general sense, priorities need to be assessed on the basis of the estimated potential for environmentally-sustainable growth of the industry and the cost-benefit of studying a particular topic.

Several of these technical priorities identify generic attempts to enhance aquaculture opportunities and production but the majority are species-specific, focussing on problems associated with the major species currently farmed in NSW (especially oysters) and the potential for new candidate species. All these research areas require significant laboratory- and pond-based experimentation. The basic procedures for much of this work are well-established, although individual studies have to be done for individual species. Further, once the experimental work is done, farm-scale trials are required before results can be ultimately translated into industrial-scale production.

Technology – Oysters

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Determine sustainable oyster stocking densities within part or all of an estuary | ARAC, DECCW |
| Develop and maintain a selective breeding program for Sydney rock oysters to achieve desired traits | NSW DPI, ARAC |
| Develop and maintain a selective breeding program for pearl oysters to achieve desired traits | NSW DPI, ARAC |
| Determine optimum post-harvest storage temperatures and procedures for Sydney rock oysters | ARAC |
| Benchmark current oyster farm practices to determine optimum current practices and to test for benefit of new practices and lines of selectively bred oysters | ARAC |
| Develop technology to extend shelf life and improve the value-chain of oysters | ARAC |
| Improve products (e.g., add value to oyster products) and product standards | ARAC |

Technology – Prawns

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------|--------------------|
| Develop cost-effective prawn feeds (and reduce dependence on fishmeal) * | NSW DPI, ARAC, NCC |
| Domesticate prawn species for culture * | NSW DPI, ARAC |
| Genetically improve prawn culture species | NSW DPI, ARAC |
| Improve prawn broodstock performance | NSW DPI, ARAC |
| Enhance access to broodstock | NSW DPI, ARAC |
| Optimise prawn pond and sediment management practices | ARAC, DECCW |
| Improve survival, growth rates and food conversion ratios of prawns | NSW DPI, ARAC |

Technology – Silver Perch

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|---------------------------------------------------------------------------------|--------------------|
| Methods for advanced production of juveniles to offset slow winter growth | ARAC |
| Reduced energy costs | ARAC |
| Adopt health management strategies * | NSW DPI, ARAC |
| Reduce feed costs for silver perch through improved feeding practices | ARAC |
| Identification of appropriate sites and site selection | NSW DPI, ARAC |
| Improve technology for commercial, cost-effective production e.g., cage culture | NSW DPI, ARAC |

Technology – Marine Fish

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Develop and improve broodstock management techniques for marine species, including Australian bass, mullet and kingfish for improved production of high quality eggs on a year-round basis * | NSW DPI, ARAC |
| Improve technology for commercial cost-effective production of marine fish fingerlings | ARAC |
| Develop improved diets with less reliance on fishmeal for grow-out of marine fish including snapper, mullet and kingfish * | NSW DPI, ARAC, NCC |
| Develop genetically superior stocks of key species | NSW DPI, ARAC |
| Reduce feeding costs through improved feeding practices | NSW DPI, ARAC |
| Identification of sites and site selection | NSW DPI, ARAC |
| Improve technology for commercial, cost-effective sea cage farming | NSW DPI, ARAC |

Technology – Other Species

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Rock lobster aquaculture and enhancement * | NSW DPI, LobMAC |
| Abalone aquaculture and enhancement * | NSW DPI, ARAC |
| Sea Urchin aquaculture and enhancement | NSW DPI, ARAC |
| Investigate the integration of alternative utilisation species into normal oyster farming regimes to enhance and diversify production from a lease * | NSW DPI, ARAC |
| Investigate potential for aquaculture of new native species | ARAC |

Technology – General

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------------------------------|---------------------------|
| Development and evaluation of recirculation technology for NSW species (freshwater and marine) * | NSW DPI, ARAC, DECCW, NCC |
| Improve and extend hatchery technology | ARAC |
| Reduce feeding costs through improved feeds and feeding practices | NSW DPI, ARAC |
| Reduce impacts from bird predation – alternative to bird netting for land-based aquaculture | ARAC |

Health Management

In addition to technological problems facing aquaculture in terms of growing species economically, significant challenges face the large-scale production of seafood through the impacts that various diseases can have. For example, massive losses of Sydney Rock Oysters from estuaries in NSW due to QX disease highlight the devastating effects of diseases if they take hold in mono-specific aquaculture leases, ponds and cages.

The priorities for research on diseases identified by NSW stakeholders mostly refer to specific diseases affecting particular aquaculture or fishing industries, especially those affecting the oyster and prawn industries. Constant monitoring is required to combat such problems, as is the development of tools to fight diseases should they occur. Diagnostics, biotoxins, genetic selection and genetic engineering are all involved in addressing such problems which all require unique expertises and skills that are very different to those in traditional fisheries science and ecological work. Further, the application of these skills needs to be applied at disease- and species-specific levels.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Develop and improve affordable diagnostic tools and improve access to qualified laboratories for aquaculture species * | NSW DPI, ARAC |
| Investigate the potential that sewage, stormwater and agricultural runoff may lead to an accumulation of chemicals, viruses and bacteria within oysters and/or the environment that will cause human health issues | NSW DPI, ARAC, DECCW, NCC |
| Develop simple testing procedures for the presence of marine biotoxins to assist aquaculture, especially farming filter feeders like oysters | NSW DPI, ARAC, DECCW, |
| Better understand QX disease and winter mortality disease in NSW * | NSW DPI, ARAC |
| Understand causes of mortality of oysters in Hastings River and other north coast estuaries | NSW DPI, ARAC |
| Implement farm management tools to deal with diseases of silver perch (i.e., | NSW DPI, ARAC |

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Winter disease) | |
| Improve disease resistant oyster stock through genetic selection * | NSW DPI, ARAC |
| Develop an assessment process for relaying of oysters which considers the disease status of each waterway * | DECCW |
| The relationship between the occurrence of an oyster disease (QX, Winter Mortality, etc) and the environment of an estuary and model/predict the severity of an outbreak * | DECCW |
| Develop appropriate protocols for on-farm disease prevention, control and treatment for prawn diseases * | NSW DPI |
| Identify potential disease threats to prawn farming * | DECCW |
| Improve rapid diagnostic testing for VNN in barramundi, Australian bass and other native species | NSW DPI, ARAC |
| Improve understanding and management of exotic and endemic diseases | ARAC, DECCW, MDBA |
| Increase understanding and management of nodavirus and other viral diseases | ARAC, MDBA |
| Develop a national approach to biosecurity, particularly for translocation of aquaculture species | ARAC, MDBA |
| Improve understanding and management of flukes and parasites for fish culture | ARAC |
| Improve knowledge base to support registration of chemicals for aquaculture | ARAC, MDBA |

External Impacts

Few priorities were identified which highlighted the importance of external impacts to aquaculture and, whilst this is understandably far fewer than those identified for wild harvest fisheries (which rely so heavily on natural conditions), it does recognise that water quality is one of the most important factors affecting NSW's most valuable seafood resource – oysters. Tackling such problems, however, is not simple and involves many groups and industries outside the oyster industry itself. As identified by DECCW, a whole-of-government and multi-industry approach is required to deal with such issues and involves scientific expertise that, in many cases, will reside outside traditional fisheries or aquaculture science. A major challenge, therefore, is to establish such priorities as research questions for relevant agencies and industries so that a unified approach to resolving these problems can be initiated.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Develop a unified Whole of Government waterway classification model with defined assessment criteria with relevance to oyster farming and other aquaculture | DECCW |
| Identify and mitigate estuaries or areas which are affected by water quality problems like acid sulphate releases, nutrient run off, chemical run off, sediment, etc. which affect the productivity of oysters and other aquaculture * | NSW DPI, ARAC, DECCW |
| Assess and minimise the impacts from agricultural and urban development to increase production and profitability of commercial, sustainable aquaculture | NSW DPI, ARAC |
| Develop strategies to understand impacts of how to best adapt to climate change | ARAC |

Concomitant Effects

Certain stakeholders identified research priorities involving the impacts that aquaculture activities may have on other species and the surrounding environment. Whilst such issues as pollution, escapees from aquaculture ponds and nutrient enrichment can be difficult to quantify, methods to do so involving field experimentation are available. Further, because of the artificial nature of most aquaculture activities, replicated experimentation to determine cause-and-effect relationships can be readily implemented in industrial operations to answer such questions. It is also worth noting that it is a requirement for most aquaculture operations in NSW to undergo detailed environmental impact assessments prior to establishment, followed by ongoing monitoring of environmental impacts.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| The environmental influence of prawn farm management practices at a range of scales from molecular to regional | DECCW |
| Assess non-lethal methods of excluding predators from aquaculture activities | DECCW, NCC |
| Evaluate and/or develop alternative commercially viable products to replace timber and tar where applicable for oyster farming | ARAC, DECCW, NCC |
| Effects on wild populations from aquaculture fish, pond run-off or artificial feeds escaping or being released | NSW DPI, DECCW, OT&LMAC |
| Environmental impacts of aquaculture on water quality and coastal environments | ARAC, DECCW, NCC |
| Assess the benefits of aquaculture to decrease pollution and improve aquatic ecosystems (i.e., seagrasses) | ARAC, DECCW |

INDIGENOUS FISHERIES

This category of research priorities involves developing an understanding of the nature, dimensions and characteristics of Indigenous fisheries and their interaction with other commercial and recreational fisheries. This is a challenging category of fisheries research in NSW (and, indeed throughout the world), having been ignored as a separate issue for much of the history of fisheries science and management. Addressing these priorities will depend on reliable and accurate information about Indigenous harvest rates, cultural and spiritual values of traditional target species and Indigenous participation in commercial and recreational fisheries and aquaculture operations.

Establishing the techniques to get the above information is challenging because there is currently a lack of expertise in this area, yet the kind of research that is needed requires culturally appropriate methodologies that have to be negotiated with individual communities. Progress in such work will probably be relatively slow initially but the first, quite significant steps are underway.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Facilitate the development of a centre for research into Aboriginal fisheries | AC (TOG), ARG, NSWALC, SIAC |
| Develop a research plan for Aboriginal fisheries | AC (TOG), ARG, NSWALC, SIAC |
| Determining catch, cultural significance of species and traditional fishing knowledge needs | AC (TOG), ARG, MDBA, SIAC |
| Evaluation of the socio-economic impact of non-Aboriginal fisheries on Aboriginal fisheries | NSW DPI, ARG, SIAC |
| Socio-economic study of the value of cultural fishing to Aboriginal communities | NSW DPI, ARG, MDBA, SIAC |
| Impact of management changes on the viability of Indigenous commercial fishers and the flow on effects to their communities: case study in NSW * | NSW DPI, ARG, NSWALC, SIAC |

POST-HARVEST AND VALUE-ADDING

Research priorities concerning the products from fisheries and aquaculture after harvesting usually fall outside what is considered conventional “fisheries science”. Despite this view, such issues form a vital component of the research needed to ensure the optimal and most beneficial use of fisheries resources. Concepts such as “whole-of-chain” approaches to achieving “triple-bottom-line” benefits for the environment, economy and society require solutions to problems associated with enhancing the economic returns that commercial fishers and aquaculturists receive for their efforts.

General priorities identified in this section included several that involve a variety of issues concerning the operation of the entire post-harvest seafood sector in NSW. The sorts of research needed in this area involve market research methodologies, economic analyses of margins and ways to enhance harvested product as it makes its way from the water to the retailer. There is a great deal of expertise and experience available in this area for other food-types in NSW and, to achieve the research priorities identified in this category, such expertise needs to be more tightly focused on the seafood industry.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Examine the dynamics of value-adding margins along the whole marketing chain for wild harvest fisheries and aquaculture products | NSW DPI |
| Improve oyster handling techniques post-harvest to ensure a high quality safe food product is delivered to the consumer * | ARAC |
| Evaluate and develop an effective oyster marketing strategy which will assist industry and provide a platform for increasing investment opportunities and consumer confidence in the industry | ARAC |
| Develop an oyster marketing standard and grading criteria | ARAC |
| Identify and implement processes for adding value to oysters and by-products | ARAC |
| Identify and develop available markets and identify critical factors limiting growth of export markets for Australian farmed prawns | NSW DPI, ARAC |
| Investigate strategies to enhance product and add value to the Estuary General Fishery | NSW DPI, EGMAC |
| Development of improved tagging and marketing of abalone | NSW DPI |
| Emerging technologies in seafood traceability systems | SFM |
| Identify, rank and design solutions to reduce barriers to consumption of Australian seafood | SFM |
| Market development of abalone, particularly through the use of product integrity and quality assurance programs to help develop unique branding | AbMAC |
| Evaluate mechanisms and new technologies to assist with direct marketing of fish by fishers | NSW DPI |
| Evaluating technology and its impact on the dynamic at the buyer-seller interface | MFMA |
| Investigating and developing strategies for utilisation performance in the post-harvest sector | MFMA |
| Identifying and implementing strategies for addressing growth limiting factors in the post harvest sector | MFMA |

SOCIO-ECONOMICS, EDUCATION AND COMMUNICATION

This category of research priorities involves the very important issues surrounding the “human dimension” of fishing. These issues concern: (i) answering questions about the socio-economic nature and cultural impacts of commercial, recreational and Indigenous fishing and aquaculture and the management decisions that affect these sectors; (ii) educating stakeholders and the general public about the myriad of issues concerning fisheries and aquaculture; and (iii) communicating information amongst stakeholders so that commercial, recreational and Indigenous fishers, aquaculturists, managers, scientists, decision-makers, environmental groups and the general public can provide advice and understand issues with the benefit of the knowledge possessed by each other.

Establishing techniques to achieve these priorities are challenging, although significant expertise exists in the field of socio-economics to address most of the questions raised. Education and communication amongst stakeholders are also areas for which established techniques exist, and applying them to fisheries, aquatic ecosystems and aquaculture in NSW should be a relatively straightforward process, especially in the current environment where a myriad of advisory committees and councils exist for most stakeholder groups.

Educating and communicating the broader public of NSW (a very populous state) is, however, much more difficult as the use of the mass media (which are the most effective, albeit costly, techniques available), do not easily lend themselves to communicating the sorts of complex, multi-faceted information that characterises fisheries issues. Nevertheless, we live in an age of ever-improving communication and an ever-more discerning public, so there exists far fewer impediments to communicating fisheries information to the public than at any time in history.

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Independent assessment of the economic value of the NSW commercial fishing industry and undertake extension and promotion activities to increase the public awareness of commercial fishing (including its value) and the results of relevant research to reduce conflict | EGMAC, EPTMAC, OPTMAC, SIAC |
| Determine the socio-economics of the Ocean Fish and Ocean Prawn Trawl fisheries and the likely impacts of NSW fisheries management strategies and Marine Parks * | NSW DPI, OFTMAC, OPTMAC |
| Examine the economics of the commercial lobster fishery (costs of catching lobsters, profitability, impacts of management and community contribution on trading of quota and sales of shares) | NSW DPI, LobMAC |
| Survey of fishers' costs and earnings to quantify their terms of trade | NSW DPI |
| Examine the technical capacity and efficiency in the NSW fishing fleet * | NSW DPI |
| Do an economic assessment of the impact of the abalone fishery | NSW DPI |
| Examine fisher-attitudes towards the environment and consequent education programmes | DECCW, MDBA |
| Survey of economic benefits of recreational fishing to coastal communities * | NSW DPI, ACoRF |
| Assess the benefits of declaring a species 'recreational only' (do recreational benefits outweigh the value of the commercial catch?) | NSW DPI, ACoRF |
| Training and extension of recirculation systems in aquaculture | DECCW |
| Increase awareness and utilisation of sustainable aquaculture practices | NSW DPI, ARAC, DECCW, NCC |
| Increase farmer awareness and adoption of relevant R&D outcomes (extension) for all aquaculture species * | NSW DPI, ARAC |
| Investigate and define the socio-economic and environmental value of fisheries and fish habitats to the community | NSW DPI, MDBA |
| Investigate the social and economic benefits (both direct and follow-on) of commercial fishing to the community | NSW DPI |

| PRIORITY PROJECTS | STAKEHOLDER GROUPS |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Investigate strategies to improve industry empowerment and development with respect to leadership and management initiatives | NSW DPI |
| Educate and communicate to the broader public of NSW the concept of sustainable seafood, and increase awareness of sustainable fishing practices in NSW | NCC |