

Volume 2

Chapters C - G

**This is the second of three volumes of the
Environmental Impact Statement on
Freshwater Fish Stocking in NSW**

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CHAPTER C CONSIDERATION OF ALTERNATIVE MANAGEMENT OPTIONS

The draft FMS presented in Chapter D provides a suite of management actions supporting a broader strategic framework. The vision, goals and objectives of the strategy are designed to ensure that fish stocking can be conducted in an ecologically sustainable manner while remaining flexible enough to adapt to other management actions concurrently addressing environmental issues. There are six activity goals and numerous management actions proposed to guide the activity and, as such, many alternatives are available within the draft FMS depending on factors that need to be addressed. This adaptive management framework provides for alternative actions to become the preferred management option should it become necessary in future.

In order to show that other feasible alternatives were considered during the preparation of the draft FMS, this chapter considers a range of alternatives to those presented in the strategy. The alternative actions proposed are at a higher policy level and may appear to be incongruous, although feasible, when compared to the proposed management structure.

Many of the alternative measures proposed for fishery management strategies dealing with commercial fisheries (alternatives such as large spatial closures, output controls and limiting the number of participants) cannot be applied to the fish stocking FMS as these do not readily transpose to management arrangements suitable for stocking.

C1 Alternate Goals and Objectives of the Draft FMS

C1.1 Alternate stocking options

The draft Fish Stocking FMS proposes the continued use of fish stocking as the most appropriate method to maintain adequate stocks of fish for recreational and conservation interests in NSW. The goals and objectives of the strategy underpin this vision and are designed to work in unison with other management plans and initiatives for protection and remediation of the environment.

Alternative stocking options to those presented in the proposed strategy include:

1. substantially increasing the level of stocking
2. substantially limiting the level of stocking, and
3. terminating stocking.

C1.1.1 Increasing the level of stocking

It is a feasible alternative to increase stocking to levels above those already achieved under existing and proposed arrangements. Current levels of stocking are constrained by the production capacity of the NSW Fisheries' hatcheries (even though production totals have been supplemented to a degree by the use of private hatcheries). Although the numbers of fish produced in NSW for stocking are high, there is room for increased production in Government hatcheries and through supplemental use of the private hatchery sector to generate more stock than presently produced.

Increasing production and stocking levels would have several flow-on benefits particularly in the generation of regional employment (increased hatchery staff), increased use of aquaculture feeds, services and products, increased recreational fishing activity, tourism and related industries.

There are, however, a number of information gaps in the existing activity particularly with regard to potential and cumulative impacts of stocking on biological diversity and other major issues posing risks to native fish populations. The draft FMS considers these issues in its management arrangements and is designed to proceed cautiously at stocking levels consistent with the current activity. Until the relevant information becomes available to fill knowledge gaps it would be difficult, given the necessary application of the precautionary principle, to justify an increase in stocking levels in the short term.

Higher costs associated with the increased production at Government hatcheries are considerable (extra staff, feeds, power, transport and equipment) and funds from the freshwater fishing trust as one source of funding could be accessed to offset these.

The use of the private sector to supplement Government stocking programs and increase stocking levels has some economic and social merit and the continued use of the Dollar-for-Dollar Native Fish Stocking Program as an opportunity for private enterprise to benefit from the activity is supported by the strategy. At the time of preparing the draft FMS, however, it is generally accepted by fishery and aquaculture managers that the private hatchery sector, although capable of significantly increasing production, should not yet be fully utilised for the large-scale production of suitable stocks to augment government stocking programs due to risks posed by the current activity. The accreditation and quality assurance systems as proposed in the draft FMS are yet to be implemented and tested while key areas of concern such as compliance, genetic resource management, disease and translocation arrangements have also yet to be developed to a point whereby technology and procedural guidelines can be transferred to the private sector.

If stocking activity increases it is expected that there will be an increase in operating costs to both public and private hatcheries, and increases in the cost of research, management and monitoring activities undertaken by the government. While some hatcheries will respond to an increase in stocking by increasing production, others may switch resources into the production of fingerlings for stocking. In the instance where stocking results in a proportionate increase in hatchery production, it is expected that variable costs of production will also rise. For example, a 10% increase in stocking levels is expected to bring about a more than 10% increase in the operating costs of public and private hatcheries. Whether this also results in an increase in fixed costs depends on the carrying capacity of the hatchery in terms of land area, ponds etc.

It is expected that there would be significant economic benefits as a result of increases in stocking activity. These benefits are mainly in the form of increased angler expenditure on tourism services and fishing related items in the regions in which stocking occurs.

The economic benefits of increases in stocking activity extend beyond just the direct effects of increases in angler expenditure, as they create expenditure and jobs in other areas of the economy. These are broadly referred to as multiplier effects, and in the case of increased expenditure related to recreational angling, are thought to be significant.

C1.1.2 Limiting the level of stocking

Opponents of stocking see this alternative as a prudent adoption of the precautionary principle. The scenario posed would be to limit stocking to minimum levels required to maintain stocks in key

recreational fishing impoundments (where impacts are considered to be the least concern) and cease all other stocking until information gaps are filled at which point production could be increased.

The draft FMS was developed to observe the precautionary principle and other principles of ESD. The limitation of stocking in certain areas is not considered appropriate due to several factors, but mainly because the draft FMS puts in place numerous mitigative measures that allow the activity to continue, minimises environmental impacts, and proposes research to better understand those and other impacts associated with the activity.

To “turn off” the activity, or part thereof, pending outcomes of research or other management issues is not considered appropriate due to the nature of the processes governing the production of stock. The five Government hatcheries in NSW currently produce around 7 million fish per annum. This level of production takes substantial management of resources and acute husbandry practices which, if affected by a halt or disruption to production cycles, may prove to be a costly measure with the potential to jeopardise the entire activity. This is not to say that the financial considerations take precedence over environmental concerns; but rather that it is unnecessary given the measures put in place to provide ongoing and continual improvement to the activity.

Well-established and highly valuable recreational fisheries may also suffer as a result of such action leading to associated losses in related industries. Partnerships between the Government and the private sector have been developed only relatively recently and the cessation or limitation of private hatchery involvement in the activity could be considered an untimely and retrogressive action.

A decrease in stocking levels is also likely to cause a decrease in expenditure on tourism services by recreational fishers. However, the extent to which this occurs depends on the degree to which recreational fishers’ perceptions of the quality of fishing is affected. There is also the possibility that recreational fishers may be undertaking other tourist activities in the region, and hence, may continue to visit the region despite the decline in the quality of fishing. Recreational fishers may also be negatively impacted as a result of a reduction on stocking levels if this results in less fish available to be caught. The social satisfaction they receive as a result of their fishing activities may decline if they perceive that their fishing opportunities have been reduced as a result of a reduction in stocking.

Angling clubs and acclimatisation societies involved in stocking are expected to be most affected in social terms by a reduction in stocking activity. With less fish available for release into public waterways, the involvement of clubs and societies in stocking activities would probably decline, hence, the social capital these groups attain as a result of stocking will be negatively affected.

C1.1.3 Termination of stocking

The termination of stocking is generally considered an extreme response to some of the concerns and uncertainties surrounding the activity. It is unlikely to prevent stocking from happening as an illegal, unmanaged activity, and would probably result in a continuation on a smaller scale of the current activity whereby genetically inferior stock are released. This is one of the many problems that the draft FMS will address by allowing stocking to continue but mitigating risks associated with the current activity and proposing research to resolve many of the uncertainties. Ceasing all stocking, could however, provide an opportunity to fill information gaps related to genetics, the impacts of stocking and more accurately assess risks and cost implications of the activity until, and if, stocking resumed.

Terminating stocking would allow the NSW Government to save approximately \$1M per annum if it ceased stock production from its five hatcheries. It would, however, also jeopardise the

significant economic benefits associated with freshwater fishing, a proportion of which is attributable to the Government's stocking program. Flow-on effects from stocking are significant to regional economies, particularly the Snowy Mountains where site-specific studies have estimated fishing to be worth approximately \$46M per annum to the local economy (Dominion, 2001). If stocking was to cease, the local economy may take many years to recover from the impact, if at all.

Although the exact contribution of stocking-related expenditure at a State level is unknown, recent data suggests that freshwater fishing is worth at least \$130M per annum to the State economy (Henry and Lyle, 2003). The same study suggests that about 42% of effort in freshwater is focussed in dams and lakes, where the majority of stocking has historically been done. This translates to approximately \$55M. Assuming that only 75% of fish in the dam are attributable to stocking, it could be estimated that stocking-related expenditure is worth at least \$41M. This would be a considerable underestimate, as it does not consider river stockings and the proportion of fish within dams attributable to stocking is likely to be more than 75%. There is also the social benefit to local communities through involvement in acclimatisation societies, other stocking organisations and the perception of improving a recreational pursuit or the conservation status of native species in collaboration with a Government organisation.

Despite the potential advantages, the termination of stocking was not considered an appropriate alternative to the management of the activity under the draft FMS due to the potentially severe negative impacts. Along with the problems of interrupting or ceasing hatchery production cycles as highlighted in the previous section, a great deal of social and economic impact would also result. To terminate the established activity could see the loss of world-class recreational fisheries and the associated industries that have evolved with stocking in NSW.

It is considered that the draft FMS puts in place sufficient safeguards to ensure the sustainability of the activity such that termination is not required to meet the established goals and objectives designed to minimise any impacts. Therefore, a pragmatic approach to the assessment of environmental impacts does not require the cessation of stocking to meet its objectives.

C1.2 Other methods to provide enhanced fishing opportunities

Where most other fisheries in NSW rely on the extraction of naturally occurring fish populations, the activity of fish stocking is more akin to 'farming' the environment to establish or maintain fisheries where they would not otherwise exist. There is a range of conflicting views on the subject and some misconception that the use of the technology has been applied without due regard to environmental sustainability. Stocking is often considered as 'over-used' and applied like a universal remedy for depleted fish stocks rather than addressing the underlying environmental problems leading to low fish populations. Pressures on recreationally targeted species often compound existing problems with stock levels. The NSW Rivers Survey (Gehrke and Harris, 1997) showed that many native species were declining in their distribution and abundance through a host of impacts and threatening processes. Degradation of NSW waterways since European settlement is widespread and significant leading to concerns about the future viability of many of the native species that were once abundant. The removal or alteration of native fish habitat through siltation, snag removal, barriers and weirs, pollution, non-native species and other impacts have all taken a severe toll on fish stocks that are then compounded by recreational fishing pressure.

There are a number of programs underway to address many of the issues highlighted above. For example, the fishways program currently being conducted by NSW Fisheries is addressing the

problems caused by obstructions to fish passage such as weirs and other barriers. Fishways are being constructed in many streams and rivers in NSW and these will ultimately improve fish populations by reconnecting waters required by certain species to complete the breeding cycle. Although not the principal intent, such measures will ultimately enhance fishing opportunities through natural recruitment. Other initiatives are in place to address many of the other impacts listed above, each leading to further opportunities for fish stocks to recover. In the long term, rehabilitation and associated stock recovery may reduce the need for stocking of native fish, but is unlikely to meet the demand for non-native salmonids. Further, fishing pressure will remain on the limited natural stocks that are available during rehabilitation and stock recovery, which can be eased by the use of stocking.

Another option to improve recreational fishing would be to develop tighter controls such as longer closed seasons, smaller bag limits and increased size limits, prohibition of certain gear such as set lines and other input controls. The Lower Murray Species Impact Statement (Sanger *et al.* 2002) made many such recommendations for that area but also promotes the use of stocking to further alleviate pressures on existing stocks.

C1.3 Other methods to enhance stocks for conservation purposes

As the State's principal aquatic resource management agency, NSW Fisheries commits a significant portion of its resources to protect rare and threatened species and for the conservation of aquatic biodiversity. Where necessary, emphasis is placed on restoring fish habitats and ensuring that sufficient viable stocks of certain species are available to support self-sustaining populations. These objectives are complemented by enforcement of the statutory provisions of the *NSW Fisheries Management Act 1994*, with regard to environmental protection and fishing restrictions that reflect the broader principles of aquatic resource management. These arrangements alone present a feasible alternative to enhance stocks for biodiversity and conservation purposes.

Conservation stocking, however, is often considered vital to any threatened species recovery plan to re-establish viable stocks, and is the only option in areas where a species has become locally extinct. This type of stocking produces far quicker results than relying on natural recruitment to re-establish populations to aid long-term recovery of the species.

The option of using environmental remediation programs solely as an alternative to stocking was not considered appropriate, as conservation stocking can be used to complement other management actions, although this has not been done in the past. Habitat rehabilitation is likely to play a greater role in the longer-term conservation of native species, but in the more immediate term, stocking will be used to re-establish populations of these species.

C2 Alternate Activity of Fish Stocking

C2.1 Alternative species

Species used in the existing or any alternative activity can be divided into two categories, namely natives and non-native salmonids. Other non-native species could not be stocked due to concurrent translocation policies. Further, it is generally accepted that the following factors severely limit the number of species that could be effectively utilised in a stocking program:

- the nature of inland waterways in NSW
- numerous anthropogenic impacts, particularly dams and the cold-water pollution associated with them, and the removal of riparian vegetation
- the existence of pest species of fish such as carp and redfin due to previous introductions, and
- species preferences of recreational anglers.

Introducing species outside their natural range is an alternative that would provide enhanced angling opportunities. Western drainage species such as golden perch, silver perch and Murray cod can all be easily produced in vast quantities and stocked into eastern drainage waterways where they would offer anglers quality catches of popular species that would not otherwise be available. This in turn would generate more interest in inland angling on the eastern drainage of NSW by increasing the variety of quality species that may be caught. Subsequent opportunities would arise for private enterprise to develop business opportunities in response (tourism and related industries).

This alternative was not considered under the draft FMS for several reasons but mainly due to the fact that introducing aquatic species outside their natural range is a threatening process for endemic populations in NSW (Fisheries Scientific Committee 2002). Therefore, the practice cannot be considered as ecologically sustainable and is unlikely to be changed although it remains an option offering potentially high economic and social benefits.

Stocking of western drainage species is conducted under the current management of the activity with the stocking of golden perch and silver perch into Glenbawn Dam and Glennies Creek Dam in the Hunter Catchment. An environmental assessment has been conducted and initial results show that no discernible impact has been experienced (NSW Fisheries, 1999). Consideration was given to terminating stocking those species (golden perch and silver perch in the Hunter catchment) under the draft FMS. However, as these events were first undertaken before a full understanding of the processes were available it is considered acceptable to continue these arrangements given the apparent low impact, enhanced fishing opportunities, input to the regional economy generated by the fishery and the proposal to continue and expand the earlier research.

C2.1.1 Native species

The native species commonly used in Harvest Stocking are comprised of the main recreationally targeted species found in the inland waters of the State (Murray cod, golden perch, silver perch and Australian bass). This was developed due to fishing pressure placed on these species and a strong demand for better fishing opportunities through stocking that led to the development of the technology to breed them.

Should demand for an alternative species become apparent and technology required to breed the species is available, the species could be stocked subject to appropriate environmental assessment. However, any species proposed must possess several attributes necessary to ensure they can be successfully produced in a hatchery situation and amenable to the stocking process. This immediately eliminates most other native species from the equation at this time, as hatchery technology and production techniques do not exist at present for most alternative species. Furthermore, alternative species need to be recognised as a targeted species in the recreational fishery. There are very few contenders at this stage to be considered as alternative species beyond those already stocked. Possible alternative species include eel-tailed catfish, spangled perch and freshwater mullet, all of which may prove to be suitable in future. However, due to a lack of demand and no other apparent requirement to consider alternative native species, the draft FMS proposes to continue using the established species in production.

C2.1.2 Salmonids

The four species of salmonids used (Atlantic salmon, brook trout, brown trout and rainbow trout) will remain the only salmonid species approved for stocking in NSW. There are no plans to import any further species of trout or salmon into NSW due to the risk of introducing disease into the salmonid aquaculture sector, therefore, no alternative species may be considered for stocking.

There is, however, an opportunity to assess the viability of these four species in terms of stocking success rates. Of the salmonids, the most successful species are the brown trout and the rainbow trout, both of which have shown the capacity to develop self-sustaining populations. Rainbow trout in particular have proved to be relatively easy to produce in large numbers and show good returns to anglers. Brown trout offer an alternative species that is also readily produced but shows poorer returns to anglers, as they much harder to catch, yet more highly prized in some circles as a result.

Rather than cease or use different species for salmonid stocking, the draft FMS will see the establishment of a schedule of permanently closed waters and another of restricted waters, which are proposed to mitigate potential impacts on aquatic species or areas of conservation concern whilst research is conducted to more accurately determine those impacts. This management response provides an opportunity for appropriate and rapid responses to areas needing protection while not jeopardising the entire salmonid fishing sector and related industries. Further, under the draft FMS, salmonids will not be stocked in any natural waters in which they have not been previously stocked.

Atlantic salmon has shown to be a poor performer in NSW, as has the brook trout. Both species offer anglers alternatives to the brown and rainbow trouts but neither have established viable populations or produced consistently good returns to anglers.

As Atlantic salmon and brook trout are relatively poor performers, alternative options are considered regarding the stocking all four species of salmonids when only two good performers have shown their worth. It could be argued that cost savings can be made by not stocking (or maintaining lines of) these species and by channelling resources into increased production of the successful brown and rainbow trout.

The option to cease stocking of Atlantic salmon and brook trout was not considered appropriate under the draft FMS. Production of these species provides greater variety for the salmonid angler and stocks of Atlantic salmon need to be maintained for future aquaculture ventures or for disaster recovery stocks for interstate purposes (such as in Tasmania). Better technology in future may

also be developed to produce more viable stocks. Should the breeding lines of these species be lost they may never be re-established in NSW.

Consideration has been given to produce daughterless trout (hatchery technology where trout only produce male offspring), and triploids (where progeny are ≥99% infertile) but these technologies are not reliable enough at present.

C2.1.3 Forage species

The production of forage species was considered as an alternative to the proposed activity. Forage species are stocked into an enclosed waterway so as to provide a source of food for other stocked fish and offer a ready source of protein and an alternative food source to naturally available species or juvenile stocked species. Stocking forage fish could feasibly improve growth rates of target recreational species and offer a level of protection to immature stock and endemic species.

The use of this alternative was not considered appropriate at this time due to a number of factors. Insufficient technology to produce stocks of forage fish, potential environmental impacts, appropriate species selection and the added cost of conducting such a program preclude serious consideration of that alternative at this time.

C2.2 Alternative catchments, waterways or locations to be stocked

Current stocking practice utilises the majority of suitable accessible waterways. Historically, the range of waters stocked in NSW was selected in response to recreational fishing effort and demand for stocking certain species. These factors and the habitat requirements of the stock have systematically shaped the current stocking regime.

There are, however, a number of other suitable waterways throughout the State that could be stocked under the draft FMS and these will remain potential sites for stocking in future to enhance recreational fishing opportunities. Most of these sites are situated relatively close to major towns in NSW, as their primary purpose is as water supply reservoirs, most of which have restricted access due to concerns about maintaining water quality. Major impoundments such as Warragamba Dam and Prospect Reservoir near Sydney are prime locations to establish harvest fisheries yet remain closed to public utility. Medium sized dams across NSW, including Avon, Cataract, Cordeaux, Nepean, Wingecarribee and Chichester are also potential sites. Until the regulating authorities that manage these waters approve public access to them, however, there is little chance that they may be developed for angling in the near future.

C2.3 Alternative stocking densities

Efforts to determine the most appropriate stocking densities for NSW waters is a management response in the draft FMS. Creating reliable formulae based on the size of the waterway and other considerations will result in the more efficient stocking rates that provide good returns to anglers. This may mean that some waters are stocked with more or less of a certain species or at a certain size or level of development. Currently, stock allocation is a management decision based on the fisheries manager's experience with the waterway and the availability of stock.

An alternative to developing reliable stocking rates is to simply stock a waterway with bulk quantities of species and let natural processes determine survival rates through fishing effort and

predation in the trophic structure. This method still runs the risk of developing overcrowded populations within the waterway leading to slow growth and poor returns to anglers and does not promote efficient stocking practices. As such, stocking will be continued at the current levels whilst research is conducted into the most appropriate rates and extent.

C2.4 Alternative stocking methods

An alternative to current stocking methods that may enhance recreational fishing opportunities is to increase the size of fish that are stocked. By stocking fish that are up to or over 50 mm may markedly increase the chances of the stock surviving initial mortality through predation and stocking stresses. This would be an effective way to enhance recreational fisheries particularly in smaller to medium size impoundments. Larger fish offer better opportunities to stock lower numbers ultimately yielding a higher survival rate. Another benefit is that stock can be readily and reliably marked by fin clipping or other tagging methods when using smaller stock.

In considering this alternative the matter of cost arises and significant trade-offs would be required to ensure the option falls within existing or acceptably higher financial inputs. Rearing fish to around 50mm (about 12 weeks old) before stocking is in the range of three to four times more expensive than producing 25mm fingerlings and would require the complete overhaul of current hatchery operation. Hatchery selection is also a concern with stocking larger fish. Fish that do well in a hatchery situation, particularly for an extended rearing program, often become domesticated and do not fare as well in a wild environment.

Given that there are few alternative stocking methods not already utilised in the current or proposed activity, and the cost implications of adopting the larger size stock option, this alternative was not considered appropriate for general implementation at this stage. However, further information on the cost/benefits and improved production infrastructure, may see the proportion of stock increase in future

C3 Management Measures Proposed in the Draft FMS

C3.1 Alternative management of the activity

C3.1.1 Hatchery management

An alternative to current and proposed hatchery management arrangements is the concept of completely out-sourcing the production of stock to private enterprise. Lucrative opportunities would exist for competent hatchery operators to provide bulk quantities of stock for the activity, effectively replacing Government production. Funding could possibly be sourced from the Recreational Freshwater Fishing Trust, Dollar-for-Dollar type programs and possibly through Government subsidies. A range of hatcheries strategically located around the State could produce stock relevant to their area of expertise or locality. Government would still manage the overall activity in relation to stocking levels, information management and priorities.

This alternative action could be argued as feasible. However, as discussed in the alternative promoting the use of the private sector to supplement Government stocking programs, it is generally accepted by fishery and aquaculture managers that the private hatchery sector is not yet ready for the large-scale production of suitable stocks to augment government stocking programs. Therefore, any consideration of out-sourcing the Government role in stocking was not considered appropriate at this time, but may be revisited following implementation and assessment of the proposed Hatchery Accreditation System.

C3.1.2 Monitoring

Monitoring of the activity under the draft FMS uses management actions such as the marking of some stock where it is considered necessary to identify hatchery reared stocked as opposed to wild stock, such as during research programs.

An alternative to marking some stock is to mark all stock prior to release. Marking all stock for release would ensure that every specimen could be identified by source, though is not considered necessary because partial marking is sufficient to meet monitoring and management requirements. Marking Australian bass for stocking in a dam or beyond an impenetrable barrier, for instance, is not required as the fish cannot breed in these waters and, therefore, all stock must be from a hatchery.

There were several issues that made the alternative of marking all fish unviable under the draft FMS. Marking agents such as alizarin complexone and other compounds are extremely expensive (up to \$10,000 per kg) and it would be an unnecessary burden to place such high cost on the production of all stock, particularly in the private hatchery sector, thereby affecting their viability. The process of marking fish with these compounds is also time consuming and may carry a high mortality rate for juvenile fish. This reduces overall production figures and exacerbates the high-cost of the product. Given the limited benefits and high-costs of adopting this alternative, it is considered impractical under the strategy. It is proposed, however, to further investigate the types of, and need for, cost-effective marking techniques.

C3.2 Alternative cost recovery regimes

The economic assessment carried out as part of this EIS shows that it is difficult to fully assess the level of cost recovery being achieved under the current management of the activity. However, the

assessment did stipulate that several aspects of the activity appeared to be fully cost recovered (research, Dollar-for-Dollar, transfer of funds from trusts) while economic benefits generated by stocking were significant to regional NSW and in the order of tens of millions of dollars. There is little doubt that the economic benefit generated by stocking far exceeds the initial fiscal input from the NSW Fisheries' budget and trust fund expenditure. This aspect of stocking is generally considered to be a redeeming feature of the activity across the board.

Alternatives to the stocking regime that would generate similar economic stimuli are difficult to hypothesise, let alone consider as a feasible alternative. The majority of expenditure by fishers and stockists is expended broadly across the State (with the exception of pockets of high economic activity such as in the Snowy region) and to replace the stimuli with something similar would take considerable business acumen and infrastructure.

However, comparing the current activity with one that would replace the stocking of public waters with the stocking of private waters as in a fish-out operation could be considered a feasible alternative. Fish-outs, as they are known colloquially, are private enterprises managed under the aquaculture system in NSW whereby members of the public pay the operator to fish a private dam that has been stocked with angling species. Fish-outs offer a reasonably cheap form of angling with a high chance of landing a fish and are particularly good opportunities for young families to engage in angling with little of the effort and resources required to seek out fish stocked in public waters. To emulate the current activity by creating numerous fish-out establishments would require extensive investment and coordination above and beyond that which exist at present. There are only 32 registered fish-out businesses in NSW, most are small-scale operations and would not be in a position to service the inland anglers already accustomed to fishing stocked public waters.

Should stocking be deemed unsustainable for argument's sake, and all stocking activity was replaced through the development of large scale fish-outs, it would be very unlikely that the full effort and expenditure attributed to the current activity would be transposed to a fish-out style regime. Fish-outs do not offer much in the form of a complete angling experience or the "great outdoors" quality of the existing fishery.

There would be a complete shift in business viability from that existing at present (tourism and related industries) to one where private operators would capture more of the share of the economic benefit spread further across the State.

It could be argued further that many people simply would no longer go fishing if the activity was reformed in such a radical manner without the benefits comparable to the existing regime, which is closely aligned with natural features of NSW countryside. Any transition period between regimes would take years and hatcheries currently geared up for high-capacity stocking would find it difficult to adjust initially and in the long-term. There is a paucity of available waters with sufficient volume that could be considered as viable operations and insufficient skilled operators at this time and construction of sufficient artificial waterways to cater for the recreational fishing contingent could prevent its success.

Current aquaculture management and industry development initiatives promote the establishment of more fish-outs in NSW as a way to supplement income from wider aquaculture operations (hatchery, grow-out) while generating regional economies. An increase of approximately 10% per annum in new establishments is considered likely over the next 10 years. This equates to approximately 50 fish out facilities in operation by 2008, if calculated exponentially.

Given that there are thousands of fishing destinations available under the current regime of stocking public waters, and even with renewed focus on fish-outs as an alternative-stocking regime, it would be highly unlikely that this level of growth would support the current level of participation.

C3.3 Alternative protocols for setting priorities for stocking

Current arrangements for setting priorities for stocking involve consultation with acclimatisation society representatives at an annual meeting held prior to the stocking season. These arrangements only relate to salmonid species while priorities for stocking native fish are developed on a more informal basis whereby managers determine the stocking schedule, which includes adequate representations from native fish angling groups.

Under the management arrangements proposed in the draft FMS, the consultation procedures with angling stakeholders, for both salmonid and native species, are to be expanded to offer more stakeholder consultation and community input achieved through meetings held in regional NSW.

An alternative to these arrangements would be to establish a stocking reference group whose main purpose is to develop stocking priorities across the State. A reference group could be established with representatives of NSW Fisheries (management, hatcheries, research), acclimatisation societies, native fish stockist, conservationists, Aboriginal groups, water resource representatives or other. Such a group would meet initially and then periodically throughout the year to assess representations for stock allocations aimed at satisfying demand through appropriate grading or other assessment criteria.

This alternative was not selected over the preferred arrangement as proposed in the draft FMS as it was considered that by expanding the consultation process in the first instance, that the same outcomes could be achieved but with significantly lower management costs.

C4 Performance Reporting and Monitoring

Performance reporting in the draft FMS relies on a series of performance indicators and trigger points related to activity goals, which if exceeded, cause the goal or the FMS to be reviewed and adjusted where necessary. This sets out a system of desired outcomes that can be achieved within a reasonable level of probability before trigger points are exceeded and is designed to ensure the overall objectives of the draft FMS are achieved within expected and reasonable variables.

An alternative performance reporting and monitoring regime could be used whereby specific outcomes are set out as tangible achievements within the management framework. Outcomes could include stock production targets (quotas), and recapture targets (returns to fishers), as the primary reportable objectives for performance and monitoring. Monitoring of these outcomes would be relatively straightforward and easily audited.

To embrace such a production and return-based system would not take into account the potential environmental and social impacts of the activity and would be more suited to an aquaculture venture on private land. As such, these alternatives were not adopted in the draft FMS.

The comparisons shown in this section reveal that although feasible alternatives are available for the management of fish stocking in NSW, a cautious and pro-active suite of management actions are put in place by the draft FMS. These cater for contingencies in a manner far more effectively than the alternatives. This is achieved with the well-being of those involved in the activity in mind, both socially and financially, while potential impacts on the environment are also adequately managed.

CHAPTER D THE DRAFT FISHERY MANAGEMENT STRATEGY FOR THE ACTIVITY

D1 Introduction to the Activity of Fish Stocking

D1.1 Brief description of the activity

The ‘activity’ of freshwater fish stocking is currently delivered by NSW Fisheries as two specific services that make up the designated fishing activity. These service components are referred to as *Harvest Stocking* and *Conservation Stocking*. Together they encompass the practice by NSW Fisheries and private groups or individuals of stocking inland waterways and the freshwater reaches of coastal drainages with native fish and/or salmonids to enhance fishing for recreational and Aboriginal cultural purposes, for religious and ceremonial purposes, and to rebuild depleted native fish populations.

According to records kept over the past 42 years, NSW Fisheries, aided by acclimatisation societies, angling clubs, conservationists and volunteers, have stocked over 80 million freshwater fish comprised of 12 species (natives and salmonids) into the waters of New South Wales. NSW Fisheries has five hatcheries producing most of the stock for the activity while a number of privately owned hatcheries produce stock for a variety of smaller scale events.

Chapter B1 provided a comprehensive description of stocking activity as it currently takes place and the risk assessment in Chapter B2 identified that all aspects of the current operation of the activity may pose risks to its ecological sustainability. This chapter (the draft FMS) proposes a number of goals, objectives and management responses designed to minimise risks and provide a strategic management framework for the activity of freshwater fish stocking into the future. The FMS for Freshwater Fish Stocking in NSW does not provide for the stocking of marine or estuarine waters, and those activities were not assessed in the risk assessment of the current activity. Any proposals to stock marine or estuarine waters would need to be subject to a separate environmental impact statement.

D1.2 The legal and policy regime

A range of legislative and policy instruments apply to or have the potential to influence fish stocking activities in NSW, including:

D1.2.1 The Fisheries Management Act 1994

The *Fisheries Management Act 1994* (the FM Act) seeks to achieve ecologically sustainable development for the fisheries of NSW through the achievement of its stated objectives, which are:

- 1) To conserve, develop and share the fishery resources of the State for the benefit of present and future generations.
- 2) In particular, the objects of the Act include:
 - a) to conserve fish stocks and key fish habitats, and

- b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and
 - c) to promote ecological sustainable development, including the conservation of biological diversity,
- and, consistently with those objects:
- d) to promote viable commercial fishing and aquaculture industries, and
 - e) to promote quality recreational fishing opportunities, and
 - f) to appropriately share fisheries resources between the users of those resources, and
 - g) to provide social and economic benefits for the wider community of New South Wales.

D1.2.2 The NSW Environmental Planning and Assessment Act

The evolution of the environmental assessment process for fishing activities in NSW stems largely from a decision handed down by the Land and Environment Court in January 2000. The Court decided that the issue of an individual commercial fishing licence had to meet the requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The effect of the decision was that the environmental impacts of certain activities authorised by NSW Fisheries had to be assessed at the time the authority (i.e. licence, permit, etc.) was issued or renewed.

It is widely accepted that in most cases the best way of assessing the impact of fishing or stocking is by considering the total impact of the activity, instead of the impacts of individual events. The Government was concerned that requiring assessment for each individual application would be an unnecessarily expensive and time-consuming activity.

After consultation with Ministerial Advisory Councils, the Government decided that the best approach would be to assess the environmental impact of fishing activities at the broader “fishery” or “activity” level. This provides the best approach for both our aquatic environment and stakeholders. The legislation was subsequently amended to provide for the development of fishery management strategies and the environmental assessment of these strategies.

D1.2.3 Threatened species legislation

There are two pieces of State legislation that incorporate provisions for the protection of threatened species, populations or ecological communities. They are the FM Act (Part 7A) and the *Threatened Species Conservation Act 1995* (TSC Act). Aquatic species listed under these acts could be affected by fish stocking and as such need to be considered during the development and implementation of the FMS for the activity. There is a third piece of legislation addressing threatened species conservation, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, discussed separately below.

In addition to listing species, populations or ecological communities that are presumed extinct, endangered or vulnerable, both of these acts contain provisions for listing Key Threatening Processes. A threatening process is eligible to be listed as a Key Threatening Process if, in the opinion of the Scientific Committee (TSC Act) or Fisheries Scientific Committee (FM Act), it:

- adversely affects 2 or more threatened species, populations or ecological communities, or
- could cause species, populations or ecological communities that are not threatened to become threatened.

A Threat Abatement Plan (TAP) is a statutory instrument outlining the actions needed to reduce or eliminate the effects of a key threatening process on the long-term survival of threatened species, populations and ecological communities.

The requirements of a TAP are that it must:

- state the criteria for assessing the achievement of the objective
- identify the actions needed to abate, ameliorate or eliminate the effects of the key threatening process
- identify the persons or public authorities who are responsible for the implementation of the measures included in the plan
- where practical provide a proposed timetable for the implementation of the plan
- state the estimated costs of the measures included in the plan
- state the date by which the plan should be subject to review by the Director-General, and
- include any other matter relating to the impact of the plan as the Director-General considers appropriate.

The Director-General must, in preparing a plan and in deciding which measures to include in it, have regard to the following:

- the likely social and economic consequences of making the plan
- the most effective and efficient use of available resources for the conservation of threatened species
- the desirability of minimising any significant adverse social and economic consequences, and
- the Director-General is to consider any measure by which the public may co-operate in the abatement, amelioration or elimination of the adverse affects of the key threatening process on threatened species, populations or ecological communities.

D1.2.3.1 *Links between the FMS and key threatening processes*

There is one existing key threatening process relating to the activity of fish stocking that is self-explanatory, titled “Introduction of fish to fresh waters within a river catchment outside their natural range” (see www.fisheries.nsw.gov.au for further information). This key threatening process implicates the activity of stocking non-native fish and stocking native fish into areas beyond their natural range as one source of the threat, and the release of aquarium fish or any other fish by illegal means as other sources. This management strategy incorporates a range of actions, which address the threat insofar as the impacts of stocking fish are concerned. The other threats relating the illegal introduction of aquarium fish or other species into natural waterways will need to be managed through the development of a threat abatement plan.

D1.2.4 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) commenced in 1999 and provides for the protection of certain matters of national environmental

significance from the impact of new activities. Matters of national environmental significance relevant to inland activities include: declared World Heritage areas, declared Ramsar wetlands, listed threatened species and ecological communities, and listed migratory species.

The NSW fish stocking program has been underway for over 100 years and this activity will continue under the management strategy, subject to more stringent environmental controls. The EPBC Act does not apply to the NSW stocking program, as it is an existing activity. However, the FMS establishes a comprehensive framework for managing the impacts of stocking on threatened species and environmental heritage.

D1.2.5 Ecologically sustainable development

Ecologically sustainable development (ESD) was defined under the National Strategy for ESD as “Using, conserving and enhancing the community’s resources so that ecological processes on which life depends, are maintained, and the total quality of life, now and into the future, can be increased” (CoA, 1992). ESD can be achieved through the implementation of the following principles:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations
- to provide for equity within and between generations and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

D1.2.6 The NSW Indigenous Fisheries Strategy

Fishing has been an integral part of the cultural and economic life of inland Aboriginal communities since they have been in this land. Fishing has been an important source of food, a basis for trade and an important part of cultural and ceremonial life. Traditionally, Aboriginal fishers had responsibility for providing not just themselves but for family and community. These cultural expectations continue in Aboriginal communities today.

In December 2002, the NSW Indigenous Fisheries Strategy and Implementation Plan (IFS) was released. The IFS seeks to protect and enhance the traditional cultural fishing activities of Aboriginal communities, and ensure Aboriginal involvement in the stewardship of fisheries resources. There are some issues that will be addressed immediately by the IFS and others that will only be resolved after lengthy negotiation involving Aboriginal communities, the broader community, fishing groups and government agencies. The IFS puts in place a process that will ensure discussion and negotiation can continue with progressive resolution of problems and challenges (see NSW Indigenous Fisheries Strategy and Implementation Plan, 2002).

The activity of fish stocking in natural freshwater waterways has several linkages to Aboriginal cultural heritage. First, conservation stocking can help to rebuild populations of threatened and depleted native species that are culturally important to Aboriginal groups, such as totem or moiety species. Second, harvest stocking can be used to provide better opportunities for Aboriginal fishers to catch fish that may now be more difficult to harvest due to the increased pressures on natural ecosystems.

This FMS supports the IFS by incorporating Aboriginal cultural fishing and values as a key consideration, by being responsive to outcomes that are negotiated under the IFS, and by promoting partnerships between government and Indigenous leaders. One key example of the links between the

FMS and the IFS is the research proposal being developed through the IFS that, among other things, seeks to identify the major species, areas and harvesting techniques of cultural importance to Aboriginal people in NSW. Information flowing from that or any other studies can be used to inform efforts to re-establish viable native fish populations to support cultural fishing practices, such as through the development of partnerships with Aboriginal communities to stock selected species and/or locations or to guide other measures to restore riverine ecosystems. Other linkages between the IFS and the FMS reflect the intent to tailor the delivery of fish stocking services to take account of Indigenous expectations and requirements, such as through the provision of information and education material, consultative mechanisms and participation in stocking events.

D1.3 The role of the Fishery Management Strategy

This draft FMS outlines the rules, regulations and programs that are proposed to manage the activity of fish stocking in future. Outlining the proposed rules allows an environmental assessment to consider the potential impacts of the activity proposed to be regulated in accordance with the FMS on biophysical, economic and social issues. Information about the impacts by other fishing (such as recreational fishing) or industry sectors (aquaculture and the aquarium trade) is also provided, although the rules applying to such sectors are dealt with under separate management or legislative arrangements. In particular, aquaculture has long been synonymous with fish stocking, but the risk assessment (Chapter B2) highlights the need to de-couple these two forms of fish production. Issues related to the aquarium trade are addressed through legislation prohibiting the release of fish into natural waterways without a permit, listing of noxious or pest species, and the concurrent program of establishing a list of species permitted for importation into NSW for use in the aquarium trade.

A key priority for the FMS is the introduction of an appropriate management regime to minimise the environmental risks that have been identified through the application of a risk management framework (in Chapter B2). That process suggests that all elements of the current activity of fish stocking, with the exception of the actual release of fish, pose some threat to ecological sustainability. Those components of the environment at risk and the elements of the activity thought to be responsible for that risk and thus in need of particular attention through the FMS are presented in Table D1 below.

Clearly, strengthening hatchery protocols and the general administration and information management elements of the activity can mitigate multiple risks. In particular, distinguishing between hatcheries that aim to produce fish for stocking as opposed to traditional aquaculture will mitigate most of the risks related to the genetic integrity of wild populations. It will also serve to make administration and compliance less complicated and allow for more targeted monitoring or research related to broodstock and their progeny. Developing and improving research and monitoring of the activity will also reduce much of the uncertainty associated with the risk assessment by identifying actual rather than potential environmental impacts of fish stocking.

This FMS has been prepared by NSW Fisheries in consultation with the Recreational Fishing Freshwater Management Planning Committee (RFFMPC), Ministerial Advisory Councils, Indigenous Fisheries Strategy Working Group and a variety of stakeholders including stocking groups, inland local councils and hatchery operators but does not in all cases reflect the views of the RFFMPC or other stakeholders.

Table D1. Elements of the current activity of fish stocking that need to be addressed in the FMS.

Note: 'Y' indicates that addressing an element will contribute to reducing the risks to the associated environmental component.

Environmental components	Elements of the activity of fish stocking to be addressed						
	Broodstock collection	Species to be stocked	Hatchery protocols	Information management	Stocking locations	Compliance & education	Research and monitoring
Ecological processes	-	Y	Y	-	-	-	Y
Threatened species	-	Y	Y	Y	Y	Y	Y
Other species	-	Y	Y	Y	Y	-	Y
Protected areas or habitats	-	Y	Y	Y	Y	Y	Y
Genetic diversity	Y	Y	Y	Y	Y	Y	Y
Diseases and pests	Y	-	Y	Y	Y	Y	Y

D1.4 Overview of the management regime under the fishery management strategy

The FMS provides a framework for the management of fish stocking activities in public freshwater rivers, streams and impoundments in NSW. The FMS covers stocking for conservation and harvesting purposes and implements these programs in a manner that reduces the environment risks of the current stocking activity. The key elements of the FMS are described below.

D1.4.1 Parameters for fish stocking

The FMS defines the parameters within which the annual stocking events by the Government (through the Fish Stocking Program run by NSW Fisheries) and private individuals or groups will be reviewed and approved. The parameters will be updated as required to be consistent with broader national or multi-jurisdictional policies being developed (e.g. National Policy for the Translocation of Live Aquatic Organisms, Murray-Darling Basin Native Fish Strategy, etc.).

D1.4.2 Species and waters that can be stocked under the FMS

The FMS details the species and waters that can be stocked under the FMS. The species and waters provided for in the FMS have been identified taking account of issues such as the translocation, genetics and historical stocking activity.

Any proposals to stock species into waters that are not covered by the FMS would need to be accompanied by a separate environmental impact assessment, except for proposals to stock in waters permanently closed to stocking, which will not be approved (unless it is conservation stocking for a recovery program – see below)

D1.4.3 Species and waters that cannot be stocked under the FMS

The FMS lists a number of waters or sections of waterways that will be permanently or temporarily closed to fish stocking:

D1.4.3.1 *Permanently closed waters*

This is a list of waters where the stocking of some or all species will not be approved due to those waterways comprising pristine or unique aquatic environments and where there are no or few official records of fish being stocked. Proposals to stock into these waterways will not be approved, even if the proponent supplied a separate environmental assessment on the proposal. The only exception to this is conservation stocking as part of a recovery program following a natural or human induced environmental catastrophe.

D1.4.3.2 *Temporarily closed waters (i.e. restricted waters)*

This is a list of waters or sections of waterways where the stocking of some or all species will not be approved due to the presence of threatened or protected species or to avoid areas of special significance (except conservation stocking for species recovery purposes). The FMS includes a mechanism to review the list every five years and to list or de-list waters based on criteria involving a range of ecological (e.g. threatened species listings, stream condition), economic (e.g. local economic dependencies) and social (e.g. history of stocking, alternative opportunities) factors.

D1.4.4 Ongoing review of FMS stocking events

Prior to any authorisation, each proposed stocking event will be subject to an explicit environmental review by relevant officers of NSW Fisheries to ensure that all matters likely to affect the environment (including those within the local area) have been properly considered and, where relevant, strict conditions are imposed on the stocking event. Stocking Review Guidelines for stocking events have been developed to guide this process (see D3.5 and FMS Appendix 1). The stocking review process will ultimately incorporate a ‘classification of waters’ scheme to ensure that each stocking event is likely to result in a high survival rate of the stocked fish (e.g. by requiring the release of certain size classes of selected species into individual waterways).

D1.4.5 Management of fish hatcheries

The FMS incorporates plans to better manage the production of fish by Government and private hatcheries for stocking purposes. This includes a proposal to develop a quality assurance and accreditation scheme for hatcheries to increase the certainty that fish supplied for stocking have been produced using best-practice techniques for broodstock collection and husbandry, management of disease risks, genetic resource management and stock identification. Policies and guidelines relating to each of these factors will be prepared and implemented along with the hatchery accreditation scheme.

D1.4.6 Information management

A central stocking database will be developed under the FMS to record all information reported by accredited hatchery operators, from proponents who undertake the stocking activity and from the various research programs that produce information relevant to the review and assessment of individual stocking events. The database will be built in a form that can be transposed to GIS software to allow for spatial management of the activity.

D1.4.7 Research

A Research Plan is presented that is based on the outcomes of the risk assessment of the existing activity to ensure that the projects being undertaken are focussed on the areas of greatest

environmental risk. Of particular importance is research into the presence of any sub-populations of native species that are stocked. Research and monitoring related to the survival of stocked fish within the receiving waters is also important to determine whether the stocking events being undertaken are providing good returns for the effort.

D1.4.8 Compliance and education

A targeted compliance strategy will be developed to focus compliance activities in the high-risk areas and utilise the improved information management system developed under the FMS. Improved education of stocking proponents and the community about the environmental risks associated with stocking is critical to promote responsible stocking. An education program will highlight the potential damage that can be caused by people placing species of fish in areas that have not been approved for stocking. The education program will also include information provided to individuals or groups about best-practice techniques for transporting and releasing fish at the stocking site.

D1.4.9 Responsiveness

The controls within the FMS, including the detailed policy and guideline documents to be subsequently developed, will be responsive to new information originating from research programs or the central information management system. The strategy will also be subject to reviews if the performance monitoring (incorporating performance indicators and trigger points) indicates that the management goals are not being met.

D2 Vision and Goals for the Activity

D2.1 Vision for the activity

The long-term vision for the activity of fish stocking is:

An activity that provides effective enhancement of freshwater recreational and Aboriginal cultural fishing in NSW and supports conservation outcomes for fish, that is undertaken within a clear management framework and consistent with the principles of ecologically sustainable development.

D2.2 Goals for the activity

The proposed goals that have been designed to achieve this vision for the activity are as follows:

1. to manage the activity in a manner that minimises impacts on aquatic biodiversity including threatened species and genetic resources
2. to enhance fishing opportunities through cost-effective stocking programs that maximise economic benefits and provide social equity from the activity for recreational fishing and Aboriginal cultural fishing purposes
3. to ensure the consistent production and release of appropriate quality stock
4. to provide efficient administrative services, information management and reporting systems
5. to improve the knowledge of the activity and ecosystems in which it operates, and
6. to maximise community understanding and voluntary compliance through education and support services while providing effective deterrence against illegal activity.

D3 Designated Stocking Activity

This FMS describes the fish stocking program proposed to service fishing (hereafter referred to as harvesting) and conservation needs within freshwater areas in NSW, as outlined in Table D2. The fish stocking program involves regular review of the species to be stocked and stocking areas, and is dependent upon the annual production of fish from public and private hatcheries across NSW.

Table D2. Overview of the Designated Stocking Activity under the FMS

Component of Designated Stocking Activity	Programs/events that make up the activity
Harvest Stocking	<ul style="list-style-type: none"> • Stocking of native species into dams, lakes, rivers and other public waterways by NSW Fisheries or authorised agents (including recreational fishers or Aboriginal people), through the Dollar-for-Dollar Native Fish Stocking Program, Australian Bass Stock Enhancement Program, and the Impoundment Stocking Program • Stocking of salmonid species into dams, lakes, rivers and other public waterways by NSW Fisheries or authorised agents through the Salmonid Stocking Program or Snowy Lakes Trout Strategy • Individual applications to stock under section 216 of the FM Act (permit to release fish) including applications from fishing clubs, acclimatisation societies, other organisations or individuals and religious/ceremonial purposes
Conservation Stocking	<ul style="list-style-type: none"> • Stocking of native species to support programs developed under Part 7A of the FM Act (e.g. threatened species recovery plans) • Compensation stocking subject to policy requirements (i.e. stock compensation requirements under NSW Coastal Policy and the NSW Fisheries Broodstock Collection Policy)

D3.1 Policies for harvest and conservation stocking

NSW Fisheries proposes to continue stocking inland waters of NSW to meet the balance between conservation and fishing interests (subject to appropriate environmental assessment), as outlined in the following sections.

D3.1.1 Harvest stocking policy

Harvest stocking will involve the stocking of native and salmonid species into specified public inland waters of NSW, subject to the following stocking policies and other provisions of the FMS.

D3.1.1.1 Native species stocking policy

1. Native species produced from approved hatcheries may be stocked into specified public inland waters of NSW to create, maintain or enhance fish stocks to levels considered necessary to provide quality recreational fishing and Aboriginal cultural fishing opportunities.
2. Native species will be stocked for harvesting purposes only in waters within their natural range and known distribution, with the exception of golden perch and silver perch into the Hunter River catchment where previous stocking of these species has occurred (*note: Murray cod were permitted to be translocated into Glenbawn Dam in 1966 but no releases of hatchery-reared stock have ever been permitted*).

3. Native species that have been historically stocked will continue to be stocked, although other native species may be used if technology to produce viable stocks becomes available, the activity is consistent with the goals and objectives of the FMS, and the activity satisfies the stocking review requirements.
4. NSW Fisheries will produce stocks of native species for stocking. Where a suitable alternative source is available from an accredited hatchery, stock may be obtained from that source. A combination of these sources may be used to meet stocking requirements.
5. Native species will only be stocked where all of the following conditions apply, unless part of a research program approved or conducted by NSW Fisheries:
 - pertinent environmental conditions are available for the welfare and optimal survival and health of the stock
 - self-sustaining populations are insufficient to support harvesting
 - the stocked waters offer reasonable access to fishers, including potential future access, and
 - sufficient demand for stocking native species in a particular area is evident during the preparation of the annual stocking program
6. Priority

An annual stocking program for fish produced in NSW Fisheries hatcheries will be developed prior to the spawning/production season, with representatives of relevant angling clubs, private hatcheries, other relevant groups and NSW Fisheries managers.

D3.1.1.2 *Salmonid stocking policy*

1. Salmonid species will be restricted to the traditionally stocked species: rainbow trout, brown trout, brook trout and Atlantic salmon. No other non-native species will be introduced into NSW for stocking under the FMS.
2. NSW Fisheries will produce the stock of salmonid species for stocking programs. Where a suitable alternative source is available from an accredited hatchery, stock may be obtained from that source. A combination of these sources may be used to meet stocking requirements.
3. NSW Fisheries may carry out any salmonid fish stocking, subject to the stocking review framework, in order to meet the objectives of the FMS.
4. Salmonids will only be stocked where all of the following conditions apply, unless part of a research program approved by or conducted by NSW Fisheries:
 - the official records held by NSW Fisheries indicate that stocking of salmonids has occurred in the waterway concerned (or section of waterway if barriers exist which prevent the movement of fish) since 1990, or when a natural or anthropogenic catastrophe/disaster removes an existing self-sustaining fished population
 - environmental conditions are available for the welfare and survival of the stock (i.e. generally between 700 and 1500m ASL, water temperatures between 5 and 25°C and dissolved oxygen levels of >5 ppm)

- self-sustaining populations are insufficient to support harvesting
- the proposed waters for stocking offer reasonable access to fishers, including potential future access
- sufficient demand for salmonid stocking in a particular area is evident through consultation and during the preparation of the annual stocking program, and
- stock produced in excess of requirements may only be released into low risk areas such as large impoundments and rivers that have been previously stocked with that species.

5. Priority

An annual stocking program will be developed following scheduled meetings held prior to the spawning/production season with representatives of relevant acclimatisation societies, other relevant groups and NSW Fisheries managers.

D3.1.2 Conservation stocking policy

1. Stocking of native species will be conducted for the purpose of supporting fisheries conservation management objectives at a State, national or international level.
2. NSW Fisheries will produce the stock of native species for conservation programs. Where a suitable alternative source of stock is available from an accredited hatchery, stock may be obtained from that source. A combination of these sources may be used to meet conservation stocking requirements.
3. Conservation stocking will be permitted where:
 - the activity forms part of a threatened species recovery plan or recognised research program relating to the conservation of a native species of fish
 - there is a justifiable need to increase the local stocks of a threatened species, or
 - the activity forms part of an enhancement program or compensation requirement of any policies or management plan recognised by the FMS (e.g. NSW Coastal Policy and broodstock collection policy).
4. Despite any other limiting provision within the FMS, stocking for conservation purposes may take place provided an appropriate environmental assessment, such as a Review of Environmental Factors or an Environmental Impact Statement, has been undertaken and duly considered prior to the stocking event.

5. Priority

The priority arrangements for conservation stocking programs will vary from time to time but will be subject to consultation with the NSW Advisory Council on Fisheries Conservation (ACFC) or equivalent body.

D3.2 Catchments, zones and species to be stocked

The State's catchments have been categorised into 'stocking zones' (Figure D1) that reflect a broader grouping of 'like' catchments. This will facilitate the review of stocking events for areas displaying similar environmental requirements and matters of environmental concern that are characteristic of each stocking zone.

Stocking zones will be classified as follows and are shown in Figure D1 (details in FMS Appendix 3): East Coast: (all eastern drainages), Montane (all salmonids), Murray (Murray, Murrumbidgee & Lachlan catchments), Darling (Darling, Macquarie, Castlereagh, Namoi, Gwydir and Macintyre catchments) and Far West (all other western catchments within NSW). The Montane zone relates to all salmonid stockings and encompasses areas within other zones where pertinent environmental conditions are available for trout and salmon. Those areas and waters are generally determined by an elevation of 700 to 1,500m ASL and where water temperature ranges between 5 and 25°C.



Figure D1. Stocking zones in NSW.

To ensure that the environmental impacts of fish stocking are minimised and in some cases avoided altogether, the species to be stocked into each catchment will be limited to those outlined in Table D3 below and subject to the controls established for stocking those species (see FMS Appendices 1-3).

In addition to the waters in Table D3, native species can be stocked into any waterway, but any such stocking events undertaken in previously unstocked waterways must meet the genetic standards established for conservation stocking, irrespective of the purpose for of the event. Account must also be taken of the relative cost and benefits of alternative measures to rebuild native fish populations, such as riverine ecosystem restoration. As outlined in D3.1.1.2, salmonids can only be stocked into waters stocked with the species since 1990.

Any proposals to stock fish that do not comply with the above, or the specifications in Table D3, will not be permitted to proceed under the FMS and would need to be subject to a separate environmental impact assessment process.

Table D3. Permissible stocking in catchments within each stocking zone.

East Coast	Species Proposed to be Stocked * indicates species stocked in Montane Zone that overlaps this catchment
Tweed River	Australian bass
Richmond	Australian bass, eastern freshwater cod, rainbow trout*, brown trout*
Clarence	Australian bass, eastern freshwater cod, rainbow trout*, brown trout*
Macleay	Australian bass, rainbow trout*, brown trout*
Hastings	Australian bass, rainbow trout*, brown trout*
Camden Haven	Australian bass, rainbow trout*, brown trout*
Manning	Australian bass, rainbow trout*, brown trout*
Port Stephens	Australian bass
Hunter	Australian bass, golden perch, silver perch, rainbow trout*, brown trout*
Lake Macquarie	Australian bass
Hawkesbury	Australian bass, rainbow trout*, brown trout*
Port Jackson	Australian bass
Lake Illawarra	Australian bass
Shoalhaven	Australian bass, rainbow trout*
Clyde	Australian bass - in impoundments only
Moruya	Australian bass - in impoundments only
Tuross	Australian bass - in impoundments only
Bega	Australian bass - in impoundments only
Towamba	Australian bass - in impoundments only
Genoa	Australian bass - in impoundments only
Snowy	Atlantic salmon, brook trout, brown trout, rainbow trout, Australian bass

Murray	Species Proposed to be Stocked * indicates species stocked in Montane Zone that overlaps this catchment
Lake George	Golden perch, silver perch, Murray cod, brown trout*, rainbow trout*
Murrumbidgee	Golden perch, Murray cod, silver perch, trout cod, Atlantic salmon*, brown trout*, brook trout*, rainbow trout*,
Murray	Golden perch, Murray cod, silver perch, Atlantic salmon*, brook trout*, rainbow trout*, brown trout*
Lake Hume	Golden perch, silver perch, trout cod, Murray cod, Atlantic salmon*, brown trout*, brook trout*, rainbow trout*,
Lachlan	Golden perch, Murray cod, silver perch, brown trout*, brook trout*, rainbow trout*
Peacock Creek	Golden perch, Murray cod, silver perch

Table D3 cont.

Darling	Species Proposed to be Stocked * indicates species stocked in Montane Zone that overlaps this catchment
McIntyre	Golden perch, Murray cod, silver perch, brown trout*, brook trout*, rainbow trout*
Gwydir	Golden perch, Murray cod, silver perch, brown trout*, brook trout*, rainbow trout*
Namoi	Golden perch, Murray cod, silver perch, brown trout*, brook trout*, rainbow trout*
Castlereagh	Golden perch, Murray cod
Macquarie	Golden perch, Murray cod, silver perch, trout cod, brown trout*, brook trout*, rainbow trout*
Darling	Golden perch, Murray cod, silver perch

Montane	Species Proposed to be Stocked
Includes parts of other zones where salmonids are stocked (as indicated above by an asterisk)	Atlantic salmon, brook trout, brown trout, rainbow trout

Far West	Species Proposed to be Stocked
Bulloo, Warrego, Paroo, Cooper, Condamine, Lake Frome, and Lake Bancannia	Nil

D3.3 Permanently closed waters

Some waters within NSW are pristine or unique environments, where there are no official records of fish stocking and minimal or no other anthropogenic influences. Such areas will be permanently closed to stocking to protect existing aquatic biodiversity and proposals to stock fish into such areas will not be considered by NSW Fisheries (irrespective of the potential level of environmental impact). The waters permanently closed to stocking are listed in Table D4. Apart from proposals to undertake conservation stocking in these areas as part of a recovery program, no proposals to stock fish for harvest purposes in these waterways will be entertained, even if an associated environmental impact assessment is completed and furnished to the government.

Table D4. Waters permanently closed to stocking.

Waterway	Feature
Blue Lake	
Club Lake	
Hedley Tarn	Glacial lakes of Kosciuszko NP that have not been stocked in the past and are likely to contain unique faunal assemblages.
Lake Albina	
Lake Cootapatamba	
Bogong Creek	Thought to be the only waterway in NSW to contain the endangered spotted tree frog.

Table D4 cont.

Waterway	Feature
Murray River between Tocumwal and Yarrawonga Weir	No stocking of trout cod into that part of the Murray, except to return broodstock. This area contains the last known wild self-sustaining population of the endangered trout cod and is the source of broodstock to produce progeny to be released into the former range of the species as part of the recovery plan.
Bulloo River catchment Condamine River catchment Cooper River catchment Lake Bancannia catchment Lake Frome Moonie River catchment Paroo River catchment Warrego River catchment	These rivers have not been previously stocked and are likely to contain unique faunal assemblages.
Waters above 1500 metres in Kosciuszko NP and any other waters within Kosciuszko NP jointly identified as trout-free by NSW Fisheries and NSW NPWS	These waters have not been substantially stocked in the past and are likely to contain unique faunal assemblages.
Natural ephemeral lakes of the Western Division as defined by the <i>Crown Lands Consolidation Act 1913</i> immediately before its repeal (subject to any regulations made under section 4(3) of the <i>Crown Lands Act 1989</i> that affect the boundary between the Western Division and the Eastern and Central Division)	These waters have not been previously stocked, are likely to contain unique faunal assemblages, and are generally considered an unsuitable environment for stocking.
All waters within the 47 currently declared Wilderness areas and 3 declared World Heritage areas	No harvest stocking within these existing 47 Wilderness or 3 World Heritage areas

D3.4 Waters with restricted stocking

Specific waters within the catchments and stocking zones will be excluded from stocking on a temporary basis (Table D5), primarily in response to the risk assessment conducted on the existing stocking activity described in Chapter B of the EIS (see Table D1 for summary). Such waters may be placed on (or removed from) the ‘schedule of restricted waters’ for a range of reasons that include, but are not limited to, those listed in Table D6.

The schedule of restricted waters includes a ‘buffer zone’ of 5km radius around most threatened species’ sightings in which stocking cannot take place. The 5km buffer zone is a precautionary measure that was determined during the risk assessment, taking into account the limited number of Australian or overseas studies regarding the movement of stocked fish (see B2.4). This buffer zone has been proposed to allow stocking to continue within a particular waterway, but alleviates the immediate and some of the subsequent pressure imposed by introducing fish, natives and non-natives, to the receiving waters. The use of a buffer zone around threatened species is a new arrangement in the management of fish stocking in Australia. It represents a significant step towards

mitigating the potential impacts of stocking on aquatic threatened species, and provides a zone within which those species can expand their distribution and abundance unhindered by the immediate pressure associated with introducing relatively large numbers of predators, albeit as juveniles. It is acknowledged that the use of a buffer zone does not guarantee that the stocked fish will not impact on threatened species, but is seen as a precautionary measure to be implemented whilst research is conducted to examine the movement and mortality of stocked fish in NSW waterways.

During the review of stocking events, consideration will be given to the presence of structures (e.g. dams, waterfalls) within the buffer zone that could negate the need to apply it in its strictest sense. As previously stated, this buffer is a precautionary measure, and in accordance with the responsive management regime of the FMS, can be changed as is deemed necessary by research or as other information becomes available.

The schedule of restricted waters will be reviewed and updated every five years in light of new information or decisions and having regard to a range of ecological (e.g. threatened species listings, stream condition, frequency and magnitude of stocking), economic (e.g. local economic dependencies) and social (history of stocking, alternative opportunities) factors.

The schedule of restricted waters should be seen as an effective compromise between the aim of continuing harvest stocking while ensuring the ongoing protection of natural fish populations, threatened species and/or the effectiveness of stocking. The schedule will be an important reference point in the stocking review framework and will ensure that fish are responsibly stocked into NSW waters.

Table D5. Schedule of restricted waters.

Note: A ‘confirmed’ sighting is one that has been substantiated by NSW Fisheries or another authorised agency as a reliable sighting.

Issue	Waterway	Stocking restriction
Endangered species		
Booroolong frog (TSC Act)	Bombowlee Creek, Brungle Creek, Gilmore Creek, Maragle Creek, Macquarie River, Native Dog Creek, Sewells Creek, Turon River (upstream of Sofala), Goobarragandra River, and additional sites recorded by NPWS by grid reference (stream or town names not identified by NPWS records)	No harvest stocking within 5km radius of confirmed threatened species sighting unless otherwise authorised by NSW NPWS (NSW Fisheries currently has a NPWS permit to stock Turon River, Gilmore Creek and Goobarragandra River)
Eastern cod (FM Act)	Upper Clarence River and tributaries (Nymboida River, Little Nymboida River, Guy Fawkes River, Boyd River, Mann River, Washpool River), Rocky Creek, Richmond River and tributaries above Kyogle	No harvest stocking within 5km radius of the extent of recovery operations (consult NSW Fisheries TSBU)
Giant barred frog (TSC Act)	Clarence, Richmond & Hastings River catchments - NPWS to provide sighting details	No harvest stocking within 5km radius of confirmed threatened species sighting
Murray hardyhead (FM Act)	Bundidgerry Creek, a tributary of the Murrumbidgee near Narrandera	No harvest stocking within Bundidgerry Creek
Oxleyan pygmy perch (FM Act)	Lake Hiawatha, coastal creeks and dune lakes at Bundjalung, Yuragir and Broadwater National Parks	No harvest stocking within 5km radius of confirmed threatened species sighting

Table D5 cont.

Issue	Waterway	Stocking restriction
Endangered populations		
Western population of olive perchlet (FM Act)	Bogan River, Condamine River, McIntyre River, Severn River, Dumaresq River	No harvest stocking within 5km radius of confirmed threatened species sighting
Western population of purple spotted gudgeon (FM Act)	Condamine River, Dumaresq River, Gwydir River, McIntyre River, Severn River and Tenterfield Ck	No harvest stocking within 5km radius of confirmed threatened species sighting
Vulnerable species		
Macquarie perch (FM Act)	Abercrombie River Goodradigbee River Hawkesbury River above Marulan and tributaries of the Hawkesbury River above Warragamba Dam including the Wingecarribee and Wollondilly Rivers Mannus Creek (flows into the Tooma River) Murrumbidgee River above Cooma Queanbeyan River above Googong Dam Shoalhaven River and its tributaries including the Mongarlowe River	Brown trout stocking not permitted
New England tree frog (TSC Act)	Clarence, Manning & Hunter River catchments - NPWS to provide sighting details	None until status of species is confirmed at which point the no harvest stocking within 5km restriction will apply
Peppered tree frog (TSC Act)	Clarence & Macleay River catchments - NPWS to provide sighting details	None until status of species is confirmed at which point the no harvest stocking within 5km restriction will apply
Southern pygmy perch (FM Act)	Billabong Creek near Holbrook, Murray River near Gunbower Island, Blakneys Ck tributary of the Lachlan River near Dalton, numerous billabongs adjacent to Murray River	No harvest stocking within billabongs and no harvest stocking within 5km radius of confirmed threatened species sightings within rivers
Stuttering frog (TSC Act)	Clarence River catchment - NPWS to provide sighting details	Partially protected by the provision in this table not to stock within wilderness areas
Protected from fishing under section 19 of the FM Act		
Australian grayling	Genoa, Towamba, Tuross, Bega, Moruya and Clyde catchment areas and their tributaries	No harvest stocking except for Australian bass into impoundments
Protected from commercial fishing under section 20 of the FM Act		
Wild Australian bass populations in far south eastern catchments	Genoa, Towamba, Tuross, Bega, Moruya and Clyde catchment areas and their tributaries	No harvest stocking except for Australian bass into impoundments
<i>Euastacus australasiensis</i>	Wentworth Falls Dam, waters above Horseshoe and Bridal Veil Falls, Leura Falls Ck, Kedumba Ck, Yosemite Ck (above Minnie Ha Ha Falls), Grose River, Morong Ck (trip of Boyd R), Gambenang Ck and tributaries	With the exception of Wentworth Falls Dam where stocking will continue, these waterways have not been previously stocked and are not proposed to be stocked. Also protected by the provision in this table not to stock within wilderness or world heritage areas

Table D5 cont.

Issue	Waterway	Stocking restriction
Species under section 20 of the FM Act cont.		
<i>Euastacus clarkae</i>	Cockerawombeeba Ck (tributary of Forbes River, Hastings catchment)	Waterway not previously stocked, not proposed to be stocked, and protected by the provision in this table not to stock within wilderness or world heritage areas
<i>E. crassus</i>	Alpine creeks around Mt Kosciuszko	This species is catered for under the 'no harvest stocking in waters above 1500m in Kosciuszko NP' provision in Table D4, and partially protected by the provision in this table not to stock within wilderness or world heritage areas
<i>E. dharawalus</i>	Wildes Meadow Ck (above Fitzroy Falls)	No harvest stocking in Wildes Meadow Ck
<i>E. gumar</i>	Gorge Ck (north-eastern tributary of Clarence River)	Waterway not previously stocked, not proposed to be stocked
<i>E. neohursutus</i>	Nana Ck (tributary of Orara R) Brimben Ck (Little Nymboida near Ulong), upper Bobo River and Flaggly Ck (near Lowanna), Moonmerri Ck (tributaries of Nymboida) Little Murray River, Boundary Ck, Coutts Water & Allans Water (tributaries of Nymboida up around Dorrigo) Sullivans & McKays Cks (tributaries of Nambucca River) Richardsons & Rosewood Ck (above Crystal Shower Falls) (tributaries of Bellinger River)	Partially protected by the provision in this table not to stock within wilderness or world heritage areas and most waters not previously stocked, not proposed to be stocked
<i>E. polysetosus</i>	Headwaters of Hunter (Tubrabucca Ck) and Manning rivers in Barrington Tops NP/Wilderness	Partially protected by the provision in this table not to stock within wilderness or world heritage areas
<i>E. reductus</i>	Upper Allyn River (Hunter River) Jerusalem Ck, Telegherry Ck, Martins Ck and Whispering Gully (upper Karuah River) Sandy Ck (west of Bulahdelah), Duffers Ck	Not previously stocked, not proposed to be stocked - also protected by the provision in this table not to stock within wilderness areas
<i>E. rieki</i>	Waters of Kosciuszko NP	This species is catered for under the 'no harvest stocking in waters above 1500m in Kosciuszko NP' provision in Table D4 and partially protected by the provision in this table not to stock within wilderness areas
<i>E. simplex</i>	Majors Ck, Little Falls Ck, Allans Water, Coutts Ck, Boundary Ck, Guy Fawkes River (tributaries of Nymboida River) Styx R, Little Styx R & Five Day Ck (tributaries of Macleay River) Falconer Ck & Fenwicks Ck (tributaries of Hastings River) Native Dog Ck	Partially protected by the provision in this table not to stock within wilderness or world heritage areas and some waterways not previously stocked

Table D5 cont.

Issue	Waterway	Stocking restriction
Species under section 20 of the FM Act cont.		
<i>Euastacus spinichelatus</i>	Fenwicks Ck (tributary of Hastings River) Joyces Ck (tributary of Yarrowitch River) & Tia River (above falls) Macleay River Cells R (Manning River) Bobbin Ck, Numble Ck	Partially protected by the provision in this table not to stock within wilderness or world heritage areas, and all waters except for Tia River not previously stocked
Species that are not listed as threatened under any legislation but are considered to be of conservation concern		
Darling River hardyhead	Glennie Ck (Macquarie River) Bowmans Ck (Hunter River) Loders Ck, Wallamore Anabanch (Namoi River) Warialda Ck (Gwydir River) Macintyre River	None until status of species is confirmed at which point the no harvest stocking within 5km restriction will apply
Mountain galaxiid (<i>Galaxias olidus</i>) variants	Certain waters of the upper Snowy River around the summit of Mt Kosciuszko (Blue Lake, Sawpit Ck and Carruthers Ck) Rosewood Ck (Bellinger River) Little Nymboida River, Bielsdown River, and Bobo River and their tributaries (Clarence River)	This species is catered for under the 'no harvest stocking in waters above 1500m in Kosciuszko NP' provision in Table D4, most waters not previously stocked nor proposed to be stocked and partially protected by the provision in this table not to stock within wilderness or world heritage areas
Non-parasitic lamprey	Moruya and Tuross rivers, lower to middle reaches	Not stocked since pre-1990 and not proposed to be stocked; also protected by the provision in this table not to stock within wilderness areas
Wild Murray cod populations	Lake Mulwala	Lake not to be stocked with Murray cod Not historically stocked with Murray cod. Excellent self-sustaining population of Murray cod present.
Non species-specific issues		
Hunter River impoundments (western drainage species in eastern drainage)	Glenbawn Dam, Glennies Creek Dam and Lake Liddell within the Hunter River system	The NSW Fisheries Introduction and Translocation Policy allows for the stocking of silver perch and golden perch into these dams but does not permit the stocking of Murray cod.
Ramsar wetlands	Blue Lake Gwydir Wetlands Hunter Estuary Wetlands (formerly known as Kooragang Island Nature Reserve) Lake Pinaroo Little Llangothlin Nature Reserve Macquarie Marshes Myall Lakes National Park Narran Lakes Nature Reserve Towra Point Nature Reserve	No freshwater harvest stocking within these nine existing sites

Table D6. Factors for listing (and de-listing) areas on the schedule of restricted waters.

Reason for restriction	Potential reasons for inclusion (and exclusion*)
Protection of threatened species, populations or ecological communities, critical habitat and/or aquatic biodiversity conservation	If, after a declaration of threatened species, population or ecological community by notification in the Government Gazette and a joint assessment by NSW Fisheries and NPWS, it is agreed that the species, population or community could be detrimentally affected by stocking fish in that area If required by threatened species recovery plan If recommended by the NSW Fisheries or another authorised agency's threatened species unit If recommended by Fish Stocking EIS
Determined as ‘unsuitable’ by classification system (see under management response 2.3a) or through the stocking review framework	If the area is defined as unsuitable under the classification of waters (e.g. temperature ranges, regularly dries out, consistently poor returns) If a specific area of concern is identified through a stocking review with respect to an individual stocking event
Places of cultural, historic or Aboriginal significance	If such places are identified as requiring special management in consultation with relevant stakeholder groups If the areas are protected from disturbance under legislation If otherwise recommended, with sufficient justification, by an authorised agency
Determined to be unsuitable for stocking due to environmental factors	If drought or flood affected If affected by toxic agents, noxious aquatic flora or disease

* Exclusions generally apply if the reverse situation to a specified trigger applies.

D3.5 Regular review of stocking events

This section outlines the process of reviewing stocking events prior to them being carried out, by either NSW Fisheries or private individuals or groups.

Fish stocking carries inherent risks that can pose significant negative impacts on the environment. Issues such as the translocation of undesirable species, potential impacts on threatened species, and the possibility of genetically inferior stock having a detrimental effect on wild populations are major issues that need to be considered as part of the ongoing stocking process to ensure that fish stocking is carried out in a way that minimises the negative impacts.

To ensure that individual stocking events are properly reviewed before being carried out, a review framework will be used (Figure D2 and see management response 1.1a later in this Chapter). The review framework will consider all matters likely to affect the environment and identifies inappropriate events early in the planning stage. Events that do not comply with the Stocking Review Guidelines (FMS Appendix 1) or otherwise fail to demonstrate compliance with the FMS will not be authorised.

D3.5.1 The process of reviewing stocking events

Reviews of stocking events, using Stocking Review Guidelines (FMS Appendix 1), will be carried out by appropriately qualified staff within NSW Fisheries with the delegated power to approve stocking permits under section 216 of the FM Act. The outcomes of each review will be counter-signed by appropriately qualified staff to advise on threatened species issues to ensure that threatened

species, populations and ecological communities and biodiversity issues are addressed before the stocking event takes place. The review process is shown diagrammatically in Figure D2.

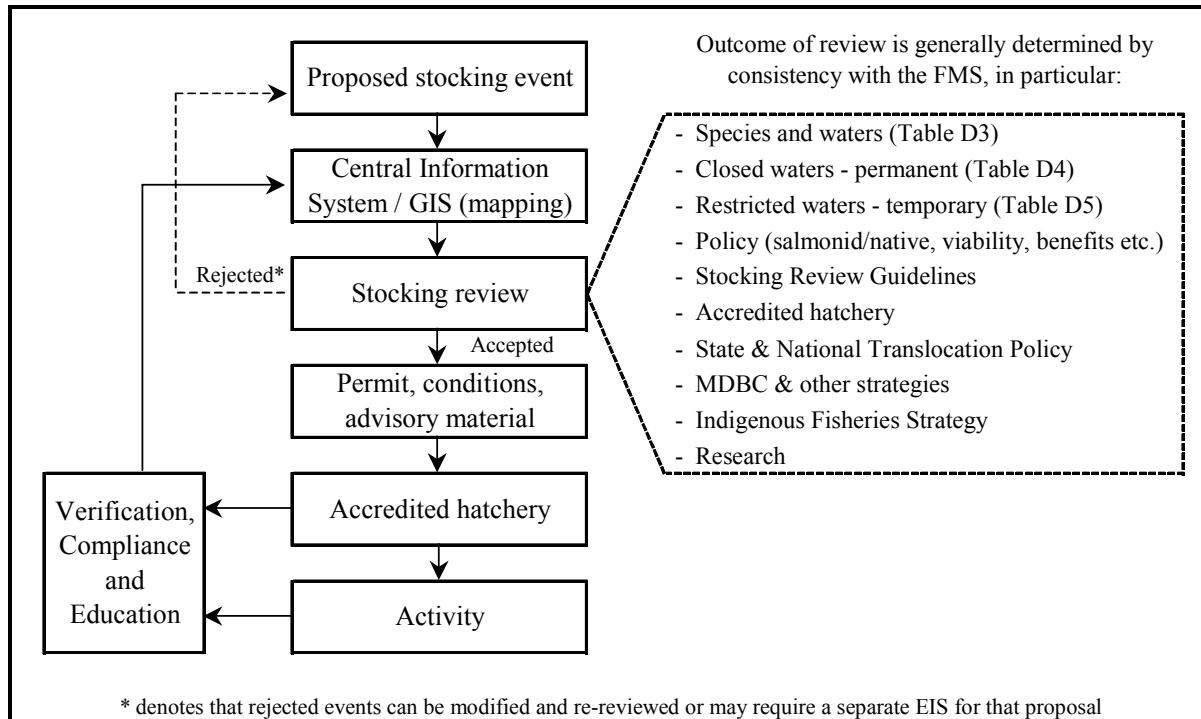


Figure D2. Diagram of the stocking review process.

D3.5.1.1 *Policy and procedures manual*

To ensure consistent application of the review process within NSW Fisheries, a Fish Stocking Policy and Procedures Manual will be developed (see management response 4.1b). The manual will describe the relevant policy, procedures, assessment protocols and management arrangements that are to be observed when reviewing a stocking event in NSW. The manual will provide consistency within the organisation and provide transparent review and permit systems to support the strategy.

D3.5.1.2 *Delegation of power*

The delegation of power to exercise the Minister's authority to issue a stocking permit under section 216 of the FM Act currently rests at the Senior Manager level, although this is subject to change from time to time by the Minister for Fisheries.

D3.5.1.3 *Stocking review guidelines*

Guidelines have been developed and will be used to assess individual fish stocking events whether the proponent is NSW Fisheries or a private individual or group (e.g. a one-off event by a fishing club to stock a particular waterway). The guidelines provide a format for rigorous review to be undertaken before any activity can take place by taking into account all matters likely to affect the environment and other relevant FMS issues. The Stocking Review Guidelines will ensure the consideration of matters such as the source and quality of the stock, translocation and disease risks, local environmental issues and potential conditions that should be applied to the event.

The Stocking Review Guidelines will be adaptive to reflect the dynamic nature of the natural environment and may be amended by the Director-General, NSW Fisheries at any time in light of new information, such as research outcomes, that could influence the decision about whether an individual stocking event should proceed.

The four parts of the guidelines are summarised below and detailed in FMS Appendix 1:

Part 1. The stocking activity - This part examines the source and quality of the stock, the appropriateness of the intended release site and general compliance with the FMS.

Part 2. Translocation of live aquatic organisms - This part is based on the National Policy for the Translocation of Live Aquatic Organisms (stocking open waters) and examines the likelihood and consequences of inadvertent translocations of non-target species into the zone through the stocking activity. It identifies translocation risks, highlights mitigating actions that need to be taken to minimise risks and leads to further assessment, where necessary.

Part 3. Local environmental issues - This part considers any potentially significant impacts at a local level that may be caused by the activity. Using the best available information on the zone, the decision-maker can determine whether further assessment or action is required.

Part 4. Review of the stocking proposal and permit arrangements - This part provides a review of the entire proposal to ensure that all matters have been taken into account and that the proposal is permissible under the FMS. It ensures a transparent appraisal of the proposal and outlines the authorisation arrangements, including the application of special conditions where necessary to mitigate unacceptable impacts.

D3.5.1.4 *Review resources*

Resources used to undertake the review of stocking events will include, but not be limited to the:

- Fish Stocking Fishery Management Strategy
- Fish Stocking Policy and Procedures Manual
- Stocking Review Guidelines
- BIONET (biodiversity information resource) - An Internet based resource developed by a consortium of State Government departments (including NSW Fisheries, Australian Museum, Botanical Gardens) and coordinated by NSW National Parks & Wildlife. Provides participating agencies with high-quality and sensitive biodiversity information not available to the public.
- NSW catchment blueprints – Developed by the Department of Infrastructure, Planning and Natural Resources to highlight areas of environmental concern
- Water Management Plans
- NSW Rivers Survey 1997 (Harris and Gehrke, 1997) – the most comprehensive survey ever undertaken in Australia that shows the distribution, diversity and abundance of native fish and alien species

- Threatened and potentially threatened species of the Murray Darling Basin (Morris *et al.* 2001) – provides data on all freshwater fish of coastal NSW and the Murray-Darling Basin. This volume includes basic biological information, distribution and conservation status of 30 threatened and potentially threatened freshwater fish species including threatening processes and recommendations to mitigate impacts
- Schedules of closed or restricted waters – schedules prepared under the FMS that lists all waters subject to no stocking or restricted stocking, including the scope and reason for the restriction (see Tables D5, D6 and D7, and management response 1.1d)
- NSW National Parks and Wildlife Service resources – including the natural resources atlas containing information on terrestrial threatened species
- Other relevant resources as they become available.

D3.5.1.5 *Forms for fish stocking events*

Forms will be designed for fish stocking events to procure the information required for the review of one-off stocking events in NSW. The forms will be designed to guide the proponents into planning events that comply with the provisions of the FMS.

The information provided in the form will be considered during the review using the Stocking Review Guidelines. Where a stocking event fails to comply with the Guidelines or has unacceptable environmental impacts, the activity will not proceed.

The forms for fish stocking events will be designed and printed following approval of the FMS by the Minister for Fisheries.

D3.5.2 *Authority to stock fish*

Stocking permits are required for events undertaken by private individuals or groups. The permits authorise the activity and outline the conditions under which the event must be carried out.

D3.5.2.1 *NSW Fisheries Fish Stocking Program*

The NSW Fisheries Fish Stocking Program involves stocking of native and salmonid fish into waters within each Stocking Zone. The details of the stocking events will be consistent with the species able to be stocked under the FMS (see Table D3) and the other controls described in this section (see also FMS Appendices 1-3).

A stocking event is deemed authorised if it is undertaken under the NSW Fisheries Fish Stocking Program and has been favourably reviewed under the Stocking Review Guidelines to ensure that local environmental issues are properly considered prior to the event. Any measures that are required for individual stocking events in order to manage potential environmental impacts must be complied with before the event progresses.

This FMS constitutes the permit to be issued by the Minister (by virtue of section 216 of the FM Act) to undertake stocking for authorised events by NSW Fisheries staff or agents of NSW Fisheries. The authority is subject to any special conditions determined during the review.

D3.5.2.2 Stocking by private individuals or groups

Following a favourable review under the Stocking Review Guidelines of a stocking event proposed by a private individual or group, NSW Fisheries will issue a permit under section 216 of the FM Act to authorise the event. The stocking permits will detail:

- the principal individual(s) or organisation(s) who will carry out the event
- the nominated species
- the approved source of the stock
- the approved number of stock to be released
- the class of the stock (age/size)
- the location of the stocking
- whether the stock must be marked with an identifying agent or technique
- the timeframe within which the fish are to be released
- compliance with any ancillary information provided with the permit (i.e. code of practice)
- the requirements for verification of the stocking event, and
- the inclusion of special conditions, where necessary, to mitigate any potential negative environmental impacts or measures to support the objectives of the FMS.

The permits will be accompanied by advisory material on ‘best-practice stocking methods’ to promote effective stocking methods and highlight environmental issues. A verification system will be in place to ensure that information relating to each stocking event is fed back into the information management system for monitoring, compliance and future management purposes.

D3.6 Management of Hatcheries Producing Fish for Stocking

To ensure the consistent production of quality stock used in the activity, NSW Fisheries is developing a Hatchery Quality Assurance Program (HQAP); a Fish Stocking Hatchery Accreditation System (HAS) and a Broodstock Collection and Management Policy.

D3.6.1 Hatchery Quality Assurance Program

A first of its kind in Australia, the HQAP (currently under development) involves the production of the freshwater native fish golden perch, silver perch and Murray cod. Prepared by senior NSW Fisheries’ scientists, hatchery managers and aquaculture managers the program is being developed in consultation with private hatchery operators and other relevant agencies. The program is designed to guide the production of these key native species in a manner that provides high quality, disease free and genetically sound stock. Implemented within the first year of commencement of the FMS and covering all aspects of hatchery production through a hazard analysis critical control approach, the HQAP will form the basis of the HAS.

The HQAP will evolve over time to include all species used in fish stocking activities in NSW. It will ultimately include production techniques for Australian bass to complete the suite of production techniques required under the Dollar-for-Dollar Native Fish Stocking Program, as well as for species

stocked for conservation purposes and salmonids. A key principle of the FMS is the requirement for hatcheries to use an effective population size (N_e) of 100 for Conservation Stocking and for the stocking of any native species into previously unstocked waterways. This principle will be effective from the date of commencement of the FMS. Similarly, an N_e of 50 will be used for all Harvest Stockings of native species for the first five years of the FMS. After five years, all stockings of native species will be required to meet the standard for Conservation Stocking (at this stage N_e is 100, but may be modified on the basis of research outcomes).

D3.6.2 Hatchery Accreditation System

Initiated under the FMS the HAS will draw on the HQAP and FMS provisions to establish minimum standards for accreditation as a ‘NSW Fish Stocking Hatchery’. Hatcheries will be accredited based on their capacity to implement agreed standards under these programs and to maintain minimum requirements in the form of appropriate infrastructure, equipment (e.g. broodstock management in Figure D3 and water filtration device shown in Figure D4), breeding techniques and relevant expertise. Several workshops and training days will initiate the system within the first three years of the commencement of the FMS while ongoing support and compliance checks will also form important components of the system.

Hatcheries will be given three years to comply with the HAS in order to provide sufficient time to set up the necessary equipment and procedures. After the three years, any hatcheries failing to comply with the HAS will not be permitted to provide fish for stocking. Some of the key initiatives within the HAS include an N_e of 50 for Harvest Stocking for the first five years, and the supply of broodstock finclips and a sample of fish from larval rearing ponds at least once a year for compliance and monitoring purposes. They will be analysed at NFC or an authorised agent to confirm compliance with the broodstock collection and management policy.

D3.6.3 Broodstock Collection and Management Policy

The collection of wild fish for use as broodstock is a critically important component of the FMS supporting the production of quality fish for stock enhancement and conservation programs. Managed by NSW Fisheries, the activity of broodstock collection receives a renewed focus under the FMS and a comprehensive Broodstock Collection and Management Policy is being developed to ensure this component of the activity is managed in accordance with the FMS and the principles of ESD. The Broodstock Collection and Management Policy will supersede the existing Broodstock Collection Policy and involve extensive consultation and progressive development and implementation during the first year of operation of the FMS.

As well as managing the collection of broodstock, the Broodstock Collection and Management Policy includes the genetic resource management guidelines being developed under the FMS (see management response 1.3a in Section D4) to control how broodstock are kept and used so as to maintain the genetic integrity of wild fish populations. The guidelines underpin the critically important use of genetic material in NSW covering issues such as appropriate conservation breeding programs, stock enhancement breeding programs, best practice broodstock sampling, rearing systems and stock release procedures.

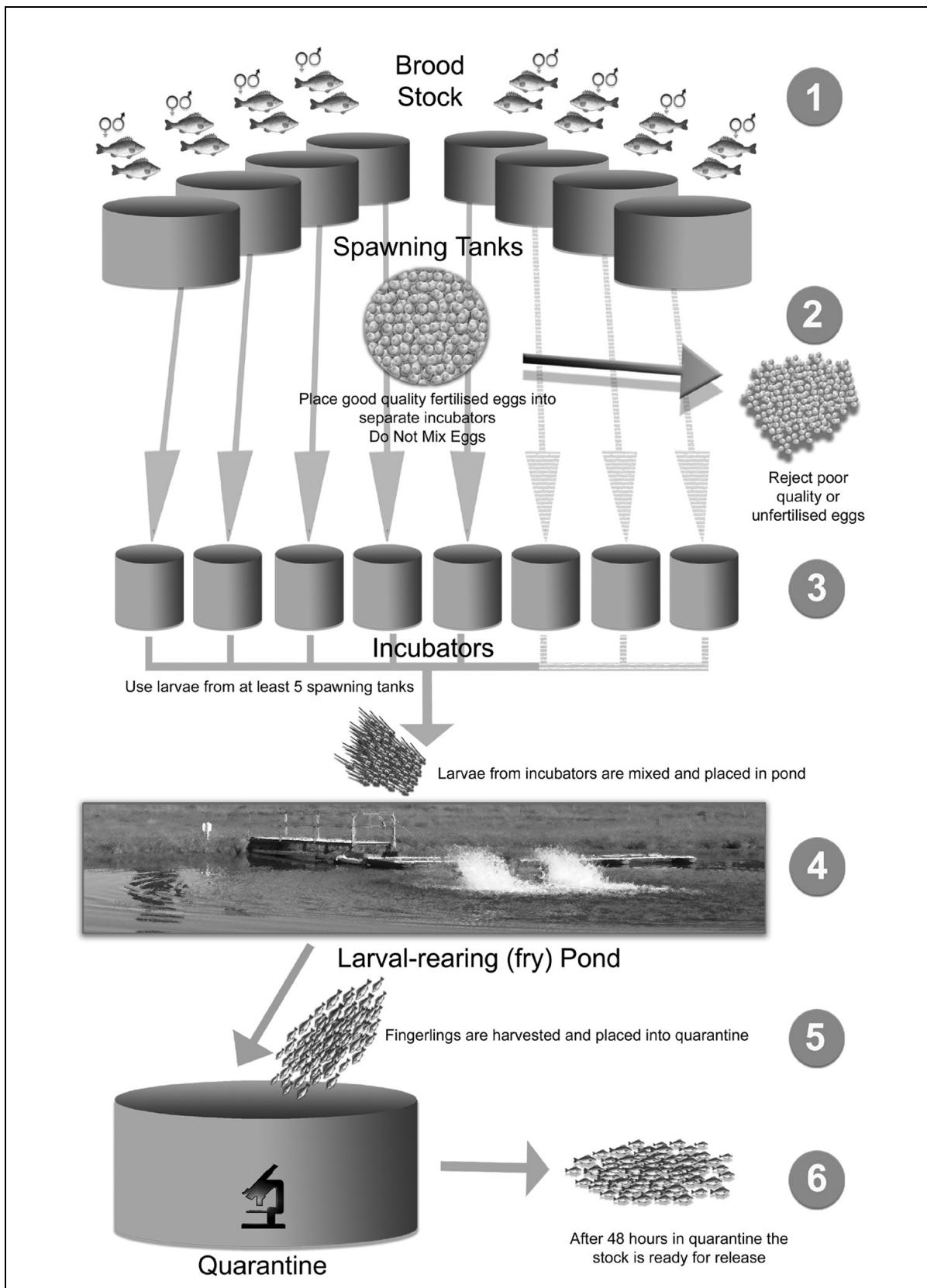


Figure D3. An example of broodstock management protocols for accreditation under the FMS.

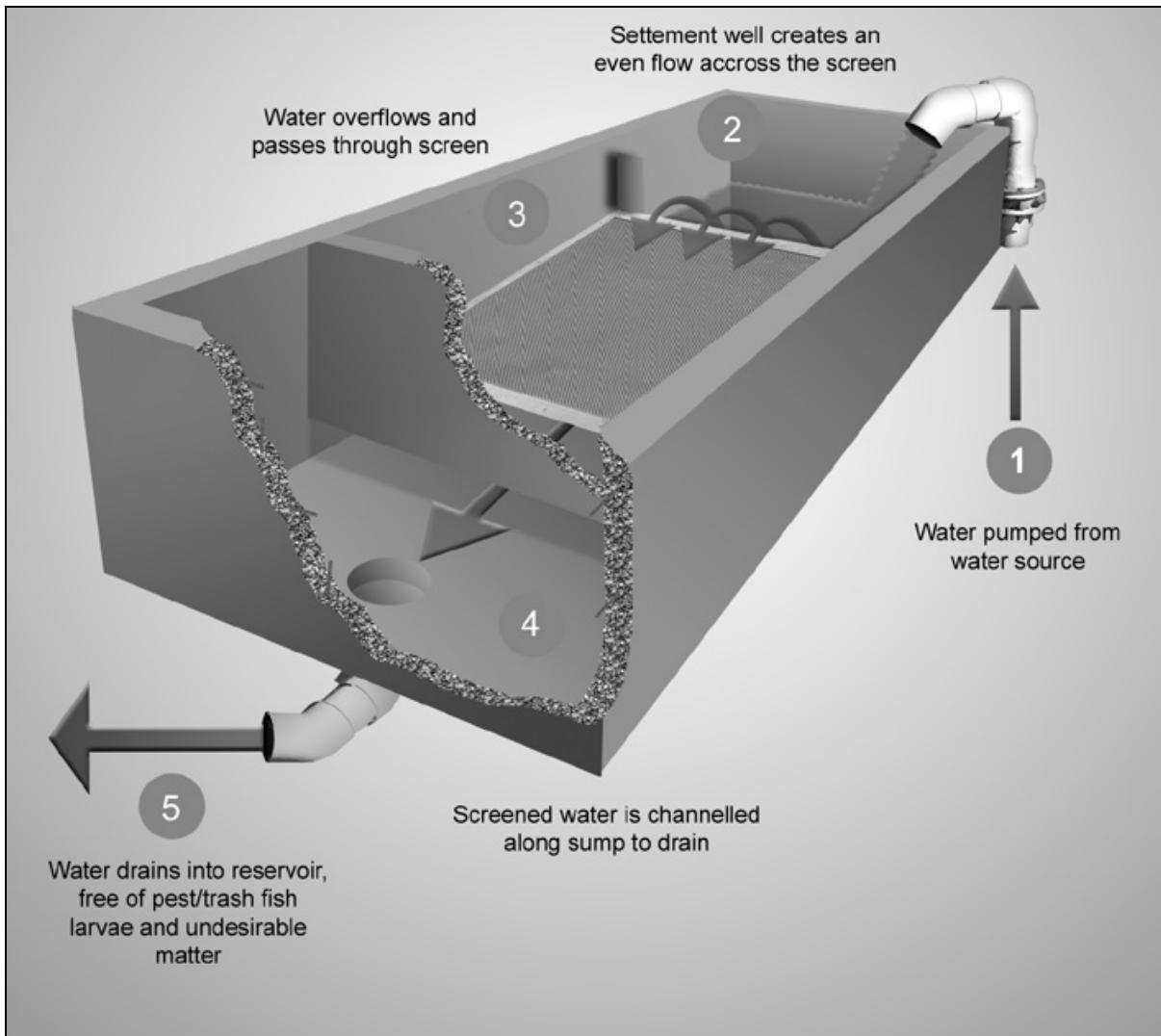


Figure D4. An example of the water filtration device required for accreditation under the FMS.

D3.7 Research

D3.7.1 Overview

This research plan describes the planned research programs designed to support the FMS and provide information that will lead to continuous improvement in the way the stocking activity is undertaken.

Should a research outcome provide information that leads to a minor change to the way stocking is undertaken, this would normally be incorporated as part of the continuous improvement theme of the FMS (without triggering a review of the management regime). Where a research outcome formally triggers a review, then the review process will be engaged as set out in section D5.2.2. However, should any research outcome dramatically alter the aim of the FMS and the change not specifically provided for, contingency planning will take place in accordance with section D5.3, subject to consultation with the relevant advisory bodies.

D3.7.2 Research priorities and timeframes

In this plan, research priorities are categorised into three levels depending on the relevance to the risks identified through the EIS process and information required to support the goals and objectives of the FMS, as follows

Level 1 (initial research): Commencement scheduled within 2 years of approval of the FMS and reviewed within 5 years of commencement

Level 2 (intermediate research): Commencement scheduled within 3 years of approval of the FMS and reviewed within 10 years of commencement

Level 3 (supportive research): Commencement scheduled within 5 years of approval of the FMS and reviewed within 10 years of commencement

D3.7.3 Funding sources

The implementation of the programs within the FMS, including research, will need to be supported by appropriate funding arrangements. The range of funding sources that exist and can be potentially accessed include State government funding, the Recreational Fishing Trust, national grant programs such as the Natural Heritage Trust, and/or funding through Commonwealth agencies. It is also likely that similar research will be undertaken in adjoining states where stocking is also widely practised – especially in Victoria and Queensland. Opportunities to conduct joint research programs with other state agencies and to apply research results from other states will be actively pursued in order to utilise the funding available in NSW in the most cost-effective manner.

Table D7. Research topics and components supporting the Fish Stocking FMS.

Research Topic	Priority	Order of components	Short description of research project and expected outcomes (including other agencies that may have a likely role in the project)	Lead agency (including other agencies that may have a likely role in the project)	Cost estimate \$ and likely funding source
1. Genetics					
1.1 Distribution of native species and sub-populations	Level 1	1. Golden perch 2. Murray cod	To research and map the distribution of native species used in the activity with regard to identifying any population substructures within each species. Research outcomes will be to provide reliable information, upon which stocking locations and broodstock collection zones are determined, thereby minimising negative impacts on genetic resources.	NSW Fisheries in conjunction with MDBC, FRDC, & VIC, QLD, ACT, SA fisheries agencies	\$450K over 3 years
	Level 2	1. Catfish		NSW Fisheries & Recreational Fishing Trust	
	Level 3	1. Silver perch	Supporting management responses 1.1a, 1.1b, 1.1c, 1.2a, 1.2b, 3.2a, 5.1a, & 5.3a.		
1.2 Library of micro-satellites	Level 1	1. <i>Macculllochella</i> suite 2. <i>Macquaria</i> suite 3. <i>Bidyanus</i> suite	A precursor to population substructure research the development of this proposal involves establishing a bank of relevant DNA sample suites and the development of ‘primers’ that are used to compare genetic variation between samples.	NSW Fisheries in conjunction with universities, MDBC, FRDC, & VIC, QLD, ACT, SA fisheries agencies	\$200K
			Supports management responses 1.1b, 1.1c, 1.3a, 1.5a, 3.2a, 5.3a		
1.3 Cumulative impacts of stocking on native species	Level 1	1. Golden perch 2. Silver perch 3. Murray cod 4. Australian bass	To research the cumulative impacts of the activity on the native populations of the four most stocked native species in terms of genetic effects on wild populations (outbreeding/inbreeding). Resulting data will be used to guide future stocking programs using these species	NSW Fisheries in conjunction with universities, MDBC, FRDC, & VIC, QLD, ACT, SA fisheries agencies	\$K (not yet determined)
			Supporting management responses 1.1b, 1.2a, 1.3a		

Table D7 cont.

Research Topic	Priority	Order of components	Short description of research project and expected outcomes	Lead agency (including other agencies that may have a likely role in the project)	Cost estimate \$ and likely funding source
1.4 Genetic Resource Protocols	Level 1	1. Conservation breeding programs 2. Native species breeding programs 3. Broodstock management	Review current literature and research the most appropriate genetic protocols under NSW conditions with regard to conservation breeding programs, native species breeding programs and broodstock management arrangements. Resulting data will guide the development and review of Genetic Resource Management Guidelines (FMS management response 1.3a).	NSW Fisheries	\$K (not yet determined)
			Supports management responses 1.1b, 1.1c, 1.3a, 1.5a, 3.2a, 5.3a.		
2. Environmental impacts of stocking					
2.1 Impacts of golden perch, silver perch and Murray cod in the Hunter Catchment	Level 2	1. Identification and status of any self-sustaining populations of GP, SP and MC 2. Environmental impacts of any self-sustaining populations to date	To investigate whether golden perch and silver perch previously stocked in the Hunter Catchment have established self-sustaining populations and to determine any environmental impacts of those species in the eastern drainage. Research outcomes will provide data for consideration in the future stocking of these waters and appropriate adjustments (such as introducing triploidy/sterile stock and adjustments to stocking densities).	NSW Fisheries	\$ Partly funded by ARC linkage project outlined in proposal 3.1 below.
			To assess the presence and status of self-sustaining populations of Murray cod in the Hunter Catchment. Murray cod have been translocated into the Hunter catchment on at least two occasions for angling enhancement and potentially through farm dam escapement with reported captures of juvenile cod suggest there may be a breeding population. Research outcomes will provide information on the extent and range of any Murray cod populations within the catchment and whether there is a case for further management arrangements to minimise any impacts.		
			Supports management responses 1.1b, 1.2a, 1.5a, 5.3a.		

Table D7 cont.

Research Topic	Priority	Order of components	Short description of research project and expected outcomes	Lead agency (including other agencies that may have a likely role in the project)	Cost estimate \$ and likely funding source
2.2 Impacts of salmonids on threatened species	Level 2	1. Booroolong frog 2. Macquarie perch 3. Southern pygmy perch	To determine the impacts of salmonids on the Booroolong frog and two threatened fish species. Outcomes will provide data relevant to future stocking programs where these species occur including the development of appropriate buffer zones and ongoing reviews of waters listed as closed to stocking.	NSW Fisheries, EA, VIC Fisheries NPWS, University of Canberra	\$K (not yet determined)
			Supports management responses 1.1b, 1.2a, 1.5a, 5.3a.		
2.3 Movement of stocked fish	Level 2	1. Salmonids 2. Native species	To determine the distance that stock may travel from the point of release. Outcomes will provide data to support accurate reviews of stocking events where threatened species or ecological communities may be affected.	NSW Fisheries in conjunction with Universities, ARC, MDBC, FRDC, &VIC, QLD, ACT SA fisheries agencies	\$ Partly funded by ARC linkage project outlined in proposal 3.1 below.
			Supports management responses 1.1b, 1.2a.		
2.4 Aquatic diseases	Level 2	1. Disease audit of NSW waters 2. Audit of all hatcheries 3. Mapping distribution of pathogens	To determine the presence of aquatic pathogens throughout NSW waters where stocking is conducted (including all hatcheries) and subsequent disease mapping within stocking zones to support accurate stocking reviews to minimise translocation risks.	NSW Fisheries in conjunction with AAHL, University of Sydney, MDBC, FRDC, &VIC, QLD, ACT SA fisheries agencies	\$K (not yet determined)
			Supports management responses 1.1b, 1.1c, 1.2a, 1.5a,		
2.5 Impacts of native fish stocking on threatened species	Level 3	1. Golden perch 2. Murray cod 3. Silver perch 4. Australian bass	To determine interactions between stocked native fish species and threatened species. The research outcomes may also support the development of appropriate stocking densities, buffer zones and ongoing reviews of waters listed as closed to stocking.	NSW Fisheries in conjunction with universities, MDBC, FRDC, &VIC, QLD, ACT SA fisheries agencies	\$K (not yet determined)
			Supports management responses 1.1b, 1.1d, 1.2a,		

Table D7 cont.

Research Topic	Priority	Order of components	Short description of research project and expected outcomes	Lead agency (including other agencies that may have a likely role in the project)	Cost estimate \$ and likely funding source
2.6 Food chain interactions	Level 3	1. Salmonids 2. Native species 3. De-stocking study	To establish reliable data regarding food chain interactions between stocked fish and the aquatic environment. The project will also examine sites no longer stocked to establish relative changes in fish and invertebrate species assemblages. Research outcomes will also support the development of appropriate stocking densities. Supports management responses 1.1d, 1.2a, 5.3a, 5.3b, 5.3c	NSW Fisheries NSW Fisheries in conjunction with universities, MDBIC, FRDC, & VIC, QLD, ACT, SA fisheries agencies	\$K (not yet determined)
3. Efficacy of stocking					
3.1 Cost effective marking techniques	Level 1	1. Native species 2. Salmonids species	To research the most cost effective and reliable marking techniques used to identify stocked individuals. Current techniques will be reviewed while other methods will be investigated for their potential use in the activity. Outcomes will guide the most appropriate technology for transfer to the private sector. Supports management responses 1.2a, 5.2a.	NSW Fisheries University of Adelaide ARC DSE VIC	\$950K over three years commencing in 2003 as an ARC linkage project
3.2 Optimal stocking practices for NSW waters	Level 1	1. Status/optimisation of harvest stocking techniques 2. Status/optimisation of conservation stocking techniques	To research the efficiency and effectiveness of current stocking methods for both harvest and conservation stocking programs. Includes appropriate classes of stock, stocking survival/mortality rate, conditioning, timing, release techniques. Information will be used to evaluate success of the activity in achieving the stated goals in the FMS. Outcomes will also guide the development of optimal stocking practices under NSW conditions. Supports management responses 1.2a, 2.3a, 5.2a, 5.3a, 5.3b.	NSW Fisheries DSE VIC ARC University of Adelaide	\$ Included in ARC linkage above project

Table D7 cont.

Research Topic	Priority	Order of components	Short description of research project and expected outcomes	Lead agency (including other agencies that may have a likely role in the project)	Cost estimate \$ and likely funding source
3.3 Impacts on Aboriginal cultural fishing practices	Level 1	1. Impacts of stocking on cultural fishing	To research the effects of stocking on Aboriginal cultural fishing	NSW Fisheries (Indigenous Fisheries Strategy)	\$K (not yet determined)

Research Team

To facilitate the research objectives of this plan NSW Fisheries will establish a research team to identify and source funding options to oversee the implementation of the research components.

Glossary of agencies and institutions

AAHL	Australian Animal Health Laboratory
ARC	Australian Research Council
DSE VIC	Department of Sustainability and Environment (Victoria)
EA	Environment Australia
FRDC	Fisheries Research and Development Corporation
MDBC	Murray-Darling Basin Commission

D4 Goals, Objectives and Management Responses

This section sets out the goals, objectives and management responses for the activity of fish stocking as proposed under the FMS.

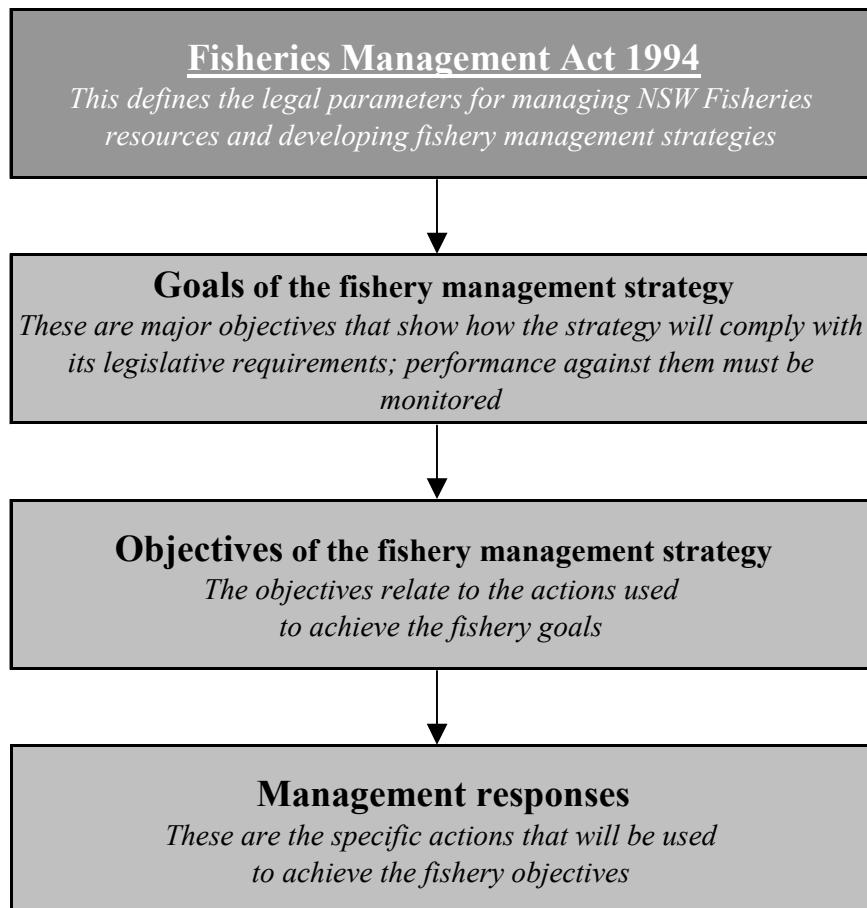


Figure D5. A model of the framework for a fishery management strategy.

The fishery management strategy contains broad goals, operational objectives and specific management responses. The link between the goals, objectives and management responses is not as simple as that portrayed in Figure D5. The reality is that most management responses assist in achieving more than one goal, and as such can not be presented in a simplistic issue, goal, objective response format (see Figure D6).

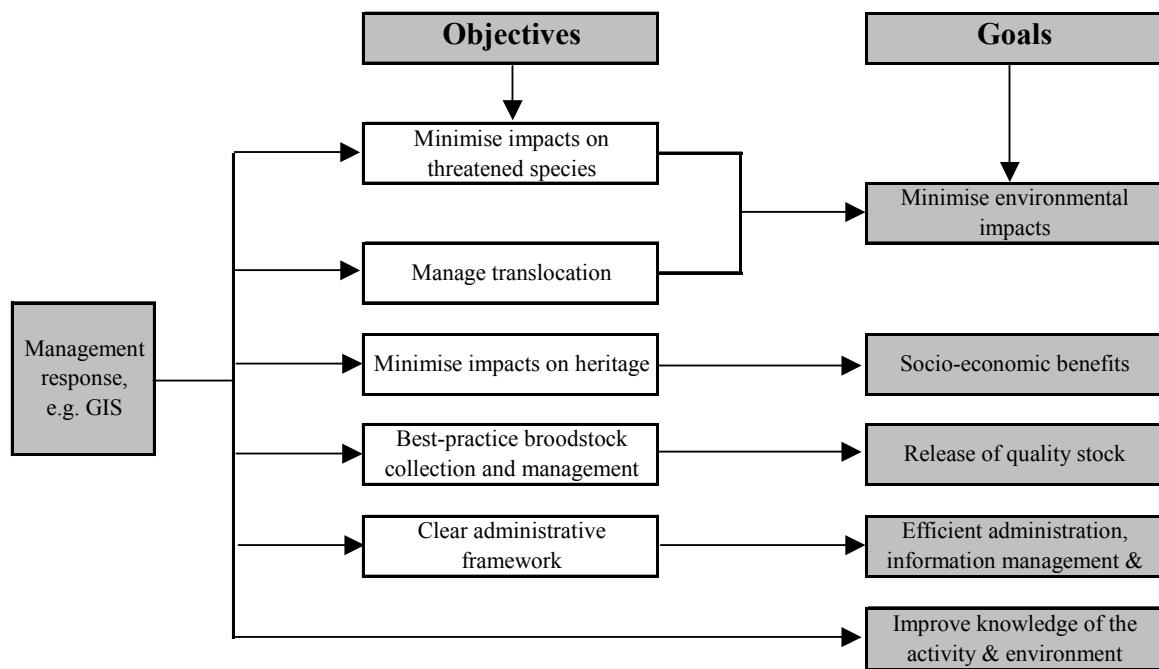


Figure D6. Example of how a single management response from the FMS affects multiple goals and objectives within the activity of fish stocking.

This complex structure has been dealt with in the following section by listing each of the management responses once only, under the objective that the response contributes most towards achieving. There are cross-references associated with each management response to the goals that the response assists in achieving (see FMS Appendix 4).

Information relating to the implementation of management responses is provided in a table located in FMS Appendix 4. The implementation table outlines the time periods within which each management response is scheduled to be implemented, as well as information relating to the head of power for implementation and the group who has the lead responsibility for carrying out the actions.

GOAL 1. To manage the activity in a manner that minimises impacts on aquatic biodiversity including threatened species and genetic resources

Objective 1.1 To develop and maintain a framework to guide appropriate assessment of stocking activities

1.1 (a) Utilise “Stocking Review Guidelines” for the ongoing assessment of stocking events

Background: Comprehensive Stocking Review Guidelines will be used to ensure that stocking events are rigorously reviewed before they proceed. The review will consider the risks likely to affect the environment as a result of stocking and will be focused on the primary concerns associated with threatened species, genetics and diseases, and potential translocation of live aquatic organisms. The stocking review framework will be an important management tool designed to ensure that an appropriate and consistent management regime is applied to all fish stocking events.

Each stocking event will be considered in light of potential risks posed by the activity in relation to the stocking zone, the relevant catchment, the individual waterway, and any other issues that warrant consideration such as public access, cultural and social issues

1.1 (b) Use reliable and current information resources to support the stocking review framework

Background: The Stocking Review Guidelines will draw on a set of reliable information sources to assist decision-makers to review stocking events. Information sources used in the review will include the most reliable base-line data available in the “BIONET” information resource (a computer-networked information resource of current natural resource information that draws on a number of data sets including spatial information on threatened species locations, ecological communities and other relevant data supplied by NSW Fisheries, Australian Museum, NPWS and Royal Botanic Gardens).

1.1 (c) Map the activity in a Geographic Information System (GIS) to:

- accurately depict the historic stocking activity
- record the ongoing activity to the best available standard
- regularly update the fish files resource
- allow accurate review of stocking events in relation to environmental considerations
- plot the presence of disease, pest species, noxious species (including aquatic weeds and algae), and
- contribute to other spatial data sets held by the Government or other authorised agencies.

Background: An important component of the FMS is the development of accurate mapping of the activity. The historic and ongoing stocking activity in NSW will be recorded on a series of (GIS-based) maps. This will provide accurate spatial information in a format that can be considered alongside other similar natural resource data also on GIS platforms. This information will be made accessible by recreational fishers and Aboriginal communities.

- 1.1 (d) Implement a schedule of restricted waters where stocking events are limited or prohibited, and review the schedule every five years in light of new information

Background: From time to time certain waters have restrictions imposed on stocking in response to environmental factors, such as the presence of a threatened species or insufficient/inadequate water. The current schedule is presented in Table D5, but it is important to note that it will be subject to a comprehensive review every five years and thus will be amended as new information becomes available. The Stocking Review Guidelines will provide another mechanism for dealing with threatened species issues relating to individual stocking events.

Objective 1.2 To minimise and/or eliminate any negative impact from the activity on threatened species, populations and ecological communities (including mammals, birds, reptiles, amphibians, fish, invertebrates and vegetation), and where possible promote their recovery

- 1.2 (a) Appropriately manage stocking in areas where the activity may adversely affect a threatened species

Background: By drawing on the resources provided by BIONET and in light of the stocking review framework, any stocking event that has the potential to affect a threatened species will be thoroughly reviewed with a view to preventing or minimising any potential impacts. The event may be modified, ceased or allowed to proceed subject to stringent conditions in order to mitigate any potential threats.

- 1.2 (b) Maintain and improve the management of Conservation Stocking programs to promote the recovery of species that are threatened or of conservation concern

Background: Protection, management and recovery of threatened species and populations is a requirement of the NSW Fisheries Management Act 1994, Threatened Species Conservation Act 1995 and the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999. Conservation Stocking forms one of the two main objectives of the FMS and conservation programs currently underway are vital for achieving the objectives of threatened species management. Existing Conservation Stocking programs are in place for the eastern freshwater cod and trout cod and stocking of other threatened species such as silver perch and Macquarie perch are a possibility in the future. Conservation Stocking activities will continue under the FMS and be refined with the benefit of better information and improved management of fish stocking, including the outcomes of research on Aboriginal cultural considerations.

Objective 1.3 To provide reliable genetic resource management in the activity

- 1.3 (a) Develop and implement genetic resource management guidelines for fish stocking in NSW

Background: These guidelines underpin the critically important use of, and potential effects on, genetic material as it relates to all fish stocking programs in NSW. Designed as a stand-alone document that is representative of current scientific literature and understanding on the subject, the guidelines will include the NSW Fisheries' policy on the use of aquatic genetic material and will provide precise standards for private hatcheries (stocking) and all NSW Government hatcheries. In essence, the guidelines will address the critically important feature of any ecologically sound stocking management system, namely adherence to genetic, evolutionary, and ecological principles (Miller & Kapuscinski, 2003).

It is recognised that there are four major components of hatchery production and each component represents a genetic risk: 1. Broodstock collection; 2. Breeding Programs; 3. Rearing Progeny; and 4. Stocking Techniques (Miller & Kapuscinski, 2003). How these factors are managed is representative of the level of genetic risks posed under the activity. Each component will be addressed by the guidelines, either outright or in conjunction with the FMS goals and management responses briefly described below.

1. Broodstock collection: The Broodstock Collection Policy (management response 3.3a) will address the point of capture techniques required to mitigate any sampling bias and provide direction on other broodstock collection issues. This will result in high quality broodstock extraction providing a solid basis for good breeding programs.

2. Breeding programs: Genetic Resource Management Guidelines (management response 1.3a) will address breeding programs through literal standards resulting in an appropriate mix of suitable progeny for harvest and conservation programs by defining the required amount of parent stock and necessary breeding crosses required to establish an effective population size (relevant to the stocking type). For the first 5 years of the FMS, the genetic standard for Harvest Stockings will require hatcheries to use an effective population size of 50, and after that 5 years to meet the Conservation Stocking standard of an effective population size of 100. Principally, the breeding programs established under the guidelines will be designed to minimise or eliminate genetic drift and inbreeding, outbreeding depression and gene pool swamping by considering and mitigating the factors resulting in these problems including population subdivisions and Evolutionarily Significant Units. Knowledge in these areas will be improved by conducting research as outlined in the research plan, in particular the research into distribution of populations (see section D.3.7. Research Topic 1.1)

3. Rearing Progeny: This area is managed under the Hatchery Quality Assurance Program (HQAP) and Hatchery Accreditation Systems (HAS) established under the FMS (management response 3.1a). These systems (each of which draw on the genetic resource management guidelines) will provide direction and guidance on how progeny are to be reared to cater for potential issues such as hatchery domestication, predator avoidance, physiology and morphology, and health and fitness for release into the wild.

4. Stocking Techniques: Management of this area is improved through the mandatory observance of the Stocking Code of Conduct (management response 3.4a) that provides direction for the appropriate release techniques to be used for hatchery progeny under the FMS.

The guidelines will be developed concurrently with the FMS and an initial version is anticipated for reference soon after the commencement of the FMS. Where the FMS and/or the guidelines generate significant changes to the way the activity is conducted, these will be progressively implemented to minimise any negative impacts on hatcheries.

Objective 1.4 To implement the FMS in a manner consistent with related Commonwealth and State endorsed programs designed to protect aquatic environments and biodiversity

1.4 (a) Manage the activity having regard to cross-jurisdictional management arrangements

Background: This FMS operates alongside other programs relating to the protection and management of aquatic resources. Consultation with other jurisdictions, such as interstate fisheries agencies or other management authorities, such as the Murray-Darling Basin Ministerial Council, will occur to ensure compatibility between programs and matters of environmental concern. Fish stocking will be managed consistently with the Native Fish Strategy for the Murray-Darling Basin. Information relating to cross-jurisdictional

management issues will be considered during the stocking review process. Where terrestrial threatened species are of concern the relevant managing agency will be consulted.

1.4 (b) Recognise and where appropriate incorporate regionally based environmental management arrangements in the stocking review framework

Background: From time to time regionally based environmental management programs may be developed as a response to localised impacts caused by a variety of factors (e.g. habitat protection plans, habitat remediation programs and catchment blueprints). The FMS should recognise these management plans in its stocking review processes and as far as practical operate to support them including the review of the appropriateness of stocking in areas undergoing habitat remediation such as fishway installations. Information will be made available to recreational fishers and Aboriginal communities about these other environmental management plans and their potential impacts on the FMS.

Objective 1.5 To appropriately manage the risks associated with translocation of live aquatic organisms during stocking activities

1.5 (a) Manage the activity consistently with State and national policies governing the translocation of live aquatic organisms and:

- incorporate issues relating to translocation of live aquatic organisms within the stocking assessment framework
- educate stakeholders on translocation issues through educational material and the permit scheme, and
- incorporate translocation management arrangements into the hatchery quality assurance program.

Background: Translocation of aquatic organisms has been identified as an area that has the potential to impact on the sustainability of the activity. Translocation issues such as disease transfer and pest/non-target species introductions are immediate threats that must be addressed by the FMS. To guide the management of this issue the policies that will be relied upon are the “Introduction and Translocation Policy (NSW Fisheries Policy Paper) 1994” and the “National Policy for the Translocation of Live Aquatic Organisms (1999)” as amended from time to time. These policies will be factored into the stocking review framework and considered in all stocking assessments, while at the same time best-practice techniques designed to minimise or eliminate translocations will be incorporated into the Hatchery Quality Assurance Program.

In the case of any direct inconsistencies or conflicts between the FMS and the translocation policies, the situation will be reviewed by NSW Fisheries and the activity or the FMS may be modified as a result

While related, the environmental impacts arising from the release of aquarium fish species via the aquarium trade (albeit accidental) do not fall within the scope of this FMS and will be managed under separate management arrangements developed by NSW Fisheries. However, greater awareness of the risks of translocation through educational material produced under this FMS will assist in educating stakeholders about the issue.

GOAL 2. To enhance fishing opportunities through cost-effective stocking programs that maximise economic benefits and provide social equity from the activity for recreational fishing and Aboriginal cultural fishing purposes

Objective 2.1 To provide sufficient quantities of quality stock to support enhanced recreational fisheries

- 2.1 (a) Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities in inland rivers and freshwater public waterways

Background: NSW Fisheries presently provides for the release of around seven million fish per year to maintain the required level of stocking for the existing activity. This program will continue in order to maintain these fisheries and the associated economic and social benefits arising from them, but will operate within the context of the new controls on stocking described in the FMS in order to reduce the environmental risks of stocking fish into natural waterways. Stocking activities will need to take account of other measures to restore native fish populations, such as riverine ecosystem restoration.

- 2.1 (b) Recognise region-specific fishery management arrangements where appropriate, such as the Snowy Lakes Trout Strategy

Background: The FMS will be flexible enough to take account of specific regional management regimes. For example, the Snowy Lakes Trout Strategy is a localised arrangement designed to promote quality recreational angling, regional economic development, and eco-tourism opportunities specifically in the Snowy Mountains Lakes area (available at the NSW Fisheries website: <http://www.fisheries.nsw.gov.au/rec/fw/snowy.htm>). It sets out a stocking regime and a number of management responses particular to that area, including research, monitoring and cross-jurisdictional liaison between NSW Fisheries, the Snowy Mountains Hydro-electric Authority, Landcare, Rivercare and the Environment Protection Authority to ensure quality sustainable fishing.

- 2.1 (c) Broaden the consultation with acclimatisation societies and angling clubs to formulate and implement stocking programs with a view to providing greater equity, access and education about the resource

Background: Under the current arrangements NSW Fisheries consults with major acclimatisation societies and fishing clubs to allocate stock produced in Government hatcheries for stocking programs across the State. This consultation process will be broadened to improve access to the benefits of the activity for the majority of stocking organisations, the general angling public, to establish a transparent allocation process, to provide a mechanism for distributing educational material and potentially as a conflict resolution opportunity.

Objective 2.2 To minimise any negative impacts of the activity on cultural heritage values and provide opportunities for Aboriginal communities to participate in stocking activities and to support cultural fishing practices

2.2 (a) Provide for the stocking of native fish for Aboriginal cultural fishing and moiety purposes

Background: Stocking events for Aboriginal cultural fishing and/or moiety purposes will take account of a number of factors, including the findings of research relating to the identification of culturally important species and areas fished by Aboriginal people, alternative means of re-establishing native fish populations, and the development of funding partnerships with Aboriginal communities to provide the necessary resources for stocking. It is envisaged that this will be progressed via a pilot scheme developed in consultation with the IFS Working Group.

Other opportunities for Aboriginal people to be involved in stocking activities are being progressed through the IFS. One current example is the increased involvement of Indigenous communities in the fish hatchery industry under the IFS. The IFS actively encourages and supports involvement by these communities in fish production for potential restocking of areas with species of cultural significance.

2.2 (b) Ensure that new information about areas or objects of cultural significance is taken into account in the stocking review framework

Background: The management regime must be able to respond appropriately to new information about items or locations of cultural significance. For example, stocking waterways near of sites of cultural significance may cause increased disturbance in the area, or, where the local Aboriginal community considers a species of cultural significance, the activity needs to minimise or prevent any impacts on that species, or class of species. Recognition of cultural sites has been incorporated into the Stocking Review Guidelines. The NSW National Parks and Wildlife Service (NPWS) is responsible for management of cultural heritage within NPWS estate and the protection of all Aboriginal objects on all lands, and their input into BIONET will help ensure protection of such sites.

2.2 (c) Consult with relevant Aboriginal groups in the assessment of any new sites proposed to be stocked

Background: Stocking has the potential to impact on Aboriginal values and beliefs and as such the relevant Aboriginal groups within the vicinity of any new stocking locations should be consulted prior to the stocking event proceeding.

Objective 2.3 Maximise economic benefits and provide social equity from the activity

2.3 (a) Develop a classification scheme for NSW waters to evaluate the potential viability of a stocking event based on the most appropriate species, class of stock for particular waters

Background: A classification scheme will be developed to support the policy on stocking in NSW and to ensure that released stock have a good chance of survival and a reasonable chance of growing-out for capture. The classification scheme will assist decision-makers during the stocking review process to evaluate the potential success of the proposed stocking based on pertinent environmental conditions and the life history stage of stock most likely to be successful in each particular area. Life history stages will include 'Larvae or fry', 'Fingerling', 'Year Old', etc., and the classifications of 'Suitable', 'Marginal' or 'Unsuitable' will be

declared for each life history stage for each species in each waterway. An example of how the classification scheme will work follows:

Example only

Species	Waters	Larvae/Fry	Fingerling	Comment
Australian Bass	Jumbuck Dam	Not Suitable	Not Suitable	Out of range
Rainbow Trout	Jumbuck Dam	Not Suitable	Marginal	Redfin predation
Brook Trout	Jing Jing Creek	Not Suitable	Not Suitable	Dries out regularly

- 2.3 (b) Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity

Background: The Dollar-for-Dollar Native Fish Stocking Program provides enhanced fishing opportunities and a link for private enterprises to benefit from the activity by stimulating regional economies through private hatchery production, fishing and tourism. Creating an environment conducive to private enterprise provides social equity and economic benefits. The Dollar-for-Dollar program also provides ancillary benefits to Aboriginal people who can also fish for species that have been stocked under that program.

- 2.3 (c) Continue to provide opportunities for religious and ceremonial stocking and increase awareness of the legislative and policy requirements with the groups involved

Background: Applications are received each year by NSW Fisheries to stock fish for religious or ceremonial purposes, e.g. Buddhist communities often seek to release a small number of fish into waterways as part of particular religious festivals. In the past NSW Fisheries has provided such groups with a permit to stock species endemic to the waters proposed to be stocked and observed the stocking event. Provided that the review of these stocking events demonstrates they are appropriate within the context of the FMS, such applications will be supported and advisory material provided to the stockists to educate them about stocking issues.

GOAL 3. To ensure the consistent production and release of appropriate quality stock

Objective 3.1 Ensure stock is of the highest standard in terms of fish health

3.1 (a) Develop and implement quality assurance standards and an accreditation system for hatcheries supplying fish for stocking:

- to ensure consistent production of genetically sound, quality, disease-free stock
- to eliminate non-target species/parasite releases and other translocation risks
- to provide continual improvement in stock production through progressive implementation of best practice techniques
- to ensure new entrants (hatchery permits) are aware of accreditation standards at the application stage, and
- to provide recognition for hatcheries achieving accreditation under the system.

Background: Hatcheries that produce stock for the current activity (including Government Hatcheries) are required to comply with the aquaculture permit system established under Part 6 of the FM Act. The conditions placed on hatcheries under this system require compliance with all facets of responsible hatchery management and operation, however, these standards are set for the aquaculture industry only and do not take into account the more robust standards required of hatcheries to produce quality fish for stocking.

All hatcheries will be required to progressively meet and demonstrate compliance with new quality assurance and accreditation standards that are considered vital to achieving key objectives of the FMS while providing a reliable quality of stock. For instance, hatcheries will be required to comply with the Genetic Resource Management Guidelines as provided for under management response 1.3a. By making accreditation mandatory and managing the progressive implementation of the requirements, all hatcheries involved in the activity will need to reach a satisfactory level of accreditation over a 3 year period, and be at the conservation stocking standard by 5 years. Such an accreditation scheme will complement any national quality assurance scheme.

3.1 (b) Ensure that stock produced in interstate hatcheries meets quality assurance standards

Background: Hatcheries can be a vector for disease, release of non-target and pest species (e.g. banded grunter), chemicals and stock of unsuitable genetic background. These are all significant potential impacts that threaten the ecology of the receiving environment. Fish produced for stocking are currently supplied through some hatcheries that operate in other jurisdictions (e.g. Queensland). Presently there are no consistent accreditation schemes governing these facilities. The implementation of hatchery standards through accreditation/quality control is the most appropriate way of ensuring consistency in quality assurance. The establishment of a nationally accredited hatchery quality assurance scheme will eventually address these issues. In the meantime, however, any stock produced by interstate hatcheries will be subject to rigorous review to ensure that standards equivalent to those applied in NSW are met.

3.1 (c) Participate in the development of FISHPLAN, the NSW component of AQUAVETPLAN

Background: AQUAVETPLAN is a national program designed to develop the response capabilities for preparedness and management of diseases in aquatic species. NSW Fisheries is currently developing an improved disease management system 'FISHPLAN' under the auspices of AQUAVETPLAN. FISHPLAN provides training (emergency response, tracing and procedural guidelines) for NSW Fisheries staff, while financial components include access to an initial response fund that would provide emergency funding to a disease issue or other incident requiring responsive management action.

3.1 (d) Link the fish stocking activity to the Aquatic Disease Watch Hotline to enable early reporting of disease outbreaks

Background: The Aquatic Disease Watch Hotline is being developed by the Aquatic Animal Health Consultative Committee (AAHCC) with industry, Commonwealth, and full State/Territory representation. As this initiative develops, NSW Fisheries will advertise the hotline number in all advisory material produced with respect to the activity.

Objective 3.2 To promote the use of appropriate technology for genetic resource management in all hatcheries involved in the activity

3.2 (a) Promote the use of appropriate technology in genetic resource management

Background: The genetic resource management guidelines, as developed under management response 1.3a will provide genetic resource management for fish produced for both Conservation Stocking and Harvest Stocking. Appropriate technology includes the use of the Passive Integrated Transponder-tag system (PIT-tags, i.e. microchip identifiers) for stock identification and husbandry, where considered necessary.

NSW Fisheries will provide leadership and extension services for the implementation of the technology across all hatcheries involved in the activity resulting in the regular use of PIT-tag system.

3.2 (b) Require, where necessary, the mandatory use of microchip technology (PIT-tag system) in broodstock management arrangements

Background: Given the relatively low-cost of the PIT-tag system, microchips (in 2002 AKA PIT-tags were \$10 each and scanners were \$440) it is considered an absorbable overhead to hatcheries. However, funding for the implementation of the guidelines and technology will be sought from relevant sources such as Fisheries Research and Development Corporation (FRDC) or trust funds established for recreational fishing, conservation, information technology or regional development.

3.2 (c) Investigate the feasibility of developing a cryogenic gene bank of NSW species to ensure the retention of genetic material for Harvest Stocking and Conservation Stocking programs

Background: No contingency plan currently exists for recovery of genetic diversity of stocked species following inbreeding depression, genetic drift, and introgression of unique subpopulations. To enable the recovery of genetic diversity, the use of a cryogenic-based gene bank can be investigated for all species stocked. A facility exists at Dubbo (Zoological Parks Board & Monash University) where genetic material can be stored cryogenically for future reference. The feasibility of the proposal (including its relative cost and benefits) needs to be comprehensively examined.

Objective 3.3 Implement best practice in broodstock collection and management

3.3 (a) Develop a broodstock policy and guidelines that address collection, husbandry and management arrangements for hatcheries engaged in the activity to:

- promote the development of a code of practice for hatcheries to encourage best practice techniques in the collection, holding and husbandry of fish
- complement genetic resource management and hatchery quality assurance programs
- ensure sustainable use and protection of broodstock resources
- monitor the level of broodstock collection to ensure that collection areas and methods are appropriate in terms of sustainability
- ensure the return of healthy broodstock to the waters of their capture
- minimise any interactions with threatened species
- provide verification procedures following collection, and
- document the relevant policy and legislation.

Background: Broodstock collection and management is essential to the sustainability of the activity and the aquaculture industry generally. Currently, broodstock collection is authorised by permit issued under section 37 of the FM Act and managed under the NSW Fisheries Broodstock Collection Policy (currently under review). Under the FMS, broodstock collection will attract a greater focus to ensure the level of demand for the resource and ongoing management of broodstock is ecologically sustainable, while ensuring appropriate genetic material is used in stocking programs. Broodstock management will be aligned with genetic resource management arrangements and used to guide the ongoing review of the stocking events. Areas where certain fish populations are of conservation concern or recovering through a recognised management plan will be protected from broodstock collection.

The development of broodstock collection and husbandry guidelines will provide hatcheries involved in fish stocking with vital information regarding critical aspects of broodstock collection operations and further information on maintenance and husbandry that are specific to the activity. The guidelines will be issued with every permit to collect broodstock and provide a source for further information across a range of topics and will include a mandatory verification form for the return of broodstock collection data.

3.3 (b) Integrate broodstock collection information with the NSW Aquaculture Information Database

Background: To support the genetic resource management and broodstock management initiatives within the FMS, broodstock collection information will be linked with the aquaculture information system (NSW Fisheries maintains all aquaculture permits and related information on a networked database). The purpose of this measure is to ensure that all fish taken from the wild can be monitored by NSW Fisheries to allow managers to track the quantum of broodstock removed from the natural population. The information will be used in compliance audits to ensure that all hatcheries comply with the broodstock collection policy, especially with regard to recognised genetic zones.

3.3 (c) Continue to provide for the issue of permits under section 37 of the *Fisheries Management Act 1994* for broodstock collection purposes consistent with the vision and goals of the FMS

Background: Permits are used to manage the taking of species by methods or by persons not normally permitted to do so under the Fisheries Management (General) Regulation 2002. The

current management of this aspect of the activity will be enhanced by including relevant advisory material to promote best-practice techniques and clearly indicate the permit holder's obligations including the specific locations from which the broodstock may be taken. The permits will be subject to conditions to ensure that the broodstock collection techniques are appropriate and that the number of fish collected does not lead to overfishing of the target species.

Objective 3.4 To promote best-practice techniques for fish stocking

3.4 (a) Develop a stocking code of conduct that defines and promotes best-practice in:

- stocking techniques
- transport medium management (including chemical treatments and disposal)
- ethical treatment and care of stock (including humane destruction and disposal methods)
- stocking verification procedures, and
- the assessment of disease and fish health at the point of release.

Background: The provision of a comprehensive code of conduct to direct the carrying out of the activity at the point of release is seen as an important management tool to ensure a consistently high level of best-practice at the stage between fish leaving the hatchery and the eventual point of release. NSW Fisheries will develop a code of conduct by drawing on the expertise of hatchery managers and stocking participants.

3.4 (b) Issue a copy of the code of conduct to each stockist before a stocking event proceeds

Background: Once developed, a copy of the code of conduct will be issued to each stockist before a stocking event can proceed. The code of conduct will be a comprehensive information resource to guide the activity at point of release.

As with any instructional material continuous improvement needs to be employed to ensure that information contained within the code is accurate and current. To ensure the code of conduct remains contemporary, it will be developed as a computer-based resource and distributed at the time the stockist is notified that the stocking event can proceed. This will ensure that the latest version is provided to stakeholders and that updated versions can be produced at a minimal cost.

GOAL 4. To provide efficient administrative services, information management and reporting systems

Objective 4.1 To provide a clear administrative framework for reviewing stocking events

4.1 (a) Develop stocking event forms in plain English

Background: To streamline the process, stocking event forms will be developed in plain English and will procure sufficient information about the event in order to allow a stocking review to be conducted. The forms should not seek information that has already been gathered and reviewed. The forms will be accompanied by relevant advisory material to assist stockists to complete the form and supply the information necessary to undertake the prerequisite review of the stocking event.

As stocking event forms are developed, all client privacy requirements will be observed and the personal information collected will be managed within the NSW Fisheries' record keeping system that is compliant with the State Records Act 1998. The forms will be continually improved to procure any further information required as the FMS is progressively implemented. This will be managed by producing only small amounts of paper-based forms at any one time and making such forms freely available by electronic means (i.e. on the NSW Fisheries web page).

4.1 (b) Develop a policy and procedures manual for NSW Fisheries' staff

Background: To provide a consistent framework for review, management and administration of the activity by NSW Fisheries, a Policy and Procedures Manual for Fish Stocking will be developed for the relevant NSW Fisheries staff. The manual will help to collate and preserve corporate memory and promote consistent management of the activity into the future.

4.1 (c) Widely distribute advisory material on stocking policy and procedures in NSW

Background: To educate the wider community about stocking, an information publication will be developed and distributed that provides accurate information about the activity. The publication will be made available in print at all NSW Fisheries' offices and various other Government outlets while also made available electronically over the Internet.

4.1 (d) Develop interactive self-assessment and education resource

Background: An interactive self-assessment resource will be developed and made available on demand as either a compact disc or via the Internet. The tool will be developed as an Adobe Acrobat © portable document format (PDF) document as this format is compatible with most computer platforms regardless of operating system. The tool will be designed to guide stockists to plan considered and appropriate stocking events and will serve also as a general information resource that incorporates issues relative to every stocking zone. Once the stockist has completed the self-assessment, the stocking event form will be able to be printed, completed and submitted to NSW Fisheries - ultimately it is intended to manage this completely as an electronic service delivery. Such a service is likely to save the time and resources of stockists (in terms of planning a stocking event) and NSW Fisheries (in terms of reviewing whether events are appropriate and can proceed).

4.1 (e) Provide an efficient enquiry/advisory service for the activity

Background: An enquiry service will be made available through offices of NSW Fisheries to provide prompt access to information about the activity and to advise on the stocking review process and management arrangements under the FMS. Information will also be made available on the Internet and through all offices of NSW Fisheries. Specialist advice will be available through three offices, namely Port Stephens (for information management & GIS data), Peel District - Tamworth (for the Dollar-for-Dollar program) and Western Regional Office – Albury (for information on stocking event reviews, allocation of stock, salmonid stocking and Government freshwater hatcheries).

4.1 (f) Provide stocking data to other information resources including:

- BIONET
- Community Access to Natural Resource Information (CANRI)
- NSW Fisheries' Aquaculture database (including compliance component), and
- NSW Fisheries GIS systems.

Background: Current management of information relating to the activity is presently fragmented and not readily transportable to other information management systems. This FMS will see the centralisation of all information relating to the activity and the provision of the data to other natural resource management systems held by NSW Fisheries and other recognised agencies with a bone-fide use for the information. Stocking data will be held centrally at the Port Stephens Fisheries Centre where it can be linked to the BIONET database (contributing to biodiversity data), the Aquaculture database (to enhance links between stocking, aquaculture production and compliance), and the GIS database (for integration of spatial data). A key benefit of this amalgamation is that it allows for accurate review, mapping and ongoing reporting of the activity.

Objective 4.2 To maintain and report accurate information relating to the activity

4.2 (a) Maintain records of all stocking events centrally

Background: The review of the current activity highlighted that record keeping of stocking activity is fragmented and could be improved by centralising the records. Under the FMS, all records pertaining to stocking events will be held centrally so they can be kept in a consistent format and reported on accurately when required to do so.

4.2 (b) Periodically report on the activity to clients and stakeholders including:

- internal and external clients
- Ministerial Advisory Councils
- the Indigenous Fisheries Working Group
- other natural resource agencies, and
- angling media.

Background: Reporting procedures provide an opportunity to convey information to those engaged in fish stocking as well as those involved in managing the activity. Reporting will take several forms under the FMS including data generated for performance indicators (FMS reviews), results of research, production reporting (aquaculture production), NSW Fisheries

Annual Report, scientific reports, via the Internet, and through submissions to advisory councils and other groups. An efficient way to meet these reporting requirements and avoid duplications is to produce a single report to report on all aspects of the activity.

Information on stocking figures and advances in management will be provided to recreational fishers and Aboriginal people through appropriate media in a culturally appropriate manner.

4.2 (c) Require hatcheries to report annually on production and other factors relevant to the activity

Background: Improved reporting procedures from hatcheries involved in fish stocking will occur under the FMS. Provisions already exist within Part 6 of the FM Act (Aquaculture Management) to require hatcheries to report on their activities when requested to do so by the Minister. Hatcheries involved in production for fish stocking will be required to report separately from aquaculture so as to collect information specifically relating to the activity. At present there is no requirement to report on fish produced for stocking as opposed to aquaculture.

4.2 (d) Conduct client satisfaction surveys

Background: To ensure the level of service provided to clients is satisfactory and consistent with the FMS, it is proposed that a client satisfaction survey be conducted after three years of commencement to gauge satisfaction from clients and guide future arrangements. These will also be used to monitor the success of the education program proposed under 6.1a. The need for and frequency of any further surveys will be determined once the results of the first survey are known.

4.2 (e) Provide advice to stocking volunteers on appropriate stocking methods, legal implications and other information

Background: Each year NSW Fisheries stocks around seven million fish into the waters of the State. Numerous volunteers assist with the stockings, which allow for an efficient dispersal of the stock and provides ownership of the resulting benefits to interested parties. To ensure that these volunteers are suitably educated with appropriate stocking practices and procedures an information package will be developed.

GOAL 5. To improve the knowledge of the activity and ecosystems in which it operates

Objective 5.1 To initiate research relating to the activity

- 5.1 (a) Facilitate research programs to fill information gaps identified in the risk assessment of the existing activity, as provided for in the Research Plan

Background: This FMS will draw on existing research programs that are relevant to the activity while actively developing the most appropriate direction of future research. A Research Plan has been developed and included in the FMS and is based on filling identified information gaps and addressing areas of highest environmental risk as identified in the Environmental Impact Statement. The research proposed in the plan will be considered in order of priority and subject to available resources, will be carried out according to the timetable set out in the plan (see section D3.7 for Research Plan).

- 5.1 (b) Publish results of research programs

Background: The results of research programs conducted under the stocking research and monitoring program will be published and made available through the appropriate reporting avenues when available.

Objective 5.2 To monitor quality and quantity of catches in enhanced fisheries

- 5.2 (a) Develop reliable marking techniques for hatchery reared stock and introduce the technology to all hatcheries involved in the activity

Background: Marking techniques have had a chequered history in terms of reliability and their ability to last for sufficient time to be effective. Markers can include compounds such as strontium hydrochloride, alizarin complexone and oxytetracycline (prophylactic treatments), scale pattern analyses, fin-clipping, tags, dyes and other substances. NSW Fisheries has developed marking techniques that are considered to be the most potentially reliable method for marking and identifying hatchery reared fish in Australian conditions. Further work and trials to develop these marking techniques for all species produced for stocking in NSW is continuing to enable the technology to be progressively introduced to hatcheries producing stock for the activity, where necessary.

As techniques for marking stocked fish are refined a program to extend the technology to all hatcheries engaged in the activity must be undertaken. The time frame for this transfer of technology depends on the time taken to refine practices and establish an extension program. Ultimately, most fish stocked under the FMS will be marked with the compound alizarin complexone to enable ready identification through otolith samples. Where marking is not considered necessary, fish may be released without committing hatcheries to any unnecessary expense and potential stress or mortality to stock resulting from the procedure.

An important part of this program will be the ongoing assessment of the success or otherwise of marking techniques. Where better technology or methods become available, they will be introduced if there is a demonstrable need to do so.

- 5.2 (b) Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity

Background: Gathering data from specific fishing events where fish are stocked provides an effective way to compile a host of information that is otherwise difficult to obtain. Monitoring of this type has been conducted for the past few years and has established important base-line data. Otolith samples are also taken from a sample of fish caught at these events for analysis to determine whether they are hatchery-reared fish or from natural populations.

- 5.2 (c) Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis

Background: Past economic surveys have confirmed the importance of the activity in areas such as the Snowy Mountains region. These will be of use to recreational fishers, fisheries managers, Aboriginal communities and the other people in regional communities who are also concerned with maintaining and increasing the value of the enhanced fisheries to the local community through the development of tourism opportunities. The economic study of the Snowy Mountains trout fishery was developed as a surveying template for examining the regional economic significance of recreational fishing activities in NSW. Further socio-economic surveys will continue in regional areas to measure the benefits of the activity to the economy and societies and/or cultures in regional areas. This will enable an assessment of the benefits of the activity compared to the expenditure of funds for stocking.

- 5.2 (d) Monitor the level of participation in fish stocking using information gathered through the general recreational fishing licensing system and other appropriate avenues

Background: The recently introduced recreational fishing licence provides an information source for recreational fisheries management. The FMS will draw on the information generated by the database and information on angler participation will be invaluable in the future planning of stocking activity and the ability to report on the activity in a wider context than is presently the case. As the general recreational fishing fee does not apply to Aboriginal fishers, other sources such as the central database for stocking applications, client satisfaction surveys and economic surveys will be used to determine the level of Aboriginal involvement.

Objective 5.3 Use research to develop better stocking practices

- 5.3 (a) Having regard to the research priorities identified in the Research Plan, initiate research into the distribution of stocked native species, including any sub-populations

Background: Recent scientific information suggests that golden perch, silver perch and Macquarie perch have distinct sub-populations within the broader species' ranges. Research to identify these sub-populations including their distributions and whether other stocked species have similar sub-specific variation will allow for more reliable review of stocking events, genetic resource management and broodstock management. In the meantime, strict broodstock collection and management policies, stocking reviews and release protocols will apply. The priority given to this research compared to other research areas has been determined as the highest priority and as such is scheduled to begin within two years of approval of the FMS.

- 5.3 (b) Apply empirical methods to determine optimum stocking density rates (in terms of efficacy and effectiveness), and assess the feasibility of developing and applying an established formulae in the longer term

Background: To promote efficiency in stocking rates, empirical methods (i.e. experimental) will be used to determine appropriate stocking densities. In the longer term, it may be possible to develop and apply stocking density formulae based on fixed factors such as the surface area, shoreline length and water volume of the receiving waterway, and variable factors such as the type and class of stock, existing stock, frequency of past stocking, harvesting pressure and availability of food and habitat values.

- 5.3 (c) Continually update the Stocking Review Guidelines and assessment resources to accurately review potential impacts from the activity

Background: The Stocking Review Guidelines established under the FMS is an active document designed to be continually improved and updated. As new information or review procedures come to hand these will be readily transposed into the review framework. The document will be assigned version numbers to ensure that only the latest version is in circulation.

This process of modifying the guidelines as new information comes to hand will equally apply to the other policy and procedures prepared under this FMS, such as the Genetic Resource Management Guidelines and guidelines developed under the Hatchery Quality Assurance Program.

GOAL 6. To maximise community understanding and voluntary compliance through education and support services while providing effective deterrence against illegal activity

Objective 6.1 To improve community understanding and public perception of the activity through an education strategy

6.1 (a) Develop and implement a culturally appropriate educational (communication) plan to:

- raise community understanding of the fish stocking activity for recreational fishing, Aboriginal cultural fishing and conservation purposes
- review effectiveness of educational material
- promote best practice in all areas of the activity, and
- maximise voluntary compliance within the activity

Background: To ensure the education component of the FMS is carried out with optimum benefit a culturally appropriate education plan will be developed. The education plan will be developed through liaison with the NSW Fisheries' Communications and Marketing Branch within the first two years of operation of the strategy. It will be designed to develop appropriate educational material in the form of advisory notes, web-based information and specific publications or fora to meet the needs of people involved in the activity or that would like to become involved. In particular, educational and promotional information will be prepared and delivered in a form that considers the expectations of recreational fishers, Aboriginal communities and other people with an interest in fish stocking. Access to information will be improved through the use of the Internet, through all NSW Fisheries' offices, Fishcare Volunteer programs, through NSW 'Natural Resource Service Centres' and will be consistent with the IFS. Educational material will be provided to all stockists prior to stocking events proceeding and whenever other opportunities arise (such as field days and in the angling media). In the first instance the FMS and EIS will be made widely available on the NSW Fisheries website, in NSW Fisheries offices and through targeted mail-outs.

6.1 (b) Develop an information kit for NSW Fisheries staff to convey accurate information on fish stocking to clients

Background: An information kit will be developed to assist NSW Fisheries staff to convey accurate information on the activity to recreational fishers, Aboriginal people and hatchery operators. The information kit will include speaking notes, transparencies, computer-based display and various other sources of educational material. There is a strong demand for such material in the regions where NSW Fisheries is often called upon to address angling clubs, environmental and community groups, schools and other institutions. The material would be regularly updated, as with other publications and education material on the activity, to ensure it evolves along with the provisions of the FMS.

Objective 6.2 To develop and deliver an effective compliance program

6.2 (a) Develop a Fish Stocking Compliance Plan

Background: A Fish Stocking Compliance Plan will be developed to ensure adequate levels of compliance by stockists with the provisions of the FMS. Compliance operations can be developed and appropriately targeted using information in the central management and records system being developed under the FMS. NSW Fisheries officers conduct patrols of waterways that are stocked with angling species, provide a general education service to the angling community and can promote compliance with the FMS provisions. The compliance plan should include the publication of compliance programs and outcomes in media to raise awareness of compliance issues and discourage illegal activity.

6.2 (b) Require persons involved in stocking to verify stocking events when complete

Background: It is important to be able to verify that the species and quantity of fish examined under the stocking review framework were actually stocked in the nominated areas. Accurate and timely data is necessary for the ongoing management and reporting of stocking, particularly for disease management and the ability to trace sources of outbreaks. A failure to comply with stocking verification procedures would attract a penalty that is dealt with under the Self Enforcing Infringement Notice System (SEINS) and could result, in extreme cases, in the rejection of future stocking events by that stocking person or group.

D5 Performance Monitoring and Review

D5.1 Performance monitoring

The complex nature of fish stocking means that many of the management responses assist in achieving multiple goals. Therefore, rather than examining the performance of each individual response or objective, it is more efficient and appropriate to measure the performance of this FMS against the six goals (i.e. the major objectives). A regular report will, however, be prepared (as outlined later in this section) detailing the progress made in implementing the management responses.

D5.1.1 Performance indicators

Performance indicators provide the most appropriate indication of whether the management goals are being attained. A number of monitoring programs are to be used to gather information to measure performance indicators. These monitoring programs are detailed later in this section in Tables D8 to D13.

With the implementation of the new research and information management programs for the activity outlined in Goal 5, a broader information base relating to the activity and its impacts will enable more precise performance indicators to be developed over time.

D5.1.1.1 Data requirements and availability

The data requirements and availability for each performance indicator in Tables D8 to D13 relate to the collection of information used to measure the performance indicators and the data that are available.

D5.1.1.2 Robustness

The robustness ratings applied to each performance indicator in Tables D8 to D13 have been selected using the definitions established by the Standing Committee on Fisheries and Aquaculture (2000), as follows:

Level	Description
High	The indicator is a direct measure of the goal, or if indirect, is known to closely reflect changes in the issue of interest
Medium	The indicator is suspected to be reasonably accurate measure against the goal, or the known error is in the conservative direction
Low	The degree to which the indicator measures against the objective is largely unknown, or known to be low. Often this will involve surrogate indicators

D5.1.2 Trigger points

Trigger points specify when a performance indicator has reached a level that suggests there is a problem with the activity and a review is required. Tables D8 to D13 establish the performance indicators and trigger points that will be used to measure whether each of the management goals described in section 4 of the FMS are being attained.

D5.1.3 Predetermined review of performance indicators and trigger points

It is likely that changes to the activities authorised under the FMS will evolve over time. It is also likely that better performance indicators will become apparent over the course of the next few years and it would then be an inefficient use of resources to continue monitoring the current performance indicators. If new information becomes available as a result of research programs, more appropriate performance indicators and trigger points can be developed and the Minister for Fisheries may amend the FMS accordingly.

A review of the appropriateness of all performance indicators and trigger points will occur not more than three years from the commencement of this FMS.

D5.2 Reporting on the performance of the FMS

There are two types of reports to be prepared under this management strategy. One is a performance report that reports generally on the performance of the fishery with respect to the management strategy. The other type of report is a review report, which is to be prepared if a performance indicator for the fishery is breached. Both types of reports are discussed in further detail below.

D5.2.1 Performance report

A performance assessment examining each performance indicator will be undertaken annually and a report on the performance indicators will be submitted to the Minister for Fisheries within two years of the commencement of the FMS, and biennially thereafter. The annual performance review is the formal mechanism for reporting on performance indicators and trigger points, and the report will be made publicly available. This report will also include a review of progress made in implementing each of the management responses.

The vast majority of management responses in the management strategy are linked to specific implementation timeframes. Some of these management actions are subject to specific trigger points that ensure reviews and appropriate remedial actions if the target timeframes are not met. If the performance report identifies that any specified target timeframe has not been met, a review will be undertaken and any necessary remedial measures recommended to the Minister for Fisheries⁷. The fishery will continue to be regarded as being managed within the terms of the management strategy whilst any remedial measures associated with breaches in timeframes or triggering of performance indicators are being considered through the review process and/or by the Minister for Fisheries.

D5.2.2 Review report in response to trigger points

If the trigger point for a performance indicator is breached, a review is to be undertaken of the likely causes for the breach. While the biennial performance report will report on whether any trigger points have been exceeded, this does not prevent a review from being conducted at any other time should it become apparent that a performance indicator has breached a trigger point, especially during the annual performance assessment process.

⁷ In some circumstances a required action may be completed outside the scheduled timeframe, but prior to the commencement of the review (e.g. an action was due for completion by December 2005, but it is actually completed in January 2006). When this occurs, it is not necessary to proceed with a review.

Where the data or information indicates that a trigger point has been breached, details will be provided to the relevant Ministerial advisory bodies and advice sought on the suspected reasons for the breach.

Reviews arising from activities exceeding trigger points should consider (but not be limited to) the following factors:

- changes in the relative production levels or other factors among hatcheries (including those beyond NSW jurisdiction)
- new biological or stock information, and
- changes in the activities or effectiveness of technology producing the species.

A review report is to be provided to the Minister for Fisheries within six months of the trigger point being breached, and must include the likely reasons for the breach (where known), and any recommendations for remedial actions.

A review report should include whether the suspected reasons for the trigger point being breached are the result of an effect of the activity or an influence external to the activity, or both.

If a review concludes that the reasons for the trigger point being breached are due to the operation of the activity, or if the FMS objectives are compromised if the activity continued to operate unchanged, management action must be taken with the aim to return the performance indicator to an acceptable range within a specified time period. The nature of any remedial action proposed would vary depending on the circumstances that have been identified as responsible for the trigger point being breached.

There may be circumstances where no change to management arrangements or the management strategy is deemed necessary following the review. For example, a review might be triggered because the number of hatcheries producing a species for stocking declines. However, there would be little cause for concern over the performance of the FMS if the decline in production of a species was clearly caused by changing market prices. Price fluctuations can result in hatcheries adjusting their activities.

If a review considers that the management objectives or the performance monitoring provisions are inappropriate and need to be modified, the management strategy itself may be amended by the Minister for Fisheries. If the reasons are considered to be due to impacts on the resource from factors external to the fishery, these factors should be identified in the review and referred to the relevant managing agency for action.

All review reports will be publicly available.

D5.2.2.1 *External drivers*

External drivers are factors that are known to potentially impact on the performance of the fishery but which are outside of the control of NSW Fisheries or the hatchery industry (e.g. environmental conditions, social changes etc.). Any external influences that may contribute to a trigger being breached will be identified during the review and, if necessary, referred to any relevant managing agency for action.

Accordingly, there may be circumstances where no change to management arrangements or the management strategy is deemed necessary following the review. For example, a review could be triggered because estimates of stocking success are not available. However, there would be little

cause for concern over the performance of the management strategy if the review was triggered due to reduced stocking due to a drought.

D5.3 Contingency plans for unpredictable events

In addition to the circumstances outlined above, the Minister for Fisheries may order a review and/or make a modification to the activity or to the FMS in circumstances declared by the Minister as requiring contingency action, or upon the recommendation of a Ministerial advisory body on recreational fishing, conservation or Indigenous issues. In the case of the former, the Minister must consult the relevant advisory body on the proposed modification or review.

These circumstances may include (but are not limited to) food safety events, environmental events, and results of research programs or unpredictable changes in stocking activity over time. Notwithstanding the above, the Minister for Fisheries may also make amendments to the FMS that the Minister considers to be minor in nature at any time.

D5.4 Monitoring stocking success

Monitoring stocking success involves the use of various marking techniques to make quantitative predictions about the ratio of populations of stocked fish versus self-sustaining populations. These calculations can vary from simple graphical presentations of landings to sophisticated computer models that predict the biomass of the stock under various harvest regimes. The data and the scientific expertise required to apply these methods vary enormously. Stock assessment processes for the activity need to be defined to suit the resources available. To achieve this outcome, short-term and medium-term approaches will be applied.

The short-term approach will be to improve marking techniques for stocked species in order that effective and cost-efficient methods are developed. The medium term approach will involve introducing a requirement for fish hatcheries involved in the activity to mark all stocked species using the techniques that have been developed. The process needs to be facilitated by NSW Fisheries and extended to all hatcheries that supply fish for stocking.

D5.5 Performance indicators and trigger points for the activity of fish stocking

Tables D8 to D13 outline the performance indicators and associated trigger points to measure the performance of the FMS in relation to the six goals of the FMS.

Table D8. Performance indicators and trigger points for Goal 1 of the FMS.

Note: Performance indicators apply to goals and not individual management responses.

GOAL 1: <i>To manage the activity in a manner that minimises impacts on aquatic biodiversity including threatened species and genetic resources</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Data required	Availability/monitoring programs	Robustness	External drivers
Status of implementation of threatened species recovery plans or threat abatement plans	Readily available from NSW Fisheries and other government agencies (e.g. NPWS)	Medium	Nil
Performance indicator (2)	Trigger point	Justification/comments	
Response of the activity to strategies, management plans or legislation (state or national) developed to protect aquatic biodiversity	The Director-General, NSW Fisheries, considers the FMS does not adequately comply with relevant strategies, management plans or legislation concerning protection of aquatic biodiversity	A number of state and national strategies, management plans and environmental protection laws are in force at present that require compliance by activities (such as fish stocking) that may compromise their effectiveness	
Data required	Availability/monitoring programs	Robustness	External drivers
Status of relevant management plans/strategies (e.g. The draft Native Fish Strategy MDBC, National/State translocation policies, and other relevant documents)	Readily available from NSW Fisheries and other government agencies (e.g. NPWS)	Medium	Nil

Table D9. Performance indicators and trigger points for Goal 2 of the FMS.

GOAL 2: <i>To enhance fishing opportunities through cost-effective stocking programs that maximise economic benefits and provide social equity from the activity for recreational fishing and Aboriginal cultural fishing purposes</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Estimates available to show effectiveness of harvest stocking programs	Estimates not available after four years of approval of the FMS	This relates to the need to have an assessment of the benefits derived from stocking to help guide future stocking events	
Data required	Availability/monitoring programs	Robustness	External drivers
Estimates should be available through research and other programs designed to define and examine the effectiveness of stocking	Results will become available as trials are completed	High	Environmental conditions
Performance indicator (2)	Trigger point	Justification/comments	
Opportunities to stock fish into waters due to classification of waters strategy	Classification of waters strategy reduces opportunities to stock by more than 25% in two years	This relates to the classification of natural waters to ensure appropriate species are released into waters with suitable environmental conditions	
Data required	Availability/monitoring programs	Robustness	External drivers
Number of stocking events not proceeded with or modified due to the classification of waters strategy	Records will be available of the number of stocking events affected by the classification regime after it has been developed and implemented	Medium	Nil
Performance indicator (3)	Trigger point	Justification/comments	
Response to Aboriginal or other cultural heritage issues	The Director-General, NSW Fisheries considers that the FMS does not adequately meet the needs of Aboriginal or other cultural heritage issues	This relates to the need for this FMS to operate in harmony with Aboriginal or other cultural heritage issues	
Data required	Availability/monitoring programs	Robustness	External drivers
Involvement of Aboriginal fishers in stocking activities	Consultation with the Indigenous Fisheries Strategy Working Group	Medium	Nil

Table D10. Performance indicators and trigger points for Goal 3 of the FMS.

GOAL 3: <i>To ensure the consistent production and release of appropriate quality stock</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Response of the activity to a disease or pest species incursion	The Director-General, NSW Fisheries certifies that the activity has not responded appropriately to a disease or pest species management program and recommends that the FMS be modified	Pests and diseases can pose significant risks to the production of fish and the receiving waters. This indicator ensures that the activity is appropriately responding to pest and disease issues, particularly the translocation of live aquatic organisms and disease control in all hatcheries engaged in the activity	
Data required	Availability/monitoring programs	Robustness	External drivers
Ongoing monitoring of pests and diseases and records of responses to pest or disease incursions	Disease notification procedures (in line with AFFA and IOE) and AQUAVETPLAN	Medium	Introduction of pests and diseases through other aquatic or land based activities
Performance indicator (2)	Trigger point	Justification/comments	
Number of hatcheries engaged in the activity receiving accreditation	Less than 40% of hatcheries achieve accreditation after five years	Hatcheries will need to meet new accreditation standards before they will be permitted to produce stock for the activity. This indicator monitors the extent to which the accreditation system reduces the number of hatcheries supplying fish for stocking	
Data required	Availability/monitoring programs	Robustness	External drivers
Record of accredited hatcheries	Data will be available through the information management system maintained by NSW Fisheries	High	General economic factors affecting hatchery businesses
Performance indicator (3)	Trigger point	Justification/comments	
Number of reported breaches of the code of conduct for stocking	Number of reported breaches increases by 20% or more in any two consecutive years	The Code of Conduct is an important resource for stockists and will guide best-practice in stocking events, particularly with respect to the release of fish into waterways	
Data required	Availability/monitoring programs	Robustness	External drivers
Reports by NSW Fisheries officers or from the community	Data will be available through the information management system maintained by NSW Fisheries	Medium	Nil
Performance indicator (4)	Trigger point	Justification/comments	
Number of hatcheries producing species for the Dollar-for-Dollar Native Fish Stocking Program	Number of hatcheries producing species for Dollar-for-Dollar Native Fish Stocking Program falls below number required to meet demand	To support the Dollar-for-Dollar Native Fish Stocking Program there must be sufficient private hatcheries producing stock to meet demand from stockist	
Data required	Availability/monitoring programs	Robustness	External drivers
Record of accredited hatcheries; and Records of interest in the Dollar-for-Dollar Native Fish Stocking Program	Data will be available through the information management system maintained by NSW Fisheries	High	General economic factors affecting hatchery businesses
Performance indicator (5)	Trigger point	Justification/comments	
Number of declared diseases that relate to stocking activities	Two or more declarations in any one year	Aims to detect any concerning patterns of disease occurrences	
Data required	Availability/monitoring programs	Robustness	External drivers
Data on the number of declared diseases is required	Data will be available through the information management system maintained by NSW Fisheries	Medium	Nil

Table D11. Performance indicators and trigger points for Goal 4 of the FMS.

GOAL 4: <i>To provide efficient administrative services, information management and reporting systems</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Data required	Availability/monitoring programs	Robustness	External drivers
Reliability of production reporting by hatcheries engaged in fish stocking	More than 20% of hatcheries fail to submit production reports by the required time	Hatcheries (Government and Private) must provide prompt reports on the production of stock for fish stocking and other matters such as presence of pests and diseases, mortalities and trends	
Performance indicator (2)	Trigger point	Justification/comments	
Data required	Availability/monitoring programs	Robustness	External drivers
Satisfaction of stocking participants with stocking programs	Satisfaction of stocking participants is demonstrably low (i.e. less than 50%).	Client satisfaction is an important facet of any management plan. As a performance indicator participants are able to make comment on the level of satisfaction regarding the services provided by NSW Fisheries in the management and administration of the activity	
Performance indicator (3)	Trigger point	Justification/comments	
Data required	Availability/monitoring programs	Robustness	External drivers
Publication of stocking information in line with education, compliance and research plans	Publications requirements missed or incomplete on two sequential occasions	This relates to the need to accurately report on the components of the FMS to a range of internal and external stakeholders, and ensuring that the FMS is taking account of new and updated information	
Details of stocking figures, research outputs and compliance outcomes	Data will be available through the information management system maintained by NSW Fisheries and the annual performance assessments	Medium	Nil

Table D12. Performance indicators and trigger points for Goal 5 of the FMS.

GOAL 5: <i>To improve the knowledge of the activity and ecosystems in which it operates</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Implementation of research plan in accordance with priorities determined through the environmental assessment process	Research plan not implemented in accordance with priorities identified in the Fish Stocking Environmental Impact Statement	A lack of knowledge about the impact of fish stocking on various environmental factors has resulted in the environmental assessment determining areas of high risk. A research plan developed under the FMS will prioritise research programs based on the areas identified as high risk	
Data required	Availability/monitoring programs	Robustness	External drivers
Research plan available and the research priorities identified	Research plan will be publicly available and progress in implementing the plan will be outlined in the biennial performance report	High	Access to government or external funding sources
Performance indicator (2)	Trigger point	Justification/comments	
Estimates of stock originating from self-sustaining populations or previously stocked fish	Estimates not available within 4 years	An important component of monitoring includes the ability to estimate proportion of stocked versus wild populations to guide management	
Data required	Availability/monitoring programs	Robustness	External drivers
Existence of estimates	Availability of estimates will be outlined in the biennial performance report	Low	Availability of accurate marking techniques
Performance indicator (3)	Trigger point	Justification/comments	
Response of the activity to research results showing genetic variations within populations of species used in stocking or other critical matters	Research demonstrates that a modification to the activity is required which the Director-General, NSW Fisheries, considers is not adequately provided for elsewhere in the FMS	Genetic variations between populations are managed by the FMS, however, if information arises through research that suggests greater genetic variation, or some other critical matter, the FMS needs to be able to adequately respond	
Data required	Availability/monitoring programs	Robustness	External drivers
Genetic distribution of species used in fish stocking	Research into genetic distribution will be an important component of the research plan	Medium	Nil
Performance indicator (4)	Trigger point	Justification/comments	
Compliance with verification requirements for stocking events	The compliance with verification requirements for stocking events reduces by more than 15% over any three consecutive year period	Compliance with the verification requirements for stocking events provides for the timely management of the activity (eg. in terms of disease traceability, information management and reporting procedures)	
Data required	Availability/monitoring programs	Robustness	External drivers
Number of instances where stocking events have taken place without the necessary compliance with verification procedures	Data will be recorded by NSW Fisheries as part of the compliance plan developed under the FMS	Medium	Nil

Table D13. Performance indicators and trigger points for Goal 6 of the FMS.

GOAL 6: <i>To maximise community understanding and voluntary compliance through education and support services while providing effective deterrence against illegal activity</i>			
Performance indicator (1)	Trigger point	Justification/comments	
Overall rate of compliance by persons engaged in the activity	Overall rate of compliance with the strategy falls below 80%	The compliance rate associated with the current operation of the activity is not easily measured. As the compliance strategy for the activity is implemented, the reporting of compliance outcomes is expected to be readily available and accurate	
Data required	Availability/monitoring programs	Robustness	External drivers
Outcomes of compliance operations	Data will be recorded by NSW Fisheries as part of the compliance plan developed under the FMS	High	Nil
Performance indicator (2)	Trigger points	Justification/comments	
Basic level of understanding by stockists of the risks associated with inappropriate stocking and of stocking management requirements	1. Less than 75% of stockists show a basic understanding of the risks and requirements after 3 years of the commencement of the FMS 2. After 3 years, the percentage of stockists showing a basic understanding declines by more than 15% of any three consecutive year period	Community understanding with the current operation of the activity is not easily measured. As the compliance and education plans are implemented, delivery of information resources will indicate approximate numbers of person availed with information about the activity. Future angler surveys will also be used to determine the level of community understanding.	
Data required	Availability/monitoring programs	Robustness	External drivers
Level of understanding, as determined through questionnaires and surveys	Every 3 years, surveys will be undertaken with potential stockists prior to stocking events	High	Influence of regional media
Performance indicator (3)	Trigger points	Justification/comments	
Applications for stocking for cultural purposes by Aboriginal persons or groups	That the number of applications to stock has not increased over every 3 year period following release of the education/communication plan	Partnerships developed through the FMS, primarily with the IFS Working Group, will increase the level of awareness and involvement in stocking by Aboriginal communities. Applications are considered an effective surrogate for determining the effectiveness of the communication strategy	
Data required	Availability/monitoring programs	Robustness	External drivers
Application forms which collect information on cultural background	Data will be available through the information management system maintained by NSW Fisheries	Medium	IFS

Appendices to the FMS

FMS Appendix 1 Stocking review guidelines

FMS Appendix 2 Profiles of species proposed for stocking

FMS Appendix 3 Proposed stocking zones

FMS Appendix 4 Implementation tables for management responses

FMS Appendix 1. Stocking review guidelines

Part 1: The stocking activity

Issue	Response	Significance of potential impacts	Comments – Action required to mitigate impacts (i.e. further assessment required; special conditions; consideration of threatened species)
1.1 Is the species approved for stocking in this zone? (see relevant Stocking Zone proposal)	Yes/No	If “No”, stocking cannot proceed	Another species or zone must be nominated
1.2 Is the proposed release site approved for stocking in the zone? (see schedule of restricted waters)	Yes/No	If “No”, stocking cannot proceed	Another waterway area must be nominated
1.3 Is stocking an appropriate management option in this case?	Yes/No	If “No”, stocking cannot proceed	Another management arrangement should be considered (e.g. habitat rehabilitation)
1.4 Does the event form part of a NSW Fisheries stocking program?	Yes/No		
1.5 Is the stock to be sourced from an accredited hatchery?	Yes/No	If “No”, stocking cannot proceed	Another source of stock must be nominated
1.6 Does the broodstock management for the stock comply with the FMS?	Yes/No	If “No”, stocking cannot proceed	Another source of stock must be nominated
1.7 Does the genetic resource management of the stock comply with the FMS?	Yes/No	If “No”, stocking cannot proceed	Another source of stock must be nominated
1.8 Is the stock required to be marked with a marking agent or technique (i.e. part of a research or monitoring program)?	Yes/No		
1.9 Will monitoring of the stock be conducted after the release?	Yes/No		
1.10 Is the likelihood of the species developing a reproducing populations following stocking of concern?	Yes/No		
1.11 Is the age class of fish appropriate for the nominated waterway?	Yes/No		
1.12 Is the stocking level appropriate for the nominated waterway?	Yes/No		
1.13 Does the proposal include a previously unstocked waterway?	Yes/No	If native species & “Yes”, must adopt Conservation Stocking protocols If salmonid & “Yes”, stocking cannot proceed	Native stock will need to be sourced from an accredited hatchery where Conservation Stocking protocols are applied.
Comments regarding issues raised in Part 1:			

Part 2: Translocation of live aquatic organisms

Issue	Response	Significance of potential impacts	Comments – Action required to mitigate any impacts (i.e. further assessment required; special conditions) – Comments relating to threatened species management
2.1 Will the transport medium and equipment be disinfected before and after transport?	Yes/No		
2.2 Is the source area and/or hatchery subject to any disease surveillance programs?	Yes/No		
2.3 Will the consignments be reliably certified free of known diseases and if so by whom?	Yes/No		
2.4 Are there any disease, parasites or unexplained mortality issues in the source area?	Yes/No		
2.5 Are there undesirable species (eg. non-target fish, parasites, blue green algae) likely to be translocated with the consignment that are not currently found in the target location?	Yes/No		
2.6 Is the consignment subject to any quarantine processes and/or treatments?	Yes/No		
2.7 Will the consignment be reliably certified free of undesirable and non-target species, and if so by whom?	Yes/No		
2.8 Are any non-target species, diseases or parasites likely to escape, and if so at what scale?	Yes/No		
2.9 In the event of an escape, what life stages (eg. gametes, fertilised eggs, juveniles, adults etc) are likely to escape?			
2.10 Based on the outcomes from the above is there a likelihood of escape?	Yes/No		
2.11 Is further assessment of translocation issues required?	Yes/No	<i>If yes, refer to the National Translocation Assessment Guidelines (stocking open waters) before proceeding to Part 3</i>	
Comments regarding issues raised in Part 2:			

Part 3: Local environmental issues

Issue	Response	Significance of potential impacts	Comments – Action required to mitigate any impacts (i.e. further review required; special conditions) – Comments relating to threatened species management
3.1 Is the nominated site subject to any local management plan or action that would preclude stocking?	Yes/No	If “Yes”, stocking cannot proceed	Another waterway area must be nominated
3.2 Are any terrestrial threatened species recovery plans in force in the area?	Yes/No		
3.3 Are any aquatic threatened species recovery plans in force in the area?	Yes/No		
3.4 Is the recovery of a threatened species likely to be adversely impacted by the stocking event?	Yes/No	If “Yes” stocking cannot proceed	Event must be amended
3.5 Is the possible distribution of the species following stocking of concern?	Yes/No		
3.6 Is the event likely to impact on cultural, heritage or aesthetic values?	Yes/No		
3.7 Are the waters suitable for stocking the nominated species in terms of climate and location?	Yes/No		
3.8 Will the activity impact on adjoining land use?	Yes/No		
3.9 Are any endangered species listed under the TSC Act known to be present within 5km of the release site?	Yes/No		
3.10 Is a loss of the aesthetic, cultural, recreational or other environmental quality of the locality likely?	Yes/No		
3.11 Is the release site either upstream or downstream of a barrier to fish passage where, according to official records, the species has not been previously stocked?	Yes/No		
3.12 Does the nominated site provide suitable access to anglers?	Yes/No		
Comments regarding issues raised in Part 3:			

Part 4: Review of the stocking proposal and permits

- | | | |
|-----|--|----------|
| 4.1 | Taking into account information under Part 1 and Part 2 of this review, is the event consistent with the Fish Stocking FMS? | Yes / No |
| 4.2 | Taking into account information under Part 3 of this review and proposed permit conditions, is the event likely to have unacceptable impacts on the local environment given the expected benefits to the angling public? | Yes / No |
| 4.3 | Does the event require further review? (e.g. an eight part test for threatened species)
(If yes, provide details and course of action in the 'Conditions' box below) | Yes / No |
| 4.4 | Having weighed up all the factors, in the delegated officer's opinion should the stocking event proceed? | Yes / No |
| 4.5 | Are special conditions required to mitigate any potential negative impacts and ensure the event satisfies the requirements of FMS?
(If yes, provide necessary conditions) | Yes / No |

Conditions required:

- A. _____
- B. _____
- C. _____
- D. _____
- E. _____
- F. _____
- G. _____

APPROVAL

Name of delegated Authorising Officer _____ Position: _____

Signature of Authorising Officer: _____ Date: ____ / ____ / ____

Name of delegated Conservation Officer: _____ Position: _____

Signature of delegated Conservation Officer: _____ Date: ____ / ____ / ____

If approved, forward papers to Permits Officer

Date received by Permits Officer: ____ / ____ / ____

FMS Appendix 2. Profiles of species proposed for stocking

A profile of each species to be stocked is detailed in the following tables. The profiles give a synopsis of the species, and where and how it is to be utilised within the NSW Fisheries Fish Stocking Program.

Native species

Australian bass

Waters to be stocked	Suitable public impoundments and coastal rivers
Conservation status	Not listed under the FM Act but known to comprise three populations
Protection status	Protected from commercial fishing under section 20 of the FM Act
Translocation status	This species will not be translocated outside its natural range (including genetic regions)
Stocking programs	NSW Fisheries' Native Fish Stocking Program Dollar-for-Dollar Native Fish Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	Three broodstock collection zones - north, central and south (see Chapter B of the EIS)
Hatcheries	Port Stephens Fisheries Centre (PSFC) Private Hatcheries
Production capacity	PSFC capacity maximum 300,000 fry per season. Only 96,000 in 2002. Private Hatcheries capacity unquantifiable. Dollar-for-Dollar production reached 183,500 in 2002.
Stocking rates	Large impoundments: stocked by NSW Fisheries on average every two years or on application. Rates dependent on production capacity, appropriate stocking density and number of events. Rivers: stocked upon application following stocking assessment.
Stocking methods	Stock transported in tankers to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Nil (catadromous species) Regulated rivers: Low. Barriers restrict breeding cycle Unregulated rivers: High. The species is endemic to the zone and may complete the breeding cycle in unregulated systems

Golden perch

Waters to be stocked	Suitable public impoundments and rivers of the western drainages and Glenbawn and Glennies Creek Dams (Hunter catchment) on the east coast
Conservation status	Not listed under schedules 4 or 5 of the FM Act
Protection status	Not protected under sections 19 or 20 of the FM Act
Translocation status	This species will only be translocated outside its natural range in the Hunter River Catchment for recreational stocking in Glenbawn Dam and Glennies Creek Dam where the species has been historically stocked
Stocking programs	NSW Fisheries' Native Fish Stocking Program Dollar-for-Dollar Native Fish Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	Broodstock collection zones to be established under FMS. Policy requires broodstock to be sourced from area to be stocked
Hatcheries	Narrandera Fisheries Centre (NFC) Private Hatcheries
Production capacity	NFC capacity maximum 2,000,000 fry per season. 1,012,000 in 2002. Private Hatcheries capacity unquantifiable. Dollar-for-Dollar production reached 601,897 in 2002
Stocking rates	Large impoundments: stocked by NSW Fisheries on average every two years or on application. Rates dependent on production capacity, appropriate stocking density and amount of applications. Rivers: stocked upon application following stocking assessment

Golden perch cont.

Stocking methods	Stock transported in tankers to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Nil. Conditions in impoundments not suitable for breeding Regulated rivers: Medium. Unregulated rivers: High. The species is endemic to the zone and may complete the breeding cycle other than in eastern drainage within thermal limits

Eastern cod

Waters to be stocked	Waters within the Richmond and Clarence catchments
Conservation status	Schedule 4 of the FM Act; Endangered IUCN
Protection status	Protected from fishing under section 19 of the FM Act
Translocation status	This species will not be translocated outside its natural range
Stocking programs	Eastern (freshwater) Cod Recovery Plan
Broodstock collection zones	Waters within the Richmond and Clarence catchments as nominated under broodstock collection permit only
Hatcheries	Private hatchery - Mr Mike Gilbert - Booma Fisheries
Production capacity	Average 35,000 per annum (currently)
Stocking rates	Determined under recovery plan
Stocking methods	Broadcast stocking of fry or fingerlings with assistance from volunteers
Likelihood of establishing self sustaining populations	High: Species is being stocked back into its natural range and managed under recovery plan. Measures to mitigate other impacts include an exclusion from stocking Australian bass into same area and protection from taking the species by section 8 fishing closures under the FM Act.

Murray cod

Waters to be stocked	Suitable public impoundments and rivers
Conservation status	Not listed under schedules 4 or 5 of the FM Act
Protection status	Seasonal fishing closure under section 8 of the FM Act
Translocation status	This species will not be translocated outside its natural range
Stocking programs	NSW Fisheries' Native Fish Stocking Program Dollar-for-Dollar Native Fish Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	No broodstock collection zones established under FMS. Policy requires broodstock to be sourced from area to be stocked
Hatcheries	Narrandera Fisheries Centre (NFC) Private Hatcheries
Production capacity	NFC capacity maximum 500,000 fry per season. 311,000 in 2002. Private Hatcheries capacity unquantifiable. Dollar-for-Dollar production reached 154,000 in 2002
Stocking rates	Large impoundments: stocked by NSW Fisheries on average every two years or on application. Rates dependent on production capacity, appropriate stocking density and number of applications. Rivers: stocked upon application following stocking assessment
Stocking methods	Stock transported in tankers to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Medium. Conditions in impoundments generally not suitable for breeding Regulated rivers: Medium. Unregulated rivers: High. The species is endemic to the zone and may complete the breeding cycle in areas within thermal limits

Silver perch

Waters to be stocked	Public impoundments and rivers subject to assessment
Conservation status	Schedule 5 of the FM Act; Vulnerable IUCN
Protection status	Protected from commercial fishing under section 20 of the FM Act
Translocation status	This species will only be translocated outside its natural range into the Hunter River Catchment for recreational stocking in Glenbawn Dam and Glennies Creek Dam where the species has been historically stocked
Stocking programs	NSW Fisheries' Native Fish Stocking Program (Dams only) Conservation Stocking (pending implementation of recovery plan)
Broodstock collection zones	Broodstock collection zones to be established under FMS. Policy requires broodstock to be sourced from area to be stocked (river stocking only)
Hatcheries	Narrandera Fisheries Centre (NFC) and Grafton Aquaculture Centre (GAC)
Production capacity	NFC capacity maximum 2,000,000 fry per season. 451,000 in 2002. GAC capacity approximately 500,000 per year. 509,000 in 2002,
Stocking rates	Large impoundments: stocked by NSW Fisheries on average every two years. Rates will dependent on production capacity and appropriate stocking density. Rivers: stocked as a conservation measure where necessary
Stocking methods	Stock transported in tankers to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Nil. Conditions in impoundments not suitable for breeding Regulated rivers: Medium. Unregulated rivers: High. The species is endemic to the zone and may complete the breeding cycle (other than in the eastern drainage)

Trout cod

Waters to be stocked	Upper reaches on the Macquarie, Murrumbidgee and Murray rivers and their tributaries
Conservation status	Schedule 4 of the FM Act; Endangered IUCN
Protection status	Protected from fishing under section 19 of the FM Act
Translocation status	This species will not be translocated outside its natural range
Stocking programs	Conservation Stocking by NSW Fisheries pending implementation of recovery plan
Broodstock collection zones	No broodstock collection zones - stock collected from known wild populations
Hatcheries	Narrandera Fisheries Centre (NFC)
Production capacity	NFC capacity maximum 129,000 fry per year. 17,000 in 2002.
Stocking rates	Subject to availability of stock and as determined under recovery plan
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings
Likelihood of establishing self sustaining populations	Medium - low. There has been little to no evidence of the species establishing self-sustaining populations despite extensive stocking for 15 years

Macquarie perch

Waters to be stocked	Macintyre, upper Murray, Murrumbidgee, Hawkesbury, Lachlan and Shoalhaven rivers and their tributaries
Conservation status	Schedule 5 of the FM Act; Endangered IUCN
Protection status	Protected from fishing under section 19 of the FM Act
Translocation status	This species will not be translocated outside its natural range
Stocking programs	Conservation Stocking by NSW Fisheries pending implementation of recovery plan
Broodstock collection zones	No broodstock collection zones - stock collected from known wild populations.
Hatcheries	Narrandera Fisheries Centre (NFC), although not producing this species at present Private Hatcheries
Production capacity	Private hatchery production not quantifiable
Stocking rates	Subject to availability of stock and as determined under recovery plan
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings
Likelihood of establishing self sustaining populations	High

Salmonid species

Atlantic salmon

Waters to be stocked	Suitable waters (dams and rivers) with a temperature range between 5° to 25°
Protection status	Protected from commercial fishing under section 20 of the FM Act
Stocking programs	NSW Fisheries Salmonid Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	No broodstock collection zones - broodstock held on-site at Gaden Trout Hatchery
Hatcheries	Gaden Trout Hatchery
Production capacity	Capacity not determined. 463,000 produced in 2002.
Stocking rates	Subject to availability of stock and allocation procedures
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Nil. Atlantic salmon is an anadromous species requiring passage to the sea to complete the breeding cycle. Rivers: Low. Species would need to traverse temperature ranges exceeding their tolerance to reach ocean waters

Brook trout

Waters to be stocked	Suitable waters (dams and some rivers) with a temperature range between 5° to 25°
Protection status	Protected from commercial fishing under section 20 of the FM Act
Stocking programs	NSW Fisheries Salmonid Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	No broodstock collection zones - broodstock held on hand at the Gaden Hatchery
Hatcheries	Gaden Trout Hatchery
Production capacity	Capacity not determined. 110,500 produced in 2002.
Stocking rates	Subject to availability of stock and allocation processes
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: Low. Brook trout need cold running streams to complete the breeding cycle but may breed in the headwaters of impoundments Rivers: Low. Evidence has shown that very few if any brook trout have established self-sustaining populations in NSW

Brown trout

Waters to be stocked	Suitable waters (dams and some rivers) with a temperature range between 5° to 25°
Protection status	Protected from commercial fishing under section 20 of the FM Act
Stocking programs	NSW Fisheries Salmonid Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	No broodstock collection zones - stock collected from known wild populations
Hatcheries	Gaden Trout Hatchery Dutton Trout Hatchery Private Hatcheries
Production capacity	Government Hatchery capacity not determined, 692,000 produced in 2002. private hatchery production capacity not determined
Stocking rates	Subject to availability of stock and allocation processes
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: High. Brown trout have shown the ability to develop self-sustaining populations in any area offering suitable habitat requirements following stocking Rivers: High (as above)

Rainbow trout

Waters to be stocked	Suitable waters (dams and some rivers) with a temperature range between 5° to 25°
Protection status	Protected from commercial fishing under section 20 of the FM Act
Stocking programs	NSW Fisheries Salmonid Stocking Program Applications for private stocking under s. 216 of the Act
Broodstock collection zones	No broodstock collection zones - stock collected from known wild populations
Hatcheries	Gaden Trout Hatchery Dutton Trout Hatchery Private Hatcheries
Production capacity	Government Hatchery capacity not determined, 2,040,000 produced in 2002. private hatchery production capacity not determined
Stocking rates	Subject to availability of stock and allocation procedures
Stocking methods	Stock transported by tanker to designated area. Broadcast stocking of fry or fingerlings or single point release
Likelihood of establishing self sustaining populations	Impoundments: High. Rainbow trout have shown the ability to develop self-sustaining populations in any area with suitable habitat requirements Rivers: High (as above)

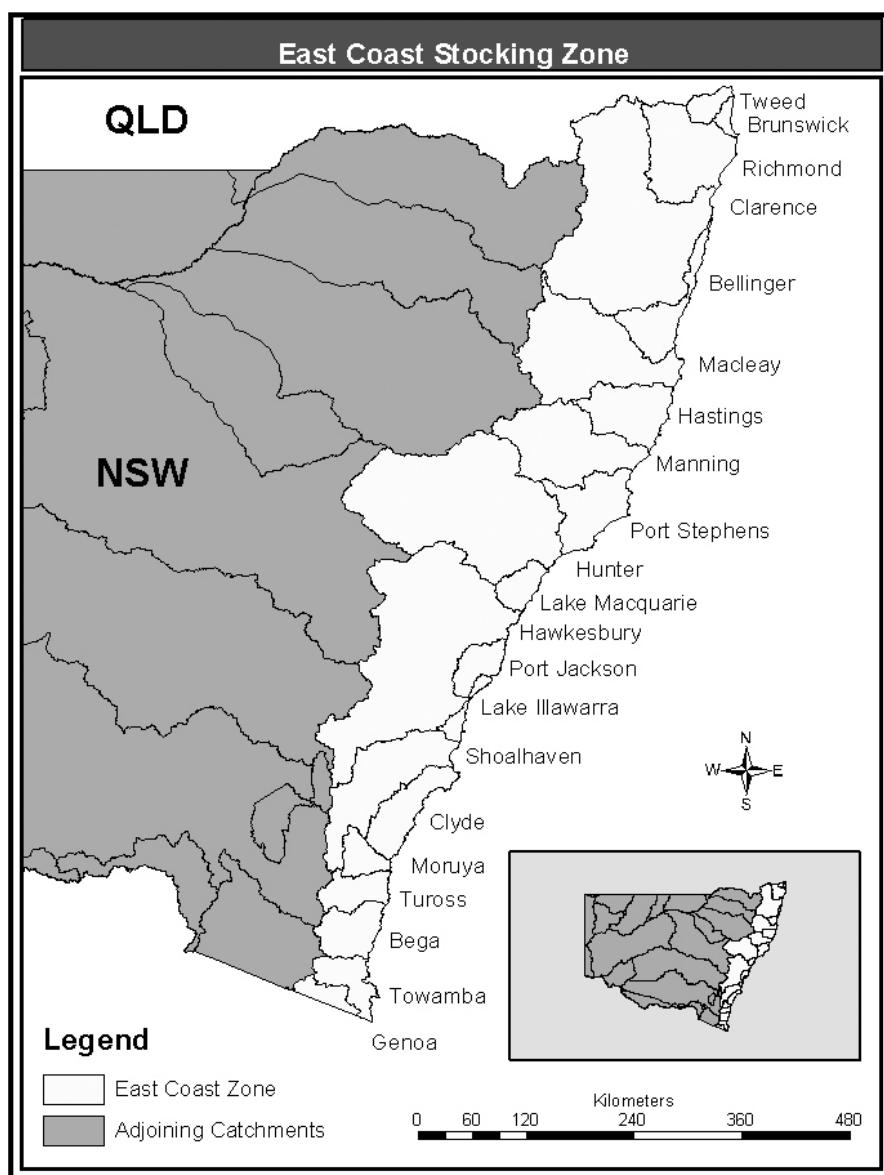
FMS Appendix 3. Proposed stocking zones

The following sections describe the activities that may take place in each of the stocking zones under the FMS. The stocking events within each stocking zone are subject to the controls outlined in Tables D3, D4 and D5 and the details provided in the following sections.

FMS Appendix 3.1 The East Coast Stocking Zone

Area of the zone

The East Coast Stocking Zone encompasses the eastern seaboard, commencing at the Queensland border and includes all coastal catchments south to the Victorian border and west to the western extremity of the nominated catchments (Appendix Figure 1 - for brevity, not every river catchment has been listed, rather they have been encompassed within other river basins, e.g. Nambucca lies within Bellinger basin). Note: The Montane Zone overlaps certain areas of this zone and salmonid species stocked in the Montane Zone are considered in that stocking zone's program.



Appendix Figure 1. Catchments within the East Coast Stocking Zone.

Objectives of the stocking activity within the zone

Stocking will be carried out to service *Harvest Stocking* and *Conservation Stocking* objectives. Specific objectives for stocking within the zone include:

- providing adequate quantities of quality stocks of native species (Australian bass, golden perch, silver perch) to provide and enhance excellent freshwater recreational fishing opportunities
- providing adequate quantities of quality stock of eastern cod to support the Conservation Stocking of that species
- providing a service for one-off stocking proposals by organisations or individuals, and
- protecting existing naturally occurring populations of the above species.

Waters to be stocked

Stocking can occur in any suitable waters in each catchment of the zone, subject to the general provisions of this FMS and the stocking review process.

Species to be stocked

Species nominated for stocking in this zone are Australian bass, golden perch and silver perch for *Harvest Stocking* and eastern freshwater cod for *Conservation Stocking*. Other native species of the eastern drainage such as Macquarie perch (eastern strain) may be considered subject to the provisions of the FMS or any threatened species recovery plan.

Appendix Table 1. Species permitted to be stocked in the East Coast Stocking Zone.

Species	Where	Purpose
Australian bass	Dams and rivers	Harvest Stocking
Golden perch	Hunter catchment only	Harvest Stocking
Silver perch	Hunter catchment only	Harvest Stocking
Eastern cod	Areas specified by Eastern Cod Recovery Plan	Conservation Stocking

Note: Salmonid species are considered in the Montane Zone Stocking Proposal.

Stocking programs

Appendix Table 2. Programs permitted in the East Coast Stocking Zone.

Program	Species	Released by
NSW Fisheries' Harvest Stocking Program*	Australian bass Golden perch** Silver perch**	NSW Fisheries or nominated volunteers
Dollar-for-Dollar Native Fish Stocking Program*	Australian bass	Angling Clubs and volunteers
Eastern Cod Conservation Stocking*	Eastern cod	Project Big Fish*** or NSW Fisheries
Private stocking event	Australian bass	Person(s) authorised by permit

*These programs are described in Chapter B of the EIS

**These species are stocked into the Hunter Catchment only in this zone

***Project Big Fish is a community-based stocking group engaged in the Eastern Cod Recovery Plan.

Stock production

The production of stock in NSW will be carried out by accredited hatcheries only and produced in-line with the Broodstock Collection Policy and Genetic Resource Guidelines for hatcheries. Where stock is sourced from an interstate hatchery, the Senior Manager conducting the review may require the proponent to provide further information on the source of stock.

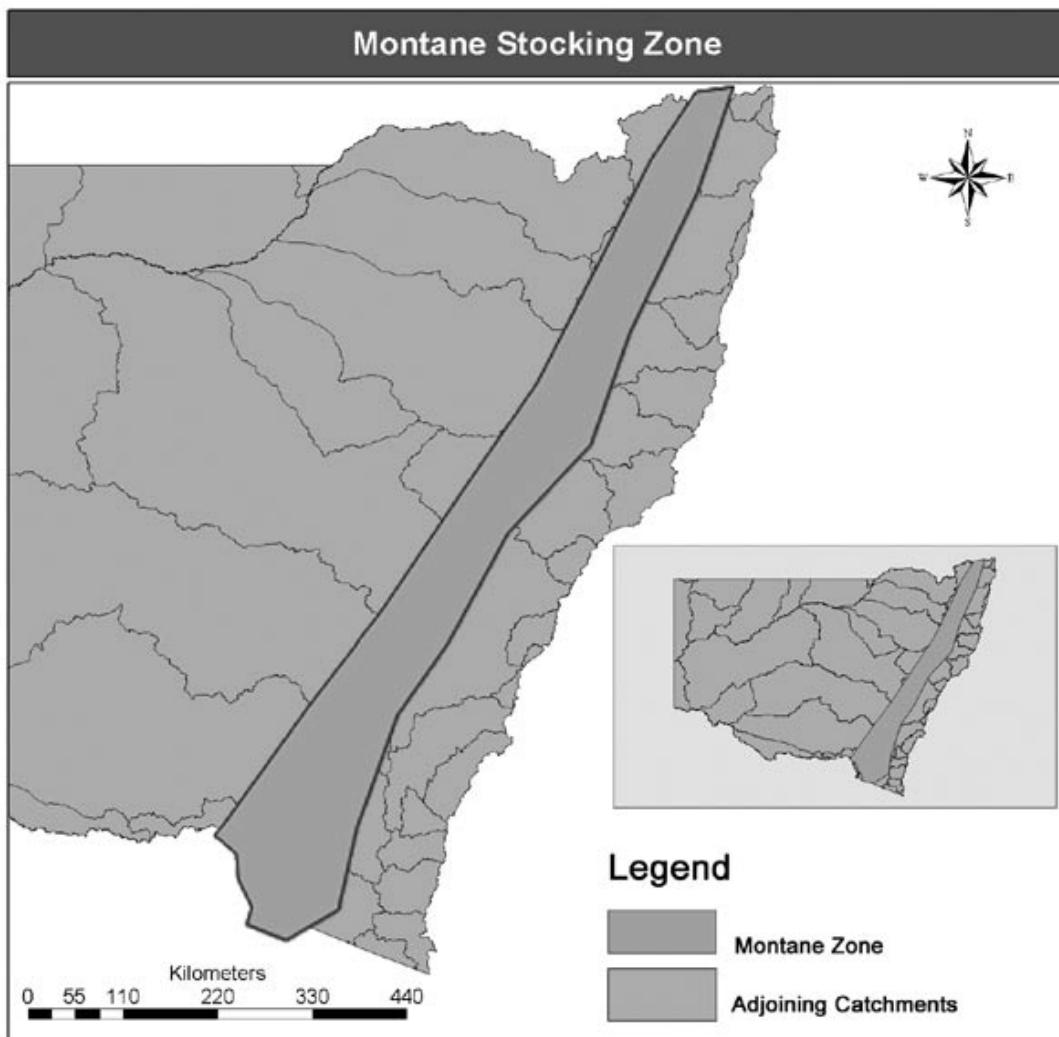
Threatened species management

Certain areas within the East Coast Zone will not be stocked with fish so as to minimise any effects of stocking on listed threatened species residing within the zone (refer to Tables D4 and D5). Other conditions may be imposed on the activity during the stocking review process if they are considered necessary for threatened species management.

FMS Appendix 3.2 The Montane Stocking Zone

Area of the zone

The Montane Stocking Zone encompasses the area with an elevation generally between 700 and 1500 metres ASL or where water temperatures range between 5°C and 25°C. The zone traverses along the Great Dividing Range of NSW between the Queensland and Victorian state borders (Appendix Figure 2). Note: The Montane Stocking Zone overlaps certain areas of catchments within other zones, however, the Montane Zone relates only to salmonid species stocked within those zones.



Appendix Figure 2. Approximate area of the Montane Stocking Zone.

Objectives of the stocking activity within the zone

Stocking will be carried out to service *Harvest Stocking* objectives as defined in the FMS (see salmonid stocking policy in section D3). Specific objectives for stocking within the zone include:

- providing adequate quantities of quality stocks of salmonid species to provide and enhance excellent freshwater recreational fishing opportunities
- providing a service for one-off stocking proposals by organisations or individuals, and

- protecting existing naturally occurring populations of species in areas such as pristine alpine habitats.

Species and waters to be stocked

All waters within the zone can be stocked with Atlantic salmon, brook trout, brown trout and rainbow trout, subject to the general provisions of this FMS and the stocking review process.

Appendix Table 3. Species and general locations permitted to be stocked in the Montane Stocking Zone.

Species	Where
Atlantic salmon	Dams, lakes and rivers historically stocked with this species (see stocking records in Chapter B). Predominantly, Lake Jindabyne, Burrinjuck Dam and Khancoban Pondage.
Brook trout	Dams, lakes and rivers historically stocked with this species (see stocking records in Chapter B). Predominantly, stocking will occur in Lake Jindabyne, Three Mile Dam at Kiandra, Dry Dam and streams including the Moonbah River.
Brown trout	Dams, lakes and rivers historically stocked with this species (see stocking records in Chapter B), except Lake Jindabyne and Lake Eucumbene (see following section on programs making up the activity).
Rainbow trout	Dams, lakes and rivers historically stocked with this species except Tantangara Reserve (see stocking records in Chapter B).

Stocking programs

Appendix Table 4. Programs permitted in the Montane Stocking Zone.

Program	Species	Released by
NSW Fisheries' Trout Stocking Program*	Salmonids (see Table 3 above)	NSW Fisheries, acclimatisation societies and/or nominated volunteers
Snowy Mountains Trout Strategy <i>Lake Eucumbene</i> <i>Lake Jindabyne</i>	Atlantic salmon (Lake Jindabyne only), brook trout and rainbow trout	NSW Fisheries (With some use of volunteers)
Private stocking applications	Australian bass	Person(s) authorised by permit

*These programs are described in Chapter B of the EIS.

Stock production

The production of stock in NSW will be carried out by accredited facilities only and produced in-line with this FMS. Where stock is sourced from an interstate hatchery, the Senior Manager conducting the review may require the proponent to provide further information on the source of stock.

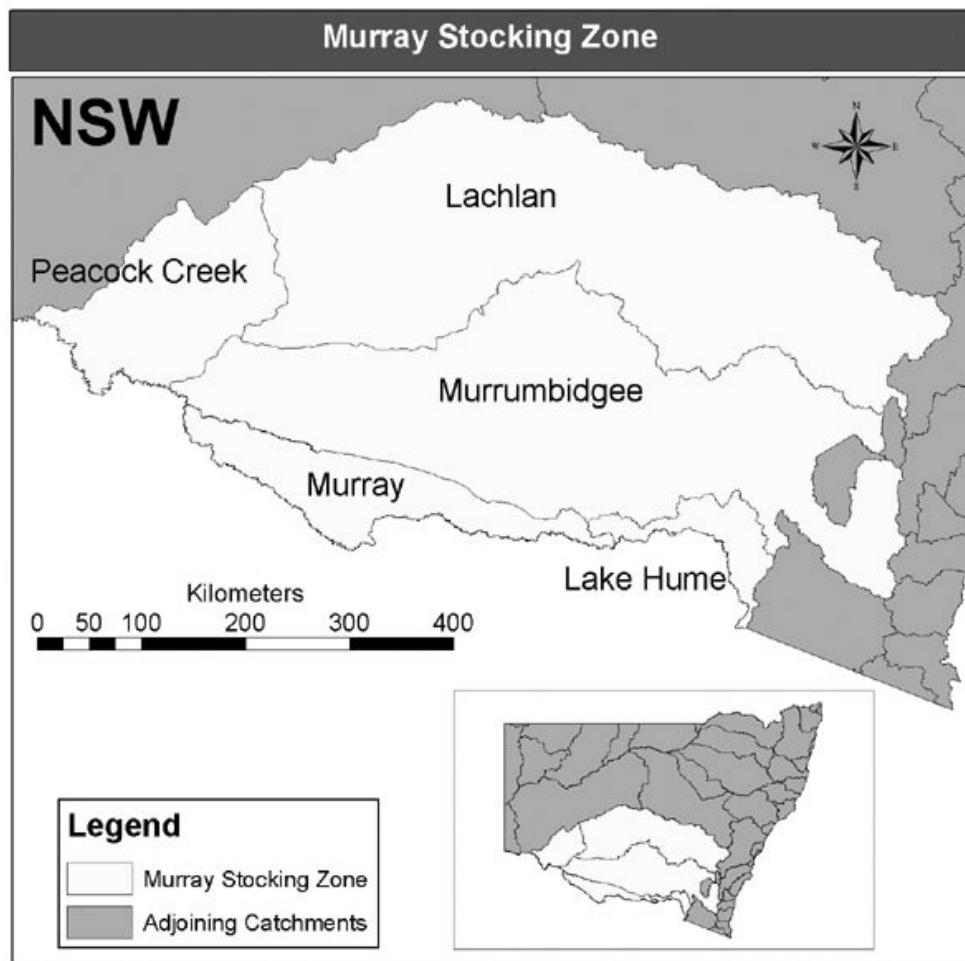
Threatened species management

Certain areas within the Montane Coast Zone will not be stocked with fish so as to minimise any effects of stocking on listed threatened species residing within the Zone (refer to Tables D4 and D5). Other conditions may be imposed on the activity during the stocking review process if they are considered necessary for threatened species management.

FMS Appendix 3.3 The Murray Stocking Zone

Area of the zone

The Murray Stocking Zone encompasses an area including the Peacock Creek, Lachlan, Murrumbidgee (excluding reaches within the ACT), Murray and Lake Hume catchments (Appendix Figure 3). Note: The Montane Zone overlaps certain areas of this zone and salmonid species stocked in the Montane Zone are considered in that stocking zone's program.



Appendix Figure 3. Catchments within the Murray Stocking Zone.

Objectives of the stocking activity within the zone

Stocking will be carried out to service *Harvest Stocking* and *Conservation Stocking* objectives as defined in the FMS. Specific objectives for stocking within the zone include:

- providing adequate quantities of quality stocks of native species (golden perch, silver perch, Murray cod) to provide and enhance excellent freshwater recreational fishing opportunities
- providing adequate quantities of quality stock of trout cod and Macquarie perch to support the Conservation Stocking of those species
- providing a service for one-off stocking proposals by organisations or individuals, and
- protecting existing naturally occurring populations of the above species.

Waters to be stocked

Stocking can occur in any suitable waters of the zone including public water storage areas, creeks and rivers, subject to the general provisions of this FMS and the stocking review process.

Species to be stocked

Species used for stocking will be restricted to native species of the western drainage of NSW (Appendix Table 5).

Appendix Table 5. Species permitted to be stocked in the Murray Stocking Zone.

Species	Where	Purpose
Golden perch	Dams and rivers	Harvest Stocking
Macquarie perch	TBA (no programs established yet)	Conservation Stocking
Murray cod	Dams and rivers	Harvest Stocking
Silver perch	Dams and rivers	Conservation Stocking Harvest Stocking
Trout cod	Rivers	Conservation Stocking

Note: It is proposed to use golden perch, silver perch (in dams only) and Murray cod for Harvest Stocking; and trout cod, Macquarie perch, and silver perch (in rivers) for Conservation Stocking. Other native species of the western drainage may be considered subject to the general provisions of the FMS.

Stocking programs

Appendix Table 6. Harvest Stocking programs permitted in the Murray Stocking Zone.

Program	Species	Released by
NSW Fisheries' Harvest Stocking Program*	Golden perch, Murray cod	NSW Fisheries
Dollar-for-Dollar Native Fish Stocking Program*	Golden perch, Murray cod	Angling Clubs
Private stocking applications	Golden perch, Murray cod	Person(s) authorised by permit

*Note: Stocking of Murray cod and golden perch into the Lower Murray River Catchment will be carried out in accordance with recommendation 17 of the Lower Murray Species Impact Statement whereby rivers will be stocked with Murray cod and golden perch in small numbers into rivers so as to ensure that overstocking will not result in artificially bred fish dominating the area while larger releases of these species are proposed in major water storages and lakes to alleviate pressure on stocks from recreational fishing.

Stock production

The production of stock in NSW will be carried out by accredited facilities only and produced in-line with the FMS. Where stock is sourced from an interstate hatchery, the Senior Manager conducting the review may require the proponent to provide further information on the source of stock.

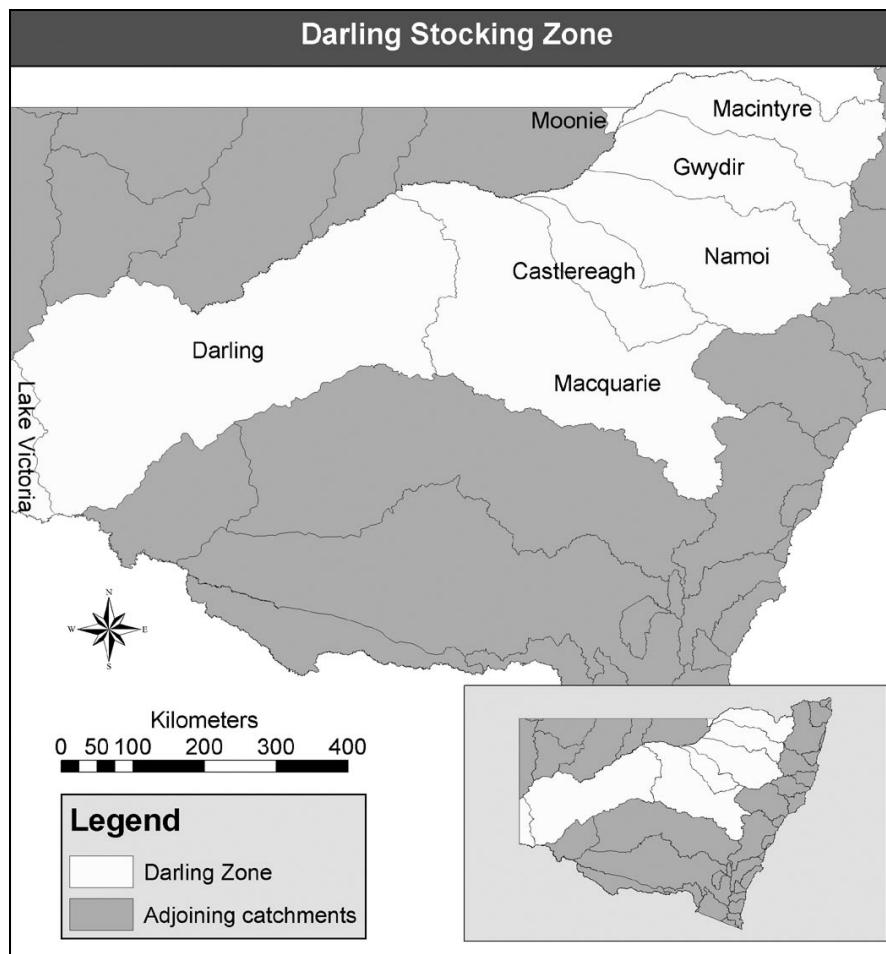
Threatened species management

Certain areas within the Murray Stocking Zone will not be stocked with fish so as to minimise any effects of stocking on listed threatened species residing within the Zone (refer to Tables D4 and D5). Other conditions may be imposed on the activity during the stocking review process if they are considered necessary for threatened species management.

FMS Appendix 3.4 The Darling Stocking Zone

Area of the zone

The Darling Stocking Zone encompasses an area including the Darling, Macquarie, Castlereagh, Namoi, Gwydir, Macintyre, Moonie and Lake Victoria catchments within NSW (Appendix Figure 4). Note: The Montane Zone overlaps certain areas of this zone and salmonid species stocked in the Montane Zone are considered in that stocking zone's program.



Appendix Figure 4. Catchments within the Darling Stocking Zone.

Objectives of the stocking activity within the zone

Stocking will be carried out to service *Harvest Stocking* and *Conservation Stocking* objectives as defined in the FMS. Specific objectives for stocking within the zone include:

- providing adequate quantities of quality stocks of native species (golden perch, silver perch, Murray cod) to provide and enhance excellent freshwater recreational fishing opportunities
- providing adequate quantities of quality stock of silver perch and Macquarie perch to support the Conservation Stocking of those species
- providing a service for one-off stocking proposals by organisations or individuals, and
- protecting existing naturally occurring populations of the above species.

Waters to be stocked

Stocking can occur in any suitable waters of the zone including public water storage areas, creeks and rivers, subject to the general provisions of this FMS and the stocking review process.

Species to be stocked

It is proposed to use golden perch, silver perch (in dams only) and Murray cod for Harvest Stocking; and trout cod, Macquarie perch, and silver perch (in rivers) for Conservation Stocking. Other native species of the western drainage may be considered for stocking subject to the provisions of the FMS and the stocking review process.

Appendix Table 7. Species permitted to be stocked in the Darling Stocking Zone.

Species	Where	Purpose
Golden perch	Dams and rivers	Harvest Stocking
Macquarie perch	(No programs established yet)	Conservation Stocking
Murray cod	Dams and rivers	Harvest Stocking
Silver perch	Dams and rivers	Conservation Stocking and Harvest Stocking
Trout cod	Rivers	Conservation Stocking

Stocking programs

Appendix Table 8. Harvest Stocking programs permitted in the Darling Stocking Zone.

Program	Species	Released by
NSW Fisheries' Harvest Stocking Program*	Golden perch, Murray cod	NSW Fisheries
Dollar-for-Dollar Native Fish Stocking Program*	Golden perch, Murray cod	Angling Clubs
Private stocking applications	Golden perch, Murray cod	Person(s) authorised by permit

* Note: these programs are described in Chapter B of the EIS.

Appendix Table 9. Conservation stocking programs permitted in the Darling Stocking Zone.

Program	Species	Released by
Macquarie Perch Conservation Stocking	Macquarie perch	NSW Fisheries
Silver Perch Conservation Stocking	Silver perch	NSW Fisheries
Trout Cod Conservation Stocking	Trout cod	NSW Fisheries

Stock production

The production of stock in NSW will be carried out by accredited facilities only and produced in-line with the NSW Fisheries' Broodstock Collection Policy and genetic resource guidelines for hatcheries to be established under the FMS. Where stock is to be sourced from an interstate hatchery, or where conservation stock is to be sourced from a private hatchery, the Senior Manager conducting the review may require the proponent to provide further information on the source of stock to allow for a thorough assessment.

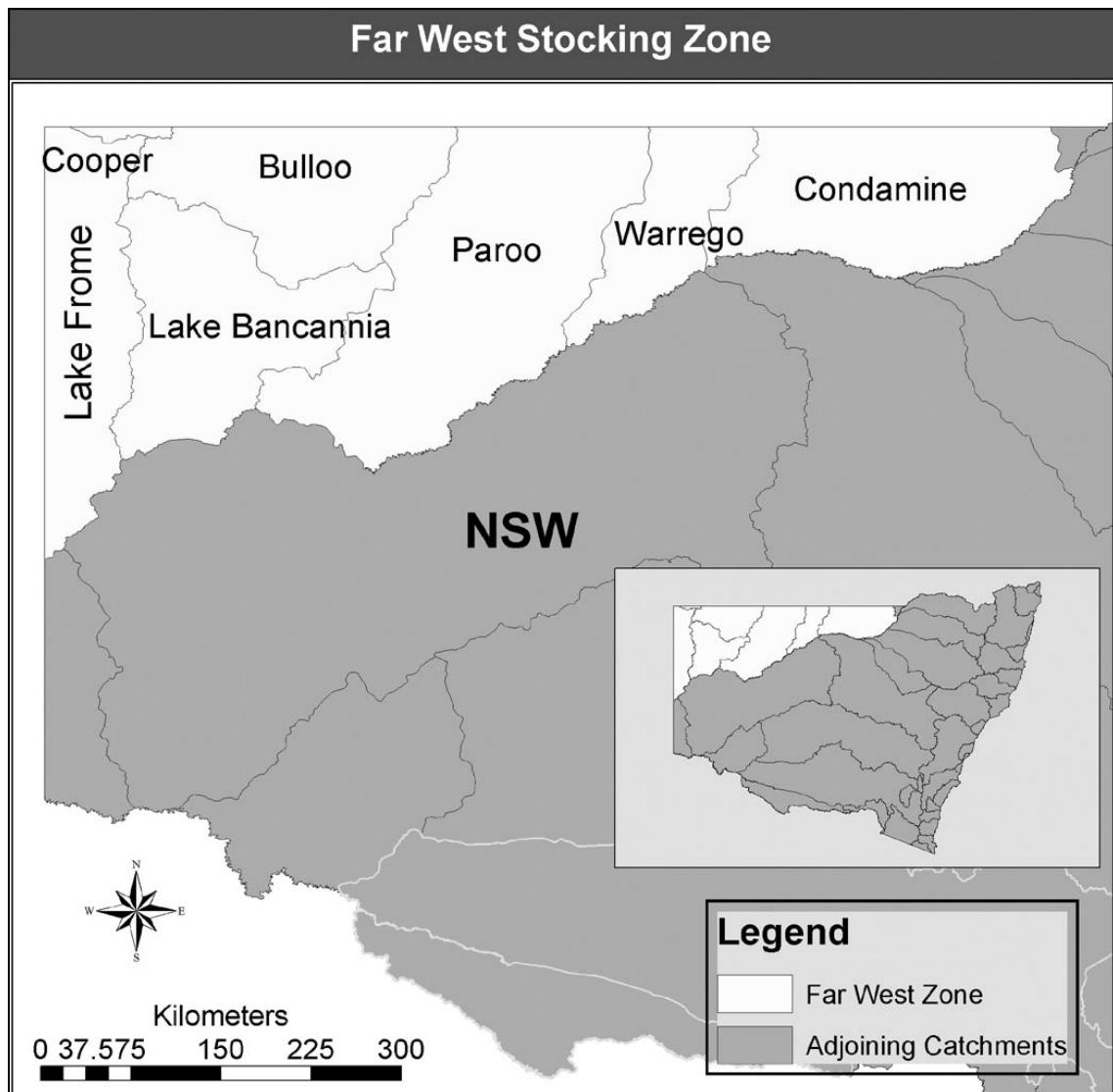
Threatened species management

Certain areas within the Darling Stocking Zone will not be stocked with fish as they are thought to contain unique faunal assemblages and/or to minimise any effects of stocking on listed threatened species residing within the Zone (refer to Tables D4 and D5). Other conditions may be imposed on the activity during the stocking review process if they are considered necessary for threatened species management.

FMS Appendix 3.5 The Far West Stocking Zone

Area of the zone

The Far West Stocking Zone encompasses an area including the Bulloo, Lake Frome, Cooper, Lake Bancannia, Paroo, Warrego, and Condamine catchments (Appendix Figure 5).



Appendix Figure 5. Catchments of the Far West Stocking Zone

Objectives of the stocking activity within the zone

Fish will not be stocked into the Far West Stocking Zone as these areas have not previously been stocked and cover environments with unique environmental attributes.

FMS Appendix 4. Implementation tables for management responses for Fish Stocking.

The following implementation tables outline the time periods within which each management response is to be implemented. The table also provides information relating to the head of power for implementation and who has the lead responsibility for carrying out the action(s). A general description of the terms used in the table with respect to timeframes is as follows:

Term	Description
Immediate	Upon the date of approval of the strategy
Short term	Within 1 year of the date of approval of the strategy
Medium term	Within 3 years of the date of approval of the strategy
Long term	In excess of 3 years of the date of approval of the strategy
As required	Whenever the circumstances warrant action
Ongoing	Continuing into the future

Where an implementation date (e.g. a particular month) has been included for a management response instead of the terms above, the date represents a specific target time within which the management response is to be implemented.

Goal 1. To manage the activity in a manner that minimises impacts on aquatic biodiversity including threatened species and genetic resources

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
1.1 To develop and maintain a framework to guide appropriate review of stocking activities	<ul style="list-style-type: none"> a) Utilise “Stocking Review Guidelines” for the ongoing assessment of stocking events b) Use reliable and current information resources to support the stocking review framework c) Map the activity in a Geographic Information System (GIS) d) Implement a schedule of restricted waters where stocking events are limited or prohibited, and review the schedule every five years in light of new information 	2,3,4,5 2,3,4,5 2,3,4,5 2,3,4,5	Ongoing Ongoing Medium term Immediate	NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries	Policy Policy - Regulatory	305 305 305 306
1.2 To minimise and/or eliminate any negative impact from the activity on threatened species, populations and ecological communities (including mammals, birds, reptiles, amphibians, fish, invertebrates and vegetation), and where possible promote their recovery	<ul style="list-style-type: none"> a) Appropriately manage stocking in areas where the activity may adversely affect a threatened species b) Maintain and improve the management of Conservation Stocking programs to promote the recovery of species that are threatened or of conservation concern 	5 3,4	Ongoing Ongoing	NSW Fisheries NSW Fisheries	Policy Policy	306 306
1.3 To provide reliable genetic resource management in the activity	a) Develop and implement genetic resource management guidelines for fish stocking in NSW	2,3,4,5	Short term	NSW Fisheries Fish hatcheries	Policy	306
1.4 To implement the FMS in a manner consistent with related Commonwealth and State endorsed programs designed to protect aquatic environments and biodiversity	<ul style="list-style-type: none"> a) Manage the activity having regard to cross-jurisdictional management arrangements b) Recognise and where appropriate incorporate regionally based environmental management arrangements in the stocking review framework 	2,3,4,5,6 2,3,4,5,6	Ongoing Ongoing	NSW Fisheries NSW Fisheries	- Policy	307 308
1.5 To appropriately manage the risks associated with translocation of live aquatic organisms during stocking activities	a) Manage the activity consistently with State and national policies governing the translocation of live aquatic organisms	2,3,4,5,6	Ongoing	NSW Fisheries	Policy	308

Goal 2. To enhance fishing opportunities through cost-effective stocking programs that maximise economic benefits and provide social equity from the activity for recreational fishing and Aboriginal cultural fishing purposes

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
2.1 To provide sufficient quantities of quality stock to support enhanced recreational fisheries	<ul style="list-style-type: none"> a) Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities in inland rivers and freshwater public waterways b) Recognise region-specific fishery management arrangements where appropriate, such as the Snowy Lakes Trout Strategy c) Broaden the consultation with acclimatisation societies and angling clubs to formulate and implement stocking programs with a view to providing greater equity, access and education about the resource 	3,4	Ongoing	NSW Fisheries	-	309
2.2 To minimise any negative impacts of the activity on cultural heritage values and provide opportunities for Aboriginal communities to participate in stocking activities and to support cultural fishing practices	<ul style="list-style-type: none"> a) Provide for the stocking of native fish for Aboriginal cultural fishing and moiety purposes b) Ensure that new information about areas or objects of cultural significance is taken into account in the stocking review framework c) Consult with relevant Aboriginal groups in the assessment of any new sites proposed to be stocked 	1,3,4,5,6	Ongoing	NSW Fisheries, stockists	Policy	310
2.3 Maximise economic benefits and provide social equity from the activity	<ul style="list-style-type: none"> a) Develop a classification scheme for NSW waters to evaluate the potential viability of a stocking event based on the most appropriate species, class of stock for particular waters b) Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity c) Continue to provide opportunities for religious and ceremonial stocking and increase awareness of the legislative and policy requirements with the groups involved 	1,3,4,5,6	Long term	NSW Fisheries	Policy	310
		1,3,4,5	Ongoing	NSW Fisheries	Policy	311

Goal 3. To ensure the consistent production and release of appropriate quality stock

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
3.1 Ensure stock is of the highest standard in terms of fish health	<ul style="list-style-type: none"> a) Develop and implement quality assurance standards and an accreditation system for hatcheries supplying fish for stocking b) Ensure that stock produced in interstate hatcheries meets quality assurance standards c) Participate in the development of FLSHPLAN, the NSW component of AQUAVETPLAN d) Link the fish stocking activity to the Aquatic Disease Watch Hotline to enable early reporting of disease outbreaks 	1,2,6 1,2,4,6 1,2 1,2	Medium term Ongoing As required Short term	NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries	Regulatory Regulatory - Regulatory	312 312 313 313
3.2 To promote the use of appropriate technology for genetic resource management in all hatcheries involved in the activity	<ul style="list-style-type: none"> a) Promote the use of appropriate technology in genetic resource management b) Require, where necessary, the mandatory use of microchip technology (PIT-tag system) in broodstock management arrangements c) Investigate the feasibility of developing a cryogenic gene bank of NSW species to ensure the retention of genetic material for Harvest Stocking and Conservation Stocking programs 	4,2 1,2,4,5,6 1,5	Short term Medium term Medium term	NSW Fisheries NSW Fisheries NSW Fisheries	- Regulatory -	313 313 313
3.3 Implement best practice in broodstock collection and management	<ul style="list-style-type: none"> a) Develop a broodstock policy and guidelines that address collection, husbandry and management arrangements for hatcheries engaged in the activity b) Integrate broodstock collection information with the NSW Aquaculture Information Database c) Continue to provide for the issue of permits under section 37 of the <i>Fisheries Management Act 1994</i> for broodstock collection purposes consistent with the vision and goals of the FMS 	1,2,5,6 1,2,4,5,6 1,2,5,6	Medium term Short term Ongoing	NSW Fisheries NSW Fisheries NSW Fisheries	Policy - Regulatory	314 314 314
3.4 Implement best practice in broodstock collection and management	<ul style="list-style-type: none"> a) Develop a stocking code of conduct that defines and promotes best-practice b) Issue a copy of the code of conduct to each stockist before a stocking event proceeds 	1,2,4,5,6 1,2,4,5,6	Short term Short term	NSW Fisheries NSW Fisheries	Various Various	315 315

Goal 4. To provide efficient administrative services, information management and reporting systems						
OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
4.1 To provide a clear administrative framework for reviewing stocking events	<ul style="list-style-type: none"> a) Develop stocking event forms in plain English b) Develop a policy and procedures manual for NSW Fisheries' staff c) Widely distribute advisory material on stocking policy and procedures in NSW d) Develop interactive self-assessment and education resource e) Provide an efficient enquiry/advisory service for the activity f) Provide stocking data to other information resources 	<ul style="list-style-type: none"> 1,2,3,5,6 1,2,3,5,6 2,5 1,2,3,5,6 1,2,3,5,6 	<ul style="list-style-type: none"> Short term Short term Medium term Ongoing Ongoing 	<ul style="list-style-type: none"> NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries 	<ul style="list-style-type: none"> - Policy - - - 	<ul style="list-style-type: none"> 316 316 316 316 317
4.2 To maintain and report accurate information relating to the activity	<ul style="list-style-type: none"> a) Maintain records of all stocking events centrally b) Periodically report on the activity to clients and stakeholders c) Require hatcheries to report annually on production and other factors relevant to the activity d) Conduct client satisfaction surveys e) Provide advice to stocking volunteers on appropriate stocking methods, legal implications and other information 	<ul style="list-style-type: none"> 1,2,5 1,2,3,5 2,5 2,6 2,6 	<ul style="list-style-type: none"> Short term - ongoing Biennially Short term - ongoing Medium term - ongoing Medium term - ongoing 	<ul style="list-style-type: none"> NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries 	<ul style="list-style-type: none"> - - - Regulatory - 	<ul style="list-style-type: none"> 317 317 317 318 318

Goal 5. To provide efficient administrative services, information management and reporting systems

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
5.1 To initiate research relating to the activity	<p>a) Facilitate research programs to fill information gaps identified in the risk assessment of the existing activity, as provided for in the Research Plan</p> <p>b) Publish results of research programs</p>	1,2,3,4 2,4,6	Short term Ongoing	NSW Fisheries NSW Fisheries	- -	319 319
5.2 To monitor quality and quantity of catches in enhanced fisheries	<p>a) Develop reliable marking techniques for hatchery reared stock and introduce the technology to all hatcheries involved in the activity</p> <p>b) Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity</p> <p>c) Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis</p> <p>d) Monitor the level of participation in fish stocking using information gathered through the general recreational fishing licensing system and other appropriate avenues</p>	1,2,3,6 2,3,6 2,3 2,3,6	Long term Ongoing As required Ongoing	NSW Fisheries NSW Fisheries NSW Fisheries NSW Fisheries	Various - - -	319 320 320 320
5.3 Use research to develop better stocking practices	<p>a) Having regard to the research priorities identified in the Research Plan, initiate research into the distribution of stocked native species, including any sub-populations</p> <p>b) Apply empirical methods to determine optimum stocking density rates (in terms of efficacy and effectiveness), and assess the feasibility of developing and applying an established formulae in the longer term</p> <p>c) Continually update the Stocking Review Guidelines and assessment resources to accurately review potential impacts from the activity</p>	1,2,3,4,6 1,2,3,4,6 1,2,3,4,6	Long term Long term Ongoing	NSW Fisheries NSW Fisheries NSW Fisheries	- - Policy	320 321 321

Goal 6. To maximise community understanding and voluntary compliance through education and support services while providing effective deterrence against illegal activity						
OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTE TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY	PAGE
6.1 To improve community understanding and public perception of the activity through an education strategy	<ul style="list-style-type: none"> a) Develop and implement a culturally appropriate educational (communication) plan b) Develop an information kit for NSW Fisheries staff to convey accurate information on fish stocking to clients 	1,2,3,4,5	Medium term	NSW Fisheries	Policy	322
6.2 To develop and deliver an effective compliance program	<ul style="list-style-type: none"> a) Develop a Fish Stocking Compliance Plan b) Require persons involved in stocking to verify stocking events when complete 	<ul style="list-style-type: none"> 1,2,3,4,5 1,2,3,4,5 	<ul style="list-style-type: none"> Medium term Short term - ongoing 	<ul style="list-style-type: none"> NSW Fisheries NSW Fisheries 	<ul style="list-style-type: none"> Policy Regulatory 	<ul style="list-style-type: none"> 323 323

CHAPTER E ASSESSMENT OF THE IMPLICATIONS OF THE DRAFT FMS

The purpose of this chapter is to determine the extents to which the draft FMS has averted or mitigated the medium and high risk issues that were identified in Chapter B. Like the analysis of the potential risks in Chapter B, the lack of data means that the following assessments of risk mitigation are also qualitative. As was described in the risk management framework adopted in Chapter B, this chapter is a theoretical appraisal of the measures proposed in the draft FMS. There are currently no measurable baselines against which a change due to the draft FMS could be measured. It is during the implementation phase of the FMS that data will be gathered, via research and monitoring, against which a more quantitative assessment will be possible. Wherever deficiencies are highlighted in the draft FMS, recommendations will be made to more appropriately address the risks or concerns.

E1 Implications of the Draft FMS for Threatened or Protected Species

E1.1 Ability of the draft FMS to mitigate risks for threatened or protected species

The draft FMS includes several measures that would provide, directly or indirectly, for the protection of listed threatened and protected species. These include specific policies or actions relating to stocking, schedules of waters permanently (Table D4) and temporarily (Table D5) closed to stocking, the Stocking Review Guidelines for evaluating stocking proposals, and management goals with associated performance indicators and trigger points designed to identify areas where management is not meeting those goals. Several of these measures represent a continuation of existing policies, while some are new initiatives. The measures, their effectiveness, and the likely change to risks to threatened species under the draft FMS are discussed below. Table E1 provides a summary of how risks to the threatened species identified as being at medium or greater risk have been addressed.

E1.1.1 Stocking policy

The stocking policy for programs proposed under the draft FMS (Chapter D3.1) contains statements that relate to threatened species conservation. Specifically, part D3.1.1.2 (3) states that “Salmonids will only be stocked where the official records held by NSW Fisheries indicate that stocking of salmonids has occurred in the waterway concerned (or section of waterway if barriers exist which could prevent the movement of fish) since 1990”.

The net effect of this policy will be that fewer waters are eligible for stocking under the proposed FMS than under current arrangements (i.e. the NSW Fisheries Introduction and Translocation Policy R94/1 [NSW Fisheries, 1994]). This policy is unlikely to affect the current distribution of salmonids in NSW, since any areas stocked before 1990 would contain salmonid species only if a self-sustaining population had become established (given that the lifespan of trout in NSW waters is less than 10 years). Areas currently free of salmonids should remain so under the FMS, and this policy may allow recovery of any species impacted by salmonids in areas that were stocked

prior to 1990 but where salmonids have not formed a self-sustaining population. No data is available on the number of such areas. This may contribute to the overall reduction of risk to threatened species, but it is difficult to quantify to what extent risk will be reduced. Some waters containing threatened species that are affected by this policy (i.e. waters that contain threatened species and have not been stocked since 1990) are outlined in Tables D4 and D5. Instances where particular species are affected by this policy are listed in Table E1.

The conservation stocking policy (D3.1.2) also provides for the stocking of native species for conservation purposes, either under an approved recovery plan, or where there is a justifiable need, or where it is required by other policies recognised by the FMS (e.g. NSW Coastal Policy and broodstock collection policy). This policy represents a continuation of the existing management arrangements and, therefore, does not alter the risks assigned to threatened species.

E1.1.2 Schedule of waters with restricted stocking

The schedules of waters permanently and temporarily closed to stocking (Tables D4 and D5) represent the most important initiatives in the FMS for the protection of threatened and protected species.

Permanently closed waters: The table of permanently closed waters specifically addresses one threatened species - the spotted tree frog. The risk to this species as identified in Chapter B is reduced by its inclusion in the table.

Temporarily closed waters: The risks to all remaining threatened and protected species identified in Chapter B as being at medium or greater risk are reduced under the FMS by their inclusion in Table D5 (restricted waters). Risks to some species are addressed directly by restrictions on particular waters, while others, such as the stuttering frog and freshwater crayfish (*Euastacus* species) are addressed indirectly through the restrictions on stocking in currently declared wilderness areas and world heritage areas, and waters not stocked with salmonids since 1990 (Table E1).

The restriction on stocking within 5km of known populations of threatened species is open to some criticism. No information exists, however, on the survival or movements of any of the fish species at the fry and fingerling stages that are stocked. Given the lack of knowledge about movement and survival of stocked fish, the 5km radius for exclusion of stocking around some threatened species is necessarily arbitrary. While it is almost certain that some fish would move further than 5km up- or downstream from where they are stocked, it is likely that dilution or thinning of the stock through mortality and natural variability in dispersal distances, would mean that the density of fish 5km from the stocking site will be orders of magnitude smaller than they were at the initial stocking site.

What is less clear is whether self-sustaining populations derived from stocked fish will:

- become established, and
- colonise areas beyond the original stocking site in subsequent years.

This latter scenario would depend on a number of factors (such as the suitability of the habitat beyond the stocking site, or the presence of barriers to movement e.g. waterfalls or weirs). The 5km limit on stocking near threatened species should therefore be seen as an interim measure in lieu of adequate knowledge, and research on the fate of stocked fish should be implemented as soon as is

practicable to rigorously determine a suitable buffer distance limit for stocking fish in waters containing threatened species. The draft FMS addresses this issue through the research plan, which will promote research into the movement of stocked fish, including a proposed ARC funded linkage-project to develop cost-effective marking techniques.

Table E1. Summary of changes under the draft FMS to the risks to threatened species at medium or greater risk under present management arrangements.

Species or population	Risk under current management		Risk under the draft FMS		Explanation for change
	Salmonids	Natives	Salmonids	Natives	
FM Act					
Murray hardyhead	L	H	L	L	Table D5: no stocking at site of known population (Bundidgerry Ck)
Macquarie perch	M	M	L-M	L-M	Table D5: no stocking of brown trout into Macquarie perch waters, Salmonid stocking policy: no stocking in waters not previously stocked (since 1990)
Southern pygmy perch	M	M-H	L-M	L-M	Table D5: no stocking w/in 5km of known populations
Australian grayling	M	M	L	L-M	Table D5: no stocking in south coast catchments except bass into impoundments
Western population of olive perchlet	L-M	M-H	L-M	L-M	Table D5: no stocking w/in 5km of known western drainage populations
Western population of purple-spotted gudgeon	M-H	M-H	L-M	L-M	Table D5: no stocking w/in 5km of known western drainage populations
Protected species					
<i>Euastacus</i> spp.	11 species from M to H	L	L or L-M	L	Incidental protection for species at risk due to wilderness/world heritage areas and partial protection by occurrence in waters not previously stocked
TSC Act					
Booroolong frog	H	L	L-M	L	Table D5: no stocking w/in 5km of known populations
Spotted tree frog	H	L	L-M	L	Table D4: no stocking at known site (Bogong Ck)
Giant barred frog	M-H	M	L-M	L-M	Table D5: no stocking w/in 5km of known populations
Peppered tree frog	H	L	L-M	L	Table D5: no stocking within 5km of known populations (none at present)
New England tree frog	H	L	L-M	L	Table D5: no stocking w/in 5km of known populations
Stuttering frog	M	L-M	L-M	L-M	Table D5: no stocking w/in 5km of known populations
Conservation concern					
Mountain galaxias	H	L	L-M	L	Southern centre of high diversity protected by measures for Kosciuszko NP, Northern centre of high diversity (southern Clarence catchment) partially protected by wilderness, and lack of previous stocking.
Murray jollytail	L-M	M	L	M	No recent sightings of this species - may need measures to protect populations discovered in future
Non-parasitic lamprey	L	M	L	L	Covered by provision not to stock southern catchments (except bass in impoundments)
Climbing galaxias	M	L	L	L	Partial protection by occurrence in waters not previously stocked
Darling River hardyhead	L	M	L	L	Table D5: no stocking w/in 5km of known populations

E1.1.3 New guidelines for the review of stocking proposals

A weakness of current management arrangements is the lack of assessment protocols for assessing stocking applications. To address this, a protocol for the review of stocking proposals has been developed in the draft FMS (D3.5.1.3, Stocking Review Guidelines), which ensures that the potential impacts of stocking on threatened species, populations and ecological communities are considered by the officer authorised to issue permits (includes referral to Threatened Species Unit). The stocking review guidelines are in three parts that consider (1) the stocking activity itself in relation to the FMS, (2) the translocation of pest organisms and diseases, and (3) local environmental issues, respectively. Parts 1 and 2 indirectly affect threatened species by ensuring that any event is broadly consistent with the FMS policies and that risks due to translocation are minimised, thereby reducing the risks to any threatened species present in the receiving environment from such sources. Part 3 considers local environmental issues, including threatened species issues. Threatened species are directly addressed in the following questions:

- 3.1. Is the nominated site subject to any management plan or action that would preclude stocking? If Yes, stocking cannot be authorised. Another area must be nominated.
- 3.2. Are any terrestrial threatened species recovery plans in force in the area?
- 3.3. Are any aquatic threatened species recovery plans in force in the area?
- 3.4. Is the recovery of a threatened species likely to be adversely impacted by the stocking event? If yes, stocking cannot be authorised. Event must be amended.
- 3.11. Is the release site either upstream or downstream of a barrier to fish passage where, according to official records, the species has not been previously stocked?

Question 3.11 takes into account the presence of barriers to fish movement such as waterfalls or weirs that could provide refuge to some threatened species in some sections of waterways (e.g. some threatened species may find refuge in the upper reaches of rivers above such barriers). Provided that the questions are answered using the best available knowledge and with appropriate application of the precautionary principle when information is lacking, the guidelines should reduce the risks to threatened species by preventing any stocking event that, according to the best available information, could adversely affect a threatened species. Joint assessment with an officer of the NSW Fisheries Threatened Species and Biodiversity Unit ensures expert input into the decision making process and thus provides further safeguards for threatened species. The Stocking Review Guidelines contribute generally to the reduction to risks to threatened species, however their precise contribution cannot as yet be quantified.

E1.1.4 Management goals and responses

To ensure its effectiveness in achieving its goals, the draft FMS outlines a series of performance indicators and trigger points that are linked to each of its six goals. The performance of the FMS will be evaluated annually, and if any of the trigger points are breached (indicating unsatisfactory performance) then the FMS will be reviewed. Goals 1 and 5, their objectives and their performance indicators address, directly or indirectly, the protection of threatened species. An assessment of the ability of the performance indicators and trigger points to adequately detect instances of poor performance is given below.

Goal 1 (*minimise impacts on aquatic biodiversity including threatened species and genetic resources*) performance indicators:

Performance indicators for this goal (Table D8) relate primarily to the response of the activity to threatened species recovery plans or threat abatement plans and other strategies, management plans or legislation relating to aquatic biodiversity. Information to assess the trigger points is readily available within the department. Breaches of the trigger point are to be determined by the Director-General of NSW Fisheries. The suggested trigger points are adequate to detect any failure to meet the objectives of the FMS from a statutory perspective.

Goal 5 (*To improve the knowledge of the activity and ecosystems in which it operates*):

This goal should be a very high priority for the FMS. Despite its potential to cause major changes to the ecology of freshwater systems, the activity of fish stocking has evolved in a vacuum of scientific knowledge about either its effectiveness or its effects on the environment. Several important knowledge gaps relating to the environmental effects of stocking have been identified in this EIS (see below), and these need to be addressed if stocking is to be managed in a sustainable manner. The research that is done should aim to reduce reliance on the precautionary principle in management of fish stocking wherever possible.

Performance indicators for Goal 5 (Table D12) will measure the timely implementation of a research plan, the availability of estimates of the effectiveness of stocking, the response of the activity to the discovery of genetic variations within wild populations of species used for stocking, and compliance with verification requirements for stocking events. The information to assess these performance indicators will be readily available within the department and the suggested trigger points are adequate to detect any failure to meet the objectives of the FMS.

E1.2 The eight-part test

A summary of the eight-part test for threatened and protected species is provided in Table E2. It should be noted that the table presents the worst-case scenario for a stocking event. This is because the eight-part test is designed to assess activities that take place on a small scale, such as individual stocking events. The activity of fish stocking comprises a large number of such events carried out on an annual basis across all of NSW. Here the eight-part test is used to assess the likely outcome of all possible (but as yet unknown) future stocking events permissible under the draft FMS. Therefore, an unknown (but probably small) proportion of all stocking events would have the outcome suggested by the eight-part test in Table E2.

Factors to be considered in the eight-part test:

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

Evaluation of the likelihood of a local extinction occurring as a result of the activity is based on the risk assessments for threatened species under the draft FMS (Table E1). Viable local populations of a threatened species are likely to be placed at risk of extinction if the risk level is

medium or greater (see Table B2.2 for interpretation or risk levels). Information supporting the risk levels assigned to threatened species can be found in Section B2.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

Disruption of the viability of an endangered population as a result of the activity is based on the risk assessments for threatened species under the draft FMS (Table E1). Any assigned risk level of medium or greater is considered likely to significantly compromise the viability of the population (see Table B2.2 for interpretation or risk levels). Information supporting the risk levels assigned to endangered populations can be found in section B2.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

Fish stocking is not considered likely to modify the habitat of any threatened species.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The activity of fish stocking would not isolate areas of habitat.

5. Whether critical habitat will be affected

Critical habitat has not yet been declared for any of the threatened species considered here, therefore this factor is not applicable to any species.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

There are no freshwater aquatic conservation reserves or similar protected areas in NSW. Some species (e.g. frogs) spend part of their life cycle in terrestrial habitats, however, the life cycle of these species cannot be completed outside aquatic habitats.

7. Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process

Stocking of any species outside its natural distribution is a key threatening process under the FM Act, therefore the answer is “yes” for any species that is considered likely to be affected by salmonids (see Table E1).

8. Whether any threatened species, population or ecological community is at the limit of its known distribution

All species have at least one limit of distribution within New South Wales. For most species, fish stocking may be permitted anywhere within the known distribution, therefore stocking could occur at the limit of the species distribution.

Table E2. Summary of the results of eight-part tests for the impacts of fish stocking on threatened and protected species listed under the FM Act, TSC Act and/or EPBC Act.

Information supporting the answers to each part can be found in Section B2.2.

Answers that would contribute towards a determination of a significant impact on a threatened species are shaded. n/a indicates that the particular factor is not applicable to this species.

Species common name	Factors considered in the eight-part test							
	I	II	III	IV	V	VI	VII	VIII
Endangered species (FM Act)								
River snail	no	n/a	no	no	n/a	no	no	yes
Eastern freshwater cod	no	n/a	no	no	n/a	no	no	yes
Trout cod	no	n/a	no	no	n/a	no	yes	yes
Oxleyan pygmy perch	no	n/a	no	no	n/a	no	no	yes
Murray hardyhead	no	n/a	no	no	n/a	no	no	yes
Vulnerable species (FM Act)								
Adam's emerald dragonfly	no	n/a	no	no	n/a	no	no	yes
Macquarie perch	no	n/a	no	no	n/a	no	yes	yes
Silver perch	no	n/a	no	no	n/a	no	no	yes
Southern pygmy perch	no	n/a	no	no	n/a	no	yes	yes
Australian grayling	no	n/a	no	no	n/a	no	yes	yes
Vulnerable populations (FM Act)								
Olive perchlet	n/a	no	n/a	n/a	n/a	no	yes	yes
Purple spotted gudgeon	n/a	no	n/a	n/a	n/a	no	yes	yes
Species protected from fishing (FM Act, Section 19)								
Isopod (<i>Crenoicus harrisoni</i>)	no	n/a	no	no	n/a	no	yes	yes
Species protected from commercial fishing (FM Act, Section 20)								
Australian bass	no	n/a	no	no	n/a	no	no	yes
Eel tailed catfish	no	n/a	no	no	n/a	no	no	yes
Estuary perch	no	n/a	no	no	n/a	no	no	yes
Freshwater crayfish	yes	n/a	no	no	n/a	no	yes	yes
Endangered species (TSC Act)								
Booroolong frog	no	n/a	no	no	no	no	yes	yes
Spotted tree frog	no	n/a	no	no	no	no	yes	yes
Giant barred frog	no	n/a	no	no	no	no	yes	yes
Vulnerable species (TSC Act)								
Peppered tree frog	no	n/a	no	no	no	no	yes	yes
New England tree frog	no	n/a	no	no	no	no	yes	yes
Stuttering frog	no	n/a	no	no	no	no	yes	yes
Giant burrowing frog	no	n/a	no	no	no	no	yes	yes
Endangered populations (TSC Act)								
Tusked frog	n/a	no	no	no	no	no	yes	yes

E1.3 Effectiveness of measures to protect listed species

From the eight-part test (Table E2) and from the preceding discussion, it is clear that the FMS adequately addresses the risks to threatened species and protected species as determined in Chapter B. In addressing some of the risks identified in Chapter B, the FMS has necessarily used the precautionary principle. It is recommended that reliance on the precautionary principle be minimised wherever possible by conducting further research into the activity of fish stocking and its effect on the environment (as outlined under Goal 5 of the FMS).

Several areas relating to threatened species that require further research have been identified in the EIS. These are listed below.

- Wherever possible, reliance on the precautionary principle should be reduced or eliminated through appropriate research programs.

- Research priority areas include:

Sampling and field experiments at ecologically relevant spatial scales to investigate the ecological impacts of fish stocking (see Downes, 2002).

Research into the fate of stocked fish. In particular, good estimates of dispersal, survival rates and the proportion of fish derived from stocking as opposed to natural recruitment are needed. Commitment to specific research is needed before calling for marking of all stocked fish.

Research into the effectiveness of stocking – excessive stocking may actually decrease the abundance of large fish (demonstrated in overseas studies on salmonids). In addition to being counterproductive to the goal of enhancing recreational fishing, stocking under such circumstances wastes resources, and poses unnecessary risks of ecological impacts, genetic impacts, disease and pest introductions.

E2 Implications of the Draft FMS for Fauna not Currently Listed as Threatened

E2.1 Impacts of the draft FMS on unlisted fauna

Four unlisted species of fish were identified in Section B2.3 as being exposed to medium risk levels or greater under the current management arrangements, and the risks to these species are reduced under the draft FMS. These species are the mountain galaxias, Murray jollytail, the Darling River hardyhead and the non-parasitic lamprey.

Unlisted species are also specifically considered in the table of closed waters, or are offered incidental protection as a result of other closures, such as the provisions for not stocking in wilderness areas. Two areas of particularly high diversity for the mountain galaxias are known (T. Raadik, DNRE Vic, pers. comm.). Under the proposed FMS, the mountain galaxias is offered partial protection in areas of particularly high diversity in the Mt Kosciuszko area and partially protected in the Upper Clarence and Bellinger by the provision not to stock in currently declared Wilderness areas, however, this species may still be at risk over other parts of its range.

The Murray jollytail and the Darling River hardyhead are exposed to a medium level of risk from stocking of native fish under the draft FMS. The risks arise from spatial overlap and the likelihood of predation by and competition with stocked species. The lack of information on these species contributes to their high-risk status. No specific measures are currently included in the FMS for the Murray jollytail. The Darling River hardyhead is addressed in Table D5, with no stocking within 5km of known populations of this species.

The non-parasitic lamprey is protected incidentally by other measures that provide for no recreational stocking except Australian bass in impoundments of south coast catchments (Clyde, Moruya, Tuross, Bega, Towamba and Genoa).

All four of these species have declined, probably in part due to historical fish stocking activity for the mountain galaxias but not necessarily for the others (Darling River hardyhead, Murray jollytail and non-parasitic lamprey). All of the species except the Murray jollytail are afforded an increased level of protection under the FMS, thereby reducing the risks from stocking.

E2.2 Recommendations of the EIS with regard to impacts on unlisted species

The status of species that are not currently listed as threatened or protected, but are nonetheless of conservation concern, should be highlighted in the advisory material used by managers and applications that may impact on them should also be referred to the TSBU.

It is difficult to make recommendations about the galaxiids, as they are currently the focus of research to clarify the number of species and their distribution and abundance. The full recovery of the mountain galaxias is not assured under the current provisions of the draft FMS regarding salmonid fisheries, but the proposed research in the FMS, and current external research, should provide some basis for establishing stronger provisions, if necessary. Efforts should be made to conserve existing

populations of these species by careful management of stocking and other issues affecting their survival, such as habitat loss and fragmentation, in order to prevent their status declining to the point where they are eligible to be listed as vulnerable or endangered.

The risks to Murray jollytail and Darling River hardyhead arise in part because of a lack of knowledge about the general biology of these species. Research is needed in order to generate a better assessment of risk. In the interim, the restrictions on stocking near populations of the Darling River hardyhead provide adequate protection for this species and similar measures should be considered for the Murray jollytail.

E3 Implications of the Draft FMS for Areas of Conservation Significance

The risk assessment conducted in Chapter B2 concluded that the aquatic components of the currently listed Wilderness and World Heritage areas are at medium risk levels under the current management arrangements. The assessment also highlighted previously unstocked waterways and/or waterways that have been largely unaffected by stocking or other anthropogenic impacts as likely to contain unique or unaltered faunal assemblages, and thus represented areas of conservation significance even though they were not formally recognised as such. Ramsar wetlands were considered to be at low risk from the current activity and this was primarily due to the lack of stocking in those areas. The impact of the current stocking activity on ecosystem processes (which would dictate an area's conservation significance) was largely undetermined in the risk assessment, but some impact was considered likely. The four conservation areas and ecosystem processes were thus all identified as requiring direct or indirect management measures within the draft FMS to ensure that any potential impacts due to stocking were mitigated. This section will assess the extent to which the draft FMS mitigates risks to the four conservation areas and ecosystem processes.

E3.1 Ability of the draft FMS to mitigate risks to areas of conservation significance

It is clear that the draft FMS has significantly reduced any risks to these areas through the listing of waters that are permanently (Table D4) or temporarily (Table D5) closed to stocking. Those areas currently listed as Wilderness or World Heritage are included in Table D4 and will be closed to stocking. Ramsar areas are listed in Table D5 as not to be stocked as part of the harvest program. This will mitigate most potential impacts in those areas, but perhaps more importantly, will not be implemented as a stand-alone measure. The draft FMS proposes a series of research programs into the environmental impacts of fish stocking, which should remove most of the uncertainty highlighted as a particular problem during the risk assessment. In particular, investigating the fate and movement of stocked fish, and their impact on threatened species and other fauna of the receiving environment, will assist in determining the adequacy of the proposed measures. Wilderness and World Heritage areas often represent the upper, more pristine reaches of catchments. Stocked fish are likely to migrate into those headwaters and if conditions permit may colonise those headwaters. That would effectively nullify the ban on stocking in those areas. Such research may indicate that a buffer zone is also required for those areas.

The draft FMS also proposes to permit the stocking of salmonids only in waterways or sections of waterways that had been stocked since 1990. The extent, magnitude and reversibility of any impacts due to stocking salmonids was often cited in the risk assessment as being poorly understood, but this precautionary measure allows any areas that have not been recently stocked to recover, assuming they had been affected by stocking. This will also assist in the identification of waters that provide pertinent environmental conditions for salmonids, the current basis of which is largely height above sea level. This serves to both minimise any potential extent of impacts due to stocking and provides stockists with greater certainty and likelihood of successful stocking.

Table D4 in the draft FMS also prohibits stocking of both natives and salmonids in some previously unstocked waterways, which were identified in the risk assessment as likely to contain unique faunal assemblages. Unfortunately, this measure does not apply to all previously unstocked

waterways, rather it is restricted to the glacial lakes of Kosciuszko NP and numerous Far West rivers. Whilst this measure affords those unique environments with adequate protection, it does not limit the potential extent of stocking. The potential extent of salmonid impact is restricted to those waters that have been previously stocked, but native species can be stocked into previously unstocked waters provided it is done so in accordance with Conservation Stocking protocols. Whilst this measure addresses genetic concerns, it fails to limit the extent of the potential impacts of stocking. More importantly, it could affect the ability to conduct scientifically rigorous research as there may not be adjacent catchments or waterways that are unaffected by stocking and thus represent baseline conditions against which stocked catchments can be compared. It will be important for authorising officers that are assessing proposals to stock previously unstocked waters that they be mindful of this potential, and that the proposal be strongly justified as it relates to the need for stocking.

Overall, this theoretical appraisal of the draft FMS concludes that the proposed measures are likely to effectively mitigate the potential impacts to areas of conservation significance. There are still many uncertainties related to the impacts of stocking in NSW waters and it will be important that the proposed research is conducted to elucidate those impacts and allow a retrospective analysis of the accuracy of these assessments and implement new measures if necessary.

E3.2 Impacts of the draft FMS on ecosystems

Ecosystems are complex systems made up of various components of the physical environment, the organisms that inhabit the physical environment and the interactions that occur within and between the components. Structure of ecosystems can be thought of in terms of the arrangement of species in space and the interactions between them (e.g. biodiversity and trophic structure). Ecosystem functioning includes such processes as the flow and cycling of energy and matter among the components of the system and can be measured in terms of nutrient or energy flux or productivity. The resilience of an ecosystem can be defined as the ability of a system to recover following disturbance.

E3.2.1 Impacts of the draft FMS on ecosystem structure

A clear example of a change to ecosystem structure as a result of fish stocking comes from New Zealand, where the introduced salmonids are believed to have replaced the native galaxiid fish in many streams, with consequent changes to invertebrate abundance and primary production (McDowall, 2003). Similar processes may occur in Australian montane streams where trout are stocked, but very little research has been done. One Australian study showed that stocking of salmonids affected the relative abundance and diversity of aquatic invertebrates (Fletcher, 1979). Stocking in lowland streams and lakes in North America affects the trophic structure through a trophic cascade (Power, 1990; Power, 1992; Strong, 1992). No work has been done on the effects of fish in Australian lowland stream or lake ecosystems.

The recent development of more holistic approaches to the management of natural resources has led to the concept of “river health”. Various techniques have been developed to measure river health in NSW. The Index of Biotic Integrity provides a measure of the difference between the predicted ideal structure of a system (in terms of the presence and relative abundance of fish species) and its actual state (Harris, 1995). It provides a useful measure of the status of fish assemblages. The AusRivAS program provides a similar rapid assessment technique for assessing “river health” using benthic invertebrate assemblages (Simpson, 1996). While these techniques provide useful rapid assessments of fish or invertebrate assemblages relative to a predicted “ideal”, they are not designed to provide any absolute measure of the state of the ecosystem, the underlying causes of change, or the

implications of any change for ecosystem functioning. Nor are they designed to provide any mechanistic understanding of the system that would allow predictions about the effects of management actions. However, these techniques are useful for identifying river reaches that are in need of remedial management action, even if it is not clear what the action should be.

E3.2.2 Impacts of the draft FMS on ecosystem functioning

Little is known about the functioning of Australian freshwater ecosystems or about how changes to ecosystem structure affect ecosystem function. It is possible that ecosystem functioning has changed as a result of fish stocking, but the nature of such change cannot be quantified. Furthermore, river regulation, water extraction and land use changes have probably had a far greater impact on the functioning of ecosystems than fish stocking.

E3.2.3 Impacts of the draft FMS on ecosystem resilience

The ability of an ecosystem to recover to its former state (in terms of structure and function) may be termed its resilience. Since little is known about the structure of Australian freshwater ecosystems, and even less about their functioning, it is difficult to assess the likely changes to resilience caused by fish stocking under the draft FMS.

E3.2.4 Ability of the draft FMS to mitigate risks to ecosystems

The current state of knowledge does not readily allow for predictions about how the impacts of fish stocking on the ecosystem will differ from pre-FMS to post-FMS management arrangements. The restrictions on stocking near threatened species of fish and frogs increases the chance of recovery of those species under the draft FMS, as it does for broader areas of conservation significance. Should this occur, some measures of ecosystem structure may improve on a local scale. On a broader geographic scale, the scale of fish stocking is unlikely to change very much under the draft FMS, although there is the potential for an increase in the extent of any impacts due to stocking native species. This potential is unlikely to be realised in the short term, however, as it will take some time for hatcheries to meet the higher Conservation Stocking protocols required for previously unstocked waterways. So overall, it is likely that similar or slightly greater numbers of fish will probably be stocked, generally in the same areas that have been stocked before. Therefore, it is predicted that there will be little change to the effects of stocking on ecosystem structure, functioning or resilience under the draft FMS as compared to the current management arrangements. However, given that the actual effects of fish stocking on the ecosystem are unknown, it is difficult to say whether or not the effects of stocking on the ecosystem are detrimental or otherwise.

It is impossible to predict the overall effect of the draft FMS on ecosystem structure, function and resilience without a good scientific understanding of these concepts and processes for Australian freshwater systems. Ecosystem-based management of fish stocking requires the recognition of, and actions to influence, all relevant processes that affect the ecology of all components of the ecosystem. At present, the effects of management decisions related to stocking are poorly known even in relation to the stocked fish and their direct prey and competitors, let alone the other parts of the food web, the flow of energy or the abiotic environment. Basic research is needed into the structure and functioning of NSW freshwater ecosystems before effective management techniques can be implemented with a high degree of confidence. The proposed research provides a good basis to fill some of those information gaps as they pertain to stocking, and the more detailed research required to more fully understand freshwater ecosystems of NSW is beyond the scope of the draft FMS.

E4 Implications of the Draft FMS for Wild Populations

This section was prepared by Spring Creek Environmental Consultants.

E4.1 Ability of the draft FMS to manage distinct populations

There is little doubt that segregated populations of fish exist within NSW waters. Therefore only a detailed population genetics study of all stocked species will provide a complete picture of population boundaries and patterns of population structuring. At present this data does not exist or is not complete enough to make detailed management decisions with. The FMS proposes to implement a research plan at the commencement of the FMS. This research plan specifically identifies the need to conduct population genetics research on golden perch, Murray cod, catfish and silver perch. This research should be considered essential and a basic minimum to the sound management of genetic resources. Additionally, before any new species are considered for stocking, a full population genetics study should be undertaken. It should be noted, that population genetics research alone will not protect distinct populations. The protection of distinct populations will only be achieved through adaptive management incorporating research findings about population subdivision. Importantly, the draft FMS proposes such research and to be responsive to the incorporation of new information (D1.4.9) and therefore is likely to adequately manage distinct populations.

The research plan lists golden perch and Murray cod as the highest priority (Level 1), with genetics research to commence within two years of the implementation of the FMS and is to be reviewed within five years, as they are the most commonly stocked native fish within NSW. Catfish have the next highest priority (Level 2), with research to commence within 3 years and reviewed within 10 years. Silver perch have been assigned a lower priority (Level 3), with research to commence in 5 years and reviewed within 10 years. Whilst it would be ideal for research into all native species to be considered a high priority, it is recognised that there needs to be different priority listing for catfish and silver perch. This is despite, but also partly because, the technology already exists to produce silver perch and catfish, and some stocking of silver perch (albeit primarily of impoundments) has occurred from the Grafton Aquaculture Centre (GAC) as an overflow from an aquaculture selective breeding program. Acknowledging that silver perch from GAC and other hatcheries are likely to have limited genetic diversity, only hatcheries accredited under the draft FMS will be able to produce fish for stocking. Given the population reductions observed in catfish throughout the Murray-Darling, conservation stocking may be warranted in future and should be based on the outcomes of the research and protocols proposed in the draft FMS.

The creation of distinct stocking areas throughout the state as listed in the FMS will go part way to managing for discrete populations, however, this will only be achieved if stockings are made back to the population broodstock are sourced. In most cases, information on population structuring is unknown, though the research plan aims to fill in this information gap. In the interim stockings should be made within relatively close proximity (same river system) to parental sourcing. However, in the case of species like eastern freshwater cod and trout cod where local extinctions have occurred, the dissemination of hatchery fish to previously inhabited areas should be encouraged. With species such as Oxleyan pygmy perch, where it has been shown that structuring occurs on a micro-geographic scale, where relatively close water bodies remain significantly isolated, it is even more important where fish are sourced and stocked. As information about population boundaries become more prevalent it can be incorporated into the stocking program. The plan to assess and manage stocking on

a local level as well as larger zones has great merit and is likely to reduce problems that have occurred in the past.

The research plan has also given priority (Level 1) to the development of a suite of molecular markers (microsatellites) for the genus *Maccullochella*, *Macquaria* and *Bidyanus*. The development of these markers is essential for population structure analysis and to monitor compliance with genetic management protocols. However, on occasion there have been noted problems with using a genus-wide suite of microsatellite markers. Problems with allelic dropout and null alleles are a result of mutations in the flanking region of microsatellites, causing problems with primer attachment. This can often be overcome with species-specific primer suites.

Despite the significant efforts proposed in the draft FMS to manage fish stocking and movements, it is still possible that fish will not be stocked into waters that have been agreed to under the stocking permit. However, the draft FMS proposes to implement a much stronger compliance regime than currently exists, including development of a compliance and education plan, integrated applications and permit system. These are in addition to the regulation making it illegal to stock fish without a permit. Stocking is an extensive and intensive activity, and whilst it would be desirable for a compliance officer to attend every stocking event to assure fish are stocked where the permit indicates, this would not be feasible.

E4.1.1 Native species for harvest stocking

Golden perch

Golden perch, though still to be well surveyed, have shown distinct population subdivision. The Lake Eyre population of golden perch appears to be a separate species and significant subdivision has been demonstrated for other catchments throughout the geographic range of the species. The draft FMS proposes not to stock Far West catchments, thus nullifying any potential impacts to the Lake Eyre population. To address the issue of population structuring within the species and significant knowledge gaps, the draft FMS proposes significant measures such as the HQAP, HAS, genetic zones, research and to return progeny into those waterways from which the broodfish were sourced.

Murray cod

There remain significant knowledge gaps for the population subdivision of Murray cod. Limited screening of Murray cod that has been done in the past was not comprehensive and further research, as proposed in the draft FMS, is warranted to delineate population boundaries. As with golden perch, most of the other measures are underpinned by the proposed research, and it is vital that it be done in order to minimise any potential impacts on the genetic integrity of Murray cod.

Australian bass

Australian bass have demonstrated moderate level of population subdivision throughout their natural range. Australian bass appear to conform to an isolation-by-distance model of structuring, whereby populations are generally more similar with increasing proximity (Jerry and Baverstock, 1998). Under the draft FMS, Australian bass have been delineated into three stocking zones: northern, southern and central. This broad level of zoning and the other measures proposed related to genetic resource management should provide adequate protection for the population subdivision demonstrated for the species.

E4.1.2 Threatened species for conservation stocking

Silver perch

The few studies of silver perch have shown some population structuring. Silver perch are listed as a threatened species and are quite rare in many locations. As a result, adult silver perch are often acquired for broodstock from previously stocked populations such as impoundments or farm dams, where most of the fish are single generation siblings (Moore and Baverstock, unpublished). The use of siblings or closely related individuals will cause large-scale inbreeding and is likely to lead to fitness reductions associated with inbreeding depression. Hatcheries that stock silver perch into NSW have been found to use a single pair of individuals or their subsequent progeny for eighteen consecutive breeding events (Moore and Baverstock, unpublished). The draft FMS outlines plans to use silver perch bred at Narrandera Fisheries Centre and Grafton Aquaculture Centre (GAC). The GAC does not produce fish specifically for stocking, instead it specialises in breeding silver perch for aquaculture research. To this end, GAC has a specific Fisheries Research and Development Corporation-funded program for the genetic improvement of silver perch for aquaculture. Therefore it is very likely that silver perch bred at GAC have been through genetic selection programs designed to produce the best fish for aquaculture environments, and thus would not be suitable for stocking programs. As proposed in the draft FMS, the GAC will need to be accredited before stocking. This, and the other measures such as the HQAP, Genetic Resource Management Guidelines and the Broodstock Management and Collection Policy, will effectively decouple those hatcheries that produce fish for stocking from those that produce fish for aquaculture. The decoupling of fish bred for aquaculture and those bred for stocking is a major leap forward in the conservation of genetic diversity.

Trout cod

There is a paucity of data with regards to the population structure of trout cod in NSW and VIC. Stocking efforts should liaise with VIC on the reciprocal transfer of broodfish between institutions providing they are from the same source population. There is evidence that the Ovens/Kings/Seven catchments are significantly different to the Murray catchment (Bearlin and Tikel, 2002). The sourcing of broodstock and the releasing of progeny should reflect these genetic differences. The measures proposed in the draft FMS related to genetic resource management should provide adequate protection for the genetic integrity of the species.

Eastern freshwater cod

Eastern freshwater cod have shown distinct population subdivision in parts of its distribution. Notably the Guy Fawkes and Sara Rivers appear to be functionally different populations to the rest of the Clarence catchment. There is substantial evidence that eastern cod progeny from a hatchery have 78% less heterozygosity and 71% less allelic diversity compared to extant wild populations (Nock *et al.*, 2003). To reduce genetic diversity by this much in a single generation it is likely that genetic protocols were not adhered to. Large numbers of genetically depauperate fish are thought to have already been released into many areas of the species former distribution. To address these concerns, the draft FMS proposes a higher level of accreditation for conservation stocking, and only permitting the release of threatened species in accordance with a Species Recovery Plan. These and the other measures proposed in the draft FMS related to genetic resource management should improve our understanding of, and provide for increased protection of the genetic integrity of the species.

Macquarie perch

Preliminary data suggests that Macquarie perch comprise distinct populations and perhaps separate species either side of the Great Dividing Range (D. Gilligan, NSW Fisheries, pers. comm.). Macquarie perch are listed as data deficient by the World Conservation Union (IUCN), as endangered under both Commonwealth and ACT legislation, vulnerable in NSW, threatened in Victoria, and as endangered according to the Australian Society for Fish Biology. In addition to stocking restrictions of other species in many areas known to contain Macquarie perch, the draft FMS also proposes a range of other measures consistent with those described above for other threatened species and should provide adequate protection for the genetic integrity of the species.

Oxleyan pygmy perch

Substantial population subdivision has been demonstrated for Oxleyan pygmy perch in southern Queensland. A study has commenced for northern NSW populations, though the results will not be known for some time. The draft FMS proposes a range of measures consistent with those described above for other threatened species and should provide adequate protection for the genetic integrity of the species.

E4.1.3 Exotic species

As the salmonids have gone through a substantial population bottleneck, in some cases several bottlenecks, during their translocation into Australia they are likely to have little genetic variation and no population level differences to manage.

E4.2 Ability of the draft FMS to manage hybridisation

Species outlined in the draft FMS that are most likely to hybridise are listed in Table E1. The likelihood for these hybridisations are quite low as long as the guidelines in the draft FMS are followed carefully. The risk associated with these potential hybridisations is very high if the protocols in the draft FMS are not adhered to. The risk of significant problems caused by hybridisation remains quite low for most species if protocols are strictly followed.

The one group that is most likely to cause problems are the terapontids, i.e. silver perch, Welch's grunter and the Barcoo grunter. There is a high probability that hybrids are present in NSW waters and currently exist as broodstock, and they have been shown to readily hybridise (Moore and Baverstock, unpublished). To ameliorate this threat, the draft FMS proposes to collect genetic samples from broodstock in all hatcheries as part of the accreditation system, development of the Broodstock Collection and Management Policy, including controls on sourcing and screening future broodstock. The HQAP and HAS will also ensure that stock received from interstate hatcheries is consistent with these policies. Overall, the draft FMS should significantly reduce the likelihood of hybridisation of native species of fish as a result of stocking, however, it cannot completely mitigate that risk due to the biological attributes and widespread nature of terapontids in the wild and within hatcheries.

The risk of hybridisation for introduced salmonids and native fish are insignificant, as Australia has no endemic salmonids. The evolutionary differences between salmonids and all other Australian fish families are far too great to pose any risk of hybridisation.

Table E3. Species thought to be most at risk of species level hybridisation and introgression

Species	Data	*Likelihood
Murray cod/ eastern cod	no hybridisation demonstrated so far	low
Murray cod/ trout cod	hybridisation demonstrated	low
Eastern/western populations of Macquarie perch	depends on species level differences	low if no translocation
Australian bass/estuary perch	hybridisation demonstrated	low
Silver perch/spangled perch	no hybridisation demonstrated	medium to low
Silver perch / Welch's grunter / Barcoo grunter	Hybridisation reported in captivity/likely to be hybrids released into wild and some may be used as broodstock	high

* likelihood is denoted as the probability of species denoted in the draft FMS creating or leading to hybridisation or introgression.

Note: if FMS is not followed carefully, risk is very high for many species

E4.3 Ability of the draft FMS to manage genetic integrity

The protocols for the genetic management of hatchery-produced fish as part of the Hatchery Quality Assurance Program (HQAP) and Hatchery Accreditation System (HAS) outlined in the FMS are quantum leaps ahead of previous efforts. Previous hatchery protocols were grossly inadequate to capture remnant genetic variation of native species, and stave off the effects of inbreeding and genetic drift (Moore and Baverstock, unpublished). The new genetic protocols are based on the management of effective population size (N_e) within the hatchery and capturing representative genetic variation across the species distribution while maintaining distinct population boundaries. The draft FMS requires hatcheries to comply immediately with an N_e of 100 for conservation stockings, and N_e of 50 for harvest stockings for a period of five years to let industry comply with the new regulations. After five years, an N_e of 100 is required for all stockings. A period of five years should provide adequate protection of genetic resources as well as allow the aquaculture industry to adjust to the increased stringency of the protocols. Additionally, stockings of native species into previously unstocked locations will be required to meet an N_e of 100 immediately. An N_e of 100 can be achieved with as little as 25 pairs of fish, however, this will only occur if it is managed correctly. It should be noted that the use of 25 pairs of fish alone will not give an N_e of 100 and is insufficient to adequately manage genetic resources over the long term. Only by following strict genetic protocols, including one on one matings, maintaining stud books to limit repeat matings between pairs, and equalising contributions between matings, will 25 pairs be enough to adequately reduce the loss of genetic diversity. Many of these considerations are sufficiently covered in the HQAP proposed in the draft FMS.

The FMS includes measures for compliance with the genetic guidelines. It requires the submission of finclip samples from all broodstock and a sample of 100 progeny from each pond (from each mating) for genetic analysis. This process should be considered mandatory and the random screening of samples should provide sufficient compliance with genetic guidelines if penalty measures are instigated.

E4.4 Genetic issues - broad recommendations

The following recommendations are not aimed at improving specific objectives or management responses of the draft FMS. Rather, the following recommendations are provided as the minimum requirements for hatcheries that propose to produce fish for stocking, and discussions with NSW Fisheries indicate that these areas will be addressed in the Genetic Resource Management Guidelines (response 1.3a) as proposed in the draft FMS.

Recommendation 1: Limit inbreeding by:

1. using large numbers of non-related broodstock (see recommendation 2)
2. limiting sibling mating (use stud books and tagging and maintain records of all matings which can be used to determine future matings), and
3. limiting random breeding among individuals (see previous point).

Recommendation 2: Maintain an effective population size (Ne) of at least 100 by:

1. using where possible at least 25 pairs of non-related broodstock (reciprocal transfer between institutions to decrease the number of fish kept on-site to a minimum of five pairs, but only if they are used to stock the same population) - generally preferable to keep a minimum of 10 pairs of fish on-site
2. equalising contributions between parents by portioning out equal numbers of progeny into different tanks/ponds for each stocking
3. maintaining equal numbers of males and females
4. preventing large fluctuations in broodstock number from year to year, and
5. separating each breeding pair into a separate tank or pond to monitor the breeding contribution and mating success of each pair.

Recommendation 3. Capture and maintain wild genetic variation by:

1. sampling at least 200 individuals over two minimum generations or 10 years, and
2. ensuring that founders have representative genetic variation by employing modern population genetic techniques.

Recommendation 4. Limit wild gene pool swamping from genetically homogeneous fingerlings by:

1. ensuring stockings comprise of progeny from at least five mating pairs
2. avoiding repeated matings of the same individuals or their progeny, and
3. exchanging broodstock regularly (from the same ESU or population).

Recommendation 5. Reduce the effects of artificial selection by:

1. releasing progeny at a young age, and
2. using only wild caught broodstock.

Recommendation 6. Reduce the probability of outbreeding depression by:

1. sourcing broodstock from the same ESU or population, and
2. avoiding translocations among ESU or populations.

E5 Implications of the Draft FMS for Fish Health

This section was prepared by Spring Creek Environmental Consultants.

The draft FMS for fish stocking proposes to manage the translocation of organisms throughout State waters using both State and national translocation policies. However, the risks associated with the translocation of organisms outside their natural range will remain high for several key reasons. The draft FMS outlines plans to maintain the stocking of silver perch (*Bidyanus bidyanus*) and golden perch (*Macquaria ambigua*) into the Hunter catchment. Additionally, and far more significantly is the ongoing problem of unwanted species contained within transport media. A plethora of native and non-native species are likely to enter ponds and aquaculture systems through external water intakes and transferred around the farm by the subsequent movement of water around the site. Most hatchery facilities do not adequately screen their intake water. The range of undesirable organisms entering via intake pipes includes fish, crustacea, protozoa, aquatic insects, algae and water plants (Tables B40-B43). Most hatcheries do not adequately check for the presence of additional organisms after harvest or in preparation for delivery, and many smaller organisms are likely to go unnoticed. However, the FMS has addressed these issues through the Hatchery Quality Assurance Program and Fish Stocking Hatchery Accreditation System, where inlet water is to be screened to eliminate unwanted species. The screens are limited to 500µm as a smaller diameter would clog with debris too rapidly and be impractical for industry to operate. As such the mesh is too coarse to be an effective screen for unwanted pathogens. The HQAP focuses on removing pathogens from filterable media within the hatchery flow-through system while fish are being maintained in quarantine prior to release. This is likely to be the most effective and practical way of reducing the spread of unwanted species and pathogens through the breeding and stocking process.

There also remains the high risk associated with individuals or groups obtaining a permit to stock a certain site and then stocking in a completely different area. As previously stated, the draft FMS proposes a series of measures to improve compliance of the activity, and until performance reports are available that indicate the degree of compliance, it can only be assumed that these measures will reduce the risk compared to the current situation.

The plan outlined in the draft FMS for the incorporation of nationally approved disease management plans should be considered essential. The draft FMS also outlined other very important strategies for managing disease, which include establishing a response fund for disease emergencies, establishing a disease mapping program, and registering with the Aquatic Disease Watch Hotline. If implemented, these programs will enhance the control of aquatic disease in NSW by the activity.

The FMS research priorities highlighted the need for an audit of aquatic diseases to be undertaken within three years (Level 2 priority) of FMS implementation. This should be considered mandatory as should further research into disease management, methods of disease control, treatment and spread.

E6 Economic Implications of the Draft FMS

This section was prepared by Dominion Consulting Pty Ltd.

E6.1 Introduction

The purpose of economic appraisal in an environmental context is “to achieve a socially efficient allocation of scarce resources i.e. one which maximises the return, including the environmental capital stock, in order to maximise economic welfare of all citizens over time” (NSW Government 1997c; annex 5). This requires that benefits and costs be measured through market values. Total social costs and benefits also include running down, or building up of the environment (NSW Government, 1997c; annex 5). This would include the fish stock and aquatic ecosystems in the current analysis.

The major economic assessment technique is cost-benefit analysis (CBA), which quantifies in dollar terms all major costs and benefits, providing a consistent basis for evaluating costs and benefit, though it does not necessarily show the distribution of benefits or costs (NSW Government, 1997c). CBA requires transparent information.

There are different types of impacts to be considered in an Environmental Economic Assessment process. According to Thomas (1998) these are:

- direct impacts of proposal
- indirect impacts, being one step removed
- cumulative impacts coming from the interaction of proposal elements
- predicted residual impacts, impacts not avoided or mitigated
- predicted probability, magnitude, distribution and timing of expected impacts, and
- forecasting of what will happen to affected components of the environment if the proposal goes ahead.

The various types of impact will be considered in the analysis of economic impacts.

E6.2 Economic assessment

The draft FMS states that stocking levels will be maintained at current levels. We will also assume that the current species mix is optimal (see box 3). We then assess potential changes in stocking activity from this base.

Whilst it is possible to identify the economic implications of the draft FMS on a State basis, it is not always possible to identify them on a regional/catchment basis for reasons of operator confidentiality. Releasing information at the catchment level may breach operator confidentiality in the instance where a catchment comprises data for less than 5 operators. As the size of many catchment areas in NSW is relatively small, figures in this section of the report will be given at the aggregate stocking zone level, as proposed in the draft FMS. The catchment areas that make up these stocking zones were presented in Figure D1.

Box 3: Optimal species mix

The presumption that proposed stocking results in the most economically advantageous mix of species assumes that we have a mature stocking regime. That is, a regime that arrives at the optimal mix of species purely as a result of the social interaction between recreational fishers and managers of the stocking resource.

If the species mix is not optimal then the economic value of the stocking resource is not being maximised. We have no way of telling whether this is the case as we do not have information on how people compare different species, either by relative expenditure on fishing trips, or by the value placed on access to the different species. Should we have these relative expenditure and relative access valuations we would be able to assess the FMS and its economic impacts more fully.

As an example of how the species mix may not be optimal consider a shift in angler preferences, away from trout towards coastal natives. Then consider the stocking regime, where stocking of trout is far more prolific than stocking of coastal natives. If there has been a shift in preferences then it would be more economically advantageous to change the species mix by reducing stocking of trout and increasing stocking of inland natives. This course of action would increase the economic benefits of stocking by increasing the satisfaction of recreational fishers who are the primary beneficiaries and income generators from stocking activities.

If there is an increase in stocking levels for a species that is more attractive to anglers, this may increase the revenue generated from stocking activities in the areas where the species is stocked. The draft FMS proposes a range of surveys into client satisfaction, angler catch and socio-economic benefit, which should determine whether this would be the case. The surveys would also allow a determination of the optimal species mix.

In order to assess the potential economic impacts of the FMS it is first necessary to determine the activities that are generating economic surplus in an economy, and, subsequently, the effects of any changes in the economy on this surplus. In the instance of fish stocking, it is the expenditure of recreational fishers, and the tourism activities these fishers undertake, that is generating economic surplus in the economy. Fuelling this expenditure is hatchery production and stocking activities.

An important factor to consider in assessing the impacts of the FMS is the potential impacts of any cost increases generated by the FMS on the economic viability of the hatchery production unit. As mentioned previously the ability of hatcheries to meet any changes in stocking levels by adjusting production is vital to the success of the stocking program and the ability of this program to generate enhanced recreational fishing opportunities. Similarly, the internalisation of costs incurred in meeting new accreditation and risk management protocols in respect of disease, may have implications for the viability of hatchery operations both in terms of implementation costs and minimising the risk of adverse incidents that might interrupt demand for stock (e.g. disease incidents).

Another important economic impact of changes in stocking levels is on direct and indirect employment. Those persons directly employed in stocking activities include public and private hatcheries staff, and NSW Fisheries staff engaged in research, management, and monitoring activities. Indirect employees include the fishing and tourism businesses. Any changes on stocking levels will have direct economic consequences for these groups.

A final area, which is of relevance in the economic assessment of this FMS, is the increased costs to government from the administration of the stocking program. As a large number of the responses in the FMS centre on improvements in information, and better reporting, as well as

establishing standards for operation, including a quality assurance program leading to hatchery accreditation, it is expected that the costs to government from administering the stocking program will increase as a result of the FMS. Whether the government chooses to bear these higher costs, or whether they choose to pass them on to industry or fishers, will have important economic consequences.

E6.3 Economic implications of the draft FMS

The economic implications of the draft FMS are to be assessed as they relate to the following areas:

1. hatcheries and related activities
2. groups involved in stocking, management or monitoring
3. fishing related organisations or businesses
4. cost recovery by NSW Fisheries
5. landowners adjacent to stocking areas, and
6. tourism.

Within these areas, it is expected that the greatest economic implications, in terms of the generation of economic surplus, and employment, will be in: the tourist industry; fishing-related organisations or businesses; and cost recovery by NSW Fisheries. Generating this surplus will be the recreational fishers, whose fishing activities in a region will be influenced by their perceptions of the number of fish available to be caught. Obviously the number of fish available to be caught is influenced by the level of stocking in a region.

The FMS will also have implications for employment in private and public hatcheries, and for revenue generated from private hatchery activities. As government hatcheries are fully subsidised, the issue of revenue generation does not come in to play. This is also the case for groups involved in the management and monitoring of the stocking activity, as these activities are government funded. In terms of employment, however, it is expected that there would be some effect on employees engaged in management and monitoring activities if stocking levels were to change.

The economic implications of a change in stocking levels on groups involved in stocking are expected to be only minor as these groups have no formal employment in stocking activities. However, if membership of these groups changes as a result of a change in stocking levels, e.g. less recreational fishers joining fishing clubs as a result of a decline in stock, this is likely to be felt in the wider economy, i.e. through a change in the economic surplus generated by recreational fishers. As far as landowners adjacent to stocking areas are concerned, the change in stocking activities will not have any economic implications.

The FMS has several risk management protocol initiatives, which are intended to increase the standard of hatchery operations. This will potentially internalise some of the costs of dealing with disease and genetic issues, which have not been addressed adequately in the past. There will be some costs for industry to implement. However, improved standards in hatcheries, as part of an ongoing stocking program, will underpin the long term viability of hatchery businesses by lowering the risks that might otherwise adversely affect their operations, such as through an interruption in product demand following a disease or pest incident or a threat to the genetic robustness of fish populations. A

number of hatchery operators expect higher standards to be implemented and the proposal in the FMS to phase in the higher standards will enable businesses to plan for the adjustments in an orderly way. Nevertheless, some private hatcheries may choose to focus their operations on aquaculture rather than implement the standards proposed for stocking or marginal operators may choose to pursue alternative business activities. There is currently insufficient information to appraise this issue further.

The management responses given in the draft FMS that have economic implications are ranked as high or low according to their overall economic impact, i.e. the degree to which the proposed management responses affect economic surplus and employment in stocking related activities (Table E4). As can be seen in this table there are only a few responses that have high economic impacts. The remainder mainly have implications for the costs of research, management and monitoring of stocking activities. Some also have social implications.

Table E4. Draft Fisheries Management Strategy Responses for stocking of fish in NSW Inland Waters (ranked by potential economic impact).

Response	Description of response	Goals	Economic issue	Economic impact
1.2 (a)	Appropriately manage stocking in areas where fish stocking adversely affects threatened species	5	closure	HIGH
2.1 (a)	Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities	3, 4	enhancement	HIGH
2.3 (a)	Develop a classification scheme for NSW waters to evaluate the potential viability of stocking proposals	1, 3, 4, 5, 6	viability	HIGH
2.3 (b)	Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity	1, 3, 4, 6	enhancement	HIGH
5.2 (b)	Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity	2, 3, 5	information	LOW
5.2 (c)	Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis	2, 3	growth	LOW
2.1 (b)	Recognise region-specific fishery management plans such as the Snowy Lakes Trout Strategy	2, 3	growth	LOW

Many of the responses listed in the draft FMS are expected to have implications for the costs of management of stocking activities. More directly, the administration and monitoring requirements of the activity is expected to increase as a result of higher standards placed on hatchery operations.

How any additional costs are distributed between NSW Fisheries, recreational fishers and hatchery operators will have implications for each of these groups.

E6.3.1 Assessment of draft FMS responses

Before presenting the impact assessment as it relates to specific activities, an overall assessment of the draft FMS responses presented in the Table E4 will be undertaken.

1.2(a) Appropriately manage stocking in areas where fish stocking adversely affects threatened species

A cessation of stocking activities in an area where existing species are threatened might have implications for hatchery production, recreational fishing opportunities and tourism. If recreational fishing opportunities in an area decline as a result of a reduction in stocking activities, and less recreational fishers visit the area, then this will also affect expenditure and tourism. However, the proposals to close some waters to stocking is unlikely to have such an effect given that fish are not currently stocked in most of the listed waters and alternative sites are available to fishing to continue at a regional level.

It is important to recognise that if action is not taken to address risks to threatened species, the economic costs will be borne by the environment and/or through recovery programs.

The draft FMS addresses these issues.

2.1(a) Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities

Given the regional benefits of stocking activity outlined in the background to this assessment, it is expected that the proposal in the FMS to continue stocking activity will have positive flow-on effects for the regions in which the activities are based. In particular, hatchery operations will benefit through continued demand for their product, i.e. through direct orders and increased certainty to make informed investment decisions.

2.1(b) Recognise region-specific fishery management plans such as the Snowy Lakes Trout Strategy

In recognising management plans, such as the snowy lakes trout strategy, there is a need to evaluate the contribution of stocking activities to the statewide strategy. For example, an area plan may suggest that species can be stocked, but statewide angler preferences may not support this.

Regional plans also provide an opportunity to take initiatives to provide species desired by tourists, for example the stocking of salmonids in Lake Jindabyne under the snowy mountains strategy.

The draft FMS addresses these issues.

2.3(a) Develop a classification scheme for NSW waters to evaluate the potential viability of stocking proposals

Developing a classification scheme for NSW waters, as proposed in the FMS, involves systematically evaluating sites to be stocked, thereby, optimising the results from stocking. Knowledge is applied to evaluating risk and probability of survival. By doing this it is possible to get the highest economic return from stocking. For example, the decision to stock fingerlings, fry or year old fish has cost and natural mortality implications that are related to suitability of the stocked waterbody.

2.3(b) Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity

The Dollar-for-Dollar program is an incentive based scheme through which angling clubs, who wish to augment the waters associated with their club activities, can raise money to provide funds, which are matched by the government who hold the recreational licence funds in trust, to buy fish to stock local waters. The major beneficiaries of this activity are the recreational fishers who have greater access to stock and improved fishing experiences, as well as the private hatcheries that derive income through the sale of stock.

The Dollar-for-Dollar program can also be used as a mechanism to encourage local stocking initiatives with potential benefits to regional economies.

The draft FMS addresses these issues.

5.2(b) Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity

At present, information gathered at major inland fishing competitions is an important source of information to assess the success of stocking programs, i.e. any increase in catch as a result of stocking can be quantified using this information. That is, fishers at major inland fishing competitions represent a key type of recreational fisher, as effort expended by these fishers is high on the days fished.

As skill and effort differs by fisher, and other natural factors can affect the rate of increase in numbers of fish as a result of stocking (e.g. natural predation and water quality), it is also important to obtain information on the effort expended by other recreational fishers.

The FMS addresses these issues through this response and the proposed client satisfaction surveys.

5.2(c) Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis

Undertaking a survey of the benefits from stocking activities, and making these results publicly available, such as was done in the Snowy Mountains, has important implications for stocking policy as it brings to light the benefits from stocking on a regional scale. In addition, recreational fishers are aware of how their dollar is being spent and how it contributes to regional development.

The Snowy example illustrates the benefits of assessing regional expenditures by fishers. This can be supplemented by analysis through regional input-output models to further illustrate the regional and statewide benefits that arise from stocking. These studies can also be used to estimate the economic value of with recreational fishing access associated with a particular area (Watson, 2002).

E6.3.2 Hatcheries and related activities

The FMS responses that are expected to have the greatest economic impact on hatcheries are 1.2(a), 2.1(a), 2.3(a) and 2.3(b). The main impact of these responses on hatcheries is through the proposed continuation of stocking activities at the current level. That is, hatcheries are key beneficiaries through opportunities to secure direct orders for stock and increased certainty to make informed investment decisions.

The FMS seeks to internalise the costs of having industry equipped with risk management protocols to face possible risks from pests, diseases and genetic sources. For example, accreditation is proposed to ensure appropriate operating standards in industry. There will be some costs for industry to implement. However, improved standards in hatcheries, as part of an ongoing stocking program, will underpin the long term viability of hatchery businesses by lowering the risks that might otherwise adversely affect their operations, such as through an interruption in product demand following a disease or pest incident or a threat to the genetic robustness of fish populations. A number of hatchery operators expect higher standards to be implemented and the proposal in the FMS to phase in the higher standards will enable businesses to plan for the adjustments in an orderly way. In assessing the costs and benefits of the FMS it is important to recognise that for many private hatcheries production of fingerlings for stocking makes up only a very small proportion of total hatchery revenue. Revenue from activities such as growing stock out for private sale, or maintaining mature stock to provide recreational fishing opportunities on-site, often represent a far greater proportion of total hatchery revenue. Nevertheless, some private hatcheries may choose to focus their operations on aquaculture rather than implement the standards proposed for stocking or marginal operators may choose to pursue alternative business activities. There is currently insufficient information to appraise this issue further.

The draft FMS is also likely to result in higher administration and management costs for hatcheries. Some of these costs may be passed on to hatcheries in the form of fees and levies, others are as a direct consequence of standards and regulations imposed on hatcheries under risk management protocols in the draft FMS (Table E5). However, hatchery standards should also bring about improvements in the efficiency of hatchery operations, minimise risks to demand (eg disease incidents) and a reduction in the operating costs if they are successfully implemented. The proposal to phase in the key standards, e.g. for genetics, should provide time for hatchery operators to plan and make informed adjustments.

Table E5. Draft Fisheries Management Strategy Responses that have economic implications for hatcheries (ranked by potential economic impact).

Response	Description of response	Goals	Economic issue	Economic impact
3.1(a)	Develop and implement quality assurance standards and accreditation for all hatcheries supplying fish for stocking	1, 2, 6	costs	HIGH
3.2(b)	Require, where necessary, the mandatory use of microchip technology (PIT-tag system) in broodstock management arrangements	1, 2, 4, 5, 6	costs	HIGH
4.1(d)	Develop interactive self-assessment tool and education resource	1, 2, 3, 5, 6	costs	HIGH
4.2(c)	Require hatcheries to report annually on production and other relevant factors.	2, 5	costs	HIGH
5.2(a)	Develop reliable marking techniques for hatchery reared stock and introduce the technology to all hatcheries involved in fish stocking	1, 2, 3, 5	costs	LOW
3.1(b)	Ensure that stock produced in interstate hatcheries meets quality assurance standards	1, 2, 4, 6	standards	LOW
3.2(a)	Promote the use of appropriate technology in genetic resource management	1, 2, 4, 5, 6	standards	LOW
3.3(a)	Develop a broodstock collection policy and guidelines.	1, 2, 5, 6	standards	LOW

E6.3.3 Groups involved in stocking, management or monitoring

As mentioned in the introduction to this assessment, the economic implications of the draft FMS for groups involved in stocking are likely to be minimal. On the other hand, the implications for organisations involved in the management and monitoring of stocking activities (i.e. NSW Fisheries) may be more substantial, although it is not possible to accurately determine the potential increase. This is because the draft FMS proposes to streamline administration and review research, but does not provide an indication of existing and possible costs. If the additional management and research occurs, it is likely that the number of jobs required to manage and monitor the activity will increase. Again, it is important to take into account that this increase is off a low base, so the flow on effect of the increased employment is likely to be minimal. Another avenue through which employment in management and/or monitoring activities undertaken by NSW Fisheries is likely to increase is as a result of the draft FMS management response 2.3(a), as classifying waters throughout the State on the basis of their suitability for stocking is likely to be a lengthy and detailed process.

E6.3.4 Fishing related organisations or businesses

All of the draft FMS responses outlined in Tables E4 and E5 are likely to have impacts on fishing businesses, such as fishing guides and tackle shops. In the instance that the draft FMS results in a significant increase in stocking levels, and hence a perception by recreational fishers that there are increased fishing opportunities, there will be major benefits to fishing businesses, such as fishing guides and tackle shops, in the form of increased expenditure by recreational fishers.

A 10% increase in angler expenditure would translate to more fishing days in the different regions and, hence, increase expenditure in different areas frequented by recreational fishers, as indicated in Table E6. Conversely, reductions in recreational fishing expenditure would negatively impact businesses dependent on fishing activity.

Table E6. Estimates of proportional increases (%) in total expenditure by region

Region	Proportion of Total Expenditure (%)	Proportional increase in total expenditure (%)				
		0.4	0.9	1.3	1.8	2.2
North Coast NSW	4.5	0.4	0.9	1.3	1.8	2.2
New England	7.4	0.7	1.5	2.2	2.9	3.7
Hunter & Central Coast NSW	2.3	0.2	0.5	0.7	0.9	1.1
Sydney	10.1	1.0	2.0	3.0	4.0	5.0
Western NSW	10.5	1.0	2.1	3.1	4.2	5.2
South Coast NSW	1.2	0.1	0.2	0.4	0.5	0.6
Southern NSW	19.9	2.0	4.0	6.0	8.0	10.0
ACT	9.8	1.0	2.0	3.0	3.9	4.9
Qld	0.9	0.1	0.2	0.3	0.4	0.5
Vic	32.6	3.3	6.5	9.8	13.1	16.3
SA	0.8	0.1	0.2	0.2	0.3	0.4
WA	0.1	0.0	0.0	0.0	0.0	0.0
Grand Total	100%	10%	20%	30%	40%	50%

The economic implications of the draft FMS for fishing clubs and acclimatisation societies are minimal. The major implications of the draft FMS for this group are expected to be social in nature. These aspects are covered in E7.

E6.3.5 Cost recovery by NSW Fisheries

Currently NSW Fisheries funds research, management and monitoring activities associated with stocking, as well as the Dollar-for-Dollar stocking program, from the recreational fishing licence trust. Through the trust fund, the stocking program is cost recovered, with recreational fishers paying the price for having better recreational fishing opportunities as a result of the stocking program.

There may be increased costs of administration and management as a result of responses in the draft FMS. Increased costs could be met through increasing the amount of funding given to these activities out of the recreational licence trust, by increasing the licence fee for recreational fishers, or through fees paid by hatcheries. In any case, the need for cost recovery by NSW Fisheries is expected to increase as a result of the draft FMS.

E6.3.6 Landowners adjacent to stocking areas

The implications of stocking activities for landowners adjacent to stocking areas are expected to be legal, rather than economic. Given that the states waterways, apart from private farm dams, are public resources, everyone can use them. However, often the land where the waterways are located is private, and hence access to this land is restricted. If stocking occurs in these waterways, and recreational fishers want access to the waterways for fishing, there could be potential conflicts between fishers and landowners. In order to avoid conflict recreational fishers may need to come to some sort of access arrangement with local landowners, or for stocking to be focussed on the more accessible waters.

E6.3.7 Tourism

The draft FMS responses are expected to have the greatest economic impact on the tourist industry, as this is where most of the economic surplus is generated as a result of stocking activities. At present, the activity of stocking in inland waterways generates significant economic surplus in terms of angler expenditure on tourist services in the regions in which stocking occurs.

E6.3.8 Increases in tourist expenditure

Estimates of increases in expenditure by fishers as a result of increases in stocking levels are presented in Table E7. These figures are based on an estimated expenditure by non-coastal freshwater recreational fishing tourists on day and overnight trips of \$47.5 million (NVS, 1999). An estimate of economic value from stocking (conservative) is also made. This is based on a ratio of recreational expenditure to the economic surplus generated as a result of expenditure by recreational fishers. This ratio is estimated to be around 7.88.

Table E7. Additional total expenditure and economic value as a result of an increase in expenditure by non-coastal freshwater recreational fishing tourists on day and overnight trips

	Percentage of additional total recreational expenditure				
\$M per annum	10%	20%	30%	40%	50%
Total additional expenditure	4.8	9.5	14.3	19	23.8
Economic value	0.6	1.2	1.8	2.4	3.0

The flow on effects of this additional tourist expenditure in NSW, in terms of the multipliers presented in section B3.5, is given in Table E8.

Table E8. Flow on effects of additional tourist expenditure in NSW

Percentage increase in tourism expenditure	Increase in total expenditure (\$M)	Flow on effects expenditure*	Direct employment effect	Indirect employment effect	Total of direct and indirect employment
10%	4.8	3.1	44	36	80
20%	9.5	6.2	86	71	157
30%	14.3	9.3	130	107	237
40%	19	12.4	173	143	316
50%	23.8	15.5	217	179	396

* based on a multiplier between 1.5 and 1.8 (i.e. average 1.65)

E6.4 Comparison between the economics of the current stocking activity and the draft FMS

The draft FMS has very few high impacting management responses

E6.4.1 Cost-benefit analysis

The economics of fisheries management allows an appraisal to be made of the contribution of stocking to the economy, and the impact of any change in stocking activity. As the FMS provides for the continuation of stocking at current levels, then it is expected that the costs and benefits of stocking activity will continue and may even expand due to increased confidence. The economic contribution of stocking activity at current levels is outlined in section B3.5. The costs of the activity are to the government, through research, monitoring and management activities undertaken by NSW Fisheries, and to public and private hatcheries, namely operating costs.

A change in the mix of species that are stocked may bring substantial economic benefit to the regions in which stocking is undertaken. However, this will only be the case if the new species mix is more optimal. For example, a change in stocking that increases the amount stocked of a species that is preferred by anglers will increase the overall economic value of stocking activities.

E6.4.2 Changes to economic multiplier effects under the draft FMS

No changes in multiplier effects are expected under the draft FMS. Changes in economic multipliers would come from significant changes in factors affecting the structure of the economy. The draft FMS is not expected to alter the structure of the economy significantly under envisaged draft FMS policies and, hence, no impacts to multiplier effects would ensue.

E6.4.3 Mitigation measures

The major proposals in the draft FMS provide for the continuation of the freshwater stocking program at the current level and address the key environmental risks that might otherwise present a threat to the activity. Mitigation measures are therefore largely not necessary.

Hatcheries are most likely to be directly affected as a result of changes in stocking policy, in particular due the introduction of higher standards. However, improved standards in hatcheries, as part of an ongoing stocking program, will underpin the long term viability of hatchery businesses by

lowering the risks that might otherwise adversely affect their operations, such as through an interruption in product demand following a disease or pest incident or a threat to the genetic robustness of fish populations. A number of hatchery operators expect higher standards to be implemented and the proposal in the FMS to phase in the higher standards will enable businesses to plan for the adjustments in an orderly way. Nevertheless, some private hatcheries may choose to focus their operations on aquaculture rather than implement the standards proposed for stocking or marginal operators may choose to pursue alternative business activities.

Where additional species or waters are to be stocked a transparent evaluation of the contribution to the overall optimum stocking mix statewide should be undertaken. This would suggest that not stocking species that contribute less to the overall economic benefits of stocking. There is a need to obtain more information on values and species preferences of recreational fishers fishing in different catchments.

E7 Social Implications of the Draft FMS

This section was prepared by Dominion Consulting Pty Ltd.

E7.1 Social implications for local communities of the draft FMS

The analysis of social impacts is constrained by available information and the resources available to the study. In some instances the available information has been supplemented by surveys (Appendix B2).

There is not an accepted fishery-specific methodology for assessing social issues. However, relevant approaches can be drawn from other natural resources industries, and general guidelines followed, such as the *NSW Government's guidelines for assessing social impacts* (NSW Government 1997b).

E7.1.1 Assessment of the social impacts of the draft FMS

Assessment of the social impacts of the draft FMS has two components:

1. assessment of the socio-economic impacts arising directly from how the fisheries management strategy impacts the resource and the social system, including the community
2. assessment of issues arising from the effect of the strategy on the social wellbeing of recreational fishers who are dependent on the resource for social satisfaction.

The draft FMS is expected to have the greatest impacts on the community, i.e. groups involved in stocking, namely fishing clubs and acclimatisation societies. This is because these groups obtain the highest social capital from the activity of stocking. Whilst the value these groups place on this social capital cannot be quantified, it is possible to analyse some of the potential impacts a change in stocking will have for these groups by examining in more detail the demographic profiles of their members.

E7.1.2 Management responses with social implications

As mentioned above, the draft FMS is expected to have the greatest implications for communities who participate in stocking activities (namely members of angling clubs and acclimatisation societies). The draft FMS will also have social implications on a wider scale, i.e. for the regional communities in which stocking activities are undertaken. More specifically, the social well being of those persons employed, either directly or indirectly, as a result of stocking activities will be affected by changes in stocking levels. The social well being of recreational fishers, who place a social value on increased recreational fishing opportunities brought about as a result of stocking, will also be affected by changes in stocking.

Before discussing the social implications of the draft FMS in more detail, the management responses given in the draft FMS that have social implications are ranked as high or low according to their overall impact, i.e. the degree to which the proposed management responses affect community values associated with stocking (Table E9).

Table E9. Draft Fisheries Management Strategy Responses for Fish Stocking in NSW Inland Waters that have social implications (ranked by potential social impact)

Response	Description of response	Goals	Issues	Impact
1.4(b)	Recognise and where appropriate incorporate regionally based environmental management arrangements in the stocking review framework	2, 3, 4, 5, 6	Socio-economic	HIGH
2.1(a)	Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities in inland rivers and freshwater public waterways	3, 4	Socio-economic	HIGH
2.1(b)	Recognise region-specific fishery management plans such as the Snowy Lakes Trout Strategy	5	Socio-economic	HIGH
2.1(c)	Broaden the consultation with acclimatisation societies and angling clubs to formulate and implement stocking programs with a view to providing greater equity, access and education about the resource	3, 4	Communication	HIGH
2.3(a)	Develop a classification scheme for NSW waters to evaluate the potential viability of a stocking event based on the most appropriate species, class of stock for particular waters	1, 3, 4, 5, 6	Socio-economic	HIGH
2.3(b)	Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity	1, 3, 4, 6	Socio-economic	HIGH
5.2(b)	Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity	2, 3, 6	Information	LOW
5.2(c)	Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis	2, 3	Information	LOW
1.1(c)	Map the activity in a Geographic Information System (GIS)	1, 2, 3, 5	Information	LOW
1.2(b)	Maintain and improve the management of Conservation Stocking programs to promote the recovery of species that are threatened or of conservation concern	3, 4	Communication	LOW
2.2(a)	Provide for the stocking of native fish for Aboriginal cultural fishing and moiety purposes	1, 3, 4, 5, 6	Socio-economic	LOW
2.2(b)	Ensure that new information about areas or objects of cultural significance is taken into account in the stocking review framework	1, 3, 4, 5	Policy	LOW
2.2(c)	Consult with relevant Aboriginal groups in the assessment of any new sites proposed to be stocked	1, 3, 4, 5	Communication	LOW

Table E9 cont.

Response	Description of response	Goals	Issues	Impact
2.3(c)	Continue to provide a service for religious and ceremonial stocking and increase awareness of the legislative and policy requirements with the groups involved	1, 3, 4, 5	Communication	LOW
4.1(c)	Widely distribute advisory material on stocking policy and procedures in NSW	2, 5	Communication	LOW
4.1(d)	Develop interactive self-assessment tool	1, 2, 3, 5, 6	Industry practice	LOW
4.1(e)	Provide an efficient enquiry/advisory service for fish stocking	1, 2, 3, 5, 6	Communication	LOW
4.2(b)	Periodically report to clients and stakeholders	1, 2, 3, 5	Communication	LOW
4.2(d)	Conduct client satisfaction surveys	2, 6	Communication	LOW
5.1(a)	Facilitate research programs to fill information gaps identified in the risk assessment of the existing activity, as provided for in the Research Plan	1, 2, 3, 4	Policy	LOW
5.1(b)	Publish results of research programs	2, 4, 6	Communication	LOW
5.2(d)	Monitor the level of participation in fish stocking using information gathered through the general recreational fishing licensing system and other appropriate avenues	2, 3	Communication	LOW
5.3(b)	Apply empirical methods to determine optimum stocking density rates (in terms of efficacy and effectiveness), and assess the feasibility of developing and applying an established formulae in the longer term	2, 3	Industry standard	LOW
6.1(a)	Develop and implement a culturally appropriate educational (communication) plan	1, 2, 3, 4, 5	Communication	LOW
6.1(b)	Develop an information kit for NSW Fisheries staff to convey accurate information on fish stocking to clients	1, 2, 3, 4	Communication	LOW
6.2(a)	Develop a Fish Stocking Compliance Plan	1, 2, 3, 4, 5	Compliance	LOW

E7.1.2.1 Draft FMS responses with a high social impact

The high impacting responses listed in Table E9 have direct consequences for the social well-being of groups involved in stocking as well as affecting community values associated with stocking more generally. In particular, the management responses are expected to enhance the involvement of groups involved in stocking activities, and raise community awareness as to the benefits of stocking.

1.4(b) Recognise and where appropriate incorporate regionally based environmental management arrangements in the stocking review framework, and

2.1 (b) Recognise region-specific fishery management plans such as the Snowy Lakes Trout Strategy.

Regionally based environmental and fishery management plans are expected to benefit local communities involved in stocking by raising the profile of stocking activities undertaken at the local

level. This is likely to increase the social capital of members of clubs and societies involved in stocking activity by raising the satisfaction they get from participating in stocking.

Regionally based management plans need to account for the role of stocking in the community and encourage even greater involvement of communities in stocking.

2.1(a) Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities in inland rivers and freshwater public waterways, and

2.3(a) Develop a classification scheme for NSW waters to evaluate the potential viability of a stocking event based on the most appropriate species, class of stock for particular waters

Continuing stocking activities in order to provide and enhance recreational fishing opportunities is likely to greatly improve the social capital of recreational fishers. As these fishers get significant social satisfaction from fishing, any increase in their perceptions as to the amount of fish available to be caught will greatly improve their social capital.

2.1(c) Broaden the consultation with acclimatisation societies and angling clubs to formulate and implement stocking programs with a view to providing greater equity, access and education about the resource

Involving acclimatisation societies and angling clubs in the consultation process and stocking arrangements gives members of clubs and societies, and the volunteers within these organisations, an improved sense of social well-being as they feel more involved in the stocking process. It may even increase participation of these clubs in the stocking process if they feel sufficiently encouraged to increase their stocking activities.

2.3(b) Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity

The draft FMS is expected to have the greatest social impact as a result of this response. The group that will be impacted most will be the angling clubs who undertake stocking activities. Results of the survey of angling clubs revealed that the Dollar-for-Dollar native fish stocking program provided members of angling clubs, and the communities in which they are based, with significant social benefits. By matching every dollar spent by angling clubs, the Dollar-for-Dollar stocking program has enabled angling clubs to release even greater numbers of stock into inland waterways. This has, in turn, increased the social satisfaction clubs receive from stocking.

For many angling clubs, stocking of inland waterways is a major event, with everyone in the club getting involved. In addition, the fundraising activities undertaken by clubs get other members of the community involved in stocking, as well as helping to raise community awareness about stocking.

The Dollar-for-Dollar stocking program also has implications for the social value placed on fishing by recreational anglers. By increasing recreational angling opportunities, stocking has helped to increase anglers' enjoyment of fishing.

E7.1.2.2 *Draft FMS responses with a low economic impact*

Most of the draft FMS responses that are low impacting have implications for the level of communication between government, the public and stakeholders. Given that the management policies in place for stocking are relatively underdeveloped, communication to the public and stakeholders, and involvement of these groups in the management process, is crucial to growth of the industry and successful management of the stocking resource.

Especially crucial to successful management of the stocking resource is research programs designed to improve information available to government on which to base their management decisions. Good information will ensure that the stocking resource is being allocated to its highest value use and this will, in turn, maximize the benefits to society from stocking.

Involving Aboriginal groups in the consultative process will further strengthen the social benefits from stocking by accounting for the value these groups place on the stocking resource. It will also help to minimize potential conflict over access to the resource by stakeholders.

The draft FMS provides for obtaining information on recreational fishing activity, including client satisfaction surveys and continuing to conduct angler-catch surveys at major inland fishing competitions. Inland fishing competitions are major social events in the calendar of angling clubs. In general, several angling clubs will participate in the competition. The social benefits anglers receive as a result of these competitions are high. Angler catch surveys help to quantify the success of stocking programs.

Similarly, the proposal to monitor the level of socio-economic benefit from fish stocking using surveys on an episodic basis will provide a means to analyse the benefits fish stocking brings to a region, in terms of expenditure by recreational anglers on tourism and fishing related services, increases the income and well-being of those persons employed in the region. Economic surveys will help to place a value on this social welfare gain and will allow estimates to be made of the value stakeholders place on access to the resource. Regionally based economic surveys will allow analysis of the regions where stocking activities are having the greatest impact on social welfare, and where the value placed on access to the resource is highest. Structuring stocking policies so that stocking is occurring in regions where the social value placed on the resource is highest will maximize the social welfare attained as a result of stocking activities.

E7.1.3 Changes in stocking activity

The FMS responses listed in Table E9 have been assessed on the basis that there is no change in stocking activities. However, if fish stocking activities change as a result of the FMS, then the social impacts of the strategy are expected to be much greater.

E7.2 Mitigation measures

The major proposals in the draft FMS provide for the continuation of the freshwater stocking program at the current level and address the key environmental risks that might otherwise present a threat to the activity. Mitigation measures are therefore largely not necessary. Any mitigating measures would most likely require NSWF to alter proposed policies in the light of feedback from stakeholder consultation. Successful mitigation will require good communication between government and stakeholder groups.

The draft FMS proposes improved communication between government and stakeholder groups involved in stocking. If these channels of communication prove to be ineffective in addressing most critical issues, alternative levels of communication should be developed. This may require even greater involvement of stakeholders in the consultative process. Involvement of hatcheries staff in the consultative process will help to mitigate any potential negative impacts of changes in stocking policy on hatcheries.

E8 Implications of the Draft FMS for Aboriginal Culture

This section was prepared by Umwelt (Australia) Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Volume 3 Appendix B3.

E8.1 Implications of the draft FMS for traditional fishing, access to fisheries resources, and places of significance

The draft Fish Stocking Fishery Management Strategy was prepared in the context of discussions and negotiations between NSW Fisheries, the Indigenous Fisheries Working Group, the NSW Aboriginal Land Council and specific regional Aboriginal community representatives about the definition of Indigenous fisheries in NSW and the development of opportunities to improve Indigenous community access to the economic benefits of fishery management. The draft FMS includes objectives (e.g. Objective 2.2) that clearly reflect the views of the Aboriginal community about their relationship to natural resources in NSW and support traditional fishing and improving access of the Aboriginal people to fishery resources for cultural reasons. The draft FMS also recognises the potential for economic involvement of and benefits to the Aboriginal community.

However, the views expressed by Aboriginal communities across NSW during this assessment process consistently indicate a perception that the current opportunities are limited or restricting. This suggests an important need for improved communication with regional Aboriginal communities about the management of fish stocking and opportunities for Aboriginal people arising from the activity.

The potential for impacts of Aboriginal sites to occur and to affect the management of fish stocking is recognised in the draft FMS (see Objective 2.2(b)). Potential impacts can readily be clarified and addressed by involving local Aboriginal communities in the management of the fishery on an ongoing basis. In particular, this involvement must provide clear avenues for communication about places of cultural significance, and also about the cultural value of individual fish species at particular locations.

Overall, the feedback from the Aboriginal community is that fish stocking is a positive activity for culture, although there is also a preference that stocking should be limited to native rather than introduced recreational species. There is a strong preference for Aboriginal people to be provided with further opportunities to participate as key stakeholders in the planning, implementation and review of the FMS.

No information has been obtained during this assessment about specific locations where the presence of recreational fisheries focusing on stocks of introduced species (trout) has impacted on the traditional species, cultural values or cultural activities of Aboriginal people. The small sample of Aboriginal people who contributed to this assessment did not suggest that trout should be removed from NSW rivers – this preference was reserved for carp, which is seen as an ecological pest. These are matters, which could be addressed in partnership research in the future.

Aboriginal people are generally not participating in fishing activities as members of recreational fishing clubs or acclimatisation societies. Fishing is a family and community activity. The draft FMS recognises the special cultural values of Aboriginal fishing, and includes objectives that will enhance the role of Aboriginal fishers as a stakeholder. A challenge for the implementation of the FMS is to develop and implement a practical and balanced consultation program for Aboriginal

interests (i.e. separate from recreational interests). The progressive implementation of the IFS is expected to support improved communication and consultation between NSW Fisheries and the Aboriginal community. There is considerable opportunity for the Fish Stocking FMS to result in positive impacts on Aboriginal fishery values.

E8.2 Implications of the draft FMS for Aboriginal communities

The policy position expressed by Aboriginal community representatives is that Aboriginal people feel they have been disadvantaged in a social and economic sense by a range of fishery management initiatives, but are continuing to work with NSW Fisheries to develop new opportunities. Fish stocking has not been nominated as a negative initiative in this regard, in that it is an activity that has never had strong Aboriginal participation.

Notwithstanding this, ongoing fish stocking is seen by the Aboriginal community as a potential opportunity to create further economic opportunities for Aboriginal people. The draft FMS recognises this potential in Objective 2.2(a) and Objective 2.3 (b). These objectives refer to support for Aboriginal communities to be involved in the hatchery industry and are consistent with the recommendations of the Indigenous Fisheries Strategy. These objectives are supported in principle by the Aboriginal community, but the mechanisms to ensure real opportunities remain to be developed.

Within the context of the Indigenous Fisheries Strategy, the success of the FMS will, in part, be dependent on the progressive refinement of implementation responsibilities and performance monitoring and review, particularly with regard to the actions relating to economic benefits and social equity.

E8.3 Implications of the draft FMS for Government policies on Indigenous fisheries issues

The current NSW Government position on specifically Indigenous fishery issues is presented in the NSW Indigenous Fisheries Strategy (IFS). The IFS was released within the same timeframes as new initiatives for ecologically sustainable river management (through Catchment Blueprints prepared by Catchment Boards and Water Management Plans prepared by regionally based Water Management Committees). All of these initiatives make provision for Indigenous participation in the planning and implementation process for aspects of natural resource management. This includes employment of Aboriginal people in state natural resource management agencies to facilitate communication with Aboriginal community groups and the establishment of Aboriginal working groups to provide input on major issues.

Table E10 reviews the Implementation Plan linked to the Indigenous Fisheries Strategy and notes the implications of the actions in the draft Fish Stocking Strategy for the Plan. The outcome of this evaluation is that the actions in the Fish Stocking FMS are generally consistent with the concepts discussed in the IFS. Facilitating opportunities for the involvement of inland regional communities in fish hatcheries, through awareness, training and community development initiatives, represents a key implementation challenge under the IFS.

A further important implication is that most of the actions identified in the IFS Implementation Plan and in the Fish Stocking FMS are in their earliest stages of implementation. Careful monitoring and review of progress, with clear opportunities to update information, protocols etc will be important in both cases.

Table E10. IFS and Fish Stocking implementation links

IFS actions	Implications of draft FMS for Fish Stocking
Create 2 year Project Manager position to support the IFWG and negotiate with Aboriginal communities	This position will assist Aboriginal communities to understand and contribute to fish stock management
Create an Indigenous Fisheries Officer for internal and external community liaison culturally appropriate fishery resource management and compliance issues	Compliance is not a major issue for the Draft FMS for fish stocking, but liaison with regional communities to raise awareness of fisheries policies and practices is an important issue arising from the FMS assessment process.
Develop and facilitate a model for community input to fishery management planning and progressive involvement in FMS	The Fish Stocking FMS can be regarded as part of the processing of developing and refining a model for Aboriginal community participation and highlights communication/participation strategies that still require modified approaches. Note that changes to the Fisheries Management Act, clarifying its objectives in relation to Indigenous fisheries, would also be of benefit here.
Develop a training module for cultural awareness training for NSW Fisheries staff (module has been developed and some staff have completed the training)	The module may require ongoing review and updating to reflect the contributions of Aboriginal communities to FMS as participation becomes more effective
Offer cultural awareness seminars for advisory committees and promote cultural awareness more broadly	The views expressed by the Aboriginal community in relation to fish stocking are consistent with views expressed about other FMS and highlight significant cultural differences in concepts about fishery management. Cultural awareness training for advisory committees is strongly supported.
Review current Indigenous cultural access to fisheries, review options with IFWG and prepare advice after consultation with communities	The draft Fish Stocking FMS recognises some of the matters raised by the Aboriginal community in relation to access to fishery resources and makes specific provision for stocking for cultural events. Ongoing review is essential.
Appoint interim (and then confirm) IFWG to advise on finalisation of the IFS and future membership	This group is a critical communication channel between regional communities and NSW Fisheries and can promote Draft FMS for fish stocking activities such as the involvement of communities in hatchery development
With advice from the IFWG identify people to represent communities	As above
Progressively identify key planning issues for communities	As with the issues about involvement (above), more effort and co-ordination is required to ensure that Aboriginal communities have opportunities to contribute constructively to planning for FMS and broader natural resource management issues.
Consult on Indigenous issues regarding fishery management and marine park planning	The assessment of the draft Fish Stocking FMS is the first step in the process on consulting with Aboriginal communities about this management program. The process to date highlights the challenges in implementing an effective consultation and awareness program.
Implement youth conferencing and warning scheme for young offenders	Not directly applicable to the Draft FMS for fish stocking
Consult with IFWG on fisheries compliance after Indigenous Fisheries Officer in place	As above

Table E10 cont.

Publicise and promote workshops to scope aquaculture opportunities in communities	Aquaculture actions in the IFS are principally directed at the coast (e.g. abalone). The Draft FMS for fish stocking has also raised the possibility of inland aquaculture hatcheries managed by Aboriginal communities.
Fund appropriate feasibility studies in areas where communities are committed to aquaculture	As above
Develop protocols for involving specialist Aboriginal agencies or economic development agencies in working with communities on aquaculture or other commercial ventures	The limited feedback available from regional communities about the draft FMS for fish stocking is that they would want to be involved in the selection of organisations to meet their needs
Identify and formalise community partnership model for an aquaculture hatchery on the coast	Not applicable to the Fish Stocking FMS
Negotiate with TAFE or other training organisations to partner Fisheries in delivering an aquaculture management program for Indigenous people	Whilst aquaculture initiatives are not applicable to the Fish Stocking FMS, this action will be an important step towards potential hatchery operation by Aboriginal people
Implement business development and extension services for Indigenous people in aquaculture	As above
Project manager to identify strategies to maintain levels of Indigenous involvement in commercial fishing	Not relevant to this FMS
Develop an employment strategy for NSW Fisheries in consultation with the IFWG	NSW ALC has raised employment as an important issue for fishery management generally, and there are potential opportunities in fish stocking, with appropriate training
Initiate/facilitate a workshop with natural resource agencies and Aboriginal representative agencies on a joint approach to employment in the sector	This workshop and follow up will provide a framework for broad employment in natural resource management – see the Boomanulla statement for the Aboriginal perspective.
Develop a framework for communities to access and use land they own for coastal aquaculture operations	Not applicable to the Fish Stocking FMS
Review aquaculture and commercial fishing opportunities with the IFWG and prepare advice to communities on skills required to sustain these businesses.	As for other training and skill development initiatives, this could be a step towards the involvement of regional Aboriginal communities in the commercial aspects of fish stocking.

E8.4 Magnitude of risk reduction to Aboriginal interests and values due to the Draft FMS

The actions identified in the draft Fish Stocking FMS refer to the three critical elements of Aboriginal community views about a constructive partnership for the management of fishery (and other natural resources). In this sense, the draft FMS will contribute to a reduction in the risks of impacts on Aboriginal cultural heritage and Aboriginal community concerns.

Opportunities for Aboriginal community participation through the FMS will need to be developed in the implementation stage. This will provide the Aboriginal community with greater certainty and confidence that opportunity for active involvement can be realised, within a partnership approach.

In part, the perception that issues have been imperfectly explored and actions poorly defined is due to the relative early stage of implementation of a broad range of strategies to involve Aboriginal communities generally in natural resource management in ways that clearly respect their cultural values and traditions. Provided fishery managers and Aboriginal communities are vigilant about monitoring and reviewing progress, and make committed efforts to engage in the ongoing implementation of the FMS, there is a reasonable expectation that this will result in strong benefits to the Aboriginal community and reduced risks to cultural heritage.

E9 Implications of the Draft FMS for Sites of Historic, Heritage or Cultural Significance

This section was prepared by Umwelt (Australia) Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Volume 3 Appendix B3.

The assessment of the existing activity found that there was a very low potential for fish stocking activities to interact with or impact on known significant historic heritage items. Continuation of fish stocking activities as proposed under the draft FMS will not increase the risk of impacts on these items.

However, if an extension of fish stocking activities is proposed by another proponent involving new stocking locations or construction of any new facility, the proponent needs to be aware of the responsibilities implied by the heritage legislation and ensure that the specific constraints associated with that location are identified. This will involve confirmation of the presence of any item listed in a relevant register or inventory and modification of the proposal, as necessary, to ensure that such items are not affected by the activity. The Stocking Review Guidelines within the draft FMS address heritage features, but it will be important for the authorising officer to ensure that the appropriate register has been utilised during the preparation of the stocking proposal.

CHAPTER F JUSTIFICATION FOR THE DRAFT FMS

F1 The Need for the Activity of Fish Stocking

This section examines the need for undertaking the activity proposed in the draft fishery management strategy (FMS) and the consequences of not undertaking the activity.

As identified throughout this document, the activity of fish stocking in NSW delivers two distinct fishery management outcomes that service the freshwater fishing sector (comprised of recreational fishers and Aboriginal cultural fishing practices) and the aquatic conservation sector. These services have developed over a long period of time and evolved to satisfy the ever-increasing requirements for quality stock in these areas. NSW Fisheries has refined the technology to breed a range of native and non-native species to meet this demand and where opportunities arise to involve private enterprise in the activity, stock has been procured from those alternative sources.

The inland waterways of NSW have demonstrated a severely reduced ability to maintain adequate stocks of fish due to factors such as environmental degradation and overfishing since European settlement. Given that the environmental remediation programs designed to naturally regenerate stocks will take years to reverse this trend, certainly in the short to medium term, fish stocking is a feasible alternative to enhance freshwater fish populations. Moreover, stocking will maintain the economic and social benefits enjoyed by the community.

F1.1 Consideration of terminating, limiting or increasing stocking

Consideration was given in the development of the draft FMS to terminating, limiting or increasing stocking (see Chapter C). Each of these scenarios proved to have unacceptable outcomes with regard to biophysical, social and economic impacts. As such, a strategy whereby minimum negative impacts could be expected within an acceptable level of probability had to be developed around a regime that mirrored, as far as practicable, the current activity. This saw the development of a system (the FMS) that provides a comprehensive set of management arrangements to maximise the benefits of stocking within an ESD framework.

F1.1.1 Re-establishing threatened or protected species within their natural range

As the State's principal aquatic resource management agency, NSW Fisheries commits a significant portion of its resources to protect threatened and protected species. In particular, they seek to conserve threatened species populations and their habitats and to protect species where their populations are at risk of further deterioration with unaided recovery. Where necessary, emphasis is placed on restoring fish habitats and ensuring that sufficient viable stocks of species are available (augmented through restocking) to support and regenerate populations.

Where a species is locally extinct from an area within its natural range and that area is isolated from other areas with remnant populations of the species, restocking is the only feasible alternative to regenerate those former populations. The natural recruitment process cannot repopulate isolated areas.

To terminate the stocking of threatened and protected species as a conservation measure would result in a reduction in management options and, therefore, lower potential for the recovery of these

species. The stocking of public impoundments and rivers with threatened species such as silver perch, eastern cod and trout cod is commonplace. Silver perch, although a threatened species, may be taken by anglers from impoundments but not rivers. To terminate or limit these types of stockings was considered inappropriate due to the benefits derived from that activity, namely to provide reserve populations of the species and where possible provide angling opportunities for otherwise prohibited species where the activity does not affect threatened populations.

The level of stocking activity in conservation stocking programs is determined by the requirement for stocks to meet the objectives of a recovery plan so the concept of a blanket increase in stocking is not a consideration.

Threatened species conservation breeding and restocking programs under the activity not only achieve a direct result to the benefit of those species but also indirectly support other objectives of conservation management. Education campaigns and angler awareness, scientific research, development of hatchery technology and protection of specific habitats all have inevitable flow-on benefits for other species. As fish stocking can generally take pressure off natural stocks that may otherwise be exploited to unsustainable levels, the proposed activity contributes to the overall abundance of species to some degree.

F1.1.2 Enhancing fishing opportunities

F1.1.2.1 Self-sustaining non-native species

This category includes two of the species of salmonids used in stocking programs, namely the brown trout and the rainbow trout. These two species are believed to have reproducing populations in virtually all stocked waters providing suitable habitat. Stock assessments of wild populations are not available, but marking studies have shown that self-sustaining populations are evident and widespread throughout the State. The Atlantic salmon and brook trout have not demonstrated an ability to develop self-sustaining populations in NSW due to biophysical attributes and specific environmental requirements.

Brown trout and rainbow trout are without a doubt the most contentious species used in stocking in NSW. Both species are considered to be high-order predators with the ability to dominate any waters in which they have been stocked.

The level of sustainability of these populations without supplementation through stocking is unknown, although if stocking was terminated or limited the current level of harvest would more than likely result in depletion of the remaining stock through fishing mortality. To ensure the ongoing viability of self-sustaining populations of these species the FMS proposes to continue stocking to ensure ongoing sustainability of the fishery.

F1.1.2.2 Non self-sustaining non-native species

These species include Atlantic salmon and the brook trout, both of which are unable to establish populations due to biophysical or habitat requirements. These species rely on stocking to provide sufficient numbers to include them in the recreational harvest. Terminating or limiting the stocking of these species would ultimately result in the decline and eventual disappearance of the targeted fishery for them. This would be seen by recreational fishers as a loss in the overall quality of the salmonid fishery and may impact on the social and economic benefits derived from stocking a wider range of salmonid species.

Stocks of these species held at the Gaden Hatchery must be maintained to ensure the ongoing viability of the reproductive lines available to NSW for both stocking and aquaculture purposes. Although not a primary consideration, the subsequent benefit is that they also have a high value in

other regards including their potential for stock enhancement of public impoundments and for reserve lines for the aquaculture industry, particularly the multi-million dollar industries in South Australia and Tasmania, as well as potentially in NSW. Both of these aquaculture industries rely on stock derived from the NSW Fisheries lines of these species. Should these species be lost from NSW, they may never be recovered due to the restriction on importing live salmonids into Australia.

To ensure the ongoing viability of these species, it is proposed under the draft FMS to continue stocking at current rates, subject to stocking assessment. There is currently a targeted fishery for these species, albeit somewhat limited relative to the fishery for brown and rainbow trout, and so the client satisfaction and economic surveys (management responses 4.2d and 5.2c, respectively) will be used to better determine the demand for these species in the longer term.

F1.1.2.3 Self-sustaining native species

This category involves most native species used in stocking programs in NSW. As described earlier in this chapter, the majority of inland fish of NSW have demonstrated a severe reduction in the ability to maintain viable stocks mainly due to environmental degradation and overfishing. The fact that populations of native species remain in the numbers they do in NSW could be attributed in part to the supplementation of stocks for angling, which reduces the overall harvest pressure. If there were no stocking of native species, there may well be even less natural stocks than available today, although as yet there is no evidence to substantiate this theory.

The FMS proposes to continue stocking to help meet the demand for native species in the recreational fishery and to meet the needs of Aboriginal cultural fishing practices, with appropriate stocking reviews, as the preferred and most balanced approach.

F1.1.2.4 Non self-sustaining native species

This category includes several species that are stocked into waters in which they cannot complete the breeding cycle. These species are Australian bass into dams and impoundments, in which this catadromous species cannot migrate to brackish waters to spawn, and silver perch and golden perch into impoundments in the Hunter Catchment (Glenbawn Dam and Glennies Creek Dam) where they do not breed because the necessary environmental triggers and habitat requirements are not available for those species.

The purpose of stocking these species in these waters is to establish recreational fishing stocks where otherwise they would not exist. The stocking of the Hunter Catchment with silver perch and golden perch was first conducted in the mid 1960s and has since seen the steady development of an excellent recreational fishery regularly featured on television angling shows and in fishing magazines.

The stocking of western species into eastern drainage waters (other than in this case) is prohibited by NSW Fisheries policy and no further eastern drainage waters will be stocked in this manner in future. Environmental assessment has been conducted and initial results show that no discernible impact has been experienced (NSW Fisheries, 1999). Given the positive perception held by anglers and the benefits of having such a fishery in the eastern drainage, it is proposed under the FMS to continue the stocking of these waters with historically used species.

The implications of terminating, limiting or increasing stocking under this program each pose fairly obvious impacts on the current situation. Terminating stocking would result in the inevitable depletion of these stocks due to the inability to regenerate in those waters. Limiting stocking would also affect available stocks and lead to depletion, while increasing stocking may or may not realise more fish.

F2 Positive and Negative Aspects of Stocking Under the Draft FMS

Table F1. Overview of the positive and negative aspects of Conservation Stocking under the draft FMS.

Issue	Conservation Stocking	
	Negative Aspects of FMS	Positive Aspects of FMS
Biophysical	<p>There still remains a potential for impacts due to the translocation of live aquatic organisms</p> <p>Increased pressure on resources of receiving environment</p>	<p>Re-establishing populations or enhancing existing populations of threatened species</p> <p>Vastly improved management of genetic issues</p> <p>Improved techniques and husbandry practices transferred to industry</p>
Social	Reduces areas available to harvest stocking	<p>Local community benefit from participation in conservation programs</p> <p>Broad community wellbeing with the knowledge that species are being conserved</p>
Economic	Expensive both in terms of hatchery requirements and research	Cheaper in the short term than many other methods to aid species recovery

Table F2. Overview of the positive and negative aspects of Harvest Stocking under the FMS.

Issue	Harvest Stocking	
	Negative Aspects of FMS	Positive Aspects of FMS
Biophysical	<p>Native species</p> <p>There still remains a potential for impacts due to translocation of live aquatic organisms</p> <p>Risks to established native populations of fish and invertebrates</p>	<p>Reduces pressure on existing natural stocks</p> <p>Reduces risks to threatened aquatic species</p> <p>Stocking of previously unstocked waterways will require higher genetic standards</p> <p>Improved techniques and husbandry practices transferred to industry</p> <p>Reduction of risks to genetic integrity of species through hatchery accreditation and stocking review processes</p> <p>Reduction of translocation risks due to assessment processes & alignment with national systems</p>
	<p>Non-native species (salmonids)</p> <p>There still remains a potential for impacts on threatened and other aquatic species as a result of stocking</p> <p>There still remains a potential for impacts due to translocation of live aquatic organisms</p> <p>Risks to established native populations of fish and artificial stocks</p>	<p>Reduces risks to threatened and non-threatened aquatic species by permanently closing numerous waterways and temporarily closing others</p> <p>Prohibits stocking of any previously unstocked waterways</p> <p>Proposes research to further investigate the impact of salmonids on native species</p> <p>Proposes research to investigate the survival and movement of stocked salmonids</p> <p>Stocking review process ensures ongoing consideration of environmental matters</p>
Social	<p>Use of non-native species</p> <p>Provides resources to a limited sector of the community</p> <p>Potential source of conflict due to access to waterways</p>	<p>Enhanced fishing opportunities</p> <p>Provides for cultural and religious practices</p>

Table F2 cont.

Issue	Harvest Stocking	
	Negative Aspects of FMS	Positive Aspects of FMS
Economic	<p>Short term increase in costs for hatcheries and thus potentially for purchasers of stock</p> <p>Diverts funding that could be used in other fish enhancement programs</p>	<p>Long term increase in certainty of program for hatchery operators</p> <p>Continued benefits to regional economies arising from fishing related industries</p> <p>Classifying natural waters to ensure conditions provide for maximum survival of stocked fish</p> <p>Cheaper in the short term than many other fish enhancement programs</p>

F2.1 Limitations on the justification process

Evaluation of the justification process is difficult to describe due to the inability to assign accepted values to components within, or affected by the activity. For instance, assigning a monetary value to the biophysical factors or social values that may be affected by the activity. In the absence of these benchmarks, the justification process relies on a sound judgement of the strategy in light of the potential for adverse effects versus the potential benefits.

The scale of an effect, such as a disease incursion or genetic shift, is extremely hard to quantify due to the nature of these and most other potential effects posed by the activity. A disease incursion may only affect a small area, but can have a lasting effect on the perceptions of the community at large. Further, where an effect is hard to detect or not detectable for many years after the event, such as in the case of genetic shift, the potential effect may be enormous in the long term yet completely indiscernible at the time.

Therefore, the justifications for the activity where perceived values are assigned to individual components of the wider activity remain intrinsically subjective. Nonetheless, an objective appraisal of the proposal shows that stocking carries inherent risks and the only feasible way to deal with the risks is to develop management responses that are designed to address and avert them. A further factor then comes in to play. Would the management responses be of such a magnitude that the entire activity becomes non-viable? In other words, should a risk management framework override common sense outcomes?

The review of the current operation of the activity showed that although there is a high awareness of the potential risks, there are insufficient risk minimisation or management response capabilities applied. The FMS has been developed to manage the activity, as far as practicable and within reasonable levels of probability, whilst providing appropriate protection of the environment and maintaining existing social and economic benefits.

F2.2 Sensitivity Analysis

Chapter C presents discussion and argument about alternative management strategies. From this, it is apparent that there are few high level, feasible and economically viable or appropriate alternatives to the suite of controls proposed in the draft FMS. Therefore, the sensitivity analysis focuses on the proposed management responses in Section 4 of Chapter D.

The alternative management regimes discussed in Chapter C to address each of the key management issues typically involve using one of the responses already proposed in the draft FMS,

but to a much greater (or lesser) extent relative to other controls. Consequently, the sensitivities of most of the alternative management regimes are covered in the sensitivity analysis carried out with respect to the management regime proposed in the draft FMS. There are a few exceptions to this and they are discussed at the end of this section.

In each case, a qualitative sensitivity analysis has been undertaken, because insufficient quantitative data exists for all three components of ecologically sustainable development (ESD): biological, economic costs and benefits, and social (Table F3). The qualitative analysis has been undertaken as indicated in the DIPNR guidelines for environmental assessment of the activity (Department of Infrastructure, Planning and Natural Resources, 2003). In this analysis, the qualitative sensitivity is the relationship between the degrees of change in the management responses (the variable) versus the likelihood of achieving the draft FMS goals (the desired outcome) within an ESD framework. In this context, each of the management responses has been assessed in terms of its likelihood in achieving the stated objectives.

The proposed draft strategy in the Fish Stocking FMS aims to manage the activity in a way that maintains sustainable inland fish stocks and healthy ecosystems, while maximising the biological, economic and social yield and appropriately sharing the resource.

In this sensitivity analysis, the linkages between goals and responses which are presented in the draft FMS (see Section 4 of Chapter D) have been incorporated as the cross reference between a specific management response for a goal and the other five goals. That is, in the analysis, Goal 1 relates to biological considerations, Goals 2 and 3 relate to equity, economic and social factors while Goals 4, 5 and 6 relate to administration, research and monitoring, compliance and education, respectively.

A common mistake in interpreting the analysis in Table F3 is to confuse ‘sensitivity’ with the ‘impact’ of the management response on the biophysical, economic and social environment. The clearest way to interpret the table is to remember: “if a little change in the management response causes a big change in the likelihood of achieving the above target, sensitivity is high. If a little change in the management response causes a little change in achieving the target, the sensitivity is low”.

Table F3. Sensitivity analysis of the proposed management responses. Where H = High sensitivity, M = Medium sensitivity. L = Low sensitivity. N/A = Not applicable. ? = Uncertain.

MR	Fish Stocking Management Response	Biological	Economic	Social
1.1a	Utilise “Stocking Review Guidelines” for the ongoing assessment of stocking events	H	H	H
1.1b	Use reliable and current information resources to support the stocking review framework	H	L	L
1.1c	Map the activity in Geographic Information Systems (GIS)	H	L	L
1.1d	Implement a schedule of restricted waters where stocking events are limited or prohibited, and review the schedule at least every five years in light of new information	H	H	H
1.2a	Appropriately manage stocking in areas where the activity may adversely affect a threatened species	H	L	M
1.2b	Maintain and improve the management of Conservation Stocking programs to promote the recovery of species that are threatened or of conservation concern	H	L	L
1.3a	Develop and implement genetic resource management guidelines for fish stocking in NSW	H	H	L

Table F3 cont.

MR	Fish Stocking Management Response	Biological	Economic	Social
1.4a	Manage the activity having regard to cross-jurisdictional management arrangements	H	L	L
1.4b	Recognise and, where appropriate, incorporate regionally based environmental management arrangements in the stocking review framework	H	M	M
1.5a	Manage the activity consistently with State and national policies governing the translocation of live aquatic organisms	H	L	L
2.1a	Continue to provide for the stocking of sufficient quantities of fish to provide or enhance quality recreational fishing opportunities in inland rivers and freshwater public waterways	N/A	H	H
2.1b	Recognise region-specific fishery management arrangements where appropriate, such as the Snowy Lakes Trout Strategy	L	H	M
2.1c	Broaden the consultation with acclimatisation societies and angling clubs to formulate and implement stocking programs with a view to providing greater equity, access and education about the resource	L	L	H
2.2a	Provide for the stocking of native fish for Aboriginal cultural fishing and moiety purposes	L	L	H
2.2b	Ensure that new information about areas or objects of cultural significance is taken into account in the stocking review framework	L	L	H
2.2c	Consult with relevant Aboriginal groups in the assessment of any new sites proposed to be stocked	L	L	H
2.3a	Develop a classification scheme for NSW waters to evaluate the potential viability of a stocking event based on the most appropriate species and class of stock suitable for particular waters	L	H	M
2.3b	Continue to develop the Dollar-for-Dollar Native Fish Stocking Program to enhance recreational fishing opportunities, including hatchery development, and provide an avenue for private enterprises to benefit from the activity	N/A	H	H
2.3c	Continue to provide opportunities for religious and ceremonial stocking and increase awareness of the legislative and policy requirements with the groups involved	N/A	L	H
3.1a	Develop and implement quality assurance standards and an accreditation system for hatcheries supplying fish for stocking	H	H	H
3.1b	Ensure that stock produced in interstate hatcheries meets quality assurance standards	M	L	H
3.1c	Participate in the development of FISHPLAN, the NSW component of AQUAVETPLAN	H	?	N/A
3.1d	Link the fish stocking activity to the Aquatic Disease Watch Hotline to enable early reporting of disease outbreaks	H	L	L
3.2a	Promote the use of appropriate technology in genetic resource management	H	L	L
3.2b	Require, where necessary, the mandatory use of microchip technology (PIT-tag system) in broodstock management arrangements	H	L	N/A
3.2c	Investigate the feasibility of developing a cryogenic gene bank of NSW species to ensure the retention of genetic material for Harvest Stocking and Conservation Stocking programs	M	N/A	N/A
3.3a	Develop a broodstock policy and guidelines that address collection, husbandry and management arrangements for hatcheries engaged in the activity	H	N/A	N/A

Table F3 cont.

MR	Fish Stocking Management Response	Biological	Economic	Social
3.3b	Integrate broodstock collection information with the NSW Aquaculture Information Database	H	M	N/A
3.3c	Continue to provide for the issue of permits under section 37 of the <i>Fisheries Management Act 1994</i> for broodstock collection purposes consistent with the vision and goals of the FMS	M	L	L
3.4a	Develop a stocking code of conduct that defines and promotes best-practice	H	N/A	M
3.4b	Issue a copy of the code of conduct to each stockist before a stocking event proceeds	H	N/A	M
4.1a	Develop stocking event forms in plain English	L	N/A	H
4.1b	Develop a policy and procedures manual for NSW Fisheries' staff	L	N/A	N/A
4.1c	Widely distribute advisory material on stocking policy and procedures in NSW	L	N/A	N/A
4.1d	Develop interactive self-assessment and education resource	N/A	N/A	H
4.1e	Provide an efficient enquiry/advisory service for the activity	N/A	N/A	H
4.1f	Provide stocking data to other information resources	L	N/A	H
4.2a	Maintain records of all stocking events centrally	L	N/A	H
4.2b	Periodically report on the activity to clients and stakeholders	N/A	N/A	H
4.2c	Require hatcheries to report annually on production and other factors relevant to the activity	M	N/A	H
4.2d	Conduct client satisfaction surveys	N/A	N/A	H
4.2e	Provide advice to stocking volunteers on appropriate stocking methods, legal implications and other information	L	L	H
5.1a	Facilitate research programs to fill information gaps identified in the risk assessment of the existing activity, as provided for in the Research Plan	H	L	H
5.1b	Publish results of research programs	N/A	N/A	M
5.2a	Develop reliable marking techniques for hatchery reared stock and introduce the technology to all hatcheries involved in the activity	H	M	L
5.2b	Continue conducting angler-catch surveys at major inland fishing competitions and gather other relevant information to the management of the activity	H	M	L
5.2c	Monitor the level of socio-economic benefit from fish stocking using surveys undertaken on an episodic basis	H	M	L
5.2d	Monitor the level of participation in fish stocking using information gathered through the general recreational fishing licensing system and other appropriate avenues	M	N/A	H
5.3a	Having regard to the research priorities identified in the Research Plan, initiate research into the distribution of stocked native species, including any sub-populations	H	N/A	L
5.3b	Apply empirical methods to determine optimum stocking density rates (in terms of efficacy and effectiveness), and assess the feasibility of developing and applying an established formulae in the longer term	L	M	H
5.3c	Continually update the Stocking Review Guidelines and assessment resources to accurately review potential impacts from the activity	L	M	H
6.1a	Develop and implement a culturally appropriate educational (communication) plan	H	N/A	H

Table F3 cont.

MR	Fish Stocking Management Response	Biological	Economic	Social
6.1b	Develop an information kit for NSW Fisheries staff to convey accurate information on fish stocking to clients	N/A	N/A	H
6.2a	Develop a Fish Stocking Compliance Plan	H	N/A	H
6.2b	Require persons involved in stocking to verify stocking events when complete	M	N/A	L

There are three management responses in Table F3 that show high sensitivity to all three facets of ESD. These proposals deal with the development of stocking review guidelines, the schedule of waters restricted from stocking, and the hatchery quality assurance and accreditation standards. The first such proposal involves the establishment of a formal and rigorous review system to support the draft FMS in its pursuit of ESD by ensuring that all matters likely to affect the environment (including economic and social considerations) are taken into account prior to stocking. The second proposal involves the closure of some waters to stocking to protect threatened species and biodiversity while the third proposal involves the development of new standards required by hatcheries to meet the requirements of the FMS.

The sensitivity analysis showed that the use of a comprehensive review system to manage stocking is very effective for achieving biological, economic and socially oriented goals, as are the use of restricted waters and quality assurance measures proposed by the other two goals.

Seven management responses have a high sensitivity to two facets of ESD, namely:

- the development of genetic resource management guidelines for fish stocking in NSW
- the requirement for all fish hatcheries involved in the activity to be accredited
- continuation and development of the Dollar-for-Dollar stocking program
- the continued stocking of public waters to provide or enhance quality recreational fishing opportunities
- the development of stocking guidelines to define and promote best practice
- development and implement of an educational (communication) plan, and
- development and implementation of a fish stocking compliance plan.

These programs, along with stocking review guidelines, restricted waters and quality assurance measures address each of the key high-risk areas that were identified in early iterations of the EIS, namely:

- potential adverse impacts on threatened species and ecological communities
- genetic resource management
- disease and fish health
- hatchery management and quality control
- translocation of live aquatic organisms
- management and administrative systems
- education and compliance
- monitoring and research

F2.3 Social and economic factors

F2.3.1 Social capital

As previously described in this document, the social benefits or “social capital” derived from stocking to the recreational angling sector and Aboriginal culture is considerable. There is a high level of awareness of the activity within the general community (greater than 75%) and a broad perception that stocking provides unique social benefits such as healthy recreational opportunities, tourism and local employment from related industries whilst also providing conservation outcomes for certain fish species. The extent that stocking groups and recreational fishers (the groups with the highest social capital stake) would be affected by reduction in stocking levels is purely speculative and driven by perceptions. However, the potential impacts are perceived by the community as significant. It is considered that lower stocking levels would negatively impact the social capital derived by these groups as well as those in regional areas adjacent to fishing areas. Higher stocking levels are considered to be able to generate more economic and social benefits while the current level of stocking is considered to have the least impact on social considerations and perceptions.

F2.3.2 Supply of fish to the community for consumption

One of the two main objectives of the current and proposed activity is to support and enhance fishing opportunities. An added benefit to fishers is the ability to obtain fish as food and the stocking of public impoundments with edible fish is perceived by the community as an appropriate use of public utilities. The amount of stocked fish taken as food is not readily quantifiable and no surveys to determine amounts have been conducted. Recent surveys of recreational and Indigenous fishing in NSW report that of the 7.7 million fishing events recorded over 6.9 million fishing days, 15% of the fishing activity occurred in freshwater rivers and a further 9% in freshwater dams and lakes, or approximately 1.2 million events (Henry and Lyle, 2003). Substantial amounts of freshwater fish were reported for freshwater anglers (including species that are stocked), yet no breakdown of figures was provided to delineate wild from stocked fish. Some conclusions could be made in relation to the amount of salmonids reported as harvested per annum (~122 tonnes), due to the fact that all salmonids in NSW must be derived from initial stocking programs. Given that the salmonid figures alone represent a substantial harvest, then it would be reasonable to suggest that stocking provides a significant quantity of fresh fish for the angling community.

F2.3.3 Economic factors

There have been no targeted social surveys undertaken in relation to the fish stocking activity in NSW and there is little available information from which to estimate social impacts of fisheries management changes. The economic and social survey undertaken by Dominion Consulting Pty Ltd (see Chapter B) on behalf of NSW Fisheries has provided some information that does allow a preliminary assessment of the nature and scale of employment associated with the activity.

Figures relating to fish stocking related employment may be found in Chapter B (Social and Economic Impacts). This section shows the level of direct and indirect employment resulting from the activity and estimates the potential worth of the entire activity in NSW.

While the total employment estimate shows that only a relatively small number of people are involved in the physical activity of producing fish for stocking (less than 100), fishers attracted to the stocked waters generate extensive employment through the need for accommodation, food, fuel and

ancillary items and services such as fishing, camping gear and fishing guides. Although there is no specific estimate of the value of fish stocking across the State and for all species, it is estimated to be worth approximately \$47.5M to the Snowy Mountains region alone, through the stocking of impoundments and rivers with salmonids. To put this dollar value into perspective, this figure represents approximately ten times the annual value of catches in the entire Ocean Hauling or Estuary Prawn Trawl commercial fisheries (NSW Fisheries, 2002).

The fish stocking activity tends to focus around large impoundments or natural waters associated with recreational inland fishing, however, a significant number of fishers engaged in the activity reside in metropolitan areas or larger towns throughout NSW and substantial financial benefit is generated through recreational fishing tourism and related expenditure.

The likelihood of maintaining or replacing these economic factors, should the fishery cease to operate, would be very low in the short term and likely to have a major impact on employment and economic benefits in areas that have developed in concert with the activity over many years. Conversely, an increase in stocking levels would more than likely create a perception in anglers' minds that greater angling opportunities would also increase and may therefore generate increased levels of fishing. Limiting the activity to only artificial waterways may also affect the quality of inland angling in NSW and the perception of anglers, neither of which are desirable when such a socially and economically valuable enterprise is at stake.

F3 Outline of Key Management Provisions to Minimise Risk

The draft FMS is a comprehensive risk management system designed to take into account all matters likely to affect the environment by way of the activity. Areas of risk identified in the review of the current operation of the activity fall into eight categories:

1. potential adverse impacts on threatened species and ecological communities
2. genetic resource management
3. disease and fish health
4. hatchery management and quality control
5. translocation of live aquatic organisms
6. management and administrative systems
7. education and compliance, and
8. monitoring and research

The key management provisions used to mitigate potential risks are described below.

Potential adverse impacts on threatened species and ecological communities

The key management provisions dealing with this area include the establishment of areas that are permanently closed to stocking, other areas where it is temporarily closed, and restricting the stocking of salmonids to previously stocked (since 1990) waters. These facets are also encompassed within an overarching formal and rigorous review system that will provide a consistent and holistic approach to the management of the activity from a State and local level. This stocking review process considers all matters likely to affect the environment and relies on best available information sources on threatened species and important ecological communities to make an accurate appraisal of every stocking event. The review system is linked to the permit administration system of NSW Fisheries and involves experts in NSW Fisheries Threatened Species and Biodiversity Unit who will ensure that any event is acceptable in relation to any potential ecological concerns.

Other initiatives developed in the FMS include the provision of education and advisory material to increase the knowledge of the activity by those involved and the wider community and through implementation of targeted compliance initiatives to maximise voluntary compliance while providing effective deterrence against illegal activity.

Cross-jurisdictional management arrangements with other fisheries agencies and other natural resource management authorities will ensure alignment with other environmental management strategies such as the Native Fish Strategy for the Murray Darling Basin (MDBMC 2002) and the National Translocation Policy (AFFA 1999).

Genetic resource management

Key management provisions for this area include the development of genetic resource management guidelines designed by experts in the field and progressive implementation of them in all hatcheries involved in the activity.

The development of broodstock collection, husbandry and management guidelines specifically for the activity would be progressively implemented in all hatcheries involved in stocking will ensure the consistent production of quality stock.

Ongoing and new research is proposed to identify and describe genetic variations within the distribution of stocked native species and identification of species with known (or suspected) significant genetic variation between populations in different areas. The research would allow the designation of appropriate broodstock collection zones and respective stocking zones.

Importantly, the genetic protocols required under the draft FMS provide a clear decoupling of aquaculture hatcheries from those that aim to provide fish for stocking purposes. This was one of the major risks of the existing activity and has been nullified through the draft FMS. To further mitigate those risks, native fish produced for harvesting purposes will have to meet stringent new standards, and after 5 years, will have to further strengthen their protocols to meet the higher standard of fish produced for conservation purposes.

Disease and fish health

Key management provisions in this area include incorporation of nationally approved AQUAVETPLAN (national disease response plan) into the strategy to provide appropriate responses to any disease incursion affecting the activity and ensuring operational procedures manuals (AQUAVETPLAN) are available to hatchery operators.

Linking the activity to an initial response fund for disease emergencies and establishment of a disease-mapping data set would assist stocking assessments and registration of the activity with the proposed national Aquatic Disease Watch Hotline.

Hatchery management and quality control

Further to the stocking review system, the environment is protected through the development and implementation of a hatchery quality control and accreditation system. This will ensure that consistent standards are applied to the production of stock in all hatcheries involved in the activity ensuring the use of healthy and genetically sound fish.

The development of guidelines that clearly describe approved methods for stocking, transport, holding, and ethical treatment and care of stock will increase awareness, best practice and quality of released stock.

The development of a refined system of annual reporting for all hatcheries involved in the activity would improve information quality and reporting arrangements.

Translocation of live aquatic organisms

All stocking proposals are to be assessed in accordance with the State and nationally recognised translocation policies. Advisory material is to be published for education and compliance programs to improve awareness of translocation issues (this topic will arise in most advisory material produced under the FMS). Mapping and ongoing maintenance of spatial data to provide the most up-to-date information will be used in stocking reviews, while management of the activity will be carried out in accordance with relevant pest-species control initiatives.

Management and administrative systems

This area will be improved to manage the vast amounts of complex information arising from the activity. The development of a formal permitting and reporting system to complement the stocking assessment system will provide a comprehensive review, licensing and reporting structure.

Procedural guidelines for consistent and successive management of the activity with NSW Fisheries will ensure that the provisions of the FMS are carried out consistently in the future regardless of internal staff changes.

Adoption of new regulatory controls on reporting and compliance requirements will provide greater protection for biophysical aspects of the activity as well as information management.

Education and compliance

Education and compliance components will receive new focus under the FMS through the development of a Fish Stocking Education Plan and a Fish Stocking Compliance Plan. The development of these plans will provide a structured approach to the establishment of education and compliance services within the activity.

This includes the development of a publication to be named 'Stocking Guidelines' to promote best-practice at the point-of-release that will also provide critically important information about the strategy and requirements of those involved.

Compliance programs will be aligned with the Aquaculture Compliance Strategy (a five-year compliance strategy developed for the aquaculture industry 2002 – 2007) and associated reporting systems where appropriate.

Monitoring and research

To provide significant support to the measures described above, the draft FMS proposes an extensive research plan to fill existing information gaps identified in Chapter B. In particular, the key areas of genetics, environmental impacts of stocking and the efficacy of stocking all have proposed programs to mitigate the risks to those elements due to the existing high level of uncertainty.

Monitoring and research of the activity will gain renewed focus under the FMS. The establishment of formal administrative systems will improve access to data and provide avenues for data analysis. The use of GIS (Geographic Information Systems) mapping to progressively monitor the activity will provide further information resources to monitor the activity and ensure environmental issues are readily identified.

Continued monitoring of survival and growth rates of marked or tagged stock will be undertaken, as will angler surveys at major fishing events where measurements, weight and identification of stocked fish are collected and assessed.

The fish stocking database will be managed in a more accurate and timely manner allowing for rapid and accurate reporting of the activity.

Fish marking technology will be implemented in private hatcheries where necessary to ensure that this technology is successfully transferred to the private sector.

F4 Justification for the Draft Strategy

Under the draft FMS, all fish liberation events in natural waters will be subject to the provisions of the stocking review system and Part 7, Division 7, section 216, of the FM Act (Protection of Aquatic Habitats). The purpose of this is to prevent the spread of diseases in fish and to prevent any adverse affect on existing fish and fish habitats by introduced species of fish.

An initial review of any stocking event is to be made before the event takes place to ensure that it forms part of an approved program under the draft FMS and that the stock is procured from an appropriate source. If the event meets the initial criteria, then a site-specific assessment is made against the potential for the activity to negatively impact on the environment. Factors addressed in the stocking review consider the fundamental aspects of the proposed event, including the natural range and distribution of the species to be stocked and whether the stocking poses any immediate threat to endangered communities or ecosystems generally.

Under this system, only bona-fide programs are considered and any ill-conceived and unacceptable events are rejected early in the process.

Other issues considered under the stocking review process include social, cultural, historic, and species-specific issues such as the presence and management of threatened species at a local level. The Threatened Species and Biodiversity Unit of NSW Fisheries (TSBU) is required to approve all events that may affect a threatened species to ensure the proposal is consistent with existing management arrangements such as a threatened species recovery plan or, where no plan exists, that the proposal is acceptable with regard to general biodiversity and habitat protection issues.

Private hatcheries that are approved to engage in the activity, as with other forms of aquaculture in NSW, are managed initially by NSW Fisheries under Part 6 of the *Fisheries Management Act 1994* (Aquaculture Management) to ensure that the appropriate performance standards for hatcheries are achieved (site selection, licensing and operations). Private hatcheries can only produce stock for waters under an approved stocking program or with a stocking permit issued by NSW Fisheries. To bolster this critically important area, a Hatchery Accreditation Scheme is to be developed under the strategy whereby each participating hatchery must demonstrate a certain level of competence and expertise, the extent of which is determined under a Hatchery Quality Assurance Program being developed by NSW Fisheries concurrently with this strategy.

Where NSW Fisheries is the proponent, fish are sourced and stocked to support an approved program under which environmental impacts are assessed. Only stock of the highest available quality is used with specific attention paid to standards of fish health and genetics to minimise risks to the receiving environment. The departmental stocking programs undergo the same rigorous stocking review system as that applied to external proposals prior to any release.

The activity itself is associated with some environmental risks, many of which are due to the high level of uncertainty surrounding the extent and magnitude of any impacts, and it is imperative that management arrangements to minimise or eliminate these risks are implemented to ensure that existing environmental problems are not exacerbated. The draft FMS is designed to recognise potential negative impacts, establish robust review and quality control systems, and provide a clear and transparent management framework for the ongoing activity within the principles of ESD and continuous improvement.

There is concern that radical changes to the existing activity may have undesirable effects that may cause major disruptions to established hatcheries and related industries that have grown to rely on a comprehensive stocking regime such as that existing today. It is important to recognise that changes should be implemented progressively and that as better information feeds into the system, a process of continual improvement will ensure that any issue, including those that may arise in future, can be adequately addressed.

The draft FMS is designed to take into account all of the above issues while providing sound solutions to potential impacts. The strategy is designed to be improved as better information becomes available with a view to maximising the potential recreational, social and economic benefits of a well-managed fish stocking activity.

F4.1 Proposed stocking regimes and the principles of ESD

The impact of the activity of fish stocking upon the environment is assessed in the EIS by an analysis of the risks associated with the proposed strategy as outlined in Chapter D. The risks associated with the draft FMS are partitioned into two components related primarily with (1) the stocked species and (2) potential impacts on threatened species, aquatic biodiversity and ecological communities (the wider environment). The estimates of the potential risks are fully detailed in Chapter E of the EIS.

The stocking activity proposed by the FMS sets out several stocking regimes to take place within specific stocking zones within NSW. These regimes are directly related to the harvest fishery outcomes and conservation stocking outcomes as described in the vision for the activity described in Chapter D, a component of which is to manage the activity within the principles of ESD.

The principles of ESD consider the environment in terms of both natural and anthropological outcomes. Actions supporting ESD are proposed to ensure that not only present generations and environments are protected, but also that present and future generations have an opportunity to enjoy the benefits of a well managed activity thereby ensuring intergenerational and intragenerational equity.

In relation to the FMS, the focus of the economic development component of fish stocking is not intended to exploit the environment to satisfy only short-term community benefits. Under the strategy, fish stocking is designed to meet community expectations with regard to fishing opportunities and conservation outcomes by maximising the benefits of the activity with ecologically acceptable boundaries. The suite of management provisions provided will ensure that as the activity continues it is complemented by better information and review systems to continually improve the performance of the activity, thus safeguarding the welfare of future generations.

The prudent management of resources for present and future generations is encapsulated within the draft FMS. Management arrangements put in place for the present activities are done so to protect, as far as possible, the equity of future generations and the resources upon which the activity relies. Any activity that poses unacceptable threats to the future welfare of the human and natural environments is not acceptable under the draft FMS and where potential hazards are identified, measures are put in place to ensure they are averted or minimised to within an acceptable level of probability.

The draft FMS objectives and management responses are set out in Section 4 of Chapter D. Risks to the environment are addressed by the following Objectives:

- 1.1 to develop and maintain a framework to guide appropriate review of stocking activities

- 1.2 to minimise and/or eliminate any negative impact from the activity on threatened species, populations and ecological communities (including mammals, birds, reptiles, amphibians, fish, invertebrates and vegetation), and where possible promote their recovery
- 1.3 to provide reliable genetic resource management in the activity
- 1.4 to implement the FMS in a manner consistent with related Commonwealth and State endorsed programs designed to protect aquatic environments and biodiversity
- 1.5 to appropriately manage the risks associated with translocation of live aquatic organisms during stocking activities
 - 2.1 to provide sufficient quantities of quality stock to support enhanced recreational fisheries
 - 2.2 to minimise any negative impacts of the activity on cultural heritage values and provide opportunities for Aboriginal communities to participate in stocking activities and to support cultural fishing practices
 - 2.3 maximise economic benefits and provide social equity from the activity
 - 3.1 ensure stock is of the highest standard in terms of fish health
 - 3.2 to promote the use of appropriate technology for genetic resource management in all hatcheries involved in the activity
 - 3.4 implement best practice in broodstock collection and management, and
 - 5.3 use research to develop better stocking practices

F4.2 Preferred stocking regimes

The preferred stocking regimes applying to individual catchments are contained with the Stocking Zone Proposals - Chapter D. These proposals set out the type of stocking proposed to be undertaken within each zone and include species to be used and the objectives sought for each zone, through stocking under the draft FMS.

CHAPTER G REFERENCES

Note: articles that have not been externally peer reviewed and published in a journal or book are denoted with an asterisk (*).

- *ABS (2003). Population data of NSW. Australian Year Book 2002, Canberra.
- *ACT Government (1999a). Macquarie perch (*Macquaria australasica*): an endangered species. Action Plan No. 13. Environment ACT, Canberra, 16 pp.
- *ACT Government (1999b). Murray river crayfish (*Euastacus armatus*): a vulnerable species. Action Plan No. 14. Environment ACT, Canberra.
- *ACT Government (1999c). Trout cod (*Maccullochella macquariensis*): an endangered species. Action Plan No. 12. Environment ACT, Canberra
- *ACT Government (1999d). Two-spined blackfish (*Gadopsis bispinosus*): a vulnerable species. Action Plan No. 11. Environment ACT, Canberra
- *ACT Government (2002). Silver Perch (*Bidyanus bidyanus*) - an endangered species. Draft Action Plan No. 26. Environment ACT, Canberra
- Allen G.R. and Burgess, W.E. 1990. A review of the glassfishes (Chandidae) of Australia and New Guinea. *Records of the West Australian Museum, Supplement No. 34*, 139-206.
- Allen, G.R. (1996a). Family Melanotaeniidae: Rainbowfishes (McDowall, R.M. editor) *Freshwater Fishes of South-Eastern Australia*, Reed Books, Sydney.
- Allen, G.R. (1996b). Family Chandidae: Glassfishes, chanda perches. In *Freshwater Fishes of Southeastern Australia* (ed. McDowall, R. M.) pp. 146-149. Reed Books, Sydney.
- Allendorf, F. W. (1991). Ecological and genetic effects of fish introductions: Synthesis and recommendations. *Canadian Journal of Fisheries and Aquatic Sciences* **48 Suppl**, 178-181.
- Allendorf, F.W. and Phelps, S.R. (1980). Loss of variation in a hatchery stock of cutthroat trout. *Transactions of the American Fisheries Society*. **109**:537-543.
- Allendorf, F.W. and Ryman, N. (1987). Genetic management of hatchery stocks. *Population Genetics and Fishery Management*. pp.148,150. (N. Ryman and F. Utter, editors) University of Washington Press, Seattle.
- Andrewartha, H.G., and Birch, L.C. (1954). *The Distribution and Abundance of Animals*. Chicago University Press, Chicago, 782 pp.
- Andrews, A. P. (1976). A revision of the family Galaxiidae (Pisces) in Tasmania. *Australian Journal of Marine and Freshwater Research* **27**, 297-349.
- Andrews, A. P. (1996). Family Bovichtidae: Congolli. In *Fishes of South-eastern Australia* (ed. McDowall, R. M.) pp. 198-199. Reed Books, Sydney.
- *Anon, (1996). Pressures on Aquatic Biodiversity from Land Use. *Australia State of the Environment* (Alexander, N. editor), CSIRO Publishing.

Anstis, M. (1997). The New England Tree Frog, *Litoria subglandulosa*. In *Threatened Frogs of New South Wales: Habitats, Status and Conservation* (ed. Ehman, H.) pp. 212-220. Frog and Tadpole Study Group of NSW Inc, PO Box A2405, Sydney South 2000.

Anstis, M., Alford, R. A., and Gillespie, G. R. (1998). Breeding biology of *Litoria boorooolongensis* (Moore, 1961), and *Litoria lesueuri* (Duméril & Bibron, 1841) (Anura: Hylidae) and comments on population declines of *L. boorooolongensis*. *Transactions of the Royal Society of South Australia* **122**, 33-43.

Arthington, A. H. (1991). Ecological and genetic impacts of introduced and translocated freshwater fishes in Australia. *Canadian Journal of Fisheries and Aquatic Sciences* **48** (Supl. 1), 33-43.

*Arthington, A. H. (1996). Recovery plan for the Oxleyan pygmy perch (*Nannoperca oxleyana*). Final Report to the Australian Nature Conservation Agency.

Arthington, A.H., McKay, R.J., Russell, D.J. and Milton, D.A. (1984). Occurrence of the introduced cichlid *Oreochromis mossambicus* (Peters) in Queensland. *Australian Journal of Marine and Freshwater Research*. **35**:267-272.

Ashburner, L.D., (1976). Australian fish face threat from foreign diseases. *Australian Fisheries*. **36**(6):18-21.

*Astles, K.L.; Winstanley, R.K.; Harris, J.H. and Gehrke, P.C. (2003). Regulated rivers and fisheries restoration project- experimental study of the effects of cold water pollution on native fish. NSW Fisheries Final Report Series No. 44, 2003, 54pp.

Aulstad, D. and Kittlesen, A. (1971). Abnormal body curvatures of rainbow trout (*Salmo gairdneri*) inbred fry. *Journal of the Fisheries Research Board of Canada*. **28**:1918-1920.

Ault, T. R., and White, R. W. G. (1994). Effects of habitat structure and the presence of brown trout on the population density of *Galaxias truttaceus* in Tasmania, Australia. *Transactions of the American Fisheries Society* **123**, 939-948.

Baltz, D.M. (1990). Autecology. *Methods for Fish Biology*. p.588. (C.B. Schreck and P.B. Moyle, editors). American Fisheries Society, Maryland.

*Barlow, C.G. and Rodgers, L.J. (1989). The Proposal to Introduce Nile perch to Australia. *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government publishing Service, Canberra.

*Battaglene, S., and Prokop, F. B. (1987). Golden Perch. NSW Department of Agriculture.

Baverstock, P.R., Joseph, L. and Degnan, S. (1993). Units of management in biological conservation. *Conservation Biology in Australia and Oceania*. pp.287-293. (C. Moritz and J. Kikkawa, editors). Surrey Beatty & Sons, Chipping Norton.

*Bearlin, A.R. and Tikel, D. (2002). Conservation genetics of Murray-Darling Basin fish: silver perch (*Bidyanus bidyanus*), Murray cod (*Maccullochella peelii*), and trout cod (*M. macquariensis*). *Managing translocation and stocking in the Murray- Darling Basin*. September 2002, Canberra, Australia.

*Berger, L., Speare, R., and Hyatt, A. (1999). Chytrid fungi and amphibian declines: overview, implications and future directions. In *Declines and Disappearances of Australian Frogs* (ed. Campbell, A.) pp. 23-33. Environment Australia, Canberra.

- Berra, T. M. (1974). The trout cod, *Maccullochella macquariensis*, a rare freshwater fish of eastern Australia. *Biol. Conserv.* **6**,53-56.
- Biggs, B. J. F., Francoeur, S. N., Huryn, A. D., Young, R., Arbuckel, C. J., and Townsend, C. R. (2000). Trophic cascades in streams: effects of nutrient enrichment on autotrophic and consumer benthic communities under two different fish predation regimes. *Canadian Journal of Fisheries and Aquatic Sciences* **57**,1380-1394.
- Bishop, K. A., and Bell, J. D. (1978). Aspects of the biology of the Australian grayling *Prototroctes maraena* Günther (Pisces: Prototroctidae). *Australian Journal of Marine and Freshwater Research* **29**,743-761.
- *Bluhdorn, D.R., Arthington, A.H. and Mather, P.B. (1989). The Introduced Cichlid, *Oreochromis mossambicus*, in Australia: A Review of Distribution, Population Genetics, Ecology, Management, Management Issues and Research Priorities. pp. 83-92. *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government publishing Service, Canberra.
- Boon, P. I., Bunn, S. E., Green, J. D., and Shiel, R. J. (1994). Consumption of cyanobacteria by freshwater zooplankton: implications for the success of 'top-down' control of cyanobacterial blooms in Australia. *Australian Journal of Marine and Freshwater Research* **45**,875-887.
- Briggs, G. (1998). Murray-Darling *Mogurnda adspersa*. *Fishes of Sahul* **12**,553-556.
- Brodziak, J; and Link, J. (2002). Ecosystem-based fishery management: what is it and how can we do it? *Bulletin of Marine Science*, **70**: 589-611.
- *Brown, A., and Nicol, S. (1998). Trout Cod Recovery Plan: Final Report 1998. Department of Conservation and Natural Resources, Flora and Fauna Branch, Melbourne.
- *Brown, A., Nicol, S., and Koehn, J. (1998). Trout Cod (*Maccullochella macquariensis*) recovery plan. Department of Natural Resources and Environment, Melbourne.
- *Brown, A.M. (1988). Genetic aspects of the propagation and distribution of fishes. *Proceedings: Fish Genetics Workshop*. pp.38-45. (S.J. Rowland and Barlow, R., editors). Cronulla NSW, August 2000. NSW Agriculture and Fisheries.
- Bryant, E.H. and Reed, D.H. (1999). Fitness decline under relaxed selection in captive populations. *Conservation Biology*. **13**:665-669.
- *BTR (1999). National Visitors Survey 1998 (draft). Via Tourism NSW, Published by BTR, Canberra.
- *Butcher, A. D. (1945). The food of indigenous and non-indigenous freshwater fish in Victoria with special reference to trout. *Victorian Fisheries and Game Department Fisheries Pamphlet No. 2*,48 pp.
- Butcher, A. D. (1967). A changing aquatic fauna in a changing environment. *IUCN Publications New Series* **9**,197-218.
- Cadwallader, P. L. (1978). Some causes of the decline in range and abundance of native fish in the Murray-Darling river system. *Proceedings of the Royal Society of Victoria* **90**,211-224.
- Cadwallader, P. L. (1979). Distribution of native and introduced fish in the Seven Creeks River system, Victoria. *Australian Journal of Ecology* **4**,361-385.

Cadwallader, P. L. (1981). Past and present distributions and translocations of Macquarie perch *Macquaria australasica* (Pisces: Percichthyidae), with particular reference to Victoria. *Proceedings of the Royal Society of Victoria* **93**,23-30.

*Cadwallader, P. L. (1996). *Overview of the impacts of introduced salmonids on Australian native fauna*. Australian Nature Conservation Agency, Canberra.

Cadwallader, P. L., and Eden, A. K. (1982). Observations on the food of rainbow trout, *Salmo gairdneri* Richardson, in Lake Purumbete, Victoria. *Bulletin of the Australian Society for Limnology* **8**,17-21.

Cadwallader, P. L., and Rogan, P. L. (1977). The Macquarie perch, *Macquaria australasica* (Pisces: Percichthyidae), of Lake Eildon, Victoria. *Australian Journal of Ecology* **2**,409-418.

Campton, D. (1987). Natural Hybridization and Introgression in Fishes: Methods of Detection and Genetic Interpretations. *Population Genetics and Fisheries Management* (Ryman, N., and Utter, F. editors) University of Washington Press, Washington.

*CARE (2002). Regional economic multipliers associated with recreational fishing expenditure estimates in the Snowy Mountain and regional NSW. Unpublished draft Input/Output modelling results supplied to Dominion Consulting by Dr Roy Powell of the Centre for Agricultural and Regional Economics Pty Ltd (CARE), NSW.

Closs, G. P., and Lake, P. S. (1994). Spatial and temporal variation in the structure of an intermittent-stream food web. *Ecological Monographs* **64**,1-21.

Closs, G. P., and Lake, P. S. (1996). Drought, differential mortality and the coexistence of a native and an introduced fish species in a southeast Australian intermittent stream. *Environmental Biology of Fishes* **47**,17-26.

*Clunie, P., and Koehn, J. (2001a). Freshwater catfish - a recovery plan. Final report for Natural Resource Management Strategy Project R7002 to the Murray Darling Basin Commission, Melbourne.

*Clunie, P., and Koehn, J. (2001b). Freshwater catfish - a resource document. Final report for Natural Resource Management Strategy Project R7002 to the Murray Darling Basin Commission, Melbourne.

*Clunie, P., and Koehn, J. (2001c). Silver Perch: A Recovery Plan. Final report for project R8002 to Murray-Darling Basin Commission: Canberra. Department of Natural Resources and Environment, Victoria.

*Clunie, P., and Koehn, J. (2001d). Silver Perch: a Resource Document. Final report for Natural Resource Management Strategy Project R7002 to the Murray Darling Basin Commission, Melbourne.

Cogger, H. G. (1996). *Reptiles and Amphibians of Australia*, 5 edition. Reed Books Australia, Melbourne, pp.

*Corcoran K, Allcock, A., Frost, T. and Johnson, L. (1999). BTR Occasional Paper No. 28, Valuing Tourism; Methods and Techniques, Bureau of Tourism Research.

Crisp, D. T., and Carling, P. A. (1989). Observations on siting, dimensions and structure of salmonid redds. *Journal of Fish Biology* **34**,119-134.

- Crowl, T. A., Townsend, C. R., and A.R., M. (1992). The impact of introduced brown and rainbow trout on native fish: the case of Australasia. *Reviews in Fish Biology and Fisheries* **2**,217-241.
- Crowley, L. E. L. M., and Ivantsoff, W. (1990). A review of species previously identified as *Craterocephalus eyresii* (Pisces: Atherinidae). *Proceedings of the Linnean Society of New South Wales* **112**,87-103.
- Daly, G. (1996). Observations on the eastern owl frog *Helioporus australiacus* (Anura: Myobatrachidae) in southeastern New South Wales. *Herpetofauna* **26**,33-42.
- Daly, G. (1998). Review of the status and assessment of the habitat of the stuttering frog *Mixophyes balbus* (Anura: Myobatrachidae). *Herpetofauna* **28**,2-11.
- Davies, P. E. (1989). Relationships between habitat characteristics and population abundance for brown trout (*Salmo trutta*) and Blackfish, *Gadopsis marmoratus* Rich., in Tasmanian streams. *Australian Journal of Marine and Freshwater Research* **40**,341-359.
- Davies, P.E. and McDowall, R.M. (1996). Salmons, Trouts and Chars. *Freshwater Fishes of South-Eastern Australia* (McDowall, R.M. editor) Reed Books, Sydney.
- Davies, P.E. and Sloane, R.D. (1988). Long term changes in brown trout and rainbow trout populations in Great Lake, Tasmania. *North American Journal of Fisheries Management* **8**, 463-74.
- Davis, T. L. O. (1977). Food habits of the freshwater catfish, *Tandanus tandanus* Mitchell, in the Gwydir River, Australia, and its effects associated with impoundment of this river by the Copeton Dam. *Australian Journal of Marine and Freshwater Research* **28**,455-465.
- Dayton, P. K., Thrush, S. F., Agardy, M. T., and Hofman, R. J. (1995). Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **5**: 205-532.
- *Dominion, (2001). An economic survey of the Snowy mountain recreational trout fishery. A report produced for New South Wales Fisheries (NSWF) funded by the Recreational Fishing Trusts. Published by NSW Fisheries, 49pp.
- *Douglas, J. W., Gooley, G. J., and Ingram, B. A. (1994). Trout cod, *Maccullochella macquariensis* (Cuvier) (Pisces: Percichthyidae), resource handbook and research and recovery plan. Department of Conservation and Natural Resources, Snobs Creek.
- Douglas, J.W., Gooley, G.J., Ingram, B.A., Murray, N.D., and Brown, L.D. (1995). Natural hybridisation between Murray Cod *Maccullochella peelii peelii* (Mitchell), and Trout Cod *Maccullochella macquariensis* (Cuvier) (Percichthyidae), in the Murray River, Australia. *Marine and Freshwater Research* **46**:729-734.
- Downes, B. J., Barmuta, L. A., Fairweather, P. G., Faith, D. P., Keough, M. J., Lake, P. S., Mapstone, B. D., and Quinn, G. P. (2002). *Monitoring Ecological Impacts: Concepts and Practice in Flowing Waters*. Cambridge University Press, Cambridge, 434 pp.
- Duffus, J.H. (2001). Risk assessment terminology. *Chemistry International* **23**(2).
- Emlen, J.M. (1991). Heterosis and outbreeding depression: a multilocus model and an application to salmon production. *Fisheries Research* **1**:187-212.
- Englund, G., and Krupa, J. J. (2000). Habitat use by crayfish in stream pools: influence of predators, depth and body size. *Freshwater Biology* **43**,75-83.

*FAO glossary, website, 2002

Faragher, R. A. (1983). Role of the crayfish *Cherax destructor* Clark as food for trout in Lake Eucumbene, New South Wales. *Australian Journal of Marine and Freshwater Research* **34**, 407-417.

Faragher, R. A. (1992). Growth and age validation of rainbow trout, *Oncorhynchus mykiss* (Walbaum), in Lake Eucumbene, New South Wales. *Australian Journal of Marine and Freshwater Research* **43**, 1033-42).

*Faragher R. A. (1993) The Lake Eucumbene study 1985-89: Findings and recommendations. NSW Fisheries Unpublished report.

Faragher R. A. and Gordon G.N.G. (1994). Comparative exploitation by recreational anglers of brown trout, *Salmo trutta* L., and rainbow trout, *Oncorhynchus mykiss* (Walbaum), in Lake Eucumbene, New South Wales. *Australian Journal of Marine and Freshwater Research* **43**, 835-45.

Faragher, R. A. and Harris, J.H. (1994). The historical and current status of freshwater fish in New South Wales. *Australian Zoologist* **29** (3-4) 166-76.

*Faragher, R. A., Brown, P., and Harris, J. H. (1993). Population surveys of the endangered fish species trout cod (*Maccullochella macquariensis*) and eastern cod (*M. ikei*). NSW Fisheries, Cronulla, NSW.

Flecker, A. S., and Townsend, C. R. (1994). Community-wide consequences of trout introduction in New Zealand streams. *Ecological Applications* **4**, 798-807.

*Fletcher, A. R. (1979). Effects of *Salmo trutta* on *Galaxias olidus* and macroinvertebrates in stream communities. MSc. Monash University, Melbourne.

Fletcher, A. R. (1986). Effects of introduced fish in Australia. In *Limnology in Australia* (eds. DeDeckker, P. and Williams, W. D.) CSIRO, Melbourne.

Fletcher, A.R., Morison, A.K. and Hume, D.J. (1985). Effects of Carp (*Cyprinus carpio* L.) on Communities of Aquatic Vegetation and Turbidity of Waterbodies in the Lower Goulburn River Basin. *Australian Journal of Marine and Freshwater Research*. 36(3):311-329.

*Fletcher, W. J., Chesson, J., Fisher, M., Sainsbury, K. J., Hundloe, T., Smith, A. D. M. and Whitworth, B. (2002). National ESD reporting framework for Australian Fisheries: the 'How to' guide for wild capture fisheries. *Fisheries Research and Development Corporation Final Report*, Project No. 2000/145, Canberra, Australia.

Francis, R. C. (1992). Use of risk analysis to fishery management strategies: A case study using orange roughy (*Hoplostethus atlanticus*) on the Chatham Rise, New Zealand. *Canadian Journal of Fisheries and Aquatic Sciences*, **49**: 922-930.

Francis, R. C. and Shotton, R. (1997). "Risk" in fisheries management: a review. *Canadian Journal of Fisheries and Aquatic Sciences*, **54**: 1699-1715.

Frankel, O.H. and Soule, M.E. (1981). *Conservation and evolution*. pp. 65-71, 91. Cambridge University Press, Sydney.

Frankenberg, R. (1966). Fishes of the family Galaxiidae. *Australian Natural History* **15**, 161-164.

- Franklin, I.A. (1980). Evolutionary change in small populations. *Conservation Biology: An Evolutionary-Ecological Perspective*. pp.135-150. (M.E. Soule and B.A. Wilcox, editors), Sauer Associates, Sunderland, Massachusetts.
- Fraser, D.J. and Bernatchez, L. (2001). Adaptive evolutionary conservation: towards a unified concept for defining conservation units. *Molecular Ecology* **10**, 2741-2752.
- Fulton, W. (1978). A new species of *Galaxias* (Pisces: Galaxiidae) from the Swan River, Tasmania. *Records of the Queen Victoria Museum Launceston* **63**, 1-8.
- Gall, G.A.E. (1987). Inbreeding. In: *Population Genetics and Fishery Management*. pp.47-87. (N. Ryman and F. Utter, editors) University of Washington Press, Seattle.
- Garcia, S. M. (2000). The FAO definition of sustainable development and the Code of Conduct for Responsible Fisheries: an analysis of the related principles, criteria and indicators. *Marine and Freshwater Research*, **51**: 535-541.
- Garman, G. C., and Nielsen, L. A. (1982). Piscivory by stocked brown trout (*Salmo trutta*) and its impact on the nongame fish community of Bottom Creek, Virginia. *Canadian Journal of Fisheries and Aquatic Sciences* **39**, 862-869.
- Gehrke, P. C., and Harris, J. H. (1994). The role of fish in cyanobacterial blooms in Australia. *Australian Journal of Marine and Freshwater Research* **45**, 905-915.
- *Gehrke, P. C., and Harris, J. H. (1996). Fish and fisheries of the Hawkesbury-Nepean River system. Final Report to the Sydney Water Corporation. NSW Fisheries, Cronulla, and Cooperative Research Centre for Freshwater Ecology, Canberra.
- *Gehrke, P. C., Gilligan, D. M., and Barwick, M. (2001). Fish communities and migration in the Shoalhaven River – before construction of a fishway. NSW Fisheries Final Report Series, No. 26.
- Gehrke, P.C. & Harris, J.H. 2000. Large scale patterns in species richness and composition of temperate riverine fish communities, south-eastern Australia. *Marine and Freshwater Research*, **51**, 165-182.
- Gillespie, G. R. (2001). The role of introduced trout in the decline of the spotted tree frog (*Litoria spenceri*) in south-eastern Australia. *Biological Conservation* **100**, 187-197.
- Gillespie, G. R. (2002). Impacts of sediment loads, tadpole density, and food type on the growth and development of tadpoles of the spotted tree frog *Litoria spenceri*: an in-stream experiment. *Biological Conservation* **106**, 141-150.
- *Gillespie, G. R. and Hero, J. (1999). Potential impacts of introduced fish and fish translocations on Australian amphibians. In *Declines and Disappearances of Australian Frogs* (ed. Campbell, A.) pp. 131-144. Environment Australia, Canberra.
- *Gillespie, G. R., and Hines, H. (1999). Status of temperate riverine frogs in south-eastern Australia. In *Declines and Disappearances of Australian Frogs* (ed. Campbell, A.) pp. 109-130. Environment Australia, Canberra.
- Gillespie, G. R., and Hollis, G. J. (1996). Distribution and habitat of the spotted tree frog, *Litoria spenceri* Dubois (Anura: Hylidae), and assessment of potential causes of population declines. *Wildlife Research* **23**, 49-75.

*Gillespie, G. R., and Robertson, P. (1998). Recovery plan for the spotted tree frog (*Litoria spenceri*). Environment Australia, Canberra.

Gjedrem, T. (1976). Possibilities for genetic improvements in salmonoids. *Journal of the Fisheries Research Board of Canada*. **33**:1094-1099.

Gowing, H., and Momot, W. T. (1979). Impact of brook trout (*Salvelinus fontinalis*) predation on the crayfish *Orconectes virilis* in three Michigan lakes. *Journal of the Fisheries Research Board of Canada* **36**,1191-1196.

Hall, S. J. (1999). *The effects of fishing on marine ecosystems and communities*, Blackwell Science, Carlton, p. 274

Ham, K. D., and Pearsons, T. N. (2001). A Practical Approach for Containing Ecological Risks Associated with Fish Stocking Programs. *Fisheries* **26**,15-23.

*Hammer, M. (2002). *Recovery Outline for the Southern Pygmy Perch in the Mount Lofty Ranges, South Australia*. Department of Environmental Biology, Adelaide University and Native Fish Australia (SA) Inc.

Hansen, B. 1999. Ambassis olive perchlet. ANGFA's A-Z Notebook of Native Freshwater Fish, ANGFA, Australia.

Hansen, M.M. and Loeschke, V. (1996). Genetic Differentiation Among Danish Brown Trout Populations, as Detected by RFLP Analysis of PCR Amplified Mitochondrial DNA Segments. *Journal of Fish Biology*. **48**:422-436.

Harada, Y., Yokota, M. and Iizuka, M. (1998). Genetic risk of domestication in artificial fish stocking and its possible reduction. *Researchers on Population Ecology*. **40**(3):311-324.

Harris, J.H. (1985). Diet of the Australian bass, *Macquaria novemaculeata* (Perciformes: Percichthyidae), in the Sydney basin. *Australian Journal of Marine and Freshwater Research* **36**,219-234.

Harris, J.H. (2002). Stocking - the fisheries panacea? *Freshwater Fishing* **59**,66-68.

*Harris, J.H. and Gehrke, P.C. (1997). *Fish and rivers in stress: the NSW rivers survey*. NSW Fisheries Office of Conservation and the Cooperative Research Centre for Freshwater Ecology, Cronulla, NSW, 298 pp.

Harris, J.H. and Rowland, S.J. (1996). Family Percichthyidae: Australian freshwater cods and basses. In *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.) Reed Books, Sydney.

*Harris, J.H. and Battaglene, S.C. (1989). The Introduction and Translocation of Native Freshwater Fishes in South Eastern Australia *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government Publishing Service, Canberra.

Hartl, D.L. and Clark, A.G. (1997). *Principles of population genetics*, Third Edition. pp.146-149, 291. Sinauer Associates, Sunderland, Massachusetts.

*Hartley, S. and Rayner, T. (2003). Office of Conservation Freshwater Fish Database, Unpublished Data. NSW Fisheries, Port Stephens.

- *Hayes, K.R. (1997). *A review of ecological risk assessment methodologies*. Technical report No. 13. Centre for Research on Introduced Marine Pests (Australia), CSIRO, Hobart. 117 pp.
- Heatwole, H., de Bavay, J., Webber, P., and Webb, G. (1995). Faunal survey of New England. IV. The Frogs. *Memoirs of the Queensland Museum* **38**, 229-249.
- Heino, M. and Godo, O. R. (2002). Fisheries-induced selection pressures in the context of sustainable fisheries. *Bulletin of Marine Science*, **70**: 639-356.
- Hildebrand, S. G. (1971). The effect of Coho spawning on the benthic invertebrates of the Platte River, Benzie County, Michigan. *Transactions of the American Fisheries Society* **100**, 61-68.
- Hill, A. M., and Lodge, D. M. (1999). Replacement of resident crayfishes by an exotic crayfish: the roles of competition and predation. *Ecological Applications* **9**, 678-690.
- Hindar, K., Ryman, N. and Utter, F. (1991). Genetic Effects of Cultured Fish on Natural Fish Populations. *Canadian Journal of Fisheries and Aquatic Sciences*. **48**:(5) 945-957.
- *Hines, H., Mahony, M., and McDonald, K. (1999). An assessment of frog declines in wet subtropical Australia. In *Declines and Disappearances of Australian Frogs* (ed. Campbell, A.) Environment Australia, Canberra.
- Hortle, M. E., and White, R. W. G. (1980). Diet of *Pseudaphritis urvillii* (Cuvier and Valenciennes) (Pisces: Bovichthyidae) from south-eastern Australia. *Australian Journal of Marine and Freshwater Research* **31**, 533-539.
- *Horwitz, P. (1990). The conservation status of Australian freshwater Crustacea. Australian National Parks and Wildlife Service, Report Series No. 14, Canberra.
- Humphries, P., and Lake, P. S. (2000). Fish larvae and the management of regulated rivers. *Regulated Rivers: Research & Management* **16**, 421-432.
- Huryn, A. D. (1996). An appraisal of the Allen paradox in a New Zealand trout stream. *Limnology and Oceanography* **41** (2), 243-252.
- Huryn, A. D. (1998). Ecosystem-level evidence for top-down and bottom-up control of production in a grassland stream system. *Oecologia* **115**, 173-183.
- *IAC (Industries Assistance Commission) 1989, *Using Input-Output Analysis and Multipliers*, Working Paper No. 12, August 1989.
- Ingram, B. A., Barlow, C. G., Burchmore, J. J., Gooley, G. J., Rowland, S. J., and Sanger, A. C. (1990). Threatened native freshwater fishes in Australia--Some case histories. *Journal of Fish Biology* **37**, 175-182.
- Ivantsoff, W. and Crowley, L.E.L.M. (1996). Blue-eyes. *Freshwater Fishes of South-Eastern Australia*. (ed. McDowall, R. M.). Reed books, Sydney.
- Ivantsoff, W., and Crowley, L. E. L. M. (1996). Silversides or Hardyheads. In *Freshwater Fishes of South Eastern Australia* (ed. McDowall, R. M.). Reed Books, Sydney.
- Jackson, P. D. (1976). A note on the food of the Australian grayling, *Prototroctes maraena* Günter (Galaxioidei: Prototroctidae). *Australian Journal of Marine and Freshwater Research* **27**, 525-528.

- Jackson, P. D. (1978a). Benthic invertebrate fauna and feeding relationships of brown trout, *Salmo trutta* Linnaeus, and River Blackfish, *Gadopsis marmoratus* Richardson, in the Aberfeldy River, Victoria. *Australian Journal of Marine and Freshwater Research* **29**, 729-742.
- Jackson, P. D. (1978b). Spawning and early development of the River Blackfish, *Gadopsis marmoratus* Richardson (Gadopsiformes: Gadopsidae), in the McKenzie River, Victoria. *Australian Journal of Marine and Freshwater Research* **29**, 293-298.
- Jackson, P. D., and Davies, J. N. (1983). Survey of the fish fauna in the Grampians region, south-western Victoria. *Proceedings of the Royal Society of Victoria* **95**, 39-51.
- Jackson, P. D., and Williams, W. D. (1980). Effects of brown trout, *Salmo trutta* L., on the distribution of some native fishes in three areas of southern Victoria. *Australian Journal of Marine and Freshwater Research* **31**, 61-67.
- *Jackson, P. D., Koehn, J. D., and Wager, R. (1992). Appendix 1: Australia's threatened fishes 1992 listing - Australian Society for Fish Biology. *Bureau of Resource Sciences Proceedings*, 213.
- Jackson, P. D., Koehn, J., Lintermans, M., and Sanger, A. C. (1996). Family Gadopsidae: Freshwater Blackfishes. In *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.) pp. 186-190. Reed Books, Sydney.
- Jennings, S.; Kaiser, M. J.; and Reynolds, J. D. (2001). *Marine Fisheries Ecology*. Blackwell Science Ltd, London, p. 417
- Jerry, D. R., and Woodland, D. J. (1997). Electrophoretic evidence for the presence of the undescribed 'Bellinger' catfish (*Tandanus* sp.) (Teleostei: Plotosidae) in four New South Wales mid-northern coastal rivers. *Marine & Freshwater Research* **48**, 235-240.
- Jerry, D.R. (1997). Population genetic structure of the catadromous Australian bass from throughout its range. *Journal of Fish Biology*. **51**:909-920.
- *Jerry, D.R. (1998). Consequences of a Catadromous Life-Strategy for Population Structuring in the Australian bass, *Macquaria novemaculeata* PhD. Thesis Southern Cross University.
- Jerry, D.R. and Baverstock, P.R. (1998). Consequences of a catadromous life-strategy for levels of mitochondrial DNA differentiation among populations of the Australian bass, *Macquaria novemaculeata*. *Molecular Ecology*. **7**:1003-1013.
- *Keenan, C. (1995). *Genetic Implications of Fish Stocking in Queensland - Getting it Right*. Queensland Fisheries Management Authority, Townsville.
- *Keenan, C., Watts, R. and Serafini, L. (1995). *Population Genetics of Golden Perch, Silver perch and Eel-tailed Catfish within the Murray-Darling Basin MDB*. Riverine Environment Research Forum. Victoria Murray Darling Basin Commission, Attwood.
- Kincaid, H.L. (1976a). Inbreeding in rainbow trout (*Salmo gairdneri*). *Journal of the Fisheries Research Board of Canada*. **33**:2420-2426.
- Kincaid, H.L. (1976b). Inbreeding depression in rainbow trout. *Transactions of the American Fisheries Society*. **105**:273-280.
- Knight, J., Moore, A.S., Brookes, L., Breen, A. and Hume, B. (in prep.) Density dependant interference competition between *Gambusia holbrooki* and three Australian native fish.

- Koehn, J. D., O'Connor, N. A., and Jackson, P. D. (1994). Seasonal and size-related variation in microhabitat use by a southern Victorian stream fish assemblage. *Australian Journal of Marine and Freshwater Research* **45**, 1353-1366.
- *Koehn, J., and O'Connor, W. G. D. (1990). *Biological information for management of native freshwater fish in Victoria*. Department of Conservation and Natural Resources, Victoria, Melbourne.
- Krueger, C. C., and May, B. (1991). Ecological and genetic effects of salmonid introductions in North America. *Canadian Journal of Fisheries and Aquatic Sciences* **48 Suppl.**, 66-77.
- Kuiter, R. H., Humphries, P. A., and Arthington, A. H. (1996). Family Nannopercidae. Pygmy perches. In *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.) Reed Books, Sydney.
- Lake, J. S. (1971). *Freshwater fishes and rivers of Australia*. Thomas Nelson, Sydney, 61 pp.
- Lande, R. and Barrowclough, G.F. (1987). Effective population size, genetic variation, and their use in population management. In: Soule, M.E. (ed) *Viable Populations for Conservation* Cambridge University Press.
- Lane, D. E. and Stephenson, R. L. (1998). A framework for risk analysis in fisheries decision-making. *ICES Journal of Marine Science* **55**:1-13.
- *Langdon, J.S. (1989). Disease Risks of Fish Introductions and Translocations. *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government Publishing Service, Canberra.
- Larson, H. K., and Hoese, D. F. (1996). Family Gobiidae, subfamilies Eleotridinae and Butinae: Gudgeons. In *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.) pp. 200-219. Reed Books, Sydney.
- Lemckert, F., and Brassil, T. (2000). Movements and habitat use of the endangered giant barred river frog (*Mixophyes iteratus*) and the implications for its conservation in timber production forests. *Biological Conservation* **96**, 177-184.
- Lever, C. (1996). *Naturalized Fishes of the World*. (Lever, C. editor) Academic Press, San Diego.
- *LGA (1998). Estimates of Visitation and Visitor's expenditure for Local Government Areas in New South Wales (1996/97). Tourism New South Wales.
- Lintermans, M. (2000). Recolonisation by the mountain galaxias *Galaxias olidus* of a montane stream after the eradication of rainbow trout *Oncorhynchus mykiss*. *Marine & Freshwater Research* **51**, 799-804.
- *Llewellyn, L. C. (1983). The Distribution of Fish in New South Wales. Australian Society for Limnology Special Publication No. 7, Sydney.
- *Lloyd, L. (1989). Native Fishes as Alternatives to the Exotic Fish, *Gambusia*, for Insect Control. *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government Publishing Service, Canberra.
- Lloyd, L.N. (1984). Exotic Fish - Useful Additions or "Animal Weeds" *Fishes of Sahul* **1**(3).

*Lloyd, L.N. (1987). *Ecology and Distribution of Small Native Fish of the Lower River Murray, South Australia and Their Interactions with Exotic Mosquitofish, Gambusia affinis holbrooki*. M.Sc. Thesis University of Adelaide.

Lynch M. (1996). A quantitative genetic perspective on conservation issues. In: Avise, J.C. and Hamrick, J.L. (eds) *Conservation Genetics: Case Histories from Nature*, Chapman & Hall, New York, pp. 471-501.

Mahony, M., Knowles, R., and Pattinson, L. (1997a). Gold-eyed barred frog, *Mixophyes iteratus*. In *Threatened Frogs of New South Wales: Habitats, Status and Conservation* (ed. Ehman, H.) pp. 78-83. Published by the Frog and Tadpole Study Group of NSW Inc, PO Box A2405, Sydney South 2000.

Mahony, M., Knowles, R., and Pattinson, L. (1997b). Stuttering barred frog, *Mixophyes balbus*. In *Threatened Frogs of New South Wales: Habitats, Status and Conservation* (ed. Ehman, H.) Published by the Frog and Tadpole Study Group of NSW Inc, PO Box A2405, Sydney South 2000.

Mahony, M., Knowles, R., Foster, R., and Donnellan, S. (2001). Systematics of the *Litoria citropa* (Anura: Hylidae) complex in northern New South Wales and southern Queensland, Australia, with the description of a new species. *Records of the Australian Museum* **53**, 37-48.

*Mallen-Cooper, M. (1992). Habitat changes and declines of freshwater fish in Australia: What is the evidence and do we need more? In *Sustainable Fisheries through Sustaining Fish Habitat Workshop, 12-13 Aug 1992* (ed. Hancock, D. A.) Australian Government Publishing Service, Canberra, Victor Harbour (Australia)

Matveev, V. (1995). The dynamics and relative strength of bottom-up vs top-down impacts in a community of subtropical lake plankton. *Oikos* **73**, 104-108.

Matveev, V. (1998). Evidence for biotic control of Australian reservoir phytoplankton communities and the potential for applied biomanipulation. *Lakes & Reservoirs: Research and Management* **3**, 105-111.

Matveev, V., and Matveeva, L. (1997). Grazer control and nutrient limitation of phytoplankton biomass in two Australian reservoirs. *Freshwater Biology* **38**, 49-65.

McDowall, R. M. (1968). Interactions of the native and alien faunas of New Zealand and the problem of fish interactions. *Transactions of the American Fisheries Society* **97**, 1-11.

McDowall, R. M. (2003). Impacts of introduced salmonids on native galaxiids in New Zealand upland streams: a new look at an old problem. *Transactions of the American Fisheries Society* **132**, 229-238.

McDowall, R. M., and Frankenberg, R. S. (1981). The Galaxiid Fishes of Australia. *Records of the Australian Museum* **33**, 433-605.

McDowall, R. M., and Fulton, W. (1996). Family Galaxiidae: Galaxiids. In: *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.). Reed Books, Sydney.

McDowall, R.M. (1996a). Family Prototroctidae: Southern Graylings. In: *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.). Reed Books, Sydney.

McDowall, R.M. (1996b). Freshwater Perches. In: *Freshwater Fishes of South-Eastern Australia*. (ed. McDowall, R. M.) Reed Books, Sydney.

- McDowall, R.M. (1996c). Southern Smelts. In: *Freshwater Fishes of South-Eastern Australia*. (ed. McDowall, R. M.) Reed Books, Sydney.
- *McIlgorm, A. and J. Pepperell (1999). A National Review of the Recreational Fishing Sector, A report by Dominion Consulting to Agriculture, Forestry and Fisheries, Australia.
- McIntosh, A. R., and Townsend, C. R. (1996). Interactions between fish, grazing invertebrates, and algae in a New Zealand stream: a trophic cascade mediated by fish-induced changes to grazing behaviour? *Oecologia* **108**, 174-181.
- McIntosh, A. R., Townsend, C. R., and Crowl, T. A. (1992). Competition for space between introduced brown trout (*Salmo trutta* L.) and a native galaxiid (*Galaxias vulgaris* Stokell) in a New Zealand Stream. *Journal of Fish Biology* **41**, 63-81.
- *McKay, R.J. (1978). *The Exotic Freshwater Fishes of Queensland*. Australian National Parks and Wildlife Service, Canberra.
- McKeown, K. C. (1934). Notes on the food of trout and Macquarie perch in Australia. *Records of the Australian Museum* **19**, 141-152.
- McMichael, G. A., Pearsons, T. N., and Leider, S. A. (1999). Behavioral interactions among hatchery-reared steelhead smolts and wild *Oncorhynchus mykiss* in natural streams. *North American Journal of Fisheries Management* **19**, 948-956.
- Meffe, G.K. and Ronald Carroll, C. (1997). Genetics: Conservation of diversity within species. In: *Principles of Conservation Biology*. pp.162 (G.K. Meffe, and C.R. Carroll, editors). Sinauer Associates, Sunderland, Massachusetts.
- Merrick, J. R. (1993). *Freshwater Crayfishes of New South Wales*. Linnean Society of New South Wales, 127 pp.
- Merrick, J. R. (1995). Diversity, distribution and conservation of freshwater crayfishes in the eastern highlands of New South Wales. *Proceedings of the Linnean Society of New South Wales* **115**, 248-258.
- Merrick, J. R. (1996). Family Terapontidae: Freshwater grunters or perches. In *Freshwater Fishes of South-Eastern Australia* (ed. McDowall, R. M.) pp. 164-167. Reed Books, Sydney.
- Miller, P.S. and Hedrick, P.W. (1993). Inbreeding and fitness in captive populations: Lessons from *Drosophila*. *Zoo Biology*. **12**:333-351.
- Miller, L.M. & Kapuscinski, A.R. (2003). Genetic Guidelines for Hatchery Supplementation Programs. In: *Population Genetics - Principles and Applications for Fisheries Scientists*. Hallerman. E.M (ed.). American Fisheries Society, Maryland, USA
- Mitro, M.G. and Zale, A.V. (2002). Estimating abundances of age-0+ rainbow trout by mark-recapture in a medium-sized river. *North American Journal of Fisheries Management* **22**(1), pp. 188-203.
- *Moffatt D., Krust, M., and Sierert, M. 1997. Drought impacts and recovery of wetland and fisheries habitat, upper Darling. Murray Darling Basin Commission and Queensland Department of Natural Resources and Mines, Project R6065.
- *Moore, A.S. and Baverstock, P.R. (2002). *Managing translocation and stocking in the Murray-Darling Basin*. September 2002, Canberra, Australia.

Morgan, G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum Supplement* **23**, 1-110.

*Morison, A. and Hume, D. (1989). Carp (*Cyprinus carpio* L.) in Australia. *Australian Society for Fish Biology Workshop - Introduced and Translocated Fishes and Their Ecological Effects*. (Pollard, D.A. editor) Magnetic Island, 24-25 August. Australian Government Publishing Service, Canberra.

Moritz, C. (1994). Defining 'Evolutionary Significant Units' for conservation. *Tree*. **9**(10):373-375

*Morris, S. A., Pollard, D. A., Gehrke, P. C., and Pogonoski, J. J. (2001). *Threatened and potentially threatened freshwater fishes of coastal New South Wales and the Murray-Darling Basin*. Report to Fisheries Action Program and World Wide Fund for Nature. NSW Fisheries, Sydney.

Moyle, P. B. (1976). Fish introductions in California: history and impact on native fishes. *Biological Conservation* **9**, 101-118.

*Murray Darling Basin Ministerial Council (2002). Draft Native Fish Strategy for the Murray-Darling Basin 2002-2012.

Musyl, M.K. and Keenan, C.P. (1992). Population Genetics and Zoogeography of Australian Freshwater Golden Perch, *Macquaria ambigua* (Richardson 1845) (Teleostei: Percichthyidae), and Electrophoretic Identification of a New Species from the Lake Eyre Basin. *Australian Journal of Marine and Freshwater Research*. **43**:1585-1601.

Musyl, M.K. and Keenan, C.P. (1996). Evidence for cryptic speciation in Australian freshwater eel-tailed catfish, *Tandanus tandanus* (Teleostei: Plotosidae). *Copeia*, 526-534.

*Nock, C., Moore, A.S., Gartside D. and Baverstock, P.R. (2003). Conservation Genetics of the Eastern freshwater cod (*Maccullochella ikei*). *An Interim Report to NSW Fisheries*

*NSW Fisheries (1999). Eastern (freshwater) cod (*Maccullochella ikei*) draft recovery plan. NSW Fisheries, Port Stephens, 36 pp.

*NSW Fisheries (2001). Trout Cod. NSW Fisheries Fish Facts (FF 4).

*NSW Fisheries (2002). Species impact statement on fishing in the lower Murray River catchment: Public consultation document, May 2002. NSW Fisheries, Nelson Bay, NSW, 136 pp.

*NSW Fisheries Scientific Committee (1999a). Information supporting the nomination of Macquarie perch as Vulnerable under the NSW Fisheries Management Act 1994 (1997 amendments). NSW Fisheries Scientific Committee, Sydney

*NSW Fisheries Scientific Committee (1999b). Recommendation for nomination of *Archaeophya adamsi* (Adams emerald dragonfly) as a vulnerable species. NSW Fisheries Scientific Committee, Sydney

*NSW Fisheries Scientific Committee (2000a). Information supporting the nomination of the river snail, *Notopala sublineata* as an Endangered Species under the NSW Fisheries Management Act 1994 (1997 amendments). NSW Fisheries Scientific Committee, Sydney

*NSW Fisheries Scientific Committee (2000b). Information supporting the nomination of the southern pygmy perch as Vulnerable under the NSW Fisheries Management Act 1994 (1997 amendments). NSW Fisheries Scientific Committee, Sydney

- *NSW Fisheries Scientific Committee (2001a). Information supporting the nomination of "degradation of native riparian vegetation along New South Wales water courses" as a Key Threatening Process under the *Fisheries Management Act 1994*. NSW Fisheries Scientific Committee, Sydney
- *NSW Fisheries Scientific Committee (2001b). Information supporting the nomination of "installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams" as a Key Threatening Process under the NSW Fisheries Management Act 1998 (1997 Amendments). NSW Fisheries Scientific Committee, Sydney
- *NSW Fisheries Scientific Committee (2001c). Information supporting the nomination of "introduction of fish to waters within a river catchment outside their natural range" as a Key Threatening Process under the NSW Fisheries Management Act 1994 (1997 amendments). NSW Fisheries Scientific Committee, Sydney
- *NSW Fisheries Scientific Committee (2001d). Information supporting the nomination of "removal of large woody debris" as a Key Threatening Process under the Fisheries Management Act 1994 (1997 Amendments). NSW Fisheries Scientific Committee, Sydney
- *NSW Fisheries Scientific Committee (2001e). Information supporting the nomination of the aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River as an endangered ecological community. NSW Fisheries Scientific Committee, Sydney
- *NSW Fisheries Scientific Committee (2001f). Recommendation for nomination of the Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment. Nelson Bay
- *NSW Fisheries Threatened Species Recovery Planning Program (2003). Eastern (freshwater) cod (*Maccullochella ikei*) recovery plan (Draft in Prep).
- *NSW National Parks and Wildlife Service (2000). Threatened Species Conservation Act 1995, NSW Scientific Committee Final Determination (the Tusked Frog).
- *NSW National Parks and Wildlife Service (2001a). Recovery plan for the spotted tree frog (*Litoria spenceri*). NSW NPWS, Southern Zone, Queanbeyan, 17 pp.
- *NSW National Parks and Wildlife Service (2001b). Threatened species information: Giant Burrowing Frog *Helioporus australiacus* (Shaw & Nodder 1795). NSW National Parks and Wildlife Service, Hurstville
- *NSW National Parks and Wildlife Service (2001c). Yellow-spotted Bell Frog (*Litoria castanea*) and Peppered Tree Frog (*Litoria piperata*) recovery plan. NPWS, Hurstville, 17 pp.
- *NSW National Parks and Wildlife Service (2002). Predation by *Gambusia holbrooki* - the plague minnow. Draft Threat Abatement Plan. Hurstville, NSW
- *NVS (1999). Tourists "Going Fishing". Results of a survey inquiry prepared by Tourism NSW from the National Visitor's Survey for NSW Fisheries. Unpublished material.
- Pearsons, T.N. and Hopley, C.W. (1999). A practical approach for assessing ecological risks associated with fish stocking programs. *Fisheries Management* **24** (9), pp 16-23.
- *Pepperell, J.G. (1996). Recreational Fishing in New South Wales, April 1995 to April 1996. Report Prepared for NSW Fisheries, 18pp plus Appendices.

*PNSW (2001) Regional Alpine Plan for the Snowy Mountains Area (Draft). Planning New South Wales, Canberra.

Polunin, N.V.C. and Pinnegar, J.K. (2002). Trophic ecology and the structure of marine food webs. In *Handbook of Fish Biology and Fisheries* (eds. Hart, P.J.B. and Reynolds, J.D.) Reed Books, Sydney.

Potter, I. C. (1996). Family Mordaciidae: Shortheaded lampreys. In *Freshwater fish of South-eastern Australia* (ed. McDowall, R. M.) Reed Books, Sydney.

Power, M. E. (1990). Effects of fish in river food webs. *Science* **250**, 811-814.

Power, M. E. (1992). Habitat heterogeneity and the functional significance of fish in river food webs. *Ecology* **73**, 1675-1688.

Raadik, T. (2001). When is a mountain galaxias not a mountain galaxias? *Fishes of Sahul* **15**, 785-789.

Ralls, K. and Ballou, J. (1983). Extinction: Lessons from zoos. *Genetics and Conservation: A reference for managing wild animal and plants populations*. pp.164-184 (C.M. Schonewald-Cox, S.M. Cambers, B. MacBryde, and Thomas, editors). Benjamin/Cummings, Menlo Park, California.

*Recovery plan for stream frogs of south-east Queensland 2001-2005. Report to Environment Australia, Canberra (2002). Recovery plan for stream frogs of south-east Queensland 2001-2005. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane

Recsei, J. (1997). 3. Eastern owl frog, *Helioporus australiacus*. In *Threatened Frogs of New South Wales: Habitats, Status and Conservation* (ed. Ehman, H.) Published by the Frog and Tadpole Study Group of NSW Inc, PO Box A2405, Sydney South 2000, Sydney.

Reinhardt, U. G., Yamamoto, T., and Nakano, S. (2001). Effects of body size and predators on intracohort competition in wild and domesticated juvenile salmon in a stream. *Ecological Research* **16**, 327-334.

Rosenberg, A. A. and Restrepo, V. R., (1994). Uncertainty and risk evaluation in stock assessment advice for U.S. marine Fisheries *Canadian Journal of Fisheries and Aquatic Sciences* **51**: 2715-2720

Rosenfeld, J. S. (2000). Contrasting effects of fish predation in a fishless and fish-bearing stream. *Archiv fur Hydrobiologie* **147**, 129-142.

Roughley, T.C. (1951). *Fish and Fisheries of Australia*. Angus and Robertson Sydney.

*Rowland, S. J. (1988). *Murray cod*. NSW Agriculture and Fisheries, Sydney, 10 pp.

Rowland, S. J. (1993). *Maccullochella ikei*, an endangered species of freshwater cod (Pisces: Percichthyidae) from the Clarence River system, NSW, and *M. peelii mariensis*, and new subspecies from the Mary River system. *Records of the Australian Museum* **45**, 121-145.

Rowland, S. J. (1996). Threatened fishes of the world: *Maccullochella ikei* Rowland, 1985 (Percichthyidae). *Environmental Biology of Fishes* **46**, 350.

*Rowland, S.J. and Ingram, B.A. (1991). Diseases of Australian native freshwater fishes with particular emphasis on the ectoparasitic and fungal diseases of Murray cod (*Maccullochella*

- peelii*), golden perch (*Macquaria ambigua*) and silver perch (*Bidyanus bidyanus*). *Fisheries bulletin* 4, NSW Agriculture and Fisheries, Sydney
- *Roy Morgan (2003) Community survey on attitudes to stocking. Prepared via Dominion Consulting for NSW Fisheries as part of the Stocking EIS. Roy Morgan Research Ltd.
- Saccheri, I., Kuussaari M., Kankare M., Vikman P., Fortelius W. and Hanski I. (1998). Inbreeding and extinction in a butterfly metapopulation. *Nature*. **392**:491-494.
- *Schiller, C. B., Bruce, A. M., and Gehrke, P. C. (1997). Distribution and abundance of native fish in New South Wales rivers. In *Fish and Rivers in Stress: the NSW Rivers Survey* (eds. Harris, G. P. and Gehrke, P. C.) pp. 71-102. NSW Fisheries Office of Conservation, Cronulla, and Cooperative Research Centre for Freshwater Ecology, Canberra.
- Shearer, K.D. and Mulley, J.C. (1978). The Introduction and Distribution of the Carp, *Cyprinus carpio* Linnaeus, in Australia. *Australian Journal of Marine and Freshwater Research* **29**: 551-563.
- Sheldon, F., and Walker, K. F. (1997). Changes in biofilms induced by flow regulation could explain extinctions of aquatic snails in the lower River Murray, Australia. *Hydrobiologia* **347**, 97-108.
- Shipway, B. (1949). Notes on the natural history of the pigmy perch (*Nannoperca vittata*). *The West Australian Naturalist* **2**, 1-9.
- Sloane, R. D. (1984). Distribution, abundance, growth and food of freshwater eels (*Anguilla spp.*) in the Douglas River, Tasmania. *Australian Journal of Marine and Freshwater Research* **35**, 325-329.
- Soule, M.E. (1980). Thresholds for survival: maintaining fitness and evolutionary potential. *Conservation biology, an evolutionary-ecological perspective*. pp.151-170. (M.E. Soule' and B.A. Wilcox, editors) Sinauer Associates, Sunderland, Massachusetts.
- Stables, T.B. Thomas, G.L., Thiesfield, S.T. and Pauley,G.B. (1990). Effects of reservoir enlargement and other factors on the yield of rainbow and cutthroat trout in Spada Lake, Washington. *North American Journal of Fisheries Management* **10**, 305-14.
- *Standards Australia/Standards New Zealand (1999). *Risk management - generic guide for establishing and implementing the risk management process - AS/NZS 4360*. Standards Australia International Ltd, Sydney, Australia and Standards New Zealand, Wellington, New Zealand.
- *Standards Australia/Standards New Zealand (2000). *Environmental risk management - principles and processes - HB 203:2000*. Standards Australia International Ltd, Sydney, Australia and Standards New Zealand, Wellington, New Zealand, 81 pp.
- Strong, D. R. (1992). Are trophic cascades all wet? Differentiation and donor-control in speciose ecosystems. *Ecology* **73**, 747-754.
- Sweetser, M.G., Bryan, S.D. and Robinson, A.T. (2002). Movement, distribution, and predation: Lepidomeda vittata and non-native salmonids in eastern Arizona. *Western North American Naturalist* **62(2)**, pp. 197-205.
- Taylor, J. N., Courtenay, W. R., and McCann, J. A. (1984). Known impacts of exotic fishes in the continental United States. In *Distribution, Biology, and Management of Exotic Fishes* (eds. Courtenay, W. R. and Stauffer, J. R.) pp. 322-373. The Johns Hopkins University Press, Baltimore.

Templeton, A.R. (1997). Coadaptation, local adaptation, and outbreeding depression. *Principles of Conservation Biology*. pp.171-172 (G.K. Meffe, and C.R. Carroll, editors). Sinauer Associates, Sunderland, Massachusetts.

Templeton, A.R., Hemmer, H., Mace, G., Seal, U.S., Shields, W.M. and Woddruff, D.S. (1986). Local adaptation, coadaptation, and population boundaries. *Zoo Biology*. **5**:115-125.

*Threatened Species Scientific Committee (2003). *Maccullochella peelii peelii* (Murray Cod, Cod, Goodoo). Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the list of Threatened Species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Environment Australia, Canberra

*Thurstan, S. (2000). Practical considerations for genetic stock management of native fish hatcheries. *Stock Enhancement of Marine and Freshwater Fisheries*. Australian Society for Fish Biology Workshop Proceedings, Albury NSW, August 2000.

*Tilzey, R. 1979. Eucumbene (1979): Where now? N.S.W. State Fisheries Leaflet 5, 1-8.

Tilzey, R. D. J. (1976). Observations on interactions between indigenous Galaxiidae and introduced Salmonidae in the Lake Eucumbene catchment, New South Wales. *Australian Journal of Marine and Freshwater Research* **27**,551-564.

Townsend, C. R., and Crowl, T. A. (1991). Fragmented population structure in a native New Zealand fish: an effect of introduced brown trout? *Oikos* **61**,347-354.

*Tyler, M. J. (1997). The action plan for Australian frogs. Environment Australia, Canberra.

Underwood, A. J. (1986). The analysis of competition by field experiments. In *Community Ecology: pattern and process* (eds. Kikkawa, J. and Anderson, D. J.) pp. 240-267. Blackwell, Melbourne.

Underwood, A. J. (1991). Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. *Australian Journal of Marine and Freshwater Research* **42**,569-587.

Underwood, A. J. (1997). *Experiments in Ecology: Their Logical Design and analysis using analysis of variance*. Cambridge University Press, Cambridge, 504 pp.

Underwood, A. J. (2000). Experimental ecology of rocky intertidal habitats: what are we learning? *Journal of Experimental Marine Biology and Ecology*, **250**: 51-76.

Underwood, A. J. and Chapman, M. G. (eds) (1995). *Coastal Marine Ecology of Temperate Australia*. University of NSW Press, Ltd, Sydney, pp. 341.

*Unmack, P. 2000. Biogeography of Australian Freshwater Fishes. MSc Thesis, Arizona State University, Arizona, USA.

Usio, N. W., and Townsend, C. R. (2000). Distribution of the New Zealand crayfish *Paranephrops zealandicus* in relation to stream physico-chemistry, predatory fish, and invertebrate prey. *New Zealand Journal of Marine and Freshwater Research* **34**,557-567.

van der Walt, B. and Faragher, R.A. (2002). Thermal marking of rainbow trout (*Oncorhynchus mykiss*) otoliths *New Zealand Journal of Marine and Freshwater Research* **36**:883-88.

- van der Walt, B. and Faragher, R.A. (2003). Otolith marking of rainbow trout fry by immersion in low concentrations of alizarin complexone *North American Journal of Fisheries Management* **23**, 141-48.
- Vrijenhoek, R.C. (1998). Conservation genetics of freshwater fish. *Journal of Fish Biology*. **53**:394-412, (Supplement A).
- *Wager, R., and Jackson, P. (1993). The action plan for Australian freshwater fishes. Queensland Department of Primary Industries, Fisheries Division, Brisbane, Queensland, for Environment Australia, Canberra.
- Waples, R.S. (1995). Evolutionary significant units and the conservation of biological diversity under the Endangered Species Act. *American Fisheries Society Symposium*. **17**:8-27.
- *Watson, G. F., Littlejohn, M. J., Hero, J.-M., and Robertson, P. (1991). Conservation status, ecology and management of the spotted tree frog (*Litoria spenceri*). Arthur Rylah Institute for Environmental Research Technical Report Series No. 116. Department of Conservation and Environment, Melbourne.
- *Watson, K. (2002). A Travel Cost Valuation Study of the Snowy Mountains Trout Fishery. Unpublished Honours Thesis, Dept. of Commerce and Economics, University of Wollongong.
- Weatherly, A. H., and Lake, J. S. (1967). Introduced fish species in Australian inland waters. In *Australian inland waters and their fauna* (ed. Weatherly, A. H.) pp. 217-239. Australian National University Press, Canberra.
- Welcomme, R.E. (1998). *International Introductions of Inland Aquatic Species*. FAO Fisheries Technical Paper, 294
- Wright, S. (1931). Evolution in Mendelian populations. *Genetics*. **16**:97-159.
- Wright, S. (1977). *Evolution and the genetics of populations. Experimental results and evolutionary deductions*. Vol. **3**. pp. 613. University of Chicago Press.