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**Environmental Regulatory Arrangements and  
Aquaculture Production**

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# Environmental Regulatory Arrangements and Aquaculture Production<sup>1</sup>

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## Abstract

Aquaculture production in Australia is subject to an unnecessarily complex array of legislation and agencies — covering environmental protection, land use planning, marine and coastal management, land tenure, and quarantine and translocation. Unwarranted, or poorly developed and implemented, arrangements can impose unnecessary costs on producers, consumers and the community, affect competitiveness, and adversely affect management of the environment. This paper assesses environmental regulatory arrangements for aquaculture, identifies potential constraints on the aquaculture industry, and opportunities for improving the efficiency and effectiveness of environmental regulatory arrangements.

**Keywords:** aquaculture, regulatory arrangements, environmental management.

## 1. The aquaculture industry in Australia

In Australia, there is increasing demand for access to land and water resources for aquaculture production. A major challenge for regulatory agencies is how to satisfy this increasing demand for access to resources, while managing potential conflicts with other resource uses. This raises issues about resource access, resource allocation and property rights. A related challenge is how to manage potential environmental impacts without unnecessarily restricting the development of the aquaculture industry.

The aquaculture industry has expressed concerns that aquaculture production is unnecessarily constrained, particularly in relation to gaining access to suitable sites, and the complexity and number of lease and licence requirements (APFA 2002; NADC 2002; PMSEIC 2002). At the same time, concerns have been expressed about the potential

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<sup>1</sup> This conference paper is based on research conducted as part of the Productivity Commission research paper *Assessing Environmental Regulatory Arrangements for Aquaculture* (PC 2004). The research paper is available from the Commission's website (<http://www.pc.gov.au>).

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environmental impacts from aquaculture, and the adequacy of regulatory arrangements to manage these impacts (ASEC 2001; ECC 2000).

This paper summarises a review of Australian environmental regulatory arrangements for aquaculture undertaken by the Productivity Commission in 2003 — *Assessing Environmental Regulatory Arrangements for Aquaculture*. The review assessed the appropriateness, efficiency, and effectiveness of planning and environmental regulatory arrangements covering marine and land-based aquaculture production in Australia.

## **Aquaculture production in Australia**

‘Aquaculture’ is the farming and culturing of aquatic organisms, including finfish (such as salmon), crustaceans (such as prawns), molluscs (such as oysters) and aquatic plants (such as microalgae for betacarotene) (FAO 2002).

In Australia, the aquaculture industry makes a significant contribution to the national economy, exports, employment and regional development. In 2001-02, the gross value of production of the industry was around \$733 million, representing some 30 per cent of total fisheries production (by value). The industry grew at around 11 per cent per year in real terms between 1991-92 and 2001-02 (ABARE 2003).

The aquaculture industry is characterised by a small number of large producers within each of the major species — southern bluefin tuna (South Australia), pearl oysters (Western Australia), salmon (Tasmania), prawns (mainly Queensland), and edible oysters (New South Wales, South Australia and Tasmania). There are many small producers across the remaining species, for example, yabbies and redclaw. Emerging species include yellowtail kingfish, snapper and abalone (ABARE 2003; Love and Langenkamp 2003).

## **Potential environmental impacts from aquaculture**

Potential environmental impacts can vary significantly across species, production system, management practices, location, number of farms, environmental carrying capacity, and condition and/or value of the environment (see table 1 for selected potential site and operation impacts). Appropriate site selection, production methods and environmental management may be able to mitigate these impacts, depending on the carrying capacity and scale of the operation.

Each sector and production system has different potential environmental impacts and levels of impact. For example, oysters and mussels typically have few operation impacts (as they require few inputs, such as feed), but may create some site location impacts, such as on visual amenity. The intensive cage culture of finfish, with introduced feed and chemical inputs, may create operation impacts through the discharging of nutrients (from

fish and food waste) and chemicals into waters in which cages are located. Cage culturing may also have other significant local and off-site operating impacts through fish escapes, interaction with wild stocks, and associated effects on fishing (both commercial and recreational).

Recognising the variation in potential environmental impacts from different types of aquaculture operations is a necessary step in developing and implementing an efficient and effective environmental management regime. In addition, aquaculture may be only one of a number of activities contributing to environmental impacts in a particular area. An understanding is required of both the cumulative impacts from different activities, and the impacts from aquaculture relative to other activities.

**Table 1. Selected potential environmental impacts of aquaculture**

<i>Production system/species</i>	<i>Potential site impacts</i>	<i>Potential operation – local impacts</i>	<i>Potential operation – off-site impacts</i>
Cage culture (eg tuna, salmon, yellowtail kingfish)	Habitat modification or loss; effects on amenity values	Marine floor degradation; lower water quality; disease; fish escape impact on wild stocks; loss of native wildlife	Disease; fish escapes and impact on wild stocks; cumulative impacts on environment; amenity values
Rack, tray and stick (eg oysters, mussels)	Habitat modification or loss; effects on amenity values	Marine floor degradation; removal of food for other filter feeders; spread of introduced marine organisms; improved water quality in some areas	Impacts on human health; cumulative impacts on environment; amenity values
Pond culturing (eg prawns)	Habitat modification or loss; effects on amenity values	Lower water quality; disease; competition with wild stocks; loss of native wildlife	Cumulative impacts on environment; amenity values

Sources: ASEC (2001); Crawford (2003); Pearson and Black (2001); PIRSA (2003); Preston et al (1997).

## 2. The broad aquaculture regulatory framework

Aquaculture production often involves the use of publicly-owned natural resources, such as Commonwealth, state or territory land and/or waters. However, the rights to access and use these natural resources are often not well defined. For example, proposals to use coastal or marine areas for aquaculture can bring conflicts with existing or potential uses, such as recreational and commercial fishing, traditional fishing, tourism, recreation, marine transport, and marine conservation. Passive use due to significant aesthetic values (for visual amenity) can also be important in some areas, for example, in parts of coastal New South Wales.

Aquaculture production on either public or private land and/or waters may also generate external costs (or negative externalities). This is where the actions of some individuals

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'spillover' and harm others in the community who are not compensated for this harm. For example, some aquaculture producers may cause water pollution that has negative impacts on other water users (in the same manner that aquaculture producers may be affected by negative water quality impacts caused by sediment and nutrient runoff from broadacre farming). The presence of negative externalities may result in inefficient allocation of resources. If transaction costs inhibit private negotiations, there may be a case for government intervention, as long as the benefits outweigh the costs of such action.

In Australia, governments have primarily used regulatory instruments to manage the potential environmental impacts of aquaculture, such as licensing of aquaculture production. At times, governments have established and allocated certain property rights to use natural resources for aquaculture production, and are exploring market-based mechanisms, such as tradeable permits. Governments should ensure that policies are not only effective, but are also the most efficient means for achieving the desired objectives. 'Good regulation' must not only bring net benefits to society, it must also be the most effective way of addressing an identified problem. Regulation should impose the least possible burden on those regulated, and on the broader community, in securing the desired objectives (Banks 2003).

### **Australian Government, state, territory and local government arrangements**

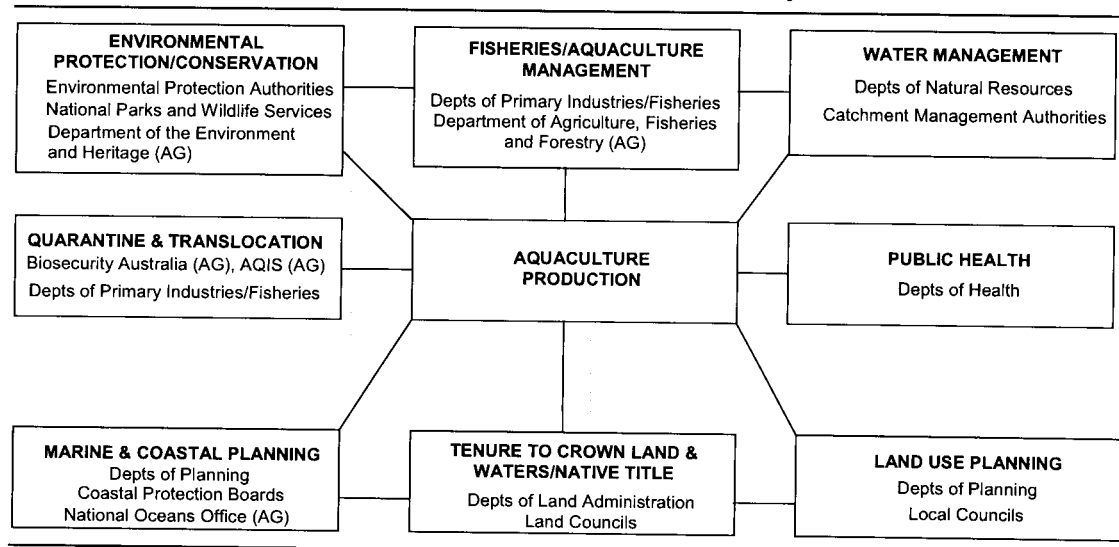
The Australian Government, and state, territory and local governments are responsible for different aspects of the broad regulatory framework for aquaculture production (see figure 1).

State and territory governments have primary responsibility for regulation of aquaculture production. Generally, state and territory departments of primary industries (or fisheries), planning, environment and land administration, as well as environment protection authorities, administer the regulatory framework and associated approvals. Aquaculture may be governed by state and territory legislation covering: fisheries or aquaculture; environment protection; coastal management; land administration; land use planning; native wildlife; and water management. Local government is usually responsible for administering development approvals for land-based aquaculture.

Different planning and environmental regulatory arrangements cover land-based and marine aquaculture given that land-based aquaculture is on public or private land, and marine aquaculture is in public waters. Depending on the location, species and type of production system, an aquaculture producer may require a number of different leases, licences and permits from various government departments and local government. In addition, large-scale land-based and marine aquaculture proposals are usually required to undergo environmental impact assessment prior to receiving approval.

The Australian Government has some direct regulatory involvement, most notably through the *Environment Protection and Biodiversity Conservation Act 1999*, the *Native Title Act 1993* and the *Quarantine Act 1908*. In Queensland, the Great Barrier Reef Marine Park Authority (Australian Government) has responsibility for regulation of aquaculture in or adjacent to the marine park, through the *Great Barrier Reef Marine Park Act 1975*.

**Figure 1. The broad regulatory framework for aquaculture**



Note: State or Territory department or agency unless identified as an Australian Government department or agency (AG).

Source: Adapted from Nash (1995).

## Agency functions and industry development

State and territory government departments that are primarily responsible for the aquaculture regulatory arrangements often have potentially conflicting functions of policy development, implementation of regulation, industry promotion and development, and aquaculture research. For example, the New South Wales and Western Australian Departments of Fisheries have a range of aquaculture functions.

There may be some size and efficiency advantages from the grouping of certain functions, but the conflict between regulatory and development roles may lead to public and industry mistrust over resource planning and allocation, regulatory approvals, monitoring and enforcement. Further, there is a risk that departments with resource planning and allocation, developmental and regulatory functions may provide conflicting or confusing advice to aquaculture operators. One approach to resolve this conflict is to place the development function in a separate department. In Queensland, for example, the Department of State Development has the lead role on aquaculture industry development while the Department of Primary Industries administers the regulatory framework.

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The Australian and state governments have provided funding to promote the growth and development of the aquaculture industry, and prepared state-wide aquaculture development strategies or plans designed to promote industry investment and employment (for example, see Lendich 2003). While some of these strategies or plans have given some attention to streamlining approval processes, most efforts have focussed on encouraging investment in the industry, and assisting potential investors with business planning, species selection, site selection, and farm management.

At times, this focus on industry development has occurred despite the compelling prior need to establish or refine environmental regulatory arrangements for aquaculture. Without appropriate regulatory arrangements, the aquaculture industry is unlikely to realise its potential, and any government funding of industry development will be less effective than otherwise.

### **Risk-based management**

Risk management incorporates the activities of risk assessment (identification and characterisation), risk management or mitigation, and risk communication (where results are provided to government, industry and community). The diverse nature of the aquaculture industry, and variability in environmental impacts across location, production systems, management practices and over time, means that incorporating effective risk management into environmental regulatory systems is critical.

The efficiency and effectiveness of aquaculture regulation could be improved by greater use of environmental risk assessment based on species, production system, management practices, site location and the condition of the environment (such as the quality of receiving waters). For example, sea cage finfish farming in enclosed bays has different environmental impacts to sea cage farming in the open ocean, and sea cage finfish farming has different environmental impacts to land-based prawn farming in ponds. Any refinement of regulation along these lines, however, would need to consider the costs (including regulatory and administrative) and benefits.

In most jurisdictions, point-source water pollution from land-based aquaculture operations (for example, water discharges from a prawn or trout farm) are highly regulated by state environment agencies. In contrast, there is often little regulation of discharges from diffuse sources of pollution (for example, runoff from pastoral activities or urban landuse), that have the potential to adversely affect the environment and some aquaculture sectors, such as shellfish. For example, the *Victorian State Environment Protection Policy (Waters of Victoria 2003)* has only limited provisions regulating management of pastoral stock, such as s. 39, which sets out that authorities are to 'encourage land holders and occupiers of Crown land to restrict stock access to surface waters'. Such activities are also unlicensed under the policy. This is in contrast to provisions for aquaculture, which include that



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producers must have appropriate licences and 'implement effective environmental management practices and appropriate environmental management systems' (s. 48).

The partial nature of environmental regulation of water quality raises questions about the appropriateness and cost-effectiveness of regulatory approaches for aquaculture, and land-based activities with potentially harmful impacts. The Productivity Commission in its report *Industries, Land use and Water Quality in the Great Barrier Reef Catchment* (PC 2003), noted that the regulation of diffuse and point source discharges in the catchments adjacent to the Great Barrier Reef World Heritage Area could be re-examined to include:

... other activities responsible for diffuse source discharges, and to ensure that the level of regulation and control was consistent with the level of threat posed by each activity. (PC 2003, p. 52)

A further issue is the level of potential environmental impacts from aquaculture (or other industries) that are currently allowed by regulation. The Queensland Aquaculture Industries Federation (QAIF) commented that:

Optimum and acceptable impact levels are critical and congruent to the issue of efficient and effective regulation. There is little point in having a development application process efficient in terms of limiting duplication, providing a timely response, and providing clear specification of information requirements if at the end of the process the application is always refused without reference to the actual impact levels. (Graham Dalton, QAIF, pers. comm., 18 December 2003)

Impact standards may need to be reviewed to ensure that they are commensurate with the risks to the environment and are not unduly constraining the operation of the aquaculture industry (or other industries).

### **3. Marine resource planning and aquaculture**

All jurisdictions use statutory and non-statutory planning processes to assess and allocate marine resources for aquaculture purposes, and provide for management of the marine environment. Marine aquaculture planning can allow up front environmental assessment and community consultation on potential aquaculture zones, prior to aquaculture development in public waters. This can help resolve conflicts over marine resource use, and avoid reactive and ad hoc assessment and site specific conflicts that can occur with individual development proposals.

Jurisdictions have used different statutory planning processes to assess and allocate marine resources for aquaculture purposes, and provide for management of the marine environment. For example:

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- Tasmania (since 1995) and South Australia (since 2001) have statutory marine aquaculture planning arrangements with marine aquaculture plans and zones used in conjunction with marine aquaculture leases;
  - Victoria and Queensland have statutory marine aquaculture planning arrangements — Victoria has recently declared nine marine aquaculture zones as fisheries reserves and is preparing reserve management plans, and Queensland has started to develop a marine aquaculture plan;
  - Western Australia has statutory planning arrangements for marine parks that may allow some commercial activity (such as aquaculture) where it is consistent with conservation; and
  - New South Wales has statutory aquaculture planning arrangements but has yet to develop aquaculture plans for marine areas.

Compared to South Australia and Tasmania, statutory marine aquaculture planning is less developed in New South Wales, Queensland and Western Australia. Slow progress with statutory marine aquaculture planning may constrain marine aquaculture development. It may also result in ad hoc approvals, and resource use conflicts, as individual aquaculture developments are assessed in the absence of a resource planning framework.

In addition to marine aquaculture planning, all governments have either prepared or are in the process of preparing or updating a number of statutory and non-statutory marine and coastal planning strategies. These strategies are in some cases not well integrated with each other, do not consider adjoining land uses, are outdated, and lack implementation plans (Caton 2002; James 2002; Ministerial Taskforce 2002). These problems can affect both aquaculture development proposals, and existing aquaculture operations through poor marine and coastal water management, with further implications for environmental sustainability.

#### **4. Land use planning and aquaculture**

Land use planning is an administrative approach to regulation of development. For example, land can be zoned for specific activities, such as rural, rural-residential, residential, commercial, or industrial, and development controls can be prescribed to manage potential impacts. Usually, land-based aquaculture would be provided for in rural or industrial zones. Such planning approaches are designed to preserve the rights associated with land titles by separating incompatible land uses (like industrial and residential uses), and manage potential environmental impacts.

A potential problem with land use zoning is the degree of flexibility of planning controls and land use definitions. While designed to provide some certainty to property owners

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regarding the nature of prospective development within their 'neighbourhood', zoning regulations and definitions also need to be flexible enough to respond to changes in community needs, and demand for new land uses.

The lack of recognition and provision for aquaculture in state-based land use planning arrangements (particularly regional and local planning schemes) can adversely affect the granting of development or planning approvals for aquaculture (AARTF 19999). Victoria, Western Australia and South Australia, for example, do not provide planning guidance to local councils on how to address land-based aquaculture in planning schemes, or how aquaculture applications should be assessed for development approval.

State land use planning strategies and/or state-wide 'model planning schemes', if not unduly prescriptive, may assist the integration of planning policy and development control, improve coordination of planning at different levels, and reduce the resources required by state and local governments in the preparation and administration of schemes. State-wide aquaculture planning guidance may help local councils to provide appropriately for land-based aquaculture in planning schemes, and inform the assessment of applications for development approval.

## **5. Lease of public waters and/or land for aquaculture**

Following resource assessment and resource use planning, governments may use different types of lease to provide the right to occupy and use public water and land resources for aquaculture purposes. Tenure may be either short- or long-term, and occupation and use of the lease area may or may not be exclusive. Conflicts may arise where lease systems do not have:

- sufficient flexibility, with different lease categories and potential uses;
- efficient and transparent methods for lease allocation and transfer; and
- adequate specification of property rights, term and renewal arrangements.

Where applicable, the lease of public land or waters for aquaculture purposes will need to address and be consistent with native title. Other than seeking court determinations over native title rights, lessees, governments and traditional owners may seek to negotiate agreements for aquaculture purposes.

### **Marine aquaculture leases**

Marine aquaculture leases can be used to allow aquaculture operators to access, occupy and use publicly-held marine (both waters and seabed) resources. However, the use of marine aquaculture leases varies significantly across jurisdictions:

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- New South Wales, South Australia and Tasmania have dedicated marine aquaculture lease arrangements, and have made considerable use of them, both in terms of the number of leases granted and the area leased;
  - Western Australia has dedicated marine aquaculture lease arrangements but has not granted any marine leases — annual aquaculture licences are used; and
  - Victoria and Queensland have no specific marine aquaculture lease arrangements and have not granted any marine aquaculture leases — these jurisdictions rely on aquaculture licences for the use of marine areas for aquaculture purposes, although the use of leases is under review.

The limited use of marine aquaculture leases in Victoria, Queensland and Western Australia has implications for industry development and the growth of marine aquaculture, particularly given the significance of marine aquaculture in Australia. Inadequate security of tenure may affect aquaculture development financing (ARRTF 1999).

Multiple selection criteria and specialist tenure allocation boards are used to assess and allocate marine leases in South Australia and Tasmania, rather than a competitive auction based on price and subject to specified conditions (Chan et al 2003). The lack of open competitive bidding processes for marine aquaculture leases based on price has potential to lead to distortions in resource use and affect economic efficiency. The use of multiple selection criteria may also raise concerns about the transparency and accountability of lease allocation processes (IC 1996).

### **Lease of public land for land-based aquaculture**

A land-based aquaculture operation may require access to, or tenure over, public land, such as coastal foreshore, a coastal reserve or a pastoral lease. This may be for land-based aquaculture itself, or for placing a pipe under or across the coastal foreshore to take and discharge sea water from a coastal land-based site.

In some jurisdictions, it can be difficult to gain access to coastal foreshore and reserves for aquaculture (and other) purposes due to a lack of defined processes for lease assessment and approval. This highlights the importance of clear assessment criteria for lease applications, and well-functioning administration and approval processes.

On pastoral leases, until recently, the main approach to accommodating non-pastoral land uses, including aquaculture, was by discretionary changes to lease conditions and rental rates by the relevant managing authority. This approach lacks transparency and may involve inconsistencies, thereby heightening investor uncertainty.

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## 6. Approvals

Various aquaculture leases, licences, permits and development approvals (collectively referred to as approvals) may be required for aquaculture production, depending on the location, species and production system (see box 1 for potential approvals for a large-scale marine operation). Approval requirements for aquaculture can create barriers to entry into the industry or expansion of existing operations.

### **Box 1. Potential approvals for a large-scale marine aquaculture operation**

Approvals that may be required for marine aquaculture, with associated land-based facilities in the coastal area include:

- a marine aquaculture lease — provides long-term tenure, and the right to occupy and use a marine site;
- an aquaculture licence to undertake aquaculture production — contains operating conditions for specific species and environmental controls;
- a permit to take breeding or culture stock;
- a works approval (to control impacts from construction) and/or an environmental licence (to control waste discharges) (may be part of aquaculture licence);
- a lease of public coastal land (for a jetty or warehouse);
- a licence for development in the tidal or coastal zone;
- a permit to clear marine and/or terrestrial vegetation; and
- a development or planning approval from local government.

Major differences between state regulatory arrangements and aquaculture and environmental approvals include:

- South Australia and Tasmania have dedicated aquaculture legislation and do not require discrete environmental approvals for marine or land-based aquaculture — environmental conditions are covered as part of an aquaculture or marine farming approval;
- New South Wales and Victoria require both aquaculture and environmental approvals for land-based aquaculture, but only an aquaculture approval for marine aquaculture (in New South Wales, considered under an integrated development approval system);
- Queensland and Western Australia require both aquaculture and environmental approvals for marine and land-based aquaculture (Queensland has an integrated development assessment system for some approvals);

- large aquaculture developments with potential for significant environmental impacts may require additional environmental assessment in New South Wales and Western Australia; and
- in all jurisdictions, except in South Australia, development approvals are not usually required for aquaculture activities in marine waters, but development approvals are required for land-based aquaculture.

In most jurisdictions, especially for larger aquaculture projects, up to five state government departments and agencies, as well as local government, are involved with processing and providing approvals for aquaculture (see table 2 for a summary of approvals required for marine aquaculture).

**Table 2. Approvals for large-scale marine aquaculture and associated land-based facilities**

<i>Approvals</i>	<i>NSW</i>	<i>VIC</i>	<i>QLD</i>	<i>WA</i>	<i>SA</i>	<i>TAS</i>
<b>Mandatory approvals</b>						
Aquaculture lease	✓			<sup>b</sup>	✓	✓
Aquaculture permit/licence	✓	✓	<sup>a</sup>	✓ <sup>b</sup>	✓	✓
Environmental discharge licence			<sup>c</sup>	✓		
Environmental works approval				✓		
Development/planning approval (land-based facility eg warehouse)	✓	✓	✓	✓	✓✓ <sup>d</sup>	✓
<b>Potential approvals</b>						
Lease of public land/water	✓	✓	✓	✓	✓	✓
Permit to impact marine plants	✓		<sup>a</sup>			
Land vegetation clearing permit	✓	✓	<sup>a</sup>	✓	✓	
Permit to take brood or culture stock	✓	✓	✓	✓ <sup>e</sup>	✓	✓
Works affecting coastal protection			<sup>a</sup>			
Works on tidal lands or waters			<sup>a</sup>			
Permit for works in GBRMP <sup>f</sup>			✓			
Discharge into GBRMP <sup>g</sup>			✓			

<sup>a</sup> Queensland is integrating most of its development related controls under the Integrated Development Assessment System (IDAS), including coastal protection and fisheries approvals. Resource allocation approvals are assessed separately outside of IDAS. <sup>b</sup> Specific pearl oyster farm leases and licences apply for pearling. <sup>c</sup> Environmental matters are considered as part of a development approval. A 'personal environmental licence' may also be required. <sup>d</sup> Development approvals are required for land-based facilities (generally from local government), and for activities in marine waters (generally from Development Assessment Commission). <sup>e</sup> Ministerial exemption. <sup>f</sup> Great Barrier Reef Marine Park. <sup>g</sup> Under review.

Prospective aquaculture operators can experience significant costs and uncertainties from dealing with multiple agencies with different regulatory responsibilities for aquaculture management (APFA 2002; Ciffolilli 2003). Prospective operators can also experience difficulties identifying which approvals they need, whether there is a hierarchy of approvals, and which agencies they need to apply to. More complex aquaculture proposals, for example, may take more than four years to be approved where extensive consultation and many different approvals are required.

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The number of individual approvals, and the time required to obtain different approvals, can create barriers to entry into the aquaculture industry or expansion of existing operations. There would seem to be scope to simplify approval systems by reducing the number of individual approvals required — for example, by introducing one approval that covers interrelated aspects of aquaculture production, including fish health and environmental management, rather than having individual aquaculture and environmental approvals.

Improved agency coordination, more streamlined processing and statutory timeframes for approval processing would provide greater certainty for applicants and incentives for prompt and efficient processing of applications by agencies. Provision of guidance to approval agencies or local government on the processing of approvals may also assist the efficiency of approval processes. There is potential for further research on the compliance costs of aquaculture approval processes in each jurisdiction, and ways to improve approval processes.

Industry uncertainty over the potential impact of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is another key issue. There may be additional ways for the Department of the Environment and Heritage (Australian Government) to work with the industry to increase understanding, and to improve the operation of the Act. For example, state aquaculture management plans may be able to be accredited under the EPBC Act, similar to the strategic environmental impact assessment and accreditation process for a 'plan of management' for a Commonwealth fishery. Individual approval under the EPBC Act for actions in accordance with an accredited aquaculture management plan may then not be required.

## **7. Monitoring and reporting**

Environmental and compliance monitoring is important for the sustainable management of aquaculture. There are, however, concerns that some arrangements can be too prescriptive. Enforcement is also critical for regulatory effectiveness, but in some jurisdictions, enforcement appears to be inadequately resourced.

At present, there appears to be limited reporting by, and auditing of, the main state agencies responsible for environmental regulatory arrangements for aquaculture. Aspects of regulatory and approval processes that could be reported on within confidentiality restrictions include: the number of applications; the number approved/rejected; discretionary approvals; exemptions; processing times; appeals; monitoring and enforcement actions. As well as potentially improving accountability and transparency, such information may help identify potential regulatory constraints and opportunities for improvements in approval processes.

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## 8. Conclusions

Environmental regulatory arrangements for aquaculture reflect the diversity of aquaculture production, its use of public and private resources, and the potential for environmental impacts. Since some aquaculture operations have potential for significant environmental impacts, some environmental regulation is clearly required. However, aquaculture production is subject to an unnecessarily complex array of legislation and agencies.

Regulatory arrangements that are unwarranted, or poorly developed and implemented, can impose unnecessary costs on aquaculture producers, consumers and the community, and adversely affect competitiveness and the environment. To be efficient and effective, regulation needs to satisfy a number of criteria, including that there are clearly defined objectives, and that the regulation is consistently and transparently applied, not unduly prescriptive, and enforceable (Banks 2003).

There is potential for greater use of innovative policy instruments to complement (or in some cases replace) existing regulatory and administrative controls (Schuele et al 2004). For example, the use of auctions for marine lease allocation, and the use of tradeable discharge permits to manage discharges of effluent, may have merit. However, the costs and benefits of innovative policy instruments, including implementation and monitoring costs, will need to be assessed. Further research is needed to help assess the likely contribution of innovative policy instruments for management of aquaculture and associated environmental impacts.

Several state governments, including those in Victoria, Queensland and Western Australia, are currently reviewing parts of their aquaculture regulatory arrangements to improve administrative arrangements and approval processes. There is an opportunity to learn from successful reforms in other jurisdictions, both in Australia and overseas, to improve environmental regulatory arrangements for aquaculture. There is potential for a well-managed aquaculture industry to continue to grow, while providing for sustainable management of the environment.

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