University of Portsmouth

CEMARE Research paper 132

Legal issues associated with 'free fish farming at sea'

H Pickering

University of Portsmouth
Centre for the Economics
and Management
of Aquatic Resources
Locksway Road
Portsmouth PO4 8JF
United Kingdom

First published University of Portsmouth 1998

For bibliographic purposes this publication may be cited as:**Legal issues associated with `free fish farming at sea'**, H Pickering. *CEMARE Res. pap.* no.132. 1998, 25p.

ISSN 0966-792X

Legal issues associated with `free fish farming at sea'

Helen Pickering

Abstract

This paper aims to achieve three ends: to identify and review the key legal questions faced by one new and upcoming activity in the marine environment, the challenges that existing legal regimes pose for such activities and to explore the particular scenario that marine ranching faces in Europe. The paper in the latter context reviews the extent to which marine ranching is a legally viable concept for the future enhancement of fish production in Europe. The paper particularly focuses on three key categories of issues which the international body of experience has shown to be important in determining the extent to which ranching operations are viable and the form they can ultimately take: ownership and exploitation rights, operational requirements and development controls. Each of these issues is explored by reviewing international experience (where appropriate) and the indigenous regimes in Europe to examine their implications for the viability of marine ranching.

Introduction

This paper aims to achieve three ends: to identify and review the key legal questions faced by one new and upcoming activity in the marine environment, the challenges that existing legal regimes pose for such activities and to explore the particular scenario that marine ranching faces in Europe. The paper in the latter context will review the extent to which marine ranching is a legally viable concept for the future enhancement of fish production in Europe.

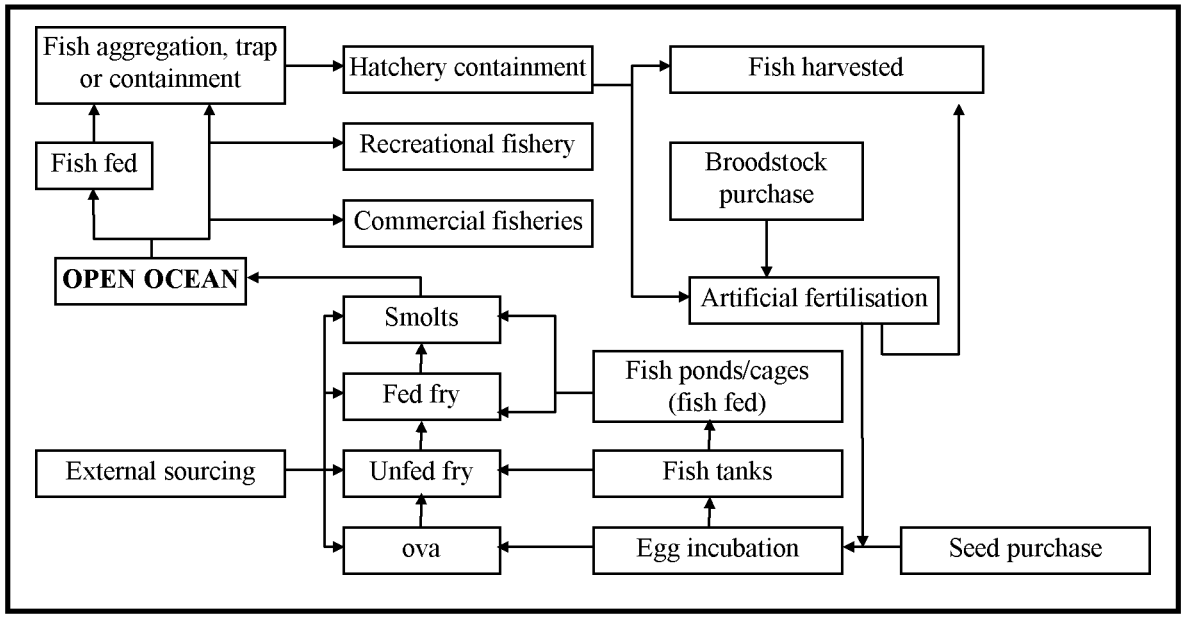
With many fish stocks subject to over-fishing and imports accounting for an increasing proportion of domestic consumption within many European countries, alternative systems of fish production are being explored: with marine ranching one of them. There have been various experimental programmes undertaken and recently marine ranching has been a focus of a workshop held under the auspices of the European Parliament Scientific and Technical Options Assessment Unit (STOA).

Marine ranching pertains to the release of hatchery-reared young fish into inshore waters for subsequent on-growing and recapture by either private, public (user groups) or co-operative beneficiaries. At one extreme, the term has been used for that which would more readily fall within the concept of stock enhancement, where the fishery as a whole is the beneficiary. While, at the other extreme it relates to private, commercial enterprises. For the purposes of this paper, the former interpretation is incorporated in the discussion of international experience and its implications for ranching in Europe. However, in the context of any European application of ranching, the concept is taken to refer to operations with named beneficiaries.

Marine ranching has an ancient pedigree, dating back to the middle ages in China and Europe where fish were stocked into water bodies for on-growing without supplementary feeding. However, ranching in a modern context is a rather young technique, with many ranching programmes largely experimental, and fully operational initiatives largely dedicated to anadromous species, notably salmon. A schematic of a ranching operation is given in figure 1. Apart from where the public fishery is the beneficiary, recapture is facilitated through a combination of natural and technical aids aimed at aggregating the ranched stocks at the recapture site: natural aids would include homing instincts while technical aids include such as artificial reefs, enhanced feeding and the training of juvenile fish to respond to positive or negative signals (for example, acoustic signals or electrical barriers).

As this paper will demonstrate, marine ranching integrates many of the contemporary techniques used in fisheries and aquaculture. However, just as with the science and technology, from a legal perspective this inheritance is not necessarily sufficient to make the concept viable. There are plethora of issues which need to be considered and addressed before this can happen. This paper will particularly focus on three key categories of issues which the international body of experience has shown to be important in determining the extent to which ranching operations are viable and the form they can ultimately take: ownership and exploitation rights, operational requirements and development controls. Each of these key issues will be explored in turn by reviewing international experience (where appropriate) and the indigenous regimes in Europe to examine their implications for the viability of marine ranching.

Figure 1. A schematic representation of a marine ranching operation.



Ownership and Exploitation Rights

The first key legal issue evident from international experience is the crucial question of rights to the resource or its exploitation, which defines the ability to reap the returns of any ranching operation. If a broad typology of international programmes is drawn up (after Orrego Vicuña (1991)) identifying the beneficiaries, sources of investment and traditional resource rights regimes (Table 1), and the history of each of the programmes is explored it becomes evident that ownership and exploitation rights are a fundamental caveat to the form and viability of any ranching programme.

Table 1. Institutional models

Exploitation/Beneficiary	Investment	Example
state	state	Former Soviet Union
public	state	USA, Canada
	state and co-operative	Ireland
	private	Ireland and Sweden
public and private	private	Oregon & California (USA)
public, co-operative and private	state, co-operative and private	Alaska
co-operative	co-operative	Japan
private	private	New Zealand, Chile, Iceland

From this typology, it is evident that the beneficiaries of ranching programmes essentially fall into three categories: commercial and sports fishermen where the fish are harvested as a public resource; ranching operatives where fish are harvested as a private resource (Isaksson 1988); and co-operatives, which are comprised of user groups such as fishermen or tribal communities (McNeil 1980, Isaksson 1988, Nasaka 1988) and exhibit elements of the previous categories depending on their constitution. It is a division which in part reflects the rationale underlying each programme, but in many cases, more particularly, the existing resource rights regime. The default position tends to be open-access (public) exploitation unless traditional rights regimes exist or legal provisions are made to the contrary.

Open access is a basic legal principle of the majority of global fisheries, dating back in Europe to the adoption of the doctrine of *mare libarum*[1] by England and Holland in 1609, which through the influence of maritime nations and colonial expansion has since spread globally. The concept, supported by ancient Roman law, was that the sea is by nature common and not susceptible to possession, including the fisheries within it. Neither individuals nor governments could claim it and its resources were, therefore, open to everyone and only reduced to possession through their being caught (Pearse, 1994). It is a concept which continues to prevail, despite the widespread adoption of a number of property right and regulatory regimes[2] as awareness of the contribution of open access to over-fishing and stock depletion and the need for management has grown. As a consequence, open access has had a strong influence on the forms of ranching adopted globally. For example, the Former Soviet Union, certain states United States of America, Canada and Sweden are all countries whose ranching programmes favour public beneficiaries: tending towards "enhancement" initiatives (Cable 1987, Isaksson 1988, 1994, Pearse 1994).

As noted, private beneficiaries have only been targeted by ranching programmes where either explicit legal provisions have successfully been implemented as an exception to this general rule, as in Oregon, California and Alaska (the latter by referendum in 1972 (McNeil 1980b)) or where there are existing private rights to the resource, as in the internal waters of Iceland (Lannan 1980, Isaksson 1988, 1994, Olsen 1994). The examples are somewhat limited in number. Several attempts have been made to enact legislation in other countries and American states to follow this lead and allow for private ranching. However, these attempts have to-date met with little success. This has been mainly due to the over-riding opposition from traditional users and the public. The key obstacles private rights have faced include: the potential impacts on markets, the political power that ranch operators may accrue and exercise, ethical questions as to whether public resources (consumed by feeding ranched fish) should be used for private gain (New Zealand (Waugh 1980) and Washington state, U.S.A. (McNeil 1980)) and the erosion of public rights (Lannan 1980, Berg 1981, Hampson 1988, Isaksson 1988, 1994).

The other option in terms of beneficiaries, co-operatives, has also been determined by either the successful enactment of enabling legislation or the existence of traditional co-operative rights regimes as in Japan, or community rights regimes as with the Treaty Indians of North America (Nasaka 1988, Olsen 1994). In Japan, exclusive co-operative exploitation rights exist, which are an extension of the traditional exclusive rights exercised by Fishermen's co-operative associations for the exploitation and management of coastal fish resources within prescribed zones (Asada et al 1983, Iwami Fishermen's Co-operative Association 1992, Ungson 1993). In North America, under treaties made with the United States in the 1800s, Treaty Indians retain certain rights and management functions in respect of fisheries.

It should be noted that the extent of the rights obtained under either of the above scenarios is often limited (McNeil 1980b). In Oregon, for example, steelhead salmon (classed as game fish) are excluded from provisions for private hatcheries (Lannan 1980). Likewise, the extent of private rights is often limited to certain prescribed waters (notably to hatchery or release sites or terminal areas where ranched and wild stocks can be separated (as in Alaska)(Heard et al 1995)). Beyond these areas public fisheries generally exist, with interceptions of ranched fish by the public high, reducing returns. Instances where this is not so and where restrictions on public fishery exist beyond the immediate area of release/recapture are confined to a few examples. In Iceland, inland waters are subject to private rights, while sea fishing for salmon has been prohibited for over sixty years (Isaksson 1988, 1994, Joñasson 1996). Similarly in British Columbia, both commercial and sports fishing for salmon has been banned (Rudd 1995), and in Florida, the fishery for Red Drum has been closed in Federally regulated waters and strict sport harvest rules imposed at the state level (Johnson and Funicelli 1991). In Alaska there is an additional constraint. Given traditional public rights in fish resources in Alaska, the not-for-profit operations created are permitted only the limited sale of

[1] "freedom of the seas". The Dutch jurist Hugo Grotius argued that property rights could only extend to that which the holder was able to defend from others. This meant that as only a narrow band of seas along the coast could be occupied, defended and in which others could be excluded, the high seas was *res nullius* - no property.

[2] Controls on vessels, engines and fishing gear, along with area closures and seasonal closures. These measures are aimed at limiting catches through restricting the technology, efficiency and amount of fishing effort.

hatchery returns, to the extent of covering production costs and facility indebtedness (cost-recovery) (Heard et al 1995).

One of the key manifestations of this pattern of rights is the pattern of investment in ranching operations, mentioned here as it will prove a key consideration in the development of policy and regulatory regimes. As with the definition of beneficiaries, a pattern of private, co-operative and public financing is evident in ranching projects to date (table 1), which largely runs with rights of exploitation. However, although not evident from the table, in the vast majority of cases, both public and private, state investment has represented the primary source of investment. While public investment has been used to support public access fisheries, even where private rights have been awarded, significant state involvement has often been required to subsidise operations. Private investment has been proving hard to attract (McEachron and Daniels 1995), largely a factor of the poor returns encountered through interceptions or natural losses (Christy 1991, Howarth and Lería 1997). Without some proprietary rights protected by law there is little incentive for private investment (Stickney 1991, Howarth and Lería 1997). Even where there are restrictions on public fishery beyond the immediate area of release/recapture and the situation would seem particularly favourable to securing private investment, it still has proven difficult to obtain. In Iceland, for example, salmon ranching operations have struggled financially, with financial institutions proving reluctant to invest (Stickney 1991). In Alaska financial difficulties have led to significant state grants and loans being required to fully cover costs, many of which remain outstanding (Knapp 1997). There are, however, a few exceptions to this general rule. In the public waters of the US Pacific Northwest a number of large companies have operated release and recapture operations, regarding losses as an acceptable cost of operations (Lannan 1980, Ungson 1993) and in Japan several large private companies have also provided financial contributions to sea ranching (Ungson 1993). Note that in Ireland and Sweden private investment is largely in the form of compensation for the effects of development projects by, for example, hydroelectric companies.

The budgets spent on ranching and enhancement programmes by national, regional and local government agencies have been sizeable. In the fiscal year 1991-2, Washington Department of Fisheries spent US $31.3 million on salmon culture as its single largest expenditure (White et al 1995). Similarly, 42.5% of Oregon's biennial budget (1993-1995) and 37% of Pennsylvania's annual budget (1991-1992) were spent on fish propagation (White et al 1995). In Norway, financial support for the Programme for the Development and Encouragement of Sea Ranching (PUSH) between 1989 to 1997 ran to a total cost of NOK 200 million (Anon 1998).

Government agencies in several countries have been exploring alternative ways to support ranching initiatives to reduce levels of government support. However, it has yet to be established whether these alternatives will be adequate and at the present time such initiatives tend to be focused on solely co-operative and public schemes (McNeil 1980, Lannan 1980, McNeil 1980b, Bachen 1993). The options explored have included fees, cost-sharing (California Fish and Game Code 1998), surcharges, taxes and cost-recovery, each aimed at the beneficiaries of ranching programmes (Anon 1993). For example, in Japan, an increasing proportion of the costs are being met by fees collected from the members of fisheries co-operatives (Nasaka 1988, Davy 1991, Iwami Fishermen's Co-operative Association 1992). In Denmark, Oregon and several other American states, charges have been attached to commercial and sport fishing licences to raise funds (ICES 1994) and in Alaska, a tax on salmon landings has been employed alongside allowing the private non-profit operators to take a "cost recovery harvest" (Alaska Administrative Code 1998).

European Property and Exploitation Rights

From the above discussion of international experience, it is evident that one of the fundamental legal and practical issues surrounding ranching lies with the basis, form and extent of ownership and exploitation rights: rights to ranched fish after release (either through rights in the fish *per se* or in their capture) (Howarth 1989, Isaksson 1994).

Turning now to Europe, it is pertinent to consider the indigenous rights' regime in the context of this international experience and its connotations for marine ranching. Within Europe the legal regime

governing marine fishery resources is one of open-access, subject to instruments of management which moderate but not supplant public rights. Only in non-tidal internal waters in certain countries are there private rights of fishery, as for example, in the United Kingdom, Norway and Ireland, where fishing rights in rivers run with the land. Which means that unless provisions are made to the contrary, any fish released into the marine environment for the purposes of marine ranching are effectively released into an open access (public) fishery, with heavy interceptions and low returns inevitable. To secure returns, private operations and co-operative operations would require the explicit provision of either exclusive property rights or exclusive harvesting rights.

In terms of private property rights, in several European countries there are legal precedents for the creation of such rights in fishery. However, this is confined to shellfish and even where this principle exists it cannot readily be extended to finfish (Eckert 1979, Pickering 1997). Fish in law are classed as wild animals ((*ferae naturae*) as distinct from domestic animals (*domitae naturae*)) and are only subject to private ownership once in ***possession***. Otherwise, as noted, they are open to capture by anyone using lawful methods (McNeil 1980b, OrregoVicuña 1991). For private rights, ranched and wild fish would need to be distinguishable (Orrego Vicuña 1991) and the owner must be able to control their movement and capture them readily throughout their whole life-cycle, as with sedentary shellfish and finfish in aquaculture units (Howarth 1989, Howarth and Lería 1997). As a general rule, unless these requirements can be satisfactorily proven, once released from the hatchery possession and ownership rights over the resource are lost (Christy 1991), just as with escapees from aquaculture units. This is a key reason for the lack of private ranching initiatives globally. Even with salmonids (a popular species for ranching initiatives) for which the ownership concept of *animus revertendi* (as applies to homing pigeons and "escaped domestic animals" in that they possess the instinct or intention to return to captivity) has been tried (Nova Scotia, Canada), its extension to finfish remains the subject of debate (Newton and Richardson 1973, Bowden 1981, Wildsmith 1982, Orrego Vicuña 1991). It is also debatable whether tagging alters this position (Anon 1998) or whether conditioning will prove adequate, although tagging is being considered, for example, by Ireland (personal communication with Department of Marine and Natural Resources) and the marking of released fish is currently employed to distinguish between ranched and wild stocks in Oregon (Oregon Revised Statutes, Chapter 508) (Pickering 1997). Where private rights exist, it should be noted that any rights are subject to statutory qualification, which in its turn can compromise the viability of private ranching operations (Thorpe 1980, Isaksson 1994).

The alternative to rights in fish are harvesting rights. Which given the open-access scenario in marine waters essentially requires licences to be issued to the operative/ co-operative as a general prohibition from fishing if harvesting rights are to be secured. There are several options available to this end with traditions in Europe, extensions of traditional fisheries management techniques. They include in increasing order of control and regulatory evolution: (a) the prohibition or control of access by fisheries authorities (either by area, species or types of fishing) along traditional lines of fisheries management; (b) the licensing of access (with or without a fee and/or quota) as an exemption from a general prohibition of access, as in Spain in respect of artificial reefs (Orden No.12020, art.19)(Christy 1991); or (c) the creation of a 'property' right in a ranching operative, or some other body, to restrict or permit access to, exploit and manage the resource and to charge fees in respect thereof. Each of these management measures has its own advantages and disadvantages which need to be considered in the selection of an appropriate model for ranching.

In terms of European traditions, the control of access by area, species or type of fishing is one of the oldest approaches employed in fisheries management. In the United Kingdom, for example, going as far back as 1285 and the Statute of Westminster the Second, which pertained to closed seasons and the regulation of the use of nets in salmon rivers. While the approach controls the type of activity conducted it does not control effort which is essential for the allocation of harvesting rights, the management of recapture rates in co-operative and public ranching programmes and the reduction of potential wild stock by-catch, especially where artificial attractors are used (Pearse 1994). Artificial attractors will have a tendency to attract both ranched and wild fish within the locality, increasing the vulnerability of wild stocks to capture (as a by-catch of the recapture of the ranched fish), exacerbating any tendency towards over-exploitation among wild stocks. This potential, in respect of unregulated artificial reefs has been noted by Milon (1989, 1991), Garcia (1990), Willmann (1990), Morton (1996), Santos, Monteiro and Lasserre (1997), Grossman,

Jones and Seaman (1997) and Whitmarsh and Pickering (1997). Without effort control within ranching operations, ranched stocks may too readily be exhausted and levels of wild stock by-catch excessive.

The second option, "license limitation" takes a number of forms, with the key distinction being between licences with a quota attached and those without. The latter, as employed in capture fisheries up to the 1970s, suffers from an absence of effort control, as with the previous option. By licences only controlling certain aspects of operations, naval architects have been able to compensate by changes to vessel and gear design (Pearse 1994). The introduction of the "quota" in the late 1970s, in conjunction with the determination and allocation of the total sustainable catch, however, addressed this problem by allocating quantitatively defined rights in the resource. Unfortunately, the quota has also proven not to be a panacea. Early schemes have encountered problems of implementation, administration and compliance and the system does not lend itself easily to highly volatile and unpredictable stocks or to situations where enforcement is weak or where by-catch is undesirable (Pearse 1994).

The third approach, the creation of a 'property' right in the reef-owner or some other body, employs what is termed in British law as a *several fishery* or Regulatory Order (Sea Fisheries (Shellfish) Act 1967, s.2(1) (several fishery), s. 1(3) (Regulatory Order). s.1(3) was amended by s. 34(a) of the Fisheries Act 1981 to include waters containing floating structures and any standing or suspended in water for the propagation or cultivation of shellfish.) as established for certain specified shellfish and extended recently to encompass lobster ranching (Sea Fisheries (Shellfish)(Amendment) Act 1997). A private 'property' right potentially grants a secure, exclusive entitlement to the management and exploitation of the resource and, possibly, its habitat and aims to make effective resource management on the part of the exploiter of the resource a matter of self-interest by providing the attributes of a real property right (Elliot 1995). It is an approach which has gained substantial interest over the last thirty years, principally deriving that interest from the action of four factors, namely: growing dissatisfaction with the existing system (Neher 1989); recognition of the potential benefits of moving from an undirected political framework of management to one with economic objectives (Neher 1989, Catanzano and Sutinen 1994); the increased feasibility of defining and defending the resource through stock assessment and remote enforcement technology, the previous lack of which had underwritten the legal concept of 'freedom of the seas'; and the modification of that legal principle under the auspices of the United Nations Conferences on the Law of the Sea which introduced the concept of national rights to marine resources (Scott 1989).

It is important to note, however, that while such mechanisms are available within Community and national legislation, their applicability in any context may depend on the species in question and the associated regulatory regime under the EU Common Fisheries Policy; the spatial extent of the operation (including the migration patterns of the ranched stocks); and whether the stocks can be regarded as purely local to the state supporting the ranching programme. For any particular species or circumstance, it will need to be determined whether the desired management technique is compatible with wider national and European regulation. Similarly it needs to be noted that even where the model of property rights is used, fisheries management techniques may well still be necessary in respect of managing the impacts of ranching operations on wild stock by-catch. There are also a number of implementation and transitional considerations of pertinence to the viability of adopting such exploitation or property rights.

The implementation and transition considerations which have governed the applicability, form and implementation of regulatory systems for ranching elsewhere in the globe and which similarly have to be considered for Europe, start with the central question as to how to design such regimes to ensure that there are adequate returns. Other factors of pertinence are given in table 2.

Table 2. Implementation and transition considerations.

- the existing property right and legal regime and any legal precedent for change
- political influence and bargaining over regulatory changes among:
    - winners and losers (e.g. fishers, competitors)
    - regulators and administrators
    - downstream interests
    - other interested parties (e.g. environmental groups, public)
- the extent of the involvement of these groups in the programme
- the nature and scale of the distributional effects
- any compensation arrangements
- the past record of regulatory change, regarding the permanence and quality of reforms
- ideological stances and the support or opposition for the scheme

(Bromley and Cernea 1989, Libecap 1989, Rettig 1989, Scott 1989, Christy 1991, Mace 1993, Knudsen 1995, Whitmarsh and Pickering 1997)

These factors will determine whether the adoption of any particular regime is possible and the changes and issues that are likely to surround it's adoption (Bye 1990). Depending on the attitudes of the potential beneficiaries, winners and losers and their consideration and involvement in the programme, a change of regulatory regime and property rights can be potentially unmanageable and costly to enforce (Eckert 1979, Libecap 1989, Scott 1989, Mace 1993, Garcia 1995, White et al 1995). The support for ranching programmes and their associated institutional frameworks in Japan reflects that those frameworks are built on the traditional co-operative rights framework and that coastal fishermen are actively integrated within the programme (Asada et al 1983, Ungson 1993). Any other approach could have been highly controversial, as demonstrated by the failed attempts to enact legislation to provide for private ranching operations in Washington state, USA (McNeil 1980b) and early conflicts between resource users and ranching in Alaska (since addressed through a public consultation and involvement initiative) (Olsen 1994).

Operational Controls

The second major legal issue of relevance is the existence or otherwise of appropriate operational controls (Ungson 1993, Isaksson 1994). Table 3 shows some the main aspects of ranching operations requiring legal consideration.

Reflecting the constraints of the existing legal, institutional and political arrangements, the politically and ecologically viable solutions identified in relation to the target species and circumstance, and the status of ranching (e.g. experimental, small scale or established nation-wide programmes) there have been a variety of regulatory frameworks adopted globally. Correspondingly, the items in table 3 are provided for to varying extents by the different nations and in different ways, either through primary or secondary legislation; parliamentary resolution (Norway) (Anon 1998); policy requirements; codes of practice; or the action of departmental discretion during an approval's process. (Idyll 1986).

It is evident that the institutional arrangements governing ranching show a marked resemblance to those existing prior to the development of the concept. This is particularly so for one off or experimental programmes, where the evaluation, authorisation and control of ranching reflects the discretionary and general powers of agencies responsible for fisheries and aquaculture. However, even where relatively large scale programmes have been in operation and there is a recognition of the need for a comprehensive regulatory regime, few comprehensive statutes have been specifically enacted to cover ranching. As in Norway, many countries lack dedicated legislation. Notable exceptions, where provisions have been made, are Japan (Nasaka 1988), Alaska (Olsen 1994), Oregon (Oregon Department of Fish and Game 1998) and California. Most ranching programmes fall within the provisions of statutes and regulations governing capture fisheries (as in Canada (Hillyer 1997) and Ireland (Department of Marine and Natural Resources, pers. com. 1998) and aquaculture. The latter is particularly pertinent to hatchery and grow-on elements of

ranching operations. Amendments or supplementary Acts to these principal bodies of law have been enacted in a number of instances to provide for any additional legal provisions deemed necessary, as with the Fisheries Amendment Act 1962 in Ireland which provides for, *inter alia*, artificial propagation for scientific purposes and the improvement of fisheries (Department of Marine and Natural Resources, pers. com. 1998, McNeil 1980b, Idyll 1986, van Houtte 1994).

Table 3. Operational aspects of ranching operations requiring legal consideration.

- allocation of responsibilities
- constitution & mandates of potential operators
- allocation of rights and leasing/licensing arrangements
- site selection, criteria & authorisation
- facility design & construction
- sourcing & genetic resource management
- introductions & translocations
- culture protocols & management
- release & recapture protocols
- stock transportation protocols
- staffing and training
- fish health & disease management
- feed management
- impact assessment & management
- inter-sectoral relations & consultation procedures
- human health & water quality management
- fisheries management - wild & ranched stocks
- insurance & fiscal provisions
- processing, marketing & sale of ranched fish
- food quality management
- resourcing
- support infrastructures

In terms of the administration and enforcement of these legal provisions for marine ranching and the development of secondary legislation, associated policy guidance and codes of practice, the lead agency tends to be fisheries associated. In a few cases dedicated divisions of governmental agencies have been created, as in Japan (Japan Sea Farming Association under the Ministry of Agriculture, Forestry and Fisheries)(Davy 1991). In other cases, dedicated planning and administration groups or committees have been formed under the auspices of government agencies, as in Alaska (with the Fisheries Rehabilitation Enhancement and Development Division (FRED) under the Alaska Department of Fish and Game) (Heard et al 1995) and in other North American states. Generally, however, even with the existence of such groups or committees, responsibility for the administration of laws and regulations governing ranching falls to those agencies with existing responsibilities for wild fisheries (notably Departments of Fisheries and state Fish and Wildlife or Game Departments (USA)) (Tilseth 1994, McEachron et al 1995). In most cases, there is a national and provisional level to the institutional framework, with possibly a further, local level as in the case of co-operatives in Japan (table 4) and the Queensland Fisheries Management Authority and state and regional zonal management committees in Queensland, Australia (Cadwallader 1997).

The ranching operation itself is subject to legal and administrative control through a system of permits, licenses or authorisations, often many in number, covering the many aspects of ranching operations listed in table 3 (Idyll 1986, Bye 1990, Tortell 1993, Kent et al 1995). The range of permits required for a private ranching operation in the state of Oregon, USA is given in table 5. The length of the list differs between countries and can be a complex maze and procedural hurdle to be overcome, potentially acting as a deterrent (Idyll 1986, Bye 1990). It is a situation often made worse by overlapping jurisdictions and different permitting and reporting arrangements at different levels of government and between different agencies, sometimes complementary and sometimes conflicting, as noted for the USA by Kent et al (1995).

Table 4. Institutional hierarchy for sea ranching in Japan

- Japan Sea Farming Association (under the Ministry of Agriculture, Forestry and Fisheries): government agency responsible for the development, planning and management of ranching programmes in Japan
- Prefectural Sea-Farming Association: supervise and manage marine ranching activities in the prefecture
- National Sea-Farming Centres: develop the fundamental technology
- Prefectural Sea-Farming Centres: produce seeds in large numbers for ranching
- Fishermen and their co-operative associations: manage wild and ranched fish within their exclusive zone through regulation and restriction, rent seed production from the Prefectural Sea-Farming Centres or operate their own hatcheries and operate release and recapture operations.

(Davy 1991, Mahnken 1991, Kotaki 1992, Isaksson 1994, Isa 1995, Kanno 1995, Kojima 1995, Ungson et al 1993, Ungson et al 1995)

The principal provisions are, however, those legal documents which convey permission to undertake hatchery, rearing, releasing and recapture activities and the right to occupy specified land and/or water areas for these purposes (Idyll 1986, van Houtte 1994, Knapp 1997). In some countries a single legal document is required, encompassing hatchery, rearing, releasing and recapture operations within one application and review procedure, as with private, non-profit salmon hatchery permits in Oregon (Oregon Revised Statutes 1998). In other countries the provisions for hatchery and rearing operations are distinct from releasing and recapture operations, requiring separate authorisations (as in Japan (Kojima 1995, Ungson et al 1995) and California, USA (California Fish and Game Code 1998)). The separation of ranching into two operations is a reflection of, *inter alia,* the balance of public and private involvement, the scale of ranching operations, the prior existence of hatcheries for aquaculture, state facilities and cost-efficiency factors (Kent et al 1995). Public ranching programmes have in the past utilised private hatchery facilities to produce and grow-on the seed and likewise private ranching initiatives have utilised the services of public hatcheries, such that the two components necessarily remain administratively distinct. It is also not uncommon for public hatcheries to exist alongside private and co-operative facilities, as in Japan and the U.S.A. (Nasaka 1988, Kotaki 1992, Ungson 1993, White et al 1995).

Table 5. Permits required by private ranching operations in Oregon, USA (among other legal requirements).

- private hatchery permit
- wildlife propagation licence
- state dredge and fill permit
- federal dredge and fill permit
- reservoir construction permit
- water rights permit
- water discharge permit
- wholesale fish dealer's licence

(Mayo Associates 1988)

The decision to authorise an operation or award a permit/licence is usually subject to a pre-defined application procedure and dependent on information supplied by the applicant, notably plans and projections in respect of the technical, biological, geographical, economic and administrative aspects of the operation (table 6). The precise information requirements vary between countries, environments (river and coastal waters), type of operator, status of the project (pilot project or fully-fledged operation) and species. The evaluation and consultation procedures the application goes through vary likewise. However, as with information requirements, there are a number of key elements common to the majority of ranching/ enhancement programmes. In terms of evaluation criteria these are given in table 7.

Table 6. Information requirements associated with the award of an operational permit/licence.

- administrative and economic aspects: constitution, interest group involvement, resourcing, objectives, targets (including production), impact assessments, performance measures, operating, monitoring, review and reporting procedures and protocols
- geographical aspects: location and design of facilities, proximity to sensitive habitats and wild stocks and location in respect of other facilities
- biological and technical aspects: resources/species used, production, rearing, releasing and recapture systems, stock health and disease management systems, impact management systems (regarding the environment and wild stocks), wild and ranched genetic stock management systems

(van Houtte 1994).

Table 7. Evaluation criteria common to the award of an operational permit/licence

- technical feasibility
- operational and financial competency of the operator
- economic and biological integrity of the project, notably that:
    - the operation will not have an adverse effect on the genetic characteristics and stock size of both wild and hatchery reared fish
    - the operation will not introduce any disease or disease agent into the environment
    - the operation will not have an adverse impact on threatened and endangered species and their habitats
    - the operation is in the best public interest, with due consideration to the costs and benefits to fishermen and the wider community
- the integrity of the operation in relation to management plans and goals.
- the possession of all supplementary permits and licences

Once awarded, performance against these criteria is monitored, with provisions provided for revoking any permit/ licence and restoring the fishery if performance does not comply (as laid out in the California Fish and Game Code 1998). In support of the criteria and attached to the permits or licences are strict conditions and caveats, specifying in detail the project and the latitude for action afforded to the operator, including details of the species, stock, size of fish, quantities, locations, times, duration and methods to be employed throughout the operation and the planning, consultation, approval, notification and reporting procedures to be adopted. Along with the duration of the permit/licence, these conditions define the scope of the operation, and in the case of private initiatives the potential to recoup a return on investment (van Houtte 1994, Isa 1995). Depending on the subject matter of the permit, permits can have a duration of days, as with that for the collection of broodstock in Texas (60 days) (Texas Administrative Code 1998), a year, as with a licence to ranch salmon in Ireland (Department of Marine and Natural Resources, pers. com. 1998) or several years, as in Washington where co-operative agreements for fish releases run for up to 5 years to maximise the contribution to the resource (Revised Code of Washington 1997). The longer the duration or the more likely permits are to be renewed or repeated, the greater is the potential for private or co-operative investment in ranching initiatives.

Turning now to Europe, the first thing to note is that explicit provision for ranching operations within Europe is lacking, as elsewhere in the globe. Unless otherwise provided for, ranching operations will fall within a plethora of international, national and provincial legal provisions and precedents which while having evolved to serve other activities, potentially encompass ranching within their scope and provisions (McNeil 1980b, Bye 1990). As can be seen from international experience, the operational controls

developed for ranching closely resemble those anterior. It is an inheritance which can either act to facilitate or constrain ranching programmes (Bye 1990) (table 8).

Table 8. The legal inheritance facing marine ranching programmes

- laws, institutional arrangements, regulations and procedures governing the management and use of fish resources and planning within the coastal zone
- the basis, form and extent of ownership and exploitation rights
- legal mandates of agencies within whose responsibilities ranching may fall (scope, priorities, autonomy)
- existing laws, institutional arrangements, regulations and procedures governing aquaculture
- existing research infrastructure (public and private)
- government activities that affect ranching indirectly (e.g. taxation, investment codes, health and safety, environmental protection, natural resources conservation, animal health and disease laws)
- laws and administrative arrangements governing other sectors which may have an impact on ranching (e.g. navigation, recreation, industrial development, etc)
- legal precedent for desirable legal frameworks
- any relevant commitments under international law
- any philosophy, guidelines, prescriptions and constraints embodied in national economic plans
- any recommendations of professional societies and non-statutory codes of practice

adapted from: MacKenzie 1983, Stickney 1991, Tortell 1993, van Houtte 1994

Some of the provisions listed in table 3, which affect both operational and control aspects (considered in the next section), may already be covered to some extent by existing provisions for mariculture, fisheries, environmental protection, pollution control and health and food safety within Europe.

For example, existing mariculture provisions may well include sourcing, hatching and on-growing operations and as such provide an important precedence or represent an appropriate management framework for certain elements of ranching operations. Among other things, they typically: define agency responsibilities; stipulate planning requirements; specify permit/licence application, appraisal, award and review procedures; specify model permit/licence conditions; and the extent of rights conferred. From the point of view of an operative, they facilitate operations by affording rights on sufficiently long (albeit varying) time scales to enable entrepreneurs to make the necessary investments. They also assign and protect the rights of farmers in the products they raise, facilitate access to the loans and other credit facilities required for investment, and control operations in terms of health, disease and environmental issues. Fisheries management, likewise, may provide a suitable base on which to build the operational controls for harvesting in co-operative and public ranching initiatives, through such as gear controls and measures for limiting by-catch. However, such legal regimes and their provisions may not necessarily be directly transferable.

The most widely used technique for exercising legal and administrative control over mariculture operations is through an authorisation system, whereby a government entity permits a person/company to operate a mariculture operation, either provided for under general fisheries legislation or aquaculture specific regulations (as in Norway - The Act of Farming of Fish, Shellfish etc. as revised) (van Houtte 1994). More unusually, in the United Kingdom, the powers of the Crown Estate Commissioners as owners [3] of the foreshore and seabed are employed to these ends. The form of the authorisation varies between authorisation, licence, permit, lease or concession, with different forms required for different aquaculture operations in certain countries. For example, in Italy, mariculture operations on artificial reefs are subject to the authorisation of the harbour masters' office, except where required for longer than 15 years, when a concession is required from the Central Fishery Direction (Fabi, pers. comm. 1996). These approaches demonstrate many similarities to those previously noted for ranching operations globally and could be a logical basis on which to build. For example, ranching operations may involve not only fish releases, but

[3] see generally Seabrooke and Pickering (1994) regarding the status of Crown ownership.

also the installation of structures on the seabed or in the water column (i.e. artificial reefs or fish aggregating devices), artificial feeding, extensive containment mechanisms, such as electrical barriers, and also exclusive harvesting within a particular area: attributes characteristic of traditional mariculture operations and provided for within the associated regulatory provisions.

Under most regimes for mariculture in Europe, authorisation is subject to the satisfaction of a detailed and extensive set of conditions, with information requirements and qualifications specified prior to awarding any licence or other authorisation (often to be accompanied by a fee). The French system is particularly comprehensive. Its information requirements include: details of the applicant, proposed location, title or deed conferring water rights, plan and nature of operation and operational facts (Decree No.85-1400, Art.7). In terms of qualifications, European Community citizenship is required, along with the possession of a specialist diploma (Brevet d'études agricole option aquaculture)(Decree No.83-228 establishing the rules governing mariculture operations as modified by the Decree of 14 September 1987) and evidence of at least three years professional experience (van Houtte *et al* 1989). The information supplied under such licensing/authorisation systems often forms the basis of an extensive consultation procedure accompanying and preceding any award. In France, for example, the application for a concession is circulated by the Chief of the maritime affairs area to member organisations of the Mariculture Committee for the district. The Mariculture Committee is consulted on all proposals to extend or decrease the area of public land put under mariculture, on plans for the management and approval of any given sector and on any scheme for the allotment of mariculture lands prepared by the administration (van Houtte *et al* 1989). The members of the Committee include interested government officials and departments (e.g. maritime prefect, inland revenue, health and welfare) and the local representative of the Marine Fisheries Scientific and Technical Institute. A public enquiry is also incorporated. While the detail of the evaluation criteria will need to be reconsidered in respect of ranching, the processes in place, along with the list of consultees are likely to be common to both aquaculture and ranching. However, the larger the area required for ranching operations and the greater the exclusivity of harvesting rights, the more convoluted and contentious the process of consultation, public enquiry and approval is likely to be.

As noted previously, once an authorisation has been granted, the terms and obligations of the authorisation (notably the extent and nature of the rights conveyed, the term or duration of those rights and the operational constraints attached) will determine the nature, security and stability of the operation, its attractiveness to potential operatives and its operational and economic viability (van Houtte *et al* 1989). For example, the rights conveyed are determined by an interaction of the concepts behind and the construction of the legal document (i.e. authorisation, licence, permit, lease or concession). In general terms (as distinct from the particulars of mariculture) a lease may confer very different rights to a licence, concession etc. A lease under English law affords the lessee, within the terms of the lease, a right which has longevity of duration, flexibility and exclusivity of use, transferability (e.g. sale), divisibility and a quality of title defendable in the courts. In contrast, a licence confers a lesser right, to do certain, limited specified acts that would otherwise be inoperative, wrongful or illegal. It does not pass any interest in property or necessarily convey exclusive use. Further to which it is revocable (albeit subject to the construction of the terms within the legal document), there are no rights of transfer or division attached and, while its loss may be compensated for, it is not legally protected. The former, therefore, offers an operative greater security of operation, greater protection of the products raised, duration for recouping a return on investment, and greater value through affording the operation a re-sale value: aspects important for private investment. An assessment of the compatibility of the rights conveyed by current practice in mariculture with the detailed requirements of the form of ranching envisaged will obviously have to precede any cross-application. Likewise in respect of the obligations/constraints attached thereto. However, current practice in these respects would seem to be facilitative as a precedent. For example, in terms of duration, in Spain the concession for marine culture lasts ten years with a possible renewal for up to a maximum of fifty years under the same terms and conditions. Unlike the models explored earlier for ranching, there is also a provision for the possibility of transferring the concession or authorisation to another person or organisation, potentially creating a resale value for the enterprise. Similar provisions are also contained within the French regime, either permitting transfer within a family or to a third party, subject to the concession being held for five years if within the family or ten years if to a third party and the payment of a fee based on the facilities and productivity of the operation. To secure the continued management of such enterprises, however, such transfers generally require the prior authorisation of the granting authority and,

as under the French regime, the beneficiaries are required to meet the same requirements as the original licensee (van Houtte *et al* 1989).

In terms of obligations/constraints, the current regulatory framework for mariculture also covers a sub-set of the operational, economic and biological integrity issues raised by ranching: *inter alia*, installation design, operational procedures, genetic resource management, fish health and disease management, interactions and fish transportation. These obligations/constraints are either provided in detail within the authorisation document or through requirements for statutory compliance. For example, in Italy, there is regulatory provision for the control of fishing within aquaculture units (OECD 1997) and in Norway and the United Kingdom preventative measures specified in respect of fish disease (extending to registration, record keeping, conditions on transportation and the removal or destruction of diseased fish) (van Houtte *et al* 1989, Arnesen 1995, EAO 1997). However, there will need to be specific attention paid to the facilitation of releases and certain other aspects, which are not provided for or for which strict provisions are currently in place to prevent (e.g. intentional and accidental fish escapes). A careful balance needs to be maintained between permitting releases and maintaining wild and ranched fish populations and genetic integrity. International experience will be useful here.

Where relevant provisions may not be provided directly by mariculture, they may be provided by parallel systems. The regulation of mariculture is not confined to mariculture specific legislation. Operations are directly affected by land and water laws (including the use of the public domain such as the foreshore or for access to water), environmental protection provisions, natural resource conservation and fish management provisions. They are also affected by regulatory regimes pertaining to public health, fiscal and import and export arrangements, among other things (van Houtte 1994). For example, in Norway, mariculture operations are regarded as ordinary polluting activities, which require a permit from the state Pollution Control Authority and must comply with pollution legislation (van Houtte *et al* 1989). Provisions governing such issues may be explicitly linked into the regulatory regime governing mariculture or operate independently. For example, the environmental integrity of any project in the United Kingdom is regulated through, *inter alia*, the dedicated Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988 which implement the European Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment and the independently acting Conservation of Seals Act 1970 and Wildlife and Countryside Act 1981 (as amended). Such requirements are common throughout European states, supplemented by a number of EU directives[4] governing pollution of the aquatic environment, consumer safety and the harmonisation of standards for marketed fish food products (Cullinan and Van Houtte 1997). As with the potential precedent set by legal regimes specific to mariculture for the operational control of ranching, these other legal regimes may well be translated. However, as noted elsewhere, prior to establishing any ranching programme, it will be essential to identify whether the scope and detail of the existing legal provisions in each of these areas satisfactorily provide for the various components of the ranching operation and what (if any) changes are necessary.

As the evolution of mariculture within European countries has been largely ad hoc in relation to needs and perceived importance (Christy 1991), there is great variation in the detail of the legal provisions developed for their governance (their comprehensivity, scope, the rights and duties conveyed and their institutional arrangements) (Bye 1990). Very few countries, for example, provide for a single and general administrative regime or for developments (such as ranching) which were unforeseen at the time of drafting (Bye 1990). Ireland and Norway are among the few countries with a single comprehensive regime (Idyll 1986, van Houtte 1994, Arnesen 1995). Irish and Norwegian legislation cover all types of waters: marine, brackish, fresh, public and private. However, most legal systems differ, in that the legal regime will reflect the historic evolution of aquaculture, which may or may not set a precedence for marine ranching (van Houtte et al 1989, van Houtte 1994). Whilst facilitative in this instance, Portugal is an example of the selective coverage of existing legal provisions, with Decree Law 261/89 being specific to brackish and salt water (OECD 1991). Similarly, the provisions may be species specific. While most countries have a global licensing system irrespective of species, in certain circumstances separate licences are required and only

[4] For example, Directive 79/923/EEC (on the quality of shellfish waters); Directive 91/492/EEC (on the protection of consumers of shellfish); Directive 91/493/EEC (sanitary rules for the production, distribution and sale of fishery products) as amended; Directive 91/67/EEC (sanitary rules for the distribution and sale of aquaculture products and fish) as amended.

certain species covered. In such cases additional legislation may be required to permit ranching for species not listed. Similar legislative moves may also be required where existing legislation is specific in other ways, such as in the form of aquaculture (e.g. pond or cage operations) covered (Pickering 1997). Hence, the application of the regulatory regime for mariculture to the regulation of ranching is not necessarily straight forward.

Likewise, existing legal provisions for fisheries management can both facilitate or constrain ranching operations. While acting as a precedent for operational harvesting controls, they can pose a serious limitation to the lawfulness of methods of recapture, and have been portrayed as a fundamental legal issue/obstacle to be faced by ranching (Howarth 1989, Cullian and Van Houtte 1997). In terms of methods of recapturing ranched fish, without specific provisions to the contrary, harvesting is subject to the dictates of legal regimes governing capture fisheries, including provisions in respect of total allowable catches (TACs), gears, closed seasons and times, licensing requirements and other aspects (Isaksson 1988, Howarth 1989, Howarth and LerPa 1997). While designed to conserve wild stocks, such regulations can seriously undermine the ability of ranch operatives to recapture ranched stocks. Further, size limits can seriously hamper the sourcing of hatchery broodstocks, which are often required to come from local wild stocks to maintain the genetic make-up of these stocks.

The development of a suitable, comprehensive and integrated regulatory framework for the operational control of ranching will be a challenging and complex task requiring careful consideration (Perry 1995, Cullinan and Van Houtte 1997). It is a task which will evidently draw on many areas of law, precedents set within domestic regimes and models adopted elsewhere and will require a thorough review of the options, including extensive consultation to ensure feasibility and acceptability (Nasaka 1988, Heard et al 1995, Cadwallader 1997). The incorporation of a wide range of interested parties (government, traditional users, aquaculture interests, academics and research bodies) into projects in Alaska and Japan has been noted as a fundamental determinant in their success (McNeil 1980, Olsen 1994, Ungson 1993), while in other countries (as previously noted) political and public opposition has undermined efforts to introduce ranching. Further, the review will need to consider developments in international law and guidance which will similarly influence national efforts, including such as the "Jakarta Mandate" adopted by the second Conference of the parties to the Convention on Biological Diversity in 1995 (which while developed for aquaculture, takes on a particular relevance for the intentional release of hatchery reared juveniles into the wild), the Code of Conduct for Responsible Fisheries adopted by the 1995 FAO Conference (FAO 1995) and the "Kyoto Declaration" adopted by the International Conference on the Sustainable Contribution of Fisheries to Food Security 1995 (De Fontaubert et al 1996, Cullinan and Van Houtte 1997).

Development Controls

One of the items listed in table 3 is site selection, criteria and authorisation. Such development controls have a key role to play in the viability and form of ranching operations and come in various guises. As noted earlier, ranching operations fall within the scope of a plethora of international, national and provisional provisions and precedents, a significant subset of these are dedicated to the rational, optimal and, increasingly, sustainable use of land and water areas. These provisions do not distinguish between the activities or developments they cover, but are generally all encompassing and involve the application of common rules. While rarely mentioned within the literature on ranching, there is an implicit or explicit requirement within each national regime for ranching operations to obtain the necessary authorisations and comply with these provisions (as indicated by Hillyer 1997, Oregon Department of Fish and Wildlife 1998). As they are rarely adjustable in the interests of any one group of activities, international examples are of limited use to this discussion. Of greater pertinence and, therefore, the foci of the subsequent discussion, are those development controls which have a bearing on the case study area, namely Europe.

As with salmon farming in the United Kingdom and Norway, the location and form of any ranching operation will be subject to obtaining permission for any onshore structures from government departments responsible for land-use zoning and development controls (Arnesen 1995). In addition to which, several countries have in place marine or coastal plans against which any proposals for development or change of activities are assessed. France, for example, has a number of development documents (e.g. Schémas d'Aptitude et d'Utilisation de la Mer (SAUM), the decision of the Inter-Ministerial Committee for National

Development, dated 26.10.1972 and Schémas de la Mise en Valeur de la Mer (SMVM), a Law dated 7.1.1983) which designate zones around the coastline for certain activities (such as industrial and harbour development, leisure activities and marine agriculture) and lay down aims for those zones. In Ireland, Greece and Norway, similar implications exist (Arnesen 1995). Where ranching operations involve facilities, containment areas or exclusive use similar to aquaculture or where ranching appears incompatible with the designated use of a zone, the success of any application for permission to develop will be subject to the zoning, priorities and provisions within those plans. In Ireland, for example, the Minister for the Marine designates areas (subject to local inquiry) in which it is lawful to engage in aquaculture activities and only in these areas may licences be granted (OECD 1989), and in Greece, as with aquaculture, ranching may be prohibited in areas characterised by, *inter alia*, tourism, swimming, recreation, professional and non-professional fisheries, unless the latter are designated beneficiaries (OECD 1997). In evaluating whether permission for development is to be given for any particular application, the categories of criteria typically employed are: consistency with any plans in place; the position and size of the proposed site; the types and dimensions of proposed equipment and facilities; the situation and impact of the operation, facilities and equipment on the local environs (e.g. environment, infrastructure, economy, employment and amenity); proximity to similar projects; interactions with other coastal activities and measures to safeguard those interests; and the results of agency and public consultation.

To these are added other legal institutions when ranching is combined with the use of submarine structures such as artificial reefs, fish aggregating devices and containment barriers: notably the bodies of law relating to property rights, safety of navigation, coastal defence and the protection of the environment (Tortell 1993, Mayo Associates 1988). The satisfaction of the requirements of these legal regimes can either feature as part of an integrated regulatory and permit system with extensive consultation (OECD 1989) or represent parallel systems requiring individual satisfaction.

The use of space (surface, water column and seabed) in rivers and tidal and marine waters for the deployment of artificial structures typically requires the acquisition of a legal right to do so. The acquisition of which can be extremely complicated, with rivers either subject to private or state ownership and tidal and marine waters subject to state ownership/control. Often the property is inalienable and cannot be the object of rights in respect of third parties (Pickering 1997). In most legal systems, the seabed belongs to the state (Christy 1991), requiring promoters to obtain permission in the form of a lease, licence, permit, concession or authorisation, depending on the legal regime and on the purpose and promoter of the ranching project (Pickering 1997). In the UK a lease to the area of seabed is required from the Crown Estate Commissioners. In Spain, the Ministry of Environment is responsible for the award of permits or leases for use of the seabed, which is retained for the public benefit. Permits are awarded where the promoter is a government ministry, while regional governments, local administrations and others apply to the Ministry for a lease. The ability to award a permit or lease and the conditions attached to any awarded depend on how the proposal fits within the legislative and policy frameworks governing the actions of the agencies involved and the use of coastal areas. For example, in Spain where property rights in marine areas are administered by state agencies and an integrated regulatory and permit system for deploying artificial reefs has been adopted, the allocation of rights to occupy the seabed are subject to the Spanish "law of coasts" which requires, *inter alia,* the following criteria to be met when artificial reefs are to be deployed:

- artificial reefs must be constructed of environmentally benign materials (no scrap materials being permitted);
- have at least 15 m of clearance over them for navigation;
- where they are designed to discourage illegal fishing practices, be designed so to maximise their efficiency;
- they must be marked on nautical charts, giving the exact location of the reef modules and the extent of the protected area;
- they must meet any site-specific conditions specified; and detail any prohibitions and special conditions with respect to fishing (Revenga *et al.* 1997).

The provisions in respect of the safety of navigation reflect international commitments under the United Nations Convention on the Law of the Sea 1982 (UNCLOS). The deployment of artificial structures potentially pre-empt both the use of the seabed and the overlying water column by other activities.

However, their deployment must not constitute an unreasonable interference of the right of innocent passage by vessels of other states through territorial waters (Honein 1991), with shipping holding clear priority in international shipping lanes (UNCLOS art.21(1))(Hayashi 1992). In many states this is supplemented by a public right of navigation by the citizens of the coastal state (which in the United Kingdom is a right to wander, subject only to measures for ensuring the safety of navigation). These requirements can potentially place significant constraints on whether, where and how such structures can be deployed, although there is a degree of latitude in their interpretation. A further requirement is that in deploying artificial structures, the coastal state is responsible for implementing measures to ensure the safety of navigation, such as charting their position, installing navigational aids and establishing a safety zone around them (Seymour 1975). These are also vital considerations for the ranch operator: while liability for damage to vessels is governed by various navigational rules and rules of tort (such as negligence), the general rule is that persons that place or abandon objects so that they become a hazard to navigation are responsible for damage so caused, unless the state accepts liability (Christy 1991). Questions of legal liability, location, structural integrity, locational stability, maintenance and monitoring therefore need to be addressed before such technical aids are to be incorporated within any ranching proposal or authorisation (Seymour 1975, Christy 1991).

Provisions also extend to the protection of submarine structures (e.g. cables and pipelines) potentially at risk from the deployment of artificial structures in close proximity and to the evaluation of deployment proposals on the grounds of coastal defence. The potential impact of any sizeable submarine structure on coastal sedimentation patterns and the possible knock-on effects for the natural defence structures of the coast (beaches and sand-banks) and downstream supplies to, for example, tourist beaches and harbour works (with loss of earnings or increased channel dredging costs, respectively) requires careful evaluation.

Where explicit legal provisions are in place for ranching and the deployment of artificial reefs or fish aggregating devices, these considerations may well be integrated within the process for determining the award of a lease or permit (as noted already) and any conditions attached thereto. However, where such a framework does not exist, a plethora of authorisations may be required. In relation to navigation, permission will be required, for example, from the Department of the Marine (Roinn na Mara) in Ireland, the Ministry of Transport and Water Management (Verkeer en Waterstaat) in the Netherlands, the Merchant Marine and Ports and Harbours Department (Orden n. 12020 de 11 de Mayo de 1982) in Spain and the Ministry of Transport in the United Kingdom. Conditions attached to that permission will prescribe measures to be taken for the safety of navigation, including the precise location at which the structure is to be placed and the lights and buoyage required to mark it. In harbour areas, permission will also be required from harbour authorities (Pickering 1997). In terms of coastal defence, permission will be required from the coast protection authorities, which are, in the UK, coast protection authorities and the Ministry of Agriculture, Fisheries and Food. In the Netherlands, this responsibility falls to the municipal, provincial and national Waterstaat (Wiggerts 1981). The extent of the bureaucracy attached to obtaining the necessary consents for the deployment of artificial reefs has already been shown to be a significant deterrent to the use of that technology in certain countries (e.g. the United Kingdom) and is likely to be so for other artificial structures. It has also resulted in the final form of many projects effectively representing a less than perfect compromise with the mandates and agendas of numerous agencies.

Another significant deterrent to the use of artificial reefs in Europe derives from the field of environmental law, which has connotations not only for the deployment of technical aids in ranching, but also for ranching *per se*. Environmental considerations currently feature prominently within the approvals process governing the marine deployment of artificial structures in European states, either through the specification of standards and conditions, inter-agency consultations or requirements for environmental impact assessments. In Spain, for example, an "ecological study supporting the suitability of the site and species" (Orden No.12020, art.8(f)) and an engineers report on the stability of the structure in the light of its construction and local currents are required in respect of artificial reefs (ibid., art.9). The environmental integrity of other coastal developments and sizeable projects are likewise provided for, aquaculture among them. The consequences and environmental provisions vary between countries, activities and developments. However, the prospect of new aquaculture and artificial reef projects is already severely hampered by environmental considerations in many European countries (OECD 1993, 1996, OSPAR 1997).

For artificial reefs, one of the major reasons for current environmental constraints lies with artificial reefs becoming enmeshed within the definition of "marine dumping": "the disposal of waste and other matter …at sea" (Art.1(1)(5)(a) UNCLOS III), irrespective of their potential benefits. Over the last twenty years a number of global and regional conventions have come into force with the aim of eliminating marine dumping, their provisions becoming increasingly stringent and restrictive. While permitting, for example, the "…placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of the convention" (London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) 1975, art. III(1)(b)(ii) and 1996 Protocol; Convention on the Protection of the Black Sea against Pollution 1992, art.3(b)(ii)) or providing for the "enhancement of the environment" within the context of conservation (e.g. Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment 1982, art.1(1)), concern that artificial reefs should not provide a means of circumventing the provisions of the conventions has led to much debate as to their status under international law. Despite attempts by the Oslo and Paris Commissions (OSPAR) (responsible for the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft 1972 and the Convention for the Protection of the Marine Environment of the North East Atlantic 1992 (not yet in force)) to resolve this debate for the North East Atlantic by producing guidelines, consensus has yet to be reached (OSPAR 1997) and it is by no means certain that any consensus will be in favour of artificial reefs. This reflects a general move towards a more "precautionary approach" in the treatment of human impacts on the environment with both international and national law, which incorporates not only the deployment of artificial structures, but also encompasses, *inter alia,* aquaculture (extending environmental considerations to ranching programmes not using artificial structures) and many other forms of human activity (Bartley 1998). With the growth of marine and estuarine conservation designations, such as Special Areas of Conservation[5], further, area specific environmental provisions enter the equation, such that taken in their entirety, the various developments in environmental law are likely to one of the key determinants of the legal viability of any ranching initiative.

Conclusions

It is evident from international experience that some of the big issues/questions faced by marine ranching lie with property rights, the development of suitable operational controls and the implications of development controls. Unless legislation is made to the contrary, these existing legal and institutional regimes will prescribe the fundamental character and details of any ranching programme and its ultimate viability, including (a) the legality of ranching *per se* or certain forms thereof, (b) the institutional frameworks, procedures and conditions governing operations and technical, biological and economic viability and (c) the manner in which the exploitation of the resource is related to the entity making the necessary investment (public and private involvement and the distribution of costs and benefits) (Mayo Associates 1988, Orrego Vicuña 1991).

In terms of property rights, at the present time any fish released into the marine environment for the purposes of marine ranching are effectively released into an open access (public) fishery, with heavy interceptions and low returns inevitable. To secure sufficient returns for private or co-operative initiatives the migratory range of the fish would have to be limited and either exclusive property rights or harvesting rights provided. Property rights in the fish themselves are not readily accomplished under the existing legal inheritance, nor are property rights in respect of the seabed and water column given the extensive migratory capacities of many species. It has yet to be determined whether the current technical aids are sufficient to the degree of exerting the locational control necessary. In terms of harvesting controls, there are useful precedents within Europe, although none have as yet represented a panacea, each having distinct advantages and disadvantages for use in this context. Their cross-application will require thorough prior evaluation. Their applicability will be a matter of the attributes of each control or property right mechanism, the species in question, the associated current regulatory regime, the spatial extent of the operation, implications for wild stocks and a number of transition considerations (including the attitudes of traditional user groups).

---

[5]Directive on the Conservation of Natural Habitats and Wild Fauna and Flora 92/43/EEC (OJ L206 22.7.92).

In terms of operational controls, it is evident that the legal and administrative regime will reflect that anterior. Some of the provisions required are already covered to some extent by existing provisions for mariculture, fisheries, environmental protection, pollution control and health and food safety within Europe. The existing regimes for aquaculture are a good example of this. There is, however, variation in the extent of current provisions for aquaculture between species and countries and as with other seemingly relevant areas of law, the regimes are not necessarily directly transferable. Existing regimes can have the effect of preventing or adversely constraining activities which are a vital part of the ranching process. The identification and development of a suitable, comprehensive and integrated regulatory framework to ensure marine ranching operations are effective, viable and appropriately managed will be a challenging and complex task requiring careful consideration on a country-by-country basis.

The third big issue covered by the discussion was development controls, one of the most inflexible components of the existing legal regime and a key constraining influence on ranching operations. Unlike operational controls, these controls are rarely adaptable to the particular requirements of any one activity. As such they represent an external constraint which can have the effect of modifying the form, location, scale, viability and even determine the very existence of marine ranching operations. The use of technical aids, on which many proposers of marine ranching operations lay their hopes for securing recapture rates, is particularly vulnerable. Such development controls, unless actively incorporated within an integrated regulatory framework will also represent a significant administrative, time and cost hurdle to be overcome by the proposers of any marine ranching initiative.

At the present time, both stock enhancement initiatives and ranching operations (of a form) are being undertaken in Europe. However, these are almost exclusively experimental, small scale and involve inland waters. They are currently regulated on the basis of discretionary powers and as one off events. Large scale operations will require the explicit consideration of the applicability and implications of existing development controls and the development of an appropriate regulatory regime for the operational control of marine ranching activities. However, the biggest constraint remains that of property rights which, without an effective solution, will effectively limit ranching to schemes using confinement technology (approximating to cage aquaculture), sedentary species, areas with traditional co-operative rights and releases for the benefit of the wider public fishery (stock enhancement). In terms of investment, one would anticipate that the scale of potential interceptions would limit any incentive for private or even co-operative investment, with a necessity for state investment the most likely outcome.

References.

"Work Group Discussion Summary", in *Marine Fish Culture and Enhancement: Conference Proceedings Seattle Washington October 4-6 1993*, ed. T. Nosho and K. Freeman (Seattle, Washington: Washington Seas Grant Programme, 1993), 45-54.

"Extracts on the Kyoto Declaration and Plan of Action on the Sustainable Contribution of Fisheries to Food Security", *INFOFISH International* 1/96 (1996): 13-15.

"The Norwegian Sea Ranching Programme. European Fish Ageing Network Institute of Marine Research, Flødevigen Marine Research Station, Norway (EFAN)" [Online] (1998) URL http://www.efan.no/sear/sea/push.html

O. A. Arnesen, "Aquaculture - A Motive Force in the Norwegian Coastal Industry. Report no. 48 to the Storting" [Online] (1995) URL http://odin.dep.no/repub/94-95/stmld/48/eindex.html

Y. Asada, Y. Hirasawa and F. Nagasaki, *Fishery Management In Japan*. FAO Fish. Tech. Paper 238 (Rome: UN Food and Agriculture Organisation, 1983).

B. Bachen, "The Impacts of Success: A Case History of Hidden Falls Hatchery", in *Proceedings of the 16th Northeast Pacific Pink and Chum Salmon Workshop, Juneau, Alaska, February 24-26 1993* (Alaska: Alaska Sea Grant College Program, 1993), 47-56.

D. M. Bartley, "A Precautionary Approach for the Introduction of New Species in Aquaculture", paper presented at *The XXXIII International Symposium on New Species for Mediterranean Aquaculture, 22-26 April 1998* (Alghero, Italy: Societa Italiana per il Progresso della Zootechnica, 1998).

E. R. Berg, "Management of Pacific Ocean Salmon Ranching: A Problem of Federalism in the Coastal Zone", *Coastal Zone Management Journal* 9(1) (1981): 41-76.

G, Bowden, *Coastal Aquaculture Law and Policy: A Case Study of California* (Boulder CO: Westview Press, 1981).

D. W. Bromley and M. M. Cernea, *The Management Of Common Property Natural Resources: Some Conceptual And Operational Fallacies* (Washington DC: The World Bank, 1989).

V. J. Bye, "Legal, Political and Social Constraints in Aquaculture", in *Belgium. Aquaculture Europe '89 - Business Joins Science,* ed. N. de Pauw and R. Billard (Bredene: European Aquaculture Society, 1990) Special Publication No.12, 123-144.

J. Cable, "Closing the British Seas" , *Marine Policy* 11(2) (1987): 90-96.

P. Cadwallader, "The Decision-Making Process in Relation to the Enhancement of Catadromous Fish Stocks in Queensland, Australia", paper presented at *The First International Symposium on Stock Enhancement and Sea Ranching, Bergen, Norway 8-11 Sept 1997* (1997).

J. Catanzano and J. G. Sutinen,. "Fishing Regulatory Tools", in *Proceedings of the Sixth Conference of the International Institute of Fisheries Economics and Trade, July 6-9 1992, Paris*, ed. M. Antona, J. Catanzano and J. G. Sutinen. (Issy-les-Moulineaux: IFREMER, 1994), 781-785.

L. Christy, "Artificial Reefs and Fish Aggregating Devices (FADs): Legal Status", *IPFC Symposium on Artificial Reefs and Fish Aggregating Devices as Tools for the Management and Enhancement of Marine Fishery Resources, Colombo, Sri Lanka, May 1990* (Bangkok: FAO Regional Office for Asia and the Pacific, 1991), 105-115.

C. Cullinan and A. Van Houtte, "Development of Regulatory Frameworks", in *Review of the State of World Aquaculture* (Rome: Inland Water Resources and Aquaculture Service, UN Food and Agriculture Organisation, 1997) FAO Fisheries Circular No. 886, Rev.1, 75-79.

F. B. Davy, "Mariculture in Japan: Current Practices", *World Aquaculture* 22(2) (1991), 30-35.

A. C. De Fontaubert, D. R. Downes and T. S. Agardy, *Biodiversity in the Seas: Implementing the Convention on Biological Diversity in Marine and Coastal Habitats* (Gland: IUCN, 1996).

R. D. Eckert, *The Enclosure of Ocean Resources: Economics and Law of the Sea* (Stanford CA: Hoover Institution Press, 1979).

G. Elliot (Sir), "Evidence from Sir Gerald Elliott", *Fish Stock Conservation and Management, House of Lords Select Committee on Science and Technology - Evidence Received up to 11 July 1995* (London: HMSO, 1995), 111-112.

Environmental Assessment Office (EAO), *The Salmon Aquaculture Review* (Victoria: Government of British Columbia, 1997).

FAO, *Code of Conduct for Responsible Fisheries* (Rome: United Nations Food and Agriculture Organisation, 1995).

S. M. Garcia, "Artificial Reefs and Fish Aggregating Devices in Southeast Asian Fisheries: Management Issues", in *Symposium on Artificial Reefs and Fish Aggregating Devices as Tools for the Management and Enhancement of Marine Fishery Resources, held by the Indo-Pacific Fishery Commission (IPFC), Colombo, Sri Lanka, 14-17 May 1990* (Bangkok: FAO, 1990), 153-163.

S. M. Garcia, "Memorandum by Dr S M Garcia, Food and Agriculture Organisation of the United Nations and Examination of Witness". *Fish Stock Conservation and Management, House of Lords Select Committee on Science and Technology - Evidence Received after 11 July 1995* (London: HMSO, 1995), 287-309.

G. D. Grossman, G. P. Jones, and W. Seaman, "Do Artificial Reefs Increase Regional Fish Production? A Review of Existing Data", *Fisheries* 22(4) (1997): 17-23.

A. A. Hampson, "The Laws Covering Salmon Ranching from the Salmon's Point of View", in *Salmon Production, Management and Allocation: Biological, Economic and Policy Issues*, ed. W. .J. McNeil (Corvallis, Oregon: Oregon State University Press, 1988), 19-24.

M. Hayashi, "The Role of National Jurisdictional Zones in Ocean Management", in *Ocean Management in Global Change*, ed. P. Fabbri (Barking, Essex: Elsevier Science, 1992), 209-226.

W. Heard, R. Burkett, F. Thrower and S. McGee, "A Review of Chinook Salmon Resources in Southeast Alaska and Development of an Enhanced Program Designed for Minimal Hatchery-Wild Stock Interaction", in *Uses and Effects of Cultured Fishes in Aquatic Ecosystems. American Fisheries Society Symposium 15, Albuquerque, New Mexico 12-17 March 1994*, ed. H. L. Schramm and R. G. Piper, (Bethesda, Maryland: American Fisheries Society, 1995), 21-36.

A. Hillyer,. *The Management and Regulatory Framework for Salmon Aquaculture in British Columbia*, report prepared for the Environmental Assessment Office (Victoria, BC: Government of British Columbia, 1997).

S. E. Honein, *The International Law Relating to Offshore Installations and Artificial Islands* (London: Lloyds of London Press, 1991).

W. Howarth, "Aquaculture Possibilities and Legal Obstructions: Salmon Ranching in the United Kingdom", *International Journal of Estuarine and Coastal Law* 4(1) (1989), 1-25.

W. Howarth, *The Law of Aquaculture* (Oxford: Fishing News Books, 1990).

W. Howarth and C. Lería, "Legal Issues Relating to Stock Enhancement and Ocean Ranching", *The First International Symposium on Stock Enhancement and Sea Ranching, Bergen, Norway, 8-11 September 1997: Book of Abstracts* (1997), 57.

ICES (International Council for the Exploration of the Sea), *Report of the Workshop to Evaluate the Potential of Stock Enhancement as an Approach to Fisheries Management, Copenhagen, 19-24 May 1994,* (Copenhagen, Denmark: ICES, 1994) CM 1994/F:9 ICES.

C. P. Idyll, "Aquaculture Legislation and Regulations in Selected Countries", in *Realisms in Aquaculture: Achievements, Constraints, Perspectives: Review Papers - World Conference on Aquaculture, Venice, Italy 21-25 September 1981*, ed. M. Bilio, H. Rosenthal and C. J. Sindermann (Bredene, Belgium: European Aquaculture Society, 1986), 545-564.

J. Isa, "Fisheries Resource Management Development by Stock Enhancement in Okinawa", in *South Pacific Commission and Forum Fisheries Agency Workshop on the Management of South Pacific Inshore Fisheries: Manuscript Collection of Country Statements and Background Papers* (Noumea, New Caledonia: South Pacific Commission, 1995) Integrated Coastal Fisheries Management Project Technical Document no. 11, Vol.1., 418-424.

A. Isaksson, "Salmon Ranching: A World Review", *Aquaculture* 75 (1988), 1-33.

A. Isaksson, "Ocean Ranching; Its Role and Contribution to Pacific and Atlantic Salmon Fisheries", in *The State of the World's Fisheries Resources: Proceedings of the World Fisheries Congress, Plenary Sessions*, ed. C. W. Voigtlander (New Delhi: Oxford and IBH Publishing, 1994), 133-149.

Iwami Fishermen's Cooperative Association, "Resources Management Through Propagation and Restocking Programmes", in *Papers Presented at the FAO/Japan Expert Consultation on the Development of Community-Based Coastal Fishery Management Systems for Asia and the Pacific, Kobe, Japan 8-12 June 1992* (Rome: FAO, 1992). FAO Fisheries Report No.474, Suppl. Vol.1, 19-25.

D. R. Johnson and N. A. Funicelli, "Spawning of the Red Drum in Mosquito Lagoon, East-Central Florida", *Estuaries* 14 (1991): 74-79.

J. Joñasson, "Selection Experiments in Salmon Ranching. II. Variation Among Release Sites and Strains for Return Rate, Body Weight and Ratio of Grilse to Total Return", *Aquaculture* 144 (1996): 277-294.

H. Kanno, "The Present State of Sea Ranching of Fish and Shellfish in Japan", in *Environmental Impacts of Aquatic Biotechnology* (Paris: OECD, 1995), 13-21.

D. B. Kent, M. A. Drawbridge and R. F. Ford, "Accomplishments and Roadblocks of a Marine Stock Enhancement Program for White Seabass in California", *American Fisheries Society Symposium* 15 (1995): 492-498.

G. Knapp, "Alaska Salmon Ranching: An Economic Review of the Alaska Salmon Hatchery Program". Paper given at the *First International Symposium on Stock Enhancement and Sea Ranching, Bergen, Norway. September 8-11 1997* (1997).
A. J. Knudsen, *Living with the Commons: Local Institutions for Natural Resource Management* Bergen, Norway: Chr. Michelsen Institute, 1995), R.1995:2.

H. Kojima, "Evaluation of Abalone Stock Enhancement through the Release of Hatchery-Reared Seeds", Mar. Freshwater Res. 46 (1995): 689-95.

K. Kotaki, *The State and Prospects of Stock Enhancement. "Saibai Gyogyo" Projects in Japan,* in *FAO/Japan Expert Consultation on the Development of community-Based Coastal Fishery Management Systems for Asia and the Pacific. Papers Presented at the FAO/Japan Expert Consultation on the Development of Community-Based Coastal Fishery Management Systems for Asia and the Pacific. 8-12 June 1992, Kobe, Japan* (Rome: FAO, 1992), FAO Fish. Rep. 474 Suppl. Vol.1, 197-204.

J. E. Lannan, "Salmon Ranching in Oregon", in *Salmon Ranching*, ed. J. E. Thorpe (London: Academic Press, 1980), 47-62.

G. D. Libecap, "Comments on Anthony D Scott's "Conceptual Origins of Rights Based Fishing"", in *Rights Based Fishing*, ed. P. A. Neher, R. Arnaston and N. Mollett (London: Kluwer Academic, 1989) 39-45.

P. M. Mace, "Will Private Owners Practice Prudent Resource Management?", *Fisheries* 18(9) (1993): 29-31.

W. C. MacKenzie, *An Introduction to the Economics of Fisheries Management* (Rome: FAO, 1983) FAO Fish. Tech. Pap. 226.

C. V. W. Mahnken, "Coho Salmon Farming in Japan", in *Culture of Salmonid Fishes*, ed. R. R. Stickney (Boca Raton, Florida: CRC press, 1991), 131-149.

Mayo Associates, *An Assessment of Private Salmon Ranching in Oregon* (Newport Oregon: Oregon Coastal Zone Management Association, 1988).

L. W. McEachron, C. E. McCarty and R. R. Vega, "Beneficial Uses of Marine Fish Hatcheries: Enhancement of Red Drum in Texas Coastal Waters", *American Fisheries Society Symposium* 15 (1995): 161-166.

L. W. McEachron and K. Daniels, "Red Drum in Texas: A Success Story in Partnership and Commitment", *Fisheries* 20(3) (1995): 6-8.

W. J. McNeil, "Legal Aspects of Salmon Ranching in the Pacific", in *Salmon Ranching,* ed. J. E. Thorpe (London: Academic Press, 1980), 383-394.

W. J. McNeil, "Salmon Ranching in Alaska", in *Salmon Ranching*, ed. J. E. Thorpe (London: Academic Press, 1980), 27-31.

J.W. Milon, "Economic Evaluation of Artificial Habitat for Fisheries: Progress and Challenges", *Bulletin of Marine Science* 44(2) (1989): 831-843

J.W. Milon, "Social and Economic Evaluation of Artificial Aquatic Habitats", in *Artificial Habitats for Marine and Freshwater Fisheries*, eds. W. Seaman, Jr. and L. M. Sprague (San Diego: Academic Press, 1991), 237-270.

B. Morton, "Artificial Reefs, Fish and Cyanide", *Marine Pollution Bulletin* 32(7) (1996): 522-523.

Y. Nasaka, "Salmonid Programs and Public Policy in Japan", *in Salmon Production, Management and Allocation: Biological, Economic and Policy Issues*, ed. W. J. McNeil (Corvallis, Oregon: Oregon State University Press, 1988), 25-31.

P. A. Neher, R. Arnason and N. Mollett (ed.), *Rights Based Fishing* (London: Kluwer Academic Publishers, 1989).

L. K. Newton and I. D. Richardson, "Marine Fish Farming - Some Legal Problems", in *Oceana* (special edition: *New Directions in the Law of the Sea*, ed. R. Churchill, K. R. Simmonds and J. Welch) 3 (1973): 61-70.

OECD, *Aquaculture: Developing a New Industry* (Paris: Organisation for Economic Co-operation and Development, 1989).

OECD, *Review of Fisheries in OECD Countries* (Paris: Organisation for Economic Co-operation and Development, 1991).

OECD, *Review of Fisheries in OECD Countries* (Paris: Organisation for Economic Co-operation and Development, 1993).

OECD, *Review of Fisheries in OECD Countries* (Paris: Organisation for Economic Co-operation and Development, 1996).

OECD, *Review of Fisheries in OECD Countries* (Paris: Organisation for Economic Co-operation and Development, 1997).

J. Olsen, "Development of the Pink Salmon Enhancement Program in Prince William Sound, Alaska", in *Proceedings of the 16th Northeast Pacific Pink and Chum Salmon Workshop, Juneau, Alaska, February 24-26 1993* (Fairbanks, Alaska: Alaska Sea Grant College Program, 1994), 57-68.

Oregon Department of Fish and Wildlife, *History and Overview of the Restoration and Enhancement Program* [online]. (1998). URL http://www.dfw.state.or.us/ODFWhtml/InfoCntrFish/RnEProgram.

F. Orrego Vicuña, "International Cooperation in Salmon Fisheries and a Comparative Law Perspective on the Salmon and Ocean Ranching Industry", *Ocean Development and International Law* 22 (1991): 133-151.

OSPAR, *Preparation of Draft Guidelines for the Construction of Artificial Reefs: Agenda Item 4. Oslo and Paris Conventions for the Prevention of Marine Pollution Programmes and Measures Committee (PRAM), Reykjavik, 30 March-3 April 1998* (London: OSPAR, 1998) PRAM 98/4/9-E.

P. H. Pearse, "Fishing Rights and Fishing Policy: The Development of Property Rights as Instruments of Fisheries Management", in *The State of the World's Fisheries Resources: Proceedings of the World Fisheries Congress, Plenary Sessions,* ed. C. W. Voigtlander (New Delhi: Oxford and IBH Publishing, 1994), 76-91.

E.A. Perry, "Salmon Stock Restoration and Enhancement: Strategies and Experiences in British Columbia", in *Uses and Effects of Cultured Fishes in Aquatic Ecosystems,* ed. H.L. Schramm and R.G. Piper (proceedings of the International Symposium and Workshop on Uses and Effects of Cultured Fishes in Aquatic Ecosystems, held in Albuquerque, New Mexico, 12 - 17 March 1994) (Bethesda, Maryland: American Fisheries Society, 1995), 152 - 161.

H. Pickering, "Legal Issues and Artificial Reefs", in *European Artificial Reef Research - Proceedings of the First EARRN Conference, Ancona, Italy 26-30 March 1996*, ed. A. C. Jensen (Southampton: Southampton Oceanography Centre, 1997), 195-232.

R. B. Rettig, "Is Fishery Management at a Turning Point? Reflections on the Evolution of Rights Based Fishing", in *Rights Based Fishing*, ed. P. A. Neher, R. Arnaston and N. Mollett (London: Kluwer Academic, 1989), 47-64.

S. Revenga, F. Fernandez, J. L., Gonzalez and E. Santella, "Artificial Reefs in Spain: the Regulatory Framework", in *European Artificial Reef Research - Proceedings of the First EARRN Conference, March 1996 Ancona, Italy*, ed. A. C. Jensen (Southampton: Southampton Oceanography Centre, 1997), 161-174.

M. Rudd, "Abalone Stock Enhancement: a Review of Rationale and Techniques", *Bulletin of the Aquaculture Association on Canada* 4 (1995): 13-16.

M. N. Santos, C. C. Monteiro and G. Lasserre, "Finfish Attraction and Fisheries Enhancement on Artificial Reefs: a Review", in *European Artificial Reef Research - Proceedings of the First EARRN Conference, Ancona, Italy, March 1996*, ed. A. C. Jensen (Southampton: Southampton Oceanography Centre, 1997), 97-114.

A. D. Scott, "Conceptual Origins of Rights Based Fishing", in *Rights Based Fishing*, ed. P. A. Neher, R. Arnason and N. Mollett (London: Kluwer Academic Publishers, 1989), 11-38.

W. Seabrooke and H. Pickering, " The Extension of Property Rights to the Coastal Zone", *Journal of Environmental Management* 42 (1994): 161-179.

J. L. Seymour, "Preliminary Legal Considerations in Developing Artificial Reefs", *Coastal Zone Management* 2(2) (1975): 149-169.

R. R. Stickney (ed.), *Culture of Salmonid Fishes* (London: CRC Press, 1991).

J. E. Thorpe, "Salmon Ranching in Britain, Ireland", in *Salmon Ranching*, ed. J. E. Thorpe (London: Academic Press, 1980), 199-211.

S. Tilseth, "Overview of Sea Ranching of Atlantic Cod and Review of the Norwegian Sea Ranching Program", *Marine Fish Culture and Enhancement Conference Proceedings, Seattle October 4-6 1993* (Seattle, Washington: Washington Sea Grant Program, 1994), 37-38.

P. Tortell, *A Review of the Environmental and Legal Implications of Artificial Reefs* (Rome: FAO, 1993), FAO Rome Fish. Circular 865.

J. R. Ungson, "Implications of Sea Ranching in Developing Countries", *NAGA* (1993 January): 11-13.

J. R. Ungson et al, "An Economic Assessment of the Production and Release of Marine Fish Fingerlings for Sea Ranching", *Aquaculture* 118 (1993): 169-181.

J. R. Ungson, Y. Matsuda, H. Hirata and H. Shllhara, "An Economic Benefit-Cost Estimation of the Red Sea Bream Ranching in Kagoshima Bay, Japan", in *International Cooperation for Fisheries and Aquaculture Development - Proceedings of the 7th Biennial Conference of the International Institute of Fisheries Economics and Trade, Taipei, Taiwan R.O.C. July 18-21 1994*, ed. D. S. Liao (Taiwan: National Taiwan Ocean University, 1995), 189-201.

A. van Houtte , N. Bonucci and W. R. Edeson, *A Preliminary Review of Selected Legislation Governing Aquaculture* (Rome: FAO, UN Development Programme, 1989).
A. van Houtte, "The Legal Regime of Aquaculture", *FAO Aquaculture Newsletter, FAN* 7 (1994): 10-13.

F. O. Vicuña, "International Cooperation in Salmon Fisheries and a Comparative Law Perspective on the Salmon and Ocean Ranching Industry", *Ocean Development and International Law* 22 (1991): 133-151.

G. D. Waugh, "Salmon and New Zealand", in *Salmon Ranching*, ed. J. E. Thorpe (London: Academic Press, 1980), 277-303.

R. J. White, J. R. Karr and W. Nehlsen, "Better Roles for Fish Stocking in Aquatic Resource Management", *American Fisheries Society Symposium* 15 (1995): 527-547.

D. Whitmarsh and H. Pickering, *Commercial Exploitation of Artificial Reefs: Economic Opportunities and Management Imperatives*, paper presented at the IXth Annual Conference of the European Association of Fisheries Economists, 28-30 April 1997, Quimper, France (Portsmouth, UK: University of Portsmouth, Centre for the Economics and Management of Aquatic Resources, 1997), CEMARE Research Paper P115.

H. Wiggerts, "Coastal Management in the Netherlands", in *Comparative Marine Policy: Perspectives from Europe, Scandinavia, Canada and the United States* (New York: Praeger Publishers on behalf of Centre for Ocean Management Studies, University of Rhode Island, 1981), 75-81.

B. H. Wildsmith, *Aquaculture: The Legal Framework* (Toronto: Emond-Montgomery, 1982)

R. Willmann, "Economic and Social Aspects of Artificial Reefs and Fish Aggregating Devices", in S*ymposium on Artificial Reefs and Fish Aggregating Devices as Tools for the Management and Enhancement of Marine Fishery Resources, held by the Indo-Pacific Fishery Commission (IPFC), Colombo, Sri Lanka, 14-17 May 1990* (Bangkok: FAO, 1990), 384-391.