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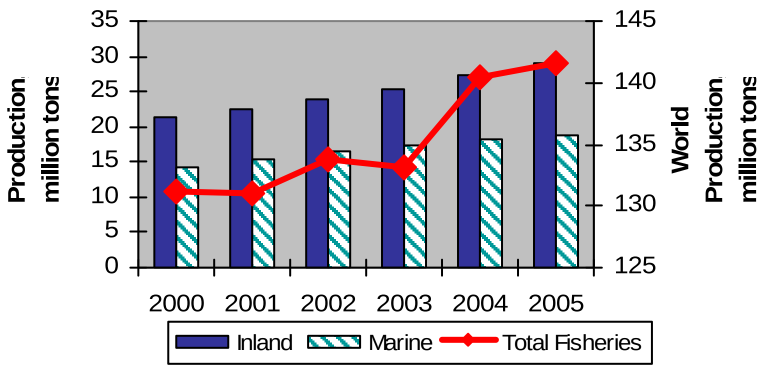
The Relationship Between Conservation Policy and Aquatic Genetic Resources

Globally there is an increased awareness of how important genetic resources are for all forms of agriculture. This awareness has resulted in questions concerning the policies countries and the international community should pursue to ensure the sustainable use of diverse genetic resources. For much of the agricultural sector national policies are of interest because of a general contraction in the amount of genetic diversity available for developing new varieties or lines that can increase agricultural productivity.

FAO (2006) reports marine and inland aquaculture has exhibited significant growth (Figure 1) in the quantity of production. During the last 30 years and across the species categories crustaceans especially marine shrimp have generally had the fastest growth rate, however all categories have a 5% or greater growth rate indicating production is growing at exponential rates (Figure 2).

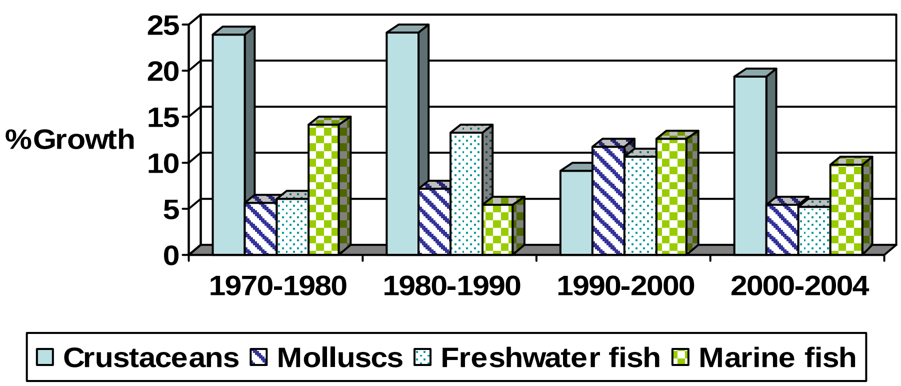
From 2000 to 2004 value of aquaculture has grown by 23% to US$71.5 billion (FAO, 2006). With this increase in production and value fish are widely traded, it is estimated that 38% (live weight equivalent) is exported. In 2004, regions showing a trade surplus included Africa, Latin America and the Caribbean, and Oceania; while those reporting a deficit include Asia, North America, and Europe (FAO, 2006).

Figure 1. World production from inland and marine aquaculture (left axis) vs total world fisheries (right axis).



As pointed out by FAO (2006) the production increases achieved to date have not been the result of genetic selection, rather it is the result of nutrition, management, and increased area of production. This type of sector development is typical of other components of the agricultural sector. For example, increased production in milk due to genetic selection did not have a significant impact on dairy production until about 1970 after quality of management and nutrition had increased. Aquaculture may follow this same developmental pattern. A key difference between aquatic species and other forms of animal agriculture is that the aquaculture industry still has the ability to capture animals from the wild and incorporate those genetics into the captive breeding populations. As long as captive populations have not been intensively selected for production characteristics the integration of wild genetics may be useful. However, once selection intensity increases and captive populations become more genetically divergent from their wild progenitors the value of such integration will be limited or counter-productive. What also must be considered in the use of aquatic species genetic variability is that selection can be more intensively practiced than other species due to the ability to propagate populations from a small number of parents. As a result, the genetic diversity in aquatic populations can rapidly decrease.

Figure 2. World aquaculture production: average annual growth rate for different species groups



Compared to livestock or crop agriculture the scale of international exchange of aquatic genetic resources is limited. There are a few key species where active trade exists. The most notable example is the shrimp industry, which obtains its genetic resources from a number of geographic locations, from which it develops specific lines, which are in turn sold globally. As selective breeding becomes more prevalent in aquaculture a similar type of model may emerge for other species. For this reason understanding the current policy landscape dealing with genetic resources will be of utility as the aquaculture industry continues to develop and the exchange of genetic resources grows. It is this issue in conjunction with the movement and exchange of aquatic animal genetic resources and the relationship to the current discussions concerning the international use and exchange of genetic resources which we wish to discuss in this paper.

Policy Landscape

Depending on the species of interest to commercial or subsistence-level producers, access to aquatic animal germplasm occurs along a continuum of formal to informal systems – ranging from well-established private sector channels to the acquisition of wild stocks directly from natural areas. The diversity of both stakeholders and systems for managing and using aquatic genetic resources necessitates that there be information exchange between aquaculture stakeholders and the negotiators representing them at the international fora in which these issues are being examined. Given the potential impact on global aquaculture of an international regime intended to manage access to and benefit sharing from the use of genetic resources, further examination of how current systems are operating could assist in the development of a regime that facilitates the conservation and sustainable use of these critical resources. The aquaculture community would benefit from engaging in deliberations of how to best inform the development of emerging international legal frameworks on access and benefit sharing issues. These emerging approaches could take a number of forms, ranging from little or no government intervention to highly regulated exchanges requiring strict contractual arrangements between private parties or between governments.

There are several pre-existing intergovernmental fora (Table 1) that produce internationally legally binding arrangements that impact all of agriculture. For example, the World Trade Organization and their efforts in Trade-Related Aspects of Intellectual Property Rights (WTO TRIPS); the Convention of Biological Diversity (CDB); and the United Nations Convention on the Law of the Sea (UNCLOS). All of these bodies deliberate on issues that impact the aquaculture community. Perhaps more relevant to agriculture and aquaculture in general are the on-going efforts at the UN Food and Agriculture Organization (FAO). Specifically, FAO's Aquaculture and Fisheries Department has served as secretariat for member countries in developing the Code of Conduct for Responsible Fisheries. Of late the Commission on Genetic Resources for Food and Agriculture (CGRFA) has added activities on aquatic genetic resources in its multi-year plan of work and in conjunction with its efforts on plants and livestock. The CGRFA may play an important role in developing arrangements concerning aquatic genetic resources because the CDB, the central forum for negotiations on access to and benefit sharing from the use of genetic resources (ABS), has turned to the CGRFA to contribute its expertise on how ABS for genetic resources relevant to food and agriculture may be best approached.

Table 1. International organizations involved with genetic resources.

Organization	**Genetic Resource Action**
Convention of Biological Diversity (CDB)	Among the CBD's objectives are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources…" (CBD, 1992). Article 15 of the Convention is focused on the issue of access to genetic resources and in 2000, the CBD created an ABS working group to "develop guidelines…to assist … with the implementation of the access and benefit-sharing provisions of the Convention" (CBD, 2002). By 2010, the CBD has tasked its ABS Working Group to develop an approach that accommodates the needs and interests of a range of stakeholders across many sectors.
World Trade Organization Trade-Related Aspects of Intellectual Property Rights (WTO TRIPS)	Article 27 of the TRIPS agreement relates to patenting. Paragraph 19 of the 2001 Doha Declaration indicates that the TRIPS Council should examine the relationship between the TRIPS Agreement and the CBD – for instance, to examine issues such as the inclusion of the origins of genetic materials in patent applications (WTO, 2008a & b).

United Nations Convention on the Law of the Sea (UNCLOS) and UN Fish Stocks Agreement	UNCLOS is the principle forum for the discussion of marine genetic resources in international waters, as discussed at the Consultative Process meeting in June 2007, though UNCLOS also deliberates marine genetic resource access and benefit-sharing issues within national jurisdictions. Marine genetic resources, as discussed in the Consultative Process meeting, primarily refer to microbial organisms found in marine environments while fish genetic resources are indirectly addressed in the UN Fish Stocks Agreement.
Commission on Genetic Resources for Food and Agriculture (CGRFA)	Addresses policy and technical aspects of genetic resource issues for all agriculturally important areas (crops, livestock, forestry, aquaculture (and capture fisheries), microbes, and insects. Responsible for the development of the International Treaty on Plant Genetic Resources. Provides guidance to FAO on their activities in this area.
World Intellectual Property Organization (WIPO)	Works generally on intellectual property (IP) aspects of genetic resource access and benefit-sharing issues (WIPO, 2008).

Much of the rationale for the CBD's focus has been an emphasis on wild populations and concerns about the use of various genetic resources as they relate to the pharmaceutical industry. It does not appear that this model is particularly effective for agriculture in general. For as Gollin et al. (2008) have illustrated the flow of livestock genetic resources from non-OECD countries to OECD countries is quantitatively and economically small. For plant genetic resources of relevance to food security, the International Treaty on Plant Genetic Resources for Food and Agriculture, adopted in 2001, was developed to govern the exchange of these resources, of which many are maintained in *ex situ* collections developed long before the CBD entered into force. Given the diversity of exchange and use patterns of genetic resources across agricultural sectors, the CBD has requested support from the CGRFA.

Management of Aquatic Genetic Resources

The future development of aquatic genetic resources for aquaculture will depend upon the private sector's interest and development of specific populations that confer an advantage to production. To date and where genetic selection is applied the aquaculture industry has been successful in developing markets for such populations. Intellectual property rights or other forms of exclusive ownership or access have rarely been sought or enforced to date for farmed fish. At issue will be to what degree ABS has relevance to the market place and whether or to what extent the CBD or an emergent ABS agreement play a role in the maintenance, utilization and conservation of aquatic genetic resources used in aquaculture. While national sovereignty over wild fish populations is provided by the CDB, arguments can be made for recognition of new countries of origin for strains, hybrids or other forms of alien fish species that have acquired distinctive properties by being farmed outside their native ranges (Pullin, 2005).

To date there are two widely different models of how to proceed in conserving and fostering the utilization of genetic resources. One example is the almost two decades of work that was put into developing the International Treaty on Plant Genetic Resources for Food and Agriculture. Under this agreement, specified plant genetic resources from contracting parties have been made part of a multilateral system. Those wishing to use genetic resources from another country must adhere to the terms of an internationally agreed upon standardized material transfer agreement. The terms of access and benefit sharing have been defined in the ITPGRFA. While the development of a treaty and material transfer agreement have been seen by some as a positive step, to date the ITPGRFA seems to have reduced the exchange of plant genetic resources between countries. At the other end of the spectrum is the livestock sector, which has strong market structure in place to handle the exchange of genetic resources. Gollin et al. (2008) suggest that for the livestock sector there is little basis for the type of formal agreement(s) that have been developed by the plant community. Pullin (2005) articulates the similarities between aquatic and livestock genetic industries in that companies produce elite lines and hybrids and then tend to distribute their products to farmers through commercial agreements, e.g., contract growing.

The aquaculture sector has addressed several aspects of germplasm exchange. In FAO's Code of Conduct for Responsible Fisheries it is recommended that states conserve genetic diversity and maintain integrity of aquatic communities. In addition, states should encourage adoption of appropriate practices in genetic improvement of broodstocks in order to minimize disease transfer. The Nairobi Declaration on the use of genetically improved and alien species in Africa (ICLARM, 2002), recognizes that:

1. Captive breeding populations can lose genetic diversity and therefore such considerations should be a basic element in broodstock management.
2. That unique wild stocks of tilapia in Africa need identification and protection from introductions of genetically improved strains.
3. Access to baseline information on fish genetic diversity needs to be strengthened.

Based upon the FAO Code of Conduct for Responsible Fisheries and the Nairobi Declaration the WorldFish Center has developed a policy and protocol for the transfer of Genetically Improved Farmed Tilapia. While this material transfer agreement is focused upon WorldFish Center to government exchange it does suggest that the necessary elements for exchanging germplasm are in place and functioning from a public sector perspective.

Use of Aquatic Genetic Resources

In the coming years, the global aquaculture industry may increasingly devote attention to broodstock development and reliance on access to wild materials will likely decrease as broodstock improvement programs mature. In the United States, hybrid striped bass (HSB) broodstock producers obtain breeding materials from wild sources on an annual basis. HSB breeding programs are still in early stages of development and it is likely that as these breeding programs mature, use of improved populations for broodstock development will decrease the need for wild stocks. Conversely, the US rainbow trout industry no longer obtains wild animals for breeding as they have well-established breeding populations with ample genetic variability though public sector researchers continue to examine traits of commercial interest in wild populations.

Until the aquaculture industry achieves a level of sophistication that no longer requires access to wild stocks for routine breeding activities, *ex situ* collections may be useful in the coming years. For example, access to *ex situ* collections may facilitate progress in breeding for specific traits of interest through identifying useful markers in wild populations for genes that may exist in lower frequencies in advanced breeding populations. Current trends in the development of cryopreservation and other aquatic animal germplasm storage techniques will facilitate the development of these collections. Over the next few decades, the development of international legal frameworks that govern the terms of access to and use of aquatic animal genetic resources will coincide with the maturation of the global aquaculture broodstock industry and the development of *ex situ* germplasm collections. Therefore, even though more detailed agreements have yet to be established, those involved in active germplasm collecting for either breeding programs or *ex situ* collections need to understand the terms by which these materials can be obtained from source countries. Currently, guidance on this issue has been outlined in the CBD text which states that obtaining materials requires both prior informed consent (PIC) and mutually agreed terms (MAT). Identifying the appropriate competent authority(ies) with whom to establish PIC and MAT can be complicated with aquatic organism germplasm, particularly in transboundary aquatic ecosystems as waters may pass through multiple jurisdictions.

Policy Considerations and Conclusions

Management and utilization of aquatic genetic resources will require access and utilization of populations that have been developed to meet various production system needs throughout the world. Public and private sector initiatives have been developed to meet market needs. There are viable markets and exchange of aquatic germplasm, the issue at hand then becomes what sort of policies are needed to protect genetic diversity and ensure that the aquaculture sector can continue to develop and contribute to the nutritional and economic well-being of people.

As previously stated aquaculture has the ability to rapidly reduce the genetic variation in aquatic populations due to short generation intervals and high reproductive rates. In addition there is a need to offer appropriate levels of protection to wild populations so they potentially can be used to contribute to the industry. This issue can be addressed at the country level by the development of national programs to assist in the management of aquatic genetic resources. A component of such a national effort is the development of a gene bank capable of storing cryopreserved samples of the species a country deems important.

Another element of the national program is the development of baseline information concerning the status of the appropriate aquatic genetic resources, which has been articulated in the Nairobi Declaration.

In addition to policies on conservation there is a critical need to develop and implement policies that address: incentives (excluding subsidies) to produce, access to markets for outputs and inputs, and facilitate integration of conservation, demand and environmental elements of aquaculture production (Blackburn, 2007).

As with other life forms ABS will be of interest to the aquaculture sector. It is becoming apparent from discussions in the livestock sector that any type of formal or informal arrangement there is a need for agreements to be flexible and to facilitate the development of the sector and not impinge upon its ability to provided needed food and economic activity.

The global agriculture community has to contend with contracting genetic diversity, the ability to introgress genes of interest into productive populations and an increased awareness about the public/private rights associated with these resources. In this arena aquaculture has special challenges and opportunities due to the industries ability to access and utilize wild populations and the vast array of life forms the industry uses to feed a hungry world. While the production challenges may be significant the multilateral agreements and initiatives discussed in this chapter clearly need the aquaculture industry's attention to insure that effective and rational agreements are developed. This will require aquaculture representatives to quickly become familiar with the topic and some long term understanding as to where the industry and its sub-sectors are headed. Only then will policy makers be in a position to effectively develop the needed policies for aquatic genetic resources.

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