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**Aquaculture and biodiversity
Developing principles for aquaculture of introduced species**

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Aquaculture and biodiversity

Developing principles for aquaculture of introduced species

Purpose

1. The purpose of this paper is to:
 - i. Provide a briefing about the use of introduced species for aquaculture in the Pacific Islands region;
 - ii. Highlight emerging new issues relating to apparent tensions between *biodiversity* and *food security*;
 - iii. Seek the views and support of Heads of Fisheries for SPC, in conjunction with national and regional stakeholders, to address these issues relating to use of introduced species in regional aquaculture.

Introduced species in Pacific aquaculture

2. Aquaculture development for food security and to increase rural livelihoods is a priority sector for most PICTs, identified in national and regional strategies and plans. For the majority of PICTs a growing “fish gap” is forecast, between the fish that can be supplied by depleted and climate-change affected coastal fisheries and that demanded by increasing populations.¹
3. Inland aquaculture in freshwater or brackish-water ponds is one of three “vehicles” (along with off-shore tuna fisheries and inshore FAD’s) identified as sources of fish production which can address the growing shortfall in domestic fish supply and prioritized for further development.
4. As in agriculture the global pool of fish species that can be domesticated, and which have agronomic traits suitable for aquaculture, is quite small. International aquaculture is following the same trend as agriculture, where genetically improved varieties of these relatively few species were developed through domestication (control over breeding) and selection for desirable traits, and then introduced to other places outside of their natural geographical ranges to help increase food production. Examples of such introductions in Pacific agriculture include pigs, chickens, cattle, goats, improved pasture grasses for livestock, trees like mahogany for forestry, or *Jatropha* bush for bio-diesel production.²
5. In Pacific aquaculture, the top five of those species so far able to support successful industries are black-lip pearl, Mexican blue shrimp, Malaysian giant freshwater prawn, tilapia fish, and *Kappaphycus* seaweed. Only one of these (Black-lip pearl) is indigenous, while the other four were introduced from outside the region.³

¹ Fish for food security in the Pacific. HoF6 Working Paper 5.

² Guidelines for invasive species management in the Pacific : a Pacific strategy for managing pests, weeds and other invasive species. SPREP, 2009.

³ SPC Pacific Regional Aquaculture Strategy and Action Plan

6. SPC continues to receive requests from member PICTs for information and guidelines about possible introduction of species for aquaculture, which recently have included: an improved variety of *Kappaphycus* seaweed; barramundi fish, Australian freshwater crayfish; and Nile tilapia.
7. It is advisable to utilise an indigenous species for aquaculture wherever possible, in order to avoid environmental or economic risks from species introductions. However, in many places there are no indigenous species capable of fulfilling aspirations for efficient agriculture or aquaculture food production. In these cases, adoption of modern approaches to Risk Assessment are strongly urged, to ensure that decisions to introduce a species for aquaculture are science-based, consultative, and provide as full an appreciation of the risks as possible. If risks are being weighed against benefits, then the case for the likelihood of benefits being achieved should be a strong one.
8. Internationally tilapia is recognised as one of the few fish species with good all-round culture characteristics (hardy, easy to breed, rapid-growth, omnivorous diet) that will see it included among the select handful of crops that can help provide animal protein at low cost. In the Pacific, the effects of climate change are predicted to improve the outlook for successful tilapia aquaculture.
9. Improved varieties of Nile tilapia developed in SE Asia are now being introduced back to Africa, where tilapia originate from. Nile tilapia has already been introduced to some PICTs in recent years. This is because the feral Mozambique tilapia introduced widely in the Pacific during the 1950s and 1960s, which forms the basis of important fisheries in some places like Sepik River in PNG or Lake Tegano in Solomon Islands, is not a variety suitable for aquaculture. Globally 90% of farmed tilapia is Nile tilapia.
10. The same characteristics that render a species good for aquaculture (hardy, breeds easily, grows rapidly, etc.) can also contribute one of the two elements necessary for a species to be considered “invasive”. The second necessary element is that the species causes environmental or economic harm, or harm to human health. The scientific literature still contains unresolved differences about whether, and to what extent, tilapia causes any harm to freshwater ecosystems.⁴

Biodiversity and food security

11. Internationally there are tensions (conflicts) emerging between the need to produce more fish for food security through fisheries and aquaculture, and the potential effects of fisheries and aquaculture development on biodiversity. For example, international initiatives to protect aquatic biodiversity typically call for (i) reductions in the amount of fishing, and/or (ii) only local species to be used for aquaculture. International initiatives to protect food security, on the other hand, call for (i) fisheries production to be sustained or increased, and (ii) use of the most efficient varieties for aquaculture.

⁴ For example, see Arthur et al. (2010) *Aquaculture* 299, 81-88, and Jenkins et al. (2009) *Aquatic Conserv: Mar. Freshw. Ecosyst.* DOI: 10.1002/aqc..

12. By the year 2050 the world will have an additional 2 billion people to feed. Since 1990 the global increases in fish production up to present-day levels have been achieved entirely through aquaculture production. Maintaining this growth in future will depend upon development and dissemination of specialized species and varieties adapted for low-cost pond culture and low-protein diets.
13. Potential for tension between biodiversity and food security exists in Pacific regional and national initiatives and mandates. For example, the 2010 *Framework for Action on Food Security in the Pacific* calls for PICTs to “Promote commercial aquaculture to supply farmed fish to urban markets; continue to support inland aquaculture where appropriate.” (Theme 3, Strategy 2, Action 7) but also to “Strengthen biosecurity and quarantine systems to curb the import of invasive species, pests and diseases and to respond as necessary at national and regional levels” (Action 1).
14. Similarly, the SPREP/SPC *Guidelines for Invasive Species Management in the Pacific* advises that “the precautionary principle should be applied to the management of introduced species. Where scientific knowledge is insufficient to assess accurately either the risk of a species becoming invasive, or its present or future impact, it should be assumed that impacts will occur and action should be taken to prevent the species spreading or becoming established.”
15. Pond aquaculture needs to be based on simple technology. This does not exist for any indigenous species, nor are any indigenous species likely to be suitable for mass production. Tilapia is the obvious species on which to base development of pond aquaculture, if PICTs continue to place priority upon this sector to meet future food-security needs. Tilapia production on medium and small scales is now increasing rapidly throughout Asia and Africa.
16. In line with the “precautionary principle” and until more scientific information is available to support assessments of “harm”, it is prudent for the time-being to adopt policies that discourage further introduction or spread of tilapia to places where it is not yet established.
17. In places where Mozambique tilapia is already well established however, the option to responsibly introduce Nile tilapia for aquaculture is one that could be explored. SPC is currently assisting Solomon Islands Ministry of Fisheries and Marine Resources to conduct a risk assessment for introduction of Nile tilapia under this particular scenario. SPC is also working with SI MFMR and Worldfish on an ACIAR-funded Inland Aquaculture assessment that considers all options (including local species) for inland fish production for food security.

Reconciling the tensions

18. Key questions for the region, that will need allocation of resources for collaborative work to provide answers, could include:
 - i. Whether, and to what extent, tilapia may cause “harm” to aquatic biodiversity or other values among PICTs?
 - ii. If there is “harm” from tilapia then how does this rank in comparison with other potential sources of “harm” to aquatic biodiversity or environmental quality, like de-forestation, unsustainable land practices, or fishing with chemicals?

- iii. For those places where Mozambique tilapia is already long-established, will the introduction of Nile tilapia for aquaculture have any significant new effects on biodiversity that were not already there before their introduction?
 - iv. How do any additional effects compare with the potential benefits of pond aquaculture that uses a suitable variety of tilapia to help fill the food security gap?
 - v. Which PICTs (or provinces of PICTs) are most in need of the potential benefits of aquaculture using an improved tilapia variety? These will likely be in tropical Melanesia, in those places where population growth is high, fish is scarce in inland areas, land and freshwater is readily available, and where rainfall is projected to increase further under climate change.
 - vi. Are there any viable local alternatives to tilapia that could efficiently deliver food-security benefits through application of aquaculture techniques?
 - vii. Are there any other viable introduced-species alternatives to tilapia that could efficiently deliver food security benefits with less risk?
19. CROP agencies, SPC members, NACA, WorldFish, FAO, and NGOs could work collaboratively and agree on a Terms of Reference for a regional project that aims to address these and any other questions, to reduce uncertainties, and to provide information that will assist PICTs to make responsible decisions about introductions of improved varieties of aquatic species for aquaculture.

Recommendations

20. Fisheries Heads are invited to:

- a. Reaffirm that the decision on whether or not to introduce exotic species or new strains of previously introduced species for aquaculture is a national responsibility;
- b. Note the importance of considering carefully the potential benefits and risks of any such introduction, including an appropriate risk assessment;
- c. Agree that, for the time being and until more scientific knowledge is available, further introduction and spread of tilapia to countries and catchments where it is not yet established should be discouraged;
- d. Encourage research to determine whether Nile tilapia introduced for aquaculture to areas where Mozambique tilapia is long-established will, either by itself or through hybridization with Mozambique tilapia, cause any significant new effects on biodiversity that were not already there before their introduction.
- e. Agree that there be review of the potential for the use of indigenous, rather than introduced, species for aquaculture;
- f. Affirm that a complete prohibition on any new introductions is not consistent with international practices of food production.