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Strength in diversity: fish sanctuaries and deep-water pools in Lao PDR

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Abstract Fish sanctuaries are types of aquatic protected areas common throughout the landlocked country of Lao PDR. The key to their successful implementation in Laos appears to be local support. Therefore, they fit well within the context of community-based fisheries/co-management programmes. Fish sanctuaries are almost always established in deep-water pools, which serve as important dry season refuges for fish. The best-known fish sanctuaries in Laos are known as Fish Conservation Zones (FCZs), and are found in the mainstream Mekong River in Khong district, Champasak province, southern Laos. In Khong, there is increasing evidence that FCZs established by villagers, but with government support, are important places of concentration for various fish species. FCZs can benefit fish stocks, especially relatively sedentary species, but also highly migratory ones. FCZs are not panaceas for solving all the fisheries problems in Laos or the Mekong River Basin, but they represent important management tools that should not be overlooked.

KEYWORDS: capture fisheries, conservation, fish refuges, fisheries co-management, marine protected areas, Mekong River.

Introduction

Fish sanctuaries are types of aquatic protected or no-take fishing areas. Found throughout the world, they are most-often associated with marine habitats (Uychiaoco, Alino & Dantis 2000; Francis, Nilsson & Waruinge 2002; Benedetti-Cechi, Bertocci, Micheli, Maggi, Fosella & Vaselli 2003), although they are also known for freshwater environments (see Hoggarth, Dam, Debnath & Halls 1999). Despite their prevalence, little has been documented about how fish sanctuaries that encompass deep-water pools function in tropical rivers, streams and other types of inland wetlands (Poulsen, Ouch, Viravong, Suntornratana & Tung 2002), and this is probably one of the reasons why they are only occasionally adopted within strategies for managing inland fisheries by governments in mainland Southeast Asia and elsewhere.

The Lao People's Democratic Republic (Lao PDR or Laos) might not appear to be a good candidate for supporting large numbers of fish sanctuaries, as the country is landlocked and has a relatively small number of large lacustrine environments. However, Laos supports a high diversity of aquatic habitats (Claridge 1996) including the Mekong River, and local systems for managing fisheries resources often include various forms of fish sanctuaries, although they have not been well documented. This paper does not provide a comprehensive overview of all the types of fish sanctuaries that exist in Laos as there are many, and a detailed survey of fisheries management systems nationwide has not yet been conducted. This paper reviews the main types of fish sanctuaries found in Laos, and the ecological and social conditions that favour the adoption of fish sanctuaries as a management strategy in various parts of the country. The paper presents a particular case of fish sanctuaries from Khong district, Champasak province, and the role of deep-water pools in the mainstream Mekong River is considered (see Fig. 1). The argument is made for adopting fish sanctuaries as a management strategy. Fish sanctuaries are needed in Laos, as many fisheries, especially for large species, are believed to be in decline because of over-fishing or inappropriate harvesting (Roberts 1993; Roberts & Baird 1995; Baird, Phylavanh, Vongsenesouk & Xaiyamanivong

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Figure 1. Lao PDR, including Khong district, Champasak province, southern Laos.

2001b; Hogan, Moyle, May, Vander Zanden & Baird 2004). The successful implementation of fish sanctuaries in the Lao context necessitates a framework that is founded on participatory community-based fisheries co-management programmes operated at the village level.

Fish sanctuaries

Fish sanctuaries can take various forms but generally require the restriction of some or all fishing activities, either year-round or seasonally, and encompass particular geographical areas defined by communities and governments at various levels. Fish sanctuaries have specific rules or norms, either written or non-written, and these are often enforced through local institutions able to apply sanctions to punish violators. Importantly, fish sanctuaries are by no means homogenous as they represent diverse forms of protected areas for fish and other aquatic animals.

In Laos, as with many other countries, the institutional arrangements associated with fish sanctuaries vary. Local governments have decreed the establishment of some fish sanctuaries on their own, communities have initiated some independently, and others have been established through partnerships between international non-governmental organisations (INGOs), communities and local governments. Village elders, who often have considerable social capital in the rural Lao context, manage some fish sanctuaries on behalf of communities. In other cases, village chiefs are the main forces behind fish sanctuaries. Sometimes groups of villages manage sanctuaries collectively. Close-knit communities with strong and respected leaders are often the most successful (Baird 2001). Furthermore, it appears that people from a wide variety of ethnic groups in Laos recognise the value of fish sanctuaries, as they are found from northern to southern Laos and in the lowlands and the uplands.

Fish sanctuaries established at the village-level are often associated with Animist beliefs, particularly the respect and fear of spirits. In some cases, protected areas for fish are not specifically labelled by local people as fish sanctuaries, but are, nonetheless, consciously protected for religious reasons. In other cases, fish sanctuaries have been established for explicitly utilitarian purposes, either to maximise resource benefits or to ensure that resources are equitably distributed within communities. Sometimes both animistic and utilitarian motives are evident. Occasionally Buddhism is called upon as a justification for fish sanctuaries, but Animism is generally more important.

Fish sanctuaries are associated with various habitats as determined by a wide range of socio-cultural, geographical and ecological factors. In Laos, fish sanctuaries cover a vast array of aquatic habitats, from large rivers to small streams and from large perennial wetlands to small seasonal pools of water. They are established to protect different habitats, species, populations and communities of aquatic life, and are often linked to the life history requirements of particular species.

Some fish sanctuaries appear to work better than others. Some are weakening, some have disappeared, and others have been newly established or recently strengthened as social and ecological conditions change.

In Laos there does not appear to be any national legislation specifically related to fish sanctuaries. There are simply a large number of fish sanctuaries situated in different, and mainly rural, parts of the country; they are managed differently, based on the local contexts in which they are located.

Deep-water pools

Natural deep-water pools are now recognised as important to the ecology of many fishes in the Mekong River Basin (Roberts & Baird 1995; Valbo-Jorgensen & Poulsen 2000; Baird, Hogan, Phylavanh & Moyle 2001a; Baird *et al*. 2001b; Poulsen *et al*. 2002; Baird & Flaherty 2005). Deep-water areas are especially important as dry season refuges (Baird *et al*. 2001b; Poulsen *et al*. 2002; Baird & Flaherty 2005), and some species also rely on them for spawning (Roberts & Baird 1995; Baird *et al*. 2001b; Baird & Flaherty 2005). Deep-water pools occur both within large rivers and in permanent and seasonal water bodies on the floodplains. In this paper, deep-water pools broadly refer to a variety of relatively deep aquatic habitats surrounded and connected to shallower aquatic environments. Therefore, even deep parts of wetland marshes or backswamps that totally dry out by the end of the dry season are considered to be a type of deep-water pool, as such areas are often critical for fish stocks, representing the last refuges for aquatic animals during the dry season (Tubtim & Hirsch 2005). In Laos, all fish sanctuaries appear to be situated in deep-water pools or depressions.

Deep-water pools are important to the fish and fisheries of the four Lower Mekong countries of Laos, Thailand, Cambodia and Vietnam. Indicative of this, local knowledge surveys conducted along the mainstream Mekong River by the Mekong River Commission's Fisheries Programme documented more than 200 reports of deep pools being important habitats for certain fishes, although the issue of deep pools was not specifically raised by the interviewers (Valbo-Jorgensen & Poulsen 2000; Poulsen *et al*. 2002). Poulsen *et al*. (2002) reported that in the Mekong River in Laos there are not less than 70 deep-water pools and that there are at least 100 downstream from the Khone Falls in Cambodia.

Hydrological conditions and fish sanctuaries in the Mekong River Basin

Rivers and streams are not homogenous, but consist of an array of habitats that are important to different life forms in different seasons, and in various ways. However, most habitats in the Mekong River Basin are heavily inundated with water in the rainy season, and dry out substantially or entirely during the dry season; i.e. hydrology is key.

Critically, the Mekong River Basin is characterised by extreme flow variations throughout the year. While the Mekong receives some of its water from the mountains of southern China and Tibet, most of the basin is subject to monsoon conditions and thus there are wide fluctuations in rainfall between the monsoon-season (May to October) and other parts of the year (Claridge 1996). In August and September, when the monsoon season peaks, the Mekong River carries about 30 times as much water than it does at the end of the dry season in March and April (Cunningham 1998). Therefore, Mekong fish typically rely on deep-water depressions to survive in the dry season. These areas provide important protection against predators from outside and within the water and are critical for many species of fish, whether in large rivers or small streams. Deep-water pools are also important because they are cooler than shallow areas; this is particularly crucial during the dry season when temperatures rise and water levels drop, making shallow areas very hot and often uninhabitable. Many Lao fishers report that fishes leave deep-water areas to feed in shallow areas during the night, but when it is particularly hot in the day most fish stay in the deep areas, especially large fishes.

Many freshwater fisheries management systems in the tropics, including ones in Laos, rely on strategies to protect fish during the spawning-season (Bush 2003), which is generally in the rainy season. However, fishers realise that when water levels are high, fish are much less vulnerable than during the low water dry season, and concentrate their protection efforts in the latter period (Baird *et al*. 2001b; Baird & Flaherty 2005).

Large dams can cause massive habitat destruction and hydrological changes (Dudgeon 2000) that can severely reduce the prospects of deep-water pools being able to support fish communities. For example, the construction of the Yali Falls dam on the Sesan River in central Vietnam has caused many deep-water pools in the Sesan River in northeast Cambodia to become silted up through high rates of sedimentation, and this is believed to have had a serious impact on many fish species, especially those that are particularly dependent on deep-water areas for their survival (Poulsen *et al*. 2002; Hirsch & Wyatt 2004). A similar problem has also been reported along the Hinboun River, in Khammouane province, central Laos, where deep-water areas have silted up below the Theun-Hinboun dam (IRN 1999; Poulsen *et al*. 2002). Moreover,

projects like blasting rapids on the Mekong River have the potential to seriously impact nearby deep-water pools because of changes in habitat and hydrology (Hubbel 2002).

Different types of fish sanctuaries in Laos

There are a large number and a wide variety of fish sanctuaries in Laos. During a fisheries survey of Luang Prabang province, northern Laos, 37% of the village representatives reported that their communities had fish sanctuaries near their villages. These protected areas were mainly associated with deep-water pools in rivers, which locals believe are important fish breeding grounds (J. Sjorslev, personal communication). Below Luang Prabang on the Mekong River, the situation is similar in Sayabouli province (Sayabouli provincial Livestock and Fisheries officials, personal communication).

In Khammouane province, central Laos, there are a large number of fish sanctuaries, albeit vastly different from those found in other parts of the country, as many are specifically associated with the limestone karst topography found in this area. A number of villages are adjacent to large limestone karsts that have underground springs and streams running out of them at their bases. Deep caves filled with water adjacent to the karsts often become the only areas with water during the dry season, and thus refuges for fish. Once the rainy season arrives and the rivers and streams begin to flow again, these pools are often the sources of the larger broodstock fish that produce the juveniles that become an important part of the diet for local people (Shoemaker, Baird & Baird 2001). Local people have determined that it is not in their best interests to fish in the cave pool fish refuges during the dry season, and there are often community rules that prohibit fishing in these areas during the dry season. Locals generally do not violate the rules, for fear of retribution from powerful spirits or from other villagers.

There are also many fish sanctuaries in southern Laos. In 1997, Salavan province's Livestock and Fisheries officials reported at least 60 fish sanctuaries in Salavan, including a number along the Xe Don River, and even some in very small streams only 1 m deep. However, officials reported that as the central government had established targets for expanding aquaculture ponds, but not for expanding the number of fish sanctuaries, the province reported fish sanctuaries as aquaculture ponds to meet the central government's quota (Salavan province Livestock and Fisheries officials, personal communication).

Fish sanctuaries have also been established in the southern province of Xekong. In the mid-1990s, the provincial government established a number of fish sanctuaries along the Xekong River by decree, but with little consultation with local people, and as a result many failed soon afterwards. Similar problems have also identified from parts of Champasak province (Hirsch 2000) and Khammouane province (personal observation). More recently, however, INGOs like CUSO and Oxfam Community Aid Abroad have supported communities and local government to establish co-management fisheries regulations with more success (personal observation).

Fish sanctuary-oriented systems in many parts of Laos, locally known as *pha pa* or *pha nong* systems in Laos, are not generally considered to be fish sanctuaries, but they include seasonal fishing restrictions of deep-water parts of enclosed natural wetlands and therefore serve the same purpose of many fish sanctuaries (Tubtim & Hirsch 2005). These systems are especially popular in areas located away from large rivers, such as the Mekong; in places where the main water bodies used for fishing are perennial or seasonal natural depressions and wetlands. These are generally protected from all or most varieties of fishing for most of the year, but on one particular day each dry season (different days for each area), when water levels reach critically low levels, villages allow fishing by all community members and sometimes neighbouring communities. After that day, fishing is often open to anyone for a month or two until the beginning of the next monsoon season when fishing is again banned. However, sometimes fishing is closed immediately after the first day of fishing.

Nowadays, some villages near Vientiane sell tickets to outsiders on the annual fishing days in particular natural ponds. This raises funds, with higher fees being collected from different people, depending on the types of gears used (personal observation). In Khammouane province, in central Laos, some villages raise funds by auctioning exclusive fishing rights for particular natural ponds to the highest bidder (Shoemaker *et al.* 2001). Other communities have permanently sold natural ponds to individuals, such as near Pakse in Champasak province, causing some government officials to become concerned about the losses to future generations from villages selling the ponds (Champasak province officials, personal communication). Villagers in parts of Xekong province sometimes allow outsiders to fish in their fish sanctuaries in the Xekong River, provided that they pay a fee to the communities who manage them (personal observation).

In Champasak and Savannakhet provinces, efforts have been made to stock natural ponds, including certain types of fish sanctuaries to improve their productivity. Using both native and non-native species, enhancement efforts have met with mixed success (Bush 2003).

Sometimes fish sanctuaries are established to protect other aquatic animals apart from fish. For example, people from one community in Savannakhet province ban fishing in two large perennial ox-bow lakes near the Xe Bang Fai River to protect a resident population of Siamese crocodiles (*Crocodylus siamensis* Schneider) that have great spiritual value for local people. Strong taboos are attached to these wetlands and fishing is totally banned in one area while being heavily restricted in the other (Shoemaker *et al*. 2001).

Sanctuaries are a potentially important tool for protecting Irrawaddy dolphins (*Orcaella brevirostris* Gray) in the mainstream Mekong River, as dolphins tend to concentrate themselves in parts of the mainstream Mekong River >8 m deep during the dry season (Baird & Mounsouphom 1997; Baird & Beasley 2005).

Fish conservation zones in Khong district, Champasak province, southern Laos

Probably the best-known examples of fish sanctuaries in Laos are the Fish Conservation Zones (FCZs) established in the 1990s in Khong district, Champasak province, southern Laos, as part of a community-based fisheries co-management initiative. These fish sanctuaries are all situated in the mainstream Mekong River (Siphandone Wetlands, or the 'four thousand islands') near the border with Cambodia. Between 1993 and 1999, 63 villages in Khong established a total of 68 FCZs with local government endorsement (see Fig. 2). Communities also received the support of two INGO-initiated projects, the Lao Community Fisheries and Dolphin Protection Project and the Environment Protection and Community Development in Siphandone Wetland Project. The first was implemented between 1993 and 1997, and the second continued from where the first left off, until it was completed in 1999 (Baird 2001). In Khong, the communities have been empowered to choose whether to have FCZs or not, and where to situate them. While local government supports the establishment of FCZs, villagers choose whether to ban fishing in particular FCZs all year round or only part of the year. Village administrations are empowered to enforce regulations and apply sanctions, including fines and gear confiscation. FCZs are but one, albeit the most important, management measure included in village fisheries co-management strategies. Other measures include banning the use of particular fishing methods, either year round or part of the year, and banning the harvesting of fish and frogs during particular seasons. In addition, for some species, harvesting juveniles is not allowed (see Baird 2001 for more details).

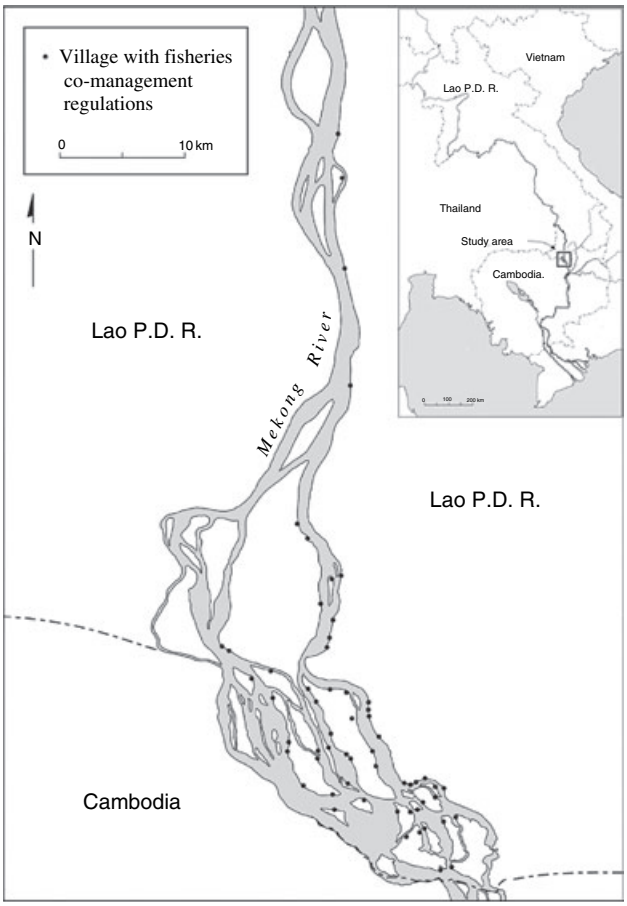

Figure 2. Villages in Khong district, Champasak province, southern Laos with fisheries co-management regulations, including fish sanctuaries.

Characteristic of almost all the fish sanctuaries in Laos, the FCZs in Khong have all been established in relatively deep depressions or pools. While some are relatively shallow, reaching just 2.5 m deep in the dry season, others are at least 50 m deep in the dry season. The mean depth is 19.5 m. The largest FCZ in area is 18 ha, the smallest 0.25 ha, and the mean size is 3.52 ha (Baird 2001).

Although not every FCZ in Khong has been well managed and has benefited fish or people, most apparently have, and evaluations of the Khong FCZs conducted both before and after support for the initiative ended have indicated that local people favour

the concept of FCZs and are likely to continue maintaining their FCZs. Most importantly, villagers generally believe that FCZs have benefited local fish stocks (T. Warren and E. Meusch, personal communication). Hogan (1997) and Cunningham (1998) have also endorsed the FCZs in Khong.

In addition, during dry season hydroacoustic studies of FCZs in Khong in 2002 and 2003, fish densities in deep-water pools were high, although stock abundance varied from area to area (Kolding 2002; Phounsavath, Photitay & Valbo-Jorgensen 2004). Kolding (2002) found that large species were particularly abundant in deep-water areas, but Phounsavath *et al.* (2004) discovered that many of the species in these areas were small, indicating that deep-water areas may also serve as nurseries for some species.

Baird & Flaherty (2005) illustrated that as a result of differing microhabitat characteristics deep-water FCZs support different communities of fishes. Various habitat factors are believed to be important, including the sizes of areas, substrate type, river velocity, the presence or absence of large rocks and logs in deep-water areas, the proximity of wetland forest areas to deep-water areas, and the gradient or slope of deep-water areas. However, it is generally believed that FCZ depth is the most important factor (Baird *et al.* 2001b; Kolding 2002; Poulsen *et al.* 2002; Phounsavath *et al.* 2004; Baird & Flaherty 2005). In Khong, local fishers are adamant that only deep-water areas justify the establishment of FCZs (Baird 2001; Baird & Flaherty 2005), and hence three villages in Khong established fisheries co-management regulations but chose not to establish any FCZs – all did not have any deep-water areas within their village territories (Baird 2001).

In 1998, fishers in Khong reported that 51 different species of fish had benefited from the establishment of FCZs, the most commonly reported ones being the carps, *Morulius* spp., following by the featherback, *Chitala blanci* (Aubenton), the seven-striped carp, *Probarbus jullieni* Sauvage, and the pangasid catfish, *Pangasius pleurotaenia* (Bleeker). Eighteen of the 51 species reported to have benefited were in the family Cyprinidae, followed by the family Pangasiidae (8 of 51) and Siluridae (7 of 51). In all, 15 families of fishes, as well as species of soft-shelled turtle, benefited from FCZs. Most of the species that benefited were relatively sedentary or only locally migratory species that inhabit deep-water areas during the dry season (Baird & Flaherty 2005). Even highly migratory fish species are likely to benefit from deep-water pools, if they are protected during particularly important or vulnerable parts of their life cycles (Baird, Flaherty & Phylavanh 2004; Baird & Flaherty 2005). Moreover, it is possible that the establishment of large numbers of FCZs in a particular river system, like the Mekong in Khong, could have synergistic effects, resulting in the scaling up of benefits through the protection of certain species that migrate to and from or through a number of FCZs. For example, migratory catfish like *Pangasius macronema* (Bleeker) rely on deep-water pools for critical protection during migrations up the mainstream Mekong River (Roberts & Baird 1995). These catfishes move upstream at night, while stopping to concentrate in deep-water pools during the day (Baird *et al.* 2001a).

Fishers in Khong use certain indicators like the surfacing of fish in deep-water areas to understand the dynamics of certain fish populations (Baird 2005a). The croaking of the smallscale croaker, *Boesemania microlepis* (Bleeker), when it spawns in deep-water pools during the dry season is an important indicator of the size of the population and of the sizes of fish in the area (Baird *et al.* 2001b; Baird 2005a). Villagers also observe fish species surfacing in deep-water pools to understand what large species are found there during the dry season (Baird 2005a).

Understanding the role of FCZs in the management of different species is still limited, but at least in Khong, a cooperative FCZ monitoring programme, although now discontinued, demonstrated that fishers have considerable potential for improving fisheries management when allowed to participate fully in the monitoring and management of FCZs (Baird 2001).

Deep-water pools just below the Khone Falls of the Mekong River in southern Laos

Deep-water pools in the mainstream Mekong River near Hang Khone village, Khong district, Champasak province provide a glimpse of how deep and shallow areas differ in terms of fishing. Fortunately, when monitoring fish catches at Hang Khone in the mid-1990s, data were collected from gillnets set deep to the bottom of deep-water areas, generally about 20 m deep. In Hang Khone, fishers rely on both deep-water gillnetting and surface gillnetting during the dry season, at which time they use 4–9 cm meshed monofilament nylon gillnets for both types of fishing. Between February and April 1994, 1997 and 1998, 150 deep-water fishing trips were compared with 218 surface fishing trips. Deep-water fishing catch-per-unit-effort levels (132–206 g set^{-1}) were much higher than for surface fishing (12–36 g set^{-1}), suggesting that fish are much more abundant in deep-water areas. Species composition also varied. Some species were not caught with surface gillnets, while others were caught in both. Many more species were caught in the deep-set gillnets.

Of the 30 species caught, 10 were found mainly in deep-water pools (i.e. *Pangasius conchophilus* Roberts & Vidthayanon, *Hemisilurus mekongensis* Bornbusch & Lundberg, *Hemipimelodus borneensis* (Bleeker), *Hemibargus wycki* (Bleeker), *Gyrinocheilus pennocki* (Fowler), *Morulius chrysophekadion* (Bleeker)/spp., *Cosmocheilus harmandi* Sauvage, *Arius stormii* (Bleeker), *Bagrichthys* spp. and *Pangasius bocourti* Sauvage).

The species found below the Khone Falls, which is a biogeographical barrier for some species of fish (Roberts 1993), include two of the 10 fish species mentioned above (*H. borneensis* and *A. stormii*). Apart from the species found only below the Khone Falls, all the species that preferred deep-water areas near Hang Khone were also reported by fishers throughout Khong to be beneficiaries of FCZs (Baird & Flaherty 2005); the fisher-managed FCZ monitoring programme in Khong also found, based on fishers' catches from near eight different FCZs, that most of the same species were common near deep-water FCZs (Baird 2001). They were also similar to the species reported as benefiting from deep-water pools by Poulsen *et al*. (2002).

Conclusions

Fish sanctuaries are not panaceas for all the problems facing inland fisheries, either in the Mekong River Basin or in other parts of the world, and not all fish sanctuaries will be appropriate based on social, institutional or ecological criteria. For example, Coates (2002) pointed out that the most important threats to Mekong fisheries come from outside the fisheries sector, especially habitat loss, particularly from large hydroelectric dam construction (IRN 1999). However, fish sanctuaries that are implemented with genuine community support, are coordinated and planned well, are in-tune with local ecological conditions, are appropriately scaled, and are designed to meet local conditions, can be useful for assisting in the management and protection of freshwater fish stocks in Laos and other countries in the Mekong River Basin, and the tropics in general. They can be important tools when implemented in the context of participatory community-based fisheries/co-management programmes. The key is full community participation, government support, and the recognition that there is not just one system that will work in all cases. In short, there is strength in maintaining diverse systems based on local conditions.

There was a time when many fisheries biologists and managers were quite skeptical of the value of establishing fish sanctuaries in rivers and streams in the Mekong River Basin (see Jensen 1999; Hirsch 2000), but there is now much greater support for these efforts, and for fishers' local ecological knowledge in general (see Valbo-Jorgensen & Poulsen 2000; Baird 2005a,b). The idea of fish sanctuaries in Laos and the Mekong River Basin is also gaining support because of increased biological evidence that fish congregate in deep-water areas during the dry season, and that certain fish species are attracted to particular habitat characteristics of different fish sanctuaries. The local ecological knowledge of fishers throughout Laos and the Mekong River Basin, including their knowledge of fish sanctuaries in deep-water areas, and the need to focus protection efforts on the dry season is also being increasingly accepted amongst fisheries researchers and practitioners in the region (see, for example, Poulsen *et al*. 2002; Baird 2005a). Fish sanctuaries represent but one of the tools available for improving management of inland fisheries in Laos and the Mekong River Basin more generally, but they have considerable potential for the future.

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