Food and Agriculture Organization of the United Nations

IUCN

Study Report:

Identification of spatial priorities for the re-opening of wetlands to maintain the water flow required for ecological functioning, biological connectivity and habitat maintenance.

Xe Champhone Ramsar Site, Lao PDR

CAWA Project, December 2017

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Contents

1. Introduction

Habitat or biological connectivity is critical for maintaining species movements, flow of resources and ecological functioning across landscapes (Noss, 1991). In aquatic systems, connectivity equates to the maintenance of water flow and connection between different 'patches' of water, and as such water or aquatic connectivity is vital for aquatic species to exist and move within the aquatic landscape (Bouvier and Boka 2009; Januchowski-Hartley et al., 2013). In wetland systems, dis-connectivity can occur for a number of reasons including via natural processes, such as seasonal hydrological changes that result in a disconnection between water bodies during dry periods, but also as a result of human-induced changes including water extraction and diversion, invasive plant growth and installation of dams and other water control infrastructure (Januchowski-Hartley et al., 2013; Perna et al 2012).

Xe Champhone wetland is located in Champhone District, Savannakhet Province in central Lao PDR. It is a complex wetland system composed of a diversity of habitat types including the Xe Champhone River, open floodplain wetlands, flood forest, oxbow lakes and a number of reservoirs and modified water bodies. The wetland system has a natural seasonal flooding and drying regime that reflects the extremes of the monsoonal climate and the distinct rainfall differences between the wet and dry seasons. It provides habitat for a range of aquatic vertebrate species such as the critically endangered Siamese crocodile (*Siamensis crocodylus*), many resident and migratory fish species, and a number of frog and turtle species including the endangered Asiatic soft shell turtle (*Amyda cartilaginea*) and the vulnerable Giant Asian Pond turtle (*Heosemys grandis*) (Claridge, 1996).

Many of these fauna species are known to undertake movements both on short and longer-term scales, such as short daily foraging movements between close proximity water bodies, but also longer seasonal breeding movements or migrations. For example, the Siamese crocodile and several migratory white fish species are known to move relatively long distances across a number of different habitat types and hydrological systems (Sokheng et al., 1999; Simpson et al., 2006b), resulting in a high dependence on aquatic system connectivity

There is also a high human population dependence on the Xe Champhone wetland for livelihoods and food security. As a result, a range of hydrological modifications exist throughout the wetland complex from small structures, such as micro-dams to increase household/village water holding capacity, up to large structures, such as weirs for controlling water levels in reservoirs. These infrastructure and modifications that block water flows to divert or hold water either seasonally or permanently contribute to reducing wetland connectivity and species movements

Two major invasive plant species are present in the wetland site, water hyacinth, *Eichhornia crassipes* and giant mimosa, *Mimosa pigra*. Mimosa is facilitated and spread through cultivation practices, thriving in disturbed soils and shallow water or wet soils typical of rice fields and along dikes, but also grows in natural wetland areas (Peh, 2010). Water hyacinth as a floating species spreads easily via flood waters, and can grow under a range of hydrological regimes from wet mud to deeper open water habitats. It occurs in both disturbed and undisturbed habitats and has the potential to reach undisturbed habitats during high water events. Both these species have reached levels of dense infestation in certain areas of Xe Champhone wetland (Claridge, 1996). Their direct impacts of displacing native vegetation and reducing water quality (Perna et al 2012) are exacerbated by their dense growth and capacity to trap and accumulate sediments effectively reducing water levels and increasing disconnection of wetland

areas. This reduces water flow connectivity restricting species movements on top of already natural limitations during dry periods. While the impacts of both species tend to be greatest during low water level periods, the dense and tall impenetrable thickets formed by, *M. pigra* (Heard and Paynter, 2009) are likely to restrict the movement of larger species at all times such as Siamese crocodile and large turtle species, i.e. *H. grandis and A. cartilaginea*.

The combined influence of invasive species impacts, infrastructure and other modifications at Xe Champhone wetland have resulted in overall reduced connectivity of wetland habitat impacting species movements, water flows and maintenance of ecological processes. This study aims to identify sites where significant 'disconnection' has occurred and re-opening management is required to improve wetland connectivity and habitat integrity. 'Re-opening' is defined as the action of re-instating or improving natural flow patterns. A range of activities to implement re-opening may be needed including invasive species management, removal of obstructions (infrastructure/dikes etc.) or improving species movements around obstacles, such as by installing fish ladders.

This study will identify and map priority sites for re-opening, identify causes and extent of disconnection at each site, outline management actions, feasibility and technical approaches to re-opening, as well as propose a work plan for on-ground implementation and recommendations for long-term sustainability of maintaining connectivity at these sites.

2. Methods

2.1 Process to identify sites and assess feasibility of management

The methodology for this study and identifying priority sites for re-opening involved several steps, including:

- Desktop research on past studies and re-opening management options
- Analysis of recent climate change vulnerability assessment data where impacts of invasive species and other habitat connectivity issues were reported. In respect to impacts of droughts and floods invasive species were often mentioned.
- Discussions with local government and other staff on past project/site knowledge, i.e. WCS projects.

  In September 2017, during the CAWA Provincial Project Committee meeting, small technical working group discussions were facilitated with one group focusing on the re-opening study. From these discussions a number of sites were identified for ground truthing and potential management including: Nong Mae Hang, Bak reservoir, Phai Jiew Reservoir, Kout Xelat Kadan, Kout Pheenoi.
- A Field mission was conducted in November 2017 to ground truth the sites identified from this process, and survey communities (see Annex 1 for questionnaire) in order to assess a number of key factors important to determining if management was appropriate and feasible.

  The survey incorporated questions on:

  - The cause and status of the disconnection
  - Size of management area
  - Site access and feasibility of management

- Community support for management
- Success of past management
- Responsibility for management
- Timing and frequency of management
- Recommended technical approaches to management

PoNRE, DoNRE and DAFO accompanied the mission and sites were visited with community members from Ban Kaengkok dong, Ban Kadan, Ban Tansoum, Ban Laohouakham, Ban Houamuang and Ban Phonkho-Taleo.

During the field visits, potential management sites were assessed and GPS locations taken to designate management area spatial attributes including dimensions (L x W) and area (ha). Photos of each site were taken and additional notes on management feasibility recorded. See Table 1 for schedule of the field mission

Table 1. Re-opening field mission schedule, Nov 2017

Date	Village	Site visited
22 Nov 2017	Ban Phonkho	Kout Khan
	Ban Kaengkok dong	Nong Mae Hang
	Ban Houamuang	Bak Reservoir FCZ
23 Nov 2017	Ban Kadan	Kout Xelat Kadan
	Ban Tansoum	Kout Pheenoi, Kout Makpheo
	Ban Tansoum, Ban Laohouakham	Phai Jiew Weir

The field notes and survey results were collated to form the basis of the results sections combined with additional knowledge from local government, IUCN team knowledge from past project experience and VA survey results. Spatial data was analyzed and maps of each site with the identified proposed management zones were created.

2.2 Gender Integration

On planning the field visit, requests and arrangements were made for both women and men to participate. The questionnaire developed included gender disaggregated questions to ensure a gender perspective, and both men and women were surveyed. However, more village men than women attended the field visits and were interviewed. This is something that will need to be addressed for future field visits. Conversely, DoNRE and DAFO staff attending were both women so overall field trip numbers and information gained were relatively equal for women and men. The management stage and consultation processes will ensure the knowledge and recommendations of both men and women are equally considered and every opportunity will be given for this to be facilitated.

3. Survey Results

Based on the VA survey and discussions with the villagers in Xe Champhone it was identified that the main causes of disconnection overall in the wetland areas is infestation by water hyacinth, *Eichhornia crassipes*, and Giant mimosa, *Mimosa pigra*. The invasive species are having a number of impacts in Xe Champhone Wetlands, which are also impacts well documented at other sites; including reducing general wetland connectivity, restricting species movements (Crocodile, fish and potentially turtles), encroaching on and closing wetland habitat and decreasing water quality and overall ecological functioning of the wetland system. Additional observed disconnection was caused by infrastructure; one site has been identified where interventions are required, and will be discussed in section 3.2.

3.1 Gender observations

In respect to issues of wetland connectivity and invasive species impacts, men and women were found to generally both report similar observations and recommendations. However, women were generally found to cite more issues in respect to water quality and where wetland food resources, such as plant species for consumption, were impacted. It is anticipated this is because women tend to collect more resources in shallow wetland areas (small fish, wetland plants etc.) where water hyacinth has the greatest impact, and men tend to fish in deeper areas such as the Xe Champhone River, where less impacts of water hyacinth may be apparent.

Table 2 below identifies the main ecological impacts of disconnection at each site with most sites experiencing a number of impacts. It also identifies where some effects on human livelihoods occur. Mimosa and water hyacinth are known to have a number of livelihood impacts including, restricting boat passage and access to fishing grounds, invading rice paddies, and/or causing entire loss of land for agricultural purposes. At the specific wetland sites identified for management in this study reduced fishing/ boat access was an impact identified by several villages.

Table 2. Main ecological and livelihood Impacts identified at the sites

Ecological Impacts	Village	Site
Fish migration restricted	Ban Tansoum	Phai Jiew Reservoir (weir)
	Ban Laohouakham	Phai Jiew Reservoir (weir)
	Ban Kadan	Kout Xelat Kadan oxbow
	Ban Kengkok dong	Nong Mae Hang oxbow
	Ban Phonkho/Ban Taleo	Koutkhan Oxbow
Crocodile movement and breeding restricted	Ban Kaengkok dong	Nong Mae Hang oxbow
	Ban Kadan	Kout Xelat Kadan
	Ban Tansoum	Kout Pheenoi oxbow
	Ban Phonkho/Ban Taleo	Koutkhan Oxbow
Closing/Loss of habitat	Ban Kadan	Kout Xelat Kadan oxbow
	Ban Hoamoung	Bak Reservoir
	Ban Kengkok dong	Nong Mae Hang oxbow

	Ban Phonkho/Ban Taleo	Koutkhan Oxbow
	Ban Tansoum	Kout Pheenoi oxbow
Reduced water flow/water quality	Ban Kadan	Kout Xelat Kadan
	Ban Phonkho/Ban Taleo	Koutkhan Oxbow
	Ban Kengkok dong	Nong Mae Hang oxbow
	Ban Hoamoung	Bak Reservoir
Livelihood impacts	**Village**	**Site**
Reduced fishing access/boat passage	Ban Kadan	Kout Xelat Kadan
	Ban Hoamoung	Bak Reservoir
	Ban Phonkho/Ban Taleo	Koutkhan Oxbow

Sites surveyed and identified for management are outlined below with details of, identified connectivity issue, management considerations and objectives/expected outcomes of management outlined.

Recommendations and technical guidelines to manage the causes of disconnection will be addressed in Section 4.

3.2 Site information & management considerations

Findings from background research, villager surveys and site field visits

Site 1: Bak Reservoir (Ban Hoamoung)

The Bak Reservoir fish conservation zone was designated in 2011. The protected area is 1000 metres by 700 metres, 65.56 hectares. Regulations state that within the boundaries, catching or hunting of any animals or blocking the flow of water is prohibited. This area is important for fish species such as Pa do (*Channa micropeltes*) and Pa Tong Dao (*Chitala ornata*).

Connectivity issue

Villagers indicate that dense patches of vegetation (several species) are impeding fish movements and free flow of water within the centre of the site during the dry season, as well as contributing to water quality issues and an increased closing of the open water area. While water depth along the perimeter of the conservation zone is ~3 metres, in the centre where the vegetation occurs it is shallower, around 1.5 metres, perhaps due to sediment accumulation exacerbating the issue.

A native species *Polygonum tomentosum*, has recently expanded and is currently the main species of concern identified by communities, in a particular area of the FCZ, close to the village and dam weir. The reason for its expansion could be due to an extended dry period prior to 2017, as it prefers shallow water areas, and changed hydrology may be contributing to altered growth patterns (Haroon and Hussain, 2017). This species while native can become dense under certain conditions. While normally a native species wouldn't be targeted for removal, the concerns from the villagers deem it a priority to address.

Management considerations

Past management

There has been no past management of the species at this site.

Future management

Local villagers interviewed recommend that patches of Polygonum be assessed for management, with a focus on a ~60 by 100 metre area close to the dam on the northern side, the total area is 0.66 hectares (Figure 1). Feasibility of management is high, with good access to the site for removal and local villagers expressing a willingness to help with the removal of the plants. This will be treated as a small pilot management site initially, as it is a native species and its response needs to be monitored carefully.

Objectives/Expected outcomes of re-opening management

Objectives are to, while maintaining a good coverage of native vegetation as fish habitat, to improve and maintain open water connectivity and maximum fish passage.

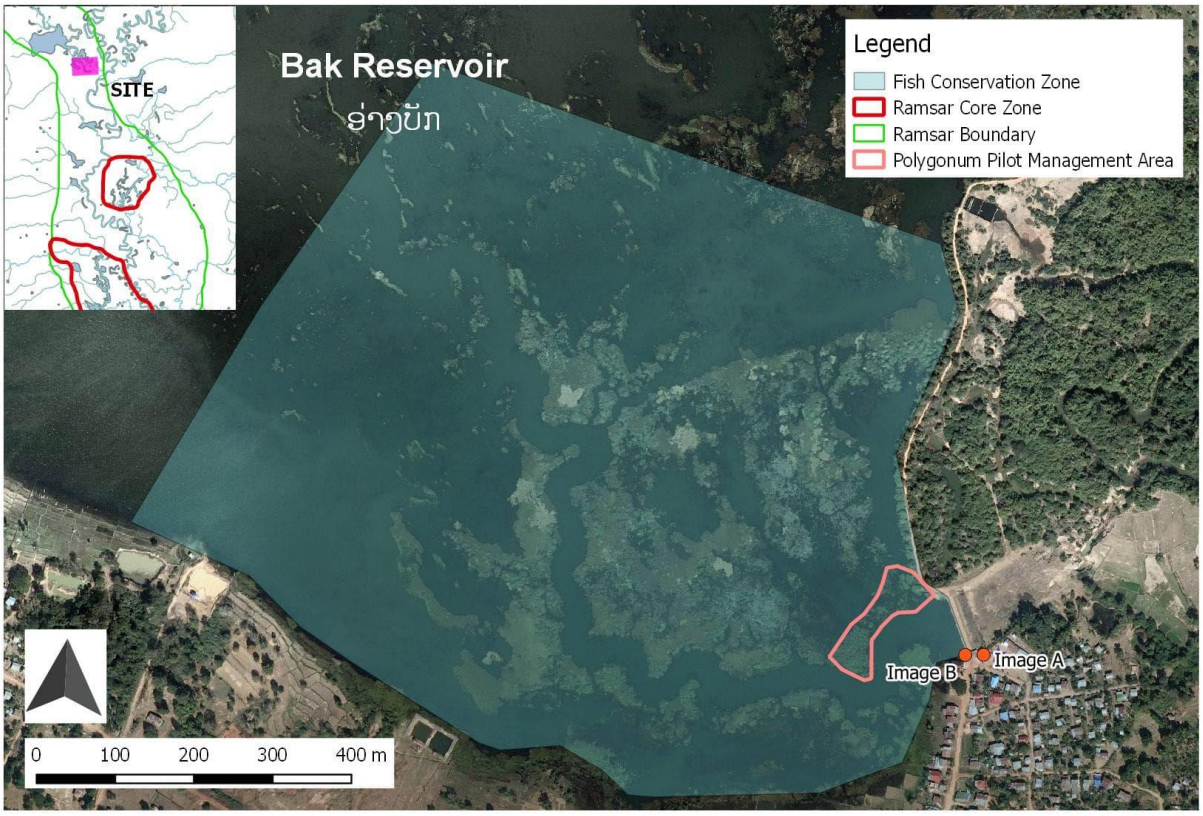

Figure 1. Site 1. Bak Reservoir - Fish Conservation Zone

Image A. Looking over the reservoir, northwest towards the Polygonum

Image B. View of the central area of the Polygonum in the reservoir

Site 2: Nong Mae Hang oxbow (Ban Kaengkok dong)

The Nong Mae Hang oxbow is a designated Crocodile Conservation Zone and approximately 8.26 hectares in size. A crocodile was recently sighted here by villagers in August 2017. Nong Mae Hang is also known as an important habitat area and spawning ground for fish, including, species such as Pa do

(*C. micropeltes*) and Pa Tong Dao (*C. ornata*), though these species have now declined. The oxbow is part of a significant thoroughfare and migration route connecting to the Xe Champhone River and Nongkan during the rainy season. The lake is also spiritually significant and there is a strong taboo against anyone fishing in the lake.

Connectivity issue

The site is densely covered by water hyacinth, and used to be largely open water. Villagers have observed reduced abundance of fish in June and July compared to the past, with fish movement restricted during the dry season. A local village woman interviewed believes water levels in the oxbow are lower due to sediment being trapped and the decomposition and build-up of water hyacinth plants. During the dry season the water depth is approximately 2 metres, while in previous years it was reported to be considerably deeper.

Management considerations

Past management

In 2010, the Wildlife Conservation Society (WCS Laos), Crocodile Conservation project coordinated the removal of water hyacinth from adjacent wetland area Nongkan (see title page image). Water hyacinth was removed with support by villagers and some transported to rice paddies to be used as compost once it had decomposed. This was repeated in June 2017 under the CAWA project. The water hyacinth was again used as compost/ fertilizer in Kaengkok dong by some villagers. A woman who was interviewed, Ms. Saisamon, successfully uses the fertilizer for a large cucumber plot and has seen an increase in productivity and economic benefit.

Future management

The proposed area of management of water hyacinth in Nong Meu Hang is ~200 metres by 70 metres, with a total area of 1.4 hectares. The feasibility of management of the site is high; the site is easily accessible by the local villagers who are willing to aid in the removal of the plant. The villagers have previously asked DoNRE for help in clearance of Nong Mae Hang. It is recommended that a first major clearance be carried out during the March-April period before rice planting season, when villagers have time and so fertilizer can also be used for the coming cultivation season. The villagers indicated they could then undertake ongoing clearance once a month. The site has good village support and awareness of benefits of management and application for fertilizer, i.e. incentive for management.

Objectives/Expected outcomes of management

With the site having spiritual significance and strong taboos on fishing, it essentially acts as a fish conservation zone and as such it is important to capitalize on this current protection by implementing additional management to improve ecological functioning of the system. Water hyacinth management is expected to significantly ‘open up’ and improve quality of habitat and passage for fish, as well as Siamese crocodiles, due to its good connection with the Xe Champhone River, during the wet season.

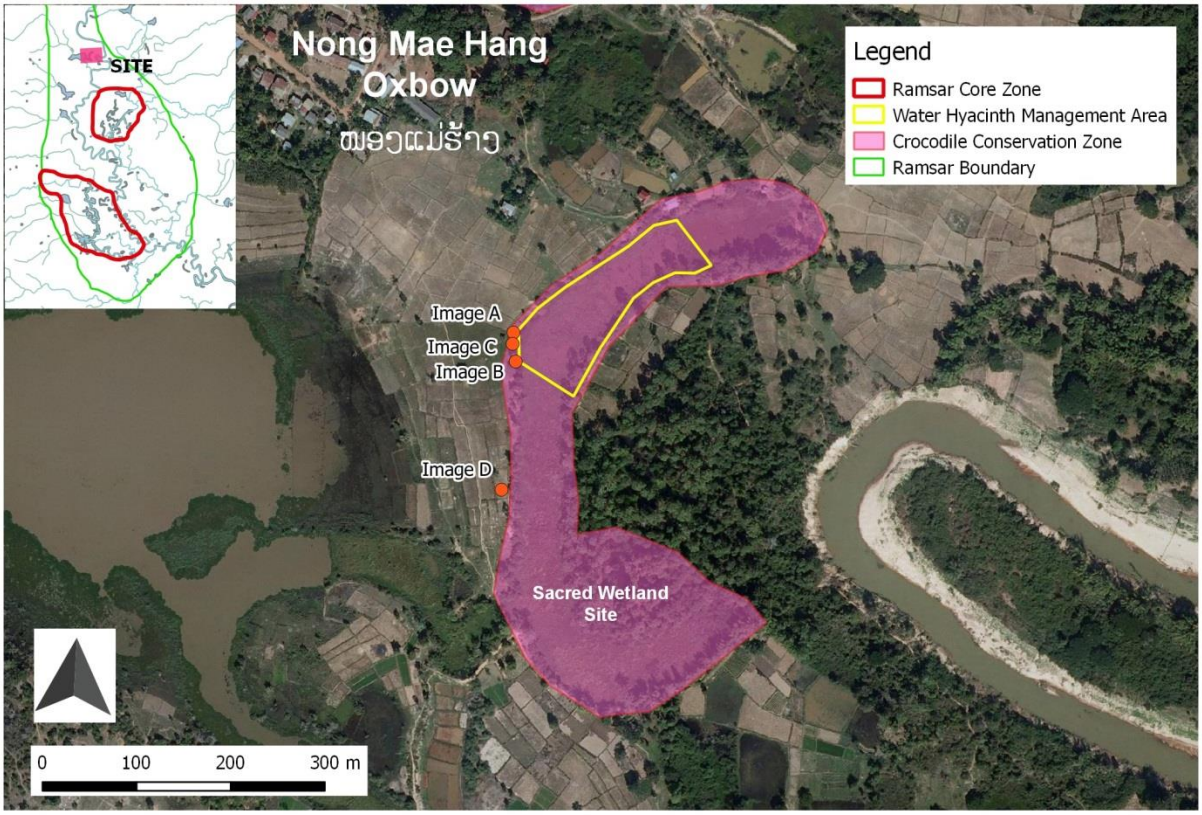

Figure 2. Site 2. Nong Mae Hang Oxbow – Crocodile Conservation Zone

Image A. Northeast view of the water hyacinth infestation

Image B. South facing view of the water hyacinth infestation

Image C. The width of the management area is approximately 75 metres

Image D. Decomposed water hyacinth has been used as fertilizer for vegetables

Site 3: Kout Xelat Kadan oxbow (Ban Kadan)

Kout Xelat Kadan oxbow is an important habitat for the Siamese Crocodile, as well as turtles (H. grandis/Tao Houa kway and *Malayemys subtrijuga*/Toa Sam San) and a number of key fish species. This oxbow has a spiritual taboo against fishing, and only small lines may be used to fish, nets are not permitted. The Crocodile Conservation Zone at this site is approximately 12.6 hectares.

Connectivity issue

The Kout Xelat Kadan oxbow has dense areas of water hyacinth and smaller but significant areas of Mimosa pigra. Villagers interviewed noted that there is a significant loss of wetland habitat in the oxbow during the dry season, restricted fish movement, and increased stress levels on fish due to poor water quality and low oxygen levels, which are all well documented impacts of water hyacinth (Perna et al., 2012). Villagers believe that decomposition of the water hyacinth has also caused a buildup of organic material, which is contributing to the lower water levels of the oxbow. Oxbow connectivity is notably worse at the end of dry season in April and May. Increased irrigation from Kout Xelat Kadan during the dry season appears to be exacerbating the issue.

Management consideration

Past management

Past management of the site was done by the WCS in 2010, with the Crocodile Conservation project aiming to re-open the links between waterways to facilitate crocodile migration. However the water hyacinth has since returned, continuing to have a negative impact on habitat and Siamese crocodile breeding.

Future management

The first area identified for management covers ~150 metres by 50 metres, 0.83 hectares, the second is approximately 200 metres by 50 metres, 1.11 hectares. Dry season water depth is approximately 3 metres at both sites. The area for *Mimosa pigra* management is approximately 0.47 hectares. The site is

easily accessible for management; the villagers come to the area daily to tend to the rice fields. Because of this, the feasibility for site management is also high, and the villagers are willing to clear the site and use the water hyacinth for fertilizer on the rice fields.

Both the men and women villagers interviewed spoke of their irrigation practices; in the past few years there has been an observable decrease in water levels due to irrigation, however, they have recently reduced their use and have seen levels stabilize.

February and March were identified as the best time for removal by Ban Kadan villagers so that it is carried out before the start of the rice planting season. They recommend that the water hyacinth removal be done once a month to ensure it is properly maintained. For mimosa control in rice fields, villagers often use a mechanical line trimmer to cut stems in May, just before the wet season to allow complete submergence of plants for an extended period. This technique has been used effectively and villagers indicate that after two years of treatment mimosa plants can be killed.

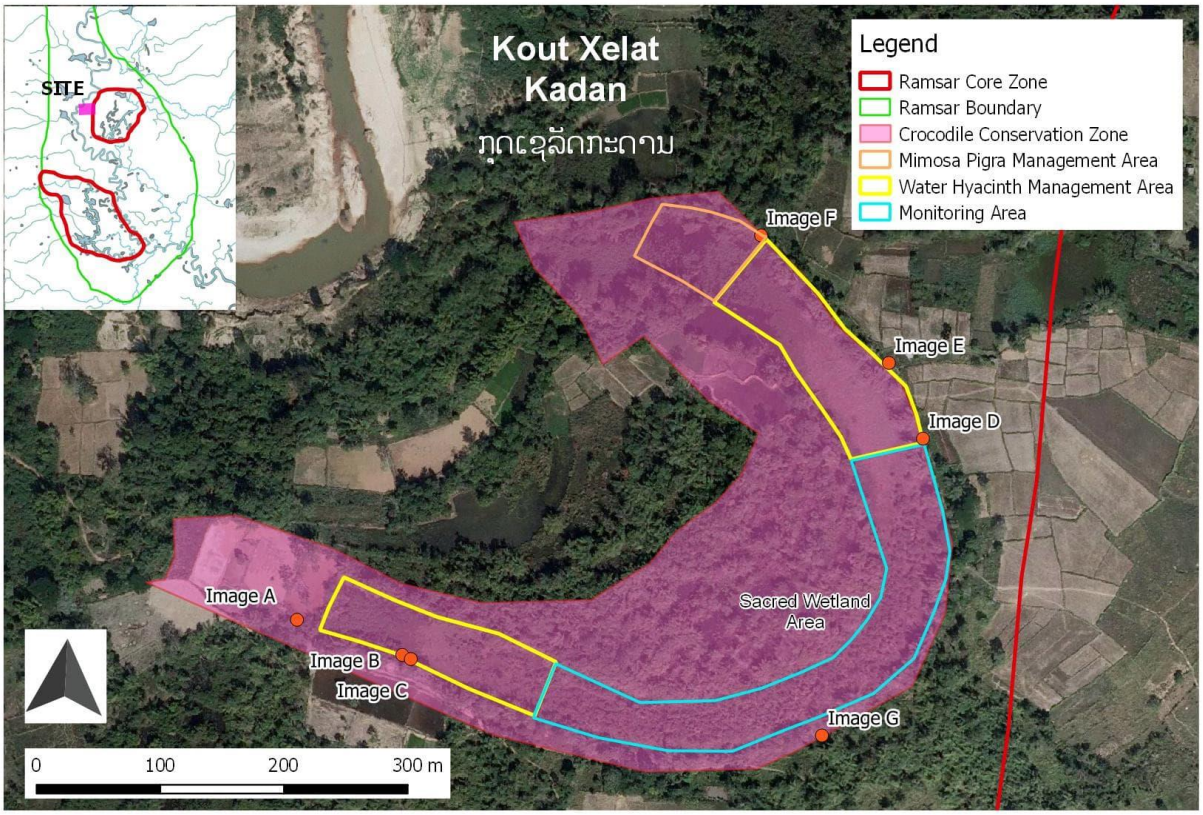

Figure 3. Site 3 Kout Xelat Kadan - Crocodile Conservation Zone

Image A. Regulation sign, with penalties for capturing crocodiles

Image B. The first management area, approximately 150 m by 50 m

Image C. Northeast view of the first management area of the water hyacinth infestation

Image D. Start of the second management area

Image E. The second management area is approximately 200 m by 50 m

Image F. Recommended are for Mimosa pigra removal at the second management site

Site 4: Kout Pheenoi & Kout Makpheo oxbows (Ban Tansoum)

Kout Pheenoi and Kout Makpheo are both crocodile conservation zones covering 7.81 and 17.78 hectares respectively, which have previously been managed under the WCS Siamese crocodile project. The oxbows provide important habitat for the Siamese crocodile and Giant Asian Pond turtle (*H. grandis*). There is a natural connection between these oxbows in the wet season but they are isolated in the dry season.

Kout Pheenoi

Kout Pheenoi is the smaller of the two oxbows. It is approximately 700 metres by 50 metres and in the dry season, the depth is between 2.5 and 3 metres at its deepest point.

Connectivity issue

Mimosa pigra has been growing along the edge of Kout Pheenoi and is now spreading into the oxbow. It is of major concern as the mimosa infestation is now encroaching on crocodile habitat and may be restricting crocodile movement within and between oxbows and Phai Jiew.

Management Considerations

Past management

Although no mimosa control has yet been undertaken in Kout Pheenoi, WCS undertook a water hyacinth control program in 2010. Results were promising and villagers cited seeing an increased number of young crocodiles after control. The management seems to have been relatively effective and no water hyacinth could be sighted during the field visit (further access visit may be required). As a result, villagers now better understand the need for crocodile conservation and they hope Mimosa management will further benefit crocodile populations in the area. Villagers are quite knowledgeable on Mimosa and are aware that its seed is easily spread by wind, and spread to new locations by water buffalo and other animals.

Future Management

The main area of Mimosa identified for management is approximately 100 metres by 30 metres, 0.32 hectares. Similar to Ban Kadan, villagers recommended using the same 'cut and flood' method in May or early June, which they currently use in rice fields, and also noted the possibility of successful control after 2-3 seasons. The site is easily accessible and the villagers have expressed their willingness to work on the removal of this species.

Objective/Expected outcomes of management

The expected outcomes of management are to increase the habitat area within Kout Pheenoi and the mobility of crocodiles and other significant species, such as large turtles both within and between Kout Pheenoi.

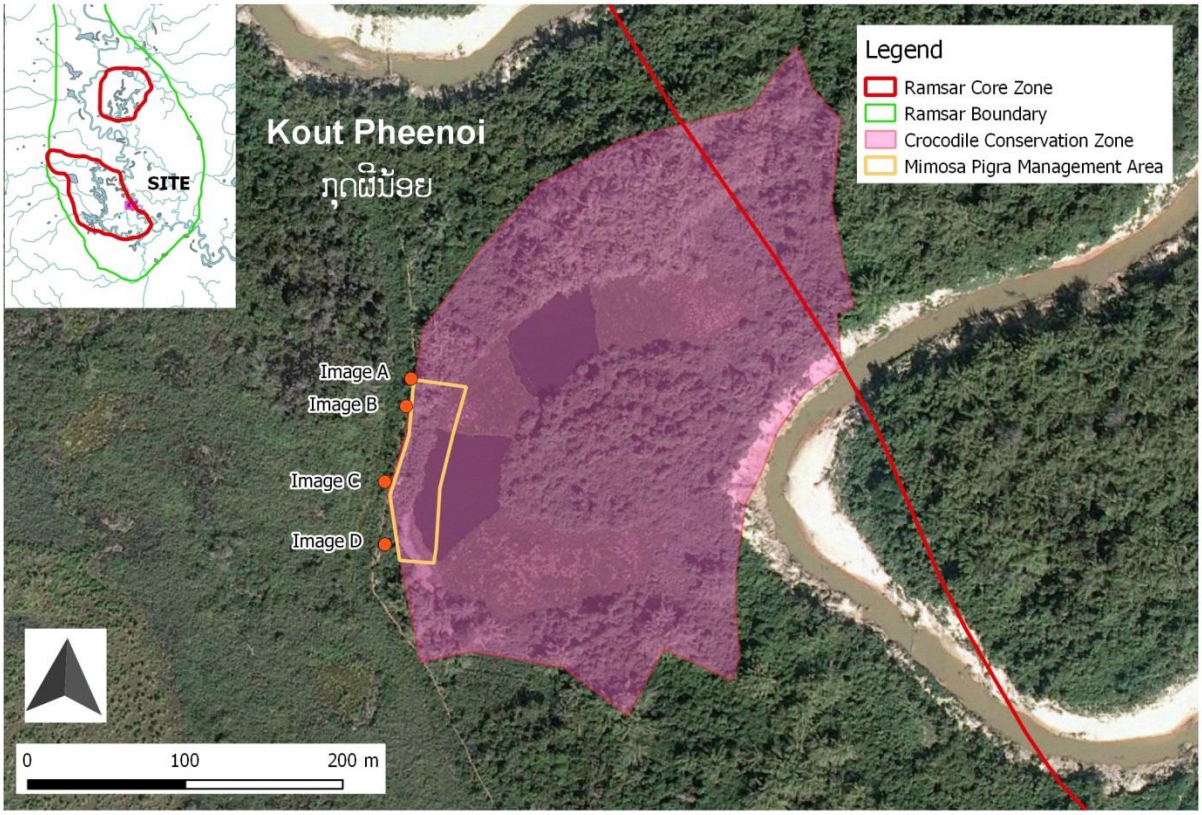

Figure 4. Site 4 Kout Pheenoi - Crocodile Conservation Zone

Image A. Regulation sign with penalties for capturing crocodiles

Image B. The management area is approximately 100 m by 30 m

Image C. *Mimosa pigra* along the edge of the management area

Image D. The spread of *Mimosa pigra* into the oxbow

Kout Makpheo

Water hyacinth control was undertaken in Kout Makpheo by WCS in 2010. From the recent field visit water hyacinth does not appear to have returned as a significant issue at this site, however the site is quite inaccessible and only a small area could be sighted. A future survey, potentially using the CAWA survey drone would be helpful here to confirm the invasive species status. This should also be conducted for Kout Pheenoi, while being more accessible, still much of the oxbow could not be sighted. The initial proposed management for Kout Makpheo is designated as 'monitoring' to assess any change to the situation, (monitoring program is outlined in section 4) at which stage a management plan will be developed.

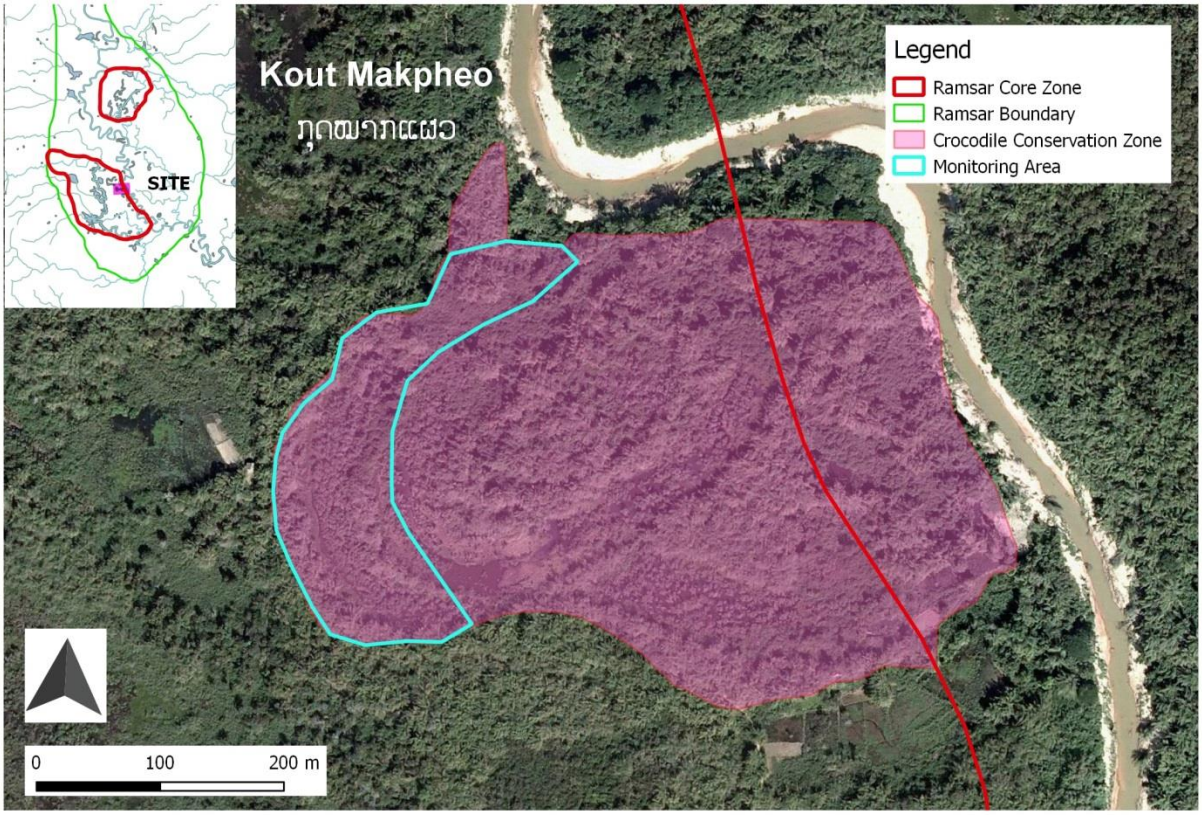

Figure 5. Site 4 Kout Makpheo - Monitoring Area

Site 5: Phai Jiew Weir (Ban Tansoum & Ban Laohouakam)

Phai Jiew dam and Weir was constructed around 1997 to create a reservoir for water storage to support irrigation in the area. The weir outflow point connects via a stream to the Xe Champhone River.

Connectivity Issue

During June and July, when water is flowing out of the reservoir, fish have been observed by villagers attempting to jump up the weir from the downstream side. The dam and weir appears to be causing disconnection of fish passage, such that the strong water flows during these months inhibit fish from moving over the weir to spawning sites.

Considerations for management

Past management

Following construction of the weir no management to assist fish passage has been undertaken

Future management

A fish way is recommended to aid in fish passage particularly during the early wet season. This will require further investigations in regards to developing fish way designs, planning proposals and confirming funding and feasibility. There is good access to the site for construction purposes, and strong support from local villagers and government DAFO & DoNRE for the project.

Objective/Expected outcomes of management

Following installation of a fish ladder and increased connectivity, passage of migratory fish is expected to be enhanced, which could lead to increased fish breeding rates and populations within the reservoir and will also generally support natural migratory and ecosystem processes.

Figure 6. Site 5 Phai Jiew Weir

Image A. The dam blocking fish migration

Image B. Proposed area of the dam for the fish ladder

Image C. Edge of the Phai Jiew Reservoir

Site 6: Kout Khan oxbows (Ban Phonkho-Taleo)

The Kout Khan oxbow complex is located approximately 3.5 km from the villages of Phonkho and Taleo. It incorporates the Kout Khan Crocodile Conservation Zone (28.57 hectares) as well as the recently established Vang Kout Khan Fish Conservation Zone (1.93 hectares). The oxbow areas provide habitat for many fish species as well several turtle species.

Connectivity Issue

Both mimosa and water hyacinth are present, but water hyacinth currently poses the biggest threat to connectivity. Over the past 4 to 5 years villagers have observed an overall increase of water hyacinth in Kout Khan.

Villagers cited the main impact the species is having is to increasingly disconnect an already narrow channel in the southern oxbow section in an area known locally as Nongpasewbin. As seen in image c. the water hyacinth is encroaching on the central area of the channel, potentially restricting crocodile and fish passage during low water periods when the channel becomes quite narrow. Villagers report that connectivity of the oxbow with surrounding water bodies decreases towards the end of the dry season, and that increasing sedimentation, exacerbated by water hyacinth, is also an issue creating shallow areas across the oxbow. A female villager, Ms. Toukvilay noted that in the past morning glory (a subsistence native vegetable) was in much higher abundance along the edges of the oxbow, but water hyacinth has since displaced it, decreasing its availability.

Another area of dense infestation is in the northern section of Kout Khan, located approximately 330m from Kout Khan South (Figure 7). Here water hyacinth spreads across the whole width of the oxbow, causing almost a complete closing of the habitat, and likely restricting movements of fish, and crocodiles if they are still present at all in this area (O. Thongsavath pers.com).

Management considerations

Past management

Past and current management of the site has only been to remove water hyacinth and mimosa from rice fields.

Future management

Water hyacinth occurs throughout the Kout Khan oxbow but 2 main areas of highest density and impact have been identified (Figure 7) – Southern area - Nongpasewbin (Kout Khan 1) and Northern area (Kout Khan 2).

In Kout Khan 1, the dense coverage through the narrow section of the Crocodile Conservation Zone is approximately 30 metres in width by 300 metres in length, covering an area of 0.83 hectares. Water depth in the middle is estimated to be 2.5 metres. Management of the area would be dependent on seasonal variations of water levels. Although the physical removal of water hyacinth is easier in the rainy season, the area surrounding Kout Kan is flooded and not accessible. The villagers cited that near the end of the dry season, March and April is the best time to access Kout Khan for water hyacinth removal. Access to the site and feasibility for management is high; Local villagers have expressed that they are willing to work on the removal process. Small patches of mimosa are also found on the edges of the Kout Khan 1 site and should be considered for management at the same time to avoid further infestation.

For the northern oxbow area (Kout Khan 2, 1.10 hectares), although it wasn't possible to access the site and see the full extent of the infestation on the ground, water hyacinth is clearly very dense in this area. This site is still a priority for management but further survey investigations are needed (i.e. potentially by CAWA drone) and as such the first site for priority control will be Kout khan 1.

Objectives/Expected outcomes of management

Objectives of management are to see improved connectivity between different areas of the oxbow and opening up of habitat, as well as improved passage for crocodiles and migratory fish, with both crocodile conservation zones and fish conservation zones present within the oxbow, it makes it a priority site to improve habitat and connectivity.

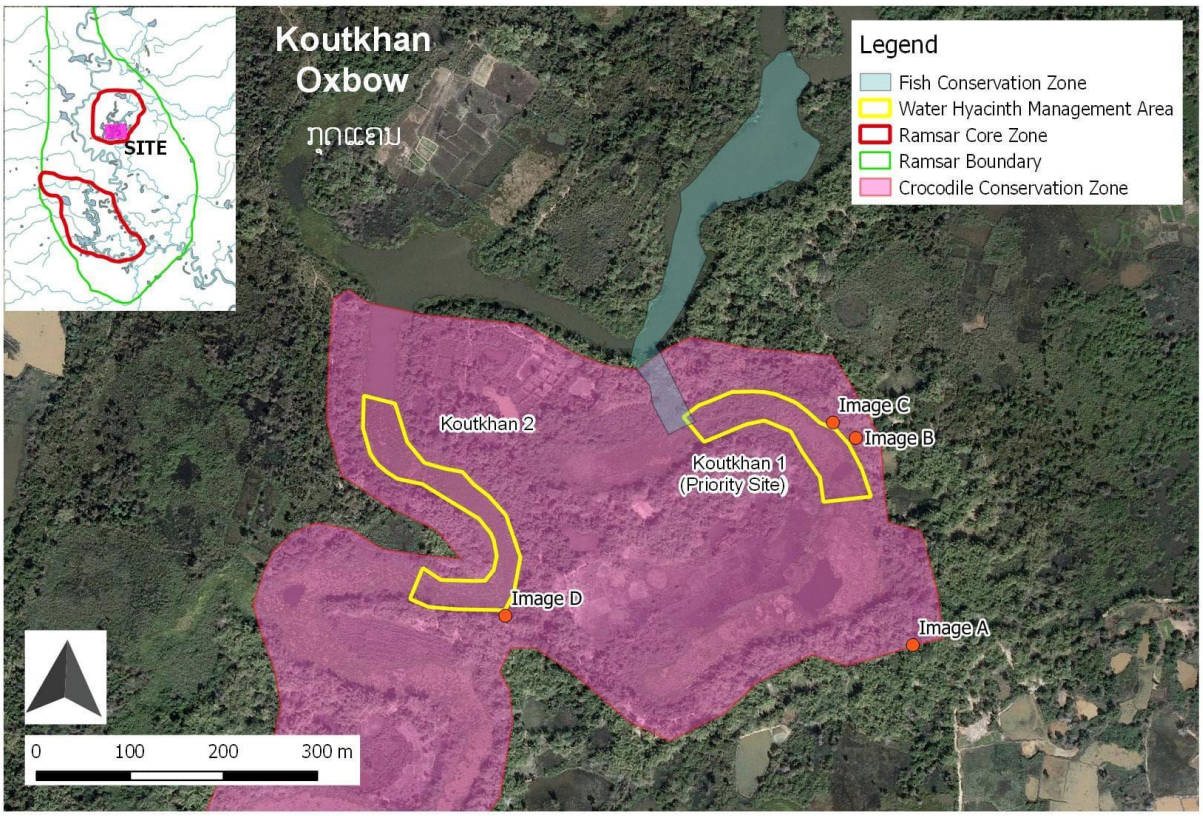

Figure 7. Site 6 Kout Khan Oxbow - Crocodile Conservation Zone

Image A. Regulation sign with penalties for capturing crocodiles

Image B. South-facing view of the narrow channel at Kout Khan 1

Image C. The management area of Kout Khan 1 is approximately 300 m by 30 m

Image D. Dense water hyacinth covers the Kout Khan 2 oxbow

4. Management recommendations

This study has identified several priority areas within the Xe Champhone Ramsar Site for re-opening works that are experiencing reduced connectivity as a result of invasive species, *Mimosa pigra* and water hyacinth, *Eichhornia crassipes*, as well as infrastructure obstruction (Phai Jiew weir). It is recommended that further assessments be undertaken on the hydrology and infrastructure of the wetland area to confirm any other potential sites with connectivity issues.

With respect to how this study relates to other weed management works/strategies in Xe Champhone, due to the widespread nature of both serious invasive species, a weed management strategy at this stage of infestation should be an 'asset protection' approach (Downey, et al., 2011). The management recommendations put forward for this study fit with this approach in that management is targeting selected high priority sites due to their significant ecological assets specifically for targeted re-opening works and not eradication or any other broader weed management objective.

Feasibilities, costs of management and practicalities for long-term sustainability, deems that smaller priority management areas within each larger site have been identified for re-opening management, in consultation with community (as identified in previous section).

Six sites, encompassing 8 designated management areas or zones, and 2 monitoring areas, have been proposed for management, based on these sites having both high priority ecological (and cultural) values as well as an assessed high feasibility and sustainability of management. This is due to both, outcomes of survey results, but also as a result of several of the villages having previously worked on similar projects and known to be committed to conservation objectives.

Table 3 below specifies these 10 areas including the site, name and size of individual management areas (ha) and re-opening management required.

Table 3. Recommended management zone areas

Site	No. management areas	Management area ID	Management area size (ha)	Re-opening management required
Bak Reservoir Fish conservation zone	1	Bak FCZ	0.60	Polygonum clearance (pilot site)
Nong Mae Hang (Crocodile conservation zone)	1	Nong Mae Hang	1.40	Water hyacinth removal
Kout Khan (Crocodile CZ; Fish CZ)	2	Kout Khan 1	0.83 0.10	Water hyacinth removal Mimosa control.
		Kout Khan 2	1.10	Water hyacinth removal
Kout Xelat Kadan (Crocodile conservation zone)	3	Xelat Kadan 1	0.84	Water hyacinth removal
		Xelat Kadan 2	1.11 0.47	Water hyacinth removal Mimosa control
		Xelat Kadan 3	2.07	Monitoring (WH/MP)
Phai Jiew Weir	1	Phai Jiew fish ladder	N/A	Fish ladder installation
Kout Pheenoi (Crocodile conservation zone)	1	Kout Pheenoi	0.32	Mimosa control
Kout Makpheo (Crocodile conservation zone)	1	Kout Makpheo	3.07	Monitoring (WH/MP)

Following designation of the individual management areas at each site, the best practice technical guidelines of re-opening management have been identified, together with a work plan of management, including priorities, timing, frequency, and responsibility for management and monitoring (Table 4). Following on from this the proposed working arrangements/agreements that will be organized with communities to ensure continuity and sustainability of management in the longer-term will be addressed.

4.1 Technical guidelines for re-opening management and monitoring

4.1.1. Water hyacinth (*Eichhornia crassipes*)

Recommended Control techniques

For control of water hyacinth, as a free floating species, all villagers surveyed indicated that manual control by hand removal is the preferred control method and the one used for its removal in rice paddies. Villagers at Ban Taleo-Phonkho and Ban Kadan indicated that, men often work in the deeper water areas and women near the edge to pull up and remove the plants. It is anticipated this will be the best technique to recommend for water hyacinth control in this program as villagers are familiar with

the technique and it is shown to be effective if repeated regularly. Manual control is a widely used method (Mallya et al., 2001). Because the goal of control is to open up areas and reduce the impact of water hyacinth, but not to entirely remove it, i.e. this is unrealistic as it is an easily spread species by flood waters, it is not critical and impossible for every plant to be removed, but should be the aim to remove as much of the infestation as possible.

Biological Control has shown to be a very effective in controlling water hyacinth in a number of countries using the two weevil beetles, *Neochetina bruchi* and *N. eichhorniae*, including in nearby Thailand (CSIRO 2017). This will be investigated as a *possible l*ong term strategy. There are normally many logistical/quarantine constraints and impacts to be assessed when looking at biological control agents, but preliminary investigations will be undertaken.

Timing of control

Villagers surveyed indicated that their preferred time for undertaking water hyacinth control was in March-April as it was a period when water levels are lower and seasonally it's a time when they have less labour demands and more free time to devote to other work, i.e. in between rice harvests. For water hyacinth the timing of control is not critical, and it really can be undertaken at any time of year with similar effectiveness. Villagers indicate though that it's easier to control when there is some water depth to aid its removal, and depends on the permanency of sites.

Schedule of control

For each management zone/area of water hyacinth identified an 'initial' removal event has been scheduled (Table 4). This is to remove the bulk of the infestation and it can be conducted over a several week period if necessary. It is anticipated that this would be a whole village activity or to be undertaken in teams and shifts as organized for water hyacinth removal from Kout Kan, by Ban Kaengkok dong (O.Thongsavath pers. com).

Once this initial removal is undertaken frequent follow up clearance will be needed to prevent the density of the infestation returning, but should involve only minimal effort if undertaken regularly. Villagers from all villages identified that this follow-up assessment and control should occur once a month as an ongoing program and this frequency is recommended.

4.1.2. Giant mimosa (*Mimosa pigra)*

Recommended control techniques

The recommended technique for controlling adult plants of *Mimosa pigra* in wetlands is to cut stems of mimosa to the ground, or as close as possible, immediately prior to commencement of the wet season or as water levels are rising (Hout, 2014; Nguyen et al., 2007). Incoming flood waters then inundate the cut stems for an extended period preventing re-growth and the plant can be killed or severely reduced in vigor. As identified, villagers already use this technique effectively in rice fields, and indicate that if this method is repeated over a 2-3 year consecutive period plants are usually killed. It has also been demonstrated as an effective method during a pilot management site set up by FAO in the village of Ban Laonat (Bouan et al 2017).

In addition to use of this technique for larger plants, smaller germinants and seedlings can be controlled by hand removal (DLRM 2013). Seed banks of Mimosa pigra can remain viable for more than 10 years (Lukitsch & Elliot, 2012) so seed germination can continue long after adult stands have died, and

monitoring for germinants needs to be continued. Burning should not be used as a method of control, because as a leguminous species, fire promotes seed germination (DLRM 2013; Nguyen et al., 2007).

Timing of control

The timing for most effective control of adult mimosa plants, using the 'cut and flood' method, should be undertaken in May-June just prior to the wet season commencing and water levels rising. Hand pulling of juveniles can be done at any time, but germination is most vigorous after flood waters have receded, and seeds germinate in the wet sediments. High densities of seedlings were observed in several areas in November 2017. Seedling areas for control should be identified as part of the monitoring program (discussed below).

Schedule of control

Control of adult plants should be undertaken consecutively over a two year period, at which time the site will move into the monitoring phase, i.e. if no regrowth is identified at the monitoring event 6 months after the second control year. If re-growth is detected a third year of management should be undertaken. Monitoring for seedling germination is to be on-going.

4.1.3. Polygonum management (pilot)

Polygonum tomentosum is a native species, and as such management needs to be carefully monitored. Only small areas of removal within the 0.6 hectare area demarcated are recommended initially. Polygonum is a rooted aquatic species but removal by hand from boat is indicated as a potentially effective method to remove the entire plant (O.Thongsavath pers. com). Trials will be conducted as a first phase of the pilot in April 2018.

4.1.4. Fishway - Phai Jiew Weir

The lifecycle of many fish includes a migratory cycle in which they move throughout several types of water bodies. As fish migrate upstream they encounter natural (e.g. a waterfall) or man-made (e.g. a dam, weir, or culvert) obstructions, which can slow or stop the migration process (Katopodis, 1992). Fish passes are designed to help fish overcome these obstacles; they become key elements for reproductive success for fish returning to their spawning grounds (FAO/DVWK, 2002). It is an ongoing challenge to design a single fishway that provides passage for all migratory species and life stages over varying hydrological changes (Godinho and Kynard, 2009). The Phai Jiew reservoir has a small-medium weir, approximately 10 to 15 metres in height. It has been observed by local villagers that during the rainy season the strong downstream flows are impeding fish migration over the weir and into Phai Jiew.

Assessing & designing fishways

To implement an appropriate fishway or fish ladder, local fish ecology and hydrology must be taken into account. Attracting fish to the entrance through appropriate water velocities is critical and depends on species behavior and motivation (Katopodis, 1992). The passage way will depend on the size of target species. The species known to attempt migration past the Phai Jiew Reservoir include *Chitala sp./ Pa* Tong kai*, Tricropodus trichopterus/*Pa ka deut*, Hypsibarbus sp.*/Pa ka bok and *Anabas testudineus*/ Pa kheng. Further assessment of the species attempting to pass through will need to be done to understand what hydrological preferences they have. A literature review of prior fish passage projects and discussion with experts can provide an idea of which type of passage should be used for Phai Jiew.

Feasibility of fishway designs

Several types of fish passage may be feasible for the Phai Jiew Reservoir:

Pool fishways are often inexpensive, consisting of a number of pools arranged in a stepped pattern. They are easy to construct, but can be sensitive to fluctuating water levels. The water level drop between pools is 200mm for adult freshwater fish (Katopodis, 2012). A similar design**, *vertical slot fishways*** (figure 8) maintain water velocities throughout the slots and can handle large variations in water levels (Katopodis, 2012), this could be advantageous for uncertain future hydrological conditions.

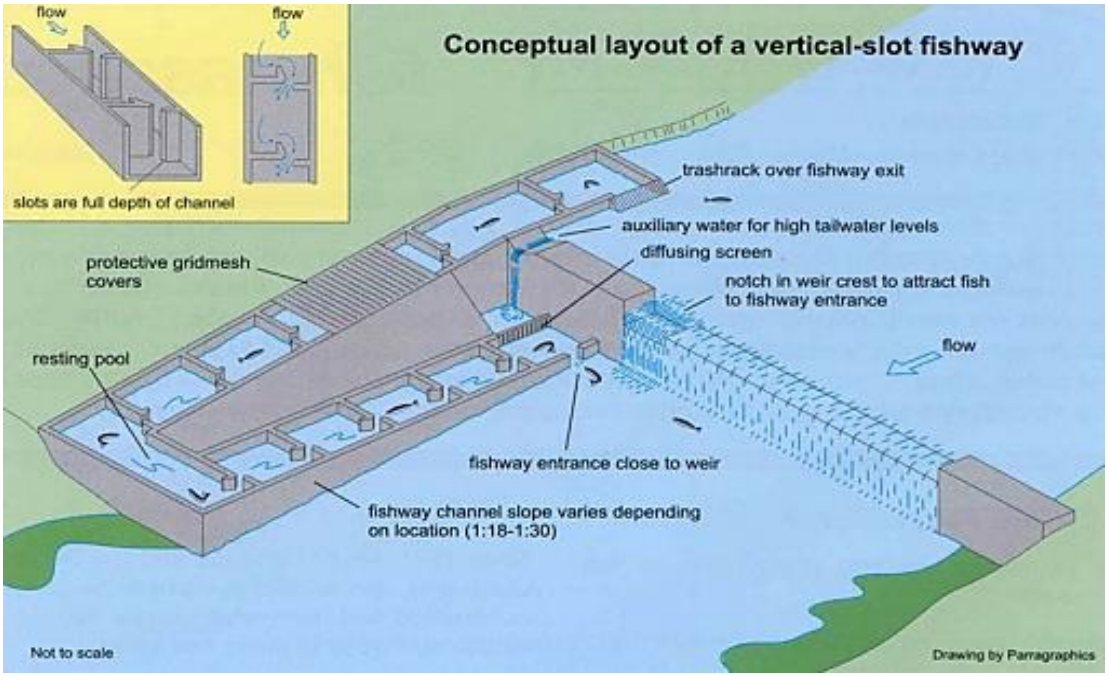

Figure 8: NSW Government, n.d. Pool-type fishway (vertical-slot)

Cone fish-ways are a pre-cast concrete structure designed to allow a broad size range of fish. The cone shaped baffles making up a series of ridges through which fish pass, they are designed to have conservative hydraulics (low velocities & turbulence levels). These fish-ways are most useful where there is limited headwater variation and relatively low (<1.5 m) head differential. This is the fish-way design constructed at Souy Weir and as it's already a design previously identified as feasible for the XCP site, it may be a possible option. However, the Phai Jiew context, particularly height differences, will need to be further assessed.

Figure 9: Cone design fish-way, Souy Weir (photo taken shortly after public opening) (A. O'Brien)

Rock ramp fishways are a low-cost solution that mimics natural structures. Construction can be done using local materials such as rocks or logs (Thorncraft and Harris, 1996).

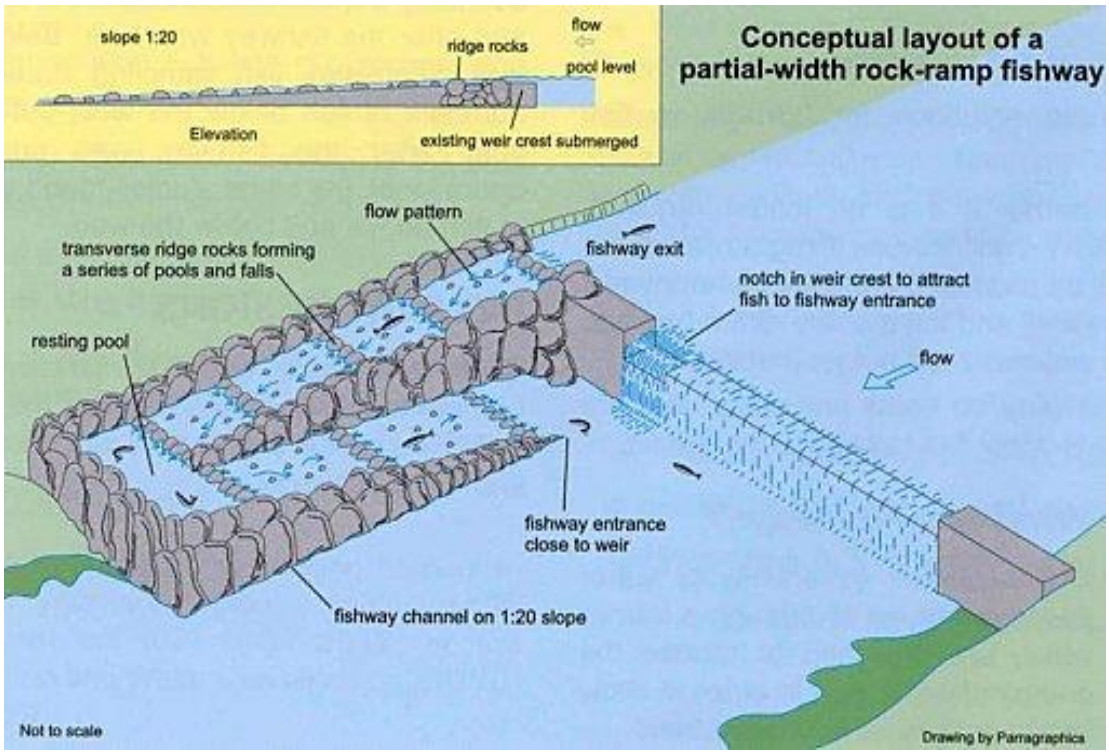

Figure 10: NSW Government, n.d. Rock Ramp fishway concept

Example of a Fish-way implementation process: Pak Peung Wetland fishway

Lessons of small fishway infrastructure implementation can be taken from the research done for the Pak Peung wetland area in Bolikamaxay Province, Lao PDR in 2008-2009. Similar to Phai Jiew, a 10 metre high concrete regulator blocks upstream migration. The process used to determine appropriate fish passage at Pak Peung was to: (i) Identify the migratory fish community; (ii) Test fish in a temporary experimental fishway; (iii) Design and build the fishway; and (iv) Assess the fishway (Baumgartner et al., 2012). A similar process could be implemented to determine the most appropriate fishway structure for Phai Jiew Weir.

Of the several species identified by villagers at Phai Jiew weir two species seen trying to jump the weir, *Chitala sp.*/ Pa Tong kai, and *Anabas testudineus*/ Pa Kheng, were also caught at Pak Peung experimental fishway (Baugmgartner et al. 2012). Creating similar fish passage conditions at Phai Jiew could increase the likelihood of these species being able to move past the weir. Conversely, two other Phai Jiew species, *Tricropodus trichopterus/ Pa Ka deut* and *Cirrinhus sp./Pa Kabok were* not observed at Pak Peung. Their ability to use fish passage ways is not documented and would require further research. The experiment at Pak Peung also found that fish smaller than 40mm could not ascend the steep slopes, the Phai Jiew fish species so far identified by villagers are above this size.

Figure11: Pak Peung Regulator with submerged temporary experimental orifice fishway for fish counting (Singhanouvong et al., 2015)

Fishway recommendations

Based on the above discussion points, the first step is to seek assessment and consultation on fish ladder feasibility and design, as well as confirm funding considerations. Potential contacts for this process could be FishBio, FAO and/or LARREC. It is proposed that the consultation process commence mid-2018. It is anticipated the most appropriate time for construction of a fish ladder at Phai Jiew Reservoir would be middle to end of the dry season, potentially in January-February 2019 (or 2020 depending on longevity of process), when water levels are low and villagers have time to assist with construction if necessary. A

site visit will need to be undertaken in collaboration with the consultant, community members from Laohouakham and Tansoum village, and local government, to further discuss the proposal, fish way design, the construction process, and support from villagers, such as through in-kind labour. Communication of the benefits, such as increase in fish populations, and sustainable resource management, should be conveyed to community members to provide incentive to support the project. Additionally, support will be provided to communities to be involved with the process and discussed during consultation processes.

4.2 Monitoring

Monitoring is essential to evaluate effectiveness of management and or to monitor areas where management is not currently occurring. All 10 management zones identified will be monitored and this has been scheduled for November of each year at the approximate 6 month point after the Mar-May main control period and just after the wet season has finished to determine changes in density of invasive species after the flood period.

Two of the 10 management zone areas have high habitat value but are currently designated monitoring areas due to, the relatively low levels of water hyacinth observed at the time of field assessment, or limited site access. These are Kout Makpheo and the central section of the Kout Xelat Kadan oxbow. These sites will be monitored at the November monitoring points and if water hyacinth or *Mimosa pigra* has increased in these areas it will be determined if they should become control zones, as shown in Table 4, for March 2019.

Any community monitoring program design needs to be a process that can be easily and quickly undertaken by community members, but that also provides good monitoring data that show changes over time. For monitoring vegetation change such as invasive species, photo points is a recognized monitoring technique and one frequently used in community monitoring programs (Hall 2002). Villagers could use mobile phones to take photos at the same designated point, for example every 3 months. Photo point monitoring sites will be set up at each management area. As mentioned in the previous section monitoring will also include identification of sites where seed germination is high and assess and develop a control strategy as needed per site, i.e. villagers to control when germinants get to a size where they can be easily hand pulled.

Table 4. Proposed management and monitoring schedule

Timing of management	Management zone	Stage of management	Management Responsibility
March 2018	Kout Khan 1 Nong Mae Hang Kout Xelat Kadan 2	Initial water hyacinth removal	Ban Taleo-Phonkho Ban Kaengkok dong Ban Kadan
April 2018	Bak FCZ	Initial Polygonum management (pilot)	Ban Hoamoung
2019	All sites	Investigate Biological control options for water hyacinth	IUCN
	Kout Pheenoi Kout Khan 1	1st year Mimosa pigra control	Ban Tansoum Ban Taleo-Phonkho

May 2018	Kout Xelat Kadan 2		Ban Kadan
Jun 2018	Phai Jiew Weir	Conduct assessment during high flow; Consult for fish ladder construction design	Ban Tansoum Ban Laohouakham
Nov 2018	All sites	Monitoring	IUCN/Community
Jan-Feb 2019	Phai Jiew Weir	Construction of fish ladder (pending assessment)	Ban Tansoum Ban Laohouakham
March 2019	Kout Khan 2 Kout Xelat Kadan 1	Initial water hyacinth removal	Ban Taleo-Phonkho Ban Kadan
	Kout Xelat Kadan 3 Kout Makpheo	Initial water hyacinth removal – if required post monitoring	Ban Kadan Ban Tansoum
May 2019	Kout Pheenoi Kout Khan 1 Kout Xelat Kadan 2	2nd year Mimosa pigra control	Ban Tansoum Ban Taleo-Phonkho Ban Kadan
Nov 2019	All sites	Monitoring	IUCN/Village

5. Management coordination

5.1 Community management

All villages visited and surveyed during the field visit expressed a willingness to support the project and contribute to re-opening management. The 6 villages involved, will be provided with assistance to undertake management effectively and which will need to be determined and negotiated via a consultative process with each village. This will be the first step in the process and is proposed for February 2018, firstly for the four villages where works are planned for March-April (Table 4).

Support provided to villages is expected to be a combination of; some monetary support possibly via contribution to village funds; equipment to aid management where necessary; and in-kind staff time from IUCN and DoNRE/DAFO to accompany, supervise and/or support each village during management events.

IUCN/DoNRE-DAFO/FAO will coordinate with villages to plan the management schedule as per the time periods agreed during the field mission, and attend and supervise the first day or two of each management event and then re-visit towards the end to assess progress and identify if additional support is needed.

Some training and capacity development activities will also be planned, and this should include provision of training in the production of fertilizer from water hyacinth, including both techniques and logistics of the process as well as applications of the fertiliser, such as a vegetable production demonstration and/or establishment of pilot projects. This is currently planned for Kaengkok dong village (led by FAO) but could be extended to other villages. Water hyacinth fertilizer is known to increase crop productivity, i.e.

rice and vegetables. Assistance with both production and transport to agricultural fields may also be required, i.e. tractors, to increase the incentive for villagers to undertake regular control.

Water hyacinth is used in other countries for making baskets, bags and various handicrafts. It will be investigated whether there is an interest/market, and what the feasibility would be in undertaking training in this area too.

5.2 Sustainable management

Sustainable management is an important consideration where management involves invasive species as the task is often on-going and not addressed or solved when the project finishes. It is proposed that the responsibilities for re-opening management are formalized, such as in a letter of agreement, between DoNRE and each village to outline the arrangements for undertaking the re-opening management and its on-going implementation. It is hoped that also by providing support to this practice for the next 3 years of the CAWA project the positive ecological benefits of management that are expected to be observed at the sites, such as increased fish populations, and therefore fishing opportunities, will provide incentive for the practice to continue once the project is finished. The training in beneficial uses of water hyacinth, i.e. fertilizer production, is also hoped to be an incentive to maintain the practice in the longer term.

Links with other projects such as future WCS projects, anticipated to re-commence with surveys and other activities in Xe Champhone in 2019, may also support management sustainability if coordination can be sorted for the continuation of management support and working with communities once the CAWA project has finished.

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Annex 1: Field sheet, Re-Opening Study, November 2017

<table>
<tr><th colspan="4">Wetland Re-opening Survey Data Sheet</th></tr>
<tr><td colspan="3">Site:</td><td>Nearest village:</td></tr>
<tr><td colspan="4">GPS Coordinates (Lat/Long or UTM):</td></tr>
<tr><td colspan="3">Recorded by:</td><td>Date:</td></tr>
<tr><td colspan="4">Description of disconnection/barrier:</td></tr>
<tr><td colspan="3">Invasive species (IS) observed:
☐ Mimosa pigra
☐ Water Hyacinth
☐ Other (specify if known)
Specify:</td><td rowspan="2">Fauna species present/impacted:
☐ Siamese Crocodile
☐ Fish (specify below if known)
☐ Turtle (specify below if known)
☐ Other
Specify species/ details of impact:</td></tr>
<tr><td>Area of site/ water body(ha)</td><td>Water depth (m)</td><td>Area of management (ha)</td></tr>
<tr><td colspan="3">Density of invasive species (low/mod/high), describe infestation of each species:</td><td>Access to site/feasibility for management:</td></tr>
<tr><td>Villager’s observations</td><td colspan="2">Women</td><td>Men</td></tr>
<tr><td>What are main impacts of identified ‘barrier’?</td><td colspan="2"></td><td></td></tr>
<tr><td>Is connectivity worse at certain times?</td><td colspan="2"></td><td></td></tr>
</table>

Past/current management practices		
Recommendations for future management		
Are there any areas where sedimentation has increased?		
Are there any other obstacles to water flow, spp. movement etc. known (dams, canals, other)		

Annex 2: List of Participants from Re opening study Trip in Xe Champhone Ramsar site. 22-23 Nov 2017

No.	Name and Surname	Lao name	Position	Organization
1	Mr. Somphone	ທ່ານ ສົມພອນ	Deputy head of Taleo village.	Ban Taleo
2	Mr. Phosavath	ທ່ານ ໂພສະຫວັດ	Deputy head of Phonkho	Ban Phonkho
3	Ms. Toukvilay	ທ່ານ ຕຸ້ກວິໄລ	Head of village Women's Union	Ban Phonkho
4	Ms. Saisamon	ທ່ານ ນາງ ສາຍສະໝອນ	Deputy head of Village	Ban Kaengkok dong
5	Mr. Phetsamon	ທ່ານ ເພັດສະໝອນ	Village Chief	Ban Hoamoung
6	Mr. Somsanouk	ທ່ານ ສົມສະໜຸກ	Deputy head of Village	Ban Kadan
7	Mr. Sisouphanh	ທ່ານ ສີສຸພັນ	Village Police	Ban Kadan
8	Ms. Mok	ທ່ານ ນາງ ໂມະ	Village Women Union	Ban Kadan
9	Mr Touy	ທ່ານ ຕຸ້ຍ	Framer	Ban Kadan
10	Mr. Bountue	ທ່ານ ບຸນຕື	VCCG	Ban Tansoum
11	Mr. Sengphet	ທ່ານ ແສງເພັດ	VCCG	Ban Tansoum
12	Ms.Phasouk Loungvixay	ທ່ານ ນາງ ພາສຸກ ຫຼວງວິໄລ	CAWA Coordinator	SVK-PoNRE
13	Ms.Keooudon Choulamontry	ທ່ານ ນາງແກ້ວອຸດອນ ຈຸລະມົນຕຼີ	CAWA Coordinator	CP- DoNRE
14	Ms.Thipphaphone Phaxaysithideth	ທ່ານ ນາງ ທິບພາພອນ ພະໄຊສິດທິເດດ	Deputy head of Livestock and Fishery	CP- DAFO
15	Ms. Amy Scott	ທ່ານ ນາງ ເອມີ ສະກອດ	WWPA	IUCN-SVK
16	Ms.Colleen CRANMER	ທ່ານ ນາງ ຄໍລີນ ເຄເມີ	WWPO	IUCN - SVK
17	Mr.Oudomxay Thongsavath	ທ່ານ ອຸດົມໄຊ ທອງສະຫວັດ	Deputy Coordinator	IUCN-SVK
18	Mr. Khamphat Xeasing	ທ່ານ ຄຳພັດ ເສື້ອສີງ	Field official	IUCN - SVK

VCCG: Village Crocodile Conservation Group.