

Name of Protected Area: Lake Kutubu Wildlife Management Area

Part 1: Basic information about the protected area

Table 1. Protected area information

Name, organisation and contact details for person(s) conducting the assessment <i>Person 1: Name, Organisation, Address, Email, Phone</i>	Gregory Peterson, SPREP/Protected Area Solutions, 283 Madill Road, Tandur, Q4570, Australia, gregpeterson53@hotmail.com; 0414300955.
<i>Person 2: Name, Organisation, Address, Email, Phone</i>	Ann Peterson, SPREP/Protected Area Solutions, 283 Madill Road, Tandur, Q4570, Australia, gregpeterson53@hotmail.com; 0414300955.
Today's Date	26/02/2017
Name (or names) of protected area	Lake Kutubu Wildlife Management Area
Size of protected area (ha)	24,057
PNG Code or number	52
World Database of Protected Areas site code (these codes can be found on www.unep-wcmc.org/wdpa/)	61533
What level or kind of protected area is it? (National Park, Wildlife Management Area, Sanctuary, Reserve, Locally Managed Marine Area etc)	Wildlife Management Area
IUCN Category	
International protected area? e.g. World Heritage or Ramsar?	Ramsar site (25/08/1998) 24,057ha (The Ramsar site coincides with the size of the WMA)
Country	Papua New Guinea
Province/s	Southern Highlands
District/s	Pimaga
Local level governments	Kutubu
Ward/s	About 18 wards
Nearest big town	Mendi (50km SW of Mendi)
Location of protected area (brief description)	Lake Kutubu is located to the east of the Kikori River (into which it drains) and sits in a depression with an altitude of 808m. It is about 19km long and 4km wide at its widest point. The surface area is 4,924 ha and it is the fifth largest lake on the island of New Guinea and the second largest in PNG (after Lake Murray, Western Province). It has a maximum depth of about 70m and a mean depth of 36m. The catchment area is about 76,000ha (Smith et al. 2016) and the Lake is fed by several streams, most of which come from underground sources. The lake is flanked by high hills (1000m) along its length and water drains from the lake via the Soro River. The highest point is Mt Kemenagi (1,397m). The western shores are poorly drained upland flood plain and basin. The north-eastern shores are a volcanic outwash plain and fan and the south-eastern shores are a flood plain that is subject to inundation. The Lake contains some islands, including Wasemi Island.
Map references	

When was the protected area gazetted or formally established?	25/06/1992
Reference for gazettal or Memorandum of Understanding (MoU)	
Who owns the protected area? please enter Government Private Community/ customary landowners, private, Other (name) and include Clan name(s)	Customary land tenure. The WMA land is owned by the people of the Foe and Fasu groups comprising about 33 villages including Kaimari, Soro, Kokaya Point, Sawmill, Tubage, Wasami, Inu, Ibu, Wanunuku, Tugiri 1, Tugiri2, Yo'obo, Seraga, Gesege, Asu and part of Hegeso. People reside on the shores of the Lake. Clans are male-dominated and patrilineal. Each clan segment holds communal and individual ownership of areas of land that are passed down from father to son. In the Foe area there are 45 main clans and several have divided into sub-clans, making a total of about 78 (Rule, 1993, cited in Jenkins & Nombri, 1997). Two other families own land in the WMA but are not resident in the WMA.
Number of households living in the protected area	Unknown – there are many
Population size within the protected area	About 14,000
Who manages the protected area? (e.g. please enter government, customary landowners [add clan names] management committee [how many and what gender])	Management Committee (8 members, 4 M, 4F). Each village has a sub-committee with 4 representatives (including male and female) – these are from Wasami, Gesege, Yo'obo and Tugiri 2. Because of population growth the other villages have been established by these four main groups. The committee has a chairman, treasurer, secretary, vice-chairman, and 4 coordinators (2 M, 2F). Currently there is no Management Plan. There have been some surveys conducted with the help of Exxon and we hope that a plan will be developed in the future. There was a Management Plan but it was not implemented.
Total number of staff (this means anyone working on the protected area in paid jobs – whether NGOs, community, rangers or customary landowners	0
<i>Temporary paid workers</i>	0
<i>Permanent paid workers</i>	0
Annual budget (US\$) – excluding staff salary costs	0
Operational (recurrent) funds	0
Project or special funds	ExxonMobil has provided a boat and motor, billboards and uniforms (K33,000). The WMA Committee reports on how the money was spent to the Manager of the Lake Kutubu Enhancement Program within ExxonMobil (when money comes from Exxon). In 2014 Exxon provided funds to develop the WMA's Resource Centre, toilets and water tanks. The WMA established the Lake Kutubu Foundation account into which money is deposited. This is used to provide support for meetings, transport and communication. Fundraising money also goes into the Foundation Account (2F and the Chair have authority over the account; and a financial report is delivered at every quarterly meeting). Training in relation to the WMA Management Plan was provided by PNG Institute of Biological Research.
Reason for protected area establishment	We have endemic species that are not found elsewhere in the world. We have wetlands and this provides clean water – it is like a tea strainer. We have many forest species – over 1000 orchid species, the landscape, the culture and the heritage. When the government decided to develop the road and there was mining development (oil and gas exploration) and land clearing we thought that this would destroy the lake and we asked the government for help to protect the area.

What are the main values for which the area is designated (Fill this out after data sheet 2)	Endemic fish; fresh water and swamp forest; plants; animals; and culture/custom.
List the primary protected area management objectives (add lines if needed after the most important objectives): <i>Management objective 1</i>	The Lake Kutubu Environment Foundation Inc (26/9/2013) identifies several objectives – (1) to protect, maintain and promote the ecological resources (e.g. the protection of 12 endemic fish species and freshwater crustacean population).
<i>Management objective 2</i>	To enhance sustainable development through the wise use of natural resources.
<i>Management objective 3</i>	Safeguard the integrity of the traditional owners and their traditions and culture.
Number of people involved in answering the assessment questions	9
Name/organisation/contact details of people participating in the assessment	<i>Jeffrey Bia'a</i> , Lake Kutubu WMA, Yo'obo Village; <i>Patrick Hebago</i> , LKWMA, Gesege Village, 71556379; <i>Alfred Dafora</i> , LKWMA, Yo'obo, 72311722; <i>Alice Kage</i> , LKWMA, Tugiri 1 Village; <i>Gabriel Kamuna</i> , LKWMA, Seraga V and Wasami Village, 70785004; <i>Esa Amaga</i> , LKWMA, Kokaya Point Village, 79226130; <i>Lucy</i> , LKWMA, Tugiri 1, 79414557, <i>Lawrence Kage</i> , Chairman, LKWMA, Tugiri 1, kagelawrence1@gmail.com, 71182774; <i>Vagi Rei</i> , CEPA.
Customary landowners/other community; CEPA, Other national government agency; Provincial govt; local level govt; Protected area staff (anyone working on the protected area in paid jobs; NGO; Donors; External experts; Others	Customary landowners, CEPA.
Please note if assessment was carried out in association with a particular project, on behalf of an organisation or donor	SPREP through the PNG Protected Area Assessment Project, which is a component of the GEF Community-based Forest and Coastal Conservation and Resource Management Project in PNG.

Part 2: What makes this protected area special and important?

The Lake provides for the livelihoods of the people (fish and prawns, and sago that grows on the lake shore). Areas around the lake are used for gardening and settlements. The lake is surrounded by limestone ridges and has many fish species and many local plants and animals that are not found anywhere else. It is a Wetland of International Significance under the Ramsar Convention. The WMA is part of the Kikori basin, one of the most biologically rich in PNG. We still practice many traditions such as the longhouses and traditional methods of burial.

Table 2. Key values of the protected area

No.	Key values	Brief description	Note if endangered species or ecosystem (IUCN)
1	Endemic fish	There are at least 12 species of endemic fish in Lake Kutubu, e.g. Lake Kutubu rainbow fish, <i>Melanotaenis lacustris</i> . These species are caught by the local communities and provide important protein in their diet. Additional information: five of the endemic fish in Lake Kutubu were reported by Enesar in 2005 to comprise up to 40% of the customary landowners' fish catches. This proportion is likely to have been affected by the introduction of tilapia which have severely reduced the number of endemic fish.	<i>Cehrax papaunus</i> , Holthuis; <i>M. lacustris</i> , <i>Oloplotosus torbo</i> Allen; and <i>Hephaestus adamsoni</i> Trewavas are vulnerable. <i>Craterocephalus lacustris</i> Trewavas is endangered. <i>Mogurnda variegata</i> , Nicholus and <i>Mogurnda furva</i> Allen & Hoese are critically endangered.
2	Water (fresh) and swamp forest	Fresh water comes into the lake. It is important for drinking. The swamp forest is the strainer for the lake and creates the fresh water.	

3	Plants	Orchids (>1000 species), bamboo, palms, salat (medicine plant), pandanus, rattans, sago (grows on the edge of the lake and is a main component of our diet).	
4	Animals	Birds (e.g. bird of paradise - for custom and ceremony, cassowary, water birds, bush fowl, water ducks), butterfly/moths, frogs, tree kangaroo (brown and black), wallabies, snakes, monitor lizard (for kundu), cuscus, long-beaked echidna, short-beaked echidna, ,	
5	Culture/custom	There is a skull cave, which is an important burial cave. There are longhouses which are traditionally used by men and boys.	

Table 3. Checklist of values/benefits

Not important 0; Important 1; Very important 2; Don't know DK

How important is the protected area for each of the listed values/benefits?	Score (0,1,2, DK)	Comment
1. Biodiversity – the presence of many different kinds of plants, animals and ecosystems	2	Biodiversity was the main reason for establishing the WMA. We want to protect it from threats (e.g. from roads and mining). Additional information: The 2006 RAPPAM provided detailed information on the WMA's biodiversity. This is summarised here, but as little or no monitoring has been conducted in the last 11 years, some of this information may be inaccurate. The vegetation is typical of a lowland to lower montane forest and includes swamp forests, <i>Nothophagus</i> and <i>Pandanus</i> forests, and aquatic or freshwater vegetation types. There are four types of habitats of aquatic and semi-aquatic plants: (i) A tall emergent zone forming the fringing littoral margins of the lake to a maximum depth of 2.5 m (during high tide). There is a marked zonation, with <i>Phragmites karka</i> occupying the more landward margins followed by the broad-leaved grass <i>Miscanthus floridulus</i> and <i>Pandanus sp.</i> and a mixture of the reed <i>Scripus grossus</i> , <i>Typha orientalis</i> and several mat-forming grasses (e.g. <i>Leersia hexandra</i>). Sometimes the smartweeds of the family Polygonaceae (e.g. <i>Polygonum attenuatum</i>) form a dominant component bordering the tall emergent zone. (ii) Aquatic mixed plant beds comprised either of a mixture of cosmopolitan species or one of the following species as a single species stand – <i>Hydrilla verticillata</i> , <i>Ceratophyllum demersum</i> , <i>Najas tenuifolia</i> , <i>Vallisneria natans</i> , <i>Ottelia allisimoides</i> and <i>Potamogeton malaianus</i> . Species occur in shallow waters to depths of 3 m or 4 m may occasionally extend into deeper waters. (iii) Aquatic Characeae plant beds dominated by <i>Nitella species</i> . This species forms a dense monospecific mat over the bottom of the lake. The Characeae community either about the mixed community, the tall emergent community or the lake edge itself where the bank was steep. Depth distribution of this aquatic plant bed was observed to range from 2.5 m to depths of 8 m. (iv) This group is confined to the mouths of Kaimari and Tugiri Creeks, which are characterised by the formation of levee banks upon which ebb (floating mat forming grasses) extend out into the lake. The diversity of terrestrial fauna in the Lake Kutubu area is also great. There are unique animals inhabiting the different habitat types despite the harsh conditions. In relation to fauna , there are 13 endemic fish species and more than 100 fresh water fish; 19 species of native mammal were recorded on Mt. Kemenagi. A rat species (<i>Rattus nov.sp.</i>) which is new to science, and a rare species of Three-striped Dasyure (<i>Myoictis melas</i>) were recorded on Mt. Kemenagi

		<p>during survey work. An additional 6 species of mammals were documented as occurring in the swamp forest by Leary (1998). These included one threatened mammal species (Long-beaked Echidna, <i>Zaglossus bruijnii</i>), and one rare species (Round-eared Tubed-nosed Bat, <i>Myctimene cyclotis</i>). Two species of tree kangaroo, Doria's tree kangaroo (<i>Dendrolagus dorianus</i>) and Goodfellow's tree kangaroo (<i>Dendrolagus goodfellowi</i>), are considered vulnerable to hunting pressures, have been recorded around the Lake. The total number of native mammal species recorded to date for the Lake Kutubu Wildlife Management Area is 25 species. There are around 250 species of birds (d'Cruz 2008). There is little information on the reptile and frogs of the Lake Kutubu area. More than 60 species of frogs occur in the area (d'Cruz 2008), including <i>Rana daemeli</i>, <i>Litoria gacilata</i>, <i>Litoria infrafrenata</i>, <i>Litoria timida</i>, <i>Hylophorbus rufescens</i>, and <i>Platymantis papuensis</i>. and 103 mammal species (d'Cruz 2008). A few other reptile species were identified like the amethystine python (<i>Morelia amethystina</i>). The total number of reptiles and amphibians recorded for the Lake Kutubu area is about 18 species, but this is not a comprehensive survey. It is recorded that a high diversity of moth species (656 species) at a site near Moro, not far from the lake and the Lake supports more species of birdwing butterfly (i.e. 5 of 8 species) than any other known sites in PNG. All are listed on Appendix II of the Convention on International Trade in Endangered Species: Goliath birdwing, the world's second largest birdwing butterfly (<i>Ornithoptera goliath</i>); Paradise birdwing (<i>Ornithoptera paradisea</i>); Meridionalis birdwing (<i>Ornithoptera meridionalis</i>); Priamus birdwing (<i>Ornithoptera priamus poseidon</i>), and Troides birdwing (<i>Troides oblongomaculatus papuensis</i>). There are over 200 species of butterflies (d'Cruz 2008). The aquatic insects were also recorded, including the Heteroptera (aquatic true bugs), Zygoptera (Damselflies), and the Gyrinidae. A total of 52 aquatic insects; 32 Heteroptera species, 16 Zygoptera species and 4 in the Gyrinidae genera were recorded (RAPPAM 2006).</p>
2. Presence of rare, threatened, or endangered species (plants and animals)	2	There are important fish. We must manage the fish so that we have our native fish. We must continue to look after the fish as they are very special to Lake Kutubu. The fish are not found anywhere else in the world and we must look after them. There are about 12 species of endemic fish in the Lake.
3. Ecosystems (e.g. wetlands, grasslands, coral reefs etc) that are rare because they have been cleared or destroyed in other areas	2	The wetlands are internationally recognized under the Ramsar Convention and are very important to protect. The swamp forest is important for helping to purify the water entering the Lake.
4. Protecting clean, fresh water	2	The Lake vegetation helps to provide fresh clean water. Additional information: Lake Kutubu is fed through a series of small creeks and subterranean rivers that flow under the surrounding limestone and karst ranges. The main surface flow comes from the Tugibu River and Kaimari Creek (NW catchment). The water is alkaline with a dominance of dissolved minerals (e.g. calcium and bicarbonates derived from the dissolution of limestone from the catchment's karst terrain) (Tappin 2016).
5. Sustaining important species in big enough numbers that they are able to survive here	2	The Lake itself provides important habitat for a range of fish, water birds and vegetation. It sustains about 12 species of endemic fish.
6. Providing a source of employment for local communities now	2	There are currently no paid staff. However, people are employed by Oil Search to undertake a range of activities (e.g. managing/clearing of the oil pipe line which passes

		through the WMA). It is important for the future for the WMA to provide employment for some of the people.
7. Providing resources for local subsistence (food, building materials, medicines etc.)	2	The people in the WMA mainly live a subsistence lifestyle and are dependent on the resources of the WMA, e.g. fish, terrestrial fauna and sago.
8. Providing community development opportunities through sustainable resource use	2	Oil Search works with the Management Committee and has provided assistance in several areas e.g. funding for a resource centre, boats, educational resources and health provision.
9. Religious or spiritual significance (e.g. tambu places)	2	Some caves are used as burial sites and these have special significance for the communities in the WMA.
10. Plant species of high social, cultural, or economic importance	2	We produce and sell tapa cloths and bags, bilums, dresses, kau kau, banana, nuts, pumpkin, sugar cane and sago.
11. Animal species of high social, cultural, or economic importance	2	Animals (e.g. bird of paradise feathers, cuscus, cassowary feathers, pig meat, fish); meat and fish are also important for protein in the diet.
12. Attractive scenery	2	The Lake is surrounded by limestone that forms a wall around the lake. It supports some local endemic plants and animals. The Lake in its natural state would be a valuable tourist asset.
13. Tourism now	2	Tourists come to the area and visit the Lodge, but currently numbers are low.
14. Potential value for tourism in the future	2	Tourism is important for future income generation.
15. Educational and/or scientific value	2	The Lake supports 12 endemic fish species; local endemic plants and animal species. There has been some scientific research in the past.
16. Maintaining culture and tradition on customary land and passing this on to future generations	2	Sites of traditional significance are mainly natural features associated with origin stories, myths or particular cultural practices and sites. Lake Kutubu is the location for a number of traditional myths. There are a number of archaeological sites including human burial sites (burial caves or ossuary) and longhouses (and this tradition will continue) - they exist mainly on the island.

Part 3: What are the threats to the protected area?

Table 4: Threats to the protected area

- H** **High** significance threats are seriously degrading values. This means they are badly damaging some value –it might be a kind of animal or plant, or your traditional gardens
- M** **Medium** threats are having some negative impact – they are damaging values but not so badly
- L** **Low** threats are present but not seriously damaging values
- 0** **N/A** where the threat is not present in the protected area or where something is happening but is not threatening the values at all

Threat type	Score (H,M,L,0)	Notes
1.1 Housing and settlement	H	There has been an influx of people looking for jobs (e.g. to work in the mine and also to sell food in the markets and there are sex workers). These people are setting up illegal squatter settlements, mainly near Moro and Soro. The landowners are seeking compensation and assistance. The settlers are cutting timber for housing (and some of these trees are special trees that may be used for medicinal purposes) and they are settling here without permission. They wash in the water, throw rubbish into the Lake and it affects the swamp forest. This is impacting on our water. Oil Search is telling the customary landowners do deal with the issue themselves. The people are requesting that there is no settlement on the WMA. There is no effective enforcement by the police officers in the region.
1.1a Population increase in the protected area community	H	Increased numbers of people from other places moving into the Kutubu area and claiming land for settlement.
1.2 Commercial and industrial areas	L	There is littering from the market and this is spread throughout the WMA including the Lake.

Threat type	Score (H,M,L,O)	Notes
1.3 Tourism and recreation infrastructure	L	There are about six lodges around the Lake and these cause some low impact.
2.1 Customary land owner and community gardens and small crops	L	The people use shifting cultivation for their gardens and this continues to maintain the vegetation. There is secondary forest regeneration, but in the long term the forest is maintained.
2.1a Drug cultivation	L	There is some marijuana growing in the WMA. This is causing social problems within the community, but this is controlled through the Council leaders.
2.1b Commercial plantations	0	
2.2 Wood and pulp plantations	0	There are no wood plantations, only selective logging by communities.
2.3 Livestock farming and grazing	0	
2.4 Marine and freshwater aquaculture	L	There were fish ponds with tilapia (as part of a CSIRO research project) and they have affected the native fish. The ponds overflowed and the tilapia entered the Lake system. Now there are thought to be only a couple of families that have ponds with tilapia.
3.1 Oil and gas drilling	M	A gas pipeline has been constructed along the Kikori River valley to a marine terminal. The oil and gas exploration has finished and the pipeline has been constructed. There was an impact during the construction phase, but the impact now is low. There is no oil and gas drilling within the WMA. There is a 50m pipeline corridor and there was some destruction of ecosystems as a result of constructing the pipeline (about 2012). There have been no oil spills or gas leaks. The vegetation is kept low along the pipeline. Two rivers drain into the Lake – if there is seepage this will impact on the Lake. There needs to be active engagement of the oil and gas companies and customary landowners to minimise the environmental impacts. Additional information: There was an inflow of a plume of white particulates from the north east, where hydrocarbon companies carried out extensive horizontal drilling in 2012-13. This resulted in a fish kill and fish displaying diseases (Smith et al. 2016, Tappin 2016).
3.2 Mining and quarrying	H	There is a quarry in the WMA. It is not a problem for us, but the landowners are in dispute over the quarry. There is prospecting for diamonds inside the WMA. They also bring helicopters in and clear areas of forest and they do not consult with us.
3.3 Energy generation	L	There are diesel generators in the WMA, but the impact is very low.
4.1 Roads and railroads (include road-killed animals)	H	The roads are old and have pot holes and they are not maintained. When the rain comes the sediment is washed into the creeks. There is dust on the vegetation along the highway and this affects some species. Trucks have crashed and they have lost their loads (e.g. oil and petrol wash into the creeks). The vehicles also transport invasive species from other areas and this will affect our WMA (e.g. there are several pest plants including piper species). The roads bring in rascals and these people cut timber and take wildlife.
4.2 Utility and service lines (e.g. electricity cables, telephone lines)	H	There are about four digicel towers and the impact is restricted in size. The community was not informed of the construction of these facilities.
4.3 Shipping lanes	0	
4.4 Flight paths	H	There is noise pollution from the aeroplanes and helicopters. There should be some compensation to the landowners who are affected by this noise. There has been no consultation between the mining company and customary landowners about the timing and frequency of flights. There is also noticeable and visible signs of emissions from the aircraft. The aircraft are intruding into special areas within the WMA where they should not be (e.g. cultural places and tambu areas) and this violates the privacy of the people and does not show respect for their traditional customs.
5.1 Hunting, killing and collecting terrestrial animals (including killing of animals as a result of human/wildlife conflict)	H	There is hunting using sling shots and dogs by the customary landowners and the squatters. This is having a high impact on birds. There is a lot of killing of birds along the roads.

Threat type	Score (H,M,L,0)	Notes
5.2 Gathering terrestrial plants or plant products (non-timber)	H	People are taking orchids and these are shipped out by planes. People are also taking the orchids and planting them in other places. There should be some checking at the airport that this does not happen and some restriction on the movement of orchids. A walk about sawmill is used to cut the trees and this results in destruction of the orchids.
5.3a Logging and wood harvesting for local/customary use	H	Trees are cut along the roadside, for use in building houses and for firewood. There is a fear that we may lose some species. Areas are allocated for the taking of timber and this usually doesn't happen close to the villages.
5.3b Logging and wood harvesting – commercial logging	L	There is no commercial logging in this area. This may occur in the future. It is occurring in areas outside the WMA.
5.4a Fishing, killing and harvesting aquatic resources for local/customary use	H	There is an increasing population and this is placing pressure on the fish stocks. There are many canoes and people fishing on the lake both in the day and night. They are using fishing line and nets (smaller mesh), poison rope, and spears. Before there were zones where you could not fish for a certain time (e.g. 2-3 year), but this no longer enforced. Fish taken are grunter and murganda (black), tilapia and carp (local names – sesabo, awarihibu, gagibu, serekade, borokao, damu angu, tadobo, koro bubar, koro, daregame).
5.4b Fishing, killing and harvesting aquatic resources for commercial use	L	There is no large scale commercial fishing, but the customary landowners do sell fish such as tilapia – fishing nets were given to the WMA by Oil Search to help catch tilapia and try to reduce their numbers in the lake.
6.1 Recreational activities and tourism	L	There is very little tourism, but there is visitation from nearby communities.
6.2 War, civil unrest and military exercises	0	
6.3 Research, education and other work-related activities in protected areas	0	
6.4 Activities of protected area managers (e.g. construction or vehicle use)	0	
6.5 Deliberate vandalism, destructive activities or threats to protected area staff and visitors	0	Some solar panels have been stolen within the WMA.
7.1 Fire and fire suppression (including arson)	H	Fire is a threat in the dry season. This is destroying some vegetation including orchids and has resulted in the loss of some houses. Fire is often started by children and they are not careful and it escapes into the forest.
7.2 Dams, hydrological modification and water management/use	0	
7.3a Increased fragmentation within protected area	L	There is some road construction and tracks that may cause a little fragmentation of the WMA.
7.3b Isolation from other natural habitat (e.g. deforestation)	0	
7.3c Other 'edge effects' on park values	H	The mining has resulted in chemicals entering the Lake. The WMA has complained to Oil Search about this. There are also illegal settlers within and on the edge of the WMA.
7.3d Loss of keystone species (e.g. top predators, pollinators etc.)	M	Some species are no longer found here – these is a loss of some fish species and seaweed (although it is coming back). There is tilapia in the lake and it is impacting on the endemic fish species. There has been no survey undertaken to identify the population numbers of the fish. The WMA is trying to talk with CEPA and others about fixing this problem.
8.1 Pest plants	H	Piper tree is spreading throughout the WMA, especially along the roads. There is also water hyacinth in the Lake (this can be carried and spread by birds or people). Elephant grass and cow grass are also present.
8.1a Pest animals	H	Wild pigs dig up the forest. There is possibly a brown tree snake (native), but it is poisonous. Cane toads are affecting the frog

Threat type	Score (H,M,L,O)	Notes
		population. There are red ants now and they never used to be here. Additional information: Small scale fish farmers began raising genetically improved farmed tilapia and carp in 2009 and introduced water hyacinth as a food for the fish (Smith et al. 2016). Heavy rains in 2010-2012 released farmed tilapia into the lake system and this is a significant threat to the native endemic fish in the lake. Smith et al. (2016) indicated that fish catches in 2015 were dominated by tilapia and that endemic species were rarely caught. Even crayfish are threatened by loss of habitat due to the abundance of tilapia. Smith et al. (2106) reported that there were 50 fish farms in five villages around the lake with two to five ponds per farm and that all farms held tilapia which reproduces easily under local conditions. A few farms had common carp - "... fish stocks at Lake Kutubu are under enormous threat" (Smith et al. 2016:29). The introduction of these invasive species was designed to improve food security and this practice has been encouraged by the PNG government and international aid agencies.
8.1b Diseases such as fungus or viruses that make native plants or animals sick	H	Some plants (e.g. kaukau) have a fungus or perhaps small insects that cause health problems for the people. Additional information: Pathogenic diseases have entered the Lake and are affecting fish stocks (Smith et al. 2016, Tappin 2016). The exotic fish species, such as tilapia may be the vectors in the spread of EUS (epizootic ulcerative syndrome) and other diseases (Smith et al. 2016). There is some research to suggest that fish farming is not economically viable for Lake Kutubu because farmers have not been trained, do not have husbandry skills, do not have locally available fish feed and their ponds are too small (Smith et al. 2016).
8.2 Introduced genetic material (e.g. genetically modified organisms)	O	
9.1 Household sewage and urban waste water	H	People wash their laundry and throw their rubbish in the creeks and this pollutes the water. This is mainly happening in the squatter settlements.
9.1a Sewage and waste water from protected area facilities	O	
9.2 Industrial, mining and military effluents	H	Chemicals enter our waterways. Additional information: A fish kill was recorded from Jan – July 2013, with fish displaying EUS. The event coincided with an inflow of a plume of white particulates from the north east, where hydrocarbon companies had carried out extensive horizontal drilling in 2012-13. As a result the mix of fish caught was reduced (Tappin 2016).
9.3 Agricultural and forestry effluents (e.g. excess fertilizers or pesticides)	O	
9.4 Garbage and solid waste	H	There is rubbish from the local people and squatters and this impacts on the waterways.
9.5 Air-borne pollutants	H	There is pollution from the burning of materials. This impacts on the vegetation and water. This is believed to have impacted on the reeds.
9.6 Excess energy (e.g. heat pollution, lights etc.)	M	There is light from the Oil Search plant and this affects both the wildlife and the people. It is especially visible at night by the local communities.
10.1 Volcanoes	O	
10.2 Earthquakes/Tsunamis	M	Earthquakes cause the loss of some trees that fall over.
10.3 Avalanches/Landslides	H	During the wet season landslides can occur and this results in sediment entering the creeks and lake. Expansion of settlement near the lake edge and resultant cutting of vegetation and planting of gardens also results in localised landslides.
10.4 Erosion and siltation/ deposition (e.g. shoreline or riverbed changes)	H	This is mainly the result of high rainfall and sediment is deposited in streams that enter the lake.
11.1 Habitat shifting and alteration	H	One of our small species of fish that used to be in the lake is no longer found there – they have run away to hide in the creeks. This may also

Threat type	Score (H,M,L,O)	Notes
		be due to pollution or tilapia. Some plants which never grew here before are now found here. Also some birds are found here that were not common in the past e.g. pelicans. There has been a change in the flight paths of some animals. There are also red ants that were not here before.
11.2 Droughts	H	There was a big drought in 2015 and this caused some of the fish to die.
11.3 Temperature extremes	H	Before it used to be hot, but now it is colder at night. It may affect some of the species in the WMA.
11.4 Storms and flooding	H	Storms affect the forest (e.g. trees fall down) and the houses and result in flooding. This can affect the swamp areas where feeding grounds for wildlife are disturbed.
11.5 Coral bleaching	0	
11.6 Intrusion by saltwater into gardens etc.	0	
11.7 Sea level rise	0	
Other (please explain)		
12.1 Loss of cultural links, traditional knowledge and/or management practices	M	The culture remains strong. However, the children are no longer learning the stories of their ancestors (perhaps the parents and elders are not passing on the culture). The children go to school and some don't know their cultural traditions. It may be due to western culture (e.g. 'the white man has come') and the influence of the churches. Elders are no longer giving talks to children in the school.
12.2 Natural deterioration of important cultural site values	0	
12.3 Destruction of cultural heritage buildings, gardens, sites by people	H	These sites have been affected by mining activities, including the building, roads and pipelines.
Other (please explain)		

Table 5. Worst threats and ways forward

Threat No.	Threat (Most significant first)	Threat number or name (copy no. from Table 4)	Nature of the threat, impact and how to reduce the impact.
1	Illegal settlements	1.1	This causes destruction of forests, hunting, fishing, We need assistance to remove the illegal settlers.
2	Taking our resources	5.1,5.2,5.3a,5.4a	The Oil Search workers come into the WMA and take our orchids, cassowary, tree kangaroo and fish. Awareness raising of surrounding communities is needed.
3	Air pollution	9.2	There is noise and emissions from aircraft and chimneys. The mining companies need to consult with customary landowners about aircraft movements.

Part 4: What is the management like in the protected area?

Table 6. Management effectiveness scores, comments, next steps

Issue	Score (0,1,2,3, NA)	Comment	Next steps
1a. Legal status	3	Legally gazetted as a WMA, but the committee members have changed since the original gazetta.	Need to re-gazette the WMA and the new Management Committee and reallocate the WMA to a new category under the new Protected Area legislation.
1b. Legal status			

Issue	Score (0,1,2,3, NA)	Comment	Next steps
2a. Protected area regulations	3	There are traditional rules relating to the bush and the water. The Committee knows the rules and also the communities. There is no official Management Plan. The rules of the WMA were gazetted in 2002 and include rules on the take of wildlife (e.g. people other than customary landowners are not permitted to take, kill or harm any plant or animal, including aquatic plants and animals), entry into culturally significant sites (e.g. burial sites) and relevant fee structures, roles and responsibilities.	We need to enforce the WMA rules by raising awareness (e.g. drama). There is a need to develop a Management Plan for the WMA.
2b. Protected area regulations			
3. Law enforcement	1	There are major deficiencies in law enforcement in the WMA. There are no rangers on the ground and offenders are not caught or punished.	The Committee could undertake a survey of the community to raise some ideas about enforcement. We should also ask NGOs for other ideas. Create a community police force to help us improve law enforcement. We also need on-ground rangers to monitor activities in the WMA. We need financial resources to enable this to happen.
4. Protected area objectives	3	There are traditional rules or objectives and the Management Committee strives to achieve these objectives. The main problem is the lack of funds to implement actions to achieve the objectives.	The objectives need to be identified in a formal Management Plan.
5. Protected area design	3	The size is good and also the shape. The WMA includes almost all of the customary landowners' land. The other people do not want a WMA.	
6. Protected area boundaries	1	The boundaries are marked by GPS, but they are not respected by everyone as there are squatters living illegally in the WMA.	Billboards are being prepared. We also need to raise awareness of the boundaries and values of the WMA.
7. Management plan	1	There is no Management Plan, but one is being prepared with the assistance of ExxonMobil. The survey work has been completed, but no information has been received by the community.	Finalise the draft Management Plan and begin the implementation of the plan and awareness raising.
7a. Planning process	1	People were involved in providing input into the draft Plan.	
7b. Planning process	0	There is no regular review as there is no Management Plan.	
7c. Planning process	0	Little survey data has been included in the planning process.	
8. Regular work plan	1	There is a weekly work plan and this is reported quarterly to the Management Committee.	When the Management Plan is developed an annual Work Plan should be developed to implement the required actions.

Issue	Score (0,1,2,3, NA)	Comment	Next steps
9. Resource inventory	2	There is information available on fish species, birds, mammals, frogs, butterflies/moths and some reptiles as well as the main vegetation types, and some specific plants such as orchids.	We need further surveys (e.g. fish surveys to determine their impact on native fish), fish inventory and surveys that target specific areas.
10. Protection systems	0	There are no protection systems or permit systems in place.	
11. Research and monitoring	0	There was some research in the early days of mining exploration.	Approach Oil Search to gain some funding to undertake regular and relevant research in the area.
12. Resource management	1	There is some active management undertaken by the Committee e.g. fish monitoring and we are seeking support and funding from other organisations. Billboards have been produced to raise awareness of the WMA. Nets have been donated to the community to catch tilapia and reduce the impact on the native fish.	
13a. Staff numbers	0	There are no paid staff employed in the WMA.	Funding is needed to enable us to employ some rangers. This may be obtained from mining companies who are engaged in our area and they could invest in our WMA.
13b. Other people working on the protected area	2	The Committee and some in the community are working to achieve conservation outcomes. On World Environment Day teams from several villages cleaned the lake.	Funding is needed to encourage more voluntary participation in the WMA.
14. Training and skills	2	Training and skills could be improved.	Training is needed in the following: book keeping, eco-tourism, tour guide, ranger training, computer, office management, surveys, report and proposal writing.
15. Current budget	0	There is no budget, but there is some fundraising within the community to help the committee with communication and transport (to enable the committee members to meet).	Funding is required, particularly from the large mining companies and income generating activities.
16. Security of budget	0		
17. Management of budget	NA		
18. Equipment	2	There is a WMA Resource Centre, with office, meeting space, water, solar power, tables, toilets, kitchen space and boat with a motor.	We need a car, hand-held radios, credit cards (to enable payment by phone), GPS, more tables and chairs for the resource centre and curtains
19. Maintenance of equipment	1	The resource centre and boat are well-maintained by volunteers.	Resources are needed to assist with maintenance of equipment and facilities.

Issue	Score (0,1,2,3, NA)	Comment	Next steps
20. Education and awareness	1	There was some awareness raising done by ExxonMobil in the past. There is some environmental education in the primary school. We engage in World Environment Day with various activities. We provide posters to the school and we are holding a big showcase of the WMA this week. All the people from within the WMA will come to visit the centre. We have developed WMA sign boards that are located at Gesege Junction and the Kaimari Gate.	Expanded education and awareness raising programs are needed. This includes the mining companies as well as surrounding communities and illegal settlers.
21. Planning for land use or marine activities	0	The outside planning interests do not consult with us in relation to many issues.	There needs to be better communication between the WMA and adjacent land use planning frameworks. EISs are needed before activities are undertaken.
22. State and commercial neighbours	1	There is some contact with Oil Search and some minor assistance.	There needs to be improved consultation and collaboration with Oil Search in relation to activities that are undertaken within and adjacent to the WMA.
23. Indigenous people/ Customary landowners	2	Customary landowners have elected representatives in their villages and these representatives meet as a formal Management Committee.	
24a. Impact on communities	1	There is communication between customary landowners and other stakeholders such as NGOs and CEPA.	
24b. Impact on communities	1	The Church in the WMA assists the villagers.	
24c. Impact on communities	1	The customary landowners support the operation of the WMA.	
25. Economic benefit	0	The principal landowners should receive a royalty payment from the use of the land where Moro is located. We, the lake people are supposed to get 10% of the royalties and the Fasu get 90%. This is to cover for the pipeline, refinery and facilities. They should pay us about K4000-5000 quarterly (but we have not been paid for 13 years, nor have Fasu). Treasury and Finance have the money and this has not been released to us. The WMA is owned by the landowners and we need to secure some funds from the royalties. There is no income from tourism.	Royalty payments that have been agreed need to be paid to the customary landowners.

Issue	Score (0,1,2,3, NA)	Comment	Next steps
26. Monitoring and evaluation	0	There is no comprehensive monitoring or evaluation. There has been some water quality monitoring undertaken by Oil Search.	Ensure that all relevant survey and monitoring data is provided in a suitable format to the customary landowners and ensure that they are comprehensively informed and engaged in relevant monitoring and evaluation tasks.
27. Visitor facilities	2	The Resource Centre is available to visitors and it displays posters with information about several important species.	We need some funding to maintain the facilities and to produce additional information for visitors. We would also like a guest house that would provide income for the WMA.
28. Commercial tourism operators	0		
29. Fees	0	The gazettal notice identifies that a fee structure was in place with K12 for entry to the WMA. Currently no fees are collected.	
30. Condition of values	1	There are significant threats to the WMA, particularly the fish and the water and swamp forests.	
30a. Condition of values	1	While many of the values remain in good condition, the introduction of tilapia into the lake system places significant pressure on all species of endemic native fish.	Collective intervention is required to establish workable methods to remove tilapia from the lake.
30b. Condition of values	1	There are programs to help remove tilapia and to uproot the piper trees.	More support is needed for threat abatement plans.
30c. Condition of values	1	Pervious partners, such as WWF withdrew their support and now the community is responsible for management.	

Part 5: Condition and trends of protected area values

Table 7. Values, condition and trend

Key value (from Table 2)	Condition Score (VG, G, F, P, DK)	Trend Score (I, S, D, DK)	Information source and justification for Assessment and HOW the condition can be IMPROVED
Endemic fish	P	D	There are 12 endemic fish species that are threatened by the introduction of tilapia and over-fishing and these are disappearing.
Freshwater and swamp forest	G	D	The karst system supplies clean fresh water to the rivers and lakes and the swamp forest acts as a water filter; there is pollution entering the swamp forest from upstream settlements (including illegal settlers) and this affects water quality.
Plants	G	DK	There are diverse vegetation systems and related plants; there has been little monitoring and we are unsure of the trends in relation to vegetation.
Animals	G	DK	There are many and diverse fauna and related habitat; there has been no monitoring and we are unsure of the trends in relation to the animals in the WMA.
Culture/custom	F	DK	There are several important aspects to culture and tradition that are practiced in the community, but there are serious problems due to external influences; we are unsure of the trend.

Table 8. Recommendations and ways forward

1.	2.	3.
We need investment to assist with the management of the WMA. This should come from co-operative funding from all stakeholders.	Surveys of biodiversity and other research are essential to inform management and also training programs are needed.	We need to develop a new Management Plan. We need to visit other protected areas to gain new ideas and new strategies. We need to enforce the WMA rules through an effective ranger program.

Table 9. Strengths and challenges (facilitator/recorder synthesis)

	Strengths	Challenges
1	The condition of some of the values remains high (e.g. fauna and flora) and this provides a foundation for eco-tourism.	Redressing the ongoing impact of tilapia and carp on the native endemic species.
2	There is a WMA Management Committee in place, with representation from all villages in the WMA.	Addressing the potential impacts from current and future mining and drilling projects when the customary landowners are not effectively consulted.
3	The Ramsar listing indicates the international importance of the landscape and biodiversity.	Receiving the agreed royalties from the national government in relation to the presence of Oil Search facilities on customary land.
4	The WMA has a functioning and purpose built resource centre with office, meeting area and kitchen.	Despite the community's wish to expand tourism, the local infrastructure and remoteness make this difficult within the WMA.
5	The culture and traditions remain relatively strong.	

References

Smith, PT, Imbun, BY & Duarte, FP 2016. Impacts of a fish kill at Lake Kutubu, Papua New Guinea, *Pacific Science*, 70(1):21-33.
Tappin, AR 2016. Rainbow fish. Available at: <http://rainbowfish.angfaqld.org.au/Lacust.htm>.