IMPLEMENTATION COMPLETION MEMORANDUM

ON

A GRANT

FROM

THE GLOBAL ENVIRONMENT FACILITY

IN THE AMOUNT OF US$975,050

TO

THE KUNMING INSTITUTE OF ZOOLOGY, YUNNAN PROVINCE, CHINA

FOR

THE LAKE DIANCHI FRESHWATER BIODIVERSITY RESTORATION PROJECT

October 28, 2008

Rural Development, Natural Resources and Environment Sector Unit
Sustainable Development Department
East Asia and Pacific Region

China

Implementation Completion Memorandum

The Lake Dianchi Freshwater Biodiversity Restoration Project

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Preface

- This Implementation Completion Memorandum (ICM) is based on a field mission undertaken by Ross Hughes (consultant) that visited Kunming, Yunnan Province and included field visits to the Lake Dianchi watershed and fish-breeding center, discussions with the Kunming Institute of Zoology (KIZ) project team and meetings with various project stakeholders in Kunming City and at field level. The field mission and meetings took place from June 15-21, 2008. Field mission activities were supplemented by a review of documents before and after the mission and by targeted 'remote dialogue' to achieve clarity of specific issues that emerged during the drafting of this report. The ICM has been reviewed by Professor Yang and his colleagues (KIZ), and Stephen Ling, Steven Oliver, Mahesh Sharma, and Tony Whitten (World Bank).

- This ICM follows the latest available template dated May 18, 2006.

A. BASIC TRUST FUND INFORMATION

TF Name	Lake Dianchi Freshwater Biodiversity Restoration Project
TF Number	TF059715
Task Team Leader	Anthony J. Whitten, EASRE
TF Amount	Total financing: GEF: US$975,050
Recipients of TF Resources	Kunming Institute of Zoology Chinese Academy of Sciences
Type of TF	GEF Child Fund
Single/Multi Donor	Multi
Donor Name	Global Environment Facility (GEF)
TF Program Source Code	GEFIA
Purpose of TF	TA – Technical Assistance
TF Approval/IBTF Clearance Date	March 17, 2003
TF Effectiveness Date	March 23, 2003
TF Closing Date	February 28, 2007 (planned) June 30, 2008 (actual)
Date of ICM Submission to TFO	

Cost and Finance Table (US$)		
	Original	Actual
GEF	997,050	975,028
Other	860,420	1,531,834[1]
Total	1,857,970	2,506,862

B. TRUST FUND DEVELOPMENT OBJECTIVES AND DESIGN

1. Original (and Revised) Trust Fund Development Objectives

(a) The objective of the project was to restore and manage habitats around the lake in order to secure the conservation of the remaining endemic species of Lake Dianchi and its immediate tributaries. This was to be achieved by providing suitable breeding habitat, comprehensively surveying the biological environment of the Lake and its immediate tributaries, establishing a program to monitor lake quality improvements (using the presence/abundance of the endemic species as indicators of improved ecosystem health), and improving public awareness of the Lake region's biological environment.

(b) To achieve the overall objective of the project, the design included five goals:

- The conservation of a community of internationally significant, threatened and severely range-restricted species.
- A demonstration of the utility of restoration for freshwater biodiversity conservation.
- The innovative use of biological indicator species for pollution remediation and monitoring.

[1] from the Chinese Academy of Science, the Yunnan Development & Reform Commission, the Yunnan Minority National Village, the Kunming Buddhism Association and the Nine Plateau Administration Office of Yunnan Environmental Protection Bureau.

- A greater awareness locally, nationally and globally of threats, challenges and opportunities related to Lake Dianchi in particular and freshwater biodiversity in general.
- An increased capacity to survey and identify freshwater biodiversity in Yunnan Province and elsewhere in China.

(c) There have been no subsequent changes to the project objective since the approval of the Medium Sized Project Brief approved by the GEF Focal Point in March 2002.

2. Original (and Revised) Trust Fund Activities/Components

Component 1 – Wetland Management and Restoration

(a) The wetland management and restoration component was designed to deliver practical and long-lasting benefits to the indigenous biodiversity of the Lake by restoring areas to some semblance of their 'natural state'. The plans for management and restoration interventions were to be integrated with broader local government plans and - acting as 'capacity builders' - to demonstrate what can be done. If successful, these would be replicated over a larger area. It was intended that the Steering Committee would assist in strengthening cooperation between the departments responsible for different aspects of Lake Dianchi management. These activities were included to slow and reverse the environmental degradation of the lake-shore and tributary ecosystems. Through financing from the local government, the project was to conduct an environmental impact assessment of the proposed restoration activities. It was envisaged that the restoration activities and restructuring of shore-line (civil works) would cover approximately 24,000 m² of shore-line and 15 ha of replanted macrophytes. There would also be benefits in the form of increased tourism and the provision of green manure and fibre from harvested macrophytes and lake-shore vegetation. The interventions were intended to reduce the incidence of algal blooms, fish kills and odors related to high nutrient loads

Component 2 – Surveys, Monitoring and Species Conservation

(b) This component sought: (i) to provide basic information on habitats and species; (ii) to give recommendations on protected areas and management; (iii) to feed into the Public Awareness component; and (iv) to collect the monitoring data necessary to provide feed-back on project impacts and recommendations for adapting plans and for expanding and/or fine tuning of interventions. The intention of this component was to gather and interpret information that would help to design and to focus the project, enabling those concerned to understand better the biological/environmental processes at work in the lake and how GEF interventions could be best applied. Monitoring was designed to include the lake, its springs, tributaries and up-stream reservoirs. Surveys of the lake basin were to identify important habitats, species and biodiversity hotspots and to develop a framework for coordinated research and survey that would feed directly into a centralized monitoring and data storage system and into species conservation plans. The survey results on the status of the endemic species and critical habitats were anticipated to highlight those in need of detailed attention and, for certain species, were expected to lead to the development of protection ordinances at local (and perhaps national) levels, to local initiatives for area conservation, and to *ex situ* conservation efforts (non-GEF) in the Kunming Institute of Zoology and perhaps elsewhere.

Component 3 – Capacity Building and Training

(c) This component was included to support other components and was expected to develop the capabilities in adaptive wetland management of offices and agencies represented on the

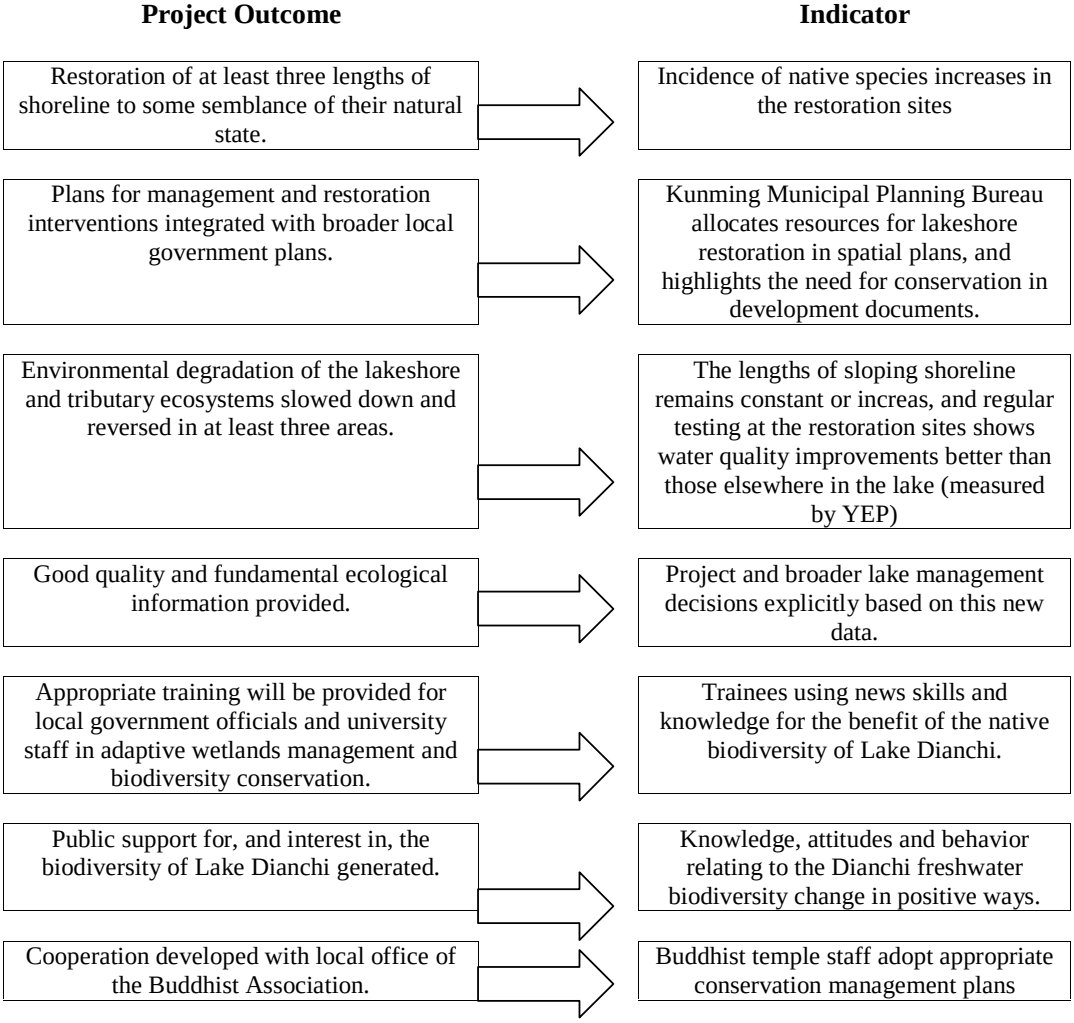
Steering Committee. This was to be achieved by combining teaching, practical study tasks and English-language training targeted at senior- and middle-level staff of fisheries offices, urban planning offices, university staff and students. It was anticipated that the mixing of trainees from a wide range of backgrounds could help 'cross-fertilize' ideas between agencies. The project design also included national and international study tours, exchanges and field visits. In addition, a small number of students were to benefit from being part supervised by foreign wetland managers and biodiversity specialists.

Component 4 Public Awareness

(d) This component was included to establish public support for, and interest in, the biodiversity of Lake Dianchi. The project design provided for the commission of a marketing and awareness strategy from a marketing company established in China in order to identify target audiences, messages and activities. The strategy was intended to guide the development of a public awareness program to be implemented by consultants with cooperation from the media. A mobile exhibition/education facility was to be developed for use in the relatively remote villages, and it was expected that the project would assist in the production of a bi-lingual book on the lake and its biodiversity. A major outcome of the project was intended to be the establishment of a strategically-located Public Awareness and Education Center in a building provided by the Yunnan Minorities Peoples' Village - 8 km from Kunming on the north-east shore of the lake. This park attracts over one million visitors each year, and from it visitors can travel by cable car south-west across the lake to the temples on Dragon Gate Mountain. The Awareness Centre was to house an exhibition, living specimens of unthreatened species, and a lecture hall, and to provide the base for the interpretation staff. Active cooperation with the local office of the Buddhist Association of China was expected to be another important outcome of the project. This is necessary because a number of springs are known to have populations of endemic species (some springs are the *only* known site for some species) and these are often associated with Buddhist temples. Using teaching materials developed in Buddhist monasteries elsewhere in China with the help of the Alliance for Religions and Conservation, the project was intended to partner with monks and adherents to ensure the safety of these sites.

3. Outcome Indicators

Indicators by outcome included in the Project Brief are listed below:



C. OUTCOMES

4. Relevance of TF Objectives, Design and Implementation

(a) International and national relevance: The project addressed a number of international and national environmental improvement objectives. At the international level, the project sought to conserve biodiversity of international importance, including the conservation of endemic fish[2]and gastropod species. At the national level, the project provided support for environmental improvements targeted by the national "Three Rivers, Three Lakes" program approved by the State Council. Before the project began, Lake Dianchi was already one of the three lakes targeted by this program. As a result of Lake Dianchi's inclusion in this program, all interventions are guided by the Five-Year Plans approved by the State Council. The project therefore offered good prospects for influencing wetland restoration approaches at other degraded lakes in China.

[2] A total of 12 endemic fish species and 28 indigenous species are found at Lake Dianchi.

(b) Provincial and local context: The project served to pilot bio-remediation approaches that could also be applied to the nine 'Plateau Lakes' of Yunnan province, each of which faces its own mix of management problems, often including the types of challenges addressed by the project at Lake Dianchi. In recent decades, rapid population and industrial growth in the Lake Dianchi watershed and changes in land-use management practices have placed enormous pressure on the aquatic ecosystem. The large number of endemic fish and other freshwater biodiversity found in the lake – including beds of submerged macrophytes that once covered most of the lake - have dwindled rapidly over recent decades, under the combined pressure of increasing nutrient loadings (leading to the development of hyper-eutrophic conditions and algal blooms) and the impact of a large number of alien and invasive species - including water hyacinth and commercially-introduced fish. These environmental changes have had considerable economic and social impacts, including water quality problems for domestic and industrial water supply, loss of tourism potential and, most significantly, declining fisheries productivity.

(c) Provincial response: This has been hampered by low levels of public and official awareness of the importance (economic, social and environmental) of a healthy freshwater wetland system. However, the last ten years or so have seen national, provincial and municipal authorities engaged in concerted efforts to reduce pollutant loads entering the lake system from domestic, industrial and agricultural sources. One of the most significant of these was the Yunnan Environment Project (YEP) covering three prefectures/municipalities in Yunnan Province that was implemented between 1997 and 2004 and supported by the Bank. The Dianchi water quality improvement component of the YEP included major investments (around US$300 million) aimed at reducing pollution discharges (including urban and peri-urban sewage collection and processing systems), institutional development and water quality monitoring. It was out of this project that the GEF project grew.

(d) World Bank Policy and Strategy Integration: The project sought to build on the YEP with a stronger focus on the restoration of the freshwater ecology of the lake and its tributaries. Bioremediation of this nature would not have been feasible without the YEP as a precursor attempting to reduce overall nutrient loads entering the lake system. Early indications are that these provincial efforts supported by the YEP are having a positive effect on the lake system, but it is not yet certain whether the reduced pollution input levels will have a substantive medium-term impact on nutrient loads and ecology because of the long lag times that initiatives of this nature have on large freshwater systems[3]. Nonetheless, the GEF wetland restoration project was included in the Bank's Country Assistance Strategy for China (2003-2006) and the subsequent Country Partnership Strategy[4] (2006-2010), a reflection of the importance placed on the need for finding successful and cost-effective approaches to ecosystems rehabilitation in China's major freshwater lake systems.

(e) Assessment of overall design: The overall design of the project, including its component structure, is assessed as being appropriate to the project objective. There is a clear justification for seeking cost-effective and sustainable approaches to wetland restoration and management for sound economic, social and environmental reasons. Whilst the importance of Lake Dianchi for indigenous and endemic freshwater biodiversity was recognized in general terms, data on the status of biodiversity - including its extraordinary wealth of endemic fish diversity - was out-of-date and very incomplete. The design of appropriate management and monitoring strategies was therefore not possible without a concerted effort to improve and up-date knowledge on the status of the lake's freshwater biodiversity. The institutional capacities needed to research, design and implement new strategies for wetland management were clearly lacking, as was public and official awareness of the values of biodiversity in the Lake Dianchi water-shed. These were seen as necessary precursors for any

[3] For reference, water retention in Dianchi Lake is estimated at 1000 days.
[4] Country Partnership Strategy for the People's Republic of China for the Period 2006-2010. China Country Management Unit, East Asia and Pacific Region. May 23, 2006.

future attempt to restore the lake's freshwater ecosystem. Inclusion of components targeting these aspects was therefore appropriate and necessary.

(f) Institutional design: There were both strengths and weaknesses in the institutional design. Execution responsibility at design was assigned to the Kunming Institute of Zoology, with a number of 'collaborating agencies' identified in the Project Brief (although not included further in budgetary elements or detailed work planning). Detailed institutional and implementation arrangements were not articulated in depth in the Project Brief, and this contributed to a general lack of active engagement by various institutions with a key stake in lake management. These include the Yunnan Environmental Protection Bureau - YEPB - (formerly the Yunnan Environment Institute), the Dianchi Management Bureau (DMB) and the local authorities of the three counties around the lake shoreline – Chenggong, Jinning and Xishan. While hard to judge, it does not seem as though the outcomes of the project would have been markedly different if a detailed institutional arrangements had been prescribed at the outset. In the case of the YEPB and the DMB, their involvement and interest in the project appears to have grown during implementation although it seems that, overall, institutional benefits to them of the activities were limited. Other collaborating agencies listed, and which did come to play a more substantial role in implementation, included the Yunnan Minorities Village, the Municipal Buddhism Association of Kunming and the Kunming Zoological Society. Their role is discussed in more detail in the assessment of the Public Awareness component. Given the institutional mandate of KIZ, and the time-scale involved, it is not surprising that the focus of project efforts has been on identifying scientific and technical advances rather than on 'mainstreaming' and 'scaling-up'. KIZ's passion and drive for conserving fish biodiversity and finding solutions to the resource degradation problems at Lake Dianchi was clearly a crucial factor in driving progress in the face of substantial technical, financial and management challenges. This experience suggests that KIZ was, perhaps, the right institutional partner for a largely experimental project of this nature. An alternative institutional arrangement might have placed implementation and management responsibility with the YEPB, with the KIZ sub-contracted for the scientific and technical aspects of the project. This would have enabled greater integration and post-project continuity with the YEP and would have offered improved prospects for developing awareness of ecological restoration approaches within provincial administration, and thus for better 'mainstreaming' of findings into planning and decision-making – an aspect of the project that has not been particularly effective. However, as indicated above, during project preparation and during the early stages of implementation YEPB was not especially interested in the subject and the project may never have taken off.

(g) Implications of institutional issues: The design anticipated that the project Steering Committee, comprising most of the above but not including local (county) authorities, would meet on a quarterly basis to provide inputs and guidance to project implementation. Three or four Steering Committee meetings took place during the early stages of implementation, but these ceased quite early because of a general lack of interest among the members and slow progress in the early days. This left no *formal* mechanism for inter-agency cooperation but other *informal* mechanisms have helped to develop engagement and to share learning and information on technical aspects. For example, the project has hosted a series of seven well-attended stakeholder meetings in which other institutes and agencies have participated. These have provided an opportunity to discuss issues such as algal blooms and *Ottelia* farming[5] with key groups of stakeholders. The project also benefited from the secondment of two staff members from the YEPB to key management positions in the project. Nonetheless, institutional weaknesses are likely to limit the extent to which project findings and recommendations are taken-up and mainstreamed into overall lake management strategies. In relation to mainstreaming, it must be recognized that time is needed to identify and finalize

[5] *Ottelia acunmiunata* is a macrophyte which is endemic to the Yunnan plateau; it used to be a traditional food plant sold in Yunnan's markets and was harvested extensively from the lake and tributaries for sale and consumption throughout the plateau.

appropriate wetland management approaches in 'experimental' projects of this nature. The lesson from this would seem to be that orchestrating Steering Committees in itself does not necessarily engender inter-agency support and that direct approaches can be of greater benefit.

(h) Other design issues: The existence of regulations that prevent shoreline re-profiling (introduced in 1988 to limit the expansion of fish-ponds into the lake) posed a major early challenge to the project. This constraint should have been identified during project design. The project responded adaptively to this challenge by building artificial structures (fences, pontoons and 'islands') to create the environment needed for re-establishment of macrophytes, notably protection from wave action during the early stages of macrophyte rehabilitation. Nonetheless, this issue meant that experience gained relied to a greater extent on structures that would, inevitably, prove economically unsustainable if scaled-up.

5. Achievement of the objective and goals

Assessment Approach and Constraints

(a) The assessment presented in this section starts with a review of the four components and then reviews the extent to which they have helped achieve the project goals and overall objective set out in the Project Brief. It should also be noted that the project did not attempt systematically to monitor its progress in achieving the outcome indicators (see 5b and 5j). Instead, the project monitored a range of biological parameters including water quality and biodiversity and habitat indicators, a reflection of the academic and technical mandate of the KIZ. There has been no systematic monitoring of the outcomes included in the Project Brief, with the exception of a review of the impact of the Public Awareness component on attitudes and behaviours. The ICM therefore draws upon a large range of different sources including a review of project documents (Annex 2), a draft of the project's final report, a presentation by (and discussions with) the project team, and discussions and meetings with project staff, stakeholders and field observations.

(b) Logical frameworks: A further complication for overall assessment of the project was that there are multiple sets of outputs, outcomes and indicators in existence. The first is included in the Project Brief agreed and approved by GEF. A second set of outcomes and indicators are included in a log frame prepared for the project. A third set is included in a 'Results Framework' prepared in May 2007 (prepared with WB support to replace the logframe as this was considered unworkable by the project team). A fourth set is included in the draft final report. Each set of outcomes and indicators differs markedly in terms of scope and content, and there is an inconsistent use in terminology between documents. For example, the goals included in the Project Brief become 'objectives' elsewhere, and there is general confusion and inconsistency in the use of terms such as outcomes, outputs and activities. It should be remembered that terminology issues relating to log frames are commonplace elsewhere in China (and East Asia) since the nuances of log frame terminology do not lend themselves well to translation. The lack of structured training on logframes and project management is a lesson learned to which this ICM returns in Section F(c). Changes to project design were not formally recognized by the Bank during the project, and so this review uses the outcomes and indicators included in the Project Brief as a framework for assessment.

Assessment of Component 1: Wetland management and restoration.

(c) Overall assessment: This component is rated as satisfactory. Efforts to restore wetlands to a semblance of their original structure and function were severely tested by a number of early setbacks and design constraints. Progress has nonetheless been made in learning from experience and developing technically viable approaches to wetland restoration that could deliver bioremediation benefits to the aquatic system as a whole. The adaptive approach that

transformed early setbacks into opportunities for further leaning and innovation is impressive. Further work is needed to analyze the economic viability of expanding these approaches, to identify localities for further 'scaling-up' and for ensuring longer-term monitoring of restoration progress. The decision by the YEPB finance the expansion of the Xialiangwang restoration work to 230 ha is an encouraging measure of progress and one that fulfils one of the two key outcome indicators for this component, albeit on a more limited scope than might have been envisaged at design. The second indicator on sloping shoreline extent and water quality improvements has been met only partially since it remains too early to expect changes in water quality at the demonstration sites, and the early setbacks on shoreline re-profiling precluded the extent to which this indicator could be met more fully.

(d) Early setbacks: Implementation of this component suffered from some early setbacks during early implementation. This is to be expected in an inherently 'experimental' project component. The early setbacks provided useful learning exercises, dispiriting though these were at the time, and they have clearly stimulated some adaptive and innovative responses that have helped to refine and improve understanding of appropriate management responses. Early setbacks included:

- Shoreline re-profiling: It emerged that the Dianchi Protection Regulation, issued in 1988 prevented the Dianchi Management Bureau from authorizing shoreline re-profiling, thus narrowing the range of options for wetland restoration and prompting a re-think of approaches available for wetland restoration. The Project Brief identified the risk that government officials would '*… lack the will to cooperate to achieve the project goals …*' but did not foresee that existing regulations prevented local authorities from approving lake re-profiling activities in the first place. This indicates a problem of project design rather than one of implementation. This design issue has important implications for post-project sustainability.

- Macrophyte grazing: Unexpectedly high levels of macrophyte grazing by various alien species decimated early plantings of macrophytes. The voracious Grass Carp (*Ctenopharyngodon idella)*[6] and perhaps muskrats and domestic waterfowl were responsible for this damage. This required a further adaptive response – the extensive use of exclusion barriers and protective nets followed by re-planting. This delayed the establishment of macrophytes and limited the extent to which macrophytes were re-established in the pilot sites. Indications from field observations and the monitoring report suggest that macrophytes are now beginning to re-establish themselves at the pilot sites within the lake (see below) but most of these remain dependent (at Baiyukou at least) on protection from invasive herbivores.[7]

- Wave protection: A floating barrier constructed to pilot wave reduction during the re-establishment phase for macrophytes was destroyed by waves during a monsoonal storm. On the one hand, this represented a significant technical 'failure' and on the other it has prompted a further rethink in approaches to wetland restoration at the Xialiangwang pilot site.

- *Bio-filtration:* Piloting of bivalve filtration at both pilot sites initially failed because of the oxygen-depleting impact of submerged, decaying water hyacinth – both pilot sites had to be first cleared of this highly invasive alien species but the negative impact of decaying plant remains in the substrate was not anticipated. Research at the pilot sites indicated the importance of substrate quality and 'planting' techniques for successful bivalve establishment.

(e) Viability of restoration models: The project responded adaptively to early setbacks, and these provided learning opportunities that ultimately proved productive. Three approaches have been piloted that seek to create a suitable physical environment to enable macrophytes and other freshwater wetland communities to recover:

[6] Grass Carp was thought to have been introduced to the Lake Dianchi system in the 1960s. Its natural range is limited to Siberia and northern China, but has now been widely introduced across China as the species grows quickly in pond and lake systems. It is unable to breed in Lake Dianchi.
[7] The exception is *Nymphoides peltata* which appears to be more resistant to grazing by grass carp

- The “in-lake embayment” model: This has been piloted at Baiyukou and involved construction of a floating barrier across the bay to reduce wave action and prevent choking by the invasive water hyacinth. A net hung from the barrier and anchored to the lakebed is deployed to exclude Grass Carp – a pernicious herbivore. The enclosed bay was then planted with macrophytes using a range of planting techniques. Willows have been planted along dykes for stabilization - and within the lake shallows to create improved fish habitat - to mimic the role of mangroves in marine and brackish ecosystems. Alien species such as the Grass Carp, red-eared slider terrapins (*Trachemys scripta)* and water hyacinth have been removed to the extent possible. Bivalve mussels have been deployed for bio-filtration in hanging cages. Guards have been hired and signboards erected to prevent further releases of invasive species. These techniques are showing signs of success as macrophytes are beginning to become re-established and the site has proved its value for experimentation and innovation. The DMB has agreed to take on management responsibility for the site after the project’s close. However, the techniques used at Baiyukou are too costly and labour intensive for practical application on a larger scale within the lake, and the multi-layered fences are not thought likely to resist wind and wave action in the longer term although they remain solid after four years.

- The “floating breakwater” model: A floating steel and car tire structure was designed and installed at Xialiangwang on a pilot basis to lower wave action on the exposed eastern shore of the lake with the aim of promoting accelerated re-establishment of macrophytes. Unfortunately, the structure was destroyed by strong storm waves and the pilot proved unsuccessful.

- The “broken dyke” model: This pilot approach was developed on abandoned fishponds at Xialiangwang and involved making selective breaks in existing embankments to allow water exchange with the main lake system. This was followed by the removal of huge quantities of water hyacinth, macrophyte and willow planting (including the use of floating islands), in a similar manner to the approach used at Baiyukou. Bivalves were restocked in the enclosures and hanging bivalve cages were also deployed; Golden Line Fish (*Sinocyclocheilus grahami*), an endemic planktivorous species, have been introduced into cages for future release into the lake system. Further back from the lake, fishponds have been planted with *Ottelia* for sale as vegetables in local markets, to strip nutrients and to provide a food source for fish production. This approach is likely to be the most viable for wider use, given the availability of similar sites around the lake (the project team estimates that around 10 percent of the lake perimeter is suitable for this approach). Early indications and field observations suggest that macrophytes are becoming well established, there is high survivorship of bivalves and turbidity was visibly lower in parts of the restored wetland (away from the lake entrance). The team reports that waterbird numbers are gradually increasing during the winter months (especially numbers of wintering black-headed gulls), encouraging signs that wetland recovery is under way. The YEPB has agreed to fund the expansion of restoration activities to an additional 230 ha and assume management responsibility for the existing and expanded area. The project team is also interested in future development of the area as a visitor attraction, using restoration activities as the main attraction and building on the lessons learned from the Mai Po study tour visit. Economic analysis would be a logical next step to understand the cost implications of scaling-up such investments (on a per hectare basis) and perhaps even estimating Internal Rates of Return (IRRs) based on initial estimates of bioremediation contributions, fisheries enhancement and *Ottelia* production potentials.

(f) Scale-up potential: The YEPB was well informed about the progress being made at the pilot sites and believes that scale-up is possible since the provincial policy entitled 'Three restores, four returns and one protection' [8] mandates the restoration of land previously reclaimed illegally from the lake. The YEPB reported that the project has provided very good demonstration values and has developed excellent models and plans to restore 32 km^2 of littoral wetland using the 'broken dyke' model developed and piloted by the project. Socio-economic conditions, local authority 'buy-in' (some potential areas are under local authority management, as was the case for the Xialiangwang fish ponds) and economic realities (e.g., compensation costs) will constrain the extent to which this approach can be scaled-up, but the project team estimates that this approach could be applied to some 10 percent of the lake's perimeter. The long-term success of macrophyte restoration will only be achieved if accompanied by tangible efforts by provincial authorities to eliminate Grass Carp from the open water fishery, since this species consumes macrophytes with voracious efficiency and, if it persists, would quickly undermine any progress on macrophyte restoration. Only limited progress has so far been made but there are promising signs that options are available to address the Grass Carp issue (see below).

(g) Macrophyte restoration: Prior to hyper-eutrophication in recent decades, Lake Dianchi supported extensive macrophyte beds over much of the lake's area (estimated at 90% of lake bed area) including extensive beds of *Ottelia acuminata*, *Potamogeton maackianus* and *Myriophyllum verticillatum.* These macrophytes played an important role in maintaining the overall nutrient balance of the lake and in so doing helped to maintain water quality and a healthy and productive fishery. Today, coverage is around two percent and the composition of macrophytes has shifted to different species assemblages, including domination in some areas by water hyacinth. The project has attempted to restore macrophytes at the pilot sites using a variety of wetland restoration models and by using a range of planting techniques. Monitoring indicates that around 13.8 ha of macrophyte beds have been re-established successfully at the pilot sites, including the successful piloting of commercially motivated *Ottelia* establishment in fish ponds to provide food for fish rearing and for market sales (see below). Willow (*Salix* sp.) has also been planted along embankments for stabilization purposes and to maximum depths of two metres on an experimental basis, aimed at creating submerged habitats for fish and aerial habitats for birds. It is too early to assess the results of these efforts although early indicators are that there has been low survivorship of *Salix* planted in water depths below two metres, but good survivorship in shallower areas.

(h) Integrated Fish and Ottelia Farming: *Ottelia* used to be a traditional food plant sold in Yunnan's markets and was harvested extensively from the lake and tributaries for sale and consumption throughout the province. Pollution, hyper–eutrophication, land reclamation from the lake, perimeter dyke construction around the lake shore-line, and over-grazing by introduced Grass Carp have all but eliminated *Ottelia* from the main lake body. Recent research suggests this could have played an important role in 'tipping' the nutrient balance of the system into its existing hyper-eutrophic state. Part of project efforts to redress this problem involved the piloting of an integrated fish - *Ottelia* aquaculture model in selected fishponds around the lake: (i) to help diversify income sources for local fish farmers; (ii) reduce nutrient inputs; fish feed is no longer needed since *Ottelia* and the zooplankton communities it supports provide adequate food for the fish ponds; and (iii) to help remove nutrients from 'non-point' agricultural sources feeding the ponds. It remains too early to assess whether there will be sufficient market demand to drive widespread *Ottelia* take-up by local fish farmers. If this does take place – and early indications of adoption are positive - then this will represent a major successful 'bioremediation outcome' of the project. The farmer participants at the 5th stakeholder workshop that focused on *Ottelia* farming were very

[8] This refers to the return of farmland for restoration of forest, the return of fishponds for the restoration of wetlands, the return of houses for the restoration of the lake shoreline; and the return of inhabitants for the protection of lake water.

positive about the initiative and the preliminary outcomes. Since trials began only in March 2008, it remains too early to draw further conclusions.

(i) Bio-filtration: With support from technical assistance from the University of Cambridge UK and with additional financial support from a grant secured from the Development Marketplace of the World Bank, the project has undertaken some innovative applied research on bio-filtration by stocking pilot areas with two species of bivalve mussel - *Anodonta woodiana* and *Corbicula* sp. *Anodonta* is thought to be capable of filtering 50 litres of water per day[9] and can survive in all but the most polluted waters of the lake. The idea is that the mussels will clear water at the pilot site sufficiently for macrophyte re-establishment which, in turn, will provide habitat for zooplankton and fish, which will contribute further to reducing algal standing stocks. Based on realistic future stocking densities of this species, it is estimated that mussel beds, if established successfully, could filter a volume of water equivalent to Lake Dianchi every 88 days using a conservative estimate (one individual per m^3) of future stocking densities. At a density of 20 *Anodonta* per m^3 (a typical density for Anodontine mussels in a healthy European lake) this would bring the volume 'turnover' of the lake to a remarkable 4.5 days – and could therefore make a major difference to the lake's water quality. Mature mussels can also be harvested for use as pig and duck food, and the KIZ is undertaking research in 'pearl seeding'. It is too early to expect conclusive results from this research, but if successful this would increase the economic attractiveness of this species. So far, over 17,000 *Anodonta* have been re-stocked in the pilot sites. Survivorship is reported to be high (over 80 percent in suitable habitats). For the time being at least, mussels are stocked in hanging net bags and placed in the enclosures to enable monitoring. Research at the fish-breeding centre is determining the viability of rearing bivalves on a commercial scale in hatchery conditions to enable accelerated scaling-up. This work has been expanded (with World Bank Development Marketplace support) to other plateau lakes in Yunnan Province, and additional grants are being actively sought to develop the potential of this work including the monitoring. All in all, the outcomes of the bio-filtration pilot work are extremely encouraging.

Assessment of Component 2: Surveys, monitoring and species conservation.

(j) Overall assessment: This component is rated as satisfactory. The program of surveys was undertaken to a high standard and has greatly improved understanding and information on the lake system's biodiversity. This information has been translated into practical management recommendations for local fisheries management authorities and others. *Ex situ* breeding of indigenous species has been initiated through the establishment of an impressive fish-breeding centre, funded largely by Yunnan Province. Success has already been achieved in breeding the endemic Golden Line Fish and release programs are expected to start once the numbers of fry reach around 1 million individuals. However, further work is still needed to put in place a comprehensive monitoring framework that covers existing water quality monitoring and broader indicators of wetland restoration progress. Most of the elements are in place, but these are not integrated sufficiently into a clear framework that could be mainstreamed for municipality implementation and supported after project closure. While it is possible that if the framework is not mainstreamed advances in the freshwater biodiversity agenda for the lake may suffer, but there were clearly cultural issues in adopting the rigorous monitoring the Bank perceived was necessary, and a mixture of charisma and sound-bites of information rather than hard-won long-term trend data may be all that is needed in a political environment.

(k) Survey work: Survey work of species and habitats were undertaken as foreseen in the project design - in the lake system, its major tributaries, springs and the Songhuaba Reservoir. The survey work identified 20 important springs around the lake that play a key role in

[9] According to data presented in the Wetland Restoration Manual.

supporting fish populations, mostly as breeding habitats. A key outcome of the survey program was the re-discovery of 12 endemic species of fish and a total of 19 species of indigenous fish that were not previously known to exist in the lake system. The surveys discovered one species of *Xenocypris* that had not been recorded at Lake Dianchi for over 30 years. Some of the endemic fish species remain extremely rare and it is also clear that further research will be needed on the taxonomic status of some species discovered in the lake. For example, an individual thought to be *Paralepidocephalus yui* was collected during the survey program in 2006. Only one other specimen of this species is known and it is the first time this species has been recorded in Lake Dianchi. Further taxonomic analysis is under way to determine whether this species is in fact a new species apparently also endemic to Lake Dianchi. Unfortunately, hopes have diminished of re-discovering the endemic Yunnan Newt (*Cynops wolterstorffi)*. The IUCN Red List categorizes the species as Extinct and the project team concurs with this assessment. The extirpation of this species around 20 years ago is thought to have taken place through a combination of habitat loss, water quality problems and predation on eggs and larvae by introduced species. The project was not able to survey the Songhuaba Reservoir as thoroughly as was initially hoped; the reservoir is considered the last hope for a number of species that have so far not yet been re-discovered, including the Yunnan Newt (although hopes for re-discovering this species have now faded). Survey permission was denied during the early stages of the project over concerns for the security of water supply for Kunming City. Following intervention from the Bank, survey permission was granted, but because of fears that boat use would encourage illegal fishing from villagers near the reservoir, the use of boats for the survey was denied. For this reason, survey data remains, to some extent, incomplete.

(l) Invasive species: The project has played an important role in drawing attention to the threat posed by various invasive species, including the red swamp crayfish (*Procambarus clarkia*), golden apple snail, (*Pomacea canaliculata*), red-eared slider turtle (*Trachemys scripta*) and muskrat (*Ondatra zibethicus*) and various actions have been undertaken to support efforts to eliminate these species from the lake system. A survey of the occurrence of red swamp crayfish was submitted to the World Bank in 2007. Golden apple snail was first discovered at Black Dragon Spring in the Lake Dianchi system in 2006, since which time concerted efforts have been made to eliminate the species before it becomes fully established – including through the active involvement of the Buddhist Association at Black Dragon Spring. A paper was published to report this discovery in the journal 'Zoological Research' in 2007. The snail re-appeared in 2007 in the main lake system and so future awareness and monitoring will be critical for ensuring this species does not become fully established in the system.

(m) Management recommendations for indigenous fish: Based on survey and monitoring data, formal management and monitoring recommendations were developed for eight sites, including five springs. These 'evidence-based' proposals have been discussed with and submitted formerly to the Fisheries Department of the Yunnan Agriculture Bureau and the National Ministry of Agriculture. These agencies are tasked with practical fisheries management actions in the lake system. The proposals provide guidance on steps needed to protect the indigenous fish species at key sites. These documents are available only in Chinese and they have not been reviewed, but there does not appear to be an overall management plan that brings together the management recommendations for the individual sites. The project has also prepared submissions for the 'Red Listing' for 13 species of endemic fish of Lake Dianchi, and papers on six of the 13 species have been published or accepted for publication. These species have been approved for inclusion on the IUCN Red List 2008. This represents another notable achievement of the project.

(n) Grass Carp elimination: The project has been encouraging provincial and local authorities to eliminate the stocking of Grass Carp in the lake, given the devastating impact that it has on the lake's ecology. Grass Carp do not breed in the lake, but are introduced accidentally during stocking operations for Silver and Big Head Carp and also escape from

fishponds where the species is grown in large numbers. The species is easy to grow in ponds and is widely consumed in Yunnan and so there is a general reluctance of local authorities to introduce restrictions, despite what is now known about its impact on the lake. The YEPB reported that it was developing regulations to control invasive species that would be implemented at local level, including by the DMB. However, these are likely to stop short of prohibiting the use of Grass Carp until alternatives are available. The project has developed ideas on what these might be: a gradual replacement of pond stocking with indigenous fish species (such as Golden Line Fish); a ban on stocking using fry from sources outside the province to prevent accidental introductions of Grass Carp fry; and the construction of a provincial fisheries nursery to supply Silver and Big Head Carp fingerlings free of inter-mixed Grass Carp. Over the longer term, the nursery could gradually move away from supplying Big Head and Silver Carp, once enough was learned on techniques for breeding indigenous planktivorous fish. It is estimated that this would cost US$3 million. Detailed cost estimates have not yet been prepared.

(o) Indigenous fish breeding: The KIZ established an Endangered Fish Conservation centre in 2006 with the support of the government of Yunnan Province and the project. The centre succeeded in breeding one endemic species in 2007 (Yang et al., 2007. Zoological Research 28(3): 329-331) - the Golden Line Fish - and the KIZ is now attempting to scale-up breeding to support a re-stocking operation and to expand research to other endemic species that could contribute to ecosystem restoration. The Golden Line Fish was selected because it used to be a dominant carnivorous species in the lake system, one that was harvested and eaten widely and commands a market price around 40 times that of the introduced Grass Carp. Efforts to re-establish this species as part of the regeneration of the lake system is therefore seen as a priority and the idea will be to link re-stocking operations to existing work with fish farmers (for example, for introduction in *Ottelia* ponds), demonstration sites and springs – the latter to substitute for release of alien species at Buddhist temples. This innovative approach has considerable potential for economic sustainability and as a useful awareness-raising tool at springs and temples. The fish-breeding centre is also researching mussel breeding with a similar goal of scaling-up mussel production and re-stocking for bio-filtration.

(p) Monitoring: Provincial and national authorities will require clear evidence that management interventions piloted by the project have been successful before they agree to scale these up and integrate them into local plans at site and provincial level. Systematic monitoring should therefore be the tool that provides this information. Various monitoring activities have taken place during the project but supervision missions highlighted concerns that monitoring was not being undertaken in a sufficiently systematic manner and was insufficiently targeted at delivering results of practical benefit for supporting management decisions and planning. Previous efforts to present monitoring information were criticized for weak statistical analysis and inappropriate use of graphs. To a considerable extent, these issues have continued to project closure, although it should also be noted that the project design did not include provision for such a systematic monitoring system. The final monitoring report provides a useful framework for future monitoring but since time series data only go back to 2006 (for pH, conductivity, temperature) and 2007 (for chlorophyll a) it is too early to develop even preliminary conclusions as to whether restoration activities are having impacts on water quality. Data is not presented on broader impacts, for example on bivalve survivorship, the presence of alien species, wintering waterbird populations, so drawing evidence-based conclusions on the actual impacts of restoration is not yet possible. It is likely that this data is being collected, but for some reason is not being reported in a systematic manner. The project has prepared a Biotic Index for Danchi Lake and this is now being repeated for the each of the other eight plateau lakes in Yunnan Province, and is scheduled for completion by end July 2008.[10] This is the first such use of this approach to

[10] Biotic Indexes (BIs) enable scientists and resource managers to assess rapidly changes in water quality and compare the quality between similar types of habitat using the composition and abundance of benthic invertebrate as indicators of water quality. This approach has a number of important advantages compared with 'conventional'

monitoring in Yunnan Province and will provide a valuable baseline for future biological changes across the entire range of plateau lakes.

(q) Database: A monitoring database has been established by the project and field data entered. The database uses an Internet Explorer interface and data is stored in a standard Microsoft Access database system. At some point, this will be made available *via* the project website. The database has had technical difficulties and the field information is only available in Chinese. The key issue will be whether the database provides ready access to information on key data and trends, for example on BIs or water quality trends over time and whether the data fields can be used to analyze data using specific variables. The KIZ have committed to continue to manage the database for monitoring purposes after completion of the project.

Assessment of Component 3: Capacity-building and training.

(r) Overall assessment: This component was rated as satisfactory. The project made a very slow start in recruiting and developing the necessary skills to manage a project of this scale, and this failing almost led to premature project closure early in 2005. Once these problems had been overcome, project management improved considerably and the project was rated as satisfactory by the November 2005 supervision mission. Improved management provided the solid platform required for progress to be made on technical and scientific aspects of other components. Most of the key activities planned under this component were executed successfully.

(s) Project management: During the early stages of project implementation, project management was a major problem. This was worsened by changes to institutional funding arrangements at the KIZ, which effectively prevented the use of KIZ's core financial resources for project co-financing. This combination of management and financing issues threatened the continuation of the project, leading the Bank to rate the project as 'partially unsatisfactory' in 2005, accompanied by a warning that the project would be closed unless dramatic improvements were made. By the time of the mid-term review, the KIZ had strengthened the team with two experienced staff, a project coordinator and project officer, both of whom were seconded from the YEP Project Management Office (PMO). Their arrival at the KIZ led to a dramatic improvement in management capacity and this 'freed-up' the project technical staff to focus on technical aspects of the project.

(t) Study tours, meetings and workshops: Several study tours were undertaken, including to Mai Po Nature Reserve in Hong Kong, Xixi National Wetland Park, Hanghou, and a study visit to Lake Dongtin. Each of these tours and visits included participants from the KIZ, project staff and other agencies, including the DMB and the Provincial Development Reform Commission and the Finance Bureau. These were reported to be successful in broadening horizons of management possibilities and have inspired work, particularly at the Xialiangwang restoration site. The study tours also helped improve the understanding of project activities and objectives with relevant local authorities and so helped broaden support for the project. Capacity-building activities included training workshops on specific wetland management issues, guest lectures and a series of six stakeholder workshops that focussed on specific wetland management challenges, such as algal blooms, *Ottelia* farming, invasive species and proposals for a wetland centre at Xialiangwang.

(u) International technical assistance: International technical assistance recruited under the project worked closely with staff and students of the KIZ and was deemed effective. The KIZ masters and doctoral degree candidates reported that they had benefited greatly from the

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approaches to point sampling water quality. For example, BIs are better at detecting pollutants that may have passed through the system before point samples are taken, are responsive to synergistic effects of multiple contaminants, and also ensure that impacts associated with all pollution sources - not just those screened by water sampling - are identified. Overall, this helps to improve the reliability of water quality monitoring and thus reduces potential risks to public and environmental health.

experimental and practical opportunities for wetland restoration and research made possible by the project. The continuity of support from the two international TAs from the beginning to the end of the project was a real highlight, and this relationship looks set to continue through further research work and continuing work on a paper for submission to *Science* journal. The high levels of enthusiasm and strong team working ethic suggest that these efforts have borne fruit and that momentum has been generated that seems likely to take work at the pilot sites forwards after project completion. The relationship with international experts may also continue with Darwin Initiative support for work on macrophytes and wetland restoration.

Assessment of Component 4: Public Awareness.

(v) Overall assessment: This component is rated as highly satisfactory. Public awareness work has been undertaken to a high standard throughout the project and has used a wide range of approaches. Early public awareness activities at local level were deemed as being 'too academic' by local authorities and farmers and so the project responded by adapting messages and delivery to ensure these better met the needs of local people. Public awareness messages have built upon and complemented the scientific and technical work being undertaken in other components of the project. An evaluation of the impact of the Public Awareness component on attitudes and behaviour showed that the component had succeeded in improving awareness of environmental problems and helped change attitudes and behaviour.

(w) Activities: The project has pursued a broad range of approaches to public awareness. The project has worked with schools, youth and faith groups (including the Buddhist Associations at Municipal and local level), installed mobile and fixed exhibits (including at the Yunnan Minorities Village and subsequently Kunming Zoological Park), used 'special days' such as local festivals, temple days, 'World Wetland Day' and 'World Biodiversity Day'; and has prepared a number of awareness and interpretation tools, such as books (including one authored by the Buddhist Association of Yunnan), posters and playing cards. The project has also exploited newspaper articles, magazines and television to convey messages about the lake's ecology, threats to the lake's ecosystem and the roles that local stakeholders can play in addressing these threats, for example by reducing pollution (e.g., from fish feed), dumping and littering and by refraining from releasing alien species during Buddhist festivals and farming practices. Public awareness work has also provided technical support for farmers in production techniques that can lower impacts on the environment (for example, establishing *Ottelia* macrophytes in fish ponds) and has supported biodiversity monitoring by encouraging local people to report sightings of unusual biodiversity, an approach that led to the reporting of a giant salamander (*Andrias davidianus*) and the discovery of a significant population of a fish species not previously known to occur in the lake.[11] An estimated 1.1 million people have viewed the displays erected in Kunming Zoological Park during the second part of 2007 alone! A website in English and Chinese has also been established that provides information about Lake Dianchi and the project.

(x) Impacts: The project commissioned two evaluations of the impacts of the Public Awareness component from the Regional Development Research Centre of Yunnan Institute of Geography, Yunnan University. The first, produced at the mid-term stage of the project, was disappointing as it lacked analytical quality. However, the second, prepared with supervisory and technical design support from the WB TTL, was published in April 2008 and was delivered to a good professional standard. This showed that the component had improved awareness of key threats and environmental issues around the lake system and had contributed to tangible improvements in behaviour, for example, by refraining from releasing introduced species. The evaluation also reported positive impacts and views of farmers in relation to *Ottelia* farming. The project reports that the impact of extensive work at schools (including the preparation and publication of textbooks and interpretational materials for

[11] The salamander may well have escaped from a local restaurant, but these examples highlight the fact that the project has succeeded in developing a broader awareness and interest in the lake's biodiversity.

classroom use) was mixed. In some cases, teachers enthusiastically embraced and used new materials, but in others teachers were reluctant to depart from the official curriculum and teaching resources.

(y) Peer-reviewed publications: Research activities supported by the project are now generating a wide range of reports and publications. The project reports that 13 scientific papers and books have been prepared, of which six have been published in peer-reviewed journals, three have been published online and two have been accepted for publication in the *Journal of Fish Biology*. This exceeds the targets set during the sixth Bank supervision mission in 2007.

(z) Progress against outcome indicators: The following matrix summarizes project achievements against outcome indicators included in the original project document.

Outcome Indicator	Summary of Progress
Incidence of native species increases in the restoration sites	• Macrophyte recovery and regeneration underway at two pilot sites. • Re-introductions of endemic fish species continue, based on successful *ex situ* breeding. • Alien/invasive species removal continues at pilot sites and springs. • Migratory waterfowl returning in larger numbers at Xialiangwang pilot site.
Kunming Municipal Planning Bureau allocates resources for lakeshore restoration in spatial plans and highlights the need for conservation in development documents.	• Resources allocated for expansion of pilot restoration work at Xialiangwang. • Invasive species regulations under development by the YEPB. • Lessons learned to be integrated into plateau lakes recovery work managed by YEPB.
The lengths of sloping shoreline remain constant or increase, and regular testing at the restoration sites shows water quality improvements better than those elsewhere in the lake (measured by YEP)	• Shoreline changes not monitored but 1988 regulation that prevents any modification to shorelines means that figures will remain similar to pre-project situation. • Too early to detect appreciable changes in water quality in the main lake and not possible to separate project impacts from those of other interventions around lake, included the YEP.
Project and broader lake management decisions explicitly based on this new data.	• YEPB indicates that it has learned greatly from project and is integrating this experience into decision-making for Lake Dianchi and other plateau lakes. • Experience not yet formalized into local plans; it is still too early for this.
Trainees using news skills and knowledge for the benefit of the native biodiversity of Lake Dianchi.	• Strong and enthusiastic engagement of KIZ students in project. • Various student-led research projects underway, including on bivalve bio-filtration, fish breeding and macrophyte research and restoration. • The development of the Wetland Restoration Manual.
Knowledge, attitudes and behaviour relating to the Dianchi freshwater biodiversity change in positive ways.	• Independent assessment indicates that changes to both attitudes and behaviour are significant and positive as a result of project activities.
Buddhist temple staff adopt appropriate conservation management plans	• Buddhist temples have engaged enthusiastically and have adopted changed management practices, including monitoring and removal of invasive species, *Ottelia* planting and encouraging visitors to temples to refrain from introducing alien species.

6. Efficiency

(a) Project management efficiency: The early stages of the project were characterized by difficulties in adapting to Bank procedures for financial management, work planning, reporting and procurement. During this period, progress was poor and generally inefficient and required higher-than-normal levels of supervisory inputs from the Bank. Management problems were effectively addressed by the project in 2005, and since then the project has been implemented with increasing levels of efficiency.

(b) Institutional efficiency: Greater efficiency might have been achieved had the project been integrated into the YEPB – the management authority for the Bank-supported YEP. However, this would also have had other detrimental effects on the project, such as a less motivated and adapative approach and ultimately the project might well have failed without this. Nonetheless, the YEPB had considerable existing management experience from the YEP and this could have been harnessed for efficient management of the project at an earlier stage of implementation. (This issue was successfully addressed by the secondment of two YEPB staff to the project after the problems that occurred during early implementation.) This would have also increased the efficiency with which results and outcomes were mainstreamed into local and provincial planning.

(c) Outcome efficiency: The project identified a number of extremely promising approaches that could lead to a more sustainable and cost-effective strategy for lake restoration and management, as compared with existing strategies that rely heavily on costly artificial remediation strategies, such as suction dredging and inter-basin water transfers.

(d) Financial management, procurement and disbursement efficiency: A review of procurement undertaken in 2006 identified no substantial issues relating to procurement. The project team is preparing a financial and procurement report for submission to the Bank as part of the final report submission. The project has disbursed 100 percent of the grant funds allocated by GEF to the project, and the project team reports that co-financing contributions have been made in full compliance with the grant agreement. The project audit of accounts to December 31, 2007 (audit dated June 23, 2008) indicates there are no issues of concern regarding financial management. T he auditor states as follows:

> *"We have audited the Lake Dianchi Freshwater Biodiversity Restoration project special purpose financial statements in accordance with the International Auditing Standards and the Government Auditing Standards of the People's Republic of China. We have expressed Auditor's Opinion on the above Financial Statements.*
>
> *As part of obtaining reasonable assurance about whether the financial statements of the project implementation of your Institute are free of material misstatements, we performed tests of your compliance with applicable provision of state laws and regulations, the grant agreement and internal control. We have not found the project break the State Laws and Regulations, and the Grant Agreement."*

A final audit of project accounts will need to be undertaken for the period January to June 2008 as part of standard project closure procedures.

7. Impacts

The main impacts of this project are:

(a) **A greatly improved information and research base** on the freshwater biodiversity of the Lake Dianchi system. This is a pre-requisite for developing and implementing sustainable and cost-effective management strategies for the lake system by Kunming Municipal authorities. Much more is now known about the existence of indigenous and endemic fish and other species of freshwater biodiversity in the lake system and the role that these used to play, and could play in future, in a sustainable and balanced freshwater ecosystem. For example, the important role that alien species have played in the degradation of the Lake Dianchi freshwater system was not previously understood to any significant extent. Previously, the loss of the enormous beds of macrophytes that would have played a key role

in maintaining water quality of the lake system was attributed to increasing nutrient loading, and hence a management focus on reducing nutrient discharges into the lake system. It is now recognized that the introduction of Grass Carp into the lake system in the 1960s was also likely to have been a critical factor. The elimination of Grass Carp from the system could therefore prove to be a cost-effective and efficient means of restoring the role of macrophytes in water quality management. Progress in *ex situ* breeding of Golden Line Fish at the new fish breeding centre is also a notable recent achievement, but it will be another year or two before there are sufficient fry available to pilot re-stocking in open water at the pilot sites at a significant scale.

(b) Improved awareness and capacities for understanding the potential role of wetland restoration in lake restoration is another important impact of the project. Despite weaknesses in the institutional design of this project, the YEPB has clearly benefited greatly from project outcomes and experience. This will play an important role in shaping local authority responses to lake management at both Dianchi and the other plateau lakes. Senior officials from the province and from the State Council have visited the project sites to review the potential of these wetland restoration approaches for other lake systems in Yunnan Province and China. Once published, the Wetland Restoration Manual should play a useful role in guiding these broader efforts elsewhere. At the local level, the evaluation of the Public Awareness component demonstrates clearly that the project has had a positive impact on both attitudes and behaviour of local stakeholders, including farmers, school children and the broader public in Kunming and around the Lake Dianchi watershed.

(c) Development of wetland restoration models has been a success, although it is too early for objective assessment of the longer-term sustainability of these models. Particular highlights are: (i) The integrated *Ottelia* – fish farming models that could deliver significant benefits for lowering nutrient loading entering the lake system as well as economic benefits for local farmers; (ii) The emergence of macrophyte restoration in combination with the 'broken dyke model' as the most appropriate model for many suitable areas around the lake. Much useful information will be gleaned from the planned scale-up by the YEPB of this pilot work at Xialiangwang. If successful, this will diversify the range of options available to local authorities for lake restoration – currently focusing on (costly) mechanical efforts, such as suction dredging; (iii) Bio-filtration using bivalves is an this innovative approach with real potential to provide a highly cost-effective and sustainable means for lowering suspended plankton loads, and thus creating better conditions for the restoration of macrophyte communities. This potential was recognized by grant support from the Bank's Development Marketplace that enabled this technique to be expanded to six other plateau lakes in Yunnan.

(d) The Wetland Restoration Manual: Experience from project-supported wetland restoration activities has been distilled into the Wetland Restoration Manual currently in its final draft stage). The aim of the Manual is to share the considerable practical experience on wetland restoration developed and tested by the project. The quality of the manual is impressive and it is clear that this document will be of substantial future use for local authorities at Lake Dianchi, the other eight plateau lakes in Yunnan Province and elsewhere in China and Asia. For this reason, it will be important to ensure this document is widely publicized and disseminated in print and electronic format after project completion.

8. Overall TF Outcome

Overall, the outcome of the project is rated as satisfactory.

D. RISK TO DEVELOPMENT OUTCOME

Outcome	Risk	Assessment
Restoration of at least three lengths of shoreline to some semblance of their natural state	Negligible to Low	The original design intended that shorelines would be re-modelled and re-profiled. The Dianchi Management Regulation of 1988 prevented any progress being made. However, the low rating assigned to this outcome reflects the high likelihood that wetland restoration efforts will continue post-project, for example through scaling-up and replication of the 'broken dyke' model approach and through *Ottelia* establishment in fish ponds around the lake's shores.
Plans for management and restoration interventions integrated with broader local government plans.	Moderate	Formalized integration into provincial and local plans had not taken place by project closure. This is partly because the results of the project will take time to emerge fully, and therefore it would be inappropriate to mainstream these approaches without a firmer basis of evidence of their likely success at a larger scale. YEPB appears enthusiastic and committed to scaling-up restoration approaches as the project supports provincial wetland restoration policy.
Environmental degradation of the lake shore and tributary ecosystems slowed down and reversed in at least three areas	Moderate	The project has improved awareness of environmental degradation issues around the lake and along tributaries and this should contribute to improve future environmental management. Post-project risks to this outcome exist as a result of development pressure, including rapid infrastructure development to serve a rapidly expanding provincial economy.
Good quality and fundamental ecological information provided.	Negligible to Low	The project has generated a wealth of information on the ecology of the lake and its tributaries, and this will inform and improve development planning throughout the watershed. The KIZ, with support from provincial sources and the Chinese Academy of Sciences, remains committed to continuing its work in and around the lake on restoration ecology.
Appropriate training will be provided for local government officials, university staff in adaptive wetlands management and biodiversity conservation	Moderate	Most training during the project was delivered to University staff and students and to local farmers. Local government officials participated in study tours but there was no systematic training program. Continuation and scaling-up of training for local officials will be a key ingredient for post-project 'success', but will only happen if resources are allocated for this by State, provincial or municipality-level authorities. The Wetland Restoration Manual will provide an important means for providing technical guidance for subsequent restoration work and is based on project experience during implementation.
Public support for, and interest in, the biodiversity of Lake Dianchi generated.	Moderate	The project made tangible progress in raising public support for (improved) biodiversity management in the Lake system. The KIZ remains committed to helping ensure that the high profile raised for these issues will be maintained to the extent possible after project completion. Involvement of the Buddhist Association of Kunming and the Kunming Zoological Park will likely contribute to longer-term public support for biodiversity conservation, even after the project is completed. The extent to which these efforts will continue after project completion will depend largely on continued commitment by Yunnan provincial authorities and Kunming Municipality. The displays at Kunming Zoological Park, for example, will remain in place for the foreseeable future.

9. Follow-on results and/or investment activities

(a) The YEPB is funding and managing an expansion of the Xialiangwang pilot site to 230 ha and is seeking additional support from other public and private sources. The YEPB views the project as complementary to other efforts to clean the lake system, including the installation of sewage treatment facilities and dredging work. The DMB has agreed to manage the Baiyukou pilot site after project completion. The Yunnan Science and Technology Bureau is supporting the KIZ with an input of approximately US$1.2 million to continue and scale-up wetland restoration activities at Xialiangwang pilot site. The KIZ will remain involved at both sites on a research basis. The Bank's Development Marketplace is providing grant support for the '*Musselling in on Pollution*' project that seeks to continue support for bivalve bio-filtration work at Lake Dianchi and expand this to six other plateau lakes. The display boards about Lake Dianchi's freshwater biodiversity will continue to be displayed at Kunming Zoological Park and will therefore continue to perform their role in public awareness-raising.

10. Replicability

(a) At the Lake Dianchi level: The YEPB has agreed to fund the scaling-up and replication of pilot approaches to 230 ha of reclaimed land adjacent to the existing Xialiangwang pilot site. Further work is needed to identify other sites where the 'broken-dyke' model could be applied. The KIZ estimates that this approach could be applied to around 10 percent of the perimeter of the lake and would be supported by provincial lake restoration policy. There are good prospects for substantial replication and scaling-up of *Ottelia* farming in fishponds around the lake, and these efforts should help reduce non-point source pollution from reaching the lake. As discussed above, bivalve and biotic indexing work expanded to cover six other plateau lakes.

(a) At the provincial level: The YEPB expressed the view that the project holds useful lessons for the other eight plateau lakes of Yunnan province. Each of these lakes faces a different mix of environmental problems, but the broad mix of approaches piloted in the project offers a useful 'menu' of options for the restoration of these lakes, ranging from controlling invasive species, macrophyte restoration, bio-filtration, fish breeding and re-introduction, and water quality monitoring. The Wetland Restoration Manual will provide a useful set of guidelines for other local authorities in the province.

(c) At the national level: Officials from the National (State) level have visited the project and pilot sites with a view to replicating project experience elsewhere in China and the Province. Lessons from the project will be of value to China's Wetland Action Plan and for the "Three Lakes, Three Rivers" policy[12] approved by the State Council.

E. PERFORMANCE

11. World Bank

(a) **Performance assessment:** The recipient expressed the view that the Bank's performance had been firm but fair and was highly regarded by the KIZ. Bank support throughout implementation has been delivered to a high standard. The Bank also provided the KIZ with support in persuading local authorities to provide access for survey teams at the Songhuaba

[12] The three lakes covered by this policy are Taihu, Chaohu and Dianchi. The policy was approved by the State Council in 2003 and will be supported by US$14.9 billion of state funds.

Reservoir, previously restricted on the grounds of protecting water supply security, and to encourage provincial authorities to undertake steps to control Grass Carp in the lake system. The latter has met with partial success as the YEPB are now drafting regulations specifically targeting the control of invasive species. The Bank's performance is rated as satisfactory.

12. Recipient

(a) **Performance assessment:** Management difficulties during the early stages of the project constrained early progress and threatened to derail the project entirely. On reflection, these problems are attributed to a lack of experience in managing grant-supported projects of this kind despite training in financial management and procurement being provided to project staff by the Bank at the beginning of the project. As a result, the project was rated as 'partially unsatisfactory' in early 2005. The project overcame management problems in mid-2005 by seconding dedicated management expertise to the project. This provided a firm foundation of support for the scientific, technical and public awareness work of the project. Throughout implementation, the project team implemented the project with enthusiasm and energy, and showed great ability to respond adaptively to emerging research priorities and unforeseen setbacks. Work had a high degree of technical and scientific rigour and was often highly innovative. Overall, the recipient's performance is rated as satisfactory.

F. LESSONS LEARNED/RECOMMENDATIONS

(a) Demonstration value: The project showed the considerable potential of ecological restoration approaches for addressing the problems of China's highly degraded freshwater lake systems. Whilst it remains too early to draw firm conclusions, initial project results are promising, and indicate that cost-effective and sustainable results are achievable if management interventions: (a) are based on a sound scientific and technical platform, and (b) are phased and integrated carefully. In this case, the different elements were an initial focus on 'getting the physical environment right' to enable ecological recovery to take place, and then sequenced interventions on specific themes (macrophytes, bivalves, fish re-introductions, developing farmer-based models), supported and linked to public awareness and monitoring work.

(b) Changing attitudes and behaviour is possible. The project has shown that it is possible to achieve positive changes on attitudes and behaviour to environmental degradation and biodiversity management at a large scale, but to do this requires a diversity of approaches, including mass media, working with schools, local authorities and faith groups and working at the farmer level. The interpretational facilities established at the Yunnan Minorities Village, and then moved to the Kunming Zoological Park, were viewed by over 1.1 million people in just six months of 2007.

(c) The importance of an early focus on management capabilities. Projects of this scale, whilst small by Bank standards, pose a major management challenge to institutions that lack prior experience of Bank systems for planning, reporting, financial management and procurement. A clear lesson to emerge from this project is the need for systematic and thorough institutional assessment and broad-based management training for project staff. This was provided by the Bank at the beginning of the project but it seems these new skills did not pervade the project team sufficiently. Ensuring that project teams are established with sufficient and dedicated management expertise is critical. This was not the case in the early stages of the project where management functions were delegated to junior and inexperienced staff. These management shortcomings nearly curtailed project activities in early 2005.

Annex 1: Main documents reviewed

Annex 1

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Jin Xiangcan, Wang Li and He Liping (2004?) *Lake Dianchi: Experience and Lessons Learned Brief.*

LBFBRP (2008). *Quarterly progress Report No 12. January 1st – March 31st, 2008*. Lake Dianchi Freshwater Biodiversity Restoration Project. Kunming Institute of Zoology, Chinese Academy of Sciences. April 30th 2008

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Xiao-Yong Chen (2008). *Annual Monitoring Report on Aquatic Biodiversity in Lake Dianchi Drainage 2007*. Lake Dianchi Freshwater Biodiversity Restoration Project.