

## *Darwin Initiative Annual Report*

Important note:

To be completed with reference to the Reporting Guidance Notes for Project Leaders – it is expected that this report will be about 10 pages in length, excluding annexes

Submission deadline 30 April 2008

### **Darwin Project Information**

|   |  |
|---|--|
| Project Ref Number  | 162/14/029   |
| Project Title   | Monitoring and simulating threats to aquatic biodiversity in the Okavango Delta        |
| Country(ies)  | Botswana   |
| UK Contract Holder Institution  | UCL  |
| UK Partner Institution(s)   |  |
| Host country Partner Institution(s)   | Harry Oppenheimer Okavango Research Centre (HOORC), University of Botswana             |
| Darwin Grant Value  | £188,441   |
| Start/End dates of Project  | 01-Jan-06 to 31-Dec-08   |
| Reporting period (1 Apr 200x to 31 Mar 200y) and annual report number (1,2,3..) | 1 Apr 2007 to 31 Mar 2008<br>Annual report 3   |
| Project Leader Name   | M. Todd & AW Mackay  |
| Project website   | <a href="http://www.geog.ucl.ac.uk/~mtodd/accord">www.geog.ucl.ac.uk/~mtodd/accord</a> |
| Author(s), date   | Mackay, A.W., Todd, M., Wolski, P. & Jones, J April 2008                               |

## 1. Project Background

The Okavango Delta (OD) in northwest Botswana is the world's second largest inland wetland region. The delta is maintained by annual pulse flooding of the Okavango River (whose catchment lies largely in the highlands of central Angola) creating wetland habitats with exceptionally high beta diversity. The annual flooding in the delta is out of phase with the local wet season so that it provides a water resource in the dry season. It is one of the WWF's top 200 eco-regions of global significance and the world's largest Ramsar site. The Okavango river system is considered by many to be the last near pristine river in Africa. However, the system is under threat from potential development initiatives in the basin and from climate change. This project (led by Todd and Mackay at UCL) aims to build capacity in key institutions involved in conservation of biodiversity in the OD, to assist in implementation of the Convention on Biological Diversity (CBD). This will involve an integrated, multi-disciplinary programme of (a) scientific research to develop baseline aquatic biodiversity characterisations (phytoplankton, macroinvertebrate and macrophyte assemblages) and their relationship with hydrological drivers, namely the hydroperiod and water quality; (b) training in methods of aquatic biological data collection, analysis and system modelling. This will enable the simulation of aquatic biological diversity responses to scenarios of future changes to basin climate and hydrology, which will be crucial to informing policy decisions for biodiversity protection/conservation within the Okavango Delta Management Plan.



## 2. Project Partnerships

In addition to the formal activities, the project partners are in email contact on an almost daily basis to ensure problems can be identified and addressed quickly. Moreover, regular contact is also maintained via *Skype*. Mackay visited HOORC twice during the last financial year (May + October 2007); Davidson visited HOORC once (July 2007); Wolski visited UCL for one week in Jan 2008 to develop a geo-referenced environmental database

The partnership between UCL and HOORC is still on course to influence the host institution's capacity to meet CBD commitments. Formal links have now been made between the following projects: (i) *Building Local Capacity for the Conservation and Sustainable use in Biodiversity in the Okavango Delta (BIOKAVANGO Project)* (a multi-million-dollar programme funded by the UN Global Environment Facility (GEF), with co-financing by the Government of Botswana, IUCN, plus several other smaller organisations; (ii) *IUCN Freshwater Biodiversity project*: Funded by EU FP6, co-ordinated by Dr Will Darwill, at IUCN, Cambridge.

HOORC have employed Jessica Jones co-ordinate biodiversity research and training across the three programmes. This has had the effect of ensuring excellent communication between the three projects, and the co-ordination of specific training (e.g. a short course in environmental monitoring held in Jan 2007, and short course in numerical analysis of environmental and ecological data held in Oct 2007).

## 3. Project progress

This project report is structured around the key milestones originally highlighted in the project timetable.

### **3.1 Progress in carrying out project activities**

#### **Sampling programme**

Three planned fieldtrips were carried out this year: April / May 2007; July 2007; October 2007. Each lasted approximately 2 weeks. During April / May 2007, samples were collected for macroinvertebrates, diatoms and aquatic macrophytes. During July 2007, samples were collected for macroinvertebrates, diatoms and some additional sites were investigated for macrophytes. During October 2007, samples were collected for macroinvertebrates and diatoms. Hydrological variables including pH, conductivity, water velocity, depth and temperature were collected for every site sampled. Other chemical analyses were also carried out. See <http://www.orc.ub.bw/datacat/darwin.php> for details.

All planned fieldwork has now been undertaken. However, an extra fieldtrip was undertaken by the HOORC team in September 2007 (led by Richard Mazebedi), which took a boat up the length of the Okavango Delta and Okavango River to the Namibian border. This is the first Darwin trip that the HOORC team have undertaken without UCL guidance, clearly highlighting that our aims of training and capacity building have been successful. These samples will eventually be added to our database.

- Macroinvertebrates have been identified and counted for all trips, so this aspect of the analyses is now complete.
- Diatoms have been counted and identified for Sep 2006, December 2006 and May 2007 trips. Remaining samples are currently being counted.
- Aquatic macrophytes have been identified and counted for the May and July 2007 trips. This aspect of the analyses is now complete.

#### **Statistics for ecology, computing and climate analyses training to be held at HOORC**

A course in multivariate statistics for ecological and environmental analyses was held at HOORC between 8<sup>th</sup> – 9<sup>th</sup> October, 2007 (see Appendix). This was a successful meeting, attended by 3 HOORC scientists and (importantly) 5 workers from 3 different government departments: Department Water Affairs, Department of Fisheries, and Department of Wildlife and National parks. Two further days were spent at HOORC working on multivariate analyses datasets collected during the Darwin programme. Training schedules and guidelines were produced for the course and are available on the website. Participants included: Dr Phillipa Hunstman-Mapila, Richard Mazabedi and Dr Piotr Wolski all from HOORC; Tumisang Moatlhodi, Connie G. Maphale and Joy M.M. Moruakgomo all from Department of Water Affairs; Gaseitsiwe Masunga, Department of Wildlife and National Parks; Thethela Bokhutlo, Fisheries Research Officer, DWNP.

#### **Key IBIs developed and statistical predictive models of IBIs and hydroperiod developed.**

Statistical analyses of the biological data has been continuous, as data have been collected and counted. Predictive models between e.g. diatoms and hydroperiod, and macroinvertebrates and hydroperiod have been developed in the first instance, although improvements to these models are currently our main objective.

IBIs are still to be developed, and these are planned for the final year of the project, in conjunction with the Biokavango and IUCN programmes – see below for further details.

#### **Database of high resolution future climate delivered fro UCL to HOORC:**

- (a) Under the NERC-GSI project we have access to estimates of precipitation and temperature from multiple GCMs at high resolution, downscaled using a pattern-scaling approach. These future climate estimates are expressed as a function of global mean temperature change rather a particular time period. These data will be available by summer 2008.
- (b) Under a NERC funded PhD studentship two sets of future estimates of precipitation and temperature at high resolution have been derived using two regional climate models (MM5 and PRECIS). These are being evaluated and will be distributed to HOORC by June 2008.

## Work begins on creating multiple 20 yr datasets of future monthly river discharge and flood extent using hydrological models driven by future climate data inputs

We are undertaking an extensive ensemble of multiple hydrological model simulations using an integrated suite of hydrological models covering (i) the Okavango river basin (ii) the Okavango delta, which will result in a probabilistic description of future flood characterising uncertainty in (i) future greenhouse gas (GHG) emissions (ii) GCM responses to GHG forcing. Work to be completed by Sept 2008.

1. Hydrological models driven by precipitation and temperature estimates from 21 GCMs from the IPCC AR4 (2007)
2. Hydrological model simulations driven by pattern-scaled GCM estimates (see (a) above)
3. Hydrological model simulations driven by estimates of precipitation and temperature from multiple RCMs (see (b) above)

### 3.2 Progress towards Project Outputs

We think that we have made very good progress with regard to the majority of the project outputs. Data analysis is still underway, but these will form the basis of forthcoming manuscripts (in addition to the 4 papers published in a special issue of Journal of Hydrology on climate change and hydrology in the Okavango Delta, guest edited by Kniveton & Todd.

### 3.3 Standard Measures

**Table 1 Project Standard Output Measures**

| Code No.          | Description   | Year 3 Total                               |
|-------------------|---|--|
| Established codes |   |  |
| <b>2</b>          | As highlighted in last year's report, we were unable to secure a second MPhil research student to be based in Botswana. However, we were able to secure 3 MSc students (2 British 1 Belgium) from UCL to undertake dissertation projects on the Okavango Delta. Two were directly linked to this Darwin project, while the third was associated with the Darwin & Biokavango project (see below for details)<br><br>The Darwin MPhil student (Botswana) will complete their degree in the next financial year | 3  |
| <b>4A/B</b>       | 6 UB undergraduates attended the HOORC winter school during 2007-2008   | 6  |
| <b>5</b>          | As highlighted in last year's report, this has changed from the original detail given in the proposal. 5 technicians from Botswana linked to our Darwin programme are receiving training in lab and field techniques. One MPhil student is still working on the programme (Mr Richard Mazebedi)   | 5 technicians (including MPhil researcher) |
| <b>6A/6B</b>      | Course on climate analysis will be held during the next financial year  |  |
| <b>6A/6B</b>      | Several HOORC staff (5) undertook further training in sampling and monitoring of the Okavango Delta:  | 5  |
| <b>6A/6B</b>      | As by prior agreement with Darwin, Mackay held a short course in multivariate statistics, with special emphasis on investigating relationships between biodiversity in the  |  |

|            |  |   |
|------------|--|---|
|            | Okavango Delta and prevailing geography + environment. Although scheduled for 2 days, 4 days were spent training (2 with lectures and practical classes; 2 with 1-2-1 tuition helping with analyses of datasets)   |   |
| 7          | Training documents for the short course in multivariate statistics are available on-line<br><br>We have also committed joint funds with IUCN and Biokavango projects to produce a training video, as indicated in the 6 month report (this currently being filmed, Apr 08) |   |
| 8          | April / May - 2 weeks (Mackay & Davidson)<br><br>July - 2 weeks (Davidson & Goldsmith)<br><br>Oct - 1 week (Mackay)<br>Total person weeks spent in Botswana = 9. This is because (as notified last year) some fieldwork from 2006-2007 was postponed til 2007-2008         | 9 |
| 11B        | Data analyses exploring relationships between each of macroinvertebrates, macrophytes and diatoms and their environment are currently being undertaken. These analyses are forming the basis for at least 2 or 3 manuscripts   |   |
| 12A        | PhD by Srivatsan Raghavan "Climate variability and change over the Okavango River basin, southern Africa" has been completed and is awaiting examination   |   |
| 12A        | Geo-referenced environmental database: see <a href="http://www.orc.ub.bw/datacat/darwin.php">http://www.orc.ub.bw/datacat/darwin.php</a>   |   |
| 14B        | preliminary ecological results were presented at the British Ecological Society in Glasgow (10 <sup>th</sup> – 12 <sup>th</sup> September). A handout of this talk is also available on the website.   |   |
| Additional | IBIs are currently still in development (see below for further details), although relationships between many taxa and hydroperiod have now been characterised.   |   |

Below we highlight three unpublished dissertations that were completed this year. Abstracts for each are given in the Appendix. Copies of these dissertations have also been lodged at the HOORC library

Gwilym Neal (MSc Conservation, UCL) *Factors influencing the distribution and diversity of aquatic macrophytes in selected regions of the Okavango Delta, Botswana*

Selina Woodward (MSc Conservation, UCL; Dissertation distinction) *The distribution, composition and diversity of diatom assemblages in relation to environmental factors in the Okavango Delta: special reference to diatom use in conservation and monitoring*

Barbara Herrero Cangas (MSc Conservation, UCL; Dissertation distinction) *Integrating gender and livelihoods in a biodiversity conservation project: a case study of the invisible stakeholders in the Okavango Delta Panhandle*

**Table 2 Project Standard Output Measures for each Year**

| Code No.          | Description                                     | Year 1 Total | Year 2 Total | Year 3 Total      | Year 4 Total | Total to date | Total planned from application |
|-------------------|---|--------------|--------------|-------------------|--------------|---------------|--------------------------------|
| Established codes |   |              |              |                   |              |               |                                |
| 2                 | MSc Qualification                               |              |              | <b>3</b>          |              |               |                                |
| 4A/B              | UB ugrads to winter school                      | 7            |              | <b>6</b>          |              |               |                                |
| 4C                | Mazebedi training                               |              | 1            | <b>1</b>          |              |               |                                |
| 5                 | Technician training                             |              | 5            | <b>5</b>          |              |               |                                |
| 6A/6B             | RF trained at UCL<br>(person x no. weeks)       | 1 x 2        | 2 x 3        |                   |              |               |                                |
| 6A/6B             | Fieldwork training                              |              | 4 x 1        | ✓                 |              |               |                                |
| 6A/B              | Training in monitoring and sampling in Botswana |              | 15 x 1       |                   |              |               |                                |
| 6A/B              | Training in multivariate statistics             |              |              | <b>8</b>          |              |               |                                |
| 7                 | Digital images<br>Training protocols / manuals  |              |              | ✓                 |              |               |                                |
| 8                 | UK staff to Botswana<br>(total no. weeks)       |              | 12           | <b>12</b>         |              |               |                                |
| 10                | On-going  |              | ✓            |                   |              |               |                                |
| 11B               | Data analyses                                   |              |              | ✓                 |              |               |                                |
| 12A               | Models of future climate change                 |              |              | ✓                 |              |               |                                |
| 12A               | Geo-referenced environmental database           |              |              | <b>1</b>          |              |               |                                |
| 13A               | Spp reference collections                       |              | 1            |                   |              |               |                                |
| 13B               | On-going  |              | ✓            |                   |              |               |                                |
| 14A               | Workshop  |              | 1            |                   |              |               |                                |
| 14B               | Conferences                                     |              |              | ✓<br><b>(BES)</b> |              |               |                                |
| 15A/B             | Press release                                   | 1            | 1            |                   |              |               |                                |
| 17A               | Dissemination networks                          | ✓            | ✓            |                   |              |               |                                |

### **3.4 Progress towards the project purpose and outcomes**

Very good progress has been made towards the project purpose of undertaking scientific research to develop baseline aquatic data on phytoplankton, macroinvertebrates and macrophyte assemblages. We have sampled a total of 123 locations from across the Okavango Delta – this is substantially more locations than we first anticipated in the report (c. 100). However, in order to account for possible seasonal influences, many of the locations were visited on more than one occasion. Thus we have in total collected biological material (e.g. macroinvertebrates) from over 230 sites – full details will be given in an ECRC Research Report which will be completed this summer (Mackay et al. in prep).

Their relationships to hydrological drivers and water quality are currently being tested. Richard Mazebedi (the Darwin MPhil student) is visiting UCL between 21<sup>st</sup> April – 4<sup>th</sup> May 2008, when the bulk of statistical analyses will be carried out.

Training in methods of aquatic biological collection and analysis has been on-going since the start of the programme.

Hydrological modelling for this project has been completed (Wolski) and estimations for every site for flood and hydroperiod have been derived.

High resolution estimates of future climate using regional climate models has also just been completed by the UCL PhD student (Srivatsan Vijayaraghavan) associated with the Darwin programme.

### **3.5 Progress towards impact on biodiversity, sustainable use or equitable sharing of biodiversity benefits**

We are now working in conjunction two other programmes (Biokavango and IUCN) to develop our IBIs for the Okavango Delta. The IBI based on Macroinvertebrates will develop from recently published work by Dallas & Mosopele (2007). We hope to develop an IBI based on aquatic macrophytes in conjunction with Dr Erwin Sieben from the University of the Free State, South Africa. An IBI based on diatoms will follow later in the year. Production of these IBIs are being co-ordinated by Jessica Jones, and will form part of the basis for future environmental monitoring of the Okavango Delta.

#### *Monitoring, evaluation and lessons*

Monitoring of our project has taken several forms. With respect to data analysis and collection, evaluation can best be measured by the number of sites visited and biological and water chemistry samples analysed – see above for details. Outputs include the environmental database developed by Wolski (see website above), production of the PhD thesis by Raghavan (supervised by Todd), the successful completion of 3 MSc dissertations at UCL and the successful upgrade of Mazebedi to MPhil.

## **4. Actions taken in response to previous reviews (if applicable)**

There were a few minor comments raised in last year's review:

*I could not get the link to HOORC to work from the Project Team page – the webpage has been updated, and all links should now work.*

*There seems to be a glitch accessing the Project Aims page directly after the Project Team page – which is the running order in the menu on the left of the webpage. The Aims page can be reached via other routes, so I am not sure why the page isn't recognised coming out of the Project Team page. Done*

## **5. Other comments on progress not covered elsewhere**

Has the design of the project been enhanced over the last year, e.g. refining methods, or exit strategy?

- Yes – we have been able to sample a greater number of sites than originally expected. This has allowed us to increase the number of sites spanning the hydrological gradient, as well as likely increasing beta diversity.

Discuss any significant difficulties encountered during the year and steps taken to overcome these if not already discussed elsewhere.

- Some water chemistry variables are not available for every trip – this was due to unforeseen malfunctions in e.g. lab equipment. However, as we have made measurements for different seasons, we are looking into ways of using annual estimates of missing variables where appropriate
- In May 2007, flooding of the Delta was particularly extensive, which meant that we were unable to visit sites in the Lower Panhandle region. Instead we spent extra time at other regions collecting more samples.

Does the project face any particular risks?

- No

## 6. Sustainability

The extensive training that we have carried out provides significant sustainability stemming from the project.

Links to Biokavango and IUCN further enhance possibility for future sustainability – for example, the data collected as part of our Darwin project will feed into the Biokavango project.

## 7. Dissemination

Details of short courses were disseminated widely amongst relevant UB academic departments and Government departments.

## 8. Project Expenditure

| Item   | Budget (please indicate which document you refer to if other than your project application) | Expenditure | Balance |
|--|---|-------------|---------|
| Rent, rates, heating, overheads etc              |   |             |         |
| Office costs (eg postage, telephone, stationery) |   |             |         |
| Travel and subsistence                           |   |             |         |
| Printing   |   |             |         |
| Conferences, seminars, etc                       |   |             |         |
| Capital items/equipment                          |   |             |         |
| Others: subcontract + MRes fees                  |   |             |         |
| Salaries (specify)                               |   |             |         |
| TOTAL  |   |             |         |

As extra fieldwork was carried out in Botswana, local travel costs were higher, but this was balanced by lower direct costs to the Travel heading.

## 9. OPTIONAL: Outstanding achievements of your project during the reporting period (300-400 words maximum). This section may be used for publicity purposes



## Annex 1 Report of progress and achievements against Logical Framework for Financial Year: 2007/08

| Project summary   | Measurable Indicators  | Progress and Achievements April 2007 - March 2008  | Actions required/planned for next period   |
|---|--|--|--|
| <p><b>Goal:</b> <i>To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but constrained in resources to achieve</i></p> <p><i>The conservation of biological diversity,</i></p> <p><i>The sustainable use of its components, and</i></p> <p><i>The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources</i></p> |  | <p><i>Official collaboration between Biokavango and IUCN programmes on wetland biodiversity and sustainable use</i></p>  | <p><i>Construction of IBIs with collaborating projects</i></p>   |
| <p><b>Purpose</b> Assist in the ability of Botswana to implement CBD in the OD region, through programme of capacity building, training and scientific research.</p>  | <p>By end of yr 3:</p> <p>HOORC staff appointed and trained.</p> <p>New knowledge on (i) aquatic ecosystem functioning (ii) hydrological responses to future climate and development scenarios. Key IBIs and predictive models developed.</p> <p>Long-term biodiversity monitoring programme established based on IBIs</p> <p>Inputs to ODMP complete.</p> | <p>These are all progressing well: they are on budget, and will be complete within the Year 4 of the programme</p>   | <p>Completion of IBIs</p> <p>Development of predictive models based on empirical data collected</p> <p>Selection of sites for long-term monitoring</p> |
| <p><b>Output 1</b> Acquisition of extensive baseline aquatic biodiversity and water quality data across hydroperiod gradients in OD.</p>  |  | <p>Over 230 sites linked to 123 locations have been visited and geo-referenced. Data for macroinvertebrates and macrophytes are complete; data for diatoms are close to completion. Data for water chemistry, flooding and hydroperiod are complete.</p> |  |

|   |  |  |
|---|--|--|
| <b>Output 2.</b> Development of robust Indices of Biological Integrity (IBIs), sensitive to hydroperiod               |  | IBIs will be developed during the final year of the project in conjunction with IUCN and Biokavango.   |
| <b>Output 3.</b> Development of future scenarios of OD flood frequency, extent and duration and biodiversity response |  | Model scenarios will be completed in final year  |
| <b>Output 4</b> Establishment of on-going systematic biodiversity monitoring programme based on identified IBIs       |  | This is currently under discussion with members of HOORC, project leaders, and regional experts.   |
| <b>Output 5:</b> Dissemination of results   |  | Initial results between biological data and environmental variables have been presented at the British Ecological Symposium 2007 (see ACCORD website). Full diatom results will be presented at the International Diatom Symposium, Sept 2008. |
| <b>Output 6:</b> Training programme for staff at HOORC/IC & Botswana students completed                               |  | This has now been completed. The MPhil student (Mazebedi) will submit his thesis at the end of the project.  |
| <b>Output 7:</b> Relationship of project to CBD established through ODMP initiatives                                  |  | This will be finalised at the end of the project   |

## Annex 2 Project's full current logframe

| Project summary  | Measurable Indicators  | Means of verification  | Important Assumptions  |
|--|--|--|--|
| <b>Goal:</b><br><b>To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve</b> <ul style="list-style-type: none"> <li>• the conservation of biological diversity,</li> <li>• the sustainable use of its components, and</li> <li>• the fair and equitable sharing of benefits arising out of the utilisation of genetic resources</li> </ul> |  |  |  |
| <b>Purpose</b><br>Assist in the ability of Botswana to implement CBD in the OD region, through programme of capacity building, training and scientific research.   | By end of yr 3:<br>HOORC staff appointed and trained.<br>New knowledge on (i) aquatic ecosystem functioning (ii) hydrological responses to future climate and development scenarios. Key IBIs and predictive models developed.<br>Long-term biodiversity monitoring programme established based on IBIs<br>Inputs to ODMP complete.    | HOORC annual reports.<br>Scientific publications.<br>Joint partner project reports         | Government remains committed to CBD, Ramsar, and National Wetlands Policy. |
| <b>Outputs</b><br>Acquisition of extensive baseline aquatic biodiversity and water quality data across hydroperiod gradients in OD.  | Within 1 <sup>st</sup> 6 months of project: Candidate field sites (up to 100 for contingency) identified from existing 15 year satellite derived flood maps and local knowledge.<br>By mid Yr 2: Datasets of baseline aquatic biological diversity archived.<br><u>Contributions to UNDP GEF Wetland Biodiversity project underway</u> | Manual of field and lab protocols<br>Data archive of biological and chemical data. Reports | Field sites accessible during periods of flooding.                         |
| Development of robust Indices of Biological Integrity (IBIs), sensitive to hydroperiod   | By end yr 2 IBIs developed and tested, and statistical models relating IBIs to hydrology developed.  | Workpackage report sent to Darwin Initiative.<br>Publications.                             | HOORC Computing facilities maintained.                                     |
| Development of future scenarios of OD flood frequency, extent and duration and biodiversity response   | By mid Yr 3: Multiple 20 yr datasets of monthly river discharge and OD flood will be created using hydrological models, from scenarios of climate change/water abstraction.  | Workpackage report completed.  | Matched personnel at UCL will remain in post.                              |

|  |   |   |   |
|--|---|---|---|
|  | Initial prediction of resulting IBI.  | Scientific publications.  |   |
| Establishment of on-going systematic biodiversity monitoring programme based on identified IBIs. | Staff trained.<br>Monitoring equipment procured.<br>In yr 3 monitoring programme initiated.   | Workpackage report completed and sent to Darwin Initiative.   | Botswana government maintains funding for HOORC.            |
| Dissemination of results   | Datasets compiled in dual archive at HOORC and UCL, accessible to all. Project website established at UCL. Journal and conference publications submitted (min. 6).<br>Press releases for local and international media.                                 | Data archives documented<br>Copies of all manuals, reports, press releases and publications sent to Darwin Initiative | Computer facilities at UCL are constantly maintained.       |
| Training programme for staff at HOORC/IC & Botswana students completed.                          | Min. 8 HOORC/IC & <u>4 Government staff</u> trained in key aspects of project science.<br>Min. 2 HOORC academic staff trained in UK.<br>2 UB Masters by research in Yr 2.<br>UB students trained during HOORC Winter School (up to 10 per yr).          | Training manuals<br>Training feedback reports<br>Attendance records for training courses<br>Master theses             | HOORC staff remain in post, and the Winter School continues |
| Relationship of project to CBD established through ODMP initiatives.                             | Annual/final project reports produced for ODMP.<br>Presentation at meeting with ODMP.<br>Workshops at start and end of project (ODMP and stakeholders).<br>Report submitted to the tri-nation Permanent Okavango River Basin Water Commission (OKACOM). | Workshop minutes, presentations and feedback compiled and sent to Darwin Initiative.                                  | Reports will positively influence ODMP                      |

|                   |   |
|-------------------|---|
| <b>Activities</b> | Activity Milestones (Summary of Project Implementation Timetable)   |
| Research          | <p>Yr 1: Identification of candidate study sites (up to 100) from historical 15-year satellite derived dataset of flood history, aerial photos and local knowledge. Sampling basin will be range of hydroperiod conditions.</p> <p>Yrs 1 &amp; 2: Data collection from sites, laboratory analysis.</p> <p>Y2-3: Development of multiple high-resolution climate predictions (for 2030-50) using General Circulation and Regional Climate Models. Multiple 20-year hydrological model simulations over OD conducted, based on various (c 10) climate change and water abstraction scenarios. Development of IBI and statistical IBI models. Initial prediction of IBIs under hydrological scenarios.</p> |
| Training          | <p>Yr 1. Staff appointed at HOORC, equipment procured.</p> <p>Yrs 1-3: Training of Batswana staff in taxonomy, field methods, advanced numerical methods, computing and climate analysis. UCL staff will visit HOORC to deliver annual 1-week courses on each component, while key HOORC academic staff will visit the UK for specialist training. Senior undergraduate students from HOORC winter school trained each year. Yr 2: 2 UB Masters research projects</p>   |
| Dissemination     | <p>Yr 1: Production of guidelines, training manuals, protocols and web site</p> <p>Yrs 1-3: Submission/presentation to ODMP. Attendance at conferences</p> <p>Yr 3: Submission of final results to international publications, ODMP, OKACOM and media.</p>  |
| Management        | <p>UCL will retain overall responsibility for management of the programme. The establishment of a web site in Yr 1 will facilitate this.</p> <p>Project planning will be finalised at workshop at start of programme (Apr 2006)</p>   |

## Annex 3 onwards – supplementary material (optional)

Gwilym Neal (MSc Conservation, UCL) *Factors influencing the distribution and diversity of aquatic macrophytes in selected regions of the Okavango Delta, Botswana.*

The aim of this study was to examine the relationships between selected physio-chemical factors and the diversity, distribution and abundance of aquatic macrophytes in three distinct regions of the Okavango Delta, Botswana. A total of 14 sample sites were visited during April-May 2007. Five sites were located with the Upper Panhandle (Shakawe), 5 sites with Xakanaka (near the Moremi Game Reserve) and 4 along the Boro River (near Chief's Island). Species abundance and richness values were calculated using Berger-Parker and Margalef alpha diversity indices. A detrended correspondence analysis (DCA) was also performed to assess species assemblages in relation to their location within the delta. A total of 22 environmental variables were also recorded from each site, but only 9 were used in the final CCA. Water depth, velocity, total phosphorus, nitrates, dissolved oxygen, dissolved organic carbon, alkalinity, conductivity and pH showed significant relationships with the distribution and abundance of both submerged and emergent macrophyte species. Hydrological variation combined with the water depth however, was found to be the dominating influence on the community assemblage and diversity of macrophyte vegetation at a regional scale. The results of the study demonstrate the need to conserve the hydrological variations within the Okavango Delta that provide the habitat heterogeneity and consequently large floristic diversity. This point is of particular concern regarding the up and coming proposals for water abstraction – a concept that must be approached with caution and thorough prior research, in order to promote and conserve the natural integrity of this unique ecosystem.

Selina Woodward (MSc Conservation, UCL; Dissertation distinction) *The distribution, composition and diversity of diatom assemblages in relation to environmental factors in the Okavango Delta: special reference to diatom use in conservation and monitoring*

The purpose of this study was to characterise the spatial variation of diatom assemblages within three key regions of the Okavango Delta: the Upper Panhandle (Shakawe), the Moremi Game Reserve (Xakanaka) and the lower delta (Boro). A total of 71 taxa were identified belonging to 16 genera, with the characteristic and dominant species in assemblages proving to be cosmopolitan. Eunotia was the most abundant and species-rich genera, but beta diversity was high and assemblages variable across the whole of the delta. Canonical correspondence analysis indicated that total dissolved solids, nitrate, conductivity and dissolved oxygen were the most important variables determining species composition. Ecological indicator values obtained from van Dam et al. (1994) were applicable in the Okavango Delta and showed the identified diatoms to be highly indicative of environmental conditions. The contribution of anthropogenic activities to these varying chemical parameters was investigated, and where identified require response from management strategies to maintain the Okavango Delta's 'pristine' condition. Diatom-based bioassessment was shown to have great potential as a valuable tool in assessing the wetland's condition (both water quality and ecosystem health) and a useful addition to management strategies.

Barbara Herrero Cangas (MSc Conservation, UCL; Dissertation distinction) *Integrating gender and livelihoods in a biodiversity conservation project: a case study of the invisible stakeholders in the Okavango Delta Panhandle*

This dissertation presents a theoretical framework of co-management and illustrates the importance of this in building the necessary linkages between environmental management and rural livelihoods. It analyses it within the context of a good governance framework, paying special attention to the importance of attaining equity amongst resource users, especially between genders. This frames the case study: "the invisible stakeholders in the Okavango Delta Panhandle" in which a real-life example of a co-management project that aims at achieving the sustainable management through the implementation of a good governance agenda in the fisheries in the Okavango Delta, Botswana. Within a national institutional context promoting the values of sustainability, the socio-economic situation of traditional subsistence basket fisherwomen is assessed/ The importance that the Biokavango Project is conferring into gender issues, and the degree to which these women are participating in the co-management process will be the main focus of this research. As such, the dissertation also aims to contribute to the emerging field of 'Gender & Fisheries' research, especially to the debate on gender equality, and women participation and inclusion in environmental and fisheries management programmes.

# Short Course at HOORC: Numerical Analyses of Biological and Environmental Data Maun, Botswana

8 and 9 October, 2007

Biological and environmental data are usually complex, consisting of many observations and many variables. This short course provides an overview of the main ordination techniques of multivariate data analysis that are relevant and useful in ecology and in the study of environmental change. Emphasis is on statistically robust and ecologically realistic numerical techniques for both descriptive and hypothesis-testing purposes. The course will draw on recently collected datasets from the "Monitoring and simulating threats to aquatic biodiversity in the Okavango Delta" project.

The structure of the course is spread over two days, and will consist of:

- One 2 hour lecture on introduction to ordinations: what is ordination, how can we use it, and interpretations
- Two 3 hour practical sessions:
  - *Indirect gradient analysis (ordination) - principal components analysis (PCA) for exploration of environmental and chemical data; correspondence analysis (CA) and detrended correspondence analysis (DCA) for exploration of biological data*
  - *Direct gradient analysis (constrained ordination) - canonical correspondence analysis (CCA) for the investigation of environmental impacts on species variation in the Okavango Delta.*

The course is planned for October 8 and 9 at the University of Botswana's Harry Oppenheimer Okavango Research Centre (HOORC) in Maun ([www.orc.ub.bw](http://www.orc.ub.bw)). It will be conducted by Dr Anson Mackay, Reader in Environmental Change, University College London (UCL). Dr Mackay's research is focused on reconstructing environmental change, especially in continental Eurasia (Lake Baikal and the Aral Sea) as well as tropical and southern Africa. He is currently the research co-ordinator of the Royal Society UK-BICER (Baikal International Centre for Ecological Research) programme and principle researcher on the UCL-HOORC Darwin aquatic biodiversity monitoring project.

Attendance itself is free. Travel, food and accommodation are the responsibility of the participants. Individuals traveling from Maun can be collected and returned from HOORC. Please register before Thursday, October 4 with Ms Jessica Jones ([jjones@orc.ub.bw](mailto:jjones@orc.ub.bw)), Tel: 681-7140.



*Checklist for submission*

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