A Biodiversity Atlas
for Lake Malawi/Nyasa/Niassa

Final Report

Digital Data Version 2.0

August 2000

Editor:

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SADC/GEF Lake Malawi Biodiversity Conservation Project

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SADC/GEF Lake Malawi Biodiversity Conservation Project

Abstract

This report and CD ROM is the release of documentation and data in support of the Biodiversity Atlas objective of the Lake Malawi Nyasa Niassa Biodiversity Conservation Project (LMBCP).

The objective of this document and accompanying compact disc is to provide and introduce the principal geographic, ecological, and taxonomic databases for the Biodiversity Atlas objective. All data are archived in one of four formats: 1) Geographic Information System, 2) relational database, 3) data tables, and 4) multimedia. Sections within this document show or describe basic elements of the data, and descriptions of software sufficient to operate the display and simple query of data. This report is introductory in scope and is not a tutorial of Geographic Information Systems or relational databases.

Independent database development is ongoing for all major project outputs. To simplify data management and sharing internationally, the database structures developed during the LMBCP project are provided here. All data can be linked to a Geographic Information System. The enclosed data provide a robust collection of information representing the status of knowledge about the physical geography, taxonomy, and ecology of the lake, and together constitute resource pool to which specific needs for further information can be focused. The manner in which the data are archived recognizes the need for flexibility as the end user has the choice of software and database design. Data integration beyond that provided here involves a need for knowledge of specific data queries by managers and scientists in the riparian nations, and also that data and software standards be established.

This report is divided into four sections. Section I lists and introduces the databases and supporting materials. The geographic databases are shown in section 2, including lake bathymetry, tectonic features in the lake and drainage, the coastal zone of Lake Malawi (shoreline types, number of fish drying racks, shoreline huts, dugout canoes), hydrodynamic model animations, fish ecology sampling sites, fish sampling sites of Ribbink and others, 1983, fish sampling sites of taxonomy, information summary sites, and high resolution sonar data from four locations in the southern basin where fish sampling has been frequent. Section 3 describes the aerial video frame surveys, and the structure of the relational or tabular databases. Section 4 provides introductory support for using the elements of the enclosed databases with an evaluation version of Map Maker Pro GIS software found on the accompanying CD ROM.

For additional database information consult the principal project scientist(s) regarding the development status of the databases, and the current version of the data at the time of your inquiry.

Correct citation for this publication using an example from section 3.7 is:

Thompson, A.B. 2000. Section 3.7 Database for fish caught in the SADC/GEF Project. *In:* Cooley, P. M., (editor). A Biodiversity Atlas for Lake Malawi Final Report. Centre for Earth Observation Science Technical Report, 7 – 1 - 00. 71 p.

Table of Contents

1.0   A Digital Biodiversity Atlas for Lake Malawi/Nyasa/Niassa

A digital atlas is more flexible than is a traditional hard copy atlas. Digital data are more readily updated, and can be used to monitor change. In the case of Malawi/Nyasa/Niassa, many of the attributes of scientific or management interest are poorly known (e.g. the distribution of fish species) or presently have a high rate of change (e.g. land cover, lake sediment dynamics). Digital information can play a more direct and ongoing role in biodiversity conservation than can a hard copy atlas. Also, digital information can provide environmental awareness of the changes occurring in the drainage basin of Malawi/Nyasa/Niassa because it can be inexpensively given very wide exposure by making select outputs available as an Internet-accessible resource.

The database designs implemented by the principal investigators of the Lake Malawi Biodiversity Conservation Project (LMBCP) are advantageous structures to maintain for two reasons. Each database is small and relatively easy to work with. For non-experts, large relational databases tend to be less flexible, more difficult to manage, and harder to update. Secondly, the development of the present databases can be expected to continue by the principal scientists internationally as the synthesis of existing and new taxonomic and ecological data become available. By keeping a like database format new additions or exchange of data are simplified. The enclosed relational or tabular databases, then, are logically viewed as a resource from which specific information can be extracted on an as needed basis.

The approach for end use of data recognizes that flexibility is key to maximize data use. The map databases provided here are shown in section II using in Map Maker Pro 2.4 Geographic Information System (GIS) format. ESRI shapefiles are also archived for vectors. This includes the physical data for the drainage basin, coastal zone, and lake (P. Cooley), and the site locations of the taxonomy (J. Snoeks), ecology (F.Duponchelle, A. Thompson), sandy shore (R.Sululu), and rocky shore fish distribution (Ribbink et al 1983) sampling programmes. Further exploration of the enclosed relational databases, or data tables, involves the extraction of a single table of data that can be moved into a GIS for display and analysis. To adopt a single GIS standard (with a proprietary file format) at this time may incur a monetary expense by users in developing nations that may limit access to the enclosed data. As a result, some multimedia information contained on the companion CD is not linked to the demonstration GIS datasets because the longer-term target mapping software is to be determined.

1.1   Biodiversity Atlas Database List (v 2.0):

The biodiversity Atlas data are divisible into vector and raster maps, relational data bases, data tables, and multi-media. All are archived on a single compact disc accompanying this document.

- Bathymetric data of Lake Malawi (20 m contour, and 20 m depth polygon file)
- Coastal Classes: rock, sand, vegetation, and combinations
- Distribution of lake shore communities
- Distribution of canoes
- Distribution of fish drying racks
- Taxonomy fish relational databases and species list for lake (J. Snoeks)
- Ecology fish relational database (F. Duponchelle and A. B. Thompson)
- Rocky shore species data (from: Ribbink et al. 1983)
- Sandy shore species data summary tables (R. Sululu)
- Digital lake current and temperature animations (P. Hamblin, NWRI, Canada)
- Select digital aerial video segments around the lake
- Aerial video comment data table
- Watersheds for drainage basin
- Rivers for drainage basin
- Rift structures - distribution of Graben's, Monoclines, and select topographic features
- False colour composite of most of Lake Malawi drainage basin (RESURS 01 satellite image, F.X. Mkanda).
- High resolution bathymetric maps (2 m contour) for select locations in the southern basin (Senga Bay, Linthipe Delta/Maleri islands, Thumbi Island West, Mumbo Island).

1.2   Multi-Media

- 4 PAL format video tapes showing all of Lake Malawi coastline and shoreline attributes
- 3 Kodak Compact Disc's showing still photography during the aerial surveys.
- LOTUS Screen Camera animations showing an overview of the Biodiversity Atlas Databases. Two *.scm files are archived.

- Microsoft Power Point (97) presentation of map databases.

1.3   Map Data Format:

- Universal Transverse Mercator coordinate system, Zone 36 South, Datum: Arc 1950 Malawi, Ellipsoid: Clarke 1880.
- Map Maker 2.4 software format, and ESRI shape file format for vectors.

1.4   Software provided on CD ROM:

- Map Maker Pro 2.4 GIS software evaluation version (21 days) for data view and export. Map Maker Pro 2.4 can be purchased for about 265 US at www.mapmaker.com. Most of the maps were built using Map Maker 2.4 build 49 found on the CD.
- Apple's "Quick time" Viewer for aerial video clips (*.mov).
- LOTUS Screen Camera animation player to view databases displayed using Map Maker
- Adobe Acrobat Reader for Map Maker technical documentation
- Photoshop Acquire Module, WINDOWS, v1.0. Adobe Photoshop is required to view the digital aerial video still photographs. If you can not open using your version of Photoshop, install this program to view the KODAK *.Pcd files.

    To successfully extract this file
            go to the DOS prompt,
            change directory to the location of the file
            type the following: dd0123.exe -d

    Note: The -d must be there in order to preserve sub-directories in the compressed archive. See the README file for remaining install instructions.

- All files found on version 2.0 CD ROM are listed in FILELIST.TXT.

1.5   Data Use

The intention for the data is for application by those within the riparian nations surrounding Lake Malawi Niassa Nyasa. Open access is granted to citizens of the three riparian countries. Publication of elements of these data are already in progress by those involved in generating the data. All users of the data should contact the principal scientist of the data in question to ensure duplication of work is avoided.

The presentation or reproduction of these data will be accompanied by acknowledgement to the source of the data by project name, i.e. SADC/GEF

Lake Malawi Biodiversity Conservation Project, and the individual(s) primarily responsible for the submission of the data.

1.6   Version History

1.0, and 1.1: Initial archive and internal distribution within LMBCP project members (Ribbink, Hecky, Snoeks, Duponchelle, Cooley, Mkanda, McCullough, Pegado, Brook). April (v 1) and May (v 1.2) 2000.

1.2 Distributed to CIDA interns for initial data review in Malawi. July 18/2000

2.0 Final release of data to riparian nations. August 2000. Version 2.0 data supercedes previous releases. Most notable additions to geographic databases: rivers clipped to lake Malawi polygon, and new watershed boundaries produced for entire drainage. Final version of report and support documentation.

1.7   GIS Software

The manner in which the data are archived recognizes that the end user of the data has the choice of software platform. As one proprietary format is desirable among users, but can not suit all, the databases are provided for use with Map Maker Pro 2.4. ESRI shape file format *shp is also provided. To ensure that the data are immediately viewable without the need to purchase a GIS, a 21 day evaluation version of Map Maker Pro 2.4 GIS has been included with the CD. Map Maker is inexpensive, high quality, and also provides export routines in a variety of GIS and data table formats. Projection transformations can be performed for all files in a directory quickly to convert many files from UTM to Lat/Long, for example. Map Maker is a strong construction tool and few systems at any price can create equal quality printed maps.

1.8   Database Contacts:

Tony Ribbink: A.Ribbink@ru.ac.za
Jos Snoeks: jsnoeks@africamuseum.be
Fabrice Duponchelle: fabrice.duponchelle@mpl.ird.fr
Paul Cooley: pcooley@cc.umanitoba.ca
Tony Thompson: tony.sufer@fmsbd.org

2.0 Biodiversity Atlas Map Databases

This section contains select digital maps supporting the Biodiversity Atlas, located on the companion CD ROM of data displayed using Map Maker Pro 2.4 software.

* note: the following maps which follow are low resolution bitmaps captured from the enclosed Map Maker Assembly (*.map) files listed in Section 4.

Lake Malawi Bathymetry
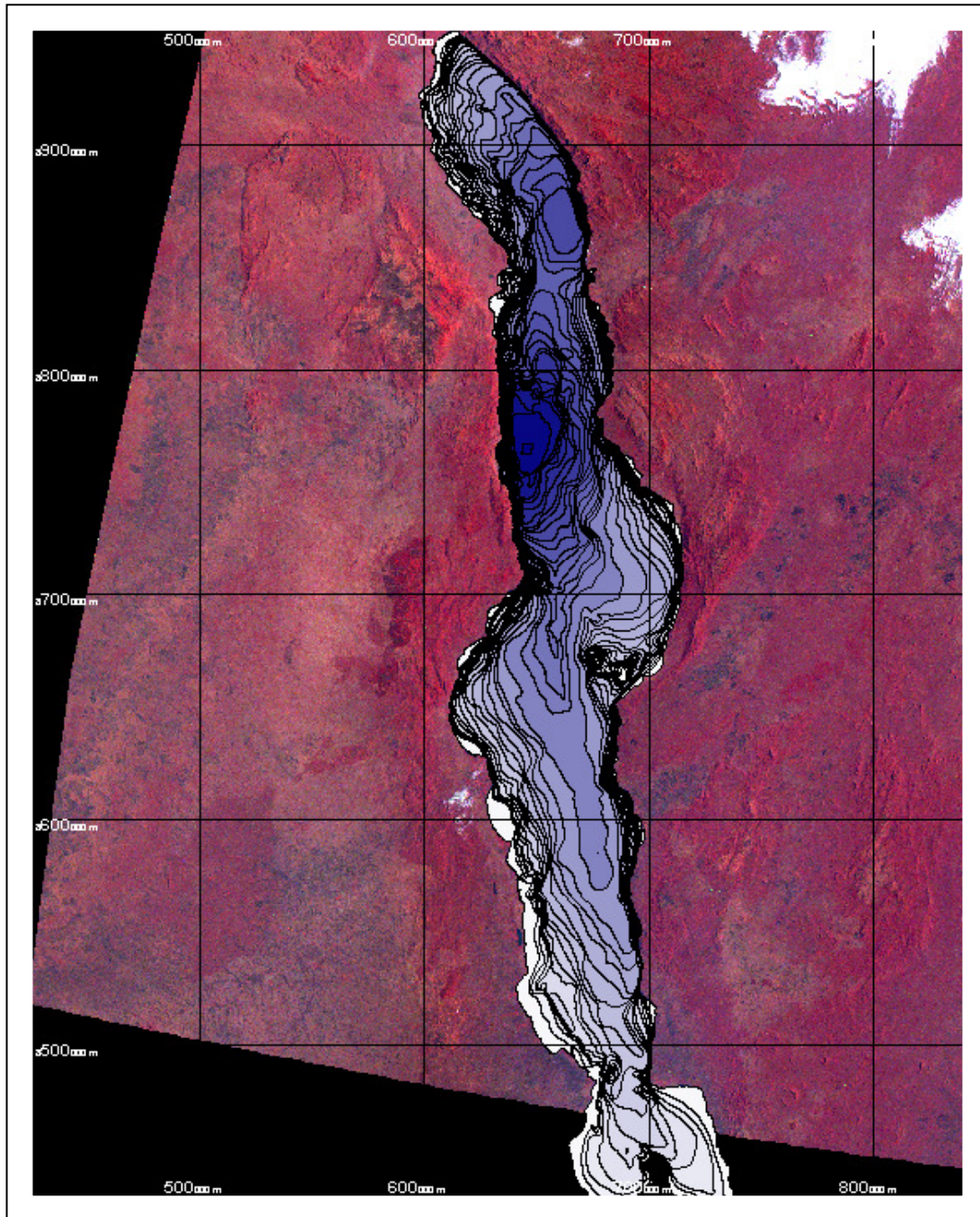
Tectonic Features

The Coastal Zone of Lake Malawi

Rifu Point, Lake Malawi

Legend - shoreline classes

- Rock
- Sand
- Vegetation
- Sand/Vegetation
- Rock/Sand/Veg
- Rock/Sand
- Gravel
- Rock/Veg

Legend - shoreline classes

- Rock
- Sand
- Vegetation
- Sand/Vegetation
- Rock/Sand/Veg
- Rock/Sand
- Gravel
- Rock/Veg

Legend - shoreline classes

■ (blue)	Rock
■ (yellow)	Sand
■ (dark green)	Vegetation
■ (green)	Sand/Vegetation
□ (white)	Rock/Sand/Veg
■ (cyan)	Rock/Sand
■ (grey)	Gravel
▨ (cross-hatch)	Rock/Veg

Legend - shoreline classes

- Rock
- Sand
- Vegetation
- Sand/Vegetation
- Rock/Sand/Veg
- Rock/Sand
- Gravel
- Rock/Veg

Shoreline attributes and lake shore communities

Presence/absence of lake shore huts along the shoreline, Southern Basin, Lake Malawi.
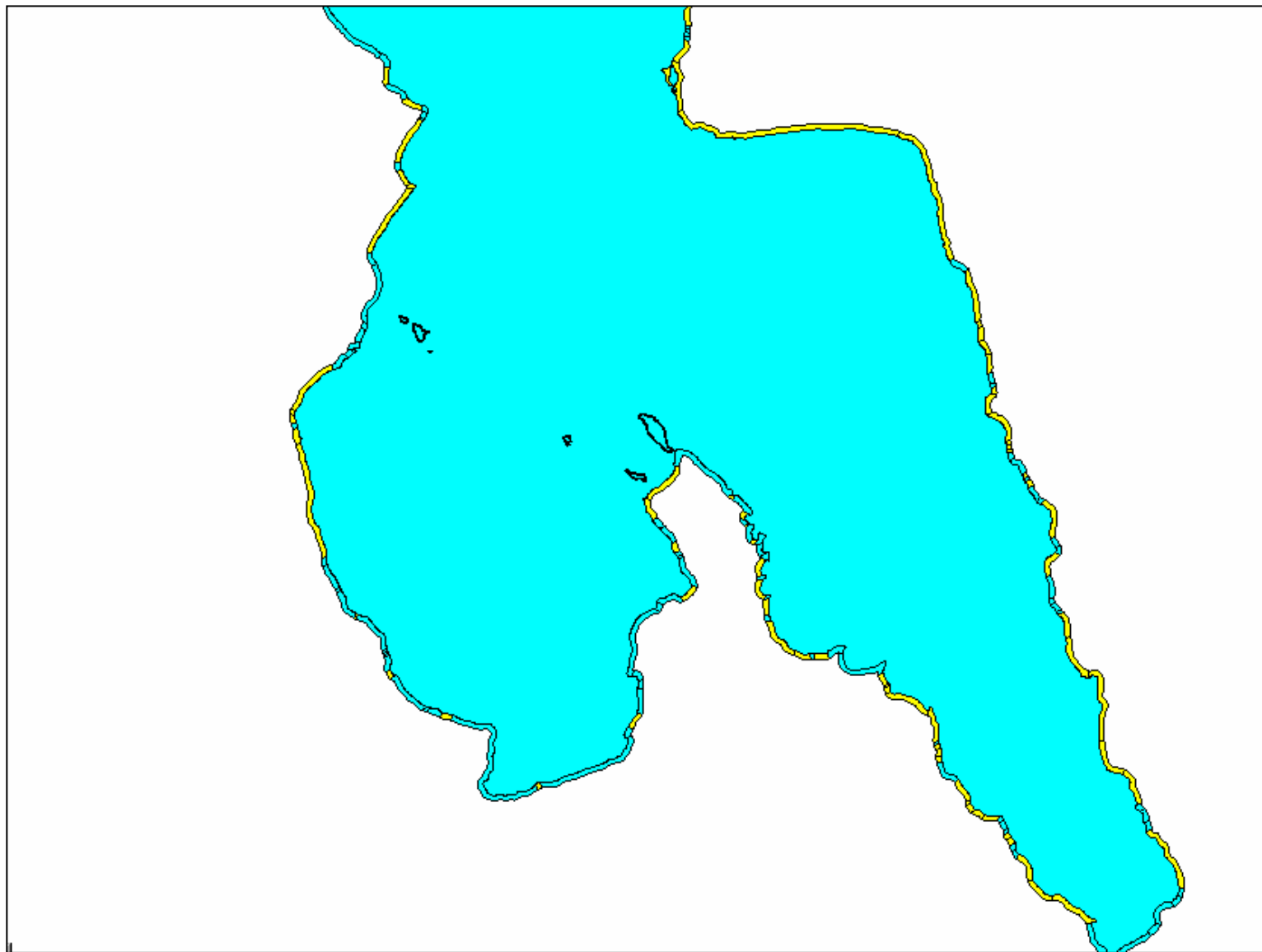
Shoreline communities with greater than 20 fish drying racks, Southern Basin, Lake Malawi
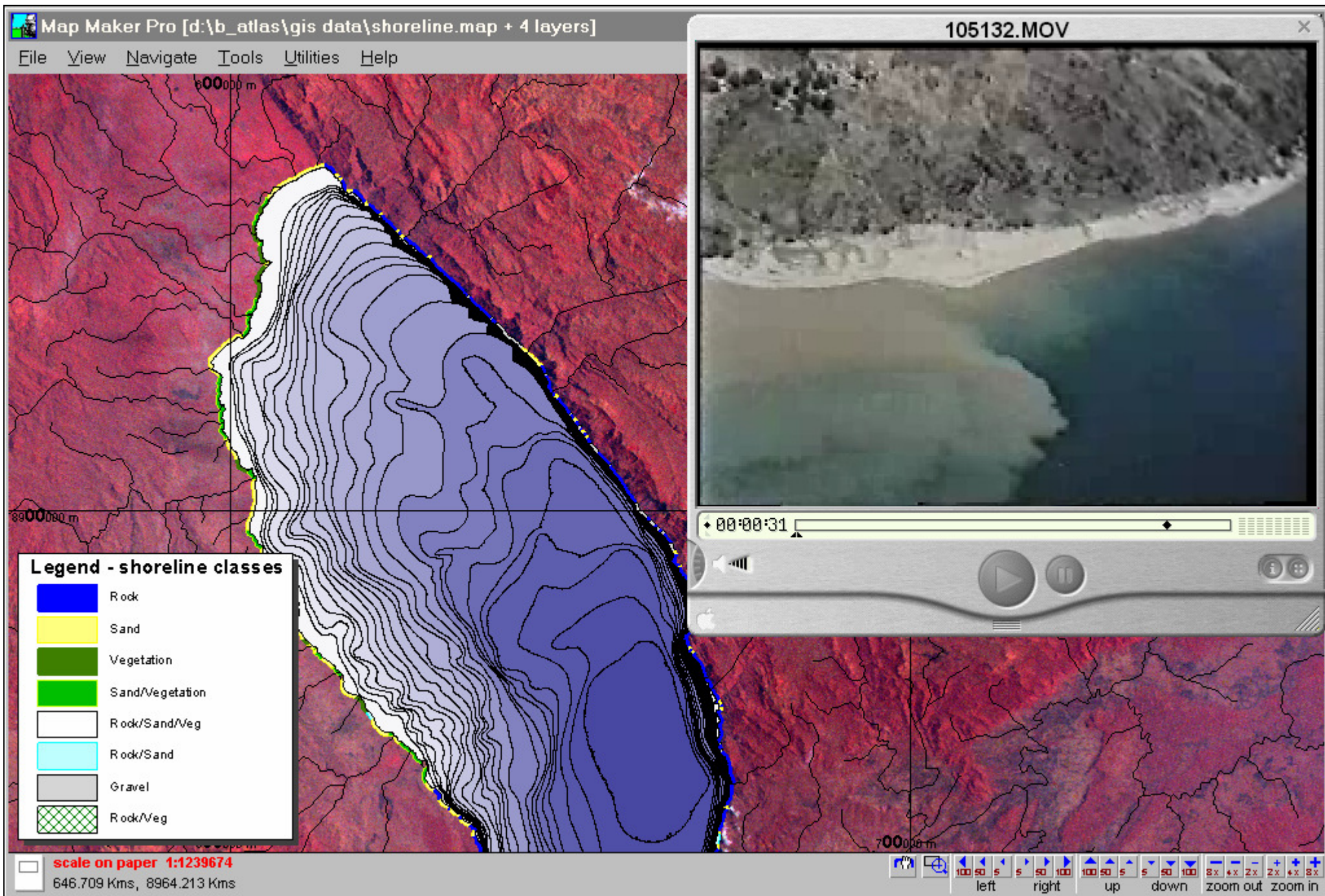
Video Comment Distribution Database

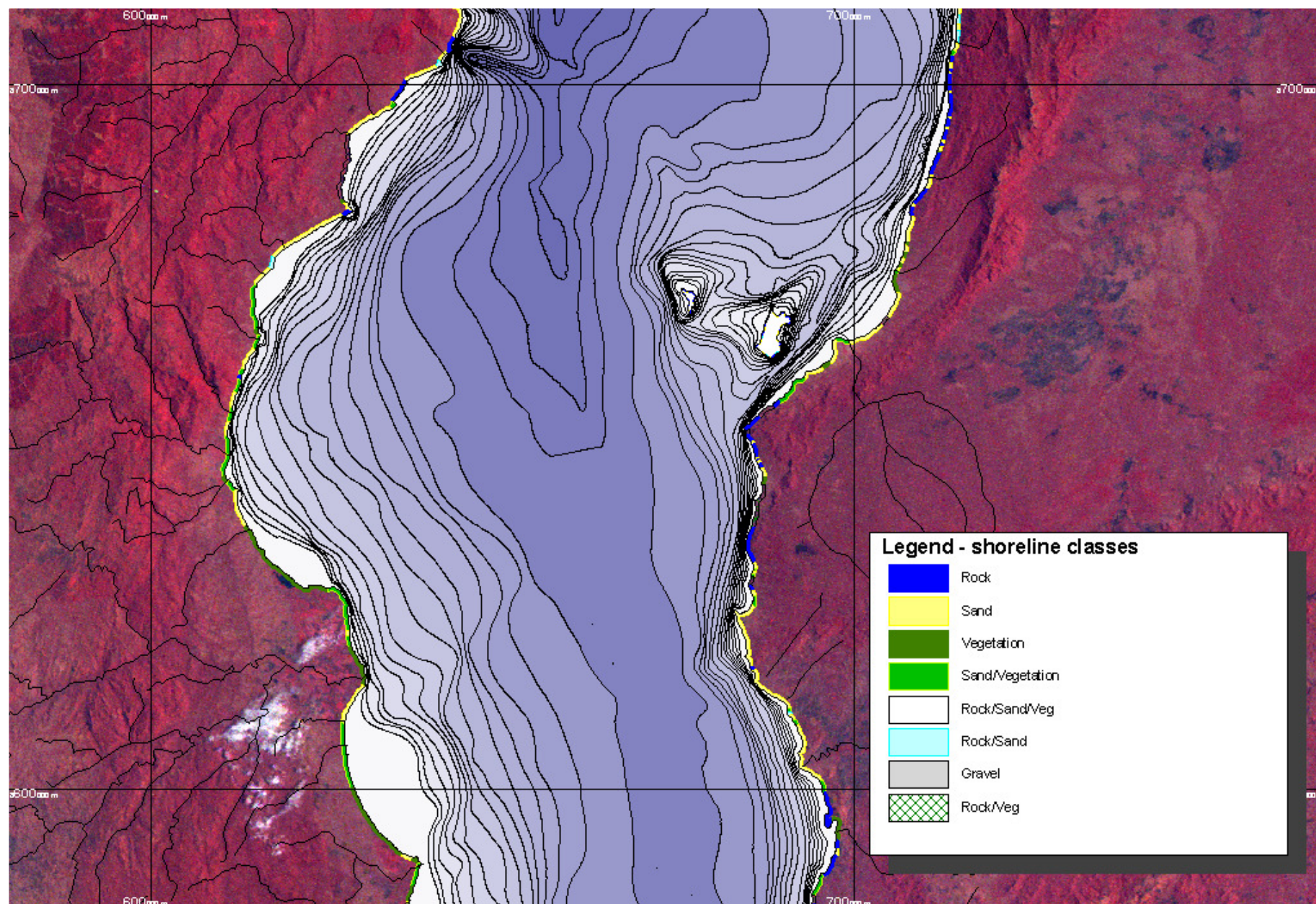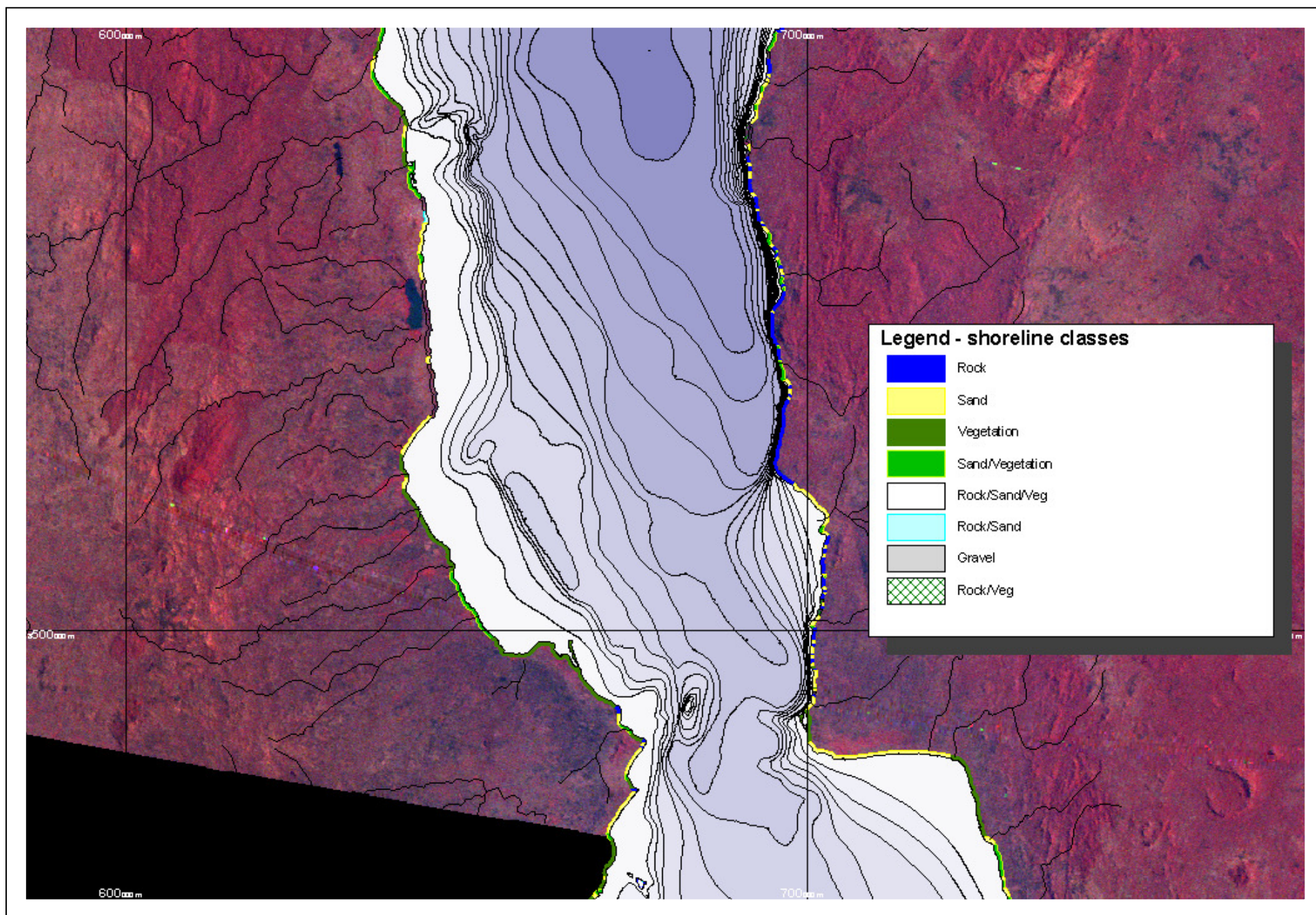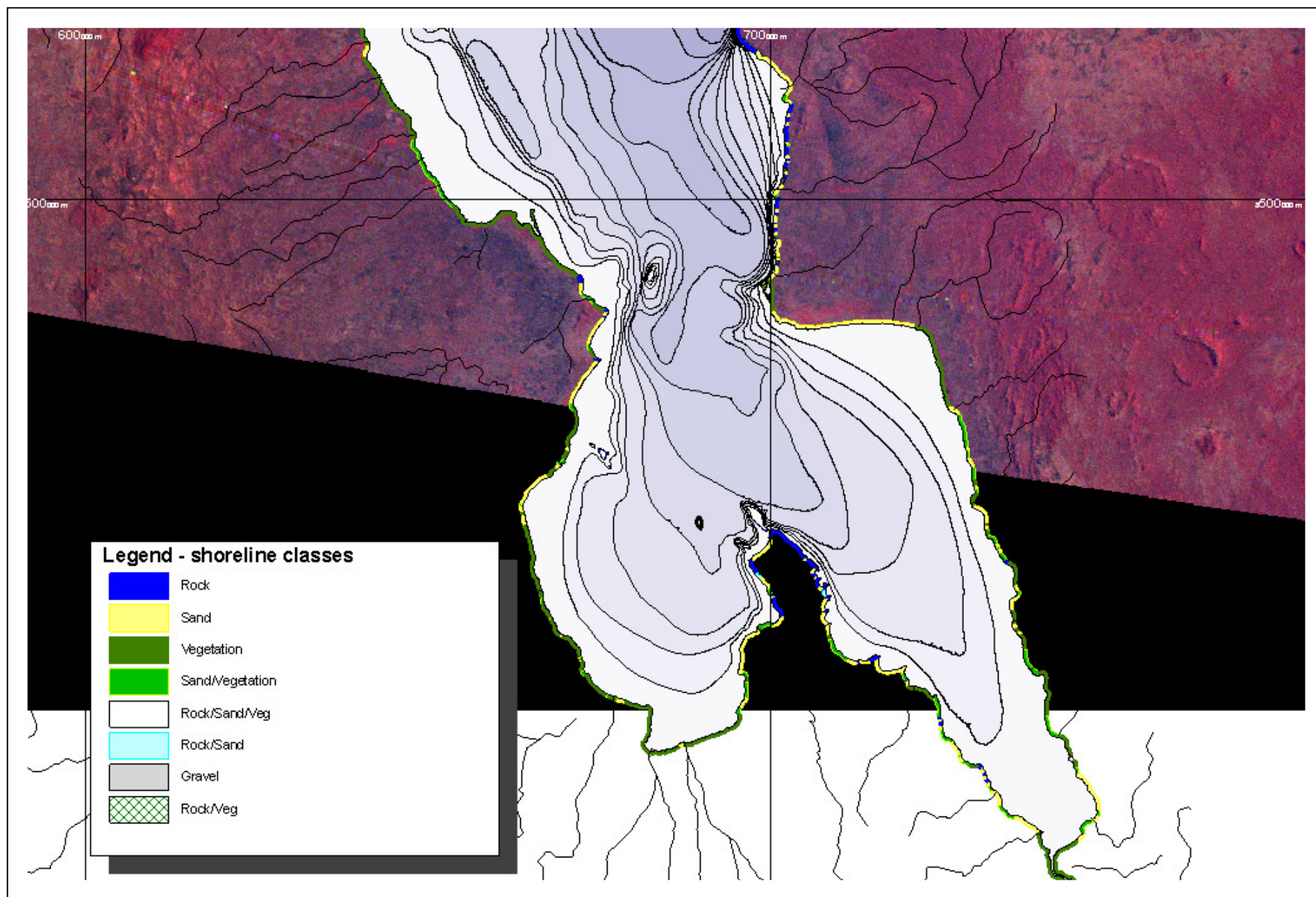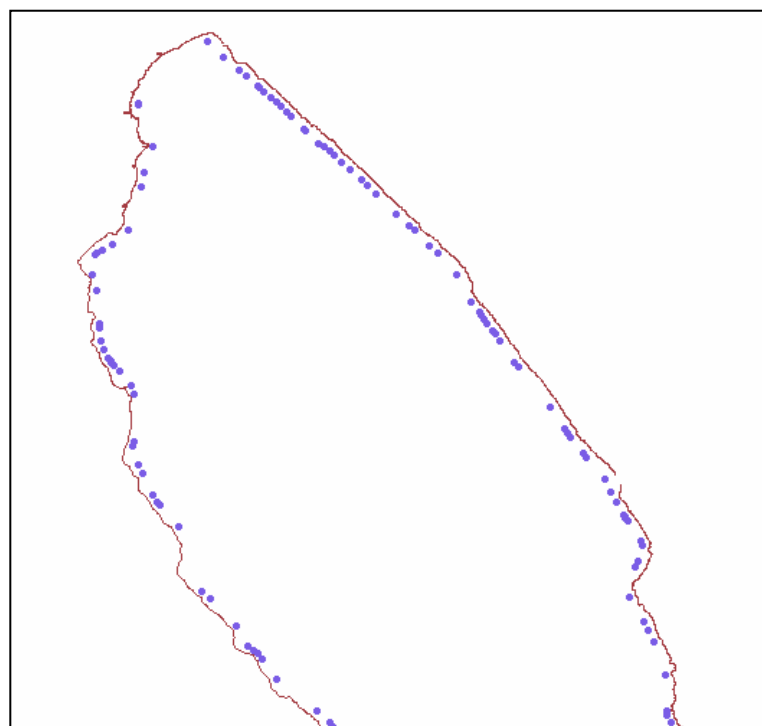|				d:\b_atlas\gis data\mmaker\community.dbf			
File	Rows	Columns					
A	B	C	D	E	F	G	H
Integer	Integer	Text	Integer	Integer	Integer	Integer	Text
MM_ID	MM_ID	LABEL	STYLE	HOUSES	RACKS	BOATS	COMMENT
53	53	54	gravel	7	0	0	0	
54	54	55	Rock	1	0	0	0	
55	55	56	Veg	3	0	0	0	
56	56	57	gravel	7	0	0	0	
57	57	58	Rock	1	1	0	0	
58	58	59	Sand Veg	4	26	0	21 canoes from comment
59	59	60	Sand	2	90	0	23 canoes from comment
60	60	61	gravel	7	74	0	0	
61	61	62	Rock	1	0	0	0	
62	62	63	gravel	7	44	0	0	
63	63	64	Rock	1	5	0	0	
64	64	65	gravel	7	0	0	0	
65	65	66	Rock	1	0	0	0	
66	66	67	Sand Veg	4	6	0	27 canoes from comment
67	67	68	gravel	7	0	0	0	
68	68	69	Rock	1	0	0	0	
69	69	70	gravel	7	11	0	0	
70	70	71	Sand	2	0	0	0	
71	71	72	Sand	2	3	0	13	
72	72	73	Rock	1	0	0	0	
73	73	74	Sand	2	0	0	0	
74	74	75	Sand	2	0	0	0	
75	75	76	Rock	1	0	0	0	
76	76	77	Sand	2	0	0	0	
77	77	78	Rock	1	0	0	0	
78	78	79	Sand Veg	4	0	0	0	
79	79	80	gravel	7	0	0	0	
80	80	81	Rock	1	0	0	0	
81	81	82	gravel	7	0	0	0	
82	82	83	Sand	2	1	0	0	
83	83	84	Rock	1	0	0	0	
84	84	85	Sand	2	16	0	0	
85	85	86	Sand	2	0	0	0	
86	86	87	Rock	1	6	0	0	
87	87	88	Sand	2	15	0	0	
88	88	89	Rock	1	0	0	0	
	332364			2047	10944	2265	920	
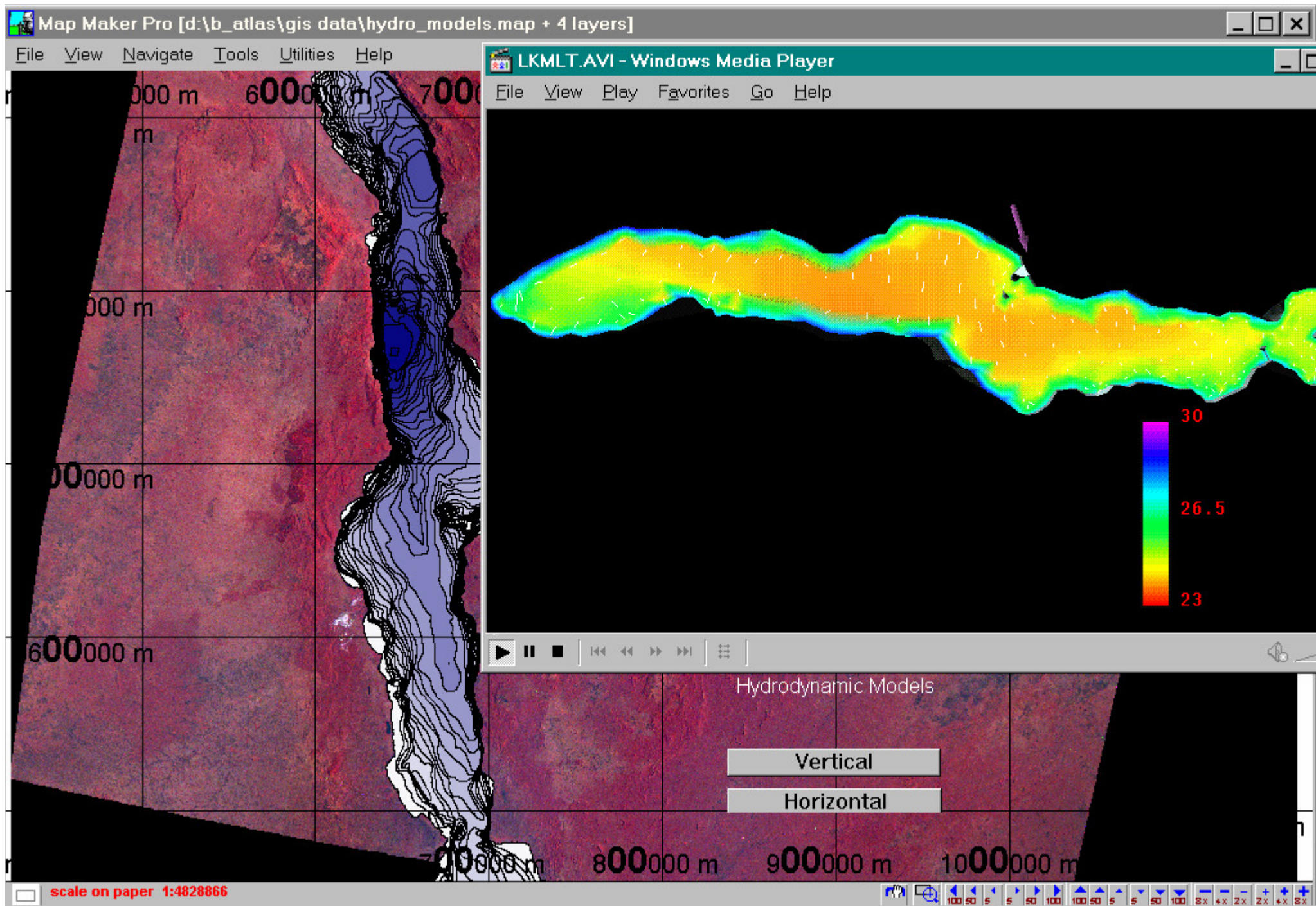
SADC/GEF Ecology fish distribution sample sites
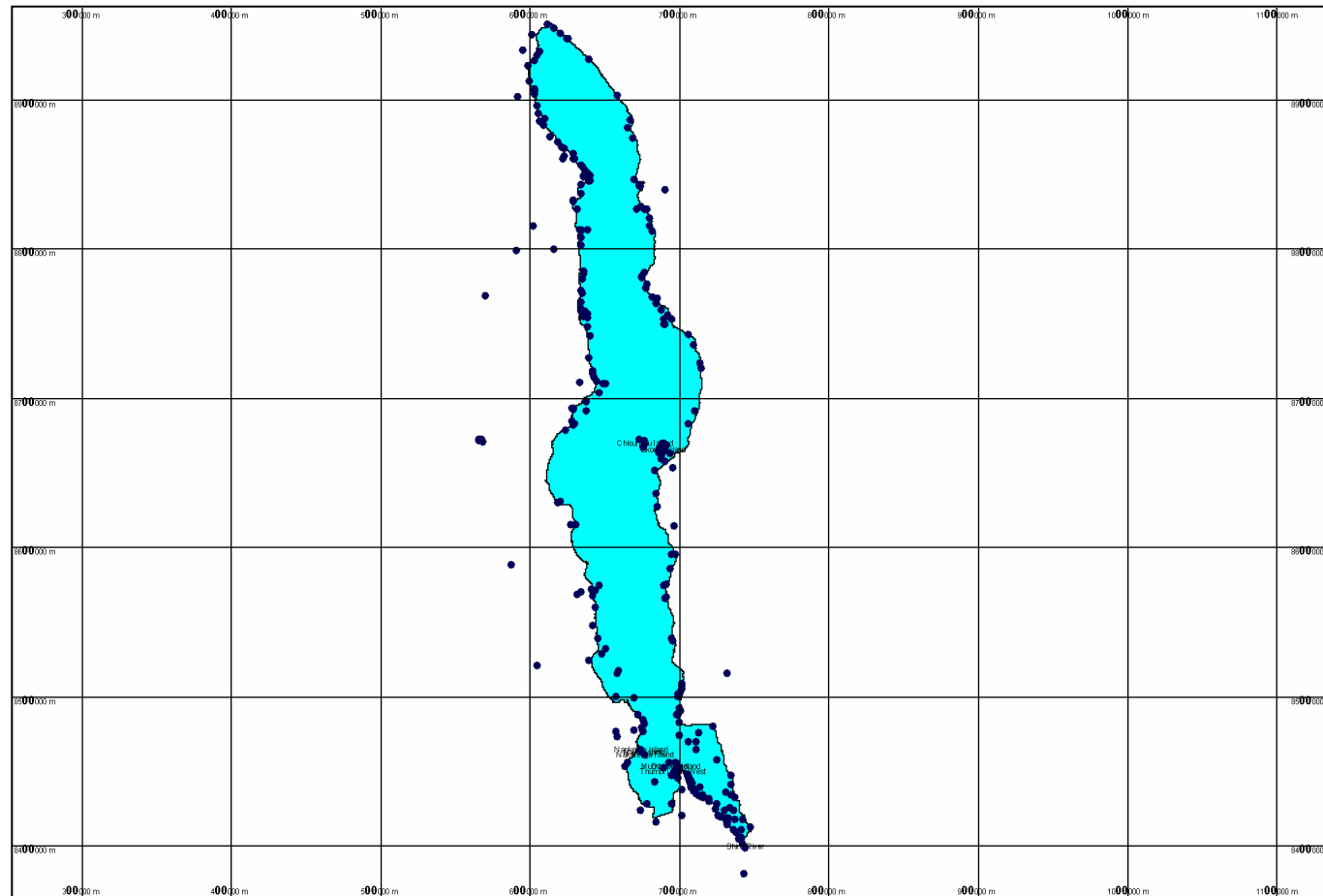
Sampling sites of: Ribbink, A. J. , B.A. Marsh, A.C. Marsh, A.C. Ribbink, and B.J.Sharp. 1983. A preliminary survey of the cichlid fishes of the rocky habitats in Lake Malawi. South African Journal of Zoology. Vol. 18, No. 3. 149 – 310.

.
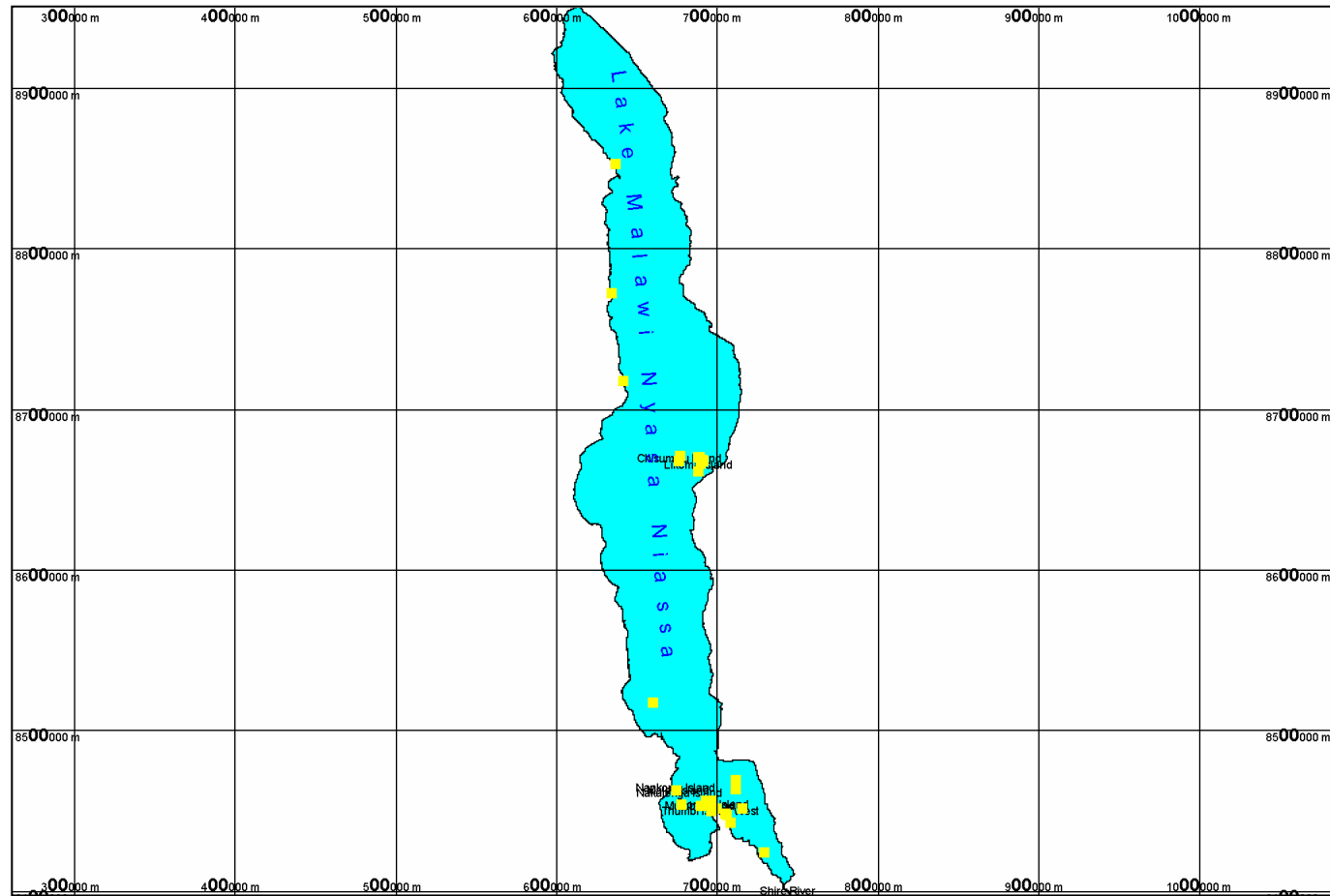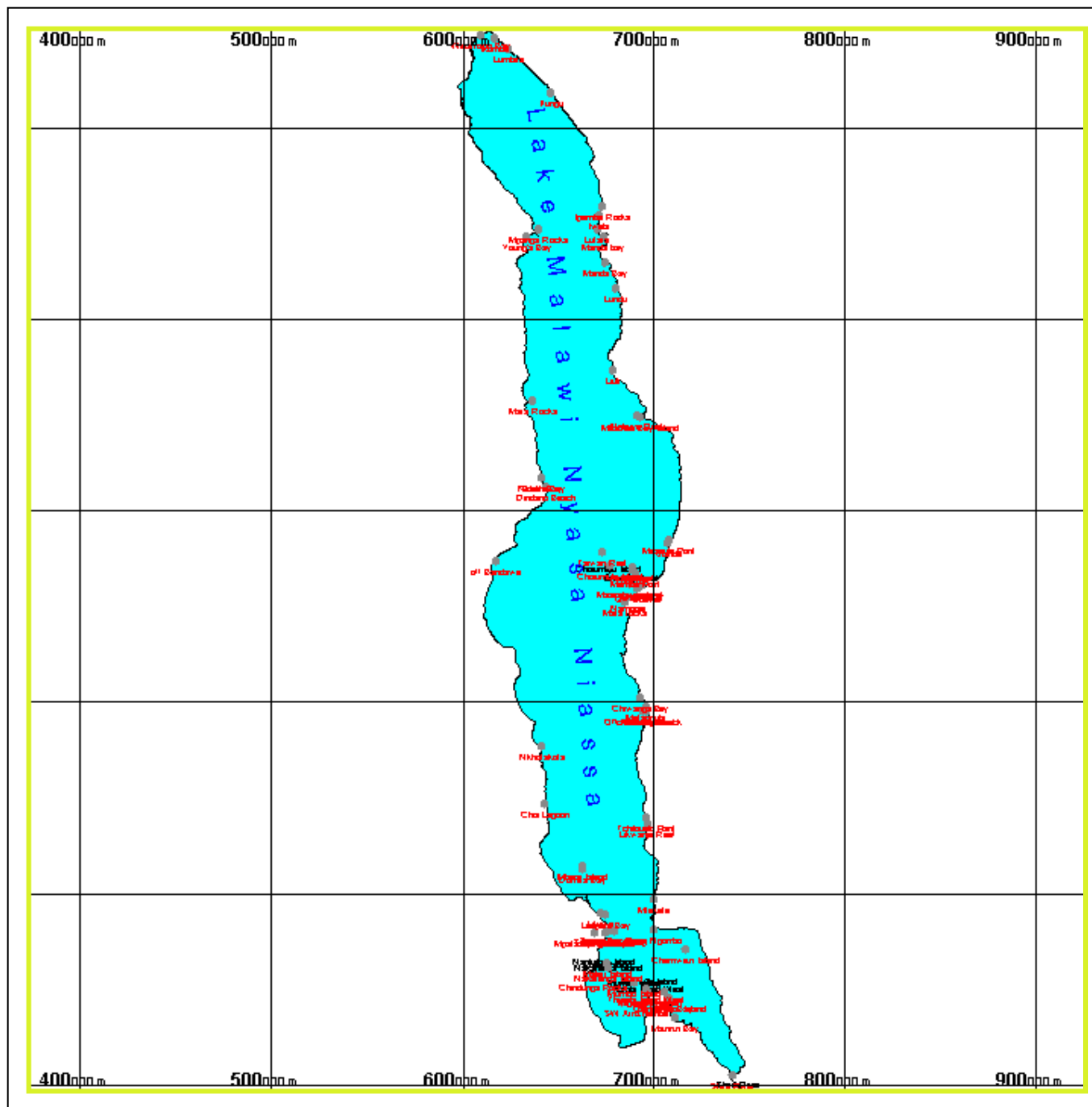
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
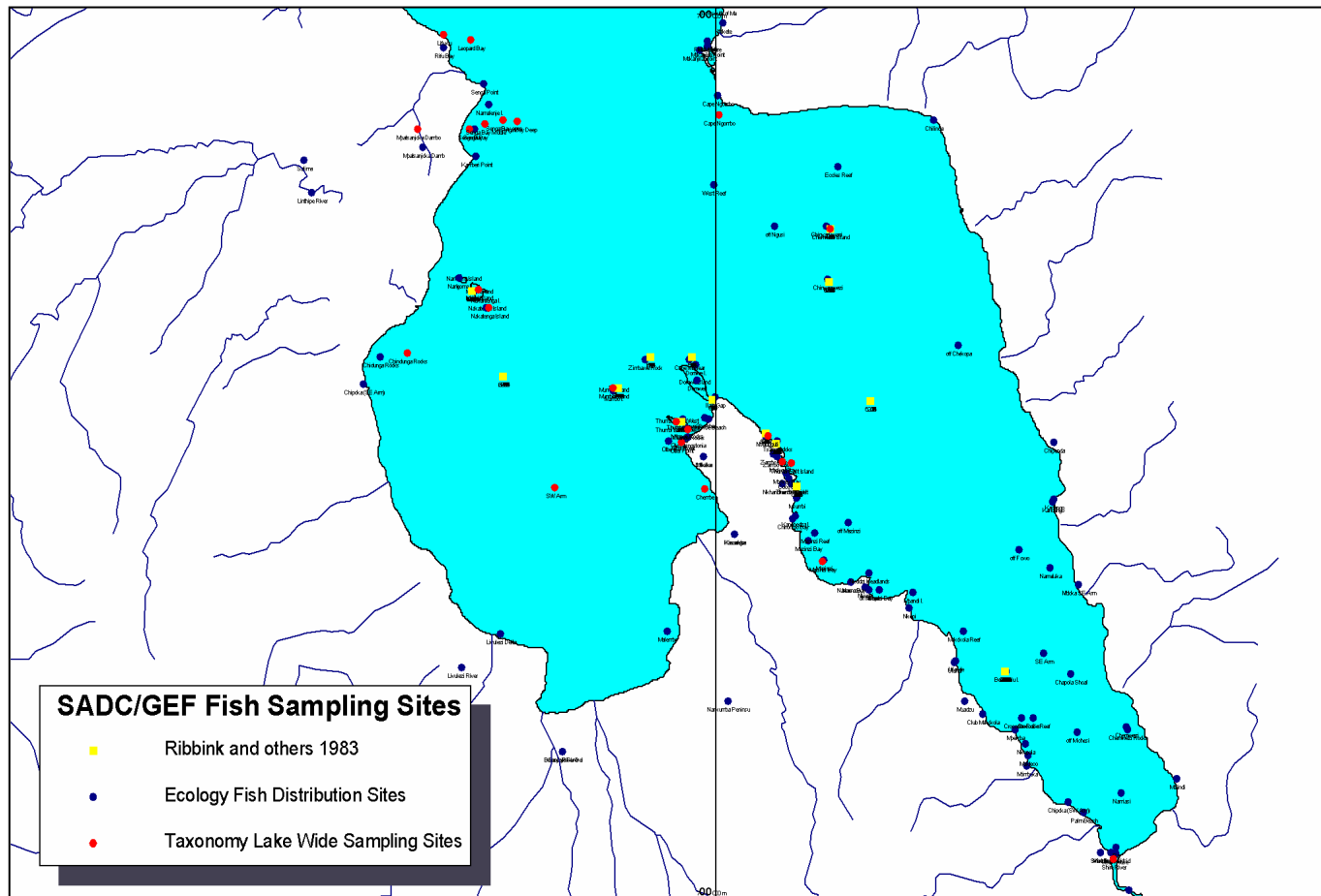
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
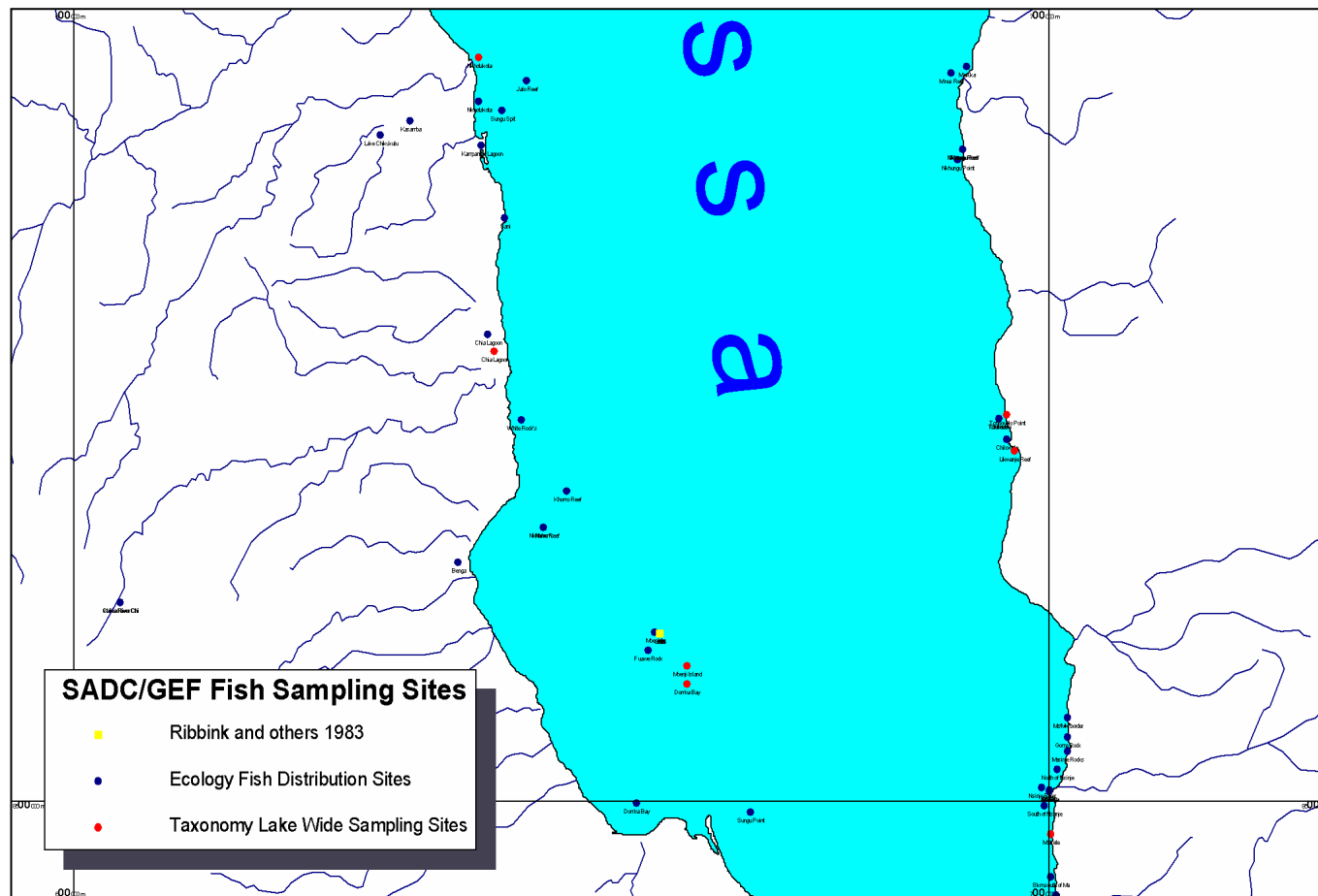
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
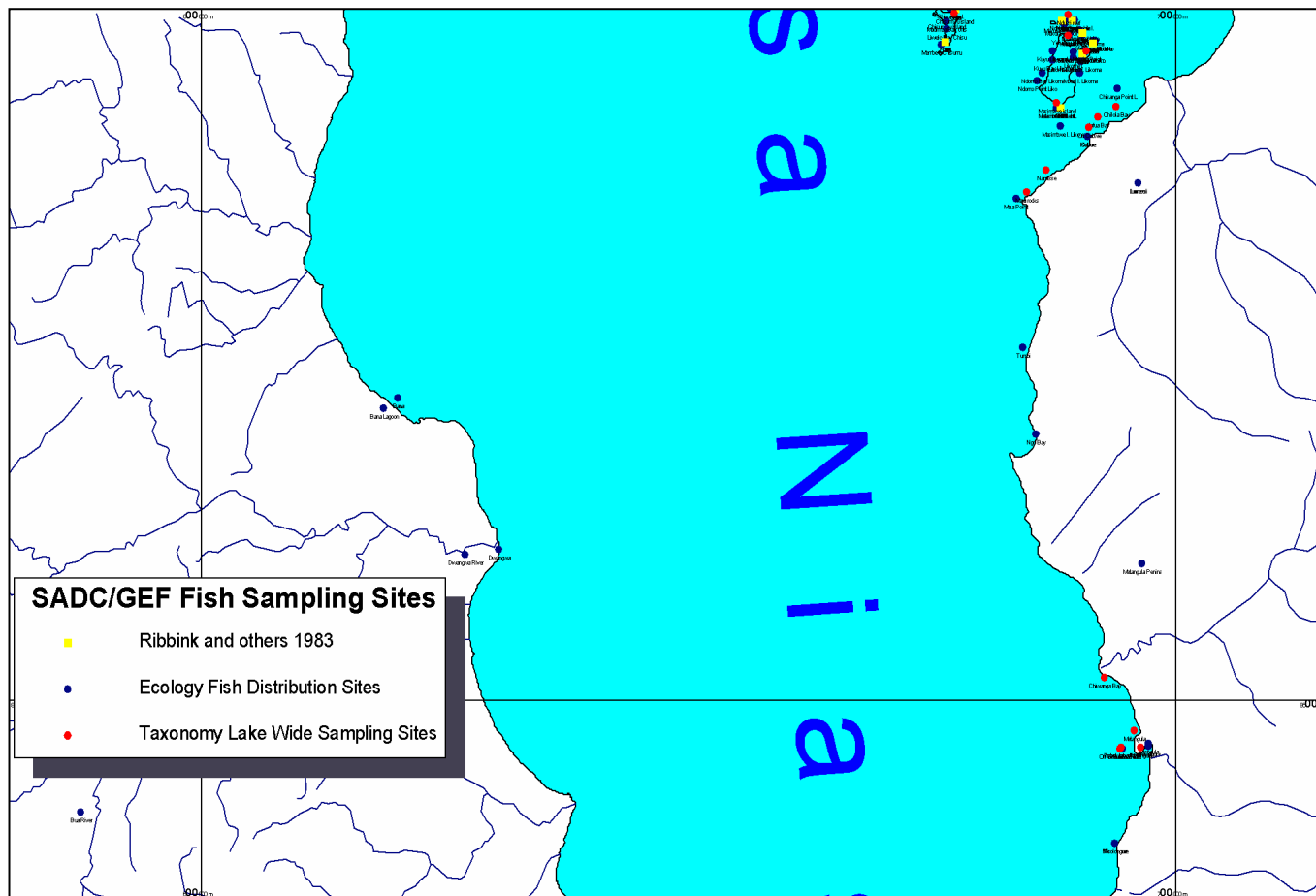
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
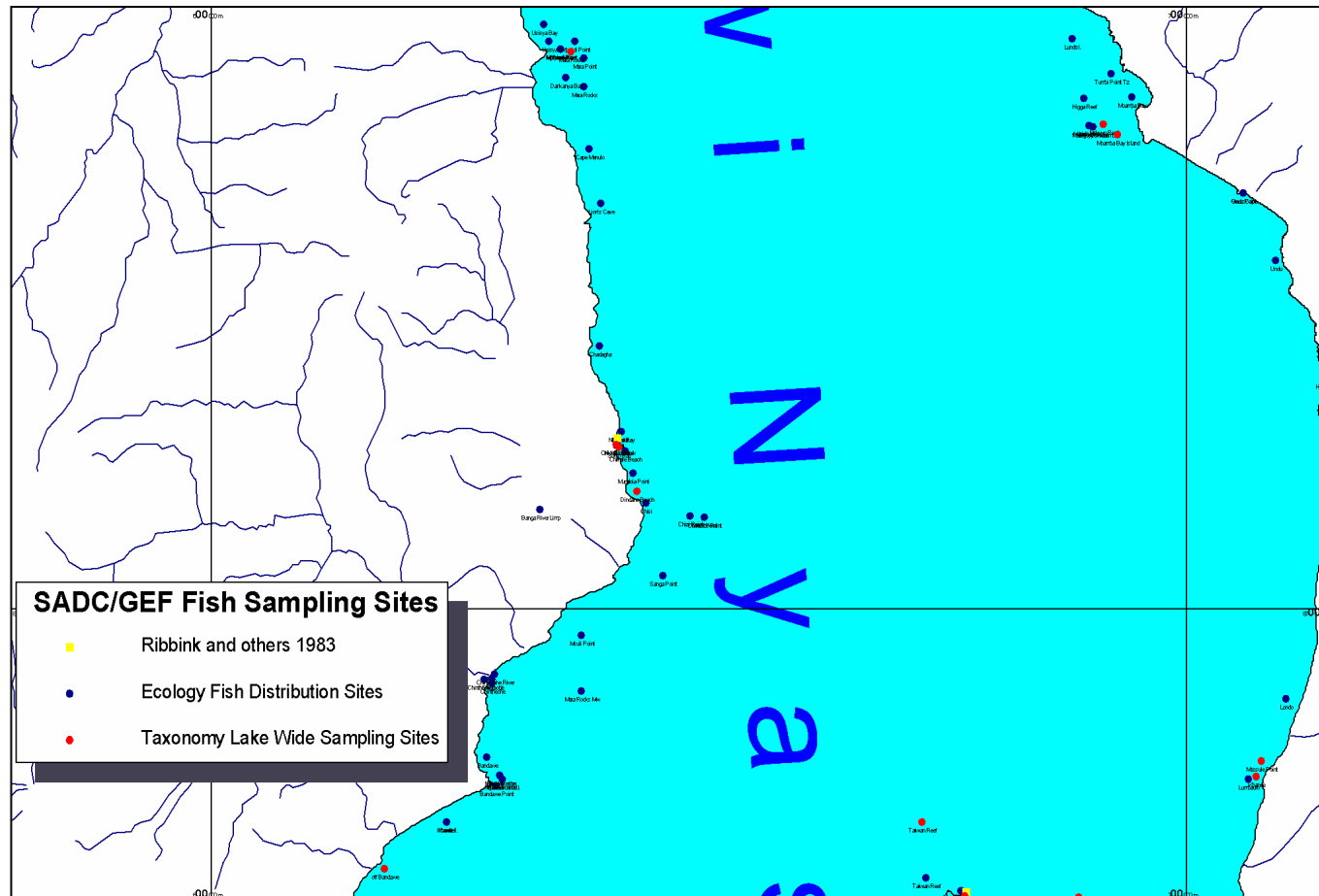
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
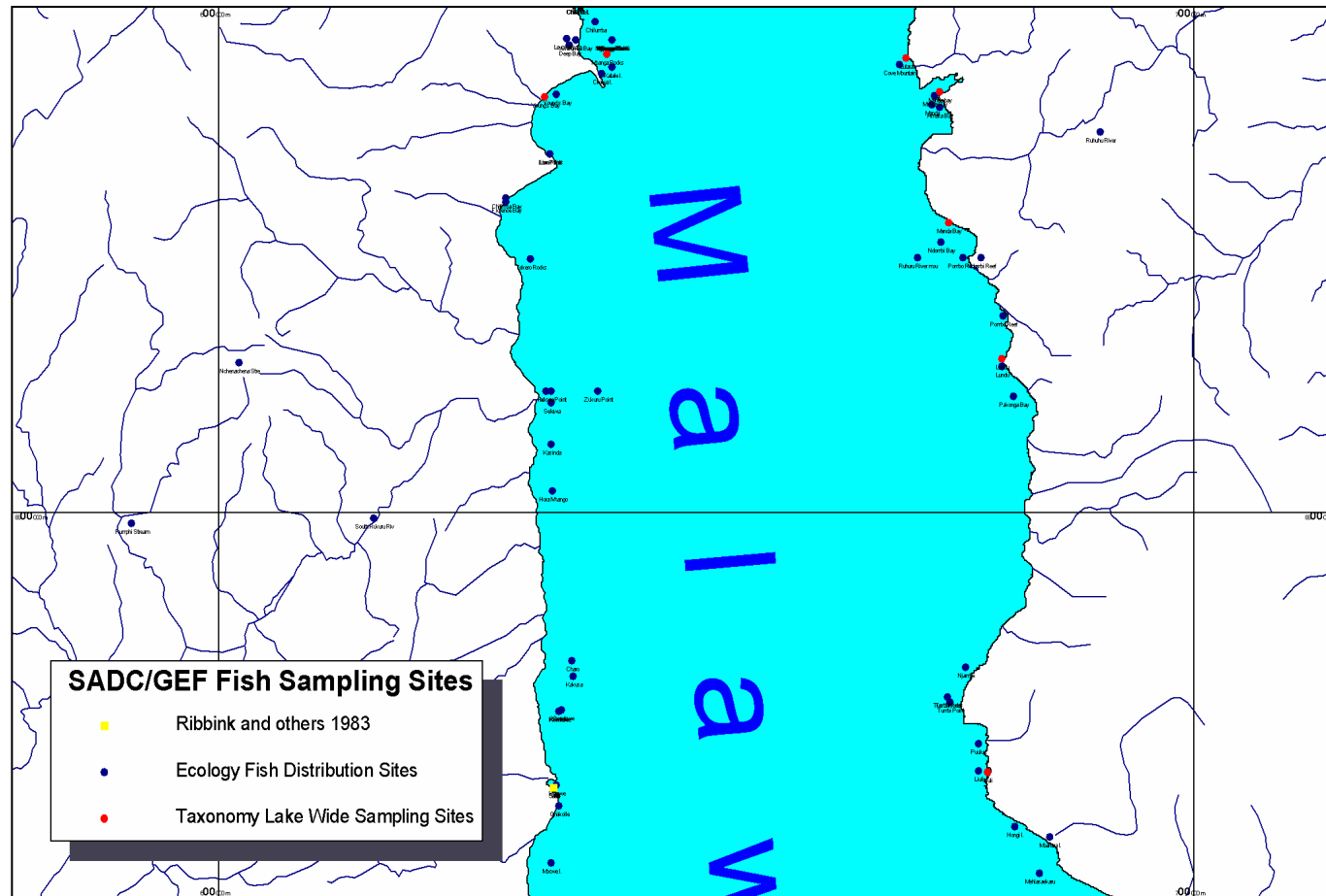
Fish Sampling Sites: SADC/GEF LMBCP and Ribbink et al. 1983
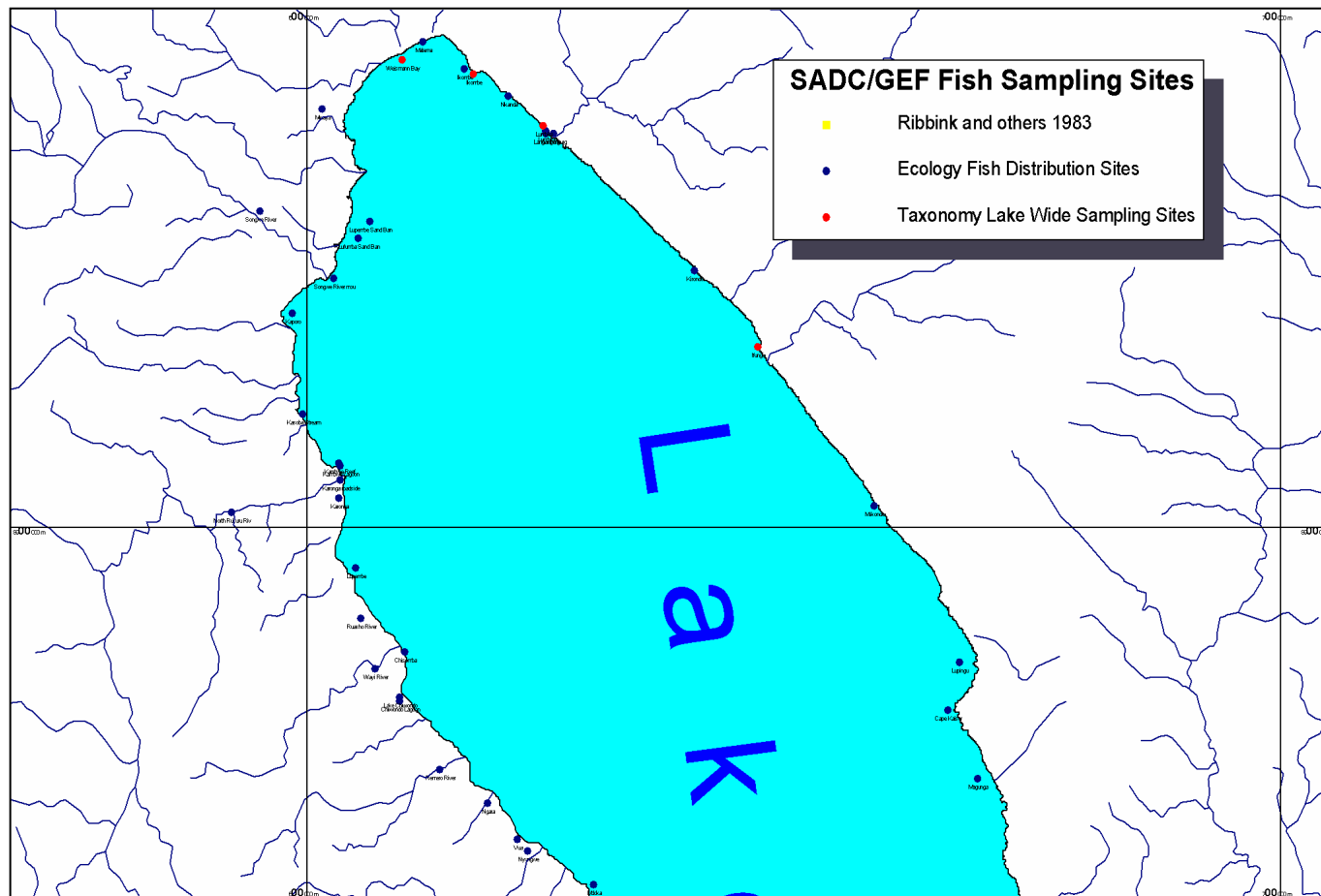
Information sites, southern basin, Lake Malawi.
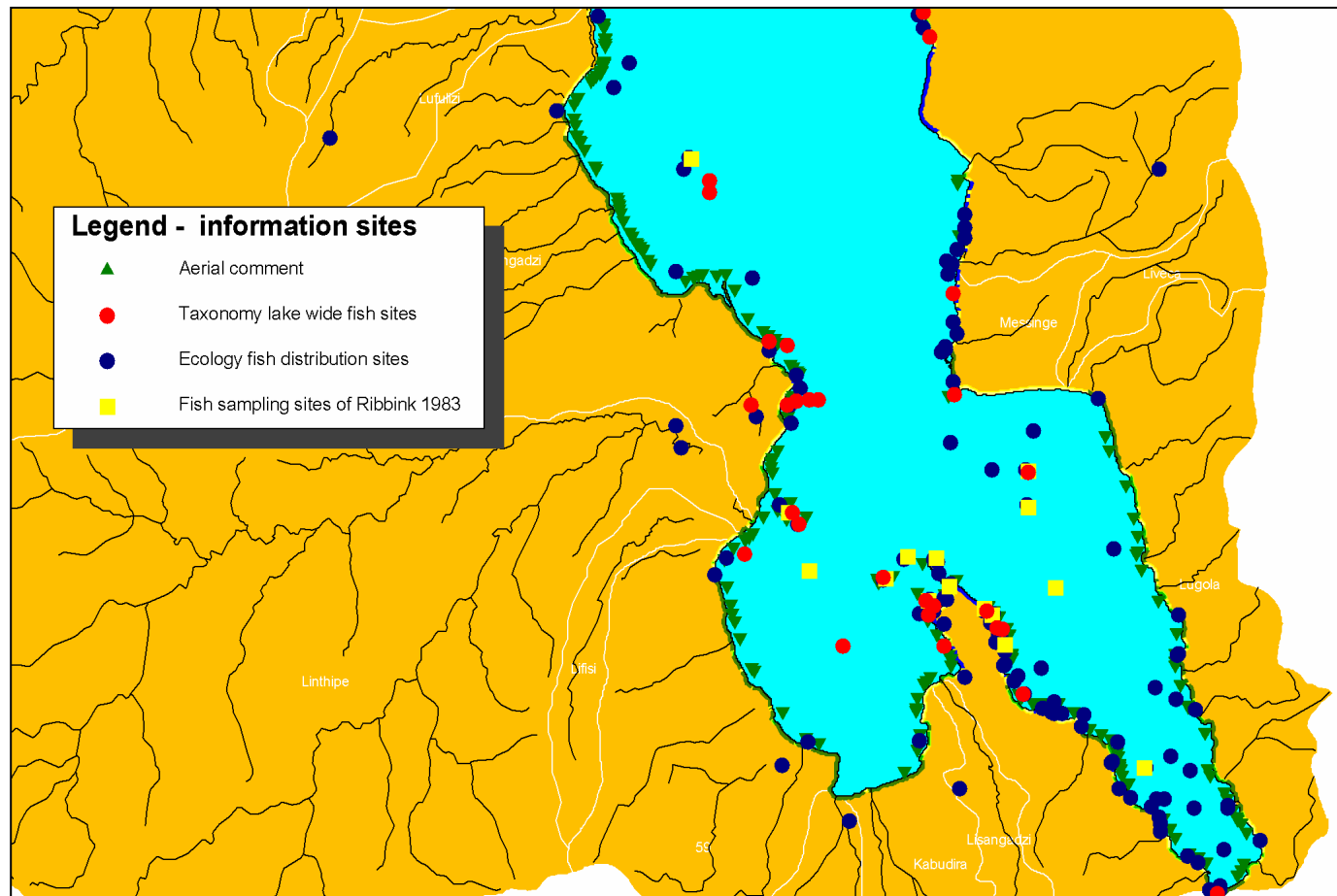
Depth distribution for Senga Bay, southern basin of Lake Malawi. Contour interval 2 metres. Maximum depth is 140 metres.
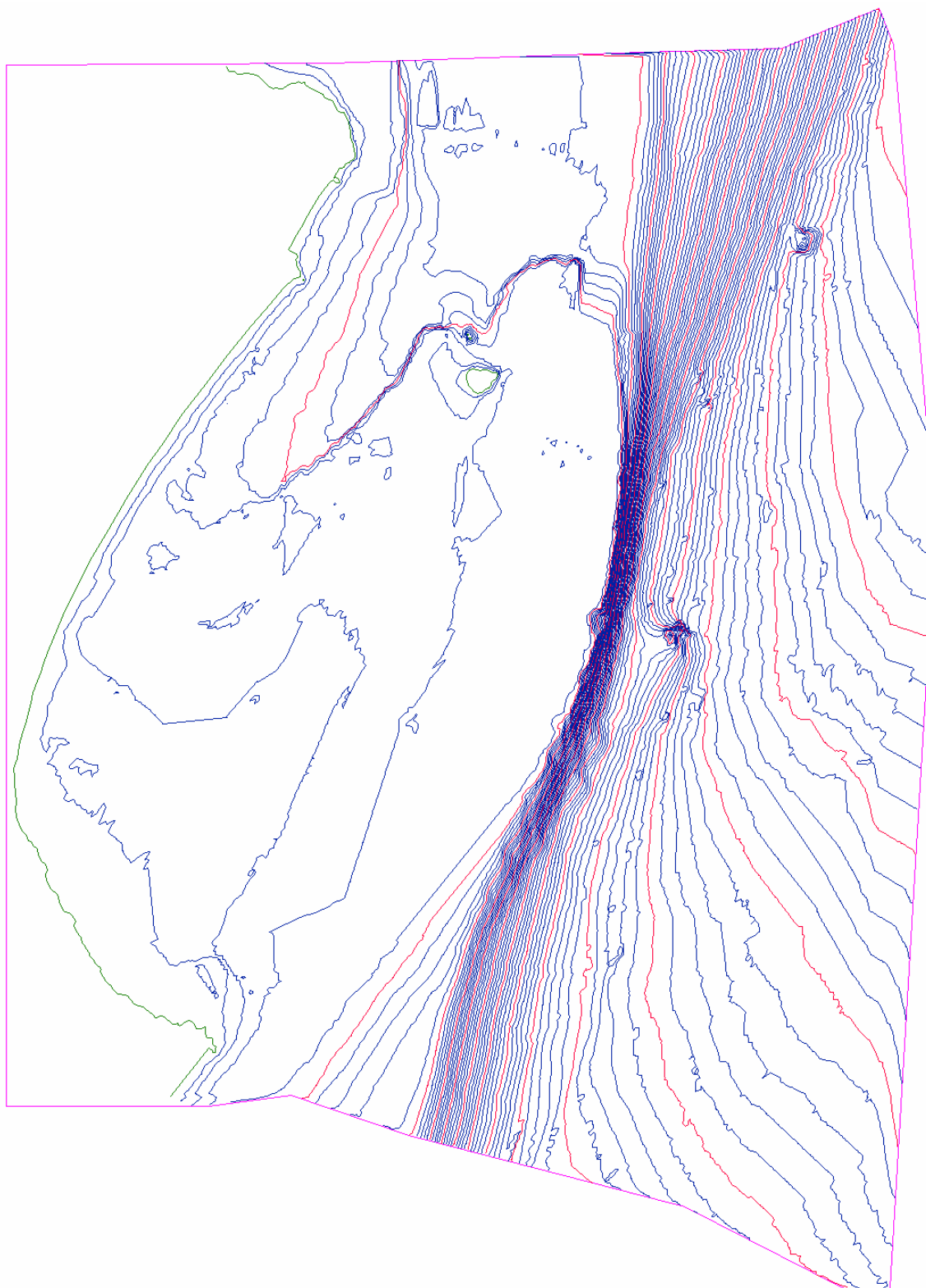
Linthipe River Delta and Nankoma, Maleri, and Nakatenga Island. Contour interval is 2 meters. Maximum depth is 82 m.
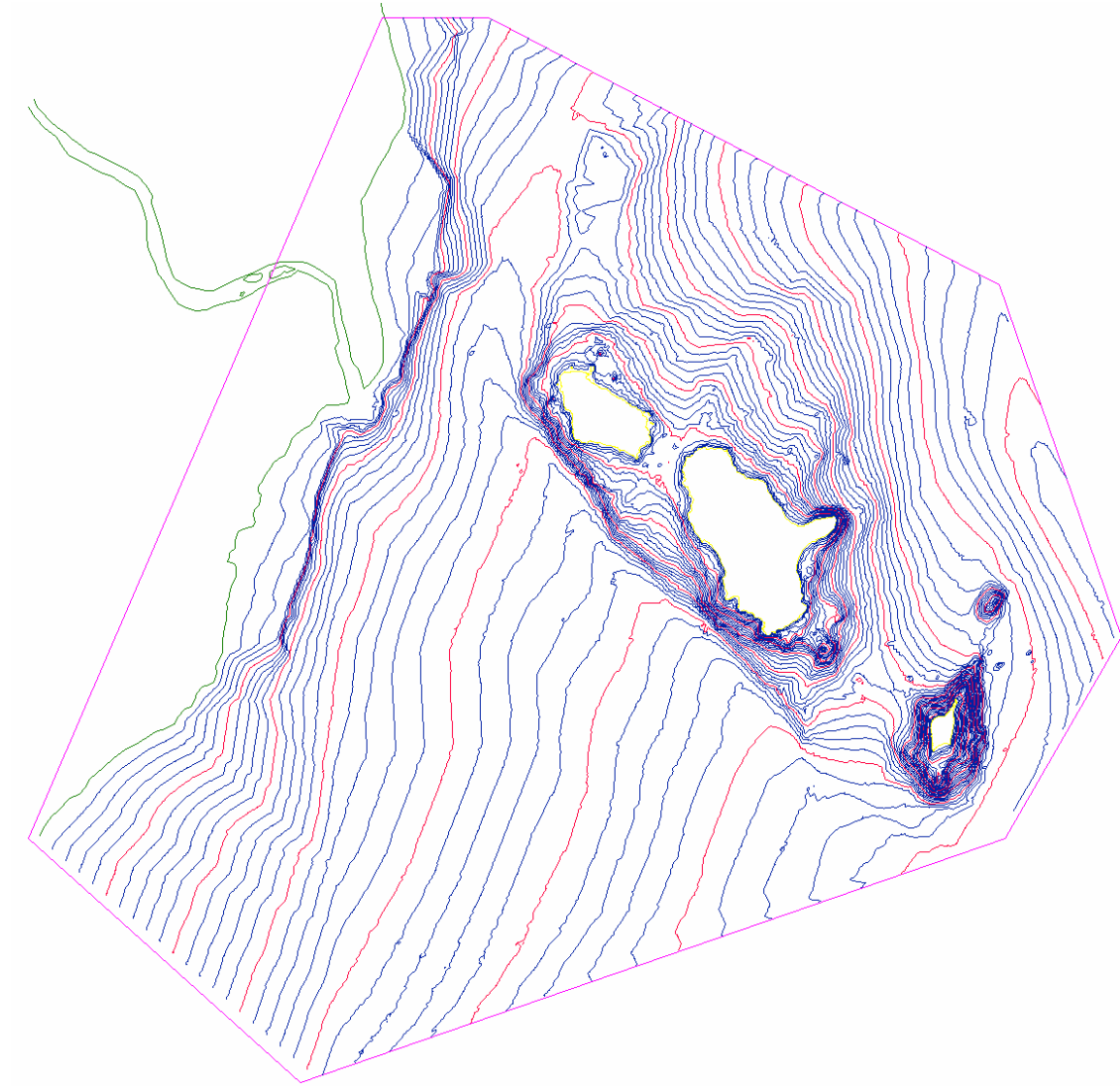
Depth distribution for Thumbi Island West and Otter Point, southern basin of Lake Malawi. Contour interval is 2 metres. Maximum depth is 102 metres.
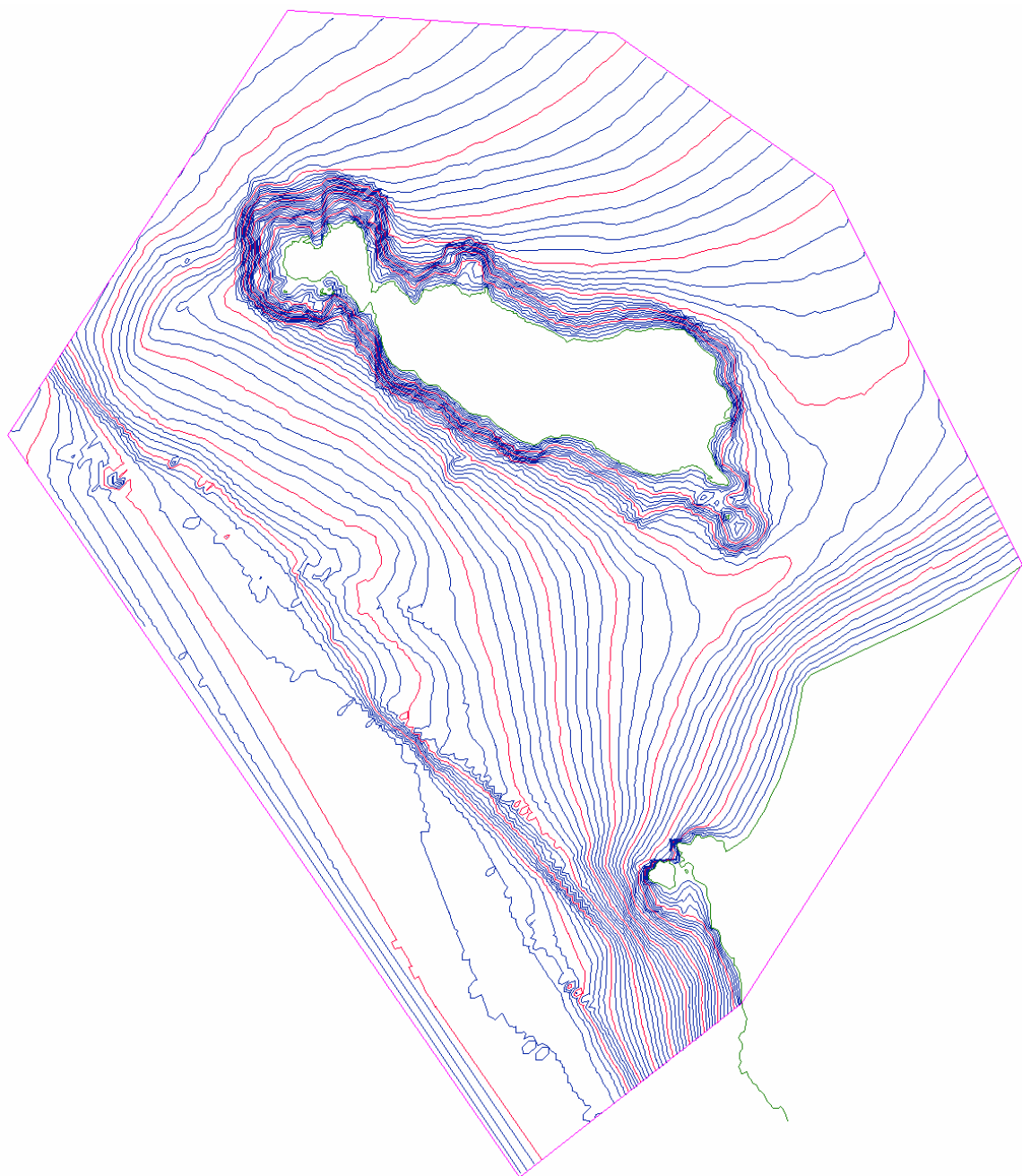
Depth distribution for Mumbo Island, southern basin, Lake Malawi. Contour interval is 2 metres. Maximum depth is 112 metres.
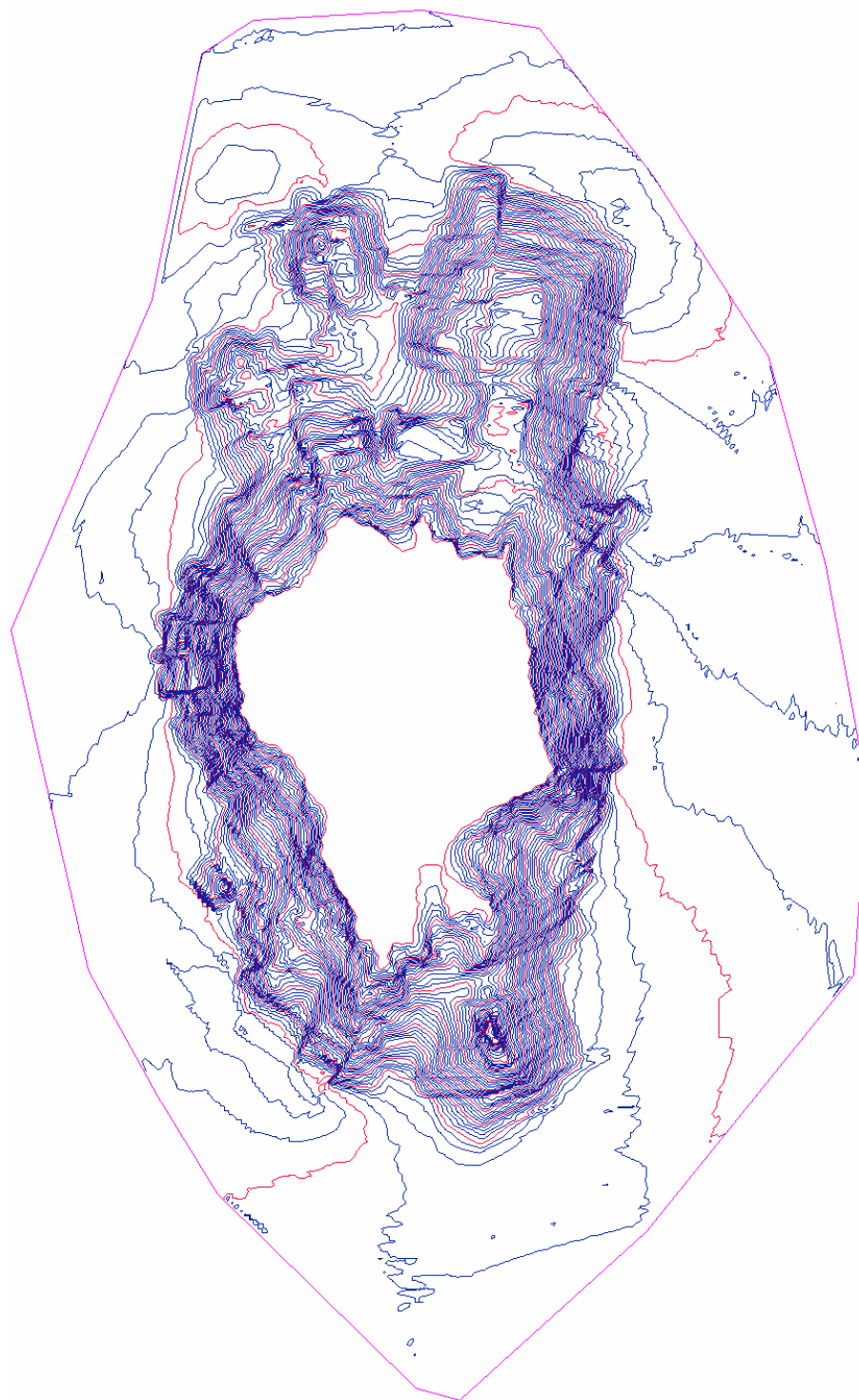
3.0 Database Descriptions

3.1 Aerial Video Frame Surveys of the Coasts of Lake Malawi

Paul M. Cooley

The understanding of the types of littoral environments found along the coasts of Lake Malawi can be better understood by integrating information on what is known about the littoral, the coasts, and the adjacent terrestrial environment. The understanding of the littoral habitats will improve the knowledge of species and community distributions in Lake Malawi.

The first aerial video frame surveys of Lake Malawi shorelines were conducted during the low water period on December 7 and 8, 1998 at about 1500 ft above present lake level, (474 m). All shoreline video data were captured using oblique viewing directions. All video frames are associated with a differential global Positioning system data stream using the time counters on both devices. Oblique video was captured from within the aircraft, a 6 seat Cessna aircraft, operated by Sefofane Air Charters Inc.

Oblique video frames were captured using a Sony Hi8 Handicam (CCDTRV72 NTSC) with 30 x digital zoom with steady shot operating. For the vertical video frames a Sony Hyper HAD CCD-Iris/RGB colour video camera was used. During the vertical surveys the white balance was set to automatic, the gain was set at zero, and the shutter was set to the SPOT setting.

Oblique Video Frame Surveys of the Lake Malawi Coastline

Video frame surveys proceeded over water in a clock wise direction beginning at Senga Bay in a northerly direction, circumnavigating the lake (see below). Most frames were captured without magnification at a direction approximately perpendicular to the shoreline. At about 5 minute intervals the video images veer to the fore and aft of the aircraft to capture the configuration of the shoreline. Increased zoom was used to assist in the enumeration of targets when fishing villages, fish drying racks, or dugout canoes were visible.

Two small gaps in the data occurred due to a storm or short term GPS battery failure. 24.8 km of video and GPS data are absent on the lakes west coast due to a storm, and 27.8 km of GPS data are absent on the Mozambique coast due to battery failure, including the area around Metangula. To complete the coastal map, the area of lost data in Malawi was interpreted using Landsat TM data (from MEMP Project). Shoreline information was provided by J. Halafo for the area around Metangula. The total distance of GPS tracks is 1649.24 km. The total

distance of shoreline video data, including repetitive tracks during initial camera tests, is 1677.04 km.
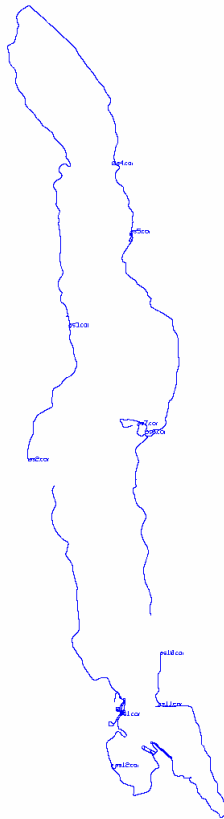
Differential GPS positions collected on the flight path along the lakeshore.

Environmental Conditions

Strong winds from the south-east were prevalent for three days prior to the survey. As a result, many low gradient shores on the western shore of the lake evidence high turbidity. High turbidity was also due to sediment plumes that commonly traced closely along the shore as a narrow band, in a northerly direction. In general, the visibility into the littoral area was good, but was spatially variable due to surface reflection and water clarity.

Coastal and Nearshore Attributes

In many nearshore areas of the lake, rock and sand subsurface boundaries are clearly evident, as are submerged macrophytes, wave wash zones, or submerged geological features. Also evident in the frames are discreet water masses between the littoral shelves and offshore waters. Shorelines from the high water levels in 1980 are clearly evident at locations along the lakes' western coast in the lake shore plains regions. In such areas, the video captures clearly define beaches likely from the 1980 high. At the current lake level many of the corresponding low gradient shorelines are now vegetated.

At the time of survey, many small and moderately sized rivers and ephemeral streams had not breached the sand bars that frequently block the river mouths during the dry season. The video frames also capture the variable onset of the rains in the coastal areas of the lake, as evidenced by sometimes dramatic changes in the apparent vigor of the vegetation from one region to another.

Video Comment Distribution Database

The comments made during the aerial surveys focused on the coastal classes, nearshore and littoral features, surrounding topography, villages, fish drying racks, and dugout canoes. These comments are linked to the position of the aircraft at the time attributes were observed. Not all features of each type are verbally commented. An example of the point distribution file is shown in figure 2.
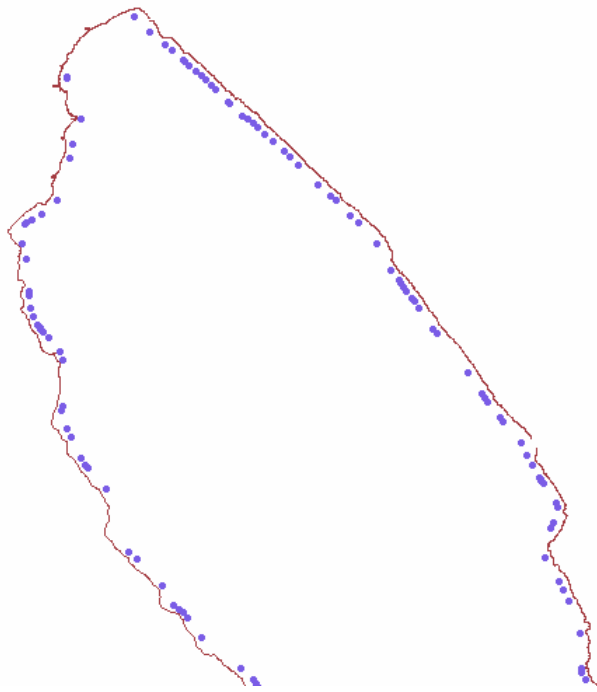
Example of the video comment distribution database for Lake Malawi, showing the north basin of the lake. Each point is linked to the feature attribute table where comments from the video are listed. Shoreline data was digitized from the coastal maps from Malawi, Mozambique, and Tanzania (see table in sect. 3.2 below).

The Coastal Classes

The coastal zone of Lake Malawi was mapped using seven nominal classes:

I)   rock
II)   sand
III)   vegetation
IV)   gravel

combination classes:
v) rock/sand,
vi) rock/vegetation,
vii) rock/sand/vegetation.

Each coastal polygon lies on the terrestrial side of the lake shore and is 500 meters wide to facilitate viewing over larger areas. Shoreline attributes were recorded including shoreline type, number of fish drying racks, huts, canoes, and other site specific observations on the shore and in the littoral and terrestrial areas.

Rock, sand, and vegetation classes are most abundant, and the combination classes are relatively rare. In general, shoreline materials shorter than 80-100 meters along the coast are the minimum size unit mapped.   Materials that evidenced sequences, like rock to sand to vegetation that are each about 100 m long are mapped as individual units with boundaries perpendicular to shore separating them.   A few areas like, for example, the mainland area south of Likoma Island, and south of Chia lagoon there are heterogeneous combinations of rock/sand/vegetation (mixed with no sequences evident) but such areas are relatively rare. In other areas, like river deltas along border faults, gravel shores may be present whereas most other low gradient shores on the lake shore plains will have sand deltas covered with vegetation.

These classes represent the area from the contemporary high water mark to the present lake level, which was approaching the annual low The time of survey occurred near the annual low water level.

A Note regarding the extraction of coastal attributes:

The rate of movement of the aircraft at mean elevation of the survey provided a 1.6 m "drift" i.e. a single pixel capture moved about 1.6 meters of distance in the along flight direction.

The surveys of the coast of Lake Malawi north of the southern basin were filmed in a single day during daylight hours. The range in distance from shore varied due to the smoothness of a flight line, and the need to maintain a flight schedule that would have us back at Senga Bay before nightfall. Consequently, the width of the coastal zone observed varies, and in some areas not all attributes can be identified. The data for each community are summed using the coastal polygons that the communities reside upon.

Primary Data Source

Twelve DGPS data files cover the lakeshore and are named as1.cor to as12.cor. The video data are contained on four VHS tapes, labeled tape 1 – 4. Five replicate sets were sent to the SAD/GEF project in Senga Bay in April, 1999. CEOS and the original recipient of this disk at the Fisheries research station at Senga Bay each have a complete set in NTSC or PAL formats, respectively.

3.2 Topographic Map Index for shoreline delineation

Index of selected coastal topographic maps for all coasts of Malawi, Mozambique, and Tanzania used in digitizing the lake shore.

Map name	Map sheet	Scale	Country	Projection	Zone	Datum	Ellipsoid	Map publis
Mbamba Bay	309/4	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Liuli	309/1	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Ngumbo	297/3	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Kyela	272/2	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Bulongwa	260/3	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Nkanda	273/1	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Ukenju	285/1	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Lupila	273/2	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Kimata	273/4	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Manda	285/3	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Lituhi	297/1	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Mbaka	259/4	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Mpapa	309/2	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Lukoma Bay	309s/2	1:50 K	Tanzania	Transverse Mercator	36 L	new 1960 Arc	clarke 1880	1972
Karonga	1	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Nyika Plateau	2	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Mzuzu	3	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Mzimba	4	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Kasungu	5	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Monkey Bay	7	1:250 k	Malawi	UTM	36 L	unknown	unknown	1996
Ponta Messuli	3	1:250 k	Mozambique	UTM	36 L	unknown	clarke 1866	1988
Metangula	10	1:250 k	Mozambique	UTM	36 L	unknown	clarke 1866	1988
Meponda	17	1:250 k	Mozambique	UTM	36 L	unknown	clarke 1866	1987
Lichinga	18	1:250 k	Mozambique	UTM	36 L	unknown	clarke 1866	1988
Mandimba	29	1:250 k	Mozambique	UTM	36 L	unknown	clarke 1866	1972

3.3 Hydraulic Animations of Lake Malawi
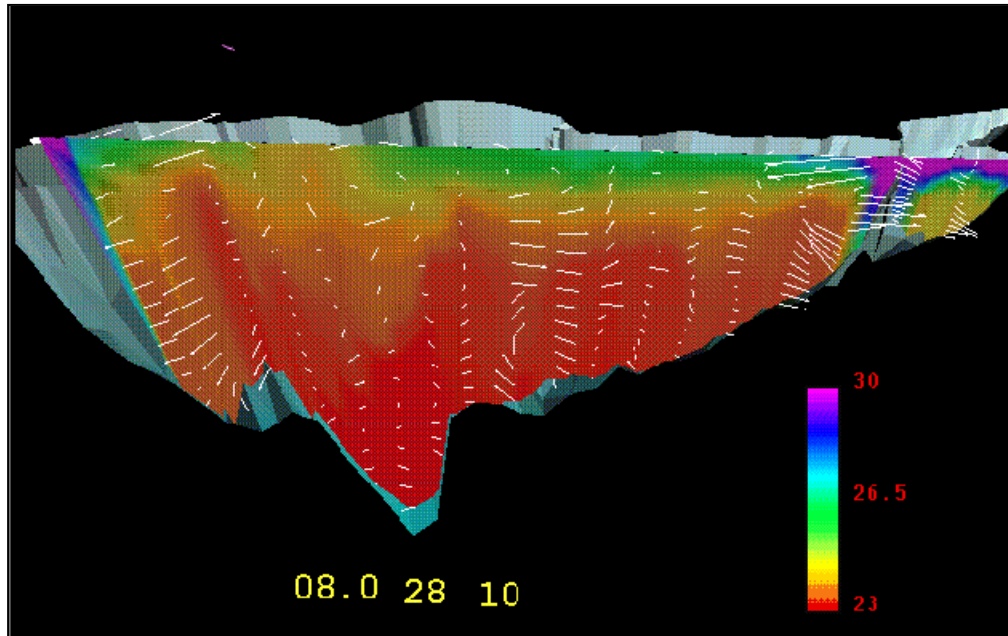
Paul Hamblin and Cheng He, Canada Centre for Inland Waters

Model: LACOM3D (lake and coastal model 3 dimensions) from a 3d coupled hydrodynamic-thermodynamic model(s) using the finite element method for horizontal discretization and the vertically stretched finite difference for the vertical. Vertical resolution varies depending on the water column depth from 20m at deep hole to 30 cm at shore

Output: 3d currents and temperatures, September 26, 1998 to January16, 1999

Interpretation: (1) vertical section view- shows dynamic behavior of flow field and temperature structure in response to wind and thermal forcing based on extrapolation of the observed Senga Bay meteorology to the whole lake. While some features are seen which are in qualitative agreement with observations such as cooler temperatures in the southeast arm, attention needs to be focused on better definition of the over-lake forcing field before a detailed comparison of model output can be made.

(2) plan view of lake surface - shows behavior of surface currents and water temperatures over approximately 100d simulation period. Warmer than observed temperatures in the nearshore zones may indicate that a more detailed vertical

resolution than the 32 layers used is needed or that horizontal mixing should be incorporated into the heat transport equation to better homogenize temperature.

White arrows are the flow vectors: (1) they show the horizontal flow at selected mesh points along the vertical plane shown. If the vectors point upwards then flow is away from viewer and if downwards, then to the viewer. Left & right directions are as would be expected. In plot (2) the flow is in the horizontal plane.

3.4 Description of Data Extracted from Ribbink et al. (1983)
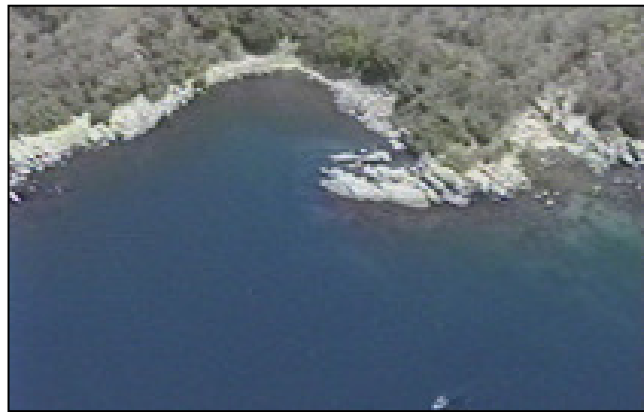
Tony Ribbink and Lucy Scott

Data extracted from the publication:

Ribbink, A. J., B.A. Marsh, A.C. Marsh, A.C. Ribbink, and B.J.Sharp. 1983. A preliminary survey of the cichlid fishes of the rocky habitats in Lake Malawi. South African Journal of Zoology. Vol. 18, No. 3. 149 – 310.

The MCMP.dbf data table of 3674 records has been provided in dbf, Map Info (mif), and Arc Info interchange (*.E00) format. This dbf table contains the following fields: unique sample ID, species name, species code, depth, abundance, habitat code, publication, figure, region, locality, lat, long, Genus, binomial_n, L_MN Park, habitat_CA, and habitat_C2, and present_ab. Details of the database codes are available from Tony Ribbink.

Codes used in the data table refer to 3 publication codes and 12 habitat codes. Database code 1: Author Spreinat, A. Title Lake Malawi Cichlids from Tanzania. Source Verduijn Cichlids, Germany, 1995. Database code 2: Author Ribbink, A.

J. Title Personal communication. Source J.L.B. Smith Institute of Ichthyology,Grahamstown, 2000

Habitat Codes: 0 = no data, 1 = pebbles < 20 cm, 2 = small rocks 20 − 50 cm, 3 = medium rocks 50 − 150 cm, 4 = large rocks 150 − 400 cm, boulders > 400 cm, 5 = boulders > 400 cm, 6 = intermediate sand/rock mix, 7 = sand, 8 = weed present, 9 = all rocks, 10 = small and medium rocks, 11 = large rocks and boulders.

3.5 Description of Sandy Shore Data

Robert Sululu

Two tables summarize the sandy shore sampling programme from the Linthipe Delta to Lifuwu, along the western coast of the southern basin of Lake Malawi. The table, "master table final Bs and GN.xls" lists the number of species for all locations by rainy season and dry season, and species present in both. The second table "haplo species only final (bs +Gn).xls" lists all haplochromines sampled. Sampling methods were beach seine (Bs) and gill nets (Gn). Robert's work is archived in his Master's thesis, University of Waterloo, Dept. of Biology.

The five sites are shown below.
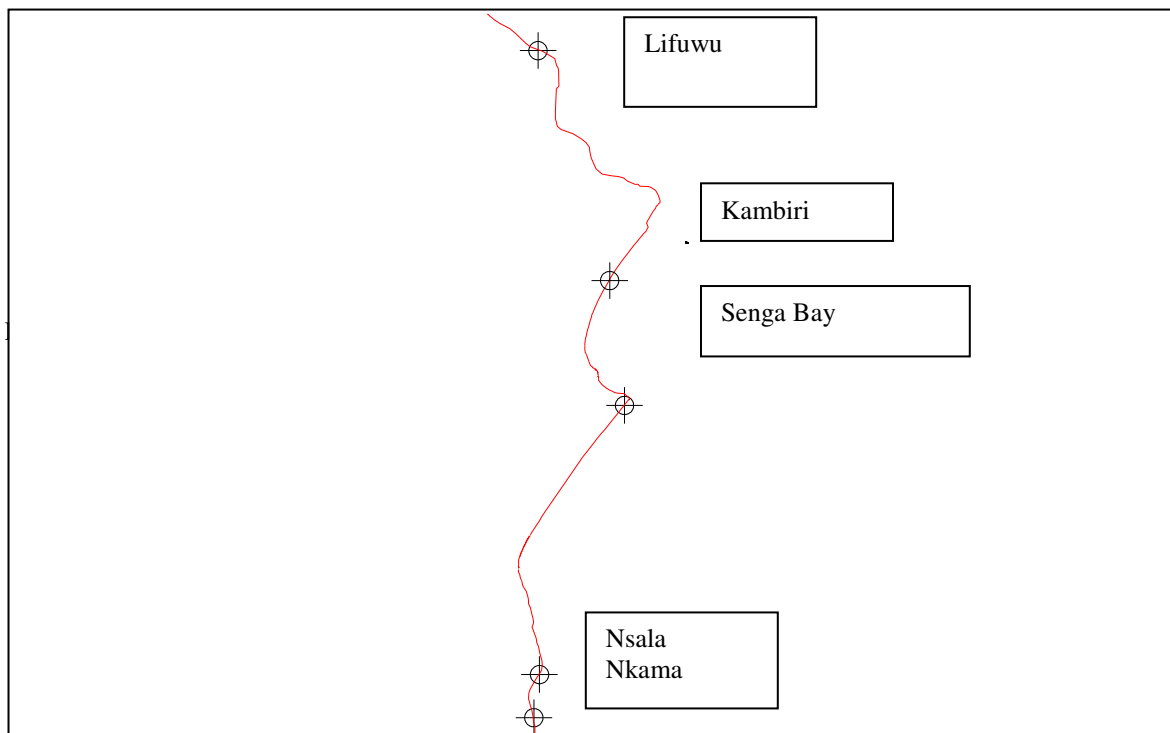
3.6 Introduction to the databases used by the Systematics/Taxonomy Team

Jos Snoeks,
Senior Systematist
SADC/GEF Lake Malawi/Nyasa Biodiversity Conservation Project

The data of this section comprises five Access databases and one Word file that are used in the systematics lab of the SADC/GEF Lake Malawi/Nyasa Biodiversity Conservation Project. The Access databases have been developed by Dr. Tony Thompson, former senior ecologist of the project, in collaboration with Dr. Jos Snoeks, senior systematist. The "lake-wide sampling program" and "collection" databases represent two of the major outputs of the team.

The "**lake-wide sampling program**" database contains all data relevant to the fish surveys jointly executed by the systematics and ecology teams. It consists of various tables, the details of which are explained below in a separate chapter on its structure. All tables can be linked with each other through certain fields. The combination of cruise and sample number is unique.

The "**collection**" database contains the data of the specimens entered in the collection at the closure of the project. This includes all mbuna species and the non-mbuna of which the identification has been reviewed. For those groups that

were collected during the lake wide sampling program but have not been reviewed, we refer the user to the lake wide sampling program database. Each specimen entered in the collection receives a unique number, made up by the year of entry (96, 97, 98, 99) followed by the cruise and sample number which is unique for every 'fishing act' and which serves as the ultimate link between all tables and databases. The last number(s) represent the number of each individual specimen within that unique sample. All entries on the columns from 'sex' to 'remarks' are optional. The collfixed.mdb table replaces collection.mdb on the CD.

The "**colour patterns mbuna**" and "**colour patterns non-mbuna**" databases contain detailed information on the colour patterns of the cichlids of the lake. They have been produced by the taxonomy team for two purposes. First, since cichlid identification relies heavily on colour patterns, there was a need to compile all information for future reference in a database, which can be updated whenever new information becomes available. However, due to time and logistical constraints, the huge pile of new information gathered by the team on the colour pattern of these fishes could not be analyzed; hence only literature information has been entered. A second, equally important goal was to initiate the production of a key based on these databases. However, this attempt, unfortunately, could not be launched since Dr. Thompson who was providing the database know-how, had to leave prematurely.

The "**library**" database includes all publications currently present on site.

The "**types**" file lists all type specimens of Lake Malawi/Nyasa cichlids and their whereabouts. Updated until end 1997.

A last database "**names**" comprising a list of names of more than 700 species currently considered valid, including working names, synonyms and trade names is near to completion, but could not be updated in time. Rather than creating confusion with an incomplete database, I prefer updating it first and waiting for a later occasion to distribute this information.

It is certainly not the intention that the information contained in the databases remains untouched. The information can be used by the scientific staff of the SADC/GEF project, but within the normal standard scientific ethics. Other scientists willing to use this information are requested to contact the senior systematist, Dr. Jos Snoeks on the address mentioned below to discuss additional exploration of the data. At this moment, already further studies are undertaken on the distribution of the cichlids within the lake, based on the information available. However, it should be stressed that these databases represent a still image in time, representing the situation at the closure of the project. Many of the taxonomic studies still continue and their results will be published in the future. Also other research programs are currently attacking taxonomic issues. This means that there is a need to update these databases

regularly. At this moment, it is not clear how this information will be made available. Therefore, if you are interested in a certain group, please contact Dr. Jos Snoeks for the latest information.

Dr. Jos Snoeks
Ichthyologist
Africa Museum
Leuvenstesteenweg, 13
B-3080 Tervuren, Belgium
Tel (32) 2 769 56 28 direct, or (32) 2 769 52 11 general
Fax (32) 2 769 56 42 or (32) 2 767 02 42
Email jsnoeks@africamuseum.be

*The following is a rather technical resume of the structure of the "**lake-wide sampling program**" database, extracted from an internal report made by Dr. Tony Thompson end of July 1997. This structure has been conserved in the current database, except for one extra field "name" that has been inserted in the fish identification table. This field contains either the same name as given during the fieldwork or the new name after re-identification.*

3.7 Database for fish caught in the SADC/GEF project

A. B. Thompson

This database is to store data on all fish processed during the current SADC/GEF Lake Malawi Biodiversity Conservation Project. It is for use by the taxonomy and ecology sections and uses MS ACCESS 95 as the programming environment. Below is a brief outline of the structure. Every attempt has been made to normalise the table design to produce an efficient fully relational structure.

There are two other databases developed by the ecology and taxonomy sections. A library database of the references kept on the site by the project and in personal collections. And a reference database that gives information on all the published literature regarding fish ecology and distributions. This database has an OLE link to excel that allows for distribution maps to be produced.

Tables:

Scientific log
This table contains information on the time, location and type of sampling undertaken. Data are entered on the 'Scientific log' sheet, usually on the ship's bridge. There are four key fields that

can be used to link with other tables. A cruise number usually only applies to one sampling trip. The sample number increases by one every time a new sample or observation is taken. The cruise and sample number together is unique, and this is checked by the calculated field Cruise_sample that will not allow duplicated data.

Field name	Data type	Field size	Variable name (in form)	Links to tables
ID	AutoNumber	Long int		
Vessel	Text	50	Vessel_Name	
Cruise number*	Number	Long int	Cruise_number_name	various
Sample number*	Number	Long int	Sample_number_name	various
Site number*	Number	Long int	Site number	Site numbers
Gear code*	Text	3	gear code	Gear codes
Date_S	Date/Time	Short date	Date_S_Name	
Date_H	Date/Time	Short date	Date_H_Name	
Time_S	Date/Time	Short time	Time_S	
Time_H	Date/Time	Short time	Time_H	
Latitude_deg_S	Number	Single	lat deg S	
Latitude_min_S	Number	Single	lat min S	
Latitude_deg_H	Number	Single	lat deg H	
Latitude_min_H	Number	Single	lat min H	
Longitude_deg_S	Number	Single	long deg S	
Longitude_min_S	Number	Single	long min S	
Longitude_deg_H	Number	Single	long deg H	
Longitude_min_H	Number	Single	long min H	
Bottom_depth_S	Number	Single	Bottom_depth_S	
Bottom_depth_H	Number	Single	Bottom depth_H	
Notes	Text	100	Notes	
Cruise_sample	Text	50	Cruise_sample_name	

Diet

This records the gut contents of fish. Each fish is identified to species using the species code and an individual number. The food item is given a three letter code and the approximate percentage by volume in the gut is estimated visually. Data recorded on the diet form.

Field name	Data type	Field size	Variable name (in form)	Links to table
Key	Autonumber	Long int		
Species code*	Text	15	Diet_species_code	Species identifications
Individual number	Number	Long int	Diet_individual_number	
Food number*	Number	Long int	food_number	Food numbers
Percent food in gut	Number	Int	Perc food	

Fish length frequency

This records the lengths of the fish sampled in the catch. The fish are sorted and put it to single species piles and given a species code consisting of the cruise, sample and initial species number representing the species number for that particular sample e.g. 2/4/3 is the second cruise, the fourth sample and the third species. Lengths are measured to the nearest cm below. The field number is a calculated field contained the raised number of fish i.e. the total number caught. This is calculated from the unraised count and the sub-sample and total sample weights. Data recorded on the fish length frequency form.

Field name	Data type	Field size	Variable name (in form)	Links to tables
Species code*	Text	15	Species_code_lf	Species identifications

Length	Number	Int	Length_lf	
Number	Number	Single	raised_count_lf	
			unraised_count_lf	
			Total_lf	
			subsample_f	

Fish sex and maturity

This records sex and maturity information from fish caught. Again the species are identified by the species code. An individual number is used when fish have been examined for gut contents and kept in the museum collection. Number refers to the number of fish of a particular length and maturity stage. Data are recorded on the fish maturity form and also on the diet form if processed in the lab.

Field name	Data type	Field size	Variable name (in form)	Links to tables
Species code*	Text	15	Species_code_name_sm1	Species identifications
Individual number	Number	Long int	Individual_number	
length	Number	Long int	length_name_sm1	
sex	Text	2	Sex_code	
number	Number	Int	number	

Sediment size

Mud samples are collected using a grab and frozen. They are processed back at the laboratory as detailed in the instructions.

Field name	Data type	Field size	Variable name (in form)	Links to tables
ID	AutoNumber	Long int		
Cruise number*	Number	Long int	Cruise number	Scientific log
Sample number*	Number	Long int	Sample number	Scientific log
Detritus	Number	Single	Detritus	
Granules	Number	Single	Granules	
Sand	Number	Single	Sand	
Silt and clay	Number	Single	Silt and clay	
Initial total volume	Number	Single	Initial total volume	
No 10	Number	Single	No 10	
No 18	Number	Single	No 18	
No 35	Number	Single	No 35	
No 60	Number	Single	No 60	
No 120	Number	Single	No 120	
No 230	Number	Single	No 230	
Visual classification	Text	50	Visual classification	

Food numbers

This is a reference table used to assign the name of the food item to the numeric code used in the diet table. Records are only added to this table when new food items are identified.

Field name	Data type	Field size	Variable name (in form)	Links to tables
Food number*	AutoNumber	Long int	Food number	Diet
Place	Number	Long int	Place	
Habitat	Text	30	Habitat	
Phylum	Text	30	Phylum	
Class	Text	30	Class	
Order	Text	30	Order	

Food name	Text	30	Food_name	

Gear codes

This is a reference table used to assign the name of the gears to the three letter code used in the scientific log table.

Field name	Data type	Field size	Variable name (in form)	Links to tables
Gear code*	Text	3	Gear code	Scientific log
Gear type	Text	50	Gear type	
Description	Text	255	Description	
Sex codes				
Field name	Data type	Field size	Variable name (in form)	
Sex	Text	1		
Description	Text	30		

Site numbers

This table contains information of site names. It does not necessarily contain information on the exact location that samples were taken, as this is included in the scientific log sheet. The main use of the table is to allow samples from a general area to be pooled together. For example, all trawl samples from Senga Bay. The locality can be in the form of a hierarchical address, as partial fields are easy to search on.

Field name	Data type	Field size	Variable name (in form)	Links to tables
SITE NUMBER*	Number	Long int	SITE NUMBER	Scientific log
LOCALITY	Text	50	LOCALITY	
SITE DESCRIPTION	Text	255	SITE DESCRIPTION	
LATITUDE DEG	Number	Single	LATITUDE DEG	
LATITUDE MIN	Number	Single	LATITUDE MIN	
LONGITUDE DEG	Number	Single	LONGITUDE DEG	
LONGITUDE MIN	Number	Single	LONGITUDE MIN	

Species identifications

This table contains the species code and the initial id. The final id is made back in the laboratory and a species number is added to the table. This allows for a correct name to be given to the piles that were initially sorted on the ship. The date altered field is a calculated field that gives the time and date a record was changed. This allows for any alterations to the table to be quickly identified.

Field name	Data type	Field size	Variable name (in form)	Links to tables
Cruise number*	Number	Long int	Cruise_number_name	various
Sample number*	Number	Long int	Sample_number_name	various
Initail species number	Number	Long int	Initial_species_number_name	
Species code*	Text	15	Species_code_name	various
Initial name	Text	50	Initial name	
Species number*	Number	Long int	Combo1	Species numbers
Notes	Text	50	Notes	
Date altered	Date/Time		si_date	

Species numbers

A table containing the designated species names and their associated numbers.

Field name	Data type	Field size	Variable name (in form)	Links to tables
SPECIES NUMBER*	Number	Long int		Species identifications
GENUS	Text	255		
SPECIES	Text	255		
CHEIRONYM	Text	255		
AUTHOR	Text	255		
SYNONYM	Text	255		
TRADE NAME	Text	255		
OTHER	Text	255		
NOTES	Text	255		

Fish sediment link

This is an unusual table that is used to identify the habitat type of each fish sample. Hense, a grab and trawl are done in the same location, but there is no way of linking them together using any of the above mentioned fields. For example, the top two fields could be linked to the species identification table and the bottom two records to the sediment size table.

Field name	Data type	Field size	Variable name (in form)
CRUISE_FISH	Number	Long int	CRUISE_FISH
SAMPLE_FISH	Number	Long int	SAMPLE_FISH
CRUISE_SEDIMENT	Number	Long int	CRUISE_SEDIMENT
SAMPLE_SEDIMENT	Number	Long int	SAMPLE_SEDIMENT

Visual basic code

Scientific log table: code for ensuring that there are no duplicated cruise and sample entries.

```
Public Function No_dup_Cr_St() As Variant
Dim ctl1 As Control
Dim ctl2 As Control
Dim ctl3 As Control
Set ctl1 = Forms![Scientific log].Cruise_number_name
Set ctl2 = Forms![Scientific log].Sample_number_name
Set ctl3 = Forms![Scientific log].Cruise_sample_name
ctl3.Value = ctl1.Value & "/" & ctl2.Value
StoreValuesExit:
Exit Function
End Function
```

Scientific log table: code for easy data entry. Copying likely duplicated entries to other fields within the same record

```
Public Function same_record() As Variant
Dim ctl1 As Control
Dim ctl2 As Control
Dim ctl3 As Control
Dim ctl4 As Control
Set ctl1 = Forms![Scientific log].Date_S_Name
Set ctl2 = Forms![Scientific log].Date_H_Name
ctl2.Value = ctl1.Value
ctl1.DefaultValue = glrcQuote & ctl1.Value & glrcQuote
ctl2.DefaultValue = glrcQuote & ctl1.Value & glrcQuote
```

```
                StoreValuesExit:
                Exit Function
                End Function
Scientific log table: code for easy data entry. Copying likely duplicated entries to other fields
within the next record
                Public Function Next_record() As Variant
                Dim ctl1 As Control
                Dim ctl2 As Control
                Dim ctl3 As Control
                Set ctl1 = Forms![Scientific log].Vessel_Name
                Set ctl2 = Forms![Scientific log].Cruise_number_name
                Set ctl3 = Forms![Scientific log].Sample_number_name
                ctl1.DefaultValue = glrcQuote & ctl1.Value & glrcQuote
                ctl2.DefaultValue = glrcQuote & ctl2.Value & glrcQuote
                ctl3.DefaultValue = ctl3.Value + 1
                StoreValuesExit:
                Exit Function
                End Function
Fish length frequency table: Code for raising sub-sample length frequency data to total sample.
                Public Function raise()
                Dim ctl1 As Control
                Dim ctl2 As Control
                Dim ctl3 As Control
                Dim ctl4 As Control
                Set ctl1 = Forms![fish length frequency].total_lf
                Set ctl2 = Forms![fish length frequency].subsample_lf
                Set ctl3 = Forms![fish length frequency].unraised_count_lf
                Set ctl4 = Forms![fish length frequency].raised_count_lf
                ctl4.Value = ctl3.Value * ctl1.Value / ctl2.Value
                StoreValuesExit:
                Exit Function
                End Function
Species identification table: code to enter date and time that a record is modified.
                Public Function Date_record_changed()
                Dim ctl1 As Control
                Set ctl1 = Forms![Species identifications].si_date
                ctl1.Value = Now
                End Function
```

Queries

Conversion to decimal positions

In general, it is easier to quickly design a new query than to have lots of queries already made up. There are exceptions to this, mainly when it is necessary to process some information in a table prior to it being displayed in a form. An example would be to convert positional data from degs and mins to decimal. The SQL code for this is written automatically when a query is developed, but it is as follows.

```
                SELECT [Scientific log].[Cruise number], [Scientific log].[Sample number],
                [Scientific log]. [Site number], [Scientific log].[Gear code], [Scientific log].Date_S,
                [Scientific log] .[Time _S], [Latitude_deg_S] +[Latitude_min_S]/60 AS DecLat_S,
                [Longitude_deg_S] +[Longitude_min_S] /60 AS DecLong_S, [Scientific
                log].[Bottom depth_S],  [Scientific log].Date_H,  [Scientific log].Time_H,
                [Latitude_deg_H] +[Latitude_min_H]/60 AS  DecLat_H,  [Longitude_deg_H]
                +[Longitude_min_H]/60 AS DecLong_H,  [Scientific log].[Bottom depth_H]
```

FROM [Scientific log];

Sorts for forms

Complicated sorts do not necessarily need a query as SQL code can be inserted into the 'order by' property of the forms control. It may however be easier to generate the SQL code from a query and then paste it into the control property.

Data sheets used on the project

The design of the data sheets is critical and must follow closely the design of the database. Generally, each sheet has an associated database table. The layout of the sheet follows the layout of the forms in the access database.

3.8 The Fish Ecology Database of the SADC/GEF Lake Malawi/Nyasa/Niassa Biodiversity Conservation Project

Fabrice Duponchelle

Though of open access to the three riparian countries, the usage of the data included in the Fish Ecology Database, which the intellectual property belongs to the Ecology Team of the SADC/GEF Project, relies upon the basic scientific ethics.

Therefore, before to start using any of these data, please contact me at the following address for any details about the data themselves and usage recommendation:

Dr. Fabrice Duponchelle, IRD, Institut de Recherche pour le Developpement (ex ORSTOM), Gamet C/O Cemagref, 361, rue J.F. BRETON, BP 5095, 34033 Montpellier cedex1, France.

TEL 33 4 67 04 63 00

FAX 33 4 67 63 57 95

e-mail fabrice.duponchelle@mpl.ird.fr or philippe.duponchelle@wanadoo.fr

4.0   Getting Started: Biodiversity Atlas Maps and Map Maker Pro

A subset of the map databases are demonstrated using Map Maker Pro 2.4 software in a Lotus Screen CAM presentation located on this disc. To view these files set your monitors screen resolution to 1024 x 768, and install LOTUS Screen CAM viewer found on the Biodiversity Atlas CD.

The Map Maker data is set to run using drive C on your IBM compatible Personal Computer with your Windows Media Viewer located in C:\windows\mplayer.exe.

Copy the data from the Biodiversity Atlas CD ROM to the root of your C: hard disk using the same directory structure, and remove the "read only" properties of the copied data. Users intending to use drive D must replace the *.map files located in the GIS DATA directory with those found in the directory "map files D". The directories named "fish databases", "screen cam", "software", "video 1 mov", and "video 2 mov" can be deleted or moved on your hard disk without affecting the GIS data.

GIS data are often provided as layers. Large datasets have many layers that can become cumbersome to load. Map Maker Pro circumvents this using what is called a Map Maker Assembly (*.map). This is a file which remembers the source data layers and reconstructs them in the right order, links map entities to the tabular databases, and assigns colors (attributes).

The Map Maker Assembly files (*.map) files listed below show the collection of geographic data, which are:

1) **Lake Malawi.map** – Lake Malawi
2) **Drainage basin.map** – watersheds for drainage
3) **Rift structures.map** - distribution of half grabens and monoclines
4) **Shoreline.map** – distribution of shoreline classes
5) **Hydro_models.map** – hydrodynamic models
6) **Ecology fish distr.map** - extract from ecology fish distribution database site numbers
7) **Ribbink 1983 fish sites.map** – fish sampling sites from MCMP.dbf
8) **Taxonomy lake wide fish sites.map** – fish sampling sites from taxonomy lake wide database, site numbers table.
9) **Info system1.map** – collection of map themes
10) **Information sites.map** – combination of sites of point data about the lake and shoreline features

To open the map files: Under the file pull down menu (PDM), select Open, then map assembly (*.map) on the left. Only map files in your current directory are

listed. Next, another dialogue appears which is named Layer Set Up. Ensure the current default styles is named "coastal classes.stl". If so, accept the defaults but note the lowest option on this dialogue allows one to display labels, or to just show the graphic objects if a lot of text is present on that layer (it can obscure the map elements and so can be shut off for clear display).

If your default style (see File PDM > default style) is not listed as coastal classes on this dialogue, do the following: select default styles, change/edit styles in the lower left corner of this dialogue, then navigate to the location of coastal classes.stl on your hard disk (i.e. the map maker directory in GIS data). Accept all defaults thereafter. Coastal classes should now be listed on the File PDM>styles as mentioned.

Once the various files in the map assembly are on screen, you may wish to change the scale of the text or width of other objects. Select View PDM, and then select Preferences. The box labeled "screen pixels per page" can be used to change the size of text. Smaller numbers reduce the size of scalable objects. Typical values range from around 1.0 with increasing size of text to 5.0.

Pan and move tools are found on the lower left corner of the programs interface. Once a zoom window has been invoked, you can zoom out to your last zoom level using a single left click on the map display.

A Map Maker Assembly (*.map) file is ascii, and can be read or modified using an ascii editor. If the hard disk used is other than C or D, use a search and replace function in the ascii editor for the existing drive and colon (e.g. c:) with (your drive letter of choice:). Note that the hydro_models.map contains a path to windows Media Player and must contain the drive, path, and executable name for your viewer. The path used here is the default install option in Win 98. An example of the contents of a Map Maker Map Assembly is found in the section named "Description of the Map Maker Assembly".

If work with the individual files (i.e. *.dra) contained in the Map Assembly is required, please consult the software documentation found on the accompanying CD ROM in the Map maker software directory. Each *.dra file is accompanied by the associated attribute table with the same name as the *.dra file in *.dbf format. Critical to the use full use of Map Maker Pro software is the use of "styles" for both colour and attribute management.

The layer manager shows the individual dra files that make up the Hydro_models.map below. It is accessed via the file pull down menu, or by right clicking your mouse on the map screen to invoke the Fast Menu.
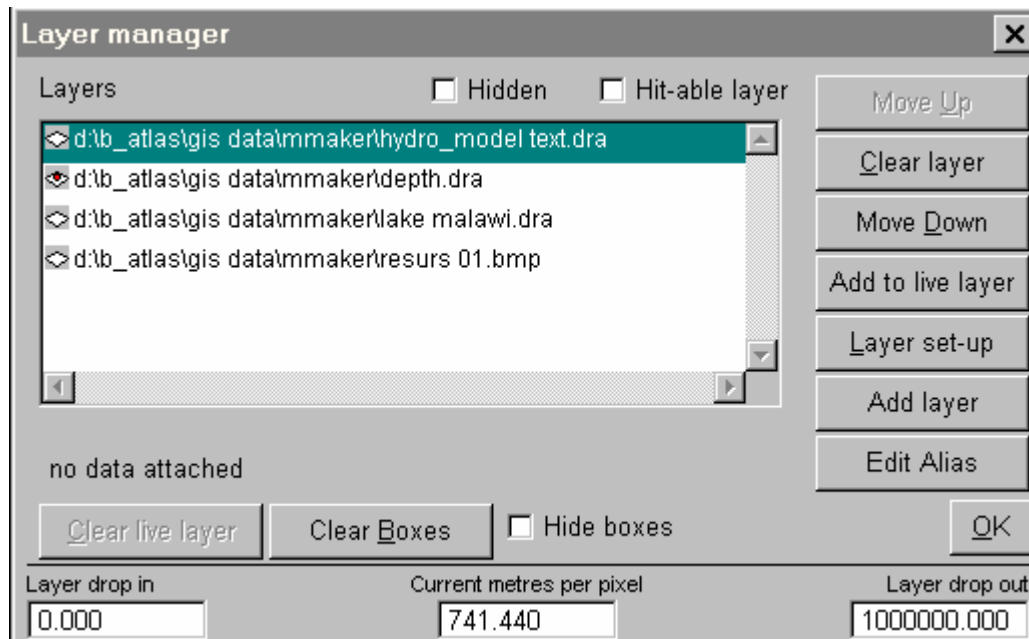
4.1 The Coastal Classes style file

The Map Maker Assembly files use the coastal classes style file, shown in part below. The styles used in this file range from 1 – 17 and each is named (e.g. rock). The symbols on the right show the colors for point, line, and polygons features, and text that will be used by Map Maker. Each of these can be changed using the edit buttons on the left side of the dialogue.
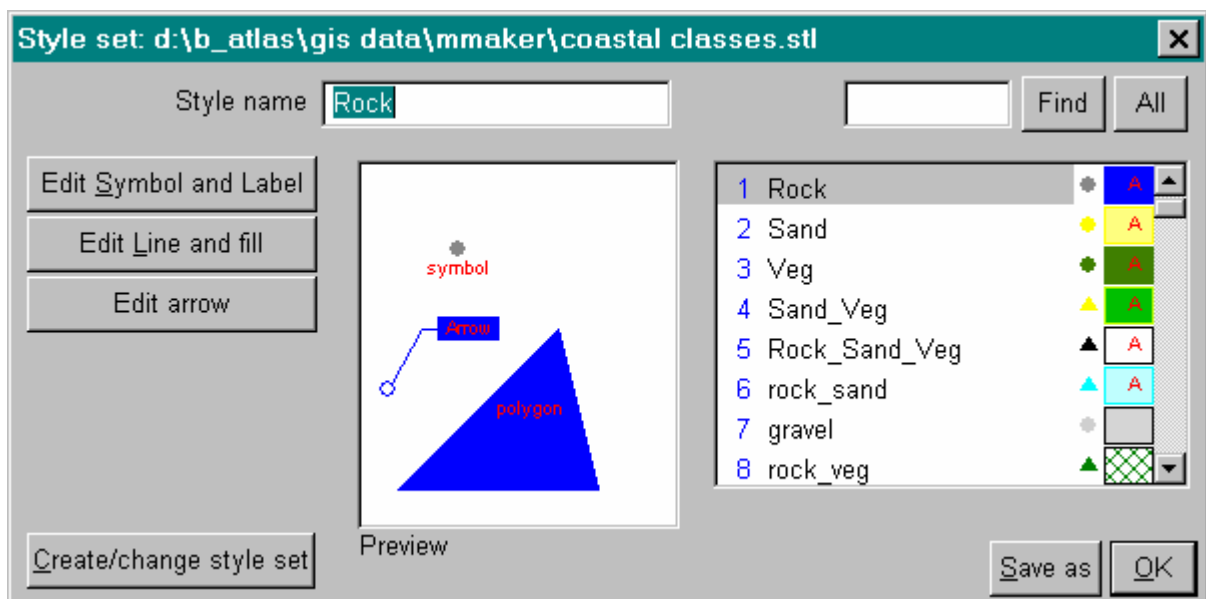
A individual Dra file can be opened with this style file, or optionally, a single colour can be assigned to all objects in one map by selecting a style name. For example the Lake Malawi.dra file can be opened and in the Layer Set Up dialogue the lake can be coloured cyan by selecting the Lake Cyan style (see below). To assign all map objects to red, enter 58 in the "all one style", and select
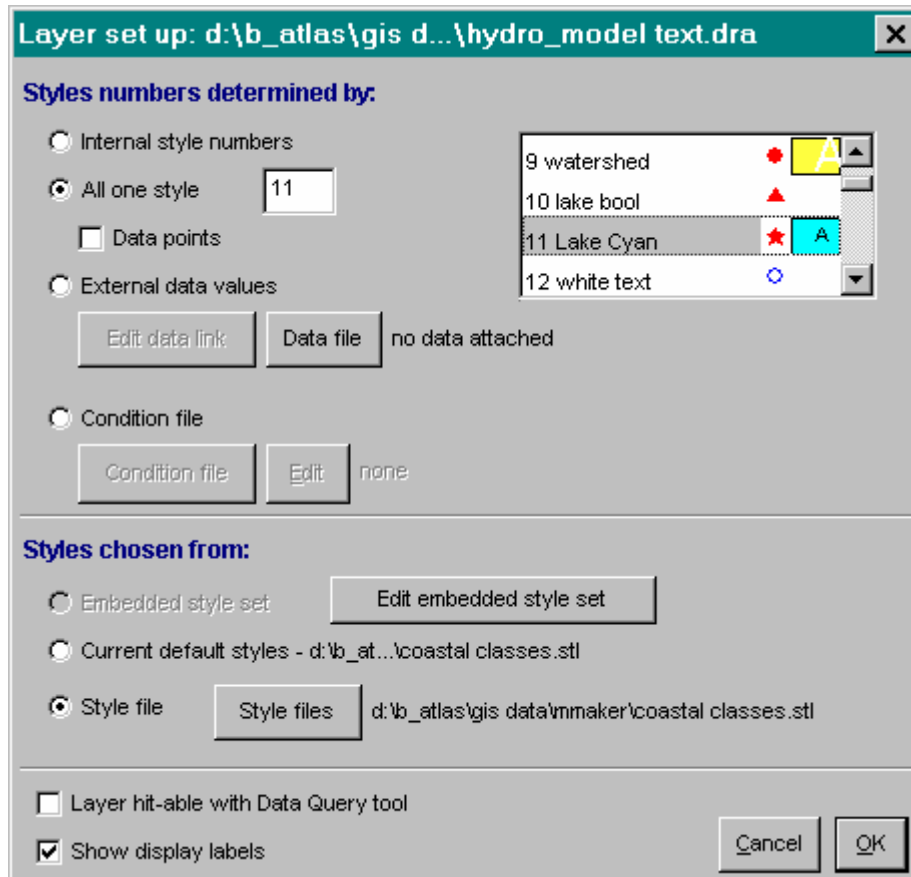
it, then press OK.

Note the check box at the bottom of the dialogue can be used to show display labels, which is useful to show names of the watersheds in the drainage basin.dra, for example.

Export routines to a wide variety of GIS software formats are found under the Utilities pull down menu.

A special thanks to Mr. Eric Dudley of Map Maker Ltd. for providing the evaluation version, and the enclosed software documentation in Adobe Acrobat *.PDF format. Mr. Dudley provided a few customizations to the software. Map Maker Pro 2.4 is available for purchase for about 265 US dollars from www.mapmaker.com.

4.2 Performing a Database Query using a Condition Statement

Database queries can be performed in Map Maker Pro, and the results of these queries can be shown graphically in a map. The examples of fish drying racks and huts in the southern basin shown in section 2 are results of such queries. For example:

1) Using the Community lake shore map to query presence/absence of fish drying racks.

Lakeshore attributes like fish drying racks tend to be associated with shoreline types. For example, the present data show that it is more likely to have settlement on low gradient beaches (when beaches are present) than on rocky coasts. In this manner, all coastal attributes are summed within each coastal polygon, rather than identifying all features individually. A coastal polygon is a homogenous shoreline class. The beach at Senga Bay is a single polygon, for example. Hence, the fishing community present on the north end of the beach will be represented along the length of Senga within this single habitat unit.

Open community.dra containing the shoreline polygons and in the Layer Set Up Dialogue, select the external database values in community.dbf where the shoreline attributes are stored. In the External link dialogue, the database is community.dbf, and the display style is Coastal classes. The style link column is style, and the object label link column is Label.

Open the community.dra by selecting OK, and zoom in to the southern basin area. Right click to Layer Manager, select Layer Set Up, select condition file racks.cnd. This file colours all objects in field "racks" of community.dbf red (style number 58) in coastal classes.stl that have a value > 1.

Select OK from Layer Manager. All shoreline segments with presence of fish drying racks are coloured red.

To create a new condition statement select File > Data > Edit condition statements.

To remove a Condition Statement when on screen, right click to Layer Manager, select external data values, and the dbf listed to the right will be community dbf. Accept dialogues and file will display the default styles for rock, sand, veg, and other combinations provided coastal classes is the style loaded from the File Pull Down Menu.

4.3 Creating Maps from Data Tables

Coordinate Conversions from Latitude and Longitude to UTM 36 South

Before a geographic map file of points can be displayed, it is often first necessary to take the coordinate positions from a data table. For example, the taxonomy relational database uses latitude and longitude in degrees and minutes which must be converted to decimal degrees, as follows:

Lat Long (Degrees, Minutes) is converted to decimal degrees by:

degrees + minutes/60 = decimal degrees.

Next, to make a map of point locations, make a Map Maker ascii LOC file with ID, x and y in the frist three columns. Save as csv (comma separated values file) in MS Excel like " test.loc" with quotes included. and the csv file (see below) will be saved as a LOC file extension read by Map Maker.

A sample of the ecology fish distribution site numbers table when saved as a CSV with the LOC extension appears as follows. Text captions for each point can follow the preceding unique ID, and coordinate pairs. The first line of the data file is an essential header that describes the name and order of data columns.

```
ID,x,y,caption
1000,34.283330,-11.383330,Lion's Cave
1001,34.250000,-11.266670,Dankanya Bay
1002,34.258330,-11.233330,Mpandi Point
1003,34.266670,-11.275000,Mara Rocks
1004,34.233330,-11.108330,Ruarwe
1005,34.221660,-10.743330,Mlowe
1006,34.183330,-10.566670,Florence Bay
1007,34.230000,-10.466670,Young's Bay
1008,34.241670,-10.421670,Deep Bay
```

Select File and Open LOC, then navigate to LOC file. In the Layer Set Up, Select All one style, choose a colour (e.g. 58 = red), then OK. Points from your LOC file will display on screen. The displayed file is Lat Long so a conversion to UTM zone 36, in the southern hemisphere, using the Clark 1880 ellipsoid. You may wish to save the LOC file as a Map Maker dra file as this format is binary (smaller and faster) than a LOC file.

To transform the positions from Lat Long decimal degrees to UTM, go to Utilities Lat Long> convert LL to meters (UTM). Provide first the current coordinate system (i.e. Lat Long), and select the information noted above and the file will be in the UTM coordinate system. Also note that Map Maker offers the ability to

easily change coordinate systems for all files in a directory using a single routine, also found under the Utilities PDM.

NOTE* Keep data of different coordinate systems in different directories. Otherwise, you may try to open two files from two coordinate systems together, and only one will be visible, or conversion of data for an entire directory from one coordinate system to another will provide unintended results.

4.4 Description of the Map Maker Assembly (*.map)

The contents of a Map Maker Assembly appears as follows using drive C and the location of Windows media player for Windows NT 4.0. The drive and path to the location of the dra files, styles, and windows media viewer can be changed in this file to match that found on your computer. This map assembly example is taken from hydromodels.map.

```
VERSION,2,Map Maker map assembly
EXTENT,805807.9600,8691393.2800,741.440000
DEFAULT STYLES,c:\b_atlas\gis data\mmaker\coastal classes.stl
ROTATION,0.0
PAGE,30.00,30.00,50.00,100.00,1,1,0,1,1.4725,0

LAYER,c:\b_atlas\gis data\mmaker\resurs 01.BMP,-1,FALSE,-1,TRUE,0,TRUE,1
VISIBILITY,0,0.000,1000000.000
STYLES,c:\b_atlas\gis data\mmaker\coastal classes.stl
END

LAYER,c:\b_atlas\gis data\mmaker\lake
malawi.DRA,10,FALSE,0,FALSE,0,TRUE,1
VISIBILITY,0,0.000,1000000.000
STYLES,c:\b_atlas\gis data\mmaker\coastal classes.stl
END

LAYER,c:\b_atlas\gis data\mmaker\depth.DRA,111,FALSE,0,FALSE,0,TRUE,1
VISIBILITY,0,0.000,1000000.000
STYLES,c:\b_atlas\gis data\mmaker\coastal classes.stl
DATA,"c:\b_atlas\gis data\mmaker\depth.dbf",3,c:\b_atlas\gis
data\mmaker\depth.gtn,7,7
END

LAYER,c:\b_atlas\gis data\mmaker\hydro_model text.DRA,-
1,FALSE,0,TRUE,0,TRUE,1
VISIBILITY,0,0.000,1000000.000
STYLES,c:\b_atlas\gis data\mmaker\coastal classes.stl
END
```

BOX,560,526,728,553
85.31,199.37,110.91,195.25
11,1,0,TRUE,TRUE,FALSE,-1,3.0,0
"C:\PROGRAM FILES\WINDOWS MEDIA PLAYER\MPLAYER2.EXE" /PLAY
/CLOSE "C:\B_ATLAS\HYDRO MODEL\LKMLS.AVI"
Vertical

BOX,560,557,729,577
85.31,194.64,111.06,191.60
11,1,0,TRUE,TRUE,FALSE,-1,3.0,0
"C:\PROGRAM FILES\WINDOWS MEDIA PLAYER\MPLAYER2.EXE" /PLAY
/CLOSE "C:\B_ATLAS\HYDRO MODEL\LKMLT.AVI"
Horizontal

TOOL,751

The last two sections of text that start with "box" provide the dimensions of the buttons that call the hydromodel animations, and provide the path to the mplayer.exe, and the path to the *.dra layers. The last line of text in each provides the name to the button to which the user clicks with the mouse.

4.5 Running the Hydraulic Animations and Video Clips

The hydrodynamic model animations are provided in two *.avi files. See Map Maker's PDF documentation for more information on clicking on maps to launch animations.

Determine the location of your Windows media viewer. For WIN98 it is probably C:\windows\mplayer.exe. For WIN NT 4.0 it may be C:\Program Files\Windows Media Player\mplayer2.exe.

If the location of Media Viewer is not C:\windows\mplayer.exe on your PC you have the simple task of remaking two button controls to enable on-screen mouse driven clicks to run the *avi hydraulic models. If the buttons named "horizontal" and "vertical" in Hydro_models.map are not visible when this map file is opened, select Furniture Maker from the Tools pull down menu. The cursor changes, then drag a shape desired for the button. A page furniture dialogue pops up, select Button Control, and OK. On the Button control enter a caption for the button, e.g. Horizontal. The lines of text shown below are pasted, including quotes, into the "file name" text box below the button name.

Two possible configurations are provided as examples:

i) B_atlas data on hard drive C (Win 98)

"C:\WINDOWS\MPLAYER.EXE" /PLAY /CLOSE "C:\B_ATLAS\HYDRO MODEL\LKMLT.AVI"

ii) B_atlas data on hard drive D (Win NT 4.0)

Similarly, in a map Maker's Note Object, another way to launch actions from a map, this text calls the vertical current and temperature model

"C:\Program Files\Windows Media Player\mplayer2.exe" /play /close "D:\B_Atlas\MMaker\hydro model\lkmls.avi"

In a separate note object, this text calls the horizontal current and temperature model

"C:\Program Files\Windows Media Player\mplayer2.exe" /play /close "D:\B_Atlas\MMaker\hydro model\lkmlt.avi"

This text string calls windows media player with auto play and close commands, and provides the path to the AVI file.

Sometimes media viewer is also given a number (e.g. mplayer2.exe) so you may need to search for that file using windows explorer and a wild card character (i.e. mplayer*.exe).

Finally, to save the entire map assembly, select File Save Map.

4.6 Quick Time Media Viewer

Quick Time *.mov was the preferred file format due to high compression capacity.

To run the aerial video segments in *.mov format first install Apple's Quick Time 4.1 viewer found on this CD (2 files). The compressed file (zip) is the source of the uncompressed file found in the SOFTWARE directory. This viewer can also be downloaded for free at www.apple.com/quicktime.

The title of each MOV file is named using the time of day when the coastal video segment started, without colons separating hours, minutes, and seconds. Surveys on the second day are followed by "_2" after the time stamp.

Map Makers Note Objects can call the Quick Time executable when clicked using Data Query. Unfortunately, Quick time does not enable autorun and close parameters as does windows media player so files must be called from the Quick Time file pull down menu. A Note Object is found in the Drawing menu item on the Tools pull down menu.   Click on the screen once, select Video, navigate to the location of the MOV file that corresponds to the location on the map. Right – click to Data Query, then double click on the blue dot on the note object. The Quick time menu bar is called. An error message may appear but can be disregarded. The digital conversion was done on a Macintosh computer that uses different sound compression than Microsoft Windows.

Note objects can call At present the Quick Time executable can not be launched from within Map Maker to autoplay the shoreline data, as is possible with Windows media viewer and AVI format files. To convert MOV to AVI, see Apples home page for Quick Time.

5.0 Meta Data

At time of CD production, the known data non-conformities are listed below.

Shoreline: discrepancies between the source shoreline maps and the Resurs 01 imagery suggest that the source topographic shoreline data is in error in the two areas noted below: 1) Amelia Bay, Tanzania (east coast across from Chilumba), 2) the coastal zone west of Lichinga, Mozambique.

Bathymetry: The source data were initially mapped in hard copy by T.C. Johnson during the Project PROBE.

The data provided here are the source data resultant from high resolution software contouring runs on the lake wide depth data.

The detailed grid from which the contours were generated is evident in the contours of low gradient areas of the lake. This artifact arose due to the steep border fault coastlines required a very detailed grid. The line generalization that is required to smooth the contours in areas of low gradient may form topological errors in the tightly spaced contours along border faults (vertex removal may cause contours to cross). A user wishing to simplify these data must closely audit the generalization process along steep coasts to prevent contour intersections. All line contours (i.e. bath56.dra) contain correct z values without errors. Raster digital elevation models derived from these contours will be unaffected with pixels as small as 100 m.

The lake bathymetry polygon file (depth.dra) is for display purposes.

Note: all files are listed in the "filelist.txt" found on the accompanying CD ROM.

6.0 Acknowledgements