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Biodiversity Special Study (BIOSS)

Survey of Aquatic Habitats and Associated Biodiversity adjacent to the Gombe Stream National Park, Tanzania

Final Consultant Report

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Pollution Control and Other Measures to Protect Biodiversity in Lake Tanganyika (RAF/92/G32)

Lutte contre la pollution et autres mesures visant à protéger la biodiversité du Lac Tanganyika (RAF/92/G32)

Le Projet sur la diversité biologique du lac Tanganyika a été formulé pour aider les quatre Etats riverains (Burundi, Congo, Tanzanie et Zambie) à élaborer un système efficace et durable pour gérer et conserver la diversité biologique du lac Tanganyika dans un avenir prévisible. Il est financé par le GEF (Fonds pour l'environnement mondial) par le biais du Programme des Nations Unies pour le développement (PNUD)"	The Lake Tanganyika Biodiversity Project has been formulated to help the four riparian states (Burundi, Congo, Tanzania and Zambia) produce an effective and sustainable system for managing and conserving the biodiversity of Lake Tanganyika into the foreseeable future. It is funded by the Global Environmental Facility through the United Nations Development Programme.

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Preface note

This report was prepared by the international consultants as part of their contract to provide dive and survey training for BIOSS regional teams.

1. INTRODUCTION

1.1 Gombe Stream National Park

Gombe Stream National Park is a small park lying in the north-eastern corner of Lake Tanganyika. The park has an area of 56 km^2 and consists of the western watershed of a coastal mountain range running south from altitudes of 3,000 m in Burundi dropping to approximately 1,500 m in the Gombe range before petering out as it hits Kigoma Bay. The park has been established for the protection of a community of chimpanzees studied by Dr Jane Goodall for more than 30 years. The park is in general heavily wooded with secondary growth having been logged before the park was established in the 1940s. There are some remaining bare areas where re-growth has not occurred. The coast of the park is 15 km long, with no offshore islands or rocks, exposed to winds from the north to the south-west, and with deep water to within 2-300 m of the lakeshore. The only villages located in the Park are those attached to the park administrative headquarters and the tourist headquarters. Although these villages contain few fishermen, there was a significant population of transient fishermen, mainly from Burundi, utilising the major part of the park shoreline at the time of this survey.

1.2 Survey Aims

The survey of Gombe Stream National Park, undertaken in October 1997, was completed in accordance with the terms of reference (UNDP/GEF/RAF/192/G32) of the Lake Tanganyika Biodiversity Project (LTBP). This survey is one of a series to be carried out on the coasts of the national parks bordering the lake. The parks to be surveyed include the Parc Nationale de Rusizi, Burundi, Gombe Stream National Park and Mahale Mountains National Park, Tanzania and Nsumbu National Park, Zambia. Further parks will be added from the territory of the Democratic Republic of Congo when the political situation allows. The surveys of the national parks will involve components of the four special studies, Biodiversity Special Study (BIOSS), Fishing Practices Special Study (FPSS), Sedimentation Special Study (SEDSS) and Pollution Special Study (POLSS), though not necessarily concurrently. The survey of the Gombe Stream National Park described here was conducted by the BIOSS teams.

The aims of the BIOSS are to:

- Identify the Distribution of Major Habitat Types with Particular Focus on Existing and Suggested Protected Areas;
- Review Current Levels of Biodiversity in Lake Tanganyika;
- Suggest Priority Areas for Conservation Based on Existing Knowledge and Recommendation from Other Special Studies Supplemented by Additional Survey Work where necessary; and,
- Develop a Sustainable Biodiversity Monitoring Programme.

The surveys of the Gombe Stream National Park coastline reported here aimed to characterise and map the distribution of habitats, determine the diversity and distribution of the associated fish fauna, and to develop and test a number of techniques for the census of crustaceans and molluscs. The Gombe surveys were also used as a training exercise to provide the newly formed dive survey teams field experience in the use of survey techniques, survey planning and logistical support, scientific diving, dive marshalling and field living conditions. The data collected on these surveys must therefore be interpreted in the knowledge that the participating survey teams were still inexperienced at that time. Two separate trips were organised to survey Gombe with three days between them (16-20/10/97 and 23-26/10/97). The first survey trip targeted sandy beach sites and the second trip targeted stream mouths and rocky habitats.

1.3 Review of Previous Work

There are no aquatic ecological surveys reported in the core scientific literature in the vicinity of Gombe National Park.

1.4 Impact of Fishing Activities

The general surveys of aquatic habitats and their associated biodiversity were designed to also allow investigation of the potential impacts of dragging fishing nets over the shallow water sandy shores within the park. The major fishing activity within the park was beach seines. Nets are dragged ashore to land catches of clupeids taken in offshore waters at night. The sandy shore areas are used as they both provide clear flat sand areas ashore for drying the catch and because nets can be dragged ashore without risk of damage from submerged rocks. The impact of dragging nets across the shallow lakebed is not clear but it has been suggested that it may have significant negative impacts on the sand dwelling cichlids which live and breed in these habitats. Of particular concern is the possibility that the nets may both destroy fish nests and capture juveniles. A number of beaches were found to exhibit a range of different fishing histories suitable for a comparative study of the potential impacts of fishing on the associated sandy shore fish communities. The survey of fish communities was designed to include these beaches.

2. METHODS

2.1 Broad Scale Distribution of Habitats

The preliminary broad scale distribution of habitats is normally determined from an analysis of the available maps and charts for the area. Examination of charts can generally provide sufficient detail on the nature of a coastline, its substrata, wave exposure, possible currents, topography and seabed inclination to allow identification of the likely range of habitats in an area. Such use of maps and charts can prove a cost-effective method for some littoral surveys where large scale mapping of biotopes can be undertaken in conjunction with detailed recording on the ground. However, few detailed maps of Lake Tanganyika exist and those that do give little detail on the littoral zone and bathymetry. The two main chart series for the Gombe area are the German charts of the Stiehler-Weigele Surveying Expedition of 1914 which were reprinted by the Admiralty in 1924, and those of the Belgian Hydrographic Survey of 1946-7. Neither was available for the current surveys although the former has since been acquired. Should charts be made available in the future, however, care should be taken in their interpretation as bathymetric detail may be confused by the significant recent fluctuations in lake level (2 m; 1991-1997; for Mpulungu, Zambia: pers. com. Dr Martin Pearce).

In cases where aerial photographs are available “base” maps may be drawn up which can then be used both to make estimates of the areas covered by the major habitats and to identify sites of potential ecological interest to the planning of subsequent more detailed surveys. The only complete aerial survey of Lake Tanganyika was that of the FAO/FINNIDA LTR Frame Survey (Hanek, Coenen & Kotilainen; 1993) which, although not examined by the project, was described as unsuitable due to the high altitude from which it was filmed (pers. com. Piet Verburg). However, the published review of the littoral habitat zones of Lake Tanganyika and their classification (Coenen, Hanek & Kotilainen, 1993), based on a combination of information from the aerial survey and the available literature, was found to be useful. It should be noted that although aerial photographs may be interpreted to map habitat distributions it is essential that the interpretations made are confirmed on the ground using techniques such as SCUBA.

Other surveys of the Tanzanian coast included those of the Tanzania Government Mapping Division of the Department of Land Use and Development. Photographs published by this department for Gombe Stream National Park have been consulted (courtesy Dr Anton Collins, Jane Goodall Institute) and found to give good detail of terrestrial habitats but, with water penetration of less than a few metres, they were of little use for identification of the littoral habitats.

In conclusion, in the case of the current surveys, little information was obtained by reference to the available maps, charts and photographs, and habitats had to be mapped mainly through field surveys using techniques such as the “Manta Tow” and habitat profile dives using SCUBA.

2.2 Manta Tow Surveys

The Manta Tow Survey technique was originally developed to assess broad changes in the benthic communities of coral reefs where the unit of interest was often the entire reef, or a large part of it (UNEP/AIMS 1993). This represents the finest level at which mapping can be carried out. This technique has the advantage of being possible using basic snorkelling equipment, costing a fraction of the cost of aerial survey, and not being resource limited. However, it is far slower than aerial survey, is limited in it’s ability to cover large areas, and requires good co-ordination between boat coxswain and snorkeller. The technique is unsuitable for areas of low water visibility and for parts of the lake where the snorkeller may be at risk from crocodiles, hippopotami, and water born pathogens such as bilhartzia. This technique is not recommended for survey of deeper water using SCUBA due to the potential for uncontrolled ascents.

This technique was, however, found ideal for mapping the 15 km of Gombe coast, as it records data of sufficient detail for project purposes, and can cover moderate distances of coastline quickly. The full protocol is described elsewhere (Standing Orders Report) but basically involves towing an observer behind an inflatable using a rope and a manta board. Several trial runs of the protocol were completed on the coast adjacent to Kigoma prior to its application to the Gombe survey. The manta board itself is merely a rectangular piece of wood, which serves as a hydroplane, with handholds and an attached underwater slate on which observations are recorded. The surveyor is towed along the surface in snorkelling gear noting changes in the benthos as it passes below. The boat is stopped every three minutes to allow the surveyor to summarise the composition of the substratum passed over during the preceding three minutes on the underwater slate.

The data recorded included, bottom topography, inclination, features of rock and sand, and biological communities which themselves are habitat forming. The latter would include large aggregations of shells, gastropod or bivalve, or extensive fields of macrophytes such as *Valisineria* or *Potamogeton* spp., with their own distinct communities known to be favoured by certain species of cichlid. A second team member in the boat recorded the position of each stop using a Global Positioning System (GPS) unit, and marked these positions on a map of the coastal section. A third observer recorded terrestrial features such as coastal topography, land cover, land use and human impact, which might have a bearing on any changes observed in the underwater biodiversity. A fourth member kept time and watched out for rocks. All observations were made during boat stops to synchronise data recorded. The fifth and final team member was the coxswain of the boat.

The results of the survey were transferred to a map of the area, usually an acetate overlaid on a photocopy, and the coastline substratum marked in using simple symbols explained by a legend. In this way the coastline was divided into sections according to the substrata present thus giving a broad scale inventory of the distribution of major habitats. Furthermore, within each substratum further distinctions were made based on the physiographic criteria mentioned above, such as the level of exposure to currents and winds. Site selection for further, more detailed survey using habitat profiles, was based upon the information provided from the manta tow survey.

2.3 Habitat Profiles

The survey techniques mentioned so far are only able to provide information on shallow water habitats except when water visibility is unusually good. SCUBA survey was therefore employed to survey the deeper water habitats at selected sites along the coast. Dive sites were chosen, on the basis of the distribution of shallow water habitats determined from the manta tow surveys, to include the full range of major habitats, wind exposures, water currents, and proximity to deep water. Time constraints did not allow the selection of random sites from within each habitat type, as in an ideal survey plan, where the number of samples would be determined according to the proportion of that habitat represented, the most widespread habitats having the greatest number of samples. For the first trip of this survey emphasis was placed on the survey of sites already identified for assessment of the potential impacts of beach seines (see section 2.5 below). Five beaches were selected to compare biodiversity levels at each beach with their beach seining history (see Table 2.1, below). The beaches chosen were Mitumba/ Kavusindi, Linda, Kakombe, Kahama and Gombe.

Once the site location was chosen, a buoyed and weighted reference line was dropped, and it's GPS position recorded. A bearing, perpendicular to the shore, was taken from the buoy. The divers would then swim from this reference line toward the shore, up the depth gradient to 5-6m, recording the changes in habitat and obvious associated communities along the way. In order to encompass as diverse a range of habitats as possible, the reference line was dropped into 25-30 m of water. Due to the early demise of the Scubapro PDS handheld sonar depth was measured by knotting the vertical line at 25 and 30 metres and plumbing the depth against these two marks. The divers descended down the vertical line and on reaching the bottom proceeded along the chosen bearing unreeling a second line marked at 10 m intervals. At each 10 m interval the depth was recorded and the habitat was described

including details of the main components of the floral and faunal communities.

Each beach was divided into northern and southern sectors with a five man dive team deployed to each. Each team included two divers to conduct habitat profiles, two to census fish, a coxswain, and on occasion two to census molluscs. This tended to overload the boats which were designed for a maximum of four divers. Once the reference line was laid and it's position and bearing toward the coast taken, the habitat profile pair or threesome dived. On reaching the end of the dive the bottom line was left in place for retrieval by the fish census team who dived in the second wave. They descended on the vertical line, unclipped the bottom line from the vertical line, and reeled it in as they progressed between depths conducting the fish censuses. The line was brought to the surface on completion of the fish census. This ensured the same area of lakebed was censused by each sampling team. If there was a third team sampling molluscs the vertical line was left in place to be lifted by the boat cover on completion of all surveys. Data were transferred from the underwater notebooks to the prepared forms each evening.

For the second trip of the survey six sites associated with stream outlets or rocky headlands were chosen as sites for profiling. Chosen sites included Mwamgongo Bay, the point north of Kisitwe Point, Mitumba, Rutanga and Bwavi. These sites were picked on the basis of information collected by manta tow and profile dives during the first trip. In addition to the habitat profiling dives PT carried out several exploratory deep dives to determine whether the shallower habitat types continued into deeper water. On these dives no records were made as they were solo dives carried out by the same person in each case.

On completion of the survey the details of horizontal distance and depth could be used to create a crude profile of the gradient in that location. As information on the structure of communities increases these gradient profiles could be filled in with observations on fauna and flora gleaned from fish and invertebrate sampling efforts, allowing eventually for species associations to be delineated. This would, when more complete, facilitate management decisions on biodiversity and resource protection.

2.4 Fish Census

A combination of census techniques was employed in an effort to obtain the most comprehensive sampling regime to include all fish species present. Two visual census techniques were used to obtain species lists and indices of diversity, and gillnet samples were taken to both provide samples for preservation in a reference collection and to confirm identifications, and for census of nocturnal species. These field surveys at Gombe were the first on the LTBP to fully test the survey techniques and any subsequent modifications recommended will be discussed below in Section 4.

2.4.1 Visual Census

Two visual census techniques were employed; the "Stationary Visual Census" (SVC), and the "Full Species Census" (FSC). The SVC is described in full in the "Standing Orders Document". In brief, a pair of divers censuses the fish population within a cylinder of water above a circular census area of 5 m radius on the lakebed. The species present and the number of individuals within each species are recorded. The census is repeated at 15 m, 10 m and 5 m depths at each site. The FSC is a modification of the "Rapid Visual Census" described in full in the "Standing Orders". During the "Habitat Profiles" a transect line is laid on the lakebed perpendicular to the shoreline along a decreasing depth gradient. The fish census is conducted along the same transect line. Following a 10 to 15 minute time interval (to allow for recovery from any disturbance to the fish during the Habitat Profile Survey) a pair of divers descends down the vertical buoyed line left to mark the deepest part of the transect. A corridor or belt transect extending 2 m either side of the transect line is censused for species of fish present – numbers of individuals are not recorded. All fish species are recorded along the transect within each 5 m depth rise, such as from 25 m to 20 m.

The SVC was employed to provide information on both species richness and relative abundance for the more sedentary and cryptic benthic species, whereas the FSC aimed to include census of the more mobile pelagic species which may be missed by the SVC. The SVC also provides a more complete picture of how fish communities may be structured relative to water depth and habitat type.

2.4.2 Gillnets

Gillnets were set to provide a second measure of species diversity sampling both nocturnal species and areas not suitable for diving visual census. The nets used were monofilament, 50 m long and 1 m deep, with multiple mesh sizes ranging from 8mm to 50 mm (diagonal mesh). Nets were set parallel to the shore at depths ranging from 3 m to 30 m. Nets were set in the morning and evening with an average soak time of 10-12 hours. Fish captured were measured (total length), weighed (combined weight for all individuals of each species within each mesh size), and identified to species.

2.4.3 Calculation of Diversity Indices

The Shannon-Weiner index was used to describe the diversity within fish communities at each site. This statistic combines information on both the number of species and their relative abundance to describe the community in terms of its diversity. The formula used for calculating this diversity was:

$$H_s = -\sum_{i=1}^{s} p_i \log_2 p_i$$

H_s	the symbol for the amount of diversity in a group of "*s*" species.
S	the number of species
p_i	the relative abundance of the i^{th} species from 0.0 to 1.0 (for example if the species under consideration is the second on the list, we label it $i = 2$; and if 10 per cent of all individuals belong to that species, $p_i = 0.1$)
$\log_2 p_i$	the logarithm (base 2) of p_i.

The negative sign is added to make *H* positive as all logarithms between 0 and 1.0 will be negative. A larger value of *H* means that if an individual is picked at random there is less certainty about which species it will be than if *H* had a lower value. For any given number of species, H_s will be greatest if the species are all equally abundant. In effect the diversity index measures two things: **species richness** (number of species present) and **species evenness** (a measure of the evenness of the distribution of individuals between species). Species evenness can be separated from the index by dividing the observed diversity value by the maximum possible if each individual belonged to a different species. Evenness (*J*) is thus defined as

$$J = H_s / H_{\max}$$

where H_s is diversity and $H_{max} = \log_2 s$. Using both values we can tell whether any difference in diversity between sites results from a difference in the number of species present or from a more even distribution of individuals between species. For example, a site with 20 species, 90% of which belong to only one species, will have lower diversity index than another site, also with 20 species, but with an equal distribution of individuals between species.

Care must be taken not to prioritise sites for conservation solely on the basis of their species diversity indices as sites with many "rare" and few "abundant" species may have a relatively low diversity index, despite their obvious conservation value. Those sites with the same number of species, all of which are the more common and more evenly distributed species,

may mistakenly be given conservation priority based on their higher diversity indices. It therefore follows that records of the locations of rarer species must also be reported.

2.5 Impact of Fishing Nets.

Five sandy beaches were chosen for study, each to be sampled four times. In order to allow for any seasonal or climatic influences sampling was to include the new and full moon periods in both dry and wet seasons. Three replicate samples were planned for each beach according to the plan in Table 2.1. All beaches were to be surveyed both by underwater visual census using divers and by bottom set multi-mesh gill nets. A team of eight divers was to dive twice each day censusing fish populations at two separate beach sites at three different depths (15 m, 10 m and 5 m) using the Stationary Visual Census technique described above. The basic habitat types of each census site would be described during the fish census. Gill nets were to be set at 4 depths, at night and during the day, for an approximate soak time of 10 to12 hours. Fish captured would be measured (total length), weighed (combined weight for all individuals of each species within each mesh size), and identified to species.

Table 2.1 Proposed sampling plan for beaches

Beach (from N to S)	Fishing History
Mitumba – the beach in front of park HQ	Not fished for 2 years
Linda	Regularly fished for many years
Kasakela/ Kakombe	Not fished for some years
Kahama	Regularly fished for many years

2.6 Other Taxa

Census techniques for molluscs and trap sampling for crabs were also tried. With the aim of testing methodology and available identification keys. Molluscs were censused using both quadrat and belt transect methods, with techniques for sieving sediments underwater being developed. The results are not reported here, and the protocols eventually adopted are reported in the BIOSS Standing Instructions. The use of traps for crabs proved not to be efficient and crabs will not be a target group for biodiversity assessments in the near future.

2.7 Selection of Survey Sites.

Survey sites were selected to include examples from the full range of the major habitat types present in addition to any of the more unusual or specialised habitats such as algal beds or stream mouths. The locations of such sites were based on the information provided by the manta tow surveys conducted at the beginning of the survey programme. In the future, should suitable maps or charts be made available, sites should also be chosen to include the full range of hydrographic features, such as river mouths and headlands, and levels of exposure to water currents and prevailing winds. Despite the lack of suitable maps for these surveys it was, however, clear that in this case the coastline was fairly uniform with regard to hydrography and exposure and site selection based on habitat type alone was considered an acceptable option. In the first survey period sites were chosen to include a range of sandy shore habitats spanning the full length of the park coastline. These sandy beach sites were chosen to include the beaches selected for their wide range of fishing histories (see section 2.5). In the second survey period a number of stream sites and rocky habitats were selected, no other unusual habitats such as algal beds or shell deposits being identified. Selection of rocky substrates proved to be difficult as the nature of the shallow water substratum was rarely reflected in that of the adjacent deeper water. This observation itself answered an important question by determining that prior knowledge of the distribution of shoreline or shallow water habitat types (as provided by aerial photography) does not necessarily provide

a good indicator for the nature of the adjacent deep water habitats. Diving surveys are therefore required to determine deep-water habitat types.

3. RESULTS

3.1 Surveys Conducted

The Gombe National Park coastline stretching for approximately 15 km from Mwamgongo Bay to the north as far as Kazinga village to the south was surveyed over a two week period. It is a very linear coast, with no prominent headlands or recessed bays, resulting in a highly homogenous physiography.

The sites surveyed are summarised below in Table 3.1. Full details of exact locations surveyed, including GPS co-ordinates, will be held on the LTBP database and are shown in Figures 3.1 and 3.2.

Table 3.1 Gear types, sites surveyed, and dates of deployment

Gear Type	Sites Surveyed	Date
Manta Board	Entire Park coastline	16/10/97
Habitat Profile Dives	Kasekela, Linda, Kahama. Bwavi, Kitwe, Rutanga, Mitumba, Linda.	17-20/10/97 24-26/10/97
Stationary Visual Census (Fish)	Kasekela, Linda, Kahama. Bwavi, Kitwe, Kavusini, Mitumba.	17-20/10/97 24-26/10/97
Full Species Census (Fish)	Linda, Rutanga, Kakombe Steam.	26/10/97
Gill Nets	Kasekela, Linda, Kakombe Stream, Kahama. Rutanga.	17-20/10/97 24/10/97
Grab Samples	Kasekela, Linda, Kahama.	17-20/10/97
Crab Traps	Kasekela, Kakombe Stream.	17-18/10/97
Mollusc Quadrats	Kasekela, Linda, Kahama.	17-20/10/97

3.2 Shallow Water Habitat Distributions

The manta tow survey was completed in six hours, an example of how effective this technique is at covering ground. An additional benefit to the manta tow technique is that it enables unknown stretches of coastline to be assessed before dropping divers into what may be crocodile or hippopotamus territory. In Gombe speed was enhanced by the coast being fairly linear and uniform in contrast to the complex of bays and headlands between Nondwa Point and Kitwe Point near Kigoma[1].

A distribution map of the habitats identified by the manta tow survey is given in Fig 3.1. Approximately 60.2% of the shallow littoral substratum was sand and 29.3% cobble/rock with other categories such as gravel, boulders and bedrock being poorly represented in the shallow littoral (Table 3.2). In summary, at depths of between 3m and 5m the substratum was divided between sandy substrata off beaches and cobble/rock substrata where terrestrial ridges drew down to the waterline.

[1] Reported in LTBP, BIOSS (1998). Aquatic Habitats and Associated Biodiversity of the Kigoma Area of Lake Tanganyika, Tanzania. Survey training.

Figure 3.1 Gombe Stream National Park showing the coarse distribution of shallow water habitats as identified by the "Manta tow surveys" and the approximate location of all "Habitat Profiles".

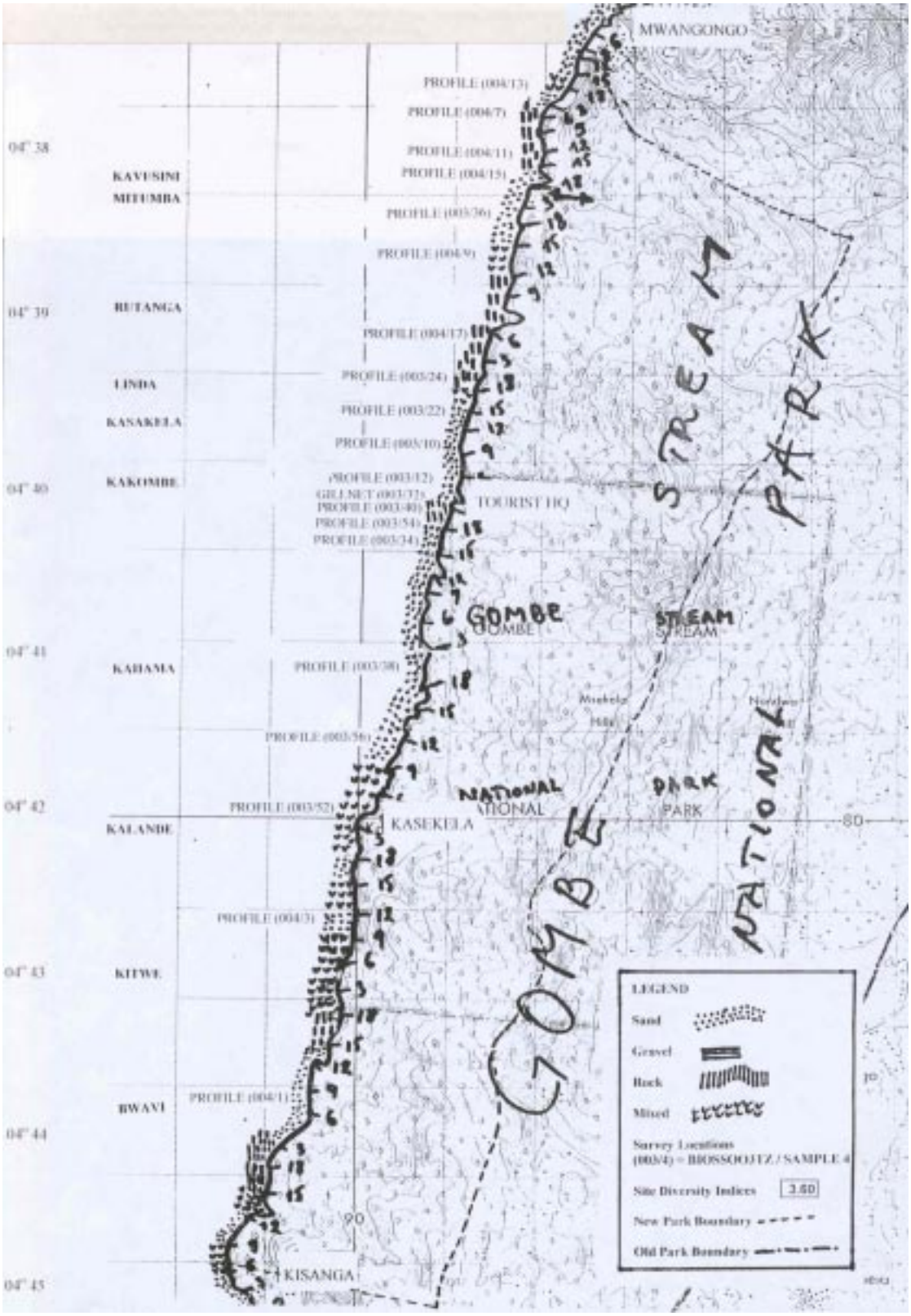


Table 3.2 Manta board substrata summary

Substratum	%
Sand	60.2
Rock - Cobbles	29.3
Gravel	6.5
Boulders	2.1
Bedrock	3

At lesser depths, shallow bays contained beaches of coarse gravel, interspersed with rocky headlands consisting of large boulder shores. The gravel extended down to a maximum of 1.5m before being replaced by sand as the predominant cover. Boulders usually gave way to sand by 6m depth although they occasionally extended deeper as at Kakombe and the point north of Kisitwe Point. This made for a quite homogenous underwater topography in contrast to the coastline around Kigoma where a less even distribution of substrata was found.

In Gombe, at depths less than 5 m, four areas stand out against the generally sandy substratum, two associated with streams, one with a headland and one with a beach. Bedrock was found in only two areas, one off the headland north of Kisitwe Point and the other off Rutanga Beach. In the third and fourth areas stream mouths were marked by a substratum composed of 80% cobble/rock, which was unique on the survey. One of these sites was off Kakombe stream and the other off an unnamed stream between Kitwe and Gombe beaches. All these areas with the exception of Gombe beach were profiled using SCUBA.

Macrophyte beds were poorly represented within the park, with only scattered *Valisineria* beds at Mhenke, Kavusindi and Rutanga. No sizeable shell deposits were found anywhere on the manta survey, either Bivalve or Gastropod.

3.3 Habitat Profiles

A total of eleven locations were chosen for profiling. The site locations are given in Fig. 3.1. 3-D cross-sectional profiles, with the basic habitat types overlaid, are given for each site in Appendix I. Four of these locations were off beaches, Kahama, Kalande, Mitumba and Rutanga, three off stream outlets, Kakombe, Mitumba and Linda and four off headlands, Kisitwe, Mwamgongo, Bwavi and Mitumba.

The composition of substrata was found to be depth dependent with bedrock the dominant deep-water substratum, whereas sand was more prevalent in shallower depths. Substrata therefore seemed to be organised in isobathymetric zones parallel to the shoreline with variations occurring as intrusions from shallower or deeper strata. Bedrock was an intrusion from a deeper zone and boulders were intrusions from the shallow littoral. Massive intrusions of bedrock into shallow waters occurred at Mwamgongo Bay and Kakombe Stream, and to a lesser extent Mitumba Stream. Sites where boulder slopes occurred were associated with headlands such as Kisitwe Point, and the points south of Mitumba and Bwavi respectively, much as was found on the manta survey.

In general therefore the majority of the shallow water habitats were found to continue unchanged into deeper water, but with some notable exceptions. Linda was one site where the shallow water habitat was predominantly of mixed sand and rock yet the profile survey found the deeper water habitat to be predominantly sand. The shallow habitat at Rutanga, classified as rock on manta survey, was found to change to100% sand below 6 m with the inclusion of 5% bedrock below 12 m. ***A significant conclusion is, therefore, that the information obtained from maps, aerial photos and manta tows on shallow water or shoreline habitats can not be extrapolated to deeper water habitats without further diving survey.***

Table 3.3 Summary data from the five beaches profiled using SCUBA, by depth.

depth strata(m)	25	20	15	10
substratum (%)				
bedrock	21	15	0	0
boulders	9	6	6	0
rock/cobble	4	17	3	0
gravel	1	1	0	0
sand	65	61	91	100

As can be seen from Table 3.3 which averages results across the five beaches, sand formed the main constituent of the substratum at all depths, increasing from a minimum of 65% at 25 m to 100% at 10 m. Conversely, bedrock decreased from 21% at 25 m to 0% at 10 m. The exception to this pattern was Mitumba Beach, where bedrock swept up to 12.7 m where it formed 30% of the substratum, possibly due to the effects the permanent stream present at this location. Unlike Kakombe however, from 12 m upwards sand constituted 100% of the substratum off Mitumba Beach, which was classified as sand on manta survey. For the beach surveys, methods for sampling sediments were not sufficiently developed to be included in the protocol. Unfortunately, a significant proportion of the biodiversity of sediments exists as infauna, and so will have to be sampled.

While retrieving a tangled gill net during the first trip off Linda beach, EA and PT observed a series of rocky ledges, beginning at 30 m and extending down to greater than 45 m, which were seen to have large numbers of fish on them, as compared to the shallower habitat. On the second trip a series of deep dives was conducted by PT off Mitumba, Rutanga and Linda beaches. All had streambeds associated with them although only Mitumba Stream is permanent. A similar series of rock steps was found in each location which, with the scale of these formations, suggests that this is a feature running through all three sites, parallel to the coast approximately 150 m distant from the shore. This topography may extend the length of the Gombe coast, although no evidence was found of it nearer Kigoma (PT: pers observ).

This formation began at 29-32 m as two or three shallow steps of 1-3 m, followed by two or three 8-10 m steps terminating on a scree slope at 65 m. On the large shelves, large rock pinnacles were present standing 8-10 m high and isolated from the steps. The rock was largely silt free and contained large crevices in which large *Lates mariae* were hiding. Fish and crustacean life was profuse, in particular associated with the vertical walls. The rock itself was very jagged, although its structure was not seen. For more information on fish species taken the results of the gill net set should be reviewed. No deep diving was conducted in the south of the park.

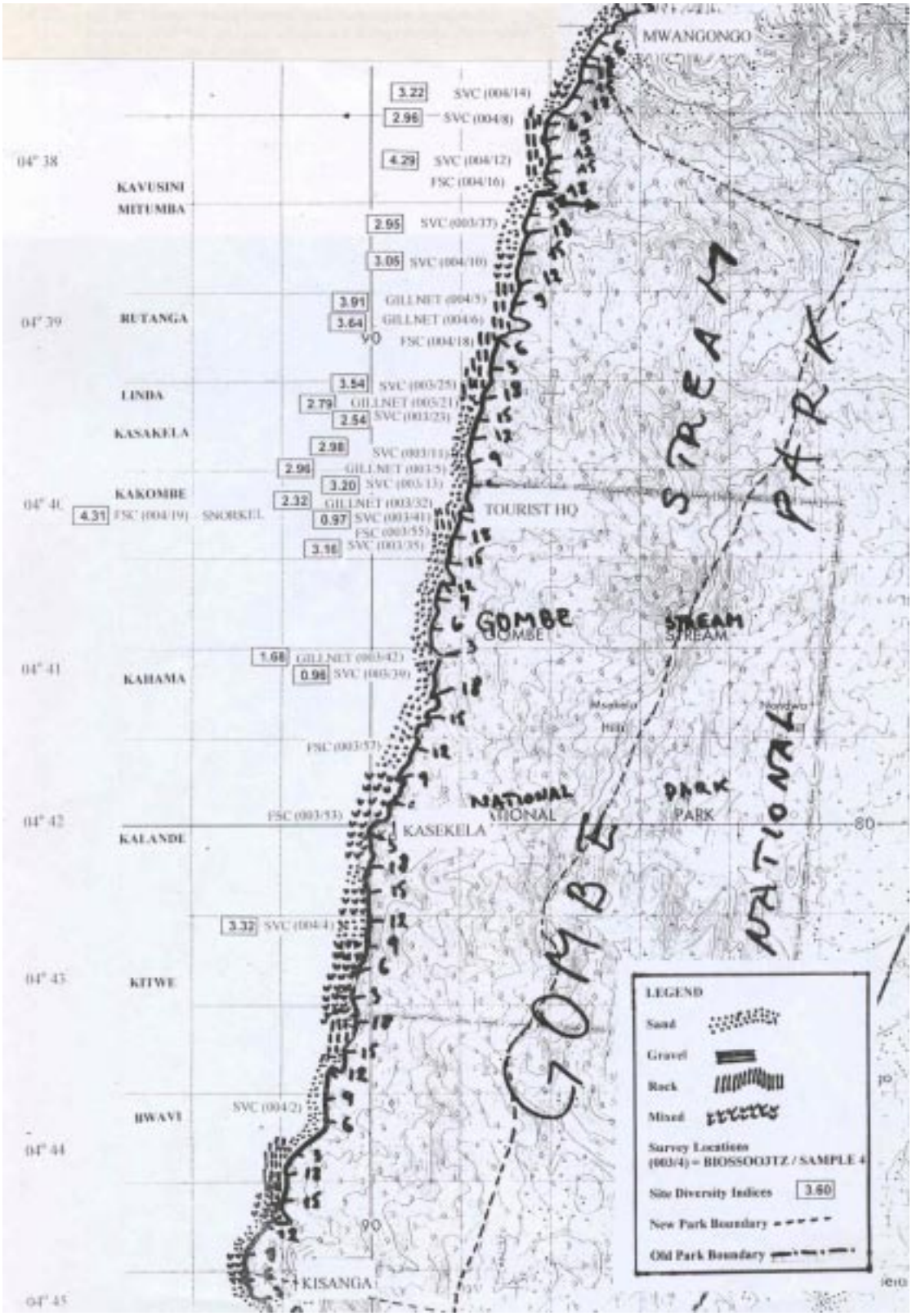
One major source of confusion during the profiling series of dives was the difficulty in site identification, as without maps or specific names for terrestrial marks, locations were known by the name of the nearest beach, which resulted in three totally distinct sites being known as “Mitumba” for example.

3.4 Fish Census.

3.4.1 Overview of Fish Distributions

A total of 20 sites were censused by diving and six by gill nets (see Fig 3.2 for site locations). Of these sites 15 were adjacent to sandy shores (BIOSS003TZ) and 11 adjacent to rocky shores and streams (BIOSS004TZ).

Figure 3.2 Gombe Stream national Park showing the approximate locations of all fish censuses (gillnets and diving) and the site diversity indices for the fish community.



The combined censuses identified 93 species of fish, comprising 80 cichlids and 13 non-cichlids (Appendix II). 12 individuals recorded as "Not Identified" may either represent additional species or may alternatively be species already recorded but not yet able to be identified by some of the less experienced surveyors – a problem which will diminish with further experience. Overall species diversity within the Gombe Park area was calculated at 4.26 and 4.27 using data from the gillnet census and SVC, respectively.

A greater number of species were recorded in the "mixed rock/sand" habitats than in the pure sand habitats with an average of 14 and 4 species recorded per census (approx. 80 m^2), respectively. The mixed rock/sand habitat typically included a great abundance of the predatory *Lamprologus elongatus* accompanied by large numbers of juveniles, a wide variety of planktivorous and benthic lamprologines, numerous *Telmatochromis* and *Julidochromis* spp., and many cave dwelling *Synodontis* and *Mastecembelus* spp. *Cyphotilapia frontosa* was common on the mixed rock/sand habitat below 15 m. In contrast, the relatively species poor fish community in the sandy habitats mainly comprised *Grammatotria lemari* and *Xenotilapia* spp. commonly observed foraging in groups of 20 to 100 individuals. The shallow water "surf zone" habitat, which in most places comprised a narrow band of cobbles and small rocks not censused during these surveys was, however, observed to support a distinct and diverse fish community dominated by Eretmodines and *Tropheus* spp. which warrants further survey.

The two sites with the greatest number of species recorded were below Mitumba Beach (27 species), the only site where the rock/bedrock substratum was recorded extending into shallow water (BIOSS004TZ, Sample 12), and below the Kakombe stream near the tourist HQ where 28 species were recorded during a single snorkel census (BIOSS004TZ, Sample 16). Additional observations below the stream mouth south of the Park HQ suggest another site of great species richness with a high density of nesting sites for *Cyathopharynx fucrifer*, *Opthalmotilapia* spp., and *Xenotilapia* spp.. Such high densities of nesting sites were not recorded at any other sites surveyed along the Gombe Park coastline.

Species were ranked both by frequency of observation and by rate of capture in the gill nets (Appendix III). *Lepidolamprologus elongatus* and *Grammatotria lemari* were the most commonly observed species being recorded on 80% of all visual censuses and making up 16.5 and 11.5 % of all individuals taken in the combined gill net catches, respectively. *Lepidolamprologus elongatus* was the most commonly recorded species on the mixed sand and rock habitats and *Grammatotria lemari* was the most frequently observed species on sand habitats. Other frequently observed species included *Neolamprologus mondabu, Neolamprologus walteri, Xenotilapia flavipinnis, Lepidolamprologus attentuatus, L. cunningtoni, Altolamprologus compressiceps,* and *Telmatochromis bifrenatus*. The distribution of "rare species" (those recorded in only one visual census and only recorded once in the nets) was widespread with no particular site recording a significant proportion. It must also be noted that at this early stage in the survey programme it is not yet clear which species should be considered "rare" within the larger scale of the whole lake. The classification of "rare species" must develop as surveys progress.

Site Diversity Indices are presented for all gill net censuses and SVC in Appendix IV and according to location on the map in Fig 3.2. Fish diversity indices, where available, are also shown in relation to habitat type and depth on the habitat profiles in Appendix I. The two sites of greatest species richness were also the sites of greatest diversity with the rocky site below Mitumba Beach (BIOSS004TZ, Sample 12) and the shallow water site below the Kakombe Stream mouth (BIOSS004TZ, Sample 16) recording diversity indices of 4.29 and 4.31, respectively.

The mixed rock/sand habitats supported a greater diversity than did the pure sand habitats with mean recorded diversities of 2.5 and 0.9, respectively. The only area of shallow bedrock identified, below Mitumba Beach, had an overall site diversity index of 3.5 (6 censuses at 3 different depths). Other such sites of shallow water bedrock should be located, if present, to determine whether such a habitat always supports such a high diversity. Species diversity increased with depth with mean diversity indices of 1.26 (5 m), 1.69 (10 m) and 1.87 (15 m) recorded over all censuses. The census of shallow water sites of less than 5m depth was, however, limited and further survey is expected to find a high diversity in these sites.

The shallow water habitats such as the "surf zone" and sites below stream mouths are considered the most vulnerable to human activities and warrant further survey to establish the full extent of their associated fish communities and their value as nesting sites.

3.4.2 Impact of Fishing Nets

Visual fish censuses were completed at six separate beach sites, five of which were also censused with gill nets. The above mentioned lack of adequate maps combined with limited local knowledge of the boundaries for the named beach sites made the identification of discrete sampling sites difficult. The sampled beach areas and the recorded diversities are given in Table 3.5. As can be seen, the survey was not able to follow the proposed plan exactly due to time constraints on the availability of trainers and the dive teams.

This preliminary study found the average fish diversity on the unfished sites (3.24) to be greater than that on the regularly fished sites (2.56). However, due to the following two limitations in the experimental design, this result can not yet be said to prove any impact from fishing. Firstly, the information regarding the history of fishing activity was found to be unreliable. For example, despite receiving information stating that Kakombe beach was not fished and had not been fished for some years, beach seining was observed off this beach during the survey period. As mentioned above this problem was further confounded by the lack of detail for determining the boundaries and locations of named beach sites.

Secondly, and most important, there was insufficient control for the effects of habitat type. Fish densities and community structure were found to be very closely linked to habitat type making it essential that the census sites being compared should be of the same habitat type if any impact of fishing is to be detected. Unfortunately the lack of survey time meant that sites could not be ground-truthed (dived) prior to the initiation of surveys and areas thought to be entirely sand (manta tow survey data) were in some cases found to also include patches of rocky substrate in deeper water. Any differences between site diversities can not therefore be attributed to fishing impact alone as it is likely that the effects of habitat type will also play a significant role. Further studies are needed where the areas censused are surveyed in detail beforehand and the census locations are marked such that identical habitat types are censused. A full and accurate fishing history is also required for each site. Further surveys are needed to establish the composition of cichlids, if any, taken in the nets as they are landed.

Table 3.4 Fish diversity indices for beach areas sampled to assess the impact of beach seines.

Beach	Fishing History	Sample #	Date sampled	Diversity (Gillnet)	Diversity (SVC)
Mitumba	Not fished for 2 years	003 – 37 004 – 10 004 – 5 004 – 6	18/10/97 25/10/97 24/10/97 25/10/97	 3.91 3.64	2.95 3.05
Linda/ Kasakela	Not fished for some years (NB: fishing was observed during the survey!)	003 – 11 003 – 13 003 – 5	17/10/97 17/10/97 17/10/97	 2.96	2.98 3.20
Kasakela/ Kakombe	Regularly fished for many years	003 – 41 003 – 35 004 – 19 003 – 32	19/10/97 18/10/97 26/10/97 18/10/97	 2.32	0.97 3.16 4.31
Kahama	Regularly fished for many years	003 –39 003 – 42	19/10/97 19/10/97	 1.68	0.96
Linda	Regularly fished for many years	003 – 23 003 – 25 003 – 21	18/10/97 18/10/97 18/10/97	 2.79	2.54 3.54
Kitwe	Not known	004 – 4	24/10/97		3.32

4. DISCUSSION

4.1 Suitability of Methods

4.1.1 Manta Tow Surveys

The manta tow was found to be highly efficient at rapid coarse mapping of shallow water habitats. It is, however, limited to use in shallow water unless visibility is unusually good. In these surveys it was assumed that surveyors could not collect accurate information from water more than 5 m deep. It is therefore essential that the technique is used in combination with the habitat profile technique using SCUBA to survey deeper water habitats. In most of the current surveys there was no overlap of depths surveyed by manta tow and by SCUBA so the results of the two could not be compared. Where overlap did occur, as on beaches such as Mitumbu, Kahama and Kalande, manta survey results were, however, verified by the habitat profiles. The manta technique was also found to have a high value for reconnaissance value for unknown areas as was to be proved in the survey of Nsumbu National Park, Zambia.

The quality of the manta survey could be greatly improved if some source of adequate maps could be accessed, either from remote sensing or cartography. For a long-term project this is a significant concern, given that few management decisions can be taken without accurate maps on which to base and represent them. In fact with good maps or charts, it could be said that half the battle is won!

4.1.2 Habitats

Profiling habitats through diving with SCUBA is a good cost-effective method for determining the habitats and communities of deeper water sites when the rough topography is already known. However, without such 'a priori' knowledge diving to ground truth habitats can be a wild goose chase, missing key features due to it's inability to cover large areas. If the charts of an area of interest are inadequate, other techniques such as side-scan sonar should be considered, as they are likely to be much more cost effective than placing divers blind into locations. This was demonstrated in Gombe for the area of deep rock, which was located by accident. A similar scenario is likely to present itself in Mahale Mountains National Park and when the survey eventually gets to the steep rocky coast of the Congo. A short survey of a well defined area would represent genuine capacity building, as other projects could use the data equally effectively.

4.1.3 Fish Census

Of the 93 fish species recorded 65 species were recorded by SVC, 69 by FSC, and 56 by gillnet census. The overlap of species recorded by each technique is summarised in Table 4.1 and is given in detail in Appendix II.

Table 4.1 Additional species recorded by each technique

Stationary Visual Census (SVC)	Full Species Census (FSC)	Gillnet Census
Additional Species: Most species were also recorded by the FSC and/or gillnets. The technique did, however, provide the most comprehensive information for computation of diversity indices.	Additional Species: (i) Pelagic species such as *Cyprichromis* spp. and *Lates* spp.. (ii) Shallow water species such as Eretmodines and *Tropheus moorii*.	Additional Species: (i) Catfish, especially if fished overnight. (ii) Pelagics such as Clupeids and *Lates* spp.

A combination of the FSC and gillnet census provided the most comprehensive species list by sampling of species from the full range of ecological niches including both pelagic and benthic species, and also nocturnal species. Surprisingly, the more rapid FSC technique was found to include the more cryptic and benthic species previously only expected to be picked up by the SVC. The SVC, although not including any additional species, did however provide the best information for computation of the species diversity indices essential for comparative study of fish communities within and between localities throughout the lake. A similar combination of all three methods is recommended for future surveys.

As mentioned above, future surveys must ensure that the results of habitat surveys are known prior to fish census such that censuses can be conducted on known habitat types. Prior knowledge of the habitat type within the census area is essential if the effect of habitat is to be eliminated from comparative studies within and between sites and over time.

4.2 Overview of Findings

A summary fact sheet for the Gombe Stream National Park survey is given in Appendix V.

4.2.1 Habitats

As mentioned above, the park shoreline is linear without prominent headlands or even moderately recessed bays. This results in the littoral zones being subject to approximately the same degree of exposure to the prevailing winds. Given the results of the manta survey and with poor bathymetric charts available, there is no knowledge of offshore reefs, outcrops or pinnacles, although the RV Echo's echo sounder gave some readings, which might suggest these features toward the south of the park. Also, no geological maps are at hand to indicate atypical rock intrusions underwater which might harbour distinct habitats and communities. Taking all these factors into account, it is likely that habitat segregation for this length of coastline will be depth dependent, with the prime habitats occurring in bands extending in a northeast-southwest direction parallel to the coastline.

The consequence to this stratified zonation, is that the key areas where foci of diversity might occur are those areas where the zonation is disrupted, where protected or isolated pockets of habitat or community may be located. The most likely of these would be stream beds, in particular permanent streams. The Kakombe stream is the best example, as all the evidence suggests that there is a channel associated with it which snakes across shallow sandy habitats while remaining sand free. For the other streams the evidence is more equivocal, that they may be cleared of sand only when the streams are in full spate. These channels would be expected to have a lesser diversity if sand filled for part of the year. However, more diving needs to be completed on all stream mouths within the park, to confirm this speculation. In particular, comparing the fauna of these channels with the adjacent sand and nearest rock might illuminate aspects of community structure.

Similarly, the deep rocky areas are likely to of far greater importance for fish diversity than the shallower sand. This may be reversed for infauna where sediment substrata are likely to be more productive, and should be sampled in future surveys. It is not certain if this deep rock extends all the way down to Kigoma, as PT dived to 50m+ north of Nondwa Point without encountering any rock steps or in fact any large areas of bedrock.

The findings from Mwamgongo Bay are unusual in that bedrock sweeps up from depth to constitute 100% at 9.2m. This is at odds with the other results, and may be due to either erroneous recording of substratum, team members still being relatively inexperienced, or alternatively this site may have been associated with some terrestrial feature which would explain this anomaly. The latter is not possible to validate from the map as no clue exists to the exact location of the dive site. The manta survey gives no clue either, as the bay is rated as sand.

4.2.2 Fish Communities

The fish communities were typical of those expected in the sand and rock habitats present. No unusual fish communities were observed. The sandy habitats encountered along much of the shallow coastline supported a relatively low diversity and abundance of fish species. However, as the proportion of rocky habitat increased with increased water depth the fish communities became more diverse and typical of a rocky habitat. The greatest diversity was found at the interface between rock and sand habitats, especially where this occurred in relatively shallow water such as at Mitumba. Isolated pockets of high diversity of both rock-dwelling and sand-dwelling species were, however, found in shallow water at the bases of stream mouths where the two habitat types meet. Preliminary observations indicate that these sites at the stream mouths also provide important nesting areas for the sand nest building cichlids with no significant nesting areas observed elsewhere. The surf zone, not censused in detail during this survey, provides a discrete habitat type where sand is cleared from the underlying rock/cobble substrate and was observed to support a distinct fish community dominated by Eretmodines and *Tropheus* species. In summary, the fish communities found were as expected for the habitats present with no rare species or environmental problems observed.

4.3 Recommendations for Further Work

- *Stream Mouth Habitats:* Further diving survey is recommended for the submerged rocky canyons below stream mouths as these sites may provide foci of biodiversity through acting as refuges for fish and other taxa in a largely sedimentary ecosystem. The sites of interest include the following. (i) The permanent stream at Kakombe (park tourist headquarters). This site was marked by a deep sand-free canyon with high fish density and diversity. It is possible that the flow of the water is sufficient to prevent sand blanketing the substratum. (ii) The stream at Mitumba beach. A site with a defined association between the stream mouth and a small area of rock although only down to 12m and not through the entire littoral. (iii) Bwavi Stream. Not yet dived. (iv) The stream flowing between Kitwe and Gombe beaches. Another area of isolated rock associated with the stream mouth. Mixed substrata were also recorded at the mouths of the annual streams at Kitwe, Nyasanga, and Nyima Gima.

- *Deep-water Habitats:* Further diving of deep-water rocky habitats is recommended as preliminary survey indicates them to be sites of potentially high faunal diversity. Deep dives to 40 m can be carried out safely only if each diver is equipped with a dive computer (Scubapro DC12 = £130). Deep rocky habitats off Gombe could be compared with the deep rock off Bangwe point, which is the only comparable ecosystem found near Kigoma. To ignore these areas would seriously weaken the aims of the project. It would also be worthwhile to investigate whether these areas are affected by any fishing techniques currently practiced.

- *Sediment Sampling:* A proper protocol for sampling sediment substrata must be set in place as soon as possible. The problems encountered by the Janaury 1998 survey of Dr Andy Cohen remote coring in Mwamgongo Bay could be solved through use of divers.

- *Indicator Taxa:* Indicator taxa need to be formalised as quickly as possible to maximise the benefit of future surveys.

- *Fish Communities:* Fish communities of the surf zone and stream mouths require more detailed survey and should be included in the programme for long-term monitoring. Their location at the land/water interface makes them most vulnerable to the effects of increased sediment loading or pollution from land based activities. The shallow-water nature of these habitats also exposes them to potential hazards such a net landing and detergents used in clothes washing. The Eretmodine species present in the surf zone habitat are known to be highly sensitive to reduced oxygen levels and would serve as suitable monitoring species within these habitats. Current information has placed the majority of cichlid sand nests at those few sites below stream mouths.

The densities of nests at these sites should be closely monitoring through snorkel census. Any change in nesting density may serve as an early warning of problems with water quality or habitat degradation.

- *Monitoring Sites:* Permanent monitoring sites should be set up below Kakombe Stream, off Mitumba Beach, and off the sandy habitats of Linda Beach where fish communities should be monitored on a monthly basis using the SVC and gill nets techniques. Gill net samples should include night-time samples.
- *Fish Reference Collections:* Fish reference collections must be compiled for each country bordering the lake as soon as possible and be checked by an expert fish taxonomist. Until these collections are completed it will difficult for the dive teams to improve their identification skills for the more unusual species and any such records of rarer species will have to be assumed erroneous with no method of confirmation.
- *Fishing Impacts.* The catch composition of cichlids taken as nets are beached needs to be determined.

4.4 Management Recommendations.

The only immediate management recommendation is that a long-term monitoring programme be set up as soon as possible and a team trained and deployed to execute the surveys. Such a team will require a minimum of two, ideally three, trained divers, currently there is only one on the park staff. Although the most common sources of habitat degradation such as from increased sedimentation and pollutants are thought unlikely to pose any immediate threat given the current tight control of such activities within the park, only such a programme of monitoring will warn us should this situation change. The only sites for current consideration as protected sites are those at the stream mouths where the high concentrations of nesting cichlids were found to be potentially vulnerable. However, prior to the implementation of any protected sites, we recommend awaiting the results of the first year of the monitoring.

The potential impact of fishing nets is still to be determined before any management recommendations can be made for this activity. A continuation of the survey of fishing sites, employing the modifications to the survey design as detailed above, is recommended.

4.5 Post script

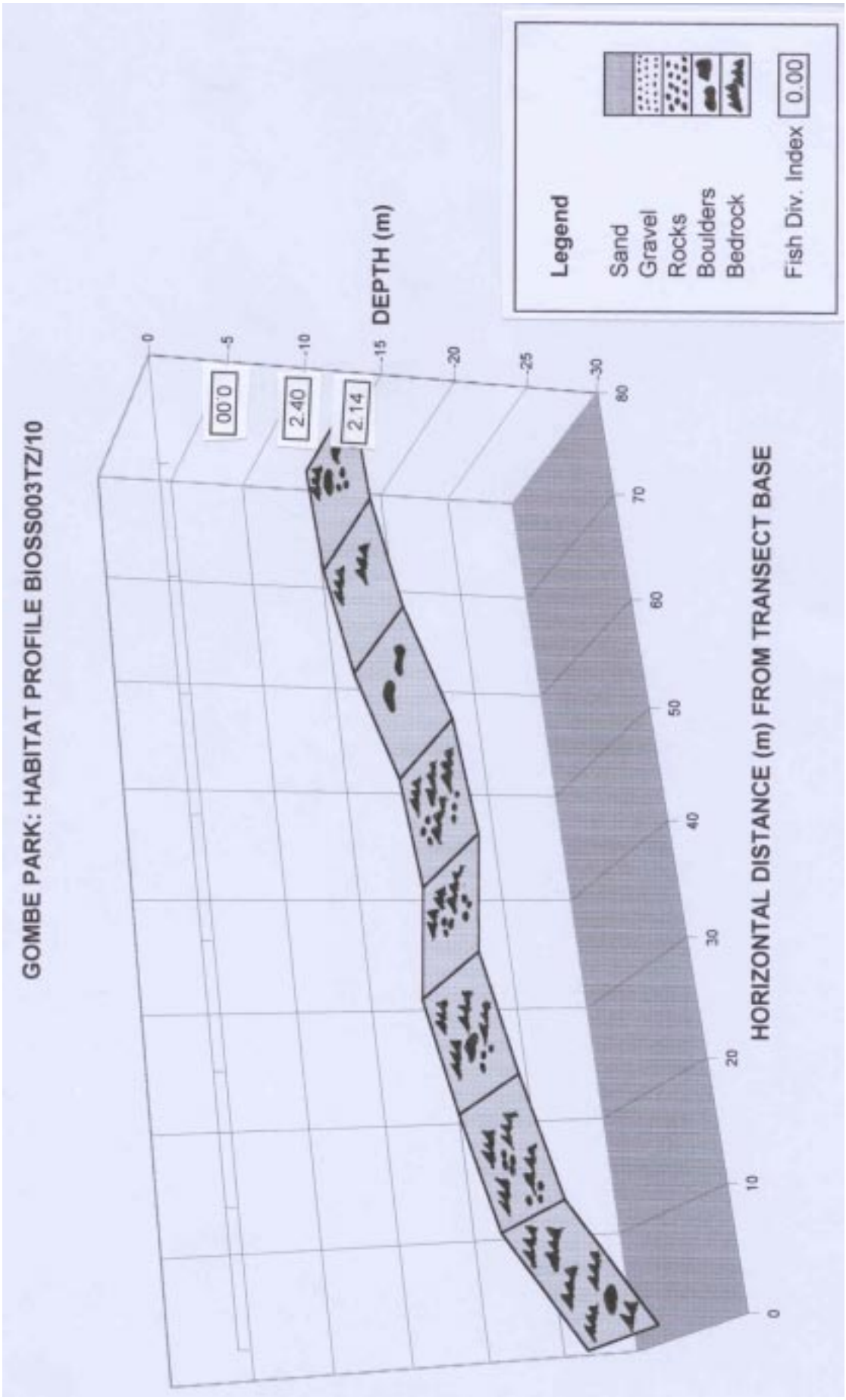
Beach seining was banned in Gombe National Park in March 1998 as a result of Tanzanian national legislation. The fishers with rights of access to Gombe were informed by two letters, one from the Department of Fisheries and the other from TANAPA. From the point of view of Gombe National Park, the main concerns about the fishing camps was the spread of disease from humans to primates, disturbance and encroachment into the park. Therefore, beach seines were not banned on any aquatic biodiversity grounds, but for other government and park management considerations.

One of the key resources the camps offered fishing communities was the flat sandy beaches for drying the catch. The villages bordering the park had very little land suitable for processing fish in this way. The majority of the beach seining done from the camps on Gombe's beaches was carried out at night. The fishing practices team report that the composition of the night seine catch was as follows: *Stolothrissa tanganyicae* 70%; *Luciolates stapersii* 25%; *Limnothrissa mioden* 4% and *Lates* species 1%.

The concern usually expressed over the use of beach seines is disturbance of sandy shore species, particularly nesting cichlids. However, the fishing practice associated with night beach seining indicates that these nets were not necessarily dragged along extensive areas of sandy habitat as has been observed elsewhere. The practice was to deploy light boats early in the evening 18.00–19.30 and they return, attracting their pelagic catch to the shores of Gombe around midnight. The land based crew then deploy the net, which encircles the light boat and the catch is then dragged ashore. The catch composition indicates that sandy shore species were not caught. The implication is that the banning of the gear without reference to its practice may prove to have been unnecessary. This aspect of the impact of fishing practices will be explored under by the FPSS field teams in association with the

socioeconomic special study.

APPENDIX 1 HABITAT PROFILES FOR GOMBE. FISH DIVERSITY INDICES WERE TAKEN AS THE HIGHEST SCORE OF THE PARI OF DIVERS AT EACH DEPTH.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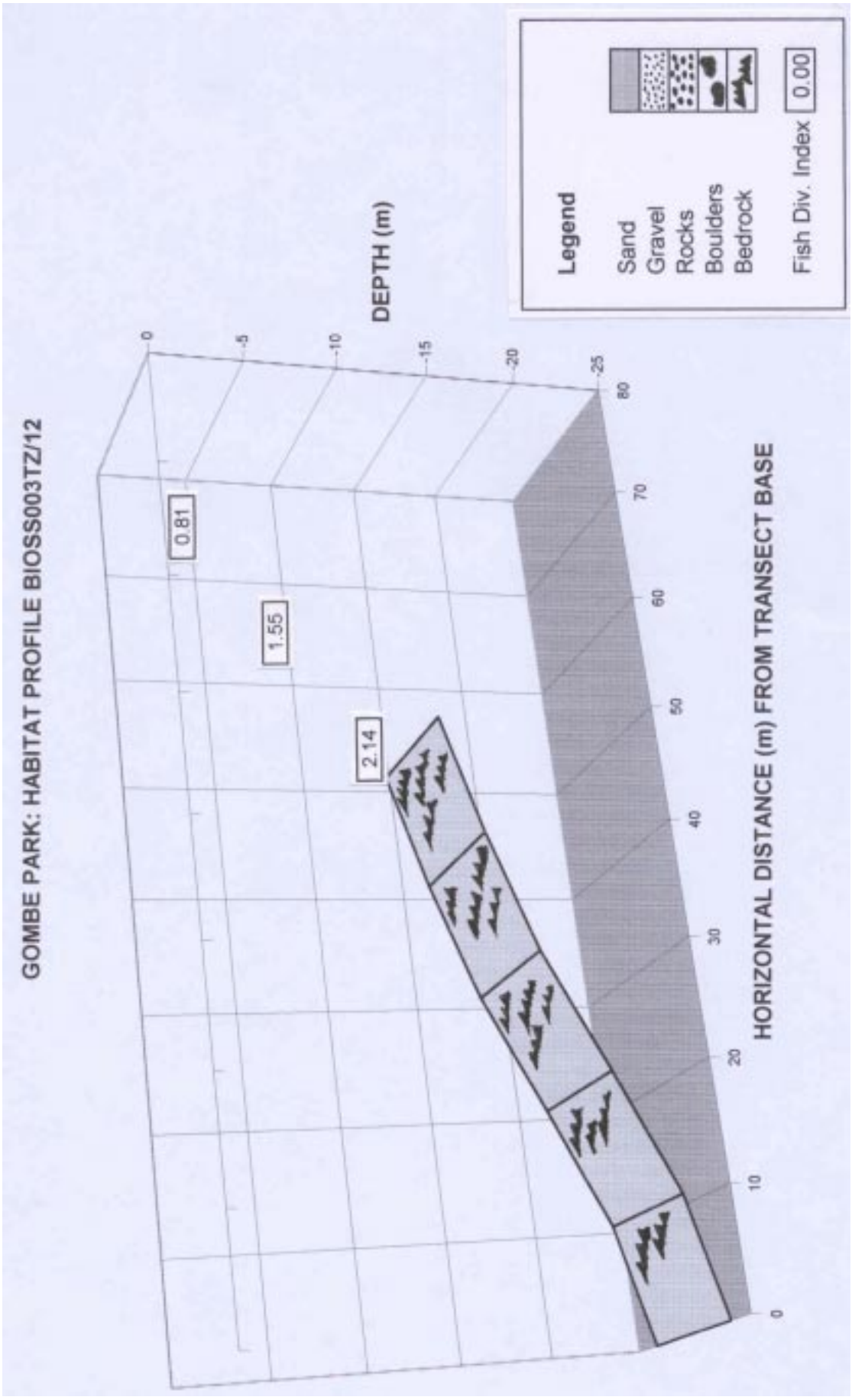
70
80
Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
0.00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HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
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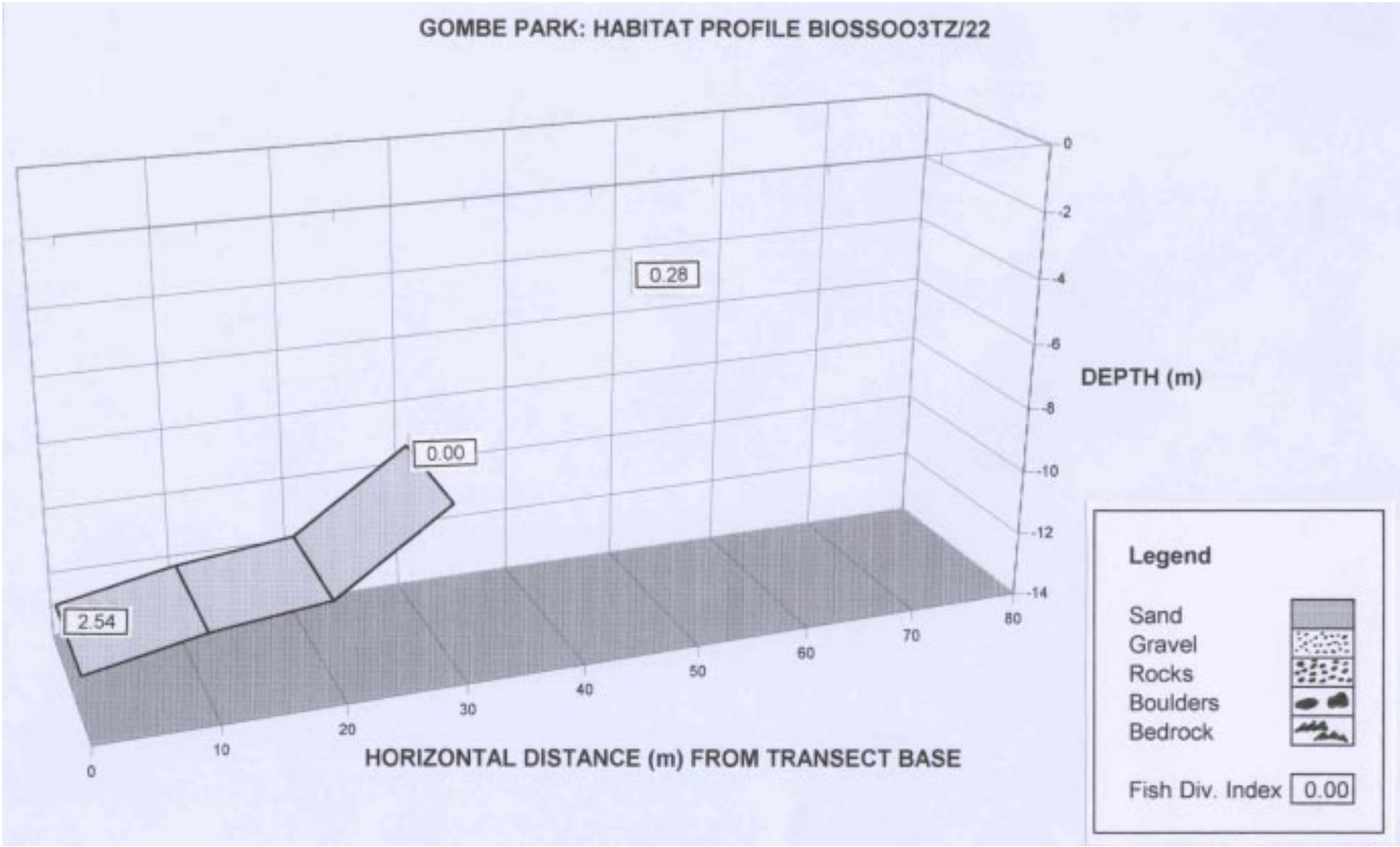
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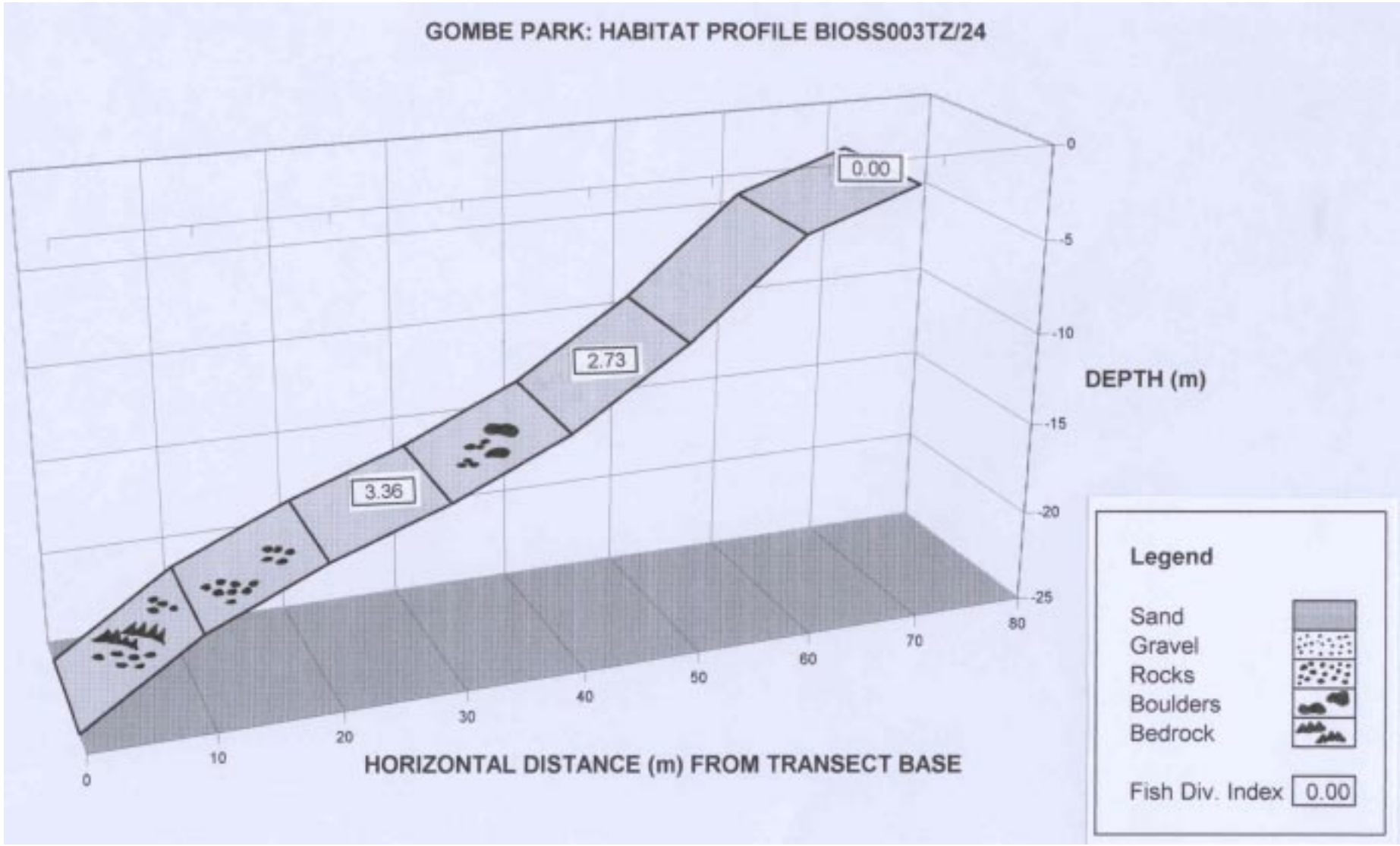
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Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
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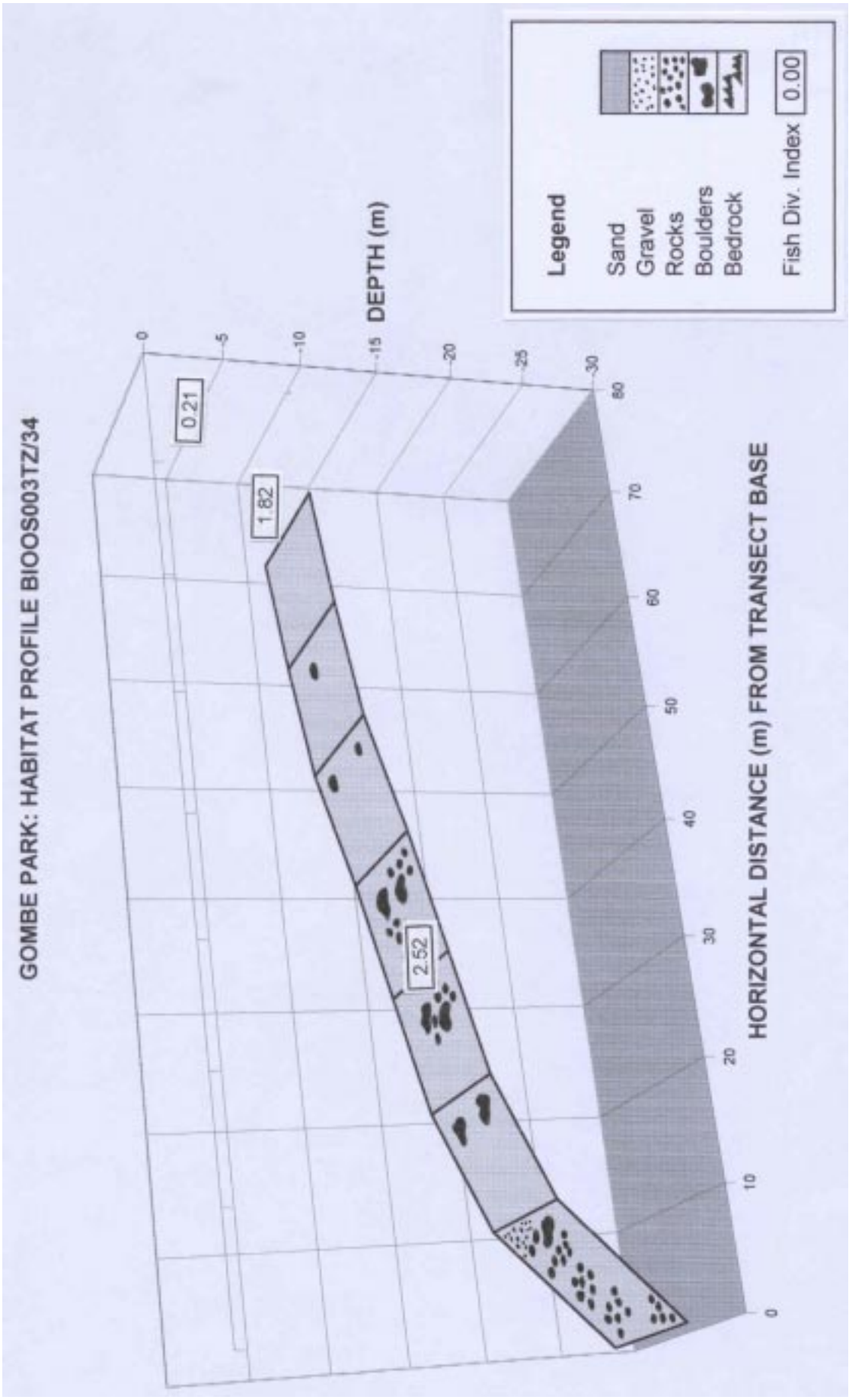
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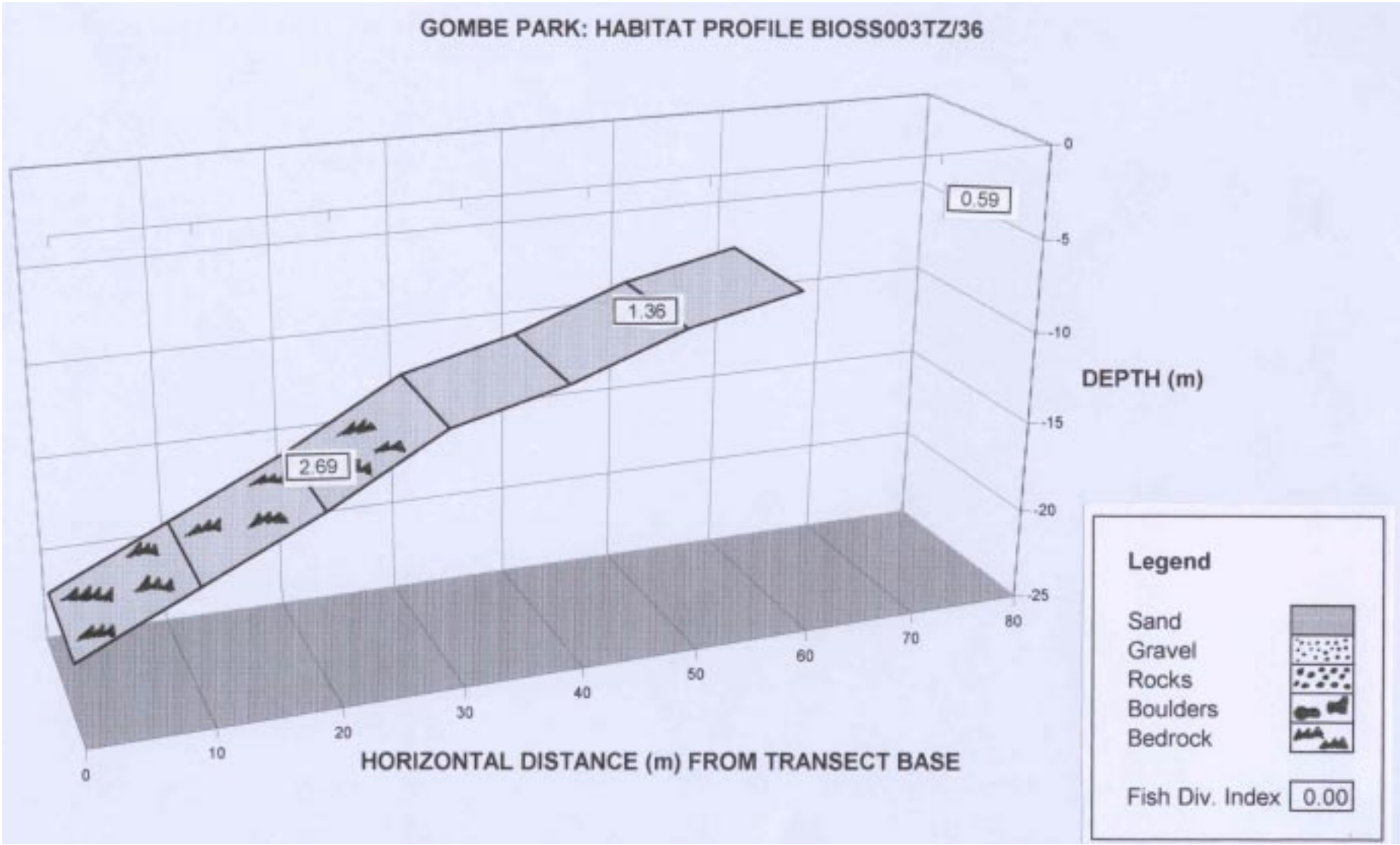
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Rocks
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Fish Div. Index
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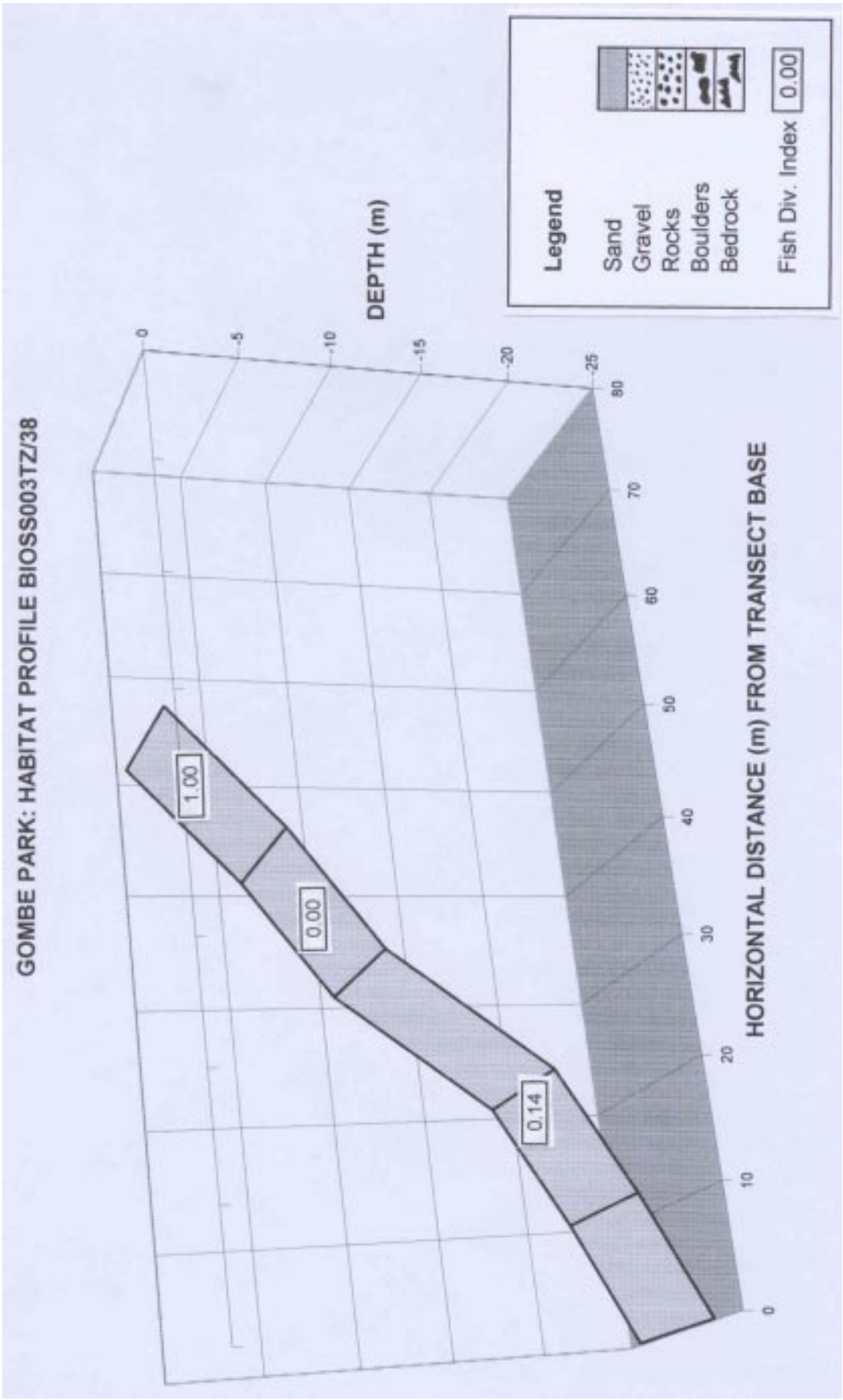
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40
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1.00
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Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
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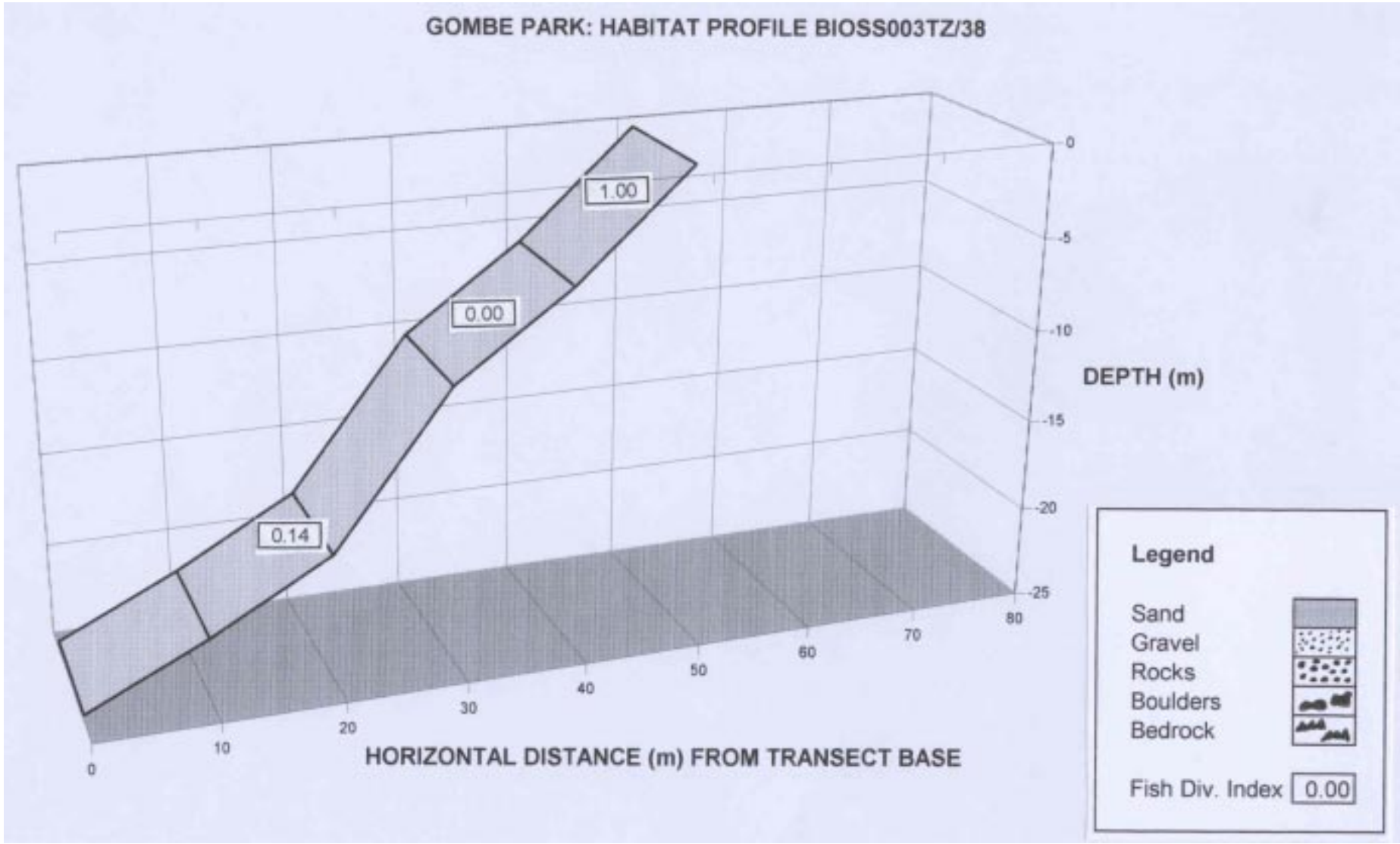
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DEPTH (m)
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HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
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Gravel
Rocks
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Bedrock
Fish Div. Index
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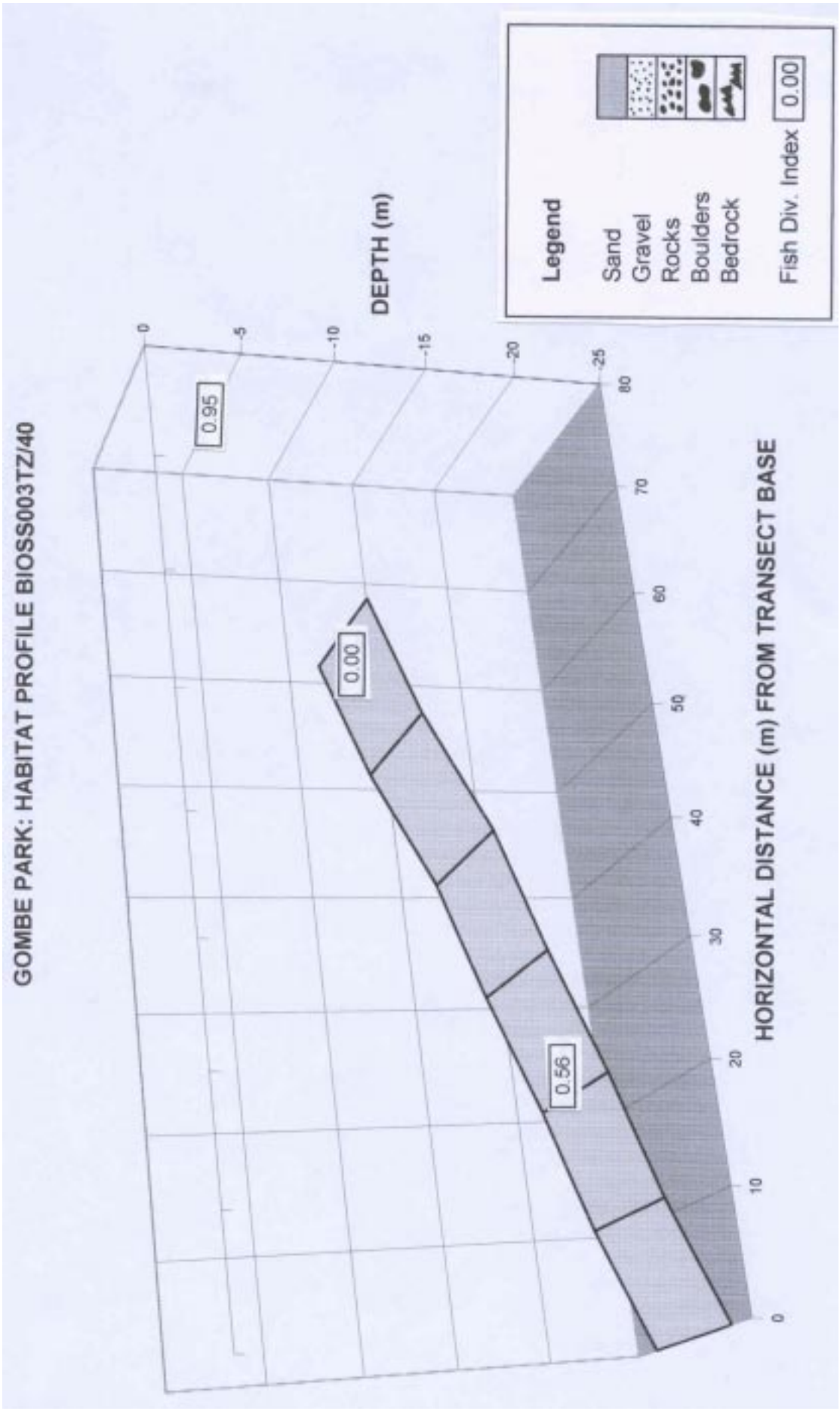
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Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
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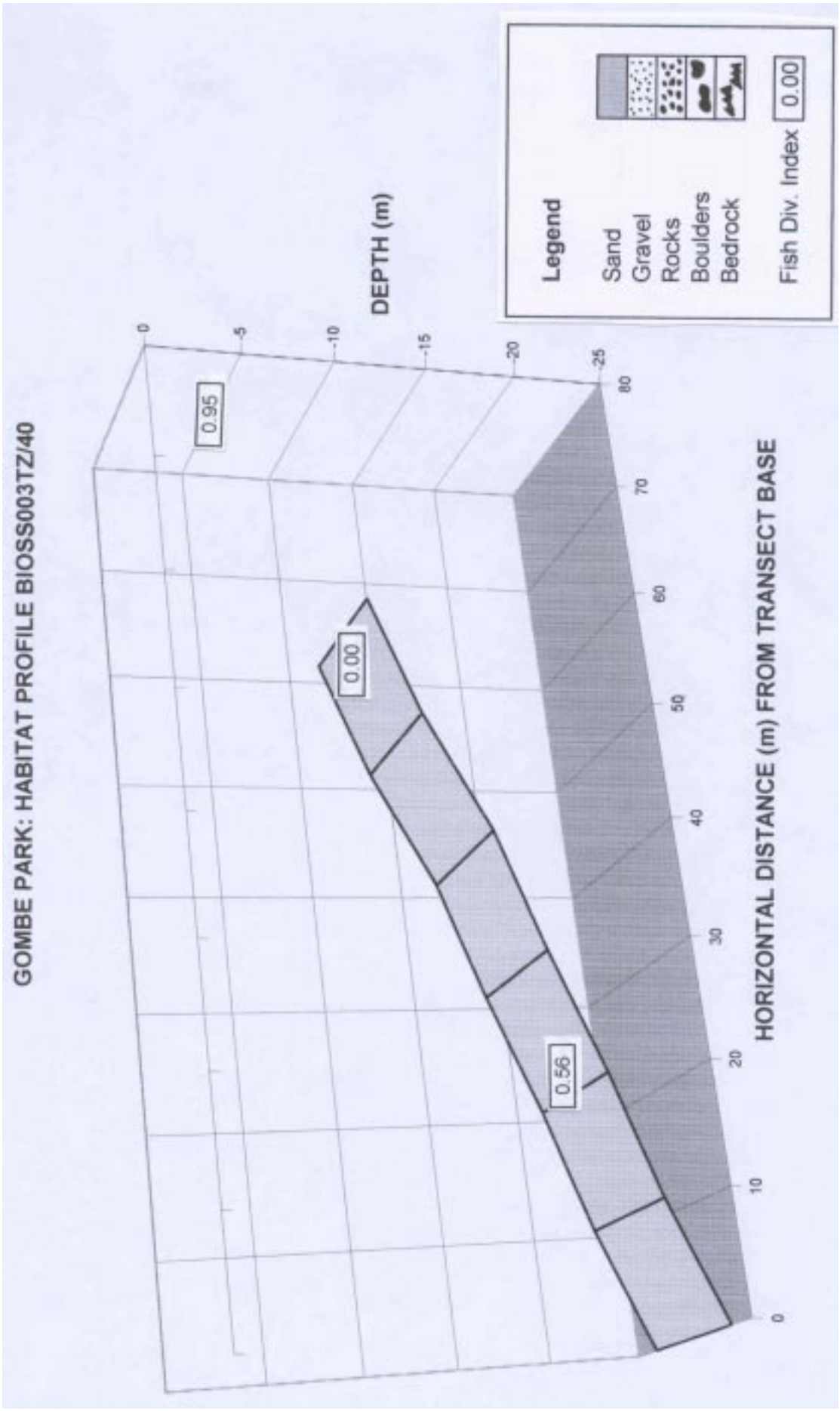
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DEPTH (m)
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-10
-15
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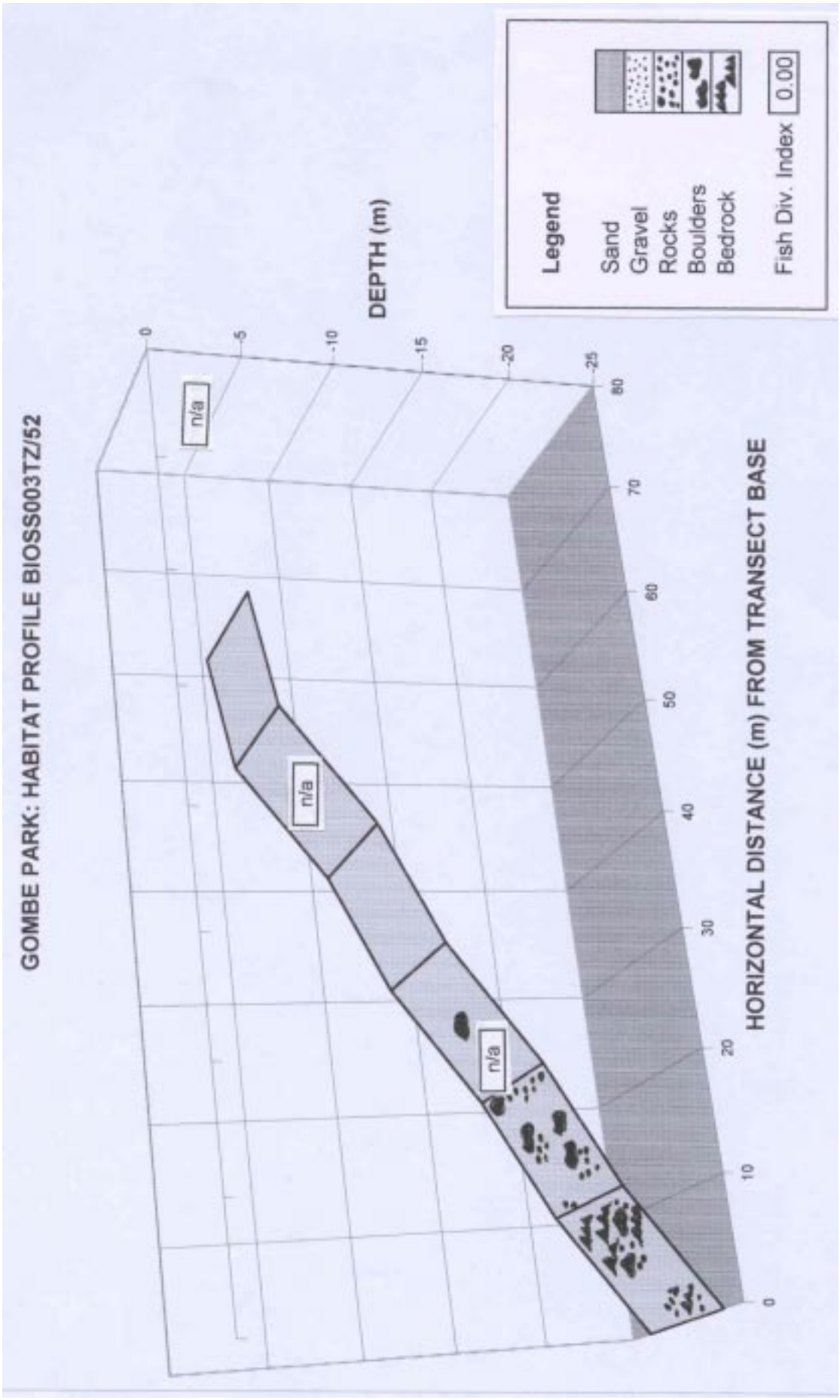
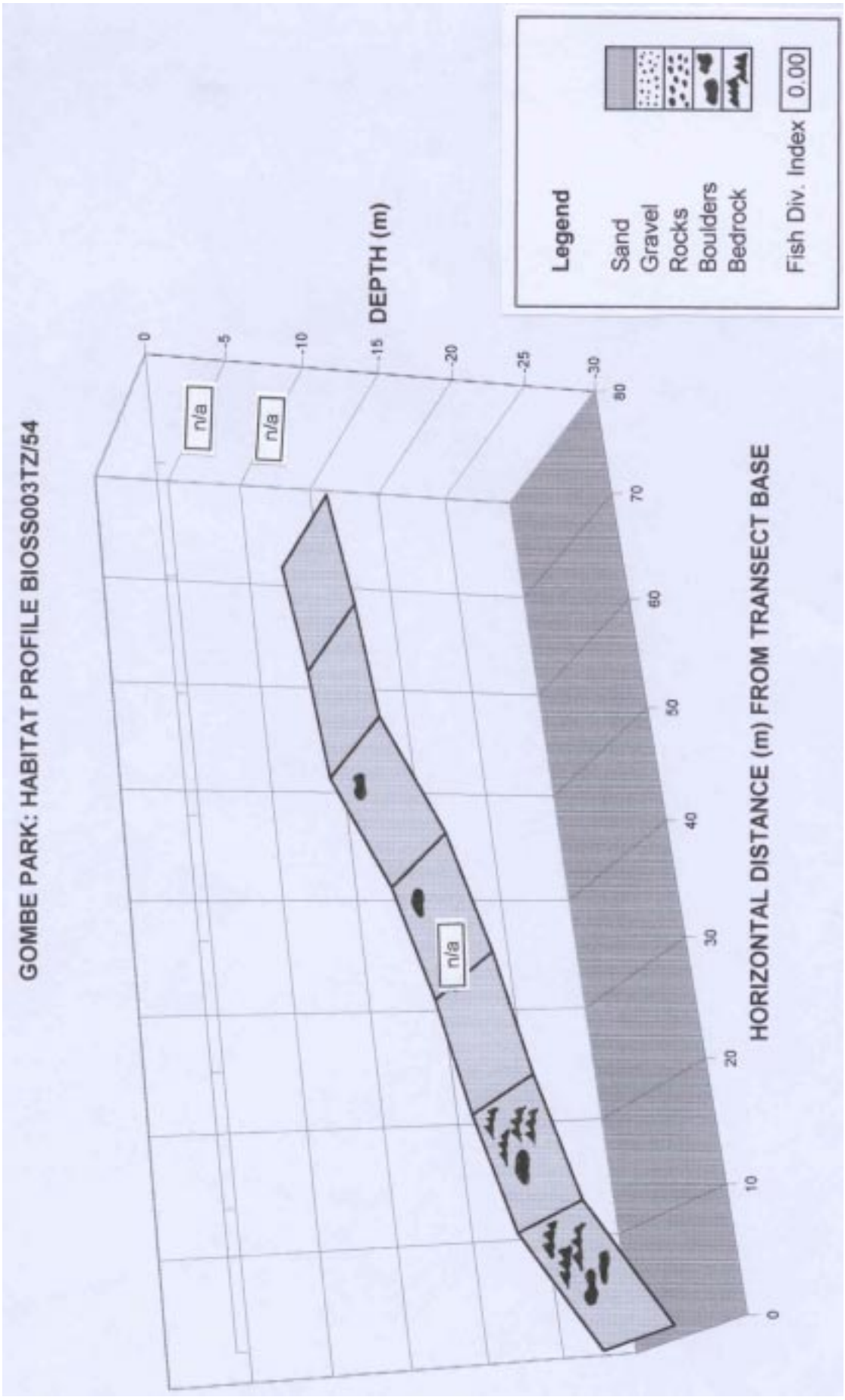
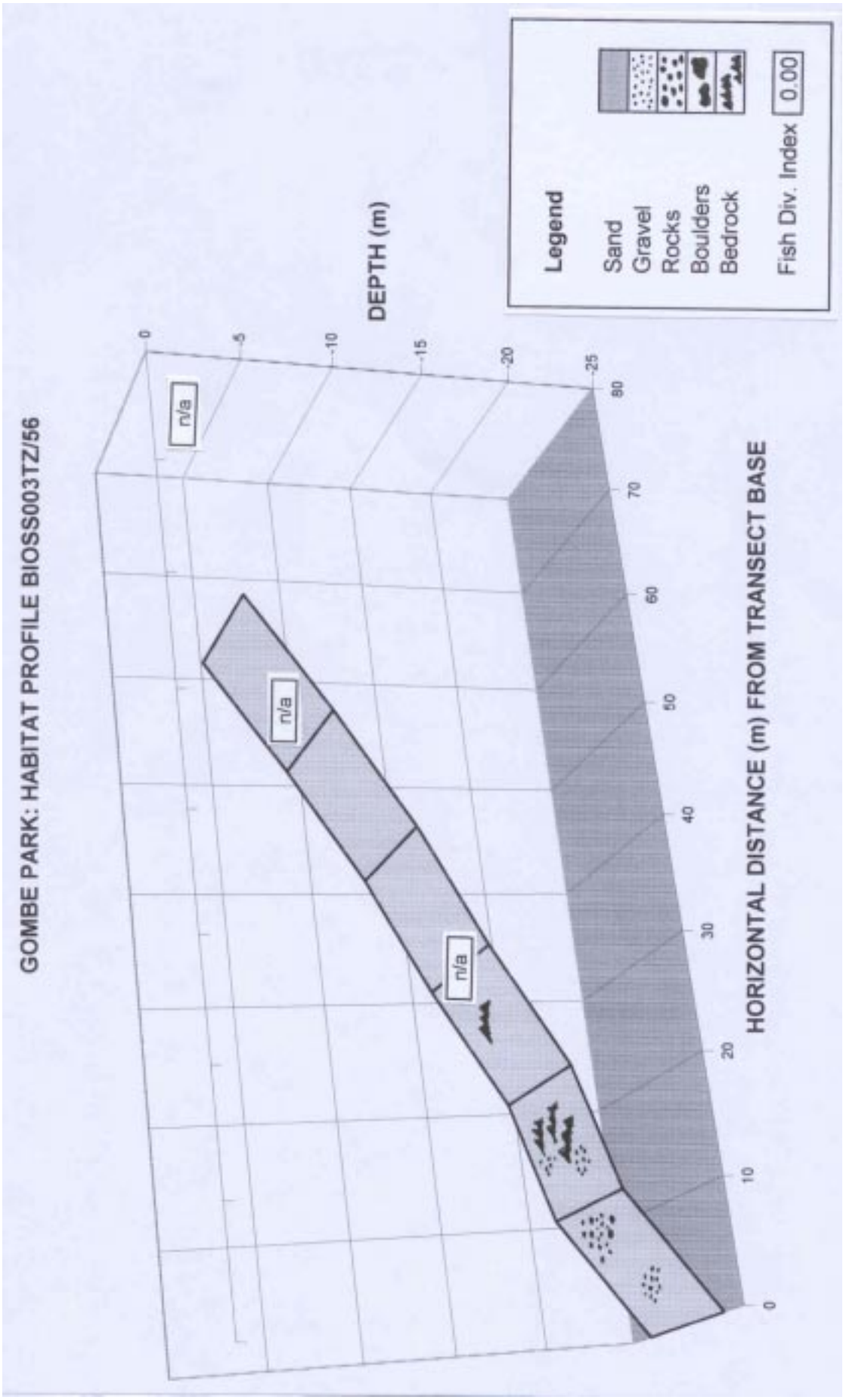
-25
0.95
0.00
0.56
HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
0
10
20
30
40
50
60
70
80
Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
0.00


GOMBE PARK: HABITAT PROFILE BIOSS003TZ/52
DEPTH (m)
0
-5
-10
-15
-20
-25
HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
0
10
20
30
40
50
60
70
80
n/a
n/a
n/a
Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
0.00


GOMBE PARK: HABITAT PROFILE BIOSS003TZ/54
DEPTH (m)
0
-5
-10
-15
-20
-25
-30
n/a
n/a
n/a
HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
0
10
20
30
40
50
60
70
80
Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
0.00


GOMBE PARK: HABITAT PROFILE BIOSS003TZ/56
DEPTH (m)
0
-5
-10
-15
-20
-25
HORIZONTAL DISTANCE (m) FROM TRANSECT BASE
0
10
20
30
40
50
60
70
80
n/a
n/a
n/a
Legend
Sand
Gravel
Rocks
Boulders
Bedrock
Fish Div. Index
0.00

APPENDIX II SPECIES LISTS FOR ALL CENSUS TECHNIQUES. GOMBE NATIONAL PARK.

		No. censuses where recorded		No.fish
Species recorded	**SVC**	**FCS**	**Combined**	**Gill Net**
Acapoeta tanganicae	1		1	
Altolamprologus compressiceps	23	14	37	4
Aulonocranus dewindti	2	2	4	
Auchenoglanis occidentalis				
Bagrus moorii				1
Benthochromis tricoti			8	8
Boulangerochromis microlepis	10	4	14	1
Cardiopharynx schoutedeni				5
Chalinochromis brichardi	6	1	7	
Clarius sp.				1
Chrysichthys graueri				15
Crysichthys platycephalus				5
Cyathopharynx furcifer	5	6	11	6
Cyphotilapia frontosa	11	10	21	2
Cyprichromis leptosoma		2	2	25
Cyprichromis micrrolepidotus				1
Ectodus descampsi	5	1	6	9
Enantiopus melanogenys		1	1	1
Eretmodus cyanostictus		2	2	
Gnathochromis pfefferi	3	1	4	2
Grammatotria lemairii	49	16	65	59
Haplochromis horei	2	1	3	
Haplotaxodon micolepis	2	3	5	9
Julidochromis marlieri	5	3	8	1
Julidochromis ornatus	1		1	
Julidochromis regani	2		2	
Lamprologus callipterus	27	14	41	10
Lamprologus kungweensis	9	3	12	
Lamprologus lemairii	13	10	23	1
Lamprologus occelatus	2		2	
Lamprologus ornatipinnis	2	3	5	
Lamprichthyes tanganicae	2	1	3	3
Lates angustifrons		2	2	1
Lepidolamprologus attenuatus	27	21	48	7
Lepidolamprologus cunningtoni	33	10	43	7
Lepidolamprologus elongatus	40	24	64	41
Lepidolamprologus profundicola	6	3	9	
Lestradea perspicax				3
Limnotilapia dardennii	16	5	21	10
Limnothrissa miodon				24
Lobochilotes labiatus	17	11	28	4
Mastacembelus sp.	11	6	17	2
Microdontochromis tenuidentata	1	2	3	
Neolamprologus boulanger**	11		11	

		No. censuses where recorded		No.fish
Species recorded	**SVC**	**FCS**	**Combined**	**Gill Net**
Neolamprologus brevis	20	11	31	
Neolamprologus brichardi	9	7	16	3
Neolamprologus fasciatus		4	4	
Neolamprologus furcifer	2	2	4	1
Neolamprologus longior	1	1	2	
Neolamprologus mondabu	34	19	53	13
Neolamprologus niger	9	11	20	2
Neolamprologus savoryi	7	4	11	
Neolamprologus sexfasciatus		1	1	
Neolamprologus tetracanthus	3	11	14	
Neolamprologus toae	2	2	4	
Neolamprologus tretacephalus	15	8	23	2
Neolamprologus walteri	23	12	35	1
Opthalmotilapia ventralis	2		2	2
Paracyprichromis brieni		1	1	
Petrochromis trewaversae ephippium	1		1	
Petrochromis famula		2	2	
Petrochromis fasciolatus	1	1	2	
Petrochromis macrognathus	5		5	1
Petrochromis orthognathus	7	4	11	
Petrochromis polyodon	5	4	9	6
Petrochromis trewaversae		1	1	2
Perissodus microlepis	15	7	22	21
Phylonemus sp.	1		1	3
Plecodus pardoxus	10	1	11	
Plecodus straeleni	7	2	9	4
Simochromis babaulti		1	1	
Simochromis diagramma	2	1	3	4
Simochromis sp.1				1
Spathodus marlieri		2	2	
Synodontis eurystomus	1	3	4	4
Synodontus multipunctatus	13	5	19	6
Synodontus petricola	3	2	5	7
Tanganicoides irsacea		2	2	
Tanganicalabes martiauxi				7
Telmatochromis bifrenatus	32	18	50	
Telmatochromis dhonti	3	1	4	
Telmatochromis temporalisi	7	9	16	
Telmatochromis vittatus	3		3	
Trematocara sp.	2		2	
Tropheus brichardi		1	1	
Tropheus duboisi	14	2	16	
Tropheus moorii		2	2	3
Varicorhinus tanganicae		1	1	1
Xenotilapia flavipinnis	36	15	51	12
Xenochromis hecqui				1
Xenotilapia ochrogenys	3	4	7	
Xenotilapia sima	14	3	17	1

		No. censuses where recorded		No.fish
Species recorded	**SVC**	**FCS**	**Combined**	**Gill Net**
Xenotilapia spilopterus			1	1
NO.ID	11		11	1
TOTAL SP.	**65**	**68**	**82**	**56**

** ID NEEDS CONFIRMATION

93 DIFFERENT SPECIES WERE RECORDED FROM ALL CENSUSES COMBINED

11 ADDITIONAL CASES WERE NOT IDENTIFIED

APPENDIX III SPECIES RANKED BY (A) NUMBER OF VISUAL CENSUS' WHEN OBSERVED, AND (B) NUMBER OF INDIVIDUALS CAPTURED IN GILL NETS.

	(a)		(b)
Species	**Visual census**	**Species**	**Gill Net**
Grammatotria lemairii	65	Grammatotria lemairii	59
Lepidolamprologus elongatus	64	Lepidolamprologus elongatus	41
Neolamprologus mondabu	53	Cyprichromis leptosoma	25
Xenotilapia flavipinnis	51	Limnothrissa miodon	24
Telmatochromis bifrenatus	50	Perissodus microlepis	21
Lepidolamprologus attenuatus	48	Chrysichthys graueri	15
Lepidolamprologus cunningtoni	43	Neolamprologus mondabu	13
Lamprologus callipterus	41	Xenotilapia flavipinnis	12
Altolamprologus compressiceps	37	Lamprologus callipterus	10
Neolamprologus walteri	35	Limnotilapia dardennii	10
Neolamprologus brevis	31	Ectodus descampsi	9
Lobochilotes labiatus	28	Haplotaxodon micolepis	9
Neolamprologus tretacephalus	23	Benthochromis tricoti	8
Lamprologus lemairii	23	Lepidolamprologus attenuatus	7
Perissodus microlepis	22	Lepidolamprologus cunningtoni	7
Limnotilapia dardennii	21	Synodontus petricola	7
Cyphotilapia frontosa	21	Tanganikalabes marteoxis	7
Neolamprologus niger	20	Synodontus multipunctatus	6
Synodontus multipunctatus	18	Cyathopharynx furcifer	6
Xenotilapia sima	17	Petrochromis polyodon	6
Mastacembelus sp.	17	Petrochromis sp.	5
Tropheus duboisi	16	Cardiopharynx schoutedeni	5
Telmatochromis temporalisi	16	Chrysichthys platycephalus	5
Synodontus sp.	16	Altolamprologus compressiceps	4
Neolamprologus brichardi	16	Lobochilotes labiatus	4
Neolamprologus tetracanthus	14	Plecodus straeleni	4
Boulangerochromis microlepis	14	Synodontis eurystomus	4
Lamprologus kungweensis	12	Simochromis diagramma	4
Plecodus pardoxus	11	Neolamprologus brichardi	3
Petrochromis orthognathus	11	Lamprichthyes tanganicae	3
NO.ID	11	Tropheus moorii	3
Neolamprologus savoryi	11	Phylonemus sp.	3
Neolamprologus boulanger?*	11	Lestradea perspicax	3
Cyathopharynx furcifer	11	Neolamprologus tretacephalus	2
Plecodus straeleni	9	Cyphotilapia frontosa	2
Petrochromis sp.	9	Neolamprologus niger	2
Petrochromis polyodon	9	Mastacembelus sp.	2
Lepidolamprologus profundicola	9	Gnathochromis pfefferi	2
Julidochromis marlieri	8	Opthalmotilapia ventralis	2
Benthochromis tricoti	8	Petrochromis trewaversae	2
Xenotilapia ochrogenys	7	Neolamprologus walteri	1
Chalinochromis brichardi	7	Lamprologus lemairii	1
Ectodus descampsi	6	Xenotilapia sima	1
Xenotilapia sp.	5	Boulangerochromis microlepis	1

	(a)		(b)
Species	**Visual census**	**Species**	**Gill Net**
Synodontus petricola	5	NO.ID	1
Petrochromis macrognathus	5	Julidochromis marlieri	1
Lamprologus ornatipinnis	5	Petrochromis macrognathus	1
Haplotaxodon micolepis	5	Xenotilapia sp.	1
Telmatochromis dhonti	4	Neolamprologus furcifer	1
Synodontis eurystomus	4	Lates angustifrons	1
Neolamprologus toae	4	Enantiopus melanogenys	1
Neolamprologus furcifer	4	Varicorhinus tanganicae	1
Neolamprologus fasciatus	4	Bagrus moorii	1
Gnathochromis pfefferi	4	Cyprichromis micrrolepidotus	1
Aulonocranus dewindti	4	Simochromis sp.	1
Auchenoglanis occidentalis	4	Xenochromis hecqui	1
Telmatochromis vittatus	3	Clarius sp.	1
Simochromis diagramma	3	Xenotilapia spilopterus	1
Lamprichthyes tanganicae	3	Aulonocranus dewindti	n/r
Haplochromis horei	3	Telmatochromis bifrenatus	n/r
Haplochromis horei	3	Neolamprologus brevis	n/r
Tropheus moorii	2	Synodontus sp.	n/r
Trematocara sp.	2	Telmatochromis temporalis	n/r
Tanganicoides irsacea	2	Tropheus duboisi	n/r
Spathodus marlieri	2	Neolamprologus tetracanthus	n/r
Petrochromis fasciolatus	2	Lamprologus kungweensis	n/r
Petrochromis famula	2	Neolamprologus boulanger?*	n/r
Opthalmotilapia ventralis	2	Neolamprologus savoryi	n/r
Neolamprologus longior	2	Petrochromis orthognathus	n/r
Microdontochromis tenuidentata	2	Plecodus pardoxus	n/r
Lates angustifrons	2	Lepidolamprologus profundicola	n/r
Lamprologus occelatus	2	Chalinochromis brichardi	n/r
Julidochromis regani	2	Xenotilapia ochrogenys	n/r
Eretmodus cyanostictus	2	Lamprologus ornatipinnis	n/r
Cyprichromis leptosoma	2	Auchenoglanis occidentalis	n/r
Varicorhinus tanganicae	1	Neolamprologus fasciatus	n/r
Tropheus brichardi	1	Neolamprologus toae	n/r
Simochromis babaulti	1	Telmatochromis dhonti	n/r
Phylonemus sp.	1	Haplochromis horei	n/r
Petrochromis trewaversae ephippium	1	Haplochromis horei	n/r
Petrochromis trewaversae	1	Telmatochromis vittatus	n/r
Paracyprichromis brieni	1	Eretmodus cyanostictus	n/r
Neolamprologus sexfasciatus	1	Julidochromis regani	n/r
Neolamprologus falciformes?*	1	Lamprologus occelatus	n/r
Microdontochromis tenuidentata	1	Microdontochromis tenuidentata	n/r
Lamprologus sp.	1	Neolamprologus longior	n/r
Julidochromis ornatus	1	Petrochromis famula	n/r
Enantiopus melanogenys	1	Petrochromis fasciolatus	n/r
Acapoeta tanganicae	1	Spathodus marlieri	n/r
Bagrus moorii	n/r	Tanganicoides irsacea	n/r
Cyprichromis micrrolepidotus	n/r	Trematocara sp.	n/r
Lestradea perspicax	n/r	Acapoeta tanganicae	n/r
Limnothrissa miodon	n/r	Julidochromis ornatus	n/r

	(a)		(b)
Species	**Visual census**	**Species**	**Gill Net**
Simochromis sp.	n/r	Lamprologus sp.	n/r
Tanganikalabes marteoxis	n/r	Neolamprologus falciformes?*	n/r
Cardiopharynx schoutedeni	n/r	Neolamprologus sexfasciatus	n/r
Clarius sp.	n/r	Paracyprichromis brieni	n/r
Chrysichthys graueri	n/r	Petrochromis trewaversae ephippium	n/r
Chrysichthys platycephalus	n/r	Simochromis babaulti	n/r
Xenotilapia spilopterus	n/r	Microdontochromis tenuidentata	n/r
Xenochromis hecqui	n/r	Tropheus brichardi	n/r

n/r mean not recorded in this type of census

* mean idenification needs confirmation

APPENDIX IV DIVERSITY INDICES FOR ALL SITES CENSUSED WITHIN THE GOMBE NATIONAL PARK

Area	Site	GPS	Date	Time	Survey	Census	Sample #	Depth(m)	Habitat	No. fish	Hs	No. species	Hmax	J (Hs/Hmax)
GOMBE	MITUMBA	0437804S 02939948E	25/10/1997	1130	BIOSS 004TZ	SVC	8/1	15	3	332	2.58	11	3.46	0.75
GOMBE	MITUMBA	0437804S 02939948E	25/10/1997	1130	BIOSS 004TZ	SVC	8/2	15	3	391	3.10	16	4.00	0.77
GOMBE	MITUMBA	0430623S 02937764E	25/10/1997	1100	BIOSS 004TZ	SVC	10/2	15	2	138	0.62	3	1.58	0.39
GOMBE	MITUMBA	0430623S 02937764E	25/10/1997	1100	BIOSS 004TZ	SVC	10/2	10	3	162	2.10	13	3.70	0.57
GOMBE	MITUMBA	0430623S 02937764E	25/10/1997	1100	BIOSS 004TZ	SVC	10/2	5	3	178	0.93	6	2.58	0.36
GOMBE	MITUMBA	0430623S 02937764E	25/10/1997	1100	BIOSS 004TZ	SVC	10/1	10	2	111	2.04	6	2.58	0.79
GOMBE	MITUMBA	0430623S 02937764E	25/10/1997	1100	BIOSS 004TZ	SVC	10/1	5	3	196	2.86	10	3.32	0.86
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1230	BIOSS 004TZ	SVC	2/1	15	2	17	1.55	4	2.00	0.77
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1230	BIOSS 004TZ	SVC	2/1	10	3	48	3.27	12	3.58	0.91
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1230	BIOSS 004TZ	SVC	2/1	5	3	103	2.28	11	3.46	0.66
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1235	BIOSS 004TZ	SVC	2/2	15	2	65	1.26	6	2.58	0.49
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1235	BIOSS 004TZ	SVC	2/2	10	3	104	3.21	14	3.81	0.84
GOMBE	BWAVI	044420S 0293634E	24/10/1997	1235	BIOSS 004TZ	SVC	2/2	5	3	222	2.47	13	3.70	0.67
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/1	15	3	198	1.79	15	3.91	0.46
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/1	10	3	131	3.05	16	4.00	0.76
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/1	5	3	144	3.04	17	4.09	0.74
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/2	15	3	239	1.96	14	3.81	0.52
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/2	10	3	212	2.78	13	3.70	0.75
GOMBE	N.BOUNDARY	0437804S 02937948E	25/10/1997	1630	BIOSS 004TZ	SVC	14/2	5	3	175	2.84	14	3.81	0.75
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/1	15	2	87	1.26	5	2.32	0.54
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/1	10	1	350	3.31	25	4.64	0.71
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/1	5	3	363	4.00	28	4.81	0.83
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/2	15	2	512	1.46	6	2.58	0.56
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/2	10	1	981	3.70	27	4.75	0.78
GOMBE	MITUMBA	043807S 0293785E	25/10/1997	1610	BIOSS 004TZ	SVC	12/2	5	3	839	3.63	27	4.75	0.76
GOMBE	KITWE	0443027S 02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/1	15	3	3292	2.35	19	4.25	0.55

Area	Site	GPS	Date	Time	Survey	Census	Sample #	Depth(m)	Habitat	No. fish	Hs	No. species	Hmax	J (Hs/Hmax)
GOMBE	KITWE	0443027S 02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/1	10	2	78	1.79	6	2.58	0.69
GOMBE	KITWE	0443027S 02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/1	5	2	56	0.13	2	1.00	0.13
GOMBE	KITWE	04430275S02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/2	15	3	4059	2.61	24	4.58	0.57
GOMBE	KITWE	04430275S02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/2	10	2	805	2.42	11	3.46	0.70
GOMBE	KITWE	04430275S02936638E	24/10/1997	1235	BIOSS 004TZ	SVC	4/2	5	2	301	0.03	2	1.00	0.03
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/2	15	2	23	0.56	2	1.00	0.56
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/2	10	2	60	0.00	1	0.00	0.00
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/2	5	2	22	0.44	2	1.00	0.44
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/1	15	2	152	0.10	2	1.00	0.10
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/1	10	2	86	0.00	1	0.00	0.00
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1600	BIOSS 003TZ	SVC	41/1	5	2	16	0.95	2	1.00	0.95
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/2	15	2	204	0.14	2	1.00	0.14
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/2	10	n/r	0				
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/2	5	n/r	200	1.00	2	1.00	1.00
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/1	15	n/r	253	0.09	2	1.00	0.09
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/1	10	n/r	0				
GOMBE	KAHAMA	0440235S 0293743E	19/10/1998	1100	BIOSS 003TZ	SVC	39/1	5	n/r	400	0.95	2	1.00	0.95
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/2	15	3	52	1.65	7	2.81	0.59
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/2	10	2	73	1.36	5	2.32	0.58
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/2	5	2	1	0.00	1	0.00	0.00
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/1	15	3	184	2.69	15	3.91	0.69
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/1	10	3	92	1.23	5	2.32	0.53
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	37/1	5	2	7	0.59	2	1.00	0.59
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/2	15	n/r	132	2.52	9	3.17	0.79
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/2	10	n/r	37	1.82	5	2.32	0.78
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/2	5	n/r	62	0.21	2	1.00	0.21
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/1	15	n/r	188	2.85	10	3.32	0.86
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/1	10	n/r	188	2.86	11	3.46	0.83
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	35/1	5	n/r	62	0.21	2	1.00	0.21

Area	Site	GPS	Date	Time	Survey	Census	Sample #	Depth(m)	Habitat	No. fish	Hs	No. species	Hmax	J (Hs/Hmax)
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	25/1	15	n/r	462	3.36	21	4.39	0.77
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	25/1	10	n/r	126	2.73	11	3.46	0.79
GOMBE	MITUMBA	0438311S 02937711E	18/10/1997	1700	BIOSS 003TZ	SVC	25/1	5	n/r	11	0.44	2	1.00	0.44
GOMBE	MITUMBA	0438311S 02937711E	10/18/1997	1700	BIOSS 003TZ	SVC	25/2	15	n/r	280	3.00	18	4.17	0.72
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	25/2	10	n/r	121	2.44	8	3.00	0.81
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	25/2	5	n/r	12	0.00	1	0.00	0.00
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/2	15	n/r	806	2.54	14	3.81	0.67
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/2	10	n/r	40	0.00	1	0.00	0.00
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/2	5	n/r	525	0.28	2	1.00	0.28
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/1	15	n/r	441	1.16	8	3.00	0.39
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/1	10	n/r	50	0.00	1	0.00	0.00
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	23/1	5	n/r	650	1.00	2	1.00	1.00
GOMBE	KASEKELA	0439995S 0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/1	15	n/r	544	2.14	12	3.58	0.60
GOMBE	KASEKELA	0439995S 0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/1	10	n/r	0				
GOMBE	KASEKELA	0439995S 0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/1	5	n/r	809	2.40	9	3.17	0.76
GOMBE	KASEKELA	0439995S0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/2	15	n/r	233	2.53	13	3.70	0.68
GOMBE	KASEKELA	0439995S0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/2	10	n/r	0				
GOMBE	KASEKELA	0439995S0293734E	17-Oct-97	1240	BIOSS 003TZ	SVC	13/2	5	n/r	723	2.70	12	3.58	0.75
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/1	15	3	289	2.14	11	3.46	0.62
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/1	10	2	227	1.55	11	3.46	0.45
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/1	5	2	8	0.81	2	1.00	0.81
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/2	15	3	178	2.37	10	3.32	0.71
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/2	10	3	90	2.38	8	3.00	0.79
GOMBE	KASEKELA	0439991S 02937333E	17-Oct-97	1200	BIOSS 003TZ	SVC	11/2	5	2	2	1.00	2	1.00	1.00
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	37/1	15	3	181	2.67	14	3.81	0.70
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	37/1	10	3	92	1.23	5	2.32	0.53
GOMBE	MITUMBA	0438311S 02937711E	18-Oct-97	1700	BIOSS 003TZ	SVC	37/1	5	2	7	0.59	2	1.00	0.59

n/r means information not recorded

APPENDIX V SUMMARY FACT SHEET FOR GOMBE STREAM NATIONAL PARK

Park Features /Description	
Location	Tanzania: south from Mwamgongo Village (4^{o}37 S, 29^{o} 38 E) to north of Kasinga village (4^{o}44 S, 29^{o} 36 E).
Length of Coastline	Approx.15 km
Coastline characteristics	Predominantly uniform and linear. No significant bays or headlands. Many small streams. Mountainous backdrop.
Terrestrial Activities	Strict concervation area with little human disturbance - chimpanzee sanctuary. High density of fishermen on shore.
Percieved Threats to lake biodiversity	Possible impact from beach seines on shallow water sand dwelling cichlid community - under investigation.
Habitat distributions	
Shallow water: 0-5m	Predominantly sand (60%) with a narrow fringe of exposed cobble and rock in the surf zone.
Mid-water: 5-30m	Predominantly sand but with the proportion of rock increasing with depth.
Deep water: > 30m	The few sites surveyed suggest a band of rock cliffs and canyons stretches for the length of the park below 35 m.
Macrophytes	No significant algal beds but *Vallisinaria* recorded in sparse beds at Mhenke, Kavusindi and Rutanga.
Shell Deposites	None observed.
Sites of interest:	(1) Mitumba beach where the bedrock, normally restricted to deeper water, comes to within 10 m of the surface.
	(2) Submerged canyons below Kakombe and Mitumba streams.
Fish Community	
General Description	Fish community typical of a mixed sand and rock habitat. No unusual species or communities observed.
Overall Diversity (shannon-weiner):	4.26 (SVC) and 4.27 (Gillnets)
Total species cichlid	80 species
Total species non-cichlid	13 species
Sites of interest:	(1) Shallow sites below stream mouths support a high diversity of species and high density of nesting sites.
	(2) The "surf zone"was observed to support a distinct fish community not yet surveyed.
Recommendations:	(1) Train a dive survey team for Gombe.
	(2) Set up and implement a monitoring programme with emphasis on the stream mouth and surf zone sites.
	(3) Compile fish reference collections
	(4) Initiate sampling programme for other fauna such as mollusc and invertebrates.