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University of Natural Resources and Life Sciences, Vienna  
Department of Water, Atmosphere and Environment

## SUSFISH Sustainable Management of Water and Fish Resources in Burkina Faso

"Aquatic communities, biodiversity and habitat use under the  
respect of human pressures in the Nakambe catchment"

D. Trauner, P. Meulenbroek, S. Stranzl, T. Koblinger  
Dr. A. H. Melcher, Dr. O. Moog, Dr. S. Schmutz

IHG – Institute of Hydrobiology and Aquatic Ecosystem Management, WAU – Department of Water, Atmosphere and Environment, BOKU



# Introduction

Important source of proteins

Diversification + pollution → decrease of diversity + biomass

Fish and benthic invertebrates (BI) are used as bioindicators worldwide

Little is known: species lists for fish vary widely, no determination key for Burkundibe BI



- Guide adapted for fish and BI collection
- Guide as methodology for sampling & water sample collection
- Sampling methods according to scientific interest
- Use for the quality of water
- Use for the quality of the environment
- Use for the control of species of particular importance
- Monitor environmental performance of aquatic ecosystem
- Implementation for Burkundibe Island in Lake Tanganyika

## Methods



## First Results



## Discussion

**Methods**

- Standardized
- Consistent
- Quantitative

Conductivity of fish collection

**Results**

- First results: species lists for fish vary widely
- Species lists for BI are missing

**Biodiversity**

- Little is known: species lists for fish vary widely
- Species lists for BI are missing

**Implementation**

- Key to Burkundibe BI index

**Methods**

- Adapted for fish and BI collection
- Use for the quality of water
- Use for the quality of the environment
- Use for the control of species of particular importance
- Monitor environmental performance of aquatic ecosystem
- Implementation for Burkundibe Island in Lake Tanganyika

**Results**

- First results: species lists for fish vary widely
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**Biodiversity**

- Little is known: species lists for fish vary widely
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## Outlook



# Introduction

Important source of proteins

Overexploitation + pollution -> decrease of diversity + biomass

Fish and benthic invertebrates (BI) are used as bioindicators worldwide

Little is known: species lists for fish vary widely, no determination key for Burkina Faso BI



Goals:

- Create adapted field protocols for sub sahalian areas
- Develop a methodology for sampling: how to sample which waterbody
- Investigate sampling uncertainty (rarefaction curve)
- Describe the spatial species distribution
- Describe types of pressures
- Describe the reaction of aquatic organisms to pressures
- Habitat requirements/preferences of aquatic organisms
- Implementation: fact sheets, knowledge transfer, cooperation

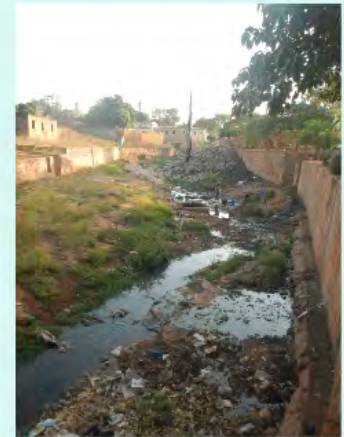
# Introduction

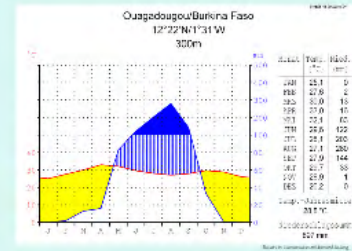
Important source of proteins

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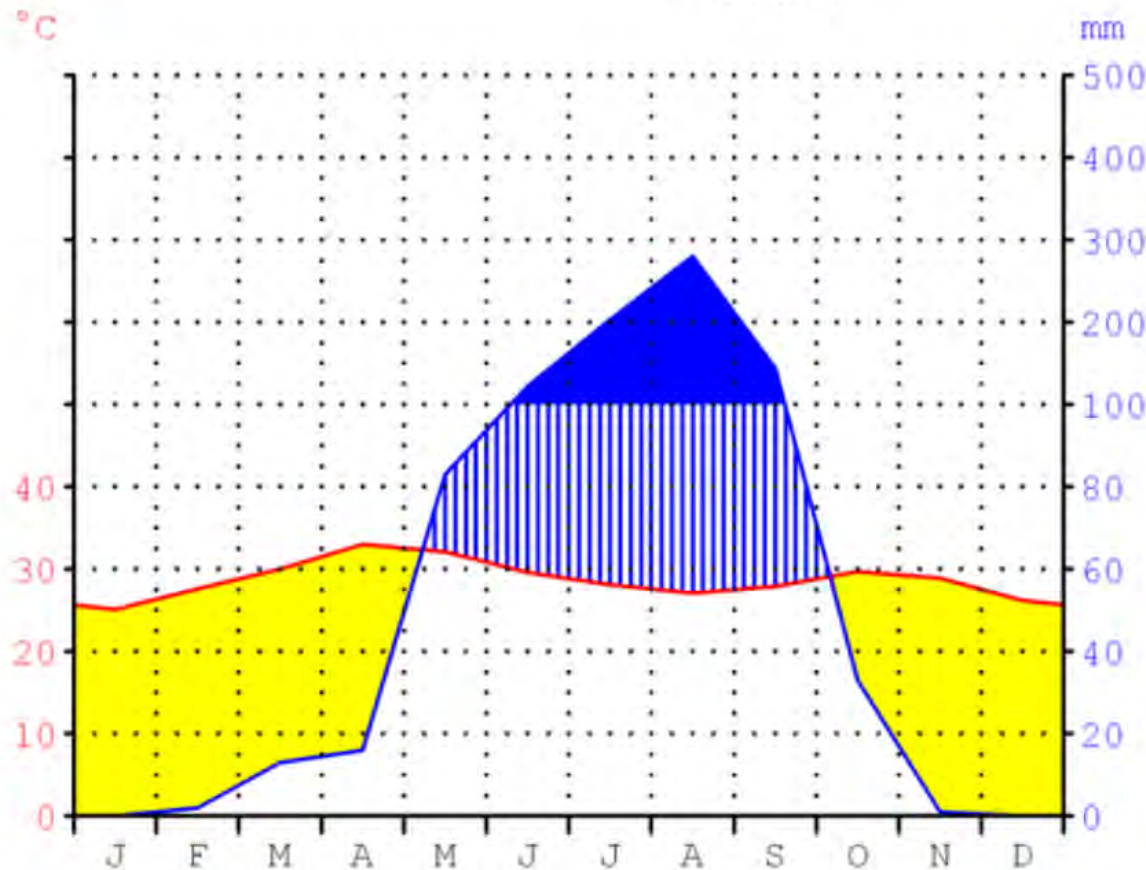
Little is known: species lists for fish vary widely, no determination key for Burkinabe BI





# Ouagadougou/Burkina Faso

12°22'N/1°31'W  
300m



Monat	Temp. (°C)	Nied. (mm)
JAN	25,1	0
FEB	27,6	2
MRZ	30,0	13
APR	33,0	16
MAI	32,1	83
JUN	29,6	122
JUL	28,1	203
AUG	27,1	280
SEP	27,9	144
OKT	29,7	33
NOV	28,9	1
DEZ	26,2	0

Temp.-Jahresmittel  
28,8 °C

Niederschlagssumme  
897 mm

Source: commons.wikimedia.org



## Kougri

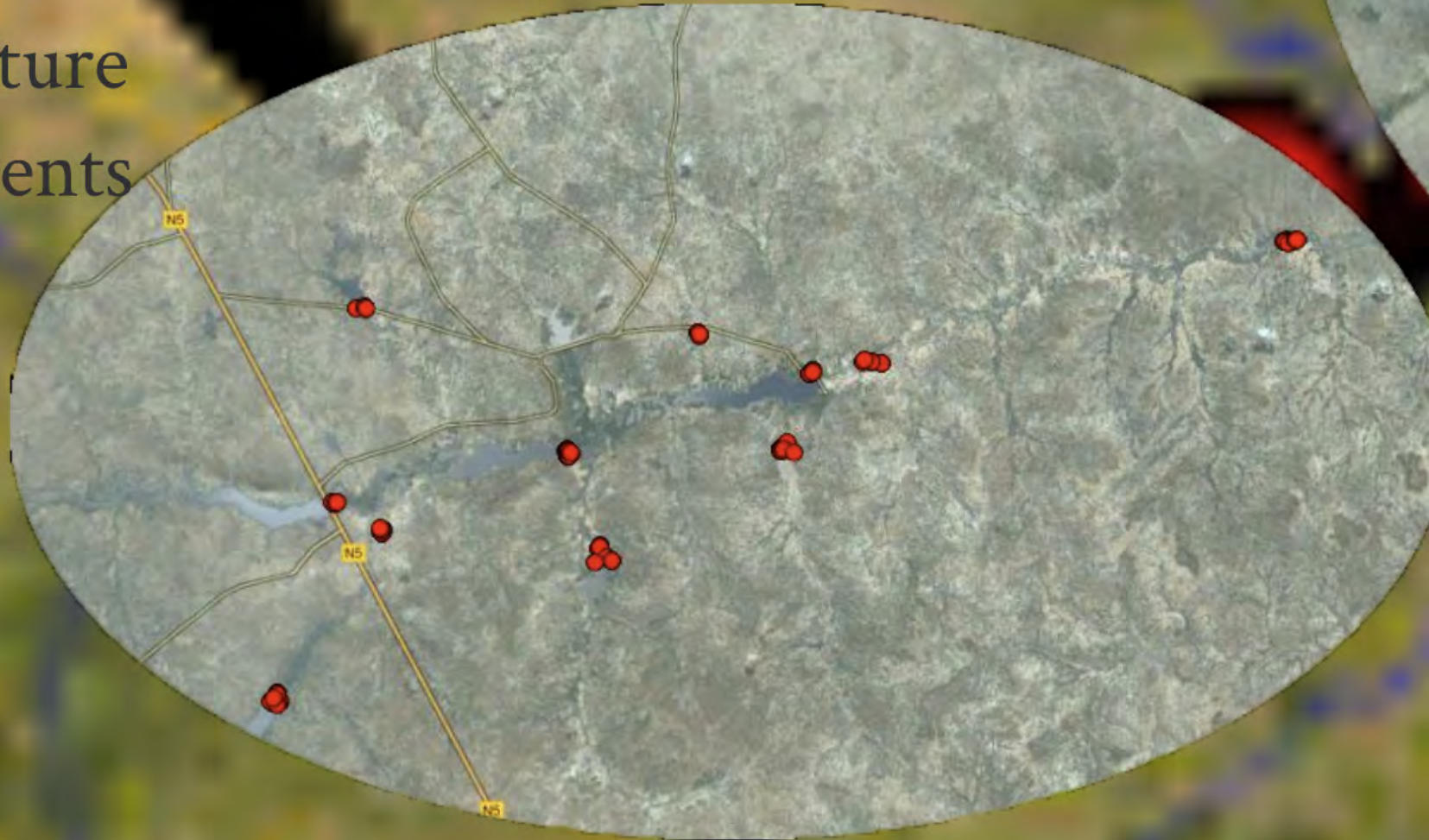
- Free flowing nakambe section
- Agriculture
- Many pressures





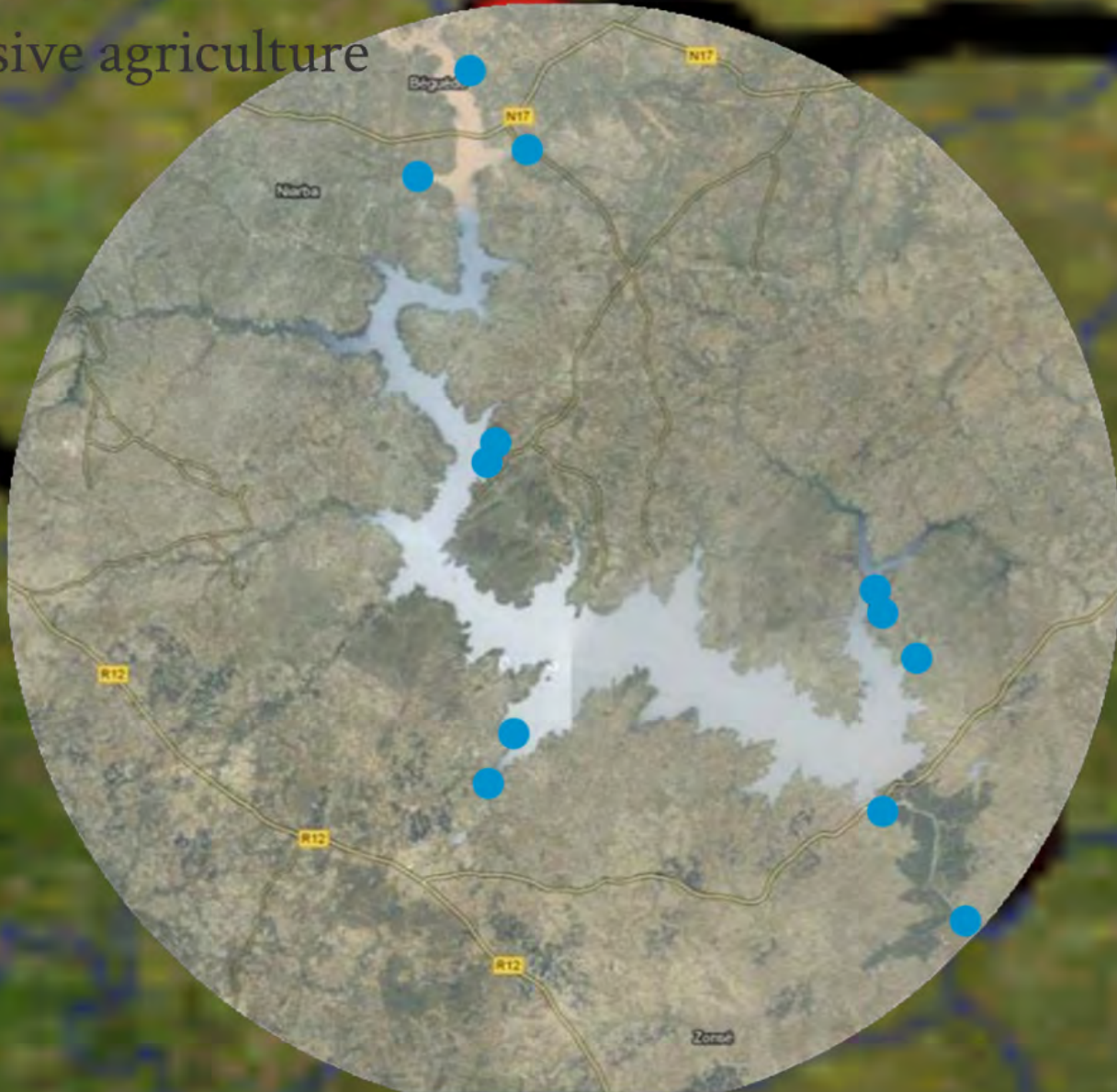
# Koubri

- Tributary to Nakambe
- Highest reservoir density
- Agriculture
- Settlements



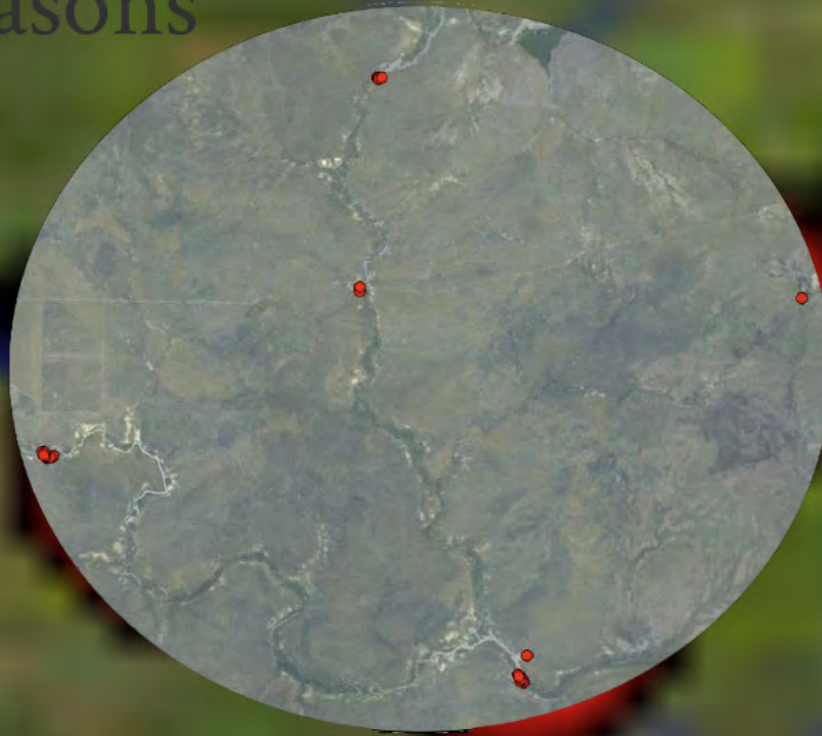
# Bagre

- Largest reservoir
- Blocks Nakambe
- Intensive agriculture



# Nazinga

- protected area
- fishing seasons



## Goals:

- Create adapted field protocols for sub sahalian areas
- Develop a methodology for sampling: how to sample which waterbody
- Investigate sampling uncertainty (rarefaction curve)
- Describe the spatial species distribution
- Describe types of pressures
- Describe the reaction of aquatic organisms to pressures
- Habitat requirements/preferences of aquatic organisms
- Implementation: fact sheets, knowledge transfer, cooperation

# Methods

## Development of a field protocol for Burkina Faso

- Inspection of different areas
- adapted other protocols
- 3 adaptations until final field protocol




## Data analysis

+external Data

- Access
- Excel
- SPSS
- PC-Ord
- Biotic indices





Fishing methods



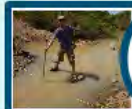
Electrofishing

- 600V
- Anode ring, 30 cm diameter

Castnet

- around 15,2m<sup>2</sup>
- meshsize 2,5cm

Habitat



- Width, depth
- Velocity
- Choriotop in %
- Shading
- Structure

Fish data



- Species name
- Abundance
- Length

Method data

- Fishing method
- Fished area (m<sup>2</sup>)
- Time
- GPS-Coordinates
- Weather

Collected Data: Fish



Physical parameters

- Conductivity
- pH, O<sub>2</sub> (%)
- Temperature

Pressures

- Land use
- Obvious
- Dam

Method data

- MHS handnet 25x25 cm
- meshsize 500 µm
- 20 single sampling units
- 20 pooled sampling units
- field picking + lab



Habitat

- Choriotop
- Waterplants
  - Water salad
  - Water hyacinth
  - Floating leaves
  - Reed



Collected Data: BI

BI data

- Taxa
- Abundance



Data analysis  
+external Data

- Access
- Excel
- SPSS
- PC-Ord
- Biotic indices



### Fishing methods



#### Electrofishing

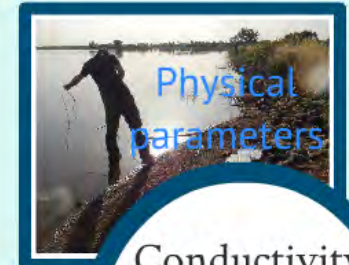
- 600V
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- around 15,2m<sup>2</sup>
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### Method data

Fishing method  
Fished area (m<sup>2</sup>)  
Time  
GPS-Coordinates  
Weather



Conductivity  
pH, O<sub>2</sub> (%)  
Temperature

### Habitat



Width, depth  
Velocity  
Choriotop in %  
Shading  
Structure

### Collected Data: Fish

### Fish data



Species name  
Abundance  
Length

### Pressures

Land use  
Obvious  
Dam

## Fishing methods



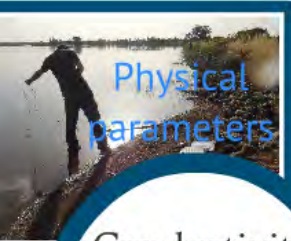
### Electrofishing

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### Physical parameters

Conductivity  
pH, O<sub>2</sub> (%)  
Temperature

MHS handnet 25x25 cm  
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20 pooled sampling units  
field picking + lab



## Habitat

### Collected Data: BI

Choriotop  
Waterplants

- Water salad
- Water haycynth
- Floating leaves
- Reed



## Pressures

Land use  
Obvious  
Dam

## BI data

Taxa  
Abundance



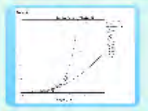
## Data analysis +external Data

- Access
- Excel
- SPSS
- PC-Ord
- Biotic indices

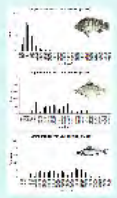
# First Results

## Basic sampling data

	Electric	Cast net
Abundance	8822	9196
Species	66	61
Exclusive species	18	11
Mean total length (mm)	66,95	106,5



## Fish biodiversity

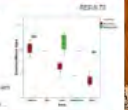


## BI Diversity

- From mid-October to mid-December 2012: 30 000 specimens collected (last peak) in 20 sampling sites in Barfleur Bay.
- According to Collector's expert: 9 NEW SPECIES (Hydracarina, Ephemera, ...)

Sample	RESULTS
Sampling date	28
Abundance	28
Mean length (mm)	28

## BIODIVERSITY

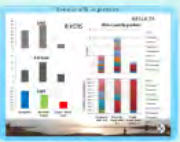
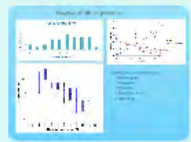


According to Collector's expert (1-2012): 9 NEW SPECIES (Hydracarina, Ephemera, ...)

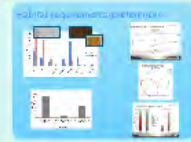
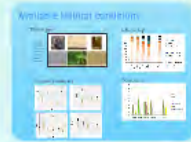
105 BI Taxa, 76 Fish species, NEW SPECIES (COLEOPTERA)

## Pressures

- Pressure categories:
- Pesticides
  - Fertilizers
  - Sewage
  - Noise
  - Urbanization
  - Roadworks
  - Air pollution
  - Global climate change
  - Urbanization

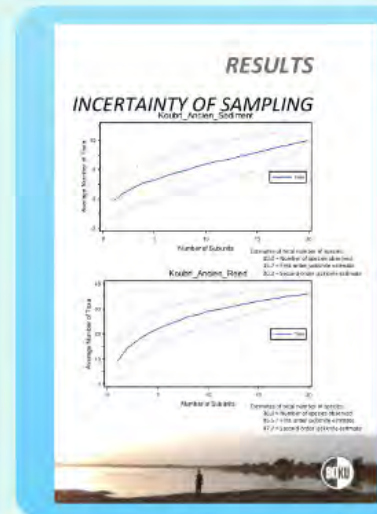
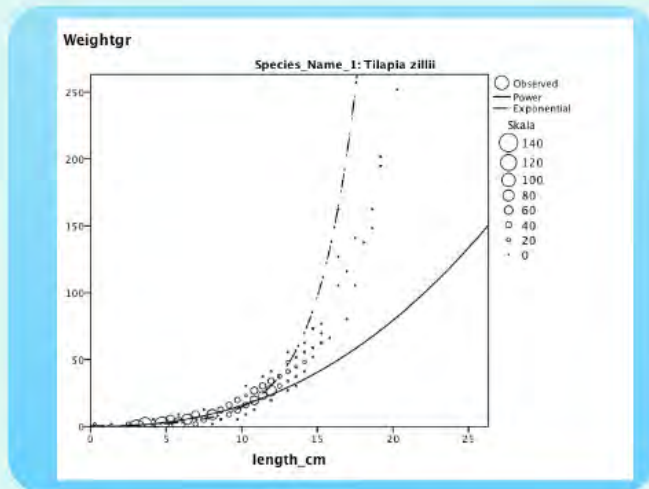


## Habitat



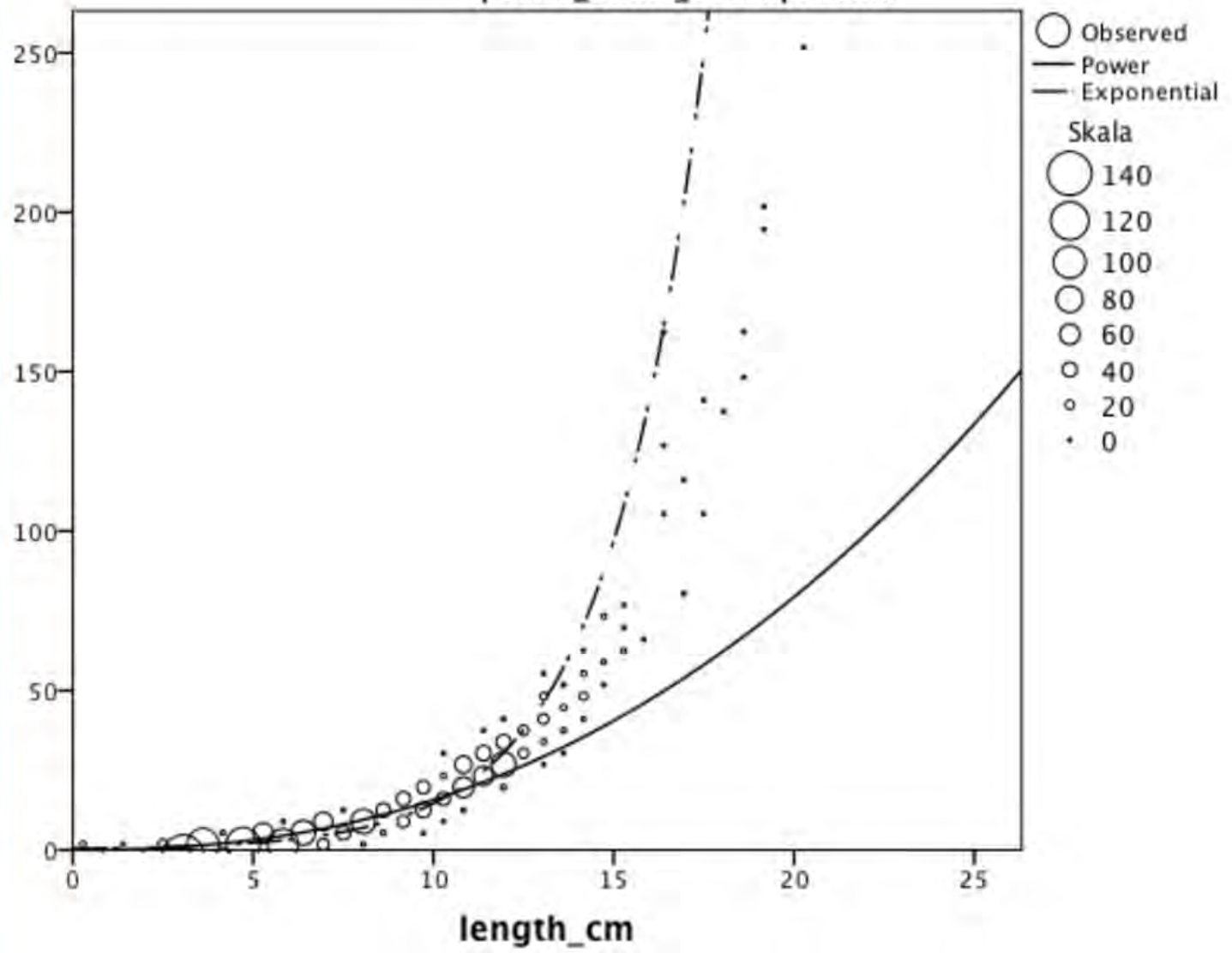
# Basic sampling data

	Electric	Cast net
Abundance	8822	9199
Species	66	61
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Mean total length (mm)	66,95	106,5



# Weightgr

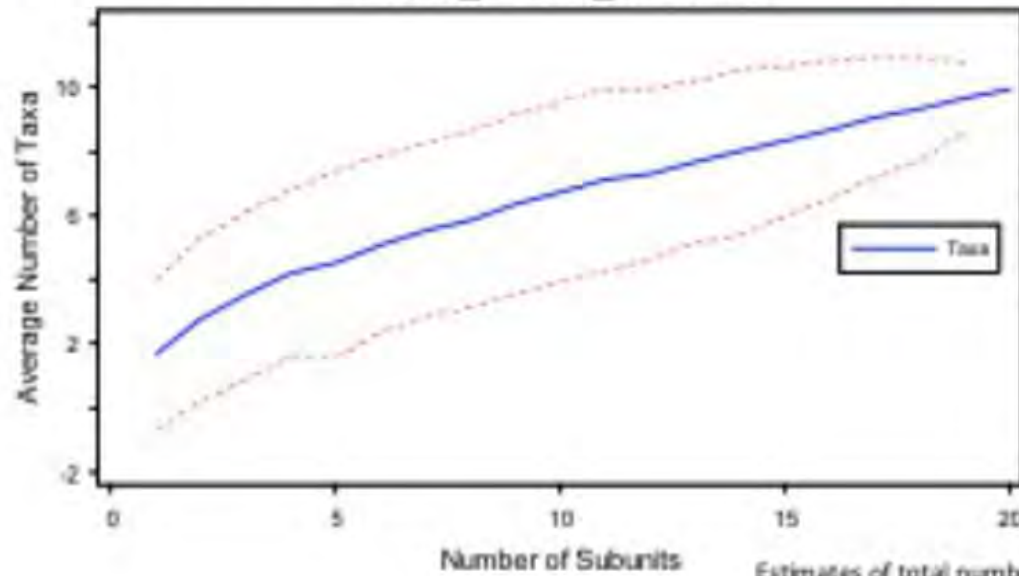
Species\_Name\_1: Tilapia zillii



# RESULTS

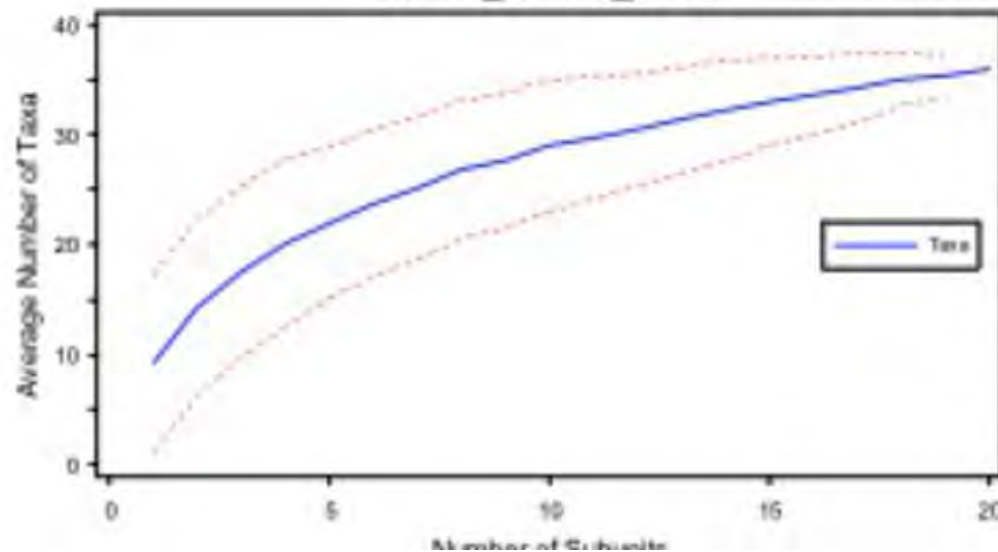
## INCERTAINTY OF SAMPLING

Koubri\_Ancien\_Sediment



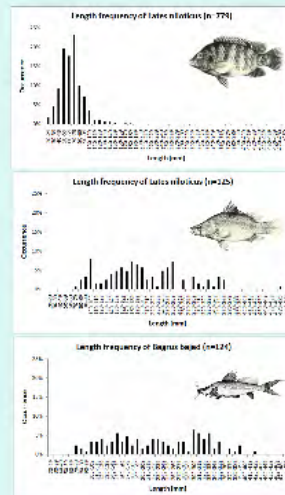
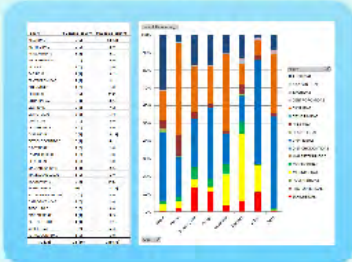
Estimates of total number of species:  
10.0 = Number of species observed  
15.7 = First-order jackknife estimate  
20.2 = Second-order jackknife estimate

Koubri\_Ancien\_Reed





# Fish biodiversity



# BI Diversity

- From mid-October to mid-December 2012: ~20 000 specimen collected (and picked) in 26 sampling sites in Burkina Faso
- According to Coleoptera expert → NEW SPECIES (Hydraenidae, Elmidae, ...more?)

## RESULTS

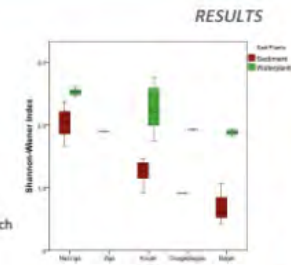
Samples	40
Sampling sites	26
Reservoirs	13
Running waters	13

Habitats	# of samples
Sediment	26
Reed	8
Floating Leaves	1
Water Salad	3
Eichhornia	2



## BIODIVERSITY

Shannon-Wiener Index



According to Coleoptera expert Dr. Jäch → NEW SPECIES (Hydraenidae, Elmidae, ... more?)

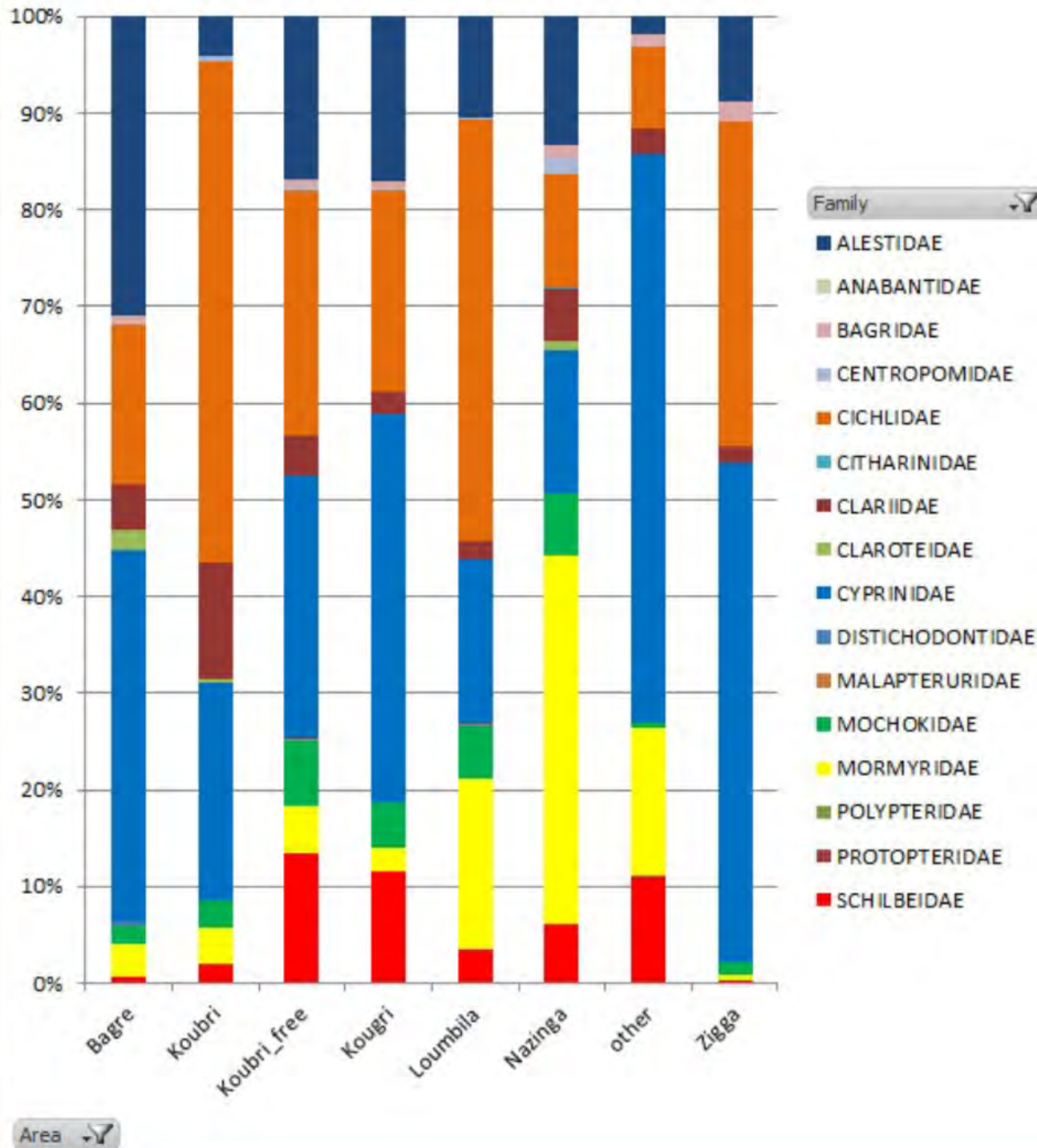
## RESULTS

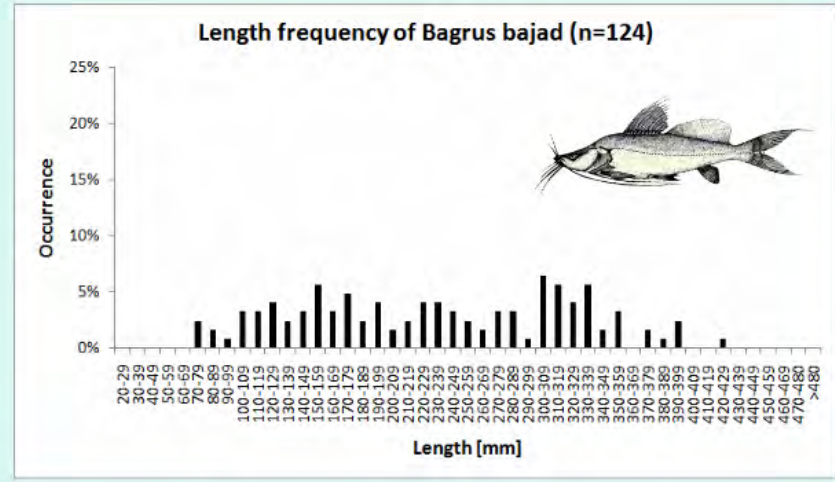
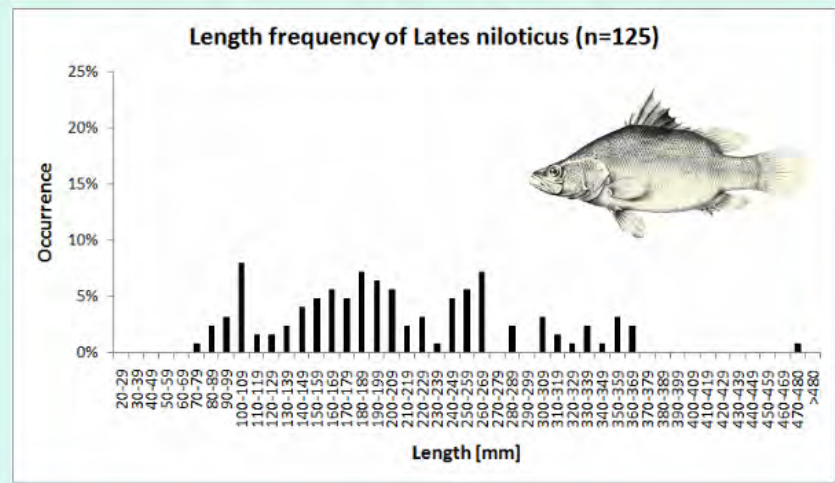
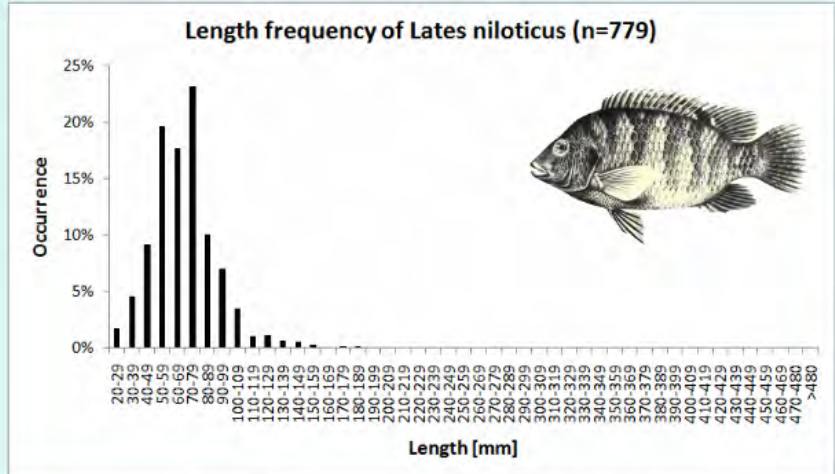


105 BI Taxa, 76 Fish species, NEW SPECIES (COLEOPTERA)

Family	# Genera (caught)	# Species (caught)
ALESTIDAE	5 (5)	14 (12)
AMPHILIIDAE	2 (0)	2 (0)
ANABANTIDAE	1 (1)	2 (1)
APLOCHEILIDAE	4 (0)	5 (0)
ARIIDAE	1 (0)	1 (0)
BAGRIDAE	1 (1)	3 (2)
CENTROPOMIDAE	1 (1)	1 (1)
CHANNIDAE	1 (0)	1 (0)
CICHLIDAE	6 (5)	11 (9)
CITHARINIDAE	2 (1)	3 (1)
CLARIIDAE	2 (2)	7 (2)
CLAROTEIDAE	3 (2)	5 (4)
CLUPEIDAE	2 (0)	2 (0)
CROMERIIDAE	1 (0)	2 (0)
CYPRINIDAE	6 (4)	23 (12)
DISTICHODONTIDAE	5 (1)	8 (1)
ELEOTRIDAE	1 (0)	1 (0)
GYMNARCHIDAE	1 (0)	1 (0)
HEPSETIDAE	1 (0)	1 (0)
MALAPTERURIDAE	1 (1)	2 (1)
MASTACEMBELIDAE	1 (0)	1 (0)
MOCHOKIDAE	2 (1)	16 (7)
MORMYRIDAE	10 (7)	21 (16)
NOTHOBRANCHIIDAE	2 (0)	2 (0)
OSTEOGLOSSIDAE	1 (0)	1 (0)
POECILIIDAE	3 (0)	3 (0)
POLYPTERIDAE	1 (1)	3 (3)
PROTOPTERIDAE	1 (1)	1 (1)
SCHILBEIDAE	3 (2)	5 (3)
TETRAODONTIDAE	1 (0)	1 (0)
<b>30 (16)</b>	<b>72 (36)</b>	<b>149 (76)</b>

Sum of Abundance\_1





- A...
- C...
- (H...
- ...



BIODIVE

Shannon  
Index

According to  
Coleoptera

# BI Diversity

- From mid-October to mid-December 2012: ~**20 000 specimen** collected (and picked) in **26** sampling sites in Burkina Faso
- According to Coleoptera expert  
→ **NEW SPECIES**  
(Hydraenidae, Elmidae, ...more?)

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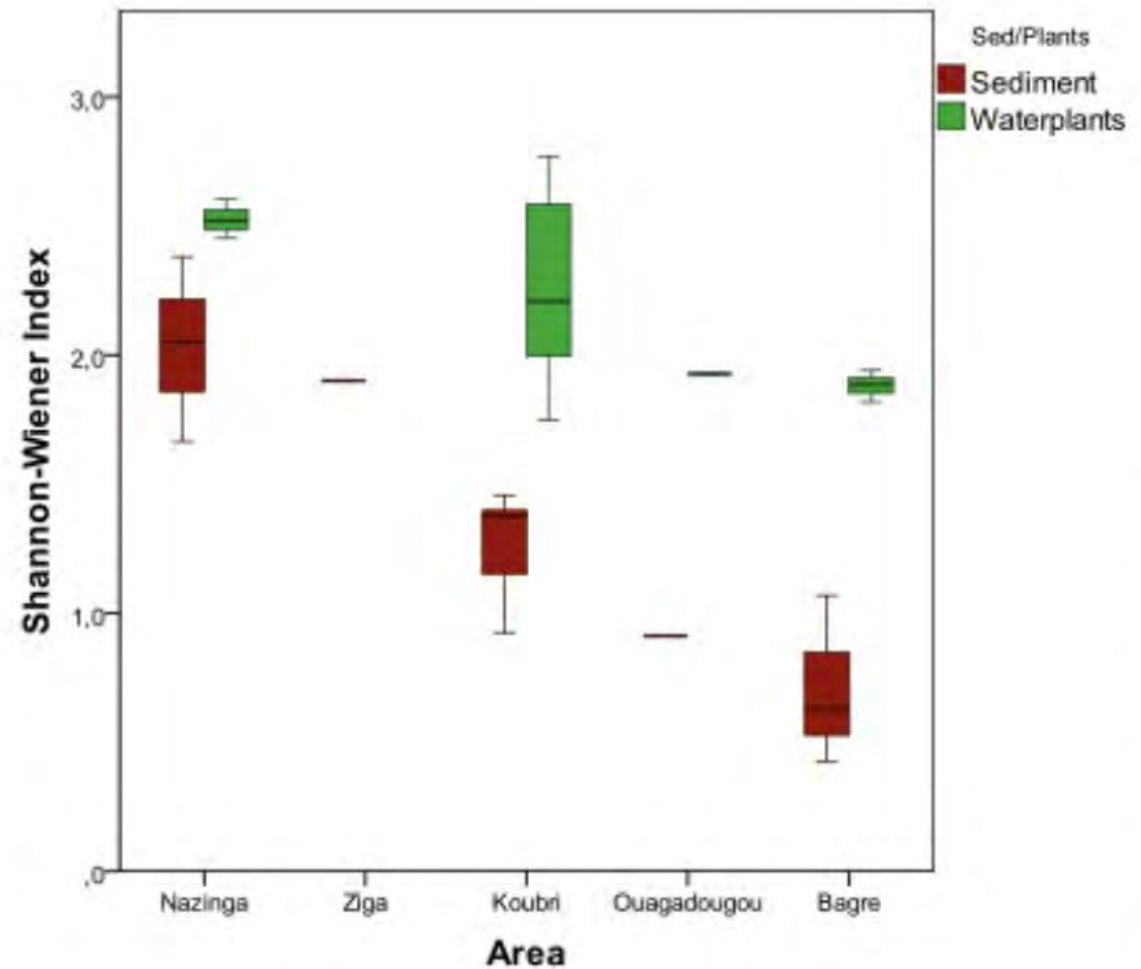


# RESULTS

## BIODIVERSITY

Shannon-Wiener  
Index

According to  
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→ NEW SPECIES  
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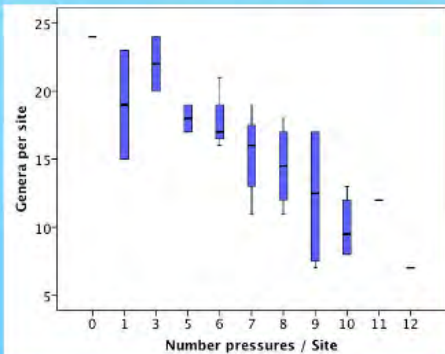
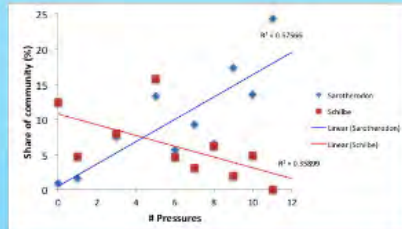
# Pressures

## Pressure categories

- Fishing
- Deforestation
- Roads
- Water abstraction
- Dams
- Channalisation
- Sandmining
- Nutrient input
- Washing/pollution
- Agriculture (subcategories)
- Urbanisation

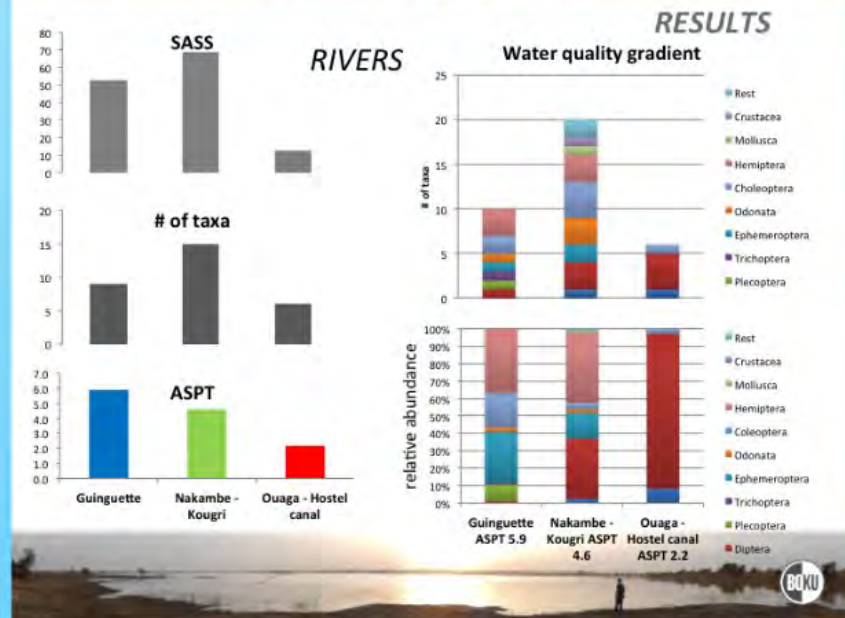


## Reaction of fish on pressures



Exclusively in low pressure sites  
 Auchenoglanis  
 Ctenopoma  
 Citharinus  
 Heterobranchus  
 Hydrocynus

## Reaction of BI on pressures



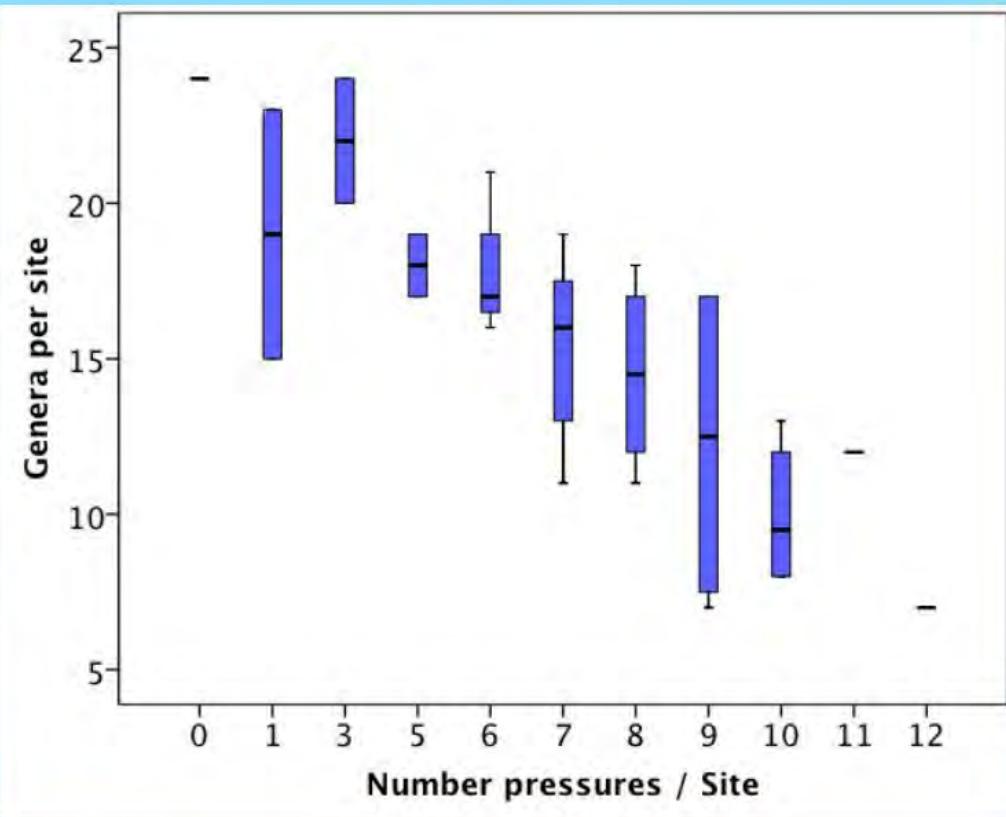
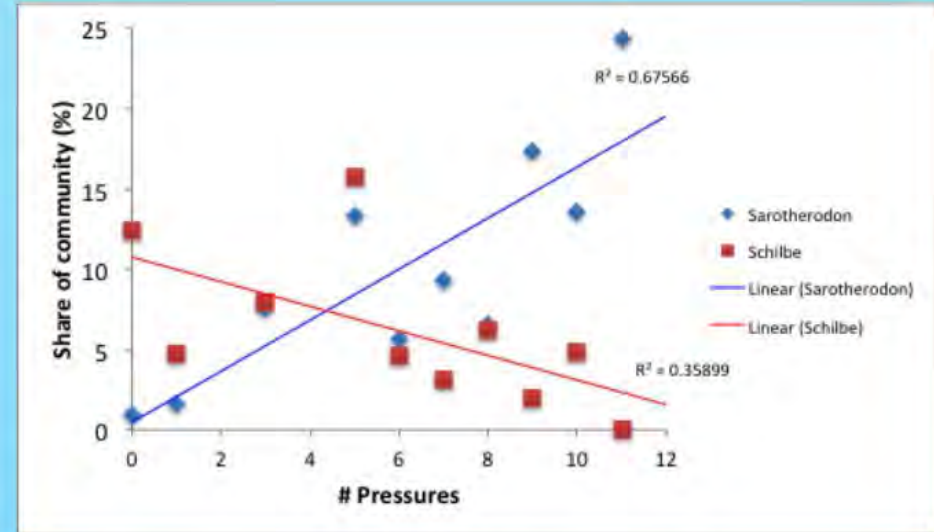
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# Reaction of fish on pressures



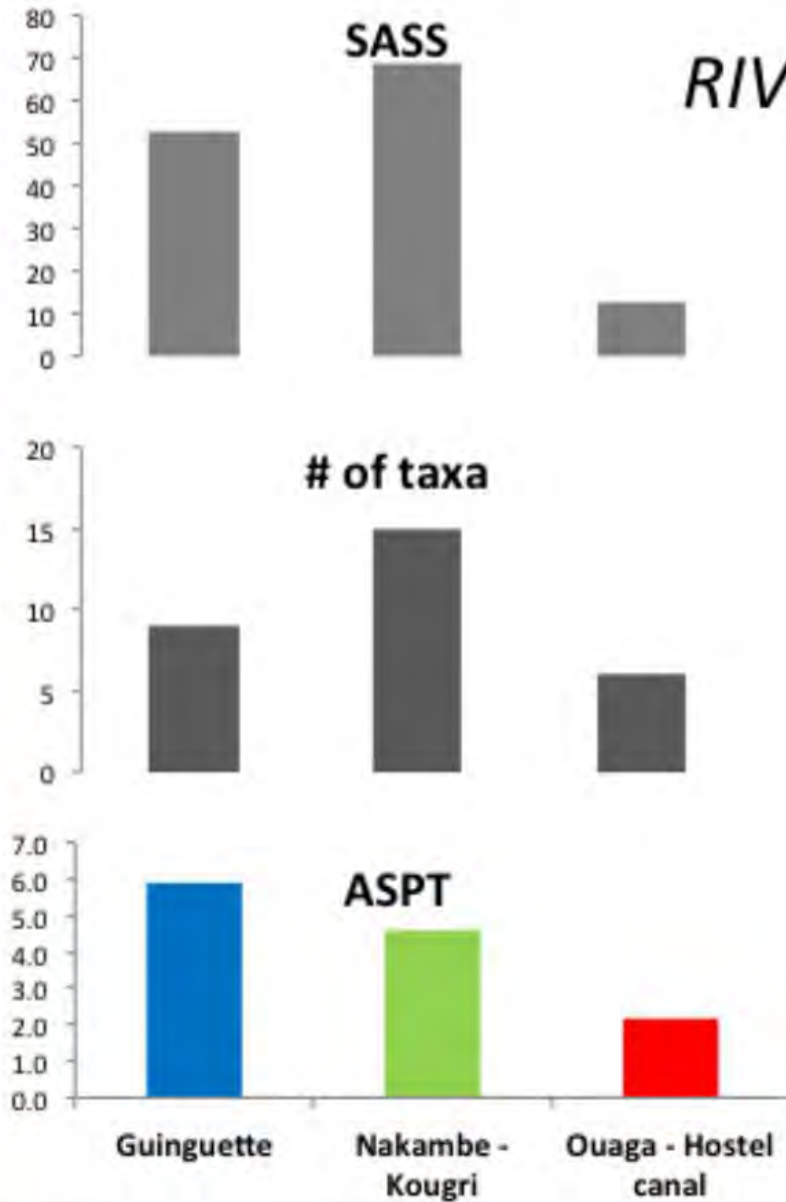
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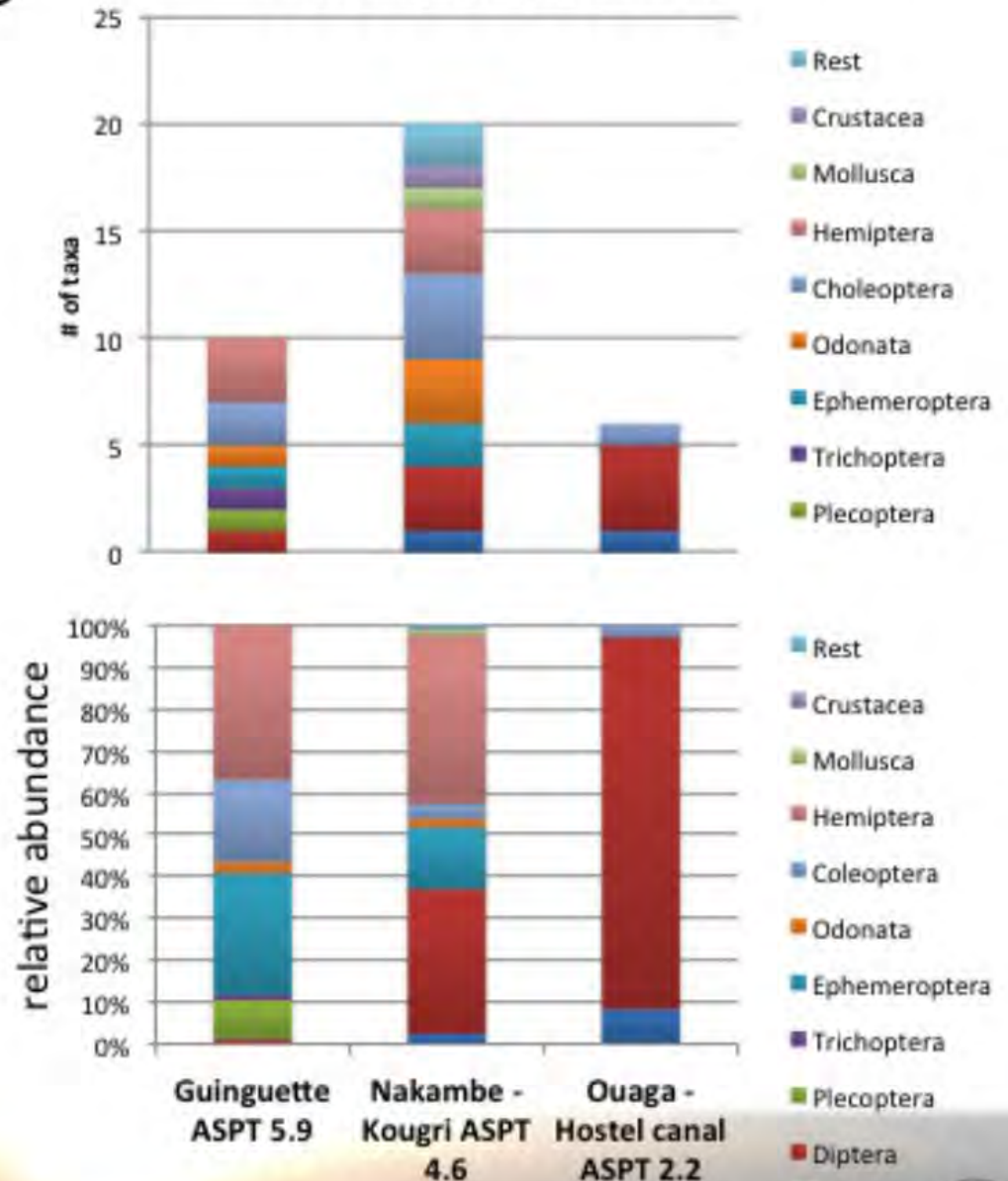
# Reaction of BI on pressures

## RIVERS



## RESULTS

### Water quality gradient



# Habitat

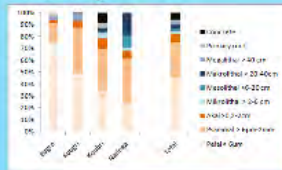
## Available Habitat conditions

### Watertypes

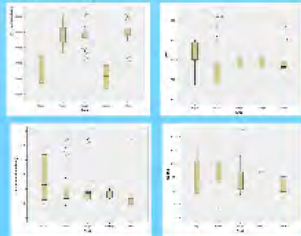
- Spillway
- Reservoir
- Discharge
- Channel
- Strait
- Pond
- Substrata



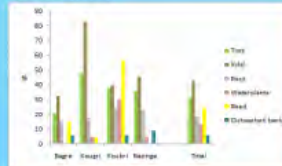
### Choriotop



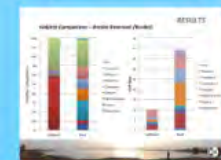
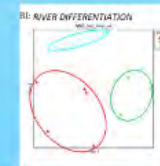
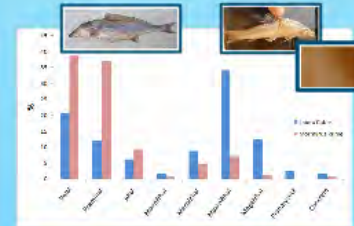
### Physical paramters



### Structures



## Habitat requirements/preferences:



# Watertypes

Spillway

Reservoir

Dissipation

Channel

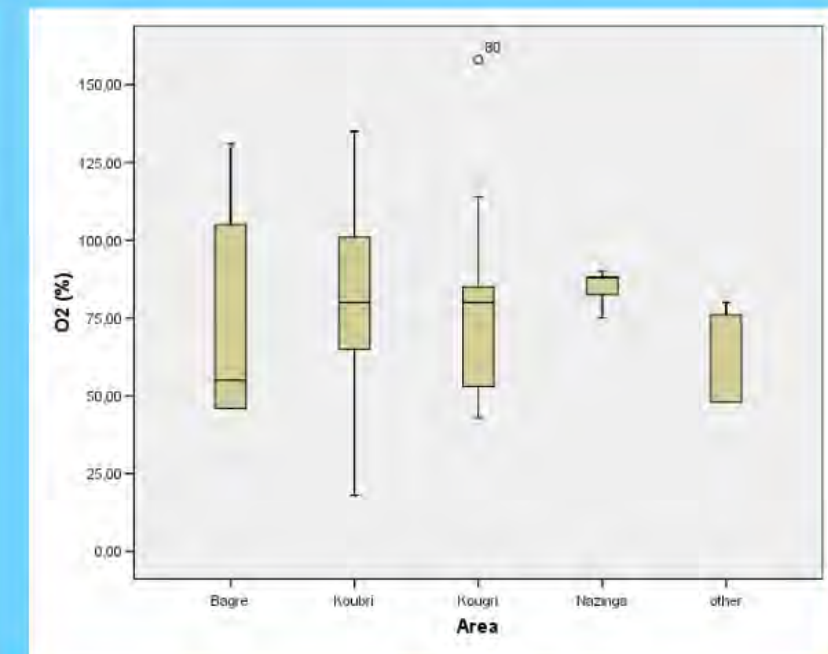
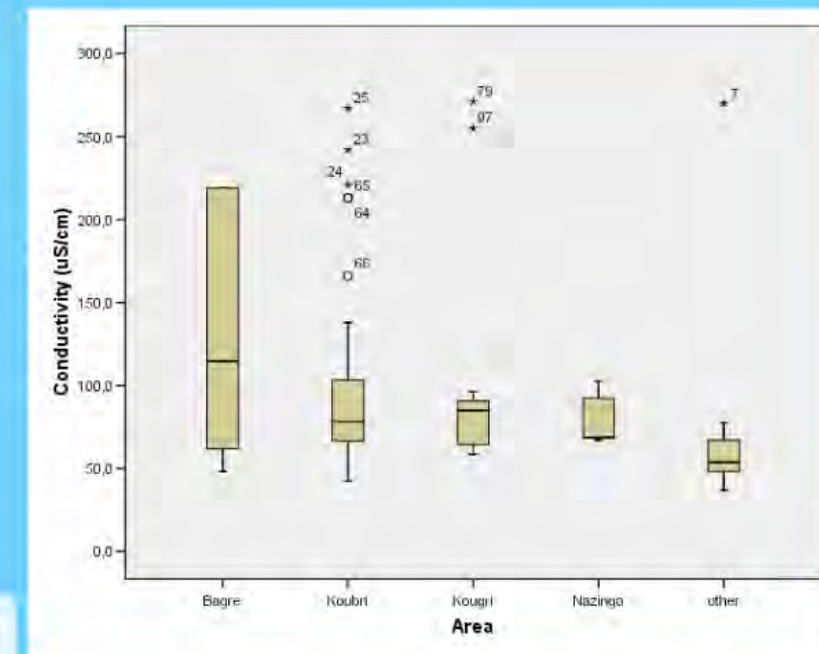
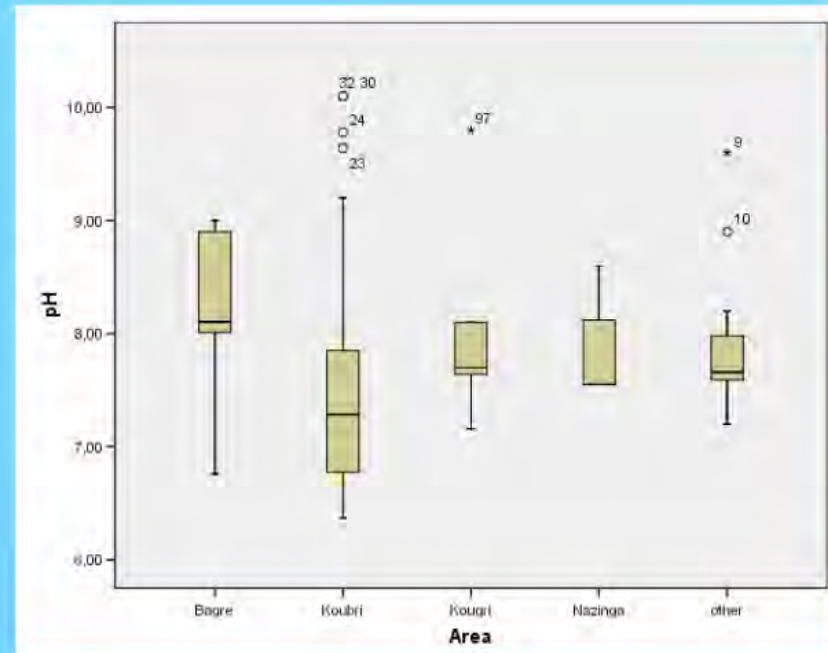
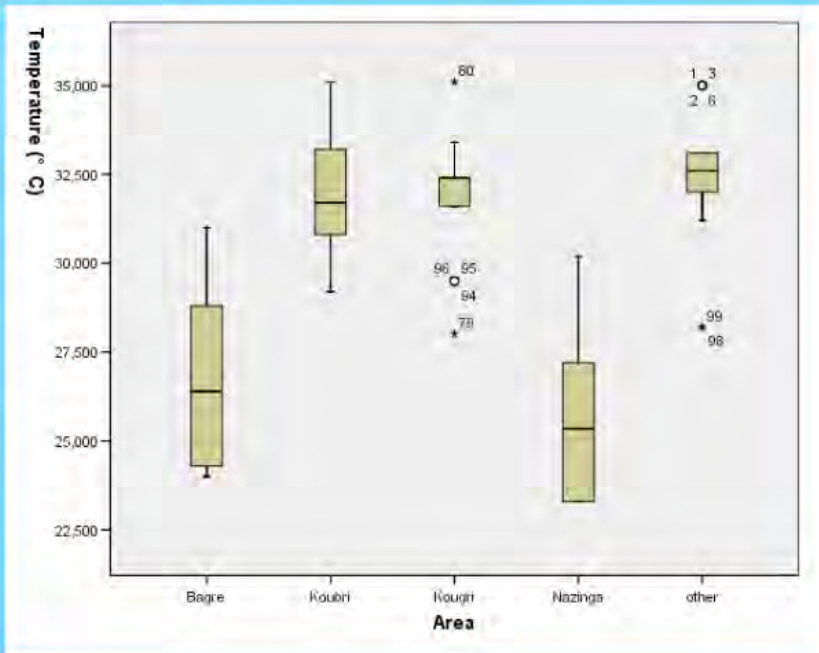
Streams

Ponds

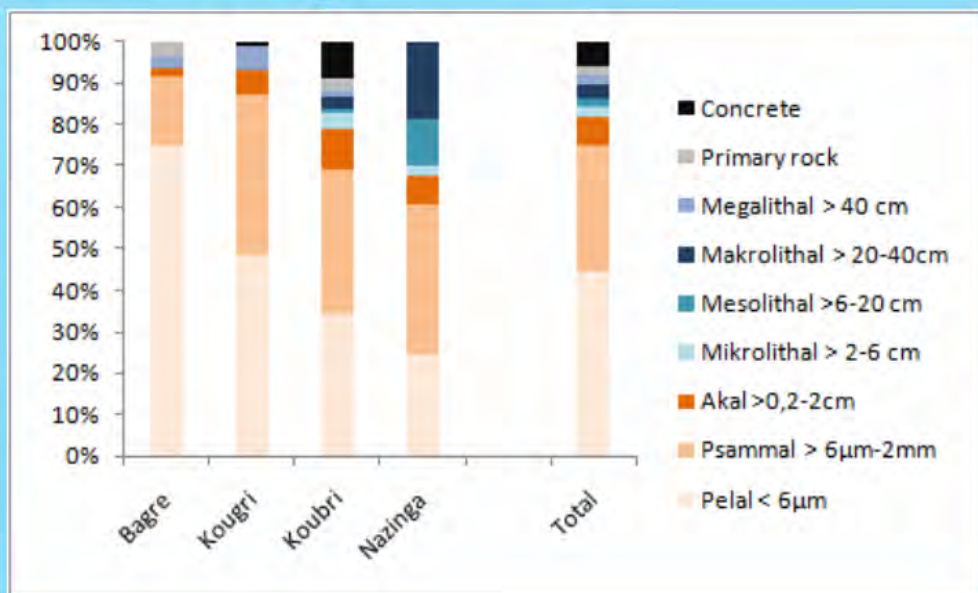
Sidearms



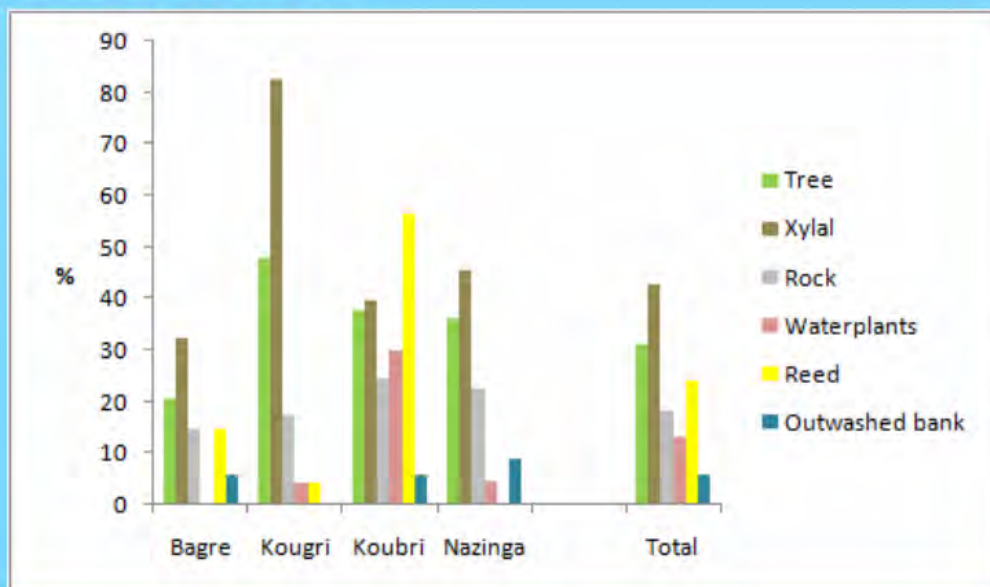
# Physical paramtters



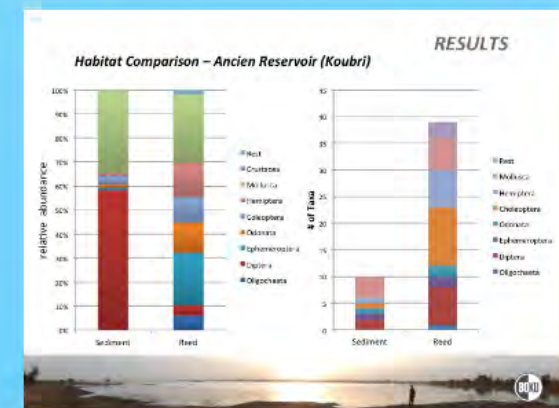
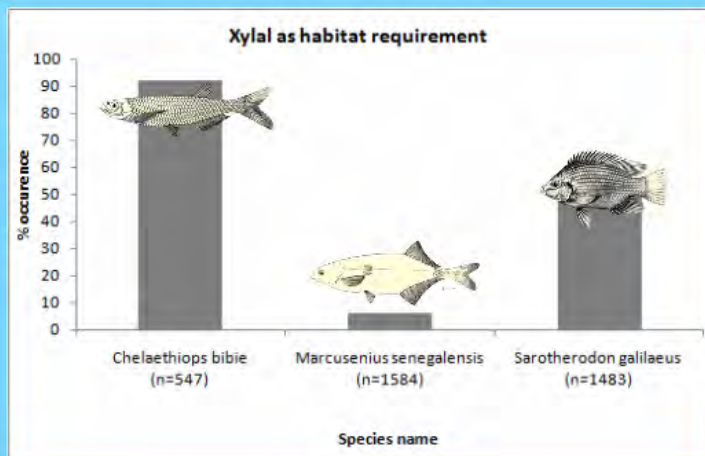
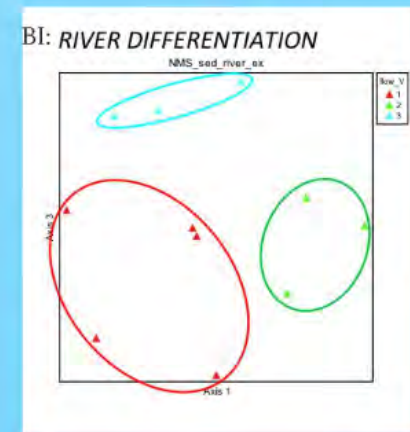
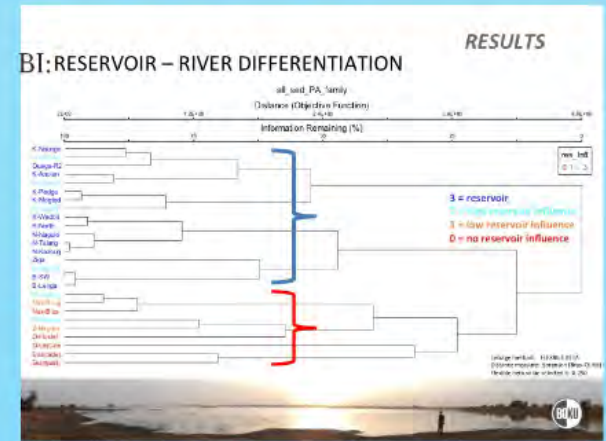
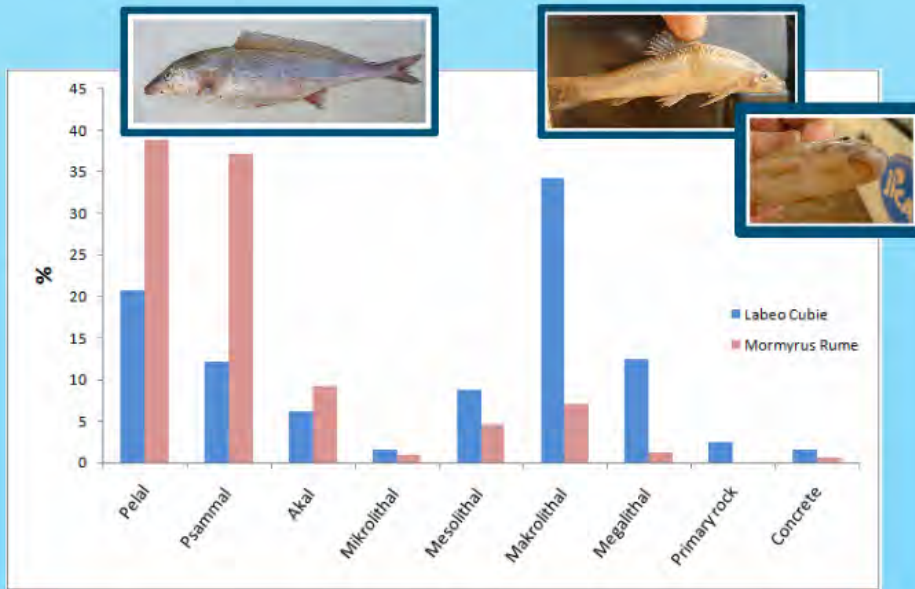
# Choriotop



# Structures

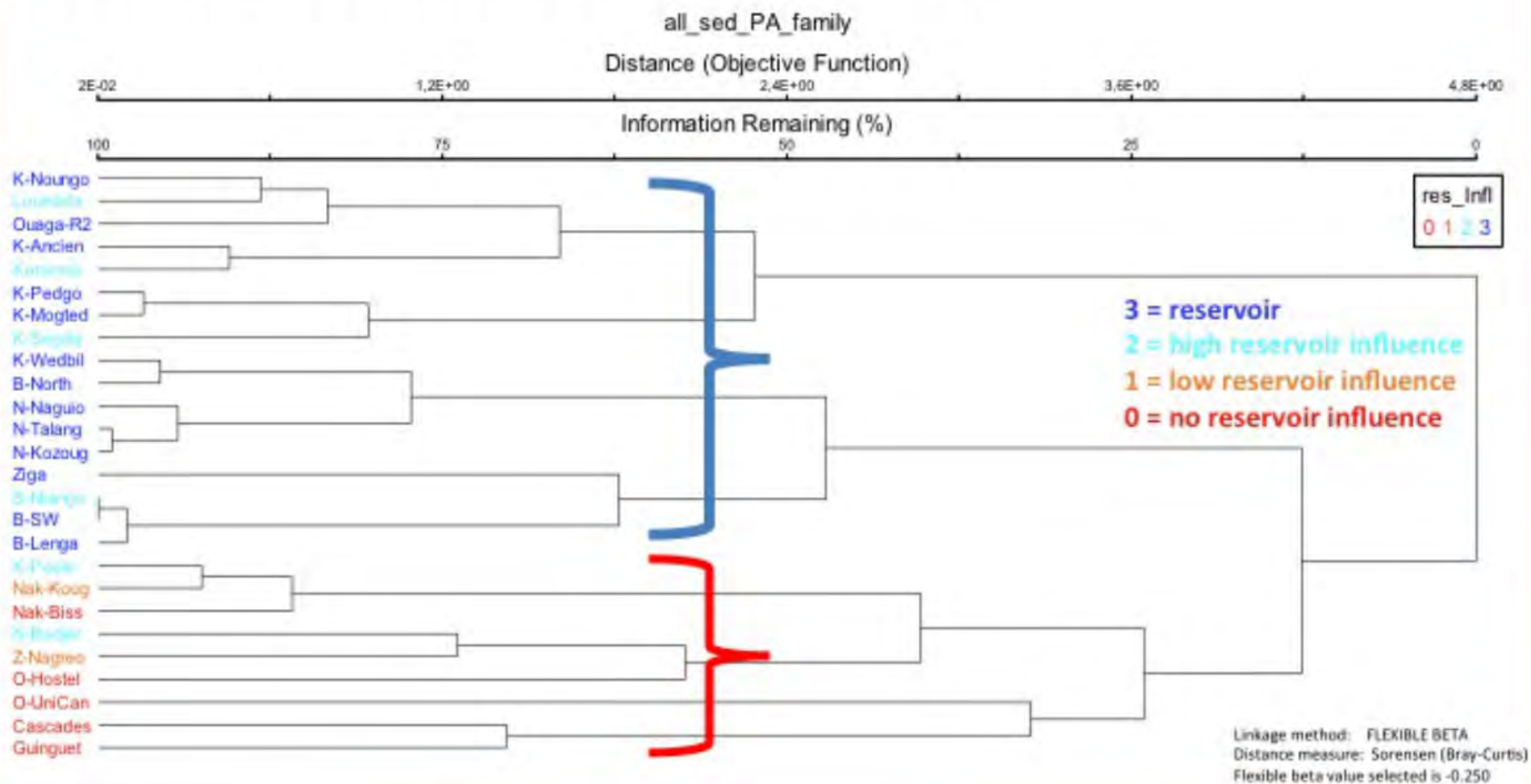


# Habitat requirements/preferences:



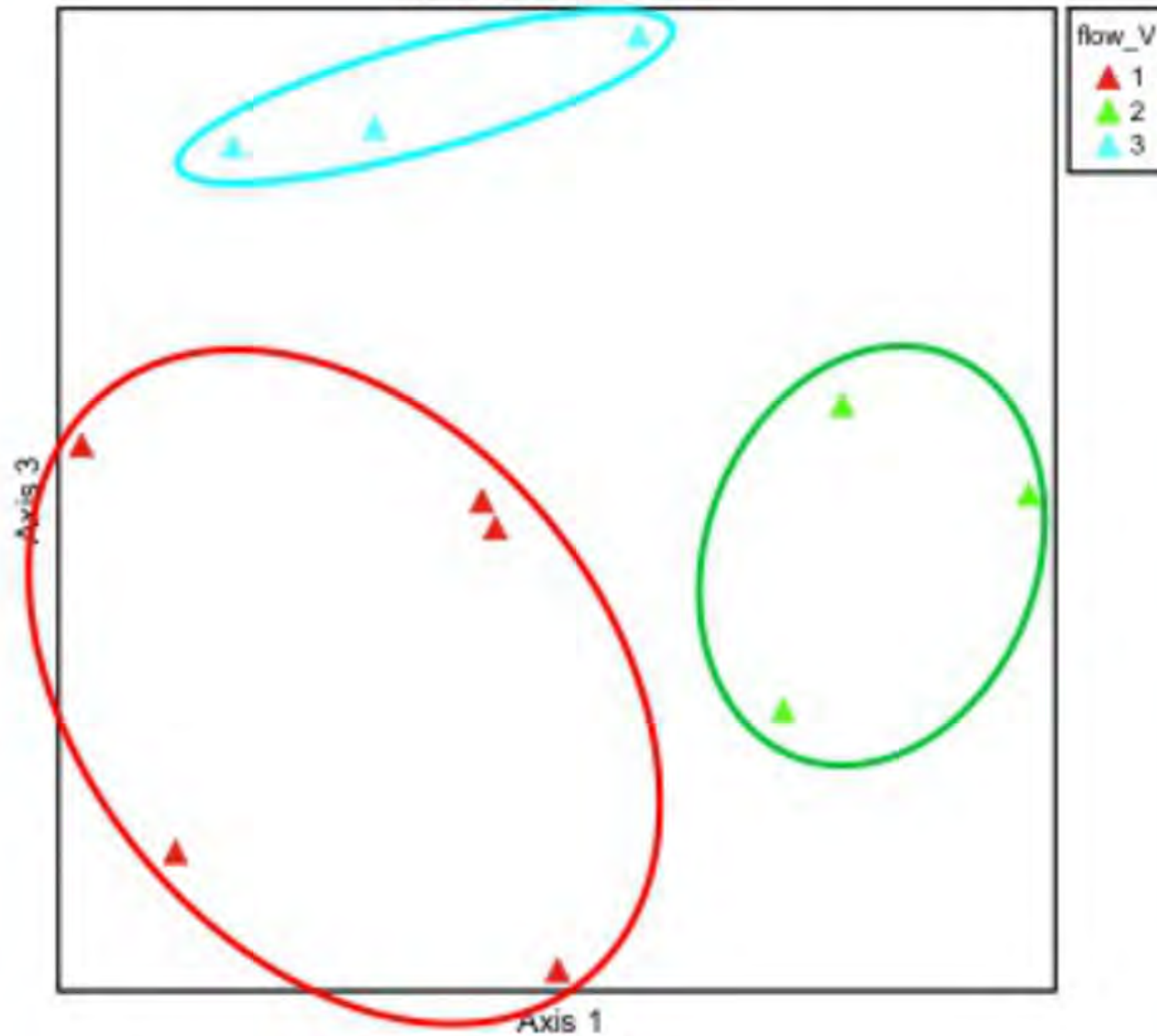
# RESULTS

## BI: RESERVOIR – RIVER DIFFERENTIATION



# BI: RIVER DIFFERENTIATION

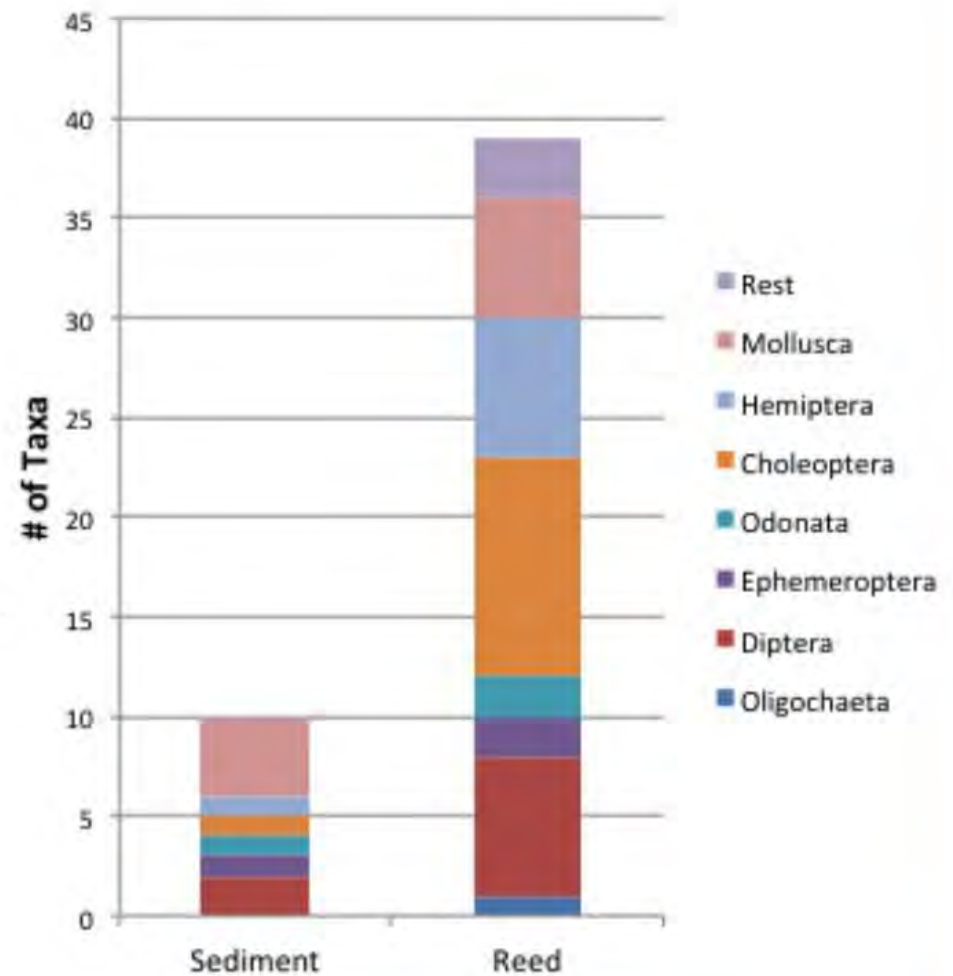
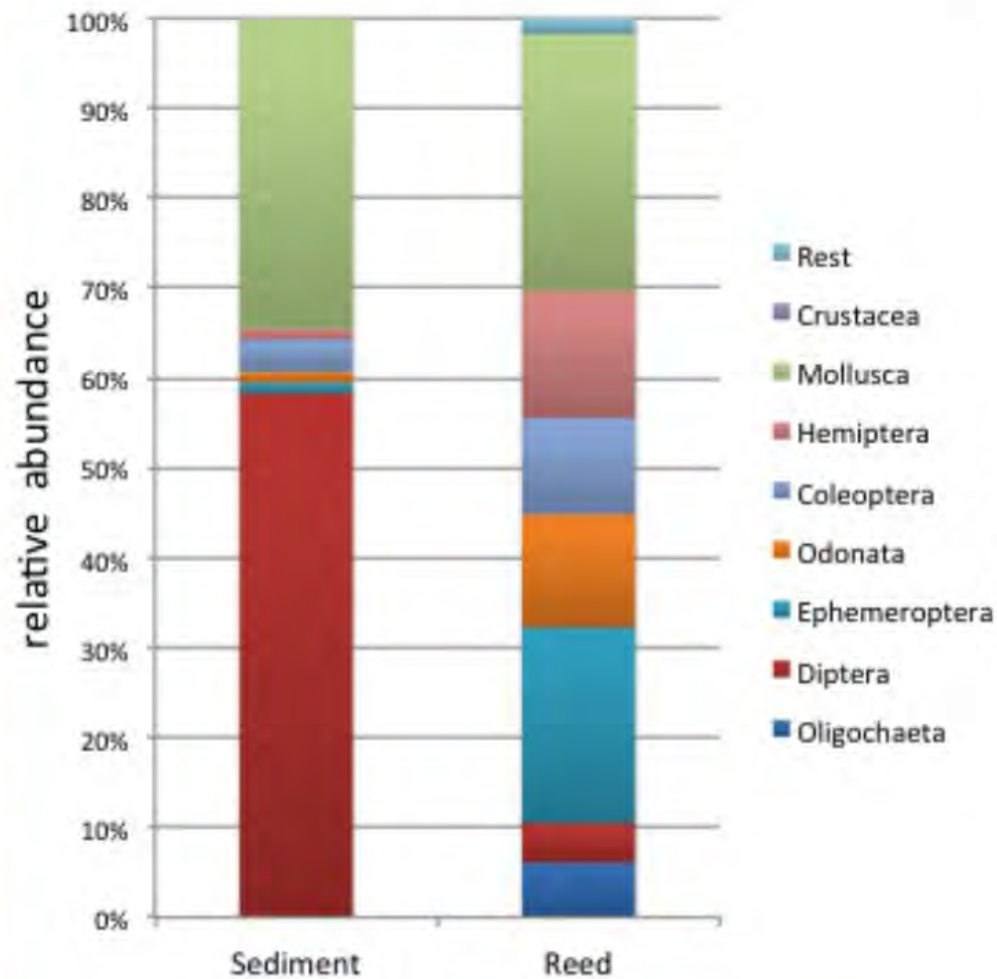
NMS\_sed\_river\_ex





# RESULTS

## Habitat Comparison – Ancien Reservoir (Koubri)



# Discussion

## Methods

Sampling challenges:

- Determination
- Quantitative sampling

Combination of fishing methods

## Habitat

- Preferences vs. minimum requirements/tolerances
- Species show different habitat requirements

## Biodiversity

- No one knows which species really occur
- Different reproduction strategies - length frequencies

## Methods

Austrian MHS sampling method not applicable  
Uncertainty of habitat availability (waterplants)

## Habitat

- Reservoirs discriminate from running waters
- Waterplants exhibit higher taxa richness + diversity
- Waterplants give a clearer species composition picture after fewer sampling units

## Biodiversity

Further species determination by experts

## Pressures

- Human impact have a significant influence
- Multiple stressors
- Indicator Taxa
- Reaction to agricultural landuse
- BI: SASS needs to be adapted

## Implementation

- Result for Burkinabe PhD students

# Results: FISH

## Methods

Sampling challenges:

- Determination
- Quantitative sampling

Combination of fishing methods

## Habitat

- Preferences vs. minimum requirements/tolerances
- Species show different habitat requirements

## Biodiversity

- No one knows which species really occur
- Different reproduction strategies - length frequencies

## Pressures

- Human impact have a significant influence
- Multiple stressors
- Indicator Taxa
- Reaction to agricultural landuse
- BI: SASS needs to be adapted

## Implementation

- Result for Burkinabe PhD students

# Results: Benthic invertebrates

## Methods

Austrian MHS sampling method not applicable  
Uncertainty of habitat availability (waterplants)

## Pressures

- Human impact have a significant influence
- Multiple stressors
- Indicator Taxa
- Reaction to agricultural landuse
- BI: SASS needs to be adapted

## Habitat

- Reservoirs discriminate from running waters
- Waterplants exhibit higher taxa richness + diversity
- Waterplants give a clearer species composition picture after fewer sampling units

## Biodiversity

Further species determination by experts

## Implementation

- Result for Burkinabe PhD students

# Outlook



## Outlook and further tasks :

- Analyse the effects of the specific stressors on the taxa composition
- Identify sensitive taxa
- Extend statistical methods
- Integration of physico-chemical parameters in pressure analysis
- Implementation into assessment methods for ecological status of Burkinabe waterbodies
- Make recommendations for conservation

# Thanks for your attention!

with gratitude for Austrian Development Cooperation

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appear

BOKU

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**SUSFISH**  
**Sustainable Management of Water and Fish Resources in Burkina Faso**

"Aquatic communities, biodiversity and habitat use under the respect of human pressures in the Nakambe catchment"

D. Trauner, P. Meulenbroek, S. Stranzl, T. Koblinger  
Dr. A. H. Meichen, Dr. D. Mosog, Dr. S. Schmitz

BHG – Institute of Hydrobiology and Aquatic Ecosystems Management, WAU – Department of Water, Atmosphere and Environment, BOKU

introduction	
Methods	
First results	
Discussion	
Outlook	