

Chapter 6: The potential influence of fluvial sediments on rock-dwelling fish communities

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Introduction

In Malawi, the increasing demographic pressure (Ferguson et al. 1993, Kalipeni 1996) has recently accelerated the unsustainable land use practices around the lakeshore and its catchments. As a result of deforestation, burning of vegetation, destruction of wet lands in the catchments for agricultural purposes and the cultivation of marginal areas such as steep slopes of hills (Mkanda 1999), massive quantities of sediment eroded from clear-cut watersheds are discharged in the rivers and eventually in the lake (Bootsma & Hecky 1993). The negative impact of excess sedimentation and water turbidity on the diversity and ecology of aquatic communities has been reported for other Great Lakes (Waters 1995, Evans et al. 1996) and Lake Tanganyika particularly (review by Patterson & Makin 1998). In Lake Tanganyika, species richness of crustacean ostracodes was found much lower at highly disturbed sites than at less disturbed sites, reductions ranging from 40 to 62%. The same pattern, though not statistically tested, was observed for fish, with reductions in species richness ranging from 35 to 65% at highly disturbed sites (Cohen et al. 1993a, Cohen et al. 1996). Lower fish diversity was also reported in areas that have become turbid as a result of recent eutrophication in Lake Victoria, where increased turbidity was recognised to be partly responsible for the decline in cichlid diversity (Seehausen et al. 1997). In Lake Malawi, the impact of sediment discharge is not yet permanent and remains associated to the rainy season. However, intensification of unsustainable land use practices increases the sediment loads and is cause of major concern (Bootsma & Hecky 1993). The limnology team of the SADC/GEF Project identified the steadily increasing sediment and nutrient loads arriving both from rivers and atmosphere as the main threat to the water quality and therefore to the stability of the lake ecosystem as a whole (Bootsma & Hecky 1999). As an example, within three days following a strong rain event in February 1998, the Linthipe River, located in the highly populated southern part of the lake, delivered about 700 000 tonnes of suspended sediment to Lake Malawi (McCullough 1999). Much of the suspended river load is made of sand and coarse silt which settled out quickly (McCullough 1999). Despite the rapid deposition of most of these sediments, from January to March-April, a sediment plume settles more or less permanently, depending on wind and currents, around the Maleri Islands in front of the river mouth. Among the potential effects of increased sediment loads on aquatic communities (listed in Patterson & Makin 1998), the reduction of light penetration affecting photosynthetic rates or sexual mate choice (Seehausen et al. 1997), the reduction of habitat complexity and destruction of spawning grounds are of direct importance for fish (Waters 1995, Evans *et al.* 1996, Lévêque 1997). As an example, over-fishing and siltation resulting from deforestation have strongly diminished the abundance of potadromous fish species in Lake Malawi (Tweddle 1992, Turner 1994b). For the littoral rocky shore, which food web is based on benthic algae growing on rocks (Worthington & Lowe-McConnell 1994), the blanketing of benthic algae by deposited sediments primarily affects the specialised aufwuchs eaters (Patterson & Makin 1998). Lake Malawi rock-dwelling *mbuna*, whose communities directly rely on the algal carpet covering the rocks (Fryer 1959, Ribbink et al. 1983, Marsh & Ribbink 1986, Reinthal 1990) and whose mobility and migration capacity are very restricted (Ribbink et al. 1983, McElroy & Kornfield

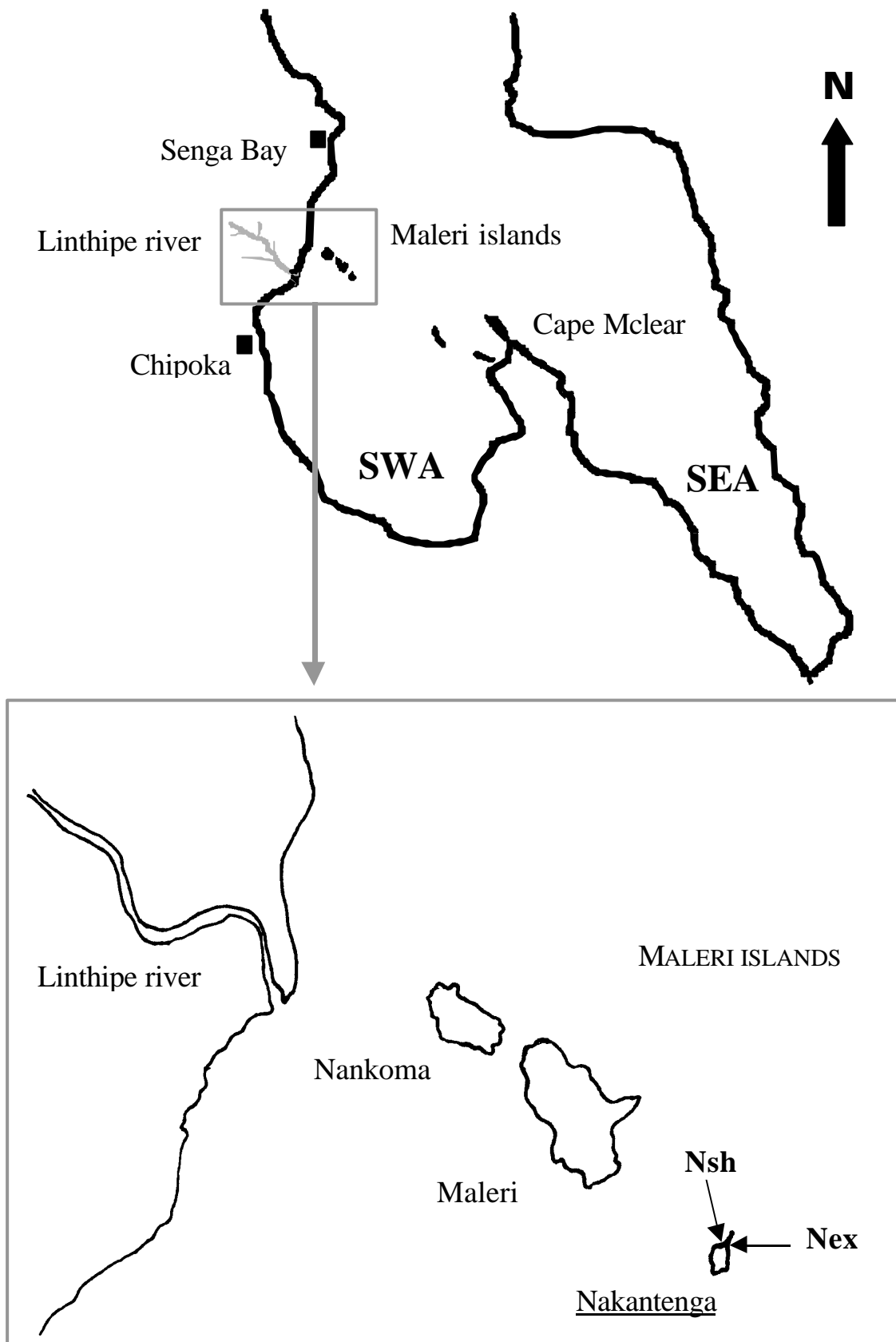


Figure S1. Southern Lake Malawi, with a detail of the Linthipe river delta and the Maleri islands. Arrows indicate the two sampling sites on Nakantenga island, Nsheltered (Nsh) and Nexposed (Nex). Detailed region redrawn from P. Cooley (1999).

1990, Van Oppen et al. 1997) should therefore be directly impacted by the increasing sediment discharges. Ribbink et al (1983) found a mantle of mud was deposited by plumes on the rocks of the Maleri Islands and postulated that it would affect the fishes access to benthic algae. Occasional observations of fish migrations from deep water to the shallows in the rocky shores of the Maleri Islands when the sediment plume was settled were reported (H. Bootsma, pers. com.). During the plume influence, the light penetration is greatly reduced and affects the benthic algal productivity on which most of the *mbuna* depend. Higgins et al. (1999) indicated how this would cause the fish to move upwards to the shallows to compensate for the shortage of food in the deeper waters. The present study, carried out in collaboration with the limnology team of the project, was designed to test for that hypothesis and to monitor the potential influence of suspended sediments on the diversity, abundance, condition and some life history traits of rock-dwelling fish communities.

Material and methods

The rainy season in the Lake Malawi/Nyasa basin usually starts in November and ends in March (Eccles 1974, Ribbink 1994). In order to assess the potential influence of suspended sediment on rock-dwelling fish communities, we decided to sample during undisturbed condition (i.e. before the rains), during the disturbed situation (i.e. the rainy season) and after a few months of recovered undisturbed situation (i.e. after the end of rains). Hence, from October 1998 to May 1999, 2 sites impacted by fluvial sediments and 2 control sites were sampled monthly.

The impacted sites were located on Nakantenga Island (Figure S1), off the Linthipe river mouth. The Linthipe is the largest river of the southern part of the lake and its catchment is one of the most densely populated around the lake (Mkanda 1999, Kingdon et al. 1999, Bootsma & Hecky 1999). The Linthipe catchment has been selected as a model for the study of land use, soil erosion and sedimentation in Lake Malawi watershed (Mkanda F.X. PhD thesis in prep., McCullough G., PhD thesis in prep.). Two sites were sampled on Nakantenga Island:

- a sheltered bay (Nsh) located on the northern shore of the island and protected from the south-easterly trade wind (*Mwera*), mainly blowing from June to September, by a natural rock barrier,
- an exposed bay (Nex) located on the other side of the rock barrier, hence submitted to the trade wind.

The control sites were located in a sediment free area, in Thumbi West Island at Cape Maclear (Figure S2). T13 is a little protected bay on the north side of the island, whereas T8 is a non protected rocky area on the northeast side of the island.

Fish species were named according to Ribbink et al. (1983). Every month from October 98 to April 99, the following sampling was carried out at each site:

- Fish diversity and abundance were estimated using underwater visual censuses at 10 m, 6 m and 2 m depth, following the protocol described in Ribbink et al. (1983). Transects were demarcated by two 6 mm diameter nylon cords, 25 m in length, held 2 m apart by a galvanised pipe at each end so that an area of 50 m² was sampled. At each site and depth, the 4 corners of the 50 m² areas were permanently marked to ensure that the censuses were done exactly at the same place every month. Fishes within the demarcated areas were counted after waiting at least 3 min for them to recover from any diver disturbance. For most species, sexually active males, in breeding dress and apparently defending territories, were counted. For each species, the number of individuals was the mean number of two consecutive censuses along the transect.

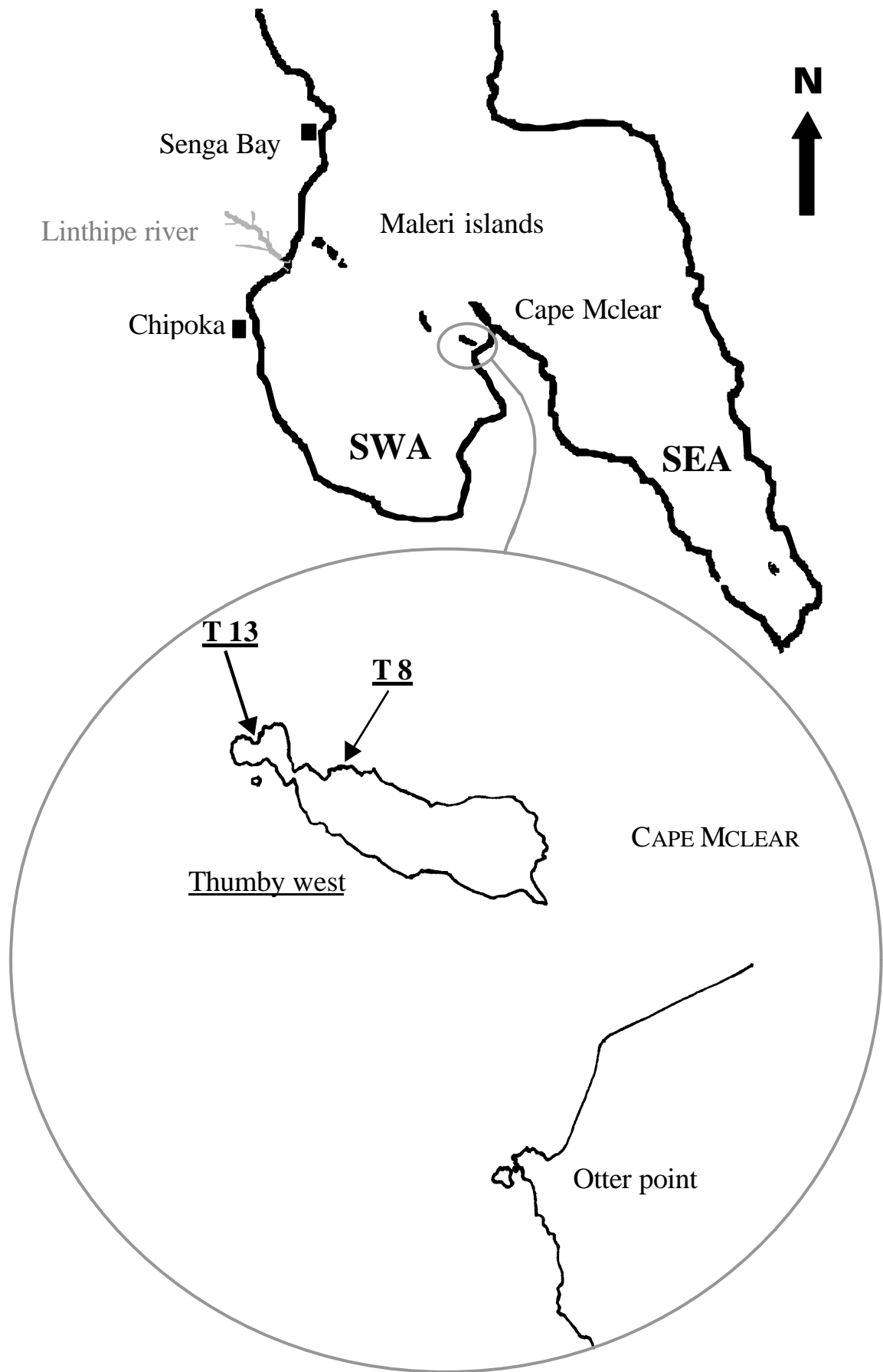


Figure S2. Southern Lake Malawi, with a detail of Cape Mclear showing the sampling sites on Thumby west island, T13 and T8. Detailed region redrawn from P. Cooley (1999).

Owing to the very bad visibility conditions at both sites in Nakantenga island in February and March 1999 (Secchi disk measurements < 2 m), visual censuses were not possible. Owing to technical problems, none of the sites was sampled in November 1998, and Thumbi sites were not sampled in October.

- At each site and depth, a 30 m length × 1.5 m height monofilament nylon gill net, constituted of three 10 m panels of 0.5, 1 and 1.5 inch mesh size, was set for two hours. Gill nets were carefully set apart from the areas used for visual censuses. The depth at the beginning and the end of setting was checked with a manual depth sounder (Echotest, Plastimo) and verified with scuba shortly after. After two hours, the fish were removed from the net, sorted to species, labelled and placed in 10% formalin for later examination. Gill nets were found to fluctuate too much in their catches to be used for diversity and abundance estimations. Indeed, parts of the net were sometimes torn by rocks either during setting or hauling, which modified the catch per unit effort (CPUE). Some fish species tended to follow the diver during the checking of the net depth, entangling themselves more than without the diver's disturbance, which also modified the CPUE. Therefore, gill nets were not used to estimate fish diversity and abundance. They were used only to assess the potential modification of life history traits during the plume, such as variations in the % of ripe females, in the condition factor, the fecundity and the egg size.

Both visual censuses and gill net samplings were always done in the morning between 8.00 and 12.00 to avoid potential diel fluctuations in fish distribution and abundance.

- Concurrently, benthic algae samples were collected by scraping at the same depths on top of flat horizontal rocks, to monitor the benthic algae biomass. Algae samples were processed by the limnology team of the project. The scrapings were collected using a thick-walled acrylic tube with an inside diameter of 4.5 cm². The base of the tube was fitted with a neoprene skirt to ensure a good seal with the rock. A plunger fitted with a stiff wire brush within the tube was used to scrape the algae off of the rock. After scraping, the sample was drawn into a syringe that was attached near the base of the scraping tube via a small tube. After collection, the sample was poured into a bottle and diluted to 250 ml. After thoroughly mixing, a subsample of this was filtered on a Whatman glass fibre GF/F filter (nominal pore size = 0.7 μm). The filter was placed in a mixture of methanol and acetone for at least 24 hours to extract algal pigments, after which chlorophyll *a* was measured on a Turner fluorometer. Based on the volume of extract, the filtration volume, and the area of rock that was scraped, the final measured volumetric chlorophyll *a* concentration was converted to an areal measurement of μg/cm². Samples were usually collected in triplicate.

- Secchi disk measurements were also carried out to monitor the water transparency.

All fish preserved in formalin were measured (SL) to the nearest 1 mm and weighed to the nearest 0.1 g. Their maturity stage was determined and the gonads in stage 4 were weighed for Gonado-Somatic Index (GSI) calculation (gonad weight/total body weight × 100) then preserved in 5% formalin for fecundity and mean oocyte weight calculation.

The maturity stage of female gonads was macroscopically determined using the slightly modified scale of Legendre & Ecoutin (1989) (Duponchelle 1997).

Stage 1: immature. The gonad looks like two short transparent cylinders. No oocytes are visible to the naked eyes. As a comparison, immature testicle is much longer and thinner, like two long tinny silver filaments.

Stage 2: beginning maturation. The ovaries are slightly larger and little whitish oocytes and apparent.

Stage 3: maturing. The ovaries continue to grow in length and thickness and are full of yellowish oocytes in early vitellogenesis.

Stage 4: final maturation. The ovaries occupy a large part of the abdominal cavity and are full of large uniform sized oocytes in late vitellogenesis.

Stage 5: ripe. Ovulation occurred, oocytes can be expelled by a gentle pressure on the abdomen. This stage is ephemera.

Stage 6: spent. The ovaries look like large bloody empty bags with remaining large sized atretic follicles. Small whitish oocytes are visible.

Stage 6-2: resting. The general aspect of the gonad recall a stage 2, but the ovarian wall is thicker, the gonad is larger, often reddish with an aspect of empty bag. This stage is distinctive of resting females, which have spawned during the past breeding season.

Stage 6-3: recovering post-spawning females. The general aspect of the gonad is like a stage 3 but with empty rooms, remaining large-sized atretic follicles and the blood vessels are still well apparent. This stage is characteristic of post-spawning females initiating another cycle of vitellogenesis.

Males were only recorded as being either in "breeding colour" or not.

The average size at first maturation (L_{50}) is defined as the standard length at which 50% of the females are at an advanced stage of the first sexual cycle during the breeding season. In practice, this is the size at which 50% of the females have reached the stage 3 of the maturity scale (Legendre & Ecoutin 1996, Duponchelle & Panfili 1998). For the estimation of L_{50} , only the fish sampled during the height of the breeding season were considered.

Fecundity is defined here as the number of oocytes to be released at the next spawn, and correspond to the absolute fecundity. It is estimated, from gonads in the final maturation stage (stage 4), by the number of oocytes belonging to the largest diameter modal group. This oocyte group is clearly separated from the rest of the oocytes to the naked eye and corresponds approximately to oocytes that are going to be released (Duponchelle 1997, Duponchelle *et al.* 2000).

Oocyte weight measurements were all carried out on samples preserved in 5% formalin. The average oocyte weight per female, was determined by weighing 50 oocytes (Peters 1963) belonging to those considered for fecundity estimates.

In order to compare mean oocyte weight and diameter among the different species, the measurements need to be made on oocytes in a similar vitellogenic stage, then on oocytes whose growth is completed. A simplified version of the method applied by Duponchelle (1997) was used to determine the GSI threshold above which the oocyte weight do no longer increase significantly. For each species, the individual oocyte weights were plotted against the GSI. The GSI corresponded to the beginning of the asymptotic part of the curve was visually determined and the fish whose GSI was inferior to the defined GSI were removed. The final GSI threshold was reached when no correlation subsisted between the mean oocyte weight and the GSI.

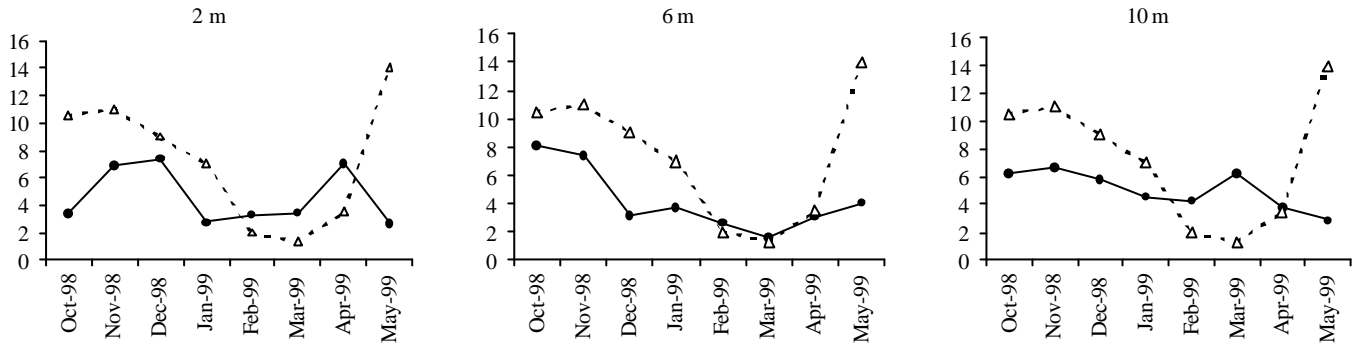
The Fulton's condition factor was calculated as $CF = 100\,000 \times W/L^3$, where W is the wet weight and L the standard length (Anderson & Gutreuter 1983). Given the well known trend of CF to increase with the length of fish (Anderson & Gutreuter 1983), the absence of relationship between length and CF over the size range sampled was checked for every species using Pearson correlation.

Statistics

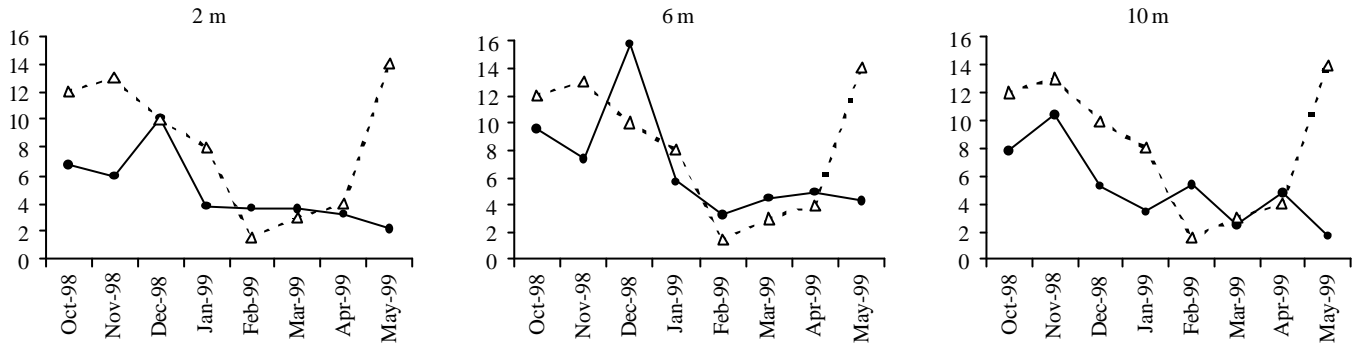
Comparisons of among months diversity and abundance of fish species were performed with one way repeated measures ANOVA using SigmaStat software (Jandel Scientific).

The temporal variation of the condition factor for every species was assessed using univariate general linear model with month, site and sex as factors and CF as the dependant

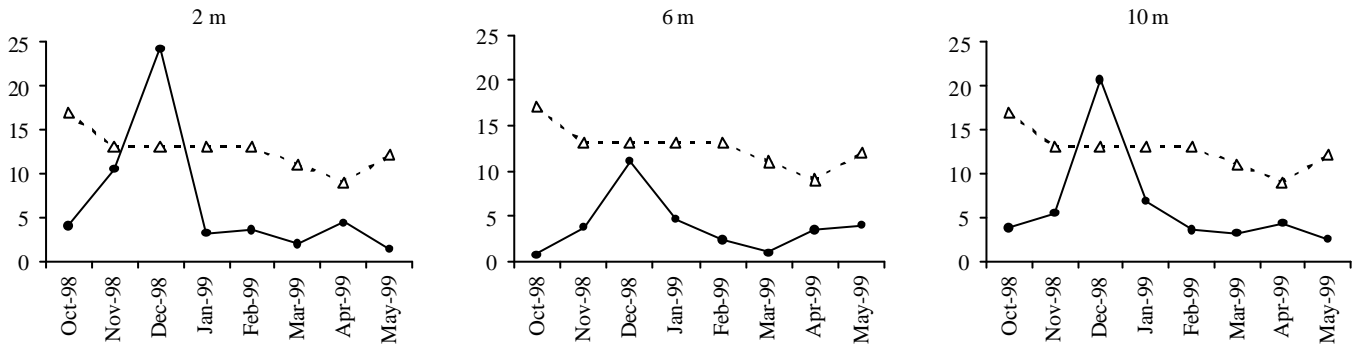
Nakantenga sheltered (Nsh)



Nakantenga exposed (Nex)



Thumby west 13 (T13)



Thumby west 8 (T8)

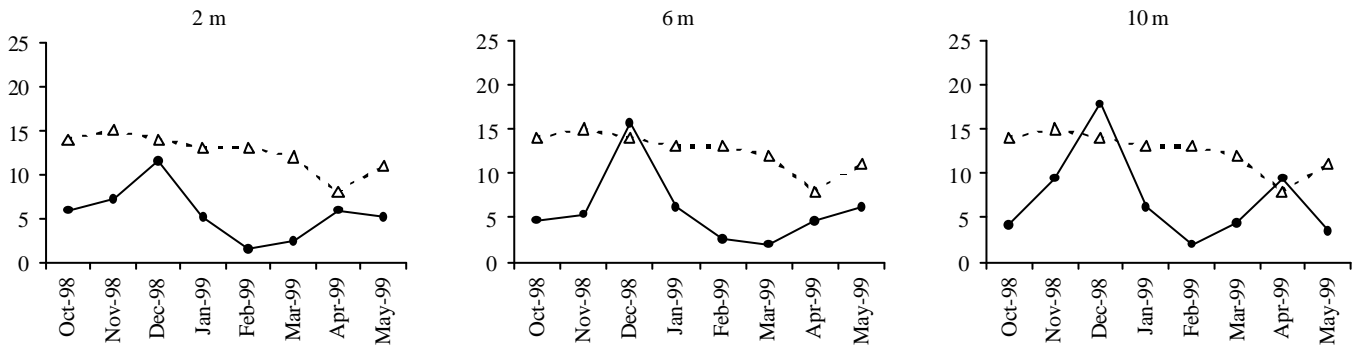


Figure S4. Monthly progression of benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) (black dots) and of light penetration estimated by Secchi disk measurements (m) (white triangles) at 2 m, 6 m and 10 m depth at each sampled site, from October 1998 to May 1999. Note the different y axis scale between Nakantenga and Thumby sites. Algae sampling was done on top of flat horizontal rocks using a scrapper. Values are averages of three replicates.

variable, using SPSS software. Given the low sample number at some sites for some species, the significance level for interaction between factors was fixed at 1%.

Results

Although rainfall patterns might be slightly different in Cape Maclear and Maleri Islands than in Senga bay, rains effectively started at the end of November 1998 (the 23rd) and stopped the 11th of April 1999 at Senga Bay station (Figure S3). Despite an effective start of the rainy season in late November, the Linthipe river discharge really began in January to reach a peak in March (Figure S3). As the sediment plume is linked to the river discharge rather than to the rains directly, therefore the period under consideration when referring herein to the rainy season is "January to May".

In February and March 1999, visibility was so poor in Nakantenga sites that visual censuses were impossible to carry out. However, while one of the two divers was scraping for benthic algae samples, the other diver was doing fish observations. Although this required to be less than 50 cm away from the fish and that it was often impossible to identify the species, behavioural observations were still possible. Fish were virtually immobile with fins held erect as they do at night. They stayed in or very close to the entrance to their hideaways among the rocks, or rested on the rocks. There was virtually no feeding, territorial or courtship behaviour.

Chlorophyll a biomass

Mean monthly benthic chlorophyll a biomass for each depth and site are presented in Figure S4. A similar temporal trend was evident at almost all sites and depths, suggesting that these data, though collected only once per month, represented real monthly trends. A chlorophyll peak was observed in December 1998 at every depth in Thumbi West sites, possibly due to an increased nutrient availability resulting from land runoff (H. Bootsma, pers. com.). Another smaller peak was observed in April-May, but apart from these peaks, chlorophyll concentration was rather similar between the dry and rainy seasons. At Nakantenga sites, there was also a slight increase in chlorophyll in December, though not apparent at all depths, but it was followed by chlorophyll concentrations that were lower than before the rainy season. This suggests a greater impact of siltation and reduced light penetration at Nakantenga. However, changes in chlorophyll concentration at the impacted sites (Nsh and Nex) were less important than expected. Indeed, from January-February to May 1999, the thickness of sediment (up to 2 cm sometimes) covering the rocks observed while diving at all depths (and especially at 6 and 10 m) should have almost completely prevented photosynthesis, even when the plume was temporary out of the island. Furthermore light penetration was severely diminished when the plume was settled, with Secchi disk measurements inferior to 4 m from February to April (Figure S4). Concern that benthic chlorophyll a concentration did not change as much as expected between the dry and the rainy season at Nakantenga matched observations on previous years at the nearby Maleri Island by the project's limnology team. The explanation probably lies in the phytoplankton production in the first few metres that had settled and mixed with the sediment (H. Bootsma, pers. com.). The question is whether this type of algae is still useful to the fish as a food source?

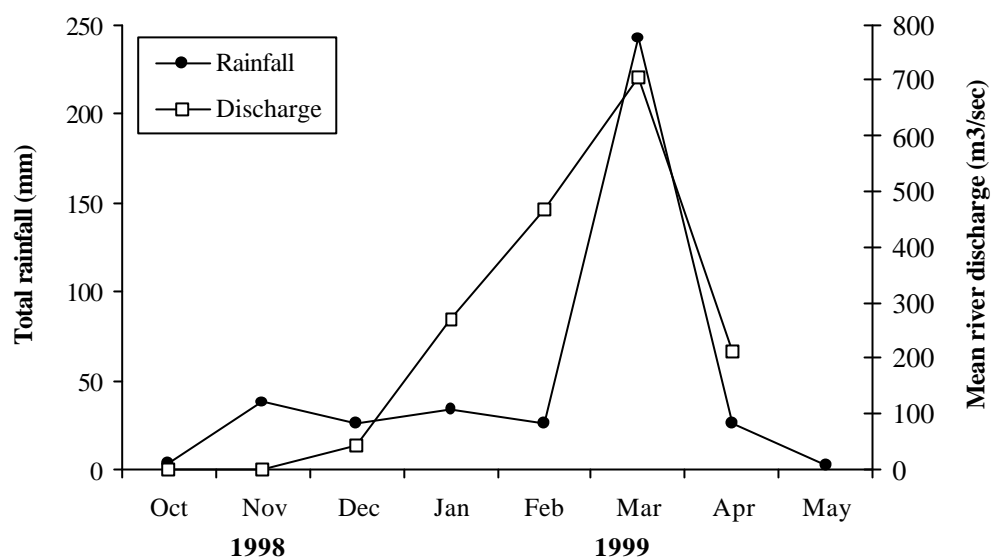


Figure S3. Total rainfall at Senga Bay station and mean Linthipe river discharge from October 1998 to April 1999.

Table S1b. Visual censuses at 2 m, 6 m and 10 m depth at Nakantenga exposed (Nex) site.

Species name	Depth (m)	Oct-98			Dec-98			Jan-99			Apr-99			May-99		
		2	6	10	2	6	10	2	6	10	2	6	10	2	6	10
<i>Pseudotropheus zebra red dorsal</i>		2	6	68	0	11	77	2	10	39	2	8	38	3	9	11
<i>Pseudotropheus zebra yellow throat</i>		15	8	0	13	6	0	19	6	0	18	4	0	17	7	0
<i>Pseudotropheus zebra black dorsal</i>		0	2	3	0	0	1	0	0	3	0	2	3	0	3	3
<i>Pseudotropheus barlowi</i>		0	9	3	0	11	1	0	4	1	0	9	1	0	6	3
<i>Pseudotropheus tropheops lilac maleri</i>		4	2	0	4	1	0	4	1	0	8	1	0	5	1	0
<i>Pseudotropheus tropheops maleri blue</i>		4	0	0	2	0	0	1	0	0	1	0	0	2	0	0
<i>Pseudotropheus tropheops orange chest</i>		10	1	2	6	2	1	7	1	0	1	1	0	6	0	0
<i>Pseudotropheus williamsi</i>		2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
<i>Pseudotropheus elongatus brown</i>		0	0	0	0	0	7	0	1	7	0	1	2	0	0	1
<i>Pseudotropheus aggressive yellowhead</i>		11	19	0	24	44	0	0	50	1	35	44	5	60	35	6
<i>Pseudotropheus aggressive blue</i>		4	0	0	6	0	0	10	0	0	8	0	0	9	0	0
<i>Pseudotropheus aggressive zebra</i>		15	0	0	6	1	0	30	4	0	4	1	0	5	0	0
<i>Pseudotropheus burrower</i>		0	21	7	0	11	10	1	12	12	4	10	0	0	15	10
<i>Melanochromis auratus</i>		2	3	2	3	2	1	2	8	8	8	2	1	5	2	0
<i>Melanochromis vermivorous</i>		0	0	0	0	4	0	1	7	0	0	1	0	0	0	0
<i>Melanochromis melanopterus</i>		3	5	3	0	0	0	0	0	1	1	0	3	0	2	1
<i>Melanochromis crabro</i>		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Petrotilapia yellow chin</i>		4	0	0	4	0	0	2	0	0	3	0	0	2	0	0
<i>Petrotilapia genalutea</i>		2	0	0	3	0	0	2	1	0	2	0	0	2	0	0
<i>Petrotilapia fuscous</i>		5	3	9	5	4	5	2	3	9	2	3	4	2	4	1
<i>Labidochromis vellicans</i>		0	0	0	2	1	0	4	4	0	3	2	0	1	2	0
<i>Labidochromis pallidus</i>		2	3	5	3	2	3	3	3	3	4	2	0	3	1	1
<i>Labeotropheus fuelleborni</i>		6	0	2	6	2	2	5	1	0	8	0	5	9	0	0
<i>Labeotropheus trewavasae</i>		1	0	1	2	1	0	0	0	1	0	0	0	0	1	0
<i>Genyochromis mento</i>		0	2	1	0	0	1	1	1	1	0	1	0	0	1	0
<i>Aulonocara gold</i>		0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
<i>Protomelas taeniolatus</i>		2	1	4	0	0	2	0	0	3	0	3	5	0	0	0
Territorial Total		94	85	110	90	104	111	97	117	91	113	95	67	133	89	39

Visual censuses

It should be kept in mind that censuses were done exactly at the same place within each site. Variations in relative abundance of species were observed among months along the rainy season. At Nakantenga sheltered (Nsh) site (Table S1a), *Ps. zebra* 'red dorsal' tended to be more abundant at 6 m and especially at 10 m during the rainy season. *Ps. zebra* 'black dorsal' was also more abundant at 6 m during the rainy season. The same increasing trends at 10 m were noticed for *Ps. elongatus* 'brown' and *Petrotilapia fuscous*, whereas *Ps. barlowi* abundance decreased at 10 m. *Ps. 'aggressive yellow head'* tended to be more abundant at 2 m but less at 6 and 10 m during the rainy months. However, diversity and abundance variations of species among months were not significant at any depth (one way repeated measures ANOVA, $F=0.7$ $p=0.593$ for 2m, $F=0.653$ $p=0.626$ for 6 m and $F=0.697$ $p=0.597$ for 10 m depth).

Table S1a. Visual censuses at 2 m, 6 m and 10 m depth at Nakantenga sheltered (Nsh) site.

Species name	Month Depth (m)	Oct-98			Dec-98			Jan-99			Apr-99			May-99		
		2	6	10	2	6	10	2	6	10	2	6	10	2	6	10
<i>Pseudotropheus zebra</i> 'red dorsal'		2	10	8	0	5	3	1	20	4	2	20	38	1	8	18
<i>Pseudotropheus zebra</i> 'yellowthroat'		8	0	0	14	0	0	15	0	0	22	0	0	13	0	0
<i>Pseudotropheus zebra</i> 'black dorsal'		2	2	3	0	1	4	0	3	5	0	7	3	0	5	4
<i>Pseudotropheus barlowi</i>		0	6	2	0	5	4	0	4	2	0	5	1	0	5	0
<i>Pseudotropheus tropheops</i> 'lilac maleri'		7	0	0	3	1	0	4	1	0	3	0	0	3	0	0
<i>Pseudotropheus tropheops</i> 'orange chest'		0	0	0	0	0	0	0	0	0	0	1	0	0	3	0
<i>Pseudotropheus williamsi</i>		1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
<i>Pseudotropheus elongatus</i> 'brown'		1	1	0	2	0	0	0	6	1	1	1	2	0	4	5
<i>Pseudotropheus</i> 'aggressive yellowhead'		3	31	11	0	22	9	3	9	7	5	8	0	8	15	0
<i>Pseudotropheus</i> 'aggressive zebra'		21	0	0	34	0	0	36	1	0	26	0	0	38	0	0
<i>Pseudotropheus burrower</i>		10	15	14	5	18	7	6	23	13	6	16	5	4	16	10
<i>Melanochromis auratus</i>		3	2	1	2	0	0	2	2	2	2	1	1	1	3	3
<i>Melanochromis vermivorus</i>		0	0	0	4	0	0	3	3	0	2	1	0	1	0	0
<i>Melanochromis melanopterus</i>		2	2	2	0	0	0	1	1	0	0	0	2	1	0	2
<i>Petrotilapia</i> 'yellow chin'		0	0	0	1	0	0	1	0	0	1	0	0	3	0	0
<i>Petrotilapia genalutea</i>		0	0	0	1	0	0	1	0	0	3	0	0	3	0	0
<i>Petrotilapia</i> 'fuscous'		0	2	2	2	0	0	1	3	1	1	2	4	1	4	10
<i>Labidochromis vellicans</i>		0	0	0	3	0	0	3	0	0	3	0	0	2	2	1
<i>Labidochromis pallidus</i>		3	3	3	3	0	0	4	2	1	5	1	5	4	3	4
<i>Labeotropheus fuelleborni</i>		1	0	0	1	0	0	1	0	0	3	0	0	1	0	0
<i>Labeotropheus trewavasae</i>		1	1	0	1	0	0	0	1	0	1	0	0	0	1	0
<i>Genyochromis mento</i>		1	1	0	2	0	0	1	0	0	1	1	0	1	2	0
<i>Aulonocara</i> 'gold'		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Protomelas taeniolatus</i>		0	0	3	0	0	0	0	0	0	0	7	5	0	0	0
Territorial Total		66	76	49	78	52	27	84	79	37	88	71	66	85	71	57

At Nakantenga exposed (Nex) site (Table S1b), *Ps. zebra* 'red dorsal' showed an opposite trend, being less abundant at 10 m during the rainy season, like *Ps. tropheops* 'orange chest' and *Petrotilapia fuscous*, which was also less abundant at 2 m. *Labeotropheus fuelleborni* and *Melanochromis auratus* tended to be more abundant at 2 m during the rainy months. *Ps. 'aggressive yellow head'* abundance tended to increase at every depth during the rainy season.

Table S2b. Visual censuses at 2 m, 6 m and 10 m depth at Thumby west T8 site.

Species name	Month Depth (m)	Dec-98			Jan-99			Feb-99			Mar-99			Apr-99			May-99		
		2	6	10	2	6	10	2	6	10	2	6	10	2	6	10	2	6	10
<i>Pseudotropheus zebra</i>		16	1	2	12	15	4	19	14	4	16	12	4	9	6	2	13	12	3
<i>Pseudotropheus zebra callainos</i>		24	9	0	1	1	0	24	1	0	18	1	0	20	0	0	15	1	0
<i>Pseudotropheus aurora</i>		0	0	2	9	8	2	0	11	3	0	12	3	0	8	2	0	10	3
<i>Pseudotropheus heteropictus</i>		0	0	9	0	0	12	0	0	13	0	1	15	0	2	14	0	1	15
<i>Pseudotropheus livingstonii</i>		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotropheus tropheops lilac</i>		0	2	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0
<i>Pseudotropheus tropheops red cheek</i>		13	14	0	2	3	0	12	1	0	16	2	0	14	2	0	11	1	0
<i>Pseudotropheus tropheops orange chest</i>		9	6	8	14	16	6	13	15	11	8	13	12	7	16	14	12	13	10
<i>Pseudotropheus tropheops intermediate</i>		0	0	6	6	6	8	1	10	8	0	9	8	0	11	9	0	10	9
<i>Pseudotropheus tropheops gracilior</i>		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotropheus williamsi</i>		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotropheus elongatus brown</i>		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotropheus elongatus slab</i>		0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0
<i>Pseudotropheus aggressive brown</i>		18	0	0	0	0	0	17	0	0	21	0	0	16	0	0	15	0	0
<i>Pseudotropheus tiny</i>		0	0	4	0	0	1	0	0	4	0	0	5	0	0	5	0	0	5
<i>Melanochromis auratus</i>		1	0	3	0	1	1	2	3	2	3	1	2	1	2	2	2	1	1
<i>Melanochromis melanopterus</i>		0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
<i>Melanochromis vermicolor</i>		8	0	0	0	0	0	10	0	0	8	0	0	11	0	0	10	0	0
<i>Melanochromis joanjohnsonae</i>		5	0	0	0	0	0	3	0	0	3	0	0	4	0	0	3	0	0
<i>Melanochromis crabro</i>		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Petrotilapia mumbo blue</i>		2	0	0	0	0	0	3	0	0	3	0	0	3	0	0	4	0	0
<i>Petrotilapia genalutea</i>		3	6	0	0	0	0	2	0	0	3	0	0	6	0	0	2	0	0
<i>Petrotilapia nigra</i>		1	0	0	6	4	3	2	8	1	1	5	1	2	7	2	1	3	1
<i>Labidochromis vellicans</i>		0	0	0	0	1	0	5	0	0	3	1	0	4	2	0	3	0	0
<i>Labidochromis freibergi</i>		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Labidochromis gigas</i>		0	0	3	2	3	2	2	3	4	0	3	4	0	2	3	1	6	3
<i>Labidochromis blue bar</i>		0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cynotilapia afra</i>		13	1	21	19	26	26	26	26	24	20	24	26	8	5	6	28	28	21
<i>Labeotropheus fueleborni</i>		10	1	0	1	2	0	13	0	0	11	2	0	16	1	0	16	0	0
<i>Labeotropheus trewavasae</i>		0	0	0	1	1	0	1	0	0	2	1	0	1	1	0	0	1	0
<i>Genyochromis mento</i>		0	2	0	0	0	0	2	1	1	1	1	1	1	1	1	1	1	1
<i>Aulonocara blue</i>		0	1	0	2	0	1	0	2	5	0	1	3	0	1	3	0	2	3
<i>Protomelas taeniolatus</i>		0	65	0	1	2	1	0	3	0	0	3	1	0	2	1	0	0	1
Territorial Total		123	205	59	77	90	69	158	99	80	138	92	86	124	69	64	137	91	76

Again, the observed variations in species diversity and abundance were not significant at any depth (one way repeated measures ANOVA, $F=0.453$ $p=0.770$ for 2m, $F=0.816$ $p=0.518$ for 6 m and $F=1.220$ $p=0.307$ for 10 m depth).

At Thumbi West T13 site (Table S2a), some species tended to be more abundant during the rainy season at 2 m (*Ps. callainos*, *Melanochromis vermivorus*, *Labidochromis vellicans*, *L. fuelleborni*), 6 m (*L. fuelleborni*) and 10 m (*Ps. tropheops 'orange chest'*). *Ps. tropheops 'intermediate'* was less abundant at 6 m during the rainy months. However, these species diversity and abundance variations among months were not significant at any depth (one way repeated measures ANOVA, $F=1.301$ $p=0.265$ for 2m, $F=0.757$ $p=0.582$ for 6 m and $F=0.833$ $p=0.527$ for 10 m depth).

Table S2a. Visual censuses at 2 m, 6 m and 10 m depth at Thumbi west T13 site.

Species name	Month Depth (m)	Dec-98			Jan-99			Feb-99			Mar-99			Apr-99			May-99		
		2	6	10	2	6	10	2	6	10	2	6	10	2	6	10	2	6	10
<i>Pseudotropheus zebra</i>		12	30	37	21	27	28	16	31	21	24	38	33	16	36	26	20	35	38
<i>Pseudotropheus zebra callainos</i>		35	20	3	33	27	4	41	17	1	57	25	3	54	24	0	46	15	2
<i>Pseudotropheus aurora</i>		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pseudotropheus heteropictus</i>		0	2	2	0	0	2	0	0	1	0	0	3	0	0	2	0	0	2
<i>Pseudotropheus tropheops lilac</i>		0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0
<i>Pseudotropheus tropheops red cheek</i>		4	4	0	4	7	1	4	5	0	6	7	0	4	4	0	3	4	0
<i>Pseudotropheus tropheops orange chest</i>		2	6	8	5	13	8	3	16	9	5	13	10	4	17	12	4	11	13
<i>Pseudotropheus tropheops intermediate</i>		0	9	5	0	3	10	0	4	8	0	2	8	0	2	7	0	1	7
<i>Pseudotropheus elongatus brown</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Pseudotropheus elongatus slab</i>		0	0	0	0	1	1	0	1	3	0	2	3	0	1	3	0	1	1
<i>Pseudotropheus aggressive blue</i>		10	0	0	6	0	0	6	0	0	6	0	0	6	0	0	5	0	0
<i>Pseudotropheus aggressive brown</i>		32	0	0	19	0	0	26	0	0	19	0	0	23	0	0	22	0	0
<i>Pseudotropheus tiny</i>		0	3	2	0	0	2	0	0	4	0	1	3	0	0	6	0	0	4
<i>Melanochromis auratus</i>		2	2	3	3	2	2	0	1	2	1	2	1	2	2	3	2	3	3
<i>Melanochromis melanopterus</i>		2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melanochromis chipokae</i>		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
<i>Melanochromis vermivorous</i>		8	2	0	14	3	0	21	1	0	10	3	2	12	2	1	16	4	1
<i>Melanochromis parallelus</i>		3	2	1	2	3	2	3	2	3	2	0	1	2	3	1	2	1	2
<i>Melanochromis joanjohnsonae</i>		6	0	0	4	1	0	6	0	0	2	0	0	5	0	0	5	0	0
<i>Petrotilapia mumbo blue</i>		1	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
<i>Petrotilapia tridentiger</i>		1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Petrotilapia genalutea</i>		2	0	0	4	0	0	1	0	0	1	0	0	2	0	0	1	0	0
<i>Petrotilapia nigra</i>		1	1	2	0	3	3	1	6	2	1	2	2	0	4	3	0	4	2
<i>Labidochromis vellicans</i>		1	2	1	4	4	4	2	4	1	5	3	0	7	2	0	5	3	1
<i>Cynotilapia afra</i>		1	9	0	5	5	0	3	5	0	4	6	0	5	6	0	10	7	0
<i>Labeotropheus fuelleborni</i>		2	4	0	8	18	0	16	13	0	11	15	0	21	18	0	14	11	0
<i>Labeotropheus trewavasae</i>		1	2	1	1	2	3	2	4	2	1	3	4	2	3	6	2	4	4
<i>Genyochromis mento</i>		0	0	2	0	0	0	1	1	1	1	1	0	2	1	3	1	2	1
<i>Aulonocara blue</i>		0	3	0	0	0	2	0	1	1	0	0	1	0	0	1	0	0	2
<i>Protomelas taeniolatus</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Territorial Total		126	103	71	134	119	72	155	112	60	158	123	74	171	125	74	162	106	84

At Thumbi West T8 site (Table S2b), *Ps. callainos* and *Ps. tropheops 'red cheek'* were found less abundant at 6 m during the rainy season. The opposite tendency was observed at 2 m for *Labidochromis vellicans* and *L. fuelleborni*, and at 6 m for *Ps. aurora* and *Ps. tropheops*

'orange chest' . This last species was also more abundant at 10 m. As for T13 site, species diversity and abundance variations among months were not significant at any depth at T8 (one way repeated measures ANOVA, $F=1.958$ $p= 0.086$ for 2m, $F=1.175$ $p=0.322$ for 6 m and $F=1.262$ $p=0.282$ for 10 m depth).

Life history traits and condition

Life history traits such as fecundity, egg size and size at maturity require large fish samples to be determined. Between months comparisons within each site were not possible owing to insufficient sample numbers. As a consequence, they were compared only for the few species abundant enough and represented at both Nakantenga and Thumbi sites. Also owing to sample number, Nex and Nsh sites were pooled as were T13 and T8, for the Nakantenga versus Thumbi west comparisons of life history traits among populations. Potential condition variations were investigated for every species abundant enough at every sampled months.

Species present at both Nakantenga and Thumbi west sites

To be accurate, length at maturity has to be determined at the height of the breeding season. Determination of the breeding season was not possible as we did not sample during a complete annual cycle. However, most of the *mbuna*, including the two species below, breed throughout the year with a peak in August to October and one in February to March (Marsh et al. 1986). Our sampling period from October 1998 to May 1999, included part of the first breeding peak and completely the second one. Therefore, length at maturity were estimated from the complete sampling period.

Labeotropheus fuelleborni

The size at maturity of *L. fuelleborni* was slightly higher at Nakantenga (66 mm) than at Thumbi west (62 mm) (Figure S5).

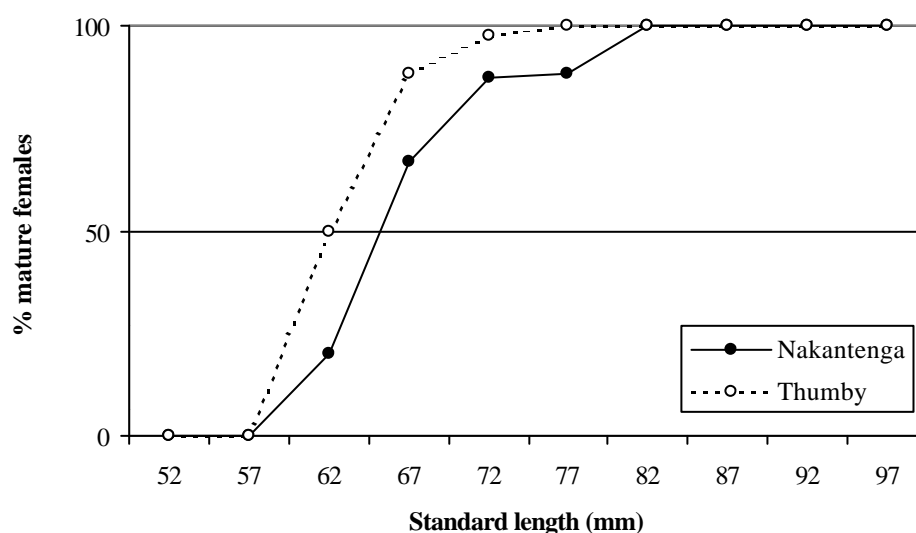


Figure S5. Mean length at first sexual maturity for *Labeotropheus fuelleborni* at Nakantenga and Thumbi west sites.

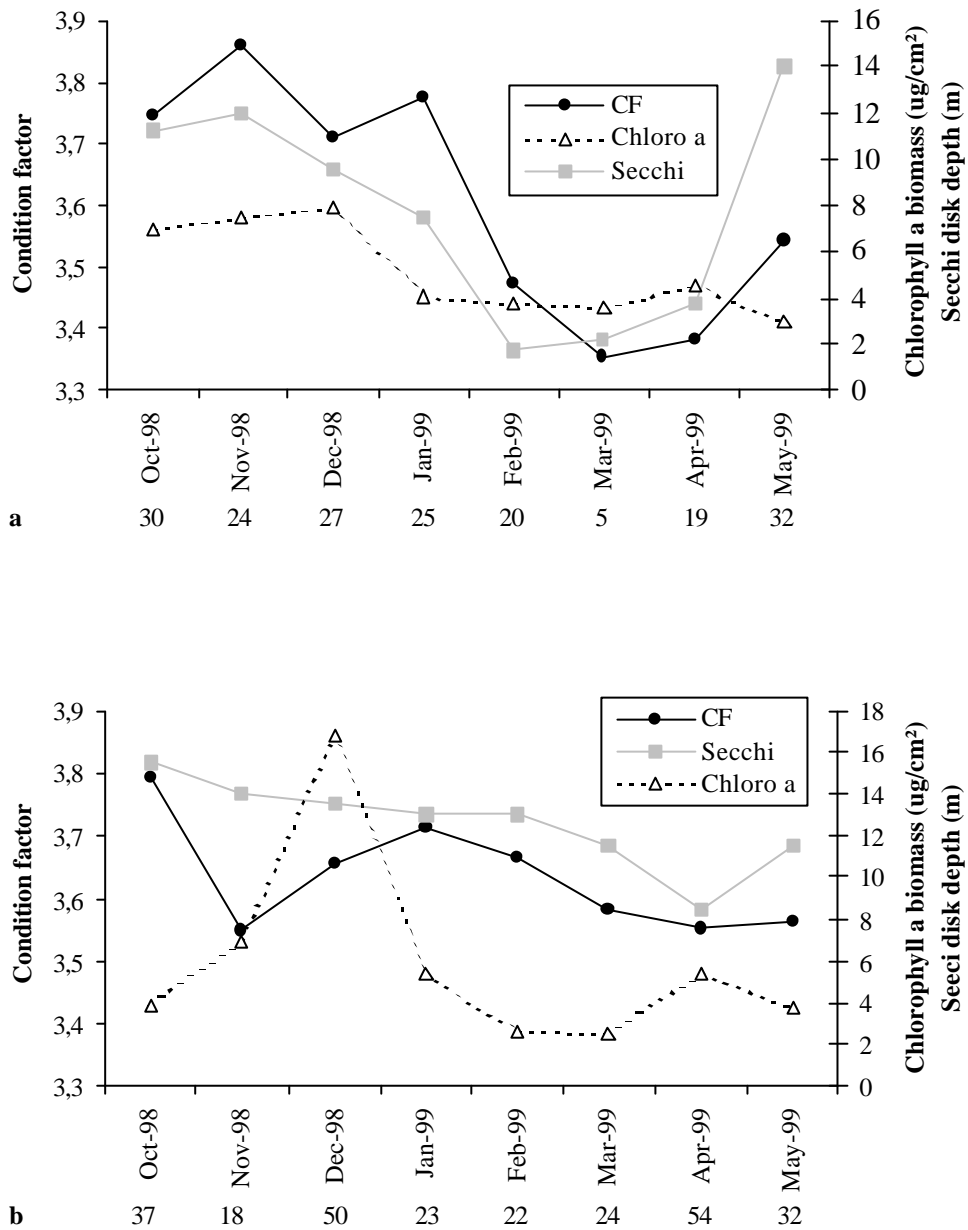


Figure S6. Monthly progression of *Labeotropheus fuelleborni* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga sites (a) and Thumby west sites (b). Numbers below the months are the corresponding sample numbers.

As the relative fecundity was not correlated to the body weight for *L. fuelleborni* at either sites (Pearson correlation $r=-0.225$, $p=0.506$ and $r=-0.298$, $p=0.140$ for Nakantenga and Thumbi populations, respectively), comparison of fecundity were done on relative fecundity. There was no significant difference (Mann-Whitney rank sum test: $T= 221$, $p=0.702$) of relative fecundity between the populations of Nakantenga ($N=11$, mean relative fecundity= 1725 ± 405 SD) and Thumbi west ($N=26$, mean relative fecundity= 1675 ± 252 SD).

The GSI threshold above which oocyte weight did no longer increase significantly was 3.8% for *L. fuelleborni*. At Nakantenga sites, only two females had a GSI superior to 3.8%, giving a mean oocyte weight of $31.9 \text{ mg} \pm 2.69$. At Thumbi west sites, 4 females had a GSI superior to 3.8%, giving a mean oocyte weight of $29.5 \text{ mg} \pm 5.21$. Owing to the low sample number at Nakantenga, statistical comparison was not possible, but the weak difference was likely to be insignificant.

Analysis of monthly progression of mean condition factor (CF) were carried out separately at Nakantenga and Thumbi sites.

At Nakantenga, no correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The monthly progression of the mean condition factor, secchi disk measurements and benthic chlorophyll a biomass are presented in Figure S6a. The significant factors were month ($F_{7,156}=4.673$, $p<0.0001$) and site ($F_{1,156}=4.565$, $p=0.034$). There was no interaction between factors. An all pairwise Tukey's multiple comparison test was then performed to identify differences among months and the results are presented in Table S3.

Table S3. Differences of mean condition factor among months for *Labeotropheus fuelleborni* at Nakantenga sites. * = significant difference ($p<0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----				*		*	
November-98		-----			*	*	*	*
December-98			-----				*	
January-99				-----	*		*	
February-99					-----			
March-99						-----		
April-99							-----	
May-99								-----

Homogeneous subsets were October, November, December and January versus February, March, April and May. The mean condition factor was significantly lower during the period from February-99 to May-99 than during the period from October-98 to January-99 ($F_{1,180}=42.657$, $p<0.0001$), indicating a significant effect of rainy season on condition factor. Despite their similar monthly progression (Figure S6a), there was no significant correlation between the mean CF and Secchi disk measurements (Pearson correlation $p>0.05$). Also, no correlation was observed between the mean CF and the chlorophyll a biomass.

At Thumbi west, no correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to search for between months, sites and sex differences. None of the factor had a significant effect on the mean condition factor, indicating that the rainy season did not significantly influence the condition of *L. fuelleborni* at Thumbi west. The monthly progression of the mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass are presented in Figure S6b. No significant correlation was found between the mean CF, Secchi disk measurements and the chlorophyll a biomass (Pearson correlation $p > 0.05$).

Pseudotropheus tropheops 'orange chest'

The mean size at maturity of *Ps. tropheops 'orange chest'* was the same (65 mm) in Nakantenga and Thumbi west sites (Figure S7).

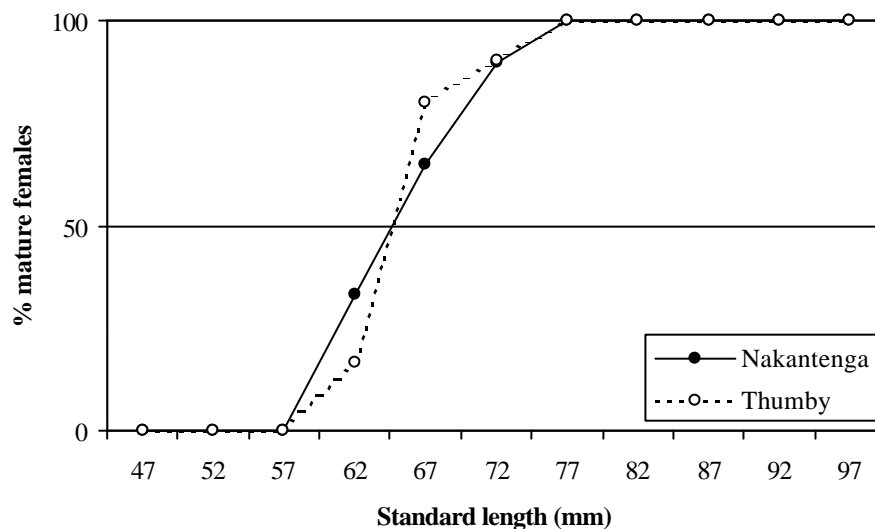
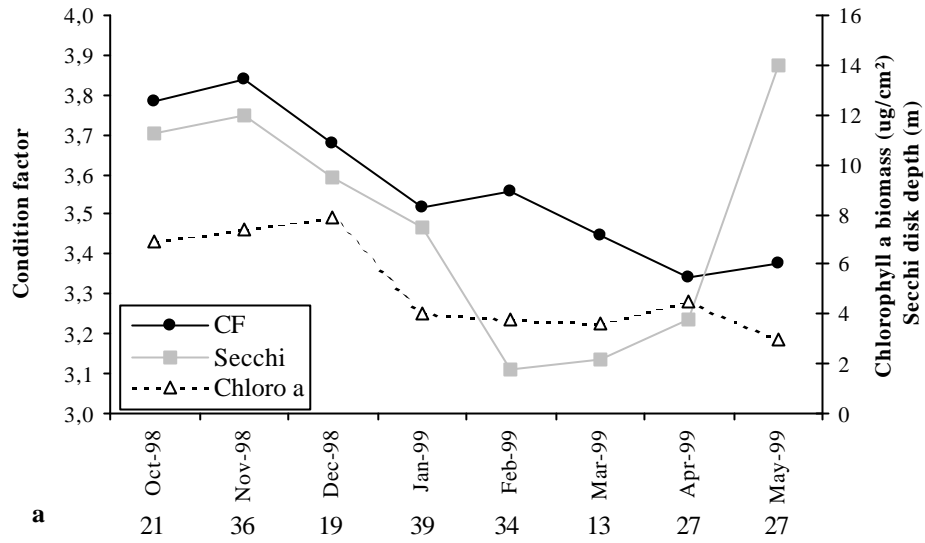


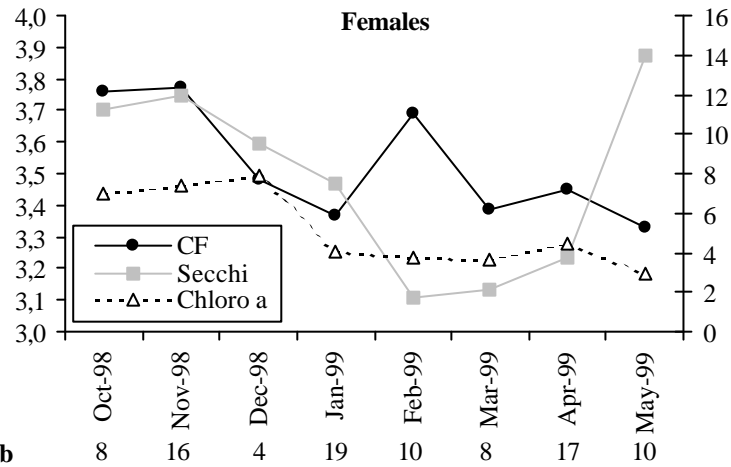
Figure S7. Mean length at first sexual maturity for *Pseudotropheus tropheops 'orange chest'* at Nakantenga and Thumbi west sites.

As the relative fecundity was not correlated to the body weight for *Ps. tropheops 'orange chest'* at either sites (Pearson correlation $r = -0.21$, $p = 0.489$ and $r = -0.28$, $p = 0.134$ for Nakantenga and Thumbi populations, respectively), comparisons of fecundity were done on relative fecundity. There was no significant difference (t-test: $t = 1.889$, 4 df, $p = 0.066$) of relative fecundity between the populations of Nakantenga ($N = 13$, mean relative fecundity = 2451 ± 495 SD) and Thumbi west ($N = 30$, mean relative fecundity = 2183 ± 395 SD).

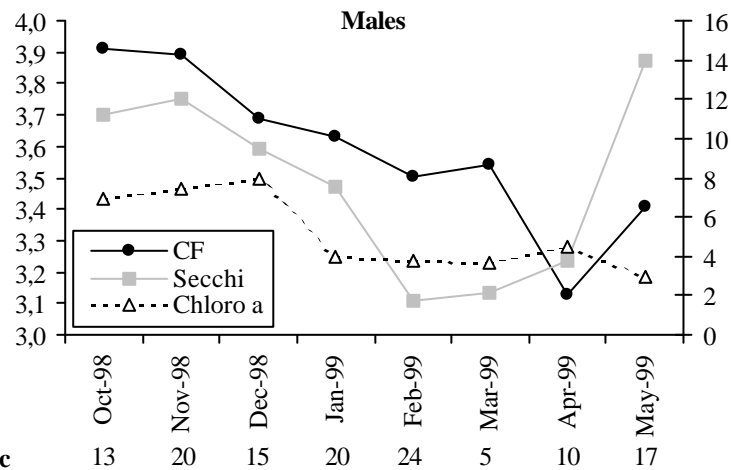
The GSI threshold above which oocyte weight did no longer increase significantly was 4% for *Ps. tropheops 'orange chest'*. At Nakantenga sites, 7 females had a GSI superior to 4%, giving a mean oocyte weight of $17.7 \text{ mg} \pm 2.73$. At Thumbi west sites, 9 females had a GSI superior to 4%, giving a mean oocyte weight of $17.4 \text{ mg} \pm 2.68$. The difference in oocyte weight between the females of two sites was not significant (t-test $t = -0.534$, 14 df, $p = 0.602$).



a



b



c

Figure S8. Monthly progression of *Pseudotropheus tropheops* 'orange chest' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga sites for females and males pooled (a), females only (b) and males only (c). Numbers below the months are the corresponding sample numbers.

Analysis of monthly progression of condition factor (CF) were carried out separately at Nakantenga and Thumbi sites.

Nakantenga: The monthly progression of the mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass are presented in Figure S8a. No correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only significant factors was month ($F_{7,189}=8.533$, $p < 0.0001$) but the interaction between month and sex was significant ($p = 0.004$). Therefore, females and males had to be separated for analysis (Figure S8b and c). No significant correlation was found between the mean CF, Secchi disk measurements and the chlorophyll a biomass for females (Pearson correlation $p > 0.05$). Despite their similar monthly progression (Figure S8c), there was no significant correlation between the mean CF and Secchi disk measurements for males. Mean CF and chlorophyll a biomass were not correlated either.

Once separated, both females and males showed significant differences of mean condition factor among months ($F_{7,79}=3.061$, $p = 0.007$ for females and $F_{7,110}=9.409$, $p < 0.0001$ for males). Results of all pairwise Tukey's multiple comparison test are presented in Table S4.

Table S4. Differences of mean condition factor among months for *Pseudotropheus tropheops* 'orange chest' females (*) and males (#) at Nakantenga sites (above the diagonal), and females and males pooled (*) at Thumbi west sites (below the diagonal). *, # = significant difference ($p < 0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----			*	#		#	* #
November-98		-----		*	#	*	*	# * #
December-98			-----					#
January-99		*		-----				#
February-99		*	*	*	-----			#
March-99		*	*	*		-----		
April-99		*	*	*	*	*	-----	
May-99		*	*	*	*			-----

The mean condition factor showed a clear tendency to decrease during the rainy season for males (Figure S8c). As CF in February differed from October-November but also from April, February was excluded from the analysis for between season comparison. The mean CF was significantly lower during the period from March-99 to May-99 than during the period from October-98 to January-99 ($F_{1,98}=35.305$, $p < 0.0001$), indicating a significant effect of rainy season on condition factor. The same tendency was observed for females (Figure S8b) despite a sudden increase in February. However, as the mean CF in January significantly differed from that of October and November (Table S4), the same months grouping could not be done for females. The statistical comparison were carried out according to the following "season" grouping: October-December versus January-May and the difference was significant ($F_{1,90}=20.438$, $p < 0.0001$).

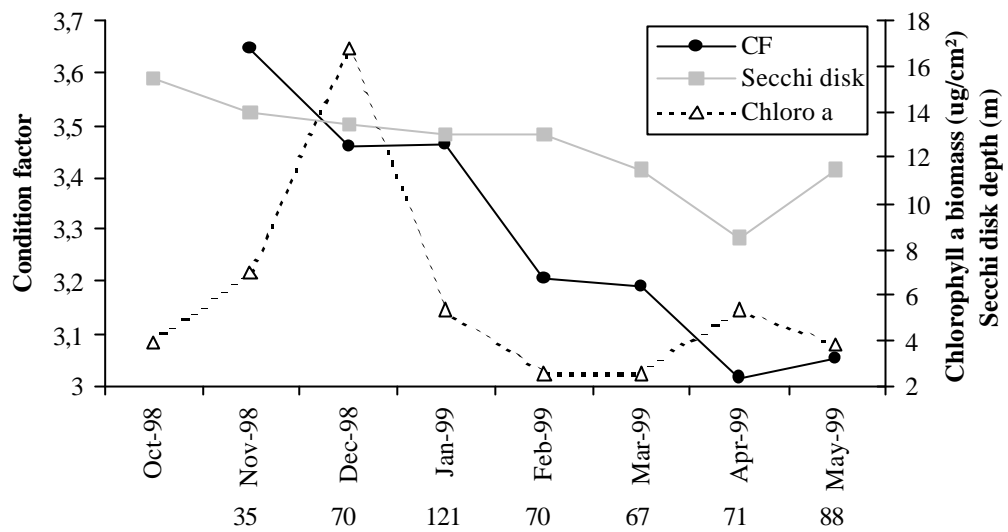


Figure S9. Monthly progression of *Pseudotropheus tropheops* 'orange chest' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumbby west sites. Numbers below the months are the corresponding sample numbers.

At Thumbi west, no correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to search for between months, sites and sex differences. The only factor with a significant effect was month ($F_{7,496} = 24.801$, $p < 0.0001$). Unlike for Nakantenga, there was no interaction between factors. Surprisingly, as Thumbi west was the control site, the mean condition factor strongly decreased from October to May (Figure S9) and differences among months were almost all significant (Table S4). The mean CF was significantly correlated to the Secchi disk measurements (Pearson correlation $r = 0.84$, $p = 0.018$), but not to the chlorophyll a biomass.

Species present only at Nakantenga sites

Pseudotropheus zebra 'red dorsal'

The monthly progression of *Ps. zebra 'red dorsal'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S10a. No correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. All three factors had a significant effect and interactions existed between all of them. Therefore, sites and sex had to be separated in analysis to test for between months differences.

At Nakantenga sheltered site (Nsh), there were significant monthly differences of CF for both females (Figure S10b, $F_{7,499} = 22.978$, $p < 0.0001$) and males (Figure S10c, $F_{7,1248} = 28.919$, $p < 0.0001$). Results of all pairwise Tukey's multiple comparison test are presented in Table S5.

Table S5. Differences of mean condition factor among months for *Pseudotropheus zebra 'red dorsal'* females (*) and males (#) at Nakantenga sheltered site (above the diagonal), and females (*) and males (#) at Nakantenga exposed site (below the diagonal). *, # = significant difference ($p < 0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----						*	# * #
November-98	*	-----					# *	# * #
December-98		*	-----				# *	# * #
January-99	*			-----			# *	# * #
February-99					-----		*	# * #
March-99	*					-----		
April-99		# *	#	*	#	# *	#	-----
May-99		*		*		*		# -----

For both females and males, homogeneous months subsets were October-February versus March-May (Figure S10a and b and Table S5). Using these subsets, CF was significantly lower in March-May than in October-February for both females ($F_{1,505} = 139.718$, $p < 0.0001$) and males ($F_{1,1254} = 192.879$, $p < 0.0001$). Hence, for *Ps. zebra 'red dorsal'*, the effect of season on CF appeared later than for *L. fuelleborni* and *Ps. tropheops 'orange chest'*. The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p > 0.05$).

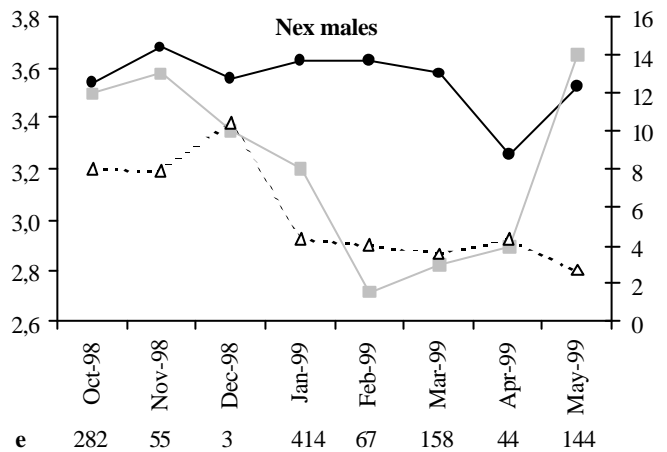
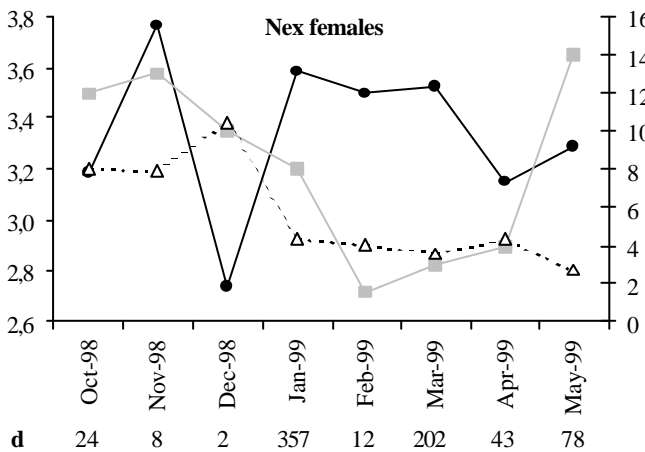
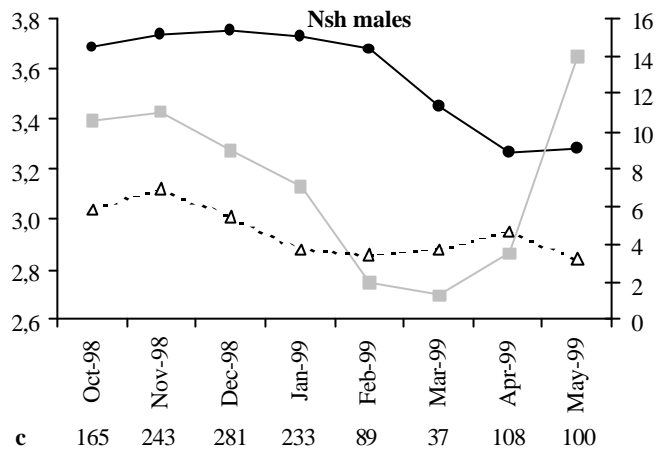
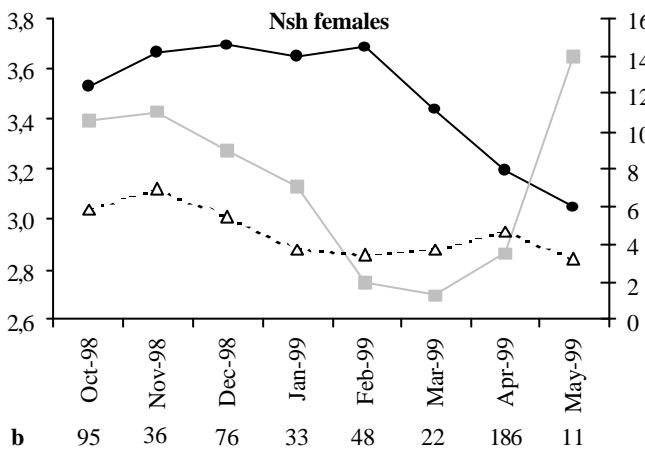
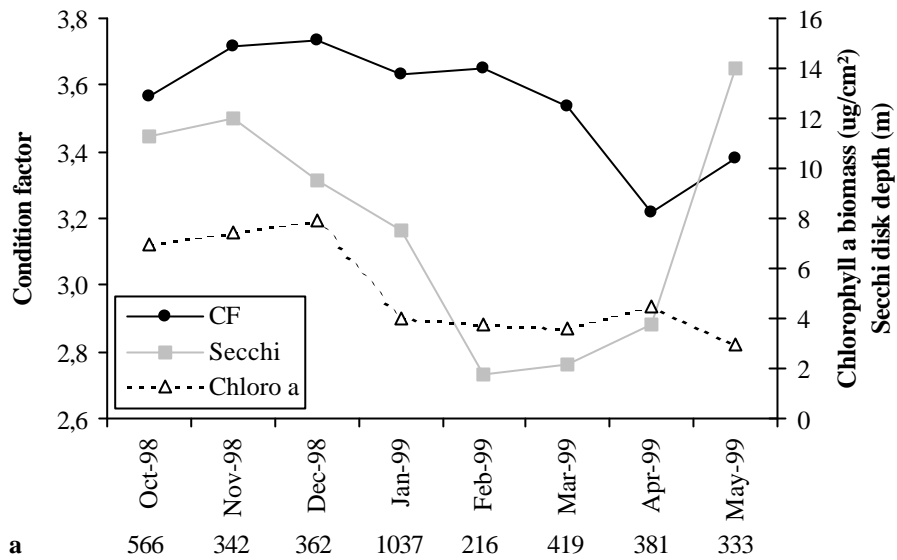


Figure S10. Monthly progression of *Pseudotropheus zebra* 'red dorsal' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga for both sites, females and males pooled (a), at Nakantenga sheltered (Nsh) for females only (b), males only (c) and at Nakantenga exposed (Nex) for females only (d), males only (e). Numbers below the months are the corresponding sample numbers.

At Nakantenga exposed site (Nex), there were also significant monthly differences of CF for both females (Figure S10d, $F_{7,718}=13.742$, $p<0.0001$) and males (Figure S10e, $F_{7,1159}=6.652$, $p<0.0001$). Results of all pairwise Tukey's multiple comparison test are presented in Table S5. Unlike at Nsh site, there was no clear pattern of seasonal variation in CF for both females and males. The mean CF was quite constant from one month to another for males apart from a drop in April (Figure S10e), while it strongly fluctuated for females (Figure S10d). Note that the very low mean CF value in December for females might be due to the very low sample number. The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p>0.05$).

Pseudotropheus zebra 'yellow throat'

The monthly progression of *Ps. zebra 'yellow throat'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S11. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to search for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only factor with a significant effect was month ($F_{7,220}=2.126$, $p=0.042$), indicating that CF differed among months. There was no interaction between factors. Results of all pairwise Tukey's multiple comparison test are presented in Table S6.

Table S6. Differences of mean condition factor among months for *Pseudotropheus zebra 'yellow throat'* (above the diagonal) and *Pseudotropheus zebra 'black dorsal'* (below the diagonal) at Nakantenga sites. * = significant difference ($p<0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----							
November-98	*	-----			*		*	*
December-98			-----	*	*	*	*	*
January-99				-----				
February-99					-----			
March-99	*	*	*	*	*	-----		
April-99		*	*				-----	
May-99	*	*	*	*	*			-----

Homogeneous months subsets were October-December versus January-May (Figure S11 and Table S6). Using these subsets, CF was significantly lower in January-May than in October-December ($F_{1,243}=42.980$, $p<0.0001$). Whereas the effect of season on CF appeared late in the rainy season (March) for *Ps. zebra 'red dorsal'*, it was noticed as soon as January for *Ps. zebra 'yellow throat'*. The mean CF was significantly correlated to the chlorophyll a biomass (Pearson correlation $r=0.943$, $p=0.0005$) but not with the Secchi disk measurements.

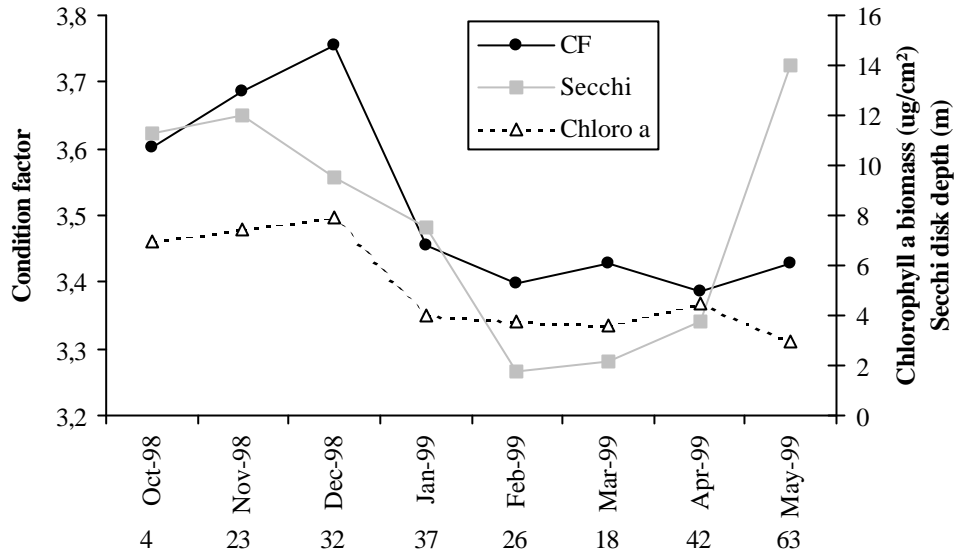


Figure S11. Monthly progression of *Pseudotropheus zebra* 'yellow throat' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass (µg/cm²) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

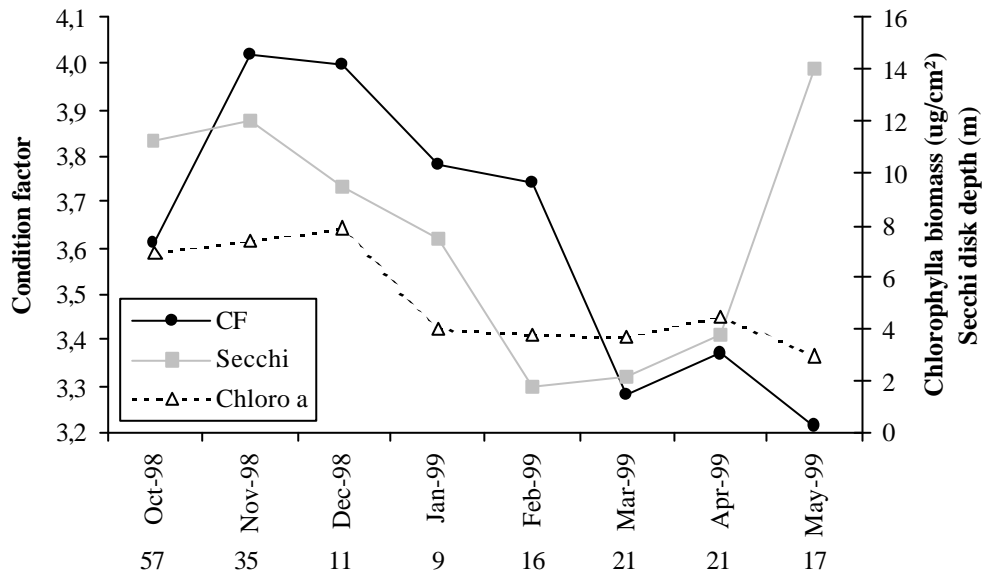


Figure S12. Monthly progression of *Pseudotropheus zebra* 'black dorsal' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass (µg/cm²) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

Pseudotropheus zebra 'black dorsal'

The monthly progression of *Ps. zebra 'black dorsal'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S12. No correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only factor with a significant effect was month ($F_{7,157} = 6.220$, $p < 0.0001$), indicating that CF differed among months. There was no interaction between factors. Results of all pairwise Tukey's multiple comparison test are presented in Table S6. Homogeneous months subsets were October-February versus March-May (Figure S12 and Table S6). Using these subsets, CF was significantly lower in March-May than in October- February ($F_{1,185} = 50.056$, $p < 0.0001$). As for *Ps. zebra 'red dorsal'*, *Ps. zebra 'black dorsal'* influence of season on CF appeared late in the rainy season. The mean CF was significantly correlated to the chlorophyll a biomass (Pearson correlation $r = 0.744$, $p = 0.034$) but not with the Secchi disk measurements.

Petrotilapia 'fuscous'

The monthly progression of *P. 'fuscous'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S13. No correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only factor with a significant effect was month ($F_{7,150} = 10.609$, $p < 0.0001$), indicating that CF differed among months. There was no interaction between factors. Results of all pairwise Tukey's multiple comparison test are presented in Table S7.

Table S7. Differences of mean condition factor among months for *Petrotilapia fuscous'* (above the diagonal) and *Pseudotropheus barlowi* (below the diagonal) at Nakantenga sites. * = significant difference ($p < 0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----		*		*	*	*	*
November-98		-----	*		*	*	*	*
December-98			-----					
January-99				-----			*	*
February-99					-----			
March-99						-----		
April-99	*	*		*	*	*	-----	
May-99	*	*		*	*	*		-----

The difference in mean CF between December and October-November might be a artefact due to the low sample number. Therefore, despite this difference, December was considered as part of the October-January group. Homogeneous months subsets were then October- January,

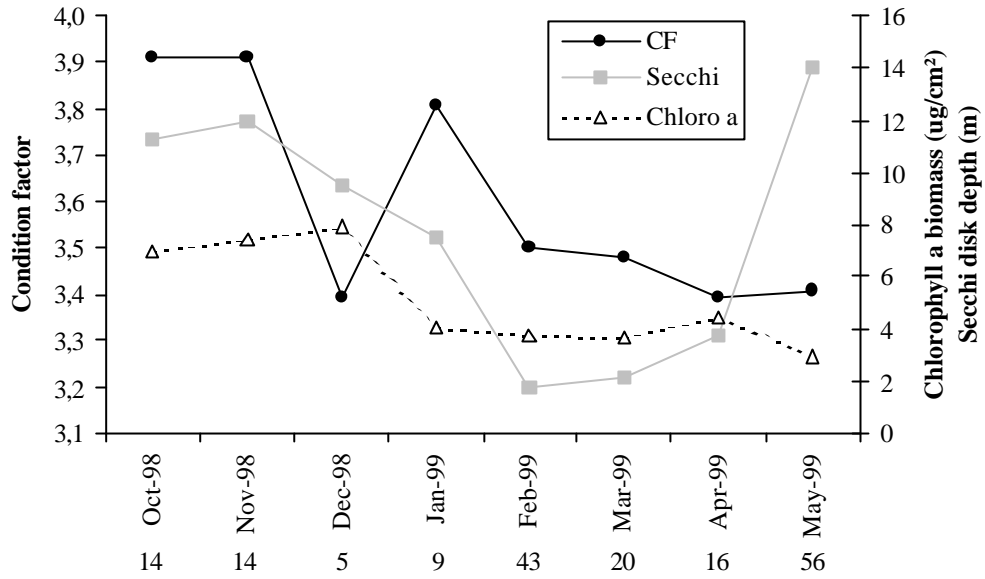


Figure S13. Monthly progression of *Petrotilapia fuscous'* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

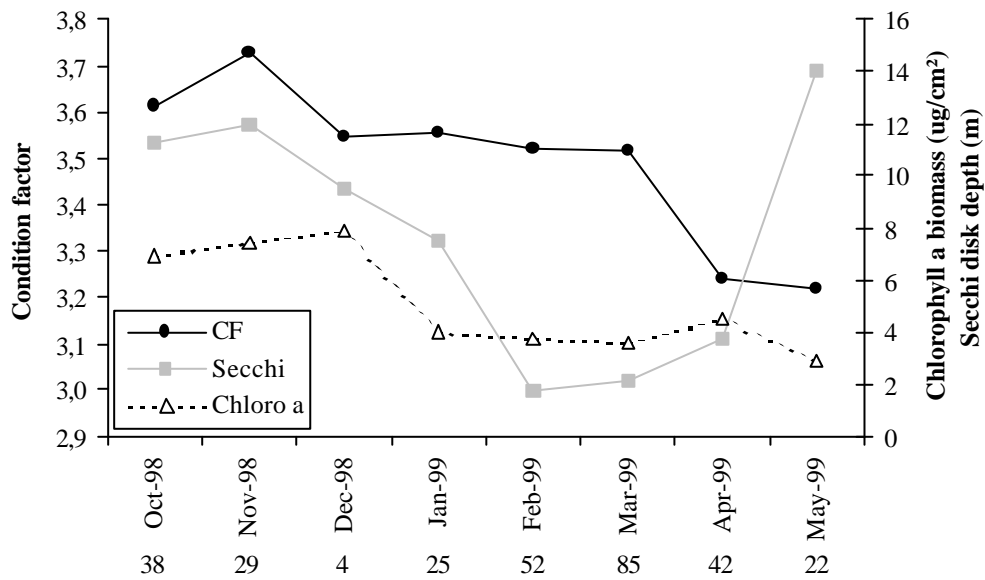


Figure S14. Monthly progression of *Pseudotropheus barlowi* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

versus February-May (Figure S13 and Table S7). Using these subsets, CF was significantly lower in February -May than in October- January ($F_{1,175}=46.847$, $p<0.0001$). Month grouping according to CF temporal variations was the same as for *L. fuelleborni* and *Ps. tropheops 'orange chest'*. The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p>0.05$).

Pseudotropheus barlowi

The monthly progression of *Ps. barlowi* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S14. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only factor with a significant effect was month ($F_{7,271}=7.967$, $p<0.0001$), indicating that CF differed among months. There was no interaction between factors. Results of all pairwise Tukey's multiple comparison test are presented in Table S7. Homogeneous months subsets were October-March versus April-May (Figure S14, Table S7). Using these subsets, CF was significantly lower during the period April-May than the period October-March ($F_{1,295}=48.287$, $p<0.0001$). The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p>0.05$).

Pseudotropheus williamsi

The monthly progression of *Ps. williamsi* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S15. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (Nex and Nsh) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. The only factor with a significant effect was month ($F_{7,171}=3.594$, $p=0.002$), indicating that CF differed among months. There was no interaction between factors. Results of all pairwise Tukey's multiple comparison test are presented in Table S8.

Table S8. Differences of mean condition factor among months for *Pseudotropheus williamsi* at Nakantenga sites. * = significant difference ($p<0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----							
November-98		-----						
December-98			-----					
January-99				-----				
February-99					-----		*	
March-99						-----	*	
April-99							-----	*
May-99								-----

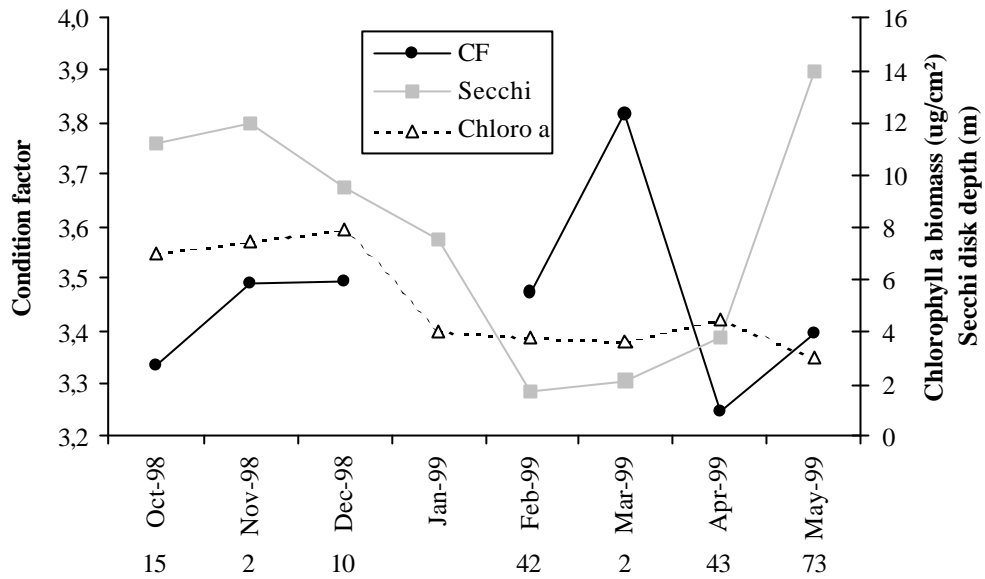


Figure S15. Monthly progression of *Pseudotropheus williamsi* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

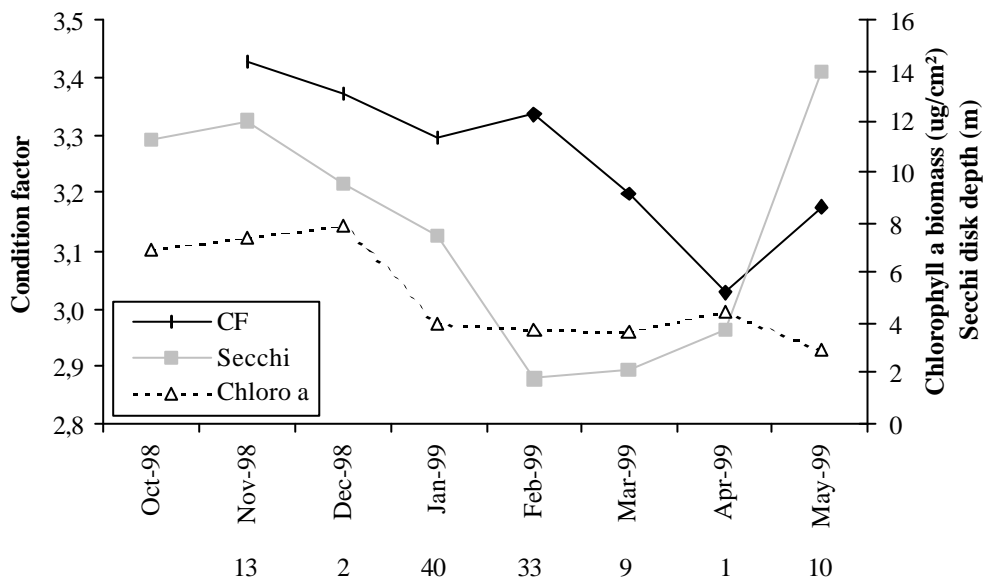


Figure S16. Monthly progression of *Pseudotropheus 'aggressive zebra'* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Nakantenga for both sites. Numbers below the months are the corresponding sample numbers.

The only month differing from the others was April, when mean condition factor was slightly lower. However, the temporal variations of the mean CF did not show any clear seasonal pattern (Figure S15) and season did not seem to have a marked effect on CF for this species. The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p>0.05$).

Pseudotropheus 'aggressive zebra'

The monthly progression of *Ps. 'aggressive zebra'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Nakantenga sites are presented in Figure S16. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months, sites and sex differences using a general linear model with month, site and sex as factors and CF as dependant variable. Despite the fact that the mean condition factor tended to decrease along the rainy season from November to May, none of the factors had a significant effect indicating that the observed differences were not significant. The mean CF was correlated neither with the Secchi disk measurements, nor the chlorophyll a biomass (Pearson correlation $p>0.05$).

Species present only at Thumbi west sites

Pseudotropheus zebra

The monthly progression of *Ps. zebra 'red dorsal'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Thumbi west sites are presented in Figure S17a. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (T13 and T13) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. All three factors had a significant effect and interactions existed between month and site, and between month and sex. Therefore, sites and sex had to be separated in analysis to test for monthly differences.

At Thumbi T13, there were significant monthly differences of CF for both females (Figure S17b, $F_{7,283}=3.96$, $p<0.0001$) and males (Figure S17c, $F_{7,654}=2.381$, $p=0.021$). Results of all pairwise Tukey's multiple comparison test are presented in Table S9.

Table S9. Differences of mean condition factor among months for *Pseudotropheus zebra* females (*) and males (#) at Thumbi T13 site (above the diagonal), and females (*) and males (#) at Thumbi T8 site (below the diagonal). *, # = significant difference ($p<0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----	*						
November-98		-----	*				#	
December-98			-----	*	*			
January-99		#		-----				
February-99		#			-----			
March-99	*	# *		*	# *	#	-----	
April-99	*	# *	#	*	# *	#		-----
May-99	*	#	#	*	# *	#		-----

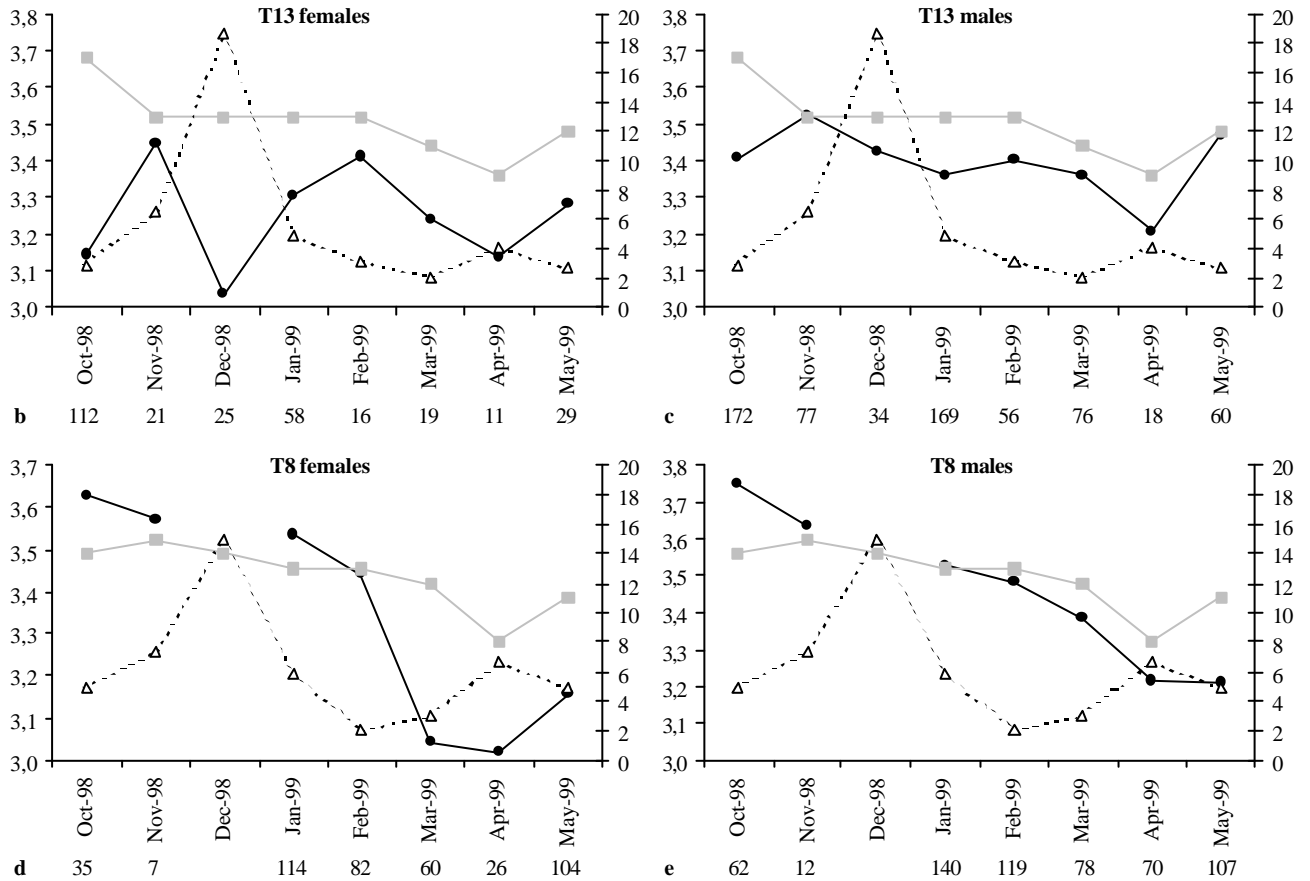
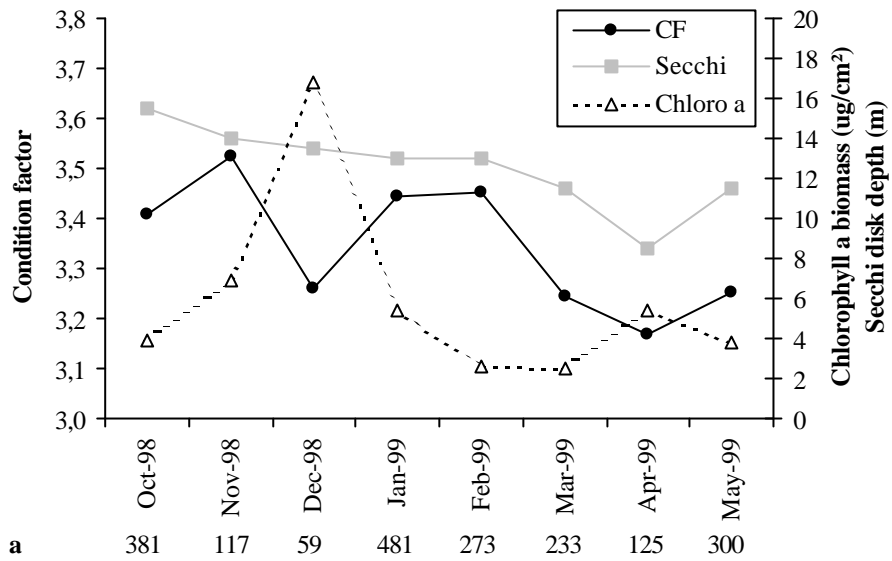


Figure S17. Monthly progression of *Pseudotropheus zebra* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumby west for both sites, females and males pooled (a), at Thumby T13 for females only (b), males only (c) and at Thumby T8 for females only (d), males only (e). Numbers below the months are the corresponding sample numbers.

Despite some significant differences among months, there was no evidence of seasonal effect on CF for females (Figure S17b), and only a slight decreasing trend for males (Figure S17c). The mean CF was correlated neither with the Secchi disk measurements, nor with the chlorophyll a biomass (Pearson correlation $p > 0.05$) for both females and males.

At Thumbi T8, there were significant monthly differences of CF for both females (Figure S17d, $F_{7,421}=21.746$, $p < 0.0001$) and males (Figure S17e, $F_{7,581}=18.289$, $p < 0.0001$). Results of all pairwise Tukey's multiple comparison test are presented in Table S9. A clear decreasing pattern of mean CF along the rainy season was observed for both females (Figure S17d) and males (Figure S17e) and the following month subsets emerged: October-February versus March-May. Using these subsets, CF was significantly lower during the period March-May than during the period October-February for both females ($F_{1,426}=119.450$, $p < 0.0001$) and males ($F_{1,586}=86.061$, $p < 0.0001$). The mean CF was significantly correlated to the Secchi disk measurements for both females ($r=0.843$, $p=0.017$) and males ($r=0.842$, $p=0.017$), but not with the chlorophyll a biomass.

Pseudotropheus tropheops 'red cheek'

The monthly progression of *Ps. tropheops 'red cheek'* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Thumbi west sites are presented in Figure S18. No correlation was observed between CF and length of fish (Pearson correlation $p > 0.05$), allowing to test for between months (October to May), sites (T13 and T8) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. Both month ($F_{7,165}=6.651$, $p < 0.0001$) and sex ($F_{1,165}=9.534$, $p=0.002$) had a significant effect on the mean condition factor. There was no interaction among factors. Results of all pairwise Tukey's multiple comparison test for months are presented in Table S10.

Table S10. Differences of mean condition factor among months for *Pseudotropheus tropheops 'red cheek'* (above the diagonal) and *Pseudotropheus callainos* (below the diagonal) at Thumbi west sites. *, # = significant difference ($p < 0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----		*		*		*	*
November-98		-----					*	*
December-98			-----					
January-99	*			-----			*	*
February-99	*				-----			
March-99	*					-----	*	*
April-99	*			*			-----	
May-99	*			*				-----

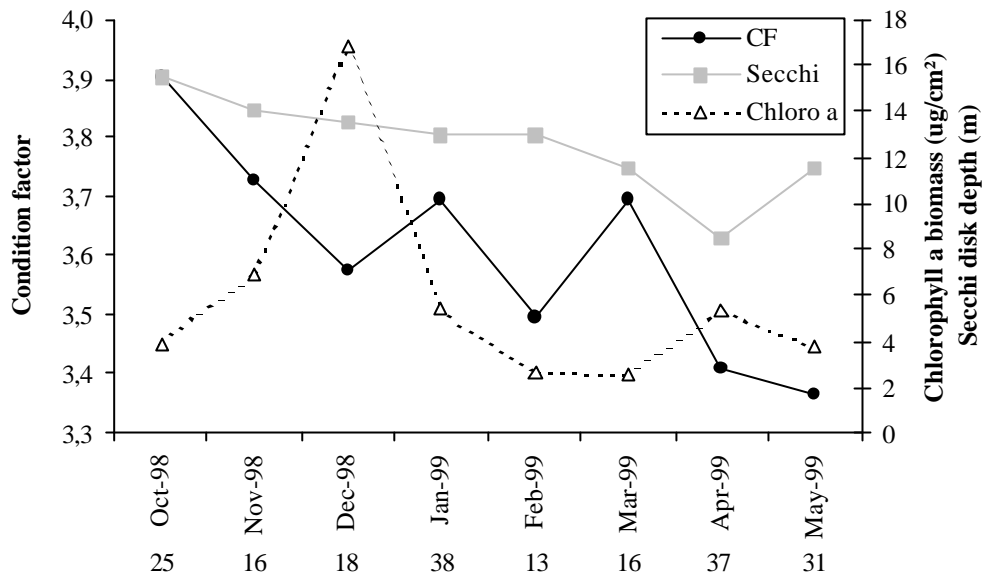


Figure S18. Monthly progression of *Pseudotropheus tropheops* 'red cheek' mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumby west for both sites. Numbers below the months are the corresponding sample numbers.

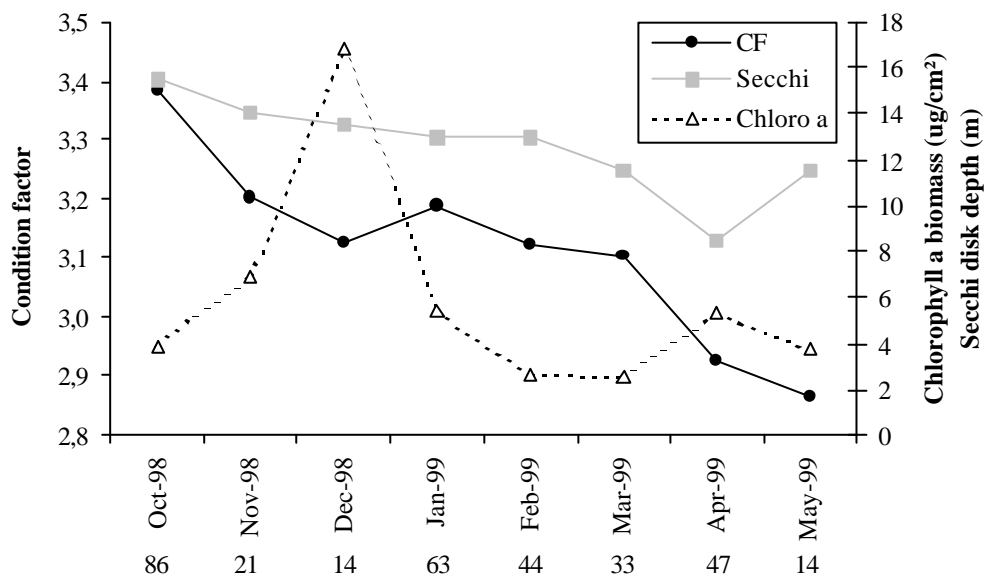


Figure S19. Monthly progression of *Pseudotropheus callainos* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumby west for both sites. Numbers below the months are the corresponding sample numbers.

Despite the clear tendency of mean CF to decrease along the rainy season (Figure S18), it was not possible to group months (i.e. October-January versus February-May) owing to the significant difference between March and April and May (Table S10). However, separating April-May from the other months, the mean CF was significantly lower in April-May ($F_{1,192}=37.886$, $p<0.0001$). The mean CF was significantly correlated to the Secchi disk measurements ($r=0.768$, $p=0.026$), but not with the chlorophyll a biomass.

Pseudotropheus callainos

The monthly progression of *Ps. callainos* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Thumbi west sites are presented in Figure S19. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (T13 and T8) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. Month had a significant effect ($F_{7,294}=4.050$, $p<0.0001$), indicating that the mean CF differed among months. There was no interaction among factors. Results of all pairwise Tukey's multiple comparison test for months are presented in Table S10. Statistical results exactly translated the trend observed on Figure S19, where the mean condition factor steadily decreased from October to December, was relatively constant from December to March then decreased again in April and May. The mean CF was significantly correlated to the Secchi disk measurements ($r=0.870$, $p=0.005$), but not with the chlorophyll a biomass.

Pseudotropheus aurora

The monthly progression of *Ps. aurora* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Thumbi west sites are presented in Figure S20. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (T13 and T8) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. Month had a significant effect ($F_{7,270}=11.242$, $p<0.0001$), indicating that the mean CF differed among months. There was no interaction among factors. Results of all pairwise Tukey's multiple comparison test for months are presented in Table S11.

Table S11. Differences of mean condition factor among months for *Pseudotropheus aurora* at Thumbi west sites. *, # = significant difference ($p<0.05$).

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
October-98	-----	*			*	*	*	*
November-98		-----	*	*	*	*	*	*
December-98			-----		*		*	
January-99				-----	*	*	*	*
February-99					-----		*	
March-99						-----	*	
April-99							-----	*
May-99								-----

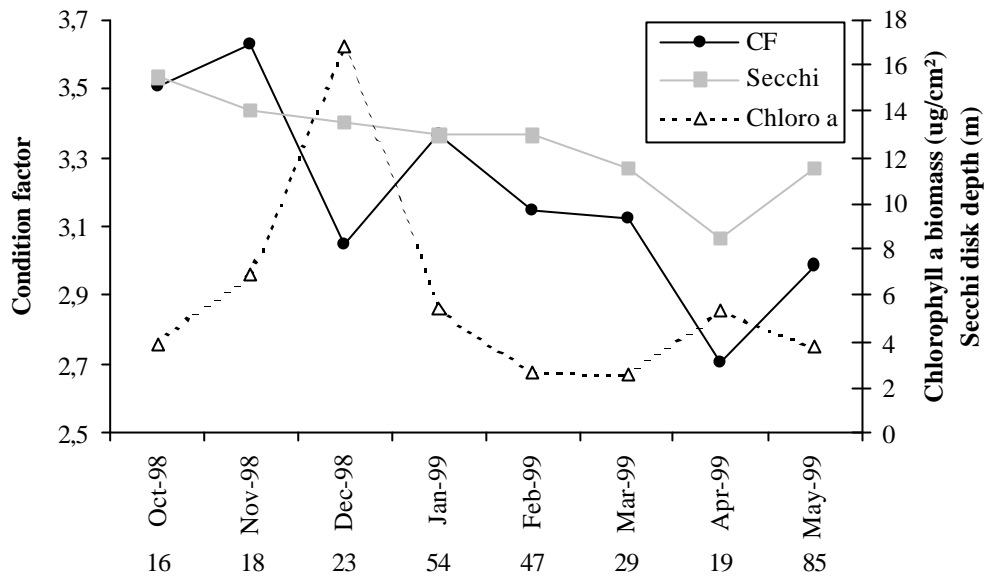


Figure S20. Monthly progression of *Pseudotropheus aurora* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumby west for both sites. Numbers below the months are the corresponding sample numbers.

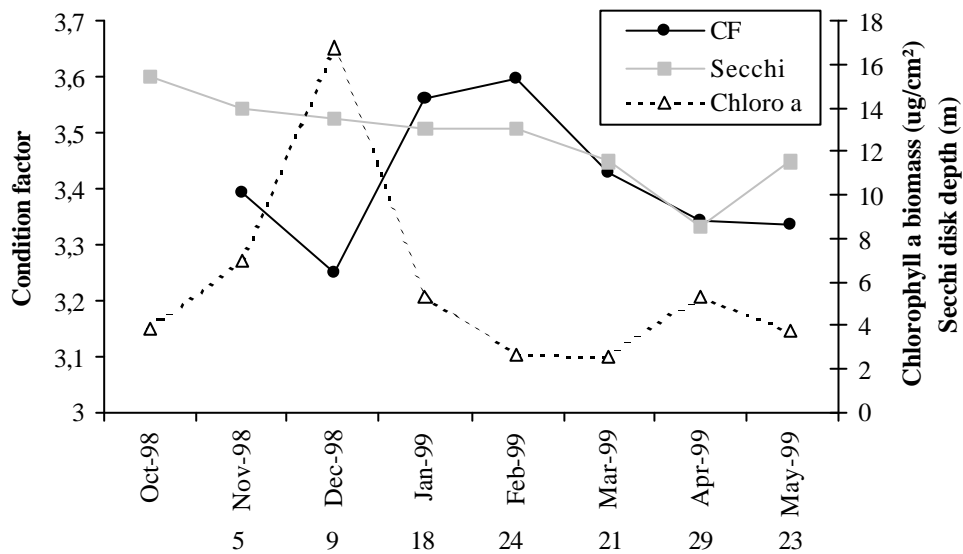


Figure S21. Monthly progression of *Petrotilapia nigra* mean condition factor, Secchi disk measurements (m) and benthic chlorophyll a biomass ($\mu\text{g}/\text{cm}^2$) at Thumby west for both sites. Numbers below the months are the corresponding sample numbers.

A similar pattern as that of *Ps. callainos* was observed for *Ps. aurora*, with the mean condition factor decreasing from November to December, a plateau phase from December to March and then another decrease in April-May (Figure S20). During what we called the plateau phase, a sharp increase of the mean CF arose in January as for most of the species at Thumbi sites, though in a lesser extent. Statistical results confirmed that most of the observed differences were significant. The mean CF was significantly correlated to the Secchi disk measurements ($r=0.829$, $p=0.011$), but not with the chlorophyll a biomass.

Petrotilapia nigra

The monthly progression of *P. nigra* mean condition factor, Secchi disk measurements and benthic chlorophyll a biomass at Thumbi west sites are presented in Figure S21. No correlation was observed between CF and length of fish (Pearson correlation $p>0.05$), allowing to test for between months (October to May), sites (T13 and T8) and sex (females and males) differences using a general linear model with month, site and sex as factors and CF as dependant variable. None of the factors had a significant effect on mean condition factor, which translated the absence of seasonal effect on CF (Figure S21). The mean CF was correlated neither with the Secchi disk measurements nor the chlorophyll a biomass.

Discussion

Parallel to this study of rocky shore fish communities (September 1998 to April 1999), the impact of suspended sediments on the abundance and species richness of near-shore sandy fishes was investigated along a sedimentation gradient from Linthipe river mouth to 35 km northwards, during the course of a Master's degree (Sululu 2000). In Lake Tanganyika, Cohen et al. (1993a) compared the biodiversity and abundance of ostracods, diatoms and fish species in sites permanently characterised by diverse degrees of sedimentation disturbances, but for which no baseline data were available to assess the state of species communities before the apparition of the permanent disturbance. The originality of both Sululu's and ours studies, compared to that of Cohen et al. (1993a), lies in that we investigated the short term effects of a temporary sediment disturbance on sites for which pre-disturbance state was (previously) assessed.

In Lake Tanganyika, sites highly impacted by sedimentation had a lower species richness and species abundance than non impacted sites, and sites characterised by an intermediate disturbance had intermediate species richness and abundance (Cohen et al. 1993a). In Lake Malawi, significant variations in the abundance and species richness of sand-dwelling fish were observed before and during the sedimentation period at the station closest to the Linthipe river mouth in gillnet catches, but not in beach seine catches (Sululu 2000). However, over all the stations sampled by beach seine, the mean abundance of cichlids rose during the rainy season, while species richness declined (Sululu 2000). Some fluctuations in the relative abundance of rock-dwelling species were observed among months at both Nakantenga and Thumbi sites. However, these variations were not significant. Thumbi west sites housed a slightly higher number of species than Nakantenga sites and on both islands exposed sites were richer than protected ones: 24, 27, 30 and 33 species for Nsh, Nex, T13 and T8 respectively. However, within each site, the number of species did not changed along the rainy season, thus during the disturbance period.

Close to the Linthipe river mouth, both species richness and abundance of sand-dwelling fishes showed overall significant negative correlation with the concentration of suspended sediments (Sululu 2000). The concentration of suspended sediment was assessed by Secchi disk measurements in our case. Correlation between species richness or abundance and

concentration of suspended sediment was not investigated as species richness and abundance did not differ significantly. On the other hand, a striking pattern appeared when looking at the relationship between the fishes mean condition factor and the Secchi disk measurements or the mean chlorophyll a biomass. Despite often similar monthly progression, there was very few significant correlation between the species mean CF and these two parameters. However, at Nakantenga, the mean CF of species, when significant, was always positively correlated to the chlorophyll a biomass ($r=0.744$, $p=0.034$ for *Ps. zebra* 'black dorsal' and $r=0.943$, $p=0.0005$ for *Ps. zebra* 'yellow throat'), whereas it was always correlated with the Secchi disk depth when significant at Thumbi West ($r=0.829$, $p=0.011$ for *Ps. aurora*; $r=0.870$, $p=0.005$ for *Ps. callainos*; $r=0.768$, $p=0.026$ for *Ps. tropheops* 'red cheek'; $r=0.843$, $p=0.017$ for females, $r=0.842$, $p=0.017$ for males *Ps. zebra* at T8). Chlorophyll a biomass was found to fluctuate very little in Thumbi West sites (Figure S4) apart from a temporary large peak resulting from land runoff. On the other hand, water clarity (assessed by Secchi disk measurements) decreased slightly but steadily from October to April-May (Figure S4). A decreased visibility might interfere with plankton foraging for the partly plankton feeding species of the *Ps. zebra* complex and account for a decreased condition. But it is more difficult to explain the influence of a slightly decreased water clarity on a preferentially aufwush feeder like *Ps. tropheops* 'red cheek', especially if the effect of water transparency does not affect algae biomass. Suspended particles, though not as abundant as at Nakantenga, might decrease the nutritional value of the benthic detritus and algae (Cohen et al. 1993b), accounting for the observed decreased condition of fish species. Next, if a slight decline of water clarity affects the fish condition, why for none of the species (not even species of the *Ps. zebra* complex) the CF was correlated to Secchi disk measurements at Nakantenga where the visibility strongly decreased? A likely explanation is that unlike the monthly mean chlorophyll biomass, which probably reflected real monthly trends (see results), monthly Secchi disk measurements, taken once a month, may not represent monthly trends at Nakantenga, but rather transient trends. Indeed, even though the island was most of the time surrounded by "cloudy waters" from February to April-May, the dense sediment plume resulting in very poor visibility was going back and forth according to wind and current direction. Given the observed steady sediment deposition on rocks from February to April-May at Nakantenga, and the subsequent decline of algal biomass, it appears logical that fish condition was rather correlated to algae biomass, even if this correlation was significant for a few species only.

At Thumbi West sites, an sudden increase of the mean condition factor was observed for all the species in January. As this increase occurred for every species, it is likely to be a consequence of the algae biomass peak recorded in December at every site in Thumbi Island.

The influence of suspended sediment on life history characteristics could only be assessed on two species present at both islands and abundant enough at both of them. For both species (*L. fuelleborni* and *Ps. tropheops* 'orange chest') no significant difference of size at maturity, fecundity or oocyte weight was observed between the site highly impacted by fluvial sediment (Nakantenga) and the control site (Thumbi West).

The mean condition factor showed a clear decreasing trend along the rainy season (i.e. during the sediment plume's influence) for every species but one at Nakantenga sites. More surprising was the same tendency, though in a lesser extent, observed at Thumbi West sites, which were supposed to be the sediment free or control sites. Although the sediment plume was seen once surrounding Mumbo Island off Cape Maclear, it never reached Thumbi West. Also there is no major river at Cape Maclear and despite deforestation problems on the steep slopes of the Nankumba peninsula resulting in some silt deposition on the rocky shores (Bootsma 1992), Thumbi West is by far less impacted by sedimentation than Nakantenga.

Table S12. Homogeneous months grouping for between-season comparison of mean condition factor per species at Nakantenga. White bars, mean CF does not differ from the dry season mean value. Black bars, mean CF significantly lower than the dry season mean value. Absence of bars means that season had no effect on the CF.

Species	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	
<i>Ps. zebra</i> 'red dorsal'	White bar					Black bar			
<i>Ps. zebra</i> 'yellow throat'	White bar			Black bar					
<i>Ps. zebra</i> 'black dorsal'	White bar					Black bar			
<i>Ps.</i> 'aggressive zebra'	White bar					Black bar			
<i>Petrotilapia</i> 'fuscous'	White bar				Black bar				
<i>Ps. barlowi</i>	White bar						Black bar		
<i>Ps. williamsi</i>									
<i>Labeotropheus fuelleborni</i>	White bar					Black bar			
<i>Ps. tropheops</i> 'orange chest' M	White bar				Black bar				
<i>Ps. tropheops</i> 'orange chest' F	White bar					Black bar			

Table S13. Homogeneous months grouping for between-season comparison of mean condition factor per species at Thumbby west. White bars: mean CF does not differ from the dry season mean value. Black bars: mean CF significantly lower than the dry season mean value. Grey bars: intermediate state. Absence of bars means that season had no effect on the CF.

Species	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	
<i>Ps. zebra</i>	White bar					Black bar			
<i>Ps.</i> <i>tropheops</i> 'red cheek'	White bar						Black bar		
<i>Ps. callainos</i>	White bar		Grey bar			Black bar			
<i>Ps. aurora</i>	White bar		Grey bar			Black bar			
<i>Petrotilapia nigra</i>									
<i>Labeotropheus fuelleborni</i>									
<i>Ps. tropheops</i> 'orange chest'	White bar		White bar		Black bar		Black bar		

Benthic algal biomass and water clarity measurements along the course of this study clearly supported this statement. However, Thumbi West might possibly not be considered as a real sediment free site, which would account for the observed results.

The decrease of mean condition factor along the rainy season did not start at the same time for every species at Nakantenga (Table S12). Depending on species, the date at which the mean CF started to significantly decrease varied from January to April, but for most of them it started in March (50%) and February (25%), which was the period when the Linthipe river discharge was maximum (Figure S3), the water clarity the worst and the algae biomass the lowest (Figure S4). A similar tendency was observed at Thumbi West site (Table S13), but the difference in CF appeared more progressively to become really significant later in the season for most of the species. It is interesting to note that for most of the species at Thumbi West, the lowest CF were recorded in April-May, when algae biomass and water clarity had already started to increase (Figure S4).

The influence of season on the mean CF was also observed to vary between sites at each island. At Nsh, for *Ps. zebra* 'red dorsal' season had the same significant effect on CF for both females and males whereas no effect was detected at Nex for either sex. At Thumbi West T8, for *Ps. zebra*, season had the same significant effect on CF for both females and males whereas no effect was detected at site T13 for either sex. Interestingly, these species are ecological equivalent on the two islands and were the two most abundant species.

The hypothesis that during the sediment plume, the fish would move upwards from the deep waters to the shallows to compensate for the shortage of food availability in the deeper waters, was not verified during this study. At Nsh site, only one species was found more abundant at 2 m during the rainy season. Two species were more abundant at 6 m and 3 at 10 m, whereas only 2 species were less abundant at 10 m and one at 6 m. At Nex site, three species were found less abundant at 10 m and one at 6 m during the rainy season, whereas at each depth one species was found more abundant. At Thumbi West sites, only three species were less abundant at 6 m during the rainy season, whereas two were more abundant at 10 m, three at 6 m and six at 2 m. Furthermore, none of these trends were significant. However, it is likely that the monthly sampling frequency was not adequate to reveal such a phenomenon, which is probably rather transient. Indeed, during one sampling at Nakantenga exposed site in February 1999, we experienced an exceptional event. A dense sediment plume was settled around the island, water visibility being less than 2 m at the surface (Secchi disk depth: 1.5 m), when a narrow band (about 20 m width) of clearer water drifted towards our site. We quickly equipped ourselves with scuba gears and slates, and jumped down the water to observe the fishes behaviour during that event. Before the arrival of the clearer water band, fishes were moving only very little, staying within a 50 cm radius from their hiding hole, some of them not moving at all, behaving as if it were night. When the clearer water band reached the site, within seconds all the fishes gathered in the water column near the surface in a huge crowd cropping frenetically upon plankton. A few minutes later, the clear water was gone and the fishes almost instantaneously returned down to their respective hiding holes, as if nothing had happened and it were night again (Ribbink & Duponchelle, unpublished data). This quick observation might actually be what happens when the wind and currents drive the plume away from the island. Opportunistic behaviour and ability to food switching of *mbuna* are well documented (Fryer & Iles 1972, McKaye & Marsh 1983, Ribbink et al. 1983, Reinthal 1990). Our hypothesis is that during darkness resulting from the dense plume's presence, *mbuna* would spend very little energy in territorial and sexual activity given the poor visibility and in feeding upon scarce and/or blanketed benthic material with diminished nutritional value. Instead of that, they would keep resting, expensing only limited amounts of

energy, awaiting for improved environmental conditions. As soon as visibility improves, they all move in the water column towards the shallows, feeding upon the large amounts of plankton flourishing from the nutrients associated with suspended particles, making up for the food deprivation endured or building up reserves. This strategy would allow the highly stenotopic *mbuna* to pass through the still-temporary disturbance occasioned by the suspended sediment. It would explain why, unlike the easily-moving sand-dwelling species, no significant variations in species richness or abundance were observed and why only a decreased body condition was recorded for *mbuna*. The stable isotope samples taken during this study but unfortunately not available at the moment might shed some light and support or reject that hypothesis.

This study is considered as preliminary. A clear decreased in body condition was observed for almost every species during the period of the sediment plume's influence. However, our results also suggest that a sampling design with much shorter sampling intervals is necessary to better understand the dynamics of rock-dwelling fish reaction to suspended sediment disturbance. A regular stomach content analysis before and during the sedimentation period would help testing our hypothesis. Multivariate analysis of the data, which would help clarifying the observed trends, was not possible given the time constraint over this report, but will be carried out ultimately. Despite the seasonal and temporary effects of suspended sediment, still restricted to the rainy season, impacts have already been detected on sandy (Sululu 2000) and rocky fish communities. Given the increase of anthropogenic activities that lead to habitat degradation and increased erosion around the Lake shore and the steadily increasing human population, this impact is very likely to considerably worsen in the coming years.