Department of Ichthyology and Fisheries Science

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Research Report Series 2008

RHODES UNIVERSITY
Department of Ichthyology and Fisheries Science
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(Final Version)

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Edited by: C.L.W. Jones & A.J. Green

Schedule of Events/Table of Content

Wednesday 8 October 2008

08h50-09h00: Welcome by Prof. P. Britz (Head of Department)

Honours seminars (Chair: Dr O. Weyl)

09h00-09h20: Ashley Grimmer (BSc Honours) – Population dynamics, reproductive and feeding biology of the invasive western mosquitofish *Gambusia affinis* (Baird & Girard, 1953) in the Great Fish River

Supervisors: Prof. T. Booth (t.booth@ru.ac.za), Dr O. Weyl (o.weyl@ru.ac.za) and Dr W. Potts (w.potts@ru.ac.za)

Funders: National Research Foundation, Rhodes University JRC

Gambusia affinis has been documented in the freshwaters of South Africa. The species is assumed to compete against, and prey on, local species thus applying biological pressure on the freshwater systems. It has, in the past century, been used extensively as a bio-control agent for the control of larval mosquitoes. However, its success is disputed with *G. affinis* having a negligible effect on mosquito numbers in problem areas, while displacing native species (Lydeard & Belk 1993; Haas et al. 2003).

Specific aims of the study will be to explain the population dynamics of this species in terms of length frequencies and sex ratios, describe aspects of the reproductive biology such as breeding times and fecundity, to calculate maturity curves, and to describe the diet and feeding preferences.

Sampling was conducted at Double Drift on the Fish River on a monthly basis between February 2008 and July 2008, using a 1 mm stretched mesh juvenile seine net (n=473). An additional a 24-hour successive sample was taken, so to assess the diel feeding patterns (n=213). Gut contents were analyzed by use of an index of relative importance, and identified to the lowest taxonomic level possible. All fish were weighed, measured (TL) and staged. Size at sexual maturity was calculated by fitting a logistic ogive to the proportion of mature fish.

An ogive indicated that males and females mature at 19.1 and 27.1 mm, respectively. These results are similar to those of Keane & Neira (2004) for the closely related *G. holbrooki*. Seasonal variation in the OSI suggests that *G. affinis* breeds during summer and early spring. This result was attenuated by the presence of mature stages of oocyte development in the ovaries during this time and lack of breeding individuals during late spring and winter. The modal lengths for each sex was found to be significantly different ($T = 14.28$, $p < 0.05$) with females reaching larger sizes than males. The sex ratio of male:female increased from 1:1 in February to 1:3.3 in July. This is expected as many wild poeciliid populations contain disproportionately high numbers of females even though equal numbers of both sexes often occurs at birth (Keane & Neira, 2004).

References

Haas R, Thomas M & Towns G (2003) An assessment for the potential use of Gambusia for mosquito control in Michigan. *Fisheries Technical Report*. 2003-2.

Keane J & Neire F (2004) First record of mosquitofish, Gambusia holbrooki, in Tasmania, Australia: stock structure and reproductive biology. *New Zealand Journal of Marine and Freshwater Research*. **38**: 857 – 867.

Lydeard C & Belk M (1993) Management of indigenous fish species impacted by introduced mosquitofish: An experimental approach. *The Southwestern Naturalist* **38**(4): 370-373.

09h20-09h40: Kate Munnik (Bsc Honours) – The biology of the river goby, *Glossogobius callidus*, in the Great Fish River, South Africa

Supervisors: Prof. A.J. Booth (t.booth@ru.ac.za), Dr W.M. Potts (w.potts@ru.ac.za) and Dr O.L.F. Weyl (o.weyl@ru.ac.za)

Funders: National Research Foundation, Rhodes University JRC

There is currently little available literature on the general biology of the river goby, *Glossogobius callidus*. It is essential to understand the fundamental aspects of the biology of this species, in order to properly evaluate its role within freshwater ecosystems of the Eastern Cape. This will allow the determination of its effects on the benthic, aquatic micro-invertebrate populations on which it feeds, and the potential for it to be used as a mechanism for pest control.

The specific objectives of this study are to determine differences in growth and size between males and females, and describe the diet of the species to determine whether there are any ontogenetic changes in this diet. Further objectives are to determine when *G. callidus* spawns, the male and female lengths at maturity and the female to male sex ratio.

Monthly sampling was done at Pikoli Dam on the Great Fish River between April and September 2008. An 8m x 1m seine net with a stretched mesh size of 2mm was used to collect samples. In the laboratory, all fish (n=400) were weighed and measured. The gonads were staged using a 6 stage macroscopic staging index. A logistic ogive was used to determine the lengths at maturity. The gut contents for three months (n=90) were analysed using the index of relative importance method.
It was found that females were more abundant than males (F:M 1.72) and males were significantly larger than females (t-value=-4.518, $p<0.001$). Gender could be determined through external observation of sexually dimorphic papilla. A logistic ogive showed *G. callidus* to reach 50 percent maturity at 37.8 mm (SL).

The average length and the number of fish caught decreased during the winter months and correlated significantly with water temperature ($r^2=0.698$). It is suspected that larger fish move to deeper waters with a decrease in temperature.

The gut content analysis showed chironomid larvae to be the most frequently occurring and most important prey species throughout the year. Seasonal shifts in diet are shown by the difference in IRI values where relative importance is seen to be shifting from chironomids to *Daphnia*. The range of orders preyed upon by *G. callidus* suggests it is an opportunistic, benthic predator.

09h40-10h00: David Churches (BSc Honours) – Resource use overlap between fishes of the littoral zone Lake Gariep, South Africa

Supervisors: Dr O. Weyl (o.weyl@ru.ac.za) and Prof. A.J. Booth (t.booth@ru.ac.za)

Funders: National Research Foundation (FA2005021600012), Rhodes University JRC

The littoral zone ichthyofauna of Lake Gariep consists mainly of six fish species which are indigenous to the Orange River and one alien invasive species. The littoral zone is considered to be an important nursery area for juvenile fish and is utilised by large quantities of fish during their early life stages. The littoral zone provides both habitat and food for these species. Since food source diversity may be limited it is important to determine whether there is any resource use overlap between the fish within the littoral zone. It is hypothesised that the alien invasive *Cyprinus carpio* may have the potential to compete with indigenous species within this zone. This may have ecological implications such as a reduction in the population size of indigenous species, if *Cyprinus carpio* is able to out-compete indigenous fish.

The first objective of this study was to determine the species composition and relative abundance within the littoral zone and whether this is influenced by the varying habitats. The second objective is to determine the dietary characteristics of the species and whether there is any overlap between the species with the use of gut content analysis providing the short term diet and stable isotope analysis to determine the medium-term dietary trends.

The study consisted of three bimonthly surveys consisting of ten sites, in May an additional 62 sites covering most of Lake Gariep's shoreline. Two hauls where conducted at each site using an 8m seine net and the habitat type and site vegetation was recorded. The fish where preserved in formalin on site. Additional samples were collected for the stable isotope analysis and preserved on ice. The samples where all identified, measured and recorded. Gut content analysis was conducted on 30 individuals of each species from the most representative size classes. The CPUE data indicates that the community structure is affected by the habitat type as well as the amount of vegetation present. The $\chi 2$ test showed that there is a difference in the community structure when communities with and without *Cyprinus carpio* are compared ($p < 0.02$). The IRI indicates that the different species are feeding on different prey items with a small amount of overlap, this result is confirmed with the stable isotope analysis which shows a clear medium term dietary trend.

10h00-10h20: Alan Foulis (BSc Honours) – Validated age and growth estimates of the spotted gully shark *Triakis megalopterus* with an evaluation of a new aging method

Supervisors: Dr M. Smale (msmale@bayworld.co.za) and Prof. A. J. Booth (t.booth@ru.ac.za)

Funder: Prof. A.J. Booth (t.booth@ru.ac.za), Rhodes University JRC

Age and growth estimates are one of the fundamentals in fisheries management for the determination of longevity, growth and maturation rates. Validating age estimates are therefore critical. No previous study has been done on *T. megalopterus*. The aims if this study were to 1) validate the age and growth of the specimens using oxytetracyclene (OTC) and 2) to investigate Computer Assisted Tomography (CT) as an alternative technique.

Material used were collected over a period of 12 years. For each shark sampled, 5-7 post-cranial vertebrae were removed, cleaned, set in polyester resin, sectioned and mounted on glass slides. Vertebral bands were interpreted twice, 3 weeks apart using transmitted light. Twelve samples were from sharks that had been previously injected with OTC and these vertebrae were read using ultraviolet light.

A von Bertalanffy growth model was fitted to the data (n=97) and predicted a theoretical maximum size (L_∞) of 1592.28 mm (Total Length), a growth coefficient (K) of 0.139 $year^{-1}$ and a theoretical age at zero length (t_0) of -1.94 years for males, $L\infty$=1701.23 mm (TL), K=0.113 and a t_0=-2.44 for females, and a $L\infty$=1449.13, K=0.207 and a t_0=-0.54 for both sexes combined. Average percent error and percent error were 7.5 % and 3.25 %, respectively. All samples injected with OTC showed complete calcium chelation and that a single opaque and translucent band pair was deposited annually.

CT scanning of the vertebrae proved unsuccessful as a method to age *T. megalopterus*.

10h20-10h55: Tea break

Honours seminars continued (Chair: Dr O. Weyl)

11h00-11h20: Craig Midgley (BSc Honours) – A study on the hooking efficiency and consequences of post capture mortality using circle and j shaped hooks on three South African fish species, red roman (*Chrysoblephus laticeps*), santer (*Cheimerius nufar*) and fransmadam (*Boopsoidea inornata*)

Supervisors: Prof. W.H.H. Sauer (w.sauer@ru.ac.za) and R. Chalmers (r.chalmers@itsnet.co.za)

With many fisheries being exploited around the world, catch and release fisheries are becoming more popular with recreational fisherman. This has lead to many gear developments to reduce post capture mortality of fish released. One important development is the use circle hooks in this fishery. Circle hooks have had success in the commercial fishing sector but seem to have limited success in recreational fisheries as they work for some species (striped marlin *Tetrapturus audax*) but not others (Muskellunge *Esox masquinogy*). No studies have been conducted on fish species around South Africa. This study will be focusing on three important recreational species off our coastline, red roman (*Chrysoblephus laticeps*), santer (*Cheimerius nufar*) and fransmadam (*Boopsoidea inornata*).

The aims and objectives of this study are to understand the difference in relative hooking efficiency, catching efficiency and the likely implications for post capture mortality, using j hooks and circle hooks. A total of 1014 fish were caught from 2 sampling trips to Bird Island, Eastern Cape South Africa. From the first trip 441 fish were caught and 573 from the second trip. All work was conducted from a ski boat at various depths from 54 random sites. For each species caught, length, hooking location and hook injury type were recorded. Any evidence of barotruama was also noted. Three hook types were used in this study, 4/O VMC sure circle hooks, 4/O VMC sports circle hooks and 4/O Mustad j hooks. Red roman, santer and fransmadam constituted 88.6% of the total catch. The results show that the overall catch rates between the three hook types did not differ from each other when using the chi-squared test ($p > 0.001$). There was no difference between the hooking locations across treatments. The amount of bleeding caused by the three hook types did not differ between treatments and was only observed in a small percentage of the fish, 3.17% of total fish from first trip and 2.83% of total fish caught on second trip.

11h20-11h40: Siyabonga Maliza (BSc Honours) – Effect of dietary lipid and energy on growth and survival of 15-25 mm captive abalone (*Haliotis midae*)

Supervisors: Dr C.L.W. Jones (c.jones@ru.ac.za) and Prof. P.J. Britz (p.britz@ru.ac.za)

Funder: Department of Agriculture

Past research suggests that abalone is capable of digesting high levels of dietary protein but its ability to utilise fat is limited. However, that work did not account for the change in protein to energy ratio (P:E), rather a constant protein level was maintained throughout all diets and as the lipid levels increased, the P:E also changed. It has been hypothesised that if the P:E is maintained at an ideal level, abalone will be able to better utilise energy from lipid.

The objectives were to compare growth, survival and feed conversion ratio (FCR) of abalone fed diets with different lipid and energy levels, with the overall aim to develop a diet with the optimal lipid level for 15 – 25 mm abalone and to develop a better understanding of abalone lipid requirements.

Hatchery reared juvenile abalone (*Haliotis midae*) in the size class 15-25 mm were obtained from HIK Abalone Farm (Pty) Ltd in Hermanus and acclimated at Port Alfred Laboratory for a period of two weeks prior to the experiment. Two-hundred abalone were stocked into each of 32 baskets, which were distributed among six tanks. Each basket was fed one of the diets, such that each diet was fed to four baskets of abalone and each basket was in a different tank. Animals were fed daily to apparent satiation and uneaten food was collected, dried and weighed. The system utilised sea water pumped from the Kowie River estuary. The experiments lasted 86 days.

Experiment 1 – To determine the effect of dietary energy and protein on growth, diets were formulated with either 34 or 39 % protein, each of which was presented with either medium energy (15.2-15.4 MJ/kg) or high energy (17.7 MJ/kg). There were no interactions between dietary energy and protein for both length and weight gain (multifactor ANOVA: $F_{(1, 12)}$=1.17, p=0.30 and $F_{(1, 12)}$=1.57, p=0.23, respectively). Both were independent of dietary protein (ANOVA: $F_{(1, 12)}$=2.8, p=0.12 and $F_{(1, 12)}$=4.7, p=0.052 respectively), with means that range from 4.2±0.5 to 5.4±0.5 mm and 1.4±0.2 to 2.0±0.3 g, respectively. An increase in dietary energy (from lipid) negatively affected abalone weight and length gain (ANOVA: $F_{(1, 12)}$=5.52, p= 0.04 and $F_{(1, 12)}$=15.8, p=0.0018, respectively), with means of 5.6±0.7 mm and 2.2±0.2 g for medium energy diets compared to means of 4.0±0.2 mm and 1.2±0.1 g for high energy diets.

Experiment 2 – To determine the effect that an increase in lipid energy has on abalone growth at a constant protein to energy ratio: At a constant P:E of 2.2 MJ/ kg, the increase in dietary energy from lipid (15.4 to 17.7 MJ/kg) had no effect on abalone length gain (ANOVA: $F_{(4, 15)}$=0.9, p=0.5 respectively), weight gain (ANOVA:$F_{(4,15)}$=0.8, p=0.5 respectively) and condition factor (ANOVA:$F_{(4,15)}$=2.1, p=0.1 respectively) between treatments. However, there was a significant increase in FCR with an increase in dietary lipid energy (Kruskal-Wallis: $H_{(4, 25)}$ =22.0, p =0.0002), that ranged progressively from 0.93±0.03 for the 15.4 MJ/kg diet to 2.1±0.18 for the 17.7 KJ/kg diet.

Growth of 15-25 mm abalone is independent of dietary protein in the range tested here (Exp. 1). Further, an increase in lipid energy had a negative effect on growth (Exp. 1) and this was not mitigated in this experiment by maintaining P:E ratio. Abalone feed efficiency decreased significantly with an increase in dietary lipid.

11h40-12h00: Brendon Lee (BSc Honours) – Cost/benefit study of fish meals replacement by soya bean meal in the diet of juvenile dusky kob, *Argyrosomus japonicus*

Supervisors: Dr C.L.W. Jones (c.jones@ru.ac.za) and Prof. P.J. Britz (p.britz@ru.ac.za)

Funders: THRIP, Aquafarm Development (Pty) Ltd and Marifeed (Pty) Ltd

Dusky kob has been identified as an ideal candidate for aquaculture in South Africa due to its large size, palatability, food value and high market price. Fish feed represents between 30 and 50% of the total production costs in an aquaculture venture. Protein makes up the largest proportion of the dusky kob's feed (40-50%). The highest quality protein source used in fish feeds is fish meal. Fish meal is however the most expensive component of fish feeds. Soya bean meal has successfully replaced fish meal as an alternative protein source; however, it can only be partially replaced by soya mean meal (30%) before negatively affecting growth and food conversion ratio (FCR).

The aims of this study were to weigh up the decrease in growth and FCR, with the decreased costs associated with the partial replacement of fish meal with soya bean meal. The objectives of the study were therefore to compare growth, FCR, protein efficiency, condition factor (CF), survival and cost of production of juvenile kob fed five diets with graded levels of fishmeal substitution, i.e. the protein content from soya bean meal was either 0, 10, 20, 30 or 40 %. All diets were formulated to contain 42 % crude protein and 10 % lipid. Fish were stocked at 10 kg/m^3 under controlled laboratory conditions and they were fed 3.8 % of their body weight per day. Each diet was fed to four random baskets of fish. They were individually weighed and measured at the start of the experiment and once per month thereafter. Preliminary results after 60 days of growth are presented here.

There were no differences in fish weight between treatments at the start of the experiment (ANOVA: $F_{(4, 15)} = 0.21$; $p = 0.93$). Mean weight of the fish after 60 days in the 0 and 10 % replacement treatments were significantly greater than those in the 40 % replacement treatment (ANOVA: $F_{(4, 15)} = 3.71$; $p = 0.027$), with overall mean weight gains of 20.6 ±0.4, 19.9 ±0.61 and 19.8 ±1.44 g for these three treatments, respectively. There were no significant difference in FCR and CF between treatments after 60 days (ANOVA: $p>0.05$). The highest profit index (2.51) and lowest incidence cost (16.72) occurred at 10% fishmeal replacement with soya bean meal.

The temperature of the system averaged 18.9±1.08 ºC (n=62), dissolved oxygen concentration averaged 6.04±0.47 mg/L (n=62) and toxic ammonia averaged 0.023±0.025 (n=9). This could explain the below average growth and FCR recorded here. The results indicate that between 10% and 20% protein replacement of fish meal with soya bean meal would result in the most efficient relationship between production and the cost of production.

Thursday 9 October 2008

Humphrey Greenwood Guest Speaker (Chair: Prof. P.J. Britz)

08h30-09h10: Rob Tilney – The biology, psychology and population dynamics of a DIFS graduate - 25 years on

Marine Fisheries and Estuarine Ecology (Chair: R. Chalmers)

09h10-09h30: Serge Raemaekers (PhD student, fifth year) – The 'legal' and 'illegal' abalone fisheries in South Africa: collapse in fisheries management

Supervisors: Prof. P. Britz (p.britz@ru.ac.za) and Dr G. Calvo-Ugarteburu (gugucalvo@yahoo.com)

Funder: Belgische Stichting Roeping

The abalone fishery in South Africa has been identified as one of South Africa's most difficult fisheries to manage. This is a result of a combination of factors, but largely refers to the significant increase in organised black market trade of abalone since the mid-1990s. This phenomenon has led to the 'abalone crisis': illegally fished abalone from South Africa, which is unreported in FAO statistics, was making an increasing contribution to the global supply, and, despite a significant focus on law enforcement, the annual Total Allowable Catch (TAC) was being gradually reduced. In February 2008, the commercial fishery was closed, which meant the battle was effectively lost.

The objective of this paper is to provide an overview of South Africa's abalone fishery, highlighting the demise of the TAC managed commercial sector and its replacement by a highly organised, open access, illegal fishery. We begin with a general description of the history and management of the commercial fishery, and then take a step back to describe a more complex fishery system, embedded in South Africa's socio-political setting, and driven by international demand. We then highlight some of the key management measures implemented by the state, primarily as a response to the significant decline in the resource. We show how the traditional, resource focussed, fishery management system did not have the capacity to incorporate the powerful social, political and economic drivers determining fisher behaviour, into a rights-based management system that was regarded as legitimate by the majority of stakeholders. We conclude with the need to revisit South Africa's abalone fishery management paradigm, and propose a way forward.

09h30-09h50: Hylton Newcombe (MSc student, second year) – The contribution towards the development of a management plan for the baitboat and sportfishery for tuna in South Africa

Supervisors: Prof. W.H.H. Sauer (w.sauer@ru.ac.za) and Dr O. Weyl (o.weyl@ru.ac.za)

Funders: World Wildlife Foundation-SA, Fresh Tuna Exporters Association,
Claude Leon Foundation

Tuna are of significant global economic importance and a prime food source. Increased fishing intensity has lead to concern over the state of the resource. The South African tuna industry comprises of three sectors: baitboat, sport and longline. Information from South Africa is very limited, and no management plan exists.

The objective of this research is to contribute to the development of a management plan for the Western and Eastern Cape commercial and recreational tuna sectors by providing a qualitative and quantitative assessment of the size and shape of the tuna fishing industry; including total catch, effort, cpue, socio-economic and economic information, age and growth estimates and population structure through genetic analysis.

The six most important landing sites in the Western Cape were monitored over a 12 month period through an access point survey. Of the total tuna caught by both recreational and commercial fishers during this period Hout Bay accounted for 87.76 %, Cape Town 15.06 %, with the remaining 4 harbours totalling 0.18 %. The tuna pole fishery is concentrated in the western Cape with more than 69 % of the crew comprised of black males and more than 85 % aged between 20-40 years. The commercial line fish sector was found to be responsible for only a small percentage of the total commercial tuna catch, while information for the recreational fishery is still being collected. In general, however, and in contrast to the commercial fishery, the charter, recreational and leisure sectors were found to be white dominated, with crew falling into two distinct categories, between 20 and 40 years and greater than 40 years.

In the Eastern Cape, most tuna is caught by recreational fishers, with an evidence of decline of *T. albacares* catches in competitions from 2004 to 2008 ($p=0.046$). In general, however, the total catch of this species in South African waters (Eastern Atlantic) rose from 402 ton in 2004 to 1156 ton in 2006. For the Eastern Cape sportfishery, fixed assets per owner are in excess of R1 040 807.18, with average running expenses per outing of R3978.74. With an average of 37.33±12.37 vessels competition per competition, this equates to a total vessel value of some R40 000 000.

There is a distinct difference in the average weight and length of the fish caught in the Eastern and Western Cape, with an average weight of *T. albacares* from the Eastern Cape of 26.28±14.46 kg, and 108.38±16.52 cm (FL), whilst the Western Cape averages 53±11.45kg; 140±11.20 cm (FL).
A study to determine the best ageing method for this species is complete, and samples of vertebrae across all size classes are currently being collected.

A number of genetic samples have been collected from both the Western and Eastern Cape and are being sequenced (with established primers) at the University of London.

09h50-10h10: Peter Watt-Pringle (MSc student, fourth year) – Activity and habitat utilization patterns of resident reef fishes inferred from high resolution spatial and temporal research angling data

Supervisor: Dr P.D. Cowley (p.cowley@ru.ac.za)

Funders: Marine and Coastal Management, South African Institute for Aquatic Biodiversity, Rhodes University JRC

Blacktail (*Diplodus sargus capensis*), zebra (*Diplodus cervinus hottentotus*) and juvenile white musselcracker (*Sparodon durbanensis*) (Sparidae) are highly resident fishes, but frequent dynamic inshore areas where they are not easy to study. Results from scientific shore-angling in the Tsitsikamma National Park were therefore analysed at a high spatial and temporal resolution to examine their localised movement behaviour. Objectives were to infer daily feeding/activity rhythms in relation to time of day and tide level, using catch per unit effort (CPUE) as a proxy for feeding activity. Habitat utilisation, in particular changes in habitat use with size, was also investigated by analysis of length data. Angling was carried out at designated localities, where effort (angling time), fish length and time of capture of all fishes was recorded. Localities were grouped into eight habitat-type zones, while angling periods and fish capture times were grouped into (i) a time of day (relative to sunrise and sunset) and (ii) a tidal phase category. Generalized Linear Models (GLMs) were used to analyse the effect of these on CPUE and fish length, controlling for season and water temperature. Angling activities were spatially and temporally correlated, possibly leading to pseudoreplication and inappropriate statistical analysis. Generalized Estimating Equations (GEEs), that extend GLMs to incorporate correlated data, were therefore also used for analyses. Blacktail feeding activity varied with both time of day ($p<0.001$) and phase of tide ($p=0.003$), with peaks close to twighlight and over high tide, but also varied considerably between habitat zones, generally being higher at sandy localities. Mean blacktail size was correlated with tidal phase ($p=0.015$), larger fish being caught over high and outgoing tides, suggesting inshore and offshore movements of larger individuals with the tidal cycle. Although the relationship between mean length and specific habitat zones was highly significant ($p<0.001$) there was no clear relationship between length and habitat type. Peak zebra feeding activity was related to time of day ($p=0.014$), as well as habitat zone ($p<0.001$), with significantly higher capture rates close to dusk, and in shallow, rocky habitats. However, zebra length was unaffected by habitat. Juvenile musselcracker feeding activity was not significantly correlated with time of day or tidal phase, but was significantly affected by habitat type ($p<0.001$), with greater numbers caught in shallow, rocky localities than sandy or deep reef areas. Conversely, mean juvenile musselcracker size was larger in deep reef and sandy habitats ($p<0.01$), suggesting increased utilisation of these habitats with increasing size. Overall, the results demonstrate the utility of high resolution spatial and temporal research angling data for studies on resident fishes within a dynamic nearshore environment. The clear effects of rhythmic cycles (time of day and tide), as well as habitat, on resident fish behaviour, as well as habitat utilisation patterns by fishes of different sizes, need to be borne in mind when designing environmental monitoring programmes.

10h10-10h30: Amber Childs (PhD student, first year) – Ontogenetic habitat use and movement behaviour of dusky kob *Argyrosomus japonicus*: implications for fisheries management

Supervisor: Dr P.D. Cowley (p.cowley@ru.ac.za)

Funders: National Research Foundation, Norwegian Research Council (SA/Norway programme for research co-operation)

Non-compliance, ineffective management regulations and a lack of law enforcement and has lead to the collapse of the South African dusky kob *Argyrosomus japonicus* stock. Consequently, alternative management strategies, such as area-based management options need to be considered. This study will make use of a suite of methods including acoustic telemetry, otolith micro-chemical constituent analysis and conventional tag-recapture techniques to investigate the movement behaviour and habitat use patterns of dusky kob in an attempt to evaluate the effectiveness of area-based management options. A detailed telemetry study in the Sundays estuary was initiated in May 2008. Twenty-three dusky kob (400−850 mm total length) were tagged with acoustic transmitters and will be monitored for one year using a comprehensive array of automated data-logging listening stations (Vemco VR2s). Sixteen VR2s were deployed in the Sundays estuary to monitor movements within this system. Additionally, two VR2s were deployed in the mouths of seven adjacent estuaries (Great Fish, Kowie, Kariega, Bushmens, Swartkops, Gamtoos, Kromme), as well as the Port Elizabeth and Coega Harbours to monitor movements between these areas. Furthermore, information obtained from a detailed fishery survey on the Sundays Estuary will be used to assess the vulnerability of dusky kob in this estuary by collating spatial/temporal fishery statistics with the observed distribution of tagged fish. Results from the fishery survey highlighted the ineffective nature of current management strategies. Of the dusky kob caught and retained by fisherman, 62 % were below the legal size limit of 600 mm TL. Preliminary results from the telemetry study indicate that juvenile dusky kob exhibit high levels of estuarine residency and made extensive use of the estuary (from the mouth to 16 km upstream), with two fish venturing as far as 21 km upstream. While dusky kob were caught and tagged throughout the estuary, fidelity towards capture site has also been observed. Multiple element microchemical composition of dusky kob otoliths will be used to identify estuary-specific signatures and ultimately ascertain whether individuals make use of single or multiple estuaries during their life-history. Otoliths from juvenile fish have been collected from both the Sundays and Swartkops estuaries during December 2007 and May/June 2008 to map the unique chemical fingerprints of these systems (i.e. their natal estuaries) and to assess possible temporal variation in the chemical signatures of the otoliths. Additional information on the movements and migrations of dusky kob will be obtained from conventional tagging data. To date, 9140 dusky kob have been tagged along the South African coastline, with an overall recapture rate of 7.6 %. Preliminary analysis of this data indicated that 83 % of recaptures were made within 10km of their release sites, while only 5 % moved more than 30 km. The preliminary findings of this study highlight the importance of estuarine nursery habitats for this over-exploited species as well as the viability of area-based management options (e.g. estuarine protected areas).

10h30-10h50: Rhett Bennett (PhD student, first year) – Habitat use, movement patterns and stock delineation of white steenbras, *Lithognathus lithognathus*

Supervisor: Dr P.D. Cowley (p.cowley@ru.ac.za)

Funders: National Research Foundation, Marine and Coastal Management, South African Institute for Aquatic Biodiversity

White steenbras (*Lithognathus lithognathus*) is one of South Africa's most sought after endemic coastal fishery species. Dependence on estuaries and residence within the inshore environment make the species highly vulnerable to overexploitation. A lack of empirical knowledge on movement patterns, habitat use and stock integrity of white steenbras have rendered current management efforts ineffective. As a result, stocks have collapsed and the species is possibly the most threatened coastal linefish species in South Africa. A thorough assessment of its life-history is necessary to provide information for effective management. This study aims to determine and describe the status, habitat use, movement behaviour and genetic diversity of white steenbras. All available current and historical fishery and fishery-independent data will be analysed to show trends in catch, effort and catch-per-unit-effort over the last three decades. Acoustic telemetry will be used to determine habitat utilization, home range dynamics and movement patterns of juvenile white steenbras within an intermittently open and a permanently open estuary, as well as the extent, timing and duration of movements between estuarine and adjacent marine environments. Longshore movement and dispersal patterns of adult white steenbras in the marine environment will be determined using acoustic telemetry and conventional tag-recapture data. Microchemical analysis of the trace elements Strontium and Calcium, from the otoliths of juvenile white steenbras collected from selected estuaries of varying salinity regimes, will provide information on the level of estuarine dependency in this species. Analysis of mitochondrial and microsatellite DNA will be used in a phylogeographic approach to: (i) assess stock structure and variability of white steenbras along the South African coastline, and (ii) assess whether population declines are reflected by reductions in genetic diversity. A telemetry study, initiated in February 2008, was conducted on sixteen juvenile white steenbras in the East Kleinemonde estuary. Manual tracking of six individuals, completed in April 2008, showed that these fish occupy distinct home ranges. Preliminary analysis of passive tracking of the remaining ten, which will be completed by the end of October 2008, suggests that the fish follow a diurnal movement pattern. Eighty-seven percent of these tagged individuals remained in the estuary after a mouth opening event, highlighting the importance of estuarine nursery habitats to this species. A subsequent telemetry study on 20 juveniles will be conducted in the permanently open Sundays estuary, commencing in February 2009. A total of 4083 white steenbras have been tagged with conventional dart tags along the South African coastline with an overall recapture of 5.02%. Additionally, 148 fish have been tagged during dedicated research trips to the beaches of Algoa Bay (Eastern Cape). This data will be used in a subsequent analysis of longshore movement patterns. Genetic samples have been collected from 218 white steenbras (81-620 mm total length) captured from Haga Haga in the east to Walker Bay in the west. By adopting the proposed methods in a holistic approach, this ongoing project will provide an improved scientific basis for the management of white steenbras and a platform for research on other estuarine-associated coastal fishery species.

10h50-11h05: Tea break

Marine Ichthyology (Chair: S. Raemaekers)

11h10-11h30: Russell Chalmers (PhD student, third year) – Development of a spatially based conservation and management plan for the Addo Elephant National Park marine protected area

Prof. W.H.H. Sauer (w.sauer@ru.ac.za)

Funders: South African National Parks,
South African Environmental Observation Network – Elwandle Node

The Agulhas bioregion has several marine protected areas (MPA's), however, the majority are situated along nearshore rocky coastlines. Recent analysis highlighted the need to increase the size and range of habitats included within the MPA network. A new MPA adjoining the Addo Elephant National Park (AENP) is proposed and incorporates habitat types thought to be poorly represented in existing MPA's in the bioregion. Due to the extent of the footprint both recreational and commercial socio-economic activities will be affected. In conjunction with National Parks, a spatially based multiple-use MPA is being designed to meet both conservation and social objectives. This presentation provides an overview of the research being undertaken to assess the biological and socio-economic environments within Algoa Bay, as a precursor towards the formulation of a management plan.

Key areas within the proposed MPA were identified and sampling was randomly stratified across area, season, depth and reef profile within Algoa Bay. Ichthyofaunal communities were assessed by means of controlled angling, underwater visual census techniques, or a combination of both. Macro-benthic invertebrate communities were assessed using photo quadrants. An assessment of the recreational/subsistence shore fishery was undertaken by means of roving creel surveys. The recreational offshore linefishery was assessed by means of weekly access point effort counts, and interviews and catch surveys during peak holiday periods. The spatial distribution of fishing effort by the linefish and squid sectors was assessed by means of aerial surveys, and the Marine and Coastal Management Vessel Monitoring System. Catch data was obtained through the National Marine Linefish System.

Linefish density differed significantly between study areas ($F_{6,205}$=5.48; $p<0.001$) with Bell Buoy having significantly lower densities than Bird Island and Woody Cape, and St Croix significantly lower densities than Bird Island. The Shannon diversity index indicated significant differences between areas ($F_{6,205}$=6.42; $p<0.0001$) with Riy Banks having higher diversity than Bell Buoy, St Croix and Woody Cape, and Bird Island and Cape Padrone also having higher diversity than Woody Cape. Analysis of the linefish community structure using ANOSIM indicated significant differences in species composition between areas ($p<0.001$). A SIMPER analysis revealed that santer was dominant at Bird Island (46 %), Cape Padrone (55 %), Woody Cape (87 %) and Belly Buoy (52 %), whereas white seacatfish dominated at St Croix (46 %), Fransmdam (38 %) at Evans, and roman (44 %) at Riy Banks.

Fisheries surveys indicated that there were strong spatial and temporal trends in recreational skiboat and shorefishing effort; with effort being concentrated around access points and peaking over the summer holiday period. Santer (46 %) dominated the recreational skiboat catches followed by geelbek (15 %), roman (10 %) and silver kob (8 %). Sparidae dominated the recreational shore catches on the eastern side of the study area coinciding with inshore reefs, while elasmobranchs dominated catches in the western areas.

Results from ecological and socio-economic studies will be integrated using MARXAN software which will aid in developing a conservation plan designed to meet the conservation objectives for the MPA while minimizing impacts on the fisheries contributing towards an ecosystem approach to management within Algoa Bay.

11h30-11h50: Jessica Escobar-Porras (MSc student, third year) – Movement patterns and preliminary population estimates of four selected endemic cattsharks: *Poroderma africanum, P. pantherinum, Haploblepharus fuscus* and *H. edwardsii* in the Eastern Cape

Supervisors: Dr W.H.H. Sauer (w.sauer@ru.ac.za) and Dr P.D. Cowley (p.cowley@ru.ac.za)

Sharks are particularly vulnerable to over-exploitation. Although catsharks are an important component of the near-shore marine biodiversity in South Africa and most of the species are endemic, little is known about their movement patterns, home range and population size. With an increasing number of recreational fishers and illegal targeting by commercial operators, this information is crucial for management purposes. The aims of this study were threefold. Firstly, to identify and analyze existing data sources for four catshark species: pyjama (*Poroderma africanum*), leopard (*P. pantherinum*), puffadder (*Haploblepharus edwarsii*) and brown (*H. fuscus*). This highlighted a number of shortcomings of existing datasets, largely because studies were not aimed solely at catsharks, and had diverse objectives. Secondly, a dedicated study was carried out over a limited area, and the data was analyzed to determine movement patterns and population numbers. Thirdly, the most appropriate methodology was identified for future studies and the results obtained were used to propose a number of conservations measures. In short, the results suggest that all four species of catsharks exhibit site fidelity and maintain small home ranges for extended periods. However some individuals revealed the capacity to travel distances in excess of 150 km. Resident catsharks populations are small. Schnabel population estimates showed that *Poroderma africanum* had the smallest population while *Haploblepharus fuscus* had the highest population size at the Rebelsrus study site near Cape St. Francis. Limited movements and small population sizes suggest that catsharks would profit from no-take marine protected areas.

11h50-12h10: Michelle Kruger (MSc student, first year) – Ichthyoplankton dynamics of the Kowie Estuary, Port Alfred

Supervisor: Dr N.A. Strydom (Nadine.Strydom@nmmu.ac.za)

Funder: National Research Foundation

Larval fishes were sampled in the Kowie Estuary and marina for a two year period between 2004 and 2005 in order to understand the composition, diversity, abundance, seasonality and distribution of larval fishes in the system. Samples were collected seasonally at 14 different sampling stations along the main channel and in the marina by means of boat-based plankton tows. WP2 nets, fitted with flowmeters, were towed at depths not exceeding 80cm from the surface at a speed of 1-2 knots for three minutes per tow. A total of 11 128 larval fishes were collected, representing 23 families and 39 taxa. Clupeidae and Gobiidae were the dominant fish families, contributing 47.0% and 24.7% respectively to the total catch over the two year period. Catches varied significantly with season and catches were highest in summer, followed by spring. Estuary dependent species dominated the overall catch (91%). All developmental stages of larval fish were found in the estuary. Common species included *Atherina breviceps, Omobranchus woodii, Clinus superciliosus, Etrumeus whiteheadi, Gilchristella aestuaria, Elops machnata, Engraulis japonicus, Caffrogobius gilchristi, C. nudiceps, Glossogobius callidus, Psammogobius knysnaensis* and *Redigobius dewaali*. Results indicate that some endemic and economically important fish species utilise the Kowie Estuary and marina as a nursery area, although nursery use in the marina in restricted given the absence of marginal water habitat due to steep sides.

12h10-12h30: Phanor Montoya-Maya (MSc student, second year) – Dynamics of ichthyoplankton and zooplankton from selected cool temperate estuaries in South Africa

Supervisors: Dr N.A. Strydom (n.strydom@ ru.ac.za) and Dr T.H. Wooldridge (tris.wooldridge@nmmu.ac.za)

Funder: National Research Foundation (FA2220000794)

The study aims to provide baseline information on composition, abundance and distribution of ichthyo- and zooplankton in selected (nine) cool temperate estuaries as well as provide some insight into the interactions between these organisms. Larval fishes and zooplankton were collected by plankton towing in selected estuaries once per season for a period of one year between 2003 and 2004. A strong seasonal component in the salinity, temperature and turbidity of the estuaries was observed. Similarities among estuaries of the same type and within the same biogeographic region were unclear. Estuaries sampled showed specific physicochemical conditions that could be related to changes in river flow and oceanic current systems. Ichthyoplankton sampling yielded a total of 49 274 early stage fishes, comprising 9 orders, 20 families, 29 genera and 47 taxa. Seven species accounted for 93.4 % of the total catch in these estuaries, namely *Gilchristella aestuaria* (78.8 %), *Caffrogobius gilchristi* (6.2 %), *Psammogobius knysnaensis* (3.5 %), *C. nudiceps* (2.5 %), *Parablennius* sp. (2.4 %), *Omobranchus woodi* (2.1 %) and *Atherina breviceps* (1.9 %). Larval fish assemblages in the study estuaries exhibited the same seasonal and spatial patterns described for temperate estuaries both in South Africa and worldwide. The assemblages were less diverse and dominated by fewer species than temperate estuaries along the south east coast of South Africa. The differences found in composition and density of the larval fish assemblages from south and west coast estuaries result from the biogeography of the area and the freshwater inflow into the estuary. Preliminary results for the zooplankton component showed similar species composition to other South African estuaries and similar seasonal and spatial patterns in the community. The calanoids copepods *Pseudodiaptomus hessei, Acartia longipatella* and *A. natalensis*, the mysids *Rhopalophtalmus terranatalis, Gastrosaccus brevifissura* and *Mesopodopsis wooldridge* and the amphipod *Grandidierella lutosa* dominate the zooplankton. Future work includes community analysis for the zooplankton component and a study on the dynamics of the plankton community in relation to the physicochemical conditions in the various types of estuaries in the region.

12h30-12h50: Enrico Gennari (PhD student, first year) – Thermal physio-ecology of the great white shark (*Carcharodon carcharias*)

Supervisors: Dr P.D. Cowley (p.cowley@ru.ac.za) and R. Johnson (Ryan@sampla.org)

Funders: South African Marine Predator Lab, South African Institute for Aquatic Biodiversity, PADI aware

The white shark (*Carcharodon carcharias*) is an ecological apex predator. Understanding its ecological niche is paramount to ensure the conservation and proper management of this species. Although it is known that white sharks are capable of maintaining body temperatures warmer than ambient water temperatures, very little research has been done on their thermal ecological niche. This project will address this research need by investigating the thermal biology and thermal habitat use of white sharks in Mossel Bay. In so doing, this project will answer questions on their thermal preferences, thermoregulatory abilities, metabolic rates, feeding periodicity and feeding satiation patterns as well as related ontogenetic variations. Anatomical dissections will be performed to gather information on the different heat exchanger systems (*retia mirabilia)*, while active acoustic telemetry will be used to study the physiology and the horizontal and vertical movement patterns of tagged white sharks. During 2008, anatomical dissections were conducted on four white sharks captured by the Natal Sharks Board and eight individuals were tagged with acoustic transmitters equipped with depth and temperature sensors. More than 400 hours of real time manual tracking allowed for the collection of over five million data points on the tagged shark's position, bottom depth, sea surface temperature, swimming depth and external water temperature at that depth. Preliminary analyses indicate different habitat use and behavioural patterns, which include two travelling, resting, "fishing" or feeding patterns. During 2009, acoustic transmitters with temperature sensors will be both fed and internally attached to the sharks to monitor stomacal and muscular temperature patterns and ultimately answer more detailed questions relating to the thermal physio-ecology of white sharks in Mossel Bay.

12h50-13h55: Lunch break

Fresh water Ichthyology and Fisheries (Chair: A. Childs)

14h00-14h20: Graham Traas (MSc student, second year) – Conservation status and management of the freshwater fishes in the Greater Addo Elephant National Park

Supervisors: Prof. A.J. Booth (t.booth@ru.ac.za) and Dr O.L.F. Weyl (o.weyl@ru.ac.za)

Funders: South African National Parks (2007-07-25OWEY), National Research Foundation (FA2005021600012**)**

Freshwater fish are considered to be the second-most imperiled vertebrate group globally. This situation is as a result of habitat destruction, pollution and the effects of alien species. South Africa's freshwater ichthyofauna is no different. Conservation of South Africa's freshwater fish is poor and less than 5% of rivers fall within protected areas. Conservation of the headwaters of a river system is of particular importance as it is commonly thought to be the best approach to conserving the ichthyofauna of a river system. Since the headwaters of some tributaries of the Sundays River fall within the Greater Addo Elephant National Park (GAENP), there is an opportunity to conserve the indigenous fishes of this system, including the endangered *Pseudobarbus afer*. For this reason, an ichthyological survey was conducted on the rivers within the GAENP to determine the distribution and conservation status of both indigenous and alien fishes in the GAENP.

For large rivers and dams, gill-nets, long-lines, fyke-nets, electro-fishing and seine-nets were used. For the tributaries, small long-lines and electro-fishing was used. Three-pass depletion electro-fishing was conducted in suitable pools to determine absolute abundance of small indigenous species. All species were measured to the nearest millimetre. Indigenous species were released, while alien species were sacrificed, sexed and visually staged. Otoliths were removed for aging purposes. Relative abundance and distribution data were compared to previous studies to determine community change and alien fish movement. Population estimates were used to determine densities of small indigenous fish.

The relative abundance of species in all rivers was found to have changed over the last decade. *Clarias gariepinus* were found to be the most successful invaders, having colonised all of the tributaries, and dominating the Sundays River. *Micropterus salmoides*, through predation, have changed the community of the Wit River from being *P. afer* dominated to *Glossogobius callidus* dominated.

Eradication of *C. gariepinus* should be undertaken in the Klein Uie and Krom Rivers. Barriers to the upstream migration of *M. salmoides* should be strengthened on the Wit River, as the Wit River has the most diverse community, and *M. salmoides* has the potential to extirpate one of the last remaining *P. afer* populations in the Eastern Cape.

14h20-14h40: Vusi Mthombeni (MSc student, second year) – The biology of Austroglanis catfishes from the Clanwilliam Olifants river system, South Africa

Supervisors: Dr O.L.F. Weyl (o.weyl@ru.ac.za) and I.R. Bills (r.bills@ru.ac.za)

Funders: Water Research Commission (K8 592), Rhodes University JRC

Some aspects on the biology of the IUCN-listed vulnerable *Austroglanis gilli* and endangered *Austroglanis barnardi* from the Clanwilliam-Olifants system were investigated to develop management recommendation necessary for their conservation.

Marginal zone analysis and marginal increment analysis from sectioned lapiliar otolith of each of the *Austroglanis* species showed seasonal pattern with a unimodal distribution and a progression of the distance between last opaque zone and the growth margin, suggesting that a single hyaline and opaque zones are laid down each year. These zones were therefore interpreted as annuli and were used to estimate age of *A. gilli* and *A. barnardi*. The oldest specimens of *A. gilli* and *A. barnardi* aged 12 and 14 years, respectively. Age length keys generated from otolith readings were used to convert lengths into age for SAIAB specimens collected prior to the commencement of this study. The instantaneous rates of mortality for the combined sexes of *A. gilli* from Rondegat, and *A. gilli* and *A. barnardi* from Noordhoeks rivers were estimated using catch curve analysis at 0.37 $year^{-1}$, 0.71 $year^{-1}$ and 0.39 $year^{-1}$, respectively.

The sexual maturity of each of the populations of *A. gilli* and *A. barnardi* is reached when approaching asymptotic length, suggesting a shift in energy use for somatic growth into gonad development. Gonado-somatic index, macroscopic staging and histological validation indicated that *A. gilli* and *A. barnardi* spawn in summer and that matured oocytes which were not spawned are resorbed at the end of the breeding season. The simultaneous occurrence of all stages of vitellogenic oocytes in the matured ovaries of each of the *Austroglanis* species suggests asynchronous, iteroperous spawning life-history style.

Austroglanis gilli occurs in a wide variety of habitats, feeding opportunistically on variety of benthic insects (mainly ephemeropteran nymphs and dipteran larvae) whereas *A. barnardi* occurs exclusively on riffles, feeding predominantly on dipteran larvae (mainly Chironomidae).

The two *Austroglanis* spp. appear to have evolved a precocial, *K*-selected life-history strategy. As a result of a potential intrinsic rate of population increase would recover slowly from reductions in population size. With a continuous increase of impacts of introduced alien fishes, hydrological manipulation of rivers and agrochemical pollution during dry summer season in the Clanwilliam-Olifants system, one would expect a shift from *K*- to *r*-selected strategy of *Austroglanis* spp. However, as *A. gilli* and *A. barnardi* occur in oligotrophic streams and must have evolved and adapted to such stable environments, both *Austroglanis* spp. may be intolerant of any disturbance in their environment, particularly agrochemical pollution. Therefore the two *Austroglanis* spp. warrant a high conservation priority to improve their current conservation status, otherwise they are most unlikely to survive for the future.

14h40-15h00: Bruce Ellender (MSc student, second year) – Quantifying utilisation trends in South Africa's largest impoundment - consequences for the indigenous yellowfishes

Supervisor: Dr O.L.F Weyl (o.weyl@ru.ac.za)

Funder: National Research Foundation (FA2005021600012)

This project is part of the Lake Gariep fisheries research programme, which aims to develop policy advice for the sustainable utilisation of fisheries resources. The overall objective of this project is to provide a quantitative assessment of the impact of angling on the smallmouth yellowfish (*Labeobarbus aeneus*) and the largemouth yellowfish (*Labeobarbus kimberlyensis*) in Lake Gariep.

Sampling was undertaken in the two open access fishing areas, namely: Oviston and Gariep. Roving Creel Surveys (RCS) were conducted using a randomly stratified sampling procedure over 14-day periods every 2 months for a 12-month period. RCS included daily effort counts and angler interviews to ascertain angling user groups, species composition and Catch Per Unit Effort (CPUE).

Generalised linear models were applied to test for temporal differences in the probability of capturing a fish and log abundance CPUE. On any sampling day time fished was the best predictor for differences in probability of capture (PC), whilst temporally month was the best predictor ($p \leq 0.05$). CPUE differed significantly between sample region and month ($p \leq 0.05$). Catches in the GD region (range: 0.53 [95% CI = 0.20:0.85 kg. $man^{-1}.h^{-1}$]: 1.63 [95% CI = 1.04:4.30 kg. $man^{-1}.h^{-1}$] were consistently higher than the OV region 0.39 [95% CI = 0.19:0.61 kg. $man^{-1}.h^{-1}$] : 0.85 [95% CI = 0.57:1.12 kg. $man^{-1}.h^{-1}$] ($p \leq 0.05$). Angler activity counts were higher in Oviston (29.4 ± 16.6 anglers/h/day) than in Gariep (16.59 ± 14.36 anglers/h/day). Total catch was estimated by a nonparametric bootstrapping procedure using the mean product of 1000 iterations of angler activity and CPUE drawn from raw data with replacement and raised by mean angling day length, PC and number of days in assessment period. Total catch [lower, upper 95% CI] was estimated at 28 [3, 86] t/year for Oviston and at 42 [4 – 97] t/year for Gariep. Catches were dominated by carp (*Cyprinus carpio*) (74 %), followed by mudfish *(Labeo capensis* (13 %) and smallmouth yellowfish (8 %). Catches of largemouth yellowfish were below 0.5 %.

Per Recruit Analysis was used to model the effects of fishing on *L. aeneus*, specifically spawner biomass per recruit (SBR) models were applied. These models require biological input parameters. *Labeobarbus aeneus* are selected for at a large size corresponding to an age of 6.05 years. Sex ratio is size dependant, at lengths >370 mm, females are >75 % of the population. Because of these sex differences and the result that females are primarily selected in anglers catches, female life history parameters were used in the analysis. Age and growth was determined using otoliths. The growth of *L. aeneus* was best described by the von Bertalanffy growth model as $L_t = 491.74\ (1- e^{-0.23(t+0.29)})$. Gonadal development was seasonal, with the gonado-somatic index peaking in January, revealing a distinct spawning season. The length at 50 % maturity was attained at a fork length of 354.73. Mortality was estimated using catch-curve analysis. Natural mortality was estimated to be 0.55 $year^{-1}$.

15h00-15h20: Henning Winker (PhD student, second year) – Understanding the role of invasive carp in South Africa's largest impoundment

Supervisors: Dr O.L.F. Weyl (o.weyl@ru.ac.za) and Prof. A.J. Booth (t.booth@ru.ac.za)

Funder: National Research Foundation (FA2005021600012)

Globally, common carp, *Cyprinus carpio,* is one of the most widely introduced fish species. The life-history traits of carp conform to those predicted for typical successful invaders, so that adverse ecological disruptions are commonplace following carp translocations. On the other hand, carp may significantly contribute to the yield in capture and recreational fisheries and can therefore contribute to food security and tourism, development priorities of South Africa's rural areas. The role of common carp in South Africa's largest man-made impoundment, Lake Gariep, was investigated by assessing post-impoundment trends in species composition, a life history study, and the food web structure using stable carbon and nitrogen isotope analysis.

An experiment was designed to validate the periodicity of growth ring deposition in carp otoliths. For this purpose, wild carp were captured, marked with oxytetracycline (OTC), stocked into ponds at low densities and harvested a year later. Analysis revealed that carp deposited two growth rings per year. Based on this result, growth of carp was described by a von Bertalanffy model as L_t = 952.3 $(1 - e^{-0.15\ (t + 0.85)})$ mm FL for females and as L_t = 793.9 $(1 - e^{-0.19\ (t + 0.86)})$ mm FL for males. Carp females matured relatively early at 333.5 mm FL with an estimated age of 2 years. Spawning season was extensive and reproductively active females were found from early spring until autumn.

Historical CPUE data from the five first years following impoundment (1971-1976) were standardised and corrected for gillnet selectivity and different fleet sizes to make them comparable with the present winter 2007 and summer 2008 gillnet surveys. Although carp dominated the current hook and line fishery, it accounted for only 1.8 % and 2.3 % of the gillnet survey catch per unit effort (CPUE in kg per 200 net night) in June 2007 and January 2008, respectively. Results from historic data reveal, however, that carp was the most abundant species in gillnet catches (>50 %) in the summer surveys 1971-1976. The initial standardised CPUE of 12.4 kg per 200 m net night in summer 1972 declined to 2.6 kg in summer 2008. This was accompanied by an increase of combined CPUE of the endemic cyprinids *Labeobarbus aeneus* and *Labeo capensis* from 1.3 kg to 95.7 kg during the same period.

Food web analysis showed that the food chain is short and dominated by omnivorous cyprinids, including carp, with the piscivore *Labeobarbus kimberlyensis* as the top predator. Carp $\delta^{15}N$ values were significantly different compared to all other species and C.I. (95%) of $\delta^{12}C$ signatures only overlapped with *L. capensis* and the African sharptooth catfish *Clarias gariepinus.* Mudfish and carp appeared to utilise more benthic food sources, while *L. aeneus* N and C signatures indicate that pelagic zooplankton is a major food source for this species.

These results suggest that although carp has life history traits typical for a successful invader, it could not out-compete the endemic riverine cyprinids in the lacustrine turbid dam environment of Lake Gariep.

15h20-15h55: Tea Break

Fresh water Ichthyology (Chair: H. Winker)

16h00-16h20: Caswell Mavimela (Msc student, University of Limpopo) – Molecular phylogeny of South African gobiid fishes of the genus Caffrogobius (Smitt, 1900), and intraspecific genetic variation of *Caffrogobius gilchristi* (Boulenger, 1900)

Report not available.

16h20-16h40: Thabo Maake (MSc student, University of Limpopo) – Systematics of the genus Glossogobius in South Africa, and genetic diversity and population structure in the river goby *Glossobobius callidus* (Smith 1937) (Teleostei, Gobiidae)

Report not available.

16h40-17h00: Albert Chakana (PhD student, first year) – Comparative phylogeography of *Pseudobarbus*, *Barbus*, *Sandelia* and *Galaxias* species in the Breede and associated river systems: implications for conservation of a threatened fauna"

Supervisor: Dr E. Swartz (e.swartz@ru.ac.za)

Report not available.

Friday 10 October 2008

Mariculture: Invertebrates (Chair: E. Thompson)

08h40-09h00: Guy Paulet (PhD student, third year) – Determining dietary DHA and EPA requirement for the culture of juvenile East Coast rock lobsters, *Panulirus homarus rubellus*

Supervisors: Prof. P.J. Britz (p.britz@ru.ac.za) and Dr. A.C. Cockcroft (cockrof@deat.gov.za)

Funders: Marine and Coastal Management, National Research Foundation

The main objective of this research is to develop a pelleted diet for on-growing juvenile lobsters caught by subsistence fisherman in order to add value to the resource. Reducing or eliminating the dependence on feeding fresh or frozen mussels to lobsters is of great importance from a practical and economic perspective. A suitable baseline diet was developed and the research focus moved towards improving this diet further, in order to improve lobster growth and condition. It is hypothesized that specific essential highly unsaturated fatty acids (HUFAs) and specific ratios of Omega-3 (n-3) to Omega-6 (n-6) fatty acids (FAs) are required for good growth in lobsters. Various concentrations of n-3s, EPA and DHA, and n-6 ARA, are under consideration in order to test this hypothesis. Refined lipids from marine (n-3) and terrestrial (n-6) sources were substituted at different levels to achieve different n-3 to n-6 ratios in the diet.

The baseline diet comprised 44% protein (of which 10% was supplied by mussel meal), 10% lipid, 1% vitamins and minerals and 10% carbohydrate binder. Inclusion of 4% gelatine resulted in good pellet retention after 12 hours soak time. In addition, effects on growth of essential nutrients (soya lecithin, choline chloride, ethoxyquin, astaxanthin, and cholesterol) are being tested. Growth trials are underway comparing these formulations with the baseline diet and the reference diet of frozen mussels. The effect on growth of adding mussel hydrolysate at different concentrations to the baseline diet will provide a cheaper alternative to more complex formulations if shown to be effective.

Behavioral trials have been conducted to provide information on shelter preference and attractiveness/ acceptability of various diets. Analysis of pleopods is being used to describe the moult state of lobsters used in the trials.

09h00-09h20: Justin Kemp (MSc student, third year) – Mariculture as a means to add value to the east coast rock lobster *Panulirus homarus rubellus* subsistence fishery: a physiological approach to define transport and growout protocols for wild caught juveniles

Supervisors: Prof. P.J. Britz (p.britz@ru.ac.za) and Dr A.C. Cockcroft (cockrof@deat.gov.za)

Funder: Marine and Coastal Management (Provincial Project 038)

In a context of declining capture fisheries and public pressure for greater access to marine resources, mariculture is receiving increasing interest from the South African government as a means to increase the diversity of economic activities in coastal regions. Undersize east coast rock lobster *Panulirus homarus rubellus* are currently harvested by subsistence fisherman along the former Transkei coastline, where the opportunity exists to add value to the resource through ongrowing. The aim of this physiological study was to assess the biological feasibility of harvesting, transporting and culturing wild caught juvenile lobsters, and thereby provide empirical data to inform the development of suitable transport and culture protocols.

The effect of temperature on the growth of juvenile lobsters was investigated. Specific growth rate (SGR) was significantly different between temperatures ($p = 0.01$), with the highest values recorded for the 24°C and 28°C treatments. Intermoult period (IMP) differed significantly between temperatures ($p = 0.0015$) with mean IMP lowest at 24°C. Apparent feed intake was significantly different between treatments ($p < 0.0001$) and exhibited a strong positive correlation with increasing temperature. Food conversion ratio (FCR) differed significantly between temperatures ($p = 0.02$) with 24°C exhibiting the most efficient FCR. The results indicate that 24°C is optimal for the growout of juvenile *P. h. rubellus.*

The second study investigated the effect of body weight, emersion, daily rhythm, feeding and ambient ammonia on the total ammonia nitrogen (TAN) excretion rate. Body weight (16.8 g – 322 g) was positively correlated to daytime TAN excretion rate (mg h^{-1}). Re-immersion after 1 h emersion in a moist environment was caused a significant increase in the TAN excretion rate for 1 hour. There was no evidence of a daily rhythm in TAN excretion. TAN excretion rates were elevated following feeding and returned to pre-feeding levels after 23 hours. TAN excretion rates at ambient TAN of 1.02±0.10 mg l^{-1} and 2.3± 0.2 mg l^{-1} were not significantly different from TAN excretion rates recorded at low ambient water TAN. Exposure to ambient TAN of 4.45±0.78 mg l^{-1} had a significant effect on the TAN excretion rate, with pronounced ammonia uptake occurring at this concentration.

The third study investigated the effects of a similar suite of factors on lobster oxygen consumption. Body weight was positively correlated total standard and active oxygen consumption. Diurnal rhythm exhibited a strong effect, with average night time values 67% greater than those recorded during the day. Feeding resulted in a postprandial peak in oxygen consumption which gradually decreased to preprandial levels. Emersion resulted in a significant increase in oxygen consumption, with lobsters rapidly recovering to pre-emersion levels after 4 h.

The project results suggest that the capture, transport and culture of juvenile *P. h. rubellus* is biologically feasible and that future commercialisation will depend on the availability of juvenile lobsters and the economic feasibility of rearing them.

09h20-09h40: Alistair Green (MSc student, third year) – Load shedding: Can abalone use dietary lipids as a source of energy

Supervisors: Dr C. L.W. Jones (c.jones@ru.ac.za) and Prof. P.J. Britz (p.britz@ru.ac.za)

Funders: Marifeed (Pty) Ltd, Roman Bay Sea Farm (Pty) Ltd, THRIP

Protein has received the most attention in abalone nutritional studies as it carries the highest cost consideration in formulated feeds and is the principle dietary component responsible for growth. However, there is evidence that the protein requirements of abalone are influenced by dietary energy. Lipids offer a highly concentrated form of energy and therefore could serve as a potential source of energy in abalone feeds, but high levels of dietary lipid have been shown to negatively affect abalone growth. However, none of the work on which these findings are based maintained a constant protein:energy ratio, and there is evidence to suggest that lipid could act as a energy source at an adequate protein:energy ratio.

To investigate the size specific dietary lipid and protein requirements of farmed *Haliotis midae*, two size classes (30 mm & 60 mm shell length) of abalone were fed various diets and were cultured under farm-like conditions in a temperature controlled partially recirculating system.

Experiment 1 - Ho: An increase in dietary lipid content improves abalone growth and survival: Abalone were fed diets with a lipid content of either 4, 7, 10, 13 and 16 %, all with the same protein:energy ratio, protein increased from 34 to 39 %. Both size classes of abalone had similar growth patterns in response to increasing dietary lipid (multifactor ANOVA: $p>0.05$), with significantly lower shell length gain for the 30 mm and 60 mm abalone (1.38±0.13 and 0.58±0.06 mm.month^{-1} respectively) abalone fed the 16 % lipid diet compared to those fed the 4 % lipid diet (1.95±0.09 and 1.05±0.07 mm.month^{-1} respectively) (ANOVA: $p<0.05$). Feed consumption rates increased significantly with an increase in dietary lipid content for both abalone size classes (ANOVA: $p<0.05$). Foot muscle glycogen content of the 60 mm abalone decreased significantly as dietary lipid increased (ANOVA: $F_{(4,15)}=2.89$; $p=0.05$).

Experiment 2 - Ho: Dietary lipids can serve as a source of energy in abalone nutrition: Abalone were fed one of four diets containing a combination of either 34 or 39 % protein, each with a lipid level of either 4 or 16 %. Abalone shell length gain was significantly lower for abalone fed the 16 % lipid diets however, the negative effects of high lipid levels were more severe when dietary protein was increased from 34 to 39 % (multifactor ANOVA: $F_{(1,24)}=9.52$; $p=0.005$). High levels of dietary lipid had a greater negative effect on the shell length gain (multifactor ANOVA: $F_{(1,24)}=6.66$; $p=0.02$) and SGR (multifactor ANOVA: $F_{(1,24)}=19.02$; $p=0.0002$) of the 30 mm abalone compared to the 60 mm abalone.

Experiment 3 – Ho: Dietary protein content can be reduced if the energy content of the diet is maintained: Abalone were fed isoenergetic diets with protein contents of either a 34 or 20 %. Starch carbohydrates and fish oil replaced the protein portion of the diet that was removed to achieve the 20 % protein level. Both size classes of abalone had similar growth patterns in response to the reduction in dietary protein (multifactor ANOVA: $p>0.05$). Dietary protein content had no effect on abalone growth for both size classes (ANOVA: $p>0.05$). Soft tissue glycogen content was lower for both size classes fed the 34 % protein diet; however, there was a greater difference in the glycogen content of the 30 mm abalone fed the 20 and 34 % diets compared to the 60 mm abalone (multifactor ANOVA: $F_{(1,12)}=5.71$; $p=0.03$).

High levels of dietary lipid negatively affected abalone growth and the 30 mm abalone were more sensitive to high levels of lipid. The negative effects of high lipid levels on growth coupled with high feed consumption rates and low soft tissue glycogen contents indicate that abalone are unable to use lipids as a source of energy and energy in formulated feeds should be supplied primarily from carbohydrates. Large numbers of the 60 mm abalone in this experiment were observed to be sexually mature and were probably investing energy into gonad development. Further studies should investigate the interaction between nutrition and gonad development, and the effect of gonad development on growth.

09h40-10h00: Matthew Naylor (MSc student, first year) – Water quality and abalone production in a serial-use raceway system

Supervisors: Prof. H. Kaiser (h.kaiser@ru.ac.za) and Dr C.L.W. Jones (c.jones@ru.ac.za)

Funders: HIK Abalone Farm (Pty) Ltd, Aquafarm Development (Pty) Ltd,
Roman Bay Sea Farm (Pty) Ltd

Gradients in water quality variables have been shown to develop between the inflow and outflow of the flow-through tanks used for commercial production of abalone *Haliotis midae*. They may cause slow abalone growth in baskets closest to the outflow. An experimental serial-use raceway allows the determination of the effect of water quality on abalone growth under farm conditions rather than laboratory environments. Identification of the most limiting water quality variable will determine tank design and management protocols and lead to greater production efficiency. This study will also highlight the advantages and disadvantages of serial-use systems for abalone culture, and provide opportunities to design grow-out systems that require less water and thus less electricity.

The system consisted of three raceways, each with seven tanks in series, with a small header tank that provided filtered sea water to the first tank in each series. Water then flowed by gravity down each system. All tanks were aerated and each held one basket stocked with abalone. Each tank also had a separate inflow providing clean water during acclimation.

The objective of the current trial was to describe the changes in water quality between tanks in the serial-use raceway in relation to accumulated biomass and flow-rate, and to determine the flow rate (L h^{-1} kg^{-1}) at which growth becomes negatively affected for selected size classes of *H. midae*.

At the start of the trial a sub-sample of abalone (n=50) from each basket were individually weighed to the nearest 0.1g (48.9±3.6 g) and measured to the nearest 0.1 mm (64.2±2.6 mm) using sigma-scan. Baskets were stocked at 8.52±0.014 kg and randomly assigned a position in the series. There were no significant differences in initial weights between baskets (ANOVA; $F_{(20,\ 1029)}$=1.38, p=0.12). The system was set to a 7-h exchange rate, which resulted in a flow rate of 34.3 L h^{-1} kg^{-1} in the first tank and 4.9 L h^{-1} kg^{-1} in the last tank in series. Water quality variables – temperature, pH, dissolved oxygen concentration, oxygen saturation, suspended solid concentration, total ammonia nitrogen (TAN), free ammonia nitrogen (FAN) and nitrite concentration – were recorded twice a week.

Gradients in these water quality variables developed between the first and last tanks in series, with the exception of temperature, dissolved oxygen and suspended solid concentration. The effect that these gradients will have on the abalone will become evident at the end of November 2008 when growth, survival and health of the abalone in each basket will be determined.

Future trials will include correlating changes in the concentration of ammonia and suspended solids with changes in abalone growth.

10h00-10h20: Sally Button (MSc student, first year) – The development of an alternate weaning technology for the abalone *Haliotis midae* using agar

Supervisors: Prof. P.J. Britz (p.britz@ru.ac.za) and Dr C.L.W. Jones (c.jones@ru.ac.za)

Funders: THRIP, Aquafarm Development (Pty) Ltd, Roman Bay Sea Farm (Pty) Ltd, HIK Abalone Farm (Pty) Ltd, Marifeed (Pty) Ltd

Weaning of postlarval abalone represents a bottleneck in abalone farm hatchery production systems. Weaning involves moving postlarvae from a diet of diatoms to a different system where they are fed an artificial diet (Abfeed®). This process includes anaesthesia, handling and simultaneous change in numerous environmental conditions including feed. At present, the weaning of postlarvae from diatoms to Abfeed® is abrupt. Subsequently, mortality rates are often high, and this is usually attributed accumulated stressors mentioned here. As adequate nutrition enables organisms to better cope with stress, it is important to develop an effective weaning technology. The use of agar provides a valuable tool to apply Abfeed® powder directly to diatom plates, so that they can be weaned onto the artificial feed, prior to anaesthesia, handling and the stress associated with the change in environment. This has the added benefits of making the diet directly accessible to postlarvae, thereby reducing energy used in locating food, and reducing solid leaching from the diet.

A technology using plate replacement was developed and tested. Half-sized plates were used to culture diatoms and postlarvae using normal farm practice. When the diatom biofilm was depleted, a second plate was inserted above the first, onto which an agar and food mixture was applied. Results showed that after 72 hours not all of the postlarvae had migrated onto the experimental plate. This trial is being repeated using polycarbon, as the polyethylene that was initially used was not suited to diatom culture.

Technology was developed to apply Abfeed® directly to depleted diatom plates. The use of a sprayer was tested initially, however the viscosity of the mixture made spraying difficult. Agar-food mixtures were then painted onto the plates in between the postlarvae, and the success of this method is currently being tested. Agar-food mixtures were applied to diatom-depleted plates every two days and postlarvae removed from these plates at different intervals (14 and 21 days) in order to determine the minimum time needed to apply the food mixture to find a result. In addition, animals were removed from three plates on day 0, following the traditional method of weaning and allowing a comparison of the new technology with old methods. Growth and survival was compared at each of these stages, and at the end of the trial. Preliminary results indicate that the technology was not successful.

The average weight of animals from both treatments was lower than the initial weight, possibly indicating that only the smaller animals survived. Furthermore, survival was low, with 0 % animals from both treatments surviving after 35 days, while an average of 36±6.68 % (mean ± SD) surviving from the traditional method (ie. those deplated on day 0 and raised in conventional weaning system).

Further tests will be done to determine the optimum agar concentration and feed inclusion levels for survival and growth, and to test the success of including fresh *Spirulina* in the agar mixtures.

10h20-10h40: Rirhandzu Mkhari (MSc student, first year) – The effect of temperature, flow rate and diatom fertilization on the growth and survival of abalone (*Haliotis midae*) spat on diatom plates

Supervisors: Prof. P.J. Britz (p.britz@ru.ac.za) and Dr C.L.W. Jones (c.jones@ru.ac.za)

Funder: Marine and Coastal Management (Environmental Affairs and Tourism)

Abalone *Haliotis midae* aquaculture is expanding in South Africa, with more than 12 commercial farms rearing abalone. Common to all these farms is the problem of low settlement success rate of abalone larvae onto diatom plates and low survival once settled. Previous research on *H. midae* has mostly focused on the grow-out of larger abalone and settlement success remains relatively uninvestigated. This study will investigate the effects of water temperature, flow-rate and level of diatom fertilization on the growth and survival of spat. A more detailed understanding of water quality requirements for spat in hatcheries allows farmers to optimize the quality of larvae and improve rearing techniques. The experimental work will be conducted at HIK abalone farm in Hermanus.

An initial growth trial will be carried out to determine the benefit of rearing abalone at a constant optimal temperature (18°C), as opposed to the current practice of rearing the spat at ambient temperature which fluctuates between 12 and 20 °C. Growth and survival will be monitored as well as pH, dissolved oxygen, ammonia, nitrite and nitrate. The water quality variables will be measured over the diurnal cycle in order to determine the optimal daily sampling time. This will provide an insight into the effect of temperature in abalone growth rate and survival.

If it is desirable to control water temperature, economics dictate that water flow rate should be minimized as heating is expensive. The effect of flow-rate on settlement success, growth and survival will thus be investigated at the optimum temperature to determine the minimum required flow-rate required to maintain diatom production and abalone growth rate and survival. An additional trial will investigate the effect of flow rate on diatom growth as well as abalone growth rate and survival. A final growth experiment will be conducted at the lower flow rate with supplemental fertilization of the diatom culture in one treatment and no fertilization in the control. Each study investigating the effect of temperature, flow-rate and diatom nutrients respectively will be carried out over three periods of three months. At the end of each experiment abalone will be randomly selected and measured for growth using sigma scan and micro balance. The results will be statistically analyzed to determine the overall impact of these parameters on growth rate and it is expected that the results of this study will increase hatcheries' production.

10h40-10h55: Tea break

Mariculture: Finfish (Chair: G. Paulet)

11h00-11h20: Siviwe Babane (MSc student, first year) – Effect of size-sorting on growth of juvenile dusky kob (*Argyrosomus japonicus*)

Superviser: Prof. H. Kaiser (h.kaiser@ ru.ac.za)

Funder: Marine and Coastal Management (Department of Environmental Affairs and Tourism)

Size-sorting is a rearing technique which aims to improve weight gain by all individuals and to increase their survival rate. This results in increasing biomass per tank. It is routinely practiced to improve growth of small fish, reduce cannibalism, decrease size variability and improve feed uptake. Dusky kob juveniles are aggressive and cannibalistic and this leads to high mortality. The dusky kob has many attributes beneficial for aquaculture and commands high prices. Many studies have been conducted on the effect of size-sorting in other fish species, however, there is a paucity of information on the effects of size-sorting in the rearing of dusky kob. Thus, a study on the effects of size-sorting will be conducted to reduce cannibalism and improve growth in this species. This study includes testing (a) the effect of diurnal rhythm in combination with feeding frequency on growth and survival; (b) the possible maternal importance for behaviour; and (c) a comparison of light and dark environments with respect to cannibalism.

The overall aim of this work is to better understand factors determining cannibalism in this species. The objectives of this study are to determine the effects of size-sorting in combination with changes in the rearing environment on growth and cannibalism in dusky kob under intensive rearing conditions; to determine to what extent size-sorting can be used to reduce cannibalism in dusky kob. Dusky kob larvae of average weight 5.5 g/fish will be obtained from the hatchery stock of Espadon Marine in East London. They will be size-sorted using a mechanical grader. Each fish will be measured, weighed and assigned into one of three treatments. In one treatment fish will be sorted above average size (large fish), the second treatment comprises fish below average size (small fish) and the third treatment will be unsorted fish. The fish will be distributed into randomly allocated six 100-L rearing tanks and the stocking density will be 100 specimens in each tank. Behavioural observations will be made to include aspects of cannibalistic behaviour and feeding behaviour. At the beginning of the study, behaviour will be defined in pilot studies and definitions be used to quantify behaviour under a variety of culture conditions.

To determine the differences in growth rates of the treatments, condition factor, body weight variability (CVBW) and the effectiveness of feed use (FCR), multifactorial analysis of variance (ANOVA) will be applied.

11h20-11h40: Lindsey Woolley (MSc Student, Second year) – The development of an artificial feed for the South African finfish industry

Supervisors: Prof. P.J. Britz (p.britz@ru.ac.za) and Dr C.L.W. Jones (c.jones@ru.ac.za)

Funders: THRIP (TP2005102700010) and Marifeed Pty (Ltd), Aquafarm Development (Pty) Ltd

Aquaculture production of Sciaenidae is on the rapid increase, both in Australia and South Africa, through the development of technologies to farm *Argyrosomus japonicus* (dusky kob). Dusky kob is successfully grown in closed recirculating systems and open sea-cages. A prototype diet formulated specifically for kob has been developed by adapting technologies developed for the local abalone feed industry.

To test the effect of different shape pellets have on kob production in cages, juvenile dusky kob with a starting weight and length (± standard error) of 14.8±0.4 g and 103±2 mm were stocked into four 3.3 m^3 cages in the Kowie River estuary at a density of 9 $kg.m^{-3}$. The fish were fed the same formulated diet (46 % protein 12 % lipid) presented as either a 2mm round, cylindrical pellet or a 2mm square, flat pellet. These pellets had a similar weight (0.06±0.17 $g.pellet^{-1}$) with different settling velocities. The square pellet settled at 45±0.3 $mm.s^{-1}$ compared to the round pellet of 65±0.5 $mm.s^{-1}$ (Kruskal-Wallis: $H_{(1,100)}$=74.27, p=0.00). The fish were fed to apparent satiation twice a day for eight weeks. The fish that were fed the square pellets grew significantly faster than the fish fed the round pellet, with a mean weight gain of 16.81±0.45 g and 13.50±0.06 g, respectively (ANOVA: $F_{(1,2)}$=53.202, p=0.018). The cylindrical and square pellets realized a similar food conversion ratio (FCR) with a combined mean 1.3±0.05 (p=0.05). The pellet settling velocity is an important characteristic in sea cage culture, since the slower a pellet moves through water the longer the period that pellet is available to the fish. Behavioural studies showed that the feeding rate of the fish fed the square pellet was longer (i.e. 101±11 s) compared to the fish fed the round pellet (i.e. 81±8 s), but did not significantly differ (ANOVA: $F_{(1,26)}$=2.12; p=0.16).

The growth and health of kob (starting weight 365±21 g) fed the prototype diet (46 % protein 18 % lipid) that was developed earlier in this program was compare to those fed an imported marine finfish diet (45 % protein 18 % lipid). Fish were stocked into eight tanks, each with its own biological filter, at a density of 20 $kg.m^{-3}$ and were fed to apparent satiation twice a day. Fish growth and FCR was similar for both treatments, with an overall mean weight gain and FCR of 218±16 g (ANOVA: $F_{(1,6)}$=1.31; p=0.30) and 1.06±0.06 (ANOVA: $F_{(1,6)}$=0.04; p=0.86), respectively. There was a parasite prevalence of 69 %, with no significant difference in parasite intensity amongst treatments (p >0.05). The water quality, blood and glycogen analyses results will be discussed.

Fish were kindly made available by Espadon Marine (Pty) Ltd and Irvin and Johnson (Pty) Ltd

11h40-12h00: Maryke Musson (MSc student, second year) – Ontogenetic development of the digestive system in dusky kob (*Argyrosomus japonicus*) larvae

Supervisors: Prof. H. Kaiser (h.kaiser@ru.ac.za) and Dr N.G. Vine (niall@espadonmarine.co.za)

Funders: Frontier Programme, Department of Environmental Affairs and Tourism, Marine and Coastal Management, Espadon Marine (Pty) Ltd

An understanding of the ontogenetic development of the larval digestive system is vital in economically important aquaculture species. Knowledge on the structural development of the digestive system combined with an understanding of the digestive and nutritional physiology can help determine the appropriate weaning strategy.

The aim of this study was to describe the major histological changes occurring during the development of dusky kob larvae under culture conditions. The information obtained will help improve current weaning strategies and husbandry practices.

Morphological and histological ontogenetic development of the digestive tract and associated organs was followed from hatching to 30 days after hatch. Each day a minimum of 5 larvae were randomly selected from the rearing tanks over 8 spawning cycles and preserved in 10% buffered formalin (pH 7.2) and stored in the dark for histological analysis. These samples were pooled together according to degree-days (DD) calculated by using 15ºC as the growth threshold temperature. During the last spawning cycle a minimum of 50 larvae were randomly selected each day, preserved and prepared for histological analysis. The samples were embedded in paraffin wax from which sections were made and stained with heamotoxylin-eosin. Each day a minimum of 5 larvae were randomly selected from the rearing tanks and fixed with 4% formaldehyde followed by immediate morphological observation under a Nikon microscope. This included total length measurements in mm, size of yolk sac and oil globule, swimbladder inflation, food ingestion, eye pigmentation and overall larval condition. A total of 4500 larvae were collected from 15 different spawning batches and either morphologically examined or histologically prepared.

At hatching the digestive tract presented as a simple tube and the mouth was still closed. The yolk sac and oil globule were still evident suggesting the larvae were reliant on endogenous nutrients. The mouth had opened by 20 DD and numerous supranuclear vacuoles appeared in the hindgut by 28 DD. The appearance of these vacuoles indicates the ability to digest protein and absorb nutrients. At 35 DD lipid vacuoles were visible in the enterocytes of the anterior midgut, indicating the ability to digest and absorb lipids. By 40 DD the oil globule had disappeared completely and the larvae were dependant on exogenous nutrients. The digestive system had differentiated into a buccopharynx with pharyngeal teeth and taste buds, an oesophagus with secretory goblet cells, a stomach, intestine, rectum and associated gastric glands by 74DD. The pancreas, liver, kidney and gall bladder were also differentiated by this stage. The intestine continued to increase in length and volume and the intestinal folds became more obvious. Goblet cells were visible in the midgut at a similar time as gastric glands appeared, and increased in number from 90 DD onwards. At 100 DD, the hindgut presented a high number of lipid vacuoles, indicating the shift of lipid absorption from the midgut to the hindgut. At this stage the larvae had a fully functional digestive system, and were able to ingest, digest and absorb complex proteins.

Based on the histological and morphological characteristics of the larval digestive tract it would be physiologically possible for the larvae to be weaned onto an artificial diet after 100 DD.

Espadon Marine (Pty) Ltd and Irvin and Johnson (Pty) Ltd are thanked for their donation of larvae for this study.

12h00-12h20: Ernst Thompson (PhD student, fourth year) – Why I should have achieved more in my first year

Supervisor: Prof. T. Hecht (t.hecht@ru.ac.za)

Funder: National Research Foundation

Artemia salina remains an integral part of intensive finfish aquaculture despite attempts to rear larvae on exclusive artificial diets. The low nutritional value in larger *A. salina* (especially 2nd instar and older) makes the need for enrichment critically important. Enrichment usually includes Poly-Unsaturated fatty acids like EPA, DHA and ARA and has shown to reduce problems during larval rearing increasing survival and growth. Despite this, very little is known about the bioavailability of nutrients in *A. salina* and as a result the rate these nutrients will be digested. This study presents the first attempt to calculate the digestibility of *A. salina* "In Vitro", using standard biochemical assays. Further to this, a GLM model will be presented to predict the nutrient release from *A. salina*, given certain enzyme levels and gut evacuation time.

Non-presenting students

Albert Esterhuizen (PhD student, third year) – Development of an artificial weaning diet for the South African abalone, *Haliotis midae*

Supervisors: Dr C.L.W. Jones (c.jones@ru.ac.za) and Prof. P.J. Britz (p.britz@ru.ac.za)

Funders: THRIP, Marifeed (Pty) Ltd, Aquafarm Development (Pty) Ltd, Norwegian Agent for Development, Rhodes University JRC.

Dietary fat requirements of juvenile abalone *Haliotis midae* remain largely undefined. Although previous studies have suggested that a dietary fat level of 3-5% is required for various species of abalone, very little work has focused on the fat requirements of juvenile abalone ranging from 3-5 mm. Diatoms are the preferred food of newly settled abalone, which are generally high in polyunsaturated fatty acids (FA) such as 20:5(n-3) (eicosapentaenoic acid) and seldom have high levels of 22:6(n-3) (docosahexaenoic acid). Dietary inclusion of fish oil that is rich in the 20:5(n-3) series may improve growth and survival of juvenile abalone. Further, there is evidence that wean-age abalone can utilize lipid as an energy source. Therefore, the main aim of this study was to test the effect that dietary energy from a lipid has on growth, health and survival of juvenile abalone during the initial stages of weaning.

Five agar based diets were prepared with similar protein:energy ratios (19.93 mg/kj) with increasing protein and energy levels: 30 to 37 % protein and 1505.5 to 1855.4 kj (diets 1 to 5). To establish the affect that protein and energy has on abalone growth, a diet containing high protein (37 %) and low energy (1500kj) with a final P:E ratio of 24.56 mg/kj was formulated (diet 6), whilst an additional diet with a low protein (30 %) and high energy (1850 kj) with a final P:E ratio of 16.1 mg/kj was also included (diet 7). Fish oil was used to increase dietary energy.

There was a negative correlation in growth with increasing lipid. There was also no interaction between protein and energy, further supporting the conclusion that increased energy from lipid does not prove beneficial. Weight increase was affected negatively with an increase in dietary lipid (ANOVA: $F_{(7,22)}$=24 and p=0.000) whilst it did not affect overall length increment (ANOVA: $F_{(7,22)}$=2.94 and p=0.25). Diets 1, 2, 3 and 6 yielded similar growth that was significant greater compared to diets 4, 5 and 7 (df=22 and p=<0.05).

The glycogen content of abalone soft tissue ranged from 0.19 % to 1.43 %. Diet 1 (30 % protein and 1505 kj) yielded a significantly higher volume of glycogen stored in the soft tissue compared to all other diets (p=0.0001), suggesting that animals fed diet 1 were not utilizing stored energy reserves to survive and were probably less physiologically stressed than those fed diets with increased lipid. It has been suggested that macro-nutrient imbalances, particularly neutral lipid excess can lead to lower digestion and absorption ability. Senegalese sole (*Solea senegalensis*) larvae fed a diet with a higher neutral lipid content led to a reduced FA absorption efficiency, possibly related to the accumulation of lipid droplets within the gut enterocytes. The same hypotheses might hold true for juvenile abalone, and might explain the negative effect that increased lipid has on abalone growth and health.

Diet and abalone tissue FA analyses will be conducted to establish the essential FA requirements for juvenile abalone during weaning.

David Kahwa (PhD student, first year) – Gametogenesis and influencing factors in relation to reproduction and induced spawning in Nile Perch (Lates niloticus) (Linnaeus, 1758)

Supervisors: Prof. H. Kaiser (h.kaiser@ru.ac.za) and Dr J. Rutaisire

The Nile perch, *Lates niloticus*, is an economically important fish species in East Africa and Uganda in particular. It is one of the main export and foreign exchange earners for Uganda and contributes 96.5% of the total catch by weight for Lake Victoria. The fishing industry is threatened by environmental and demographic pressures. Lack of information on the reproductive biology of the species has hampered its domestication. Therefore, the objective of this study is to investigate aspects of the reproductive biology of *L. niloticus* and to generate information on which technologies for the culture of this species can be based.

The study will be conducted in two phases: The first phase of 12 months will involve study of aspects of the reproductive biology and the second phase of 14 months will involve collection and conditioning of broodstock for induced spawning and egg incubation.

Live fish caught in gill nets have been purchased from contracted fishermen. Using heparinised syringes and Eppendorf vials were kept on ice, 5 ml of blood or blood equivalent to 5% of the total biomass of the specimen have been collected using the caudal vein placed into two Eppendorff tubes, labelled and kept on ice. The tubes were centrifuged at 3200 rpm for five minutes and the serum was kept in labelled screw-cup 2-ml vials and stored in liquid nitrogen until extraction of hormonal steroids.

The fish were sexed, weighed, total and standard length recorded, dissected to validate the hand-sexing, gonadal staging, the weight of the gonads and mesenteric fat and liver indices have been recorded. The gonads were preserved in Bouin's solution for 24 hours and transferred to a 75%-alcohol solution in which they were kept until processing for histological processing in the laboratory. Fish will be sampled throughout the year.

Of the thirty five fish (2.5 to 25 kg / fish) sexed by observing the genitalia and assigning sex 80% had been positively sexed following validation through dissection. *Lates niloticus* males have two openings, the most anterior being the anal opening and the posterior being the genital opening. Female *L. niloticus* have three distinct openings on the genital papilla (urethra) with the most anterior being the anal opening, the middle is the oviduct and the posterior the urethra. However, some females had partially opened oviduct openings.

Determination of blood plasma working dilutions for Estradiol (E_2) hormonal assays using Enzyme Linked Immunosorbent Assay (ELISA): Blood samples from large, medium and small size *L. niloticus* were serially diluted using the following dilutions 1:2, 1:4, 1:8, 1:16, 1:32. and were read using ELISA Micro plate reader MODEL: SIRIOS. S/N435233.The lowest detectable plasma concentration of estradiol was: 2.525 picograms and the highest concentration 17.661 picograms of estradiol in the plasma.

Gonad tissues collected in the previous months (May to September 2008) are being processed in the histology laboratories at Makerere University Faculty of Veterinary medicine. Field sample collection is on going up to June 2009.

Bruce Donovan (MSc student, third year) – A retrospective re-assessment of the Port Alfred Commercial and Recreational Boat-based Linefishery

Supervisors: Prof. T. Hecht (t.hecht@ru.ac.za) and Dr O. Weyl (o.weyl@ru.ac.za)

Funders: Marine and Coastal Management, National Research Foundation

Prior to the 1994 democratic elections and the subsequent re-structuring of the South African fisheries management environment, a study was done by Hecht and Tilney (1989) semi-quantitatively describing the Port Alfred commercial linefishery and presenting management suggestions based on the findings. Together with an assessment of the current status of the fishery, this data was used to retrospectively re-assess the fishery with the aim of evaluating the management strategies that were implemented by Marine and Coastal Management (MCM).

In 1987 the Port Alfred fishery was the third largest fishery along the south and south-east coast of South Africa. The 54 commercially vessels licensed in the area (of which 23 operated on a full-time basis) were fishing the area to its maximum capacity. Based on their work, Hecht and Tilney (1989) made the recommendation to restrict any further growth of the fishery.

The fishery currently consists of only 3 full-time commercial operators (despite a total of 12 licenses being issued for the area). The Port Alfred linefishery is numerically dominated by recreational fishers; however, due to output restrictions such as daily bag-limits for these fishers, the few remaining commercial operators still contribute the majority of the total yearly catch.

There have been considerable changes in both the species composition and the size distribution of the landed catch. In particular there is a significant decrease in the abundance and size of k-selected reef dwelling species. There is an observed increase in average size of the silver kob (*Argyrosomus inodorus*) landed. This is, however, evidence of the change in management environment (i.e. an increased minimum size limit) and not necessarily and indication of recovering stocks.

Preliminary results have shown that in addition to the perceived declining fish stocks, the collapse of the commercial fishery can be attributed to the miss-allocation of commercial licenses and poor market prices for fish in relation to the increased overhead operating costs.

Mpho Ramoejane (MSc student, first year) – Phylogeography and conservation management of genetic lineages of *Labeo umbratus* and *L. capensis* (Cyprinidae) in South Africa

Supervisors: Dr E. Swartz (e.swartz@ru.ac.za) and Dr O. Weyl (o.weyl@ru.ac.za)

Funder: National Research Foundation

Two tunnels, namely Orange-Fish and Cookhouse, act as a pathway for several fish species from the Orange River system to Great Fish and Sundays River systems. These species includes *Labeo umbratus* and *L. capensis. Labeo umbratus* was found naturally in the Great Fish and Sundays River systems before the inter-basin transfer. Apart from conservation concerns about the introgression of potentially unique genetic lineages of this species, a phylogeographic investigation will offer an opportunity to test biogeographic hypotheses on the evolution and connection between the abovementioned river systems. *Labeo capensis* on the other hand used to be found only in the Orange River systems. The two species are reported to hybridize in impounded waters (e.g. Hardap Dam in Namibia) but not in the rest of Orange River system.

Overall aim: To assess the impact of historic and anthropogenic events on the genetic diversity and integrity of *Labeo umbratus.*

Objectives:

- Identify and map genetic lineages of *Labeo umbratus*.
- Identify which evolutionary processes might have resulted in current genetic diversity patterns
- Relate the population history to climatic and geological events
- Confirm whether *L. umbratus* and *L. capensis* hybridize and assess genetic integrity of *L. umbratus* stocks.
- Make recommendations to conservation authorities on how to best manage genetic diversity.

Materials and methods

Labeo umbratus will be given the first priority in this study; therefore sampling will firstly be done across its distribution. Twenty specimens (DNA and voucher specimens) will be collected from each locality. Specimens from the Great Fish and Sundays will be collected in dams that were built before the opening of the Orange-Fish IBT schemes. Where possible, *Labeo capensis* will be collected as well. Specimens will be caught using gill nets, seine nets, fyke nets and electric fishing. Laboratory analysis will focus on mitochondrial DNA sequencing and basic morphological character evaluation. Depending on progress, a nuclear gene will be added to strengthen the genetic analysis.

Results:

The first samples were collected from Gariep Dam where *L umbratus* and *L. capensis* occur in sympatry naturally. This was done to test whether mitochondrial DNA could be used to distinguish the two species in their natural range. A genetic divergence of 0.5% in the mitochondrial cytochrome *b* gene between these two species was found, suggesting recent speciation, but with a sufficient number of mutations to distinguish the species. Samples from the Great Fish and Sundays River systems are currently being analyzed to test whether there are different historically isolated lineages in *L. umbratus* and whether there is hybridization between the latter and *L. capensis*.

Terrence Stonier (MSc student, third year) – Population study of the chokka squid *Loligo reynaudic*

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Report not available.

Index: funder, supervisor and author