
**AGE OF SQUID *LOLIGO REYNAUDII* D'ORBIGNY, 1845, AND ITS
POSSIBLE USE TO TEST EFFECTIVENESS OF THE CLOSED
SEASON IN PROTECTING THIS RESOURCE**

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Picture 1: Male squid contest on the spawning grounds. By South African National Biodiversity Institute (SANBI).

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Abstract

This study presents age distributions representing populations of adult *Loligo reynaudii*, together with the results of spawning and commercial catches to assist in understanding the beneficial role of the closed season. The results were based on 791 samples collected during three closed seasons (November: 2003, 2004 and 2005) and out of closed season during April/May 2005. Age and predicted growth were examined by counting daily rings on statolith microstructures. The age in days after hatching ranged from 168 to 484 days (71-425 mm) in males and from 125 to 478 days (83-263 mm) in females. Average age at spawning was found to be 323 days in males and 316 days in females. Population estimates of growth rates were best described by a linear growth model which revealed that males grew faster than females in length as they grew older with growth rate ranging between 0.63 to 0.83 mm per day for males and between 0.22 to 0.32 mm per day for females. Back-calculated hatch dates and later egg-laying events for parental populations were determined. Results from back calculated egg laying dates (presented as percentage of frequency of all laying dates) indicated a highest total of 36%, 39% and 15% of eggs from all samples were laid during the closed season and nine days after the closed season during year 2003, 2004 and 2005 respectively. Monthly commercial total catches (2002-2005) showed an increase from November soon after the fishery resumed, up until the month of January. Daily catches were highest in November (up to 290 tonnes) relative to the daily catches observed in December and January in all the years. Results led to the conclusion that the closed season (25 October to 22 November) is beneficial for both the chokka resource and the fishery. This is because: a) there is time for enough spawning biomass to accumulate, which subsequently results in high catches (good fishery), in the current year, best immediately after season opens in November; b) there is a link in the results between egg laying dates in the period of closed season and immediately afterwards, and the magnitude of catches in last nine days of November.

Key words: marine fisheries management; *Loligo reynaudii*; statolith; age; hatch date; egg-laying date; commercial jig catches; closed season

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Chapter 1

1. Introduction

1.1 General background

The squid *Loligo reynaudii* d'Orbigny, 1845 commonly known as “chokka” in South Africa (Department of Agriculture, Forestry and Fisheries, DAFF, 2016), belongs to the class of cephalopods. Cephalopods represent one of the most important commercial marine resources in the world (Sifner, 2008; Rodhouse *et al.*, 2014; Arkhipkin *et al.*, 2015). Interest in cephalopods has increased over the last three decades, not only because of increased exploitation (Caddy, 1995; Bettencourt *et al.*, 1996; Rodhouse *et al.*, 2014), but also because they play an important role in the marine ecosystem (Bettencourt *et al.*, 1996; Lipinski *et al.*, 1998; Lipinski, 1998).

Cephalopods constitute economically important fisheries in many parts of the world (Bettencourt & Guerra, 2001) and South Africa is no different. Chokka squid is the main cephalopod of economic importance in the South African fishing industry (Augustyn, 1990; Augustyn *et al.*, 1992). It has a high economic value, not because of the magnitude of the catch, which has never surpassed 20 000 tonnes per year, but because of its price, which is close to US\$6 per kg (Roel, 1998; DAFF, 2016). Chokka squid is mainly exported, freshly frozen, to European markets (Augustyn *et al.*, 1992). At the level of the South African national fishing industry, chokka is, on average, placed number five in economic value after the demersal, pelagic, rock lobster and abalone fisheries (Roel *et al.*, 1998). The chokka squid fishery is also of great importance, particularly in the Eastern Cape, because it provides jobs for a large number of people and contributes to the local gross domestic product (GDP) (Roel, 1998).

Chokka squid occurs in the southern African waters: eastern South Atlantic and South Western Indian Ocean, from Angola (10°S) on the west coast of Africa, to Cape Agulhas (35°S), and on the east coast to beyond (28°E) Port Alfred (Augustyn, 1990; FAO, 2010). The marine environment around southern African waters which houses chokka squid is recognised as one of the most diverse, complex, and highly variable anywhere in the world (Lutjeharms *et al.*, 2001; Roberts, 2005; Sauer *et al.*, 2013). The oceanography of the east

coast of South Africa and the outer Agulhas Bank is strongly influenced by the warm, fast-flowing Agulhas current (Roberts, 2005), whereas the West Coast oceanography is completely different, dominated by the cold Benguela upwelling system (Shannon & Nelson 1996, Sauer *et al.*, 2013).

Like most other exploited cephalopods in the world, chokka squid is a fast-growing, short-lived species (Augustyn *et al.* 1994, Lipinski & Durholtz 1994). It reaches sexual maturity in its first year of life, an event which terminates in mass aggregations and spawning over traditional spawning grounds off the Eastern Cape (Sauer *et al.*, 1992, van der Vyver *et al.*, 2015; Lipinski *et al.*, 2016; Lipinski *et al.*, unpublished). Spawning peaks around November (Augustyn, 1990; Lipinski *et al.*, 1998).

Chokka squid is mainly caught by a local jig fishery, which primarily targets spawning aggregations off South Africa's south coast, and as a by-catch of both juveniles and adults in a trawl fishery, which generally targets hake (*Merluccius spp.*) and Agulhas sole (*Austroglossus pectoralis*) (Roel & Butterworth, 2000; Olyott *et al.*, 2006). Before 1980, the chokka squid was a by-catch from demersal trawlers that targeted fish species (Augustyn *et al.*, 1992). However, increased demand over the years led to the formation of a directed squid jig fishery (FAO, 2010).

As with any other commercially harvested species, suitable management measures of a resource stock are required for its good management. According to Augustyn *et al.* (1992), the first management measure undertaken for the newly established jig fishery was to set an upper limit on the number of permits issued. This process took place between 1986 and 1988 and resulted in a considerable decrease in the number of active boats from 560 to 235 (Augustyn *et al.*, 1992). In 1988, a closed period of about a month (October to November) was enforced during the peak of the spawning season (Augustyn, 1990; DAFF, 2016) in an attempt to ensure that at least a significant portion of the spawning process would take place undisturbed by fishing (Roel, 1998). Similar reasoning was used to justify the permanent closure of the Tsitsikamma Coastal National Park (which falls within the area of chokka distribution and spawning). Another measure attempted to control effort increase

was by preventing vessels from upgrading, but faced strong opposition at the time of implementation (Roel, 1998).

The principal method used at present to manage the chokka squid fishery is effort control (Roel and Butterworth, 2000), which limits access to the fishery through a complete closure for four weeks during October and November (Olyott *et al.*, 2006). An extension to this closed season and additional closed seasons were also implemented during subsequent years. In addition to the effort reduction per year, chokka squid benefit by having a period of relative calm for forming concentrations and laying eggs, in accordance with the disturbance hypothesis (considerable interference with spawning aggregations by the fishing fleet will impact on the biomass in the following year (Roel, 1998; Lipinski *et al.*, unpublished)).

The biomass of any marine population (cephalopods included) in any given year stems from the stock of the previous generation (or generations), the size of which is influenced by many factors: biological, environmental and systemic. The resulting biomass is usually quantified and described at the time of recruitment (which is variably defined). For the purpose of this thesis, ‘recruitment’ means spawning population. In fish, the link between parental stock biomass and resulting spawning biomass is a hotly debated topic (e.g. Subbey *et al.*, 2014; Thorson *et al.*, 2014; Zimmermann *et al.*, 2018; Szuwalski *et al.*, 2019). In the case of squid, the issue has been poorly researched to date (e.g. Ish *et al.*, 2004; Rodhouse *et al.*, 2014). A short and by no means exhaustive, review of these debates is given in the Literature Review.

The closed season (introduced in 1988 as a four-week closed season and amended temporarily to five weeks in 1994) was selected on the basis of the observed catch trends in the jig fishery since 1985, which showed that the availability of spawning squid generally peaked in the final three months of the year (Augustyn *et al.*, 1992), as reflected in the commercial catches. This observation was confirmed by trends in the Gonadosomatic Index and mean sizes given by Sauer (1991). Therefore, the closure of the fishery for four weeks during this peak of the spawning season was enforced in an attempt to protect

spawning squid so that at least a substantial portion of the spawning process would take place undisturbed by the jig fishing activities, and so aid recruitment the following year. After the inception of the closed season, high daily commercial catches have been observed post closed season (22 November-January) (Marine and Coastal Management (MCM) catch and effort database). The closed season was introduced over 30 years ago, with few studies to investigate any changes in spawning activity or timing of spawning events. The increase in commercial catches after the closed season may indicate the positive role of the closed season in protecting the spawning squid during a critical period of their life history; it was this observation that led to the objectives of the present project.

This study was initiated to assist in evaluating the effectiveness of the timing of the closed season based on age estimations from statoliths collected from squid-directed surveys during November/December 2003–2005, and from a demersal trawl survey during April 2005. The estimated ages of chokka during these surveys assisted in back-calculating the dates when the chokka paralarvae hatched and eggs were spawned.

1.2 Objectives /Aim

The main aim of this study is to determine the ages of sampled *Loligo reynaudii* to help evaluate whether the closed season is beneficial as a management tool for the chokka squid resource.

The specific objectives of this study are to:

1. Determine and present the age structure of chokka squid (a snapshot) on a population level based on data from 2003 to 2005.
2. Evaluate the role of the closed season using catch data
3. Test the hypothesis that egg-laying events may be linked with sudden increases of squid abundance after the season opens by using back-calculated timing of egg-laying events.

Chapter 2

2. Literature Review

2.1 Understanding the life cycle of *Loligo reynaudii*

Sound knowledge of the life history and population dynamics is essential for assessment and management purposes of any species (Raya *et al.*, 2010; Rodhouse *et al.*, 2014). The life cycle of the chokka squid *Loligo reynaudii* d'Orbigny, 1845, in southern African waters has been described by several authors (e.g. Augustyn, 1989; Augustyn *et al.*, 1992, 1994; Oylott *et al.*, 2006, 2007; Sauer *et al.*, 2013; van der Vyver *et al.*, 2015; Lipinski *et al.*, 2016), and the main spawning areas of chokka squid were mapped as being inshore between Plettenberg Bay and Port Alfred on the south-east coast of South Africa (Sauer *et al.*, 1992, Lipinski *et al.*, 2016). Other identified spawning grounds were considered of minor importance (Lipinski *et al.*, 2016).

Augustyn *et al.* (1992) have described different stages of the life cycle of chokka, consisting of (a) spawning, (b) hatching, (c) a passive planktonic phase, (d) an active planktonic phase, (e) maturation and migration. These processes can be related to the basic stages in the life cycle: larvae, juvenile, sub-adult, and adult. Egg masses of loliginid squid are laid on the bottom in large numbers, and, although the eggs are easily available to potential predators, no major predation on eggs has been reported in spite of the fact that loliginid egg beds have been intensively researched by divers and underwater remotely operated vehicles (ROVs) in different oceans and at different latitudes (Rodhouse *et al.*, 2014). Newly hatched chokka, referred to as paralarvae, are weak swimmers and lead a passive, planktonic existence (Augustyn *et al.*, 1994). Paralarvae have been detected mainly around spawning grounds but are present along the whole south coast of South Africa (Augustyn *et al.*, 1994).

According to Rodhouse *et al.* (2014), feeding conditions are crucially important for squid population dynamics from the early life stages, even though the paralarvae still have some endogenous yolk reserves during the first days after hatching, while they are already

hunting prey. Feeding requirements drive juvenile chokka squid offshore from the spawning grounds in search of food, dispersing them over the entire shelf. As sub-adults, they will then reach either the area just offshore of their spawning grounds, or the southern and western Agulhas Bank, or the farthest extent of their habitat on the southern West Coast, depending on individual circumstances of growth and maturity, and on the environmental conditions. From there, the chokka may migrate back to the inshore south coast as mature adults.

Prior to 2010, Augustyn (1989) and Augustyn *et al.* (1992, 1994) had suggested that the life cycle of chokka squid was simple and constant, with a single paralarval pool emerging in the east where spawning grounds are found. The paralarval pool then drifted towards the west, having one main nursery area, and one long spawning movement of adult squid eastwards, back to the main spawning grounds for the cycle to start again (Lipinski *et al.*, 2016). This life cycle scheme was based on data taken during research conducted both on commercial vessels and on the research vessel *Africana* from 1983 to 2000. However, a more thorough analysis of historical data, together with additional analyses of recent data (after 2000), have resulted in a revised life cycle scheme (Lipinski *et al.*, 2016) which revealed complex distribution patterns of paralarvae emerging from different spawning aggregations in different areas, rather than a simple, single paralarval pool, as initially proposed. Rodhouse *et al.* (2014) states that there are three groups of chokka squid: the first located along the eastern part of the south coast of South Africa, the second from the Agulhas Bank and the West Coast of South Africa, and the third off Angola. South African populations have a complicated structure and are subject to mixing of many micro-cohorts, taking into consideration the dynamic character of each spawning aggregation. It was noted that considerable losses of paralarvae were likely to occur during their drift in various directions (Roberts & Mullon, 2010). Morphometric and genetic studies done on adult squid have indicated that the subpopulations of chokka squid separated morphologically and occurring in the three different parts of the coast are genetically the same (van der Vyver *et al.*, 2015; Lipinski *et al.*, 2016).

2.1.1 Reproduction

According to Jackson (2004), numerous loliginids, including chokka squid, are semelparous multiple spawners (Melo & Sauer, 1999). Spawning of chokka was detected by looking at the availability and distribution of egg capsules (Augustyn *et al.*, 1992), and though it is also possible to detect chokka squid spawning concentrations by using conventional echo sounders (Sauer *et al.*, 1992), it is usually necessary to dive (depths less than 50 m) and observe spawning squid at the spawning area. Logistically, diving time is limited unless the spawning areas are detected by jigging and marked with a marker buoy. However, the spawning areas are stable for several weeks if the weather is reasonably good. Spawning occurs on the sea bed, mostly in inshore areas of less than 50 m depth and occasionally in deeper waters (Sauer *et al.*, 1992; Roberts & Sauer, 1994, Roberts *et al.*, 2012; DAFF, 2016), and the spawning pattern appears as a mushroom-shaped echogram (Sauer *et al.*, 1992; Lipinski *et al.*, 1998). Inshore spawning sites are located both in relatively protected bays and in open, exposed parts of the coast, where the egg strands are found below the zones of high wave energy, usually below 15 m (Augustyn, 1989, 1990; Sauer *et al.*, 1992).

The location of the most important spawning areas has been identified between Plettenberg Bay and Algoa Bay, although there are localised spawning areas as far west as False Bay and as far east as Port Alfred (Augustyn *et al.*, 1992; Lipinski *et al.*, 2016). The locality of the spawning sites has also been identified from the occurrence of eggs in trawl nets during demersal scientific surveys (Roberts & Sauer, 1994). Spawning is believed to occur throughout the year (Augustyn, 1990; Sauer, 1991); however, clear peaks in adult abundance in winter and summer recorded from trawl and jig data support the existence of at least two major spawning peaks in most years, although much inter-annual variability exists (Olyott *et al.*, 2006). Spawning squid arrive at the spawning sites in separate (by sex) schools, which interact only on the spawning grounds (Sauer *et al.*, 1992).

The substratum chosen by squid for egg-laying is mostly sand, frequently in large and relatively sheltered bays, where most of the jigging takes place (Augustyn *et al.*, 1992). These sites are stable during a season and are abandoned only when weather conditions

become unfavourable for spawning. Histological analysis (Sauer & Lipinski, 1990) suggests that individual squid may spawn over a period of weeks or months.

Egg beds comprise either a few egg strands or numerous strands which form beds up to 4 m in diameter (Sauer *et al.*, 1992, Lipinski *et al.*, 2016). The mean number of eggs per strand is 148 ± 37 (Sauer *et al.*, 1993, Lipinski *et al.*, 2016). Fishing activity is concentrated in depths of less than 60 m, suggesting that the major spawning grounds are found in fairly shallow water (Sauer *et al.*, 2013). Nevertheless, catches of mature/spawning animals in deeper water (>60 m) and validated echograms off the south and eastern Cape have shown potential spawning (Roberts *et al.*, 2002), and eggs recovered from research trawls (Roberts & Sauer, 1994; Roberts *et al.*, 2012) have revealed that the inshore spawning areas may extend to deeper waters.

Hanlon *et al.* (2002) provide a general description of the behaviour of chokka squid during mating. Adult spawning squid will swim eastwards to where the spawning grounds are found. Prior to arrival, most females will already have stored sperm in the seminal receptacle, indicating ‘head-head’ mating. Behavioural dynamics have shown that females have access to sperm from different males and that multiple parenthood within the offspring of individual females may be common (Sauer *et al.*, 2013).

2.1.2 Early stages

The embryonic development of chokka was first described by Blackburn *et al.* (1998) and was further advanced by Oosthuizen *et al.* (2002) who expanded the classification of the early stages. Eggs of chokka are enclosed in cases in the shape of ‘fingers,’ about 9 cm long (Sauer *et al.* 2013). Each of these cases contains around 150 eggs, which are normally about 2 mm in diameter and yolk rich. The yolk has a sac around it which enables the survival of a newly hatched paralarvae for about three to five days, depending on the surrounding temperature (Sauer *et al.*, 2013; Oosthuizen & Roberts, 2009). Environmental factors, particularly temperature, play a key role in embryological development.

Initially, laboratory experiments showed paralarvae will not develop or survive well in temperatures $>20^{\circ}\text{C}$ or $<9^{\circ}\text{C}$ (Oosthuizen, 1999). A more recent study by Oosthuizen and Roberts (2009) found that downwelling can extend as deep as 120 m and as far offshore as 20 km, resulting in temporary intrusions of warmer water $>10^{\circ}\text{C}$. This phenomenon possibly explains why successful egg development has been found on the mid-shelf spawning grounds previously thought to be too cold (Roberts & Sauer, 1994), and accounts for the fact that a significant percentage of successful spawning takes place in relatively deep water (>60 m).

The aggregations of chokka squid paralarvae were found along the south coast of South Africa between September and December (data for years 1985–1991) (Sauer *et al.*, 2013). It was assumed that paralarvae may experience substantial losses when being transported off the shelf into open ocean (Roberts & Mullon, 2010; Lipinski *et al.*, 2016). However, this is mediated by their negative buoyancy and vertical migration habits, which may slow down their horizontal displacement (Martins *et al.*, 2010).

2.1.3 Distribution and abundance

Van der Vyver *et al.* (2015) describe the distribution of the chokka squid as largely influenced by the warm Agulhas current and the cold Benguela current upwelling system along the south-east coast. According to Lipinski (1998) and Sauer *et al.* (2013), chokka squid, unlike most marine fish, do not enjoy population security resulting from multi-generational age structure on account of its fast growth. This is however compensated by individual variation as well as complicated vertical and horizontal distribution patterns (Lipinski, 1998; Sauer *et al.*, 2013).

Early published accounts on the distribution of chokka point out that these animals are dispersed and isolated (Crawford, 1982). However, the first comprehensive review on distribution, compiled by Augustyn (1989) and based on demersal research trawl data, demonstrated that this species occupied the shelf between Port Alfred and the Orange River and was very abundant. It is now understood that chokka squid is also found in southern Angola (Shaw *et al.*, 2010), but is almost entirely absent on the Namibian shelf.

Most of the adult biomass of chokka is concentrated on the south-east coast of South African waters (Augustyn, 1989, 1991; Augustyn, *et al.*, 1993). Even though chokka squid accumulate in dense spawning shoals inshore (Augustyn, 1990), the offshore distribution is more uniform and widespread (Augustyn, 1989) and chokka squid are caught in most research trawls at depths shallower than about 200 m.

The biomass, distribution, size composition and reproductive data indicate that the population characteristics of chokka in the western part of its distribution differ from those of chokka further east, as proposed by Augustyn (1989). It is hypothesised that squid from the western Agulhas Bank grow more slowly and mature at a larger size (Olyott *et al.*, 2007) than those on the eastern Agulhas Bank. The size distribution is also much narrower, and gonadal development is not as far advanced for those on the western Agulhas Bank within the same time period (Sauer *et al.*, 2013). On the West Coast, most of the chokka are located south of 34° 30'S at depths of less than 300 m.

2.1.4 Migration and horizontal movements (including range expansion)

The limits of chokka distribution are reasonably well known, but data on the temporal and spatial dynamics of the stock are limited. A study by Augustyn (1989) indicates that offshore vertical movements are known from simple interpretations (occurrence in bottom trawls during the day and hunting close to the surface during the night) and hydroacoustic research (Lipinski & Soule, 2007; Roberts *et al.*, 2002; Soule *et al.*, 2010). Roberts *et al.* (2002) found evidence of large concentrations present in deeper water in the early mornings. Inshore, distances of up to 200 km have been measured between tagging and recapture positions on the inshore spawning grounds, and a generally eastward direction of migration of adults on the inshore spawning grounds has been established (Augustyn, 1989; Sauer *et al.*, 2000; Sauer 2013). This distance and direction suggest that there is some change in intensity in the immigration and emigration by juveniles and small sub-adults from, and by larger adults to the spawning areas on the south-east coast (Sauer *et al.*, 2000; Sauer *et al.*, 2013; Lipinski *et al.*, 2016). However, these movements have not been

quantified yet. The timing, duration, and intensity of immigration may contribute to determining the biomass at any given time in the area (Augustyn, 1991; Roberts & Sauer, 1994). Sauer *et al.* (2013) state that it is likely that a squid may remain within a relatively small area or, alternatively, migrate more than 1000 km within a year. They further suggest that there is no indication of a range extension for chokka squid over a long period of time (Sauer *et al.*, 2013).

2.1.5 Feeding ecology and behaviour

Investigations into the diet of adult chokka on their spawning grounds (Lipinski, 1987; Sauer & Lipinski, 1991; Lipinski, 1992) demonstrate that chokka squid mainly feed at night (28.5%) rather than in the day (6.7%), when most of the stomachs examined were empty (Sauer *et al.*, 2013). Stomach contents consisted mainly of a single prey item (90.8%). Teleosts formed the dominant prey item during the night, while squid dominated during the day feeding. According to Sauer *et al.* (2013), dominant species found in the stomachs of chokka were *Bregmaceros sp.*, *L. reynaudii*, *Betaeus sp.* and *Nereis sp.* The average stomach mass was 0.6% of the body weight on the spawning grounds, whereas on the feeding grounds it was usually around 2%.

Venter *et al.* (1999) investigated predation by chokka paralarvae. Although the number of individuals investigated (six) was small, the authors found several species ingested, among them, *Calanus agulhensis*, euphausiids, and polychaetes. Subsequently, *C. agulhensis* has been recognised as the most important paralarval prey (Roberts, 2005). Lipinski (1990) was the first to publish an account of feeding behaviour based both on aquarium observations and field studies. In aquarium experiments (temperature constant at 16°C), live mullet (*Liza richardsoni*) were provided as food in numbers that far exceeded the squid's requirements. In a limited space (circular tank of about 5 m in diameter and 0.8 m deep) squid easily caught their prey but were not successful with mullet larger than half the size of their mantle length. Feeding usually started from the dorsal side just past the head. Ingestion of food was completed within 10 minutes. The weight of stomachs immediately after ingestion varied from 2 to 6.3% of the predator's body weight (mean 4.1%).

2.1.6 Predators

Chokka squid is the main cephalopod prey of many coastal predators. These predators include seabirds, such as penguins (Rand, 1960; Randall *et al.*, 1981) and gannets (Batchelor & Ross, 1984; Klages *et al.*, 1992); marine mammals, including fur seals (Lipinski & David, 1990; Augustyn *et al.*, 1994; Stewardson, 2001) and dolphins (Ross, 1984). Chokka squid is food to several fish species, both pelagic fishes, such as yellowtail, (Smale, 1986) and demersal teleosts, including kob (*Argyrosomus spp.*) (Griffiths, 1997; Smale & Bruton, 1985), hake (Lipinski *et al.*, 1992) and sharks (Smale, 1991; Smale & Compagno, 1997; Smale & Goosen, 1999; Lipinski & Soule, 2007). These predators attack successfully because, *inter alia*, they are larger and faster than their prey.

Sauer & Smale (1991), and Smale *et al.* (2001) found that spawning attracts other predators and allows behavioural interactions. Feeding has also been described based on the spawning aggregations between predators and their squid prey. Ambush predation by both sharks and rays allows slow-moving taxa, such as cat sharks (*Poroderma spp.*) and the diamond ray (*Gymnura natalensis*), to lie immobile either in the egg beds or in sand bordering the egg beds, waiting to attack egg-laying females when they attach the egg strands. Other species, such as short-tail stingray (*Dasyatis brevicaudata*), swim actively over the egg beds and trap squid close to the substrate (Smale *et al.*, 2001).

In the water column, smaller teleosts may attack mating individuals and feed on the ejecta from mating squid which escape the attack (Smale *et al.*, 2001). Prey variation according to locality and time in seals and fishes is a reflection of distribution patterns, abundance and behaviour of prey; inshore predators show a preference for highly abundant prey during the spawning aggregations (Augustyn *et al.*, 1992; Lipinski & David, 1990; Sauer & Smale, 1991; Stewardson, 2001). Predators may also feed on squid when more nutritionally valuable prey is absent (Randall *et al.*, 1981). Sauer *et al.* (2013) describe the diversity of predatory species around the spawning aggregation and the susceptibility of mating pairs during egg-laying. Judging by the behavioural responses of the squid to a suite of predators, Smale *et al.* (2001) state that the rapid dispersal of aggregated spawning squid with the arrival of both seals and dolphins infers that these homeotherms pose a particularly high threat to mating squid. Even though eggs are highly abundant potential prey, few, if any,

predators feed on them (Smale *et al.*, 2001). Although nothing is known about predation upon paralarvae, they are likely to be preyed on by both vertebrate and invertebrate pelagic planktivores.

2.2 Ageing of squid

Panfili *et al.* (2002) and Hermosilla *et al.* (2010) assert that knowledge about the age and growth of fishes is essential for understanding the vital traits of species and populations such as life span, age at recruitment, age at sexual maturity, reproduction periods, migrations, and mortality. Raya *et al.* (2010) argue that determination of age and growth is critical in knowing the life history of harvested species and in modelling the dynamics of their populations; this is information necessary for assessment and management purposes. Age data is one of the important components of the information and may be used to carry out a stock assessment. Determining age correctly, and calculating growth parameters accurately are highly important in almost all aspects of fisheries management (Maartens & Booth, 2001). Life cycle studies are incomplete without the knowledge of longevity (life span) and how fast the animals achieve their maximum size (growth rates) (Arkhipkin & Shcherbich, 2012). In cephalopods, age determination helps in understanding their life history and facilitates modelling their population dynamics which, in turn, are very important in fisheries science, mainly for management purposes (Bettencourt & Guerra, 2001).

Different techniques have been applied to determine the age and growth of organisms, depending on the type of organism under study. There are two widely used methods for estimating growth in cephalopods: the indirect and the direct techniques (Gonzalez *et al.*, 1996; Sifner, 2008). The indirect technique is based on analysing the length frequency data (Modal Progression Analysis-MPA) obtained from experimental surveys or commercial landings. The direct method (analysis of size at age data) is based on growth increments in statoliths, stylets and beaks (the latter two in octopods), cephalopod growth in captivity and tagging and recapturing in the wild (Sifner, 2008). In the absence of accurate age data, understanding squid growth, recruitment, and productivity relies on indirect methods using catch data. However, when indirect methods are used to study growth of fish populations,

based on the modal progression of length distribution over a period of time alone, these methods are not considered the most appropriate to apply to cephalopod populations (Caddy, 1991). Results of a study carried out to compare the growth of squid based on statolith ageing (direct technique) and length frequency analysis (indirect technique) gave two conflicting results, where the length frequency analysis suggested that squid growth was asymptotic and that the life cycle was perennial, while ageing results showed that the life span was short, and growth was rapid (Jackson, 1991). Another statolith ageing analysis study by Butler and Fuller (1999) concurs with Jackson (1991) who state that squid do not grow asymptotically, as suggested by the length frequency results. More recent studies have shown that length frequency analysis grossly underestimates the growth and overestimates the life span (Jackson, 2004; Arkhipkin & Roa-Ureta, 2005).

The direct method is carried out by identifying and interpreting growth increments in calcified structures such as otoliths and scales of fish, in the statoliths of cephalopods, and among other structures which produce reliable estimations of the absolute age of wild marine animals (Lipinski, 2001; Boyle & Rodhouse, 2005; Sifner 2008; Perales-Raya *et al.*, 2010). Squid statoliths are described as a pair of calcareous structures similar to fish otoliths (Rodhouse & Hatfield 1990a; Butler 1999) that function in balance and hearing and contain much information about the lives of squid. Lipinski (2001) regards statoliths as living archives of the life cycle of squids.

Statoliths meet the essential criteria for a squid ageing tool because they contain interpretable growth increments that can be correlated with a regular determinate time scale, and they continue to grow at a measurable rate throughout the life of the squid (Arkhipkin & Shcherbich, 2012). According to Lipinski *et al.* (1998), Clarke (1966) first suggested that micro increments in squid statoliths might be useful for age determination, based on advice received from Prof. J.Z. Young.

In general, cephalopods are fast-growing species, and show continuous growth patterns, sometimes without approaching asymptotic size limits (Alford & Jackson, 1993; Pecl, 2004). Studies on the estimation of age and growth of squid based on statolith indicate that

most cephalopod species are short lived, and they exhibit rapid growth rates (Jackson, 1989; Lipinski, 2001) which are influenced markedly by various factors (Gonzalez *et al.*, 1996). Environmental conditions such as temperature, food availability, and geographic differences are the main factors that affect the growth patterns in squid (Forsythe, 1993; Hatfield, 2000; Jackson & Moltschaniwskyj, 2001; Sukramongkol *et al.*, 2006; Rodhouse *et al.*, 2014). Temperature change can alter the squid growth rate markedly (Forsythe, 2004) by changing the growth rhythm of individuals of the same age. Villanueva *et al.* (2003) linked the impact of temperature upon growth, showing that the embryonic development of squid lasts for a week to a few months, depending on the environmental water temperature. These conditions consequently affect the statolith growth of the squid embryo. The sensitivity of squid to temperature highlights an important issue as to how they might respond to the potential impact of recent changes in the ocean temperature (Jackson, 2004). Rodhouse *et al.* (2014) deal at length with the impact of temperature upon paralarval survival, growth rate, age of juvenile benthic settlement and timing of reproduction.

The best techniques that have been developed to age squid based on statolith analysis (Lipinski, 1978; Spratt, 1978) require the removal of statoliths from each individual, the visualisation of increments, and the enumeration and subsequent interpretation of these readings. These procedures have been applied to chokka squid (Augustyn *et al.*, 1994; Lipinski & Durholtz, 1994; Sauer *et al.*, 2013), and are currently considered a reliable and validated technique (Hermosilla *et al.*, 2010). In chokka, the daily deposition of statolith growth increments were validated under different conditions and stages of development. In the field, as well as in the laboratory, daily increment deposition in statoliths of adult chokka in the field was determined by tetracycline marking and recapture (Lipinski *et al.*, 1998; Durholtz *et al.*, 2002). In the laboratory, statolith increments of embryos and paralarvae of *Loligo vulgaris* were validated under different temperature conditions by multiple tetracycline marking, and have shown that cool temperatures can affect statolith increment deposition (Villanueva *et al.*, 2003).

Different methods have been implemented to process statoliths; however, preparation and counting of increments is an extremely time-consuming technique (Lipinski *et al.*, 1991; Durholtz *et al.*, 2002). Improved procedures such as the use of improved resins (that enable mounted statolith to be adjusted to different planes during grinding) and the use of wet grinding (to minimise scratching and reduce the need for polishing) combined with advances in statolith image analysis in recent years may reduce the difficulty of squid ageing (Arkhipkin & Shcherbich, 2012).

A number of problems associated with statolith ageing have been identified. One of them is the difference in the increment resolution between different types of microscopes used: light microscopy (poor resolution) and scanning electron microscopy (over-resolution) (Lipinski & Durholtz, 1994). Nevertheless Lipinski & Durholtz, 1994, proposed that both should be used and improved. Other statolith problems identified by Arkhipkin and Shcherbich (2012) in their study comparing statolith to fish otolith were that the shapes of statoliths are more complicated than otoliths and that statoliths are fairly small in size. In spite of the difficulties raised by the age determination in cephalopods, ageing methods based on the study of incremental growth structures (Lipinski & Durholtz, 1994; Bettencourt & Guerra, 2000) are considered the most appropriate (Jackson, 2004; Perales-Raya *et al.*, 2010).

The daily growth increment of the statolith is the paired dark and light growth layer produced over 24-hour periods, which has been validated by time-labelling and rearing experiments (Dawe *et al.*, 1986; Lipinski, 1986; Lipinski *et al.*, 1998; Jackson & Forsythe, 2002; Durholtz *et al.*, 2002). Past and current research supports the one increment per day hypothesis.

Information from studies of statolith increments can contribute not only to establishing the maximum age of the individuals (longevity), but also their life span and growth rate, and provide specific information on the growth and maturation process, growth modelling, cohort analysis, hatching dates, migrations and ecological information on the life history of species (Bettencourt *et al.*, 1996; Jackson, 2004; Arkhipkin & Shcherbich, 2012).

Juvenile loliginids hatch out with a relatively large, well-developed statolith, and statolith increments are usually clear in many of the species studied (Lipinski, 1986; Jackson, 2004).

Different growth models have been applied to fit the squid size at age data, ranging from simple linear to complicated sigmoid curves, and even two stage growth functions consisting of the early exponential phase and the later decreasing power phase (Arkhipkin & Roa-Ureta, 2005). Unlike most fish and invertebrates, where von Bertalanffy's asymptotic growth model is widely accepted for growth rate comparisons, there is no agreement yet on how to best describe mathematically the ontogenetic growth of cephalopods in general, and squid in particular (Jackson, 2004). However, the single model that has satisfied squid growth requirements (a growth model that has a positive acceleration of growth and has the ability of the major model to contain simpler models as particular cases in a nested structure) was the four-parameter Schnute (1981) general growth model which provided the best fit in a study by Arkhipkin & Roa-Ureta (2005).

2.3 Spawning biomass and recruitment relationship

According to Goodyear (1993), establishing a minimum conservation standard for Spawning Potential Ratio (SPR) based on a safer criterion is critical. He suggests adopting a standard for SPR consistent with average recruitment rates that would produce some agreed-upon fraction of recruitment required for Maximum Sustainable Yield (MSY). These levels should be somewhat higher than the minimum consistent with population persistence and would therefore be more protective of the stock (Goodyear, 1993). He further shares that, in deterministic stock-recruitment relationships, there is a level of parental stock that produces a maximum of excess recruitment which is averaged for a real (stochastic) model. Fishing at an exploitation rate that results in such a parental stock and also maximises the biomass yield per recruit to the population is an idea of MSY (Goodyear, 1993).

Theoretically, the MSY requires (1) a stock size that produces maximum excess recruitment, and (2) exploitation of the excess recruits in a manner which maximises yield for each harvested recruit. This approach would require harvesting all the excess recruits

at the time of their maximum biomass, but fisheries of wild stocks cannot generally be executed in this manner (Goodyear, 1993). Consequently, from a practical point of view, MSY and maximum rate of fishing mortality (FMSY) are not unique parameters, because the maximum yield attainable from a stock involves both the production of recruits and their exploitation. However, on the production side, there is a unique value of spawning stock in deterministic stock-recruitment models that produces maximum excess recruitment. Since equilibrium requires harvesting all the excess recruits, there is a unique fishing mortality rate FMSY that accomplishes this.

A study by Myers and Barrowman (1996) on whether fish recruitment is related to spawners abundance found that results are not caused by autocorrelation in recruitment, and the necessary relationship between recruitment and subsequent spawner abundance. In each of the three tests, the hypotheses that there are no relationships between spawners, and subsequent recruitment were rejected. These inferences held for almost every species and family analysed. The researchers also observed that many of the populations for which wide ranges of spawner biomass data were available, were those that had been fished to low levels, perhaps due, in part, to a rejection of spawner-recruitment relationships (Myers & Barrowman, 1996). Three different approaches to the general question on the relationship between spawners biomass and recruitment were considered, and in each case, the results were consistent with the hypothesis that recruitment is indeed linked to abundance of spawners. Myers (2001) noted that spawner abundance is slightly positively correlated with subsequent recruitment.

An exploratory study into the effects of spawning stock size on the recruitment abundance stocks of eleven round fish in waters off New England revealed that for most stocks, higher recruitment occurred at high stock sizes, and lower recruitment at low stock sizes (Brodziak *et al.*, 2011). Thus, for most stocks, spawning stock affected the survival ratios and extreme values of recruitment, as one would expect if compensatory processes were important determinants of recruitment. Results suggest that the odds of obtaining higher recruitment increase when a stock is kept above the median level of spawning biomass (Brodziak *et al.*, 2011).

Subbey *et al.* (2014) explain that, although recruitment forcing may be better understood when studied across populations (Myers & Barrowman, 1996; Myers, 2001), the basic challenge remains that the information available for most exploited stocks is inadequate for precise modelling, even for those species which have long time series (e.g. North Sea or Barents Sea gadoid stocks). Additionally, in an ever-changing climate, recruitment modelling, and forecasting will remain central to fisheries science for the next 100 years. Recruitment models will be required to develop and evaluate harvest control rules in management plans, set precautionary and MSY reference points, and predict likely changes to stock productivity caused by changes to habitat, regime, or local climate (Subbey *et al.*, 2014). While the task involved is far from simple, developments in recent years (in field experiments and conceptual modelling) give grounds for optimism. In other cases where an environmental factor has not been identified and verified as having predictive ability for future recruitment, analysts may choose to explain autocorrelated residuals using an explicit correlation parameter, and hence propagate this uncertainty during model estimation and forecasting (Thorson *et al.*, 2016).

Although it remains open whether correlations represent direct mechanistic links, the analysis demonstrates how trends in recruitment dynamics and the underlying drivers can be identified (Zimmermann *et al.*, 2019). Determining these major patterns shared among stocks helps to identify the processes and ecological links that are of actual relevance for population dynamics and, thus, fisheries management. The results from these studies may provide insights beyond empirically ascertained synchrony through linear correlations, which were found in a low number of stocks, despite substantially more available data and a much broader approach than in past studies (Myers & Barrowman, 1996). These results suggest that underlying common trends and simultaneously occurring strong and weak year classes are masked by additional stock-specific dynamics and noise, or have nonlinear characteristics that cannot be adequately detected by simple Pearson's correlations (Zimmermann *et al.*, 2019). The latter correlations include interactions between stocks that may increase competition or predation under favourable recruitment conditions, undermining synchronous recruitment success. Although it can be concluded that direct synchrony between stocks may exist, it remains largely undetectable over entire recruitment time series, except for a few closely linked stocks. Understanding recruitment

dynamics and improving their predictability could therefore help to reduce the forecast uncertainty in stock assessments, and boost the quality of management advice and sustainability of the world's fisheries (Zimmermann *et al.*, 2019).

Zimmermann *et al.* (2019) explain that, besides the spawning stock biomass (SSB) itself, which was confirmed as a significant driver of recruitment success, stock demographics and the condition of those spawners are also assumed to be relevant for reproductive output and, subsequently, recruitment. This assumption is, however, not necessarily confirmed by statistical analysis.

Cephalopods usually show non-synchronous spawning and recruitment (Rodhouse *et al.*, 2014). The cephalopod stocks are generally regarded as resilient, rapidly bouncing back after over-exploitation. However, it is also possible that the large natural fluctuations have obscured collapses caused by over-fishing, even (or perhaps especially) in the ommastrephids. Stock-recruitment relationships have been found for some short-lived animals (e.g. shrimps), but in schooling marine animals, because of density-dependent population regulation, the spawning biomass of a cohort is not necessarily proportional to the numbers recruited (Rochet, 2000, as cited in Rodhouse *et al.*, 2014). Although reliable spawner-recruitment relationships may be important and useful for stock forecasting and management of cephalopod stocks, there is no clear relationship between spawning stock abundance and subsequent recruitment in cephalopod stocks (Rodhouse *et al.*, 2014). The authors add that annual variability in oceanographic conditions may cause recruitment variability, which renders spawner-recruitment relationships unreliable.

In some cases, Ricker (1975) and Beverton and Holt (1957) models were fitted to the cephalopod spawner-recruitment data for forecasting recruitment in the following year. However, estimation parameters in these nonlinear models using spawner-recruitment data usually contain statistical problems that are mainly derived from observation errors in the explanatory variables (Walters & Martell, 2004). These problems lead to a tendency to over-estimate stock size, particularly in the case of low spawning stock size, which then tends to mislead stock management strategies (Walters & Martell, 2004). Ish *et al.* (2004) reviewed the history of the fishery for *Loligo opalescens* on an annual time scale. Season analyses suggest that cohorts of squid persist offshore and move inshore for reproduction

throughout the season. In order to predict the timing of the inshore movement of squid, a life history model using stochastic dynamic programming was developed. This model made it possible to link squid growth and reproduction with environmental factors, particularly upwelling, temperature, and food abundance in a consistent Darwinian framework. Using the model, Ish *et al.* (2004) predicted the timing of squid movement inshore in cold and warm environments, and the amount of biomass inshore in weekly intervals.

Since two aims of this project are related to changes in chokka abundance from year to year and within a year (“Evaluate the role of the closed season using catch data”; and: “ Test the hypothesis that egg laying events may be linked with sudden increases of squid abundance after the season opens by using back-calculated timing of egg-laying events.”), it was important to briefly review stock-recruitment relationship in squid.

Chapter 3

3. Material and methods

3.1 Study area: Distribution of stations

The study was conducted on the south-east coast of South Africa. The area surveyed was between Plettenberg Bay and Port Alfred, around 24° and 26°E, the site of the traditional spawning grounds of chokka. Data for the study were collected at the end of the closed season (in November) during dedicated squid research cruises on *FRS Algoa* in November and December 2003 to 2005, and again in April and May 2005, on board *FRS Africana*, during the demersal survey.

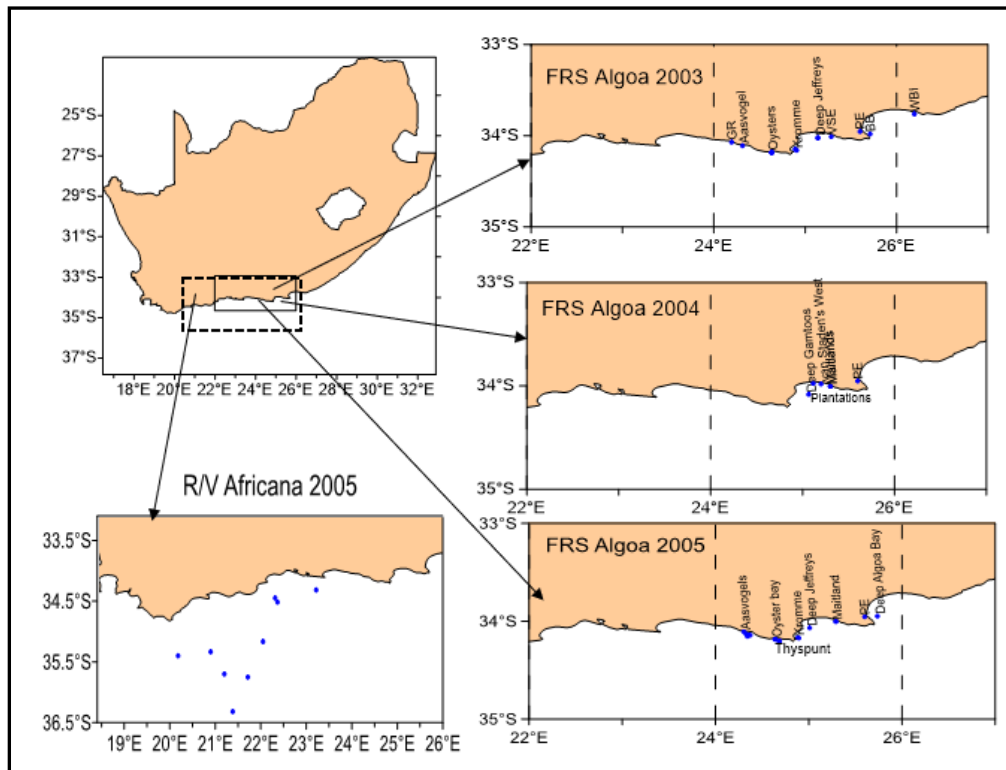


Figure 1: Distribution of stations where chokka data were collected during November 2003, 2004 and 2005 and April 2005. The areas surveyed during the 2003 November squid survey; (from left to right): Groot Rivier (GR), Aasvögels, Oysters, Kromme, Deep Jeffreys, Van Staden's East (VSE), Bell Buoy (BB), and west of Bird Island (WBI). The areas investigated during the 2004 squid survey were Deep Gamtoos, Plantations, Van Staden's and Maitlands. The areas investigated during the 2005 November squid survey included: Aasvögels, Oyster Bay, Kromme, Deep Jeffreys, Maitlands and Deep Algoa Bay. PE – Port Elizabeth. April/May 2005 demersal survey was conducted at random, no names for sampled positions were recorded.

The survey in 2003 took place from 18 November to 6 December. The areas investigated during the 2003 squid survey were: Groot Rivier (GR), Aasvögels, Oysters, Kromme, Deep Jeffreys, Van Staden's East (VSE), Bell Buoy (BB), and west of Bird Island (WBI). All marks were actively fished by commercial vessels when surveyed.

In 2004, the survey began on 14 November and ended on 1 December 2004. The areas investigated during the 2004 squid survey were Deep Gamtoos, Plantations, Van Staden's West, Van Staden's East and Maitlands. All marks were actively fished by commercial vessels when surveyed, except Maitlands, where the majority of surveys occurred during the closed season.

The survey in 2005 commenced on 15 November and finished on 1 December 2005. The areas investigated during the 2005 squid survey included: Aasvögels, Oyster Bay, Thyspunt, Kromme, Deep Jeffreys, Maitlands, and Deep Algoa Bay. All marks were actively fished by commercial vessels when surveyed, except Maitlands, where the majority of surveys occurred during the closed season.

In April 2005, the survey lasted from 7 April to 2 May 2005. Demersal trawl surveys use bottom trawls with specific mesh size, for example a liner of 12-mm mesh anchovy net in the codend. These surveys are usually conducted at random and, for this reason, there are no names for the positions plotted in the graph shown in Figure 1. According to Lipinski (1994), differences in basic biological parameters of the population (e.g. length frequency) show that jigging is a more selective, and therefore biased, method of sampling than bottom trawling.

3.2 Source of data

The study was based on the samples already collected during the April/May 2005 cruise by *FRS Africana* and towards the end of the closed season in November during dedicated squid research cruises by *FRS Algoa* in November and December 2003, 2004, and 2005. The *FRS Africana* cruise was a standard ground fish survey, whereas the main aim of *FRS Algoa* cruises was to conduct hydroacoustic research on the largest concentrations of chokka in the area of its distribution.

Jigging was conducted to sample the chokka squid in order to obtain mean length and weight data, to collect age and growth data, and to tag squid. Squid from which statoliths were taken, were randomly selected if they were males. Females were, however, scarce, and for this reason, all were taken as samples, and their sizes were fairly uniform. *R/V Africana* samples were obtained by a standard bottom trawl. According to Dawe and Natsukari (1991), random sampling for each sex of squid may be the most suitable scheme for providing a sample which best reflects the parent population and is the most statistically suitable scheme.

Table 1 summarises the data collected in the three years considered in this study.

Table 1: Survey details of *Loligo reynaudii* during the years considered in this study.

Vessel	Month & year sampled	Total no. of individuals	Females	Males	Total no. Aged	Ratio in % (F to M)
FRS Algoa	Nov/Dec 2003	185	66	106	185	36 to 57
FRS Algoa	Nov/Dec 2004	428	215	206	423	50 to 48
RV Africana	April/May 2005	300	151	149	92	50 to 50
FRS Algoa	Nov/Dec 2005	303	141	162	91	47 to 53

A total of 185 in 2003 (of which 13 were unidentified sex), 428 in 2004 (of which seven were juveniles), 300 in April 2005, and 303 in November 2005 were collected. Squid that could not be sexed were classed as juvenile or unidentified and are not included in the male or female numbers in Table 1. Sample data recorded for each station included species, catch date, geographical location of capture, sampling gear, depth, mantle length (in mm), sex, maturity stage and total weight (in grams).

3.4 Statolith dissection

Age was estimated from daily increments in the statolith. Statoliths (both left and right) were dissected from fresh animals (Lipinski 1981), washed in distilled water and stored in 70% ethanol. Both statoliths were later air-dried and prepared for light microscopy following the procedures described by Lipinski and Durholtz, (1994) and Lipinski *et al.*, (1998).

3.4.1 Statolith preparation for light microscopy

One statolith from each pair was embedded horizontally in resin, using a gelatine capsule as a mould. Heat-curing orthodontic acrylic resin (Japanese Bio resin) was used. Once the statolith were cured in resin, the resin block was trimmed in the oblique frontal plane and polished on both sides. Polished blocks were attached to a glass slide (such that the anterior surface of the statolith faced up) by means of nail varnish, and oriented so that the edge of the slide headed the desired plane of sectioning. The grinding progress was checked regularly under the microscope to avoid over-grinding. The resin blocks on the glass slide were then ground again until increments appeared. Grinding was stopped when the nucleus was visible and before it was ground away. The ground surface was further polished and the blocks with statoliths were removed and remounted on a clean glass slide (ground surface down). Finally, the block was ground in a plane parallel to that of the surface of the slide, and when the specimen had reached the desired thickness, the surface was polished, and the specimen was ready for viewing under the microscope (Lipinski & Durholtz, 1994).

3.5 Counting increments

Prepared statoliths were viewed and photographed using a high-resolution Zeiss digital camera (AxioCam MRc) mounted on a Zeiss Axioskop compound microscope. Age estimation analyses were conducted on the digitised images. Each daily increment was considered to consist of the 'dark ring' and the adjacent 'light ring' (Figure 2) as proposed by Lipinski *et al.* (1991) and Bettencourt *et al.* (1996).

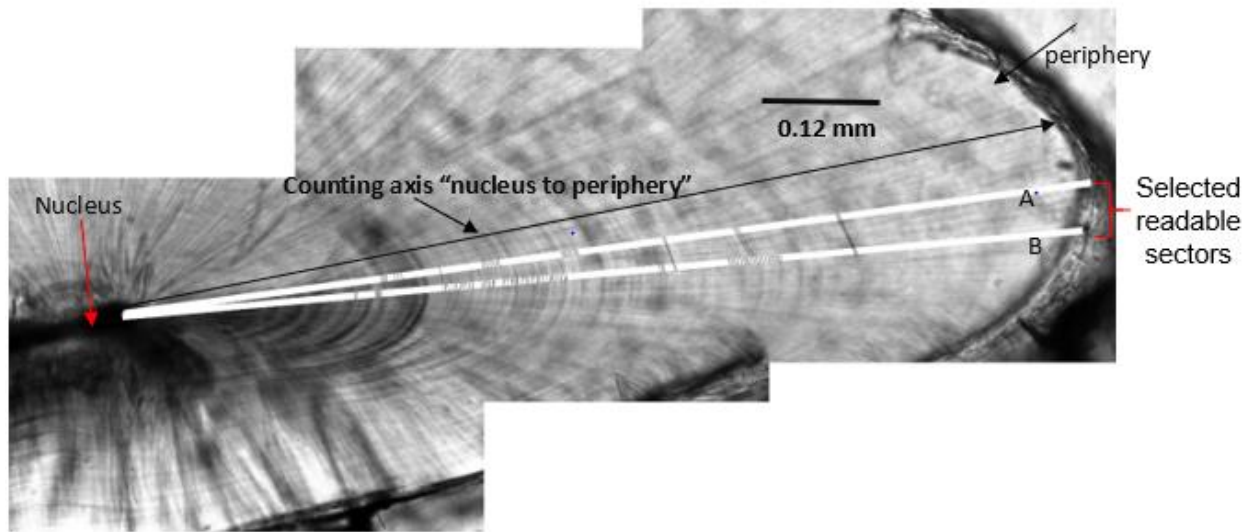


Figure 2: Section of statolith image of *Loligo reynaudii* viewed and captured through a light microscope for increment counting.

Increments were counted along a “nucleus to periphery” axis that had the highest proportion of readable sectors (Figure 2). In sectors that were unreadable along that axis (line A in Figure 2), an alternative axis (line B in Figure 2), where daily increments were visible in the sector, was used. Where no increments could be detected in a given sector, the number of increments was estimated either through interpolation (using the average increment width in the adjacent sectors), or by extrapolation where the peripheral sector was not readable (using the average increment width in the immediately adjacent readable sector). Counting of daily increments on each section of the statolith was done only once by an experienced reader and because of this, error between counts was not quantified. A total of 185 in 2003, 428 in 2004 (all statoliths collected), 91 in November 2005 (low success rate of 30%), and 92 in April 2005 (low success rate of 30%) squid of both sexes were aged and used in this study. The low success rate for 2005 material was attributed to technical problems (statoliths kept for too long in weak alcohol and subsequently not easy to grind).

3.6 Back-calculation of spawning time

To estimate the collected squid birth date and egg-laying date, knowledge of the exact date of capture of every individual was important (Sukramongkol *et al.*, 2006). Dates of birth for individual chokka squid were estimated by back-calculation from the date of capture (day and month of year) using the age estimated from statolith daily increments. The egg-laying dates of individual squid were estimated by back-calculation from the date of birth and egg development time of chokka based on the findings of Oosthuizen *et al.*, 2002 (Figure 3).

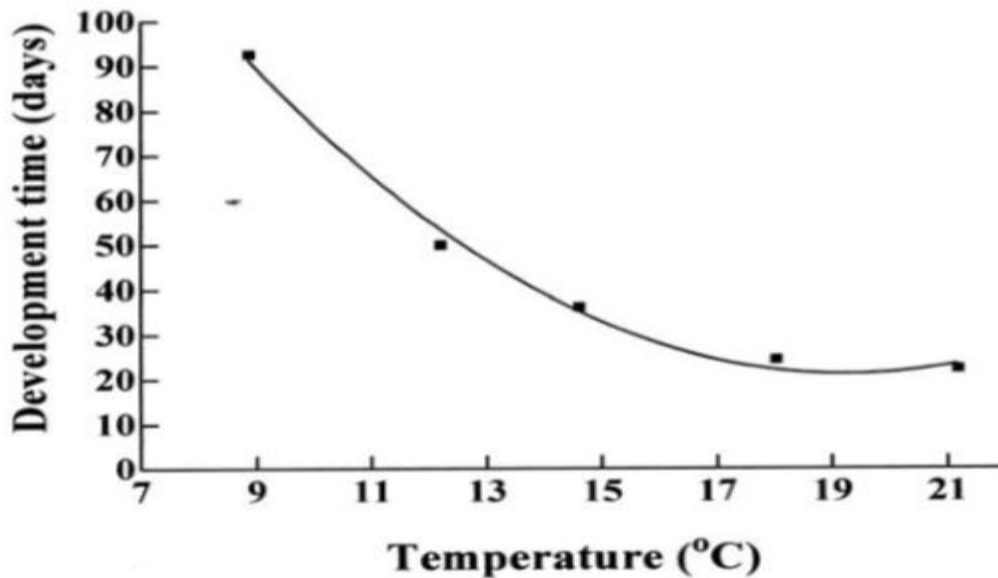


Figure 3: Relationship between the egg development time and stable temperatures for *Loligo reynaudii* (from Oosthuizen *et al.*, 2002)

According to Oosthuizen *et al.* (2002), temperature influences the egg development of chokka squid. Temperature data used in this study was obtained from a Thermistor string which was deployed in St Francis Bay at the squid buoy at a depth of 24 m. Daily temperature data were collected and recorded at depths 9, 14, 18, 21 and 24 metres over the years. Modal temperatures on squid spawning sites in November 2002, 2003, and 2004 were on average 17.65 °C, 18.35 °C and 18.96 °C, respectively. This resulted in a hatching

time of approximately 27 days in year 2002, and 26 days in the years 2003 and 2004. The peak egg-laying date for each survey year was determined by selecting the date with the highest egg-laying frequency.

The estimated distributions of egg-laying events were determined by counting the occurrence of the date when eggs were laid. The egg laying date's distributions were then related to the squid annual closed season, and the jig commercial catches of the same and following years. Comparison between closed season and nine days before and after the closed season catches was done. The period of nine days before to nine days after the closed season was chosen because catches were reported per month and, in the case of November, only nine days after the closed season were referred to as the catch of the whole month. Nine days before the closed season was intended for purposes of symmetry.

3.7 Commercial catches

Commercial catch data of the squid jig fishery were extracted from the Marine and Coastal Management-MCM catch and effort database and were used as an indicator of chokka abundance. The extracted information included the total catches of each month between Plettenberg Bay and Port Alfred from 1985 to 2006, as well as daily catches in last days of November (open season).

3.8 Data analysis

Surfer 12 was used to plot positions on the maps where chokka squid was collected. All data analyses were done in *R* (R Core Team 2019) and a variety of *R* packages including: Wickham 2019; Elzhov et al. 2016; Wickham and Bryan 2019; Henry and Wickham 2019. IBM SPSS version 25 software was employed for the Kolmogorov-Smirnov test which was used to probe differences in the age distribution between males and females. Excel 2013 was also used for drawing graphs. For all statistical tests conducted, a 0.05 significance level was considered as the decision threshold.

3.8.1 Predicted growth (Age versus Length)

Five types of growth models (Linear growth model, Exponential growth model, Power growth model, Gompertz growth model and the Francis growth model) were considered and fitted to the growth data of *Loligo reynaudii*. However, of the five models listed, only three fitted. The Gompertz and Francis growth model could not be fitted to the data and were dropped (disagreement with Arkhipkin and Roa-Ureta, 2005, was noted). The three models that were fitted were:

Linear growth model: $ML=a+b(age)$

Exponential growth model: $ML=a(e^{b_{age}})$

Power growth model: $ML=a(age)^b$

where a and b were model parameters from the above three models to be estimated.

These models were fitted to all growth data; that is, males, females, and all other unsexed individuals. How well each of the models performed was assessed based on information criteria (AIC , BIC) and root mean squared prediction error. Model diagnostics were looked at by plotting residuals versus actual observations (measured mantle length). This was done to see whether there were any systematic patterns in the prediction from the model. Further analysis was done based on the model that was found to best fit the whole data of *L. reynaudii*. The difference in growth patterns between males and females was assessed by comparing bootstrap distributions of model parameters and by explicitly incorporating sex as a covariate in the linear growth model. Parameters from the bootstraps were then used to generate predicted length for males, females, and all data combined. The lower, median and upper quartiles were sectioned as 2.5, 50, and 97.5 percentile of the prediction for the males, females and all data.

Chapter 4

4. Results

4.1 Abundance of chokka

Figure 4 presents the total monthly commercial jig catches (in tonnes) of chokka that were caught during the years 2002 to 2005 between the area of Plettenberg Bay and Port Alfred. The monthly catch records for each year are shown in Table 7, Appendix 1.

Similar trends were displayed in the jig catches of all the years (Figure 4). January catches were all above 600 in all years, with year 2004 having the highest catch of 1 925. However, a noticeable decrease was evident in the catches of all the years during the month of February with 2002 and 2003 having the lowest catches. Low catches ranging between 160 and 592 were seen from the month of March up to the month of August. An increase in the catches is shown from November in all years, except 2002, which presented a decrease. November catches seem to be better than catches between January to October, even though the fishery operated for only nine days in November after the closed season. December catches were highest in years 2003, 2002, 2005, and January catches were highest in 2004. Year 2004 showed the highest catches in most of the months compared to the other years, except for the months of April, May, August, November, and December.

The total catch in tonnes for the year was highest in 2004 (8512), followed by 2003 (7294), then year 2002 (6523), and lastly, 2005 (6018) (Appendix 1, Table 7).

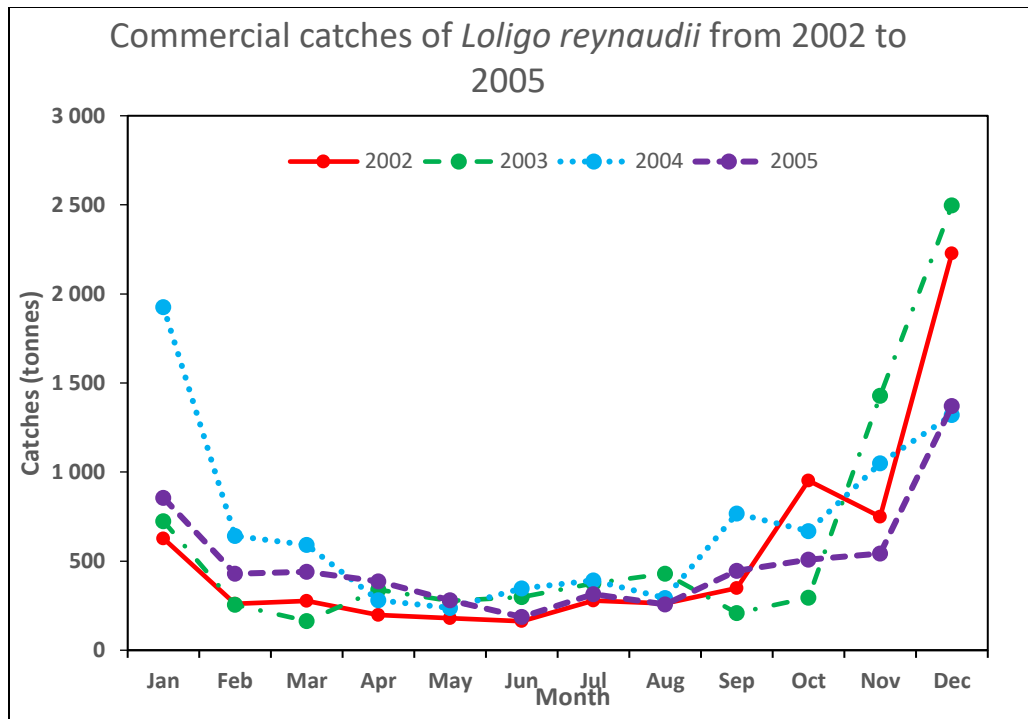


Figure 4: Monthly commercial jig catches of *Loligo reynaudii* between Plettenberg Bay and Port Alfred for the years 2002 to 2005.

The overall trend (Figure 4) is that commercial catches of chokka in all years increased from November soon after the fishery resumed. The catches continued to increase in December for all years, up to the month of January, particularly for the year 2004.

Table 8 in Appendix 1 shows monthly catches of chokka during a 21-year period from 1985 to 2006. The catches were commercially fished from the area between Plettenberg Bay and Port Alfred. Figure 5 presents and compares the annual mean commercial catches of the time series between nine days before and nine days after the closed season, during the closed season, and at other times of the year. ‘Other times’ refer to the month of

December to the 15th of October. The mean is a standard arithmetic mean which was computed as $\text{mean catch} = \frac{\text{sum}(\text{catch})}{\text{total number of records}}$.

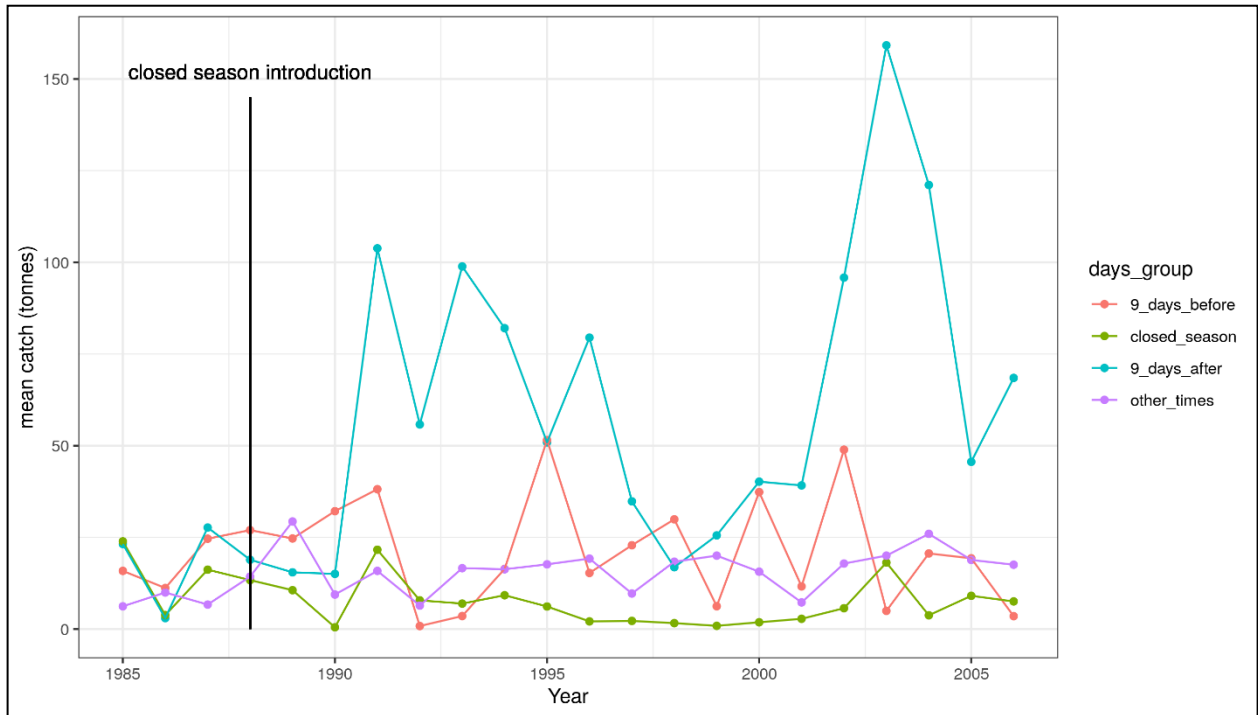


Figure 5: Annual mean catches of *Loligo reynaudii* between Plettenberg Bay and Port Alfred for the years 1985 to 2006: comparison between nine days before and nine days after closed season, during closed season, and other times..

Looking at all the trends over time, mean catches in the nine days (22 to 30 November) period after the closed season recorded the highest catch in most of the years except during the years 1986, 1988 to 1990, and 1998. The highest mean catch in the period nine days after the closed season was 160 tonnes which was recorded in 2003, followed by year 2004 with a mean catch of 120 tonnes. Mean catches of period within nine days before the closed season subsided between zero and 50 tonnes whereas mean catches recorded during the closed season and other times of the year were all below 30 tonnes. Noticeable changes in the mean catches of the nine days after the closed season are evident from 1991, two years after the inception of the closed season. Very low mean catches of close to zero were evident during the closed season from 1996 to year 2000. It is important to note that catches in the closed season were experimental catches only, executed under special permission for boats doing research. The latest year (2006), revealed an increase in the mean catch in the

period nine days after the closed season and a drop in the mean catches of other periods. Overall, mean catches were high within the nine days after the closed season, and low during the closed season (for obvious reasons) and other times.

The line graph presented in Figure 6 shows results of daily catches from 22 to 30 November for the years 2002 to 2005. The days (22 to 30 Nov) represent the period of nine days fished in November after the fishery resumed. The results clearly show high catches in 2003 for most days (except the 22nd and 28th day), followed by year 2004, then 2002 and lastly 2005. The highest catch of 290 tonnes is observed on the 23rd day of November in the year 2003.

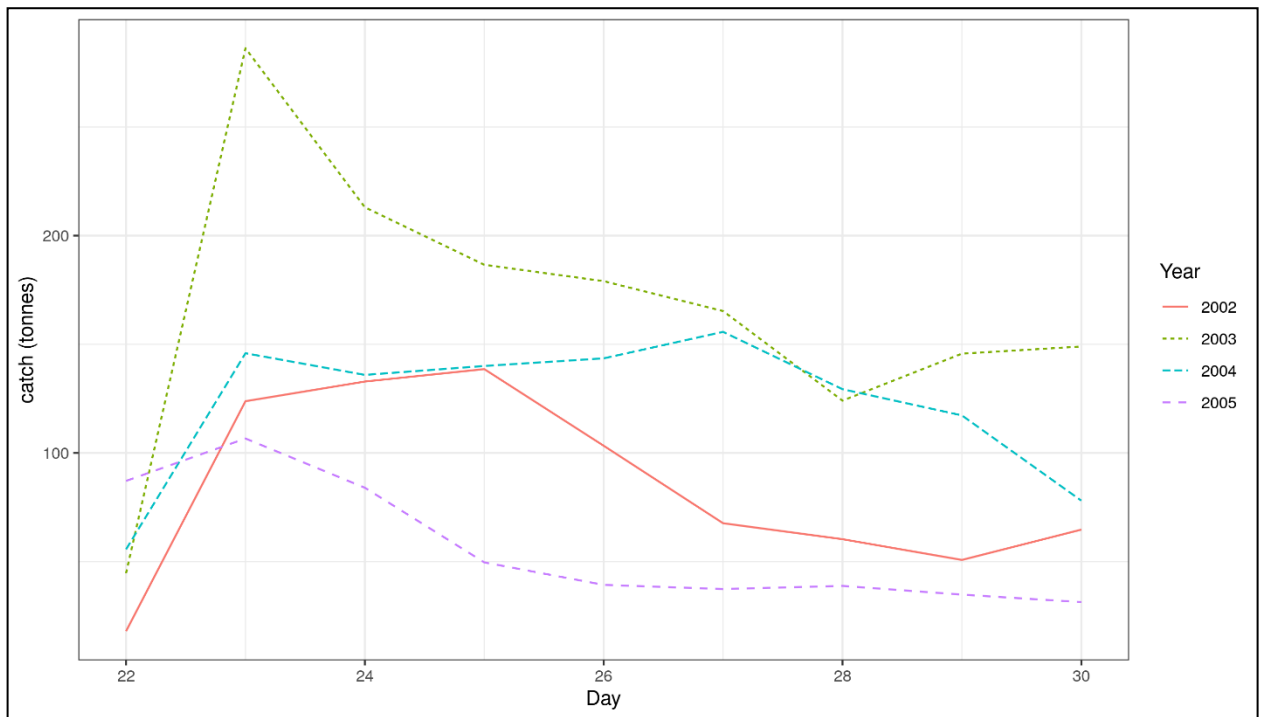


Figure 6: Daily catches of *Loligo reynaudii* from 22 to 30 November of 2002 to 2005 between the area of Plettenberg Bay and Port Alfred.

Comparison of daily catches (in tonnes) of chokka from day 22 to 30 between the month of November, December and January was done and results are presented in Figure 7. The same days for each month were selected for the results to be comparable. The daily catches were compared for the years of 2002 to 2005 between the area of Plettenberg Bay and Port Alfred.

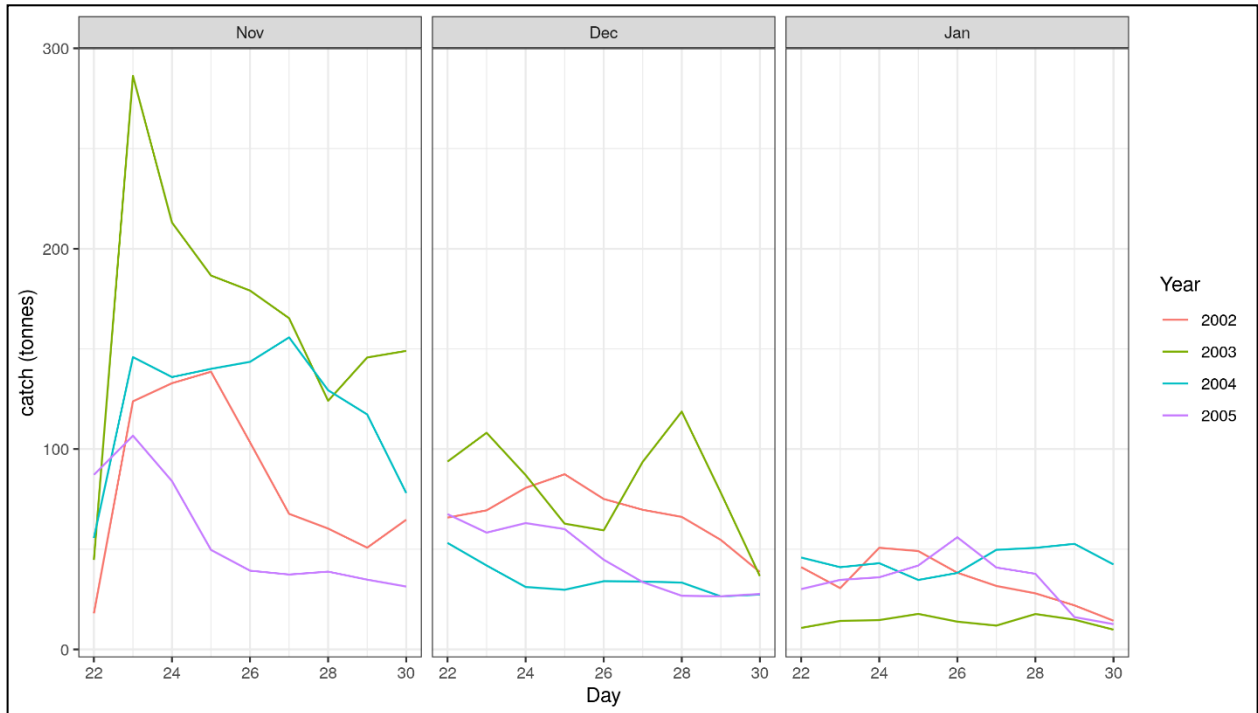


Figure 7: Relative daily catches of *Loligo reynaudii* between day 22 to 30 of the months: November, December and January from 2002 to 2005. Catches between Plettenberg Bay and Port Alfred only.

The results in Figure 7 show high catches per day in November for all the years considered in this graph, relative to the daily catches seen in the months of December and January in all the years. Year 2003 indicated the highest catch during the month of November with the peak on the 23rd day (290), followed by 2004, then 2002, and lastly 2005. December of years 2003 and 2002 were the top two years, showing high daily catches. Daily catches did not exceed 55 tonnes in any year during the month of January, with 2003 showing the lowest daily catches.

4.2 Age distribution

Ages of *L. reynaudii* estimated from counting the statolith increments are presented in Kernel density graphs (Figures 8 and 9). A total of 791 individual samples from survey year 2003 to 2005 were aged, of which 410 were males, 361 were females, 7 juveniles, and 13 unidentified. Juveniles and unidentified individuals were not considered in the results presented in Figures 8 and 9. Age distribution was separated into quartiles (25%, 50% and 75%) for better description. The one-year mark is represented by a dot and the number 365 on each graph.

The age distribution for all sampled chokka combined ranged from 125 days old to 484 days old, with a mean age of 318 days, and a median of 330 days old (Figure 8). The distribution shows spawning longevity of a maximum of 484 days (1 year 4 months) old. Seventy-five percent of the samples were comprised of individuals that were 353 days older or less. The general structure of all ages shows that the bulk of chokka squid were less than one year old during the spawning period.

The male ages ranged from 168 days to 484 days, with a calculated mean age of 323 days and a median of 334 days. Of the males, 75% were 356 days older or less (Figure 8). Females were, on average, 316 days old, with a median of 324 days. Of the females, 75% of females were 348 days or less (Figure 8). The female ages ranged from 125 days to 478 days.

Female distribution exhibited larger numbers of younger ages than the male distribution, whereas the male distribution showed more older ages than the female distribution. A Kolmogorov-Smirnov test was performed to examine the difference in the distribution of the males and females. The results (Appendix 2, Table 9) indicated a significant difference in the distribution of ages between males and females ($P < 0.05$).

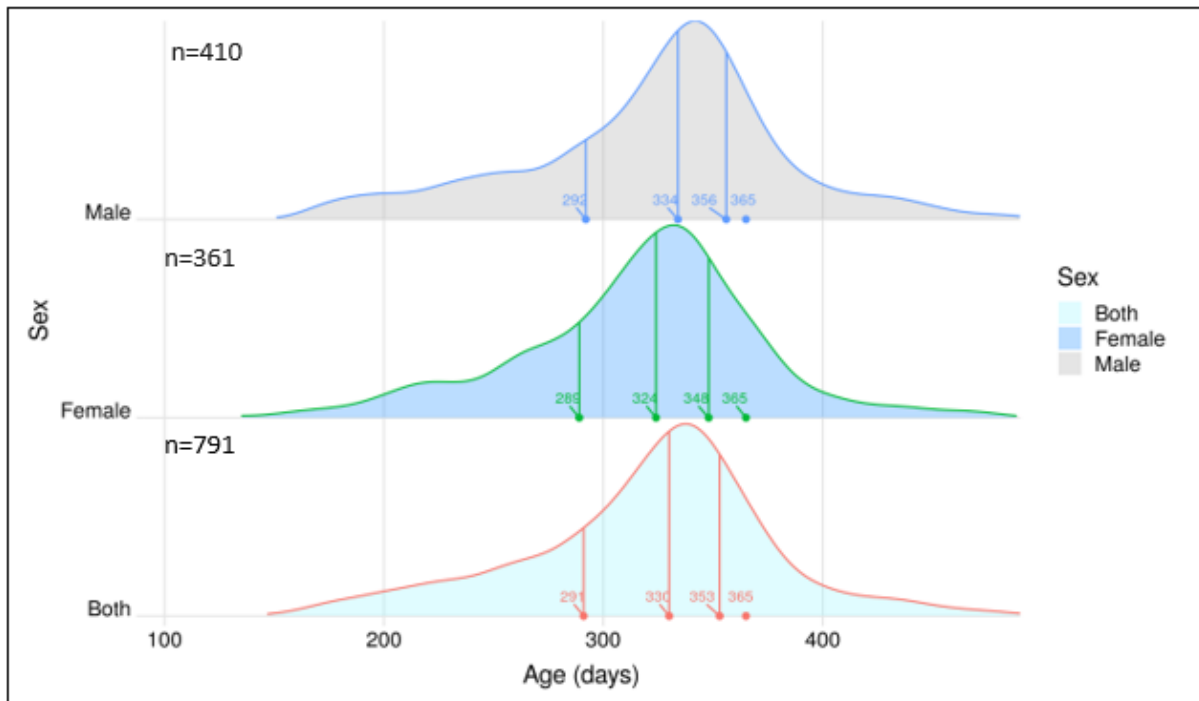


Figure 8: Male, female and all aged age distribution of *Loligo reynaudii* from years 2003 to 2005 survey. One-year mark represented by a dot and number 365 just after the 75% quartile line.

4.2.1 Age distributions per sex category for each survey year (2003 to 2005)

Figure 9 presents the age distribution for male and female chokka sampled during the surveys carried out in November 2003, November 2004, April 2005, and November 2005. Age distribution for females ranged from 125 days to 478 days, with males ranging from 168 days to 484 days, based on the age data collected from surveys carried out in the years 2003 to 2005. Separate female and male age ranges for each year are shown in Table 2.

Computed means in females were found to be 350 days, 326 days, 251 days, and 277 days for November 2003, November 2004, April 2005, and November 2005, respectively. Averages in males were found to be 364 days, 325 days, 265 days and 286 days for November 2003, November 2004, April 2005 and November 2005, respectively. The average age for males was high in all years, except in survey 2004, relative to the average age for the females in all the surveyed years.

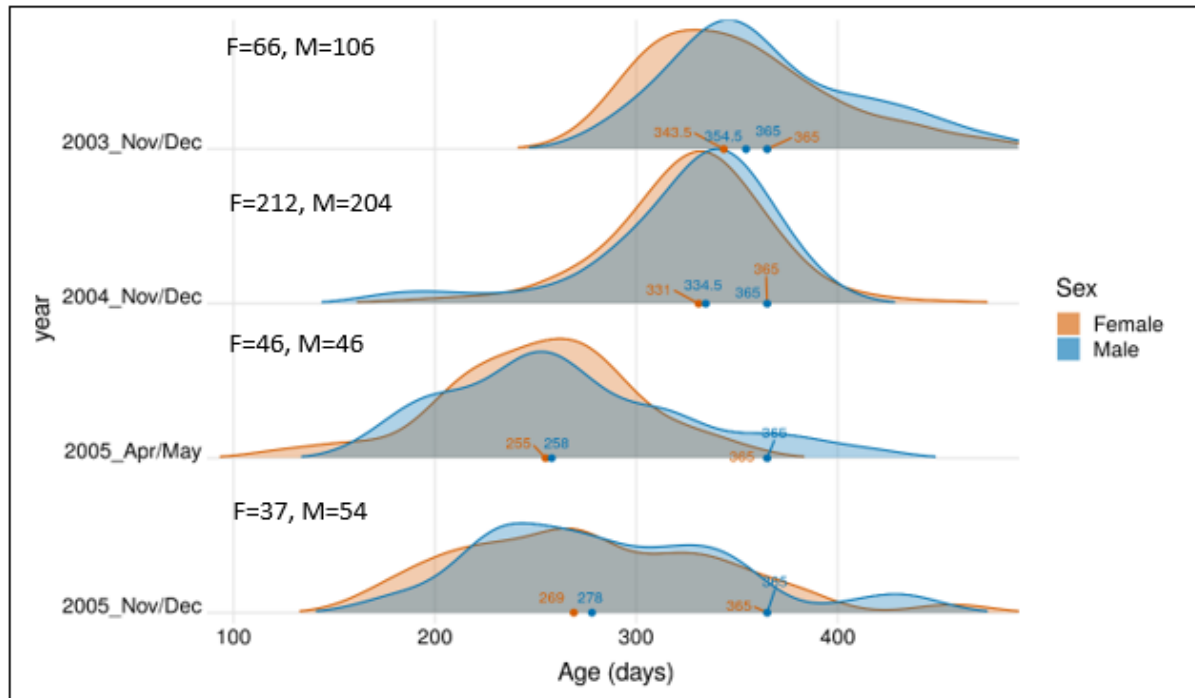


Figure 9: Male and female age distribution of *Loligo reynaudii* between Plettenberg Bay and Port Alfred for the surveys conducted during November 2003, November 2004, April 2005 and November 2005.

Male and female ages from the 2003 survey showed a right skewed age distribution with a median of 343 days in females, and 354 days in males.

Males sampled from the 2004 survey were characterised by a long, left-hand tail distribution (Figure 9) with a median age of 335 days. Female age distribution, on the other hand, was almost normally distributed with a slight skew to the left, with a median of 331 days old.

Age distribution of males during the April 2005 survey was close to normally distributed, showing a small right-hand tail with a median of 258 days. Females, on the other hand, displayed a shape slightly skewed to the left with a median of 255 days.

Male and female age distribution shapes in November 2005 survey are not well defined, having a median of 278 days in males and 269 days in females.

Spawning squid in 2005 were relatively younger for the April as well as November snapshot than the spawning squid during the 2003 and 2004 surveys. Overall results from

all surveyed years shows that there were more of the older male individuals than females, except for 2004, which showed a few older females, with no males of the same age. In all the years, the mean ages (Table 2) of spawning squid for both males and females were less than one year. Overall age distribution shows that most of the male and female ages were below 365 days (one year) during spawning.

Table 2: Summary of the estimated age distributions between male and females collected during survey year 2003, 2004 and 2005.

Sample month and year	Estimated age (days)					
	Male			Female		
	Total no.	Range	mean+-SE	Total no.	Range	mean+-SE
Nov-2003	106	281-484	364 +-4.50	66	278-478	350 +-5.58
Nov-2004	204	168-397	325 +-3.15	212	175-464	326 +-2.7
Apr-2005	46	172-417	265 +-8.6	46	125-350	251 +-6.7
Nov-2005	54	177-439	286 +-8.66	37	170-457	277 +-10.65

4.3 Back-calculated birth dates and timing

Back-calculation of birth dates and egg-laying dates was performed for all collected and aged data from surveys of November 2003, November 2004, April 2005, and November 2005. Distribution of back-calculated birth dates from November survey in all years are presented in Figure 10. The figure shows the number of births of chokka per day during the closed season, nine days before and nine days after the closed season, and other times during the rest of the year. ‘Other times’ refers to any other day during the year other than the closed season and the nine days before and after the closed season. The number of chokka squid hatched (over 4) per day was highest within the nine days after the chokka fishing season had resumed. Closed season scored the second highest number of chokka hatched per day, followed by nine days before the closed season, and lastly, during ‘other times’ of the year which indicated two births per day. The number of births per day seemed

to increase a few weeks before the closed season and continued to increase up to a few weeks after the closed season.

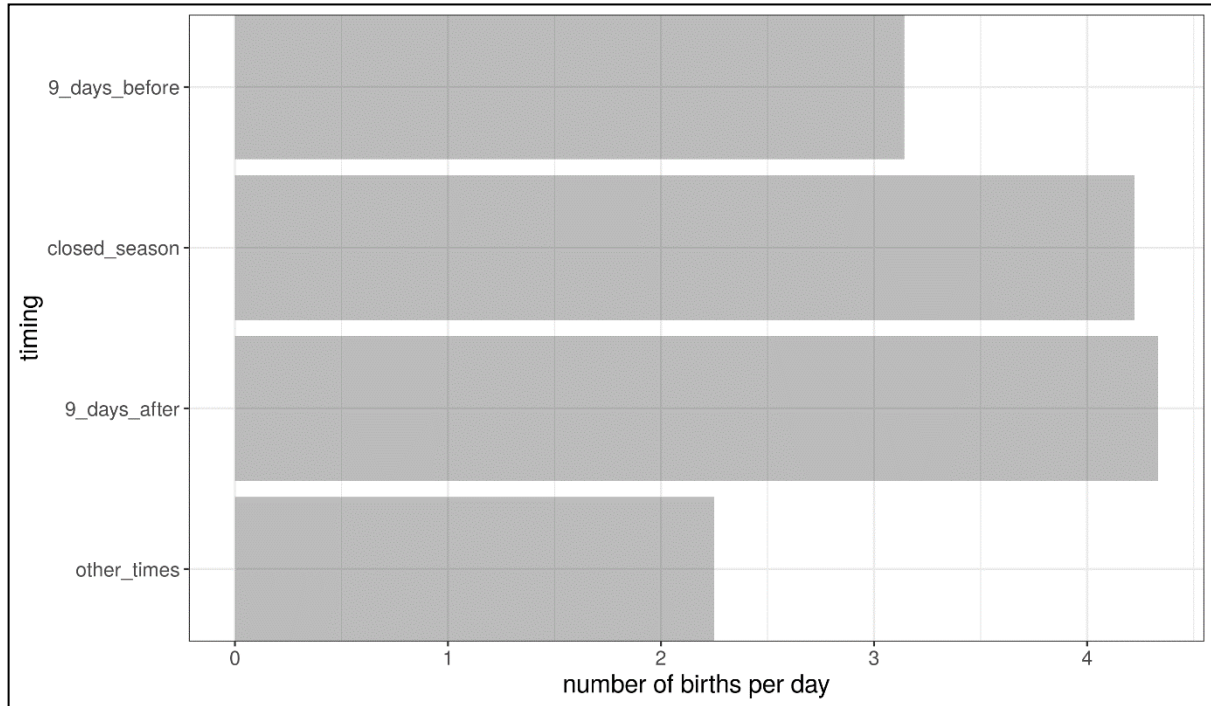


Figure 10: Number of *Loligo reynaudii* hatched per day during the closed season, relative to nine days before and nine days after the closed season, and other times during the year.

4.3.1 Back-calculated egg-laying dates and timing

The concentration of back-calculated egg-laying dates during different days of the year is shown in Figure 11. The results revealed in this figure, are derived from data collected during November 2003, November 2004 and November 2005 survey. Data from April 2005 is not included as it was collected at a different season of the year, but is presented as an individual graph in Figure 12 (2004 Season). The density of the egg-laying dates was compared between nine days before and nine days after the closed season, and during the closed season. Overall, egg-laying was mainly concentrated towards the end of the year from 290 to 340 days.

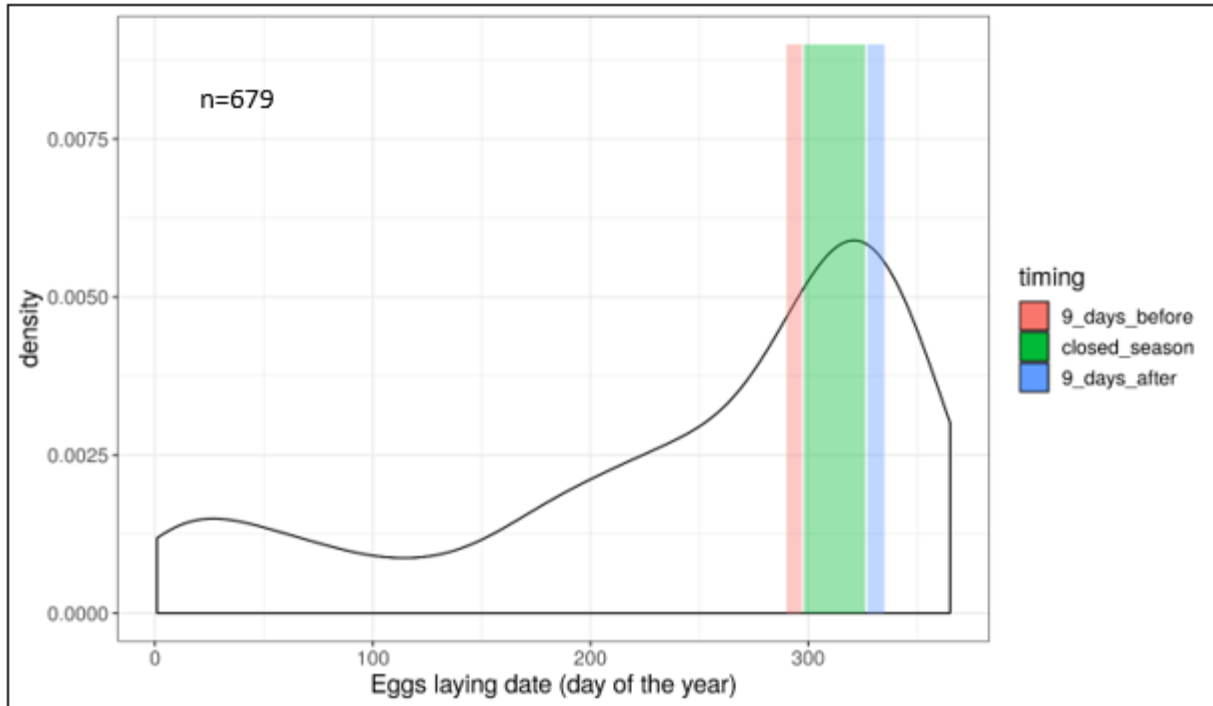


Figure 11: Density (concentration of eggs laid per day) distribution of egg-laying dates of *Loligo reynaudii* in one year. Smoothed intensity was compared between nine days before the closed season, during the closed season, and nine days after the closed season, based on data collected during November 2003, November 2004 and November 2005 surveys.

The density of the eggs laid at different days of year differed throughout the year. The density (frequency) of the egg-laying dates shown in Figure 11 was lowest from day 50 to day 150, which was around end of February to the end of May. By the beginning of June, at about day 160, an increase in the density of eggs laid is evident. A noticeable, sharp increase is shown from day 260 (end September), reaching its peak in November on day 320 of the year. A drop in the density is evident from day 325 though still high compared to the density seen from day 1 to day 250 of the year. Overall, the highest density of egg-laying was shown to be between day 270 and day 365 (September, October, November and December). Peak density of egg-laying is indicated during the closed season; the second highest density is observed nine days after the closed season, followed by density occurring nine days before the closed season.

The results from determining the density of the back-calculated egg-laying dates on each day throughout the year in four different seasons, is presented in Figure 12. The density of the egg-laying dates was compared between the closed season and in the period nine days before and after the closed season. Seasonal trends were also compared to each other (2002/03, 2003/04, 2004 and 2004/05).

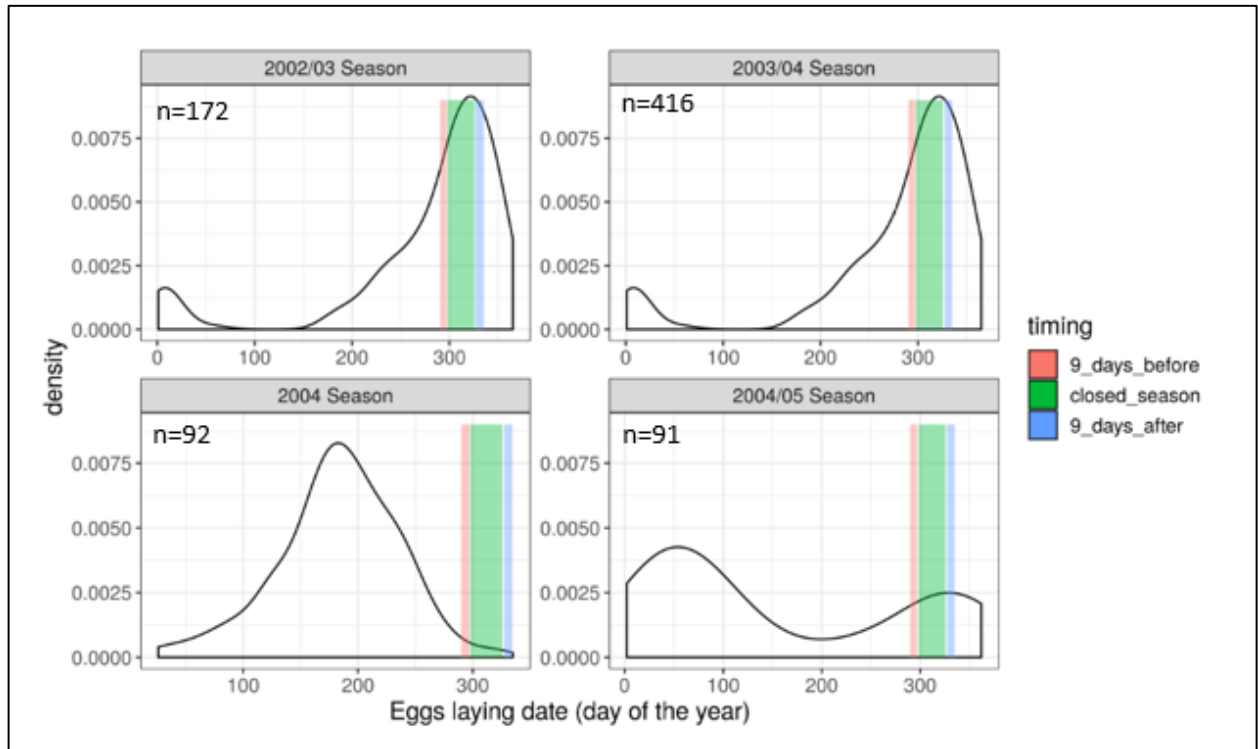


Figure 12: Density graphs showing days where most of the *Loligo reynaudii* eggs were laid in a year.

Back-calculated egg-laying dates resulting from data collected during the November 2003 and 2004 surveys (season 2002/03 and season 2003/04, Figure 12) show a similar trend throughout the year. Egg-laying activity were seen from day 0 to day 10 (beginning of January); however, a decline in the eggs laid is apparent immediately after the 10th day in January up to day 50 (mid-February). No egg-laying dates were recorded from day 60 to day 150, that is, from the end of February to towards the end of May. A rise in density of the egg-laying dates is shown from day 151. A gradual increase continues up to day 260 where a steep increase is revealed, reaching its peak on day 320, which is the 2nd week of

November. The highest frequency of eggs laid is indicated during the closed season, followed by the second highest frequency observed in the period nine days after the closed season, which is followed by density in the period nine days before the closed season. Overall, egg-laying dates were more frequent during the closed season, and a week or more before and after the closed season. The seasons (2002/03 and 2003/04) indicate that most of the chokka squid collected at the end of November and beginning of December 2003 and 2004 survey originate from eggs laid from September to December the previous year (2002) and at the beginning of January 2003. The squid ages ranged from nine months to a year and were a few months old when they were caught, associating the mean ages of the 2003 and 2004 surveys shown in Table 2.

Season 2004 results (Figure 12) reveal an almost normal distribution of the egg-laying dates. Less density in eggs laid is shown at the beginning of the year and also in the last two months of the year. The highest density is displayed on day 180 in the month of June, followed by steep drop. The results from this season suggest that the majority of chokka squid sampled from beginning of April to beginning of May 2005 originated from eggs laid down at end of June the previous year. The average age of the specimens caught was about 274 days old.

Season 2004/05 results (Figure 12) show that most eggs were laid during February (day 55) and November (on day 325) implying that squid collected during Nov/Dec 2005 survey originated from eggs laid down in November and December 2004, but mostly at the end of February 2005, with ages ranging from 275 days to a year and a month. Less density of egg-laying was indicated between day 140 and day 250 (month May to July). Data collected in November 2005 show squid considerably younger, on average, than those captured in 2003 and 2004.

Detailed back-calculated egg-laying dates and their percentage frequency from data collected during November 2003, November 2004, November 2005 and April 2005 surveys are presented in Appendix 3, Figures 20 to 23 and described below.

Back-calculated spawning dates from the 2003 survey started from 28 June 2002 and continued up to the end of February 2003. The frequency distribution of the egg-laying

dates in 2002/2003 (Appendix 3: Figure 20) was unimodal, with a peak number of six individuals observed on 8 November 2002 (Appendix 3: Figure 20, Table 3). The distribution was characterised by a long left-hand tail with a median at 5–6 November 2002. The percentage frequency revealed that 27% of the chokka in the sample originated from eggs laid during the closed season and a further 9% within nine days subsequently (Appendix 3: Figure 20). Five percent of the eggs were laid nine days before the closed season.

Chokka squid collected during the November 2004 survey were hatched in the period from 23 July 2003 to mid-June 2004. Egg-laying date frequencies (Appendix 3: Figure 21) indicate a right skewed distribution with a median at 17–18 December 2003 and a peak on 29 November 2003 (Appendix 3: Figure 21, Table 3), with the highest frequency number of ten (Table 3). The frequency in percentage showed that 26% of the chokka in the sample originated from eggs laid during the closed season, and an additional 13% within nine days subsequently (Appendix 3: Figure 21,). Only 2% of the eggs were laid nine days before the closed season started. Relative to the 2002/2003 egg-laying season, the 2003/2004 egg-laying season continued up to mid-June, while the 2002/2003 egg-laying events continued only up to the end of February.

Spawning squid collected during the November 2005 survey were spawned from July 2004 to June 2005. Frequencies of the egg-laying dates in 2004/2005 (Appendix 3: Figure 22) were characterised by a shape slightly skewed to the left with multi-modal distributions having two as the highest frequency. The most eggs laid in a single day was on 19 November 2004 (Table 3), with the median at 19 January 2005. However, only 12% of the chokka in the sample came from eggs laid during the closed season, and 3% within nine days afterwards. Zero percent of eggs were found to have been laid nine days before the closed season started.

Back-calculation results from the April 2005 spawning squid showed a peak of egg-laying events on 29 June 2004 (Appendix 3: Figure 23, Table 3). Egg-laying events occurred from 26 January 2004 to 15 November 2004. More eggs were laid between May and August

than were laid in the months from January to April and from September to November. Only 2% of the chokka were found to have been laid during the closed season and none were laid during the nine days before and after the closed season.

Back-calculation results of the surveys done in November showed that the highest frequencies of the egg-laying dates were likely to occur during the annual squid closed season (25 October–22 November), extending to days or weeks later after the fishing season resumed, with the exception of the April and November 2005 surveys that indicated high frequencies of egg-laying dates during the month of May or February, respectively.

4.3.2 Egg-laying peak dates and timing

Table 3 presents results of the egg-laying peak dates and peak number revealed from each surveyed month and year. Percentage of frequency for the egg-laying dates from their respective egg-laying season during the closed season is also indicated. Figure 13 shows the timing of the egg-laying peak dates for each season. Season 2003/2004 recorded the highest spawning peak number of ten. Second was the 2002/2003 season with a spawning peak number of six, followed by the 2004/2005 season from survey April/May 2005 with a peak number of three and lastly, the 2004/2005 season from November/December 2005 survey, with a peak number of two (Table 3).

Table 3: Summary of the peak dates and timing of egg-laying events for *Loligo reynaudii*.

Survey month and year	Egg-laying peak date	Egg-laying season	Peak number	% of eggs laid during C. S
November/December 2003	08 November 2002	2002/2003	6	27
November/December 2004	29 November 2003	2003/2004	10	26
April/May 2005	29 June 2004	2004/2005	3	2
November/December 2005	19 November 2004	2004/2005	2	12

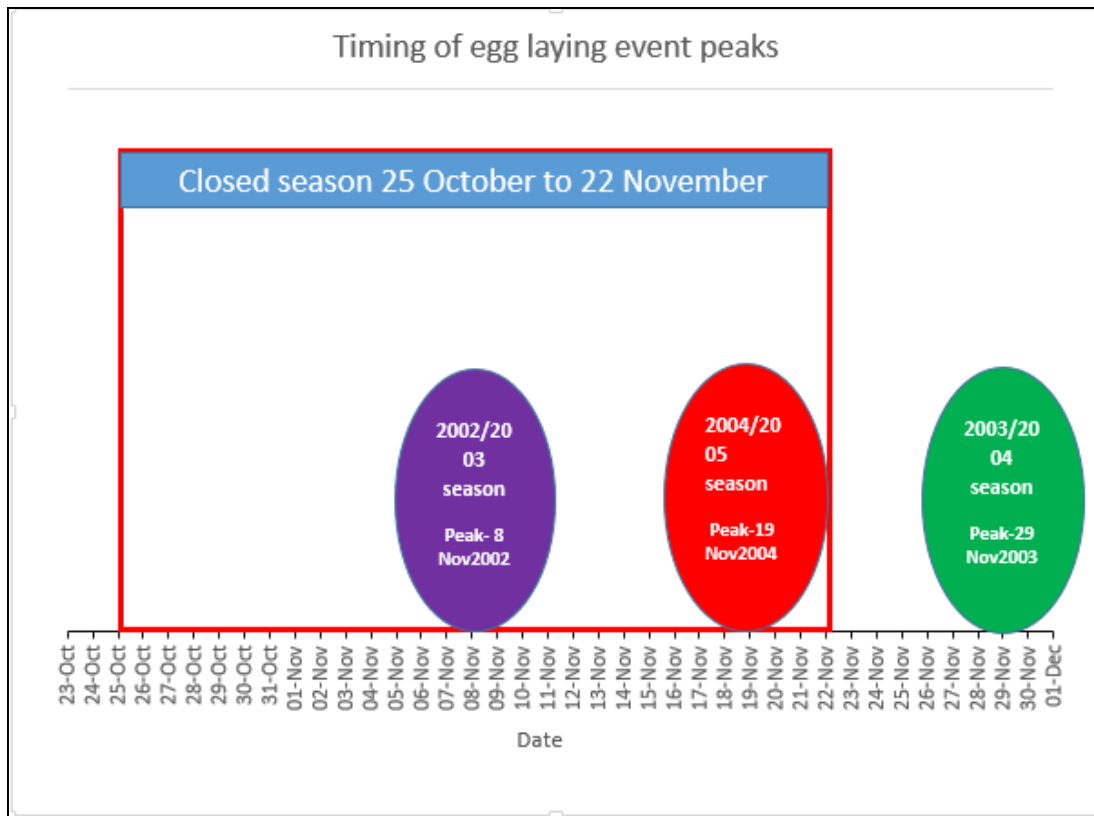


Figure 13: Timing of the highest egg-laying frequency for *Loligo reynaudii*.

The position of the peak (shown on Figure 13) in each survey year during the closed season and the strength of the peak (peak number in Table 3) may be linked to the chokka abundance shown in Figures 4 and 6. Eggs laid in November will reflect in the following year's November commercial catches; the greater the overlap of the egg-laying dates within the closed season in November, the better the catches in November the following year. The egg-laying peak number in the season 2002/2003 was found to be six with 27% of the eggs being laid during the closed season of 2002 and resulted in the highest catch of 1429 tonnes in November 2003. Daily catches in November after the closed season (Figure 6) also indicate that Year 2003 catches were highest. The second highest percentage (26%) of eggs laid during closed season is indicated in the 2003/2004 season with a recorded peak number of 10 and resulted in the second highest catch of 1049 tonnes seen in November 2004 (Figure 4) and the second highest daily catches represented in Figure 6. The 2004/2005 season exhibited the lowest percent (12%) of eggs laid during the closed season, with a peak number of two, which resulted in the lowest commercial catch of 543 tonnes in

November 2005 (Figure 4). Lowest catches are also displayed in the commercial daily catches of the year 2005. Overall, the greater the number of eggs laid during the closed season (October/November), the better the catches after the fishery resumes, and the better the catches in November the following year.

4.4 Mantle length

A total of 410 male and 361 female chokka were included in the mantle length (ML) analysis. Each period surveyed attained different total numbers (Table 4), with November 2004 having the highest (n=416) and November 2005 having the lowest sample number (n=91).

Figures 14 to 17 present the percentage of length frequency in different length classes for the surveys 2003–2005 November and 2005 April. Mantle length of chokka squid in the November 2003 survey (Figure 14) ranged from 150 mm to 263 mm in females, and from 182 mm to 425 mm in males. Mantle length distribution was different for each sex.

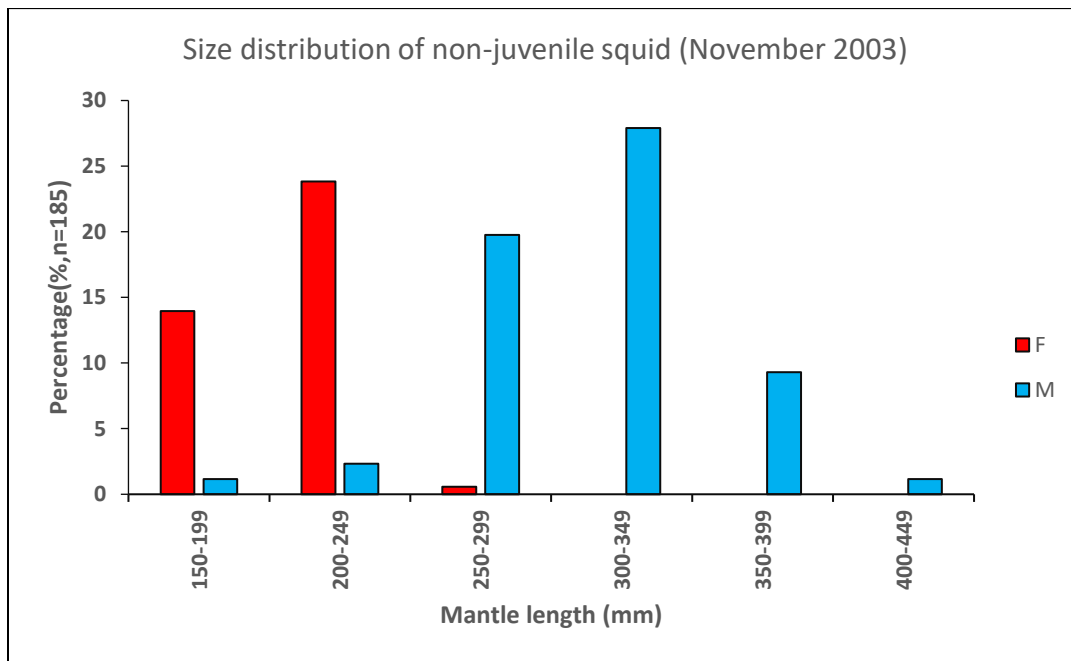


Figure 14: Length frequency (ML) distribution of females and males of *Loligo reynaudii* hatched in 2002/2003 season. November/December 2003 survey

The male distribution was relatively normal, with a small right-hand tail and a mean of 309 mm, while female distribution was characterised by a long right-hand tail with a mean of 205 mm. Females had the highest length frequency percentage of 23% in the 200–249 mm length class, whereas 27% of males were in the 300–349 mm length class. No females larger than 300 mm were observed.

Mantle length of chokka squid in the November 2004 survey ranged from 71 mm to 375 mm in males and from 83 mm to 240 mm in females (Figure 15 and Table 4). The male length distribution was slightly skewed to the left with a mean length of 244 mm, and the highest percentage of 27% was observed in the 221 mm–270 mm length class. The female length was skewed to the left with a mean length of 176 mm, and the highest frequency percentage of 37% observed in the 171 mm–220 mm length class.

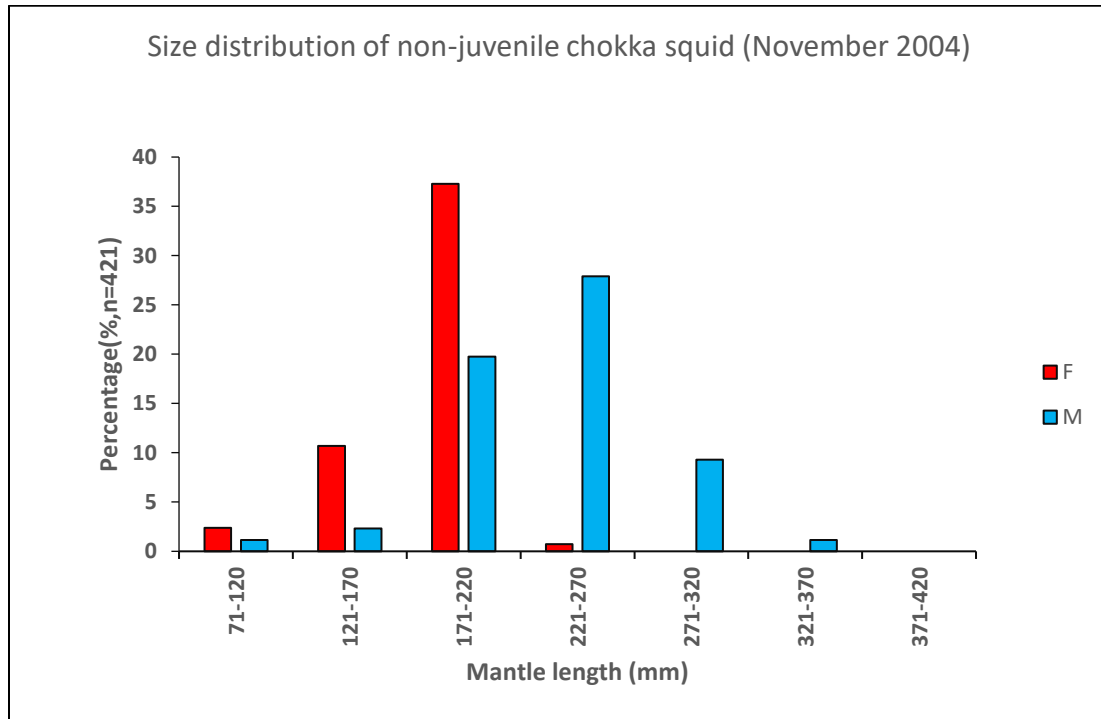


Figure 15: Length frequency (ML) distribution of females and males of *Loligo reynaudii* hatched in 2003/2004 season. November/December 2004 survey.

The length distribution of male and female chokka from the November 2005 survey were different, with larger numbers of smaller females and larger males (mm) (Figure 16). The mean length for males was 235 mm, whereas female mean length was 174 mm. Mantle length data for males ranged from 98 mm to 380 mm, whereas that for females ranged between 98 mm to 220 mm.

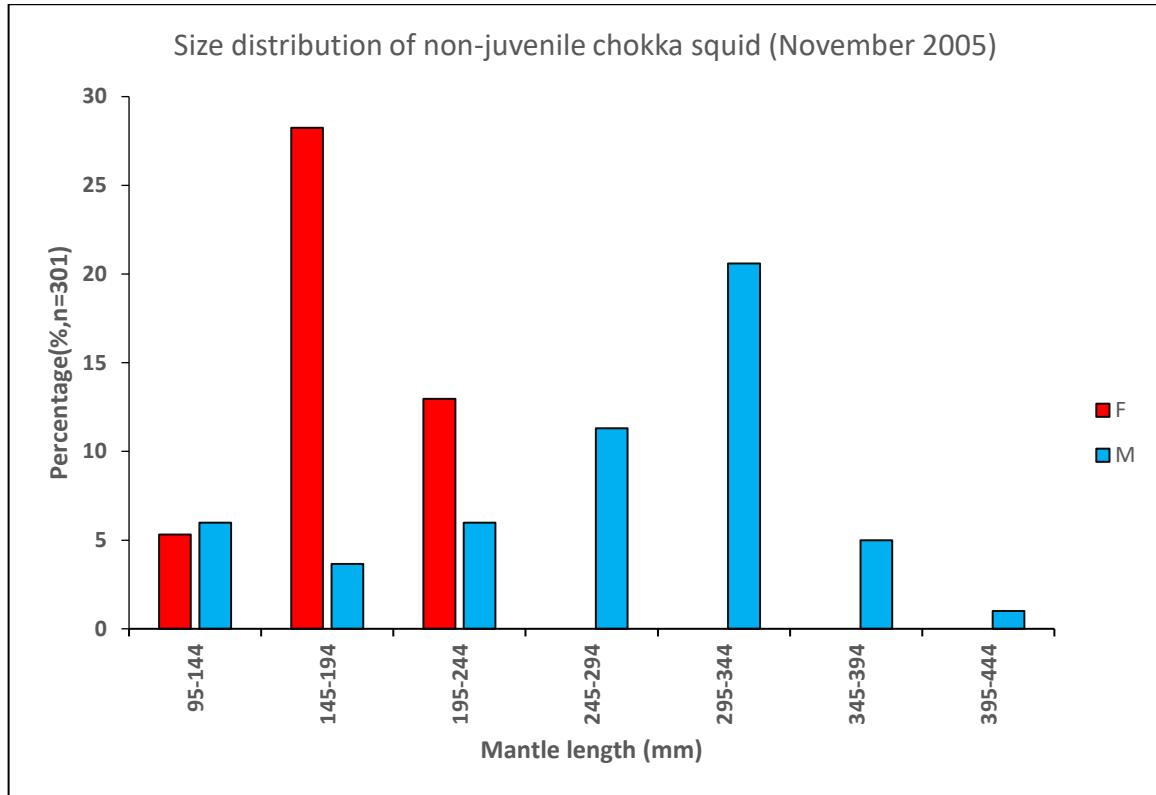


Figure 16: Length frequency (ML) distribution of females and males of *Loligo reynaudii* hatched in 2004/2005 season. November/December 2005 survey.

The highest frequency percentage was 28% in females, in the 145–194 mm length class, while males were 3% in the same length class. Males showed the highest frequency percentage of 20%, which was observed in the 295 mm to 344 mm length class.

In the April 2005 survey sample, mantle length distribution (Figure 17) of chokka ranged from 100 mm to 348 mm in males, and from 134 mm to 212 mm in females. Male length distribution was characterised by a long right-hand tail with a mean length of 197 mm (Figure 17). The highest length frequency percentage observed was 15% in males (150–200 mm) and 31% in females (150–200 mm).

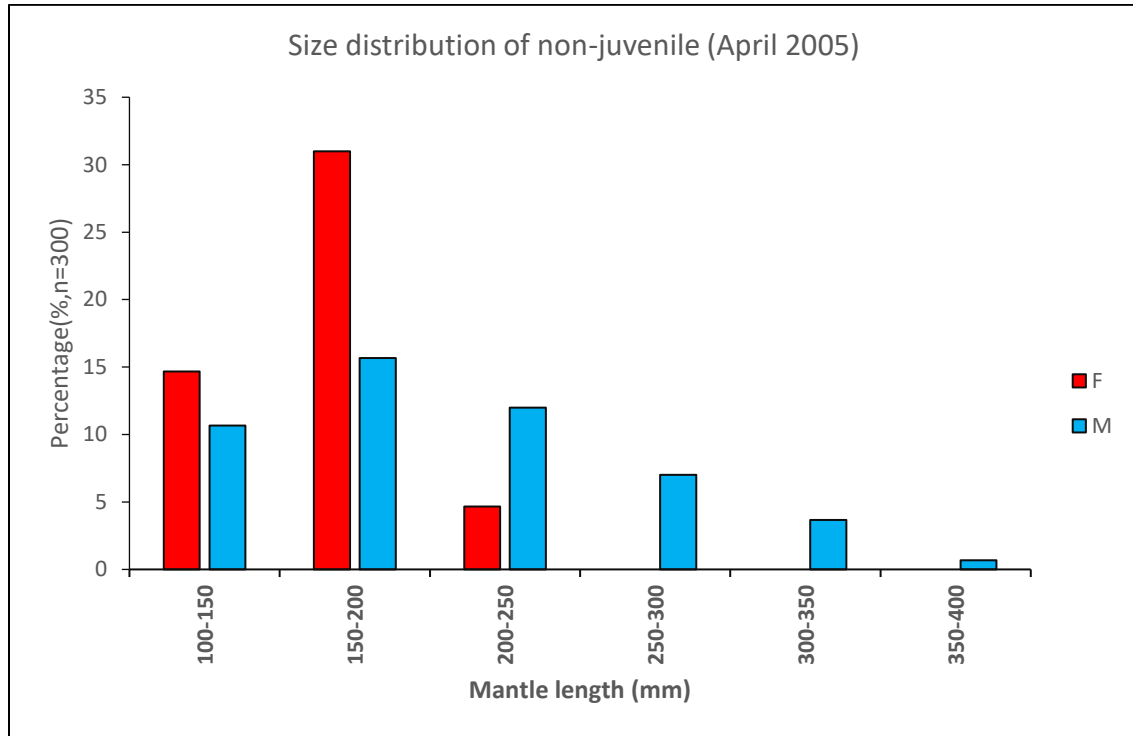


Figure 17: Length frequency (ML) distribution of females and males of *Loligo reynaudii* hatched in 2004 season. April/May 2005 survey.

Table 4: Summary of male and female mantle length during the period under study.

Year	Mantle length(mm)					
	Male			Female		
	Total no.	Range	mean+-SE	Total No.	Range	mean+-SE
Nov-03	106	182-425	309 +-4.16	66	150-263	205 +-2.46
Nov-04	204	71-375	245 +-5.1	212	83-240	176 +-1.8
Apr-05	46	100-348	197 +-8.106	46	134-212	166 +-3.41
Nov-05	54	98-380	235 +-11.59	37	98-220	174 +-5.68

The largest chokka (both male and female) were observed in the 2003 survey (Figure 14) relative to 2004 (Figure 15) and 2005 (Figures 16 and 17).

4.4.1 Predicted growth – Age versus mantle length

The male ages for all the years (2003–2005) ranged from 168 days to 484 days, with the mean age of 323 days. Male chokka varied in length from the smallest of 71 mm to the largest of 425 mm with a mean mantle length of 254 mm. The female age distribution ranged from 125 days to 478 days with a mean age of 316 days. The mantle length distribution ranged from 83 mm to 263 mm with a mean length of 180 mm.

Model selection

As noted in the method section, model selection was based on standard information theoretic criterion (AIC and BIC). The lower the AIC and BIC value of the model, the best the model fit the data. The AIC and BIC results for the three models are presented in Table 5. Linear growth model was found to be the best model to fit all data of chokka squid sampled, based on the information criteria (AIC, BIC) and root mean squared prediction error.

Table 5: Model performance, as measured by the AIC and BIC, for the three models fitted

Type	model name	values
AIC	Linear	8526.35
	Power	8526.42
	Francis	8528.34
BIC	Linear	8540.29
	Power	8540.37
	Francis	8546.93

Model diagnostics for the three models were assessed and presented in Figure 18. The results revealed no systematic pattern in the residuals which is a good indication that there was no non-linear relationship.

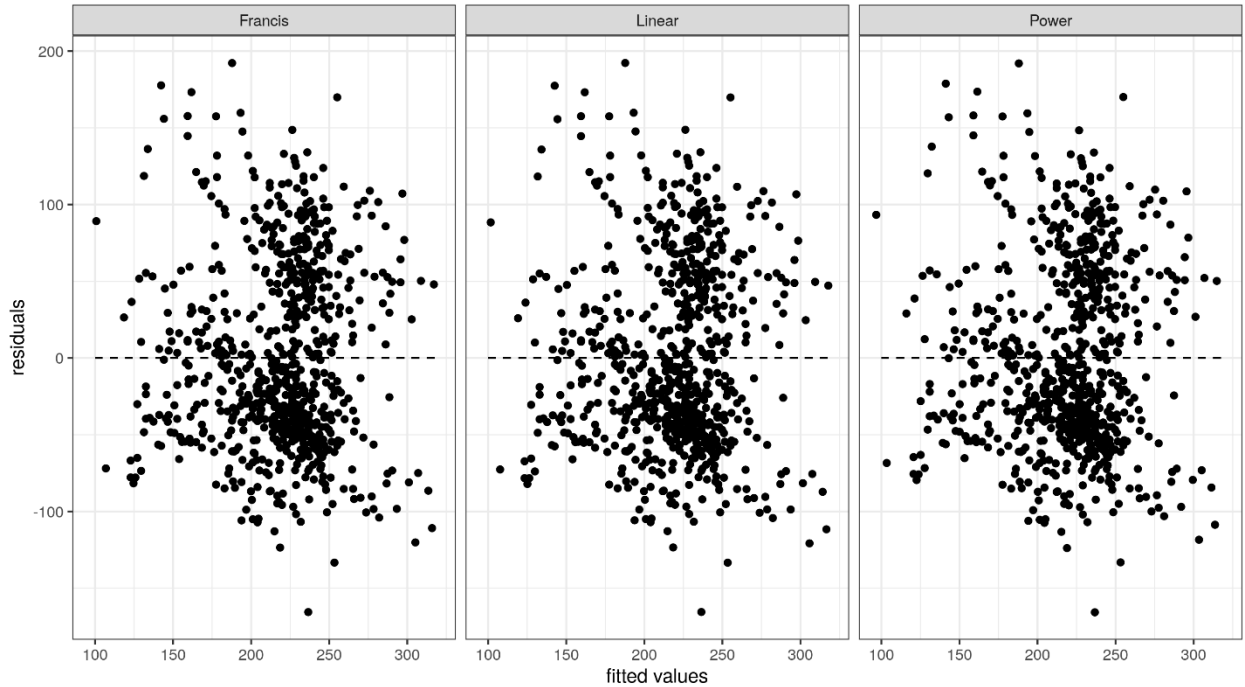


Figure 18: Model diagnostic plots of fitted values vs residuals.

Bootstrap estimated parameters from the linear growth model were used to generate predicted growth in length shown in Figure 19. As narrated above, the linear growth model fitted all the data, and chokka squid length was described as a function of age by applying the following equation:

$$ML \text{ (mm)} = a + b \text{ (age)}$$

The linear growth model results (Figure 19, Table 6) show that males grew faster than females in length as they grew older. Growth rate ranged between 0.63 to 0.83 mm per day (b value in Table 6) for males and between 0.22 to 0.32 mm per day (b value in Table 6) for the females. Overall, males have a faster growth rate (more than two and half times faster) than females.

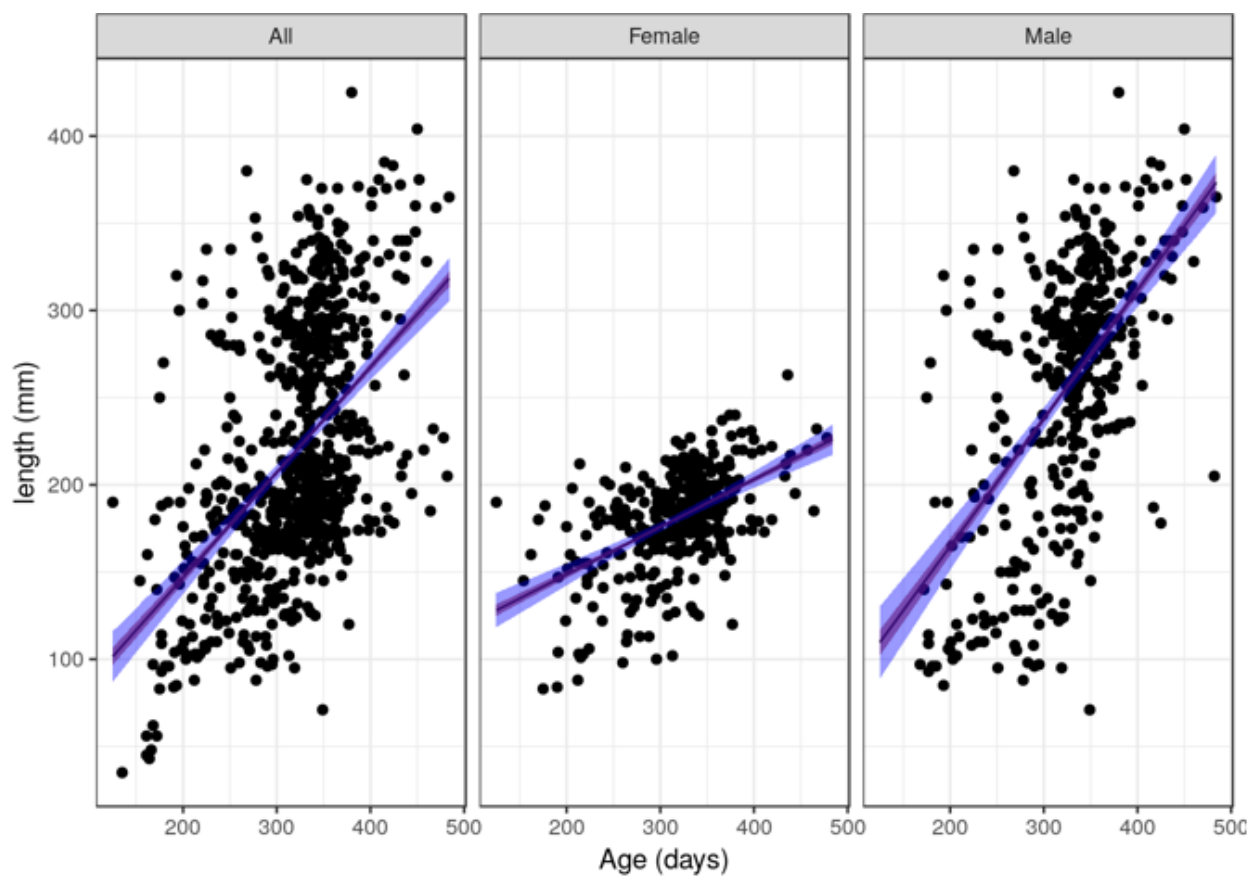


Figure 19: Observed mantle length versus age relationship and prediction from linear regression for *Loligo reynaudii* during the period 2003 to 2005. All (ML (mm)=49.34+0.67*age); Male (ML (mm)=50.95+0.83*age); Female (ML (mm)=110.21+0.32*age).

Table 6: Summary statistics of estimated parameters for males, females, and all data combined from survey done in year 2003 to 2005.

Sex	Coefficients	Quantile_2.5	Quantile_50	Quantile_97.5
All	a	3.22	26.24	49.34
	b	0.53	0.60	0.67
Female	a	78.16	94.02	110.21
	b	0.22	0.27	0.32
Male	a	-15.46	17.84	50.95
	b	0.63	0.73	0.83

Chapter 5

5. Discussion

This study aimed at understanding the role of the chokka annual closed season (25 October to 22 November) by using age distributions of adult *Loligo reynaudii* collected during survey years of 2003 to 2005, together with the results of spawning and commercial catches.

Roel (1998) and Roel and Butterworth (2000) proposed a ‘disturbance hypothesis’ as an explanation for the generally perceived beneficial influence of the closed season both on the resource and the industry. According to this hypothesis, the period of fishery closure is useful as a stabilising period, allowing spawning chokka squid to settle, accumulate, and spawn without any possible disruptive effects of fishing activities. However, testing this hypothesis with precision is difficult; it would require more behavioural research and a more precise definition of ‘disturbance’ applied to spawning squid. It has been observed that predator activities, rather than fishing activities (e.g. Sauer *et al.*, 1992), may break up the spawning concentration (Lipinski & Soule, 2007). ‘Disturbance’ then may just be a simple reduction in the size of the concentration (‘fishing it out’) and a simple reduction in the number of egg pods deposited on the substrate, as a consequence.

Catch of chokka squid prove beneficial role of a closed season.

Differences in monthly catches were evident from the results, and similar trends were revealed in all the years considered (2002 to 2005). Increase in the monthly total catches of chokka squid were shown from November soon after the fishery resumed. The catches continued to increase in December for all years, up to the month of January, particularly for the year 2004. Year 2003 recorded the highest monthly catch in November and December; year 2004 recorded the highest annual total catch relative to the other years. These results are consistent with a DAFF report of 2016 and Sauer *et al.* (2013) findings affirming that catches in the jig fishery in the past years have fluctuated quite considerably

from year to year, with the highest catch of just over 12 000 tonnes recorded in 2004. More recently, jig catches have remained relatively stable at around 9000 tonnes.

Mean catches from 1985 to 2006 indicated high mean catches within nine days after the closed fishing season. A noticeable increase in the mean catches of the nine days after the closed season were observed from year 1991, two years after the inception of the closed season, suggesting that the closed season is beneficial to the resource. Daily catches recorded in November after the resumption of the fishery were shown to be highest in the year 2003 relative to 2002, 2004 and 2005. November daily catches were found to be highest compared to daily catches during a similar period in December and January. Considerably increased daily catches in November are by themselves a strong proof that the closed season is beneficial. This comparison has not been done before for chokka squid and the results were important to validate this hypothesis.

The closure of fishing during spawning periods is effective and beneficial for chokka squid because the larger number of spawning squid (not fished out) will substantially increase the reproductive output. (Arendse *et al.*, 2006). Another reason for the increase in catches after the resumption of the fishing season could be explained by the “accumulating effect” of the closed season. There are two possible explanations: the “vacuum cleaner effect,” that is, the accumulation of spawning squid on the spawning grounds without a biomass increase; and alternatively, a genuine increase in stock size as a result of the closed season.

Age distribution, structure and preliminary comments about growth (age versus length).

The number of increments which were defined as age in days after hatching for chokka squid for the years 2003 to 2005 ranged from 168 to 484 days (71–425 mm) in males and from 125 to 478 days (83–263 mm) in females.

Average age was shown to be 323 days in males and 316 days in females. On average, spawning female chokka squid were younger than spawning male chokka squid, signifying that females join spawning aggregations at an earlier age than the males do. However, all

mean ages of chokka for spawning males and females were found to be under 365 days (one year) in all the surveyed years of study (Figures 8 and 9). This agrees well with previously published data (Lipinski & Durholtz, 1994). Results presented in this study are the first large-scale, population-oriented analysis of age and longevity for this species. Findings are comparable with most other exploited loliginid cephalopods in the world, all of which are short-lived species (Jackson, 1990; Gonzalez *et al.*, 1996; Jackson 2004). These age results therefore demonstrate that spawning loliginid squid, both male and female, are on average, under one year old when forming spawning aggregations.

Distribution of ages was not the same between males and females in all the years considered. The Kolmogorov-Smirnov test result indicated a significant difference between the age distribution of males and females. The total number of chokka squid per sex revealed that more males were collected than females (males $n=410$, females $=361$), presumably because there were more males than females available during the surveys (Lipinski, 1994), and assuming that success rate in processing readable statoliths was the same for both sexes. According to Lipinski, 1994; Sauer *et al.*, 2013, jigging results in catching many more males than females; and virtually all females caught on spawning grounds, had been fertilised. Hanlon *et al.* (2002) used hand-held video recordings (on SCUBA) to monitor the squid spawning grounds, the results of which led to a supposition that the working sex ratio on the spawning grounds may often be skewed towards males, indicating a ratio in the order of ca 1.4 Male:1 Female. These results were supplemented and confirmed by results from monthly data collected from the jig fishery in 1988, showing that males outnumbered females in 11 of the 15 months studied (Olyott *et al.*, 2006; Sauer *et al.*, 2013).

The population estimates of growth rates in this study were best described by a linear growth model. The results indicated that, as they grew older, males grew faster in length than the females. Growth rate ranged between 0.63 to 0.83 mm per day for males and between 0.22 to 0.32 mm per day for the females. These results show that males have a faster growth rate (more than two and half times faster) than females. According to a study

by Durholtz *et al.* (2000), males of *L. reynaudii* were observed to grow significantly larger (ML) and faster than the females.

Linking the age distribution in chokka during the closed season with similar length (ML) distribution allowed the development of an idea of what age ranges may prevail in similar conditions from year to year without a long and costly ageing procedure. This link is approximate and rather crude and is subject to further research developing a long time series, as well as many other conditions and corrections, but it may serve a useful purpose in modelling squid population dynamics in the interim.

To date, analysis of statolith microstructures is considered the most effective method for ageing squid (Jackson, 2004; Perales-Raya *et al.*, 2010) and for studying growth in many natural squid populations, despite the lengthy process of statolith preparation.

Hatching date and egg-laying date back calculations

Back-calculated hatch date distribution results indicated that relatively more eggs were hatched within the remaining nine days after the closed season in November than in other periods. According to Oosthuizen *et al.* (2002), temperature influences the egg development of chokka squid. Linking the results of the egg development times of approximately 27 days in 2002, and 26 days in 2003 and 2004 to the hatch date distributions, the results strongly imply that most eggs were laid within the 29 days of the closed season.

Results from back-calculated egg-laying dates of squid collected from November and beginning December of 2003, 2004, and 2005 indicated that a high density of eggs was laid during the closed season, which suggests that squid collected during November/December of 2003, 2004 and 2005 originated from eggs laid from September to December in the previous year. The back-calculated egg-laying date results from squid collected from April/May 2005 survey suggest that the majority of chokka squid sampled originated from eggs laid down at the end of June the previous year (2004). Detailed back-calculated egg-laying dates and their frequency in percentage from data collected during November 2003, November 2004, November 2005 and April 2005 surveys were done and the results

revealed that eggs were laid in most months of the year. However, a high frequency was seen (over 25% of all samples during the closed season each year, plus over 9% within nine days after the closed season) during October and November in the survey years, 2003 and 2004. For November 2005, the relatively low number of statoliths processed resulted in a lack of distinct peaks; however, a relatively high frequency (12%) of eggs laid was still observed during the closed season. Back-calculation of chokka collected from the survey done in April 2005 revealed that egg-laying activities occurred throughout the year, with 2% during the closed season; however, the highest frequency of egg-laying was found to have occurred towards the end of June. These results concur with the knowledge that chokka squid spawn throughout the year, with the existence of two main spawning periods, the greater of which is at the end of the year. According to Augustyn *et al.* (1994), Augustyn and Roel (1998), Oosthuizen *et al.* (2002), and DAFF (2016), spawning occurs throughout the year, with spawning peaks between September to January, and then May to July. Olyott *et al.* (2006) have shown that clear peaks in adult abundance in winter and summer recorded from trawl and jig data support the presence of the two main spawning peaks, the much larger of them occurring in October–December. Behavioural observations (Sauer *et al.*, 1992) indicate that the spawning intensity of chokka squid is at its maximum during the months of October to December.

The egg-laying frequency distribution results also indicated a slight difference in timing of peak spawning between years: for the 2003 survey, egg-laying peak dates were during the closed season (25 October to 22 November) whereas for the survey year 2004, the peak date was a week later, after the fishing season had resumed. The most numerous back-calculated egg-laying events occurred in the middle of the closed season, or shortly afterwards (Table 3, Figure 13) for years 2003 and 2004. Year 2005 in November, even though it did not show a distinct peak of egg-laying events, also had the most numerous egg-laying event at the end of the closed season (Appendix 3, Figure 22).

Since spawning chokka are, on average about a year old, back-calculated egg-laying events for squid sampled any time of the year will yield dates one year earlier. Therefore, any type of sampling squid for ageing (including random sampling throughout the year) will not by itself prove any benefits of the closed season for a population of semelparous squid with

terminal spawning at the end of the life cycle. Mature squid sampled during the closed season have originated (egg-laying and/or hatching) to large extent (more than 35%) during the previous closed season and the period immediately afterwards (Appendix 3: Fig. 20-22). The remaining number (up to 65%) of egg-laying and/or hatching of chokka has been dispersed throughout the year. This dispersal results from the natural variability in size, age, and dominant water temperatures during ontogenetic development (the latter according to the Forsythe rule; Forsythe, 2004). The extent of this variability may be related to the closed season, as spatial and temporal spawning of chokka is much more fragmented when fishers are operating than during the closed season. Likewise, the stock-recruitment relationship may be much weaker in exploited populations than in virgin populations (which, at present, cannot be researched but only modelled). Short-lived, semelparous squid may regain quasi-virgin status of the population relatively quickly during the closed season given its length. In this sense, the closed season may be beneficial to the resource in restoring the most natural spawning scenario, where squid take full advantage of best spawning grounds.

Thus, the obvious, known (before this project) benefits of the closed season, but not sufficiently researched and demonstrated, were: a) increased abundance of squid in November (benefit to the resource in more spawners present on most suitable grounds; benefit to the fisheries as the opening of the season immediately yields maximum returns); b) more eggs laid on most suitable grounds without fragmentation into relatively smaller concentrations. Another possible benefit is less variability (including fragmentation) and more stability. To research this, however, a much larger data set is required. The final benefit is a possible increase in biomass from year to year.

The position of egg-laying events in time within and after the closed season appears to be related to the magnitude of catches in November (Figure 4 and 13). These findings (distributions of egg-laying events, their strength, and their position within the closed season) suggest a link between egg-laying events during the closed season and the increase in abundance immediately after the closed season the following year. The egg-laying peak number in the season 2002/2003 was six with 27% of the eggs laid during the closed season

of 2002 and resulted in the highest catch of 1429 tonnes in November 2003. Daily catches in November after the closed season (Figure 6) also indicated that Year 2003 catches were highest. The second highest percentage (26%) of eggs laid during the closed season was in the 2003 season with a recorded peak number of ten, which resulted in the second highest catch of 1049 tonnes seen in November 2004 (Figure 4). The 2004/2005 season showed the lowest percent (12%) of eggs laid during the closed season with a peak of two which was followed by the lowest commercial catch of 543 tonnes in November 2005 (Figure 4). Lowest catches are also evident in the commercial daily catches of the 2005. The greater the number of eggs laid during the closed season (October/November), the better the catches after the fishery resumed, and the better the catches in November the following year. However, the relationship between the spawning biomass in one year and the resulting recruitment, and a spawning biomass of the next generation is a hotly debated topic in fisheries science. Ish *et al.* (2004) have found that an approach similar to the one adopted in this study predicted the maximum abundance of market squid of California (*Doryteuthis opalescens* Berry, 1911) in mid- to late autumn. Real maximum abundance for this squid occurs in late spring and summer. Szuwalski *et al.* (2019) investigated relations between the spawning biomass and recruitment in 52 forage fish stocks. Their main conclusion was that recruitment may ‘precede’ the spawning biomass, but very seldom vice versa.

So many different factors impact the life cycle from spawning biomass to recruitment and many different scenarios are possible, e.g. a small biomass resulting in large recruitment, or large biomass resulting in small recruitment. Evidence presented by Rodhouse *et al.* (2014) suggests there is no relationship between spawning biomass and recruitment in cephalopods in general. However, in the case of the chokka squid, the results of this study certainly indicate a testable hypothesis of a direct link. An alternative hypothesis may be of ‘instantaneous accumulation and gathering’ (IAG). In terms of this alternative hypothesis, the closed season acts as a ‘vacuum cleaner,’ accumulating squid in a relatively small area which then results in bumper catches when the closed season ends. This is in agreement with chokka behaviour and life cycle (Lipinski *et al.*, 2016). In this hypothesis, the biomass of the previous generation may be irrelevant. However, the ‘vacuum cleaner’ must have enough material to accumulate. Chokka have been under fishing pressure for

many years, with effort levels claimed to be dangerously high (e.g. Roel & Butterworth, 2000; Glazer & Butterworth, 2006).

As outlined in the Literature Review (sub-chapter “Spawning biomass and recruitment relationship”), classical discussion on stock-recruitment relationships have drifted from clear and well-defined stock assessment applications (e.g. Goodyear, 1993), through a relative settlement hypothesis (e.g. Myers & Barrowman, 1996; Brodziak *et al.*, 2001), to recent in-depth analyses pointing out enormous complications in this field (e.g. Subbey *et al.*, 2014; Thorson *et al.*, 2014; Zimmermann *et al.*, 2018; Szuwalski *et al.*, 2019). Therefore, testing the hypotheses mentioned above will not be a simple matter.

Conclusion

This study was conducted on the south-east coast of South Africa between Plettenberg Bay and Port Alfred areas. It presented age distributions representing populations of adult chokka based on large samples collected during three closed seasons (2003, 2004, and 2005). Linear growth model indicated that males grow at a faster rate than females. Back-calculated hatch dates and subsequent egg-laying events for parental populations were determined. A link between the initial (parental) spawning stock and the resulting spawning stock was explored on the basis of squid age (slightly less than one year on average, for both sexes), distribution of egg-laying events (frequency of eggs laid during the closed season: 27% in 2003, 26% in 2004 and 12% in 2005, whereas eggs laid during nine days after the closed season were 9% in 2003, 13% in 2004 and 3% in 2005), strength of egg-laying events, and the high abundance of squid immediately after the end of the closed season. Results found led to the conclusion that the closed season is beneficial for the resource (chokka) and the fishery because it allows sufficient spawning biomass to settle, accumulate and spawn. Further research should concentrate on working on accumulated statolith collections (in DAFF, South Africa) to create a meaningful time series of back-calculated egg-laying events over many years. In parallel, catch patterns in the weeks following the end of the closed season should be investigated in detail. These patterns should be correlated with egg-laying events in preceding years to test the hypothesis of a direct link between the parental spawning biomass and the resulting spawning biomass. All

other possibilities of explaining these links should be carefully considered and alternative hypotheses proposed and tested.

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Appendix 1

Total monthly commercial catches of *Loligo reynaudii* caught between the area of Plettenberg Bay and Port Alfred from 1985 to 2006.

Table 7: Chokka commercial jig catches in tonnes from 2002 to 2005.

PLETTENBERG BAY TO PORT ALFRED				
Year	2002	2003	2004	2005
Jan	626.49	723.203	1925.407	855.303
Feb	260.819	255.346	641.792	428.831
Mar	277.265	164.219	591.475	440.473
Apr	197.957	339.316	280.287	386.324
May	180.409	277.388	237.596	280.097
Jun	162.691	298.844	346.588	186.704
Jul	278.344	376.086	391.344	314.473
Aug	261.552	430.065	292.94	257.675
Sep	349.359	209.053	767.419	446.015
Oct	952.276	295.323	668.123	508.979
Nov	748.744	1428.579	1049.405	542.567
Dec	2227.868	2497.383	1320.547	1370.613
Total	6523.774	7294.805	8512.923	6018.054

Table 8: Monthly commercial catches (in tonnes) for *Loligo reynaudii* from 1985 to 2006 between the area of Plettenberg Bay and Port Alfred

Years	1	2	3	4	5	6	7	8	9	10	11	12
1985	77.042	28.331	11.998	179.14	34.106	27.053	7.756	44.03	271.82	454.66	808.44	675.13
1986	147.04	66.621	26.716	20.53	58.368	398.62	722.79	848.35	483.27	214.28	124.95	229.36
1987	110.23	35.531	0.997	1.048	4.064	153.78	352.66	83.01	223.67	587.46	498.1	702.34
1988	77.666	9.886	117.91	69.205	51.646	36.718	198.85	522.89	780.22	1167.6	27.049	1779.8
1989	935.43	259.99	829.28	624.26	803.61	1717.9	1072.4	1034.7	1144.7	965.39	5.163	343.33
1990	165.45	164.51	275.45	167.45	12.121	5.089	54.695	363.31	720.45	610.84	15.146	689.45
1991	31.37	62.379	95.411	287.37	47.944	289.6	714.72	387.14	1393.4	1154	1357.9	719.89
1992	70.951	83.303	68.883	26.43	7.004	110.98	44.099	164.69	265.78	136.56	615.75	982.32
1993	201.6	27.993	44.503	243.88	225.81	360.73	609.69	607.22	466.61	255.86	807.91	2464.7
1994	1659.3	464.82	237.31	275.64	179.25	367.26	496.55	177.24	214.9	233.27	864.21	1129.2
1995	980.28	357.26	355.33	302.14	613.15	489.26	403.71	326	502.01	903.58	434.8	1009.4
1996	737.59	424.34	699.89	601.02	794.81	438.8	225.98	485.19	476.32	422.47	680.78	1028.9
1997	400.79	67.46	298.93	190.25	54.035	105.15	126.18	244.36	354.06	576.32	218.1	1015.6
1998	409.06	248.01	716.67	276.34	439.89	531.91	321.99	526.88	320.13	667.03	42.326	1773.1
1999	943.16	358.42	495.63	433.56	1139.4	922.54	545.37	306.06	218.21	218.95	133.27	928.17
2000	383.37	437.47	252.85	322.71	475.26	616.83	538.71	378.87	576.03	686.97	336.07	707.52
2001	395.95	64.982	65.263	146.22	161.94	147.02	99.111	52.199	207.46	279.53	356.73	852.75
2002	681.65	288.96	316.89	231.2	208.73	192.76	330.99	302.81	391.05	1054.2	785.19	2349.6
2003	774.4	287.09	172.13	408.5	317.48	354.08	454.77	490.79	250.96	341.98	1543.3	2799.2
2004	2205.7	741.29	670.18	316.63	279.41	387.16	464.32	362.25	853.29	732.57	1134.5	1473.4
2005	946.42	501.41	508.37	455.2	322.69	220.9	364.59	295.03	539.25	537.39	577.22	1512.2
2006	1212.4	728.33	618.27	315.59	254.35	254.17	378.95	317.86	179.7	421.75	622.51	1032.7

Appendix 2

K-S test results of age distribution between males and females during a three-year period from 2003 to 2005.

Table 9: Kolmogorov-Smirnov test results of age distribution between males and females of *Loligo reynaudii*.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Age (Days) is the same across categories of Sex.	Independent-Samples Kolmogorov-Smirnov Test	.008	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix 3

This section presents the back-calculated egg-laying dates for the surveys carried out in the years 2003, 2004 and 2005. Individual surveyed years are presented separately, indicating the percentage of eggs that were laid during the closed season, nine days before and nine days after the closed season.

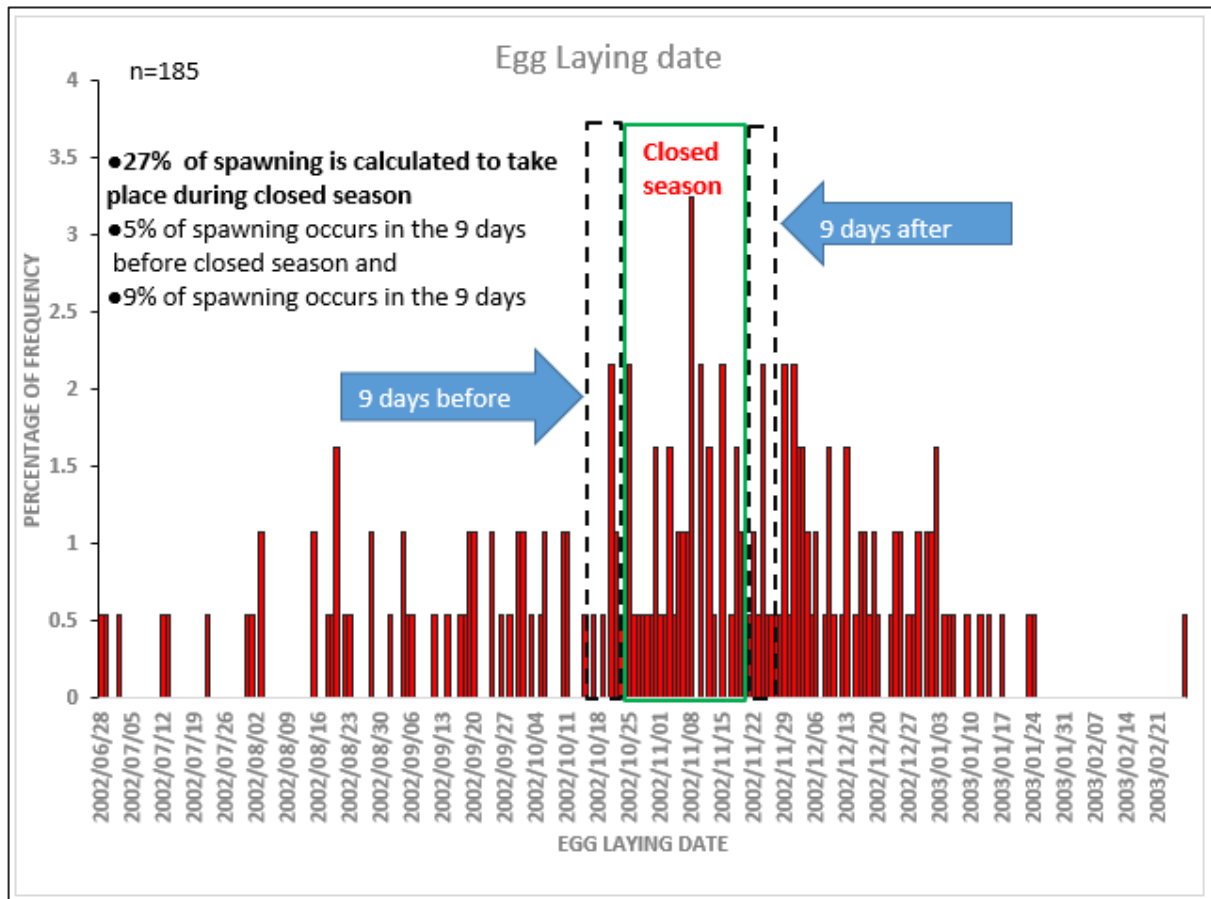


Figure 20: Percentage frequency of egg-laying dates for *Loligo reynaudii* hatched in 2002/2003 season. Sample collected in November/December 2003.

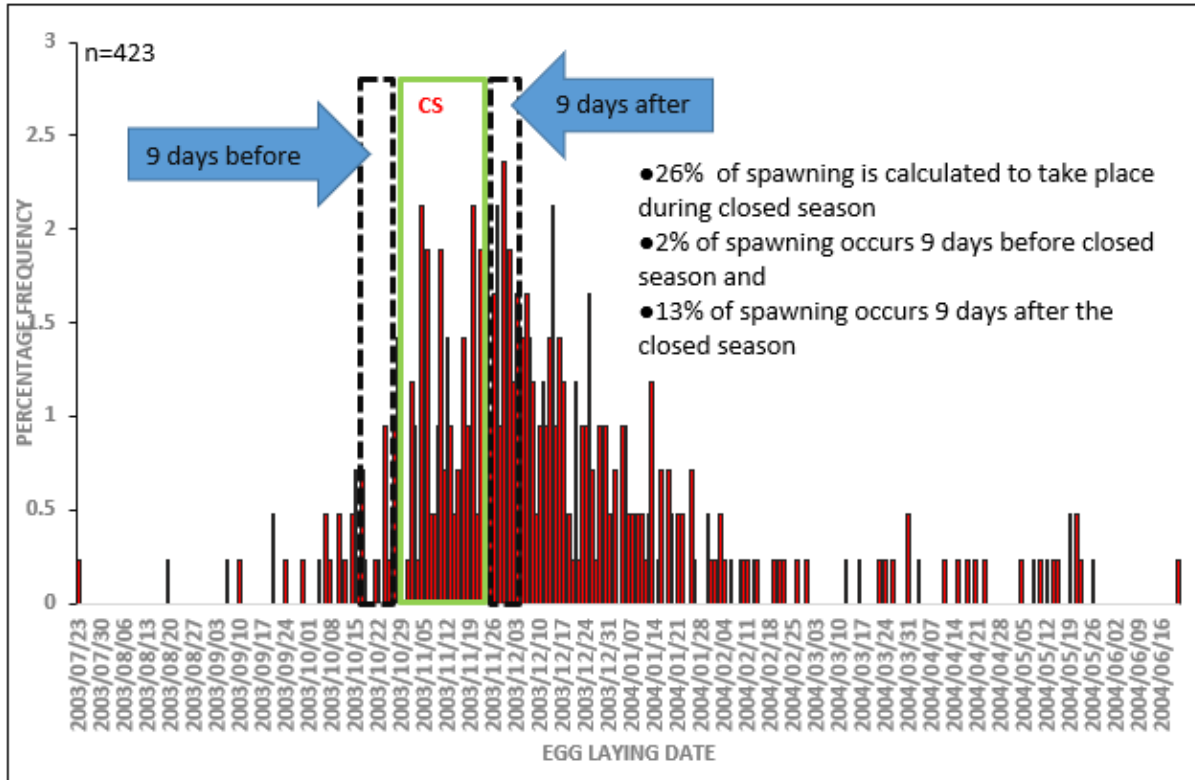


Figure 21: Percentage frequency of egg-laying dates for *Loligo reynaudii* hatched in the 2003/2004 season. Sample collected in November/December 2004.

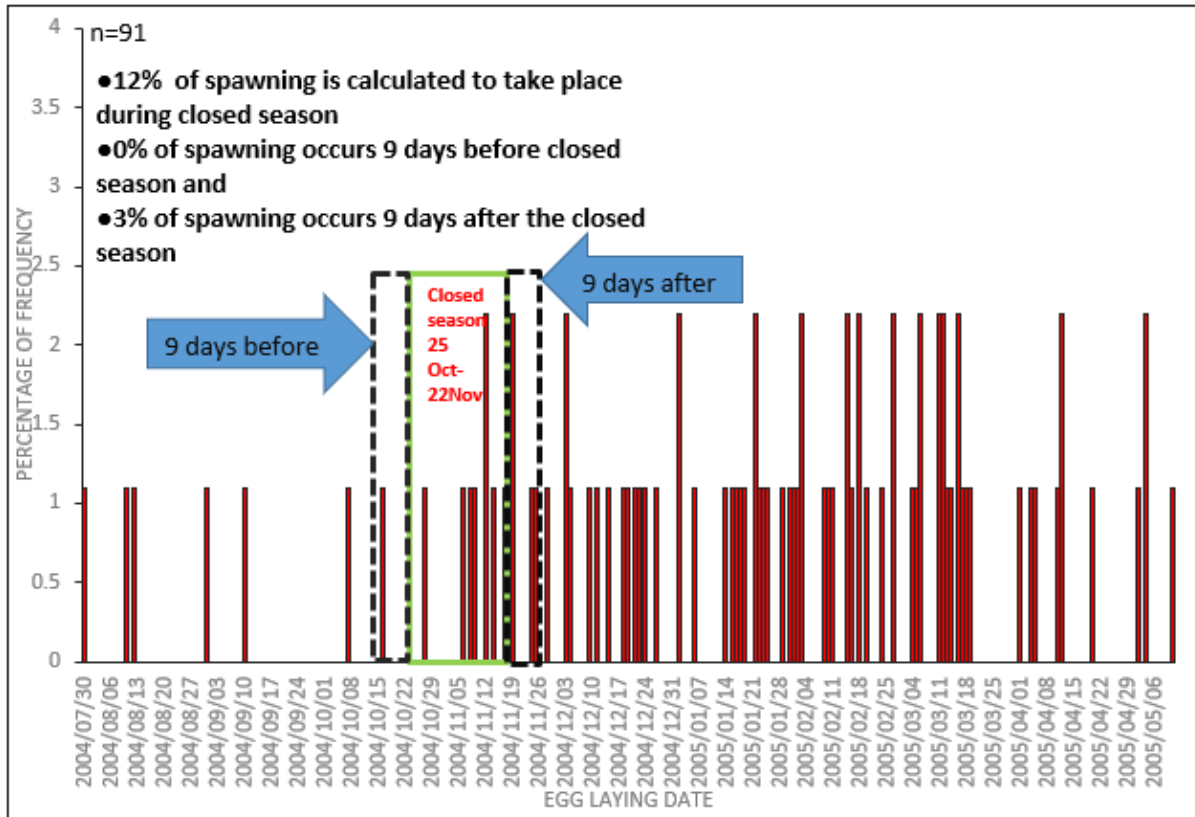


Figure 22: Percentage frequency of egg-laying dates hatched in the 2004/2005 season for *Loligo reynaudii*. Sample collected in November/December 2005.

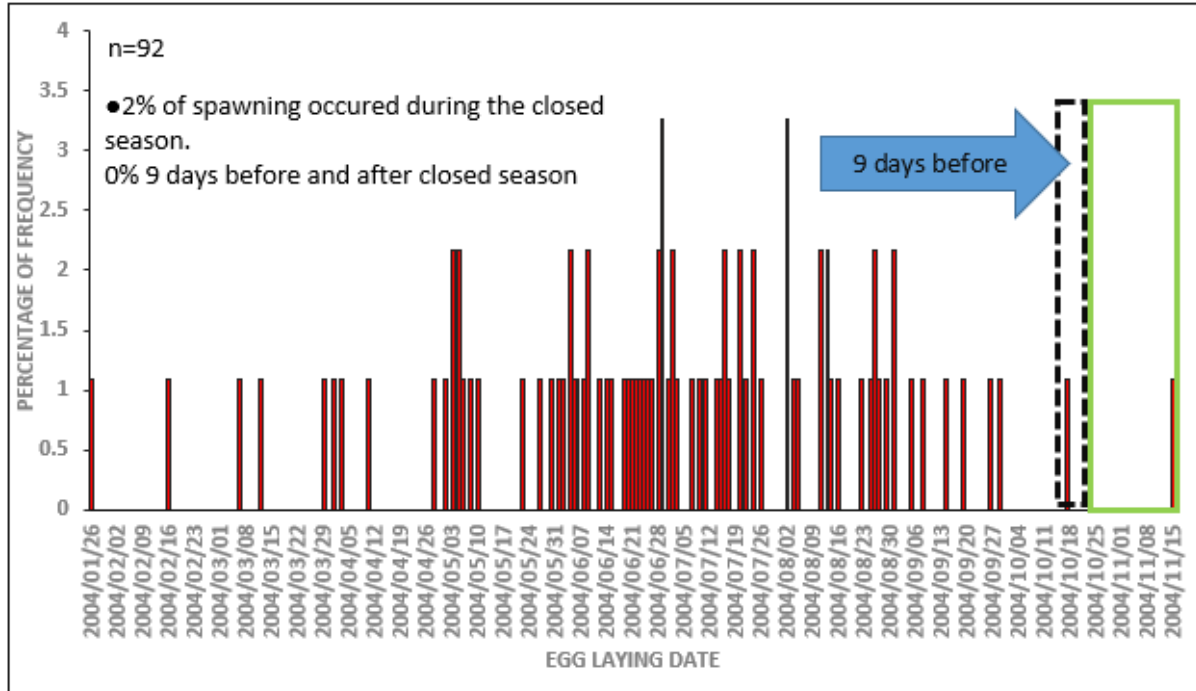


Figure 23: Percentage frequency of egg-laying dates in 2004 season for *Loligo reynaudii*. Sample collected in April/May 2005.

Appendix 4

Tables 10 to 13 include the biological data, age data and the back-calculation results of *L. reynaudii* for the survey years November 2003 to 2005 and April 2005.

Table 10: November 2003 chokka survey data.

	2003 survey							
Ref#	Catch date	Statolith length	Sex	ML (mm)	Wt(g)	Age (Days)	Hatch date	Egg- Laying date
LVR/2003A/085 R	2003/11/22		U	197		330	2002/12/27	2002/11/30
LVR/2003A/103 R	2003/11/23		U	207	192	325	2003/01/02	2002/12/06
LVR/2003A/105 R	2003/11/23		U	197		242	2003/03/26	2003/02/27
LVR/2003A/106 R	2003/11/23		U	215	218	366	2002/11/22	2002/10/26
LVR/2003A/108 R	2003/11/23		U	190	168	339	2002/12/19	2002/11/22
LVR/2003A/109 R	2003/11/23		U	202		337	2002/12/21	2002/11/24
LVR/2003A/110 R	2003/11/23		U	196	188	353	2002/12/05	2002/11/08
LVR/2003A/111 R	2003/11/23		U	183	158	299	2003/01/28	2003/01/01
LVR/2003A/112 R	2003/11/23		U	191	148	329	2002/12/29	2002/12/02
LVR/2003A/114 R	2003/11/23		U	186	158	321	2003/01/06	2002/12/10
LVR/2003A/115 R	2003/11/23		U	181	138	364	2002/11/24	2002/10/28
LVR/2003A/117 R	2003/11/23		U	185	148	353	2002/12/05	2002/11/08
LVR/2003A/118 R	2003/11/23		U	188	106	353	2002/12/05	2002/11/08
LVR/2003A/004 R	2003/11/18		F	213	234	351	2002/12/02	2002/11/05
LVR/2003A/005 R	2003/11/18		F	210	210	363	2002/11/20	2002/10/24
LVR/2003A/006 R	2003/11/18		F	193	168	365	2002/11/18	2002/10/22
LVR/2003A/007 R	2003/11/18		F	213	236	325	2002/12/28	2002/12/01
LVR/2003A/009 R	2003/11/18		F	228	248	376	2002/11/07	2002/10/11
LVR/2003A/010 R	2003/11/18		F	176	112	313	2003/01/09	2002/12/13
LVR/2003A/011 R	2003/11/18		F	231	238	355	2002/11/28	2002/11/01

LVR/2003A/012 R	2003/11/18		F	172	128	298	2003/01/24	2002/12/28
LVR/2003A/013 R	2003/11/18		F	237	246	366	2002/11/17	2002/10/21
LVR/2003A/014 R	2003/11/18		F	231	260	397	2002/10/17	2002/09/20
LVR/2003A/031 R	2003/11/19		F	169	116	303	2003/01/20	2002/12/24
LVR/2003A/032 R	2003/11/19		F	198	190	345	2002/12/09	2002/11/12
LVR/2003A/033 R	2003/11/19		F	227	262	478	2002/07/29	2002/07/02
LVR/2003A/034 R	2003/11/19		F	232	308	467	2002/08/09	2002/07/13
LVR/2003A/035 R	2003/11/19		F	196	164	296	2003/01/27	2002/12/31
LVR/2003A/036 R	2003/11/19		F	200	176	363	2002/11/21	2002/10/25
LVR/2003A/038 R	2003/11/19		F	220	232	388	2002/10/27	2002/09/30
LVR/2003A/039 R	2003/11/19		F	150	128	294	2003/01/29	2003/01/02
LVR/2003A/041 R	2003/11/19		F	230	270	387	2002/10/28	2002/10/01
LVR/2003A/057 R	2003/11/21		F	210	192	369	2002/11/17	2002/10/21
LVR/2003A/058 R	2003/11/21		F	240	282	380	2002/11/06	2002/10/10
LVR/2003A/059 R	2003/11/21		F	263	296	436	2002/09/11	2002/08/15
LVR/2003A/060 R	2003/11/21		F	214	238	373	2002/11/13	2002/10/17
LVR/2003A/061 R	2003/11/21		F	225	210	317	2003/01/08	2002/12/12
LVR/2003A/068 R	2003/11/21		F	222	252	419	2002/09/28	2002/09/01
LVR/2003A/069 R	2003/11/21		F	218	246	357	2002/11/29	2002/11/02
LVR/2003A/070 R	2003/11/21		F	205	190	433	2002/09/14	2002/08/18
LVR/2003A/101 R	2003/11/23		F	218	218	398	2002/10/21	2002/09/24
LVR/2003A/102 R	2003/11/23		F	214	228	315	2003/01/12	2002/12/16
LVR/2003A/104 R	2003/11/23		F	195	170	335	2002/12/23	2002/11/26
LVR/2003A/107 R	2003/11/23		F	211	212	314	2003/01/13	2002/12/17
LVR/2003A/113 R	2003/11/23		F	199	164	337	2002/12/21	2002/11/24
LVR/2003A/136 R	2003/11/24		F	195	184	296	2003/02/01	2003/01/05
LVR/2003A/137 R	2003/11/24		F	210	254	316	2003/01/12	2002/12/16

LVR/2003A/139 R	2003/11/24		F	212	234	434	2002/09/16	2002/08/20
LVR/2003A/140 R	2003/11/24		F	196	176	278	2003/02/19	2003/01/23
LVR/2003A/141 R	2003/11/24		F	190	174	297	2003/01/31	2003/01/04
LVR/2003A/142 R	2003/11/24		F	200	212	350	2002/12/09	2002/11/12
LVR/2003A/143 R	2003/11/24		F	217	226	439	2002/09/11	2002/08/15
LVR/2003A/151 R	2003/11/26		F	198	176	325	2003/01/05	2002/12/09
LVR/2003A/152 R	2003/11/26		F	200	200	317	2003/01/13	2002/12/17
LVR/2003A/153 R	2003/11/26		F	190	166	297	2003/02/02	2003/01/06
LVR/2003A/154 R	2003/11/26		F	185	164	316	2003/01/14	2002/12/18
LVR/2003A/155 R	2003/11/26		F	170	128	311	2003/01/19	2002/12/23
LVR/2003A/156 R	2003/11/26		F	180	136	325	2003/01/05	2002/12/09
LVR/2003A/157 R	2003/11/26		F	197	176	356	2002/12/05	2002/11/08
LVR/2003A/158 R	2003/11/26		F	184	156	307	2003/01/23	2002/12/27
LVR/2003A/159 R	2003/11/26		F	176	134	279	2003/02/20	2003/01/24
LVR/2003A/160 R	2003/11/26		F	176	136	335	2002/12/26	2002/11/29
LVR/2003A/171 R	2003/11/27		F	220	244	408	2002/10/15	2002/09/18
LVR/2003A/172 R	2003/11/27		F	220	240	381	2002/11/11	2002/10/15
LVR/2003A/173 R	2003/11/27		F	213	218	310	2003/01/21	2002/12/25
LVR/2003A/174 R	2003/11/27		F	227	244	332	2002/12/30	2002/12/03
LVR/2003A/175 R	2003/11/27		F	223	244	355	2002/12/07	2002/11/10
LVR/2003A/176 R	2003/11/27		F	203	208	332	2002/12/30	2002/12/03
LVR/2003A/177 R	2003/11/27		F	200	198	358	2002/12/04	2002/11/07
LVR/2003A/178 R	2003/11/27		F	209	194	316	2003/01/15	2002/12/19
LVR/2003A/179 R	2003/11/27		F	192	176	396	2002/10/27	2002/09/30
LVR/2003A/180 R	2003/11/27		F	187	158	333	2002/12/29	2002/12/02
LVR/2003A/191 R	2003/11/29		F	226	236	400	2002/10/25	2002/09/28
LVR/2003A/192 R	2003/11/29		F	211	210	343	2002/12/21	2002/11/24

LVR/2003A/193 R	2003/11/29		F	215	206	343	2002/12/21	2002/11/24
LVR/2003A/194 R	2003/11/29		F	214	184	306	2003/01/27	2002/12/31
LVR/2003A/195 R	2003/11/29		F	206	200	338	2002/12/26	2002/11/29
LVR/2003A/196 R	2003/11/29		F	205	194	344	2002/12/20	2002/11/23
LVR/2003A/200 R	2003/11/29		F	183	142	352	2002/12/12	2002/11/15
LVR/2003A/001 R	2003/11/18		M	275	274	366	2002/11/17	2002/10/21
LVR/2003A/002 R	2003/11/18		M	327	356	346	2002/12/07	2002/11/10
LVR/2003A/003 R	2003/11/18		M	333	444	321	2003/01/01	2002/12/05
LVR/2003A/008 R	2003/11/18		M	285	358	281	2003/02/10	2003/01/14
LVR/2003A/015 R	2003/11/18		M	294	342	393	2002/10/21	2002/09/24
LVR/2003A/016 R	2003/11/18		M	308	432	348	2002/12/05	2002/11/08
LVR/2003A/017 R	2003/11/18		M	185	332	324	2002/12/29	2002/12/02
LVR/2003A/018 R	2003/11/18		M	310	430	339	2002/12/14	2002/11/17
LVR/2003A/019 R	2003/11/19		M	280	386	347	2002/12/07	2002/11/10
LVR/2003A/020 R	2003/11/19		M	313	410	344	2002/12/10	2002/11/13
LVR/2003A/021 R	2003/11/19		M	340	528	429	2002/09/16	2002/08/20
LVR/2003A/022 R	2003/11/19		M	258	490	367	2002/11/17	2002/10/21
LVR/2003A/023 R	2003/11/19		M	335	254	353	2002/12/01	2002/11/04
LVR/2003A/024 R	2003/11/19		M	289	336	347	2002/12/07	2002/11/10
LVR/2003A/025 R	2003/11/19		M	307	352	404	2002/10/11	2002/09/14
LVR/2003A/026 R	2003/11/19		M	303	392	365	2002/11/19	2002/10/23
LVR/2003A/027 R	2003/11/19		M	311	328	349	2002/12/05	2002/11/08
LVR/2003A/028 R	2003/11/19		M	320	404	323	2002/12/31	2002/12/04
LVR/2003A/029 R	2003/11/19		M	312	416	358	2002/11/26	2002/10/30
LVR/2003A/030 R	2003/11/19		M	205	382	482	2002/07/25	2002/06/28
LVR/2003A/040 R	2003/11/19		M	182	122	294	2003/01/29	2003/01/02
LVR/2003A/044 R	2003/11/21		M	359	640	470	2002/08/08	2002/07/12

LVR/2003A/045 R	2003/11/21		M	375	574	409	2002/10/08	2002/09/11
LVR/2003A/046 R	2003/11/21		M	328	442	460	2002/08/18	2002/07/22
LVR/2003A/049 R	2003/11/21		M	340	518	403	2002/10/14	2002/09/17
LVR/2003A/050 R	2003/11/21		M	323	446	356	2002/11/30	2002/11/03
LVR/2003A/051 R	2003/11/21		M	314	404	394	2002/10/23	2002/09/26
LVR/2003A/052 R	2003/11/21		M	272	298	356	2002/11/30	2002/11/03
LVR/2003A/053 R	2003/11/21		M	275	302	352	2002/12/04	2002/11/07
LVR/2003A/054 R	2003/11/21		M	267	290	304	2003/01/21	2002/12/25
LVR/2003A/055 R	2003/11/21		M	254	250	334	2002/12/22	2002/11/25
LVR/2003A/056 R	2003/11/21		M	232	176	368	2002/11/18	2002/10/22
LVR/2003A/062 R	2003/11/21		M	404	654	450	2002/08/28	2002/08/01
LVR/2003A/063 R	2003/11/21		M	371	596	387	2002/10/30	2002/10/03
LVR/2003A/064 R	2003/11/21		M	345	458	448	2002/08/30	2002/08/03
LVR/2003A/065 R	2003/11/21		M	360	460	448	2002/08/30	2002/08/03
LVR/2003A/066 R	2003/11/21		M	340	470	337	2002/12/19	2002/11/22
LVR/2003A/067 R	2003/11/21		M	308	348	340	2002/12/16	2002/11/19
LVR/2003A/071 R	2003/11/21		M	350	480	365	2002/11/21	2002/10/25
LVR/2003A/072 R	2003/11/21		M	325	418	344	2002/12/12	2002/11/15
LVR/2003A/073 R	2003/11/21		M	323	466	371	2002/11/15	2002/10/19
LVR/2003A/074 R	2003/11/21		M	295	408	432	2002/09/15	2002/08/19
LVR/2003A/075 R	2003/11/21		M	328	424	341	2002/12/15	2002/11/18
LVR/2003A/076 R	2003/11/21		M	330	384	359	2002/11/27	2002/10/31
LVR/2003A/077 R	2003/11/21		M	302	442	340	2002/12/16	2002/11/19
LVR/2003A/078 R	2003/11/21		M	270	274	325	2002/12/31	2002/12/04
LVR/2003A/079 R	2003/11/21		M	280	296	323	2003/01/02	2002/12/06
LVR/2003A/080 R	2003/11/21		M	286	260	316	2003/01/09	2002/12/13
LVR/2003A/082 R	2003/11/21		M	279	292	353	2002/12/03	2002/11/06

LVR/2003A/083 R	2003/11/21		M	282	298	300	2003/01/25	2002/12/29
LVR/2003A/084 R	2003/11/21		M	272	302	289	2003/02/05	2003/01/09
LVR/2003A/086 R	2003/11/22		M	425	876	380	2002/11/07	2002/10/11
LVR/2003A/087 R	2003/11/22		M	368	504	402	2002/10/16	2002/09/19
LVR/2003A/088 R	2003/11/22		M	372	440	432	2002/09/16	2002/08/20
LVR/2003A/089 R	2003/11/22		M	297	354	417	2002/10/01	2002/09/04
LVR/2003A/090 R	2003/11/22		M	365	502	484	2002/07/26	2002/06/29
LVR/2003A/091 R	2003/11/22		M	375	520	452	2002/08/27	2002/07/31
LVR/2003A/092 R	2003/11/22		M	298	390	310	2003/01/16	2002/12/20
LVR/2003A/093 R	2003/11/22		M	290	340	354	2002/12/03	2002/11/06
LVR/2003A/094 R	2003/11/22		M	345	426	366	2002/11/21	2002/10/25
LVR/2003A/095 R	2003/11/22		M	330	400	345	2002/12/12	2002/11/15
LVR/2003A/096 R	2003/11/22		M	360	546	401	2002/10/17	2002/09/20
LVR/2003A/097 R	2003/11/22		M	358	484	355	2002/12/02	2002/11/05
LVR/2003A/098 R	2003/11/22		M	383	588	424	2002/09/24	2002/08/28
LVR/2003A/099 R	2003/11/22		M	385	490	415	2002/10/03	2002/09/06
LVR/2003A/100 R	2003/11/22		M	370	610	417	2002/10/01	2002/09/04
LVR/2003A/119 R	2003/11/23		M	285	388	382	2002/11/06	2002/10/10
LVR/2003A/120 R	2003/11/23		M	276	276	330	2002/12/28	2002/12/01
LVR/2003A/121 R	2003/11/23		M	260	286	330	2002/12/28	2002/12/01
LVR/2003A/122 R	2003/11/23		M	240	258	299	2003/01/28	2003/01/01
LVR/2003A/123 R	2003/11/23		M	260	268	318	2003/01/09	2002/12/13
LVR/2003A/127 R	2003/11/24		M	302	406	364	2002/11/25	2002/10/29
LVR/2003A/128 R	2003/11/24		M	323	414	388	2002/11/01	2002/10/05
LVR/2003A/129 R	2003/11/24		M	332	546	362	2002/11/27	2002/10/31
LVR/2003A/130 R	2003/11/24		M	352	536	344	2002/12/15	2002/11/18
LVR/2003A/131 R	2003/11/24		M	275	290	284	2003/02/13	2003/01/17

LVR/2003A/133 R	2003/11/24		M	327	406	341	2002/12/18	2002/11/21
LVR/2003A/134 R	2003/11/24		M	318	410	362	2002/11/27	2002/10/31
LVR/2003A/135 R	2003/11/24		M	313	506	347	2002/12/12	2002/11/15
LVR/2003A/144 R	2003/11/26		M	356	528	335	2002/12/26	2002/11/29
LVR/2003A/145 R	2003/11/26		M	329	458	389	2002/11/02	2002/10/06
LVR/2003A/146 R	2003/11/26		M	332	506	420	2002/10/02	2002/09/05
LVR/2003A/147 R	2003/11/26		M	331	320	394	2002/10/28	2002/10/01
LVR/2003A/148 R	2003/11/26		M	292	374	319	2003/01/11	2002/12/15
LVR/2003A/149 R	2003/11/26		M	278	298	337	2002/12/24	2002/11/27
LVR/2003A/150 R	2003/11/26		M	230	212	291	2003/02/08	2003/01/12
LVR/2003A/161 R	2003/11/27		M	320	486	429	2002/09/24	2002/08/28
LVR/2003A/162 R	2003/11/27		M	338	444	369	2002/11/23	2002/10/27
LVR/2003A/163 R	2003/11/27		M	305	352	334	2002/12/28	2002/12/01
LVR/2003A/164 R	2003/11/27		M	304	374	371	2002/11/21	2002/10/25
LVR/2003A/165 R	2003/11/27		M	292	378	302	2003/01/29	2003/01/02
LVR/2003A/166 R	2003/11/27		M	301	416	362	2002/11/30	2002/11/03
LVR/2003A/167 R	2003/11/27		M	257	288	311	2003/01/20	2002/12/24
LVR/2003A/168 R	2003/11/27		M	250	262	336	2002/12/26	2002/11/29
LVR/2003A/169 R	2003/11/27		M	250	246	327	2003/01/04	2002/12/08
LVR/2003A/170 R	2003/11/27		M	260	274	337	2002/12/25	2002/11/28
LVR/2003A/181 R	2003/11/29		M	331	554	437	2002/09/18	2002/08/22
LVR/2003A/182 R	2003/11/29		M	338	410	328	2003/01/05	2002/12/09
LVR/2003A/183 R	2003/11/29		M	328	540	409	2002/10/16	2002/09/19
LVR/2003A/184 R	2003/11/29		M	309	442	349	2002/12/15	2002/11/18
LVR/2003A/185 R	2003/11/29		M	292	376	318	2003/01/15	2002/12/19
LVR/2003A/186 R	2003/11/29		M	328	428	355	2002/12/09	2002/11/12
LVR/2003A/187 R	2003/11/29		M	313	412	308	2003/01/25	2002/12/29

LVR/2003A/188 R	2003/11/29		M	308	412	392	2002/11/02	2002/10/06
LVR/2003A/189 R	2003/11/29		M	283	358	334	2002/12/30	2002/12/03
LVR/2003A/190 R	2003/11/29		M	318	354	436	2002/09/19	2002/08/23

Table 11: November 2004 chokka survey data.

	2004 Survey							
Ref#	Catch Date	Statolith length	Sex	ML (mm)	Wt (g)	Age (Days)	Hatch date	Egg-Laying date
LVR/2004A/011 L	2004/11/14		F	216	206	325	2003/12/25	2003/11/29
LVR/2004A/011 R	2004/11/14		F	216		368	2003/11/12	2003/10/17
LVR/2004A/012 R	2004/11/14		F	205	172	328	2003/12/22	2003/11/26
LVR/2004A/013 L	2004/11/14		F	200	164	332	2003/12/18	2003/11/22
LVR/2004A/013 R	2004/11/14		F	200	106	317	2004/01/02	2003/12/07
LVR/2004A/014 L	2004/11/14		F	200		253	2004/03/06	2004/02/09
LVR/2004A/014 R	2004/11/14		F	200		311	2004/01/08	2003/12/13
LVR/2004A/015 L	2004/11/14		F	185	168	310	2004/01/09	2003/12/14
LVR/2004A/016 L	2004/11/14		F	189	150	330	2003/12/20	2003/11/24
LVR/2004A/016 R	2004/11/14		F	189		275	2004/02/13	2004/01/18
LVR/2004A/017 R	2004/11/14		F	173	118	312	2004/01/07	2003/12/12
LVR/2004A/018 L	2004/11/14		F	173	104	299	2004/01/20	2003/12/25
LVR/2004A/018 R	2004/11/14		F	173	96	268	2004/02/20	2004/01/25
LVR/2004A/020 L	2004/11/14		F	173		275	2004/02/13	2004/01/18
LVR/2004A/020 R	2004/11/14		F	173		263	2004/02/25	2004/01/30
LVR/2004A/032 R	2004/11/18		F	186	190	260	2004/03/03	2004/02/06
LVR/2004A/032 L	2004/11/18		F	186	190	262	2004/03/01	2004/02/04
LVR/2004A/033 L	2004/11/18		F	223	248	323	2003/12/31	2003/12/05
LVR/2004A/033 R	2004/11/18		F	223	248	322	2004/01/01	2003/12/06

LVR/2004A/034 R	2004/11/18		F	192	184	341	2003/12/13	2003/11/17
LVR/2004A/034 L	2004/11/18		F	192	184	377	2003/11/07	2003/10/12
LVR/2004A/035 R	2004/11/18		F	211	186	336	2003/12/18	2003/11/22
LVR/2004A/035 L	2004/11/18		F	211	186	352	2003/12/02	2003/11/06
LVR/2004A/036 L	2004/11/18		F	195	192	315	2004/01/08	2003/12/13
LVR/2004A/037 R	2004/11/18		F	194	202	300	2004/01/23	2003/12/28
LVR/2004A/038 R	2004/11/18		F	177	162	336	2003/12/18	2003/11/22
LVR/2004A/039 R	2004/11/18		F	178	158	299	2004/01/24	2003/12/29
LVR/2004A/039 L	2004/11/18		F	178	158	300	2004/01/23	2003/12/28
LVR/2004A/040 R	2004/11/18		F	211	240	337	2003/12/17	2003/11/21
LVR/2004A/040 L	2004/11/18		F	211	240	374	2003/11/10	2003/10/15
LVR/2004A/041 R	2004/11/19		F	208	208	334	2003/12/21	2003/11/25
LVR/2004A/041 L	2004/11/19		F	208	208	366	2003/11/19	2003/10/24
LVR/2004A/042 R	2004/11/19		F	193	170	313	2004/01/11	2003/12/16
LVR/2004A/042 L	2004/11/19		F	193	170	313	2004/01/11	2003/12/16
LVR/2004A/043 L	2004/11/19		F	182	160	257	2004/03/07	2004/02/10
LVR/2004A/045 L	2004/11/19		F	162	112	368	2003/11/17	2003/10/22
LVR/2004A/046 R	2004/11/19		F	187	132	306	2004/01/18	2003/12/23
LVR/2004A/047 R	2004/11/19		F	178	158	328	2003/12/27	2003/12/01
LVR/2004A/047 L	2004/11/19		F	178	158	330	2003/12/25	2003/11/29
LVR/2004A/048 R	2004/11/19		F	198	156	380	2003/11/05	2003/10/10
LVR/2004A/048 L	2004/11/19		F	198	156	332	2003/12/23	2003/11/27
LVR/2004A/049 R	2004/11/19		F	182	152	265	2004/02/28	2004/02/02
LVR/2004A/053 R	2004/11/19		F	157	116	346	2003/12/09	2003/11/13
LVR/2004A/054 R	2004/11/19		F	192	184	308	2004/01/16	2003/12/21
LVR/2004A/056 R	2004/11/19		F	167	128	342	2003/12/13	2003/11/17
LVR/2004A/057 R	2004/11/19		F	173	122	286	2004/02/07	2004/01/12

LVR/2004A/058 R	2004/11/19		F	163	100	293	2004/01/31	2004/01/05
LVR/2004A/059 R	2004/11/19		F	175	132	335	2003/12/20	2003/11/24
LVR/2004A/060 R	2004/11/19		F	174	132	294	2004/01/30	2004/01/04
LVR/2004A/101 R	2004/11/20		F	215	220	336	2003/12/20	2003/11/24
LVR/2004A/102 R	2004/11/20		F	173	146	344	2003/12/12	2003/11/16
LVR/2004A/103 R	2004/11/20		F	177	140	324	2004/01/01	2003/12/06
LVR/2004A/104 R	2004/11/20		F	173	174	350	2003/12/06	2003/11/10
LVR/2004A/105 R	2004/11/20		F	218	216	336	2003/12/20	2003/11/24
LVR/2004A/106 R	2004/11/20		F	180	172	397	2003/10/20	2003/09/24
LVR/2004A/107 R	2004/11/20		F	190	164	349	2003/12/07	2003/11/11
LVR/2004A/108 R	2004/11/20		F	175	116	320	2004/01/05	2003/12/10
LVR/2004A/109 R	2004/11/20		F	163	110	295	2004/01/30	2004/01/04
LVR/2004A/110 R	2004/11/20		F	170	118	315	2004/01/10	2003/12/15
LVR/2004A/111 R	2004/11/20		F	170	86	298	2004/01/27	2004/01/01
LVR/2004A/112 R	2004/11/20		F	178	100	299	2004/01/26	2003/12/31
LVR/2004A/113 R	2004/11/20		F	160	90	286	2004/02/08	2004/01/13
LVR/2004A/114 R	2004/11/20		F	145	70	318	2004/01/07	2003/12/12
LVR/2004A/115 R	2004/11/20		F	125	64	341	2003/12/15	2003/11/19
LVR/2004A/116 R	2004/11/20		F	127	64	316	2004/01/09	2003/12/14
LVR/2004A/117 R	2004/11/20		F	133	70	290	2004/02/04	2004/01/09
LVR/2004A/118 R	2004/11/20		F	135	72	307	2004/01/18	2003/12/23
LVR/2004A/119 R	2004/11/20		F	127	76	268	2004/02/26	2004/01/31
LVR/2004A/121 R	2004/11/24		F	168	134	290	2004/02/08	2004/01/13
LVR/2004A/122 R	2004/11/24		F	190	170	359	2003/12/01	2003/11/05
LVR/2004A/123 R	2004/11/24		F	165	118	339	2003/12/21	2003/11/25
LVR/2004A/124 R	2004/11/24		F	179	148	405	2003/10/16	2003/09/20
LVR/2004A/127 R	2004/11/24		F	182	148	360	2003/11/30	2003/11/04

LVR/2004A/128 R	2004/11/24		F	177	134	326	2004/01/03	2003/12/08
LVR/2004A/130 R	2004/11/24		F	193	194	348	2003/12/12	2003/11/16
LVR/2004A/131 R	2004/11/24		F	195	198	304	2004/01/25	2003/12/30
LVR/2004A/132 R	2004/11/24		F	194	182	343	2003/12/17	2003/11/21
LVR/2004A/133 R	2004/11/24		F	184	176	337	2003/12/23	2003/11/27
LVR/2004A/134 R	2004/11/24		F	179	152	326	2004/01/03	2003/12/08
LVR/2004A/135 R	2004/11/24		F	205	196	332	2003/12/28	2003/12/02
LVR/2004A/136 R	2004/11/24		F	180	160	342	2003/12/18	2003/11/22
LVR/2004A/137 R	2004/11/24		F	189	166	335	2003/12/25	2003/11/29
LVR/2004A/161 R	2004/11/24		F	162	100	331	2003/12/29	2003/12/03
LVR/2004A/162 R	2004/11/24		F	185	168	464	2003/08/18	2003/07/23
LVR/2004A/163 R	2004/11/24		F	183	156	360	2003/11/30	2003/11/04
LVR/2004A/164 R	2004/11/24		F	180	146	419	2003/10/02	2003/09/06
LVR/2004A/165 R	2004/11/24		F	143	66	307	2004/01/22	2003/12/27
LVR/2004A/167 R	2004/11/24		F	102	38	313	2004/01/16	2003/12/21
LVR/2004A/168 R	2004/11/24		F	100	34	296	2004/02/02	2004/01/07
LVR/2004A/169 R	2004/11/24		F	88	32	212	2004/04/26	2004/03/31
LVR/2004A/170 R	2004/11/24		F	113	48	278	2004/02/20	2004/01/25
LVR/2004A/182 R	2004/11/25		F	165	134	350	2003/12/11	2003/11/15
LVR/2004A/183 R	2004/11/25		F	175	160	359	2003/12/02	2003/11/06
LVR/2004A/184 R	2004/11/25		F	175		310	2004/01/20	2003/12/25
LVR/2004A/186 R	2004/11/25		F	202	202	381	2003/11/10	2003/10/15
LVR/2004A/187 R	2004/11/25		F	152	84	278	2004/02/21	2004/01/26
LVR/2004A/188 R	2004/11/25		F	188		416	2003/10/06	2003/09/10
LVR/2004A/189 R	2004/11/25		F	185	185	348	2003/12/13	2003/11/17
LVR/2004A/193 R	2004/11/25		F	161	116	355	2003/12/06	2003/11/10
LVR/2004A/194 R	2004/11/25		F	130	64	272	2004/02/27	2004/02/01

LVR/2004A/195 R	2004/11/25		F	130	74	333	2003/12/28	2003/12/02
LVR/2004A/196 R	2004/11/25		F	127	60	336	2003/12/25	2003/11/29
LVR/2004A/197 R	2004/11/25		F	113	48	288	2004/02/11	2004/01/16
LVR/2004A/198 R	2004/11/25		F	103	38	218	2004/04/21	2004/03/26
LVR/2004A/199 L	2004/11/25		F	103	34	213	2004/04/26	2004/03/31
LVR/2004A/200 R	2004/11/25		F	84	20	190	2004/05/19	2004/04/23
LVR/2004A/211 R	2004/11/26		F	175	140	329	2004/01/02	2003/12/07
LVR/2004A/212 R	2004/11/26		F	167	122	322	2004/01/09	2003/12/14
LVR/2004A/214 R	2004/11/26		F	165	112	297	2004/02/03	2004/01/08
LVR/2004A/256 R	2004/11/27		F	212	208	327	2004/01/05	2003/12/10
LVR/2004A/257 R	2004/11/27		F	205	196	325	2004/01/07	2003/12/12
LVR/2004A/258 R	2004/11/27		F	177	138	313	2004/01/19	2003/12/24
LVR/2004A/260 R	2004/11/27		F	183	154	341	2003/12/22	2003/11/26
LVR/2004A/261 R	2004/11/27		F	170	122	343	2003/12/20	2003/11/24
LVR/2004A/262 R	2004/11/27		F	185	156	343	2003/12/20	2003/11/24
LVR/2004A/263 R	2004/11/27		F	183	162	355	2003/12/08	2003/11/12
LVR/2004A/264 R	2004/11/27		F	194	182	361	2003/12/02	2003/11/06
LVR/2004A/266 R	2004/11/27		F	177	152	345	2003/12/18	2003/11/22
LVR/2004A/267 R	2004/11/27		F	200	184	340	2003/12/23	2003/11/27
LVR/2004A/268 R	2004/11/27		F	185	166	355	2003/12/08	2003/11/12
LVR/2004A/269 R	2004/11/27		F	182		341	2003/12/22	2003/11/26
LVR/2004A/270 R	2004/11/27		F	197	180	374	2003/11/19	2003/10/24
LVR/2004A/281 R	2004/11/27		F	191	164	340	2003/12/23	2003/11/27
LVR/2004A/282 R	2004/11/27		F	175	154	333	2003/12/30	2003/12/04
LVR/2004A/283 R	2004/11/27		F	180	140	334	2003/12/29	2003/12/03
LVR/2004A/284 R	2004/11/27		F	163	114	349	2003/12/14	2003/11/18
LVR/2004A/285 R	2004/11/27		F	169	130	365	2003/11/28	2003/11/02

LVR/2004A/286 R	2004/11/27		F	183	160	313	2004/01/19	2003/12/24
LVR/2004A/287 R	2004/11/27		F	192	170	336	2003/12/27	2003/12/01
LVR/2004A/288 R	2004/11/27		F	172	144	332	2003/12/31	2003/12/05
LVR/2004A/289 R	2004/11/27		F	190	158	371	2003/11/22	2003/10/27
LVR/2004A/290 R	2004/11/27		F	188	148	350	2003/12/13	2003/11/17
LVR/2004A/301 R	2004/11/28		F	200	218	340	2003/12/24	2003/11/28
LVR/2004A/302 R	2004/11/28		F	195	170	335	2003/12/29	2003/12/03
LVR/2004A/303 R	2004/11/28		F	190	176	334	2003/12/30	2003/12/04
LVR/2004A/304 R	2004/11/28		F	187	170	313	2004/01/20	2003/12/25
LVR/2004A/305 R	2004/11/28		F	181	160	362	2003/12/02	2003/11/06
LVR/2004A/306 R	2004/11/28		F	207	212	354	2003/12/10	2003/11/14
LVR/2004A/308 R	2004/11/28		F	177	162	263	2004/03/10	2004/02/13
LVR/2004A/309 R	2004/11/28		F	197	170	336	2003/12/28	2003/12/02
LVR/2004A/310 R	2004/11/28		F	185	166	302	2004/01/31	2004/01/05
LVR/2004A/321 R	2004/11/28		F	194	174	332	2004/01/01	2003/12/06
LVR/2004A/322 R	2004/11/28		F	198	192	334	2003/12/30	2003/12/04
LVR/2004A/323 R	2004/11/28		F	186	148	359	2003/12/05	2003/11/09
LVR/2004A/324 R	2004/11/28		F	177	148	257	2004/03/16	2004/02/19
LVR/2004A/325 R	2004/11/28		F	190	178	331	2004/01/02	2003/12/07
LVR/2004A/326 R	2004/11/28		F	171	132	321	2004/01/12	2003/12/17
LVR/2004A/327 R	2004/11/28		F	181	150	324	2004/01/09	2003/12/14
LVR/2004A/328 R	2004/11/28		F	208	198	325	2004/01/08	2003/12/13
LVR/2004A/329 R	2004/11/28		F	202	184	318	2004/01/15	2003/12/20
LVR/2004A/330 R	2004/11/28		F	210	208	367	2003/11/27	2003/11/01
LVR/2004A/341 R	2004/11/29		F	185	162	314	2004/01/20	2003/12/25
LVR/2004A/342 R	2004/11/29		F	196	180	350	2003/12/15	2003/11/19
LVR/2004A/345 R	2004/11/29		F	181	164	295	2004/02/08	2004/01/13

LVR/2004A/346 R	2004/11/29		F	163	128	315	2004/01/19	2003/12/24
LVR/2004A/347 R	2004/11/29		F	198	198	334	2003/12/31	2003/12/05
LVR/2004A/348 R	2004/11/29		F	195	172	340	2003/12/25	2003/11/29
LVR/2004A/349 R	2004/11/29		F	173	146	373	2003/11/22	2003/10/27
LVR/2004A/350 R	2004/11/29		F	185	166	296	2004/02/07	2004/01/12
LVR/2004A/361 R	2004/11/29		F	193	182	343	2003/12/22	2003/11/26
LVR/2004A/362 R	2004/11/29		F	176	132	349	2003/12/16	2003/11/20
LVR/2004A/363 R	2004/11/29		F	187	172	338	2003/12/27	2003/12/01
LVR/2004A/364 R	2004/11/29		F	173	122	326	2004/01/08	2003/12/13
LVR/2004A/365 R	2004/11/29		F	173	142	325	2004/01/09	2003/12/14
LVR/2004A/366 R	2004/11/29		F	163	124	302	2004/02/01	2004/01/06
LVR/2004A/367 R	2004/11/29		F	178	146	329	2004/01/05	2003/12/10
LVR/2004A/368 R	2004/11/29		F	175	138	363	2003/12/02	2003/11/06
LVR/2004A/369 R	2004/11/29		F	165	128	367	2003/11/28	2003/11/02
LVR/2004A/370 R	2004/11/29		F	174	128	347	2003/12/18	2003/11/22
LVR/2004A/371 R	2004/11/30		F	202	188	373	2003/11/23	2003/10/28
LVR/2004A/372 R	2004/11/30		F	174	148	387	2003/11/09	2003/10/14
LVR/2004A/373 R	2004/11/30		F	182	156	321	2004/01/14	2003/12/19
LVR/2004A/374 R	2004/11/30		F	173	138	411	2003/10/16	2003/09/20
LVR/2004A/375 R	2004/11/30		F	193	164	334	2004/01/01	2003/12/06
LVR/2004A/378 R	2004/11/30		F	240	314	374	2003/11/22	2003/10/27
LVR/2004A/379 R	2004/11/30		F	182	150	323	2004/01/12	2003/12/17
LVR/2004A/380 R	2004/11/30		F	209	194	316	2004/01/19	2003/12/24
LVR/2004A/397 R	2004/11/30		F	185	156	366	2003/11/30	2003/11/04
LVR/2004A/398 R	2004/11/30		F	183	168	329	2004/01/06	2003/12/11
LVR/2004A/399 R	2004/11/30		F	162	118	312	2004/01/23	2003/12/28
LVR/2004A/400 R	2004/11/30		F	173	130	310	2004/01/25	2003/12/30

LVR/2004A/401 R	2004/11/30		F	162	120	331	2004/01/04	2003/12/09
LVR/2004A/402 R	2004/11/30		F	193	168	343	2003/12/23	2003/11/27
LVR/2004A/403 R	2004/11/30		F	165	120	364	2003/12/02	2003/11/06
LVR/2004A/404 R	2004/11/30		F	162	112	326	2004/01/09	2003/12/14
LVR/2004A/421 R	2004/12/01		F	192	174	335	2004/01/01	2003/12/06
LVR/2004A/422 R	2004/12/01		F	195	186	444	2003/09/14	2003/08/19
LVR/2004A/424 R	2004/12/01		F	203	198	371	2003/11/26	2003/10/31
LVR/2004A/425 R	2004/12/01		F	183	162	359	2003/12/08	2003/11/12
LVR/2004A/426 R	2004/12/01		F	176	158	313	2004/01/23	2003/12/28
LVR/2004A/427 R	2004/12/01		F	175	146	324	2004/01/12	2003/12/17
LVR/2004A/428 R	2004/12/01		F	174	130	398	2003/10/30	2003/10/04
LVR/2004A/429 R	2004/12/01		F	175	140	345	2003/12/22	2003/11/26
LVR/2004A/430 R	2004/12/01		F	157	106	375	2003/11/22	2003/10/27
LVR/2004A/438 R	2004/12/01		F	122	52	238	2004/04/07	2004/03/12
LVR/2004A/439 R	2004/12/01		F	197	174	356	2003/12/11	2003/11/15
LVR/2004A/440 R	2004/12/01		F	203	106	368	2003/11/29	2003/11/03
LVR/2004A/441 R	2004/12/01		F	170	138	289	2004/02/16	2004/01/21
LVR/2004A/442 R	2004/12/01		F	185	166	294	2004/02/11	2004/01/16
LVR/2004A/443 R	2004/12/01		F	178	144	344	2003/12/23	2003/11/27
LVR/2004A/444 R	2004/12/01		F	150	94	319	2004/01/17	2003/12/22
LVR/2004A/445 R	2004/12/01		F	148	120	369	2003/11/28	2003/11/02
LVR/2004A/446 R	2004/12/01		F	172	142	362	2003/12/05	2003/11/09
LVR/2004A/447 R	2004/12/01		F	172	120	341	2003/12/26	2003/11/30
LVR/2004A/448 L	2004/12/01		F	148	108	291	2004/02/14	2004/01/19
LVR/2004A/449 R	2004/12/01		F	125	60	308	2004/01/28	2004/01/02
LVR/2004A/450 R	2004/12/01		F	130	66	228	2004/04/17	2004/03/22
LVR/2004A/456 R	2004/12/01		F	191	174	308	2004/01/28	2004/01/02

LVR/2004A/457 R	2004/12/01		F	183	158	318	2004/01/18	2003/12/23
LVR/2004A/458 R	2004/12/01		F	141	88	300	2004/02/05	2004/01/10
LVR/2004A/459 R	2004/12/01		F	114	48	265	2004/03/11	2004/02/14
LVR/2004A/460 R	2004/12/01		F	83	22	175	2004/06/09	2004/05/14
LVR/2004A/208 R	2004/11/25		J	56	10	161	2004/06/17	2004/05/22
LVR/2004A/210 R	2004/11/25		J	43	4	164	2004/06/14	2004/05/19
LVR/2004A/356 R	2004/11/29		J	62	12	168	2004/06/14	2004/05/19
LVR/2004A/357 R	2004/11/29		J	56	10	172	2004/06/10	2004/05/15
LVR/2004A/358 R	2004/11/29		J	48	8	166	2004/06/16	2004/05/21
LVR/2004A/359 R	2004/11/29		J	45	6	161	2004/06/21	2004/05/26
LVR/2004A/360 R	2004/11/29		J	35	4	135	2004/07/17	2004/06/21
LVR/2004A/001 R	2004/11/14		M	375	615	332	2003/12/18	2003/11/22
LVR/2004A/002 R	2004/11/14		M	335	402	251	2004/03/08	2004/02/11
LVR/2004A/003 R	2004/11/14		M	283	316	353	2003/11/27	2003/11/01
LVR/2004A/004 R	2004/11/14		M	370	558	348	2003/12/02	2003/11/06
LVR/2004A/005 L	2004/11/14		M	354	506	323	2003/12/27	2003/12/01
LVR/2004A/005 R	2004/11/14		M	358	530	334	2003/12/16	2003/11/20
LVR/2004A/007 L	2004/11/14		M	326	302	308	2004/01/11	2003/12/16
LVR/2004A/008 L	2004/11/14		M	342	424	345	2003/12/05	2003/11/09
LVR/2004A/008 R	2004/11/14		M	342		301	2004/01/18	2003/12/23
LVR/2004A/009 L	2004/11/14		M	290	332	310	2004/01/09	2003/12/14
LVR/2004A/010 L	2004/11/14		M	295	250	344	2003/12/06	2003/11/10
LVR/2004A/019 L	2004/11/14		M	145		299	2004/01/20	2003/12/25
LVR/2004A/021 R	2004/11/18		M	318	476	328	2003/12/26	2003/11/30
LVR/2004A/022 L	2004/11/18		M	295	348	293	2004/01/30	2004/01/04
LVR/2004A/022 R	2004/11/18		M	295	382	338	2003/12/16	2003/11/20
LVR/2004A/023 R	2004/11/18		M	317	378	221	2004/04/11	2004/03/16

LVR/2004A/024 L	2004/11/18		M	295	382	379	2003/11/05	2003/10/10
LVR/2004A/025 R	2004/11/18		M	286	328	240	2004/03/23	2004/02/26
LVR/2004A/025 L	2004/11/18		M	286	328	310	2004/01/13	2003/12/18
LVR/2004A/026 R	2004/11/18		M	295	350	361	2003/11/23	2003/10/28
LVR/2004A/026 L	2004/11/18		M	295	350	354	2003/11/30	2003/11/04
LVR/2004A/027 R	2004/11/18		M	305	416	345	2003/12/09	2003/11/13
LVR/2004A/028 R	2004/11/18		M	280	278	320	2004/01/03	2003/12/08
LVR/2004A/030 R	2004/11/18		M	323	388	317	2004/01/06	2003/12/11
LVR/2004A/061 R	2004/11/19		M	205	144	311	2004/01/13	2003/12/18
LVR/2004A/062 R	2004/11/19		M	153	78	280	2004/02/13	2004/01/18
LVR/2004A/063 R	2004/11/19		M	180	104	341	2003/12/14	2003/11/18
LVR/2004A/064 R	2004/11/19		M	173	114	299	2004/01/25	2003/12/30
LVR/2004A/065 R	2004/11/19		M	195	132	287	2004/02/06	2004/01/11
LVR/2004A/067 R	2004/11/19		M	262	318	293	2004/01/31	2004/01/05
LVR/2004A/068 R	2004/11/19		M	300	374	292	2004/02/01	2004/01/06
LVR/2004A/069 R	2004/11/19		M	255	300	374	2003/11/11	2003/10/16
LVR/2004A/071 L	2004/11/19		M	335	384	375	2003/11/10	2003/10/15
LVR/2004A/072 R	2004/11/19		M	323	540	308	2004/01/16	2003/12/21
LVR/2004A/073 R	2004/11/19		M	312	400	364	2003/11/21	2003/10/26
LVR/2004A/074 R	2004/11/19		M	295	394	297	2004/01/27	2004/01/01
LVR/2004A/075 R	2004/11/19		M	337	444	355	2003/11/30	2003/11/04
LVR/2004A/077 R	2004/11/19		M	305	394	316	2004/01/08	2003/12/13
LVR/2004A/081 R	2004/11/20		M	320	462	348	2003/12/08	2003/11/12
LVR/2004A/083 R	2004/11/20		M	322	386	384	2003/11/02	2003/10/07
LVR/2004A/084 R	2004/11/20		M	297	436	305	2004/01/20	2003/12/25
LVR/2004A/085 R	2004/11/20		M	332	490	350	2003/12/06	2003/11/10
LVR/2004A/086 R	2004/11/20		M	336	518	347	2003/12/09	2003/11/13

LVR/2004A/088 R	2004/11/20		M	265	296	316	2004/01/09	2003/12/14
LVR/2004A/089 R	2004/11/20		M	263	260	374	2003/11/12	2003/10/17
LVR/2004A/090 R	2004/11/20		M	333	440	356	2003/11/30	2003/11/04
LVR/2004A/091 R	2004/11/20		M	253	270	358	2003/11/28	2003/11/02
LVR/2004A/094 R	2004/11/20		M	175	64	330	2003/12/26	2003/11/30
LVR/2004A/095 R	2004/11/20		M	97	30	295	2004/01/30	2004/01/04
LVR/2004A/096 R	2004/11/20		M	156	78	269	2004/02/25	2004/01/30
LVR/2004A/097 R	2004/11/20		M	140	68	292	2004/02/02	2004/01/07
LVR/2004A/098 R	2004/11/20		M	96	34	290	2004/02/04	2004/01/09
LVR/2004A/099 R	2004/11/20		M	108	36	289	2004/02/05	2004/01/10
LVR/2004A/100 R	2004/11/20		M	71	14	349	2003/12/07	2003/11/11
LVR/2004A/138 R	2004/11/24		M	320	464	371	2003/11/19	2003/10/24
LVR/2004A/139 R	2004/11/24		M	340	550	351	2003/12/09	2003/11/13
LVR/2004A/140 R	2004/11/24		M	293	426	354	2003/12/06	2003/11/10
LVR/2004A/141 R	2004/11/24		M	280	342	330	2003/12/30	2003/12/04
LVR/2004A/142 R	2004/11/24		M	273	378	327	2004/01/02	2003/12/07
LVR/2004A/143 R	2004/11/24		M	295	340	360	2003/11/30	2003/11/04
LVR/2004A/144 R	2004/11/24		M	288	348	345	2003/12/15	2003/11/19
LVR/2004A/145 R	2004/11/24		M	225	212	336	2003/12/24	2003/11/28
LVR/2004A/148 R	2004/11/24		M	235	218	335	2003/12/25	2003/11/29
LVR/2004A/149 R	2004/11/24		M	257	266	324	2004/01/05	2003/12/10
LVR/2004A/150 R	2004/11/24		M	235	206	384	2003/11/06	2003/10/11
LVR/2004A/152 R	2004/11/24		M	245	174	332	2003/12/28	2003/12/02
LVR/2004A/154 R	2004/11/24		M	195	162	331	2003/12/29	2003/12/03
LVR/2004A/155 R	2004/11/24		M	175	102	318	2004/01/11	2003/12/16
LVR/2004A/156 R	2004/11/24		M	145	70	350	2003/12/10	2003/11/14
LVR/2004A/157 R	2004/11/24		M	108	36	269	2004/02/29	2004/02/03

LVR/2004A/158 R	2004/11/24		M	95	30	251	2004/03/18	2004/02/21
LVR/2004A/159 R	2004/11/24		M	88	26	278	2004/02/20	2004/01/25
LVR/2004A/171 R	2004/11/25		M	328	456	368	2003/11/23	2003/10/28
LVR/2004A/172 R	2004/11/25		M	320	334	320	2004/01/10	2003/12/15
LVR/2004A/173 R	2004/11/25		M	280	386	397	2003/10/25	2003/09/29
LVR/2004A/174 R	2004/11/25		M	282	322	345	2003/12/16	2003/11/20
LVR/2004A/175 R	2004/11/25		M	292	306	302	2004/01/28	2004/01/02
LVR/2004A/176 R	2004/11/25		M	262	314	334	2003/12/27	2003/12/01
LVR/2004A/177 R	2004/11/25		M	261	248	318	2004/01/12	2003/12/17
LVR/2004A/178 R	2004/11/25		M	233	216	334	2003/12/27	2003/12/01
LVR/2004A/180 R	2004/11/25		M	155		285	2004/02/14	2004/01/19
LVR/2004A/202 R	2004/11/25		M	126	56	309	2004/01/21	2003/12/26
LVR/2004A/203 R	2004/11/25		M	124	54	321	2004/01/09	2003/12/14
LVR/2004A/204 R	2004/11/25		M	106	38	198	2004/05/11	2004/04/15
LVR/2004A/205 R	2004/11/25		M	113	44	210	2004/04/29	2004/04/03
LVR/2004A/206 R	2004/11/25		M	95	28	319	2004/01/11	2003/12/16
LVR/2004A/207 R	2004/11/25		M	85	22	193	2004/05/16	2004/04/20
LVR/2004A/215 R	2004/11/26		M	275	376	349	2003/12/13	2003/11/17
LVR/2004A/216 R	2004/11/26		M	272	336	292	2004/02/08	2004/01/13
LVR/2004A/218 R	2004/11/26		M	287	356	329	2004/01/02	2003/12/07
LVR/2004A/219 R	2004/11/26		M	322	342	342	2003/12/20	2003/11/24
LVR/2004A/220 R	2004/11/26		M	280	392	337	2003/12/25	2003/11/29
LVR/2004A/221 R	2004/11/26		M	288	344	342	2003/12/20	2003/11/24
LVR/2004A/222 R	2004/11/26		M	276	336	348	2003/12/14	2003/11/18
LVR/2004A/223 R	2004/11/26		M	240	270	339	2003/12/23	2003/11/27
LVR/2004A/224 R	2004/11/26		M	285	368	354	2003/12/08	2003/11/12
LVR/2004A/225 R	2004/11/26		M	310	292	359	2003/12/03	2003/11/07

LVR/2004A/226 R	2004/11/26		M	290	326	383	2003/11/09	2003/10/14
LVR/2004A/227 R	2004/11/26		M	370	532	365	2003/11/27	2003/11/01
LVR/2004A/228 R	2004/11/26		M	292	280	365	2003/11/27	2003/11/01
LVR/2004A/229 R	2004/11/26		M	270	328	339	2003/12/23	2003/11/27
LVR/2004A/231 R	2004/11/26		M	318	378	321	2004/01/10	2003/12/15
LVR/2004A/232 R	2004/11/26		M	242	252	325	2004/01/06	2003/12/11
LVR/2004A/234 R	2004/11/26		M	225	222	306	2004/01/25	2003/12/30
LVR/2004A/235 R	2004/11/27		M	200		290	2004/02/11	2004/01/16
LVR/2004A/236 R	2004/11/27		M	323	312	338	2003/12/25	2003/11/29
LVR/2004A/237 R	2004/11/27		M	268	332	347	2003/12/16	2003/11/20
LVR/2004A/238 R	2004/11/27		M	282	360	326	2004/01/06	2003/12/11
LVR/2004A/239 R	2004/11/27		M	266	306	334	2003/12/29	2003/12/03
LVR/2004A/240 R	2004/11/27		M	273	330	318	2004/01/14	2003/12/19
LVR/2004A/241 R	2004/11/27		M	238	236	333	2003/12/30	2003/12/04
LVR/2004A/243 R	2004/11/27		M	310	446	306	2004/01/26	2003/12/31
LVR/2004A/244 R	2004/11/27		M	255	318	336	2003/12/27	2003/12/01
LVR/2004A/245 R	2004/11/27		M	306	408	338	2003/12/25	2003/11/29
LVR/2004A/246 R	2004/11/27		M	285	350	332	2003/12/31	2003/12/05
LVR/2004A/247 R	2004/11/27		M	324	500	369	2003/11/24	2003/10/29
LVR/2004A/248 R	2004/11/27		M	292	354	328	2004/01/04	2003/12/09
LVR/2004A/249 R	2004/11/27		M	280	326	366	2003/11/27	2003/11/01
LVR/2004A/250 R	2004/11/27		M	215	140	331	2004/01/01	2003/12/06
LVR/2004A/251 R	2004/11/27		M	211	100	345	2003/12/18	2003/11/22
LVR/2004A/252 R	2004/11/27		M	196	158	334	2003/12/29	2003/12/03
LVR/2004A/253 R	2004/11/27		M	155	96	272	2004/02/29	2004/02/03
LVR/2004A/254 R	2004/11/27		M	165	86	311	2004/01/21	2003/12/26
LVR/2004A/255 R	2004/11/27		M	182	104	357	2003/12/06	2003/11/10

LVR/2004A/271 R	2004/11/27		M	349	524	344	2003/12/19	2003/11/23
LVR/2004A/272 R	2004/11/27		M	285	360	373	2003/11/20	2003/10/25
LVR/2004A/273 R	2004/11/27		M	279	274	351	2003/12/12	2003/11/16
LVR/2004A/275 R	2004/11/27		M	200	192	341	2003/12/22	2003/11/26
LVR/2004A/276 R	2004/11/27		M	232	234	377	2003/11/16	2003/10/21
LVR/2004A/277 R	2004/11/27		M	232	244	357	2003/12/06	2003/11/10
LVR/2004A/278 R	2004/11/27		M	235	250	381	2003/11/12	2003/10/17
LVR/2004A/280 R	2004/11/27		M	193	152	347	2003/12/16	2003/11/20
LVR/2004A/291 R	2004/11/28		M	280	350	254	2004/03/19	2004/02/22
LVR/2004A/292 R	2004/11/28		M	244	252	357	2003/12/07	2003/11/11
LVR/2004A/294 R	2004/11/28		M	230	170	309	2004/01/24	2003/12/29
LVR/2004A/296 R	2004/11/28		M	252	280	335	2003/12/29	2003/12/03
LVR/2004A/297 R	2004/11/28		M	310	410	381	2003/11/13	2003/10/18
LVR/2004A/298 R	2004/11/28		M	252	262	360	2003/12/04	2003/11/08
LVR/2004A/299 R	2004/11/28		M	330	450	285	2004/02/17	2004/01/22
LVR/2004A/311 R	2004/11/28		M	288	394	322	2004/01/11	2003/12/16
LVR/2004A/312 R	2004/11/28		M	300	410	312	2004/01/21	2003/12/26
LVR/2004A/313 R	2004/11/28		M	275	364	371	2003/11/23	2003/10/28
LVR/2004A/314 R	2004/11/28		M	296	424	348	2003/12/16	2003/11/20
LVR/2004A/315 R	2004/11/28		M	278	408	364	2003/11/30	2003/11/04
LVR/2004A/316 R	2004/11/28		M	259	264	356	2003/12/08	2003/11/12
LVR/2004A/317 R	2004/11/28		M	296	390	359	2003/12/05	2003/11/09
LVR/2004A/318 R	2004/11/28		M	296	390	371	2003/11/23	2003/10/28
LVR/2004A/319 R	2004/11/28		M	207	174	325	2004/01/08	2003/12/13
LVR/2004A/320 R	2004/11/28		M	211	172	350	2003/12/14	2003/11/18
LVR/2004A/331 R	2004/11/29		M	283	308	363	2003/12/02	2003/11/06
LVR/2004A/332 R	2004/11/29		M	264	326	303	2004/01/31	2004/01/05

LVR/2004A/333 R	2004/11/29		M	283	368	346	2003/12/19	2003/11/23
LVR/2004A/334 R	2004/11/29		M	297	442	334	2003/12/31	2003/12/05
LVR/2004A/335 R	2004/11/29		M	268	316	331	2004/01/03	2003/12/08
LVR/2004A/337 R	2004/11/29		M	295	248	349	2003/12/16	2003/11/20
LVR/2004A/338 R	2004/11/29		M	233	186	374	2003/11/21	2003/10/26
LVR/2004A/339 R	2004/11/29		M	260	286	365	2003/11/30	2003/11/04
LVR/2004A/340 R	2004/11/29		M	240	256	354	2003/12/11	2003/11/15
LVR/2004A/351 R	2004/11/29		M	132	60	322	2004/01/12	2003/12/17
LVR/2004A/352 R	2004/11/29		M	128	46	286	2004/02/17	2004/01/22
LVR/2004A/353 R	2004/11/29		M	123	52	224	2004/04/19	2004/03/24
LVR/2004A/354 R	2004/11/29		M	124	42	257	2004/03/17	2004/02/20
LVR/2004A/355 R	2004/11/29		M	93	32	177	2004/06/05	2004/05/10
LVR/2004A/381 R	2004/11/30		M	225	154	319	2004/01/16	2003/12/21
LVR/2004A/382 R	2004/11/30		M	285	402	345	2003/12/21	2003/11/25
LVR/2004A/383 R	2004/11/30		M	275	214	345	2003/12/21	2003/11/25
LVR/2004A/384 R	2004/11/30		M	222	218	332	2004/01/03	2003/12/08
LVR/2004A/385 R	2004/11/30		M	246	298	360	2003/12/06	2003/11/10
LVR/2004A/386 R	2004/11/30		M	255	278	373	2003/11/23	2003/10/28
LVR/2004A/387 R	2004/11/30		M	243	276	362	2003/12/04	2003/11/08
LVR/2004A/388 R	2004/11/30		M	262	326	344	2003/12/22	2003/11/26
LVR/2004A/389 R	2004/11/30		M	241	264	350	2003/12/16	2003/11/20
LVR/2004A/390 R	2004/11/30		M	224	210	341	2003/12/25	2003/11/29
LVR/2004A/391 R	2004/11/30		M	197	196	342	2003/12/24	2003/11/28
LVR/2004A/392 R	2004/11/30		M	185	136	340	2003/12/26	2003/11/30
LVR/2004A/393 R	2004/11/30		M	196		342	2003/12/24	2003/11/28
LVR/2004A/394 R	2004/11/30		M	155	84	335	2003/12/31	2003/12/05
LVR/2004A/395 R	2004/11/30		M	115	48	249	2004/03/26	2004/02/29

LVR/2004A/396 R	2004/11/30		M	102	36	207	2004/05/07	2004/04/11
LVR/2004A/406 R	2004/12/01		M	157		335	2004/01/01	2003/12/06
LVR/2004A/407 R	2004/12/01		M	292	426	340	2003/12/27	2003/12/01
LVR/2004A/408 R	2004/12/01		M	303	410	334	2004/01/02	2003/12/07
LVR/2004A/409 R	2004/12/01		M	302	376	364	2003/12/03	2003/11/07
LVR/2004A/410 R	2004/12/01		M	268	348	378	2003/11/19	2003/10/24
LVR/2004A/411 R	2004/12/01		M	287	350	320	2004/01/16	2003/12/21
LVR/2004A/412 R	2004/12/01		M	287	418	396	2003/11/01	2003/10/06
LVR/2004A/413 R	2004/12/01		M	258	304	339	2003/12/28	2003/12/02
LVR/2004A/414 R	2004/12/01		M	262	296	347	2003/12/20	2003/11/24
LVR/2004A/415 R	2004/12/01		M	275	300	396	2003/11/01	2003/10/06
LVR/2004A/416 R	2004/12/01		M	262	244	344	2003/12/23	2003/11/27
LVR/2004A/417 R	2004/12/01		M	228	234	330	2004/01/06	2003/12/11
LVR/2004A/418 R	2004/12/01		M	218	212	354	2003/12/13	2003/11/17
LVR/2004A/419 R	2004/12/01		M	252	280	329	2004/01/07	2003/12/12
LVR/2004A/420 R	2004/12/01		M	163	96	289	2004/02/16	2004/01/21
LVR/2004A/431 R	2004/12/01		M	200	162	316	2004/01/20	2003/12/25
LVR/2004A/432 R	2004/12/01		M	166	124	326	2004/01/10	2003/12/15
LVR/2004A/433 R	2004/12/01		M	160	92	337	2003/12/30	2003/12/04
LVR/2004A/435 R	2004/12/01		M	132	60	297	2004/02/08	2004/01/13
LVR/2004A/437 R	2004/12/01		M	120	48	295	2004/02/10	2004/01/15
LVR/2004A/451 L	2004/12/01		M	110	44	201	2004/05/14	2004/04/18
LVR/2004A/452 R	2004/12/01		M	114	42	177	2004/06/07	2004/05/12
LVR/2004A/453 R	2004/12/01		M	96	28	185	2004/05/30	2004/05/04
LVR/2004A/454 R	2004/12/01		M	96	32	181	2004/06/03	2004/05/08
LVR/2004A/455 R	2004/12/01		M	97	32	168	2004/06/16	2004/05/21

Table 12: November 2005 chokka survey data.

		Nov2005 Survey						
Ref#	Catch date	Statolith length	Sex	ML (mm)	Wt(g)	Age (Days)	Hatch date	Egg-Laying date
LQR301	2005/11/15	41	M	354	502	336	2004/12/14	2004/11/18
LQR306	2005/11/15	42	M	257	238	405	2004/10/06	2004/09/10
LQR308	2005/11/15	42	M	224	144	297	2005/01/22	2004/12/27
LQR309	2005/11/15	39	M	209	188	310	2005/01/09	2004/12/14
LQR310	2005/11/15	38	M	174	76	235	2005/03/25	2005/02/27
LQR314	2005/11/15	39	F	200	196	246	2005/03/14	2005/02/16
LQR322	2005/11/15	46	M	380	636	268	2005/02/20	2005/01/25
LQR323	2005/11/15	45	M	340	448	434	2004/09/07	2004/08/12
LQR328	2005/11/15	42	M	233	144	247	2005/03/13	2005/02/15
LQR329	2005/11/15	44	M	220	156	223	2005/04/06	2005/03/11
LQR335	2005/11/15	40	F	193	162	269	2005/02/19	2005/01/24
LQR340	2005/11/15	40	F	171	126	221	2005/04/08	2005/03/13
LQR342	2005/11/16	45	M	320	414	292	2005/01/28	2005/01/02
LQR348	2005/11/16	42	M	286	242	230	2005/03/31	2005/03/05
LQR349	2005/11/16	44	M	283	270	236	2005/03/25	2005/02/27
LQR350	2005/11/16	43	M	255	214	330	2004/12/21	2004/11/25
LQR364	2005/11/17	43	M	305	302	322	2004/12/30	2004/12/04
LQR369	2005/11/17	42	M	277	332	261	2005/03/01	2005/02/03
LQR375	2005/11/17	42	F	198	148	266	2005/02/24	2005/01/29
LQR411	2005/11/18	46	M	340	468	439	2004/09/05	2004/08/10
LQR412	2005/11/18	48	M	342	524	279	2005/02/12	2005/01/17
LQR414	2005/11/18	49	M	353	522	277	2005/02/14	2005/01/19
LQR415	2005/11/18	45	M	323	426	290	2005/02/01	2005/01/06
LQR419	2005/11/18	45	M	304	412	221	2005/04/11	2005/03/16
LQR421	2005/11/18	44	F	213	174	345	2004/12/08	2004/11/12
LQR426	2005/11/20	46	M	335	436	225	2005/04/09	2005/03/14
LQR427	2005/11/20	42	M	300	276	196	2005/05/08	2005/04/12
LQR431	2005/11/21	44	F	211	200	321	2005/01/04	2004/12/09
LQR432	2005/11/21	42	F	203	178	384	2004/11/02	2004/10/07
LQR435	2005/11/21	37	F	162	102	277	2005/02/17	2005/01/22
LQR437	2005/11/23	43	M	291	240	348	2004/12/10	2004/11/14
LQR438	2005/11/23	42	M	282	270	238	2005/03/30	2005/03/04
LQR442	2005/11/23	42	M	270	272	179	2005/05/28	2005/05/02
LQR444	2005/11/23	40	M	193	132	226	2005/04/11	2005/03/16

LQR446	2005/11/23	38	F	198	186	206	2005/05/01	2005/04/05
LQR448	2005/11/23	42	F	180	148	170	2005/06/06	2005/05/11
LQR449	2005/11/23	41	F	197	176	261	2005/03/07	2005/02/09
LQR450	2005/11/23	42	F	196	180	314	2005/01/13	2004/12/18
LQR452	2005/11/23	42	F	173	102	285	2005/02/11	2005/01/16
LQR453	2005/11/23	41	F	190	166	366	2004/11/22	2004/10/27
LQR456	2005/11/23	39	M	140	68	267	2005/03/01	2005/02/03
LQR458	2005/11/23	38	M	128	56	270	2005/02/26	2005/01/31
LQR459	2005/11/23	37	M	128	56	279	2005/02/17	2005/01/22
LQR460	2005/11/23	35	M	122	52	246	2005/03/22	2005/02/24
LQR461	2005/11/23	33	M	120	48	207	2005/04/30	2005/04/04
LQR462	2005/11/23	33	M	108	38	223	2005/04/14	2005/03/19
LQR465	2005/11/23	41	F	188	182	177	2005/05/30	2005/05/04
LQR473	2005/11/23	42	F	122	56	199	2005/05/08	2005/04/12
LQR474	2005/11/23	34	F	104	42	191	2005/05/16	2005/04/20
LQR475	2005/11/23	34	F	106	44	224	2005/04/13	2005/03/18
LQR476	2005/11/23	46	M	296	364	252	2005/03/16	2005/02/18
LQR479	2005/11/23	44	M	150	82	269	2005/02/27	2005/02/01
LQR480	2005/11/23	40	M	125	56	236	2005/04/01	2005/03/06
LQR481	2005/11/23	37	M	109	42	177	2005/05/30	2005/05/04
LQR482	2005/11/23	41	F	187	152	252	2005/03/16	2005/02/18
LQR483	2005/11/23	44	F	182	152	230	2005/04/07	2005/03/12
LQR484	2005/11/23	43	F	190	138	343	2004/12/15	2004/11/19
LQR485	2005/11/23	41	F	185	164	236	2005/04/01	2005/03/06
LQR486	2005/11/23	40	F	176	146	200	2005/05/07	2005/04/11
LQR487	2005/11/23	41	F	180	132	343	2004/12/15	2004/11/19
LQR490	2005/11/23	38	F	120	52	377	2004/11/11	2004/10/16
LQR491	2005/11/23	32	F	98	34	260	2005/03/08	2005/02/10
LQR493	2005/11/25	44	M	310	354	347	2004/12/13	2004/11/17
LQR495	2005/11/25	40		266	270	356	2004/12/04	2004/11/08
LQR497	2005/11/25	41		185	172	232	2005/04/07	2005/03/12
LQR498	2005/11/25	39	F	177	118	233	2005/04/06	2005/03/11
LQR499	2005/11/25	43	M	310	346	252	2005/03/18	2005/02/20
LQR500	2005/11/25	43	M	303	336	355	2004/12/05	2004/11/09
LQR501	2005/11/25	44	M	295	316	312	2005/01/17	2004/12/22
LQR502	2005/11/25	43	M	277	264	331	2004/12/29	2004/12/03
LQR503	2005/11/25	41	M	278	292	352	2004/12/08	2004/11/12
LQR505	2005/11/25	40	M	238	190	257	2005/03/13	2005/02/15
LQR506	2005/11/25	41	M	230	180	358	2004/12/02	2004/11/06

LQR507	2005/11/25	42	M	180	102	340	2004/12/20	2004/11/24
LQR508	2005/11/25	43	M	178	100	425	2004/09/26	2004/08/31
LQR512	2005/11/25	46	F	201	188	289	2005/02/09	2005/01/14
LQR514	2005/11/25	43	F	220	220	457	2004/08/25	2004/07/30
LQR516	2005/11/25	38	F	174	138	285	2005/02/13	2005/01/18
LQR517	2005/11/25	43	F	190	146	323	2005/01/06	2004/12/11
LQR520	2005/11/25	39	F	187	144	311	2005/01/18	2004/12/23
LQR524	2005/11/28	39	M	135	58	304	2005/01/28	2005/01/02
LQR525	2005/11/28	34	M	124	56	318	2005/01/14	2004/12/19
LQR526	2005/11/28	38	M	122	52	316	2005/01/16	2004/12/21
LQR528	2005/11/28	33	M	110	42	230	2005/04/12	2005/03/17
LQR529	2005/11/28	30	M	98	34	283	2005/02/18	2005/01/23
LQR539	2005/11/28	33	F	110	40	264	2005/03/09	2005/02/11
LQR540	2005/11/28	34	F	101	36	215	2005/04/27	2005/04/01
LQR542	2005/11/29	39	M	185	112	335	2004/12/29	2004/12/03
LQR543	2005/11/29	42	F	192	162	340	2004/12/24	2004/11/28
LQR544	2005/11/29	43	F	202	184	314	2005/01/19	2004/12/24
LQR547	2005/11/29	40	F	183	150	274	2005/02/28	2005/02/02

Table 13: April 2005 chokka survey data.

		Apr2005 Survey						
Ref#	Catch Date	Statolith length	Sex	ML (mm)	Wt(g)	Age (Days)	Hatch date	Egg-laying date
LQR001	2005/04/07	37	F	185	156	254	2004/07/27	2004/06/29
LQR003	2005/04/07	37	F	167	128	279	2004/07/02	2004/06/04
LQR011	2005/04/07	38	M	190	150	197	2004/09/22	2004/08/25
LQR014	2005/04/07	39	M	135	72	231	2004/08/19	2004/07/22
LQR017	2005/04/07	40	M	140	90	172	2004/10/17	2004/09/19
LQR021	2005/04/07	41	F	160	122	162	2004/10/27	2004/09/29
LQR024	2005/04/07	44	F	190	204	254	2004/07/27	2004/06/29
LQR025	2005/04/07	40	F	147	100	191	2004/09/28	2004/08/31
LQR026	2005/04/07	41	F	161	120	243	2004/08/07	2004/07/10
LQR032	2005/04/09	40	F	135	76	210	2004/09/11	2004/08/14
LQR039	2005/04/09	41	M	150	90	263	2004/07/20	2004/06/22
LQR042	2005/04/09	41	F	143	90	222	2004/08/30	2004/08/02
LQR043	2005/04/09	41	F	154	104	239	2004/08/13	2004/07/16
LQR044	2005/04/09	43	F	146	82	222	2004/08/30	2004/08/02
LQR045	2005/04/09	42	F	146	96	336	2004/05/08	2004/04/10
LQR046	2005/04/09	48	M	234	276	315	2004/05/29	2004/05/01
LQR047	2005/04/09	44	M	186	174	257	2004/07/26	2004/06/28
LQR050	2005/04/09	50	M	261	384	308	2004/06/05	2004/05/08
LQR051	2005/04/09	40	F	137	78	294	2004/06/19	2004/05/22
LQR052	2005/04/09	38	F	141	96	239	2004/08/13	2004/07/16
LQR053	2005/04/09	42	F	135	70	264	2004/07/19	2004/06/21
LQR054	2005/04/09	39	F	146	96	256	2004/07/27	2004/06/29
LQR067	2005/04/10	51	M	225	260	287	2004/06/27	2004/05/30
LQR069	2005/04/10	39	M	200	184	285	2004/06/29	2004/06/01
LQR070	2005/04/10	38	M	150	90	254	2004/07/30	2004/07/02
LQR072	2005/04/10	40	F	182	174	277	2004/07/07	2004/06/09
LQR073	2005/04/10	38	F	160	138	258	2004/07/26	2004/06/28
LQR076	2005/04/10	45	M	280	374	260	2004/07/24	2004/06/26
LQR080	2005/04/10	39	M	170	136	212	2004/09/10	2004/08/13
LQR081	2005/04/11	45	F	210	186	263	2004/07/22	2004/06/24
LQR082	2005/04/11	42	F	190	184	283	2004/07/02	2004/06/04
LQR087	2005/04/11	45	M	236	252	392	2004/03/15	2004/02/16
LQR151	2005/04/13	40	F	170	128	284	2004/07/03	2004/06/05
LQR153	2005/04/13	35	F	148	102	280	2004/07/07	2004/06/09
LQR156	2005/04/13	38	M	185	182	314	2004/06/03	2004/05/06
LQR161	2005/04/14	40	F	170	138	276	2004/07/12	2004/06/14
LQR165	2005/04/14	41	F	205	193	311	2004/06/07	2004/05/10
LQR166	2005/04/14	42	M	242	296	348	2004/05/01	2004/04/03
LQR167	2005/04/14	37	M	165	122	202	2004/09/24	2004/08/27
LQR168	2005/04/14	40	M	162	130	316	2004/06/02	2004/05/05
LQR169	2005/04/14	41	M	200	182	236	2004/08/21	2004/07/24
LQR170	2005/04/14	38	M	195	194	225	2004/09/01	2004/08/04

LQR171	2005/04/14	44	F	200	206	350	2004/04/29	2004/04/01
LQR172	2005/04/14	41	F	190	180	224	2004/09/02	2004/08/05
LQR176	2005/04/14	38	M	190	170	184	2004/10/12	2004/09/14
LQR178	2005/04/14	43	M	262	292	376	2004/04/03	2004/03/06
LQR185	2005/04/14	38	F	134	70	275	2004/07/13	2004/06/15
LQR187	2005/04/14	33	M	100	34	203	2004/09/23	2004/08/26
LQR188	2005/04/14	35	M	105	34	271	2004/07/17	2004/06/19
LQR189	2005/04/14	35	M	105	38	200	2004/09/26	2004/08/29
LQR190	2005/04/14	36	M	110	44	236	2004/08/21	2004/07/24
LQR192	2005/04/15	38	F	150	96	228	2004/08/30	2004/08/02
LQR195	2005/04/15	40	F	160	154	319	2004/05/31	2004/05/03
LQR196	2005/04/15	44	M	187	134	417	2004/02/23	2004/01/26
LQR197	2005/04/15	39	M	167	124	283	2004/07/06	2004/06/08
LQR198	2005/04/15	41	M	186	158	317	2004/06/02	2004/05/05
LQR199	2005/04/15	40	M	213	202	260	2004/07/29	2004/07/01
LQR200	2005/04/15	39	M	192	196	241	2004/08/17	2004/07/20
LQR201	2005/04/15	40	F	185	172	324	2004/05/26	2004/04/28
LQR203	2005/04/15	42	F	212	272	214	2004/09/13	2004/08/16
LQR209	2005/04/15	37	M	177	144	259	2004/07/30	2004/07/02
LQR210	2005/04/15	40	M	170	126	354	2004/04/26	2004/03/29
LQR212	2005/04/15	42	F	195	218	268	2004/07/21	2004/06/23
LQR213	2005/04/15	37	F	160	130	204	2004/09/23	2004/08/26
LQR215	2005/04/15	42	F	202	228	241	2004/08/17	2004/07/20
LQR217	2005/04/15	43	M	250	314	250	2004/08/08	2004/07/11
LQR219	2005/04/15	50	M	348	734	371	2004/04/09	2004/03/12
LQR221	2005/04/17	38	F	160	116	256	2004/08/04	2004/07/07
LQR224	2005/04/17	36	F	156	126	210	2004/09/19	2004/08/22
LQR226	2005/04/17	41	M	240	274	254	2004/08/06	2004/07/09
LQR229	2005/04/17	40	M	250	304	175	2004/10/24	2004/09/26
LQR230	2005/04/17	41	M	214	234	321	2004/05/31	2004/05/03
LQR231	2005/04/17	39	F	140	80	291	2004/06/30	2004/06/02
LQR232	2005/04/17	38	F	147	86	268	2004/07/23	2004/06/25
LQR233	2005/04/17	39	F	152	98	201	2004/09/28	2004/08/31
LQR234	2005/04/17	36	F	145	102	154	2004/11/14	2004/10/17
LQR235	2005/04/17	38	F	155	90	219	2004/09/10	2004/08/13
LQR236	2005/04/17	40	M	202	182	287	2004/07/04	2004/06/06
LQR239	2005/04/17	38	M	170	124	221	2004/09/08	2004/08/11
LQR240	2005/04/17	41	M	220	226	273	2004/07/18	2004/06/20
LQR248	2005/04/17	37	M	143	88	196	2004/10/03	2004/09/05
LQR249	2005/04/17	46	M	280	332	246	2004/08/14	2004/07/17
LQR252	2005/04/17	40	F	190	184	125	2004/12/13	2004/11/15
LQR255	2005/04/17	39	F	180	162	242	2004/08/18	2004/07/21
LQR256	2005/04/17	42	M	215	256	248	2004/08/12	2004/07/15
LQR257	2005/04/17	37	M	120	54	237	2004/08/23	2004/07/26
LQR258	2005/04/17	47	M	320	518	193	2004/10/06	2004/09/08
LQR260	2005/04/17	42	M	225	238	260	2004/07/31	2004/07/03
LQR261	2005/04/18	43	F	205	214	282	2004/07/10	2004/06/12
LQR262	2005/04/18	39	F	190	166	298	2004/06/24	2004/05/27

LQR263	2005/04/18	39	F	180	178	250	2004/08/11	2004/07/14
LQR264	2005/04/18	38	F	155	128	222	2004/09/08	2004/08/11