

**Aspects of the biology of elasmobranchs in a subtropical embayment in
Western Australia and of chondrichthyan fisheries in Indonesia**

**This thesis is presented for the degree of
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DECLARATION

**I declare that the information contained in this
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Abstract

The first aim of this thesis was to test the hypothesis that the spatial and food resources in the nearshore waters of a subtropical embayment in Western Australia (Shark Bay) will be partitioned within and amongst the main elasmobranch species that occur in that large water body. The size and age compositions, growth rates and reproductive biology of females and males of the nervous shark *Carcharhinus cautus* in Shark Bay were then determined to better understand the mode of life of this abundant species in this embayment. The second aim was to determine the species and size compositions of chondrichthyans landed by fisheries employing different methods in south-eastern Indonesia. The implications of these data for management were next determined and aspects of the reproductive biology of the most abundant of those species were explored, in a very preliminary manner.

The nearshore, shallow waters of Shark Bay are used as a nursery area by several shark species and the different habitats in those waters are partitioned, to a certain degree, amongst those species. Ten species of shark (5 families), five species of ray (4 families) and twelve species of teleost (10 families) were caught in those waters. *Carcharhinus cautus* was the most abundant species, contributing 59.9% to the total number of elasmobranchs and 42.3% to all fish caught. This species and *Negaprion acutidens* were collected mainly or entirely from unvegetated sites, whereas *Rhizoprionodon acutus*, *Carcharhinus brevipinna* and *Chiloscyllium punctatum* were caught largely or exclusively at the seagrass site. The number of elasmobranch species and number of individuals of elasmobranchs were greatest in the seagrass site and least in the unvegetated site where no vegetation was present nearby, and they were significantly less in the latter site than in the one where dense mangroves were present nearby. These two biotic variables were also

significantly greater in summer and autumn than in winter when temperatures were lowest. The species composition of elasmobranchs in each habitat type almost invariably differed significantly from that in each of the other habitat types and there was evidence that the species composition of elasmobranchs varied in a similar seasonal manner at the three unvegetated sites. *Carcharhinus cautus*, and probably also *Hemigaleus microstoma* and *Chiloscyllium punctatum*, were the only species that completed their life cycles in the nearshore, shallow waters of Herald Bight. However, the capture of the juveniles of a further four species with umbilical scars emphasises the importance of these waters as a nursery habitat for shark species.

The dietary compositions of one ray species (*Rhinobatus typus*) and three shark species (*Carcharhinus cautus*, *Negaprion acutidens*, *Rhizoprionodon acutus*) undergo size-related changes and differ among these species, thereby reducing the potential for competition for food within and among these four species. *Rhinobatus typus* fed almost exclusively on penaeid prawns and portunid crabs, which is reflected in its narrow dietary breadth, whereas different species of teleosts constituted a major component of the diets of each size class of the three shark species. The relative contributions of the different species of teleost to the diets of the three shark species varied. The variations in dietary composition among the four species reflect differences in behaviour, modes of feeding and relative mouth sizes.

Carcharhinus cautus copulates in late October–early November, shortly followed by ovulation (and thus conception) and parturition occurs about 11 months later. The reproductive cycle of *C. cautus* is biennial. Female and male *C. cautus* reached *ca* 28 and 32% of their lengths at their maximum observed ages, respectively, at the time of parturition. Females and males of *C. cautus* attained maximum total lengths of 1330 and 1110 mm, respectively, and maximum ages after parturition of 16 and 12 years,

respectively. Maturity was attained at about 1010 mm by females and 910 mm by males and at least 50% of females and males had become mature by the end of their sixth and fourth years of life, respectively. The three-parameter von Bertalanffy growth curves provided reasonably good fits to the lengths at age of females and males of *C. cautus* during just postnatal life and throughout the whole of pre- and postnatal life. However, the four-parameter Schnute growth curve significantly improved the fit to these data for both females and males from conception and for females from birth. The question of when, from a biological view point, it might be appropriate to switch from using a von Bertalanffy growth curve to the more complex Schnute growth curve are discussed.

A total of 139 chondrichthyan species, comprising 77 species of shark representing 17 families, 61 species of ray representing 11 families and a single species of holocephalan, were recorded at the ten landing sites surveyed in south-eastern Indonesia. However, it should be recognised that up to 49 of the 139 chondrichthyan species recorded have apparently not yet been described and thus assigned a species name. The most speciose and commonly recorded families were the Dasyatidae and Carcharhinidae, which collectively contributed 84.8%, respectively, to the total number of individuals of all species. The use of MDS ordination demonstrated that the species compositions at the eight main landing sites reflected to a greater extent the fishing methods used rather than the geographical location of those sites. Data on the reproductive biology of males demonstrated that a number of elasmobranch species were fished prior to the time that they attained maturity.

The three most abundant chondrichthyan species that were caught both as juveniles and adults were *Dasyatis kuhlii*, *Dasyatis zugei* and *Himantura walga*. Since the reproductive cycle of each of these species did not follow a seasonal pattern, the timing of conception and parturition and the duration of gestation of these species could not be determined. The fecundity of these three species was very low, *i.e.* maximum of two but

usually only a single embryo. The size at maturity of the three species, using data on the prevalence of mature fish, ranged from minima of 163 mm for females and males of *H. walga* to maxima of 237 mm for females and 239 mm for males of *D. kuhlii*. The translucent zones on the vertebral centra of *D. kuhlii* were apparently deposited annually and were thus used to estimate the ages of the individuals of this species. The maximum estimated ages of female and male *D. kuhlii* were 15 and 10 years, respectively.

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Publications

The publications listed below form the basis for chapters 5 and 4, respectively.

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