

An updated check list of the ichthyofaunal species assemblage of the Tsitsikamma National Park, South Africa

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This work summarises ichthyological research in the Tsitsikamma National Park (TNP) over the past 20 years, and an updated species check list of fishes has been compiled. A total of 202 species of fishes from 84 families has been recorded within the boundaries of the national park. All species which have been included were identified from visual transects, rotenone collections, estuarine surveys, ichthyoplankton surveys, mark/recapture studies and personal observations. The ichthyofauna is a diverse assemblage of chondrichthyans and teleosts, 75 (37.1%) of which are components of commercial and recreational fisheries along the east coast. Surveys also indicate that the TNP provides refuge to all life history stages for 17 of the commercial and recreational teleost species. The need for more detailed collections of previously neglected teleost and chondrichthyan groups is recognised. The number of species and diversity demonstrates that the TNP appears not only to afford protection to exploited fish species, but also fulfills one of the basic requirements of Marine Protected Areas—that of conserving biodiversity (of fishes).

Key words: Tsitsikamma ichthyofaunal species assemblage; teleosts; chondrichthyans; Marine Protected Areas; biodiversity.

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Introduction

The Tsitsikamma National Park (TNP), proclaimed on 4 December 1964, extends from Oubosstrand (34°03' S, 24°11'E) in the east to Grootbank (34°00'S, 23°30'E) in the west (Fig. 1). Apart from the three kilometer open fishing area at Storms River, the TNP is a no-take Marine Protected Area (MPA), and incorporates approximately 75 km of extremely rugged and relatively inaccessible rocky coastline. The seaward boundary of the park extends from as little as 800 meters from the spring low water mark at its western-most end to as much as 3 nautical miles.

The east and west coasts of southern Africa are characterised by different physical, chemical and biological features, mainly as a result of the difference in the two major boundary current systems, *viz.* the warm Agulhas Current which flows down the east coast and the cold Benguela Current which flows up the west coast as far as southern Angola (Shannon 1989). The waters of the eastern seaboard of South Africa are predominantly influenced by tropical Indian Ocean waters in the form of the fast-flowing Agulhas Current. Further south, the influence of cooler waters which are part of the equatorward drift of southeast Atlantic waters becomes stronger. Based primarily on the



Fig. 1. The Tsitsikamma National Park situated along the southeast coast of South Africa. The seaward boundary of the TNP is displayed. The dark and unshaded regions indicate reef and sand areas respectively.

temperature regime of the sea and using distributional patterns of representatives from sandy beach communities, macroalgae, amphipods, hydrozoans and fish, the coast of southern Africa can be divided into three biogeographical provinces (Brown & Jarman 1978; McLachlan *et al.* 1981; Hockey & Buxton 1989; Bolton & Anderson 1990). These are a cool west coast temperate province, a warm south coast temperate province, and a warm east coast sub-tropical province, and they display transitional zones between them rather than distinct boundaries. The overlap between east and south coast (Port St. Johns to Woody Cape), and south and west coast provinces (Cape Agulhas to Cape Peninsula), means that the TNP lies centrally within the bounds of the warm south coast temperate faunal province. A more recent approach (Emanuel *et al.* 1992) of dividing the coast into zoogeographic provinces using distributional records of 2000 invertebrate species also places the study area comfortably within this coastal province.

The main objectives of the TNP are to conserve a representative section of the southern Cape coastline with its associated terrestrial and marine flora and fauna, and to provide an educational and recreational service for tourists while at the same time acting as a site for further research into both land and sea based ecosystems (Robinson & De Graaff

1994). In addition, and perhaps most importantly, the marine environment provides a refuge for exploited invertebrate and fish species. Over the last 20 years, ichthyological research in the TNP has largely been directed at juveniles and adults of the reef fish species such as *Chrysoblephus cristiceps*, *C. laticeps*, *Petrus rupestris*, *Diplodus sargus capensis*, *D. cervinus hottentotus*, *Pachymetopon grande*, *Sparodon durbanensis*, *Cheimerius nufar*, *Polysteganus undulosus*, *P. praeorbitalis* and *Epinephelus marginatus*, which are important components of the recreational and commercial linefisheries. These studies concentrated on aspects of fish biology (Penrith 1972; Robinson 1976; Smale 1986, 1988, 1990; Buxton 1990; Buxton & Clarke 1991, 1992; Lang & Buxton 1993; Mann & Buxton 1992, 1997, 1998; Mann-Lang & Buxton 1996), life history styles (Buxton & Garratt 1990; Buxton 1993a) and management (Crawford & Crous 1982; Buxton & Smale 1989; Smale & Punt 1991; Buxton 1992, 1993b). In the last nine years, ichthyoplankton work has become a regular part of the TNP research program, with studies concentrating on species composition, distribution and dispersal patterns (Tilney & Buxton 1994; Tilney *et al.* 1996; Wood 1998). The potential of *C. laticeps* and *Argyrozona argyrozona* as candidate aquaculture species led to the description of their egg and larval stages (Davis 1996; Davis & Buxton 1996) based on artificially fertilized eggs from captured adult specimens in this national park.

In previous studies on the distribution patterns of the littoral ichthyofauna of the TNP, Buxton & Smale (1984) recorded 65 species from 29 families, while Burger (1990) identified 116 species from 46 families. The latter study omitted several species recorded by Buxton & Smale (1984) namely the humpback toadfish *Chatrabus melanurus*, bigeye clingfish *Diplecogaster megalops* and African gurnard *Trigloporus lastoviza africanus*. Hanekom *et al.* (1997) presented a list based on shore angling catches in the 1 km area open to shore angling within the TNP with the only new addition being *Raja clavata*. This paper draws on the species lists

compiled in these previous studies and adds many new species which have been identified from more recent research activities.

Methods and Materials

An updated check list which includes all stages of the life history found in the TNP has been produced by combining the surveys of Buxton & Smale (1984), Burger (1990), Tilney & Buxton (1994), Hanekom *et al.* (1997) and Wood (1998). The list incorporates data from recent estuarine surveys, the ongoing offshore & shore-tagging programs and *ad hoc* diving collections or observations. Fish species whose distribution includes the southeast coast in general (Smith & Smith 1966, Smith & Heemstra 1986) are not included unless they have been specifically observed or sampled within the park. Buxton & Smale (1984) and Burger (1990) made use of visual census techniques, rotenone collections and fishing to compile their species lists. Fish larvae were sampled on a regular basis from 1990 using standard 57 cm diameter bongo nets and rectangular midwater trawls (RMT) fitted with 333 μ or 505 μ mesh sizes, and light traps (Tilney & Buxton 1994; Tilney *et al.* 1996; Wood 1998). As part of the National State of the Environment Programme, several of the larger estuaries within the park (Groot – west, Bloukrans, Lottering, Elandsbos, Storms, Elands, Groot – east, and the Salt River) were sampled using gill and seine nets in November 1994 and September 1995 respectively. Seine netting was performed during daylight hours using a 30 m x 1.7 m net with 15 mm bar mesh, while gill netting was performed at night using 10 m x 1.7 m or 20 m x 1.7 m fleets of nets comprised of 45 mm, 75 mm and 100 mm stretch mesh monofilament panels (T. Harrison *unpubl. data*). The boat-based tagging programme which was initiated in 1985 is conducted from a 6-m semi-rigid inflatable or a 7-m ski-boat. Handlines fitted with nylon of 50 kg or 100 kg breaking strain and hooks ranging in size from 1/0 to 8/0 are used. Chokka squid (*Loligo vulgaris reynaudii*), octopus (*Octopus vulgaris*), pilchard (*Sardinops sagax*) and other bait-fish (*Boopsoidea inornata*, *Spondyliosoma emarginatum* and *Pachymetopon aneum*) are the most common baits used. The depths sampled ranged between 10 m and 65 metres. The shore-based rock and surf tagging programme consisted of monthly trips from 1991 to 1997 and bimonthly trips from 1998 to the present. The area fished was between the Lottering and Klip rivers, in the western half of the park. Fiberglass or graphite rods of 3.5–4.5 m, multiplying reels with 10–20 kg line, two to five 56–140 g sinkers, and hooks ranging in size

Table 1

Species of fish recorded in the Tsitsikamma National Park, either as adults (A), juveniles (J) or larvae (L). Source references are as follows, 1 - Buxton and Smale (1984), 2 - Burger (1990), 3 - Tilney and Buxton (1994), 4 - Hanekom et al. (1997), 5 - Wood (1998), 6 and 7 - fish caught during offshore and rock and surf based tagging projects in the TNP respectively, 8 - fish sampled during the National State of the Environment Program estuarine survey, 9 - Diving or Personal Observations. * denotes a species endemic to southern Africa according to Smith and Heemstra (1986), SSF# - Smith's Sea Fishes reference number; # - see footnote

Order & Family	Species	SSF#	Common name	Life history Stages	Source Reference	
Order Myxiniiformes						
Myxiniidae	<i>Eptatretus hexatrema</i>	1.1	Sixgill hagfish	#	9	
Order Hexanchiformes						
Hexanchidae	<i>Notorynchus cepedianus</i>	2.4	Broadnose sevengill shark	#	6, 9	
Order Squaliformes						
Squalidae	<i>Squalus megalops</i>	5.26	Bluntnose spiny dogfish	J, A	6	
Order Orectolobiformes						
Rhincodontidae	<i>Rhincodon typus</i>	8.1	Whale shark	#	9	
Order Carcharhiniformes						
Carcharhinidae	<i>Carcharhinus brachyurus</i>	9.5	Copper shark	#	2, 6, 7, 9	
	<i>Carcharhinus brevipinna</i>	9.6	Spinner shark	#	6	
	<i>Carcharhinus obscurus</i>	9.14	Dusky shark	#	6	
	<i>Galeorhinus galeus</i>	9.20	Southern shark	J, A	2, 6, 7	
	<i>Mustelus mustelus</i>	9.27	Smooth-hound	A	2, 6, 7	
	<i>Mustelus palumbes</i> *	9.28	Whitespotted smooth-hound	J, A	6	
	<i>Prionace glauca</i>	9.32	Blue shark	A	6, 9	
	<i>Triakus megalopterus</i> *	9.36	Spotted gullyshark	J, A	2, 6, 7	
	Scyliorhinidae	<i>Halaelurus natalensis</i> *	11.7	Tiger catshark	#	6
		<i>Haploblepharus edwardsii</i> *	11.8	Puffadder shyshark	J, A	2, 6, 7
		<i>Haploblepharus obscurus</i> *	11.9	Brown shyshark	J, A	2, 6, 7
		<i>Haploblepharus pictus</i> *	11.10	Dark shyshark	#	2
		<i>Poroderma africanum</i> *	11.13	Striped catshark	J, A	1, 2, 6, 7
		<i>Poroderma pantherinum</i> *	11.15	Leopard catshark	J, A	1, 2, 6, 7
	Sphyrnidae	<i>Scyliorhinus capensis</i> *	11.16	Yellowspotted catshark	J, A	6, 7
		<i>Sphyrna zygaena</i>	13.3	Smooth hammerhead	#	2, 6
Order Lamniformes						
Lamnidae	<i>Carcharodon carcharias</i>	14.1	Great white shark	#	2	
	<i>Isurus oxyrinchus</i>	14.2	Shortfin mako	#	9	
Odontaspidae	<i>Eugomphodus taurus</i>	19.1	Spotted ragged-tooth	J, A	1, 2, 6	
Order Pristiformes						
Pristidae	<i>Pristis pectinata</i>	22.2	Largetooth sawfish	#	9	
Order Torpediniformes						
Torpedinidae	<i>Torpedo fuscomaculata</i>	23.1	Blackspotted electric ray	#	2	
Order Rajiformes						
Rajidae	<i>Raja clavata</i>	25.8	Thornback skate	#	4	
Rhinobatidae	<i>Rhinobatos annulatus</i> *	27.2	Lesser guitarfish	J, A	2, 7	
Order Myliobatiformes						
Myliobatidae	<i>Myliobatis aquila</i>	28.2	Eagleray	#	2, 7	
	<i>Pteromylaeus bovinus</i>	28.3	Bullray	#	9	
Mobulidae	<i>Mobula diabolus</i>	29.2	Devilray	#	9	
Dasyatidae	<i>Dasyatis marmoratus capensis</i>	30.3	Blue stingray	A	9	
	<i>Gymnura natalensis</i> *	30.7	Backwater butterflyray	#	2	
Order Anguilliformes						
Congridae	<i>Conger wilsoni</i>	40.8	Cape conger	#	1, 2	

Table 1 (continued)

Order & Family	Species	SSF#	Common name	Life history Stages	Source Reference
Order Clupeiformes					
Clupeidae	<i>Etrumeus whiteheadi</i> *	54.2	Redeye roundherring	L	3, 5, 9
	<i>Gilchristella aestuaria</i> *	54.3	Estuarine roundherring	J, A	8
Clupeidae	<i>Sardinops sagax</i>	54.12	South African pilchard	L, J, A	3, 5, 9
Engraulidae	<i>Engraulis japonicus</i>	55.1	Cape anchovy	L, J, A	3, 5, 9
Order Gonorhynchiformes					
Gonorhynchidae	<i>Gonorhynchus gonorhynchus</i>	57.1	Beaked sandfish	L, J	5
Order Siluriformes					
Ariidae	<i>Galeichthys ater</i> *	59.2	Black seacatfish	A	2
	<i>Galeichthys feliceps</i> *	59.3	White seacatfish	A	1, 2
Plotosidae	<i>Plotosus nkunga</i>	60.2	Eel-catfish	#	9
Order Stomiiformes					
Stomiidae	<i>Stomias boa boa</i>	67.2	Scaly dragonfish	L	5
Order Myctophiformes					
Myctophidae	<i>Diogenichthys atlanticus</i>	86.42	Lanternfish	L	5
	<i>Lampanyctodes hectoris</i>	86.72	Onderbaadjie	L	5
	<i>Symbolophorus barnardi</i>	86.119	Lanternfish	L	5
Order Gadiformes					
Gadidae	<i>Gaidropsarus capensis</i> *	88.1	Cape rockling	L, J, A	1, 2, 3, 5
Merlucciidae	<i>Merluccius capensis</i>	89.4	Shallow-water hake	L, A	5, 6
Moridae	<i>Physiculus capensis</i> *	90.7	Deepsea cod	L	5
Bregmacerotidae	<i>Bregmaceros atlanticus</i>	92.1	Codlet	L	5
	<i>Bregmaceros nectabanus</i>	92.3	Codlet	L	5
Order Ophidiiformes					
Ophidiidae	<i>Genypterus capensis</i> *	96.9	Kingklip	L	5
Bythitidae	<i>Bidenichthys capensis</i> *	98.1	Freetail brotula	J, A	1, 2
	<i>Dermatopsoides talboti</i>	98.6	Lesser orange brotula	#	2
	<i>Grammonoides opisthodon</i> *	98.8	Bighead brotula	#	2
Order Batrachoidiformes					
Batrachoididae	<i>Batrachthys apaiatus</i> *	100.3	Snakehead toadfish	#	2
	<i>Chatrabus hendersoni</i> *	100.5	Chocolate toadfish	#	2
	<i>Chatrabus melanurus</i> *	100.6	Humpback toadfish	#	1
Order Lophiiformes					
Lophiidae	<i>Lophius upsicephalus</i> *	101.4	Monk	L	5
Order Gobiesociformes					
Gobiesocidae	<i>Apletodon pelegri</i>	110.1	Chubby clingfish	#	2
	<i>Chorisochismus dentex</i> *	110.2	Rocksucker	J, A	2
	<i>Diplecogaster megalops</i> *	110.3	Bigeye clingfish	#	1
Order Atheriniformes					
Atherinidae	<i>Atherina breviceps</i> *	111.1	Cape silverside	J, A	8
Order Beloniformes					
Belonidae	<i>Petalichthys capensis</i>	113.2	Cape needlefish	A	9
Order Beryciformes					
Berycidae	<i>Centroberyx spinosus</i> *	126.3	Short alfonsino	#	1, 2
Order Zeiformes					
Zeidae	<i>Zeus capensis</i>	138.4	Cape dory	L	5
Order Syngnathiformes					
Syngnathidae	<i>Syngnathus acus</i>	145.29	Longsnout pipefish	L, J	2, 3, 5
Macroramphosidae	<i>Macroramphosus scolopax</i>	147.2	Slender snipefish	L	5

Table 1 (continued)

Order & Family	Species	SSF#	Common name	Life history Stages	Source Reference
Order Scorpaeniformes					
Tetrarogidae	<i>Coccotropsis gymnoderma</i> *	150.2	Smoothskin scorpionfish	L, J, A	1, 2, 3, 5
Congiopodidae	<i>Congiopodus spinifer</i> *	152.1	Spinenose horsefish	L	3, 5
	<i>Congiopodus torvus</i> *	152.2	Smooth horsefish	A	9
Triglidae	<i>Chelidonicichthys capensis</i> *	157.1	Cape gurnard	L, A	3, 5, 6
Triglidae	<i>Chelidonicichthys kumu</i>	157.2	Bluefin gurnard	A	9
	<i>Trigloporus lastoviza africanus</i> *	157.7	African gurnard	#	1
Order Perciformes					
Kuhliidae	<i>Kuhlia mugil</i>	164.1	Barred flagtail	J, A	2
Serranidae	<i>Acanthistius sebastoides</i> *	166.1	Koester	J, A	1, 2, 7
	<i>Epinephelus andersoni</i> *	166.34	Catface rockcod	#	9
	<i>Epinephelus emarginata</i>	166.43	Yellowbelly rockcod	J	1, 2, 6, 7
	<i>Serranus cabrilla</i>	166.76	Comber	L, #	2, 5
Teraponidae	<i>Terapon jarbua</i>	173.2	Thornfish	A	9
Scombroptidae	<i>Scombrops hoops</i> *	176.6	Gnomefish	#	1, 2
Pomatomidae	<i>Pomatomus saltatrix</i>	178.1	Elf	J, A	1, 6, 7, 8
Haemulidae	<i>Pomadasys commersonnii</i> 1	79.10	Spotted grunter	J, A	1, 7, 8
	<i>Pomadasys olivaceum</i>	179.17	Piggy	L, J, A	1, 2, 3, 5, 6, 7
Sparidae	<i>Pomadasys striatum</i> 1	79.18	Striped grunter	J, A	1, 2
	<i>Argyrozona argyrozona</i> *	183.5	Carpenter	L, J, A	1, 2, 5, 6
	<i>Boopsioidea innornata</i> *	183.6	Fransmadam	L, J, A	1, 2, 5, 6, 7
	<i>Cheimerius nufar</i>	183.7	Santer	J, A	2, 7
	<i>Chrysoblephus cristiceps</i> *	183.9	Dageraad	J, A	1, 2, 6
	<i>Chrysoblephus gibbiceps</i> *	183.10	Red stumpnose	J, A	1, 2, 6
	<i>Chrysoblephus laticeps</i> *	183.11	Roman	L, J, A	1, 2, 5, 6, 7
	<i>Chrysoblephus puniceus</i>	183.13	Slinger	J	6
	<i>Cymatoceps nasutus</i> *	183.15	Black musselcracker	J, A	1, 2, 6, 7
	<i>Diplodus cervinus hottentotus</i> *	183.16	Zebra	L, J, A	1, 2, 3, 5, 7
	<i>Diplodus sargus capensis</i>	183.17	Blacktail	L, J, A	1, 2, 3, 5, 7, 8
	<i>Gymnocrotaphus curvidens</i> *	183.18	Janbruin	J, A	1, 2, 7
	<i>Lithognathus lithognathus</i> *	183.20	White steenbras	J, A	1, 2, 7, 8
	<i>Lithognathus mormyrus</i>	183.21	Sand steenbras	J, A	1, 2, 7
	<i>Pachymetopon aneum</i> *	183.22	Blue hottentot	J, A	1, 2, 6, 7
	<i>Pachymetopon blochii</i> *	183.23	Hottentot	A	6
<i>Pachymetopon grande</i>	183.24	Bronze bream	J, A	1, 2, 7	
<i>Pagellus bellottii natalensis</i>	183.25	Red tjor-tjor	L, J, A	1, 3, 5, 6	
<i>Petrus rupestris</i> *	183.26	Red steenbras	J, A	1, 2, 6, 7	
<i>Polysteganus undulosus</i> *	183.32	Seventy-four	J	6, 9	
<i>Porcostoma dentata</i> *	183.33	Dane	#	1	
<i>Pterogymnus lanarius</i> *	183.34	Panga	J, A	1, 6	
<i>Rhabdosargus globiceps</i> *	183.35	White stumpnose	J, A	1, 2, 8	
<i>Rhabdosargus holubi</i> *	183.36	Cape stumpnose	L, J, A	1, 2, 5, 7, 8	
<i>Sarpa salpa</i>	183.39	Strepie	L, J, A	1, 2, 5, 7	
<i>Sparodon durbanensis</i> *	183.40	White musselcracker	J, A	1, 2, 7	
<i>Spondylisoma emarginatum</i> *1	83.41	Steenjtjie	L, J, A	1, 2, 3, 5, 6, 7	
Centracanthidae	<i>Spicara axillaris</i> *	184.2	Windtoy	#	2
Dichistidae	<i>Dichistius capensis</i> *	187.1	Galjoen	J, A	1, 2, 7
	<i>Dichistius multifasciatus</i>	187.2	Banded galjoen	J, A	2, 7

Table 1 (continued)

Order & Family	Species	SSF#	Common name	Life history Stages	Source Reference
Parascorpididae	<i>Parascorpius typus</i> *	188.1	Jutjaw	#	2
Scorpididae	<i>Neoscorpius lithophilus</i> *	190.1	Stonebream	J, A	2, 7
Monodactylidae	<i>Monodactylus falciformis</i>	193.2	Cape moony	L, J, A	1, 2, 3, 5, 8
Mullidae	<i>Parupeneus rubescens</i>	196.10	Blacksaddle goatfish	#	1, 2
Sciaenidae	<i>Argyrosomus innotodorus</i>	199.1a	Silver kob	J, A	1, 6, 8
	<i>Argyrosomus japonicus</i>	199.1b	Dusky kob	J	2, 7
	<i>Atractoscion aequidens</i>	199.3	Geelbek	L, J, A	1, 3, 5, 7
	<i>Umbrina canariensis</i>	199.8	Baardman	#	2
	<i>Umbrina ronchus</i>	199.9	Slender baardman	#	9
Pomacanthidae	<i>Pomacanthus rhomboides</i>	204.12	Old woman	J	9
Chaetodontidae	<i>Chaetodon blackburnii</i>	205.3	Brownburnie	J	9
	<i>Chaetodon marleyi</i> *	205.11	Doublesash butterflyfish	J, A	1, 2
	<i>Heniochus acuminatus</i>	205.22	Coachman	J	9
Oplegnathidae	<i>Oplegnathus conwayi</i> *	206.1	Cape knifejaw	J, A	1, 2
	<i>Oplegnathus robinsoni</i> *	206.3	Natal knifejaw	J	9
Carangidae	<i>Decapterus macrosoma</i>	210.27	Slender scad	L	5
	<i>Lichia amia</i>	210.33	Garrick	J, A	2
	<i>Seriola lalandi</i>	210.44	Giant yellowtail	L, J, A	1, 2, 5
	<i>Trachurus trachurus capensis</i>	210.52	Maasbanker	L, J, A	2, 3, 5
Cheilodactylidae	<i>Cheilodactylus fasciatus</i> *	215.1	Redfingers	L, J, A	1, 2, 3, 5
	<i>Cheilodactylus pixi</i> *	215.2	Barred fingerfin	J, A	1, 2
	<i>Chirodactylus brachydactylus</i> *	215.3	Twotone fingerfin	L, J, A	1, 2, 6
	<i>Chirodactylus grandis</i> *	215.4	Bank steenbras	J, A1	, 2
Pomacentridae	<i>Abudefduf sordidus</i>	219.5	Spot damsel	#	9
	<i>Chromis dasygenys</i> *	219.13	Bluespotted chromis	#	9
Labridae	<i>Coris caudimacula</i>	220.21	Spottail coris	#	9
	<i>Labroides dimidiatus</i>	220.41	Bluestreak cleaner wrasse	#	9
Mugilidae	<i>Liza richardsonii</i> *	222.7	Southern mullet	L, J, A	2, 5, 8
	<i>Liza tricuspidens</i> *	222.8	Striped mullet	J, A	8
	<i>Mugil cephalus</i>	222.10	Flathead mullet	L	5
	<i>Myxus capensis</i> *	222.11	Freshwater mullet	J, A	8
Congrogadidae	<i>Halidesmus scapularis</i> *	227.1	Snakelet	J, A	1, 2
Champsodontidae	<i>Champsodon capensis</i>	229.1	Gaper	L	5
Blenniidae	<i>Chalaroderma ocellata</i> *	235.7	Two-eyed blenny	#	1, 2
	<i>Parablennius cornutus</i> *	235.31	Horned blenny	#	2
	<i>Parablennius pilicornis</i>	235.33	Ringneck blenny	L, #	1, 2, 3, 5
	<i>Plagiotremus rhinorhynchus</i>	235.37	Twostripe blenny	#	9
	<i>Plagiotremus tapeinosoma</i>	235.38	Piano blenny	#	2
	<i>Scartella emarginata</i>	235.40	Maned blenny	L	5
	<i>Xiphiasia setifer</i>	235.42	Snakeblenny	#	9
Tripterygiidae	<i>Cremnochorites capensis</i> *	236.1	Cape triplefin	#	2
Clinidae	<i>Blennioclinus brachycephalus</i> *	237.1	Lace klipfish	#	1, 2
	<i>Blennioclinus stella</i> *	237.2	Silverbubble klipfish	#	2
	<i>Blennophis striatus</i> *	237.4	Striped klipfish	#	1, 2
	<i>Cirrihibarbis capensis</i> *	237.7	Barbelled klipfish	#	2
	<i>Climacoporus navalis</i> *	237.8	Fleet klipfish	#	2
	<i>Clinus acuminatus</i> *	237.10	Sad klipfish	#	2
	<i>Clinus agilis</i> *	237.11	Agile klipfish	#	2
	<i>Clinus berrisfordi</i> *	237.12	Onrust klipfish	#	2
	<i>Clinus cottoides</i> *	237.14	Bluntnose klipfish	#	2
	<i>Clinus nematopterus</i> *	237.18	Chinese klipfish	#	2
	<i>Clinus robustus</i> *	237.19	Robust klipfish	#	2
	<i>Clinus superciliosus</i> *	237.22	Super klipfish	#	2
	<i>Clinus taurus</i> *	237.23	Bull klipfish	#	2
	<i>Clinus venustris</i> *	237.24	Speckled klipfish	#	2
	<i>Pavoelinus graminis</i> *	237.28	Grass klipfish	#	2
	<i>Pavoelinus laurentii</i> *	237.30	Rippled klipfish	#	1

Table 1 (continued)

Order & Family	Species	SSF#	Common name	Life history Stages	Source Reference
	<i>Caffrogobius caffer</i> *	240.20	Banded goby	#	2
	<i>Caffrogobius multifasciatus</i> *	240.21	Prison goby	A	8
	<i>Caffrogobius natalensis</i> *	240.22	Baldy	A	8
	<i>Caffrogobius saldanha</i> *	240.24	Commafin goby	#	2
	<i>Psammogobius knysnaensis</i> *	240.87	Knysna sandgoby	L, J, A	5, 8
Zanclidae	<i>Zanclus canescens</i>	244.1	Moorish idol	#	2
	<i>Pavoclinus pavo</i> *	237.34	Peacock klipfish	#	1, 2
	<i>Pavoclinus profundus</i> *	237.35	Deepwater klipfish	#	1, 2
	<i>Xenopoclinus kochi</i> *	237.37	Platanna klipfish	#	2
	<i>Xenopoclinus leprosus</i> *	237.38	Leprous platanna klipfish	#	1, 2
Ammodytidae	<i>Gymnammodytes capensis</i> *	238.2	Cape sandlance	L	3, 5
Callionymidae	<i>Paracallionymus costatus</i> *	239.6	Ladder dragonet	L	3, 5
Gobiidae	<i>Caffrogobius agulhensis</i> *	240.19	Agulhas goby	#	1
2Gempylidae	<i>Thyrsites atun</i>	247.8	Snoek	L	5
Trichiuridae	<i>Lepidopus caudatus</i>	248.4	Buttersnoek	L	5
Scombridae	<i>Scomber japonicus</i>	249.11	Mackerel	L, J, A	5, 6, 9
Stromateidae	<i>Centrolophus niger</i>	254.1	Black ruff	L	5
Order Pleuronectiformes					
Bothidae	<i>Arnoglossus capensis</i> *	259.1	Cape flounder	L	5
Cynoglossidae	<i>Cynoglossus capensis</i> *	261.3	Sand tonguefish	L	3, 5
	<i>Cynoglossus zanzibarensis</i>	261.9	Redspotted tonguefish	L	3, 5
Soleidae	<i>Austroglossus pectoralis</i> *	262.3	East coast sole	L	5
	<i>Heteromycteris capensis</i> *	262.5	Cape sole	L, J	3, 5, 8
	<i>Monochirus ocellatus</i>	262.7	Foureyeye sole	L	5
	<i>Solea bleekeri</i> *	262.12	Blackhand sole	L	3, 5
	<i>Solea fulvomarginata</i> *	262.13	Lemon sole	#	2
	<i>Synaptura marginata</i>	262.14	Shallow-water sole	L	3
	<i>Synapturichthys kleini</i>	262.15	Lace sole	L	5
Order Tetraodontiformes					
Ostraciidae	<i>Tetrosomus concatenus</i>	266.9	Triangular boxfish	A	9
Tetraodontidae	<i>Amblyrhynchotes honckenii</i>	268.1	Evileye blaasop	L, J, A	2, 3, 7
Diodontidae	<i>Diodon hystrix</i>	269.6	Porcupinefish	#	9
	<i>Lophodiodon calori</i>	269.8	Fourbar porcupinefish	J	9
	Molidae <i>Mola mola</i>	270.2	Ocean sunfish	A	2

Footnote: The symbol # denotes those species which could not be recognised either as juvenile or adult due to lack of biological knowledge or because life history stages were not referred to in the literature from which they were drawn. In certain cases where diving or personal observations have been used it has also not been possible to determine whether fish were adults or juveniles. In some, e.g. *Serranus cabrilla* and *Parascorpius typus* the symbols L, # and J, # respectively denote that larvae or juveniles were positively identified but while larger specimens were observed their maturity state could not be determined.

from 1/0 to 3/0 were used. Baits used include redbait (*Pyura stolonifera*), white mussel (*Donax serra*), a variety of polychaete worms, chokka, octopus and pilchard. This data set also includes observations and *ad hoc* collections during other activities such as scuba diving and snorkeling.

Results and Discussion

A total of 202 species of fishes from 84 families which have been positively identified

within the boundaries of the TNP (Table 1). The results show that a variety of sampling gear is required to compile a comprehensive species list. For example, rotenone collections by Buxton & Smale (1984) and Burger (1990) provided cryptic reef fish such as the bythitids, batrachoidids, gobiesocids, gobies, clinids, *Halidesmus scapularis*, and blennies which are rarely observed or correctly identified while swimming visual transects. Hook and line fishing for the two mark/ recapture

studies allowed for the identification of a number of sharks (*Squalus megalops*, *Carcharhinus brevipinna*, *C. obscurus*, *Mustelus palumbes*, *Halaelurus natalensis* and *Scyliorhinus capensis*) and the teleost *Pachymetopon blochii*. The survey of estuaries within the park revealed six previously unrecorded species (Table 1), namely *Gilchristella aestuaria*, *Atherina breviceps*, *Liza tricuspidens*, *Myxus capensis*, *Caffrogobius multifasciatus* and *C. natalensis*.

The introduction of ichthyoplankton studies in recent years resulted in many new distribution records for the TNP. These included *Etrumeus whiteheadi*, *Engraulis japonicus*, *Gonorhynchus gonorrhynchus*, three species of Myctophidae, *Stomias boa boa*, *Physiculus capensis*, *Bregmaceros atlanticus*, *Bregmaceros nectabanus*, *Genypterus capensis*, *Lophius upsicephalus*, *Zeus faber*, *Macroramphosus scolopax*, *Congiopus spinifer*, *Chelidonichthys capensis*, *Decapterus macrostoma*, *Scartella emarginata*, *Champsodon capensis*, *Gymnamodytes capensis*, *Paracallionymus costatus*, *Thyrsites atun*, *Lepidopus caudatus*, *Centrolophus niger* and all the Pleuronectiformes except *Solea fulvomarginata* which was recorded by Burger (1990). While the adults of these larval fish may be found in a wide range of habitats, mostly comprising deeper offshore waters which would not have been sampled by conventional means, most have pelagic eggs and all have pelagic larvae which are prone to drifting in the ocean's currents. Unspoiled reef and softer sediments undamaged by trawling within the TNP may well provide greater opportunities for settlement of larvae after which sub-adults migrate to join the main stocks. For example, adult *T. atun* are regularly caught at the snoek banks, situated at 34°14'00"S, 24°05'04"E to the east of the TNP, but have never been recorded in the park. Their larvae were, however, sampled on a number of occasions within the park's boundaries (Wood 1998).

Lastly, collections and personal observations while snorkeling or scuba diving allowed for the identification of 27 additional species,

namely *Eptatretus hexatrema*, *Rhincodon typus*, *Isurus oxyrinchus*, *Pristis pectinata*, *Mobula diabolus*, *Pteromylaeus bovinus*, *Dasyatis crysonota*, *Plotosus nkunga*, *Congiopus torvus*, *Chelidonichthys kumu*, *Petalichthys capensis*, *Epinephelus andersoni*, *Terapon jarbua*, *Umbrina ronchus*, *Pomacanthus rhomboides*, *Chaetodon blackburnii*, *Heniochus acuminatus*, *Oplegnathus robinsoni*, *Abudefduf sordidus*, *Chromis dasygenys*, *Coris caudimacula*, *Labroides dimidiatus*, *Plagiotremus rhinorhynchus*, *Xyphiasia setifer*, *Tetrosomus concatenatus*, *Diodon hystrix* and *Lophodiodon calori*. The fish species listed in Smith & Smith (1966) were not considered as this publication was aimed at the popular market and comprises mostly anecdotal information. A few of the records were also considered dubious, for example *Scomberomorus commerson* and *S. plurilineatus* are listed as being found in the TNP, while *Neoscorpis lithophilus* is referred to as a rare vagrant from Natal waters. The two scombrid species are clearly inhabitants of warmer northern waters, while the shore-based tag-and-release project has shown *N. lithophilus* to be a common resident in the Tstisikamma National Park.

The utilisation of estuaries and the surf zone adjacent to estuaries as nursery or developmental areas for fish larvae and post-larvae which have been spawned at sea has been documented (Lasiak 1981; Whitfield 1983, 1989a, 1989b; Wallace *et al.* 1984). Five species of larvae have been sampled in the TNP immediately beyond the surf zone opposite a small unnamed river whose mouth is in the form of a waterfall plunging into the sea. These larvae belong to groups of fishes which are dependent on estuaries to varying degrees for closure of their life cycles (Whitfield 1998) and while they obviously cannot enter the river via the waterfall, the presence of freshwater inflow still appears to attract them. According to the classification of estuarine-dependent species by Whitfield (1998), *Psammogobius knysnaensis* is a resident estuarine species which may also have freshwater or marine spawning populations, *Rhabdosargus holubi* and

Monodactylus falciformis are euryhaline species whose juveniles are dependent on estuaries and *Solea bleekeri* and *Heteromycteris capensis* are euryhaline marine species whose juveniles occur mainly in estuaries but may also be found at sea.

The species check list, although incomplete, indicates the diversity of the ichthyofauna in the TNP, and serves to highlight shortcomings in research efforts in the past, e.g. the lack of any dedicated research efforts aimed at the chondrichthyans means that this group is poorly represented in the list. Many of the records which appear are based upon visual observations and, as such, assigning juvenile or adult status to them was not always possible. This problem is not only associated with the chondrichthyan species but includes teleost species which have been included from personal observations, e.g. *Epinephelus andersoni*, *A. sordidus*, *C. dasygenys*, *C. caudimacula*, *L. dimidiatus*, *P. rhinorhynchus*, *X. setifer*, *Umbrina ronchus* and *P. nkunga*. Traditionally, research efforts in the TNP have been aimed at reef associated species and, as such, pelagic and sand-associated groups have been neglected. Their representation amongst the species list must be considered as incomplete. Included amongst this group are *Genypterus capensis*, *Lophius upsicephalus* and *Zeus capensis* which have only been recorded in their larval form. While *Merluccius capensis* has been recorded in its larval and adult forms in the TNP juveniles have yet to be caught or observed. However, stomach contents of *A. argyrozona* caught in the park have revealed fresh juvenile *M. capensis* (and *M. paradoxus*) specimens, but *A. argyrozona* appear to be more nomadic than resident (*S. Brouwer unpubl. data*) and could have ingested the juvenile *M. capensis* while foraging in waters outside the park.

The poor status of our knowledge regarding the biology of many littoral species means that a number of species, most notably the blennies, clinids and gobies but also including *Porcostoma dentata*, *Umbrina canariensis* and *Solea fulvomarginata*, recorded by Buxton & Smale (1984) and Burger (1990)

have not had any life history stages assigned to them (Table 1). The majority ($n = 177$) of fish appearing in Table 1 can be considered common residents or regular visitors to the TNP. Of these, one species (*Gilchristella aestuaria*) is restricted to estuaries and two species (*Bidenichthys capensis* and *Batrachthys apaiatus*) are confined to the intertidal zone (Smith & Heemstra 1986). Others ($n = 13$), however, are tropical or subtropical vagrants which are seen on rare occasions when exceptionally warm waters prevail inshore for short periods. These include *Rhincodon typus*, *Pristis pectinata*, *Mobula diabolus*, *Terapon jarbua*, *P. dentata*, *Pomacanthus rhomboides*, *Chaetodon blackburnii*, *Heniochus acuminatus*, *A. sordidus*, *C. dasygenys*, *C. caudimacula*, *L. dimidiatus* and *Monochirus ocellatus*. Eight teleost species are classified as oceanic by Smith & Heemstra (1986) and as such seldom stray inshore to within the confines of the TNP. Of these, five are pelagic or mesopelagic and include *Stomias boa boa*, *Diogenichthys atlanticus*, *Lampanyctodes hectoris*, *Symbolophorus barnardi* and *Centrolophus niger*. The remaining three, namely *Physiculus capensis*, *Lophius upsicephalus* and *Lepidopus caudatus* are benthopelagic or benthic.

According to island biogeography theory, species diversity is a function of island size and proximity to similar habitats (Preston 1962) and is maintained at an equilibrium determined by rates of extinction and immigration (MacArthur & Wilson 1967). In applying the equilibrium theory to conservation biology it was originally thought that a large nature reserve would mean greater diversity than a number of smaller ones (Diamond 1975). The more modern trend, however, is the belief that number of habitats determines diversity such that several small reserves incorporating many habitat ranges would support more species than a single large reserve whose area comprises fewer and similar habitat types (Attwood *et al.* 1997). The TNP is one of the largest MPAs in southern Africa and incorporates many different types of habitat. Currently, comparisons with smaller reserves are not possible,

however, the position of the TNP in the warm south coast temperate faunal province as well as the levels of fish species diversity and richness seems to side with the single large reserve producing maximum diversity argument. In terms of conserving biodiversity, all species should be considered, but this leads to a dilemma. For example, the majority of the fish species connected with the linefishery are endemic, and are sedentary and highly territorial as adults, but they have relatively mobile juveniles and pelagic egg and larval phases which disperse. Other species such as gobiids which have demersal eggs, and clinids which are viviparous do not have great dispersal potential. One of the functions of the TNP is the conservation and management of linefish species. As such, reserve size should be determined based upon the life history of the species concerned, i.e. large enough to support viable spawner stocks yet small enough for dispersal of young to exploited areas (Attwood *et al.* 1997).

Another approach which appears to consider biodiversity as a secondary consideration is that of Bond (1989) who stated that the importance of a region should not be judged in terms of the number of species it contains but in the quality and importance of what it contains.

The TNP contains abundant spawning populations of some of the component species of the south coast linefishery, e.g. *Chrysoblephus laticeps* and *Petrus rupestris* (Buxton 1993a) and, as such, should be considered important from a conservation and management perspective. In addition, many of the species which are components of the trawl, purse-seine and linefisheries along the east coast are represented by multiple life history stages in the TNP (Table I).

Seined and/or trawled pelagic species such as *Etrumeus whiteheadi*, *Sardinops sagax*, *Engraulis japonicus*, *Trachurus trachurus capensis* and *Scomber japonicus*, and linefish such as *A. argyrozona*, *C. laticeps*, *D. s. capensis*, *D. c. hottentotus*, *Pagellus bellottii natalensis*, *R. holubi*, *Sarpa salpa*,

Atractoscion aequidens and *Seriola lalandi* have all been recorded in their larval, juvenile and adult stages.

Certain species such as *Lichia amia*, *Argyrosomus innodorus*, *A. japonicus*, *Pomatomus saltatrix*, *Pomadasyss commersonii*, *Cymatoceps nasutus*, *P. rupestris* and *Dichistius capensis* appear to spend only parts of their life cycle in the park, passing through during seasonal feeding or reproduction related migrations.

All these species have been recorded as juveniles and adults (Table I) and it is only their larval stages which are absent. The absence of these larvae is not a certainty because larval patchiness could easily be invoked to explain their absence from the ichthyoplankton sampling program.

The majority of fishes in the TNP are, however, of no importance to any fishery and as such are free from exploitation. The presence of larvae, juveniles and adults indicates that some of these species are represented during all stages of their life history within the TNP, e.g. *Gaidropsarus capensis*, *Coccotropsis gymnoderma*, *Cheilodactylus fasciatus*, *P. knysnaensis* and *Amblyrhynchotes honckenii*. Others, such as *Symbolophorus barnardi*, *Physiculus capensis*, *Chorisochismus dentex*, *Macroramphosus scolopax*, *Congiopodus spinifer*, *C. torvus*, *Acanthistius sebastoides*, *Chaetodon marleyi*, *Halidesmus scapularis* and *Paracallionymus costatus* have only been recorded during selected life history stages.

In any one of these scenarios the TNP can be seen to fulfill three of the objectives outlined for MPAs (see Attwood *et al.* 1997). These are the maintenance of marine systems and genetic diversity, the protection of exploited species and their habitats, and the protection and management of areas vital to the life cycles of exploited species.

Many of the MPAs worldwide are considered too small to offer protection from outside influences (McAllister 1995) and it is recognised that island biogeography theory studies should be incorporated when deter-

mining reserve sizes in different ecosystems. In determining the optimum size for a place such as the TNP, larval distribution, length of planktonic phase, and local current patterns must be used in combination so that reserve size becomes based upon distances from fishing grounds which could conceivably be covered by dispersing ichthyoplankton.

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