

Tracking the decline of the world's largest seabream against policy adjustments

Sven E. Kerwath*, Denham Parker, Henning Winker, Warren Potts, Bruce Mann, Christopher Wilke, Colin Attwood

*Corresponding author: svenk@daff.gov.za

Marine Ecology Progress Series 610: 163–173 (2019)

Additional information documenting the decline of the red steenbras stock is provided here. This includes a portfolio of evidence (Table S1) that collates and summarizes stock trend information for the period 1948-2014 according to total catch (TC), relative abundance (CPUE), percentage catch composition (CC), estimated fishing pressure (E) and the authors' perceptions of the red steenbras population trend. The portfolio of evidence also provides the broad study location, the general context of the study, a comment on the relevant findings and the associated reference number that refers to the bibliography of scientific papers provided in Table S3. In addition, Table S2 provides select segments extracted from each scientific paper that typifies the research findings regarding red steenbras. Finally, Table S4 provides references to the Government Gazettes detailing the changes in regulations pertaining to red steenbras fishing which correspond to the figures in the manuscript.

Table S1: A portfolio of evidence for the decline of red steenbras in South Africa. The Ref. column refers to the bibliography of scientific papers provided in Table S3.

Date	TC	CPUE	CC	E	P	Province covered	Context	Comment on relevant findings	Ref.
1948	↑	-	-	-	↓	National	Angling information	-	1
1982	↑	-	↑	-	-	Western & Eastern Cape	Trends in redfish fisheries	-	2
1984	↓	-	↓	↑	↓	KwaZulu-Natal	Management of deep reef fishery species in KZN	Basis for the establishment of the first linefish management plan and associated regulations	3
1985	↑	↑	↑	↑	-	Eastern Cape	Trends in ski-boat fishery	-	4
1985	-	-	-	-	-	Eastern Cape	Feeding biology of sparids	-	5
1988	-	-	-	-	↓	Eastern Cape	Distribution and reproduction of red steenbras	-	6
1988	-	↓	-	↑	↓	National	Temporal trend in linefish catches of red steenbras	100% decrease in CPUE (1922-1950)	7
1988	-	-	-	-	↓	Eastern Cape and KwaZulu-Natal	Seasonal abundance and spawning migrations	-	8
1989	-	↓	-	↑	-	Eastern Cape	Trends in Port Alfred linefishery	Red steenbras grouped in 'sparid' category	9
1991						South Western Cape	Trends in shore angling	Declining trend in catches	10

Date	TC	CPUE	CC	E	P	Province covered	Context	Comment on relevant findings	Ref.
1991	-	-	-	-	↓	Western & Eastern Cape	Age and growth of red steenbras	Per-recruit assessment indicates the stock is overfished	11
1991	-	-	-	-	↓	National	Species specific profiles and research priority	Critical; seriously depleted	12
1993	↑	-	-	↑	↓	National	Possible management measures for red steenbras	-	13
1993	↑	↑	-	?	↑	Eastern Cape	Trends in commercial catches	Observed increase in CPUE but likely a result of hyperstability	14
1997	↓	-	-	↑	↓	Western & Eastern Cape	Assessment of linefishery	Only one red steenbras was sampled	15
1999	-	-	↓	-	↓	KwaZulu-Natal	Long-term trends in linefish catches	Listed as critical	16
1999	-	↓	-	-	↓	Western Cape	Long-term trends in linefish catches in Western Cape	Collapsed	17
2000	↑	↓	↓	↑	↓	Western Cape	Long-term trends in linefish catch and effort in Western Cape	84% decline in CPUE	18
2000	-	↓	↓	↑	↓	National	Species specific profiles and research priority	Overall decline in CPUE	19
2002	-	-	-	-	↓	National	Movement patterns of Red steenbras	-	20
2002	-	-	-	-	↓	National	Movement patterns of reef fishes and management implications	Juveniles highly resident but eastward movement of adults towards Transkei-	21
2003	-	-	-	-	↓	Eastern Cape	Assessment of Transkei linefishery	-	22
2010	↓	-	↓	↓	↓	Eastern Cape	Assessment of Port Alfred linefishery	-	23
2013	-	↓	↓	↓	↓	National	Species specific profiles and research priority	< 5% of pristine level; stock collapsed	24
2014	-	↓	-	-	↓	National	Species specific population assessment	Probability of capture declines by 96%	25

↑↓ - Increase and decrease, respectively

TC – Total catches; total number/mass of fish caught

CPUE – Catch Per Unit Effort; index of abundance

CC – Catch Composition; proportion of red steenbras in total catches

E – Estimate of fishing pressure

P – Author's perceptions of the red steenbras population trend

(-) – Not given and/or unknown

Table S2: Segments extracted from literature which typify the research findings regarding red steenbras.

Reference	Extracts from literature
1	It is difficult to account for the present scarcity - the few hundreds as compared with the thousands of 20 years ago.
2	On the basis of catch returns red steenbras have been the major contributor in Algoa Bay and Port Alfred
3	Catches of five tonnes in eight hours were reported in the press, but by the late sixties seventy-four and steenbras had become hard to find.
4	Red steenbras listed as a commonly caught species in the ski-boat fishery
5	-
6	The reported trends of decreased abundance of <i>P. rupestris</i> were not confirmed during this study owing to the absence of reliable long-term data on trends in catch and effort in the study area
7	There was a significant drop in the total catches of red steenbras between 1922-1950. Catch per unit effort during the same period fluctuated quite considerably, but a linear regression revealed that there was, nevertheless, an overall drop of over 100%. As present-day catches appear to be far lower than those of the late 1940's and effort is considerably higher, it would appear that this ominous trend has continued.
8	Fishing mortality on breeding stocks is therefore high and, in the case of <i>P. undulosus</i> , has resulted in greatly decreased catches (van der Elst and Garratt 1984). <i>Petrus rupestris</i> could follow a similar fate if not adequately protected, especially along the Transkei coast, where skiboats target for this prime species in the absence of fishery regulations.
9	-
10	Recently obtained catch data from Bloukrans, on the coast of what is now the De Hoop Nature Reserve, are shown in Figure 3. This figure indicates that the mean annual total catch of reef fish (red steenbras <i>Petrus rupestris</i> , poenskop <i>Cymatoceps nasutus</i> , dageraad <i>Chrysoblephus cristiceps</i> , red stumpnose <i>C. gibbiceps</i> and yellowbelly rock-cod <i>Epinephelus guaza</i>), which are accessible from the shore in that area, have declined markedly since 1965, even though effort is likely to have increased.
11	Per-recruit analysis suggests that they are highly susceptible to overfishing, particularly because juveniles are effectively unprotected by current minimum size regulations. The consequences of this include the possibility of growth- and recruitment-overfishing.
12	Research needs: High priority
13	-
14	The information presented in this study prompts a re-evaluation of the conservation status and management of copper steenbras, not only in the Transkei but throughout its distributional range
15	-
16	The absence of refuges on the KwaZulu Natal south coast is clearly reflected in the overexploitation of reef fish there, and the rapidity with which migrating shoals of reef fish such as red steenbras are depleted when they arrive.
17	The red steenbras population has collapsed (Griffiths 1997c), and they are not caught by either shore or commercial fishers at Hermanus. Red steenbras and seventyfour were entirely absent from linefish catches in the latter period.
18	Fishery-independent data indicate that the cpue of red steenbras on inshore reefs in the Southern Cape declined dramatically between 1931-1933 and 1986-1993 (see below). Reports of red steenbras becoming less abundant in the False Bay, Plettenberg Bay and Tsitsikamma areas during the early 1950s (Schoeman 1957) suggest that this trend was widely spread.
19	Furthermore, re-introduction of the closed season should be considered as a precautionary measure
20	-
21	The present study shows that juveniles of <i>P. rupestris</i> as well as <i>A. argyrozona</i> (<26cm Griffiths 2000b) are resident on inshore reefs where behaviour is best described as station keeping. Later they join spatially distant adult populations; in the case of <i>A. argyrozona</i> this involves offshore 'natal ranging' but in <i>P. rupestris</i> also includes (>800km) eastward 'migration'. Substantial eastward migration was observed during a second mark-recapture study conducted in the Tsitsikamma National Park thereby supporting the hypothesis (Smale 1988) that adult <i>P. rupestris</i> congregate off the east coast, in the Transkei region.
22	Many of the species caught in the Transkei region possess one or more life-history characteristics

Reference	Extracts from literature
	(slow growth, late maturity, sex change, forming of aggregations) that render them vulnerable to overfishing (Mann 2000), and several species are already overexploited, e.g. slinger (Punt et al. 1993), dageraad (Buxton 1992), seventyfour (Chale-Matsau et al. 2001), red steenbras (Penney and Wilke 1993), Scotsman (Garratt et al. 1994), poenskop (Buxton and Clarke 1989), kob (Griffiths 1997a, b) and geelbek (Griffiths 2000b).
23	In 1985-87 red steenbras dominated the commercial sparid group landings by weight (44.4%). However, since then it has made an insignificant contribution to total landings.
24	Total commercial lineboat catch also dropped to less than 10% of the 1990 values. Moreover, the frequency of encounter steadily declined to 4% of that in the late 1980s. These data were instrumental in the decision taken to close the fishery in November 2012.
25	Declines in population size at the start of the time series (1987-1991) were previously estimated at more than 90% compared to historical reference points (1931-33) for both red steenbras and dageraad (Griffith 2000). The standardized time-series for red steenbras and dageraad capture probabilities presented in this study provide strong evidence of further severe population declines over the last 27 years.

Table S3: Bibliography corresponding to citations used in Table 2 & 3.

Reference	
1	Biden CL (1948) Sea-angling fishes of the Cape. Juta and co. Ltd, Cape Town.
2	Crawford RJM, Crous H (1982) Trends in commercial handline catches of redfishes along the Southern Cape coast, Republic of South Africa. <i>Koedoe</i> 25: 13–31
3	van der Elst RP, Garratt PA (1984) Draft management proposals for the Natal deep reef fishery. Unpublished Report, Oceanographic Research Institute, Durban, p 1-32
4	Smale MJ, Buxton CD (1985) Aspects of the recreational ski-boat fishery off the Eastern Cape, South Africa. <i>South African Journal of Marine Science</i> 3: 131–144
5	Smale MJ (1986) The feeding biology of four predatory reef fishes off the south-eastern Cape coast, South Africa. <i>South African Journal of Zoology</i> 21: 111–130
6	Smale MJ (1988) Distribution and reproduction of the reef fish <i>Petrus rupestris</i> (Pisces: Sparidae) off the coast of South Africa. <i>South African Journal of Zoology</i> 23: 272–287
7	Garratt PA, Adkin F (1988) Marine linefish catch statistics: Red steenbras (<i>Petrus rupestris</i>). Unpublished Report, Oceanographic Research Institute (ORI), Durban, p 1-25
8	Garratt PA (1988) Notes on seasonal abundance and spawning of some important offshore linefish in Natal and Transkei waters, southern Africa. <i>South African Journal of Marine Science</i> 7: 1–8
9	Hecht T, Tilney RL (1989) The Port Alfred fishery: a description and preliminary evaluation of a commercial linefishery on the South African east coast. <i>South African Journal of Marine Science</i> 8: 103–117
10	Bennett BA (1991) Conservation in the marine environment: some problems with the management of shore-angling in the Southwestern Cape. <i>Southern African Journal of Aquatic Science</i> 17: 12-18
11	Smale MJ, Punt AE (1991) Age and growth of red steenbras <i>Petrus rupestris</i> (Pisces: Sparidae) on the south-east coast of South Africa. <i>South African Journal of Marine Science</i> 10: 131–139
12	Van der Elst RP, Adkin F (1991) Marine linefish: priority species and research objectives in southern Africa. Special Publication No. 1, Oceanographic Research Institute (ORI), Durban, p 96
13	Penney AJ, Wilke CG (1993) The red steenbras: a species under siege? In: Beckley LE, van der Elst, RP (eds) Fish, Fishers and Fisheries. Proceedings from the Second South African Marine linefish Symposium. Special Publication No. 2, Oceanographic Research Institute (ORI), Durban, p 32-35
14	Hecht T, Buxton CD (1993) Catch trends in the Transkei commercial linefishery. In: Beckley LE, van der Elst RP (eds) Fish, Fishers and Fisheries. Proceedings of the Second South African Marine Linefish Symposium, Durban, 23-24 October 1992. Special Publication No. 2, Oceanographic Research Institute (ORI), Durban, p 127-133
15	Brouwer SL (1997) An assessment of the South African East Coast linefishery from Kei Mouth To Stil Bay. MSc dissertation, Rhodes University, Grahamstown, South Africa
16	Penney AJ, Mann-Lang JB, van der Elst RP, Wilke CG (1999) Long-term trends in catch and effort in the KwaZulu-Natal nearshore linefisheries. <i>South African Journal of Marine Science</i> 21: 51–76

Reference

- 17 Attwood CG, Farquhar M (1999) Collapse of linefish stocks between Cape Hangklip and Walker Bay, South Africa. *South African Journal of Marine Science* 21: 415–432
- 18 Griffiths MH (2000) Long-term trends in catch and effort of commercial linefish off South Africa's Cape Province: snapshots of the 20th century. *South African Journal of Marine Science* 22: 81–110
- 19 Booth AJ, Smale MJ (2000) Red steenbras (*Petrus rupestris*). In: Mann BQ (eds) Southern African marine linefish status reports. Special Publication No. 7, Oceanographic Research Institute (ORI), Durban, p 168-169
- 20 Brouwer SL (2002) Movement patterns of red steenbras *Petrus rupestris* tagged and released in the Tsitsikamma National Park, South Africa. *South African Journal of Marine Science* 24: 375–378
- 21 Griffiths MH, Wilke CG (2002) Long term movement patterns of five temperate-reef fishes (Pisces: Sparidae): implications for marine reserves. *Marine and Freshwater Research* 53: 233–244
- 22 Fennessy ST, McDonald AM, Mann BQ, Everett BI (2003) An Assessment of the Recreational and Commercial Skiboat Fishery in the Transkei. *African Journal of Marine Science* 25: 61–78
- 23 Donovan B (2010) A retrospective assessment of the Port Alfred linefishery with respect to the changes in the South African fisheries management environment. MSc dissertation, Rhodes University, Grahamstown, South Africa
- 24 Mann BQ, Kerwath SE (2013) Red steenbras (*Petrus rupestris*). In: Mann BQ (eds) Southern African marine linefish species profiles. Special Publication No. 9, Oceanographic Research Institute (ORI), Durban, p 252-254
- 25 This study

Table S4: References to Government Gazettes detailing amendments to fisheries regulations for red steenbras.

-
- (a) RSA (Republic of South Africa) 1984. Sea Fisheries Act (Act 58 of 1973) Regulation Amendments. Government Gazette South Africa (3782).
 - (b) RSA (Republic of South Africa) 1990. Sea Fisheries Act (Act 12 of 1988) Regulation Amendments. Government Gazette South Africa 301 (12667).
 - (c) RSA (Republic of South Africa) 1991. Sea Fisheries Act (Act 12 of 1988) Regulation Amendments. Government Gazette South Africa (13096).
 - (d) RSA (Republic of South Africa) 1992. Sea Fisheries Act (Act 12 of 1988) Regulation Amendments. Government Gazette South Africa 326 (14192).
 - (e) RSA (Republic of South Africa) 1994. Sea Fisheries Act (Act 12 of 1988) Regulation Amendments. Government Gazette South Africa 346 (15607).
 - (f) RSA (Republic of South Africa) 1997. Marine Living Resources Act (Act 18 of 1998) Regulation Amendments. Government Gazette South Africa 389 (18357).
 - (g) RSA (Republic of South Africa) 1998. Marine Living Resources Act (Act 18 of 1998) Regulation Amendments. Government Gazette South Africa 399 (19205).
 - (h) RSA (Republic of South Africa) 2000. Marine Living Resources Act (Act 18 of 1998) Declaration of an emergency. Government Gazette South Africa 426 (21949).
 - (i) RSA (Republic of South Africa) 2005. Marine Living Resources Act (Act 18 of 1998) Regulation Amendments. Government Gazette South Africa 478 (27453).
 - (j) RSA (Republic of South Africa) 2012. Marine Living Resources Act (Act 18 of 1998) Regulation Amendments. Government Gazette, South Africa 569 (35903).

Additional information illustrating the results from the cluster analyses conducted for the South-West and East. Table S5 lists all species and their abbreviations that were included in the analysis. Biplots illustrate the location clusters relative to the species-specific eigenvectors of the first and second principal component scores (PCs) for and East (Figure S1) and South-West (Figure S2).

Table S5: List of species included in the cluster analysis to identify factors for ‘fishing strategies’ in the East (E) and South-West (SW) coast regions, together with abbreviations used in Figures S1 and S2.

Name	Abbreviation	Family/Group	Species	Coast
Red steenbras	RDST	Sparidae	<i>Petrus rupestris</i>	SW, E
Dageraad	DGRD	Sparidae	<i>Chrysoblephus cristiceps</i>	SW, E
Roman	ROMN	Sparidae	<i>Chrysoblephus laticeps</i>	SW, E
Red stumpnose	RSTM	Sparidae	<i>Chrysoblephus gibbiceps</i>	SW, E
Slinger	SLNG	Sparidae	<i>Chrysoblephus puniceus</i>	E
Englishman	ENGL	Sparidae	<i>Chrysoblephus anglicus</i>	E
Carpenter	CRPN	Sparidae	<i>Argyrozona argyrozona</i>	SW, E
Hottentot	HTTN	Sparidae	<i>Pachymetopon blochii</i>	SW
Seventy four	SVNT	Sparidae	<i>Polysteganus undulosus</i>	SW, E
Santer	SNTR	Sparidae	<i>Cheimerius nufar</i>	SW, E
Fransmadam	FRNS	Sparidae	<i>Boopsoidea inornata</i>	SW
Panga	PANG	Sparidae	<i>Pterogymnus lanarius</i>	SW, E
Poenskop	PNSK	Sparidae	<i>Cymatoceps nasutus</i>	SW, E
Blue hottentot	BLHT	Sparidae	<i>Pachymetopon aeneum</i>	SW, E
Scotsman	SCTS	Sparidae	<i>Polysteganus praeorbitalis</i>	E
Steenjie	STNT	Sparidae	<i>Spondylisoma emarginatum</i>	SW
Strepie	STRP	Sparidae	<i>Sarpa salpa</i>	SW
White stumpnose	WSTM	Sparidae	<i>Rhabdosargus globiceps</i>	SW
Rockcods	RCCD	Serranidae	<i>Epinephelus spp</i>	E
Cape gurnard	CGRD	Triglidae	<i>Chelidonichthys capensis</i>	SW, E
King mackerel	KMCK	Scombridae	<i>Scomberomorus commerson</i>	E
Striped bonito	BONT	Scombridae	<i>Sarda orientalis</i>	SW
Mackerel	MCKR	Scombridae	<i>Scomber japonicas</i>	SW, E
Tunas	TUNA	Scombridae	<i>Tunas spp</i>	SW
Geelbek	GLBK	Sciaenidae	<i>Atractoscion aequidens</i>	SW, E
Kob	KOB	Sciaenidae	<i>Argyrosomus spp</i>	SW, E
Squaretail kob	STKB	Sciaenidae	<i>Argyrosomus thorpei</i>	E
Elf	ELF	Pomatodidae	<i>Pomatomus saltatrix</i>	SW, E
Kingklip	KKLP	Ophidiidae	<i>Genypterus capensis</i>	
Snoek	SNOK	Gempylidae	<i>Thyrsites atun</i>	SW
Shallow water Hake	HAKE	Merlucciidae	<i>Merluccius capensis</i>	SW, E
Cape horse mackerel	HMKC	Carangidae	<i>Trachurus trachurus capensis</i>	SW, E
Yellowtail	YLTL	Carangidae	<i>Seriola lalandi</i>	SW, E
Sharks	SHRK	Sharks		SW, E
Rays	RAY	Rays		SW

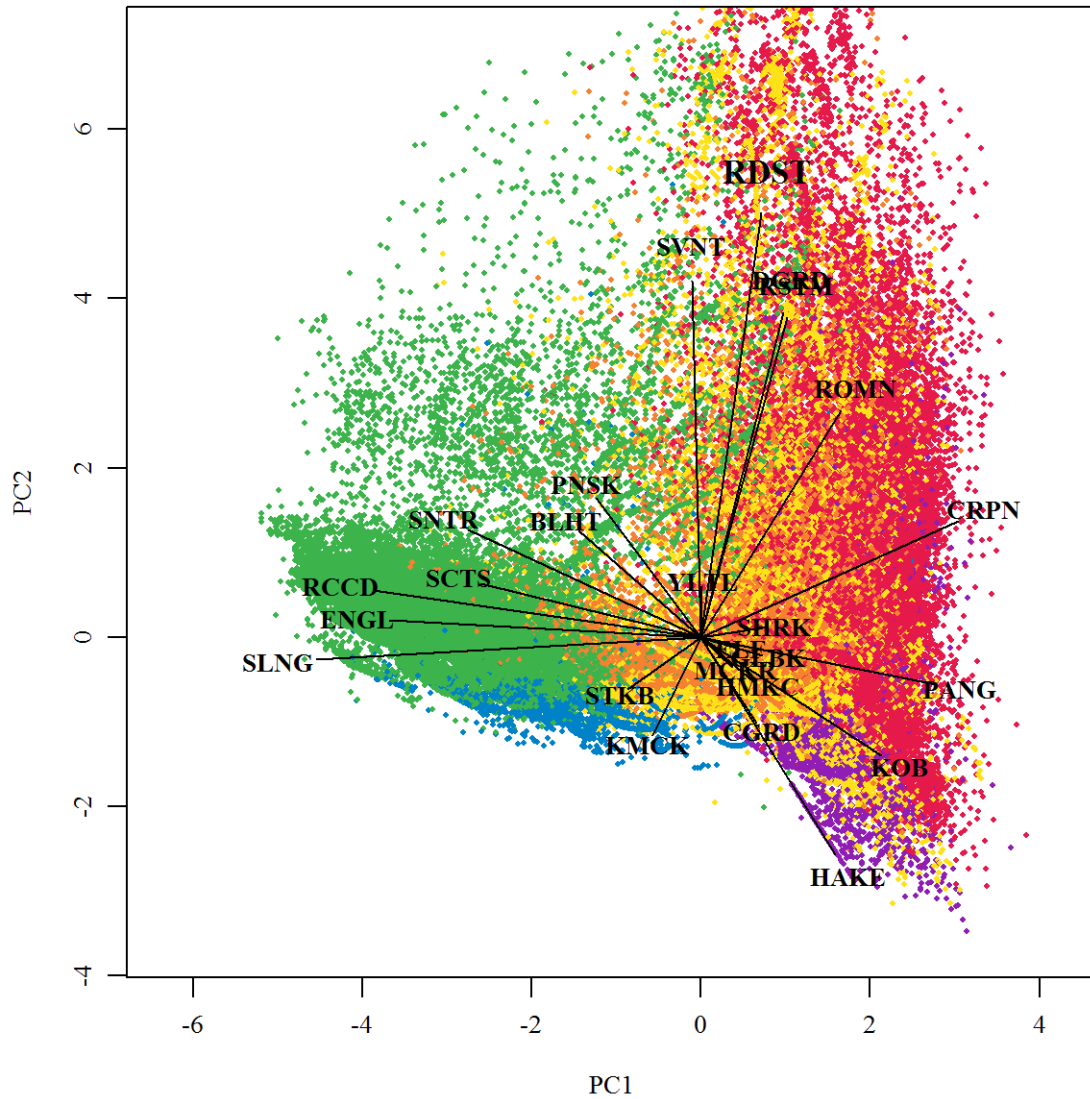


Figure S1. Biplot showing the location clusters relative to the species-specific eigenvectors of the first and second principal component scores (PCs) for the East coast region (E), with red steenbras (RDST) being superimposed. Species names for the abbreviations used in this plot are provided in Table S5.

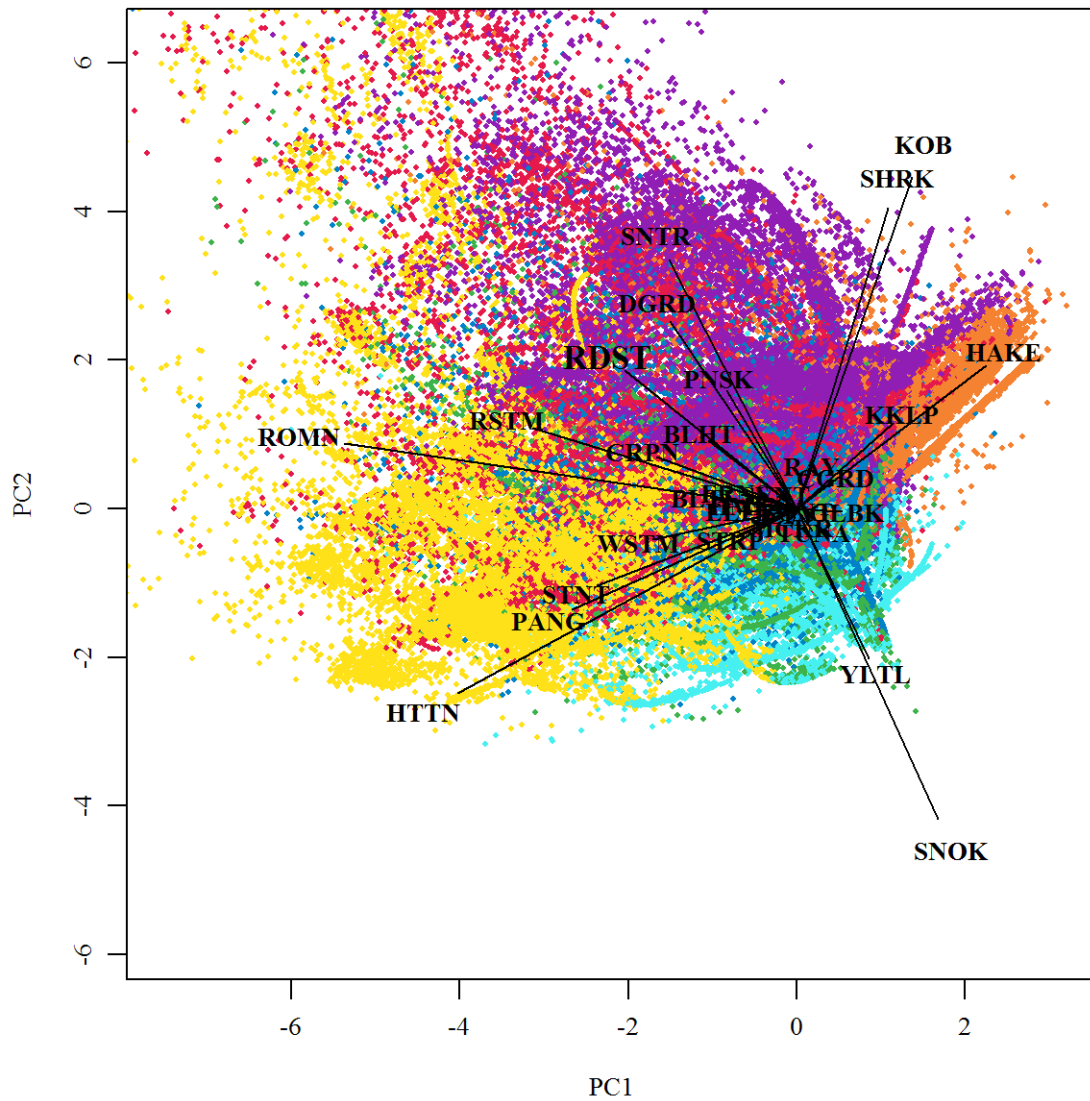


Figure S2. Biplot showing the location clusters relative to the species-specific eigenvectors of the first and second principal component scores (PCs) for the South-West coast region (S), with red steenbras (RDST) being superimposed. Species names for the abbreviations used in this plot are provided in Table S5.