

3.6 Fish community status or ‘health’

3.6.1 Introduction

It is generally agreed that biological communities, by integrating the effect of changes across a wide array of environmental factors (chemical, physical and biological), are good indicators of ecosystem health (Karr *et al.*, 1986; Roux *et al.*, 1993). Furthermore, the concept of biological community health is useful within the broader management context because in general, the idea of healthy ecosystems is readily comprehended and widely accepted by the public. Also, biological communities may be the only practical means of evaluating certain impacts which are difficult to measure, for instance diffuse source impacts or habitat degradation (Roux *et al.*, 1993).

It is not financially or technically feasible to evaluate all the organisms in an entire ecosystem at all times. Many groups of organisms have been proposed as indicators of ecosystem health and, although no single group is favoured by the majority of biologists, it appears that fish and macroinvertebrates have received most attention, at least in South African river systems (Roux *et al.*, 1993). In terms of estuaries, botanical characteristics (Coetzee *et al.*, 1996; 1997), fish (Cooper *et al.*, 1994) and birds (Turpie, 1995) have been used to determine the importance, health and conservation of South African estuaries.

The use of fish as indicators of estuarine health (Cooper *et al.*, 1994) was based on the Community Degradation Index (CDI) developed by Ramm (1988; 1990). The CDI, which measures the degree of dissimilarity (degradation) between a potential fish assemblage and the actual measured fish assemblage, was modified into the Biological Health Index (BHI) to provide a measure of the similarity (health) between the potential and actual fish assemblages (Cooper *et al.*, 1994). The BHI was calculated using the formula:

$$\text{BHI} = 10 (J) [\text{Ln} (P) / \text{Ln} (P_{\text{max}})]$$

where: J = the number of species in the system ÷ the number of species in the reference community; P = the potential species richness (number of species) of each reference

community and P_{\max} = the maximum potential species richness from all the reference communities. The index ranges from 0 (poor) to 10 (good).

During the execution of this project the BHI was used to assess the state of South Africa's estuaries (Cooper *et al.*, 1993; Harrison *et al.*, 1994; 1995; 1996; 1997; 1999). Although the BHI has proved a useful tool in condensing information on estuarine fish assemblages into a single numerical value, the index is only based on presence/absence data and does not take into account the relative proportions of the various species present. Furthermore, the BHI formula incorporates two separate measures, health and importance, and combines these into a single index. The health component (J) is a measure of the degree to which the present condition of an estuary deviates from some reference condition while the importance component [$\ln P / \ln P_{\max}$] reflects its contribution to the region as a whole.

The aim of this section is to provide an assessment of the fish community status or 'health' of South Africa's estuaries using a number of community attributes including species richness, composition and relative abundance. Environmental stress or degradation generally results in a change in the number of species (richness), their identity and their relative abundance from 'diverse' communities consisting of many species in relatively low proportions to 'simple' assemblages dominated by a few species (Odum, 1983; Fausch *et al.*, 1990).

3.6.2 Methods

For each estuary sampled, the number of species and their relative abundance was calculated. However, to view this fish community data in context, reference or baseline conditions are needed against which this data can be compared (EPA, 1990; Fausch *et al.*, 1990; Roux *et al.*, 1993). The fish community characteristics of each estuary type within each biogeographic region, described in the previous section was used as a reference here. In the case of cool-temperate estuaries, the community characteristics of the entire region was used as the reference condition. This is due to the low number of estuaries and the poor species diversity of the region.

The number of species captured in each estuary was compared to the average number (95% confidence) for the group to which it belonged. Since species diversity tends to be reduced in stressed biotic communities (Odum, 1983), all exotic and translocated species were first removed from each estuary as their inclusion would artificially increase the species richness of the estuaries in which they occurred. Each estuary was then rated according to whether the number of taxa exceeded the average (>95% upper confidence interval), approximated the average (95% confidence) or was below the average (<95% lower confidence interval) of its reference group. Scores of 5, 3, and 1 were assigned to each of the ratings respectively.

A comparison of the amount of overlap in species composition or relative abundances of a sample and some reference condition can be used to indicate biological integrity (Fausch *et al.*, 1990). The species assemblage of each estuary was compared with a reference species assemblage of each estuary type based on the most frequently captured taxa. The most frequently captured species for each group of estuary types corresponding to the upper 95% confidence interval of the mean number of taxa was selected as the reference. The species composition of each system was then compared to the reference assemblage using the Bray-Curtis measure based on presence/absence. In this form the calculation is similar to Sørensen's similarity coefficient (IS_S) which measures the ratio of the common to the average number of species in two samples (Clarke & Warwick, 1994). By expressing the actually measured coinciding species occurrences against theoretically possible ones, this index includes a statistical probability term (Mueller-Dombois & Ellenberg, 1974).

An assessment of the proportions of the various species present in each estuary was also undertaken by comparing the percent abundance of the species within each estuary with the percent abundance of the species captured in the group to which it belonged. The number of species corresponding to the upper 95% confidence interval of the mean number of taxa was chosen as the cut-off. The percent species abundance of each estuary was compared with its reference community using the Bray-Curtis similarity measure. In both the qualitative and quantitative assessments, exotic and translocated species were included in the assemblages for each estuary type, but were excluded from the reference condition. The

reason for this is that the contribution of exotic species to the fish community structure of an estuary is indicative of a deviation from the norm or reference conditions particularly in terms of their relative abundance. To keep the similarity values within the range 0 to 10, the Bray-Curtis measure was adjusted by dividing the percent similarity results by 10.

For both the qualitative and quantitative assessments, the estuaries were rated according to whether the fish communities approximated, deviated slightly from, or deviated strongly from the reference condition based on the 10th and 50th percentiles of the similarity values for ALL the estuaries. Scores were assigned to each of the categories where similarity values above the 50th percentile were assigned a score of 5, similarities between the 50th and 10th percentiles had a score of 3, and similarity values below the 10th percentile had a score of 1.

3.6.3 Results & discussion

Cool-temperate estuaries

For estuaries in the cool-temperate region, the species richness of seven systems exceeded the upper 95% confidence limit of the average number of species for the entire region. Nine estuaries had an average (95% confidence) species richness while the species richness of the remaining eight systems fell below the lower 95% confidence interval (Figure 3.9). Estuaries which were relatively species poor were mostly small systems while those which had high numbers of species were generally larger estuaries.

Based on presence/absence of species, three systems (Olifants, Bot and Klein) exhibited a high similarity to the reference fish assemblage of the region. Thirteen systems exhibited a moderate similarity to the total reference assemblage while the remaining eight estuaries yielded a relatively low similarity (Figure 3.10).

A comparison of relative abundance revealed that the vast majority of the estuaries in the region had a relatively high similarity to the reference (Figure 3.11). This is probably due to the high dominance of *L. richardsonii* in the region. Two systems, the Sand and Kleinmond had relatively low similarity values. Although the Sand had a high species richness, the low similarity based on relative abundance may be a reflection of the high numerical dominance of *G. aestuaria* in the system. This species accounted for 78% of the total number of fishes captured in the Sand. A similar situation may have occurred in the Kleinmond where *P. knysnaensis* was the dominant species, accounting for over 75% of the total catch numerically.

In terms of their overall fish communities, only two systems, the Krom and Kleinmond, had relatively low scores in the region (Figure 3.12).

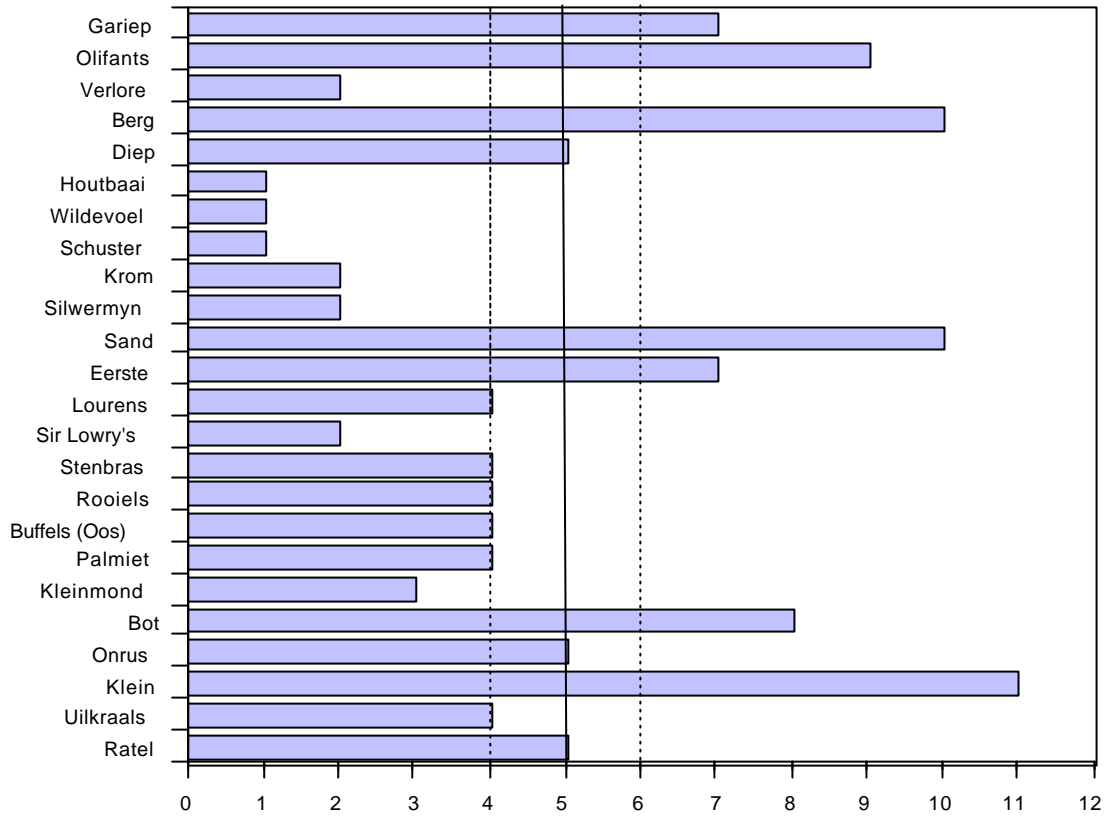


Figure 3.9. Species richness of estuaries in the cool-temperate region. The mean number of taxa and the 95% confidence intervals for all estuaries in the region are also indicated.

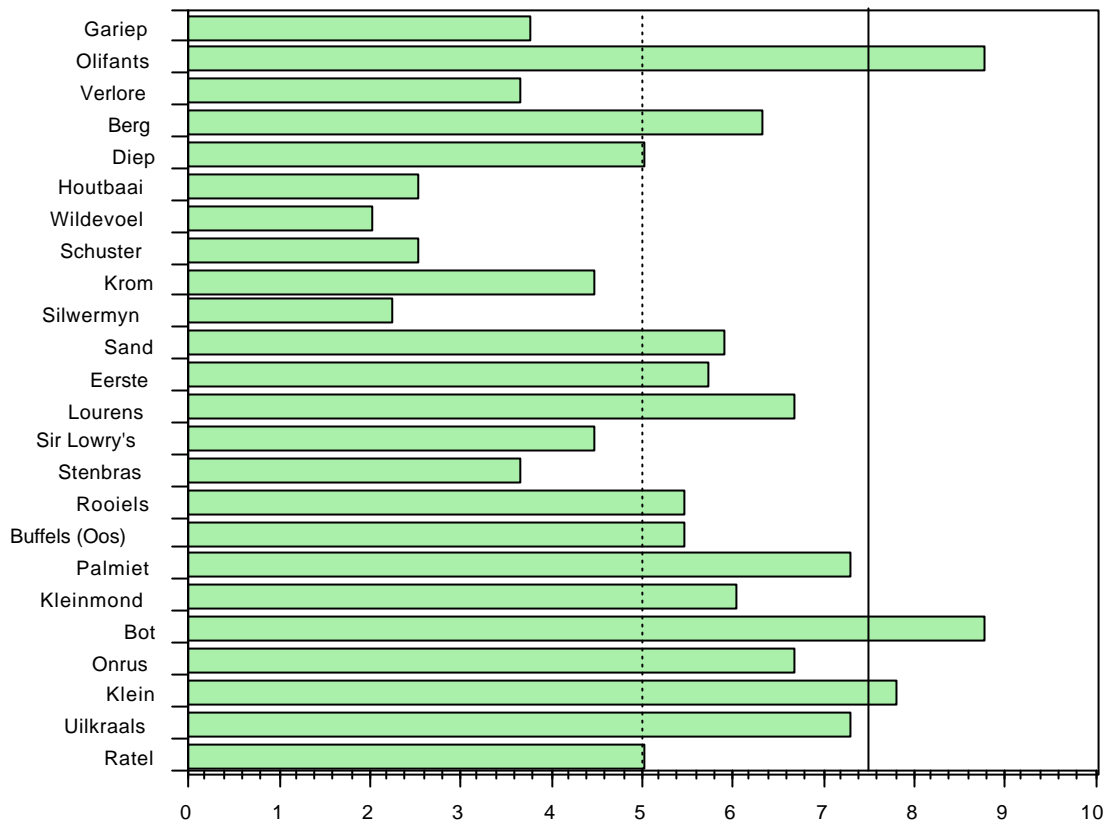


Figure 3.10. Bray-Curtis similarities (based on presence/absence) of fish assemblages of cool-temperate estuaries to the most frequently captured species in the region. The 10th and 50th percentiles of the similarity values are also indicated.

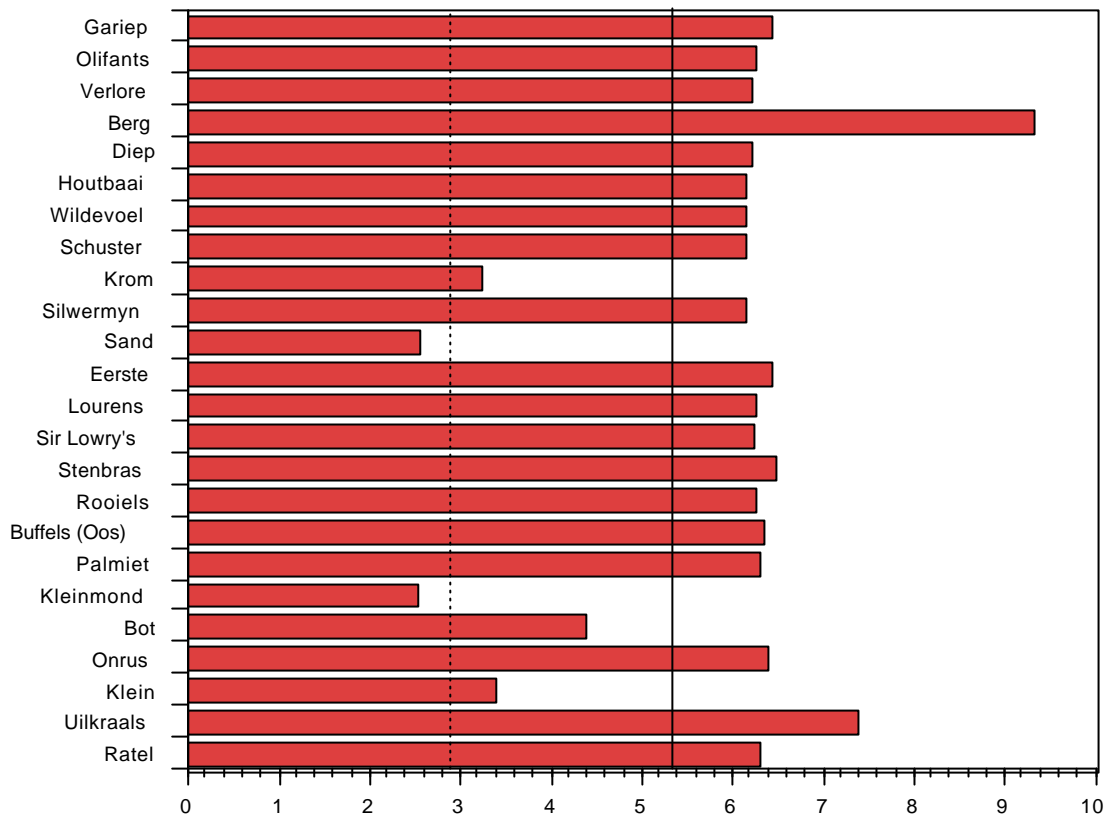


Figure 3.11. Bray-Curtis similarities (based on % abundance) of fish assemblages of cool-temperate estuaries to the most frequently captured species in the region. The 10th and 50th percentiles of the similarity values are also indicated.

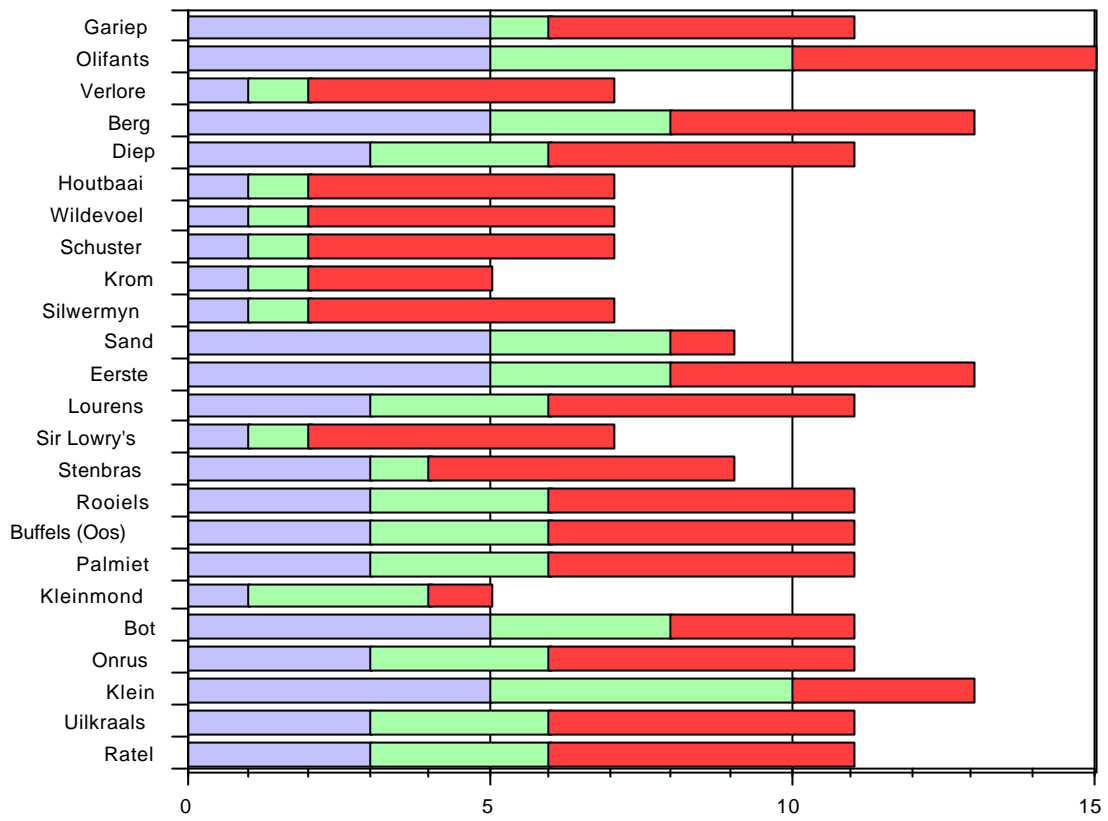


Figure 3.12. Rating of cool-temperate estuaries based on species richness, presence/absence and % abundance of their fish communities.

Warm-temperate estuaries

Type A estuaries

For type A estuaries in the warm-temperate zone, six systems had a species richness above the average for the group. Seven estuaries had an average (95% confidence) species richness and the remaining four systems had a species richness below the average (< lower 95% confidence interval) for the group (Figure 3.13).

In terms of their species assemblages, six systems had relatively high similarity values, eight estuaries had moderate values and three systems (Matjies, Slang, Mtendwe) had relatively low similarities (Figure 3.14). In the case of the Matjies and Slang this is probably a reflection of the low number of species captured in these systems.

Based on the relative abundance of their species, six estuaries had relatively high similarity values, eight systems exhibited moderate similarities, and the remaining three systems had relatively low similarities (Figure 3.15). These were the Klipdriffontein, Klipdrif (Oos) and Slang. In the case of the Klipdriffontein and Klipdrif (Oos), the high numerical dominance of *L. richardsonii* (93% and 97% respectively) may account their low similarity values. The fish community of the Slang was dominated by juvenile mullet (98%) and this probably also accounted for its low similarity to the reference community.

In terms of their overall fish communities, 11 estuaries were rated relatively high, two systems had moderate overall ratings, and the remaining four estuaries had relatively poor ratings (Figure 3.16).

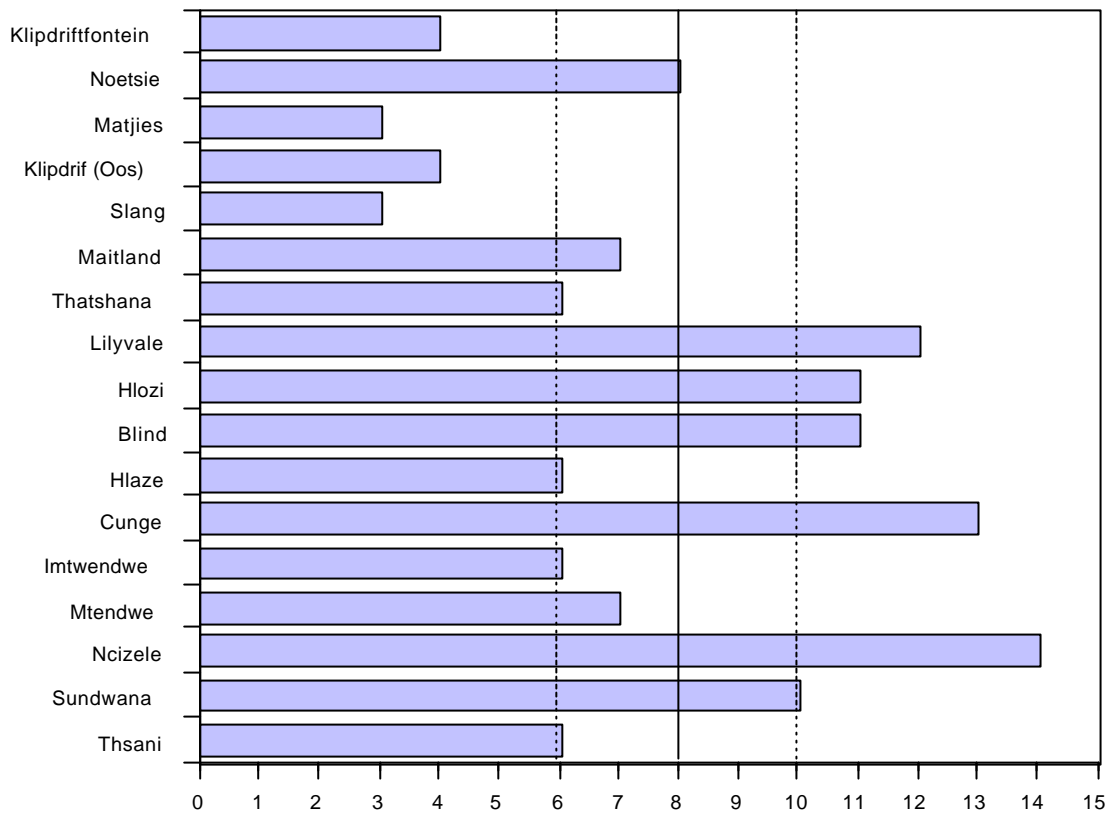


Figure 3.13. Species richness of type A estuaries in the warm-temperate region. The mean number of taxa and the 95% confidence interval for all type A estuaries in the region are also indicated.

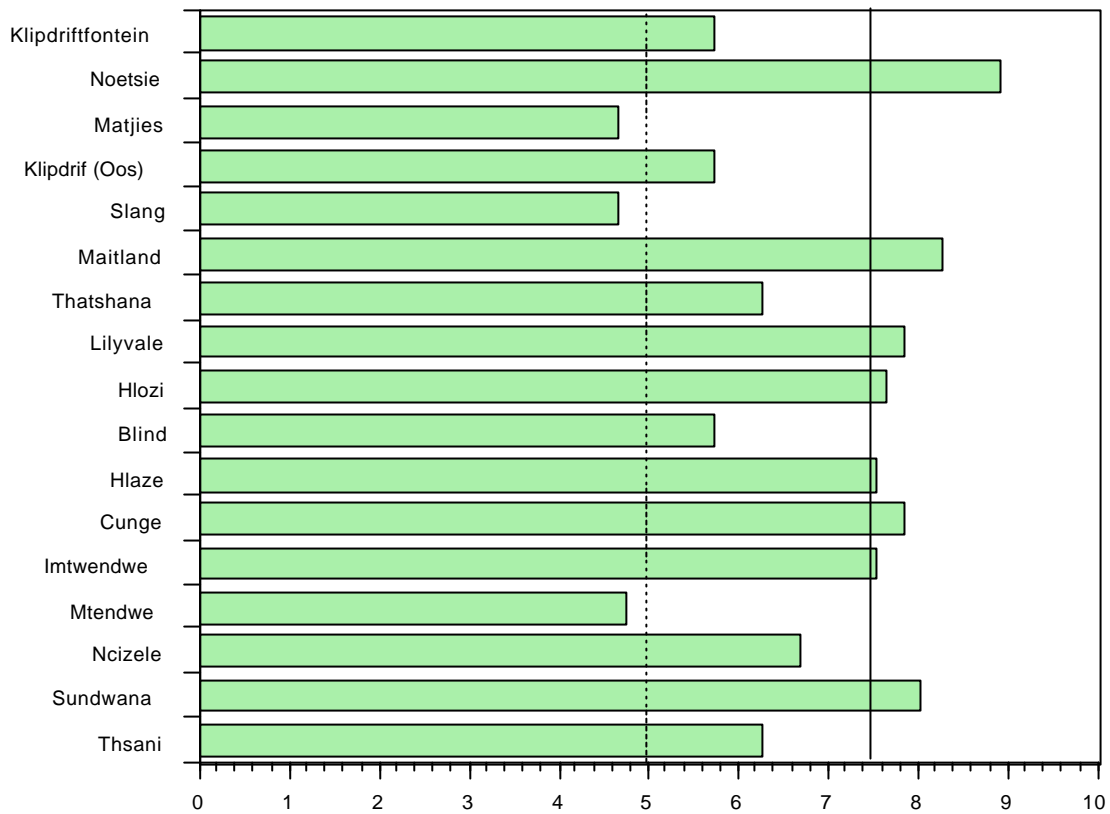


Figure 3.14. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type A estuaries to the most frequently captured species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

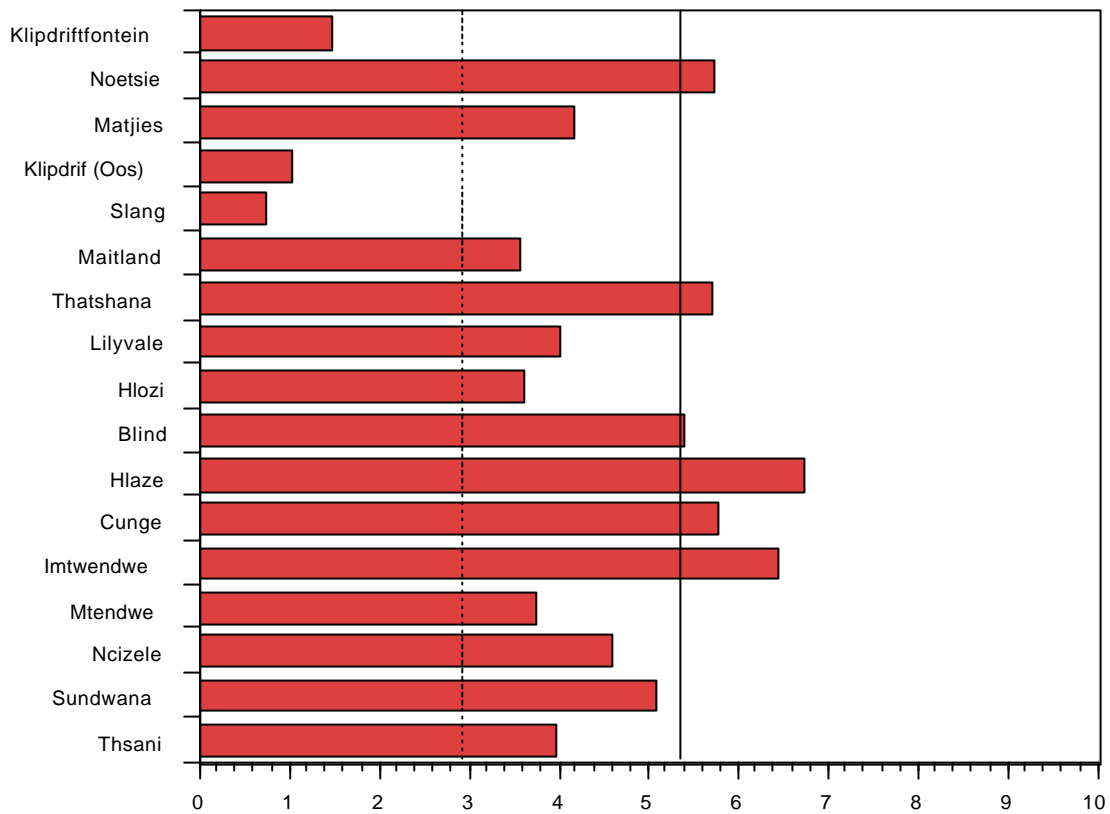


Figure 3.15. Bray-Curtis similarities (based on % abundance) of fish assemblages of type A estuaries to the most abundant species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

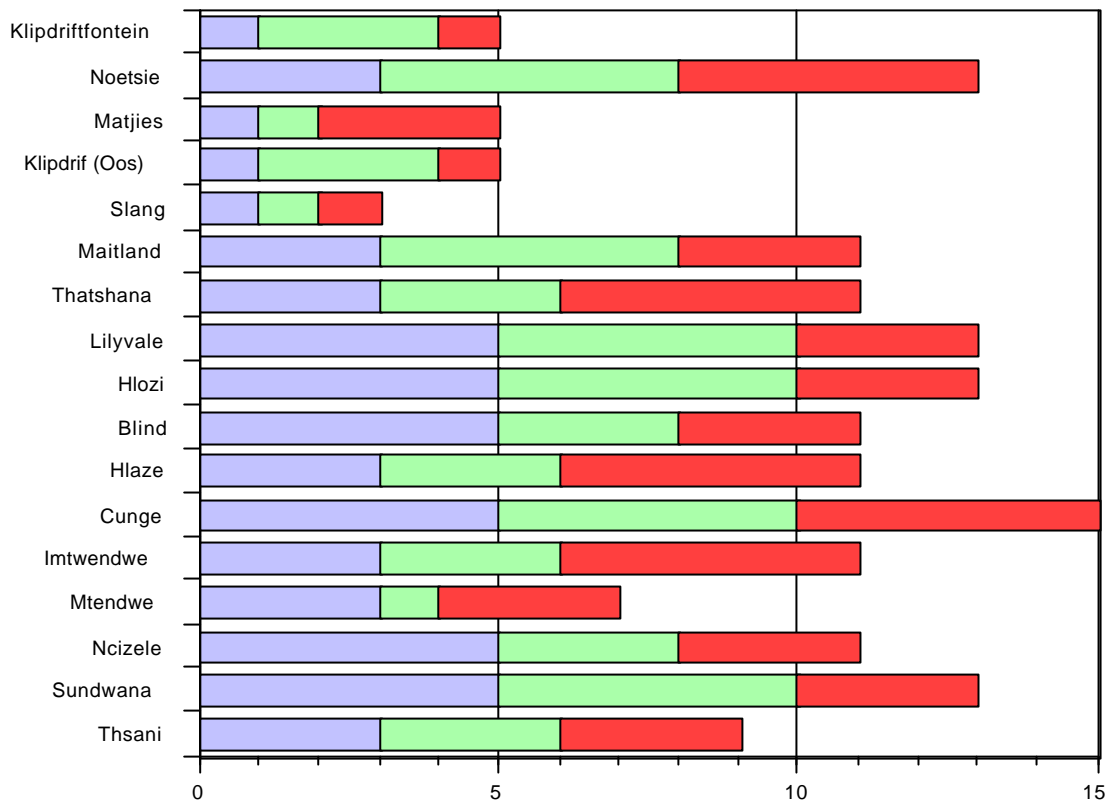


Figure 3.16. Rating of type A estuaries in the warm-temperate region based on species richness, presence/absence and % abundance of their fish communities.

Type B estuaries

Sixteen type B estuaries had a species richness above the upper 95% confidence interval of the mean for the group. Twelve systems had an average (95% confidence) species richness and the remaining 14 had a richness below the lower 95% confidence interval of the average (Figure 3.17).

In terms of presence/absence, most of the estuaries had relatively high similarities, seven systems had moderate similarity values and only one estuary (Groot (Wes)) had a relatively low similarity (Figure 3.18). This is probably a result of the low number of species captured in the system during this survey.

Based on relative abundance, 30 estuaries had relatively high similarity values and nine systems were moderately similar to the reference assemblage. The remaining three estuaries (Touw, Groot (Wes), Ngogwane) had relatively low similarity values (Figure 3.19) suggesting that these systems were dominated by different species in relation to the reference. The Touw estuary was dominated by *L. richardsonii* (37%), *R. holubi* (18%), and *Liza* spp. (13%) while the Groot (Wes) was dominated by *L. lithognathus* (34%), *L. richardsonii* (30%) and *P. knysnaensis* (25%). The dominant fishes captured in the Ngogwane were *M. capensis* (76%) and *G. aestuaria* (11%).

A total of 31 estuaries in type B had a good overall rating based on all three measures of their fish communities. Ten systems had a moderate overall rating while only one estuary, Groot (Wes), had a low overall rating (Figure 3.20).

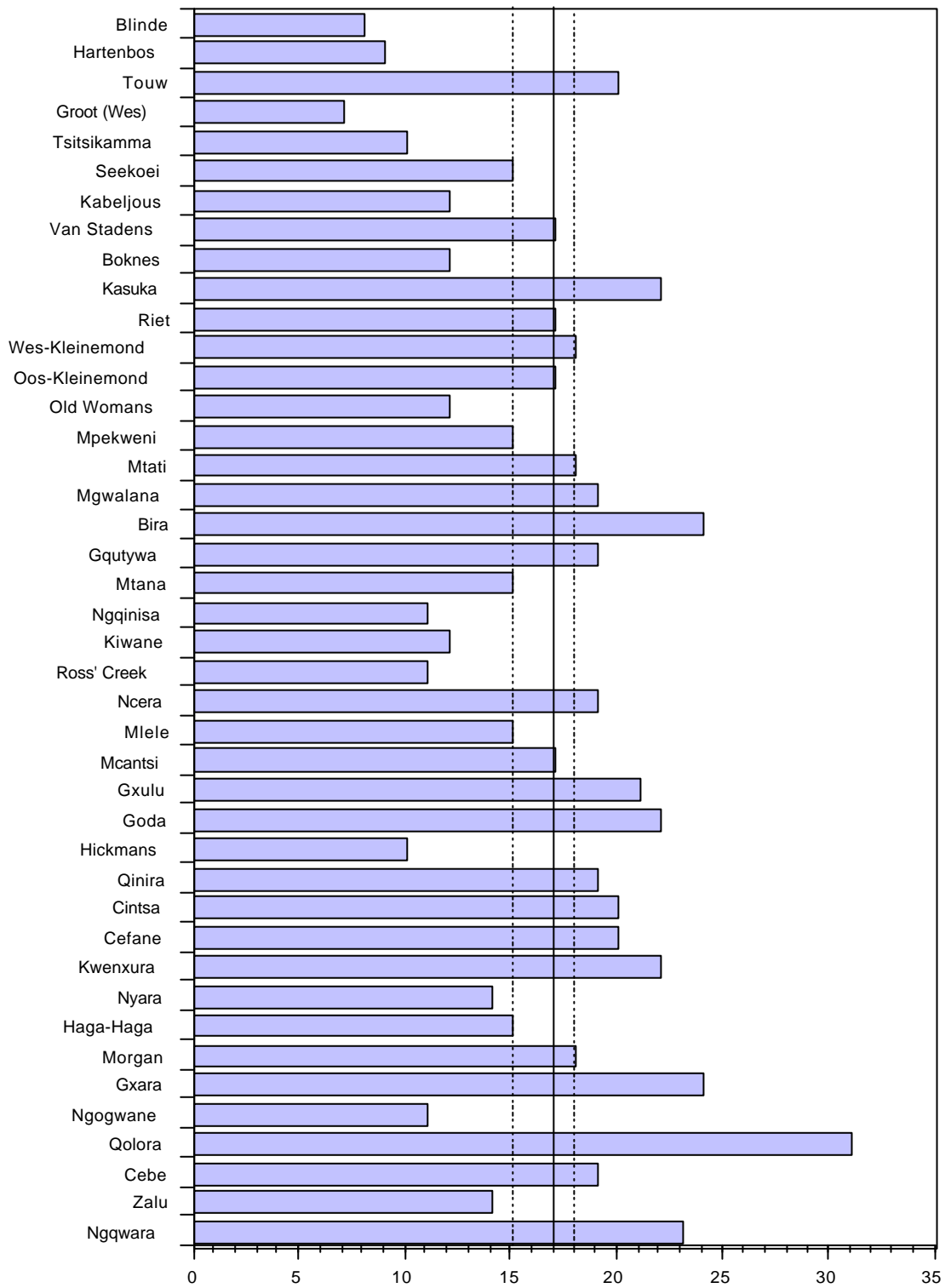


Figure 3.17. Species richness of type B estuaries in the warm-temperate region. The mean number of taxa and the 95% confidence interval for all type B estuaries in the region are also indicated.

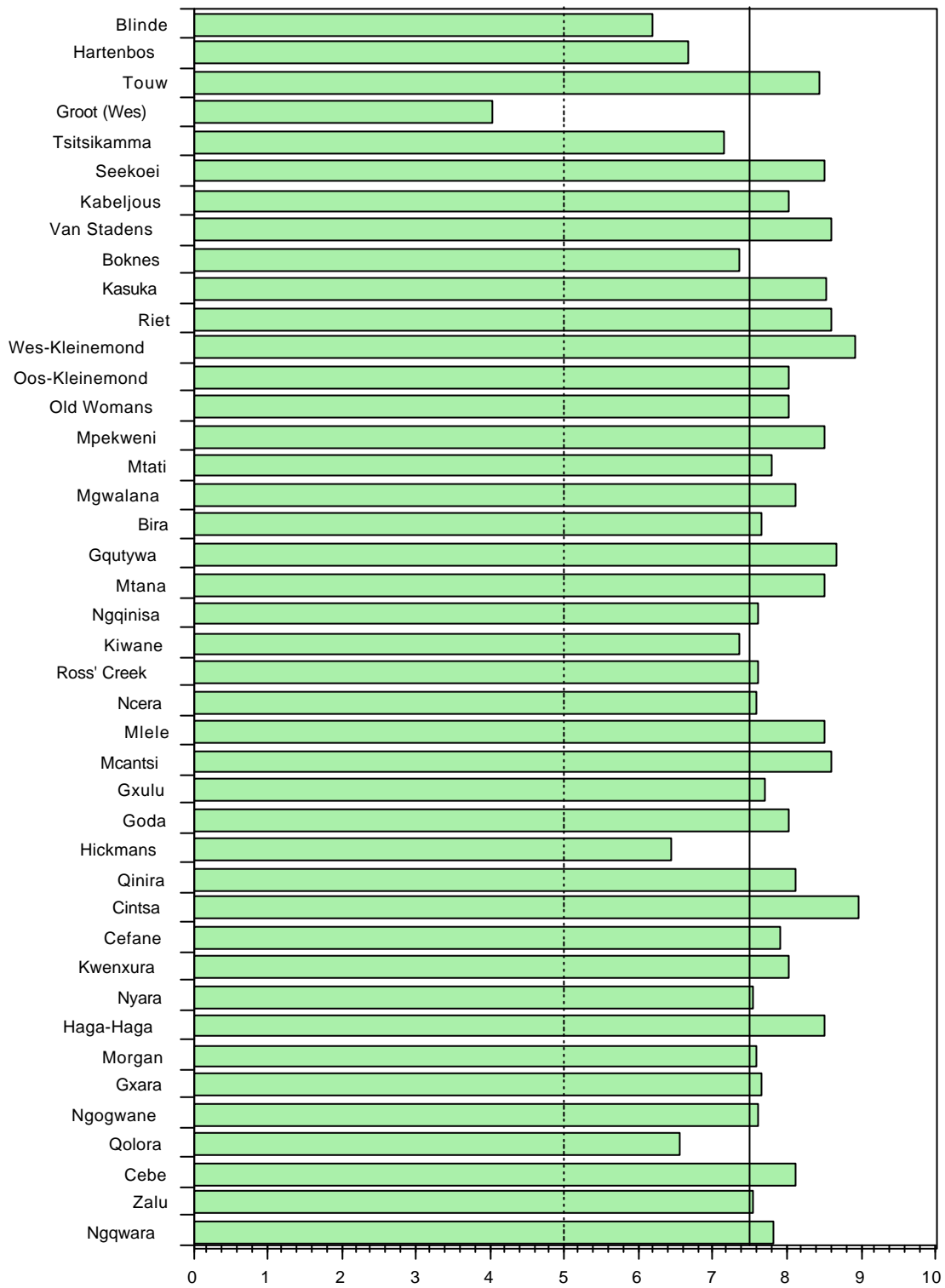


Figure 3.18. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type B estuaries to the most frequently captured species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

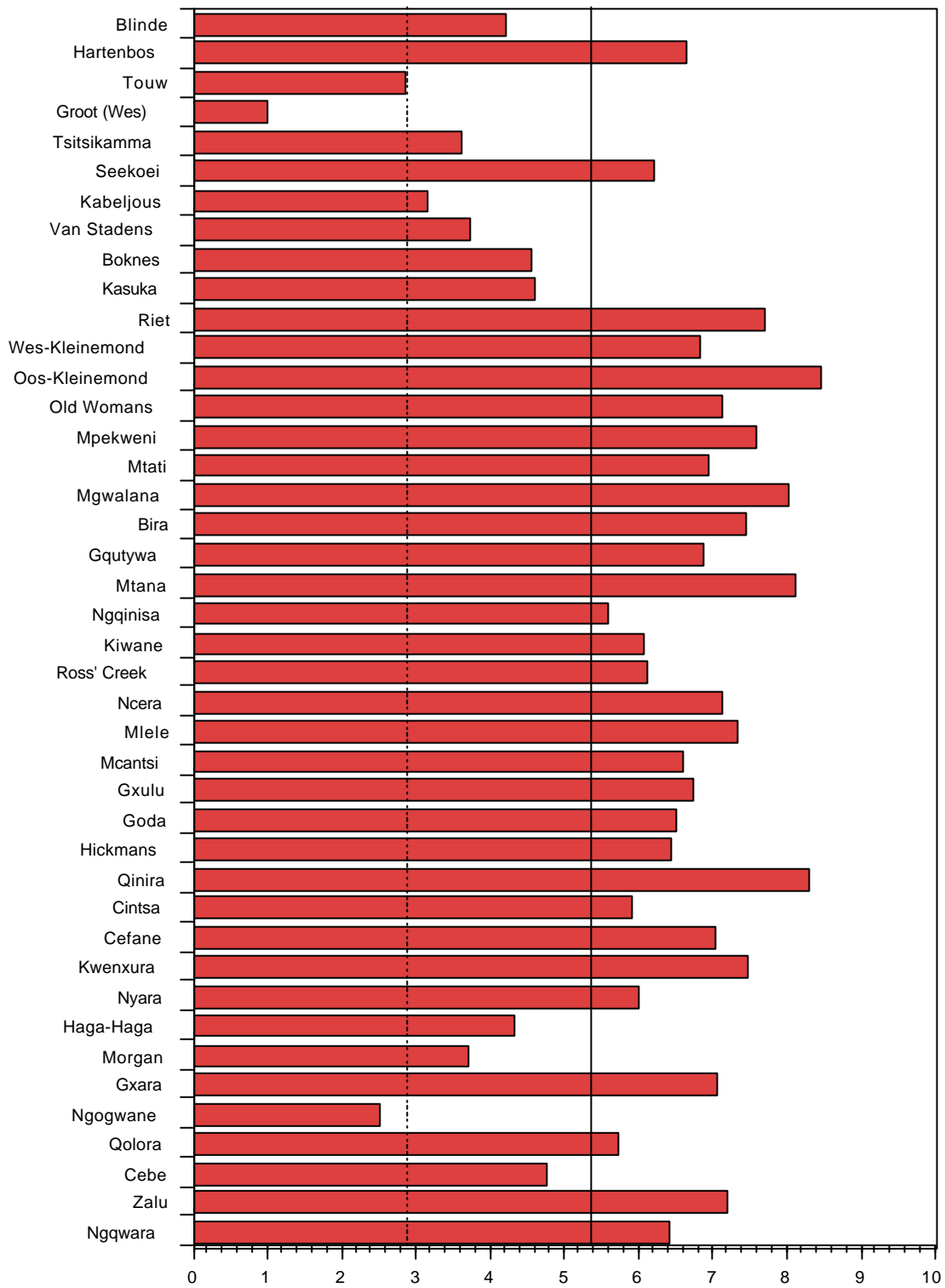


Figure 3.19. Bray-Curtis similarities (based on % abundance) of fish assemblages of type B estuaries to the most abundant species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

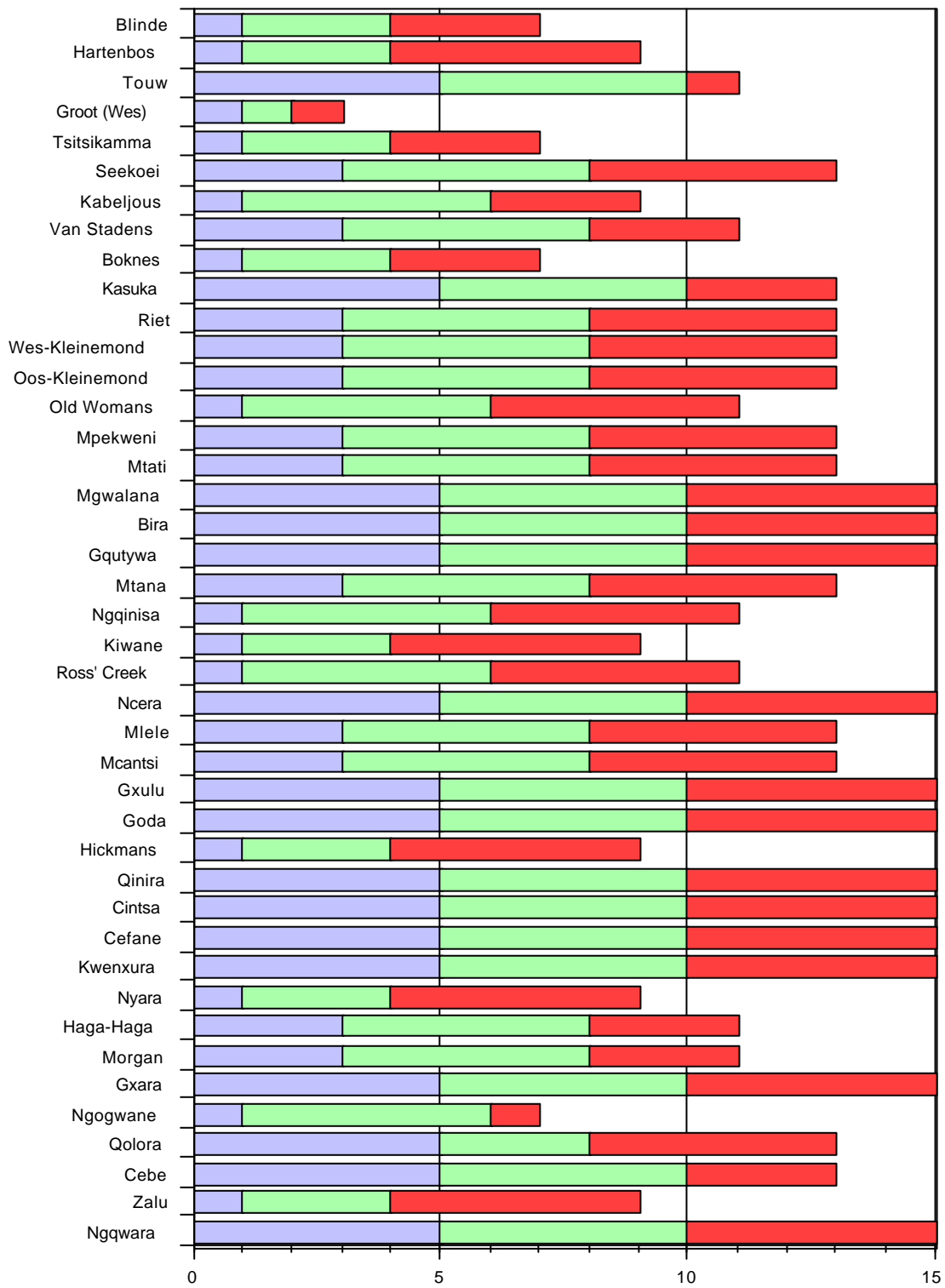


Figure 3.20. Rating of type B estuaries in the warm-temperate region based on species richness, presence/absence and % abundance of their fish communities.

Type D estuaries

In type D systems, four estuaries had species richness values which exceeded the upper 95% confidence interval of the mean for the group. Four estuaries had an average (95% confidence) species richness and two systems, the Lottering and Storms, had a below average (< lower 95% confidence limit) species richness (Figure 3.21).

Based on their species assemblages, two systems (Gwaing and Elands) had relatively high similarity values, six systems had a moderate similarities and the remaining two systems (Storms and Lottering) had relatively low similarity values (Figure 3.22).

In terms of relative species abundance, two estuaries (Maalgate and Groot (Oos) had high similarity values, three had moderate similarities and five estuaries had relatively low similarity values (Figure 3.23). Of these estuaries, a high dominance by *L. richardsonii*, *M. capensis*, and *M. falciformis* may account for the low similarity values of the Gwaing, Lottering and Storms respectively. *Liza richardsonii* accounted for 96% of the total catch in the Gwaing, *M. capensis* comprised 98% of the fish total abundance in the Lottering and *M. falciformis* comprised 81% of the catch in the Storms. In the case of the Kaaimans and Sout, the low similarity values may be a reflection of these systems being dominated by different species in relation to the reference assemblage.

Overall, three estuaries in this group had a high rating based on all three fish community parameters. Five estuaries were rated moderately and the remaining two estuaries (Lottering and Storms) had a low overall rating (Figure 3.24). The low overall rating in the Storms may be a reflection of sampling difficulties as this system is very deep and fjord-like.

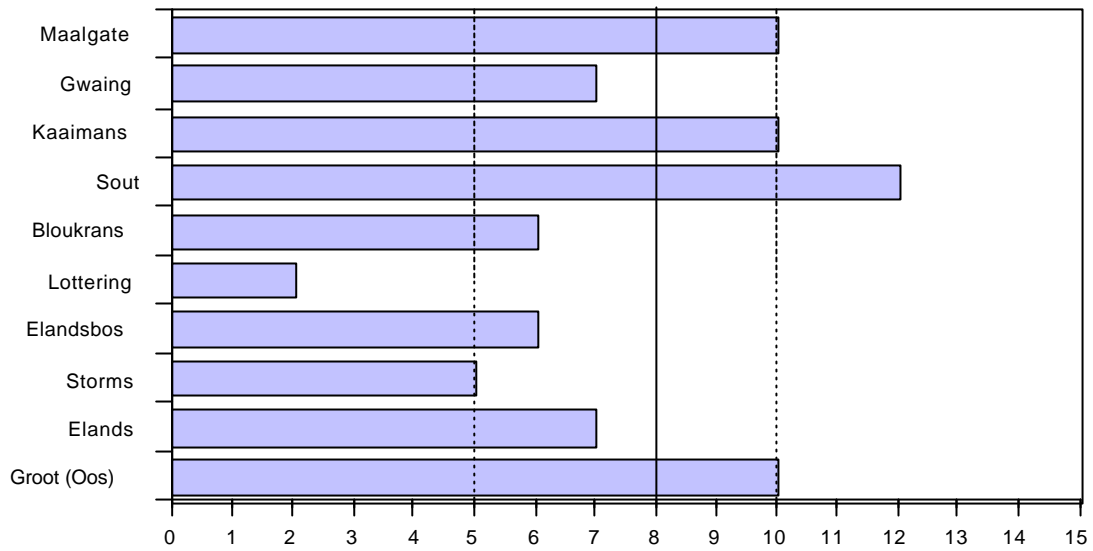


Figure 3.21. Species richness of type D estuaries in the warm-temperate region. The mean number of taxa and the 95% confidence interval for all type D estuaries in the region are also indicated.

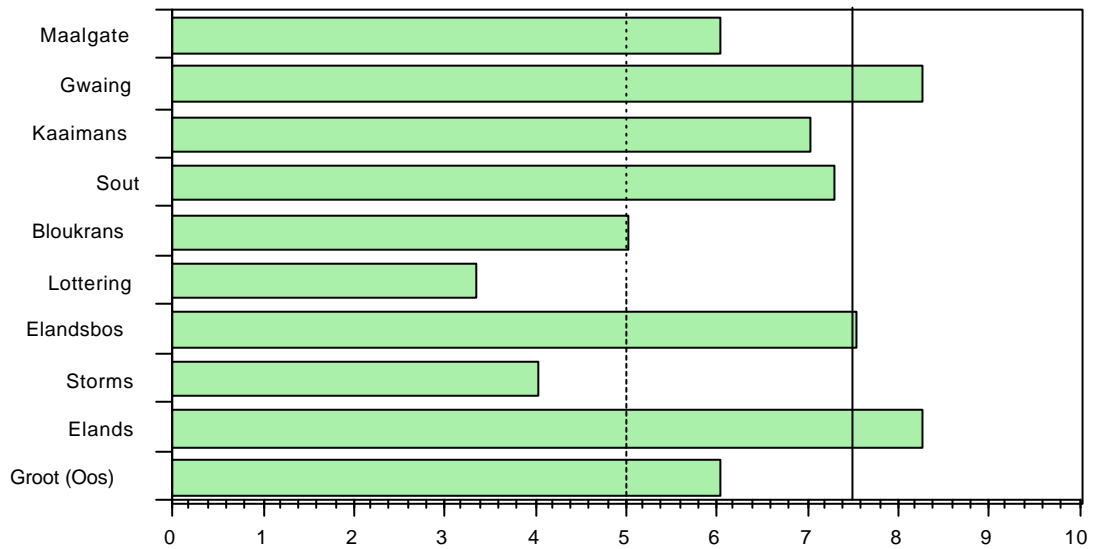


Figure 3.22. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type D estuaries to the most frequently captured species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

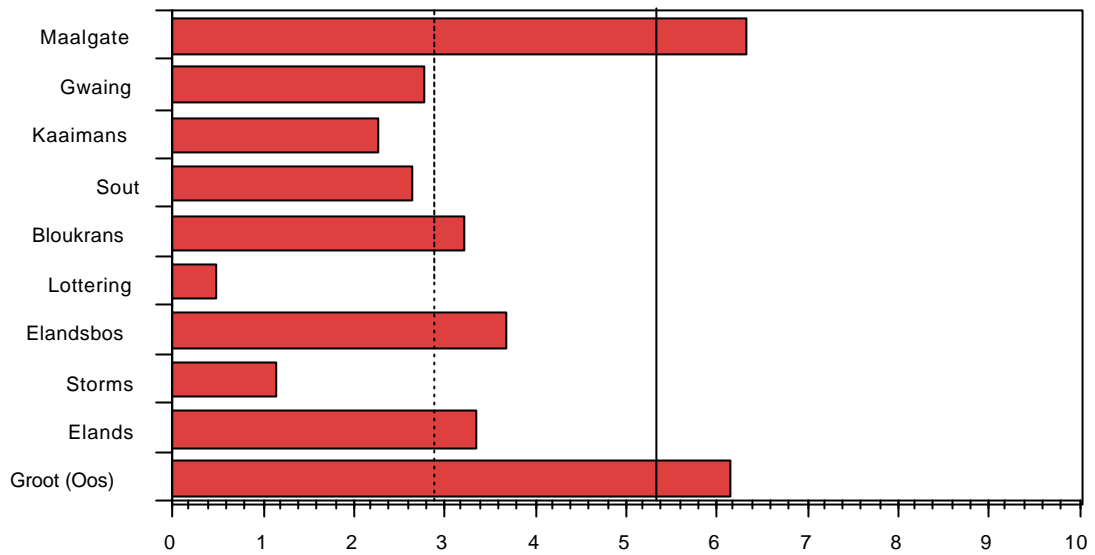


Figure 3.23. Bray-Curtis similarities (based on % abundance) of fish assemblages of type D estuaries to the most abundant species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

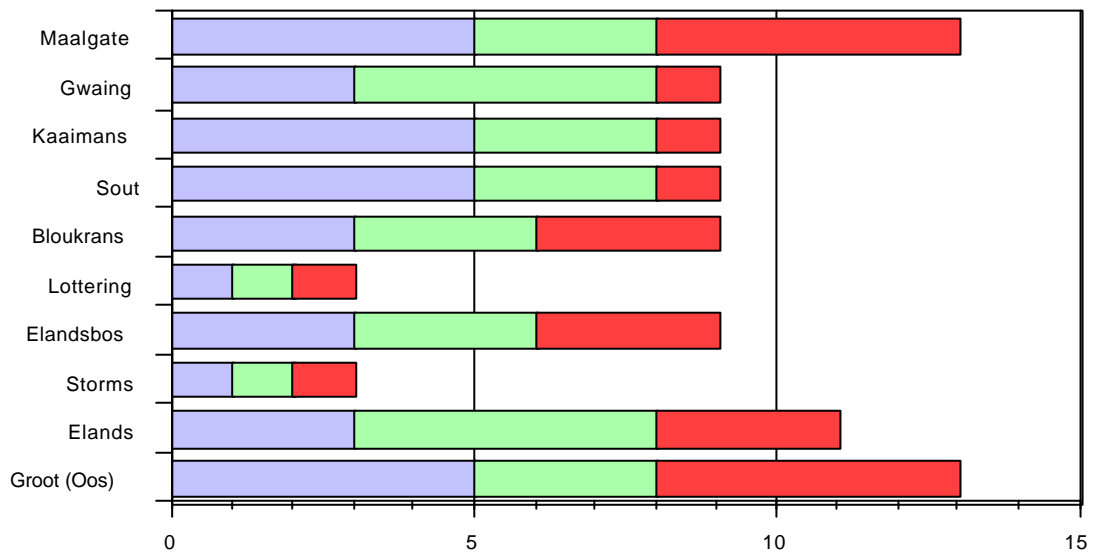


Figure 3.24. Rating of type D estuaries in the warm-temperate region based on species richness, presence/absence and % abundance of their fish communities.

Type E estuaries

Five estuaries belonging to type E in the warm-temperate region had a species richness which exceeded the average (>upper 95% confidence interval) for the group. Six systems had an average (95% confidence) species richness, and four estuaries had a species richness below the average (<lower 95% confidence interval) (Figure 3.25). Based on both presence/absence and relative abundance, all the type E estuaries in this region had moderate to high similarities to the reference communities (Figures 3.26 & 3.27). In terms of their overall ranking, nine systems were rated good while the remaining six systems had moderate ranking. No systems were rated poor (Figure 3.28).

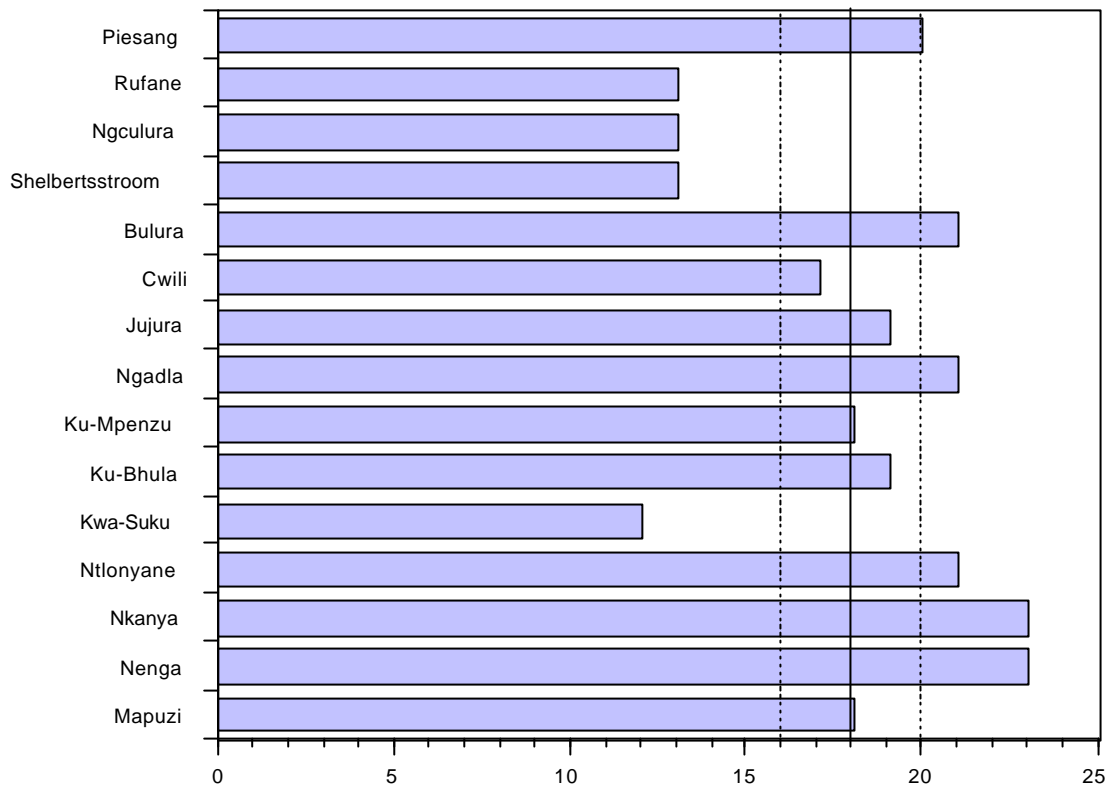


Figure 3.25. Species richness of type E estuaries in the warm-temperate region. The mean number of taxa and the 95% confidence interval for all type E estuaries in the region are also indicated.

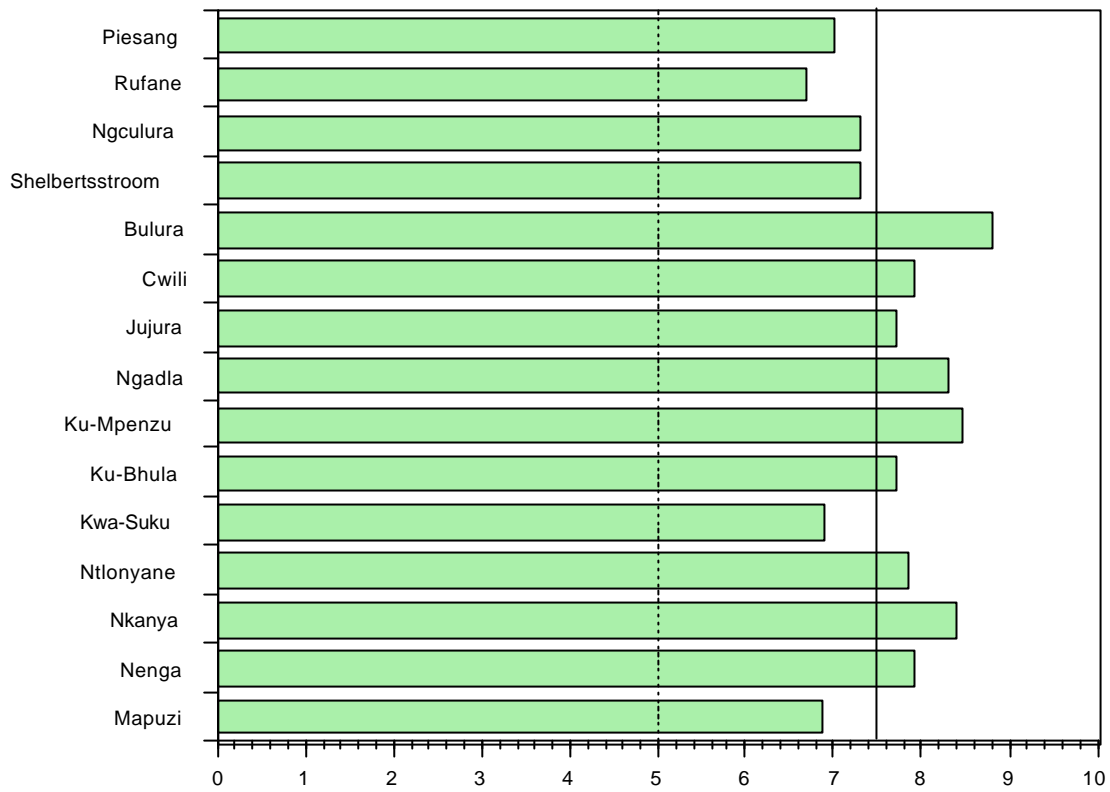


Figure 3.26. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type E estuaries to the most frequently captured species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

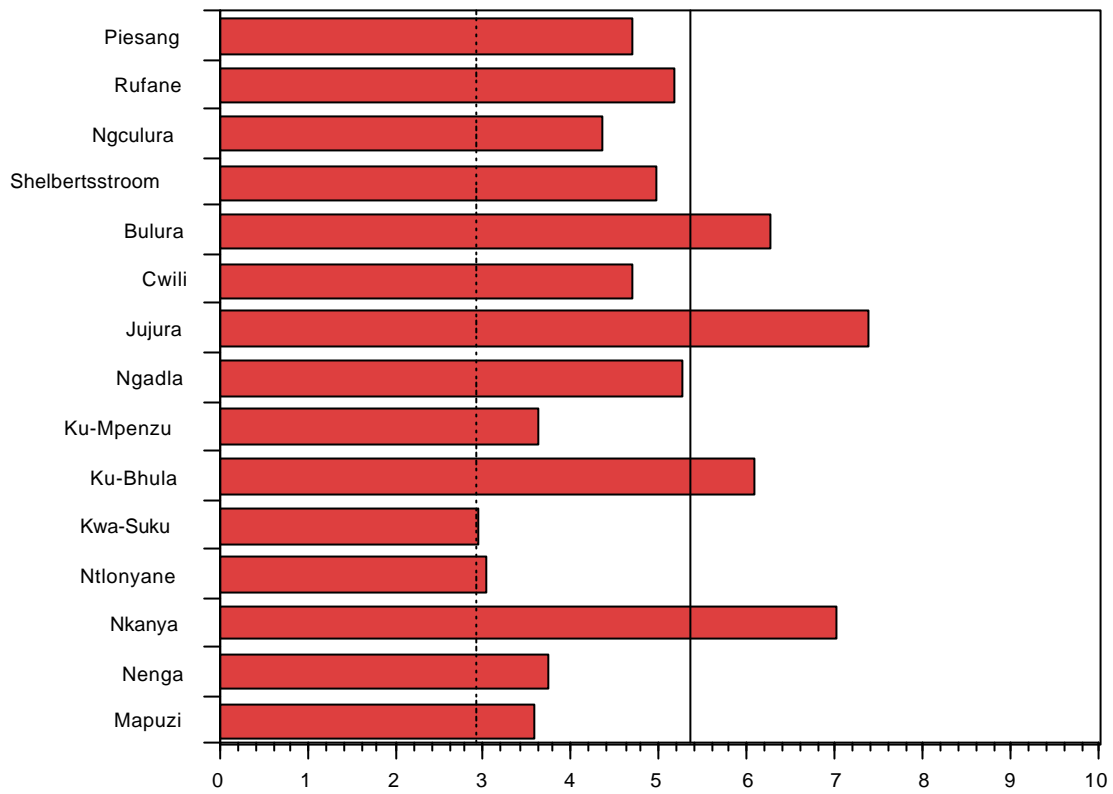


Figure 3.27. Bray-Curtis similarities (based on % abundance) of fish assemblages of type E estuaries to the most abundant species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

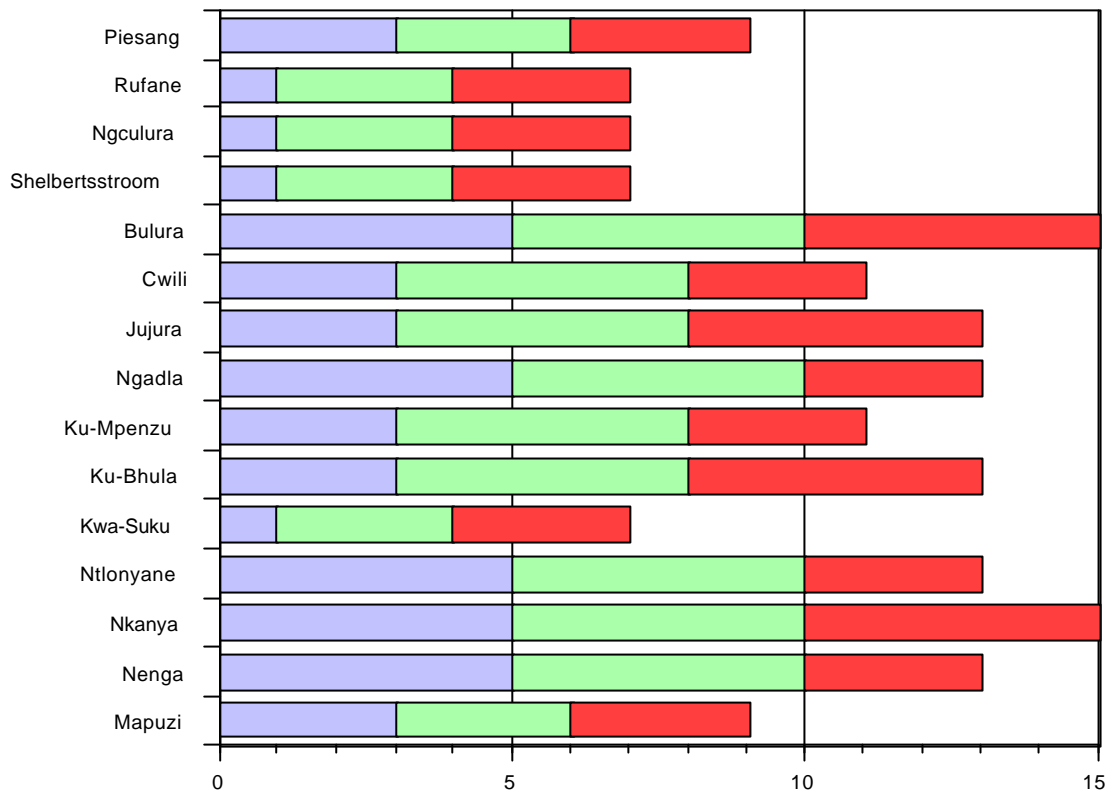


Figure 3.28. Rating of type E estuaries in the warm-temperate region based on species richness, presence/absence and % abundance of their fish communities.

Type F estuaries

Fourteen type F systems had an above average (>95% confidence interval) richness, seven systems had an average (95% confidence) species richness while the remaining 14 estuaries had a species richness below the 95% confidence interval of the average for the group (Figure 3.29). Most of these estuaries are situated at the southern limit of this biogeographic region and this may account for the relatively low species richness recorded.

In terms of their fish assemblages, all the estuaries of this type had moderate to high similarities to the reference assemblage (Figure 3.30).

Based on their species relative abundance, 20 systems had relatively high similarities, 12 estuaries had moderate similarities and the remaining three systems (Breë, Duiwenhoks, Great Kei) had relatively low similarity values (Figure 3.31). This is a reflection of these estuaries being dominated by different species in relation to the reference community. The fish community of the Breë was dominated by *L. richardsonii* (44%), *C. gilchristi* (17%) and *L. dumerilii* (10%). In the Duiwenhoks, *Liza* spp. (43%), *L. richardsonii* (29%) and *A. breviceps* (17%) were the dominant taxa. The fish fauna of the Great Kei was dominated by *M. cephalus* (20%), *S. bleekeri* (15%) and *P. commersonnii* (15%).

Overall, 21 estuaries were rated good, 12 systems had a moderate rating and two systems (Duiwenhoks and Great Kei) had relatively poor ratings (Figure 3.32).

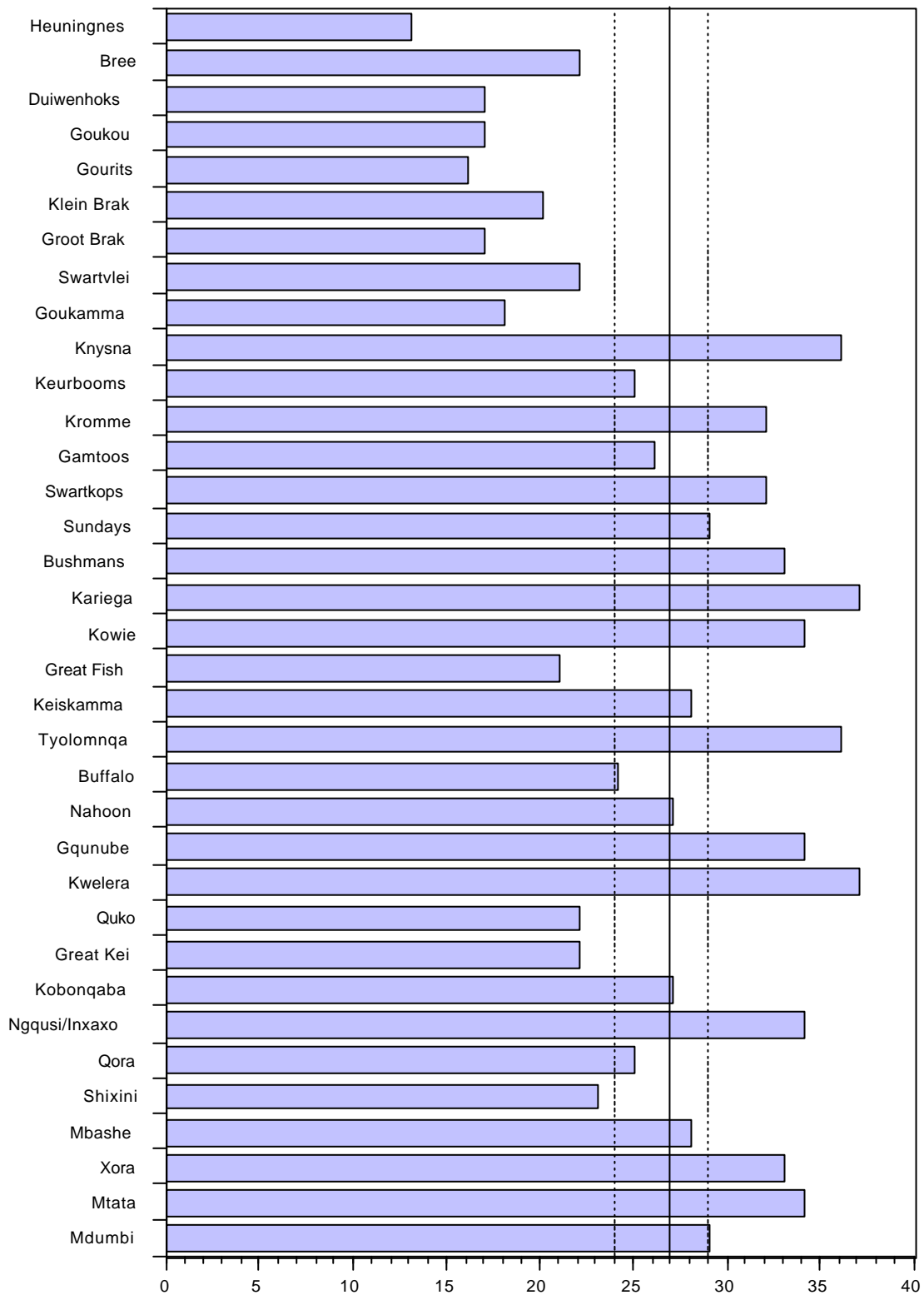


Figure 3.29. Species richness of type F estuaries in the warm-temperate region. The mean number of taxa and the 95% confidence interval for all type F estuaries in the region are also indicated.

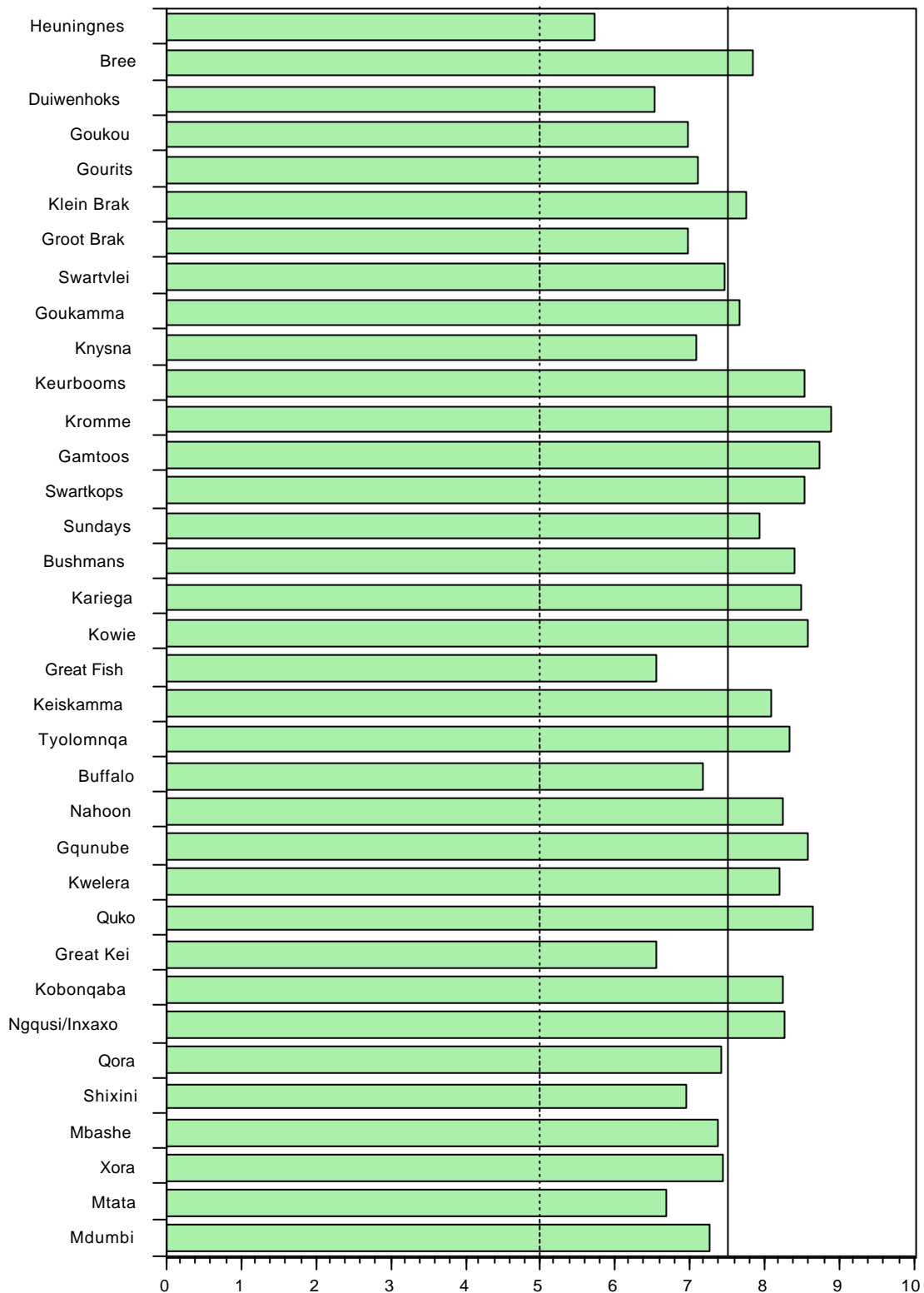


Figure 3.30. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type F estuaries to the most frequently captured species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

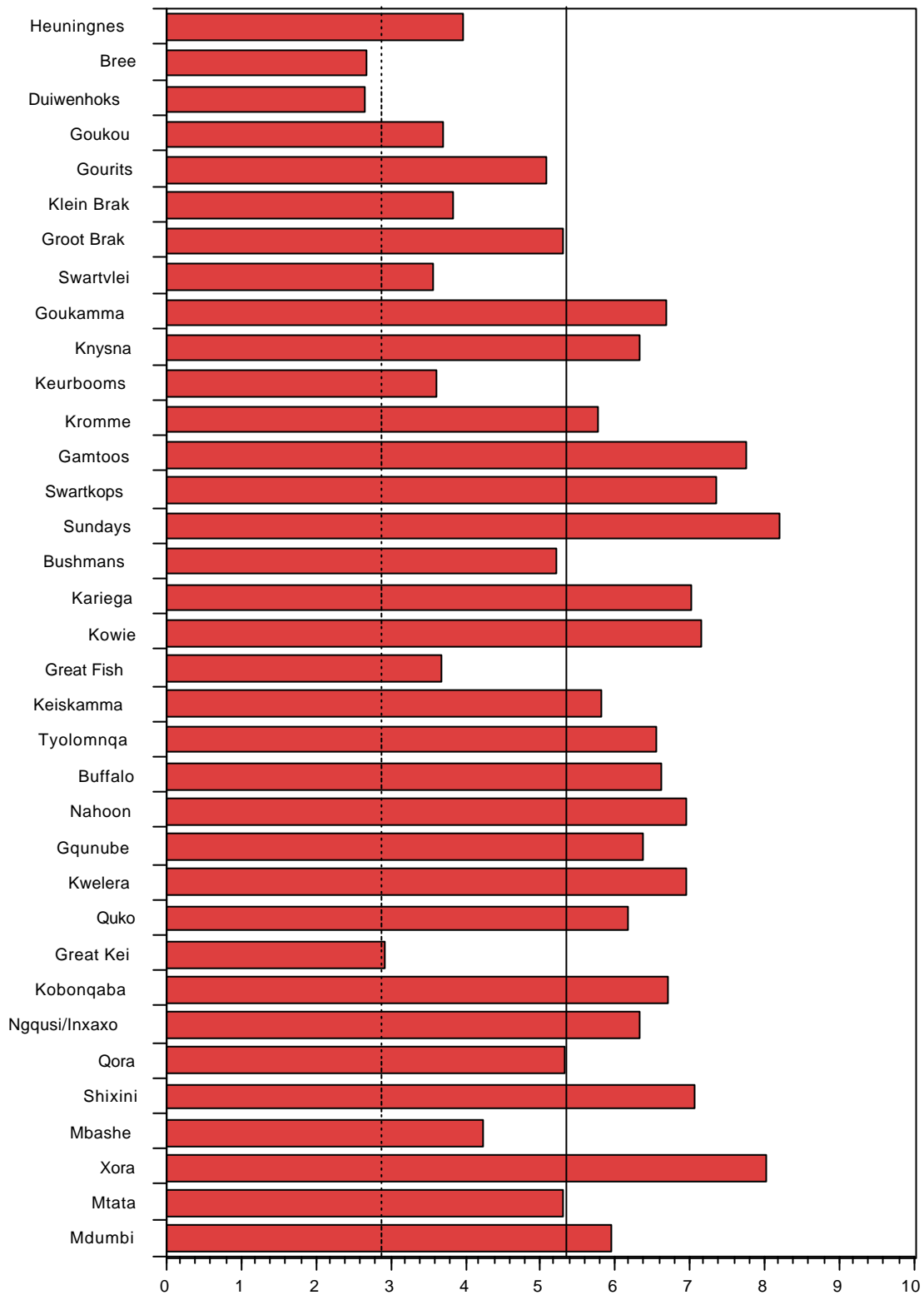


Figure 3.31. Bray-Curtis similarities (based on % abundance) of fish assemblages of type F estuaries to the most abundant species for this type of system in the warm-temperate region. The 10th and 50th percentiles of the similarity values are also indicated.

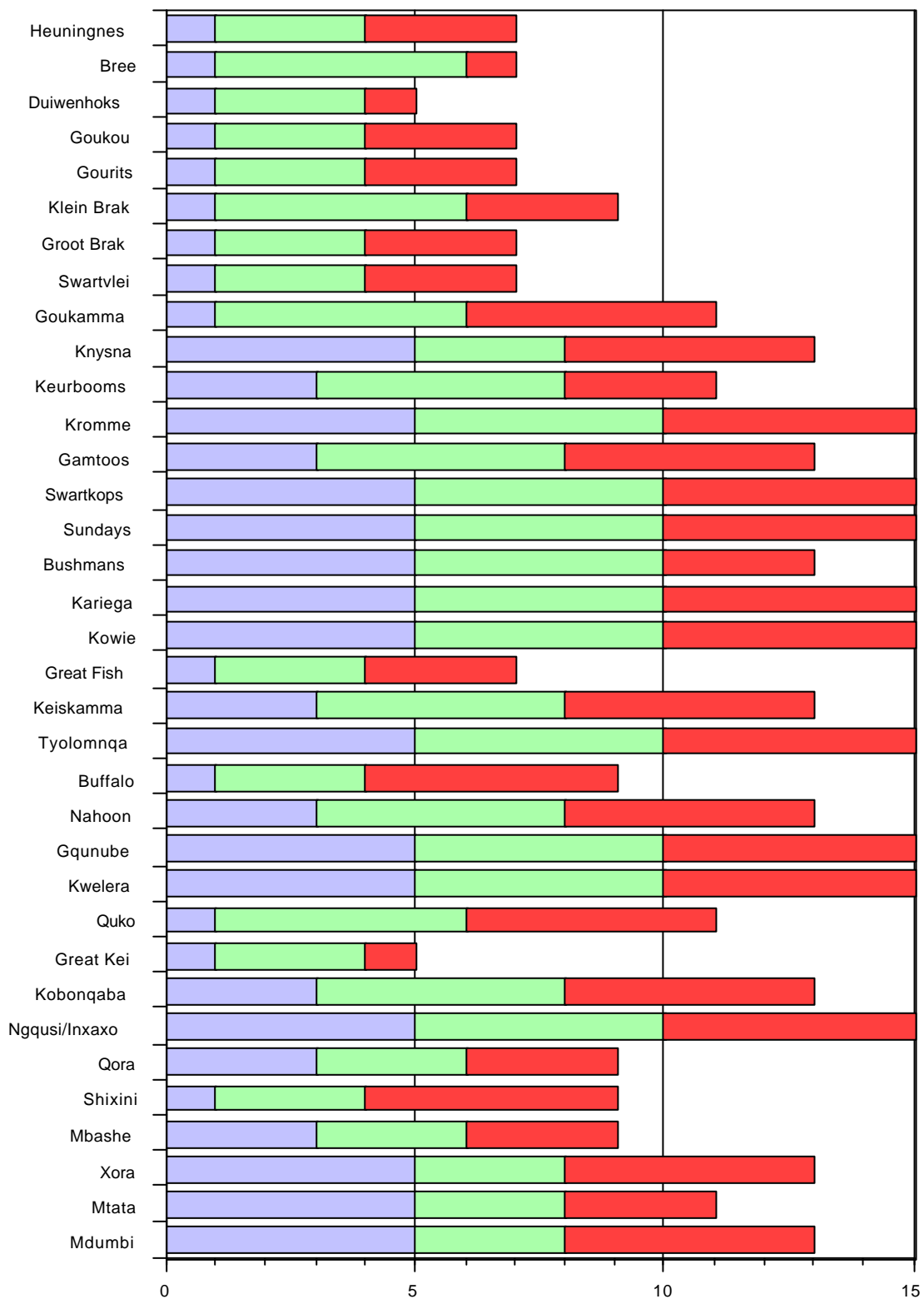


Figure 3.32. Rating of type F estuaries in the warm-temperate region based on species richness, presence/absence and % abundance of their fish communities.

Subtropical estuaries

Type A estuaries

Of the type A estuaries in the subtropical region, one system (Gxwaleni) had a relatively high species richness and one system (Damba) had a relatively low richness. The remaining four estuaries had an average (95% confidence) species richness (Figure 3.33). In terms of their fish community structure, almost all the systems had moderate to high similarities to the reference faunal assemblages both qualitatively and quantitatively. Only the Gxwaleni had a relatively low similarity based on percent species abundance (Figures 3.34 & 3.35). Overall, all the estuaries belonging to this type were rated moderate to good (Figure 3.36).

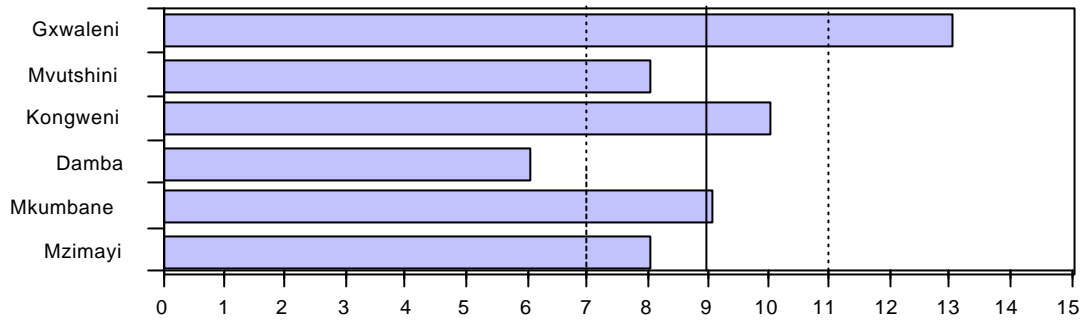


Figure 3.33. Species richness of type A estuaries in the subtropical region. The mean number of taxa and the 95% confidence interval for all type A estuaries in the region are also indicated.

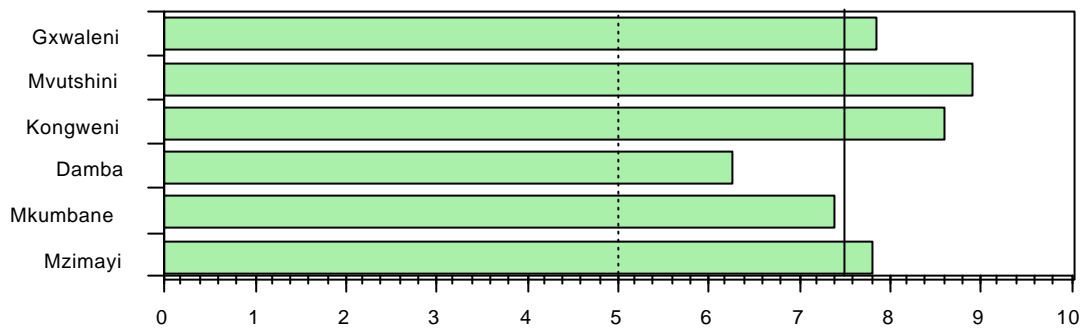


Figure 3.34. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type A estuaries to the most frequently captured species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

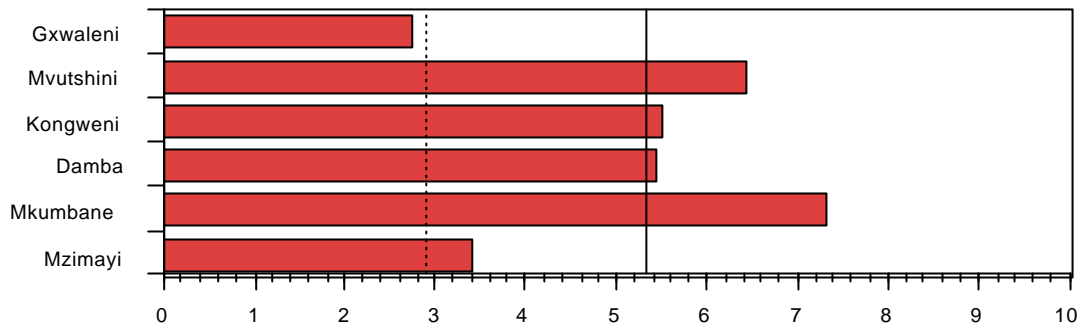


Figure 3.35. Bray-Curtis similarities (based on % abundance) of fish assemblages of type A estuaries to the most abundant species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

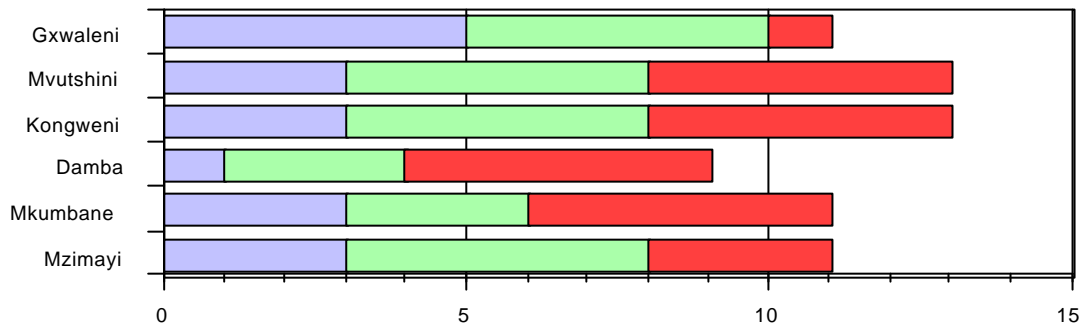


Figure 3.36. Rating of type A estuaries in the subtropical region based on species richness, presence/absence and % abundance of their fish communities.

Type B estuaries

Eight estuaries belonging to type B had a relatively high species richness, six systems had an average (95% confidence) species richness while the remaining nine estuaries had a species richness below the 95% confidence limit of the mean for this group (Figure 3.37).

The fish communities in almost all the estuaries had moderate to high similarities to the reference ichthyofaunal assemblages based on both presence/absence and percent abundance (Figures 3.38 & 3.39). The low number of species captured in the Kaba may account for its relatively low similarity value based on presence/absence. Although the Zinkwasi had a high species richness, this system had a relatively low similarity value based on percent abundance. The fish fauna in the Zinkwasi was dominated by *V. cunnesius* (34%) and *A. productus* (24%).

Overall, almost all the estuaries belonging to type B in this region had moderate to high rankings based on all three analyses. Only the Kaba had a relatively low overall rating (Figure 3.40).

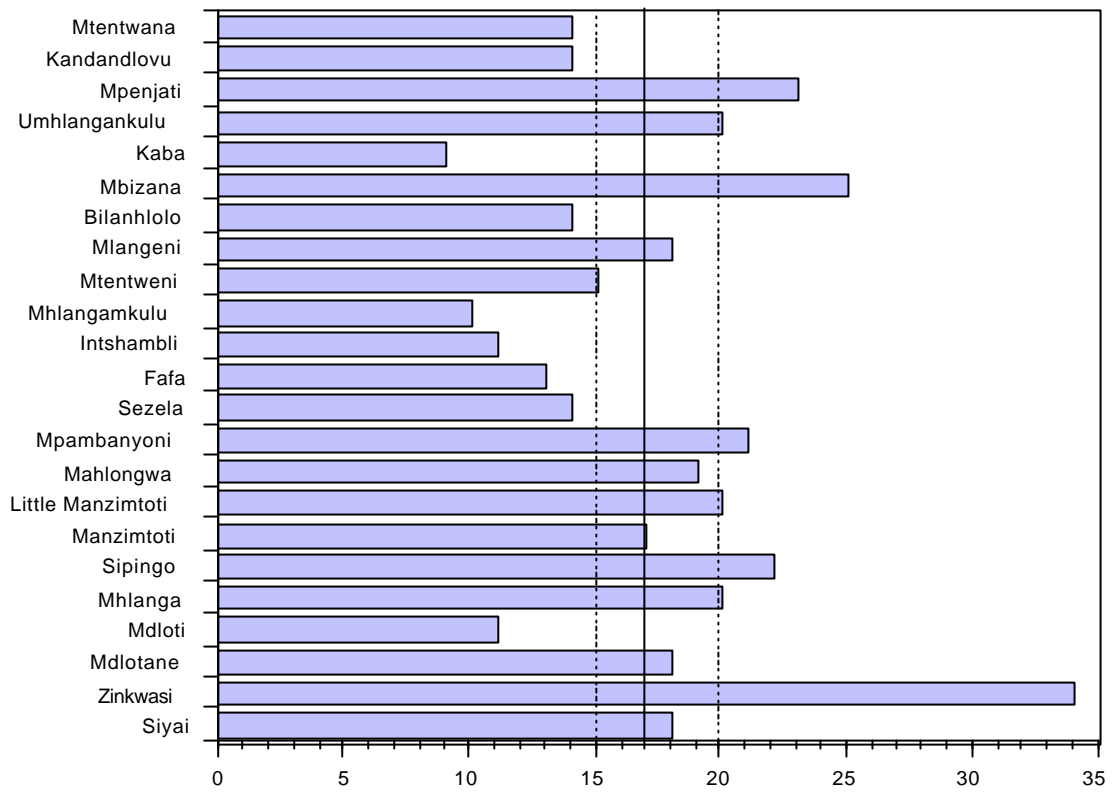


Figure 3.37. Species richness of type B estuaries in the subtropical region. The mean number of taxa and the 95% confidence interval for all type B estuaries in the region are also indicated.

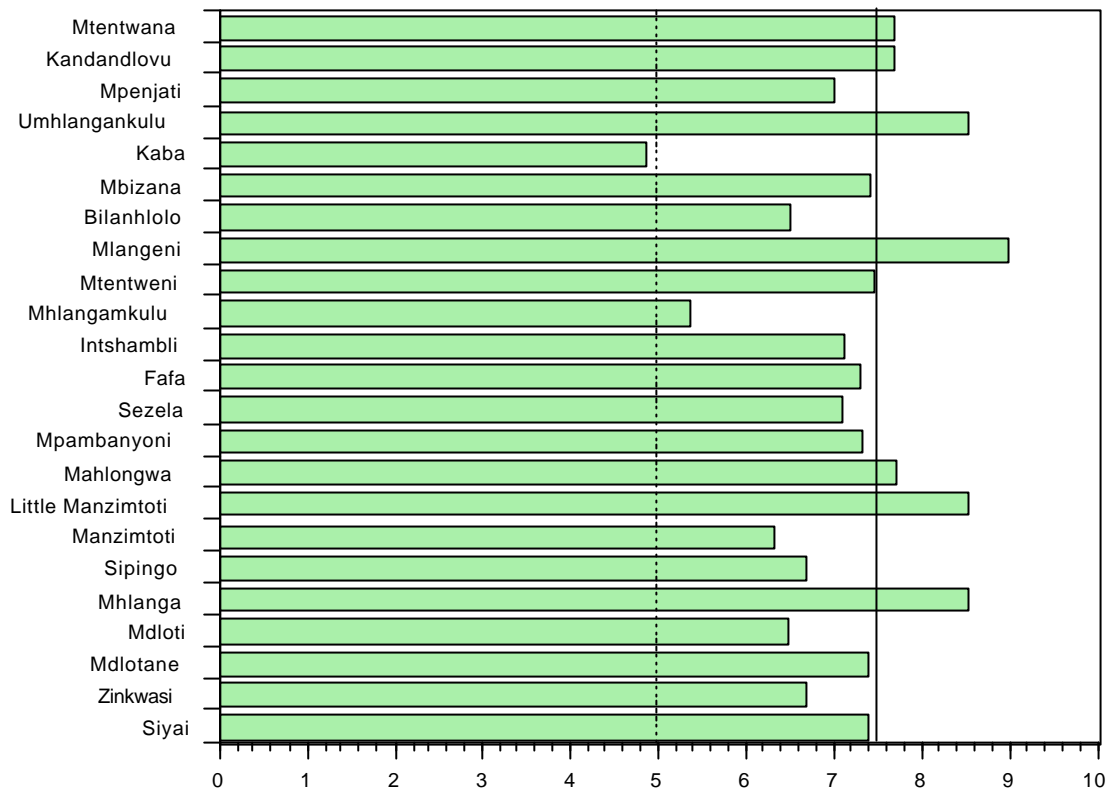


Figure 3.38. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type B estuaries to the most frequently captured species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

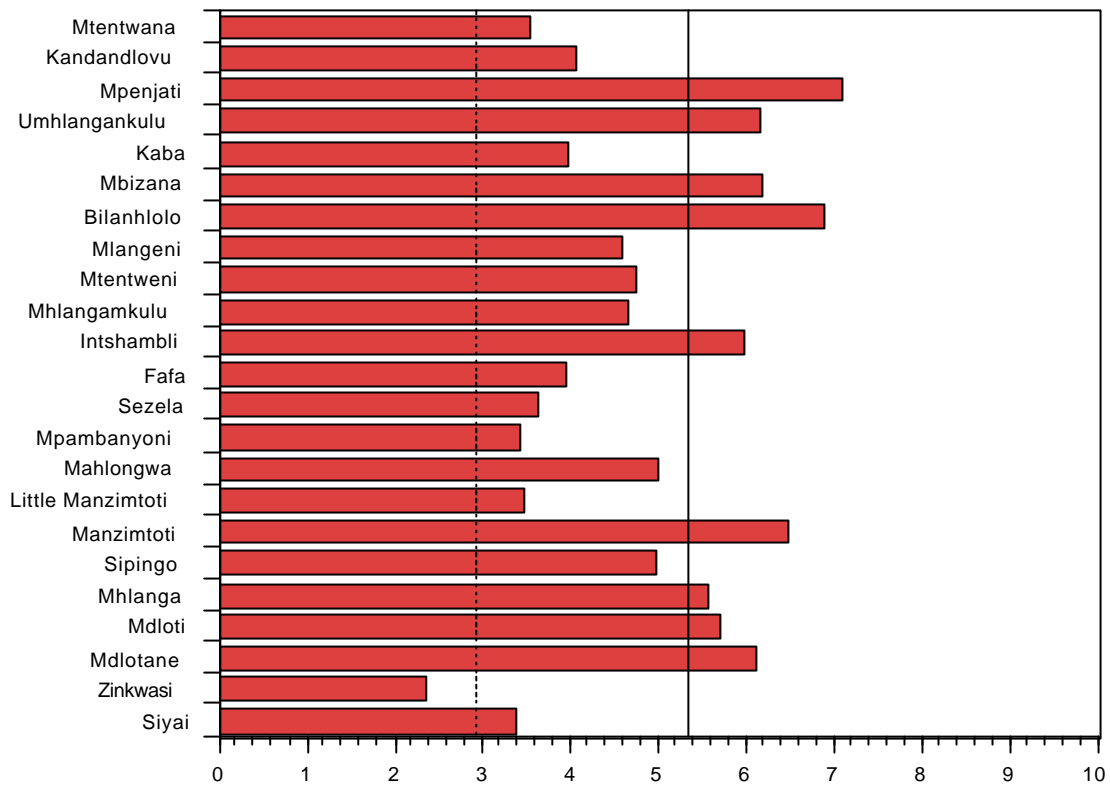


Figure 3.39. Bray-Curtis similarities (based on % abundance) of fish assemblages of type B estuaries to the most abundant species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

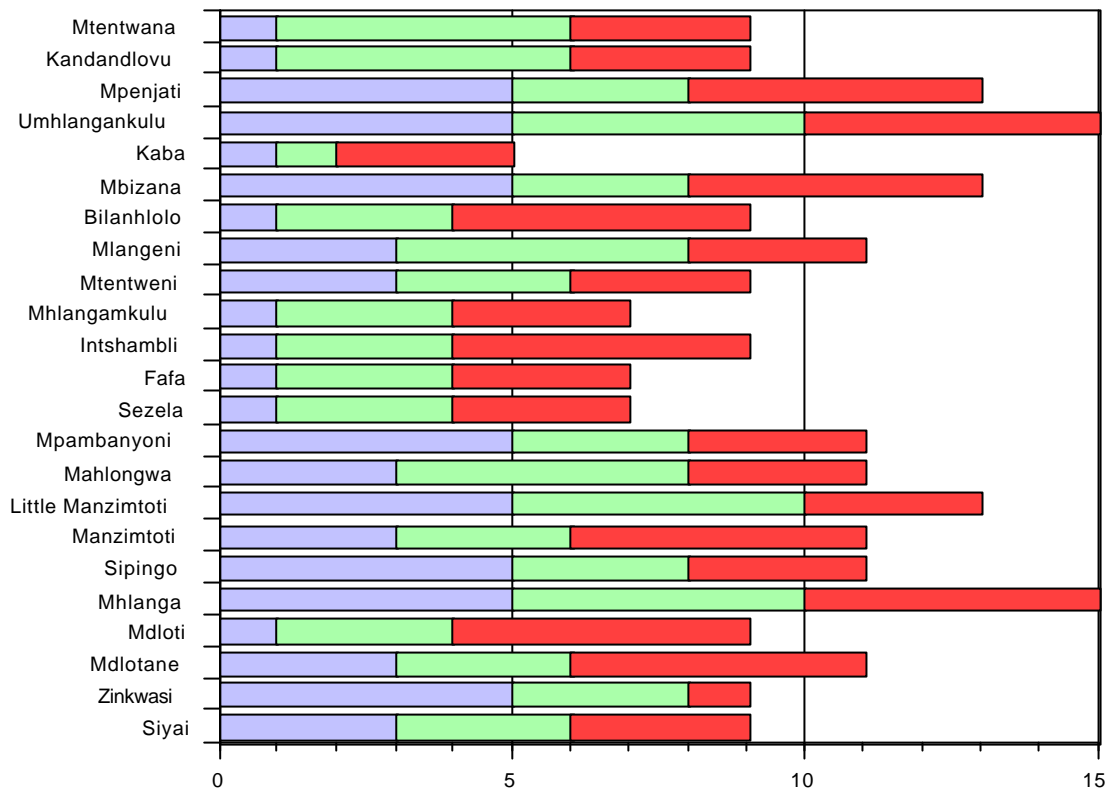


Figure 3.40. Rating of type B estuaries in the subtropical region based on species richness, presence/absence and % abundance of their fish communities.

Type E estuaries

Three type E estuaries had a relatively high species richness. Five systems had an average (95% confidence) species richness and the remaining five estuaries had relatively low species richness (Figure 3.41).

In terms of their fish community structure, almost all the systems belonging to type E estuaries had moderate to high similarities to the reference faunal assemblages both qualitatively and quantitatively. Only the Mgobezeleni had a relatively low similarity based on percent species abundance (Figure 3.42 & 3.43). During this study a total of 14 species was captured in the Mgobezeleni and the numerically dominant fishes included *V. robustus* (41%), *M. cephalus* (21%) and *L. macrolepis* (14%).

Overall, most the estuaries were rated moderate to good. Again, only the Mgobezeleni had a relatively poor overall score (Figure 3.44).

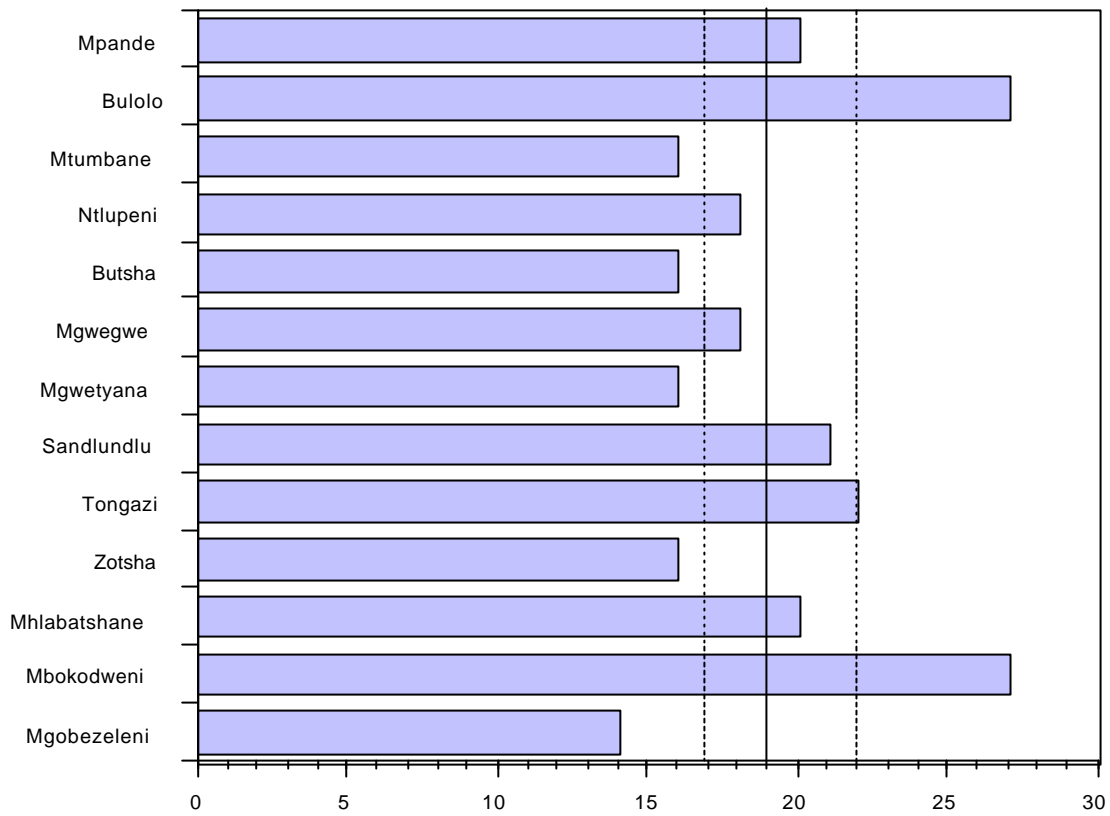


Figure 3.41. Species richness of type E estuaries in the subtropical region. The mean number of taxa and the 95% confidence interval for all type E estuaries in the region are also indicated.

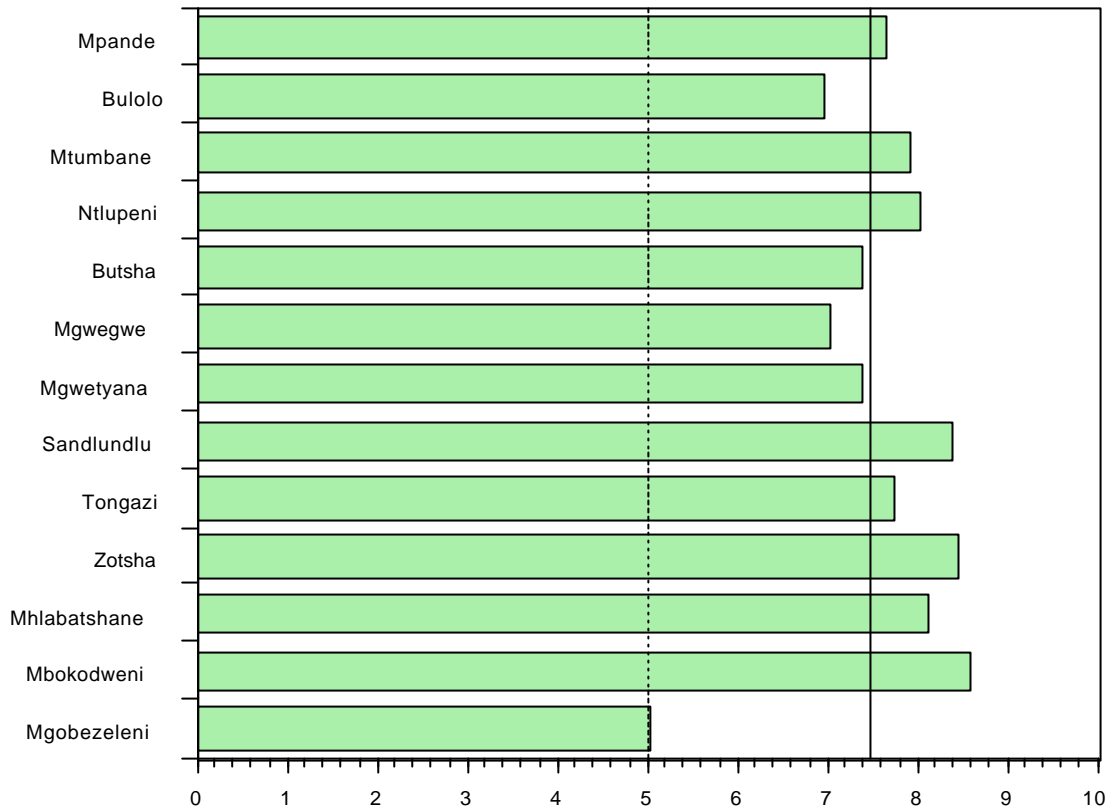


Figure 3.42. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type E estuaries to the most frequently captured species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

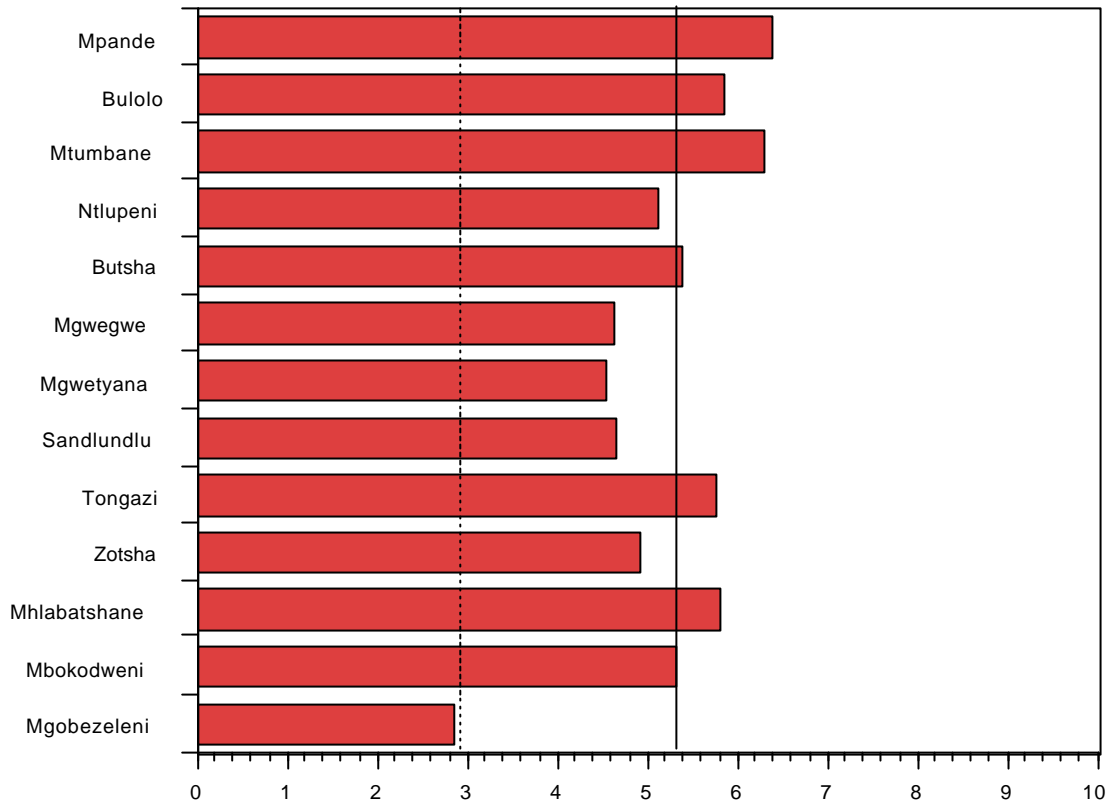


Figure 3.43. Bray-Curtis similarities (based on % abundance) of fish assemblages of type B estuaries to the most abundant species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

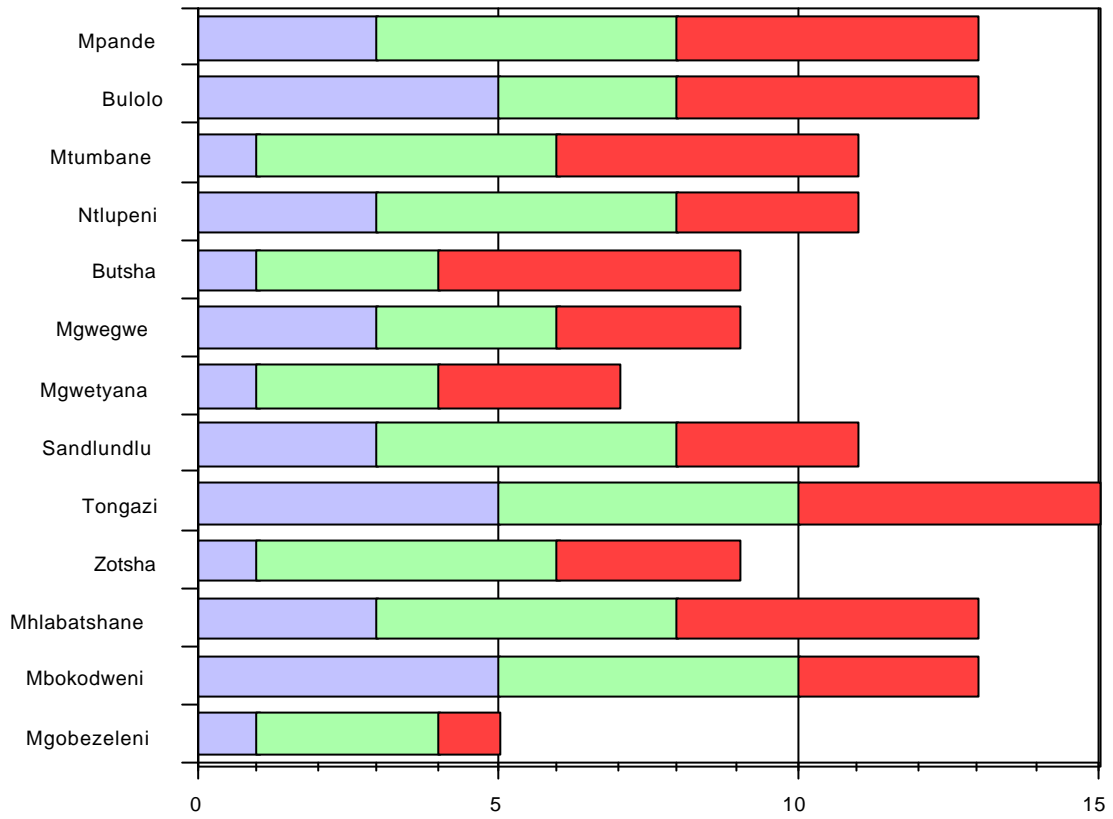


Figure 3.44. Rating of type E estuaries in the subtropical region based on species richness, presence/absence and % abundance of their fish communities.

Type F estuaries

In type F estuaries, four systems had a high species richness, 12 estuaries had an average (95% confidence) richness while the remaining five systems had a relatively poor species richness (Figure 3.45). In terms of their fish species composition, most of the estuaries had moderate to good similarities to the reference assemblage both qualitatively and quantitatively. Two systems, the Mvoti and Kosi Bay, had relatively poor similarity values in both analyses (Figures 3.46 & 3.47). These two systems also had a relatively low overall ranking. The remaining estuaries had moderate to good ratings (Figure 3.48).

A total of some 163 fish species have been recorded from the Kosi Bay system (Blaber & Cyrus, 1981). The vast majority of these, however, are stenohaline marine species which are associated with a small reef situated in the mouth area of the system. Blaber (1978) lists a total of 24 common fish species which penetrate beyond the estuary. During this study 18 taxa were recorded from the system and these were dominated by *A. natalensis* (28%), *L. macrolepis* (16%), *G. methueni* (16%), *T. jarbua* (14%) and *V. robustus* (11%). The low overall ranking of Kosi Bay is most likely due to the clear conditions encountered during this survey making fish capture difficult due to increased net avoidance.

In the Mvoti estuary, 13 taxa were recorded. *Liza* spp. (28%), *V. cunnesius* (13%), *Valamugil* spp. (12%), *O. mossambicus* (11%), *M. capensis* (10%), *M. cephalus* (9%), *T. jarbua* (7%), juvenile mullet (Mugilidae) (5%) and *C. gariepinus* (3%) were the numerically dominant taxa. Begg (1984) noted that the Mvoti was a river-dominated system which contained a distinctive fauna quite dissimilar to other estuaries in KwaZulu-Natal. The low rating for the Mvoti during this study may be due to the strong freshwater influence in the system limiting its utilisation by marine species which characterises this group of estuaries.

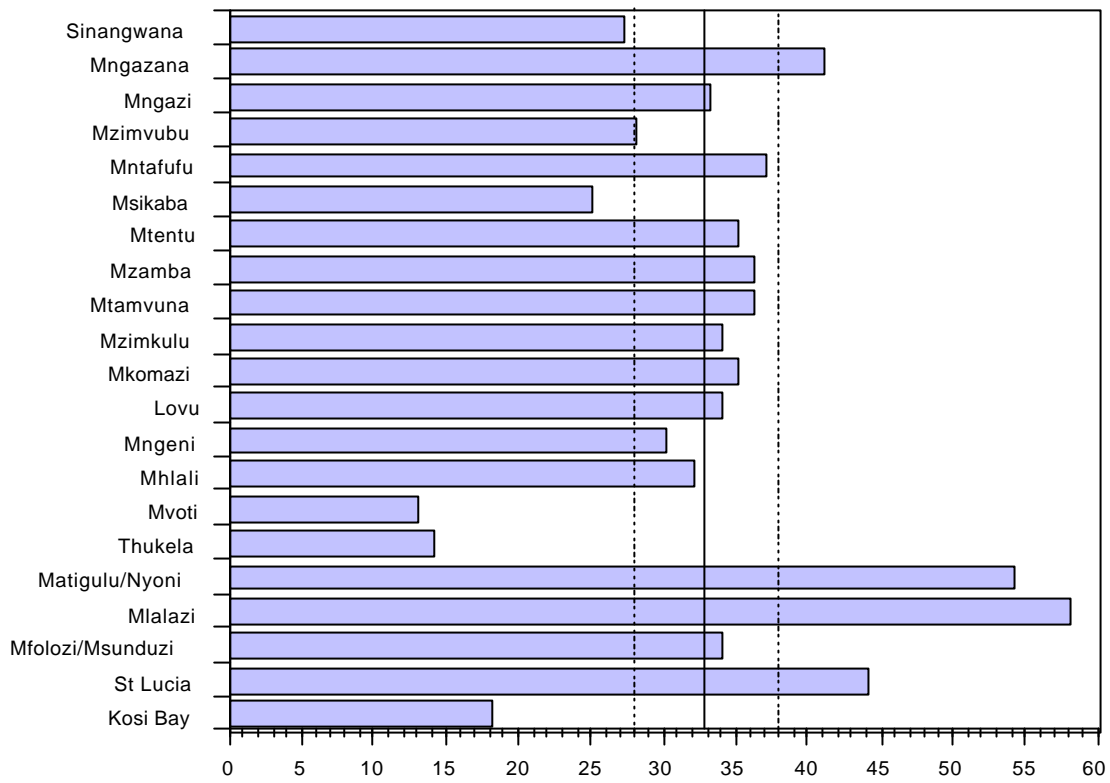


Figure 3.45. Species richness of type F estuaries in the subtropical region. The mean number of taxa and the 95% confidence interval for all type F estuaries in the region are also indicated.

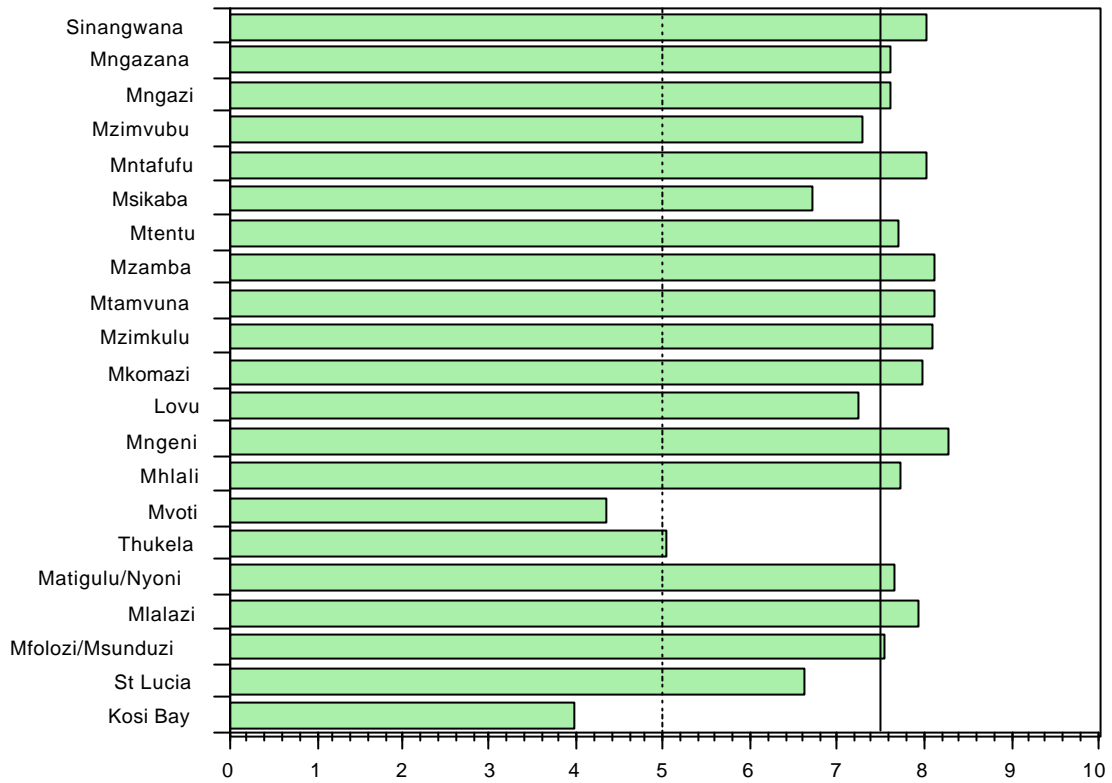


Figure 3.46. Bray-Curtis similarities (based on presence/absence) of fish assemblages of type F estuaries to the most frequently captured species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

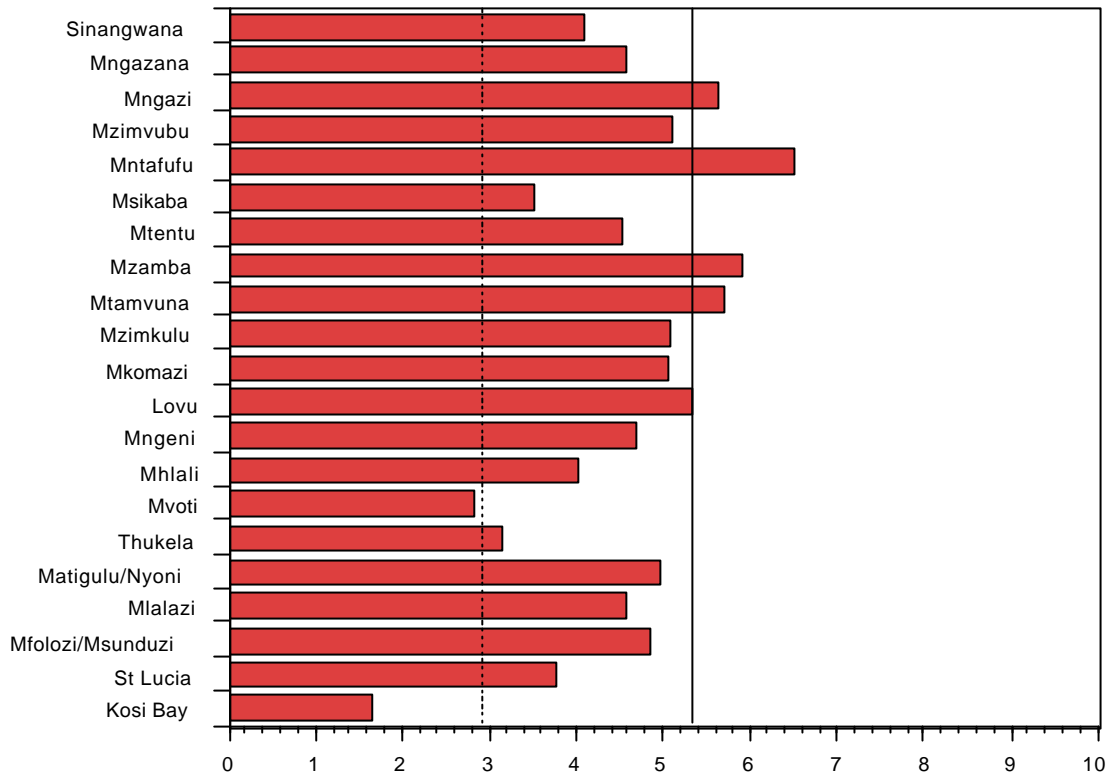


Figure 3.47. Bray-Curtis similarities (based on % abundance) of fish assemblages of type F estuaries to the most abundant species for this type of system in the subtropical region. The 10th and 50th percentiles of the similarity values are also indicated.

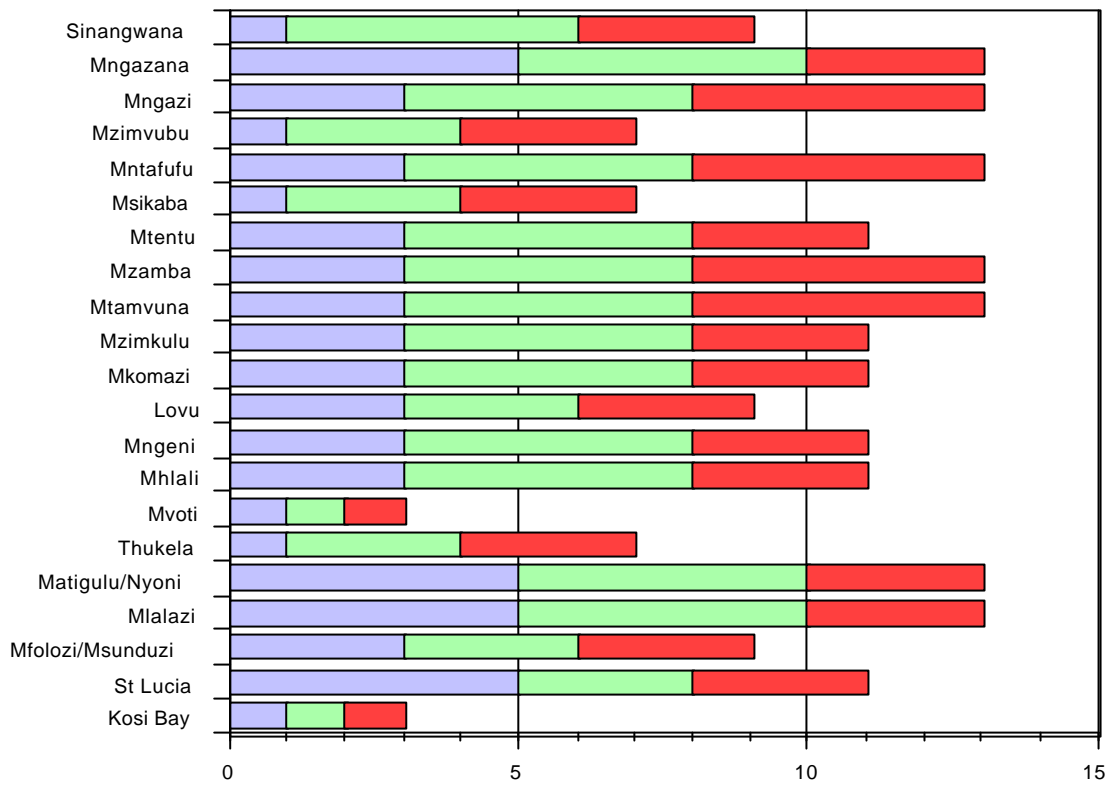


Figure 3.48. Rating of type F estuaries in the subtropical region based on species richness, presence/absence and % abundance of their fish communities.

3.7 Summary & conclusions

The fish fauna of 206 estuaries has been sampled. This represents approximately 70% of all the 'estuaries' along the South African coast. Using data from these surveys the three biogeographic regions which characterise this coastline were identified. These were the cool-temperate west coast from the Gariep estuary to Cape Agulhas, the warm-temperate region from Cape Agulhas to the Mdumbi estuary, and the subtropical region from the Mdumbi to Kosi Bay.

Based on their physical/geomorphological characteristics, a number of estuary types were identified within each biogeographic region, and each estuary type appeared to contain fairly distinctive fish assemblages. Aspects of the fish community structure of each estuary type within each biogeographic zone was described. This served as a reference against which the fish communities within each estuary could be compared.

Based on an analysis of their species richness, composition and relative abundance, two systems (8%) in the cool-temperate region had low ratings. Ten estuaries (42%) were rated as moderate and the remaining 12 systems (50%) had a good overall rating. Of a total of 119 estuaries analysed in the warm-temperate region, nine (8%) had a relatively poor overall rating, 35 (29%) were rated moderate and the remaining 75 (63%) had a good overall rating. In the subtropical region, three estuaries (5%) were rated poor, 23 (36%) had a moderate overall rating and the remaining 37 (59%) had a good rating.

Although the results presented here provide a useful summary of the status of the fish communities in South Africa's estuaries, these results only incorporate a few components of the fish community structure and are based on a single survey. Future studies should incorporate other aspects of the fish community structure such as biomass composition, life-history styles and trophic structure. Long-term data sets are also required to establish the range of the natural variation between and within estuaries on a seasonal basis. Furthermore, a number of estuaries, particularly in the Transkei, have not been sampled and these gaps in the state of information need to be filled. Investigations into other biotic components (vegetation, zooplankton, zoobenthos, and birds) should also be undertaken to

ensure a more complete appraisal of the ecological integrity of the nation's estuarine resource.