# A new approach to describing estuarine wader communities

*Peter Reay & Sara McMahon*

Reay, P.J. & McMahon, S. 1993. A new approach to describing estuarine wader communities *Wader Study Group Bull.* 71: 44-46.

*Peter Reay & Sara McMahon, Department of Biological Sciences, University of Plymouth, Drake Circus, Plymouth, Devon, PL4 8AA, UK.*

## INTRODUCTION

Although the United Kingdom's Birds of Estuaries Enquiry (BoEE), now part of the Wetland Bird Survey (WeBS), has been running since 1969 (Prater, 1981; Waters and Prys-Jones, 1992), coverage on some estuaries has been patchy and intermittent. This certainly applies to the Tamar Estuarine Complex on the border between Devon and Cornwall in South-West England. Since December 1988, however, year-round monthly counts for all 13 sections of the complex have been carried out, and thus a wealth of data has been accumulated (specifically, over 500 observations for each species of wader, wildfowl and gull using the complex). As well as contributing to the national survey, these data are being used in a detailed analysis of the waterfowl community, past and present, of the complex.

One immediate problem has been how best to describe the present community as a basis for comparing it with those of earlier years and other estuaries. Here we describe an attempt to do this diagrammatically using simple measures of abundance, seasonality and spatial distribution, all of which are easily calculated from the data available.

The Tamar Estuarine Complex (latitude 50°20'N; longitude 4°10'W) consists of approximately 1250 ha of intertidal mudflats and is classified as a partially mixed, drowned river valley estuary. The major part of the complex, involving the Rivers Tamar, Tavy, Lynher and Tiddy, enters the western side of Plymouth Sound, whereas the River Plym enters the eastern side. On the Complex the mean peak winter count of waders for the last five year period was in excess of 9000 birds. The only species occurring in nationally important numbers is the Avocet *Recurvirostra avosetta* and there are no internationally important species. Twenty eight species of wader have been recorded on BoEE count dates since December 1988.

## METHODS

Synchronised monthly counts of waders for the three calendar years 1989, 1990 and 1991 have been used. The counts were carried out by a team of 18 amateur birdwatchers operating on a predetermined spring-tide date each month, with one or two counters covering each of the 13 sections. Most counts were made between half-ebb and low tide and are considered to represent the feeding distribution of the birds.

There are several possible approaches to transforming these raw data into measures of abundance, seasonality and spatial distribution. Perhaps the simplest approach would have been to use maximum counts, or the 'highest average monthly count' of Prater (1981), combined with the numbers of months and sections when and where a particular species occurred. However, such indices are open to strong bias and are wasteful of information. Accordingly we have adopted the following alternatives for each species in any one year.

*Abundance.* Mean monthly abundance (A) for the whole complex has been calculated from total annual abundance (T). Thus (A = T/12) and comes close to representing annual usage.

*Seasonality* and *Spatial Distribution*. For these we have adopted Levins' Measure of Niche Breadth, as described by Krebs (1989), to provide a simple measure of the distribution of the counts in the different months (S = seasonal niche-breadth) and sections (D = area niche-breadth). If a species occurs only in one month or section then (S) or (D) respectively will have the minimum value (1), but if it is completely evenly distributed between months or sections then (S) or (D) will have maximum values (12 and 13 respectively, in this study).

$$S = \frac{T^2}{\sum_{i=1}^{12} (N_i)^2}$$

$$D = \frac{T^2}{\sum_{j=1}^{13} (M_j)^2}$$

where T = total annual abundance

$N_i$ = number in ith month (sections combined)

$M_j$ = number in jth section (months combined)

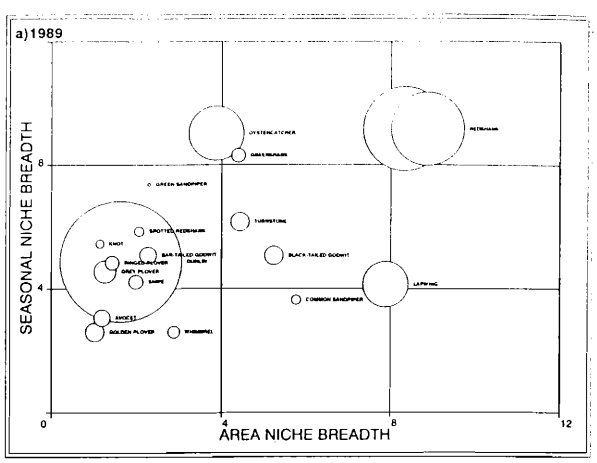
As well as annual values, overall means for (A), (S) and (D) have also been calculated for the 1989-91 period. All data processing and the calculation of the indices has been carried out using Quattro Pro 4 (Borland International) spreadsheets. Quattro Pro 4 has also been

christened Tamargrams, (D) and (S) respectively form the x and y axes with (A) being represented by the size of the bubbles.

## RESULTS AND DISCUSSION

The Tamar wader community is described in Table 1 with the main species ranked in terms of their mean monthly abundance. A diagrammatic representation of this community for each of the three years of the study period is shown in Figure 1. The overall mean pattern for 1989-91 is given in Figure 2. Where the niche-breadths have been standardized on a scale from 0 to 1.0 by dividing S and D by the total number of resource states (months or sections respectively). We suggest that Figure 2 provides an instantaneous, easily assimilated visual image of the Tamar wader community at the present time which will be particularly useful for comparing present and past community structure and for comparing the Tamar with other estuaries. The bubbles do not appear to be randomly distributed and there is overall, a broad correlation between the two measures of niche breadth. For example no species appears to have both a wide distribution (area niche breadth) and narrow seasonality (seasonal niche breadth). The most abundant species, the Dunlin (*Calidris alpina*), although found in all sections and months is very much concentrated into one section and the winter months. In contrast, to the next two most common species, the Curlew (*Numenius arquata*) and Redshank (*Tringa totanus*), both measures of niche breadth of the Dunlin are narrower. In general , although there is a reasonable spread among the species in terms of seasonal niche breadth, area niche breadth values are strongly skewed towards the narrow end, presumably reflecting habitat preferences (Figure 3).

Figure 1a. Tamargram for the main wader species on the Tamar Estuary Complex in 1989.




Comparison of the patterns for each of the three years suggests considerable interannual constancy,at least for the most abundant species. However, there are examples of variation in abundance, seasonality and spatial distribution between years. Some of these represent real differences in ecology, (e.g. Reay 1992), whereas others are due to the timing of counts in relation to the peak occurrences of passage migrants (particularly in the case of Whimbrel *Numenius phaeopus* and Golden Plover *Pluvialis apricaria*) and still others may be influenced by counting errors. Such variation does not invalidate the approach adopted here, but it does suggest that it would be unwise to base community description on a single year's data.

We have been unable to find studies in either the avian or general ecology literature which have used the approach to community description adopted here. For waders, usually only a list of species and some index of abundance is given, and clearly not all studies have the information on seasonality and spatial distribution that is now available for the Tamar. Our graphical approach is very simplistic, but fulfils the original aim. Moreover, the databank collected should lend itself to further analysis (such as ordination techniques), and once equivalent data for other estuaries become available, may provide useful insight into the dynamics of estuarine wader communities. For comparative purposes, however, it would seem appropriate to use an abundance measure based on density (N $ha^{-1}$) and to standardize Levins' Measure of both seasonal and area niche-breadths on a scale from 0 to 1.0, as in Figure 2. On the Tamar the sections are of approximately equal linear dimension, but vary in terms of area; boundaries between sections have been determined by ease of access and observation. What differences would a division into, say, 20 sections of equal mud-flat area make to the Tamargram? Other questions include whether these diagrams can sensibly be used to compare estuaries of different sizes, and the extent to which a particular species will always occupy approximately the same position on the diagram. The authors welcome comments.

## ACKNOWLEDGEMENTS

Thanks are due to all the Tamar bird counters for the collection of raw data and to David N Price of the University of Plymouth for his initial recommendation of, and help with, Quattro Pro.

## REFERENCES

Krebs, C.J. 1989. *Ecological Methodology*. Harper and Row, New York.

Prater, A.J. 1981. *Estuary Birds of Britain and Ireland*. T. & A.D. Poyser, Carlton.

Reay, P.J. 1992. Behaviour of a flock of wintering Avocets. (Abstract). *Wader Study Group Bulletin*. 64: 11.

Waters, R. & Prys-Jones, R.P. 1982. The Birds of Estuaries Enquiry - results from the 1989/90 and 1990/91 winters. *Wader Study Group Bulletin*. 64: 19-21.

Figure 1b. Tamargram for the main wader species on the Tamar Estuary Complex in 1990.

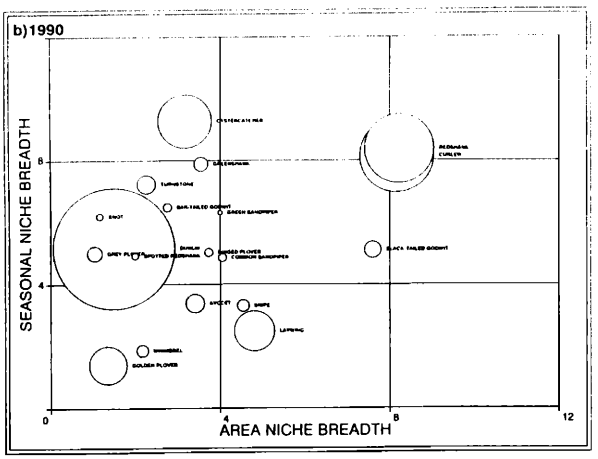



Figure 1c. Tamargram for the main wader species on the Tamar Estuary Complex in 1991.

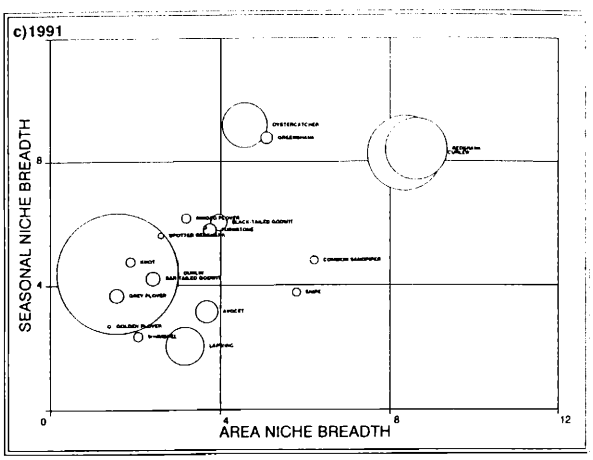



Figure 2. Standardized Tamargram for the main wader species on the Tamar Estuary Complex 1989-91.

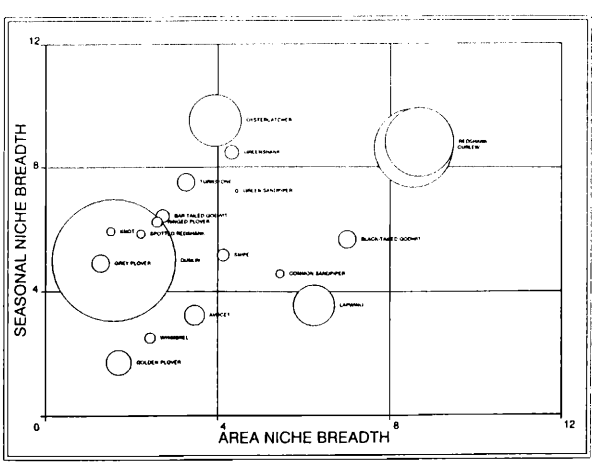



Figure 3a. Niche breadth frequencies for the main species of Tamar wader in terms of area.

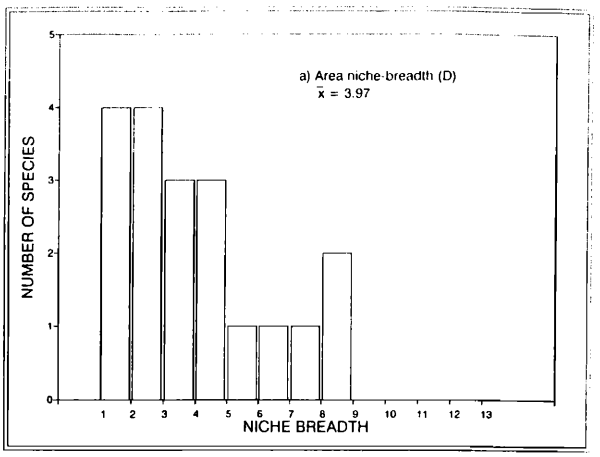



Figure 3b. Niche breadth frequencies for the main species of Tamar wader in terms of season.

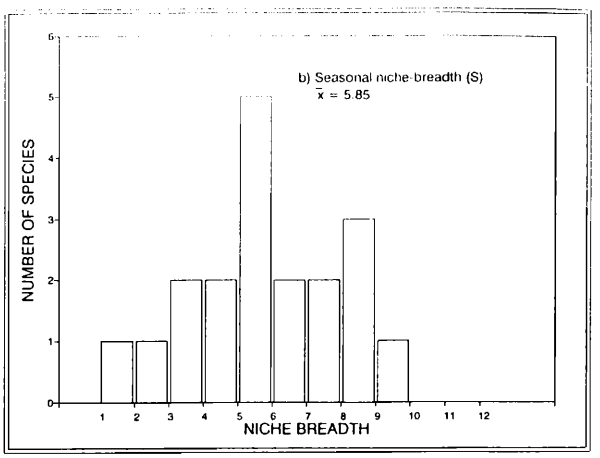



Table 1. Overall mean monthly abundance (A), maximum monthly abundance (MA), Levins' time-niche breadth (S) and Levins area-niche breadth (D) for the main wader species of the Tamar Estuary Complex 1989-91.

| | | A | MA | S | D |
|---|---|---|---|---|---|
| DUNLIN | *Calidris alpina* | 1499.33 | 5784 | 5.01 | 1 59 |
| CURLEW | *Numenius arquata* | 610.83 | 1154 | 8.62 | 8 54 |
| REDSHANK | *Tringa totanus* | 478.31 | 1057 | 8.80 | 8 69 |
| OYSTERCATCHER | *Haematopus ostralegus* | 269.11 | 615 | 9.52 | 3 92 |
| LAPWING | *Vanellus vanellus* | 177.14 | 1333 | 3.55 | 6 24 |
| GOLDEN PLOVER | *Pluvialis apricaria* | 67.08 | 1700 | 1.73 | 1 71 |
| AVOCET | *Recurvirostra avosetta* | 42.03 | 240 | 3.23 | 3 45 |
| GREY PLOVER | *Pluvialis squatarola* | 33.03 | 151 | 4.92 | 1 27 |
| BLACK-TAILED GODWIT | *Limosa limosa* | 32.83 | 118 | 5.70 | 7 00 |
| TURNSTONE | *Arenaria interpres* | 31.25 | 115 | 7.53 | 3 26 |
| GREENSHANK | *Tringa nebularia* | 20.50 | 67 | 8.48 | 4 32 |
| BAR-TAILED GODWIT | *Limosa lapponica* | 18.53 | 89 | 6.46 | 2 71 |
| SNIPE | *Gallinago gallinago* | 14.81 | 94 | 5.18 | 4 12 |
| WHIMBREL | *Numenius phaeopus* | 13.67 | 135 | 2.50 | 2 43 |
| RINGED PLOVER | *Charadrius hiaticula* | 12.03 | 80 | 6.25 | 2 58 |
| COMMON SANDPIPER | *Actitis hypoleucos* | 8.75 | 48 | 4.59 | 5 46 |
| KNOT | *Calidris canutus* | 7.61 | 38 | 5.95 | 1 51 |
| SPOTTED REDSHANK | *Tringa erythropus* | 6.83 | 26 | 5.88 | 2 21 |
| GREEN SANDPIPER | *Tringa ochropus* | 1.94 | 7 | 7.23 | 4 43 |