Northwest Atlantic　　Fisheries Organization

Changes in the concentration of flatfish off Newfoundland from 1971 to 1994

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We calculated the degree of concentration of the flatfish by using the standard method used in econometrics to study the distribution of income among individuals (Dagum 1985, Myers and Cadigan 1995). The flatfish we consider are American plaice (*Hippoglossoides platessoides*), turbot (*Reinhardtius hippoglossoides*), witch flounder (*Glyptocephalus cynoglossus*), and yellowtail flounder (*Limanda ferruginea*). For each year from 1971 to 1994 where data are available we calculate a Lorenz curve for the fall research surveys in NAFO regions 2J, 3K, 3L, 3N, and 3O for the strata used in the surveys.

To calculate concentration, consider the n strata used in the surveys. Let x_i be the estimated biomass in strata i such that $x_1 \leq x_2 \leq \cdots \leq x_n$. Let the area of stratum i be a_i. The Lorenz curve is the polygon joining the points $(A_h/A_n, L_h/L_n), h = 0, 1, \ldots, n)$ where $L_0 = 0$ and $L_h = \sum_{i=1}^{h} x_i$ is the total number of fish in the h strata with the fewest individuals, and $A_0 = 0$ and $A_h = \sum_{i=1}^{h} a_i$ is the total area of the h strata with the fewest individuals. Hence, the Lorenz curve has as its abscissa the cumulative area arrayed by increasing biomass, and as its ordinate the corresponding proportion of the total population of fish. If fish were equally distributed among strata, the Lorenz curve would be the identity function. As the distribution of fish becomes more unequal, i.e., more concentrated, the Lorenz curve bends downwards and to the right within the unit square. Twice the area between the identity function and the Lorenz curve is known as the Gini index, and is the most commonly accepted measure of the concentration.

The increase in concentration of cod over time in the research surveys is clear from the Lorenz curves (Fig. 1a) and the Gini index (Fig. 1b). This would make these species very vulnerable to overfishing because their catchability will be very high.

References

Myers, R. A. and N. G. Cadigan. 1995. Was an increase in natural mortality

responsible for the collapse of northern cod? Can. J. Fish. Aquat. Sci. in press.

Dagum, C. 1985. Lorenz curve. p. 156-161. *In* S. Kotz and N. L. Johnson [ed.] Encyclopedia of statistical sciences. Vol 5. Wiley and Sons, New York.

Figure Legends

Fig. 1a. Lorenz diagrams for flatfish species around Newfoundland. The Lorenz curve bends downwards and to the right within the unit square as cod become more concentrated. If fish were equally distributed among strata, the Lorenz curve would be the identity function (dotted line).

Fig. 1b. Concentration index or Gini index for 1a.

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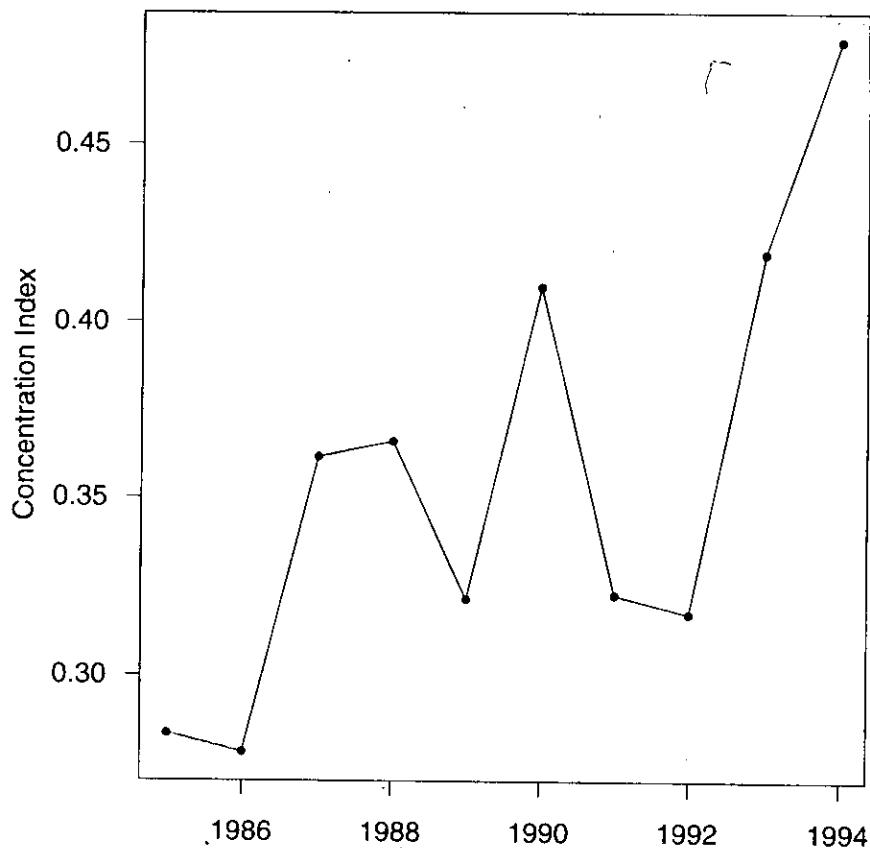
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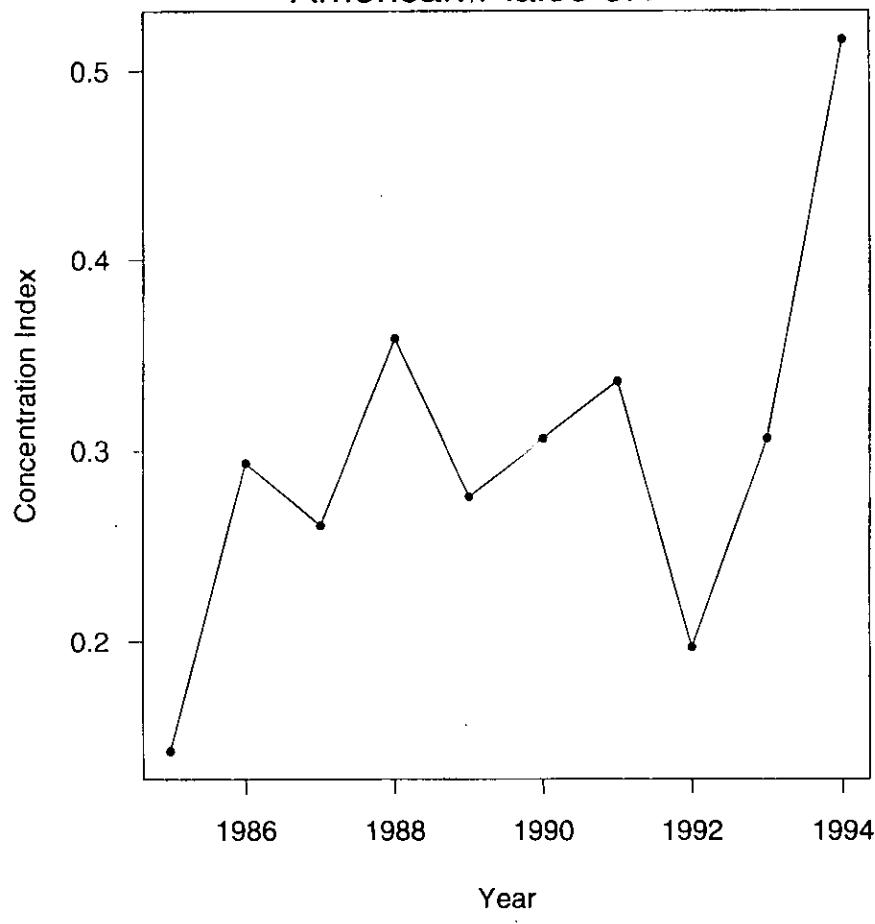
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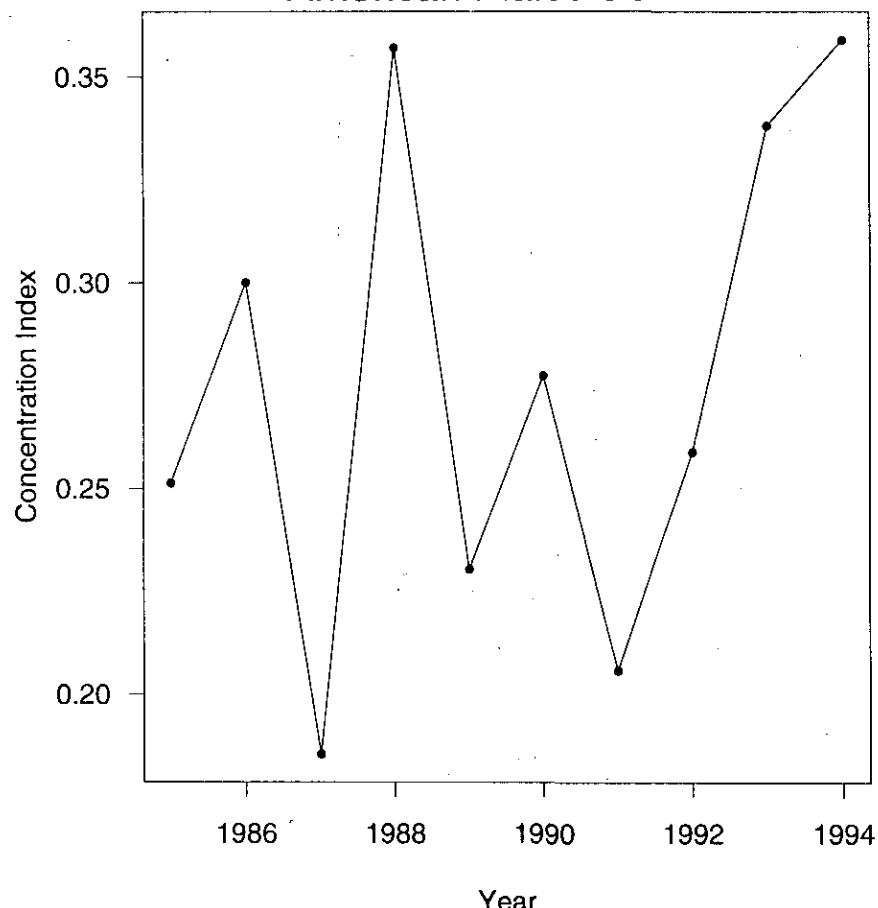
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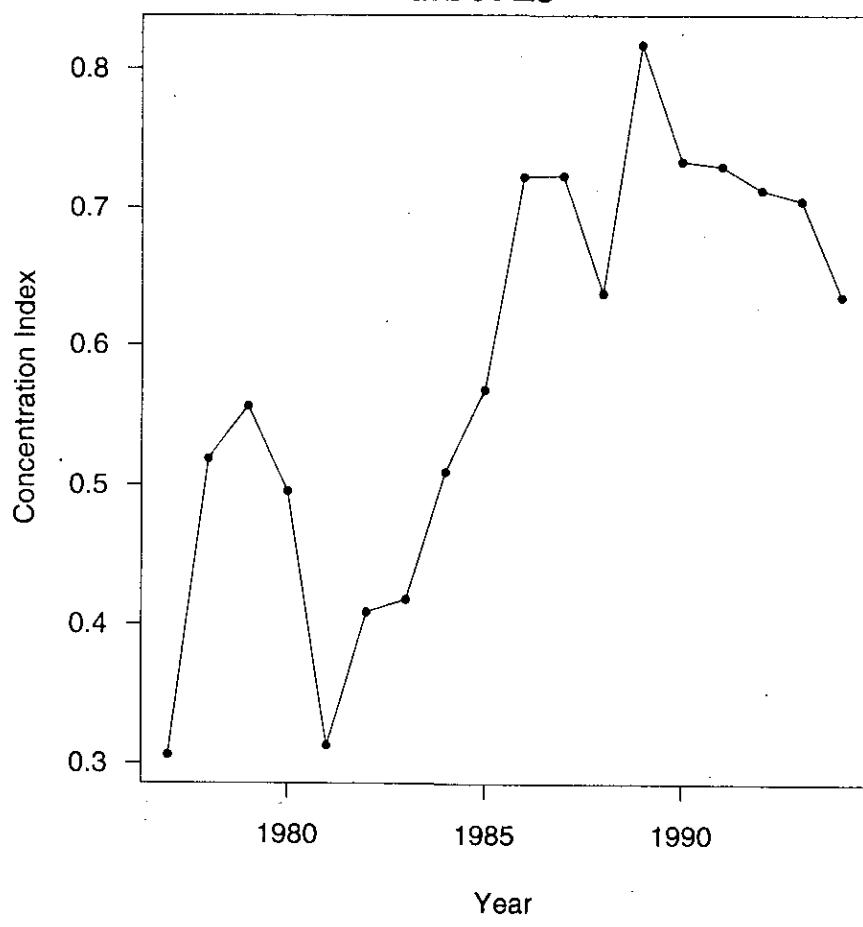
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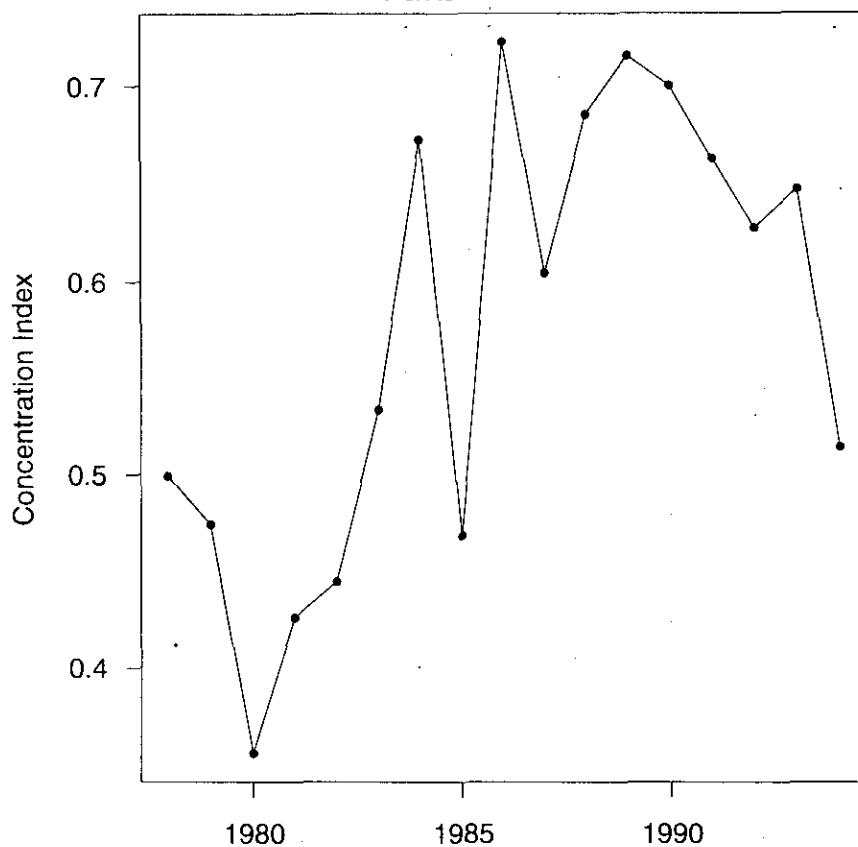
Year

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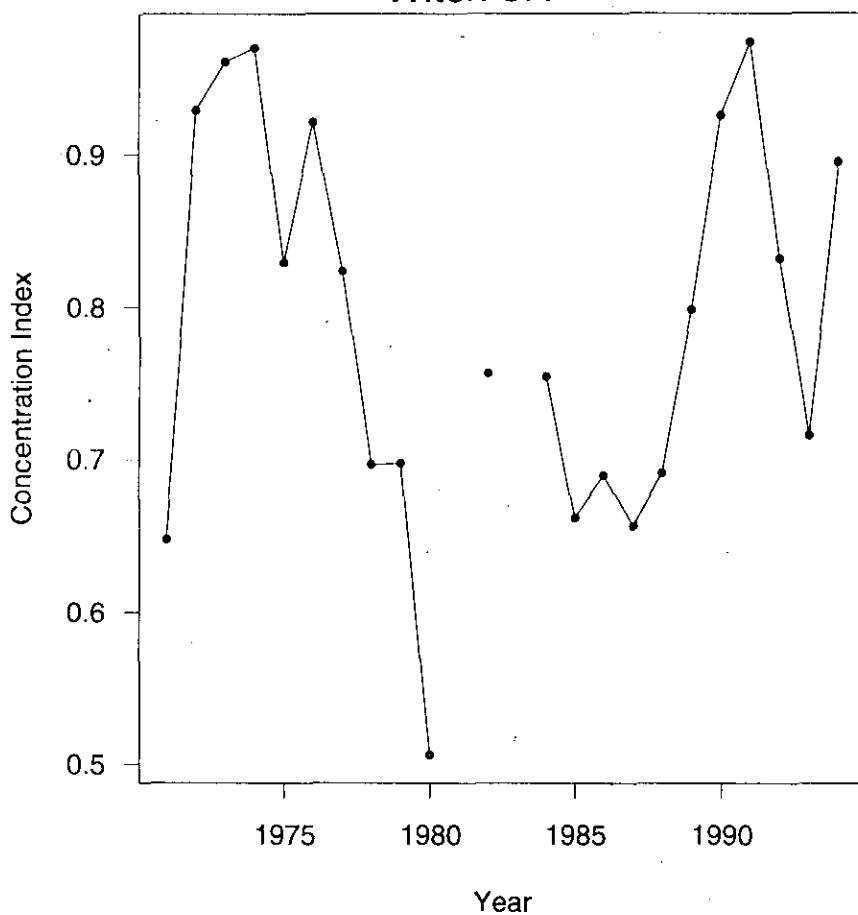
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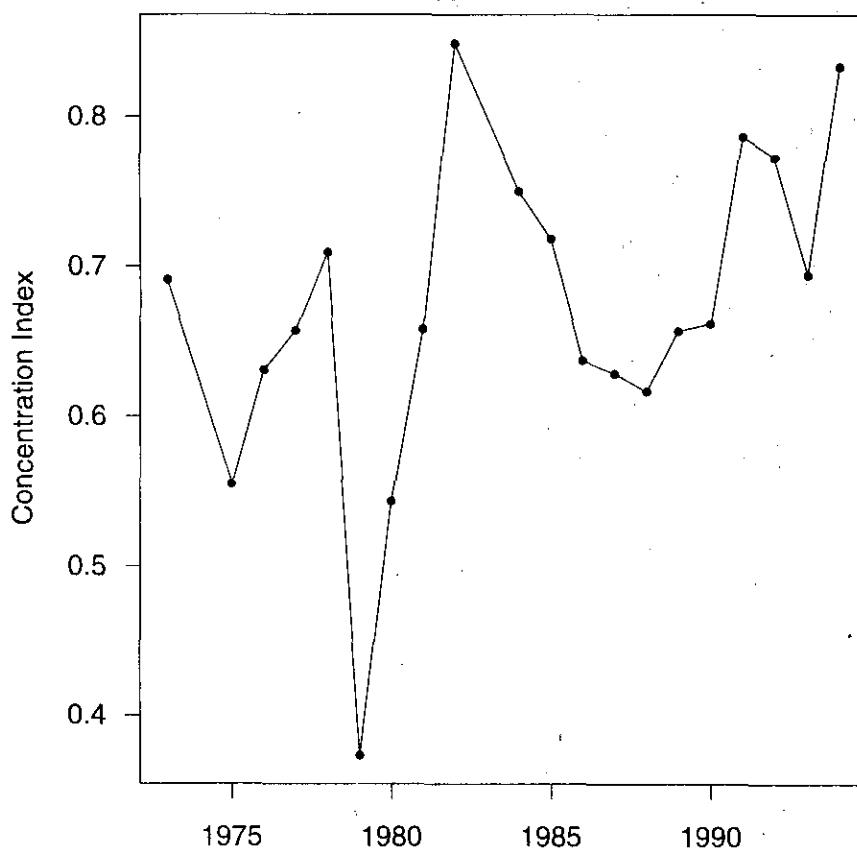
Yellowtail 3LNO

American Plaice 3L

Cumulative % Biomass

Cumulative % Area
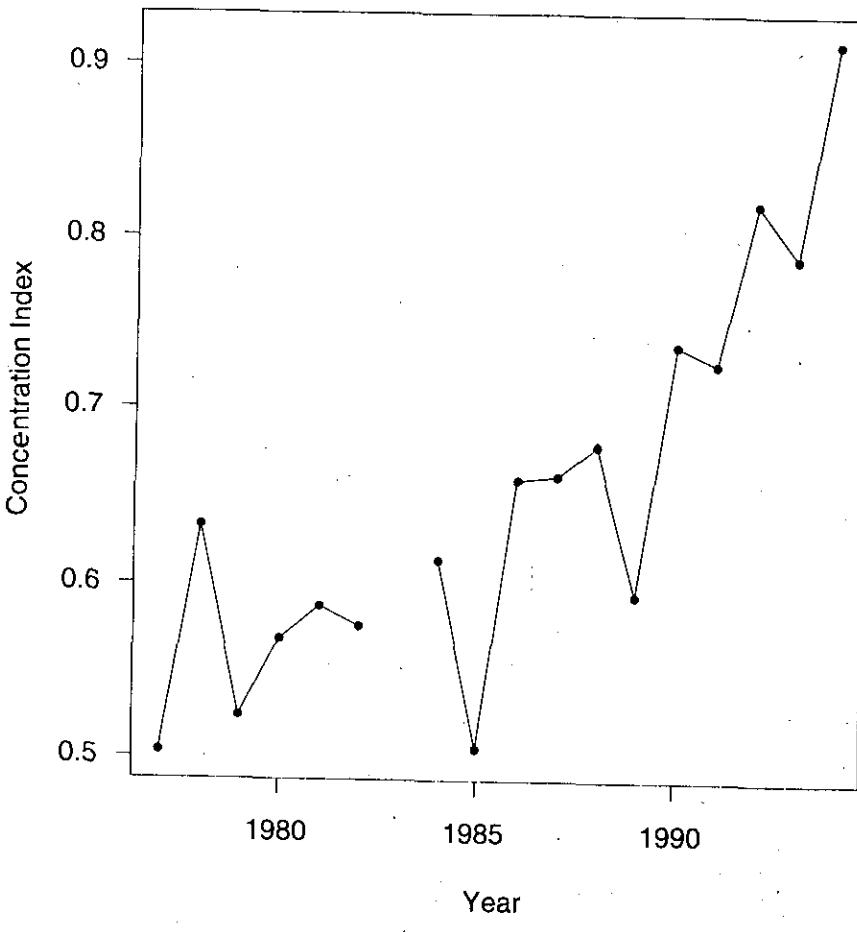
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1986

1987

1988

1989

1990
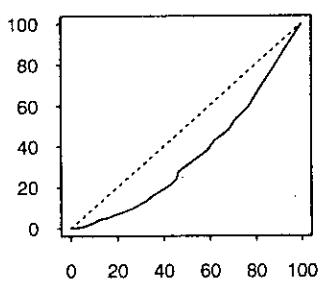
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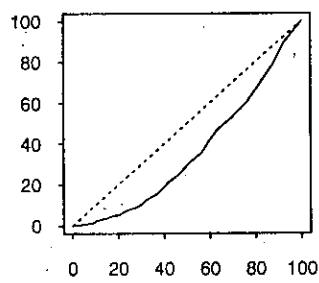
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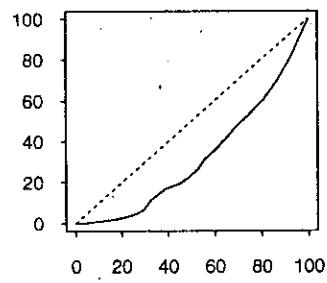
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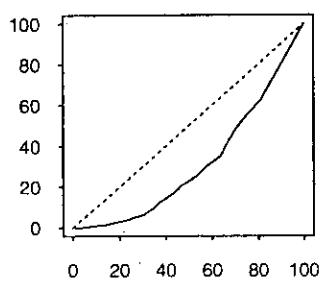
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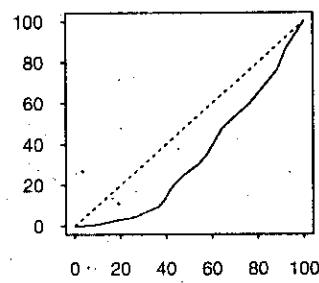
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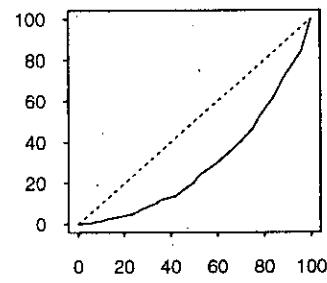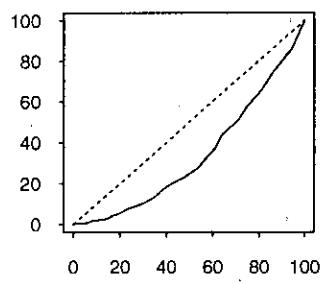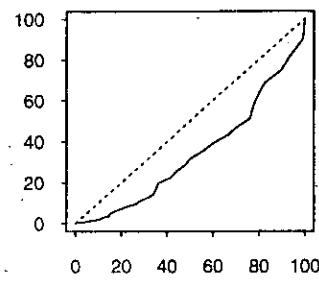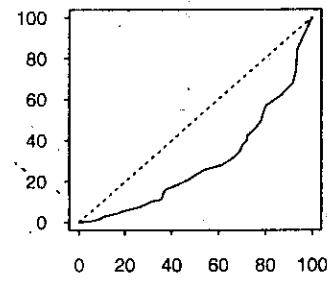
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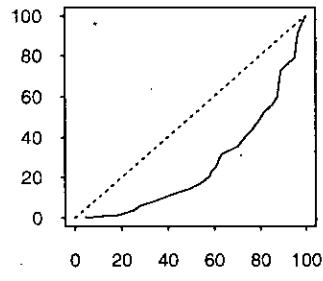
Cumulative % Area

American Plaice 3O

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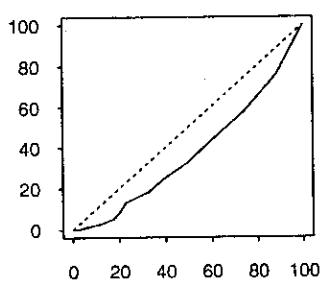
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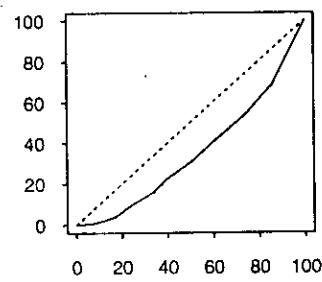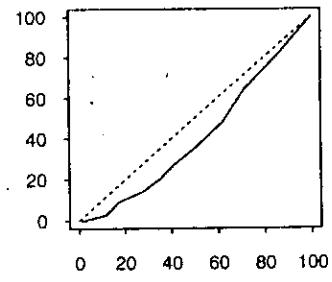
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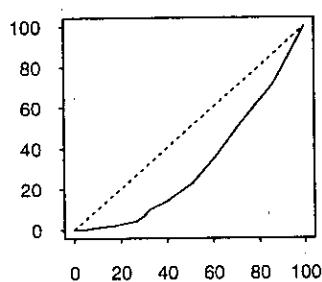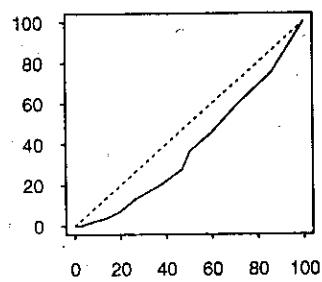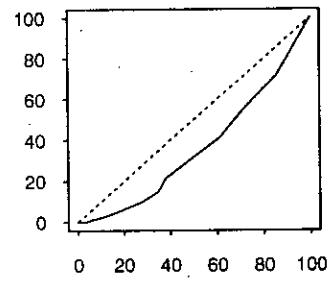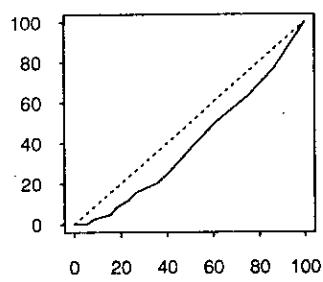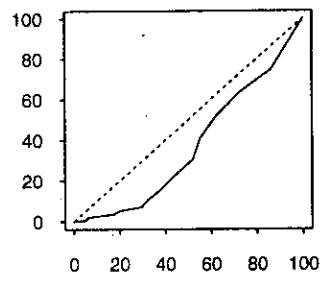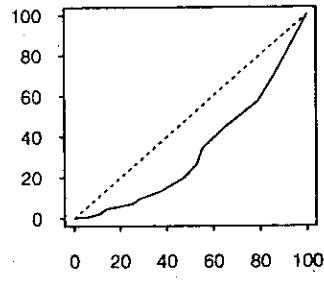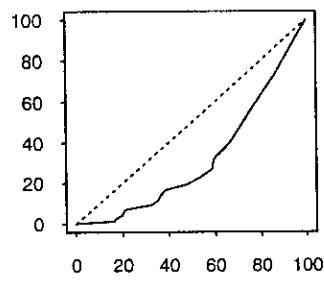
Turbot 2J

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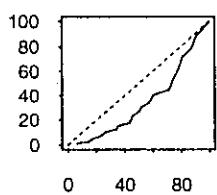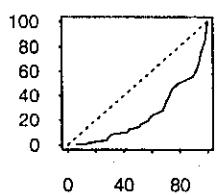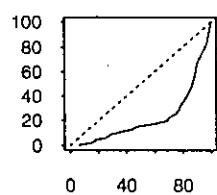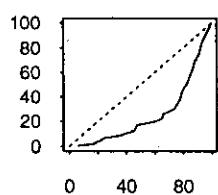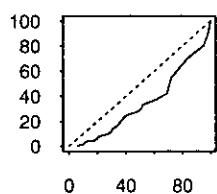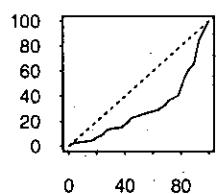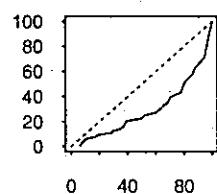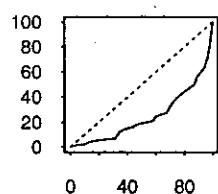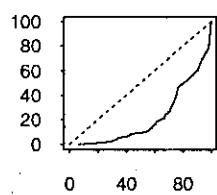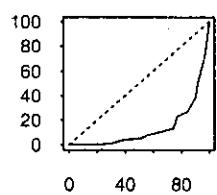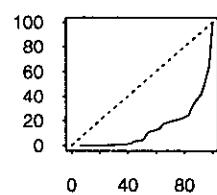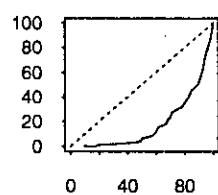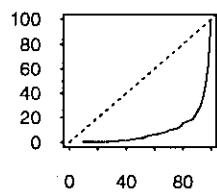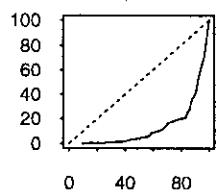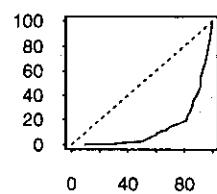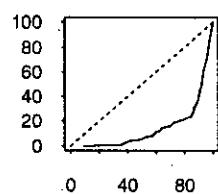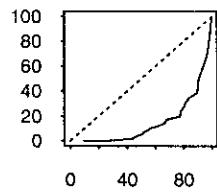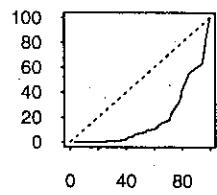
Cumulative % Area

Turbot 3K

Cumulative % Biomass

Cumulative % Area

Witch 3N

Cumulative % Biomass

Cumulative % Area

Witch 3O

Cumulative % Biomass
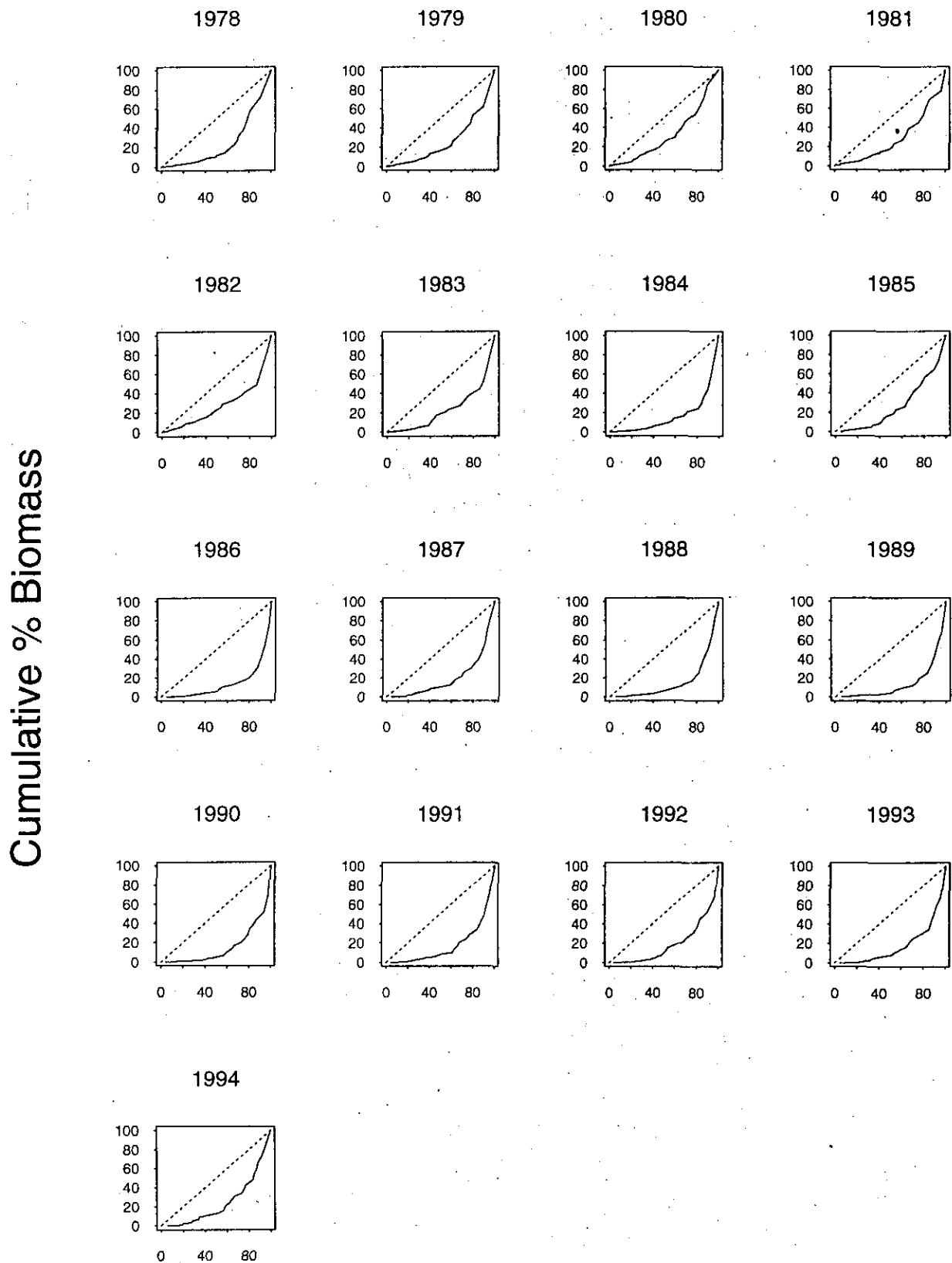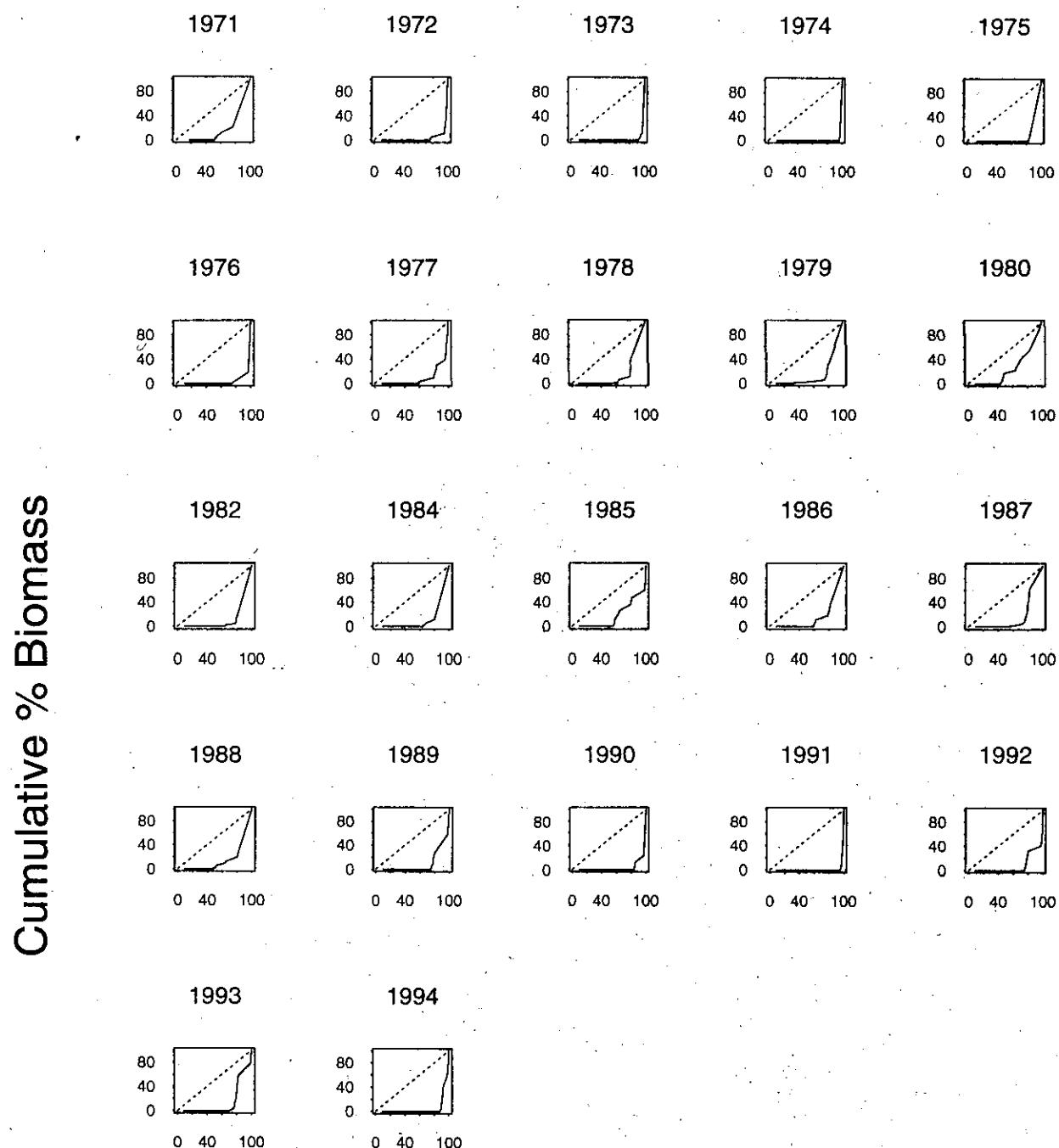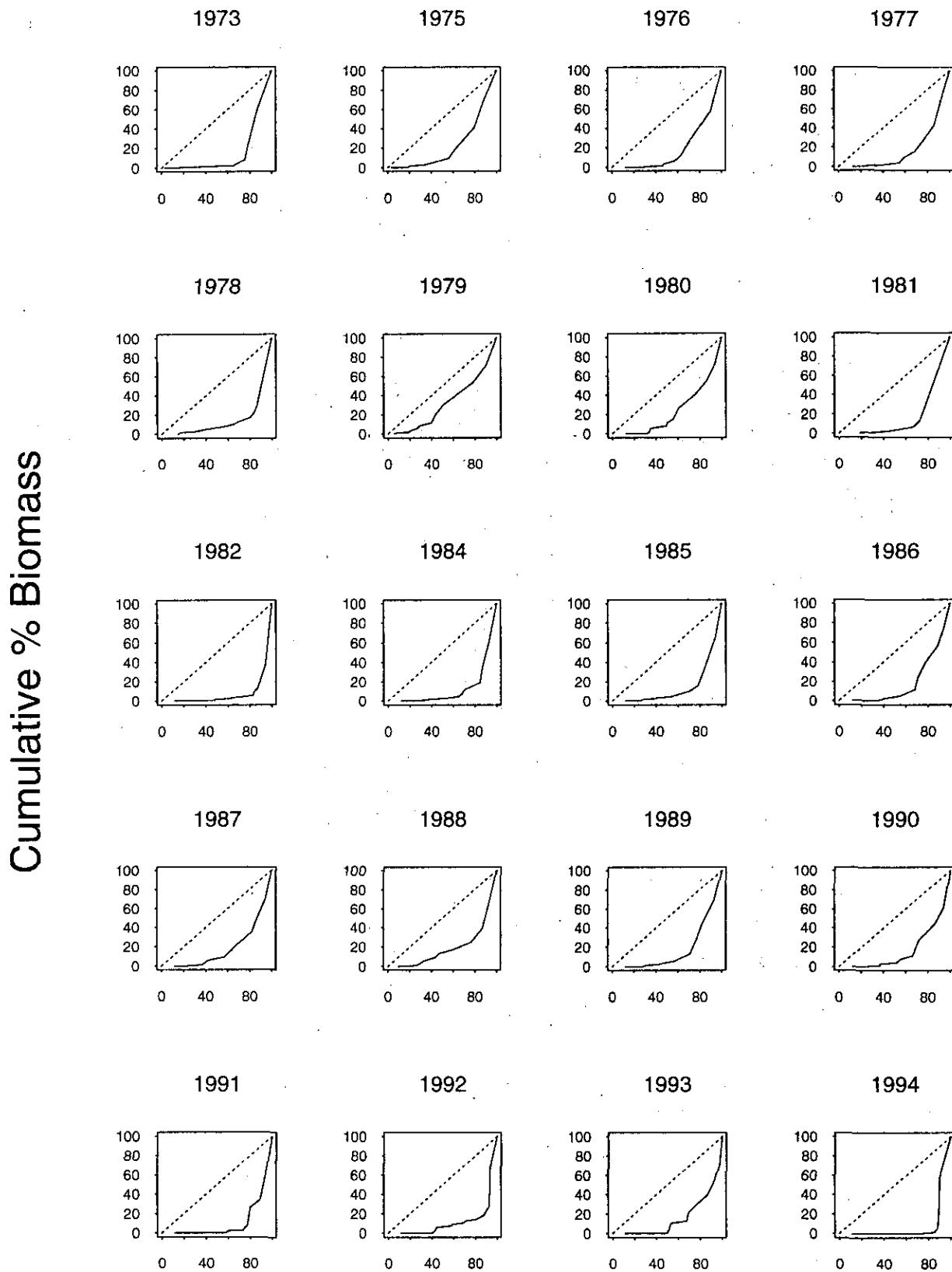
Cumulative % Area

Yellowtail 3LNO

Cumulative % Biomass (y-axis)

Cumulative % Area (x-axis)