Graphical analyses of the catch age composition for red drum.

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It is first important to note that the catch at age data used in this working paper includes the inferred deaths from the recreational B2 (catch and release) fishery component. Preliminary estimates of the age composition of this catch component were considered too unreliable to use in the assessments for both the northern and southern region red drum stocks. This component represents approximately 20% of the total catch for both stocks, with considerable annual variability. A figure for this has been prepared for the AW report. Hence, age composition information presented in this working paper will not be exactly the same as that used in the stock assessment model, but should be broadly indicative.

The size and age structure of total catch is important information in most stock assessments. A simple graphical display is shown in Figure 1 for the northern red drum stock. The top panel shows the total annual catch, the middle panel shows the annual age composition, and the bottom panel shows the relative size of catch compared to the same ages in other years. The areas of the bubbles are proportional to size. Computational details are given in the Appendix. Figure 1 demonstrates that the total catch for the northern red drum stock has considerable inter-annual variability. It is composed of primarily ages 1-3. Age 1 fish were caught more frequently prior to 1992. The distribution of catch at older ages has considerable inter-annual variability, perhaps due to their infrequent occurrence and sampling error.

Standardized proportions at year (*SPAY*; see Appendix) can show cohort patterns more clearly. These are shown in the top panel of Figure 2. They give the trends in the middle panel of Figure 1. Strong cohorts are not evident in the catches. Exceptions are the 1990 cohort which was relatively strong at ages 1-5 and 7. The 1996 and, to a lesser extent, the 1997 cohorts can be tracked for several ages. Standardized proportions at year (*SPYA*) shown in the bottom panel of Figure 2 give the trends relative to the average for the proportions in the bottom panel of Figure 1. They show more clearly when catches are above or below average. For example, they show that catches in 2007 at ages 1, 6, and 9 were average in the time series, whereas catches at other ages were all above average.

SPAY plots are provided by the *FLEDA* component of the *FLR* (Fisheries Library in R) package for the R statistical software. *FLEDA* provides exploratory analysis of stock assessment data.

Catches for the southern region red drum stock (top panel Figure 3) were highest in 1984-5 and 1987. Catches since 2000 have been slightly higher than in the 1990's. Overall, catches for this stock show less inter-annual variability compared to the northern region

stock (Figure 1). Ages 1-4 dominate the catches (middle panel, Figure 3). The *SPAY* and *SPYA* plots show three periods of fairly consistent age compositions:

1. 1982-1990. Catches at age one are more prevalent.
2. 1991-1999/2000. Catches at ages 6-9 are more prevalent.
3. 2000/2001-2007. Catches at ages 2-5 are more prevalent.

This suggests potential changes in fishery selectivity.

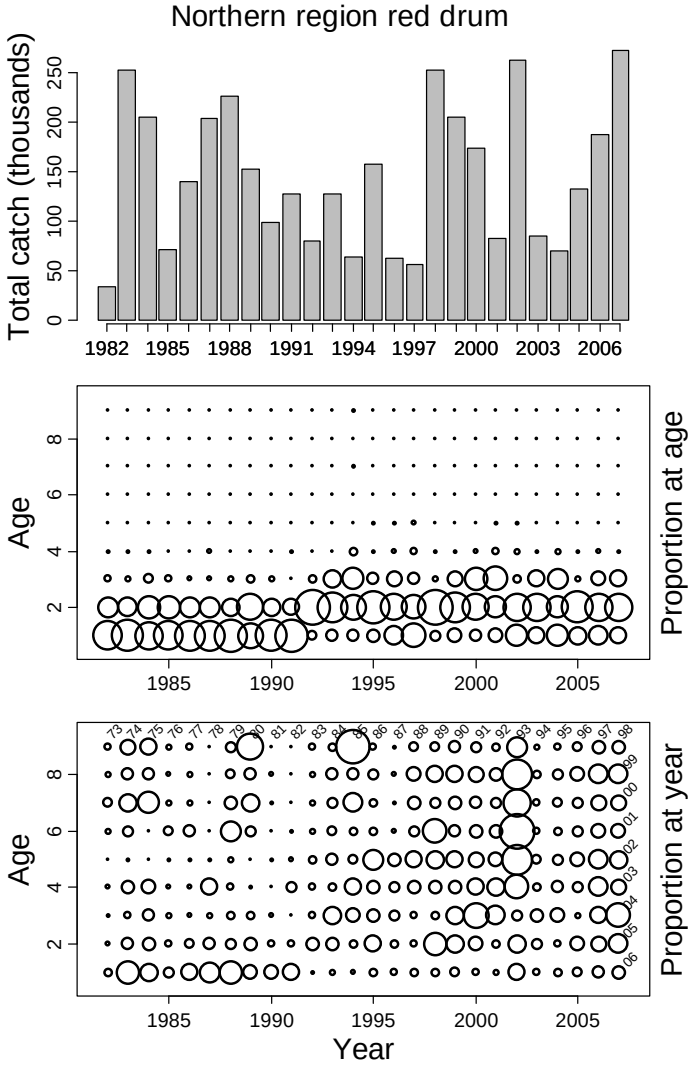

Figure 1. Top panel: Total annual catch for the northern region red drum stock. Middle panel: annual proportion at age. Bottom panel: proportion at year for each age. Cohorts are indicated along the margins of the bottom panel.

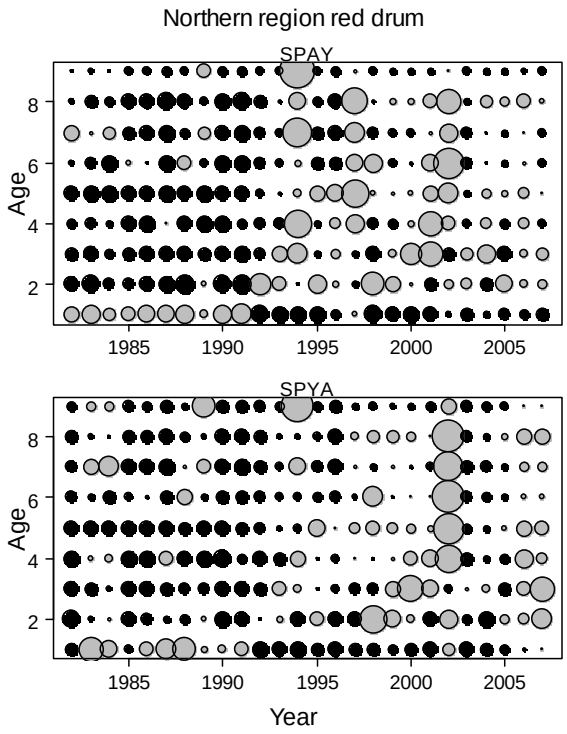

Figure 2. Top panel: standardized proportion at age (*SPAY*) for the northern region red drum stock. Bottom panel: standardized proportion at year (*SPYA*). Black denotes negative values, and grey denotes positive. Bubble areas are proportional to absolute values. A small bubble means the proportion is near average in size for that age in the time series.

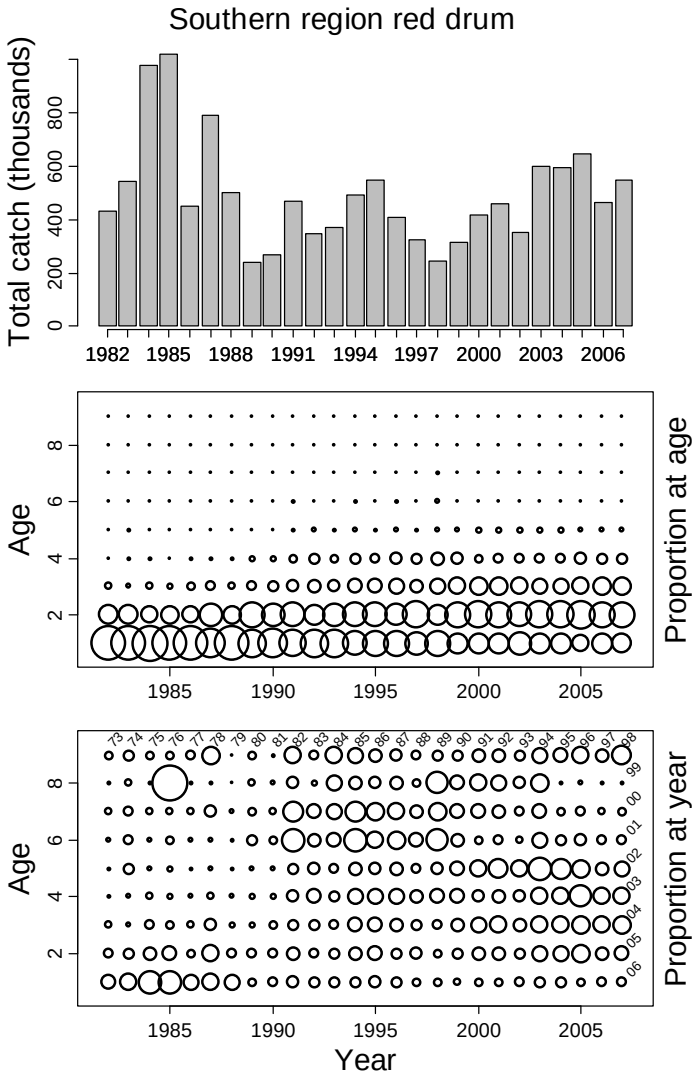

Figure 3. Top panel: Total annual catch for the southern region red drum stock. Middle panel: annual proportion at age. Bottom panel: proportion at year for each age. Cohorts are indicated along the margins of the bottom panel.

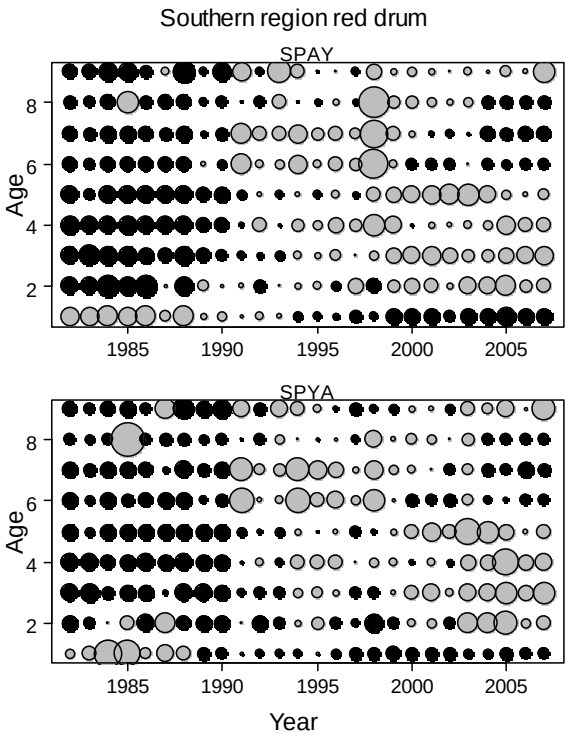

Figure 4. Top panel: standardized proportion at age (*SPAY*) for the southern region red drum stock. Bottom panel: standardized proportion at year (*SPYA*). Black denotes negative values, and grey denotes positive. Bubble areas are proportional to absolute values. A small bubble means the proportion is near average in size for that age in the time series.

Appendix

The proportions in the middle panel of Figures 1 and 3 are computed as

$$p_{a|y} = \frac{C_{ay}}{\sum_a C_{ay}}.$$

They show the age (a) composition of the catch each year (y), and can be used to track cohorts trends. We use the notation $a|y$ to denote age within year. Similarly, the proportions in the bottom panel are computed as

$$p_{y|a} = \frac{C_{ay}}{\sum_y C_{ay}}.$$

These proportions give the size of a catch relative to the time series; that is,

$$\frac{C_{ay_1}}{C_{ay_2}} = \frac{p_{y_1|a}}{p_{y_2|a}}.$$

The standardized proportions at age (*SPAY*) in Figures 2 and 4 are computed as

$$p_{a|y}^{std} = \frac{p_{a|y} - \overline{p}_{a|y}}{Y^{-1}\sum_y \left(p_{a|y} - \overline{p}_{a|y}\right)^2},\ \overline{p}_{a|y} = \frac{\sum_y p_{a|y}}{Y}.$$

Standardized proportions at age (*SPYA*) in Figures 2 and 4 are computed as

$$p_{y|a}^{std} = \frac{p_{y|a} - \overline{p}_{y|a}}{Y^{-1}\sum_y \left(p_{y|a} - \overline{p}_{y|a}\right)^2},\ \overline{p}_{y|a} = \frac{\sum_y p_{y|a}}{Y} = Y^{-1}.$$