## Appendix A3: Estimation of Virginia and North Carolina Wave-1 Harvest, 1996-2004

DT: 7/11/2005

TO: ASMFC Striped Bass Technical Committee

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RE: MRFSS North Carolina Wave-1 2004 harvest

### Introduction

During the March 2005 Striped Bass Technical Committee (STB TC) meeting, the results for the 2004 wave-1 North Carolina (NC) harvest were reported. This was the first time wave-1 was directly sampled by the Marine Recreational Fisheries Statistics Survey (MRFSS), and the results were both predictable and a cause for concern. A total of 177,288 striped bass (equivalent to 3,615,670 lb) were harvested during wave-1 in North Carolina.

Anecdotal knowledge has suggested that North Carolina, Virginia, and possibly other states had a sizeable wave-1 fishery. The 2004 wave-1 harvest values for North Carolina and the wave-1 tag return data (Figure 1) for North Carolina and Virginia support this suggestion. However, information is still lacking on what the previous annual harvest rates were, as well as the level of exploitation in Virginia and elsewhere during wave-1. The STB TC requested an examination of the data that included suggestions for how to incorporate these data efficiently into the coastwide STB assessment.

The goal of this analysis is to determine if tag return data during wave-6 and wave-2 are correlated with the reported total harvest and, if so, if a proxy ratio may be utilized to back-calculate wave-1 data for North Carolina and Virginia.

### Data

Striped bass tag return data from North Carolina and Virginia were provided by the U.S. Fish and Wildlife Service (USFWS). Data were queried from the MRFSS website (http://www.st.nmfs.gov/st1/recreational/queries/effort/effort_time_series.html) on July 11, 2005 for North Carolina and Virginia, having selected variables by harvest (A+B1), all oceans combined, and all modes combined.

### Methods

Tag return and MRFSS data were merged by wave and by year and were analyzed for each state. SAS 9.1 was utilized to calculate Pearson's correlation coefficient (PROC CORR), generate linear regressions, and conduct ANOVA or analysis of variance (PROC REG) to test for similarities between tag return and total harvest data by wave. Only wave-6 (November and December) and Wave-2 (March and April) data were analyzed.

**Results**

*North Carolina*

Tag returns were positively correlated with total harvest (0.5828) during wave-6 (Figure 2). ANOVA indicated significant evidence ($p$-value = 0.0366) that total harvest could explain the proportion of tag returns during wave-6.

Tag returns were positively correlated with total harvest (0.9518) during wave-2 (Figure 3). ANOVA indicated significant evidence ($p$-value < 0.0001) that total harvest could explain the proportion of tag returns during wave-2.

*Virginia*

Tag returns were positively correlated with total harvest (0.5827) during wave-6 (Figure 4). Although ANOVA did not indicate statistically significant evidence ($p$-value = 0.0599) that total harvest could explain the proportion of tag returns during wave 6, the given p-value indicates suggestive, but inconclusive, evidence that the null hypothesis is false, possibly representing biological significance.

Tag returns were slightly negatively correlated with total harvest (-0.4007) during wave-2 (Figure 5). ANOVA did not indicate significant evidence ($p$-value = 0.4311) that total harvest could explain the proportion of tag returns during wave-2. However, the tag return data were not consistent from year to year and a negative correlation was expected.

**Estimates of Wave-1 Harvest 1996-2004**

Based on the above analyses and suggestion from the Striped Bass TC, Table 1 contains estimates for total harvest for each state.

*North Carolina*

Wave-1 total harvest for 1996-2003 is based on the NC specific 2004 wave-1 ratio of tag returns to MRFSS total harvest numbers. There were 47 tags returned during the wave-1 fishery period for the ocean fishery. The MRFSS reported harvest (A+B1) was 177,288 striped bass during the same period. This resulted in a 2004 ratio tags to harvest of 0.000265. This ratio was applied to the wave-1 tag returns for the NC ocean fishery to provide a back-calculated total harvest for wave-1 in NC.

*Virginia*

Unlike NC, a 2004 wave-1 total harvest was not reported. However, analysis of the tag returns suggested that a winter fishery similar to that of North Carolina occurred off VA during 2004. The July 11$^{th}$ report to the TC did indicate that VA wave-6 tag returns were positively correlated to harvest and implied biological significance, though wave-2 analysis did not. Personal communication with Sara Winslow (NCDMF) confirmed that the winter fishery begins in the latter half of wave-6 and continues into wave-1 in northeastern NC, and similar trends would be expected for southeastern VA. Anecdotally, this suggested that wave-6 and wave-1 harvest would show some level of correlation in fishing activity. Using known wave-1 tag returns, a mean ratio (0.000167) of tag returns to harvest for VA wave-6, 1996-2004, was utilized to back-calculate the total wave-1 harvest.

## Summary

The 2004 wave-1 total harvest for North Carolina corresponds with observed recreational effort that begins during wave-6 and continues into wave-1 throughout the coastal waters of northeastern North Carolina and southeastern Virginia (Sara Winslow, NCDMF, personal communication).

Analysis indicates that tag return data can be used to explain total harvest in wave-6 and wave-2 in North Carolina. If the assumption that wave-1 follows a similar trend is acceptable by the STB TC, then wave-1 data before 2004 could be back-calculated for North Carolina striped bass harvest. There are two possible methods for back-calculation (Figure 6). One would be using the direct 2004 ratio of tag returns to reported total harvest. The other would be to use the combined ratio of tag returns to total harvest for both wave-6 and wave-2.

Correlation analysis for Virginia did indicate total harvest could be explained by tag returns, although ANOVA did not provide strong evidence for or against the reported correlation. However, tag return evidence does show a wave-1 striped bass fishery is occurring in Virginia (Figure 1), and using the wave-6 mean ratio of tag returns to reported total harvest for 1996-2004 could be utilized to back-calculate the wave-1 striped bass recreational fishery (Figure 7).

## Appendix A3 Tables

Table 1. Estimates of wave-1 harvest by the winter striped bass recreational fisheries off Virginia and North Carolina.

| Year | Total harvest values (projected) | |
|---|---|---|
| | NC | VA |
| 1996 | 18,860 | 5,985 |
| 1997 | 49,037 | 83,793 |
| 1998 | 15,088 | 89,778 |
| 1999 | 18,860 | 107,734 |
| 2000 | 7,544 | 53,867 |
| 2001 | 18,860 | 53,867 |
| 2002 | 75,442 | 89,778 |
| 2003 | 79,214 | 53,867 |
| 2004 | 177,288* | 155,616 |

*actual harvest

## Appendix A3 Figures

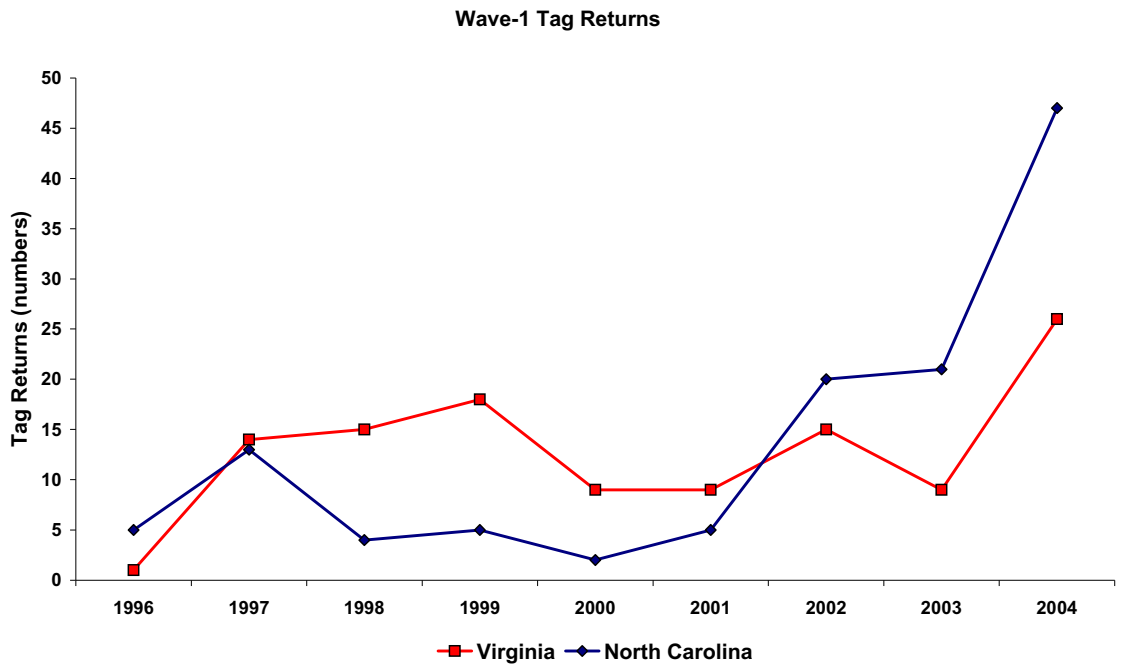


Figure 1. Wave-1 tag returns for Virginia and North Carolina

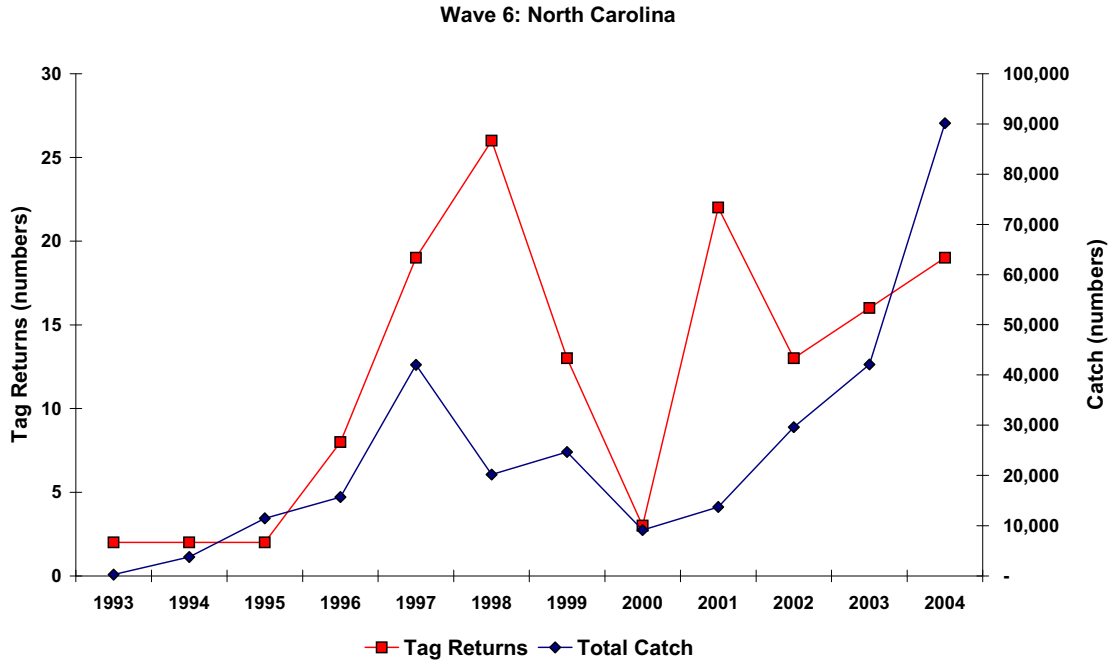


Figure 2. Wave-6 tag returns versus total harvest for North Carolina

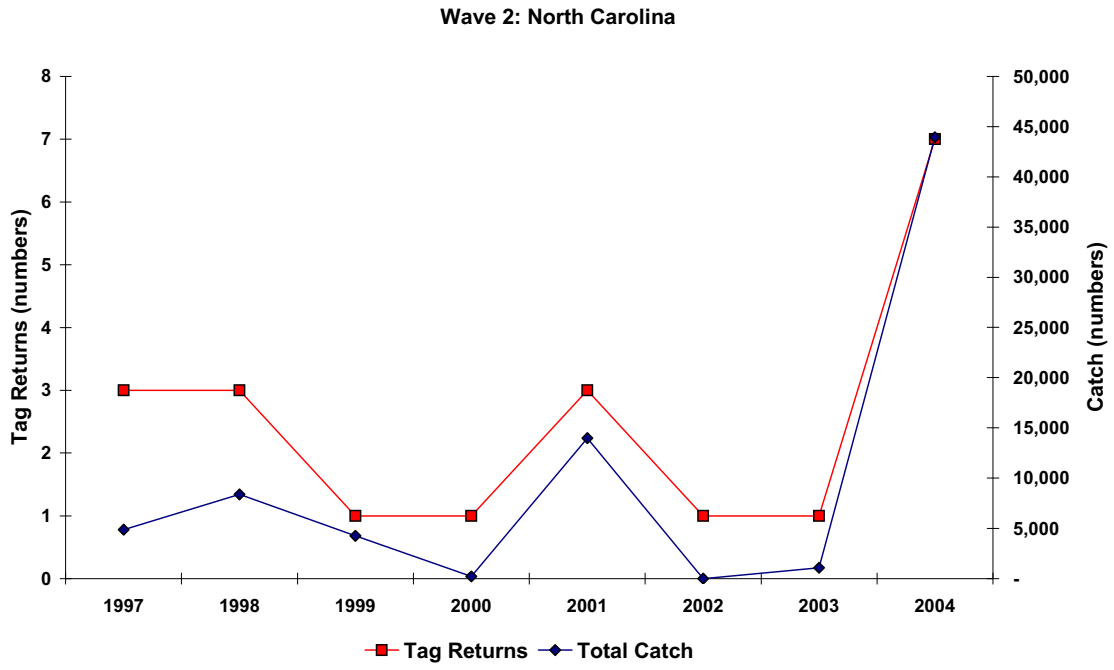


Figure 3. Wave-2 tag returns versus total harvest for North Carolina

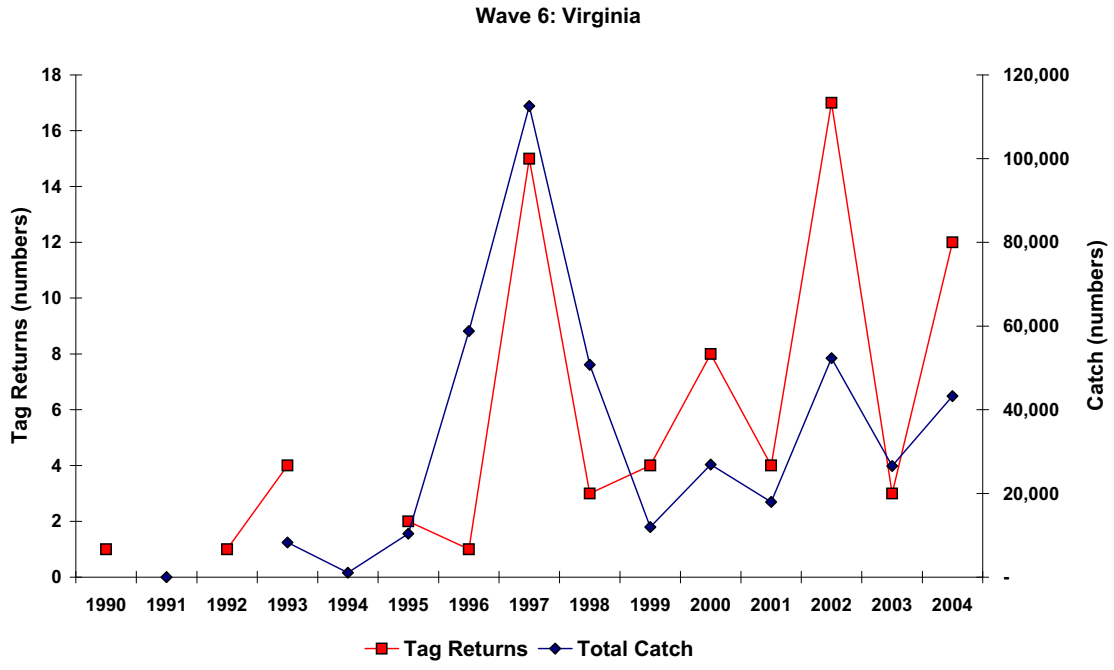


Figure 4. Wave-6 tag returns versus total harvest for Virginia.

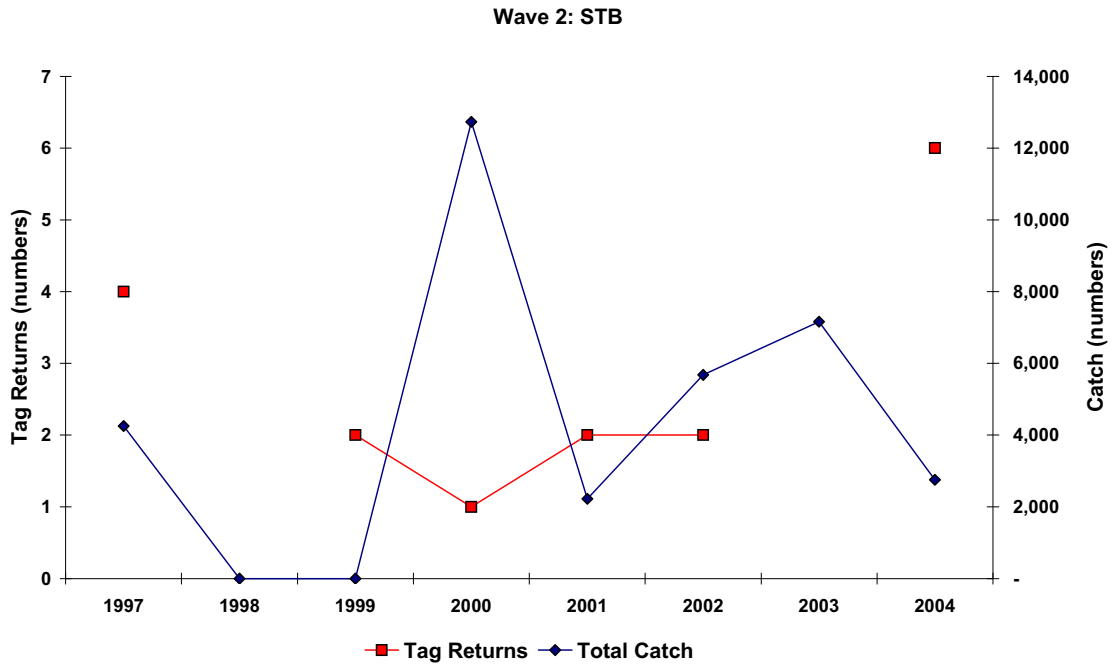


Figure 5. Wave-2 tag returns versus total harvest for Virginia

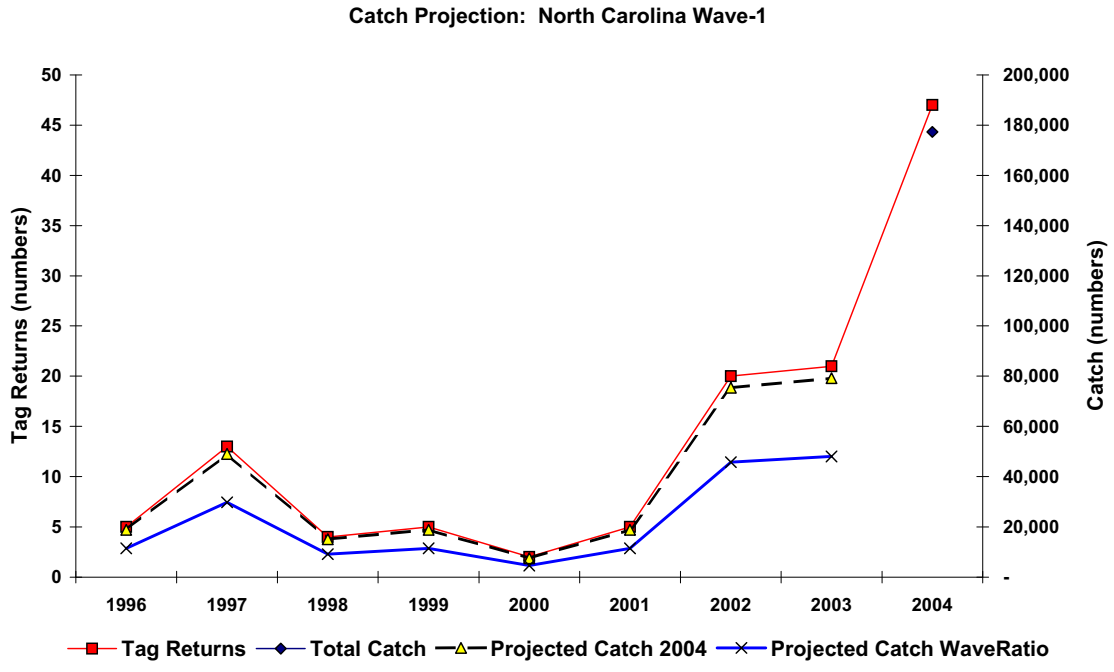


Figure 6. Comparison of harvest projections for North Carolina wave-1

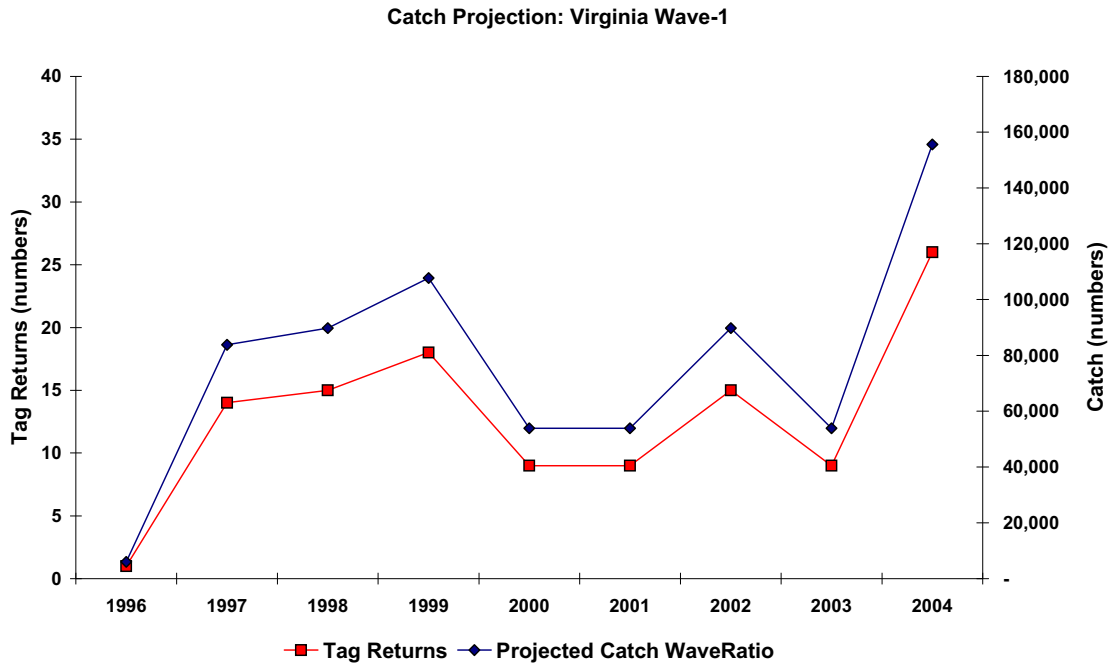

Figure 7. Harvest projection for Virginia wave-1

**Estimation of Virginia Wave 1 Harvest in 2005 and 2006**

In Appendix C of the 2005 stock assessment, a memo from Joe Grist states "Personal communication with Sara Winslow (NCDMF) confirmed that the winter fishery begins in the latter half of wave-6 and continues into wave-1 in northeastern NC, and similar trends would be expected for southeastern VA." If the fisheries are similar because of their close proximity, it follows that complete information on harvest from NC in 2005 and 2006 could be used to provide more realistic estimates of harvest in Virginia during wave 1.

If it is assumed that the number of tags returned from killed fish is proportional to the numbers of fish harvested regardless of location, the ratio of the NC harvest in wave 1 to tag returns from NC harvested fish will provide a means by which harvest in Virginia can be estimated in the same wave using Virginia wave 1 tag returns:

VA harvest = NC harvest/NC tag returns*VA tag returns

"Killed" tag numbers from only recreational anglers fishing were extracted from the USFWS tag database using the following codes:

Region = "COAST",
disposition="K"
recapturertype="H" or "S",
event=1
capmonth =1 or 2
capyear=2005 or 2006
State = "NC" (or "VA")

To match the tag data, estimates of wave 1 NC harvest from charter/private boats in the state territorial seas for 2005 and 2006 were extracted from the MRFSS website.

Estimates of harvest are given below

| | Wave 1 | | | | Wave 1 | |
|---|---|---|---|---|---|---|
| | NC | NC | Ratio | | VA | Est. |
| Year | Harvest | Tag Returns | (har/tags) | | Tag Returns | Harvest |
| 2005 | 71981 | 14 | 5141.50 | | 7 | 35991 |
| 2006 | 84144 | 23 | 3658.43 | | 23 | 84144 |