



**NOAA
FISHERIES**

Northeast
Fisheries
Science Center

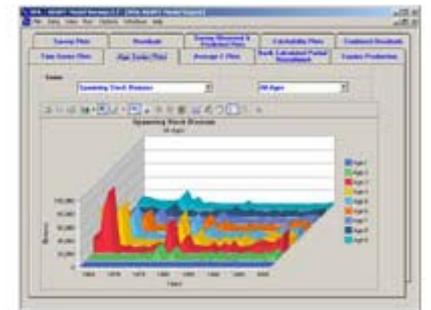
NOAA Fisheries Toolbox for Stock Assessment

TOR # 2 Assessment Process

By Chris Legault

Welcome to the NOAA Fisheries Toolbox Version 3.1

The NOAA Fisheries Toolbox (NFT) is a suite of biological modeling software programs that can be used in fisheries stock assessments.



<http://nft.nefsc.noaa.gov/index.html>

May 20, 2014

Overview of NOAA Fisheries Toolbox

24 programs freely available

NOAA's National Marine Fisheries Service
NOAA Fisheries Toolbox

General

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- » Toolbox Design
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Model List

- » A Stock Production Model Incorporating Covariates
- » Age Structured Assessment Program
- » Age Structured Projection Model
- » An Index Method
- » Collie-Sissenwine Analysis
- » Depletion Corrected Average Catch Model
- » Dual Zone VPA
- » Kolman Filter
- » Length Based Yield Per Recruit
- » Management Strategy Evaluation
- » Productivity and Susceptibility Analysis
- » Population Simulator
- » Rivard Weights
- » Statistical Catch at Age Model
- » Statistical Catch at Length Model
- » Stock Recruitment Fitting Model
- » Stock Synthesis Version 3
- » Survival Estimation In Non-Equilibrium situations
- » Virtual Population Analysis
- » Visual Report Designer
- » Yield Per Recruit

Welcome to the
NOAA Fisheries Toolbox
Version 3.1

The NOAA Fisheries Toolbox (NFT) is a suite of biological modeling software programs that can be used in fisheries stock assessments.

Currently Available Models

Estimation of Stock Size and Mortality	Version	Date Updated
• A Stock Production Model Incorporating Covariates (ASPIC)	5.34.9	2/08/2011
• Age Structured Assessment Program Model (ASAP)	3.0.14	11/12/2013
• Collie-Sissenwine Analysis (CSA)	4.2.2	9/24/2013
• Dual Zone Virtual Population Analysis (VPA-2BOX)	3.05	8/4/2004
• Statistical Catch at Age Model (STATCAM)	1.4.1	5/2/2008
• Statistical Catch at Length Model (SCALE)	1.0.11	9/13/2013
• Stock Synthesis Version 3 (SS3)	3.45f	10/18/2012
• Virtual Population Analysis (VPA)	3.3	3/7/2013

Management Scenario Projections

- [Age Structured Projection Model](#) (AGEPRO) 4.2.2 9/17/2013

Biological Reference Points

- [Age Based Yield Per Recruit](#) (YPR) 3.3 9/17/2013
- [An Index Method](#) (AIM) 2.4.0 12/22/2011
- [Length Based Yield Per Recruit](#) (YPRLEN) 2.1 4/20/2012
- [Stock Recruitment Fitting Model](#) (SRFIT) 7.0.1 3/18/2010

Model Performance Evaluation

- [Population Simulator](#) (POPSIM) 7.5 5/25/2012
- [Management Strategy Evaluation](#) (MSE) 3.4.3 9/20/2012
- [Visual Report Designer](#) (VisRpt) 1.6.1 4/2/2008

Models for Data Limited Situations

- [Depletion Corrected Average Catch Model](#) (DCAC) 2.1.1 10/4/2012
- [Survival Estimation in Non-Equilibrium situations](#) (SEINE) 1.3 9/15/2008

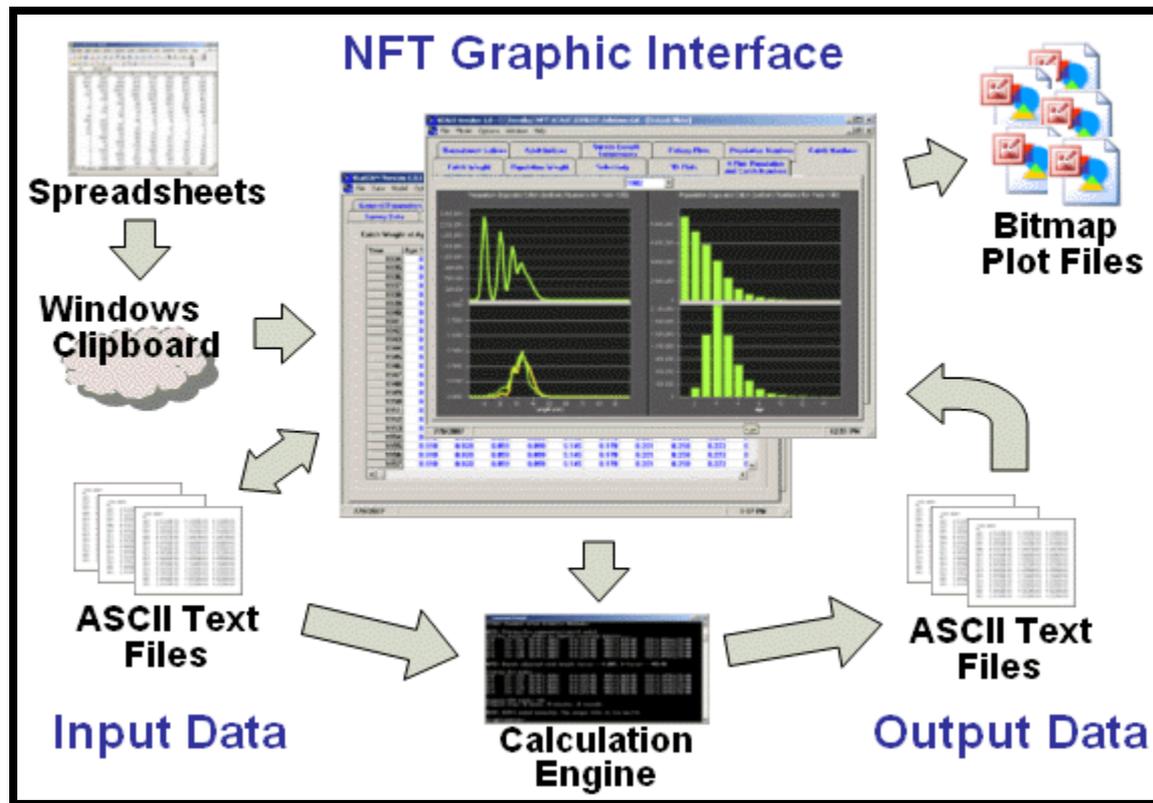
Additional Tools

Feature	Model											
	DCAC	SEINE	AIME	ASPC	CSA	SCAE	VPA	VPA2BOX	AMAK	STACAM	ASAP	SS3
Data / Observation Error												
Total catch (landings+discards)	●	●	●	●	●	●	●	●	●	●	●	●
Catch at age (CAA)							●	●	●	●	●	●
Catch at length (CAL)						●						●
Address variation in CAA or CAL		●							●	●	●	●
Age specific indices of abundance for tuning							●	●	●	●	●	●
Age-aggregated tuning indices			●	●	●	●	●	●	●	●	●	●
Tag-recapture								●				●
Process / Model Specification												
Stock recruitment function									●		●	●
Sexual dimorphism in growth rates						●		●				●
Spatial heterogeneity								●				●
Incorporate long term historical landings	●		●		●				●	●	●	●
Handle gaps in age or length information		●				●			●	●	●	●
Multiple fleets									●	●	●	●
Handle differences between sexes						●		●				●
Automatic retrospective analyses			●	●			●			●	●	
Independently estimate temporal changes in catchability for surveys									●		●	●
Address variations in biological sampling intensity over time									●	●	●	●
Consider measurement error for individual times series observations									●		●	●
Uncertainty / Forecasting / BRPs												
MCMC									●	●	●	●
Bootstrap			●	●	●		●	●				●
Estimation of BRP for F			●	●					●	●	●	●
Estimation of BRP for SSB				●					●	●	●	●
Linkage to external/internal forecasting program			●	●			●					●
Model Complexity												
Model Complexity	1	1	1	1	1	1	2	2	3	3	3	4

(1=Low, 2=Medium, 3=High, 4=Very High)

Toolbox Design

- Separation of GUI and calculation engine
- Communication via text files



Toolbox Process

Scientist writes calculation engine code

- ADMB, Fortran, C++

NFT programmer works with scientist to develop graphic user interface

- Visual Basic and ChartFx

Test data sets are created and run to ensure proper interactions between GUI and engine

Beta version released internally

Feedback provided to improve GUI

Official version released on Toolbox website

Oversight provided by NMFS Assessment Methods Working Group

Why Use Toolbox?

Pros

- Easier than writing your own
- Tested
- Common platform
- Familiarity
- Focus on results
- Simplifies data handling and result plotting
- Documents what was done when

Cons

- No generalized program can handle every situation
 - More generalized harder to fully test and document
- Cannot customize
- Data format is specific to program

Often easiest to start with an existing file and modify it

File Data View Run Options Windows Help

- Create New Case
- Open Existing Input Data File
- Save Input Data As...
- Export Data to R Object
- Exit

Weighting Factors	Advanced	Catch Multiplier	Sensitivity Analysis
Maturity	Stock Estimates	Options-1	Options-2
Catch Weights	Stock Weights	SSB Weights	Survey Selection

NOAA's National Marine Fisheries Service

NOAA Fisheries Toolbox

Virtual Population Analysis

Input File: None Selected

Model Name: []

First Year in Catch: []

Last Year in Catch: []

First Age in Catch: []

Last Age in Catch: []

Catch Data Includes Plus Group:

Number of Surveys Available: []

Number of Surveys Used: 0

SET

The SET button dimensions the problem. Cannot proceed until problem is dimensioned.

Windows allow you to switch between input and results

The screenshot shows the VPA/ADAPT Version 3.3 software interface. The title bar reads 'VPA/ADAPT Version 3.3 - [Input Data]'. The menu bar includes 'File', 'Data', 'View', 'Run', 'Options', 'Windows', and 'Help'. The 'Windows' menu is open, showing '1 Input Data' (checked) and '2 VPA/ADAPT Model Results'. Below the menu is a tabbed interface with several tabs: 'General Data', 'Catch at Age', 'Catch Weights', 'Stock Weights', 'SSB Weights', 'Survey Selection', 'Run Mode', 'Weighting Factors', 'Advanced', 'Catch Multiplier', 'Sensitivity Analysis', 'Survey Data', 'Natural Mortality', 'Maturity', 'Stock Estimates', 'Options-1', and 'Options-2'. The 'Natural Mortality' tab is selected and highlighted with a red box. Below the tabs is a data table with columns for 'Age 0' through 'Age 6' and rows for years from 1982 to 1998. The 'Natural Mortality' tab is highlighted with a red box, and a red arrow points from the 'Windows' menu to it. A second red box highlights the 'Natural Mortality' tab, and a red arrow points from it to a text box on the right.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
▶ 1982	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1983	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1984	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1985	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1986	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1987	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1988	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1989	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1990	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1991	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1992	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1993	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1994	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1995	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1996	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1997	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1998	0.200	0.200	0.200	0.200	0.200	0.200	0.200

Tabs within Windows allow you to enter different data or look at different results

Data can be entered in a number of ways

Text

Pull down menu

Check box

The screenshot shows the VPA/ADAPT Version 3.3 software interface. The main window displays a data entry table with the following columns: Index, Survey Tag, Start Age, End Age, Survey Type, Survey Time, Use T+1 Year Value in Retro, and Use Survey in Model. The table contains 18 rows of data. Annotations with red arrows point to specific elements: 'Text' points to the 'Survey Tag' column, 'Pull down menu' points to the 'Survey Type' column, and 'Check box' points to the 'Use T+1 Year Value in Retro' column. A red box highlights the 'Survey Type' dropdown menu for row 3, which is currently set to 'WEIGHT'.

Index	Survey Tag	Start Age	End Age	Survey Type	Survey Time	Use T+1 Year Value in Retro	Use Survey in Model
1	NEC_W	1	1	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	NEC_W	2	2	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	NEC_W	3	3	WEIGHT	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	NEC_W	4	4	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	NEC_W	5	7	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	NEC_S	1	1	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7	NEC_S	2	2	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8	NEC_S	3	3	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9	NEC_S	4	4	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10	NEC_S	5	7	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11	NEC_F	2	2	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12	NEC_F	3	3	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
13	NEC_F	4	4	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
14	MA_S	1	1	NUMBER	1-JAN	<input type="checkbox"/>	<input type="checkbox"/>
15	MA_S	2	2	NUMBER	1-JAN	<input type="checkbox"/>	<input checked="" type="checkbox"/>
16	MA_S	3	3	NUMBER	1-JAN	<input type="checkbox"/>	<input checked="" type="checkbox"/>
17	MA_F	2	2	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input type="checkbox"/>
18	MA_F	3	3	NUMBER	1-JAN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Hint: click on another tab after entering a number to ensure it is written to input file

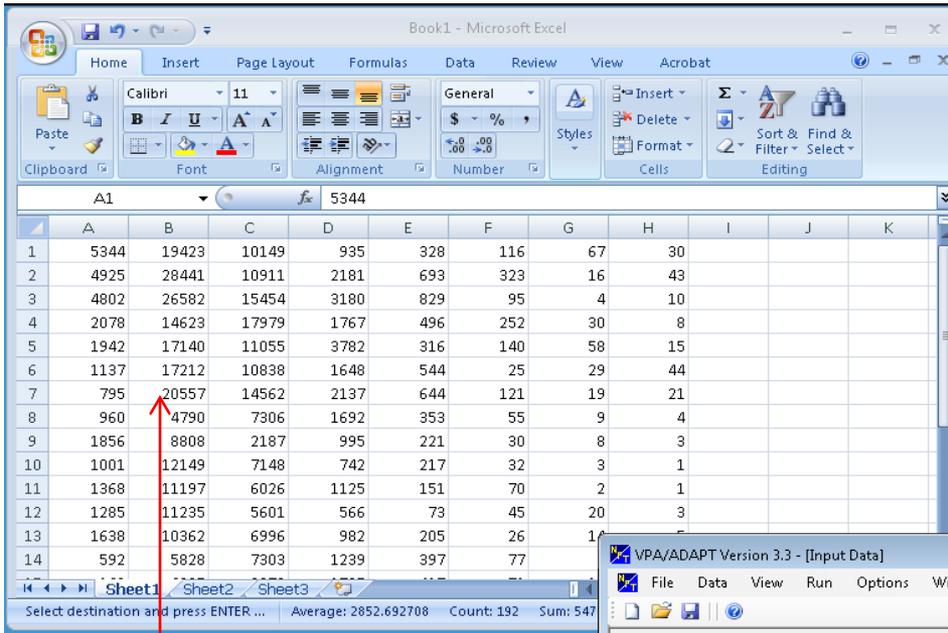
Right mouse button to enables fill options

The screenshot shows the VPA/ADAPT Version 3.3 - [Input Data] window. The main data table has columns for years (1997-2013) and ages (Age 1-7). The 'Age 1' column is highlighted in blue and contains the value 0.2 for all years. A context menu is open over the 'Age 1' column, with 'Fill Right' selected. A red arrow points from a text box to the 'Fill Right' option.

Run Mode	Rivard	Weighting Factors	Advanced	Catch Multiplier	Sensitivity Analysis
General Data	Catch at Age	Catch Weights	Stock Weights	SSB Weights	Survey Selection
Survey Data	Natural Mortality	Maturity	Stock Estimates	Options-1	Options-2

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1997	0.2							
1998	0.2							
1999	0.2							
2000	0.2							
2001	0.2							
2002	0.2							
2003	0.2							
2004	0.2							
2005	0.2							
2006	0.2							
2007	0.2							
2008	0.2							
2009	0.2							
2010	0.2							
2011	0.2							
2012	0.2							
2013	0.2							

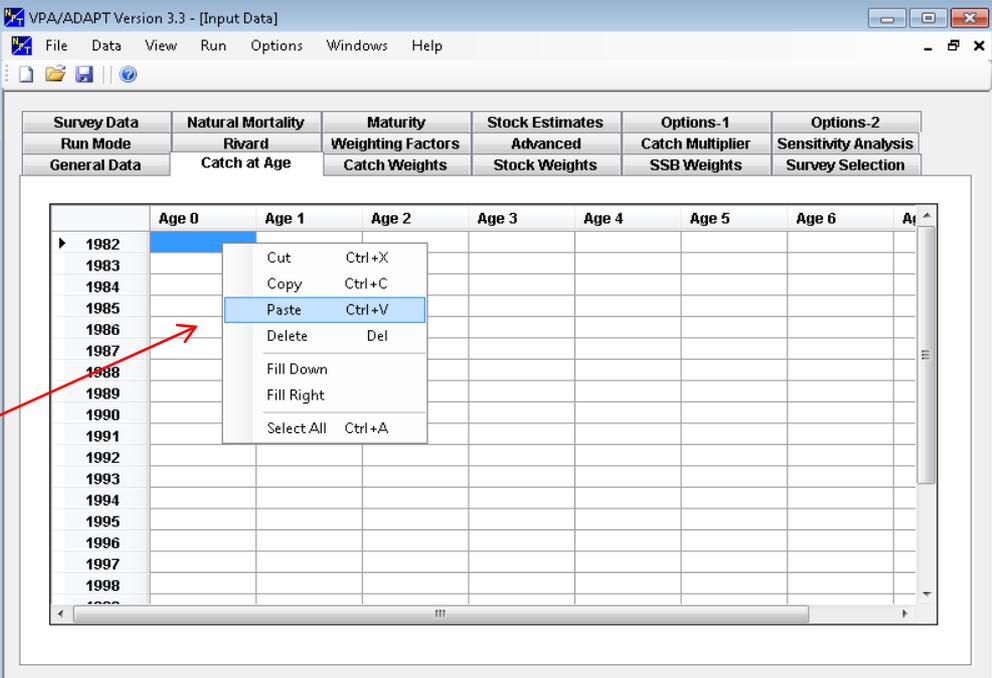
First the cell was filled down. Then the column was highlighted and can now be filled right.



Can copy and paste between the Toolbox grid and spreadsheets in Excel

Select range of cells in Excel and copy

Select upper left corner of range in Toolbox grid using right mouse button and paste. Same precision in Excel appears in grid. Be careful to have same number of rows and columns!



Where to get help

The screenshot shows the VPA/ADAPT Version 3.3 - [Input Data] application window. The Help menu is open, with options: About VPA/ADAPT, Using VPA/ADAPT, and Reference Manual. A red box highlights the Help menu and the 'Using VPA/ADAPT' option. A red arrow points from this option to a text box on the right. The main interface features a grid of tabs: Survey Data, Natural Mortality, Maturity, Options-1, and Options-2. Below the tabs is the NOAA's National Marine Fisheries Service logo and the text 'NOAA Fisheries Toolbox Virtual Population Analysis'. The input fields show: Input File: C:\NFT\VPV33\EXAMPLE\FLUKE2.DAT, Model Name: Summer flounder: June 2006, First Year in Catch: 1982, Last Year in Catch: 2005, First Age in Catch: 0, Last Age in Catch: 7, Catch Data Includes Plus Group: checked, Number of Surveys Available: 51, Number of Surveys Used: 41, and a SET button.

Learn which version in About.
Online help files in Using.
More detailed Reference Manuals sometimes available.

VPA Version 3.2

Hide Back Print Options

Contents Search

- General
- Methods
 - Rivard Calculation Method
 - Specifying Stock Estimates
 - Calculating Full F in the Terminal Year
 - Partial Recruitment Vector
 - Full F Classic Method
 - Full F Average Method
 - Full F Modified Heincke Method
 - Calculating F at Oldest True Age in Ter**
 - Calculating F in the Oldest True Age Cl
 - Heincke Method
 - Understanding the Plus Group Diagnos
- Input Data
- Output

Calculating F at Oldest True Age in Terminal Year

The calculation of fishing mortality at the oldest true age class in the terminal year is selected by the user as one of two methods by clicking one of the options on the **Options-1** tab

F at Oldest Age in Terminal Year

Use F Multiplied by Input Partial Recruitment

Use F at Oldest True Age Calculation Method

- The user may select that F at the oldest true age in the terminal year is equal to Full F multiplied by the input partial recruitment at the oldest true age

$$F_{A-1,T} = F_{FULL} * PR_{A-1}$$

$F_{A-1,T}$ = Fishing Mortality in Oldest True Age (A-1) in Terminal Year T
 F_{FULL} = Fully Recruited Fishing Mortality in Year T
 PR_{A-1} = Input Partial Recruitment at Oldest True Age in Year T

In this case [the calculation of Full F](#) and the several factors that affect its value play a strong role in the value of F in the oldest true age in the Terminal year
- The user may alternatively select to [calculate F at the oldest true age in the terminal year in the same manner as in all other years](#).

In this case Full F is calculated as above, but the value of F at the oldest true age in the terminal year is calculated in the same manner as in all other years.

The user should be aware that although Full F is not used directly under this option, in some cases Full F may influence the value of F at the oldest true age.

These cases arise when due to the lack of a stock estimate in year T+1 a value for fishing mortality in a given age class must be calculated. These values are filled in by multiplying the input partial recruitment by Full F.

If the filled in F's are in the range of the F at oldest true age calculation, then they will influence F at the oldest true age in the terminal year.

If a sufficient number of stock estimates were provided so as to not affect the inclusive range of the F oldest true age calculation, then Full F will play no role.

VPA/ADAPT Version 3.2

Online help

VPA/ADAPT Version 3.0
Reference Manual

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Running the Program

The screenshot shows the VPA/ADAPT Version 3.3 software interface. The 'Run' menu is open, with 'Run VPA/ADAPT Model' highlighted. A red box highlights the 'Run' menu and the 'Run Mode' column of the table below. A red arrow points from the 'Run VPA/ADAPT Model' option to a text box on the right.

Survey Data	Natural Mortality	Maturity	Stock Estimates	Options-1	Options-2
Run Mode	Rivard	Weighting Factors	Advanced	Catch Multiplier	Sensitivity Analysis
General Data	Catch at Age	Catch Weights	Stock Weights	SSB Weights	Survey Selection

NOAA's National Marine Fisheries Service

NOAA Fisheries Toolbox

Virtual Population Analysis

Input File: C:\NFT\WPAV33\EXAMPLE\FLUKE2.DAT

Model Name: Summer flounder: June 2006

First Year in Catch: 1982

Last Year in Catch: 2005

First Age in Catch: 0

Last Age in Catch: 7

Catch Data Includes Plus Group:

Number of Surveys Available: 51

Number of Surveys Used: 41

SET

Sometimes called "Launch" instead of "Run". Once program has been run, input file can be opened and results scanned in without re-running the program (checks for same file name and later date of output than input file).

Viewing Output Files

VPA/ADAPT Version 3.3 - [Input Data]

File Data View Run Options Windows Help

Select Program for Viewing Output Files

Command Window Stays Open When Running VPA

Run Mode	Board	Weighting Factors	Advanced	Catch Multiplier	Sensitivity Analysis
Survey Data	Natural Mortality	Maturity	Stock Estimates	Options-1	Options-2
General Data	Catch at Age	Catch Weights	Stock Weights	SSB Weights	Survey Selection

NOAA's National Marine Fisheries Service

NOAA Fisheries Toolbox

Virtual Population Analysis

Input File: **None Selected**

Model Name:

First Year in Catch:

Last Year in Catch:

First Age in Catch:

Last Age in Catch:

Catch Data Includes Plus Group:

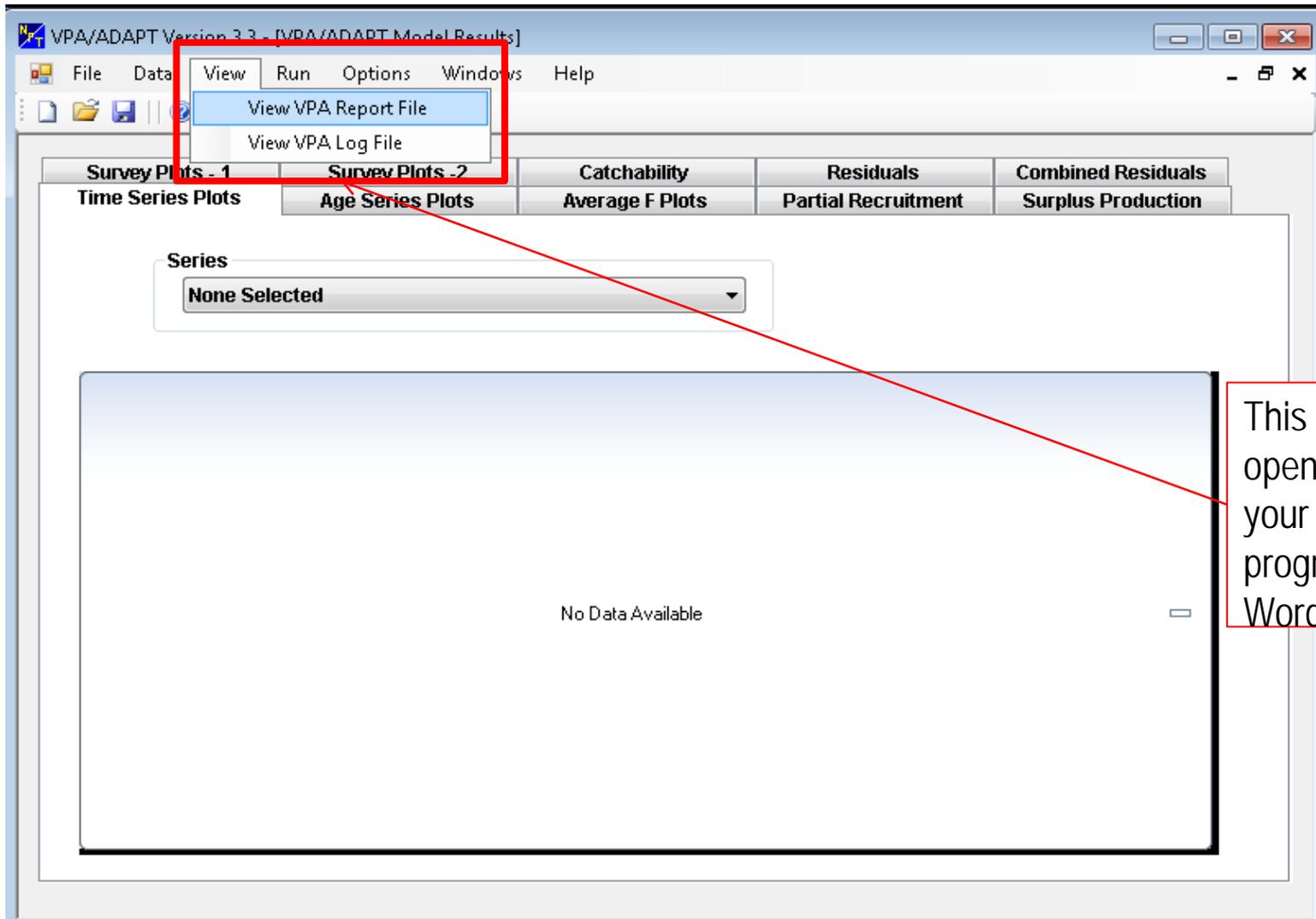
Number of Surveys Available:

Number of Surveys Used:

SET

Need to select a viewer for each program. A text editor that can handle a large number of columns is recommended (e.g. WordPad, Notepad++, Tinn-R)

Viewing Output Files II

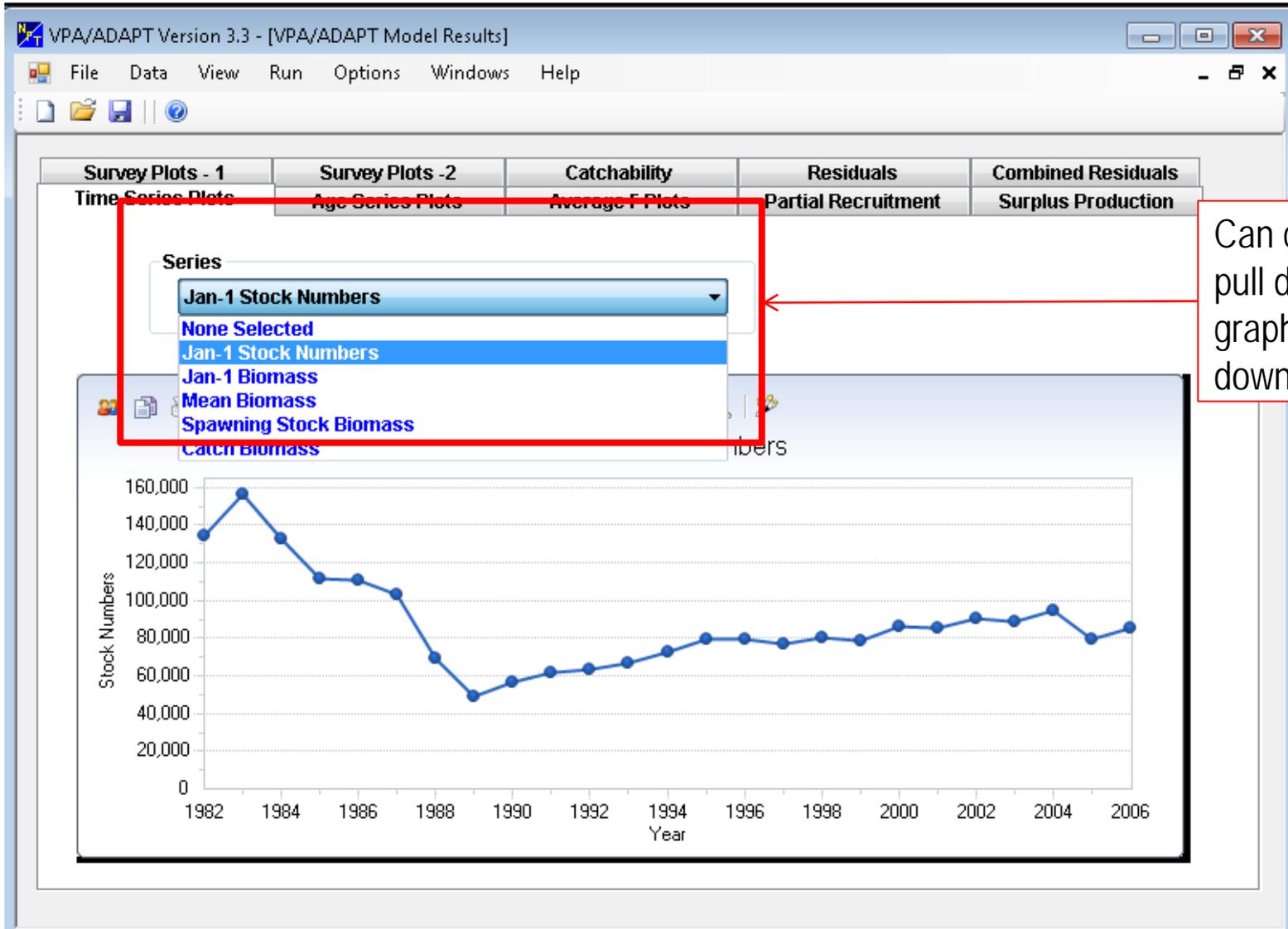


This selection will open report file using your designated program (e.g. WordPad)

Viewing Output Files III

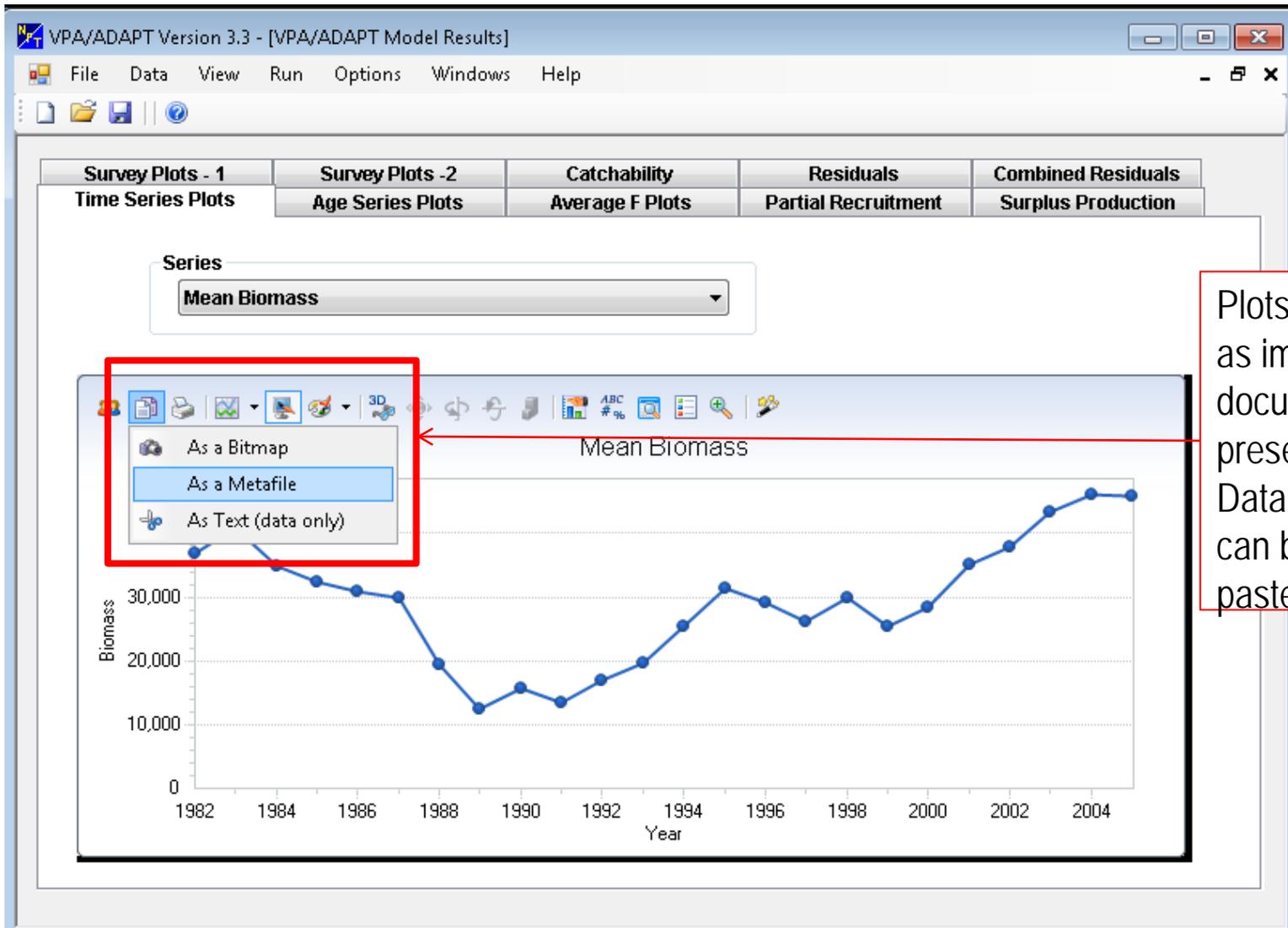
- A number of programs allow creation of rdat files
 - R scripts have been created for VPA and ASAP
 - Generate many png files quickly and easily
 - Generate pdf of all the plots
 - Facilitates creation of comparison tables and figures from multiple runs

Graph Tips and Tricks I



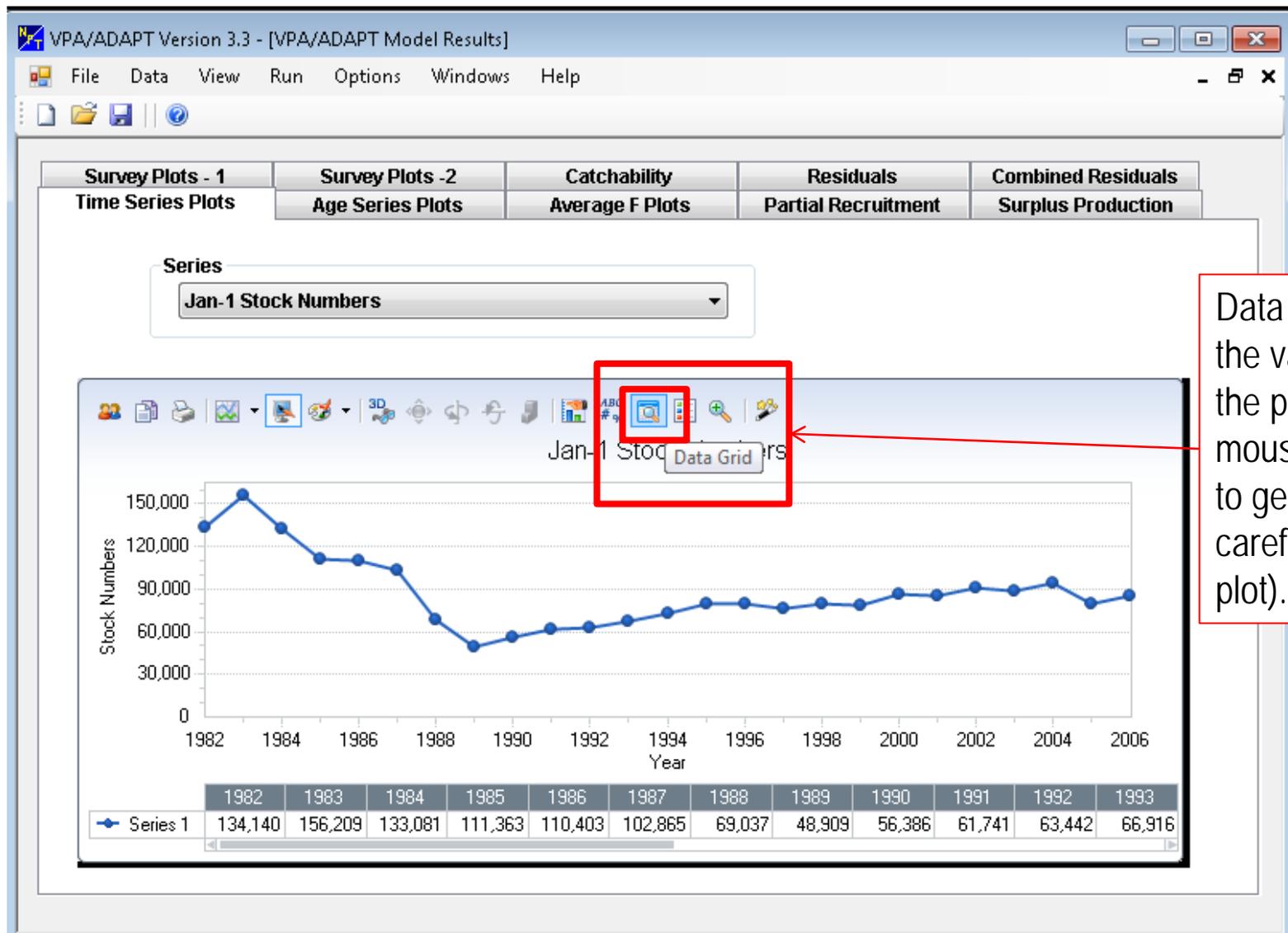
Can cycle through pull down menus of graphs using up and down arrows

Graph Tips and Tricks II



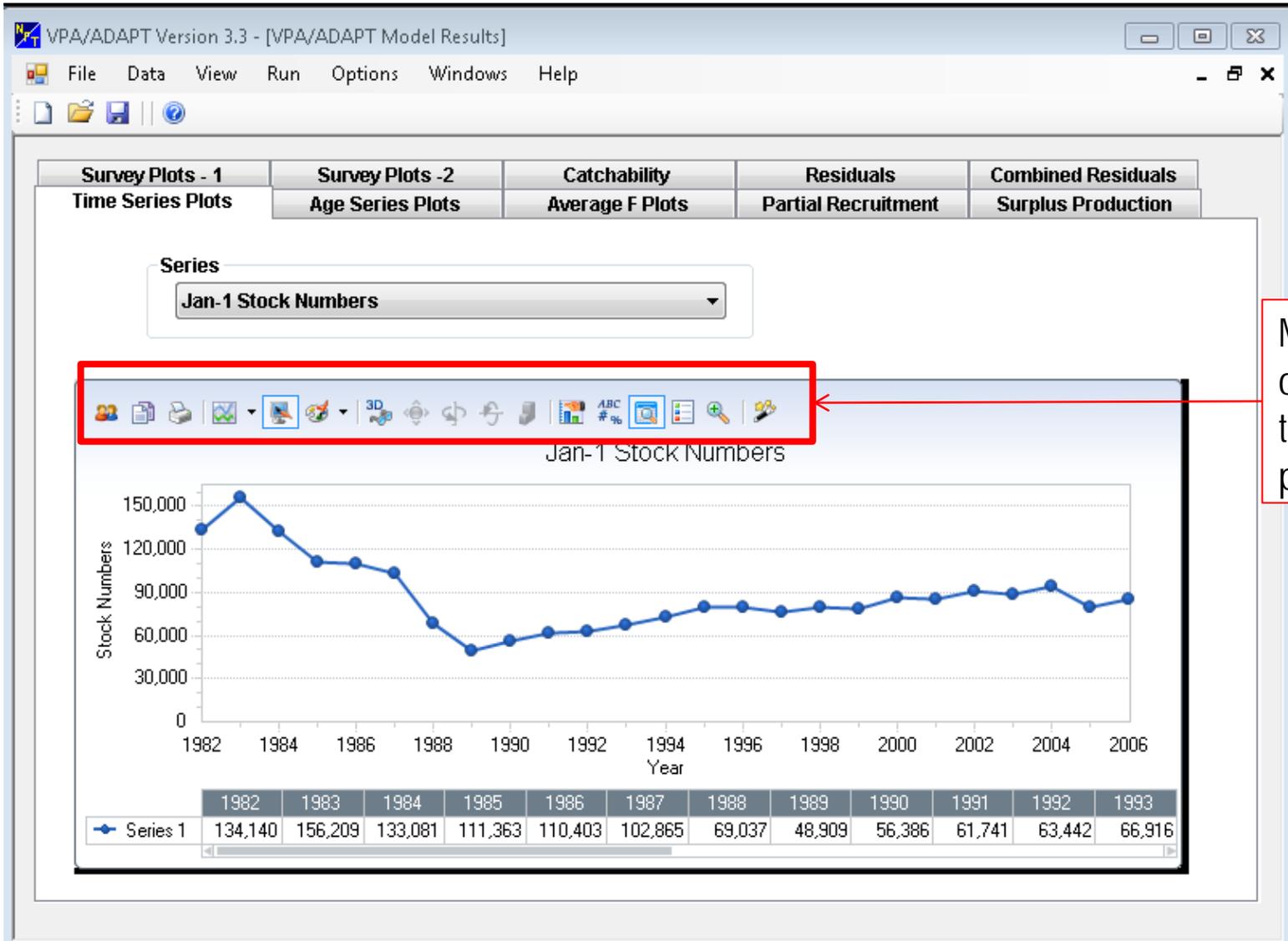
Plots can be saved as images for use in documents or presentations. Data from the plots can be saved and pasted into Excel.

Graph Tips and Tricks III



Data Grid shows the values used in the plot. Can also mouse over points to get values (be careful at edges of plot).

Graph Tips and Tricks IV



Many other options available to customize plots

Bookkeeping

Number of output files varies by program

- Can usually look in Help to decode file extensions

Can run multiple input files from same directory if they have different names

- Keeping track of runs is an important part of stock assessment!

Can open multiple versions of Toolbox programs

- Allows on screen side-by-side comparison
- Do NOT run multiple programs at same time!

Strengths

- Common look and feel
- Intuitive data entry and results review
- Tested
- Documents what was run when
- Code available for many of the programs
- Excellent teaching tools
- Reduces learning curve steepness which facilitates trying new approaches from other scientists
- Facilitates communication and testing at meetings
 - Reliable on the fly accommodation of requests
- Easy cross-testing of different models

Challenges

- NFT Programmer Alan Seaver retired April 30, 2014
- Visual Basic difficult to maintain as Windows changes
- Limited to Windows platform
- Adapting current models to new programming environments
- Keeping up with the Jones's—ICES progress

Solutions

- Ensure programming support
- Build on current Toolbox to allow multiple platforms
- Increase communication among Centers regarding stock assessment modeling
 - National Stock Assessment Workshop?
- Increase communication worldwide via increased participation in ICES and other scientific venues