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Two stock-assessment programs for a programmable pocket calculator

by

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Continuing advances in computing power of pocket electronic calculators now allow stock-assessment calculations usually performed by computers to be carried out virtually at an assessment meeting table. Programs for virtual population analysis and catch projections for the newly-released HP-67 calculator are presented here.

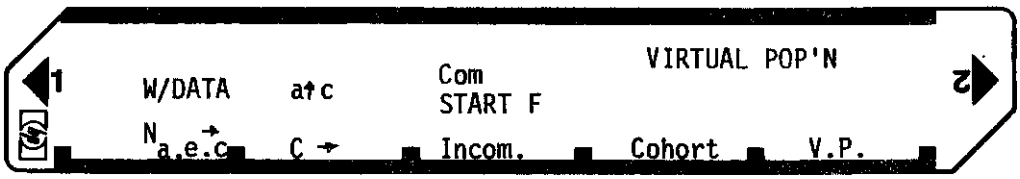
Virtual Population Analysis

The first program performs cohort or exact virtual population analysis on a year-class of up to 19 age-groups. Data are retained so that alternative values for natural and fishing mortalities can be examined without re-entering data. The exact solution follows the method of Doubleday, 1976. F is estimated to 0.001 or the predicted catch is within 0.001 of the observed catch, whichever occurs first.

Catch Projection

A standard catch projection for up to ten age-groups is performed. Either TAC or F may be set and the other calculated. Changing the units of population size makes corresponding changes on the units of output so that the desired number of significant digits can be retained.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter Number of ages · M	N_a·M	A	M
2	Enter CATCH AT AGE shown during pause		B	1.00
				Na+1
3	Correct wrong entry: age ↑ catch	a↑n	f B	n
4	Enter starting F fishing incomplete	F	C	PoP
	fishing complete	F	f C	PoP
5	Cohort Analysis : output flashes		D	age
				F
				PoP
6	V.P. Analysis : output flashes		E	age
				F
				PoP
7	WRITE DATA		f A	

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A	31 25 11	Decode Nages m
	g FRAC	32 83	STO in D-E
	h LST x	35 82	
	f INT	31 83	
	STO D	33 14	
	R↓	35 53	
	STO E	33 15	
	h RTN	35 22	
	g LBL 2	32 25 11	
010	f W/DATA	31 41	WRITE DATA
	h RTN	35 22	
	f LBL B	31 25 12	Data Entry
	h CF 3	35 61 03	prompted by
	1	01	pauses
	h STI	35 33	
	f LBL 0	31 25 00	
	h PAUSE	35 72	
	h F? 3	35 71 03	
	GTO 1	22 01	
020	GTO 0	22 00	
	f LBL 1	31 25 01	
	STO (i)	33 24	
	f ISZ	31 34	
	RCL D	34 14	
	h RCI	35 34	
	g X↔Y	32 71	
	GTO 0	22 00	
	h RTN	35 22	
	g LBL b	32 25 12	Correct catch
030	h Y↑X	35 52	entries
	h X↑2	35 24	
	h Y↑X	35 52	
	STO (i)	33 24	
	h RTN	35 22	
	f LBL C	31 25 13	Given F, find
	STO C	33 13	pop in last year
	f GSB 9	31 22 09	with fishing
	RCL C	34 13	incomplete
	RCL E	34 15	
040	+	61	
	CS	42	
	g X↔Y	32 52	
	CS	42	
	1	01	
	+	61	
	÷	81	
	h RTN	35 22	
	g LBL c	32 25 13	Same as C but
	STO C	33 13	fishing assumed
050	f LBL 9	31 25 09	complete
	RCL D	34 14	
	h STI	35 33	
	RCL (i)	34 24	
	RCL C	34 13	
	ENTER	41	
	ENTER	41	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL E	34 15	
	+	61	
	÷	81	
060	÷	81	
	f DSZ	31 33	
	h RTN	35 22	
	f LBL D	31 25 14	Cohort analysis
	STO 0	33 00	
	f LBL 6	31 25 06	
	RCL E	34 15	
	2	02	
	÷	81	
	g X↔Y	32 52	
070	RCL (i)	32 24	
	x	71	
	RCL E	34 15	
	g X↔Y	32 52	
	RCL 0	34 00	
	x	71	
	+	61	
	STO B	33 12	
	RCL 0	34 00	
	↓	81	
080	f LN	31 52	
	RCL E	34 15	
	-	51	
	h F? 2	35 71 02	
	h RTN	35 22	
	h RCI	35 34	
	f -X-	31 84	
	h R↓	35 53	Display Results
	f -X-	31 84	
	RCL B	34 12	
090	f -X-	31 84	
	STO 0	33 00	
	f DSZ	31 33	
	GTO 6	22 06	
	h X≠0 RTN	35 22	
	f LBL E	31 25 15	VP
	STO 0	33 00	
	f LBL 2	31 25 02	
	h SF 2	35 51 02	
	f GSB 6	31 22 06	Cohort F
100	f GSB 8	31 22 08	overestimate
	STO A	33 11	
	RCL (i)	34 24	Second F
	RCL 0	34 00	underestimate
	÷	81	
	RCL E	34 15	
	g X↔Y	32 52	
	÷	81	
	1	01	
	-	61	
110	f LN	31 52	
	f GSB 8	31 22 08	
	STO B	33 12	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	g LBL d	32 25 14	Interpolate
	RCL A	34 11	V catch
	f INT	31 83	to find next F
	RCL B	34 12	
	g FRAC	32 83	
	f x↑X	31 54	
	CS	42	
120	EEX	43	
	CS	42	
	1	01	
	+	61	
	x	71	
	RCL B	34 12	
	f INT	31 83	
	RCL A	34 11	
	g FRAC	32 83	
	f x↑y	31 54	
130	EEX	43	
	CS	42	
	1	01	
	-	51	
	x	71	
	+	61	
	RCL A	34 11	
	g FRAC	32 83	
	f √x	31 54	
	RCL B	34 12	
140	g FRAC	32 83	
	f √x	31 54	
	-	51	
	÷	81	
	ENTER	41	
	f INT	31 83	has F changed
	RCL A	34 11	on the third digit?
	f INT	31 83	
	g X=Y	32 51	
	GTO e	22 31 15	
150	h R↓	35 53	
	h R↓	35 53	
	EEX	43	
	3	03	
	÷	81	New F
	f GSB B	31 22 08	New catch
	RCL A	34 11	Move A to B
	STO B	33 12	New catch to A
	h R↓	35 53	
	STO A	33 11	
160	GTO d	22 31 14	
	g LBL e	32 25 15	Output result of
	RCL A	34 11	last F
	f INT	31 83	
	EEX	43	
	3	03	
	÷	81	
	ENTER	41	
	ENTER	41	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL A	34 11	
170	g FRAC	32 83	
	EEX	43	
	2	02	
	x	71	
	f LBL 7	31 25 07	Disp age
	h RCI	35 84	F
	f -X-	31 89	
	h R^	35 54	
	f -X-	31 84	
	RCL E	34 15	
180	+	61	
	g e^x - 1	32 52	
	RCL 0	34 00	
	x	71	
	f -X-	31 84	
	STO 0	33 00	
	f DSZ	31 33	
	GTO 2	22 02	
	R/S	84	
	f LBL 8	31 25 08	Calculate catch
190	ENTER	41	(10^{3E}) Int pred
	ENTER	41	$+ 10^{3}\left(\frac{\text{catch}}{\text{catch obs}}\right)$
	RCL E	34 15	ln X
	+	61	
	ENTER	41	
	g e^x	32 52	
	1	01	
	-	51	
	÷	81	
	÷	81	
200	RCL 0	34 00	
	x	71	
	RCL 1	34 24	
	÷	81	
	ENTER	41	
	f RND	31 24	
	1	01	
	-	51	
	f X=0	31 51	Test predicted catch
	GTO 7	22 07	observed
210	h R↓	35 53	
	EEX	43	within 10^3 of 1
	2	02	
	÷	81	
	h X↔Y	35 52	
	f RND	31 24	
	EEX	43	
	3	03	
	x	71	
	-	61	
220	h RTN	35 22	

REGISTERS

0 P_{n-1}	1 CATCH$_1$	2 CATCH$_2$	3 CATCH$_3$	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8 ...	S9 CATCH$_{10}$

A	B	C	D	E	I
F-CATCH	F. CATCH	F	Nages	m	Index

LABELS

A	B	C	D	E
Na m	DATA IN	START F	COHORT	VP
a W/DATA	b CORRECT DATA	c START F	d USED	e USED
0	1	2	3	4
5	6	7	8	9

FLAGS

0	
1	
2	DISP?
3	DATA IN?

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☐
2	☒	☒
3	☒	☐

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	3

Program Description

Program Title VIRTUAL POPULATION ANALYSIS

Name Dr. W. G. Doubleday **Date** 19/4/77

Address Fisheries Research Branch - Dept of Fisheries and Environment

City Ottawa, Ont **State** Canada **Zip Code**

Program Description, Equations, Variables, etc.

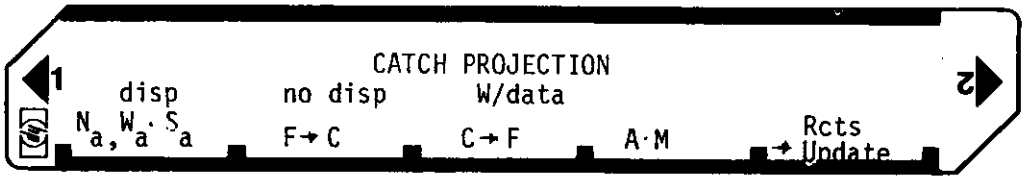
Pope, J.G., 1972 An investigation of the accuracy of virtual population analysis using Cohort Analysis
Int. Comm. Northwest Atl. Fish Res. Bull. 9:65-71

Doubleday, W.G., 1975 A simple iterative solution to the catch equation. Int. Comm.
Northwest Atl. Fish. Res. Doc. 75/42

Operating Limits and Warnings

F is accurate to - 0.001
display catch at age by h REG
Step 17 can be changed to R/S if the pause is too short.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
0	Set display flag if req'd (stop with fb)		f a	
1	No. of ages - m entered	A.m	D	A.m
2	Numbers at age	millions	A	1,000
	(program displays age group- pauses)			etc.
	Wt at age and partial refs., 0 for	gm·fraction		1,000
	fully recruited age groups			etc.
3	If F is known go to 4, if catch is known,			
	enter catch in metric tons	C	C	F
	F flashes and is stored in B			
	Go to 5			
4	Enter F	F	B	Catch
5	Enter new recruits to update	millions	E	
	or return to 4 or 5			
6	Return to 4 or 5 for the next year			
	If fa is used, age, catch in nos,			age
	catch in Wt, and survivors are			C Nos
	displayed for each age			C Wt
				survivors

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL A	31 25 11	
	CF 3	35 61 03	
	CF 2	35 61 02	
	RCL A	34 11	
	h STO I	35 33	
	1	01	
	f LBL 1	31 25 01	
	h PAUSE	35 72	DATA Entry
	h F? 3	35 71 03	
010	GTO 2	22 02	N Million fish
	GTO 1	22 01	or
	f LBL 2	31 25 02	
	f DSZ	31 33	Wgr . partial f
	h SPACE	35 84	
	STO (i)	33 24	
	f ISZ	31 34	
	CLX	44	
	1	01	
	-	61	
020	f DSZ	31 33	
	GTO 1	22 01	
	P:S	31 42	
	h F 2	35 71 02	
	h RTN	35 22	
	RCL A	34 11	
	h STO I	35 33	
	h SF 2	35 51 02	
	I	01	
	GTO 1	22 01	
030	g LBL a	32 25 11	Display by age
	h SF 0	35 51 00	
	h RTN	35 22	
	f LBL B	31 25 12	
	f X=0	31 71	
	0	00	
	STO B	33 12	
	RCL A	34 11	
	h STO I	35 33	Given F,
	0	00	
040	STO F	33 15	Calculate
	g LBL d	32 25 14	Catch
	f DSZ	31 33	
	g SPACE	35 84	
	g GSB E	32 22 15	
	f ISZ	31 34	
	f DSZ	31 33	
	GTO f d	22 31 14	
	RCL F	34 15	
	h RTN	35 22	
050	g LBL b	32 25 12	
	h CF 0	35 61 00	Display total catch
	h RTN	35 22	or F only
	f LBL C	31 25 13	given catch,
	STO C	33 13	
	0	00	
	STO D	33 14	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	h F? D	35 71 00	
	h SF 2	35 51 02	Turn off display
	h CF 0	35 61 00	for approximations
060	1	01	
	f LBL 4	31 25 04	
	f GSB B	31 22 12	
	RCL C	34 13	
	-	81	
	ENTER	41	
	f RND	31 24	
	1	01	
	h X:Y	35 52	
	g X=Y	32 51	test catch
070	GTO 6	22 06	
	h Ry	35 53	
	h Ry	35 53	
	EEx	43	linear interpolation
	2	02	
	-	81	
	RC B	34 12	
	f RND	31 24	
	EEX	43	
	3	03	
080	x	71	
	-	61	
	STO F	33 15	
	EEX	43	
	CS	42	
	2	02	
	RCL D	34 14	
	g FRAC	32 83	
	2	51	
	RCL F	34 15	
090	f INT	31 83	
	x	71	
	RCL E	34 15	
	g FRAC	32 83	
	EEX	43	
	CS	42	
	2	02	
	-	51	
	RCL D	34 14	
	f INT	31 83	
100	x	71	
	+	61	
	RCL F	34 15	
	g FRAC	32 83	
	RCL D	34 14	
	FRAC	32 83	
	2	51	
	2	81	
	EEX	43	
	3	03	
110	+	81	
	RCL B	34 12	
	h X:Y	35 52	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	g X=Y	32 51	test
	GTO 6	22 06	
	RCL E	34 15	
	STO D	33 14	
	h X Y	35 52	
	GTO 4	22 04	
	g LBL C	32 25 13	
120	f W/DATA	31 41	Write data
	h RTN	35 22	
	f LBL D	31 25 14	
	STO A	33 11	M stored in A
	h RTN	35 22	
	f LBL E	31 25 15	New recruits
	RCL A	34 11	
	h STO I	35 33	
	h X&Y	35 52	
	f LBL 0	31 25 00	Update
130	f DSZ	31 33	
	h SPACE	35 84	
	RCL (i)	34 24	
	f INT	31 83	
	RCL (i)	34 24	
	g FRAC	32 83	
	X	71	
	h X Y	35 52	
	STO (i)	33 24	
	h X Y	35 52	
140	f RCI	31 34	
	f DSZ	31 33	
	GTO 0	22 00	
	h RTN	35 22	
	g LBL e	32 25 15	Catch at age
	f P S	31 42	stores with
	RCL (i)	34 24	number at age
	g FRAC	32 83	
	f X=Y	31 51	
	1	01	
150	RCL B	34 12	
	x	71	
	Enter	41	
	Enter	41	
	RCL A	34 11	
	g FRAC	32 83	
	-	61	
	Enter	41	
	CS	42	
	g X Y	32 52	
160	P S	31 42	
	RCL (i)	34 24	
	f INT	31 83	
	STO (i)	33 24	
	h R↓	35 63	
	STO (i)	33 61 24	
	h R↓	35 63	
	2	81	
	1	01	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	h R↓	35 54	
170	CS	42	
	-	61	
	x	71	
	x	71	
	f P:S	31 42	
	RCL (i)	34 24	
	f INT	31 83	
	X	71	
	f P S	31 42	
	h F? 0	35 71 00	
180	f GSB 5	31 22 05	
	RCL F	34 15	
	e	61	
	STO F	33 15	
	h RTN	35 22	
	f LBL 5	31 25 05	Display
	Enter	41	
	Enter	41	
	RCL A	34 11	
	h RCI	35 34	
190	f INT	31 83	
	-	61	
	f INT	31 83	
	f -X-	31 84	
	f P:S	31 42	
	CLX	44	
	RCL (i)	34 24	
	f INT	31 83	
	-	81	
	f -X-	31 84	
200	h R↓	35 53	
	f -X-	31 84	
	f P S	31 42	
	RCL (i)	34 24	
	f INT	31 83	
	RCL (i)	34 24	
	g FRAC	32 83	
	X	71	
	f -X-	31 84	
	h X Y	35 52	
210	h RTN	35 22	
	f LBL 6	31 25 06	When C converges
	RCL B	34 12	recall F and
	f -X-	31 84	reset display flag
	h F 2	35 71 02	for return to B
	h SF 0	35 51 00	
	GTO B	22 12	
220			

REGISTERS									
0 $N_A C^Z$	1 $N_{A'} C^Z$	2 ...	3	4	5	6	7	8	9
S0 MA:FA	S1	S2	S3	S4	S5	S6	S7	S8	S9
A A.m	B F	C Catch	D Accumulate	E Accumulate	I Counter				

LABELS					FLAGS	SET STATUS		
A Input	B Catch/F	C F/Catch	D A M	E Update	0 Disp	FLAGS	TRIG	DISP
8 Disp	b no Disp	c W/DATA	d used	e used	1 -	ON OFF		
0 used	1 used	2 used	3	4 used	2 Disp.	0 SC ☐	DEG ☒	FIX ☐
5 used	6 used	7	8	9	3 Entry	1 ☐ ☒	GRAD ☐	SCI ☐
						2 ☐ ☒	RAD ☐	ENG ☐
						3 ☐ ☒		n 3

Program Description

Program Title	CATCH PROJECTION			
Name	Dr. W.G. Doubleday		**Date**	19/4/77
Address	Fisheries Research Branch, 580 Booth St.			
City	Ottawa	State Ontario	Zip Code	

Program Description, Equations, Variables, etc.

The catch equation of Beverton and Holt is used.
F is found from C by linear interpolation.

Operating Limits and Warnings In finding F, interpolation ends with agreement to the third digit of F or the ratio if predicted to observed catch.

Accuracy is to one unit in the third digit of estimated F.