BioVeL – Biodiversity Virtual e-Laboratory

Workflow Documentation

Killer whale demography workflow
Portal execution

September 2014

Capacities Programme of Framework 7: EC e-Infrastructure Programme – e-Science Environments - INFRA-2011-1.2.1

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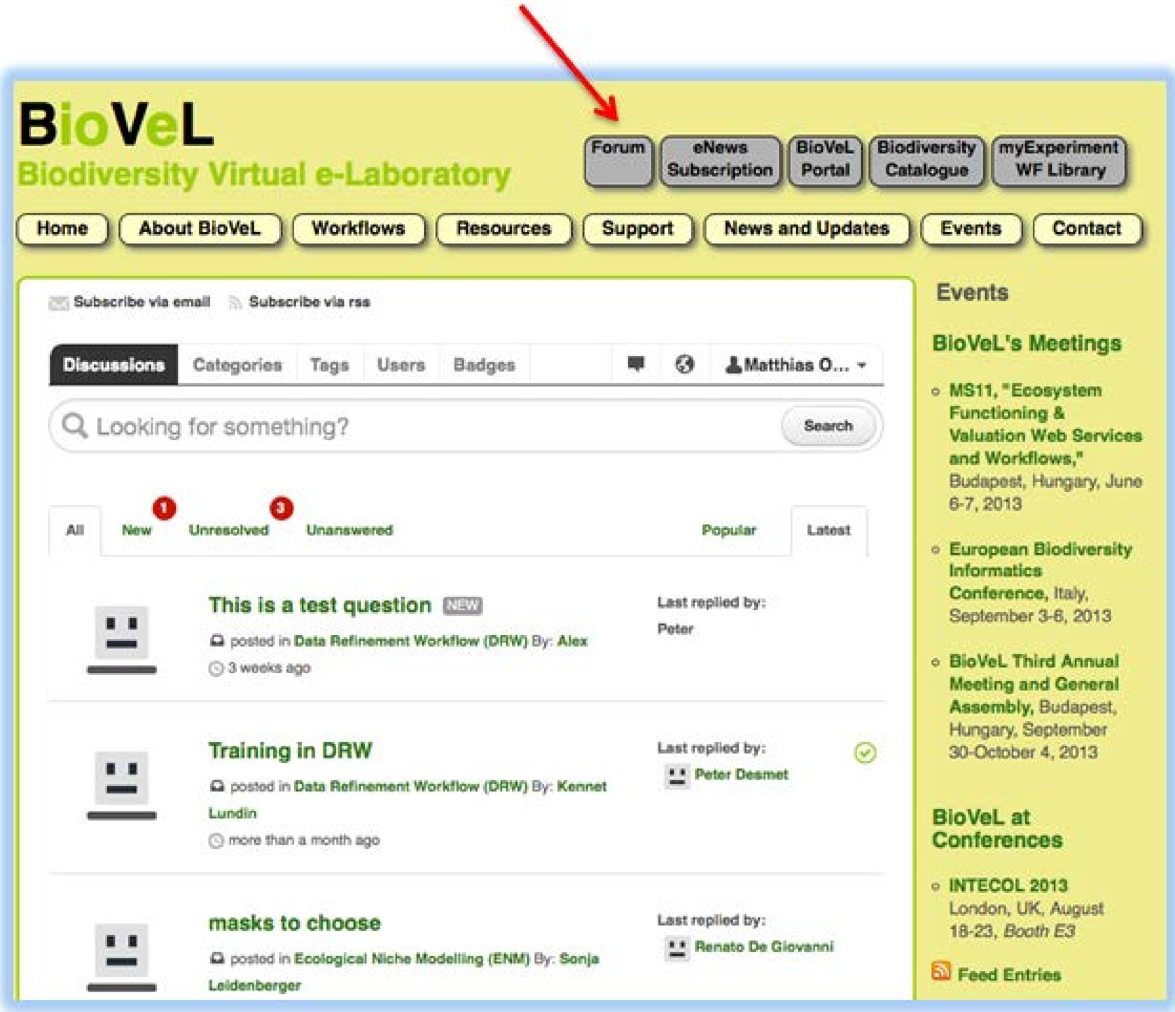
Contents

1. Sources of help

You can obtain help with using BioVeL workflows and services from 3 places:

1) From the BioVeL documentation website, here: https://wiki.biovel.eu/x/BIBp
2) By using the BioVeL community discussion Forum on our website, www.biovel.eu. If you have questions go to the Forum by clicking the grey button shown below and post your help request or question there.



By emailing to support@biovel.eu

Killer whale demography

2. Input files for tutorial

The workflow accepts input data in a .csv, coma delimited. The examples input files for the tutorial are available and described below. In this tutorial, two input files are used.

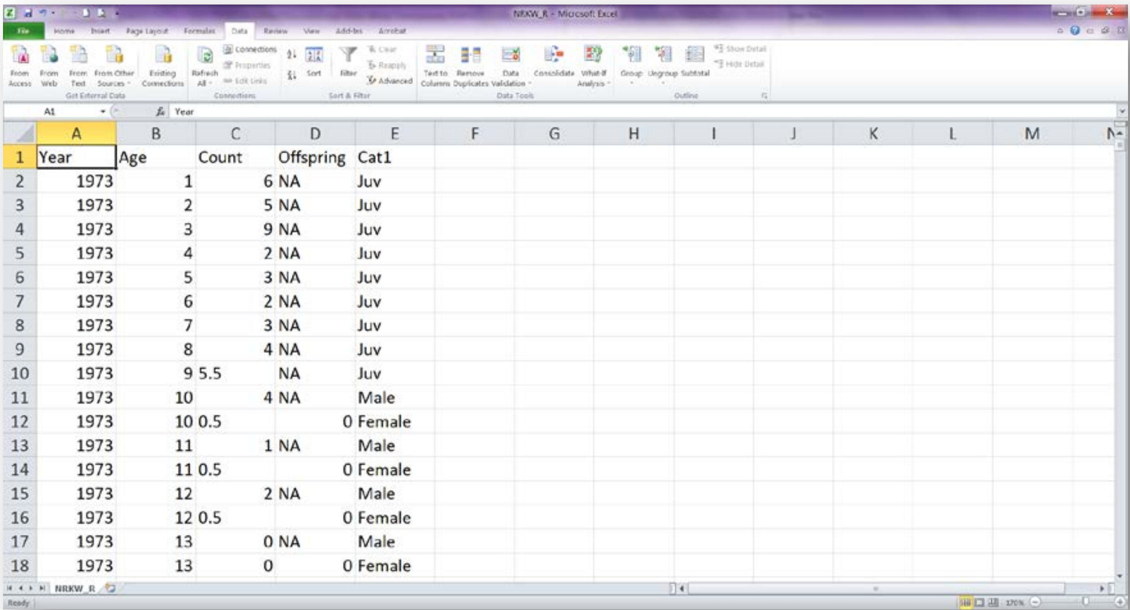
2.1 Input data

To download click here on the file name or they can be downloaded at myExperiment (http://www.myexperiment.org/packs/667.html):

Orcinus orca input data:

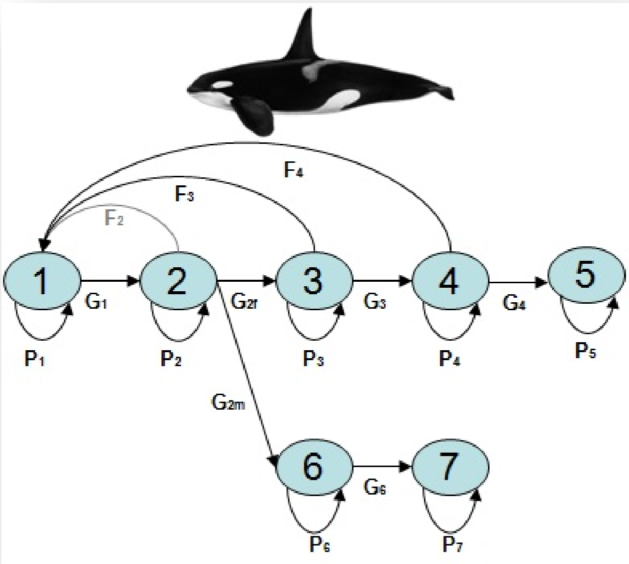
- NRKW_R or SRKW_R
- VR_combined

NRKW_R or SRKW_R: The input data (a .csv-file) has to have the format of a table containing the *Orcinus orca* demographic data with the columns named: Year, Age, Count, Offspring and Cat1. Each year, the number of individuals per age and the number of offspring per age reproductive female category are counted (females ≥ 10 years old). IF A Female category does not have offspring equals to 0. For the called column, Cat1; Ages 1 to 9 belongs to Juv (Juveniles) and 10 to 88 (this tutorial) belongs to Female or Male. Juv and Male categories must have a NA offspring.



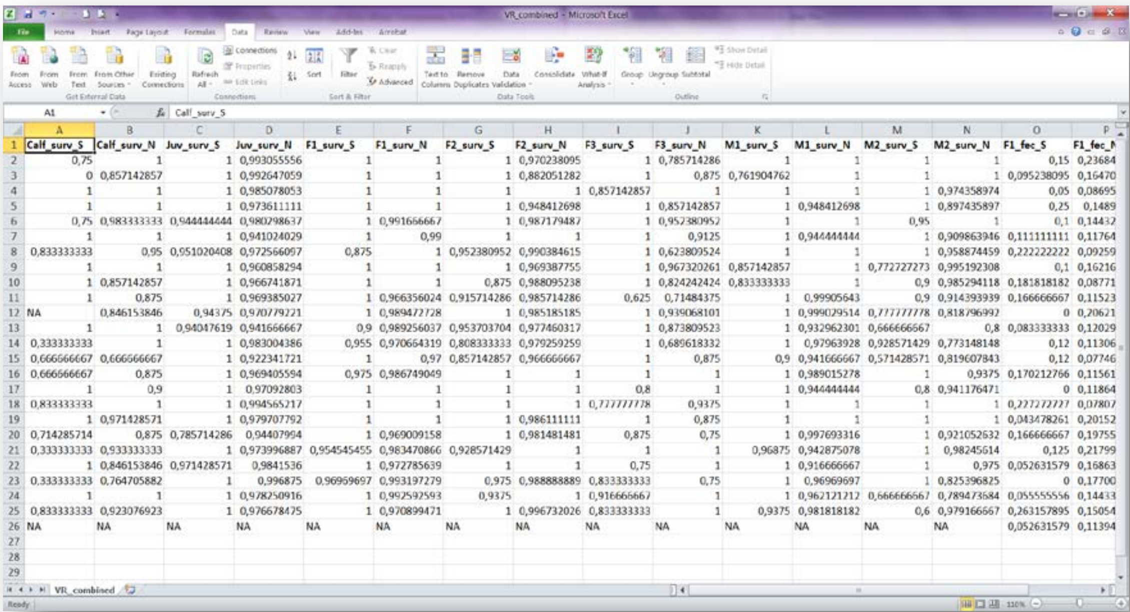
Year	Age	Count	Offspring	Cat1
1973	1	6	NA	Juv
1973	2	5	NA	Juv
1973	3	9	NA	Juv
1973	4	2	NA	Juv
1973	5	3	NA	Juv
1973	6	2	NA	Juv
1973	7	3	NA	Juv
1973	8	4	NA	Juv
1973	9	5.5	NA	Juv
1973	10	4	NA	Male
1973	10	0.5	0	Female
1973	11	1	NA	Male
1973	11	0.5	0	Female
1973	12	2	NA	Male
1973	12	0.5	0	Female
1973	13	0	NA	Male
1973	13	0	0	Female

VR_combined



The stage-structured life cycle of resident killer whales with seven life stages:
(1) calves; (**Calf**)
(2) juveniles; (**Juv**)
(3) young reproductive females; (**F1**)
(4) old reproductive females; (**F2**)
(5) post-reproductive females; (**F3**)
(6) young mature males; and (**M1**)
(7) old mature males (**M2**).
Fi represent fertility; Gi represent stage transition probabilities, with female and male juvenile-to-adult transitions indicated as G2f and G2m, respectively; and, Pi represent the probability of surviving and remaining in stage i

The input data (a .csv-file) has to have the format of a table containing the survival and fecundity rates per stage, per year, per population of the *Orcinus orca.* E.g. Calf_surv_S = 0, 75 will the survival value of the first year (in this case 1987) of the SRKW calves stage.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Calf_surv_S	Calf_surv_N	Juv_surv_S	Juv_surv_N	F1_surv_S	F1_surv_N	F2_surv_S	F2_surv_N	F3_surv_S	F3_surv_N	M1_surv_S	M1_surv_N	M2_surv_S	M2_surv_N	F1_fec_S	F1_fec_N
2	0,75	1	1	0,993055556	1	1	1	0,970238095	1	0,785714286	1	1	1	1	0,15	0,23684
3	0	0,857142857	1	0,992647059	1	1	1	0,882051282	1	0,875	0,761904762	1	1	1	0,095238095	0,16470
4	1	1	1	0,985078053	1	1	1	1	0,857142857	1	1	1	1	0,974358974	0,05	0,08695
5	1	1	1	0,973611111	1	1	1	0,948412698	1	0,857142857	1	0,948412698	1	0,897435897	0,25	0,1489
6	0,75	0,983333333	0,944444444	0,980298637	1	0,991666667	1	0,987179487	1	0,952380952	1	1	0,95	1	0,1	0,14432
7	1	1	1	0,941024029	1	0,99	1	1	1	0,9125	1	0,944444444	1	0,909863946	0,111111111	0,11764
8	0,833333333	0,95	0,951020408	0,972566097	0,875	1	0,952380952	0,990384615	1	0,623809524	1	1	1	0,958874459	0,222222222	0,09259
9	1	1	1	0,960858294	1	1	1	0,969387755	1	0,967320261	0,857142857	1	0,772727273	0,995192308	0,1	0,16216
10	1	0,857142857	1	0,966741871	1	1	0,875	0,988095238	1	0,824242424	0,833333333	1	0,9	0,985294118	0,181818182	0,08771
11	1	0,875	1	0,969385027	1	0,966356024	0,915714286	0,985714286	0,625	0,71484375	1	0,99905643	0,9	0,914393939	0,166666667	0,11523
12	NA	0,846153846	0,94375	0,970779221	1	0,989472728	1	0,985185185	1	0,939068101	1	0,999029514	0,777777778	0,818796992	0	0,20621
13	1	1	0,94047619	0,941666667	0,9	0,989256037	0,953703704	0,977460317	1	0,873809523	1	0,932962301	0,666666667	0,8	0,083333333	0,12029
14	0,333333333	1	1	0,983004386	0,955	0,970664319	0,808333333	0,979259259	1	0,689618332	1	0,97963928	0,928571429	0,773148148	0,12	0,11306
15	0,666666667	0,666666667	1	0,922341721	1	0,97	0,857142857	0,966666667	1	0,875	0,9	0,941666667	0,571428571	0,819607843	0,12	0,07746
16	0,666666667	0,875	1	0,969405594	0,975	0,986749049	1	1	1	1	1	0,989015278	1	0,9375	0,170212766	0,11561
17	1	0,9	1	0,97092803	1	1	1	1	0,8	1	1	0,944444444	0,8	0,941176471	0	0,11864
18	0,833333333	1	1	0,994565217	1	1	1	1	0,777777778	0,9375	1	1	1	1	0,227272727	0,07807
19	1	0,971428571	1	0,979707792	1	1	1	0,986111111	1	0,875	1	1	1	1	0,043478261	0,20152
20	0,714285714	0,875	0,785714286	0,94407994	1	0,969009158	1	0,981481481	0,875	0,75	1	0,997693316	1	0,921052632	0,166666667	0,19755
21	0,333333333	0,933333333	1	0,973996887	0,954545455	0,983470866	0,928571429	1	1	1	0,96875	0,942875078	1	0,98245614	0,125	0,21799
22	1	0,846153846	0,971428571	0,9841536	1	0,972785639	1	1	0,75	1	1	0,916666667	1	0,975	0,052631579	0,16863
23	0,333333333	0,764705882	1	0,996875	0,96969697	0,993197279	0,975	0,988888889	0,833333333	0,75	1	0,96969697	1	0,825396825	0	0,17700
24	1	1	1	0,978250916	1	0,992592593	0,9375	1	0,916666667	1	1	0,962121212	0,666666667	0,789473684	0,055555556	0,14433
25	0,833333333	0,923076923	1	0,976678475	1	0,970899471	1	0,996732026	0,833333333	1	0,9375	0,981818182	0,6	0,979166667	0,263157895	0,15054
26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,052631579	0,11394

2.1 Related publications

Vélez-Espino, L.A., John K.B. Ford, Eric Ward, Chuck K. Parken, Larrie LaVoy, Ken Balcomb, M. Bradley Hanson, Dawn. P. Noren, Graeme Ellis, Tom Cooney, and Rishi Sharma. 2013. Sensitivity of resident Killer Whale population dynamics to Chinook salmon abundance. Completion Report, Pacific Salmon Commission, Southern Boundary Restoration and Enhancement Fund, Vancouver BC. 191 p.

Vélez-Espino, L.A., Ford, J.K.B., Araujo, H.A., Ellis, G., Parken, C.K, & Balcomb, K. 2014. Comparative demography and viability of northeast Pacific resident killer whale populations at risk. Can. Tech. Rep. Fish. Aquat. Sci. 3084: vi + 56 p.

Vélez-Espino, L.A., John K.B. Ford, H. Andres Araujo, Graeme Ellis, Charles K. Parken and Rishi Sharma. *2014*. Relative importance of Chinook salmon abundance on resident killer whale population growth and viability. Aquatic Conservation: Marine and Freshwater Ecosystems. Article first published online: 21 AUG 2014. DOI: 10.1002/aqc.2494

3. Tutorial:

This workflow analyses the demography and population growth of resident killer whale populations. Originally created for comparative studies of North-eastern Pacific populations at risk, Southern Resident Killer Whales (SRKW) and the Northern Resident Killer Whales (NRKW), the workflow can be used for other killer whale populations or cetaceans counting with census data and life cycles that can be represented using the matrix models described in this document.

This workflow performs the following analyses:

- Vital rates estimation and probability distributions
- Construction of Birth-flow Matrix Model
- Eigen analysis
- Elasticity analysis (deterministic and stochastic)
- Damping time

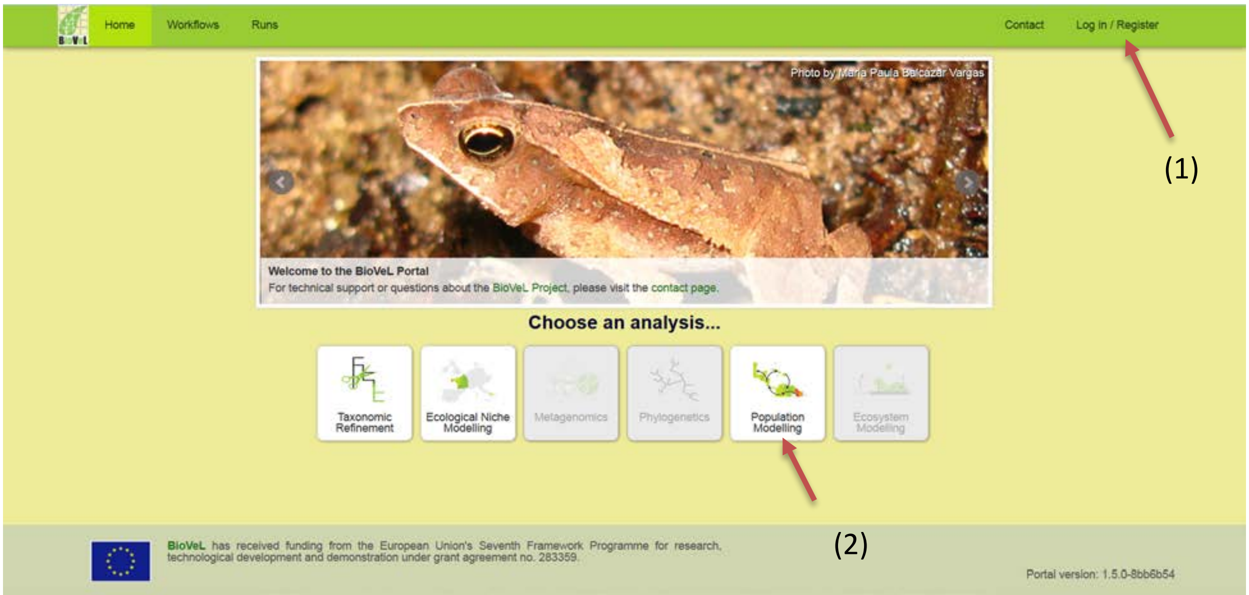
This tutorial explains the type of input data needed to run the workflow. The corresponding analysis use data from two distinct *O. orca* populations in Canada, Southern Resident Killer Whales (SRKW) and the Northern Resident Killer Whales (NRKW).

Two distinct populations of resident killer whales (*Orcinus orca*) in the north-eastern Pacific Ocean have been identified in Canada and the U.S. as being of conservation concern. The Southern Resident Killer Whale (SRKW) population is currently listed as endangered under the U.S. Endangered Species Act on the grounds of its small population size and vulnerability to demographic stochasticity and catastrophic events such as oil spills (NMFS 2008). In Canada, under the Species At Risk Act (COSEWIC 2008), SRKW is listed as endangered due to its small and declining population size while the Northern Resident Killer Whale (NRKW) population is listed as threatened due to its small population size. The major threats identified for these two populations are nutritional stress associated with prey abundance levels and availability, particularly Chinook salmon (*Oncorhynchus tshawytscha*) (COSEWIC 2008, Ford et al. 2010a, 2010b), pollution and contaminants, and disturbances from vessels and sound (COSEWIC 2008, NMFS 2008). An important difference in the population-size trajectories of these two populations is that, in spite of their home range overlap and potential access to similar resources, SRKW has remained at a population size of less than 100 individuals for the last four decades with an average of 85 individuals in the last decade. NRKW population size has been generally increasing for the last four decades with 268 individuals at the end of 2011.

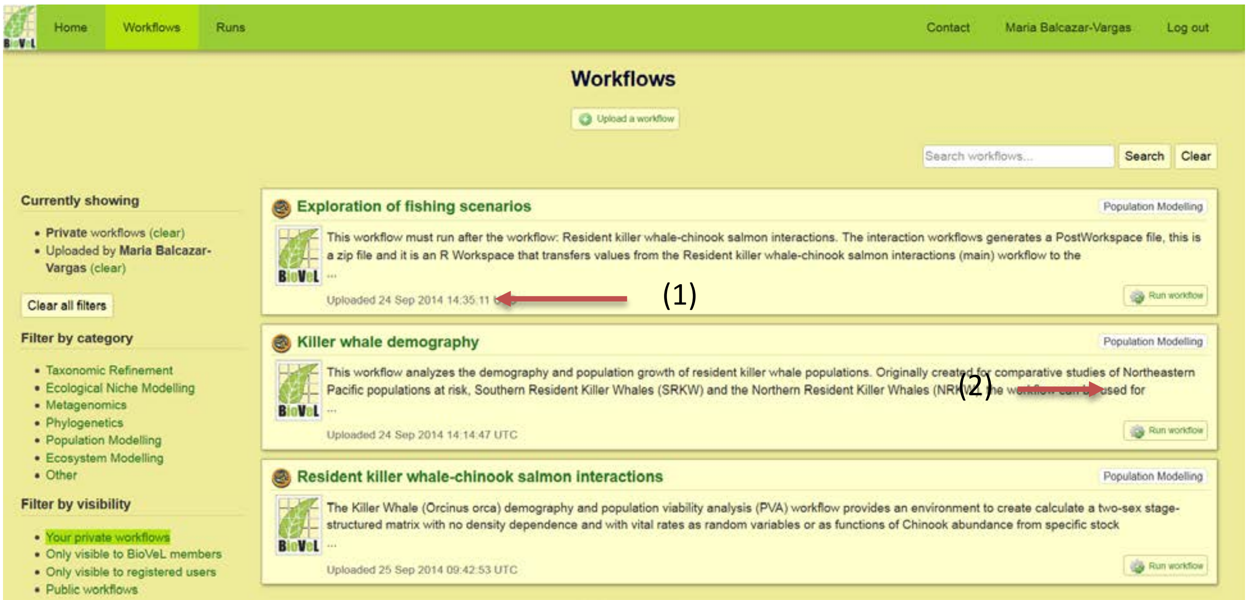
Killer whale demography workflow

In your browser (preferably Firefox or Chrome) navigate to the [BioVeL Portal](http://portal.biovel.eu/) page (http://portal.biovel.eu/) and log in with your username and password (1). You will need to register if you have not already done so.

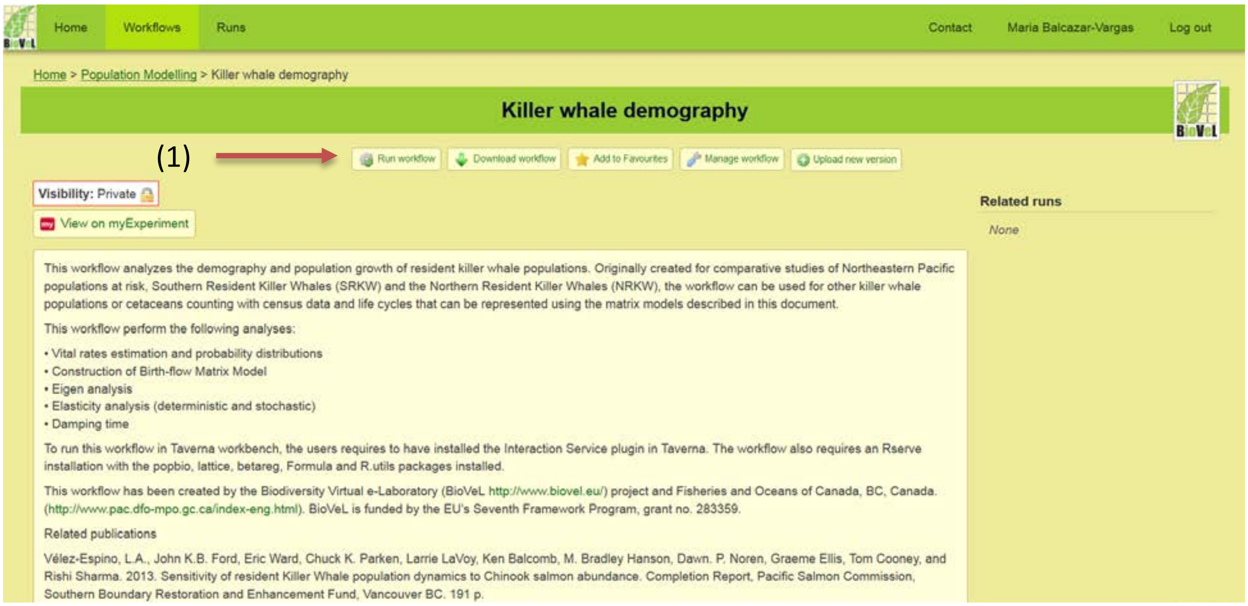
Choose the Population Modelling analysis and click, this will show you a list of relevant analysis:



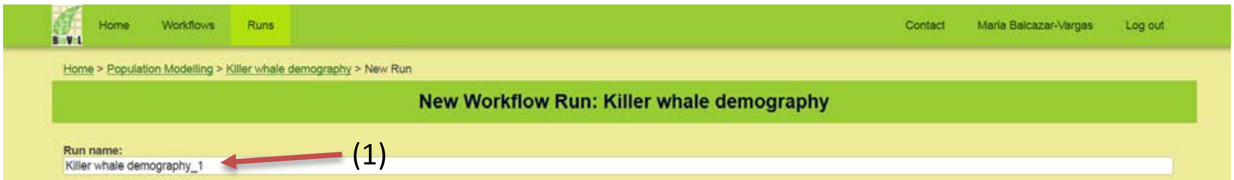
On the resulting page choose the workflow *Killer whale demography* (1) you can also directly run the workflow using the 'Run workflow' button at the bottom-right (2).



On the resulting page click on the 'Run Workflow' button at the top (1).



On the next page you can edit the name of the workflow run to make it easier for you to identify it later (e.g. *Killer whale demography_1*).

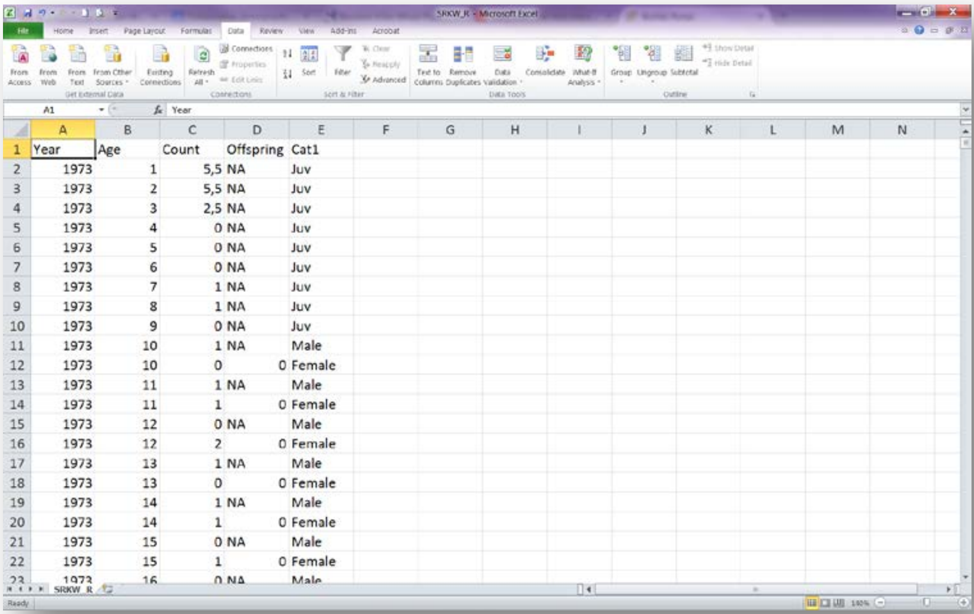


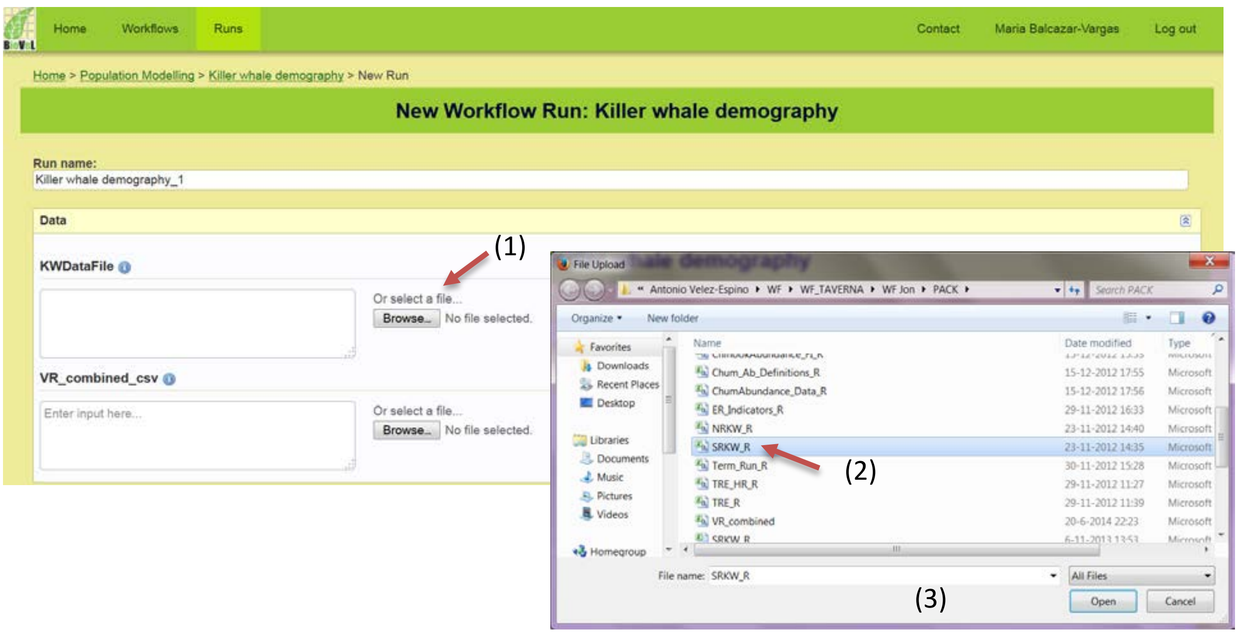
3.1 Input Ports

3.1.1 Data

KWDataFile: it's a .csv file. Population File. This is a .csv file with the census data (i.e., counts) by age and group (juvenile, male or female) for the study population. For animals of uncertain year of death, amortized partial values were used. For instance, an animal with probable death over a span of two years was counted as 0.5 for the first year and 0.0 for the second year. Here, two files can be used as input: SRKW_R.csv ***or*** NRKW_R.csv

To open the file. Click in choose file, a window dialog appears and the user selects the file e.g. SRKW_R.csv and then clicks the Open button.





***VR_combined*:** Time series of vital rates (fecundity and survival by life stage) for both populations. To open the file. Click in choose file, a window dialog appears and the user selects the file e.g. VR_combined.csv and then clicks the Open button.

3.1.2 Parameters

To determine the parameters, type in each box the value of the variable (1).

***EndYear*:** Last year to be considered in the analysis.

e.g.: 2011

***population*:** It is the name of the analysed population.

e.g.: SRKW

***Sims*:** Number of simulations that are used for generation of stochastic vital rate elasticities. This input indicates the number of stochastic matrices generated from randomly drawn vital rates. After computing population growth and elasticities for each of these matrices, a bootstrap is used to compute stochastic population growth and mean elasticities and their 95% confidence intervals.

e.g.: 10000

***Standr_Data*:** Use standardized data? YES or NO

e.g.: NO

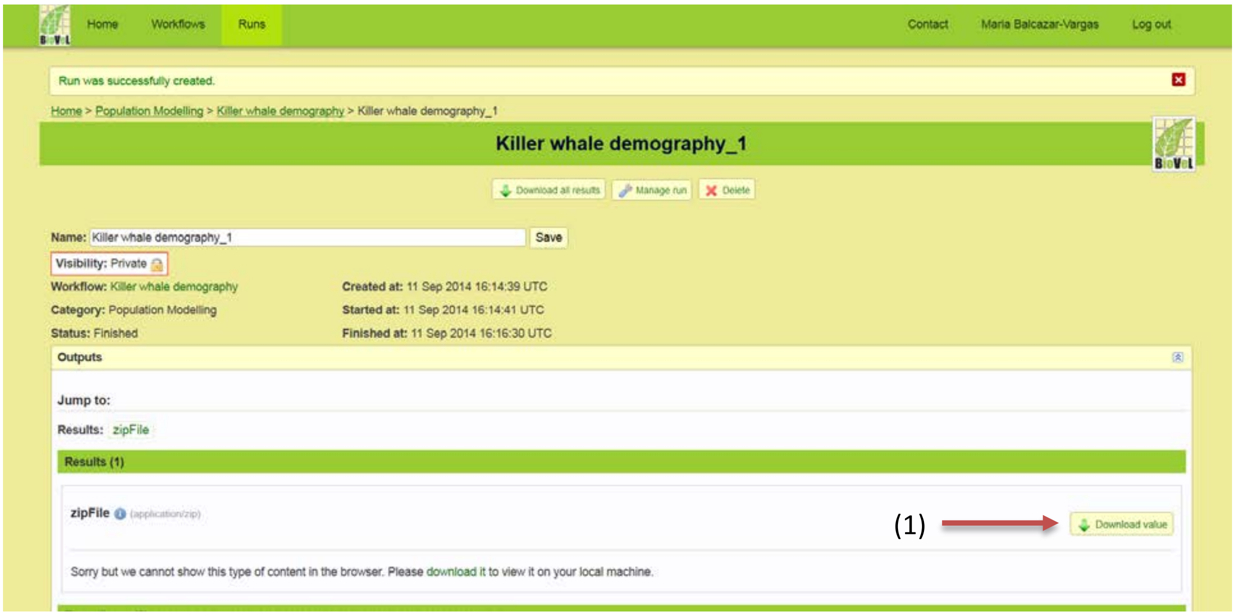
StartYear: First year to be considered in the analysis.

e.g.: 1987

After the user has filled out the input ports and has clicked the ***Start Run***, the workflow performs the analysis. To complete all the analysis may take few minutes, depends on the number of ***Sims*** to carry out the analyses.

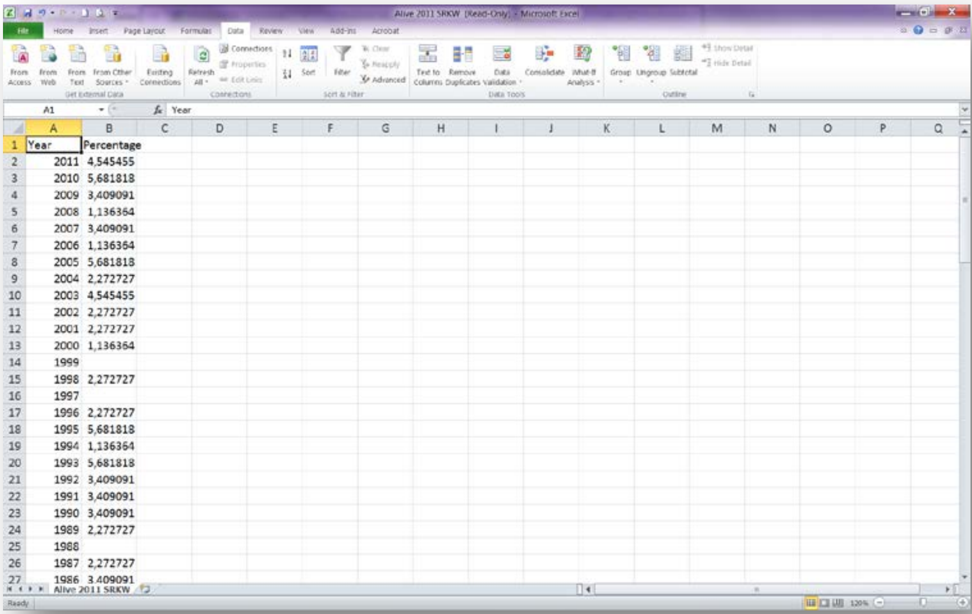
3.3 Outputs

Once the analyses are finished, the user can download all the results by clicking Download value button (1). Numerical and graph results will be download as a zip file that can be save by the user. The numerical results are .csv files than can be opened with Excel and the plot files are .PDF files. A second result is the PostWorkspace, a zip file that is needed to run the second workflow: Exploration of fishing scenarios workflow.



3.3.1 Results

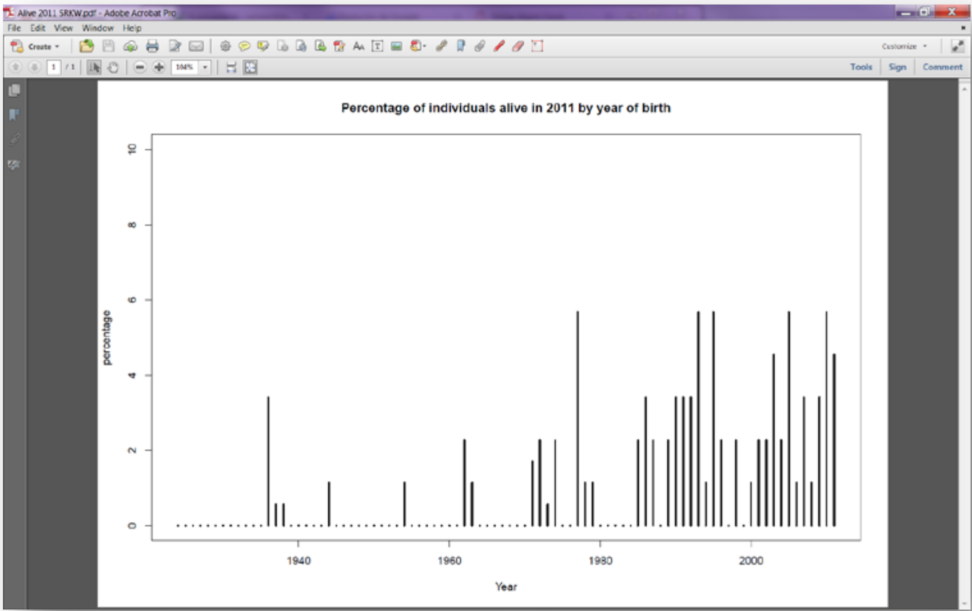
Alive End Year Population (csv): Percentage of individuals alive in the last year of the study by year of birth. The sum of percentages for the selected time period indicates the number of individuals born during the study and alive the last year.



Year	Percentage
2011	4,545455
2010	5,681818
2009	3,409091
2008	1,136364
2007	3,409091
2006	1,136364
2005	5,681818
2004	2,272727
2003	4,545455
2002	2,272727
2001	2,272727
2000	1,136364
1999	
1998	2,272727
1997	
1996	2,272727
1995	5,681818
1994	1,136364
1993	5,681818
1992	3,409091
1991	3,409091
1990	3,409091
1989	2,272727
1988	
1987	2,272727
1986	3,409091

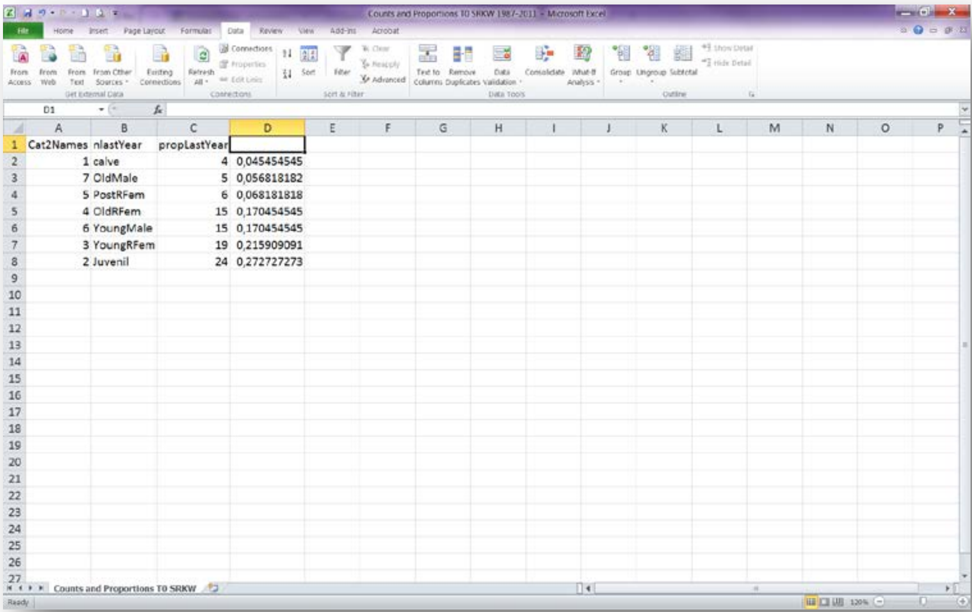
Alive 2011 SRKW.csv

Alive End Year Population (pdf): Graphical output for “Alive End Year Population”



Alive 2011 SRKW.pdf

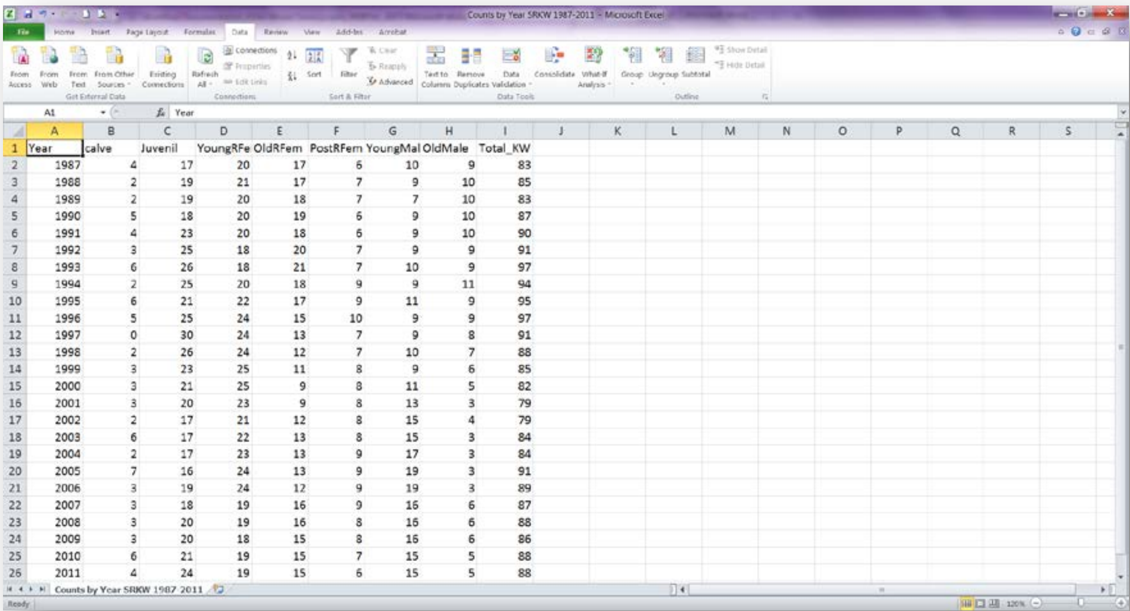
Counts and Proportions T0 Population Start year-End year (csv): Number of individuals and relative proportion by stage in the last year of the selected time period. These proportions are used to represent initial conditions for projections



Cat2Names	nlastYear	propLastYear	
1	calve	4	0,045454545
7	OldMale	5	0,056818182
5	PostRFem	6	0,068181818
4	OldRFem	15	0,170454545
6	YoungMale	15	0,170454545
3	YoungRFem	19	0,215909091
2	Juvenil	24	0,272727273

Counts and Proportions T0 Population Start year-End year (csv)

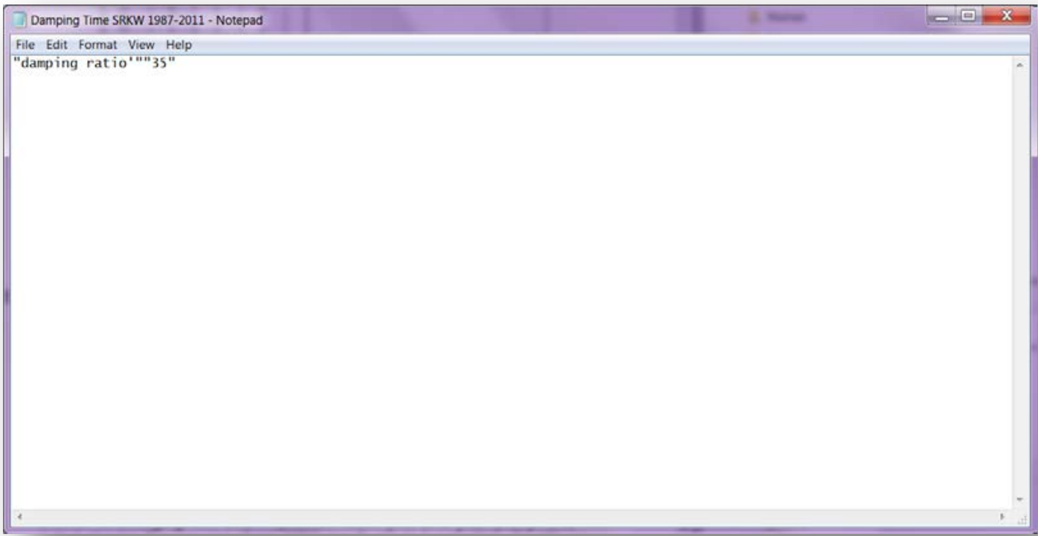
Counts by Year Population Start year-End year (csv): Number of individuals by life stage (calves, juveniles, young reproductive females, old reproductive females, post-reproductive females, young mature males, and old mature males) and year through the selected time period. Last column represents total population size



Year	calve	Juvenil	YoungRFe	OldRFem	PostRFem	YoungMal	OldMale	Total_KW
1987	4	17	20	17	6	10	9	83
1988	2	19	21	17	7	9	10	85
1989	2	19	20	18	7	7	10	83
1990	5	18	20	19	6	9	10	87
1991	4	23	20	18	6	9	10	90
1992	3	25	18	20	7	9	9	91
1993	6	26	18	21	7	10	9	97
1994	2	25	20	18	9	9	11	94
1995	6	21	22	17	9	11	9	95
1996	5	25	24	15	10	9	9	97
1997	0	30	24	13	7	9	8	91
1998	2	26	24	12	7	10	7	88
1999	3	23	25	11	8	9	6	85
2000	3	21	25	9	8	11	5	82
2001	3	20	23	9	8	13	3	79
2002	2	17	21	12	8	15	4	79
2003	6	17	22	13	8	15	3	84
2004	2	17	23	13	9	17	3	84
2005	7	16	24	13	9	19	3	91
2006	3	19	24	12	9	19	3	89
2007	3	18	19	16	9	16	6	87
2008	3	20	19	16	8	16	6	88
2009	3	20	18	15	8	16	6	86
2010	6	21	19	15	7	15	5	88
2011	4	24	19	15	6	15	5	88

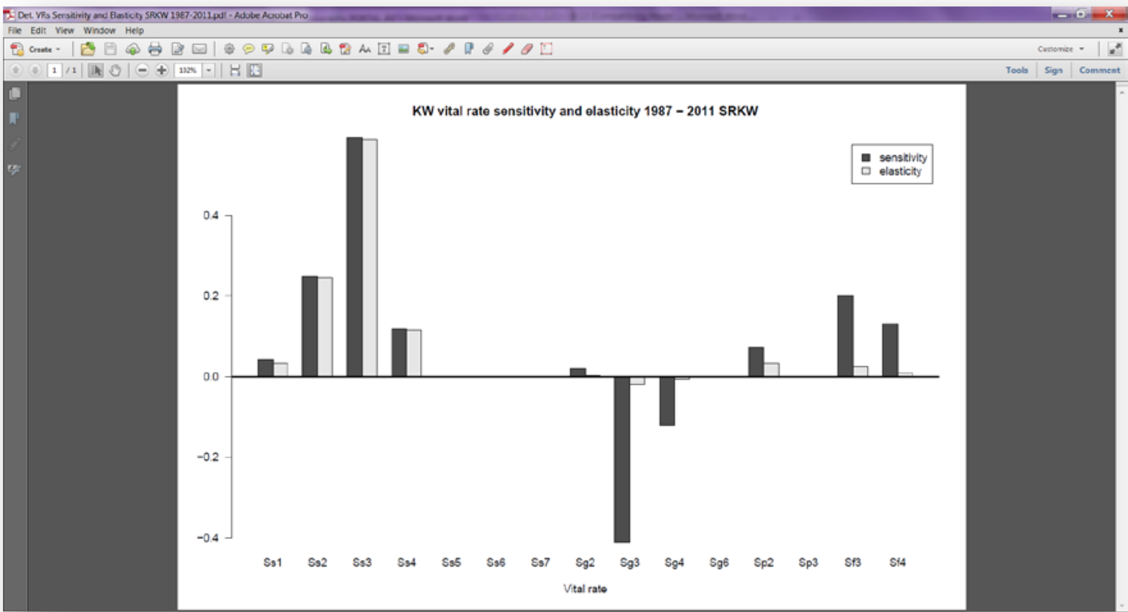
Counts by Year SRKW 1987-2011

Damping Time Population Start year-End year (txt): Damping time (τ) is defined as $\tau = \ln(z)/\ln(\rho)$, where ρ is the damping ratio and z is the number of times the contribution of λ_1 (dominant eigenvalue) becomes as great as that of λ_2 (subdominant eigenvalue). Damping times at z = 10 were used to define minimum time horizons for projections of population size.



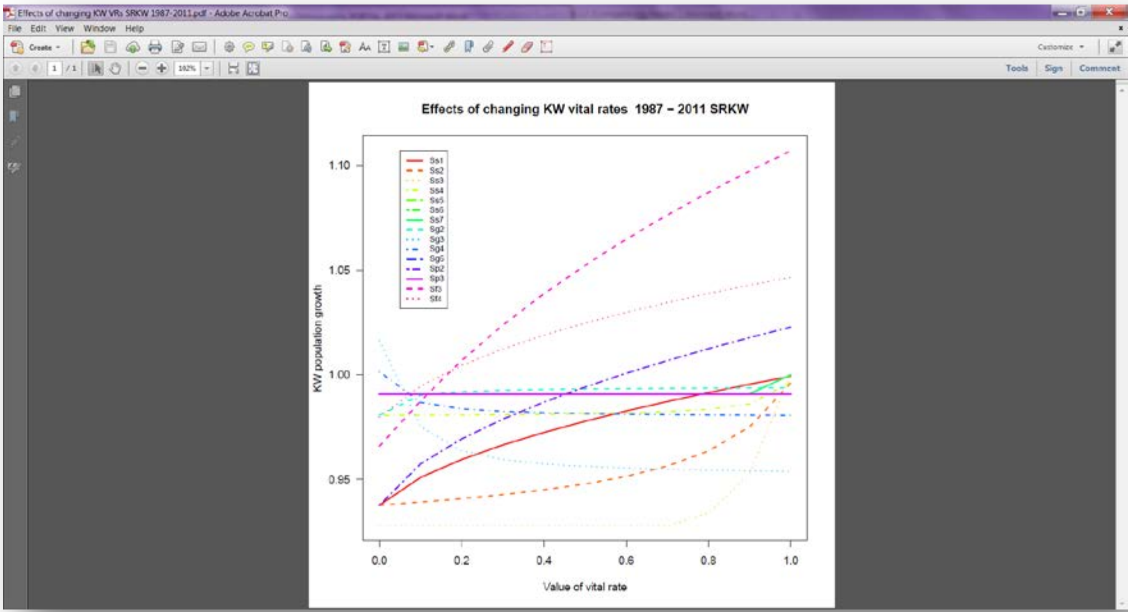
Damping Time SRKW 1987-2011

Det. VRs Sensitivity and Elasticity Population Start year-End year (pdf): Graphical output for sensitivities and elasticities of vital rates (survival, fecundity and stage transition probabilities)



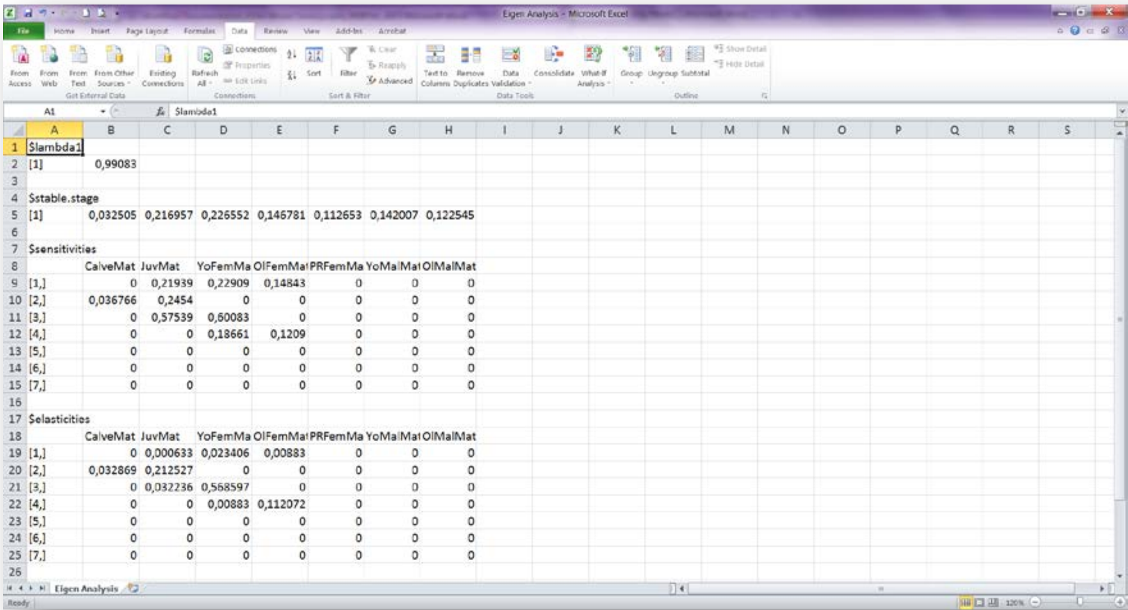
Det. VRs Sensitivity and Elasticity SRKW 1987-2011

Effects of changing KW VRs Population Start year-End year (pdf): Graphical output showing the response of population growth rate to hypothetical vital rate values ranging from 0.0 to 1.0. Some of these values could be biologically unfeasible (e.g., a fecundity rate of 1.0 would indicate every year all females in the stage produce a viable calf)



Effects of changing KW VRs SRKW 1987-2011

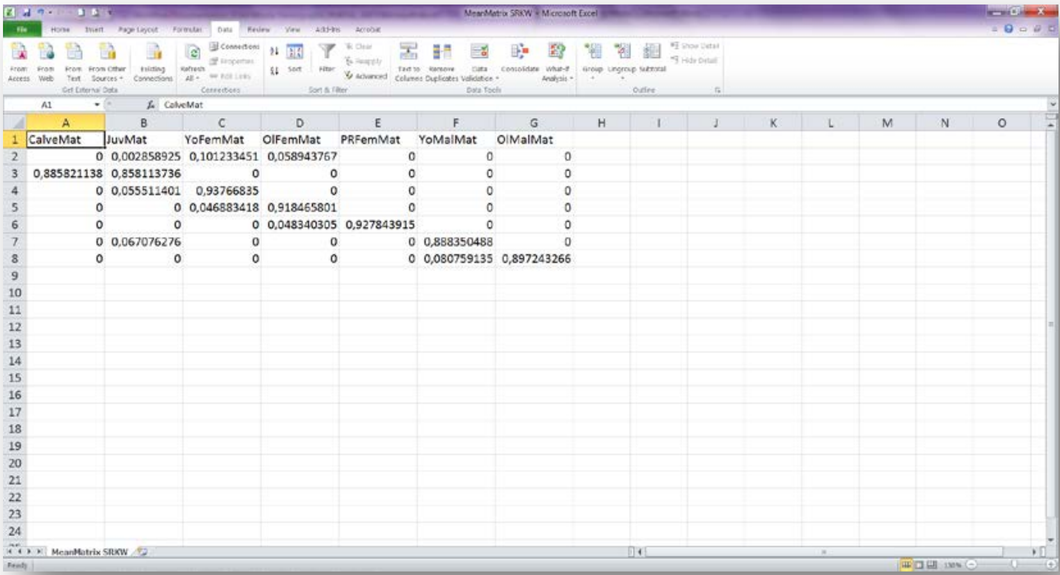
Eigen Analysis (txt): Dominant eigenvalue (asymptotic population growth rate), stable stage distribution, sensitivities, elasticities, reproductive value, and damping ratio based on mean matrix of selected population.



	A	B	C	D	E	F	G	H
1	$lambda1							
2	[1]	0,99083						
3								
4	$stable.stage							
5	[1]	0,032505	0,216957	0,226552	0,146781	0,112653	0,142007	0,122545
6								
7	$sensitivities							
8		CalveMat	JuvMat	YoFemMa	OlFemMat	PRFemMa	YoMalMat	OlMalMat
9	[1,]	0	0,21939	0,22909	0,14843	0	0	0
10	[2,]	0,036766	0,2454	0	0	0	0	0
11	[3,]	0	0,57539	0,60083	0	0	0	0
12	[4,]	0	0	0,18661	0,1209	0	0	0
13	[5,]	0	0	0	0	0	0	0
14	[6,]	0	0	0	0	0	0	0
15	[7,]	0	0	0	0	0	0	0
16								
17	$elasticities							
18		CalveMat	JuvMat	YoFemMa	OlFemMat	PRFemMa	YoMalMat	OlMalMat
19	[1,]	0	0,000633	0,023406	0,00883	0	0	0
20	[2,]	0,032869	0,212527	0	0	0	0	0
21	[3,]	0	0,032236	0,568597	0	0	0	0
22	[4,]	0	0	0,00883	0,112072	0	0	0
23	[5,]	0	0	0	0	0	0	0
24	[6,]	0	0	0	0	0	0	0
25	[7,]	0	0	0	0	0	0	0
26								

Eigen Analysis (opens in excel)

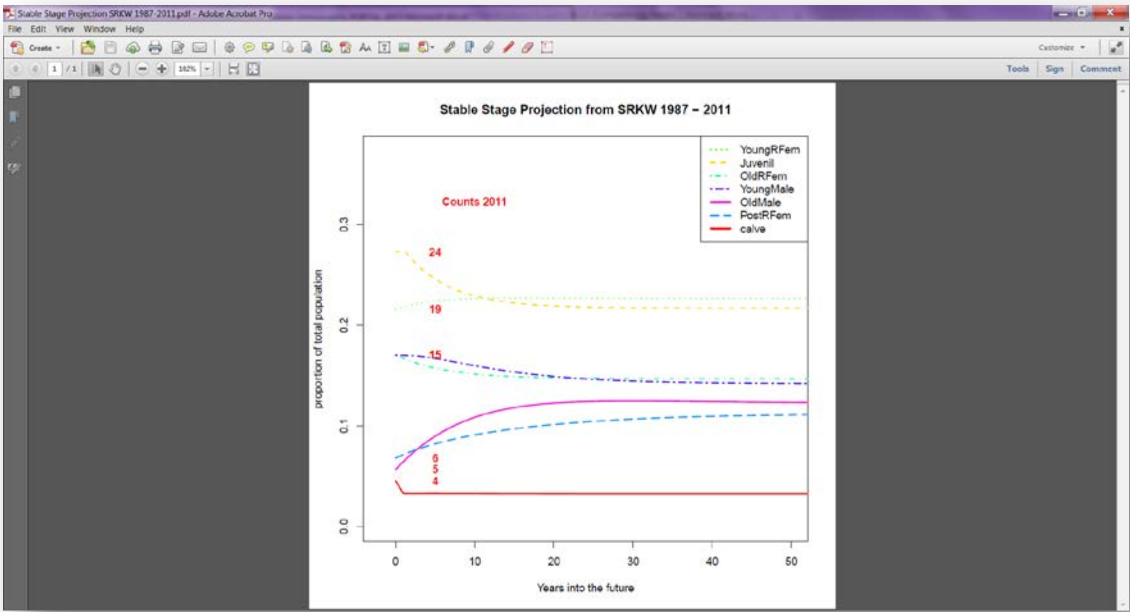
MeanMatrix Population (csv): Two-sex, stage structured matrix based on mean vital rate (survival and fecundity) values for the selected time period. A birth-flow matrix model is used with seven life stages and fixed transition probabilities based on stage duration (details in Vélez-Espino et al. 2014).



CalveMat	JuvMat	YoFemMat	OlFemMat	PRFemMat	YoMalMat	OlMalMat
0	0,002858925	0,101233451	0,058943767	0	0	0
0,885821138	0,858113736	0	0	0	0	0
0	0,055511401	0,93766835	0	0	0	0
0	0	0,046883418	0,918465801	0	0	0
0	0	0	0,048340305	0,927843915	0	0
0	0,067076276	0	0	0	0,888350488	0
0	0	0	0	0	0,080759135	0,897243266

MeanMatrix SRKW

Stable Stage Projection Population Start year – End year (pdf): Graphical output showing the change in stage composition with time towards stable stage distribution. Initial values correspond to counts and proportions in the last year of the study

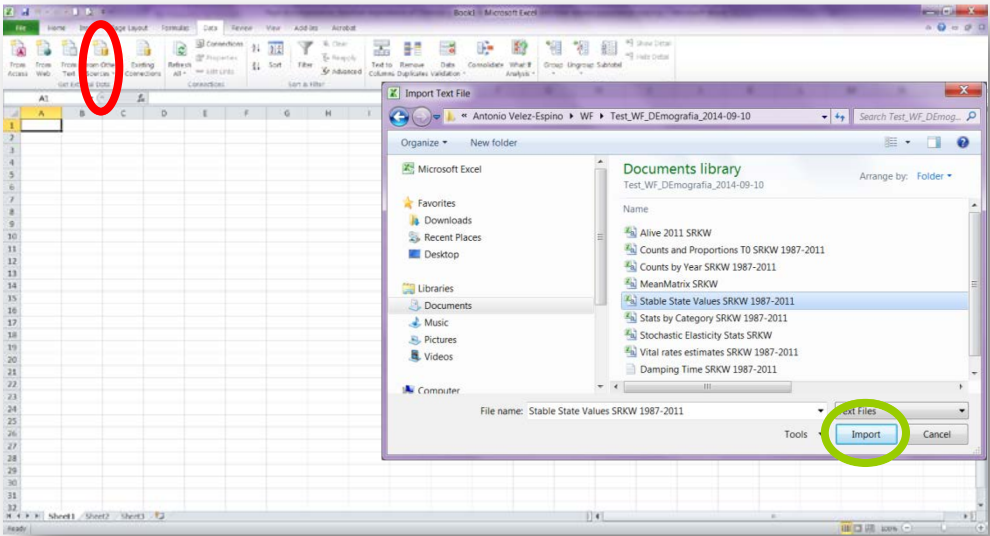


Stable Stage Projection SRKW 1987-2011

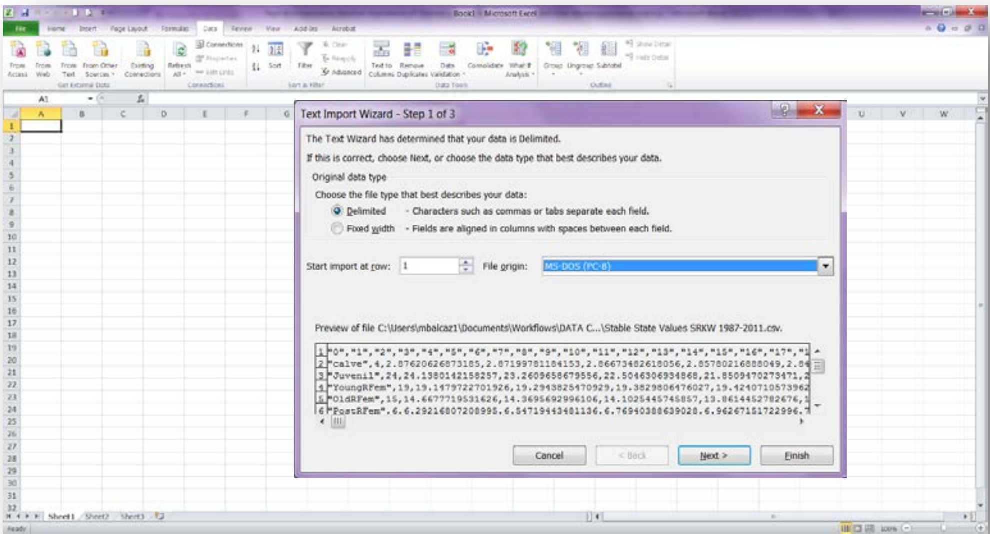
Stable State Values Population Start year – End year (csv): Long-term projections of population size by life stage based on transient dynamics.

Note: If the user used ≥ 1850 ***Sims***, you need to open the file as follows:

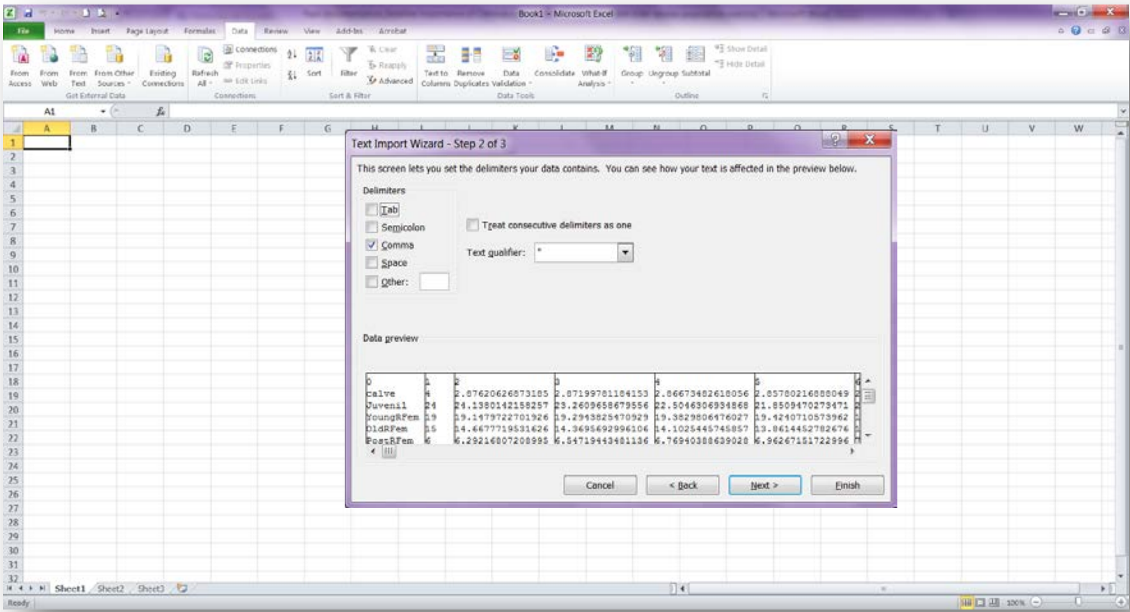
1. Open excel (versions 2007 onwards)
2. Go to Data tab
3. Click on From text (red oval)
4. Open the Folder where the file *Stable State Values SRKW 1987-2011.csv* is.
5. Import the file *Stable State Values SRKW 1987-2011.csv* (green oval).



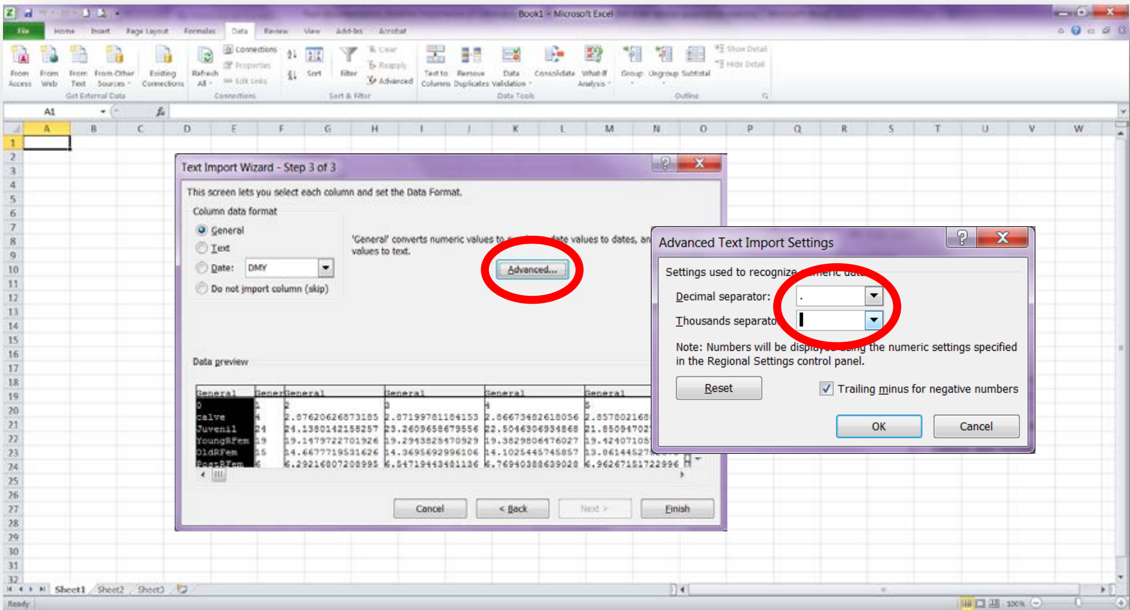
6. Follow three steps to open the file
   a. Text import wizard: step 1:
      i. Choose Delimited
      ii. File origin: MS DOS (PC-8)
      iii. Click next



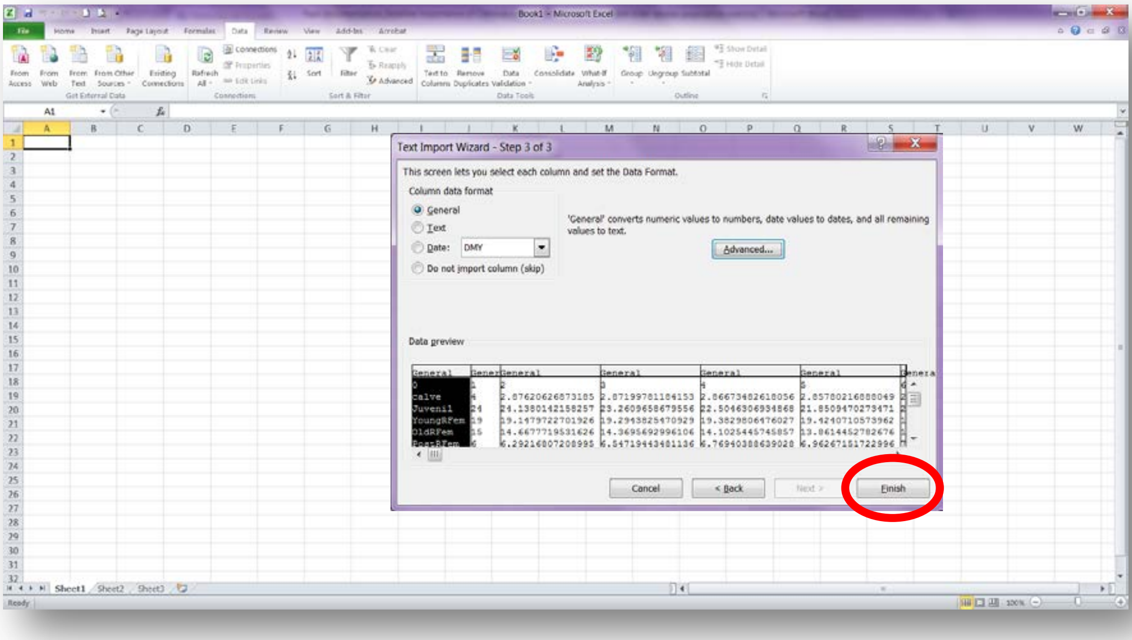
b. Text import wizard: step 2:
   i. Choose Coma delimited
   ii. Click next



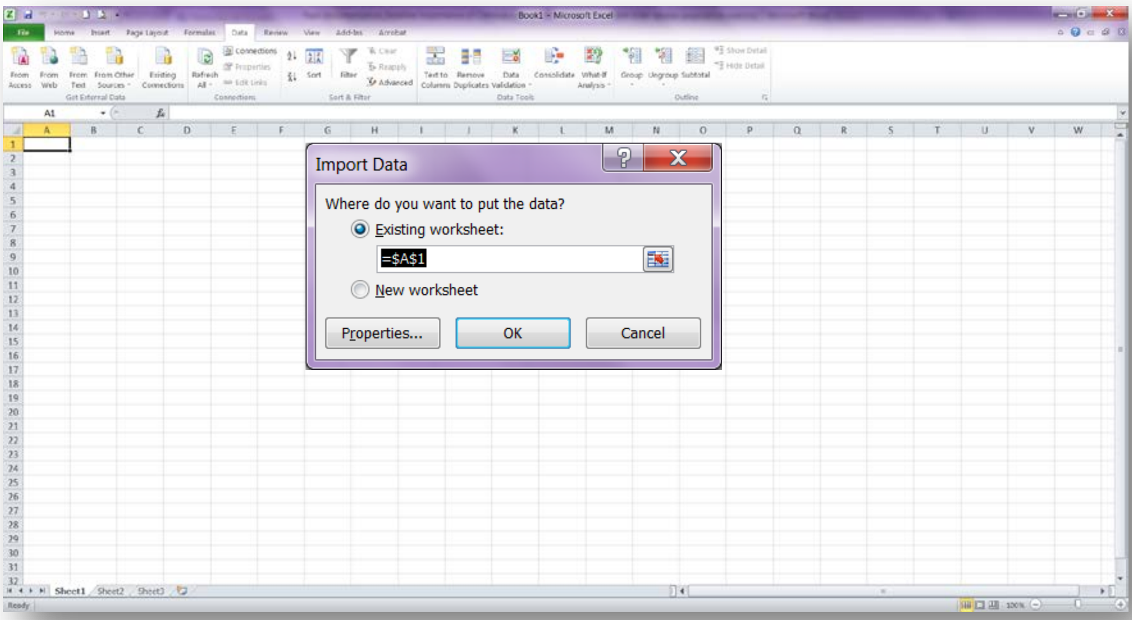
c. Text import wizard: step 3:
   i. Click in Advance (red oval) and the Advance Text Import Settings window appears.
   ii. Decimal separator: decimal numbers must be separated by a period, red oval).
   iii. Thousands separator: choose empty space (red oval).
   iv. Click ok

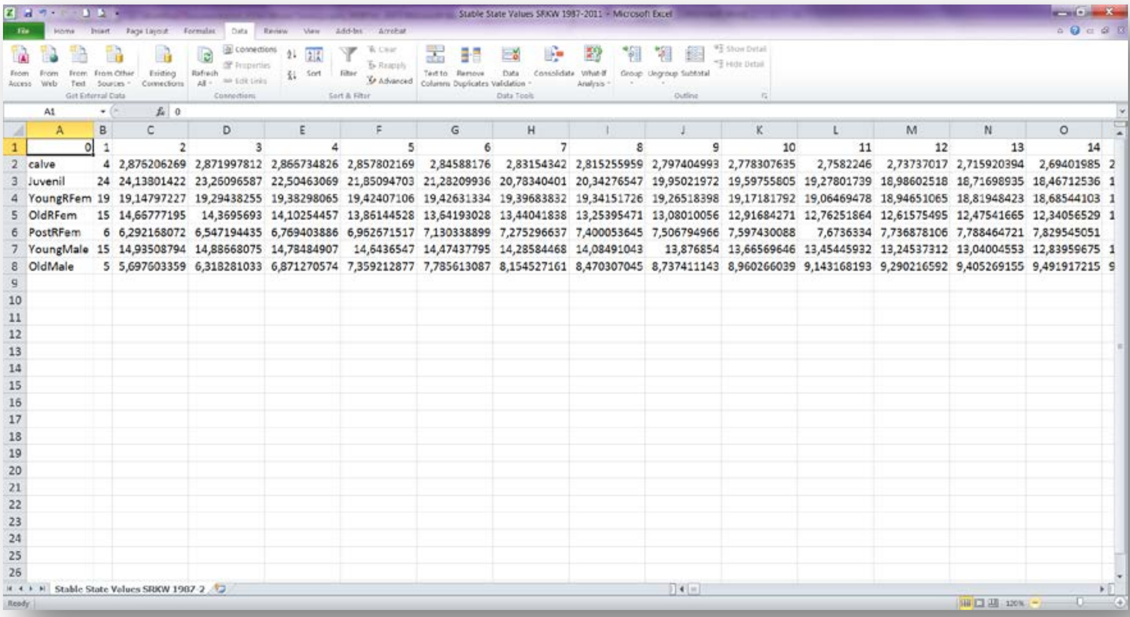


7. Click in Finish.



8. Import Data window appears, asking Where do you want to put the data, choose Existing worksheet.



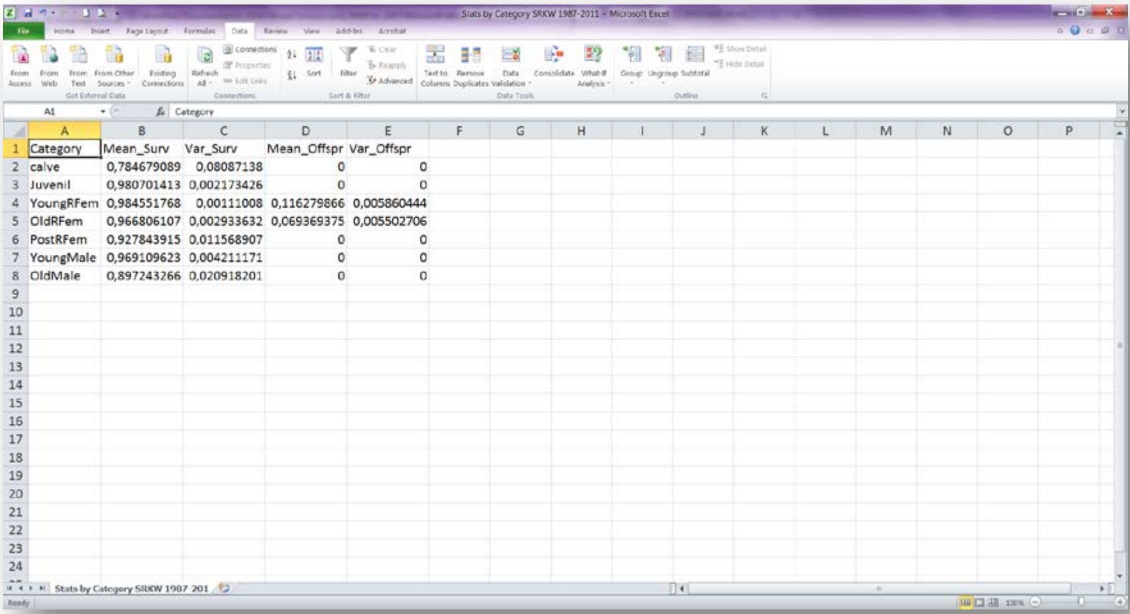


0	1	2	3	4	5	6	7
calve	4	2,876206269	2,871997812	2,866734826	2,857802169	2,84588176	2,83154342
Juvenil	24	24,13801422	23,26096587	22,50463069	21,85094703	21,28209936	20,78340401
YoungRFem	19	19,14797227	19,29438255	19,38298065	19,42407106	19,42631334	19,39683832
OldRFem	15	14,66777195	14,3695693	14,10254457	13,86144528	13,64193028	13,44041838
PostRFem	6	6,292168072	6,547194435	6,769403886	6,962671517	7,130338899	7,275296637
YoungMale	15	14,93508794	14,88668075	14,78484907	14,6436547	14,47437795	14,28584468
OldMale	5	5,697603359	6,318281033	6,871270574	7,359212877	7,785613087	8,154527161

0	8	9	10	11	12	13	14
calve	2,815255959	2,797404993	2,778307635	2,7582246	2,73737017	2,715920394	2,69401985
Juvenil	20,34276547	19,95021972	19,59755805	19,27801739	18,98602518	18,71698935	18,46712536
YoungRFem	19,34151726	19,26518398	19,17181792	19,06469478	18,94651065	18,81948423	18,68544103
OldRFem	13,25395471	13,08010056	12,91684271	12,76251864	12,61575495	12,47541665	12,34056529
PostRFem	7,400053645	7,506794966	7,597430088	7,6736334	7,736878106	7,788464721	7,829545051
YoungMale	14,08491043	13,876854	13,66569646	13,45445932	13,24537312	13,04004553	12,83959675
OldMale	8,470307045	8,737411143	8,960266039	9,143168193	9,290216592	9,405269155	9,491917215

Stable State Values SRKW 1987-2011

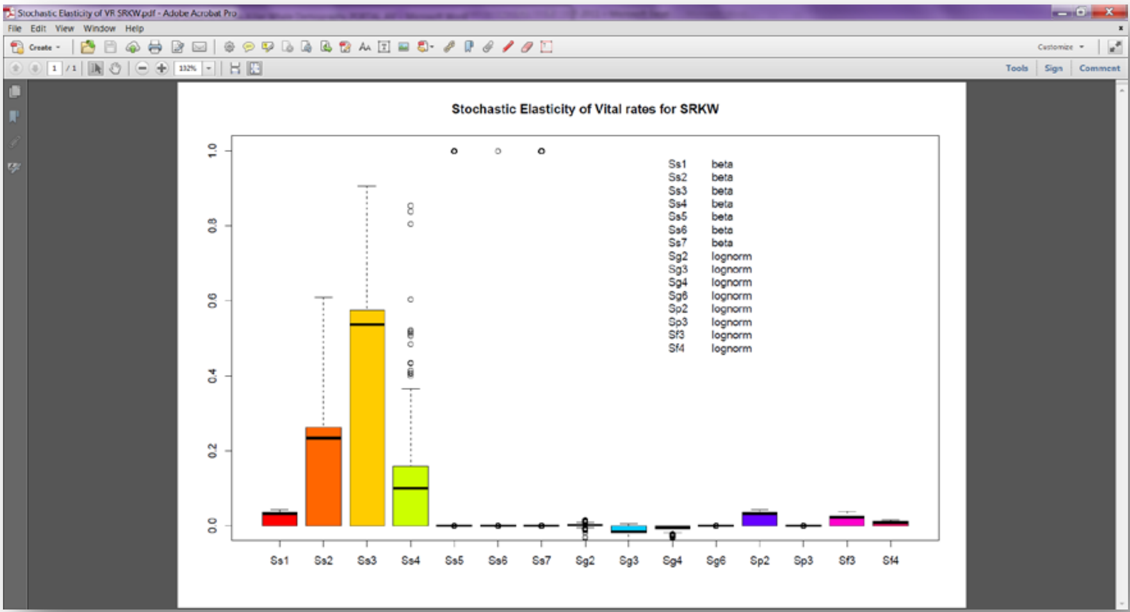
Stats by Category Population Start year – End year (csv): Mean and variance of vital rates (survival and fecundity) by life stage. Mean and variance generated from annual values during the selected time period are used to generate vital rate probability distributions (see "Stochastic_Vital_rates").



Category	Mean_Surv	Var_Surv	Mean_Offspr	Var_Offspr
calve	0,784679089	0,08087138	0	0
Juvenil	0,980701413	0,002173426	0	0
YoungRFem	0,984551768	0,00111008	0,116279866	0,005860444
OldRFem	0,966806107	0,002933632	0,069369375	0,005502706
PostRFem	0,927843915	0,011568907	0	0
YoungMale	0,969109623	0,004211171	0	0
OldMale	0,897243266	0,020918201	0	0

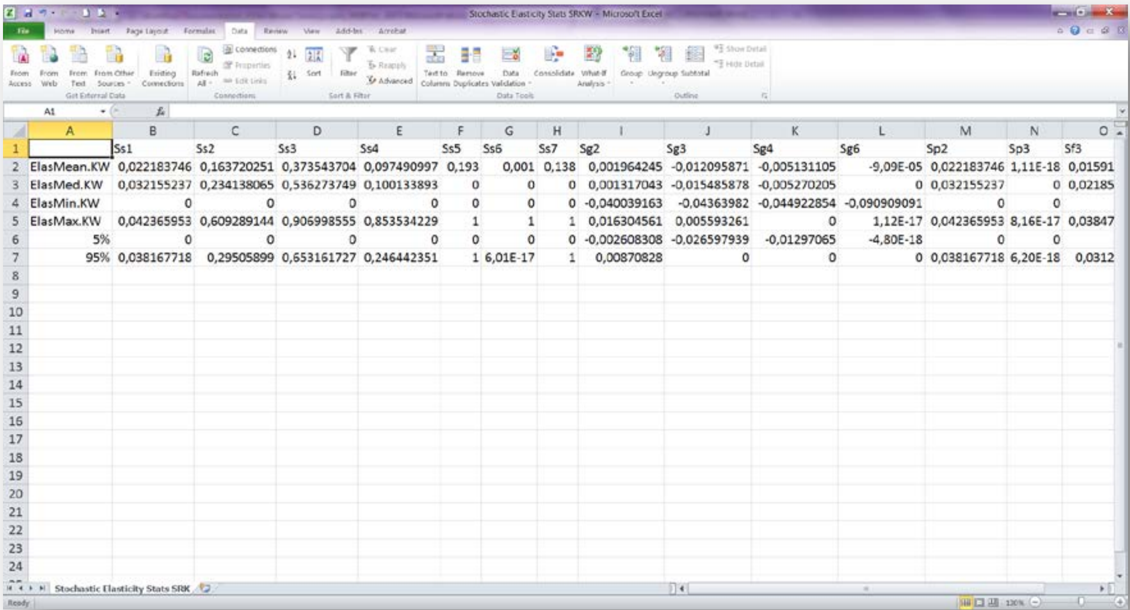
Stats by Category SRKW 1987-2011

Stochastic Elasticity of VR Population (pdf): Graphical output for stochastic elasticities of vital rates based on "Stochastic_Vital_rates"



Stochastic Elasticity of VR SRKW

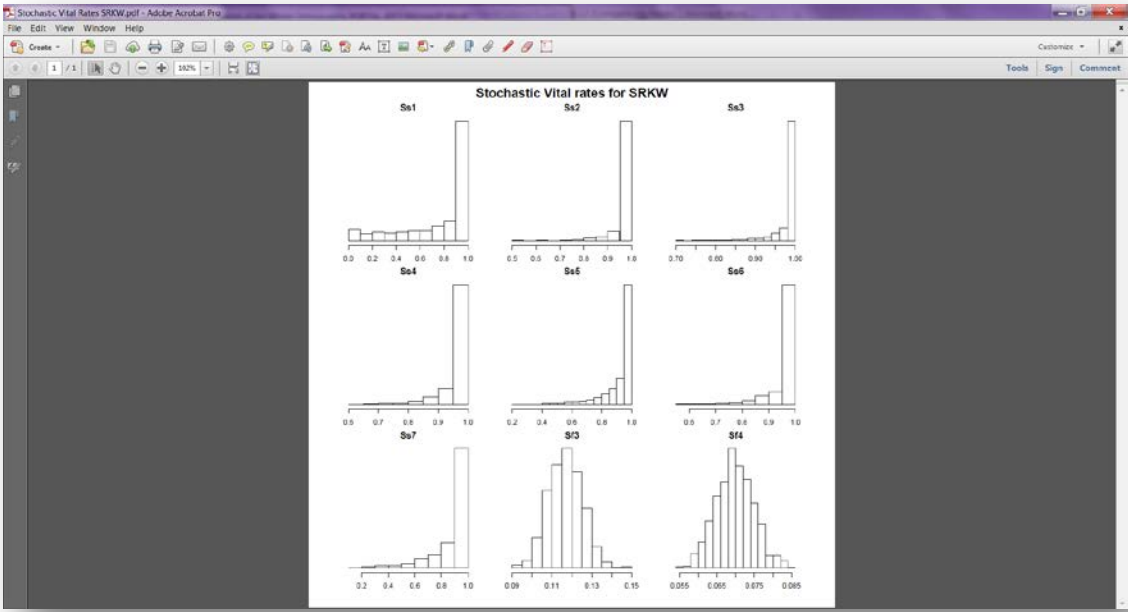
Stochastic Elasticity Stats Population (csv): Mean, median, minimum, maximum, and 95% confidence limits of stochastic elasticities of vital rates.



	Ss1	Ss2	Ss3	Ss4	Ss5	Ss6	Ss7	Sg2	Sg3	Sg4	Sg6	Sp2	Sp3	Sf3
ElasMean.KW	0,022183746	0,163720251	0,373543704	0,097490997	0,193	0,001	0,138	0,001964245	-0,012095871	-0,005131105	-9,09E-05	0,022183746	1,11E-18	0,01591
ElasMed.KW	0,032155237	0,234138065	0,536273749	0,100133893	0	0	0	0,001317043	-0,015485878	-0,005270205	0	0,032155237	0	0,02185
ElasMin.KW	0	0	0	0	0	0	0	-0,040039163	-0,04363982	-0,044922854	-0,090909091	0	0	
ElasMax.KW	0,042365953	0,609289144	0,906998555	0,853534229	1	1	1	0,016304561	0,005593261	0	1,12E-17	0,042365953	8,16E-17	0,03847
5%	0	0	0	0	0	0	0	-0,002608308	-0,026597939	-0,01297065	-4,80E-18	0	0	
95%	0,038167718	0,29505899	0,653161727	0,246442351	1	6,01E-17	1	0,00870828	0	0	0	0,038167718	6,20E-18	0,0312

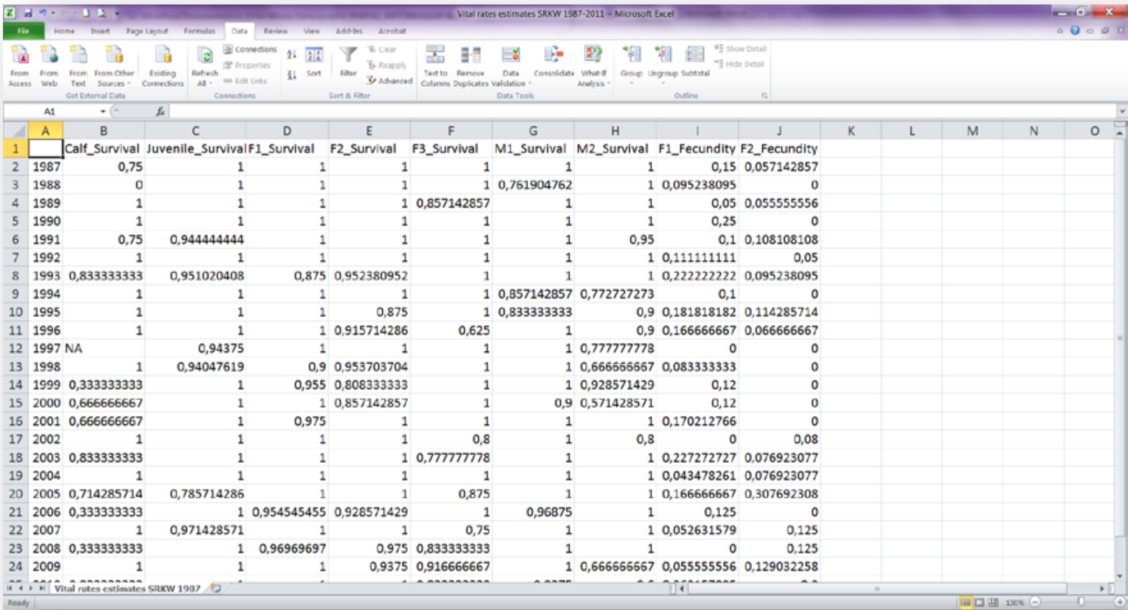
Stochastic Elasticity Stats SRKW

Stochastic Vital Rates Population (pdf): Graphical output for vital rate probability distributions. Beta distribution used for survival; lognormal distribution used for fecundity.



Stochastic Vital Rates SRKW

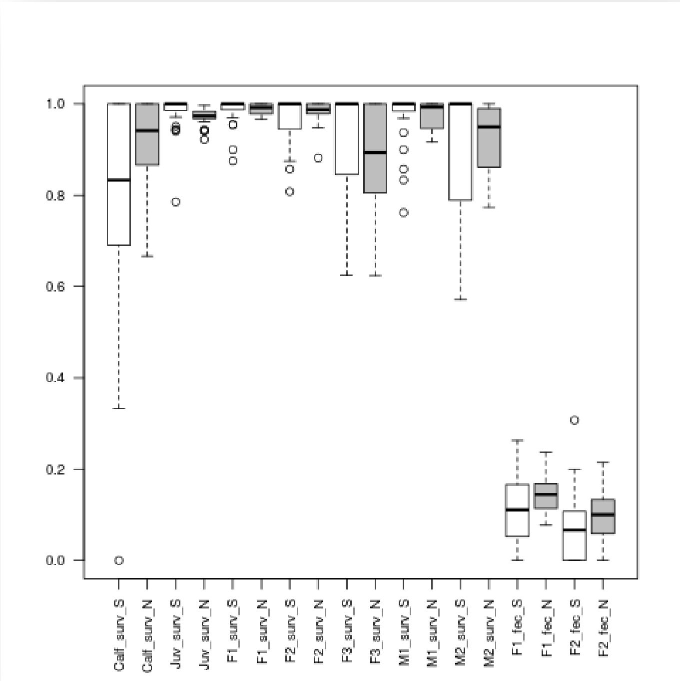
Vital rates estimates Population Start year – End year (csv): Vital rate (survival and fecundity) values by year and life stage through the selected time period



	Calf_Survival	Juvenile_Survival	F1_Survival	F2_Survival	F3_Survival	M1_Survival	M2_Survival	F1_Fecundity	F2_Fecundity
1987	0,75	1	1	1	1	1	1	0,15	0,057142857
1988	0	1	1	1	1	0,761904762	1	0,095238095	0
1989	1	1	1	1	0,857142857	1	1	0,05	0,055555556
1990	1	1	1	1	1	1	1	0,25	0
1991	0,75	0,944444444	1	1	1	1	0,95	0,1	0,108108108
1992	1	1	1	1	1	1	1	0,111111111	0,05
1993	0,833333333	0,951020408	0,875	0,952380952	1	1	1	0,222222222	0,095238095
1994	1	1	1	1	1	0,857142857	0,772727273	0,1	0
1995	1	1	1	0,875	1	0,833333333	0,9	0,181818182	0,114285714
1996	1	1	1	0,915714286	0,625	1	0,9	0,166666667	0,066666667
1997	NA	0,94375	1	1	1	1	0,777777778	0	0
1998	1	0,94047619	0,9	0,953703704	1	1	0,666666667	0,083333333	0
1999	0,333333333	1	0,955	0,808333333	1	1	0,928571429	0,12	0
2000	0,666666667	1	1	0,857142857	1	0,9	0,571428571	0,12	0
2001	0,666666667	1	0,975	1	1	1	1	0,170212766	0
2002	1	1	1	1	0,8	1	0,8	0	0,08
2003	0,833333333	1	1	1	0,777777778	1	1	0,227272727	0,076923077
2004	1	1	1	1	1	1	1	0,043478261	0,076923077
2005	0,714285714	0,785714286	1	1	0,875	1	1	0,166666667	0,307692308
2006	0,333333333	1	0,954545455	0,928571429	1	0,96875	1	0,125	0
2007	1	0,971428571	1	1	0,75	1	1	0,052631579	0,125
2008	0,333333333	1	0,96969697	0,975	0,833333333	1	1	0	0,125
2009	1	1	1	0,9375	0,916666667	1	0,666666667	0,055555556	0,129032258

Vital rates estimates SRKW 1987-2011

VR_combined (.png): Box plot with the survival and fecundity probabilities of each stage.



VR_combined

4. References

This workflow was created using and based on Packages '*popbio'* in R. (Stubben & Milligan 2007; Stubben, Milligan & Nantel 2011), lattice and betareg.

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