

EPP 2009

HIV epidemic trends in the ART era
Generalized epidemics

UNAIDS/WHO Working Group
on Global HIV/AIDS & STI Surveillance

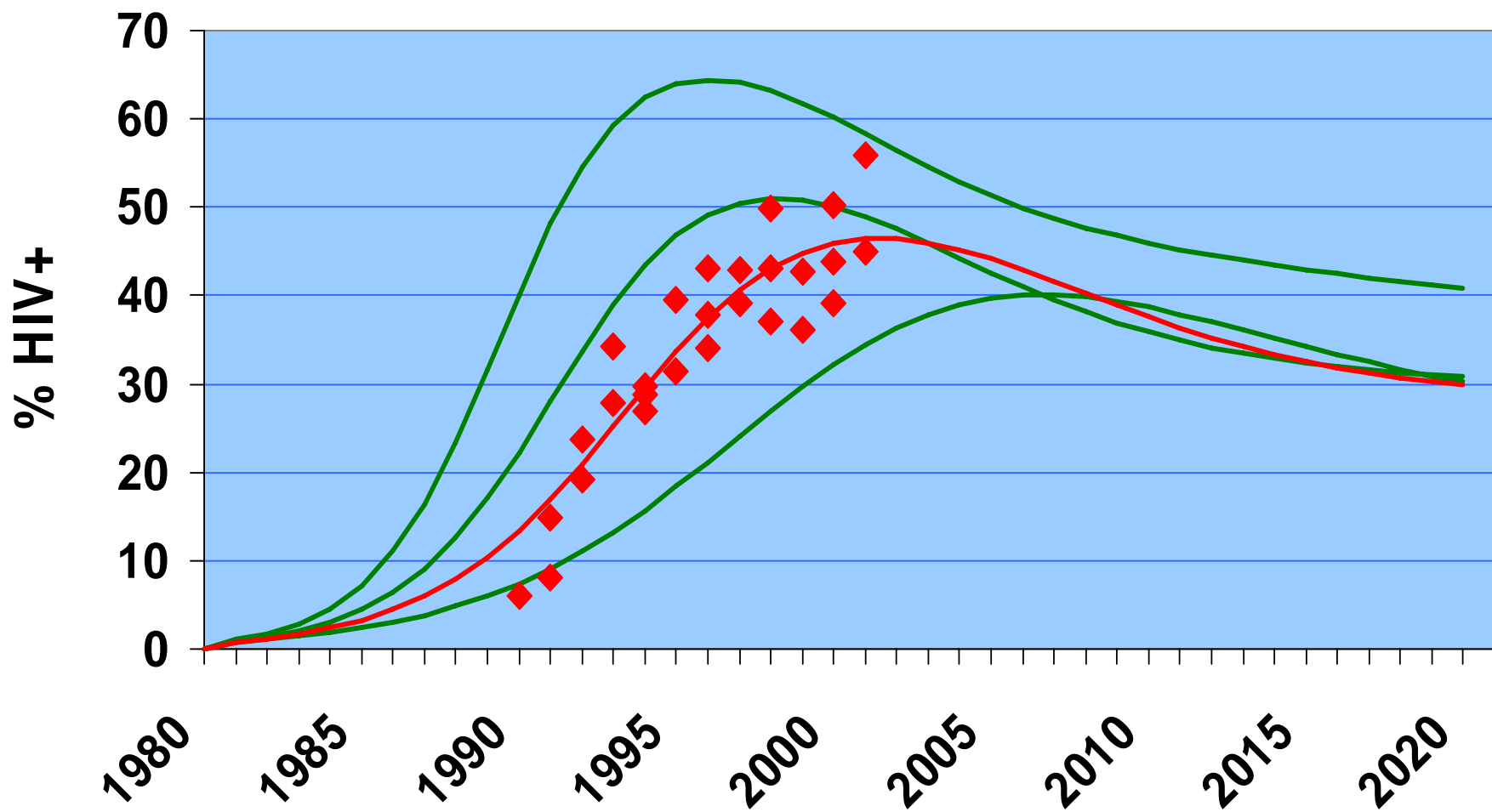
UNAIDS Estimation & Projection Package 2009



- Objectives

- Build models of national epidemics
 - Geographically appropriate
 - Containing the key sub-populations
- Provide short-term projections of HIV prevalence (<5 years)
- Serve as input to Spectrum for assessing incidence, impacts, ART and PMTCT needs, etc.

EPP's job: fit the model to the data

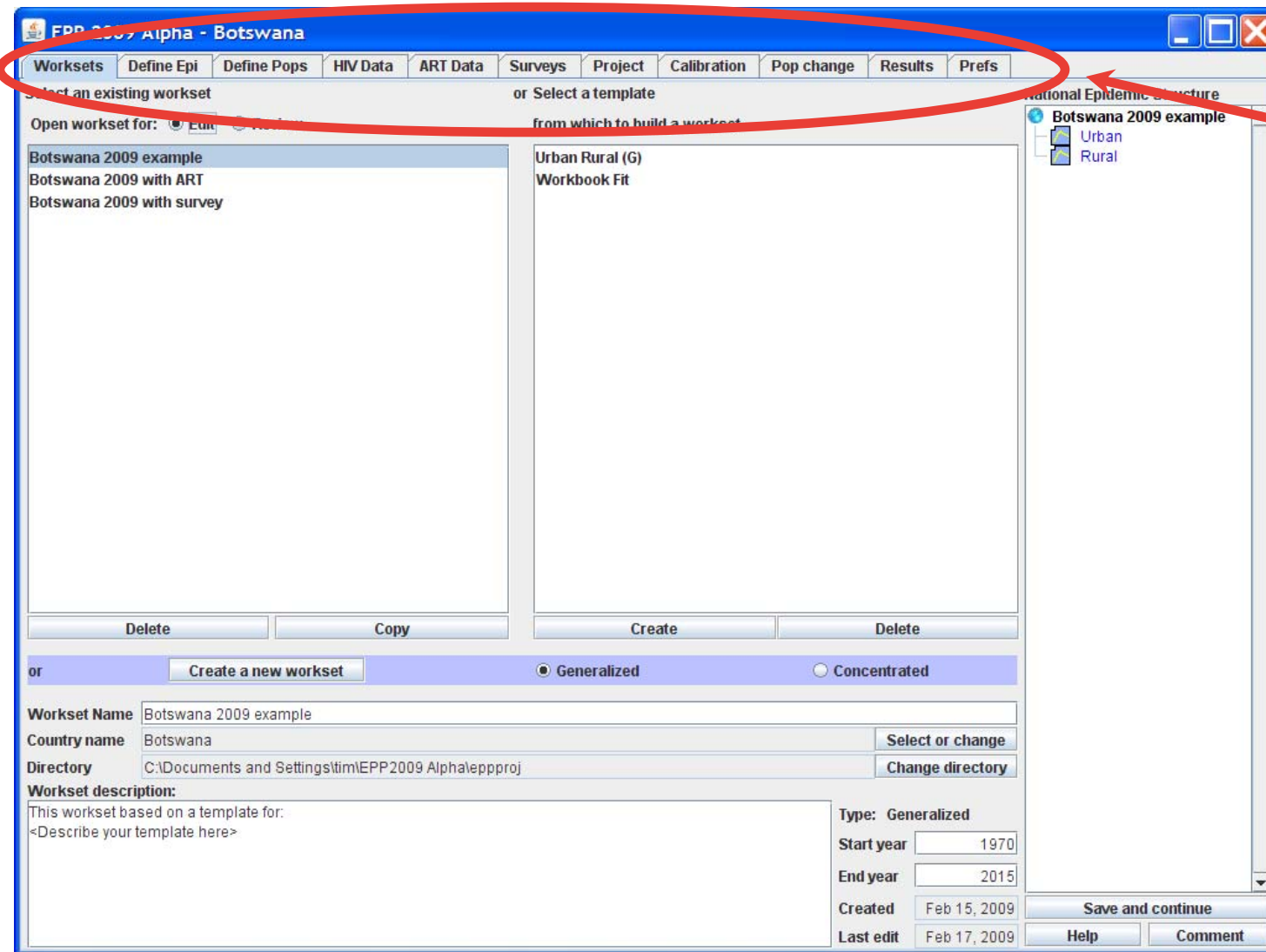


What's new in EPP 2009?

- Includes influence of ART on prevalence and incidence in fitting the epidemic
- Uses an improved algorithm to generate better fits and more accurate uncertainties
- Allows user to calibrate projections after fitting
- Permits changing urban/rural populations
- Calculates and displays contributions to incidence from urban and rural populations

What are the steps in modeling a national HIV epidemic?

EPP 2009 leads you through each important step

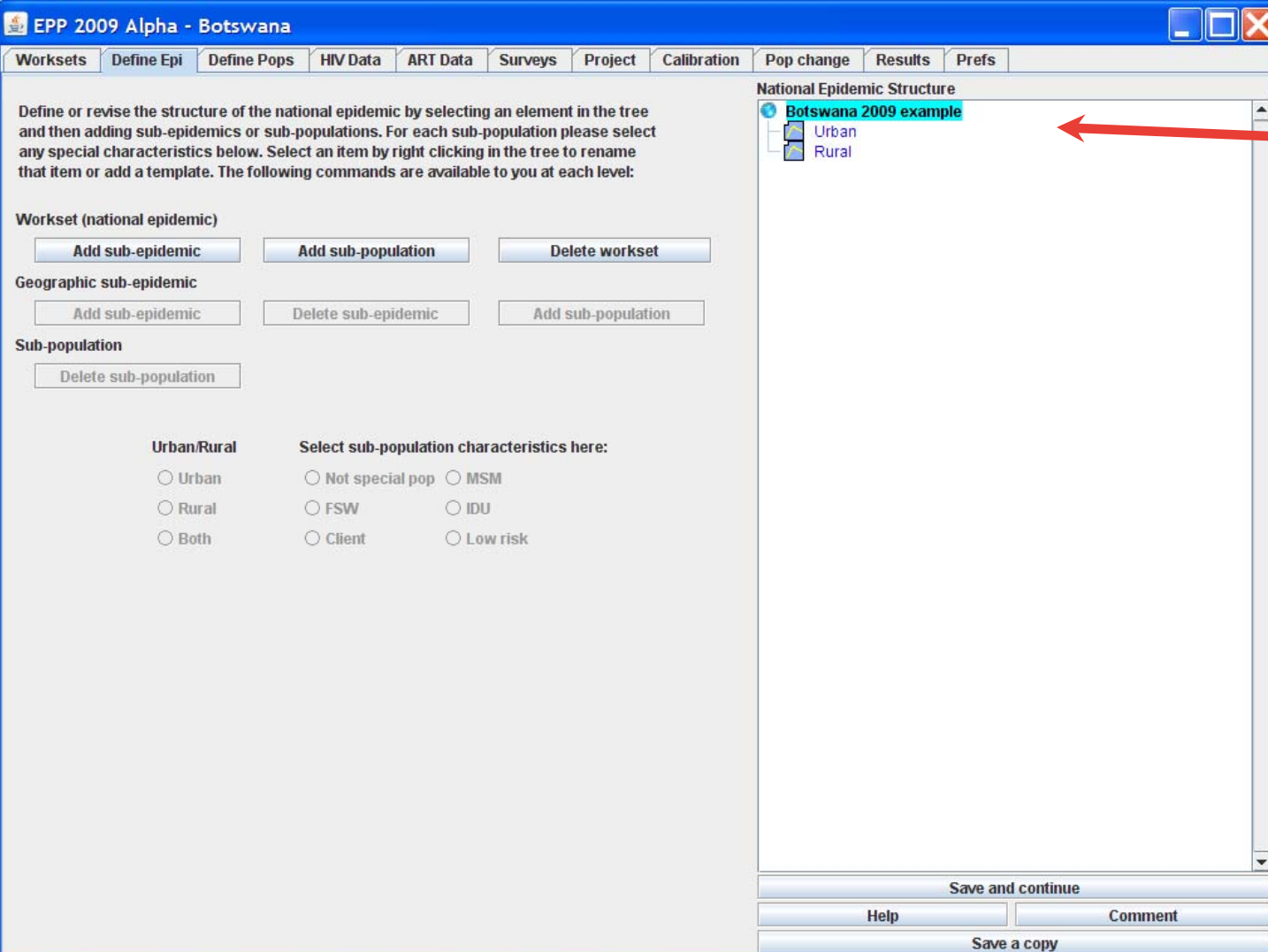


Each “tab” represents a step in the process

Note new larger interface – more data shown, bigger graphs

The EPP Define Epi page

Create your own epidemic tree in panel on the right



EPP 2009 Alpha - Botswana

Worksets Define Epi Define Pops HIV Data ART Data Surveys Project Calibration Pop change Results Prefs

Define or revise the structure of the national epidemic by selecting an element in the tree and then adding sub-epidemics or sub-populations. For each sub-population please select any special characteristics below. Select an item by right clicking in the tree to rename that item or add a template. The following commands are available to you at each level:

Workset (national epidemic)

Add sub-epidemic Add sub-population Delete workset

Geographic sub-epidemic

Add sub-epidemic Delete sub-epidemic Add sub-population

Sub-population

Delete sub-population

Urban/Rural

Urban Rural Both

Select sub-population characteristics here:

Not special pop FSW Client MSM IDU Low risk

National Epidemic Structure

- Botswana 2009 example
 - Urban
 - Rural

Save and continue Help Comment Save a copy

Need to know - defining an epidemic

- What are sub-populations and sub-epidemics?
 - Sub-population is an epidemic in a specific group
 - Has a population size and HIV & ART data associated with it
 - A sub-epidemic is an epidemic made up from multiple epidemics in sub-populations and/or other sub-epidemics
- Sub-populations can have special characteristics
 - Urban, rural or both
 - Client, FSW, IDU, MSM, low-risk

A bigger HIV data page

EPP 2009 Alpha - Botswana

Worksets Define Epi Define Pops HIV Data ART Data Surveys Project Calibration Pop change Results Prefs

Data in % (0.0 to 100) for: Rural

Year	In	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
MEDIAN PREV		6.10	10.10	15.75	19.40	29.90	31.55	33.70	30.00	32.04	32.88	34.82	36.71	
MEAN PREV		6.10	10.10	15.22	19.50	28.90	32.18	33.02	30.27	37.10	32.06	35.83	36.65	
Site 1 (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	33.70	-	31.34	-	-	-	-
(N)		-	-	-	-	-	-	300	-	300	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	17.80	-	38.90	-	-	-	-	-	-	-	-
(N)		-	-	300	-	300	-	-	-	-	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	28.20	-	32.04	-	34.82	42.90	-
(N)		-	-	-	-	-	-	300	-	300	-	300	300	-
Site (%)	<input checked="" type="checkbox"/>	-	12.70	-	-	-	33.10	-	33.53	-	-	-	-	-
(N)		-	300	-	-	-	300	-	300	-	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	6.10	-	-	-	-	-	-	-	-	-	-	-	-
(N)		300	-	-	-	-	-	-	-	-	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	19.40	-	-	-	-	-	-	-	-	-
(N)		-	-	-	300	-	-	-	-	-	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	-	-	-	40.00	42.35	-	-
(N)		-	-	-	-	-	-	-	-	-	300	300	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	-	-	-	36.97	43.87	-	-
(N)		-	-	-	-	-	-	-	-	-	300	300	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	-	-	-	35.56	36.62	-	-
(N)		-	-	-	-	-	-	-	-	-	300	300	-	-
Site (%)	<input checked="" type="checkbox"/>	-	7.50	-	-	-	-	-	-	-	-	-	-	-
(N)		-	300	-	-	-	-	-	-	-	-	-	-	-
Site (%)	<input checked="" type="checkbox"/>	-	-	19.90	-	29.90	-	34.40	-	41.79	-	44.57	36.71	-
(N)		-	-	300	-	300	-	300	-	300	-	300	300	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	-	-	-	-	-	32.29	30.21	-
(N)		-	-	-	-	-	-	-	-	-	-	300	300	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	16.00	-	21.80	-	24.67	-	40.68	34.01	33.06	-
(N)		-	-	-	300	-	300	-	300	-	300	300	300	-
Site (%)	<input checked="" type="checkbox"/>	-	-	-	-	-	23.10	-	30.00	-	37.46	-	35.40	50.94
(N)		-	-	-	-	-	300	-	300	-	300	-	300	300

Sub-populations with no data: 0 Display: % HIV N Both

Buttons: Add sites, Delete sites, Undelete sites, Print, Save and continue, Help, Comment, Save a copy

Data is entered by sites for each sub-pop

For each site give HIV prevalence & sample size

EPP 2009's first big change – ART Data

Enters number on 1st and 2nd line ART nationally

Divides that ART among the sub-populations

EPP 2009 Alpha - Botswana

Worksets Define Epi Define Pops HIV Data **ART Data** Surveys Project Calibration Pop change Results Prefs

Enter the number of adults who received 1st and 2nd line ART and how that ART was distributed among the sub-populations. Specify the number of adults who received 1st and 2nd line ART nationally under "National adult ART coverage". Then specify how that ART was distributed among the sub-populations as either the number in that sub-population receiving ART or the percentage (from 0 to 100) of all national ART provided to members of that sub-population. After entering values for the number of adults on ART through this year, if you wish to extend the trend of the last 3 years for the future, push the "Project ART" button. Otherwise enter the anticipated number of adults on ART in future years. Make any changes to the eligibility criterion and progression rate from HIV infection to need for treatment before starting. All ART values entered on this page are as of December 31st of the year specified.

Person is eligible to receive ART if: CD4 < 200 CD4 < 350

Progression from HIV infection to need for treatment: Normal Pattern Fast Pattern

Year	1st or 2nd 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
First year survival on ART											
Percent surviving 1st year of ART (%)	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
National adult ART coverage											
Number of adults on ART	1st line	0	0	0	0	4000	8000	12000	16000	20000	24000
	2nd line	0	0	0	0	0	0	0	0	0	0
	TOTALS	0	0	0	0	4000	8000	12000	16000	20000	24000
Distribution of ART among sub-populations											
Number											
Still to be assigned among sub-populations (N)	1st	0	0	0	0	0	0	0	0	0	0
	Urban	1st	0	0	0	4000	8000	12000	16000	20000	24000
	Rural	1st	0	0	0	0	0	0	0	0	0

Display ART distribution as: N on ART from this sub-pop % of those on ART from this sub-pop

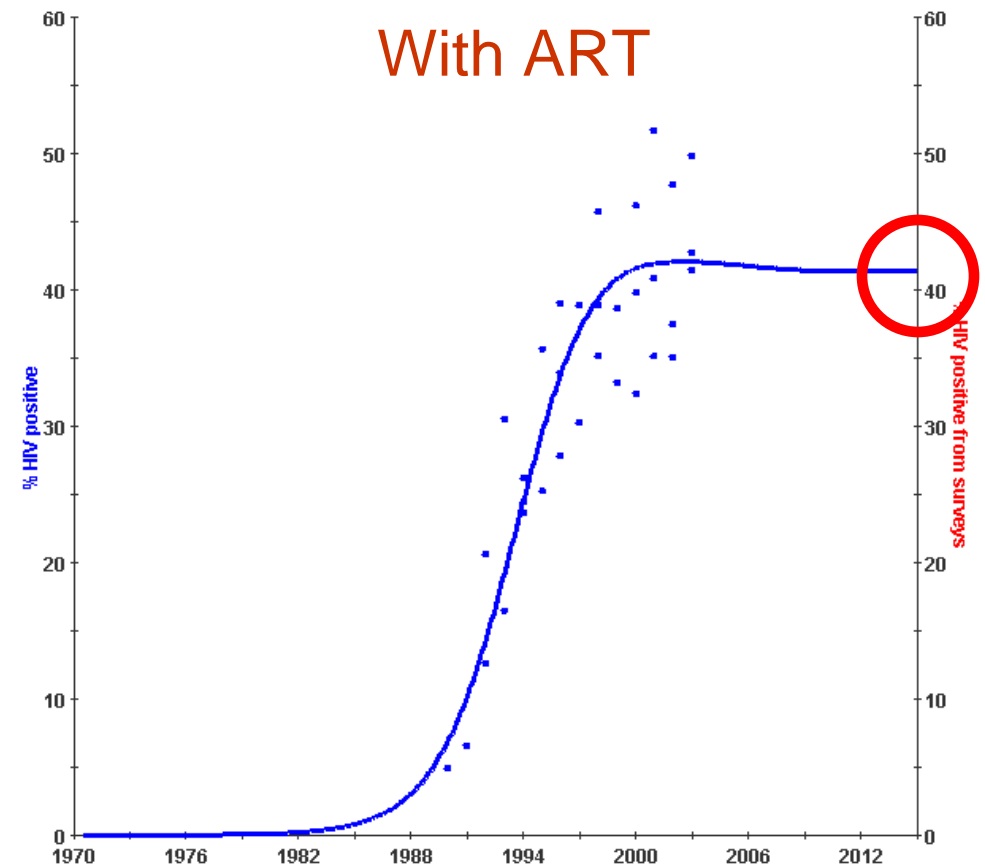
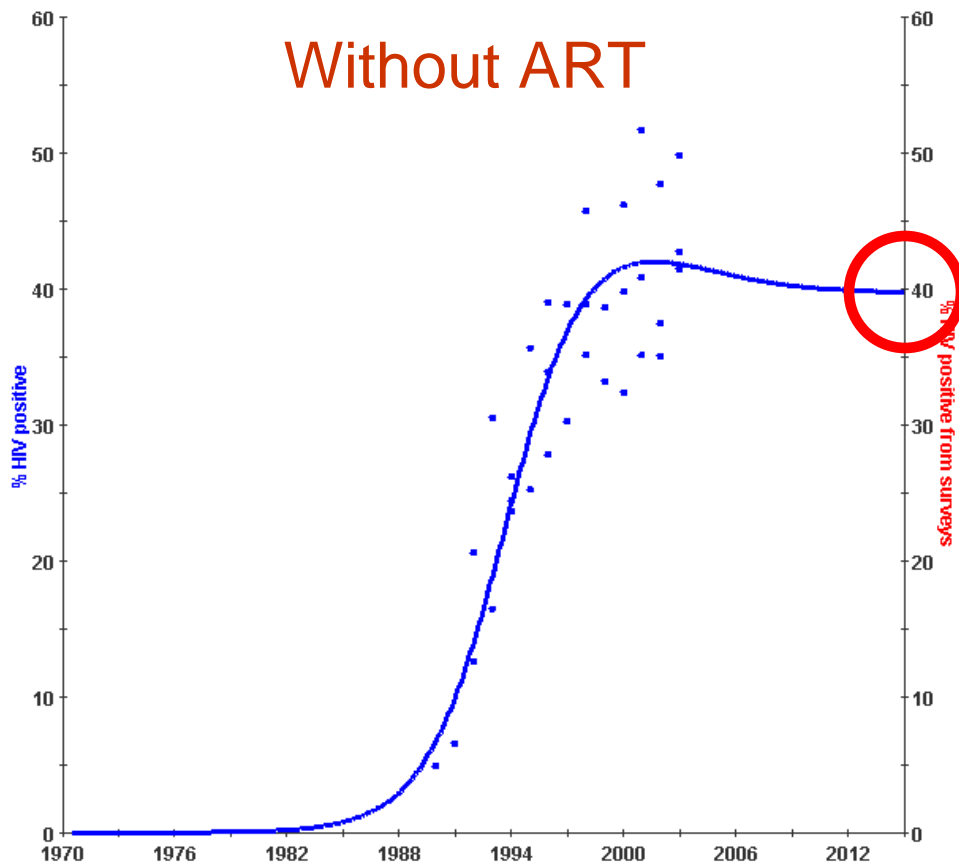
Display distribution for: 1st line ART 2nd line ART

Project ART Help Comment Save a copy Save and continue

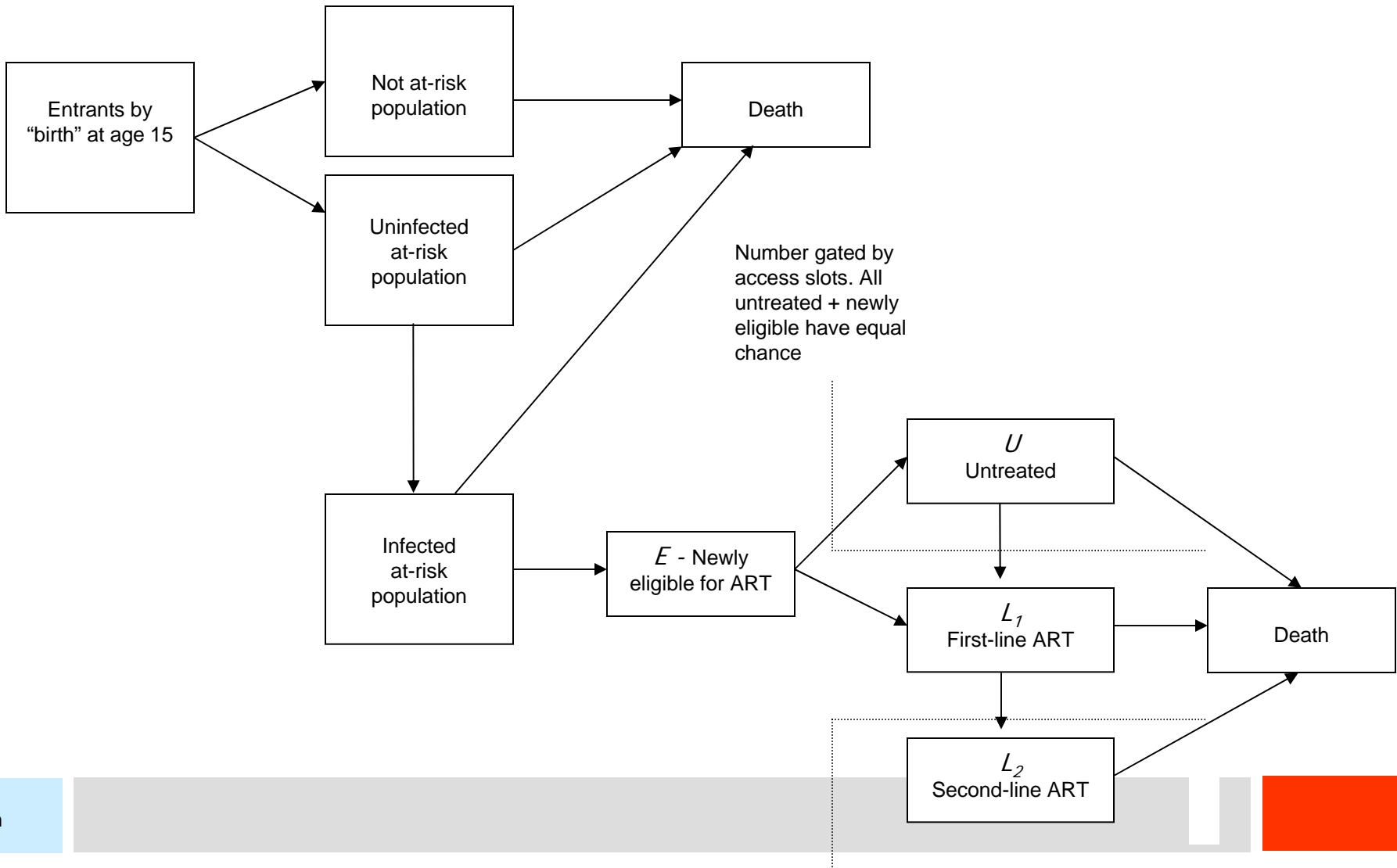
Why an ART data page?

- ART is expanding rapidly across the globe
- People live much longer on ART
- This means HIV prevalence increases

ART increases HIV prevalence



EPP 2009 has expanded model with ART



Summary of features of ART data page

- User fills in blue cells only, others automatic
- Can specify sub-population distribution as
 - Absolute numbers on ART in sub-population or
 - Percent of national ART in that sub-population
- “Still to be assigned” must be zero before leaving page
 - NOTE: needs to be true for both 1st and 2nd line ART
- Remember to check inputs against calculated coverage (on “Results” page: ART results)

Providing more input to fitting – Surveys Page

EPP 2009 Alpha - Botswana

Worksets Define Epi Define Pops HIV Data ART Data **Surveys** Project Calibration Pop change Results Prefs

You have already entered your surveillance data, however, before fitting your epidemic you may wish to include any additional data from general population HIV prevalence surveys that have been done, for example a national DHS or other large-scale survey. You may enter up to 3 results from such surveys below and they will be used during fitting to ensure the fits better reflect the actual trends in your national situation. After fitting, the Calibration Page will provide you the option to make final adjustments to each sub-population's projection before combining them into a national projection.

Include surveys in the fitting process. The age range for all surveys in this workset is: 15+ ▾

Survey 1: %HIV+ in year Standard error: % Sample size:

Survey 2: %HIV+ in year Standard error: % Sample size:

Survey 3: %HIV+ in year Standard error: % Sample size:

Do not include any surveys in the fitting process

National Epidemic Structure

- Botswana 2009 with survey
 - Urban
 - Rural

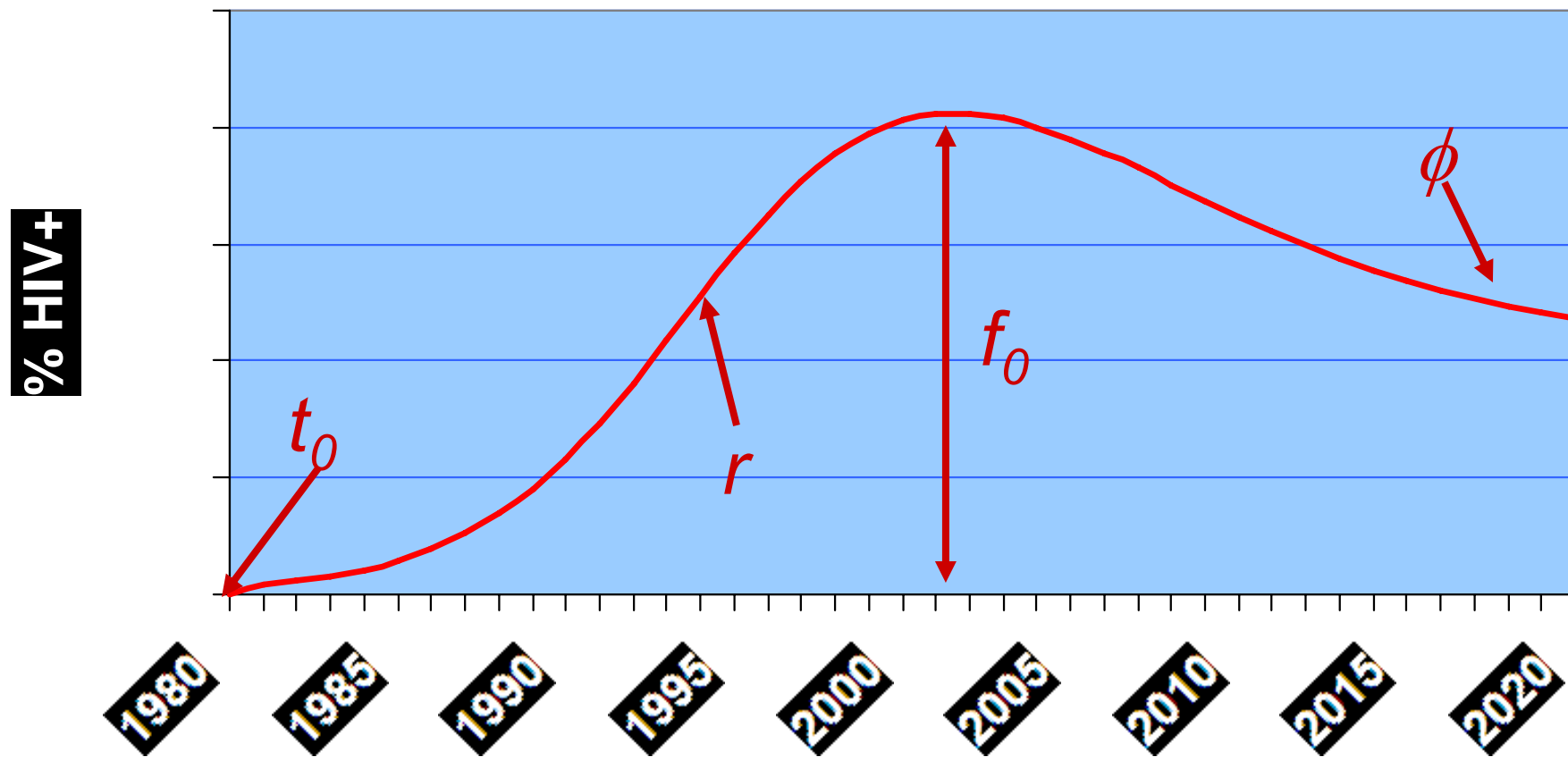
Save and continue Help Comment Save a copy

Can enter up to 3 surveys for each sub-pop

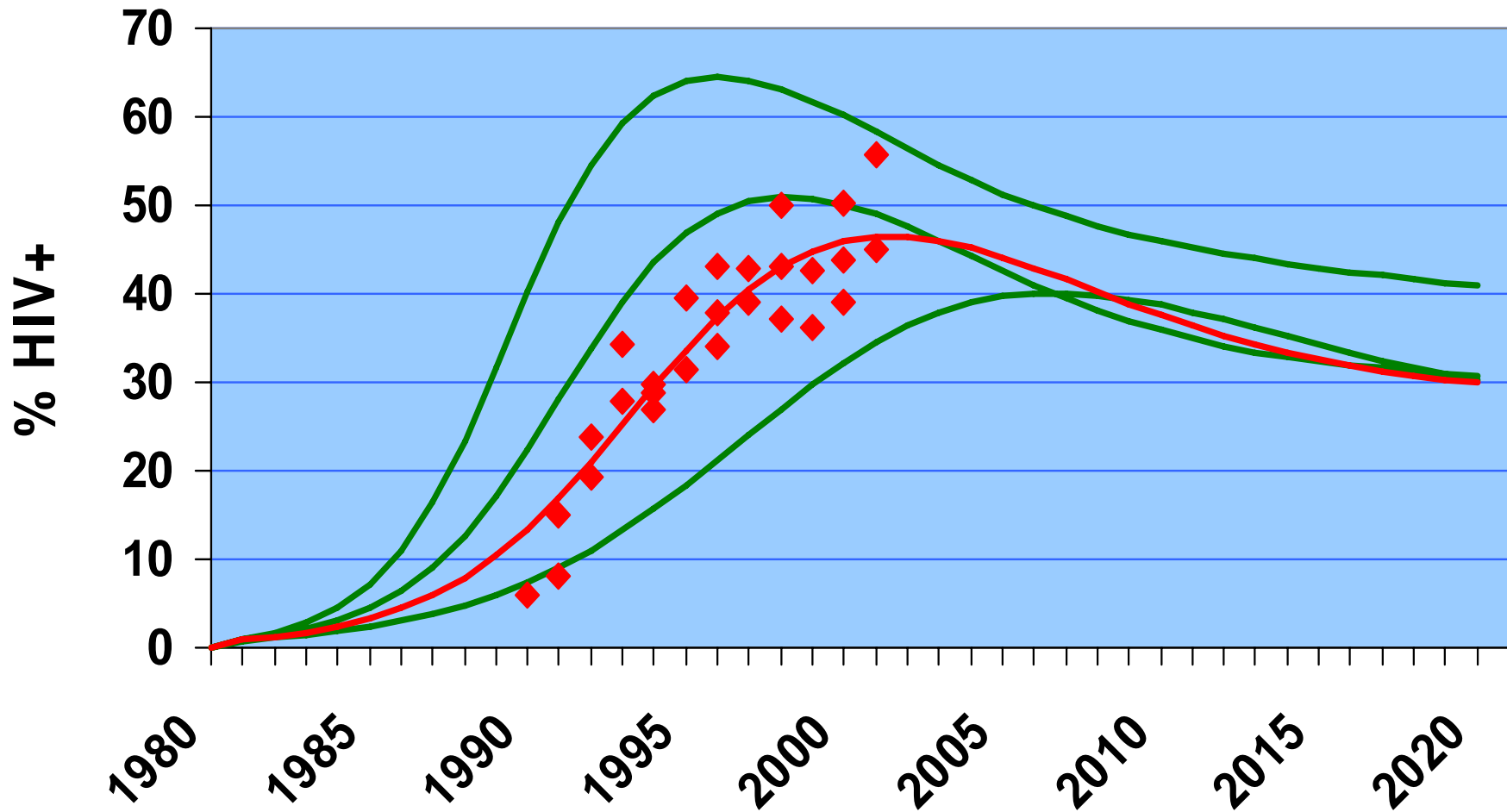
What does EPP fitting do?

- Fits plausible epidemiological model to existing data
- Modified Reference Group model – 4 fitting parameters
 - r – controlling the rate of growth
 - f_0 – the proportion of new risk pop entrants
 - t_0 – the start year of the epidemic
 - ϕ – behavior change parameter

UNAIDS Reference Group model



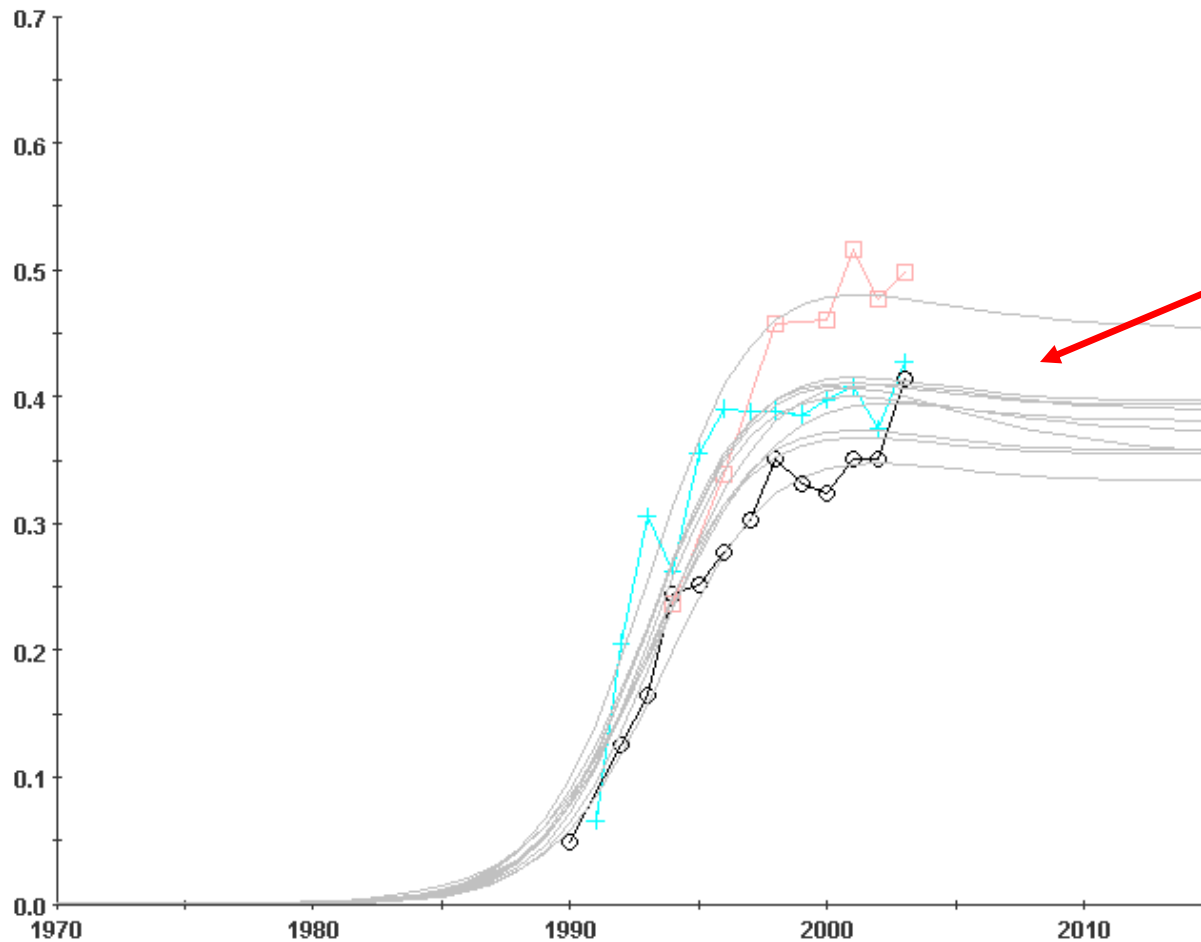
EPP's job: fit the model to the data



How does EPP 2009 fit data?

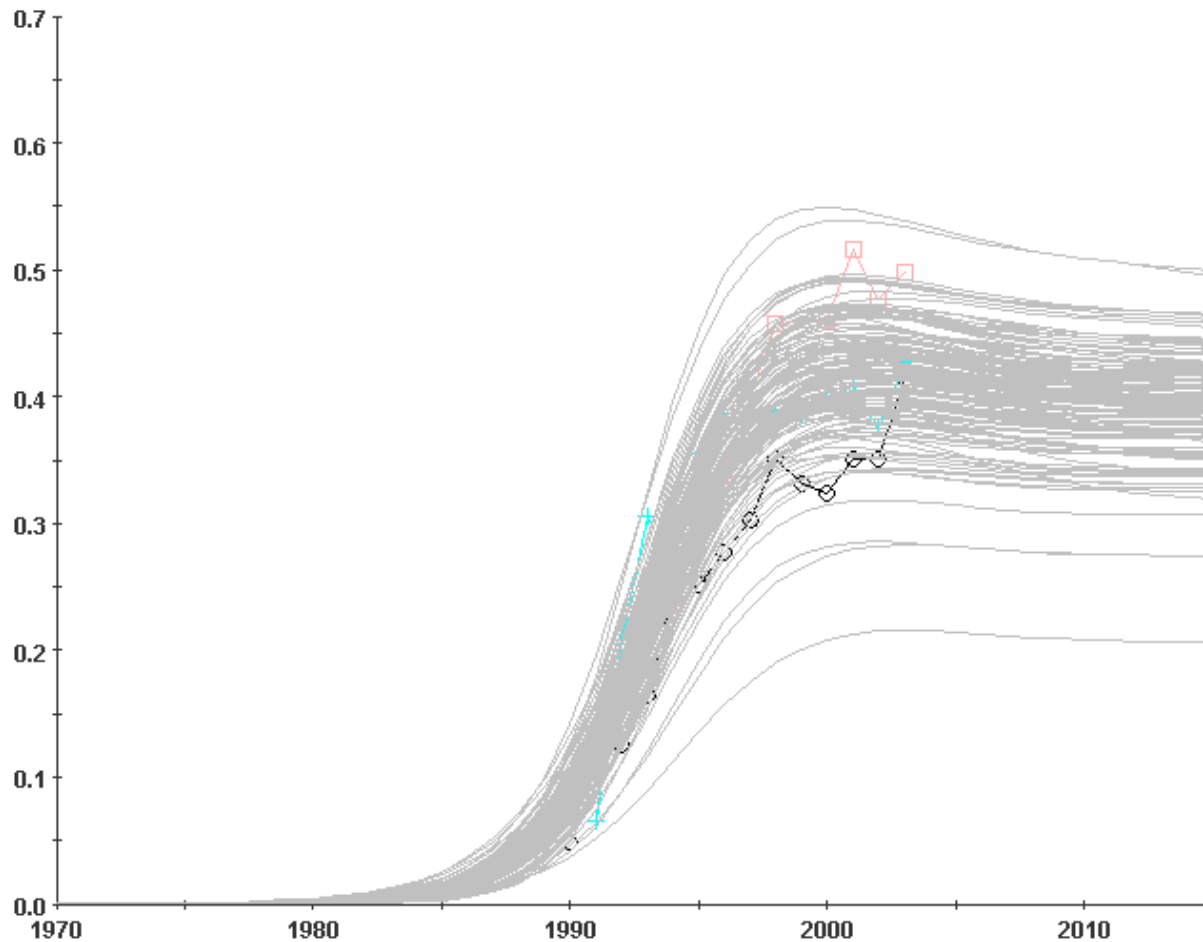
Using a process called IMIS
developed by Le Bao & Adrian Raftery

Then sample around highest weight curve



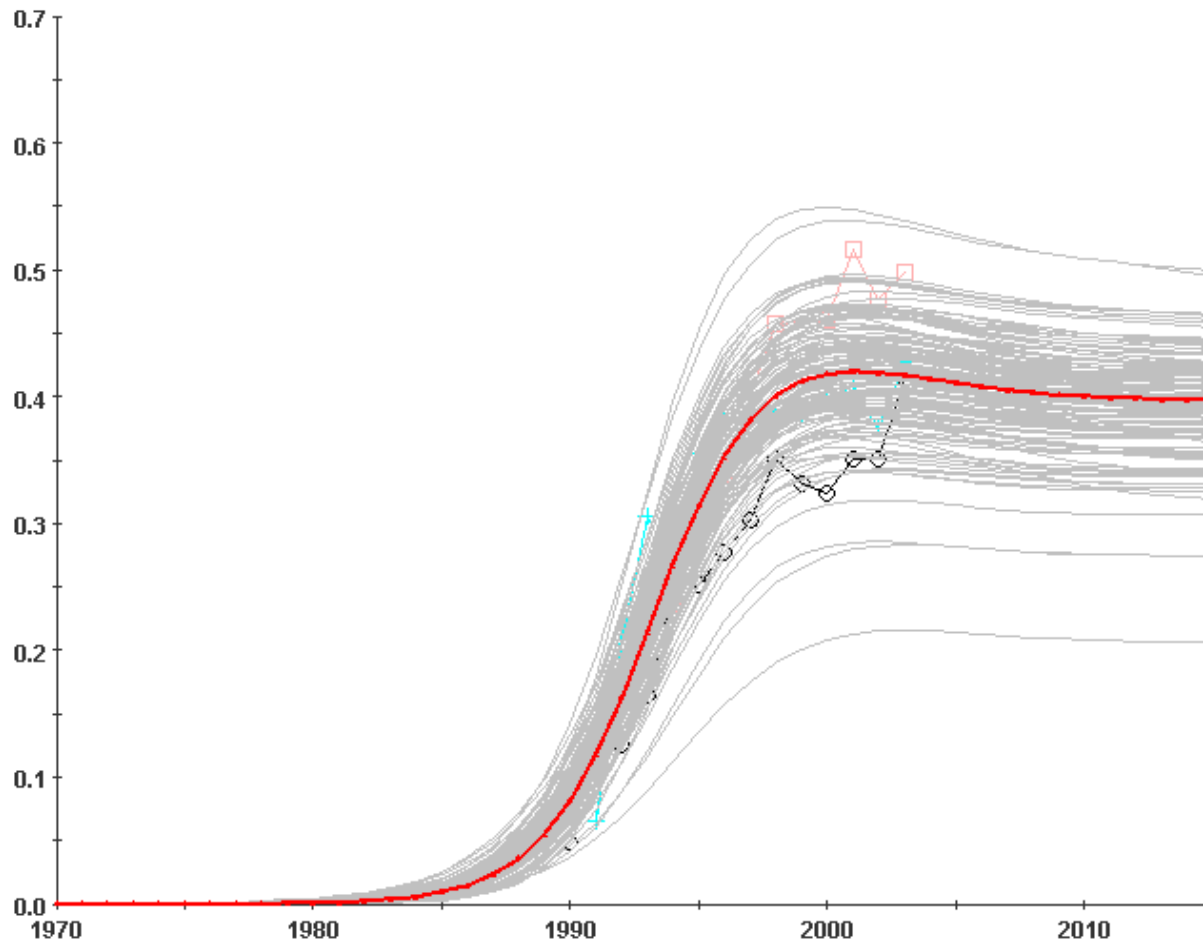
Finds some new curves around the best fitting one, i.e. one with highest weight

EPP 2009 repeats until lots of curves close to data



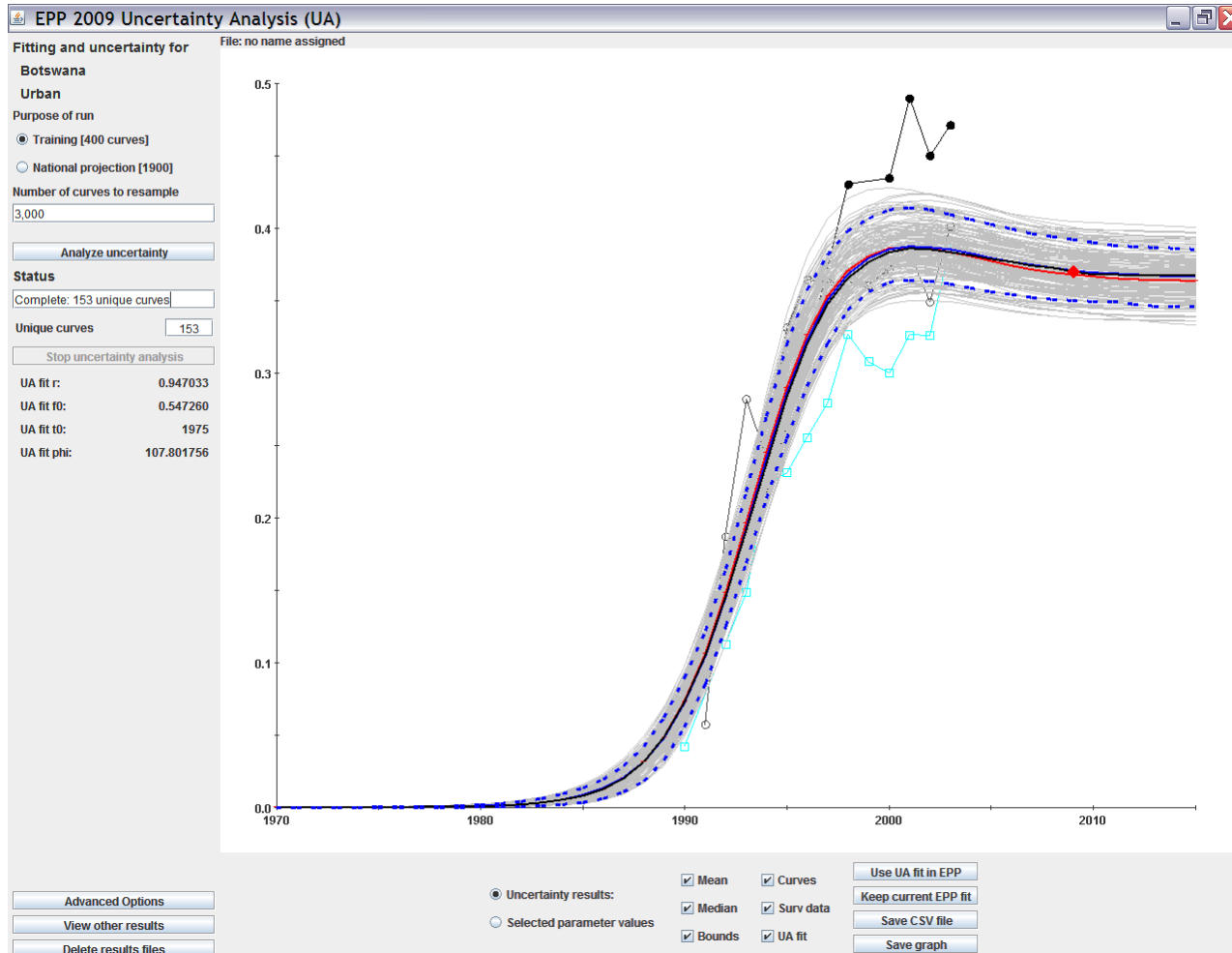
An iterative process that may run up to 200 times and generate many 1000s of curve

EPP 2009 picks the best one as the UA fit



The one that fits the data best is chosen as the UA fit

This is done on the Uncertainty Analysis Page



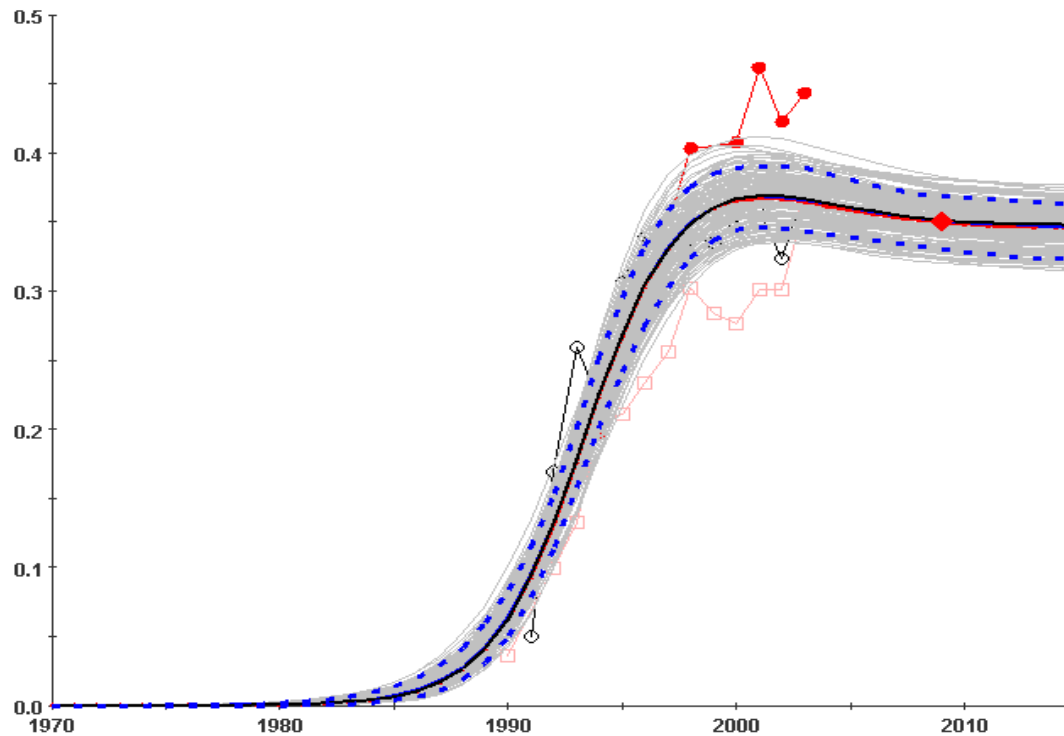
You get to this when clicking “Assess uncertainty” on the Project page

Important features of fitting interface

- Two modes
 - Training
 - Generates about 400 curves (if not fitting to surveys)
 - Takes about 2-5 minutes
 - For national projection
 - Generates about 1900 curves (if not fitting to surveys)
 - Takes 30 minutes or more for most data sets

While fitting EPP 2009 also assesses
the uncertainty in the fit

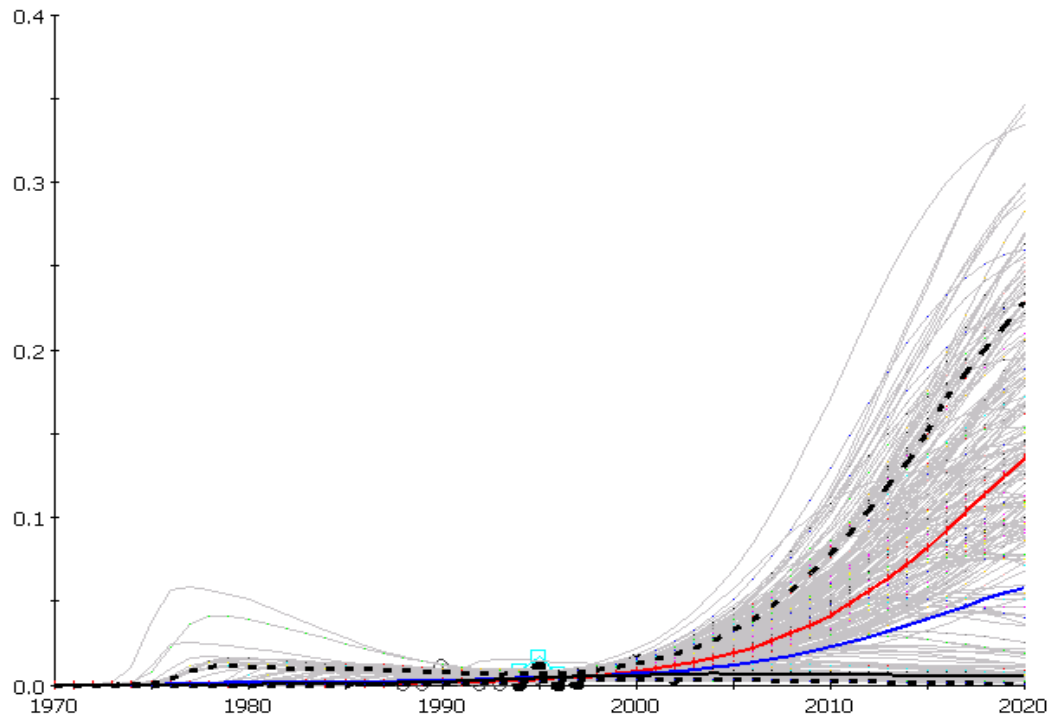
Some countries have the curves with high weights tightly bundled



Botswana urban through 2003 – future of epidemic tightly constrained

Botswana urban through 2002

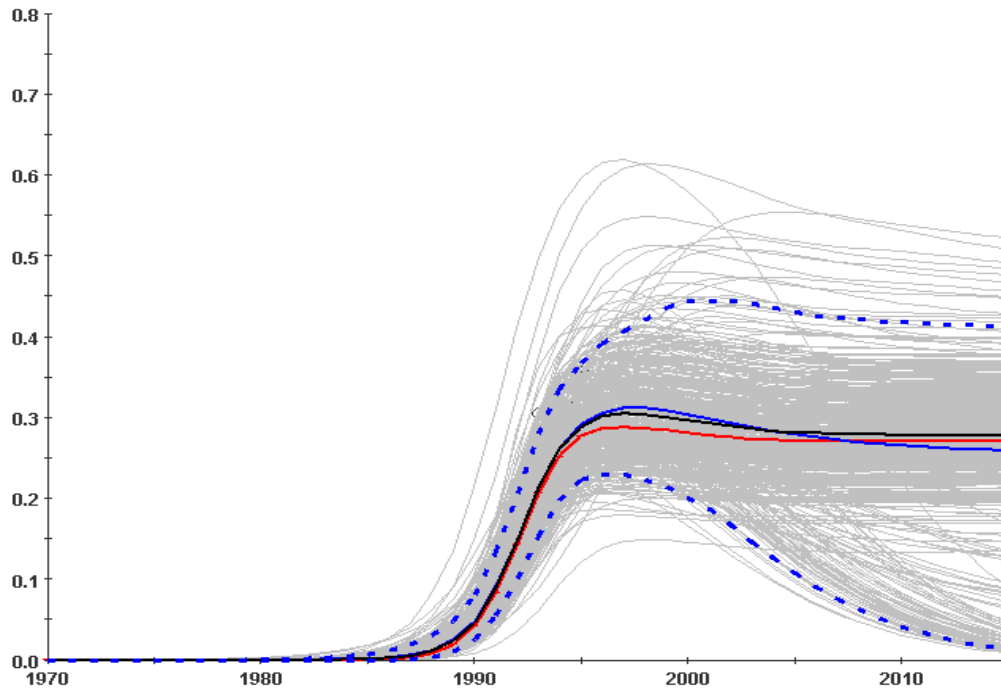
In other countries the data does not constrain possible curves much at all



Uncertainty
 about the
 future is huge

Senegal urban through 2003

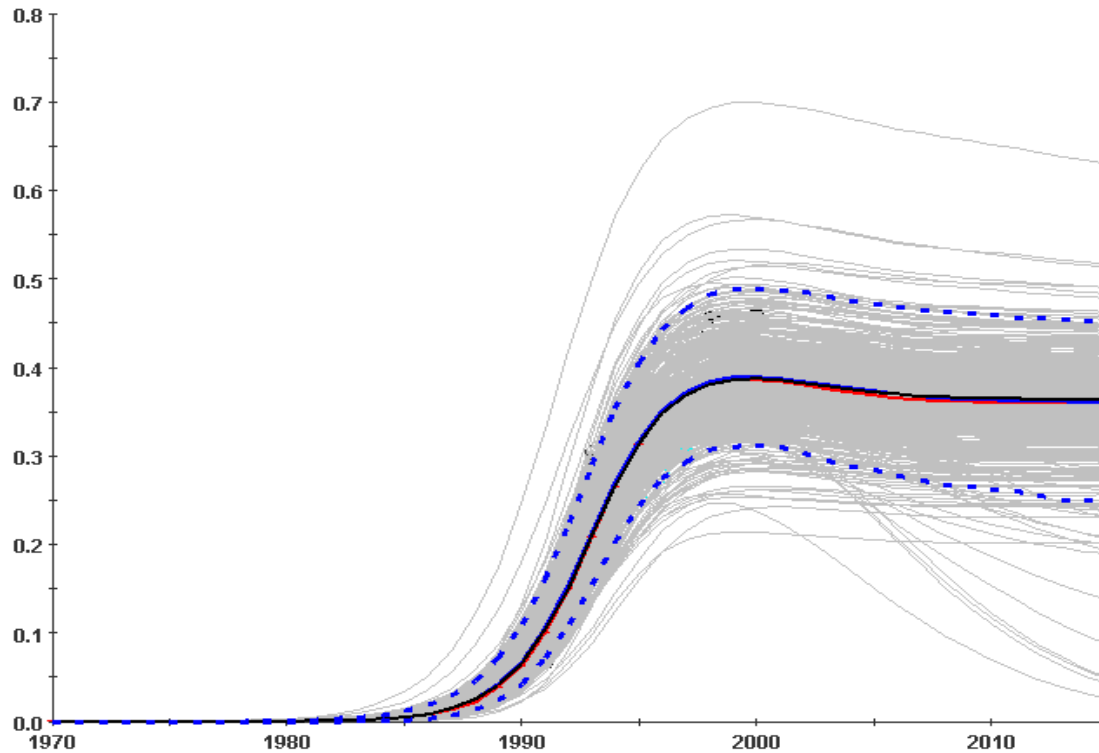
Uncertainty decreases as more data becomes available



Very uncertain

Botswana urban using only data through 1995 – data still rising

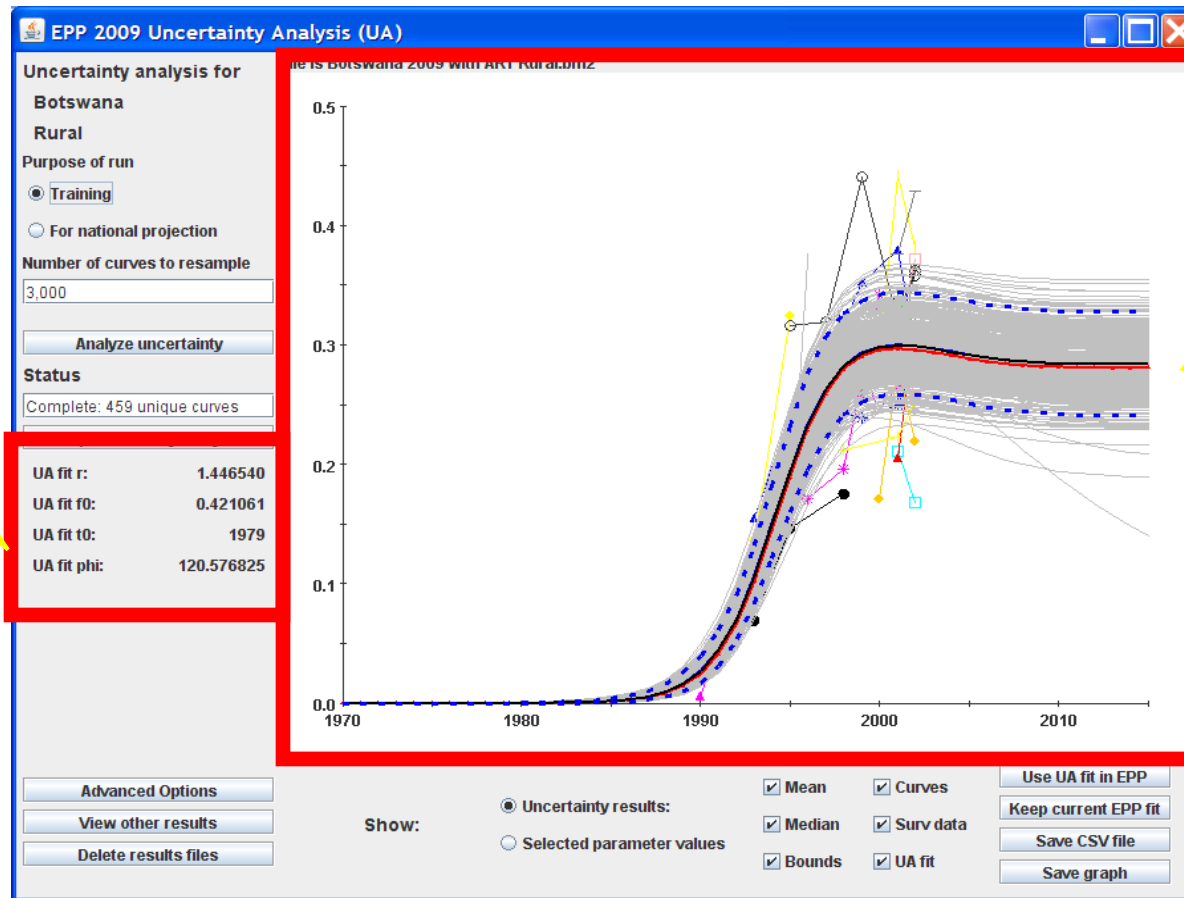
Uncertainty decreases as more data becomes available



Uncertainty is getting smaller

Botswana urban using only data through 2000 – points starting to level off

Uncertainty can be seen in fitting results display



Parameters of best fitting curve found in sample

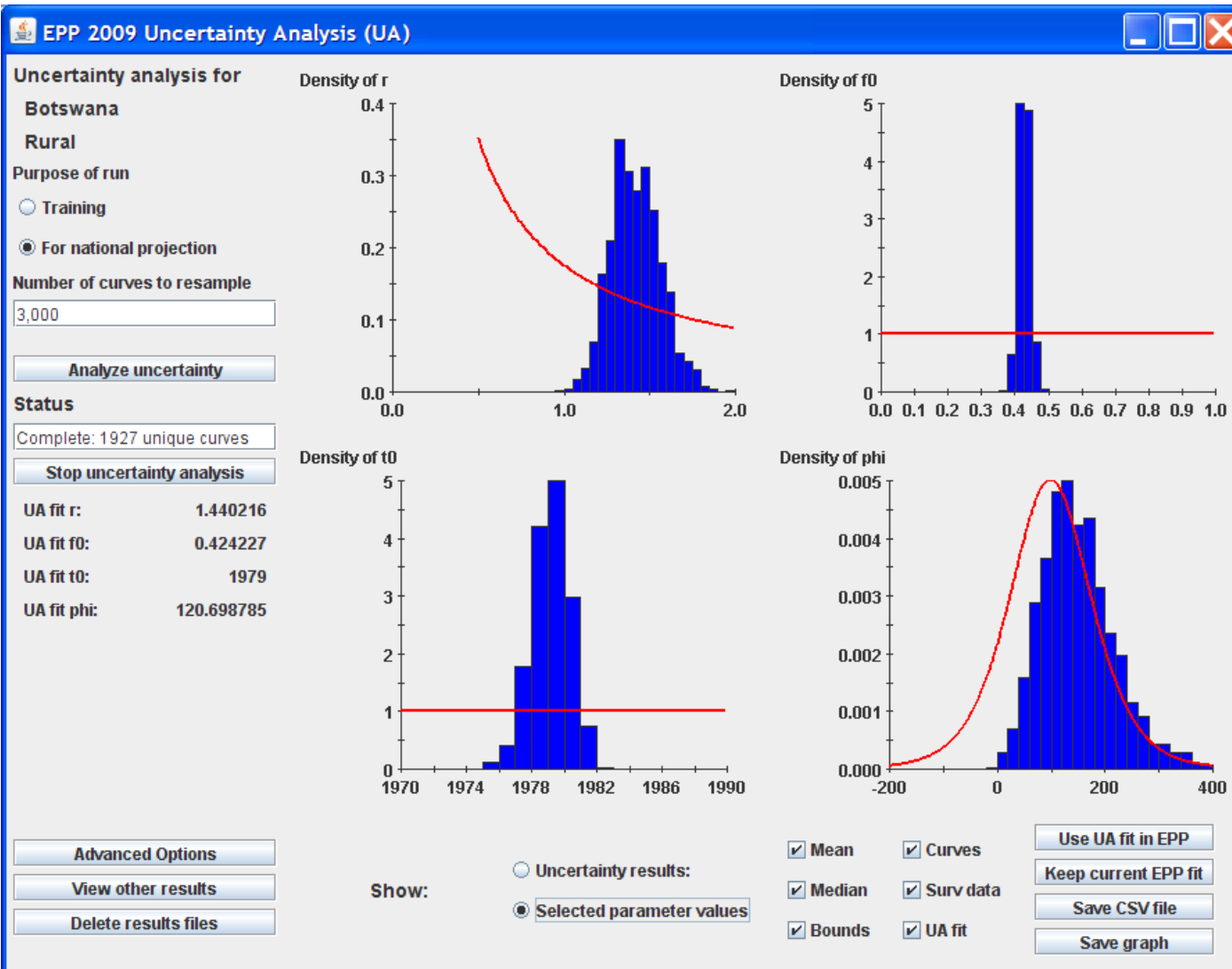
Graph with:
 Surveillance data
 Unique curves (light gray)
 Bounds (dashed lines)
 Best curve (UA fit - red)
 Mean (blue)
 Median (black)

What do the checkboxes at the bottom refer to?

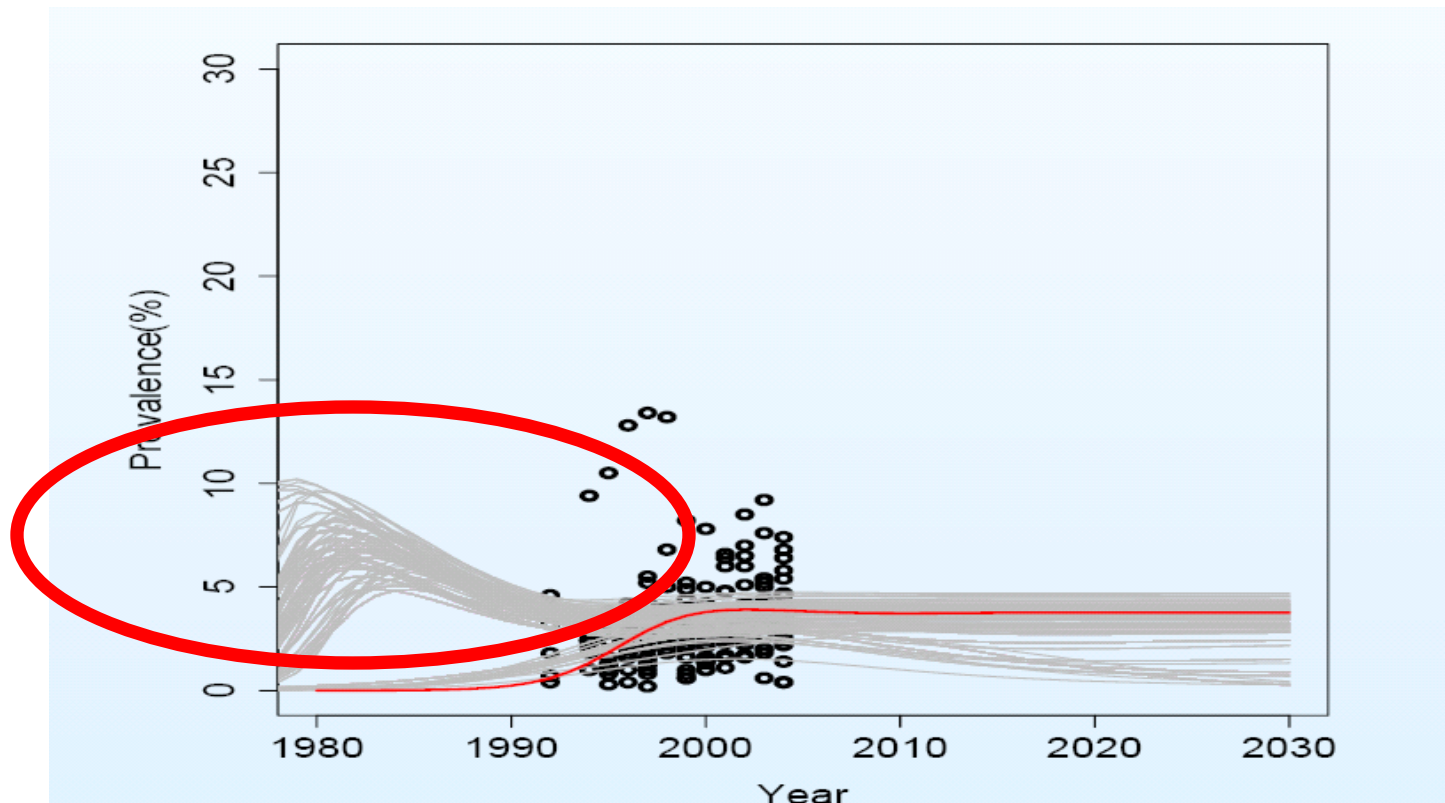
- Surv data – the actual surveillance values
 - Presented by site so you can see site trends
- Curves – the unique resampled curves
- UA fit curve – the most likely among the sampled curves
 - “best fit” for us
- Bounds
 - 95% confidence bounds (95% of curves fall between the dashed lines)
- Mean and median
 - Year by year, the mean & median of all resampled curves

Display of parameters for the chosen curve

“Selected parameter Values”: Shows histogram of the values of the parameters selected among resampled curves



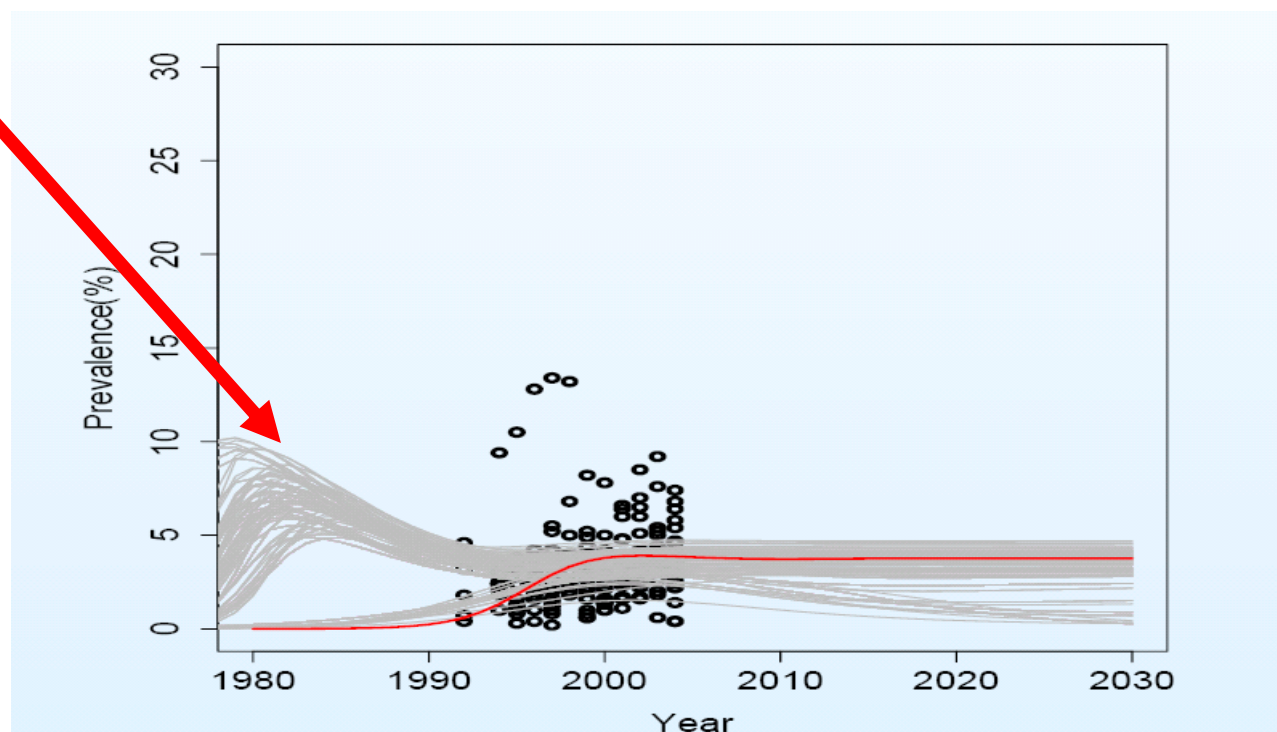
Many curves can fit the same data – some we know are not realistic



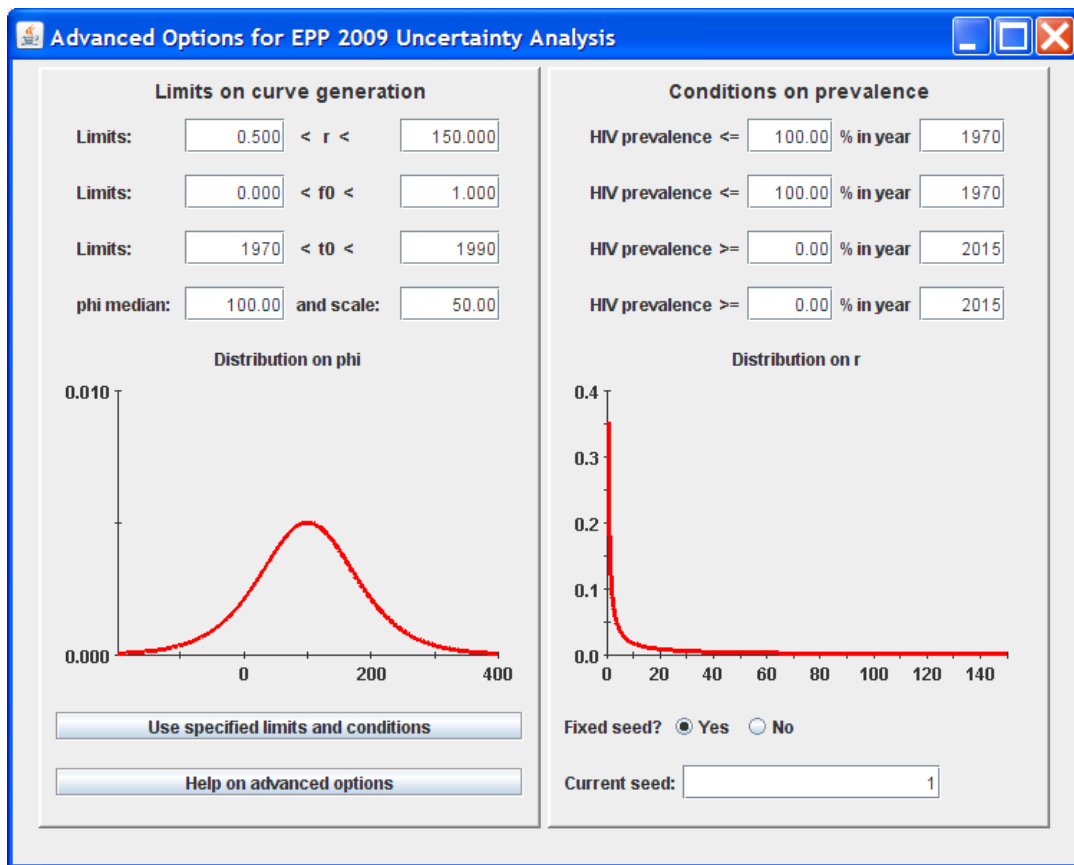
Source: Adrian Raftery

Conditions on prevalence (right hand side)

- Sometimes we get a cluster of curves we know are not feasible
- Condition
 - $Prev < 1\%$ in 1985 will eliminate these
- Apply with caution or you can eliminate valid curves



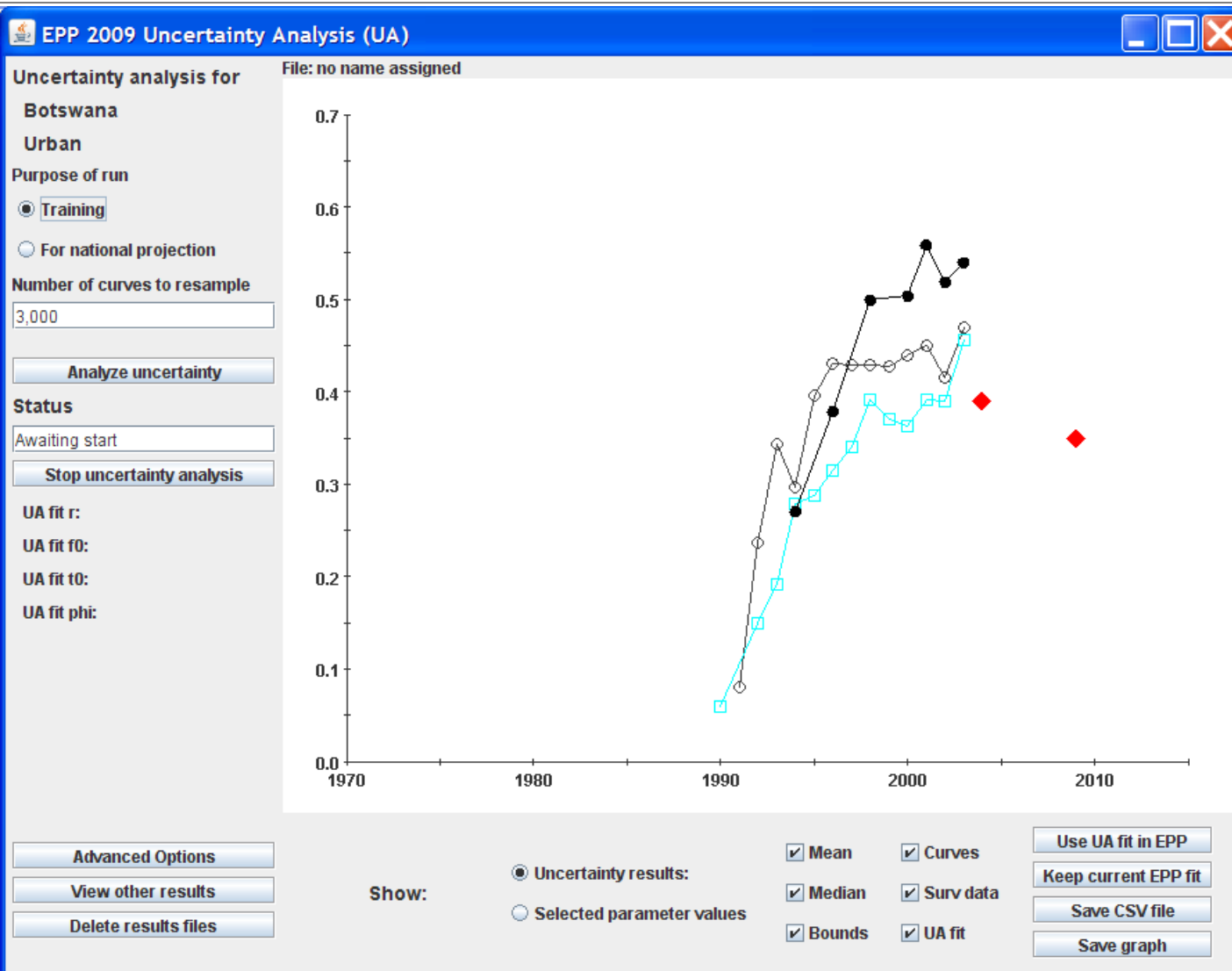
Prior parameter distributions in “Advanced Options”



Prior distributions:
left hand side

What happens if we include surveys?

Surveys show up in red on the graph before fitting

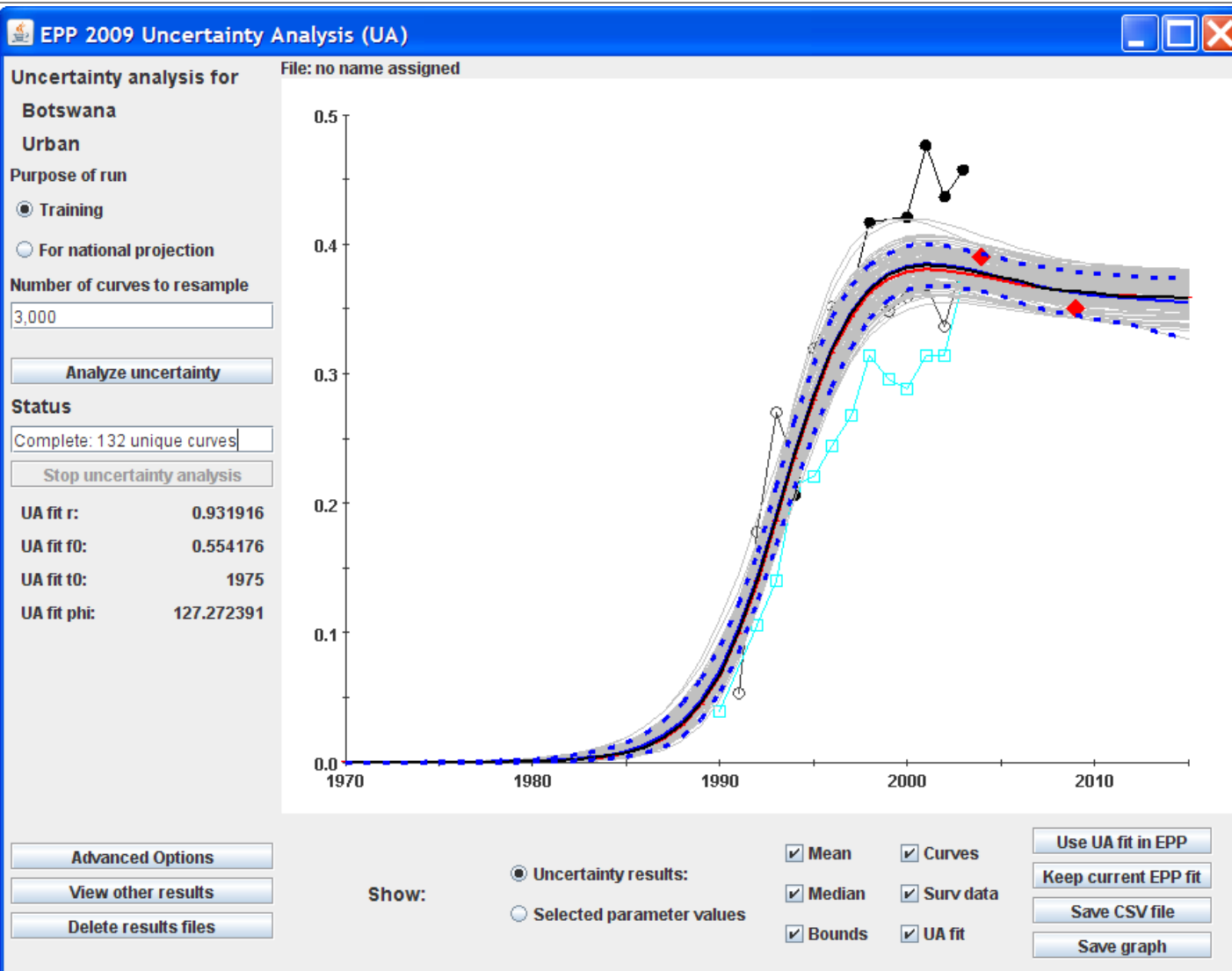


What happens if we include surveys?

After fitting uncertainty bounds are narrower

- Surveys assumed to be better estimates

ANC data is downward scaled



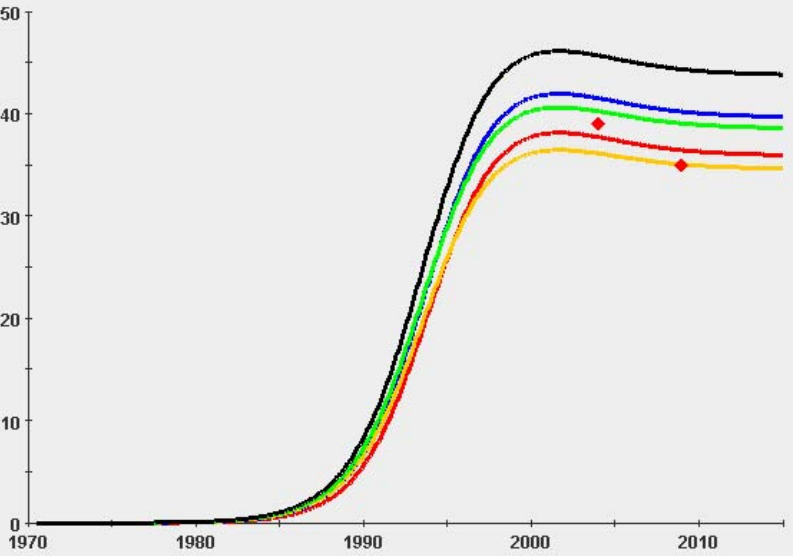
The EPP 2009 Calibration page

EPP 2009 Alpha - Botswana

Worksets Define Epi Define Pops HIV Data ART Data Surveys Project Calibration Pop change Results Prefs

Before displaying national results you may wish to do some final adjustments to your sub-population projections. If you entered survey data for a particular sub-population you may wish to adjust the final curve to match that data. If you don't have surveys you may wish to use the average urban and rural offsets seen in countries with national surveys. If you know the data has a bias upward or downward, you may wish to scale the results to reflect that bias. Choose one of the following options:

- Adjust the results taking into account all surveys
- Adjust the results to global defaults for urban/rural bias in surveillance data
- Adjust the result for this projection to agree with the most recent survey
- Adjust HIV prevalence to a value of % HIV+ in year
- Scale the results up or down by a factor of
- No adjustments needed, use the results as they are



National Epidemic Structure

- Botswana 2009 with survey
 - Urban
 - Rural

Save and continue
Help Comment
Save a copy

6 calibration options provided

Display shows the result of each option

One you choose will be used to change the outcomes on the Results page

The EPP 2009 Pop change page

EPP 2009 Alpha - Botswana - Review Mode

Worksets Define Epi Define Pops HIV Data ART Data Surveys Project Calibration Pop change Results Prefs

The percentage of the national population living in urban areas may change. Because urban and rural HIV prevalence is often very different, such population shifts can affect your national prevalence results. The top of the table below shows the United Nations Population Division trends for the percentage of urban population and the current overall percentage of urban population from your projections. Most people will not need to change these values. However, should you wish to adjust the percentage of urban and rural population, you can do so by changing the values in the lower part of the table. In all cases, you should reduce the unassigned population percentage in each year to zero. If you wish to match the UN urban percentages, click "Adjust to UN values" at the bottom of the page. When done, click on "Save and continue" to review your final national prevalence results.

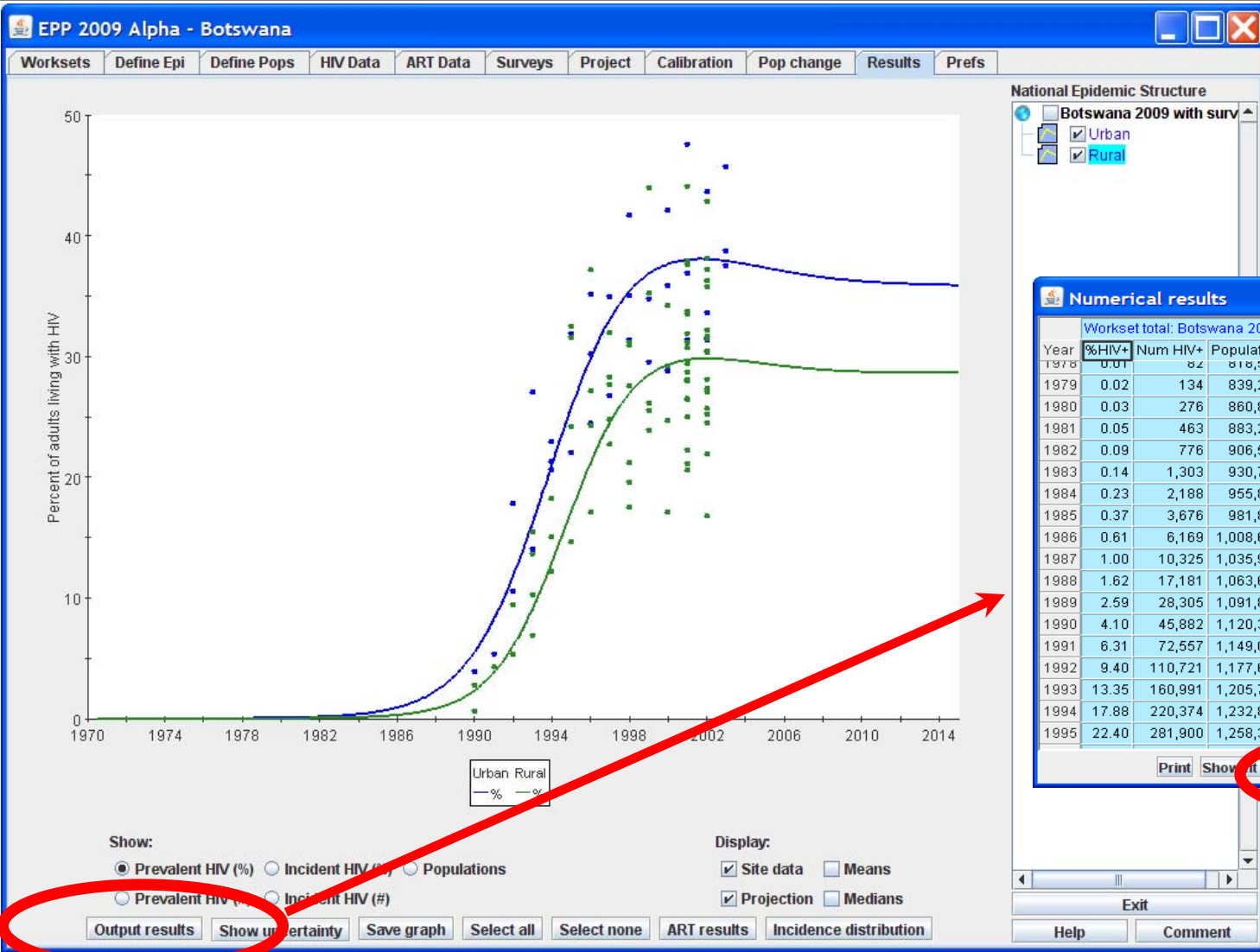
Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
National urban population										
UN Pop Division % urban	15.0	15.8	16.7	17.5	18.3	19.2	20.0	20.8	21.7	22.5
Current workset % urban	16.0	16.9	17.8	18.7	19.6	20.5	21.4	22.3	23.2	24.0
Percentage of national population in each sub-population										
Still to be assigned among sub-populations (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urban	16.0	16.9	17.8	18.7	19.6	20.5	21.4	22.3	23.2	24.0
Rural	84.0	83.1	82.2	81.3	80.4	79.5	78.6	77.7	76.8	76.0

Adjust to UN values Help Comment Save a copy Save and continue

Top row – UN Pop
% urban
2nd row – your
workset's % urban

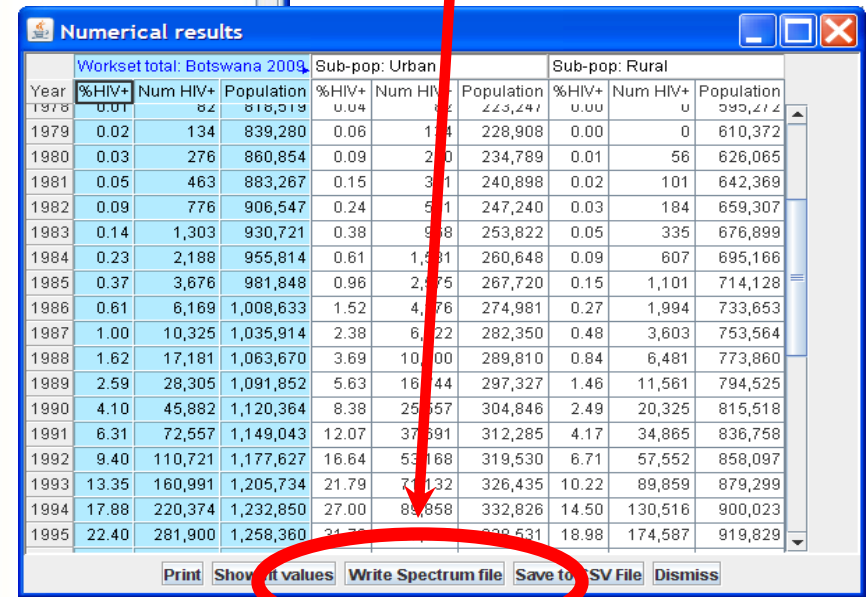
Bottom –
distribution of
population among
your sub-pops

Results page – putting your projections together



“Output results”

- show outcomes
- create Spectrum file “*.spt”



Numerical results

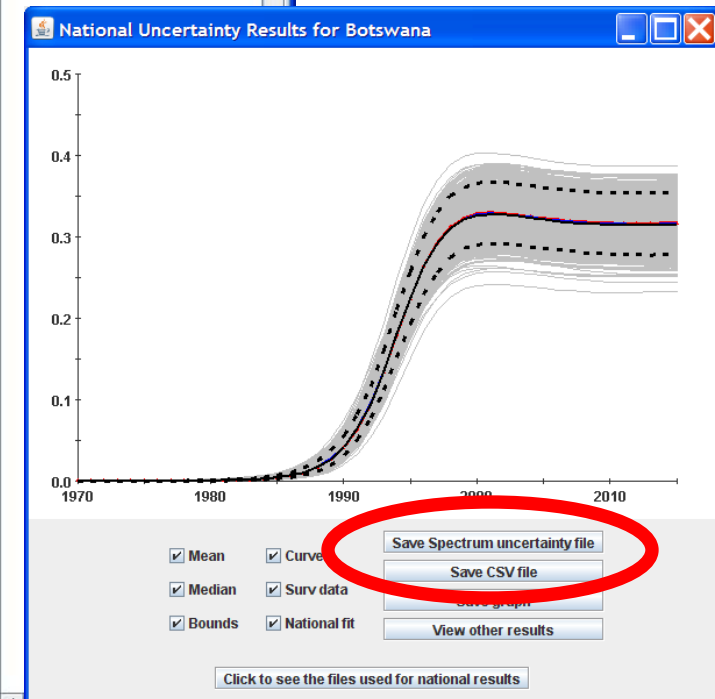
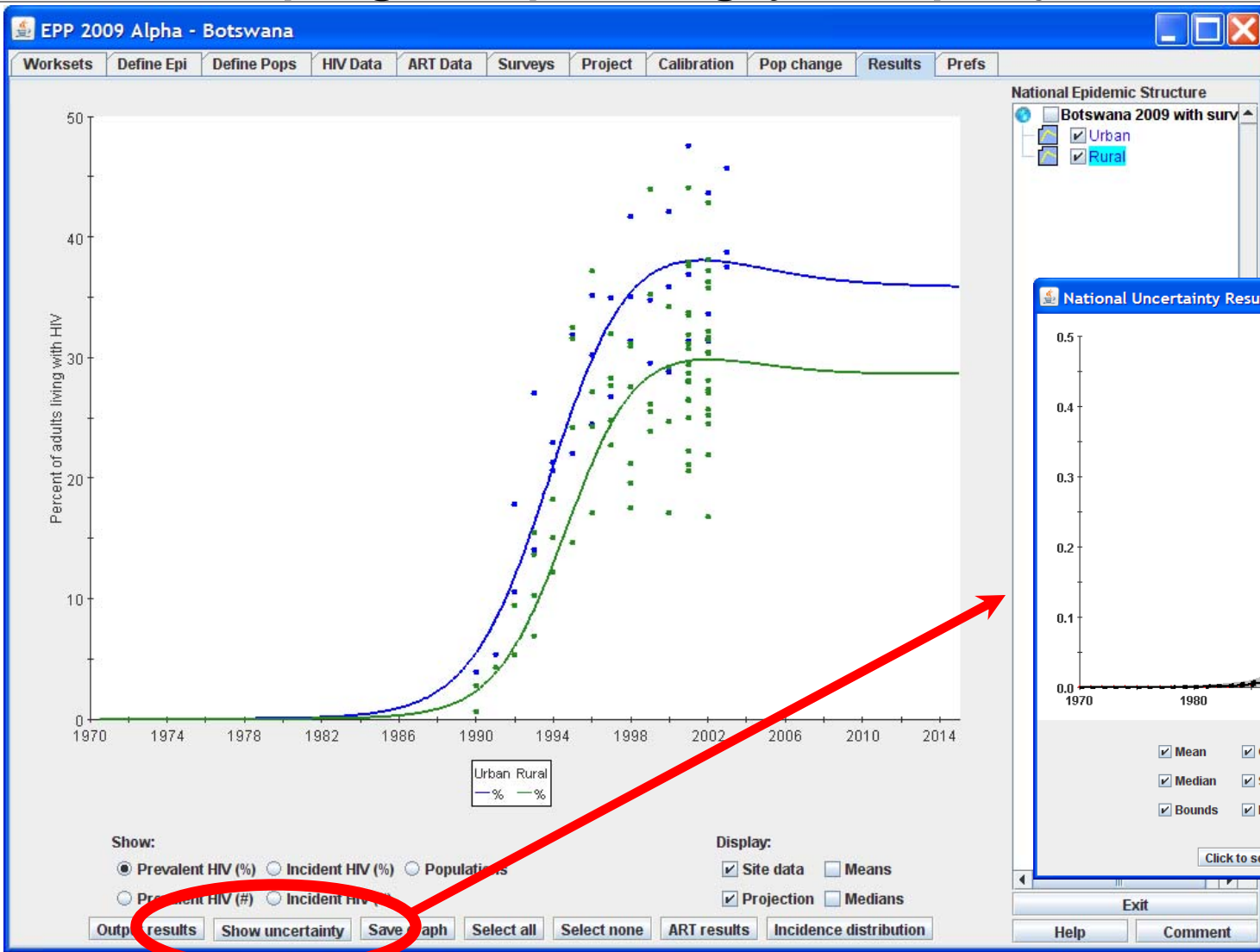
Workset total: Botswana 2009, Sub-pop: Urban, Sub-pop: Rural

Year	%HIV+	Num HIV+	Population	%HIV+	Num HIV+	Population	%HIV+	Num HIV+	Population
1979	0.02	134	839,280	0.06	174	228,908	0.00	0	610,372
1980	0.03	276	860,854	0.09	270	234,789	0.01	56	626,065
1981	0.05	463	883,267	0.15	371	240,898	0.02	101	642,369
1982	0.09	776	906,547	0.24	571	247,240	0.03	184	659,307
1983	0.14	1,303	930,721	0.38	978	253,822	0.05	335	676,899
1984	0.23	2,188	955,814	0.61	1,581	260,648	0.09	607	695,166
1985	0.37	3,676	981,848	0.96	2,775	267,720	0.15	1,101	714,128
1986	0.61	6,169	1,008,633	1.52	4,776	274,981	0.27	1,994	733,653
1987	1.00	10,325	1,035,914	2.38	6,222	282,350	0.48	3,603	753,564
1988	1.62	17,181	1,063,670	3.69	10,000	289,810	0.84	6,481	773,860
1989	2.59	28,305	1,091,852	5.63	16,744	297,327	1.46	11,561	794,525
1990	4.10	45,882	1,120,364	8.38	25,657	304,846	2.49	20,325	815,518
1991	6.31	72,557	1,149,043	12.07	37,691	312,285	4.17	34,865	836,758
1992	9.40	110,721	1,177,627	16.64	53,168	319,530	6.71	57,552	858,097
1993	13.35	160,991	1,205,734	21.79	70,132	326,435	10.22	89,859	879,299
1994	17.88	220,374	1,232,850	27.00	89,858	332,826	14.50	130,516	900,023
1995	22.40	281,900	1,258,360	31.33	109,531	339,531	18.98	174,587	919,829

Print Show values Write Spectrum file Save to CSV File Dismiss

Results page – putting your projections together

“Show uncertainty”
 - Gives national uncertainty from combining projections

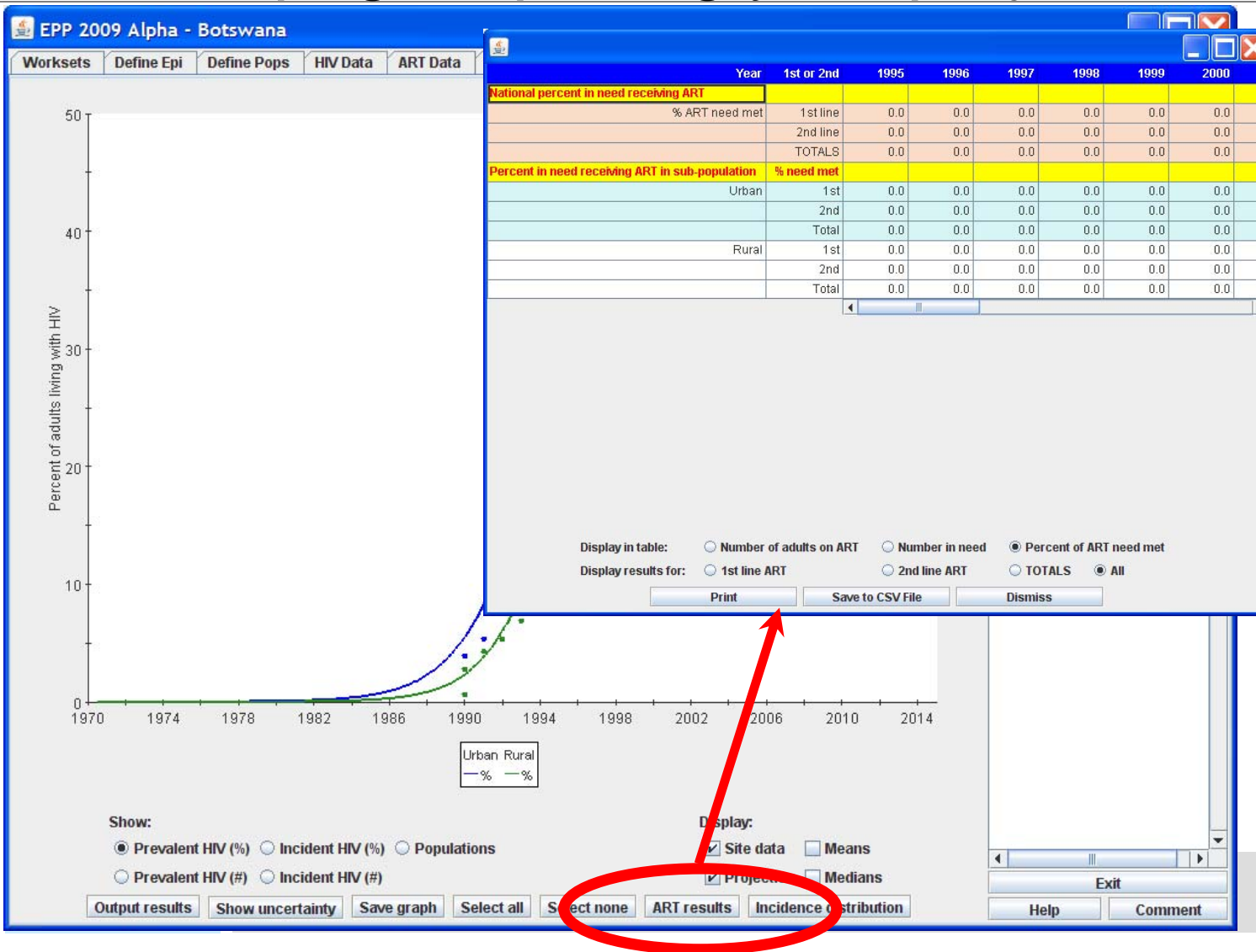


Saving an uncertainty file for Spectrum

- Click “Save Spectrum uncertainty file”
- A file with the extension *.spu will be saved, which can be read by Spectrum

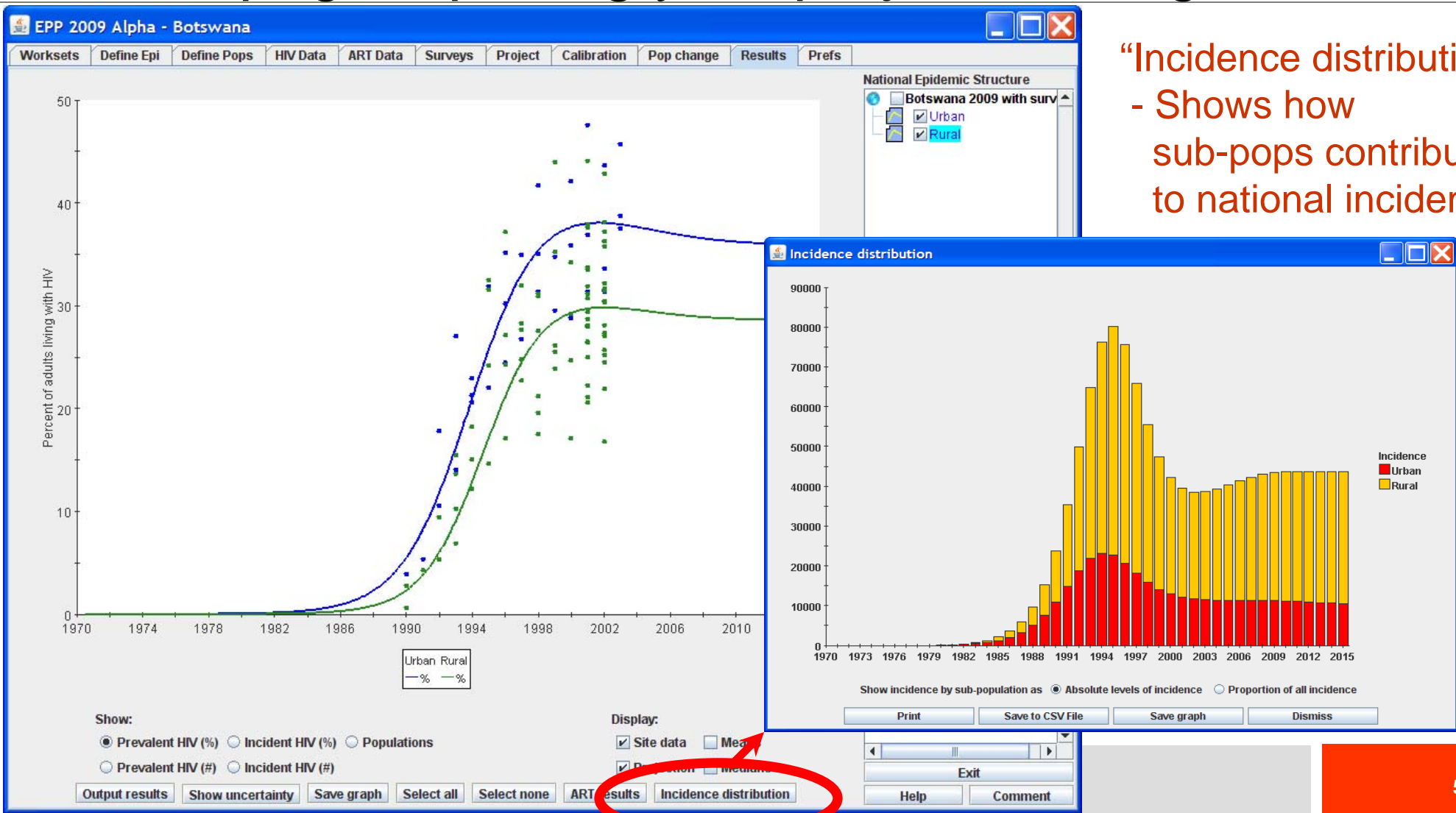
Results page – putting your projections together

“ART results”
 - Summarizes ART findings for National projection
 - Check whether ART coverage for future projection is reasonable. If not, go back to ART data and change inputs.



Results page – putting your projections together

“Incidence distribution”
 - Shows how sub-pops contribute to national incidence



So to review, to fit a generalized epidemic

- Fill in everything until you get to Projection Page as in the past (and documented in the EPP 2007 manual)
- Press “Assess uncertainty” button on Projection page
- Press “Analyze uncertainty” button & wait for it to finish
- Press the “Use UA fit in EPP”
- On the Projection Page, hit “Save and Continue”
 - This is important – DON’T FORGET IT!!! (you’ll lose results)
- Move on to fitting the next sub-population

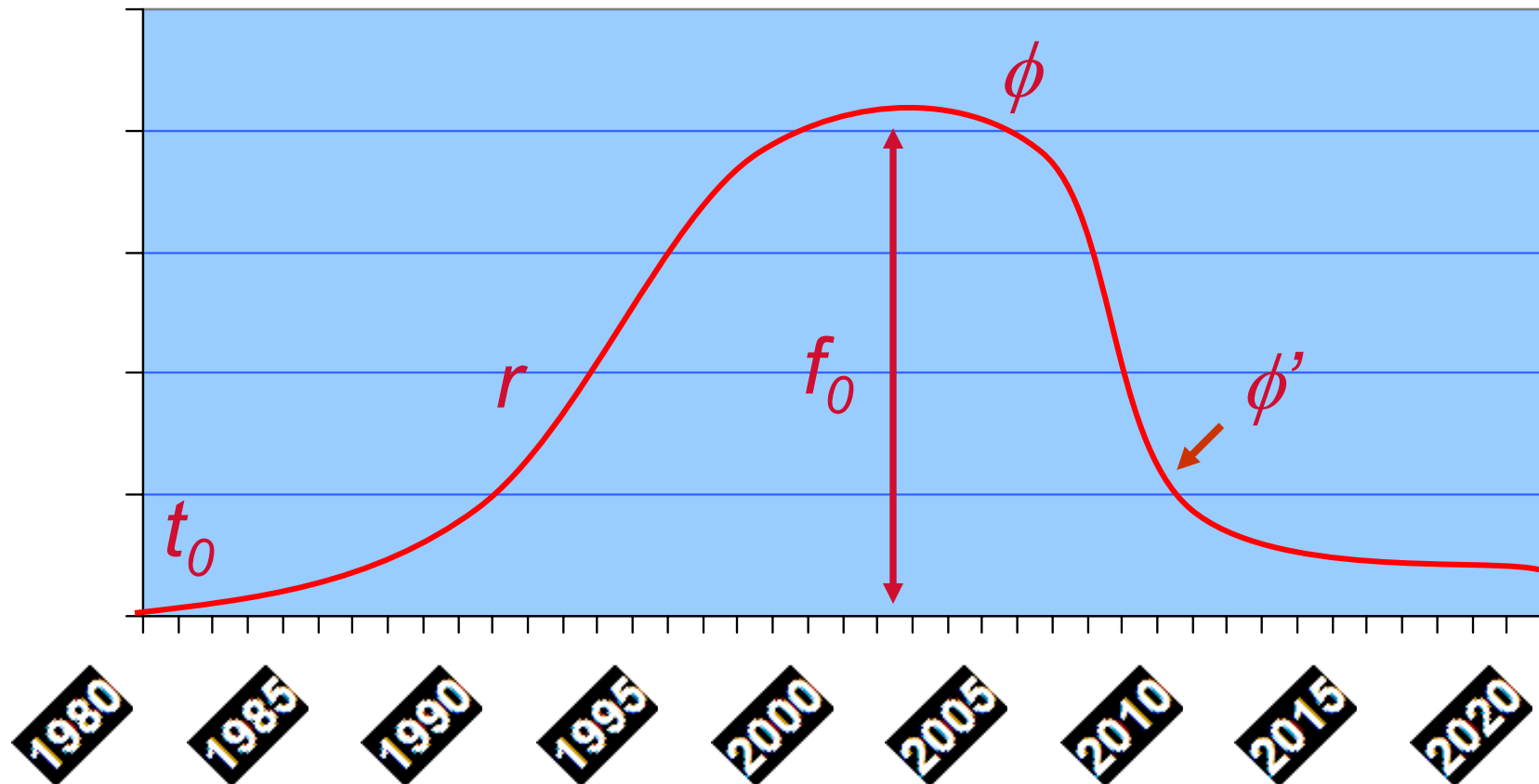
Warning

- Do not use older EPP files from EPP 2007
 - Many things have changed in EPP 2009
 - Files will run, but may give wrong results

ϕ – shift

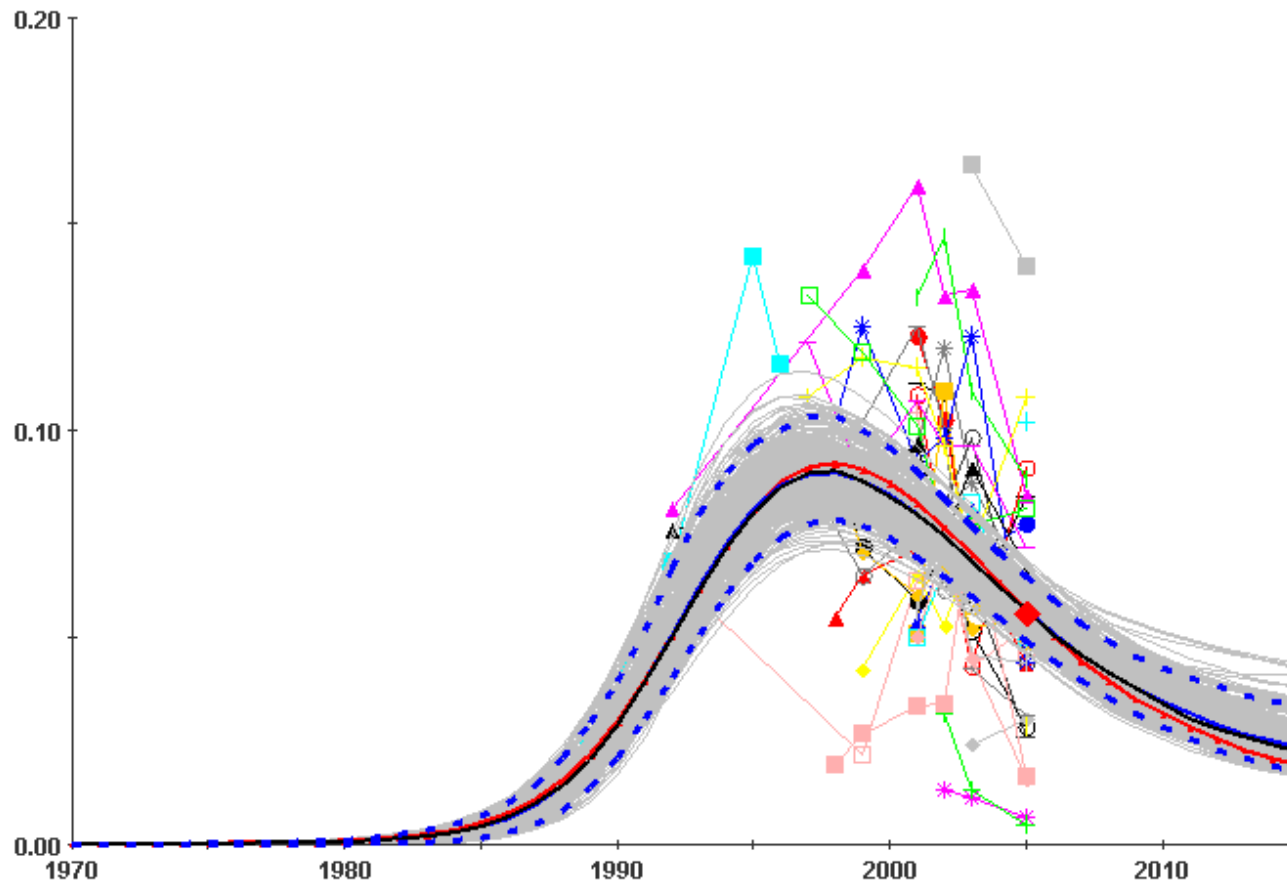
- Advanced users – under development
- Deals with following situations:
 - ANC prevalence declines so steep that the prevalence trend implies implausibly low incidence
 - Prevalence decline followed by stabilisation or increase of prevalence
- Use advanced options to set prior distributions of additional parameters

Modified Reference Group model



ϕ shift - example

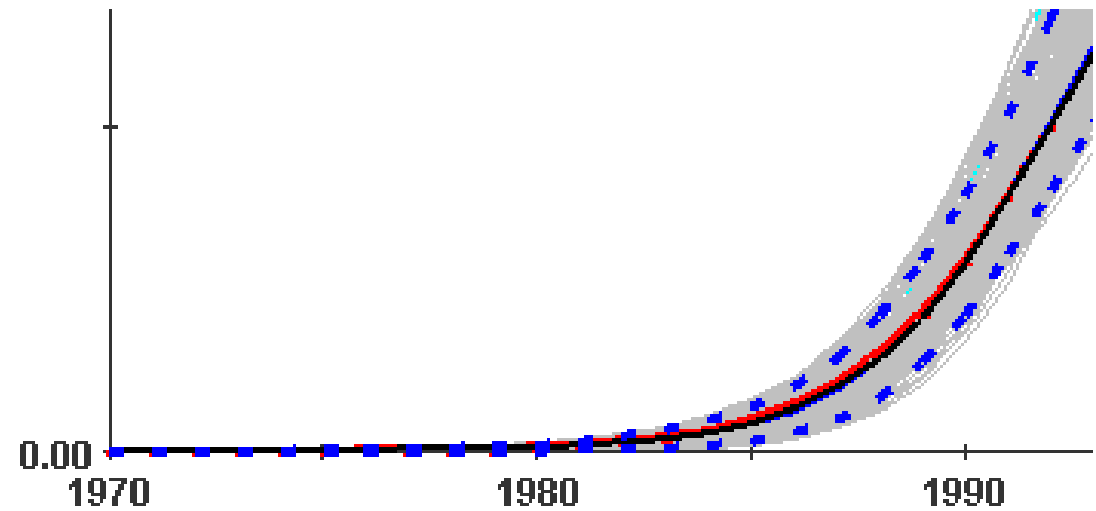
Limits for run: 0.5<r<150.0 | 0.0<t0<1.0 | 1970<t0<1990 | phi: (100, 50) | phi': (0, 2) | t phi'> 2000 | -5<phi'<5 | inc > 0.00%



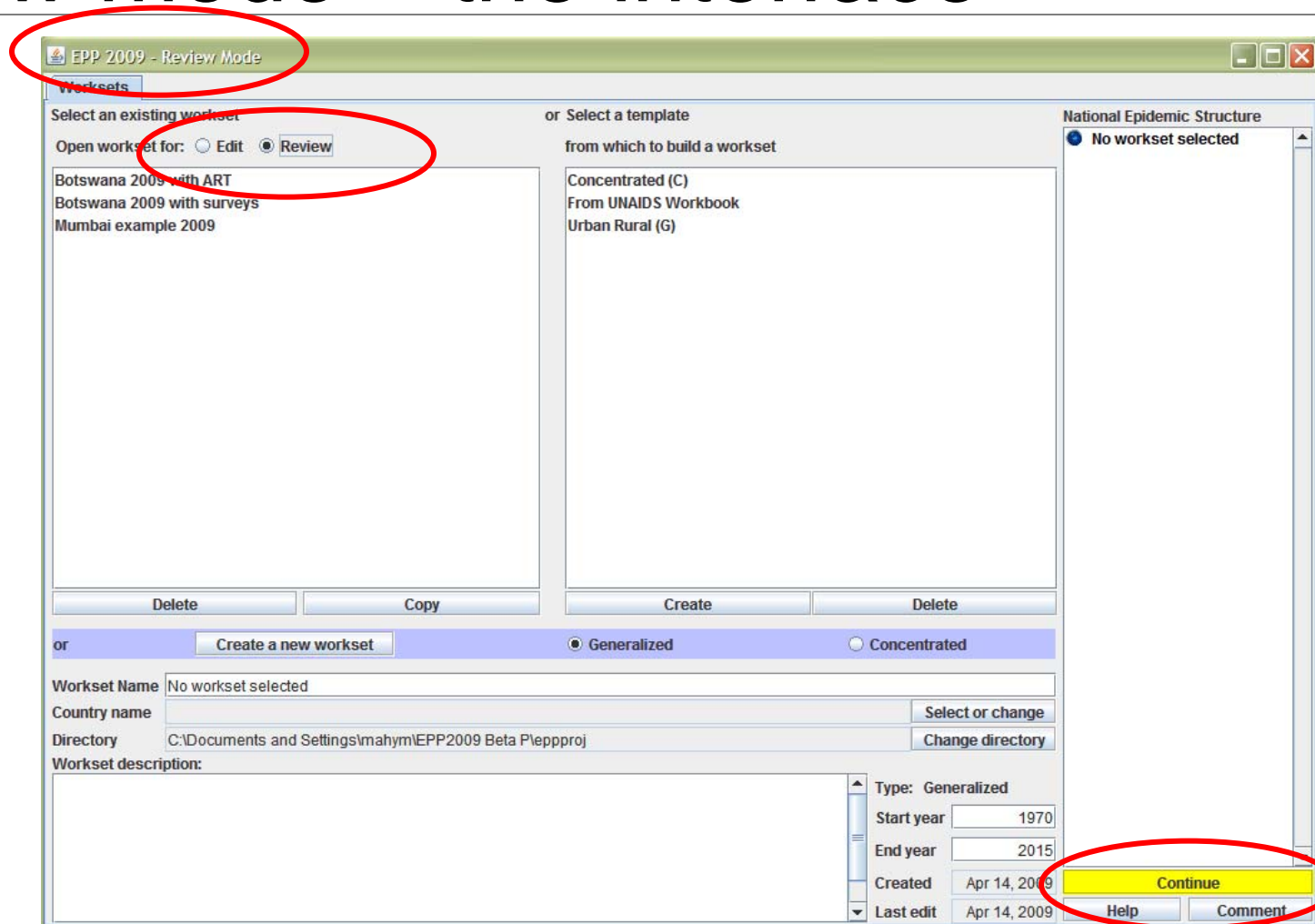
Incidence in final year

ϕ shift – example parameters

UA fit r:	1.926920
UA fit f0:	0.230830
UA fit t0:	1971
UA fit phi:	-20.214259
UA fit phi':	-0.031191
UA phi' start:	2002
UA phi' end:	2015



Review mode – the interface



Example of complete run-through of the process for a country with calibration

Demonstration and The End