VSP 7.0: Remedial Investigations (RI) of UXO Prone Sites & Visual Sample Plan

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ESTCP

VSP 7
Visual Sample Plan

Outline

I. VSP 7.0 Updates
II. UXO Guide
III. Remedial Investigation (RI) Focus
   - TOI Rate Estimation
   - Impact Area Discovery Updates (Formerly called Find Target Areas)
IV. Grids vs. Transects
V. Upcoming Classes
VI. Things not to say as a VSP Expert
VII. Conclusions & Conversations

Motivation: New VSP RI Tools & Structure

Remedial Investigations (RI) projects need more consistently applied sampling designs and tools

- Some inappropriate applications of non-RI VSP modules
- UXO Estimator and VSP were often awkwardly cobbled together (neither tool completely met needs)

Solution:

1. ESTCP established a VSP-RI advisory group
2. RI survey and data evaluation objectives were defined
3. Developed new VSP Modules for RI survey design and analysis to clearly address RI objectives

VSP 7.0

- Released March 2014
- New VSP-RI Additions Include
  - VSP UXO Expert Guide
  - VSP-RI Sampling Goal Menu Item
    - 3 primary survey design and analysis objectives
  - HTML-based Help Files (also available on vsp.pnnl.gov/help)
  - UXO-Estimator Replacement
- Other new Features added
  - Map tile servers connections
  - Improved graph views

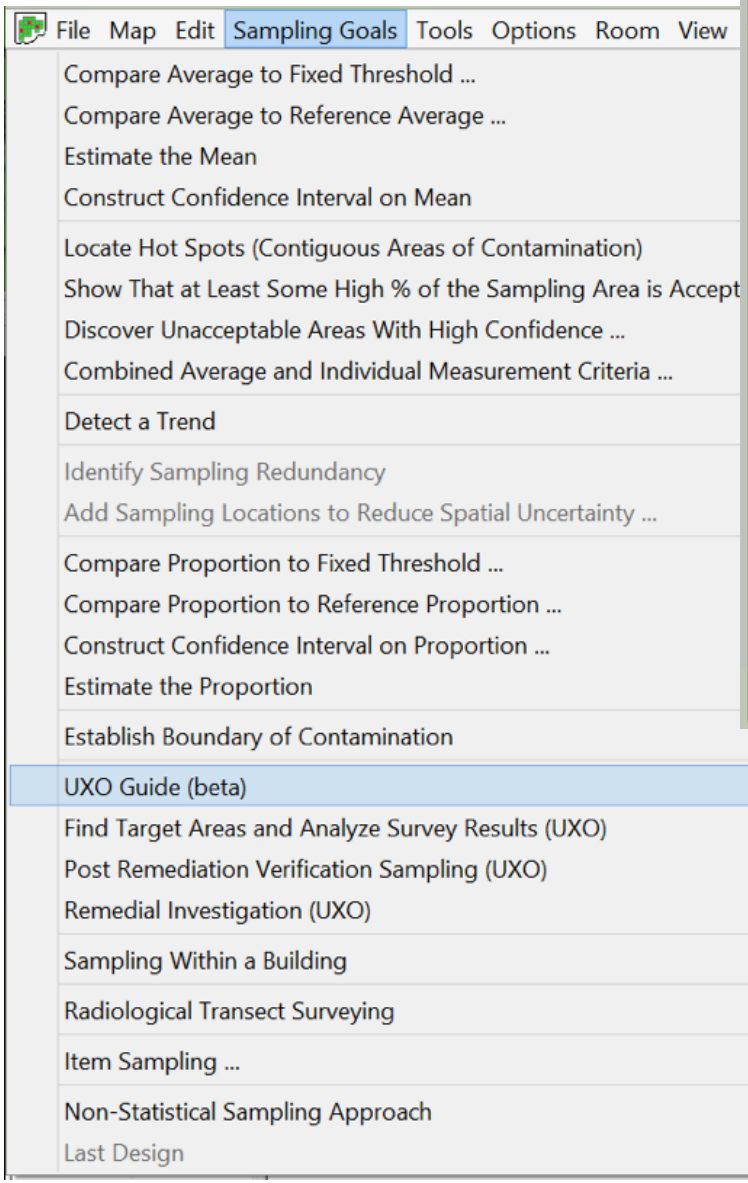
VSP Users (Since 5.0 as of 4/3/14)		
USA	**Sites**	**# Users**
	EPA	1768
	DOE	1044
	States	1059
	Army	1511
	Navy	740
	Air Force	330
	Other DoD	106
	NRC	203
	Other	495
Total USA		**7256**
International	UK	529
	Canada	362
	Australia/NZ	217
	Brazil	133
	Spain	91
	Other/Unknown	1415
Total International		**2747**
Total Recent Unique Users		**10003**

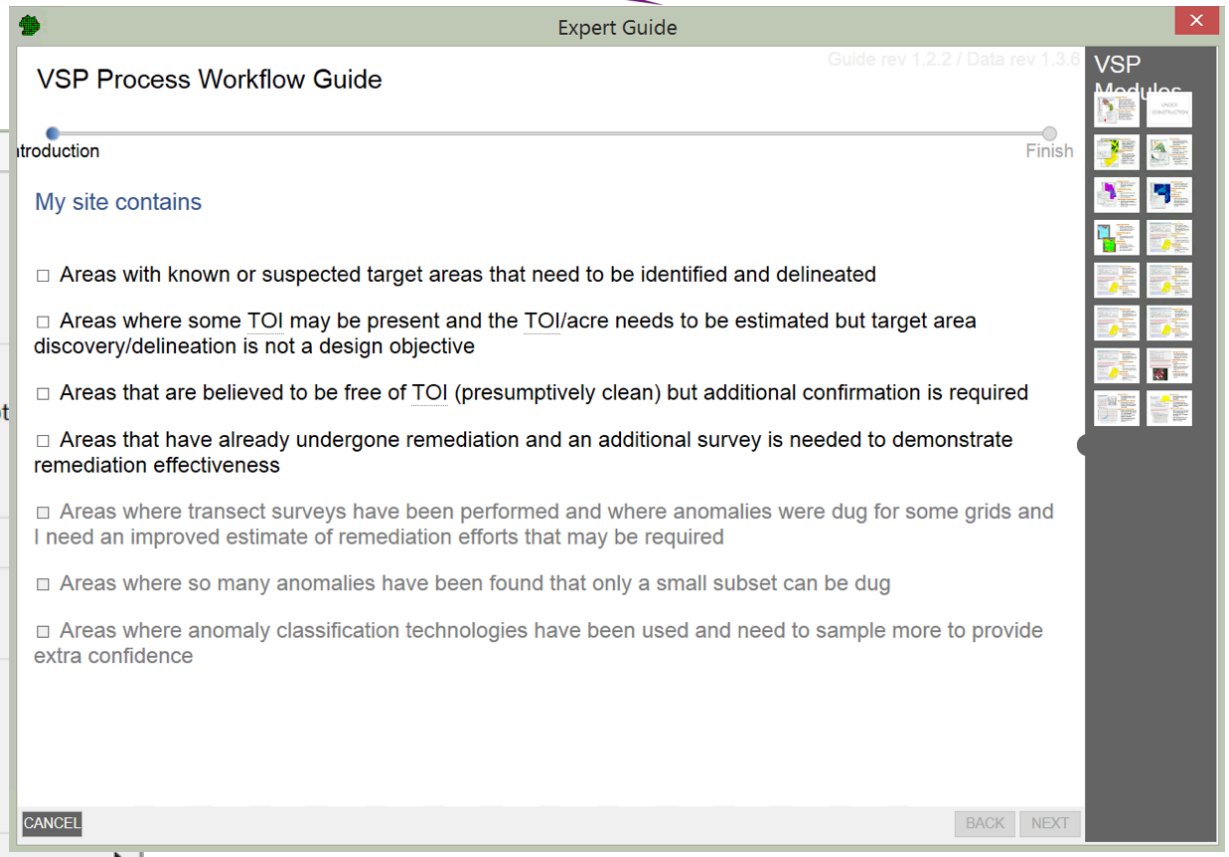
VSP Workflow Guidance in Expert Mentor

Objective: Provide guidance to VSP users on which UXO related module to protect against misuse (>15 module options).

1. Developed decision objective flowchart that leads user to the appropriate VSP module
2. Created descriptive summaries for each VSP module
3. Incorporated work into the VSP-UXO Guide
4. Rolled out in VSP 7.0

Expert Guide (UXO)





Using the expert guide

Expert Guide

VSP Process Workflow Guide

Guide rev 1.2.2 / Data rev 1.3.6

ntroduction | Confidently Estimate TOI | Munitions-Free Areas | Delineate Areas | Finish

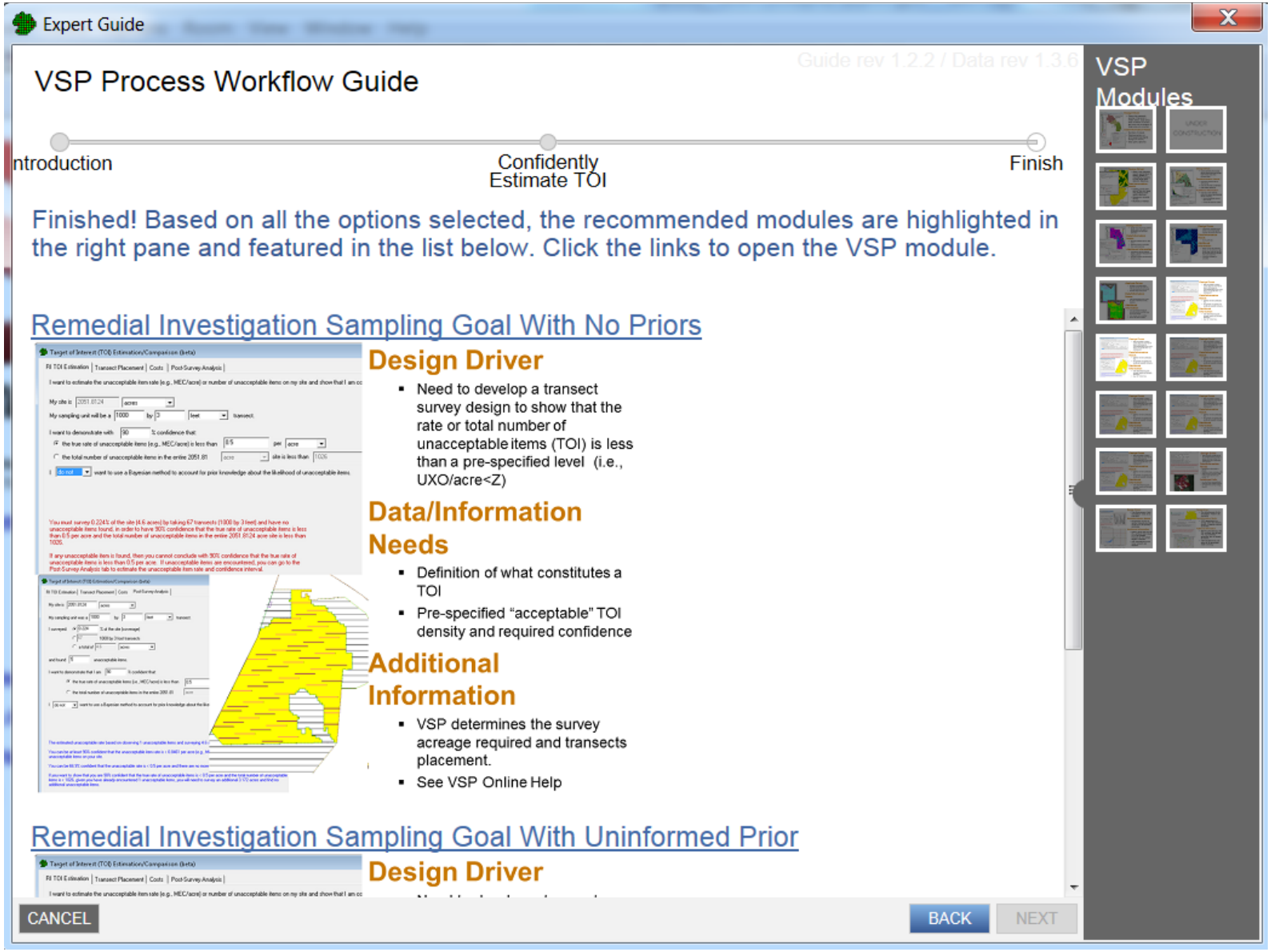
My site contains

- [x] Areas with known or suspected target areas that need to be identified and delineated
- [x] Areas where some TOI may be present and the TOI/acre needs to be estimated but target area discovery/delineation is not a design objective
- [x] Areas that are believed to be free of TOI (presumptively clean) but additional confirmation is required
- [ ] Areas that have already undergone remediation and an additional survey is needed to demonstrate remediation effectiveness
- [ ] Areas where transect surveys have been performed and where anomalies were dug for some grids and I need an improved estimate of remediation efforts that may be required
- [ ] Areas where so many anomalies have been found that only a small subset can be dug
- [ ] Areas where anomaly classification technologies have been used and need to sample more to provide extra confidence

VSP Modules

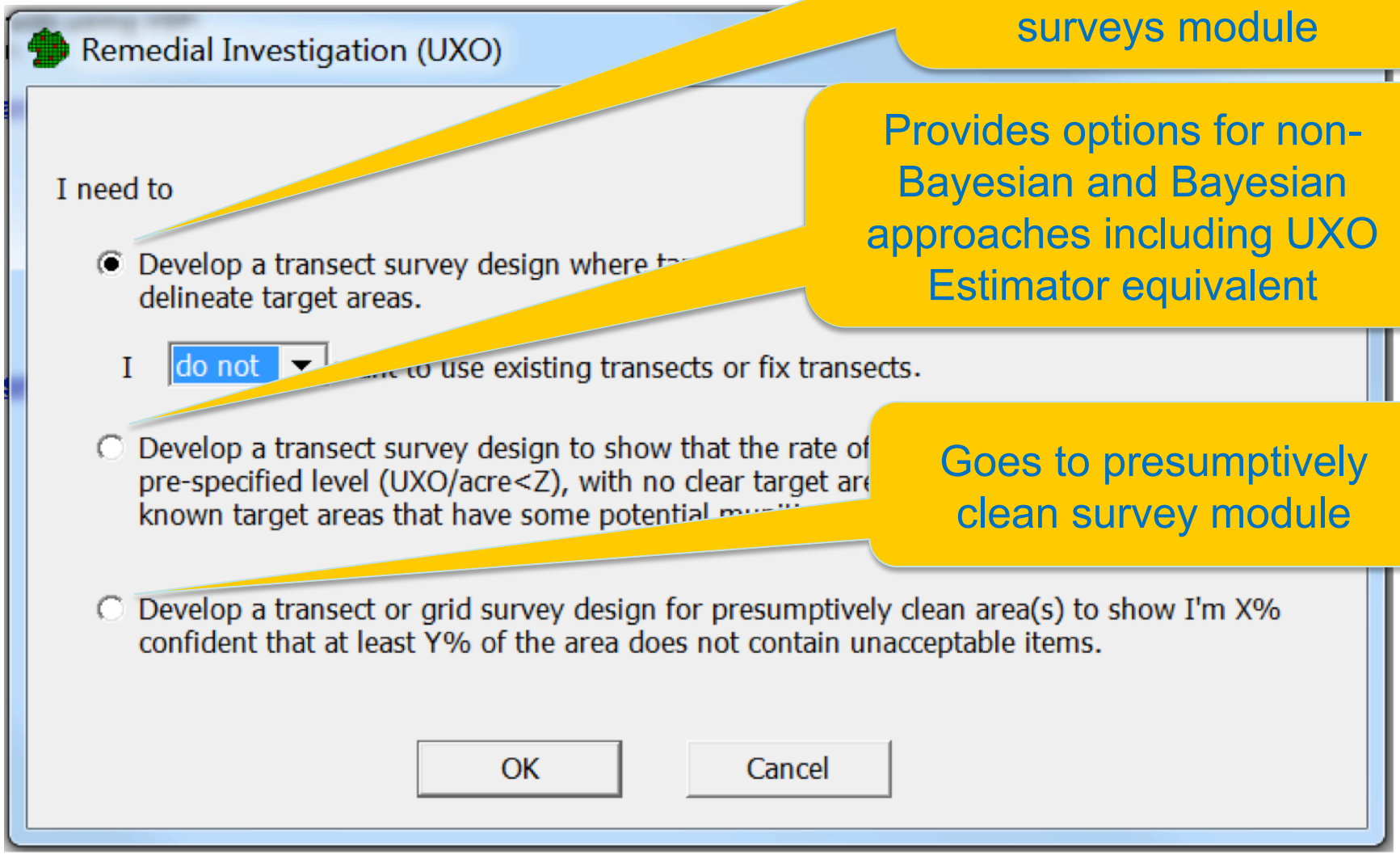
CANCEL | BACK | NEXT

Directs to Correct VSP Module



RI Survey Objectives

- Three primary objectives identified



Takes user to impact area discovery module or to augment existing surveys module

Provides options for non-Bayesian and Bayesian approaches including UXO Estimator equivalent

Goes to presumptively clean survey module

TOI Rate Estimation

I want to estimate the unacceptable item rate (e.g., MEC/acre) or number of unacceptable items on my site and show that I am confident that it is no more than some value.

My site is 300 acres

My sampling unit will be a 1000 by 3 feet transect.

I want to demonstrate with 95 % confidence that:

- (●) the true rate of unacceptable items (e.g., MEC/acre) in the site ranges from 0 to no more than .5 per acre
- ( ) the true number of unacceptable items in the entire site ranges from 0 to no more than 150

I do not want to use a Bayesian method to account for prior knowledge about the likelihood of unacceptable items.

Design	Survey Acreage
Non Bayesian	5.93 (87 transects)

You must survey 1.98% of the site (5.9322 acres) by taking approximately 87 transects (1000 by 3 feet) and have no unacceptable items found. If no unacceptable items are found, your best estimate of the true rate of unacceptable items is 0 per acre and you can be 95% confident that the true unacceptable item rate is no larger than 0.5 per acre and there are no more than 150 unacceptable items on the entire 300 acre site.

If any unacceptable item is found, then you cannot conclude with 95% confidence that the true rate of unacceptable items is no larger than 0.5 per acre. If unacceptable items are encountered, you can go to the Post-Survey Analysis tab to estimate the unacceptable item rate and confidence interval.

If I want to have no more than a 20 % chance of concluding that the true rate of unacceptable items (i.e., MEC/acre) is greater than 0.5 per acre, then the true rate of unacceptable items must be equal to or less than 0.04 per acre.

TOI Rate Estimation

RI TOI Estimation | Transect Placement | Costs | Post-Survey Analysis

I want to estimate the unacceptable item rate (e.g., MEC/acre) or number of unacceptable items on my site and show that I am confident that it is no more t

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I want to demonstrate with 95 % confidence that:

- (•) the true rate of unacceptable items (e.g., MEC/acre) in the site ranges from 0 to no more than .5 per acre
- ( ) the true number of unacceptable items in the entire site ranges from 0 to no more than 150

I do want to use a Bayesian method to account for prior knowledge about the likelihood of unacceptable items.

I want to use an uninformed prior. (An uninformed prior is equivalent to UXO Estimator).

You must survey 1.96% of the site (5.8931 acres) by taking approximately 86 transects (1000 by 3
have no unacceptable items found. If no unacceptable items are found, your best estimate of the
of unacceptable items is 0 per acre and you can be 95% confident that the true unacceptable ite
no larger than 0.5 per acre and there are no more than 150 unacceptable items on the entire 300
assuming your prior information is correct.

If any unacceptable item is found, then you cannot conclude with 95% confidence that the true rate of unacceptable items is no larger than .5 per acre. If unacceptable items are encountered, you can go to the Post-Survey Analysis tab to estimate the unacceptable item rate and confidence interval.

Design	Survey Acreage
Non Bayesian	5.93 (87 transects)
Uninformed Bayesian	5.89 (86 transects) (UXO Estimator)

RI TOI Estimation | Transect Placement | Costs | Post-Survey Analysis

I want to estimate the unacceptable item rate (e.g., MEC/acre) or number of unacceptable items on my site and show that I am confident that it is no more than some value.

TOI Rate Estimation

My site is 300 acres

My sampling unit will be a 1000 by 3 feet transect.

I want to demonstrate with 95 % confidence that:

- (•) the true rate of unacceptable items (e.g., MEC/acre) in the site ranges from 0 to no more than .5 per acre
- ( ) the true number of unacceptable items in the entire site ranges from 0 to no more than 150

I do want to use a Bayesian method to account for prior knowledge about the likelihood of unacceptable items.

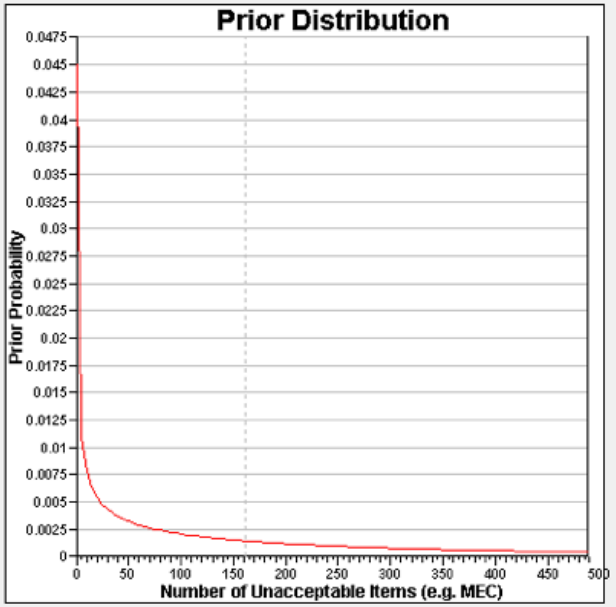
I want to use an informed prior. (An uninformed prior is equivalent to UXO Estimator).

I am quite sure (with probability > 0.75) that the maximum number of unacceptable items on this site is no more than 325

There is a greater chance of having 162 or fewer unacceptable items than there is of having > 162 unacceptable

You must survey 1.07% of the site (3.1958 acres) by taking approximately 47 transects (1000 by 3 feet) and have no unacceptable items found. If no unacceptable items are found, your best estimate of the true rate of unacceptable items is 0 per acre and you can be 95% confident that the true unacceptable item rate is no larger than 0.5 per acre and there are no more than 150 unacceptable items on the entire 300 acre site, assuming your prior information is correct.

If any unacceptable item is found, then you cannot conclude with 95% confidence that the true rate of unacceptable items is no larger than .5 per acre. If unacceptable items are encountered, you can go to the Post-Survey Analysis tab to estimate the unacceptable item rate and confidence interval.



Log Y-Scale

Design	Survey Acreage
Non Bayesian	5.93 (87 transects)
Uninformed Bayesian	5.89 (86 transects)
Informed Bayesian	3.19 (47 transects)

RI TOI Estimation | Transect Placement | Costs | Post-Survey Analysis

I want to estimate the unacceptable item rate (e.g., MEC/acre) or number of unacceptable items on my site and show that I am confident that it is no more than some value.

TOI Rate Estimation

My site is 300 acres

My sampling unit will be a 1000 by 3 feet transect.

I want to demonstrate with 99 % confidence that:

- (•) the true rate of unacceptable items (e.g., MEC/acre) in the site ranges from 0 to no more than .5 per acre
- ( ) the true number of unacceptable items in the entire site ranges from 0 to no more than 150

I do want to use a Bayesian method to account for prior knowledge about the likelihood of unacceptable items.

I want to use an informed prior. (An uninformed prior is equivalent to UXO Estimator).

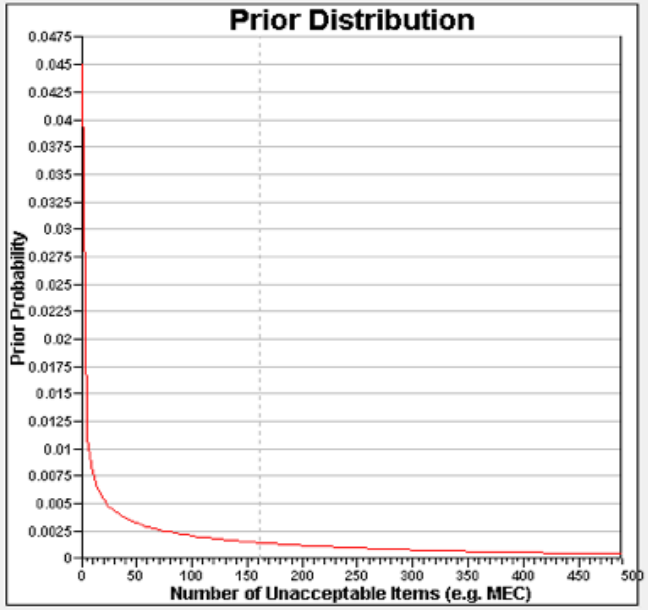
I am quite sure (with probability > 0.75) that the maximum number of unacceptable items on this site is no more than 325

There is a greater chance of having 162 or fewer unacceptable items than there is of having > 162 unacceptable

You must survey 1.98% of the site (5.9331 acres) by taking approximately 87 transects (1000 by 3 feet) and have no unacceptable items found. If no unacceptable items are found, your best estimate of the true rate of unacceptable items is 0 per acre and you can be 99% confident that the true unacceptable item rate is no larger than 0.5 per acre and there are no more than 150 unacceptable items on the entire 300 acre site, assuming your prior information is correct.

If any unacceptable item is found, then you cannot conclude with 99% confidence that the true rate of unacceptable items is no larger than .5 per acre. If unacceptable items are encountered, you can go to the Post-Survey Analysis tab to estimate the unacceptable item rate and confidence interval.

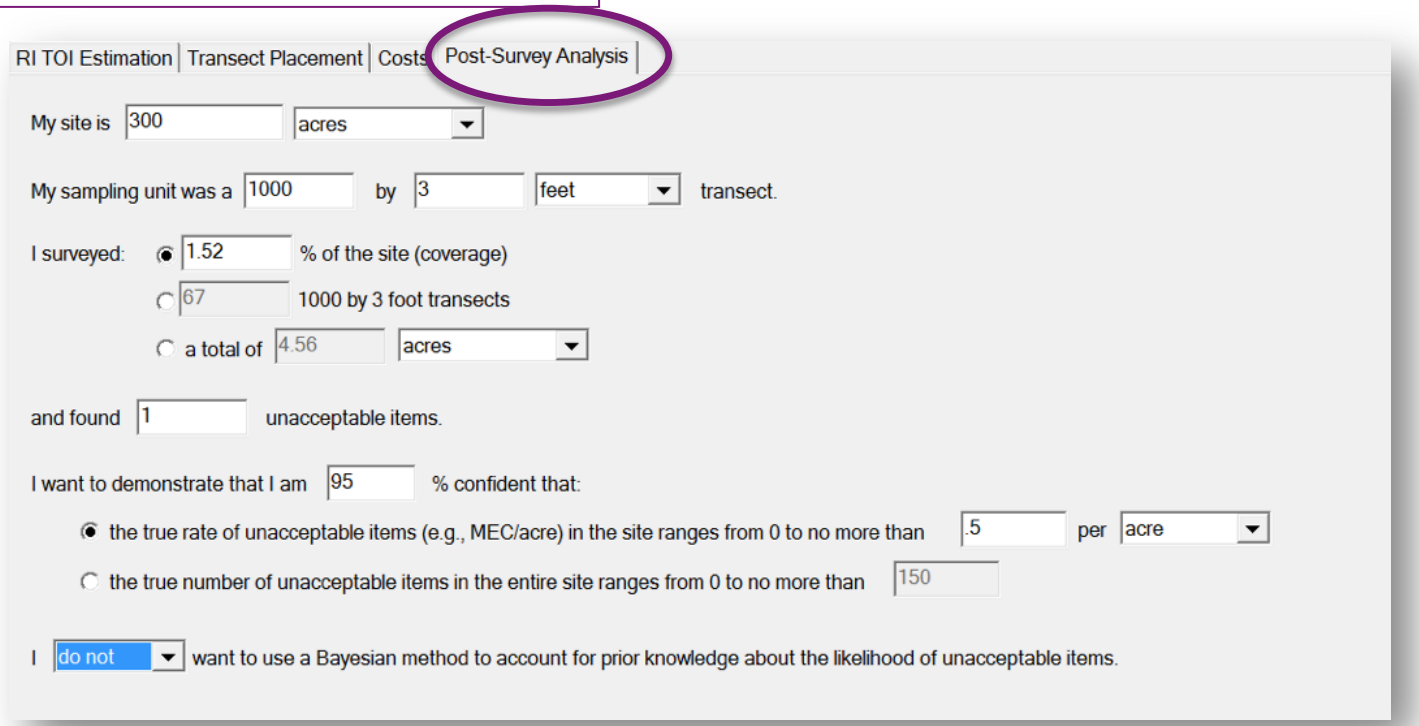
Design	Survey Acreage	Confidence
Non Bayesian	5.93 (87 transects)	95
Uninformed Bayesian	5.89 (86 transects)	95
Informed Bayesian	3.19 (47 transects)	95
Informed Bayesian	5.93 (87 transects)	**99**



☐ Log Y-Scale

Post-Survey Analysis

- Non-Bayesian
- Data analysis summaries provided in blue



Estimate:

Your best estimate of the unacceptable rate based on observing 1 unacceptable items and surveying 4.56 acres is 0.2193 per acre.

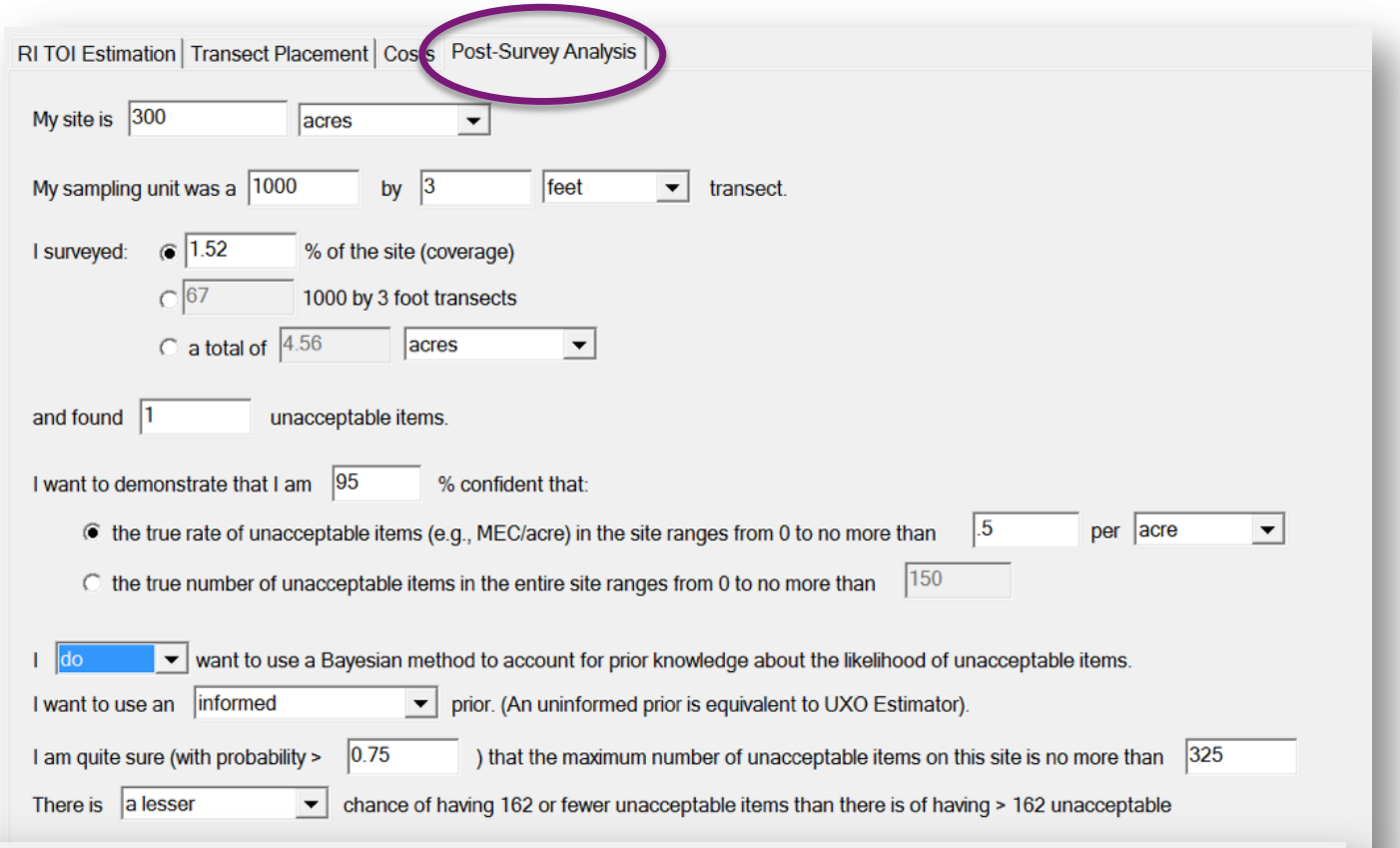
You can be at least 95% confident that the unacceptable item rate is no larger than 1.037 per acre and there are no more than 311 unacceptable items on your site.

You can be 66.7% confident that the unacceptable rate is no larger than 0.5 per acre and there are no more than 150 unacceptable items.

If you want to show that you are 95% confident that the true rate of unacceptable items is no larger than 0.5 per acre and the total number of unacceptable items is no more than 150, given the fact that you have already encountered 1 unacceptable items, you will need to survey an additional 4.81 acres and find no additional unacceptable items.

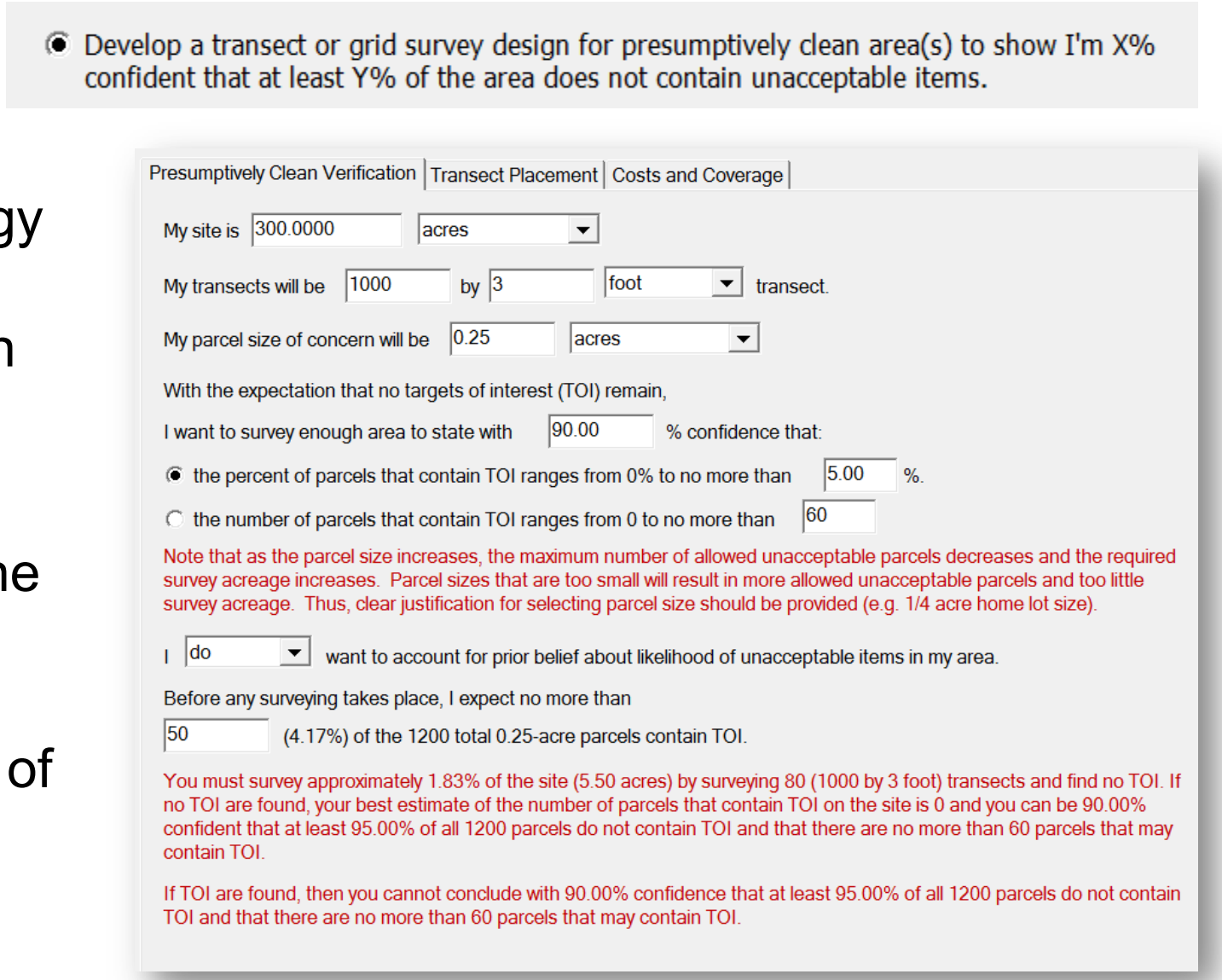
Post-Survey Analysis

- Bayesian
- Data analysis summaries provided in blue
- Confidence bounds use priors

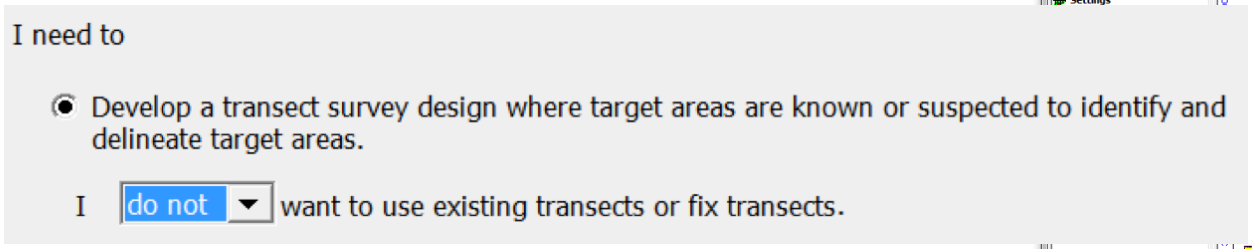


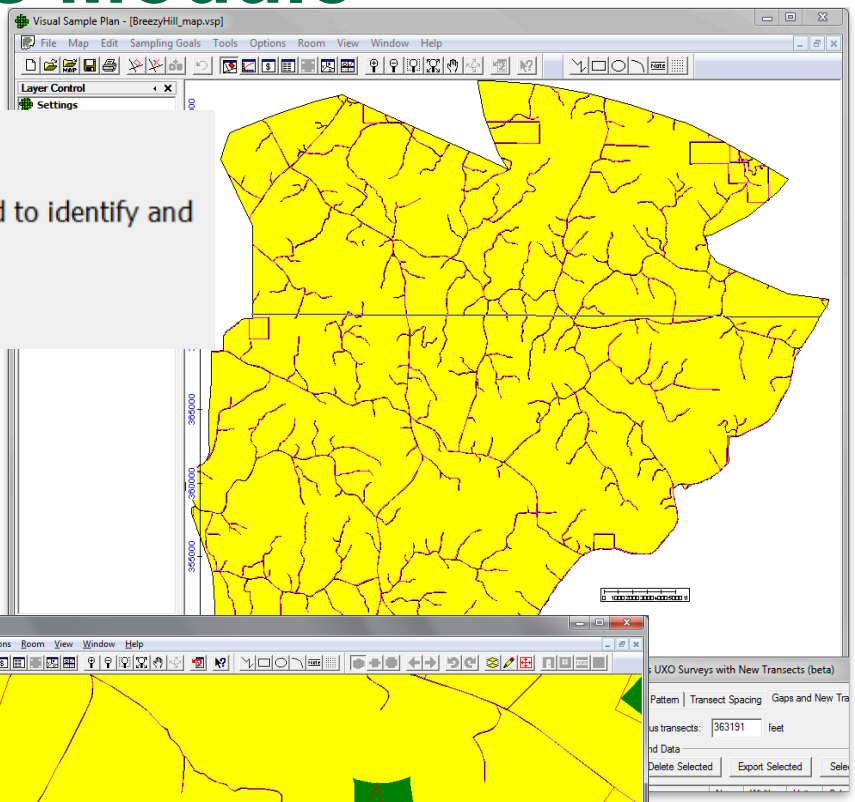
Presumptively Clean

- Similar methodology to post remediation verification
- Requires the user to define a parcel size of concern

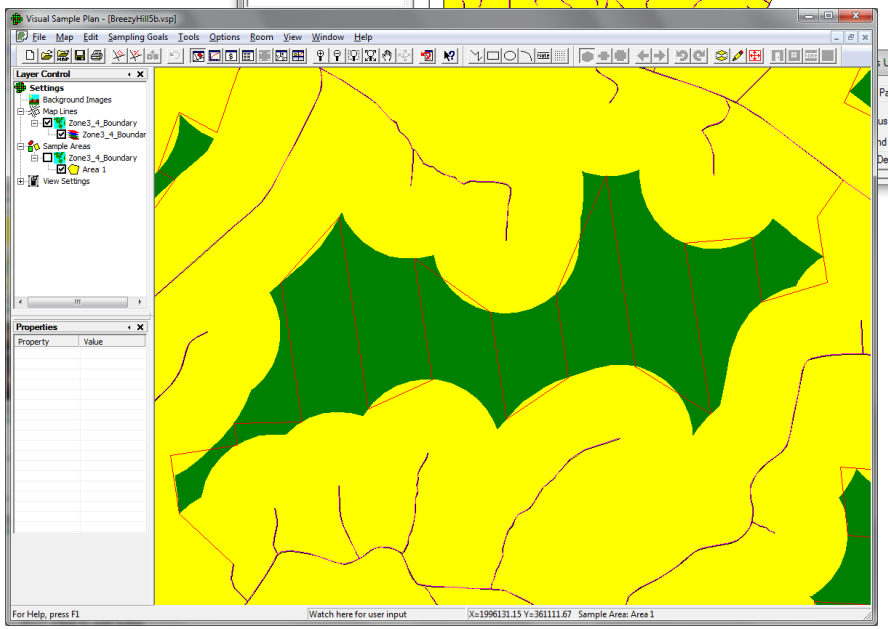


Augmented Transects Module



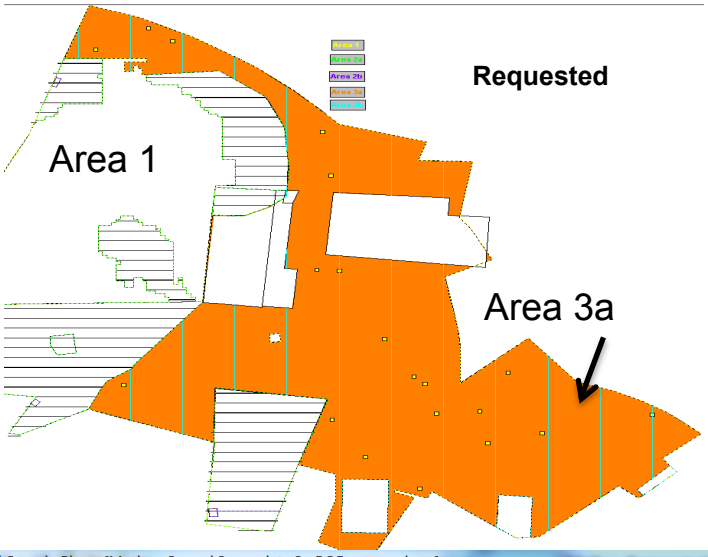


- ACOE funded new module for augmenting existing surveys to meet TA detection objective
- Successfully applied on Breezy Hill site
- Added as an option within VSP 7.0

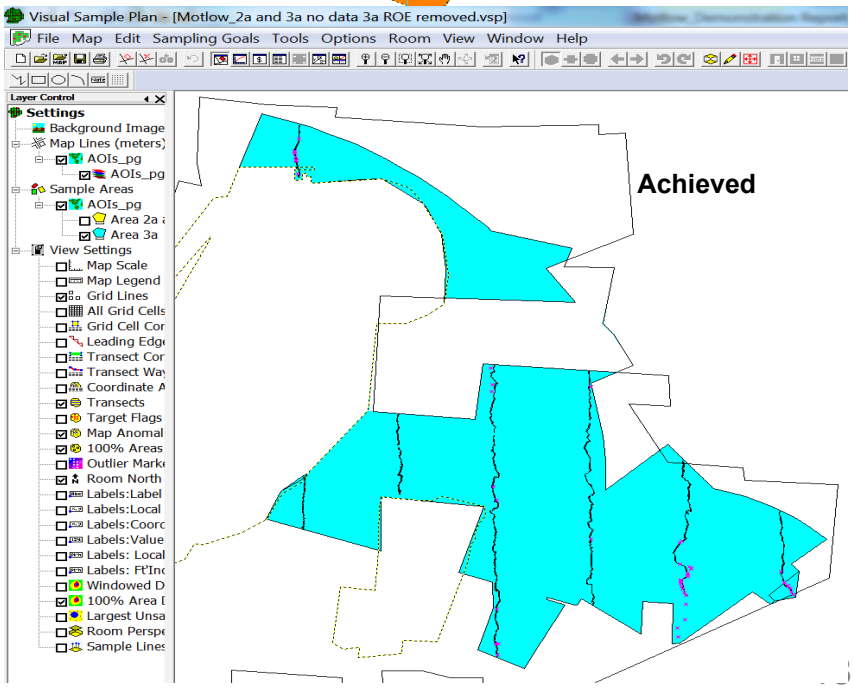


Motlow: TOI/Acre Estimation

- Wanted to show 90% confident that TOI/Acre < 0.5
- Used uninformed prior (UXO Estimator equivalent)
- Requested 4.6 acres of transect surveys

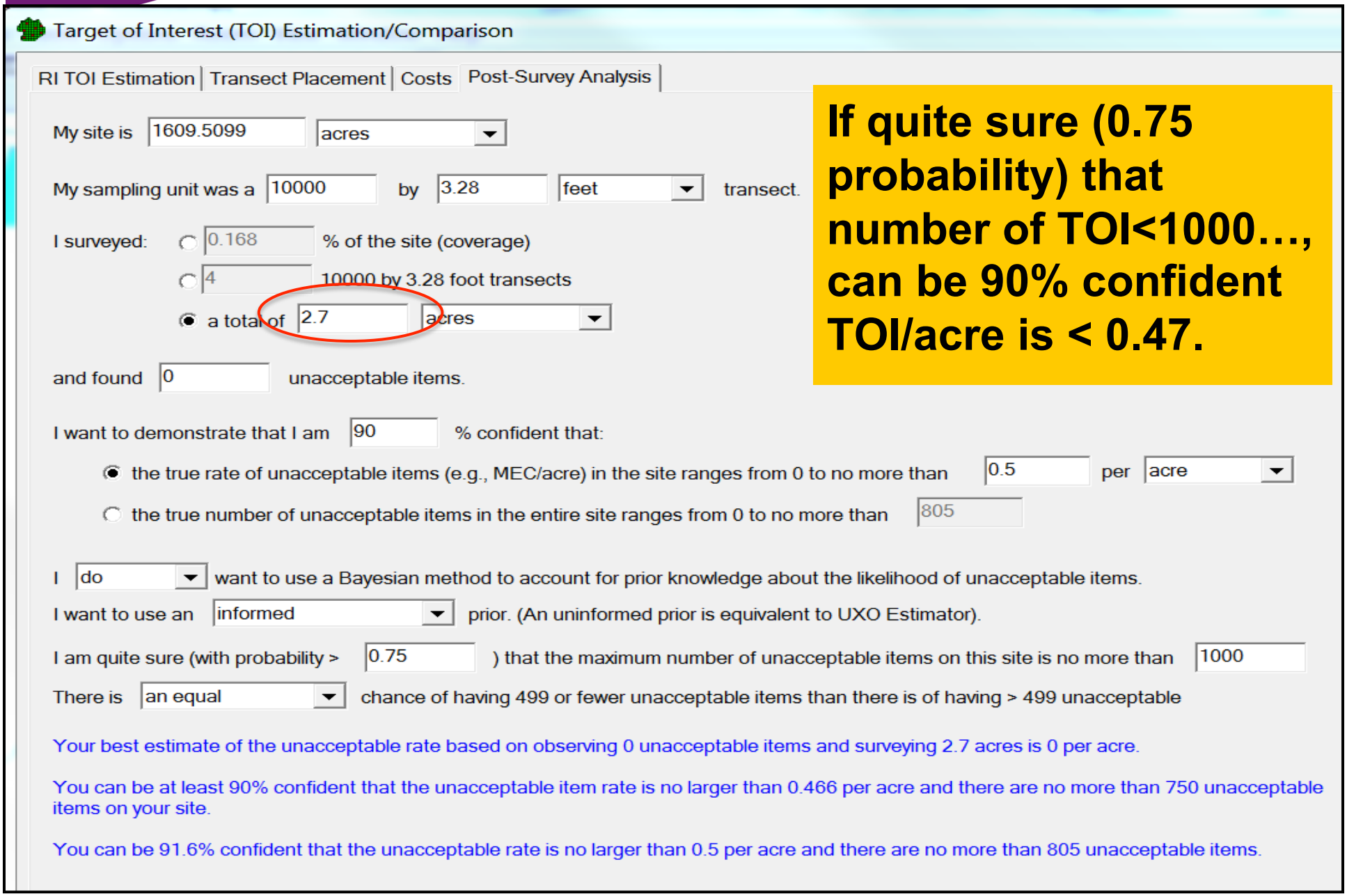


- Made reasonable Bayesian prior design as well
- Cleanup of Area 1 where target areas were prevalent, <800 TOI found



- Cost limited demonstration to 2.7 acres of transect surveys
- No TOI found

Motlow Area 3a: TOI/Acre Analysis

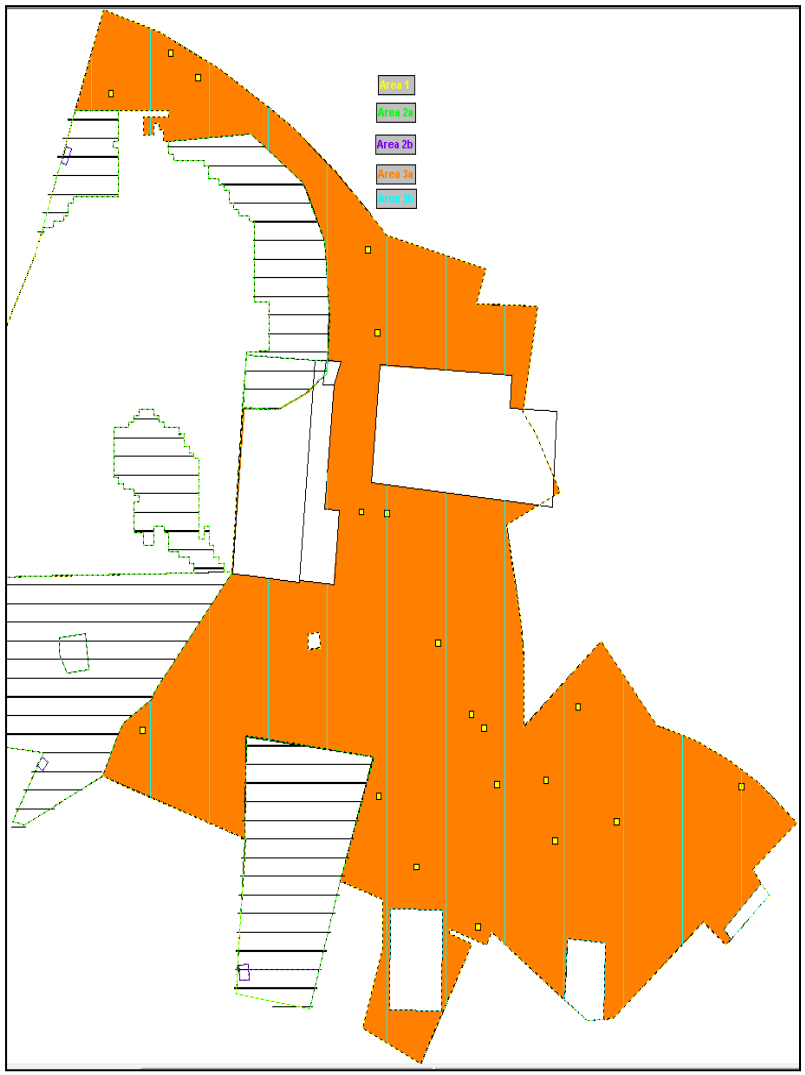


If quite sure (0.75 probability) that number of TOI<1000…, can be 90% confident TOI/acre is < 0.47.

Grids vs. Transects

Grids vs. Transects

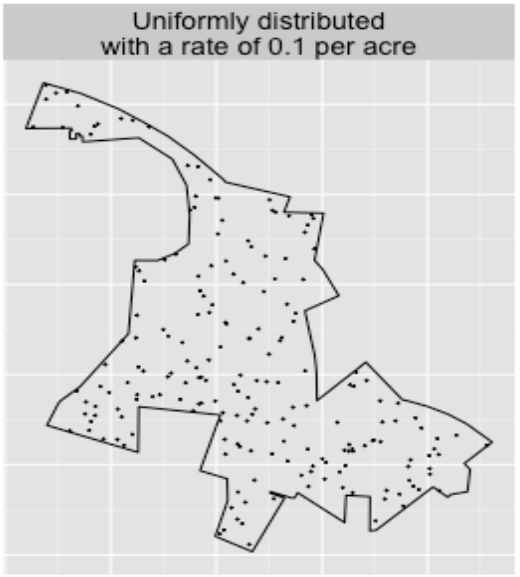
- Using Area 3a boundary, via simulation examined effect of grids vs. transects on actual achieved confidence for TOI/acre estimation
  - varied TOI clustering
  - varied survey unit dimensions

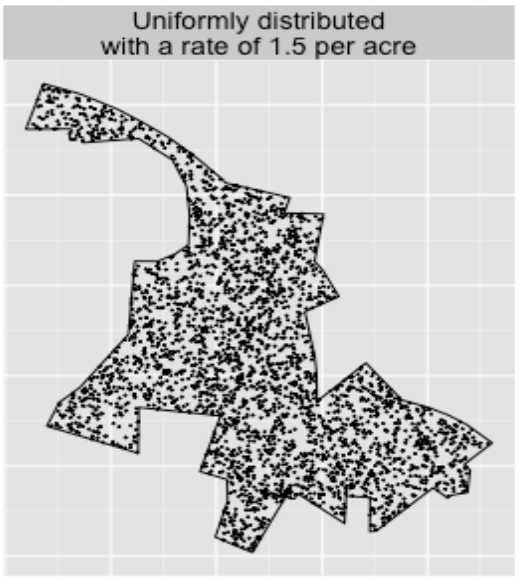


Sample Unit Dimensions (meters)

- *Transects*
  - 1x50, 1x100, 1x500, & 1x1000
  - 3x50, 3x100, 3x500, & 3x1000
  - 6x50, 6x100, 6x500, & 6x1000
- *Grids*
  - 50x50, 50x100, & 100x100

TOIs for 5 Rates per Acre



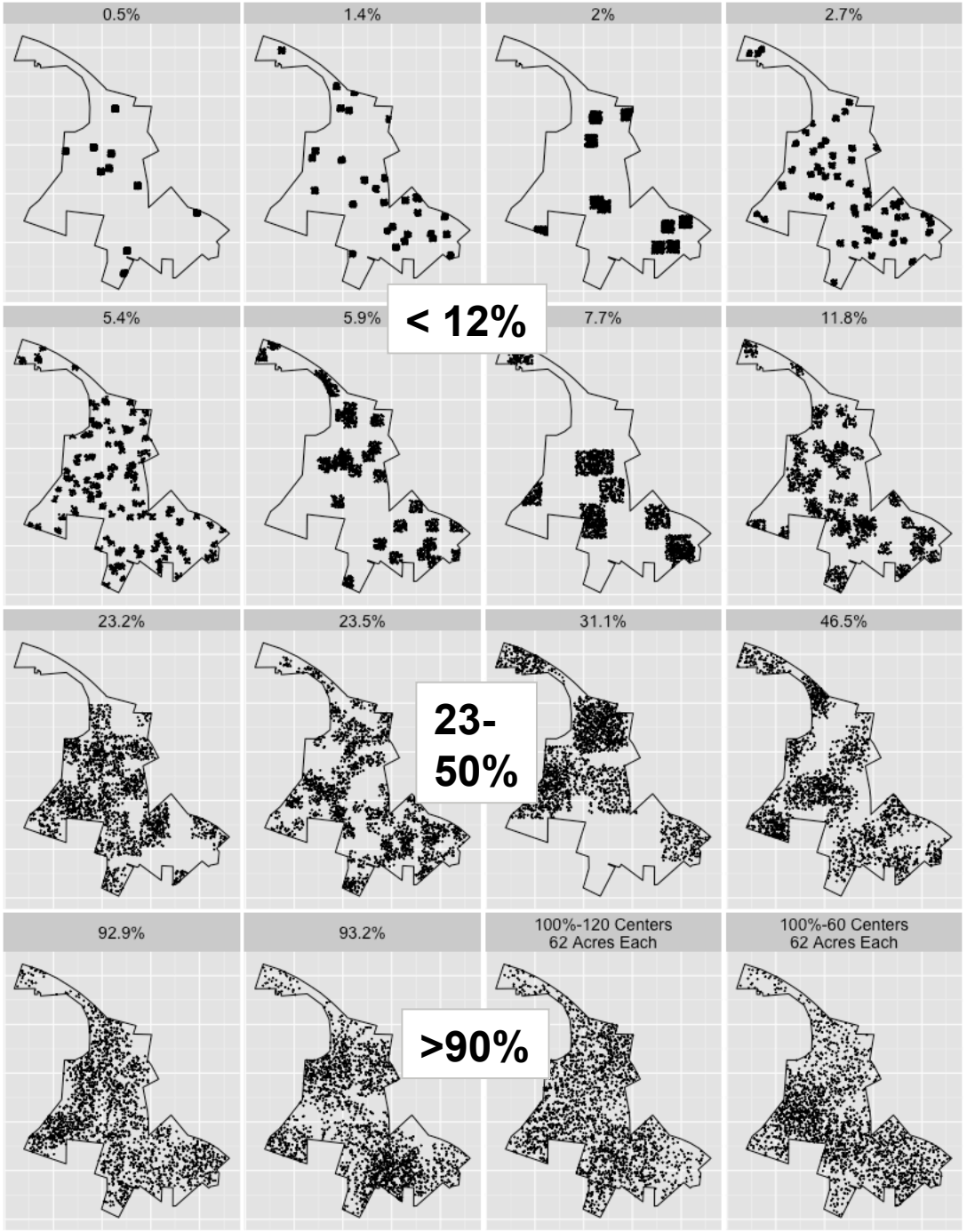


- The base case uniformly distributes TOI at five different rates
  - 0.1, 0.5, 1.0, 1.5, 2.0

All survey dimensions met objectives equally well as expected

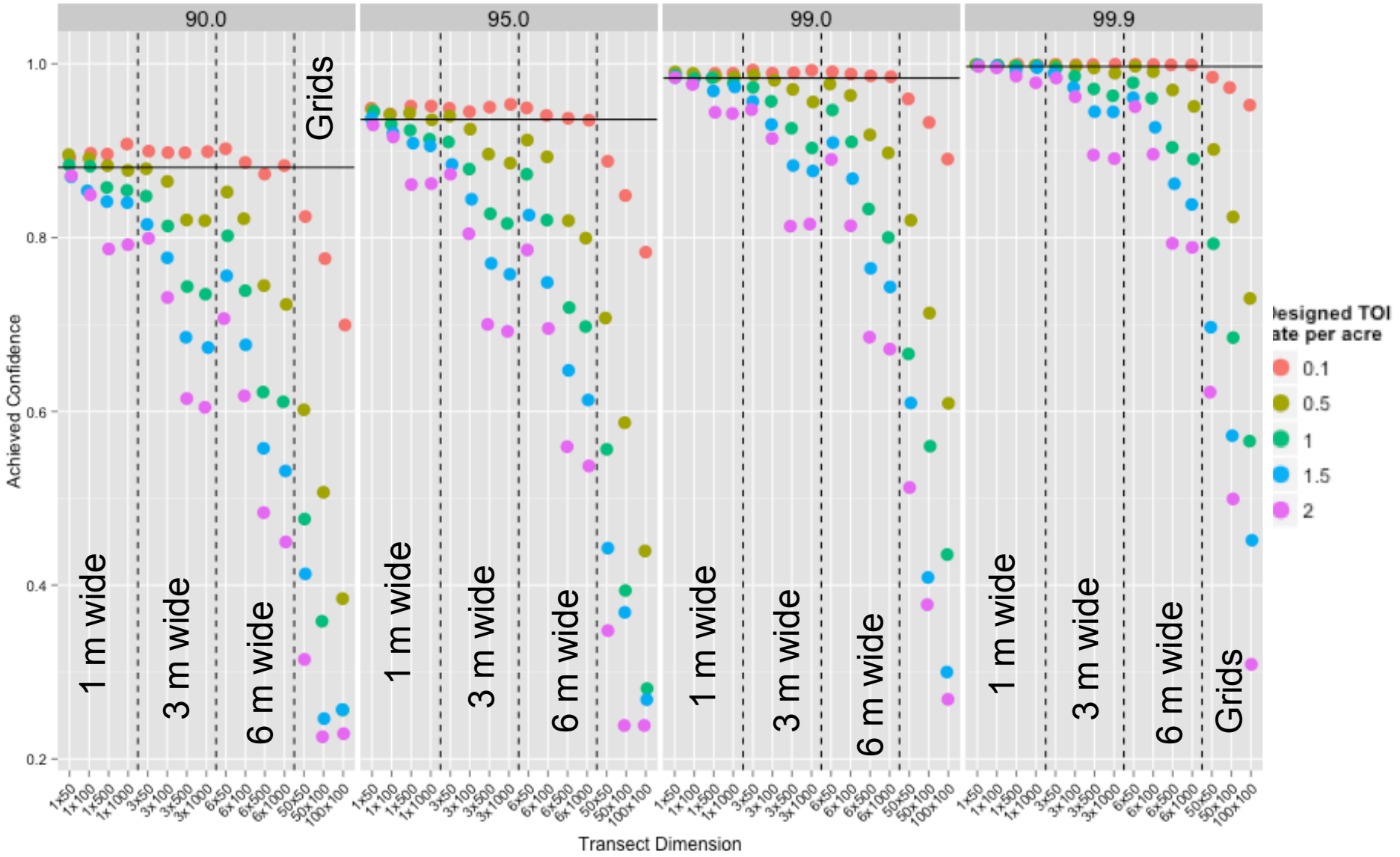
Grids vs. Transects

- 16 different levels of clustering were used for Area 3a at 5 different rates
  - 0.1,
  - 0.5,
  - **1.0 (picture shown)**,
  - 1.5,
  - 2.0



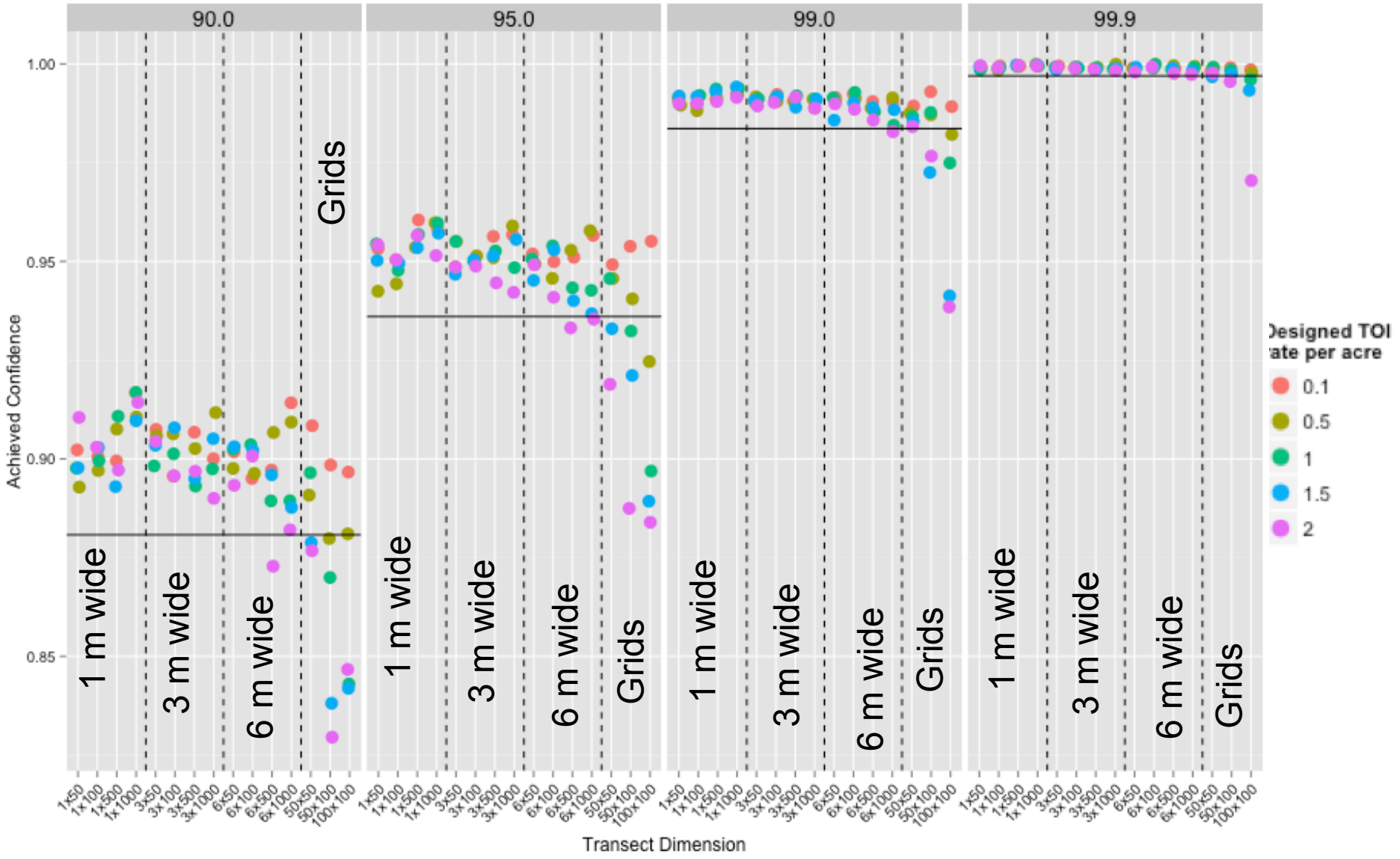
Grids vs. Transects: <12%

Confidence performance: TOI points can lie in no more than 12% of the sample area



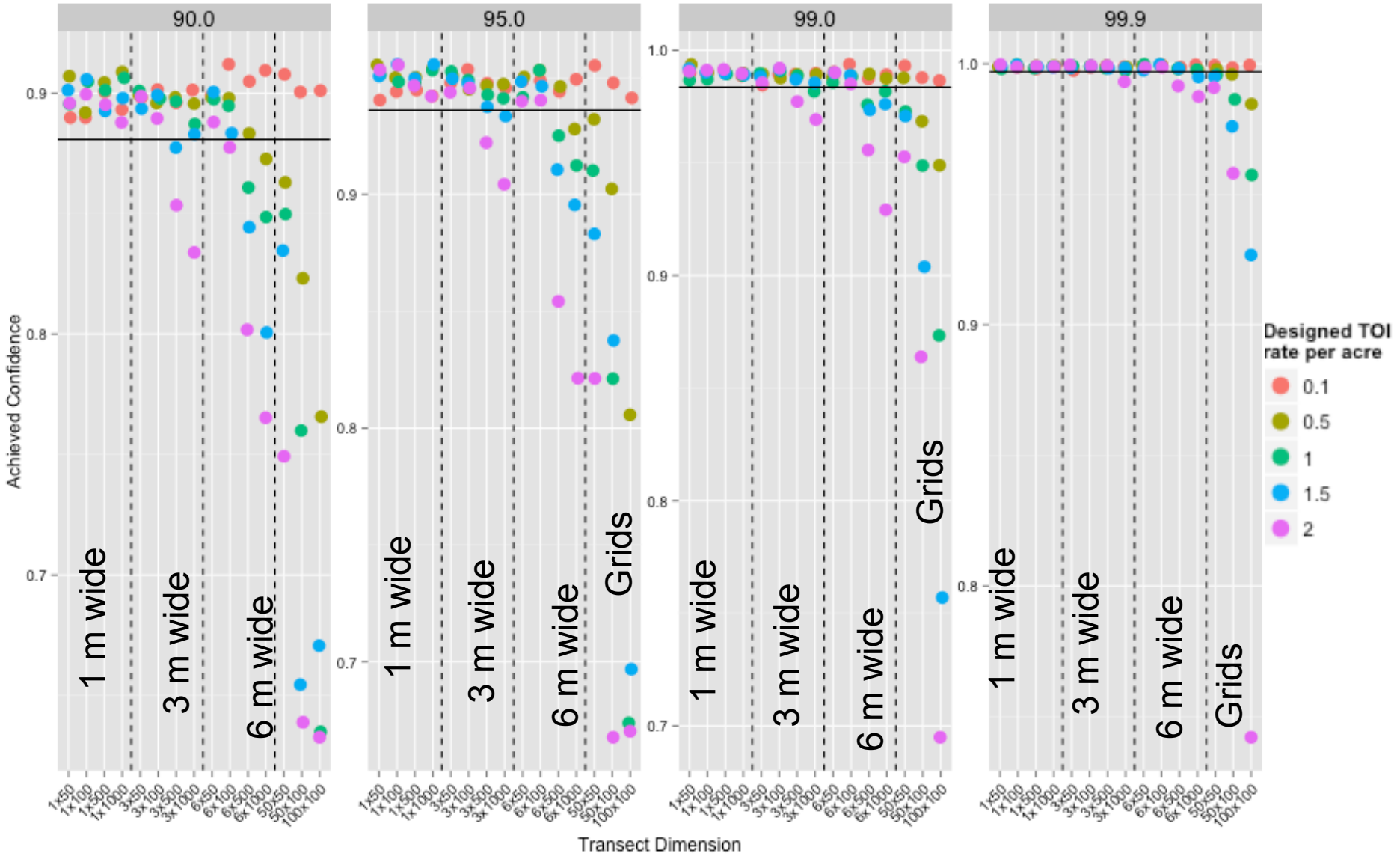
Grids vs. Transects: >90%

Confidence performance: TOI points can lie in greater than 90% of the sample area



Grids vs. Transects: 23% to 50%

Confidence performance: TOI points can lie in between 23% and 50% of the sample area



Grids vs. Transects Findings

- Any dimension of surface area sampling is going to have difficulties with tightly clustered TOI (<12%)
  - ♦ This is really the area where users should be using impact area discovery designs
- Standard long narrow transects are the most robust to TOI clustering (1 m to 3 m wide)
- Grid sampling is not robust to departures from uniformly distributed TOI (homogeneity)

VSP-UXO Training Courses

Last Course

- Apr 15-16, 2014 Huntsville

Upcoming

- Exploring multiple locations for FY14-15
  - Planning three for fall/winter
- Late Summer and two in the Winter months
- Contact J. Hathaway with interest to host course

Top 5 Things not to say when you are supposed to be the VSP-UXO expert

1. When asked why you are surveying X% of the site, you say, “I used the VSP”.
   - With over 15 UXO based designs and over 50 other designs saying you used “the VSP” is like saying you used “Windows” to do your analysis
2. I didn’t know that they offered training courses
3. It is impossible to know which design to use in VSP
   - With the UXO Guide and improved RI dialogue we hope that even the non-VSP expert can arrive at the correct design
4. VSP only has designs for target area discovery
5. You tell your boss, “We can’t get it the software is too expensive”
   - It is free at vsp.pnnl.gov