Field Studies and Data Collection in Support of a Baseline ERA

Aquatic Toxicology Laboratory

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Outline

- Site-specific data
- The MSU-ATL
- Approach
- Study design
- The bottom line

Why do we need site-specific data now?

- Accurate estimate of risk to humans and wildlife populations
  - Errors and Inadequacies of presently available biological data set precludes confident, correct decision making
- Scale risks relative to remedial options
- Establish appropriate and technically defensible cleanup goals
- Achieve a global settlement for remediation, restoration and future liability

Why do we need site-specific data?

- Follows USEPA guidelines
- Minimizes the impact of overly conservative assumptions
- Confines assumptions to the bounds of reality
- Focuses and maximizes effectiveness and eliminates unneeded remedial actions and monitoring (cost effective)
- Adds credibility and defensibility to PRP-proposed remedial actions
- Adds credibility to negotiation and litigation process
- Establishes current conditions

Why do we need site-specific data?

- **USEPA guidelines**
  - US EPA (1997): Ecological Risk Assessment Guidance for Superfund: Process for designing and conducting ecological risk assessments. EPA 540-R-97-006.
  - US EPA (1998): Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F.

Site-specific field studies are nearly always required for sound decision making. This is especially true for large complex systems.

Why do we need site-specific data?

- **USEPA guidelines**

Ecological Risk Assessment Review

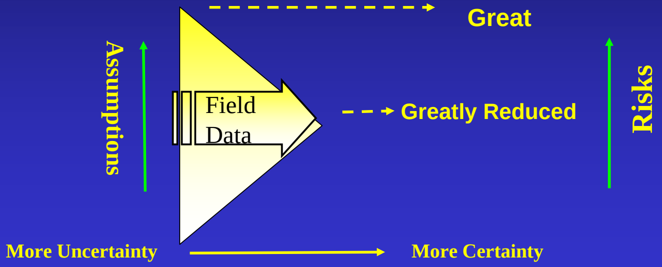
December 19, 2003

"A definitive ERA should be based on a wide variety of techniques for measuring and characterizing ecological risks at sites, such as described in guidelines for ERA from EPA (EPA 1997 and 1998) and as recommended by the National Academy of sciences (2001); which Dow intends to consider when performing its definitive ERA as required under its License. These include measurements, not estimates, of the following:

- **The abundance, diversity, and characteristics of exposed invertertbrate, fish and wildlife communities, and**
- **The reproductive success in fish, birds, and mammals "**

Why do we need site-specific data?

- USEPA guidelines
- Minimizes the impact of overly conservative assumptions



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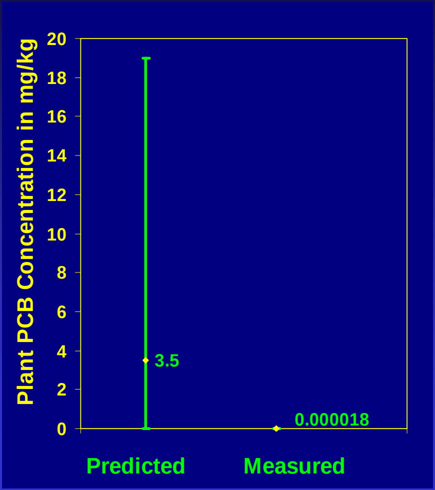
Why do we need site-specific data?

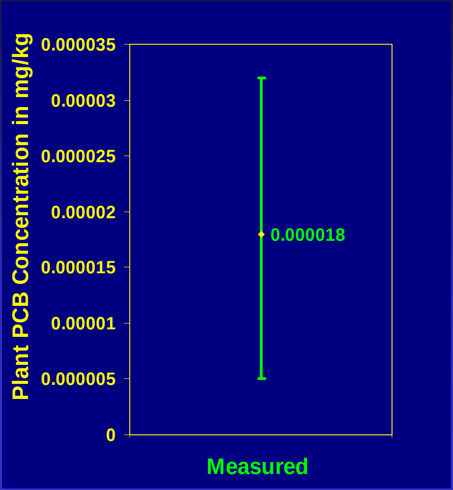
- USEPA guidelines
- Minimize the impact of overly conservative assumptions

(Example) PCB Concentrations in Plants

- In the absence of measured values, values must be predicted from the literature
- Literature based bioaccumulation factors vary greatly due to study design, congener profile, etc.
- Uncertainty multiplied by conservative assumptions results in elevated predicted tissue conc.
- Measured values provide a more accurate conc. in plant tissue (~ 900 fold lower)

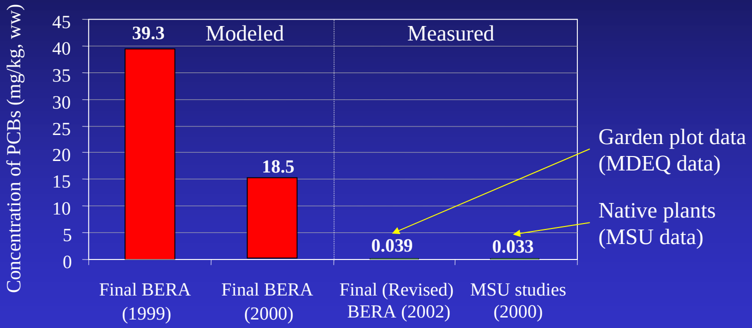
Uncertainties of Predicted vs. Measured Values (Case Study)





Site-Specific Data, Uncertainty and Estimates of Risk

Modeled versus site-specific measured plant data
(Kalamazoo River)



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Ok the value of site-specific data is clear !

Why should we have the MSU-ATL collect it ?

Why the MSU-ATL

- **World class capability**
  - Team of motivated professionals
  - State of the art research facilities
  - Experience in developing, executing and reporting results of high quality, site-specific ecological studies
    - 6th most cited group worldwide in the fields of ecology and the environment over the period of 1993-2003. “InCites Highly Cited Author Recognition-2003”
    - Identified by current contents as being in the top 0.5 % worldwide of active authors in ecology and environmental toxicology. “ISI Highly Cited Author Recognition-2002, ISI Highly cited.com.”
  - Experience working with the trustees
  - Respected by the trustees

Why the MSU-ATL

- **World class capability**
- **Independent and credible**
  - Publicly funded institution for advancing and disseminating knowledge in the public service
  - Involve the public and local activists
  - Publish all findings in peer reviewed literature
  - Conduct research in an open and transparent environment
  - We are local members of the community
  - Short chain of custody
  - Provide the highest quality data to stakeholders simultaneously

Why the MSU-ATL

- World class capability
- Independent and credible
- Cost effective
  - Government subsidized
  - Motivated professionals willing to accept experience and professional association in lieu of monetary compensation
  - The MSU-ATL is essentially on-site resulting in zero loss of effectivity due to housing, food and travel costs.

Why the MSU-ATL

- World class capability
- Independent and credible
- Cost effective
- Intangibles
  - Advancement of science
  - The training of students in wildlife toxicology

The Goal

Provide a scientifically defensible site-specific risk of harm evaluation for wildlife residing within the Tittabawassee River basin

The Approach

- Strictly adhere to USEPA guidelines
- Collect site-specific data minimizing the impact of conservative bias
- Utilize a multiple lines of evidence approach
- Conduct all research in an open and transparent manner
- Utilize local assets
- Provide data to all interested parties simultaneously

Risk is a Function of Exposure and Hazard

- Multiple lines of evidence can be established for both exposure and hazard

Reduce Uncertainty

Multiple Lines of Evidence Approach

Line of Evidence #1 - Bottom up (daily dietary dose)

Concentration of Stressors measured in the diet of wildlife.

$$\frac{\text{Stressor Concentrations in Diet}}{\text{Toxicity Reference Value}} = \text{Hazard Quotient}$$

Toxicity Reference Value: *Value determined by the literature to be indicative of adverse exposure for a specific receptor*

Reduce Uncertainty

Multiple Lines of Evidence Approach

Line of Evidence #1 - Bottom up (daily dietary dose)

Concentration of Stressors measured in the diet of wildlife.

Line of Evidence #2 - Top Down (Tissue Conc.)

Concentration of Stressors measured in selected tissue

$$\frac{\text{Stressor Concentrations in Tissue}}{\text{Toxicity Reference Value}} = \text{Hazard Quotient}$$

Toxicity Reference Value: *Value determined by the literature to be indicative of adverse exposure for a specific receptor*

Lines of Evidence for Baseline Risk Assessment

- **Line of Evidence #1 - Bottom up (daily dietary dose)**
- **Line of Evidence #2 - Top Down (Tissue-based exposure)**
- **Line of Evidence #3 - Population Health (Productivity)**
  - # Nestlings Fledged per Nest
  - Weight, Length and Overall Appearance
  - Receptor Abundance
  - Population Demographics

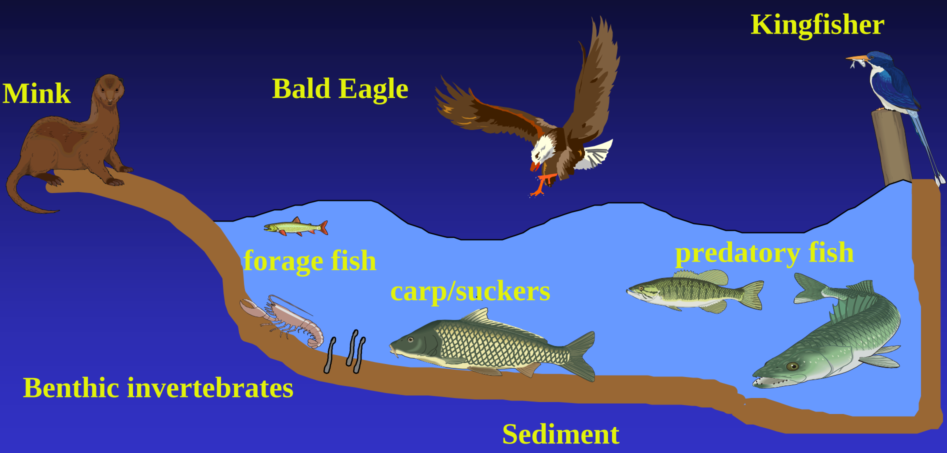
Lines of Evidence for Baseline Risk Assessment

- Line of Evidence #1 - Bottom up (daily dietary dose)
- Line of Evidence #2 - Top Down (Tissue-based exposure)
- Line of Evidence #3 - Population Health (Productivity)
- Line of Evidence #4 - Targeted Health measurements
  - Gross Abnormalities
  - Nest attentiveness
  - Nest neatness
  - Nest Weight
  - Plumage
  - Biomarkers

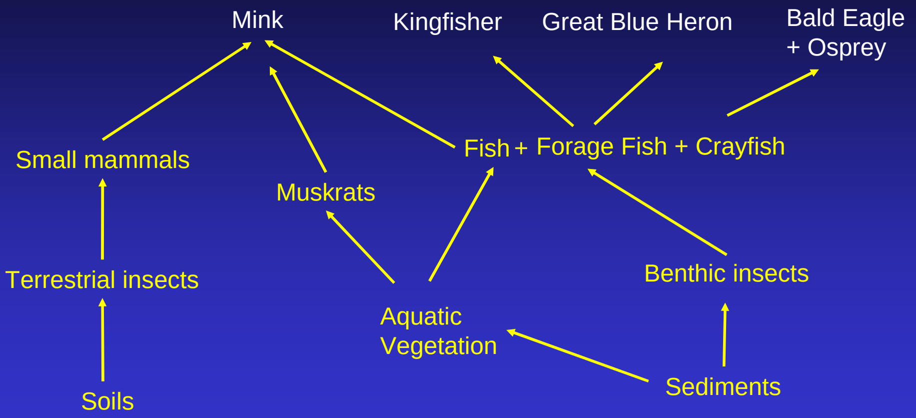
Site-Specific Data

- Food Web Characterization/Dietary Items Sampling
  - Primary
  - Revised
- Passerine Study
- Bald Eagle Study
- Great Horned Owl Study
- Mink Study
- Shrew Study
- Walleye Study
- Great Blue Heron/Kingfisher Study

Conceptual Site Model =Aquatic



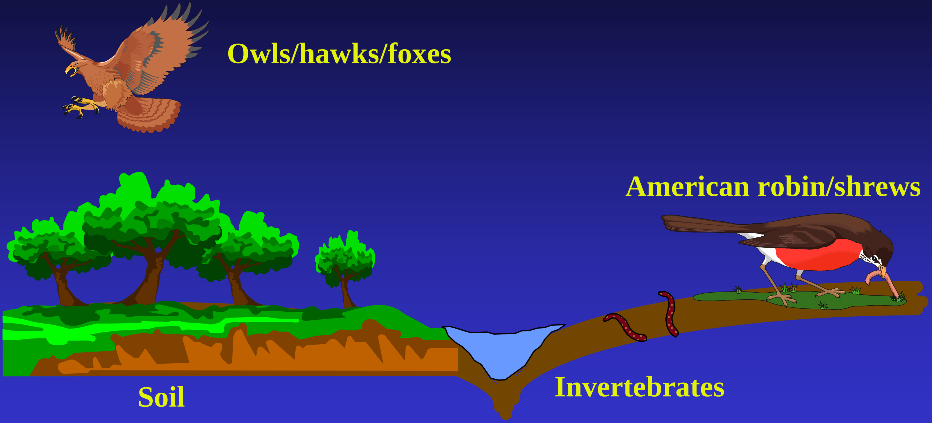
Aquatic Exposure Pathways



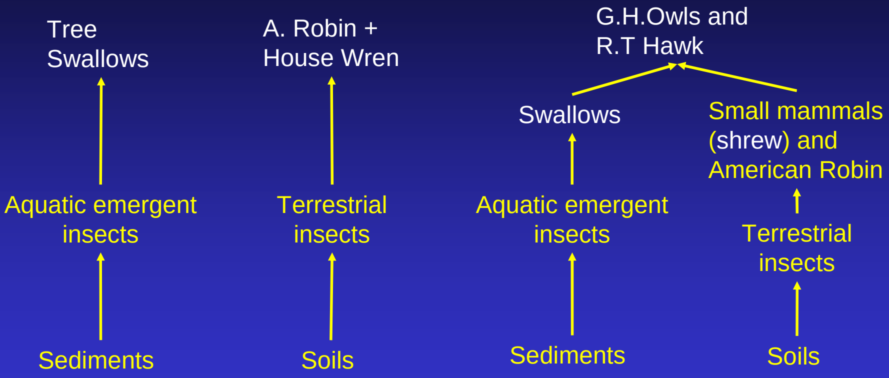
Samples Collected (to date)

12 Mink (2 locations)
20 muskrats (2 locations)
38 small mammals (3 locations)
8 sediment and soil samples (3 locations)
9 plant samples (aquatic and terrestrial 3 locations)
12 groups of aquatic emergent insect (by order, 3 locations)
6 groups of benthic invertebrates (by order, 3 locations)
52 fish of various species and size classes (6 locations)
14 groups of terrestrial invertebrates (by order, 3 locations)
6 groups of earthworms (3 locations)
5 crayfish samples (4 locations)

Conceptual Site Model =Terrestrial



Preliminary Exposure Pathways



Samples Collected (to date)

20 muskrats

38 small mammals (3 locations)

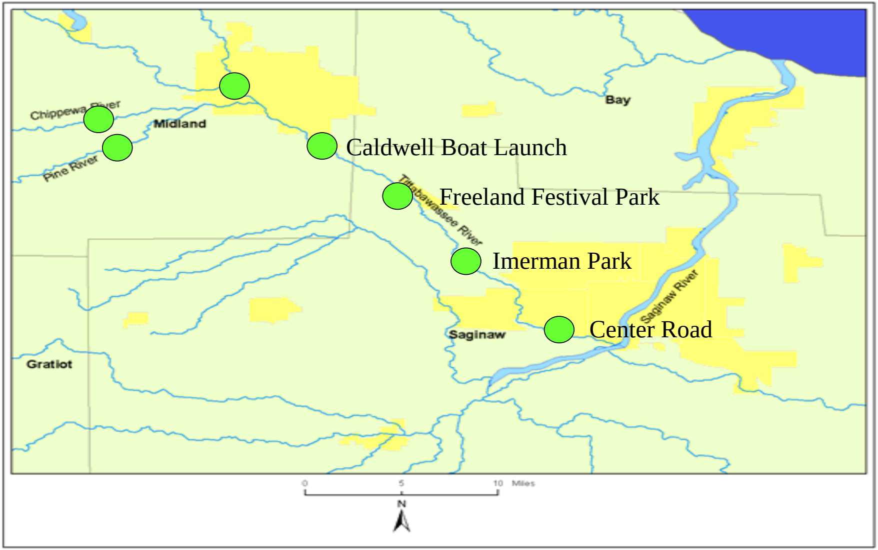
8 sediment and soil samples

9 plant samples (aquatic and terrestrial)

10 fox squirrels (two locations)

14 groups of terrestrial invertebrates (by order, 3 locations)

6 groups of earthworms (3 locations)



Chippewa River
Midland
Pine River
Caldwell Boat Launch
Freeland Festival Park
Tittabawassee River
Imerman Park
Bay
Saginaw
Saginaw River
Center Road
Gratiot
0
5
10
Miles
N

Aquatic Emergent Insect Sampling

Benthic Invertebrate Sampling

Benthic Invertebrate Sampling

Invertebrate sorting

Small Mammal Sampling

Terrestrial Invertebrate Sampling

Samples Collected (to date)

12 mink
20 muskrats
10 squirrels
38 small mammals (3 locations)
8 sediment and soil samples (3 locations)
9 plant samples (aquatic and terrestrial)
12 groups of aquatic emergent insect (by order, 3 locations)
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52 fish or groups of fish, of various species and size classes (6 locations)
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6 groups of earthworms (3 locations)
4 crayfish samples

Site-Specific Data

- Food Web Characterization/Dietary Items Sampling
  - Primary
  - Revised
- Passerine Study
- Bald Eagle Study
- Great Horned Owl Study
- Mink Study
- Shrew Study
- Walleye Study
- Great Blue Heron/Kingfisher Study

Passerine Studies

Methodologies

- Bottom up assessment
  - Determine dietary composition
  - Analyze identified dietary items for contaminants
  - Predict exposures
- Top down assessment
  - Contaminants in adult tissues
  - Contaminants in eggs
  - Contaminants chicks
- Passerine productivity
- Passerine population health

Passerine Studies

Assessment of Tittabawassee River basin Raptors

Great Horned Owls
(Bubo virginianus)

Bald Eagle
(Haliaeetus leucocephalus)

Raptors Studies (Bald Eagle)

Methodology

- **Bottom up exposure assessment**
  - **locate natural nests**
  - **determine dietary composition**
  - **Analyze dietary items for contaminants**
- **Top down exposure assessment**
  - **collect chick blood serum (analyze for contaminants, biomarkers)**
  - **Collect addled eggs**
  - **Eggshell electron micrograph**
- **Productivity assessment**

Bald Eagle Egg PCB Concentrations

Bald Eagle Study

Methods: Productivity

- For Each of Three Regions
  - Identify occupied nest in two breeding territories per/region
  - Vissualy identify # hatchlings/nest
  - Visualy identify # fledglings/nest

Non-destructive Tissue Sampling

Great Horned Owl Study Overview

Methodology

Bottom up exposure assessment

- Collect prey remains and regurgitated pellets to identify site specific dietary composition
- Collect and analyze identified dietary items for contaminants

Top down exposure assessment

- Place nesting platforms on site
- Analyze nestling blood plasma for contaminants
- Analyze fresh and addled eggs for contaminants

Quantify site abundance

- Survey resident owl populations in downstream area vs background site

Quantify site productivity

- Confirm successful fledglings at each active nest

Great Horned Owl Study Overview
Nesting Platforms

Non-destructive Tissue Sampling

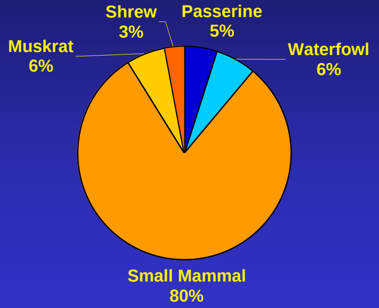
Great Horned Owl Study

Methodology: Dietary Composition

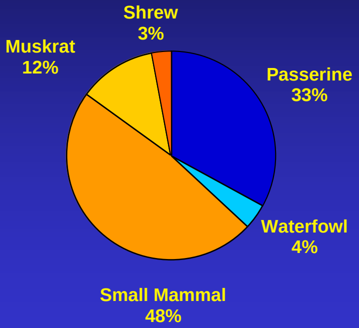
- **Regurgitated pellets**
  - –Base of nest tree
  - –Associated feeding perch
- **Prey remains**
  - –Within nest
  - –Base of nest tree

Great Horned Owl Dietary Composition

Reference area Dietary Composition
Pellet and Prey Remains Analysis
n=35



Target area Dietary Composition
Pellet and Prey Remains Analysis
n=102



Evaluation of Mink Abundance, Exposure & Habitat Suitability

Mink
(*Mustela vison*)

Mink Study

- Mink often represent “worst-case scenario” for aquatic ecosystem exposure to dioxins and furans:
  - Feed at the top of the food chain
  - Are sensitive to the effects of D’s and F’s
  - Small home range
- Presently no data on exposure, habitat quality, mink abundance and population health

Mink Study

Methods

- Bottom up assessment
  - Determine dietary composition
  - Analyze identified dietary items for contaminants
  - Predict exposures
- Top down assessment
  - Quantify contaminants in mink liver
  - Quantify contaminants in mink whole body
- Mink population health
  - Population demographics
  - Reproductive history
  - abundance
- Mink habitat suitability

Mink Study

Methods (Mink Trapping)

Strategy: Mink Presence/Abundance

- **Mink are generally nocturnal and secretive, therefore variety of methods are being utilized**
  - **Track surveys**
  - **Mink scat**
  - **Winter trapping**

Strategy: Habitat Suitability

- Quality of habitat is related to:
  - adult survival rate
  - reproduction
  - vitality of offspring
  - length of time site remains suitable for occupancy

Strategy: Habitat Suitability

- Use Mink Habitat Suitability Index (HSI) to quantify habitat suitability
  - developed by U.S. Fish and Wildlife Service
  - field verified for Great Lakes regions
- Compare predicted mink distribution and abundance to measured values

Assessment of Tittabawassee River basin Shrews

Northern Short-tailed Shrew
Blarina brevicauda

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Short-tail Shrew Study

Methods

- Top down assessment
  - Quantify contaminants in whole body (6 from 3 locations)
- Shrew population health
  - abundance (trapping effort)

Assessment of Tittabawassee River basin Kingfishers/Great blue Herons

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Belted Kingfisher

(*Ceryle alcyon*)

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Great blue Heron

(*Ardea herodias*)

Belted Kingfisher/ Great blue Heron

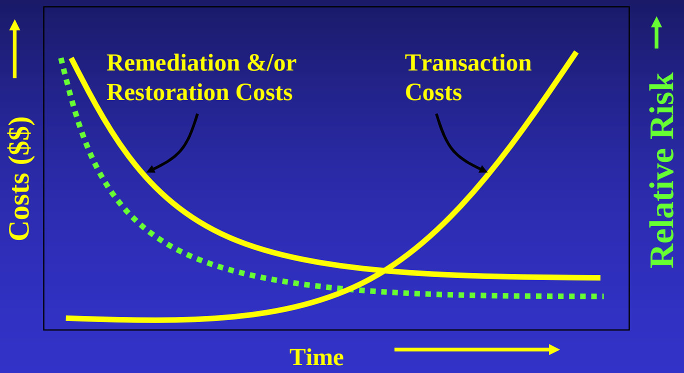
Methods

- **Bottom up assessment**
  - Analyze dietary items for contaminants (forage fish)
  - Predict exposures
  - Determine site-specific diet if necessary
- **Top down assessment**
  - Quantify contaminants in nestling plasma
  - Quantify contaminants in eggs
- **Population health**
  - Productivity
  - abundance
- **Habitat suitability**

The Bottom Line

- **Cost-benefit analysis**

Costs and Relative Risks Compared to Remediation & Restoration Costs Over Time



The Bottom line

- Cost Benefit
  - Government subsidized (low overhead)
  - Motivated professionals willing to accept experience and professional association in lieu of monetary compensation
  - The MSU-ATL is essentially on-site resulting in zero loss of effectivity due to housing, food and travel costs

The Bottom line

- Present Project
  - Have meet or exceeded sample sizes for all matrix
  - Increased level of effort by one third
  - On time
  - On budget

Bottom line

Samples (Targeted vs. Collected)

Targeted	Collected	
6	12	mink
6	20	muskrats
6	10	squirrels
36	38	small mammals (3 locations)
6	8	sediment and soil samples (3 locations)
6	9	plant samples (aquatic and terrestrial)
9	12	groups of aquatic emergent insect (by order, 3 locations)
6	6	groups of benthic invertebrates (by order, 3 locations)
48	52	fish or groups of fish, of various species and size classes (6 locations)
12	14	groups of terrestrial invertebrates (by order, 3 locations)
6	6	groups of earthworms (3 locations)
3	4	crayfish samples

The Bottom line

- On Time
  - All sampling complete
  - Sample processing nearing compleation
  - Analysis will begin mid-January
  - Will meet projected date of release

The Bottom line

- On budget
  - MSU-ATL personnel have spent an estimated 890 hours in the field
  - Field labor costs average ~16 dollars per hour

The Bottom line

- Site-specific data will be required for a technically defensible ERA
- No one can do it better than the MSU-ATL
- We need to begin ASAP so as not to miss this springs reproductive cycle