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Class Level Environmental Risk Assessment

An Effective and Innovative Tool for Real Property Liability Management

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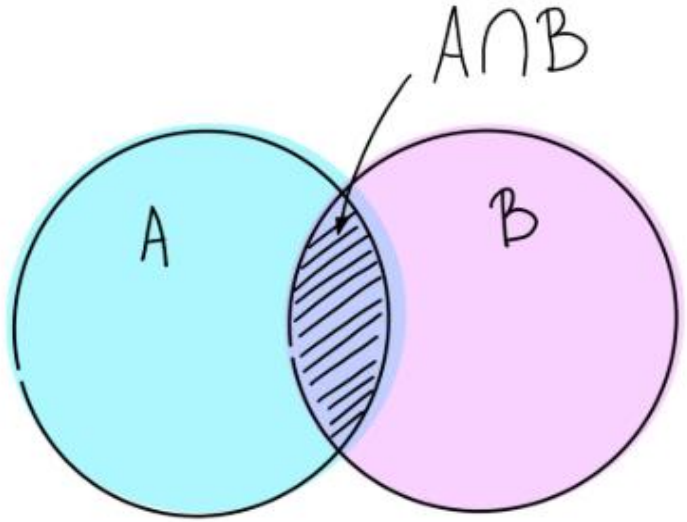
Outline

- Definition of Class RA and Benefits
- Case Study: Multiple Navigation Aid Stations (NAS) along river
  - Preparation and Planning
  - Data Management & Analysis
  - Results & Extension of Inference
- Pros / Cons of Approach
- Potential Uses

Class Level Risk Assessment

Traditional Risk Assessment methods applied to a sub-set of analog Sites with extension of risk inference to all Sites through Conditional Probability Theory



Benefits realized -

- ✓ Assessment of environmental liabilities on multiple properties with similar activities without characterizing every individual property
- ✓ Tool to narrow down a large portfolio of properties to a limited list of higher priority sites to allocate limited remedial funding

Case Study

Multiple Navigation Aid Stations (NAS)
Preparation and Planning Stage

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Goal and Objectives

Identify potential classes of NAS that result in high probability of contamination and assess the potential human health and ecological risks associated with the differing classes of NAS. Staged tasks as follows:

- Differentiate differing classes of NAS based on activities and infrastructure
- Define likelihood and magnitude of contamination associated with the differing classes of NAS
- Design and complete field sampling program on a sub-set of differing classes of NAS to validate contamination likelihood and magnitude assumptions
- Assess the range of human health and ecological risks across the sub-set of NAS
- Extend risk inference from sub-set of NAS to all NAS along the river using conditional probability theory

Navigational Aid Stations (NAS)

- More than 300 NAS
  - Aid watercraft in navigation
  - Installed between 1943 and 1990
  - 1700 km of river
  - Each NAS is less than 1 ha

- Activities/ Infrastructure
  - Passive NAS (makers only)
    - Periodic sanding and painting
  - Lighted NAS (batteries)
    - Potential disposal / storage
  - Atypical NAS (burn pits/ helipad)
    - Historic disposal/ burning of batteries
    - Potential for fuel





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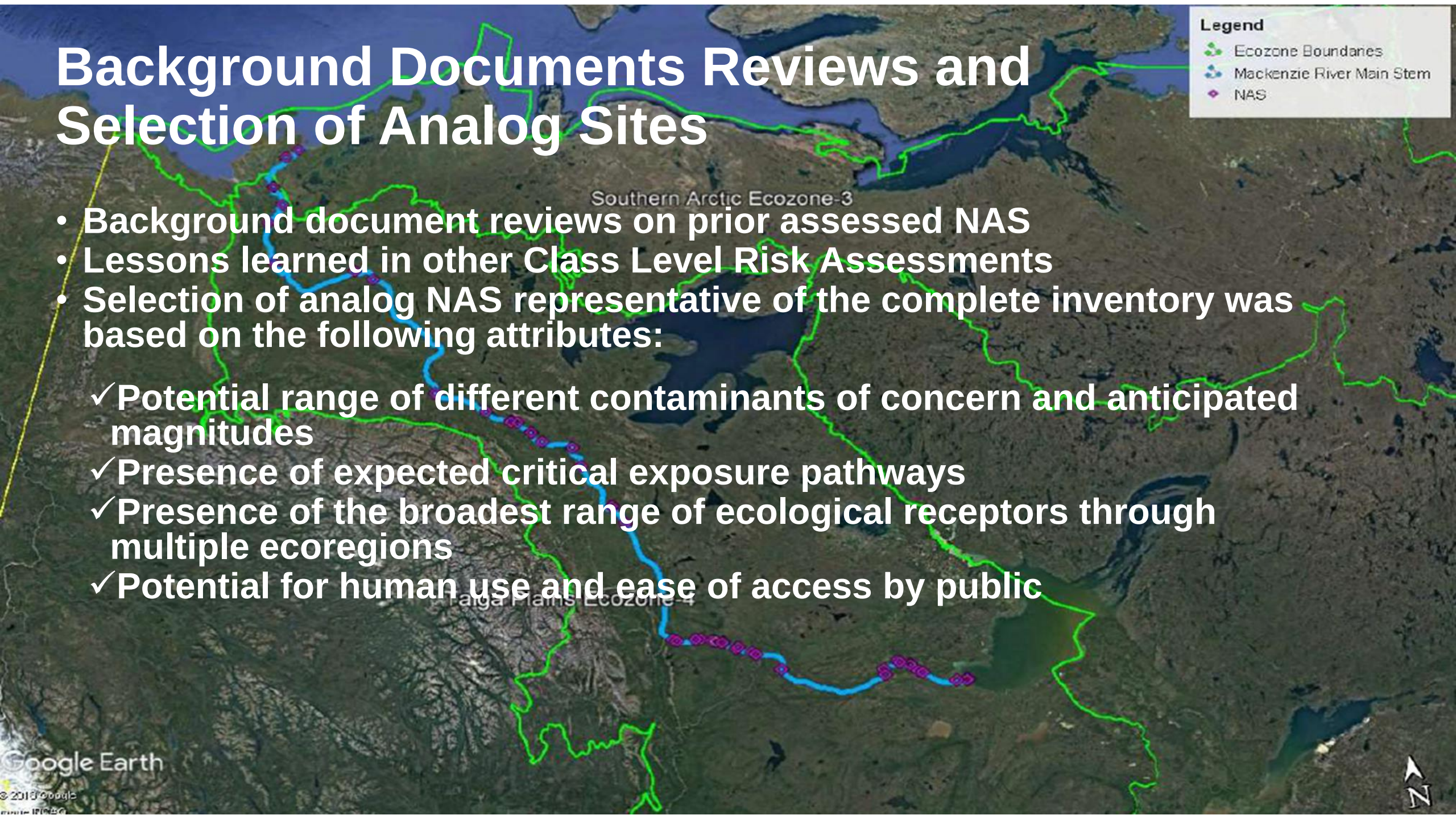
Background Documents Reviews and Selection of Analog Sites

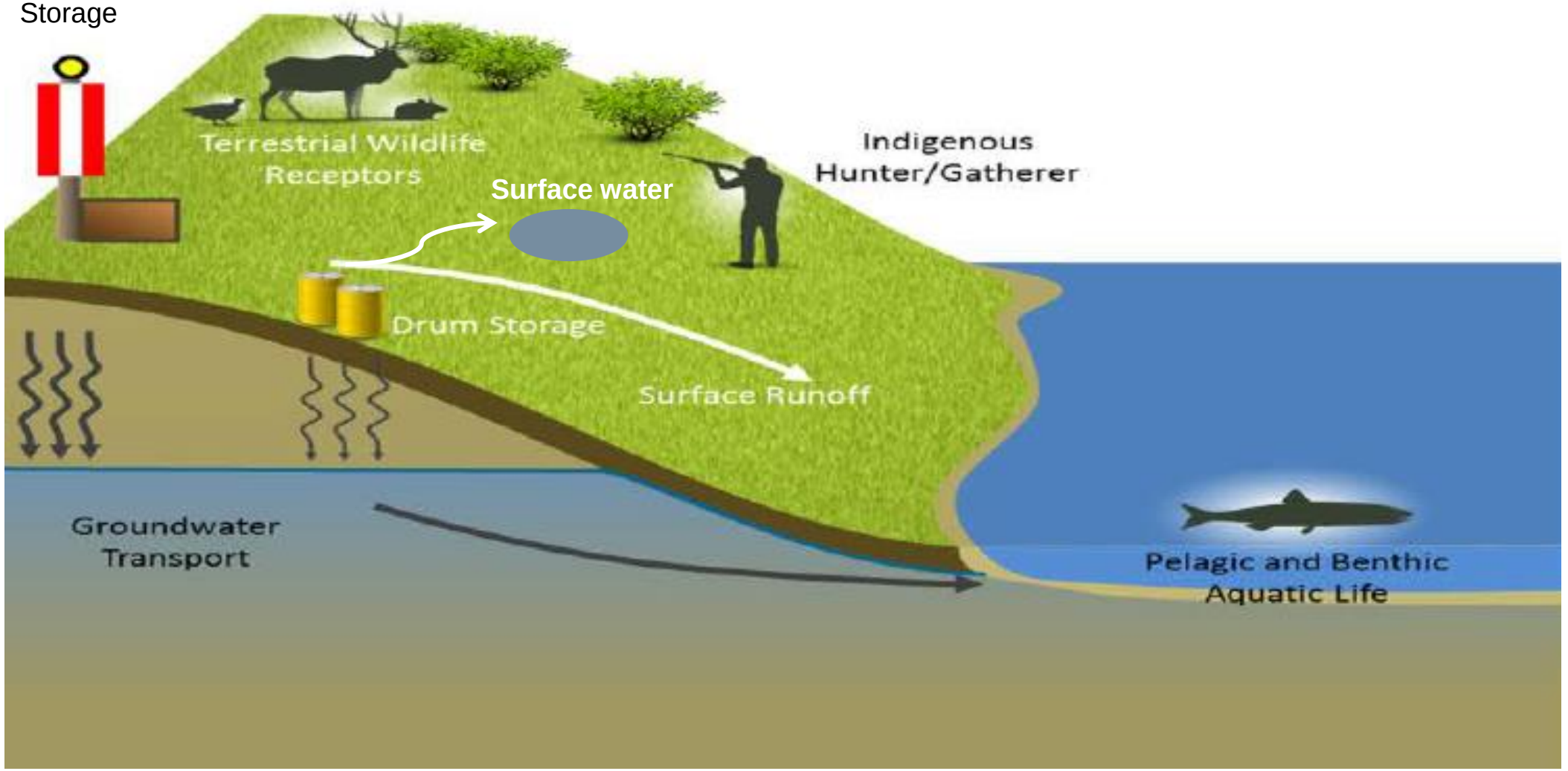


- Background document reviews on prior assessed NAS
- Lessons learned in other Class Level Risk Assessments
- Selection of analog NAS representative of the complete inventory was based on the following attributes:

  ✓Potential range of different contaminants of concern and anticipated magnitudes
  ✓Presence of expected critical exposure pathways
  ✓Presence of the broadest range of ecological receptors through multiple ecoregions
  ✓Potential for human use and ease of access by public

Conceptual Exposure Model

Navigation Light with Battery Storage



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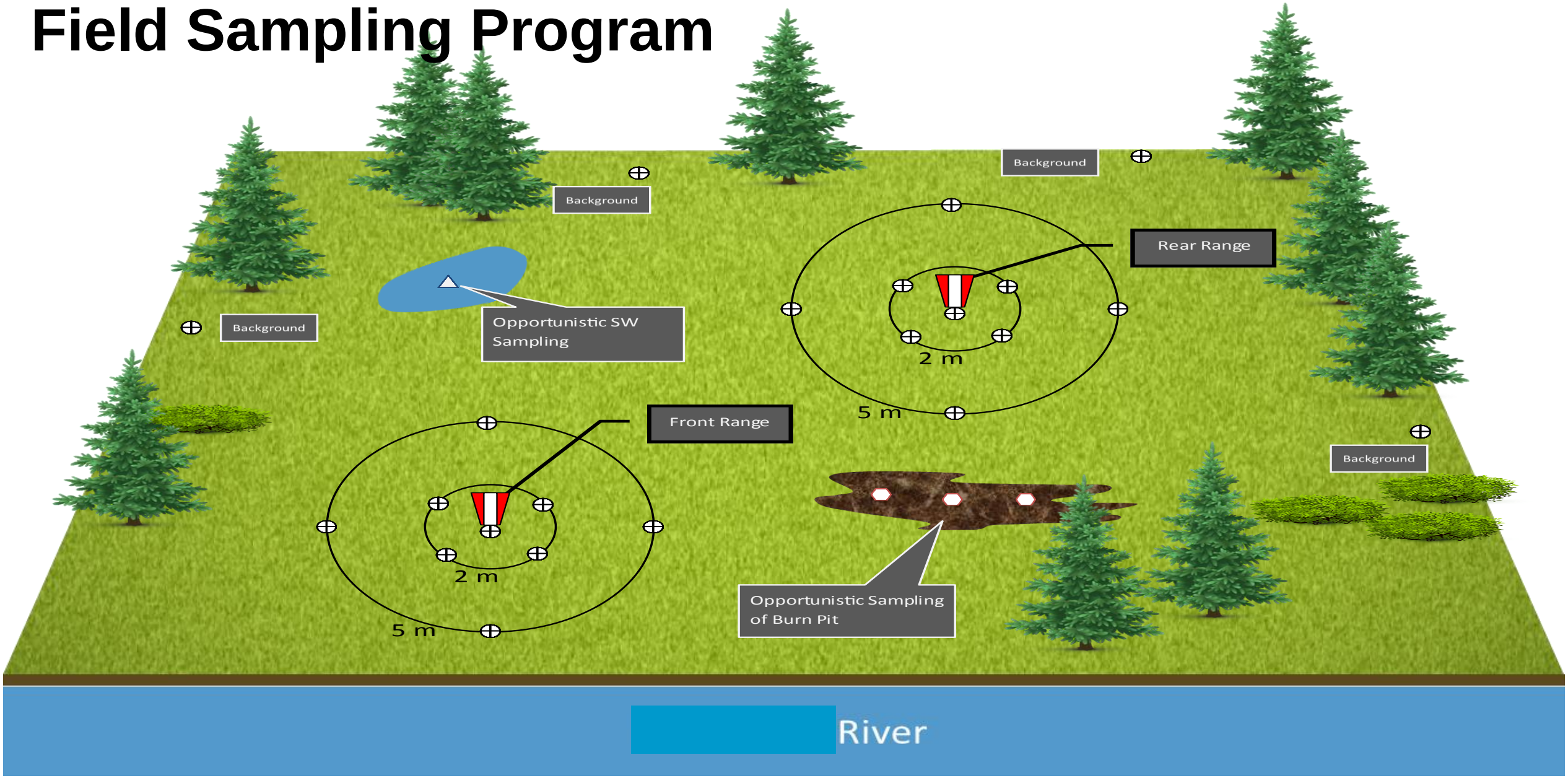
Field Sampling Program



⊕ Soil Sample
⬡ Opportunistic Soil Sample in Burn Pits
△ Opportunistic Water Sample

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Case Study

Data Management and Analysis Stage

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Likelihood and Magnitude of Contamination

Identified Site Features/Areas	# of Soil Samples
Total Number of Soil Samples	1110
Total Number of NAS	46
Sample Collection Breakdown	
Battery Disposal Areas	25 + 4
Battery Storage Areas	51
Helicopter Pad	43
Marker Towers	793
Background	189

Contaminant Class	# of Observations
Metals*	1048
Hexavalent Chromium	483
Boron (Hot Water Soluble)	426
Petroleum Hydrocarbons (CCME F1-F4)	120
Benzene, Toluene, Ethylbenzene and Xylenes	120
Polycyclic Aromatic Hydrocarbons	3
Dioxins and Furans	1
Soil pH	627

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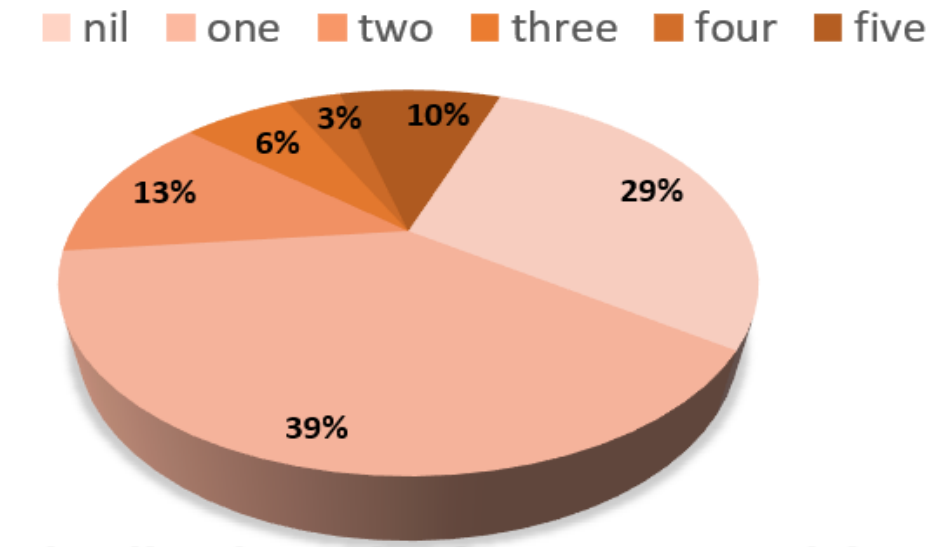
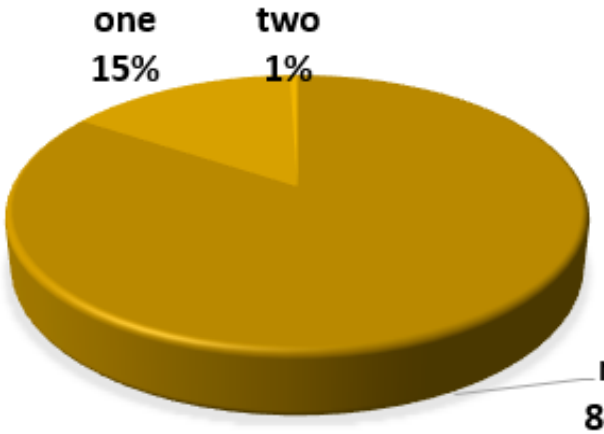
A-Prior Infrastructure Risk Weighting

A-priori risk weighting:

- Passive NAS with no batteries (score 0)
- Lights/Batteries (+1)
- Battery Disposal (+2)
- Fuel Storage (+1)
- Evidence of Historical Burn Pits (+1)
- Lead Paint (+1)



Distribution of Infrastructure Risk Weighting: Assessed NAS



DISTRIBUTION OF INFRASTRUCTURE RISK WEIGHTING: UNASSESSED NAS

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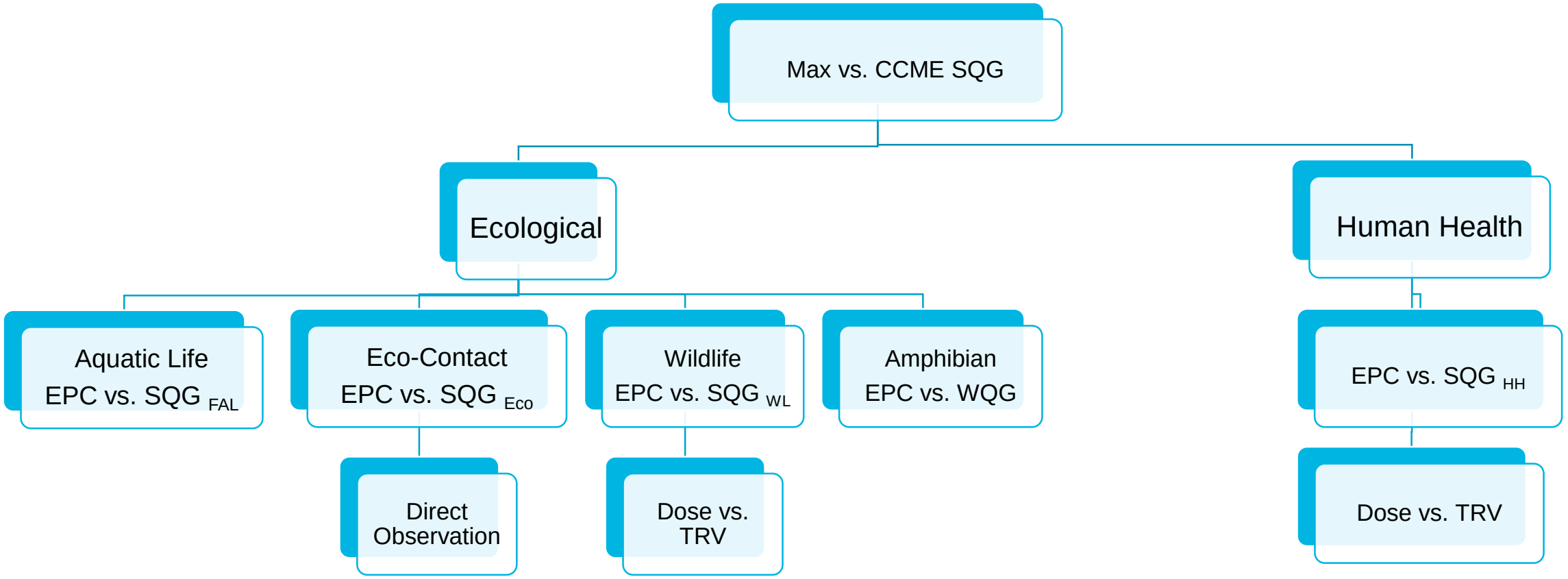
Benchmark Screening Approach: Site by Site



EPC = *exposure point concentration*: statistical upper bound site-by-site
Ratio EPC:SQG = Hazard Quotient (HQ)

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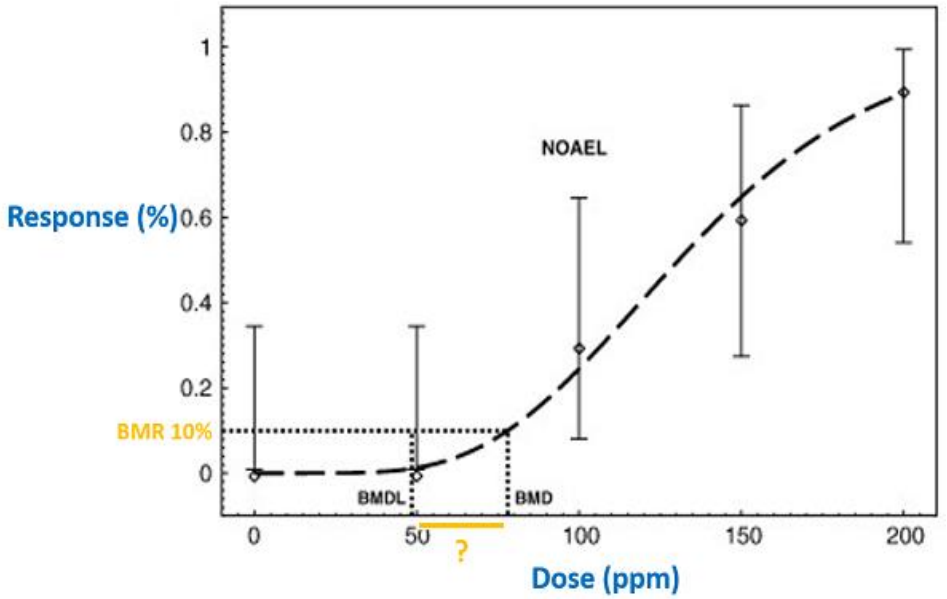
Benchmarks and TRVs

- **Soil Quality Guidelines (SQG)**
  - **Selection Criterion: Specificity to Receptor Group and Robust Science:**
    - **Council of Ministers of the Environment (direct human and eco-contact)**
    - **BC Contaminated Sites Regulation (aquatic life)**
    - **US EPA Eco-Soil Screening (wildlife)**
- **Toxicity Reference Values (TRV)**
  - **Health Canada (humans)**
  - **US EPA Eco-Soil Screening (wildlife)**



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Case Study

Results and Extension of Inference Stage

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Human Health RA Results

- Screening
  - 13% of NAS assessed fail initial benchmark screening
    - Arsenic, Lead, Mercury, Zinc, Copper
    - NAS Infrastructure Risk Weighting Between Nil - Five
- Dose Estimate
  - Health Canada's Guidance on less than chronic exposure
    - Tier 1 (Chronic Exposure Scenario vs. Chronic TRVs)
  - Final Hazard Quotients between 0.01 and 0.57
  - Incremental Lifetime Cancer Risk < 10^{-5}
- Human Health Risk Not Influencing Risk Rankings

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Weighting Ecological Lines of Evidence

Line of Evidence			Soil Based HQ/ Dose Estimate Line of Evidence	Biological Observation Line of Evidence
Attribute	Importance	Numerical Weighting		
Magnitude of Response	Negligible	0	HQ ≤ 1	-
	Low	1	1 < HQ < 2	-
	Moderate	2	2 < HQ < 10	-
	High	3	≥ 10	Observational Information (R.P. Bio.).
Evidence for Causality	Low	1	EPC relative to SQG	-
	Moderate	2	Dose relative to TRV	-
	High	3	-	Observational Information (R.P. Bio.)
Ecological Relevance	Low	1	EPC relative to SQG	-
	Moderate	2	Dose relative to TRV	-
	High	3	-	Observational Information (R.P. Bio.)

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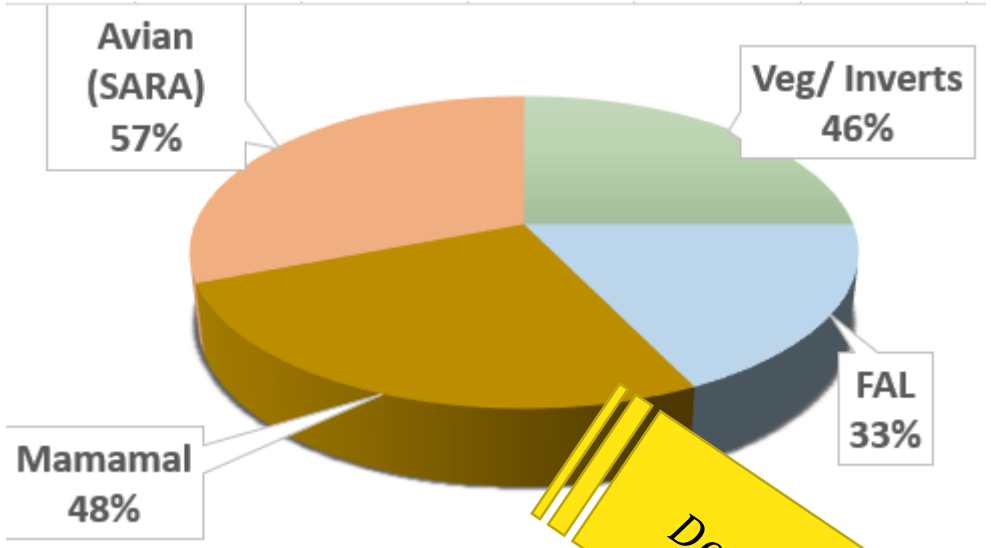
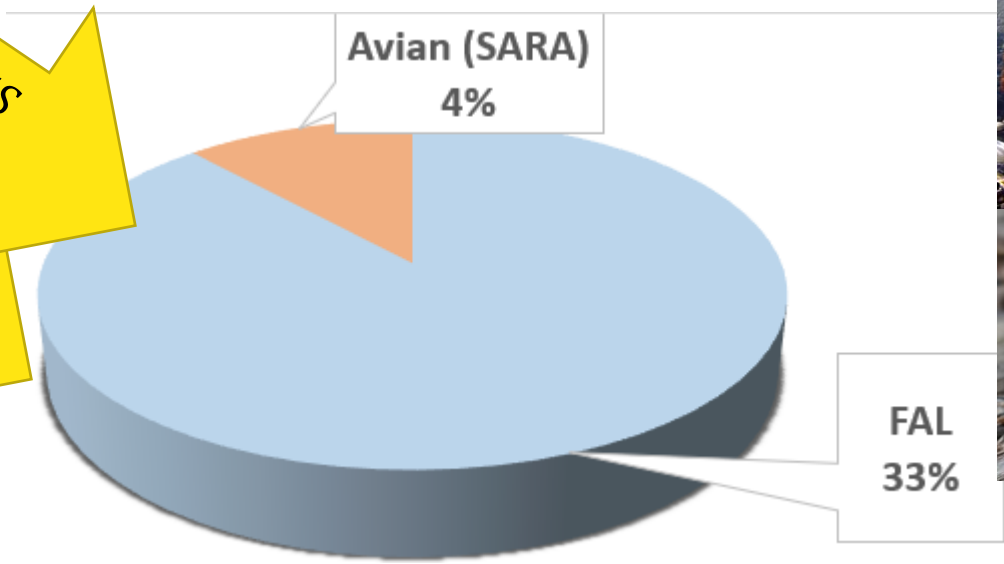
Ecological RA Results: % HQ > 1 in 46 NAS



$$\text{Dose} = \frac{IR_s \times C_s \times FS}{BW}$$

Biological Observation



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Risk Rankings by Receptor with Overall Risk Levels

Human Health Risk	Ecological Risk						Risk Level	Infrastructure Risk Rank
	Amphibians	Vegetation	Aquatic Life	Mammals	Avian SAR	Total Eco Risk Ranking		
0	0	0	**3**	0	**8**	**11**	High	5
0	0	0	**3**	0	**4**	**7**	Moderate	4
0	0	0	**3**	0	0	**3**	Low	1
0	0	0	**3**	0	0	**3**		3
0	0	0	**3**	0	0	**3**		3
0	0	0	**2**	0	0	**2**	Negligible	3
0	0	0	**2**	0	0	**2**		5
0	0	0	**1**	0	0	**1**		1
0	0	0	**1**	0	0	**1**		0
0	0	0	**1**	0	0	**1**		1
0	0	0	**1**	0	0	**1**		2
						1		2
						1		1
						1		0
0	0	0	**1**	0	0	**1**		1
0	0	0	0	0	0	0		1
0	0	0	0	0	0	0		0

$$RiskRank_{RoC} = Mag_{RoC} \times Caus_{RoC} \times Rel_{RoC}$$

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Data Gap / Uncertainties

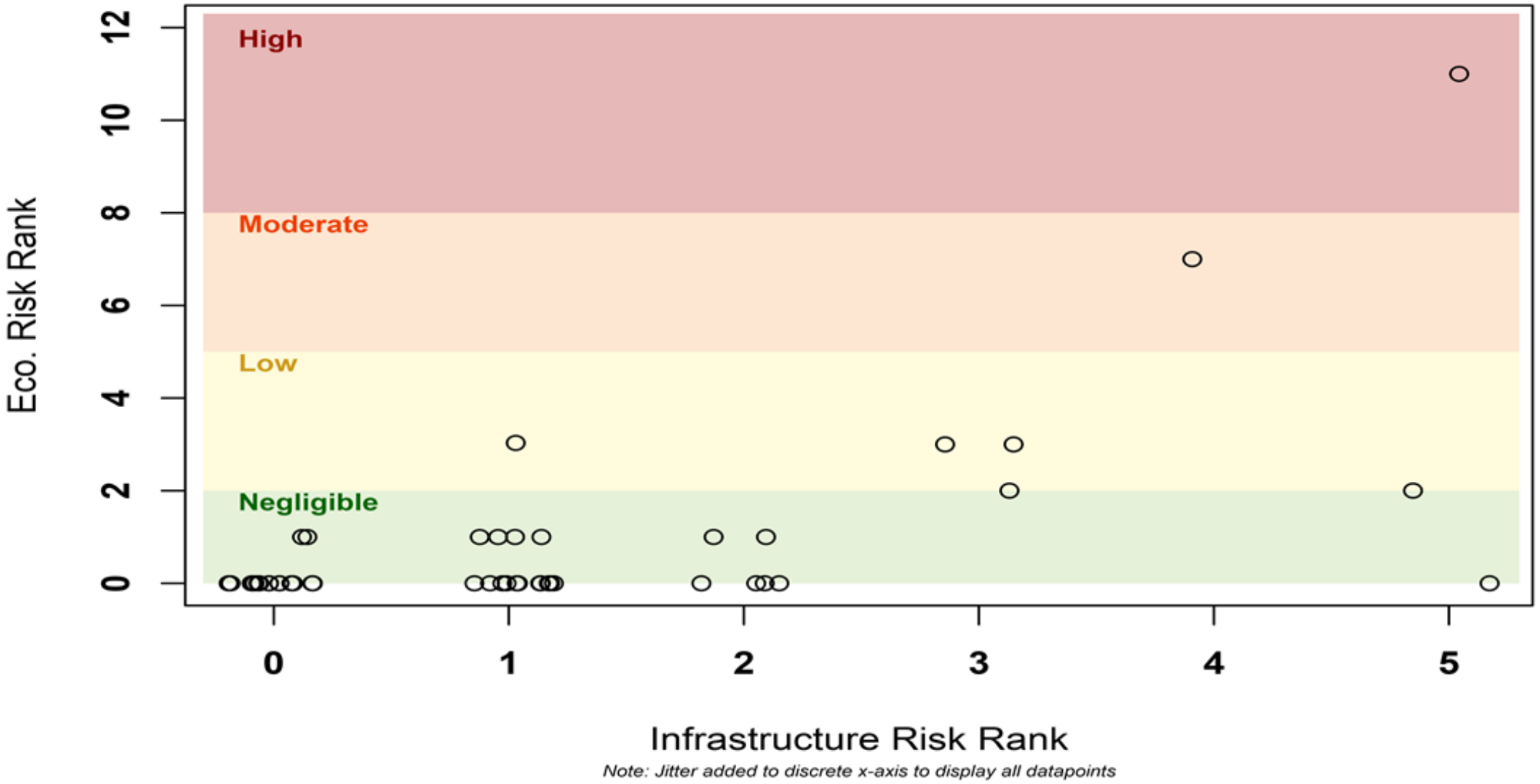
- Through Preparation / Planning
  - Mitigation of data gaps during field collection; and
  - Efficient use of field time to visit a maximum number of Sites

- Data Analysis on a Site-by-Site Basis
  - Eliminates the chance of overlooking high risk potentials that may have been missed in an area-wide, or watershed-wide “averaging” process

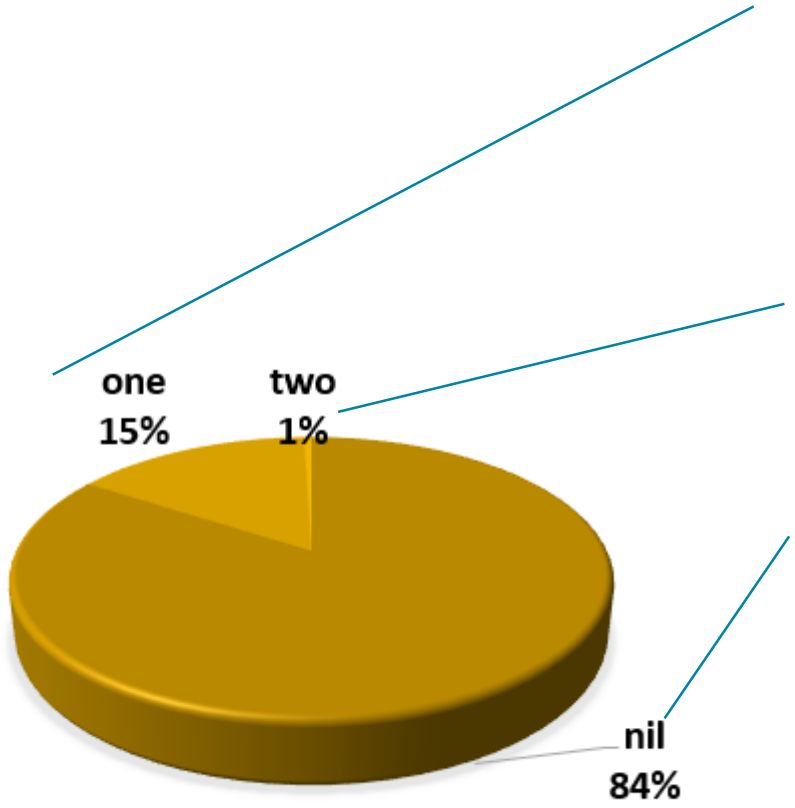
- Conservative Assumptions in Risk Assessment
  - Over estimate of human exposure given the remote nature of small NAS
  - Soil contamination often very small volumes associated with battery storage

- Uncertainties and Improvements
  - Soil based benchmark approach
    - Lacks the ‘ecology’
    - Rapid and comparable assessment of multiple Sites
  - Risk Ranking Driven by Uncertain States that Could Benefit form Secondary or Tertiary Lines of Evidence:
    - Aquatic Life: Soil leachate procedure, or install drive point piezometers
    - Avian SARA: DNA screening to validate presence/ absence

Extension of Risk Inference to All NAS



Extension of Risk Inference:
Predict Risk for 197 Unassessed NAS



DISTRIBUTION OF INFRASTRUCTURE RISK
WEIGHTING: UNASSESSED NAS

28 Lighted NAS – Insufficient Information
Minimal Data Collection Recommended
2 Lighted NAS (previously assessed) – Negligible Risk

1 Lighted NAS with lead paint (previously assessed) – Negligible Risk

166 Passive NAS – Negligible Risk

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Pros/Cons of Class Level Risk Assessment

Pros	Cons
Efficient and cost effective when assessing each Site is not feasible	Require database of properties / site history prior to assessment
Dataset can be updated and analysis rerun to maintain current liability records	Sites need to have similar infrastructure and undergo similar activities
Considers risks on Site-by-Site basis	If dataset too small, false associations may be drawn
Simplicity of soil based benchmark approach	Require environmental quality benchmarks
Results easy to communicate	-

Potential Uses and Benefits

Oil and Gas Leases ?

- **Similar Activities**
- **Small Footprint**
- **Limited Background Documents**

Benefits

- **Leveraged metadata on Sites sharing similarities**
- **Evidence based management and portfolio planning**
- **Operational and financial efficiencies**

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