Protecting Family Drinking Water in Rural Alaska

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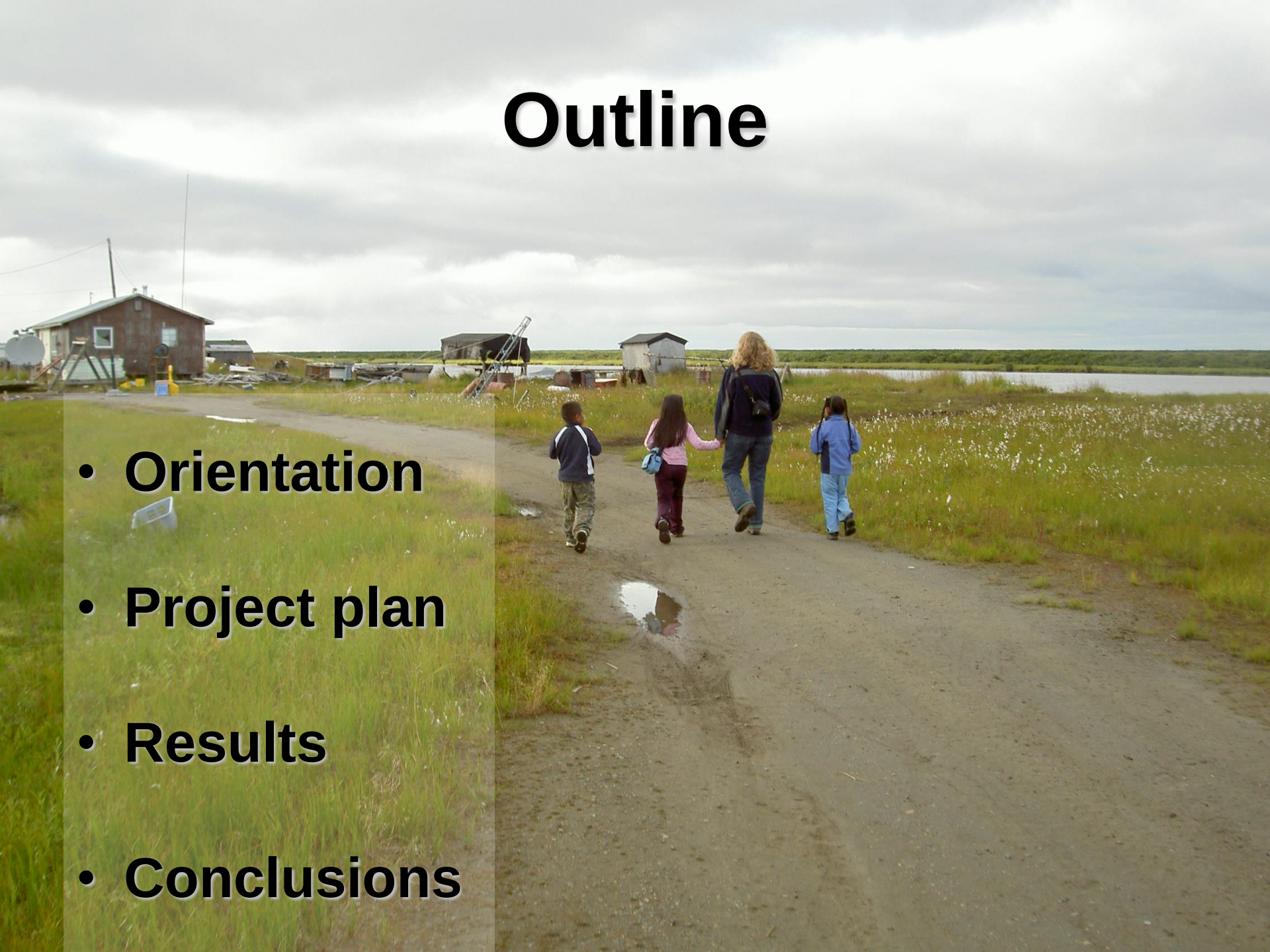
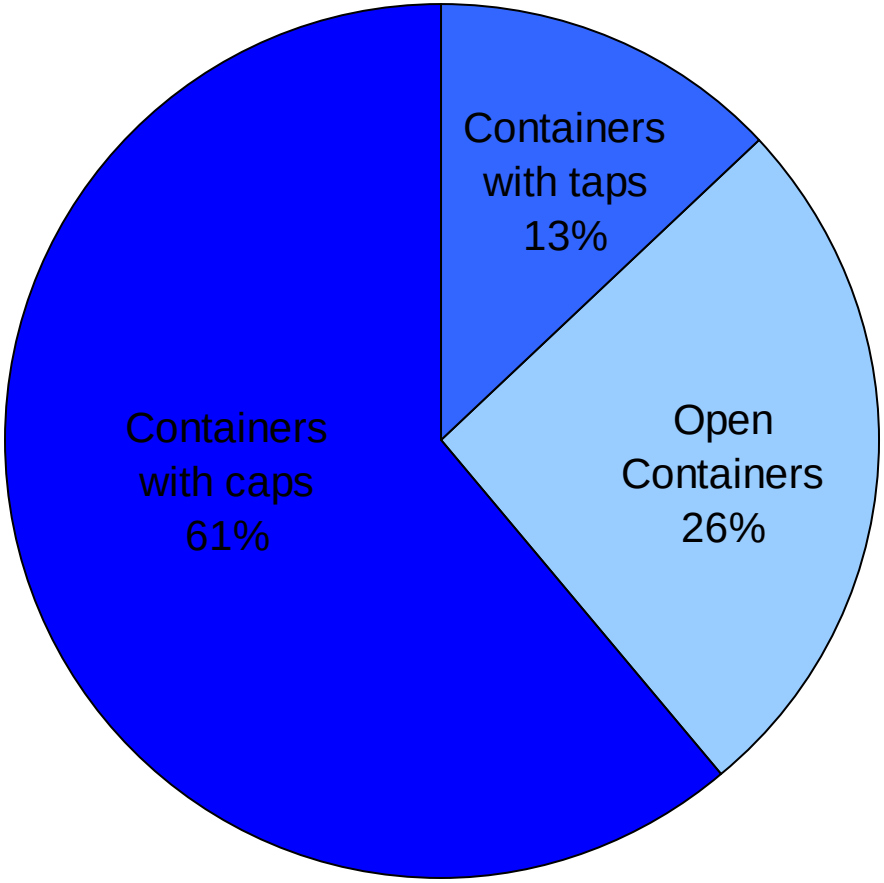
Outline

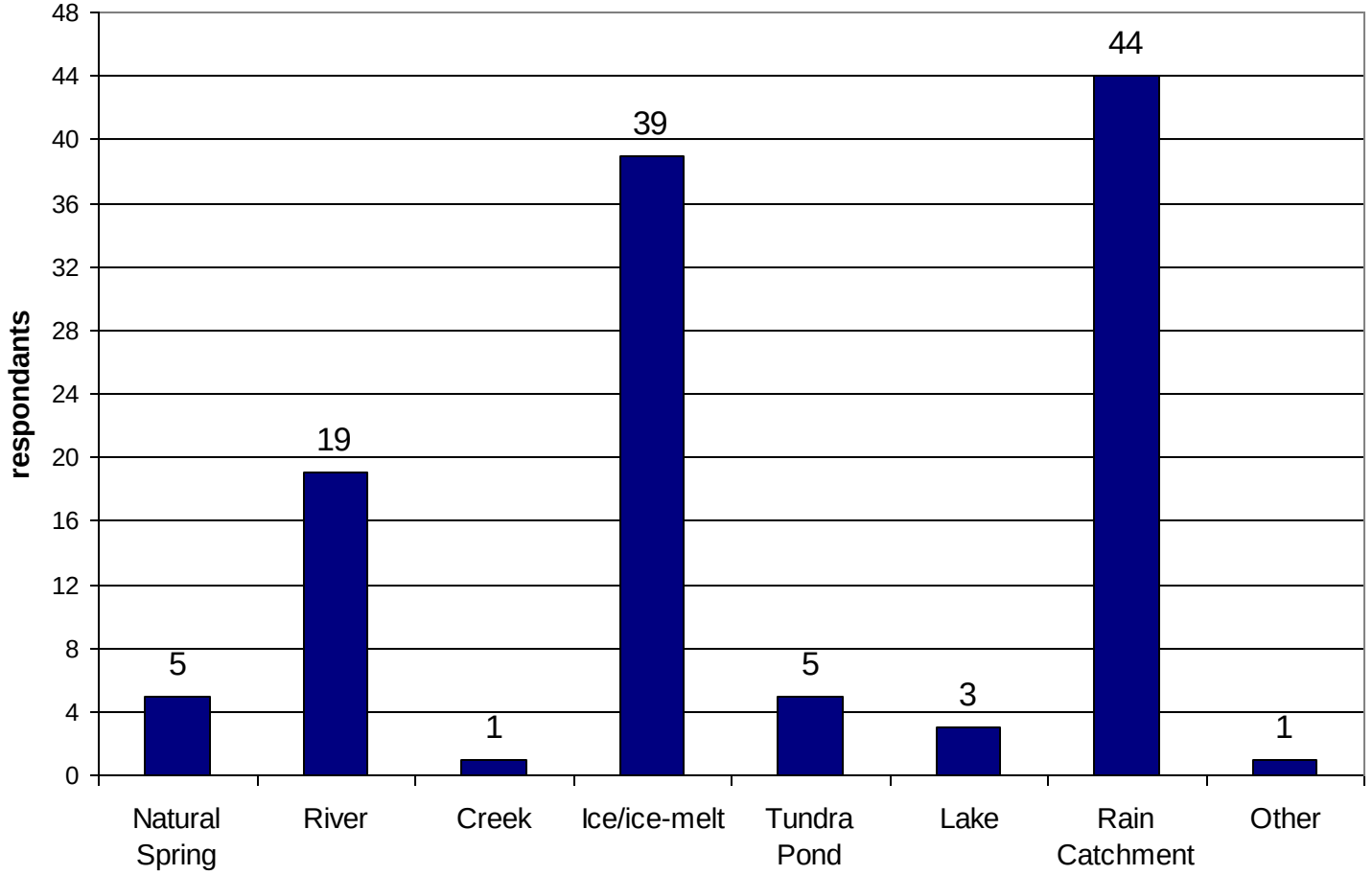


- Orientation
- Project plan
- Results
- Conclusions

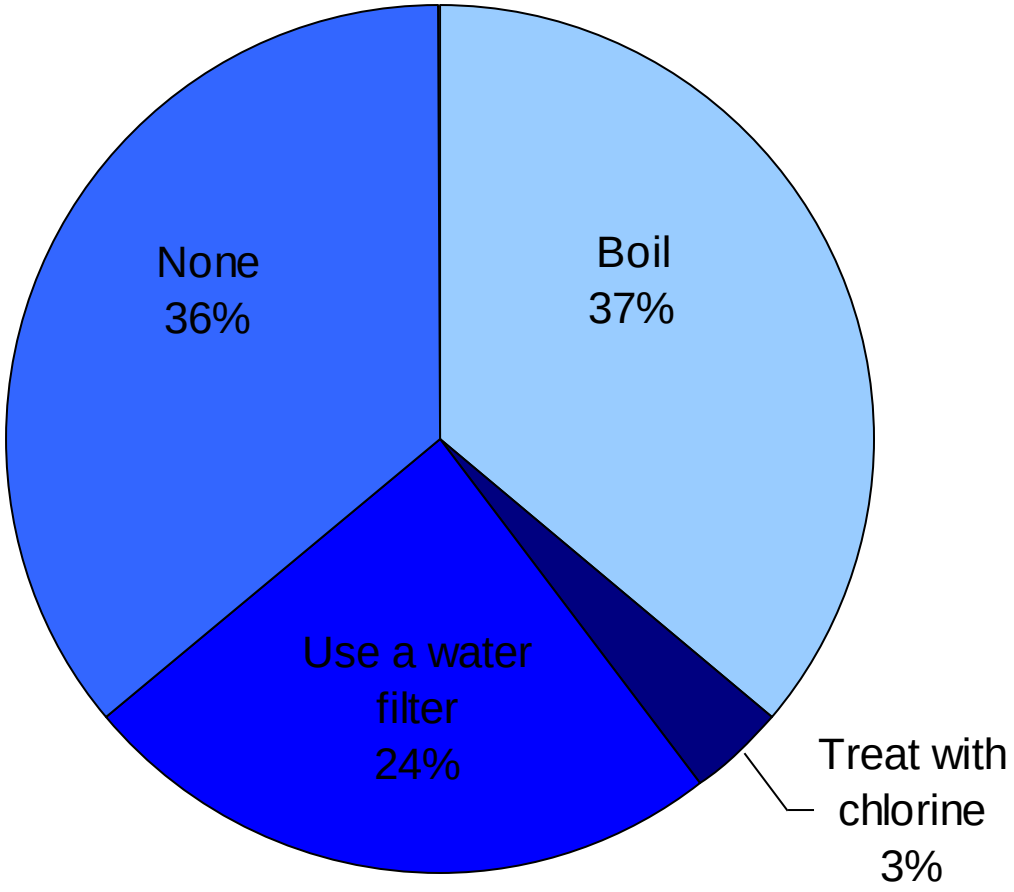
How do you transport water to your home?



Traditional drinking water sources used



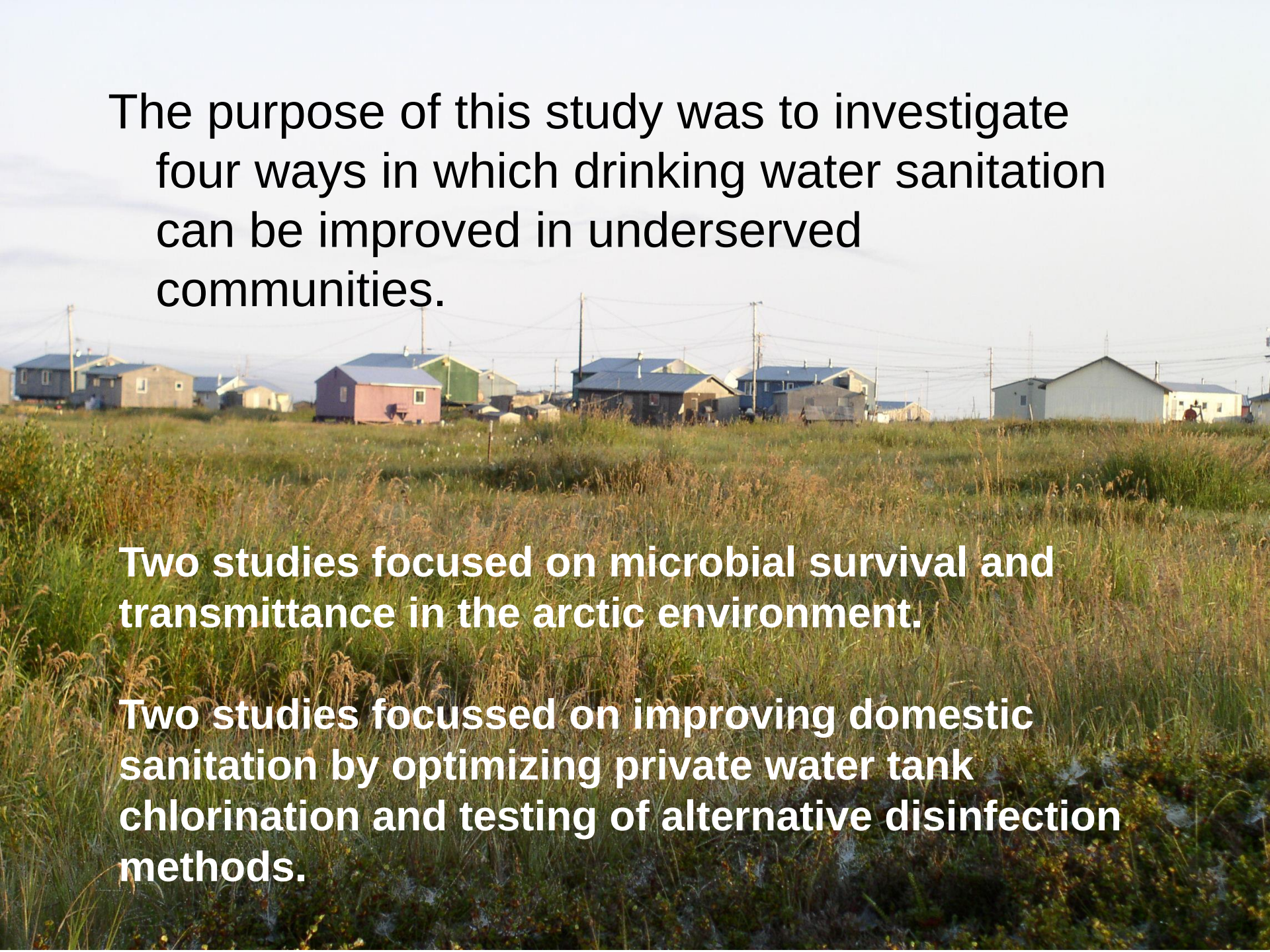
Means of purifying traditional drinking water



We seek to mesh traditional subsistence ways, healthy lifestyles, and new approaches to drinking water protection in rural Alaska.

Half of all project funds went to community involvement and outreach activities. We hope that the results from this research will benefit other communities.

Photo: Molly Chambers



The purpose of this study was to investigate four ways in which drinking water sanitation can be improved in underserved communities.

Two studies focused on microbial survival and transmittance in the arctic environment.

Two studies focussed on improving domestic sanitation by optimizing private water tank chlorination and testing of alternative disinfection methods.

Methods: sampling strategy

- Broad sweep—where is the contamination?
  - presence/absence samples between airports
- Puddles, lakes and river
  - total number samples from smaller area
- ATV and boot experiments

Samples and observations

- Broad outdoor sampling on a grid
- Source tracking methods
- Observation of flow
- Swabs of objects that move (ATVs, shoes)
- Swabs of surfaces inside
- Samples of stored water, collection surfaces, and wash water

Fecal indicators

- Colilert
  - Total coliform: not specific fecal indicator
  - ***E. coli***: fecal indicator
- Enterolert
  - ***Enterococcus***: fecal indicator
  - less susceptible to desiccation
- Enumeration (MPN)
  - Quantitray/2000
  - Range: < 1 to > 2419.6

Source tracking and pathogens

- Human vs. non-human bacteria by molecular markers
  - *Enterococcus*
  - Bacteroidetes

- *Giardia* and *Cryptosporidium*
  - In water: IMS/IFA
  - In stools: ColorPac, rapid immunoassay

ATV and Boot Experiments

- Do ATV tires move fecal contamination?
  - June: town + dump return
  - August: returning from dump ’06
  - July: returning from dump ‘07
- Do shoes bring fecal contamination inside?
  - June: volunteers around town
  - August:
    - 20 paths around town: town→school
    - 5 paths: mud→boardwalk

Coliform survival tests

Dog Poop
E. coli

Fly Safari

Birds as
Living
Dinosaurs

Wolves

Geese

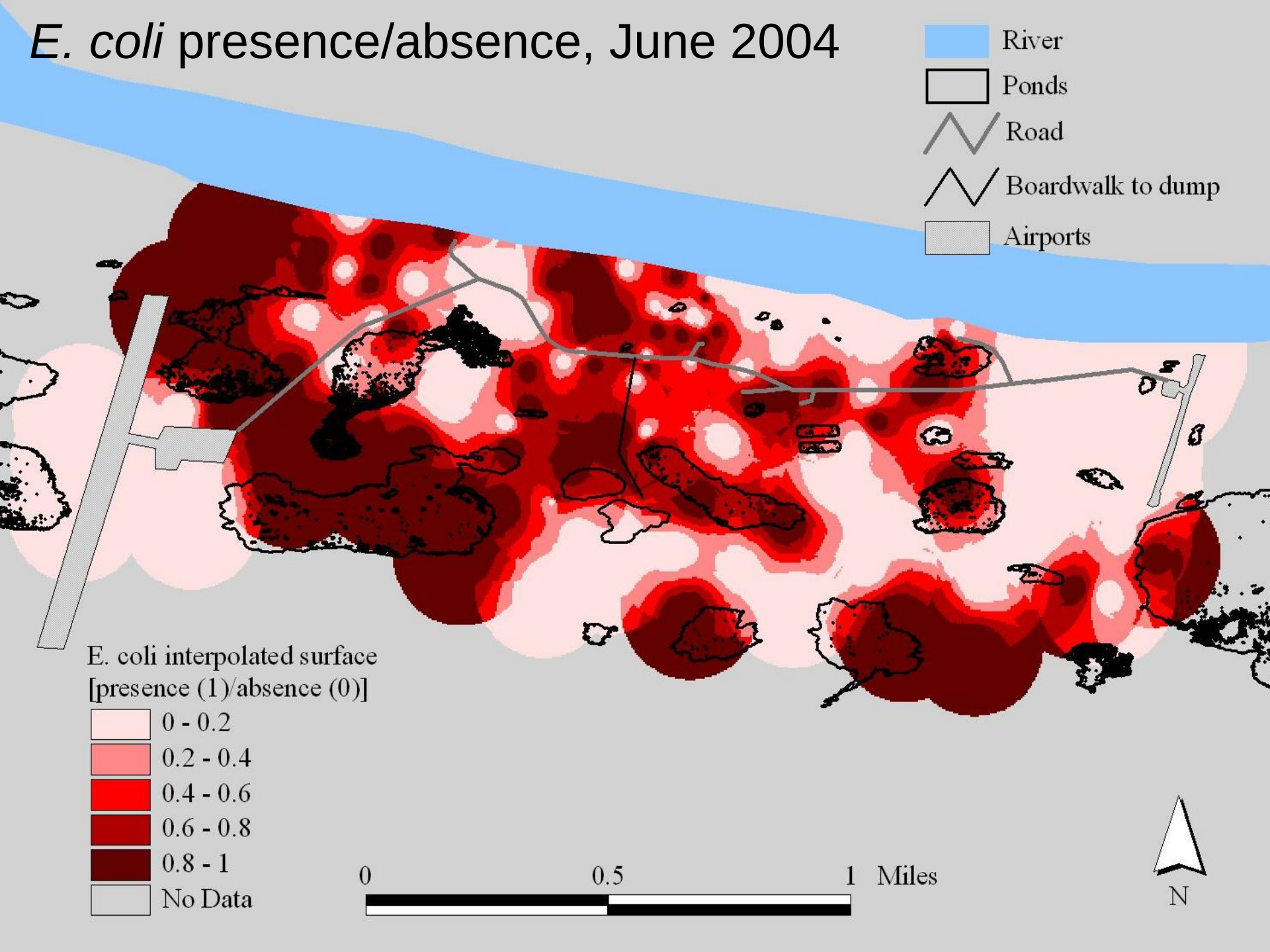
Handwashing

Eek School,
Alaska

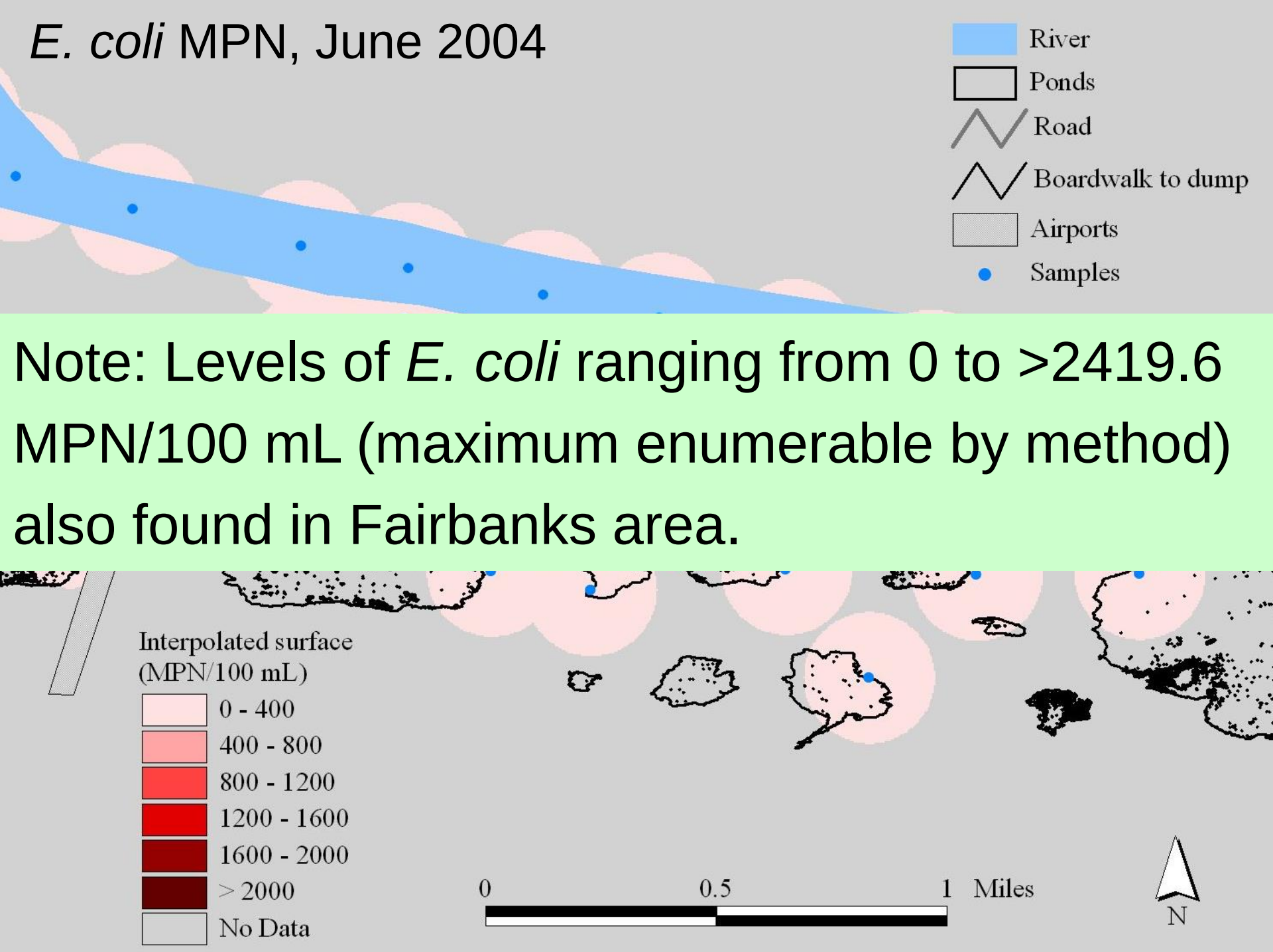
"Non-stop Science"

Results

E. coli presence/absence, June 2004

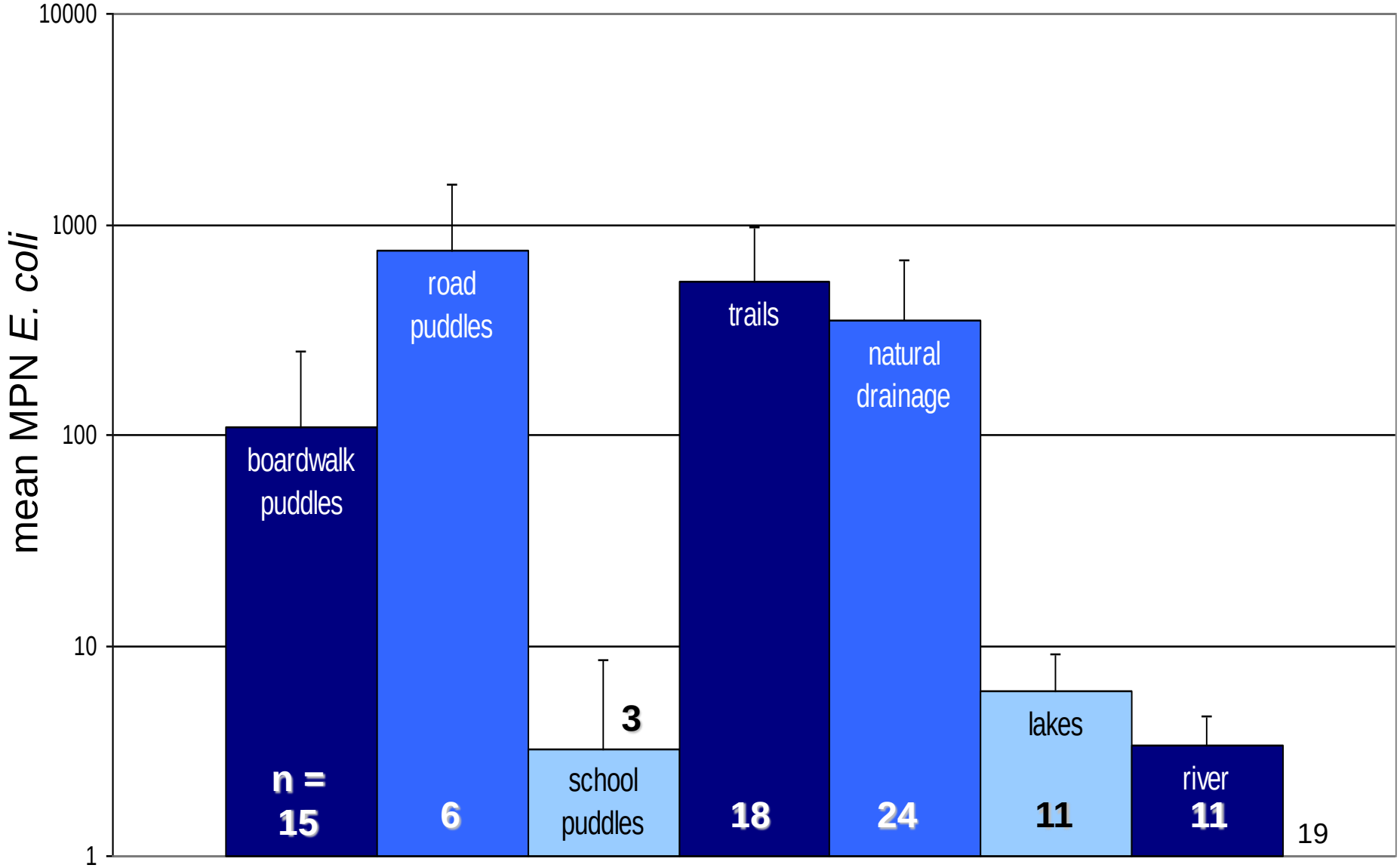


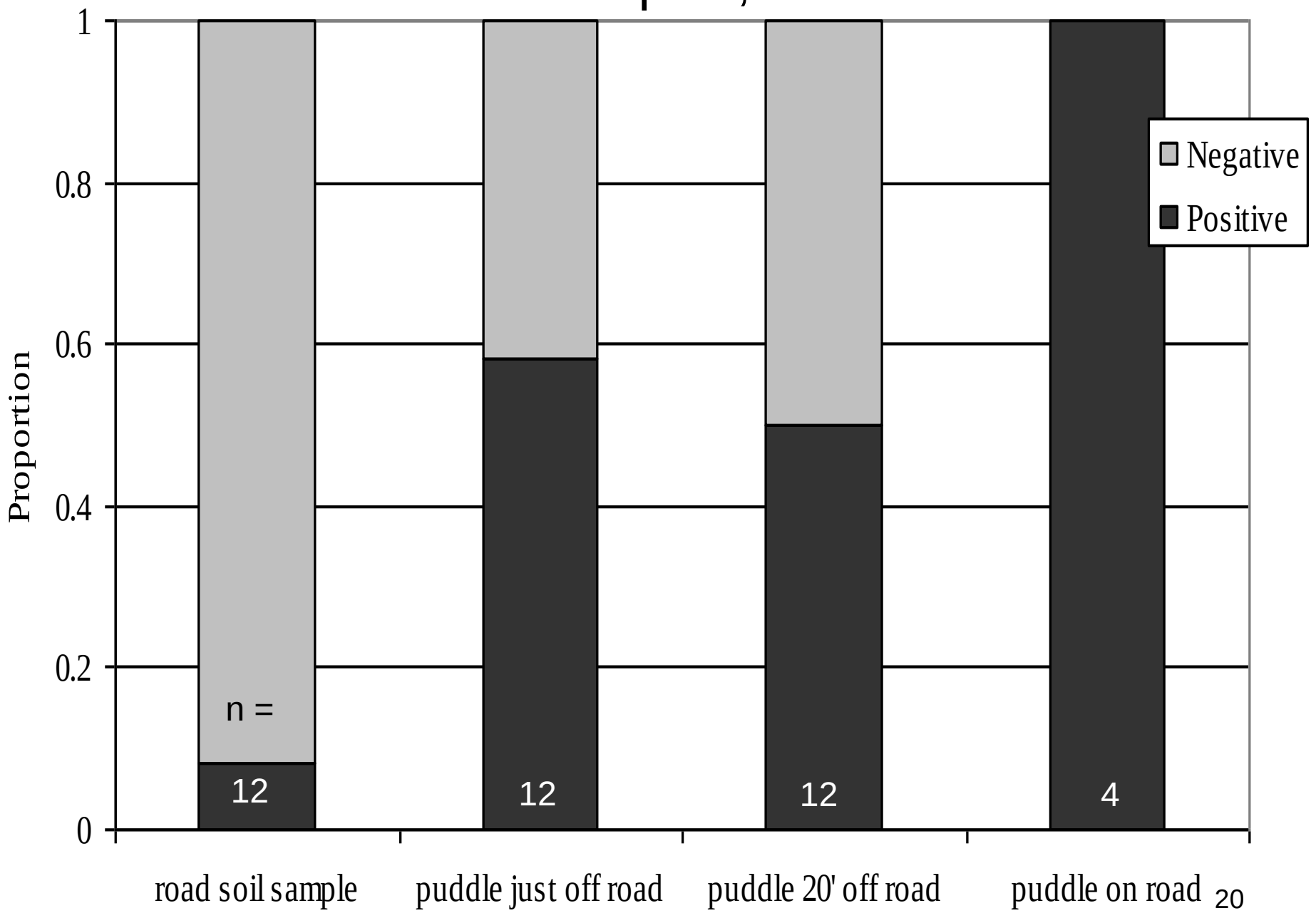
E. coli MPN, June 2004



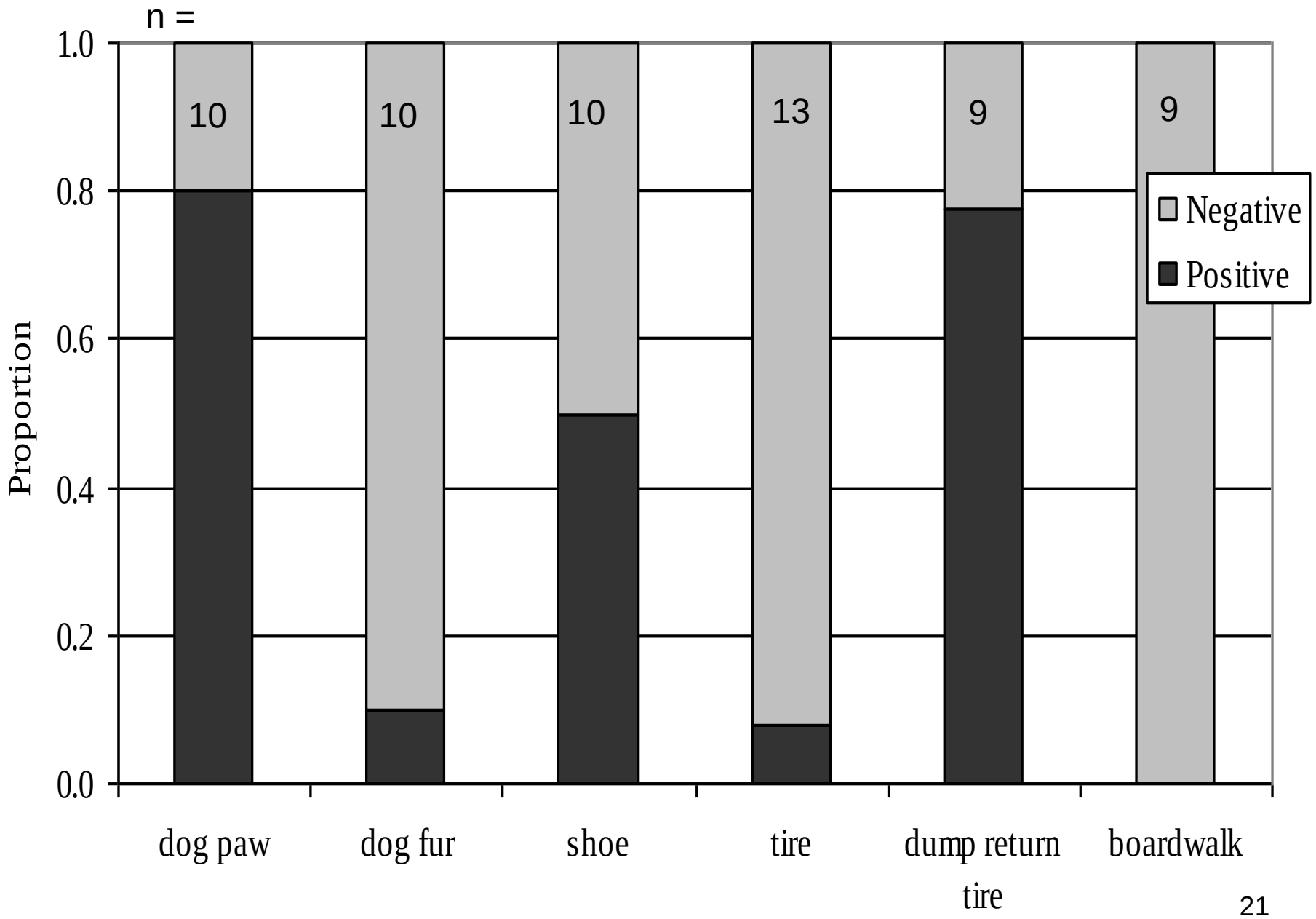
Note: Levels of *E. coli* ranging from 0 to >2419.6 MPN/100 mL (maximum enumerable by method) also found in Fairbanks area.

E. coli in puddles, lakes, and river

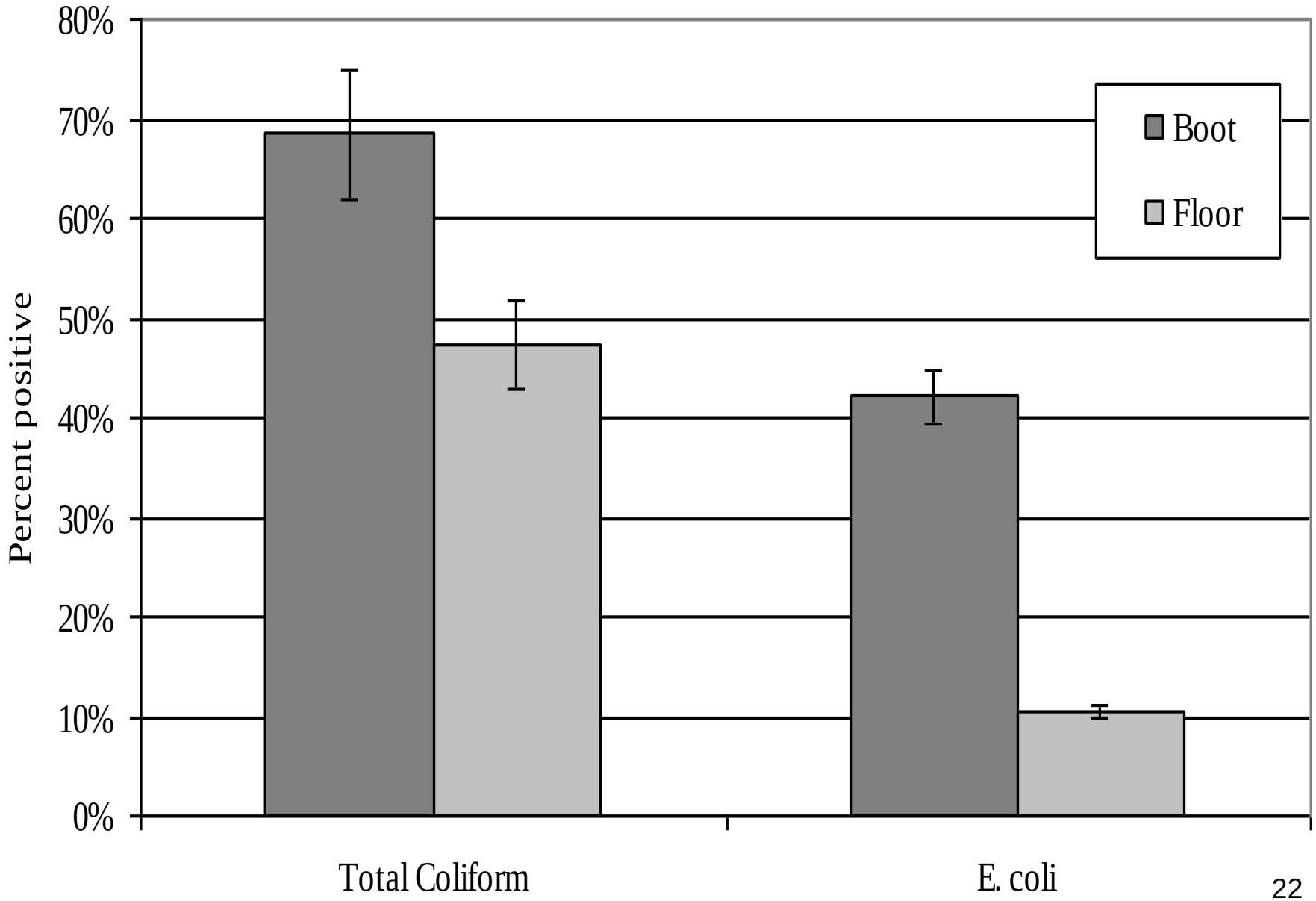



E. coli road samples, June 2004
1
0.8
0.6
0.4
0.2
0
Proportion
Negative
Positive
n =
12
12
12
4
road soil sample
puddle just off road
puddle 20' off road
puddle on road

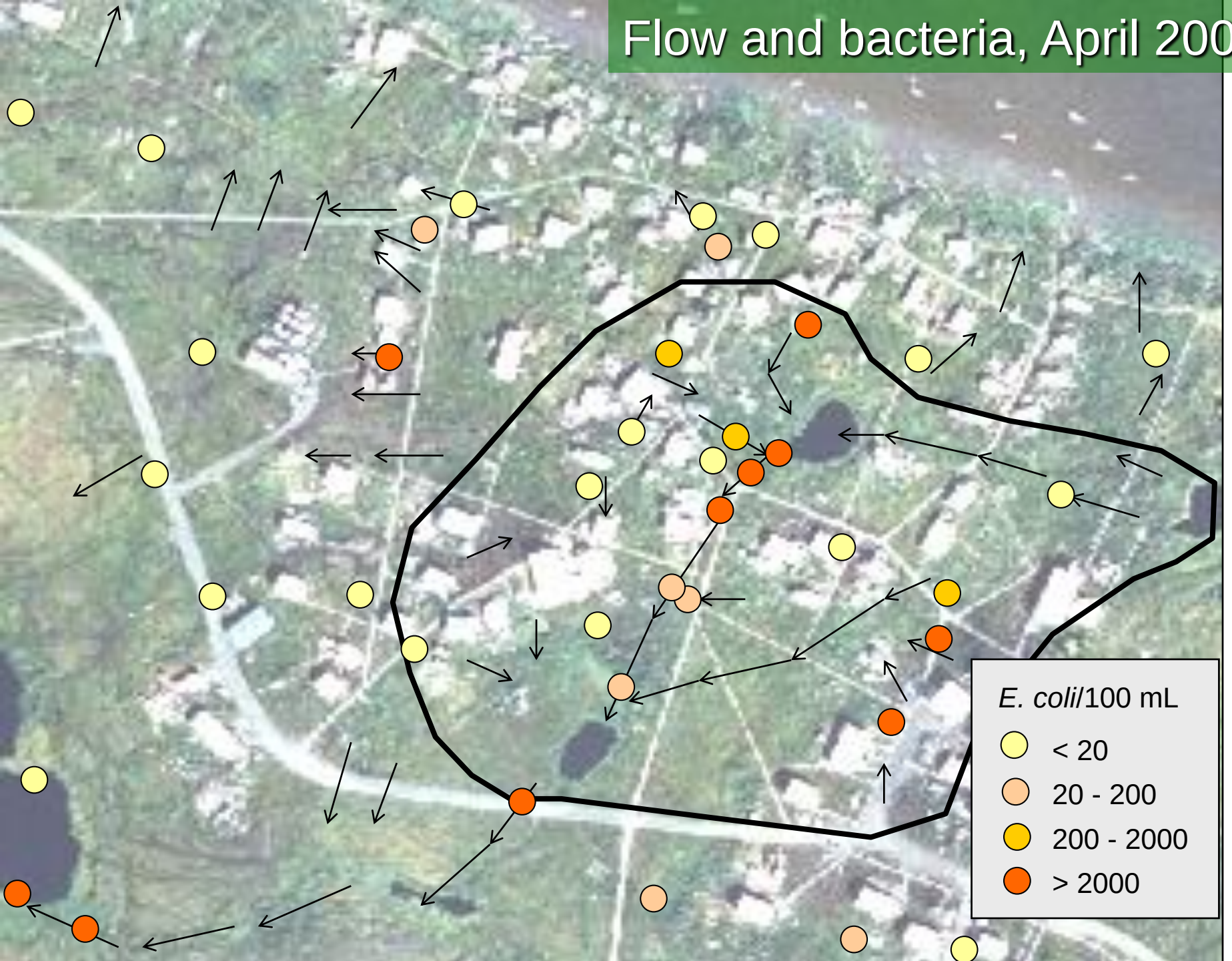
E. coli swabs, June 2004



Boot and floor swabs, August 2004



Flow and bacteria, April 2005



Surfaces—*Enterococcus* detected at least once

Home

- Kitchen counter
- Kitchen floor
- Water dipper

School

- Bathroom sink handle
- Bathroom stall handle
- Bathroom door
- Basketball

In Fairbanks...

Dry cabin with dog: kitchen counter, kitchen floor

UAF: bathroom door

Washbasins and Hands

- Total coliform in all basins
- *E. coli* rarely present
- *Enterococcus* usually present and > 1000 MPN/100 mL
- *Enterococcus* not detected on hands washed in basin (n = 4)

Water barrels and catchments

- No *E. coli* in barrels (n = 11)
- When multiple samples per home... (n = 4)
  - Increase in total coliform from outside to inside barrels, or inside barrel to inside bucket
- Catchment surfaces (downspout, roof, gutter)
  - No total coliform or *E. coli* (n = 1)
  - No *Enterococcus* (n = 3)
- Catchment-fed tank—no total coliform

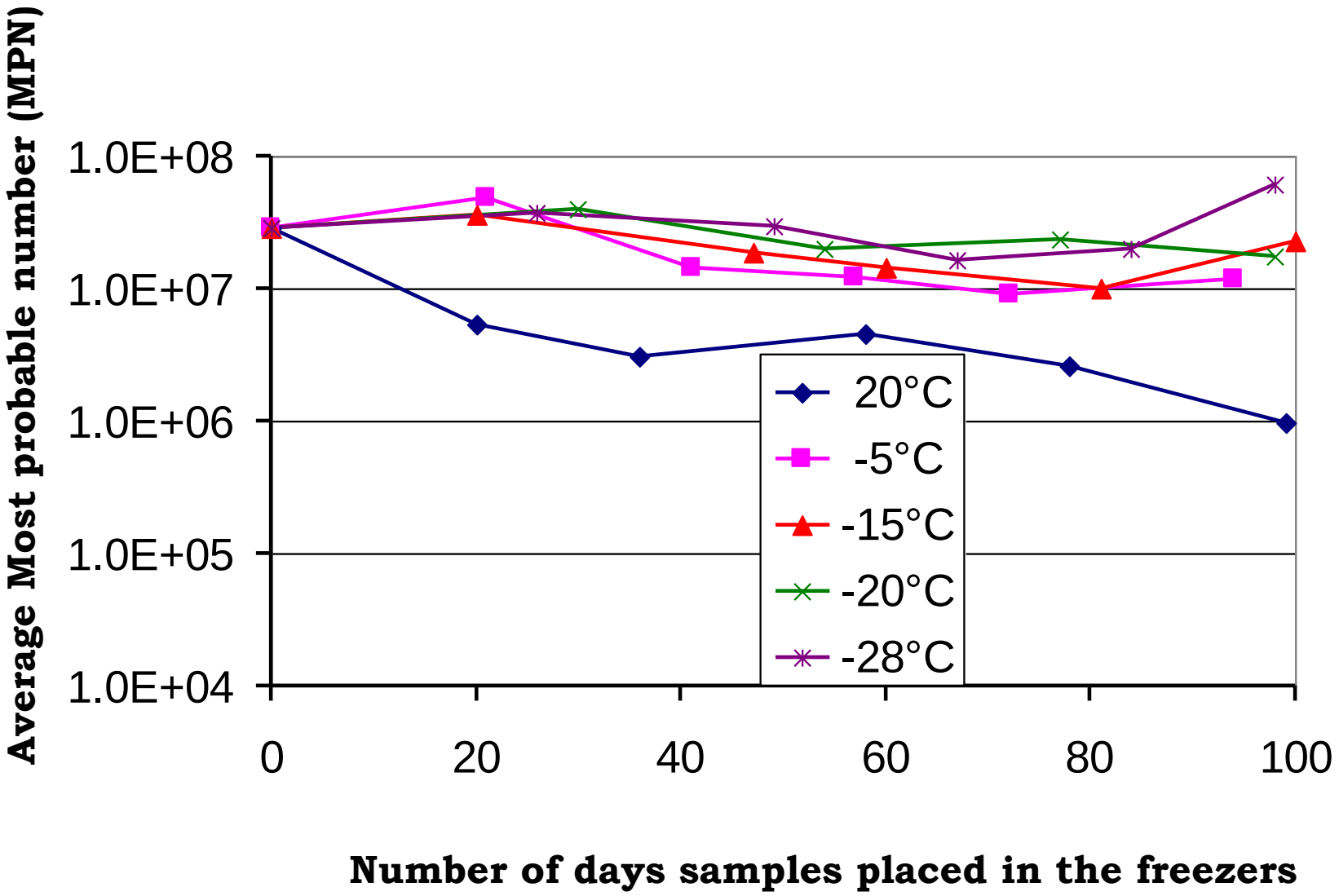
Source tracking, April 2005

	Enterococcus CFU/mL	***Human Enterococcus ID***	***Human Bacteroidetes ID***
Positive control	Inhibited	-	+
Negative control	$> 10^5$	-	-
Culvert sample	$> 10^5$	+	+
House pond sample	$> 10^5$	-	-

Cryptosporidium and *Giardia*

- Stool—no *Cryptosporidium* or *Giardia*
  - Dogs: 2 composite samples
  - Honeybucket bags at dump: 8 composite samples
- Water—no *Cryptosporidium*
  - Washeteria intake: no *Giardia* cysts/4 L
  - Dump pond: 5 intact *Giardia* cysts/3 L (more broken cyst walls)

Coliform population at 49% soil moisture content



Follow-up ATV experiment

i. Tarp experiment designed to simulate and test conditions when ATVs drive through tundra puddles after leaving the dump area.

ii. Puddle sampling at the dump and nearby community boardwalk intersections.

Honeybucket bags

Tarp Experiment (Tarp 1 Control)

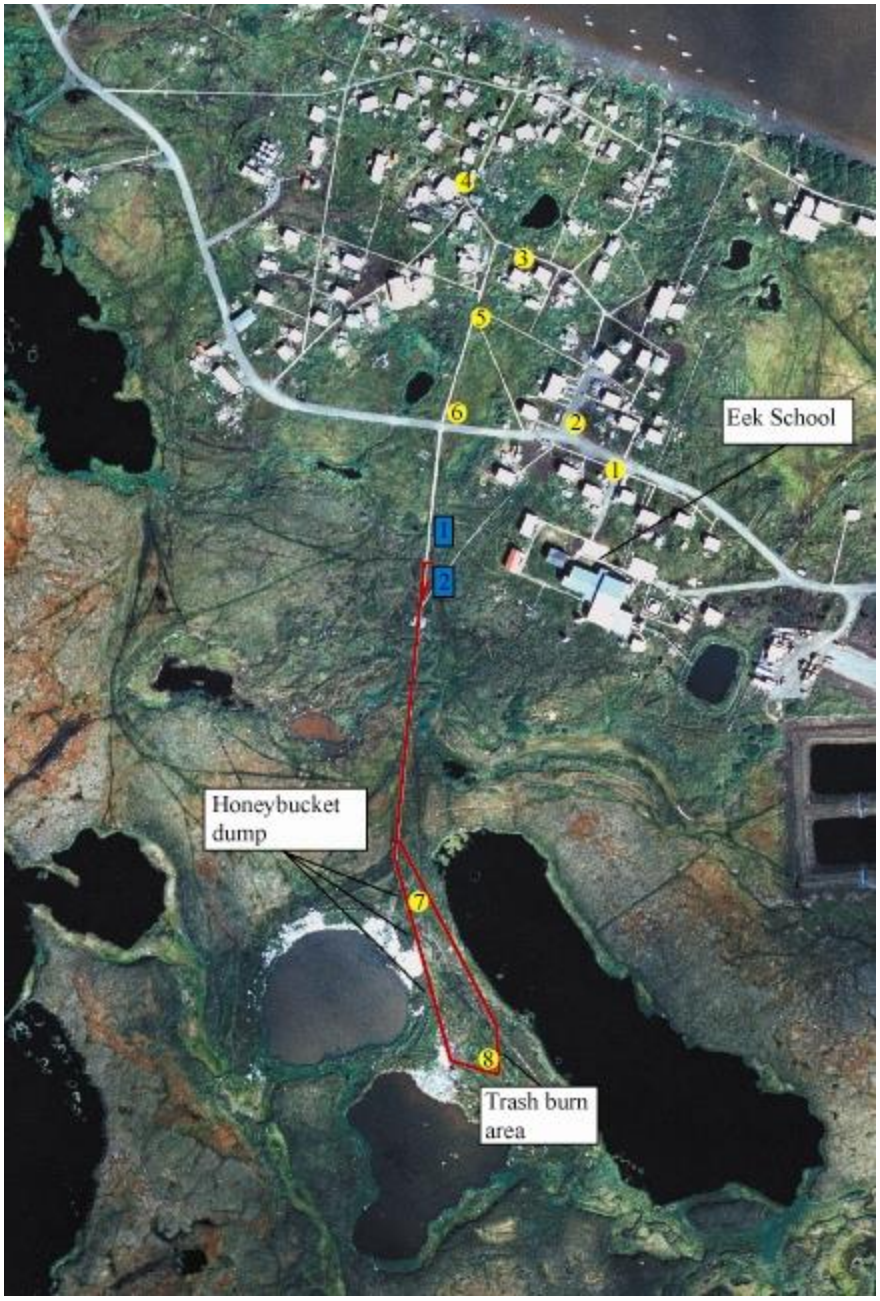
i. ATV was parked for 24 hours, after which it was driven on the dry gravel road to burn off any remaining *E. coli.*

ii. The machine was driven through Tarp 1 (distilled water) and a water sample + replicates were taken.

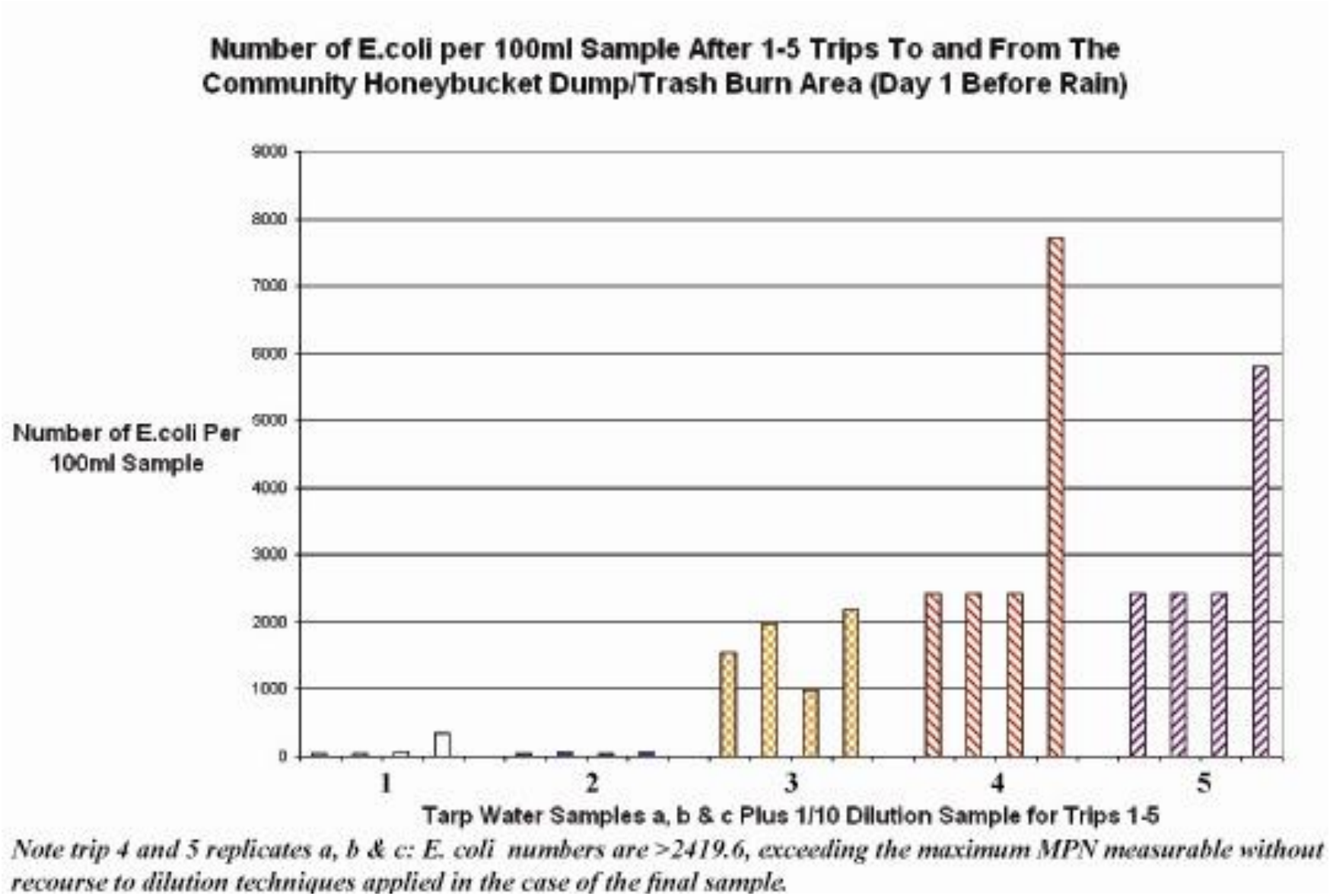
EPA IGAP Environmental Coordinator, Janet McIntyre completes a procedure to determine whether any E. coli are present on tires prior to the experiment

Tarp Experiment Method (Tarp 2)

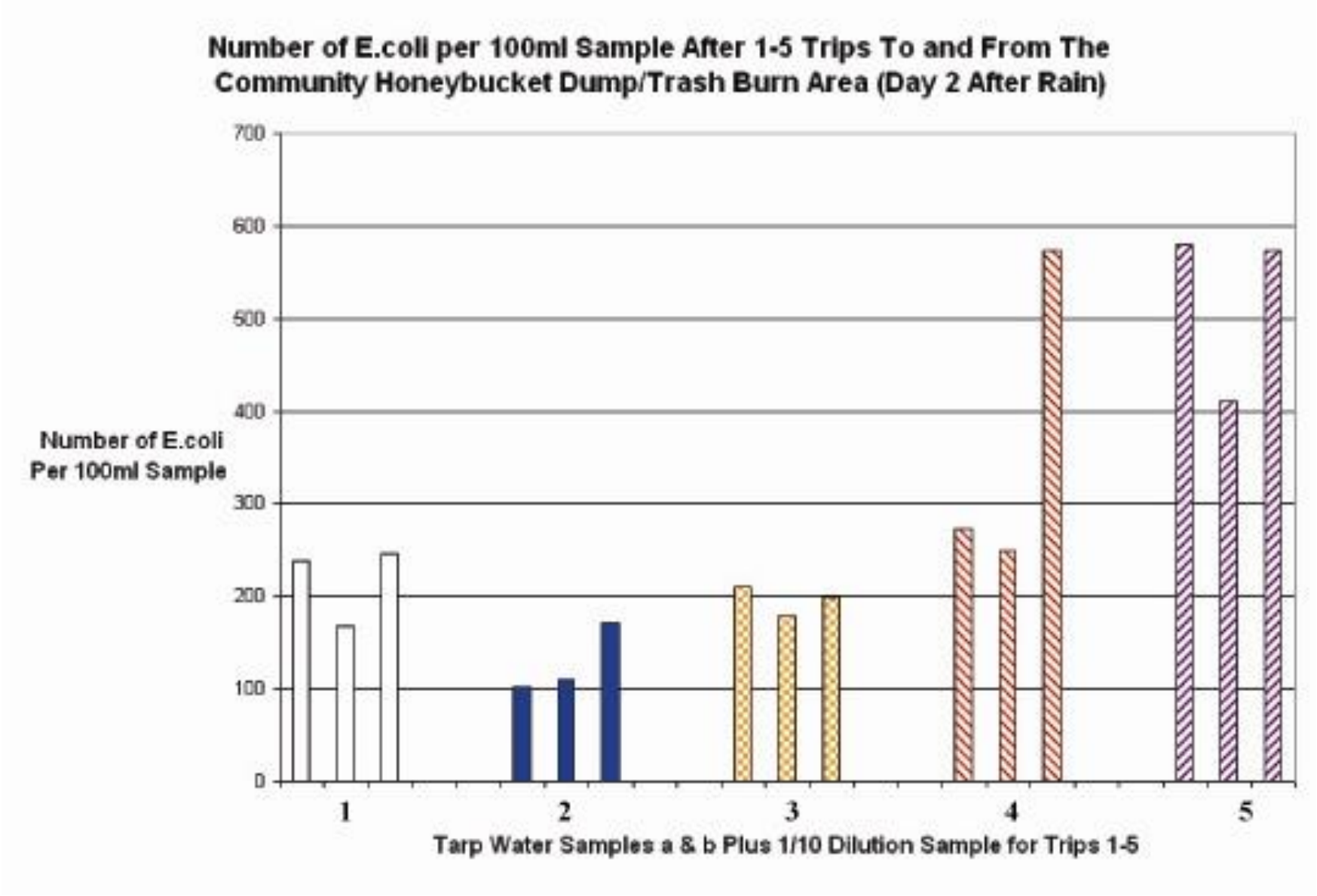
- The ATV was driven to the honeybucket dump and fire burn area (Red route) before crossing Tarp 2.
- A water sample plus replicates were collected and the procedure was repeated 4 times.
- Tarp 2 experiment was repeated on day 2, after rain.



Results – Tarp 2, Day 1



Results – Tarp 2, Day 2



Conclusions

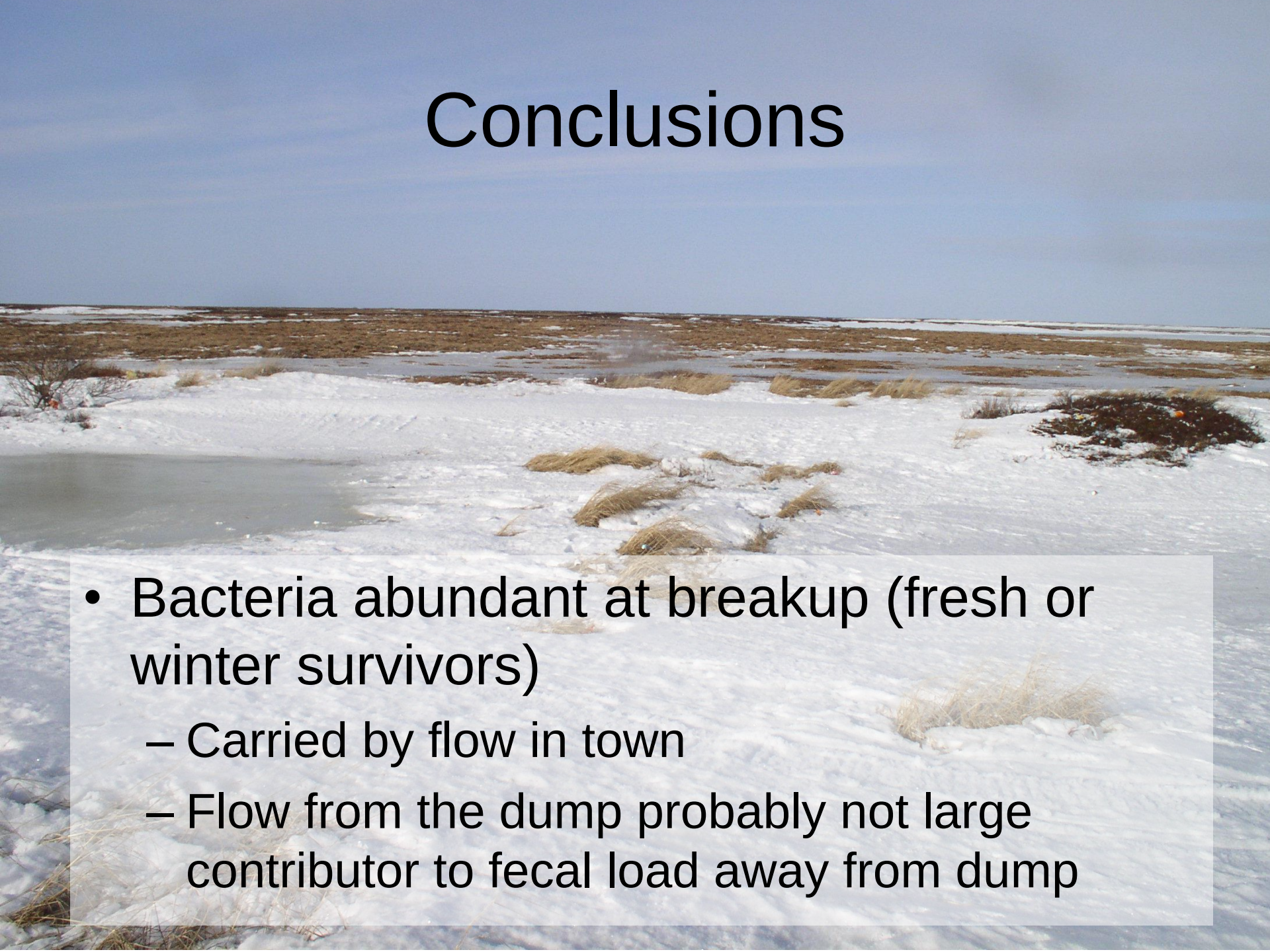
- More than a background level of fecal bacteria present in the village
  - Much visibly attributable to dogs
  - Some molecularly attributable to humans

Conclusions

- Fecal contamination can be transported from the dump on ATV tires and into the house on shoes

Photo: Malcolm Ford

Conclusions



- Bacteria abundant at breakup (fresh or winter survivors)
  - Carried by flow in town
  - Flow from the dump probably not large contributor to fecal load away from dump

Conclusions

- Surfaces not frequently or heavily contaminated, however...
  - Dippers
  - Kitchen counters

Contact with
food and water

Conclusions

- Washbasin water contains viable fecal bacteria
  - Potential source of pathogens within home
  - Gray water disposal is potential source of outdoor human fecal contamination in town

Photo: Malcolm Ford