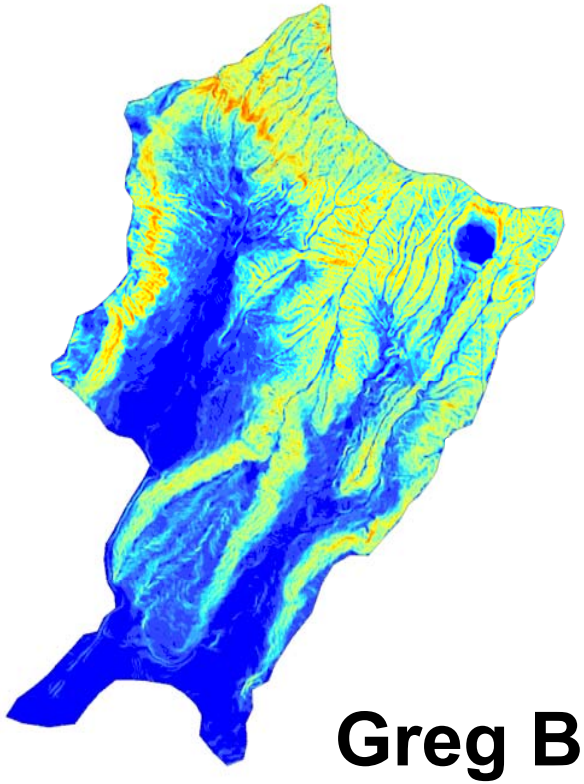
Effects of Feral Pigs on Runoff & Water Quality in the Mānoa Watershed: Experimental Design & Preliminary Results



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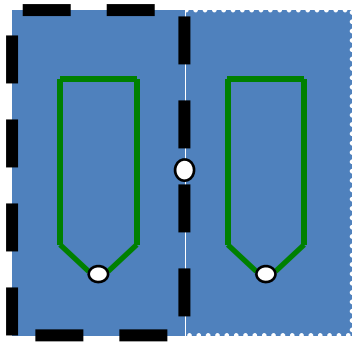
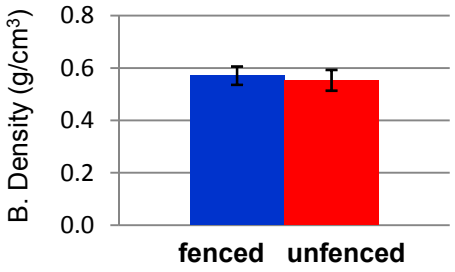
Outline

- Justification
- Previous research on ungulate browsing
- Project objectives & hypotheses
- Experimental design & sampling
- Preliminary results
- Conclusions



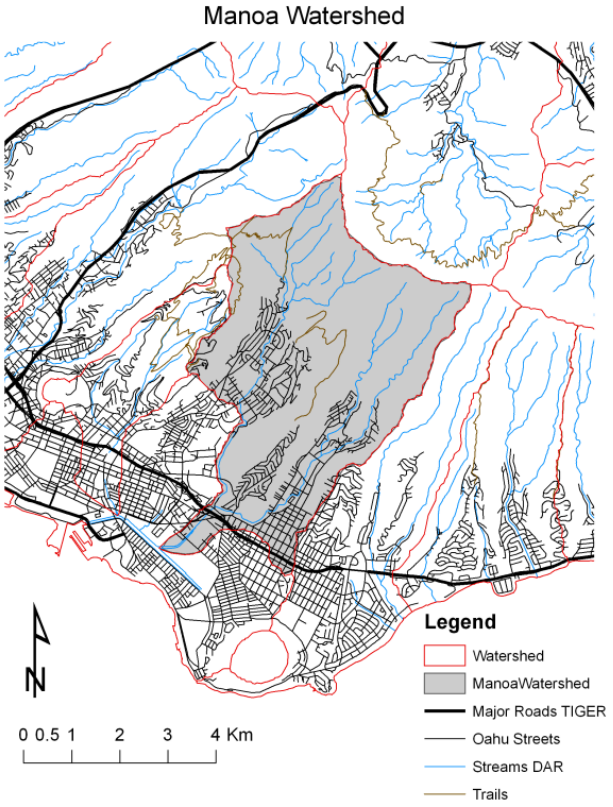


Introduction

- HI DoH (1993) estimated that as much as 75% of the sediments in the Ala Wai Canal come from forested areas in upper sections of the Mānoa watershed

- Recently, a number of community meetings held about feral pigs and hunting program was initiated

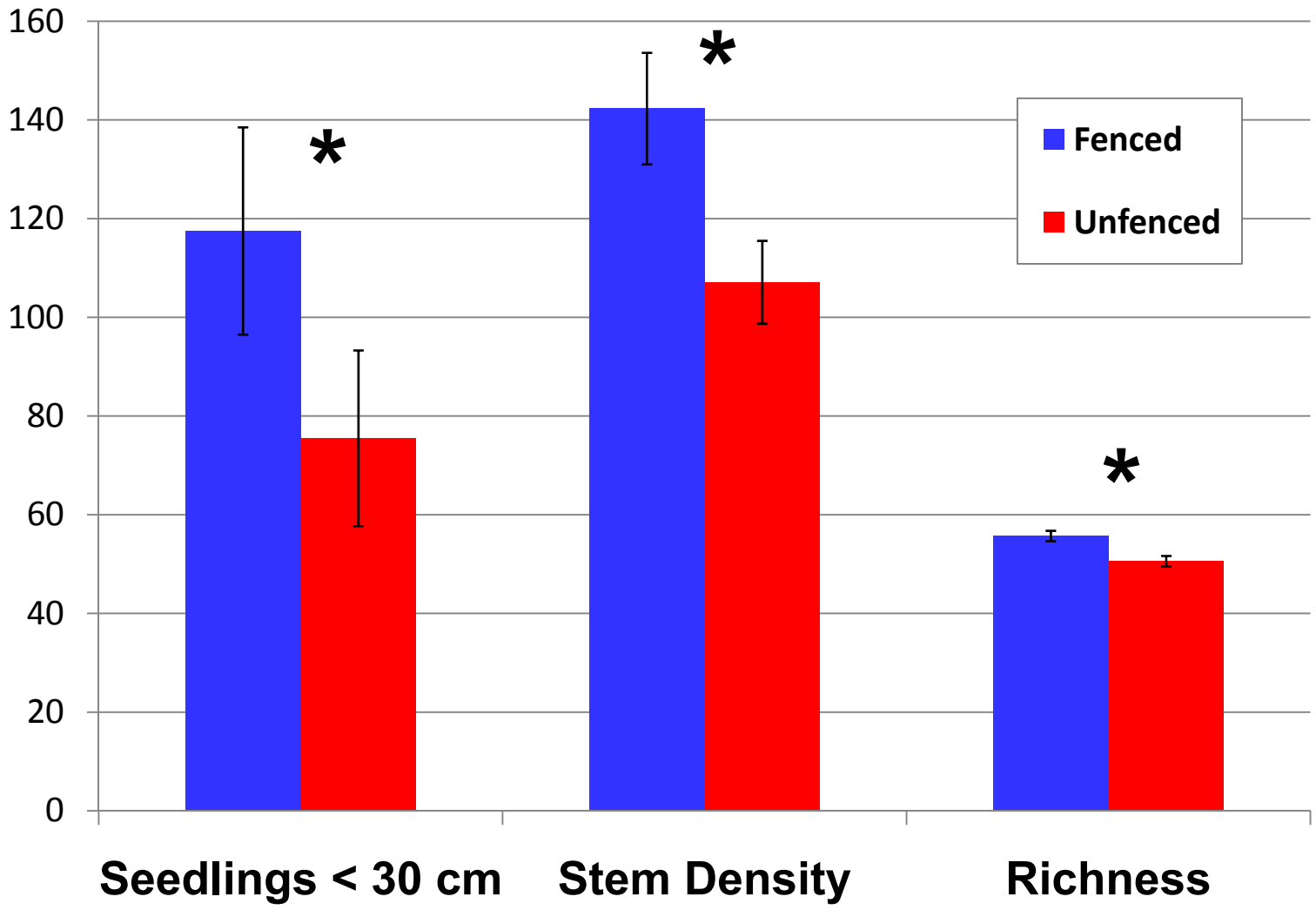
- *To what degree do feral pigs contribute to runoff and erosion in this watershed?*



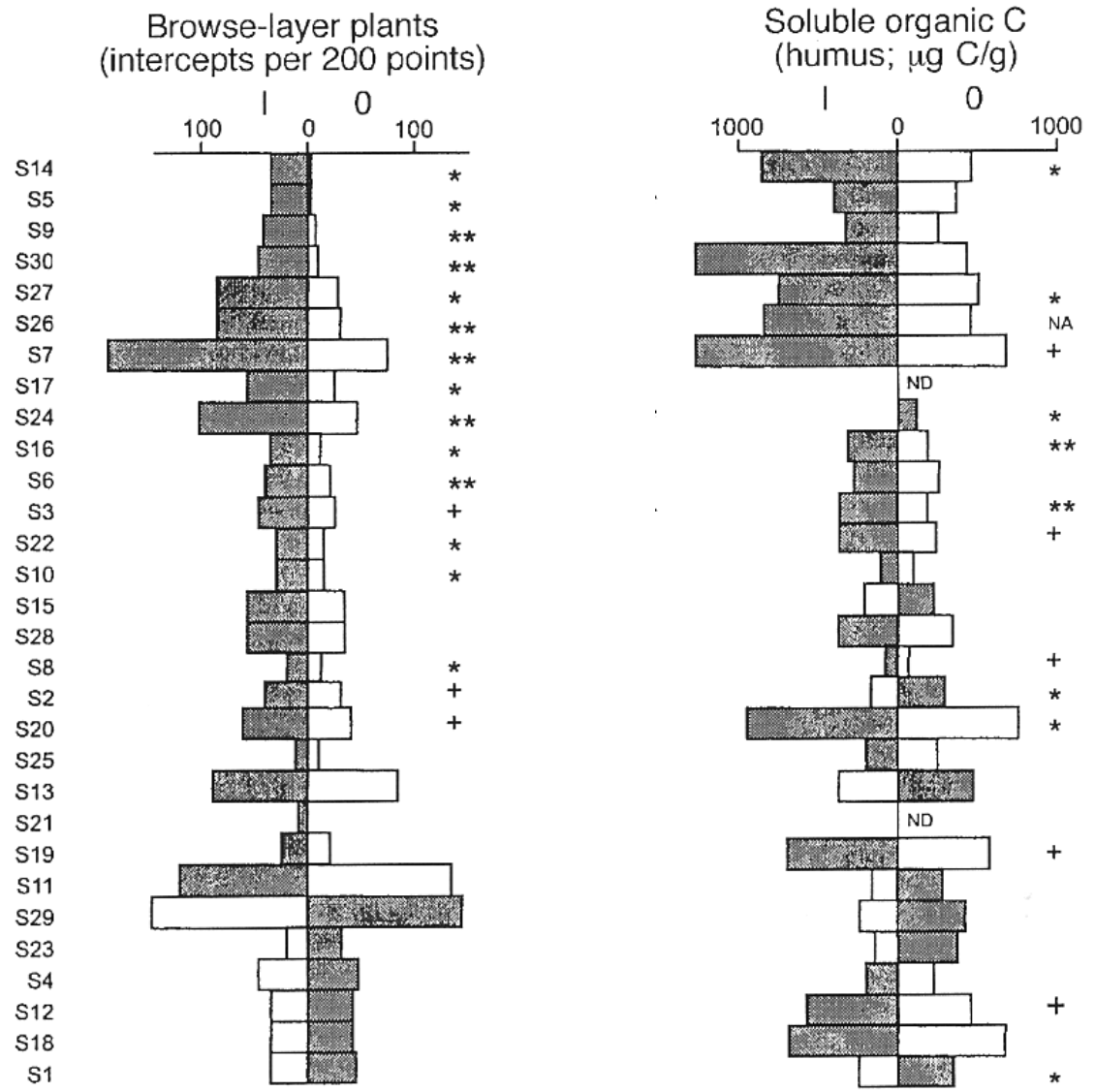
Previous Studies in HI, NZ, Aust., etc.

- Feral ungulates impact plant density, plant diversity, recruitment (Bratton ‘75, Stone & Loope ‘87, Ickles et al. ‘01, Wardle et al. ‘01)
- Feral pigs damage & destroy vegetation via browsing, felling, debarking, creating wallows, treading on paths (Diong ‘82, Anderson ’94, Ickes et al. ‘01)
- Feral pigs are vectors for exotic plant species in HI (Diong ‘82, Stone & Loope ‘87, Anderson ‘94)
- Feral ungulates effect soil nutrient levels, mineralization rates, arthropod communities (Howe ‘79, Singer et al. ‘82, Wardle et al. ‘01)

A hāpuʻu knocked over and browsed by feral pigs



(Modified from Ickes et al. 2001)



I = Inside exclosure
O = Outside exclosure

Shaded bar indicates larger value.

FIG. 2. Plant density and soil chemical properties inside and outside of 30 browsing mammal exclosure plots. I, inside exclosure; O, outside exclosure. For each panel, locations are arranged in order of decreasing effect of browsers on the density of plants in the browse layer (calculated as [density inside exclosure − density outside exclosure]/[density inside

(Wardle et al. 2001)

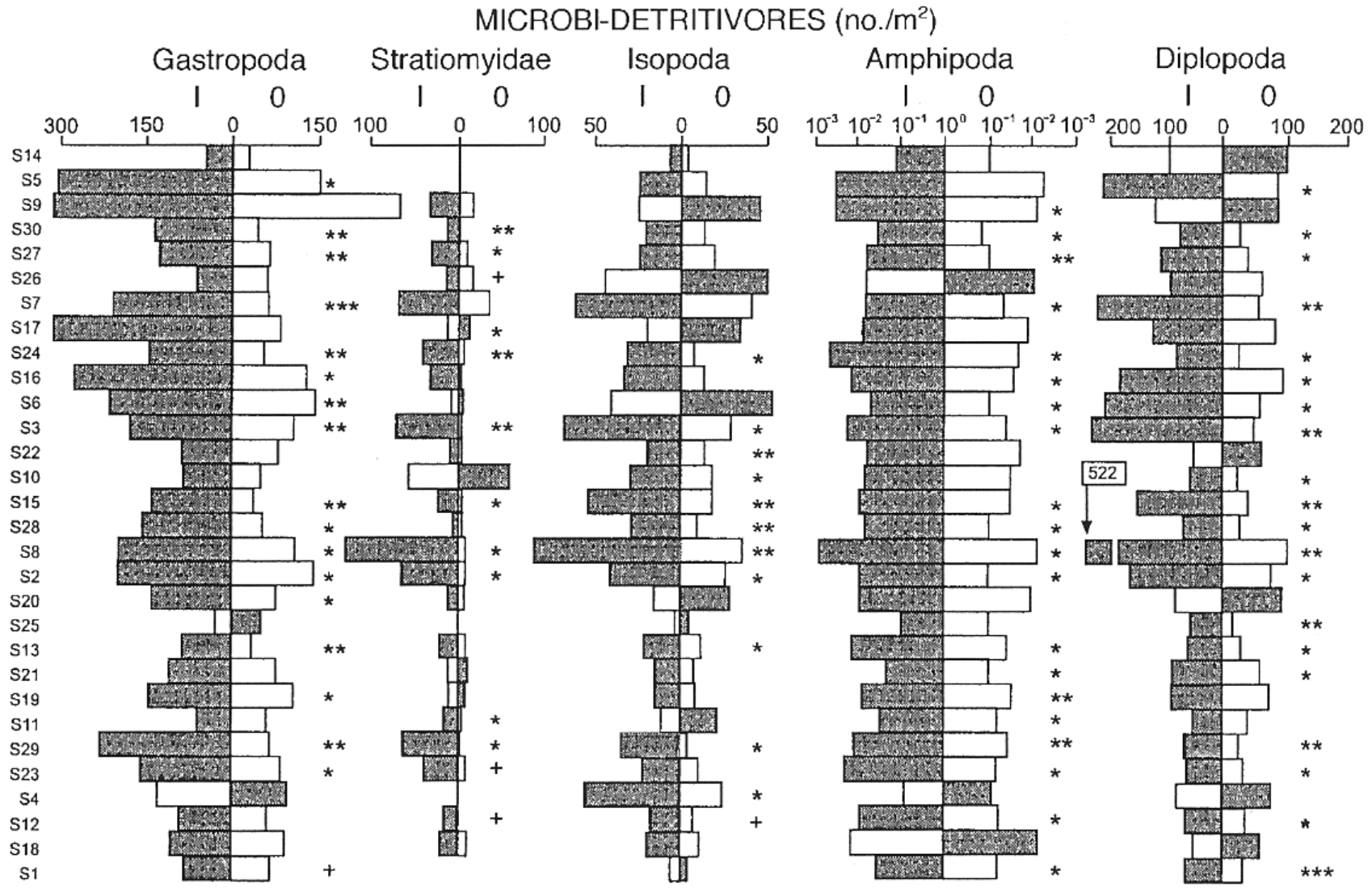
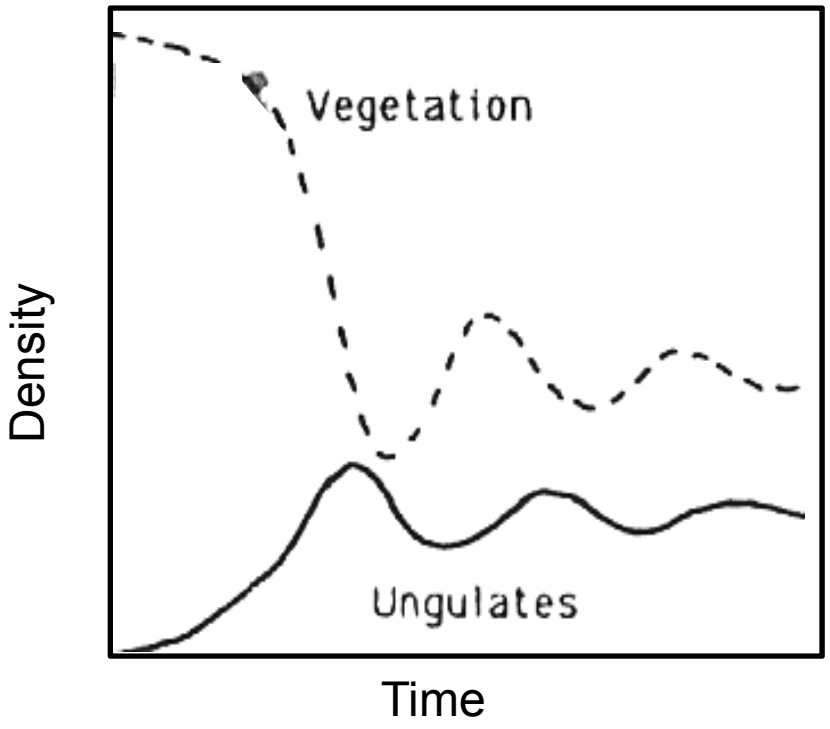
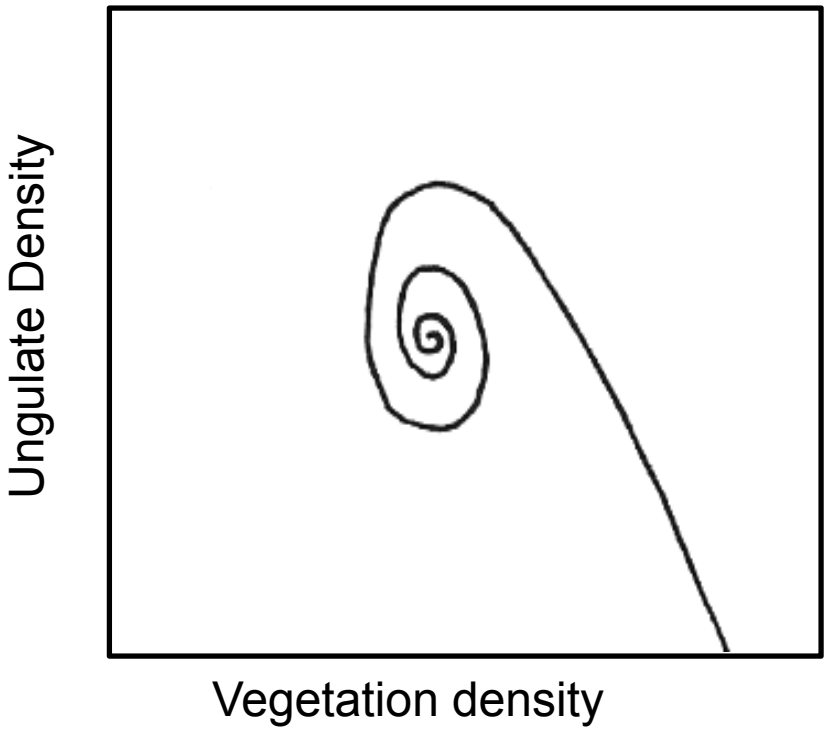


FIG. 10. Populations of macrofaunal groups in litter inside and outside of 30 browsing mammal exclosure plots. Symbols and legend are as for Fig. 2, and locations are arranged in the same rank order for each panel are as for Fig. 2.

(Wardle et al. 2001)





(Modified from Hone 1988)

Effects of pigs on runoff and WQ

- Speculation & anecdotal evidence that feral pig browsing also increases runoff, erosion, sediment & nutrient loading into streams (Bratton ‘74, Diong ’82, Stone & Loope ‘87)

- Quantitative data as to effects of feral pigs on runoff & erosion still lacking for Hawaii

Project Objectives

- **Determine how much runoff is typically generated in the upper forested areas of the Mānoa watershed**
- **Evaluate how characteristics of slope, soil type, ground cover, canopy cover, and feral pig disturbance influence runoff and soil loss**
- **Determine if differences exist between runoff amount, sediment and nutrient loads between fenced and unfenced plots**

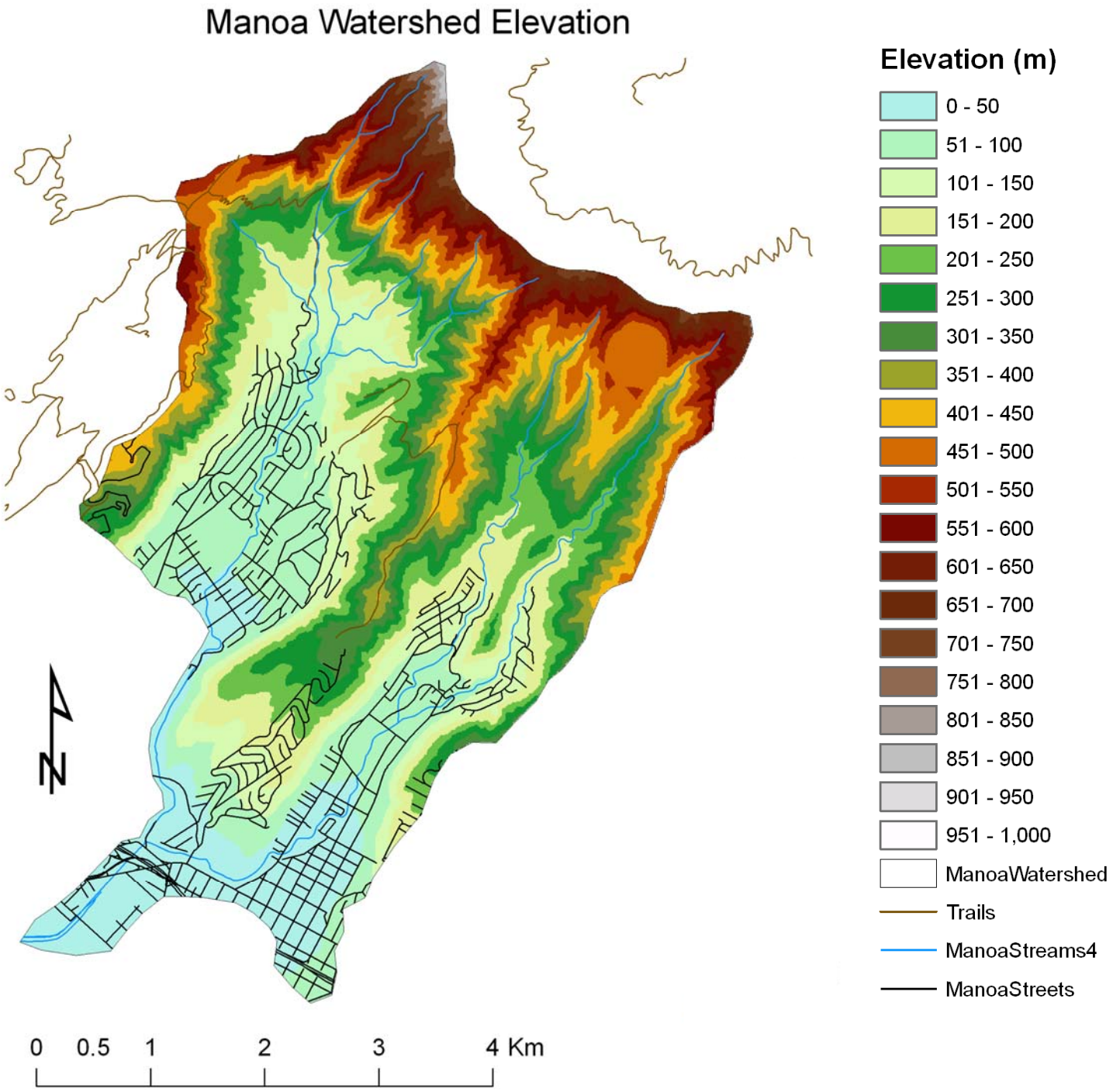
Hypotheses

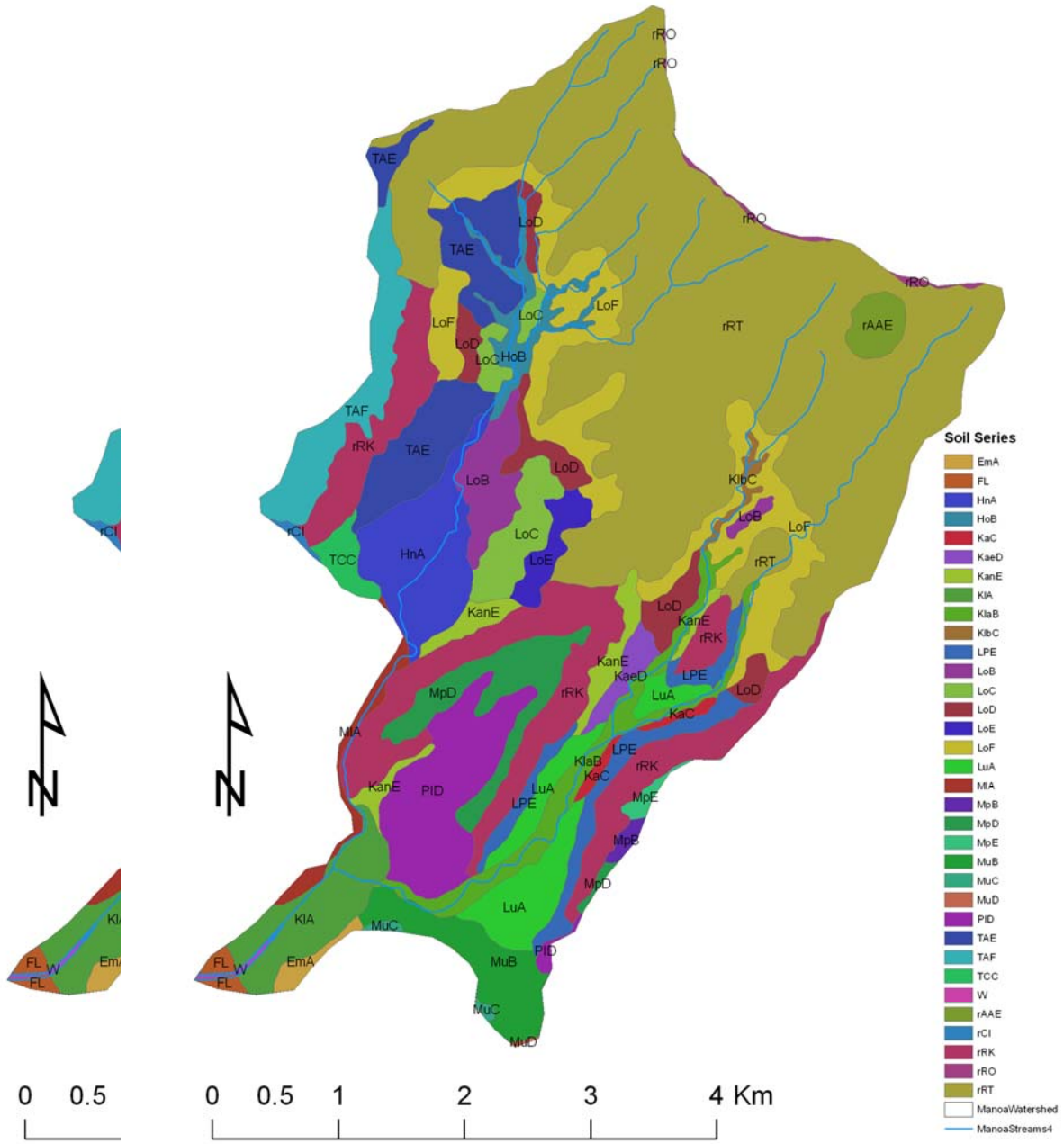
- **Unfenced plots open to pig activity will exhibit greater runoff and erosion than fenced plots in which pig activity has been excluded.**

- **Unfenced plots will exhibit higher soil nutrient concentrations and subsequently export greater amounts of N and P in runoff.**

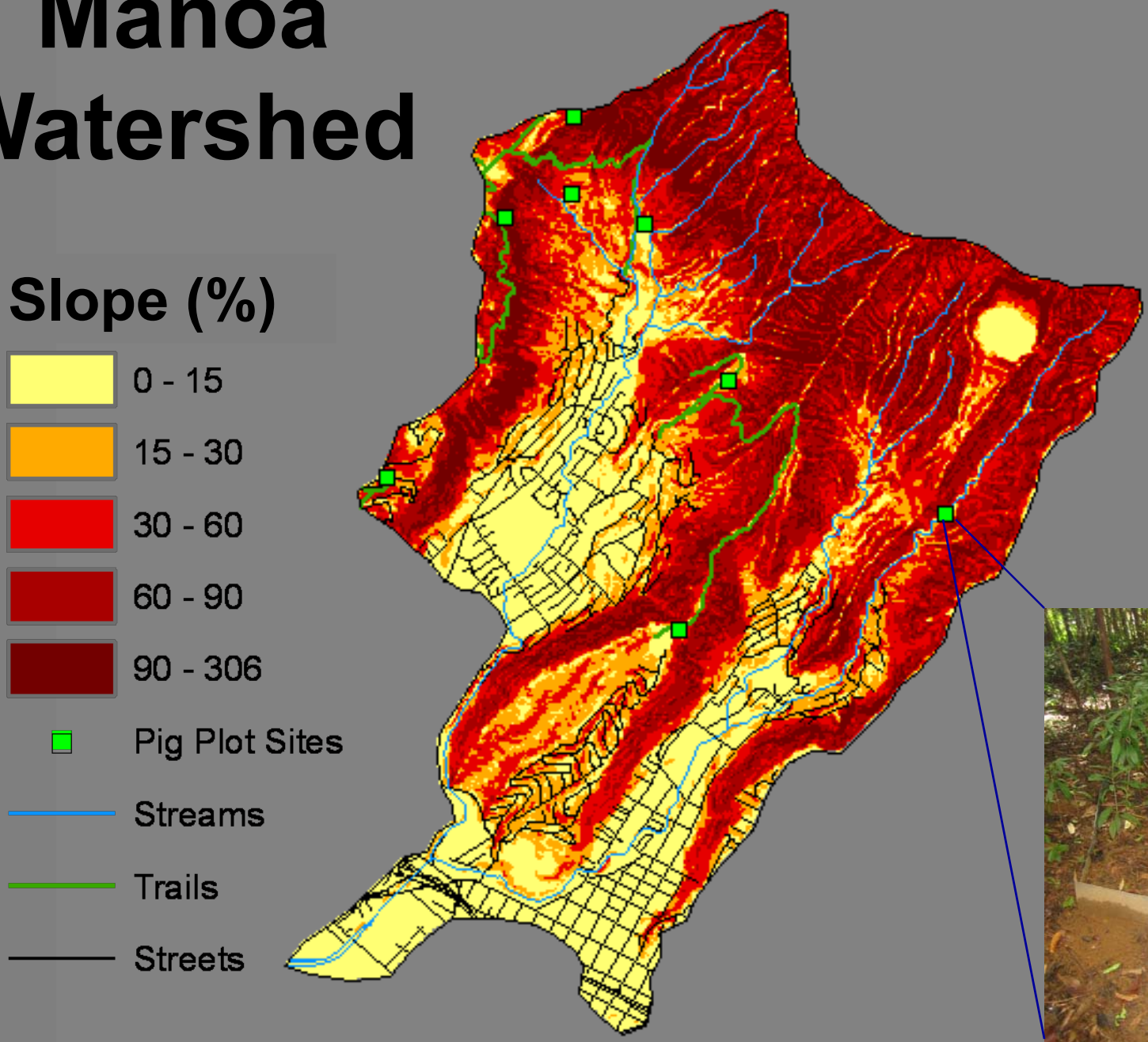
Site Selection

- 8 representative sites within Mānoa Watershed
- Paired fenced & unfenced plots at each site
- Selection based on:
  - Slope < 30%
  - Accessibility (w/i 250 m of trails)
  - Spatial coverage

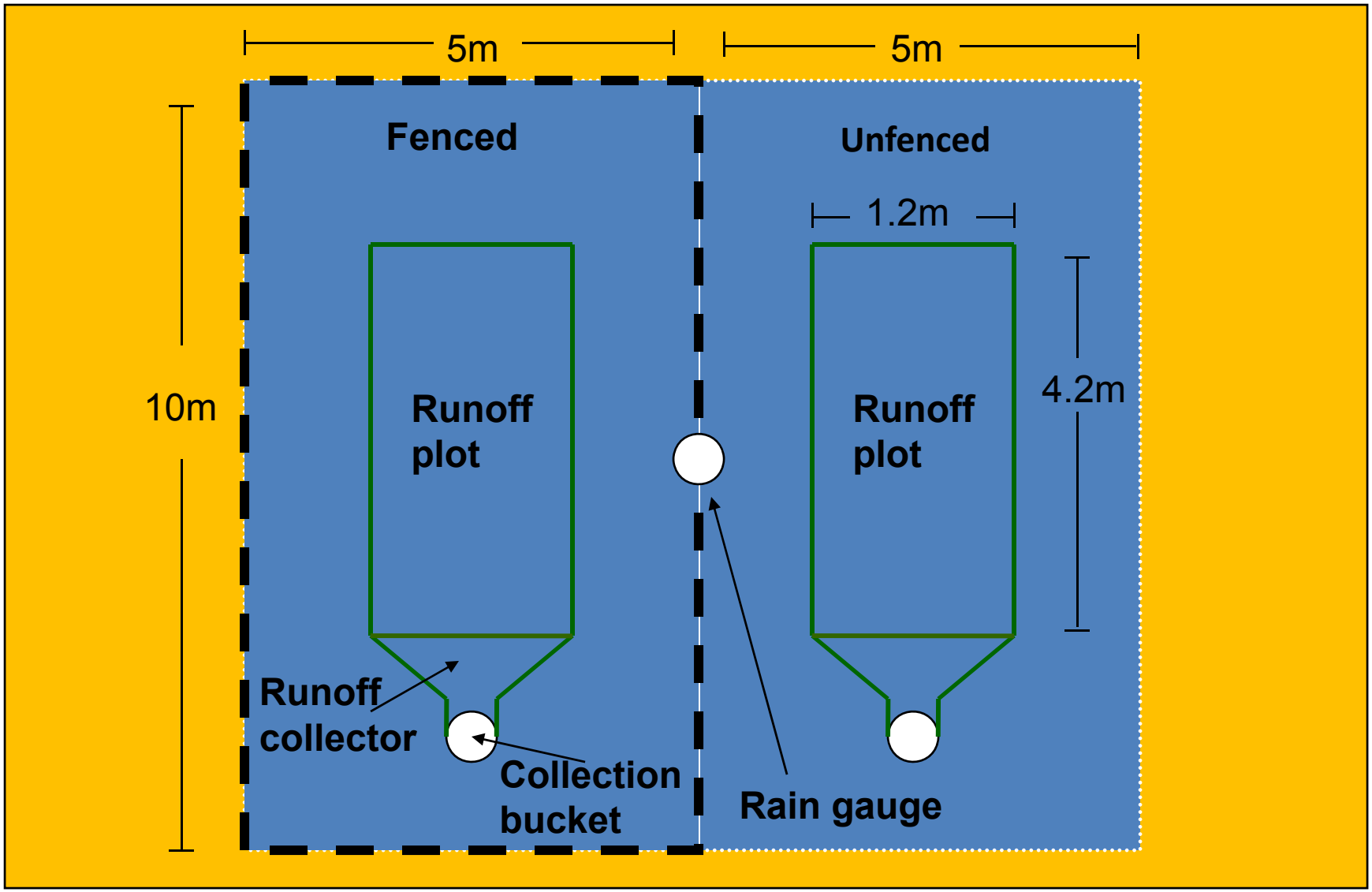

Manoa Watershed Elevation
Elevation (m)
0 - 50
51 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
451 - 500
501 - 550
551 - 600
601 - 650
651 - 700
701 - 750
751 - 800
801 - 850
851 - 900
901 - 950
951 - 1,000
ManoaWatershed
Trails
ManoaStreams4
ManoaStreets
N
0 0.5 1 2 3 4 Km


Manoa Watershed Soils
rRO
TAE
LoD
rAAE
rRT
LoF
LoC
HoB
TAF
rRK
LoB
rCl
TCC
HnA
KlbC
KanE
KaeD
rRK
LPE
LuA
KaC
MpD
MIA
KlaB
PID
MpE
MpB
MuC
MuD
KlA
EmA
FL
W
MuB
0 0.5
0 0.5 1 2 3 4 Km
Soil Series
EmA
FL
HnA
HoB
KaC
KaeD
KanE
KlA
KlaB
KlbC
LPE
LoB
LoC
LoD
LoE
LoF
LuA
MIA
MpB
MpD
MpE
MuB
MuC
MuD
PID
TAE
TAF
TCC
W
rAAE
rCl
rRK
rRO
rRT
ManoaWatershed
ManoaStreams4

Mānoa Watershed



Plot Layout


5m
5m
Fenced
Unfenced
1.2m
10m
4.2m
Runoff plot
Runoff plot
Runoff collector
Collection bucket
Rain gauge

Data Collection

- Soil sampling
- Ground, understory, canopy cover monitoring
- Runoff collection

Site Characteristics

Site	Slope (%)	Elevation (m)	Soil Series
Pauoa Flats	6	538	Rough Mountainous
Mānoa Cliffs	8	450	Rough Mountainous
Waahila Ridge	14	340	Manana
Lyon	15-16	215	Lolekaa
Mānoa Falls	16-18	171	Lolekaa
Round Top	25-26	340	Tantalus
Puu Pia	26	209	Lolekaa
Palolo	25-27	225	Rough Mountainous

Soil Sampling

- Soil cores taken from upper 20 cm in 9/07
- 6 site^{-1} for total of 48
- Bruland Lab:

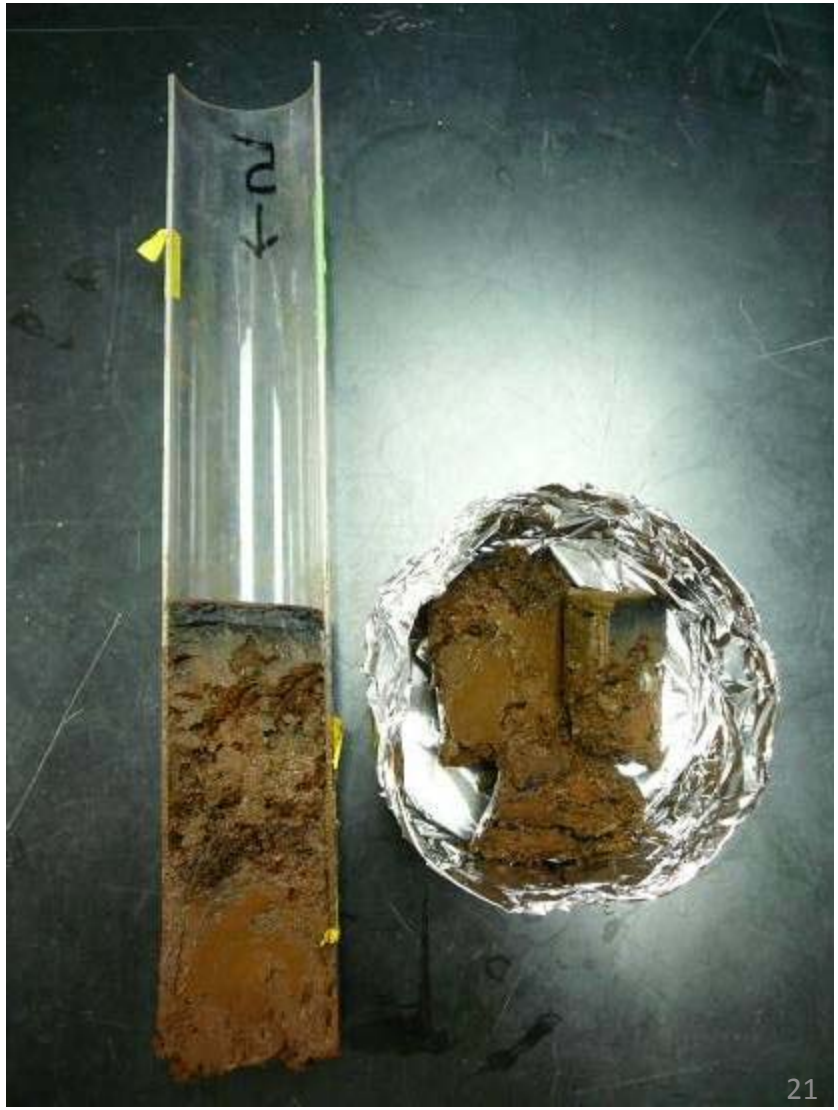
  Moisture, bulk density
- ADSC:

  pH

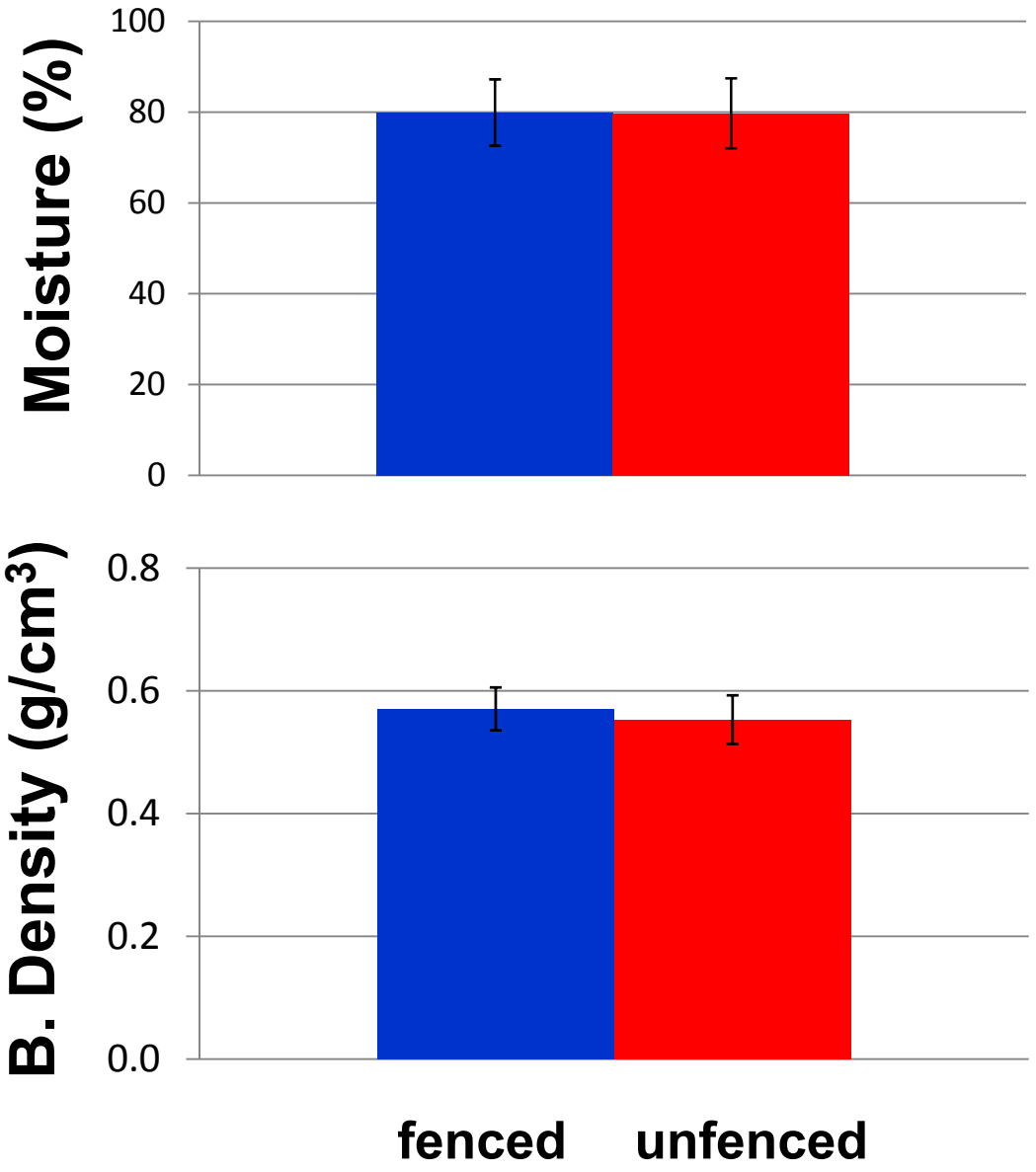
  NO_3-N, NH_4-N (KCl)

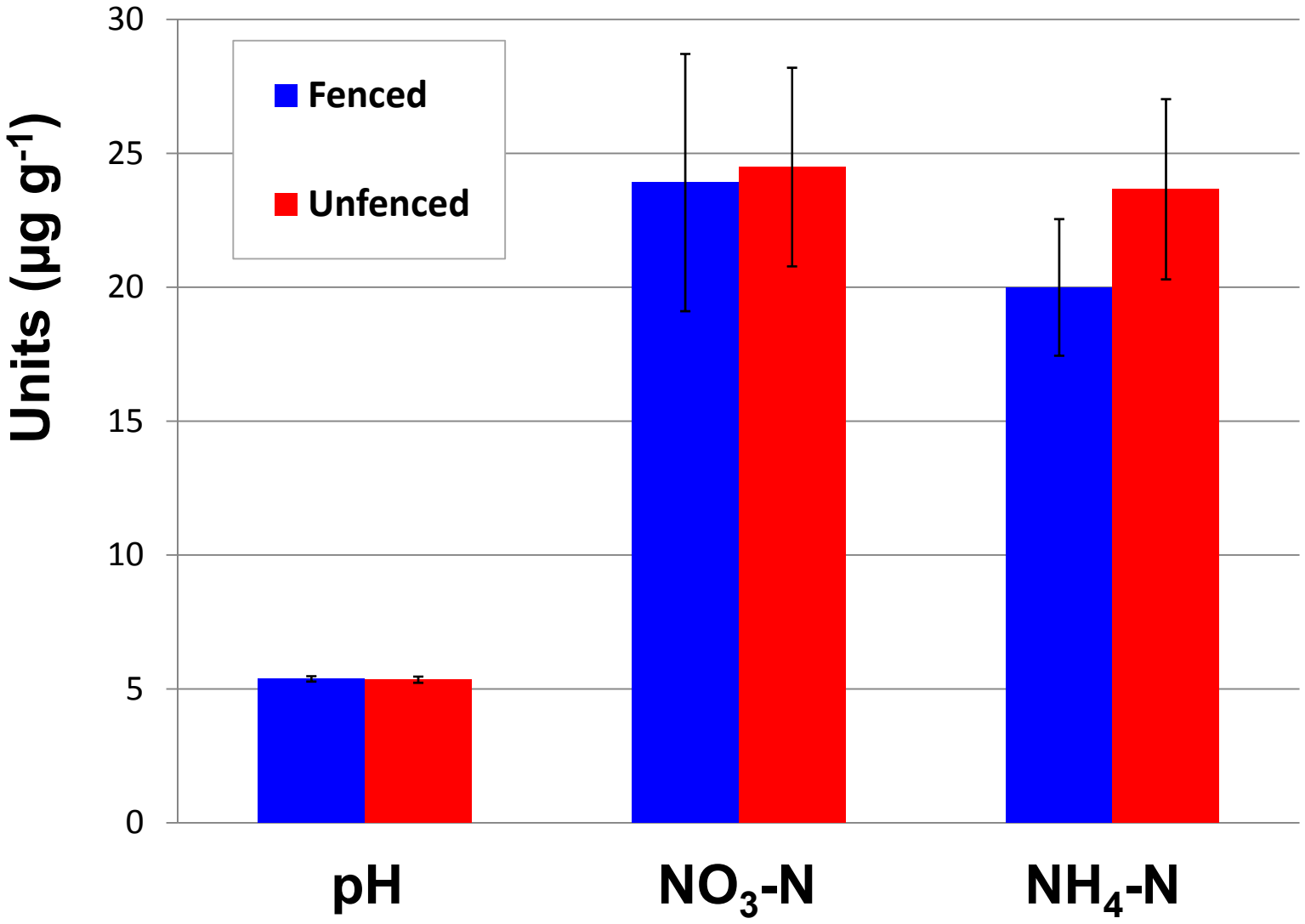
  Extr. P (Olsen)

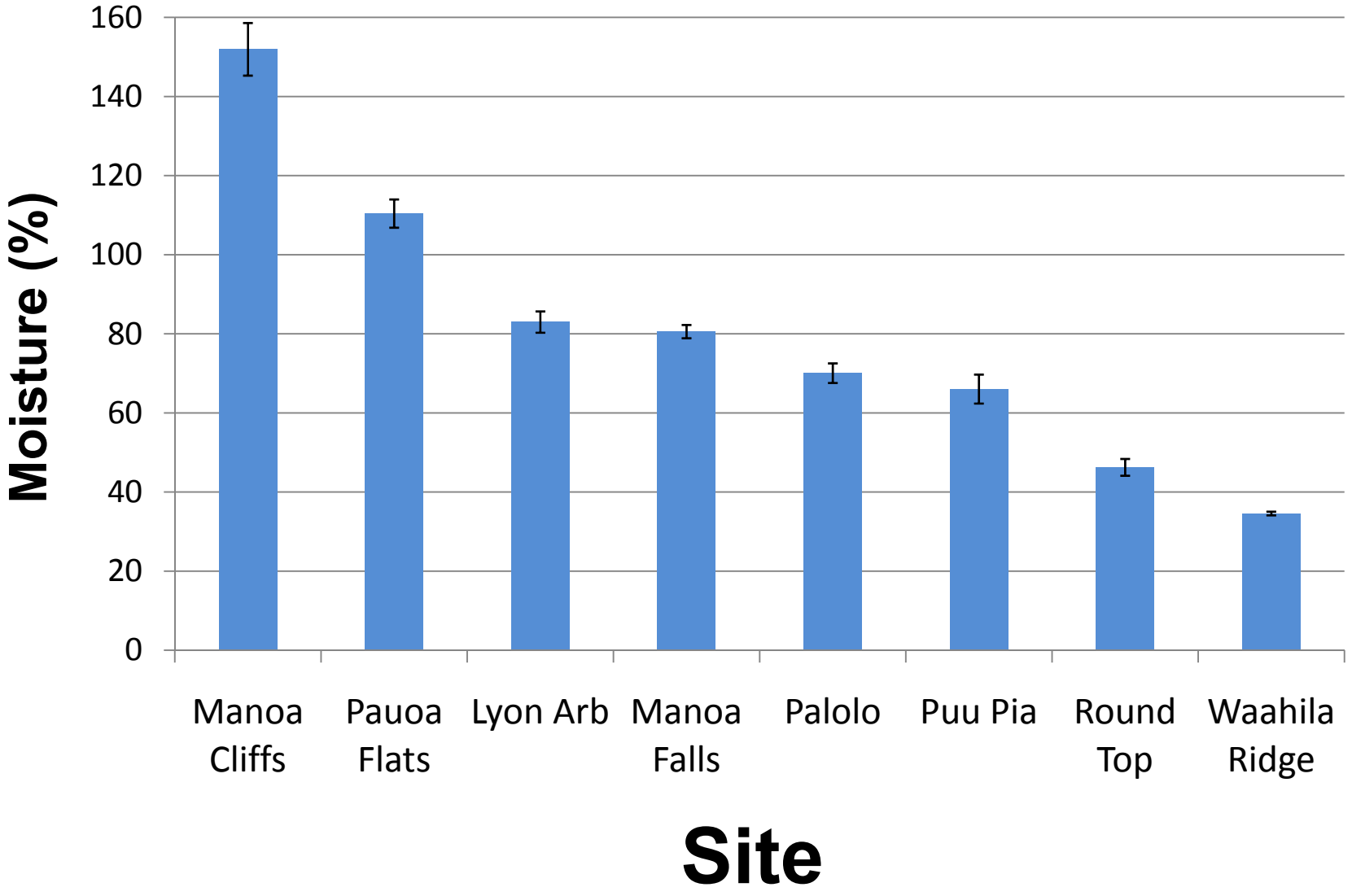
  Extr. Ca, Mg, K (NH_4OAc)



Preliminary Soil Data




Units (µg g-1)
30
25
20
15
10
5
0
Fenced
Unfenced
pH
NO3-N
NH4-N


Moisture (%)
160
140
120
100
80
60
40
20
0
Manoa Cliffs
Pauoa Flats
Lyon Arb
Manoa Falls
Palolo
Puu Pia
Round Top
Waahila Ridge
Site

Vegetation Monitoring

- Estimate cover within plots:

  Canopy

  Understory

  Ground (bare, rock, root, litter, vegetative)

Runoff Sampling

Runoff samples will collected 11/07, 12/07, 1/08, 2/08, analyzed for:

On site

- Volume

Bruland Lab

- TSS

ADSC

- NO_3-N, NH_4-N
- TP, TN, Ca, Mg, Fe

Runoff collection started 11/13/07

Long-Term Plan: Maintain & monitor plots over time, ask other questions regarding vegetation, soil arthropods, earthworms, biogeochemistry, pathogens, microbial communities, etc.

Conclusions

- **Studies have shown feral pigs effect plant density, survival, composition, diversity.**

- **Much less work on the effects of pigs on runoff, erosion, sediment transport and water quality, especially in HI.**

- **Need quantitative data on the effects of feral pigs and fencing on runoff and erosion in Hawaiian watersheds for cost-benefit analyses, valuation of ecosystem services.**

- **Unique opportunity to quantify how feral pigs alter ecosystem structure and function, examine management & policy options, as well as social, cultural and economic dimensions of this issue.**

Acknowledgements

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For more information: http://www.ctahr.hawaii.edu/brulandg/