Impact of Cattle Production on Water Quality-South Florida

59th Annual Beef Cattle Short Course

Pat Hogue
Extension Agent-CED/Livestock
Okeechobee County

And I will seed grass in thy fields for cattle, that thou mayest eat and be full – *Deuteronomy 11-15*

He causeth the grass to grow for the cattle, and herb for the service of man; that he may bring forth food out of the earth – *Psalms 104-14*

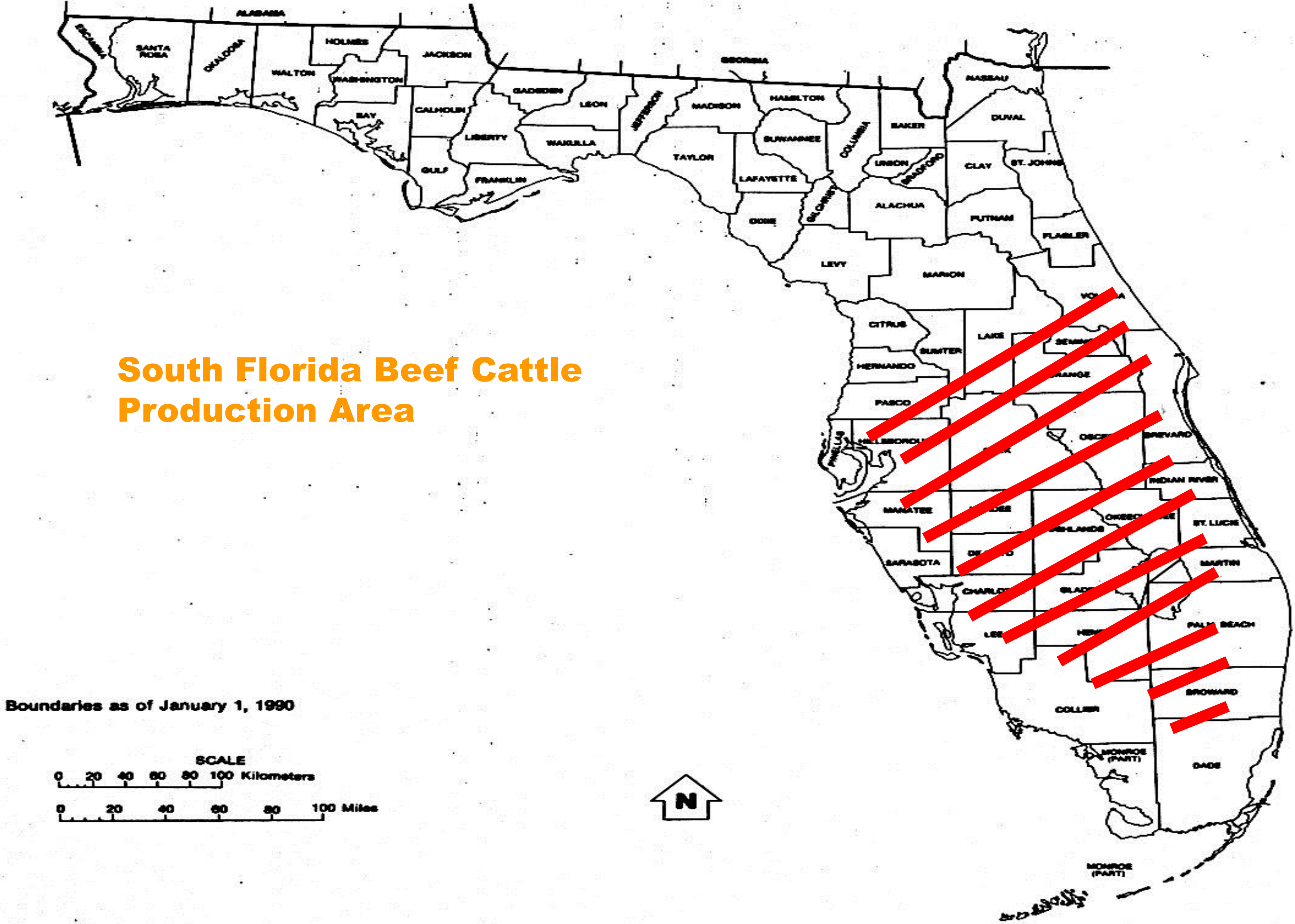
Water Quality Issues

Phosphorus loading to ground and runoff waters

Large acreages represented by cattle grazing

Direct access to water bodies by cattle

South Florida Beef Cattle Production Area



South Florida Beef Producing Counties

719,000 head of cows
  77% of total cows in Florida
1,179,000 head of cattle and calves
  69% of total cattle and calves in Florida

5,069,347 acres
  31.3% of land area

2,591,448 farm land   16% of land area

Soil Phosphorus, Cattle Stocking Rates, and Water Quality in Subtropical Pastures in Florida

John Capece, Kenneth Campbell, Patrick Bohlen, Donald Graetz, and Kenneth Portier

Large scale research pasture project at Buck Island Ranch:

- 420 ha (1038 acres) – 8 improved summer, 8 semi-improved winter
- 4 stocking rates – no cattle, low, medium, high
- 5 years – 1998-2003

Designed to investigate the influence of beef cattle stocking rate on nutrient loads in surface runoff

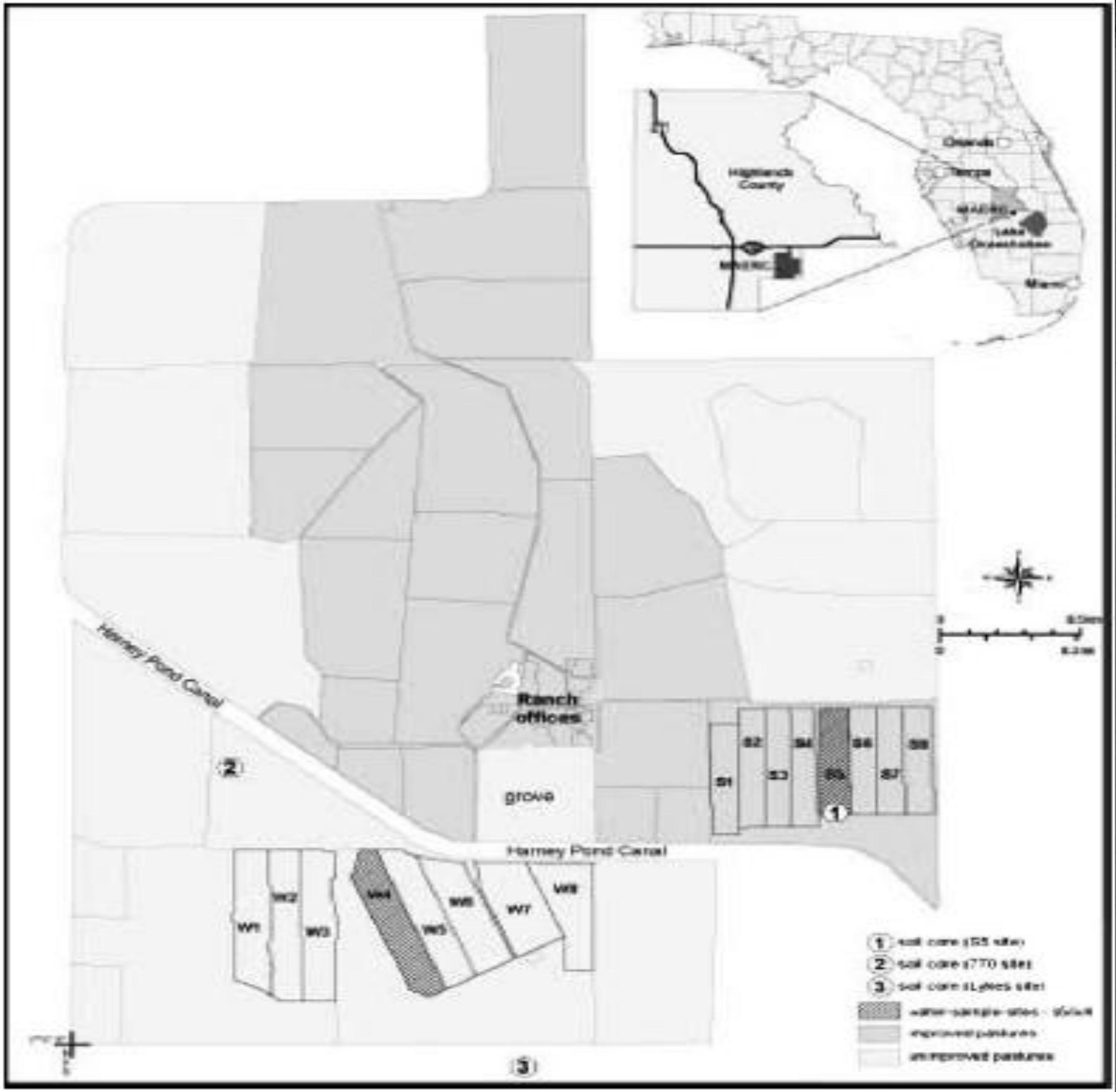


Figure 1. Map of the MacArthur Agro-Ecology Research Center (MAERC) showing locations o three soil cores and locations of two pastures (S5, W4) where runoff water was collected.

Table 1. Design of the cattle stocking rate experiment, showing the distribution of the two replicate stocking rate treatments among the experimental pastures in the two main pasture types. One animal unit is equivalent to one cow-calf pair (USDA 2003).

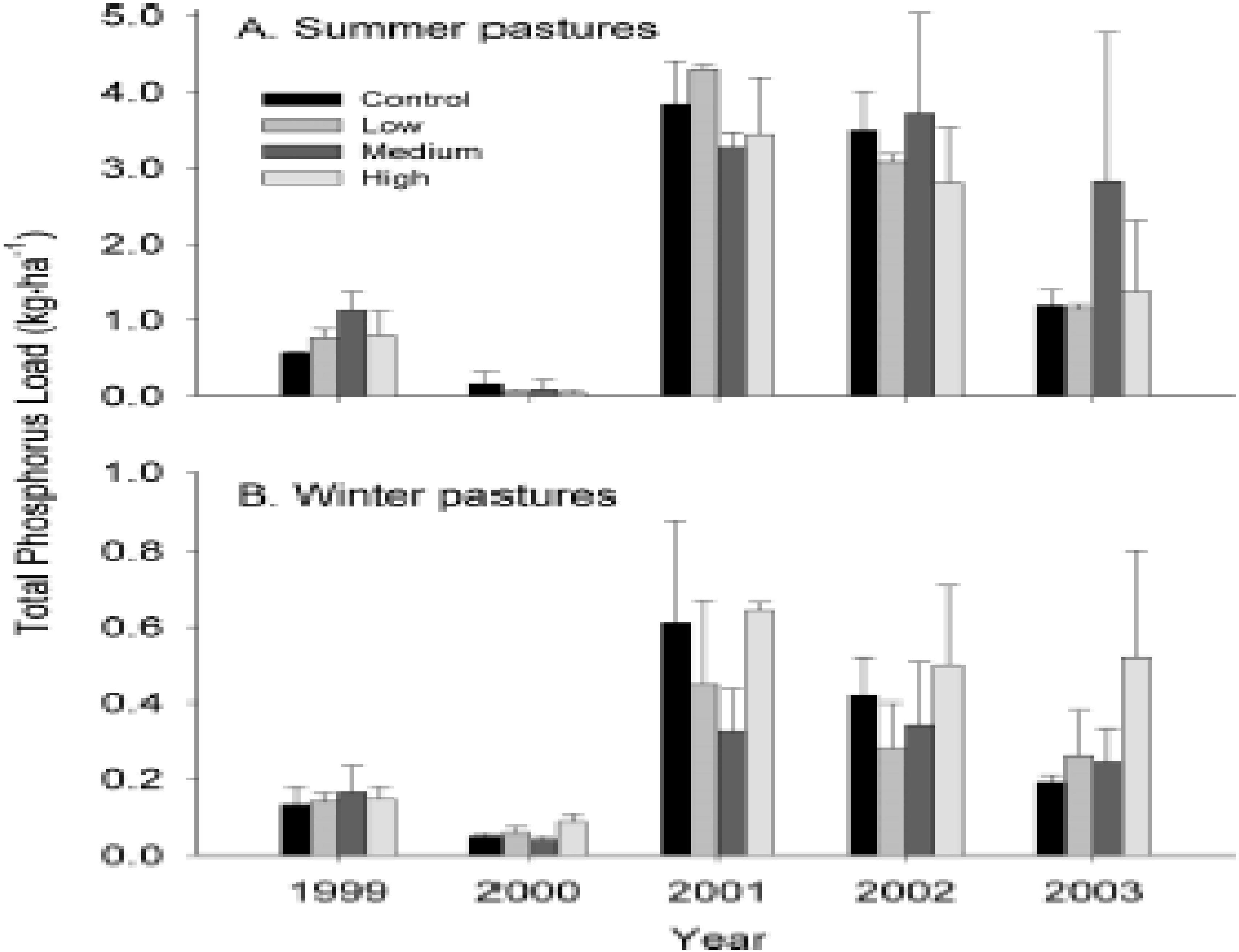
	Treatment		
Block	Description	Animal Units	Hectares/Unit
Summer	Control	0	N/A
	Low	15	1.3
	Medium	20	1.0
	High	35	0.6
Winter	Control	0	N/A
	Low	15	2.1
	Medium	20	1.6
	High	35	0.9

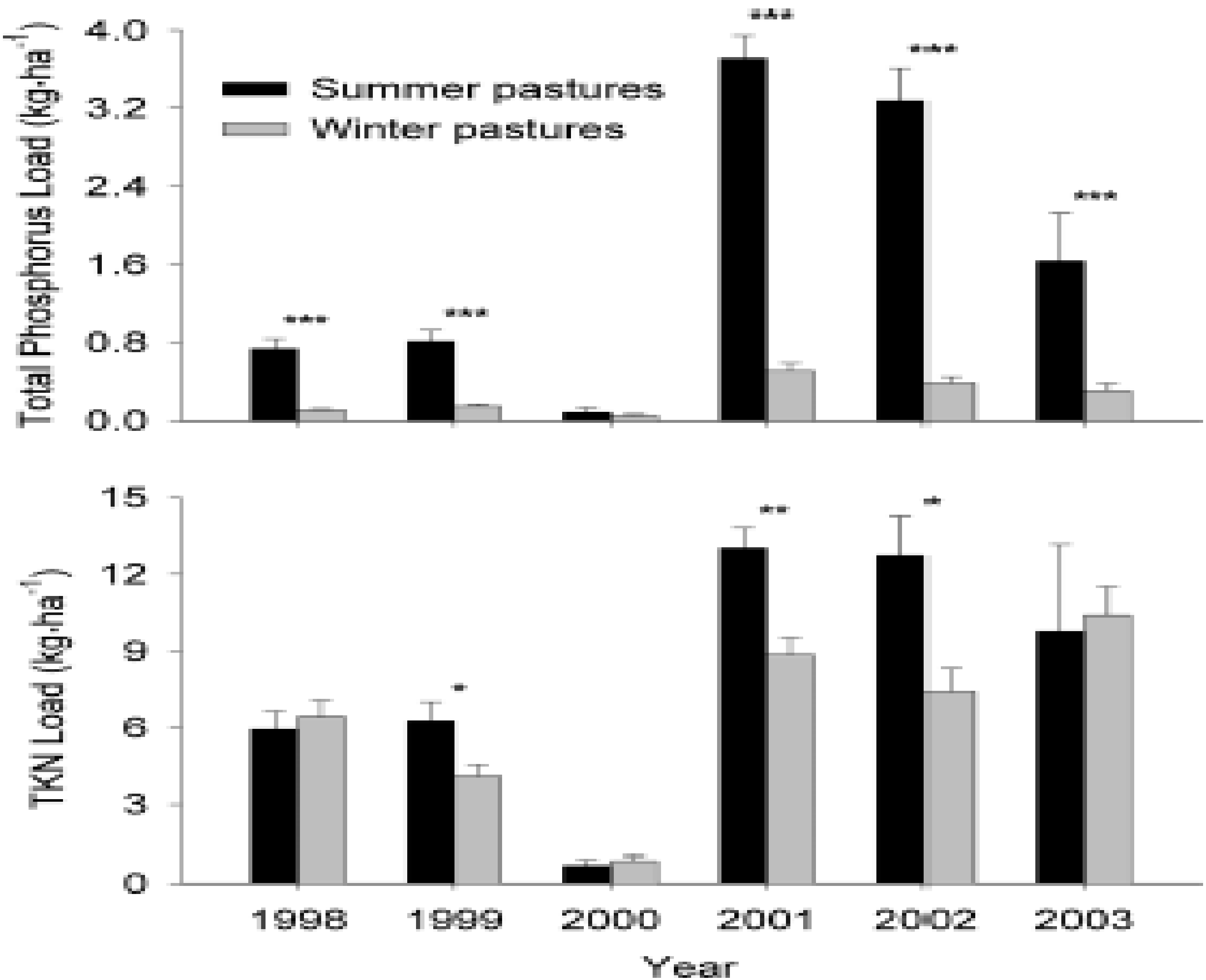
Table 3. Concentrations of total phosphorus (TP) and total Kjeldahl nitrogen (TKN) in summer and winter pasture runoff by stocking rate for 1998–2003. Values are average concentrations in mg · L^{-1} for all samples collected during the indicated calendar year.

Block	Treatment	1998	1999	2000	2001	2002	2003	Average
		TP mg · L^{-1}						
Summer	Control	0.56	0.58	0.45	0.94	0.82	0.78	0.69
	Low	0.40	0.58	0.41	0.98	0.66	0.74	0.63
	Medium	0.21	0.58	0.22	0.79	0.92	0.99	0.62
	High	0.69	0.57	0.28	0.79	0.60	0.56	0.58
	Average	0.47a	0.58a	0.34	0.88a	0.75a	0.77a	0.63a
Winter	Control	0.10	0.14	0.18	0.13	0.12	0.05	0.12
	Low	0.07	0.11	0.47	0.15	0.17	0.11	0.18
	Medium	0.07	0.15	0.13	0.11	0.12	0.09	0.11
	High	0.08	0.09	0.34	0.20	0.18	0.25	0.19
	Average	0.08b	0.12b	0.28	0.15b	0.15b	0.13b	0.15b
Pooled SEM[1]		0.06	0.04	0.12	0.05	0.11	0.1	0.06
		TKN mg · L^{-1}						
Summer	Control	3.43	4.98	2.76	3.92	3.16	3.22	3.58
	Low	3.63	4.39	2.82	3.62	3.00	3.12	3.43
	Medium	3.11	4.77	2.13	3.92	4.26	5.23	3.90
	High	3.84	4.37	2.27	3.52	3.15	2.94	3.35
	Average	3.50	4.63	2.50	3.75a	3.39	3.63	3.57
Winter	Control	3.67	3.79	3.69	3.09	3.05	3.11	3.40
	Low	3.50	6.60	4.46	2.82	2.85	3.05	3.88
	Medium	3.51	3.04	4.27	2.93	2.58	2.64	3.16
	High	3.60	3.68	4.23	2.80	2.61	2.81	3.29
	Average	3.57	4.28	4.16	2.91b	2.77	2.90	3.43
Pooled SEM[1]		0.15	0.86	0.66	0.17	0.27	0.44	0.32

[1]Pooled model standard error for pasture type effect.

[ab]Pasture type averages followed by different lowercase letters are significantly different ($P < 0.05$).


A. Summer pastures
B. Winter pastures
Control
Low
Medium
High
Total Phosphorus Load (kg·ha⁻¹)
5.0
4.0
3.0
2.0
1.0
0.0
0.8
0.6
0.4
0.2
1999
2000
2001
2002
2003
Year


Total Phosphorus Load (kg·ha-1)
4.0
3.2
2.4
1.6
0.8
0.0
Summer pastures
Winter pastures
***
***
***
***
***
***
TKN Load (kg·ha-1)
15
12
9
6
3
0
*
**
*
1998
1999
2000
2001
2002
2003
Year

Results & Discussion

Results do not show that increasing stocking rates would increase nutrient loads, therefore reducing stocking rate would not be effective BMP for reducing non-point source pollution

Did show higher nutrient loads from improved pastures vs. semi-improved (native) pastures, indicating relationship to historical fertilization practices in improved pastures

Results indicate approaches focused on decreasing P inputs rather than cattle management practices (stocking rates) would be more effective for reducing P loads

Levels and Changes of Soil Phosphorus in Subtropical Beef Cattle Pastures

Gilbert Siqua, Mary Williams, Samuel Coleman

Study objective: To investigate the long term effect of pasture management (grazing + haying) on soil P dynamics (levels and changes) in subtropical beef cattle pastures with bahiagrass and rizhoma peanut, with, or without P fertilization.

Long term study from 1988 to 2000

Prior to study, pastures were fertilized based on soil test results and recommendations by UF/IFAS Soil Test Lab

Table 2. Grazing management and fertilizer application in STARS, Brooksville, FL (1983–2000).

Pasture unit	Year	Sampling site	Forage type	N ($kg\,ha^{-1}\,yr^{-1}$)	P_2O_5 ($kg\,ha^{-1}\,yr^{-1}$)	K_2O ($kg\,ha^{-1}\,yr^{-1}$)	Pasture mgt.
MS	1983–1989	MS25, MS26, MS27	BG	90	0	45	GZ
		MS5, MS6, MS8	RP	—	—	—	GZ + HY
	1990–1997	MS25, MS26, MS27	BG	76.5	0	0	GZ
		MS5, MS6, MS8	RP	0	38.8	67.6	GZ + HY
	1998–2000	MS25, MS26, MS27	BG	90	0	67.6	GZ
		MS5, MS6, MS8	RP	0	38.8	67.6	GZ + HY
TY	1983–1989	TY37, TY38, TY39	BG	90	0	45	GZ
		TY1A, TY10, TY11,TY12	BG	90	22.5	45	GZ + HY
		TY33, TY34	RP	0	38.8	67.6	GZ + HY
	1990–1997	TY37, TY38, TY39	BG	76.5	0	0	GZ
		TY1A, TY10, TY11,TY12	BG	76.5	0	0	GZ + HY
		TY33, TY34	RP	0	38.8	67.6	GZ + HY
	1998–2000	TY37, TY38, TY39	BG	76.5	0	0	GZ
		TY1A, TY10, TY11,TY12	BG	76.5	0	0	GZ + HY
		TY33, TY34	RP	0	38.8	67.6	GZ + HY

BG—Bahiagrass.
RP—Rhizoma Peanuts.
GZ—Grazed Pasture.
HY—Hayed Pasture.

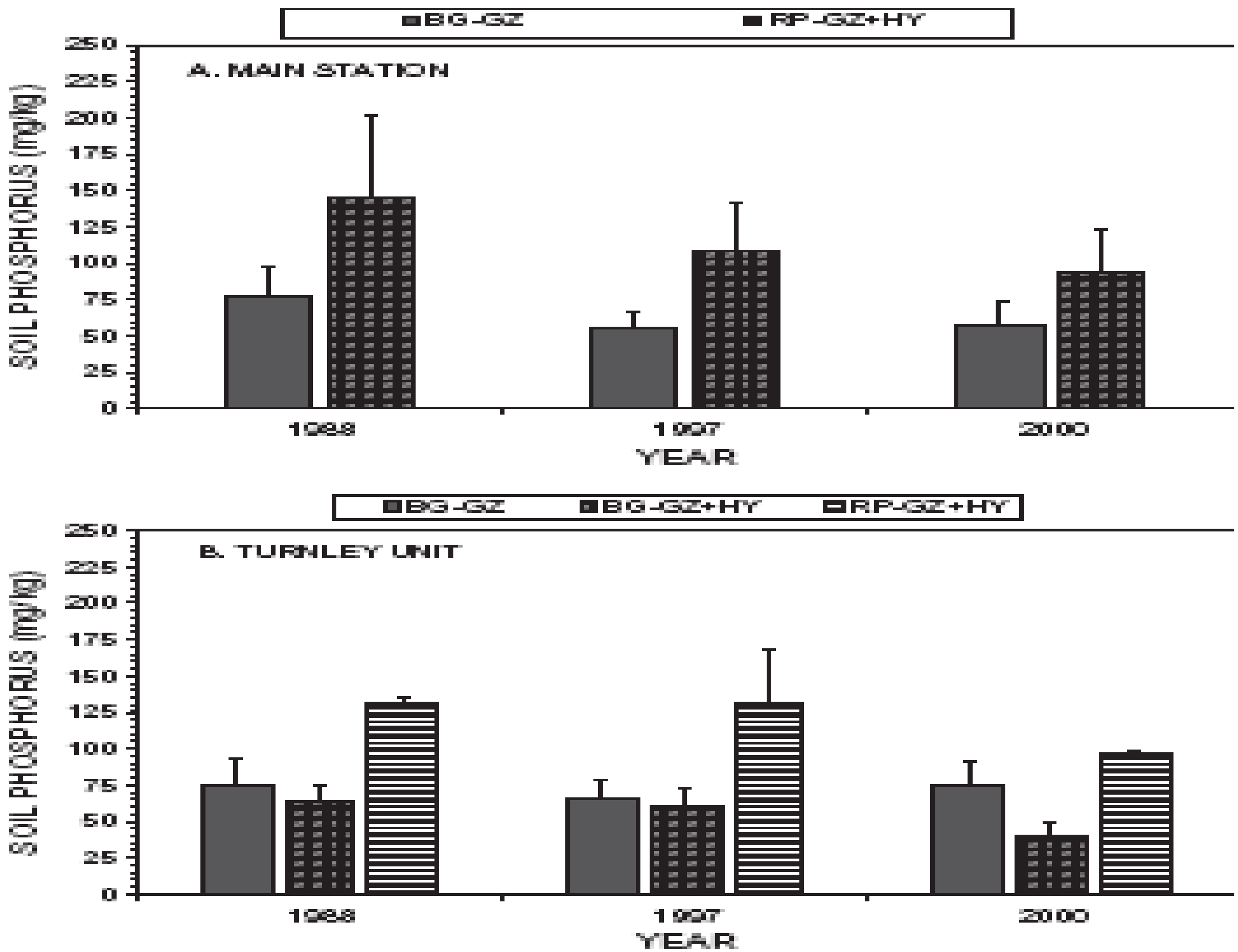


Figure 1. Soil P levels between pasture locations with bahiagrass and rhizoma peanut in STARS, Brooksville, FL from 1988 to 2000.

Table 3. Levels of soil phosphorus in STARS beef cattle pastures with or without P fertilization from 1988 to 2000.

Fertilizer treatment	1988	1997	2000	Mean
With P fertilizer	140.0 ± 40.9a[a]	121.8 ± 33.9 a	95.2 ± 19.9a	119.0
No P fertilizer	71.2 ± 15.5b	60.3 ± 11.6 b	56.2 ± 19.1b	62.6
Mean	105.6	91.1	75.7	

[a]Means on each column followed by common letter are not significantly different from each other at $p \leq 0.05$.

Results and discussion

Environmentally, soil P levels in STARS pastures are declining. During 12 year study, no P build up in STARS pastures despite the annual application of P, and in-field daily loading of animal waste

Levels and changes of soil P at STARS from 1988 to 2000 were responsive and sensitive to P fertilization

Differences among pasture units for soil P may not be of environmental concern, but are important from fertility management point of view

Quantifying phosphorus levels in soils, plants, surface water, and shallow groundwater associated with bahiagrass-based pastures

Gilbert Siqua, Robert Hubbard, Samuel Coleman

3 year study (2004-2006) looking at soil, plant, surface and shallow ground water P on a sloped pasture that was part of a rotational grazing system.

Hypothesis of study was that properly managed cow-calf operations in subtropical agroecosystem would not be a major contributors to excess loads of P in surface and ground water

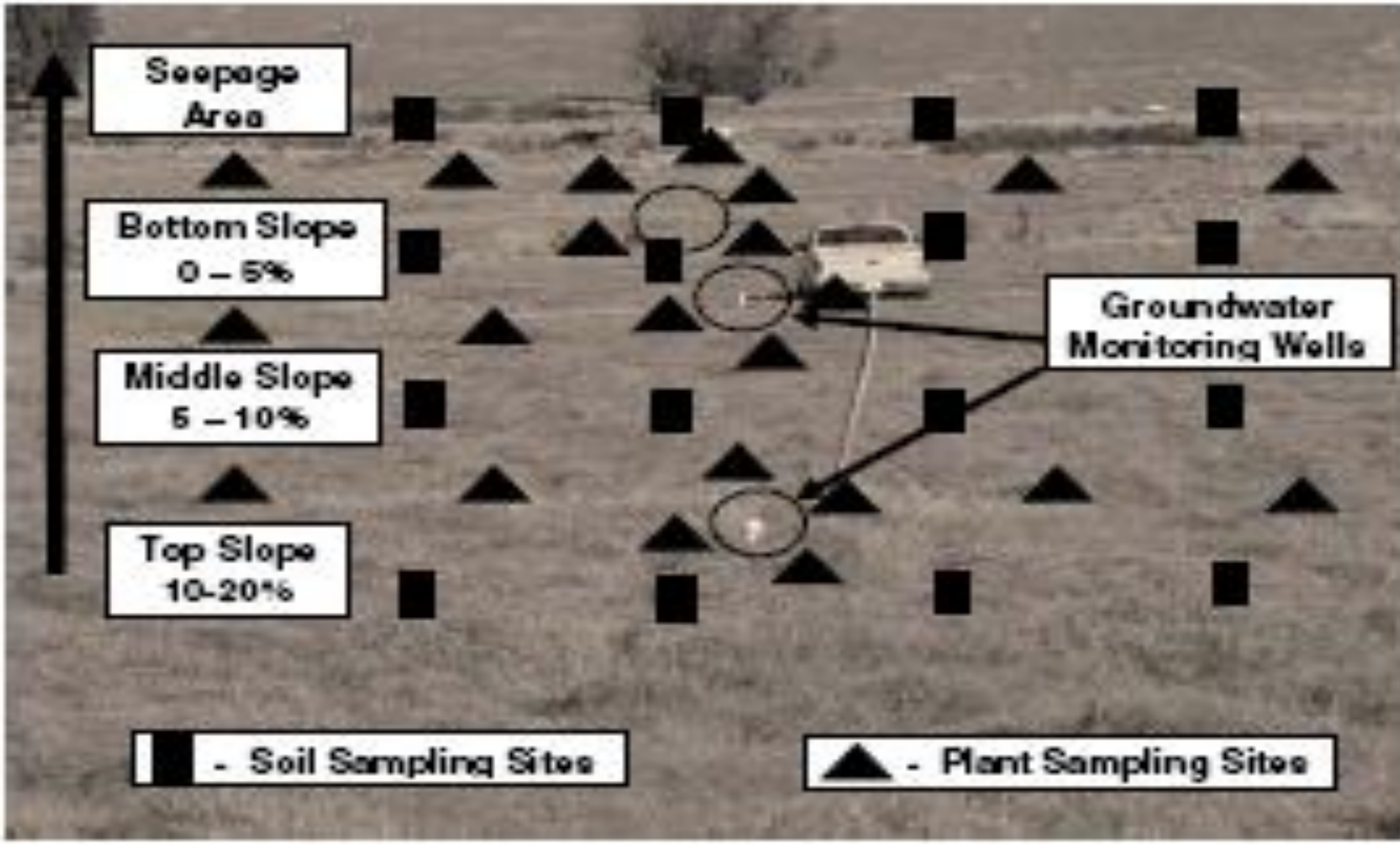


Fig. 1 Aerial view of the study site showing the different locations of the groundwater monitoring wells, soil sampling sites, and plant sampling sites

Table 1 Monthly grazing activity and estimates of phosphorus contributions from cattle excreta (manure)

Months	Average days grazed per pasture	Average number of animals per ha	Animal unit per month[a]	Total manure excreted[b]	Total manure phosphorus excreted[c]	Total phosphorus after losses[d]
January	13.8	2.6	1.0	913	1.73	1.47
February	9.4	2.5	0.8	669	1.27	1.08
March	13.5	2.1	0.9	753	1.43	1.22
April	12.0	2.0	0.7	619	1.18	1.00
May	12.7	2.1	0.7	654	1.24	1.05
June	12.0	2.4	0.9	748	1.42	1.21
July	6.9	3.3	0.7	628	1.19	1.01
August	9.1	3.6	0.8	734	1.39	1.18
September	8.2	4.8	1.1	947	1.80	1.53
October	6.7	5.3	1.1	976	1.85	1.57
November	6.6	3.6	0.8	705	1.34	1.14
December	9.4	3.7	1.2	1,037	1.97	1.67
Total	–	–	10.8	9,347	17.81	15.14

[a] Animal units per month (450 kg cow/calf unit)

[b] Total manure excreted (kg as excreted)=(number of animal units per month × total annual animal manure excretion/12). Total manure excretion (as excreted) per animal per year=10.4 metric tons (Kellogg et al. 2000)

[c] Total phosphorus excreted=total manure excreted × percent total phosphorus in manure (0.19%; Kellogg et al. 2000)

[d] Total phosphorus after losses=based on losses of about 15% (during and after animal excretion)

Table 2 Average (±std. error of mean) concentration of total phosphorus in groundwater, surface water, soils, and bahiagrass in pasture associated with beef cattle operations

Year	Shallow groundwater (mg L^{-1})	Surface water (mg L^{-1})	Soils (mg kg^{-1})	Bahiagrass (mg kg^{-1})
2004	0.28 ± 0.14ab	1.63 ± 0.27a	14.52 ± 1.0a	2,513.33 ± 111.34a
2005	1.29 ± 0.53a	0.35 ± 0.89b	6.61 ± 0.33b	2,790.33 ± 88.42a
2006	0.03 ± 0.01ab	0.33 ± 0.08b	6.18 ± 0.61b	2,597.67 ± 98.75a
Mean	0.67	0.55	9.10	2,633.78
$LSD_{(0.05)}$	1.17	0.46	2.31	301.32

Means in columns within each subheading followed by common letter(s) are not significantly different from each other at $p \leq 0.05$

Fig. 3 Average concentration of total phosphorus in shallow groundwater and surface water at different landscape positions. *Line above each bar* represents standard error of the mean. Means of total phosphorus in shallow groundwater are significantly different ($p \leq 0.05$) when superscript located at top bar is different

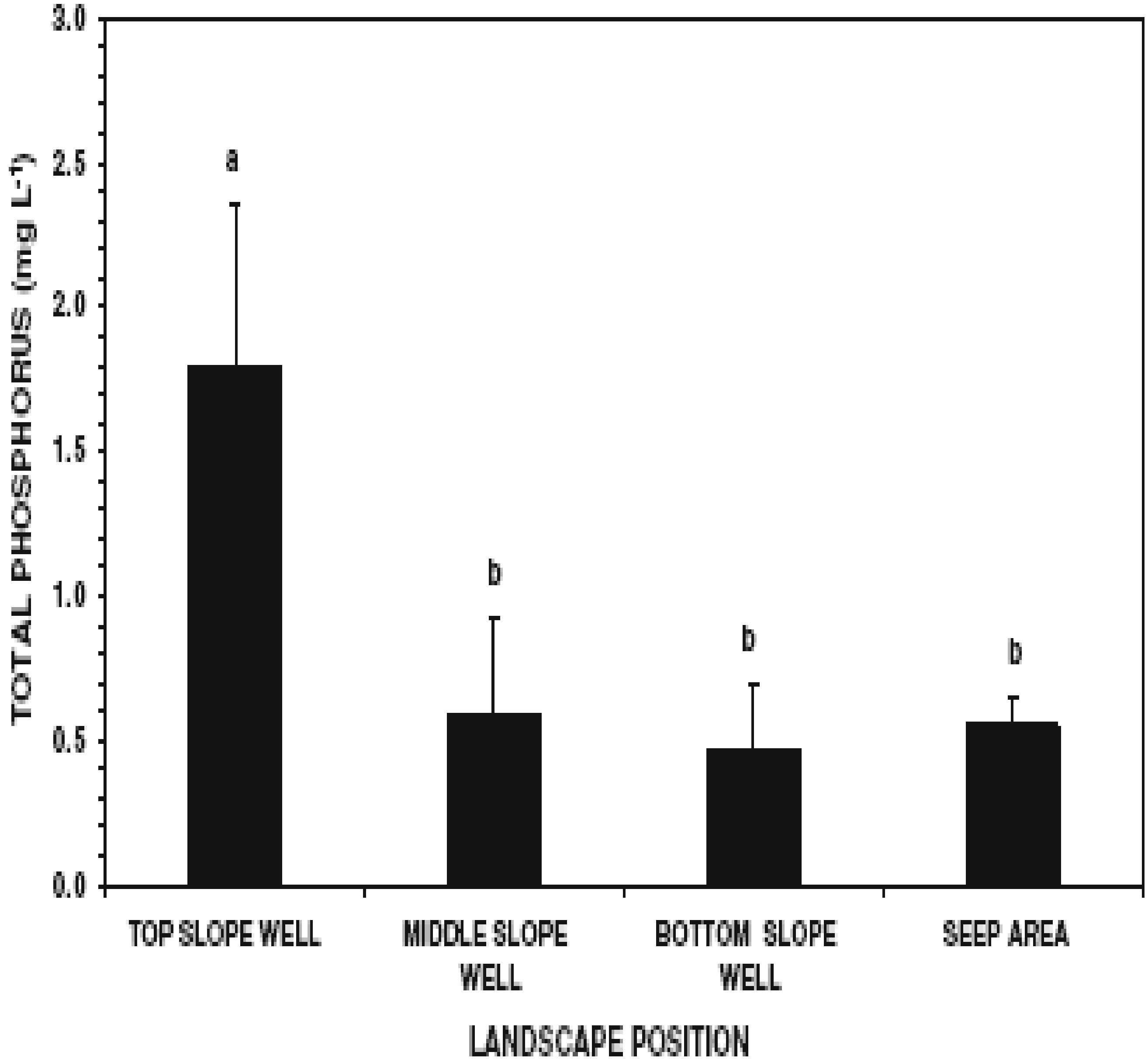


Table 5 Average herbage mass and phosphorus uptake of bahiagrass as affected by landscape position by year interactions

Landscape position	Year	Herbage mass (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})
Top slope	2004	777.5 ± 37.2d	1.9 ± 0.1c
	2005	6,842.5 ± 1,037.0a	20.4 ± 0.1a
	2006	3,104.0 ± 443.3bc	8.8 ± 1.5bc
Average		3,575.0 ± 505.8	10.4 ± 0.6
Middle slope	2004	680.0 ± 3.5d	1.6 ± 0.1c
	2005	4,216.5 ± 182.2b	11.3 ± 0.9b
	2006	2,214.5 ± 71.3bcd	5.8 ± 0.4bc
Average		2,370.3 ± 85.7	6.2 ± 0.5
Bottom slope	2004	625.5 ± 8.4d	1.7 ± 0.1c
	2005	1,571.0 ± 10.9 cd	4.4 ± 0.04bc
	2006	1,440.5 ± 9.5 cd	3.4 ± 0.1bc
Average		1,212.3 ± 9.6	3.2 ± 0.08

Means within each columns followed by common letter(s) are not significantly different from each other at $p \leq 0.05$

Results and discussion

Highest concentrations of soil total P were not found at bottom slope position, but at middle and top slope positions closest to mineral feeders and water tanks

On average, concentrations of total P in surface water was not distinctly different from amount of total P in shallow groundwater

Concentration of total P in top slope wells was significantly greater than samples of middle, bottom and seepage areas

Slight increase in total P in soil, but suggests that current recommendations for P might be somewhat low to maintain and sustain growth of bahiagrass

Conclusions

Current pasture management including cattle rotation in terms of grazing days and current fertilizer (inorganic+manures+urine) application rates for bahiagrass offer little potential for negatively impacting the environment.

Properly managed livestock operations contribute negligible loads of total P to shallow groundwater and surface water

Overall, there was no buildup of total P in bahiagrass based pastures.

Agronomic and Environmental Impacts of Phosphorus Fertilization of Low Input Bahiagrass Systems in Florida

A.K Obour, M.L. Silveira, J.M. Vendramini, L.E. Sollenberger,
G.A. O'Connor, and J.W. Jawitz

Evaluated effects of revised N and P fertilizer recommendations on forage yield and nutritive value and potential effects on water quality in bahiagrass on a Spodosol.

Treatments were three N rates (0, 56 and 112 kg N/ha) and four P rates (0, 5, 10, and 20 kg P/ha)

Results

Linear response in yield to N applications both years, yields greater in 2008 due to increased rainfall

Variable yield response to P application depending on year and environmental conditions

Tissue P concentration increased linearly with P application rates

Crude protein increased linearly with increasing N application rates, but unaffected by increasing P application rates

P applications showed no effect on soil P concentrations in Ap, E, and Bh horizons over 2 years

No significant effect on water-extractable P (WEP) concentrations across treatments after 2 years of applications for Ap, E, and Bh horizons

Table 5. Leachate P concentration at the various depths as affected by year and P application rate.

Depth	2007			2008		
	P rate (kg ha^{-1})					
	0	10	20	0	10	20
cm	mg L^{-1}					
15	0.4ab	0.07b	0.5a	0.2b	0.09b	0.5a
30	0.9a	0.05c	0.3b	0.3a	0.10b	0.4a
60	0.01a	0.07a	0.009a	0.005a	0.03a	0.03a
90	0.1a	0.02a	0.01a	0.009a	0.03a	0.11a
150	0.03a	0.008a	0.006a	0.009a	0.01a	0.02a

Conclusions

Bahiagrass yields response to P depends on environmental conditions and can vary from year to year

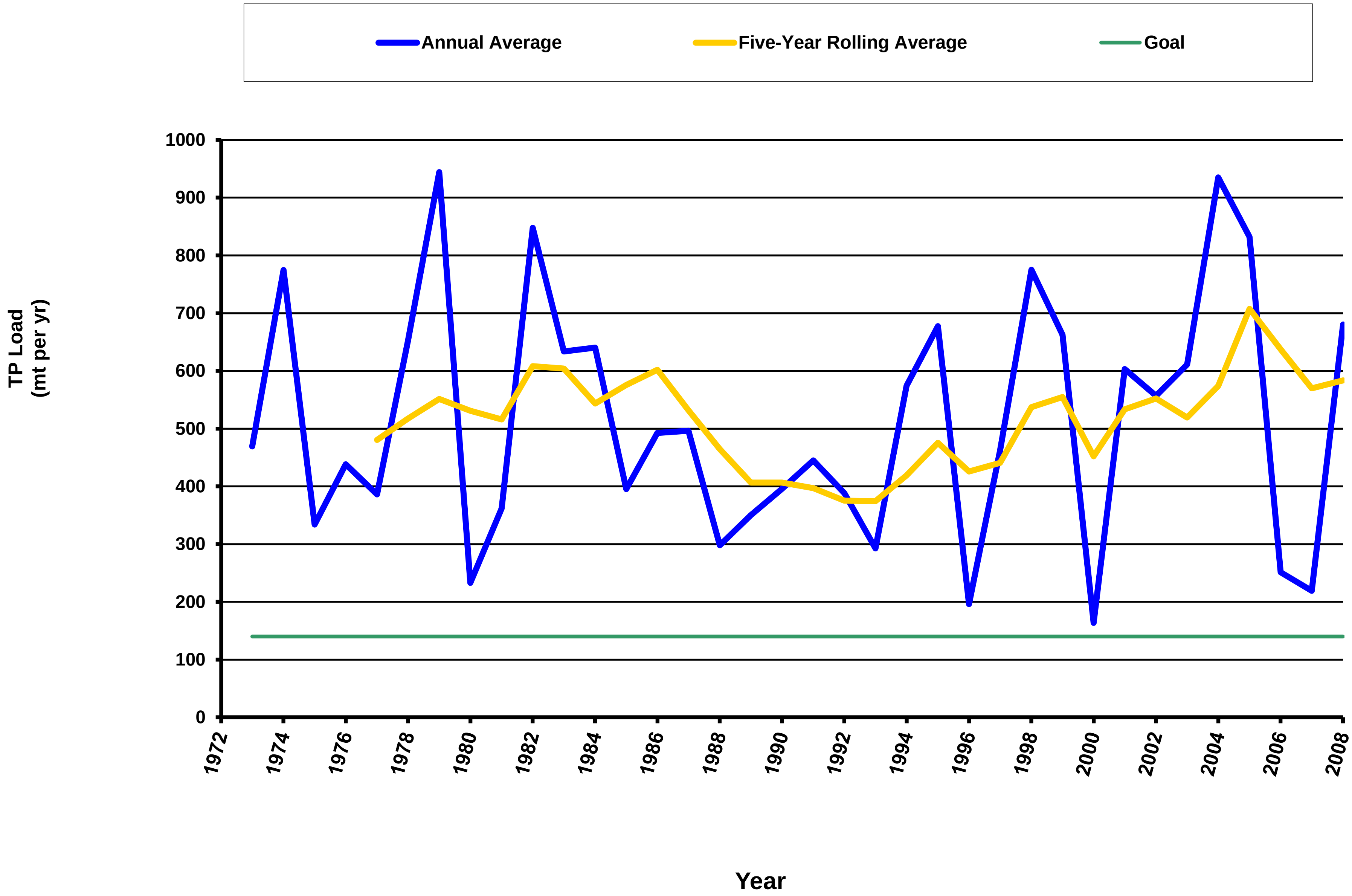
Tissue P and P uptake affected by P application rates, but no effect on CP concentrations

Mehlich-1 extractable P in Ap, E, and Bh horizons not effected by P application rate

P application had no effect on leachate P concentration

Results showed P fertilization at agronomic rates to low input bahiagrass systems has no environmental impacts on water quality

A Humble Extension Agents thoughts for Inclusion in P load Conversation


Annual Average
Five-Year Rolling Average
Goal
1000
900
800
700
600
500
400
300
200
100
0
TP Load
(mt per yr)
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year

Buffer Value: N/A

MEHLICH I EXTRACTABLE		v. low	low	medium	high	v. high
PHOSPHORUS (ppm P)	364+	*******	*******	*******	*******	*******
POTASSIUM (ppm K)	39	*******	*******	*		
MAGNESIUM (ppm Mg)	106	*******	*******	*******	***	
CALCIUM (ppm Ca)	6199+					

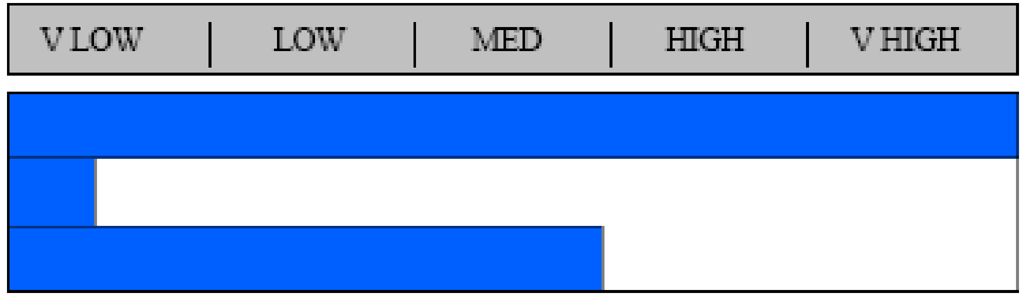
MEHLICH I EXTRACTABLE		v. low	low	medium	high	v. high
PHOSPHORUS (ppm P)	120+	*******	*******	*******	*******	*******
POTASSIUM (ppm K)	31	*******	*****			
MAGNESIUM (ppm Mg)	44	*******	*******	*******	*	
CALCIUM (ppm Ca)	2000+					

SOIL TEST RESULTS AND THEIR INTERPRETATIONS

Target pH:	5.5
pH (1:2 Sample:Water)	6.8
A-E Buffer Value:	N/A

<u>MEHLICH-1 EXTRACTABLE</u>

PHOSPHORUS	(ppm P)	> 137
POTASSIUM	(ppm K)	8
MAGNESIUM	(ppm Mg)	29
CALCIUM	(ppm Ca)	> 1015

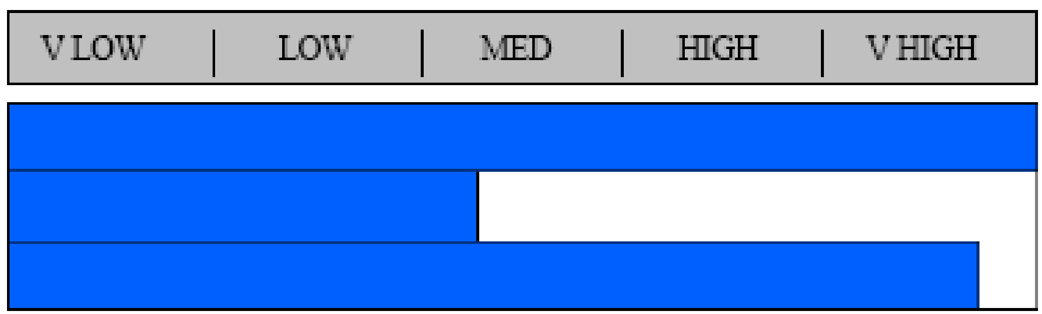


SOIL TEST RESULTS AND THEIR INTERPRETATIONS

Target pH:	6.5
pH (1:2 Sample:Water)	7.4
A-E Buffer Value:	N/A

<u>MEHLICH-1 EXTRACTABLE</u>

PHOSPHORUS	(ppm P)	> 448
POTASSIUM	(ppm K)	42
MAGNESIUM	(ppm Mg)	64
CALCIUM	(ppm Ca)	> 6400



Rainfall and Dryfall

1976-77 bulk rainfall study showed highest N and P concentrations in spring and summer, but total loadings of N 1.15 g and 0.12g P/m² year were above permissible rates (relative to eutrophication) for shallow lakes

1993-2001 Everglades REC multi-collection site rainfall data for P concentration avg. ranged from 0.0234 – 0.2082 mg/L

1992-96 rain and dryfall study by SFWMD, 13 sites showed avg. 9.4 ug/L **P in rainfall, and 37.2** ug/L **P in dryfall**

Florida Population and Cattle Demographics

Population:

1970	1980	2000	2005
6,789,437	9,746,961	15,982,378*	19,400,913

Cattle:

1970	1975	2000	current
1,230,000	1,670,000	994,000	942,000

> population in S. Florida Beef Production area in 2005 11,867,706

* 4^{th} highest population in US

** 2030 population projection 28,685,796, 3^{rd} in US

"Mi caca es su caca."