# Phosphorus — Natural versus Pollution Levels: Lake Okeechobee Case Study

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## Introduction

The quality of our environment has become the predominant issue of today. In Florida, as well as other states in the country, there has been particular concern over the quality of our lakes. The United States Environmental Protection Agency has estimated that, of the 12 million lakes found in the United States, 25% are currently facing water quality problems (Nair and Graetz, 1997). Eutrophication of lakes (enrichment of lakes with nutrients) can result in serious algal blooms. These algal blooms can lead to the death of fish and other aquatic life. Phosphorus and nitrogen are of particular concern to aquatic resource managers because they are generally the nutrients responsible for controlling aquatic plant and algal growth (Havens and Steinman, 1995). This is also true for Florida where the Water Management Districts have determined that these two nutrients are the main culprits.

A classic example of a serious lake quality problem in Florida which has received national attention is Lake Okeechobee, where in 1986 one of the largest algal blooms ever documented appeared in the lake. Aerial observation indicated that the bloom covered up to 120 square miles in the western quarter of the lake. After three or four weeks, the bloom completed its growth cycle and the algae began dying. The resulting low levels of dissolved oxygen and high ammonia concentrations killed virtually all invertebrate life within the area. This particular bloom caused a great deal of concern, not only because of its magnitude, but because of the algal species involved: *Anabaena circinalis*, a noxious blue-green algae commonly dominant in highly eutrophic lakes. Initial studies showed that phosphorus was generally the factor controlling algal growth in the lake. Since that time, a major emphasis has been placed on controlling phosphorus inputs to Lake Okeechobee in order to prevent further eutrophication, which would bring about drastic changes in the diversity of flora and fauna in the lake.

The Taylor Creek–Nubbin Slough watershed has been identified by the South Florida Water Management District as responsible for 29% of the phosphorus (more than any other watershed) entering the lake, while accounting for only 4% of the water *inflow*. Approximately 73% of the phosphorus entering the lake from the Taylor Creek–Nubin Slough basin has been attributed to high-density dairy operations. Another 23% of the phosphorus from the basin has been identified as coming from improved beef cattle pastures, with the remaining 4% coming from the urban areas and wetlands.

The South Florida Water Management District has indicated that a 90% reduction in phosphorus entering the lake from the Taylor Creek– Nubbin Slough watershed is required to prevent accelerated eutrophication of Lake Okeechobee. Adaptation and implementation of ***Best Management Practices*** (BMPs) in the area have begun to reduce the amount of phosphorus entering the lake from dairy operations. However, additional reductions in phosphorus loss from the Taylor Creek–Nubin Slough watershed are required to achieve the targeted 90% cutback (Rechcigl and Bottcher, 1995).

The loss of phosphorus from agricultural land is thought to have limited agronomic significance, but it can potentially have dramatic environmental and ecological impacts—such as accelerated eutro-phication of surface waters (as described above), and pollution of ground water. Many scientists believed that the phosphorus fertilization rates previously recommended by IFAS could be substantially reduced without production losses. Not only would lower fertilizer recommendations be a cost savings to the grower, but they could also help eliminate the accelerated eutrophication of surface waters such as in Lake Okeechobee, and reduce pollution of ground water. We conducted a study designed to determine the optimum phosphorus fertilization rate for bahiagrass grown on sandy soils commonly found in south Florida, as well as the influence of different phosphorus fertilization rates on ground and surface water quality.

## Design of Study

Forty plots were developed in 1988 on an established, unlimed, and grazed bahiagrass pasture that had not been fertilized with phosphorus since 1982 (Rechcigl and Bottcher, 1995). The ex-

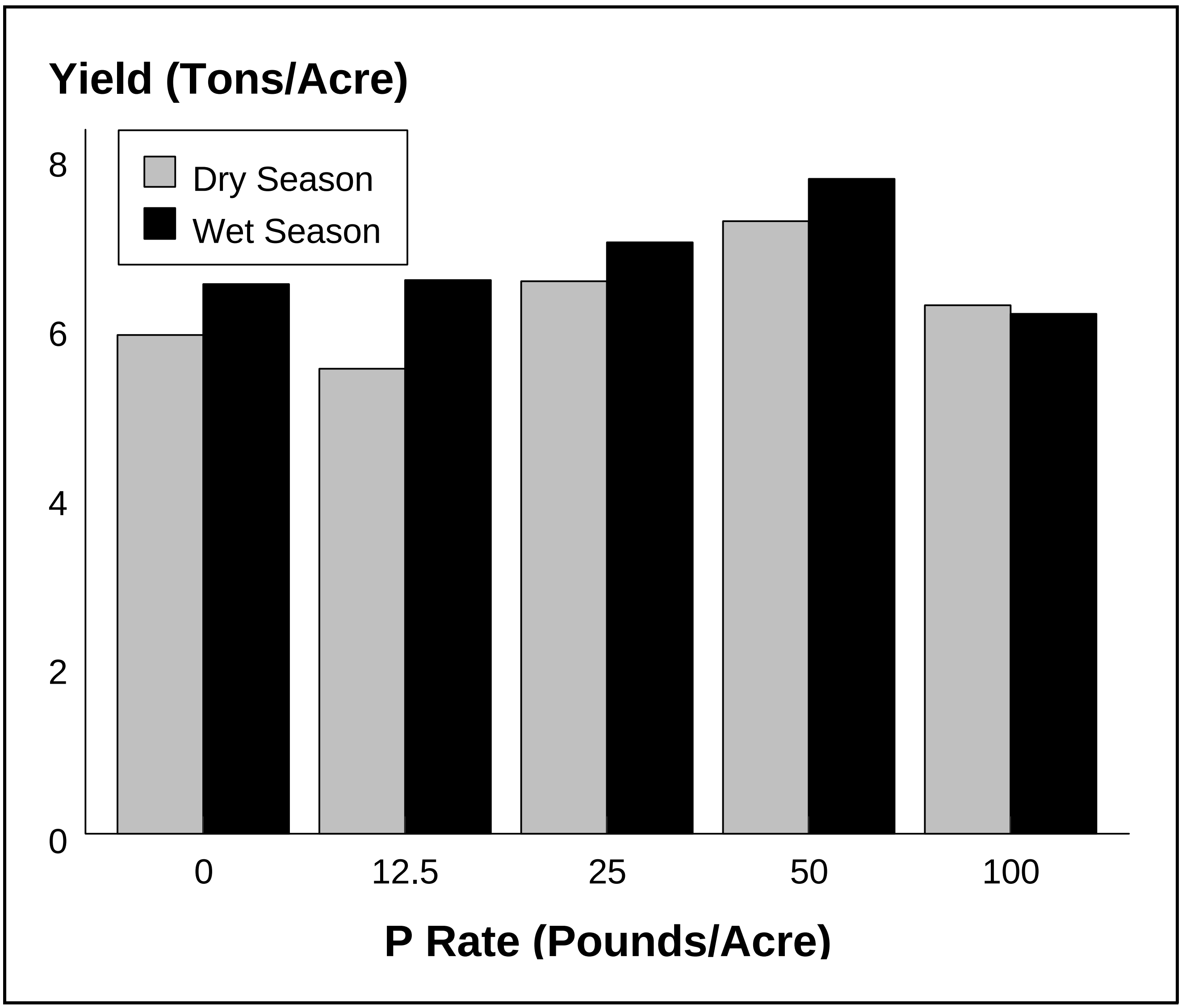


**Figure 1.** Influence of phosphorus rate and time of application on bahiagrass yields

periment was conducted at a beef cattle ranch in Okeechobee County. Each plot was side-drained by ditches, which permitted the collection of run-off from plots. Ground water wells were installed in each plot at 2 and 4' depths to measure ground water quality. Water samples were collected after every major rainfall and analyzed for phosphorus. The phosphorus fertilization rates used were 0, 12.5, 25, 50 and 100 lb phosphate per acre, applied either in the dry season (March) or the wet season (June). All plots also received 150 lb nitrogen per acre. Plots were harvested monthly for yield and nutrient analysis. Soil samples were taken from each soil horizon every 3 months for elemental analysis.

## Results

**Yield and Tissue Data.** Final results from this 3-year study indicate that phosphorus fertilization rates could be reduced dramatically without adverse effects on bahiagrass yield or quality

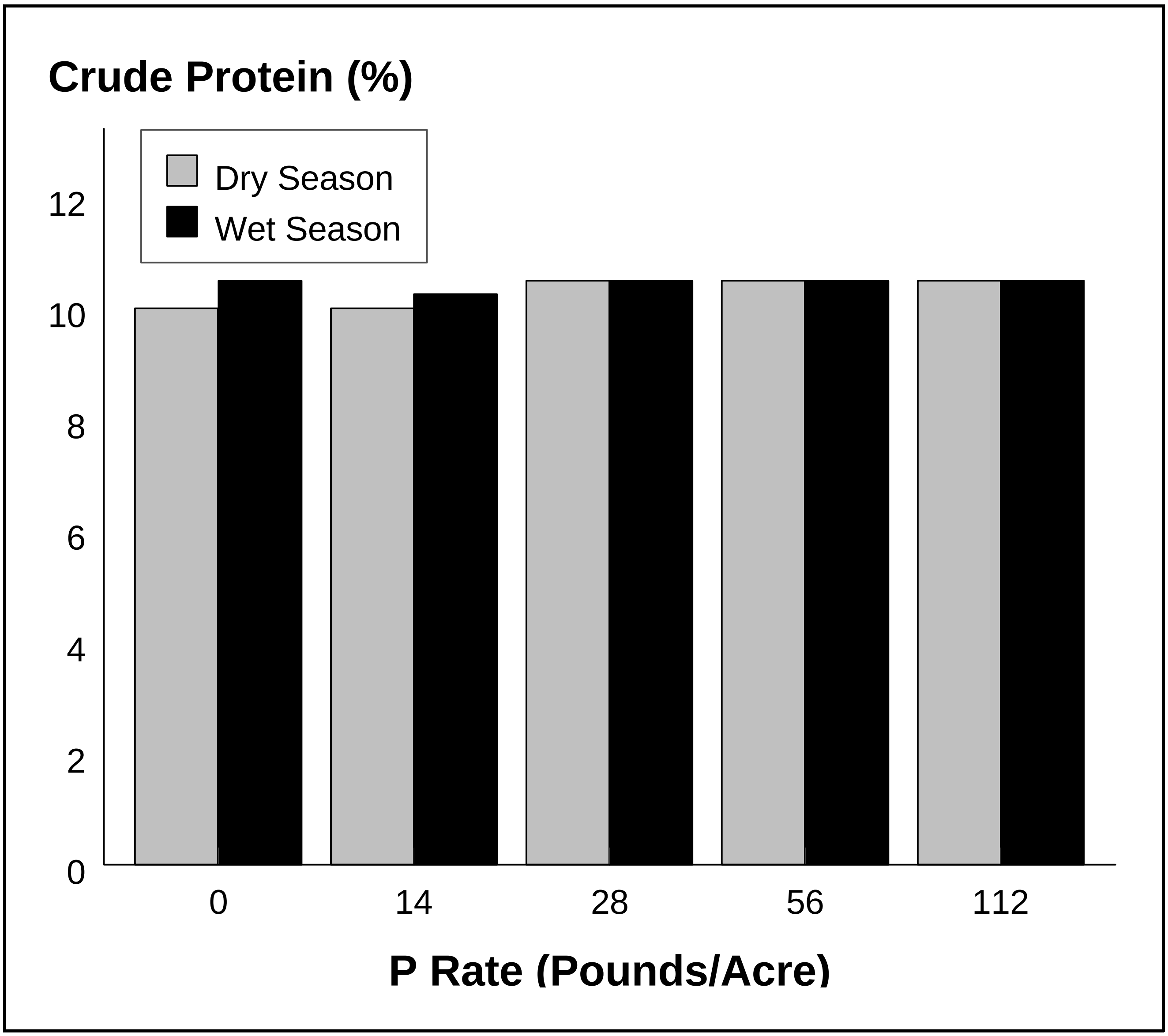


**Figure 2.** Influence of phosphorus rate and time of application on percentage of crude protein

and that, in fact, there may be ***no*** economic advantage in applying phosphorus to bahiagrass (Figures 1 and 2). This study also indicates that there are no differences in forage yields, whether phosphorus is applied in the dry season (March) or the wet season (July).

Phosphorus concentration in the forage tissue and phosphorus uptake increased with increasing phosphorus application rates (Figure 3). However, the percentage of the applied phosphorus recovered in the tissue decreased with increasing application rates. An interesting point is that the treatment using 50 lb phosphate per acre produced a phosphorus recovery rate in the plant tissue 165% of that applied (Figure 4). This means that more phosphorus was recovered in the plant tissue than was applied. Therefore, there was no net loss of phosphorus from the system because phosphorus uptake was greater than the amount of phosphorus applied. For plots receiving 100 lb phosphate per acre, phosphorus recovery was 75% of that applied. This indicates that as much as 25% of the phosphorus applied to these plots

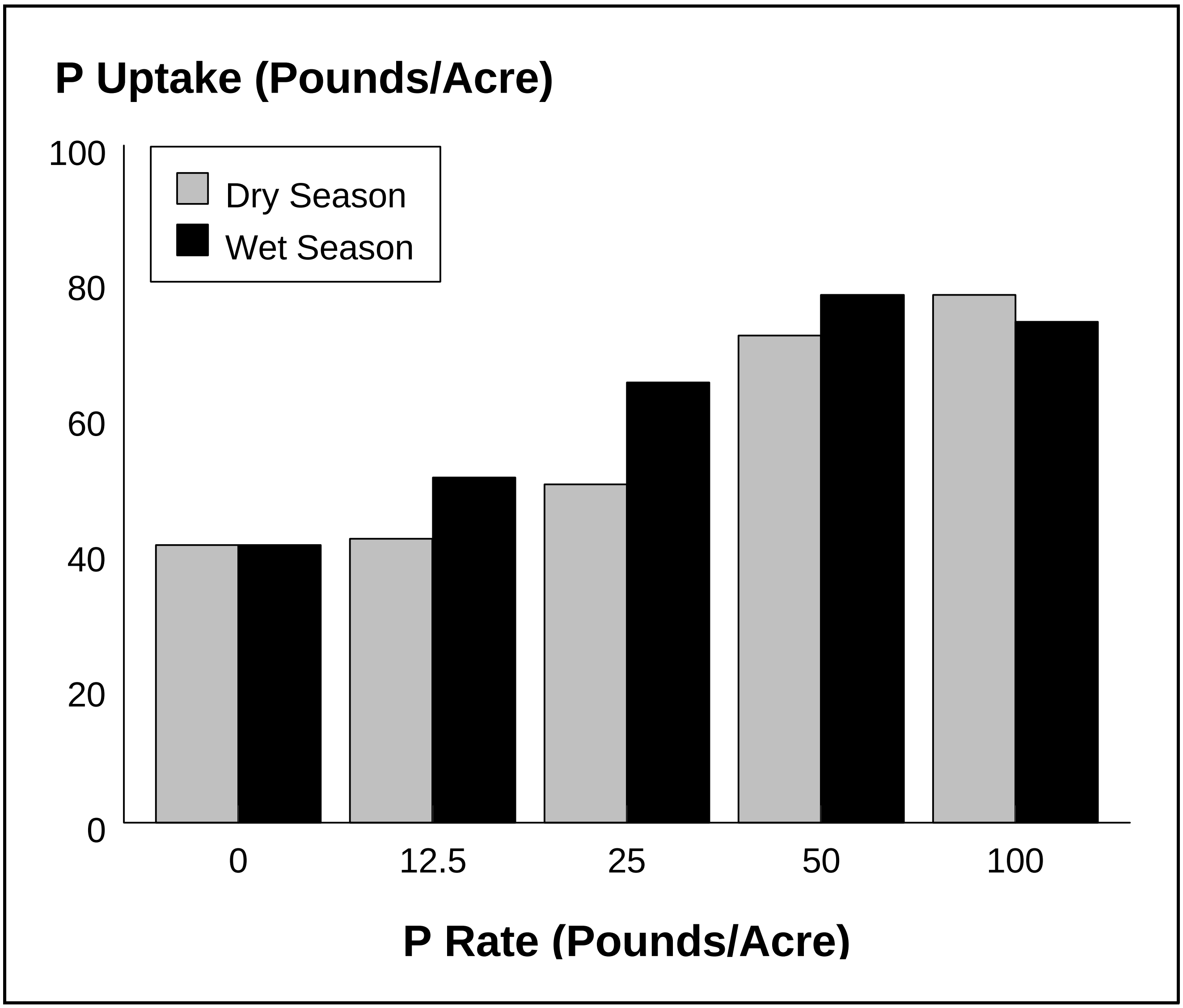


**Figure 3.** Influence of phosphorus rate and time of application on P uptake

was not taken up by the plants and is therefore subject to leaching.

**Soil Data.** Extractable phosphorus in the Ap horizon (0-6 inches) generally increased with increasing phosphorus application rate (Figures 5 and 6). The levels of phosphorus in the Bh (hard pan) horizon (30-36 inches) were up to two times greater than those found in the surface.

**Root Activity.** This study also showed that bahiagrass roots were able to extend into the subsurface hard pan (Bh horizon), suggesting that phosphorus located in the hard pan may be utilized by deep rooted forages such as bahiagrass. Thus, it appears that the hard pan is a valuable source of naturally occurring phosphorus for bahiagrass.

**Water Quality.** Phosphorus concentrations in runoff from the experimental plots were not affected by season of application (data not shown). However, phosphorus concentrations were significantly affected by phosphorus application rate

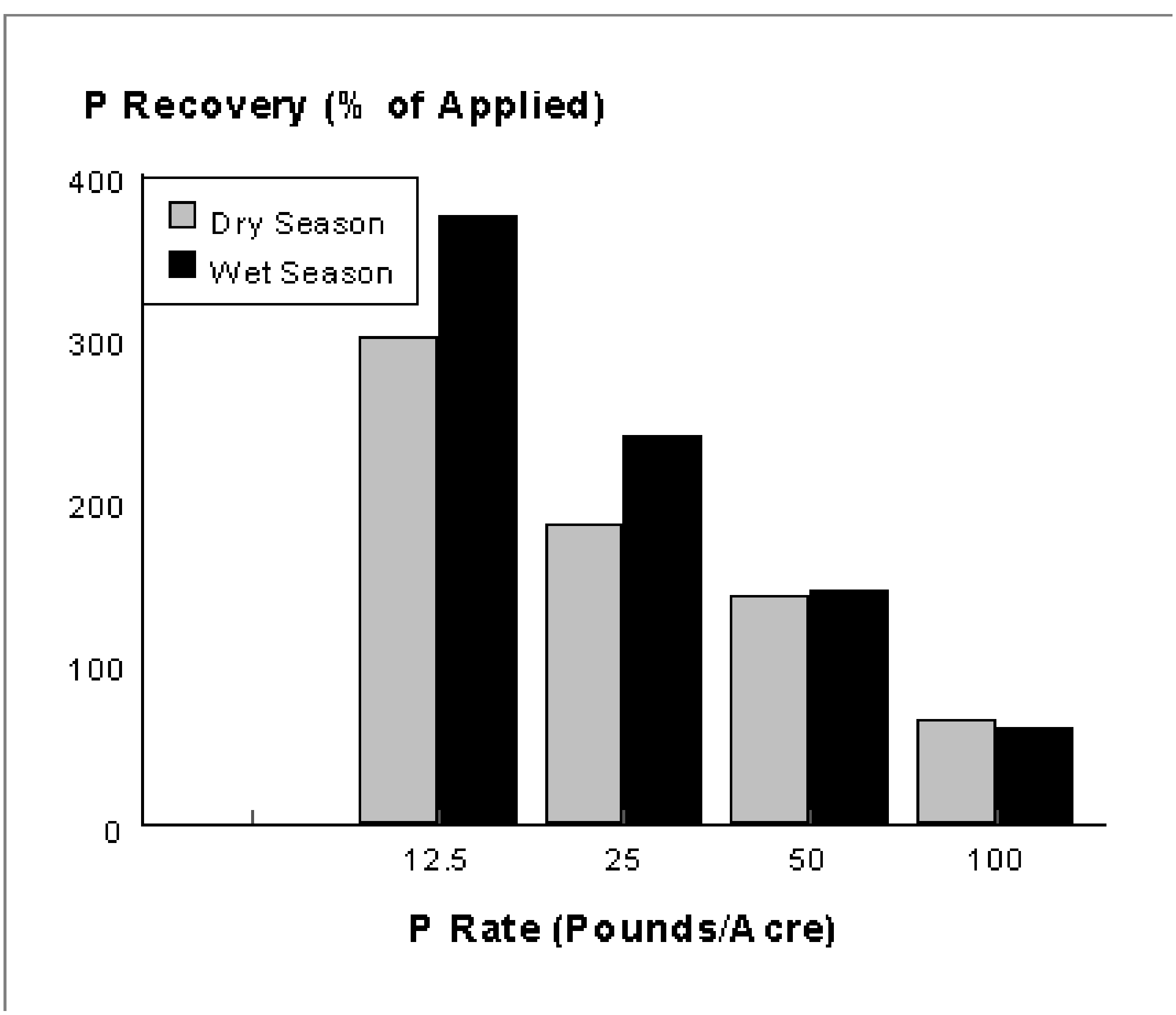


**Figure 4.** Influence of phosphorus rate and time of application on P recovery by bahiagrass

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(Figure 7). Substantial reductions in phosphorus concentration in surface runoff were achieved by reducing phosphorus applications from 100 to 25 lb phosphate per acre. Phosphorus concentrations were reduced from 33 to 60%, while total phosphorus losses were reduced between 17 and 78% as phosphorus rates were reduced from 100 to 25 lb phosphate per acre. However, one of the most significant findings was that the level of phosphorus in all water sam-ples still exceeded the total phosphorus standard of .35 ppm phosphorus for surface waters established by the South Florida Water Management District for improved pastures. This may be a result of the naturally high levels of phosphorus found in Florida soils, considering that Florida soils are naturally high in phosphate.

## Conclusions

As a result of this and other studies, IFAS has revised its fertilizer recommendations for forages. The major change in fertilizer recommendations is a substantial decrease (60 to 100%) in phos-

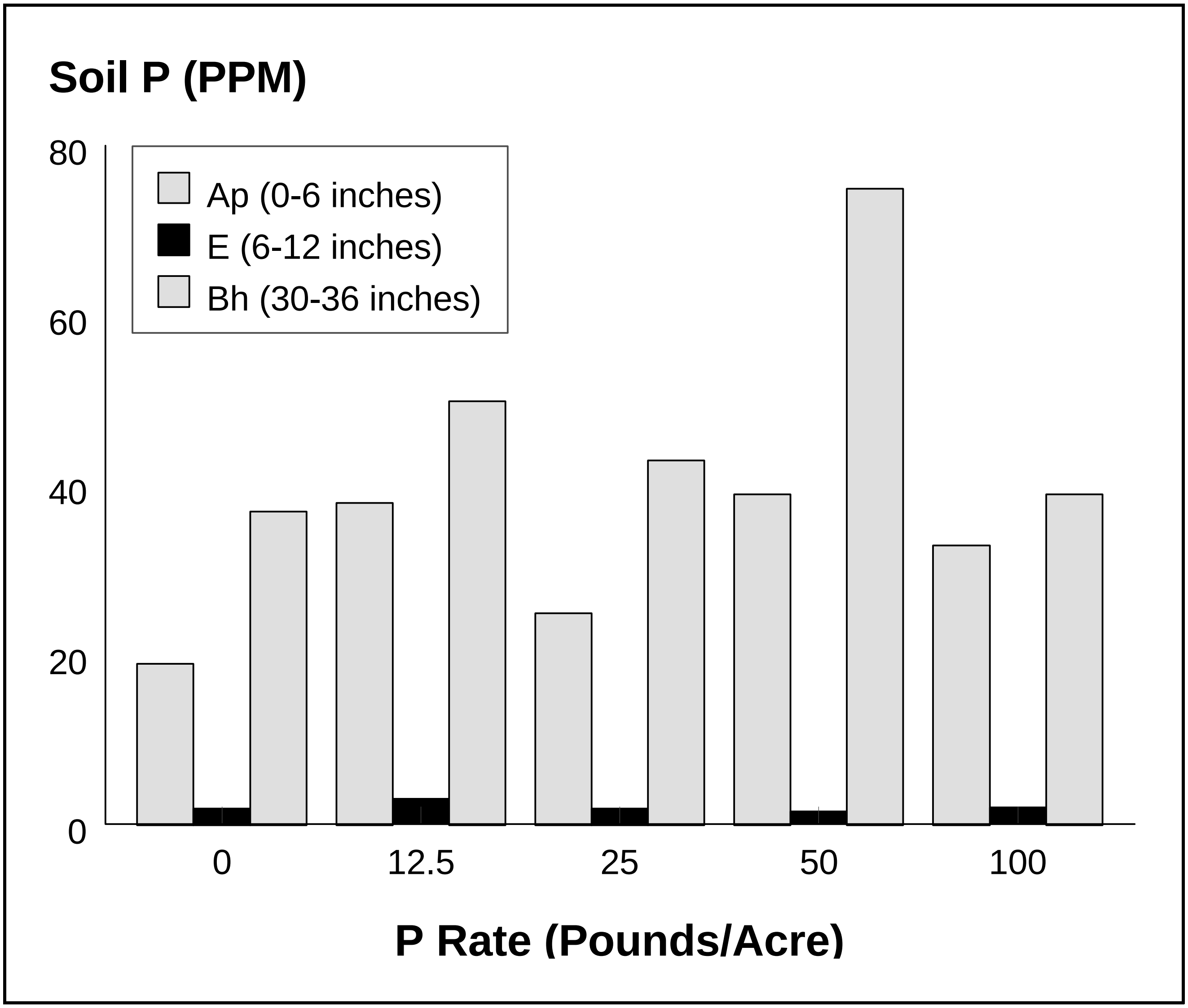


**Figure 5.** Influence of phosphorus rates applied during the dry season (March) on extractable soil phosphorus in the Ap (0-6 inches), E (6-12 inches), and Bh (30-36 inches) horizons; soil samples were taken April, 1998

phorus fertilization rate. The University of Florida is even considering recommending that phosphorus ***not*** be applied to bahiagrass in southern Florida. This is because all studies conducted to date in south Florida show no economic advantage in the addition of phosphorus to bahiagrass pastures. These reductions in phosphorus fertilization should result in substantial cost savings to ranchers and also help to reduce the possibility that phosphorus may be getting into surface waters such as Lake Okeechobee.

## References

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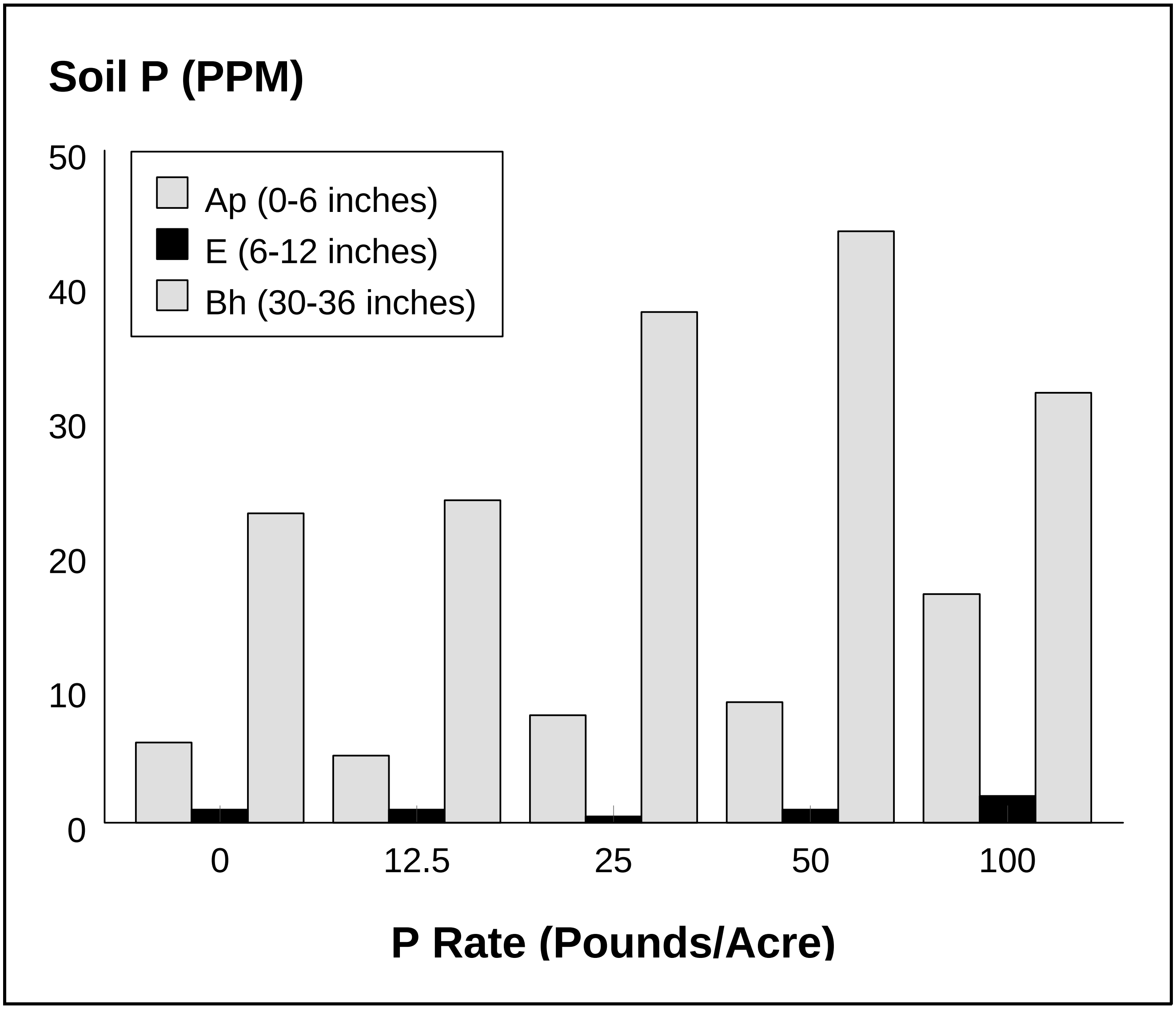


**Figure 6.** Influence of phosphorus rates applied during the wet season (July) on extractable soil phosphorus in the Ap (0-6 inches), E (6-12 inches), and Bh (30-36 inches) horizons; soil samples were taken April, 1998

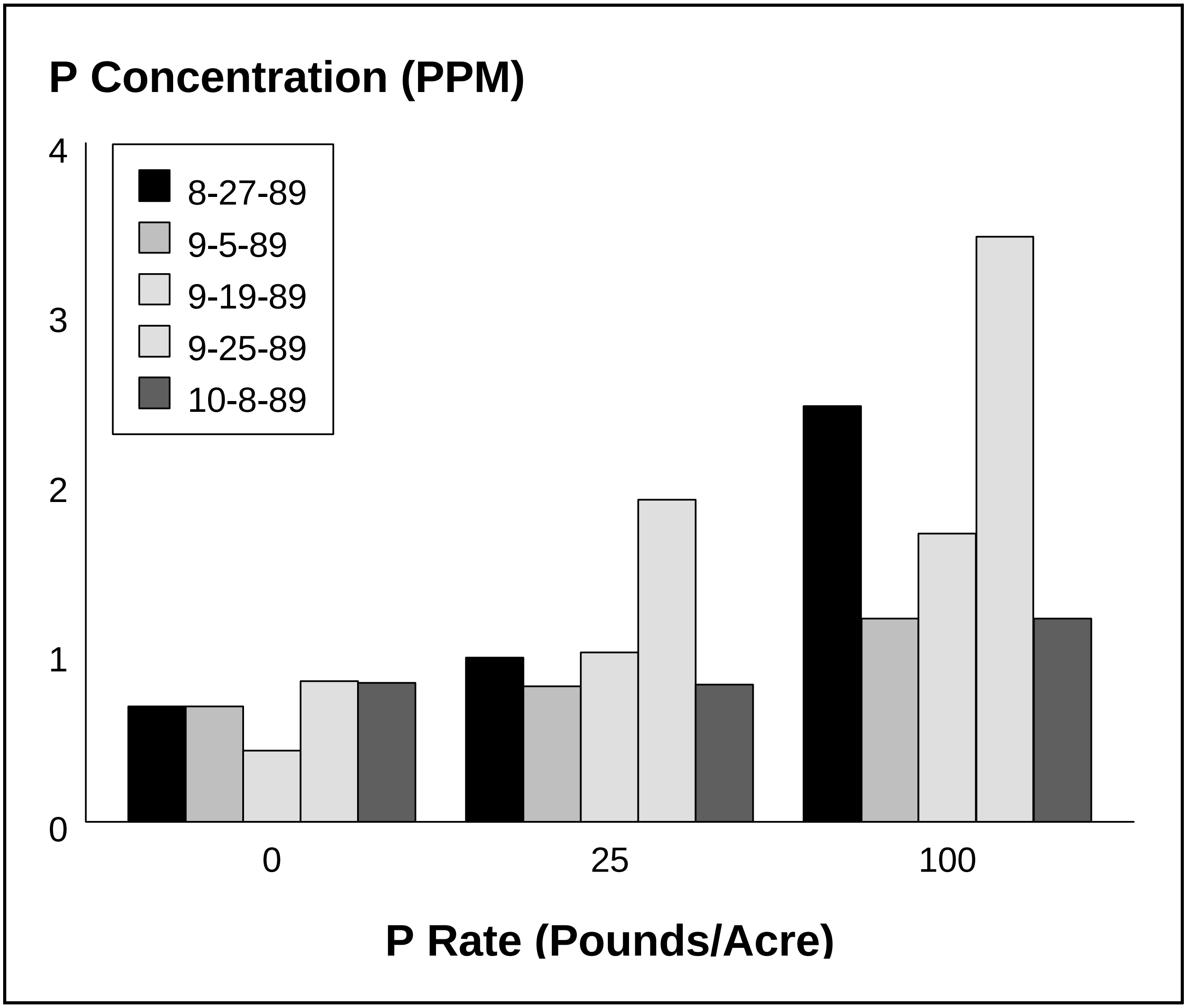


**Figure 7.** Influence of fertilizer P rates on P concentrations in surface runoff