Interactions among climate, humans, and playa wetlands on the Southern High Plains

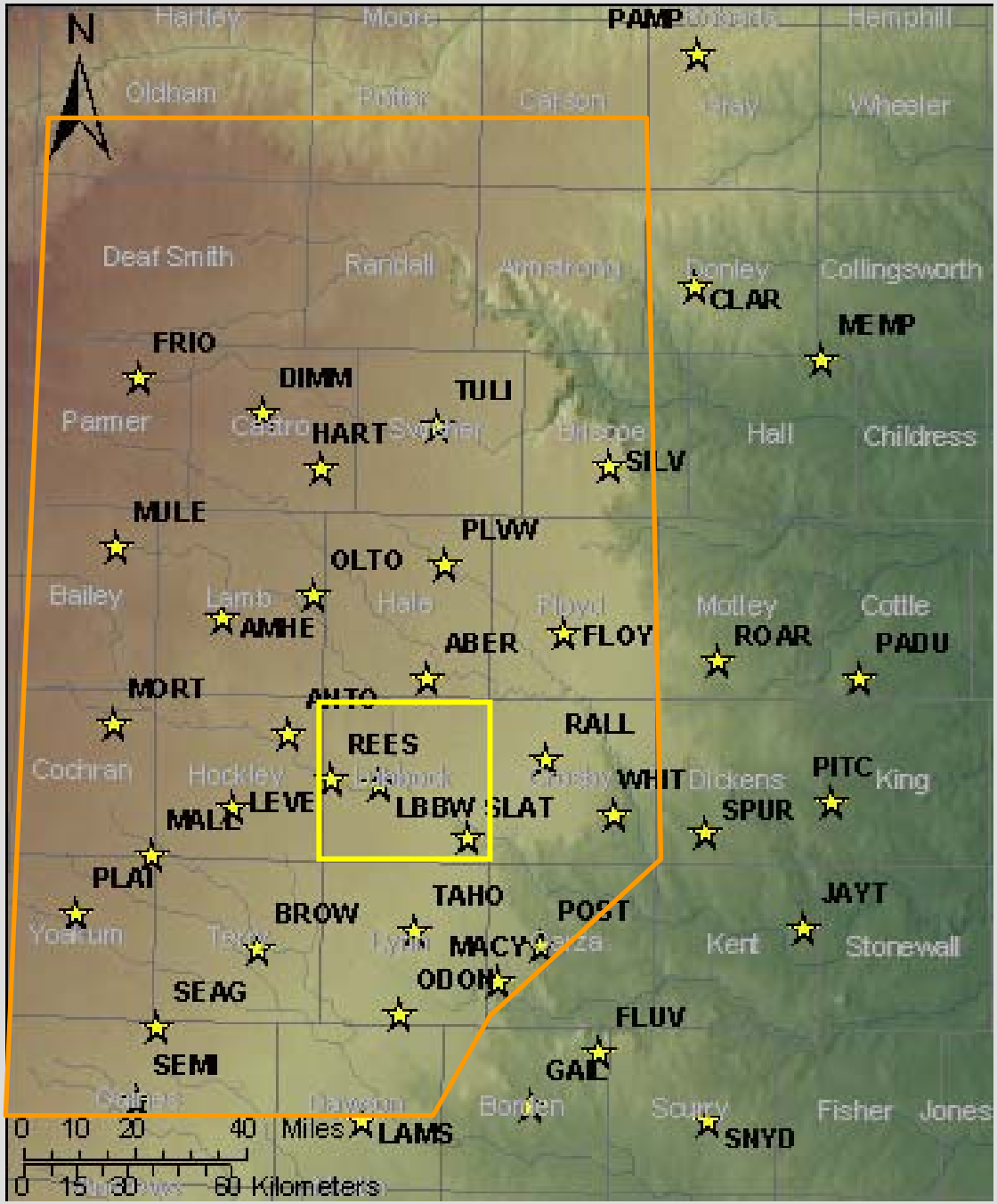
- S. McMurry, L. Smith, W. P. Dayawansa, D. Willis, C. Martin, K. Dixon, and C. Theodorakis

- Texas Tech University

- Lubbock, Texas

Description of region

- Southern High Plains
- About 20,000 playas
- Each playa within its own watershed
- Heavy agriculture, mostly cotton and under irrigation from the Ogallala
- Significant wildlife use of playas



Weather stations are scattered throughout the Southern High Plains.

Data from these stations are continuously updated and available online.

Lubbock County

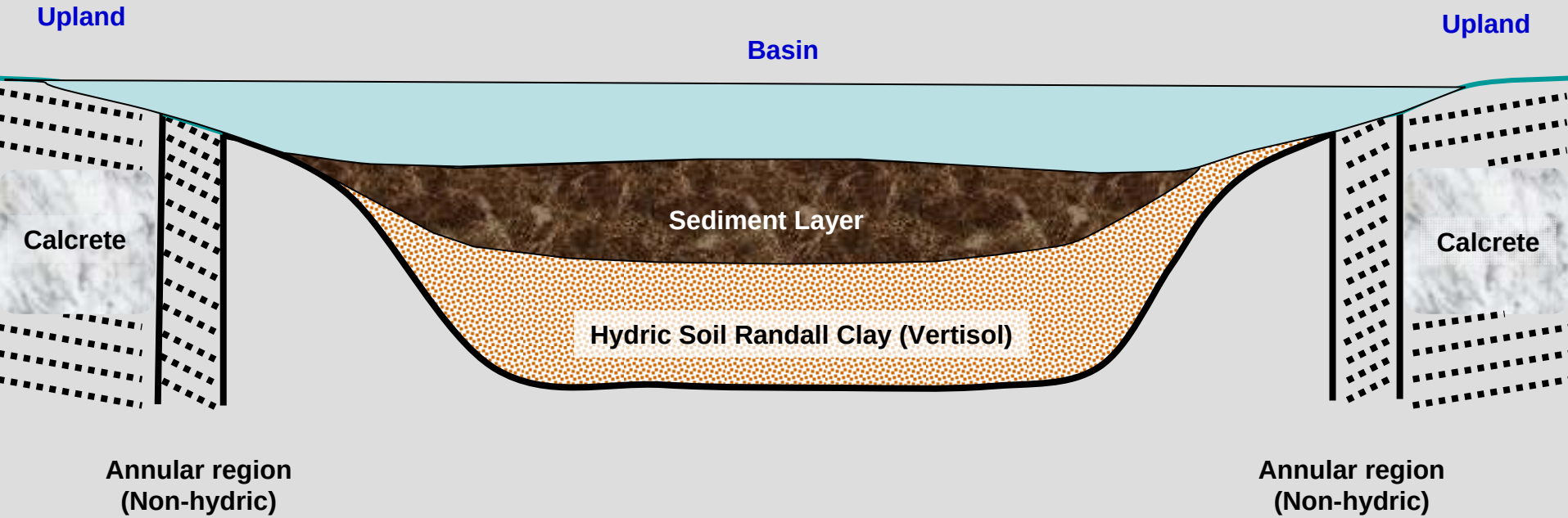
Study site

40 miles

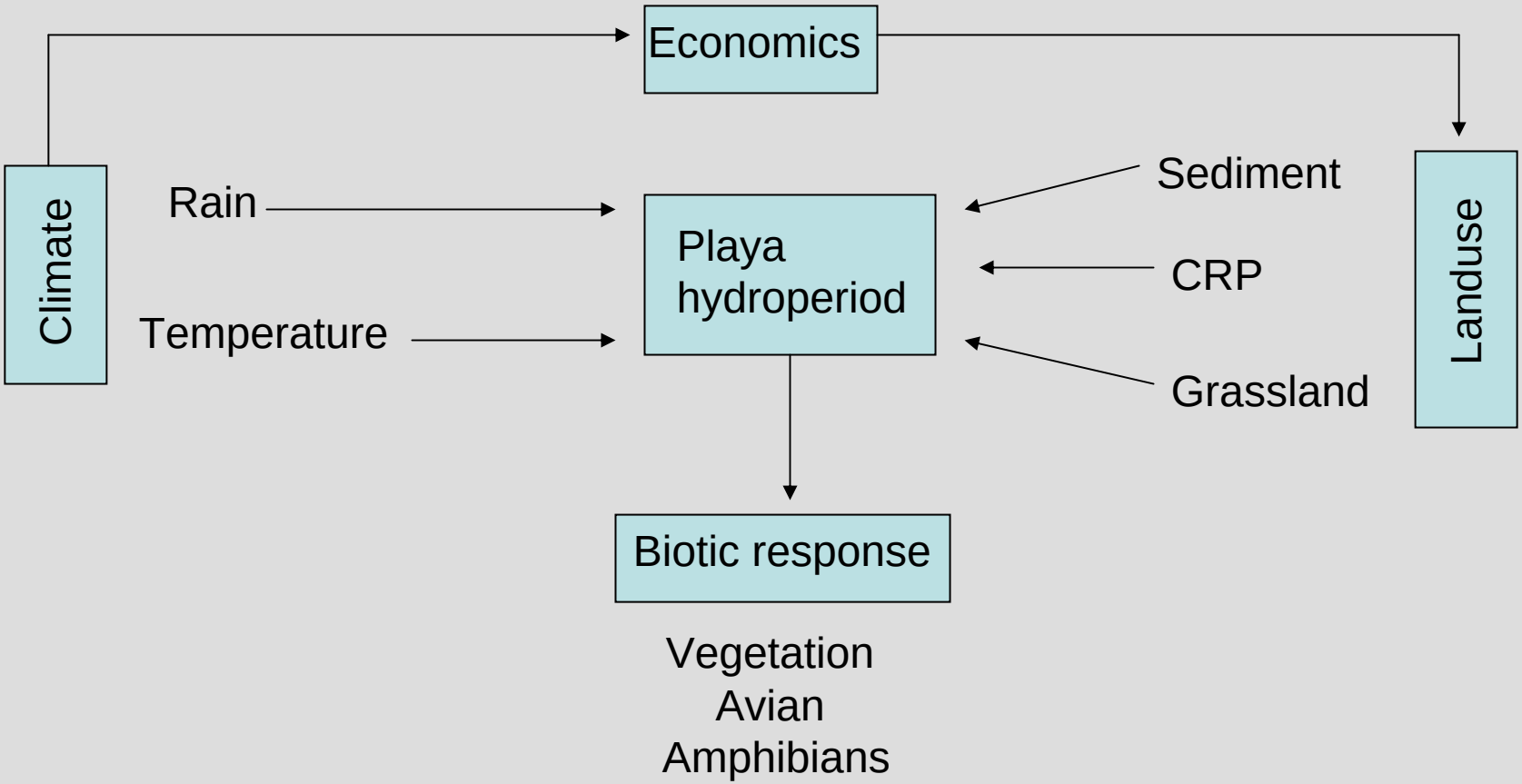

OGALLALA AQUIFER
WYOMING
SOUTH DAKOTA
NEBRASKA
COLORADO
KANSAS
OKLAHOMA
NEW MEXICO
TEXAS


2004 3 29

Playa Cross-section



- Hypothesis: Climatic variation and landuse practices dictate hydroperiod and spatial distribution of wet playas, influencing the ecological structure of vegetation and animal communities that rely on playas for many life requisites.



Experimental Design

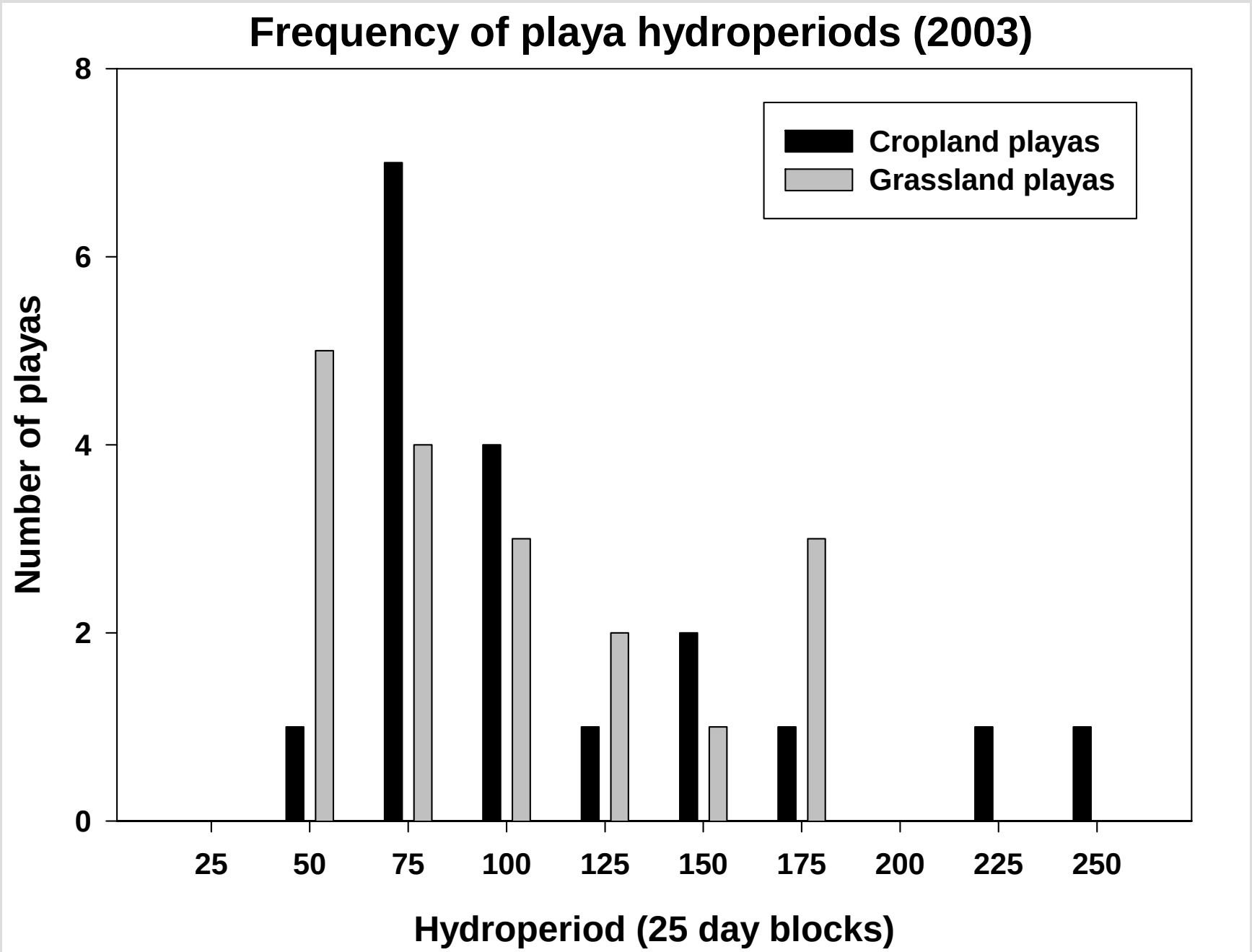
- Southern High Plains in west Texas
- 40 wet playas selected per year (20 cropland and 20 grassland)
- Sample amphibian, avian, and vegetative communties
- Determine playa hydroperiod, volume, sediment depth.
- Estimate extreme temperature and precipitation patterns.
- Estimate sediment runoff into playas.

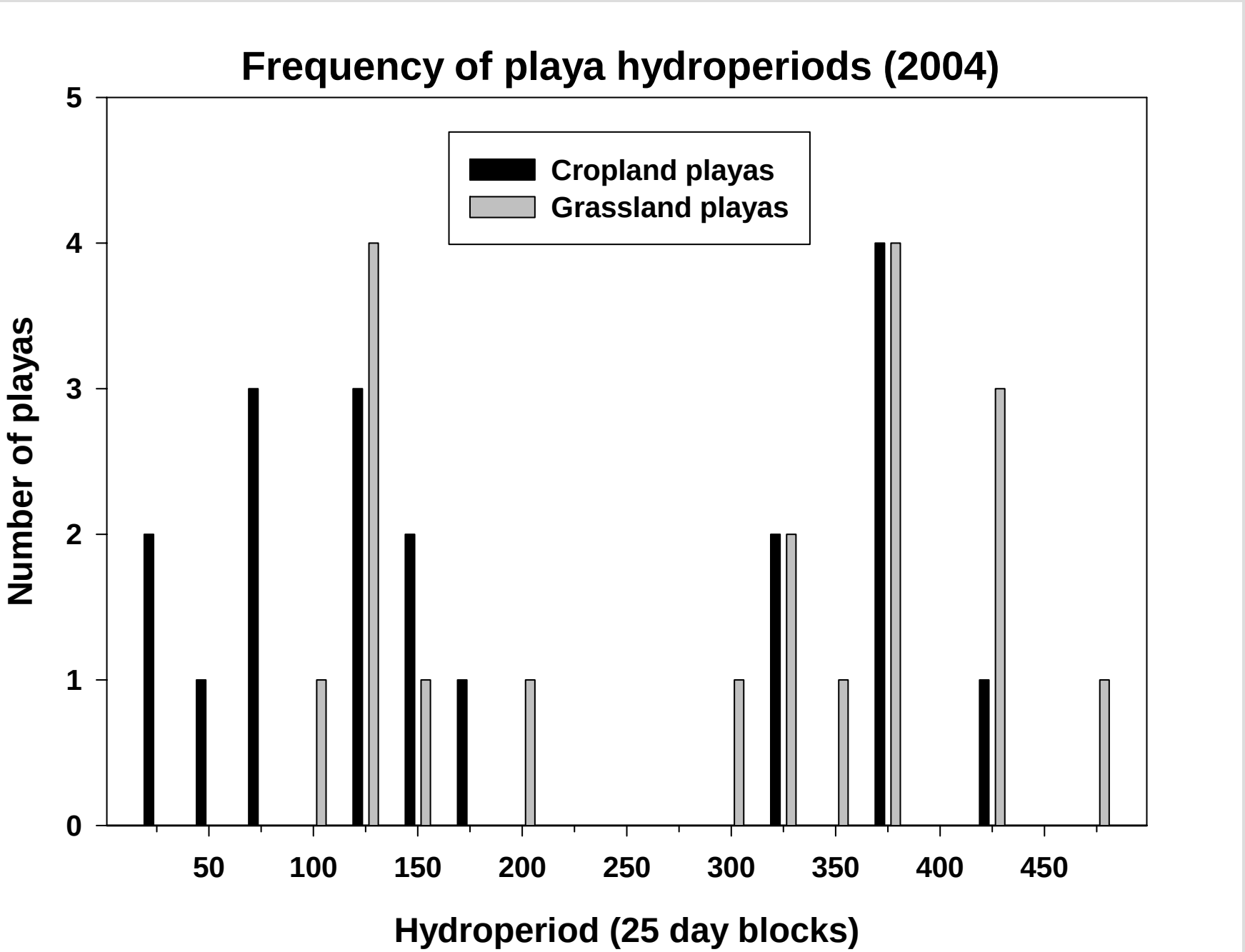
Playa characteristics (Means for 2003 and 2004)

	Grassland		Cropland	
Factor	**Medium**	**Fine**	**Medium**	**Fine**
N	5	34	20	18
Area (ha)	6.5	13.7	8.9	11.5
Basin depth (cm)	59	49	54	44
Volume ($m^3 \times 10^3$)	31	67	39	42
Sed depth (cm)	20	8	53	31
Sed Vol. ($m^3 \times 10^3$)	12	13	38	30
Volume loss (%)	53	29	231	137

Cropland playas have greater depth and volume of sediment than grassland playas

Cropland playas have greater loss of volume than grassland playas


Frequency of playa hydroperiods (2003)
Cropland playas
Grassland playas
Number of playas
0
2
4
6
8
25
50
75
100
125
150
175
200
225
250
Hydroperiod (25 day blocks)


Frequency of playa hydroperiods (2004)
Cropland playas
Grassland playas
Number of playas
0
1
2
3
4
5
50
100
150
200
250
300
350
400
450
Hydroperiod (25 day blocks)

Vegetation in playas (Mean±SE)

Factor	Grassland	Cropland
Height (cm)	21 (2)	17 (3)
Structure (%)	4.6 (0.7)	5.1 (1.0)
Cover (%)	35.6 (4.8)	20.1 (3.2)
No. Species	9 (1)	8 (1)

Percent vegetation cover greater in grassland playas than cropland playas

Avian Results

- Preliminary results from
  - June 2003 – May 2004 &
  - June 2004 – Feb 2005

- No differences in mean species richness between land uses

- Wet playas had higher mean species richness than dry playas

Table 1. Total mean species richness (by playa within a season), standard error (SE), and number (n) of wet and dry playas in each treatment of SHP, June 2003 to May 2004.

		Cropland Playas			Grassland Playas		
		Mean	SE	n	Mean	SE	n
Wet							
	Summer	17.95	1.65	20	17.75	1.34	20
	Fall	19.83	4.16	6	18.00	2.02	10
	Winter	11.50	3.50	2	3.00	0.82	4
	Spring	12.22	1.52	18	13.71	2.21	14
Dry							
	Summer	3.27	0.68	11	4.10	0.55	11
	Fall	5.33	1.09	18	4.22	0.47	18
	Winter	4.10	0.90	20	2.10	0.28	20
	Spring	5.24	0.69	17	4.53	0.74	15

Avian Results

- Differences in species composition
  - Greater frequency of exotic species in cropland playas ($p<0.01$)
  - Some species restricted to grassland playas (i.e. long-billed curlew)
    - 2003-2004
      - 4/20 for cropland
      - 14/20 for grassland

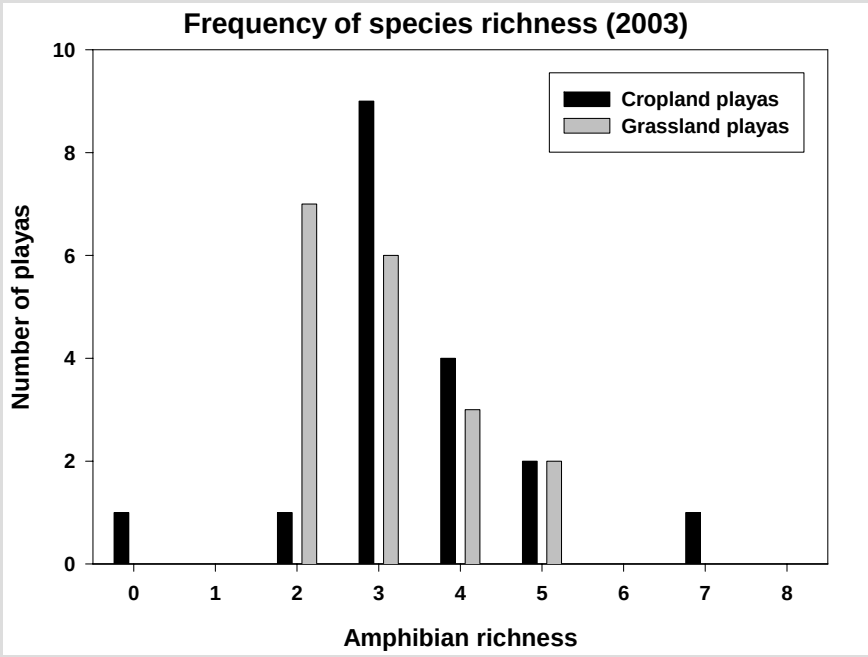
Avian Conclusions

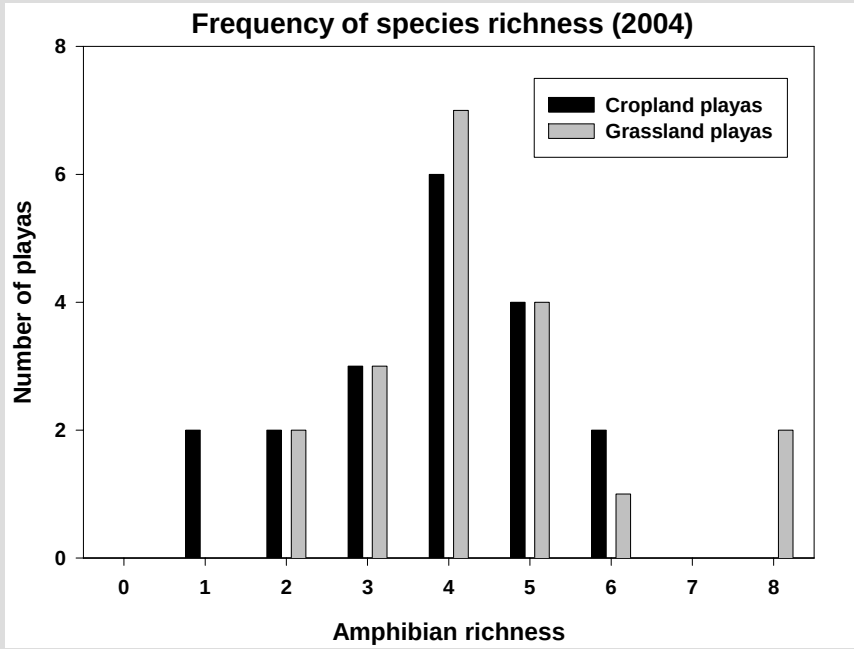
- No differences in mean species richness between cropland and grassland treatment
- Had differences in species composition
- Results support species-area relationship in wet playas
- Previous study on wetland plants had the same trend
- Further analyses will test for land use preference by guild using density and species diversity indices

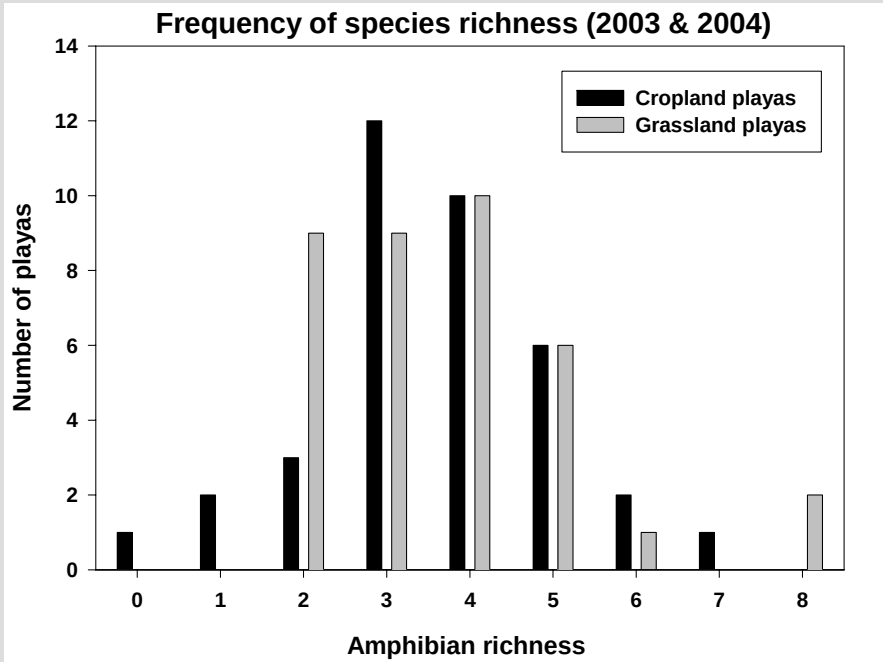
Amphibian Results

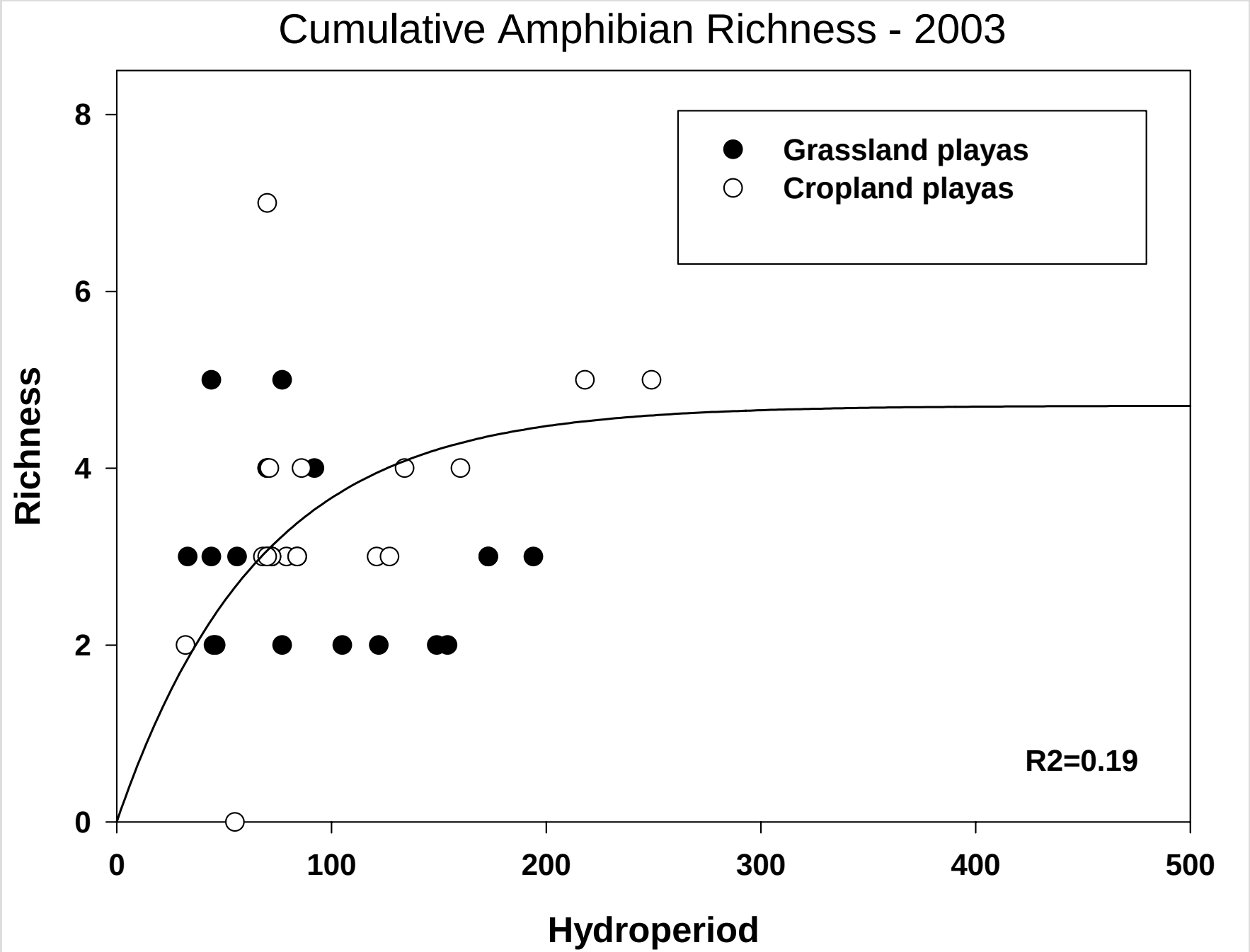
	2003		2004	
	Grassland	**Cropland**	**Grassland**	**Cropland**
Richness	**3.1 (0.2)**	**3.4 (0.3)**	**4.3 (0.4)**	**3.8 (0.4)**
Min. species	**2**	**0**	**2**	**1**
Max. species	**5**	**7**	**8**	**6**
Total species	**6**	**8**	**10**	**8**
Hydroperiod (d)	**97 (33-194)**	**100 (32-249)**	**269 (78-453)**	**193 (18-418)**

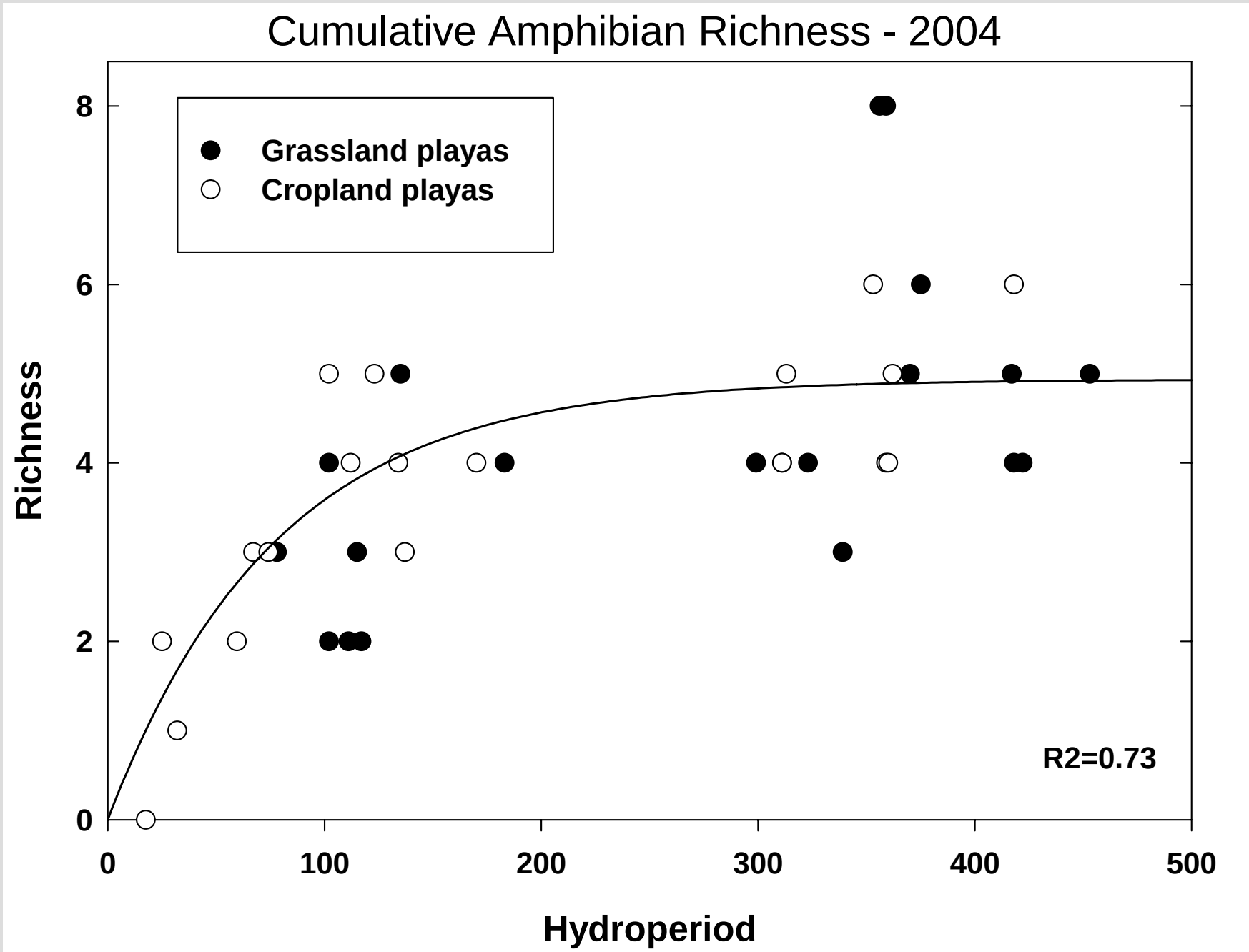
No differences in mean richness between grassland and cropland playas


Frequency of species richness (2003)
Cropland playas
Grassland playas
Number of playas
Amphibian richness
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10


Frequency of species richness (2004)
Cropland playas
Grassland playas
Number of playas
Amphibian richness
0
1
2
3
4
5
6
7
8
0
2
4
6
8


Frequency of species richness (2003 & 2004)
Cropland playas
Grassland playas
Number of playas
Amphibian richness
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
14


Cumulative Amphibian Richness - 2003
Grassland playas
Cropland playas
R2=0.19
Richness
Hydroperiod
0
2
4
6
8
0
100
200
300
400
500


Cumulative Amphibian Richness - 2004
Grassland playas
Cropland playas
R2=0.73
Richness
Hydroperiod
0
2
4
6
8
0
100
200
300
400
500

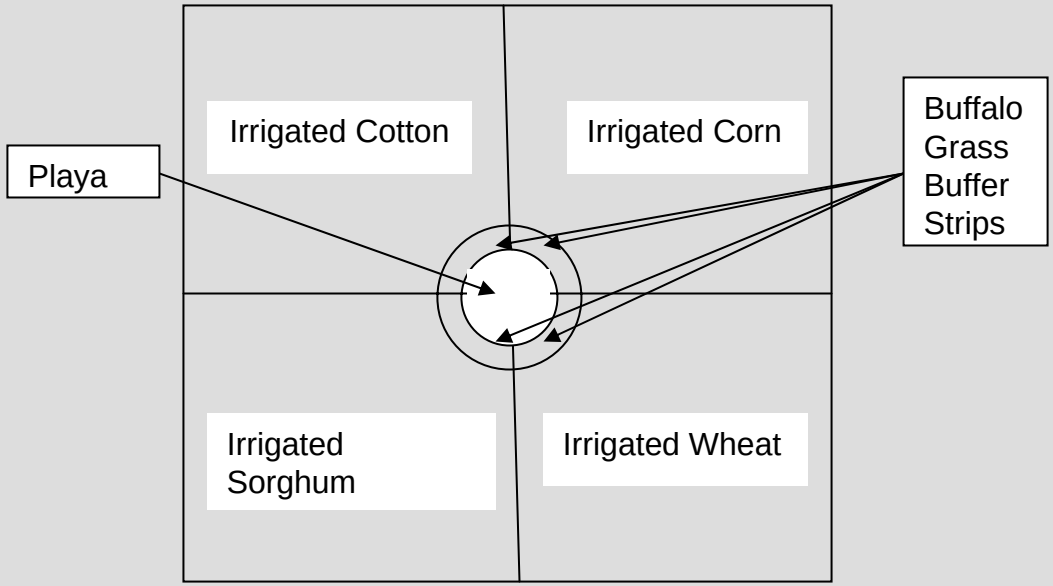
Proportion of playas within a hydroperiod category that contained a particular species

Hydroperiod (days)	Spea	Buco	Pscl	Rabl	Bude	Buwo	Gaol	Accr	Raca	Amti
≤50	78	78	22	11	0	11	0	0	0	22
>50	92	85	65	37	6	13	15	6	10	46
≤100	88	70	52	24	0	3	6	3	0	48
>100	91	94	66	40	9	19	19	6	15	40

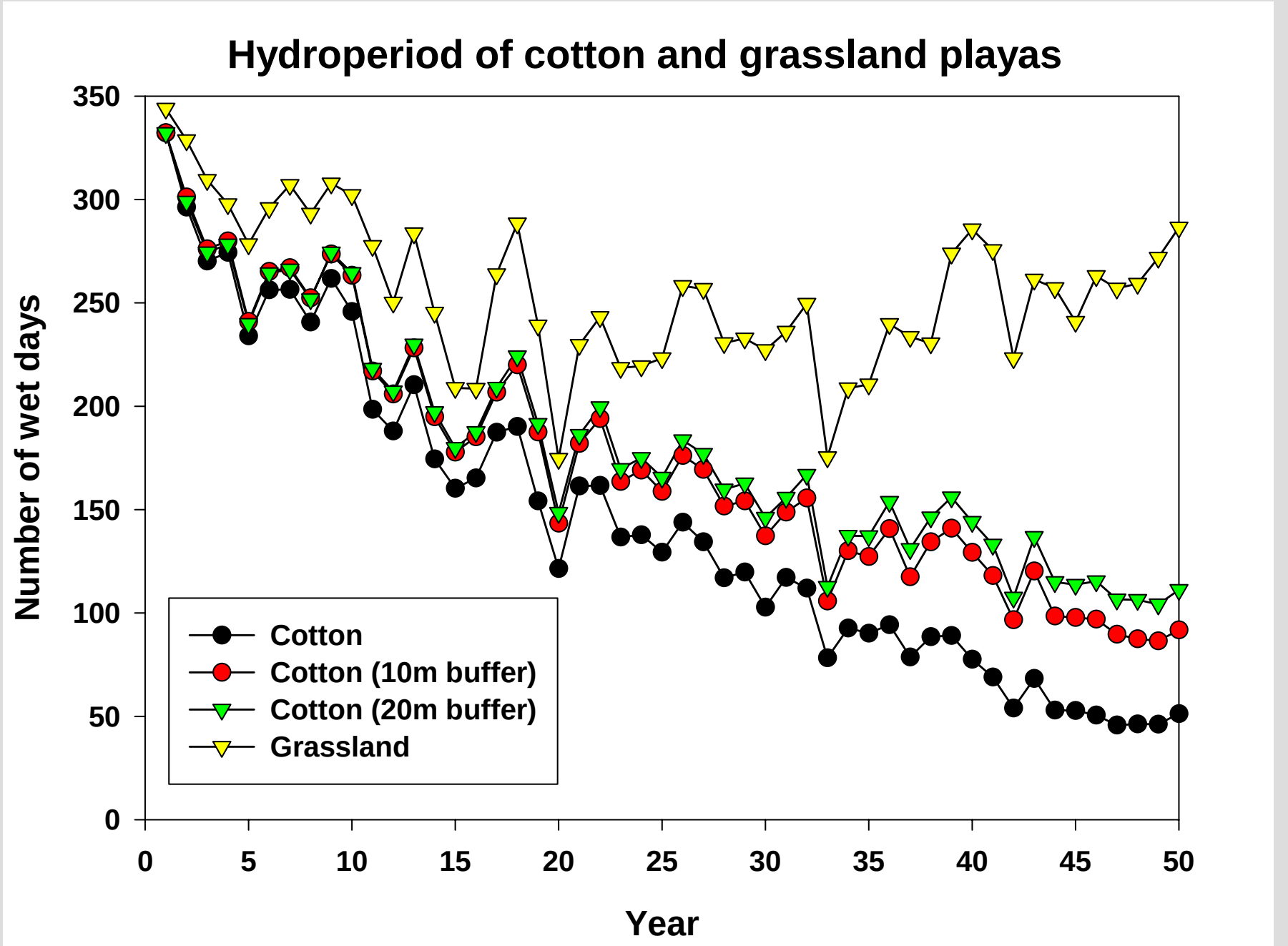
Amphibian Conclusions

- Richness does not differ between landuse types
- Richness does relate to hydroperiod
- Species with long hydroperiod requirements and less common species rarely found in playas with hydroperiods less than 100, and especially 50 days.

Modeling



Representative playa watershed to be modeled in APEX.


Hydroperiod of cotton and grassland playas
Number of wet days
Year
0
50
100
150
200
250
300
350
0
5
10
15
20
25
30
35
40
45
50
Cotton
Cotton (10m buffer)
Cotton (20m buffer)
Grassland

Overall Conclusions

- Fewer wet playas and shorter hydroperiods = reduced biodiversity of birds and amphibians
- For example, 18 vs 4 species of birds in wet vs dry playas in summer & fall
  - Thus, as playas are lost or hydroperiods shortened, fewer playas will be available to support bird communities and existing playas will support birds for a shorter period of time.
- Also, several amphibian species are not present in playas with hydroperiods less than 50 days, and even 100 days.
  - Thus, as playas fill with sediment and hydroperiod is further reduced, only the dominant amphibian species will persist.
- Playa function is impaired before it is fossilized.
  - Although some amphibian species may breed, tadpoles may never metamorphose.
  - Mitigation strategies can slow sedimentation and extend the functional life of the playa.

Acknowledgments

- Jo Szu (Ross) Tsai
- Louise Venne
- Undergraduate technicians