Wildlife Monitoring Studies for Regulatory Decisions

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Wildlife Monitoring Studies In the Regulatory Setting

- What Endpoints to Monitor
- How to Quantify Effects
- Spatial Scale
- Temporal Scale/Cycles
- Confounding Factors

Monitoring Endpoints

- Population v.s. individual level
- Abundance
- Reproductive success
- Habitat utilization and/or preference
- Importance of specific species
- Behavioral responses
- Indices such as diversity, richness, others...

Mexican Spotted Owls

- In a four year study of the effects of military noise on Mexican Spotted Owls, nesting behavior and reproductive success were chosen as important indicators of effects.
- Unexpectedly, although territories are fully occupied, the owls did not nest in the first two years of study.
- This kind of "behavioral response" was not anticipated.

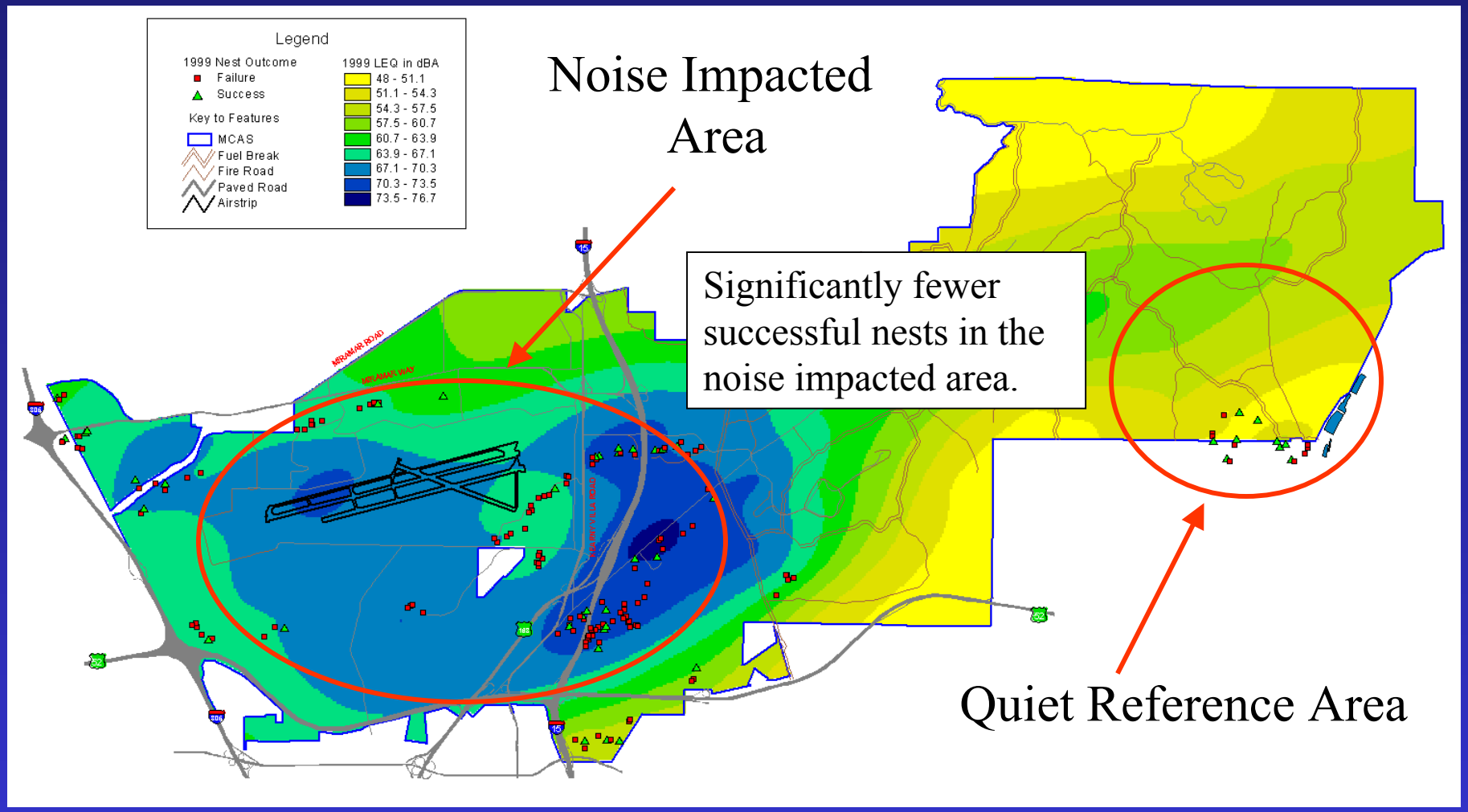
Quantification of Effects

- Statistical methods are often focused on testing for "significant" effects.
- Statistical and biological significance are usually not interchangeable.
- Confidence intervals often provide more useful information.
- Multiple variable relationships must often be accounted for.

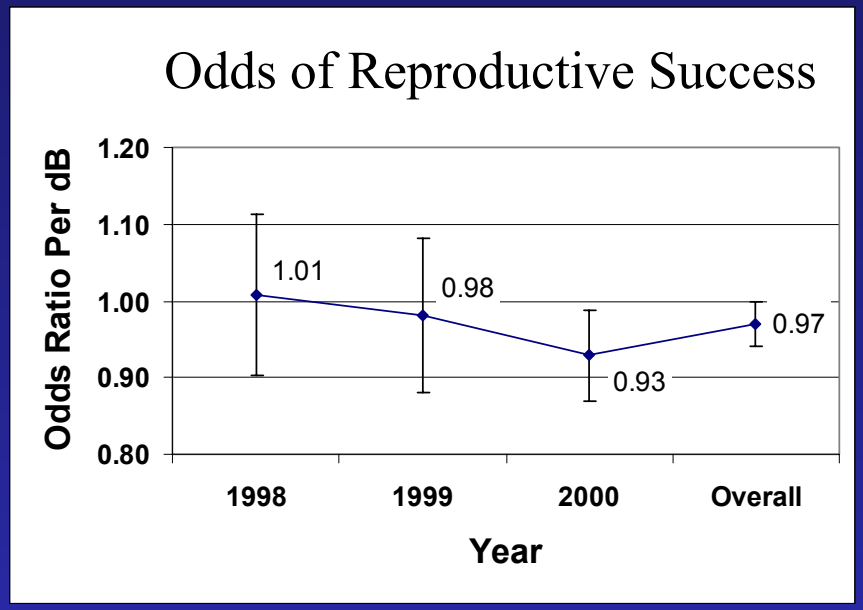
Sounds Like a News Flash...

- “Recent study concludes reproductive success of the ….. is significantly lower in and around……. only man could be the culprit ….. details at 11:00.

Noise Levels Near a Military Instalation



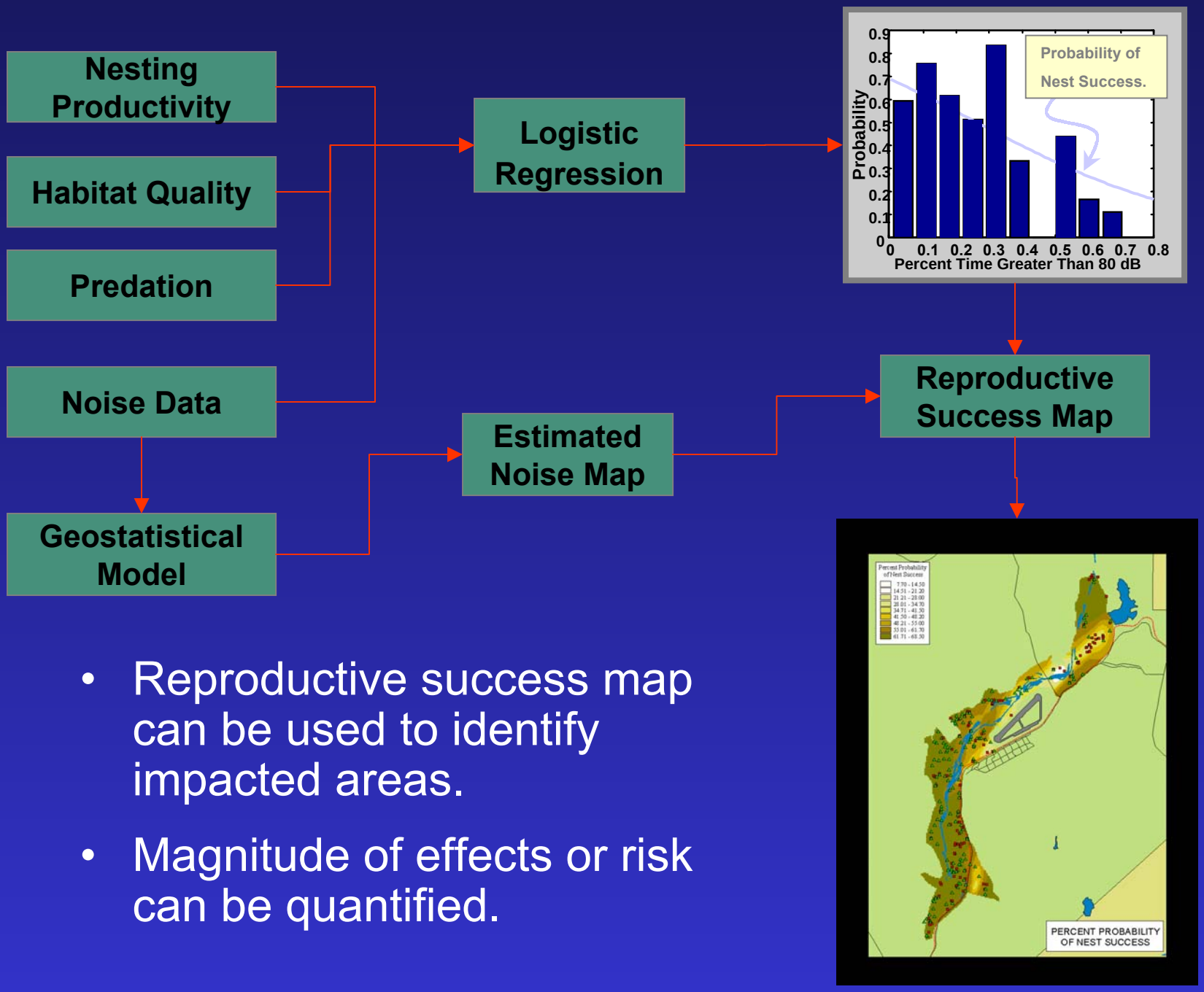
Confidence Intervals



- This graph with confidence intervals shows that there is an effect.
- The confidence intervals demonstrate the magnitude of the effect.

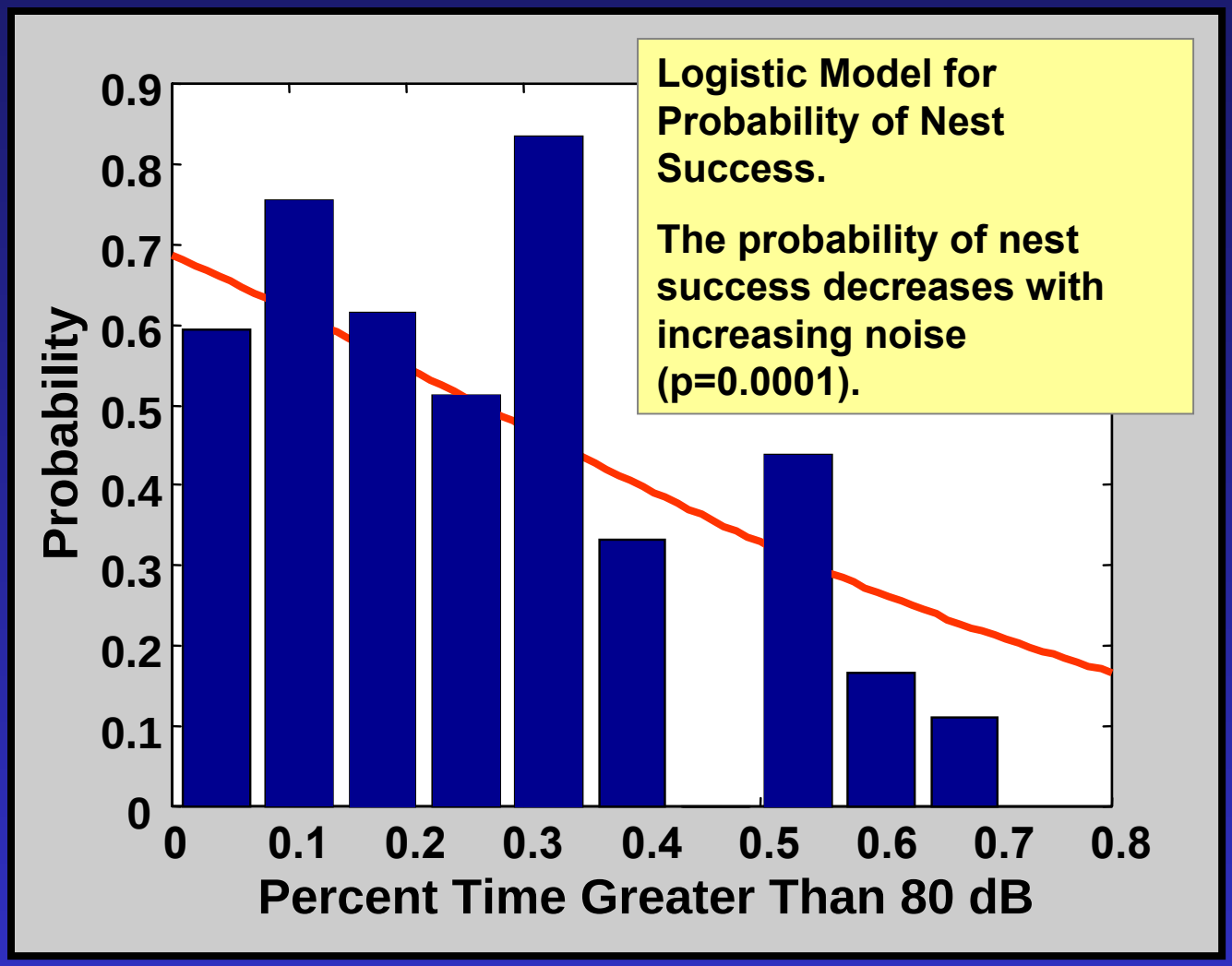
Spatial Scale

- Studies were conducted to evaluate the effect of aircraft noise and airport operations on the reproductive success of an endangered passerine species.
- What is the magnitude of effects and how spatially extensive are the effects?
- What is the relative importance of large effects over small spatial extents vs low level effects over larger extents?

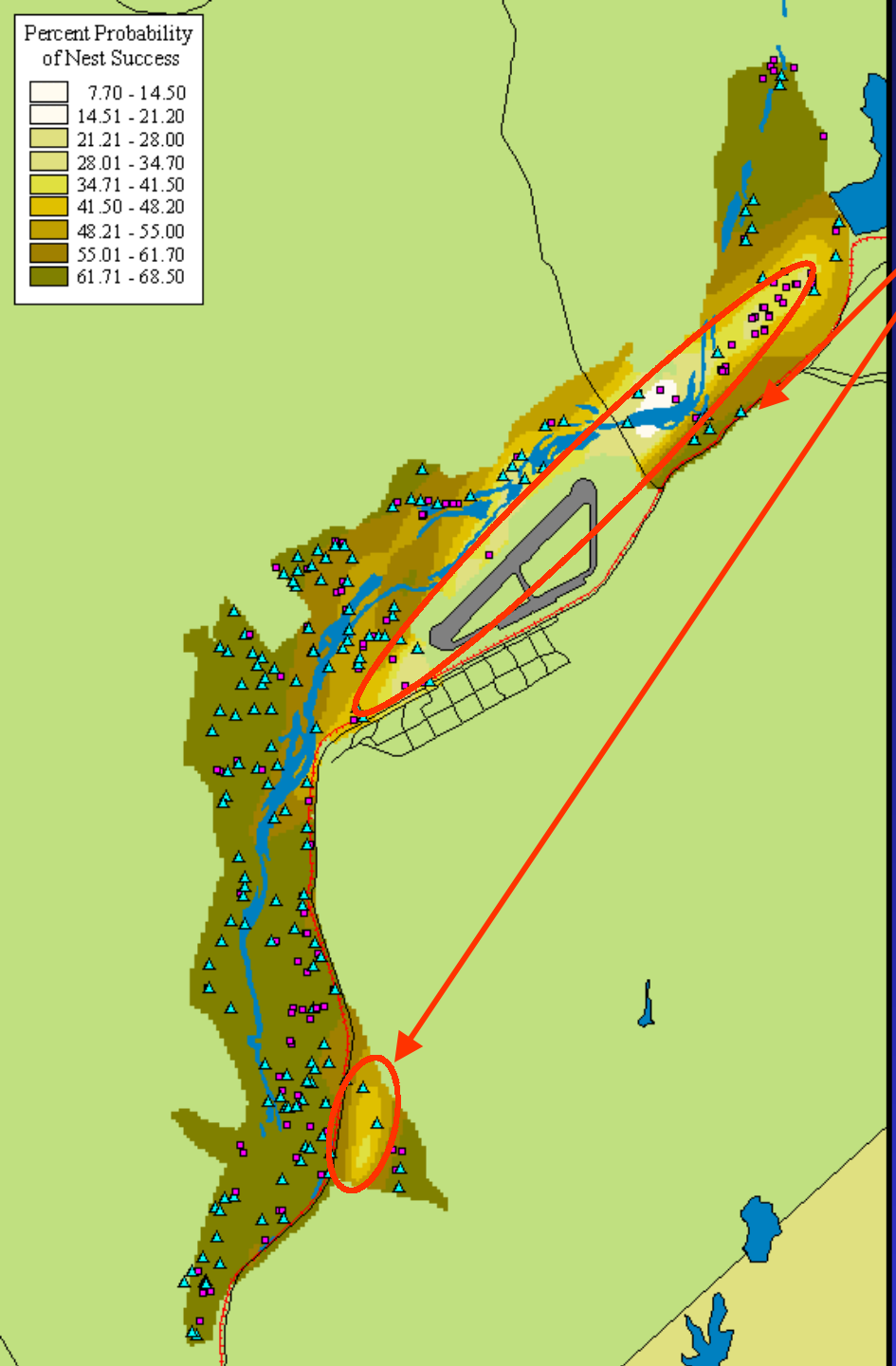


- Reproductive success map can be used to identify impacted areas.
- Magnitude of effects or risk can be quantified.

Probability of Nest Success as a Function of Percent Events > 80 dB



Note: This analysis is preliminary. The logistic model is not adjusted for variations in habitat quality.



Spatial extent (scale) of effects.

- The noise productivity dose response is "significant".
- However, the spatial extent is relatively small.
- Impacted areas tend to have lower habitat quality than non-impacted areas.
- Mitigation schemes should account for such factors.

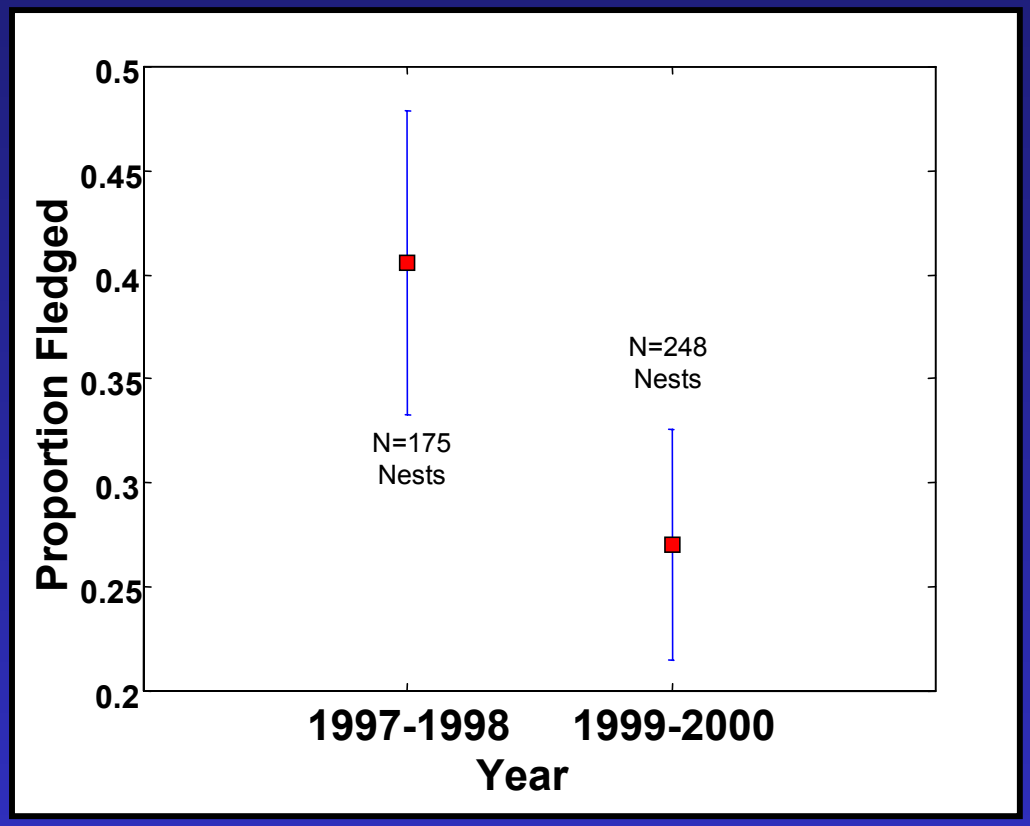
Temporal Scale and Cycles

- Wildlife studies are expensive and often conducted over short periods of time.
- Short term effects may be confounded with long term cycles.
  - Climatic variation and drought cycles.
  - Population density dependent effects.

Before After Study

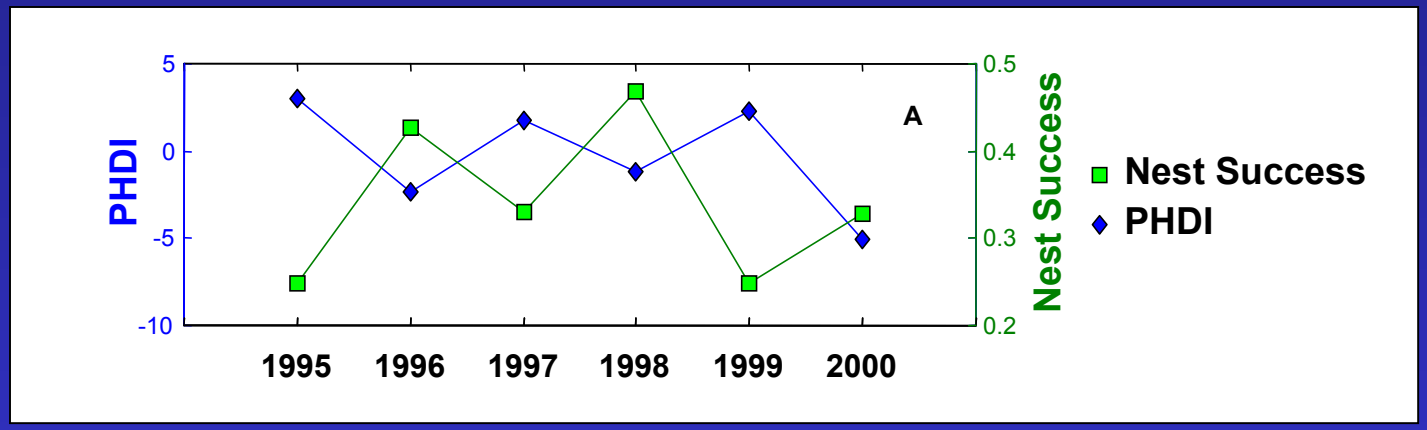
- A before/after study was conducted to evaluate effects of a change in activities at a military installation.
- Before after data are susceptible to confounding factors.
- The effects of confounding can sometimes be controlled for through analysis of covariance.
- Before after control impact studies may serve to “control” for confounding factors indirectly.

Before After Study of Nesting Success



Temporal Cycles

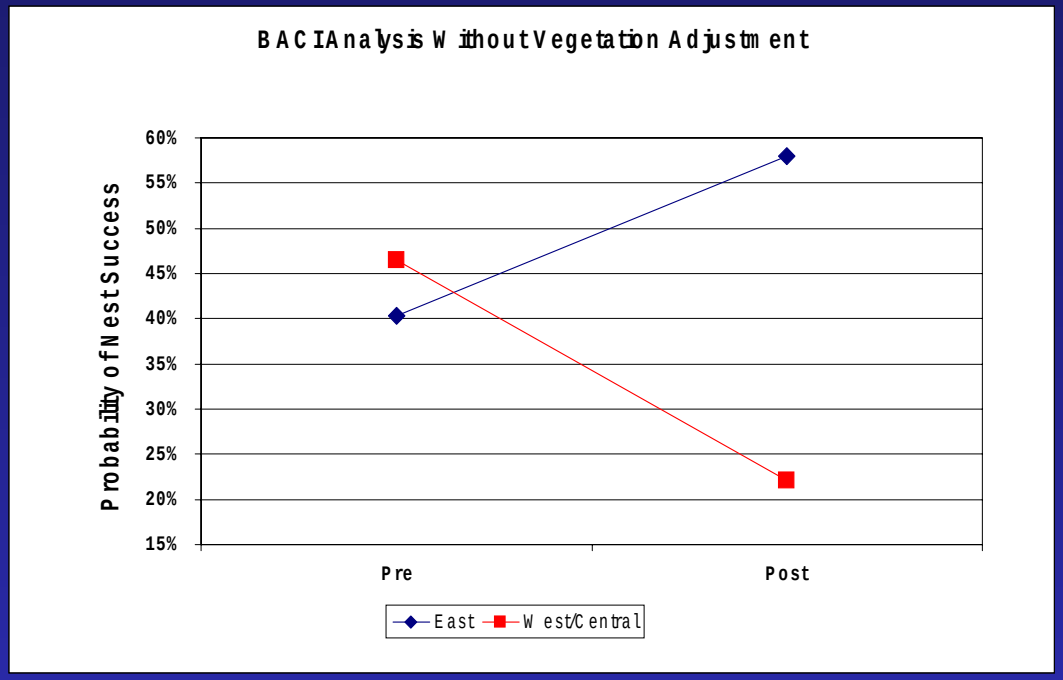
- Nesting success was correlated with the PHDI over the study period
- The before after effect could be due to the effects of drought conditions.



Before After Control Impact

- Data are collected before and after the “impact” at the impacted and a non-impacted sites.
- An effect is inferred when control/impact differences are differ before and after the event of interest.
- This is equivalent to testing for an interaction in a two way analysis of variance.
- The result is not a true experiment because allocation of treatments is not randomized, but spurious results due to uncontrolled factors are minimized.

Before After Control Impact



- Parallel lines would indicate no effect.
- Note the direction of pre-event treatment/control area differences are the reverse of those post treatment.

Summary

- Regulatory studies are observational and cannot typically resolve cause and effect relationships.
- Quantifying the spatial and temporal extent of impacts is important, because mining impacts may be transient and of limited extent.
- Effects must be evaluated in the context of other potentially confounding factors such as climate, habitat quality, predation.
- Habitat quality and selection should be included in quantification of effects.

Long-Term Monitoring Techniques to Evaluate Wildlife Use of Reclaimed Areas

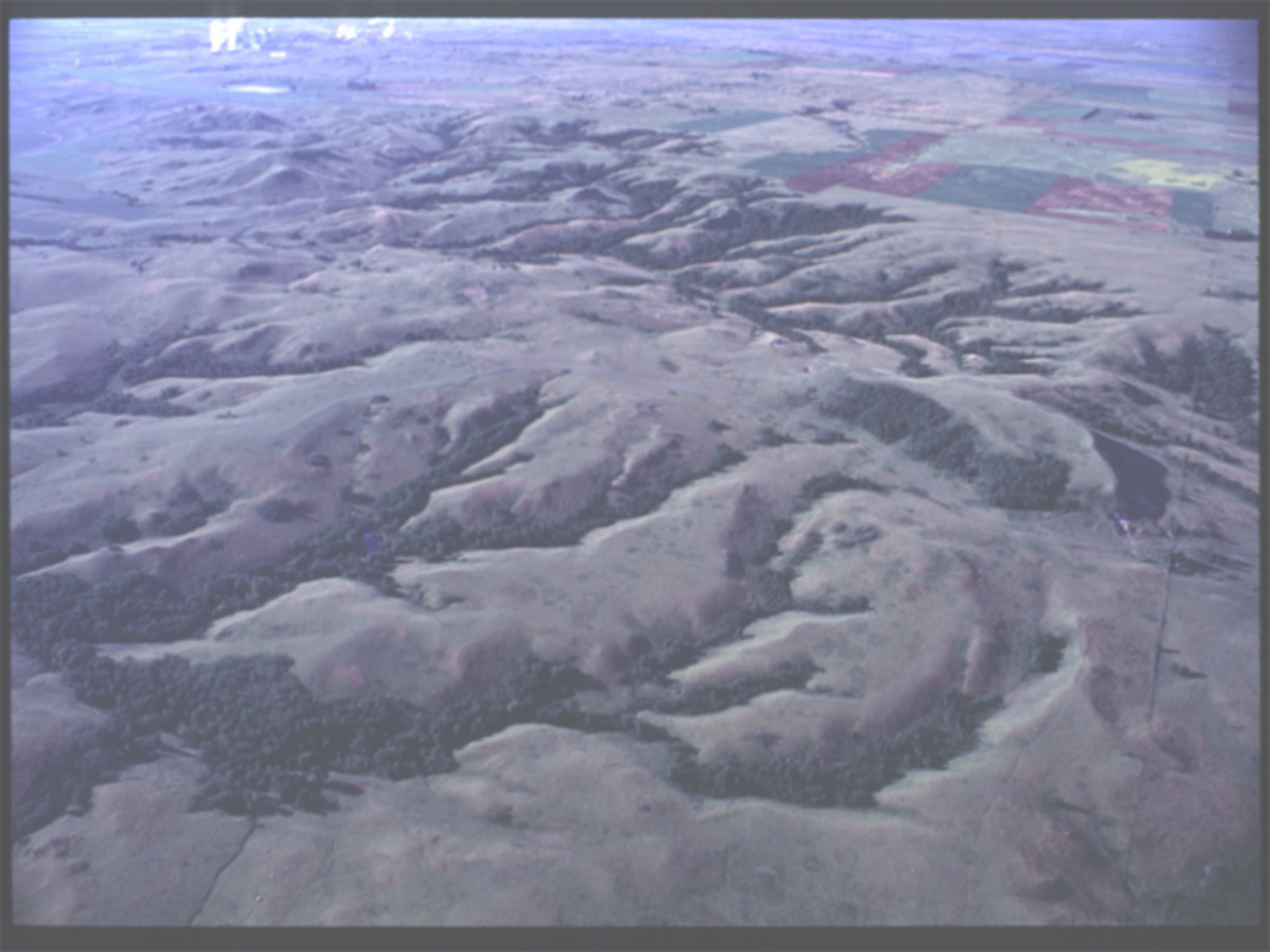
Presented by Kelly Krabbenhoft
at the OSM Bond Release Forum

August 2001

COTEAU

Study Area

- Approximately 45,000 acres, of which 24,000 acres is currently permitted
- Monitored as 4 separate areas:
- West Mine Area (WMA): 18,000 acres
- North Mine Area (NMA): 8,000 acres
- Coteau Mine Area (CMA): 7,000 acres
- East Mine Area (EMA): 12,000 acres



Methods

- 1. Semi-Annual Aerial Surveys
- 2. Spring Waterfowl Counts
- 3. Surveys of Sharp-tailed Grouse Leks
- 4. Hunter Harvest Surveys
- 5. Incidental Wildlife Observations

Semi-Annual Aerial Surveys

Conducted during January & September

Transects flown in a similar fashion from year to year

Summer Aerial Survey Results: Pronghorn Antelope

	WA	CMA	NA	EMA
1994	15	16	7	9
1995	12	34	33	0
1996	39	38	18	14
1997	11	4	41	10
1999	25	7	1	34
2000	12	15	0	13

Winter Aerial Survey Results: Pronghorn Antelope

	WA	CMA	NA	EMA
1995	0	1	0	0
1996	0	2	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	23	0	0	4
2001	0	0	0	0

Summer Aerial Survey Results: Mule Deer

	WA	CMA	NA	EMA
1994	0	0	0	14
1995	0	0	0	4
1996	2	3	0	19
1997	0	0	2	2
1999	7	1	0	14
2000	6	4	7	13

Winter Aerial Survey Results: Mule Deer

	WA	CMA	NA	EMA
1995	0	3	0	10
1996	12	13	0	22
1997	12	16	0	13
1998	18	0	0	7
1999	15	0	0	17
2000	25	6	0	21
2001	22	0	16	8

Summer Aerial Survey Results: Whitetail Deer

	WA	CMA	NA	EMA
1994	0	0	0	4
1995	6	0	0	5
1996	4	2	0	7
1997	1	0	0	3
1999	13	0	0	5
2000	16	0	0	1

Winter Aerial Survey Results: Whitetail Deer

	WA	CMA	NA	EMA
1995	28	0	0	6
1996	33	0	0	24
1997	1	5	0	18
1998	39	0	0	13
1999	23	0	0	12
2000	19	0	0	0
2001	26	0	17	4

Spring Waterfowl Counts

Inventory and monitor waterfowl use trends within reclaimed wetlands during responsibility period.

CUTEAU

Spring Waterfowl Survey Results

	I-06-01	G-08-01	G-12-01
1994	NA	37(6)	2(2)
1995	NA	64(11)	13(6)
1996	65(8)	68(7)	18(5)
1997	139(10)	47(7)	11(5)
1998	122(13)	26(6)	9(6)
1999	93(11)	21(7)	6(5)
2000	143(13)	15(7)	6(3)
2001	138(11)	27(8)	1(1)

COTEAU

Surveys of Sharp-Tailed Grouse Leks

Grouse Lek Survey Results

	#36	#15	#27
1994	16*	13*	N/A
1995	36*	15*	N/A
1996	32*	15*	N/A
1997	17	9	N/A
1998	19	12	8
1999	13	11	12
2000	9	13	2
2001	N/A	8	10

Hunter Harvest Survey

- Provides details of areas hunted and game harvested.
- Records of total wildlife observations are obtained.

Hunter Harvest Survey Results

	Deer	Pheasant	Partridge	Grouse	Canadian Geese	Ducks
1994	4	23	0	0	30	N/A
1995	2	48	3	0	17	N/A
1996	2	49	6	3	27	13
1997	3	9	0	0	14	13
1998	5	16	0	1	14	51
1999	5	35	3	5	67	58
2000	3	122	29	18	30	30

Incidental Wildlife Observations

- 1. Migratory Birds
- 2. Songbird Nests
- 3. Game Bird Broods

Conclusions

- The variability inherent in wildlife populations within the Northern Great Plains is recorded by following these methodologies.
- Provides data to assess wildlife use of reclaimed habitats for bond-release.

Songbird Response to Woodland Reclamation

Presented by
Kelly Krabbenhoft

OSM Bond Release Forum
August 2001

Study Area

Glenharold Mine near Stanton, ND

(Reclaimed 111 woodlands containing 242 acres on 1979 law areas)

Woodland Sites Censused

- Native Draw WD-10a: 13.6 acres
- Native Draw WD-11: 26.1 acres
- Reclaimed Draw WDDS-2: 5.8 acres (1982)
- Reclaimed Draw WDDS-3: 7.6 acres (1984)

Songbirds Indicative of Mature Woodlands

- Yellow warbler (10 years)
- Common yellowthroat (12 years)
- Yellow-breasted chat (12 years)
- Brown thrasher (6 years)
- Gray catbird (14 years)
- Rufous-sided towhee (13 years)
- Song sparrow (N/A)
- Clay-colored sparrow (6 years)

Census Method

International Spot Map Method

6-8 visits to each draw each spring (May 20 - June 20)

Native and Reclaimed Woodland Comparisons

- Bird Species Diversity (BSD): H’
- Species Richness
- Breeding Bird Densities

Results

FIGURE 1: Changes in the number of territorial males recorded in woody draw monitoring sites

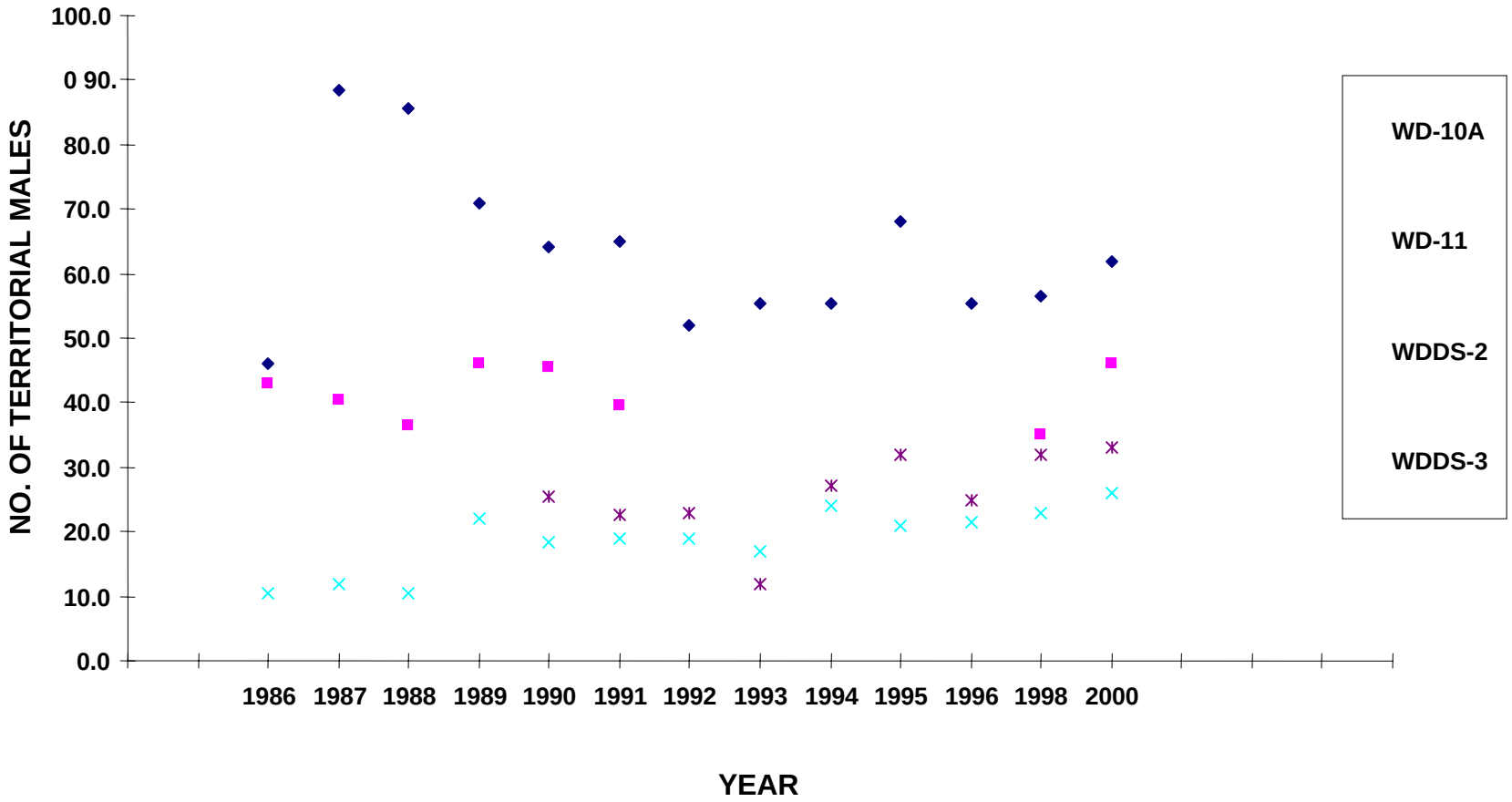


FIGURE 1: Changes in the number of territorial males/acre recorded in woody draw monitoring sites.

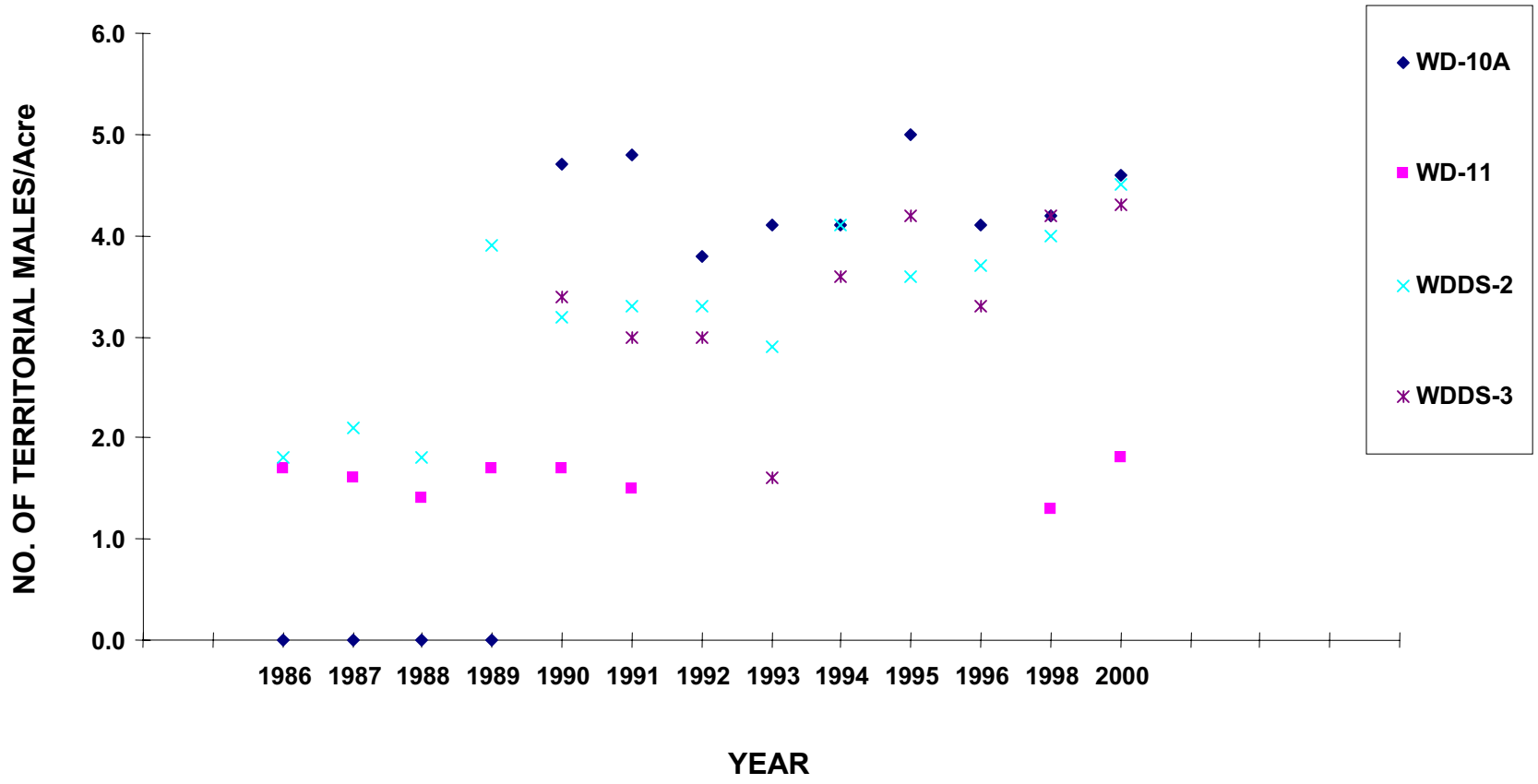


FIGURE 2: Changes in the number of breeding species detected on monitoring sites over time.

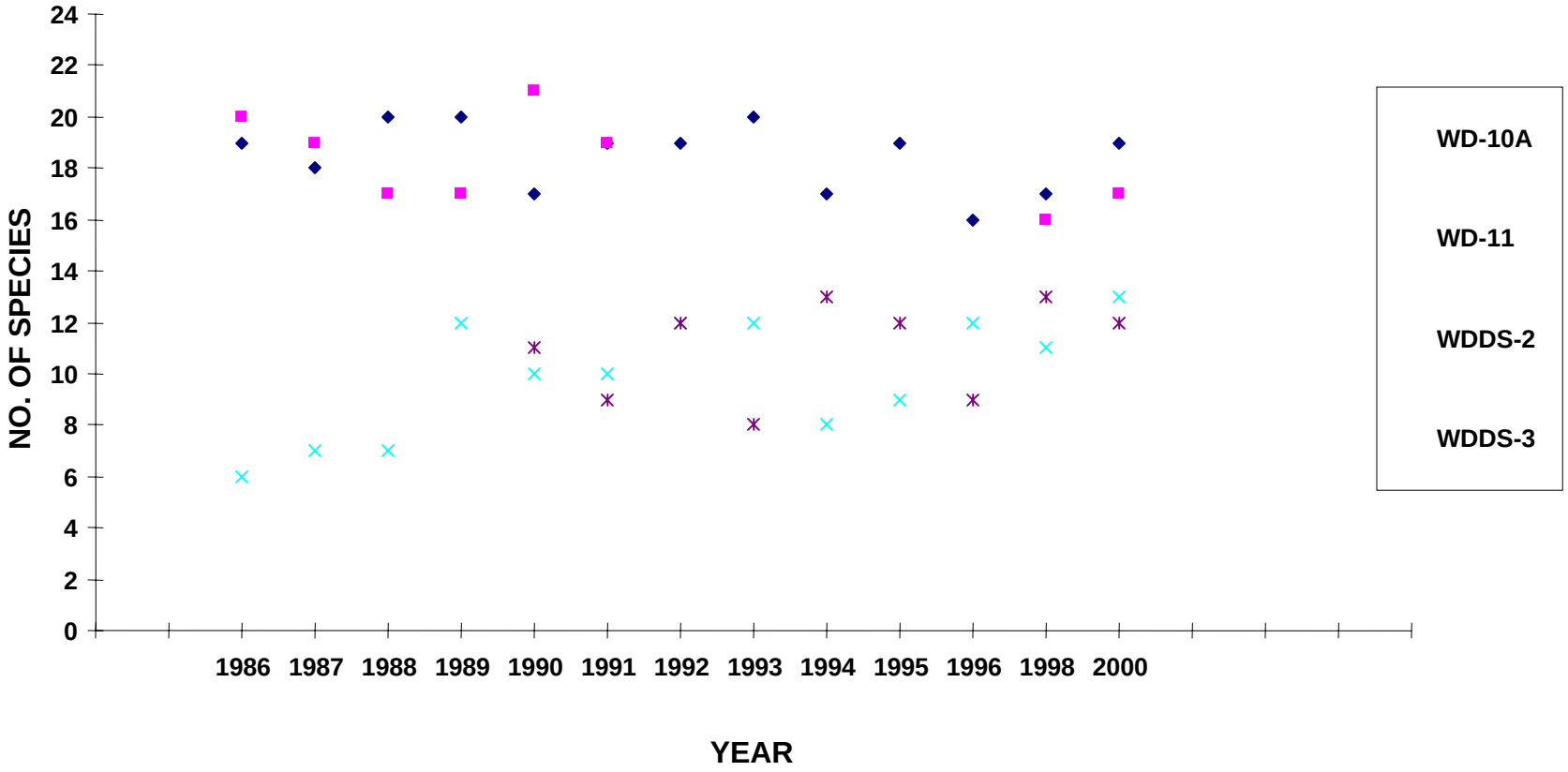
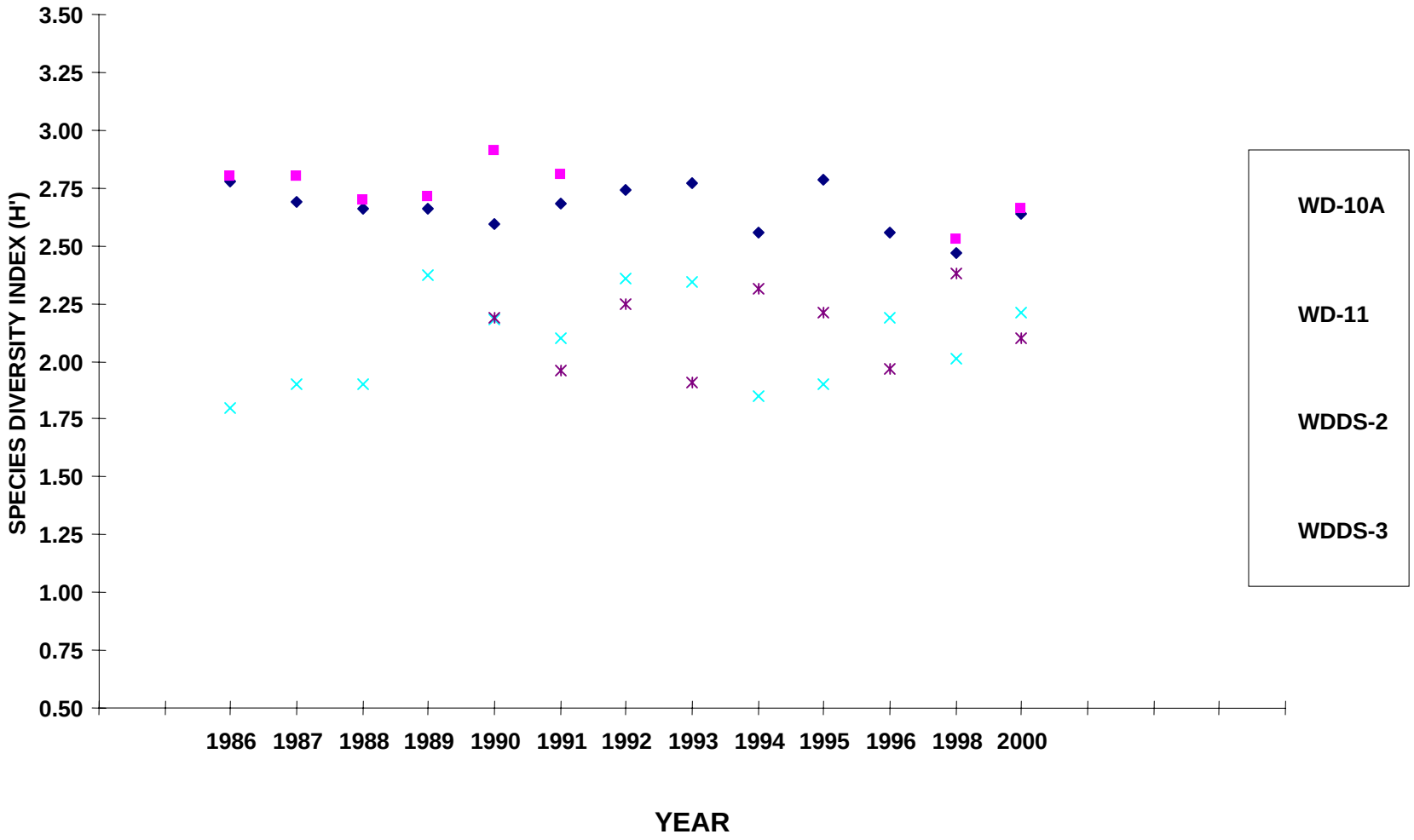


FIGURE 3: Changes in Species Diversity (H') over time



Conclusions

Following the 10-year responsibility period, *songbirds indicative of mature structured woodlands may not be present*

However, data show improved species diversity, richness and increased territorial pairs as reclaimed woodland structural characteristics change over time.

Following nearly 20 years of monitoring songbird use in reclaimed woodlands, trend data show positive changes in songbird communities that indicate successful woodland reclamation.

Consequences of Mining, Reclamation, and Mitigation for Raptors in the Powder River Basin of Wyoming

Kort M. Clayton

Thunderbird Wildlife Consulting, Inc.

Gillette, WY

Presented at OSM Bond Release Forum

August 2001

History

- Large scale mining since early 1980's
- Nesting raptor surveys at baseline
- Various strategies for annual raptor monitoring
- TWC (formerly PRES) has been involved with raptor studies in the Basin since 1979

Objectives

- Summarize existing data to evaluate the consequences of over 20 years of mining, mitigation, and reclamation for raptor populations in the Basin

- Discuss the use of reclamation by raptors and the implications for bond release

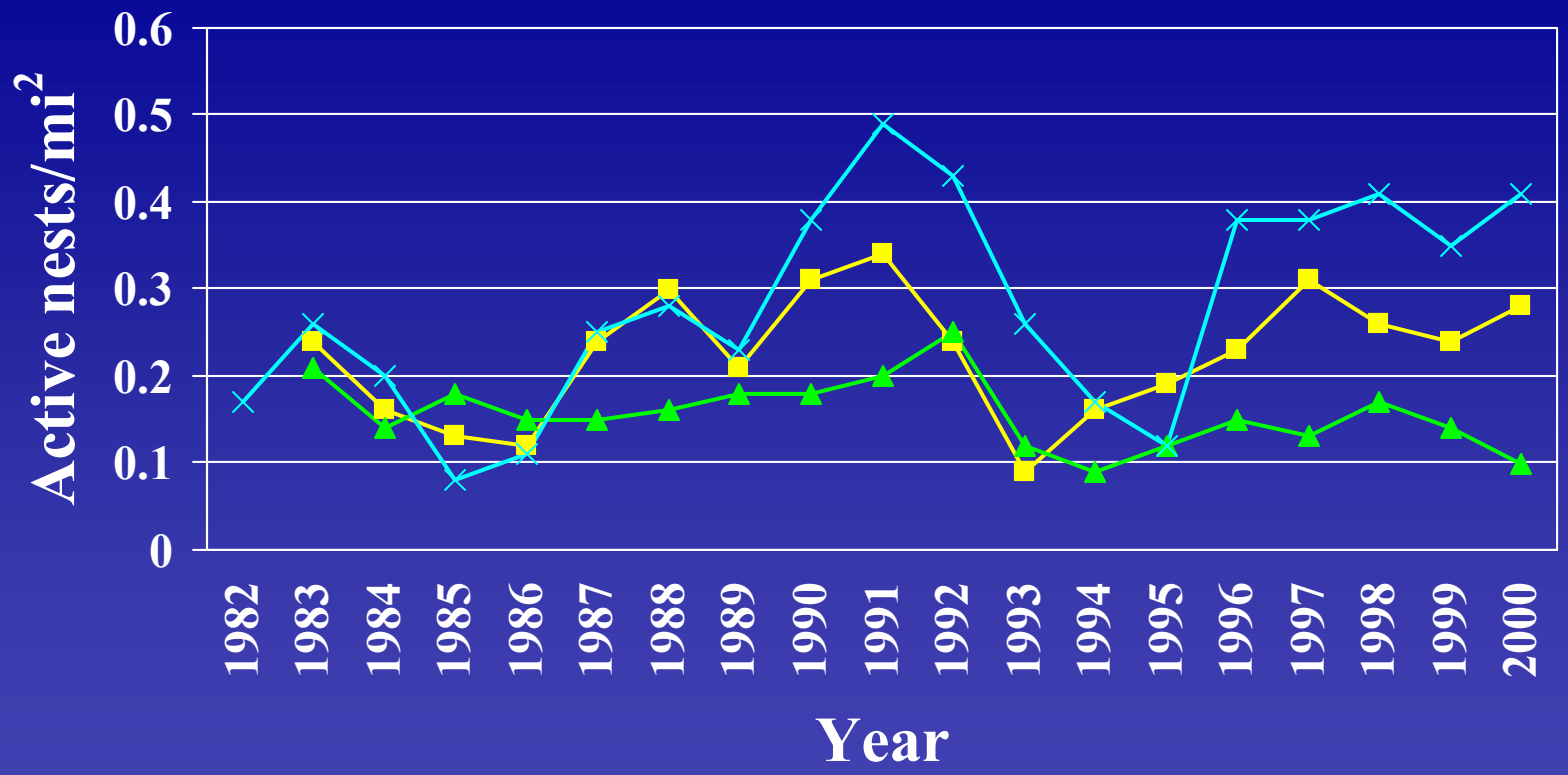
Methods

- Raptor Monitoring
  - Annual nest and productivity surveys
  - Ground based surveys, vs. aerial
  - Permit area and one- or two-mile perimeter
- Lagomorph Monitoring
  - Annual vehicular spotlight surveys

Methods

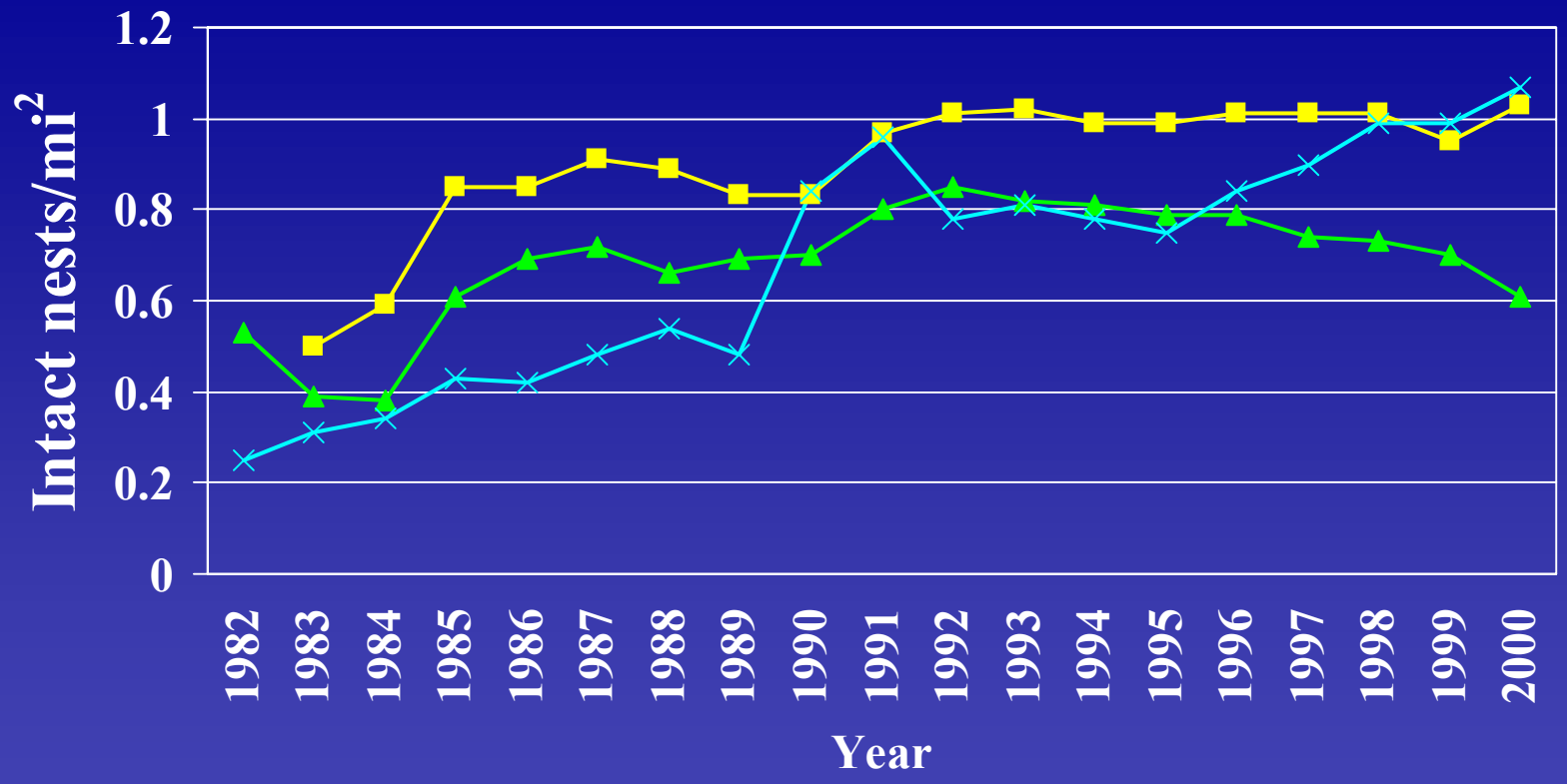
- Raptor Mitigation
  - Inactive nests relocated to maintain the resource
  - Inactive nests relocated to maintain alternate nests within an active territory
  - Active nests strategically located to encourage continued use
  - Platforms and snags erected to create new or alternate nesting opportunities

Nesting Raptor Population



Thunderbird Wildlife Consulting, Inc.

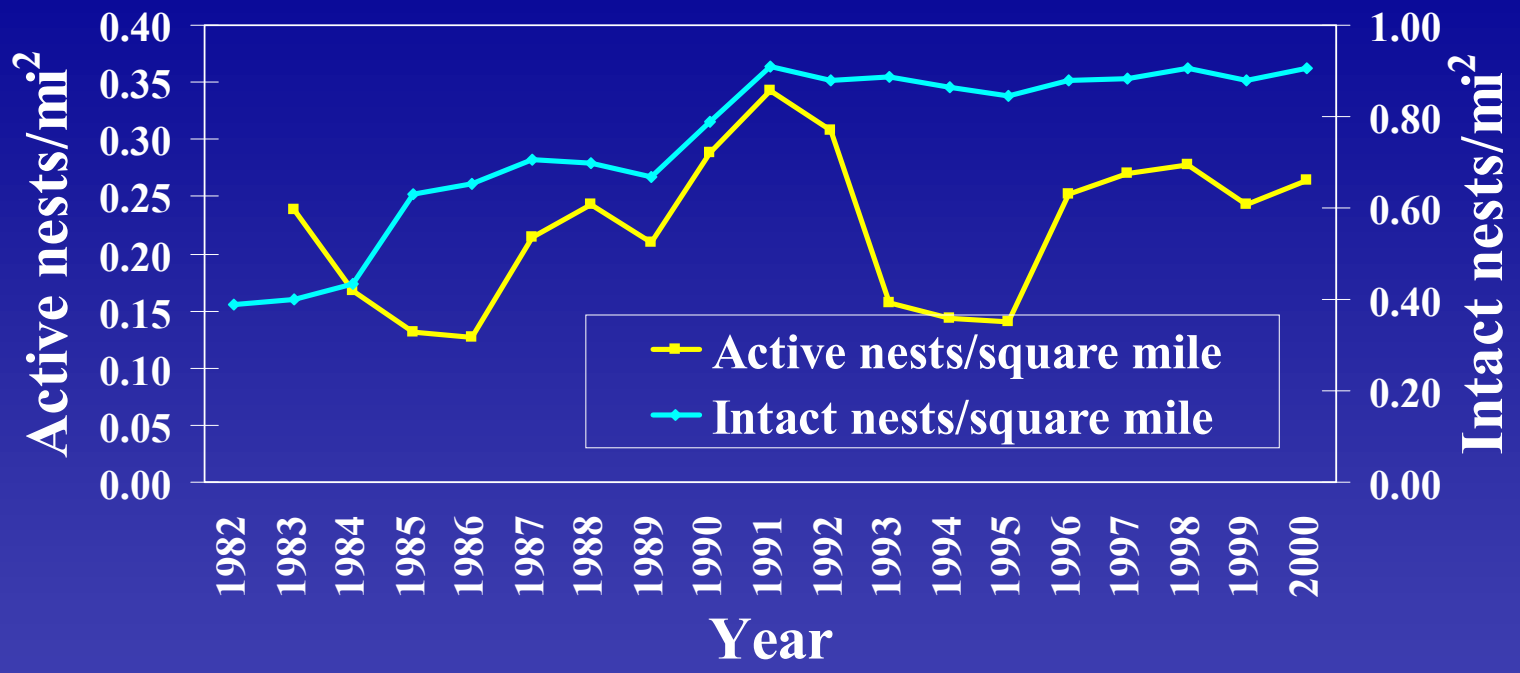
Raptor Nest Availability



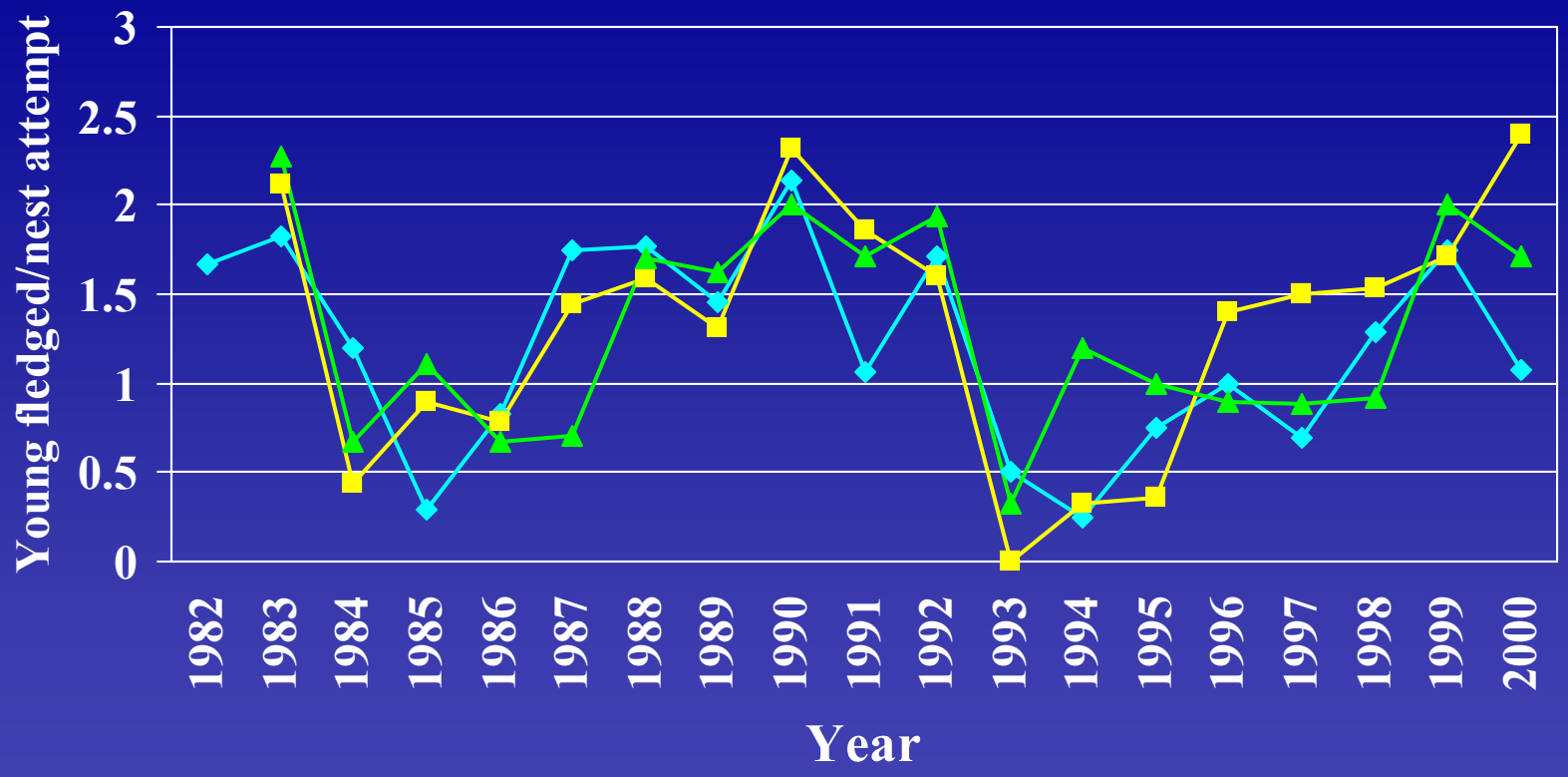
Thunderbird Wildlife Consulting, Inc.

Nests and Nesting

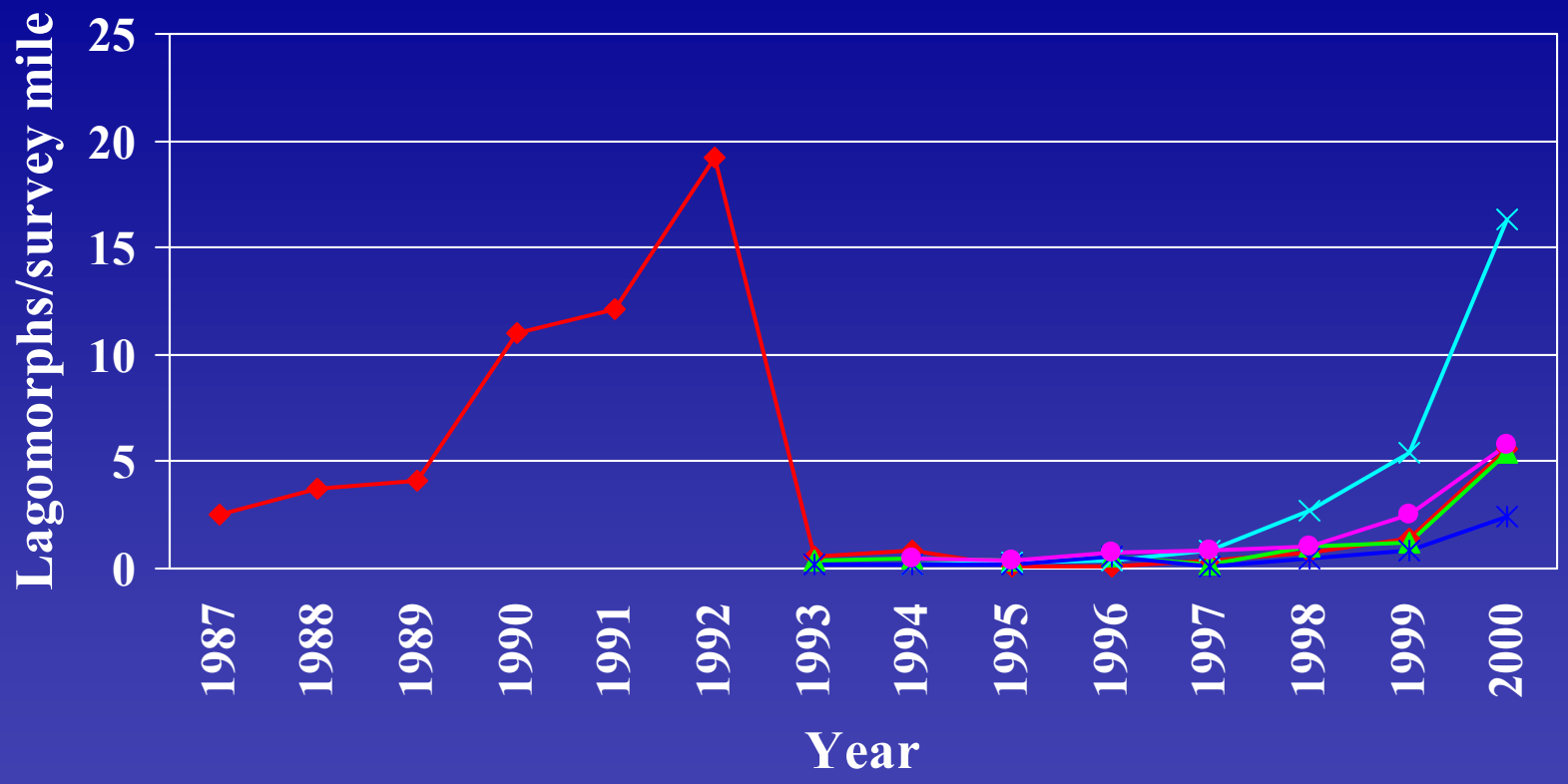
(mean n = 151 intact and 42 active annually)



Large Raptor Productivity

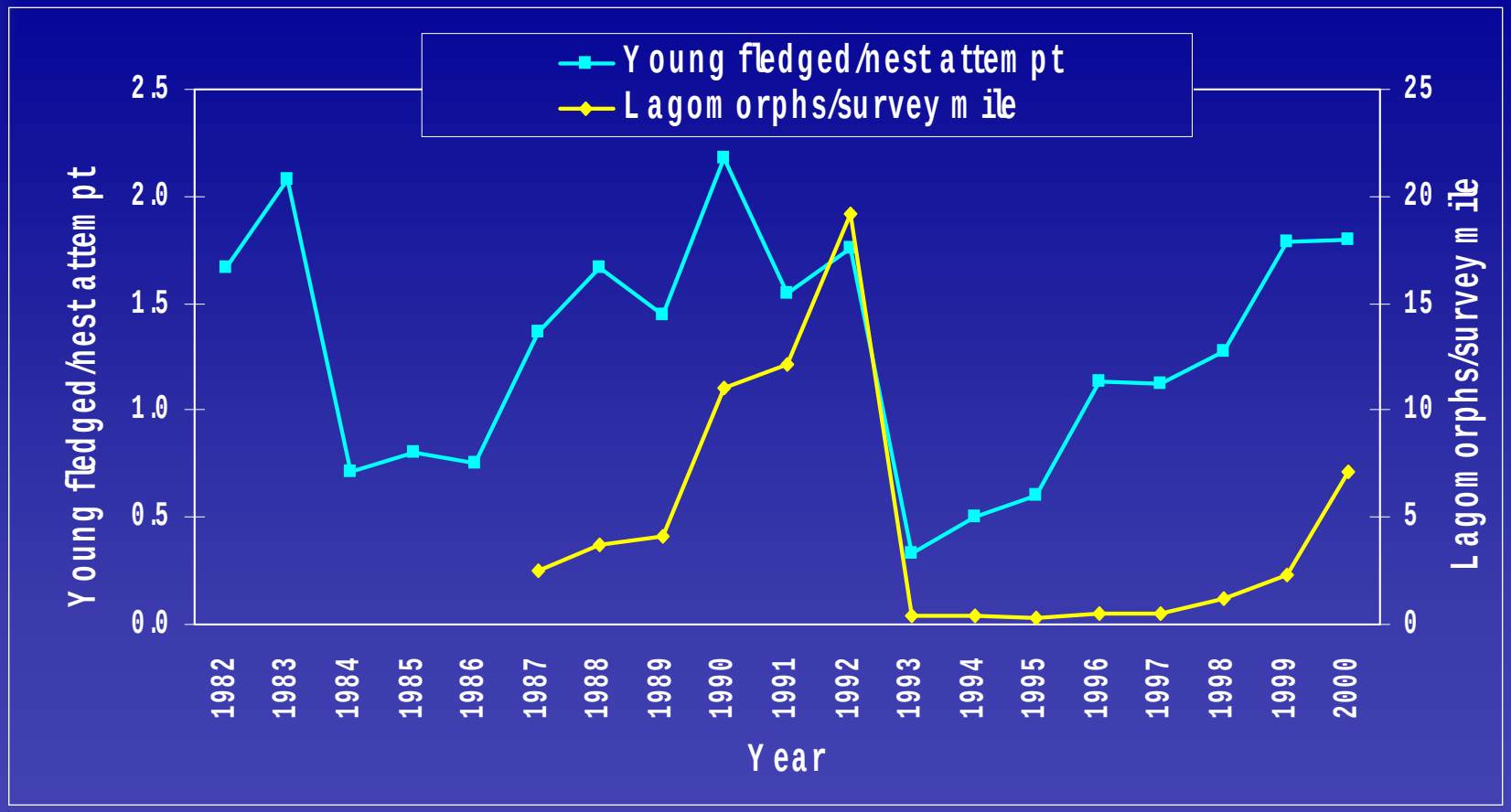


Lagomorph Abundance



Thunderbird Wildlife Consulting, Inc.

Raptor Productivity and Prey Abundance



Thunderbird Wildlife Consulting, Inc.

Mitigation Summary

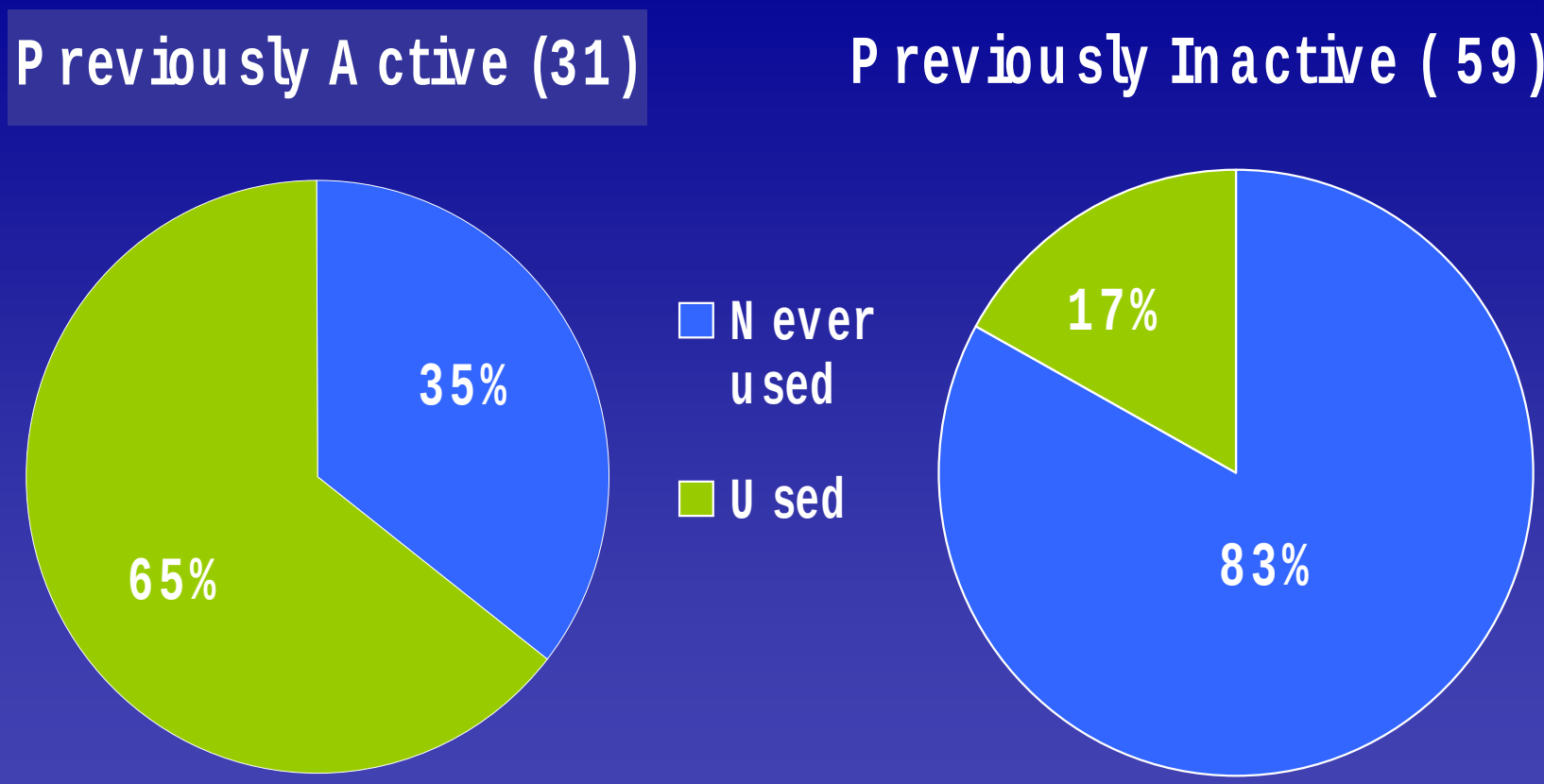
- 20 years, 10 mines, 90 nests
- Relocated or created to mitigate for:
  - Ferruginous hawk - 42
  - Golden eagle - 26
  - Red-tailed hawk - 10
  - Burrowing owl - 7
  - Swainson's hawk - 3
  - Great horned owl - 2

Mitigation Summary

- Purpose of mitigation event (n = 90):
  - Relocation of inactive nests or creation of alternate nests – 59
  - Replacement or relocation of previously active nests – 31

- Raptor use of mitigation nests (n = 90):
  - Never used – 60
  - Used – 30

Raptor Use of Mitigation Nests



Raptor Use of Reclamation

- Nesting
  - Platforms and snags
  - Ground nesting species
- Perching and foraging

Reclamation as Raptor Habitat

- Nesting
  - Nest relocation sites, snags, and platforms
  - Suitable nesting habitat
- Foraging
  - Adequate prey base (rodents and lagomorphs)
  - Hunting perches

Raptor Nesting Requirements

- Nest/nest site availability
- Foraging opportunities – prairie dogs?
- Territory availability
- Limited human disturbance

- Current reclamation practices appear to create adequate raptor habitat
- Use of reclamation should increase over time

Acknowledgements

Antelope Coal Company

Powder River Coal Company

RAG Coal West, Inc.

Thunder Basin Coal Company, LLC

Triton Coal Company, LLC

Howard and Bonnie Postovit

Creating Wetlands for Wildlife on Mined Lands: Lessons From Bentonite Mining

Mark McKinstry

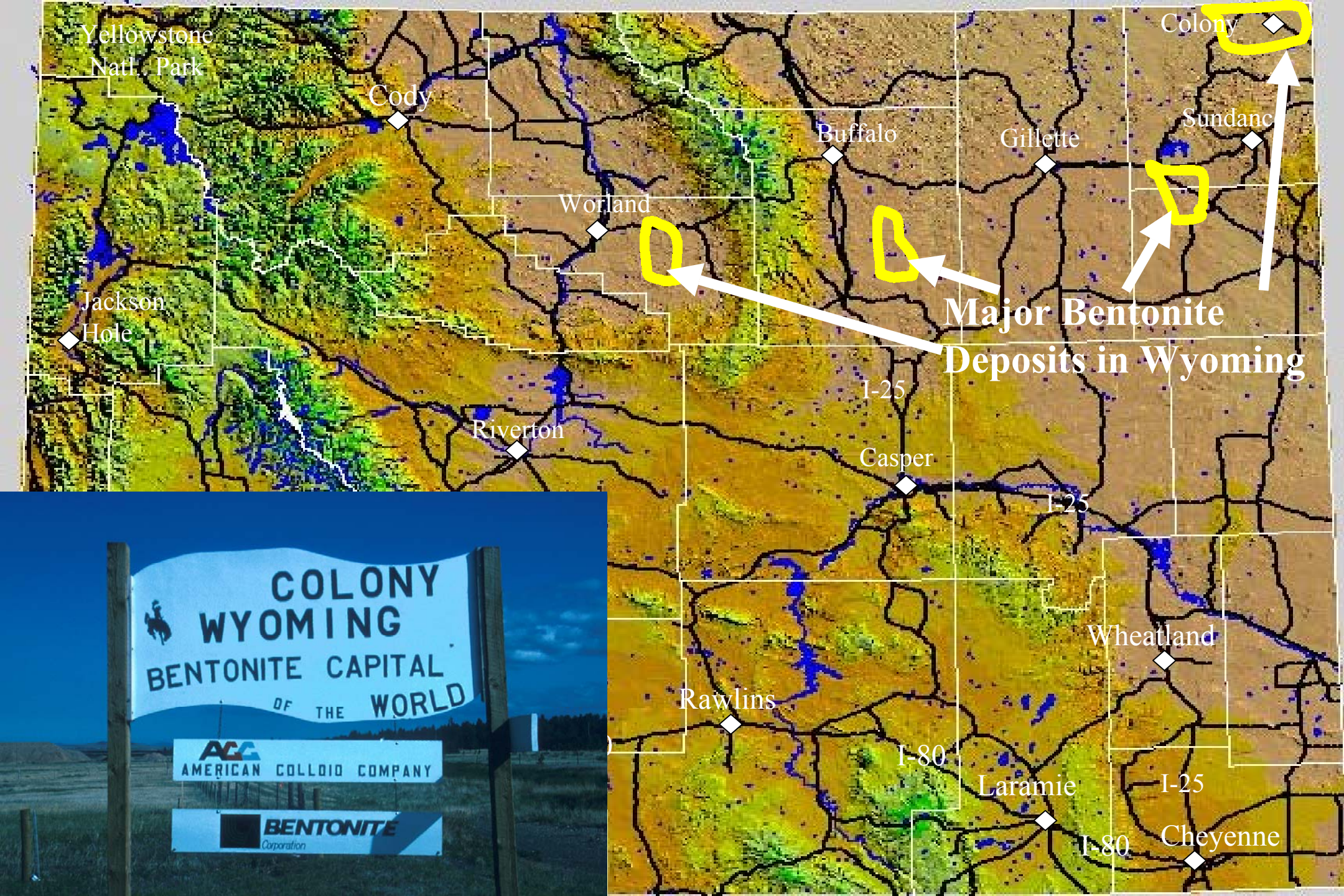
Wyoming Cooperative Fish and Wildlife Research Unit

University of Wyoming

Presented at
OSM Bond Release Forum
August 2001

Bentonite the "Clay of 1000 Uses"

Drilling mud
Kitty litter
Beer
Pond and ditch sealant
Makeup
Hazardous waste cleanup
Number of Uses Increasing


Yellowstone
Natl. Park
Cody
Buffalo
Gillette
Colony
Sundance
Worland
Jackson
Hole
Major Bentonite
Deposits in Wyoming
I-25
Riverton
Casper
I-25
Wheatland
Rawlins
I-80
Laramie
I-25
I-80
Cheyenne
COLONY
WYOMING
BENTONITE CAPITAL
OF THE WORLD
ACC
AMERICAN COLLOID COMPANY
BENTONITE
Corporation

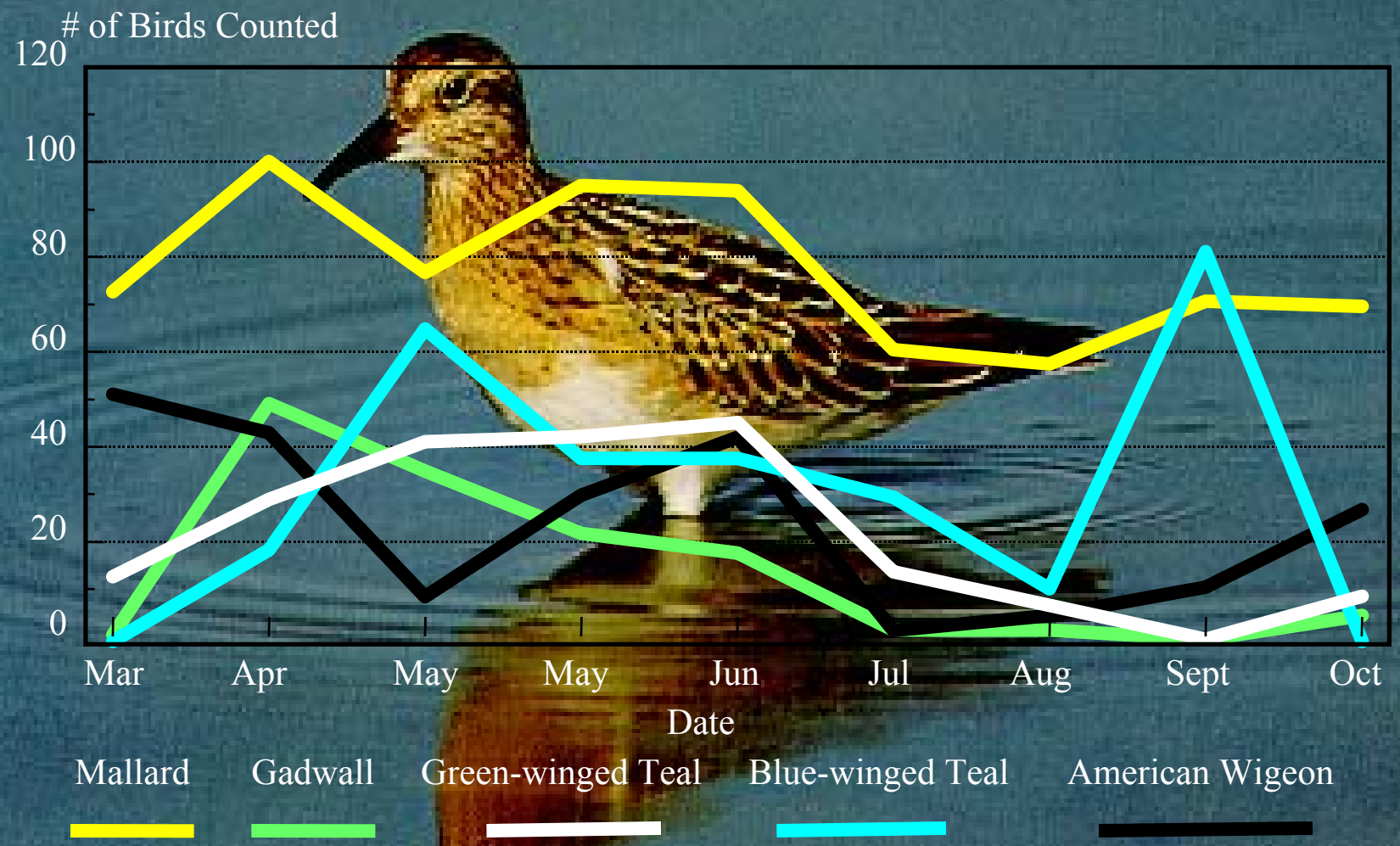
Wyoming DEQ-AML Review

- 1985 DEQ-AML began reclamation under SMCRA
- 1986 Army COE and 404c CWA
- 236 sites, 886 wetlands
- 3,320 ha terrestrial, 180 ha wetlands, $40.6 million
- Wetlands 1 ha, <2 m deep, added design features
- Terrestrial plant propagation, none for wetlands
- 1991 WG&FD evaluated wetlands for waterfowl

Objectives Waterfowl Research

- Identify variables important to waterfowl use that can be manipulated during the construction phase.
- Determine differences between wetlands used by waterfowl and those not used.
- Determine predictability (accuracy) of wetland creation.

Puddle Duck Surveys at 80 Wetlands



Summary Waterfowl Use

- Large Wetlands (> 1 ha)
- Wetland Complexes (> 5 within 1 km)
- Submersed Vegetation
- Emergent Vegetation
- Habitat Variety

  deep, shallow
  permanent, ephemeral
  large, small

Wetlands 14:284-292; N. Am. Wildl. & Natur. Resour. Conf. 59:303-308; Wildl. Water Development Symposium 2:86-100; Ecological Engineering (in press 2001); Predicting Species Occurrences (in press)

Poor Aquatic Plant Growth

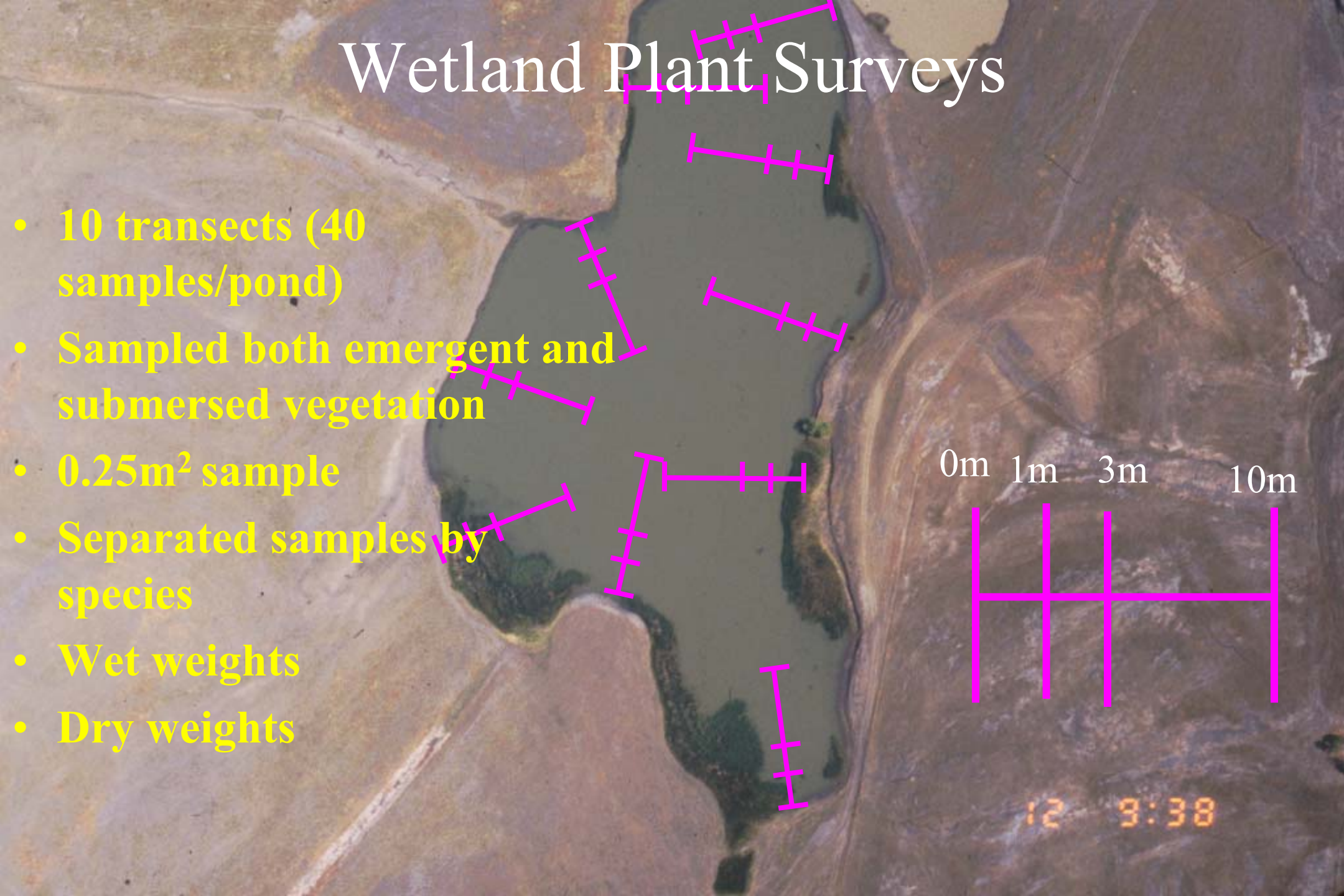
- Suitable propagules
  - few natural wetlands
  - wind dispersed, animal transport
- Poor growing conditions
  - highly sodic
  - unconsolidated substrates
  - highly turbid
- Adapted species??

Current and Future Research

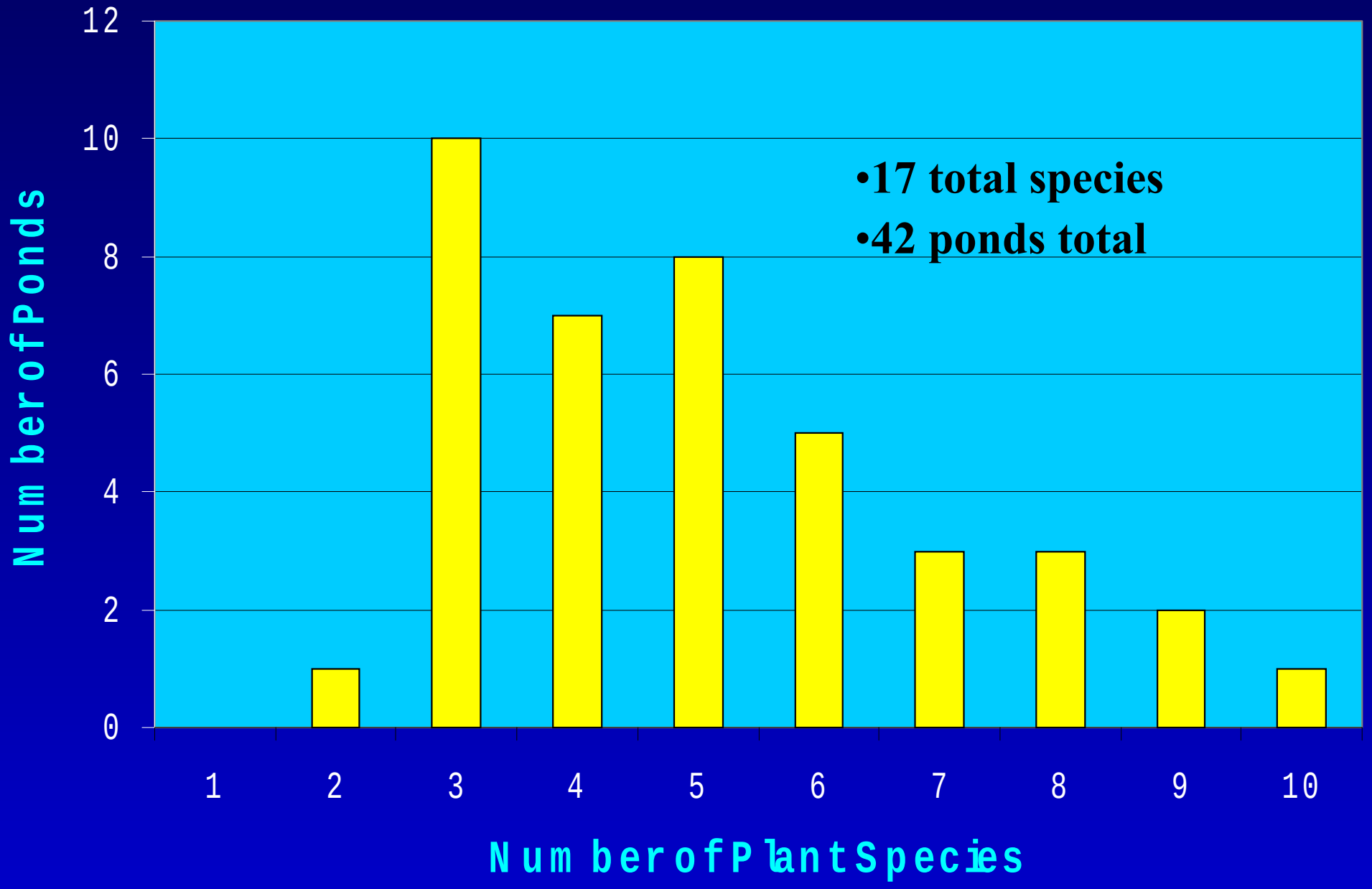
- Wetland Plant Succession (ongoing)
- Wetland Plant Propagation (ongoing)
- Salvaged Wetland Soil (Ongoing)
- Waterfowl Use (2002)
  - source vs sink
  - productivity, predation
  - use of complexes

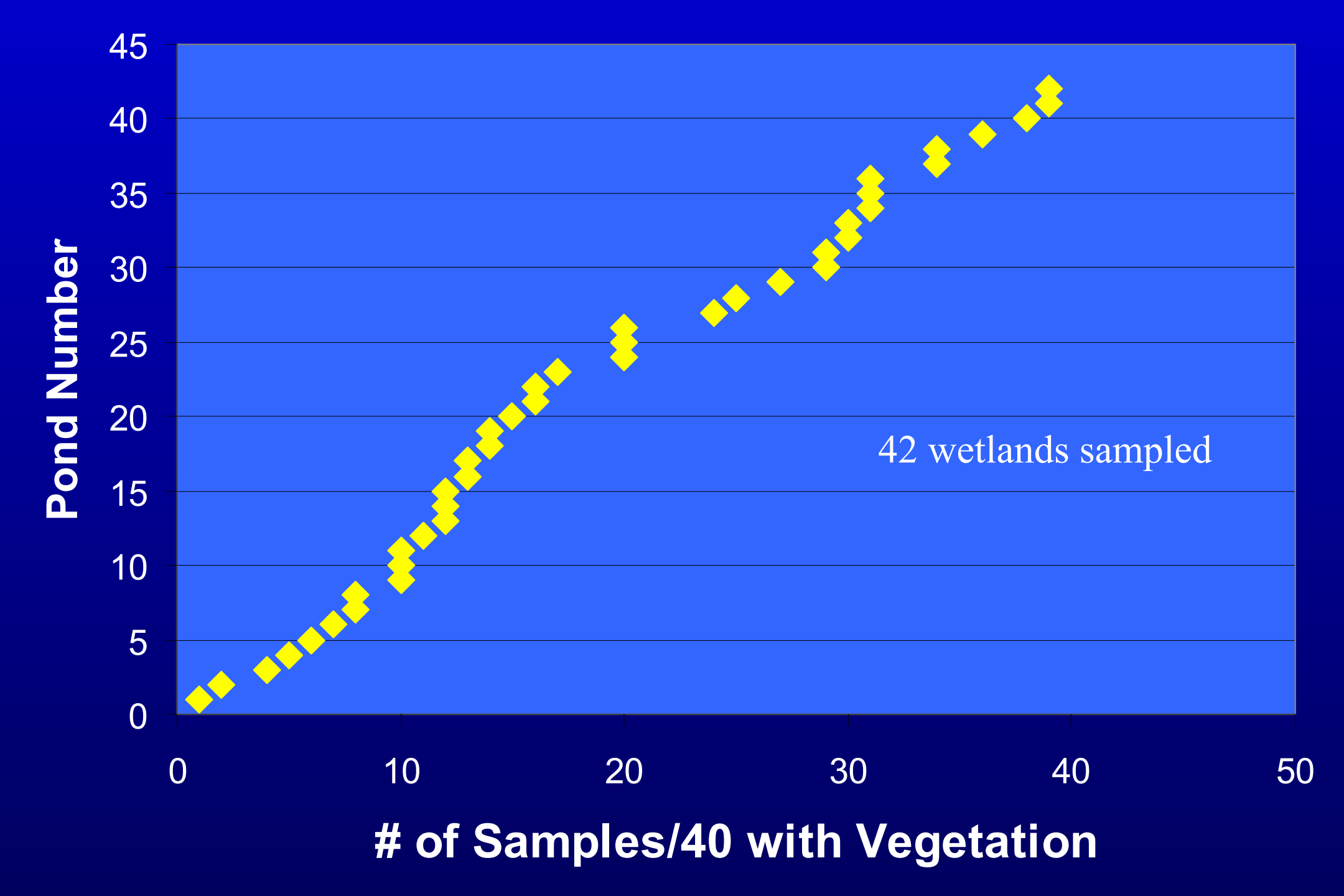
Wetland Plant Surveys

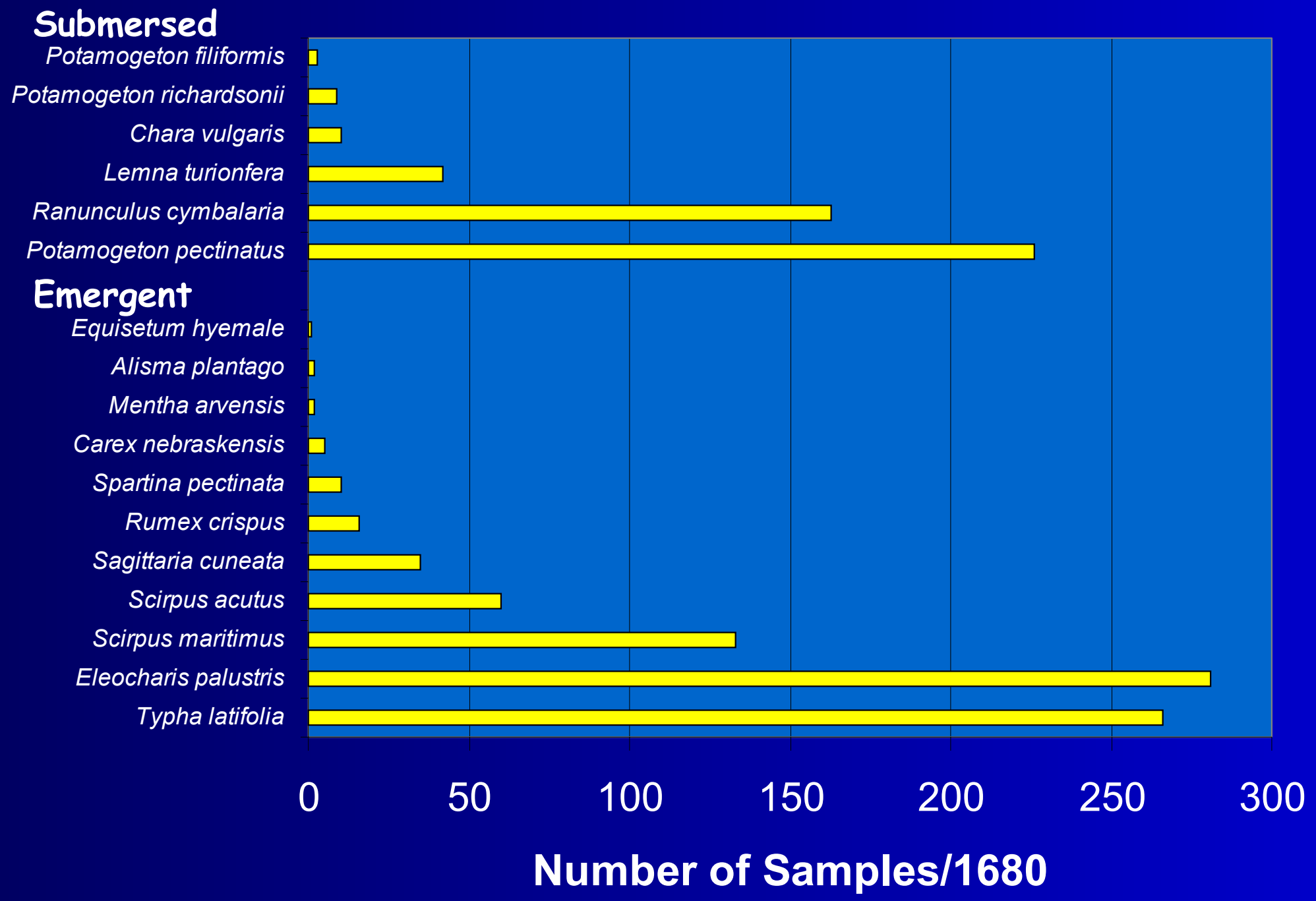
- 10 transects (40 samples/pond)
- Sampled both emergent and submersed vegetation
- 0.25m^2 sample
- Separated samples by species
- Wet weights
- Dry weights



Total Number of Plant Species at a Pond




Pond Number
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
# of Samples/40 with Vegetation
42 wetlands sampled


Submersed
Potamogeton filiformis
Potamogeton richardsonii
Chara vulgaris
Lemna turionfera
Ranunculus cymbalaria
Potamogeton pectinatus
Emergent
Equisetum hyemale
Alisma plantago
Mentha arvensis
Carex nebraskensis
Spartina pectinata
Rumex crispus
Sagittaria cuneata
Scirpus acutus
Scirpus maritimus
Eleocharis palustris
Typha latifolia
0
50
100
150
200
250
300
Number of Samples/1680

Sago Pondweed (*Potamogeton pectinatus*)

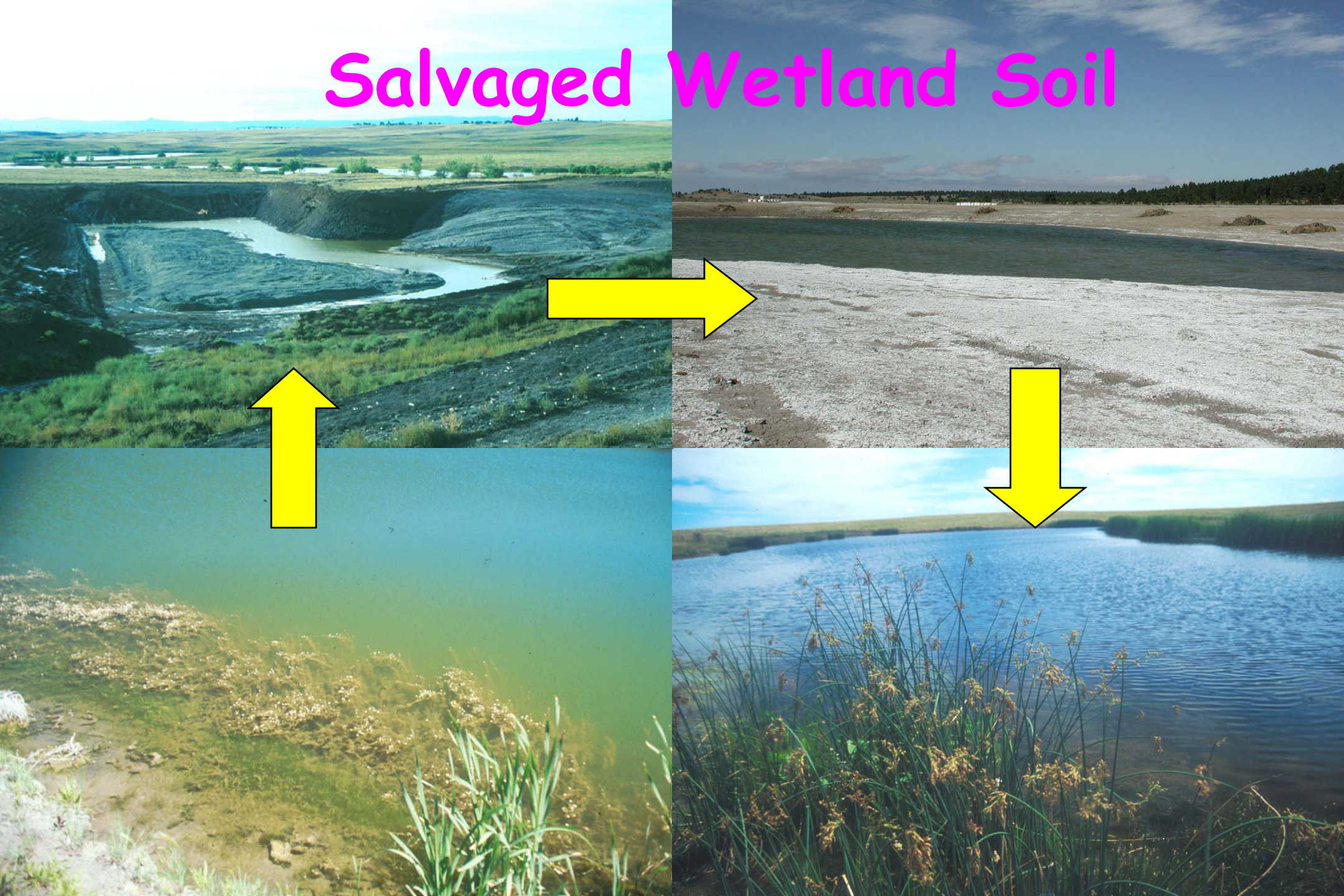
Wild Celery (*Vallisneria americana*)

Softstem bulrush (Scirpus validus)

Initial Results (Plantings)

- Several species show promise (Sago pondweed, wild celery, softstem bulrush, Alkali bulrush)
- Limited wet-meadow plants (dry shorelines)
- Plant material better than seeds
- Spring plantings (water level, ice, better conditions)
- Expensive (e.g. $2-3,000/wetland for plant material)

Salvaged Wetland Soil



THANKS

- Wyoming Department of Environmental Quality
- Wyoming Game and Fish Department
- US Environmental Protection Agency
- Ducks Unlimited
- Individuals
  - Tim Richmond (WYDEQ-AML), Gary Butler Steve Tessmann(WG&F), Ed Stearns and Jim Dunn (EPA), Matt Buhler, Brad Crompton, Jon Haschke, Ken Keffer, Sean Mohren, Kevin Rompola, Shane Rothmeyer, Kelly Gordon, Kenton Taylor (UW)

Questions??

Managing Wildlife Habitats in Reclamation

Mark A. Rumble

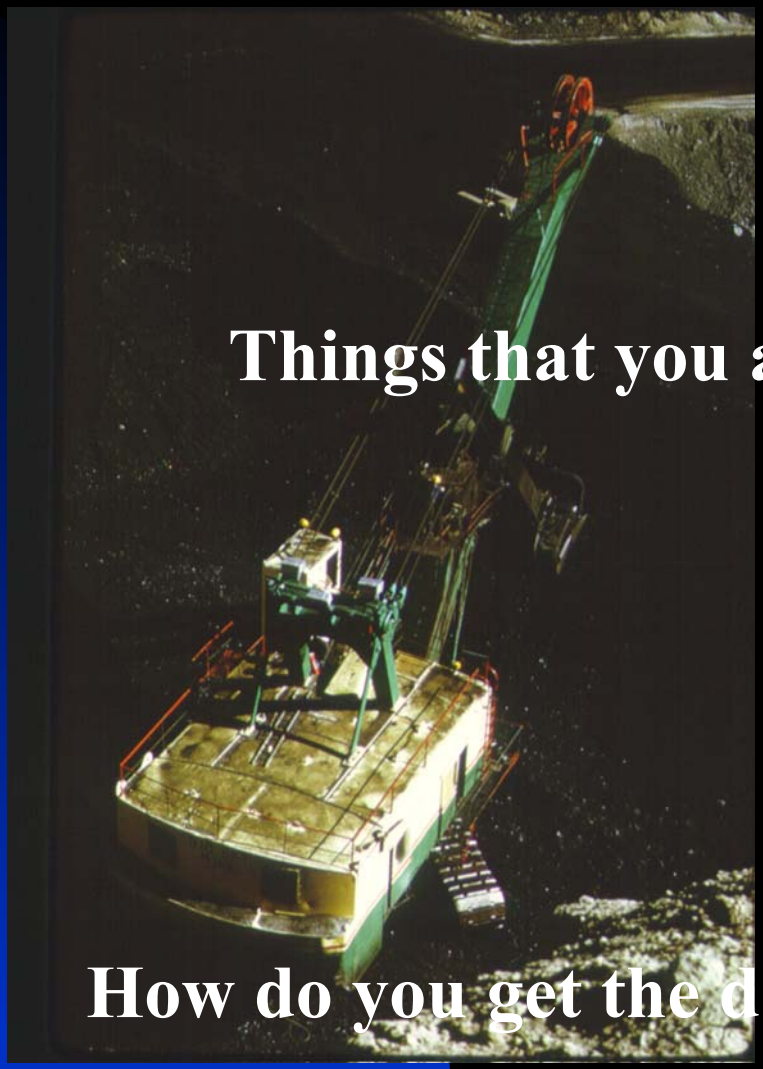
USDA Forest Service, Rocky Mountain Research Station, Rapid City, SD.

Shawn C. Fritcher and Lester D. Flake

Department of Fisheries and Wildlife Sciences, South Dakota State University, Brookings, SD.

Presented at OSM Bond Release Forum
August 2001

After:



Things that you are all familiar with

How do you get the desired conditions in future?

Introduction

- Lots of discussion on various wildlife uses of reclaimed mined lands.
- Present a context for which to manage wildlife ecologically.

Underlying Principles

- One of basic tenets of wildlife management is wildlife relation to vegetation communities (habitats).
- Wildlife species occurrences and abundance respond to habitat structure.
- Some research has argued that individual species exhibit greater associations with plant species than habitat structure.

However, across landscapes – vegetation structure is represented by particular species

- Basal area of green ash/ acres is was correlated with:
  - Tree density +
  - Overstory cover +
  - Overstory patchiness –
  - Mid-story vegetation density –
  - Understory vegetation density –

- Chokecherry density correlated with:
  - Total tree density +
  - Overstory canopy closurer –
  - Vegetation density 1 –3 m +
  - Vegetation patchiness 1-3 m -

Current and Past Research Direction

- Toward greater understanding of microhabitat relations.
- Need to know what habitat characteristics a species responds to but also how to create this on a landscape.
- Also need plant and animal community relations with ecological foundation.
- If habitat characteristics managing for are not linked to ecological processes, they probably are not sustainable.

Given all the relations of various wildlife species to these vegetation and structure variables, it is not hard to see why managing biodiversity one species at a time is not working.

Next Alternative:

However, it is critical to note "WILDLIFE DON'T HAVE HABITAT REQUIREMENTS, SPECIES DO".

Manage for wildlife at different at landscape scale.

Use successional vegetation models to take ecological approach to managing vegetation that provides for key or featured wildlife species or simply for biodiversity by providing habitat diversity within vegetation types, across landscapes, and across regions.

TES Species Relations to Seral Stages

Early Seral

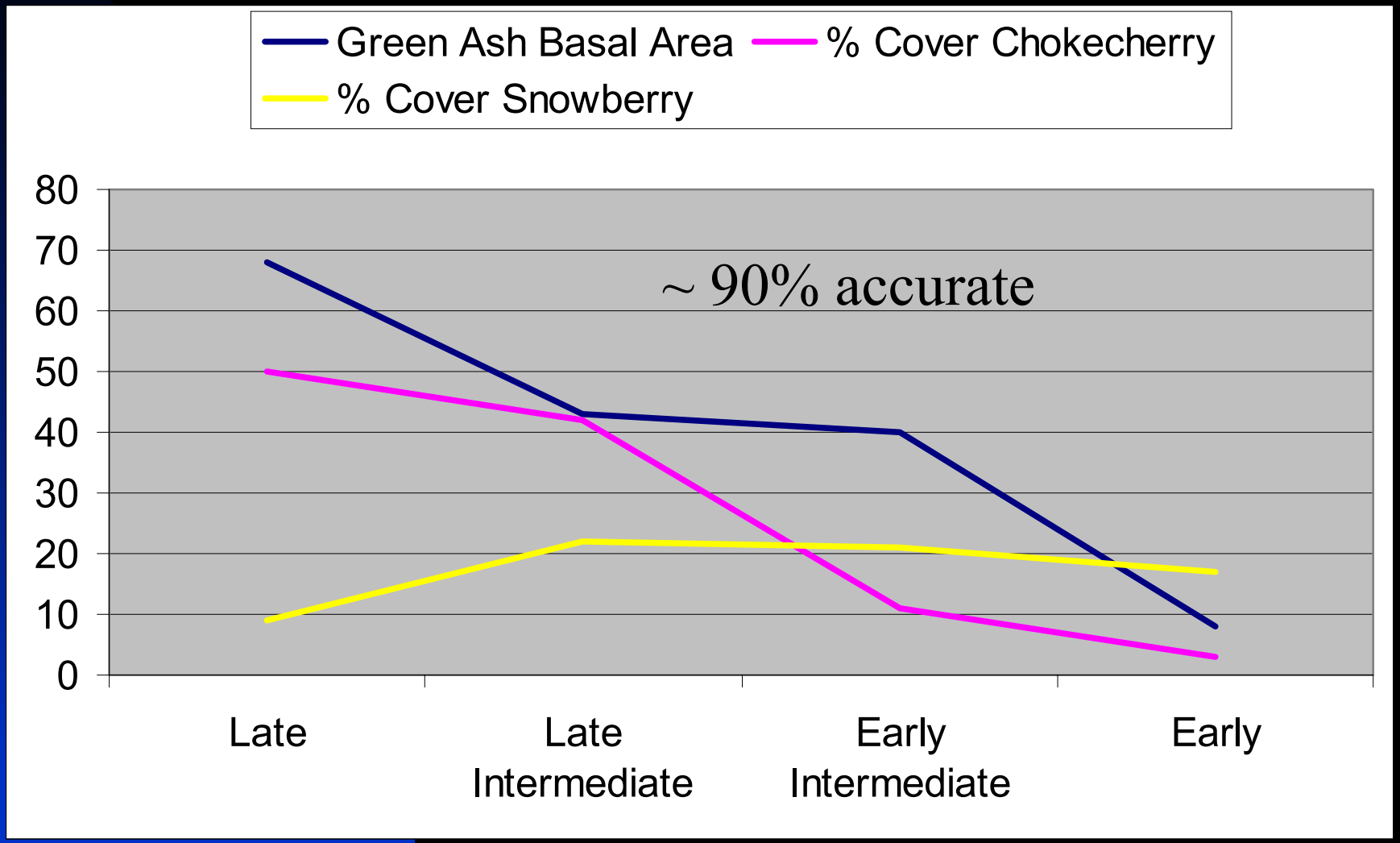
Black-footed ferrets
Mountain plover
Burrowing owls
Swift fox

Late Seral

Greater prairie chicken
Sage grouse

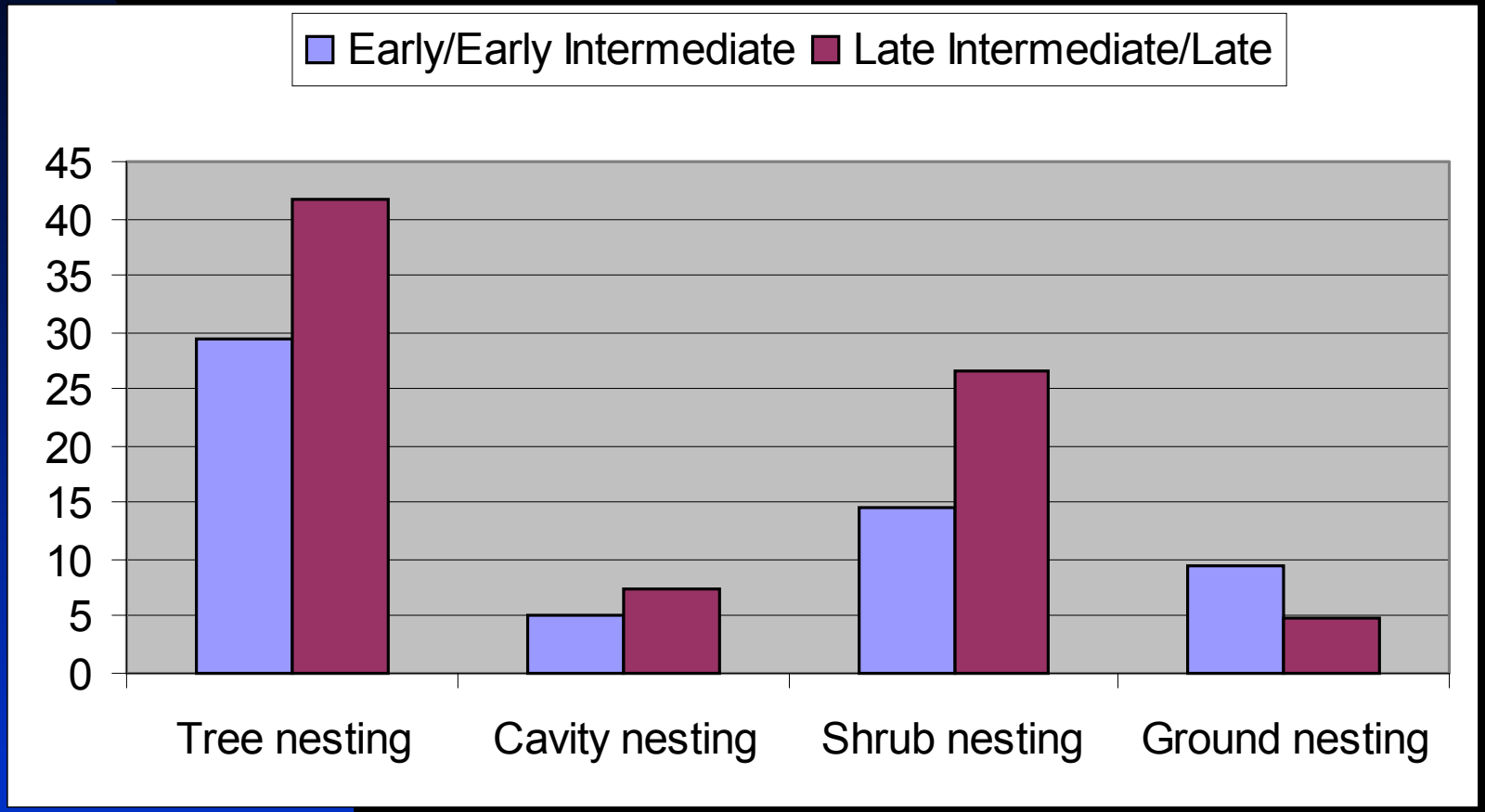
Swift fox

Green Ash Woodlands

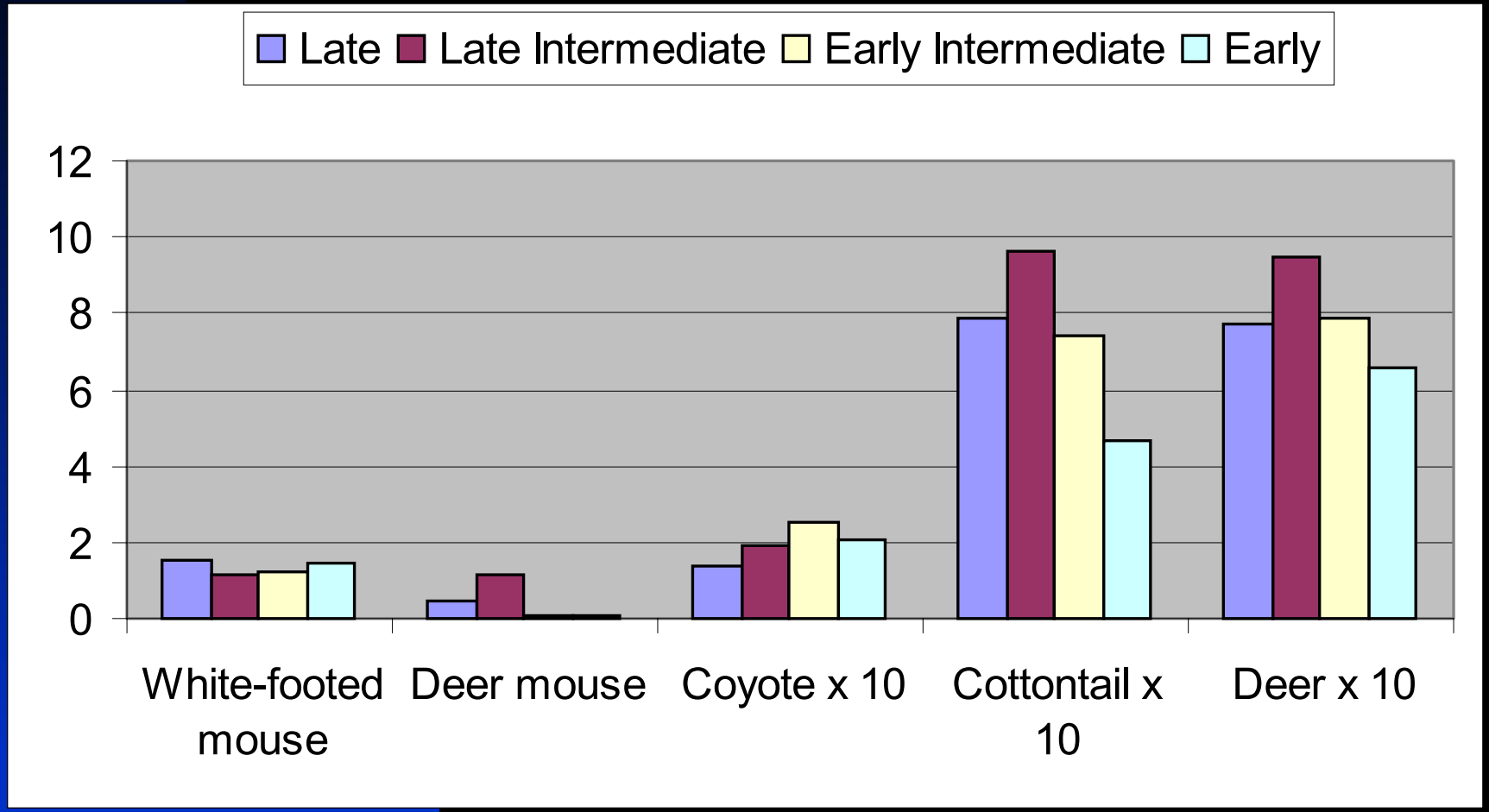


Green Ash Woodlands

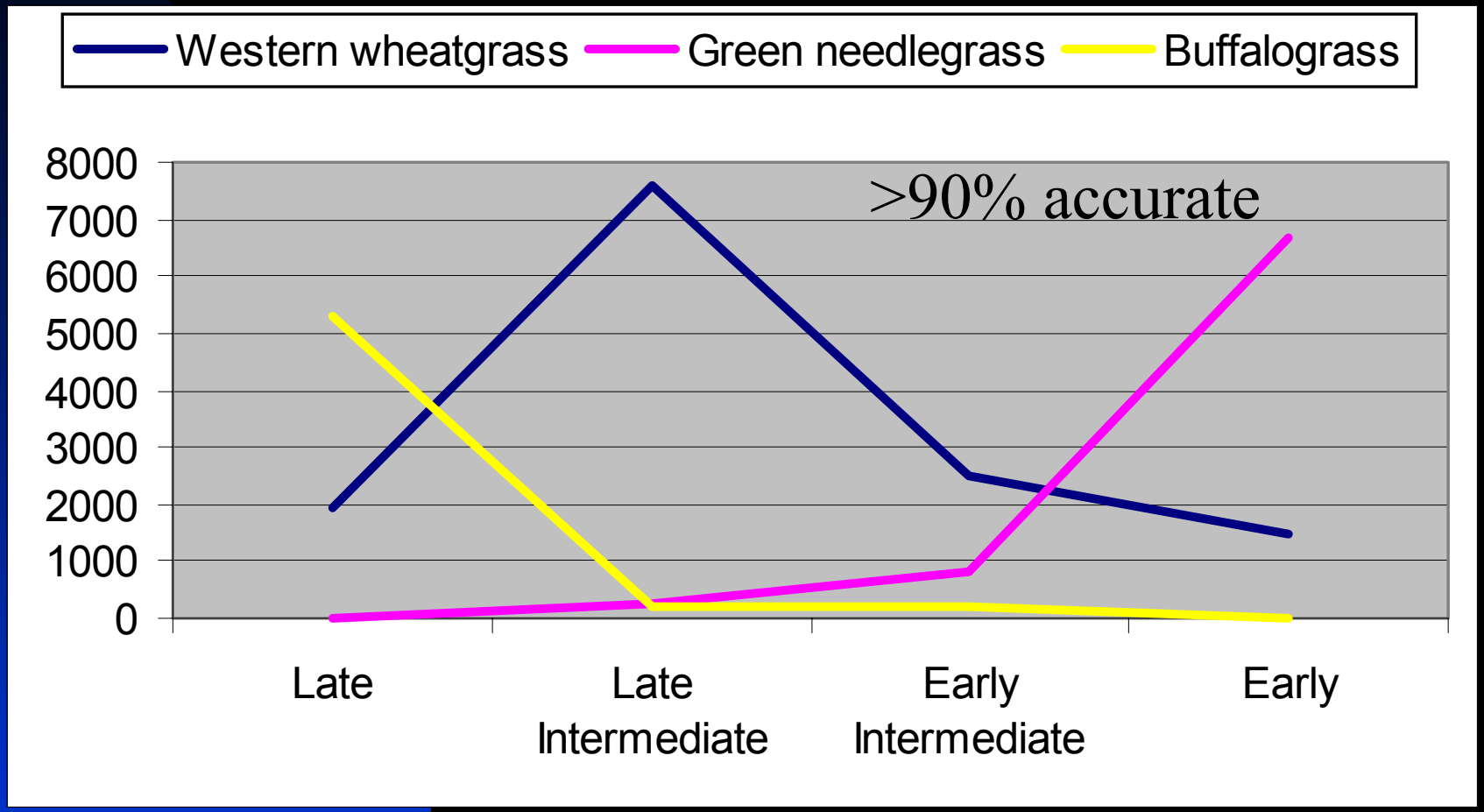
Birds in Green Ash in Relation to Seral Stage



Mammals

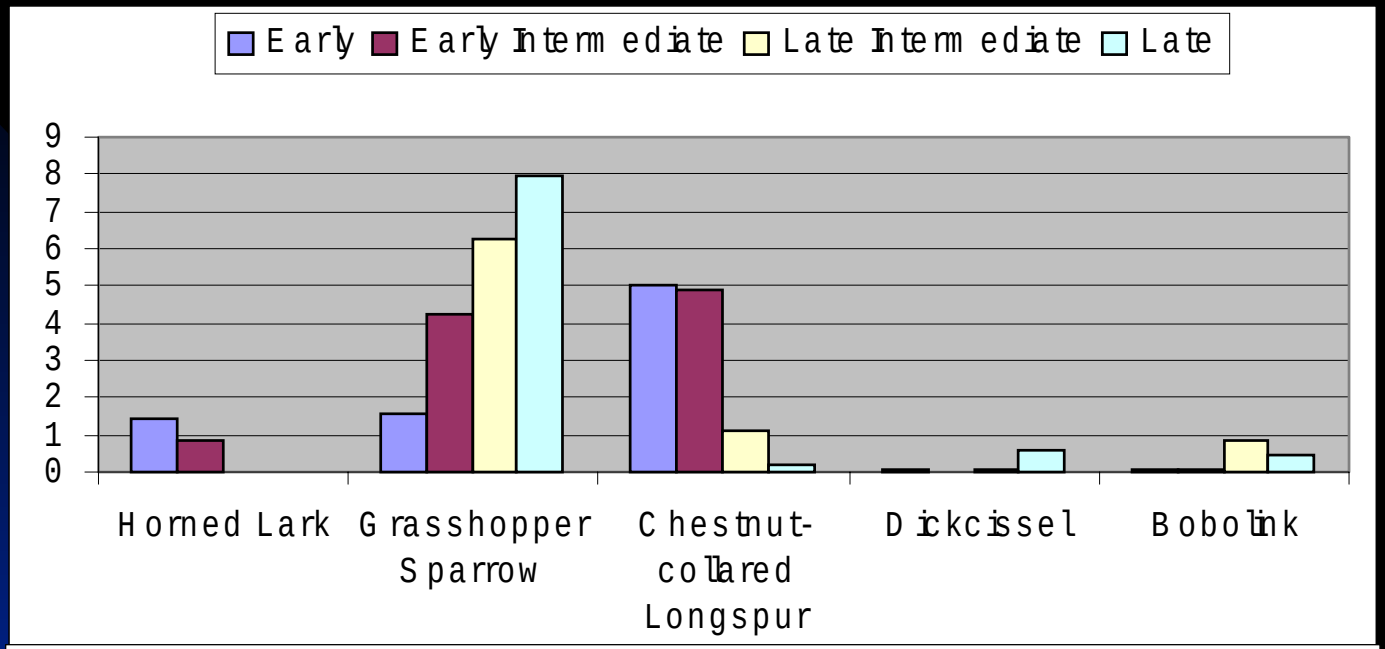

Late
Late Intermediate
Early Intermediate
Early
12
10
8
6
4
2
0
White-footed mouse
Deer mouse
Coyote x 10
Cottontail x 10
Deer x 10

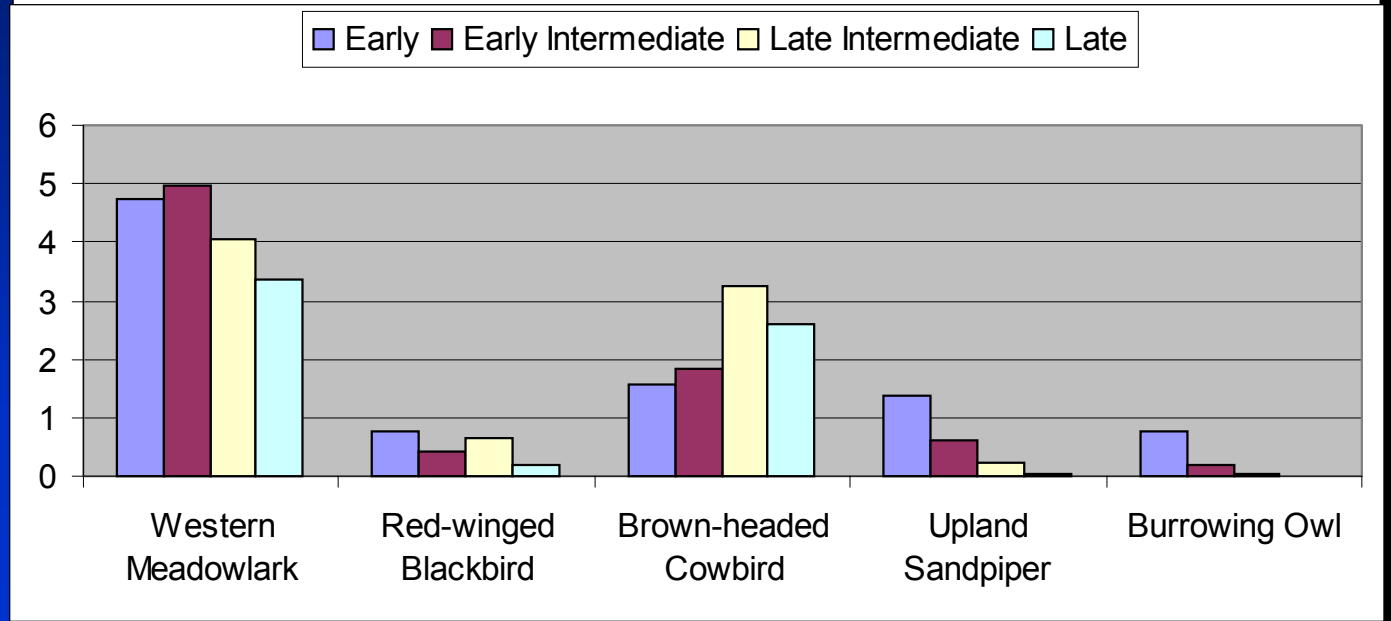
Mixed-grass Prairie



Mixed-grass Prairie

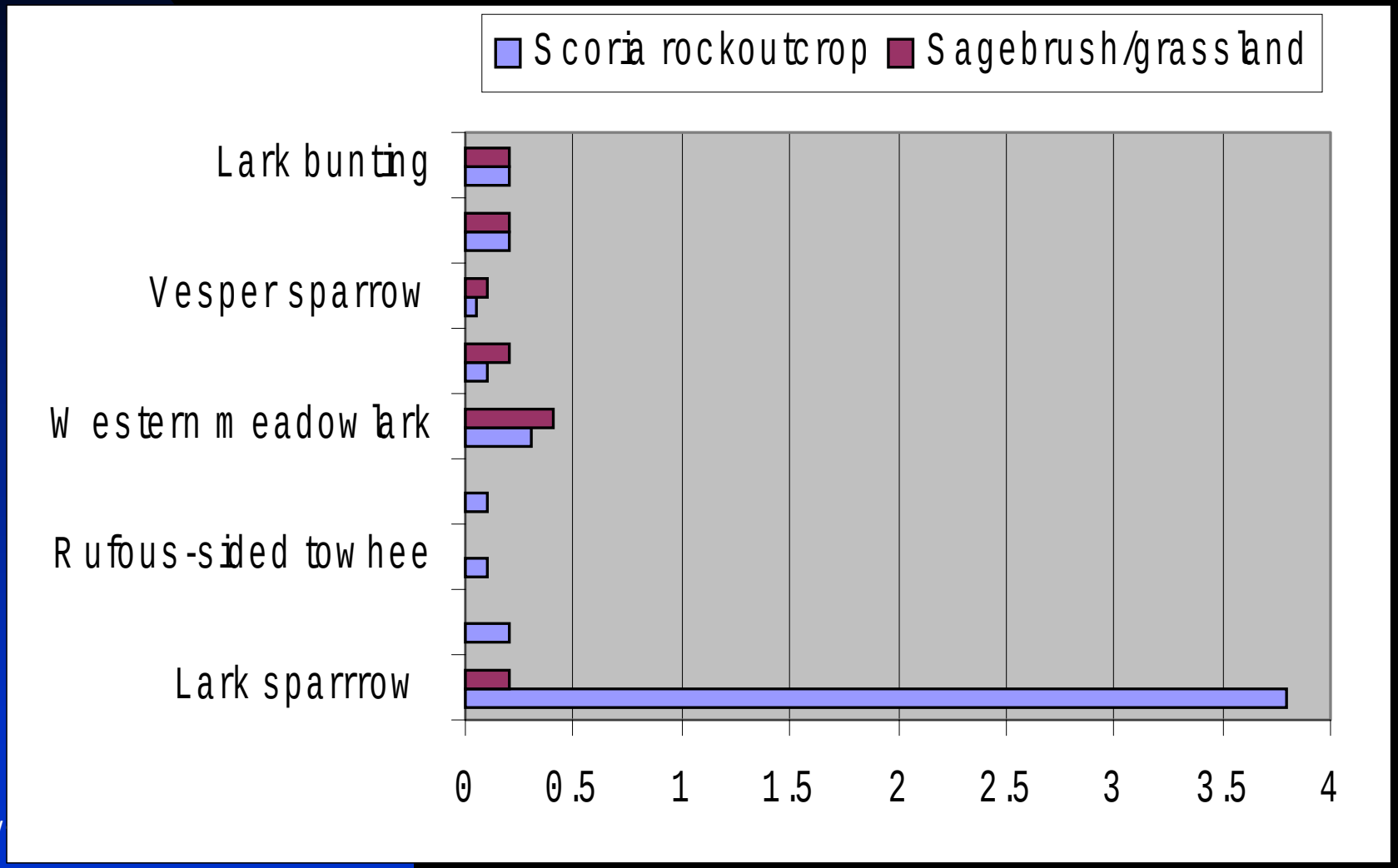
Mixed-grass Prairie Birds





Wyoming Sagebrush/grassland

Birds in Rocks and Sagebrush/grassland



What is wrong with diversity and richness?

	Early	Early Intermediate	Late Intermediate	Late
Mixed-grass diversity	**0.9**	**0.8**	**0.7**	**0.7**
Mixed-grass richess	**15**	**13**	**12**	**15**
Green ash diversity	**3.1**	**3.3**	**3.5**	**3.4**
Green ash richness	**9**	**12**	**13**	**12**

They tend to vary little among seral stages within a vegetation type and are hard to identify with.

For Example:

- Wildlife don’t have habitat requirements.
- Neither do species richness or diversity.
- It is impossible to manage for **“Wildlife”!**

What This Means

- We recommend identifying species that are desirable and managing for appropriate ecological conditions or seral stages.

Alternatively,

- Coarse filter approach, based on vegetation types and plant communities (seral stages). A little bit of everything across landscapes will ensure biodiversity of most species.
- This coarse filter approach necessitates understanding ecological relations between plant communities and the various associated species.

Tools

Patience

Monitoring

- This coarse filter approach also provides a context for monitoring vegetation communities (seral stages) that is very cost effective.

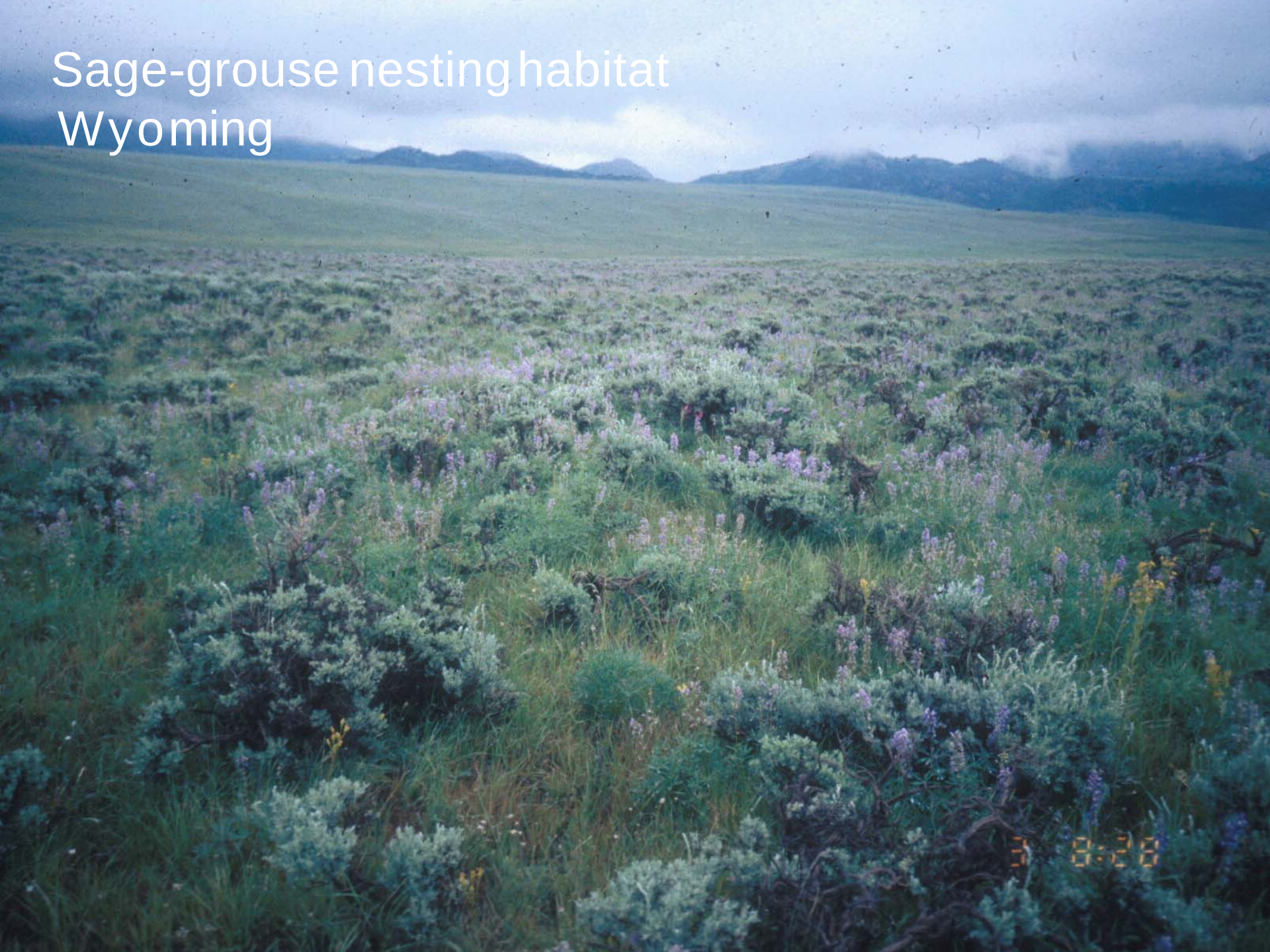
Sage Grouse

Presented by Matthew Holloran
OSM Bond Release Forum
August 2001

Sage Grouse Distribution in Wyoming (1952)

Sage Grouse Distribution in Wyoming (1998)

Sage-grouse nesting habitat
Wyoming


Sage-grouse nesting habitat
Wyoming

Sage-grouse nesting habitat
Wyoming

Sage-grouse nesting habitat
Wyoming

Sage-grouse nesting habitat
Wyoming

Sage-grouse nesting habitat
Wyoming

Sage-grouse nesting habitat
Wyoming

Sage-grouse chick
1 to 2 days old

Sage-grouse early brood-rearing habitat
Wyoming

Sage-grouse early brood-rearing habitat Wyoming

Sage-grouse early brood-rearing habitat Wyoming

Sage-grouse early brood-rearing habitat Wyoming

Sage-grouse summer habitat
Wyoming

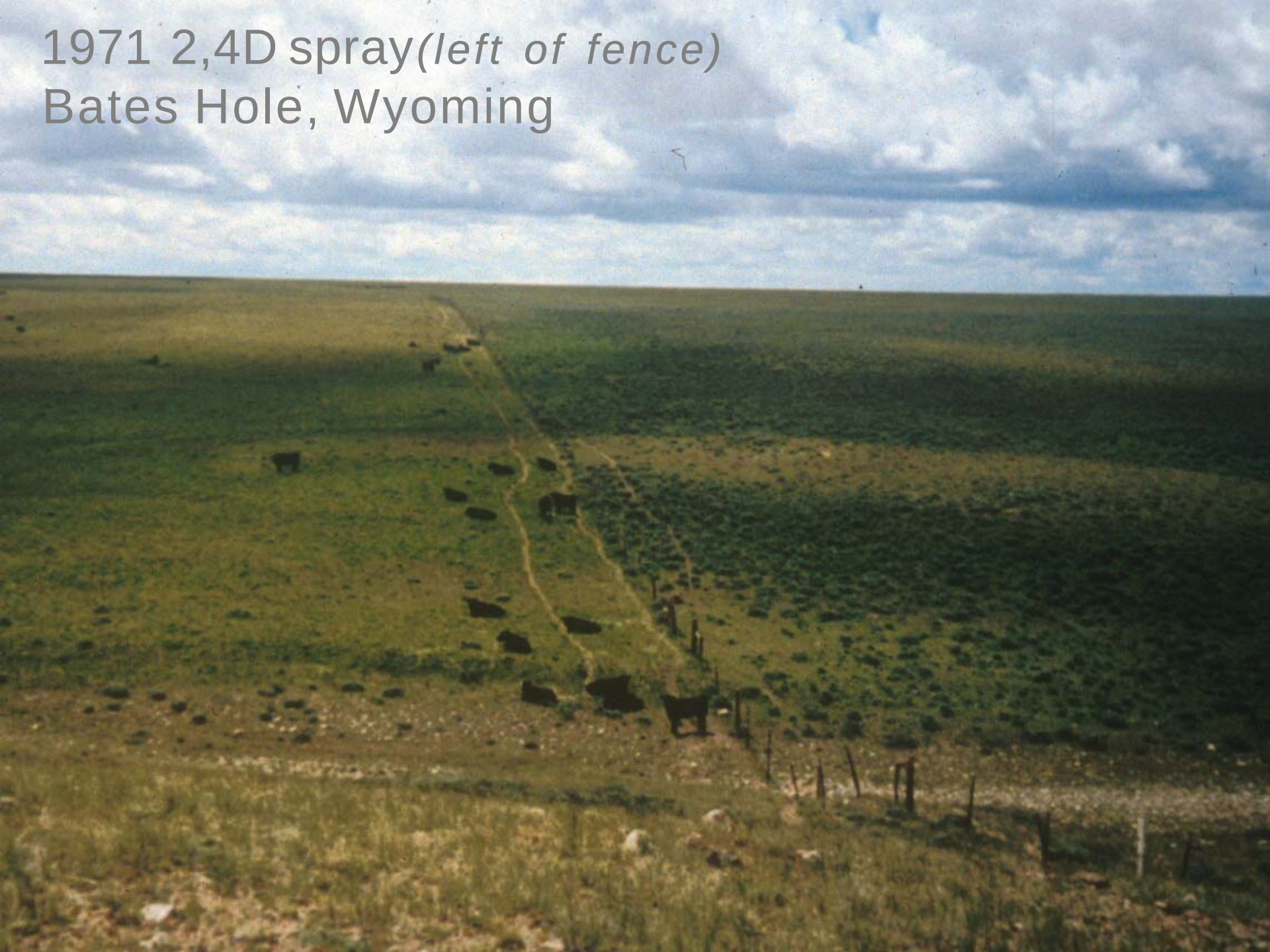
Sage-grouse summer habitat
Wyoming

Sage-grouse winter habitat
Wyoming

Sage-grouse winter habitat
Idaho(photo by Dr.Jack Connelly)

Natural gaswell
Pinedale Mesa,Wyoming

Road in natural gas field
Pinedale, Wyoming


1971 2,4D spray*(left of fence)*
Bates Hole, Wyoming

Geographic Information Systems and Energy Minerals

Office of Surface Mining

GIS Habitat Workshop

Gillette, WY Aug 27, 2001

Mike Price

ESRI Mining and Earth Sciences Solutions Manager

380 New York Street

Redlands, CA 92373

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New Age Volumetrics, Moab Style

Why Miners Use GIS

- **Mine Smarter**
  - Efficiently manage extensive sets of spatial data
- **Mine Cheaper**
  - Achieve high benefit to cost ratio soon after implementation
- **Mine Better**
  - Higher efficiency at all stages of Mining - Exploration, Operations, Reclamation
- **Mine Cleaner and Safer**
  - Perform environmental optimization through life of project; Manage a safe workplace

The Mining GIS Data Model
Addresses:

- **Many Commodities**
  - Precious Metals, Base Metals, Industrial Minerals, Energy Minerals, Special Commodities
- **Numerous Sectors, Disciplines**
  - Market/Geopolitical Assessment, Exploration, Cadastral, Land Management, Permitting, Environmental, Mine Planning, Financial Modeling, Facilities Management, Mine Operations, Remediation
- **Differing User Profiles**
  - Private,/Public Company, Government Agency , Educational Institution, Engineering/Consulting Firm

The Enterprise GIS Model

Includes:

Initial Project Activities
Involve:

- Mineral Economists assessing
  - Mineral commodity markets
  - Viable extractive technologies
  - Environmental and technical issues
- Financial Analysts analyzing
  - Profitable mineral commodities
  - Client locations
  - Competing suppliers
  - Geopolitical implications
  - Financial models
  - Project financial health, make changes as necessary

Early Field Activities
Require:

- Exploration Geologists, who
  - Plan new programs
  - Identify potential resources
  - Search for new deposits
  - Model discoveries
  - Expand current operating reserves

An Exploration Data Model
Could Incorporate:

Infrastructure

Land Status

Survey, Cadastral

Mineralization

Hydrology

Geochemistry

Geophysics

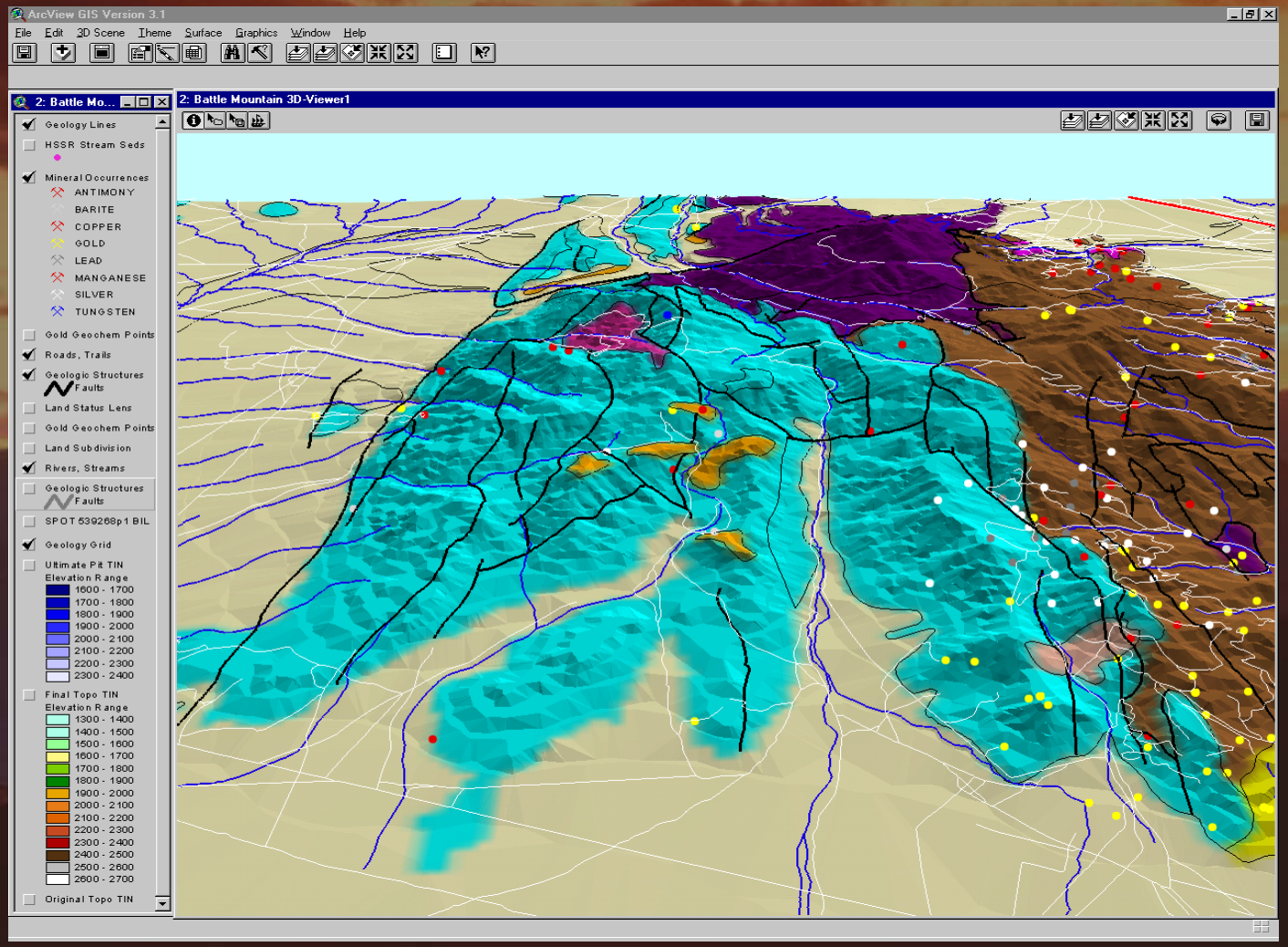
Geology

Topography

Imagery

Exploration Geologic Mapping

Battle Mountain, NV



Early Project Activities
Also Include:

- Survey Crews that
  - Define local project coordinate systems
  - Tie mine the mine grid to regional and global grids
  - Apply GPS, especially in remote areas with limited established geodetic control
  - Provide rapid data posting and analysis

Survey, Cadastral Training
KJBC, Discovery Bay, Jamaica

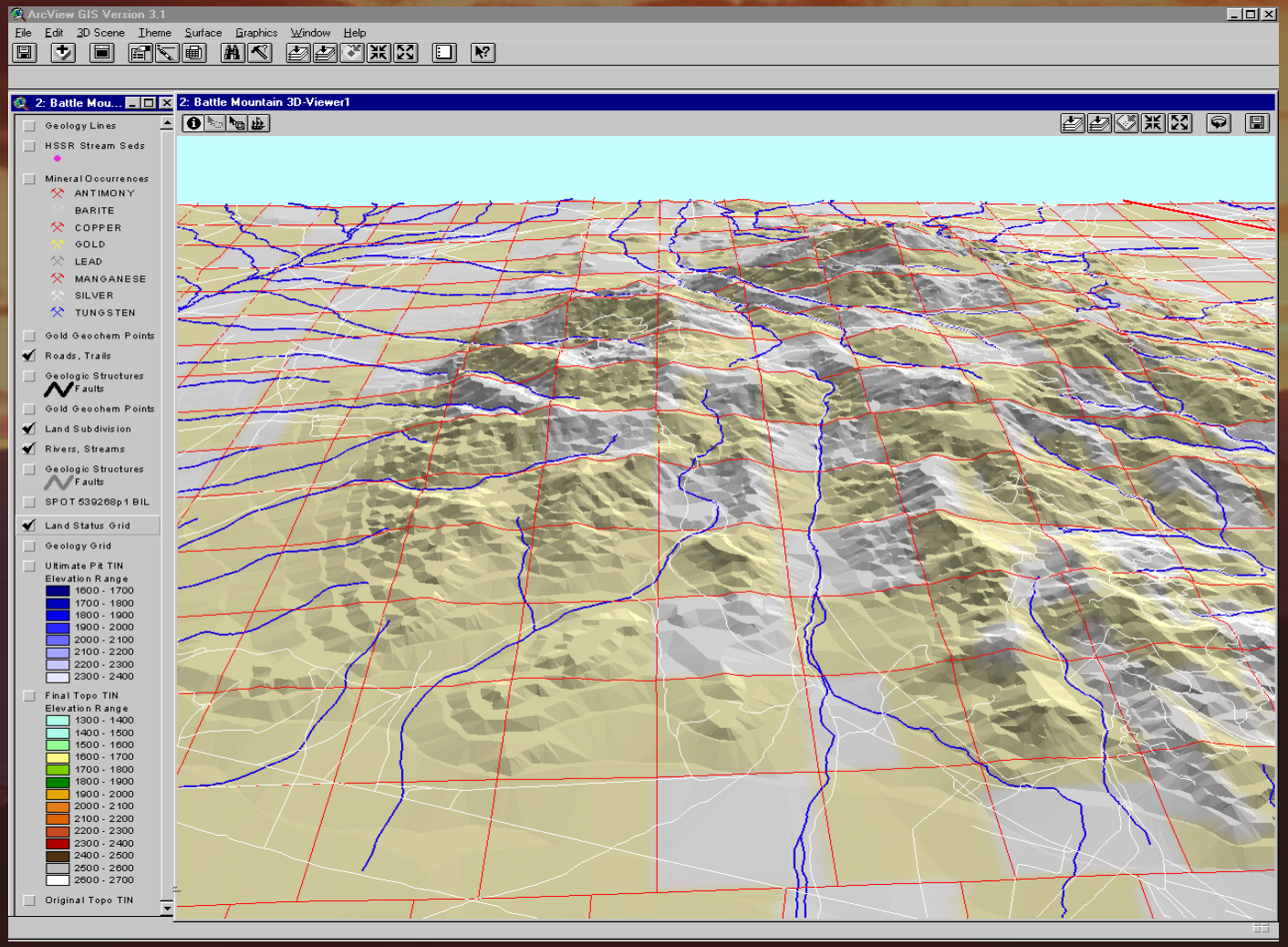
Preliminary Project Activities

Also Employ:

- Land Managers who track
  - Lease responsibilities
  - Royalty payments
  - Property negotiations
- Field agents responsible for
  - On-site Permitting
  - Regulatory compliance
  - Negotiations with surface owners

Land Management Model

Battle Mountain, NV



Mine Operations
Require:

- Mine Engineers who
  - Plan, coordinate, and execute long term and short term plans
  - Tie GIS-based information to traditional mine modeling and operations software
  - Guide mining activities throughout the life of project

Mine Operations
Employ:

- Production Engineers who
  - Monitor mined materials in the face, in transit, and at the stockpile
  - Optimize product quality through stockpiling and blending
  - Calculate efficient, accurate volumetrics for
    - overburden removal
    - product extraction
    - stockpiles

Mine Operations
Also Need:

- Production Engineers who also
  - Apply LIDAR terrain analysis
  - Shorten data analysis and development time terrain models
  - Volumetric updates in days, not weeks or months

Mine Operations
Require:

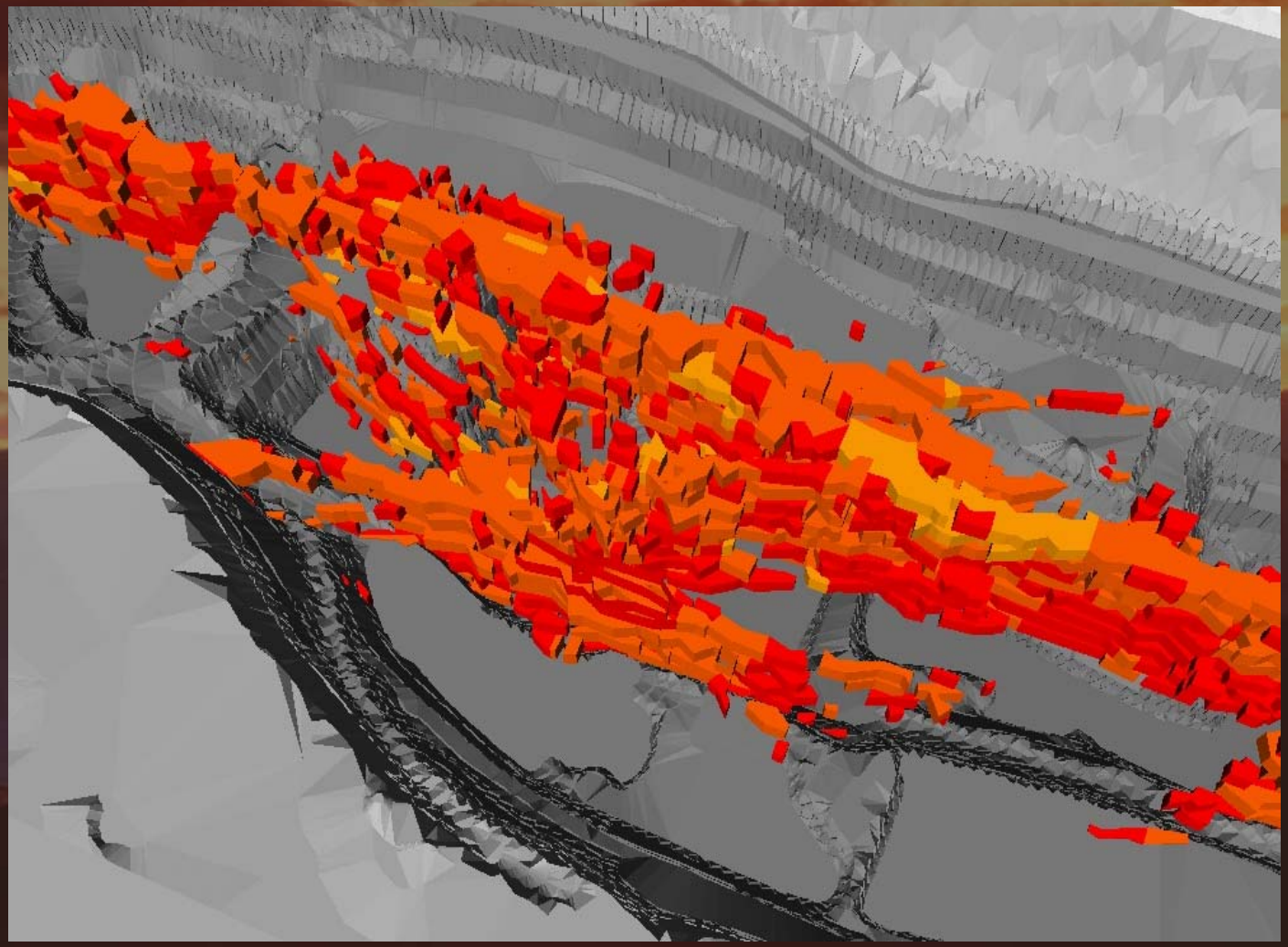
- Facility Managers who
  - Combine spatial data with operations and site plans to
    - optimize mobile mine fleets
    - track maintenance of fixed and mobile equipment
    - design and monitor plant assets
  - Use GPS receivers and radio data links on mobile mining equipment to
    - monitor real-time activity, efficiency, and availability
  - Apply GPS-controlled digging and grading to
    - eliminate the need for field staking
    - reduce exposure of personnel to workplace hazards

Surface Mine Modeling

St. Anne Parish, Jamaica

Ore Body Reconciliation

Northern NV



Mine Operations
Also Need:

- Accountants, Planners and Financial Analysts who
  - Link spatial data to cost and performance information
  - Monitor variable cost models
  - Optimize resources - manpower, equipment, energy
- Project/Facility Managers that
  - Obtain and evaluate current, accurate information
  - Monitor and assess the economic health of their operation or company

Mine Operations
May Also Have:

- Fleet Dispatchers who
  - Employ GIS-based routing and tracking to
    - plan best-case delivery routes
    - optimize the transportation fleet
    - minimize the impact to other highway users

Production Scheduling

St Ann Parish, Jamaica

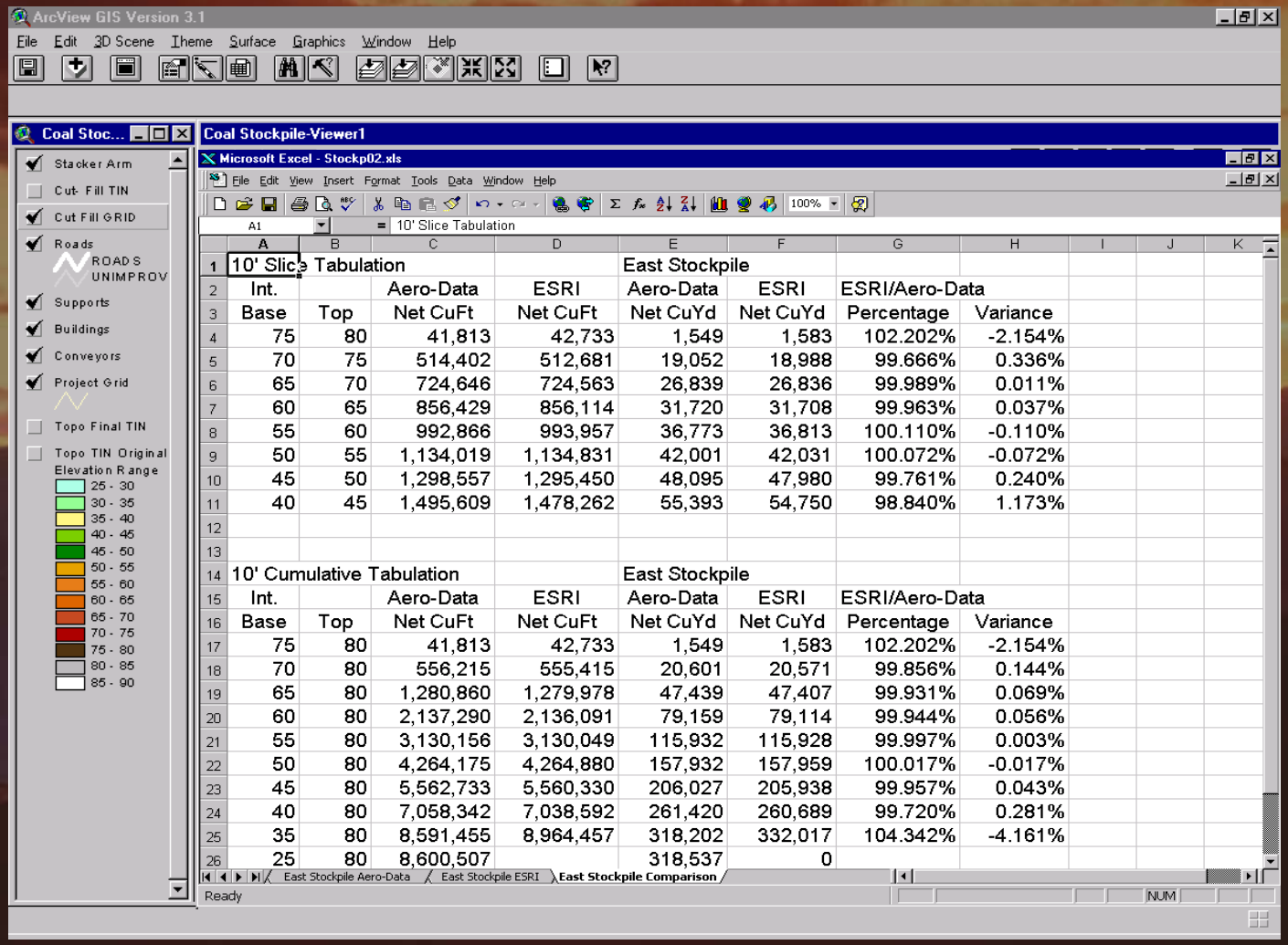
DH Quality, TAA >= 44.0%

Hole Code	Hole No	Lift	From	To	Base Elev	P2O5	SiO2	Mn	ZnO	TAA	THA	MHA
1.1	1	1	0	20	1637	0.702	1.240	0.200	0.057	45.660	42.293	3.367
1.2	1	2	20	35	1622	0.731	0.859	0.218	0.059	45.176	42.076	3.100
1.3	1	3	35	44	1613	0.683	0.766	0.262	0.059	45.600	42.315	3.285
2.1	2	1	0	20	1627	0.702	1.220	0.344	0.064	43.078	36.741	6.337
2.2	2	2	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.1	3	1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.2	3	2	20	35	1596	0.738	1.440	0.613	0.103	41.914	39.253	2.661
4.1	4	1	0	20	1585	1.130	1.670	0.718	0.056	42.665	36.126	6.539
4.2	4	2	20	35	1570	1.040	1.220	0.625	0.075	43.151	38.538	4.613
4.3	4	3	35	50	1555	1.110	1.130	0.723	0.122	42.908	36.504	6.404
5.1	5	1	0	15	1573	0.653	1.330	0.121	0.055	44.622	40.045	4.577
6.1	6	1	0	17	1566	0.798	1.140	0.152	0.053	44.830	41.565	[illegible]
7.1	7	1	0	20	1554	0.957	0.459	0.325	0.060	42.716	39.000	3.716
7.2	7	2	20	30	1544	1.640	0.614	0.355	0.068	44.320	40.117	4.203
8.1	8	1	0	20	1543	0.565	0.782	0.172	0.045	45.619	42.151	3.468
8.2	8	2	20	35	1528	0.680	0.873	0.284	0.055	45.019	43.017	2.002
8.3	8	3	35	55	1508	0.703	0.446	0.178	0.055	45.747	42.537	3.210
9.1	9	1	0	20	1564	0.631	0.894	0.227	0.053	45.320	42.780	2.540
10.1	10	1	0	20	1547	0.838	0.661	0.380	0.033	45.335	42.595	2.740
10.2	10	2	20	35	1532	0.835	0.482	0.464	0.050	44.121	42.402	1.719
10.3	10	3	35	50	1517	0.842	2.670	0.563	0.029	44.850	42.595	2.355
10.4	10	4	50	59	1508	0.808	0.454	0.300	0.039	44.364	41.981	2.383
11.1	11	1	0	20	1538	0.721	0.340	0.125	0.036	45.578	42.981	2.597
11.2	11	2	20	27	1531	0.675	0.228	0.427	0.060	46.727	44.334	2.393
12.1	12	1	0	20	1530	0.570	0.581	0.165	0.041	48.055	44.240	3.815
12.2	12	2	20	30	1520	0.555	0.857	0.148	0.044	47.084	43.274	3.810
13.1	13	1	0	20	1521	0.353	0.439	0.258	0.020	44.291	42.023	2.268
13.2	13	2	20	35	1506	0.696	0.458	0.159	0.036	44.341	41.363	2.978
13.3	13	3	35	42	1499	0.686	0.381	0.114	0.034	48.417	45.821	2.596
14.1	14	1	0	20	1513	0.646	0.328	0.121	0.034	45.505	42.151	3.354

Grade/Tonnage Data

Stockpiles, Volumes

SE United States



	A	B	C	D	E	F	G	H
1	10' Slice Tabulation				East Stockpile			
2	Int.		Aero-Data	ESRI	Aero-Data	ESRI	ESRI/Aero-Data	
3	Base	Top	Net CuFt	Net CuFt	Net CuYd	Net CuYd	Percentage	Variance
4	75	80	41,813	42,733	1,549	1,583	102.202%	-2.154%
5	70	75	514,402	512,681	19,052	18,988	99.666%	0.336%
6	65	70	724,646	724,563	26,839	26,836	99.989%	0.011%
7	60	65	856,429	856,114	31,720	31,708	99.963%	0.037%
8	55	60	992,866	993,957	36,773	36,813	100.110%	-0.110%
9	50	55	1,134,019	1,134,831	42,001	42,031	100.072%	-0.072%
10	45	50	1,298,557	1,295,450	48,095	47,980	99.761%	0.240%
11	40	45	1,495,609	1,478,262	55,393	54,750	98.840%	1.173%
12								
13								
14	10' Cumulative Tabulation				East Stockpile			
15	Int.		Aero-Data	ESRI	Aero-Data	ESRI	ESRI/Aero-Data	
16	Base	Top	Net CuFt	Net CuFt	Net CuYd	Net CuYd	Percentage	Variance
17	75	80	41,813	42,733	1,549	1,583	102.202%	-2.154%
18	70	80	556,215	555,415	20,601	20,571	99.856%	0.144%
19	65	80	1,280,860	1,279,978	47,439	47,407	99.931%	0.069%
20	60	80	2,137,290	2,136,091	79,159	79,114	99.944%	0.056%
21	55	80	3,130,156	3,130,049	115,932	115,928	99.997%	0.003%
22	50	80	4,264,175	4,264,880	157,932	157,959	100.017%	-0.017%
23	45	80	5,562,733	5,560,330	206,027	205,938	99.957%	0.043%
24	40	80	7,058,342	7,038,592	261,420	260,689	99.720%	0.281%
25	35	80	8,591,455	8,964,457	318,202	332,017	104.342%	-4.161%
26	25	80	8,600,507		318,537	0		

Environmental Departments
are Coordinated by:

- Environmental Affairs Managers that
  - Monitor the project throughout its life
  - Optimize environmental compliance and restoration activities
  - Link reclamation plans to regulatory obligations
  - Reduce bulky, expensive paper documentation through Electronic Permitting

Environmental Departments

Rely on:

- Regulatory and Public Affairs Staff who
  - Construct realistic 3D pre-mining project renderings of the project
  - Facilitate public, agency meetings during permitting and operation
  - Support timely bond release on reclaimed lands

Environmental Departments
Also Need:

- Hydrologists/Hydrogeologists who
  - Build surface and groundwater models from topography, soils mapping, geochemistry data
  - Implement, monitor water quality compliance and erosion control programs
  - Identify problems long before they become difficult and costly to repair

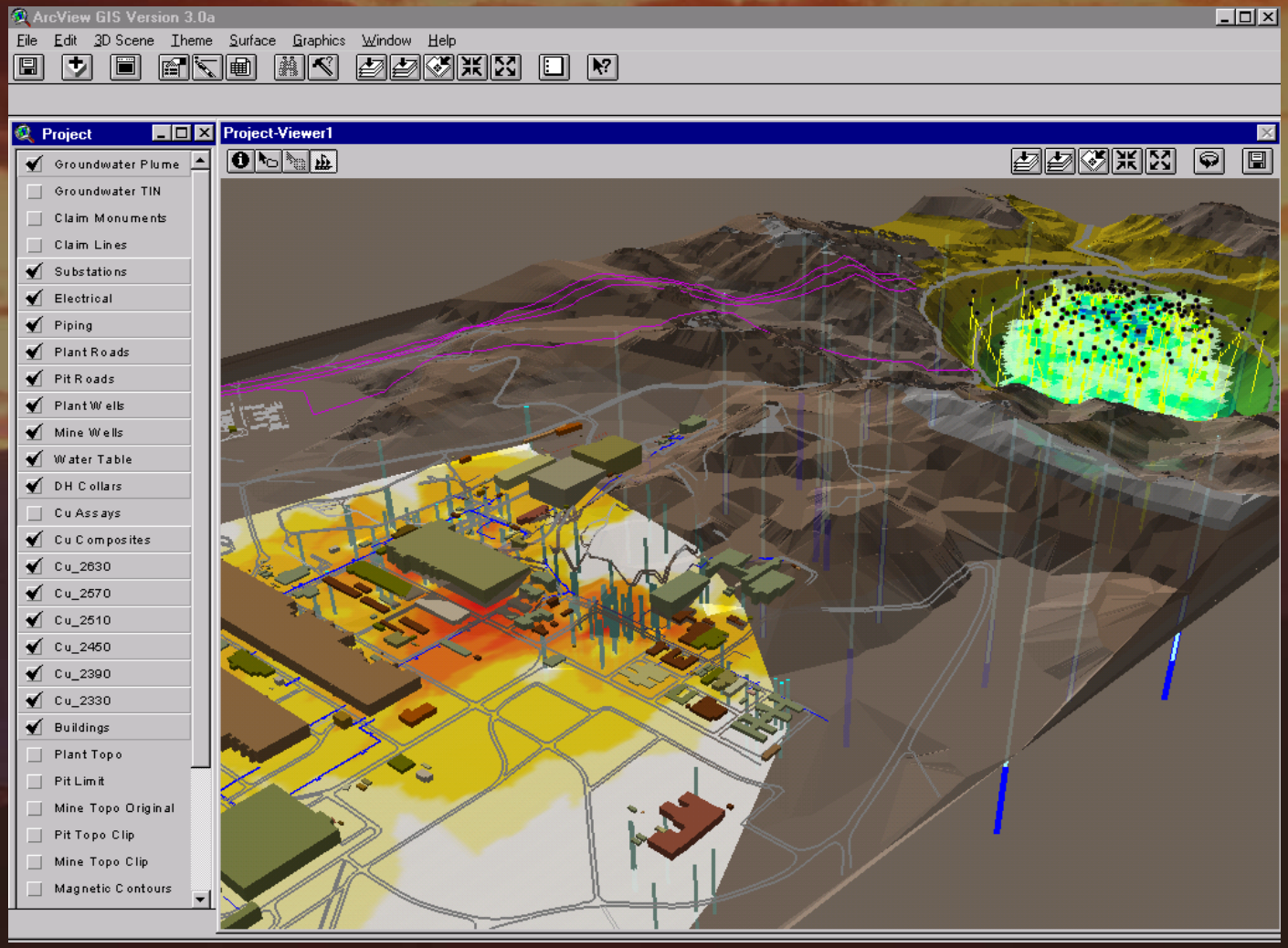
Environmental Departments

Use:

- Reclamation and Remediation Crews that
  - Use GPS-based to collect field data
    - baseline data
    - operational data
  - Guide resloping and revegetation activities
  - Balance proposed restoration activities with actual construction

Enterprise Solutions

Hypothetical Model



Important GIS Issues

GIS Implementation Issues

- Implementation and deployment GIS requires
  - Understanding
  - Commitment
  - Support
- Adequate computer hardware
- Users must learn and apply new methods and procedures
- Startup training and periodic refreshers benefit all users

Data Integration Concerns

- Traditional methods of spatial data acquisition include paper mapping and hand plotting
- Digital spatial data are often now available in Computer Aided Drafting and Design (CADD) formats amenable to GIS implementation
- Tabular data occurs in CADD, database, text, and custom formats

Data Management Needs

- Mining operations generate huge quantities of spatial and tabular data
- Management must commit to a centralized or distributed system of data acquisition, maintenance, and distribution
- Large operations: centralized data management
- Small operations: localized data management

Data Sharing Concerns

- GIS accesses data in many common spreadsheets and databases
- Base data are stored in centralized or departmentalized locations
- Start-up data sets are available on the Internet
- High-resolution satellite imagery provides cost effective, timely look at the mine from space

Software Compatibility Issues

- Spatial data stored and accessed in CADD formats
- GIS software efficiently imports CADD data
- CADD maps are viewed, queried, and analyzed in their native format
- CADD files may be converted to a GIS format, where they may be edited, reprojected, and expanded

Software Compatibility Issues

- Mine modeling programs import and export spatial data in a CADD format
- Some programs also transfer data as native GIS shapes or coverages
- CADD and GIS files may be accessed and edited across a network, by both CADD and GIS users

Software Compatibility Issues

- Mines share data across LANs
- LAN issues include standard software, current versioning, standard data formats
- Mining GIS users develop data standards to share between operating divisions, government regulators, and the public

Summary

- Geographic Information Systems resides in the boardroom, the mine office,and deep within the mine or pit
- GIS empowers the modern mine operator to mine “smarter, better, cheaper, cleaner, and safer”

Mining Industry Solutions

Mike Price ESRI
Mining Industry Solutions Manager

October 2001

Why Miners Use GIS

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  - Efficiently manage extensive sets of spatial data
- Mine Cheaper
  - Achieve high benefit to cost ratio soon after implementation

Why Miners Use GIS

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- Mine Cleaner and Safer
  - Perform environmental optimization through life of project; Manage a safe workplace

Mining Industry Mission

- ESRI will provide the best GIS solutions to the Mining Industry through software innovation, development, implementation, and training

Mining Industry Mission

- ESRI will work with the Mining Industry and ESRI Business Partners to enhance GIS technology throughout Mining and Earth Sciences

Core Guiding Principles

- Develop, deliver, and support the highest quality of Spatial/GIS software in the world
- Continually improve and enhance GIS products to address needs of the Mining Industry

Core Guiding Principles

- Provide timely and technically valid user support
- Develop and implement Industry based training programs and data samples

Core Guiding Principles

- Encourage user software innovation and support Business Partner participation in the Mining Industry
- Listen to user and Business Partner comments, needs, and concerns

Key GIS Issues

- Overall software functionality in Mining
- Field applicability, reliability, ruggedness, ease of use
- Mining-based training and support

Key GIS Issues

- 3D, Spatial, Image, and Tracking functionality
- Mining software integration, CAD adaptation
- Data sources, standards, and distribution

Mining User Model

- Commodity Specific
  - Precious Metals, Base Metals, Industrial Minerals, Energy Minerals, Special Commodities
- Sector/Discipline Defined
  - Market/Geopolitical Assessment, Exploration, Cadastral, Land Management, Permitting, Environmental, Mine Planning, Financial Modeling, Facilities Management, Mine Operations, Remediation
- Company Structure
  - Private, Public, Government, Education, Consulting, Single Commodity, Multiple Commodity

Enterprise Model

Strategic Issues

- Ongoing, accelerated development
- Distributor, Business Partner, consultant pairings
- Development and delivery of high-quality Industry-based training
- ArcView-based 3D, Spatial, Image,Tracking, Mining Extensions

Strategic Issues

- Mine modeling, Environmental, CAD interfaces
- Symbology standards, data development
- Open, facilitated GIS discussion within Mining Industry

Software Solutions

- Core Software
  - ArcView GIS
  - ArcInfo
  - ArcPad
  - ArcSDE
  - ArcObjects
  - ArcIMS
- Extensions, Applications
  - 3D Analyst
  - Spatial Analyst
  - Image Analysis
  - Tracking Analyst
  - CAD Reader
  - Projection Utilities
  - Business Partner Applications and Toolkits

Major Mining Clients

- Metals, Industrial
  - Placer Dome
  - AngloGold
  - Barrick Gold
  - BHP Minerals
  - Phelps Dodge
  - Kennecott/RTZ
  - Inco Ltd.
  - North Mining
  - Cominco American
  - Kaiser Aluminum
  - Alcoa Aluminum
  - Cliffs Mining/LTV Steel
  - Hibbing Taconite
  - Potash Corporation Saskatchewan
- Energy, Government
  - Peabody Western Coal
  - BHP Coal
  - Kentucky Coal
  - Usibellli Coal
  - De Beers
  - Vulcan Materials
  - Teichert Aggregates
  - US Geological Survey
  - US Bureau of Land Management
  - Natural Resources Canada
  - Australian Geological Survey Organisation
  - Jamaica Bauxite Institute
  - State Geological Surveys
  - …..and Many More

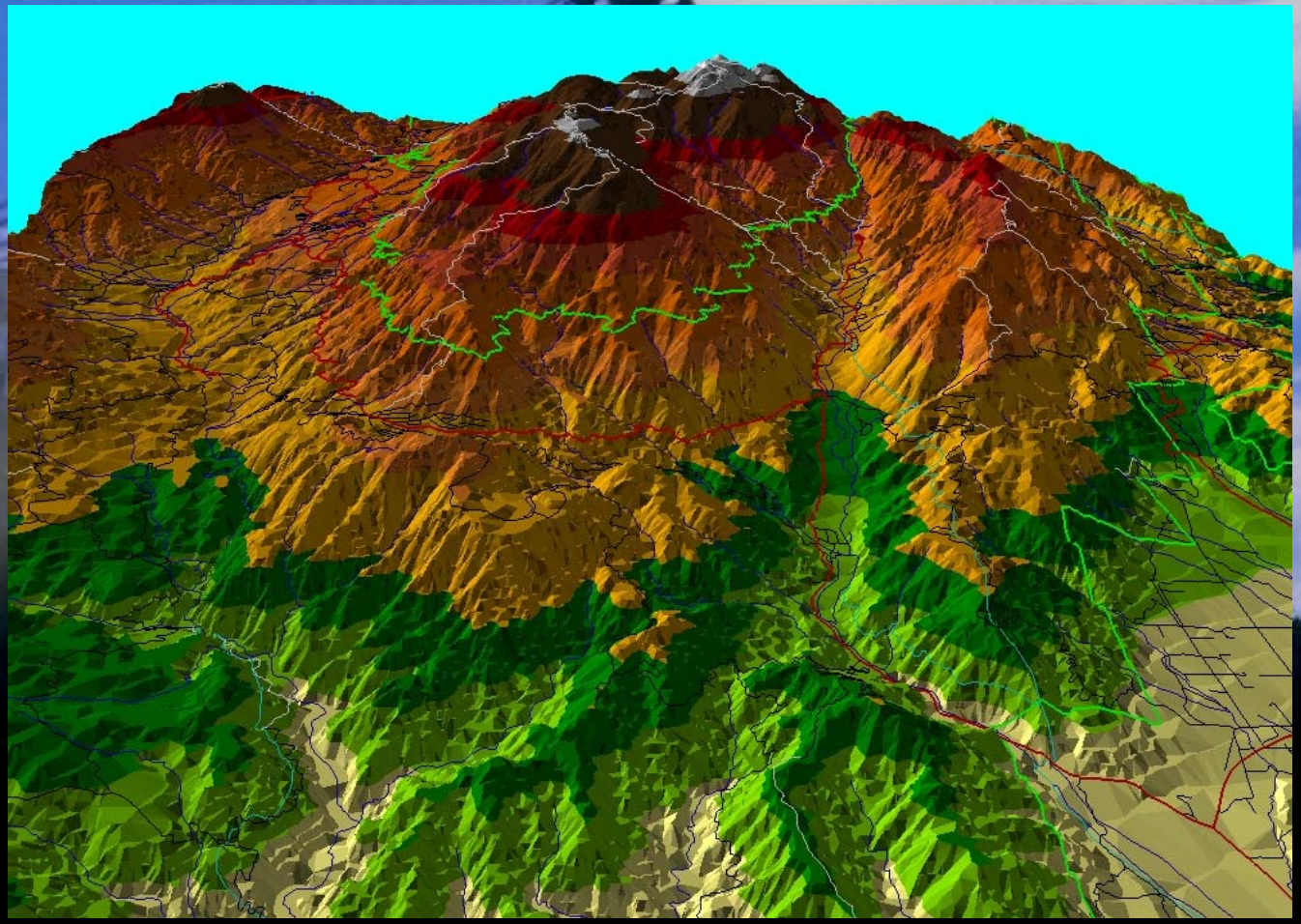
2001 Trade Activities

- Exhibitions
  - SME Annual Meeting
    - Feb 01 Denver, CO
  - SAGEEP
    - Mar 01 Denver, CO
  - ASSMR
    - Jun 01 Albuquerque, NM
  - PUG/MUG Meetings
    - Jul 01 San Diego, CA
  - GSA Annual Meeting
    - Nov 01 Boston, MA
  - Northwest Mining
    - Dec 01 Spokane, WA
- Advertising
  - Engineering & Mining Journal
  - Mining Engineering
  - Coal Age
  - Paydirt
  - Northern Miner

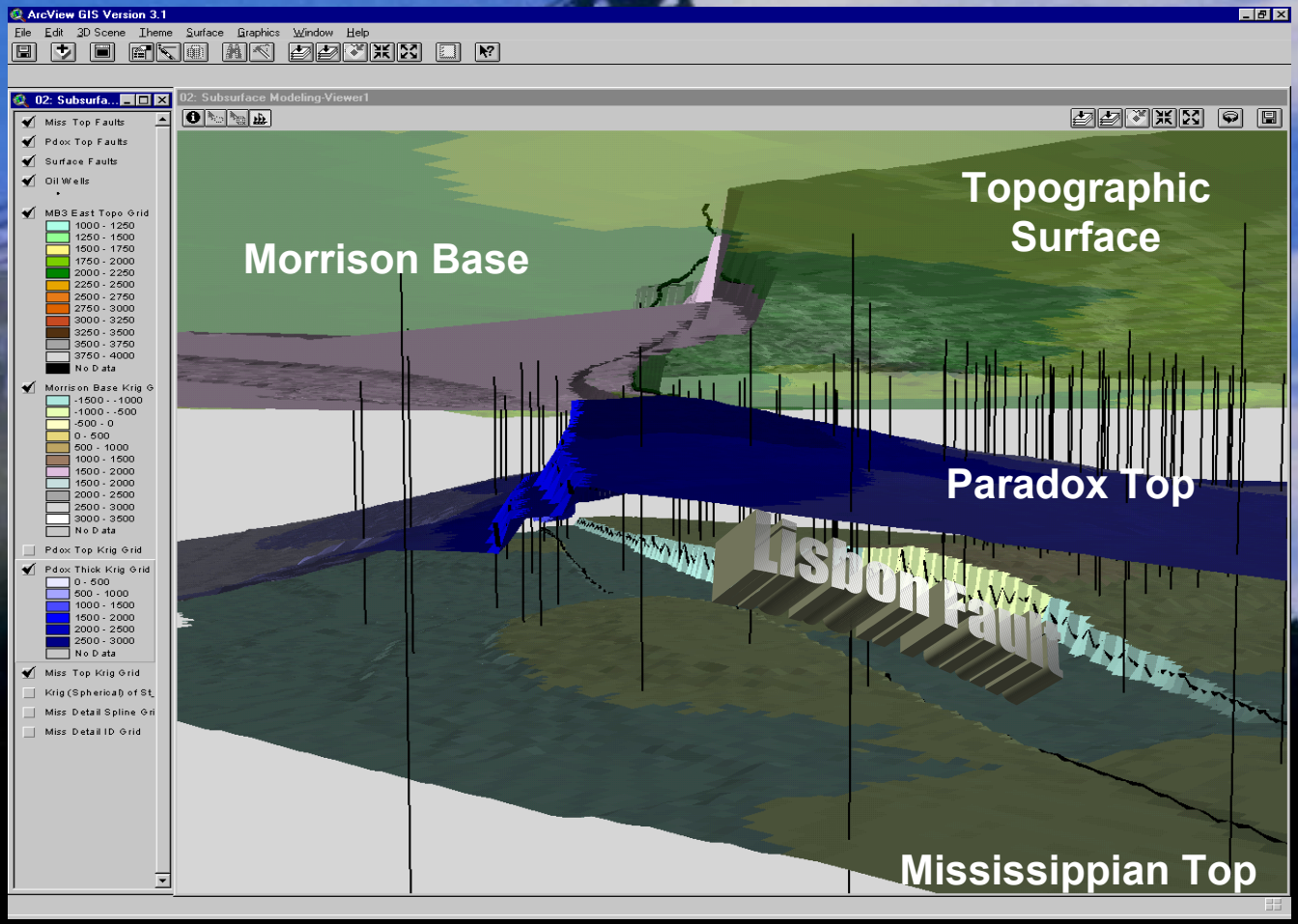
So…

Let’s Have a Look at GIS in Mining!!

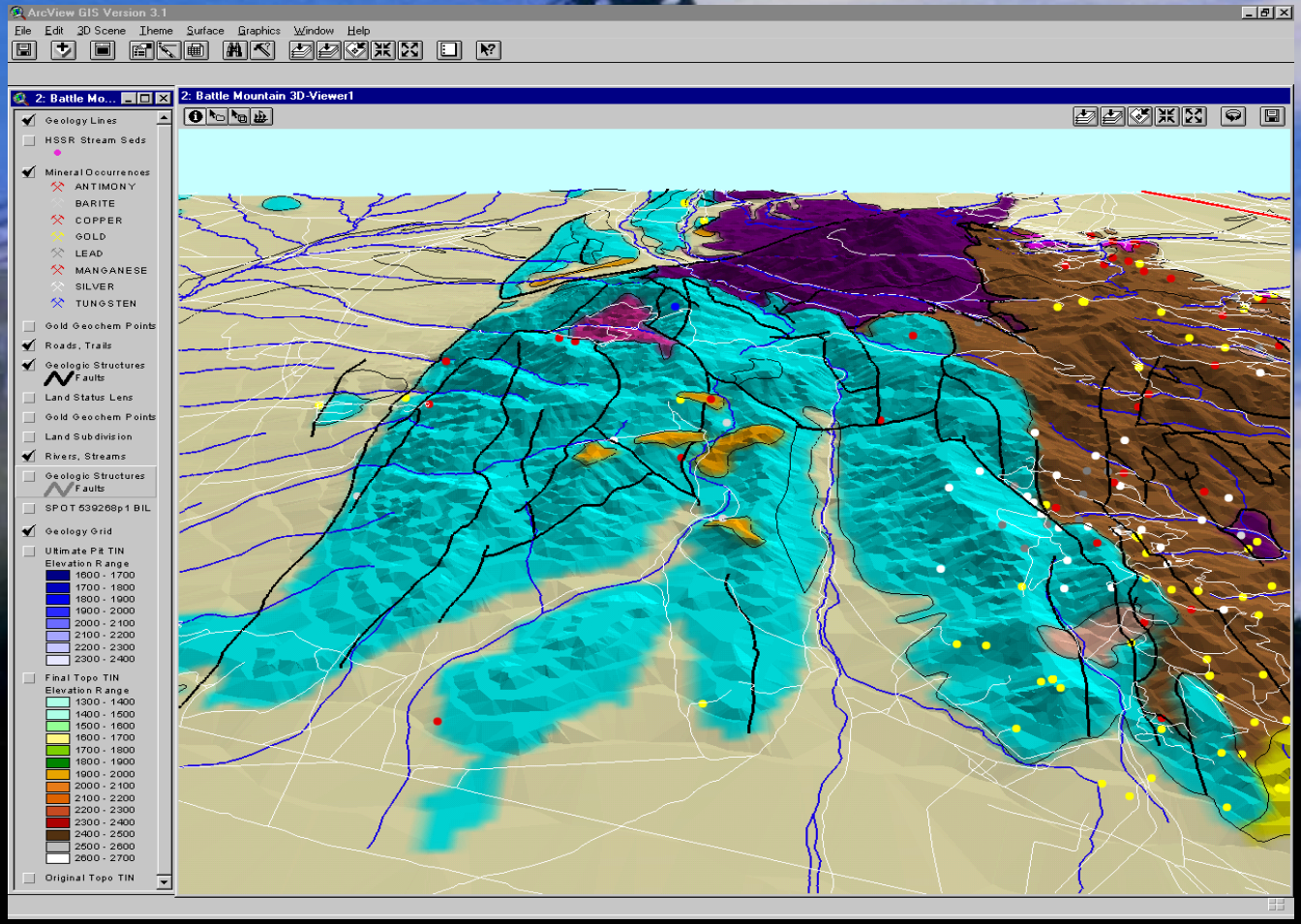
Terrain Modeling



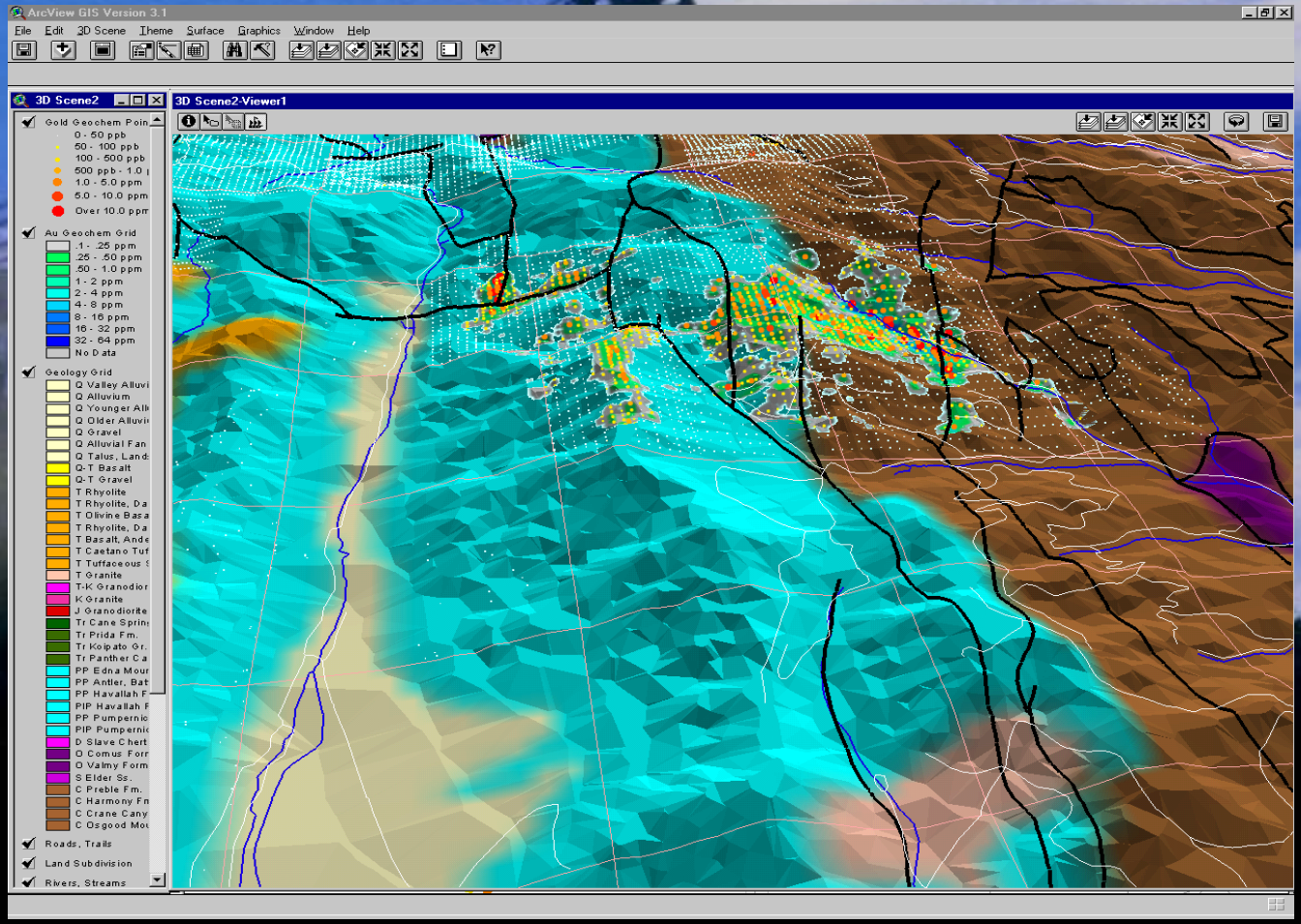
3D Visualization



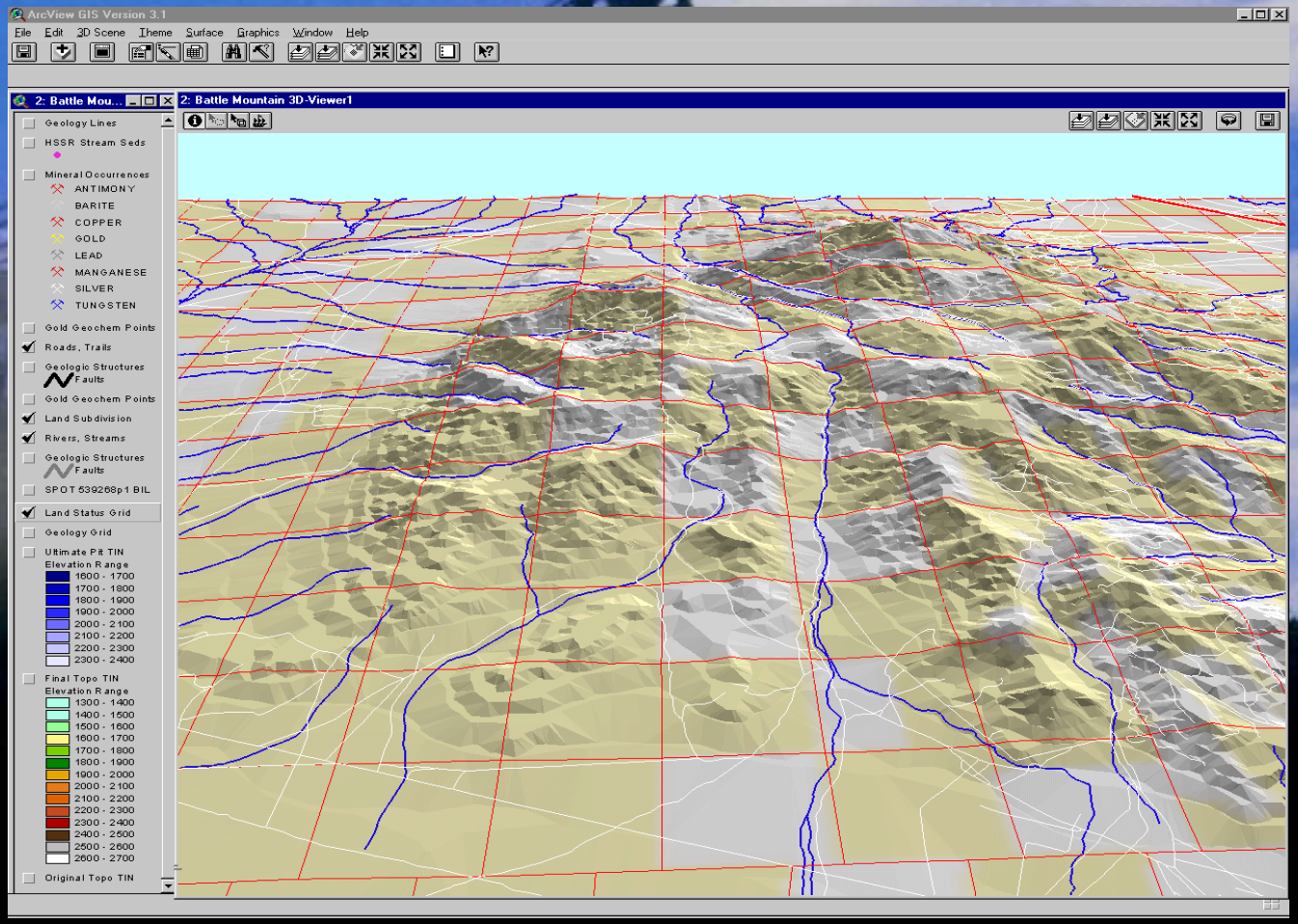
Exploration Geology



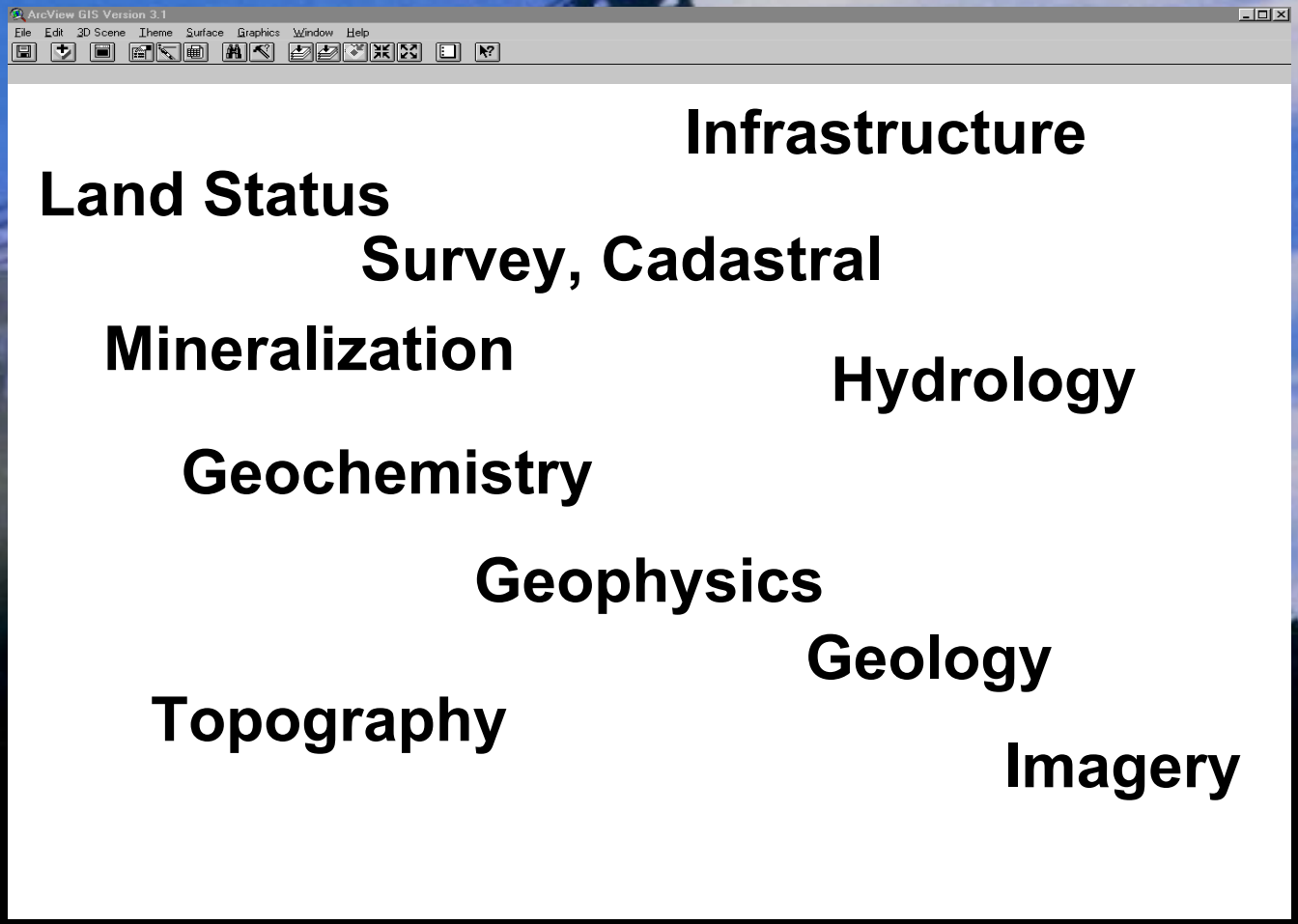
Geochemistry



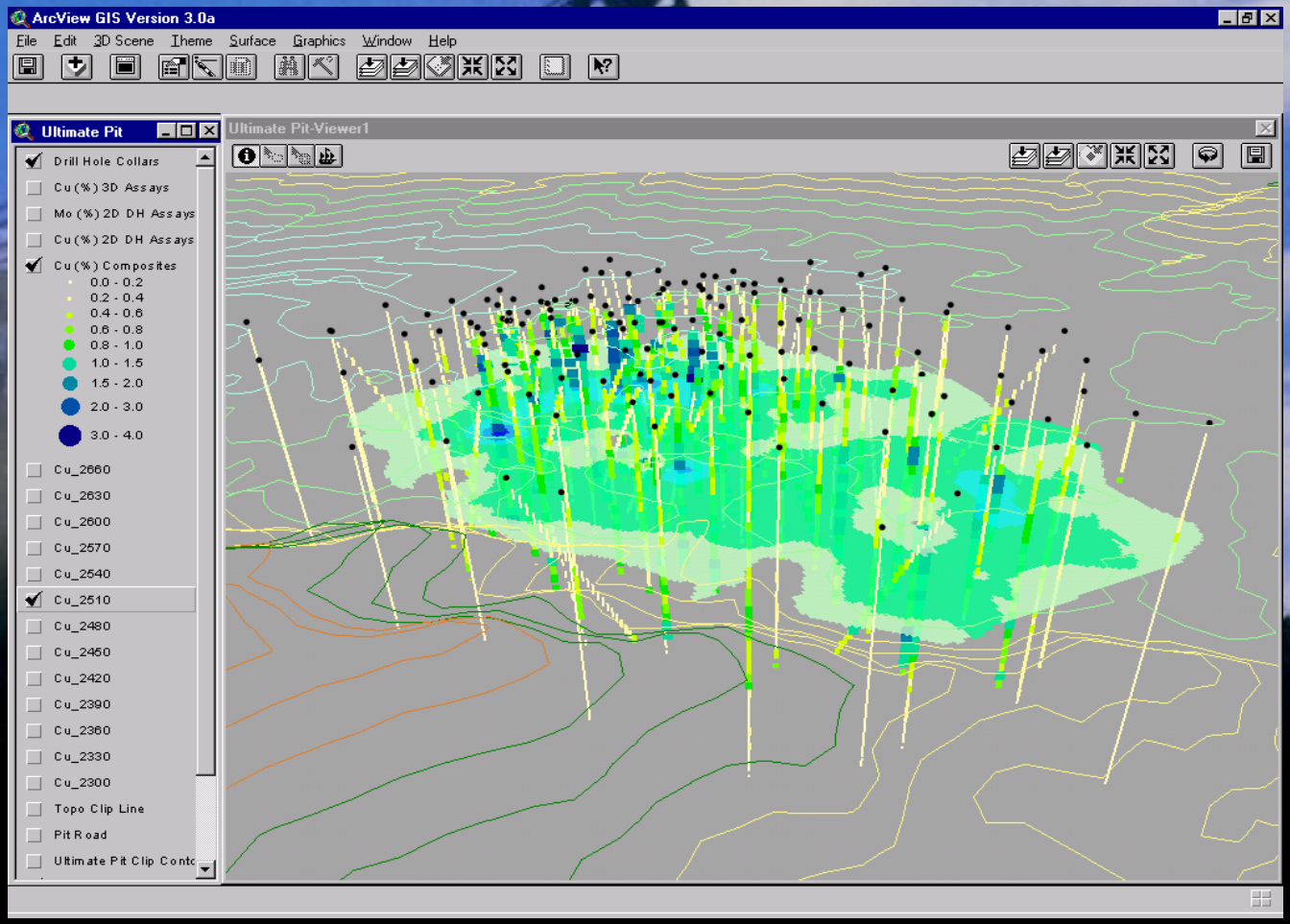
Land Management



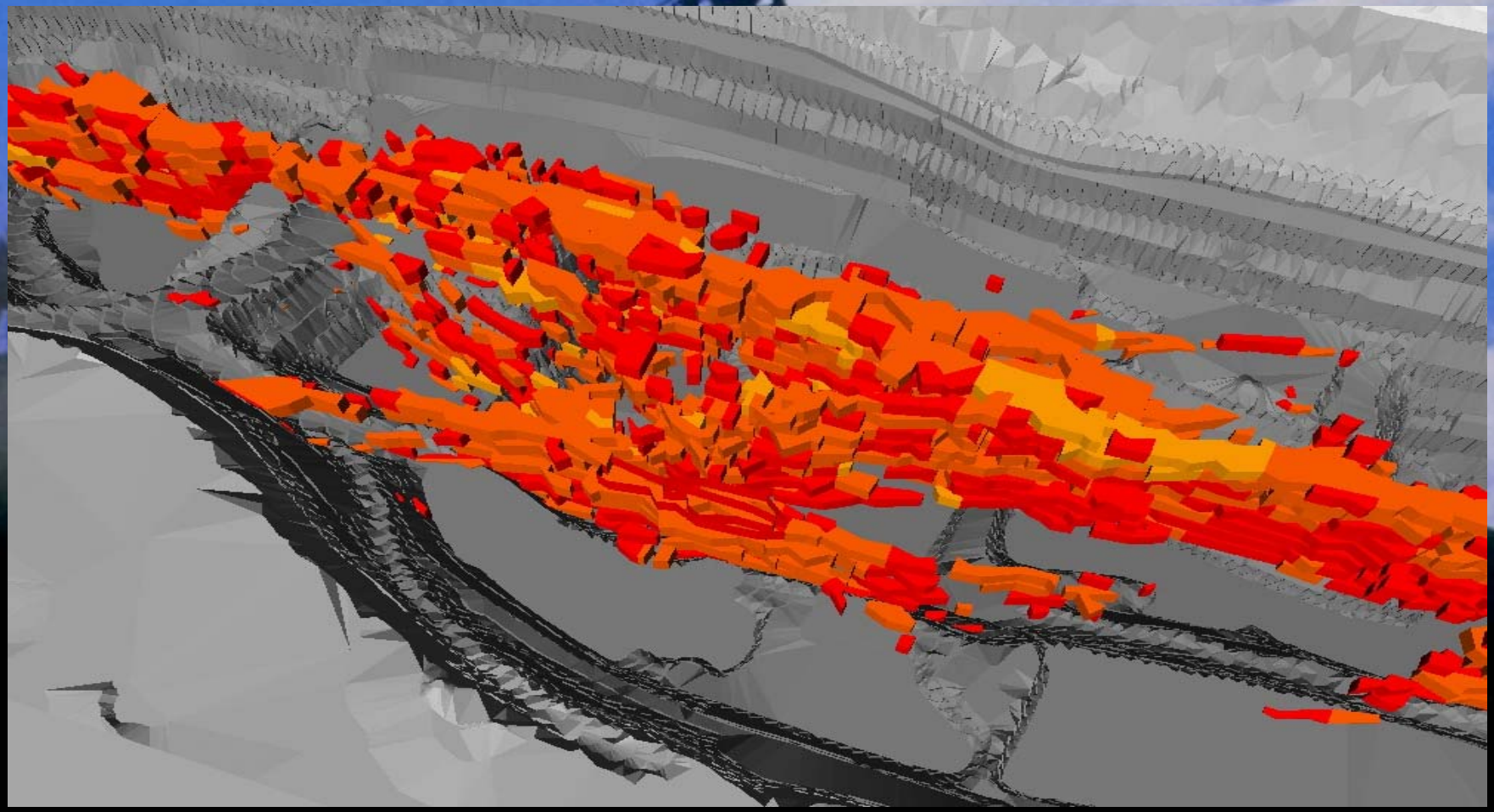
Geologic Data Model



Ore Body Definition

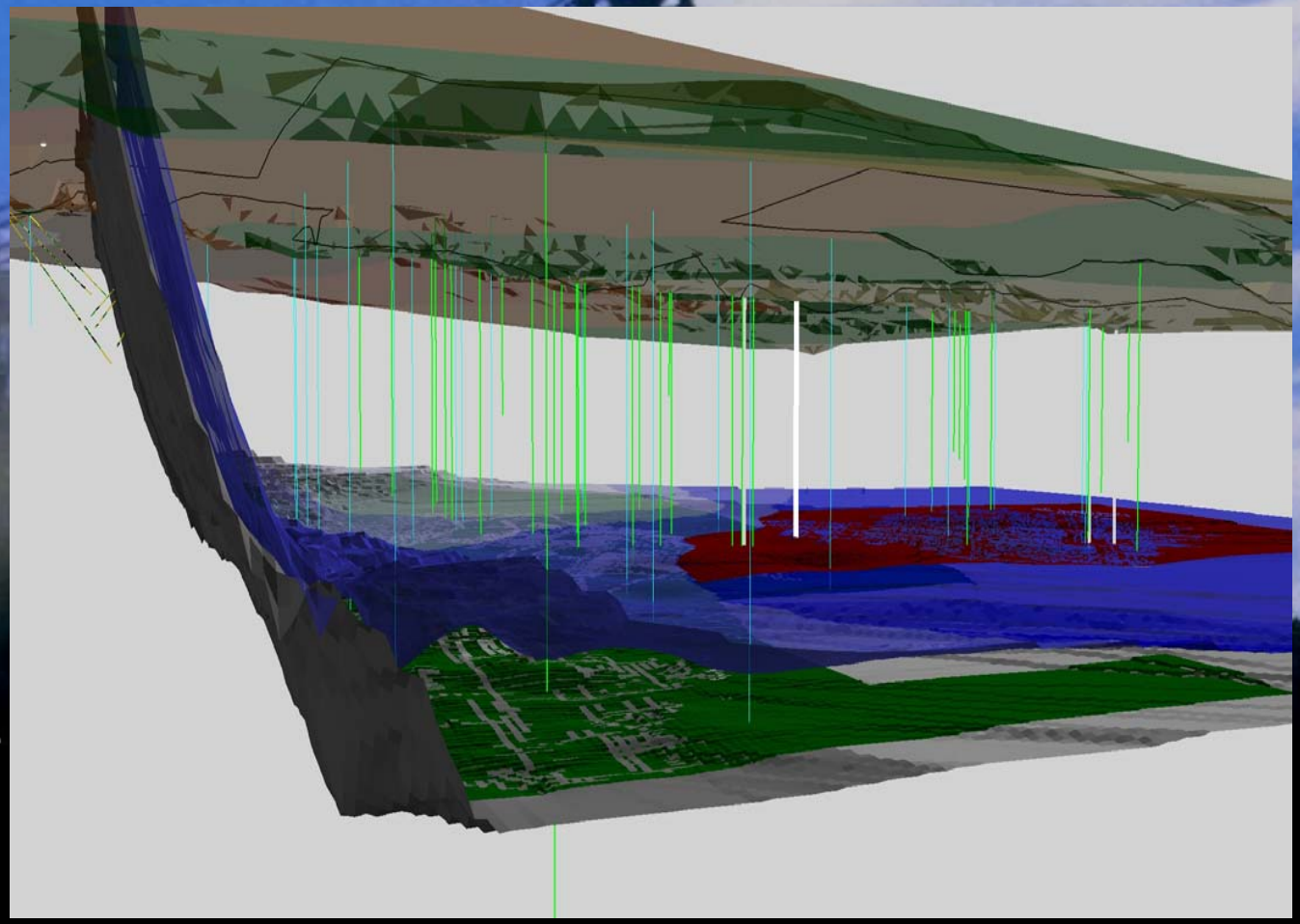


Surface Mine Modeling



Surface Mine Modeling

Subsurface Analysis



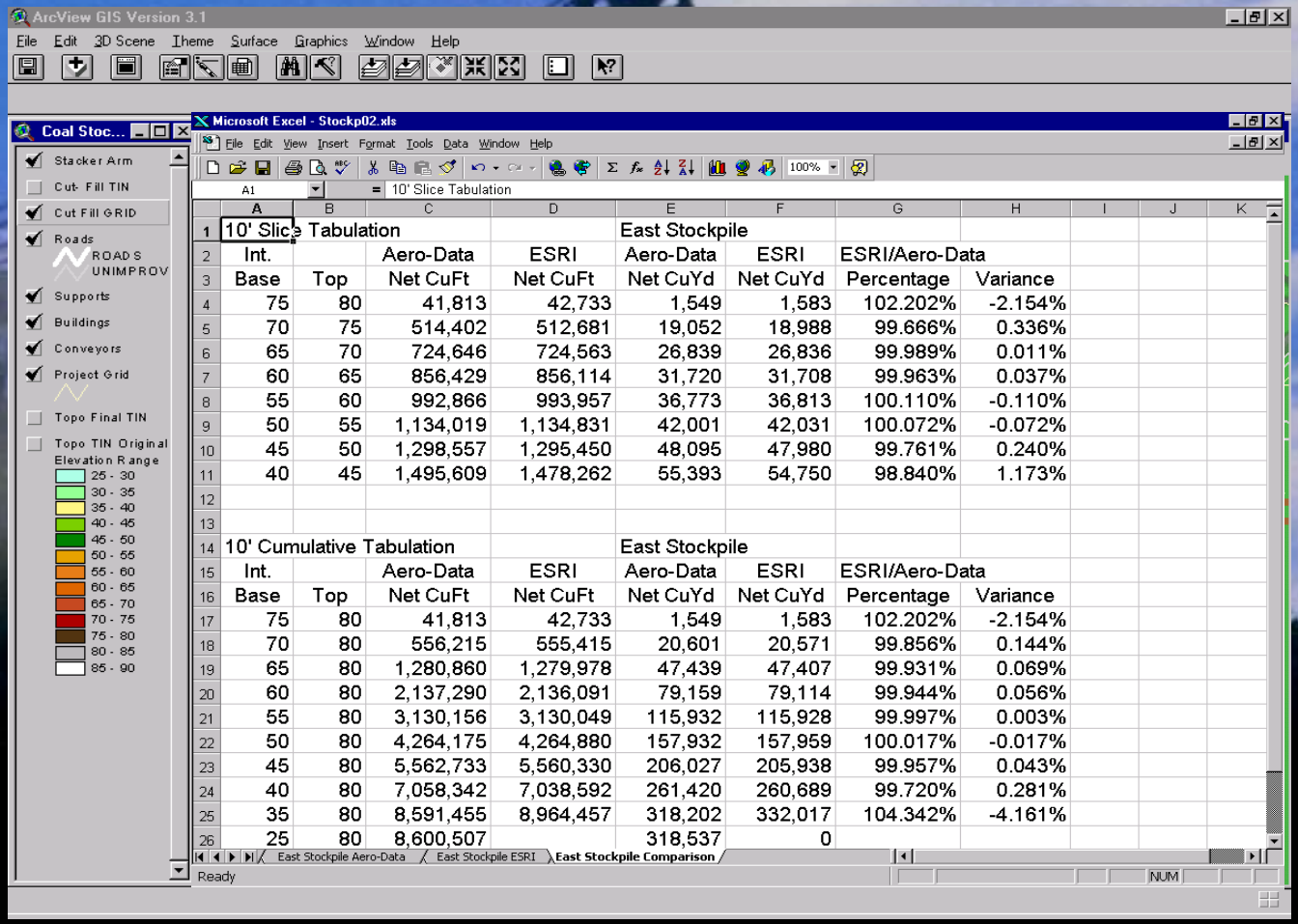
Production Scheduling

DH Quality, TAA >= 44.0%

Hole Cod	Hole Na	Lift	From	To	Base Elev	P2O5	SiO2	Mn	ZnO	TAA	THA	MHA
1.1	1	1	0	20	1637	0.702	1.240	0.200	0.057	45.660	42.293	3.367
1.2	1	2	20	35	1622	0.731	0.859	0.218	0.059	45.176	42.076	3.100
1.3	1	3	35	44	1613	0.683	0.766	0.262	0.059	45.600	42.315	3.285
2.1	2	1	0	20	1627	0.702	1.220	0.344	0.064	43.078	36.741	6.337
2.2	2	2	20	38	1609	0.778	1.430	0.557	0.070	42.592	36.934	5.658
3.1	3	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37.900	3.266
3.2	3	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.253	2.661
4.1	4	1	0	20	1585	1.130	1.670	[illegible]	0.056	42.665	36.126	6.539
4.2	4	2	20	35	1570	1.040	1.220	0.625	0.075	43.151	38.538	4.613
4.3	4	3	35	50	1555	1.110	1.130	0.723	0.122	42.908	36.504	6.404
5.1	5	1	0	15	1573	0.653	1.330	0.121	0.055	44.622	40.045	4.577
6.1	6	1	0	17	1566	0.798	1.140	0.152	0.053	44.830	41.565	3.265
7.1	7	1	0	20	1554	0.957	0.459	0.325	0.060	42.716	39.000	3.716
7.2	7	2	20	30	1544	1.640	0.614	0.355	0.068	44.320	40.117	4.203
8.1	8	1	0	20	1543	0.565	0.782	0.172	0.045	45.619	42.151	3.468
8.2	8	2	20	35	1528	0.680	0.873	0.284	0.055	45.019	43.017	2.002
8.3	8	3	35	55	1508	0.703	0.446	0.178	0.055	45.747	42.537	3.210
9.1	9	1	0	20	1564	0.631	0.894	0.227	0.053	45.320	42.780	2.540
10.1	10	1	0	20	1547	0.838	0.661	0.380	0.033	45.335	42.595	2.740
10.2	10	2	20	35	1532	0.835	0.482	0.464	0.050	44.121	42.402	1.719
10.3	10	3	35	50	1517	0.842	2.670	0.563	0.029	44.850	42.595	2.355
10.4	10	4	50	59	1508	0.808	0.454	0.300	0.039	44.364	41.981	2.383
11.1	11	1	0	20	1538	0.721	0.340	0.125	0.036	45.578	42.981	2.597
11.2	11	2	20	27	1531	0.675	0.228	0.427	0.060	46.727	44.334	2.393
12.1	12	1	0	20	1530	0.570	0.581	0.165	0.041	48.055	44.240	3.815
12.2	12	2	20	30	1520	0.555	0.857	0.148	0.044	47.084	43.274	3.810
13.1	13	1	0	20	1521	0.353	0.439	0.258	0.020	44.291	42.023	2.268
13.2	13	2	20	35	1506	0.696	0.458	0.159	0.036	44.341	41.363	2.978
13.3	13	3	35	42	1499	0.686	0.381	0.114	0.034	48.417	45.821	2.596
14.1	14	1	0	20	1513	0.646	0.328	0.121	0.034	45.505	42.151	3.354

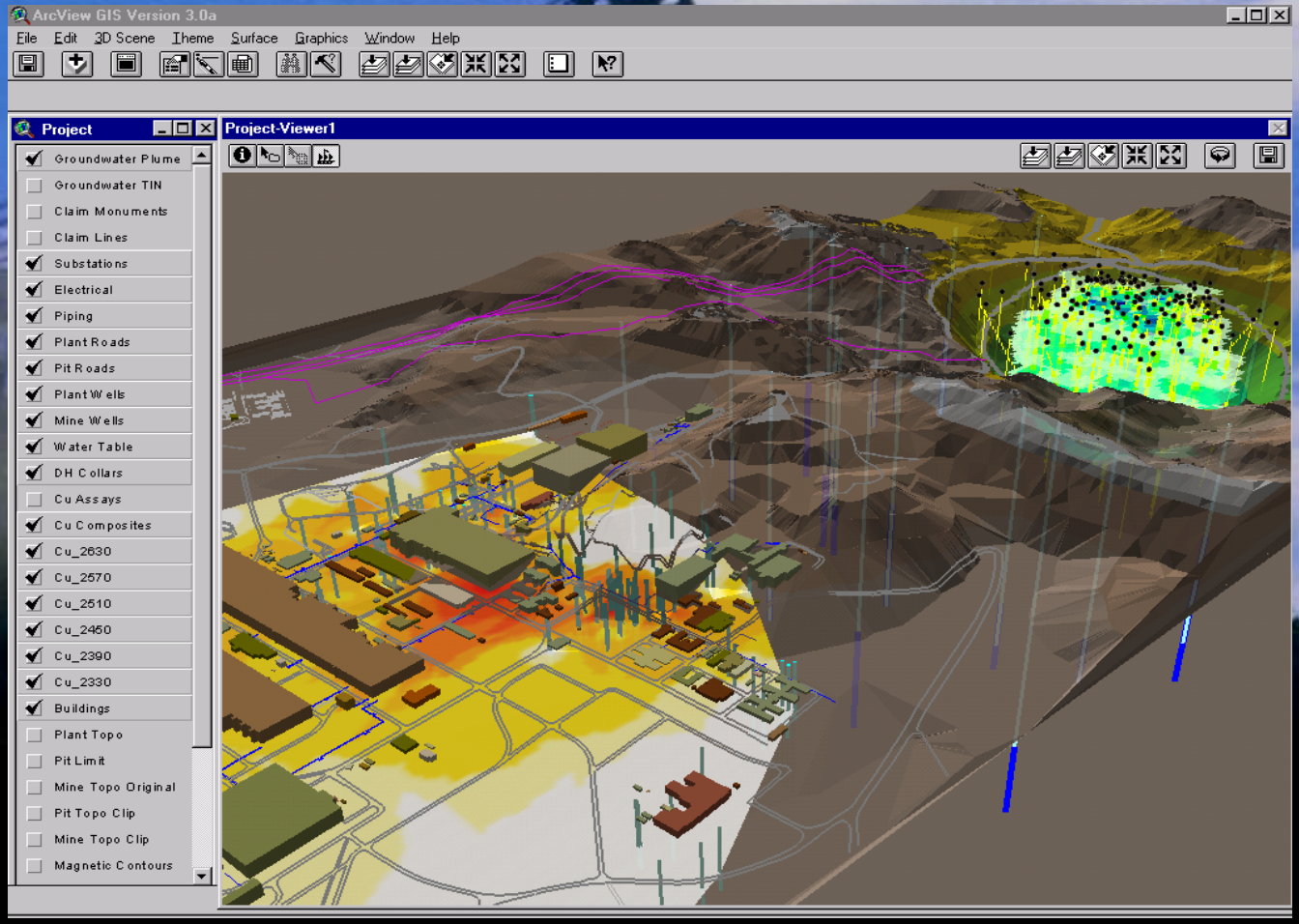
Grade/Tonnage Data

Stockpiles, Volumes

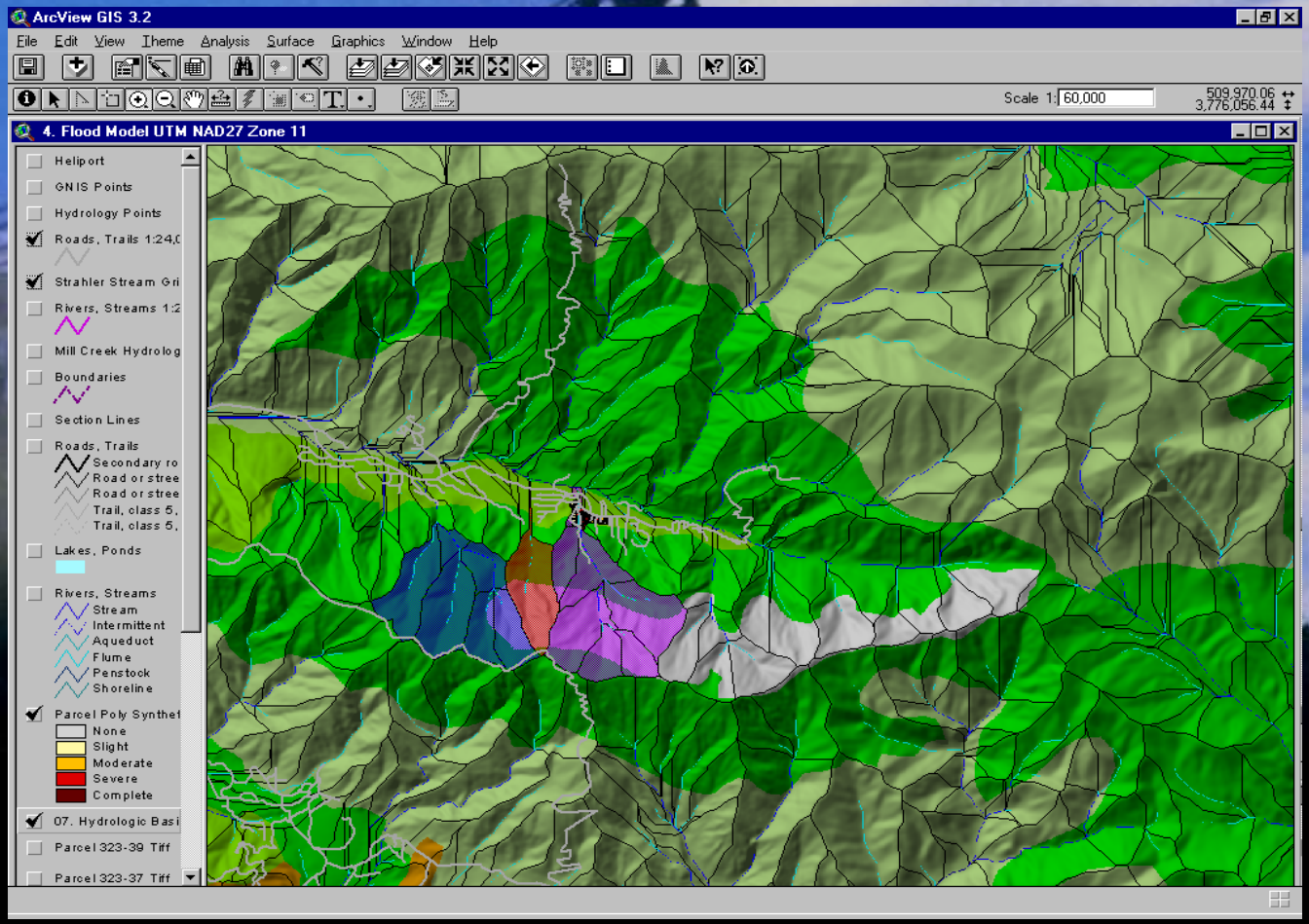


	A	B	C	D	E	F	G	H
1	10' Slice Tabulation				East Stockpile			
2	Int.		Aero-Data	ESRI	Aero-Data	ESRI	ESRI/Aero-Data	
3	Base	Top	Net CuFt	Net CuFt	Net CuYd	Net CuYd	Percentage	Variance
4	75	80	41,813	42,733	1,549	1,583	102.202%	-2.154%
5	70	75	514,402	512,681	19,052	18,988	99.666%	0.336%
6	65	70	724,646	724,563	26,839	26,836	99.989%	0.011%
7	60	65	856,429	856,114	31,720	31,708	99.963%	0.037%
8	55	60	992,866	993,957	36,773	36,813	100.110%	-0.110%
9	50	55	1,134,019	1,134,831	42,001	42,031	100.072%	-0.072%
10	45	50	1,298,557	1,295,450	48,095	47,980	99.761%	0.240%
11	40	45	1,495,609	1,478,262	55,393	54,750	98.840%	1.173%
12								
13								
14	10' Cumulative Tabulation				East Stockpile			
15	Int.		Aero-Data	ESRI	Aero-Data	ESRI	ESRI/Aero-Data	
16	Base	Top	Net CuFt	Net CuFt	Net CuYd	Net CuYd	Percentage	Variance
17	75	80	41,813	42,733	1,549	1,583	102.202%	-2.154%
18	70	80	556,215	555,415	20,601	20,571	99.856%	0.144%
19	65	80	1,280,860	1,279,978	47,439	47,407	99.931%	0.069%
20	60	80	2,137,290	2,136,091	79,159	79,114	99.944%	0.056%
21	55	80	3,130,156	3,130,049	115,932	115,928	99.997%	0.003%
22	50	80	4,264,175	4,264,880	157,932	157,959	100.017%	-0.017%
23	45	80	5,562,733	5,560,330	206,027	205,938	99.957%	0.043%
24	40	80	7,058,342	7,038,592	261,420	260,689	99.720%	0.281%
25	35	80	8,591,455	8,964,457	318,202	332,017	104.342%	-4.161%
26	25	80	8,600,507		318,537	0		

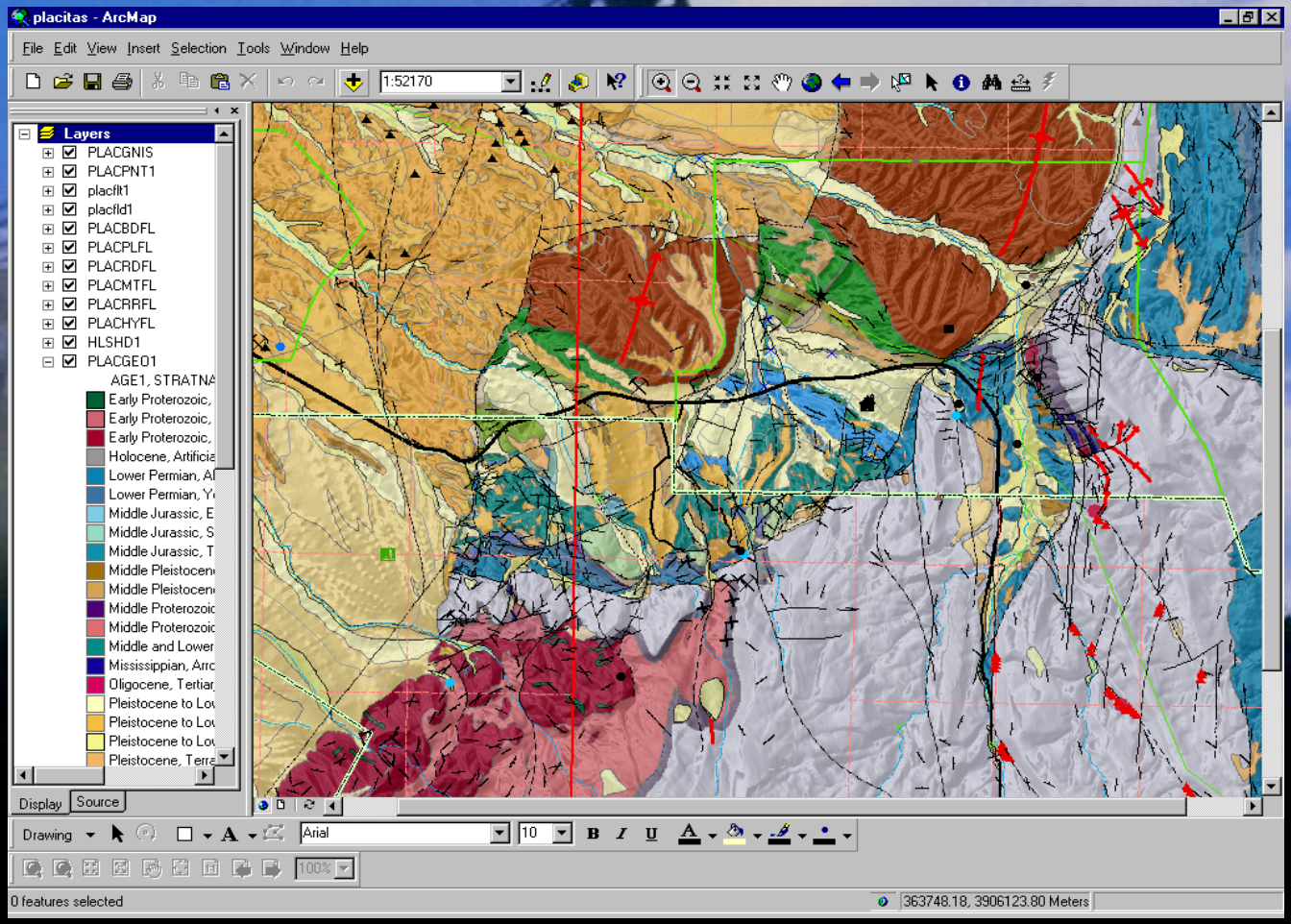
Enterprise Solutions



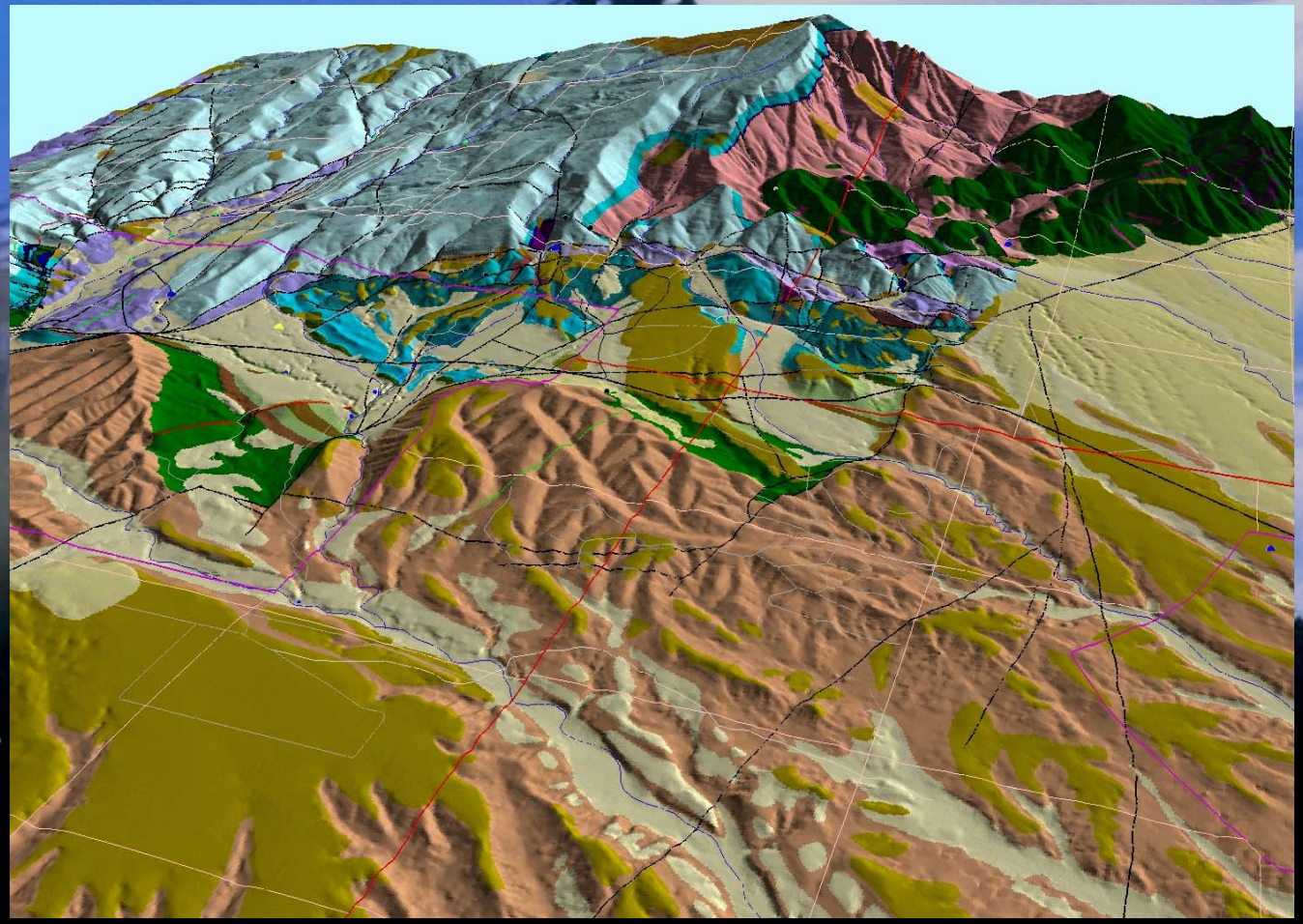
Hydrologic Modeling



Map Production



Next Generation



SMRC Bond Release
The Initial Steps at San Juan Mine

Orlando Estrada
Environmental Specialist
San Juan Coal Company
and
David Clark
Reclamation Specialist
State of New Mexico Mining and Minerals Division

Presented at OSM Bond Release Forum
August 2001

3. 2. 2001

File reference - OSM Forum
Date – 06/06/01

Division – BHP Coal N.M.
Operations, Environmental

SAN JUAN COAL COMPANY
"World leaders in SAFETY"

BHP Coal
New Mexico

BHP

Introduction

- Final Bond Release Application of NW Pinon at SJCC's San Juan Mine
  - 152 Acres of reclaimed land
  - 85 Acres of undisturbed land
  - Reclaimed 1986-88
  - Release Application submitted Dec 21, 2000

5. 25. 2001

NW Pinon Phase III Bond Release Area Application

- Revegetation Success Criteria
- Livestock Grazing Plan
- Study Design
- Sample Methods

Revegetation Success Criteria

Table 1. MMD-approved revegetation success standards (SJM 1997).

Vegetative Parameter	Revegetation Success Standard
Cover[a]	Yearly normalized mean[b]
Production[a]	Yearly normalized mean[b]
Woody Species	190 per acre
Diversity	Two grasses[c] and two woody species[d]

[a] Cover and production values reflect only the current year's growth of perennial plant species.

[b] Cover and production yearly normalized means are obtained by sampling five vegetation types within one reference area and weighting mean cover and production values by the proportion of each type within the lease area. These weighted values are the revegetation success standards for 1998 and 1999.

[c] Two *perennial* grass species with relative *perennial* herbaceous cover values 5%, with no species comprising more than 70% relative *perennial* herbaceous cover. (Note: Words in italics have been added to clarify the standard per discussions with MMD, 1997.)

[d] Two woody species with density values 10% of total woody species density, with no one species making up more than 85% of the total woody species density.

Livestock Grazing Plan

- **Consecutive winter grazing seasons**
  - One dormant season grazing (December)
  - One early growing season grazing (April)
- **Stocking rate of .12 AUM/acre**
  - Recommended rate of .05 AUM/acre
  - BLM optimum rate of .12 AUM/acre
- **Body Condition before and after each grazing period**

12. 7. 1999

Study Design

- Grazed vegetation on reclaimed and reference area sampled
- 1998 Data Collected
  - **Vegetation cover, species diversity, production, shrub density, shrub production.**
- 1999 Data Collected
  - **Vegetation cover and production only**

Sample Methods

- Vegetation & Total Ground Cover
- Species Diversity
- Production
- Shrub Density
- Stocking Rates
- Data Analysis

Vegetation and Total Ground Cover

- Randomly located 50-m point intercept transects
  - **Random-Selecting X & Y coordinates from a map grid overlay; then determined in field**
- Direction of transect randomly determined
- Cover data collected at .5m intervals along 50m transect (100 points)
- Each transect treated as one sample

Species Diversity

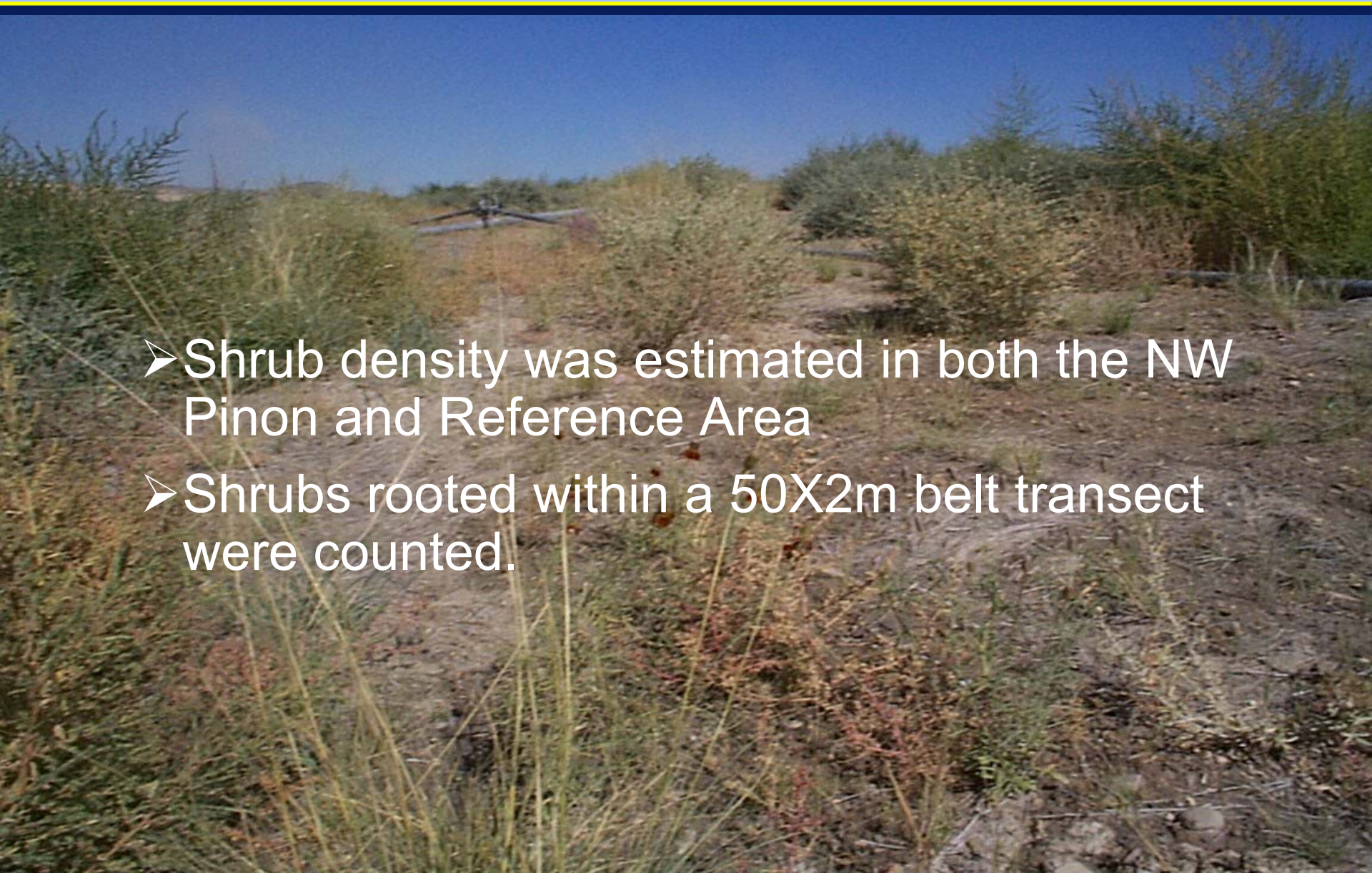
Species Diversity was evaluated by:

- Computing grass species contributing between 5% and 70% herbaceous cover
- Computing subshrub/shrub species density contributing between 10% & 85% woody species density

Production

- 1998-99 Vegetation production was estimated from clipped plots
  - **Current years growth, within vertical projection of random located 1X1m quadrates, were clipped**
  - **Only perennial & biennial species were used**
  - **Clippings segregated by species, dried to constant weight & weighted to nearest .1gram**

Shrub Density



- Shrub density was estimated in both the NW Pinon and Reference Area
- Shrubs rooted within a 50X2m belt transect were counted.

Stocking Rates

- Stocking rate for the NW Pinon and Reference area was .12 AUM/acre

Revegetation Success Summary
Table 6

Table 6. Summary of data showing revegetation success, NW Piñon reclaim area.

	Area			
	NW Piñon Reclaim		Reference Area	
Revegetation Success Parameters	1998	1999	1998	1999
Cover by perennial species	22.93%	41.13%	15.62%	27.11%
Production by perennial species	53.7 g/m[b]	43.6 g/m[b]	21.7 g/m[b]	29.7 g/m[b]
Woody species[a] stems per acre[b,c]	640.4	--	--	--
Perennial grass diversity[b,c]	*Hilaria jamesii* @ 36.2% of relative herbaceous perennial cover *Sporobolus airoides* @ 60.2% of relative herbaceous perennial cover	--	--	--
Woody species[a] diversity[b,c]	*Atriplex canescens* @ 33.5% of woody species relative density *Ceratoides lanata* @ 37.6% of woody species relative density *Gutierrezia sarothrae* @ 12.9% of woody species relative density	--	--	--

[a] Includes subshrubs, shrubs, and trees (i.e., *Tamarisk chinensis*). Excluding *Gutierrezia sarothrae*, there would be an average of 549.4 woody stems per acre.

[b] These three parameters were evaluated using technical standards, so a reference area comparison is not required.

[c] Demonstration of the woody species stems per acre and diversity standards were not required in 1999.

Livestock Summary

- 1998

  Pre-grazing: 54% BCS#6, 39% BCS#7, 7% BCS#8

  Post-grazing: 7% BCS#5, 50% BCS#6, 43% BCS#7

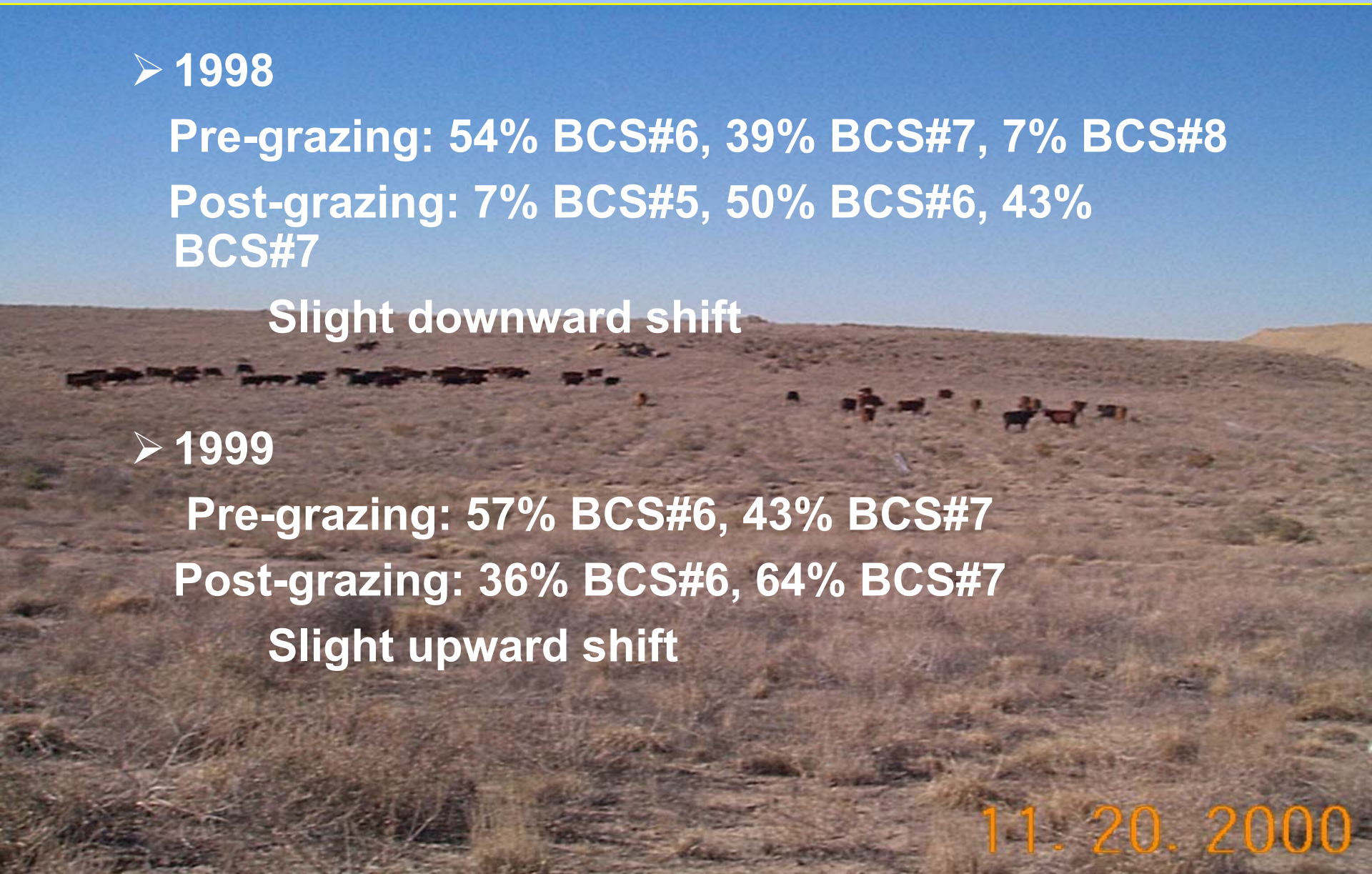
  Slight downward shift

- 1999

  Pre-grazing: 57% BCS#6, 43% BCS#7

  Post-grazing: 36% BCS#6, 64% BCS#7

  Slight upward shift



Final Conclusions

- SJM's NW Pinon reclaim met or exceeded all revegetation success standards
- All Cattle were in BCS #5s, #6s, and/or #7s
- Demonstrates that NW Pinon reclaim area attained revegetation success while supporting the primary postmining land use of livestock grazing.

5. 25. 2001

Final Phase III Bond Release Approval

- New Mexico Mining and Minerals Division approved SJCC's Final Bond Release Application on May 24, 2001.
- On June 04, 2001, OSM concurred with MMD's approval of SJCC's Final Bond Release .

THE END

Sage Grouse Management and Population Trends in Northeast Wyoming

Olin O. Oedekoven
District Wildlife Biologist
Wyoming Game and Fish Department

Presented at OSM Bond Release Forum
August 2001

Sage Grouse Species

Gunnison and Northern Sage Grouse

Sage Grouse Biology

Sage Grouse Biology

- Annual Survival Rates for Yearling and Adult Females – 35 - 85%
- Annual Survival Rates for Yearling and Adult Males – 46 – 54 %

Much higher annual survival rates compared to other upland bird species.

Sage Grouse Biology

- Nest initiation rates: 55 – 85%
- Nest success rates: 12 – 86%
- Re-nesting rates: <20%
- Proportion of females successfully hatching a brood: 15 – 70%

Lower annual production and lower recruitment rates that most other upland bird species. High variability in production attributed to habitat quality.

Sage Grouse Management and Data Collection in Wyoming

Sage Grouse Management

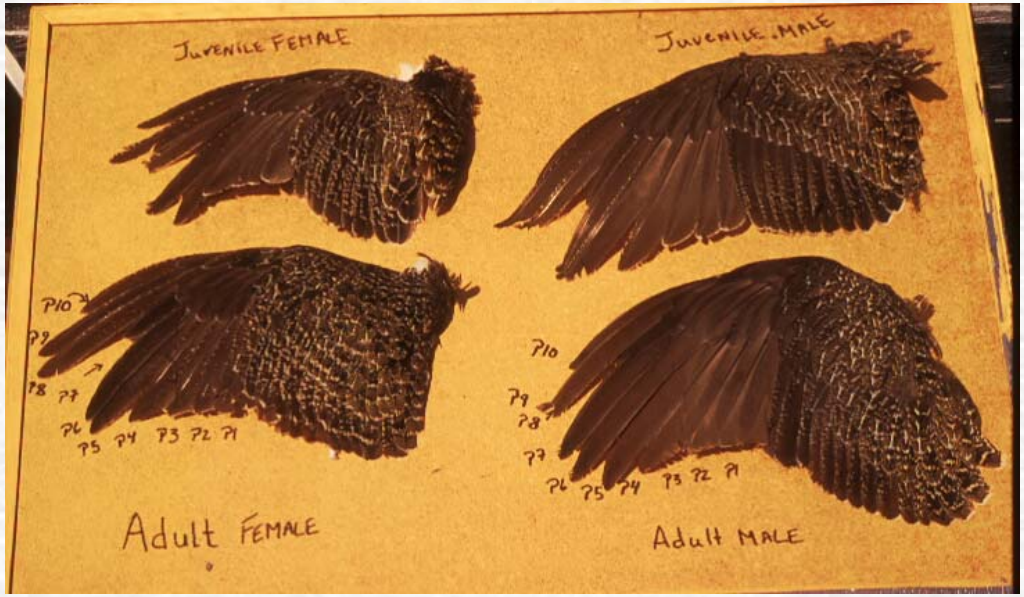
- Lek Surveys and Counts
  - Surveys – 1 Visit/lek every 1-3 years
  - Counts – 3 Visits/lek every year
  - Basis for Population Trend Analysis

Sage Grouse Management

- Brood Surveys
  - Trends in Recruitment Rates
  - Conducted in August

Sage Grouse Management

- Wing Collections for Aging and to Determine Reproductive Rates
  - Age Structure of Population
  - Recruitment Rates



Sage Grouse Management

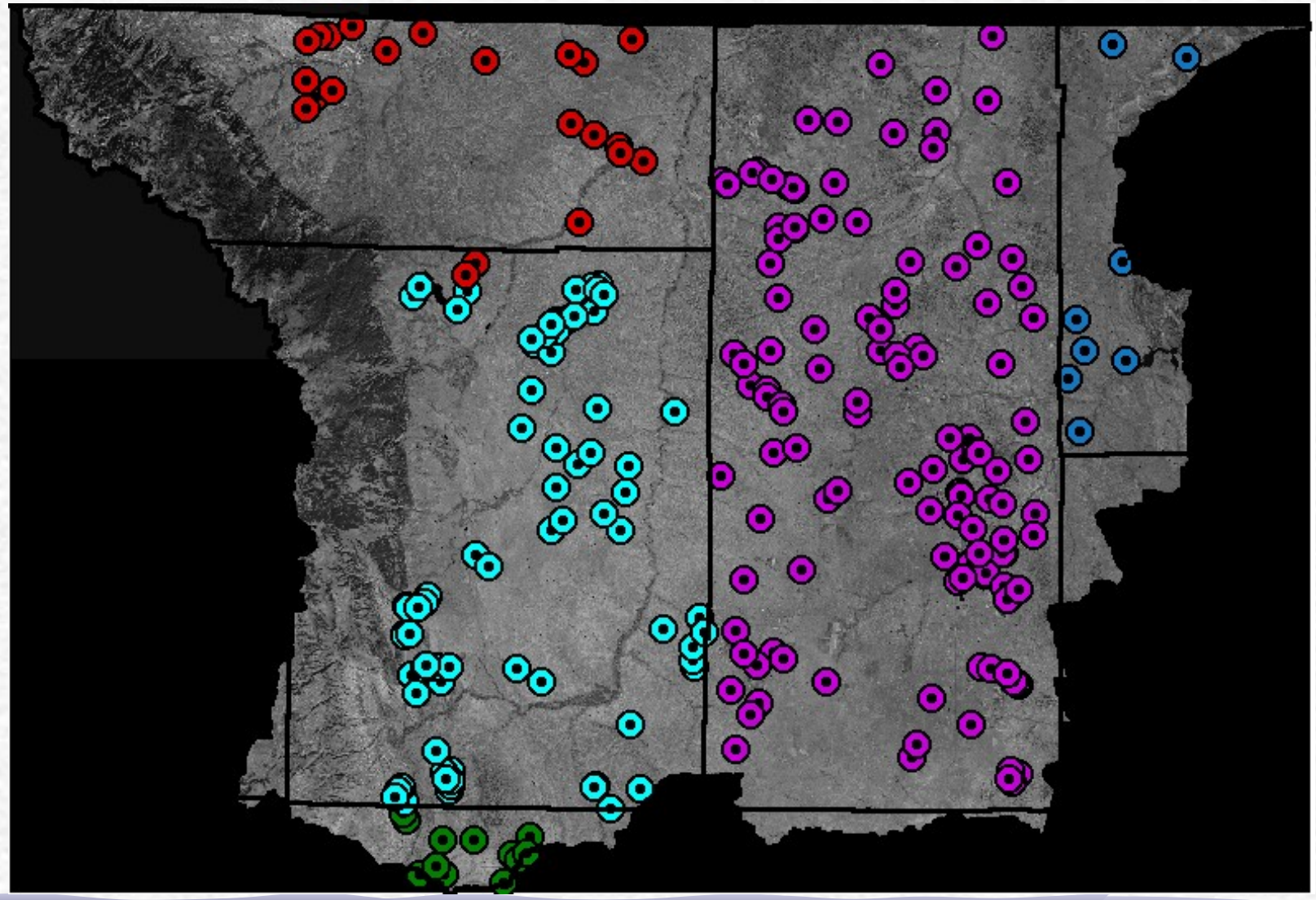
- Harvest Surveys
  - Hunter Contacts
  - Department Questionnaires

Sage Grouse Management

- Environmental Commenting/Habitat Protection
  - Review NEPA Documents
  - Habitat Recommendations to Operators

Sheridan Region Sage Grouse Leks

Sheridan Region Sage Grouse Leks



Sheridan Region Sage Grouse Leks

- Sheridan County: 23 Leks
- Johnson County: 87 Leks
- Natrona County (portion): 13 Leks
- Campbell County: 136 Leks
- Crook County (portion): 8 Leks
- Montana Border: 2 Leks
- Total Known Leks: 269

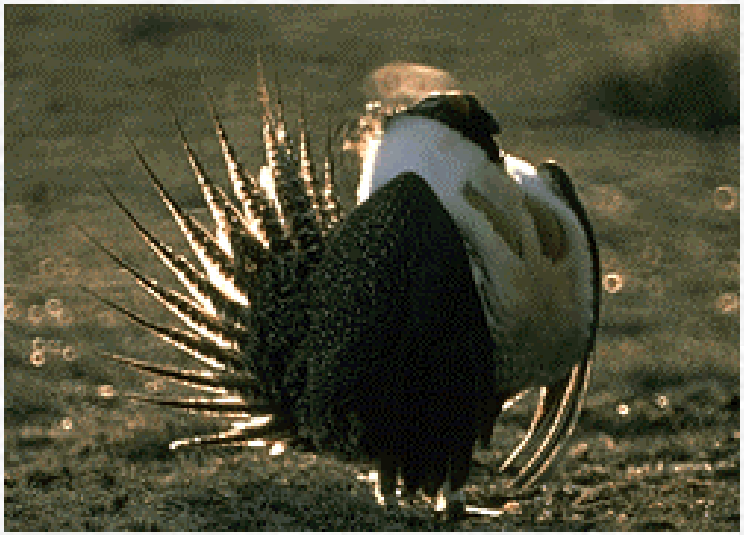
As Of: 2001 Survey

Sheridan Region Sage Grouse Leks

- Current or Suspected Active: 230 Leks
- Historical Leks: 39 Leks
  - Roads
  - Mining
  - Crop Development
  - Subdivisions

As Of: 2001 Survey

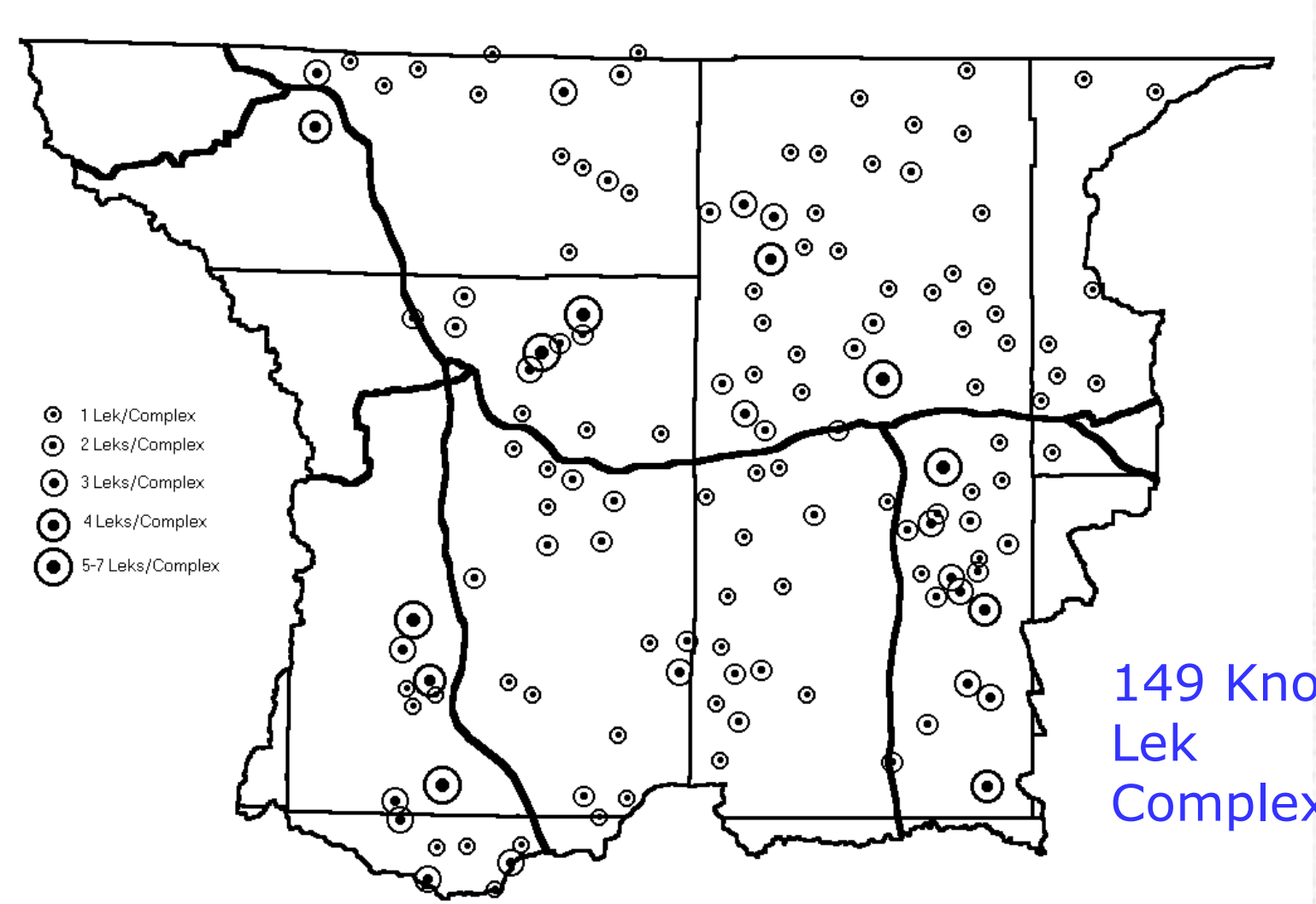
Sheridan Region Sage Grouse Leks



- Private Land: 203 Leks
- BLM Land: 33 Leks
- USFS Land: 8 Leks
- State Land: 25 Leks

As Of: 2001 Survey

Sheridan Region Lek Complexes

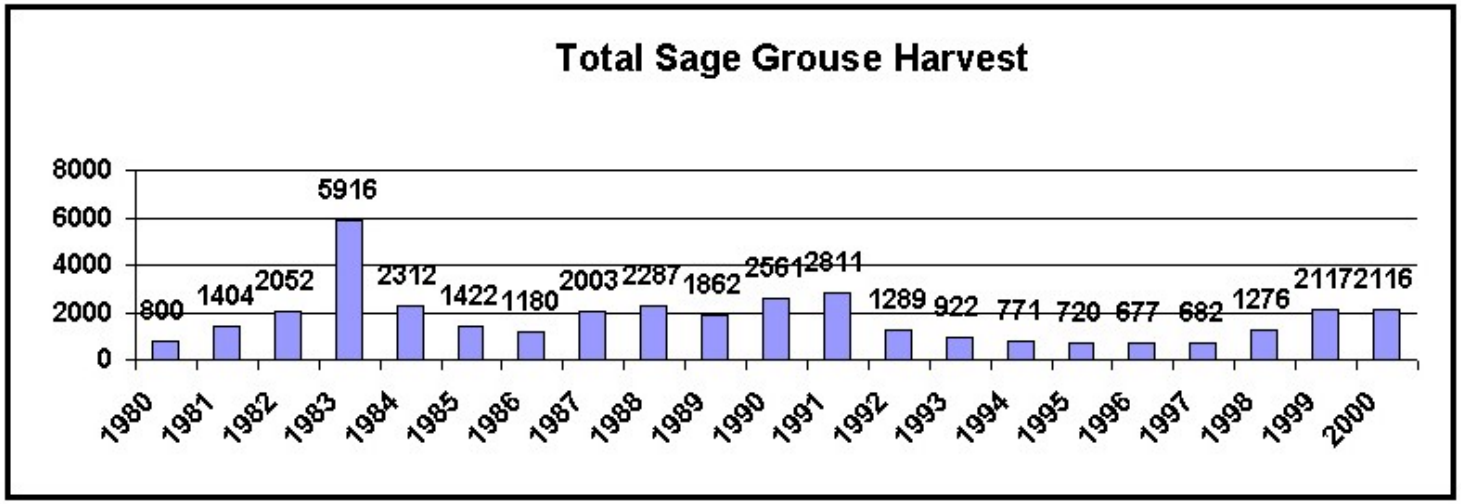


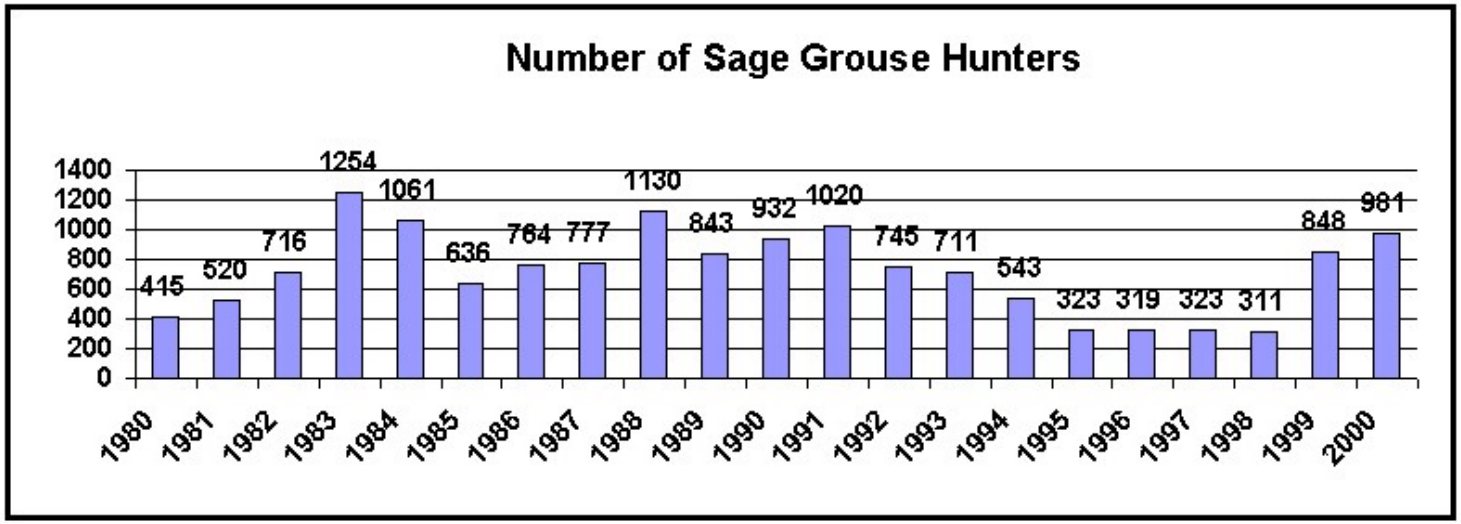
149 Known Lek Complexes

Grouse Lek Complexes form the basis for population analysis.

Sheridan Region Sage Grouse Population Trends

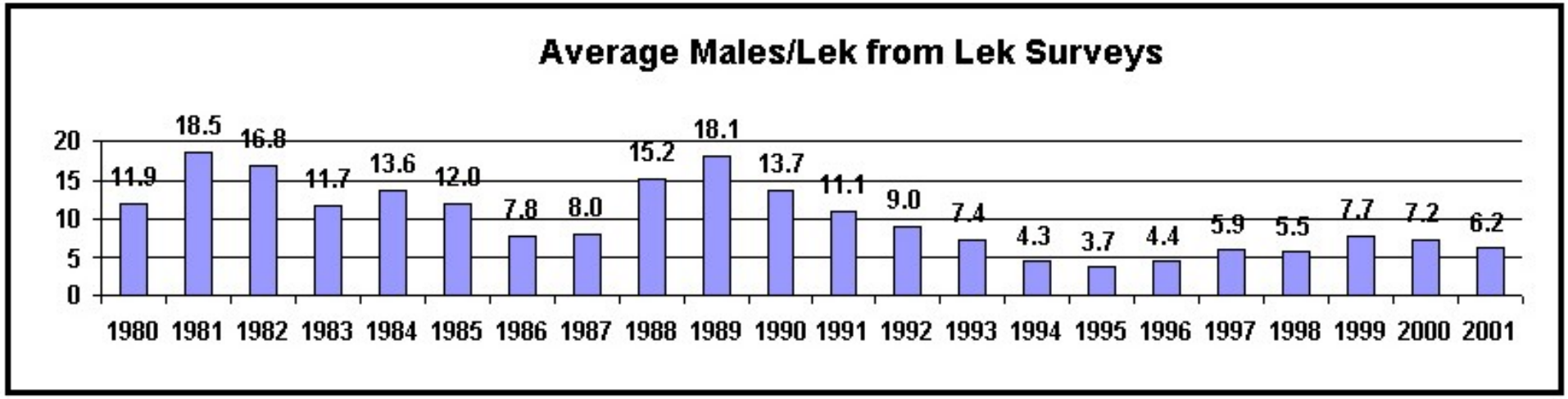
Sheridan Region Sage Grouse Harvest





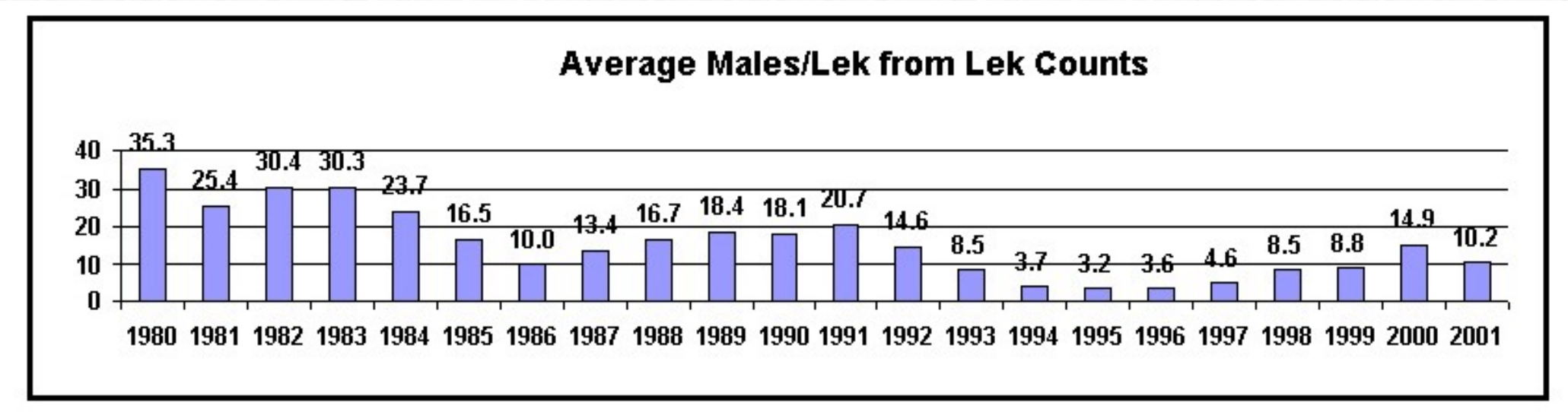
Grouse hunting is largely dependent upon the relative abundance of the birds.

Sage Grouse Lek Survey Results



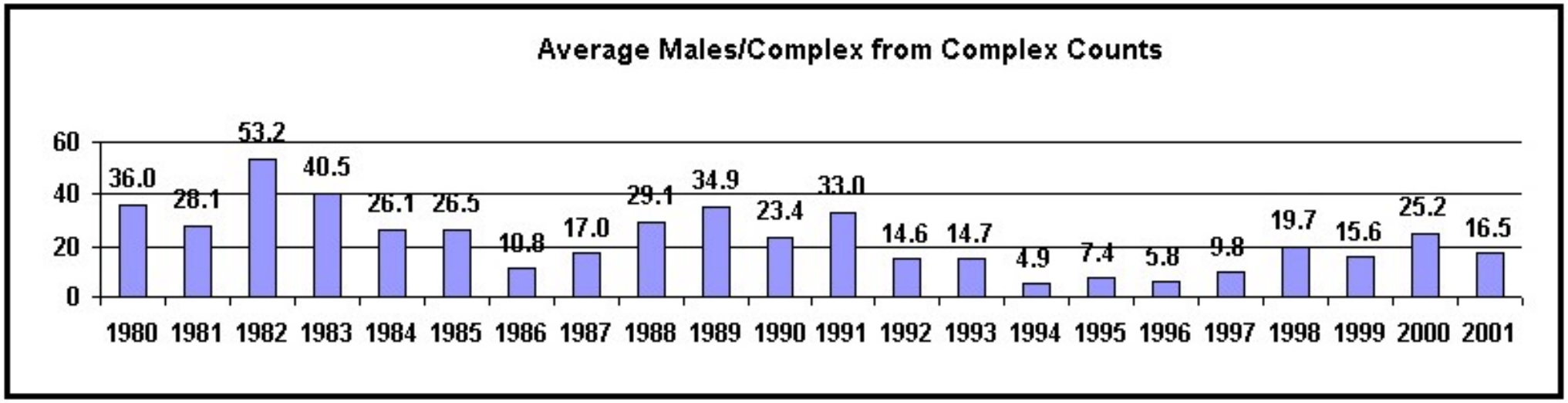
Relative downward trend in male grouse attendance at the leks as shown in the lek survey results.

Sage Grouse Lek Count Results



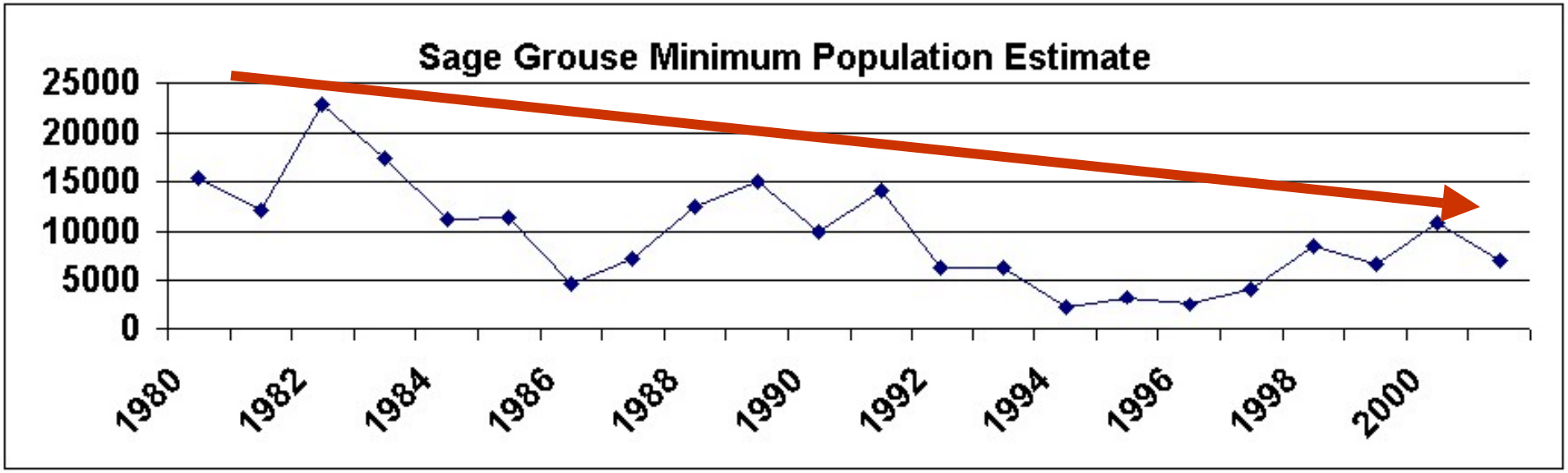
Lek counts provide a more reliable trend for population analysis. Results tend to match other indicators including harvest and survey results.

Sage Grouse Lek Complex Results



Lek Complex counts provide the best indicator for sage grouse population trends. Results for the Sheridan Region also match trends observed Statewide.

Sheridan Region Sage Grouse Population Estimates



Population estimates based on lek complex counts. Average complex population estimate based on a sex ratio of 2 females for every male. Total population estimate multiplies Average Complex Population Estimate by the total number of lek complexes in the last year of the report, typically the maximum number of possible lek complexes for the analysis area.

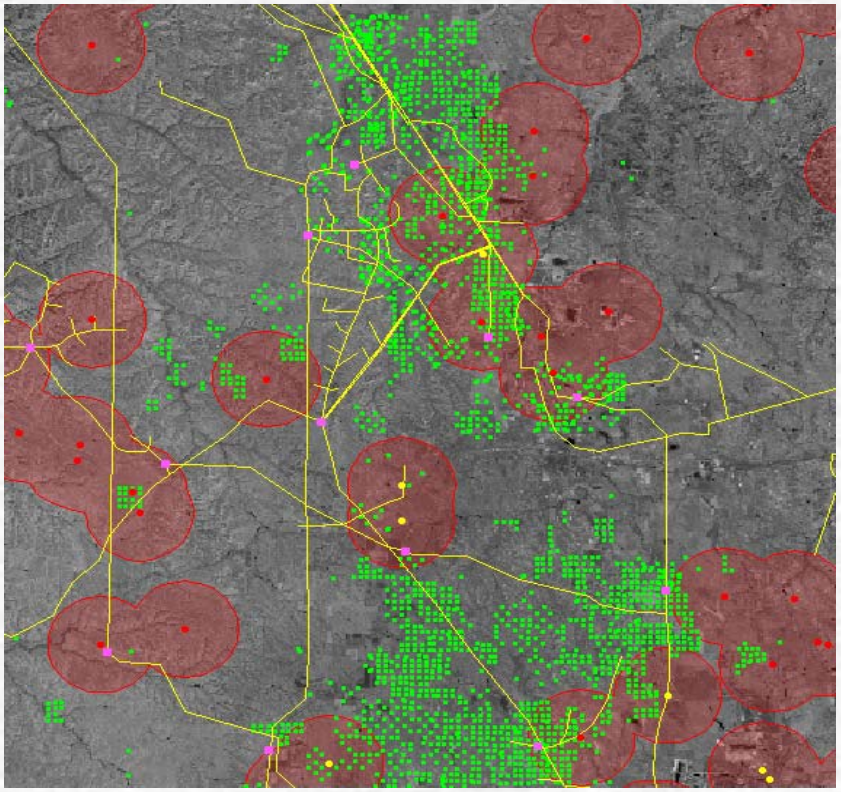
Although numbers are relative and only reflect the minimum population size, analysis provides a valuable trend of the sage grouse population. Trends match hunters and harvest.

Sage Grouse Population Declines

- Predation – small mammals, birds, foxes, badgers, coyotes, eagles
- Weather – drought, severe winters, spring storms
- Hunting – season timing
- Habitat loss – fragmentation, encroachment, loss of sagebrush habitats

Not any particular one, but a combination of factors has contributed to the decline in sage grouse numbers.

Cumulative Effects



Effects of coal-bed methane wells (green dots) and associated pipelines (yellow lines) on sage grouse and their habitats (leks and 2 mile radius of the lek).

Direct Habitat Loss and Fragmentation

Sage Grouse Habitat Requirements

Connelly, J. W., Michael Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin, 28(4):967-985

Lyon, Alison G. The Potential Effects of Natural gas Development on Sage Grouse Near Pinedale, Wyoming. M.S. Dept. of Zoology and Physiology, May 2000

Sage Grouse Habitat Requirements

Breeding Habitat

	Height (cm)	Canopy%
Mesic sites		
Sagebrush	40-80	15-25
Grass-forb	>18	>25
Arid sites		
Sagebrush	30-80	15-25
Grass-forb	>18	>15

Sage Grouse Habitat Requirements

Brood Rearing Habitat

	Height (cm)	Canopy%
Mesic sites		
Sagebrush	40-80	10-25
Grass-forb	variable	>15
Arid sites		
Sagebrush	40-80	10-25
Grass-forb	variable	>15

Sage Grouse Habitat Requirements

Winter Habitat

	Height (cm)	Canopy%
Mesic sites		
Sagebrush	25-35	10-30
Grass-forb	N/A	N/A
Arid sites		
Sagebrush	25-35	10-30
Grass-forb	N/A	N/A

Sage Grouse Research Efforts in Northeast Wyoming

Sage Grouse Research Efforts in Northeast Wyoming

- Research project funded by Powder River Coal Company and conducted by Thunderbird Wildlife Consultants, Inc.
- Evaluate Sage Grouse habitat use and distributions
- April 2001 – Radio Collared 8 female and 2 male sage sage grouse on leks north and northeast of North Antelope/Rochelle Coal Mines

AML Project for 2002??

Thank You!

WYOMING GAME & FISH DEPARTMENT

Mitigation for Culverting a Stream Used by Colorado River Cutthroat Trout

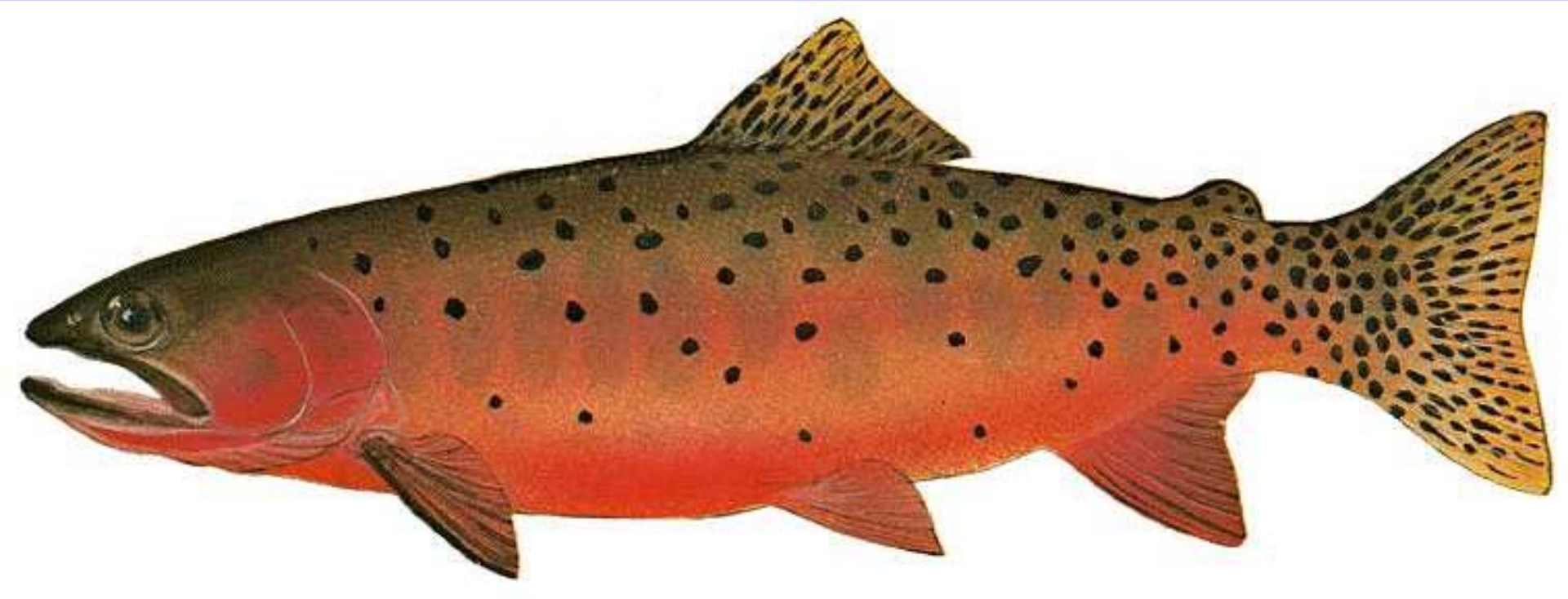
Presented by Paul Baker
at OSM Bond Release Forum
August 2001

8/21/2001 10:20am

8/21/2001 11:46am

8/21/2001 11:15am

Colorado River Cutthroat



Yellowstone Cutthroat

Pride & Performance
GENWAL
RESOURCES
INC.
CRANDALL
CANYON
MINE
8/21/2001 11:30am

8/21/2001 11:29am

8/21/2001 10:45am

Steps in Preserving the Crandall Canyon Fish Population

- Screen put in Scad Valley Creek
- Fish removed from Scad Valley Creek above the screen
- Crandall Canyon fish captured, sampled, tagged, and put in Scad Valley Creek
- Modifications made in upper Crandall Creek
- Most genetically pure fish returned to upper Crandall Creek

Screen in Scad Valley Creek

8/21/2001 10:49am

8/21/2001 10:52am

8/21/2001 10:55am

8/21/2001 10:56am

8/21/2001 10:57am

8/21/2001 10:59am

Migration Barrier in Scad Valley Creek

Migration Barrier in Tie Fork

Nuck Woodward Migration Barrier

8/23/2001 5:17pm

- Crandall Creek Mitigation Costs
  - $25,000 to DWR for genetic testing, moving fish, and monitoring state lands in Crandall Canyon watershed
  - $96,000 to USFS for fish habitat enhancement in Crandall Canyon and to monitor FS lands in Crandall Canyon
  - $105,000 to joint DWR/USFS account for other fish and riparian habitat enhancement, such as migration barriers, corral, etc.

RECLAMATION REGRADE

Presented by
Reg Hoff

OSM Bond Release Forum
August 2001