WFS 536: Wetland Management

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Lecture Outline

I. Annual Cycle of Waterfowl

II. Waterfowl Diet & Nutritional Requirements

III. Moist-soil Management

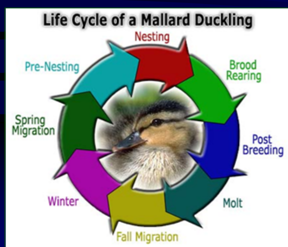
IV. Agriculture Management

What is the Annual Cycle?

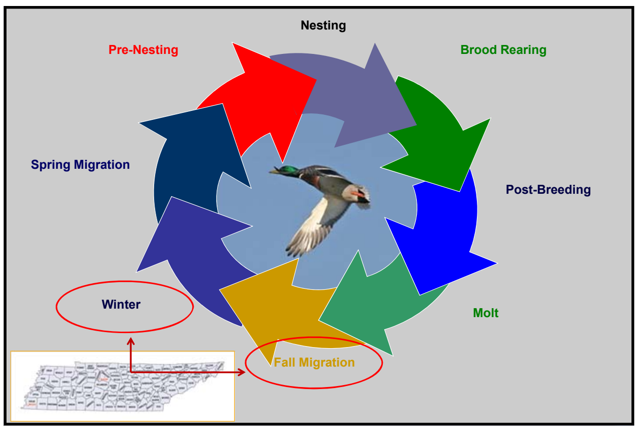
- Series of inter-related events that occur during a year in the life of an animal
- Think about "home range" size
- What is the home range of:
  - A Quail?
  - A White-tailed Deer?
  - A Black Bear?
  - A Mallard?

Annual Cycle of Waterfowl

The complex of physiological & behavioral events experienced by waterfowl during the course of a year.



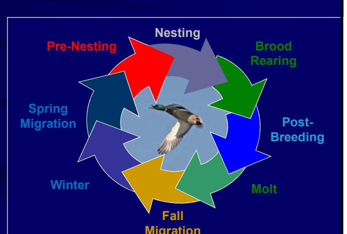
1. Breeding
2. Fall Migration
3. Winter
4. Spring Migration



The Annual Cycle
Different needs at different times

What major events happen to a duck during the year?

- Species variation
- Latitudinal variation
- Cross-seasonal effects
- Management at all stages

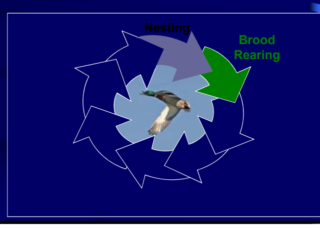


Nesting

- Most waterfowl nest in the northern U.S. and Canada
  - Exceptions? = CANG, WODU, HOME
- Laying requires lots of protein = invertebrates!
- More resources means more eggs

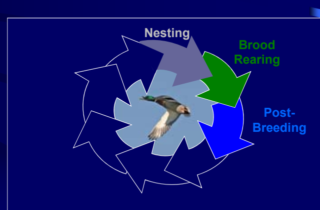
Brood Rearing

- Same species that nest here
- Requirements similar to nesting phase
- Ducklings need
  - Invertebrates
  - Cover
- Managing some wetland area as summer marsh is beneficial



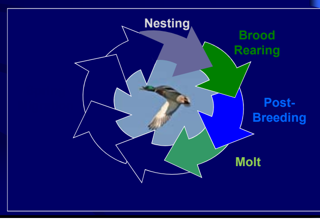
Post-Breeding

- Females and broods begin to move among wetlands
- Less need for cover
  - Drakes molting
  - Hens nearing molt
  - Switch to plant foods
- Loafing sites



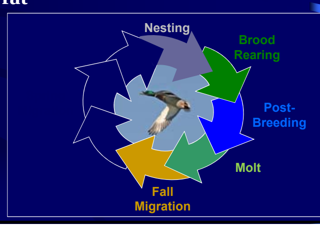
Molt

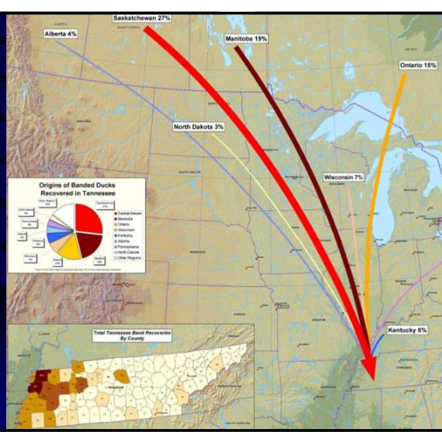
- Energetically costly time of the year
- Wing molt requires lots of protein and essential amino acids
  - Found in natural wetland and plant seeds
- Birds not mobile

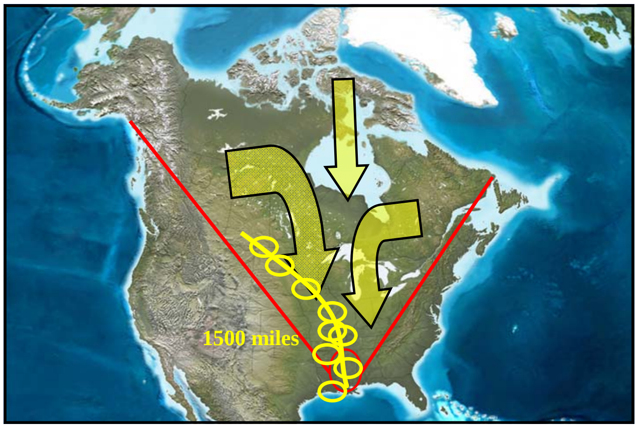


Fall Migration

- Mid-latitude stopover habitats are very important
- High energy foods (fatty) are very important
  - High carbohydrate foods
  - M.S. / Ag. crops high in fat
- Thermal cover
- Refuge
- Hunting
- Slow & methodical

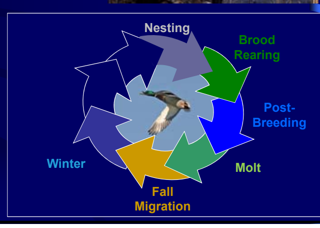






Winter

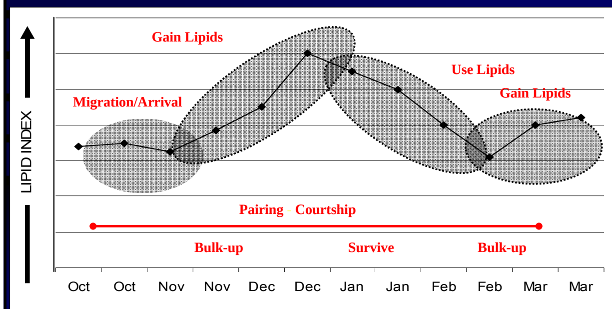
- **Pre-alternate / Pre-basic molt**
- **Pair bonds**
- **High energy needs**
- **Courtship**
- **Cross-seasonal effects**
- **Open water**
- **Hunting**



Fall - Winter: FIXED BIOLOGICAL DEMANDS

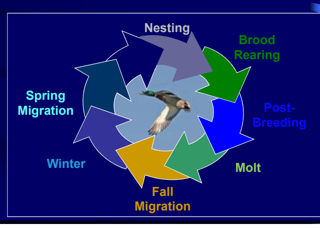
- Food
  - Body condition and survival, feather replacement
- Water
  - Provides habitat for food acquisition and resting
- Cover
  - Forested wetlands & emergent wetlands - Pairing
- Refuge
  - Survival, feeding, pair bonding, “source” for hunting, philopatry

Patterns of body mass during WINTER



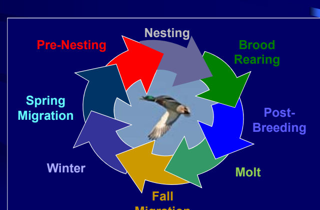
Spring Migration

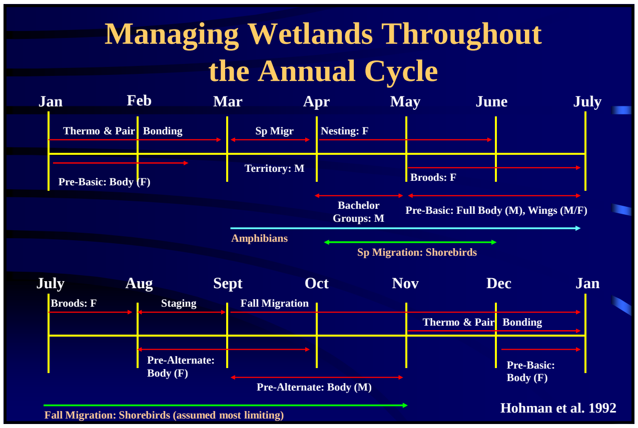
- Often overlooked but <u>critical</u> stage
  - relationship between spring condition and reproduction
- Spring food low?
- Seeds → invertebrates
- High-speed

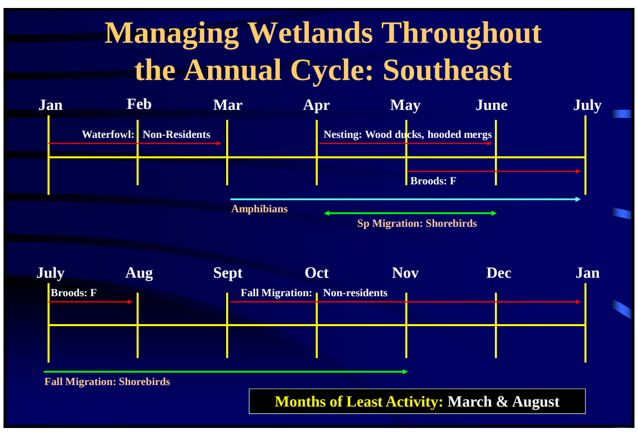


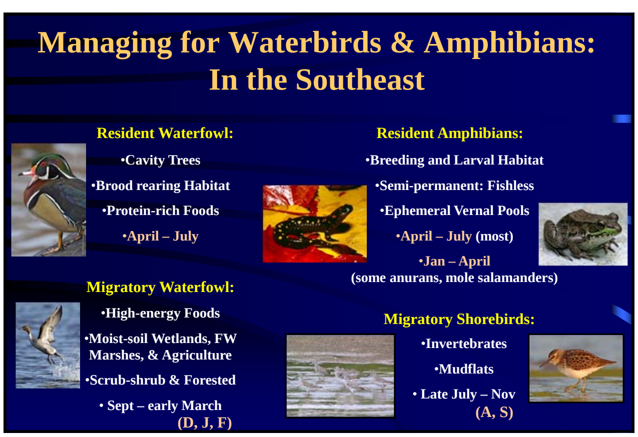
Pre-Nesting

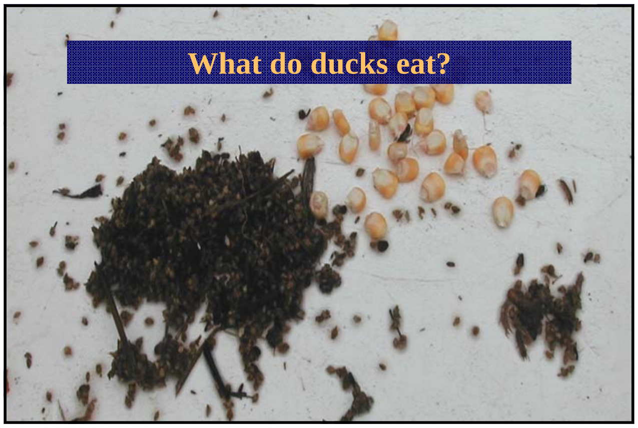
- Stopover sites and temporary wetlands important
- Some ducks carry reserves to lay eggs (i.e., snow geese)
  - Endogenous resources
- Some get protein at breeding areas (i.e., ruddy ducks)
  - Exogenous resources
- Heavier birds nest earlier and are more successful

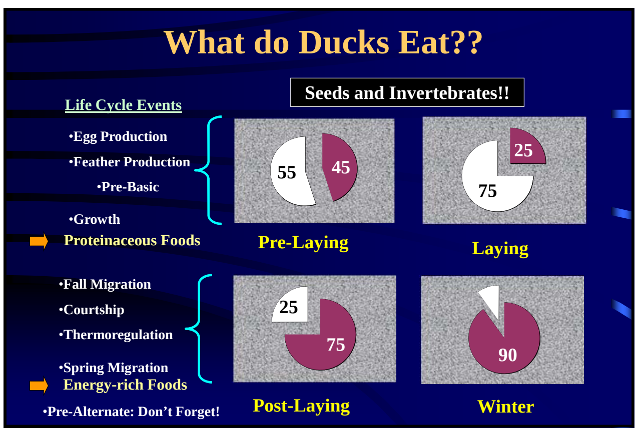


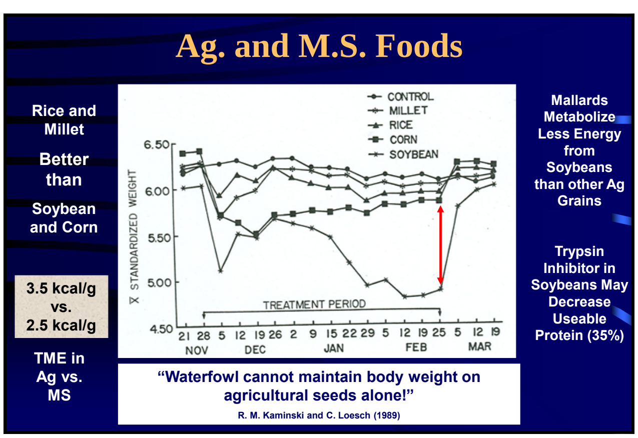

Managing Wetlands Throughout the Annual Cycle
Jan
Feb
Mar
Apr
May
June
July
Thermo & Pair Bonding
Sp Migr
Nesting: F
Territory: M
Pre-Basic: Body (F)
Broods: F
Bachelor Groups: M
Pre-Basic: Full Body (M), Wings (M/F)
Amphibians
Sp Migration: Shorebirds
July
Aug
Sept
Oct
Nov
Dec
Jan
Broods: F
Staging
Fall Migration
Thermo & Pair Bonding
Pre-Alternate: Body (F)
Pre-Basic: Body (F)
Pre-Alternate: Body (M)
Fall Migration: Shorebirds (assumed most limiting)
Hohman et al. 1992

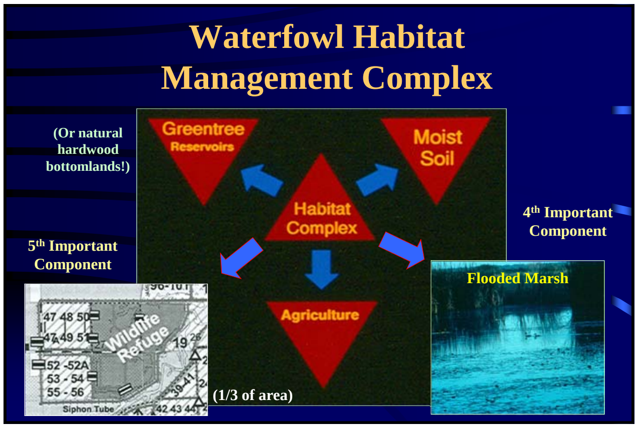

Managing Wetlands Throughout the Annual Cycle: Southeast
Jan
Feb
Mar
Apr
May
June
July
Waterfowl: Non-Residents
Nesting: Wood ducks, hooded mergs
Broods: F
Amphibians
Sp Migration: Shorebirds
July
Aug
Sept
Oct
Nov
Dec
Jan
Broods: F
Fall Migration: Non-residents
Fall Migration: Shorebirds
Months of Least Activity: March & August

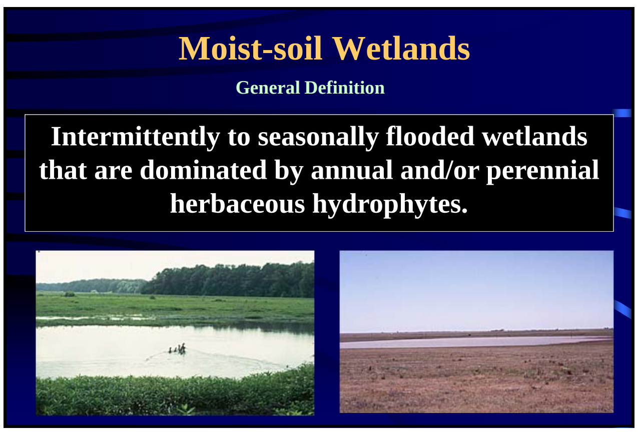

Managing for Waterbirds & Amphibians: In the Southeast
Resident Waterfowl:
•Cavity Trees
•Brood rearing Habitat
•Protein-rich Foods
•April – July
Resident Amphibians:
•Breeding and Larval Habitat
•Semi-permanent: Fishless
•Ephemeral Vernal Pools
•April – July (most)
•Jan – April
(some anurans, mole salamanders)
Migratory Waterfowl:
•High-energy Foods
•Moist-soil Wetlands, FW Marshes, & Agriculture
•Scrub-shrub & Forested
• Sept – early March
(D, J, F)
Migratory Shorebirds:
•Invertebrates
•Mudflats
• Late July – Nov
(A, S)

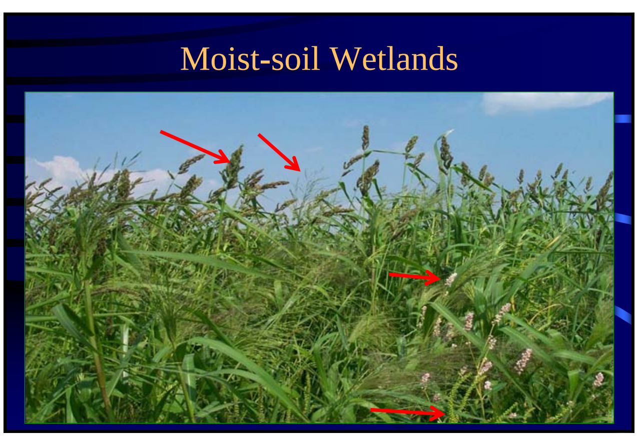

What do ducks eat?

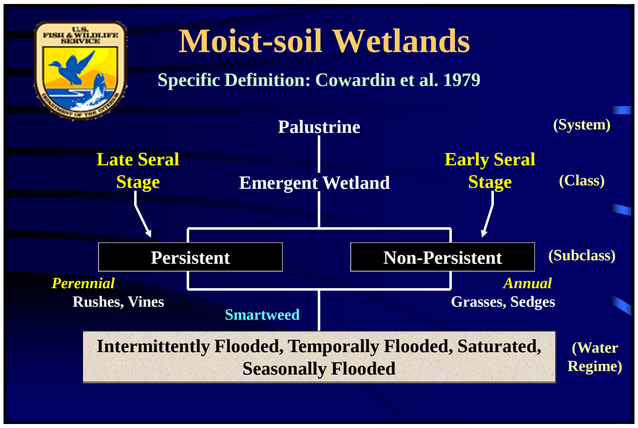

What do Ducks Eat??
Seeds and Invertebrates!!
Life Cycle Events
•Egg Production
•Feather Production
•Pre-Basic
•Growth
Proteinaceous Foods
55
45
Pre-Laying
25
75
Laying
•Fall Migration
•Courtship
•Thermoregulation
•Spring Migration
Energy-rich Foods
•Pre-Alternate: Don't Forget!
25
75
Post-Laying
90
Winter


Ag. and M.S. Foods
Rice and Millet
Better than
Soybean and Corn
3.5 kcal/g vs. 2.5 kcal/g
TME in Ag vs. MS
CONTROL
MILLET
RICE
CORN
SOYBEAN
X̄ STANDARDIZED WEIGHT
6.50
6.00
5.50
5.00
4.50
TREATMENT PERIOD
21 28 5 12 19 26 2 9 15 22 29 5 12 19 25 5 12 19
NOV DEC JAN FEB MAR
"Waterfowl cannot maintain body weight on agricultural seeds alone!"
R. M. Kaminski and C. Loesch (1989)
Mallards Metabolize Less Energy from Soybeans than other Ag Grains
Trypsin Inhibitor in Soybeans May Decrease Useable Protein (35%)

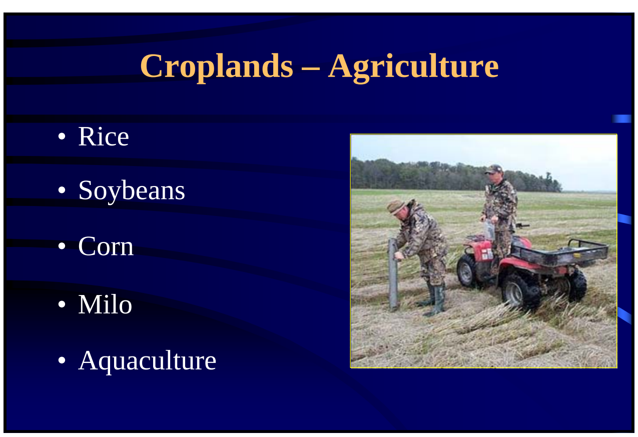

Waterfowl Habitat Management Complex
(Or natural hardwood bottomlands!)
Greentree Reservoirs
Moist Soil
Habitat Complex
4th Important Component
5th Important Component
Flooded Marsh
Agriculture
Wildlife Refuge
Siphon Tube
(1/3 of area)

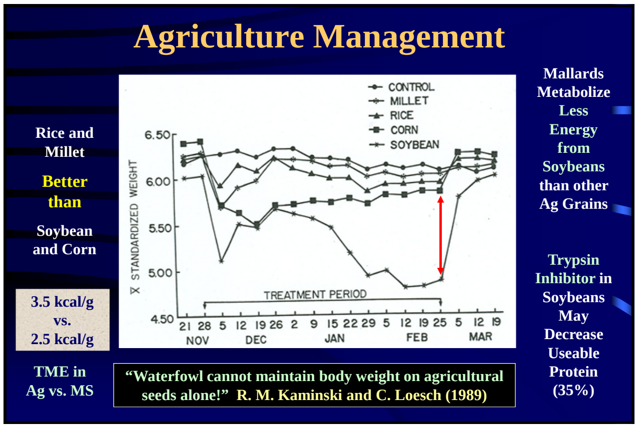

Moist-soil Wetlands
General Definition
Intermittently to seasonally flooded wetlands that are dominated by annual and/or perennial herbaceous hydrophytes.


Moist-soil Wetlands


Moist-soil Wetlands
Specific Definition: Cowardin et al. 1979
Palustrine
(System)
Late Seral Stage
Emergent Wetland
Early Seral Stage
(Class)
Persistent
Non-Persistent
(Subclass)
Perennial
Rushes, Vines
Smartweed
Annual
Grasses, Sedges
Intermittently Flooded, Temporally Flooded, Saturated, Seasonally Flooded
(Water Regime)


Moist-soil Waterbirds


Croplands – Agriculture
• Rice
• Soybeans
• Corn
• Milo
• Aquaculture


Agriculture Management
Rice and Millet
Better than
Soybean and Corn
3.5 kcal/g vs. 2.5 kcal/g
TME in Ag vs. MS
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MILLET
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SOYBEAN
X STANDARDIZED WEIGHT
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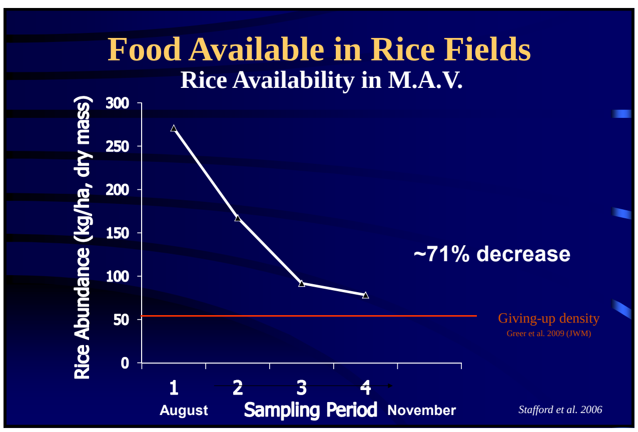
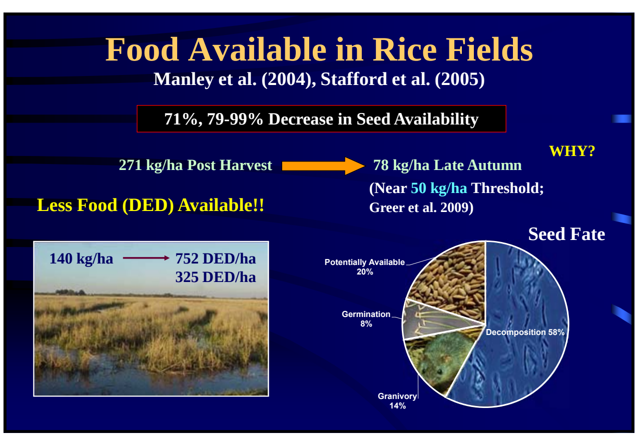

Food Available in Rice Fields
Rice Availability in M.A.V.
Rice Abundance (kg/ha, dry mass)
300
250
200
150
100
50
0
~71% decrease
Giving-up density
Greer et al. 2009 (JWM)
1 2 3 4
August
Sampling Period
November
Stafford et al. 2006


Food Available in Rice Fields
Manley et al. (2004), Stafford et al. (2005)
71%, 79-99% Decrease in Seed Availability
WHY?
271 kg/ha Post Harvest
78 kg/ha Late Autumn
(Near 50 kg/ha Threshold; Greer et al. 2009)
Less Food (DED) Available!!
140 kg/ha
752 DED/ha
325 DED/ha
Seed Fate
Potentially Available 20%
Germination 8%
Decomposition 58%
Granivory 14%

Food Available in Rice Fields

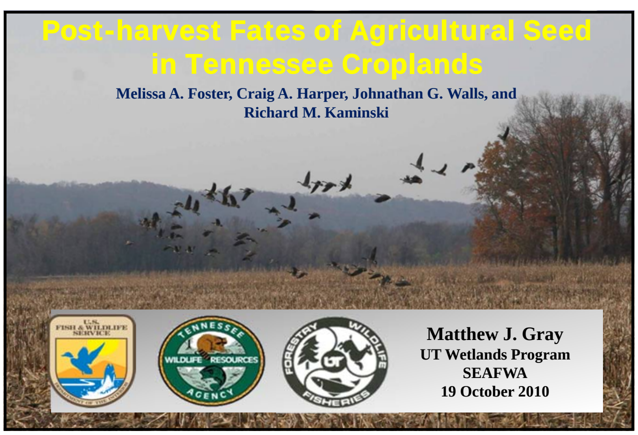
Harvested Rice Field vs. Moist-Soil

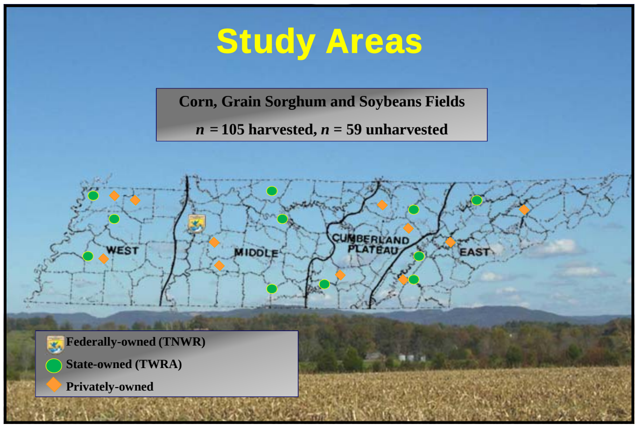
Habitat	Mean (kg/ha)	DUDs
Rice	78 ± 15%	897
Moist-Soil	496 ± 13%	4,196

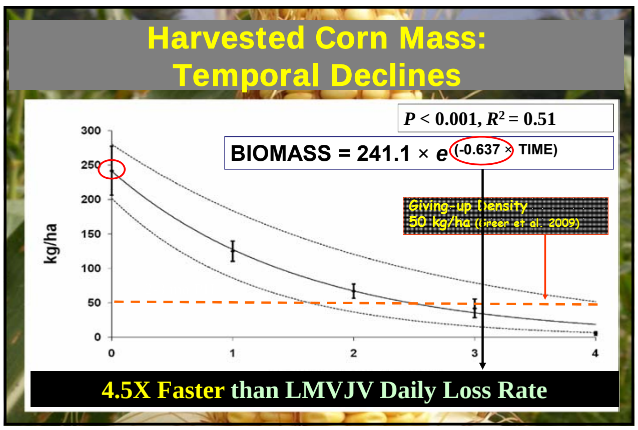
** 5-6 times more food and DUDs

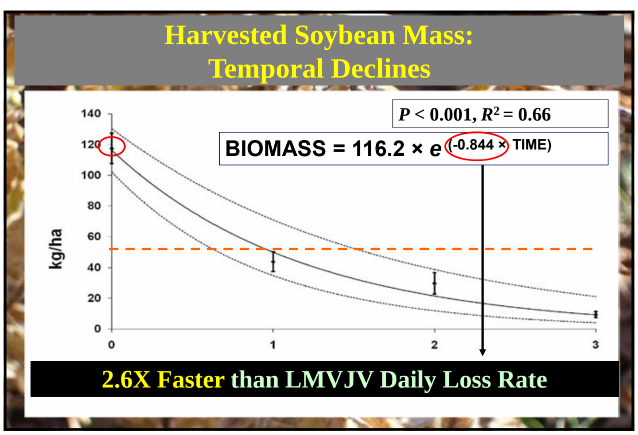
Table 5. Carrying capacity of selected foraging habitats (expressed as duck-use days/ac [DUDs/ac]) for mallards wintering in the Lower Mississippi Valley Joint Venture area.

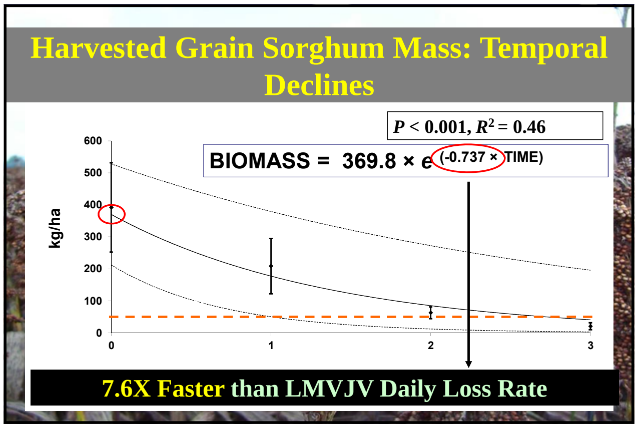
Habitat	Food available (kg/ha) [a]	True metabolizable energy (TME; kcal/g) [b]	DUDs/ac [c]
Moist-soil	600 [d]	2.47 [e]	1,883
Harvested crops			
Rice	80 [f]	3.34 [g]	139
Soybean	60 [h]	2.65 [g]	37
Unharvested crops			
Rice	5,240 [i]	3.34 [g]	24,025
Soybean	1,334 [i]	2.65 [g]	4,716
Milo	3,811 [i]	3.49 [j]	18,192
Corn	5,716 [i]	3.67 [k]	28,820
Japanese millet	1,500 [l]	2.61 [m]	5,245
Bottomland hardwoods			
30% red oak	81 [n]	2.67 [o]	115
40% red oak	93 [n]	2.67 [o]	161
50% red oak	106 [n]	2.67 [o]	207
60% red oak	118 [n]	2.67 [o]	253
70% red oak	131 [n]	2.67 [o]	299
80% red oak	143 [n]	2.67 [o]	345
90% red oak	156 [n]	2.67 [o]	391
100% red oak	168 [n]	2.67 [o]	436

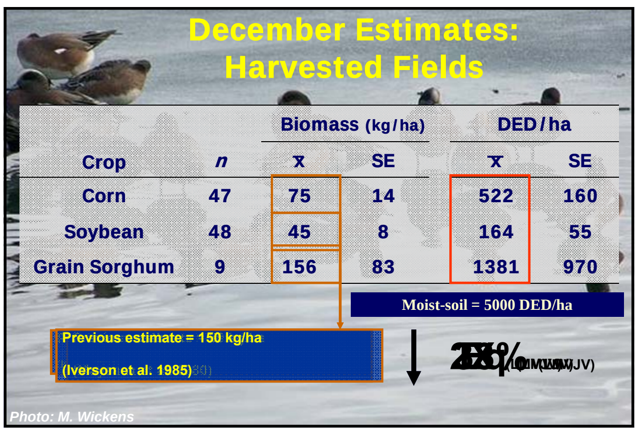



Study Areas
Corn, Grain Sorghum and Soybeans Fields
n = 105 harvested, n = 59 unharvested
WEST
MIDDLE
CUMBERLAND PLATEAU
EAST
Federally-owned (TNWR)
State-owned (TWRA)
Privately-owned


Harvested Corn Mass: Temporal Declines
P < 0.001, R2 = 0.51
BIOMASS = 241.1 × e(-0.637 × TIME)
Giving-up Density
50 kg/ha (Greer et al. 2009)
kg/ha
300
250
200
150
100
50
0
0
1
2
3
4
4.5X Faster than LMVJV Daily Loss Rate


Harvested Soybean Mass: Temporal Declines
P < 0.001, R2 = 0.66
BIOMASS = 116.2 × e(-0.844 × TIME)
kg/ha
140
120
100
80
60
40
20
0
0
1
2
3
2.6X Faster than LMVJV Daily Loss Rate





December Estimates: Harvested Fields

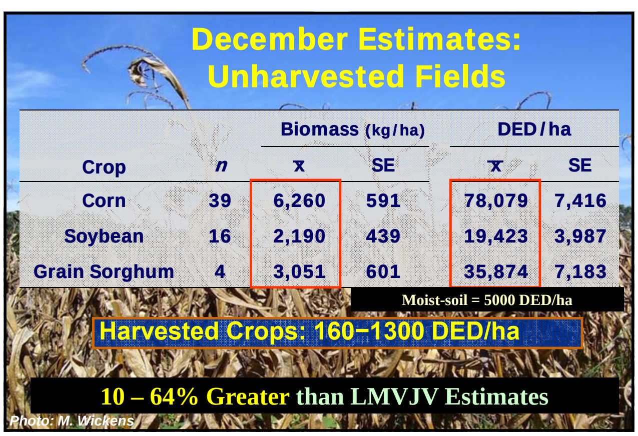
Crop	*n*	Biomass (kg/ha) x̄	Biomass (kg/ha) SE	DED/ha x̄	DED/ha SE
Corn	47	75	14	522	160
Soybean	48	45	8	164	55
Grain Sorghum	9	156	83	1381	970

Moist-soil = 5000 DED/ha

Previous estimate = 150 kg/ha (Iverson et al. 1985)

(LMVJV)

Photo: M. Wickens



December Estimates: Unharvested Fields

Crop	*n*	Biomass (kg/ha) x̄	Biomass (kg/ha) SE	DED/ha x̄	DED/ha SE
Corn	39	6,260	591	78,079	7,416
Soybean	16	2,190	439	19,423	3,987
Grain Sorghum	4	3,051	601	35,874	7,183

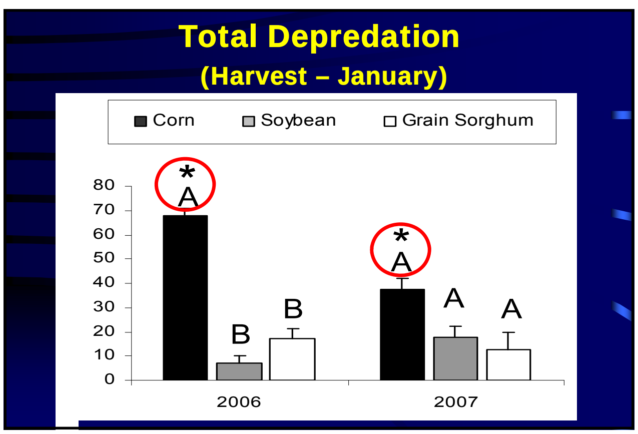
Moist-soil = 5000 DED/ha

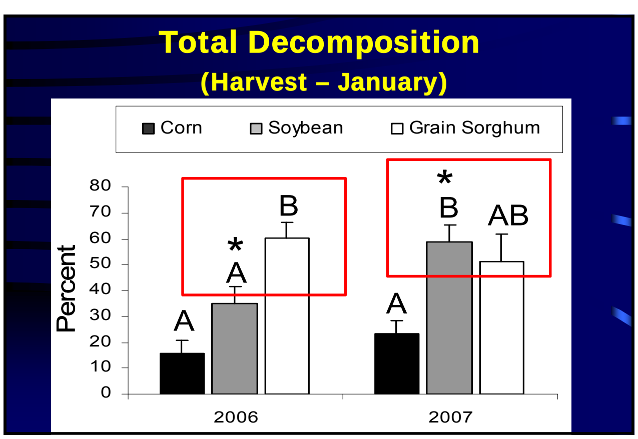
Harvested Crops: 160–1300 DED/ha

10 – 64% Greater than LMVJV Estimates

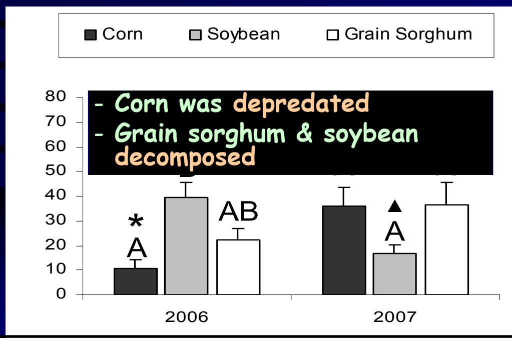
Photo: M. Wickens


Part II: QUANTIFYING SEED FATE
In harvested fields, there is less available seed and it is disappearing quickly.
What is happening to it?


Total Depredation
(Harvest – January)
Corn
Soybean
Grain Sorghum
80
70
60
50
40
30
20
10
0
*
A
B
B
*
A
A
A
2006
2007


Total Decomposition
(Harvest – January)
Corn
Soybean
Grain Sorghum
Percent
80
70
60
50
40
30
20
10
0
A
*
A
B
A
*
B
AB
2006
2007

Total Germination
(Harvest – January)



What have we learned?

1. Less food than we thought…

2. How do we mitigate decreased quality of foraging habitats?

Management of Moist-soil Wetlands for Waterfowl

Matthew J. Gray
University of Tennessee

Moist-soil Management Unit

A location of moist-soil management, often surrounded by levees (impoundments)

<40 ha, 100 ac

Moist-soil Management Complex

A group of interconnected moist-soil impoundments that can be managed independently

Hydrologic Management

(Fredrickson and Taylor 1982)

Spring Drawdown:

Duration	Date
•Fast (2-3 days)	•Early (April)
•Slow (2-3 weeks)	•Late (July)
➡ Plant Diversity and Foods	➡ Annuals & Breeding

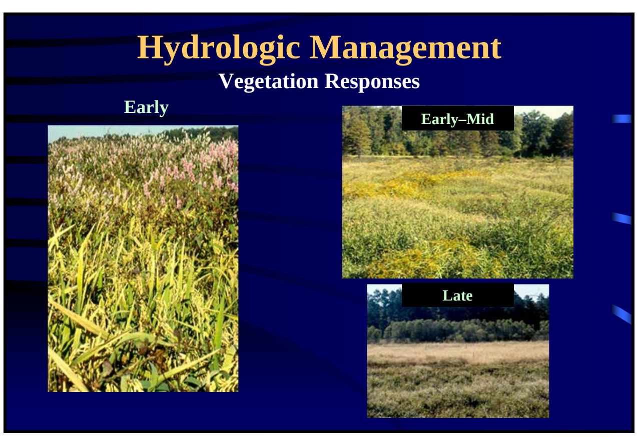
Multiple Combinations Good!

Irrigation:
- •Flooded shallowly (e.g., <10 cm) — Eco. Trap
- •Offset drought — 2-3 Weeks

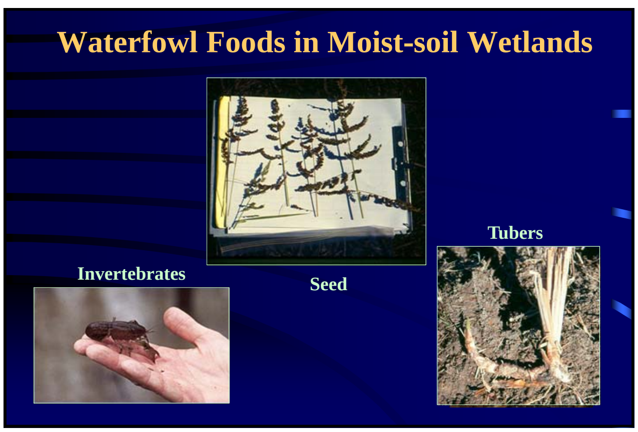
Winter Flooding:
- •Flood slow (2-4 weeks) & Sequential
- •Flood shallow (e.g., 10-20 cm) — Sept.


Hydrologic Management
Drawdown


Hydrologic Management
Growth & Irrigation


Hydrologic Management
Vegetation Responses
Early
Early–Mid
Late


Hydrologic Management
Fall Flooding & Bird Response


Waterfowl Foods in Moist-soil Wetlands
Tubers
Invertebrates
Seed


Hydrologic Management
Water Control Structures
Drop-board
Flap Gate
Screw Gate
"Tongue-and-Groove"


Hydrologic Management
www.crisafulli.com
Moving Water
www.gator-pump.com
Gravity (reservoirs, rivers)
Cheapest!
Diesel or PTO-Pumps & Wells
Towable PTO-Pumps
Crisafulli® & Gator®
Electric Pump & Wells


Hydrologic Management – Case Study 1
Evaluating Vegetative Quality and Waterfowl Use on Active and Reduced Management Regimes in Moist-soil Wetlands on WRP lands in Mississippi
Active management with late draw-down (early summer)
+ duck response
+ vegetation response compared to Active


Hydrologic Management – Case Study 1
Crayfish Harvest Potential and Ecosystem Services in Managed Moist-soil Wetlands
Active management with late draw-down (early summer)
+ Crayfish Harvest Potential (1 - 7.7 kg/ha/day)
+ water quality benefits
+ wildlife habitat

Mechanical Manipulations of Moist-soil Wetlands

(Fredrickson and Taylor 1982; Gray et al. 1999)

(Disking, Tilling, Scraping or Mowing)

Primary Goal: Set back Succession — 2-3 Years (Rotation)

Spring Manipulations: *(Historically: Northerly Approach)*

- Immediately after Early Spring Drawdown

Disking is Best!

Autumn Manipulations: *(SE Approach)*

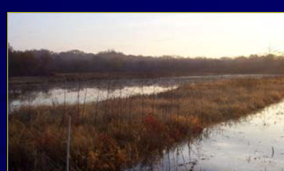
- As soon as possible after Early or Late Drawdowns

Delays → Heavy Precipitation, Breeding Waterfowl

- Long growing season and climate conditions can produce dense and continuous stands of hydrophytes

Secondary Goal: Waterfowl Access

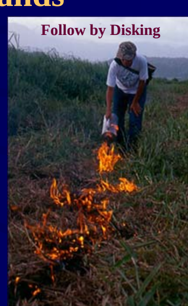
Fall Moist-soil Management

Natural Manipulations of Moist-soil Wetlands

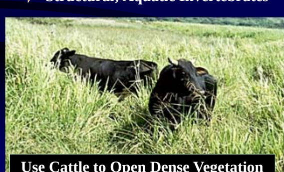
Burning: (Use w/ Disking to set back succession)

- Release Nutrients
- Increase Nutritive Quality (Coastal Wetlands)
- Increase Plant H'
- Increase Aquatic Invert Biomass

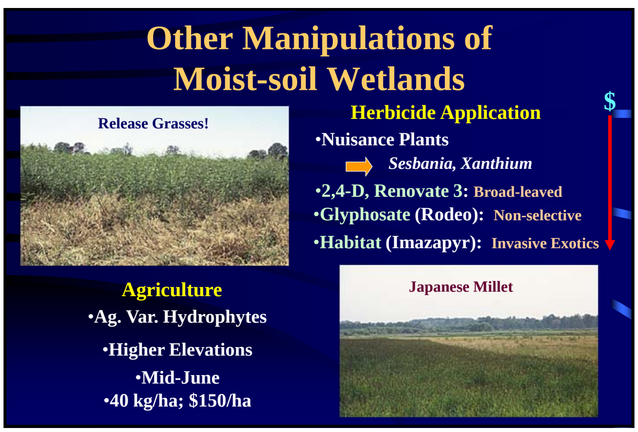


Grazing: *(similar to mowing)* (Early Succession)

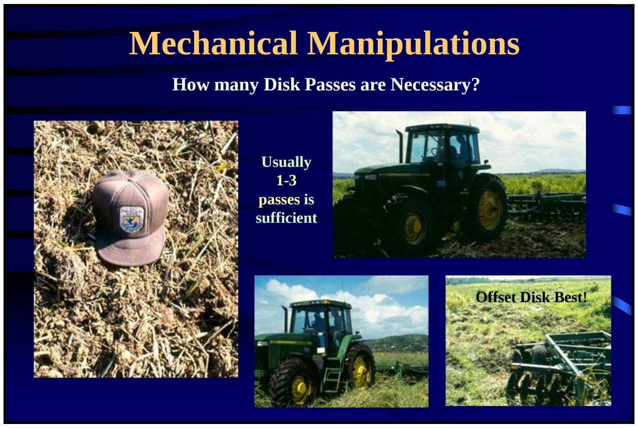
→ Structural; Aquatic Invertebrates

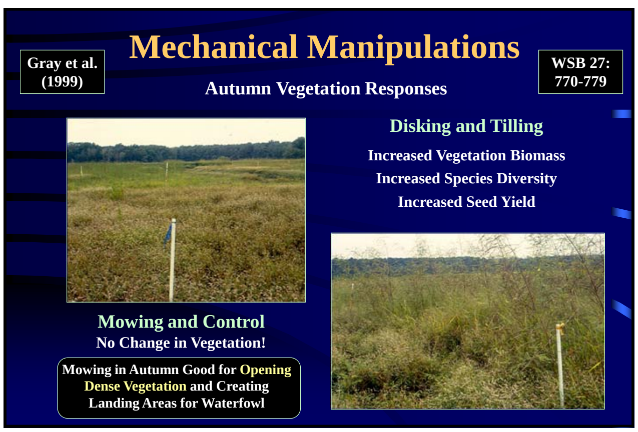


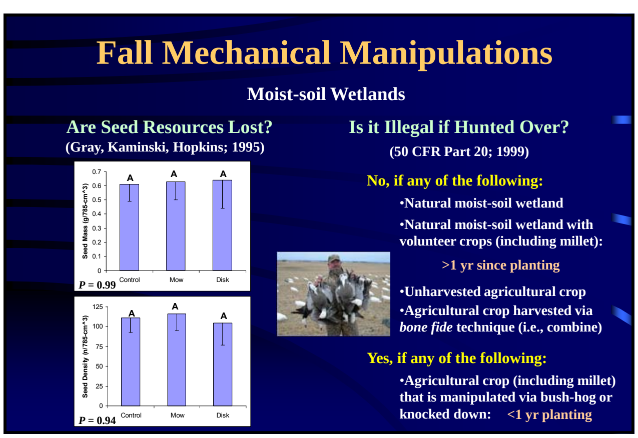

Natural Manipulations of
Moist-soil Wetlands
Rockefeller State Refuge

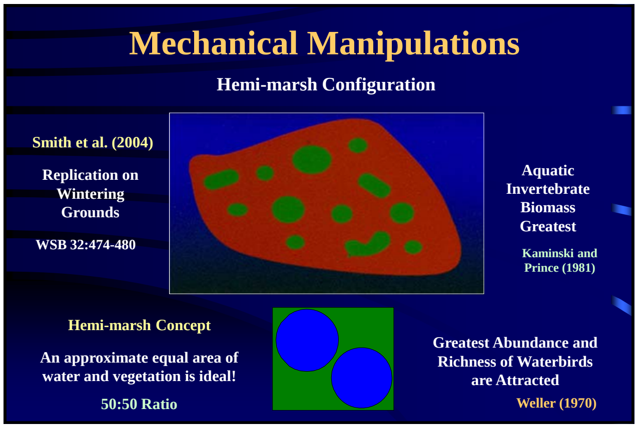

Other Manipulations of
Moist-soil Wetlands
Release Grasses!
Herbicide Application
•Nuisance Plants
Sesbania, Xanthium
•2,4-D, Renovate 3: Broad-leaved
•Glyphosate (Rodeo): Non-selective
•Habitat (Imazapyr): Invasive Exotics
$
Agriculture
•Ag. Var. Hydrophytes
•Higher Elevations
•Mid-June
•40 kg/ha; $150/ha
Japanese Millet


Why Forego Mechanical
Manipulations until Autumn?
3 Primary Reasons


Mechanical Manipulations
How many Disk Passes are Necessary?
Usually 1-3 passes is sufficient
Offset Disk Best!

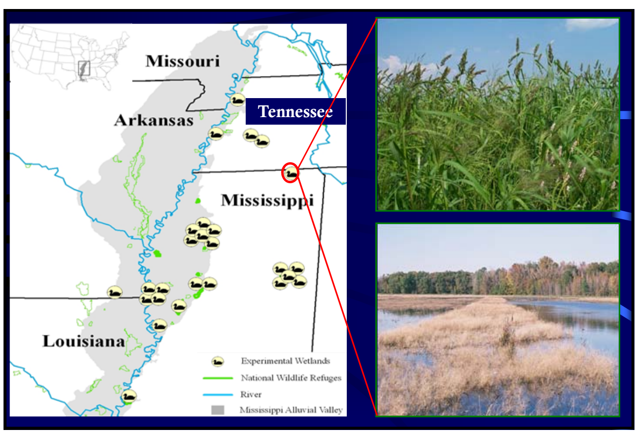

Gray et al. (1999)
Mechanical Manipulations
WSB 27: 770-779
Autumn Vegetation Responses
Disking and Tilling
Increased Vegetation Biomass
Increased Species Diversity
Increased Seed Yield
Mowing and Control
No Change in Vegetation!
Mowing in Autumn Good for Opening Dense Vegetation and Creating Landing Areas for Waterfowl


Fall Mechanical Manipulations
Moist-soil Wetlands
Are Seed Resources Lost?
(Gray, Kaminski, Hopkins; 1995)
Seed Mass (g/785-cm^3)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
A A A
Control Mow Disk
P = 0.99
Seed Density (n/785-cm^3)
0 25 50 75 100 125
A A A
Control Mow Disk
P = 0.94
Is it Illegal if Hunted Over?
(50 CFR Part 20; 1999)
No, if any of the following:
•Natural moist-soil wetland
•Natural moist-soil wetland with volunteer crops (including millet):
>1 yr since planting
•Unharvested agricultural crop
•Agricultural crop harvested via bone fide technique (i.e., combine)
Yes, if any of the following:
•Agricultural crop (including millet) that is manipulated via bush-hog or knocked down: <1 yr planting


Mechanical Manipulations
Hemi-marsh Configuration
Smith et al. (2004)
Replication on Wintering Grounds
WSB 32:474-480
Aquatic Invertebrate Biomass Greatest
Kaminski and Prince (1981)
Hemi-marsh Concept
An approximate equal area of water and vegetation is ideal!
50:50 Ratio
Greatest Abundance and Richness of Waterbirds are Attracted
Weller (1970)


The Hemi-marsh

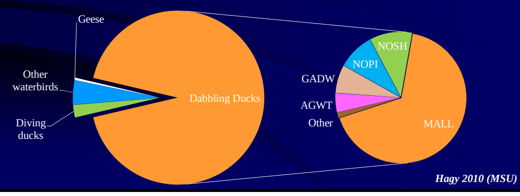

Mechanical Management of M.S. Vegetation


Missouri
Arkansas
Tennessee
Mississippi
Louisiana
Experimental Wetlands
National Wildlife Refuges
River
Mississippi Alluvial Valley


Control
Buffers
Mow
Disk

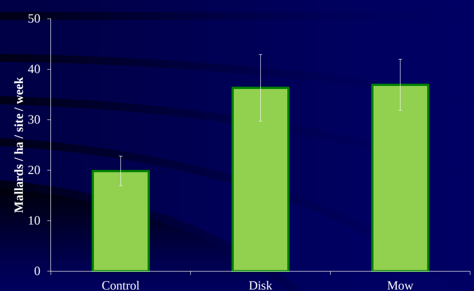
Analysis – Waterbird Community

- Waterbirds
  - Mallards
  - All dabbling ducks
  - Dabbling ducks other than Mallards
  - Diving ducks
  - All waterbirds
  - Waterbirds other than dabbling ducks



Hagy 2010 (MSU)

Results – Waterbird Surveys

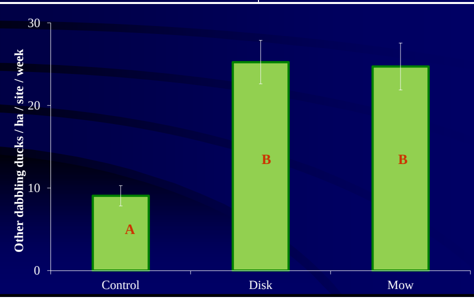


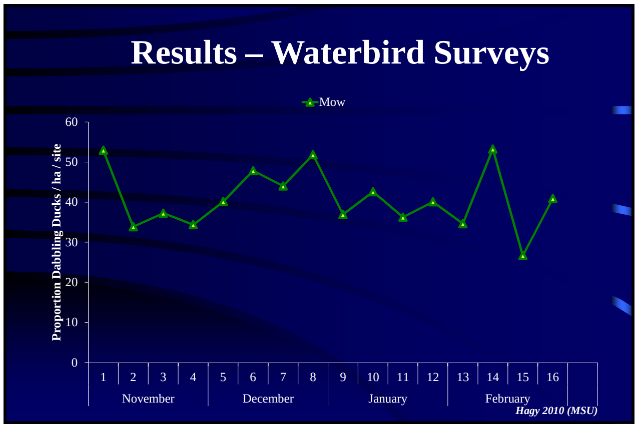
Hagy 2010 (MSU)

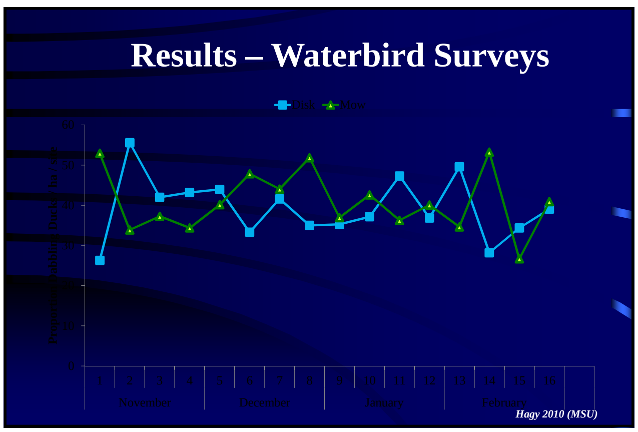
Experiment 2

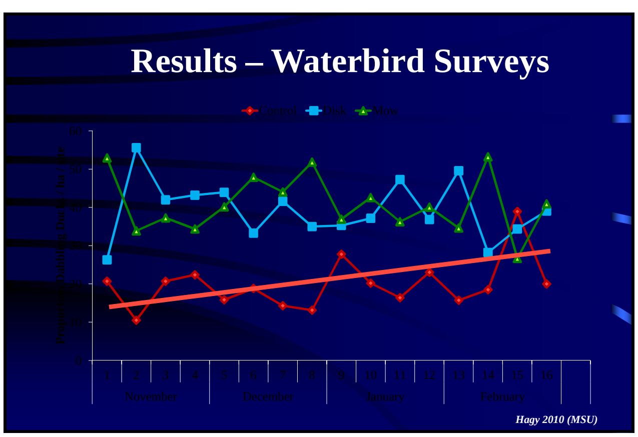
Results – Waterbird Surveys

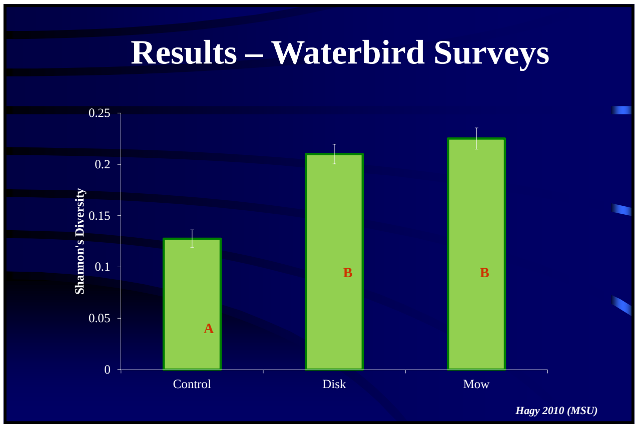
Other dabbling ducks = treatment	$F = 6.83$, $P = 0.001$
(-) water depth	$F = 6.27$, $P = 0.001$

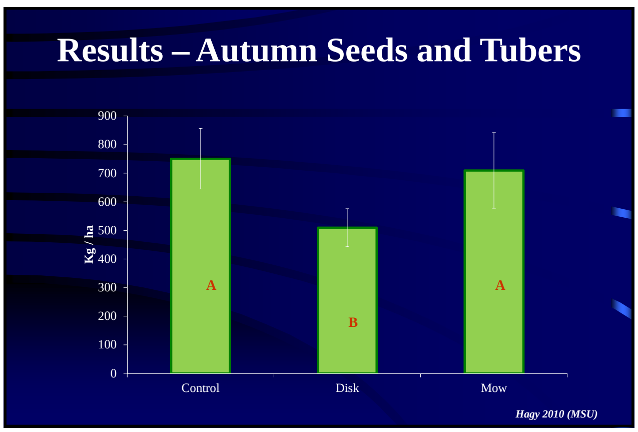


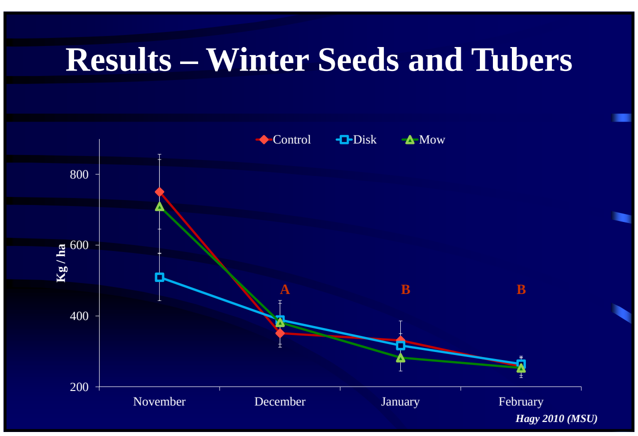

Results – Waterbird Surveys
Mow
Proportion Dabbling Ducks / ha / site
0
10
20
30
40
50
60
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
November
December
January
February
Hagy 2010 (MSU)


Results – Waterbird Surveys
Hagy 2010 (MSU)

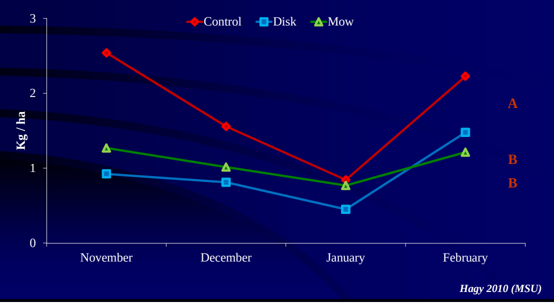

Results – Waterbird Surveys
Hagy 2010 (MSU)


Results – Waterbird Surveys
Shannon's Diversity
0.25
0.2
0.15
0.1
0.05
0
A
B
B
Control
Disk
Mow
Hagy 2010 (MSU)


Results – Autumn Seeds and Tubers
Kg / ha
900
800
700
600
500
400
300
200
100
0
A
B
A
Control
Disk
Mow
Hagy 2010 (MSU)


Results – Winter Seeds and Tubers
Control
Disk
Mow
Kg / ha
800
600
400
200
A
B
B
November
December
January
February
Hagy 2010 (MSU)

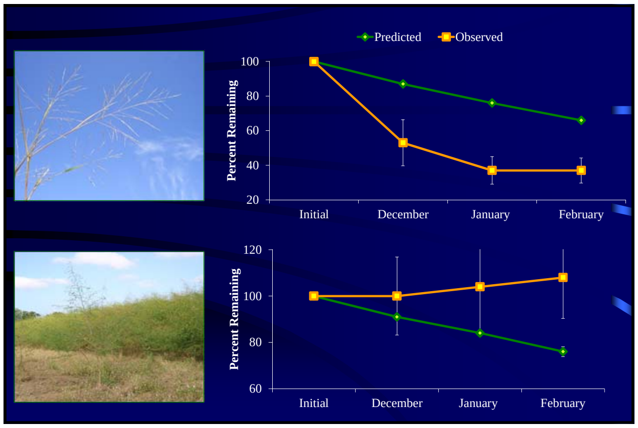
Results – Invertebrates



Fall mowed and disked moist-soil vegetation

Seed and Tuber Use

1. Surveyed food-use literature to identify taxa commonly consumed by dabbling ducks
2. Compared:
   i. observed seed abundances (core sample estimates)
   ii. predicted seed abundances (calculated using decomposition rates and November abundances)
3. Estimated effects of removing taxa not identified as “duck food”



Seed and Tuber Use

Taxa	Reference[a]
Althaea officinalis	5
Amaranthus spp.	6, 8, 12
Bidens spp.	2, 10, 11, 15
Carex spp.	6, 9, 10, 11
Cyperus spp. (seeds)	1, 4, 5, 6, 7, 8, 10, 11, 14, 15
Cyperus spp. (tuber)	2, 14
Digitaria spp.	8, 9, 10
Diodia virginiana	8, 9, 14
Echinochloa spp.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15
Eleocharis spp.	1, 5, 6, 8, 10, 11, 14, 15
Heliotropium spp.	1, 10, 11, 14
Leersia oryzoides	3, 4, 8, 10, 11
Oryza sativa	1, 3, 4, 5, 6, 7, 8, 11, 14, 15
Panicum spp.	1, 4, 5, 6, 7, 8, 9, 13, 14, 15
Paspalum spp.	1, 5, 6, 7, 8, 9, 11, 15
Polygonum hydropiperoides	3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15
Polygonum lapathifolium	3, 9, 10, 13, 15
Polygonum pensylvanicum	3, 7, 9, 10, 13, 15
Rhynchospora spp.	5, 6, 9, 15
Sagittaria spp.	9
Scirpus spp.	1, 8, 11
Setaria spp.	8, 9
Sida spinosa	9, 13
Sorghum bicolor	2, 7, 15
Urochloa platyphylla	4, 6, 8, 9, 15

Summary

- Partial fall mowing
  - + seeds and tubers
  - + dabbling duck abundance and diversity
  - + invertebrate abundance and diversity
- Shallow flooding (<16 cm)
- Similar winter seed and tuber abundances among treatments (260 kg/ha)
- Ducks don't eat everything!
- Moist-soil wetlands must be managed to maximize food availability

Winter Cropland Management

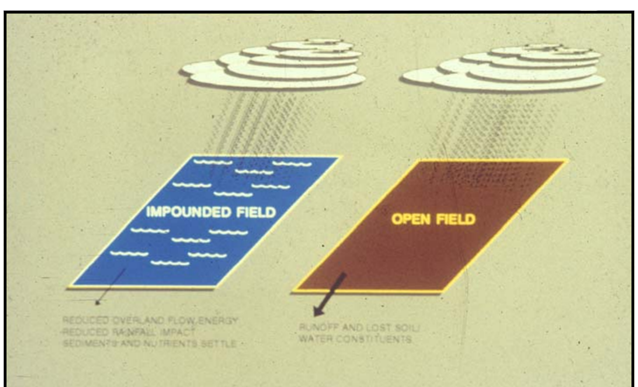
- Flooding
- Stubble manipulation
- Supplemental seeding
- Moist-soil borders and patches
- Grassy crop remnants
- Ratooning

Manley et al. 2005; 2009

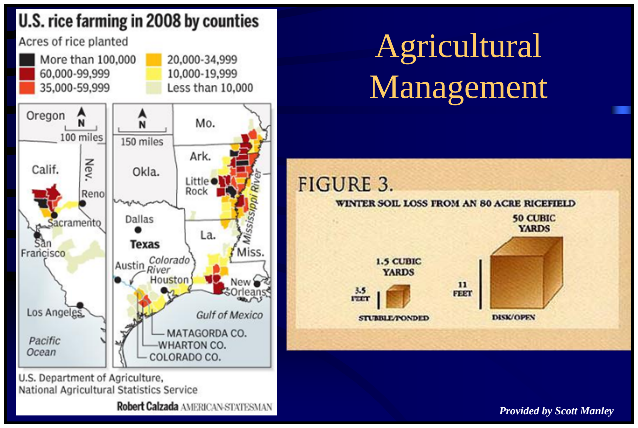
Winter Flooding Benefits

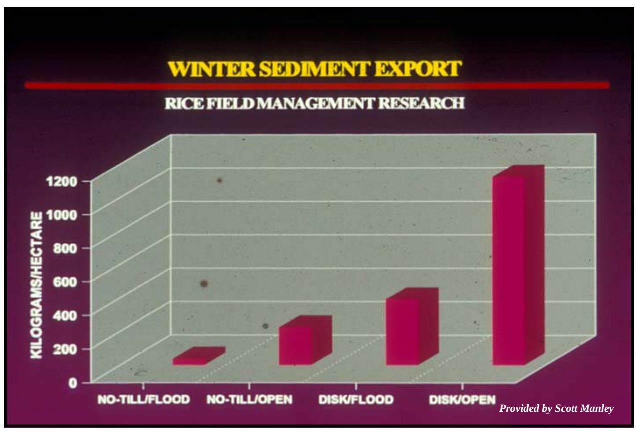
- Food for waterfowl
- Decomposes crop residues
- Reduces winter weeds
- Reduces herbicide use in spring ($25-30/acre)
- Replenishes ground water
- Improves water quality
- Prevents soil loss
- Waterfowl hunting and wildlife watching

Manley et al. 2005; 2009

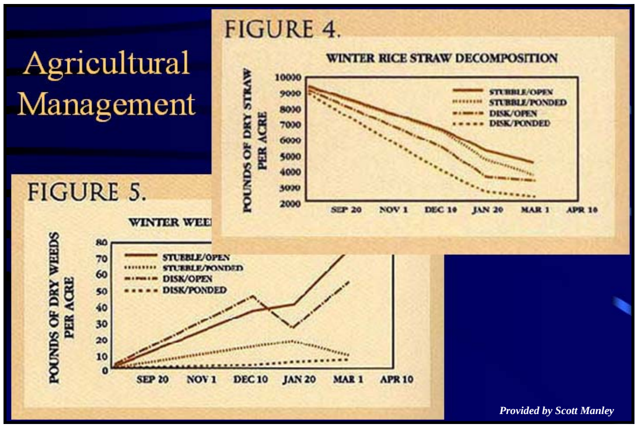


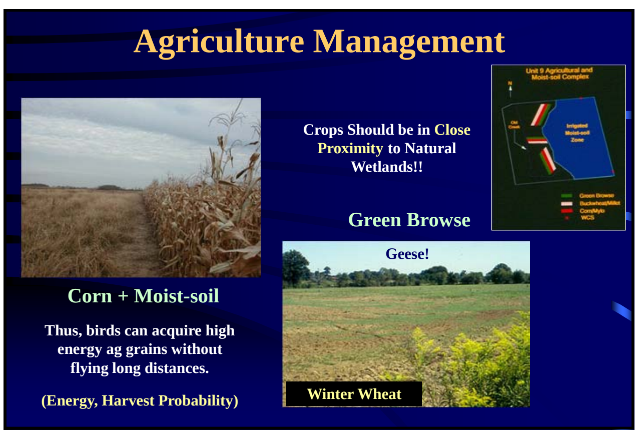
Provided by Scott Manley


U.S. rice farming in 2008 by counties
Acres of rice planted
More than 100,000
60,000-99,999
35,000-59,999
20,000-34,999
10,000-19,999
Less than 10,000
U.S. Department of Agriculture, National Agricultural Statistics Service
Robert Calzada AMERICAN-STATESMAN
Agricultural Management
FIGURE 3.
WINTER SOIL LOSS FROM AN 80 ACRE RICEFIELD
1.5 CUBIC YARDS
50 CUBIC YARDS
STUBBLE/PONDED
DISK/OPEN
Provided by Scott Manley


WINTER SEDIMENT EXPORT
RICE FIELD MANAGEMENT RESEARCH
KILOGRAMS/HECTARE
NO-TILL/FLOOD
NO-TILL/OPEN
DISK/FLOOD
DISK/OPEN
Provided by Scott Manley


No-till / Flood
No-till / Open
Disk / Flood
Disk / Open
Provided by Scott Manley





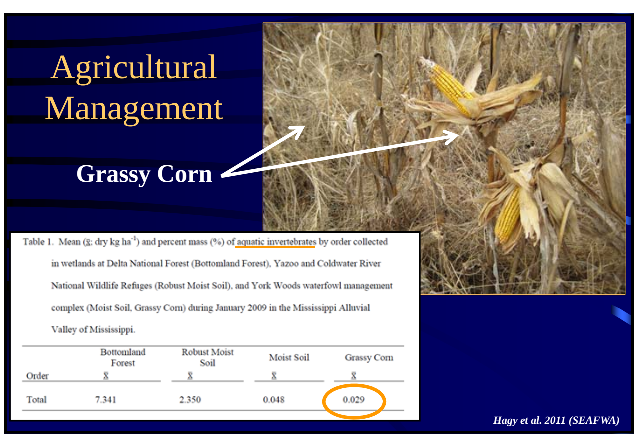
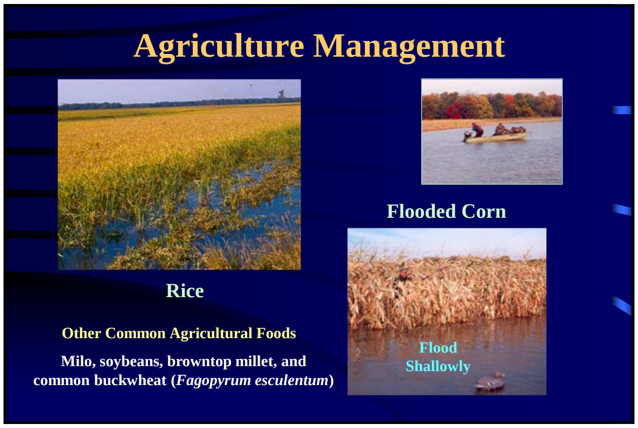
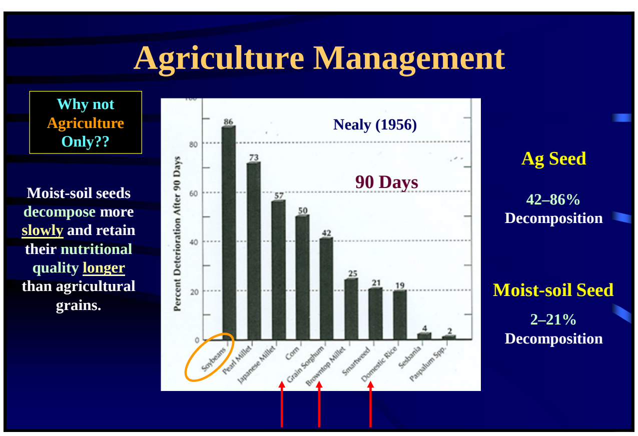


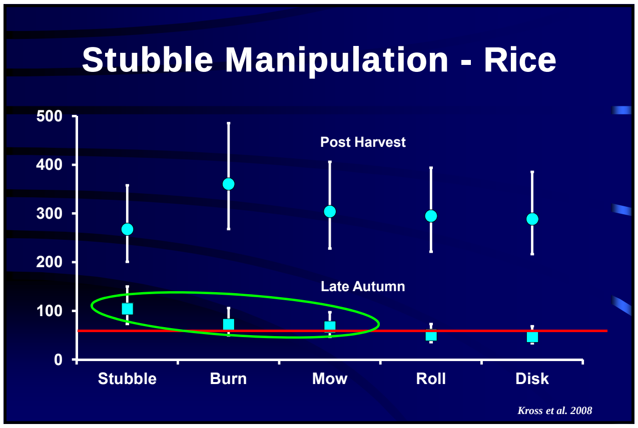
Table 1. Mean (x̄; dry kg ha-1) and percent mass (%) of aquatic invertebrates by order collected in wetlands at Delta National Forest (Bottomland Forest), Yazoo and Coldwater River National Wildlife Refuges (Robust Moist Soil), and York Woods waterfowl management complex (Moist Soil, Grassy Corn) during January 2009 in the Mississippi Alluvial Valley of Mississippi.

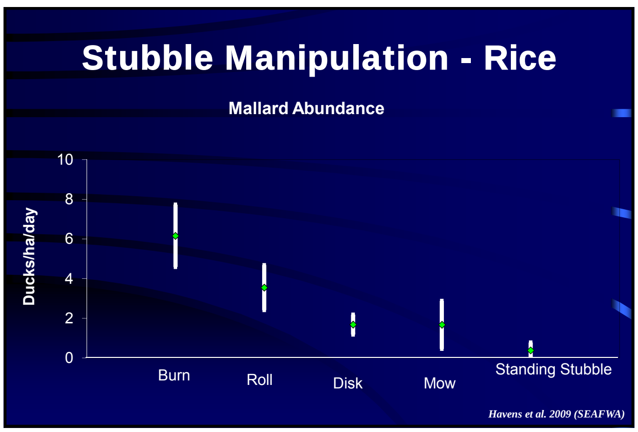
	Bottomland Forest	Robust Moist Soil	Moist Soil	Grassy Corn
Order	x̄	x̄	x̄	x̄
Total	7.341	2.350	0.048	0.029


Agriculture Management
Flooded Corn
Rice
Other Common Agricultural Foods
Milo, soybeans, browntop millet, and common buckwheat (Fagopyrum esculentum)
Flood Shallowly

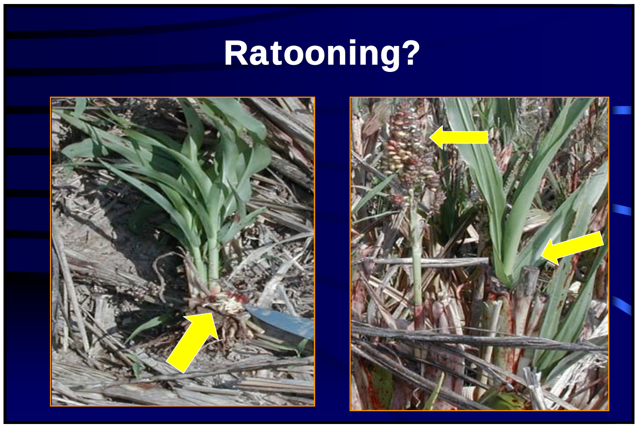

Hunting Agriculture
Harvested Fields
Flooded Fields


Agriculture Management
Why not Agriculture Only??
Moist-soil seeds decompose more slowly and retain their nutritional quality longer than agricultural grains.
Nealy (1956)
90 Days
Percent Deterioration After 90 Days
86
73
57
50
42
25
21
19
4
2
Soybeans
Pearl Millet
Japanese Millet
Corn
Grain Sorghum
Browntop Millet
Smartweed
Domestic Rice
Sesbania
Paspalum Spp.
Ag Seed
42–86% Decomposition
Moist-soil Seed
2–21% Decomposition

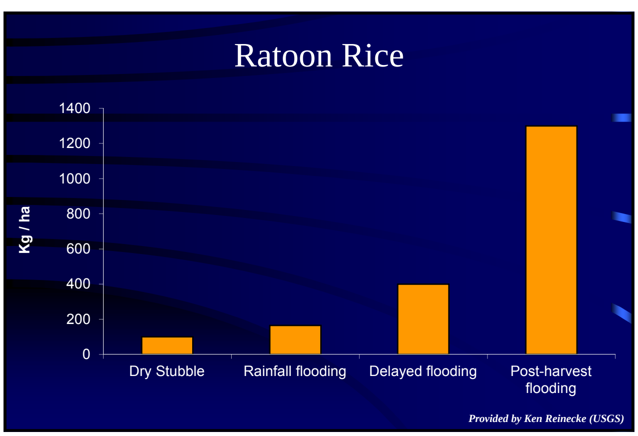

Stubble Manipulation - Rice
500
400
300
200
100
0
Post Harvest
Late Autumn
Stubble
Burn
Mow
Roll
Disk
Kross et al. 2008


Stubble Manipulation - Rice
Mallard Abundance
Ducks/ha/day
10
8
6
4
2
0
Burn
Roll
Disk
Mow
Standing Stubble
Havens et al. 2009 (SEAFWA)

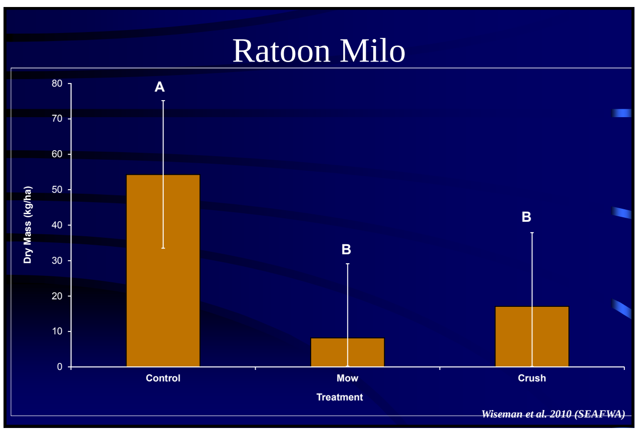

Burn to conserve waste rice, attract ducks, reduce stubble, & $ave

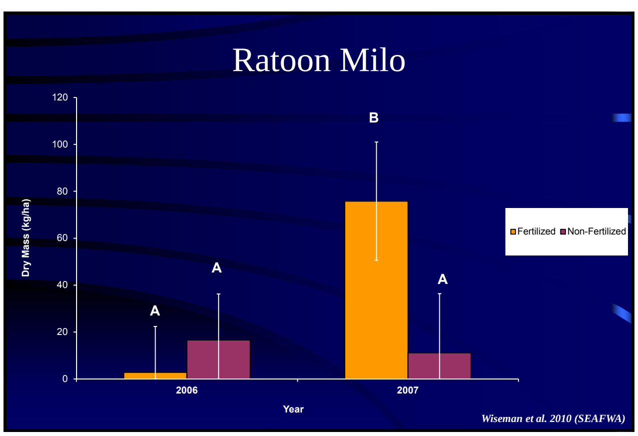

Ratooning?


"Ratoon" Rice for Ducks


Ratoon Rice
Kg / ha
1400
1200
1000
800
600
400
200
0
Dry Stubble
Rainfall flooding
Delayed flooding
Post-harvest flooding
Provided by Ken Reinecke (USGS)


Ratoon Milo

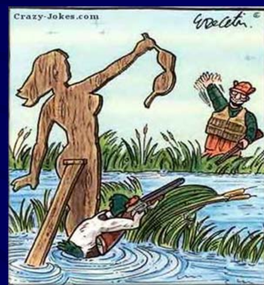

Ratoon Milo
Dry Mass (kg/ha)
80
70
60
50
40
30
20
10
0
A
B
B
Control
Mow
Crush
Treatment
Wiseman et al. 2010 (SEAFWA)

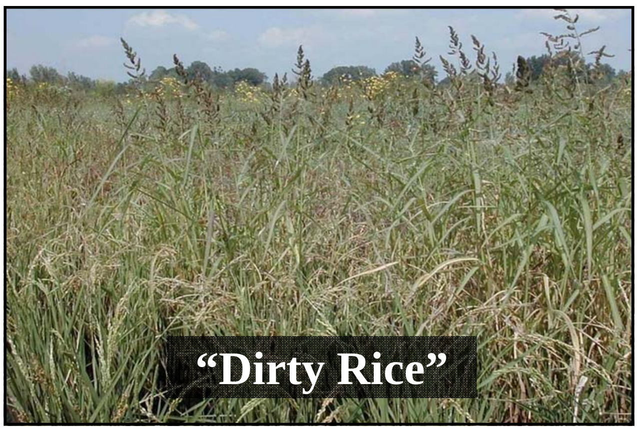

Ratoon Milo
Dry Mass (kg/ha)
120
100
80
60
40
20
0
A
A
B
A
2006
2007
Year
Fertilized
Non-Fertilized
Wiseman et al. 2010 (SEAFWA)

Cropping for Ducks

Making Moist-soil "Hot"

- "Dirty" Rice
- "Grassy" Corn
- "Grassy" Milo



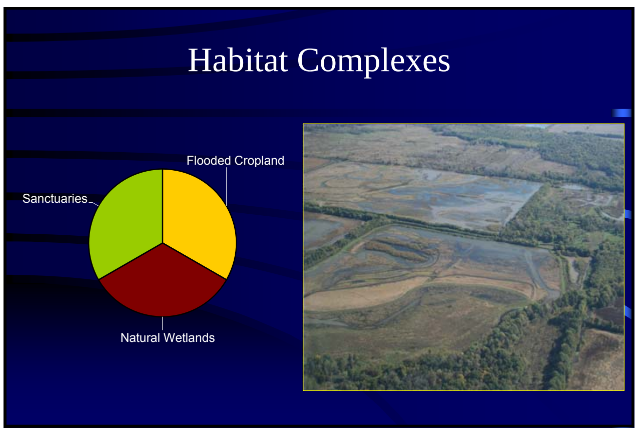


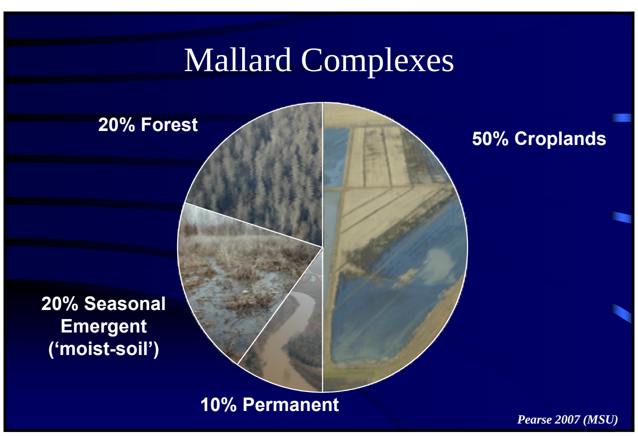

"Grassy Corn"


The Grassy Corn Difference
Moist-soil alone
~2,320 DUDs/acre
Unharvested Corn
~23,500 DUDs/acre


Field Borders, Patches, or Margins


Why all of the Habitats?


Habitat Complexes
Flooded Cropland
Sanctuaries
Natural Wetlands

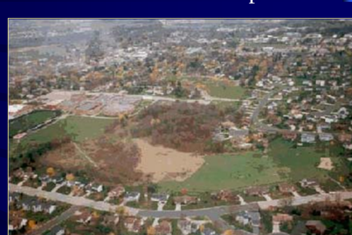

Mallard Complexes
20% Forest
50% Croplands
20% Seasonal
Emergent
('moist-soil')
10% Permanent
Pearse 2007 (MSU)

Why manage so intensively?

Succession

Wetland Management Summary

- Pre-human habitat conditions will never be replaced
- Human needs vs.
  - Water Quality
  - Wildlife
  - Space



Less space = Better conditions in remaining natural habitat

Wetland Management Summary

- Natural wetlands have been highly altered or drained completely
- Private entities and conservation initiatives have stopped loss, but not replaced historical areas (e.g., WRP, CRP, Hunters, etc.)
- Natural wetlands may not ever be truly replaced
  - Altered flooding regimes
  - Timber demand
  - Cellulosic ethanol
  - People

Reduced Quantity = Increased Quality

To fulfill Wildlife and Waterfowl Annual Cycle Needs

Create Hunting Access

Walk-in Access Ramps

Hand or Power Winch

Boat Pull-over Sites