"Obtaining Reliable Estimates of Duck-energy days"

Photo by: R. M. Kaminski

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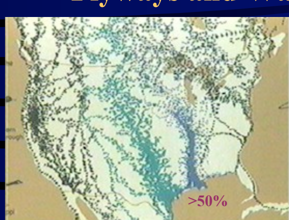
Lecture Structure

I. North American Waterfowl Management Plan

II. Duck-energy days

III. Estimating Food Resources

Flyways and Waterfowl Trends

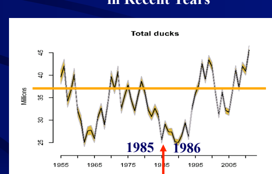


Flyways:

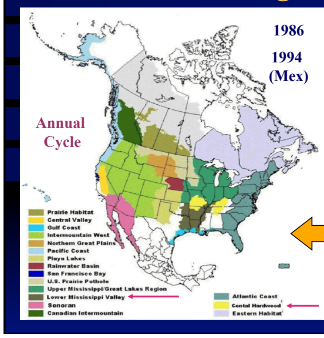
- •Atlantic
- •Central
- •Mississippi
- •Pacific

Declines:

- •1985 Reached All-time Low in Recent Years



North American Waterfowl Management Plan



United States, Canada, Mexico

Strategy to restore continental waterfowl populations to benchmark levels in the 1970s.

Achieved:

Protection, Restoration, and Enhancement

Implemented:

Joint Ventures

(Lower MS Valley)

Quantity and Quality of Waterfowl Habitat

Waterfowl Foraging Carrying Capacity

(Reinecke et al. 1989)

Duck energy-days

The number of waterfowl that can be sustained in a given area for a given amount of time.

Carrying Capacity =

$DED_{cropland} + DED_{moist\text{-}soil\ wetlands} + DED_{hardwood\ bottomlands}$

1 DED = quantity of food necessary to feed 1 duck for 1 day

Habitat Specific Carrying Capacity

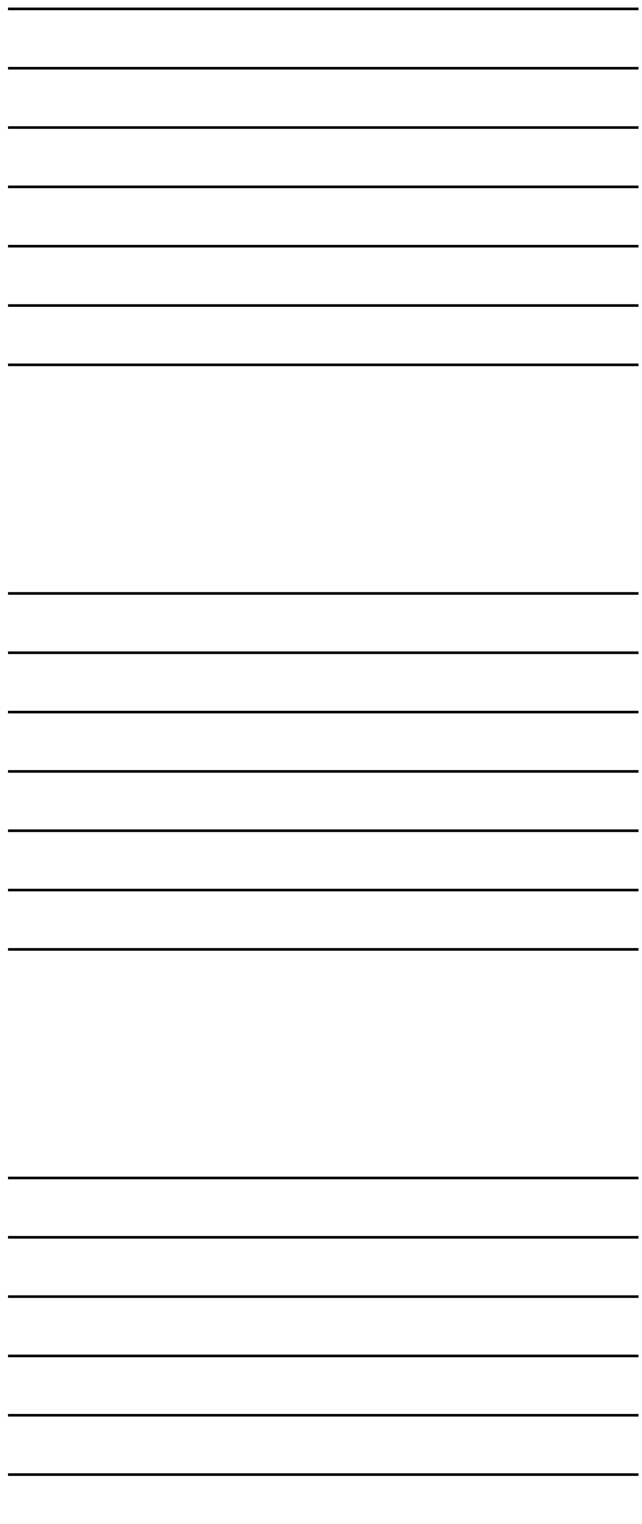
(e.g., Cropland)

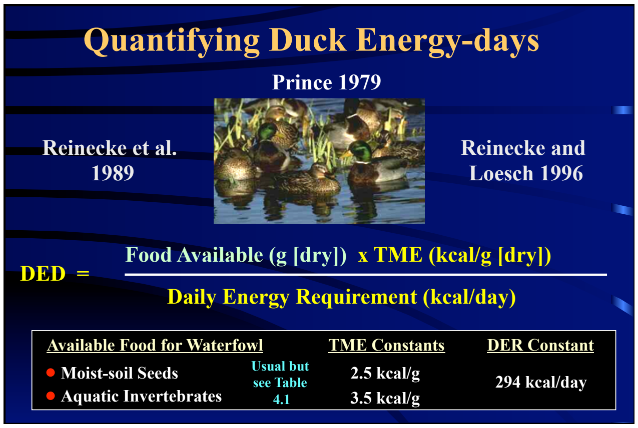
$DED_{cropland} =$

Echinochloa crusgalli var. *frumentacea*

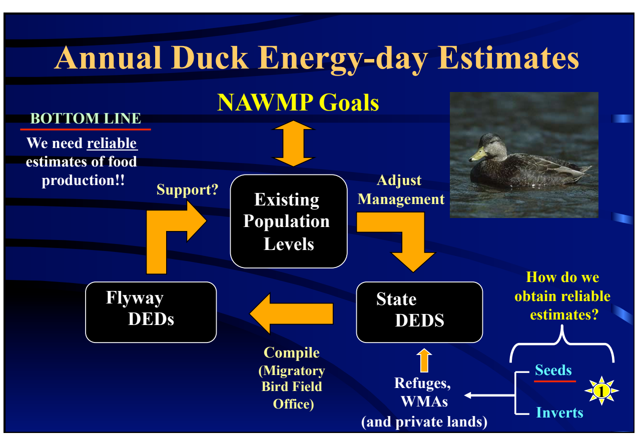
$DED_{seeds} + DED_{invertebrates}$

+




Quantifying Duck Energy-days
Prince 1979
Reinecke et al. 1989
Reinecke and Loesch 1996
DED =
Food Available (g [dry]) x TME (kcal/g [dry])
Daily Energy Requirement (kcal/day)
Available Food for Waterfowl
TME Constants
DER Constant
Moist-soil Seeds
Aquatic Invertebrates
Usual but see Table 4.1
2.5 kcal/g
3.5 kcal/g
294 kcal/day


Why Estimate Duck Energy-days?
•To Determine if Sufficient Food Resources Exist on Migrating & Wintering Grounds to Support Continental Waterfowl Populations
TWRA =87.5 Million DED
•To Determine Refuge or Management Area Contributions to Fulfilling Continental Goals of NAWMP
State & Regional Objectives
For Example, (TN NWR)
13.3 million DEDs = 121,000 ducks for 110 days
(795K)
•To Evaluate Management Practices


Annual Duck Energy-day Estimates
NAWMP Goals
BOTTOM LINE
We need reliable estimates of food production!!
Support?
Existing Population Levels
Adjust Management
Flyway DEDs
State DEDS
How do we obtain reliable estimates?
Compile (Migratory Bird Field Office)
Refuges, WMAs (and private lands)
Seeds
Inverts

Quantifying Available Food

3 Methods:

1) "Constants"

•An estimate of mass from <u>previous direct</u> sampling or published yields (i.e., crops).

Most Common

2) Direct Estimate

•An estimate of mass from <u>current direct</u> sampling in your wetland or ag areas.

3) Prediction Models

•An estimate of mass from <u>current indirect</u> sampling in your wetland or ag areas.

Commonly Used "Constants"

Seed:

Reinecke et al. 1989			kg/ha	TME kcal/g[1]
Croplands (Post-harvest)	•Rice:	(80)	140–223**	3.34
	•Grain Sorghum:	(TX)	148–436	3.50
Moist-soil Wetlands *All Plant Species Combined*			600 (200–1200)	2.5
Hardwood Bottomlands	•20%:		18	3.5
Acorns: % Basal Area of Red Oaks	•40%:		36	3.5

Aquatic Invertebrates:

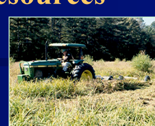
All Species Combined

Arner et al. 1974; Wehrle et al. 1995

•Crop	0		—
•MS	15	(1-31)	3.5
•HBL	10		3.5

[1] <u>Assumes</u> no deterioration and bird uniformity.

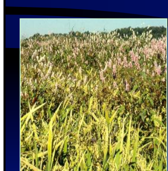
Using Constants for Food Resources



Advantages: •Easy to Use, No Fieldwork, Inexpensive (*estimate area only*)

Disadvantages: •Refuge or Unit Estimates are Merely a Consequence of Area.

Ignores habitat quality and management!



•Estimates from the 80s or outside the Southeast may not be reliable in the Lower MAV and TN.

➢New evidence suggests they may <u>overestimate</u> DED.

•Seed and invertebrate resources are <u>not</u> constant!

For seeds, there is annual and spatial variability in seed production.

For inverts, peak invertebrate production may not correspond to bird use (late winter, March).

Direct Estimation of Food Resources

	Seeds	Invertebrates
Field Work		
Lab Work		

Specialized Equipment: Nets, Clippers, Refrigerated Storage, Sieves, Sorting Trays, Dryer, Desiccator, Balance

Direct Estimation of Food Resources

Steps:

n=30
1-m²

1) Randomly establish sampling plots.
2) Clip vegetation prior to flooding.
3) Collect invertebrates after flooding.
4) Thresh seeds from vegetation.
5) Sort invertebrates from samples.
6) Dry seeds and invertebrates.
7) Weigh seeds and invertebrates.
8) Express dry mass [kg] estimates per ha.

➡ Time and Monetarily Consuming
➡ Need Specialized Equipment

Good Estimate

Direct Estimation of Food Resources

Advantages:
- •The most accurate method for estimating site-specific food resources.
- •Wetland-specific estimates.

Disadvantages:
- •Time Consuming
- •Specialized Equipment Required
- •Expensive

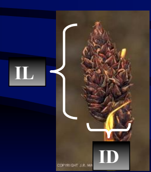
(intense field and lab work)

Most wetland managers do NOT have the resources to directly estimate seed and invertebrate production annually (or several times during flooding).

Estimating Food Resources Using Prediction Models

(Laubhan & Fredrickson 1992; Gray et al. 1999a,b; Sherfy & Kirkpatrick 1999)

Seed Yield = $ß_0 + ß_1$ (Plant Morphology)



Plant Height

Variables: Easy, fast, and strongly correlated with seed production!

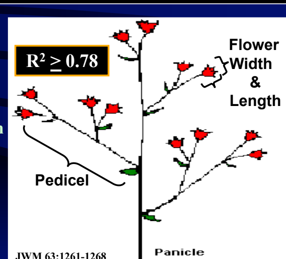
Methods: *Plant Morphological Study*

5 species: *Echinochloa crusgalli, Cyperus erythrorhizos, Polygonum hydropiperoides, Panicum dichotomiflorum, Rynchospora globularis*
n = 60 plants/species/year, 1993 and 1994

L & F (1992)

- Plant Height
- Inflorescence Length
- Infl. Base Diameter
- Infl. Volume
- # of Inflorescences

$R^2 \geq 0.78$



New Variables

- Number of Pedicels
- Number of Flowers
- Flower Width
- Flower Height

Too Complex & Spatial Variability

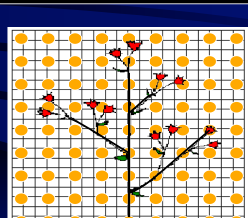
Methods: *Dot Study*

5 species: *Echinochloa crusgalli, Setaria viridis, Panicum agrostoides, Panicum dichotomiflorum, Rynchospora globularis*
n = 30 plants/species/year, 1994

Preparation

- Plant Press
- Room Temperature
- Pedicels Separated

WSB 34:156-158
Conway, unpubl. data



JWM 63:1269-1272

$R^2 \geq 0.92$

Processing

- Dot grid (9 dots/cm²)
- Dots Obscured by Seed Counted

Too Tedious & Time Consuming!

Estimating Food Resources with Models

Advantages:

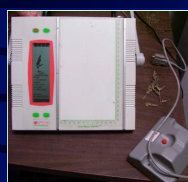
- Wetland-specific estimates.
- Faster, "easier", and less expensive than direct sampling.
- Accurate estimate of food production.

(BUT, maybe only where model was developed)

Disadvantages:

- Models tend to be manager unfriendly.
  - Mathematical and botanical jargon.
  - Variables can be tedious to measure.
- Spatial dependency.
  - Can give inaccurate estimates outside of region (or management area) where model was developed.

New Technology for Estimating Seed Yield in Moist-soil Wetlands



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Scanning Technology

Prediction Models

Seed Head Area → Seed Production

Portable | **Desktop**

1-mm^2 Resolution

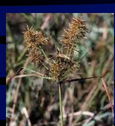
Very fast and accurate?

Objectives

1) Test if scanned seed-head area explained significant variation in seed mass
2) Compare amount of variation explained between portable and desktop scanners and the dot grid
3) Compare amount of time necessary to scan seeds and count dots obscured by seed
4) Develop prediction models for all three methods for use in moist-soil management

7 Common Moist-soil Plant Species

Plant Species

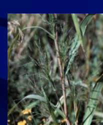

redroot flatsedge
Cyperus erythrorhizos


barnyard grass
Echinochloa crusgalli


Walter's millet
Echinochloa walteri


rice cutgrass
Leersia oryzoides


red sprangletop
Leptochloa filiformis


fall panicum
Panicum dichotomiflorum


curlytop knotweed
Polygonum lapathifolium

Collection

September 2005 & 2006

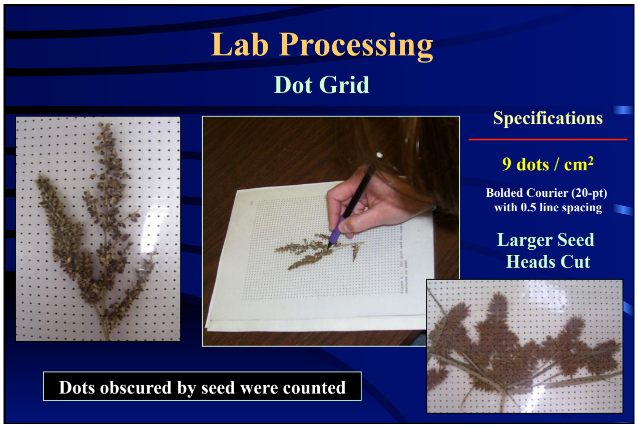
Tennessee National Wildlife Refuge
Duck River Unit


Clipped


Bagged

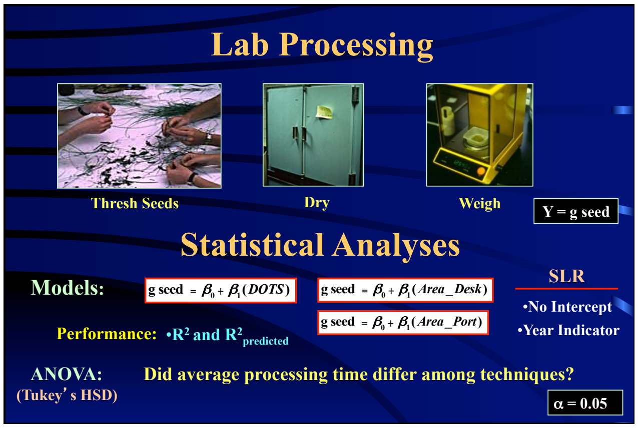

Pressed & Stored

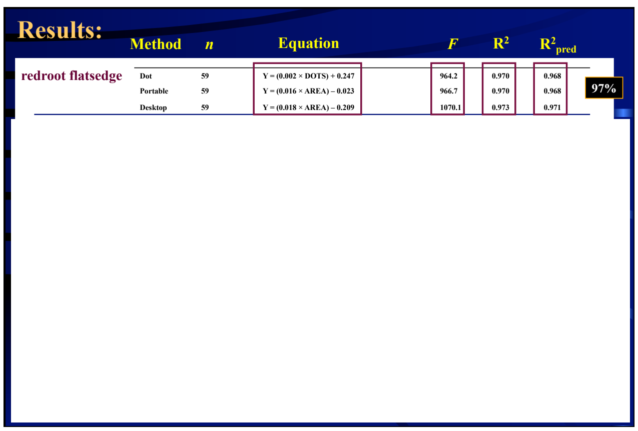
n = 30 plants per species per year


Lab Processing
Dot Grid
Specifications
9 dots / cm^2
Bolded Courier (20-pt) with 0.5 line spacing
Larger Seed Heads Cut
Dots obscured by seed were counted

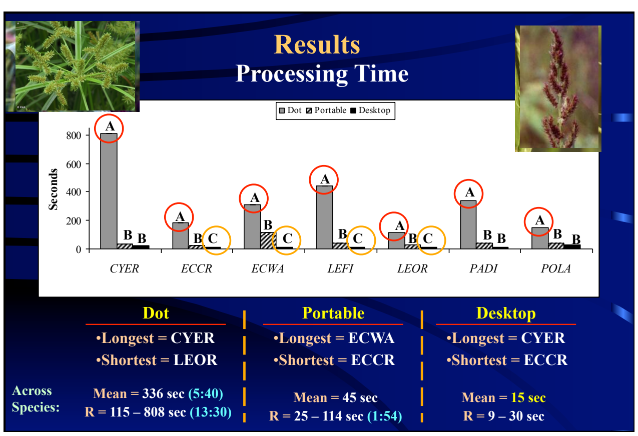

ADC BioScientific
AM 300 Area Meter
$5500
Lab Processing
Portable Scanner
Specifications
22 x 12 cm
Contrast = 5
Contrast = 3
(rice cutgrass)
Larger Seed Heads Cut


LI-COR
LI-3100 Area Meter
$8900
Lab Processing
Desktop Scanner
All Methods
Specifications
25 cm (double)
Length Not Limited
Time Processed





	Method	n	Equation	F	R^2	R^2_{pred}
redroot flatsedge	Dot	59	Y = (0.002 × DOTS) + 0.247	964.2	0.970	0.968
	Portable	59	Y = (0.016 × AREA) – 0.023	966.7	0.970	0.968
	Desktop	59	Y = (0.018 × AREA) – 0.209	1070.1	0.973	0.971



What Conclusions Can Be Made?

Model Performance: Strong Positive Relationship

- Dot grid and both scanners explained substantial variation!
  - → $R^2 > 0.87$
- All models had high predictive ability!
  - → $R^2_{pred} > 0.84$

Processing Time: 15 Seconds!

- Dot Grid took 22X longer than desktop scanner
- Portable Scanner took 3X longer than desktop scanner

Recommend Desktop Scanner Due to Efficiency

How To Use Models

Steps: 1)

Establish Survey Locations

Ten 1-m² Plots

2) Count Stem Density per Species

3) Collect Seed Head (s) from Plant

4) Bag and Press Seed Head

5) Scan Seed Head Per Plant

6) Average Scanned Area Per Species — 50 cm²

7) Predict Seed Yield Per Plant

$$g\ seed = -0.203 + 0.026(Area)$$

$$g\ seed = -0.203 + 0.026(50)$$

1.1 g seed / plant

How To Use Models

Steps:

8) Average Stem Density per Species — 10 plants / m²

9) Multiply Seed Prediction x Stem Density — 11 g / m²

10) Sum Seed Yield Across Species — 11 g / m² (one species)

11) Convert g/m² to kg/ha — 110 kg / ha (succession??)

12) Multiply by Wetland Area — 10 ha = 1110 kg

13) Calculate DEDs

"Foraging Efficiency" = -50 kg / ha

$$DED = \frac{1060\ kg \times 2500\ kcal / kg}{294\ kcal/day} = 9014\ DEDs$$

÷ 110 days

82 Ducks per Day for 110 Days

Wetlands Program
University of Tennessee-Knoxville

We'll Process Seed Heads for You!

- $20 / m^2 plot if seed heads are pressed
- $25 / m^2 plot if seed heads are <u>not</u> pressed
- $800 per plant species to develop new models

Steps:
1) Collect One Random Seed Head per Species per Plot
2) Count Stem Density per Species per Plot — *n* = 10 plots
3) Press Seed Heads for One Week or Mail Directly to UT

Products per Impoundment:
- Seed Production and DED per Plant Species
- Total Seed Production and Total DED

Summary of Problems with Current DED Estimates

1) "Constants"
   - May Overestimate.
   - Not site-specific.
   - Cannot Evaluate Management.
2) Direct Estimation
   - Costs too much.
3) Prediction Models
   - Not Manager Friendly??
   - Regional Bias??

Estimating Seed Yield and Duck-energy Days in Moist-soil Wetlands

http://fwf.ag.utk.edu/mgray/DED/DED.htm

Seed Prediction Equations: Journal of Wildlife Management 73:1229-1232

Plant Species	Method	Enter Dots (#) or Scanned Area (cm^2)	Enter Stem Density (plants / m^2)	Prediction = kg seed / ha	Prediction =DED / ha	Enter Wetland Acreage (ha)	Prediction =Total Kg Seed	Prediction =Total DED
Redroot flatsedge	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Barnyard grass	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Walter's millet	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Red sprangletop	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Rice cutgrass	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Fall panicum	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
Curlytop knotweed	Dot			0	0		0	0
	Portable			0	0		0	0
	Desktop			0	0		0	0
			Total=	0	0	Total=	0	0