"Obtaining Reliable Estimates of Duck energy-days"

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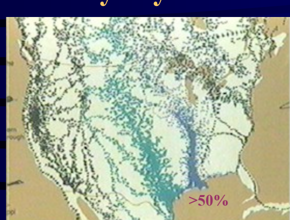
Lecture Structure

I. North American Waterfowl Management Plan

II. Duck energy-days

III. Estimating Food Resources

Flyways and Waterfowl Trends

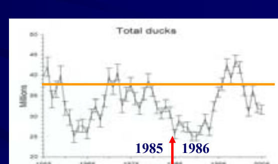


Flyways:

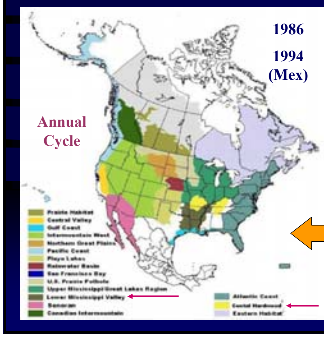
- Atlantic
- Central
- Mississippi
- Pacific

Declines:

- 1985 Reached All-time Low in Recent Years



North American Waterfowl Management Plan



1986

1994 (Mex)

Annual Cycle

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

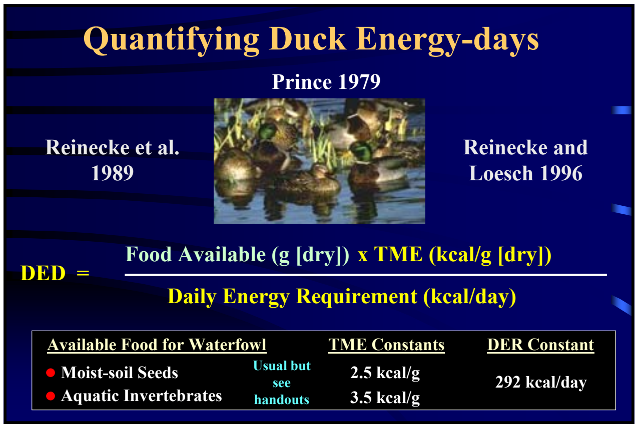
(e.g., Cropland)

$DED_{cropland} =$

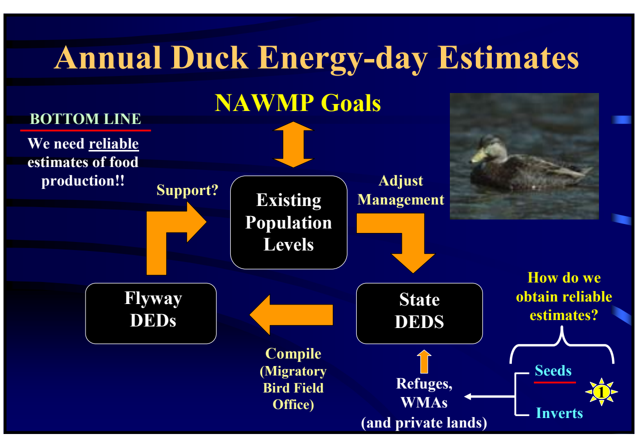
Echinochloa crusgalli var. *frumentacea*

$DED_{seeds} + DED_{invertebrates}$

\+


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 handouts
2.5 kcal/g
3.5 kcal/g
292 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 = (795K)
121,000 ducks for 110 days
•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 previous direct sampling or published yields (i.e., crops). **Most Common**

2) **Direct Estimate**
   - An estimate of mass from current direct sampling in your wetland or ag areas.

3) **Prediction Models**
   - An estimate of mass from current indirect 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*	(Senescence)		450 (100–600)	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] Assumes no deterioration and bird uniformity.

Food Available in Rice Fields

Manley et al. (2004), Stafford et al. (2005)

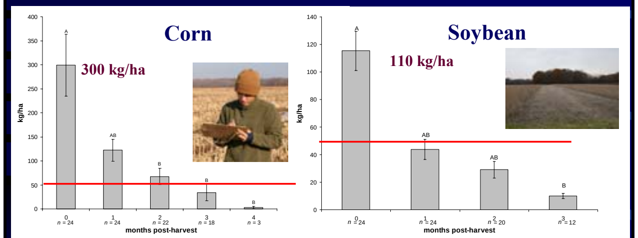
71%, 79-99% Decrease in Seed Availability

271 kg/ha Post Harvest → 78 kg/ha Late Autumn (Near 50 kg/ha Theoretical Threshold) WHY?

Need New Estimates of Waste Grain!!

Waste Grain in Tennessee

Foster and Gray: 2005 Results

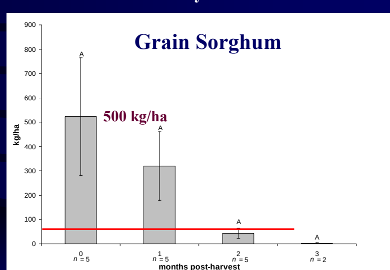


January = 35 kg / ha

January = 17 kg / ha

Waste Grain in Tennessee

Foster and Gray: 2005 Results

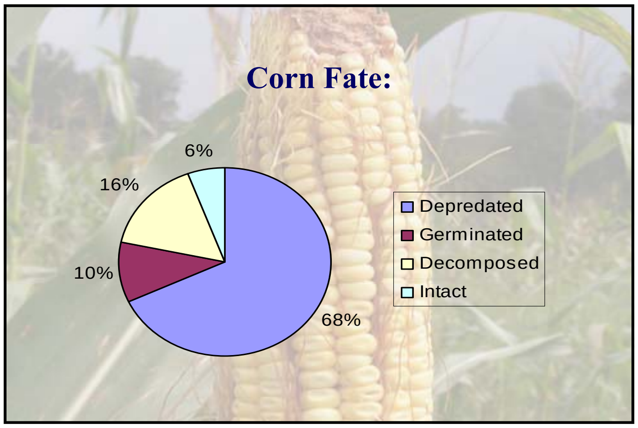


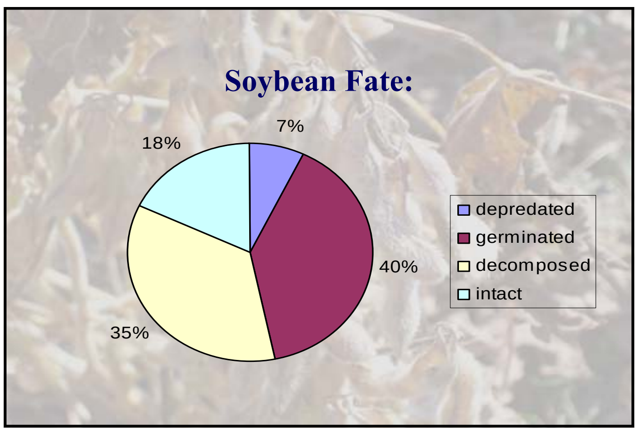
January = 11 kg / ha

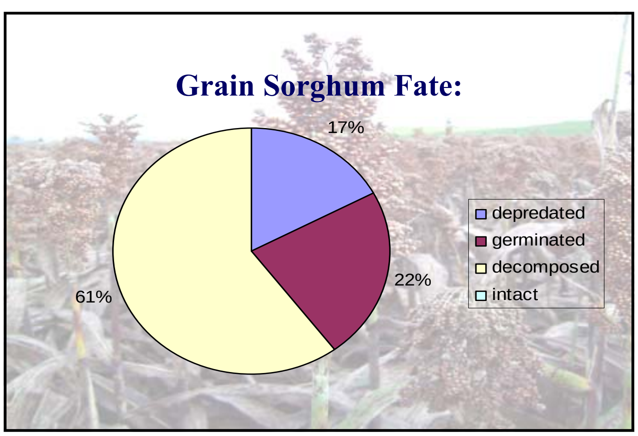
January Estimates:

Harvested

Crop	Fields (*n*)	Biomass (kg/ha) mean	Biomass (kg/ha) SE	DED/ha	LMVJV estimate (DED/ha)	
Corn	24	34.60	13.91	194.4	1250	- 84%
Grain sorghum	5	11.22	4.31	0	1188	Zero!
Soybean	24	16.90	4.30	19.9	89	- 78%


Corn Fate:
6%
16%
10%
68%
Depredated
Germinated
Decomposed
Intact


Soybean Fate:
7%
18%
40%
35%
depredated
germinated
decomposed
intact

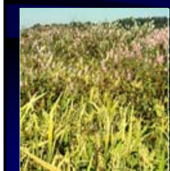

Grain Sorghum Fate:
17%
22%
61%
depredated
germinated
decomposed
intact

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!



•MAV Estimates from the 80s may not be reliable.

➢New evidence suggests they may overestimate DED.

•Seed and invertebrate resources are not constant!

For seeds, what there is at senescence, may not be what is available to birds when they arrive.

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-m^2

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 Seed Resources

A New Technique: The "Seed-vac"

Penny et al. (2006)

88% Recovery Rate
Correction Factor = 1.14

Direct Estimation of Food Resources

Advantages:

- The most <u>accurate</u> method for estimating site-specific food resources.
- <u>Wetland-specific</u> estimates.

Disadvantages:

- Time Consuming
- Specialized Equipment Required
- Expensive

(intense field and lab work)

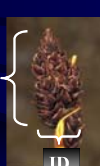
Most wetland managers do <u>NOT</u> have the resources to directly estimate seed and invertebrate production annually (or several times during flooding).

Estimating Food Resources Using Prediction Models

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

$$\text{Seed Yield} = \beta_0 + \beta_1 \text{(Plant Morphology)}$$

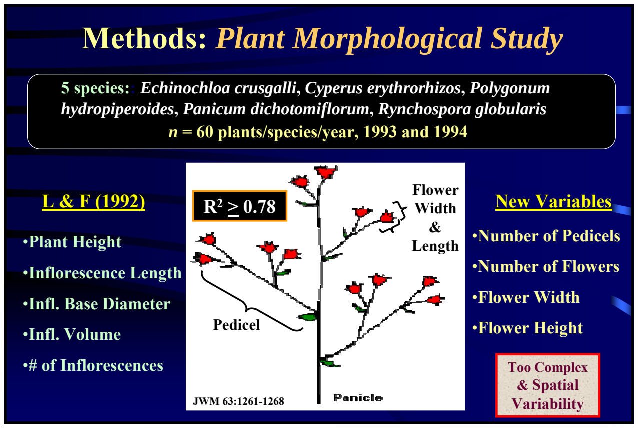
IL

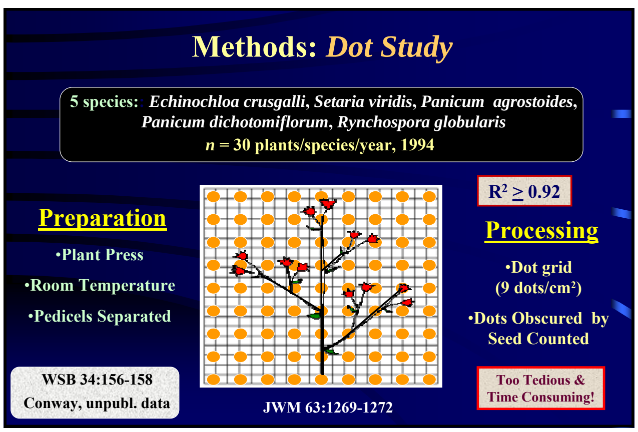


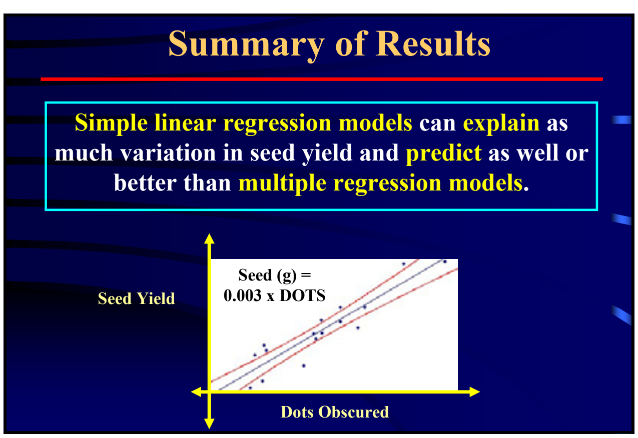
ID

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
R² ≥ 0.78
Flower Width & Length
Pedicel
JWM 63:1261-1268
Panicle
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
R² ≥ 0.92
Processing
•Dot grid (9 dots/cm²)
•Dots Obscured by Seed Counted
Too Tedious & Time Consuming!


Summary of Results
Simple linear regression models can explain as much variation in seed yield and predict as well or better than multiple regression models.
Seed Yield
Seed (g) = 0.003 x DOTS
Dots Obscured

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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Institute of Agriculture
Wetlands Program

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

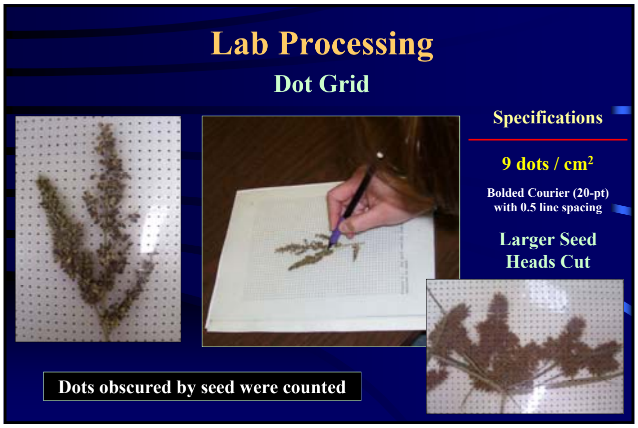
Tennessee National Wildlife Refuge
Duck River Unit

Clipped

Bagged

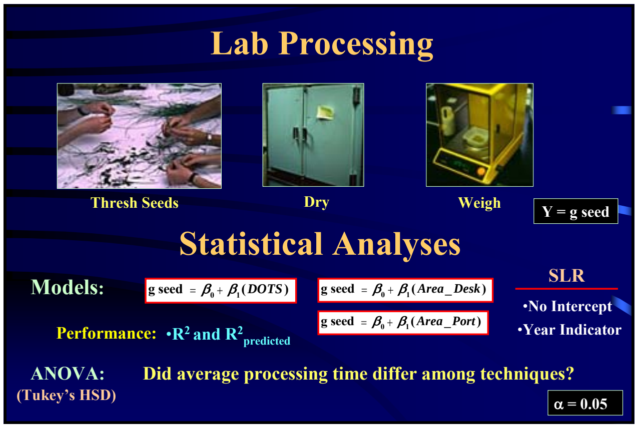
Pressed & Stored

n = 30 plants per species per year


Lab Processing
Dot Grid
Specifications
9 dots / cm2
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

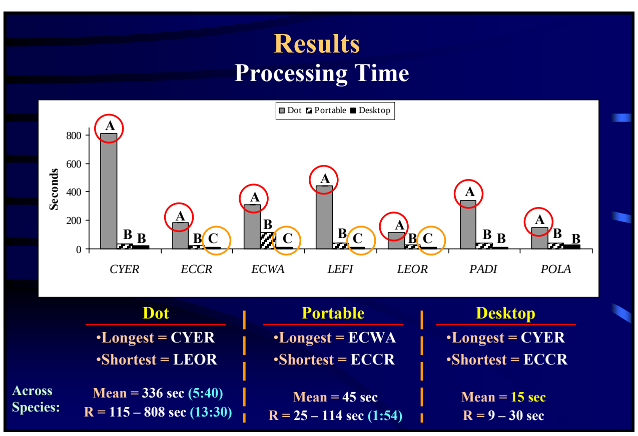

LI-COR
LI-3100 Area Meter
$8900
Lab Processing
Desktop Scanner
All Methods
Time Processed
Specifications
25 cm (double)
Length Not Limited
Videos



Results:

	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

97%



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:

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

15 Seconds!

Recommend Desktop Scanner Due to Efficiency

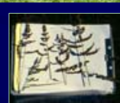
How To Use Models

Steps: 1)

Establish Survey Locations

Ten 1-m² Plots

2) Count Stem Density
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

$\text{g seed} = -0.203 + 0.026(\textit{Area})$

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

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

$$\text{DED} = \frac{1060 \text{ kg} \times 2500 \text{ kcal / kg}}{292 \text{ kcal/day}} = 9075 \text{ DEDs}$$

÷ 110 days

83 Ducks per Day for 110 Days

Excel® Spreadsheet
- Scanned Area
- Stem Density

Computing Duck Energy-days

Wetland	Area	Seed Yield	MTE	DER	DED
Mandri	138 ha	150 $\frac{kg}{ha}$	2500 $\frac{kcal}{kg}$	292 $\frac{kcal}{day}$	178K
Santa Teresa	73 ha	600 $\frac{kg}{ha}$	2500 $\frac{kcal}{kg}$	292 $\frac{kcal}{day}$	377K

½ Million DEDs

6 Months

Oct -March

3083 Ducks/Day

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??

Now It's Your Turn!!!

Duck Energy-Day Assignment

Due: 28 March 2008; 5:00 pm