"Obtaining Reliable Estimates of Duck-use Days"


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Lecture Structure

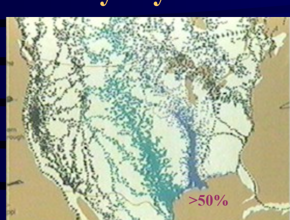
I. North American Waterfowl Management Plan

II. Duck-use Days

III. Estimating Food Resources

IV. Research Needs

Flyways and Waterfowl Trends

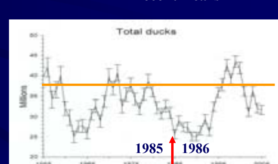


Flyways:

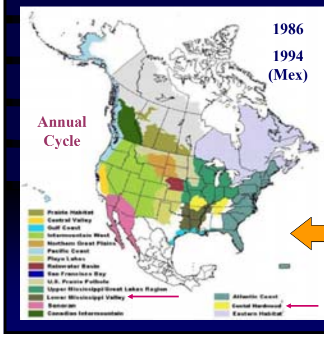
- •Atlantic
- •Central
- •Mississippi
- •Pacific

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-use Days

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

Carrying Capacity =

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

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

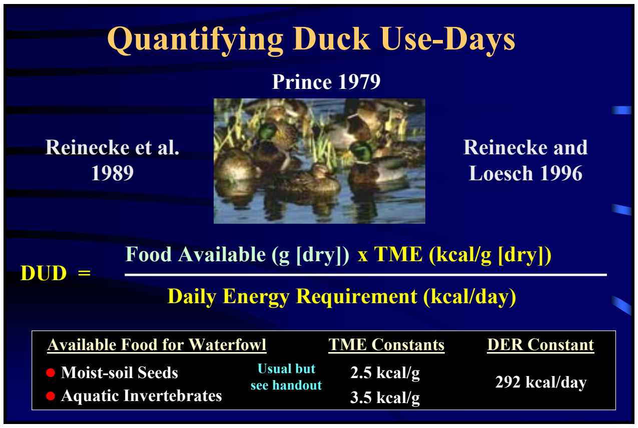
Habitat Specific Carrying Capacity

(e.g., Cropland)

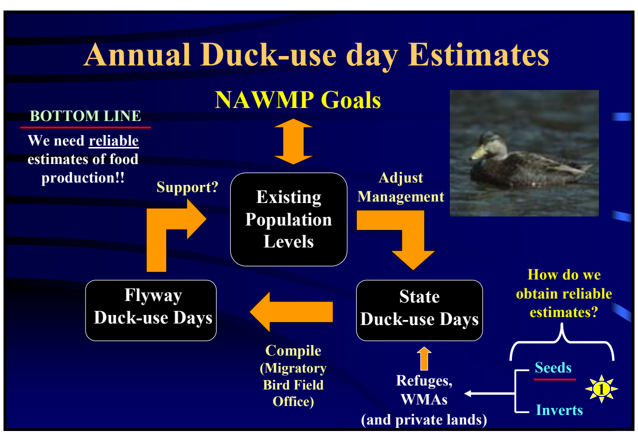
Echinochloa crusgalli var. *frumentacea*

$$DUD_{cropland} = DUD_{seeds} + DUD_{invertebrates}$$

\+


Quantifying Duck Use-Days
Prince 1979
Reinecke et al. 1989
Reinecke and Loesch 1996
DUD = 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 handout
2.5 kcal/g
3.5 kcal/g
292 kcal/day


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


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

Quantifying Available Food

3 Methods:

Aquatic Invertebrates and Seeds

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	•Rice:	(80)	140–223**	3.34
(Post-harvest)	•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

	kg/ha		TME kcal/g[1]
•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)

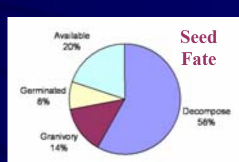
71%, 79-99% Decrease in Seed Availability

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

WHY?

Less Food (DUD) Available!!

140 kg/ha → 752 DUD/ha
325 DUD/ha



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 <u>overestimate</u> DUD.

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

<u>Steps</u>:

<u>n</u>=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. :*in review*

88% Recovery Rate
Correction Factor = 1.14

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)

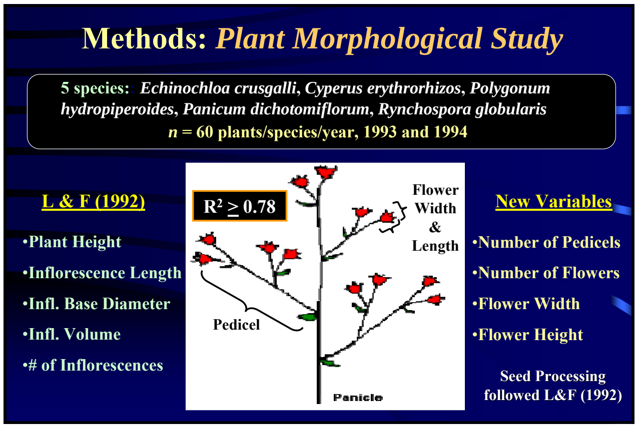
Most wetland managers do NOT have the resources to directly estimate seed and invertebrate production annually (or several times during flooding).

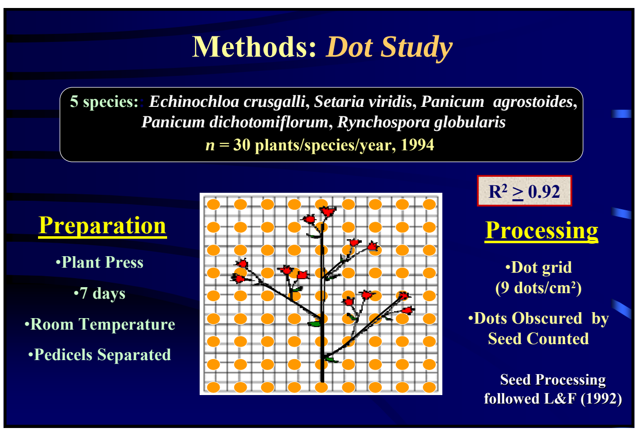
Estimating Food Resources Using Prediction Models

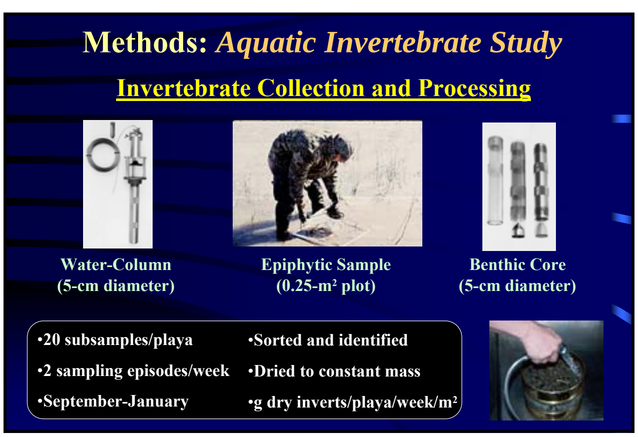
(Laubhan & Fredrickson 1992; Gray et al. 1999a,b; Sherfy & Kirkpatrick 1999)

Seed Yield = $ß_0 + ß_1$ (Plant Measurements, Dots)

Invertebrate Biomass = $ß_0 + ß_1$ (Water Quality, Depth)


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
$R^2 \geq 0.78$
Flower Width & Length
Pedicel
Panicle
New Variables
•Number of Pedicels
•Number of Flowers
•Flower Width
•Flower Height
Seed Processing followed L&F (1992)


Methods: Dot Study
5 species: Echinochloa crusgalli, Setaria viridis, Panicum agrostoides, Panicum dichotomiflorum, Rynchospora globularis
n = 30 plants/species/year, 1994
Preparation
•Plant Press
•7 days
•Room Temperature
•Pedicels Separated
$R^2 \geq 0.92$
Processing
•Dot grid (9 dots/cm^2)
•Dots Obscured by Seed Counted
Seed Processing followed L&F (1992)


Methods: Aquatic Invertebrate Study
Invertebrate Collection and Processing
Water-Column (5-cm diameter)
Epiphytic Sample (0.25-m^2 plot)
Benthic Core (5-cm diameter)
•20 subsamples/playa
•2 sampling episodes/week
•September-January
•Sorted and identified
•Dried to constant mass
•g dry inverts/playa/week/m^2

Methods: *Aquatic Invertebrate Study*

Predictor Variables

***Water Variables*:**

- Conductivity
- Dissolved Oxygen
- Temperature
- pH
- Water Depth

***Induced Variables*:**

- Inundation duration
- Treatment (managed, unmanaged)

Seed Prediction Results: *4 Models*

	Our Data L & F	Best Model	L & F (1992)	Dot Model
$R^2_{adjusted}$	0.68-0.92	0.78-0.97	0.79-0.96	0.92-0.97
$R^2_{predicted}$	0.23-0.88	0.31-0.97	NAV	0.91-0.96
MSE	0.002-0.39	0.001-0.18	NAV	0.001-0.009
C_p	48.2-495.0	3.9-6.6	NAV	NAP
VIF	1.1-34.8	3.9-12.0	NAV	NAP

NAV = Not Available, NAP = Not Applicable

Invertebrate Prediction Results (*Single Variable Models*)

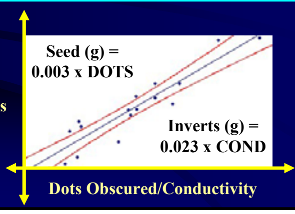
Increasing *p*, Increased $R^2 \leq 0.03$ Increasing *p*, Increased VIF ≥ 10

	$R^2_{adjusted}$	$R^2_{predicted}$	MSE
Conductivity	0.604	0.582	333.14
Treatment	0.587	0.562	347.48
pH	0.581	0.564	352.83
DO	0.494	0.483	426.40
Depth	0.469	0.451	449.09
Time	0.396	0.379	508.49
Temperature	0.371	0.365	529.34

Summary of Results

Simple linear regression models can explain as much variation in seed yield and aquatic invertbrate biomass and predict as well or better than multiple regression models.

Seed Yield/
Invert Biomass



Dots Obscured/Conductivity

Estimating Available Food via Equations

Steps:
n=30
1-m²

1) Randomly establish sampling plots.
2) Clip 1 randomly selected plant per spp.
3) Count plant density per spp. per plot.
4) Measure water quality or depth.
5) Measure plant morphology or count number of dots covered by seed.
6) Estimate dry seed/plant & invertebrate mass/m² using prediction equations.
7) Multiply estimate of seed mass/plant/spp. by $\bar{x}$ plant density for each species.
8) Convert estimates to kg/ha & $\sum_{Species} kg/ha$ *

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.

Should use suite of equations developed closest to your site.

(MS, MO, VA)

Computing Duck-use Days

Steps:

1) Estimate food resources per ha.
2) Multiply #1 by the TME of food resource.
   ➡ Use Published or Own Estimate(s)
3) Divided the product of #1 and #2 by the daily energy requirement of waterfowl.
   ➡ Use Published or Own Estimate(s)
4) Compute DUD by multiplying #3 by area (ha) of wetland and $\sum_{Habitat} \sum_{Food} DUD$
5) Express DUD as a total or daily estimate (i.e., divide by hydroperiod).

"Foraging Efficiency" Correction Factor for #1: –50 kg/ha

Computing Duck Use-Days

Wetland	Area	Seed Yield	MTE	DER	DUD
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 Duck Use-Days

6 Months

Oct -March

3083 Ducks/Day

Summary of Problems with Current DUD Estimates

None Address Temporal Changes

1) "Constants" (Kaminski & Reinecke Recent Research)
   - May Overestimate.
   - Not site-specific.
   - Cannot Evaluate Management.
2) Prediction Models
   - Not Manager Friendly: confusing, tedious.
   - Should Not Be Used Across Regions.
3) Direct Estimation
   - Costs too much.

How much food is here when ducks arrive?

Some Ideas for Future Research

Constants

Constants commonly used for seed (moist-soil, acorns, and agricultural grains) and aquatic invertebrates need to be verified.

(only been done for rice)

	1980s Estimates		Current Estimates
Moist-soil:	450 kg/ha		?
Rice:	140 kg/ha	→	78 kg/ha (Available for Ducks)
Corn:	325 kg/ha	(Illinois)	?
Sorghum:	292 kg/ha	(Texas)	?
Acorns:	80 kg/ha		?

Inverts in Moist-soil & Hardwood Bottomlands (start in west Tennessee then replicate through MAV)

Some Ideas for Future Research

Prediction Models

Seed-head Area Meter: $0.067\ cm^2$ – ? Resolution

Scanner: $300

Software: $1500

15 minutes

Scanner: $8,200

Very fast and accurate

Scanner: $5,000

Gray et al.