The Principle of Amphibian Husbandry
What is Husbandry?

The discipline of care and breeding of animals in captivity.

Using Scientific Principles
Taking good care of your animals.
Maintaining Welfare (Well Being)

How do we know? Metrics

- Absence of disease
- Normal Behaviors
- No Abnormal Behaviors
- Can reproduce
- Not Dead – The dead do not have welfare
Needs

- Appropriate Environment
- Water in appropriate form
- Appropriate Food
- Appropriate Intra-specific interaction
- Energy
  - Light
  - Heat
  - UVB
Know Your Animals

These are not reptiles, birds, or mammals

Amphibians are much closer to fish than they are to reptiles, birds, and mammals

Think of the amphibian as a fish with legs
Homeostasis
The inside/outside barrier
Amphibians are common victims...and good taste

My complexity is exceeded only by my good looks
Different animals have different requirements
Know your subject!

- Review Literature
- Ask others
- Observe and learn from your animals
- Share
The appropriate environment is 95% of good amphibian husbandry.
Enclosure
One species, several life stages

Enclosures may be designed for only one life stage
Enclosure Functions

- Maintenance
- Breeding
- Larval Rearing
- For Metamorphosis
- Growth of juveniles
The Environment

Heterogeneity
Creating a micro-environments
Environment

Think on the viewpoint of the amphibian

Different micro environments are necessary for difference physiological process.
The Enclosure
It’s a system

An Open System

Energy
Water and food
Enclosure
Appropriate Environment
Biological and Chemical Processes
Energy
Water, food and waste
Environment Parameters

- Temperature
- Water in the air (Water Vapor)
- Water as a liquid
- Substrate
- Cage furnishings (for function, and physical and psychological needs)
- Light
  - Photo Period
  - Quality
  - UVB
Temperature Gradient

Gravel

25°C

25°C

30°C

Water

40°C
Cage Temperature

Cage Temperature Environment

Cage Temperature

Case 1  Case 2  Case 3  Case 4  Case 5  Case 6  Case 7  Case 8  Case 9  Case 10

COL1  COL2  COL3  COL4  COL5  COL6  COL7  COL8  COL9  COL10

Temperature Levels:
- 46
- 42
- 38
- 34
- 30
- 26
The importance of thermal options in many species

General Rules: Start with lower temperature and add heat in specific areas
Hibernation

The period of low temperature dormancy
Water

H$_2$O Quality will be presented later in the workshop.
Water as a Liquid

- Accessible
- Appropriate quality
- Appropriate form
  - Standing water
  - Running water
  - Surface moisture
  - Mist and Rain
Standing Water
Flowing water
Mist and Rain Systems
Water Vapor (It's all relative)

- Relative Humidity (RH)
- Microenvironments
  - May be very different in different parts of cage.
- The amount of water in the air compared to the amount of water the air can hold
- Increase in temperature increases the amount of water the air can hold
- Lower pressures increase the amount of water the air can hold
RH Microenvironment

- 65% RH
- 75% RH
- 100% RH
- 40% RH

Gravel → Water
Frogs and other amphibians absorb water through their skins

Drinking patch
Drinking Patch
Substrate

It's more than just the stuff on the bottom of the cage
Substrates (Artificial)

- Paper towels
- Astroturf
- Rubber mats
- Screening
- Cage bottom (none)
Substrates (Natural)

- Gravel
- Coconut husks
- Potting soil
- Moss
  - Living
  - Dead
- Sand
- Rocks
- Mulch
Gravel
Foundation of the environment
Moss growing on palm husk on gravel
Potting Soil

Bucket of soil
Leaf litter
Substrates (Additives)

- Activated carbon
- Dolomite (CaCO$_3$)
Maintaining and cleaning the environment
Water in – Water out

- Drainage
  - Water flow
  - Cleaning
Adding drains to a glass tank

It is easier than you think

Caution: Make sure the tank glass is not tempered
Bulkhead Fitting
The False Bottom
Drainage of Substrate
A drainage system
Cage structures

- Environmental Complexity
- Refugia
- Visual barriers
- Breeding sites
Refugia
Perching
Oviposition Sites
Creating an Environment

North American Cave Salamander
Other living components in the Enclosure

- Plants
- Bacteria
- Invertebrates
Light and UVB is important component of the amphibian environment.
Halogen bulbs

Produce light, excellent UVB, and a heat spot

This is one of many products available
Air Exchange

Air flow is particularly important for some species.
Remember containment!
Other considerations

- Social groups
- Medical Treatment
- Disease control
What about larvae?
A day’s work

Bufo houstonensis

Ceratophrys
Larval Production Tank
Larva Habitats

Dendrobates
Quick Cups
Dendrobatids
A second birth

Metamorphosis
Simple Metamorphosis Chamber

All stages must be accommodate Larval → Juvenile
Metamorphosis enclosures
Bring it all together
Bringing it all together
Brining it all together
Display
Science and Husbandry
Husbandry should be considered a discipline.
Science

Helps us get closer to understanding the truth
Problem Solving

What keepers do every day!
What you can’t measure, you can’t understand.
Measurements

- Temperature
- Mass
- Length
- Light
- Events
- Observable behavior
- Etc.
Measuring Technology
Infrared remote temperature sensing
Newer Technology
Data Loggers
Digitized Data

Launch

HOBO Temp, RH, 2x External (C) 1999 Onset  S/N: 280810
Date: 04/21/99  21:20:44  Deployment: 3

Description: Zone 1 Temperature and RH

Interval (Duration): 1 Mins (2 Days, 18 Hrs, 11 Mins)

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<th>Channels</th>
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<tr>
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<td>°F</td>
<td>69.71</td>
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<td>% RH</td>
<td>1, 2</td>
<td>%</td>
<td>38</td>
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(*) Next to channel identifier denotes a selectable sensor channel.

Battery: [Good]

- Wrap around when full [overwrite oldest data]
- Delayed Start: 04/22/99 12:00:00

Enable/Disable Channels...
Digitized Data
Example

Halogen Bulbs
D2 – D3 Conversion
Is there a low cost source for UVB that could be used for amphibian husbandry?
The Ability to Measure
Precision

![Graph showing wavelength and intensity with a peak at 295nm]
# Confirmation with a Biological Metric

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Applied Science
Kihansi Spray Toads
Example:

You start feeding your frogs a new vitamin supplement. They breed a month later. Did the vitamins help them to breed?

The three Cs
The three Cs

- Coincidence
- Correlative
- Causative
Life’s complexities

- Life is a very complex system
- Reptiles and Amphibians are very complex
- Rarely Black and White
The scientific method

1. Observations
2. ?Question?
3. Hypothesis
4. Prediction
5. Test: Experiment or More Observation
6. Analysis

If the answer is NO, repeat the process.

If the answer is YES, go back to Imagination & Intuition.
Water quality and development

Example

Phyllobates vittatus
Which water supply is better for rearing *Dendrobatid* larvae?

- Aged Water
- Carbon Filter Water
- Softened Carbon Filtered Water
- RO water

Hypothesis: RO water, which is closest to rainwater, will be a superior medium for rearing *Phyllobates*. 
The Experiment

- Four Groups
- Four Different Water Sources
- Each Fed Same Diet
- Each Provided Same Husbandry (enclosures, water volume, temperature, light, water changes, etc.)
- Compare Metamorphic Success and Deaths
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<tr>
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<td>11</td>
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<tr>
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<td>All Groups</td>
<td>36</td>
<td>42</td>
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Using data analysis tools
Visualization

Bivariate Distribution: EVENT x RX

P=0.518
Learn what others have done

- Library
  - Books
  - Articles
- The value of peer review
- INTERNET
- Contact others that work with the species
Few groups of animals in zoos afford more opportunity for research than the Amphibia!

Focus on what is needed to save them
Gracias