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Chronic Wasting Disease Risk Analysis Workshop: An Integrative Approach

By Shana Gillette, Joshua Dein, Mo Salman, Bryan Richards, and Paulo Duarte, editors

Open-File Report 2004-1418

U.S. Department of the Interior
U.S. Geological Survey

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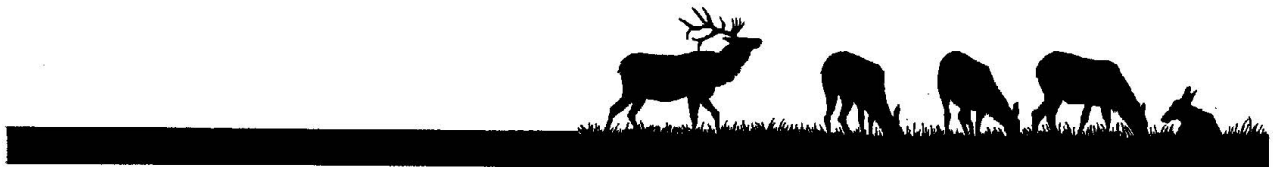


Workshop Summary

Introduction

Risk analysis tools have been successfully used to determine the potential hazard associated with disease introductions and have facilitated management decisions designed to limit the potential for disease introduction. Chronic Wasting Disease (CWD) poses significant challenges for resource managers due to an incomplete understanding of disease etiology and epidemiology and the complexity of management and political jurisdictions. Tools designed specifically to assess the risk of CWD introduction would be of great value to policy makers in areas where CWD has not been detected.

To this end, the U.S. Geological Survey (USGS) created a steering committee representing states, native communities, federal, academic, and non-government entities. This committee formulated a collaborative process for the development of CWD risk assessment tools applicable to both free-ranging and captive populations. The committee recommended a workshop be held on the topic and suggested the format, content, and potential participants.

Identified objectives of the workshop included:

1. Identify and discuss the needs of various government and non-government groups involved with assessing, managing, and/or preventing CWD.
2. Identify current gaps in CWD research specifically in relation to information applicable to the risk analysis process.
3. Construct a general, consensual, framework model (Figure 1) that incorporates all factors identified as potentially associated with the presence or absence of CWD (Table 1).

The resulting CWD Risk Analysis Workshop was held May 11–13, 2004 in Fort Collins, Colorado. The workshop was attended by 28 individuals representing a cross-section of management, research, and non-government organizations. Experts with experience in a variety of risk analysis approaches and representatives from public and private user groups presented in the plenary session. The remainder of the workshop consisted of facilitated breakout sessions and all-group discussions.

The framework model (Figure 1) reflects the workshop discussions and subsequent review and comments from workshop participants and steering committee members.

Risk Analysis Group Breakout Discussion

Discussion centered on three topics: (1) tools and process for analyzing risk, (2) risk factors, and (3) the information collection needed to implement a risk analysis.

Design Considerations for Risk Analysis Tools

- Should be applicable, usable, and realistic.
- Should help a state assess its level of risk for introducing and detecting CWD.
- Could provide managers with a standardized tool for comparing Area A with Area B by providing some type of relative comparison.

Suggested Directions for a Risk Analysis Model

- Would be developed for use in areas in which CWD has not yet been reported.
- Would scientifically identify or build some confidence that the disease is absent in an area.
- Would focus on animal health (as opposed to including a risk analysis for human health).
- Should take into consideration temporal and spatial elements (i.e., white-tailed deer behavior can change dramatically across the landscape).

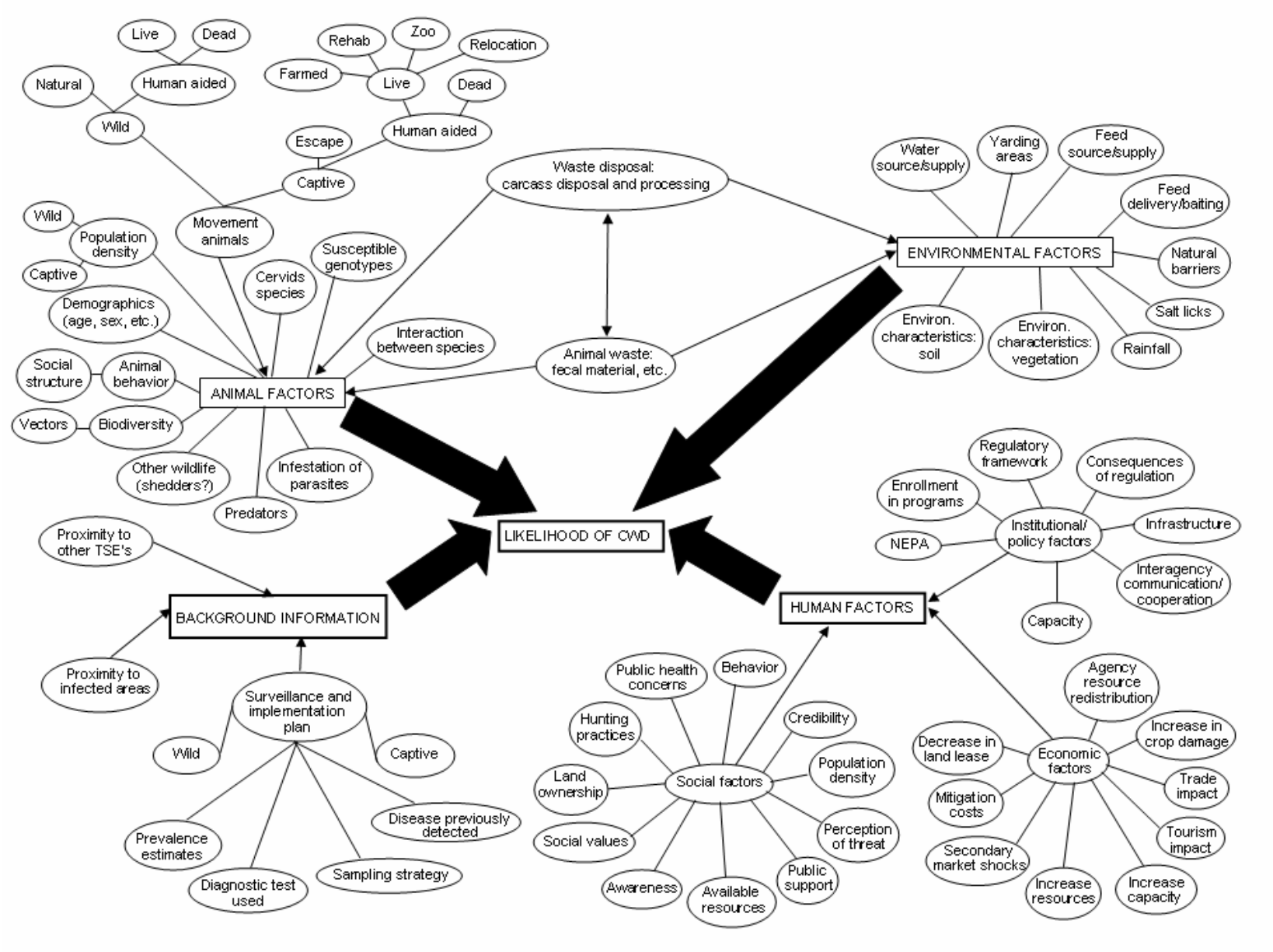


Figure 1. Framework model: Risk of CWD introduction.

- Should assess possible pathways, assess their strength, and then look at possible mitigation. For example, pathway analysis could help target surveillance design and implementation.
- Could be modified from an already existing agricultural model (i.e., OIE "chain of events" model) to build a link between captive and wild populations.

Information Collection Needs

- Managers need to know, based on the data that they already have, their ability to say with certainty whether they do or do not have the disease. The risk analysis process would help managers identify where there are gaps of information and how filling those gaps could contribute to increasing certainty about the disease.
- States are proposing different strategies at a 95% confidence for detecting a 1% prevalence of CWD. But states need to know: How long do they have to collect data before they can say anything?
- Surveillance methods need to be evaluated to have some feeling of the confidence level before the levels of risk can be determined.
- It is necessary to know how well pathways are regulated.

User Group Breakout Discussion

Discussion centered on three topics: (1) management priorities in states that do not yet have CWD, (2) user-identified risk factors associated with CWD, and (3) information collection needs.

Management Priorities in Assessing and Preventing CWD

- Create awareness.
- Enlist buy-in from groups and entities such as Native American groups.
- Design enforceable regulation of intrastate movement or importation of cervid and cervid products.
- Develop an enforcement network.
- Develop measures that are fair.
- Conduct fact-finding to help inform policy decisions.
- Need to know where to focus surveillance efforts, how, why, and when.
- Surveillance efforts need to be fair and include all stakeholders.

Information Collection Needs

- Develop more effective testing.
- Develop effective ways to measure environmental contamination.
- Better understand the role of susceptible species in CWD spread.
- Better understand the role of predators in CWD (e.g., predators solve the problem, prion transmission through predator).
- Better define the size and appropriate sample of affected populations.
- Resolve conflicting or poorly formatted information.
- Need information that can be translated and condensed from scientist to user and vice versa (with referral to in-depth information).
- Need to know how long surveillance should be conducted in order to say with some certainty that the area does not have CWD.
- Need to regularly circulate information to agencies.

Questions That Arose During the Discussion

- Does the risk analysis process include not only the risk factors associated with the introduction of the disease, but also the factors associated with maintaining the disease?
- What is the best way to sample for a rare event?

Mixed Group Discussion

The mixed group incorporated contributions from both groups into the framework model. Additional risk factors were also added when the group as a whole decided to include risk factors associated not only with the introduction of CWD, but also with the susceptibility of an area to CWD spread and establishment. Two exercises were conducted to clarify how risk factors should be scored, ranked, and defined within the model.

Future Directions

Phase One: Workshop, May 2004

The CWD Risk Analysis Workshop represented phase one of the USGS-funded collaborative project to develop CWD risk assessment tools.

Phase Two: Framework Model, June–July 2004

This stage of the project has entailed refining the framework model (Figure 1) developed at the workshop from the identified risk factors compiled by workshop participants (Table 1); working on the pathways for introduction, spread, and presence of CWD; and characterizing data related to each factor (i.e., availability, quality).

Phase Three: Development of Quantitative Model, August 2004 — ongoing

In this phase of the project, a quantitative model will be developed to estimate the likelihood of introduction and spread of CWD into new areas and the likelihood of presence or absence of the disease in areas where CWD has not been reported. The model will be built based on the best scientific information available for each factor, taking into consideration the relative importance of each factor as determined by workshop participants and other collaborators. The model will first be tested using hypothetical scenarios for the introduction and spread of the disease. Then the model will be assessed for its practicality and reliability using selected states/areas where CWD has not been reported.

Phase Four

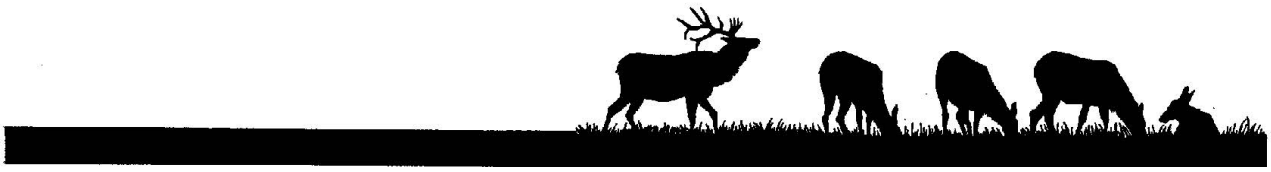
Phase four of the project will focus on the development of tools that will help resource managers analyze evidence related to CWD risk and guide the development of appropriate preventive and/or control measures. The tools will be tested for usability and practicality by selected users. After refinement, tools will be released for general application.

2004 funds have supported phases 1, 2, and the initial stages of phase 3.

Table 1. Risk factors–importance to Chronic Wasting Disease introduction (compiled and revised by workshop participants). *Risk factors were compiled from the rating exercise conducted during the workshop and revised based on comments provided after the workshop.

Importance to CWD introduction	Risk factors*
High	Disease previously detected
	Movement of animal/wild/natural
	Movement of animal/wild/human-aided/live relocation
	Movement of animal/captive/escape
	Movement of animal/captive/human-aided/live/farmed
	Movement of animal/captive/human-aided/live/rehab
	Movement of animal/captive/human-aided/live/zoo
	Natural barriers
	Prevalence
	Proximity to infected area
Medium	Animal behavior
	Animal products in commerce
	Movement of animal/wild/human-aided/dead
	Movement of animal/captive/human-aided/dead
	Number of captive facilities: CWD positive or unknown status
	Waste disposal: carcass
	Waste disposal: process
Low	Biodiversity
	Demographics: captive
	Demographics: wild
	Feed delivery
	Feed supply
	Number of captive facilities: certified and CWD negative
	Other wildlife (shedders?)
	Population density: captive
	Population density: wild
	Soil
	Species interaction
	Susceptible genotypes
	Vectors
	Vegetation
	Water supply
	Wildlife feeding and baiting
Opinion split between Medium and High. Factors could shift in level of importance when more research information is available.	Animal behavior
	Animal waste
	Proximity to TSEs
	Social political (e.g., inconsistent regulations between states, enforcement

These ratings were compiled from the rating exercise conducted during the workshop and revised based on comments provided after the workshop.



Workshop Presentations

Welcome to the Chronic Wasting Disease Workshop

Josh Dein, USGS National Wildlife Health Center

History and Background

- CWD historically in Colorado and Wyoming
- Detection in WI created national attention
- Congressional directions to U.S. Department of the Interior and U.S. Department of Agriculture
- Nine NWHC CWD research projects
- Mostly focus on biology of disease
- Risk analysis focus on management tools
  - Emphasis on areas from which CWD has not been reported

Project Concepts

- Risk analysis standard procedure in dealing with domestic animal diseases
  - Managers would benefit from access to risk analysis tools
  - Most agencies without capacity to do risk analysis
- Different perspectives on risk analysis for CWD
  - Complexities of CWD
  - Captive and free-ranging animals
  - Human dimensions

Project Teams

- Investigator Team
  - Dein, Duarte, Gillette, Salman
- Steering Committee
  - Burnham, Creekmore, Dein, DeVos, Forsythe, Gillette, Montour, Pritchard, Schmidt, Scott, Salman, Wild
- Project Planning
- Must integrate captive and free-ranging animals
- Workshop to create risk analysis framework
  - Risk Analysts
  - User Groups
- Limited to 30 individuals
  - Participants should represent disciplines and user groups
  - Products must be practical and flexible
- Project Goals
- No pre-defined outcome other than creation of practical risk analysis framework
- Participants must establish framework and components
- Identify knowledge gaps
- Phase II
  - Add to framework
  - Put into practice in volunteer agencies

Charges to Workshop

- Think broadly and creatively
- Represent your “group”

- Do not defend your turf
- Communicate effectively

Chronic Wasting Disease of Deer and Elk: Background and Status

Lynn Creekmore, USDA, APHIS, VS, National Center for Animal Health Programs, Eradication and Surveillance Team

Chronic Wasting Disease

- Transmissible spongiform encephalopathy (TSE) of deer and elk characterized by progressive weight loss and eventual death
- Leading theory is that CWD is caused by a prion (proteinaceous infectious agent) capable of transforming normal body proteins to an abnormal form

CWD History

- First recognized as clinical syndrome in mule deer in a CO research facility—1967
- The same clinical syndrome with lesions compatible with a spongiform encephalopathy at a research facility in Wyoming (1978)
- Animal inoculations identified it as a TSE
- First identified in a free-ranging deer in 1981

Host Range

- No evidence of natural infection of any non-cervid species
- Known susceptible cervid species include: mule deer, N.A elk, white-tailed deer, black-tailed deer, MD and WTD hybrids

CWD Diagnostics

- Postmortem tests on brain and/or lymphoid tissue
- IHC—"Gold Standard"
- ELISA and other technologies licensed only for use in wildlife and for certain tissues/species
- Ante mortem test—tonsillar biopsy, limited use
- More tests being developed

CWD Epidemiology

- Transmission is most likely horizontal
- Vertical transmission does not appear to be important
- Environmental contamination may play an important role
- Minimum incubation period: 15 months (mule deer)/12 months (elk) in experimental infections
- Maximum incubation period is unknown: 25 months (mule deer) to 34 months (elk) in high dose oral inoculation
- Shedding and exposure routes are unknown
- Time from infection to shedding is unknown
- Evidence of transmission of disease from captive animals to wildlife and vice versa
- In wildlife, natural expansion with a few "mysteries"
- Movement of infected animals: Primary means for spread of disease in the captive cervid industry

Surveillance in Captive Deer and Elk

- The number of animals sampled has increased:
  From 115 in Fiscal year 1998 to 12,045 in FY 2003

Proposed APHIS CWD Herd Certification Program

- Goal—to eliminate CWD from captive cervids in the United States
- Voluntary
- Captive elk and deer
- Fencing requirements
- Animal identification and herd inventory
- Surveillance of deaths over 16 months
- Herd status—years of surveillance
- Response to a positive herd—depopulation
- Interstate movement allowed only if participating in herd certification program
- State programs
- Status of the proposed regulation

Can We Avoid the Introduction of Diseases?

Mo Salman, Professor of Veterinary Epidemiology, Animal Population Health Institute, College of Veterinary Medicine, Colorado State University

Avoiding Disease Introduction

- Risk, trust, and trade (exchange of animals)
- Zero risk approach to trade
- If in doubt, keep it out…

But Often…

- Excessively stringent measures
- Barriers to trade
- Lack of scientific basis

Zero Risk to Trade

- Zero risk does not exist
- Trade implies risk
- Lack of trade also implies risk
  Unregulated trade

Risk Analysis

Evaluation of the likelihood of entry, establishment and spread of a disease and the associated potential biological and economic consequences and its impact on public health

A process composed of:

- Hazard identification
- Risk assessment

- Risk management
- Risk communication

Characteristics

- Consistent
- Scientifically based
- Flexible
- Transparent

When to do a Risk Analysis?

- During the process of recognition for a specific disease status
- When importing animals or animal products
- When the health status of a country or zone changes
- To promote the export of commodities

Three Questions

- What can go wrong?
- How likely is it?
- If it happens, what is the magnitude of the consequences?

Types of Risk Analysis: Qualitative and Quantitative

Quantitative Approaches

Advantages

- More profound
- Notion of the probability of occurrence of an adverse event
- Informed decision making

Disadvantages

- Require time
- Require good quality data
- Not possible to apply in all circumstances

Qualitative Approaches

Advantages

- Faster
- Applicable to a broader scope of circumstances

Disadvantages

- Less profound
- Do not provide a numerical probability of occurrence of an adverse event
- Less precise decision making

Hazard

- Source for potential damage
- Cause of the adverse event

Risk

- Probability of occurrence of an adverse event and the magnitude of consequences

Hazard Identification

- Identify pathogenic agents
- Determine diseases present in the exporting region or zone
- Determine the validity of control measures
- Establish priorities

Risk Assessment

- Release assessment
- Exposure assessment
- Consequence assessment
- Risk estimation

Release Assessment

Describes Possible Pathways for the Introduction of a Disease Agent

- Biological/agent factors, environmental/ecological factors, host factors

Exposure Assessment

Describes the Pathways Leading to the Introduction of the Disease/Having the Disease Present

- Magnitude and movement of the host species
- Density and distribution of susceptible animal populations
- Immunity, vectors, seasonality

Uncertainty

- There are no exact values for each parameter
- It is necessary to produce an estimate that incorporates uncertainty and variability

Consequence Assessment

Direct Impacts

- Public health, biological, and ecological consequences
- Social and political consequences
- Economic consequences

Indirect Consequences

- Cost of control and eradication
- Compensation
- Trade losses (including tourism)
- Environmental consequences

Risk Estimation

Integration of the Results from

- Release assessment
- Exposure assessment
- Consequence assessment

Risk Management

- Risk evaluation—determination of the appropriate level of protection
- Option evaluation
- Implementation
- Monitoring and review

Risk Communication

Need transparency in communication between the official sector (decision making body), beneficiaries (importers, consumers, producers) and risk recipients.

Conclusions

- Risk analysis reduces subjectivity and provides a documented process
- Allows a more informed decision making process
- But requires training and good quality data

Domestic Animal Health Risk Analysis

Tom Kasari, Senior Risk Analyst, USDA/APHIS/VS/CEAH/CADIA

Animal Health Based Risk Analysis

- The evaluation of the likelihood of entry, establishment, and spread of a disease or pest (on a local, regional, state, or national scale)
- The associated potential biological and economic consequences to the indigenous livestock population and public health

Epidemiology and Risk Analysis

- Animal health risk analysis relies on epidemiology
- The ‘risk’ of risk analysis is to become merely a probabilistic exercise
- Veterinary epidemiology ensures biological coherence in the risk analysis process

Critical Questions that Should Shape any Animal Health Based Risk Analysis

- What can go wrong?
- How likely is the event(s) to occur?
- If the event(s) happen, what is the consequence(s) and extent of damage?

Guidelines for Risk Analysis: OIE International Animal Health Code List A and B Diseases

Release Assessment

Identifies the biological pathway(s) for introduction of a disease or pest into a particular environment

- Biological factors
- Country factors
- Commodity factors

Determine the Likelihood of Occurrence

1. Authority, organization and infrastructure
   - Organizational chart of veterinary medical force
   - Roles, responsibilities, enforcement capability
   - Cooperative activities
2. Disease status in the region
   - Geographical and environmental characteristics of region
   - Critical look at premise level disease outbreak:
     Type, location, temporal, epidemiology, response, control
3. Disease status of adjacent regions
   - Geographic and environmental characteristics
   - Disease outbreaks and control
4. Disease control program
   - Epidemiologic investigations
   - Testing, quarantines, depopulation, indemnity
5. Vaccination status
6. Separation from adjacent regions
   - Natural and other barriers
   - Sufficiency of barriers to prevent disease entry
7. Movement control from higher risk regions and biosecurity
   - Inspection, testing, biosecurity
   - Quarantine
   - Analyses
8. Livestock demographics and marketing practices
9. Disease surveillance
   - Surveys
   - Passive
   - Mandatory reporting
10. Diagnostic laboratory capacity
    - Number and location
    - Training
11. Emergency response capability
    - Protocol to identify disease
    - Policy, procedure, infrastructure
    - Trace-back capability
    - Control procedures

Summarize Questionnaire Information

Conclusion(s)

Risk factor(s)

Mitigation factor(s)

Exposure Assessment

- Describe the biological pathway(s) necessary for exposure of animals and humans to the hazards released from a given risk source
- Determine the likelihood of occurrence

Consequence Assessment

Biologic Consequences

- Number of affected herds/animals
- Method of spread and contact rates
- Morbidity and mortality

Risk Estimation

- Integrates results of release, exposure, and consequence assessments to produce overall measures of risk associated with the hazard initially identified
- Takes into account entire risk pathway from hazard identification to unwanted event

Conclusions

- Risk analysis is a tool for decision making
- Establishes a logical biologically coherent framework
- Improves the objectivity of the process
- Requires good quality data

Risk Management

- Determine risk reduction measures to achieve the desired level of protection
- Identify points in the pathway that have the greatest incidence on risk
- Decision analysis
- Iterative process

Release Assessment

1. Authority, organization and infrastructure
2. Disease status in the region
3. Disease status of adjacent regions
4. Disease control program
5. Vaccination status
6. Separation from adjacent regions
7. Movement control from higher risk regions and biosecurity
8. Livestock demographics and marketing practices
9. Disease surveillance

10. Diagnostic laboratory capacity
11. Emergency response capability

Translocation Risk Analysis

Laura Hungerford, Department of Epidemiology and Preventive Medicine, University of Maryland

Risk Analysis

- Helps add science to policy decision making
- Transparent method to organize, assess, and study a problem/question/issue
- Incorporates consequences and risk of their occurrence
- Increases communication
  - Multidisciplinary, stakeholders
- Identifies data gaps and research needs

Conservation Breeding Specialist Group (IUCN/SSC/CBSG)

- Disease transmission is a risk in reintroduction or translocation
- Extinction may be a risk if there is no reintroduction or translocation
- Decisions must be made with limited information—leads to extremism
- Risk analysis provides a framework for decision making under uncertainty
- Workshops to assess constituent needs
- Exploration of tools
- Development of applications and workbook
- Workshops to train users in basics of risk analysis and tools

Endpoints of Risk Models

- Decision pathways, conceptual diagrams, simulations

Decision Tree Models

- Well suited to “linear” questions
- “Decision” or “cumulative event” based
- Predict consequences of a set of actions
- Can incorporate probabilities and distributions

Creating a Decision Tree

- Identify and bound the problem
- Structure the decision problem
- Characterize the information needed
- Identify and bound the problem
- Structure the decision problem
- Characterize the information needed
  - Uncertainties, variability, outcomes
  - Regulatory, known data, surveillance, new, etc.
  - Revise the structure of the decision tree

Conceptual Diagrams

- Objectives: create a conceptual model of an imminent intervention
  Example: could develop a conceptual model of measles transmission
  Village/Families ►Trackers ►Gorillas

Simulations

Example of modeling approach: dynamic model of raccoon population with density and movements

- Dynamic model of raccoon population with density and movements
- Base grid maps of raccoon habitat barriers and populations (GRASS)
- Dynamic model of raccoon population with density and movements
- Base grid maps of raccoon habitat, barriers, and populations (GRASS)
- Link to run model within each cell of grid over many iterations using SME

How Can these Tools Help with CWD?

- Organize and store knowledge about a disease process
- Predict risk or consequences of disease
- Predict effectiveness of programs
- Identify gaps and important factors
- Develop policy
- Multidisciplinary collaboration

Contaminant Risk Analysis

Jennifer Orme Zavaleta, USEPA; Phil Rossignol, OSU; Jane Jorgensen, CleverSet

Contaminant Risk Analysis

- Risk Analysis is an essential component of risk characterization
  Application of methods of analysis to understand consequences of a hazard and options for its management

Ecological Framework

- Problem formulation—conceptualization of risk problem/development of assessment plan
- Analysis—estimate of exposure and exposure-response profiles
- Risk characterization—summary of the estimate of likelihood of adverse effects

Profiles of Exposure and Stressor-Response

Exposure Profile

- Product of characterization of exposure
- Summarizes spatial and temporal patterns of co-occurrence of stressor with ecological and human receptors

Stressor-Response Profile

- Product of characterization of effects
- Summarizes relationships between exposure and effect

Contaminant Risk Analysis

Risk Analysis Techniques Inadequate

- Unresponsive to the problem
- Unable to deal with uncertainty
- Too endpoint or route specific

Contaminant Risk Analysis: Emerging Disease

- We developed two novel community-level models as new tools to integrate risk analysis of emerging infectious disease
- Models assess risk of disease in perturbed complex systems
- First community model is deterministic, qualitative predictions of disease risk
- Second community model is probabilistic, model of disease transmission learned from observational data

First Community-Level Model

- Qualitative community modeling procedure to predict vector-borne disease risk within an ecological community
- Most disease models are quantitative, at the population level
- By-pass community-level interactions
- Community structure important for vector-borne, parasitic diseases

Our Procedure is Based on:

- A quantitative biomathematical model of vector-borne disease transmission, and
- Recent developments in qualitative community modeling

Most, if not all, Disease Cycles in Ecological Systems Consist of at Least Three Organisms

- Competent host
- Parasite
- Non-competent host

Commonly, there may also be Additional:

- Competent and non-competent intermediate hosts
- Competent and non-competent vectors
- Human beings
- Domestic animals
- Predators and resources of any of the above

Further, if a Vector (or Intermediate Host) is Involved, the Important Epidemiologic Parameters of Zoonotic Disease Transmission are:

- Ratio of vector abundance/competent host abundance

- Ratio of competent host abundance/non-competent host abundance
- Parasite incubation periods in host and vector (intrinsic and extrinsic)
- Life expectancy of vector and competent host

A Solution has been to Assess Complex Systems from a Qualitative Perspective (Loop Analysis)

- Qualitative models are used to understand variable interactions when variables are difficult to measure
- Loop analysis is a type of signed digraph that gives a pictorial display of a complex community
- From a loop model, a community matrix is developed
- Adjoint predicts direction of change following a press perturbation
- Weighted predictions tests indeterminacy of predictions
- Change in life expectancy matrix

Proposal

- A general model of complex systems and risk of emerging disease

Assumptions

- Pathogens, toxicants, and "misinformation" are not system variables, but exploiters of system turnover
- Intensity of transmission and morbidity are functions of relative abundance and residence time (inverse of turnover)

Practical Goal

- Identification of emerging "hot sub-systems"

What are "Hot Sub-Systems"?

- "Hot sub-systems" are subsets of variables within a system that emerge as having the capacity to maintain an etiological agent following a perturbation
- A perturbation to a potentially distant variable will cause transmission parameters (relative abundances and life expectancies) to change such as to create a subsystem with the potential to sustain an etiological agent
- Possible application: overlay on a geographic map for rapid assessment

Second Modeling Procedure: Probabilistic Relational Modeling (PRM)

- A heuristic model discovery technique, community structure not known
- Observational, independently collected data
- Qualitative and quantitative information
- Develops multiple, simultaneous hypotheses
- PRM uses machine learning technology and relational data to construct biologically-consistent qualitative and quantitative models
- PRMs produce two types of information:
  - Qualitative visualization of variable relationships in Bayesian networks
  - Quantitative probability distributions

Conclusions

- Theory of disease imbedded in complex systems
- Rapid qualitative assessment of risk of general complex system
- Specific quantitative assessment of 'hot sub-systems'
- Application to very complex but poorly defined systems

The Role of Economic Analysis in Understanding Risk

Kenneth W. Forsythe Jr., Trade Risk Team Leader, USDA/APHIS/VSUSDA/APHIS/VS

The Role of Economic Analysis

- Essential to the understanding of risk
- Helps put probabilistic outcomes from risk analysis into perspective
- Serves as a basis for comparing different sources or different types of risk
- Provides a measure of expected costs of uncertain pest or disease events
- Can get a likelihood weighted economic consequence—dollar is weighted by likelihood that the disease event will occur
- Can get an expression of impact of disease events in terms of monetary units

The Measurement of Economic Consequences

Cannot be done in isolation, has to be done in concert with biological and epidemiological evaluations. Different tools in risk analysis, both on the epidemiologic and economic side, need to be linked together in some logical way. Can use information on the biological and physiological effects of the disease agent on susceptible host in linkage with economic analysis.

Some of the Typical Tools Used to Test Transmission of Disease

- State transition models, markov chains, spatial analysis

Key Issues in Modeling Disease Spread are Uncertainty and Variability

Challenge of analyses, selecting appropriate level of detail for analysis depends on resources to be brought in and the available data and magnitude of decision. For CWD, may want to look at effects on hunting industry and losses to surrounding communities.

Key Part in Analysis is Linkage Between all Types of Tools

- May want to bring a micro analysis (economic effect on herd on the premises using partial budgeting) into a macro analysis (using a state transition model as a basis for the macro analysis) to get regional impact of disease.
- Economic welfare analysis can help estimate incursion of shifts of supply and demand on economic welfare, it is a market-based analysis that looks at how the market adjusts as the disease spreads.
- There are many types of interactions with these types of shifts, can model interactions of these impacts.
- Input/output modeling could help capture the multiplier effects in the community— for example, if resources are lost due to a reduction in hunting how much additional revenue is lost in the surrounding communities.

Association Between CWD in Free Ranging Cervids and Human TSEs

Samantha MaWhinney (Univeristy of Colorado Health Sciences Center), John Pape, Jeri E. Forster, C. Alan Anderson, Patrick Bosque, Ken Gershman, Mike Miller

Association between CWD in Free Ranging Cervids and Human TSEs

We investigated an association between Colorado deaths from neurological disorders consistent with CJD and/or human TSEs.

Predictors of Interest

- Residence in a county where CWD is endemic
- Death year

Deer and elk hunter databases, which would indicate an increase risk of CWD exposure, were not available for analysis.

However, the Colorado Division of Wildlife has identified seven counties (Boulder, Larimer, Logan, Morgan, Phillips, Sedgwick, and Weld) as CWD endemic areas.

Based on combined data from the years 1999 to 2001, these counties represent 74% (31377/42665) of deer hunter applicants in the endemic areas.

Death Certificate Data: Years 1979–2001
Total Deaths (Age 12+): N=506,335
CWD Endemic Counties: N=81,916 (16%)
Non-endemic counties: N=424,419 (84%)

Logistic regression was used to model the probability of death from CJD as a function of CWD endemic county residence (yes/no).

Age, marital status, gender, death year, ICD-9/ICD-10, and season were also considered

CJD and human TSEs can be difficult to diagnose and may be misclassified.

- Expanded definitions of events to include deaths due to dementia and neurodegenerative disorders
- We considered sensitive and more specific event definitions for death age >12 and 12–55
- Alzheimer's age restricted (12–55) in all analyses

Analyses

- Sensitive event definition (broad)
- Sensitive with age restriction on events
- More specific event definition (restricted)
- More specific with age restriction on events
- Specific event definition (CJD)

Issues with CWD Endemic County Analysis

- CJD deaths may be more likely to occur in larger metropolitan areas, due to health care availability
- Cannot assess exposure to CWD or harvested animals
  - "Many" residents of CWD endemic counties not exposed
  - "Many" residents of non-endemic counties exposed
- Population Migration
- Others

Conclusions

- No (or low) increase in incidence of CJD
  Insufficient statistical power to detect small changes in a rare event
  Long incubation period for CJD, not sufficient time to observe all CJD cases
- Efforts by Colorado Division of Wildlife successful in decreasing exposure to CWD as epidemic spreads among deer and elk

CWD Risk Management from a State Perspective

Jim DeVos, Research Branch Chief, Arizona Game and Fish Department

Challenges that States Face in CWD Detection and Management

- States have tremendous variation in state wildlife health expertise in CWD, rely on information from groups like these and from experts
- States deal with a variety of customers, no longer only deal with biological issues related to management. Now a variety of public groups come to commission meetings.
- Risk perception is important as it relates to how the public deals with the disease. CWD has the public's attention in a way that no other wildlife disease has. In Arizona, 20 phone calls per week are received from the public about health risk.

Strict Policies Bring Conflict

- With breeders
- With wildlife agencies/livestock
- In other states where share authority

Arizona Experience

1. Cases in New Mexico and Utah heightened attention
2. Passed emergency rule
   - Cannot bring in native cervids
   - Heightened reporting
   - Movement restrictions
3. Permanent rule—took 18 months to put in place, precluded introduction of any cervid, could only move cervids in the state if they were being taken out of the state or to slaughter.
4. People say rules are too restrictive and they ask where the science is that precludes all cervids (the state did make some concessions to the zoos).
5. In fact, the restrictions may be too liberal because carcass movements or feeding of wildlife were never addressed.

States Need Information on Risk-Specific Issues to Make Good Decisions

Need CWD risk analysis, because need to have science supporting decisions instead of intuition and supposition.

Need educational material to help agencies disseminate information that is the most accurate and true.

State Management of CWD

Leah C. Dorman, Veterinary Medical Officer, Ohio Department of Agriculture, Division of Animal Industry

White-tailed deer are the only native species in Ohio. The deer population is 681,000; over 550 propagator permits have been issued, over 8,000 white-tailed deer are in captivity, and 11 hunter preserves are in southeastern Ohio. Currently, no CWD has been found in Ohio.

Deer Testing in Ohio

1994–metro parks
1996, 1998, 2000, 2002, 2003–statistical survey during deer hunting season (voluntary)
TB since 1994
Added CWD in 2002 and increased to yearly CWD surveillance
Also test "suspect" cases

CWD Surveillance

2002–665 free ranging deer in northwestern and southeastern Ohio
2003–Target high density deer population and areas around captive cervids
2003–669 free ranging deer in northwestern and southeastern Ohio; 99% confidence, prevalence of CWD is less than 1%
2003–Captive CWD monitoring program began

Ohio CWD Monitored Herd

Objective: Monitor CWD status of animals in enrolled herds
Voluntary
Requirement to test any cervid over 16 months of age that dies for any reason

Movement Requirements

Ohio has interstate regulations for cervidae to help prevent the spread of CWD (and other diseases like TB and brucellosis)

Currently no intrastate movement requirements

Regulatory action should not drive the industry underground

The Native American Fish and Wildlife Society CWD Project

Laurie Montour, CWD Coordinator, Native American Fish and Wildlife Society

The Native American Fish and Wildlife Society (NAFWS) has received funding from USDA to provide training to tribes in endemic states for collection of tissue samples and submission to laboratories for analysis. The purpose is to fill a need for determining the presence and extent of the disease in Indian Country. The NAFWS CWD Project is fairly young: only four months old. Yet we have identified over 100 tribal communities in at least 12 states who may be affected by CWD. Three (now four as of 8/15/04) young Native biologists are working out of their home reservations to conduct outreach, gain support for training, and set up the actual training sessions in time for fall hunting season. Support for the Project and the willingness to get training is nearly uniform across all tribes, even those who have had previous training.

Until the NAFWS Project, the coverage of CWD sampling in Indian Country varied greatly. A handful of reservations already conduct sampling, even less reservations have a surveillance strategy. A standout is the Cheyenne River Sioux Tribe in South Dakota, recognized as having one of the best strategies, and is being used as a model for others to adapt. One of the challenges for surveillance strategy planning is the resources available to tribes. Some tribes have extensive natural resource departments–the Navajo Nation even has its own veterinarians trained in farm and wildlife disease detection. Other tribes have a one-person office dealing with all natural resource issues. Although deer, elk and where available, moose, can be significant sources of meat for Native families, there are more studies in Canada than in the United States documenting actual Native dietary consumption.

Although CWD has been reported in seven states where there are Native American lands, the disease has not yet been detected on tribal lands per se. One reason is because we have not yet really looked for the disease. It is expected that no CWD positive wild animal samples will be discovered this coming hunting season from tribal lands. Nevertheless, since samples will be taken where none have been taken before, all things are possible.

Cultural perspectives, practices, and even communication vary from Indian Nation to Indian Nation. This is why it is so critical to have our own Native biologists who are part of the community. For example, reverence for other living things, our brothers, prevents sport and trophy hunts, or for that matter, hunts for scientific purposes. Yet in order not to be misunderstood by those unfamiliar with metaphysical aspects of relationships, neither overt permission nor denial may be provided for a hunt that excludes animals for important food or ceremonial purposes. Other reservations sell pricey trophy licenses to non-Native hunters and derive a source of revenue to run their natural resource departments.

Cultural practices may also include potential risk factors. Raw brains are used to naturally tan hides to make them soft. Spinal cord is consumed, although infrequently. Those who use the brains are a small group of skilled individuals, and those who consume the spinal cord are rare too. However, depending upon the frequency of these known practices, there may be a greater risk of exposure if indeed evidence comes to bear that humans can acquire debilitating symptoms.

A risk analysis could help identify uses, routes of human exposure and frequency to assess risk to individuals, their families, and tribal communities as a whole. This in turn, can assist to identify measures to minimize or contain risk. For the risk analysis to be useful and practical, it needs to measure risk in a manner that does not require specialized data collection or epidemiological knowledge.

CWD Risk: Perspectives from Sportsmen-Conservationists and the Outdoor Industry

Gary Wolfe, CWD Alliance Project Leader

The CWD Alliance was created in January 2002 to “promote responsible and accurate communication regarding CWD; and support strategies that effectively control CWD to minimize its impact on wild deer and elk populations.”

Hunters Want to Know About

Food Safety

- Is it safe to eat deer and elk?
- Is CWD a human health risk?
- If so, what is the risk and how does it compare to other risk factors?

Prevalence

- Does CWD occur in my hunting area?
- If so, can I get my deer or elk tested for CWD?
- What is the prevalence?

Impact and Transmission

- What is the impact of CWD on deer and elk herds?
- What is the impact of CWD on hunter opportunity?
- Can CWD be eradicated?
- How is CWD spread, and what is being done to stop the spread of CWD?
- What role do game farms play in disease transmission?
- Are carcass transportation regulations necessary to help prevent the spread of CWD?
- What role does predation play in controlling CWD?

Research and Surveillance

- Convenient and quick CWD test is needed
- Rapid results from laboratory CWD tests
- A "field test" for CWD
- Timely results of CWD research
- Remind hunters of precautions before hunting season
- A definitive answer to the human health risk

The outdoor industry has the same information needs as the hunting public. In addition, the outdoor industry wants to know how CWD will affect hunter participation and how a change in hunter participation may affect the industry.

The CWD Alliance is interested in provided hunters, the general public, and policy makers with the best information available on CWD.

Current Alliance Activities

- Provides information through its website
- Serves as a media resource, has a speaker's bureau
- Is producing a video for hunters
- Participates on CWD task forces, committees
- Provides expert testimony to commissions, legislatures, and the U.S. Congress

CWD Risk Workshop: A Partial Cervid Industry Perspective

Ray Favero, President American Elk Products Board

Thank You

The farmed cervid industry greatly appreciates the opportunity for input into this workshop

About Myself

- MS and PhD in management and reproductive physiology
- President American Elk Products Board
- Have 85 head elk herd
- Provide reproductive services for the farmed cervid industries

Effects of CWD on the Farmed Cervid Industry

- Decreased animal movement
- Decreased product movement

- Decreased animal prices
- Decreased number of farms

Why People Raise Deer and Elk

- Economics
- Agriculture
- Love of the animals
- Most started as hunters
- High respect for environment

Disease Track Record

- Brucellosis--nearly eliminated
- TB
  - Industry helped develop test
  - Industry helped develop program
  - High acceptance of program
  - Nearly eliminated disease
- TB
  - Millions of dollars spent on testing, no positives. Yet, program has not changed.
  - Yet, in Michigan, in wild, not much concern

Science Needed

- Where did CWD originate
- Epidemiologists
- Consistent science based on facts

Industry Goals

- Reestablish trade
- Treat fairly
- Have a voice in our future
- Treat like other livestock
- Standardization of rules: acceptance of state programs by other states.

Voluntary Programs

- The acceptance of a program will be influenced by:
  - Ease of enrollment
  - Ease of maintenance
  - Consistency with other programs and species
- Past record
  - Scrapie, several programs, little success
- Need input and acceptance by the associations to convince membership

Illinois Example

- Excellent relationship with past state veterinarian
- Fantastic Department of Agriculture staff
- 2-tiered program

- One of the highest acceptance rates of voluntary programs, over 90%
- Compare this to neighboring Wisconsin

Risks

- From wild
- Risk from farmed
- Risk from movement of wild for restocking
- Risk from movement of wild for rehabilitation

Dual Regulation

- When producers question a rule or requirement, the typical response is that rule came from the other agency
- Somebody needs to be responsible for the rules that they make.
- Attend meetings
- Explain and justify rules

CWD UM&R

- Long time waiting, now—few or no states will use it

Peeves

- Where did CWD originate?
- Now many agencies "don't care"
- Captive cervids–**PLEASE** differentiate between privately owned and governmentally owned

Suggestions

- Not all deer or elk farmers are crooks
- Visit some farms (IL for example)
- Respect (sometimes you have to show a little respect before you can receive it)

Summary

Deer farming has great potential as an income source. It can be used to produce viable products on marginal land. The main factor that inhibits this industry is state and federal regulation. The main challenge is developing tagging and licensing systems that prevent wild animals from being represented as farmed.

Chronic Wasting Disease Risk Analysis Workshop: Federal Management Needs

Margaret A. Wild, National Park Service, Biological Resource Management Division

Federal Land Management Agencies Approach to Wildlife Management

- Defer to State: Forest Service, Bureau of Land Management

- Combine Authority: U.S. Fish and Wildlife Service, Department of Defense, Department of Energy, Bureau of Reclamation
- Exercises Authority: National Park Service

Federal Differences

- Agency mission and mandates
- Primarily National Park Service and U.S. Fish and Wildlife Service
- Security/access limitations
- Primarily Department of Defense, Department of Energy, Bureau of Reclamation
- National Environmental Policy Act (NEPA)
- Areas are dispersed "islands"
- May result in differences in ability to perform surveillance

National Park Service Director's Guidance Regarding CWD

- Coordinate and cooperate with states
- Surveillance program at "high risk" parks
- Removal and testing of suspect deer and elk from any park
- Environmental compliance (NEPA and Section 7)
- Movement restrictions
- Outreach

Direction is Needed on:

Coarse Level

- A short list of the most important risk factors

Fine Level

- What information is necessary?
- How can we access that information?
- What can we do if we do not have the information?
- How do we determine the relative importance of risk factors?

How do we Prioritize Efforts?

Exposure Risk

- Adjacent to CWD wildlife
- Adjacent to CWD captive cervids
- Adjacent to any TSE animals
- High concentration of captive cervids
- Translocations from CWD areas
- Carcass transport from CWD areas
- Population characteristics and movements

Amplification Risk

- Areas with high wild cervid densities
- Contaminated environments
- Lack of large predators

- Artificial concentration of wild cervids
- Favorable environmental conditions
- Population characteristics and movements

We Need to Know Where Risk is to Focus Resources to:

- Implement/intensify surveillance
- Implement/intensify prevention efforts
- Inform decisions on cervid movement
- Inform decisions on management, e.g., in areas where amplification would likely result
- Develop contingency plans

Risk Communication

Shana Gillette, Research Social Scientist, U.S. Geological Survey

Factors that Heighten Perception of Risk

Stark Images

- Dreadful ways to die
- Constant media coverage
- Individuals identifiable
- Personal connection

Loss of Control over the Outcome

Inability to Select the Risk

- People perceive less risk when they have the freedom to select the risks they will undertake.

Magnitude of Threat to Future Generations

- Risks appear greater when they concern children

Nature of Risk is Human-Created or Natural

- Human-created risk is perceived as greater than natural risks (i.e., microwaves are often perceived as more harmful than sun rays)

Frequency of Occurrence

- It is easier to adjust to risk. Over time, the perceived risk diminishes.

Risk is Unfamiliar

- Known risks are part of everyday cognitive ranking, it is more difficult to place new risks on already established cognitive maps.

How People Respond to Perceived Risk

Denial →Dialogue →Social Interrelations

Denial

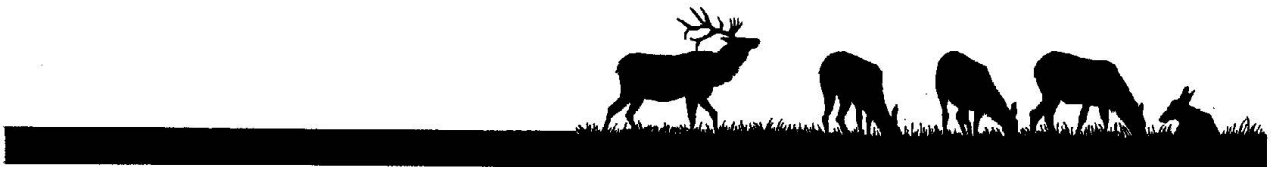
- Perceived risk = irrational behavior
- Real risk = truth

Dialogue: Engagement in a reasonable dialogue

- Describe how exposure can be reduced
- Describe what is being done to reduce risk
- Describe trade-offs
- Compare risks with benefits
- Compare with natural background levels

Social Interrelations: The Slow Construction of Trust and Credibility

- Transparency
- Meaningful involvement
- Communication pathways



Workshop Agenda

CWD Risk Analysis Workshop: An Integrative Approach

May 11–13, 2004
USGS Fort Collins Science Center
Fort Collins, Colorado

Tuesday May 11, 2004

10:15–2:15	**Risk Analysis Presentations** A comprehensive approach to CWD risk analysis will draw from a wide range of risk analysis concepts and methods. In the Tuesday morning session, speakers will provide brief, 15–20 minute overviews of how they approach risk analysis in their respective fields. Each presentation will be followed by a 10-minute Q/A session.
2:30–4:45	**Presentations on User and Management Needs** An effective risk analysis provides a structured process that helps decision-makers understand the risks associated with certain courses of action. In order to better match the risk analysis process with user needs and incorporate those needs in the framework building process, the afternoon session will include speakers from user and management groups. Each speaker will provide brief, 15–20 minute overviews of their needs regarding CWD. Each presentation will be followed by a 10-minute Q/A session.
8:00–8:30	**Continental Breakfast**
8:30–9:15	**Welcome, Workshop Overview, and Introductions** *Josh Dein, USGS National Wildlife Health Center*
9:15–10:00	**CWD: Background and Status** *Lynn Creekmore, USDA Veterinary Services*
10:00–10:30	**Risk Analysis Overview** *Mo Salman, Colorado State University*
10:30–10:45	**Break**
10:45–11:15	**Domestic Animal Risk Analysis** *Thomas Kasari, Centers for Epidemiology and Animal Health (CEAH)*
11:15–11:45	**Translocation Risk Analysis** *Laura Hungerford, University of Maryland School of Medicine*
11:45–12:15	**Contaminant Risk Analysis** *Jennifer Orme-Zavaleta, EPA*
12:15–1:15	**Lunch (Provided)**
1:15–1:45	**Economic Risk Analysis** *Ken Forsythe, CEAH*
1:45–2:15	**Human Health Risk Analysis** *Samantha MaWhinney, University of Colorado, Preventive Medicine and Biometrics*
2:15–2:30	**Break**
2:30–3:10	**State Management Needs** *Jim DeVos, Arizona Game and Fish Department* *Leah Dorman, Ohio Department of Agriculture*
3:00–3:20	**Tribal Management Needs** *Laurie Montour, Native American Fish and Wildlife Society*
3:20–3:45	**Break**

Tuesday May 11, 2004 (continued)

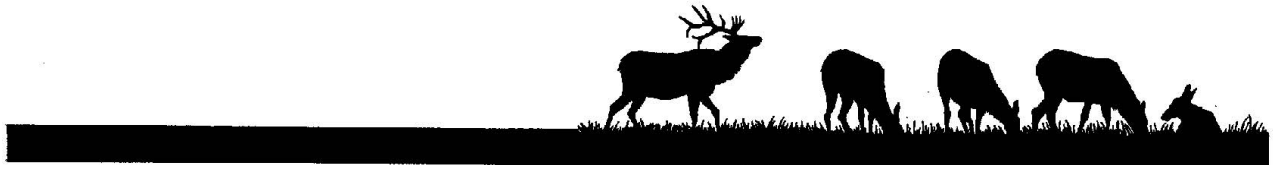
3:45–4:25	**Resource User Needs** *Gary Wolfe, CWD Alliance Project Leader* *Ray Favero, Illinois Elk Producers Association*
4:25–4:45	**Federal Management Needs** *Margaret Wild, National Park Service*
4:45–5:00	**Review and Adjourn**

Wednesday May 12, 2004

9:00–11:00	**Risk Analysis Discussion Group** The risk analysis group will develop a consensus on the appropriate approaches for a CWD risk analysis framework that identifies the likelihood that the disease is absent in a certain geographic location given specific, disease-associated factors.
9:00–11:00	**User/Management Discussion Group** The user/management group will build a list of their needs, prioritize that list, and discuss CWD disease-associated factors.
11:00–noon	**Reconvene and Report** Each group will give a short, 15-minute presentation on their findings and will receive feedback and questions from the overall group.
1:30–3:00	**Mixed Groups** Two mixed groups of risk analysts and users will meet separately to discuss how a risk analysis framework can best match user needs.
3:00–4:00	**Reconvene for Overall Discussion** Each group will give a short, 15-minute presentation on their findings and will receive feedback and questions from the overall group.
8:00–8:30	**Continental Breakfast**
8:30–9:00	Review from Yesterday, Overview of Risk Communication—Shana Gillette, PASA USGS
9:00–9:30	Overview of Discussion Group Objectives
9:30–11:00	Discussion Groups
11:00–12:00	Reconvene and Report
12:00–1:00	**Lunch (Provided)**
1:00–1:30	Overview of Mixed Group Objectives
1:30–3:00	Mixed Groups
3:00–4:00	Reconvene for Overall Discussion
4:00–4:30	Review of Objectives for Tomorrow and Adjourn

Thursday May 13, 2004

9:00–11:30	**Outline, Draft, and Review Plan of Action** The steering committee will provide a pre-model of the framework discussed on Wednesday. An overall discussion about the pre-model will further refine it and lead to consensus on a framework model for the risk analysis process that is to follow. This model will identify where gaps of knowledge exist and it will indicate where the model can be demonstrated or applied.
8:00–8:30	Continental Breakfast
8:30–9:00	Review and Discuss Conclusions from Yesterday's Sessions
9:00–10:00	Outline Plan of Action
10:00–10:15	**Break**
10:15–11:30	Draft and Review Plan of Action (Continued…)
11:30–12:00	**Workshop Review and Adjourn**



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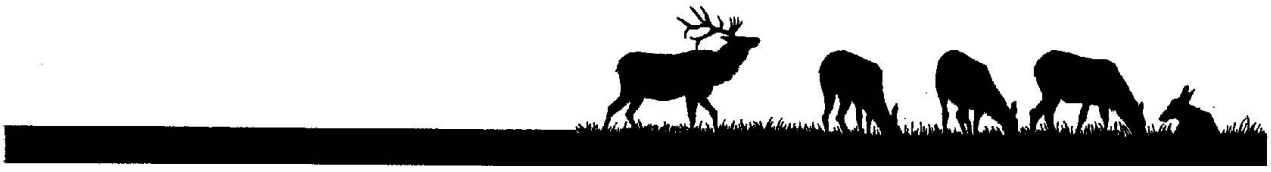


Participant Research Interests

Jeff Beringer
Resource Scientist
Missouri Department of Conservation

Jeff Beringer is a resource scientist with the Missouri Department of Conservation (MDC). He received his B.S. from the University of Wisconsin-Stevens Point and M.S. from the University of Tennessee. His job duties include deer and turkey research and management.

Ken Burnham
Statistician, USGS Biological Resource Discipline
Colorado Cooperative Fish and Wildlife Research Unit

Ken Burnham's graduate degrees are in statistics (Ph.D. in 1972); he has some background in biology and ecology. He has worked for 31 years (several Federal agencies and jobs) as a statistician. He is now with USGS (Colorado Coop Unit), on campus at CSU, with a graduate faculty appointment. His interests are in statistics applied to fish, wildlife and ecology issues, especially sampling and inferences about biological populations (e.g., capture-recapture), and what is known as data-based model selection.

Len Carpenter
WMI Southwest Field Representative
Wildlife Management Institute

Len Carpenter was employed by the Colorado Division of Wildlife and working on mule deer research at the time when the disease in mule deer was first recognized at the foothills research facility. Over the 25 years that he worked with the Colorado Division of Wildlife he experienced several deer and elk with CWD in all stages of development and was involved in supervision of on-going CWD research. He participated in the attempt in the mid-1980's by the Division to rid the foothills research facility of CWD by killing all animals and on environmental treatments. Since working with WMI, he has served as the key liaison to the Institute regarding CWD activities and is a participant in the CWD Alliance project.

Lynn Creekmore
Staff Veterinarian/Wildlife Disease Liaison
USDA-APHIS-VS

Lynn Creekmore is a senior staff veterinarian and wildlife disease liaison for USDA, APHIS, VS, National Center for Animal Health Programs, Eradication and Surveillance Team. She joined USDA in October 1999 and is working on the development of the USDA's national CWD program for farmed elk and deer. She obtained her veterinary degree from the University of Tennessee in 1986 followed by additional graduate work at the University of Georgia. From 1987–1992, she worked as a staff diagnostician for the Southeastern Cooperative Wildlife Disease Study, University of Georgia in Athens where her primary focus was on wildlife disease issues in upland game species of the Southeast. From 1992–1999, she was employed as a wildlife disease specialist at the U.S. Department of the Interior's National Wildlife Health Center in Madison, Wisconsin. There she worked on disease issues in migratory and endangered species in the western United States.

Joshua F. Dein
Veterinary Medical Officer, USGS—National Wildlife Health Center

Joshua Dein is a veterinary medical officer at the USGS National Wildlife Health Center in Madison, Wisconsin. His education includes an undergraduate degree in biology and graduate work in ornithology/entomology, environmental education, veterinary medicine, and pathology. He is involved in a wide range of projects at NWHC, and is the principal investigator for the development of the National Biological Information Infrastructure Wildlife Disease Information Node. WDIN is in the process of developing a National CWD Data Clearinghouse. He conceived of the CWD Risk Analysis Workshop as a method to bring state, tribal federal, and private groups to work together and develop integrative CWD management strategies.

Jim DeVos
Research Branch Chief
Arizona Game and Fish Department

Jim DeVos, in his position as research branch chief with the Arizona Game and Fish Department, is actively involved in CWD issues in the state—working with veterinarians and other scientists on rulemaking that takes into account the latest scientific findings regarding CWD risk.

Duane R. Diefenbach
Assistant Unit Leader and Adjunct Associate Professor of Wildlife Ecology
USGS Pennsylvania Cooperative Fish and Wildlife Research Unit

Duane R. Diefenbach is assistant unit leader of the USGS, Pennsylvania Cooperative Fish and Wildlife Research Unit at The Pennsylvania State University. Prior to that he served as wildlife biometrician for the Pennsylvania Game Commission (1992–1999). His research interests center around the quantitative aspects of wildlife management, particularly estimation of population parameters and harvest management of game species. Pennsylvania recently enacted harvest restrictions on male white-tailed deer such that only those with 3 or 4 antler points on a side (depending on the management unit) can be legally harvested (termed "antler restrictions"). His current research related to white-tailed deer and deer hunting includes: (1) studying the effect of antler restrictions on survival and harvest rates of male deer; (2) acceptance of antler restriction regulations by deer hunters and their perceived changes in the age-sex structure of the deer population; (3) effect of changes in age-sex structure of the deer population on dispersal patterns in yearling male white-tailed deer; and (4) movements, spatial distribution, and habitat use of deer hunters. He participated in the USGS workshop on surveillance strategies for chronic wasting disease (Samuel and others, 2003) and serves as an advisor to the committee responsible for developing Pennsylvania's chronic wasting disease response plan.

Leah C. Dorman
Veterinary Medical Officer
Ohio Department of Agriculture

Leah Dorman is a veterinary medical officer for the Ohio Department of Agriculture, Division of Animal Industry, covering 15 counties in northwestern Ohio. Her responsibilities include participating in the Ohio cervid committee, Chronic Wasting Disease work group, coordinating Ohio's CWD surveillance, and implementing and planning emergency management activities. She graduated from Ohio State University in 1995 with her DVM and also did her undergraduate work at OSU as an animal science major.

Paulo de C. Duarte
Post-doctoral Fellow, Animal Population Health Institute
College of Veterinary Medicine and Biomedical Sciences

Paulo Duarte is a veterinarian who graduated in Brazil in 1992 where he was involved in various professional activities including large animal internal medicine (mainly equine), surgery and reproduction, small animal anesthesia, and technical activities in the pharmaceutical industry. In 1997, he enrolled in the Master of Preventive Veterinary Medicine program at the University of California, Davis, where he also, recently, obtained his PhD in epidemiology. Currently, he is a Post-Doctoral fellow at the Animal Population Health Institute (APHI), Colorado State University. His main research interest is infectious disease epidemiology, more specifically, risk analysis, diagnostic tests, disease surveillance, and food safety.

Ray Favero
Central Region Director, Illinois Elk Producers Association

Ray Favero has a MS and PhD in management and reproductive physiology. He has served as president of the North American Elk Breeders Association and is currently president of the American Elk Products Board. He has traveled in Asia on federally sponsored trade missions for the farmed cervid industries. Favero's family has participated in the cervid industry for more than 35 years. He currently has an 85-head elk herd and provides reproductive services for the farmed cervid industries.

Kenneth W. Forsythe, Jr.
Trade Risk Team Leader, USDA/APHIS/VS/CEAH

Ken Forsythe's background and training are in agricultural economics, animal health risk analysis, and international trade. He has been with the U.S. Department of Agriculture for 13 years. His areas of expertise include developing methodology to evaluate the economic effects of potential changes to federal, state, and industry animal health programs and in developing new cost-effective programs for the surveillance and monitoring of animal health. His personal interest is in the integration of methods from different disciplines, such as economics and epidemiology, to develop more complete analyses of animal health issues.

Shana Gillette
Social Science Analyst, Policy Analysis and Science Assistance Division (PASA)
USGS Fort Collins Science Center

Shana Gillette received her Ph.D. in communication (with an emphasis in the interdisciplinary study of social science and biology/ecology) from the University ofWashington in 1998. She is currently a research social scientist at PASA. She works on social science research studies which support and complement the biological research that is conducted at the Fort Collins Science Center. Some of her current research interests are risk communication and the integration of social data in modeling how human activities impact the environment and wildlife behavior.

Laura L. Hungerford
Associate Professor, Dept. of Epidemiology and Preventive Medicine
University of Maryland School of Medicine

Research Interests: Infectious diseases, epidemiology and the application of techniques for geographic information systems, spatial statistical analysis, and dynamic modeling in the study of zoonoses and other diseases.

Thomas R. Kasari
Veterinary Medical Officer/Senior Risk Analyst
USDA/APHIS/VS/CEAH

Tom Kasari is a senior analyst who joined CEAH earlier this year. His experience as an animal disease risk analyst is long, but briefly includes many years as a professor of veterinary medicine at Texas A&M, disease modeling, economic modeling, and clinical veterinary medicine. He is currently part of the risk assessment group in the Center for Epidemiology and Animal Health doing assessments from a regulatory point of view.

Patrice Klein
FDA—Center for Food Safety and Applied Nutrition

Patrice Klein is a veterinary officer in the USPHS stationed at the FDA working on food safety issues pertaining to emerging zoonotic diseases such as Chronic Wasting Disease, Johne's disease (possible link to Crohn's disease in people), reptile associated salmonellosis, and foot and mouth disease.

Stephen Koontz
Associate Professor, Agricultural and Resource Economics

Research Interests: Agricultural marketing and prices, commodity marketing, and market organization and performance.

Sam MaWhinney
Assistant Professor, Dept. of Preventive Medicine and Biometrics
University of Colorado Health Sciences Center

Research Interests: Statistical computing, infectious diseases, and longitudinal HIV immunological models

Laurie Montour
CWD Project Coordinator
Native American Fish and Wildlife Society

Research Interests: Wildlife disease, disease surveillance methods, training, education, and outreach

Dan O'Brien
Veterinary Specialist
Rose Lake Wildlife Disease Laboratory

Dan O'Brien is a Wildlife Veterinary Specialist with the MDNR's Rose Lake Wildlife Disease Laboratory, and the statewide epidemiology specialist for MDNR. He holds doctoral degrees in Veterinary Medicine and Epidemiology from Michigan State University. His current responsibilities include investigation, surveillance, control and research of various wildlife diseases, with emphasis on bovine tuberculosis and Chronic Wasting Disease.

Jennifer Orme-Zavaleta
Acting Director, Western Ecology Division
USEPA/Nat'l Health and Environmental Effects Research Lab

Jennifer Orme-Zavaleta has been with EPA nearly 23 years working in research, risk assessment, regulatory development, strategic planning and now research implementation. Her educational and professional background cuts across human and risk assessment. She has degrees in toxicology, wildlife science, and public health. Her personal research interest involve the assessment of environmental changes that influence wildlife and public health.

John Pape
Epidemiologist, Communicable Disease Epidemiology Program
Colorado Dept. of Public Health and Environment

John Pape supervises the field epidemiologist staff of the communicable disease epidemiology program and is responsible for zoonotic disease surveillance and control in the state of Colorado. He has authored and coauthored scientific journals on a variety of zoonotic diseases including bat rabies, tick-borne relapsing fever, feline plague and hantavirus.

Randy Pritchard
Veterinary Medical Officer
USDA/APHIS/VS/CEAH

Research Interests: Chronic Wasting Disease Specialist

Bryan Richards
CWD Program Coordinator
USGS-National Wildlife Health Center

Research Interests: CWD disease management, research, and outreach

Mo Salman
Professor of Veterinary Epidemiology, Animal Population Health Institute
College of Veterinary Medicine and Biomedical Sciences

Research Interests: Analytical veterinary epidemiology, national and international animal disease surveillance systems, studies on animal populations, and epidemiology of infectious diseases

Andrew Seidl
Associate Professor, Extension Economist—Public Policy
Department of Agricultural and Resource Economics

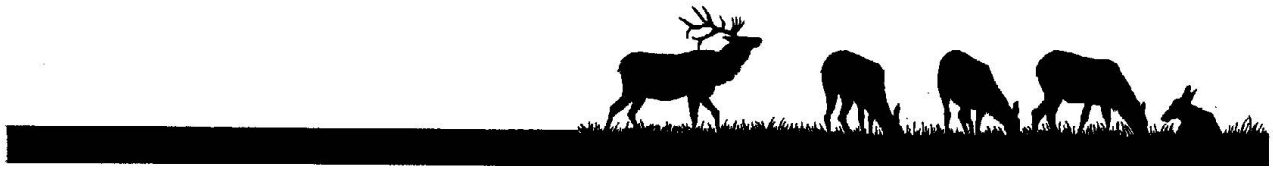
Research Interests: Agricultural and resource policy, community economic development, natural resource economics

Margaret A. Wild
Wildlife Veterinarian, Biological Resource Management Division
National Park Service

Research Interests*:* Wildlife biology in national parks, wildlife disease surveillance

Gary J. Wolfe
Project Leader, CWD Alliance

Gary Wolfe attended college at the University of New Mexico, majoring in biology and chemistry, then earned masters and doctorate degrees in wildlife biology from Colorado State University. Gary joined the staff of the fledgling Rocky Mountain Elk Foundation in 1986 as the organization's second field director. He spent 15 years with the Elk Foundation in various positions. Following his retirement from the Elk Foundation, Gary was soon recruited to assist several organizations with their efforts to address chronic wasting disease, and has served as the CWD Alliance's project leader since January 2002. He represents the Alliance on the multi-state CWD Task Force, and the International Association of Fish and Wildlife Agencies' Wildlife Health Committee. He has presented testimony at congressional CWD hearings, developed a comprehensive CWD website, and has spoken at numerous CWD conferences and symposia in both the United States and Canada.



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