Modeling Approaches Useful for Predicting Change: *Making Progress in a Data-Poor World*

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Presentation 17 October 2008, USGS Wildlife Potential Habitat Forecasting Framework (WILDCAST) workshop, Fairbanks AK

Goal: to produce a documented knowledge-based forecasting tool called the WILDlife Potential Habitat ForeCASTing Framework (WILDCAST).

climate change

other environmental stuff

things we just don't know

wildlife species, habitats, functions

climate change

geography,
topography,
hydrology

influence on vegetation
& land cover types

occurrence & distribution
of wildlife habitats

occurrence & distribution of
wildlife species & functions

climate change

geography,
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influence on vegetation
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unknown &
unmodeled
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Goal: to produce a documented knowledge-based forecasting tool called the WILDlife Potential Habitat ForeCASTing Framework (WILDCAST).

General Purpose of the WILDCAST Tool?

- to describe some pattern
- to compare a pattern with some goal
- to explain the pattern (mechanisms)
- to predict outcomes in other geographic areas
- to predict outcomes in future time periods
- to diagnose problems
- to identify best parameters for monitoring
- to identify best parameters for conservation
- (others)

Who is the Audience for the WILDCAST Tool?

- ourselves, to guide further research
- other researchers
- managers in land management agencies
- politicians
- the general public
- local people
- the courts
- attorneys
- (others)

*Goal: to produce a documented knowledge-based **forecasting tool** called the WILDlife Potential Habitat ForeCASTing Framework (WILDCAST).*

Forecasting

What do we want to forecast (to future time periods)?

- climate change
- influence of climate change on vegetation & land cover types
- wildlife response

Forecasting

1. How accurate do we have to be?
   - *predicting direction of change*

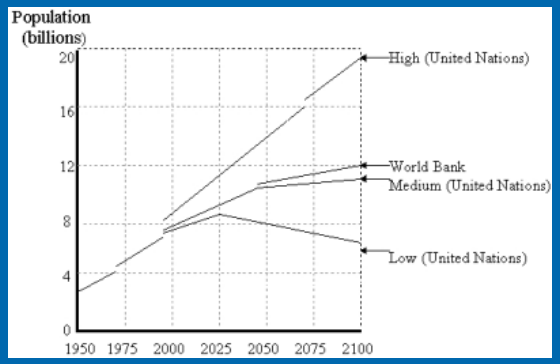
climate

vegetation,
land cover

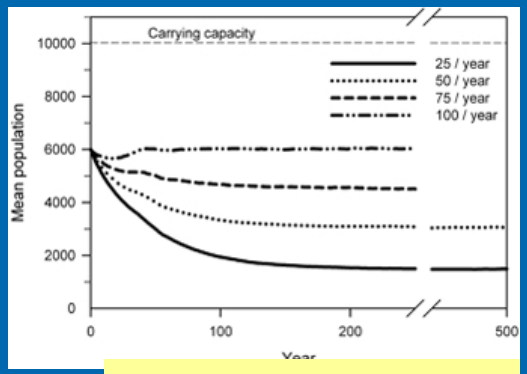
wildlife
habitats

wildlife
species

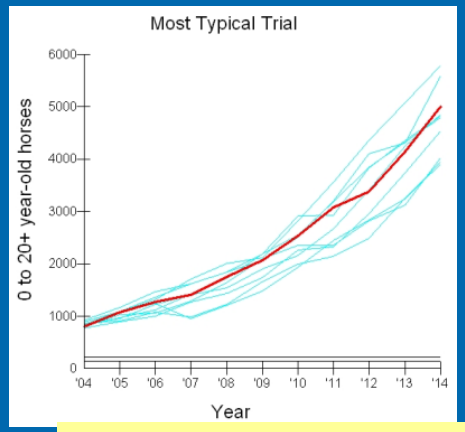
Examples of “horsetail” graphs predicting future events



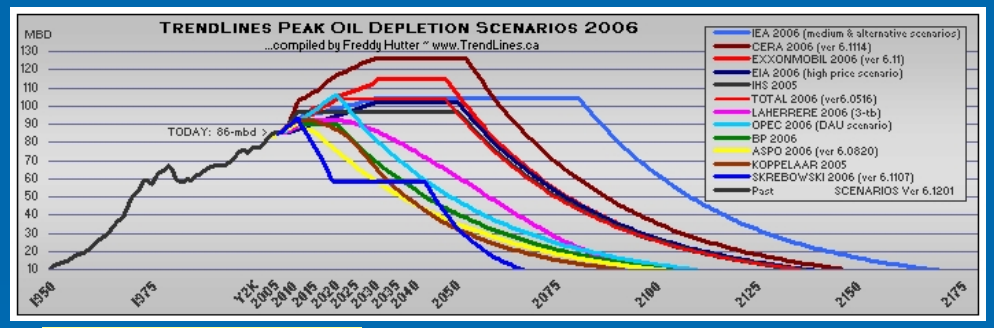
Human population growth



Population viability analysis

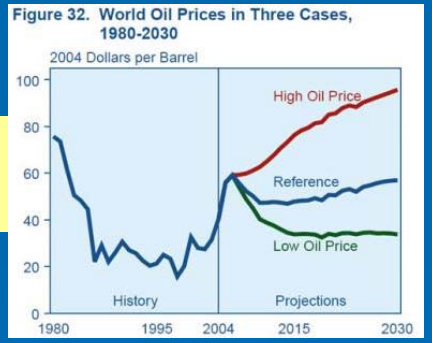


Wild horse population growth

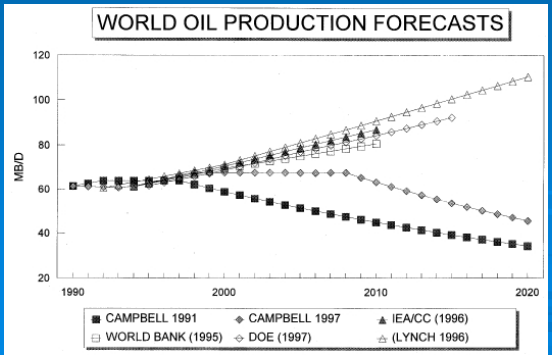


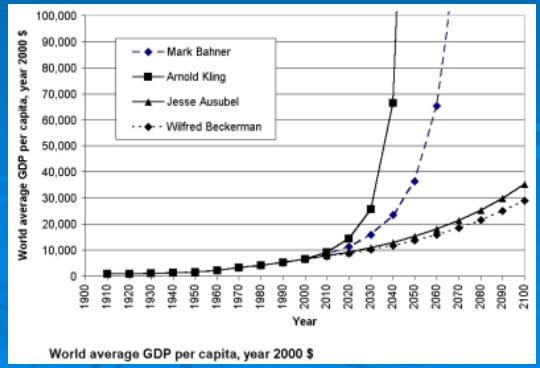
Future oil depletion

Future oil prices



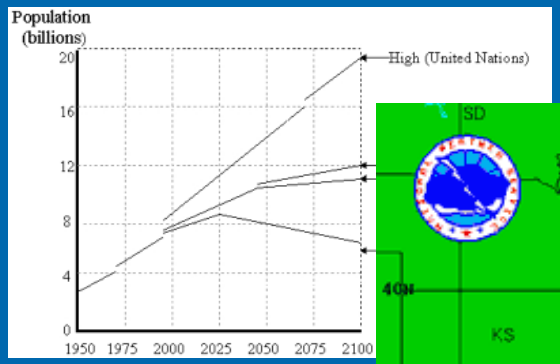
Future oil production





Future world average GDP

Examples of “horsetail” graphs predicting future events



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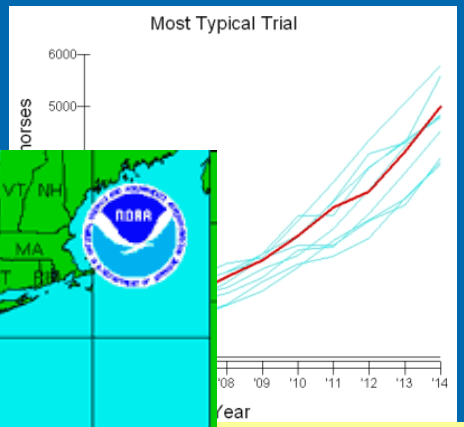
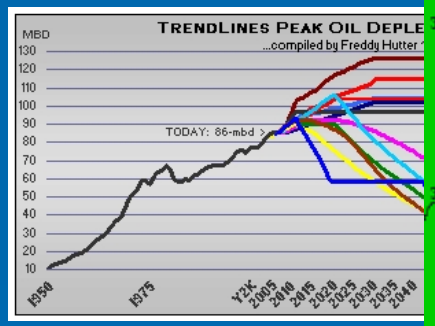
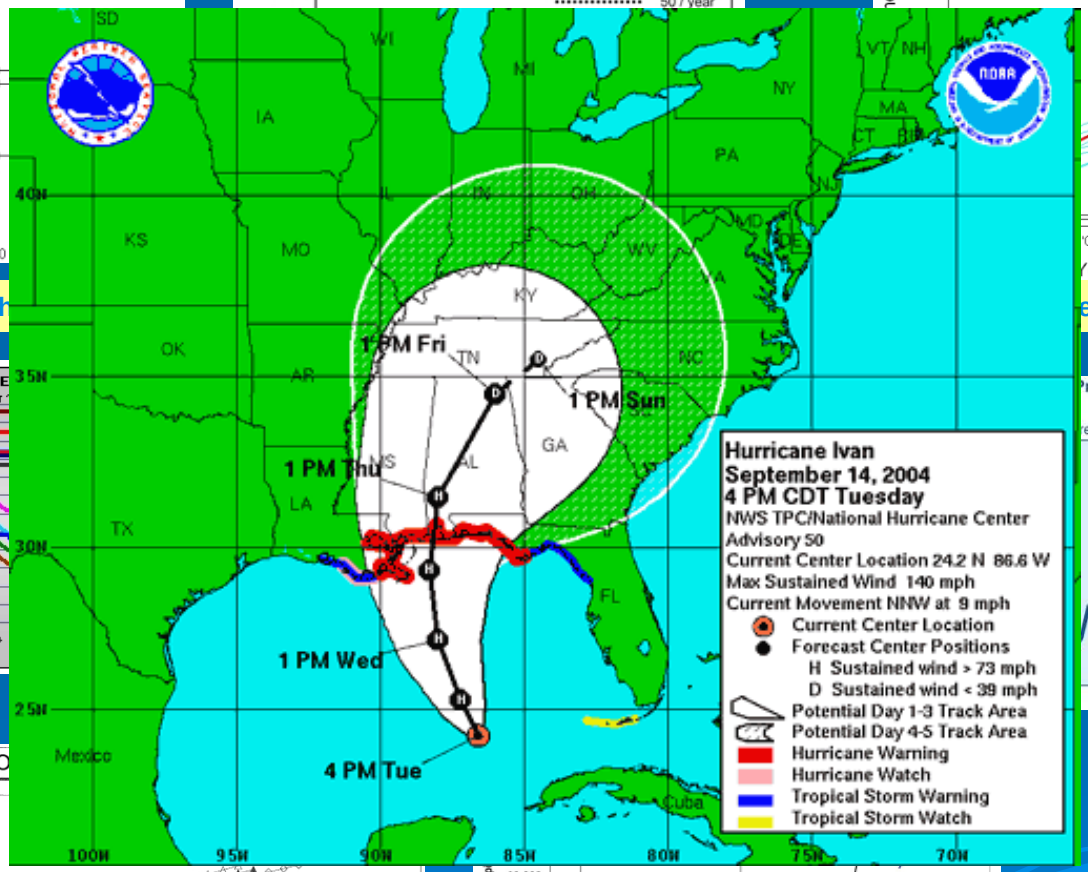
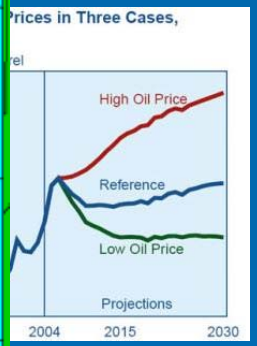


e population growth

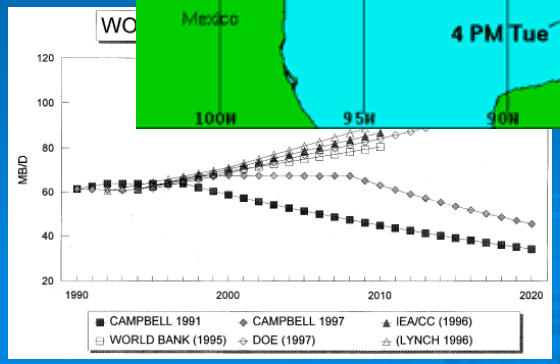


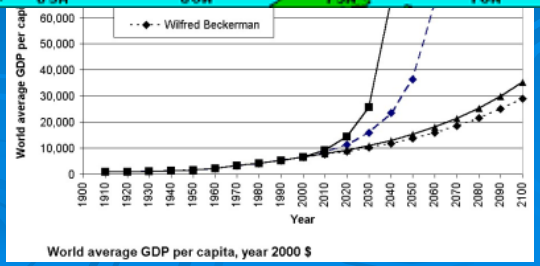
Future oil depletion





Future oil production





Future world average GDP

Forecasting

1. How accurate do we have to be?
   - predicting direction of change

2. How precise do we have to be?
   - acceptable levels of habitat & species occurrence, abundance, & distribution

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1. How accurate do we have to be?
   - predicting direction of change

2. How precise do we have to be?
   - acceptable levels of habitat & species occurrence, abundance, & distribution

3. What scales should we address?
   - levels of spatial or temporal resolution

Ways to solve difficult problems … that is, problems that are analytically intractable:

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   - *build, test, and update the submodels*

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   - *can use range of values, different functions*
   - *it's ok to have more than one plausible model!*

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   - *build, test, and update the submodels*
2. make best estimates for state variables and their relationships (functions)
   - *can use range of values, different functions*
   - *it's ok to have more than one plausible model!*
3. use a combination of information sources
   - *can use methods of expert paneling, combining information, meta-analysis, traditional knowledge*

Some approaches for building the WILDCAST tool and models

Influence diagrams

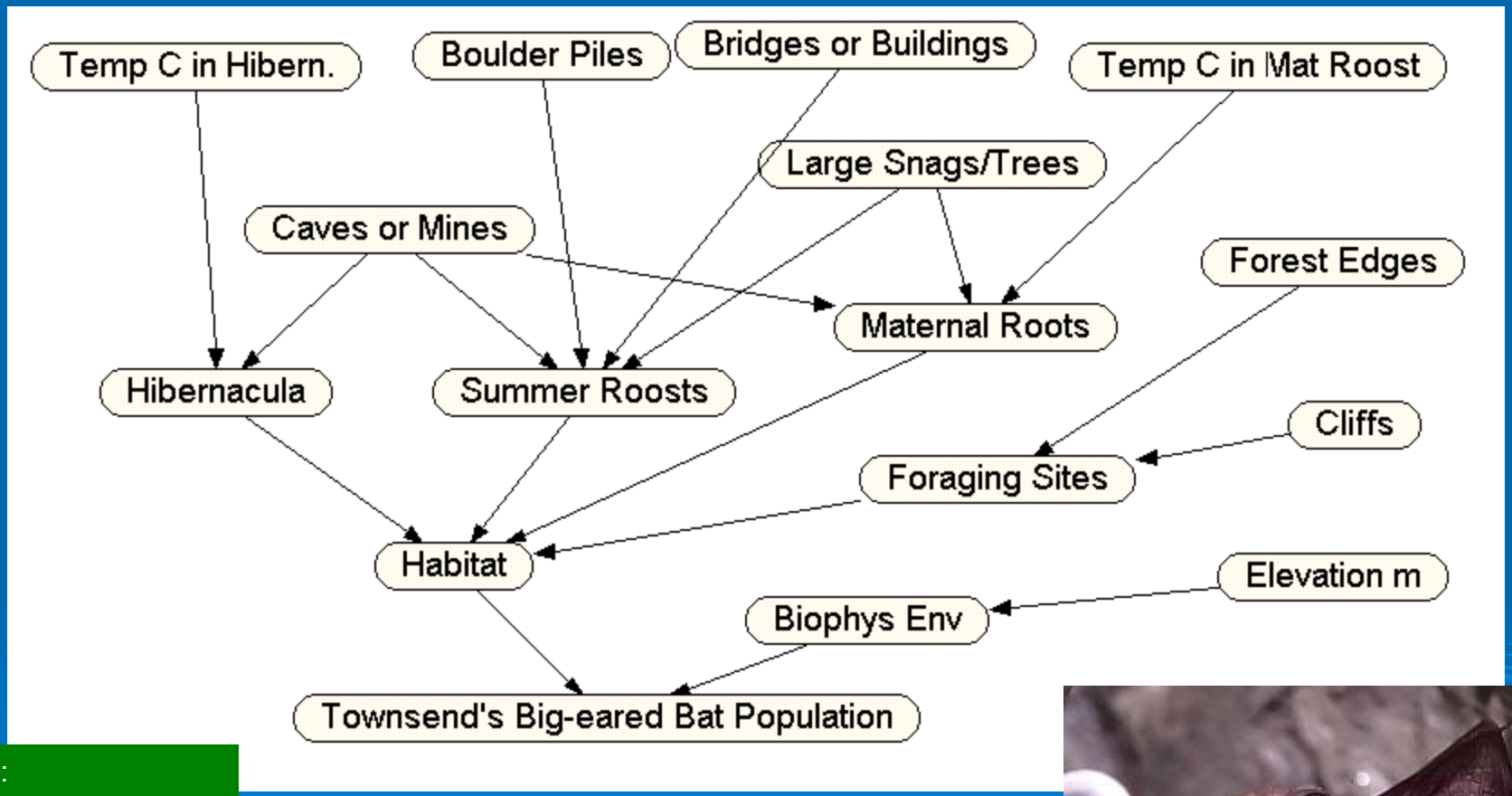
Influence diagrams –

“Concept maps”
“Concept diagrams”
“Cognitive maps”
“Mental maps, Mind maps”

http://intraspec.ca/cogmap.php

http://www.cs.joensuu.fi/~marjomaa/Knowledge_Representation/doc/Knowledge_Representation-56.htm

Influence diagrams



Source:

Marcot, B. G., et al. 2001. Forest Ecology and Management 153(1-3):29-42.

climate change

geography,
topography,
hydrology

influence on vegetation
& land cover types

unknown &
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effects

occurrence & distribution
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wildlife species & functions

Influence diagrams – computer tools

- Mindjet MindManager Pro
- Inspiration
- Personal Brain
- Netica
- cMap
- FreeMind

Mindjet MindManager Pro
http://www.mindjet.com

Mindjet MindManager Pro - [sample decision map for delisting]

File Edit View Insert Topic Format Tools Window Help

sample decision map for delist...

Map View

Detail Filter Enter search text

Key decision
Decision made
Need more time
Legend

Final Decision: TBD

Issue: to delist the Bloated Salamander

History / Background: Bloated Salamanders occur only in wet talus resulting from landslides

Delisting decision
12/3/2006 - Rev. 7

Option 3: downlisting only
- Pros
  - 1 retains controls over viability outcome
  - 2 reduced uncertainty of local extirpation
- Cons
  - 1 need to redo listing planning documents

Option 2: complete delisting
- Pros
  - 1 no further Section 7 hurdles
  - 2 no further expenditures for habitat acquisition
- Cons
  - 1 unclear viability results

Option 1: no change in listing status
- Pros
  - 1 insufficient demographic data to show recovery
  - 2 unclear change in disturbance dynamics
- Cons
  - 1 further expenditures to retain listing
  - 2 possibly wrong precedence

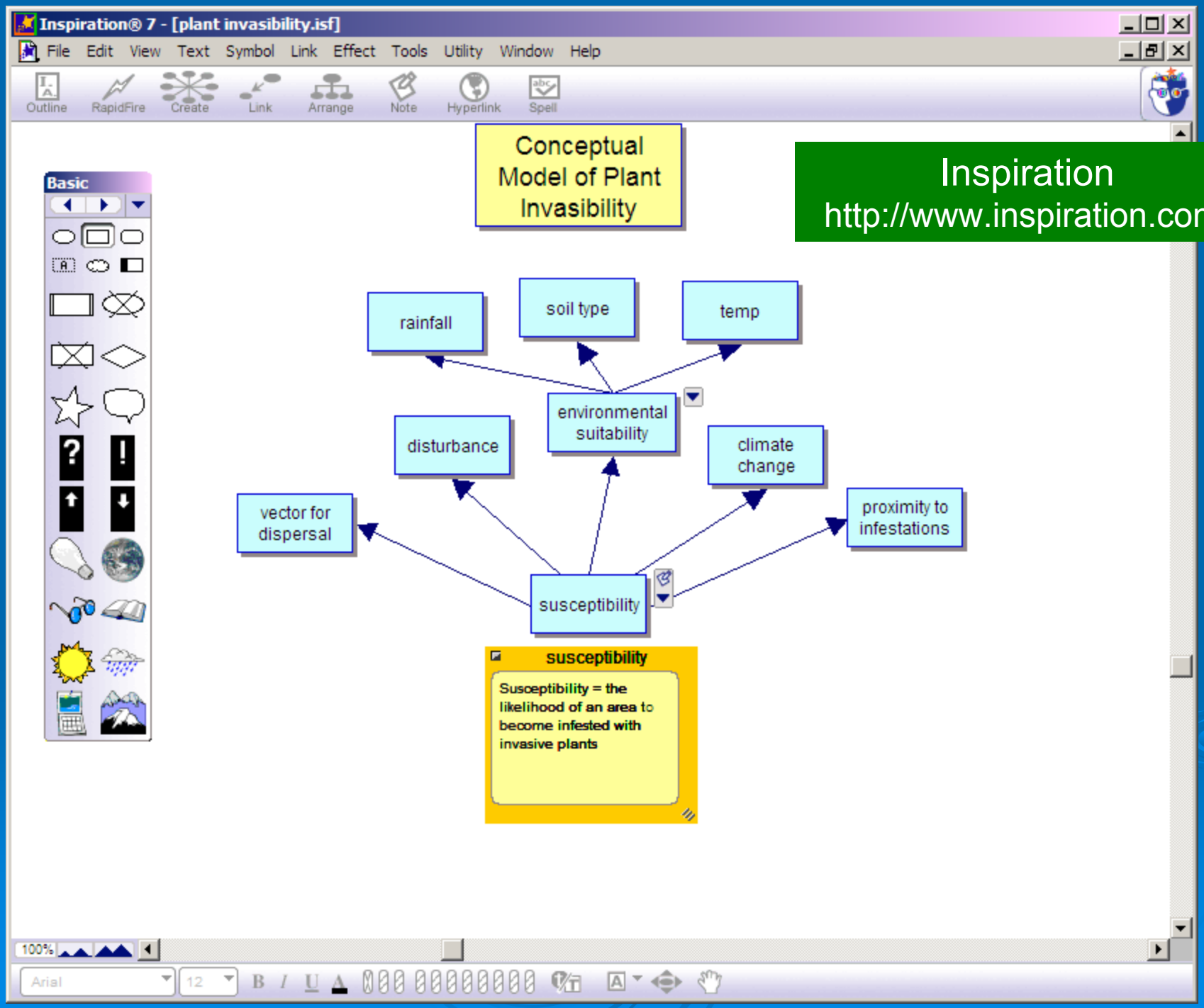
demonstration only

My Maps

Map Shortcuts
- Add shortcut to current map
- Add shortcut to existing map(s)...
- Add new collection
- My Projects

Folder Shortcuts
- Add folder shortcut...
- MindMaps
  - generic concept map
  - hypothesis testing
  - Mindjet_MindManager_custom_
  - Mindjet_MindManager_Managin
  - Mindjet_MindManager_Project_
  - Mindjet_MindManager_Risk_Ma
  - Mindjet_MindManager_Scope_S
  - NSO listing factors, criteria, acti
  - risk assessment
  - sample decision map for delistin

My Maps | Map Markers | Task Info | Map Parts | Library | Search | Learning | Map Explorer


Inspiration® 7 - [plant invasibility.isf]
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Outline RapidFire Create Link Arrange Note Hyperlink Spell
Basic
Conceptual Model of Plant Invasibility
Inspiration
http://www.inspiration.com/
rainfall
soil type
temp
environmental suitability
disturbance
climate change
vector for dispersal
proximity to infestations
susceptibility
susceptibility
Susceptibility = the likelihood of an area to become infested with invasive plants
100%
Arial
12

PersonalBrain - S&M Species [C:\My Brains]

Brain Thought Options Window Help

Recent

SM Species (C:\My Brains)

Fungi Lichens Bryophy... Vascular... Mollusks Amphibi...

Surve...

Amphibians

Plethodon vandykei

Del Norte Salam...

micro... preda... topog...

Broad-Scale Model

aquat... caves distur... geology
PNV ... ppt temp ... topog...
uplan...

population conditions

demo... genet...

Microsite-Scale Model

core ... dispe...

Search:

Man... Amphibians microclimate Del Norte Sala...

Notes Properties Search History

File Edit Arial 12

Key Environmental Correlates for Van Dyke's Salamander

** DRAFT **
Alpha version 0.10 by Bruce Marcot, 03/30/2000

Species expert: Charlie Crisifulli

for:
Survey and Manage Species Project
USDA Forest Service
Northwest Forest Plan
Pacific Northwest Regional Office

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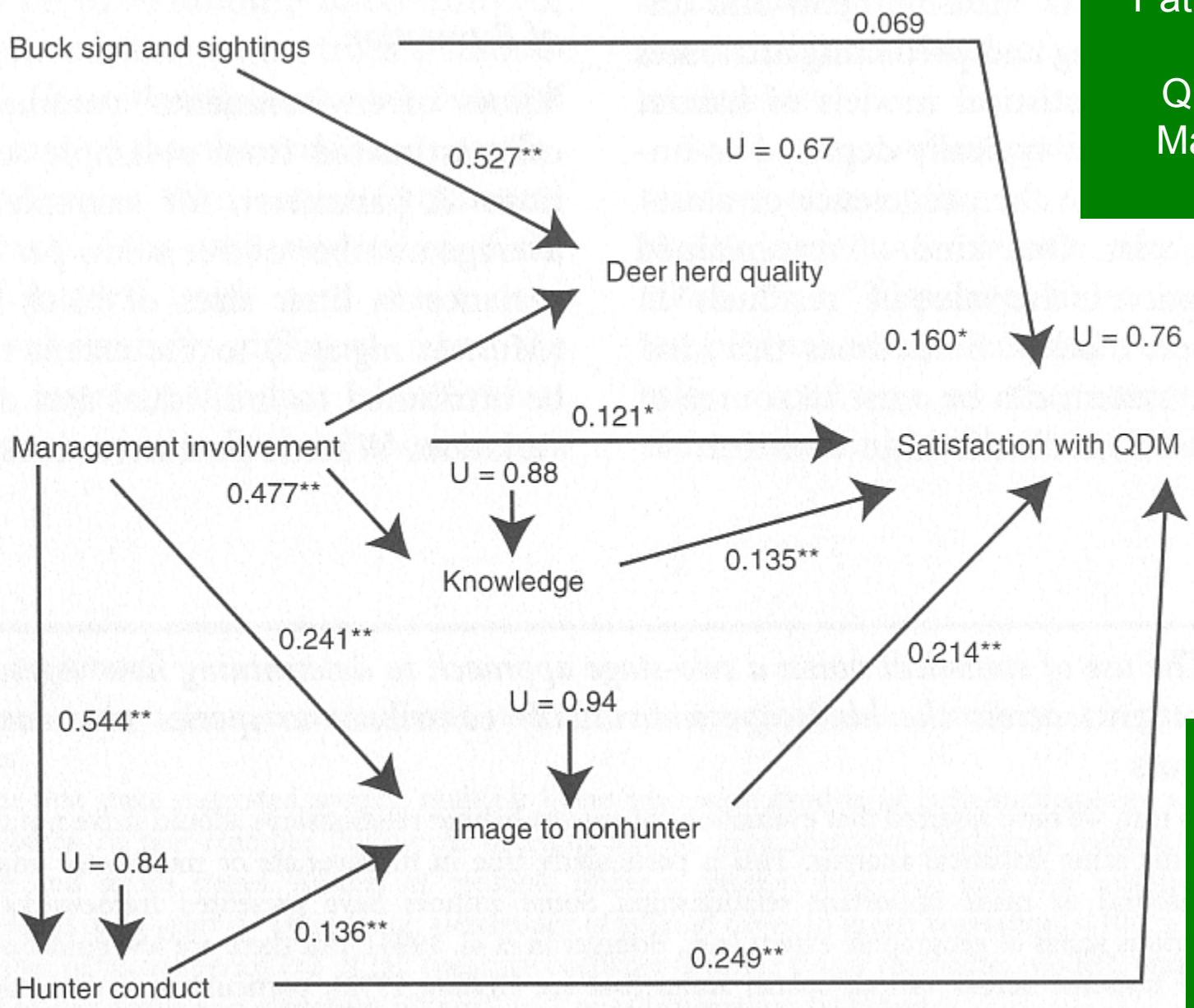
information compiled for use in a Bayesian belief network model

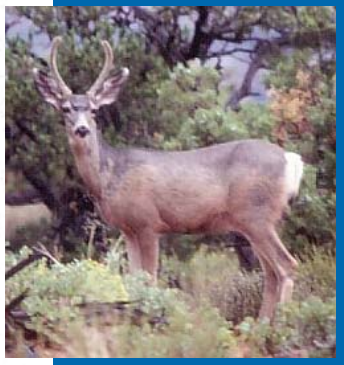
Personal Brian
http://www.thebrain.com/

From influence diagrams …

to models !

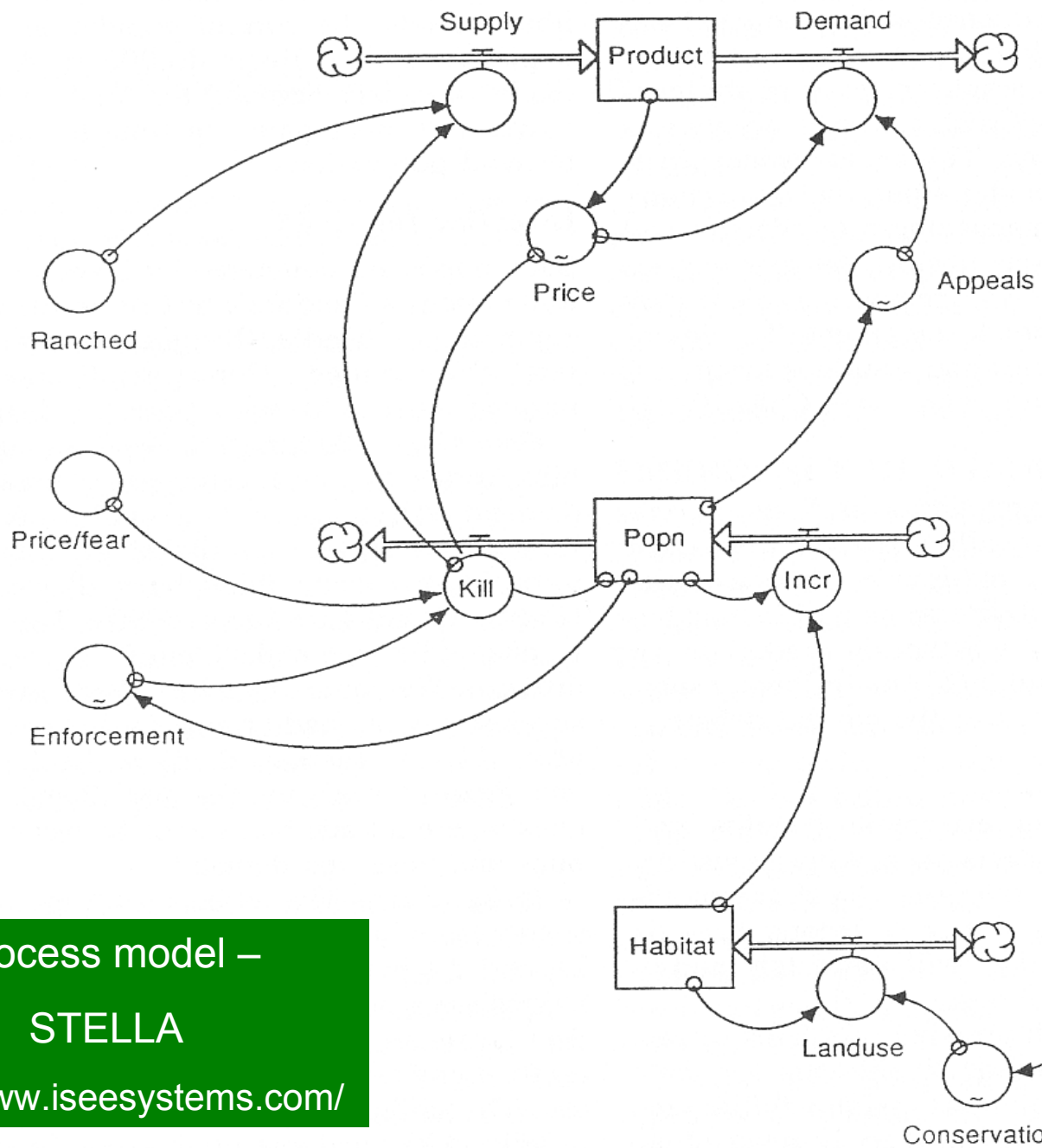
Path regression … Quality Deer Management (QDM)





Source:

Woods, G. R., D. C. Guynn, W. E. Hammitt, and M. E. Patterson. 1996. Determinants of participant satisfaction with quality deer management. Wildl. Soc. Bull. 24(2):318-324.

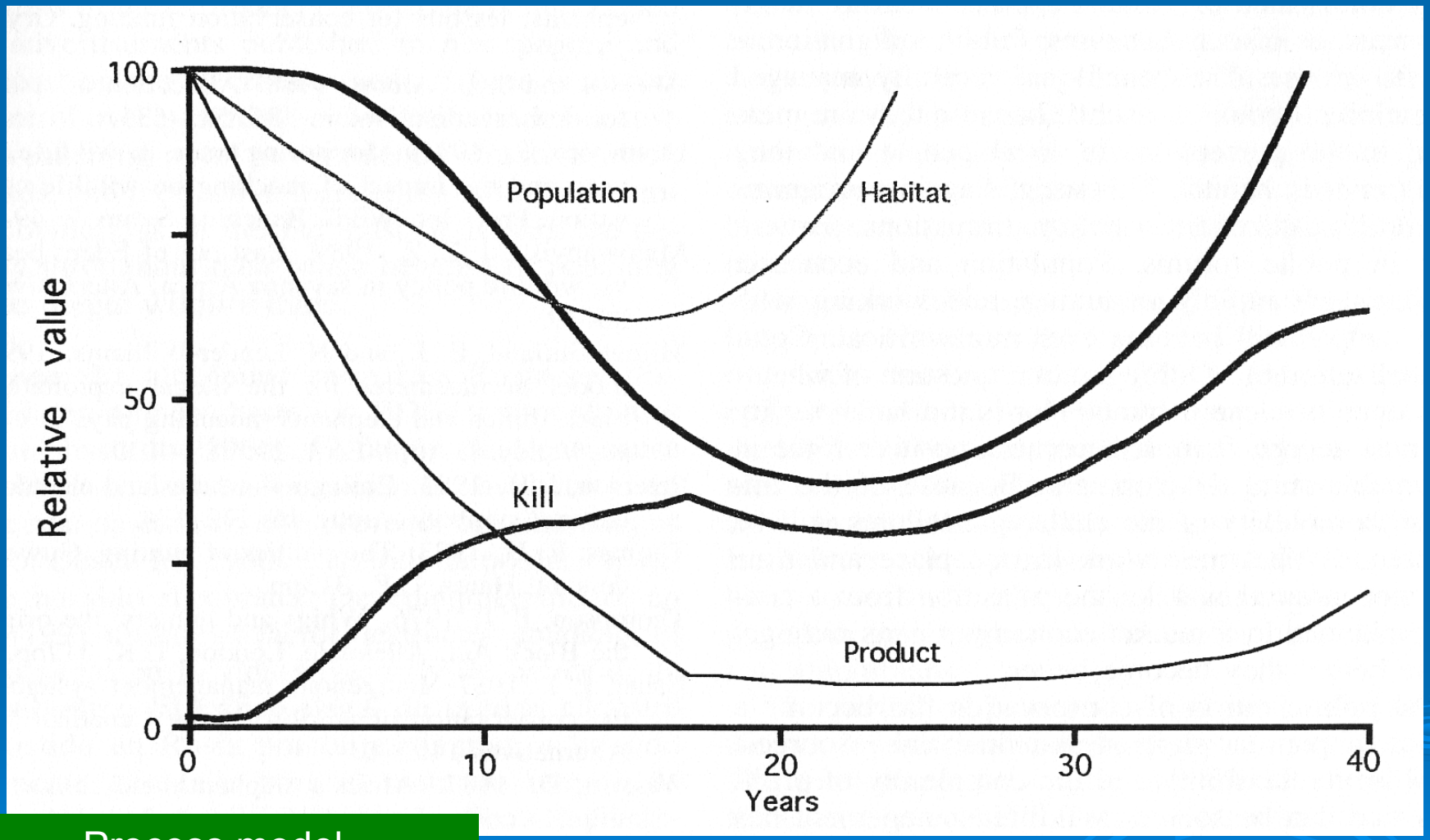


Source:

Hudson, R. J. 1995. Paths to conservation. Pp. 318-322 in: J. A. Bissonette and P. R. Krausman, ed. Integrating people and wildlife for a sustainable future. The Wildlife Society, Bethesda, Maryland. 715 pp.

Process model – STELLA

http://www.iseesystems.com/



Process model – STELLA

http://www.iseesystems.com/

Two approaches for WILDCAST

Wildlife-Habitat Relationships Modeling

Bayesian Network Modeling

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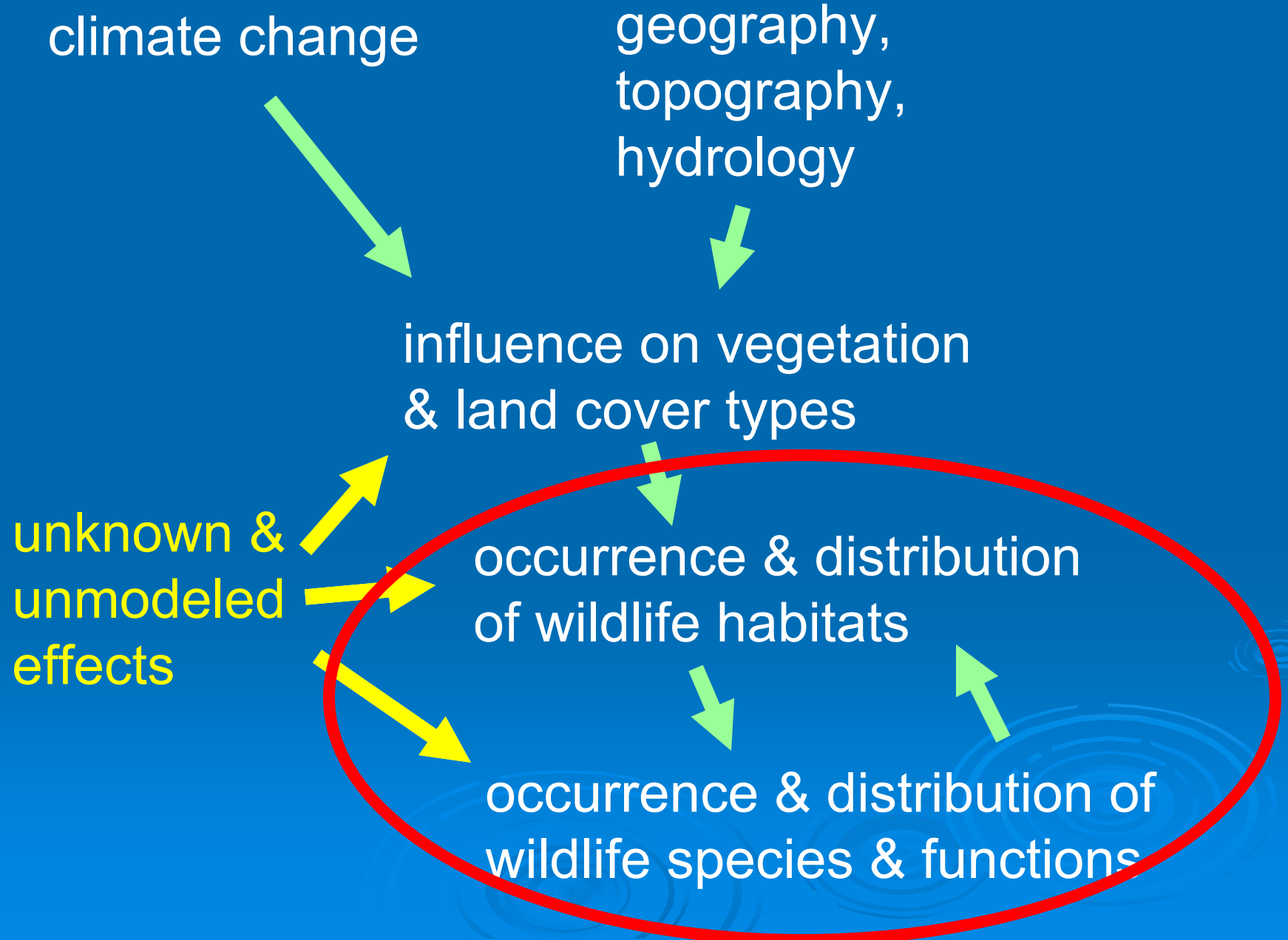
Wildlife-Habitat Relationships Modeling

Bayesian Network Modeling


climate change
geography, topography, hydrology
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unknown & unmodeled effects
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Wildlife-Habitat Relationships Matrix

Species	Habitat A	Habitat B	Habitat C	Habitat D
Vole	***H***	***H***	***L***	***L***
Loon	***L***	***M***	***M***	***M***
Wolf	***M***	***M***	***M***	***H***

Wildlife-Habitat Relationships Matrix

Species				Habitat D
Vol				***L***
Loo				***M***
Wolf	***M***	***M***	***M***	***H***

source of information

-expert judgment

-anecdotal observations

-field studies

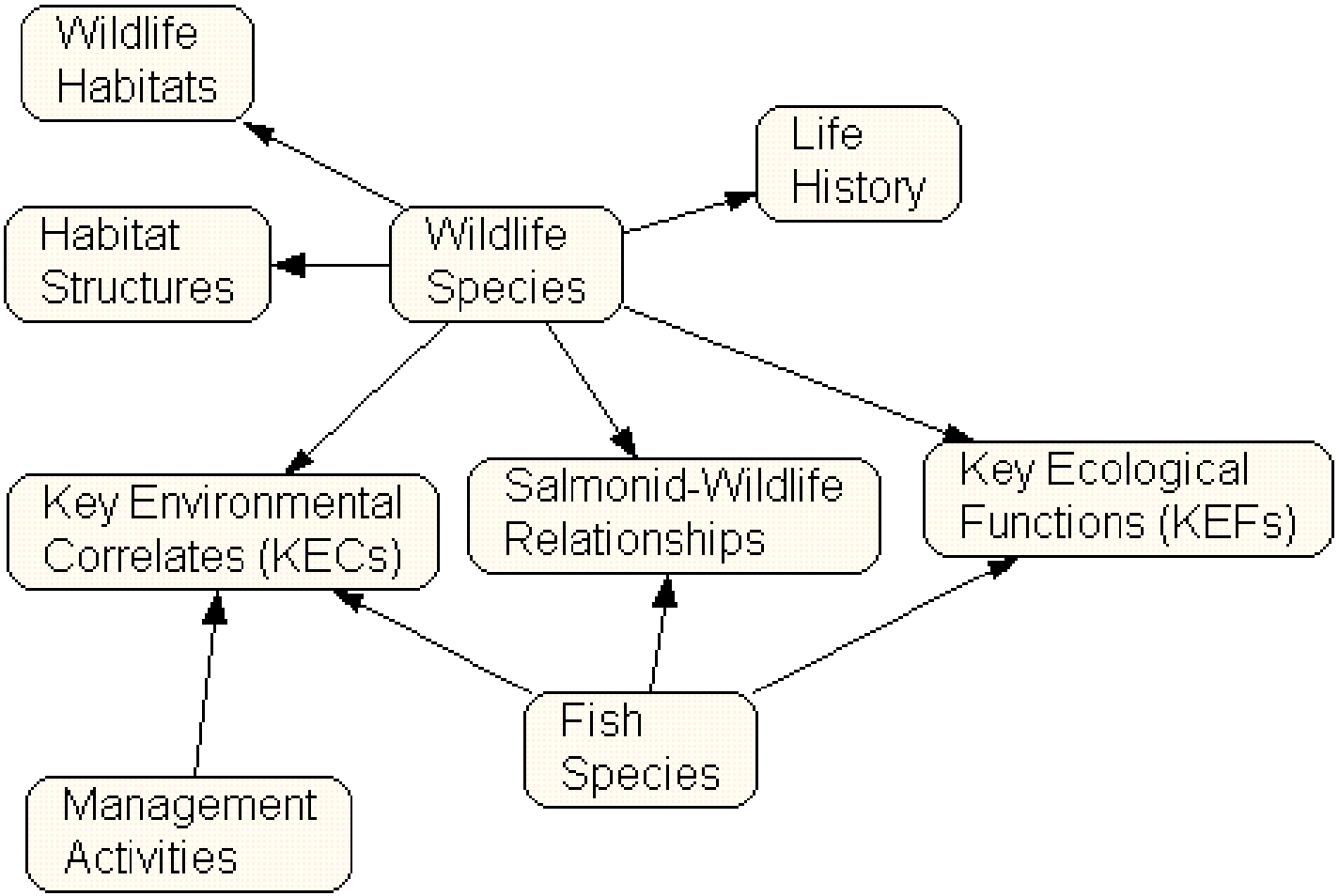
-literature reviews

Wildlife-Habitat Relationships Modeling:

Species-Habitat Relationships in Washington and Oregon

fish, amphibians, reptiles, birds, mammals

Species-Habitat Relationships in Washington and Oregon



Species-Habitat Relationships in Washington and Oregon

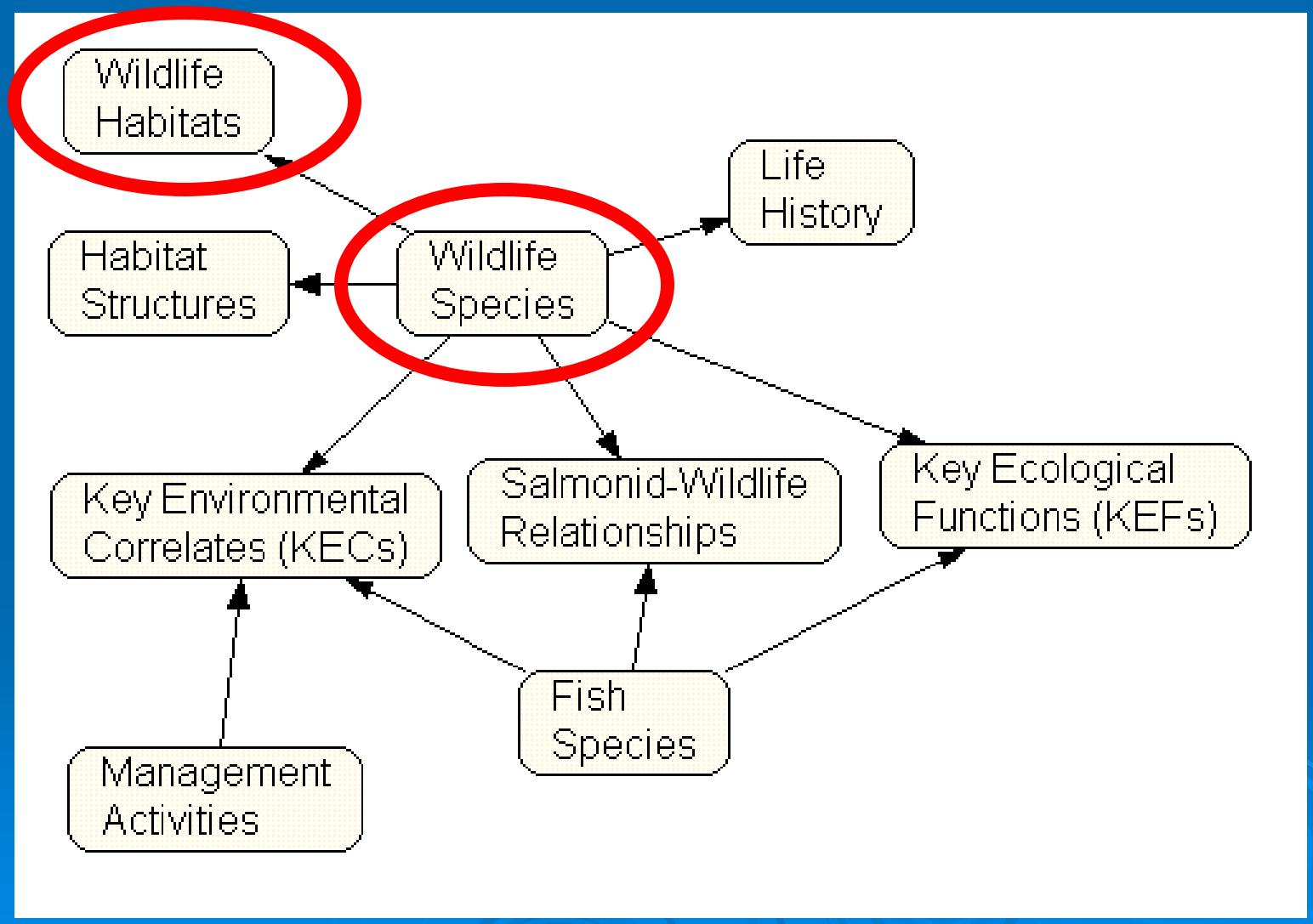


Table : HabRef.db

	Habitat No.	Habitat Name
1	1	Westside Lowlands Conifer-Hardwood Forest
2	10	Alpine Grasslands and Shrublands
3	10H	Historical occurrence-Alpine Grasslands and Shrublands
4	10U	Unsure occurrence-Alpine Grasslands and Shrublands
5	11	Westside Grasslands
6	11H	Historical occurrence-Westside Grasslands
7	11U	Unsure occurrence-Westside Grasslands
8	12	Ceanothus-Manzanita Shrublands
9	12H	Historical occurrence-Ceanothus-Manzanita Shrublands
10	12U	Unsure occurrence-Ceanothus-Manzanita Shrublands
11	13	Western Juniper and Mountain Mahogany Woodlands
12	13H	Historical occurrence-Western Juniper and Mountain Mahogany Woodlands
13	13U	Unsure occurrence-Western Juniper and Mountain Mahogany Woodlands
14	14	Eastside Canyon Shrublands
15	14H	Historical occurrence-Eastside Canyon Shrublands
16	14U	Unsure occurrence-Eastside Canyon Shrublands
17	15	Eastside Grasslands
18	15H	Historical occurrence-Eastside Grasslands
19	15U	Unsure occurrence-Eastside Grasslands
20	16	Shrub-steppe
21	16H	Historical occurrence-Shrub-steppe
22	16U	Unsure occurrence-Shrub-steppe
23	17	Dwarf Shrub-steppe
24	17H	Historical occurrence-Dwarf Shrub-steppe
25	17U	Unsure occurrence-Dwarf Shrub-steppe
26	18	Desert Playa and Salt Scrub Shrublands
27	18H	Historical occurrence-Desert Playa and Salt Scrub Shrublands

Table : WildHabs.DB

	New SPPID	Common Name	Habitat	Activity	Assoc	Confidence
929	40,690.00	Mallard	23	B	C	3
930	40,690.00	Mallard	25	B	C	3
931	40,690.00	Mallard	28	F	A	3
932	40,690.00	Mallard	29	O	P	3
933	40,690.00	Mallard	30	F	A	3
934	40,700.00	Blue-winged Teal	11	R	P	2
935	40,700.00	Blue-winged Teal	15	R	P	2
936	40,700.00	Blue-winged Teal	19	B	C	3
937	40,700.00	Blue-winged Teal	21	F	A	2
938	40,700.00	Blue-winged Teal	22	B	C	3
939	40,700.00	Blue-winged Teal	28	F	P	2
940	40,710.00	Cinnamon Teal	11	R	P	2
941	40,710.00	Cinnamon Teal	15	R	P	2
942	40,710.00	Cinnamon Teal	19	F	C	3
943	40,710.00	Cinnamon Teal	21	F	A	2
944	40,710.00	Cinnamon Teal	22	B	C	3
945	40,710.00	Cinnamon Teal	28	F	P	2
946	40,720.00	Northern Shoveler	11	R	A	2
947	40,720.00	Northern Shoveler	15	R	A	2
948	40,720.00	Northern Shoveler	19	R	A	2
949	40,720.00	Northern Shoveler	21	F	C	3
950	40,720.00	Northern Shoveler	22	B	C	3
951	40,720.00	Northern Shoveler	28	F	P	2
952	40,730.00	Northern Pintail	15	R	A	2
953	40,730.00	Northern Pintail	18	F	P	2
954	40,730.00	Northern Pintail	19	F	A	3
955	40,730.00	Northern Pintail	21	F	C	3
956	40,730.00	Northern Pintail	22	B	C	3
957	40,730.00	Northern Pintail	28	F	C	3

Activity:
F=Feed
R=Reproduce
B=Feed & Reproduce
O=Other

Association:
C=Closely Associated
A=Associated
P=Present

Confidence:
1=low
2=medium
3=high

Table : :PRIV:ANSWER.DB

	Common Name
1	American Badger
2	Belding's Ground Squirrel
3	Burrowing Owl
4	Chukar
5	Columbian Ground Squirrel
6	Deer Mouse
7	Eastern Kingbird
8	Ferruginous Hawk
17	Prairie Falcon
18	Pronghorn Antelope
19	Red-tailed Hawk
20	Sage Grouse
21	Savannah Sparrow
22	Say's Phoebe
23	Sharp-tailed Grouse

Query : spp in WH1.qbe

WildHabs.DB	New SPPID	Common Na	Habitat	Activity	Assoc	Confidence
☐	☐	☑	☐ 15	☐	☐ C	☐

Habitat 15 = Eastside Grassland
Assoc C = closely associated

Species-Habitat Relationships in Washington and Oregon

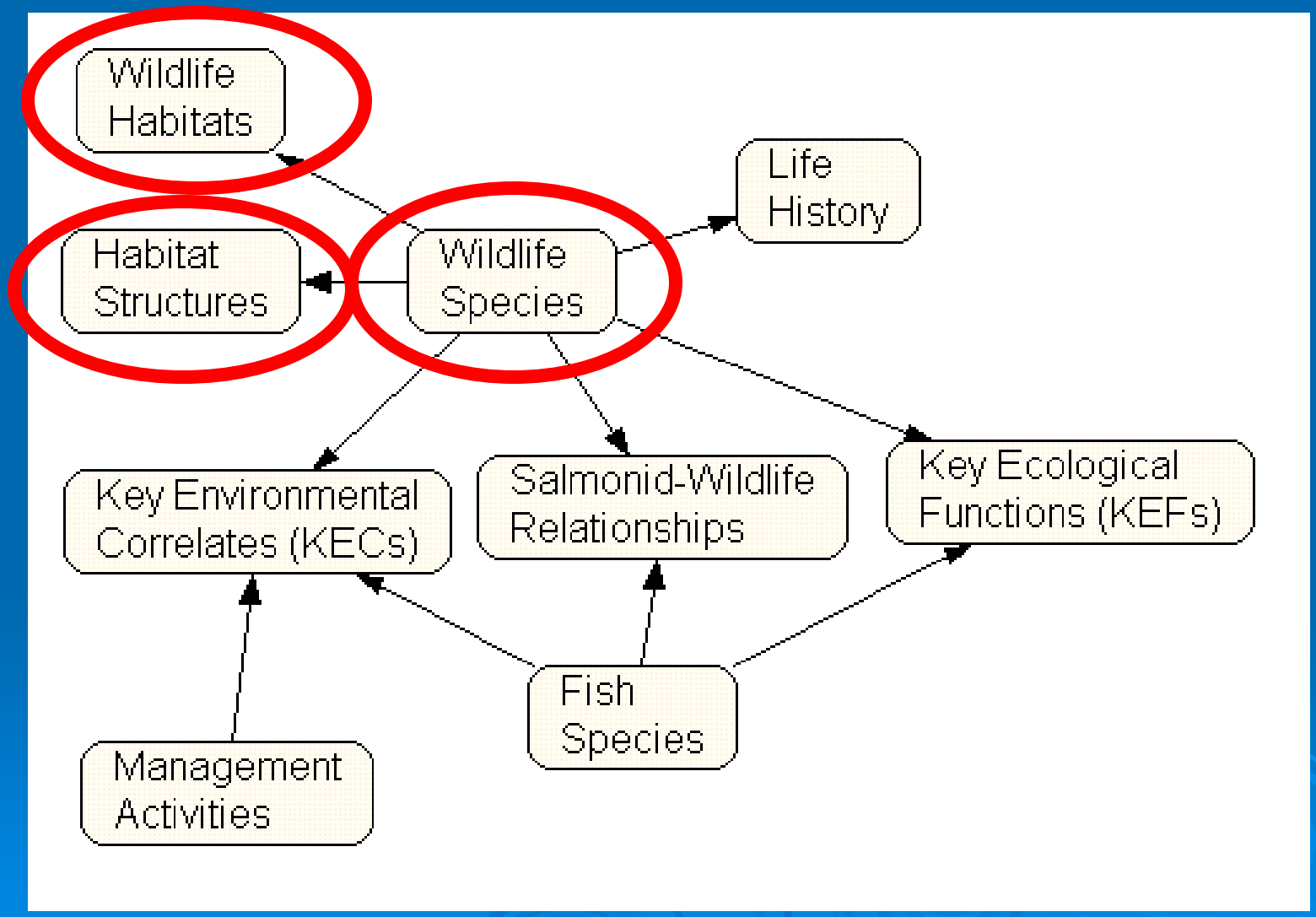


Table : strucLU.DB

	Structure Condition	Structure Number
1	Giant Tree-Multi-Story	26.00
2	Grass/Forb-Closed	2.00
3	Grass/Forb-Open	1.00
4	Large Tree-Multi-Story-Closed	25.00
5	Large Tree-Multi-Story-Moderate	24.00
6	Large Tree-Multi-Story-Open	23.00
7	Large Tree-Single Story-Closed	16.00
8	Large Tree-Single Story-Moderate	15.00
9	Large Tree-Single Story-Open	14.00
10	Medium Tree-Multi-Story-Closed	22.00
11	Medium Tree-Multi-Story-Moderate	21.00
12	Medium Tree-Multi-Story-Open	20.00
13	Medium Tree-Single Story-Closed	13.00
14	Medium Tree-Single Story-Moderate	12.00
15	Medium Tree-Single Story-Open	11.00
16	Sapling/Pole-Closed	7.00
17	Sapling/Pole-Moderate	6.00
18	Sapling/Pole-Open	5.00
19	Shrub/Seedling-Closed	4.00
20	Shrub/Seedling-Open	3.00
21	Small Tree-Multi-Story-Closed	19.00
22	Small Tree-Multi-Story-Moderate	18.00
23	Small Tree-Multi-Story-Open	17.00
24	Small Tree-Single Story-Closed	10.00
25	Small Tree-Single Story-Moderate	9.00
26	Small Tree-Single Story-Open	8.00

Table : strucLU.DB

	Structure Condition	Structure Number
1	Giant Tree-Multi-Story	26.00
2	Grass/Forb-Closed	
3	Grass/Forb-Open	
4	Large Tree-Multi-Story-Closed	
5	Large Tree-Multi-Story-Moderate	
6	Large Tree-Multi-Story-Open	
7	Large Tree-Single Story-Closed	
8	Large Tree-Single Story-Moderate	
9	Large Tree-Single Story-Open	
10	Medium Tree-Multi-Story-Closed	
11	Medium Tree-Multi-Story-Moderate	
12	Medium Tree-Multi-Story-Open	
13	Medium Tree-Single Story-Closed	
14	Medium Tree-Single Story-Moderate	
15	Medium Tree-Single Story-Open	
16	Sapling/Pole-Closed	
17	Sapling/Pole-Moderate	
18	Sapling/Pole-Open	
19	Shrub/Seedling-Closed	
20	Shrub/Seedling-Open	
21	Small Tree-Multi-Story-Closed	
22	Small Tree-Multi-Story-Moderate	
23	Small Tree-Multi-Story-Open	
24	Small Tree-Single Story-Closed	
25	Small Tree-Single Story-Moderate	
26	Small Tree-Single Story-Open	

The forest structural conditions are based upon the following attributes:

Tree Size (dbh)

Shrub/Seedling	< 2.5 cm
Sapling/Pole	2.5-24 cm
Small Tree	25-37 cm
Medium Tree	38-49 cm
Large Tree	50-75 cm
Giant Tree	> 76 cm

Percent Canopy Cover

Open	10-39%
Moderate	40-69%
Closed	70-100%

Number of Canopy Layers

Single Story	1 stratum
Multi-story	2 or more strata

Table : :PRIV:ANSWER.DB

	Structure Condition
1	Grass/Forb-Closed
2	Grass/Forb-Open
3	Low Shrub-Closed Shrub Overstory-Mature
4	Low Shrub-Closed Shrub Overstory-Old
5	Low Shrub-Closed Shrub Overstory-Seedlin
6	Low Shrub-Open Shrub Overstory-Mature
7	Low Shrub-Open Shrub Overstory-Old
8	Low Shrub-Open Shrub Overstory-Seedling
9	Medium Shrub-Closed Shrub Overstory-Ma
10	Medium Shrub-Closed Shrub Overstory-Olc
11	Medium Shrub-Closed Shrub Overstory-Se
12	Medium Shrub-Open Shrub Overstory-Matu
13	Medium Shrub-Open Shrub Overstory-Old
14	Medium Shrub-Open Shrub Overstory-Seec
15	Medium shrub-Closed Shrub Overstory-Mat
16	Medium shrub-Closed Shrub Overstory-Old
17	Medium shrub-Closed Shrub Overstory-See
18	Medium shrub-Open Shrub Overstory-Matu
19	Medium shrub-Open Shrub Overstory-Old
20	Medium shrub-Open Shrub Overstory-Seec
21	Tall Shrub-Closed Shrub Overstory-Mature
22	Tall Shrub-Closed Shrub Overstory-Old
23	Tall Shrub-Closed Shrub Overstory-Seedlin
24	Tall Shrub-Open Shrub Overstory-Mature
25	Tall Shrub-Open Shrub Overstory-Old
26	Tall Shrub-Open Shrub Overstory-Seedling

The shrubland and grassland structural conditions are based upon the following attributes:

Shrub Height

Low <0.5 m
Medium 0.5-2.0 m
Tall 2.0-5.0 m

Percent Shrub Cover

Open 10-69% shrub cover
Closed 70-100% shrub cover

Shrub Age Class

Seedling/Young negligible crown decadence
Mature <25% crown decadence
Old 26-100% crown decadence

Table : :PRIV:ANSWER.DB

	Common Name
1	Chukar
2	Columbian Ground Squirrel
3	Deer Mouse
4	Eastern Kingbird
5	Ferruginous Hawk
6	Montane Vole
7	Northern Pocket Gopher
8	Northern Shrike
9	Nuttall's (Mountain) Cottontail
10	Prairie Falcon
11	Red-tailed Hawk
12	Say's Phoebe
13	Swainson's Hawk
14	Western Kingbird
15	Western Pipistrelle
16	Western Small-footed Myotis
17	White-tailed Jackrabbit

?

Nonfst.db SCUrban.db stconxwalk.DB strucLU.DB

HP\SHPSTRUC\

Habitat 15 = Eastside Grassland
Assoc C = closely associated

Tall, Open, Old shrub stage

Query : <Untitled>

SCNonfst.db	SPPID	Common Name	Structure Condition	SC-Occ	SC-Assoc	SC
☐	☐	☑ join1	☐ Tall Shrub-Open Shrub Overstory-Old	☐	☐ not blank	☐

WildHabs.DB	New SPPID	Common Na	Habitat	Activity	Assoc	Confidence
☐	☐	☐ join1	☐ 15	☐	☐ C	☐

Species-Habitat Relationships in Washington and Oregon

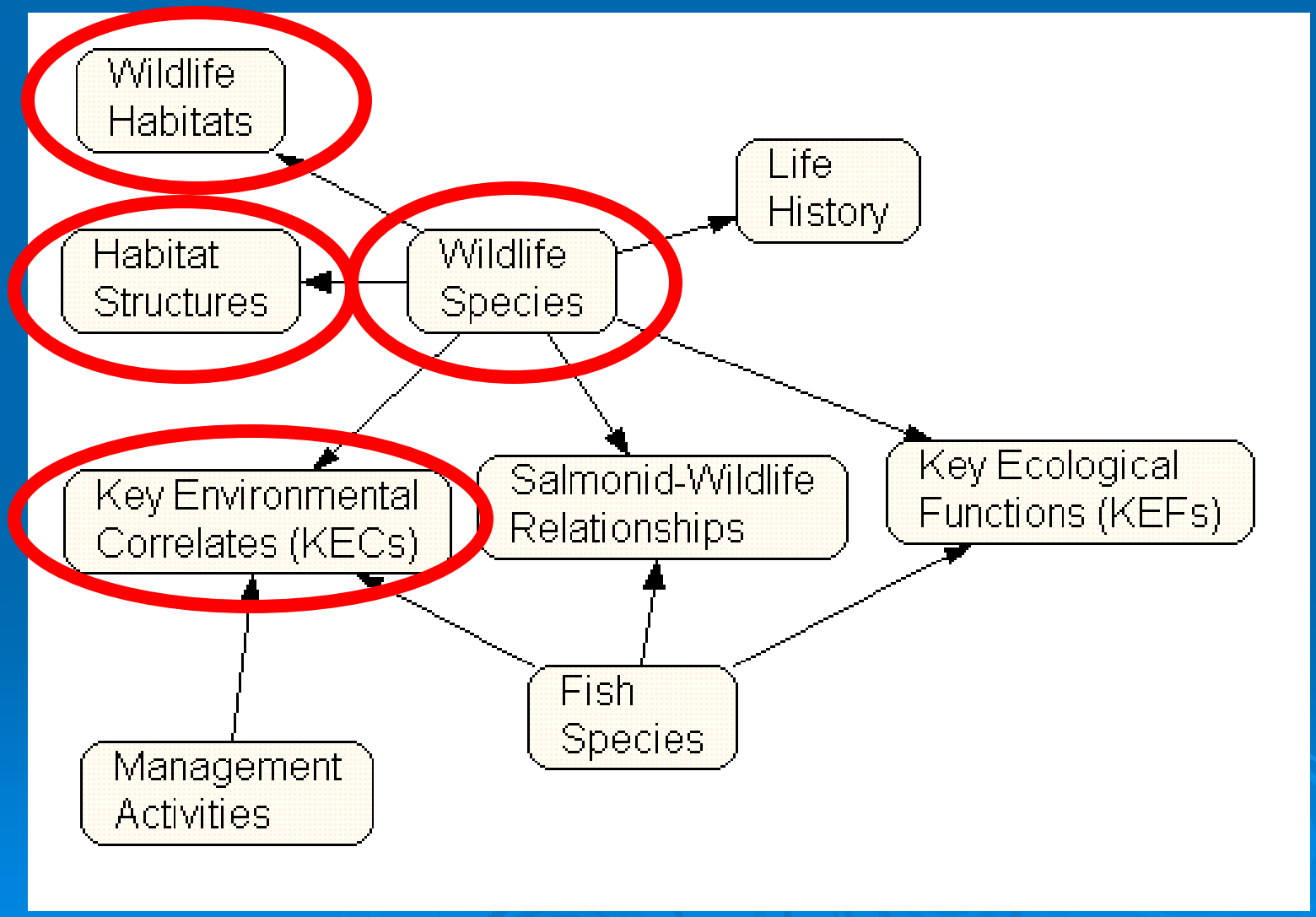


Table : :PRIV:ANSWER.DB

	Habitat Elements	HabElemsDescription
1	1	Forest, Shrubland, & Grassland Habitat Elements
2	1.1	forest/woodland vegetative elements or substrates
3	1.1.1	down wood (includes downed logs, branches, and rootwads, in any context)
4	1.1.1.1	decay class
5	1.1.1.1.1	hard [class 1, 2]
6	1.1.1.1.2	moderate [class 3]
7	1.1.1.1.3	soft [class 4, 5]
8	1.1.1.2	down wood in riparian areas
9	1.1.1.3	down wood in upland areas
10	1.1.10	fungi
11	1.1.11	roots, tubers, underground plant parts
12	1.1.12	ferns
13	1.1.13	herbaceous layer
14	1.1.14	trees
15	1.1.14.1	snags
16	1.1.14.1.1	decay class
17	1.1.14.1.1.1	hard [class 1, 2]
18	1.1.14.1.1.2	moderate [class 3]
19	1.1.14.1.1.3	soft [class 4, 5]
20	1.1.14.10	large live tree branches
21	1.1.14.11	tree canopy layer
22	1.1.14.11.1	sub-canopy
23	1.1.14.11.2	above canopy
24	1.1.14.11.3	tree bole
25	1.1.14.11.4	canopy
26	1.1.14.2	snag size (dbh)

Table : :PRIV:ANSWER.DB

	Habitat Elements	HabElemsDescription
1	1	Forest, Shrubland, & Grassland Habitat Elements
2	1.1	forest/woodland vegetative elements or substrates

Table : :PRIV:ANSWER.DB

	Habitat Elements	HabElemsDescription
1	1	Forest, Shrubland, & Grassland Habitat Elements
2	2	Ecological Habitat Elements
3	3	Non-vegetative, Abiotic Habitat Elements
4	4	Freshwater Riparian & Aquatic Bodies Habitat Elements
5	5	Marine Habitat Elements
6	7	Fire as a Habitat Element
7	8	Anthropogenic-related Habitat Elements

18	1.1.14.1.1.2	moderate [class 3]
19	1.1.14.1.1.3	soft [class 4, 5]
20	1.1.14.10	large live tree branches
21	1.1.14.11	tree canopy layer
22	1.1.14.11.1	sub-canopy
23	1.1.14.11.2	above canopy
24	1.1.14.11.3	tree bole
25	1.1.14.11.4	canopy
26	1.1.14.2	snag size (dbh)

Table : :PRIV:ANSWER.DB

	Common Name
1	Eastern Kingbird
2	Montane Vole
3	Northern Pocket Gopher
4	Northern Shrike
5	Red-tailed Hawk

an.db stconxwalk.DB strucLU.DB

Query : <Untitled>

SCNonfst.db	SPPID	Common Name	Structure Condition	SC-Occ	SC-Assoc
		join1	Tall Shrub-Open Shrub Overstory-Old		not blank

WildHabs.DB	New SPPID	Common Na	Habitat	Activity	Assoc	Confidence
		join1	15		C	

HabElems.DB	SPPID	Common Na	POS	NEG	Habitat Elements	HabElemsComments
		join1			4.7	

Habitat 15 = Eastside Grassland
Assoc C = closely associated

Tall, Open, Old shrub stage

Wetlands

Species-Habitat Relationships in Washington and Oregon

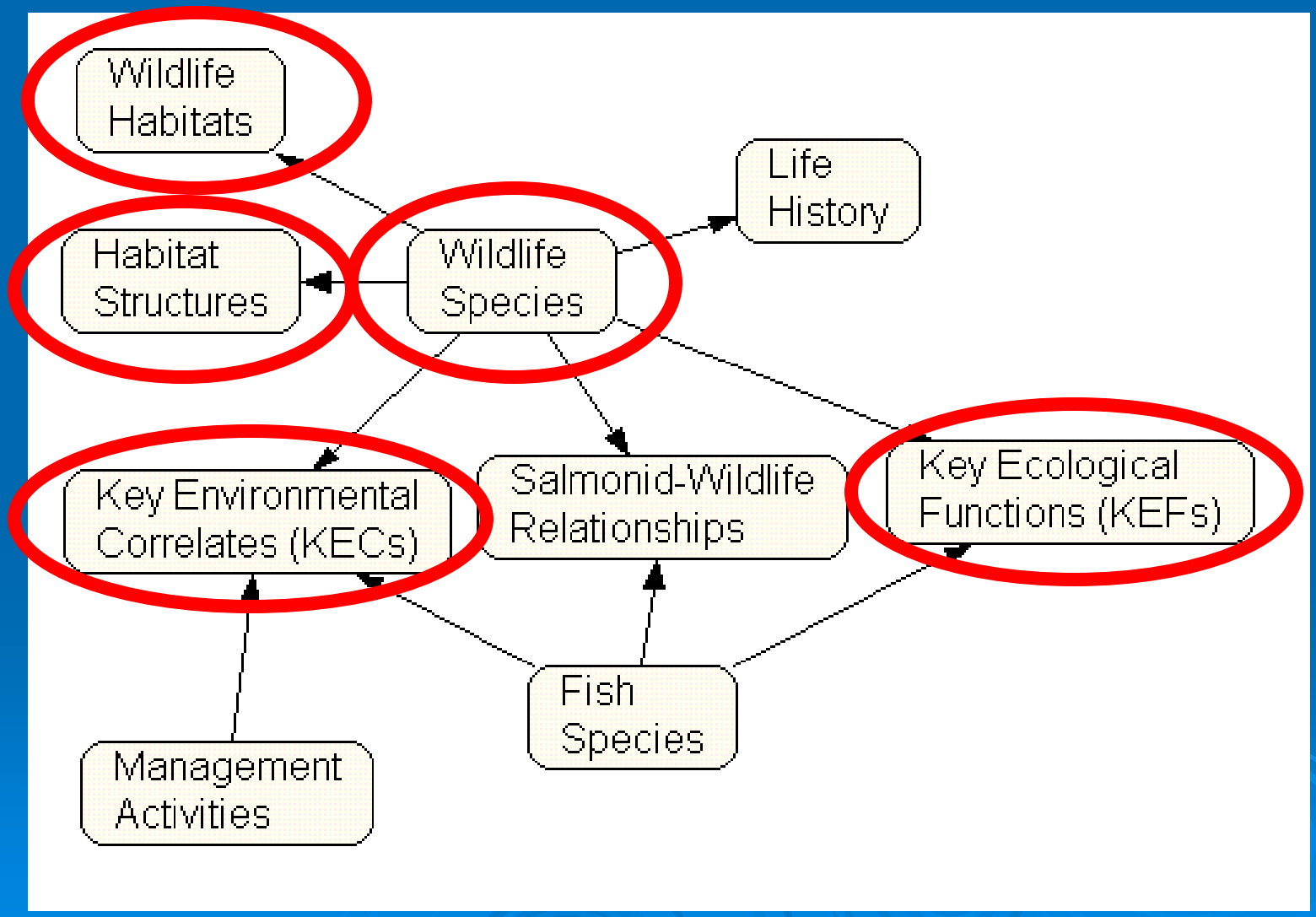


Table : KEFdesc.DB

	SHP-KEF	DESCRIPTION
1	1	Trophic relationships
2	1.1	heterotrophic consumer
3	1.1.1	primary consumer (herbivore) (also see below under Herbivory)
4	1.1.1.1	foliovore (leaf-eater)
5	1.1.1.10	flower/bud/catkin feeder
6	1.1.1.11	aquatic herbivore
7	1.1.1.12	feeds in water on decomposing benthic substrate
8	1.1.1.13	bark/cambium/bole feeder
9	1.1.1.2	spermivore (seed-eater)
10	1.1.1.3	browser (leaf, stem eater)
11	1.1.1.4	grazer (grass, forb eater)
12	1.1.1.5	frugivore (fruit-eater)
13	1.1.1.6	sap feeder
14	1.1.1.7	root feeders
15	1.1.1.8	nectivore (nectar feeder)
16	1.1.1.9	fungivore (fungus feeder)
17	1.1.2	secondary consumer (primary predator or primary carnivore)
18	1.1.2.1	invertebrate eater
19	1.1.2.1.1	terrestrial invertebrates
20	1.1.2.1.2	aquatic macroinvertebrates
21	1.1.2.1.3	freshwater or marine zooplankton
22	1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
23	1.1.2.2.1	piscivorous (fish eater)
24	1.1.2.3	ovivorous (egg eater)
25	1.1.3	tertiary consumer (secondary predator or secondary carnivore)
26	1.1.4	carrion feeder

Table : KEFdesc.DB

	SHP-KEF	DESCRIPTION
19	1.1.2.1.1	terrestrial invertebrates
20	1.1.2.1.2	aquatic macroinvertebrates
21	1.1.2.1.3	freshwater or marine zooplankton
22	1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
23	1.1.2.2.1	piscivorous (fish eater)
24	1.1.2.3	ovivorous (egg eater)
25	1.1.3	tertiary consumer (secondary predator or secondary carnivore)
26	1.1.4	carrion feeder

Table : :PRIV:ANSWER.DB

	SHP-KEF	DESCRIPTION
1	1	Trophic relationships
2	2	aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
3	3	organismal relationships
4	4	carrier, transmitter, or reservoir of vertebrate diseases
5	5	soil relationships
6	6	wood structure relationships (either living or dead wood)
7	7	water relationships
8	8	vegetation structure and composition relationships

Table : :PRIV:ANSWER.DB

	Common Name
1	Columbian Ground Squirrel
2	Deer Mouse
3	Montane Vole
4	Northern Pocket Gopher

an.db stconxwalk.DB strucLU.DB

Query : <Untitled>

SCNonfst.db	SPPID	Common Name	Structure Condition	SC-Occ	SC-Assoc
		join1	Tall Shrub-Open Shrub Overstory-Old		not blank

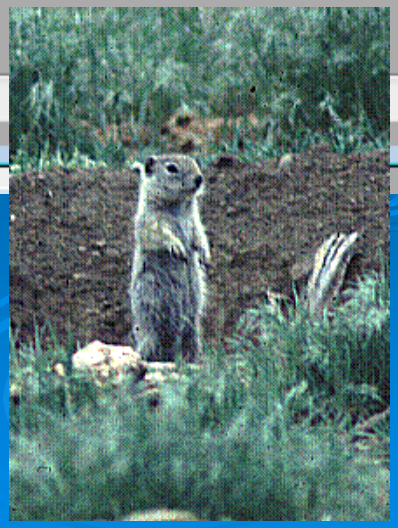
WildHabs.DB	New SPPID	Common Na	Habitat	Activity	Assoc	Confidence
		join1	15		C	

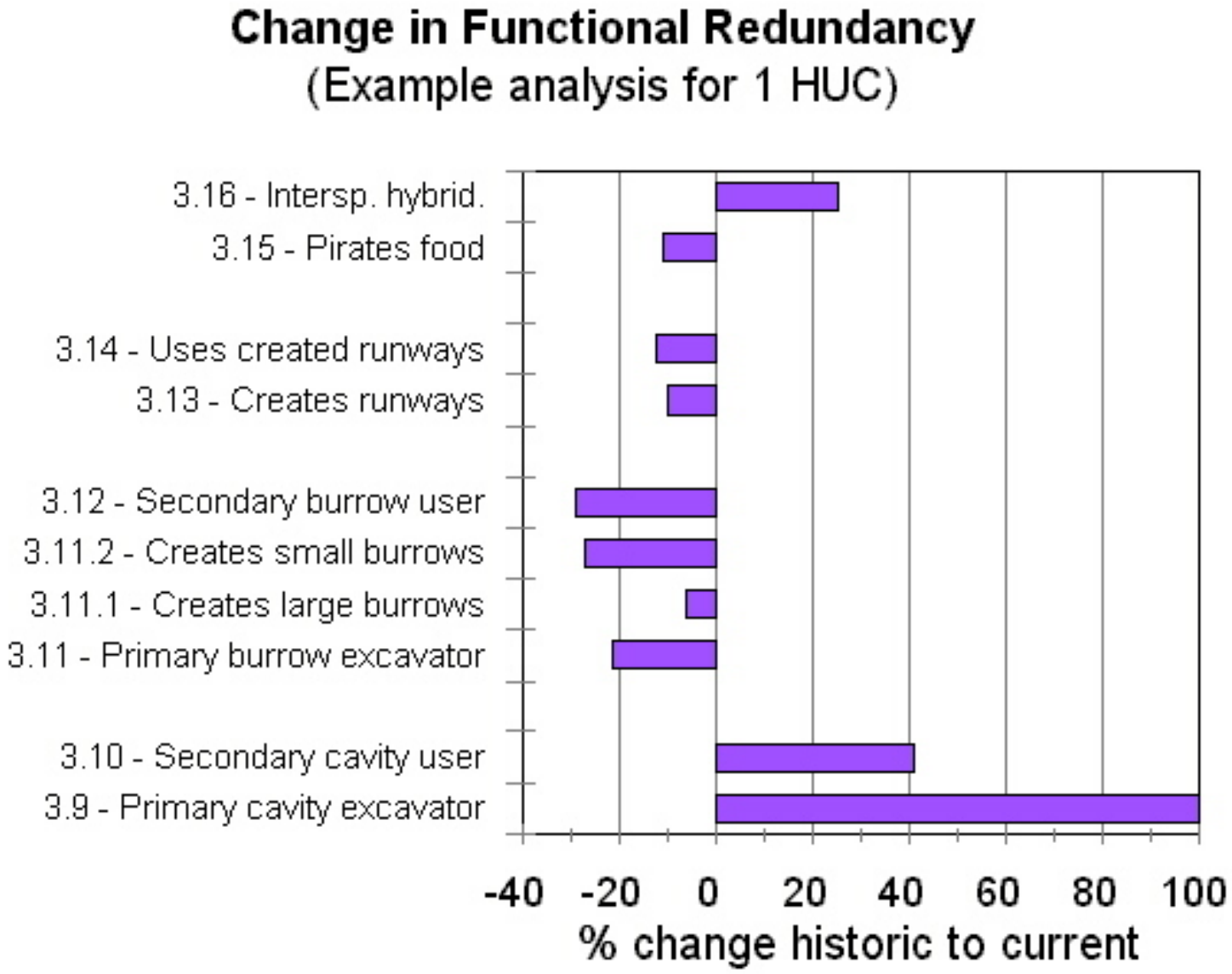
KEFs599.DB	New SPPID	Common Name	SHP-KEF
		join1	3.11

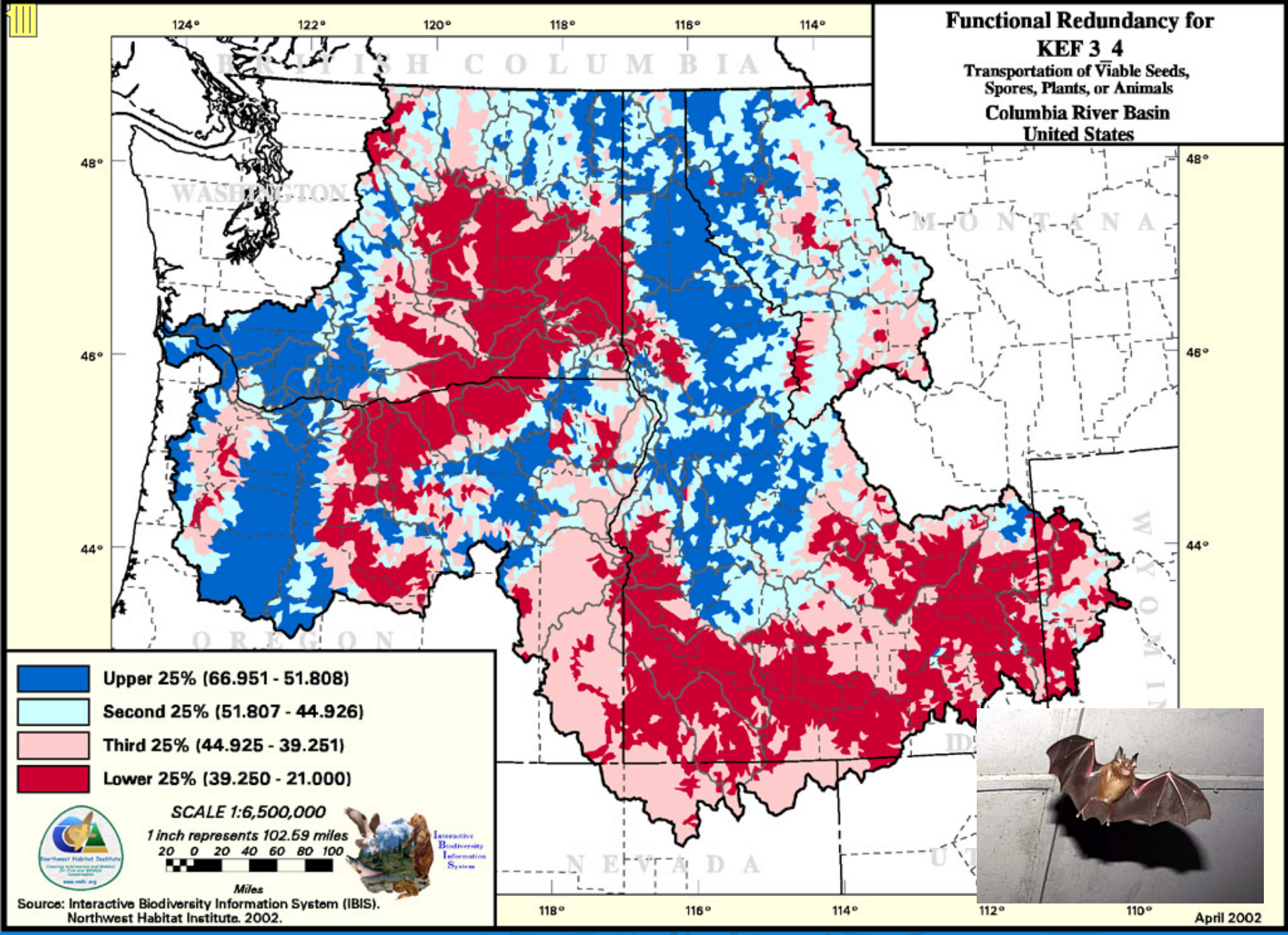
Habitat 15 = Eastside Grassland
Assoc C = closely associated

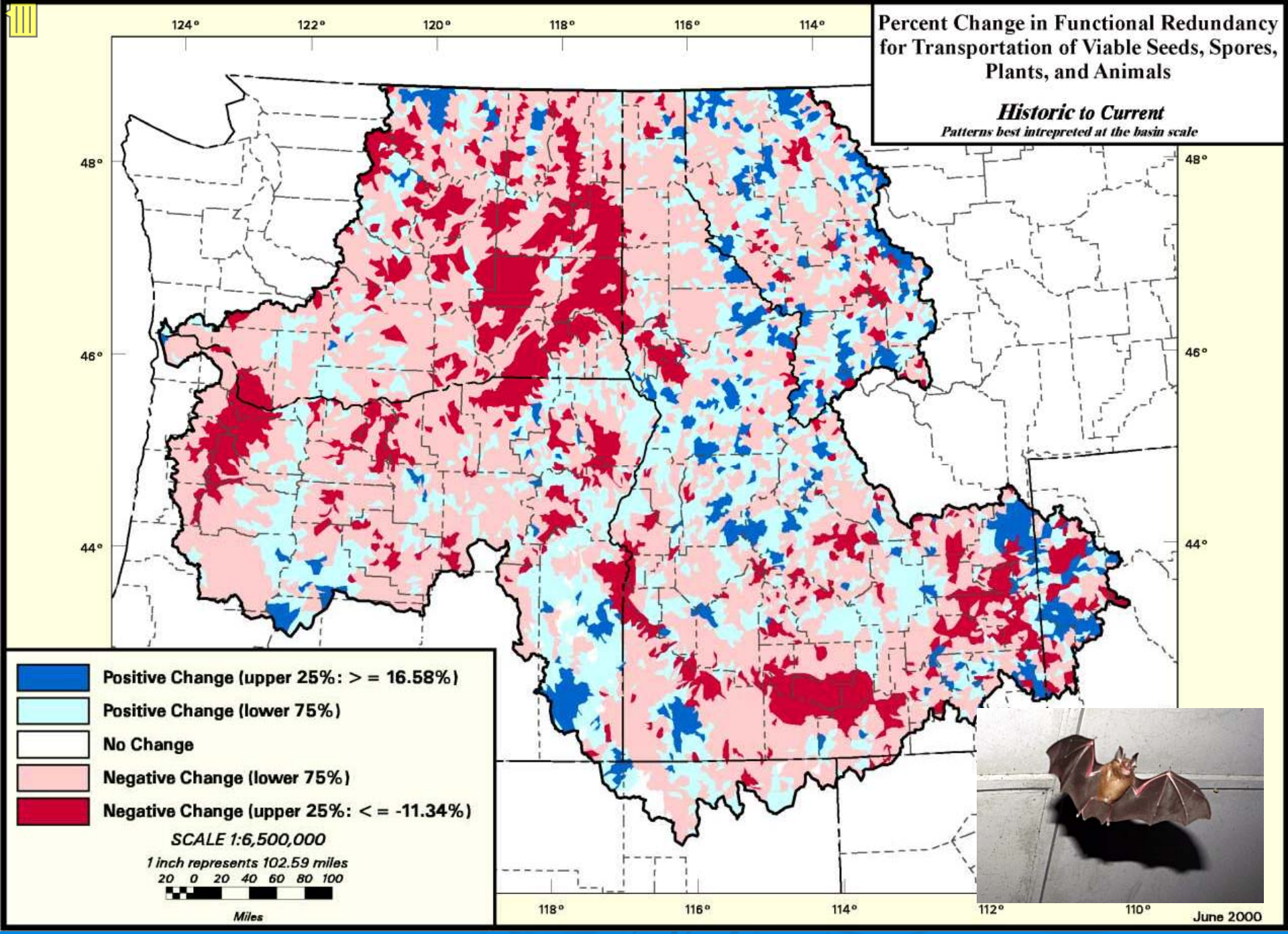
Tall, Open, Old shrub stage

Primary burrow excavator




Change in Functional Redundancy
(Example analysis for 1 HUC)
3.16 - Intersp. hybrid.
3.15 - Pirates food
3.14 - Uses created runways
3.13 - Creates runways
3.12 - Secondary burrow user
3.11.2 - Creates small burrows
3.11.1 - Creates large burrows
3.11 - Primary burrow excavator
3.10 - Secondary cavity user
3.9 - Primary cavity excavator
-40
-20
0
20
40
60
80
100
% change historic to current


Functional Redundancy for
KEF 3_4
Transportation of Viable Seeds, Spores, Plants, or Animals
Columbia River Basin
United States
124°
122°
120°
118°
116°
114°
48°
46°
44°
BRITISH COLUMBIA
WASHINGTON
MONTANA
OREGON
NEVADA
Upper 25% (66.951 - 51.808)
Second 25% (51.807 - 44.926)
Third 25% (44.925 - 39.251)
Lower 25% (39.250 - 21.000)
SCALE 1:6,500,000
1 inch represents 102.59 miles
20 0 20 40 60 80 100
Miles
Interactive Biodiversity Information System
Source: Interactive Biodiversity Information System (IBIS).
Northwest Habitat Institute. 2002.
112°
110°
April 2002


Percent Change in Functional Redundancy for Transportation of Viable Seeds, Spores, Plants, and Animals
Historic to Current
Patterns best intrepreted at the basin scale
124°
122°
120°
118°
116°
114°
48°
46°
44°
112°
110°
Positive Change (upper 25%: > = 16.58%)
Positive Change (lower 75%)
No Change
Negative Change (lower 75%)
Negative Change (upper 25%: < = -11.34%)
SCALE 1:6,500,000
1 inch represents 102.59 miles
20 0 20 40 60 80 100
Miles
June 2000

The Species-Environment Relations Page

Bruce G. Marcot

[This page is designed for wildlife biologists, ecologists, natural resource planners, and others in the fields of wildlife and natural resource management ... although teachers, students, and anyone else are welcome to explore. Opinions and information are those of Bruce Marcot, and are not intended to reflect those of other people or organizations.]

Quick start: Here is a reading list

The Key Ecological Functions (KEFs) Page

Bruce G. Marcot
publication links updated: 15 June 2007

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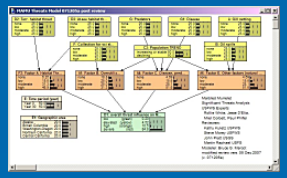
Contents of This Page:

What Are KEFs?
Classification of KEFs
A Taxonomy of Patterns of Key Ecological Functions (KEFs)
Some Hypotheses on Ecological Functions
KEFs Used in Regional and Species Assessments

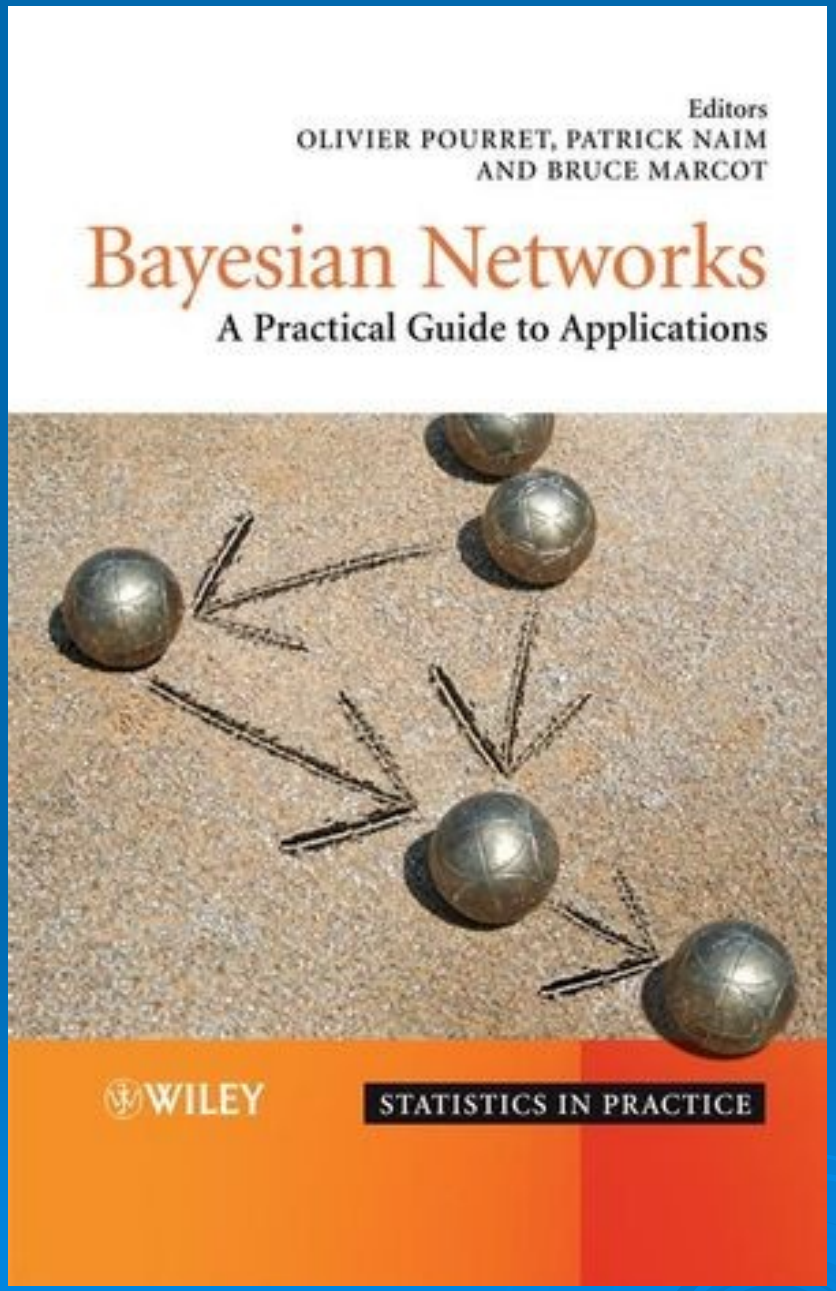
http://www.spiritone.com/~brucem/plexeco.htm

Two approaches for WILDCAST

Wildlife-Habitat Relationships Modeling



Bayesian Network Modeling



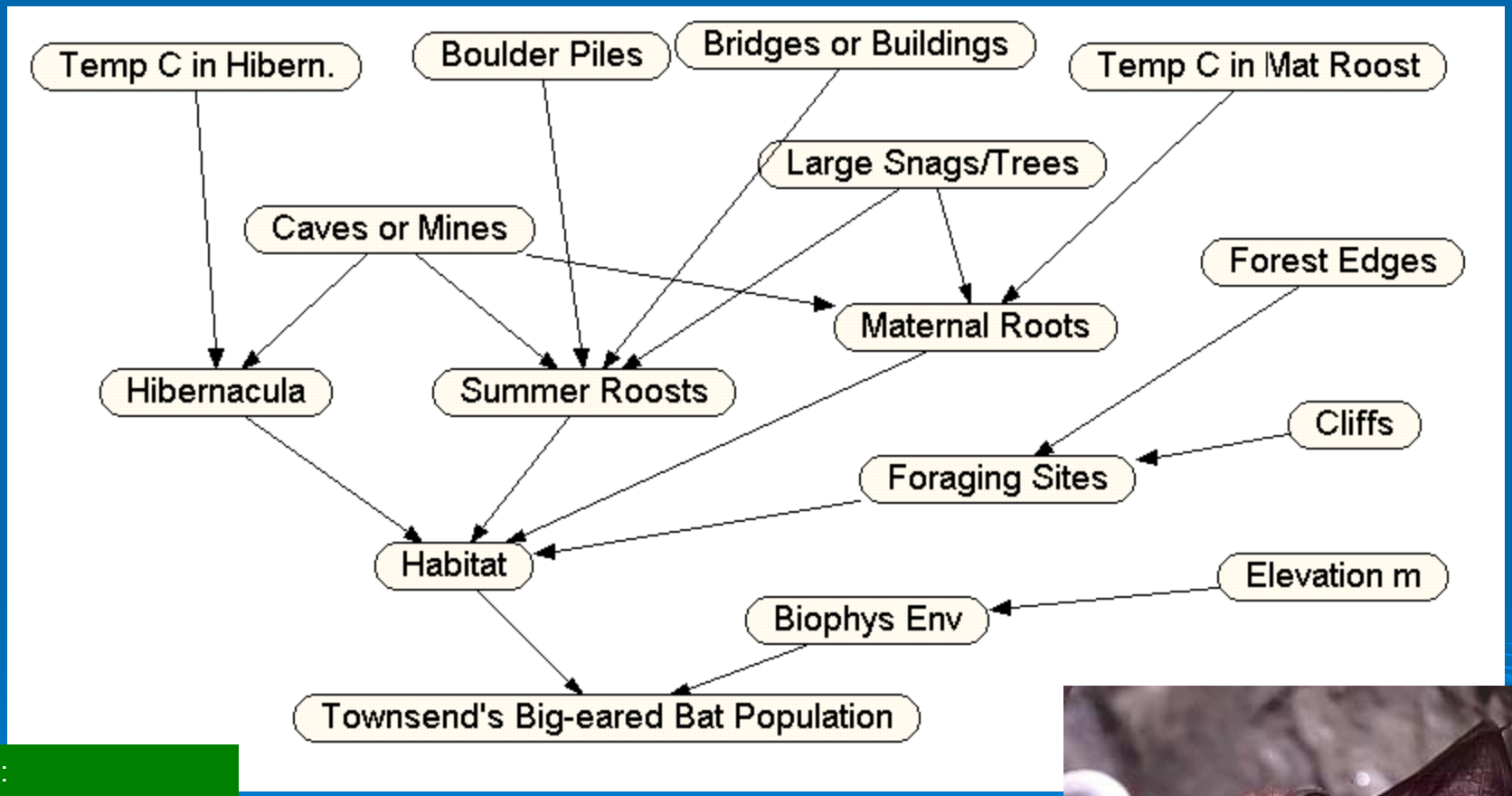
Creating Bayesian Network Models in Ecology

Bruce G. Marcot

updated 19 August 2008

http://www.spiritone.com/~brucem/bbns.htm

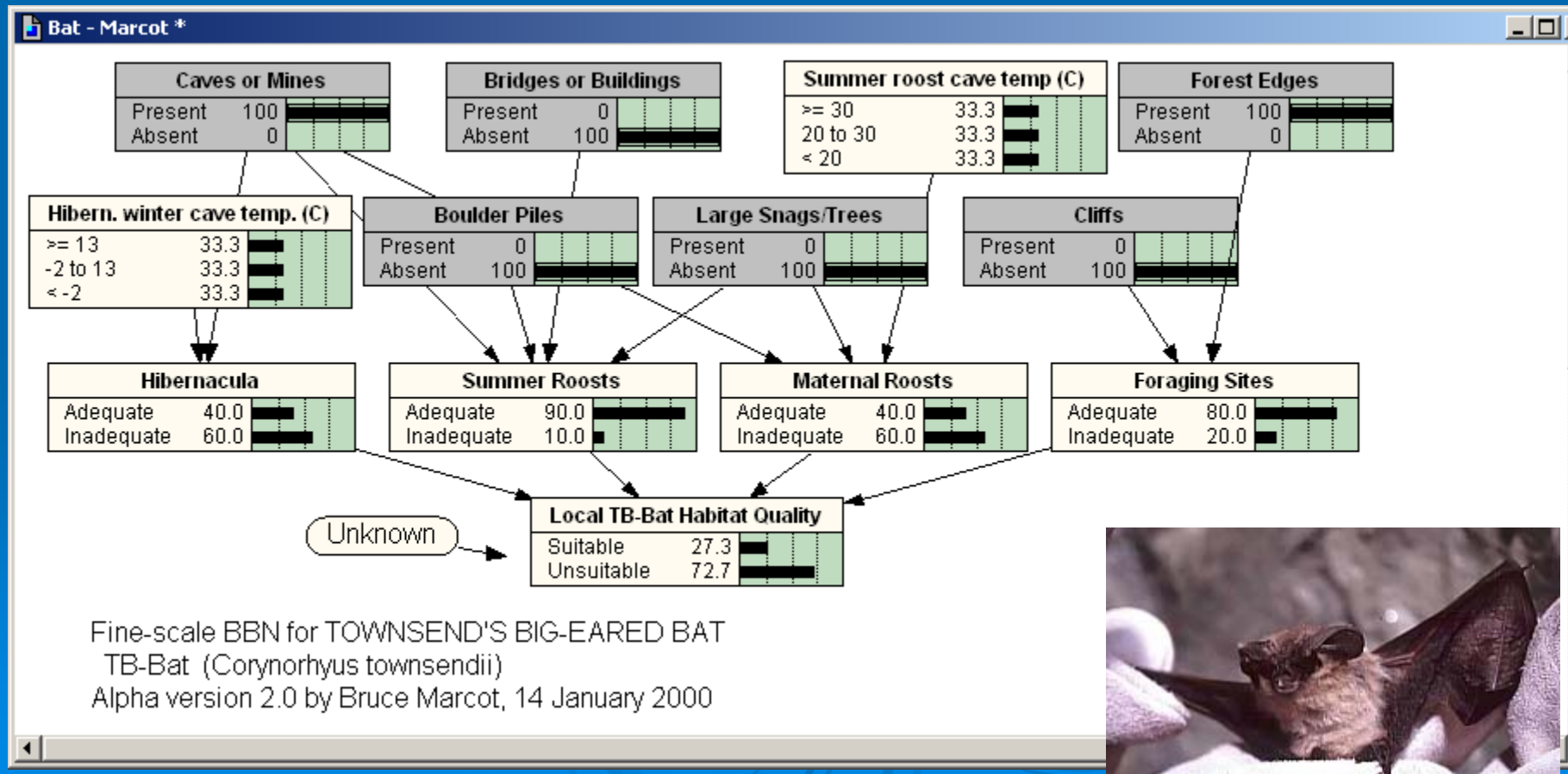
Influence diagrams



Source:

Marcot, B. G., et al. 2001. Forest Ecology and Management 153(1-3):29-42.

Bayesian Network Model



What is a Bayesian Network?

What is a Bayesian Network?

- Uses Bayesian “learning” statistics
- Bayes’ Theorem:

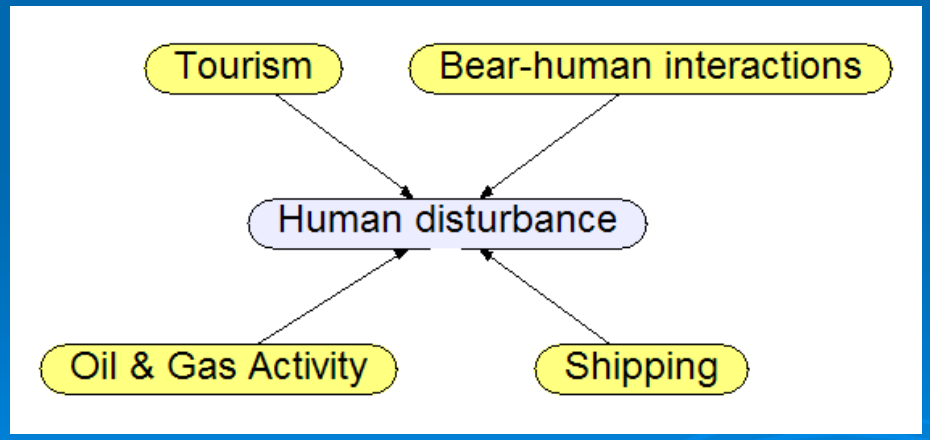
$$P(S \mid H) = \frac{P(H \mid S)P(S)}{P(H)}$$

S = species abundance, presence

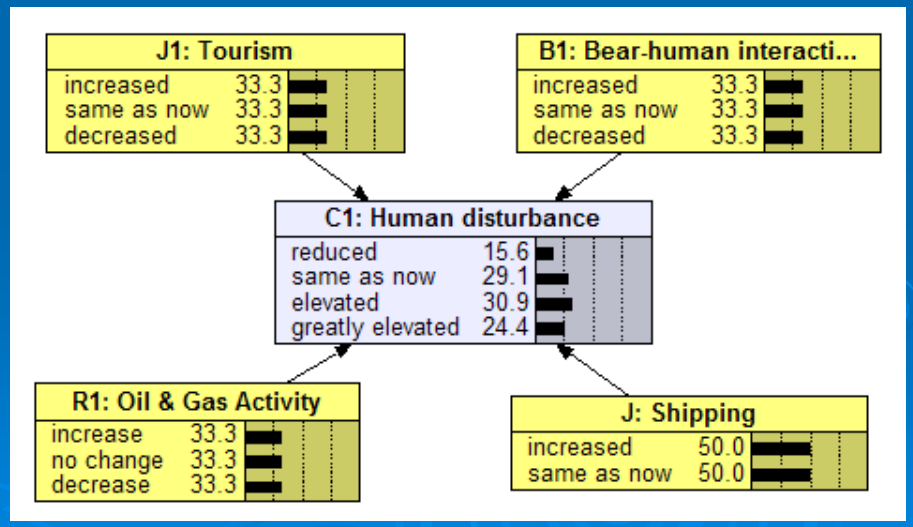
H = habitat conditions

What is a Bayesian network?

- A graphical model of causal effects
- Variables linked by probabilities
- Combines field data & expert knowledge



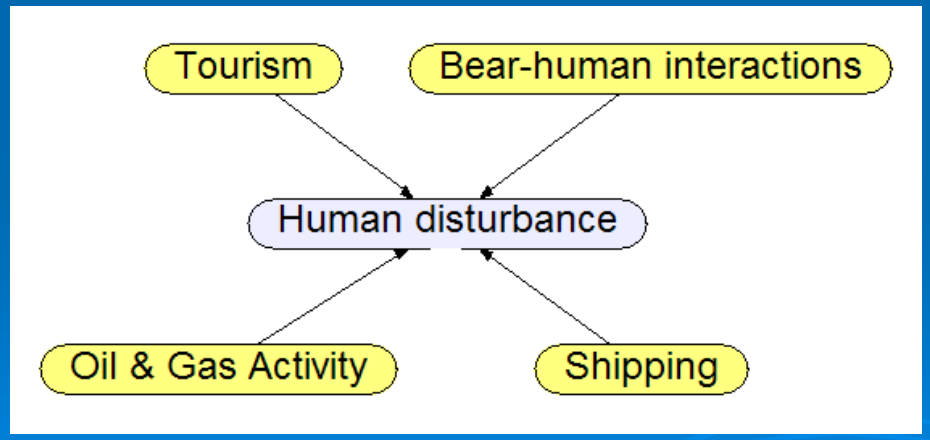
Graphical model



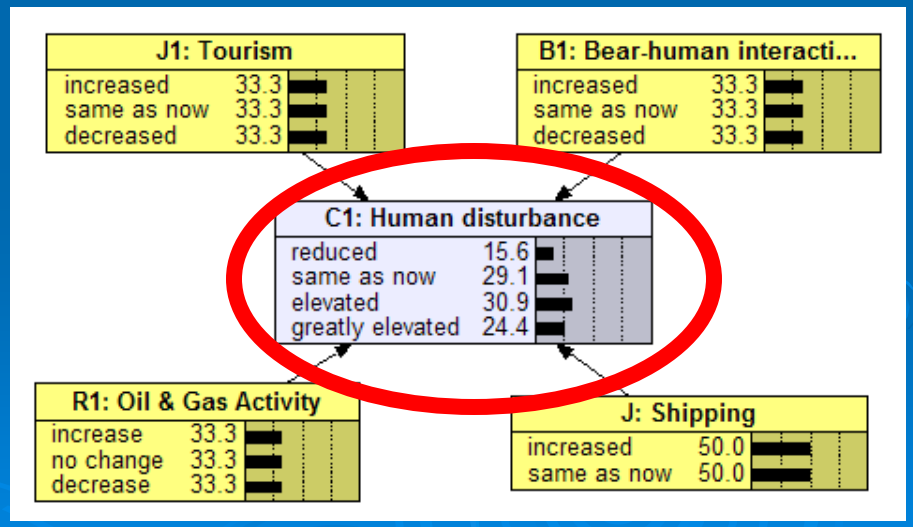
With probabilities

What is a Bayesian network?

- A graphical model of causal effects
- Variables linked by probabilities
- Combines field data & expert knowledge



Graphical model



With probabilities

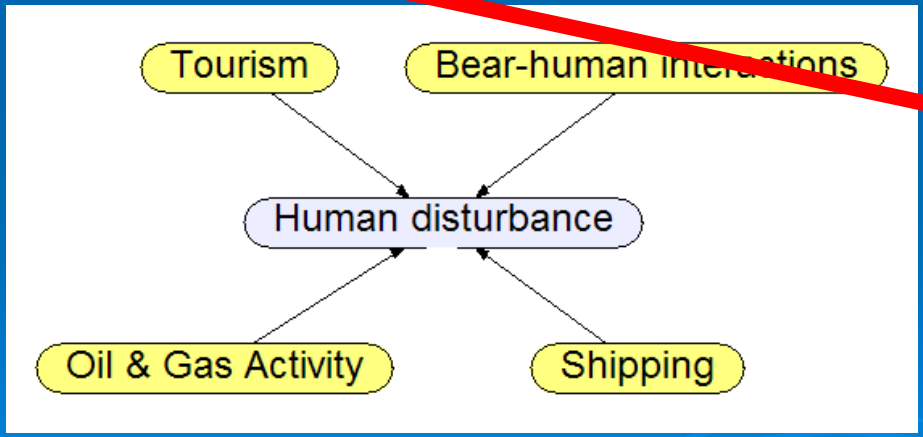
C1 Table (in net outcome_model_070821b_w_Year_2)

Node: C1

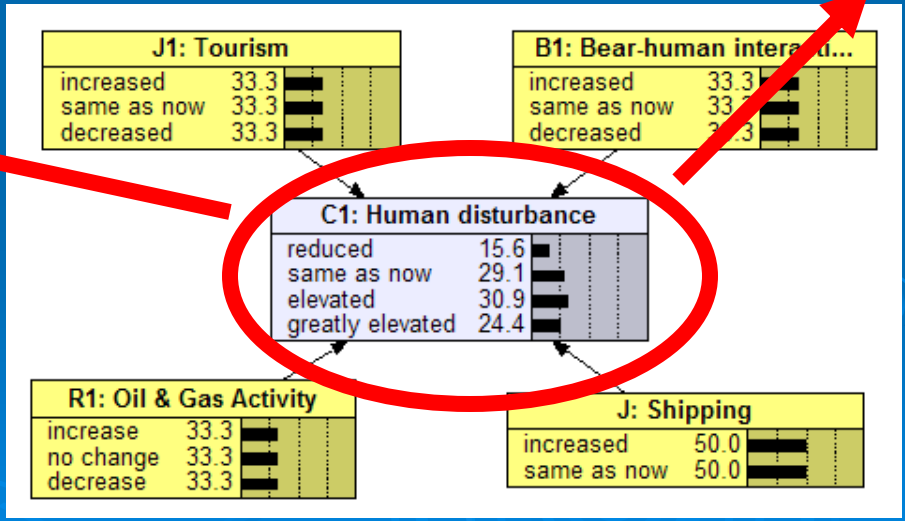
Apply | Okay | Reset | Close

Chance | % Probability

Bear-human interactions	Shipping	Oil & Gas Activity	Tourism	reduced	same as now	elevated	greatly elevated
increased	increased	increase	increased	0.000	0.000	0.000	100.00
increased	increased	increase	same as now	0.000	0.000	0.000	100.00
increased	increased	increase	decreased	0.000	0.000	10.000	90.000
increased	increased	no change	increased	0.000	0.000	0.000	100.00
increased	increased	no change	same as now	0.000	0.000	10.000	90.000
increased	increased	no change	decreased	0.000	0.000	20.000	80.000
increased	increased	decrease	increased	0.000	0.000	30.000	70.000
increased	increased	decrease	same as now	0.000	0.000	60.000	40.000
increased	increased	decrease	decreased	0.000	0.000	50.000	50.000
increased	same as now	increase	increased	0.000	0.000	0.000	100.00
increased	same as now	increase	same as now	0.000	0.000	20.000	80.000
increased	same as now	increase	decreased	0.000	0.000	30.000	70.000



Graphical model



With probabilities

C1 Table (in net outcome_model_070821b_w_Year_2)

Node: C1

Apply | Okay | Reset | Close

Chance | % Probability

Bear-human interactions	Shipping	Oil & Gas Activity	Tourism	reduced	same as now	elevated	greatly elevated
increased	increased	increase	increased	0.000	0.000	0.000	100.00
increased	increased	increase	same as now	0.000	0.000	0.000	100.00
increased	increased	increase	decreased	0.000	0.000	10.000	90.000
increased	increased	no change	increased	0.000	0.000	0.000	100.00
increased	increased	no change	same as now	0.000	0.000	10.000	90.000
increased	increased	no change	decreased	0.000	0.000	20.000	80.000
increased	increased	decrease	increased	0.000	0.000	30.000	70.000
increased	incre						40.000
increased	incre						50.000
increased	sam						100.00
increased	sam						80.000
increased	sam						70.000

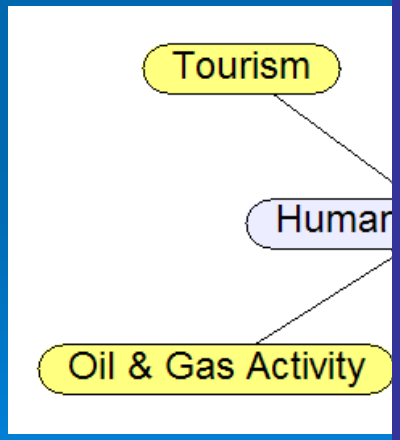
source of information

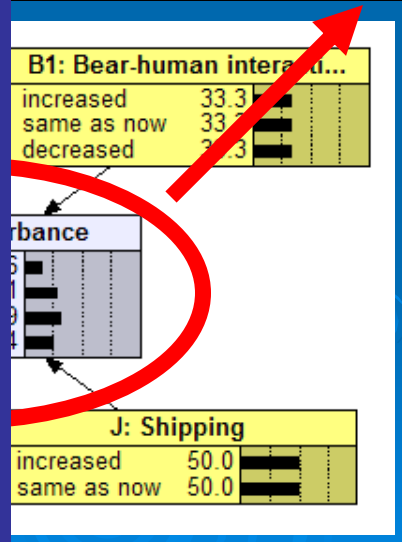
-expert judgment

-anecdotal observations

-field studies

-literature reviews





Gra

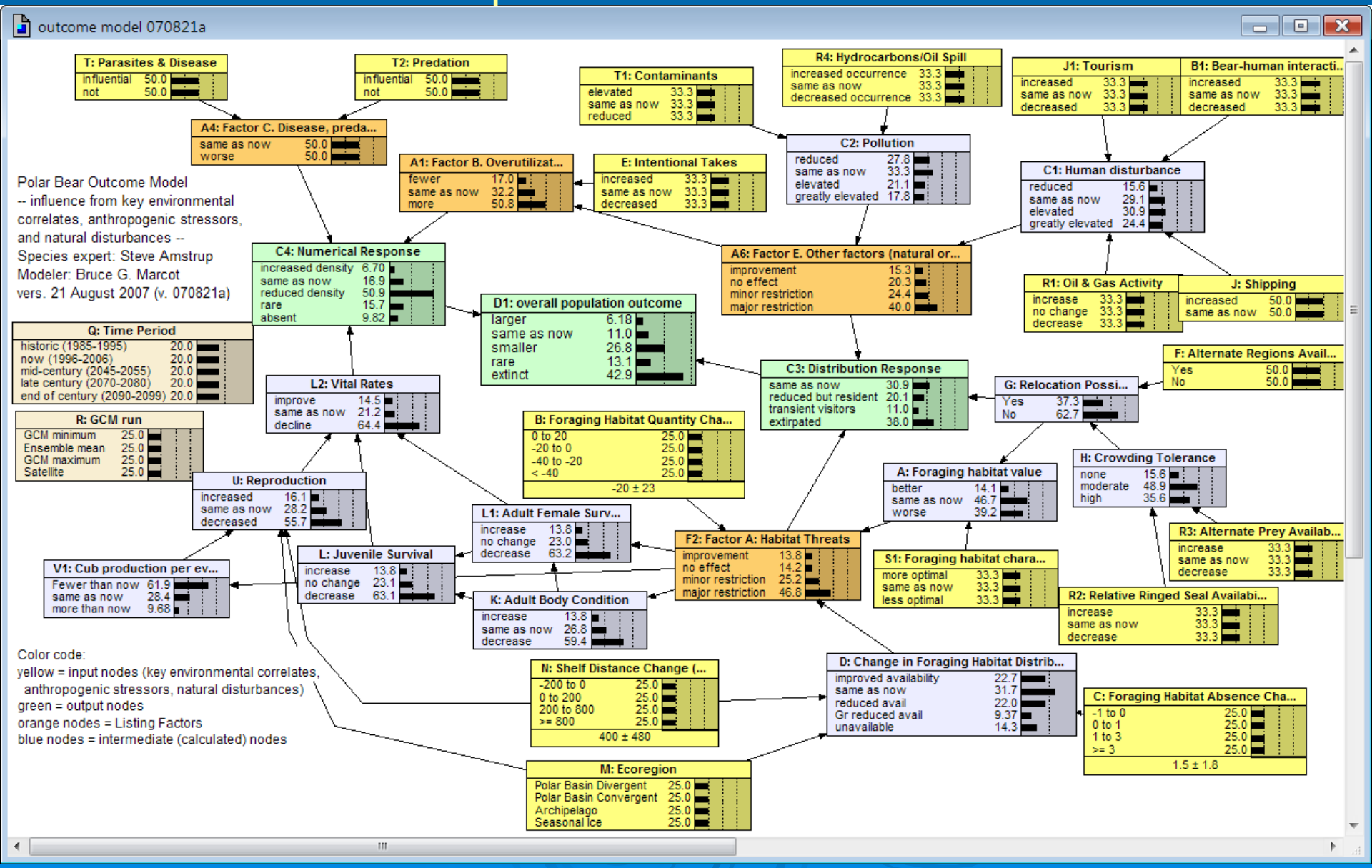
with probabilities

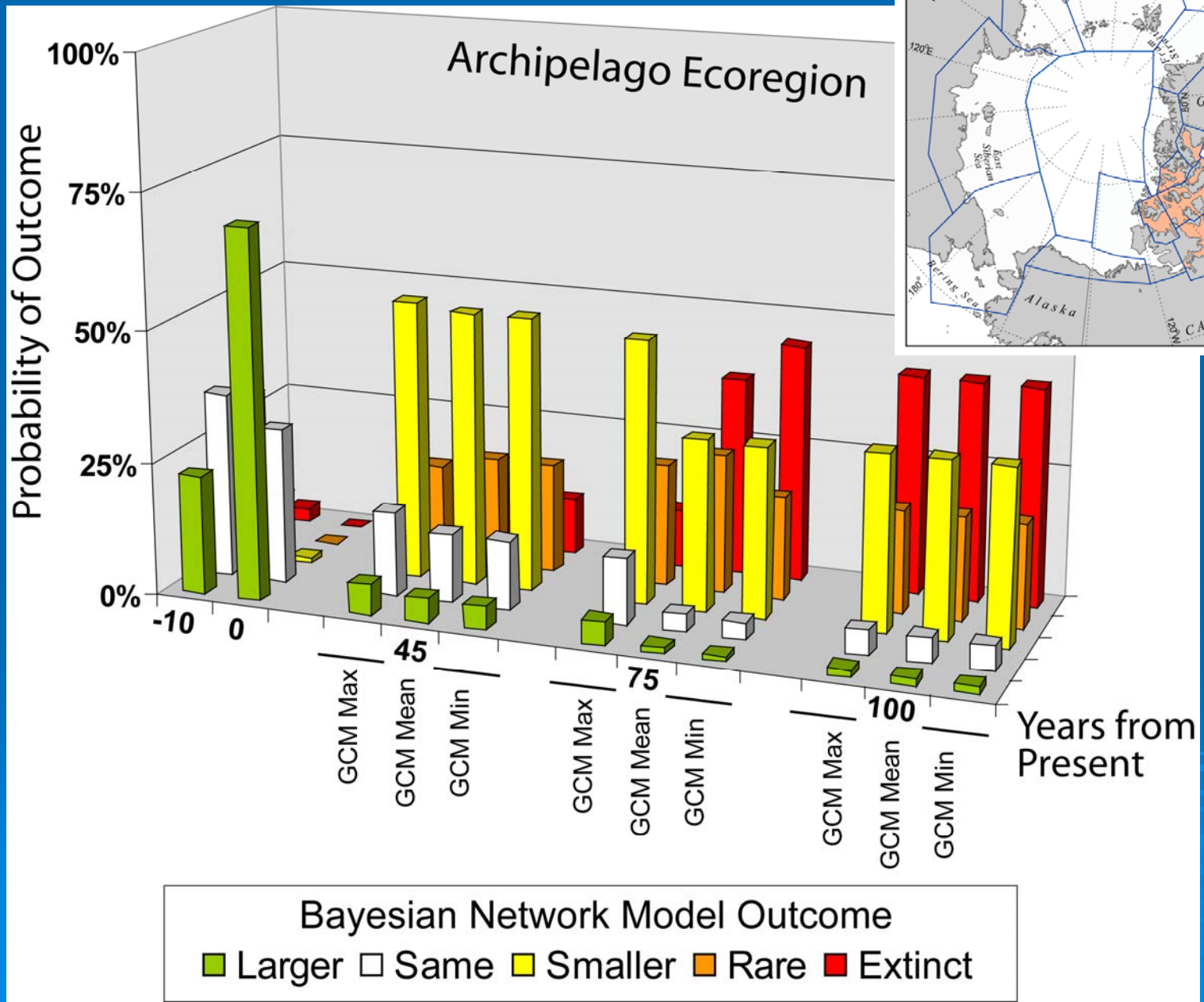
*Goal: to produce a documented **knowledge-based** forecasting tool called the WILDlife Potential Habitat ForeCASTing Framework (WILDCAST).*

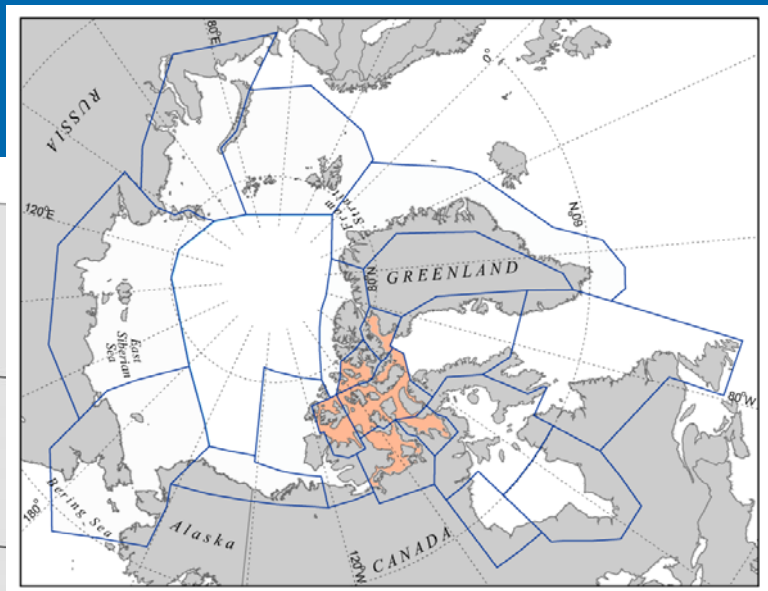
Polar Bear Analysis

- USFWS – to list the polar bear as a threatened species? (USGS team – Steve Amstrup)
- Who will polar bear populations persist in light of multiple stressors?

Bayesian Network Polar Bear Population Stressor Model

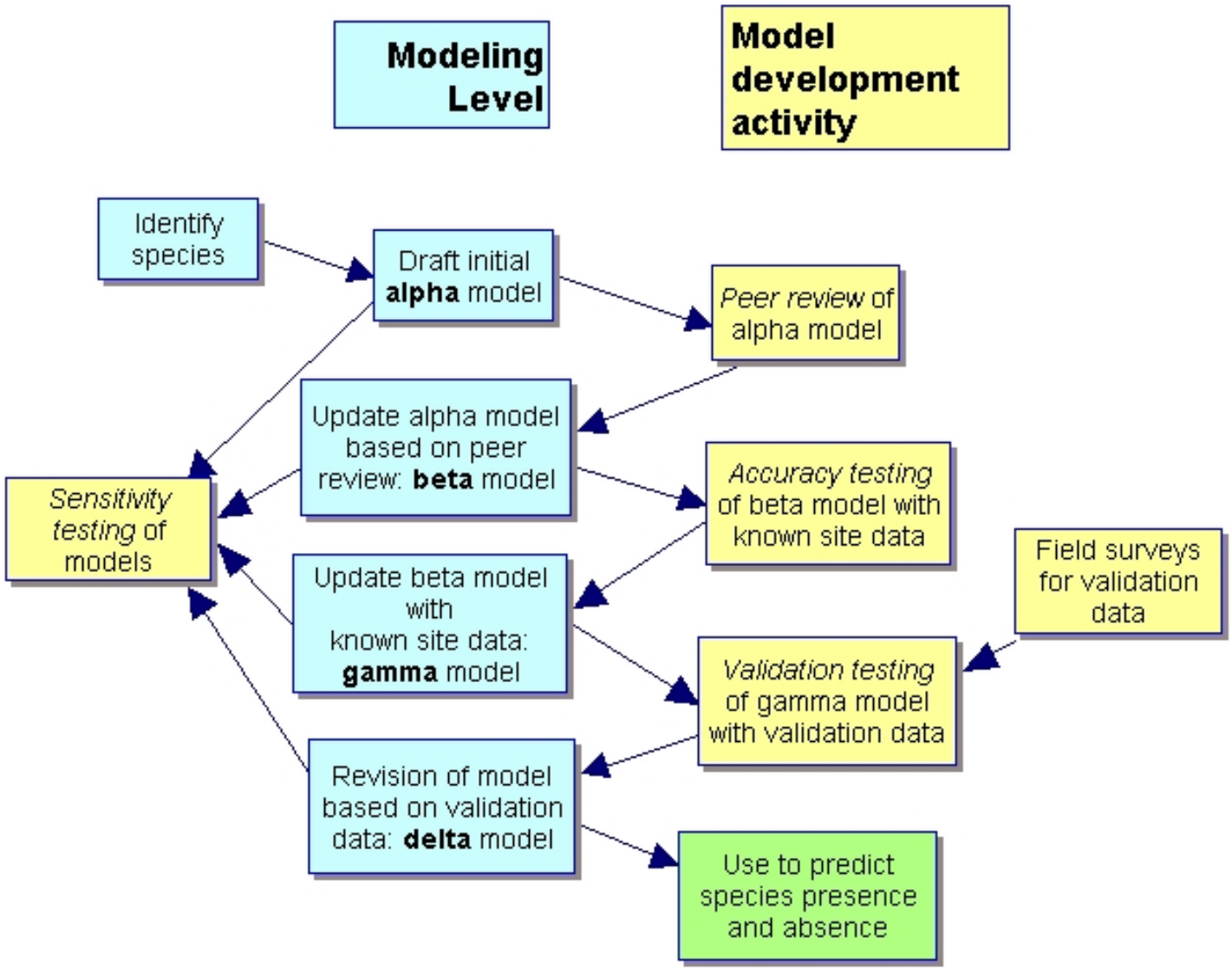



Archipelago Ecoregion
Probability of Outcome
100%
75%
50%
25%
0%
-10
0
45
75
100
GCM Max
GCM Mean
GCM Min
Years from Present
Bayesian Network Model Outcome
Larger
Same
Smaller
Rare
Extinct


RUSSIA
GREENLAND
East Siberian Sea
Bering Sea
Alaska
CANADA
120°E
180°
120°W
80°W
60°N
80°N

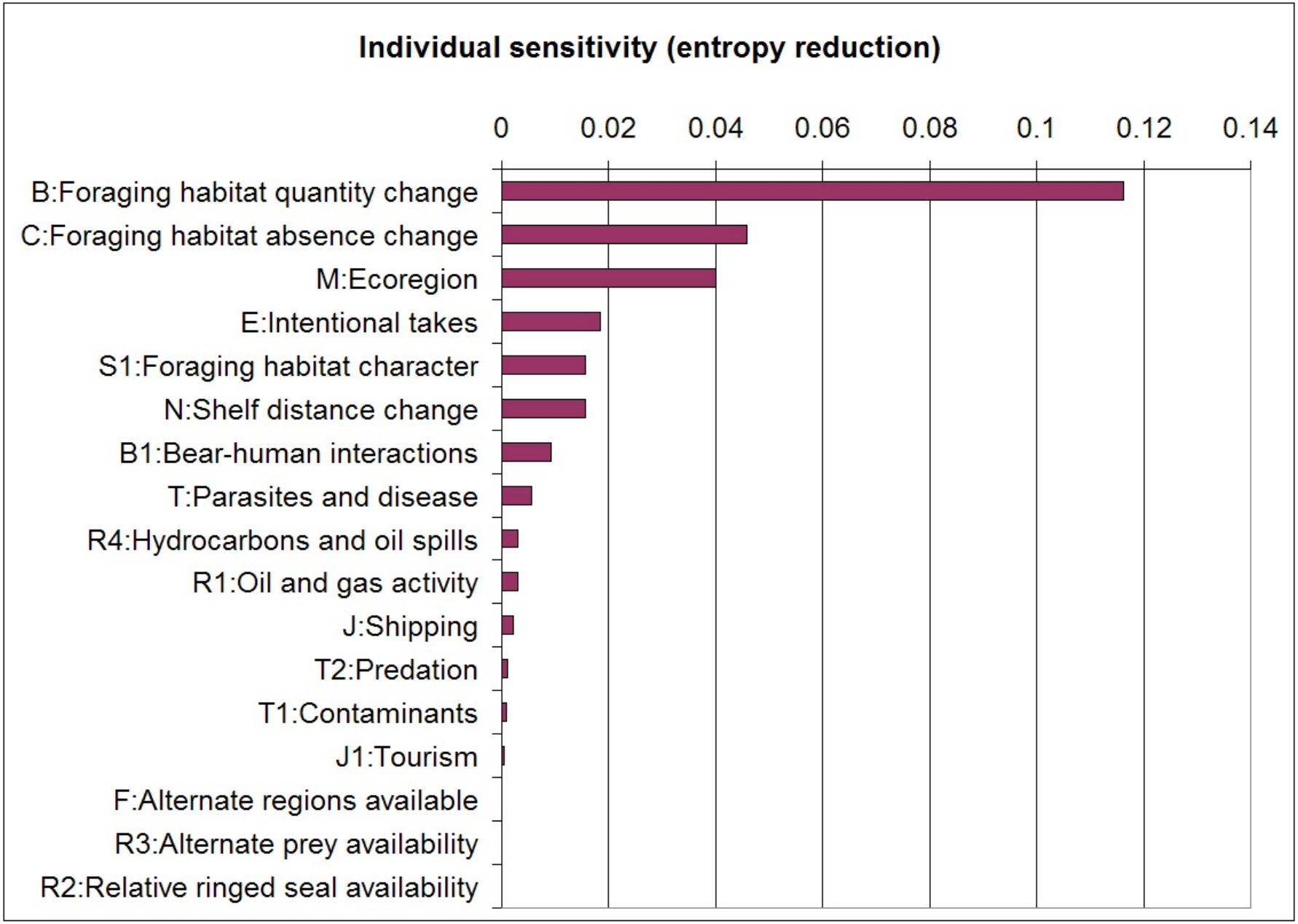
Creating BN Models

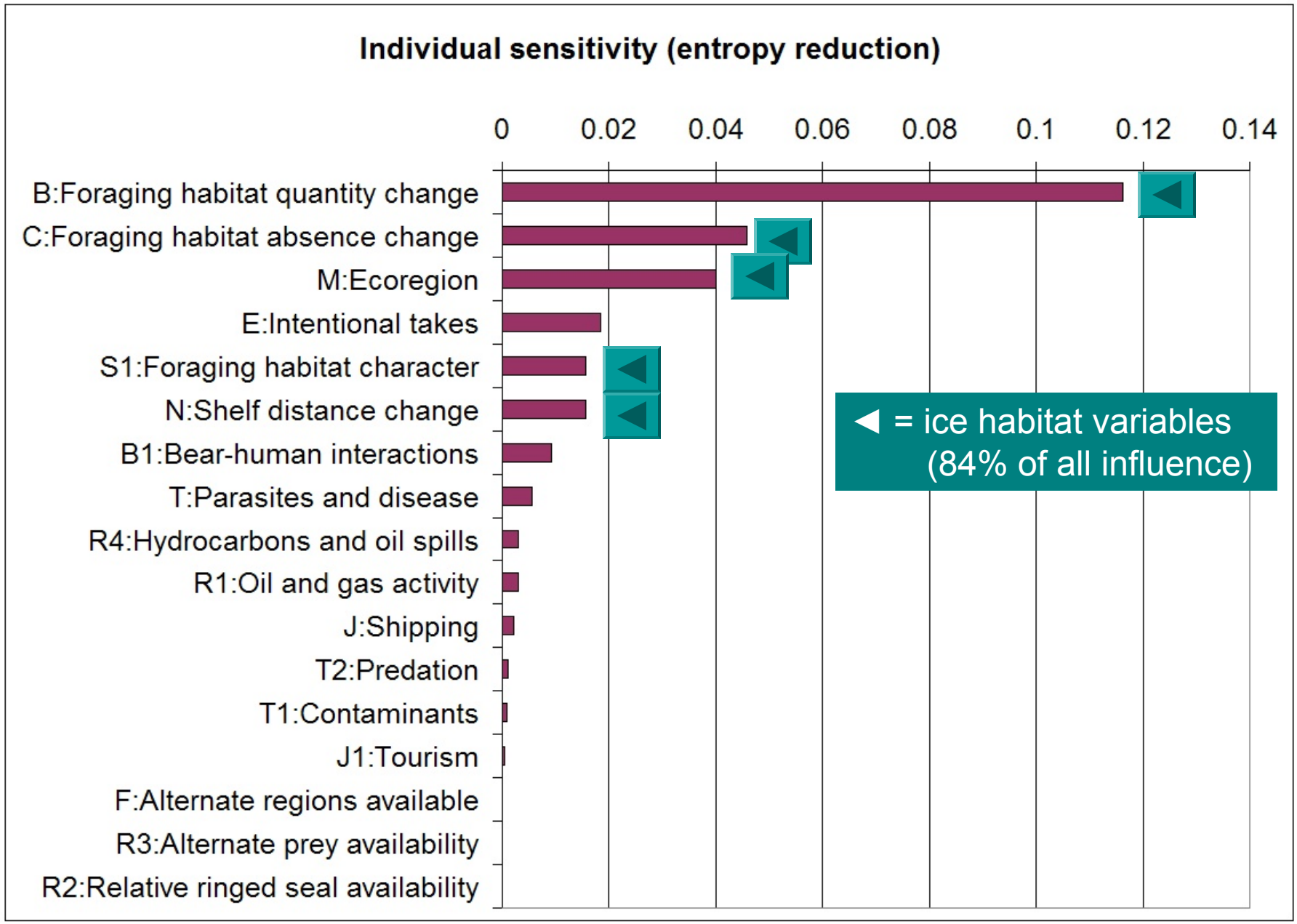
Creating BN Models



Testing BN Models

- Sensitivity testing


Individual sensitivity (entropy reduction)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
B:Foraging habitat quantity change
C:Foraging habitat absence change
M:Ecoregion
E:Intentional takes
S1:Foraging habitat character
N:Shelf distance change
B1:Bear-human interactions
T:Parasites and disease
R4:Hydrocarbons and oil spills
R1:Oil and gas activity
J:Shipping
T2:Predation
T1:Contaminants
J1:Tourism
F:Alternate regions available
R3:Alternate prey availability
R2:Relative ringed seal availability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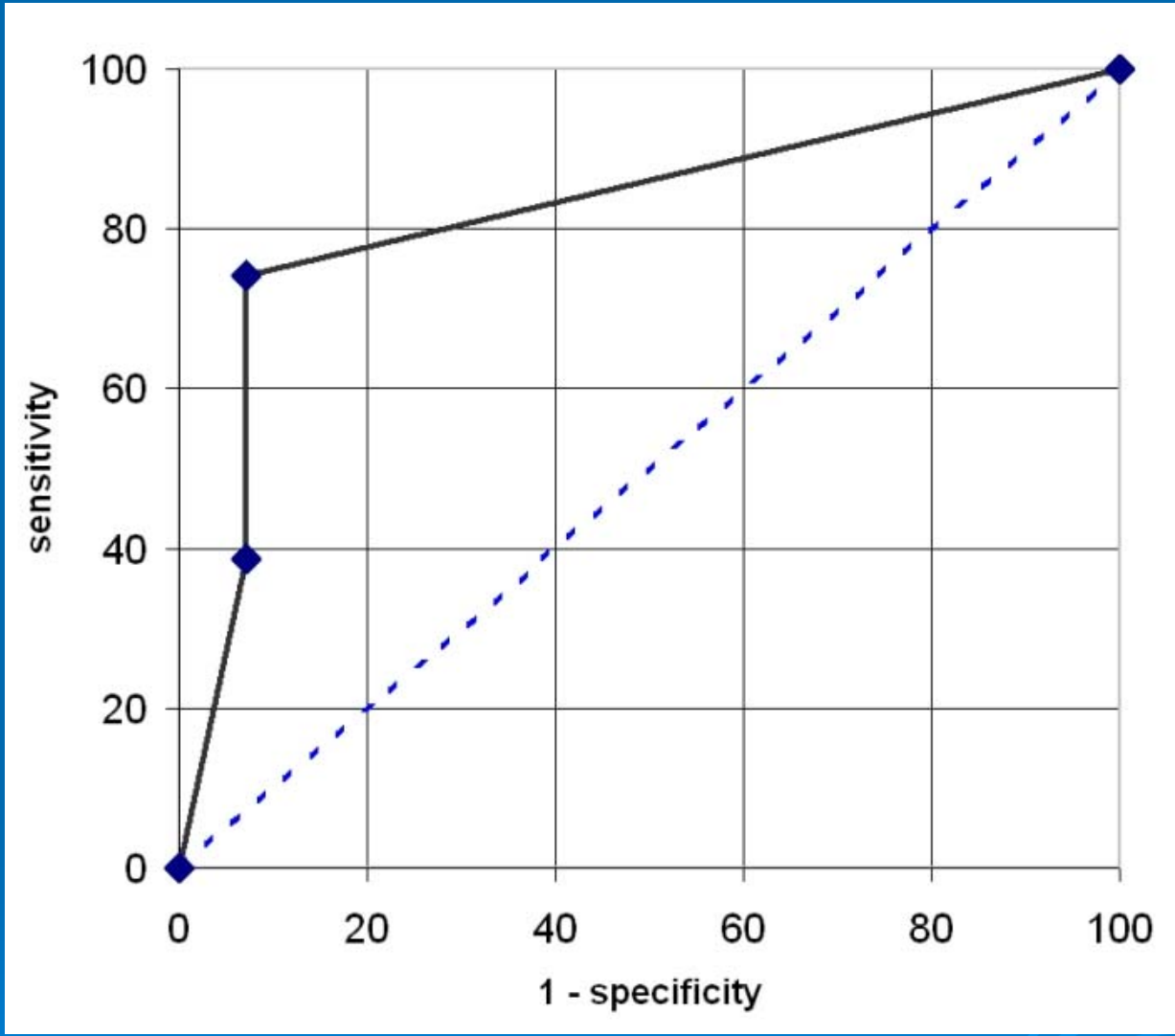
T2:Predation
T1:Contaminants
J1:Tourism
F:Alternate regions available
R3:Alternate prey availability
R2:Relative ringed seal availability
◄ = ice habitat variables
(84% of all influence)

Testing BN Models

- Accuracy testing

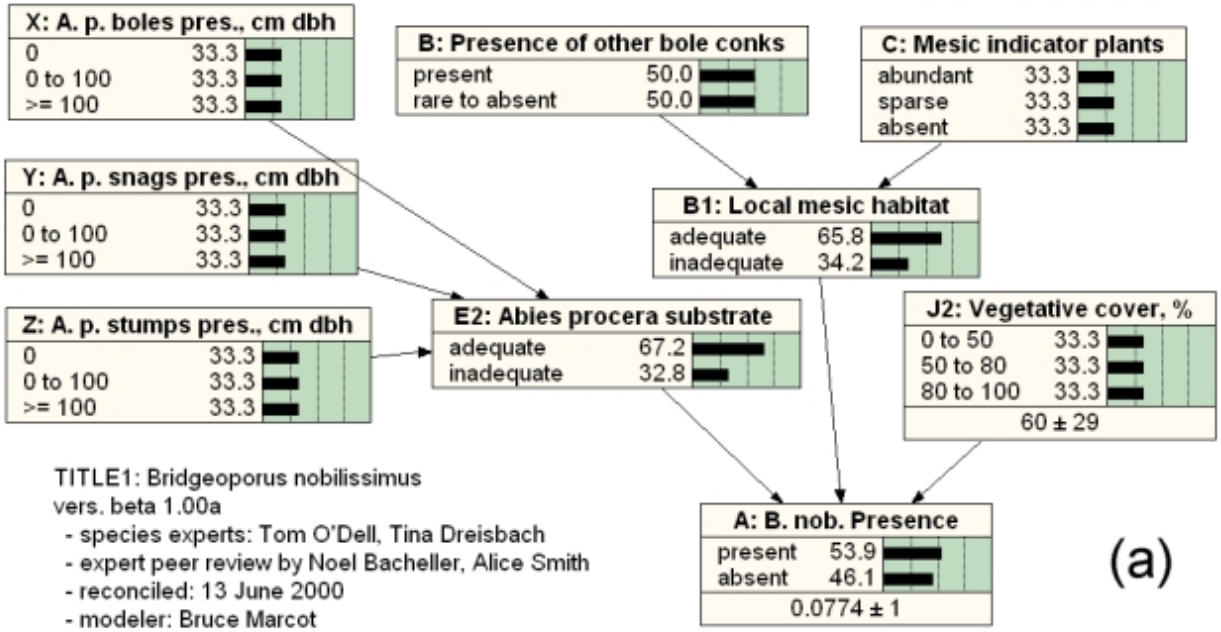
Predicted		
Present	**Absent**	***Actual***
Correct	**Type I error; false negative**	**Present**
Type II error; false positive	**Correct**	**Absent**



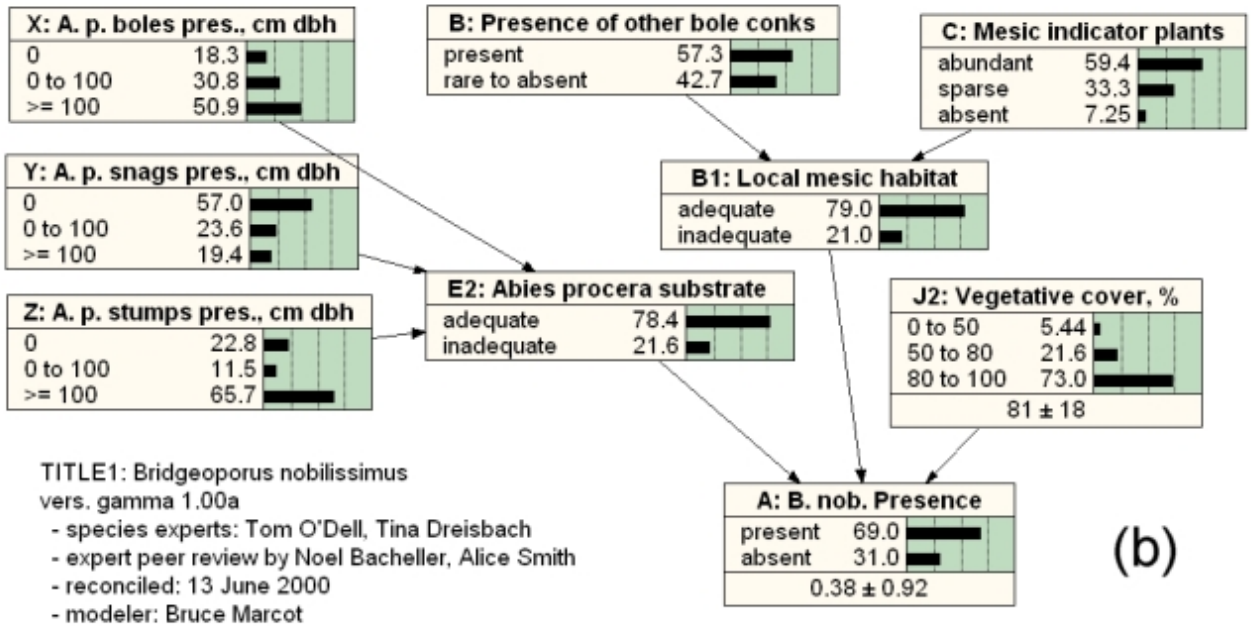
receiver operating characteristic curve

Updating BN Models

Using case data to update BN models

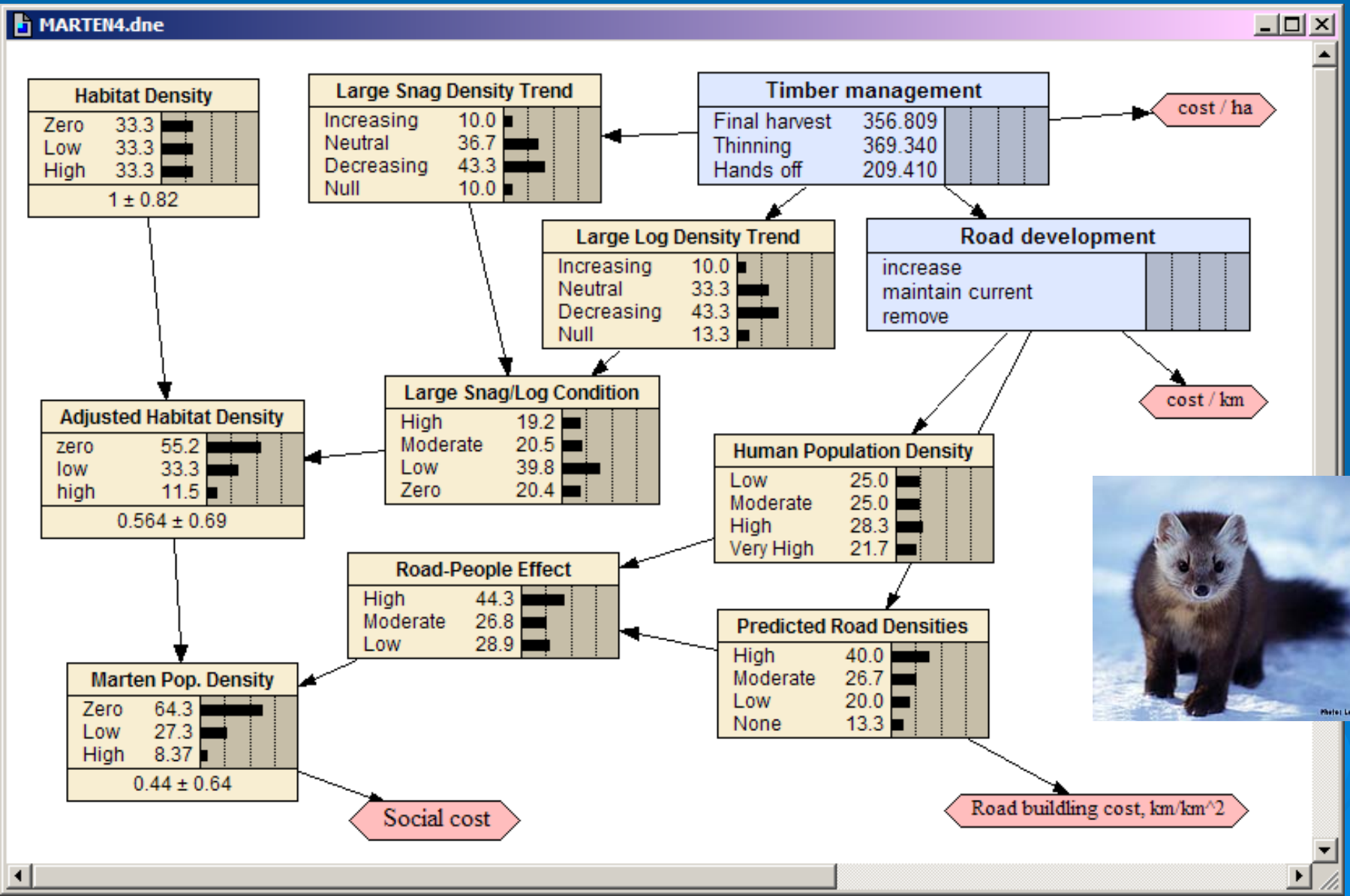


original model based on expert judgment

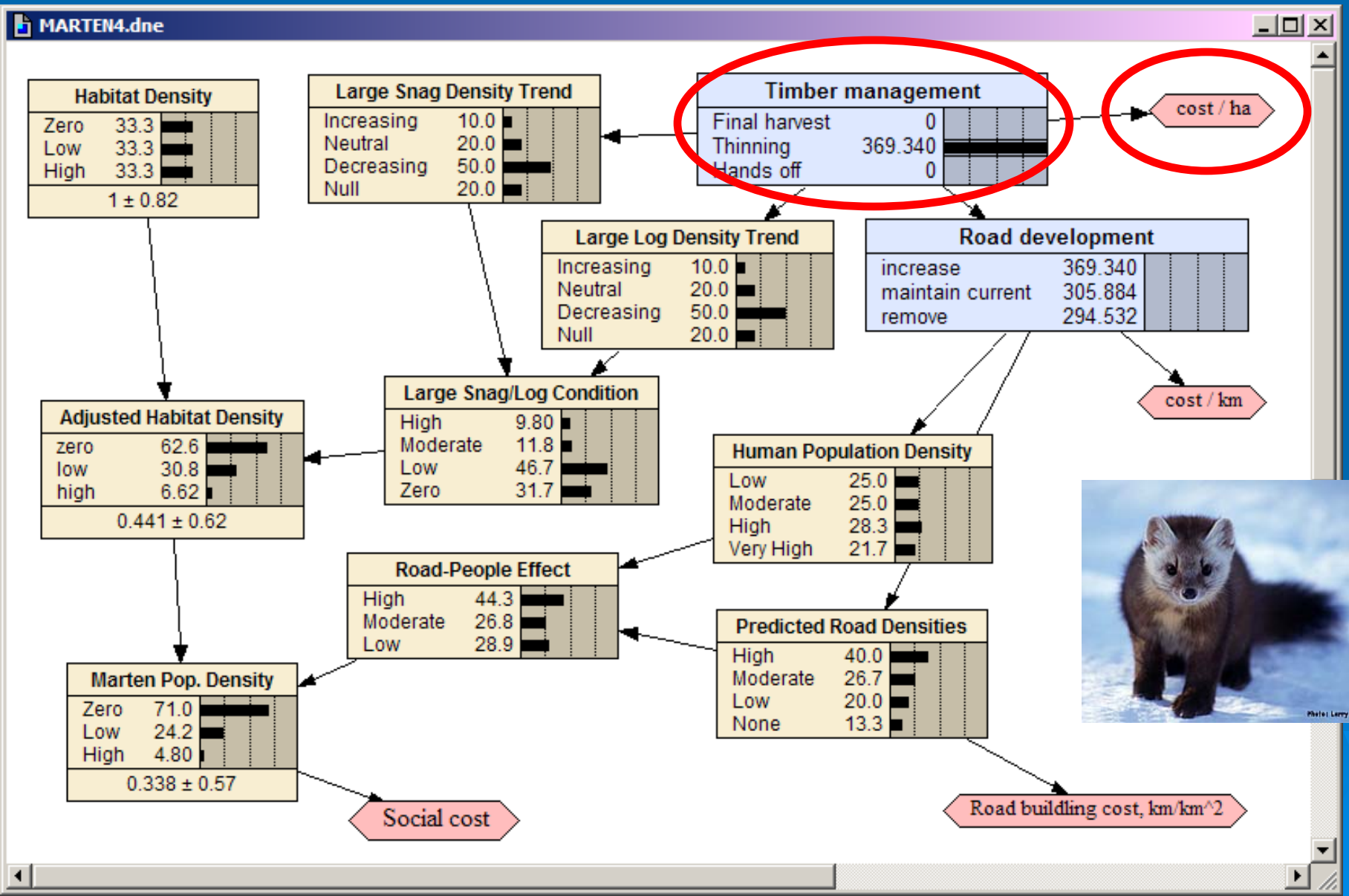


revised model based on field data

Belief Network *Decision* Model



Belief Network *Decision* Model



Modeling Approaches Useful for Predicting Change: *Making Progress in a Data-Poor World*

What are the objectives and audience for WILDCAST?

What do we want to forecast, at what accuracy, precision, and scale(s)?

Possible modeling approaches:

- influence diagrams
- wildlife-habitat relationships models
- Bayesian networks

END
OF
TRAIL