Assessing Decision-Risk in Range Maps and Distribution Models for Use in Conservation and Management

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Assessing Risk in Distribution Modelling (SDM):
The Plan for the Presentation

- Background and philosophical musings on SDMs and modelling in general
- Observations related to decision-risk and application of SDMs to management
  - Types of decision-risk in a world of models
  - A structured process for SDM documentation and evaluation
- A proposal for a 2-level integrated education and training platform targeting:
  - Those who construct SDMs; and
  - Those tasked with evaluating SDMs for application to a management / conservation issues
- Time for questions!

Assessing Risk in Distribution Modelling (SDM):
Some Background

- Let's start from scratch with …

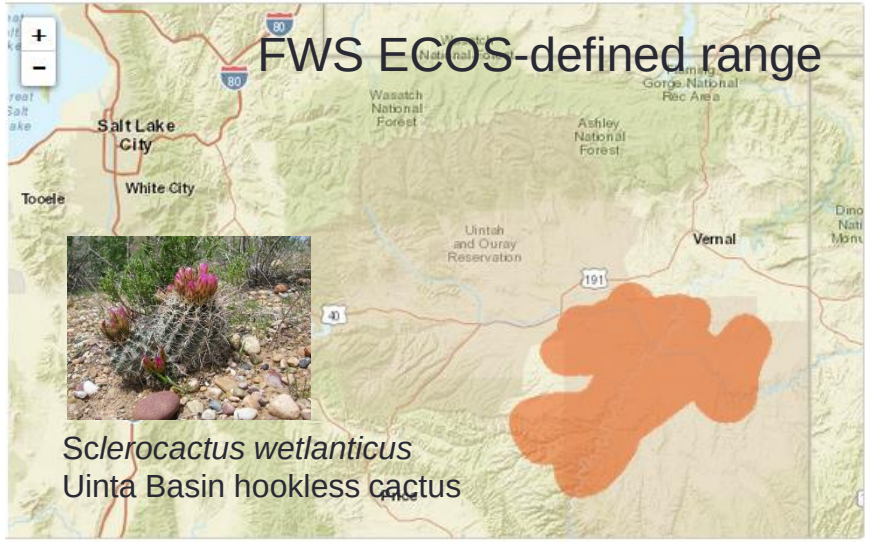
Some Background on Species Distribution Models and Habitat Range Maps (SDM)

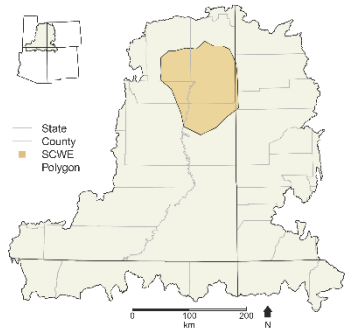
For the rest of this presentation, I use the phrase "**distribution model**" or the acronym "**SDM**" to represent all the flavors of geographic range map products.

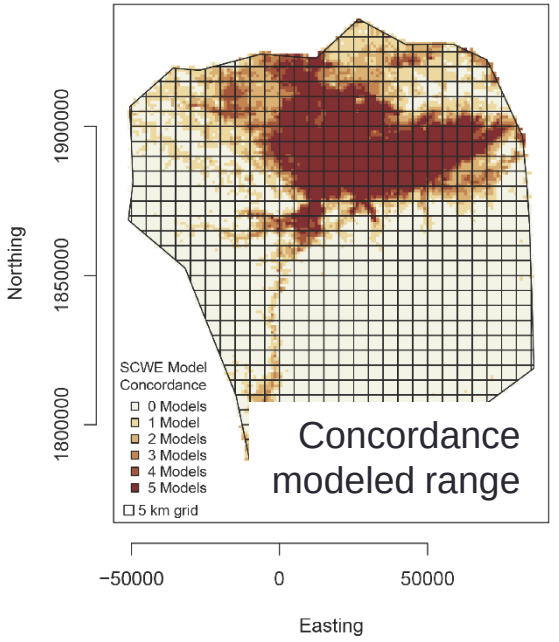
Battles over (your favorite) lexicon *per se* can commence later …

Assessing Risk in Distribution Modelling (SDM):
Some Background

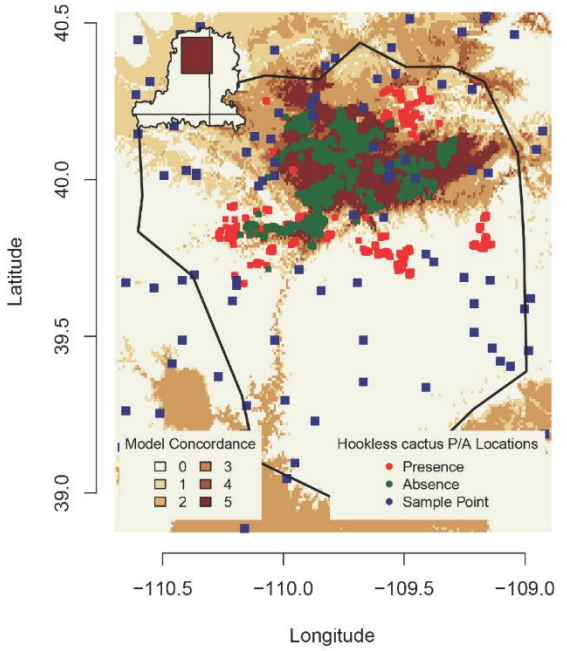
- **Why should we care?**
  - **The geographic range (a SDM) of species / habitat is integral to virtually all species-based decision processes**
  - EXAMPLE: *Sclerocactus wetlanticus* Uinta Basin hookless cactus







Biologist-based generalized range



Concordance model w/locations and evaluation points

Assessing Risk in Distribution Modelling (SDM):
Some Background

- Use and application of geographic range does not exist in a vacuum, requiring some form of objective / question / hypothesis as the foundation
  - In the world of distribution models, this framework can be categorized as:

- **Why** is the element of interest **there**?
- **Where** is the element of interest **located** in space?
- **How much** of the element is there?
- **How** is the element **changing** over time?

Decision-risk is **NOT** the same for each of these applications

Distribution modelling must start here … **with an intended application and use**!

Assessing Risk in Distribution Modelling (SDM):
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  - In the world of distribution models, this framework can be categorized as:

- **Why** is the element of interest **there**?
  - Models that determine the underlying ecological reasons the element is located in particular locations and not elsewhere
- **Where** is the element of interest **located** in space?
- **How much** of the element is there?
- **How** is the element **changing** over time?

Assessing Risk in Distribution Modelling (SDM):
Some Background

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  - In the world of distribution models, this framework can be categorized as:

- **Why** is the element of interest **there**?
- **Where** is the element of interest **located** in space?
  - The use of GIS, linked with ecological understanding, provides us with an astonishing array of map products depicting where elements are located on landscapes
- **How much** of the element is there?
- **How** is the element **changing** over time?

Assessing Risk in Distribution Modelling (SDM):
Some Background

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- **Why** is the element of interest **there**?
- **Where** is the element of interest **located** in space?
- **How much** of the element is there?
  - Estimation of species population numbers / quantities of habitat is fundamental to sound management and conservation
- **How** is the element **changing** over time?

Assessing Risk in Distribution Modelling (SDM):
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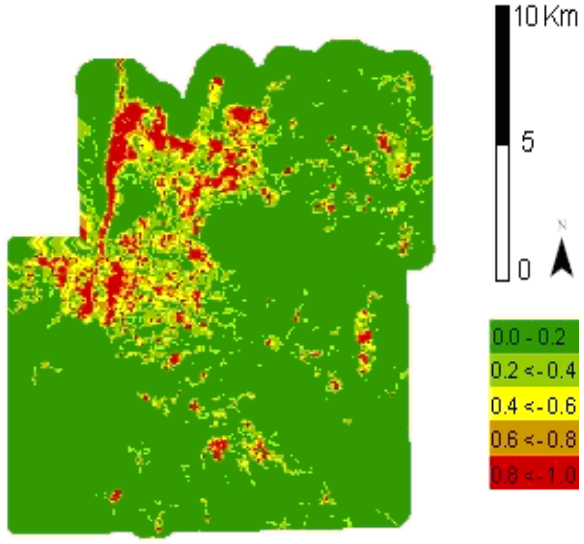
- **Why** is the element of interest **there**?
- **Where** is the element of interest **located** in space?
- **How much** of the element is there?
- **How** is the element **changing** over time?
  - Distributions are not static (ie, time-invariant), but do shift across landscapes due to many ecological and human-based factors

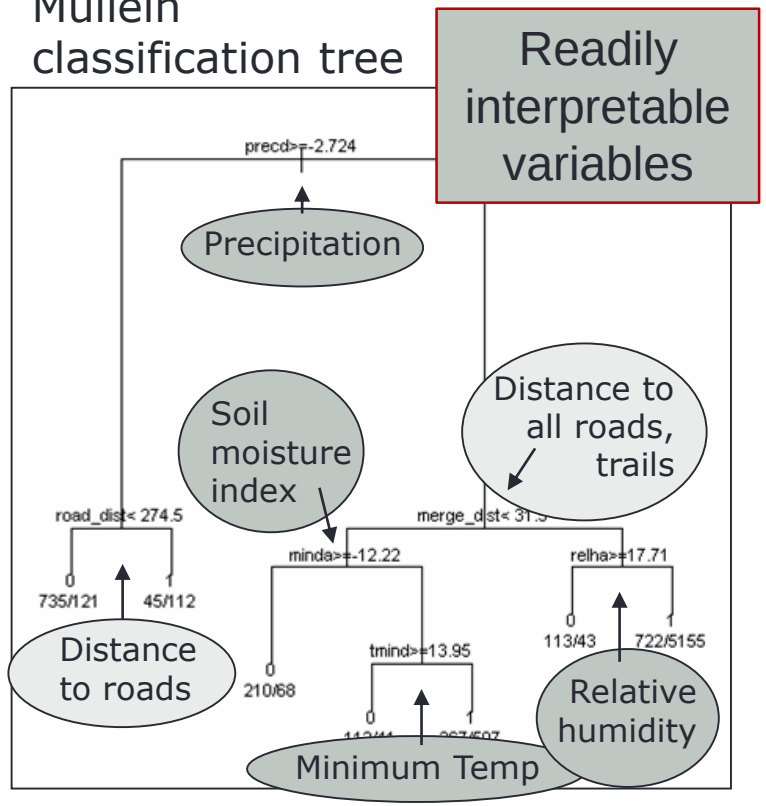
Assessing Risk in Distribution Modelling (SDM):
Some Common SDM Applications and Why

- A predictive model of likely locations of an invasive plant, the common mullein, in Lava Beds National Park, USA
  - What variables predict presence of the invasive mullein?
  - Can these predictors be managed?

WHY Application:
SDM output where goal is both management use and variable interpretation



Mullein classification tree

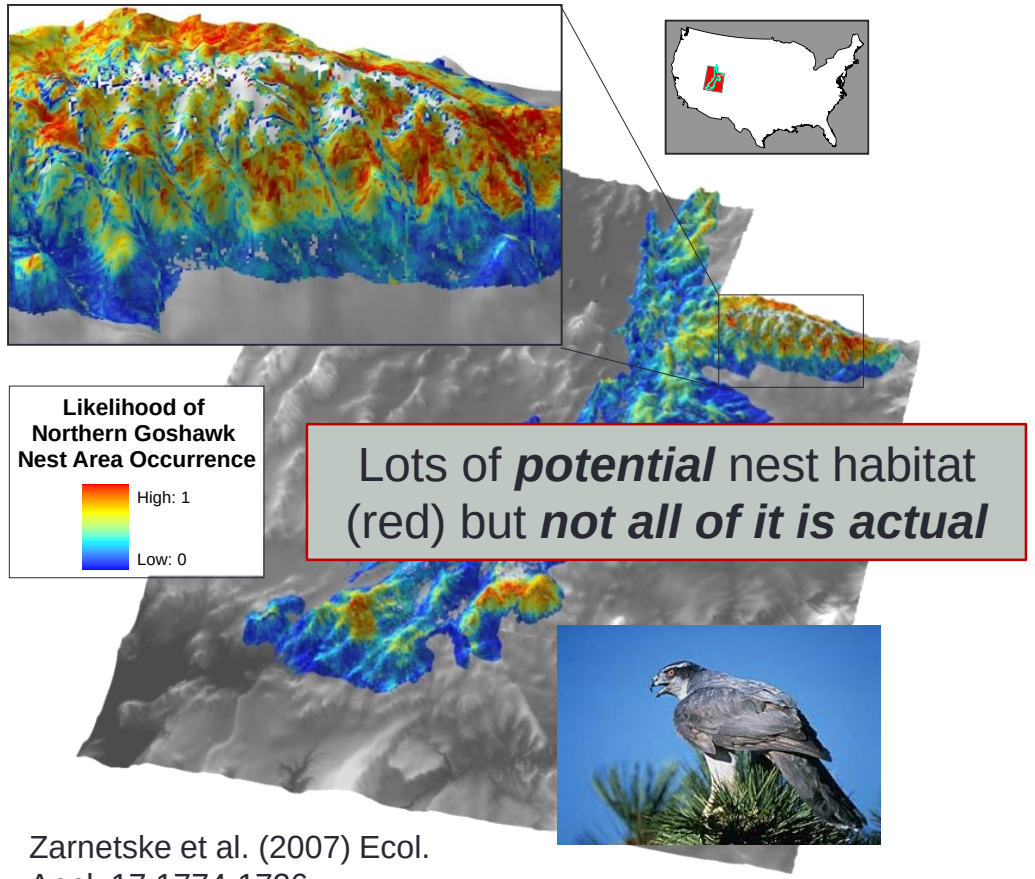


Cutler et al. (2007) Ecology 88:2783-2793.

Assessing Risk in Distribution Modelling (SDM):
Some Common SDM Applications and Why

- A spatial model of nesting habitat for the northern goshawk, Intermountain West, USA
  - Where are goshawk nests likely to be found?
  - Where can timber be harvested that minimizes potential impacts on nesting habitat?

WHERE application:
SDM of a wide-ranging species where only a single life history element – the nest site – is of concern

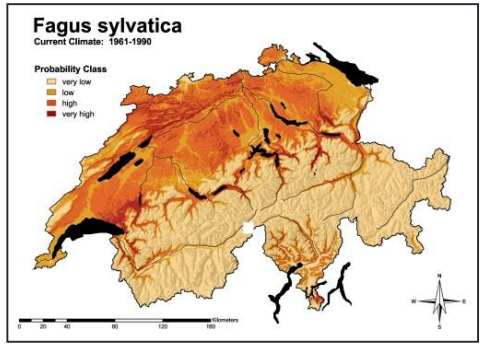


Zarnetske et al. (2007) Ecol. Appl. 17:1774-1726.

Assessing Risk in Distribution Modelling (SDM):
Some Common SDM Applications and Why

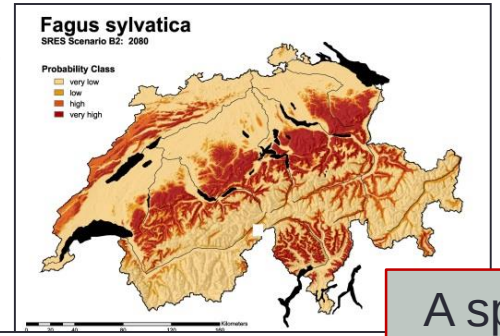
- A model of likely future distribution of the European beech due to expected climate change, Switzerland
  - How is distribution of the beech changing with respect to projected climate change?
  - Can the beech survive the projected change?

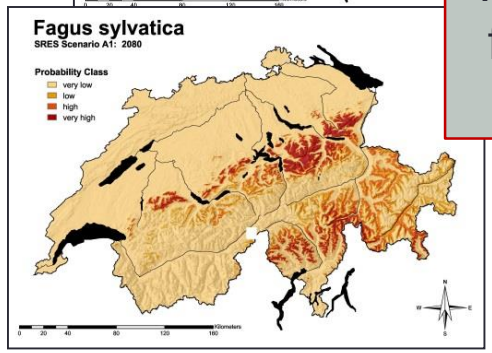
CHANGE application: SDM used in a climate change forecast model



Current distribution of European beech ca.2000

Best and worse case distributions.2080





A spatial forecast model

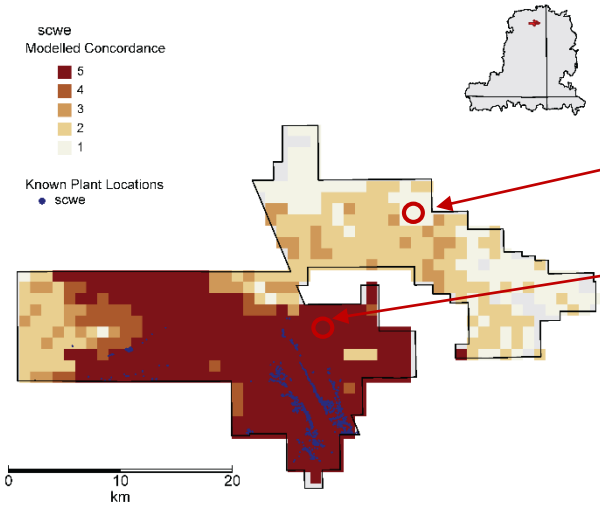
Courtesy: N. Zimmermann, WSL & Zurich ETH, Switzerland

Assessing Risk in Distribution Modelling (SDM):
Some Common SDM Applications and Why

- Use of plant community SDMs to optimize consultation surveys in regions of oil and gas development
  - Data structure allows for different survey decisions based on species status, strength of models, and ownership

WHERE application: Use of SDMs to facilitate and optimize required survey efforts

ESA listed hookless cactus *Sclerocactus wetlandicus*



SCWE locations (blue) in relation to SCWE model concordance and Crescent Point energy proposal

Consider proposed well heads

Low model concordance:
Survey not warranted?

High model concordance:
Survey warranted?

An ESA-listed species:
Survey warranted at all locations?

The decision pool

A regulatory use model

Assessing Risk in Distribution Modelling (SDM):
Some Common SDM Applications and Why

- A model of landscape frequencies of 4 lichens of special concern, Pacific Northwest, USA
  - How "many"[1] of each lichen species is there?
  - Is this enough for management purposes?

Lobaria oregana P = 194/802 = 24.2%
580,214 ha ± 36,259 ha plots
Bryoria spiralifera P = 153/802 = 19.1%
455,540 ha ± 33,212 ha plots
Nephroma bellum P = 75/802 = 9.4%
222,975 ha ± 24,588 ha plots
Hypogymnia oceanica P = 52/802 = 6.5%
155,842 ha ± 20,838 ha plots

Edwards et al. (2007) Ecol. Appl. 14:414-424.

HOW MANY application:
A ***non-spatial*** SDM estimating frequency on a landscape;
Can be linked to time

An abundance trend model

[1]Defined as number of 1 ha plots likely to contain the lichen

Assessing Risk in Distribution Modelling (SDM):
Some Modelling Caveats

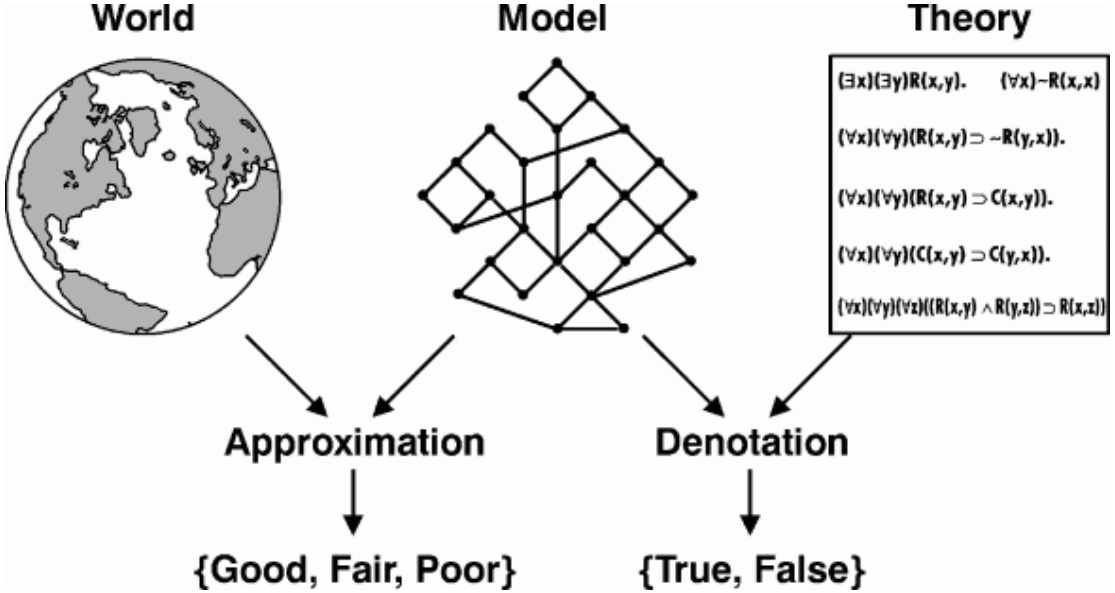
- So these are "models," and I've some unease about their application …

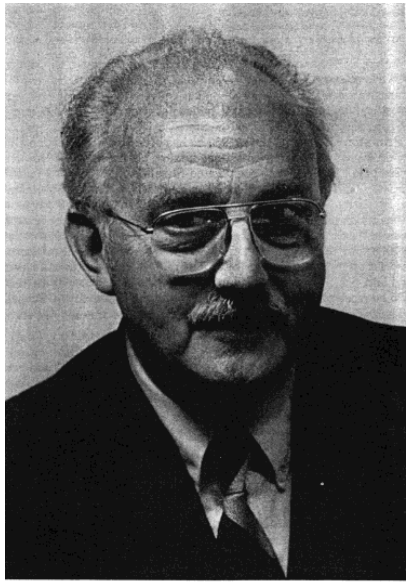
Those Too-Often-Forgotten Modelling Caveats

Caveats that extend to ***ALL*** models
used in management and conservation,
not just SDMs

Assessing Risk in Distribution Modelling (SDM):
Those Too-Often-Forgotten Modelling Caveats

- "All models are wrong. ***Some are useful***."[1]
  - G. P. E. Box, a truly distinguished Statistician





George E. P. Box

[1]My bold and italics.

Assessing Risk in Distribution Modelling (SDM):
Those Too-Often-Forgotten Modelling Caveats

- "All models are wrong. Some are useful."
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- "There are three kinds of lies: lies, damn lies, and ***statistics***."[1]
  - Variously attributed to B. Disraeli, British politician, and Mark Twain, American humorist

M. Twain

B. Disraeli

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Cheerfully stolen from: *A Hitchhiker's Guide to the Galaxy*, Douglas Adams

[1]My insertion, and bold and italics.

Assessing Risk in Distribution Modelling (SDM):
Those Too-Often-Forgotten Modelling Caveats

- Why the caveats?
  - We forget these at risk to our own (and our respective agency) decision environments
  - They **provide operational – and even philosophical – bounds** to research and management involving generation and application of any model, respectively
  - They remind us **models are tools**, and **that** sometimes tools "**break**," and don't always work as well as intended …
    - (… and that a hammer can't always fix everything)
  - They flat-out infer that **no single model is ever, ever "best."** Period. Get over it.
  - They **poke ironic fun** at our (increasing, and perhaps over-emphasis) on statistics to the exclusion of common sense and sound ecological stories

So what are the issues, then, with SDMs ??

Assessing Risk in Distribution Modelling (SDM):
The Problem Statement

- Back to the initial, simple observation
  - **The geographic range of species / habitat is integral to virtually all species-based decision processes**
- We can generate these distributions, but while the theoretical and conceptual bases for SDMs are well-grounded in defensible, published literature …
- But … direct application to management and conservation of species lags

So why the lag?
Why the lack of direct applications?

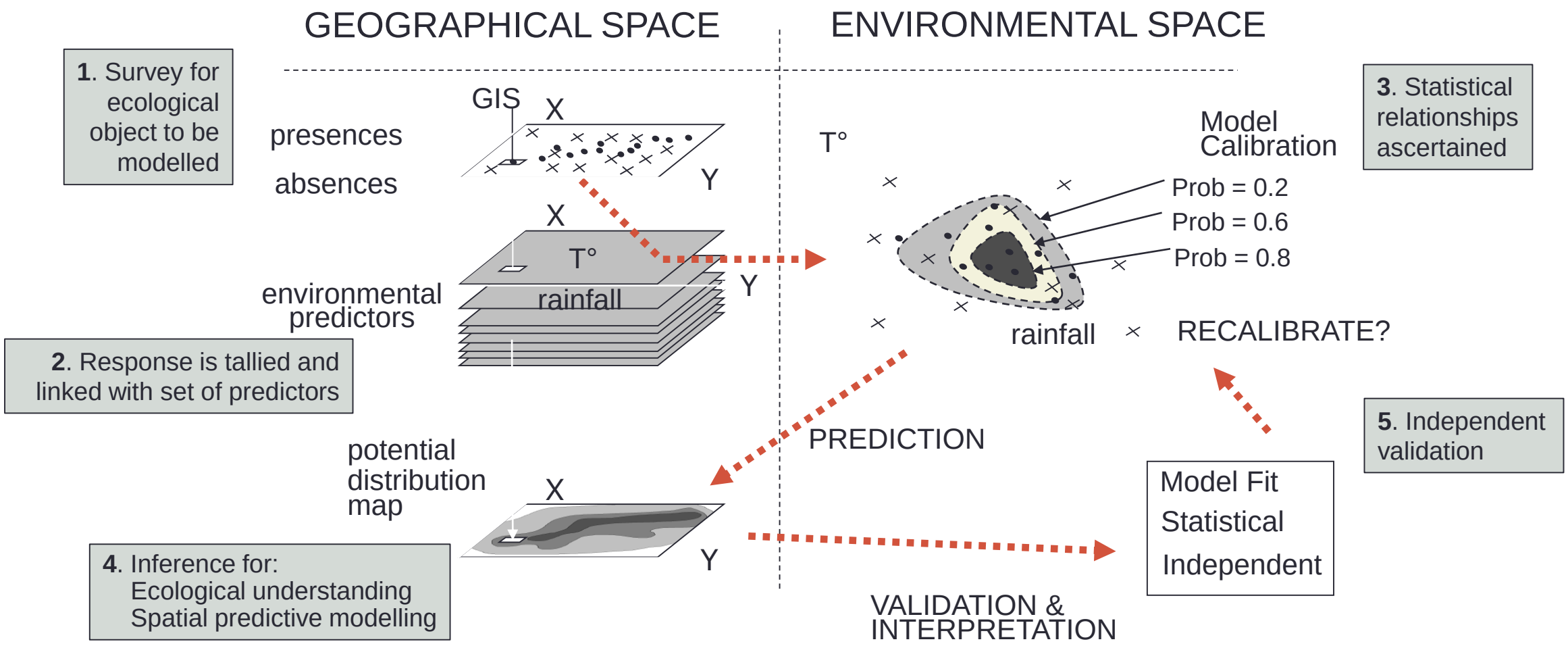
Assessing Risk in Distribution Modelling (SDM):
But First, What is a SDM?

- SDMs are models, and as such are abstractions of (perceived) reality used to:
  - Increase ecological understanding of ecological systems and their elements
  - Solve critical conservation issues, often through prediction

- SDMs are derived from different philosophical perspectives
  - **Grinnellian** => basis for wildlife-habitat relationships
  - **Eltononian** => functional roles in communities and ecosystems
  - **Hutchinsonian** => fundamental and realized niches

Ignoring the philosophical perspective will affect decision-risk

Assessing Risk in Distribution Modelling (SDM):
The Typical SDM Construction Procedure



Assessing Risk in Distribution Modelling (SDM):
But First, What is a SDM?

- The SDM process is conceptually simple, but we're back to the problem statement, somewhat modified by what we now know …

How do I (we) assess decision-risk associated with a SDM and its application to management and conservation issues?

Assessing Risk in Distribution Modelling (SDM):
Back to the Problem Statement

- Reasons for lack of SDM application include, but are not limited to, perceptions that :
  - SDMs are overly complicated and difficult to interpret;
  - Not well-grounded in natural history and lack "common sense;"
  - Questionable data quality and quantity and resultant impacts on SDM construction; and
  - Confusion over SDM output depicting potential versus actual, true distribution
  - as well as other application, eg "My Favorite Pixel Syndrome," and technical, eg mismatched pixel resolutions, concerns

Assessing Risk in Distribution Modelling (SDM): Background

- Concerns best overcome by:
  - Careful consideration of appropriate modelling processes; and
  - Along with demonstrable application to timely conservation and management needs

- **Goal is to meet and minimize these concerns while creating decision-quality SDMs for application to management and conservation needs**

- **Achieving this goal rests on proper training and education of SDM developers, *AND* the decision-makers who apply these models**

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- The framework has been laid …

So what constitutes decision-risk concerns related to distribution and habitat models?

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- Our biggest decision-risk concern, and why we strive for defensible science such as decision-quality SDMs, is because[1]:
  - **Scientific defensibility** in the U.S. based on *Daubert v. Merrell-Dow*, U.S. Supreme Court (1993), whereby:
    - Technique(s) employed (eg, SDM modelling process) must be recognized in the scientific community (ie, publications, focus of research, frequent usage); ***and***
    - Be relevant and reliable to the issue (ie, have application)
  - U.S. judges have considerable latitude in accepting (or rejecting) evidence

- Further, case law presumes primacy of USFWS-supported analyses (eg models like SDMs) over others[1]
  - (This is currently under challenge, as best I understand)

[1]PS. I am not an attorney, but do, on occasion, find I agree with Shakespeare regarding how to deal with them!

Assessing Risk in Distribution Model
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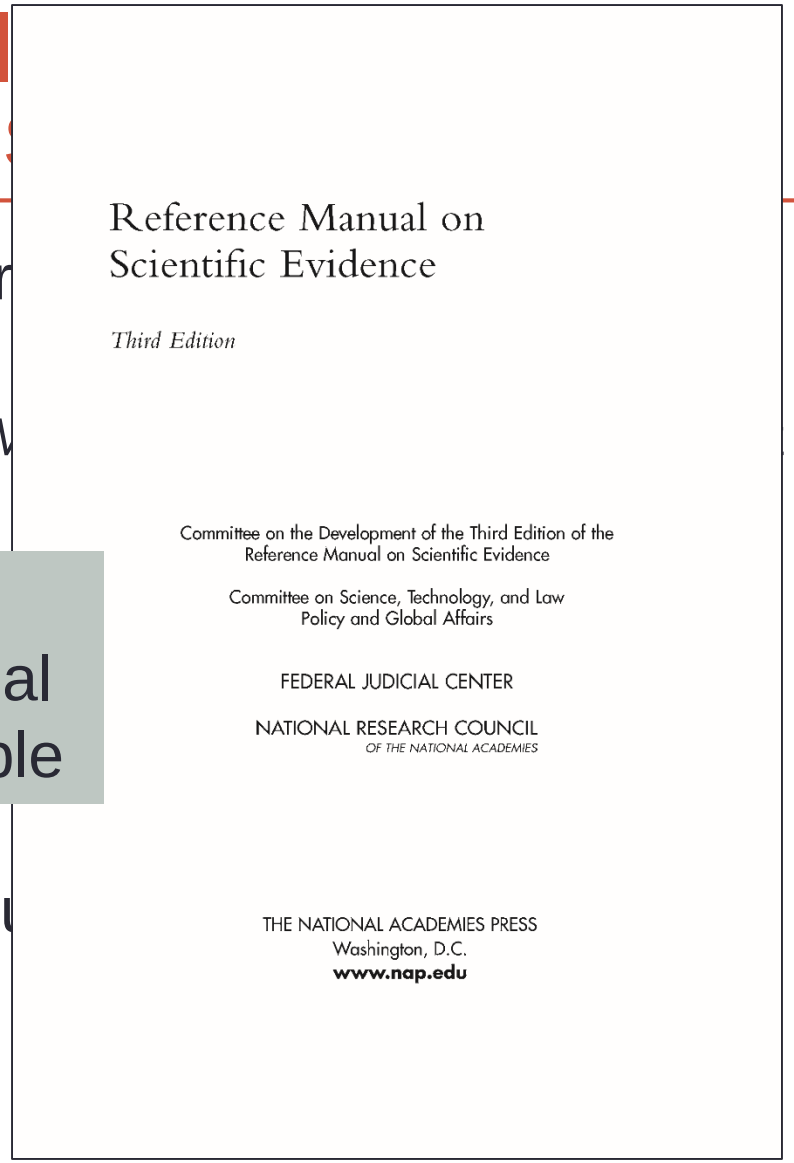
  - **Scientific defensibility** in the U.S. based on *Daubert v. M* (1993), whereby:
    - Technic commu
    - Be relev
  - U.S. judg

When Judges need guidance, this National Academy of Sciences manual becomes, in essence, the Judicial Bible



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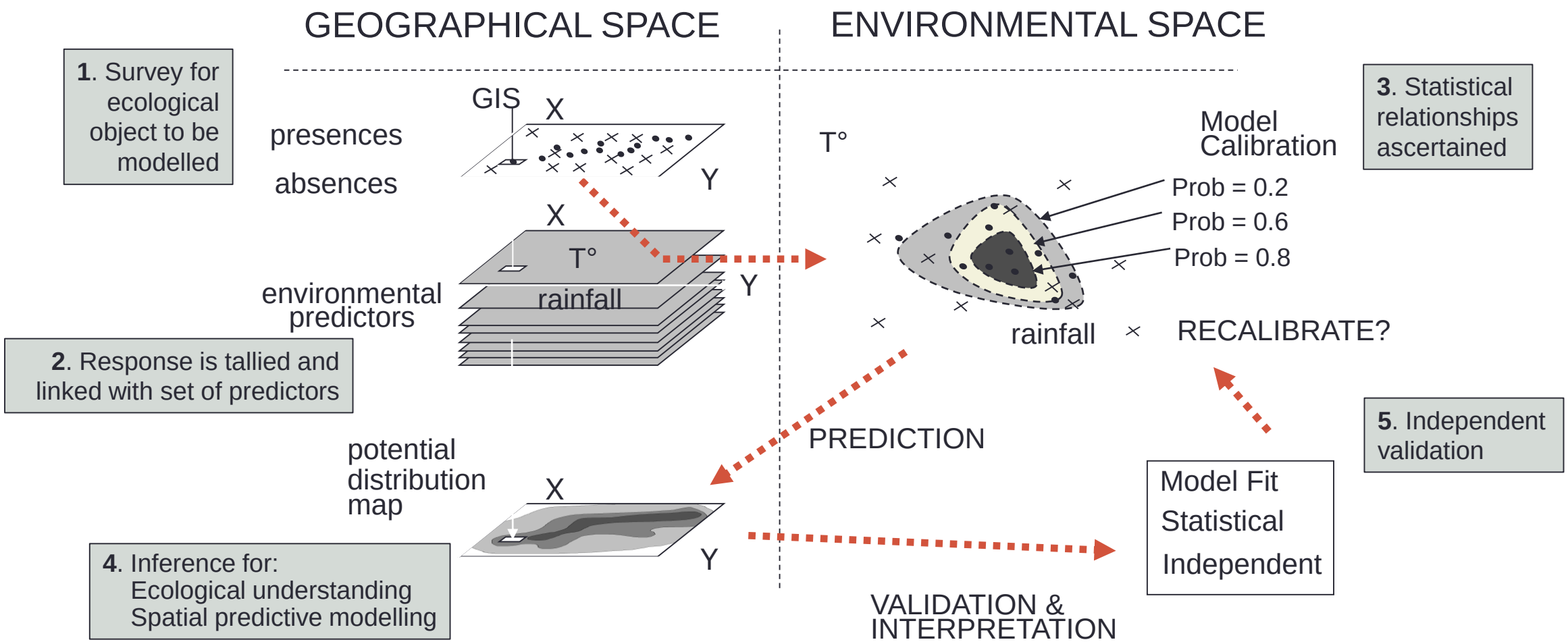
Assessing Risk in Distribution Modelling (SDM):
Recall This Previous Slide … and the Steps of a SDM



Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- Decision-risk occurs at all the SDM construction steps, which re-labeled are:
  - SDM data acquisition, vetting, and organization;
  - SDM construction;
  - SDM assessment and validation; and
  - SDM implementation

←

Remember!
These steps first require a question / objective / intended use

- The decision-risk arises every time an analytical decision is made during SDM construction

- As SDMs are built, analytical decisions are made at ***ALL*** these steps, and their associated elements
  - We often call analytical decisions associated with SDM construction[1] "**best-practices**"

[1]Phrase applies to ALL models in management and conservation

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- By definition, "**best-practices**" generically viewed as:
  - "A procedure [or procedures] that has been shown by research and experience to produce optimal results; and
  - That is established or proposed as a standard suitable for widespread adoption"[1]

- Yet all "**best-practices**" are, to their root, based on subjective decisions derived from (often conflicting) literature
  - EXAMPLE: Which statistical model to select for a SDM?
    - Many, many choices here, with strong-willed camps of proponents (aka acolytes) …
  - EXAMPLE: Is re-sampling data an appropriate form of model validation?
    - Great for assessing model bias, but not a valid form of independent validation (says I …)
  - EXAMPLE: Can I build a SDM with 100 sample points?
    - Yes. No. It depends. Try 42 sample points – that's worked before.

[1]Slightly modified from Merriam-Webster

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- **IMPORTANT CAVEAT:**

  No single analytical process can eliminate decision-risk as described

- Nonetheless, decision-risk can be can be minimized with careful consideration of the basis of all analytical decisions

- Distilled to its base, two necessary steps in minimizing decision-risk are …
  - #1: Consider the "form" of the decision-risk
    - Philosophical, technical, intractable
  - #2: Proper documentation (ie, justification) and evaluation of all analytical steps and the underlying decisions
    - SDM builders currently do a poor job of this

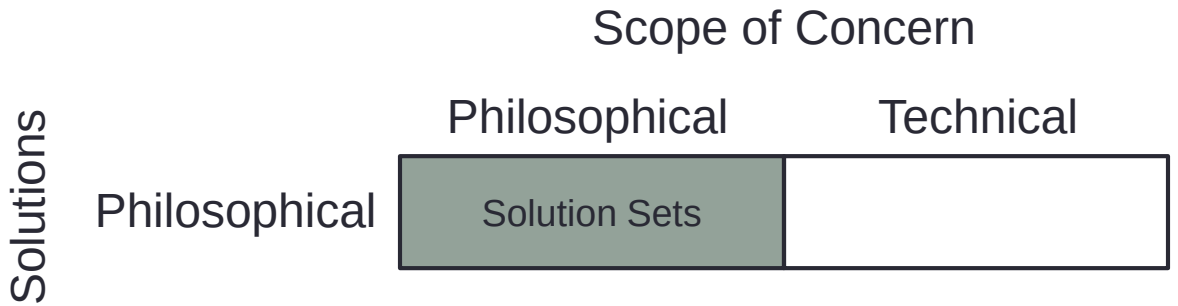
Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- So if SDM builders do a poor job of assessing and documenting risk …

How do we overcome this shortcoming and enhance application of SDMs in management and conservation?

Assessing Risk in Distribution Modelling (SDM):
#1: The Forms of Decision-Risk

- Scopes of SDM decision-risk conveniently labeled as **philosophical** or **technical** or **intractable**
  - EXAMPLE Philosophical:
    - **Reliability of a "modeled" vs. a "known" location**
    - You either believe in models and their potential for application to management, or you do not
    - **OPINION**: cannot logically employ PVA, occupancy modelling, mark-recapture population estimation modelling, etc., and reject SDM

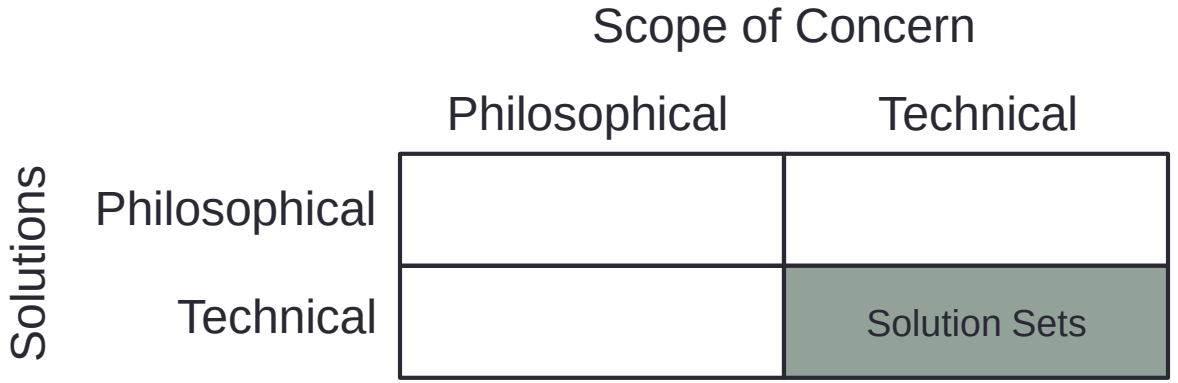


You simply do not like use of models in management; this is a philosophical stance

I cannot help you

Assessing Risk in Distribution Modelling (SDM):
#1: The Forms of Decision-Risk

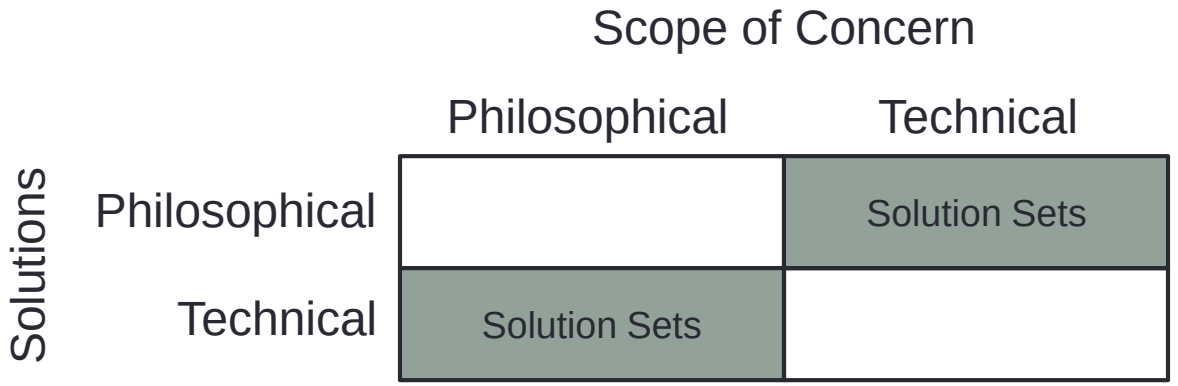
- Scopes of SDM decision-risk conveniently labeled as **philosophical** or **technical** or **intractable**
  - EXAMPLE Technical:
    - **Selection of a classification threshold to translate continuous probability to a binary presence:absence**
    - Numerous threshold options; choice based on SDM application objective(s)
    - **OPINION**: there may be (intense) discussion over choice, but technical, defensible solutions exist



Resolution can be reached, and can be backed with appropriate science-based literature, etc.

Assessing Risk in Distribution Modelling (SDM):
#1: The Forms of Decision-Risk

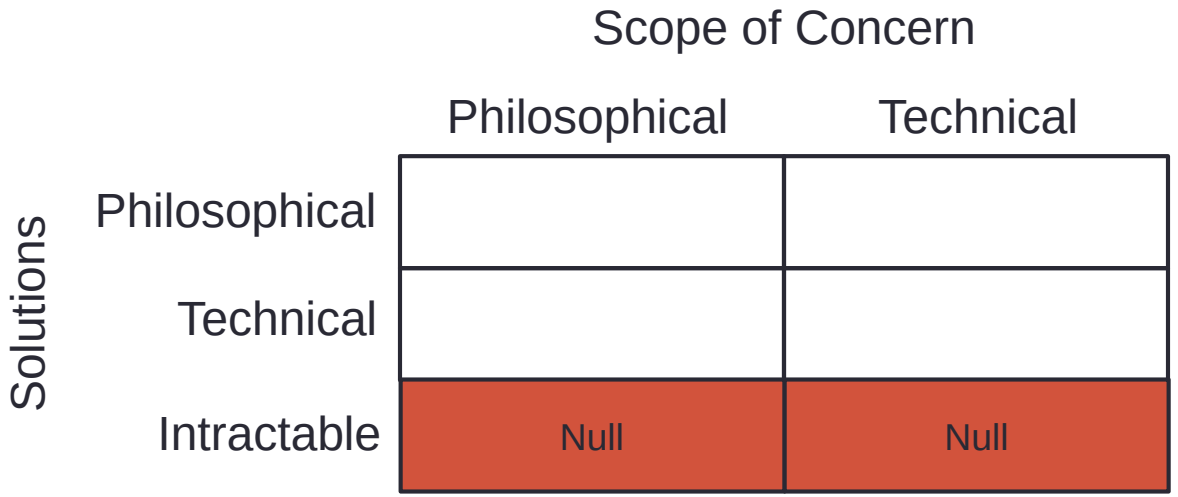
- Scopes of SDM decision-risk conveniently labeled as **philosophical** or **technical** or **intractable**
  - EXAMPLE Mixtures:
    - **Philosophical choice of statistical algorithm can be technically resolved**
    - **Technical concern over historical data can be resolved philosophically**
    - **OPINION**: mixtures of philosophical and technical scopes of concern can usually be resolved with combinations of technical and philosophical expertise



No single end-user "wins" 100% of their perspective

Assessing Risk in Distribution Modelling (SDM):
#1: The Forms of Decision-Risk

- Scopes of SDM decision-risk conveniently labeled as **philosophical** or **technical** or **intractable**
  - EXAMPLE Intractable:
    - **Data densities insufficient for any reasonable SDM (or other modelling) effort**
    - Some SDM concerns are simply intractable, and no resolution exists
    - **OPINION**: be brutally honest; **don't "push" a non-defensible modelling environment**



Uncomfortable "solution" to many, but absence resources to obtain more data the only logical end point

Assessing Risk in Distribution Modelling (SDM):
#1: The Forms of Decision-Risk

- Categorizing SDM concerns into three groups provides a structured approach:
  - To begin examining the characteristics of each concern;
  - For determining if one (or more) level(s) of resolution exist for the concerns[1]; and
  - As a basis for assigning decision-risk

- How might this structured approach be expressed?
  - List concerns related to SDM creation and application
  - Developed posed queries for the concerns
  - *a priori* provide answers related to your (and your agency) decision-risk environment
  - Assess SDM process and (subjectively?) determine if concerns addressed
  - Use the concerns as part of the analytical pathway for those tasked with SDM creation

[1]NOTE: Absent resolution, I define the concern as intractable

Assessing Risk in Distribution Modelling (SDM):
#2: Documentation and Evaluation

- More and more papers coming out regarding "best practices" and SDMs
  - Not unexpectedly, all differ in flavor, but all striving to generate decision-quality SDMs

- Four basic criticisms[1] regarding SDMs include:
  - Overly complicated and difficult to interpret;
  - Not well-grounded in natural history and lack "common sense;"
  - Quality and quantity of data input can have significant impact on SDM construction; and
  - Confusion over SDM output depicting potential versus actual, true distribution

- Sofaer[2] et al., Bioscience (2019) doi:10.1093/biosci/biz045, provide one means of reducing these concerns

[1]There are more ways to portray these concerns
[2]Helen was a GREAT post doc and was just hired by USGS

Assessing Risk in Distribution Modelling (SDM):
#2: Documentation and Evaluation

- Sofaer et al. organize documentation and evaluation of SDMs using classic red, yellow, green criteria, assigning labels of Problematic, Acceptable, Ideal, respectively
  - **CAUTION**: This evaluation process does **NOT** eliminate role of subjectivity (hence the "traffic light" colors)
  - It merely reduces subjectivity by requiring careful documentation of model construction steps

		Problematic	Acceptable	Ideal	References
Species Data	Presence data quality	Poor or unassessed quality of data (precision, accuracy, taxonomy). No consideration of biases introduced by poor detection.	Spatial error in coordinates < spatial grain of model. Correction of taxonomic inconsistencies. Confirmation of outlying presences and spatial thinning as needed.	Consistently accurate records or weighting of occurrences to place greater weight on locations with lower coordinate error. Detection biased considered.	(Graham et al. 2008, Lozier et al. 2009)
	Absence/ background data	Background data does not reflect sampling bias in presence locations. Background data across broader extent than presence data.	Sampling of background points to mimic sampling biases in data and/or sensitivity analyses to evaluate effects of different background datasets.	Design-based sampling of presence and absence or datasets combined in statistically compatible manner.	(Barbet-Massin et al. 2012, Guillera-Arroita et al. 2015, Phillips et al. 2009)
	Evaluation data	Based on training data.	Based on cross-validation of training data.	Based on independent data from separate sampling effort.	(Fourcade et al. 2018, Roberts et al. 2017)

Assessing Risk in Distribution Modelling (SDM):
#2: Documentation and Evaluation

- The structured documentation and evaluation process provides a means for SDM model builders to evaluate models iteratively during construction
  - Intent is a defensible analytical flow of model construction and evaluation

NOTE "Intended use" to help guide documentation and evaluation process

And don't forget that "intended use" falls under 4 categories of questions, each with different risk!!

		Flatwoods Salamander	European gypsy moth (2013 GIS version)	European gypsy moth (2016 statistical version)	Cheatgrass	Uinta Basin hookless cactus	Bog turtle
	Intended use	Incorporation into regional conservation plan to support conservation and management needs for a diverse stakeholder group	Guide APHIS surveillance program	Guide APHIS surveillance program	Guide herbicide application for control	Guide pre-management survey locations in relation to proposed energy extraction locations	To support environmental review conducted by agencies and species recovery efforts
Species Data	Presence data quality						
	Absence/ background data						
	Evaluation data						

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- How do we implement this decision-risk assessment process?

Let's see some examples

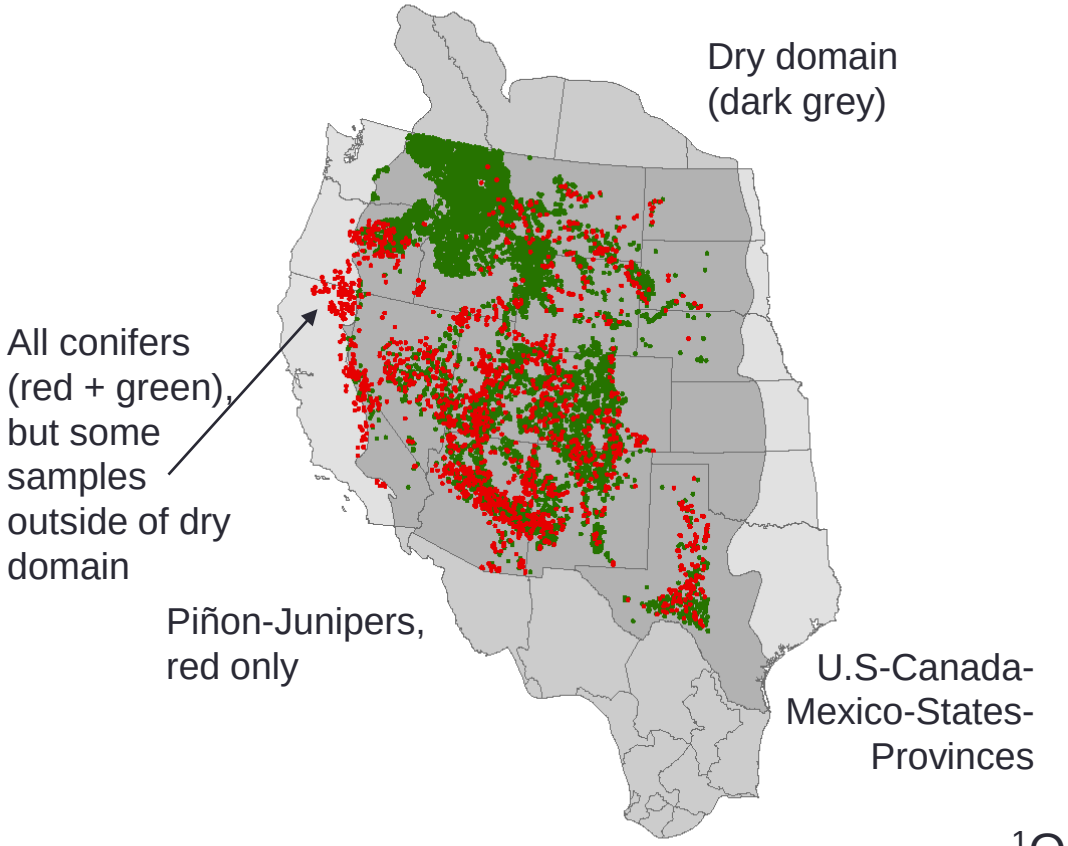
Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision-Risk Concerns

- **CONCERN: Geographic vs. environmental vs. land tenure** coverage
  - Land-tenure boundaries affect both the geographic and environmental data domains, as well as interpolation, extrapolation, and projection domains
  - Trans-boundary models require close cooperation; often this is difficult, reflecting different SDM modelling and application objective(s) that require resolution

- **RESPONSE**: Resolvable; trans-boundary and coverage issues should be considered upfront
  - EXAMPLE: Species having sample data from extent larger than a land tenure unit
    - Build SDM with all data to ensure geographic and environmental coverage, clip SDM to land tenure
  - EXAMPLE: Species having data from smaller land tenure extent than known range
    - Build SDM; be wary of extrapolation outside data bounds

Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision-Risk Concerns

- Land tenure will affect modelling domains, and hence output …



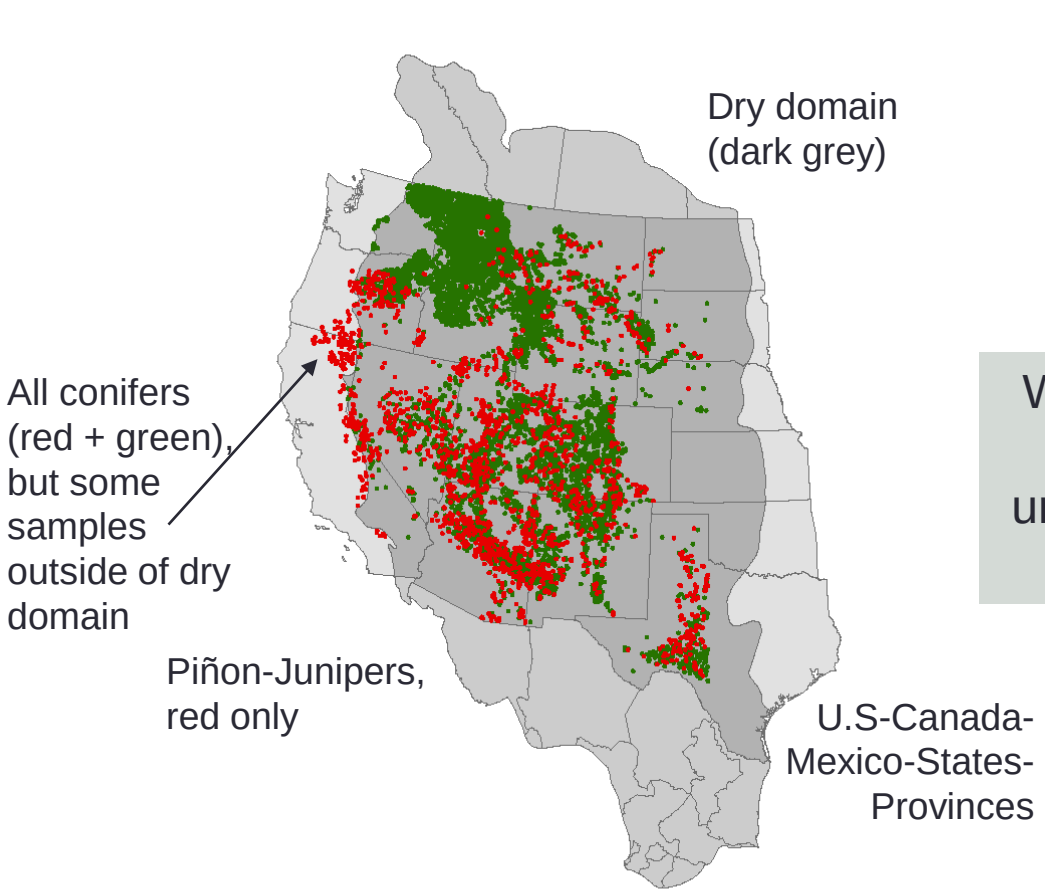
Let's assume piñon-juniper habitat management is our concern.

We need a piñon-juniper woodlands SDM to address the so-called " piñon-juniper encroachment"[1] argument

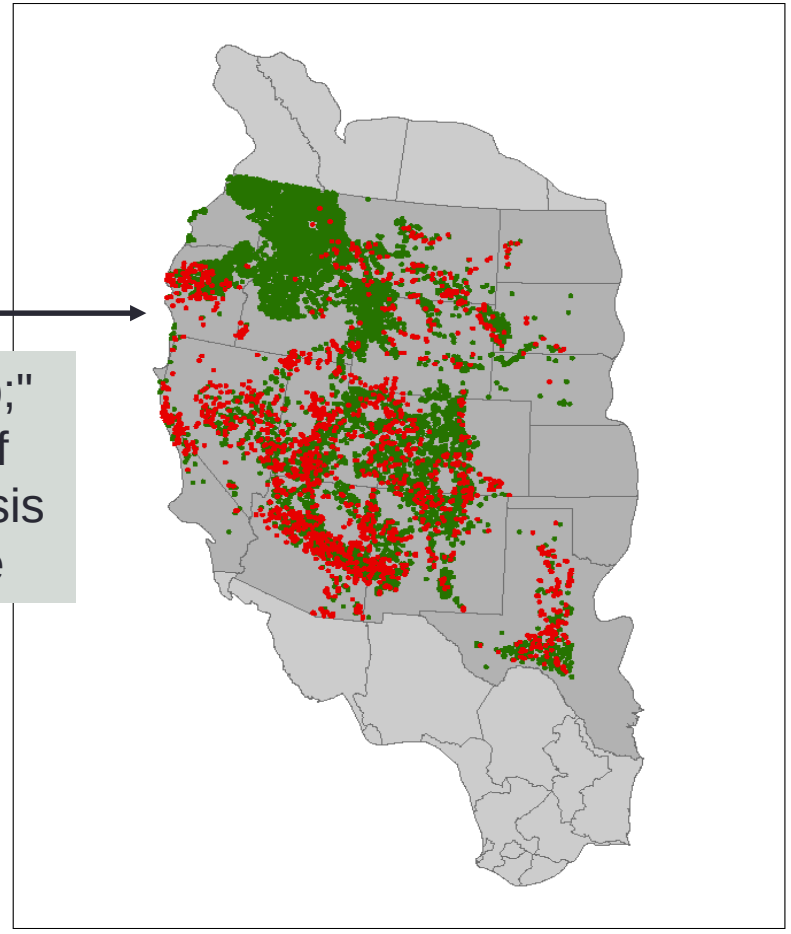
[1]OPINION: How I hate use of this term, "encroachment"

Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision-Risk Concerns

- Land tenure will affect modelling domains, and hence output …

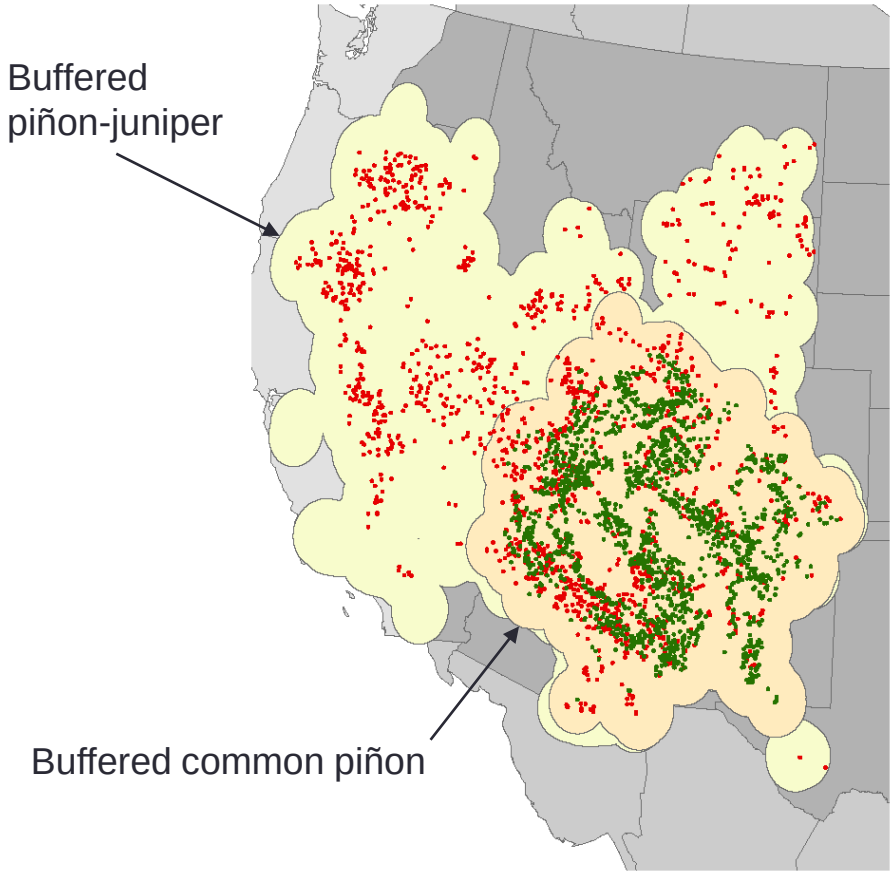


We often "clip;" reasonable if underlying basis is defensible

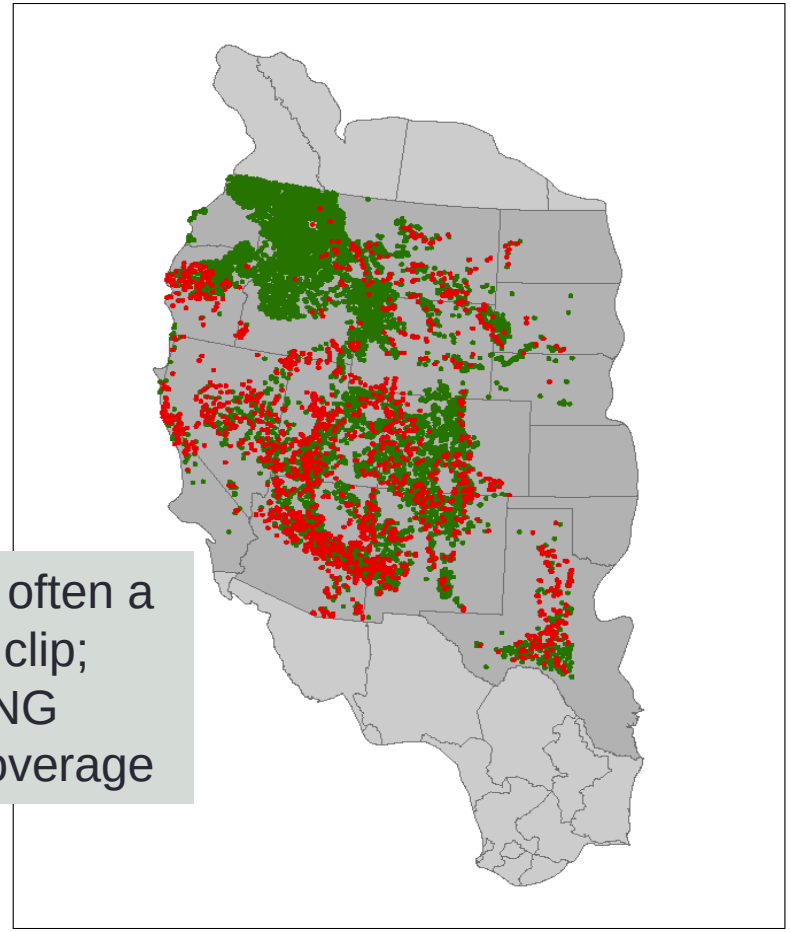


Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision-Risk Concerns

- Land tenure will affect modelling domains, and hence output …



Buffered data often a defensible clip; ASSUMING geographic coverage

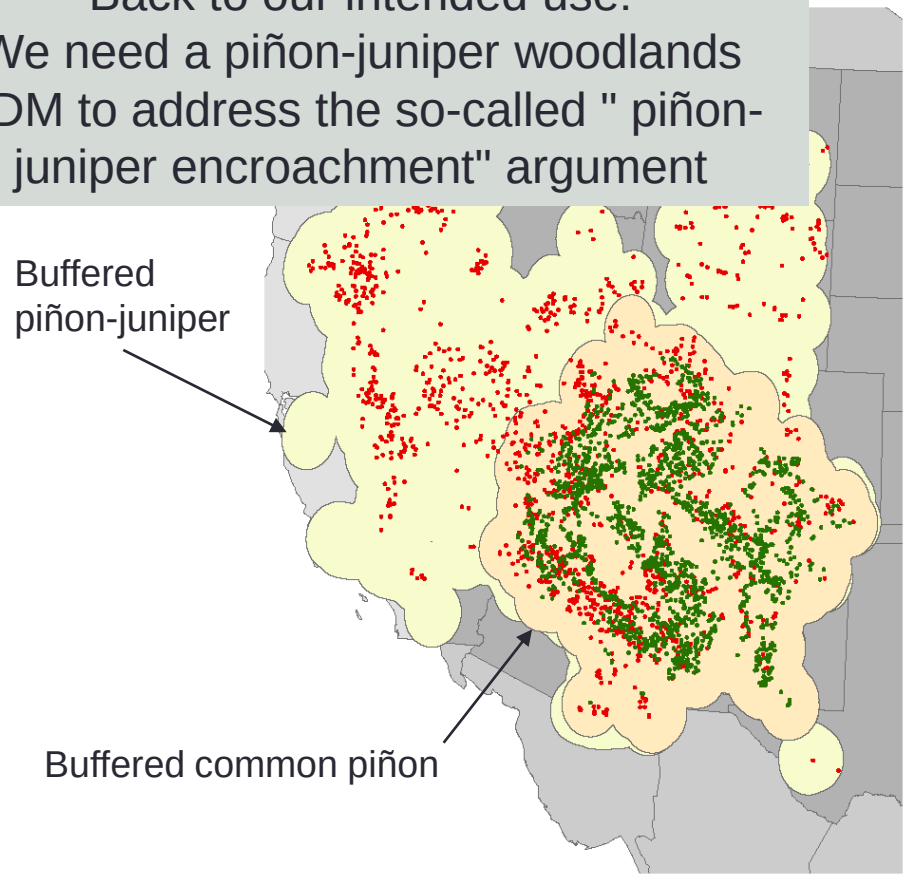


Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision-Risk Concerns

- Some possible analytical decision elements for decision-risk assessment
  - SDM builder chose a buffered domain
    - What is basis of buffer? **Arbitrary, 50 km.**
  - SDM builder used only FS FIA data
    - Are we missing other data? **Yes.**
    - Is their absence an issue? **No. FIA is design-based.**
  - SDM builder excluded PJ species with geographic centers in Mexico but do extend into the US
    - Does this exclusion affect SDM output? **Not sure.**

- All of these (there are more) are subjective !!

Back to our intended use:
We need a piñon-juniper woodlands SDM to address the so-called " piñon-juniper encroachment" argument



Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #1: Decision Risk Concepts

Tom's answers to the boss(es)

- Some possible analytical decision elements for decision-risk assessment
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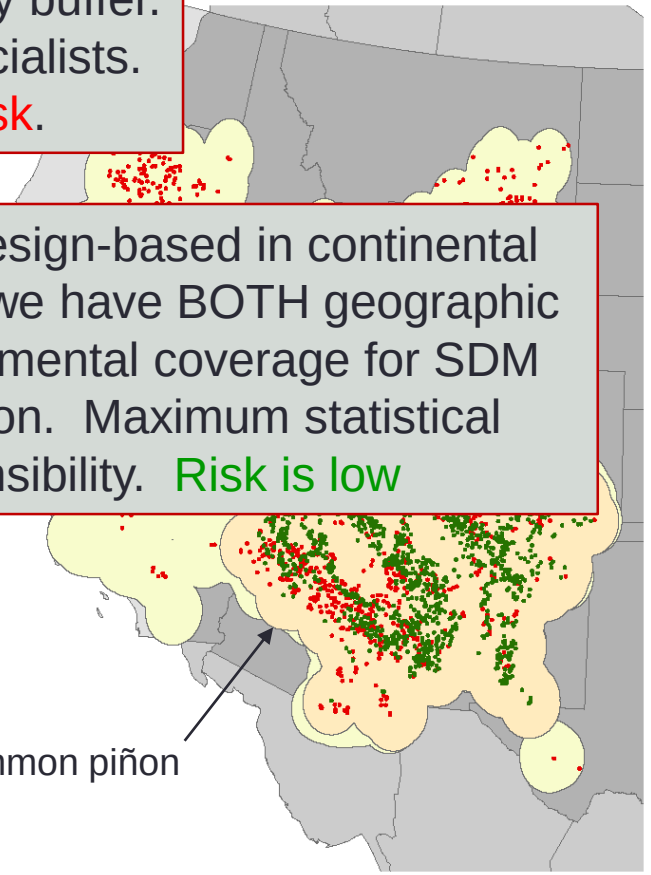
  - SDM builder excluded PJ species with geographic centers in Mexico but do extend into the US
    - Does this exclusion affect SDM output? **Not sure.**
- All of these (there are m

No literature basis for any buffer. No answer from PJ specialists. Live with it. High risk.

FS FIA is design-based in continental US. Hence we have BOTH geographic and environmental coverage for SDM construction. Maximum statistical defensibility. Risk is low

PJ specialists state Mexican PJ species likely spatially co-mingled with US species. SDM output will likely include them. Moderate risk.



Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #2: Decision-Risk Concerns

- **CONCERN: "Single Model Realization"** of a SDM
  - A single **space-time static** SDM is built and presented as *fait accompli*
  - Two elements to consider:
    - Is this a single model realization of a species distribution **in space**? **In time**?
    - Are multiple statistical tools applied to the data?

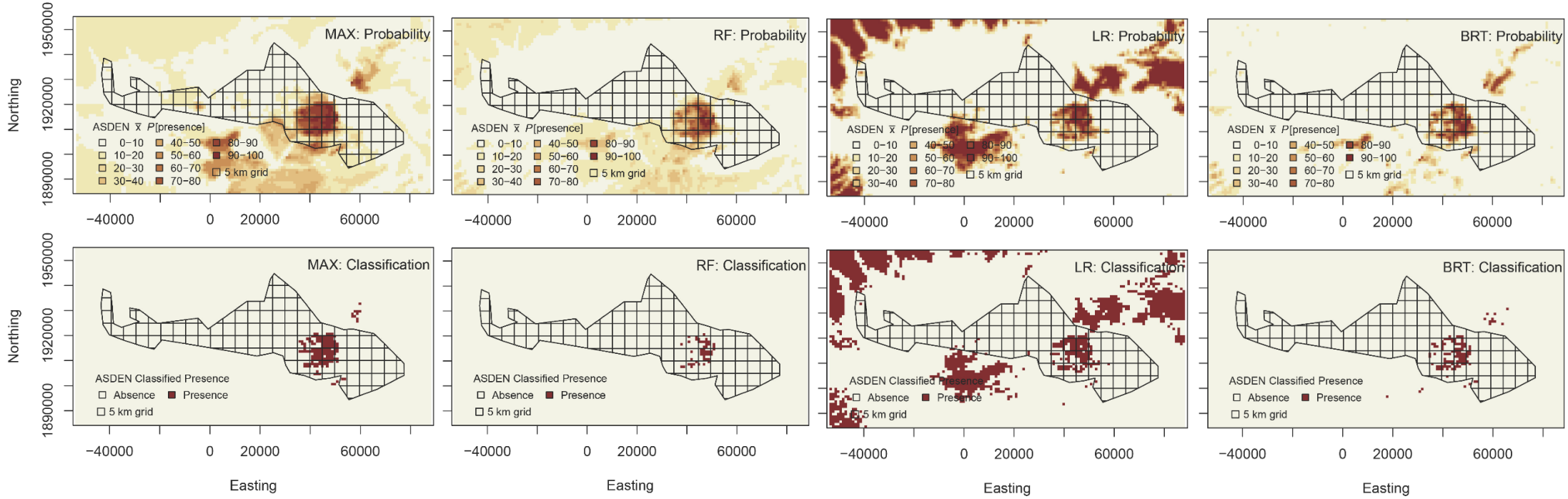
- **RESPONSE**: Partly resolvable; you will agree to resource allocations or not
  - EXAMPLE: Historical data only used; no commitment to future data collection
    - **Intractable, ie, no solution**; model accepted as is or discarded
  - EXAMPLE: Data sources are sufficient to construct initial SDM, but limited in space
    - Use SDM as **hypothesized distribution;** implement design-based sampling to enhance SDM
  - EXAMPLE: SDM data sources are rich in time and space
    - Generate an **ensemble of models** using different statistical tools

Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #2: Decision-Risk Concerns

- Consider the outputs below, representing **different statistical models**

  Maximum Entropy, Random Forests, Logistic Regression, and Boosted Regression Tree predication and classification models;
  Note differences in spatial prediction and classification

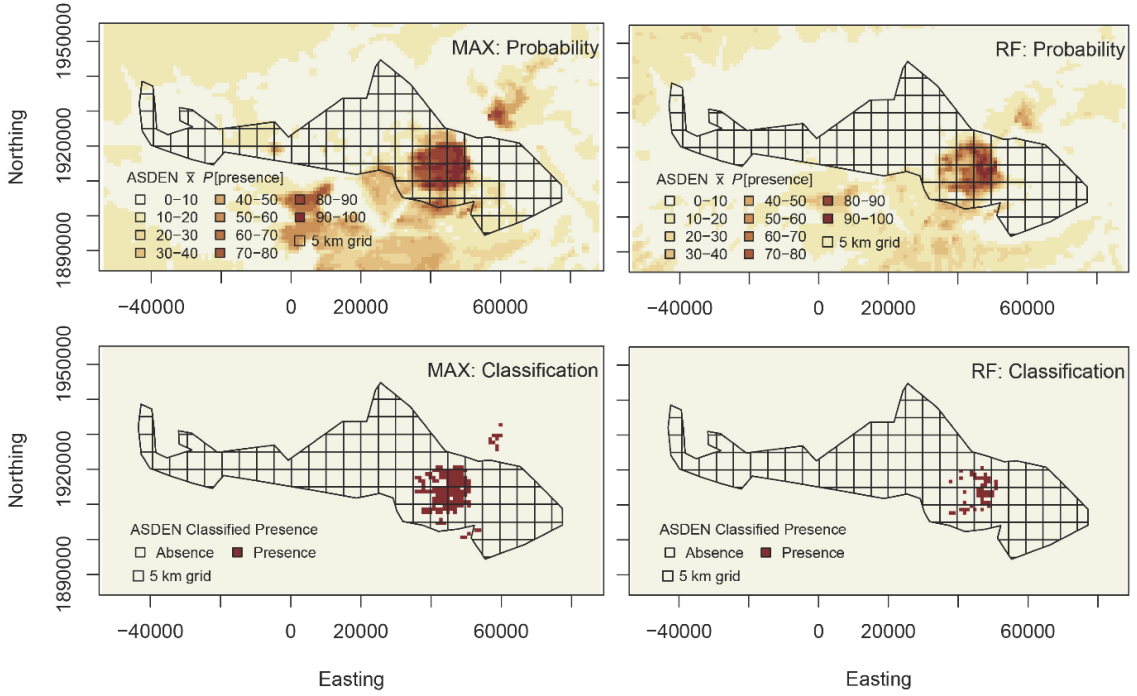
Elizabeth's milkvetch
Astragalus desperatus



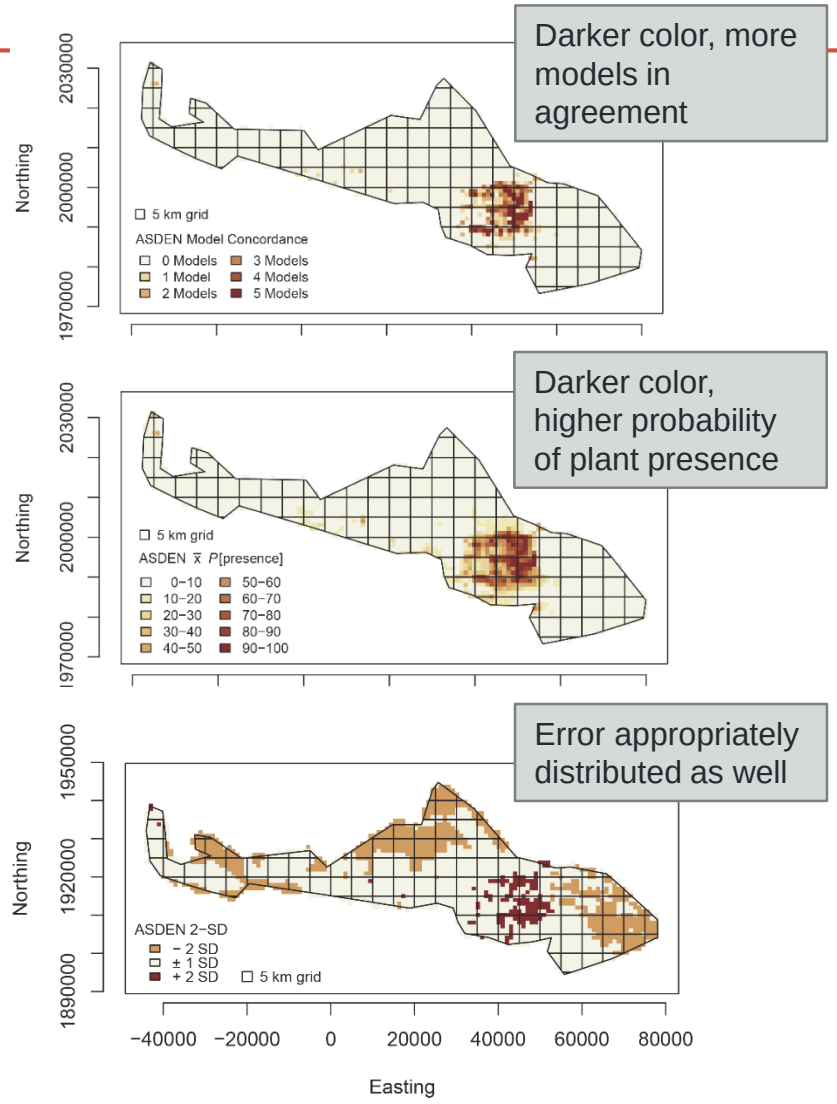
Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #2: Decision-Risk Concerns

- Consider the outputs below, representing different statistical models **and a resultant ensemble model**

Ensemble of 5 different statistical models., including error →



Note clustering in same general areas

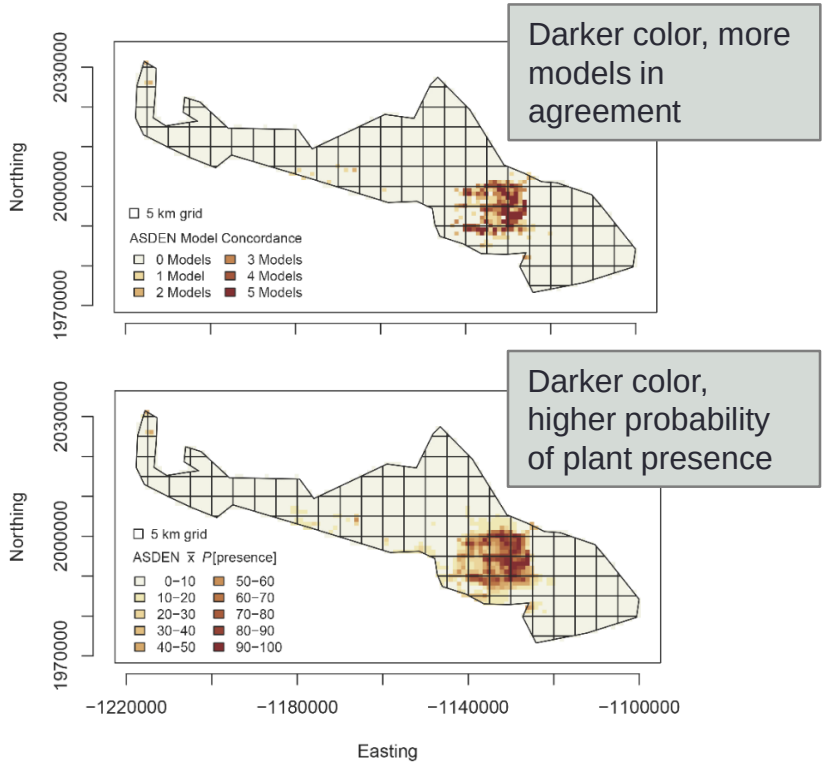


Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #2: Decision-Risk Concerns

- Some possible analytical decision elements for decision-risk assessment
  - SDM builder used 5 statistical models
    - Why those 5? **Code was available.**
    - Are others equally applicable? **Yes.**
  - SDM builder presents a concordance map depicting where models overlap spatially
    - How many models – 5? 4? 3? 2? Just 1? – must predict at a spatial location for my management decision basis? **Not provided.**
  - SDM builder provides no measure of uncertainty
    - Give 5 models, can builder provide some measure of variability in prediction across the species' range? **Yes, but not provided.**

Ensemble of 5 different statistical models.

Elizabeth's milkvetch
Astragalus desperatus



Assessing Risk in Distribution Modelling (SDM):
EXAMPLE #2: Decision Risk Concerns

Tom's answers to the boss(es)

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  - SDM builder provides no measure of uncertainty
    - Give 5 models, can builder provide some measure of variability in prediction across the species' range? **Yes, but not provided.**

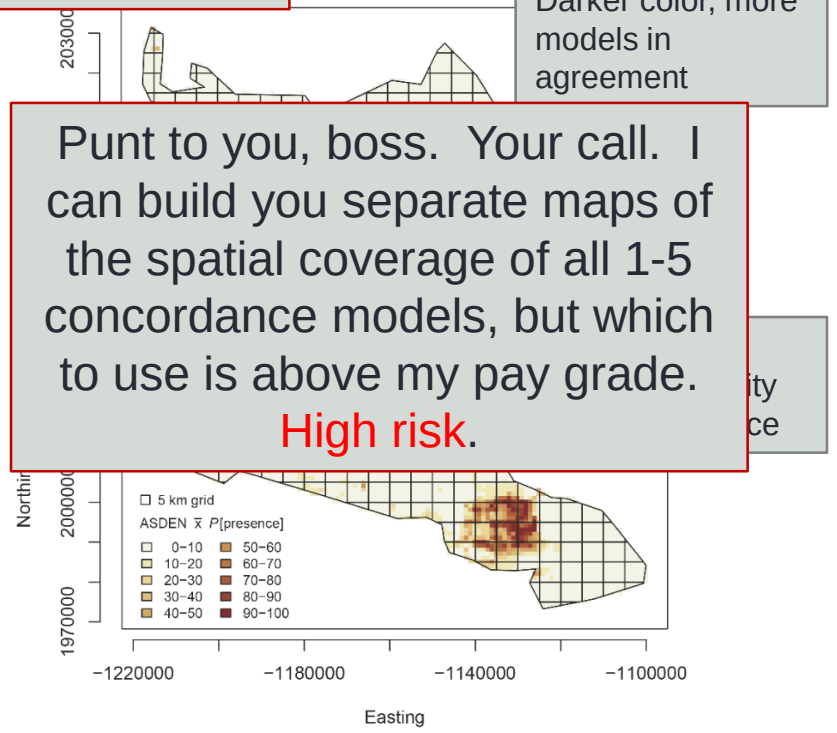
Oops. Can do. Will do. Low risk.

Data are organized so can build more models. However, data densities insufficient for two statistical model forms. Low risk

zabeth's milkvetch
agalus desperatus

Darker color, more models in agreement

Punt to you, boss. Your call. I can build you separate maps of the spatial coverage of all 1-5 concordance models, but which to use is above my pay grade. High risk.



Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- We've seen just a few examples of many …

So how do I – a potential end-user of SDM – ensure that builders provide such information to me?

Assessing Risk in Distribution Modelling (SDM):
What Constitutes Decision-Risk Concerns with SDMs?

- **Recall that …**

  decision-risk occurs at all the SDM construction steps, consisting of:
  - SDM data acquisition, vetting, and organization;
  - SDM construction;
  - SDM assessment and validation; and
  - SDM implementation

- As SDMs are built, analytical decisions are made at ***ALL*** these steps, and their associated elements, and risk occurs

So here's our solution, one we're now implementing nationwide.

Assessing Risk in Distribution Modelling (SDM):
The Proposal

- The **Goal: An education and training platform in SDM construction and evaluation processes** targeting both SDM developers and decision-makers
  - This education and training platform seeks to alleviate SDM concerns by implementing analytical processes that educate state, Federal, NGO, and other biologists on the development and proper application of SDMs

- Two courses developed:
  - **COURSE #1:**

    Decision-Risk and Application of Distribution Models to Management and Conservation
  - **COURSE #2:**

    Species and Habitat Distribution Modelling Using R[1]

[1]R is a collection of statistical packages for analysis of data

Course #1: Decision-risk & Species Distribution Modelling
Course Structure

- **Course #1 target audience**
  - State, Federal, and other leadership (ie, decision-makers) with responsibilities to evaluate application of SDMs and resultant map products in conservation and management
- It provides an evaluation framework, based on a set of decision-risk elements, that decision-makers can apply to any SDM
  - NOTE: these elements are also incorporated in Course #2 such that model-builders address these elements during model construction
- Instructional content consists of "real-world" SDM examples
- Course format is both recorded / live webinar envisioned at ~1 hr duration

Course #2: Distribution Modelling Using R
Course Structure

- **Course #2 target audience**
  - State, Federal, Tribal, NGO, academic, and other biologists with responsibilities to create SDMs and resultant map products
  - This is a "hands dirty" course, "drink-water-from-a-firehose," 5-day build-a-model course
- Course participants should have skill sets including:
  - Moderate to advanced experience in R
  - Early graduate-level understanding of basics statistics
  - Basic understanding of RMarkdown
- Interest in, or responsibility for, the application of SDMs to species of management and conservation in their respective regions

Education & Training in Distribution Modelling:
The Principal Partners

- These include …
  - The **Association of Fish and Wildlife Agencies (AFWA)**, which serves as a link to states
  - The **USGS** will function as the facilitator for the training and education platforms
  - The **USFWS** has significant roles in transferring science to cooperators, especially states, through established means such as the **National Conservation Training Center**
  - **USFWS Ecological Services** is providing personnel and monetary resources via its **Species Range Project**
  - **States** and the USFWS, along with land management agencies like **BLM**, **NPS**, and the **USFS**, have both data and a need for SDMs, thereby being logical partners in this endeavor
  - Last, large chunks of data are often, but not exclusively, housed within state **Heritage Programs**; thus, **NatureServe** is a logical partner as well

Education & Training in Distribution Modelling:
CY 2019 Goals

- Course #1: "Decision-makers" course
  - Webinar versions completed end of 1st QTR 2019; hosted thru NCTC
  - Presentation "roll-out" at 2019 N. American
  - Decision-makers workshop Fall 2019 AFWA mtg, St Paul, MN
- Course #2: "Model-builders" course
  - 1 "training the trainers" (NCTC); specialized instruction for the FWS
  - 3 participant-based courses (Bozeman, MT [May]; NCTC [Jul], Atlanta [Fall])
  - 4th course possible late 2019 (Northeast)
- Topical coverage of both courses reviewed and approved 6 Dec 2018

Education & Training in Distribution Modelling:
Course Roll-outs

- Advertisements for May and July "model builders" courses out next week via AFWA listserves, FWS, and others

- Ideal attendees:
  - "Pairings" of state and FWS / Federal /NGO biologists who have a species of joint interest
  - **NOTE**: I will not preclude consideration "stand-alone" biologists as attendees

- Cost structure
  - I'm free … USGS Ecosystems covering my costs
  - FWS has agreed to cover hotel / per diem costs of all attendees
  - Thus, state folks need only the resources get to course locations

Education & Training in Species Distribution Modelling:
CY 2019 Goals

- For further information contact:
  - Thomas C. Edwards, Assistant Leader and Professor
  - USGS Utah Cooperative Fish and Wildlife Research Unit, and
  - Department of Wildland Resources, Utah State University
  - t.edwards@usu.edu / tce@usgs.gov

The End

Questions?