

# Integrated Monitoring of Biodiversity – Sharing in the world of Big Data

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# Main types of environmental monitoring

## Compliance Monitoring

Company measures X to assess compliance with regulations

Local spatial extent.  
Time period finite

Designed to answer specific ? for life of project.

**Example:**

Environmental Protection & Enhancement Act Approvals

## Trend Monitoring

Volunteers/ staff measure X in same sites to see how X changes over time

Large spatial extent  
Time period infinite

NOT designed to answer any specific question

**Example:**

ABMI

## Applied Research

Researchers compare in time/ space using control/ treatments how X varies

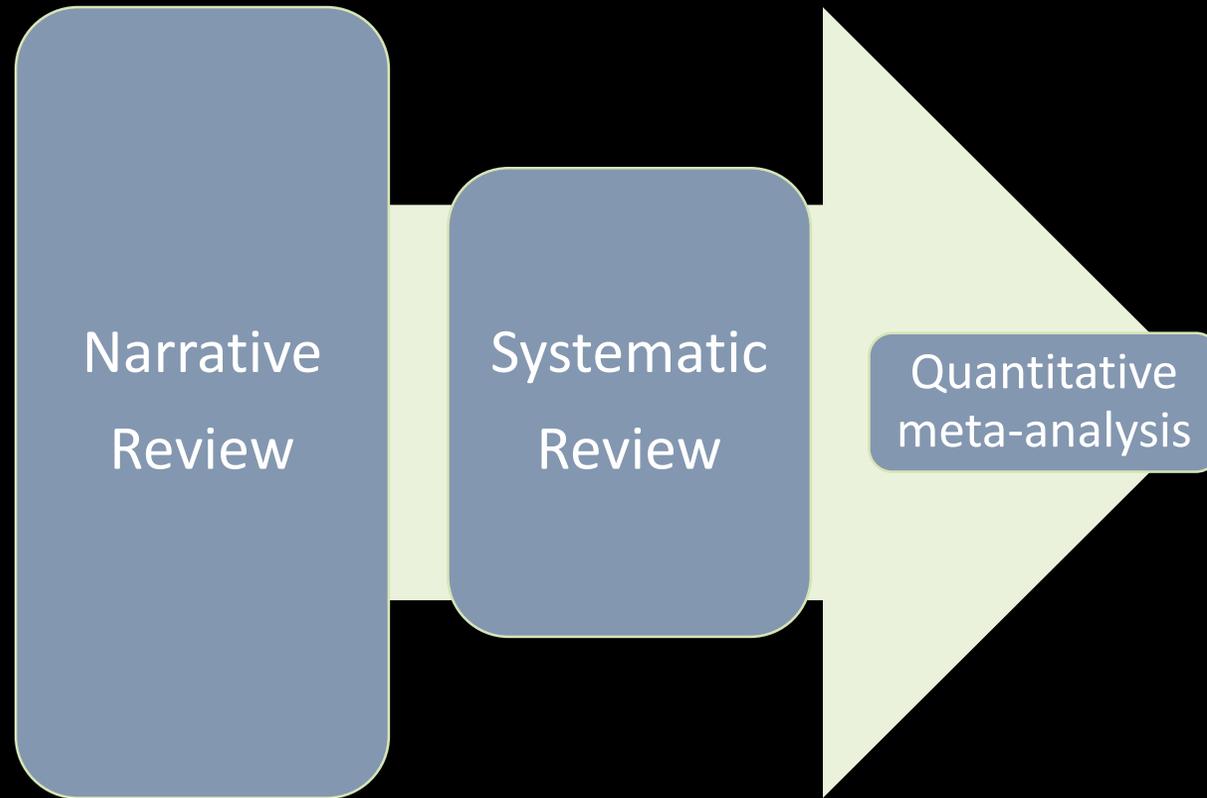
Spatial scales often local  
Time period often short

Designed to answer specific question once & then move on

**Example:**

Erin Bayne's career

# How most environmental monitoring data is used



# Limitations of meta-analysis

File drawer problem

Can't double-check raw data

Only show graphical results

Variation in spatial scale

Is habitat defined the same way?

Forgot to report variance estimate

Variation in statistical methods

Variation in field methods

Did not report sample size

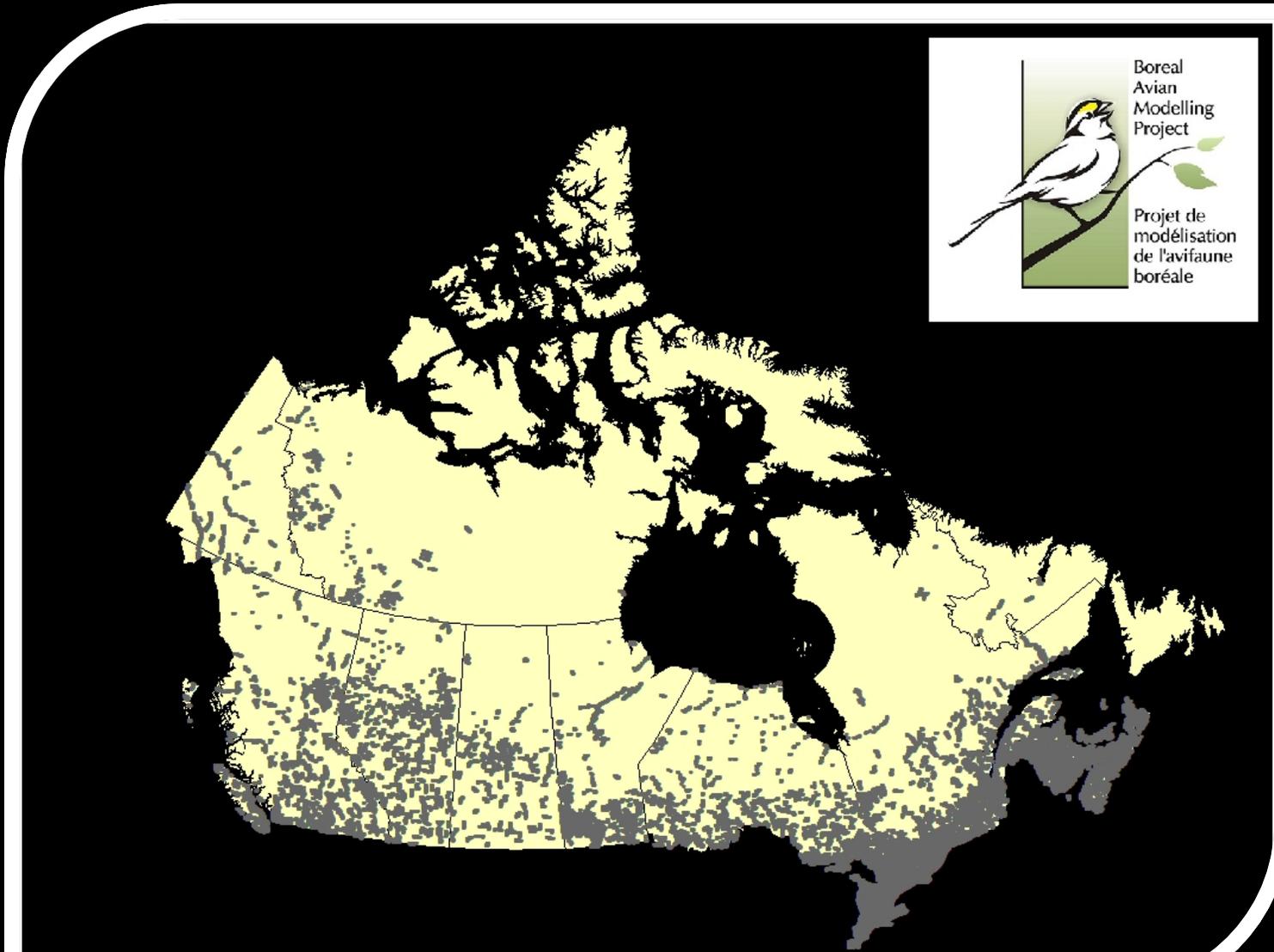
Violation of statistical assumptions

Did not report measure of central tendency

Ill-defined statistical population

Limits you to original questions

# But what if we had the raw data?



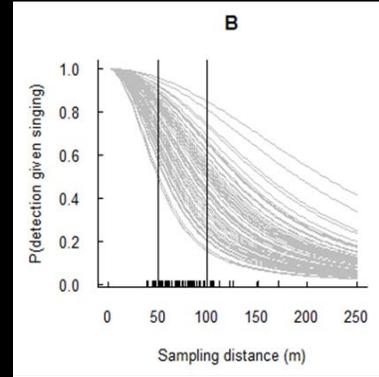
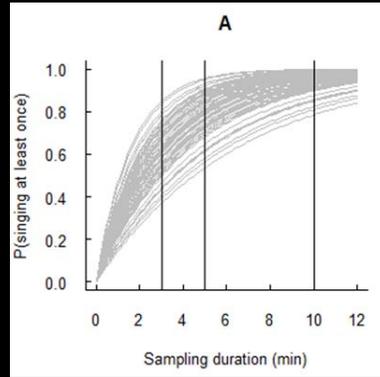
# The messy part of big data

$$E[Y_{j.}] = D A [p(t_j) - p(t_{j-1})] q(r_K)$$

$$\hat{C}_i = \hat{A}_i \hat{p}(t_j)_i$$

$$p(t_j) = \int_0^{t_j} \phi \exp(-t\phi) dt = 1 - \exp(-t\phi)$$

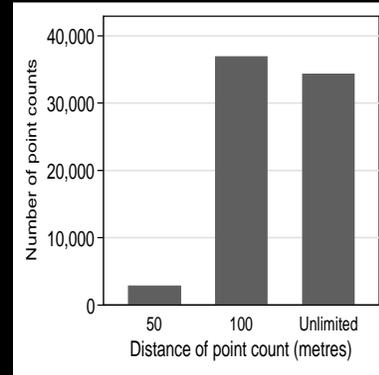
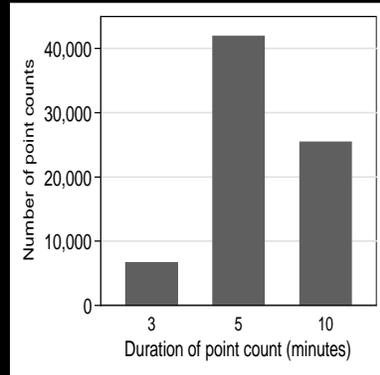
$$\lambda_i = D_i A_i \hat{p}(t_j)_i \hat{q}(r_K)_i$$



$$g(r) = \exp(-r^2 / \tau^2)$$

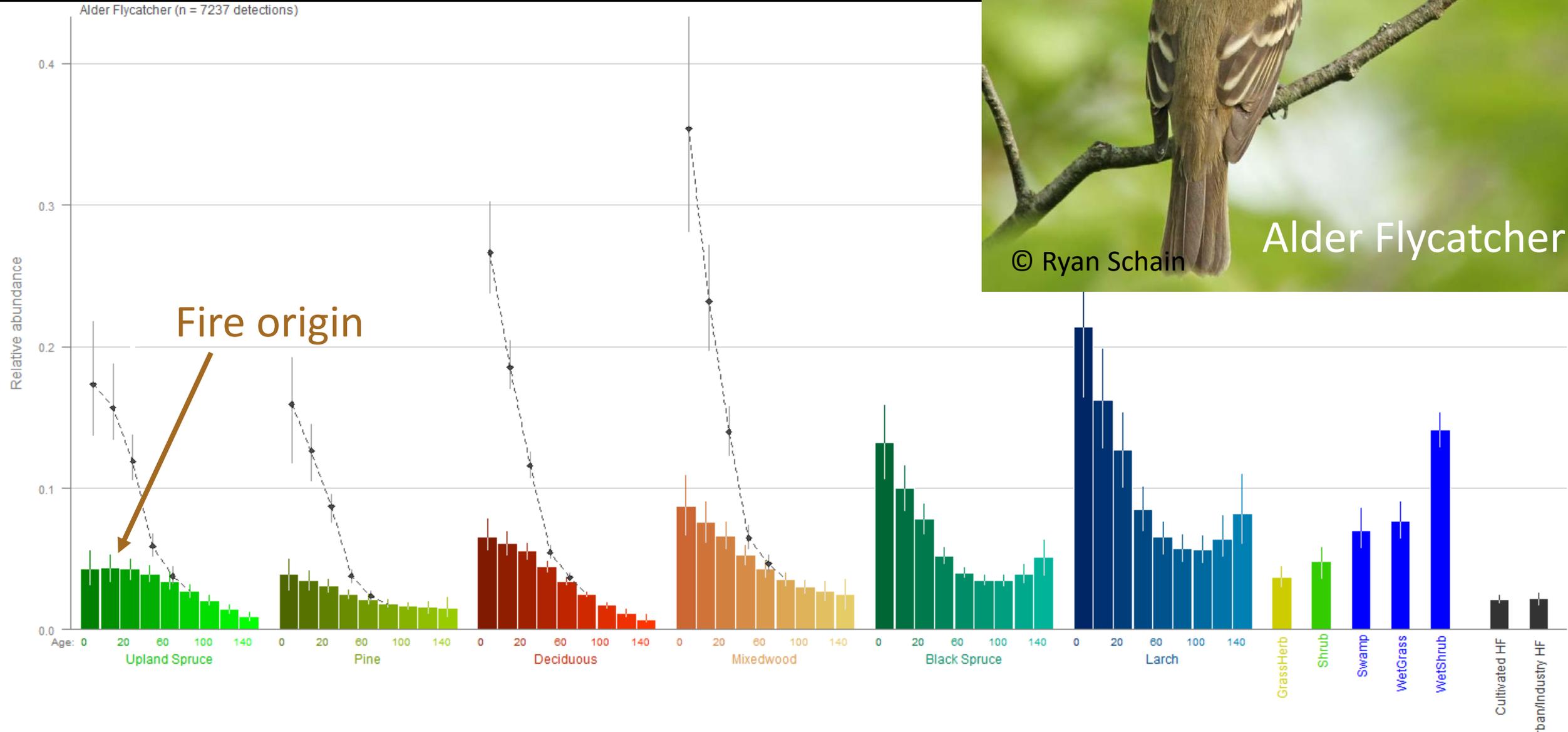
$$\hat{q}(r_K)_i = \frac{\hat{\tau}_i^2}{r_K^2} \{1 - \exp(-r_K^2 / \hat{\tau}_i^2)\}$$

$$E[Y_{.j}] = N p(t_j) q(r_K) = D A p(t_j) q(r_K)$$

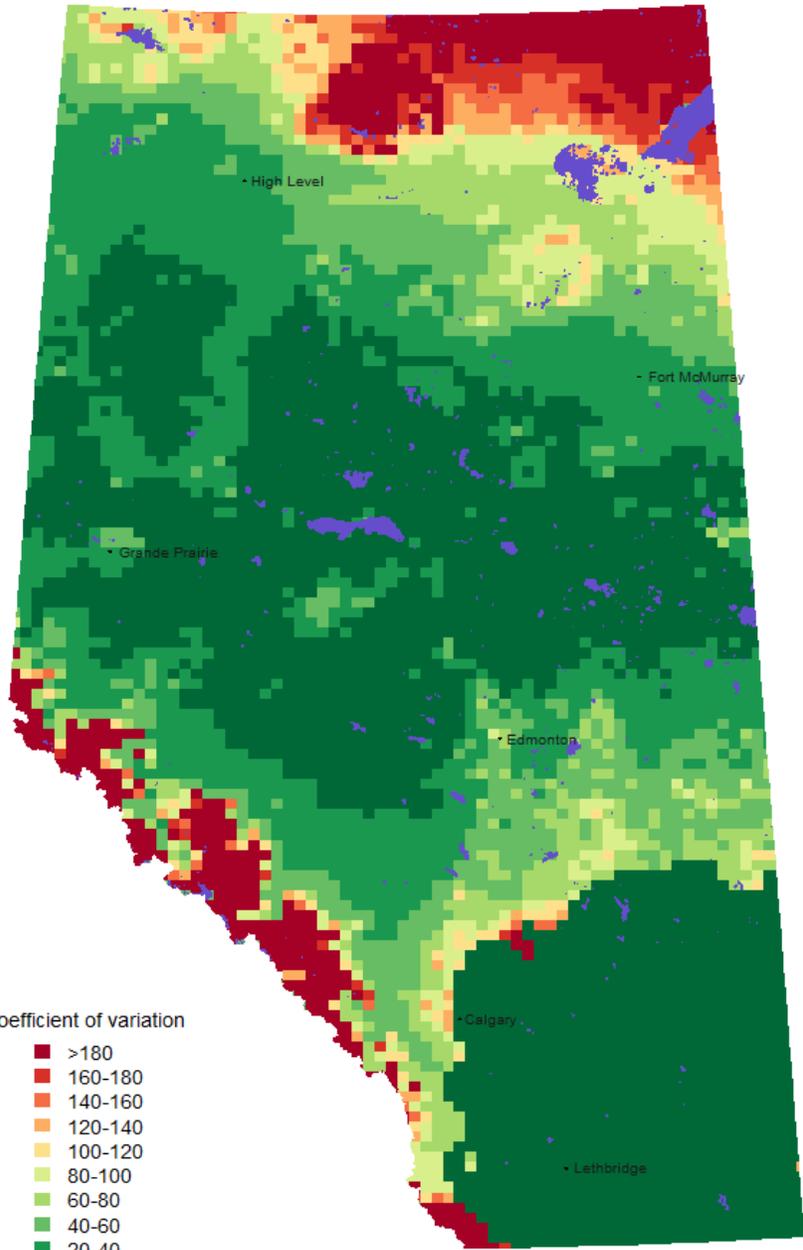


$$q(r_K) = \int_0^{r_K} c(r) g(r) dr = \frac{\int_0^{r_K} \pi 2r \exp(-r^2 / \tau^2) dr}{\pi r_K^2} = \frac{\pi \tau^2 u(r_K)}{\pi r_K^2} = \frac{s(r_K)}{\pi r_K^2}$$

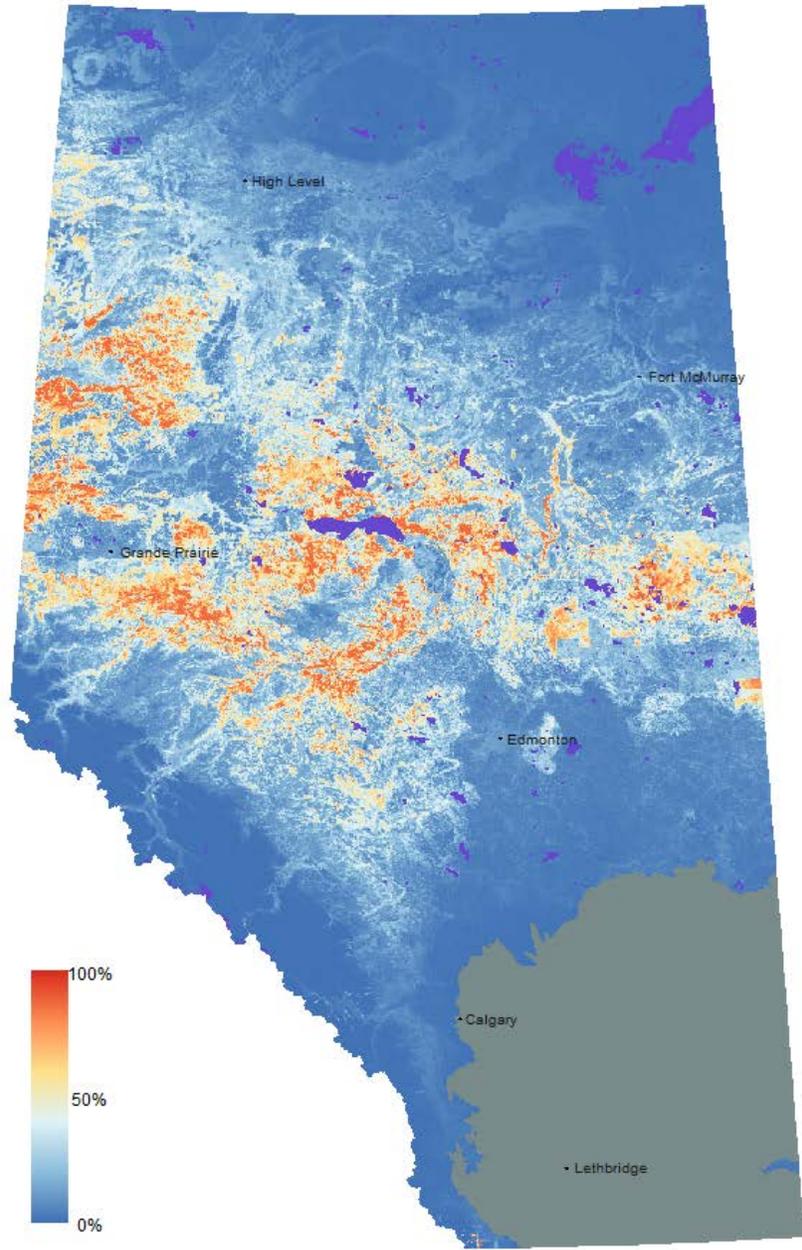
# What we can do now!



Black-throated Green Warbler CoV



Black-throated Green Warbler  
Current abundance



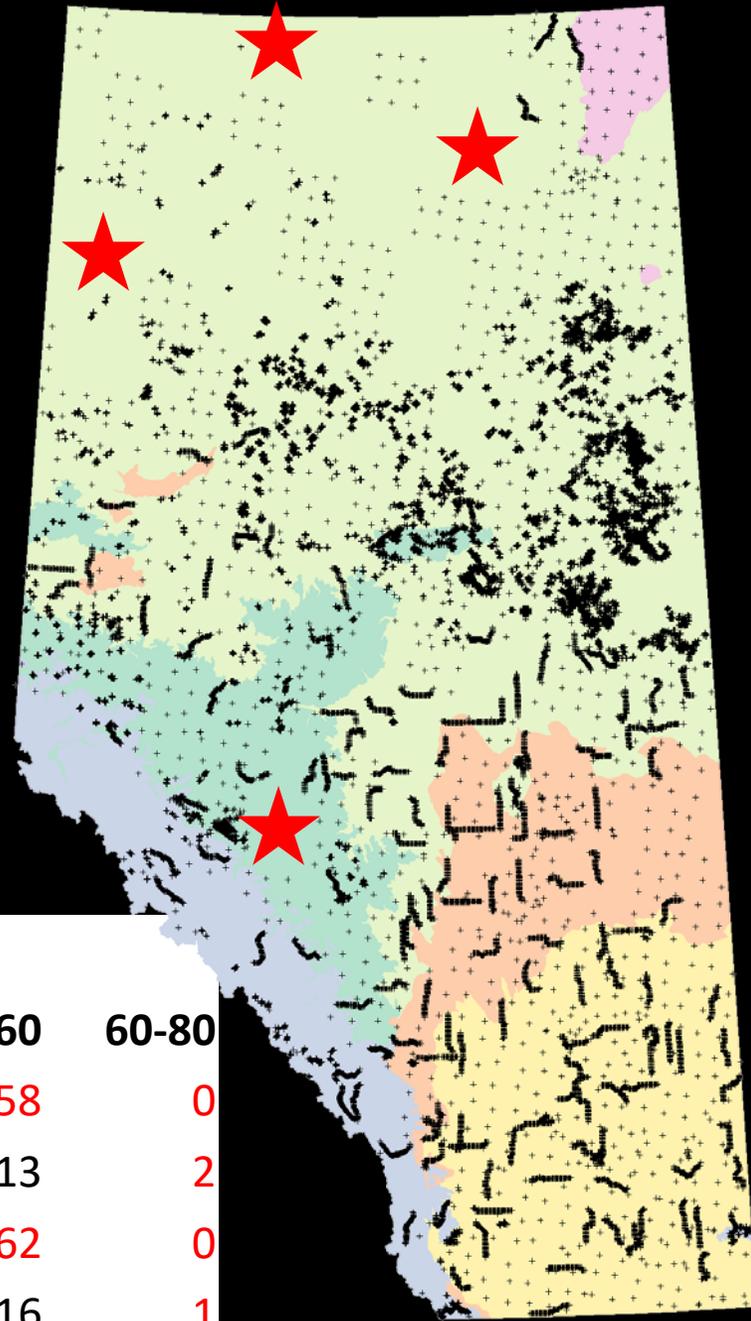
# Distribution maps

We can now make predictions at meaningful scales  
Also can assess uncertainty & know where we really need more data

# Gaps in habitat and space

Data sources:

- ABMI (33K)
- BAM (53K)
- BBS (78K) ← 1-10 min counts
- ECCC (9K)
- BU (63K)



	Fire					Harvest				
	0-10	10-20	20-40	40-60	60-80	0-10	10-20	20-40	40-60	60-80
Deciduous	180	163	731	1862	10208	4093	3140	1788	58	0
Mixedwood	86	129	151	387	1305	669	429	508	113	2
Pine	1083	360	715	1141	2256	631	368	261	62	0
Spruce	147	201	67	42	409	828	616	1038	116	1

# Reducing the messiness





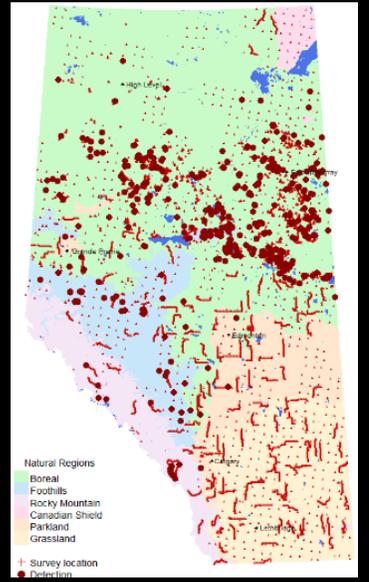
# Data Download

CODE	INDIV_ID	0 MIN	1 MIN	2 MIN	3 MIN	4 MIN	5 MIN	6 MIN	7 MIN	8 MIN	9 MIN	AC	CONFIDENCE
AMRO	1											ONE	Confident
GANG	1											ONE	Confident
GRYE	1											ONE	Confident
HERG	1											ONE	Confident
LCSP	1											ONE	Confident
LISP	1											ONE	Confident
LISP	2											ONE	Confident
OGFL	1											ONE	Confident
PAWA	4											ONE	Confident
PAWA	2											ONE	Confident
PAWA	3											ONE	Confident
PAWA	1											ONE	Confident
RNDR	2											ONE	Confident
RNGR	1											ONE	Confident
RUBL	1											ONE	Confident
SWTH	1											ONE	Confident
UNTR	1											ONE	Unknown far

<input type="checkbox"/>	2018	Sambaa Ke Winter Road CWS Northern Region 2018	675	560	WR
<input type="checkbox"/>	2018	Post-disturbance Temporal Gradient	123	23	PDTG
<input checked="" type="checkbox"/>	2018	Wetlands 2018	1963	1274	Y
<input checked="" type="checkbox"/>	2017	Big Grids 2017	0	0	BG
<input type="checkbox"/>	2017	Mackenzie Valley Winter Road CWS Northern Region 2017	319	297	WR
<input type="checkbox"/>	2018	Natural Disturbance Long-term Monitoring Program CWS Northern Region 2018	57	57	FR
<input checked="" type="checkbox"/>	2018	Big Grids 2018	1142	552	BG
<input type="checkbox"/>	2013	Wetlands 2013	0	0	Y

speciesReport-4

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V		
project name	project year	location	recording_date	recording_time	latitude	longitude	utm_northing	utm_easting	utm_zone	species_code	recording_method	rain	wind	industry	nois	audio	quality	transcriber	species	indiv	abundance	scientific name	species
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	CWSP	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Sporella passio	Chipping
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	GRAJ	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Perisoreus c	Gray Ja
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	LITR	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Light traffic	Light tr
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	OCWA	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Oreothylpis c	Orange
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	PUFI	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Haemorrhous	Purple
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	SWTH	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Catharus ust	Swains
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	SWTH	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			2	ONE		Vireo gilvus	Warblin
Retention	2018	RETN-01-01	2018-06-20	5:10:00	54.29411	-118.53386	6017330.4	400170.068	U11	WAVI	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Vireo gilvus	Warblin
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Retention	2018	RETN-03-01	2018-06-23	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	YBFL	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Empidonax f	Yellow
Retention	2018	RETN-03-01	2018-06-23	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	LIND	180 3m 1SPM	Frequently hit	No wind dete	Low volume	No audio qui	Brandon Law			1	ONE		Melospiza lir	Lincoln
Retention	2018	RETN-03-01	2018-06-23	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	LISP	180 3m 1SPM	Frequently hit	No wind dete	Low volume	No audio qui	Brandon Law			1	ONE		Moderate ra	Moder
Retention	2018	RETN-03-01	2018-06-23	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	MORA	180 3m 1SPM	Frequently hit	No wind dete	Low volume	No audio qui	Brandon Law			1	ONE		Catharus ust	Swains
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Retention	2018	RETN-03-01	2018-06-14	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	AMRO	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Turdus migr	Americ
Retention	2018	RETN-03-01	2018-06-14	5:11:00	54.488033	-118.89612	6039477.26	377175.891	U11	OCWA	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Oreothylpis c	Orange
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Retention	2018	RETN-03-04	2018-06-18	5:10:00	54.499146	-118.90554	6040729.98	376599.101	U11	ALFL	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Empidonax a	Alder F
Retention	2018	RETN-03-04	2018-06-18	5:10:00	54.499146	-118.90554	6040729.98	376599.101	U11	BCCH	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Poecetes atr	Black-c
Retention	2018	RETN-03-04	2018-06-18	5:10:00	54.499146	-118.90554	6040729.98	376599.101	U11	LISP	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Melospiza lir	Lincoln
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Retention	2018	RETN-03-04	2018-06-18	5:10:00	54.499146	-118.90554	6040729.98	376599.101	U11	PSI	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Spirus pinus	Pine Sca
Retention	2018	RETN-03-04	2018-06-18	5:10:00	54.499146	-118.90554	6040729.98	376599.101	U11	SWTH	180 3m 1SPM	No rain dete	No wind dete	No industrial	No audio qui	Brandon Law			1	ONE		Catharus ust	Swains
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# We have made big strides on integrating old school bird point counts & ARUs

- ABMI and BAM are leading on an open data initiative for birds across Canada in conjunction with ECCC
- Next steps are to do this for non-vocal species
  - initiative underway in Lower Athabasca to integrate mammal data
  - Coordinating all camera data into WildTrax
  - Developing data systems to store and share other mammal data:
    - Aerial surveys
    - Snow tracking
    - Track plates
    - Trapping
    - Hair snares
- Other taxa?

# Our ultimate goal should be

- To create a system where all environmental monitoring information gets used effectively to make good decisions in a spirit of transparency and openness
- To do so in timely fashion so that research/ monitoring gets in the hands of everyone as quickly as possible and in as many formats as possible (peer-reviewed papers, maps, raw data, decision support tools)
- Our issues are big enough we can't wait around & need to make environmental monitoring nimble enough to make good decisions