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Invasive species eDNA Biomonitoring Research → Operation

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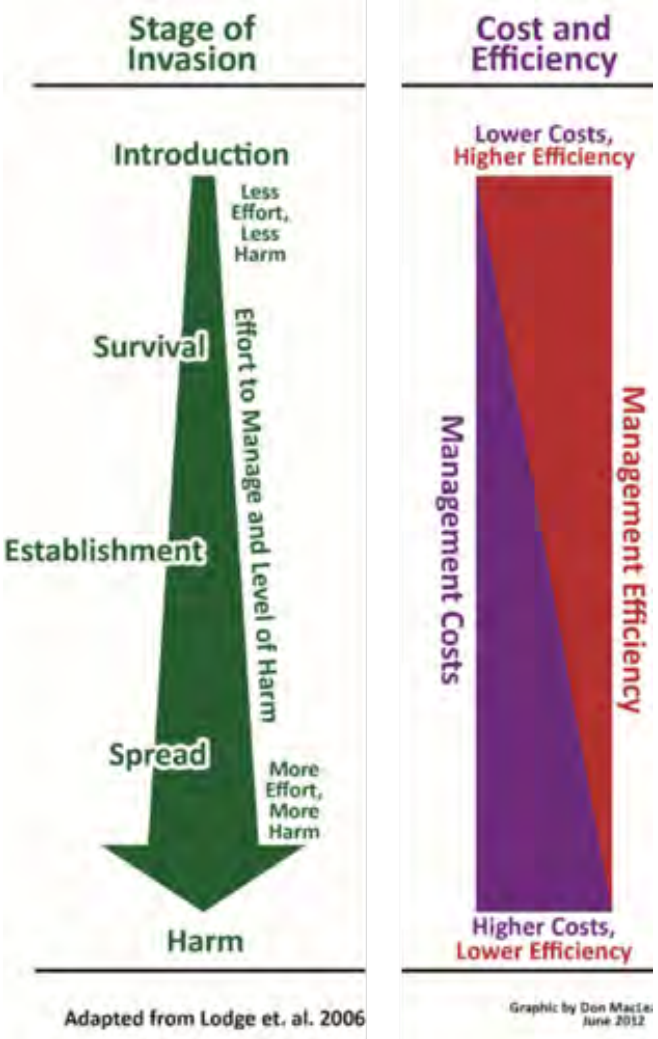

Photo: David Britton/USFWS

Photo: Ryan Hagerty/USFWS

Photo: Sam Stukel/USFWS

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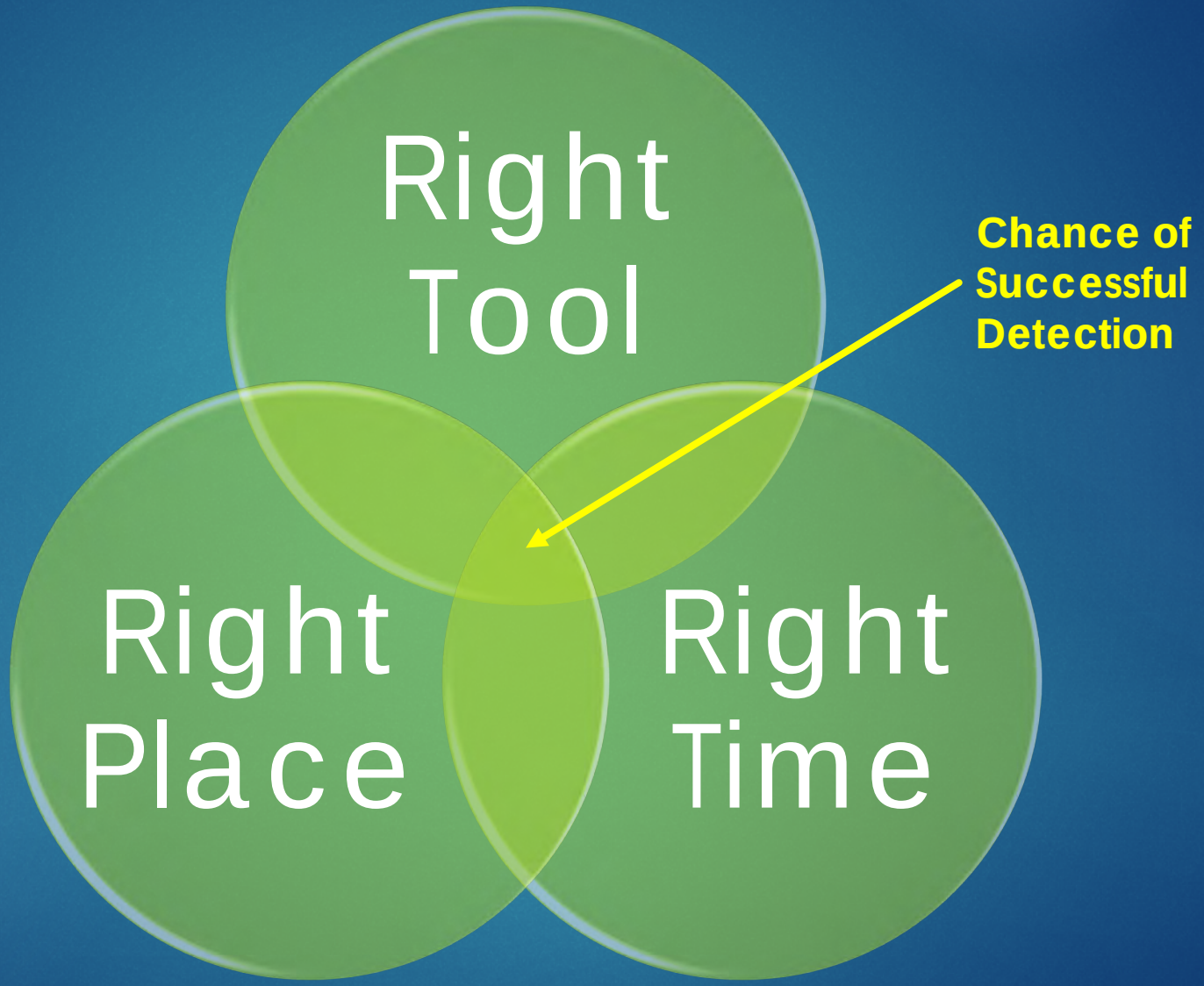
We are here

Prevention > **Detection** > Response

Program Assessment

Decision Making



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	"Macro" Tools (e.g. fishing)	Molecular Tools (e.g. eDNA)
Advantages	Detection is deterministic… Yes = Yes Few ways to false positive	Large time/space integration Low time/money investment High Sensitivity
Compromises	Large investment (usually) Many ways to false negative Small time/space integration	Detection is probabilistic… Yes = p(Yes) Nuance/uncertainty in interpretation Large time/space integration

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E.G. when target is rare:

Sample effort to achieve 95% prob detection in at least 1 sample…

74 - 149

plankton tow samples

Winder M, Sepulveda AJ, **Hoegh** A (2022) An initial assessment of plankton tow detection probabilities for dreissenid mussels in the western United States. Management of Biological Invasions 13(4): 659–678

2 - 30

eDNA samples

Sepulveda AJ, **Amberg** JJ, Hanson E (2019) Using environmental DNA to extend the window of early detection for dreissenid mussels. Management of Biological Invasions 10(2): 342–358

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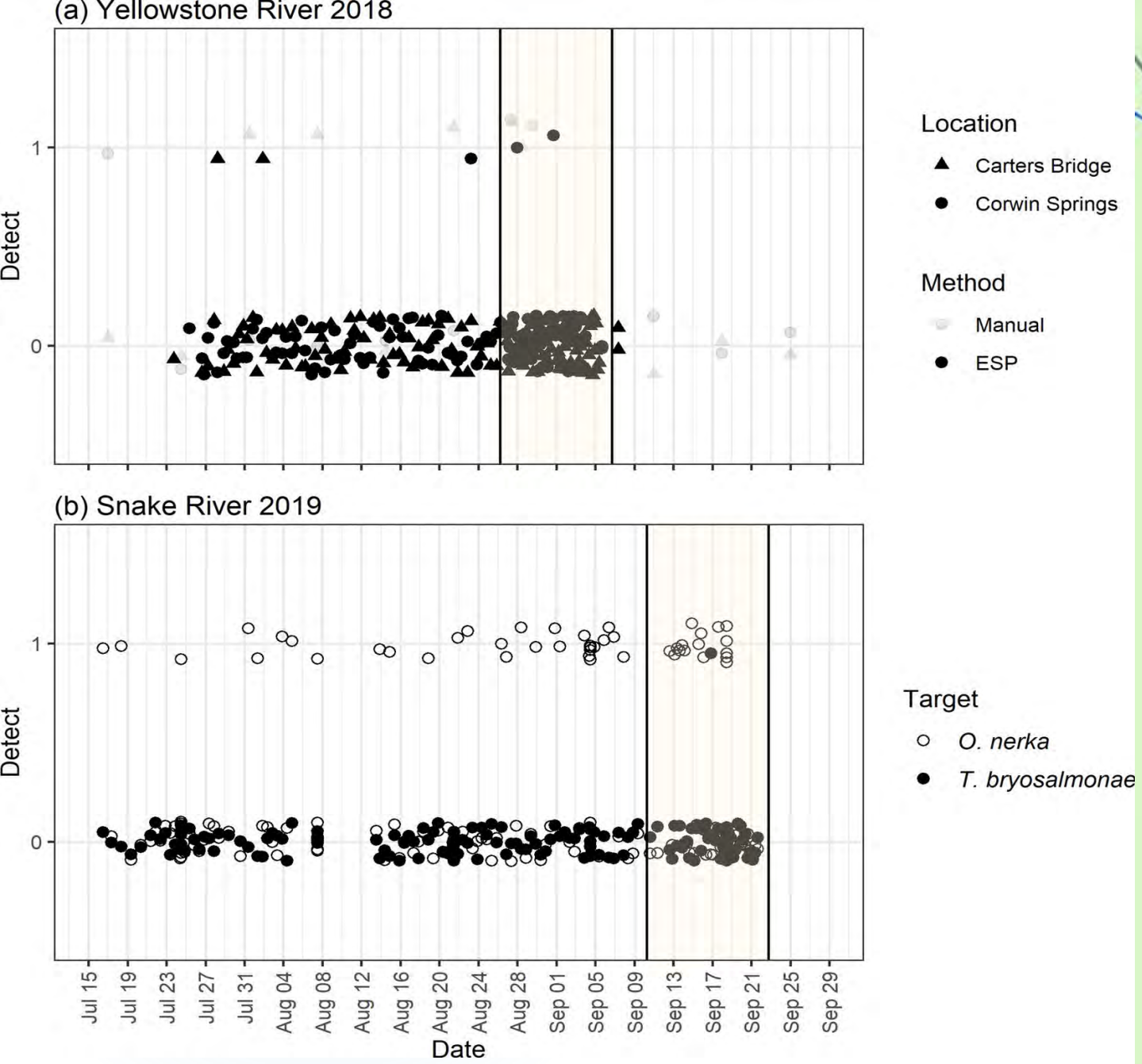

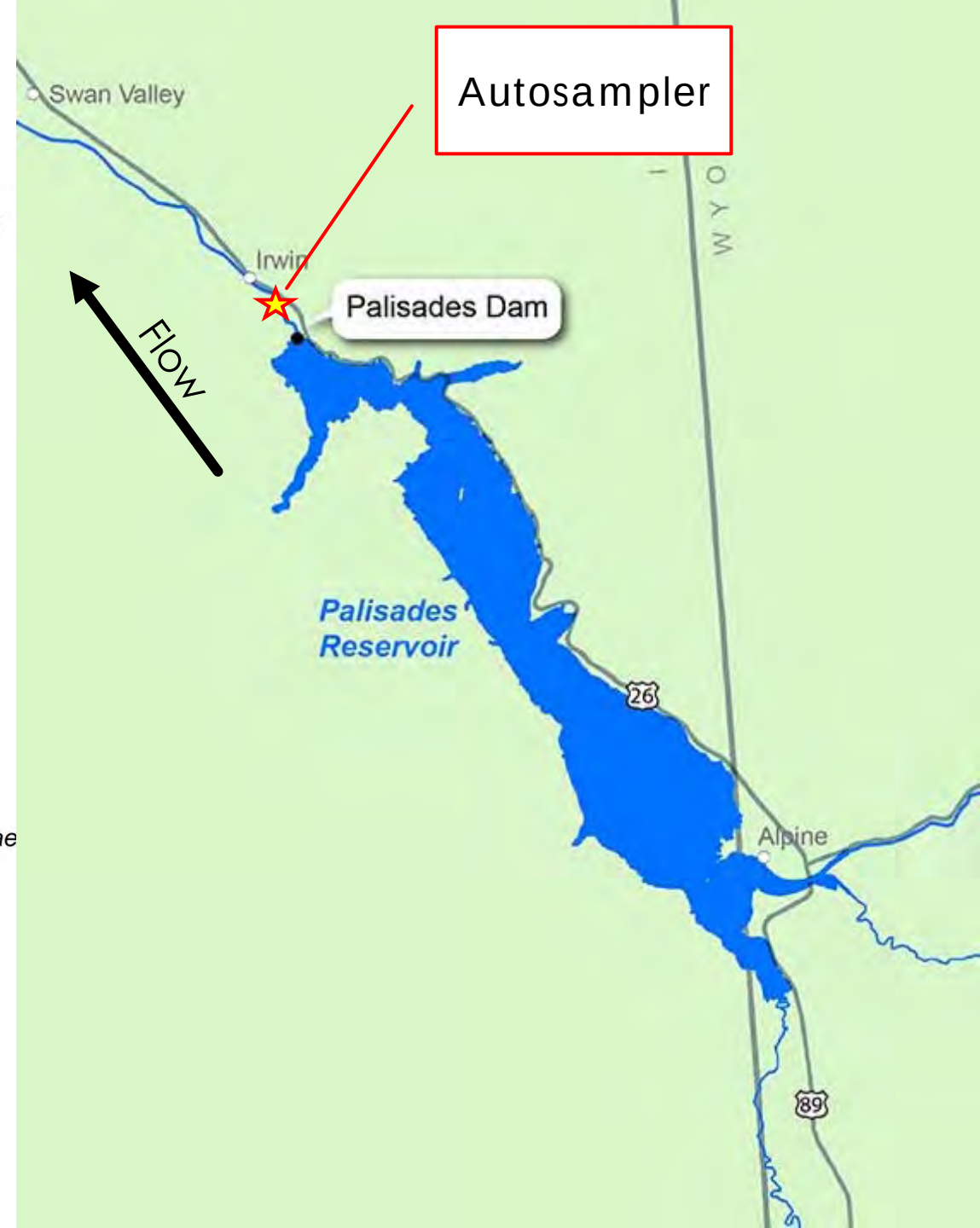

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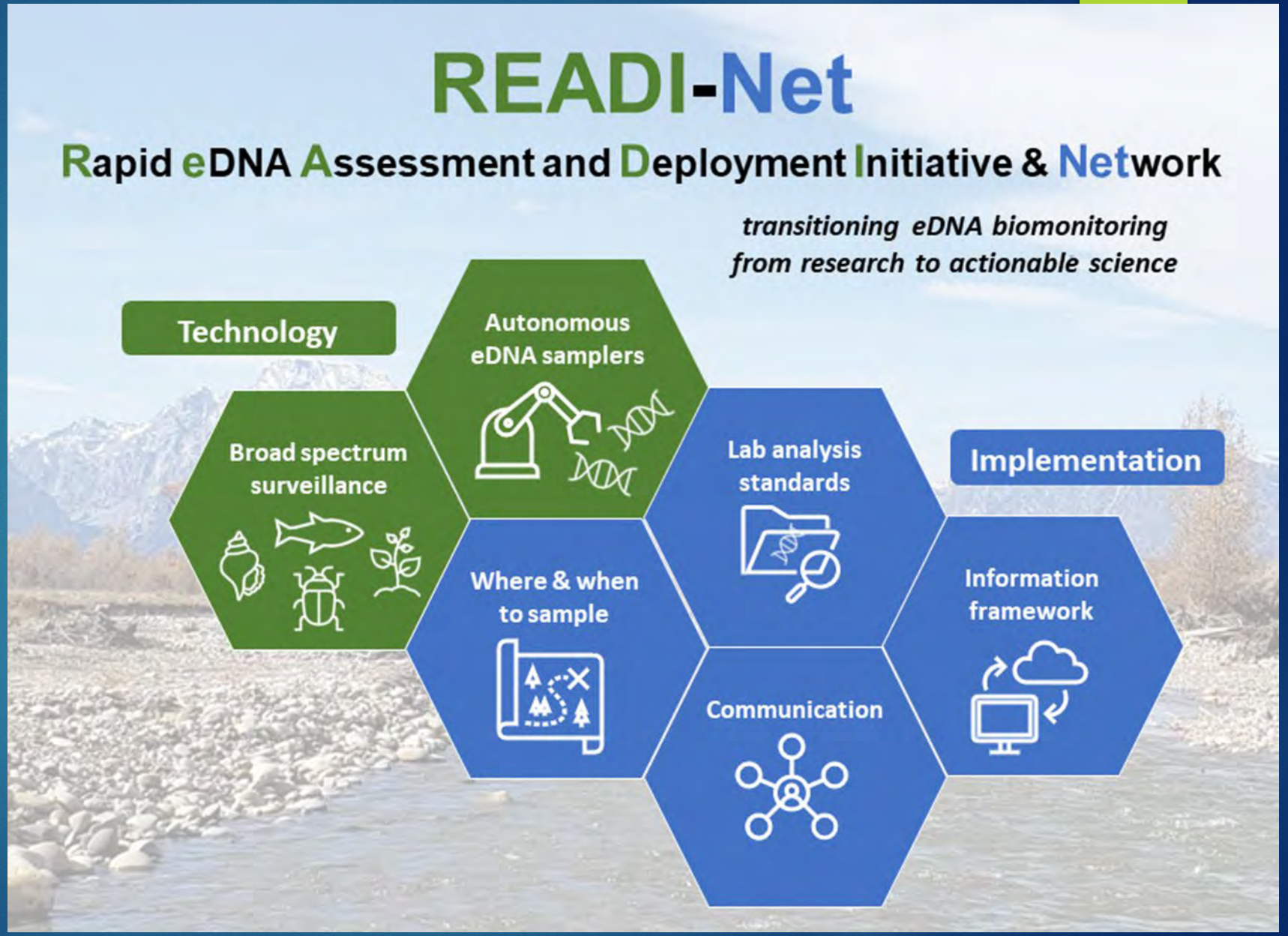
Sepulveda, A.J., Birch, J.M., Barnhart, E.P., Merkes, C.M., Yamahara, K.M., Marin III, R., Kinsey, S.M., Wright, P.R. and Schmidt, C., 2020. Robotic environmental DNA bio-surveillance of freshwater health. *Scientific Reports*, *10*(1), p.14389.

- Improve trust in eDNA methods, results, & communication
- Improve eDNA detection technology
- Reduce impacts and costs of invasive species



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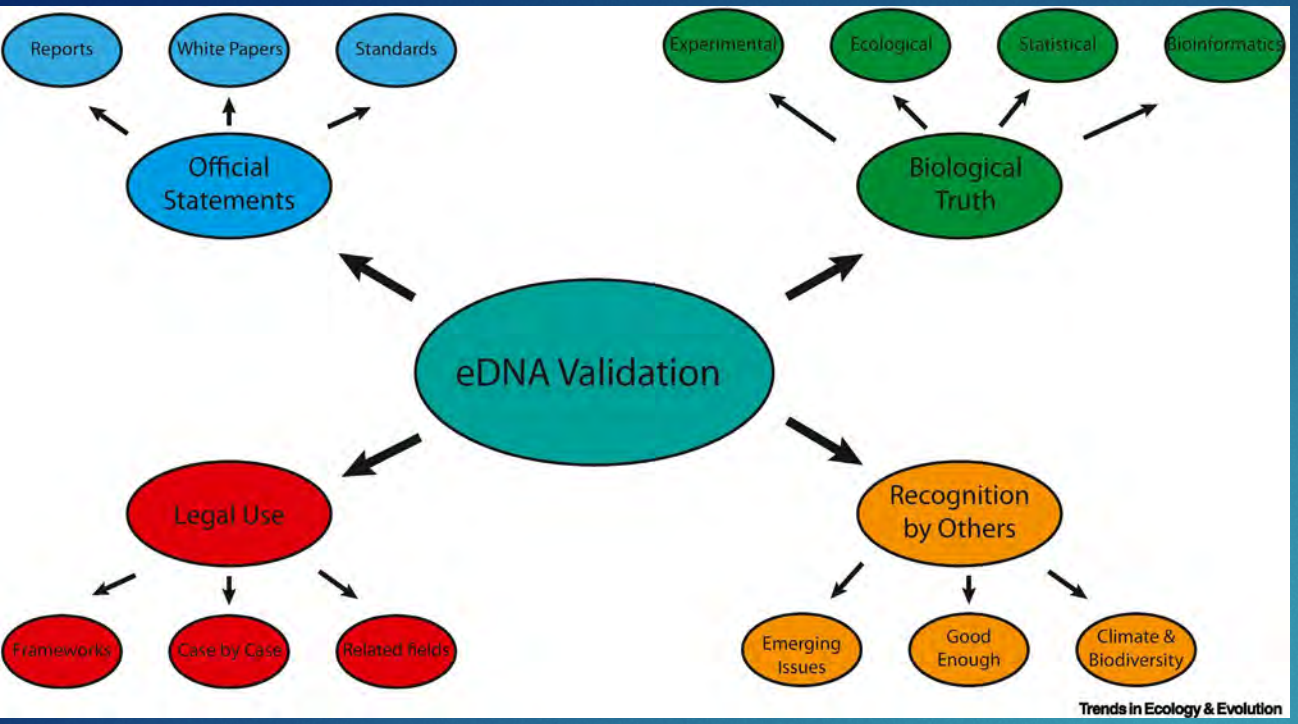
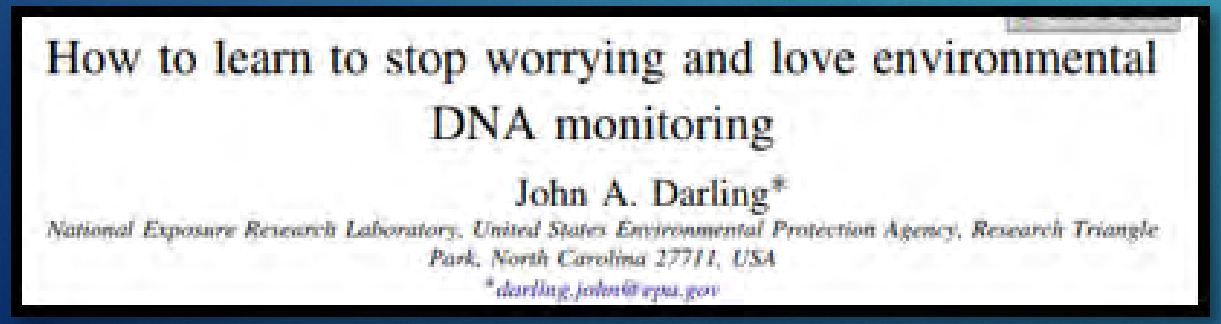


Hajibabaei 2022
https://doi.org/10.1016/j.tree.2022.06.015



How to learn to stop worrying and love environmental DNA monitoring

John A. Darling*

National Exposure Research Laboratory, United States Environmental Protection Agency, Research Triangle Park, North Carolina 27711, USA

*darling.john@epa.gov

Establish lab protocols and set lab performance baselines

- 20+ USA & CAN labs
- 4-phase intercalibration exercise
- Establish baselines & test against complexities

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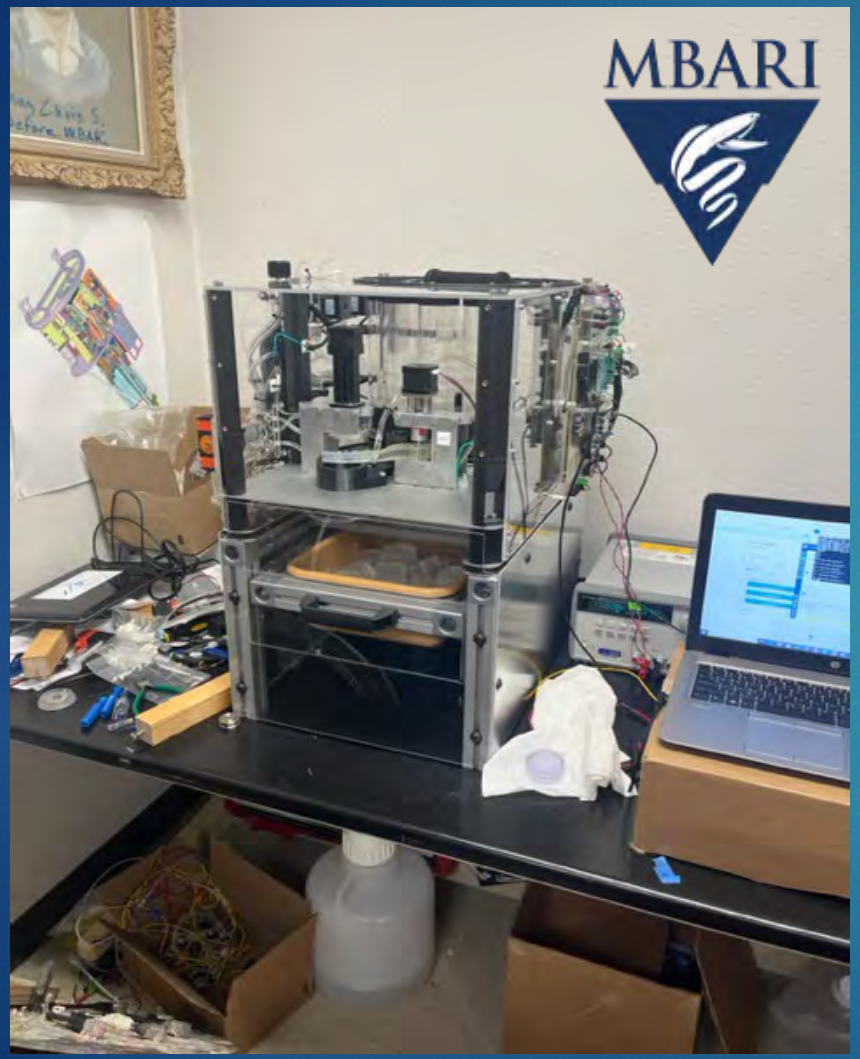
Automation = Improved Repeatability



Autonomous eDNA samplers

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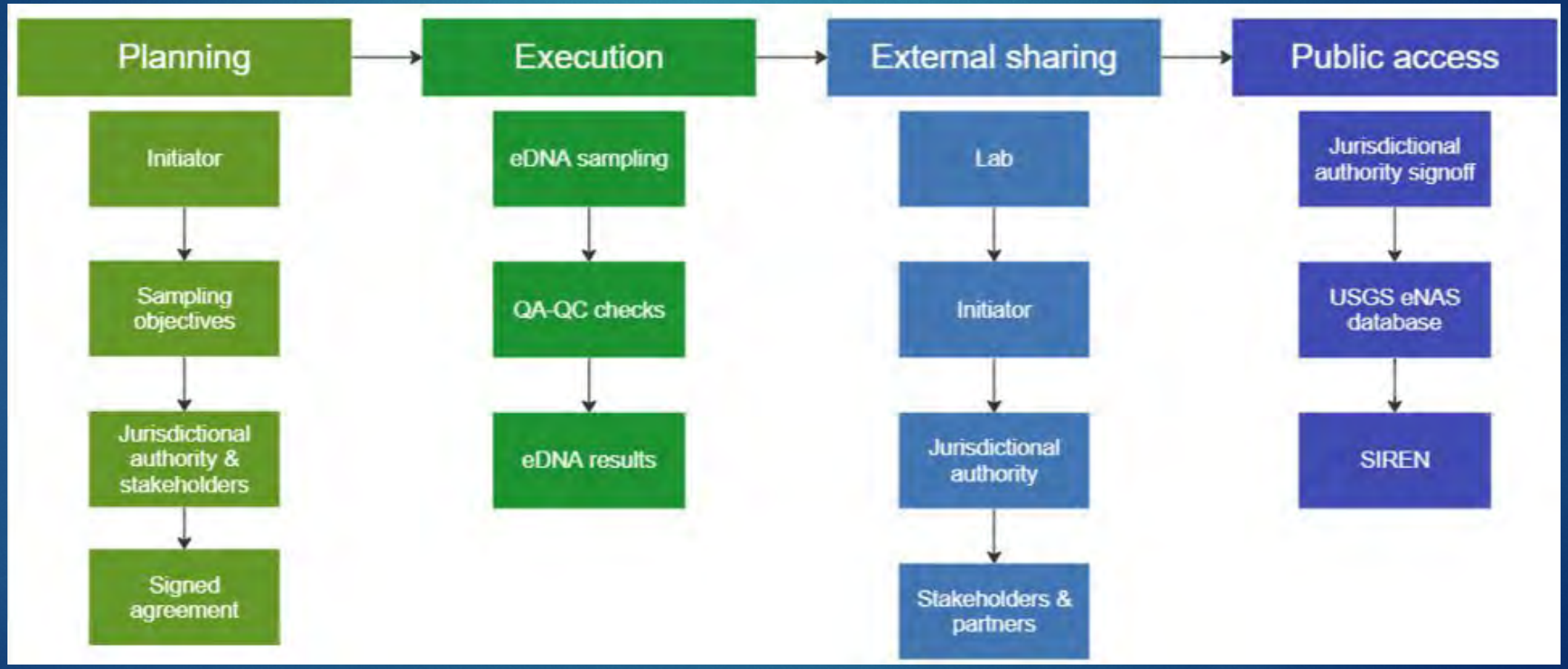
Example Workflow and Communication Plan



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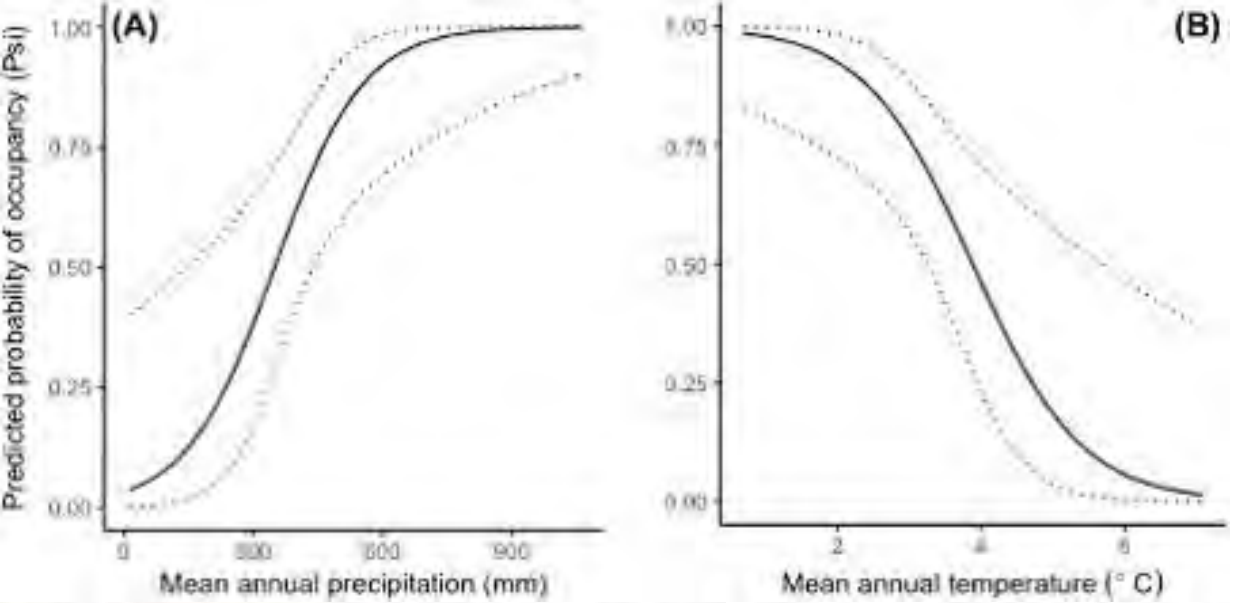
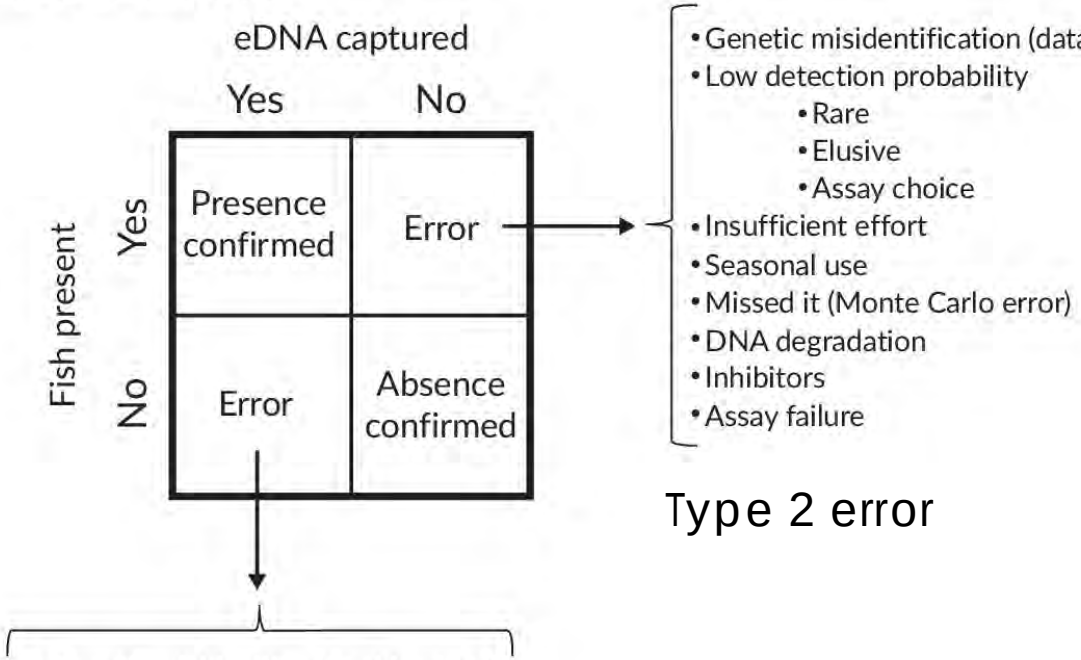


Smith, M.M. and Goldberg, C.S. (2020), Occupancy in dynamic systems: accounting for multiple scales and false positives using environmental DNA to inform monitoring. Ecography, 43: 376-386. https://doi.org/10.1111/ecog.04743

(b) Environmental DNA

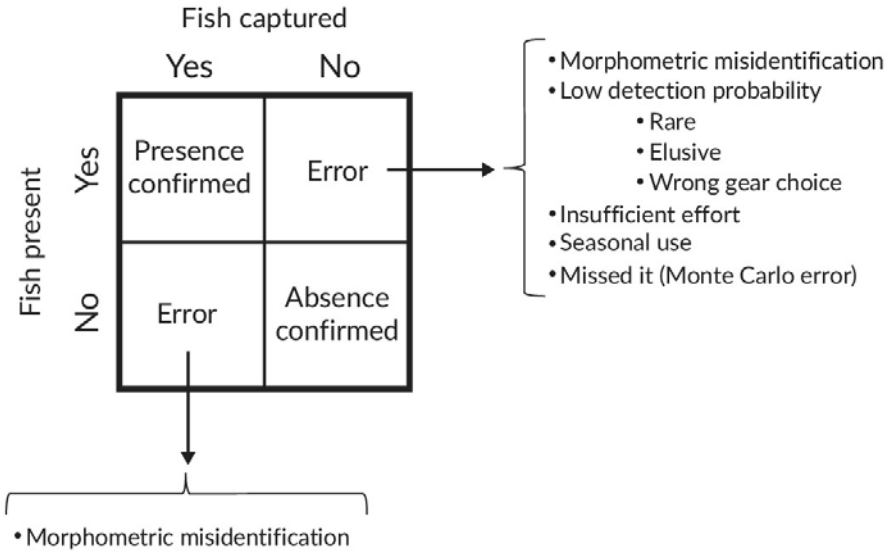


Type 2 error

- Genetic misidentification (database)
- Hybridization (looks like fish A, has the mitochondria of fish B)
- Dead fish (arguably not an error)
- Contamination
- DNA persistence in the system
- Vectors of DNA transport

Type 1 error

(a) Traditional gears



Jerde, CL. Can we manage fisheries with the inherent uncertainty from eDNA? *J Fish Biol*. 2021; 98: 341–353. https://doi.org/10.1111/jfb.14216

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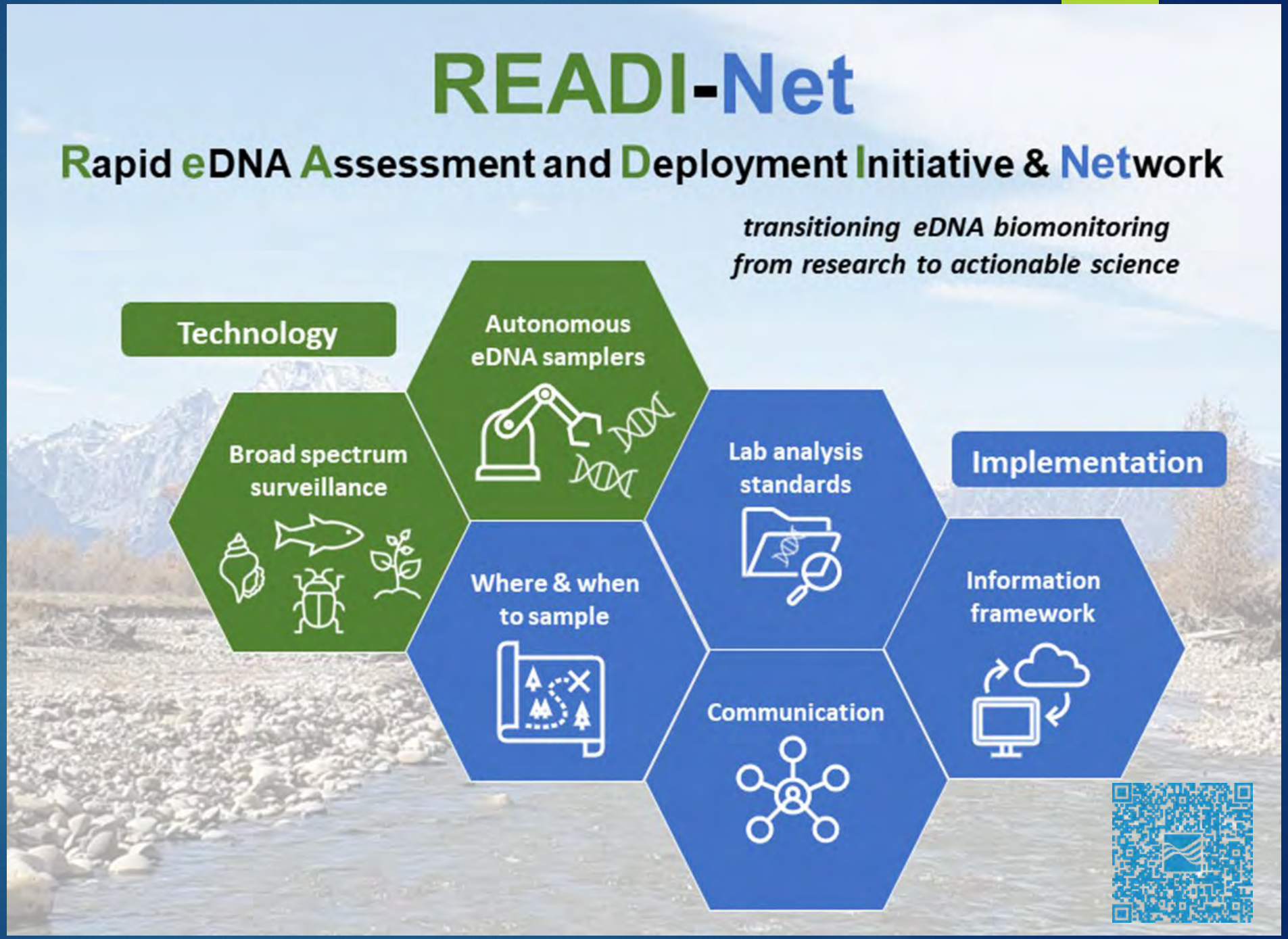

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	Tasks	Client	eDNA lab lead	Jurisdictional Authority	Partners & stakeholders	Date Completed	Accountable Signature
1	Determine jurisdictional authority	RA	C		C		
2	Alert jurisdictional authority that eDNA sampling will occur	RA	I	C	I		
3	Flow of eDNA results: who can talk to who?	R	R	A	I		
4	Sampling goals & objectives	RA	C	C	I		
5	Readiness level of eDNA assay for goals & objectives	C	RA	C	I		
6	Positive and negative eDNA detection criteria	R	RA	C	C		
7	Field sampling methods	RA	C	C	I		
8	Lab analysis methods	C	RA	C	I		
9	QA/QC methods	C	RA	C	I		
10	Communicate results to client	C	RA	I			
11	Communicate results to jurisdictional authority	RA	C	C			
12	Share results with partners & stakeholders	I	I	RA	I		
13	Draft media release	RA	C	R	I		
14	Send results to public database	C	RA	C	I		

R = Responsible
A = Accountable
C = Consulted
I = Informed

	Name	Email	Signature	Date
Project lead / Client				
eDNA lab lead				
Jurisdictional Authority				
Partner/Stakeholder #1				
Partner/Stakeholder #2				
Partner/Stakeholder #3				