Essential Public Administration Skills for the Savvy Civic Scientist: Aspen Decline in Southeast Idaho

by

Brandy Nisbet-Wilcox

A Capstone Project
Submitted in Partial Fulfillment
Of the Requirements for the Degree of
Master of Public Administration in the Department of Political Science
Idaho State University
Fall 2025

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Brandy Nisbet-Wilcox find it satisfactory and recommend that it be accepted.

_____

Dr. Shin Kue Ryu

Committee Chair

_____

Dr. Mark McBeth

Committee Member

_____

Keith Weber

Graduate Faculty Representative

DEDICATION

To my family and friends, old and new. To all the many talented and dedicated educators who made me feel like I could be anyone, do anything, and maybe even change the world one day. To the inspiring colleagues and mentors that I have had the honor to meet along the way. To Nyx for showing up right when I needed it the most and making even my darkest days a little more magical. To Tut for believing in me even when I forget to. And to Liza, always.

ACKNOWLEDGEMENTS

I would like to acknowledge Keith Weber for all of his support and guidance throughout my MPA program and the Bureau of Land Management for funding the research on aspen populations in southeastern Idaho that allowed me to be here to pursue this degree. Special thanks to Ben Dyer, Kasey Hill, Gregory Mann, Brian R. Holmes, and Cynthia McClellan for your input and insight on the aspen project. Thank you to all of the professors who I have had the honor of working with and learning from during my time at ISU, including Drs. Mark McBeth, Shin Kue Ryu, and Donna Lybecker. I would also like to thank the classmates who have challenged me and who I have been able to learn from and alongside throughout the program. Thank you to all of the students and staff who have been a part of the GIS TReC community over the last two years. Thanks to Saymen Clifton, the most positive field assistant/field cheerleader/4WD driving coach I could have asked for. Thanks to your contributions, our model can now tell it's an aspen by the way it is, we did not get eaten by bears, and my cat is not an orphan. Additionally, thank you to my NASA DEVELOP mentors including Kenton Ross, Amanda Clayton, Stephanie Burke, and Joseph Spruce for your encouragement and support during my time with DEVELOP and as I navigated the graduate school application process.

TABLE OF CONTENTS

ABSTRACT

Essential Public Administration Skills for the Savvy Civic Scientist: Aspen Decline in Southeast Idaho

Many scientists are experts in their particular field of research, but find themselves perplexed throughout their early careers when compelling scientific evidence is not translated into rational decision making and policies on issues like climate change and natural resources management. The transformation of data into actionable information that can be used by decision/policy makers is a critical skill that often eludes career scientists and natural resource managers as they are rarely taught in an explicit way. To bridge this gap, this paper proposes a curriculum of essential public administration skills for scientists and natural resource managers working in the public sector that could be integrated into physical science education at three levels including 1) an introductory course for STEM undergraduate majors, 2) a more theory-rich course for STEM graduate students, and 3) a dual-degree option for graduate students pursuing careers in public science to work toward an MS and an MPA concurrently by taking classes in both their universities' physical and political science departments. Highlights include communication skills like moving beyond the science deficit model, embracing the power of narrative and framing, understanding the political nature of funding, multiple streams theory, and tools of participative democracy for working through polarization. A case study focusing on aspen (*populus tremuloides*) decline in eastern Idaho showcases the applicability of these skills to research projects with natural resources management implications. Ultimately, the goal is to prepare STEM professionals for careers at the intersection of science and decision making, empowering them to navigate the political environment that their work is influenced by and seeks to influence as they work to address today's pressing environmental challenges.

INTRODUCTION

This paper will provide an overview of Public Administration (PA) scholarship including key concepts, theories, frameworks, techniques, and practical applications of themes beginning with a brief introduction to the scholarship from a broad perspective, then working through topics including Ethics, Public personnel Management, Public Organizational Theory, Program Assessment and Evaluation, Public Budget and Finance, and Community and Regional Planning. From there, it will dive into more specialized topics focusing on environmental administration including Public Policy Analysis, Environmental Politics and Policy, Disaster Policy and Administration, and Landscape Ecology.

Building upon the concepts outlined in the overview section, this paper will propose a curricula of essential PA skills the author sees as being particularly useful to scientists working in the fields of Earth and environmental sciences whose research is funded by public sources and intended to inform decisions for the public good. A case study about aspen *(Populus tremuloides)* ecology and management by the Bureau of Land Management will be used to demonstrate the practical application of public administration theories and frameworks on research with natural resources management implications. A multi-tiered implementation of the curriculum is proposed starting with 1) an introductory PA course tailored to STEM undergraduate students that could be substituted for another general education requirement, 2) a more in-depth and theoretical version of the course for STEM graduate students, and 3) ultimately the creation of more dual degree MPA/ Master of Science programs that combine the strengths of research universities' political

science and physical science departments to offer a high-value and accessible degree program that will help scale up the production of public STEM professionals who are prepared to work at the intersection of science and decision making about today's pressing issues.

OVERVIEW OF PUBLIC ADMINISTRATION SCHOLARSHIP

1. Introduction to Public Administration

In a democracy like the democratic republic seen in the United States, public administrators exercise administrative discretion, despite not being elected to their positions. As fiduciaries of public information, funding, and resources, their decisions have tangible consequences on real people and directly help to shape our society. With this great power comes the great responsibility to make well-informed, ethical decisions that serve the greater good of the public over any individual's potentially self-serving personal preferences and are well aligned with the ethos of our representative democracy. Elected and appointed officials have a more direct pulse on the current desires of the voting body, but career administrators are often subject matter experts who provide long-term institutional knowledge and work towards providing public services to those who need them without interruption regardless of the changing elected body, though this may not always be possible in extenuating circumstances. Public administrators can act as agents of change by bringing new programs, policies, and services to life as well as buffers from the pendulum of bipartisan public opinion.

Friedrich - Finer Debate

Friedrich argues that administrators should exercise discretion and should be subject matter experts who are responsible for professionalism whereas Finer argued that public servants should be most responsive to elected officials and political appointees at the top of their agencies to ensure democratic influence on the operations of the bureaucracy. This debate is still relevant to this day

as it brings to question the boundaries and balance of democratic responsiveness and professional effectiveness.

Public demands for **transparency** and **accountability** as well as formal and informal adjudication processes provide some checks and balances on the power of the bureaucracy. **Government Sunshine Laws** and the **Freedom of Information Act** ensure that the public is kept abreast of pertinent conversations and decisions made on their behalf by the administration. The advent of the Internet age and rapid improvements in information and communication technology (ICT) have allowed faster and more current updates and access to essential services while opening up new avenues for agencies to communicate with the public and for the public to have their voice heard when it comes to upcoming decisions. The use of these tools collectively is referred to as **e-Government** or **digital democracy**, which presents important opportunities for the streamlining of efforts and the ability to do more/faster/better with the same or fewer resources. However, with the adoption of rapidly changing technology comes new and evolving challenges with cybersecurity in a post 9/11 world.

In contrast to private industry that can quickly eliminate a product or service if it is not providing a strong monetary return on investment, essential public goods and services must persist even if they are not turning a profit, hence the importance of evaluating programs on the basis of outcomes and impact (Guy & Ely, 2022). Program assessments, evaluations, needs assessments, and performance evaluations are all tools that can be used to measure differing metrics of programmatic success and aid in determining the need for a given program or intervention as well as identifying areas for improvement. Evaluations are also key instruments for helping organizations to allocate scarce resources to their most essential programs during the budgeting process.

A budget is much more than just abstract numbers on a page. It is a reflection of values, goals, and mission put into action. A public budget specifically is a reflection of a society's current and long-term priorities.

Public administration ethics can trace its philosophical roots to various schools of thought from utilitarianism, to deontology, teleology, ethics as virtue, ethics as regime values, and more. A culture of ethics should be modeled by public organizational leaders and built into daily organizational life.

Public organizations are complex and are shaped by their environments while simultaneously shaping the environment that they operate within. Organizations are made up of people with diverse backgrounds, perspectives, and desires. They are also influenced by strong internal and external coalitions. They have symbolic meaning in our lives and the stories that we tell to make sense of our organizational lives shape the organizations that we work for.

Public sector management comes with a variety of complex challenges, but public managers must ensure that government operations perform well and provide for the needs of the constituency regardless of the challenges or barriers. A key difference between the public and private sector is that private sector entities are encouraged to do anything that they can to increase the profitability of their goods or services so long as they are not doing anything explicitly illegal, whereas public sector entities are held to a much more rigorous standard in that they are only allowed to function by doing things that are explicitly legal. In comparison to private sector entities, two of the many challenges that public sector institutions face are 1) bringing on and retaining talented personnel and 2) dealing with sometimes cumbersome public demands for transparency and accountability.

Merit-based hiring is often a long and difficult process in the public sector and pay is often significantly lower in public sector jobs than in comparable private sector jobs. Public sector managers are challenged to find ways to recruit and retain talented employees when they are unable to offer monetary incentives like big raises and yearly bonuses, a big draw to many private sector positions. This is where an emphasis on mission and impact is critical to draw in, retain, and motivate talented employees with a passion for serving the public and making a positive impact.

Additionally, while public demands for transparency promote accountability, build trust in government, and may prevent certain acts of bureaucratic overreach, they can also result in costly measures that take significant time, energy, and resources to provide - bogging officials down with red tape and reporting requirements, thus making it difficult for public agencies to keep up with while trying to deliver and improve current critical programs and services.

According to Pollitt 2016, the adoption of new technologies and contracted networks of governance are major scholarly topics in the field of academic public administration today. The adoption of new information communication technologies like websites, social media, public-facing databases, geographic information systems, and other web and artificial intelligence-based tools may be a step in the right direction allowing for greater transparency (and efficiency) with less time and energy inputs. Additionally, by the strategic use of contracting out services, government agencies are often able to streamline and improve the delivery of services while reducing direct costs and lowering public personnel requirements.

2. Public Administration Ethics

2.1 Introduction

Public administrators are fiduciaries of public information, funds, and resources, and as such they exercise a great deal of discretion and make decisions that have direct and indirect consequences for the public that they serve. In a democratic society where accountability is key, it is imperative that public administrators are equipped with a set of accessible tools for making decisions in an ethical manner. This brief literature review will outline some of the foundational schools of thought and ethical decision-making frameworks that administrators should be familiar enough with to employ when they inevitably encounter ethical dilemmas within the scope of their duty. According to Martinez (2009), there is no one right school of thought or ethical framework for public administrators but being able to apply one or more of the following theories will empower administrators to make stronger ethical decisions.

2.2 Four types of "right vs right" dilemmas

To set the stage for making ethical decisions, one must first be able to tell the difference between a right vs wrong dilemma (or a moral temptation) and a right vs. right dilemma (an ethical dilemma). Right vs. wrong dilemmas are about as straightforward as they sound. They involve a choice between something that is clearly wrong and something that is morally acceptable. Ethical dilemmas or right vs. right dilemmas revolve around a choice between two or more things that can be considered morally correct despite being at odds with one another. Right vs. right dilemmas can typically be sorted into four fundamental types as listed below (Kidder, 1995):

1. Short term vs. long term
2. Individual vs. community
3. Justice vs. mercy

4. Truth vs. loyalty

Identifying which of these right vs. right dilemmas your scenario falls under is a good first step towards working out a solution.

2.3 Some ethical schools of thought

There are many ethical theories and schools of thought that one can study, but here are a few that might be especially helpful for public administrators to understand and implement as they encounter ethical dilemmas in their work. Here I will briefly discuss utilitarianism, deontology, teleology, ethics as regime values, and virtue ethics.

2.3.1 Utilitarianism

Utilitarian thinkers like Jeremy Bentham, David Hume, and John Stuart Mill argue that people making rational decisions are trying to maximize happiness while minimizing pain. The ethical goal of utilitarianism is to make decisions that result in the greatest good for the greatest number. Here, the outcome of a decision is what gets morally judged rather than the means of attaining that outcome. From a utilitarian perspective, the ends can justify the means as long as the end results in the greatest good for the greatest number of people.

2.3.2 Deontology

From a deontological perspective, actions should follow a set of universal, duty-based rules. The morality of an action is determined by the steps that one takes to achieve an outcome. Immanuel Kant is an important philosopher of the deontological school of thought who argues that one must only act in a way that would be an acceptable universal law should everyone act in that manner. Even if the consequences of an action result in the greatest good for the greatest number of people, the ends do not justify the means if the action taken was in defiance of universal law.

2.3.3 Teleology

From a teleological perspective, it is the results of an action that determine the morality of that action. Pragmatists often fall into this school of thought. Aristotle is an important thinker associated with teleological ethics. Here, the ends can justify the means and it does not matter so much how you arrive at an end goal as long as the consequences of the action result in a positive outcome.

2.3.4 Ethics as regime values

Using the lens of ethics as regime values, the source of ethical public administration decisions comes from the ethos of the society in which the decisions are being made. John Rohr would argue that in the United States context, the key source of public administration ethics should be the Constitution and rulings by the US Supreme Court. This is an important lens to consider as one seeks to make ethical decisions, but even "definitive" sources like the Constitution and US Supreme Court rulings can be ethically fallible and are subject to change over time.

2.3.5 Ethics as social equity

Here, a key goal of ethics is social equity. A important thinker in this camp is John Rawls who writes about the "veil of ignorance" - if government decision makers did not know their place in society, they would ensure that decisions made would not harm the least privileged groups for fear that they could be impacted themselves and would therefore have more incentive to design a fair and equitable society.

2.4 The public administrator as an ethical agent

Since the adoption of the merit system in the public sector, the public administrator's role in organizations has evolved. From moral neutrality dictating that public administrators' roles should be so well-defined that no discretion would be necessary to the administrative science school that believed that the pursuit of universal ideals would prevent any moral ambiguity within

the public service, to new organizational insights in new public management where structure and mission of an organization determines the level of discretion exercised by administrators at various levels, we have arrived at a time where it is apparent that administrators make value-based decisions and should therefore be held accountable for them (Martinez, 2009). Organizations are shaped by individuals just as individuals are shaped by organizations. So, it is important to ensure that an ethical ethos is baked into the foundation of public organizations. Administrators in leadership positions have a responsibility to act as a moral agent, ensuring that individuals, no matter their rank, understand the mission of the organization and the ethical standards that they are all responsible for upholding.

2.5 Issues that may arise

Organizations that do not put an emphasis on mission and ethics may be at risk of succumbing to one of any number of issues including administrative evil and public whistleblowing.

2.5.1 Administrative evil

If an organization drifts too far from its mission and/or individual roles, are compartmentalized and so heavily specialized that those working for the organization do not know how their work fits into the bigger picture, even the most ethical of administrators may fall victim to administrative evil (Adam, 2011). Administrative evil is the phenomenon where average people do work that contributes to nefarious purposes and usually, they are not even aware of this. One of the most famous examples is the Holocaust, in which countless administrators doing banal tasks contributed to the mass genocide of Jewish people in Germany. In an attempt to understand how this was possible, the Stanford Prison Experiment and the Milgram experiments determined that with enough pressure from authority, most people are capable of justifying morally questionable

actions as just following orders and that organizational culture shapes behavior. Most people are not "bad apples" but when exposed to a bad barrel, we are capable of any number of horrific actions.

2.5.2 Ethics of dissent

As humans are interpretive beings, dissent is bound to come up in any organization. How administrative leaders handle that dissent will dramatically impact the outcomes of their organization. If employees know that their opinions are valued even when they dissent from the status quo, they will be more likely to voice those opinions via sanctioned pathways without fear of retaliation. If employees do not feel that their opinions are valued or there are no clear paths to voice dissent in a productive, non-retaliatory manner, they might be more inclined to "go guerrilla" (O'Leary, 2010) and start making unsanctioned decisions or going around the chain of command to publicly voice their dissent via the whistleblowing route. If an employee believes that an organization has drifted so far from its mission that the decisions being made are no longer ethical in nature, whistleblowing can have a positive impact by shedding light on corruption that must be addressed. However, whistleblowing can also result in public backlash and a loss of trust in government which is also detrimental to the institution.

2.6 In summation

Ethical behavior and decision making is everyone's responsibility within a public organization. Administrators are not elected by public will, however their roles can allow for great amounts of discretion to be exercised. It is critically important that administrators make ethical decisions as they are fiduciaries of public information, funds, resources, and trust. Having a foundational understanding of several ethical lenses and frameworks to deploy when faced with

ethical dilemmas can empower administrators to serve as moral agents within their organization which results in higher quality service to the public.

3. Public Personnel Management

Public personnel management is distinct from private sector management because public sector employees are public servants responsible for providing public goods and services using public funds while maintaining high levels of transparency, accountability, and trust. Public sector managers do not have the same extrinsic rewards and incentives at their disposal as tools of motivating employees to work harder or to celebrate the hard work achieved by high-productivity employees like private sector managers do. Instead, they must be able to tap into employees' intrinsic public service motivation and focus on the shared mission of the organization to elicit a sense of pride and fulfillment in employees who could theoretically be paid better if they were to pursue private sector work. Recruiting and retaining employees with strong public service motivation is critical to ensuring the successful delivery of essential public programs and services. Here I will outline four approaches to public personnel management including the 1) managerial, 2) legal, 3) political, (Rosenbloom, 2016) and 4) ethical approaches. I will also discuss how to implement principled negotiation techniques (Fisher, Ury, & Patton, 2011) and best practices for career administrators to work together with elected officials and political appointees.

The managerial approach to public personnel management focuses on efficiency, effectiveness, and neutrality. The legal approach is founded in the US Constitution, laws, and court rulings. It is a necessary approach, but not sufficient on its own. The political approach focuses on responsiveness, equity, representation, neutrality, accountability, and transparency (Rosenbloom, 2016). The ethical view rounds out these approaches by filling in some of the less tangible but no less important gaps including avoiding conflicts of interest, impartiality, and the spirit of the public service ethos in working with public employees (McBeth et al., 2019).

Combined, these four approaches help to weigh the impacts of and appropriateness of certain alternative solutions to challenges that may come up in the public sector.

Negotiation is a critical skill for public personnel management as we are all negotiators. As an employee, a colleague, a partner, a friend, all of our relationships grant us opportunities every day to negotiate. Often, we get emotional when in conflict which can put a strain on our relationships. We take a stance on one side of an argument or negotiation, dig our heels in, and the conflict heats up. When both (or all) parties involved in the negotiation are more focused on their individual desires than on working together to find a solution to the underlying problem, this is called positional bargaining. Positional bargaining is common, but usually not the most effective method of negotiation. Fisher et. al. suggest principled negotiation as a smarter way to play the negotiation game that focuses on troubleshooting the underlying problem rationally while protecting your relationships. The four key tenets of principled negotiation as described in *Getting to Yes* are as follows: 1) Separate the people from the problem; 2) Focus on interests, not positions; 3) Invent options for mutual gain; and 4) Insist on using objective criteria (Fisher et. al., 2011, p. 17). We will briefly go through each of these below.

Separate the People from the Problem

In any conflict, it is easy to let emotions cloud judgment and see the person that you are in conflict with as the problem instead of focusing on the challenge at hand. This can not only set the tone for the negotiation in a negative and adversarial way, but it can also damage your relationship with the person(s) that you are negotiating with. By separating the people from the problem, you are able to approach the issue with a more open mind, get to know one another's perspectives, and work together to find one or more satisfactory solutions.

Focus on Interests, Not Positions

In any negotiation, each player might pick a black and white position or material outcome that they desire and stick with it for fear of being seen as weak or giving in. When focusing on positions, it is easy to leave options that might benefit both parties on the table. Fisher et. al. suggests focusing on interests instead. Interests can be understood as the "why" behind a position. There are often multiple positions that could satisfy the same interest, but if the parties in conflict do not understand the interest behind a given position, they may not be able to come to an agreement that is mutually satisfactory. By taking the time to understand what everyone is looking to get out of the negotiation, you open up an opportunity to work collaboratively towards solving the problem at hand.

Invent Options for Mutual Gain

When the interests of both or all negotiating parties are clearly laid out, this opens up the opportunity for creative problem solving. Participants are able to figuratively and literally face the problem, instead of each other (Fisher et. al, 2011, p. 63) while exploring options that will allow for mutual benefit toward all of the interests at hand. For example: two children are arguing over who gets how much of a single orange (Fisher et. al, 2011, p. 59). In positional bargaining, they would both want the whole orange and the only "fair" compromise would be splitting the orange in half. But when looking at interests, we find out that one child wants to eat the inner fruit and one wants to bake a cake with the peel. Knowing these interests, an option for mutual gain would be to give the snacky child the whole fruit and the culinary child the whole peel. This option mutually benefits both parties more than the compromise of a 50/50 split based on the original positions. When brainstorming solutions for a problem together, the involved parties are much less likely to leave options on the table that would have been more satisfying to the group at large than the most obvious compromise.

Insist on Using Objective Criteria

A set of objective criteria must be implemented in order to keep negotiations fair for all parties involved. Criteria should be set and agreed upon by both/all parties at the beginning of the negotiation and have a focus on principle rather than preference (Fisher et. al., 2011, p. 89). Some example criteria that parties could agree to abide by throughout negotiations could be scientific findings or professional standards, expert opinions, industry protocol, or law and legal precedent. These criteria are the ground rules/standards for the negotiation and give everyone a shared goal to go back to if things start to veer off or heat up due to emotions.

Merit vs. popular will

One of the central tensions in public administration is between merit or subject matter expertise and the popular will. This is core to working relationships between career administrators and political appointees. Administrators may assume that political appointees are underinformed about the work that they do and more concerned about their reputations and ensuring their reelection than they are about doing things correctly. Political appointees may assume that career administrators are out of touch and resistant to change. However, together, they make up the heart the public service and can achieve more with their powers combined than apart. Career professionals bring subject matter expertise and stability through changing political tides and political appointees bring an understanding of the current public will. Together, they can get things done effectively and in a way that is representative of democratic ethos (Nadler & Schulman, 2006).

4. Public Administration Organizational Theory

Organizational theory gives us an unfamiliar look into the familiar world of organizations. According to Bolman & Deal (2021), there are four primary frameworks that can help us understand the organizations that make up our daily lives. These are 1) the structural frame, 2) the human resources frame, 3) the political frame, and 4) the symbolic frame. Organizational leaders can become trapped by a single primary frame through which they view organizations, but skillful leaders are able to reframe organizational life through the different theoretical perspectives when one is not sufficient to navigate complexity. Here I will discuss how perception impacts the way that we understand the world around us, then outline the core ideas underlying the four theoretical frames and instances in which each may be appropriate to apply, and finally, I will note the importance of practicing reframing and being able to pull from the strengths of each frame when navigating organizational situations.

4.1 Perception and inattentional blindness

Different people perceive problems differently. **Perception** is constructed by our existing mental models. According to perception literature, mindsets are often quick to form and resistant to change (Heuer, 1999), and this helps to explain why organizational leaders can so easily be trapped by a single default frame based on an early success in their career. It is also applicable in emergency management situations when news media is covering an issue and the information that people hear first tends to stick with them very strongly, making it difficult to regain trust when new or conflicting information becomes available. When faced with new information, we use **anchoring** to help us make decisions, though this results in an overreliance on the first piece of

information that we receive (Kahneman, 2011). People are susceptible to **inattentional blindness** (Võ & Wolfe, 2013) we tend to perceive what we expect to perceive. Conversely, we tend not to perceive what we are not expecting to perceive. This is why when an organization is facing challenges, it can be helpful to have consultants who are not as close to a situation to come in and evaluate a program or organization with a fresh perspective.

4.2 The Structural Frame

The structural frame assumes that organizational structure shapes productivity, efficiency, effectiveness, and human behavior. Furthermore, this frame is built on the assumptions that organizations are rational and exist to achieve set objectives, that they increase efficiency and performance by specializing and dividing labor into its component parts, and that most organizational problems can be solved by restructuring. The structural frame's intellectual roots can be traced back to Frederick Taylor's Scientific Management which focused on efficiency and hierarchy; Max Weber's Ideal Bureaucracy with its emphasis on vertical hierarchy and work conducted by value-neutral, impersonal workers; Woodrow Wilson's Politics-administration dichotomy and its assumptions that public administrator should be removed from politics; and Luther Gulick's classic Plan, Organize, Staff, Direct, Coordinate, Report, Budget (POSDCORB) and its top-down structure.

Classical bureaucratic theory works well when the task at hand is straightforward, the environment in which an organization exists is stable and predictable, the product or service that you produce stays the same over time, when precision and efficiency are the most important benchmarks of success, and when the people involved are compliant. It falls short when more creativity and more discretion is required to perform a task and can lead to a reduction in morale if people begin to feel dehumanized by the mechanization of work.

If classical bureaucracy treated organizations as machines, open systems theory treats organizations as organisms that both shape and are shaped by the environments in which they operate. In this framework, organizations must adapt to survive as their operating environment evolves. However, if an organization evolves too heavily just to survive a changing environment without keeping their original purpose in focus, it can result in **mission drift** where the core mission is lost.

4.3 The Human Resources Frame

The human resources frame focuses on the complex individuals who make up organizations with their diverse backgrounds, perspectives, and varying preferences. Public sector employees tend to demonstrate public service motivation (PSM) wherein they find fulfillment in service and may even align their identities with the mission of the organization that they work for. If an organization is a poor fit for the people who work there and it is not helping them to meet their needs, people may attempt to push back to regain control and improve fit, or they may leave. Self Determination Theory **(SDT)** (Deci & Ryan, 2012) focuses on people's innate desires to seek **competence** (a mastery of the work that they do), **autonomy** (ability to self-direct work rather than having all of their actions prescribed by a supervisor), and **relatedness** (feeling of connectedness that fits meaning of work into a greater purpose and connects them to others).

4.4 The Political Frame

The political frame focuses on how power influences organizations in the form of coalitions that can be either internal or external to the organization. Power here means the ability to get someone to do something that they otherwise would not have done without being influenced. Coalitions can be formal or informal and influence how we are able to get things done in organizations. To many, the idea of "playing politics" has a negative connotation. However,

politics is a social activity and it is linked to both cooperation and conflict and is the way that we make, maintain, and adjust the rules that we live by. Assumptions of the political frame are that organizations are coalitions with enduring differences amongst members focused on the allocation of scarce resources which leads to conflict which must be worked through using negotiation to achieve goals and make decisions. In this context, conflict is necessary to move an organization forward and politics is how we navigate this conflict.

4.5 The Symbolic Frame

The symbolic frame focuses on the power of narratives, symbolic gestures, and theatre in organizations. Symbols are "something that stands for or suggests something else; conveys socially constructed meanings beyond its intrinsic or obvious functional use" (Zott & Huy, 2007). Symbols help employees find meaning in their work and lives. Processes like meetings, decision making, and public engagement can be rituals. Strategic planning can be a symbolic act of theatre as well. While strategic planning may not always be closely linked to stated objectives (Mintzberg, 1994), the act of planning is a major component of an organization's ongoing drama, especially in times of transition. They can play several symbolic roles within an organization including 1) as symbols, 2) as games, 3) as excuses for interaction, and 4) as advertisements (Cohen & March, 1974).

4.6 Tying it all together

It is easy for leaders to get trapped by their dominant frame. But effective leaders are able to reframe, think flexibly, and use multiple frames to view organizational challenges through. Each frame provides powerful tools for navigating change which is especially challenging in large complex organizations.

5. Program Assessment and Evaluation

Program assessment and evaluation are methods of inquiry that can be used to determine the need for a certain program or intervention, the efficacy with which a program or intervention is hitting its desired outputs and contributing to achievement of long-term outcomes in a cost-effective manner. They are critical not only for the benefit of the organization that is subject to an assessment or an evaluation, but also as necessary measures of accountability and transparency to ensure that public money is being used wisely and for the intended purpose. **Assessment** is an ongoing process, typically performed internally within the program or organization being assessed, and its purpose is to understand how well programs are working, how cost-effective a program is, and identify areas for improvement. **Evaluation** on the other hand is performed with far less frequency and is usually performed by an external third-party so as to prevent bias from people too close to a program to see it holistically and objectively. The focus of an evaluation is typically more structural in nature than an assessment and evaluators will build out a program logic model to map out program functions and activities and connect those activities to outputs and outcomes in a schematic fashion. Evaluations can be met with resistance from organizations being evaluated, but this can be circumvented by cultivating a culture of evaluation within the program and a curiosity to understand what is working, what is not, and how it can be improved.

Due to their more immediately observable nature, program outputs are often used as a metric of a program's utility, however, outputs can be a faulty metric and should not be considered as directly equivalent to outcomes. It can be hard to tell the impact of a given program over time. It can also be difficult to assess based on metrics about an ongoing program rather than by building assessment at the inception of a program.

Designing an evaluation comes down to determining what questions to ask and how to ask them. Quantitative inquiry is easier to measure and perform calculations on, but it rarely tells the whole story and depending on how we set up or weigh certain metrics will determine the results that we find and how well our results reflect reality. Qualitative inquiry is harder to measure and difficult to quantify, but helps to provide valuable context in the form of stakeholder interviews and free-form responses to surveys among other options. Sometimes one method of inquiry is clearly better than the other depending on what you are trying to evaluate, but usually a combination of the two or a "mixed-methods" approach will provide a more well-rounded picture of the program in question.

It is tempting to assign causation to variables that appear to be correlated with certain program outcomes or outputs, but it is essential to recognize that correlation is not equivalent to causation unless you can confidently eliminate any other possible confounding factors as potentially driving the behavior that you are seeing in your data. Some challenges that come up when performing evaluations is that sometimes there is a lack of necessary data, sometimes existing data is inconsistent, messy, or just not in the proper format to evaluate on, and sometimes there is too much data but not the right kind or it is difficult to even know where to start. An additional challenge that can be encountered is the Hawthorne effect, a phenomenon where respondents to interviews or surveys may not answer truthfully because of the presence of the interviewer. This was notable in the 2013 evaluation of the Environmental Protection Agency's (EPA) Hazardous Waste Determination Program where polluters frequently cited the confusing nature of regulations to shift blame away from their non-compliance as they had a natural incentive to not want to face the consequences by admitting willful noncompliance to a representative of a regulatory agency like the EPA.

Before performing an evaluation, there are several questions one should ask to determine whether an evaluation is feasible and/or necessary:

1. Who are the clients and stakeholders for the proposed evaluation?
2. What are the questions and issues that need to be addressed by an evaluation?
3. What resources including time, money, human resources, and organizational support are available to do the evaluation?
4. What do we already know given the key evaluation questions?
5. What is the logic and structure of the program to be evaluated?
6. Which research design alternatives are available, desirable, and feasible to answer the key evaluation questions?
7. What kind of environment does the program operate within and how does this affect the comparisons that an evaluator can make between other comparable programs?
8. What data sources are available and appropriate given the issues, questions, program structure, and environment that the program operates within?
9. Which evaluation strategy is most feasible and which is most defensible given the issues that may have come up in points 1-8?
10. Based on the answers to all of these questions, should the evaluation be undertaken?

If the answers to these questions indicate the feasibility and necessity of an evaluation such that you decide to move forward, the steps to design an evaluation framework for execution are as follows:

1. Define the purpose and scope of the evaluation
2. Identify stakeholders and their needs
3. Develop a logic model of the program
4. Select evaluation metrics and indicators that will be used to in the evaluation
5. Choose evaluation methods (quantitative, qualitative, or mixed-methods)
6. Collect and analyze data
7. Interpret findings and generate recommendations
8. Communicate results of the evaluation to key stakeholders
9. Implement recommended changes and monitor the progress towards improving program effectiveness
10. Institutionalize a culture of evaluation within the organization.

Performance assessments are sometimes used to determine the cost efficiency and effectiveness of a program or intervention. They can also be used as a measure to see if a program is having the intended effect and if not, whether adjustments can be made to help it improve outputs

and outcomes or whether it should be eliminated altogether. It is important to note that the lack of cost-efficiency is not necessarily an appropriate reason to terminate a public program or service in the public sector. An assessment that shows that a program is not cost efficient but is having the intended effect and producing positive externalities for society and the people being served by an organization could be a good reason to adjust operations to achieve the same results in a more financially viable or sustainable manner by making suggested adjustments.

Lastly, I will mention a word of caution about program evaluation as noted in Radin (2006). No matter how well-designed an evaluation is and how smartly the mixed-methods inquiry is set up, evaluations will always be a flattening of reality. A full picture is never possible and it is challenging under the best circumstances to assign causation to variables operating in a complex and often subjective environment. That said, the exercise of assessment and evaluation is still useful and it is difficult to improve what you cannot measure. But in the public sector, there are often very different metrics of a program's success than those used in the profit-driven private sector. The role of government is to provide public goods and services to those who need them, often independently of their ability to afford them. Therefore long-ranging outcomes and confounding externalities often play a role that is difficult to measure even by the most skillful of evaluators.

6. Public Budgeting and Finance

A public budget is more than simple numbers on a page. It is a demonstration of a society's values and a plan for ensuring that these values are enacted. Public sector budgeting is distinctly different from private sector budgeting in that the public sector is responsible for providing public goods and services to be delivered to constituents regardless of the ability of any one individual to pay. These goods and services are considered nonexcludable. Budgeting is a political process that involves setting goals and objectives, allocating scarce resources, measuring progress towards objectives, and working within control structures put in place to ensure accountability that public monies are not being spent in unsanctioned ways. The budget cycle can be broken down into four main phases which are repeated as necessary:

1. Budget preparation
2. Budget review and adoption
3. Budget implementation
4. Evaluation of results

Governments have different types of expenditures and revenue sources. The US federal government uses individual income taxes as a discretionary revenue source and social insurance taxes as an obligated funding source where the largest mandated expenditures are entitlements like social security and Medicare while the largest discretionary expenditure is on defense. State and local governments get their revenues from property and sales taxes, fees for services, and transfers from other governments. The federal government is able to run a deficit (receipts are less than spending) which has accumulated in significant amounts of national debt. State and local governments are typically required to run a balanced budget. Capital budgeting is mainly used by state and local governments to invest in critical infrastructure like roads, buildings, and sometimes

major equipment. Capital budgets are kept separate from operating budgets as a way to spread the cost of an investment over the useful life of an asset to be paid for over time by those who will benefit from their use without overburdening today's taxpayers. State and local governments can finance these expenditures by taking out loans, selling bonds, or participating in public private partnerships where private entities are contractually obligated to build and maintain an asset or infrastructure for a period of time in exchange for the right to monetize use, then after a set period of time the asset will be transferred back to the government that initiated the agreement.

The legislative budget process involves hearings, committees, proposal and adoption of budgets by the legislature, and action by a chief executive. Oversight measures include the legislative branch having the power to check the chief executive and ensure that programs are having the intended impact at the most cost-effective price point for tax payers. Competition between programs and agencies for scarce resources can influence oversight, which can also be more performative than genuine.

There are different types of budgeting systems including performance budgeting which is based on evaluation results linking program inputs to results and total quality management which focuses on continuous quality improvement of service delivery. Zero-base budgeting is another system of budgeting which assumes a starting base of zero for all programs and each budget request must be tailored to the exact needs of the organization. This is a useful exercise in practice, but given how time-consuming it is, it is not typically feasible. Instead, many governments and organizations take a more incremental approach to budgeting where each program or agency starts with a base of their funding amount for the previous fiscal year and must justify any adjustments proposed for the new fiscal year. When budget cuts must be made, there are two main approaches. The first is in the spirit of zero-base budgeting or total quality management where program and

performance evaluations are used to determine which agencies or programs are effective and deserving of ongoing funding and which are not. The second is an across the board cut where all programs or agencies have their base budget from the previous fiscal year cut by a certain percentage. This is a less tailored approach, but the time and resources that it takes to implement is significantly less intensive than the more targeted approach.

It is difficult to reform budgeting systems for many reasons including how difficult it can be to measure the results of programs, strategies do not always lead to associated goals, agencies are competing for scarce resources and have overlapping objectives, it can be hard to measure the results of programs, there is managerial resistance to reform, and more.

7. Public Policy Analysis

Evaluations of public policy are complicated by the fact that humans have limited or **bounded rationality** and that we are living in a highly polarized society. **Affective polarization** and **identity politics** hinder our ability to reach consensus about important issues that impact everyone because we paint each other into ideological boxes (Mason, 2018). There are a variety of reasons why we may be experiencing a rise in our polarization as a society. For example, polarization could in part be attributed to our lack of bridging social capital caused by the fragmentation of our social lives due to increasing reliance on technology and lack of civil exposure to people with differing ideas from our own in everyday situations (Putnam, 2015). Additionally, we are prone to the **blindspot bias** (Pronin & Hazel, 2023) where we assume that we are more rational than average and less susceptible to bias than our peers. We also make snap judgements about things, ideas, and people using system I thinking, rather than taking the time and expending the cognitive energy to rationally consider alternative ideas and perspectives using **system II thinking** (Tversky & Kahneman, 1974), which leaves us very set in our ways and not as open to changing our minds based on new or conflicting information. All of these factors combine to make consensus-based policy decisions among stakeholders at the local, state, and national levels extremely challenging.

The **policy cycle** consists of six more or less distinct phases including 1) problem definition and agenda setting, 2) constructing policy alternatives and policy formulation, 3) choice of solutions/selection of preferred policy option, 4) policy design, 5) policy implementation and monitoring, and 6) policy evaluation which circles back into phase 1) problem definition and agenda setting. Using Kingdon's (1984) **multiple streams framework**, there are three streams relating to policy issues that must converge in order to open a **window of opportunity** that will

allow an issue to get onto the policy agenda. The first is the **problem stream** and this is where a focusing event could bring a problem more clearly into the public eye. The second is the **policy stream** where proposals that could solve a problem are shopped often by policy entrepreneurs, interest groups, and think tanks. The last is the **politics stream** which represents the public attitude towards a given issue. If any one of the three streams is not intersecting on a given issue, it is very unlikely to make it onto the policy agenda.

Increasingly, data can play a role in helping policy makers create well-informed, evidence-based decisions. However, data should not be mistaken for information which requires careful interpretation from a subject matter expert to be translated into useful information. Keep in mind also that data can be manipulated or displayed in ways that are misleading (Best, 2005) and should be approached with a critical eye. Scientists can fall victim to the science deficit model of science communication (Simis et al., 2016) where they assume that the only reason a rational consumer of information would not believe scientific evidence is because they just don't understand it well enough. When communicating scientific information to a non-technical audience, it is much more effective to use narratives and highlight the why behind the work rather than just the technical details. Connecting the work to the bigger picture helps to provide necessary and compelling context.

When considering any policy, it is important to take into consideration the various stakeholders involved. Stakeholders can be plotted using a power-interest matrix where the x-axis represents low to high political power and the y-axis represents low to high interest to determine who is most critical to the conversation (Bryson, 2004). The four quadrants are described as follows:

- Low power/low interest (Crowd)

- High power/low interest (Context setters)
- Low power/high interest (Subjects)
- High power/high interest (Key players)

It is important to keep your crowd up to date with relevant information, make sure not to make policy decisions that will overly negatively impact subjects, and keep key players actively engaged in the policy formulation process.

The **narrative policy framework** (McBeth et al., 2007) allows us to move beyond a rational model of policy analysis and breaks policy issues into their narrative component pieces. Any good narrative will have characters including heroes, villains, and victims. It will also have a plot with rising action and oftentimes a focusing event that brings an issue to the forefront of public attention and spurs the characters into action. Sometimes the resolution or policy will be satisfying, other times less so, and sometimes, there is no resolution in sight for the characters if an issue falls out of the public eye before a policy can make it to fruition. Because of human's limited rationality, different people may view different components of a policy narrative differently. One person's hero may be another person's villain and one person's happy ending may be another's disappointment.

It may seem impossible to get people to engage meaningfully across ideological boundaries given the highly polarized landscape of our society today. However, tools of democracy like the discourse rules described by Fox and Miller (1996) and a communitarian commitment to place and one another based on civic engagement like Kemmis (1990), can help to bring diverse stakeholders together, bridge the us vs. them divide of affective polarization, de-escalate existing tensions, get people talking across political and ideological divides, and ultimately aid in finding enough common ground for stakeholders to strap on their democratic shoes (Clemons & McBeth, 2020)

in order to codesign creative solutions that everyone can live with (even if no one is fully satisfied with the policy outcomes).

8. Environmental Politics and Policy

The **narrative policy framework** (Jones, McBeth, & Shanahan, 2022) helps us understand environmental policy and emphasizes that people understand the world by connecting with a narrative or story. In most policy narratives, we can find a villain, a victim, a hero, a conflict, and hopefully a resolution. However, depending on where you stand, one person's villain may be another person's hero or victim or vice versa. A focusing event can disrupt the equilibrium of our day to day lives and bring an issue into the public eye. Policy resolutions can be seen as a triumph, a failure, or a disappointing compromise that misses the mark.

One of the major historical environmental debates is that of conservation vs preservation. Conservation is the idea that we should manage natural resources in a way that maintains function and productivity to allow for continued wise use of those resources. Whereas preservation focuses on maintaining ecosystems in their "most natural state". Gifford Pinchot, the US Forest Service (USFS), and President Theodore Roosevelt represented the conservation camp. John Muir, the Sierra Club, and the National Parks Service (NPS) represented the preservation camp. This debate came to a head when politicians were looking for places to create new reservoirs and decided to dam the Hetch Hetchy Valley in Yosemite to provide water for San Francisco.

Three of the key ethical frameworks for environmental politics are 1) anthropocentric, 2) biocentric, and 3) ecocentric. The anthropocentric view has its roots in western Christianity and sees humans as the only living things with intrinsic moral value, argues for saving nature for utilitarian reasons, and views humans as distinctly apart from nature, though with moral authority to rule over it. The biocentric view is more common among indigenous peoples and sees all living things as having intrinsic moral value. The ecocentric view focuses on the intrinsic value and function of ecosystems as a whole.

Global environmental change worldviews can be viewed on a spectrum. The four worldviews can be categorized as 1) **market liberals**, 2) **institutionalists,** 3) **bioenvironmentalists**, and 4) **social greens** (Clapp & Dauvergne, 2011). **Market liberals** see growing the economy as the key to reducing poverty and solving environmental issues. They see globalism as positive and that everyone needs a certain income before they can care about protecting the environment. They see technology and innovation as important tools and believe that environmental problems stem from a lack of economic growth, poverty in developing countries, and bad policy. **Institutionalists** believe that cooperation and global institutions will solve our environmental problems because without regulations, people will not always do the right thing so limits must be created including on the global economy. **Bioenvironmentalists** focus on ecosystems and see that the path forward towards solving environmental issues requires a major decrease in consumption, economic growth, and human population. They believe that the Earth has a carrying capacity and focus on the biological limits on complex ecosystems which need to be protected by strong rules. **Social greens** have the most radical of the four worldviews and want to make a massive change in the system. They believe that social and environmental problems are inseparable, that unequal access to resources and unequal contact with the environment creates harm, and that globalization exasperates inequality and domination of both humans and the environment. To social greens, overconsumption of scarce resources creates poverty and degrades the environment.

Environmental narratives throughout the decades:

- 1950s - Science, technology, and industry will save the day
- 1960s – Health focus - industrial growth is good because of agricultural innovations, but it is also bad because of high levels of pollution causing serious health issues.
    - Here we saw the growth of legislation on water quality, the Endangered Species Act (ESA), Wild and Scenic Rivers, and the National Environmental Protection Act

    - Rachel Carson's Silent Spring catalyzed a hearing that ultimately led to many bills restricting the use of pesticides and most importantly the EPA and NEPA were created in part due to this hearing.
- 1970s – Government saves the day
    - NEPA was signed into law by President Nixon. This establishes environmental impact statements.
    - Clean Water Act of 1972 regulated discharges of pollutants and quality standards for surface waters
- 1980s – Decentralization and privatization (Reagan)
- 1990s – Global awareness and gridlock (international component)
- 2000s – International concerns, security issues following 9/11 terrorist attacks
- 1990s to 2010s and beyond – Think globally, act locally

Policies often take into account a single major focus, but fail to consider others to the detriment of other important issues. Additionally, it is essential to know the history of legislation and regulations to give context to the current landscape of contradictory regulations. You can't change what you don't know or understand and even if you don't want to change it, it can be frustrating to work within a system that you don't understand.

9. Community & Regional Planning

Community and regional planning is all about land use. It is how we shape the physical landscapes around us. As human populations grow and change, so too do our physical requirements. Planning requires input from diverse stakeholders including technical experts, elected officials, and community members. Effective planning brings people together, ensures that residents of a community or region have access to the things that they need including housing, transportation, places of employment, places of enjoyment like cultural spaces, entertainment, and green spaces, educational facilities, food, clean water, electricity, sanitation services, and more. Good planning ensures that people living in a community have all access to what they need to survive as well as what they need to thrive. Poor planning can leave communities fragmented, sprawling, or heavily polluted.

Thoughtful zoning practices are critical in the modern planning process. Ideally, the most fertile, agriculturally productive, or biodiverse lands must be zoned to prevent harmful development because it is challenging if not impossible to fully revert a developed piece of land back into an ecologically sound and productive habitat. This is a particularly important best practice to keep in mind as so many productive areas are rapidly being converted to development, subdivisions, and ranchettes. Conversely, land with low productivity should be zoned for development including various types of residential zones, commercial zones for value-added economic endeavors, educational facilities, industrial zones, transportation networks, etc. Cities should be economic hubs for knowledge-based work and play while prioritizing dense, good quality, affordable housing.

There are several key reports or plans related to the planning process. First, planners need to have a strong understanding of the region from a broad and holistic perspective. This includes

getting the lay of the land, identifying where key agricultural plots are, where valuable natural resources are, where the commercial and industrial centers are located, and how the pieces fit together from a functional and economic standpoint. Subsequent plans narrow in on smaller areas leading to a comprehensive plan. The comprehensive plan puts it all together as a shared vision for the physical future of a community. Planning is partly a technical undertaking, but it is also a political one and in order to navigate the planning process successfully, it is important to take into consideration the diversity of stakeholders involved.

Land use zoning impacts everything, from where people can build and live, how people use transportation, our physical health and mental well-being (from how much we walk, to our level of exposure to industrial pollutants in our air and water). It sets the tone for our communities and influences what we do, where and how we work, and how we interact with our neighbors and fellow community members. It has a significant impact on our exposure and vulnerability to natural disasters and climatic influences like wildfires and flooding. It can also influence fire frequency because people living in close proximity to fuel sources increase the risk of ignition of wildfires in drought-stressed western ecosystems.

Effective planning and zoning is one of our first lines of defense against natural disasters in emergency management situations especially in the wildland urban interface (WUI). Zoning determines how we decide where and how to build structures. The government has to ensure that private industry follows best practices to protect consumers from cheap/fast/shoddy workmanship from major corporations that only have the bottom line in mind. Building into the wildland urban interface (WUI) without ensuring that all structures have enough defensible space increases the risk of damage in case of a wildland fire while also increasing the risk to insure these structures. If homeowners are unable to afford insurance because insurance companies will not ensure their

property, then it becomes a question of who is responsible for providing aid in the eventuality of a disaster. If FEMA is responsible, then the ethical ramifications of using taxpayer money to help people who build homes in places that we know carry such a high risk of disaster that insurance agencies will not assume the risk should be considered. If we stop building in areas that are this risky and disaster prone to begin with, the cost of natural disasters in terms of human lives, health, and taxpayer money could be much lower. Currently, most disaster funding and action is reactive after a devastating event (ex: wildfires, hurricanes, 9/11 terrorist attacks, etc.) but mitigation dollars go much farther and can help to prepare for and sometimes even prevent more costly and devastating and dangerous outcomes. However, it is difficult to fund proactively when there are so many other pressing disasters and societal challenges to attend to. It seems like if the danger is out of sight, then it is also out of mind. This is where strategic zoning and best-evidence based land and resource management practices come into play to make communities safer in the face of increasingly frequent natural disasters.

10. Disaster Policy & Administration

One of the major questions at the core of disaster policy and administration is who should be financially responsible when disasters occur. Some would argue that it should be individuals or entities that decide to build infrastructure in high disaster risk areas (if you aren't actively managing or mitigating to prevent damage in the case of disaster, then why should the government bail you out with taxpayer dollars?). Others think that it is the responsibility of the government, be it local, state, or federal, to provide relief to individuals or organizations impacted by disaster. However, this is deeply complicated by the fact that local and state jurisdictions are often reluctant to accept federal zoning when they would prefer to have more locally-centered decisions made about zoning. But without broad federal zoning regulations, buildings and people often end up in hazard zones which when inevitably hit by disaster require federal funds to help provide relief.

4-Phased Cycle of Emergency Management

1. Mitigation
2. Preparedness (and prevention)
3. Response
4. Recovery (short and long term)

Mitigation can be structural or non-structural and is usually performed at a local level to reduce the risk of damage from a natural disaster. In order to mitigate effectively, risk must first be properly identified. Some examples of potential mitigation measures include building seawalls to prevent flooding or thinning overstocked forests to reduce the risk of a devastating wildfire in dry areas. Though the return on investment for mitigation dollars is high due to the potential to prevent damage in the event of a real disaster, state and local governments have limited budgets and may not always be able to justify the cost of expensive mitigation measures in the face of uncertain future emergencies. **Preparedness** and prevention are activities that take place ahead of

a disaster and can either lower the risk of a disaster happening and/or ensure that communities are ready with protocol before disaster strikes. If a disaster is detected early with technologies that can predict or detect early signs of disasters like fires, floods, tsunamis, and earthquakes, then **response** activities can be initiated even before a disaster has happened. If no early warning systems are available, then response happens as soon as a disaster is detected. **Recovery** takes place in the short-term ensuring that people have access to food, water, shelter, and other necessities and in the long term with activities like rebuilding and relocating after disaster.

Institutional History of U.S. Disaster Management

The history of US disaster management is characterized by a number of reactionary decisions made after a sequence of disasters that showed cracks in critical disaster preparedness, mitigation, response, and recovery infrastructure which ultimately led to the iteration of disaster management that we have today. Here I will briefly outline five of the important legislative acts that have shaped the landscape of US disaster management.

For much of US history, disasters were legally considered "acts of God", but as science advanced to the point of giving us a better understanding of the geologic and climatic functions driving disasters, we became better equipped to mitigate and respond to disasters more proactively (or often reactively

The Cold War era and the threat of nuclear warfare led to an increase in civil defense measures. **The Civil Defense Act of 1950** was passed by Congress and President Truman - this created the Federal Civil Defense Administration (FCDA) with the purpose of formulating national policy to guide states in shouldering the burden of most national civil defense measures (US Department of Homeland Security, 2006). This devoted significant funding to shelter initiatives. Along with this, in response to a flood in the Midwest, the **Federal Disaster Relief Act of 1950**

(FDRA) was enacted with the FCDA. This was a landmark decision that shifted disaster-related decision-making power away from Congress and to all future presidents. It set a standard process for how governors would request federal disaster relief from the president.

After some major administrative restructuring, the **Disaster Relief Act of 1974** authorized in law the emergency declaration category (on top of the existing major disaster declaration category), established an Individual and Grant (IFG) program, and stressed a multi-hazards approach to mitigating and responding to disasters.

The **Stafford Act of 1988** is a critical piece of legislation in the history of disaster management as it gave presidents the power to declare emergencies to mobilize federal funds rapidly when emergencies take place. This was later amended by the Disaster Mitigation Act of 2000 which gave FEMA the authority to encourage pre-disaster mitigation actions by providing federal funds for state and local efforts towards preparedness and mitigation.

FEMA was created by **Executive Order 12127** on March 31, 1979 by President Carter and this was the first time that disaster management was more or less centralized under a single organizational entity headed by an official (FEMA director) directly responsible to the president. In the reorganization, FEMA absorbed several entities that had previously handled various components of disaster management. FEMA was tasked with leading the coordination of federal efforts with state, local, public, and private sectors in disaster response. The focus of disaster management and mitigation evolved and shifted over time and the emphasis on civil defense eventually became an emphasis on defense against and prevention of terrorism.

In response to the 9/11 terrorist attacks on the twin towers, Congress and President George W. Bush enacted the **Homeland Security Act of 2002** which created the Department of Homeland Security (DHS) and initiated a large-scale restructuring of the federal disaster response agencies.

This removed FEMA from the office of the president and shifted the overall emergency response focus dramatically towards terrorist threats, which ultimately left the US vulnerable to extreme natural disasters as evidenced by the failed response to Hurricane Katrina.

The **Post-Katrina Emergency Management Reform Act (PKEMRA) of 2006** largely restored FEMA's status to strengthen and re-empower the agency to spearhead emergency preparation, mitigation, response, and recovery efforts in response to the failed activities in response to Hurricane Katrina. The FEMA director was once more given a direct line to the president to make the process of declarations of emergency more agile and effective.

Stages of a National Emergency Declaration

In the US, there are several steps or stages to declaring a national emergency. I will outline these steps describing the institutions that are involved, the criteria that must be satisfied to move up the chain of command, and the resources that get mobilized upon successful declaration of a national emergency or major disaster. The steps referenced are shown in Figure 4-1 of Sylves 2020. The process starts at the local scale then escalates in a stepwise manner to the county level, then the state governors, then through several levels of FEMA from regional to headquarters to the FEMA director, then directly to the president.

First, an incident must occur. This incident can be any number of natural disasters or man-made threats. Once the event has taken place or is ongoing, local government agencies assess the damage (and potential further damage) from the incident and local recovery capability. If local agency personnel determine that response and recovery are beyond the scope of what they are capable of at the local level, a mayor or County Judge will send a letter of request and a disaster

summary outline to the governor of their state letting them know that the severity of the disaster exceeds local response capability.

If it is determined based on review of the initial supporting documents that the disaster is beyond the ability to respond at a local or state level, then the governor of the affected state will make a request through the regional FEMA office after which state and federal officials will conduct an on-site Preliminary Damage Assessment (PDA) to show that local and state emergency management infrastructure, funding, and personnel is insufficient to handle the disaster at hand thus deeming a request for supplementary federal assistance necessary. Around this same time, the governor will initiate their state's emergency plan.

As the situation escalates, the governor's request and PDA will be summarized by FEMA regional personnel and sent up to FEMA headquarters where the director of FEMA will further assess eligibility of the disaster and devise a recommended course of action to share with the president. The recommendation from FEMA is primarily based on estimated amounts of damage to public infrastructure in relation to the requesting state's population. At this point, the president will either grant or deny the declaration of emergency. If the declaration is denied, the requesting governor may appeal the decision within 30 days if they still believe that federal assistance is necessary. If the declaration is issued, then a number of resources and processes are rapidly mobilized to send aid to the affected state.

Once an emergency is declared, then FEMA and other agencies will formulate response and recovery plans and projects for the affected communities and get to work. Money from the president's Disaster Relief Fund gets mobilized to help cover the cost of damages that the local and state level is unable to cover. If the need is determined, then the declaration will also include a public assistance program to help state and local governments with repairs to critical

infrastructure as well as to individuals and households in need of temporary housing and other assistance.

Regarding speed, cost-effectiveness, and accountability:

Under a "business as usual" scenario, government entities, universities, and research institutions work slowly and may be bogged down by "red tape". People are distrustful of government (a founding tenant of the United States ethos) and of scientists and they demand transparency and accountability to prevent government overreach, corruption, and any changes that are too rapid. It is a safeguard and a key function of the United States' checks and balances. However, with more and more restrictions, regulations, and reporting obligations, public work on even simple functions becomes difficult, slow, and expensive to manage the associated administrative burden. This is the same with public science. This makes things slower and results in less output for more public money. This diminishing return on public investment can be seen as an added factor contributing to public distrust of government and science. Once (often well-meaning) rules are put in place, new ones just get tacked on top which creates unwieldy, contradictory requirements that are difficult to fulfill.

To reduce some of the confusion and burden, we should do a full inventory and evaluation of existing administrative requirements with a focus on the purpose of those reporting requirements and regulations. This inventory and evaluation could be used to remove requirements that are no longer relevant, cut out conflicting requirements and reduce duplicative efforts for a more streamlined approach. Adopting an "audit" approach to reporting could allow organizations to modernize. New technologies like artificial intelligence could be used to complete the bulk of required reports while managers and scientists would double-check outputs to ensure high levels

of accuracy while spending less time on administrative tasks and more time on their specialized, technical jobs.

Under a "state of emergency" scenario such as during a natural disaster or global pandemic, the President, state Governors, and local governments can act quickly to deploy leadership and critical services much more effectively. Less red tape allows for greater collaboration which results in getting more things done. Getting more things done in an effective and expedient manner helps to rebuild public trust in governments. Of course, doing away with all existing safeguards could result in corruption and gross abuses of power. But this state of emergency protocol proves that we can act quickly, efficiently, and effectively to get things done for the public good. Perhaps there is a middle ground scenario where governments and public agencies can build more trust with more waste while balancing political acceptability and accountability with the essential expertise of subject matter experts who deploy administrative discretion.

11. Research Problems in Landscape Ecology

The following section sets up the case study that will be used to demonstrate key PA themes in the application section of this capstone report. While the topic of aspen is presented through a technical landscape ecology perspective here, it will be explored through PA lenses moving forward.

ECOLOGY OF ASPEN

Brandy Nisbet-Wilcox, Graduate Research Assistant, Idaho State University GIS Training and Research Center, brandynisbetwilco@isu.edu

Keith Weber, GIS Director, Idaho State University GIS Training and Research Center, webekeit@isu.edu

1. Introduction

Aspen (*Populus tremuloides*) are the most widespread broadleaf tree in North America and are frequently the only broadleaf species in otherwise conifer-dominated boreal landscapes (Kitchen et al. 2019). Often referred to as a keystone species (Wilson 1992), aspen serve a disproportionately important role in the biodiversity and functioning of the ecosystems in which they appear (Kay 1997). They also provide a number of critical ecosystem services including nutrient cycling, carbon sequestration, and both food and shelter for many species of plants, insects, microbes, and animals (Kouki and Martikaenen, 2004). Aspen exist across diverse ecological settings and as a result, exhibit a variety of ecological roles, making generalizations challenging and context specific studies of aspen necessary for well-informed management (Romme et al. 2001). This paper explores the complex ecology of aspen focusing on (1) the abiotic habitat factors that aspen tend to inhabit, (2) landscape mosaic/patch dynamics, biodiversity, and ecosystem services (biogeochemical cycling), (3) competition, and (4) the role of disturbance in determining aspen habitat. Finally, this paper describes the setting for this particular study.

2. Abiotic Factors

As the most widely distributed tree species in North America, aspen thrive across a diverse range of habitats from boreal forests to montane areas (Mitton & Grant, 1996). The range of aspen-dominated landscapes are largely shaped by abiotic factors including temperature, precipitation, snowpack and timing of snowmelt, soil composition, elevation and other topographic factors.

2.1 Climate and precipitation

Climatic conditions are highly variable over aspen's range, especially annual precipitation and temperature extremes. Precipitation within aspen's native range across North America can be as low as 16 cm annually in the semiarid west and may exceed 750 cm in Canada (DeByle and Winkour, 1985). In addition, aspen can tolerate a wide range of temperature extremes, and have been documented in areas that experience winter minimum temperatures as low as -57° C and summer high temperatures up to 41° C (Perala et al. 1990). Given these relatively broad conditions, the range of aspen is still limited by growing season temperatures, availability of sunlight, and its requirement for a surplus water supply when the overall water balance exceeds evapotranspiration (Perala et al. 1990).

Declining winter snowpack (Mote et. al. 2005 and 2018) and both faster and earlier spring snowmelt may impact aspen populations (Brodie et. al. 2012). The reason for this is two-fold: (1) aspen have a relatively shallow root system and are unable to tap into deep groundwater supplies as done by conifers. As a result, aspen rely largely on snowmelt and rainfall during the growing season to satisfy water needs. (2) A deep snowpack may help young aspen suckers avoid being browsed by elk and deer simply by being covered during the winter months. In contrast, a shallow snowpack (a) leaves aspen suckers vulnerable to browsing during these months, (b) melts more quickly in the spring and early summer, and (c) provides limited water during the growing season. Stress from drought conditions damages aspen's xylem and this damage accumulates over time, which allows the impact of drought to persist sometimes for years after a prolonged period of drought (Anderegg et al. 2013).

2.2 Soils and topography

Aspen grow on a variety of soils ranging from shallow and rocky to deep loamy sands and heavy clays (USDA, 1975). Soils that are well drained, loamy, and high in organic matter, calcium, magnesium, potassium, and nitrogen tend to support aspen well (Boyle et al. 1973). While soils tend to be only a minor limiting factor for aspen, another study suggests soil structure may be linked to the age and successional type of aspen stands with stable aspen habitats frequently associated with a thick mollic horizon and Pachic Cryoborolls soil type (Cryer & Murray, 1992). Stands tend to expand into soils with thinner mollic horizons, but tend to thicken the rich mollic horizon as the trees mature and drop leaves and build organic matter in the soil (Buol et al. 1989). Seral stands that interface with conifers that encroach are often on less rich soils. Aspen functional types are influenced by the structure and composition of the soil that they grow in while also influencing the soil composition and structure (Cryer & Murray, 1992).

The elevational distribution of aspen in North America ranges from sea level on the Atlantic and Pacific coasts to approximately 3500 meters in northern Colorado (DeByle & Winokur, 1985). Near the northern limit of the range, aspen are not found above 910 meters and near the southern limit, aspen do not occur below about 2440 meters. Individual aspen trees tend

to be poorly developed at either end of the elevation limits with most trees in Colorado and Utah found between 1280 and 3350 meters (Perala et al. 1990). In the Intermountain West, aspen can be found on all aspects and grow well wherever there is sufficient soil moisture. However, north-facing slopes tend to provide more favorable soil moisture conditions (Mueggler, 1988).

2.3 The aspen niche in the Greater Yellowstone Ecosystem

While there have not been extensive studies characterizing aspen's niche in eastern Idaho specifically, a study by Brown et al. 2006 focused on characterizing aspen's niche within the Greater Yellowstone Ecosystem (GYE). Given that the GYE is at largely higher elevations than most of eastern Idaho, the findings from this study are not entirely transferable, though it does provide a thorough characterization for a neighboring geographic region. Brown's study reports aspen are typically found between 1559 to 2921 meters in elevation. It also reported that aspen grow best in warmer and more mesic conditions with low conifer cover and clay-rich soils (> 40% clay), though outliers were found in soil types that contained as little as 17% clay, which is within the range of described aspen soils in Buol et al. 1989 and Cryer & Murrey 1992. Aspen's niche in the GYE is characterized by warm temperatures (average annual temperature of 2.1° C with average annual temperature ranging from –2.1° to 6.1° C), more mesic areas with high availability of sunlight (shortwave radiation values > 68.9 W m^2) and annual precipitation from snowpack and rainfall ranging between 33.8 to 153.4 cm per year. At the landscape scale, patches of aspen stands are often found interspersed between patches of sagebrush steppe, grasslands, and lower-elevation conifer forests (Rogers et al. 2020).

3. Beacons of biodiversity

3.1 Diversity of flora and fauna

Highly productive and structurally diverse, non-riparian aspen forests support greater biodiversity than any other upland forest type in the western United States (Chong et al. 2001; Mueggler 1985), providing critical ecosystem services including the indirect sunlight needed to support a biologically diverse understory (Mueggler 1985). When aspen dominated landscapes transition to other types, notable biodiversity is lost in vascular plants, nonvascular plants, vertebrates, and invertebrate organisms (Bartos and Amacher 1998; Bartos and Campbell 1998a, b; Kuhn 2011). Furthermore, many species of plants, animals, insects, and microbes rely on the services provided by aspen (Kouki and Martikainen 2004) including hare, black bear, deer, elk, grouse, and numerous songbirds (Scott and Crouch 1987; Patton and Jones 1977). Old and decaying aspen are important for wildlife (DeByle and Winkour, 1985), suggesting the ecological importance of aspen across all life stages. Aspen corridors also enhance the connectivity of a variety of species including pollinators, small mammals, and birds that would otherwise be subject to the negative impacts of habitat fragmentation (DeByle and Winkour, 1985). Connected networks of aspen maintain ecological processes and species interactions, but as aspen-dominated ecosystems decline, so do these benefits and many species suffer as a result.

3.2 Trophic interactions

The recruitment of aspen suckers following disturbance can be negatively impacted by browsing and grazing ungulates like deer and elk (Walker et al. 2014). While cattle typically do not browse aspen, they can still negatively impact sucker recruitment by trampling young stems (Bork et al 2013). Case studies in the GYE suggest long term large herbivore exclusion in areas where aspen are starting to regenerate could result in higher aspen recruitment rates (Beschta et al. 2016). The re-establishment of predator-prey dynamics through the reintroduction of wolves in the GYE has been shown to reduce ungulate populations and establish a landscape of fear (Laundre & Ripple, 2010) which influences the behavior and spatial range of prey animals. This population reduction may in turn help decrease winter browsing pressure from deer and elk and promote beneficial use of aspen groves by beavers who improve their local hydrology, which may subsequently allow aspen to better establish after a disturbance (Beschta et al. 2016).

3.3 Carbon sequestration and biogeochemical cycles

With shallow root systems and abundant deciduous leaves, aspen are effective at sequestering large amounts of carbon and provide enough indirect sunlight for a biologically diverse understory (Boča and Van Miegroet, 2017). Their rapid growth and high nutrient demand also play a role in enriching soils (Ste-Marie and Pare, 1999) and cycling nutrients including water, carbon, nitrogen, and phosphorus (Kurth et al. 2014).

4. Competition is key

4.1 Conifers

Across much of its range, aspen compete with conifers (Bartos, 2001). At lower elevations (below 2000 m) and under more xeric conditions --where soil moisture is limiting-- juniper (*Juniperus spp.*) can quickly encroach in areas previously dominated by aspen (Wall et al. 2001). Extended drought conditions and long periods between disturbance by fire can limit aspen's ability to regenerate clonally, leaving stands vulnerable to replacement by more drought tolerant species like juniper. Juniper encroachment often coincides with drier, warmer climate conditions that are well-suited for juniper seed production and establishment. Unlike aspen which cycles nutrients quickly and enriches soils to promote a biodiverse understory, juniper acidifies the soil and cycles nutrients much more slowly, making it difficult for aspen to re-establish (Bates et al. 2006).

At the upper end of aspen's elevational range, competition with conifers such as Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) is more common. Aspen grow quickly after disturbance by fire, but after enough time post-disturbance taller conifers tend to shade out aspen causing individual aspen stands to decline. However, the cycle of competition restarts after another major disturbance. Under current climate conditions, lowland aspen stands and aspen in wet microsites near streams transition to conifer cover more slowly while upland

mixed aspen/conifer stands experience more rapid conifer establishment. A 2009 study quantifying successional rates in western aspen woodlands determined an average fire return interval of 50-70 years is desirable for the maintenance of aspen in upland areas where conifers are present. Under longer fire return intervals, many aspen in mixed aspen/conifer forests could be lost within 80-200 years (Strand et al. 2009). However, with increasing fire frequency (Weber & Yadav, 2020) this trend may be reversed in favor of aspen. Conversely, increasing drought severity (Anderegg et al. 2013) causes stress to aspen and could negate potential gains from increasing fire disturbance.

4.2 Other damaging agents

In addition to browsing pressure and competition with other vegetation types for critical resources like water, nutrients, and sunlight, aspen is also susceptible to numerous damaging agents including diseases and pests. Some of the more common infections in the western US include various shoot blights, leaf spots, leaf rust fungi, powdery mildew, viruses, trunk rot fungi, bacteria, and an array of cankers (Perala, 1990). As a host to a wide variety of insects (DeByle & Winkour, 1985), only a few types have been known to potentially cause severe damage to aspen. These groups of concern are 1) defoliators like the western tent caterpillar (*Malacasoma califonicum*) and leaf miners like the aspen leaf miners (*Phyllocnistis populiella*), aspen blotch miners (*Phyllonorycter tremuloidiella* and *Lithocolletic salicifoliella),* 2) borers like the poplar borer (*Superda calcaruta*) which opens up channels that make aspen more susceptible to fungal infections, and 3) sucking insects including the vagabond aphid (Mordvilkoja vagabunda) which causes a twisted gall of leaves at twig tips and aphids of the genus *Pemphigus* as well as leafhoppers in the genera *Idiocerus* in the western US which cause leaf browning and can rupture twig bark (Perala, 1990).

All of these factors including competition, disturbance, insects, and diseases are critical components of a functioning aspen ecosystem and under ideal conditions, would not be cause for concern. However, changing climate patterns like increasingly prolonged and severe drought conditions leave aspen stressed, resulting in increased vulnerability to infection by secondary agents like insects and disease (Sucoff, 1982).

5. Disturbance dynamics and conservation measures

Aspen woodlands can range from highly fire-dependent seral communities succeeded by conifers to relatively stable, self-replacing, non-seral communities that may not require fire to stimulate regeneration (Shinneman et al. 2013). While aspen do reproduce sexually, their ability to produce asexually to form an aggregation of genetically identical stems following a disturbance like fire or clearcutting gives them a competitive advantage to act as an early successional species in comparison to slower-growing, non-clonal conifers (Burton, 1966). Aspen's vegetative growth mechanisms are often enhanced by disturbance, allowing for quick succession into suitable areas post-disturbance (Long & Mock, 2012). Fire return intervals vary

greatly, but in a well-functioning ecosystem, fire is frequent enough (50-70 years) to stimulate sufficient post-disturbance suckering to satiate browsing requirements (Endress et al. 2012).

Understanding disturbance dynamics can help natural resource managers to make ecologically informed management decisions in aspen-dominated systems. Research in the field of environmental conservation shows that small prescribed fires may encourage some aspen regeneration, but may not facilitate long-term aspen gain due to continued pressure from over-browsing, rapid establishment of grasses and shrubs, and limited reduction of competing conifer populations (Wilde 2014). Wilde 2014 also suggests higher severity, controlled fires may be a useful management tool to improve aspen regeneration and recruitment by reducing conifer competition while increasing suckering and growth rate and encouraging higher concentrations of defensive compounds including phenolic glycosides and condensed tannins (Lindroth & Clair, 2013) which may increase aspen's resilience to herbivory (Wan et al. 2014).

6. Landscape legacies

In addition to being shaped by a variety of abiotic factors, aspen distribution is also influenced by humans, who simplify landscape patterns (Krummel et al. 1987) through activities such as fire suppression, expansion of the wildland urban interface (WUI), clearcutting, and emitting large quantities of greenhouse gases that contribute to warming climate trends (Romme et al. 2001). Historic fire suppression over the 20th century dramatically altered fire return interval and forest structure in fire-adapted ecosystems leaving a wide range of long-lasting impacts on landscapes across the western US. This resulted in dense, overstocked forests, a large accumulation of flammable forest material, compromised forest health and resilience, and as a result increasingly large and destructive wildfires.

Between shifting narratives surrounding wildfire, changing leadership, and prescribed fires gone wrong, the pendulum of management frameworks has fluctuated over the course of the 20th century and into the 21st. Presently, land management agencies like the Bureau of Land Management (BLM) are seeking more holistic, proactive approaches to caring for historically fire-adapted landscapes like those that aspen inhabit, but historic fire suppression will continue to have impacts on ecosystems throughout the western US for many years to come. It is important to note that managing to restore landscapes to a previous "natural state" can be problematic, as what we perceive as the natural state of a landscape today is likely the result of centuries worth of human interactions and alterations (Turner & Gardner, 2015).

7. This study

While aspen has been declining across the western United States (Singer et al. 2019) there have been numerous studies investigating losses of aspen in Colorado, but few studies with focus on aspen in eastern Idaho. This study aims to quantify trends in aspen population size and distribution on a landscape scale across four Bureau of Land Management field districts in eastern Idaho (Figure 1). The study uses remotely sensed data from Landsat 5 Thematic Mapper

(TM), Landsat 8 Operational Land Imager (OLI), and Landsat 9 Operational Land Imager Plus (OLI+) in addition to aerial imagery, climate data, and *in situ* observations. These data will be used to build a model that can detect/predict aspen in order to investigate trends, changes, and relationships in aspen populations at a landscape scale. Project partners at the Bureau of Land Management plan to use findings from this study to inform future targeted management decisions with the goal of promoting aspen health and overall ecosystem function in aspen-dominated landscapes within their jurisdictional boundaries.

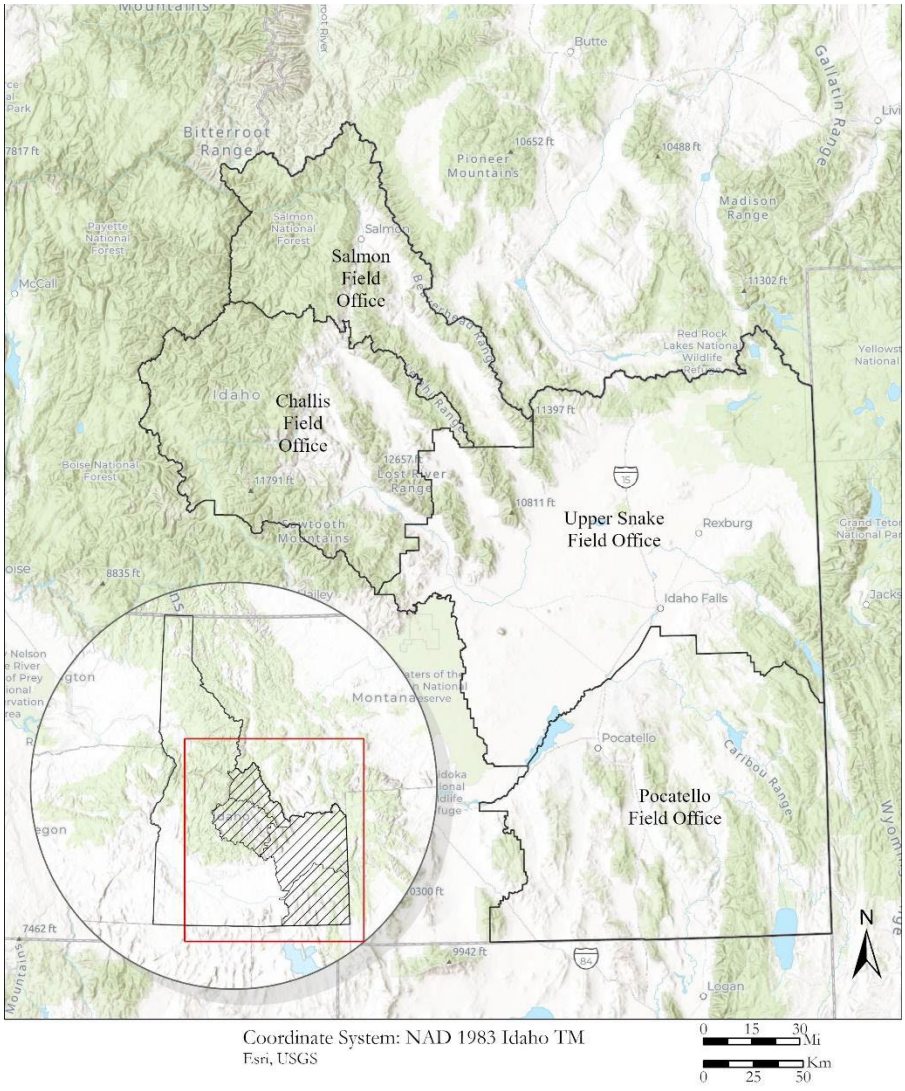

Figure 1. *The study area comprised of four Bureau of Land Management field offices in eastern Idaho; Pocatello, Salmon, Challis, and Upper Snake.*

8. Notes from the field season

Over the course of the 2024 summer field season, we were able to observe aspen on the landscape across eastern Idaho. In the southern portion of our study area (lower elevations of 1600-1750 m, many aspen stands were patches near water surrounded by sagebrush steppe. These stands seemed to be minimally disturbed by browsing, though there was an abundance of cattle that appeared to be trampling some of the young aspen recruits. Towards the center of our study area (at elevations of 1750-1900 m), aspen were found in larger swaths of mixed-age stands, interspersed with sagebrush steppe and Douglas fir forests. Towards the northeast section of the study area (at higher elevations 1900-2200 m), we found much smaller stands interspersed among dense lodgepole pine forest, with more evidence of disturbance by ungulate browsing. The understory of aspen patches varied widely in composition across the surveyed areas, but was often lush.

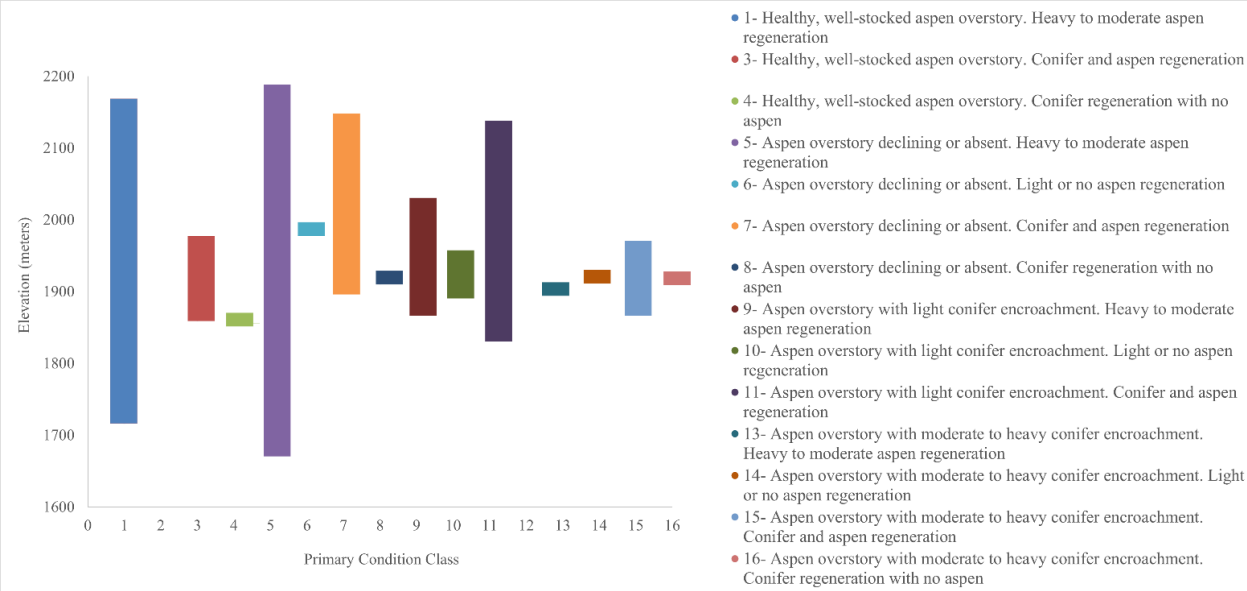

Figure 2. *Primary condition class of aspen stands surveyed during the 2024 summer field season compared to elevation of sample points. Stands with healthy, absent, or declining aspen canopy cover but vigorous aspen regeneration ranged from 1650 to 2200 m in elevation. Stands with varying degrees of conifer encroachment and aspen regeneration were more limited in range from around 1850 m to 2100 m.*

Aspen stands felt cool and damp in comparison to adjacent sagebrush steppe patches and, much brighter and warmer in comparison to dense, well shaded coniferous forest. Touted as beacons of biodiversity on the landscape, the sounds of aspen stands were distinct from those heard in other cover types. While standing in an aspen grove, you could almost always hear songbirds, the low buzz of insects, the distinct rustle of aspen's namesake trembling leaves, and the faint sound of nearby running water.

Observations from the aspen stand health survey suggest the health and successional status of stands within the sampled area varies widely (Figure 2). Some stands appeared to be in good health with abundant mixed age stems, minimal crown damage, low to no evidence of browsing, minimal conifer encroachment, and a diverse understory. Others appeared to be in poor or declining condition with minimal sucker recruitment, browsing damage, and substantial conifer cover. As part of a larger study, these observations will provide additional context when used in conjunction with historical satellite imagery and ancillary datasets to analyze trends in aspen populations and potential climatic drivers of distribution change over eastern Idaho.

9. CITATIONS

Anderegg, W. R., Plavcová, L., Anderegg, L. D., Hacke, U. G., Berry, J. A., & Field, C. B. (2013). Drought's legacy: multiyear hydraulic deterioration underlies widespread aspen forest die-off and portends increased future risk. *Global change biology*, *19*(4), 1188-1196. https://doi.org/10.1111/gcb.12100

Bartos, Dale L.; Amacher, Michael C. 1998. Soil properties associated with aspen to conifer succession. *Rangelands.* 20(1): 25–28. Retrieved 5 August 2025 from https://repository.arizona.edu/handle/10150/639107

Bartos, Dale L.; Campbell, Robert B., Jr. 1998a. Decline of quaking aspen in the Interior West—examples from Utah. *Rangelands.* 20(1): 17–24. Retrieved 5 August 2025 from http://hdl.handle.net/10150/639108

Bartos[1], D. L. (2001). Landscape dynamics of aspen and conifer forests. In S*ustaining Aspen in Western Landscapes: Symposium Proceedings: June 13-15, 2000, Grand Junction, Colorado* (p. 5). US Department of Agriculture, Forest Service, Rocky Mountain Research Station. Retrieved 5 August 2025 from https://research.fs.usda.gov/treesearch/35804

Bates, J. D., Miller, R. F., & Davies, K. W. (2006). Restoration of quaking aspen woodlands invaded by western juniper. *Rangeland Ecology & Management*, 59(1), 88-97. https://doi.org/10.2111/04-162R2.1

Beschta, R. L., Painter, L. E., Levi, T., and Ripple, W. J. (2016). Long-term aspen dynamics, trophic cascades, and climate in northern Yellowstone National Park. *Canadian Journal of Forest Research*, *46*(4), 548-556. https://doi.org/10.1139/cjfr-2015-0301

Boča, A., and Van Miegroet, H. (2017). Can carbon fluxes explain differences in soil organic carbon storage under aspen and conifer forest overstories? *Forests*, *8*(4), 118. https://doi.org/10.3390/f8040118

Bork, E. W., Carlyle, C. N., Cahill, J. F., Haddow, R. E., & Hudson, R. J. (2013). Disentangling herbivore impacts on Populus tremuloides: a comparison of native ungulates and cattle in

Canada's Aspen Parkland. *Oecologia*, *173*(3), 895-904. https://doi.org/10.1007/s00442-013-2676-x

Brown, J. K., & Simmerman, D. G. (1986). *Appraising fuels and flammability in western aspen: a prescribed fire guide* (Vol. 205). US Department of Agriculture, Forest Service, Intermountain Research Station. https://doi.org/10.2737/INT-GTR-205

Brown, K., Hansen, A. J., Keane, R. E., and Graumlich, L. J. (2006). Complex interactions shaping aspen dynamics in the Greater Yellowstone Ecosystem. *Landscape ecology*, *21*, 933-951. https://doi.org/10.1007/s10980-005-6190-3

Brodie, J., Post, E., Watson, F., and Berger, J. (2012). Climate change intensification of herbivore impacts on tree recruitment. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1732), 1366-1370. https://doi.org/10.1098/rspb.2011.1501

Boyle, J. R., Phillips, J. J., & Ek, A. R. (1973). " Whole tree" harvesting: nutrient budget evaluation. *Journal of Forestry*, *71*(12), 760-762. https://doi.org/10.1093/jof/71.12.760

Buol, S. W., Hole, F. D., & McCracken, R. J. (1989). *Soil genesis and classification* (No. ED. 3, pp. xiv+-446). Retrieved 5 August 2025 from https://www.cabidigitallibrary.org/doi/full/10.5555/19911958139

Campbell, R. B., and Bartos, D. L. (2001). Aspen ecosystems: objectives for sustaining biodiversity. Retrieved 5 August 2025 from https://digitalcommons.usu.edu/aspen_bib/791/

Chong, G. W., Simonson, S. E., Stohlgren, T. J., & Kalkhan, M. A. (2001). Biodiversity: aspen stands have the lead, but will nonnative species take over. Shepperd, WD; Binkley, D.; Bartos, DL; Stohlgren, TJ, 13-15. Retrieved 5 August 2025 from https://research.fs.usda.gov/treesearch/35833

Cryer, D. H., & Murray, J. E. (1992). Aspen regeneration and soils. *Rangelands Archives*, *14*(4), 223-226. Retrieved 5 August 2025 from https://repository.arizona.edu/handle/10150/638881

DeByle, N. V., and Winokur, R. P. (1985). *Aspen: ecology and management in the western United States* (Vol. 119). US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. Retrieved 5 August 2025 from https://digitalcommons.usu.edu/aspen_bib/2991/

Endress, B. A., Wisdom, M. J., Vavra, M., Parks, C. G., Dick, B. L., Naylor, B. J., and Boyd, J. M. (2012). Effects of ungulate herbivory on aspen, cottonwood, and willow development under forest fuels treatment regimes. *Forest Ecology and Management*, *276*, 33-40. https://doi.org/10.1016/j.foreco.2012.03.019

Fechner, G. H., & Barrows, J. S. (1976). *Aspen stands as wildfire fuel breaks* (No. 4). US Department of Agriculture, Forest Service,[Rocky Mountain Forest and Range Experiment Station].

Fitzgerald, S. (2010). Appendix II: *Insect, Disease, and Animal Damage*. Land manager's guide to aspen management in Oregon. Retrieved 5 August 2025 from https://ir.library.oregonstate.edu/concern/open_educational_resources/cn69m438d

Geraghty, J. J., Miller, D. W., Van Der Leenden, F., & Troise, F. L. (1973). Water atlas of the United States. Retrieved 5 August 2025 from http://hdl.handle.net/1969.3/25106

Kay, Charles E. 1997. Is aspen doomed? *Journal of Forestry.* 95(5): 4–11. Retrieved 5 August 2025 from https://stopthespraybc.com/wp-content/uploads/2013/08/is-aspen-doomed.pdf

Kay, C. E., and Bartos, D. L. (2000). Ungulate herbivory on Utah aspen: assessment of long-term exclosures. *Rangeland Ecology and Management/Journal of Range Management Archives*, *53*(2), 145-153. Retrieved 5 August 2025 from https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/9494/9106

Kitchen, S. G., Behrens, P. N., Goodrich, S. K., Green, A., Guyon, J., O'Brien, M., and Tart, D. (2019). Guidelines for aspen restoration in Utah with applicability to the Intermountain West. Retrieved 5 August 2025 from https://digitalcommons.usu.edu/aspen_bib/7812/

Kouki, J., Arnold, K., and Martikainen, P. (2004). Long-term persistence of aspen–a key host for many threatened species–is endangered in old-growth conservation areas in Finland. *Journal for Nature Conservation*, *12*(1), 41-52. https://doi.org/10.1016/j.jnc.2003.08.002

Krummel, J. R., Gardner, R. H., Sugihara, G., O'neill, R. V., & Coleman, P. R. (1987). Landscape patterns in a disturbed environment. *Oikos*, 321-324. https://doi.org/10.2307/3565520

Kuhn, T. J., Safford, H. D., Jones, B. E., and Tate, K. W. (2011). Aspen (*Populus tremuloides*) stands and their contribution to plant diversity in a semiarid coniferous landscape. *Plant Ecology*, *212*, 1451-1463. https://doi.org/10.1007/s11258-011-9920-4

Kurth, V. J., Bradford, J. B., Slesak, R. A., & D'Amato, A. W. (2014). Initial soil respiration response to biomass harvesting and green-tree retention in aspen-dominated forests of the Great Lakes region. *Forest Ecology and Management*, *328*, 342-352. https://doi.org/10.1016/j.foreco.2014.05.052

Laundré, J. W., Hernández, L., & Ripple, W. J. (2010). The landscape of fear: ecological implications of being afraid. *The open ecology journal*, *3*(1). Retrieved 5 August 2025 from https://www.predatordefense.org/docs/research_LandscapeOfFear_Laundre_2010.pdf

Lindroth, R. L., & Clair, S. B. S. (2013). Adaptations of quaking aspen (Populus tremuloides Michx.) for defense against herbivores. *Forest Ecology and Management*, *299*, 14-21. https://doi.org/10.1016/j.foreco.2012.11.018

Long, J. N., and Mock, K. (2012). Changing perspectives on regeneration ecology and genetic diversity in western quaking aspen: implications for silviculture. Canadian Journal of Forest Research, 42(12), 2011-2021. https://doi.org/10.1139/x2012-143

Mitton, J. B., & Grant, M. C. (1996). Genetic variation and the natural history of quaking aspen. *Bioscience*, *46*(1), 25-31. https://doi.org/10.2307/1312652

Mock, K. E., Rowe, C. A., Hooten, M. B., Dewoody, J., and Hipkins, V. D. (2008). Clonal dynamics in western North American aspen (Populus tremuloides). *Molecular Ecology*, *17*(22), 4827-4844. https://doi.org/10.1111/j.1365-294X.2008.03963.x

Mote, P. W., Hamlet, A. F., Clark, M. P., and Lettenmaier, D. P. (2005). Declining mountain snowpack in western North America. *Bulletin of the American meteorological Society*, *86*(1), 39-50. https://doi.org/10.1175/BAMS-86-1-39

Mote, P. W., Li, S., Lettenmaier, D. P., Xiao, M., and Engel, R. (2018). Dramatic declines in snowpack in the western US. *Npj Climate and Atmospheric Science*, *1*(1), 2. https://doi.org/10.1038/s41612-018-0012-1

Mueggler, W.F. 1985. Vegetation associations. In: DeByle, N. V., and Winokur, R. P. (1985). *Aspen: ecology and management in the western United States* (Vol. 119). US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 45-55. https://doi.org/10.2737/RM-GTR-119

Mueggler, W. F. (1988). *Aspen community types of the Intermountain Region* (Vol. 250). Intermountain Forest and Range Experiment Station, Forest Service, US Department of Agriculture. https://doi.org/10.2737/INT-GTR-250

Perala, D. A., Burns, R. M., & Honkala, B. (1990). Populus tremuloides Michx.-Quaking Aspen. *Silvics of North America: Hardwoods; Burns, RM, Honkala, BH, Eds*, 555-569. Retrieved 5 August 2025 from https://dendro.cnre.vt.edu/DENDROLOGY/USDAFSSilvics/160.pdf

Pyne, S. J. (1982). Fire in America: A cultural history of wildland and rural fire. Princeton, NJ: Princeton University Press. Retrieved 5 August 2025 from https://www.cabidigitallibrary.org/doi/full/10.5555/19830686042

Rogers, P. C., Pinno, B. D., Šebesta, J., Albrectsen, B. R., Li, G., Ivanova, N., and Kulakowski, D. (2020). A global view of aspen: conservation science for widespread keystone systems. Glob Ecol Conserv 21: e00828. https://doi.org/10.1016/j.gecco.2019.e00828

Romme, W. H., Floyd-Hanna, L., Hanna, D. D., & Bartlett, E. (2001). Aspen's ecological role in the West. USDA Forest Service Proceedings. RMRS-P-18, 2001. Retrieved 5 August 2025 from https://research.fs.usda.gov/treesearch/35832

Shinneman, D. J., Baker, W. L., Rogers, P. C., & Kulakowski, D. (2013). Fire regimes of quaking aspen in the Mountain West. *Forest Ecology and Management*, *299*, 22-34. https://doi.org/10.1016/j.foreco.2012.11.032

Singer, J. A., Turnbull, R., Foster, M., Bettigole, C., Frey, B. R., Downey, M. C., and Ashton, M. S. (2019). Sudden aspen decline: a review of pattern and process in a changing climate. *Forests*, *10*(8), 671. https://doi.org/10.3390/f10080671

Ste-Marie, C., and Paré, D. (1999). Soil, pH and N availability effects on net nitrification in the forest floors of a range of boreal forest stands. Soil Biology and Biochemistry, 31(11), 1579-1589. https://doi.org/10.1016/S0038-0717(99)00086-3

Stephens, S. L., & Ruth, L. W. (2005). Federal forest-fire policy in the United States. *Ecological applications*, *15*(2), 532-542. https://doi.org/10.1890/04-0545

Strand, E. K., Vierling, L. A., Bunting, S. C., & Gessler, P. E. (2009). Quantifying successional rates in western aspen woodlands: current conditions, future predictions. *Forest Ecology and Management*, *257*(8), 1705-1715. https://doi.org/10.1016/j.foreco.2009.01.026

Sucoff, E. (1982). Water relations of the aspens. *University of Minnesota Agriculture Experiment Station*, Technical Bulletin 338. Retrieved 5 August 2025 from https://conservancy.umn.edu/server/api/core/bitstreams/42f287b3-7cab-4a97-a15e-cef8c406f62b/content

Turner, M. G., Gardner, R. H., O'neill, R. V., & O'Neill, R. V. (2015). *Landscape ecology in theory and practice* (Second Edition). Springer New York. https://link.springer.com/book/10.1007/978-1-4939-2794-4

U.S. Department of Agriculture, Soil Conservation Service. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Soil Survey Staff, coord. U.S. Department of Agriculture, Agriculture Handbook 436. Washington, DC. 754 p. https://doi.org/10.1016/S0016-7061(00)00097-5

Walker, S. C., Anderson, V. J., and Fugal, R. A. (2015). Big game and cattle influence on aspen community regeneration following prescribed fire. *Rangeland Ecology and Management*, *68*(4), 354-358. https://doi.org/10.1016/j.rama.2015.05.005

Wall, T. G., Miller, R. F., & Svejcar, T. J. (2001). Juniper encroachment in aspen in the Northwest Great Basin. Rangeland Ecology & Management/Journal of Range Management Archives, 54(6), 691-698. https://doi.org/10.2307/4003673

Wan, H. Y., Rhodes, A. C., and St. Clair, S. B. (2014). Fire severity alters plant regeneration patterns and defense against herbivores in mixed aspen forests. *Oikos*, *123*(12), 1479-1488. https://doi.org/10.1111/oik.01521

Weber, K. T., & Yadav, R. (2020). Spatiotemporal trends in wildfires across the Western United States (1950–2019). *Remote Sensing*, *12*(18), 2959. https://doi.org/10.3390/rs12182959

Wilde, T. W. (2014). The Effect of Large Fire on Aspen Recruitment. *Journal of the NACAA*, *7*(1). Retrieved 5 August 2025 from https://www.nacaa.com/journal/5d5dd006-5bb7-4422-b1dd-b7eed1877eee

Wilson, Edward O. 1992. The diversity of life. New York: W. W. Norton and Company. 424 p.

1. APPLICATION AND ANALYSIS

Background

Aspen distribution in southeast Idaho, 20th century wildfire management, and essential public administration skills for the savvy civic scientist

Aspen (*Populus tremuloides*) are the most widespread broadleaf tree in North America and are frequently the only broadleaf species in otherwise conifer-dominated boreal landscapes (Kitchen et al. 2019). Often referred to as a keystone species (Wilson 1992), aspen serve a disproportionately important role in the biodiversity and functioning of the ecosystems in which they appear (Kay 1997). They also provide a number of critical supporting ecosystem services including nutrient cycling, carbon sequestration, and both food and shelter for many species of plants, insects, microbes, and animals thus supporting a biodiverse ecosystem (Kouki and Martikaenen, 2004). In addition to the critical role that aspen play in their ecological niche, they also provide essential ecosystem services that humans depend on including cultural services, provisioning services in the form of pulp and paper production, and supporting services in the form of habitat for rich species biodiversity (Millenium Ecosystem Assessment, 2003). Studies have shown aspen's potential to serve as natural "fuels breaks" (Fechner & Barrows, 1976) due to their high water content and bark that is less flammable than that found on conifer. Aspen trees are quick to regenerate after stimulation from disturbance like wildfires and clear-cutting, but recruitment of young suckers can be impeded by heavy herbivory from native ungulates in low-snow years. At the landscape scale, aspen populations in the West have been declining in Utah and Colorado where instances of Sudden Aspen Decline (SAD) have been observed. Our study of aspen in southeast Idaho indicates that at the landscape level, aspen may have declined between 2004 and 2025, though at the watershed basin level, results of a trend analysis varied along a

latitudinal gradient with watersheds in the northern portion of the study area showing a more pronounced decline than seen in watersheds in the southern portion of the study area. At the more local level of individual stands, some may be expanding in size while others remain stable or show decline. Potential drivers of these changes include increased frequency and severity of drought in the region (aspen require a surplus of water where available water is greater than evapotranspiration) (Perala,1990), changes in fire return intervals and fire severity caused by human manipulation of wildland fire regimes over the 20th century, climatic shifts including increased winter minimum temperatures, decreased growing season precipitation, and decreased winter snowpack, notably in higher elevation areas in the northern watersheds of the study area.

Understanding how aspen populations are changing and key drivers of change can help land managers at the Bureau of Land Management make evidence-based decisions about how and where to focus scarce management resources towards the management of aspen within their jurisdiction. Given the wide array of ecosystem services that aspen provides including the ability to serve as natural fuels breaks, this information is particularly valuable not only to land managers, but also to emergency managers and people residing within the ever-expanding wildland urban interface (WUI).

Some of the main strategies that land managers have available to them for managing aspen-dominant ecosystems are 1) prescribed burns to stimulate aspen suckering and reduce competition from less fire-resistant conifer species, 2) allowing wildland fires to burn rather than suppressing fires as soon as possible which will result in stimulating aspen regeneration and reduce conifer competition, 3) clearcutting of aspen to generate suckering of an older stand and/or selective thinning of conifer to reduce competition, 4) maintaining exclosures to limit the impacts of herbivory on sucker recruitment in the first few years after a treatment, 5) reintroducing apex

predators to restore trophic cascades which could also limit the impacts of over-browsing, and 6) doing nothing or maintaining the status quo. None of these potential strategies are without their challenges and valid arguments for opposition. Burn-based strategies may be seen as overly intrusive and could be opposed for their potential downwind effects. Clearcutting may not be economically viable given the small size of many aspen stands and would likely have to be done in conjunction with exclosures to have the desired effect of increasing sucker recruitment. Reintroduction of apex predators to restore trophic cascades is a hot button topic, particularly for those in the livestock community and recreationists, and may not always go according to plan. If none of the active treatment options are acceptable to potentially impacted communities, land managers may have to default to doing nothing, though identified trends are likely not to improve without some form of intervention.

Given the vast acreage of land that the BLM manages and the limited resources that it has to manage with including time, financial resources, and people power, it is not possible to manually inventory every aspen stand within their jurisdiction, nor is it reasonable to attempt to actively treat all areas that contain aspen or could contain aspen. This is where satellite remote sensing techniques can be used as a cost-effective way to help to model the approximate location of aspen stands across the landscape over time to produce maps showing an estimation of where stands exist and how they have changed over time. Areas identified via these models to be declining more rapidly can be prioritized for additional ground-truthing and potential treatment. Given the disruptive nature of available treatment options, potential health impacts for nearby or downwind communities, and differences in public opinion across ideological divides, even the most evidence-based treatment plan can be met with public pushback which can result in delayed, changed, or eliminated plans to proceed.

To the researcher whose data indicated areas where treatment of aspen-dominant ecosystems would provide great benefit and to the land manager using their subject matter expertise and first-hand knowledge of the land in question to craft a smart management plan to encounter public pushback to the point of not being able to implement scientifically sound management practices, this can be a confusing and frustrating situation. In order to navigate this common scenario where public opinion and political forces prevent implementation of sound plans, STEM professionals would benefit from being well-versed in essential public administration skills.

Problem:

Many scientists are skilled in the scientific method and are experts in their particular field of research, but are often perplexed throughout the early parts (optimistically) if not throughout the entirety of their careers when what they assume is crystal clear data is not translated into rational decision making and policies (ex: climate change). The transformation of data into actionable information that can be used by decision/policy makers is a critical skill that often eludes scientific professionals. These same scientists will often "fall up the ladder" and get promoted into roles where leadership and communication skills as well as a general knowledge of complex human dynamics within complex organizations are essential. Yet these skills are rarely taught to career scientists or natural resource managers in any explicit way. Some of these skills can be learned intuitively through trial and error on the job, but many individuals could benefit from having training, earlier in their academic and professional careers, to help them as scientific leaders and communicators. Having this sooner and in a way that primes them for careers in public service or working on research that is publicly funded would allow more scientists to be proactive rather than reactive, save a lot of frustration, and share a common language that would empower them to make bolder, more effective, and more innovative moves. We go into the sciences with

enthusiasm, curiosity, and a drive to make the world a better place, then when we get into our careers, we are faced with red tape, burdensome administrative requirements, "bureaucracy", confusing organizational cultures, polarized groups, and decision-makers who either don't understand the science or make politically-motivated decisions.

To bridge the gap, we need to start everyone in society off with a strong foundation in the scientific method via education (scientifically literate public can be more critical as they consume news media and make choices in their civic lives). But we also need to teach everyone, including scientists, the interdisciplinary skills required to navigate professions, communicate work, influence policy, and understand the democratic "why" of the work that they do to benefit society. Many things that we need to know may get picked up in the workplace, but it is easy to pick up bad habits from managers who "fell up the ladder" without ever receiving formal theoretical training on best practices. To prepare scientists to successfully navigate public service careers, formal educational opportunities must be made available on how to navigate the political forces that they will encounter throughout their careers including public service ethics, alternatives to the science deficit model for communicating science, principled negotiation, and tools of participative democracy.

**Personal anecdote:* *Having spent time outside of the hallowed halls of academia, fresh out of my undergraduate Earth science education, it was a significant culture shock seeing how the on-the-ground reality compared to my idealistic understanding from school. I spent over seven years learning through experience and when the opportunity to pursue a graduate education arose, I picked an MPA program to fill those necessary skill gaps to help me navigate my career at the intersection of public science and public policy. To many, it sounded like a side-step, but to me, it*

felt critically important. As I wrap up my MPA, I wish that I knew more of these things starting my career.

Proposed Solution:

To address the issue of including human skills as a part of training, I suggest a streamlined PA curriculum that can be integrated into physical science education. Current general education requirements in the humanities help set the stage for these skills, and research-specific ethics training is valuable. However, these things alone are not enough to prepare early career scientists for the challenges they may face as they pursue (often unknowingly) careers in public or civic science. I would recommend that this "PA Essentials for Civic Scientists" be a required (or at least offered) course for all undergraduate STEM majors with an interest in pursuing careers in the public sector. Given the already rigorous demands of most GE undergraduate requirements, it should be easily substituted for an existing required course. A more rigorous and theoretical version could be offered to STEM graduate students.

Ideally, we would have PA-based grad programs that cater to the specific training needs of STEM graduate students looking to pursue careers in public science (e.g. Environmental Sciences & Public Administration MS EVS/MPA dual degrees – two degrees in three years for students who want to bridge the communications gap between environmental sciences and public policy). A lot of universities have strong departments in PA and the physical sciences that could combine forces to offer this type of joint degree.

Conversely, with the growing focus on intersectional work and the political nature of evidence-based decision-making, MPA-type programs would benefit both themselves and those with STEM backgrounds by spending more time marketing to and recruiting students and

professionals with STEM backgrounds. The MPA would likely be appealing to them and this would increase the number of students and ultimately professionals with this increasingly critical well-rounded skillset and knowledge base. Additionally, MPA programs could require (rather than suggest) some formal training in the natural sciences, particularly for students with an emphasis in environmental administration, health administration or criminology. Being well-versed or at least introduced to emerging technologies and current research in their field would not only increase competitiveness of graduates in the job market but also prepare future administrators to build legitimacy in their skillsets while empowering them to converse and collaborate with the subject matter experts who will inform decisions that they will have to make in their chosen career fields. (This requirement could be waived for students who can pass a basic science entrance exam or who are starting their programs with a science degree/work experience in a field closely related to their area of emphasis.)

**Personal note:* *I more or less "cobbled together" a similar curriculum for myself. Coming into graduate school with my background in the physical sciences, I had never heard of nor considered pursuing a degree in public administration prior to a discussion that I had with Keith about my goals to work at the intersection of science and policy/decision making.*

Publicly funded science conducted by publicly funded scientists, whether they are directly employed at a public research institution like a university of federal/state agency or their work at a private or nonprofit institution, is funded by tax-payer dollars and thus is conducted by a public administrator. To understand this, it is necessary to define a **public administrator**– an unelected fiduciary of public money with the responsibility to provide or produce a public good or service. The public goods produced by scientists are not the physical commodities that many think of, but rather research on topics of importance to the population of society and the knowledge that informs

critical policy decisions and innovations that drive our economy. Ask the average scientist who they serve or what principles guide their daily work, and many will mention that the scientific method, scientific best practices, etc. guide them. Few may respond with the government or the public. To me, it seems that there is a disconnect in understanding, an "**information asymmetry**" between public scientists and the democracy that they serve. These unknowing administrators or "street level administrators" tend to think more about the work that they do and its technical/scientific merit and implications rather than the role that they and their work plays in a democratic society at large. As public administrators, STEM professionals have a great deal of professional discretion, but still must be accountable to the public and work with political appointees to ensure adherence to current values of the society that they serve.

Here, I propose a pilot for this sort of curriculum and demonstrate the applicability of themes to the BLM aspen decline case study, a plan for implementation, discuss some of the possible challenges that could arise, and recommend methods for overcoming those challenges.

2. Analysis Through PA Theories and Concepts

There are a number of public administration theories and concepts that can be applied to the aspen case study and add depth and context that would otherwise be missed by looking at the issue from a purely technical perspective. These same theories and concepts can be applied to many other scientific cases and are therefore recommended as the "essential PA skills for the savvy civic scientist" core curriculum. Here I will outline these key themes as they relate to the aspen project.

2.1 Ditch the deficit

The science deficit model is pervasive throughout the science communication lexicon and suggests that the only reason why a member of the public would not accept the "subjective" truth and utility of scientific research is because they just don't know about it yet (Simms et al. 2016). However, assuming that your public audience is ignorant at best and highly irrational at worst is not a good starting point for effective communication of research findings. For instance, if a land manager trying to pitch an evidence-based management plan for improving aspen health in eastern Idaho went into a public hearing and dismissed valid public concerns as a lack of rationality and misunderstanding of the science, achieving an outcome where minds are changed and necessary buy-in for the plan is received will likely not come to fruition. It is important to keep in mind that

sometimes when people voice opposition to a proposed intervention, it is not for a lack of understanding of the science behind the intervention, it is out of concern for the impact that the intervention will have on their own lives. Moving forward with a plan without public buy-in can have negative effects on public organizations and be seen as government overreach. Federal plans that impact local communities can also be tricky to navigate because solutions may not seem tailored enough to the local community for political acceptance.

2.2 The power of narrative

Narratives can help us to create shared meaning and make sense of our worlds. They can shape and be shaped by our organizations. They can influence how we see ourselves and others and how we behave in different situations. As such, narratives can be powerful tools to help convey the findings of scientific research in ways that can help people understand their utility and move them to action. Narratives have several things in common including heroes, villains, or victims, a plot, conflict, and hopefully some sort of satisfying resolution or in the example of the aspen case, a satisfying policy recommendation in the form of an acceptable management plan.

Save the jargon for your journal. While it is necessary to be able to communicate in explicit technical detail about your research to members of your discipline's community to ensure repeatability and rigorous peer review, it is also necessary to be able to speak about your work in different ways depending on who you are speaking to and why you are sharing the findings of your work with them. With today's changes in communication styles, shortening of attention spans, and the prevalence of media sound bites and short form video clips, it is essential to be able to succinctly convey the takeaways of your work in a way that captures audience interest and is clear enough to limit the potential of being misinterpreted (which is of course much easier said than done). When communicating with anyone about your work, it is important to know your audience.

There is no “general” audience and therefore every time you communicate your work you should be cognizant of who you are speaking to. Non-experts including the public and decision makers need to understand why your work matters far more than the minutia of what you did. In order to have a lasting impact, compelling storytelling techniques can help you to make your work matter to whoever you are speaking to about it. Ultimately, the way that you frame your work matters because to a non-technical audience, the why behind your findings and recommendations is far more important than the how and the what.

Let the data speak. This is important and it alludes to a core ethical tenant of scientific research. I interpret this to mean that you should not force your data to tell a story that it really cannot support. It means checking your biases at the door (to the best of your human ability) and letting go of preconceived notions of what your results “should” be even if it means reporting on less than perfect results or results that are contrary to your pet hypothesis or the result that you think that your funding agency was hoping for. That said, the data cannot always speak for itself, and to be an effective spokesperson for your data, narrative can be a useful tool.

2.3 Know your history

Humans are the ultimate ecosystem engineers. Though the impacts of prior human activity and policy choices may be difficult to quantify and tie directly to observations of physical scientific phenomena as direct drivers of change like climatic and biophysical driving forces, it is still worth making note of. Understanding the ways in which humans have meddled or managed provides valuable context that can potentially help to fill gaps in your research left by more quantitative data. In the context of aspen, a disturbance-dependent species, in Idaho, historic wildfire governance and policy, particularly fire suppression trends throughout the twentieth century, has

had an impact on fire return intervals in the fire-adapted landscapes that aspen inhabit and therefore, may be another key driver affecting aspen populations today.

In addition to being shaped by a variety of abiotic factors, aspen distribution is also influenced by humans, who simplify landscape patterns (Krummel et al. 1987) through activities such as fire suppression, expansion of the wildland urban interface (WUI), clearcutting, and emitting large quantities of greenhouse gases that contribute to warming climate trends (Romme et al. 2001). Historic fire suppression over the 20th century dramatically altered fire return interval and forest structure in fire-adapted ecosystems leaving a wide range of long-lasting impacts on landscapes across the western US. This resulted in dense, overstocked forests, a large accumulation of flammable forest material, compromised forest health and resilience, and as a result increasingly large and destructive wildfires.

Forest and fire management policy in the twentieth century focused heavily on fire suppression with little emphasis on fuels management, which reshaped the forested landscape of the western United States and resulted in a large accumulation of flammable forest materials. This suppression and fuel accumulation has resulted in overstocked/extremely dense forests, lower forest health and resilience, interrupted fire return-intervals, and ultimately a number of large, destructive wildfires. In 1905, Congress passed the Forest Transfer Act, which transferred federally owned forests from the US Department of the Interior (DOI) to the US Department of Agriculture (USDA), which put the newly formed Forest Service (USFS) in charge of managing the national forests (Stephens & Ruth, 2005). Under the direction of Gifford Pinchot, USFS pursued a "wise use" conservation strategy for forest resources and Congress eventually allocated funds and gave the forest service the legal means of pursuing fire suppression on a national scale. Major fires in 1910 impacted fire governance significantly and prevented the use of "light burning"

or what is referred to as prescribed fire today. Under the 1911 Weeks Act and 1924 Clarke-McNary Act, USFS formed cooperative agreements for fire management with other federal and state agencies including the National Parks Service and Bureau of Land Management. For decades, fuels continued to accumulate, but major efforts were made to suppress fire and large allocations of funds went into firefighting (much more so than into ecological research or forestry professionals who might have been able to encourage a more holistic approach to management in historically fire-adapted landscapes). With rising populations and large investments into firefighting, people continued to expand infrastructure into the wildland urban-interface (WUI), which resulted in more human activity along the boundaries of forested areas, more fires, and more suppression. In 1933, USFS started utilizing the Civilian Conservation Corps (CCC) to aid in their fire suppression efforts.

After World War II, mechanized and air-based wildland fire-fighting strategies became more effective, but ecological studies started indicating that low-intensity fire was a critical part of ecosystem functioning and eventually these studies started having more influence on policy decisions. Notably, between 1968 and 1978, a more balanced management approach that allowed for prescribed burning under certain conditions emerged (Pyne, 1982). However, between shifting narratives surrounding wildfire, changing leadership, and prescribed fires gone wrong, the pendulum of management frameworks continued to fluctuate. Presently, land managers are seeking more holistic, proactive approaches to caring for historically fire-adapted landscapes, but the legacy of fire suppression echoes through our ecosystems and this is something that will take decades of concerted, coordinated efforts to recover from.

Between shifting narratives surrounding wildfire, changing leadership, and prescribed fires gone wrong, the pendulum of management frameworks has fluctuated over the course of the 20th

century and into the 21st. Presently, land management agencies like the Bureau of Land Management (BLM) are seeking more holistic, proactive approaches to caring for historically fire-adapted landscapes like those that aspen inhabit, but historic fire suppression will continue to have impacts on ecosystems throughout the western United States for many years to come. It is important to note that managing to restore landscapes to a previous "natural state" can be problematic, as what we perceive as the natural state of a landscape today is likely the result of centuries worth of human interactions and alterations (Turner & Gardner, 2015).

2.4 Become a policy hydrologist (timing is key)

So much of the implementation of new policy and ideas is dependent on the social and political climate of the time. Having conclusive research findings and well-informed management plans is not always enough to get new policies or interventions implemented. Even though current research may indicate that aspen is declining in certain areas in Idaho, management plans that include active, expensive, or potentially disruptive interventions that could impact local communities in the WUI might not garner the political momentum or public approval to be implemented until a major event like a devastating wildfire or sustained drought catalyzes further action. These sort of **focusing events** can catalyze the convergence of the three streams of policy making including 1) the problem stream, 2) the policy stream, and 3) the political stream (Kingdon, 1984). When these three streams converge, there is a window of opportunity in which a problem could get enough attention to get on the policy agenda and that a certain policy or treatment proposed to mitigate the problem could get enough public buy-in to finally get implemented. Some people, often referred to as policy entrepreneurs, will have pet policies that they want to get implemented to solve a certain problem that they have identified and will wait until an event that could be used to bring their issue into focus occurs. Once it does, they will swoop in and attempt

to push their pet policy when the streams have converged and the window of opportunity is opened. This is not a recommendation that public scientists or natural resource managers get into the business of policy entrepreneurship, but staying up to date on current events could be a strategic way of getting plans onto the agenda at a time when the public may be willing to support the proposed solution.

Any possible intervention to enhance aspen on the landscape will come with tradeoffs and downwind effects. For example, interventions involving fire can come at the expense of negative health impacts from smoke travelling to nearby communities. They could also put nearby communities at risk if a burn gets out of control and spreads into developed areas of the wildland urban interface (WUI). Clearcutting or selective thinning options change the landscape for a significant amount of time on human time-scales. People may not want to see what appears to be destruction of beloved public forested areas even if the alternative is risking greater, less controllable destruction in the face of a potential mega-fire. Options that prevent human use or make areas more dangerous for people and/or livestock like exclosures and reintroduction of apex predators may be disliked by the politically powerful livestock communities as well as hunters and other outdoor enthusiasts.

2.5 Put on your democratic shoes

Good science should be a key piece of the puzzle informing decisions being made about issues, but it takes a diverse set of perspectives to make the best possible decisions that are both evidence-based and representative of the will of key stakeholders who will be impacted by the decision. For this reason, there should be a representative number of perspectives from scientists and other subject matter experts, from elected officials, and from key interest groups. Good science

should inform, but you need diverse perspectives at the table to ensure the best ideas come forward. Embrace alternative ways of knowing including traditional ecological knowledge (TEK) and indigenous traditional ecological knowledge (ITEK). Tools of participative democracy like futuring, discourse rules (Fox & Miller, 1996), and a communitarian commitment to place and one another based on civic engagement (Kemmis, 1990) can help bridge ideological divides and allow for community driven co-creation and adoption of politically acceptable solutions.

When trying to implement an active management plan for aspen that will impact members of a local community, land managers at the BLM could hold town hall meetings, put together a task force made up of the various stakeholders involved, and facilitate civil discourse that could ultimately lead to the development and acceptance of a management plan.

2.6 Subject matter matters - but so does representativeness

STEM professionals working in the public sector often serve as subject matter experts and may find it confusing or frustrating when evidence-based recommendations founded on solid research are not implemented or are seemingly ignored by political appointees. This gets into the idea of a politics-administration dichotomy. The role of career administrators as subject matter experts brings stability to the public service through changes in political priorities as new administrations come and go. But subject matter expertise alone is not sufficient for employees working in the public service. It is critical for administrative careerists to work together with their agency's political appointees who have a strong understanding of the current political climate and public will. While politics ought not sway scientists to change the process in which they conduct research, having a sense for current public priorities can help to steer work in a direction that is consistent with the current priorities of society.

2.7 Get in the zoning zone

Practical and evidence-based zoning decisions can help mitigate risk of exposure to harmful natural disasters like wildfires, earthquakes, and floods. As the wildland urban interface (WUI) expands into drought-prone and overstocked western forests, risk of human-caused ignition increases and proximity of structures to flammable materials puts people in danger. Results from the aspen research project could potentially be used to inform land managers at the BLM of areas to target limited intervention money towards highest impact areas to prevent catastrophic ecosystem fragmentation and collapse of function and loss of essential ecosystem services including the possible benefit of aspen as a natural fuel break due to the high moisture content of aspen and associated understory and somewhat fire-resistant bark.

2.8 Be first be right (emergency response lessons)

Data to the untrained eye is not synonymous with information. To transform data into information requires interpretation by someone who understands where the data came from, the processes that were performed on it, and the implications of the results. To ensure that this information is actionable, these results must be communicated in a way that is understandable to your decision-making audience.

Data in the wrong hands can be translated into information that may range from accidentally false to purposefully misleading which can spread like wildfire in the Internet age where everyone with access to a phone and the internet can create and share content without fully understanding what it is that they are sharing, what they are consuming, and the impact that it can have. Because first impressions are quick to make and difficult to change, it is critical when

working as a STEM professional to quickly and clearly communicate your work as a reputable expert via a reputable channel during crisis situations or run the risk of having your message lost in the media storm causing widespread potentially harmful but also potentially avoidable confusion and misinformation.

2.9 Essential leadership skills

STEM professionals may get promoted through their organizational ladders because they are skillful at their jobs, but are not supported with appropriate leadership training. Here I will outline some essential PA skills that would be beneficial to STEM professionals promoted into leadership roles. However, they are not exclusive to those in official leadership capacities and can be used effectively by anyone working in a public organization.

Be a multi-frame leader who can see organizations and their challenges and pathologies through a structural, human resources, political, and symbolic frame (Bolman & Deal, 2021). Leaders tend to get trapped by their dominant frame, but skillful leaders are able to reframe situations and tap into the strengths of multiple frames knowing that organizations shape and are shaped by their environment and different structural configurations work better for different types of work in different situations. Organizations are also made up of people with differing backgrounds, ideas, and perspectives and if organizations do not fit our personnel well, then trouble is bound to ensue. Coalitions within and external to organizations influence the work that we do and can be used to our advantage without being coercive or sleezy. Stories, gestures, and theatre are all part of how we make meaning of our lives and work. On the topic of framing, it is essential as a leader in the public sector to frame a team or organization's mission and lead with vision to inspire and motivate public scientists who demonstrate public service motivation. Be a

principled negotiator (Fisher, Ury, & Patton, 2011). When dealing with any sort of conflict, it is crucial to separate the people from the problem, focus on malleable interests rather than fixed positions, invent options for mutual gain, and insist on using objective criteria to ensure fair and civil discourse between parties in conflict.

2.10 The political nature of funding

Scientists often like to say that science is not political. The idea behind this is that we ought not let politics bias the work that we do. However, it is important to acknowledge that politics does play a role in determining what types of research gets funded by public sector entities with public funding. It may also play a role in what ultimately gets published by certain journals at any given point in time. Publicly funded research outcomes are nonexcludable public goods and as such, disseminating results as actionable information to decision makers and sharing the why behind your work with the public is just as important as reporting clear and accurate technical accounts of your work to your professional society.

2.11 PA ethics for civic scientists

In your career, you will more than likely encounter any number of ethical dilemmas or situations that do not sit right with you, though you may not be able to immediately identify a clear reason. An ethical dilemma is not simply an idea or a situation that you do not agree with. Nor is it a clear-cut situation where a clear "right" scenario is up against a clear "wrong" scenario (when something clearly right is weighed against something clearly wrong, it can be called a "moral temptation" (Kidder, 1995)). Here we will define an ethical dilemma as a matter of "right" vs "right". Four types of ethical dilemmas that you might encounter are as follows:

1. Honesty vs. loyalty - This one was confusing to me from the perspective of someone who received the majority of my educational and professional training in the physical sciences. A working motto of science is to "let the data speak", so making decisions based on one's loyalty to a person or idea rather than telling the truth seems counterintuitive.
2. Individual vs. community - What is best for the individual is not always what is best for the community and vice versa. Sometimes a choice has to be made that jeopardizes one or the other. In PA, typically we make decisions that result in the greatest good for the greatest number of people, but in American democracy centered on rugged individualism, the individual is often seen as just as important if not more so than the community.
3. Justice vs. mercy - Being just and giving second chances are both valid options.
4. Short term vs. long term - This is a major decision that has to be made when budgeting, planning or zoning a community, or in emergency situations.

2.12 Theory of Reality Relativity

Reality is a social construct. Subjectivity and differences in interpretation are inevitable. There are only so many facets of reality that we can quantify and even if we were able to quantify as many things as possible, it would still result in a flattened reality. We need qualitative lenses and analyses to help fill in the gaps that "pure rationality" leaves within a greater context. By broadening our perspectives past rational, value-neutral quantitative analysis, we move closer to a more realistic understanding of the world around us and are able to more adeptly maneuver in a democratic landscape.

Quote: When we try to pick out anything by itself, we find it hitched to everything else in the universe. - John Muir.

3. Challenges, Failures, and Successes

Universities are large, complex organizations made up of a variety of people who all bring their own backgrounds, experiences, biases, preferences, and blind spots to the mix. They exist within a complex political landscape of other organizations competing for scarce resources. Large, complex organizations like a public university have a certain momentum in place that might make it difficult (though not impossible) to chart a new course forward. They are also highly visible to the public and a diverse array of stakeholders who may be skeptical of change. Even well-funded colleges and universities have limited time, funds, and faculty resources. Academic departments may already feel overworked and overwhelmed or that they are already offering the best possible version of their own established programs/curricula that they see no need to and/or little pressure or motivation to adjust course or add on programs or offer more classes when there isn't active demand from stakeholders or orders from further up the hierarchy. There may also be academic, political, and affective polarization at play where misconceptions between faculty in different academic disciplines may be reluctant to work across disciplinary boundaries. Though interdisciplinary collaboration is becoming more common, misconceptions and

miscommunications are still bound to occur. For example: physical scientists may think that political and other social sciences are too subjective, perhaps too "touchy-feely", and may bristle against the idea of "playing politics". Political scientists may view physical scientists as difficult to communicate with or naively rational to the point of being detached from reality.

Navigating change in a complex organization like a major research university can be challenging. However, using strategies based on the four frames of organizational theory (Bolman & Deal, 2021) can help to prevent some of the major challenges associated with an organization in change. When implementing plans that divert from the status quo, people may be reluctant due to personal or professional uncertainties and because they do not want to feel incompetent going out of their comfort zones. Some human resource frame strategies that could help with this are to ensure that employees receive adequate training to develop the skills necessary to implement new courses and programs while encouraging participation and involvement from employees across the departments that will be combining forces to offer interdisciplinary educational opportunities. Another change barrier that may come up is that the addition of new programs could lead to confusion, people who are set in their ways may feel a loss of direction, clarity, or stability, and in an extreme circumstance, this could result in chaos. To mitigate these barriers using the structural frame there must be clear communication and realignment with the goals of the new educational offerings. Faculty members who are comfortable doing things in the way that they always have been done and enjoy their current levels of power and autonomy may be reluctant to change that could leave them feeling disempowered. To mitigate this challenge using the political frame, leaders of this change can help to develop arenas where faculty across disciplines can form new coalitions. And finally, for faculty whose identity is deeply tied to the current work that they do, a change could represent a loss of meaning and purpose as they struggle to find their footing in an

uncertain environment. To mitigate this challenge using the symbolic frame, transition rituals can be created to commemorate and mourn the pace while embracing and celebrating the potential of the future.

There are already a number of fellowships targeted specifically at building science communication skills (Dudo et al., 2020). The idea seems to be to equip promising scientists with the necessary communication skills to convey findings in an actionable way to the public and non-technical decision-makers. However, as en vogue as the topic of science communication is and as valuable as these fellowship programs may be, I do not think that competitive fellowship programs that train small cohorts are sufficient to scale up the training of public scientists and natural resource managers at a sustainable pace that will keep us on track to solve current pressing issues like climate change, the depletion of scarce natural resources, and the growing biodiversity crisis. While these programs have their place, I think that science communication is only the starting point and that prospective scientists and natural resource managers who will be working on publicly funded research with the intention of informing decision-making and policy would benefit greatly from earlier exposure to a range of public administration topics in a formal, repetitive, and buildable package.

There are snappy one-year professional masters or masters of advanced studies (MAS) programs that offer a fast-paced, interdisciplinary degree option that covers science and policy popping up at major research universities like University of California, San Diego: https://csp.ucsd.edu/prospective-students/cost-and-funding/ . While programs like this will certainly help to bridge the gap between science and policy like my proposed intervention does, they may be prohibitively expensive for many people who would be interested in pursuing work at the intersection of science and decision making. Though a one-year program is quick, the

estimated cost of attendance for UCSD's MAS in Climate Science and Policy was approximately $50,000/year not including the cost of textbooks, transportation, and housing in pricy La Jolla/San Diego. While higher education can be a worthwhile investment, these professional masters' programs do not offer any sort of tuition assistance in the form of graduate teaching and research assistantships like more traditional degree programs. While universities do need to make enough money to sustain operations and while those sorts of specialized degrees help fill a gap and produce professionals with critical interdisciplinary skills, the high cost of attendance and lack of traditional funding supports for prospective students raises the barrier to entry and limits cohorts to primarily those who can afford to attend. This ultimately reduces the diversity of backgrounds, experiences, and perspectives at the table to those of a select few.

4. Recommendations and Conclusions

In conclusion, scientists, natural resource managers, and other STEM professionals working in the public sector are street-level public administrators, often unknowingly. In their careers as subject matter experts, they are entrusted with the allocation of scarce public resources and exercise discretion in their roles. Current educational offerings lay a necessary foundation for critical subject matter expertise but are lacking in the political education that is necessary to effectively navigate workplace dynamics, political polarization, community engagement, and successfully translate good science into sound policy and management decisions. Disciplinary silos are old hat. STEM professionals still need disciplinary training and strong affiliations, but must be prepared to engage in inter and cross-disciplinary collaborations throughout their careers. Big challenges including but not limited to climate change, disaster management in a changing climate with more frequent and severe disasters, natural resource and public lands management, the transition to clean energy, and the ongoing biodiversity crisis require interdisciplinary collaboration on both the research side and the decision-making side. Ideally decision-makers should be well-versed in the scientific method, but they are already stretched thin and should not be expected to know the ins and outs of niche, technical scientific research. Scientists and other STEM professionals should be trained to bridge the communication divide and clearly communicate their work in a way that is accessible to the public and useful to key decision-makers by harnessing the power of narrative and navigating polarization.

Increasingly, there are science communication fellowships and professional degree programs popping up to fill this skills gap, and while this is necessary and important to produce scientists with a well-rounded skill-set, they are often highly selective or prohibitively expensive, which creates high barriers to entry for many talented young scientists with the drive to learn these

skills, but without the resources to front the cost. There are of course traditional MPA programs at many universities with emphasis areas like environmental administration that would serve public sector scientists well and offer more funding opportunities in the form of teaching and research assistantships, allowing a greater number of students to attain these degrees, however they are not heavily marketed to STEM students and the curriculum has a lot of required material that may not be of direct interest to those pursuing STEM careers despite the applicability. STEM graduate programs largely prepare students for careers in research and academia without much emphasis on less theoretical and more practical careers in public service, though many MS holders do end up in the public sector without much formal training on the political nature of public sector work. A dual-degree MPA/Masters in Environmental Science (MS EVS) program is offered at the University of North Carolina Wilmington which offers the benefits of both degrees for students seeking environmental science and management careers in the public sector, offering the funding advantages of a traditional graduate program and combining graduate-level training in environmental sciences and public policy. A few other programs like this exist, but in order to keep up with the workforce demand for scientists with a well-rounded and interdisciplinary skillset to tackle Earth's wicked problems, we need to scale up production.

I propose that any major university with a political science/public administration department and ecology, geology, earth, climate, or environmental science departments consider joining forces across disciplinary lines to build this sort of combined MPA/MS degree program leveraging the strengths of each department to create something even greater than the sum of its parts. This will be no easy task given the complexity and political nature of large research universities. Steps will need to be taken to bridge ideological and disciplinary divides and navigate affective polarization to ensure civil interactions between involved parties. Town halls with

faculty, administrative staff, students, alumni, and local community members will help determine priorities.

If the task of creating new dual-degree programs seems too daunting for a given university, there are intermediate steps that could be taken to help ensure that STEM students with an interest in public service have early exposure to the types of public administration tools that would benefit them in their careers. Firstly, introduction to public administration classes could be counted as an acceptable substitute for some other general education requirement in the humanities for STEM undergraduate students. It could also be a recommended or required course for STEM students on a public service trajectory. Secondly, a STEM-focused PA seminar could be offered for upper division STEM undergraduates and STEM graduate students who would be required to frame their current research through essential PA themes for greater depth and context into the real-world implications of their work as demonstrated through the example of the aspen study in southeast Idaho. Finally, an evaluation could be designed to measure impacts and outcomes of the first two pilot steps, the results of which could help universities determine whether to move forward with the implementation of a dual-degree MPA/MS program for aspiring public STEM professionals.

5. Frequently Asked Questions (FAQs)

To wrap things up, I will pose some questions that might come up about the proposed integration of PA themes into STEM education.

Q1: ***Couldn't STEM students just take an introduction to public administration class?***

A1: Absolutely! This would be an excellent step towards exposing STEM students seeking careers in the public sector to many of the key themes that I argue are essential for civic scientists to be well-versed in. However, in order for this to be an accessible option for students already hard-pressed to complete the rigorous requirements of their degree program on top of university general education requirements, it should be allowed to be substituted for another general education requirement, rather than in addition to existing requirements. Additionally, it should be a strongly recommended class for STEM students seeking public service careers, not just an obscure elective course option. To increase the applicability for STEM graduate students working on research, students should be encouraged to explore their research topic or related research interests through the lens of politics, policy, and public administration to add depth and context to the work that they are already doing.

Q2: ***Programs like what you are recommending already exist. Why bother going to the trouble of building additional programs at other universities?***

A2: Many students go into STEM degree programs and ultimately STEM professions in part because of an innate sense of scientific curiosity, in part hoping to find a job that pays well upon graduation, and oftentimes in part because they wish to make the world a better place. These students are bright, idealistic, and full of the raw materials that make up public service motivation. MPA programs would do well to serve these students who will go on to do important interdisciplinary work in the public sector as subject matter experts, natural resource managers, and ultimately public administrators, whether they are aware of it or not. The more talented minds that are trained in both a technical discipline and public administration, the better equipped we will be as a society to tackle the wicked problems of our time.

REFERENCES

Adam, G. B. (2011). The problem of administrative evil in a culture of technical rationality. Public Integrity, 13(3), 275-286.

Argyris, C. (1957). Personality and Organization: the Conflict between System and the Individual. *Harpers*.

Best, J. (2005). "Lies, calculations and constructions: beyond 'how to lie with statistics'". *Statistical Science*, 210-214.

Bolman, L. G., & Deal, T. E. (2021). *Reframing Organizations: Artistry, Choice, and Leadership (7th ed.)*. Jossey-Bass.

Brewer, G. A., & Kellough, J. E. (2016). Administrative values and public personnel management: Reflections on civil service reform. *Public Personnel Management*, *45*(2), 171-189.

Bryson, J. M. (2004). What to do when stakeholders matter: stakeholder identification and analysis techniques. *Public management review*, *6*(1), 21-53.

Christensen, R. K., Paarlberg, L., & Perry, J. L. (2017). Public service motivation research: Lessons for practice. *Public Administration Review*, *77*(4), 529-542.

Clapp, J., & Dauvergne, P. (2011). Peril of Prosperity? Mapping Worldviews of Global Environmental Change. *Paths to a Green World: 2. The Political Economy of the Global Environment*.

Clemons, R., & McBeth, M. K. (2020). *Public policy praxis: A case approach for understanding policy and analysis*. Routledge.

Cohen, M. D., & March, J. G. (1974). Leadership and ambiguity: The American college president.

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. *Handbook of theories of social psychology*, *1*(20), 416-436.

Drew, T., Võ, M. L. H., & Wolfe, J. M. (2013). The invisible gorilla strikes again: Sustained inattentional blindness in expert observers. *Psychological science*, *24*(9), 1848-1853.

Dudo, A., Besley, J. C., & Bennett, N. (2020). Landscape of science communication fellowship programs in North America. *Rita Allen Foundation*.

Fox, Charles J., and Hugh T. Miller. 1996. *Postmodern Public Administration: Toward Discourse.* Thousand Oaks, CA: Sage.

Fechner, G. H., & Barrows, J. S. (1976). *Aspen stands as wildfire fuel breaks* (No. 4). US Department of Agriculture, Forest Service,[Rocky Mountain Forest and Range Experiment Station].

Ferrara, J. A., & Ross, L. C. (2005). Getting to know you: Rules of engagement for political appointees and career executives. *Learning the Ropes: Insights for Political Appointees*, 37-80.

Fisher, R., Ury, W. L., & Patton, B. (2011). *Getting to yes: Negotiating agreement without giving in*. Penguin.

Garry, M., & Wade, K. A. (2005). Actually, a picture is worth less than 45 words: Narratives produce more false memories than photographs do. *Psychonomic bulletin & review*, *12*(2), 359-366. https://doi.org/10.3758/BF03196385

Guy, Mary E. and Todd L. Ely. 2022. *Essentials of Public Service: An Introduction to Contemporary Public Administration.* Chapter 15, Public Integrity. 2nd ed. Melvin & Leigh, Publishers.

Homeland Security National Preparedness Task Force, *Civil Defense and Homeland Security: A Short History of National Preparedness Efforts* (Washington, DC: U.S. Department of Homeland Security, 2006), 7.

Heuer, R. J. (1999). *Psychology of intelligence analysis*. Center for the Study of Intelligence.

Kay, C. E., and Bartos, D. L. (2000). Ungulate herbivory on Utah aspen: assessment of long-term exclosures. *Rangeland Ecology and Management/Journal of Range Management Archives*, *53*(2), 145-153. Retrieved 5 August 2025 from https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/9494/9106

Kahneman, D. (2011). Thinking, fast and slow. *Farrar, Straus and Giroux*.

Kemmis, D. (1990). *Community and the Politics of Place*. University of Oklahoma Press.

Kingdon, John W. 1984/1995. *Agendas, Alternatives, and Public Policies,* 2nd ed. New York: HarperCollins.

Kidder, R. M. (1995). How good people make tough choices. New York: Morrow.

Kitchen, S. G., Behrens, P. N., Goodrich, S. K., Green, A., Guyon, J., O'Brien, M., and Tart, D. (2019). Guidelines for aspen restoration in Utah with applicability to the Intermountain West. Retrieved 5 August 2025 from https://digitalcommons.usu.edu/aspen_bib/7812/

Kouki, J., Arnold, K., and Martikainen, P. (2004). Long-term persistence of aspen–a key host for many threatened species–is endangered in old-growth conservation areas in Finland. *Journal for Nature Conservation*, *12*(1), 41-52. https://doi.org/10.1016/j.jnc.2003.08.002

Krummel, J. R., Gardner, R. H., Sugihara, G., O'neill, R. V., & Coleman, P. R. (1987). Landscape patterns in a disturbed environment. *Oikos*, 321-324. https://doi.org/10.2307/3565520

Lewis, C. W., & Gilman, S. C. (2005). Obeying and implementing the law. In The ethics challenge in public service: A problem-solving guide. (pp. 52–73). Chapter 2, John Wiley & Sons.

Martinez, J. M. (2009). Public Administration Ethics for the 21st Century. Praeger.

Maslow, A. H. (1943). A theory of human motivation. *Psychological review*, *50*(4), 370.

Mason, L. (2018). *Uncivil agreement: How politics became our identity*. University of Chicago Press.

McBeth, M., Brewer, A., Smith, M. (2019) Teaching social media and public administration: Applying four approaches to an emerging issue. *Teaching Public Administration, 38*(2), 1-19. https://doi.org/10.1177/0144739419886630

McBeth, Mark K., Elizabeth A. Shanahan, Ruth J. Arnell, and Paul L. Hathaway. 2007. "The Intersection of Narrative Policy Analysis and Policy Change Theory." *Policy Studies Journal,* 35(1): 87–108.

McDavid, J. C., Huse, I., & Hawthorn, L. R. (2018). *Program evaluation and performance measurement: An introduction to practice*. Sage Publications.

McGregor, D. (1960). Theory X and theory Y. *Organization theory*, *358*(374), 5.

Mintzberg, H. (1994). *Rise and fall of strategic planning*. Simon and Schuster.

Mosher, F. C. (2016). Democracy and the public service. In Representative Bureaucracy (pp. 19-22). Routledge.

Nadler, J., & Schulman, M. (2006). Relationships between elected officials and staff.

O'Leary, R. (2010). Guerrilla employees: Should managers nurture, tolerate, or terminate them?. Public Administration Review, 70(1), 8-19.

Orr, K., & Bennett, M. (2017). Relational leadership, storytelling, and narratives: Practices of local government chief executives. *Public Administration Review*, *77*(4), 515-527. https://doi.org/10.1111/puar.12680

Pollitt, Christopher. 2016. Advanced Introduction to Public Management and Administration. Edward Elgar Publications.

Pronin, E., & Hazel, L. (2023). Humans' bias blind spot and its societal significance. *Current Directions in Psychological Science*, *32*(5), 402-409.

Putnam, R. D. (2015). Bowling alone: America's declining social capital. In *The city reader* (pp. 188-196). Routledge.

Pyne, S. J. (1982). Fire in America: A cultural history of wildland and rural fire. Princeton, NJ: Princeton University Press.

Radin, B. A. (2006). *Challenging the performance movement: Accountability, complexity, and democratic values*. Georgetown University Press.

Rehman, S. U., Nietert, P. J., Cope, D. W., & Kilpatrick, A. O. (2005). What to wear today? Effect of doctor's attire on the trust and confidence of patients. *The American journal of medicine*, *118*(11), 1279-1286. https://doi.org/10.1016/j.amjmed.2005.04.026

Romme, W. H., Floyd-Hanna, L., Hanna, D. D., & Bartlett, E. (2001). Aspen's ecological role in the West. USDA Forest Service Proceedings. RMRS-P-18, 2001. Retrieved 5 August 2025 from https://research.fs.usda.gov/treesearch/35832

Rosenbloom, D. H. (2016). 3a. Public administrative theory and the separation of powers. In *The constitutional school of American public administration* (pp. 78-94). Routledge.

Schmidt, M. (2000). *The Teton Dam Collapse: An Organizational Analysis*. Public Administration Review, 60(1), 70-79.

Simis, M. J., Madden, H., Cacciatore, M. A., & Yeo, S. K. (2016). The lure of rationality: Why does the deficit model persist in science communication?. *Public understanding of science*, *25*(4), 400-414.

Sylves, R. T. (2020). *Disaster policy and politics: Emergency management and homeland security* (3e ed.). CQ Press.

Turner, M. G., Gardner, R. H., O'neill, R. V., & O'Neill, R. V. (2015). *Landscape ecology in theory and practice* (Second Edition). Springer New York. https://link.springer.com/book/10.1007/978-1-4939-2794-4

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *science*, *185*(4157), 1124-1131.

United States Environmental Protection Agency (EPA). (2013). *Hazardous Waste Determination Program Evaluation: Final Report*. EPA-100-K-12-010. Retrieved from: https://www.epa.gov/sites/default/files/2015-09/documents/haz-waste-determination_0.pdf

Vroom, V. H. (1964). Work and motivation.

Wilson, Edward O. 1992. The diversity of life. New York: W. W. Norton and Company. 424 p.

Zott, C., & Huy, Q. N. (2007). How entrepreneurs use symbolic management to acquire resources. *Administrative science quarterly*, *52*(1), 70-105. https://doi.org/10.2189/asqu.52.1.70